

# APPENDIX A

SUMMARY OF ABUNDANCES, LIFETIMES,  
OZONE DEPLETION POTENTIALS (ODPs),  
RADIATIVE EFFICIENCIES (REs),  
GLOBAL WARMING POTENTIALS (GWPs), AND  
GLOBAL TEMPERATURE CHANGE POTENTIALS (GTPs)

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*Cover photo: Experimental apparatus used in fundamental kinetic and photochemical laboratory studies. Laboratory measurements provide key input to the derivation of the parameters reported in this appendix. Photo: W. von Dauster, NOAA.*

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## SUMMARY OF ABUNDANCES, LIFETIMES, OZONE DEPLETION POTENTIALS (ODPs), RADIATIVE EFFICIENCIES (REs), GLOBAL WARMING POTENTIALS (GWPs), AND GLOBAL TEMPERATURE CHANGE POTENTIALS (GTPs)

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# Appendix A

## Introduction

Table A-1 in this appendix contains a compilation of atmospheric abundance, lifetime, ozone depletion potential (ODP), and radiative metrics for ozone depleting substances (ODSs), replacement compounds, and related species covered under the umbrella of the present ozone assessment. The table builds upon the metrics reported in various previous assessments from the Intergovernmental Panel on Climate Change (IPCC, 2013) and the World Meteorological Organization and United Nations – Environment (WMO, 2014).

The abundances and metrics reported in Table A-1 were evaluated based on the best available data and analysis methods as described in the table heading footnotes. Table entries have associated abundance, lifetime, ODP, and radiative metric footnotes that provide the literature source, parameters, or method used to derive the reported metric. Long- and short-lived (lifetimes  $< \sim 0.5$  years) source compounds are included in the table. Metrics given for short-lived species are dependent on the time and location of their emission because they do not become atmospherically well-mixed and, hence, the abundances and metrics reported are not valid for all emission scenarios.

In the absence of experimental kinetic or photochemical data for some molecules, the OH radical reactivity and UV photolysis rates were estimated using structure activity relationships (SARs), trends in reactivity and photolysis for a class of compounds, or comparison with similar molecules where experimental data are available. In the absence of experimental infrared absorption spectra, radiative efficiencies were calculated, in some cases, based on theoretically calculated spectra (e.g. for many of the hydrochlorofluorocarbons (HCFCs) included in the table).

The ODPs and global warming potentials (GWPs) given in the table may differ, in some cases, from the official metrics for controlled substances reported in the Montreal Protocol Handbook (Handbook, 2018) due to consideration of recent experimental data, methods of analysis, and/or assessment recommendations (Ammann et al., 2017; Burkholder et al., 2015; IPCC, 2013; Ko et al., 2013; WMO, 2014).

## Appendix A

## SUMMARY OF ABUNDANCES, LIFETIMES, OZONE DEPLETION POTENTIALS (ODPs), RADIATIVE EFFICIENCIES (REs), GLOBAL WARMING POTENTIALS (GWPs), AND GLOBAL TEMPERATURE CHANGE POTENTIALS (GTPs)

**Table A-1. Atmospheric abundances, lifetimes, ozone depletion potential (ODPs), radiative efficiencies (REs), Global Warming Potentials (GWPs) for 20 and 100-year time horizons, and Global Temperature change Potentials (GTPs) for 20, 50, and 100-year time horizons.** Atmospheric abundances are taken from the present Assessment as noted in the footnotes. Global, annually averaged, atmospheric lifetimes (total, arising from tropospheric OH reaction, and arising from stratospheric loss) were derived using the methods and kinetic and photochemical data described in the footnotes. The ODPs reported here are semi-empirical values or from atmospheric model calculations as cited in the compounds footnote. The radiative metrics reported here are based on a CO<sub>2</sub> abundance of 391 ppm (the CO<sub>2</sub>

| Industrial Designation or Chemical Name | Chemical Formula                                                                  | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-----------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                         |                                                                                   |                                           |                                                |                                     |                                                               |  |
| Carbon dioxide                          | CO <sub>2</sub>                                                                   | 402.9 ppm                                 |                                                |                                     | –                                                             |  |
| Methane                                 | CH <sub>4</sub>                                                                   | 1842 ppb                                  | 12.4                                           | 12.4                                | 10.4                                                          |  |
| Fossil methane #                        | CH <sub>4</sub>                                                                   |                                           | 12.4                                           | 12.4                                | 10.4                                                          |  |
| Nitrous oxide                           | N <sub>2</sub> O                                                                  | 329 ppb                                   | 121                                            | 123                                 | –                                                             |  |
| <b>Hydrocarbons</b>                     |                                                                                   |                                           |                                                |                                     |                                                               |  |
| Propene                                 | CH <sub>2</sub> =CHCH <sub>3</sub>                                                | –                                         | 0.35 days (0.27–0.50 days)                     | 0.4 days (0.27–0.50 days)           | 0.4 days (0.27–0.50 days)                                     |  |
| Isobutene                               | (CH <sub>3</sub> ) <sub>2</sub> C=CH <sub>2</sub>                                 | –                                         | 0.20 days (0.15–0.29 days)                     | 0.2 days (0.15–0.29 days)           | 0.2 days (0.15–0.29 days)                                     |  |
| Propane, R-290                          | CH <sub>3</sub> CH <sub>2</sub> CH <sub>3</sub>                                   | –                                         | 12.5 days (9.9–27 days)                        | 15 days (9.9–27 days)               | 15 days (9.9–27 days)                                         |  |
| Isobutane, R-600a                       | (CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>3</sub>                                 | –                                         | 6.0 days (5.2–10.7 days)                       | 7 days (5.2–10.7 days)              | 7 days (5.2–10.7 days)                                        |  |
| n-pentane                               | CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>   | –                                         | 3.4 days (2.7–6.5 days)                        | 3 days (2.7–6.5 days)               | 3 days (2.7–6.5 days)                                         |  |
| Cyclopentane                            | c-CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> | –                                         | 2.7 days (2.2–5.3 days)                        | 3 days (2.2–5.3 days)               | 3 days (2.2–5.3 days)                                         |  |
| Isopentane                              | (CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> CH <sub>3</sub>                 | –                                         | 3.4 days (2.9–6.0 days)                        | 4 days (2.9–6.0 days)               | 4 days (2.9–6.0 days)                                         |  |
| <b>Oxygenated Hydrocarbons</b>          |                                                                                   |                                           |                                                |                                     |                                                               |  |
| Methyl formate                          | CH <sub>3</sub> OCHO                                                              | –                                         | 66 days (60–143 days)                          | 87 days (60–143 days)               | 87 days (60–143 days)                                         |  |
| Isopropanol                             | (CH <sub>3</sub> ) <sub>2</sub> CHOH                                              | –                                         | 2.0 days (1.5–2.9 days)                        | 2 days (1.5–2.9 days)               | 2 days (1.5–2.9 days)                                         |  |
| Methylal                                | CH <sub>3</sub> OCH <sub>2</sub> OCH <sub>3</sub>                                 | –                                         | 2.2 days (1.5–2.8 days)                        | 2 days (1.5–2.8 days)               | 2 days (1.5–2.8 days)                                         |  |
| <b>Chlorofluorocarbons</b>              |                                                                                   |                                           |                                                |                                     |                                                               |  |
| CFC-11                                  | CCl <sub>3</sub> F                                                                | 230.2 ppt                                 | 52                                             | 52                                  | –                                                             |  |
| CFC-12                                  | CCl <sub>2</sub> F <sub>2</sub>                                                   | 515.9 ppt                                 | 102                                            | 102                                 | –                                                             |  |
| CFC-13                                  | CClF <sub>3</sub>                                                                 | 3.0 ppt                                   | 640                                            | 640                                 | –                                                             |  |
| CFC-112                                 | CCl <sub>2</sub> FCCl <sub>2</sub> F                                              | 0.4 ppt                                   | 59                                             | 63.6                                | –                                                             |  |

absolute GWPs for the 20- and 100-yr time horizons are  $2.495 \times 10^{-14}$  and  $9.171 \times 10^{-14}$  W yr/(m<sup>2</sup> kg); the CO<sub>2</sub> absolute GTPs for the 20-, 50-, and 100-yr time horizons are  $6.841 \times 10^{-16}$ ,  $6.167 \times 10^{-16}$ , and  $5.469 \times 10^{-16}$  K/kg, see Chapter 6) and are consistent with the values reported in IPCC (2013) and the last ozone assessment (WMO, 2014). Radiative efficiencies were calculated using the methods given in Hodnebrog et al. (2013) with lifetime and stratospheric temperature change adjustments applied. Climate-carbon feedbacks are included for CO<sub>2</sub> (see IPCC (2013) for further details). The derivation of GTP assumes a climate sensitivity of 1.06 K (W m<sup>-2</sup>)<sup>-1</sup>, equivalent to a 3.9 K equilibrium temperature increase in response to a doubling of CO<sub>2</sub>, toward the higher end of the uncertainty in climate sensitivity. For further details on the specific values used see Supplementary Material Section S8.12 and references therein in IPCC (2013).

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |       |    |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-------|----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |       |    |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |       |    |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |       |    |
|  |                                                   | 0                | 1.375e-5                                                                       | 1                         | 1             | 1                         | 1            | 1             | A1                          | L1                          |       | R1 |
|  |                                                   | 0                | 3.63e-4                                                                        | 84                        | 28            | 67                        | 14           | 4             | A2                          | L1                          |       | R1 |
|  |                                                   | 0                | 3.63e-4                                                                        | 85                        | 30            | 68                        | 15           | 6             | A2                          | L1                          |       | R1 |
|  | 123                                               | –                | 3.00e-3                                                                        | 264                       | 265           | 277                       | 282          | 234           | A3                          | L:2,3                       | O1    | R1 |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |       |    |
|  | –                                                 | 0                | 1.5e-4                                                                         | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             |                             | O2    | R2 |
|  | –                                                 | 0                | 6.8e-5                                                                         | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             |                             | O2    | R2 |
|  | –                                                 | 0                | 3.6e-4                                                                         | <1                        | <1            | <1                        | <1           | <1            |                             |                             | O2    | R2 |
|  | –                                                 | 0                | 2.5e-4                                                                         | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             | L4                          | O2    | R2 |
|  | –                                                 | 0                | 1.7e-4                                                                         | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             | L4                          | O2    | R2 |
|  | –                                                 | 0                | 1.3e-4                                                                         | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             | L4                          | O2    | R2 |
|  | –                                                 | 0                | 2.4e-4                                                                         | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             | L4                          | O2    | R2 |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |       |    |
|  | –                                                 | 0                | 0.045                                                                          | 40                        | 11            | 12                        | 1.8          | 1.5           |                             | L5                          | O2    | R2 |
|  | –                                                 | 0                | 1.4e-3                                                                         | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             |                             | O2    | R2 |
|  | –                                                 | 0                | 4.0e-3                                                                         | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             | L6                          | O2    | R2 |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |       |    |
|  | 55                                                | 1.0              | 0.26                                                                           | 7,090                     | 5,160         | 7,160                     | 5,480        | 2,920         | A4                          | L:2,3                       |       | R3 |
|  | 103                                               | 0.73–0.81        | 0.32                                                                           | 10,800                    | 10,300        | 11,300                    | 11,000       | 8,590         | A4                          | L:2,3                       | O:3,4 | R3 |
|  | –                                                 | 1.0              | 0.25                                                                           | 10,900                    | 13,900        | 11,700                    | 14,200       | 15,900        | A4                          | L7                          | O5    | R3 |
|  | 65.4                                              | 0.98             | 0.29                                                                           | 5,500                     | 4,370         | 5,631                     | 4,715        | 2,875         | A4                          | L:2,8                       | O6    | R4 |

| Industrial Designation or Chemical Name            | Chemical Formula                                        | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|----------------------------------------------------|---------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                                    |                                                         |                                           |                                                |                                     |                                                               |  |
| CFC-112a                                           | CClF <sub>2</sub> CCl <sub>3</sub>                      | 0.07 ppt                                  | 51                                             | 52                                  | –                                                             |  |
| CFC-113                                            | CCl <sub>2</sub> FCClF <sub>2</sub>                     | 71.7 ppt                                  | 93                                             | 93                                  | –                                                             |  |
| CFC-113a                                           | CCl <sub>3</sub> CF <sub>3</sub>                        | 0.66 ppt                                  | 59                                             | 55                                  | –                                                             |  |
| CFC-114                                            | CClF <sub>2</sub> CClF <sub>2</sub>                     | 15 ppt                                    | 189                                            | 189                                 | –                                                             |  |
| CFC-114a                                           | CCl <sub>2</sub> FCF <sub>3</sub>                       | 1 ppt                                     | ~100                                           | 105                                 | –                                                             |  |
| CFC-115                                            | CClF <sub>2</sub> CF <sub>3</sub>                       | 8.5 ppt                                   | 540                                            | 540                                 | –                                                             |  |
| CFC-216ba                                          | CClF <sub>2</sub> CClF <sub>2</sub> CF <sub>3</sub>     | 38 ppq                                    | –                                              | 135                                 | –                                                             |  |
| CFC-216ca                                          | CClF <sub>2</sub> CF <sub>2</sub> CClF <sub>2</sub>     | 20 ppq                                    | –                                              | ~135                                | –                                                             |  |
| (E)-R316c ((E)-1,2-dichlorohexafluoro-cyclobutane) | (E)-1,2-c-C <sub>4</sub> F <sub>6</sub> Cl <sub>2</sub> |                                           | 75                                             | 75                                  | –                                                             |  |
| (Z)-R316c ((Z)-1,2-dichlorohexafluoro-cyclobutane) | (Z)-1,2-c-C <sub>4</sub> F <sub>6</sub> Cl <sub>2</sub> |                                           | 114                                            | 114                                 | –                                                             |  |
| Hydrochlorofluorocarbons                           |                                                         |                                           |                                                |                                     |                                                               |  |
| HCFC-21                                            | CHCl <sub>2</sub>                                       |                                           | 1.7                                            | 1.7                                 | 1.8                                                           |  |
| HCFC-22                                            | CHF <sub>2</sub> Cl                                     | 235.3 ppt                                 | 11.9                                           | 11.9                                | 13.0                                                          |  |
| HCFC-31                                            | CH <sub>2</sub> FCI                                     | 0.080 ppt                                 | 1.2                                            | 1.2                                 | 1.3                                                           |  |
| HCFC-121                                           | CHCl <sub>2</sub> CCl <sub>2</sub> F                    |                                           | –                                              | 1.11                                | 1.17                                                          |  |
| HCFC-121a                                          | CHClFCCl <sub>3</sub>                                   |                                           | –                                              | 2.67                                | 2.96                                                          |  |
| HCFC-122                                           | CHCl <sub>2</sub> CClF <sub>2</sub>                     |                                           | –                                              | 0.9                                 | 0.96                                                          |  |
| HCFC-122a                                          | CHClFCCl <sub>2</sub> F                                 |                                           | –                                              | 3.1                                 | 3.4                                                           |  |
| HCFC-122b                                          | CHF <sub>2</sub> CCl <sub>3</sub>                       |                                           | –                                              | 9.31                                | 12.6                                                          |  |
| HCFC-123                                           | CHCl <sub>2</sub> CF <sub>3</sub>                       |                                           | 1.3                                            | 1.3                                 | 1.38                                                          |  |
| HCFC-123a                                          | CHClFCClF <sub>2</sub>                                  |                                           | 4.0                                            | 4.0                                 | 4.3                                                           |  |
| HCFC-123b                                          | CHF <sub>2</sub> CCl <sub>2</sub> F                     |                                           | ~6                                             | 11.8                                | 15.1                                                          |  |
| HCFC-124                                           | CHClF <sub>2</sub> CF <sub>3</sub>                      | 1.1 ppt                                   | 5.9                                            | 5.9                                 | 6.3                                                           |  |
| HCFC-124a                                          | CHF <sub>2</sub> CClF <sub>2</sub>                      |                                           | ~9.2                                           | 17                                  | 19                                                            |  |
| HCFC-131                                           | CHCl <sub>2</sub> CHClF                                 |                                           | –                                              | 0.76                                | 0.752                                                         |  |
| HCFC-131a                                          | CH <sub>2</sub> ClCCl <sub>2</sub> F                    |                                           | –                                              | 2.57                                | 2.8                                                           |  |
| HCFC-131b                                          | CH <sub>2</sub> FCCl <sub>3</sub>                       |                                           | –                                              | 2.33                                | 2.55                                                          |  |
| HCFC-132                                           | CHClFCHClF                                              |                                           | –                                              | 1.73                                | 1.81                                                          |  |
| HCFC-132a                                          | CHCl <sub>2</sub> CHF <sub>2</sub>                      |                                           | –                                              | 1.12                                | 1.18                                                          |  |
| HCFC-132b                                          | CH <sub>2</sub> ClCClF <sub>2</sub>                     |                                           | –                                              | 3.5                                 | 3.7                                                           |  |
| HCFC-132c                                          | CH <sub>2</sub> FCCl <sub>2</sub> F                     |                                           | 4.3                                            | 4.1                                 | 4.5                                                           |  |
| HCFC-133                                           | CHClFCHF <sub>2</sub>                                   |                                           | –                                              | 3.1                                 | 3.21                                                          |  |
| HCFC-133a                                          | CH <sub>2</sub> ClCF <sub>3</sub>                       | 0.38 ppt                                  | 4.0                                            | 4.6                                 | 4.7                                                           |  |
| HCFC-133b                                          | CH <sub>2</sub> FCClF <sub>2</sub>                      |                                           | –                                              | 7.2                                 | 7.71                                                          |  |
| HCFC-141                                           | CH <sub>2</sub> ClCHClF                                 |                                           | –                                              | 1.14                                | 1.19                                                          |  |
| HCFC-141a                                          | CH <sub>2</sub> FCHCl <sub>2</sub>                      |                                           | –                                              | 0.50                                | 0.49                                                          |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |       |    |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-------|----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |       |    |
|  | 53.8                                              | 0.86             | 0.26                                                                           | 4,770                     | 3,455         | 4,823                     | 3,690        | 1,970         | A4                          | L:2,8                       | O6    | R4 |
|  | 94.5                                              | 0.81–0.82        | 0.30                                                                           | 6,560                     | 6,080         | 6,830                     | 6,510        | 4,860         | A4                          | L:2,3                       | O:3,4 | R3 |
|  | 57.5                                              | 0.73             | 0.25                                                                           | 5,040                     | 3,750         | 5,114                     | 4,020        | 2,230         | A4                          | L:2,8                       | O6    | R4 |
|  | 191                                               | 0.50             | 0.31                                                                           | 7,710                     | 8,580         | 8,180                     | 9,010        | 8,530         | A4                          | L:2,3                       | O:3,4 | R3 |
|  | 106.7                                             | 0.72             | 0.29                                                                           | 6,960                     | 6,670         | 7,287                     | 7,175        | 5,650         | A4                          | L:2,8                       | O6    | R4 |
|  | 664                                               | 0.26             | 0.20                                                                           | 5,780                     | 7,310         | 6,210                     | 7,500        | 8,290         | A4                          | L:3,9                       | O:3,4 | R3 |
|  | 135                                               | 0.35             |                                                                                |                           |               |                           |              |               | A4                          | L10                         | O7    |    |
|  | ~135                                              | ~0.35            |                                                                                |                           |               |                           |              |               | A4                          | L10                         | O7    |    |
|  | 76                                                | 0.46             | 0.28                                                                           | 4,750                     | 4,050         | 4,909                     | 4,375        | 2,935         |                             | L11                         | O8    | R5 |
|  | 115                                               | 0.54             | 0.31                                                                           | 5,500                     | 5,400         | 5,773                     | 5,800        | 4,715         |                             | L11                         | O8    | R5 |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |       |    |
|  | ~35                                               | 0.036            | 0.15                                                                           | 545                       | 150           | 190                       | 26           | 20            | A5                          | L:12,13                     | O9    | R3 |
|  | 161                                               | 0.024–0.034      | 0.21                                                                           | 5,310                     | 1,780         | 4,230                     | 845          | 265           | A5                          | L:3,12,13                   | O3    | R3 |
|  | ~35                                               | 0.019            | 0.0587                                                                         | 230                       | 65            | 77                        | 11           | 9             | A5                          | L1                          | O9    | R6 |
|  | 20                                                | 0.030            | 0.183                                                                          | 245                       | 65            | 80                        | 11           | 9             | A5                          | L14                         | O10   | R7 |
|  | 27.3                                              | 0.066            | 0.180                                                                          | 580                       | 160           | 235                       | 29           | 22            | A5                          | L14                         | O10   | R7 |
|  | 21                                                | 0.022            | 0.17                                                                           | 220                       | 60            | 70                        | 10           | 8             | A5                          | L14                         | O9    | R3 |
|  | 34                                                | 0.067            | 0.21                                                                           | 865                       | 235           | 375                       | 44           | 33            | A5                          | L14                         | O9    | R3 |
|  | 35.5                                              | 0.170            | 0.213                                                                          | 2,330                     | 715           | 1,705                     | 255          | 102           | A5                          | L14                         | O10   | R7 |
|  | 31                                                | 0.01             | 0.15                                                                           | 290                       | 80            | 98                        | 14           | 11            | A5                          |                             | O11   | R3 |
|  | 65                                                | 0.039            | 0.23                                                                           | 1,350                     | 370           | 660                       | 72           | 51            | A5                          |                             | O9    | R3 |
|  | 54                                                | 0.124            | 0.24                                                                           | 3,400                     | 1,130         | 2,700                     | 530          | 168           | A5                          | L14                         | O10   | R7 |
|  | 98                                                | 0.022            | 0.20                                                                           | 1,870                     | 530           | 1,120                     | 121          | 74            | A5                          |                             | O5    | R3 |
|  | 161                                               | 0.026            | 0.241                                                                          | 4,675                     | 1,825         | 4,085                     | 1,260        | 330           | A5                          | L14                         | O10   | R7 |
|  | 20                                                | 0.019            | 0.101                                                                          | 115                       | 30            | 36                        | 5            | 4             | A5                          | L14                         | O10   | R7 |
|  | 31                                                | 0.056            | 0.169                                                                          | 645                       | 175           | 260                       | 32           | 24            | A5                          | L14                         | O10   | R7 |
|  | 26                                                | 0.054            | 0.132                                                                          | 460                       | 125           | 175                       | 22           | 17            | A5                          | L14                         | O10   | R7 |
|  | 39                                                | 0.025            | 0.152                                                                          | 440                       | 120           | 155                       | 21           | 17            | A5                          | L14                         | O10   | R7 |
|  | 24                                                | 0.020            | 0.131                                                                          | 245                       | 65            | 81                        | 12           | 9             | A5                          | L14                         | O10   | R7 |
|  | 67                                                | 0.038            | 0.202                                                                          | 1,175                     | 320           | 540                       | 61           | 45            | A5                          | L14                         | O10   | R6 |
|  | 41                                                | 0.062            | 0.17                                                                           | 1,155                     | 315           | 570                       | 62           | 44            | A5                          |                             | O9    | R3 |
|  | 68                                                | 0.017            | 0.173                                                                          | 1,010                     | 275           | 435                       | 51           | 38            | A5                          | L14                         | O10   | R7 |
|  | 103                                               | 0.019            | 0.15                                                                           | 1,295                     | 355           | 680                       | 72           | 50            | A5                          | L15                         | O9    | R8 |
|  | 110                                               | 0.024            | 0.206                                                                          | 2,645                     | 765           | 1,740                     | 205          | 108           | A5                          | L14                         | O10   | R7 |
|  | 30                                                | 0.022            | 0.0772                                                                         | 170                       | 45            | 56                        | 8            | 6             | A5                          | L14                         | O10   | R7 |
|  | 20                                                | 0.011            | 0.0594                                                                         | 55                        | 15            | 17                        | 3            | 2             | A5                          | L14                         | O10   | R7 |

| Industrial Designation or Chemical Name | Chemical Formula                                      | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-----------------------------------------|-------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                         |                                                       |                                           |                                                |                                     |                                                               |  |
| HCFC-141b                               | CH <sub>3</sub> CCl <sub>2</sub> F                    | 24.4 ppt                                  | 9.4                                            | 9.4                                 | 10.7                                                          |  |
| HCFC-142                                | CH <sub>2</sub> ClCHF <sub>2</sub>                    |                                           | –                                              | 2.6                                 | 2.73                                                          |  |
| HCFC-142a                               | CH <sub>2</sub> FCHClF                                |                                           | –                                              | 1.58                                | 1.64                                                          |  |
| HCFC-142b                               | CH <sub>3</sub> CClF <sub>2</sub>                     | 22.2 ppt                                  | 18                                             | 18                                  | 19.3                                                          |  |
| HCFC-151                                | CH <sub>2</sub> ClCH <sub>2</sub> F                   |                                           | –                                              | 0.49                                | 0.487                                                         |  |
| HCFC-151a                               | CH <sub>3</sub> CHClF                                 |                                           | –                                              | 1.16                                | 1.2                                                           |  |
| HCFC-221aa                              | CHCl <sub>2</sub> CCl <sub>2</sub> CCl <sub>2</sub> F |                                           | –                                              | 0.93                                | 0.98                                                          |  |
| HCFC-221ab                              | CHClFCCl <sub>2</sub> CCl <sub>3</sub>                |                                           | –                                              | 2.67                                | 2.96                                                          |  |
| HCFC-221ba                              | CHCl <sub>2</sub> CClFCCl <sub>3</sub>                |                                           | –                                              | 1.11                                | 1.17                                                          |  |
| HCFC-221da                              | CCl <sub>3</sub> CHClCCl <sub>2</sub> F               |                                           | –                                              | 3.29                                | 3.71                                                          |  |
| HCFC-221ea                              | CCl <sub>3</sub> CHFCCl <sub>3</sub>                  |                                           | –                                              | 3.52                                | 3.99                                                          |  |
| HCFC-222aa                              | CHCl <sub>2</sub> CCl <sub>2</sub> CClF <sub>2</sub>  |                                           | –                                              | 1.11                                | 1.17                                                          |  |
| HCFC-222ab                              | CHClFCCl <sub>2</sub> CCl <sub>2</sub> F              |                                           | –                                              | 2.67                                | 2.96                                                          |  |
| HCFC-222ac                              | CHF <sub>2</sub> CCl <sub>2</sub> CCl <sub>3</sub>    |                                           | –                                              | 9.29                                | 12.6                                                          |  |
| HCFC-222ba                              | CHCl <sub>2</sub> CClFCCl <sub>2</sub> F              |                                           | –                                              | 1.11                                | 1.17                                                          |  |
| HCFC-222bb                              | CHClFCClFCCl <sub>3</sub>                             |                                           | –                                              | 3.15                                | 3.54                                                          |  |
| HCFC-222ca                              | CHCl <sub>2</sub> CF <sub>2</sub> CCl <sub>3</sub>    |                                           | –                                              | 1.38                                | 1.47                                                          |  |
| HCFC-222da                              | CCl <sub>2</sub> FCHClCCl <sub>2</sub> F              |                                           | –                                              | 4.48                                | 5.23                                                          |  |
| HCFC-222db                              | CCl <sub>3</sub> CHClCClF <sub>2</sub>                |                                           | –                                              | 4.62                                | 5.42                                                          |  |
| HCFC-222ea                              | CCl <sub>3</sub> CHFCCl <sub>2</sub> F                |                                           | –                                              | 4.68                                | 5.49                                                          |  |
| HCFC-223aa                              | CHCl <sub>2</sub> CCl <sub>2</sub> CF <sub>3</sub>    |                                           | –                                              | 1.11                                | 1.17                                                          |  |
| HCFC-223ab                              | CHClFCCl <sub>2</sub> CClF <sub>2</sub>               |                                           | –                                              | 3.18                                | 3.54                                                          |  |
| HCFC-223ac                              | CHF <sub>2</sub> CCl <sub>2</sub> CCl <sub>2</sub> F  |                                           | –                                              | 9.29                                | 12.6                                                          |  |
| HCFC-223ba                              | CHCl <sub>2</sub> CClFCClF <sub>2</sub>               |                                           | –                                              | 1.39                                | 1.47                                                          |  |
| HCFC-223bb                              | CHClFCClFCCl <sub>2</sub> F                           |                                           | –                                              | 3.18                                | 3.54                                                          |  |
| HCFC-223bc                              | CHF <sub>2</sub> CClFCCl <sub>3</sub>                 |                                           | –                                              | 10.6                                | 15.1                                                          |  |
| HCFC-223ca                              | CHCl <sub>2</sub> CF <sub>2</sub> CCl <sub>2</sub> F  |                                           | –                                              | 1.38                                | 1.47                                                          |  |
| HCFC-223cb                              | CHClFCF <sub>2</sub> CCl <sub>3</sub>                 |                                           | –                                              | 3.88                                | 4.45                                                          |  |
| HCFC-223da                              | CCl <sub>2</sub> FCHClCClF <sub>2</sub>               |                                           | –                                              | 6.48                                | 7.86                                                          |  |
| HCFC-223db                              | CCl <sub>3</sub> CHClCF <sub>3</sub>                  |                                           | –                                              | 6.47                                | 8.02                                                          |  |
| HCFC-223ea                              | CCl <sub>2</sub> FCHFCCl <sub>2</sub> F               |                                           | –                                              | 6.28                                | 7.74                                                          |  |
| HCFC-223eb                              | CCl <sub>3</sub> CHFCClF <sub>2</sub>                 |                                           | –                                              | 6.46                                | 8.02                                                          |  |
| HCFC-224aa                              | CHClFCCl <sub>2</sub> CF <sub>3</sub>                 |                                           | –                                              | 3.15                                | 3.54                                                          |  |
| HCFC-224ab                              | CHF <sub>2</sub> CCl <sub>2</sub> CClF <sub>2</sub>   |                                           | –                                              | 11.3                                | 15.1                                                          |  |
| HCFC-224ba                              | CHCl <sub>2</sub> CClFCF <sub>3</sub>                 |                                           | –                                              | 1.39                                | 1.47                                                          |  |
| HCFC-224bb                              | CHClFCClFCClF <sub>2</sub>                            |                                           | –                                              | 4.1                                 | 4.45                                                          |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |        |     |    |
|--|---------------------------------------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|--------|-----|----|
|  |                                                   |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |        |     |    |
|  | 72.3                                              | 0.069–0.102                                                                    | 0.16                      | 2,590         | 800                       | 1,900        | 285           | 114                         | A5                          | L:3,13 | O4  | R3 |
|  | 60                                                | 0.019                                                                          | 0.110                     | 645           | 175                       | 260          | 32            | 24                          | A5                          | L14    | O10 | R7 |
|  | 42                                                | 0.015                                                                          | 0.113                     | 400           | 110                       | 140          | 19            | 15                          | A5                          | L14    | O10 | R7 |
|  | 212                                               | 0.023–0.057                                                                    | 0.19                      | 5,140         | 2,070                     | 4,530        | 1,490         | 390                         | A5                          | L:3,13 | O4  | R3 |
|  | 20                                                | 0.008                                                                          | 0.0306                    | 40            | 10                        | 12           | 2             | 2                           | A5                          | L14    | O10 | R7 |
|  | 33                                                | 0.015                                                                          | 0.0629                    | 200           | 55                        | 66           | 9             | 7                           | A5                          | L14    | O10 | R7 |
|  | 20                                                | 0.027                                                                          | 0.183                     | 140           | 38                        | 46           | 7             | 5                           |                             | L14    | O10 | R7 |
|  | 27                                                | 0.069                                                                          | 0.181                     | 405           | 110                       | 165          | 20            | 15                          |                             | L14    | O10 | R7 |
|  | 20                                                | 0.032                                                                          | 0.174                     | 160           | 44                        | 53           | 8             | 6                           |                             | L14    | O10 | R7 |
|  | 29                                                | 0.083                                                                          | 0.243                     | 670           | 180                       | 300          | 34            | 25                          |                             | L14    | O10 | R7 |
|  | 30                                                | 0.088                                                                          | 0.219                     | 640           | 175                       | 295          | 33            | 24                          |                             | L14    | O10 | R7 |
|  | 20                                                | 0.028                                                                          | 0.224                     | 220           | 60                        | 73           | 10            | 8                           |                             | L14    | O10 | R7 |
|  | 27                                                | 0.061                                                                          | 0.234                     | 560           | 150                       | 225          | 28            | 21                          |                             | L14    | O10 | R7 |
|  | 35                                                | 0.191                                                                          | 0.221                     | 1,620         | 500                       | 1,185        | 175           | 71                          |                             | L14    | O10 | R7 |
|  | 20                                                | 0.028                                                                          | 0.210                     | 210           | 56                        | 68           | 10            | 8                           |                             | L14    | O10 | R7 |
|  | 29                                                | 0.071                                                                          | 0.199                     | 560           | 150                       | 245          | 28            | 21                          |                             | L14    | O10 | R7 |
|  | 22                                                | 0.034                                                                          | 0.205                     | 250           | 68                        | 86           | 12            | 10                          |                             | L14    | O10 | R7 |
|  | 31                                                | 0.097                                                                          | 0.283                     | 1,120         | 305                       | 580          | 62            | 43                          |                             | L14    | O10 | R7 |
|  | 31                                                | 0.100                                                                          | 0.265                     | 1,080         | 295                       | 570          | 61            | 41                          |                             | L14    | O10 | R7 |
|  | 31                                                | 0.101                                                                          | 0.245                     | 1,010         | 280                       | 535          | 57            | 39                          |                             | L14    | O10 | R7 |
|  | 20                                                | 0.024                                                                          | 0.195                     | 205           | 56                        | 68           | 10            | 8                           |                             | L14    | O10 | R7 |
|  | 31                                                | 0.059                                                                          | 0.282                     | 855           | 230                       | 375          | 43            | 32                          |                             | L14    | O10 | R7 |
|  | 35                                                | 0.164                                                                          | 0.289                     | 2,265         | 695                       | 1,660        | 245           | 99                          |                             | L14    | O10 | R7 |
|  | 23                                                | 0.029                                                                          | 0.258                     | 340           | 92                        | 116          | 16            | 13                          |                             | L14    | O10 | R7 |
|  | 31                                                | 0.059                                                                          | 0.235                     | 710           | 195                       | 310          | 36            | 27                          |                             | L14    | O10 | R7 |
|  | 36                                                | 0.185                                                                          | 0.249                     | 2,140         | 680                       | 1,640        | 282           | 99                          |                             | L14    | O10 | R7 |
|  | 22                                                | 0.029                                                                          | 0.234                     | 310           | 83                        | 105          | 15            | 12                          |                             | L14    | O10 | R7 |
|  | 30                                                | 0.073                                                                          | 0.238                     | 875           | 240                       | 420          | 46            | 33                          |                             | L14    | O10 | R7 |
|  | 37                                                | 0.111                                                                          | 0.313                     | 1,850         | 525                       | 1,155        | 129           | 74                          |                             | L14    | O10 | R7 |
|  | 33                                                | 0.117                                                                          | 0.229                     | 1,350         | 385                       | 845          | 94            | 54                          |                             | L14    | O10 | R7 |
|  | 33                                                | 0.114                                                                          | 0.282                     | 1,620         | 460                       | 1000         | 110           | 64                          |                             | L14    | O10 | R7 |
|  | 33                                                | 0.117                                                                          | 0.262                     | 1,540         | 440                       | 965          | 108           | 62                          |                             | L14    | O10 | R7 |
|  | 29                                                | 0.049                                                                          | 0.247                     | 800           | 215                       | 345          | 40            | 30                          |                             | L14    | O10 | R7 |
|  | 45                                                | 0.141                                                                          | 0.306                     | 2,945         | 960                       | 2,305        | 430           | 142                         |                             | L14    | O10 | R7 |
|  | 24                                                | 0.023                                                                          | 0.215                     | 310           | 83                        | 105          | 14            | 12                          |                             | L14    | O10 | R7 |
|  | 51                                                | 0.047                                                                          | 0.283                     | 1,180         | 320                       | 585          | 64            | 45                          |                             | L14    | O10 | R7 |

| Industrial Designation or Chemical Name | Chemical Formula                                      | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-----------------------------------------|-------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                         |                                                       |                                           |                                                |                                     |                                                               |  |
| HCFC-224bc                              | CHF <sub>2</sub> CCIFCCl <sub>2</sub> F               |                                           | –                                              | 11.3                                | 15.1                                                          |  |
| HCFC-224ca                              | CHCl <sub>2</sub> CF <sub>2</sub> CClF <sub>2</sub>   |                                           | –                                              | 1.79                                | 1.92                                                          |  |
| HCFC-224cb                              | CHClFCCl <sub>2</sub> CF <sub>2</sub>                 |                                           | –                                              | 1.57                                | 1.64                                                          |  |
| HCFC-224cc                              | CHF <sub>2</sub> CF <sub>2</sub> CCl <sub>3</sub>     |                                           | –                                              | 12.5                                | 19                                                            |  |
| HCFC-224da                              | CClF <sub>2</sub> CHClCClF <sub>2</sub>               |                                           | –                                              | 10.4                                | 12.3                                                          |  |
| HCFC-224db                              | CCl <sub>2</sub> FCHClCF <sub>3</sub>                 |                                           | –                                              | 9.39                                | 12                                                            |  |
| HCFC-224ea                              | CCl <sub>2</sub> FCHFCClF <sub>2</sub>                |                                           | –                                              | 9.16                                | 11.6                                                          |  |
| HCFC-224eb                              | CCl <sub>3</sub> CHFCF <sub>3</sub>                   |                                           | –                                              | 8.88                                | 11.9                                                          |  |
| HCFC-225aa                              | CHF <sub>2</sub> CCl <sub>2</sub> CF <sub>3</sub>     |                                           | –                                              | 11.8                                | 15.1                                                          |  |
| HCFC-225ba                              | CHClFCClFCClF <sub>3</sub>                            |                                           | –                                              | 4.2                                 | 4.45                                                          |  |
| HCFC-225bb                              | CHF <sub>2</sub> CClFCClF <sub>2</sub>                |                                           | –                                              | 15.9                                | 19                                                            |  |
| HCFC-225ca                              | CHCl <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>     |                                           | 0.02 ppt                                       | 1.9                                 | 2.0                                                           |  |
| HCFC-225cb                              | CHClFCCl <sub>2</sub> CClF <sub>2</sub>               |                                           | 0.04 ppt                                       | 5.9                                 | 6.3                                                           |  |
| HCFC-225cc                              | CHF <sub>2</sub> CF <sub>2</sub> CCl <sub>2</sub> F   |                                           | –                                              | 14.1                                | 19                                                            |  |
| HCFC-225da                              | CClF <sub>2</sub> CHClCF <sub>3</sub>                 |                                           | –                                              | 16.3                                | 19.5                                                          |  |
| HCFC-225ea                              | CClF <sub>2</sub> CHFCClF <sub>2</sub>                |                                           | –                                              | 15.3                                | 18.1                                                          |  |
| HCFC-225eb                              | CCl <sub>2</sub> FCHFCClF <sub>3</sub>                |                                           | –                                              | 13.4                                | 17.7                                                          |  |
| HCFC-226ba                              | CHF <sub>2</sub> CClFCClF <sub>3</sub>                |                                           | –                                              | 17                                  | 19                                                            |  |
| HCFC-226ca                              | CHClFCCl <sub>2</sub> CF <sub>3</sub>                 |                                           | –                                              | 5.47                                | 5.8                                                           |  |
| HCFC-226cb                              | CHF <sub>2</sub> CF <sub>2</sub> CClF <sub>2</sub>    |                                           | –                                              | 21.6                                | 24.7                                                          |  |
| HCFC-226da                              | CF <sub>3</sub> CHClCF <sub>3</sub>                   |                                           | –                                              | 27.7                                | 32.6                                                          |  |
| HCFC-226ea                              | CClF <sub>2</sub> CHFCClF <sub>3</sub>                |                                           | –                                              | 24.9                                | 28.8                                                          |  |
| HCFC-231aa                              | CHCl <sub>2</sub> CCl <sub>2</sub> CHClF              |                                           | –                                              | 0.799                               | 0.839                                                         |  |
| HCFC-231ab                              | CH <sub>2</sub> ClCCl <sub>2</sub> CCl <sub>2</sub> F |                                           | –                                              | 1.61                                | 1.73                                                          |  |
| HCFC-231ac                              | CH <sub>2</sub> FCCl <sub>2</sub> CCl <sub>3</sub>    |                                           | –                                              | 2.33                                | 2.55                                                          |  |
| HCFC-231ba                              | CHCl <sub>2</sub> CClFCHCl <sub>2</sub>               |                                           | –                                              | 0.56                                | 0.586                                                         |  |
| HCFC-231bb                              | CH <sub>2</sub> ClCClFCCl <sub>3</sub>                |                                           | –                                              | 2.54                                | 2.8                                                           |  |
| HCFC-231da                              | CHCl <sub>2</sub> CHClCCl <sub>2</sub> F              |                                           | –                                              | 0.54                                | 0.557                                                         |  |
| HCFC-231db                              | CHClFCHClCCl <sub>3</sub>                             |                                           | –                                              | 1.34                                | 1.43                                                          |  |
| HCFC-231ea                              | CHCl <sub>2</sub> CHFCCl <sub>3</sub>                 |                                           | –                                              | 0.76                                | 0.799                                                         |  |
| HCFC-231fa                              | CCl <sub>2</sub> FCH <sub>2</sub> CCl <sub>3</sub>    |                                           | –                                              | 6.26                                | 7.71                                                          |  |
| HCFC-232aa                              | CHClFCCl <sub>2</sub> CHClF                           |                                           | –                                              | 1.65                                | 1.77                                                          |  |
| HCFC-232ab                              | CHCl <sub>2</sub> CCl <sub>2</sub> CHF <sub>2</sub>   |                                           | –                                              | 1.01                                | 1.07                                                          |  |
| HCFC-232ac                              | CH <sub>2</sub> ClCCl <sub>2</sub> CClF <sub>2</sub>  |                                           | –                                              | 2.56                                | 2.8                                                           |  |
| HCFC-232ad                              | CH <sub>2</sub> FCCl <sub>2</sub> CCl <sub>2</sub> F  |                                           | –                                              | 2.33                                | 2.55                                                          |  |
| HCFC-232ba                              | CHCl <sub>2</sub> CClFCHClF                           |                                           | –                                              | 0.99                                | 1.04                                                          |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |    |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |    |
|  | 45                                                | 0.141            | 0.308                                                                          | 2,965                     | 970           | 2,320                     | 430          | 142           |                             | L14                         | O10 | R7 |
|  | 28                                                | 0.028            | 0.262                                                                          | 480                       | 130           | 173                       | 23           | 18            |                             | L14                         | O10 | R7 |
|  | 35                                                | 0.022            | 0.248                                                                          | 400                       | 108           | 139                       | 19           | 15            |                             | L14                         | O10 | R7 |
|  | 37                                                | 0.174            | 0.314                                                                          | 3,215                     | 1,090         | 2,600                     | 550          | 165           |                             | L14                         | O10 | R7 |
|  | 67                                                | 0.096            | 0.349                                                                          | 3,180                     | 1,010         | 2,425                     | 410          | 146           |                             | L14                         | O10 | R7 |
|  | 43                                                | 0.119            | 0.285                                                                          | 2,420                     | 745           | 1,780                     | 265          | 107           |                             | L14                         | O10 | R7 |
|  | 43                                                | 0.117            | 0.312                                                                          | 2,600                     | 795           | 1,895                     | 275          | 114           |                             | L14                         | O10 | R7 |
|  | 35                                                | 0.126            | 0.235                                                                          | 1,915                     | 580           | 1,380                     | 195          | 83            |                             | L14                         | O10 | R7 |
|  | 54                                                | 0.094            | 0.264                                                                          | 2,820                     | 935           | 2,240                     | 440          | 139           |                             | L14                         | O10 | R7 |
|  | 74                                                | 0.025            | 0.254                                                                          | 1,175                     | 320           | 590                       | 65           | 45            |                             | L14                         | O10 | R7 |
|  | 100                                               | 0.069            | 0.319                                                                          | 4,030                     | 1,520         | 3,470                     | 985          | 260           |                             | L14                         | O10 | R7 |
|  | 44                                                | 0.025            | 0.220                                                                          | 470                       | 127           | 170                       | 22           | 18            | A5                          | L3                          | O5  | R3 |
|  | 101                                               | 0.033            | 0.290                                                                          | 1,860                     | 525           | 1,110                     | 120          | 73            | A5                          | L3                          | O5  | R3 |
|  | 55                                                | 0.110            | 0.344                                                                          | 4,080                     | 1,455         | 3,410                     | 835          | 230           |                             | L14                         | O10 | R7 |
|  | 100                                               | 0.071            | 0.302                                                                          | 3,860                     | 1,475         | 3,340                     | 980          | 255           |                             | L14                         | O10 | R7 |
|  | 99                                                | 0.068            | 0.340                                                                          | 4,210                     | 1,560         | 3,590                     | 975          | 260           |                             | L14                         | O10 | R7 |
|  | 55                                                | 0.105            | 0.287                                                                          | 3,310                     | 1,155         | 2,725                     | 630          | 180           |                             | L14                         | O10 | R7 |
|  | 161                                               | 0.019            | 0.267                                                                          | 3,790                     | 1,480         | 3,310                     | 1,020        | 265           |                             | L14                         | O10 | R7 |
|  | 98                                                | 0.013            | 0.261                                                                          | 1,680                     | 465           | 965                       | 105          | 66            |                             | L14                         | O10 | R7 |
|  | 174                                               | 0.022            | 0.341                                                                          | 5,370                     | 2,385         | 4,915                     | 1,970        | 540           |                             | L14                         | O10 | R7 |
|  | 185                                               | 0.025            | 0.251                                                                          | 4,315                     | 2,210         | 4,105                     | 2,075        | 665           |                             | L14                         | O10 | R7 |
|  | 180                                               | 0.023            | 0.307                                                                          | 5,095                     | 2,455         | 4,775                     | 2,195        | 650           |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.022            | 0.128                                                                          | 98                        | 27            | 31                        | 5            | 4             |                             | L14                         | O10 | R7 |
|  | 23                                                | 0.042            | 0.180                                                                          | 280                       | 75            | 98                        | 13           | 10            |                             | L14                         | O10 | R7 |
|  | 26                                                | 0.058            | 0.156                                                                          | 350                       | 94            | 135                       | 17           | 13            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.015            | 0.114                                                                          | 62                        | 17            | 19                        | 3            | 2             |                             | L14                         | O10 | R7 |
|  | 27                                                | 0.063            | 0.163                                                                          | 400                       | 108           | 159                       | 20           | 15            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.015            | 0.136                                                                          | 70                        | 19            | 22                        | 3            | 3             |                             | L14                         | O10 | R7 |
|  | 21                                                | 0.036            | 0.144                                                                          | 185                       | 50            | 63                        | 9            | 7             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.021            | 0.131                                                                          | 96                        | 26            | 30                        | 4            | 4             |                             | L14                         | O10 | R7 |
|  | 33                                                | 0.143            | 0.213                                                                          | 1,230                     | 350           | 755                       | 83           | 49            |                             | L14                         | O10 | R7 |
|  | 245                                               | 0.036            | 0.177                                                                          | 300                       | 82            | 106                       | 14           | 11            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.024            | 0.143                                                                          | 150                       | 41            | 49                        | 7            | 6             |                             | L14                         | O10 | R7 |
|  | 29                                                | 0.053            | 0.222                                                                          | 590                       | 160           | 235                       | 29           | 22            |                             | L14                         | O10 | R7 |
|  | 26                                                | 0.050            | 0.213                                                                          | 515                       | 140           | 198                       | 25           | 19            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.023            | 0.162                                                                          | 165                       | 45            | 54                        | 8            | 6             |                             | L14                         | O10 | R7 |

| Industrial Designation or Chemical Name | Chemical Formula                                     | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-----------------------------------------|------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                         |                                                      |                                           |                                                |                                     |                                                               |  |
| HCFC-232bb                              | CH <sub>2</sub> CICClFCCl <sub>2</sub> F             |                                           | –                                              | 2.56                                | 2.8                                                           |  |
| HCFC-232bc                              | CH <sub>2</sub> FCClFCCl <sub>3</sub>                |                                           | –                                              | 3.64                                | 4.14                                                          |  |
| HCFC-232ca                              | CHCl <sub>2</sub> CF <sub>2</sub> CHCl <sub>2</sub>  |                                           | –                                              | 0.70                                | 0.737                                                         |  |
| HCFC-232cb                              | CH <sub>2</sub> CICF <sub>2</sub> CCl <sub>3</sub>   |                                           | –                                              | 4.47                                | 5.21                                                          |  |
| HCFC-232da                              | CHCl <sub>2</sub> CHCICClF <sub>2</sub>              |                                           | –                                              | 0.82                                | 0.859                                                         |  |
| HCFC-232db                              | CHClFCHCICCl <sub>2</sub> F                          |                                           | –                                              | 1.51                                | 1.61                                                          |  |
| HCFC-232dc                              | CHF <sub>2</sub> CHCICCl <sub>3</sub>                |                                           | –                                              | 2.83                                | 3.15                                                          |  |
| HCFC-232ea                              | CHCl <sub>2</sub> CHFCCl <sub>2</sub> F              |                                           | –                                              | 0.83                                | 0.872                                                         |  |
| HCFC-232eb                              | CHClFCHFCCl <sub>3</sub>                             |                                           | –                                              | 2.04                                | 2.22                                                          |  |
| HCFC-232fa                              | CCl <sub>2</sub> FCH <sub>2</sub> CCl <sub>2</sub> F |                                           | –                                              | 9.23                                | 12.5                                                          |  |
| HCFC-232fb                              | CCl <sub>3</sub> CH <sub>2</sub> CClF <sub>2</sub>   |                                           | –                                              | 10.2                                | 14.4                                                          |  |
| HCFC-233aa                              | CHClFCCl <sub>2</sub> CHF <sub>2</sub>               |                                           | –                                              | 2.63                                | 2.87                                                          |  |
| HCFC-233ab                              | CH <sub>2</sub> CICCl <sub>2</sub> CF <sub>3</sub>   |                                           | –                                              | 2.57                                | 2.8                                                           |  |
| HCFC-233ac                              | CH <sub>2</sub> FCCl <sub>2</sub> CClF <sub>2</sub>  |                                           | –                                              | 3.71                                | 4.14                                                          |  |
| HCFC-233ba                              | CHClFCClFCHClF                                       |                                           | –                                              | 2.1                                 | 2.23                                                          |  |
| HCFC-233bb                              | CHCl <sub>2</sub> CClFCHF <sub>2</sub>               |                                           | –                                              | 1.27                                | 1.34                                                          |  |
| HCFC-233bc                              | CH <sub>2</sub> CICClFCClF <sub>2</sub>              |                                           | –                                              | 4.75                                | 5.21                                                          |  |
| HCFC-233bd                              | CH <sub>2</sub> FCClFCCl <sub>2</sub> F              |                                           | –                                              | 3.71                                | 4.14                                                          |  |
| HCFC-233ca                              | CHCl <sub>2</sub> CF <sub>2</sub> CHClF              |                                           | –                                              | 1.27                                | 1.34                                                          |  |
| HCFC-233cb                              | CH <sub>2</sub> CICF <sub>2</sub> CCl <sub>2</sub> F |                                           | –                                              | 4.57                                | 5.21                                                          |  |
| HCFC-233cc                              | CH <sub>2</sub> FCF <sub>2</sub> CCl <sub>3</sub>    |                                           | –                                              | 6.26                                | 7.71                                                          |  |
| HCFC-233da                              | CHCl <sub>2</sub> CHCICF <sub>3</sub>                |                                           | –                                              | 0.896                               | 0.939                                                         |  |
| HCFC-233db                              | CHClFCHCICClF <sub>2</sub>                           |                                           | –                                              | 2.37                                | 2.52                                                          |  |
| HCFC-233dc                              | CHF <sub>2</sub> CHCICCl <sub>2</sub> F              |                                           | –                                              | 3.55                                | 3.96                                                          |  |
| HCFC-233ea                              | CHCl <sub>2</sub> CHFCClF <sub>2</sub>               |                                           | –                                              | 0.982                               | 1.03                                                          |  |
| HCFC-233eb                              | CHClFCHFCCl <sub>2</sub> F                           |                                           | –                                              | 2.32                                | 2.51                                                          |  |
| HCFC-233ec                              | CHF <sub>2</sub> CHFCCl <sub>3</sub>                 |                                           | –                                              | 4.13                                | 4.77                                                          |  |
| HCFC-233fa                              | CCl <sub>2</sub> FCH <sub>2</sub> CClF <sub>2</sub>  |                                           | –                                              | 15.4                                | 23.3                                                          |  |
| HCFC-233fb                              | CCl <sub>3</sub> CH <sub>2</sub> CF <sub>3</sub>     |                                           | –                                              | 16.4                                | 29.3                                                          |  |
| HCFC-234aa                              | CHF <sub>2</sub> CCl <sub>2</sub> CHF <sub>2</sub>   |                                           | –                                              | 6.51                                | 7.54                                                          |  |
| HCFC-234ab                              | CH <sub>2</sub> FCCl <sub>2</sub> CF <sub>3</sub>    |                                           | –                                              | 3.76                                | 4.14                                                          |  |
| HCFC-234ba                              | CHClFCClFCHF <sub>2</sub>                            |                                           | –                                              | 3.39                                | 3.61                                                          |  |
| HCFC-234bb                              | CH <sub>2</sub> CICClFCF <sub>3</sub>                |                                           | –                                              | 4.84                                | 5.21                                                          |  |
| HCFC-234bc                              | CH <sub>2</sub> FCClFCClF <sub>2</sub>               |                                           | –                                              | 7.01                                | 7.71                                                          |  |
| HCFC-234ca                              | CHClFCF <sub>2</sub> CHClF                           |                                           | –                                              | 2.74                                | 2.9                                                           |  |
| HCFC-234cb                              | CHCl <sub>2</sub> CF <sub>2</sub> CHF <sub>2</sub>   |                                           | –                                              | 1.65                                | 1.74                                                          |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |    |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |    |
|  | 29                                                | 0.053            | 0.222                                                                          | 590                       | 160           | 235                       | 29           | 22            |                             | L14                         | O10 | R7 |
|  | 30                                                | 0.075            | 0.205                                                                          | 770                       | 210           | 360                       | 40           | 29            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.017            | 0.130                                                                          | 95                        | 26            | 30                        | 4            | 4             |                             | L14                         | O10 | R7 |
|  | 31                                                | 0.090            | 0.208                                                                          | 950                       | 260           | 490                       | 53           | 37            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.019            | 0.178                                                                          | 151                       | 41            | 48                        | 7            | 6             |                             | L14                         | O10 | R7 |
|  | 24                                                | 0.033            | 0.200                                                                          | 310                       | 84            | 108                       | 15           | 12            |                             | L14                         | O10 | R7 |
|  | 28                                                | 0.060            | 0.184                                                                          | 540                       | 145           | 225                       | 27           | 20            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.019            | 0.165                                                                          | 142                       | 38            | 45                        | 7            | 5             |                             | L14                         | O10 | R7 |
|  | 25                                                | 0.045            | 0.183                                                                          | 390                       | 104           | 143                       | 19           | 15            |                             | L14                         | O10 | R7 |
|  | 35                                                | 0.176            | 0.267                                                                          | 2,255                     | 690           | 1,645                     | 242          | 99            |                             | L14                         | O10 | R7 |
|  | 36                                                | 0.194            | 0.249                                                                          | 2,255                     | 710           | 1,710                     | 280          | 103           |                             | L14                         | O10 | R7 |
|  | 32                                                | 0.043            | 0.185                                                                          | 545                       | 145           | 220                       | 27           | 20            |                             | L14                         | O10 | R7 |
|  | 31                                                | 0.042            | 0.194                                                                          | 560                       | 150           | 225                       | 27           | 21            |                             | L14                         | O10 | R7 |
|  | 35                                                | 0.057            | 0.250                                                                          | 1,030                     | 280           | 490                       | 54           | 39            |                             | L14                         | O10 | R7 |
|  | 38                                                | 0.031            | 0.202                                                                          | 475                       | 128           | 178                       | 23           | 18            |                             | L14                         | O10 | R7 |
|  | 23                                                | 0.023            | 0.171                                                                          | 245                       | 66            | 81                        | 11           | 9             |                             | L14                         | O10 | R7 |
|  | 53                                                | 0.057            | 0.261                                                                          | 1,365                     | 375           | 730                       | 78           | 53            |                             | L14                         | O10 | R7 |
|  | 35                                                | 0.057            | 0.257                                                                          | 1,060                     | 290           | 500                       | 56           | 40            |                             | L14                         | O10 | R7 |
|  | 23                                                | 0.023            | 0.174                                                                          | 245                       | 67            | 83                        | 12           | 9             |                             | L14                         | O10 | R7 |
|  | 37                                                | 0.069            | 0.250                                                                          | 1,260                     | 345           | 660                       | 71           | 49            |                             | L14                         | O10 | R7 |
|  | 33                                                | 0.100            | 0.246                                                                          | 1,650                     | 465           | 1,020                     | 112          | 66            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.017            | 0.142                                                                          | 142                       | 38            | 46                        | 7            | 5             |                             | L14                         | O10 | R7 |
|  | 40                                                | 0.034            | 0.238                                                                          | 630                       | 170           | 245                       | 31           | 24            |                             | L14                         | O10 | R7 |
|  | 35                                                | 0.055            | 0.245                                                                          | 970                       | 265           | 445                       | 50           | 37            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.019            | 0.183                                                                          | 200                       | 54            | 65                        | 9            | 8             |                             | L14                         | O10 | R7 |
|  | 30                                                | 0.038            | 0.221                                                                          | 575                       | 155           | 220                       | 28           | 22            |                             | L14                         | O10 | R7 |
|  | 31                                                | 0.068            | 0.236                                                                          | 1,080                     | 295           | 540                       | 58           | 41            |                             | L14                         | O10 | R7 |
|  | 46                                                | 0.207            | 0.321                                                                          | 4,020                     | 1,495         | 3,435                     | 940          | 250           |                             | L14                         | O10 | R7 |
|  | 37                                                | 0.247            | 0.204                                                                          | 2,635                     | 1,010         | 2,285                     | 675          | 175           |                             | L14                         | O10 | R7 |
|  | 47                                                | 0.062            | 0.198                                                                          | 1,500                     | 425           | 940                       | 105          | 60            |                             | L14                         | O10 | R7 |
|  | 41                                                | 0.039            | 0.215                                                                          | 980                       | 265           | 465                       | 51           | 37            |                             | L14                         | O10 | R7 |
|  | 57                                                | 0.028            | 0.215                                                                          | 885                       | 240           | 400                       | 45           | 34            |                             | L14                         | O10 | R7 |
|  | 67                                                | 0.035            | 0.218                                                                          | 1,265                     | 350           | 680                       | 73           | 49            |                             | L14                         | O10 | R7 |
|  | 77                                                | 0.045            | 0.279                                                                          | 2,245                     | 645           | 1,455                     | 170          | 91            |                             | L14                         | O10 | R7 |
|  | 51                                                | 0.025            | 0.205                                                                          | 685                       | 185           | 280                       | 34           | 26            |                             | L14                         | O10 | R7 |
|  | 29                                                | 0.020            | 0.199                                                                          | 400                       | 110           | 141                       | 19           | 15            |                             | L14                         | O10 | R7 |

| Industrial Designation or Chemical Name | Chemical Formula                                     | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-----------------------------------------|------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                         |                                                      |                                           |                                                |                                     |                                                               |  |
| HCFC-234cc                              | CH <sub>2</sub> CICF <sub>2</sub> CCIF <sub>2</sub>  |                                           | –                                              | 9.46                                | 10.6                                                          |  |
| HCFC-234cd                              | CH <sub>2</sub> FCF <sub>2</sub> CCl <sub>2</sub> F  |                                           | –                                              | 6.64                                | 7.71                                                          |  |
| HCFC-234da                              | CHCICFCHCICF <sub>3</sub>                            |                                           | –                                              | 2.67                                | 2.82                                                          |  |
| HCFC-234db                              | CHF <sub>2</sub> CHCICCF <sub>2</sub>                |                                           | –                                              | 5.69                                | 6.18                                                          |  |
| HCFC-234ea                              | CHCl <sub>2</sub> CHFCH <sub>2</sub> F               |                                           | –                                              | 1.06                                | 1.11                                                          |  |
| HCFC-234eb                              | CHCICFCHCICCF <sub>2</sub>                           |                                           | –                                              | 2.88                                | 3.04                                                          |  |
| HCFC-234ec                              | CHF <sub>2</sub> CHFCFCl <sub>2</sub> F              |                                           | –                                              | 5.32                                | 6.04                                                          |  |
| HCFC-234fa                              | CClF <sub>2</sub> CH <sub>2</sub> CClF <sub>2</sub>  |                                           | –                                              | 31                                  | 43.4                                                          |  |
| HCFC-234fb                              | CCl <sub>2</sub> FCH <sub>2</sub> CF <sub>3</sub>    |                                           | ~45                                            | 45                                  | 98                                                            |  |
| HCFC-235ba                              | CHF <sub>2</sub> CClFCH <sub>2</sub> F               |                                           | –                                              | 8.8                                 | 9.5                                                           |  |
| HCFC-235bb                              | CH <sub>2</sub> FCFCH <sub>2</sub> CF <sub>3</sub>   |                                           | –                                              | 7.21                                | 7.71                                                          |  |
| HCFC-235ca                              | CH <sub>2</sub> CICF <sub>2</sub> CF <sub>3</sub>    |                                           | –                                              | 9.82                                | 10.6                                                          |  |
| HCFC-235cb                              | CHCICFCH <sub>2</sub> CH <sub>2</sub> F              |                                           | –                                              | 4.45                                | 4.7                                                           |  |
| HCFC-235cc                              | CH <sub>2</sub> FCF <sub>2</sub> CClF <sub>2</sub>   |                                           | –                                              | 14.2                                | 15.7                                                          |  |
| HCFC-235da                              | CHF <sub>2</sub> CHCICF <sub>3</sub>                 |                                           | –                                              | 7.55                                | 8.09                                                          |  |
| HCFC-235ea                              | CHCICFCH <sub>2</sub> CF <sub>3</sub>                |                                           | –                                              | 7.36                                | 7.88                                                          |  |
| HCFC-235eb                              | CHF <sub>2</sub> CHFCFCl <sub>2</sub>                |                                           | –                                              | 3.18                                | 3.33                                                          |  |
| HCFC-235fa                              | CClF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>    |                                           | –                                              | 61.7                                | 88.6                                                          |  |
| HCFC-241aa                              | CH <sub>2</sub> CICCl <sub>2</sub> CHCICF            |                                           | –                                              | 1.43                                | 1.52                                                          |  |
| HCFC-241ab                              | CH <sub>2</sub> FCFCl <sub>2</sub> CHCl <sub>2</sub> |                                           | –                                              | 0.77                                | 0.803                                                         |  |
| HCFC-241ac                              | CH <sub>3</sub> CCl <sub>2</sub> CCl <sub>2</sub> F  |                                           | –                                              | 5.18                                | 6.18                                                          |  |
| HCFC-241ba                              | CH <sub>2</sub> CICCFCHCl <sub>2</sub>               |                                           | –                                              | 0.79                                | 0.826                                                         |  |
| HCFC-241bb                              | CH <sub>3</sub> CClFCCl <sub>3</sub>                 |                                           | –                                              | 7.76                                | 10                                                            |  |
| HCFC-241da                              | CHCl <sub>2</sub> CHCICFCH <sub>2</sub> F            |                                           | –                                              | 0.56                                | 0.581                                                         |  |
| HCFC-241db                              | CH <sub>2</sub> CICFCHCICF <sub>2</sub>              |                                           | –                                              | 0.53                                | 0.549                                                         |  |
| HCFC-241dc                              | CH <sub>2</sub> FCHCICCl <sub>3</sub>                |                                           | –                                              | 0.75                                | 0.786                                                         |  |
| HCFC-241ea                              | CHCl <sub>2</sub> CHFCHCl <sub>2</sub>               |                                           | –                                              | 0.42                                | 0.429                                                         |  |
| HCFC-241eb                              | CH <sub>2</sub> CICFCHCl <sub>3</sub>                |                                           | –                                              | 1.05                                | 1.11                                                          |  |
| HCFC-241fa                              | CHCl <sub>2</sub> CH <sub>2</sub> CCl <sub>2</sub> F |                                           | –                                              | 0.53                                | 0.555                                                         |  |
| HCFC-241fb                              | CHCICFCH <sub>2</sub> CCl <sub>3</sub>               |                                           | –                                              | 1.48                                | 1.59                                                          |  |
| HCFC-242aa                              | CHF <sub>2</sub> CCl <sub>2</sub> CH <sub>2</sub> Cl |                                           | –                                              | 2.13                                | 2.29                                                          |  |
| HCFC-242ab                              | CH <sub>2</sub> FCFCl <sub>2</sub> CHCICF            |                                           | –                                              | 1.78                                | 1.91                                                          |  |
| HCFC-242ac                              | CH <sub>3</sub> CCl <sub>2</sub> CClF <sub>2</sub>   |                                           | –                                              | 8.09                                | 10                                                            |  |
| HCFC-242ba                              | CHCICFCH <sub>2</sub> CH <sub>2</sub> Cl             |                                           | –                                              | 1.99                                | 2.11                                                          |  |
| HCFC-242bb                              | CHCl <sub>2</sub> CClFCH <sub>2</sub> F              |                                           | –                                              | 1.03                                | 1.09                                                          |  |
| HCFC-242bc                              | CH <sub>3</sub> CClFCCl <sub>2</sub> F               |                                           | –                                              | 8.09                                | 10                                                            |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |    |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |    |
|  | 85                                                | 0.054            | 0.267                                                                          | 2,705                     | 835           | 1,990                     | 300          | 120           |                             | L14                         | O10 | R7 |
|  | 48                                                | 0.063            | 0.281                                                                          | 2,160                     | 615           | 1,370                     | 155          | 87            |                             | L14                         | O10 | R7 |
|  | 50                                                | 0.024            | 0.203                                                                          | 660                       | 180           | 268                       | 33           | 25            |                             | L14                         | O10 | R7 |
|  | 72                                                | 0.039            | 0.271                                                                          | 1,820                     | 510           | 1,070                     | 115          | 71            |                             | L14                         | O10 | R7 |
|  | 23                                                | 0.014            | 0.158                                                                          | 205                       | 55            | 67                        | 10           | 8             |                             | L14                         | O10 | R7 |
|  | 52                                                | 0.026            | 0.241                                                                          | 845                       | 230           | 355                       | 42           | 32            |                             | L14                         | O10 | R7 |
|  | 45                                                | 0.052            | 0.276                                                                          | 1,745                     | 485           | 990                       | 105          | 68            |                             | L14                         | O10 | R7 |
|  | 108                                               | 0.132            | 0.347                                                                          | 6,225                     | 3,405         | 6,005                     | 3,330        | 1,170         |                             | L14                         | O10 | R7 |
|  | 58                                                | 0.40             | 0.264                                                                          | 5,190                     | 3,490         | 5,190                     | 3,685        | 1,760         |                             |                             | O9  | R7 |
|  | 121                                               | 0.018            | 0.225                                                                          | 2,375                     | 715           | 1,700                     | 238          | 102           |                             | L14                         | O10 | R7 |
|  | 110                                               | 0.017            | 0.237                                                                          | 2,140                     | 620           | 1,410                     | 167          | 87            |                             | L14                         | O10 | R7 |
|  | 126                                               | 0.018            | 0.215                                                                          | 2,455                     | 765           | 1,830                     | 288          | 110           |                             | L14                         | O10 | R7 |
|  | 85                                                | 0.014            | 0.234                                                                          | 1,375                     | 375           | 710                       | 76           | 53            |                             | L14                         | O10 | R7 |
|  | 146                                               | 0.021            | 0.282                                                                          | 4,040                     | 1,450         | 3,385                     | 840          | 230           |                             | L14                         | O10 | R7 |
|  | 112                                               | 0.017            | 0.227                                                                          | 2,130                     | 620           | 1,430                     | 175          | 88            |                             | L14                         | O10 | R7 |
|  | 111                                               | 0.017            | 0.227                                                                          | 2,085                     | 605           | 1,385                     | 165          | 86            |                             | L14                         | O10 | R7 |
|  | 69                                                | 0.012            | 0.274                                                                          | 1,160                     | 315           | 510                       | 59           | 44            |                             | L14                         | O10 | R7 |
|  | 204                                               | 0.051            | 0.297                                                                          | 6,780                     | 5,320         | 6,930                     | 5,730        | 3,430         |                             | L14                         | O10 | R7 |
|  | 24                                                | 0.035            | 0.116                                                                          | 187                       | 51            | 64                        | 9            | 7             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.020            | 0.0937                                                                         | 81                        | 22            | 25                        | 4            | 3             |                             | L14                         | O10 | R7 |
|  | 32                                                | 0.112            | 0.191                                                                          | 1,090                     | 300           | 610                       | 65           | 42            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.020            | 0.121                                                                          | 108                       | 29            | 34                        | 5            | 4             |                             | L14                         | O10 | R7 |
|  | 34                                                | 0.163            | 0.191                                                                          | 1,545                     | 450           | 1,050                     | 131          | 64            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.014            | 0.100                                                                          | 63                        | 17            | 19                        | 3            | 2             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.014            | 0.119                                                                          | 71                        | 19            | 22                        | 3            | 3             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.019            | 0.115                                                                          | 97                        | 26            | 31                        | 5            | 4             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.011            | 0.081                                                                          | 38                        | 10            | 12                        | 2            | 1             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.027            | 0.125                                                                          | 147                       | 40            | 48                        | 7            | 6             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.014            | 0.117                                                                          | 70                        | 19            | 22                        | 3            | 3             |                             | L14                         | O10 | R7 |
|  | 22                                                | 0.037            | 0.152                                                                          | 255                       | 69            | 87                        | 12           | 10            |                             | L14                         | O10 | R7 |
|  | 29                                                | 0.039            | 0.131                                                                          | 340                       | 93            | 129                       | 17           | 13            |                             | L14                         | O10 | R7 |
|  | 27                                                | 0.034            | 0.132                                                                          | 290                       | 78            | 103                       | 14           | 11            |                             | L14                         | O10 | R7 |
|  | 42                                                | 0.125            | 0.227                                                                          | 2,065                     | 610           | 1,430                     | 185          | 87            |                             | L14                         | O10 | R7 |
|  | 37                                                | 0.033            | 0.151                                                                          | 370                       | 100           | 135                       | 18           | 14            |                             | L14                         | O10 | R7 |
|  | 21                                                | 0.021            | 0.133                                                                          | 168                       | 46            | 55                        | 8            | 6             |                             | L14                         | O10 | R7 |
|  | 42                                                | 0.125            | 0.244                                                                          | 2,220                     | 655           | 1,535                     | 199          | 93            |                             | L14                         | O10 | R7 |

| Industrial Designation or Chemical Name | Chemical Formula                                     | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-----------------------------------------|------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                         |                                                      |                                           |                                                |                                     |                                                               |  |
| HCFC-242ca                              | CHCl <sub>2</sub> CF <sub>2</sub> CH <sub>2</sub> Cl |                                           | –                                              | 1.09                                | 1.15                                                          |  |
| HCFC-242cb                              | CH <sub>3</sub> CF <sub>2</sub> CCl <sub>3</sub>     |                                           | –                                              | 12.3                                | 18.7                                                          |  |
| HCFC-242da                              | CHClFCHClCHClF                                       |                                           | –                                              | 1.32                                | 1.38                                                          |  |
| HCFC-242db                              | CHCl <sub>2</sub> CHClCHF <sub>2</sub>               |                                           | –                                              | 0.73                                | 0.761                                                         |  |
| HCFC-242dc                              | CH <sub>2</sub> ClCHClCClF <sub>2</sub>              |                                           | –                                              | 1.2                                 | 1.25                                                          |  |
| HCFC-242dd                              | CH <sub>2</sub> FCHClCCl <sub>2</sub> F              |                                           | –                                              | 0.83                                | 0.871                                                         |  |
| HCFC-242ea                              | CHCl <sub>2</sub> CHFCHClF                           |                                           | –                                              | 0.72                                | 0.756                                                         |  |
| HCFC-242eb                              | CH <sub>2</sub> ClCHFCCl <sub>2</sub> F              |                                           | –                                              | 1.24                                | 1.31                                                          |  |
| HCFC-242ec                              | CH <sub>2</sub> FCHFCCl <sub>3</sub>                 |                                           | –                                              | 1.7                                 | 1.84                                                          |  |
| HCFC-242fa                              | CHCl <sub>2</sub> CH <sub>2</sub> CClF <sub>2</sub>  |                                           | –                                              | 0.74                                | 0.768                                                         |  |
| HCFC-242fb                              | CHClFCH <sub>2</sub> CCl <sub>2</sub> F              |                                           | –                                              | 1.61                                | 1.71                                                          |  |
| HCFC-242fc                              | CHF <sub>2</sub> CH <sub>2</sub> CCl <sub>3</sub>    |                                           | –                                              | 4.14                                | 4.78                                                          |  |
| HCFC-243aa                              | CHF <sub>2</sub> CCl <sub>2</sub> CH <sub>2</sub> F  |                                           | –                                              | 2.99                                | 3.25                                                          |  |
| HCFC-243ab                              | CH <sub>3</sub> CCl <sub>2</sub> CF <sub>3</sub>     |                                           | –                                              | 8.33                                | 10                                                            |  |
| HCFC-243ba                              | CHF <sub>2</sub> CClFCH <sub>2</sub> Cl              |                                           | –                                              | 3.63                                | 3.88                                                          |  |
| HCFC-243bb                              | CHFClCClFCH <sub>2</sub> F                           |                                           | –                                              | 2.67                                | 2.82                                                          |  |
| HCFC-243bc                              | CH <sub>3</sub> CClFCH <sub>2</sub> Cl               |                                           | –                                              | 15.6                                | 18.7                                                          |  |
| HCFC-243ca                              | CH <sub>2</sub> ClCF <sub>2</sub> CHClF              |                                           | –                                              | 2.89                                | 3.14                                                          |  |
| HCFC-243cb                              | CHCl <sub>2</sub> CF <sub>2</sub> CH <sub>2</sub> F  |                                           | –                                              | 1.46                                | 1.54                                                          |  |
| HCFC-243cc                              | CH <sub>3</sub> CF <sub>2</sub> CFCl <sub>2</sub>    |                                           | 19.5                                           | 18                                  | 27.1                                                          |  |
| HCFC-243da                              | CHF <sub>2</sub> CHClCHClF                           |                                           | –                                              | 1.97                                | 2.07                                                          |  |
| HCFC-243db                              | CH <sub>2</sub> ClCHClCF <sub>3</sub>                |                                           | –                                              | 1.44                                | 1.51                                                          |  |
| HCFC-243dc                              | CH <sub>2</sub> FCHClCF <sub>2</sub> Cl              |                                           | –                                              | 2.03                                | 2.13                                                          |  |
| HCFC-243ea                              | CHFClCHClCHClF                                       |                                           | –                                              | 1.57                                | 1.64                                                          |  |
| HCFC-243eb                              | CHCl <sub>2</sub> CHFCHF <sub>2</sub>                |                                           | –                                              | 0.90                                | 0.938                                                         |  |
| HCFC-243ec                              | CH <sub>2</sub> ClCHFCH <sub>2</sub> Cl              |                                           | –                                              | 1.7                                 | 1.78                                                          |  |
| HCFC-243ed                              | CH <sub>2</sub> FCHFCHCl <sub>2</sub>                |                                           | –                                              | 2.03                                | 2.17                                                          |  |
| HCFC-243fa                              | CHCl <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>    |                                           | –                                              | 0.78                                | 0.813                                                         |  |
| HCFC-243fb                              | CHFClCH <sub>2</sub> CF <sub>2</sub> Cl              |                                           | –                                              | 2.24                                | 2.36                                                          |  |
| HCFC-243fc                              | CHF <sub>2</sub> CH <sub>2</sub> CFCl <sub>2</sub>   |                                           | –                                              | 5.07                                | 5.73                                                          |  |
| HCFC-244ba                              | CH <sub>2</sub> FCClFCHF <sub>2</sub>                |                                           | –                                              | 5.17                                | 5.49                                                          |  |
| HCFC-244bb                              | CH <sub>3</sub> CClFCH <sub>2</sub> F                |                                           | –                                              | 16.6                                | 18.7                                                          |  |
| HCFC-244ca                              | CH <sub>2</sub> ClCF <sub>2</sub> CHF <sub>2</sub>   |                                           | –                                              | 6.39                                | 6.82                                                          |  |
| HCFC-244cb                              | CH <sub>2</sub> FCF <sub>2</sub> CHClF               |                                           | –                                              | 4.02                                | 4.24                                                          |  |
| HCFC-244cc                              | CH <sub>3</sub> CF <sub>2</sub> CF <sub>2</sub> Cl   |                                           | –                                              | 31.2                                | 38.1                                                          |  |
| HCFC-244da                              | CHF <sub>2</sub> CHClCHF <sub>2</sub>                |                                           | –                                              | 3.88                                | 4.09                                                          |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |    |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |    |
|  | 22                                                | 0.022            | 0.144                                                                          | 193                       | 52            | 63                        | 9            | 7             |                             | L14                         | O10 | R7 |
|  | 36                                                | 0.206            | 0.251                                                                          | 3,045                     | 1,025         | 2,450                     | 510          | 154           |                             | L14                         | O10 | R7 |
|  | 29                                                | 0.024            | 0.147                                                                          | 238                       | 64            | 80                        | 11           | 9             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.015            | 0.119                                                                          | 106                       | 29            | 33                        | 5            | 4             |                             | L14                         | O10 | R7 |
|  | 28                                                | 0.023            | 0.170                                                                          | 250                       | 68            | 83                        | 12           | 9             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.017            | 0.159                                                                          | 162                       | 44            | 52                        | 8            | 6             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.015            | 0.119                                                                          | 106                       | 29            | 33                        | 5            | 4             |                             | L14                         | O10 | R7 |
|  | 23                                                | 0.025            | 0.167                                                                          | 255                       | 69            | 85                        | 12           | 10            |                             | L14                         | O10 | R7 |
|  | 24                                                | 0.034            | 0.174                                                                          | 365                       | 98            | 129                       | 17           | 14            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.015            | 0.153                                                                          | 138                       | 37            | 43                        | 6            | 5             |                             | L14                         | O10 | R7 |
|  | 26                                                | 0.031            | 0.203                                                                          | 400                       | 109           | 140                       | 19           | 15            |                             | L14                         | O10 | R7 |
|  | 31                                                | 0.075            | 0.198                                                                          | 1000                      | 270           | 500                       | 54           | 38            |                             | L14                         | O10 | R7 |
|  | 37                                                | 0.036            | 0.154                                                                          | 620                       | 168           | 265                       | 31           | 23            |                             | L14                         | O10 | R7 |
|  | 49                                                | 0.085            | 0.205                                                                          | 2,095                     | 625           | 1,465                     | 195          | 89            |                             | L14                         | O10 | R7 |
|  | 58                                                | 0.033            | 0.146                                                                          | 710                       | 195           | 330                       | 37           | 27            |                             | L14                         | O10 | R7 |
|  | 50                                                | 0.027            | 0.161                                                                          | 580                       | 157           | 235                       | 29           | 22            |                             | L14                         | O10 | R7 |
|  | 94                                                | 0.088            | 0.264                                                                          | 4,010                     | 1,500         | 3,440                     | 955          | 252           |                             | L14                         | O10 | R7 |
|  | 37                                                | 0.035            | 0.182                                                                          | 710                       | 192           | 295                       | 35           | 27            |                             | L14                         | O10 | R7 |
|  | 27                                                | 0.020            | 0.147                                                                          | 290                       | 78            | 99                        | 14           | 11            |                             | L14                         | O10 | R7 |
|  | 54                                                | 0.19             | 0.315                                                                          | 5,130                     | 2,060         | 4,540                     | 1,495        | 390           |                             |                             | O9  | R6 |
|  | 42                                                | 0.022            | 0.162                                                                          | 430                       | 116           | 158                       | 21           | 16            |                             | L14                         | O10 | R7 |
|  | 34                                                | 0.018            | 0.138                                                                          | 270                       | 73            | 92                        | 13           | 10            |                             | L14                         | O10 | R7 |
|  | 43                                                | 0.023            | 0.203                                                                          | 555                       | 150           | 206                       | 27           | 21            |                             | L14                         | O10 | R7 |
|  | 36                                                | 0.019            | 0.172                                                                          | 365                       | 99            | 127                       | 17           | 14            |                             | L14                         | O10 | R7 |
|  | 21                                                | 0.014            | 0.141                                                                          | 170                       | 46            | 55                        | 8            | 6             |                             | L14                         | O10 | R7 |
|  | 38                                                | 0.020            | 0.182                                                                          | 420                       | 113           | 148                       | 20           | 16            |                             | L14                         | O10 | R7 |
|  | 32                                                | 0.026            | 0.215                                                                          | 590                       | 159           | 218                       | 28           | 22            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.012            | 0.120                                                                          | 125                       | 34            | 40                        | 6            | 5             |                             | L14                         | O10 | R7 |
|  | 45                                                | 0.024            | 0.231                                                                          | 700                       | 189           | 265                       | 34           | 26            |                             | L14                         | O10 | R7 |
|  | 44.0                                              | 0.056            | 0.263                                                                          | 1,765                     | 490           | 975                       | 104          | 68            |                             | L14                         | O10 | R7 |
|  | 90                                                | 0.017            | 0.173                                                                          | 1,310                     | 360           | 730                       | 78           | 51            |                             | L14                         | O10 | R7 |
|  | 148                                               | 0.027            | 0.238                                                                          | 4,140                     | 1,600         | 3,600                     | 1,080        | 280           |                             | L14                         | O10 | R7 |
|  | 101                                               | 0.018            | 0.173                                                                          | 1,580                     | 450           | 985                       | 109          | 63            |                             | L14                         | O10 | R7 |
|  | 79                                                | 0.015            | 0.178                                                                          | 1,065                     | 290           | 520                       | 57           | 41            |                             | L14                         | O10 | R7 |
|  | 173                                               | 0.039            | 0.277                                                                          | 6,120                     | 3,360         | 5,905                     | 3,290        | 1,160         |                             | L14                         | O10 | R7 |
|  | 77                                                | 0.015            | 0.182                                                                          | 1,050                     | 285           | 505                       | 56           | 40            |                             | L14                         | O10 | R7 |

| Industrial Designation or Chemical Name | Chemical Formula                                     | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-----------------------------------------|------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                         |                                                      |                                           |                                                |                                     |                                                               |  |
| HCFC-244db                              | CH <sub>2</sub> FCHClCF <sub>3</sub>                 |                                           | –                                              | 2.44                                | 2.54                                                          |  |
| HCFC-244ea                              | CHF <sub>2</sub> CH <sub>2</sub> CHCl                |                                           | –                                              | 2.39                                | 2.5                                                           |  |
| HCFC-244eb                              | CH <sub>2</sub> ClCH <sub>2</sub> CF <sub>3</sub>    |                                           | –                                              | 2.04                                | 2.12                                                          |  |
| HCFC-244ec                              | CH <sub>2</sub> FCH <sub>2</sub> CF <sub>2</sub> Cl  |                                           | –                                              | 2.88                                | 3.01                                                          |  |
| HCFC-244fa                              | CH <sub>2</sub> CHClCH <sub>2</sub> CF <sub>3</sub>  |                                           | –                                              | 2.37                                | 2.48                                                          |  |
| HCFC-244fb                              | CHF <sub>2</sub> CH <sub>2</sub> CF <sub>2</sub> Cl  |                                           | –                                              | 7.76                                | 8.35                                                          |  |
| HCFC-251aa                              | CH <sub>2</sub> FCCL <sub>2</sub> CH <sub>2</sub> Cl |                                           | –                                              | 1.26                                | 1.34                                                          |  |
| HCFC-251ab                              | CH <sub>3</sub> CCl <sub>2</sub> CHCl                |                                           | –                                              | 1.73                                | 1.85                                                          |  |
| HCFC-251ba                              | CH <sub>2</sub> ClCClFCH <sub>2</sub> Cl             |                                           | –                                              | 1.34                                | 1.4                                                           |  |
| HCFC-251bb                              | CH <sub>3</sub> CClFCHCl <sub>2</sub>                |                                           | –                                              | 1.02                                | 1.07                                                          |  |
| HCFC-251da                              | CH <sub>2</sub> ClCHClCHCl                           |                                           | –                                              | 0.69                                | 0.719                                                         |  |
| HCFC-251db                              | CH <sub>2</sub> FCHClCHCl <sub>2</sub>               |                                           | –                                              | 0.40                                | 0.416                                                         |  |
| HCFC-251dc                              | CH <sub>3</sub> CHClCFCl <sub>2</sub>                |                                           | –                                              | 0.52                                | 0.535                                                         |  |
| HCFC-251ea                              | CH <sub>2</sub> ClCH <sub>2</sub> CHCl <sub>2</sub>  |                                           | –                                              | 0.47                                | 0.489                                                         |  |
| HCFC-251eb                              | CH <sub>3</sub> CH <sub>2</sub> CCl <sub>3</sub>     |                                           | –                                              | 0.68                                | 0.709                                                         |  |
| HCFC-251fa                              | CHClFCH <sub>2</sub> CCl <sub>2</sub> H              |                                           | –                                              | 0.33                                | 0.339                                                         |  |
| HCFC-251fb                              | CH <sub>2</sub> ClCH <sub>2</sub> CCl <sub>2</sub> F |                                           | –                                              | 0.45                                | 0.467                                                         |  |
| HCFC-251fc                              | CH <sub>2</sub> FCH <sub>2</sub> CCl <sub>3</sub>    |                                           | –                                              | 0.65                                | 0.676                                                         |  |
| HCFC-252aa                              | CH <sub>2</sub> FCCL <sub>2</sub> CH <sub>2</sub> F  |                                           | –                                              | 1.94                                | 2.07                                                          |  |
| HCFC-252ab                              | CH <sub>3</sub> CCl <sub>2</sub> CH <sub>2</sub> F   |                                           | –                                              | 4.41                                | 4.93                                                          |  |
| HCFC-252ba                              | CH <sub>2</sub> ClCClFCH <sub>2</sub> F              |                                           | –                                              | 2.19                                | 2.31                                                          |  |
| HCFC-252bb                              | CH <sub>3</sub> CClFCHClF                            |                                           | –                                              | 2.87                                | 3.04                                                          |  |
| HCFC-252ca                              | CH <sub>2</sub> ClCF <sub>2</sub> CH <sub>2</sub> Cl |                                           | –                                              | 2.47                                | 2.61                                                          |  |
| HCFC-252cb                              | CH <sub>3</sub> CF <sub>2</sub> CHCl <sub>2</sub>    |                                           | –                                              | 1.19                                | 1.25                                                          |  |
| HCFC-252da                              | CH <sub>2</sub> ClCHClCH <sub>2</sub> F              |                                           | –                                              | 1.0                                 | 1.04                                                          |  |
| HCFC-252db                              | CH <sub>2</sub> FCHClCHClF                           |                                           | –                                              | 1.15                                | 1.2                                                           |  |
| HCFC-252dc                              | CH <sub>3</sub> CHClCClF <sub>2</sub>                |                                           | –                                              | 0.77                                | 0.799                                                         |  |
| HCFC-252ea                              | CH <sub>2</sub> ClCH <sub>2</sub> CHClF              |                                           | –                                              | 1.02                                | 1.06                                                          |  |
| HCFC-252eb                              | CH <sub>2</sub> FCH <sub>2</sub> CHCl <sub>2</sub>   |                                           | –                                              | 0.65                                | 0.67                                                          |  |
| HCFC-252ec                              | CH <sub>3</sub> CH <sub>2</sub> CCl <sub>2</sub> F   |                                           | –                                              | 0.84                                | 0.882                                                         |  |
| HCFC-252fa                              | CHClFCH <sub>2</sub> CHClF                           |                                           | –                                              | 1.15                                | 1.19                                                          |  |
| HCFC-252fb                              | CHCl <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> F  |                                           | –                                              | 0.66                                | 0.684                                                         |  |
| HCFC-252fc                              | CH <sub>2</sub> ClCH <sub>2</sub> CClF <sub>2</sub>  |                                           | –                                              | 0.94                                | 0.972                                                         |  |
| HCFC-252fd                              | CH <sub>2</sub> FCH <sub>2</sub> CCl <sub>2</sub> F  |                                           | –                                              | 0.70                                | 0.732                                                         |  |
| HCFC-253ba                              | CH <sub>2</sub> FCCLFCH <sub>2</sub> F               |                                           | –                                              | 3.66                                | 3.86                                                          |  |
| HCFC-253bb                              | CH <sub>3</sub> CClFCH <sub>2</sub> F                |                                           | –                                              | 7.85                                | 8.46                                                          |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |    |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |    |
|  | 57                                                | 0.012            | 0.164                                                                          | 600                       | 162           | 235                       | 29           | 23            |                             | L14                         | O10 | R7 |
|  | 57                                                | 0.012            | 0.191                                                                          | 685                       | 185           | 267                       | 33           | 26            |                             | L14                         | O10 | R7 |
|  | 51                                                | 0.011            | 0.151                                                                          | 460                       | 125           | 170                       | 22           | 17            |                             | L14                         | O10 | R7 |
|  | 64                                                | 0.013            | 0.226                                                                          | 975                       | 265           | 410                       | 49           | 37            |                             | L14                         | O10 | R7 |
|  | 56                                                | 0.012            | 0.185                                                                          | 655                       | 178           | 255                       | 32           | 25            |                             | L14                         | O10 | R7 |
|  | 111                                               | 0.020            | 0.285                                                                          | 3,060                     | 900           | 2,080                     | 260          | 127           |                             | L14                         | O10 | R7 |
|  | 23                                                | 0.028            | 0.0752                                                                         | 129                       | 35            | 43                        | 6            | 5             |                             | L14                         | O10 | R7 |
|  | 27                                                | 0.037            | 0.110                                                                          | 260                       | 70            | 93                        | 12           | 10            |                             | L14                         | O10 | R7 |
|  | 29                                                | 0.027            | 0.0951                                                                         | 173                       | 47            | 59                        | 8            | 7             |                             | L14                         | O10 | R7 |
|  | 21                                                | 0.023            | 0.109                                                                          | 151                       | 41            | 49                        | 7            | 6             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.016            | 0.0821                                                                         | 77                        | 21            | 24                        | 4            | 3             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.009            | 0.0631                                                                         | 35                        | 9             | 11                        | 2            | 1             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.012            | 0.122                                                                          | 85                        | 23            | 26                        | 4            | 3             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.011            | 0.0776                                                                         | 50                        | 14            | 15                        | 2            | 2             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.016            | 0.134                                                                          | 124                       | 34            | 39                        | 6            | 5             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.008            | 0.0739                                                                         | 33                        | 9             | 10                        | 2            | 1             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.011            | 0.107                                                                          | 66                        | 18            | 20                        | 3            | 2             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.015            | 0.103                                                                          | 91                        | 25            | 28                        | 4            | 3             |                             | L14                         | O10 | R7 |
|  | 31                                                | 0.029            | 0.105                                                                          | 310                       | 83            | 113                       | 15           | 12            |                             | L14                         | O10 | R7 |
|  | 42                                                | 0.056            | 0.153                                                                          | 1,010                     | 275           | 520                       | 56           | 39            |                             | L14                         | O10 | R7 |
|  | 44                                                | 0.027            | 0.0992                                                                         | 330                       | 89            | 125                       | 16           | 12            |                             | L14                         | O10 | R7 |
|  | 51                                                | 0.032            | 0.147                                                                          | 640                       | 173           | 265                       | 32           | 24            |                             | L14                         | O10 | R7 |
|  | 47                                                | 0.029            | 0.126                                                                          | 470                       | 127           | 186                       | 23           | 18            |                             | L14                         | O10 | R7 |
|  | 24                                                | 0.019            | 0.146                                                                          | 265                       | 71            | 87                        | 12           | 10            |                             | L14                         | O10 | R7 |
|  | 27                                                | 0.016            | 0.0897                                                                         | 135                       | 37            | 44                        | 6            | 5             |                             | L14                         | O10 | R7 |
|  | 29                                                | 0.017            | 0.101                                                                          | 176                       | 48            | 58                        | 8            | 7             |                             | L14                         | O10 | R7 |
|  | 22                                                | 0.013            | 0.149                                                                          | 174                       | 47            | 55                        | 8            | 7             |                             | L14                         | O10 | R7 |
|  | 27                                                | 0.016            | 0.112                                                                          | 173                       | 47            | 57                        | 8            | 7             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.011            | 0.0922                                                                         | 90                        | 24            | 28                        | 4            | 3             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.015            | 0.175                                                                          | 223                       | 60            | 71                        | 10           | 8             |                             | L14                         | O10 | R7 |
|  | 29                                                | 0.017            | 0.143                                                                          | 250                       | 67            | 82                        | 12           | 9             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.011            | 0.114                                                                          | 113                       | 31            | 35                        | 5            | 4             |                             | L14                         | O10 | R7 |
|  | 25                                                | 0.015            | 0.153                                                                          | 217                       | 59            | 70                        | 10           | 8             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.012            | 0.155                                                                          | 164                       | 45            | 52                        | 8            | 6             |                             | L14                         | O10 | R7 |
|  | 73                                                | 0.017            | 0.131                                                                          | 810                       | 221           | 380                       | 42           | 31            |                             | L14                         | O10 | R7 |
|  | 108                                               | 0.024            | 0.184                                                                          | 2,260                     | 665           | 1,545                     | 195          | 94            |                             | L14                         | O10 | R7 |

| Industrial Designation or Chemical Name | Chemical Formula                                    | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-----------------------------------------|-----------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                         |                                                     |                                           |                                                |                                     |                                                               |  |
| HCFC-253ca                              | CH <sub>2</sub> ClCF <sub>2</sub> CH <sub>2</sub> F |                                           | –                                              | 4.23                                | 4.47                                                          |  |
| HCFC-253cb                              | CH <sub>3</sub> CF <sub>2</sub> CHClF               |                                           | –                                              | 3.48                                | 3.66                                                          |  |
| HCFC-253da                              | CH <sub>2</sub> FCHClCHF <sub>2</sub>               |                                           | –                                              | 1.67                                | 1.74                                                          |  |
| HCFC-253db                              | CH <sub>3</sub> CHClCF <sub>3</sub>                 |                                           | –                                              | 1.02                                | 1.06                                                          |  |
| HCFC-253ea                              | CH <sub>2</sub> ClCHFCHF <sub>2</sub>               |                                           | –                                              | 1.44                                | 1.5                                                           |  |
| HCFC-253eb                              | CH <sub>2</sub> FCHFCHClF                           |                                           | –                                              | 1.5                                 | 1.56                                                          |  |
| HCFC-253ec                              | CH <sub>3</sub> CHFCClF <sub>2</sub>                |                                           | –                                              | 1.13                                | 1.17                                                          |  |
| HCFC-253fa                              | CHClFCH <sub>2</sub> CHF <sub>2</sub>               |                                           | –                                              | 1.83                                | 1.9                                                           |  |
| HCFC-253fb                              | CH <sub>2</sub> ClCH <sub>2</sub> CF <sub>3</sub>   |                                           | –                                              | 1.05                                | 1.09                                                          |  |
| HCFC-253fc                              | CH <sub>2</sub> FCH <sub>2</sub> CClF <sub>2</sub>  |                                           | –                                              | 1.48                                | 1.54                                                          |  |
| HCFC-261aa                              | CH <sub>3</sub> CCl <sub>2</sub> CH <sub>2</sub> F  |                                           | –                                              | 1.06                                | 1.11                                                          |  |
| HCFC-261ba                              | CH <sub>3</sub> CClFCH <sub>2</sub> Cl              |                                           | –                                              | 2.19                                | 2.31                                                          |  |
| HCFC-261da                              | CH <sub>2</sub> ClCHClCH <sub>2</sub> F             |                                           | –                                              | 0.45                                | 0.462                                                         |  |
| HCFC-261db                              | CH <sub>3</sub> CHClCHClF                           |                                           | –                                              | 0.47                                | 0.478                                                         |  |
| HCFC-261ea                              | CH <sub>2</sub> ClCHFCH <sub>2</sub> Cl             |                                           | –                                              | 0.54                                | 0.554                                                         |  |
| HCFC-261eb                              | CH <sub>3</sub> CHFCHCl <sub>2</sub>                |                                           | –                                              | 0.31                                | 0.315                                                         |  |
| HCFC-261fa                              | CH <sub>2</sub> ClCH <sub>2</sub> CHClF             |                                           | –                                              | 0.57                                | 0.591                                                         |  |
| HCFC-261fb                              | CH <sub>2</sub> FCH <sub>2</sub> CHCl <sub>2</sub>  |                                           | –                                              | 0.33                                | 0.339                                                         |  |
| HCFC-261fc                              | CH <sub>3</sub> CH <sub>2</sub> CCl <sub>2</sub> F  |                                           | –                                              | 0.61                                | 0.638                                                         |  |
| HCFC-262ba                              | CH <sub>3</sub> CClFCH <sub>2</sub> F               |                                           | –                                              | 3.4                                 | 3.59                                                          |  |
| HCFC-262ca                              | CH <sub>3</sub> CF <sub>2</sub> CH <sub>2</sub> Cl  |                                           | –                                              | 3.2                                 | 3.33                                                          |  |
| HCFC-262da                              | CH <sub>2</sub> FCHClCH <sub>2</sub> F              |                                           | –                                              | 0.92                                | 0.956                                                         |  |
| HCFC-262db                              | CH <sub>3</sub> CHClCHF <sub>2</sub>                |                                           | –                                              | 0.64                                | 0.662                                                         |  |
| HCFC-262ea                              | CH <sub>2</sub> FCHFCH <sub>2</sub> Cl              |                                           | –                                              | 0.83                                | 0.856                                                         |  |
| HCFC-262eb                              | CH <sub>3</sub> CHFCHClF                            |                                           | –                                              | 0.66                                | 0.685                                                         |  |
| HCFC-262fa                              | CH <sub>2</sub> ClCH <sub>2</sub> CHF <sub>2</sub>  |                                           | –                                              | 0.80                                | 0.828                                                         |  |
| HCFC-262fb                              | CH <sub>2</sub> FCH <sub>2</sub> CHClF              |                                           | –                                              | 0.87                                | 0.902                                                         |  |
| HCFC-262fc                              | CH <sub>3</sub> CH <sub>2</sub> CF <sub>2</sub> Cl  |                                           | –                                              | 1.2                                 | 1.24                                                          |  |
| HCFC-271ba                              | CH <sub>3</sub> CClFCH <sub>3</sub>                 |                                           | –                                              | 5.0                                 | 5.37                                                          |  |
| HCFC-271da                              | CH <sub>3</sub> CHClCH <sub>2</sub> F               |                                           | –                                              | 0.27                                | 0.278                                                         |  |
| HCFC-271ea                              | CH <sub>3</sub> CHFCH <sub>2</sub> Cl               |                                           | –                                              | 0.30                                | 0.302                                                         |  |
| HCFC-271fa                              | CH <sub>2</sub> ClCH <sub>2</sub> CH <sub>2</sub> F |                                           | –                                              | 0.34                                | 0.345                                                         |  |
| HCFC-271fb                              | CH <sub>3</sub> CH <sub>2</sub> CHClF               |                                           | –                                              | 0.49                                | 0.506                                                         |  |
| Hydrofluorocarbons                      |                                                     |                                           |                                                |                                     |                                                               |  |
| HFC-23                                  | CHF <sub>3</sub>                                    | 28.9 ppt                                  | 228                                            | 228                                 | 243                                                           |  |
| HFC-32                                  | CH <sub>2</sub> F <sub>2</sub>                      | 10 ppt                                    | 5.4                                            | 5.4                                 | 5.5                                                           |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |    |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |    |
|  | 79                                                | 0.018            | 0.135                                                                          | 960                       | 265           | 485                       | 52           | 37            |                             | L14                         | O10 | R7 |
|  | 71                                                | 0.017            | 0.183                                                                          | 1,080                     | 295           | 490                       | 56           | 41            |                             | L14                         | O10 | R7 |
|  | 44                                                | 0.012            | 0.118                                                                          | 335                       | 91            | 118                       | 16           | 13            |                             | L14                         | O10 | R7 |
|  | 30                                                | 0.009            | 0.120                                                                          | 208                       | 56            | 68                        | 10           | 8             |                             | L14                         | O10 | R7 |
|  | 39                                                | 0.011            | 0.113                                                                          | 275                       | 75            | 95                        | 13           | 10            |                             | L14                         | O10 | R7 |
|  | 40                                                | 0.011            | 0.125                                                                          | 320                       | 86            | 110                       | 15           | 12            |                             | L14                         | O10 | R7 |
|  | 33                                                | 0.009            | 0.183                                                                          | 350                       | 95            | 116                       | 16           | 13            |                             | L14                         | O10 | R7 |
|  | 46                                                | 0.012            | 0.175                                                                          | 545                       | 147           | 196                       | 26           | 20            |                             | L14                         | O10 | R7 |
|  | 31                                                | 0.009            | 0.121                                                                          | 215                       | 58            | 70                        | 10           | 8             |                             | L14                         | O10 | R7 |
|  | 40                                                | 0.011            | 0.194                                                                          | 490                       | 132           | 168                       | 23           | 18            |                             | L14                         | O10 | R7 |
|  | 23                                                | 0.020            | 0.0727                                                                         | 132                       | 36            | 43                        | 6            | 5             |                             | L14                         | O10 | R7 |
|  | 44                                                | 0.031            | 0.0827                                                                         | 310                       | 84            | 118                       | 15           | 12            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.009            | 0.0338                                                                         | 26                        | 7             | 8                         | 1            | 1             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.009            | 0.0625                                                                         | 50                        | 14            | 15                        | 2            | 2             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.010            | 0.0493                                                                         | 45                        | 12            | 14                        | 2            | 2             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.006            | 0.0618                                                                         | 33                        | 9             | 10                        | 2            | 1             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.011            | 0.0746                                                                         | 73                        | 20            | 23                        | 3            | 3             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.006            | 0.0557                                                                         | 32                        | 9             | 10                        | 1            | 1             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.012            | 0.137                                                                          | 145                       | 39            | 45                        | 7            | 5             |                             | L14                         | O10 | R7 |
|  | 69                                                | 0.020            | 0.125                                                                          | 835                       | 227           | 380                       | 43           | 32            |                             | L14                         | O10 | R7 |
|  | 66                                                | 0.019            | 0.117                                                                          | 730                       | 197           | 320                       | 37           | 27            |                             | L14                         | O10 | R7 |
|  | 28                                                | 0.009            | 0.0587                                                                         | 107                       | 29            | 34                        | 5            | 4             |                             | L14                         | O10 | R7 |
|  | 21                                                | 0.007            | 0.0813                                                                         | 103                       | 28            | 32                        | 5            | 4             |                             | L14                         | O10 | R7 |
|  | 25                                                | 0.009            | 0.0657                                                                         | 107                       | 29            | 34                        | 5            | 4             |                             | L14                         | O10 | R7 |
|  | 21                                                | 0.007            | 0.0982                                                                         | 128                       | 35            | 40                        | 6            | 5             |                             | L14                         | O10 | R7 |
|  | 25                                                | 0.008            | 0.0858                                                                         | 135                       | 37            | 43                        | 6            | 5             |                             | L14                         | O10 | R7 |
|  | 26                                                | 0.009            | 0.0991                                                                         | 170                       | 46            | 54                        | 8            | 6             |                             | L14                         | O10 | R7 |
|  | 34                                                | 0.011            | 0.168                                                                          | 395                       | 107           | 131                       | 18           | 15            |                             | L14                         | O10 | R7 |
|  | 83                                                | 0.028            | 0.106                                                                          | 1,225                     | 340           | 675                       | 72           | 47            |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.004            | 0.0261                                                                         | 17                        | 5             | 5                         | 1            | 1             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.004            | 0.0330                                                                         | 23                        | 6             | 7                         | 1            | 1             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.004            | 0.0284                                                                         | 22                        | 6             | 7                         | 1            | 1             |                             | L14                         | O10 | R7 |
|  | 20                                                | 0.007            | 0.0652                                                                         | 75                        | 20            | 23                        | 3            | 3             |                             | L14                         | O10 | R7 |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |    |
|  | 4420                                              | 0                | 0.18                                                                           | 11,085                    | 12,690        | 11,825                    | 13,340       | 13,150        | A6                          | L3                          |     | R3 |
|  | 124                                               | 0                | 0.11                                                                           | 2,530                     | 705           | 1,440                     | 154          | 98            | A6                          | L3                          |     | R3 |

| Industrial Designation or Chemical Name | Chemical Formula                                                                                                  | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                         |                                                                                                                   |                                           |                                                |                                     |                                                               |  |
| HFC-41                                  | CH <sub>3</sub> F                                                                                                 |                                           | 2.8                                            | 2.8                                 | 2.9                                                           |  |
| HFC-125                                 | CHF <sub>2</sub> CF <sub>3</sub>                                                                                  | 20.4 ppt                                  | 31                                             | 30                                  | 32                                                            |  |
| HFC-134                                 | CHF <sub>2</sub> CHF <sub>2</sub>                                                                                 |                                           | 9.7                                            | 10                                  | 10.5                                                          |  |
| HFC-134a                                | CH <sub>2</sub> FCF <sub>3</sub>                                                                                  | 90 ppt                                    | 14                                             | 14                                  | 14.1                                                          |  |
| HFC-143                                 | CH <sub>2</sub> FCHF <sub>2</sub>                                                                                 |                                           | 3.5                                            | 3.6                                 | 3.70                                                          |  |
| HFC-143a                                | CH <sub>3</sub> CF <sub>3</sub>                                                                                   | 19.1 ppt                                  | 51                                             | 51                                  | 57                                                            |  |
| HFC-152                                 | CH <sub>2</sub> FCH <sub>2</sub> F                                                                                |                                           | 146 days (114-335 days)                        | 172 days (114-335 days)             | 172 days (114-335 days)                                       |  |
| HFC-152a                                | CH <sub>3</sub> CHF <sub>2</sub>                                                                                  | 6.7 ppt                                   | 1.6                                            | 1.6                                 | 1.55                                                          |  |
| HFC-161                                 | CH <sub>3</sub> CH <sub>2</sub> F                                                                                 |                                           | 66 days (51-154 days)                          | 80 days (51-154 days)               | 80 days (51-154 days)                                         |  |
| HFC-227ca                               | CF <sub>3</sub> CF <sub>2</sub> CHF <sub>2</sub>                                                                  |                                           | 28.2                                           | 30                                  | 32                                                            |  |
| HFC-227ea                               | CF <sub>3</sub> CHFCF <sub>3</sub>                                                                                | 1.2 ppt                                   | 36                                             | 36                                  | 37.5                                                          |  |
| HFC-236cb                               | CH <sub>2</sub> FCF <sub>2</sub> CF <sub>3</sub>                                                                  |                                           | ~13                                            | 13.4                                | 14                                                            |  |
| HFC-236ea                               | CHF <sub>2</sub> CHFCF <sub>3</sub>                                                                               |                                           | 11.0                                           | 11.4                                | 11.9                                                          |  |
| HFC-236fa                               | CF <sub>3</sub> CH <sub>2</sub> CF <sub>3</sub>                                                                   | 0.15 ppt                                  | 222                                            | 213                                 | 253                                                           |  |
| HFC-245ca                               | CH <sub>2</sub> FCF <sub>2</sub> CHF <sub>2</sub>                                                                 |                                           | 6.5                                            | 6.6                                 | 6.9                                                           |  |
| HFC-245cb                               | CF <sub>3</sub> CF <sub>2</sub> CH <sub>3</sub>                                                                   |                                           | 47.1                                           | 39.9                                | 43                                                            |  |
| HFC-245ea                               | CHF <sub>2</sub> CHFCHF <sub>2</sub>                                                                              |                                           | 3.2                                            | 3.2                                 | 3.3                                                           |  |
| HFC-245eb                               | CH <sub>2</sub> FCHFCF <sub>3</sub>                                                                               |                                           | 3.2                                            | 3.2                                 | 3.3                                                           |  |
| HFC-245fa                               | CHF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>                                                                  | 2.4 ppt                                   | 7.9                                            | 7.9                                 | 8.2                                                           |  |
| HFC-263fb                               | CH <sub>3</sub> CH <sub>2</sub> CF <sub>3</sub>                                                                   |                                           | 1.1                                            | 1.1                                 | 1.16                                                          |  |
| HFC-272ca                               | CH <sub>3</sub> CF <sub>2</sub> CH <sub>3</sub>                                                                   |                                           | 2.6                                            | 9                                   | 9.7                                                           |  |
| HFC-281ea                               | CH <sub>3</sub> CHFCH <sub>3</sub>                                                                                |                                           | 23 days (19-46 days)                           | 27 days (19-46 days)                | 27 days (19-46 days)                                          |  |
| HFC-329p                                | CHF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>                                                  |                                           | ~30                                            | 32                                  | 34                                                            |  |
| HFC-338pcc                              | CHF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CHF <sub>2</sub>                                                 |                                           | 12.9                                           | 13.5                                | 14.0                                                          |  |
| HFC-356mcf                              | CH <sub>2</sub> FCH <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>                                                  |                                           | 1.2                                            | 1.2                                 | 1.26                                                          |  |
| HFC-356mff                              | CF <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>                                                   |                                           | 8.3                                            | 8.5                                 | 8.9                                                           |  |
| HFC-365mfc                              | CH <sub>3</sub> CF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>                                                   | 0.94 ppt                                  | 8.7                                            | 8.9                                 | 9.3                                                           |  |
| HFC-43-10mee                            | CF <sub>3</sub> CHFCF <sub>2</sub> CF <sub>3</sub>                                                                | 0.27 ppt                                  | 16.1                                           | 17.0                                | 17.9                                                          |  |
| HFC-458mfcf                             | CF <sub>3</sub> CH <sub>2</sub> CF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>                                   |                                           | 22.9                                           | 23.8                                | 25.5                                                          |  |
| HFC-55-10mcff                           | CF <sub>3</sub> CF <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>                   |                                           | 7.5                                            | 7.7                                 | 8.0                                                           |  |
| HFC-52-13p                              | CHF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>                                  |                                           | 32.7                                           | 35.2                                | 37.0                                                          |  |
| HFC-72-17p                              | CHF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> -CF <sub>2</sub> CF <sub>3</sub> |                                           | –                                              | 23.8                                | 24.9                                                          |  |
| <b>Unsaturated Hydrofluorocarbons</b>   |                                                                                                                   |                                           |                                                |                                     |                                                               |  |
| HFO-1123                                | CHF=CF <sub>2</sub>                                                                                               |                                           | –                                              | 1.4 days                            | 1.4 days                                                      |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |  |     |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|--|-----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |  |     |
|  | 65                                                | 0                | 0.02                                                                           | 430                       | 116           | 177                       | 21           | 16            |                             | L:12,13                     |  | R3  |
|  | 595                                               | 0                | 0.23                                                                           | 6,280                     | 3,450         | 6,040                     | 3,350        | 1180          | A6                          | L:3,13                      |  | R3  |
|  | 240                                               | 0                | 0.19                                                                           | 3,625                     | 1,135         | 2,725                     | 440          | 164           |                             |                             |  | R3  |
|  | 267                                               | 0                | 0.16                                                                           | 3,810                     | 1,360         | 3,170                     | 770          | 215           | A6                          | L:3,13                      |  | R3  |
|  | 100                                               | 0                | 0.13                                                                           | 1,250                     | 340           | 580                       | 64           | 48            |                             |                             |  | R3  |
|  | 612                                               | 0                | 0.16                                                                           | 7,050                     | 5,080         | 7,110                     | 5,390        | 2,830         | A6                          | L3                          |  | R3  |
|  | –                                                 | 0                | 0.04                                                                           | 64                        | 17            | 20                        | 3.0          | 2.4           |                             |                             |  | R3  |
|  | 39                                                | 0                | 0.10                                                                           | 545                       | 148           | 190                       | 26           | 21            | A6                          | L:3,13                      |  | R3  |
|  | –                                                 | 0                | 0.02                                                                           | 20                        | 6             | 6                         | <1           | <1            |                             |                             |  | R3  |
|  | 640                                               | 0                | 0.27                                                                           | 5,260                     | 2,865         | 5,070                     | 2,795        | 975           |                             | L16                         |  | R3  |
|  | 673                                               | 0                | 0.26                                                                           | 5,250                     | 3,140         | 5,140                     | 3,180        | 1,260         | A6                          | L:3,17                      |  | R3  |
|  | 305                                               | 0                | 0.23                                                                           | 3,540                     | 1,235         | 2,915                     | 670          | 192           |                             |                             |  | R3  |
|  | 270                                               | 0                | 0.30                                                                           | 4,190                     | 1,370         | 3,290                     | 620          | 202           |                             |                             |  | R3  |
|  | 1350                                              | 0                | 0.24                                                                           | 6,785                     | 7,680         | 7,230                     | 8,090        | 7,870         |                             |                             |  | R3  |
|  | 165                                               | 0                | 0.24                                                                           | 2,530                     | 720           | 1,600                     | 180          | 102           |                             |                             |  | R3  |
|  | 550                                               | 0                | 0.24                                                                           | 6,340                     | 4,000         | 6,280                     | 4,150        | 1,800         |                             |                             |  | R3  |
|  | 95                                                | 0                | 0.16                                                                           | 860                       | 233           | 375                       | 44           | 32            |                             |                             |  | R3  |
|  | 90                                                | 0                | 0.20                                                                           | 1,070                     | 290           | 460                       | 54           | 40            |                             |                             |  | R3  |
|  | 149                                               | 0                | 0.24                                                                           | 2,980                     | 880           | 2,040                     | 260          | 124           | A6                          | L3                          |  | R3  |
|  | 40                                                | 0                | 0.10                                                                           | 250                       | 68            | 83                        | 12           | 9.5           |                             |                             |  | R3  |
|  | 185                                               | 0                | 0.07                                                                           | 1,580                     | 480           | 1,140                     | 163          | 69            |                             | L18                         |  | R3  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             | A6                          |                             |  | R9  |
|  | 675                                               | 0                | 0.31                                                                           | 4,720                     | 2,630         | 4,565                     | 2,595        | 935           |                             | L19                         |  | R3  |
|  | 360                                               | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |  | R9  |
|  | 40                                                | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |  | R9  |
|  | 190                                               | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |  | R9  |
|  | 190                                               | 0                | 0.22                                                                           | 2,660                     | 810           | 1,915                     | 271          | 115           | A6                          |                             |  | R3  |
|  | 365                                               | 0                | 0.359                                                                          | 3,770                     | 1,470         | 3,295                     | 1,015        | 265           | A6                          |                             |  | R10 |
|  | 375                                               | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |  | R9  |
|  | 175                                               | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |  | R9  |
|  | 710                                               | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L20                         |  | R9  |
|  | 525                                               | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L21                         |  | R9  |
|  | –                                                 | 0                | 0.0019                                                                         | <1                        | <<1           | <<1                       | <<1          | <<1           |                             | L22                         |  | R11 |

| Industrial Designation or Chemical Name                                    | Chemical Formula                                                   | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|----------------------------------------------------------------------------|--------------------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                                                            |                                                                    |                                           |                                                |                                     |                                                               |  |
| HFO-1132a                                                                  | CH <sub>2</sub> =CF <sub>2</sub>                                   |                                           | 4.0 days (3–5.7 days)                          | 4.6 days (3–5.7 days)               | 4.6 days (3–5.7 days)                                         |  |
| HFO-1141                                                                   | CH <sub>2</sub> =CHF                                               |                                           | 2.1 days (1.4–3.1 days)                        | 2.5 days (1.4–3.1 days)             | 2.5 days (1.4–3.1 days)                                       |  |
| HFO-1234ye(E)                                                              | (E)-CHF=CFCHF <sub>2</sub>                                         |                                           | <5 days                                        | <5 days                             | <5 days                                                       |  |
| HFO-1234ye(Z)                                                              | (Z)-CHF=CFCHF <sub>2</sub>                                         |                                           | <5 days                                        | <5 days                             | <5 days                                                       |  |
| HFO-1225ye(E)                                                              | (E)-CF <sub>3</sub> CF=CHF                                         |                                           | 4.9 days (3.7–6.9 days)                        | 5.7 days (3.7–6.9 days)             | 5.7 days (3.7–6.9 days)                                       |  |
| HFO-1225ye(Z)                                                              | (Z)-CF <sub>3</sub> CF=CHF                                         |                                           | 8.5 days (6.2–12 days)                         | 10 days (6.2–12 days)               | 10 days (6.2–12 days)                                         |  |
| 2,3,3,4,4-pentafluorocyclobut-1-ene                                        | c-CH=CFCF <sub>2</sub> CF <sub>2</sub> -                           |                                           | –                                              | 270 days                            | 270 days                                                      |  |
| HFO-1234ze(E)                                                              | (E)-CF <sub>3</sub> CH=CHF                                         |                                           | 16.4 days (12.8–24 days)                       | 19 days (12.8–24 days)              | 19 days (12.8–24 days)                                        |  |
| HFO-1234ze(Z)                                                              | (Z)-CF <sub>3</sub> CH=CHF                                         |                                           | 10.0 days                                      | 10.0 days                           | 10.0 days                                                     |  |
| 3,3,4,4-tetrafluorocyclobut-1-ene                                          | c-CH=CHCF <sub>2</sub> CF <sub>2</sub> -                           |                                           | –                                              | 84 days                             | 84 days                                                       |  |
| HFO-1234yf                                                                 | CF <sub>3</sub> CF=CH <sub>2</sub>                                 |                                           | 10.5 days (8.4–16 days)                        | 12 days (8.4–16 days)               | 12 days (8.4–16 days)                                         |  |
| HFO-1261zf                                                                 | CH <sub>2</sub> FCH=CH <sub>2</sub>                                |                                           | 0.7 days (0.5–1.0 days)                        | 0.8 days (0.5–1.0 days)             | 0.8 days (0.5–1.0 days)                                       |  |
| HFO-1234yc                                                                 | CF <sub>2</sub> =CFCH <sub>2</sub> F                               |                                           | ~2 days                                        | ~2 days                             | ~2 days                                                       |  |
| HFO-1225zc                                                                 | CF <sub>2</sub> =CHCF <sub>3</sub>                                 |                                           | ~2 days                                        | ~2 days                             | ~2 days                                                       |  |
| HFO-1234zc                                                                 | CF <sub>2</sub> =CHCHF <sub>2</sub>                                |                                           | <5 days                                        | <5 days                             | <5 days                                                       |  |
| HFO-1336mzz(E)                                                             | (E)-CF <sub>3</sub> CH=CHCF <sub>3</sub>                           |                                           | – (~16–30 days)                                | 122 days                            | 122 days                                                      |  |
| HFO-1336mzz(Z)                                                             | (Z)-CF <sub>3</sub> CH=CHCF <sub>3</sub>                           |                                           | 22 days (16.3–32 days)                         | 27 days (16.3–32 days)              | 27 days (16.3–32 days)                                        |  |
| HFO-1243zf                                                                 | CF <sub>3</sub> CH=CH <sub>2</sub>                                 |                                           | 7.0 days (5.5–11 days)                         | 9 days (5.5–11 days)                | 9 days (5.5–11 days)                                          |  |
| HFO-1345zf                                                                 | C <sub>2</sub> F <sub>5</sub> CH=CH <sub>2</sub>                   |                                           | 7.6 days (5.8–11.4 days)                       | 9 days (5.8–11.4 days)              | 9 days (5.8–11.4 days)                                        |  |
| HFO-1438mzz(E)                                                             | (E)-CF <sub>3</sub> CH=CHCF <sub>2</sub> CF <sub>3</sub>           |                                           | – (16–30 days)                                 | 122 days                            | 122 days                                                      |  |
| HFO-1447zf                                                                 | CH <sub>2</sub> =CHCF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub> |                                           | – (6–10 days)                                  | 9 days (6–10 days)                  | 9 days (6–10 days)                                            |  |
| 3,3,4,4,5,5,6,6,6-Nonafluorohex-1-ene                                      | C <sub>4</sub> F <sub>9</sub> CH=CH <sub>2</sub>                   |                                           | 7.6 days                                       | 9 days                              | 9 days                                                        |  |
| 3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooct-1-ene<br>HFO-174-13fz           | C <sub>6</sub> F <sub>13</sub> CH=CH <sub>2</sub>                  |                                           | 7.6 days                                       | 9 days                              | 9 days                                                        |  |
| 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10-Heptadecafluorodec-1-ene<br>HFO-194-17fz | C <sub>8</sub> F <sub>17</sub> CH=CH <sub>2</sub>                  |                                           | 7.6 days                                       | 9 days                              | 9 days                                                        |  |
| HFO-1438ezy(E)                                                             | (E)-(CF <sub>3</sub> ) <sub>2</sub> CFCH=CHF                       |                                           | –                                              | 43 days                             | 43 days                                                       |  |
| <b>Chlorocarbons and Hydrochlorocarbons</b>                                |                                                                    |                                           |                                                |                                     |                                                               |  |
| Methyl chloroform                                                          | CH <sub>3</sub> CCl <sub>3</sub>                                   | 2.6 ppt                                   | 5.0                                            | 5.0                                 | 6.1                                                           |  |
| Carbon tetrachloride                                                       | CCl <sub>4</sub>                                                   | 80.5 ppt                                  | 26.0                                           | 32                                  | –                                                             |  |
| Methyl chloride                                                            | CH <sub>3</sub> Cl                                                 | 555 ppt                                   | 0.9                                            | 0.9                                 | 1.57                                                          |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |    |     |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|----|-----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |    |     |
|  | –                                                 | 0                | 0.004                                                                          | <1                        | <1            | <1                        | <1           | <1            |                             |                             |    | R3  |
|  | –                                                 | 0                | 0.002                                                                          | <1                        | <1            | <1                        | <1           | <1            |                             |                             |    | R3  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L23                         |    | R9  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L23                         |    | R9  |
|  | –                                                 | 0                | 0.01                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             |                             |    | R3  |
|  | –                                                 | 0                | 0.02                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             |                             |    | R3  |
|  | –                                                 | 0                | 0.20                                                                           | 236                       | 64            | 74                        | 11           | 8.8           |                             | L24                         |    | R12 |
|  | –                                                 | 0                | 0.04                                                                           | 4                         | <1            | <1                        | <1           | <1            |                             |                             |    | R3  |
|  | –                                                 | 0                | 0.02                                                                           | 1                         | <1            | <1                        | <1           | <1            |                             | L21                         |    | R3  |
|  | –                                                 | 0                | 0.10                                                                           | 40.6                      | 11            | 12                        | 1.8          | 1.5           |                             | L24                         |    | R12 |
|  | –                                                 | 0                | 0.02                                                                           | 1                         | <1            | <1                        | <1           | <1            | A7                          |                             |    | R3  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |    | R9  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L23                         |    | R9  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L23                         |    | R9  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L23                         |    | R9  |
|  | –                                                 | 0                | 0.13                                                                           | 60                        | 16            | 18                        | 2.7          | 2.2           |                             | L25                         |    | R13 |
|  | –                                                 | 0                | 0.07                                                                           | 6                         | 2             | 2                         | <1           | <1            |                             |                             |    | R3  |
|  | –                                                 | 0                | 0.01                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             |                             |    | R3  |
|  | –                                                 | 0                | 0.01                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             |                             |    | R3  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L26                         |    | R9  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |    | R9  |
|  | –                                                 | 0                | 0.03                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             | L27                         |    | R3  |
|  | –                                                 | 0                | 0.03                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             | L27                         |    | R3  |
|  | –                                                 | 0                | 0.03                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             | L27                         |    | R3  |
|  | –                                                 | 0                | 0.34                                                                           | 42                        | 11            | 12                        | 1.9          | 1.6           |                             | L28                         |    | R14 |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |    |     |
|  | 38                                                | 0.14–0.17        | 0.07                                                                           | 555                       | 153           | 300                       | 32           | 21            | A8                          | L:3,13                      | O3 | R3  |
|  | 44                                                | 0.89             | 0.174                                                                          | 3,790                     | 2,110         | 3,670                     | 2,080        | 750           | A8                          | L:13,29                     | O3 | R15 |
|  | 30.4                                              | 0.015            | 0.004                                                                          | 16                        | 4.3           | 5.1                       | <1           | <1            | A8                          | L:3,13,30                   | O3 | R15 |

| Industrial Designation or Chemical Name                      | Chemical Formula                                     | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|--------------------------------------------------------------|------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                                              |                                                      |                                           |                                                |                                     |                                                               |  |
| Methylene chloride                                           | CH <sub>2</sub> Cl <sub>2</sub>                      | 34 ppt                                    | 144 days (95–1070 days)                        | 180 days (95–1070 days)             | 180 days (95–1070 days)                                       |  |
| Chloroform                                                   | CHCl <sub>3</sub>                                    | 8.9 ppt                                   | 149 days (97–1145 days)                        | 183 days (97–1145 days)             | 183 days (97–1145 days)                                       |  |
| 1,2-Dichloroethane                                           | CH <sub>2</sub> ClCH <sub>2</sub> Cl                 | 12.8 ppt (10.4–18.3)                      | 65.0 days (41–555 days)                        | 82 days (41–555 days)               | 82 days (41–555 days)                                         |  |
| Chloroethane                                                 | CH <sub>3</sub> CH <sub>2</sub> Cl                   |                                           | 39 days (26–280 days)                          | 48 days (26–280 days)               | 48 days (26–280 days)                                         |  |
| 1-Chloropropane                                              | CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> Cl   |                                           | 14 days (10–80 days)                           | 16 days (10–80 days)                | 16 days (10–80 days)                                          |  |
| 2-Chloropropane                                              | CH <sub>3</sub> CHClCH <sub>3</sub>                  |                                           | 18 days (13–95 days)                           | 22 days (13–95 days)                | 22 days (13–95 days)                                          |  |
| Unsaturated Hydrochlorocarbons and Chlorocarbon              |                                                      |                                           |                                                |                                     |                                                               |  |
| Chloroethene (vinyl chloride)                                | CH <sub>2</sub> =CHCl                                |                                           | 1.5 days (0.9–2.2 days)                        | 1.7 days (0.9–2.2 days)             | 1.7 days (0.9–2.2 days)                                       |  |
| 1,2-dichloroethene                                           | CH <sub>2</sub> =CCl <sub>2</sub>                    |                                           | 0.9 days (0.5–1.3 days)                        | 1 days (0.5–1.3 days)               | 1 days (0.5–1.3 days)                                         |  |
| (E)-1,2-dichloroethene                                       | (E)-CClH=CClH                                        |                                           | – (3.2–6.7 days)                               | 5.5 days (3.2–6.7 days)             | 5.5 days (3.2–6.7 days)                                       |  |
| (Z)-1,2-dichloroethene                                       | (Z)-CClH=CClH                                        |                                           | – (3.2–6.7 days)                               | 5.2 days (3.2–6.7 days)             | 5.2 days (3.2–6.7 days)                                       |  |
| Trichloroethene                                              | CHCl=CCl <sub>2</sub>                                | 0.3 ppt                                   | 4.9 days (3.3–7.1 days)                        | 5.6 days (3.3–7.1 days)             | 5.6 days (3.3–7.1 days)                                       |  |
| Perchloroethene                                              | CCl <sub>2</sub> =CCl <sub>2</sub>                   | 1.5 ppt                                   | 90 days (66–245 days)                          | 110 days (66–245 days)              | 110 days (66–245 days)                                        |  |
| Unsaturated Chlorofluorocarbons and Hydrochlorofluorocarbons |                                                      |                                           |                                                |                                     |                                                               |  |
| CFO-1113<br>Chlorotrifluoroethene                            | CF <sub>2</sub> =CFCl                                |                                           | 1.4 days (0.8–2.1 days)                        | 1.5 days (0.8–2.1 days)             | 1.5 days (0.8–2.1 days)                                       |  |
| HCFO-1233zd(E)                                               | (E)-CF <sub>3</sub> CH=CHCl                          |                                           | 26 days (21–39 days)                           | 42.5 days (34–64 days)              | 42.5 days (34–64 days)                                        |  |
| HCFO-1233zd(Z)                                               | (Z)-CF <sub>3</sub> CH=CHCl                          |                                           | – (20–40) days                                 | 13 days                             | 13 days                                                       |  |
| HCFO-1233xf<br>(2-chloro-3,3,3-fluoro-1-propene)             | CF <sub>3</sub> CCl=CH <sub>2</sub>                  |                                           | – (20–40) days                                 | 42.5 days (34–64 days)              | 42.5 days (34–64 days)                                        |  |
| CFO-1215yc<br>(3-chloro-1,1,2,3,3-fluoro-1-propene)          | CF <sub>2</sub> =CFCF <sub>2</sub> Cl                |                                           | ~5 days (3–7 days)                             | ~5 days (3–7 days)                  | ~5 days (3–7 days)                                            |  |
| CFO-1316yff<br>(4,4-dichloro-1,1,2,3,3,4-fluoro-1-butene)    | CF <sub>2</sub> =CFCF <sub>2</sub> CFCl <sub>2</sub> |                                           | ~5 days (3–7 days)                             | ~5 days (3–7 days)                  | ~5 days (3–7 days)                                            |  |
| Bromocarbons, Hydrobromocarbons and Halons                   |                                                      |                                           |                                                |                                     |                                                               |  |
| Methyl bromide                                               | CH <sub>3</sub> Br                                   | 6.8 ppt                                   | 0.8                                            | 0.8                                 | 1.8                                                           |  |
| Methylene bromide                                            | CH <sub>2</sub> Br <sub>2</sub>                      | 0.9 ppt (0.6–1.7)                         | 123 days (80–890 days)                         | 150 days (80–890 days)              | 150 days (80–890 days)                                        |  |
| Bromoform                                                    | CHBr <sub>3</sub>                                    | 1.2 ppt (0.4–4.0)                         | 24 days (15–88 days)                           | 16 days (8–23 days)                 | 57 days (15–88 days)                                          |  |
| Halon-1201                                                   | CHBrF <sub>2</sub>                                   |                                           | 5.2                                            | 4.9                                 | 5.7                                                           |  |
| Halon-1202                                                   | CBr <sub>2</sub> F <sub>2</sub>                      | 0.01 ppt                                  | 2.9                                            | 2.5                                 | –                                                             |  |
| Halon-1211                                                   | CBrClF <sub>2</sub>                                  | 3.6 ppt                                   | 16.0                                           | 16                                  | –                                                             |  |
| Halon-1301                                                   | CBrF <sub>3</sub>                                    | 3.3 ppt                                   | 65.0                                           | 72                                  | –                                                             |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |     |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|-----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |     |
|  | –                                                 | –                | 0.028                                                                          | 37                        | 10            | 11                        | 1.7          | 1.4           | A8                          |                             |     | R15 |
|  | –                                                 | –                | 0.07                                                                           | 66                        | 18            | 20                        | 3.0          | 2.2           | A8                          |                             |     | R15 |
|  | –                                                 | –                | 0.01                                                                           | 5.1                       | 1.4           | 1.5                       | <1           | <1            | A8                          |                             |     | R3  |
|  | –                                                 | –                | 0.004                                                                          | 1.8                       | <1            | <1                        | <1           | <1            |                             |                             |     | R2  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |     | R9  |
|  | –                                                 | –                | 0.005                                                                          | 0.9                       | <1            | <1                        | <1           | <1            |                             |                             |     | R2  |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |     |
|  | –                                                 | –                | 8.8e-4                                                                         | <1                        | <<1           | <<1                       | <<1          | <<1           |                             |                             |     | R2  |
|  | –                                                 | –                | 1.17e-3                                                                        | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             |                             |     | R2  |
|  | –                                                 | <0.0003          | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             | O12 | R9  |
|  | –                                                 | <0.0003          | 2.95e-4                                                                        | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             |                             | O12 | R2  |
|  | –                                                 | <0.004           | 5.74e-3                                                                        | <1                        | <1            | <1                        | <<1          | <<1           | A9                          |                             | O12 | R2  |
|  | –                                                 | –                | 0.053                                                                          | 21.7                      | 5.9           | 6.5                       | 1.0          | 0.8           | A9                          |                             |     | R2  |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |     |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |     | R9  |
|  | –                                                 | <0.0004          | 0.067                                                                          | 13.5                      | 3.7           | 4.0                       | 0.6          | 0.5           |                             |                             | O12 | R16 |
|  | –                                                 | <0.0004          | 0.025                                                                          | 1.5                       | 0.4           | 0.45                      | 0.07         | 0.06          |                             |                             | O12 | R16 |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L31                         |     | R9  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L32                         |     | R9  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L32                         |     | R9  |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |     |
|  | 26.3                                              | 0.57             | 0.004                                                                          | 7.6                       | 2             | 2.4                       | <1           | <1            | A9                          | L:3,13                      | O3  | R3  |
|  | –                                                 | 3–4              | 0.01                                                                           | 5.3                       | 1.4           | 1.6                       | <1           | <1            | A9                          | L2                          | O12 | R3  |
|  | –                                                 | 1–5              | 0.003                                                                          | <1                        | <1            | <1                        | <<1          | <<1           | A9                          | L2                          | O12 | R9  |
|  | 35                                                |                  | 0.15                                                                           | 1,240                     | 340           | 675                       | 72           | 48            |                             | L33                         |     | R3  |
|  | 36                                                | 1.7              | 0.27                                                                           | 720                       | 196           | 285                       | 35           | 27            | A9                          | L:2,3                       | O3  | R3  |
|  | 41                                                | 6.9–7.7          | 0.29                                                                           | 4,590                     | 1,750         | 3,950                     | 1,130        | 300           | A9                          | L:2,3                       | O3  | R3  |
|  | 73.5                                              | 15.2–19.0        | 0.30                                                                           | 7,930                     | 6,670         | 8,160                     | 7,160        | 4,700         | A9                          | L:2,3                       | O3  | R3  |

| Industrial Designation or Chemical Name     | Chemical Formula                                      | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|---------------------------------------------|-------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                             |                                                       |                                           |                                                |                                     |                                                               |  |
| Bromochloromethane                          | CH <sub>2</sub> BrCl                                  | 0.10 ppt (0.07–0.12)                      | 137 days (89–1050 days)                        | 165 days (89–1050 days)             | 165 days (89–1050 days)                                       |  |
| Bromodichloromethane                        | CHBrCl <sub>2</sub>                                   | 0.3 ppt (0.1–0.9)                         | 78 days (38–250 days)                          | 66 days (38–250 days)               | 95 days (56–460 days)                                         |  |
| Dibromochloromethane                        | CHBr <sub>2</sub> Cl                                  | 0.3 ppt (0.1–0.8)                         | 59 days (28–225 days)                          | 59 days (28–225 days)               | 71 days (45–325 days)                                         |  |
| bromoethane                                 | CH <sub>3</sub> CH <sub>2</sub> Br                    |                                           | 41 days (28–260 days)                          | 50 days (30–260 days)               | 50 days (30–260 days)                                         |  |
| 1,2-dibromoethane                           | CH <sub>2</sub> BrCH <sub>2</sub> Br                  |                                           | 70 days (44–590 days)                          | 89 days (44–590 days)               | 89 days (44–590 days)                                         |  |
| n-bromopropane                              | CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> Br    |                                           | 12.8 days (9–65 days)                          | 15 days (9–65 days)                 | 15 days (9–65 days)                                           |  |
| Iso-bromopropane                            | CH <sub>3</sub> CHBrCH <sub>3</sub>                   |                                           | 16.7 days (12–88 days)                         | 20 days (12–88 days)                | 20 days (12–88 days)                                          |  |
| Halon-2301                                  | CH <sub>2</sub> BrCF <sub>3</sub>                     |                                           | 3.4                                            | 3.2                                 | 3.2                                                           |  |
| Halon-2311 / Halothane                      | CHBrClCF <sub>3</sub>                                 | 0.010 ppt                                 | 1.0                                            | 1.0                                 | 1.1                                                           |  |
| Halon-2401                                  | CHBrCF <sub>3</sub>                                   |                                           | 2.9                                            | 2.9                                 | 3.1                                                           |  |
| Halon-2402 isomer                           | CF <sub>3</sub> CFBr <sub>2</sub>                     |                                           | –                                              | 2.5                                 | –                                                             |  |
| Halon-2402                                  | CBrF <sub>2</sub> CFBrF <sub>2</sub>                  | 0.42 ppt                                  | 20.0                                           | 28                                  | –                                                             |  |
| <b>Unsaturated Bromofluorocarbons</b>       |                                                       |                                           |                                                |                                     |                                                               |  |
| Bromotrifluoroethene                        | CFBr=CF <sub>2</sub>                                  |                                           | 1.4 days (0.9–2.0 days)                        | 1.6 days (0.9–2.0 days)             | 1.6 days (0.9–2.0 days)                                       |  |
| 1-Bromo-2,2-fluoroethene                    | CHBr=CF <sub>2</sub>                                  |                                           | 2.3 days (1.5–3.4 days)                        | 2.7 days (1.5–3.4 days)             | 2.7 days (1.5–3.4 days)                                       |  |
| 2-Bromo-3,3,3-fluoro-1-propene              | CH <sub>2</sub> =CBrCF <sub>3</sub>                   |                                           | 2.7 days (1.8–3.9 days)                        | 3.2 days (1.8–3.9 days)             | 3.2 days (1.8–3.9 days)                                       |  |
| 2-bromo-3,3,4,4,4-fluoro-1-butene           | CH <sub>2</sub> =CBrCF <sub>2</sub> CF <sub>3</sub>   |                                           | 3.1 days (2.0–4.6 days)                        | 3.7 days (2.0–4.6 days)             | 3.7 days (2.0–4.6 days)                                       |  |
| 4-bromo-3,3,4,4-fluoro-1-butene             | CH <sub>2</sub> =CHCF <sub>2</sub> CF <sub>2</sub> Br |                                           | 6.5 days (4.7–9.5 days)                        | 7.5 days (4.7–9.5 days)             | 7.5 days (4.7–9.5 days)                                       |  |
| <b>Unsaturated Bromochlorofluorocarbons</b> |                                                       |                                           |                                                |                                     |                                                               |  |
| 4-bromo-3-chloro-3,4,4-trifluoro-1-butene   | CH <sub>2</sub> =CHCClCFBrF <sub>2</sub>              |                                           | –                                              | 4.5 days                            | 4.5 days                                                      |  |
| <b>Fully Fluorinated Species</b>            |                                                       |                                           |                                                |                                     |                                                               |  |
| Nitrogen trifluoride                        | NF <sub>3</sub>                                       | 1.5 ppt                                   | 500.0                                          | 569                                 | –                                                             |  |
| Perfluorotriethylamine                      | N(C <sub>2</sub> F <sub>5</sub> ) <sub>3</sub>        |                                           | –                                              | >1000                               | –                                                             |  |
| Perfluorotripropylamine                     | N(C <sub>3</sub> F <sub>7</sub> ) <sub>3</sub>        |                                           | –                                              | >1000                               | –                                                             |  |
| Perfluorotributylamine                      | N(C <sub>4</sub> F <sub>9</sub> ) <sub>3</sub>        |                                           | –                                              | >1000                               | –                                                             |  |
| Perfluorotripentylamine                     | N(C <sub>5</sub> F <sub>11</sub> ) <sub>3</sub>       |                                           | –                                              | >1000                               | –                                                             |  |
| Sulphur hexafluoride                        | SF <sub>6</sub>                                       | 8.9 ppt                                   | 3,200.0                                        | 3,200                               | –                                                             |  |
| (Trifluoromethyl)sulfur pentafluoride       | SF <sub>5</sub> CF <sub>3</sub>                       | 0.153 ppt                                 | 800.0                                          | 650–950                             | –                                                             |  |
| PFC-14 (Perfluoromethane)                   | CF <sub>4</sub>                                       | 82.7 ppt                                  | 50,000.0                                       | 50,000                              | –                                                             |  |
| PFC-116 (Perfluoroethane)                   | C <sub>2</sub> F <sub>6</sub>                         | 4.6 ppt                                   | 10,000.0                                       | 10,000                              | –                                                             |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |     |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|-----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |     |
|  | –                                                 | –                | 0.022                                                                          | 17                        | 4.7           | 5.2                       | 0.8          | 0.6           | A9                          |                             |     | R2  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             | A9                          | L2                          |     | R9  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             | A9                          | L2                          |     | R9  |
|  | –                                                 | <0.46            | 0.0060                                                                         | 1.7                       | 0.5           | 0.5                       | <1           | <1            |                             |                             | O12 | R2  |
|  | –                                                 | –                | 0.012                                                                          | 3.7                       | 1.0           | 1.1                       | 0.17         | 0.14          |                             |                             |     | R2  |
|  | –                                                 | <0.17            | 0.002                                                                          | 0.2                       | <1            | <1                        | <<1          | <<1           |                             |                             | O12 | R2  |
|  | –                                                 | –                | 0.004                                                                          | 0.4                       | 0.1           | 0.1                       | <1           | <1            |                             |                             |     | R2  |
|  | –                                                 | –                | 0.14                                                                           | 620                       | 167           | 270                       | 31           | 23            |                             |                             |     | R3  |
|  | 20                                                | ~1.6             | 0.13                                                                           | 151                       | 41            | 49                        | 7            | 6             | A9                          |                             | O13 | R3  |
|  | 45                                                | –                | 0.19                                                                           | 675                       | 184           | 285                       | 34           | 25            |                             | L33                         |     | R3  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L34                         |     | R9  |
|  | 41                                                | 15.7             | 0.31                                                                           | 3,920                     | 2,030         | 3,730                     | 1,900        | 615           | A9                          | L:3,13                      | O3  | R3  |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |     |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             | O14 | R9  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             | O14 | R9  |
|  | –                                                 | <0.05            | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             | O12 | R9  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             | O14 | R9  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             | O14 | R9  |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |     |
|  | –                                                 | –                | 0.0135                                                                         | <1                        | <1            | <1                        | <<1          | <<1           |                             | L35                         | O14 | R17 |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |     |
|  | 740                                               | 0                | 0.20                                                                           | 12,460                    | 15,750        | 13,420                    | 16,250       | 18,035        | A10                         | L:3,36                      |     | R3  |
|  | –                                                 | 0                | 0.68                                                                           | 8,150                     | 10,610        | 8,800                     | 10,880       | 12,500        |                             | L37                         |     | R18 |
|  | –                                                 | 0                | 0.82                                                                           | 7,055                     | 9,180         | 7,620                     | 9,410        | 10,815        |                             | L37                         |     | R18 |
|  | –                                                 | 0                | 0.97                                                                           | 6,470                     | 8,420         | 6,980                     | 8,630        | 9,910         | A10                         | L37                         |     | R18 |
|  | –                                                 | 0                | 1.07                                                                           | 5,780                     | 7,520         | 6,240                     | 7,710        | 8,860         |                             | L37                         |     | R18 |
|  | –                                                 | 0                | 0.57                                                                           | 17,500                    | 23,500        | 18,900                    | 23,800       | 28,200        | A10                         | L7                          |     | R3  |
|  | –                                                 | 0                | 0.59                                                                           | 13,500                    | 17,400        | 14,500                    | 17,800       | 20,200        | A10                         | L38                         |     | R3  |
|  | –                                                 | 0                | 0.09                                                                           | 4,880                     | 6,630         | 5,270                     | 6,690        | 8,040         | A10                         | L7                          |     | R3  |
|  | –                                                 | 0                | 0.25                                                                           | 8,210                     | 11,100        | 8,880                     | 11,200       | 13,500        | A10                         | L7                          |     | R3  |

| Industrial Designation or Chemical Name               | Chemical Formula                                                    | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-------------------------------------------------------|---------------------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                                       |                                                                     |                                           |                                                |                                     |                                                               |  |
| PFC-c216 (Perfluorocyclopropane)                      | c-C <sub>3</sub> F <sub>6</sub>                                     |                                           | 3,000.0                                        | 3,000                               | –                                                             |  |
| PFC-218 (Perfluoropropane)                            | C <sub>3</sub> F <sub>8</sub>                                       | 0.63 ppt                                  | 2,600.0                                        | 2,600                               | –                                                             |  |
| PFC-c316 (Perfluorocyclobutene)                       | c-C <sub>4</sub> F <sub>6</sub>                                     |                                           | –                                              | 1.2                                 | 1.2                                                           |  |
| PFC-c318 (Perfluorocyclobutane)                       | c-C <sub>4</sub> F <sub>8</sub>                                     | 1.44 ppt                                  | 3,200.0                                        | 3,200                               | –                                                             |  |
| PFC-31-10 (Perfluorobutane)                           | n-C <sub>4</sub> F <sub>10</sub>                                    |                                           | 2,600.0                                        | 2,600                               | –                                                             |  |
| PFC-c418 (Perfluorocyclopentene)                      | c-C <sub>5</sub> F <sub>8</sub>                                     |                                           | 31.0 days                                      | 1.1                                 | 1.1                                                           |  |
| PFC-41-12 (Perfluoropentane)                          | n-C <sub>5</sub> F <sub>12</sub>                                    | 0.148 ppt                                 | 4,100.0                                        | 4,100                               | –                                                             |  |
| PFC-51-14 (Perfluorohexane)                           | n-C <sub>6</sub> F <sub>14</sub>                                    |                                           | 3,100.0                                        | 3,100                               | –                                                             |  |
| PFC-61-16 (Perfluoroheptane)                          | n-C <sub>7</sub> F <sub>16</sub>                                    |                                           | 3,000.0                                        | 3,000                               | –                                                             |  |
| PFC-71-18 (Perfluorooctane)                           | n-C <sub>8</sub> F <sub>18</sub>                                    |                                           | 3,000.0                                        | 3,000                               | –                                                             |  |
| PFC-91-18 (isomer mixture)                            | C <sub>10</sub> F <sub>18</sub>                                     |                                           | 2,000.0                                        | 2,000                               | –                                                             |  |
| PFC-c91-18(Z) (Perfluorodecalin(Z))                   | (Z)-C <sub>10</sub> F <sub>18</sub>                                 |                                           | 2,000.0                                        | 2,000                               | –                                                             |  |
| PFC-c91-18(E) (Perfluorodecalin(E))                   | (E)-C <sub>10</sub> F <sub>18</sub>                                 |                                           | 2,000.0                                        | 2,000                               | –                                                             |  |
| PFC-1114                                              | CF <sub>2</sub> =CF <sub>2</sub>                                    |                                           | 1.1 days<br>(0.7–1.6 days)                     | 1.2 days<br>(0.7–1.6 days)          | 1.2 days<br>(0.7–1.6 days)                                    |  |
| PFC-1216                                              | CF <sub>3</sub> CF=CF <sub>2</sub>                                  |                                           | 4.9 days<br>(3.3–7.1 days)                     | 5.5 days<br>(3.3–7.1 days)          | 5.5 days<br>(3.3–7.1 days)                                    |  |
| Perfluorobuta-1,3-diene                               | CF <sub>2</sub> =CFCF=CF <sub>2</sub>                               |                                           | 1.1 days                                       | 1.1 days                            | 1.1 days                                                      |  |
| Perfluorobut-1-ene                                    | CF <sub>3</sub> CF <sub>2</sub> CF=CF <sub>2</sub>                  |                                           | 6.0 days                                       | 6 days                              | 6 days                                                        |  |
| Perfluorobut-2-ene (71% (E) and 29% (Z) isomer blend) | CF <sub>3</sub> CF=CFCF <sub>3</sub>                                |                                           | 31.0 days                                      | 31 days                             | 31 days                                                       |  |
| (E)-Perfluoro-2-butene                                | (E)-CF <sub>3</sub> CF=CFCF <sub>3</sub>                            |                                           | –                                              | 22 days                             | 22 days                                                       |  |
| (Z)-Perfluoro-2-butene                                | (Z)-CF <sub>3</sub> CF=CFCF <sub>3</sub>                            |                                           | –                                              | 35 days                             | 35 days                                                       |  |
| Perfluoro(2-methyl-2-pentene)                         | (CF <sub>3</sub> ) <sub>2</sub> C=CFCF <sub>2</sub> CF <sub>3</sub> |                                           | –                                              | 192 days                            | 192 days                                                      |  |
| Halogenated Ethers                                    |                                                                     |                                           |                                                |                                     |                                                               |  |
| HFE-125                                               | CHF <sub>2</sub> OCF <sub>3</sub>                                   |                                           | 119.0                                          | 135                                 | 147                                                           |  |
| HFE-134 (HG-00)                                       | CHF <sub>2</sub> OCHF <sub>2</sub>                                  |                                           | 25.4                                           | 26.9                                | 28.4                                                          |  |
| HFE-143a                                              | CH <sub>3</sub> OCF <sub>3</sub>                                    |                                           | 4.8                                            | 4.9                                 | 5.05                                                          |  |
| HFE-152a                                              | CH <sub>3</sub> OCHF <sub>2</sub>                                   |                                           | –                                              | 1.8                                 | 1.85                                                          |  |
| HFE-227ea                                             | CF <sub>3</sub> CHFOCF <sub>3</sub>                                 |                                           | 46.7                                           | 54.8                                | 58                                                            |  |
| HCFE-235ca2 (enflurane)                               | CHF <sub>2</sub> OCF <sub>2</sub> CHFCI                             |                                           | 4.3                                            | 4.42                                | 4.62                                                          |  |
| HCFE-235da2 (isoflurane)                              | CHF <sub>2</sub> OCHClCF <sub>3</sub>                               | 0.11 ppt                                  | 3.5                                            | 3.5                                 | 3.7                                                           |  |
| HFE-236ca                                             | CHF <sub>2</sub> OCF <sub>2</sub> CHF <sub>2</sub>                  |                                           | 20.8                                           | 22.0                                | 23.1                                                          |  |
| HFE-236ea2 (desflurane)                               | CHF <sub>2</sub> OCHFCF <sub>3</sub>                                | 3.2 ppt                                   | 10.8                                           | 14.1                                | 14.8                                                          |  |
| HFE-236fa                                             | CF <sub>3</sub> CH <sub>2</sub> OCF <sub>3</sub>                    |                                           | ~7.5                                           | ~7.5                                | ~8                                                            |  |
| HFE-245cb2                                            | CF <sub>3</sub> CF <sub>2</sub> OCH <sub>3</sub>                    |                                           | 5.0                                            | 5.0                                 | 5.24                                                          |  |
| HFE-245fa1                                            | CHF <sub>2</sub> CH <sub>2</sub> OCF <sub>3</sub>                   |                                           | 6.6                                            | ~6.7                                | ~7                                                            |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |     |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|-----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |     |
|  | –                                                 | 0                | 0.23                                                                           | 6,850                     | 9,200         | 7,400                     | 9,310        | 11,000        | A10                         | L39                         |     | R19 |
|  | –                                                 | 0                | 0.28                                                                           | 6,640                     | 8,900         | 7,180                     | 9,010        | 10,700        | A10                         | L39                         |     | R3  |
|  | –                                                 | 0                | 0.25                                                                           | 425                       | 115           | 141                       | 20           | 16            |                             | L24                         |     | R12 |
|  | –                                                 | 0                | 0.32                                                                           | 7,110                     | 9,540         | 7,680                     | 9,660        | 11,500        | A10                         | L7                          |     | R3  |
|  | –                                                 | 0                | 0.36                                                                           | 6,870                     | 9,200         | 7,420                     | 9,320        | 11,000        | A10                         | L39                         |     | R3  |
|  | –                                                 | 0                | 0.28                                                                           | 322                       | 87            | 106                       | 15           | 12            |                             | L40                         |     | R20 |
|  | –                                                 | 0                | 0.41                                                                           | 6,350                     | 8,550         | 6,860                     | 8,650        | 10,300        | A10                         | L7                          |     | R3  |
|  | –                                                 | 0                | 0.44                                                                           | 5,890                     | 7,910         | 6,370                     | 8,010        | 9,490         | A10                         | L7                          |     | R3  |
|  | –                                                 | 0                | 0.50                                                                           | 5,830                     | 7,820         | 6,290                     | 7,920        | 9,380         | A10                         | L39                         |     | R3  |
|  | –                                                 | 0                | 0.55                                                                           | 5,680                     | 7,620         | 6,130                     | 7,710        | 9,140         | A10                         | L39                         |     | R3  |
|  | –                                                 | 0                | 0.55                                                                           | 5,390                     | 7,190         | 5,820                     | 7,290        | 8,570         |                             | L39                         |     | R3  |
|  | –                                                 | 0                | 0.56                                                                           | 5,430                     | 7,240         | 5,860                     | 7,340        | 8,630         |                             | L39                         |     | R3  |
|  | –                                                 | 0                | 0.48                                                                           | 4,720                     | 6,290         | 5,090                     | 6,380        | 7,500         |                             | L39                         |     | R3  |
|  | –                                                 | 0                | 0.002                                                                          | <1                        | <1            | <1                        | <1           | <1            |                             |                             |     | R3  |
|  | –                                                 | 0                | 0.01                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             |                             |     | R3  |
|  | –                                                 | 0                | 0.003                                                                          | <1                        | <1            | <1                        | <1           | <1            |                             |                             |     | R3  |
|  | –                                                 | 0                | 0.02                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             | L41                         |     | R3  |
|  | –                                                 | 0                | 0.07                                                                           | 6                         | 2             | 2                         | <1           | <1            |                             |                             |     | R3  |
|  | –                                                 | 0                | 0.068                                                                          | 5                         | 1.3           | 1.4                       | <1           | <1            |                             |                             |     | R3  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |     | R9  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |     | R9  |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |     |
|  | 1665                                              | 0                | 0.41                                                                           | 12,615                    | 12,980        | 13,315                    | 13,860       | 11,960        |                             |                             |     | R3  |
|  | 500                                               | 0                | 0.44                                                                           | 11,840                    | 5,965         | 11,215                    | 5,530        | 1,735         |                             |                             |     | R3  |
|  | 130                                               | 0                | 0.18                                                                           | 1,950                     | 540           | 1,060                     | 113          | 75            |                             |                             |     | R3  |
|  | 56                                                | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |     | R9  |
|  | 968                                               | 0                | 0.44                                                                           | 8,920                     | 6,630         | 9,060                     | 7,110        | 3,930         |                             |                             |     | R3  |
|  | 100                                               | 0.04             | 0.41                                                                           | 2,190                     | 600           | 1,125                     | 121          | 84            |                             |                             | O13 | R3  |
|  | 86                                                | 0.03             | 0.42                                                                           | 1,800                     | 490           | 820                       | 93           | 68            | A11                         |                             | O13 | R3  |
|  | 436                                               | 0                | 0.56                                                                           | 9,855                     | 4,420         | 9,050                     | 3,700        | 1,020         |                             |                             |     | R19 |
|  | 316                                               | 0                | 0.45                                                                           | 6,440                     | 2,300         | 5,385                     | 1,320        | 365           | A11                         |                             | O13 | R3  |
|  | 196                                               | 0                | 0.36                                                                           | 3,350                     | 980           | 2,240                     | 273          | 138           |                             | L42                         |     | R3  |
|  | 134                                               | 0                | 0.33                                                                           | 2,360                     | 655           | 1,280                     | 136          | 91            |                             |                             |     | R3  |
|  | 168                                               | 0                | 0.31                                                                           | 2,960                     | 845           | 1,880                     | 214          | 119           |                             | L43                         |     | R3  |

| Industrial Designation or Chemical Name  | Chemical Formula                                                                    | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                          |                                                                                     |                                           |                                                |                                     |                                                               |  |
| HFE-245fa2                               | CHF <sub>2</sub> OCH <sub>2</sub> CF <sub>3</sub>                                   |                                           | 5.5                                            | 5.5                                 | 5.8                                                           |  |
| HFE-254cb1                               | CH <sub>3</sub> OCF <sub>2</sub> CHF <sub>2</sub>                                   |                                           | 2.5                                            | 2.5                                 | 2.62                                                          |  |
| HFE-254eb2                               | CH <sub>3</sub> OCHFCH <sub>2</sub> CF <sub>3</sub>                                 |                                           | 88 days (69–200 days)                          | 110 days (69–200 days)              | 110 days (69–200 days)                                        |  |
| HFE-263fb2                               | CF <sub>3</sub> CH <sub>2</sub> OCH <sub>3</sub>                                    |                                           | 23 days (19–47 days)                           | 28 days (19–47 days)                | 28 days (19–47 days)                                          |  |
| HFE-263m1                                | CF <sub>3</sub> OCH <sub>2</sub> CH <sub>3</sub>                                    |                                           | 0.4                                            | ~145 days                           | ~145 days                                                     |  |
| HFE-329mcc2                              | CHF <sub>2</sub> CF <sub>2</sub> OCF <sub>2</sub> CF <sub>3</sub>                   |                                           | ~25                                            | ~25                                 | ~25                                                           |  |
| HFE-338mmz1                              | (CF <sub>3</sub> ) <sub>2</sub> CHOCHF <sub>2</sub>                                 |                                           | 21.2                                           | 22.3                                | 23.5                                                          |  |
| HFE-338mcf2                              | CF <sub>3</sub> CH <sub>2</sub> OCF <sub>2</sub> CF <sub>3</sub>                    |                                           | ~7.5                                           | ~7.5                                | ~8                                                            |  |
| HFE-347mmz1 (Sevoflurane)                | (CF <sub>3</sub> ) <sub>2</sub> CHOCH <sub>2</sub> F                                | 0.16 ppt                                  | ~2                                             | 1.9                                 | 1.96                                                          |  |
| HFE-347mcc3 (HFE-7000)                   | CH <sub>3</sub> OCF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>                    |                                           | 5.0                                            | 5.1                                 | 5.3                                                           |  |
| HFE-347mcf2                              | CHF <sub>2</sub> CH <sub>2</sub> OCF <sub>2</sub> CF <sub>3</sub>                   |                                           | ~6.6                                           | ~6.7                                | ~7                                                            |  |
| HFE-347pcf2                              | CHF <sub>2</sub> CF <sub>2</sub> OCH <sub>2</sub> CF <sub>3</sub>                   |                                           | 5.9                                            | 6.1                                 | 6.3                                                           |  |
| HFE-347mmy1                              | (CF <sub>3</sub> ) <sub>2</sub> CFOCH <sub>3</sub>                                  |                                           | 3.7                                            | 3.7                                 | 3.8                                                           |  |
| HFE-347mcf                               | CHF <sub>2</sub> OCH <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>                   |                                           | 5.6                                            | 5.8                                 | 6.0                                                           |  |
| HFE-356mec3                              | CH <sub>3</sub> OCF <sub>2</sub> CHFCF <sub>3</sub>                                 |                                           | ~3                                             | 2.5                                 | 2.62                                                          |  |
| HFE-356mff2                              | CF <sub>3</sub> CH <sub>2</sub> OCH <sub>2</sub> CF <sub>3</sub>                    |                                           | 105 days (79–270 days)                         | 128 days (79–270 days)              | 128 days (79–270 days)                                        |  |
| HFE-356pcf2                              | CHF <sub>2</sub> CH <sub>2</sub> OCF <sub>2</sub> CHF <sub>2</sub>                  |                                           | ~6                                             | ~6                                  | ~6                                                            |  |
| HFE-356pcf3                              | CHF <sub>2</sub> OCH <sub>2</sub> CF <sub>2</sub> CHF <sub>2</sub>                  |                                           | 3.5                                            | 3.5                                 | 3.7                                                           |  |
| HFE-356pcc3                              | CH <sub>3</sub> OCF <sub>2</sub> CF <sub>2</sub> CHF <sub>2</sub>                   |                                           | ~3                                             | 2.5                                 | 2.62                                                          |  |
| HFE-356mmz1                              | (CF <sub>3</sub> ) <sub>2</sub> CHOCH <sub>3</sub>                                  |                                           | 61 days (49–128 days)                          | 65 days (49–128 days)               | 65 days (49–128 days)                                         |  |
| HFE-365mcf3                              | CF <sub>3</sub> CF <sub>2</sub> CH <sub>2</sub> OCH <sub>3</sub>                    |                                           | 19.3 days (17–42 days)                         | 25 days (17–42 days)                | 25 days (17–42 days)                                          |  |
| HFE-365mcf2                              | CF <sub>3</sub> CF <sub>2</sub> OCH <sub>2</sub> CH <sub>3</sub>                    |                                           | 0.6                                            | 219 days                            | 219 days                                                      |  |
| HFE-374pc2                               | CHF <sub>2</sub> CF <sub>2</sub> OCH <sub>2</sub> CH <sub>3</sub>                   |                                           | 64 days (49–128 days)                          | 76 days (49–128 days)               | 76 days (49–128 days)                                         |  |
| HFE-43-10pccc124 (H-Galden 1040x, HG-11) | CHF <sub>2</sub> OCF <sub>2</sub> OC <sub>2</sub> F <sub>4</sub> OCHF <sub>2</sub>  |                                           | 13.5                                           | 14.1                                | 14.7                                                          |  |
| HFE-449s1 (HFE-7100)                     | C <sub>4</sub> F <sub>9</sub> OCH <sub>3</sub>                                      |                                           | 4.7                                            | 4.8                                 | 5.0                                                           |  |
| <i>n</i> -HFE-7100                       | <i>n</i> -C <sub>4</sub> F <sub>9</sub> OCH <sub>3</sub>                            |                                           | 4.7                                            | 4.8                                 | 5.0                                                           |  |
| <i>i</i> -HFE-7100                       | <i>i</i> -C <sub>4</sub> F <sub>9</sub> OCH <sub>3</sub>                            |                                           | 4.7                                            | 4.8                                 | 5.0                                                           |  |
| HFE-54-11mecf                            | CF <sub>3</sub> CHFCF <sub>2</sub> OCH <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub> |                                           | 8.8                                            | 9.1                                 | 9.5                                                           |  |
| HFE-569sf2 (HFE-7200, isomer mix)        | C <sub>4</sub> F <sub>9</sub> OC <sub>2</sub> H <sub>5</sub>                        |                                           | ~0.8                                           | 0.8                                 | 0.8                                                           |  |
| <i>n</i> -HFE-7200                       | <i>n</i> -C <sub>4</sub> F <sub>9</sub> OC <sub>2</sub> H <sub>5</sub>              |                                           | 0.8                                            | 0.8                                 | 0.8                                                           |  |
| <i>i</i> -HFE-7200                       | <i>i</i> -C <sub>4</sub> F <sub>9</sub> OC <sub>2</sub> H <sub>5</sub>              |                                           | 0.8                                            | 0.63                                | 0.65                                                          |  |
| HFE-236ca12 (HG-10)                      | CHF <sub>2</sub> OCF <sub>2</sub> OCHF <sub>2</sub>                                 |                                           | 25.0                                           | 26.5                                | 28.0                                                          |  |
| HFE-338pcc13 (HG-01)                     | CHF <sub>2</sub> OCF <sub>2</sub> CF <sub>2</sub> OCHF <sub>2</sub>                 |                                           | 12.9                                           | 13.4                                | 14.0                                                          |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |     |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|-----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |     |
|  | 145                                               | 0                | 0.36                                                                           | 2,910                     | 810           | 1,670                     | 179          | 114           |                             |                             |     | R3  |
|  | 74                                                | 0                | 0.26                                                                           | 1,110                     | 300           | 440                       | 54           | 42            |                             |                             |     | R3  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |     | R9  |
|  | –                                                 | 0                | 0.04                                                                           | 6                         | 1.6           | 1.8                       | <1           | <1            |                             | L44                         |     | R3  |
|  | –                                                 | 0                | 0.13                                                                           | 102                       | 28            | 31                        | 4.7          | 3.8           |                             | L45                         |     | R3  |
|  | 580                                               | 0                | 0.53                                                                           | 6,960                     | 3,360         | 6,520                     | 3,010        | 895           |                             | L46                         |     | R3  |
|  | 440                                               | 0                | 0.44                                                                           | 6,000                     | 2,715         | 5,525                     | 2,290        | 635           |                             |                             |     | R3  |
|  | 196                                               | 0                | 0.44                                                                           | 3,180                     | 930           | 2,120                     | 259          | 131           |                             | L47                         |     | R3  |
|  | 46                                                | 0                | 0.32                                                                           | 685                       | 185           | 250                       | 33           | 26            | A11                         |                             | O13 | R3  |
|  | 135                                               | 0                | 0.35                                                                           | 1,970                     | 545           | 1,090                     | 116          | 76            |                             |                             |     | R3  |
|  | 168                                               | 0                | 0.42                                                                           | 3,010                     | 860           | 1,910                     | 215          | 121           |                             |                             |     | R3  |
|  | 155                                               | 0                | 0.48                                                                           | 3,170                     | 890           | 1,930                     | 211          | 126           |                             |                             |     | R3  |
|  | 104                                               | 0                | 0.32                                                                           | 1,330                     | 365           | 625                       | 69           | 51            |                             |                             |     | R3  |
|  | 150                                               | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |     | R9  |
|  | 74                                                | 0                | 0.30                                                                           | 930                       | 250           | 370                       | 46           | 35            |                             | L48                         |     | R3  |
|  | –                                                 | 0                | 0.17                                                                           | 74                        | 20            | 22                        | 3.4          | 2.8           |                             |                             |     | R3  |
|  | 145                                               | 0                | 0.37                                                                           | 2,650                     | 745           | 1,595                     | 174          | 105           |                             | L49                         |     | R3  |
|  | 97                                                | 0                | 0.38                                                                           | 1,640                     | 445           | 750                       | 84           | 62            |                             |                             |     | R3  |
|  | 74                                                | 0                | 0.32                                                                           | 990                       | 270           | 390                       | 48           | 37            |                             | L48                         |     | R3  |
|  | –                                                 | 0                | 0.15                                                                           | 33                        | 8.9           | 9.8                       | 1.5          | 1.2           |                             | L35                         |     | R3  |
|  | –                                                 | 0                | 0.05                                                                           | 4.7                       | 1.3           | 1.4                       | <1           | <1            |                             | L50                         |     | R3  |
|  | –                                                 | 0                | 0.26                                                                           | 215                       | 58            | 66                        | 10           | 8             |                             | L51                         |     | R19 |
|  | –                                                 | 0                | 0.30                                                                           | 97                        | 26            | 29                        | 4.4          | 3.6           |                             |                             |     | R3  |
|  | 315                                               | 0                | 1.02                                                                           | 8,180                     | 2,920         | 6,835                     | 1,680        | 464           |                             |                             |     | R3  |
|  | 128                                               | 0                | 0.36                                                                           | 1,530                     | 420           | 825                       | 88           | 59            |                             |                             |     | R3  |
|  | 128                                               | 0                | 0.42                                                                           | 1,790                     | 490           | 960                       | 102          | 69            |                             |                             |     | R3  |
|  | 128                                               | 0                | 0.35                                                                           | 1,490                     | 410           | 800                       | 85           | 57            |                             |                             |     | R3  |
|  | 212                                               | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L52                         |     | R9  |
|  | 27                                                | 0                | 0.30                                                                           | 210                       | 57            | 66                        | 10           | 8             |                             | L53                         |     | R3  |
|  | 27                                                | 0                | 0.35                                                                           | 235                       | 65            | 75                        | 11           | 9             |                             | L53                         |     | R19 |
|  | 22                                                | 0                | 0.24                                                                           | 129                       | 35            | 40                        | 5.9          | 4.8           |                             | L53                         |     | R3  |
|  | 500                                               | 0                | 0.65                                                                           | 11,165                    | 5,575         | 10,550                    | 5,140        | 1,591         |                             | L54                         |     | R3  |
|  | 304                                               | 0                | 0.86                                                                           | 8,595                     | 3,000         | 7,085                     | 1,630        | 466           |                             |                             |     | R3  |

| Industrial Designation or Chemical Name                                                              | Chemical Formula                                                                                        | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                                                                                      |                                                                                                         |                                           |                                                |                                     |                                                               |  |
| HG-02<br>(1,1'-Oxybis[2-(difluoromethoxy)-1,1,2,2-tetrafluoroethane])                                | HF <sub>2</sub> C(OCF <sub>2</sub> CF <sub>2</sub> ) <sub>2</sub> OCF <sub>2</sub> H                    |                                           | 26                                             | 26.9                                | 28.4                                                          |  |
| HG-03<br>(1,1,3,3,4,4,6,6,7,7,9,9,10,10,12,12-Hexadecafluoro-2,5,8,11-tetraoxadodecane)              | HF <sub>2</sub> C(OCF <sub>2</sub> CF <sub>2</sub> ) <sub>3</sub> OCF <sub>2</sub> H                    |                                           | 26                                             | 26.9                                | 28.4                                                          |  |
| HG-04(1,1,3,3,4,4,6,6,7,7,9,9,10,10,12,12,13,13,15,15-Eicosafluoro-2,5,8,11,14-pentaoxapentadecane)  | HCF <sub>2</sub> O(CF <sub>2</sub> CF <sub>2</sub> O) <sub>4</sub> CF <sub>2</sub> H                    |                                           | 26                                             | 26.9                                | 28.4                                                          |  |
| HG-20                                                                                                | HF <sub>2</sub> C(OCF <sub>2</sub> ) <sub>2</sub> OCF <sub>2</sub> H                                    |                                           | 25.0                                           | 26.5                                | 28.0                                                          |  |
| HG-21                                                                                                | HF <sub>2</sub> COCF <sub>2</sub> CF <sub>2</sub> OCF <sub>2</sub> OCF <sub>2</sub> O-CF <sub>2</sub> H |                                           | 13.5                                           | 13.4                                | 14.0                                                          |  |
| HG-30                                                                                                | HF <sub>2</sub> C(OCF <sub>2</sub> ) <sub>3</sub> OCF <sub>2</sub> H                                    |                                           | 25.0                                           | 26.5                                | 28.0                                                          |  |
| 1-Ethoxy-1,1,2,2,3,3,3-heptafluoropropane                                                            | CF <sub>3</sub> CF <sub>2</sub> CF <sub>2</sub> OCH <sub>2</sub> CH <sub>3</sub>                        |                                           | 0.8                                            | 0.75                                | 0.77                                                          |  |
| Fluoroxene                                                                                           | CF <sub>3</sub> CH <sub>2</sub> OCH=CH <sub>2</sub>                                                     |                                           | 3.6 days                                       | 3.6 days                            | 3.6 days                                                      |  |
| 1,1,2,2-Tetrafluoro-1-(fluoromethoxy)ethane                                                          | CH <sub>2</sub> FOCF <sub>2</sub> CF <sub>2</sub> H                                                     |                                           | 6.2                                            | 6.2                                 | 6.5                                                           |  |
| 2-Ethoxy-3,3,4,4,5-pentafluorotetrahydro-2,5-bis[1,2,2,2-tetrafluoro-1-(trifluoromethyl)ethyl]-furan | C <sub>12</sub> H <sub>5</sub> F <sub>19</sub> O <sub>2</sub>                                           |                                           | 1.0                                            | 0.81                                | 0.83                                                          |  |
| Fluoro(methoxy)methane                                                                               | CH <sub>3</sub> OCH <sub>2</sub> F                                                                      |                                           | 73.0 days                                      | 73 days                             | 73 days                                                       |  |
| Difluoro(methoxy)methane                                                                             | CH <sub>3</sub> OCHF <sub>2</sub>                                                                       |                                           | 1.1                                            | 1.1                                 | 1.1                                                           |  |
| Fluoro(fluoromethoxy)methane                                                                         | CH <sub>2</sub> FOCH <sub>2</sub> F                                                                     |                                           | 0.9                                            | 0.9                                 | 0.9                                                           |  |
| Difluoro(fluoromethoxy)methane                                                                       | CH <sub>2</sub> FOCHF <sub>2</sub>                                                                      |                                           | 3.3                                            | 3.2                                 | 3.3                                                           |  |
| Trifluoro(fluoromethoxy)methane                                                                      | CH <sub>2</sub> FOCF <sub>3</sub>                                                                       |                                           | 4.4                                            | 4.2                                 | 4.4                                                           |  |
| HG'-01                                                                                               | CH <sub>3</sub> OCF <sub>2</sub> CF <sub>2</sub> OCH <sub>3</sub>                                       |                                           | 2.0                                            | 1.7                                 | 1.74                                                          |  |
| HG'-02                                                                                               | CH <sub>3</sub> O(CF <sub>2</sub> CF <sub>2</sub> O) <sub>2</sub> CH <sub>3</sub>                       |                                           | 2.0                                            | 1.7                                 | 1.74                                                          |  |
| HG'-03                                                                                               | CH <sub>3</sub> O(CF <sub>2</sub> CF <sub>2</sub> O) <sub>3</sub> CH <sub>3</sub>                       |                                           | 2.0                                            | 1.7                                 | 1.74                                                          |  |
| HFE-329me3                                                                                           | CF <sub>3</sub> CFHCF <sub>2</sub> OCF <sub>3</sub>                                                     |                                           | 40.0                                           | 33.6                                | 35.3                                                          |  |
| 2-Chloro-1,1,2-trifluoro-1-methoxyethane                                                             | CH <sub>3</sub> OCF <sub>2</sub> CHFCI                                                                  |                                           | 1.4                                            | 1.43                                | 1.49                                                          |  |
| PFPME<br>(perfluoropolymethylisopropyl ether)                                                        | CF <sub>3</sub> OCF(CF <sub>3</sub> )CF <sub>2</sub> OCF <sub>2</sub> OCF <sub>3</sub>                  |                                           | 800.0                                          | 800                                 | –                                                             |  |
| HFE-216                                                                                              | CF <sub>3</sub> OCF=CF <sub>2</sub>                                                                     |                                           | 8.4 days                                       | 1.6 days                            | 1.6 days                                                      |  |
| <b>Fluoroesters</b>                                                                                  |                                                                                                         |                                           |                                                |                                     |                                                               |  |
| Trifluoromethyl formate                                                                              | HC(O)OCF <sub>3</sub>                                                                                   |                                           | <3.5                                           | <3.5                                | 3.7                                                           |  |
| Perfluoroethyl formate                                                                               | HC(O)OCF <sub>2</sub> CF <sub>3</sub>                                                                   |                                           | <3.5                                           | <3.6                                | 3.7                                                           |  |
| Perfluoropropyl formate                                                                              | HC(O)OCF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>                                                   |                                           | <2.6                                           | <2.6                                | 2.7                                                           |  |
| Perfluorobutyl formate                                                                               | HC(O)OCF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>                                   |                                           | 3.0                                            | <2.6                                | 2.7                                                           |  |
| 2,2,2-Trifluoroethyl formate                                                                         | HC(O)OCH <sub>2</sub> CF <sub>3</sub>                                                                   |                                           | 0.4                                            | 200 days                            | 204 days                                                      |  |
| 3,3,3-Trifluoropropyl formate                                                                        | HC(O)OCH <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>                                                   |                                           | 0.3                                            | 99 days                             | 110 days                                                      |  |
| 1,2,2,2-Tetrafluoroethyl formate                                                                     | HC(O)OCHFCF <sub>3</sub>                                                                                |                                           | 3.2                                            | 3.1                                 | 3.2                                                           |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |  |     |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|--|-----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |  |     |
|  | 500                                               | 0                | 1.15                                                                           | 10,435                    | 5,260         | 9,885                     | 4,875        | 1,527         |                             | L54                         |  | R3  |
|  | 500                                               | 0                | 1.43                                                                           | 9,745                     | 4,910         | 9,230                     | 4,550        | 1,426         |                             | L54                         |  | R3  |
|  | 500                                               | 0                | 1.46                                                                           | 7,970                     | 4,015         | 7,545                     | 3,720        | 1,166         |                             | L54                         |  | R3  |
|  | 500                                               | 0                | 0.92                                                                           | 11,630                    | 5,810         | 10,995                    | 5,350        | 1,658         |                             | L55                         |  | R19 |
|  | 304                                               | 0                | 1.71                                                                           | 10,925                    | 3,815         | 9,005                     | 2,070        | 592           |                             | L56                         |  | R19 |
|  | 500                                               | 0                | 1.65                                                                           | 16,500                    | 8,240         | 15,600                    | 7,595        | 2,352         |                             | L55                         |  | R19 |
|  | 25                                                | 0                | 0.28                                                                           | 221                       | 60            | 70                        | 10           | 8.3           |                             | L51                         |  | R19 |
|  | –                                                 | 0                | 0.01                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             | L51                         |  | R19 |
|  | 153                                               | 0                | 0.34                                                                           | 3,040                     | 855           | 1,860                     | 205          | 121           |                             | L51                         |  | R19 |
|  | 28                                                | 0                | 0.49                                                                           | 165                       | 45            | 52                        | 7.6          | 6.2           |                             | L57                         |  | R3  |
|  | –                                                 | 0                | 0.07                                                                           | 46                        | 13            | 14                        | 2            | 2             |                             | L58                         |  | R19 |
|  | 35                                                | 0                | 0.17                                                                           | 515                       | 139           | 168                       | 24           | 19            |                             | L59                         |  | R19 |
|  | 30                                                | 0                | 0.19                                                                           | 470                       | 127           | 150                       | 22           | 18            |                             | L59                         |  | R19 |
|  | 92                                                | 0                | 0.30                                                                           | 2,155                     | 585           | 950                       | 109          | 82            |                             | L59                         |  | R19 |
|  | 120                                               | 0                | 0.33                                                                           | 2,620                     | 715           | 1,315                     | 142          | 100           |                             | L59                         |  | R19 |
|  | 51                                                | 0                | 0.29                                                                           | 685                       | 185           | 245                       | 33           | 26            |                             | L60                         |  | R19 |
|  | 51                                                | 0                | 0.56                                                                           | 770                       | 210           | 275                       | 37           | 29            |                             | L60                         |  | R3  |
|  | 51                                                | 0                | 0.76                                                                           | 740                       | 200           | 260                       | 35           | 28            |                             | L60                         |  | R3  |
|  | 680                                               | 0                | 0.48                                                                           | 6,900                     | 3,955         | 6,715                     | 3,955        | 1,485         |                             | L61                         |  | R3  |
|  | 42                                                | 0                | 0.21                                                                           | 455                       | 123           | 156                       | 22           | 17            |                             | L62                         |  | R3  |
|  | –                                                 | 0                | 0.65                                                                           | 7,500                     | 9,710         | 8,070                     | 9,910        | 11,300        |                             | L63                         |  | R3  |
|  | –                                                 | 0                | 0.02                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             | L64                         |  | R3  |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |  |     |
|  | 110                                               | 0                | 0.31                                                                           | 2,150                     | 590           | 985                       | 111          | 82            |                             | L65                         |  | R19 |
|  | 110                                               | 0                | 0.44                                                                           | 2,130                     | 580           | 970                       | 110          | 81            |                             | L66                         |  | R19 |
|  | 83                                                | 0                | 0.50                                                                           | 1,380                     | 375           | 555                       | 68           | 52            |                             | L66                         |  | R19 |
|  | 83                                                | 0                | 0.56                                                                           | 1,240                     | 335           | 500                       | 61           | 47            |                             | L66                         |  | R19 |
|  | 20                                                | 0                | 0.16                                                                           | 155                       | 42            | 48                        | 7            | 6             |                             | L67                         |  | R19 |
|  | 20                                                | 0                | 0.13                                                                           | 56                        | 15            | 17                        | 2.5          | 2.1           |                             | L68                         |  | R19 |
|  | 98                                                | 0                | 0.35                                                                           | 1,670                     | 455           | 720                       | 84           | 63            |                             | L69                         |  | R19 |

| Industrial Designation or Chemical Name                              | Chemical Formula                                                                     | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|----------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                                                      |                                                                                      |                                           |                                                |                                     |                                                               |  |
| 1,1,1,3,3,3-Hexafluoropropan-2-yl formate                            | HC(O)OCH(CF <sub>3</sub> ) <sub>2</sub>                                              |                                           | 3.2                                            | 3.1                                 | 3.2                                                           |  |
| Perfluorobutyl acetate                                               | CH <sub>3</sub> C(O)OCF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub> |                                           | 21.9 days                                      | 22 days                             | 22 days                                                       |  |
| Perfluoropropyl acetate                                              | CH <sub>3</sub> C(O)OCF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>                 |                                           | 21.9 days                                      | 22 days                             | 22 days                                                       |  |
| Perfluoroethyl acetate                                               | CH <sub>3</sub> C(O)OCF <sub>2</sub> CF <sub>3</sub>                                 |                                           | 21.9 days                                      | 22 days                             | 22 days                                                       |  |
| Trifluoromethyl acetate                                              | CH <sub>3</sub> C(O)OCF <sub>3</sub>                                                 |                                           | 21.9 days                                      | 22 days                             | 22 days                                                       |  |
| Methyl carbonofluoride                                               | FCOOCH <sub>3</sub>                                                                  |                                           | 1.8                                            | 1.8                                 | 1.8                                                           |  |
| 1,1-Difluoroethyl carbonofluoride                                    | FC(O)OCF <sub>2</sub> CH <sub>3</sub>                                                |                                           | 0.3                                            | 110 days                            | 110 days                                                      |  |
| 1,1-Difluoroethyl 2,2,2-trifluoroacetate                             | CF <sub>3</sub> C(O)OCF <sub>2</sub> CH <sub>3</sub>                                 |                                           | 0.3                                            | 110 days                            | 110 days                                                      |  |
| Ethyl 2,2,2-trifluoroacetate                                         | CF <sub>3</sub> C(O)OCH <sub>2</sub> CH <sub>3</sub>                                 |                                           | 21.9 days                                      | 22 days                             | 22 days                                                       |  |
| 2,2,2-Trifluoroethyl 2,2,2-trifluoroacetate                          | CF <sub>3</sub> C(O)OCH <sub>2</sub> CF <sub>3</sub>                                 |                                           | 54.8 days                                      | 180 days                            | 180 days                                                      |  |
| Methyl 2,2,2-trifluoroacetate                                        | CF <sub>3</sub> C(O)OCH <sub>3</sub>                                                 |                                           | 0.6                                            | 1.0                                 | 1.0                                                           |  |
| Methyl 2,2-difluoroacetate                                           | HCF <sub>2</sub> C(O)OCH <sub>3</sub>                                                |                                           | 40.1 days                                      | 124 days                            | 124 days                                                      |  |
| Difluoromethyl 2,2,2-trifluoroacetate                                | CF <sub>3</sub> C(O)OCHF <sub>2</sub>                                                |                                           | 0.3                                            | 110 days                            | 110 days                                                      |  |
| 1,1,2-Trifluoro-2-(trifluoromethoxy)-ethane                          | CHF <sub>2</sub> CHFOCF <sub>3</sub>                                                 |                                           | 9.8                                            | 9.0                                 | 9.3                                                           |  |
| 1-Ethoxy-1,1,2,3,3,3-hexafluoropropane                               | CF <sub>3</sub> CHFCF <sub>2</sub> OCH <sub>2</sub> CH <sub>3</sub>                  |                                           | 0.4                                            | 147 days                            | 150 days                                                      |  |
| 1,1,1,2,2,3,3-Heptafluoro-3-(1,2,2,2-tetrafluoroethoxy)-propane      | CF <sub>3</sub> CF <sub>2</sub> CF <sub>2</sub> OCHF <sub>2</sub> CF <sub>3</sub>    |                                           | 67.0                                           | 59.4                                | 62                                                            |  |
| 1,1,2,2-Tetrafluoro-3-methoxypropane                                 | CHF <sub>2</sub> CF <sub>2</sub> CH <sub>2</sub> OCH <sub>3</sub>                    |                                           | 14.2 days                                      | 26 days                             | 26 days                                                       |  |
| 3,3,3-Trifluoro-propanal                                             | CF <sub>3</sub> CH <sub>2</sub> CHO                                                  |                                           | 2 days                                         | 5 days                              | 5 days                                                        |  |
| <b>Halogenated Alcohols</b>                                          |                                                                                      |                                           |                                                |                                     |                                                               |  |
| 3,3,3-Trifluoropropan-1-ol                                           | CF <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH                                   |                                           | 12 days                                        | 15 days                             | 15 days                                                       |  |
| 2,2,3,3,3-Pentafluoropropan-1-ol                                     | CF <sub>3</sub> CF <sub>2</sub> CH <sub>2</sub> OH                                   |                                           | 0.3                                            | 172 days                            | 172 days                                                      |  |
| 4,4,4-Trifluorobutan-1-ol                                            | CF <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> OH                   |                                           | 4 days                                         | 5.4 days                            | 5.4 days                                                      |  |
| 2,2,3,3,4,4,5,5-Octafluorocyclopentanol                              | -(CF <sub>2</sub> ) <sub>4</sub> CH(OH)-                                             |                                           | 0.3                                            | 110 days                            | 110 days                                                      |  |
| 1,1,1,3,3,3-Hexafluoropropan-2-ol                                    | (CF <sub>3</sub> ) <sub>2</sub> CHOH                                                 |                                           | 1.9                                            | 1.9                                 | 1.95                                                          |  |
| 3,3,4,4,5,5,6,6,7,7,7-Undecafluoroheptan-1-ol                        | CF <sub>3</sub> (CF <sub>2</sub> ) <sub>4</sub> CH <sub>2</sub> CH <sub>2</sub> OH   |                                           | 20 days                                        | 17 days                             | 17 days                                                       |  |
| 3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-Pentadecafluorononan-1-ol              | CF <sub>3</sub> (CF <sub>2</sub> ) <sub>6</sub> CH <sub>2</sub> CH <sub>2</sub> OH   |                                           | 20 days                                        | 17 days                             | 17 days                                                       |  |
| 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-Nonadecafluoroundeca-1-ol | CF <sub>3</sub> (CF <sub>2</sub> ) <sub>8</sub> CH <sub>2</sub> CH <sub>2</sub> OH   |                                           | 20 days                                        | 17 days                             | 17 days                                                       |  |
| 2,2,3,3,4,4,4-Heptafluorobutan-1-ol                                  | CF <sub>3</sub> CF <sub>2</sub> CF <sub>2</sub> CH <sub>2</sub> OH                   |                                           | 0.6                                            | 0.55                                | 0.55                                                          |  |
| 2,2,3,3-Tetrafluoro-1-propanol                                       | CHF <sub>2</sub> CF <sub>2</sub> CH <sub>2</sub> OH                                  |                                           | 91.2 days                                      | 93 days                             | 93 days                                                       |  |
| 2,2,3,4,4,4-Hexafluoro-1-butanol                                     | CF <sub>3</sub> CHFCF <sub>2</sub> CH <sub>2</sub> OH                                |                                           | 112 days (85–280 days)                         | 134 days (85–280 days)              | 134 days (85–280 days)                                        |  |
| 2-Fluoroethanol                                                      | CH <sub>2</sub> FCH <sub>2</sub> OH                                                  |                                           | 20.4 days                                      | 16 days                             | 16 days                                                       |  |
| 2,2-Difluoroethanol                                                  | CHF <sub>2</sub> CH <sub>2</sub> OH                                                  |                                           | 40 days                                        | 61 days                             | 61 days                                                       |  |
| 2,2,2-Trifluoroethanol                                               | CF <sub>3</sub> CH <sub>2</sub> OH                                                   |                                           | 0.3                                            | 167 days                            | 167 days                                                      |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |  |     |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|--|-----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |  |     |
|  | 96                                                | 0                | 0.33                                                                           | 1,175                     | 320           | 510                       | 59           | 44            |                             | L68                         |  | R19 |
|  | –                                                 | 0                | 0.12                                                                           | 6                         | 2             | 2                         | <1           | <1            |                             | L70                         |  | R19 |
|  | –                                                 | 0                | 0.11                                                                           | 6                         | 2             | 2                         | <1           | <1            |                             | L71                         |  | R19 |
|  | –                                                 | 0                | 0.10                                                                           | 8                         | 2             | 2                         | <1           | <1            |                             | L71                         |  | R19 |
|  | –                                                 | 0                | 0.07                                                                           | 8                         | 2             | 2                         | <1           | <1            |                             | L71                         |  | R19 |
|  | 58                                                | 0                | 0.07                                                                           | 350                       | 95            | 126                       | 17           | 13            |                             | L69                         |  | R19 |
|  | –                                                 | 0                | 0.17                                                                           | 90                        | 24            | 27                        | 4.1          | 3.4           |                             | L72                         |  | R19 |
|  | –                                                 | 0                | 0.27                                                                           | 103                       | 28            | 31                        | 4.7          | 3.9           |                             | L68                         |  | R19 |
|  | –                                                 | 0                | 0.05                                                                           | 5                         | 1             | 1                         | <1           | <1            |                             | L73                         |  | R19 |
|  | –                                                 | 0                | 0.15                                                                           | 85                        | 23            | 26                        | 3.9          | 3.2           |                             | L73                         |  | R19 |
|  | 34                                                | 0                | 0.18                                                                           | 315                       | 86            | 103                       | 15           | 12            |                             | L73                         |  | R19 |
|  | –                                                 | 0                | 0.05                                                                           | 35                        | 9             | 10                        | 1.6          | 1.3           |                             | L73                         |  | R19 |
|  | –                                                 | 0                | 0.24                                                                           | 99                        | 27            | 30                        | 5            | 4             |                             | L68                         |  | R19 |
|  | 250                                               | 0                | 0.35                                                                           | 3,765                     | 1,145         | 2,720                     | 390          | 164           |                             | L74                         |  | R3  |
|  | 20                                                | 0                | 0.19                                                                           | 88                        | 24            | 27                        | 4            | 3             |                             | L74                         |  | R3  |
|  | 1400                                              | 0                | 0.58                                                                           | 7,750                     | 5,980         | 7,910                     | 6,435        | 3,755         |                             | L74                         |  | R3  |
|  | –                                                 | 0                | 0.03                                                                           | 3                         | 0.9           | 1                         | <1           | <1            |                             | L75                         |  | R3  |
|  | –                                                 | 0                | 0.004                                                                          | <1                        | <1            | <1                        | <1           | <1            |                             | L76                         |  | R3  |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |  |     |
|  | –                                                 | 0                | 0.02                                                                           | 1.6                       | <1            | <1                        | <1           | <1            |                             | L77                         |  | R3  |
|  | –                                                 | 0                | 0.14                                                                           | 99                        | 27            | 30                        | 4.6          | 3.7           |                             |                             |  | R3  |
|  | –                                                 | 0                | 0.01                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             |                             |  | R3  |
|  | –                                                 | 0                | 0.16                                                                           | 47                        | 13            | 14                        | 2            | 2             |                             | L78                         |  | R3  |
|  | 62                                                | 0                | 0.26                                                                           | 670                       | 182           | 245                       | 32           | 25            |                             |                             |  | R3  |
|  | –                                                 | 0                | 0.06                                                                           | 2                         | <1            | <1                        | <1           | <1            |                             | L79                         |  | R3  |
|  | –                                                 | 0                | 0.07                                                                           | 1.8                       | <1            | <1                        | <1           | <1            |                             | L79                         |  | R3  |
|  | –                                                 | 0                | 0.05                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             | L79                         |  | R3  |
|  | –                                                 | 0                | 0.20                                                                           | 124                       | 34            | 38                        | 5.7          | 4.6           |                             | L80                         |  | R3  |
|  | –                                                 | 0                | 0.11                                                                           | 48                        | 13            | 14                        | 2            | 1.8           |                             | L81                         |  | R3  |
|  | –                                                 | 0                | 0.19                                                                           | 86                        | 23            | 26                        | 4.0          | 3.2           |                             |                             |  | R3  |
|  | –                                                 | 0                | 0.02                                                                           | 3                         | 0.8           | 0.9                       | <1           | <1            |                             |                             |  | R3  |
|  | –                                                 | 0                | 0.04                                                                           | 18                        | 5             | 5                         | 0.8          | 0.7           |                             |                             |  | R3  |
|  | –                                                 | 0                | 0.10                                                                           | 103                       | 28            | 31                        | 4.7          | 3.8           |                             |                             |  | R3  |

| Industrial Designation or Chemical Name               | Chemical Formula                                                                      | Atmospheric Abundance (2016) <sup>a</sup> | WMO (2014) Total Lifetime (years) <sup>b</sup> | Total Lifetime (years) <sup>c</sup> | Tropospheric (OH Reactive loss) Lifetime (years) <sup>d</sup> |  |
|-------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------|------------------------------------------------|-------------------------------------|---------------------------------------------------------------|--|
|                                                       |                                                                                       |                                           |                                                |                                     |                                                               |  |
| 2,2-3,3,4,4,5,5,5-fluoro-1-pentanol                   | CF <sub>3</sub> CF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CH <sub>2</sub> OH    |                                           | 142 days (111–330 days)                        | 172 days (111–330 days)             | 172 days (111–330 days)                                       |  |
| <b>Halogenated Ketones</b>                            |                                                                                       |                                           |                                                |                                     |                                                               |  |
| NOVEC-1230, FK-5-1-12 Perfluoro(2-methyl-3-pentanone) | CF <sub>3</sub> CF <sub>2</sub> C(O)CF(CF <sub>3</sub> ) <sub>2</sub>                 |                                           | 7.0 days (7–14 days)                           | 7 days (7–14 days)                  | –                                                             |  |
| NOVEC-774 Tetradecafluoro-2,4-dimethylpentan-3-one    | (CF <sub>3</sub> ) <sub>2</sub> CFC(O)CF(CF <sub>3</sub> ) <sub>2</sub>               |                                           | –                                              | –                                   | –                                                             |  |
| Perfluoro(2-methyl-3-hexanone)                        | CF <sub>3</sub> CF <sub>2</sub> CF <sub>2</sub> C(O)CF(CF <sub>3</sub> ) <sub>2</sub> |                                           | –                                              | –                                   | –                                                             |  |
| <b>Iodocarbons</b>                                    |                                                                                       |                                           |                                                |                                     |                                                               |  |
| Methyl iodide                                         | CH <sub>3</sub> I                                                                     | 0.8 ppt (0.3–2.1)                         | 7 days (3.5–9.6 days)                          | <14 days (3.5–14 days)              | 197 days                                                      |  |
| Trifluoroiodomethane                                  | CF <sub>3</sub> I                                                                     |                                           | 4 days (0.7–4 days)                            | <5 days (0.7–5 days)                | 3.0                                                           |  |
| Bromoiodomethane                                      | CH <sub>2</sub> BrI                                                                   |                                           | –                                              | ≤60 mins                            | 145 days                                                      |  |
| Chloroiodomethane                                     | CH <sub>2</sub> ClI                                                                   |                                           | –                                              | <100 mins                           | 145 days                                                      |  |
| Diiodomethane                                         | CH <sub>2</sub> I <sub>2</sub>                                                        |                                           | –                                              | ≤5 mins                             | 4 days                                                        |  |
| Iodoethane                                            | CH <sub>3</sub> CH <sub>2</sub> I                                                     |                                           | 4 days (2.4–13.9 days)                         | <4 days (2.4–13.9 days)             | 52 days (13–94 days)                                          |  |
| <i>n</i> -iodopropane                                 | CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> I                                     |                                           | –                                              | <2 days                             | 15 days                                                       |  |
| <i>i</i> -iodopropane                                 | CH <sub>3</sub> CHICH <sub>3</sub>                                                    |                                           | –                                              | <1 day                              | 13 days                                                       |  |
| 1-iodo-heptafluoropropane                             | CF <sub>3</sub> CF <sub>2</sub> CF <sub>2</sub> I                                     |                                           | <2 days                                        | <2 days                             | 3.0                                                           |  |
| <b>Special Compounds</b>                              |                                                                                       |                                           |                                                |                                     |                                                               |  |
| Carbonyl fluoride                                     | COF <sub>2</sub>                                                                      |                                           | – (5–10 days)                                  | 7 days (5–10 days)                  | –                                                             |  |
| Phosphorus tribromide                                 | PBr <sub>3</sub>                                                                      |                                           | – (<0.01 days)                                 | – (<0.01 days)                      | –                                                             |  |
| Ammonia                                               | NH <sub>3</sub>                                                                       | –                                         | – (Few days)                                   | – (Few days)                        | 110 days                                                      |  |
| Carbonyl Sulfide                                      | COS                                                                                   | 505 ppt                                   | –                                              | 2                                   | –                                                             |  |
| Sulfuryl fluoride                                     | SO <sub>2</sub> F <sub>2</sub>                                                        | 2.3 ppt                                   | 36.0                                           | 36.0                                | >300                                                          |  |

|  | Stratospheric<br>Lifetime<br>(years) <sup>e</sup> | ODP <sup>f</sup> | Radiative<br>Efficiency<br>(W m <sup>-2</sup> ppb <sup>-1</sup> ) <sup>g</sup> | GWP<br>20-yr <sup>h</sup> | GWP<br>100-yr | GTP<br>20-yr <sup>i</sup> | GTP<br>50-yr | GTP<br>100-yr | Footnotes                   |                             |     |     |
|--|---------------------------------------------------|------------------|--------------------------------------------------------------------------------|---------------------------|---------------|---------------------------|--------------|---------------|-----------------------------|-----------------------------|-----|-----|
|  |                                                   |                  |                                                                                |                           |               |                           |              |               | A: Abundance<br>L: Lifetime | O: ODP<br>R: RE, GWP, & GTP |     |     |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             |                             |     | R9  |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |     |
|  | –                                                 | 0                | 0.03                                                                           | <1                        | <1            | <1                        | <1           | <1            |                             | L82                         |     | R3  |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L83                         |     | R21 |
|  | –                                                 | 0                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L83                         |     | R21 |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |     |
|  | –                                                 | <0.42            | 6.0e-4                                                                         | <<1                       | <<1           | <<1                       | <<1          | <<1           | A12                         | L:20,84,<br>85,86           | O12 | R2  |
|  | –                                                 | <0.09            | –                                                                              | –                         | –             | –                         | –            | –             | A12                         | L:84,<br>85,86              | O12 | R22 |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             | A12                         | L:84,<br>87,88              | O15 | R22 |
|  | –                                                 | <0.07            | –                                                                              | –                         | –             | –                         | –            | –             | A12                         | L:84,<br>87,88              | O12 | R22 |
|  | –                                                 | –                | –                                                                              | <<1                       | <<1           | <<1                       | <<1          | <<1           | A12                         | L:84,<br>87,89              | O15 | R2  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L:84,86,<br>87,90           | O15 | R22 |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L:84,<br>87,90              | O15 | R22 |
|  | –                                                 | –                | –                                                                              | <<1                       | <<1           | <<1                       | <<1          | <<1           |                             | L:84,87,<br>90              | O15 | R2  |
|  | –                                                 | <0.04            | –                                                                              | –                         | –             | –                         | –            | –             |                             | L:84,91                     | O16 | R23 |
|  |                                                   |                  |                                                                                |                           |               |                           |              |               |                             |                             |     |     |
|  | 0                                                 | –                | 8.0e-3                                                                         | <1                        | <1            | <1                        | <1           | <1            |                             | L92                         |     | R2  |
|  | –                                                 | –                | –                                                                              | –                         | –             | –                         | –            | –             |                             | L92                         | O14 | R9  |
|  | 0                                                 | –                | 1.4e-3                                                                         | <1                        | <1            | <1                        | <1           | <1            |                             | L82                         |     | R2  |
|  | 0                                                 | –                | 5.7e-3                                                                         | 43                        | 12            | 16                        | 2.0          | 1.6           | A10                         | L93                         |     | R2  |
|  | 630                                               | 0                | 0.20                                                                           | 6,840                     | 4,090         | 6,690                     | 4,140        | 1,650         | A10                         | L:13,94                     |     | R3  |

## Table Heading Footnotes

- a The data given in the abundance column are only intended to provide a “snapshot” of the compound’s atmospheric abundance. The chapter and table(s) cited in the compound’s footnote provides the analysis details, previously reported abundances and trends, and references. This summary does not represent a comprehensive survey of the abundance of all molecules included in the table. Compounds included in this table fall into several different abundance classifications: (1) compounds with known sources and global observations for which values are reported in the table, (2) compounds with known sources, but with only local or regional observations for which some values are reported in the table (note that the abundances for very short-lived substances (VSLs) may represent local observations that can vary with location, altitude, and season), (3) compounds with natural and/or man-made sources that are not addressed in the report chapters, and (4) compounds with no presently known sources or observations.
- b Total lifetime reported in WMO (2014).
- c Total lifetime ( $\tau_{Total}$ ) is defined as the combination of the total atmospheric lifetime ( $\tau_{Total}^{Atm}$ ), which includes tropospheric loss (OH reaction and UV photolysis) and stratospheric loss (reactions with OH and O(<sup>1</sup>D) and UV photolysis), with the lifetimes due to ocean and soil uptake. Except where noted in the footnotes, tropospheric loss due to Cl atom reaction is not included. Mesospheric loss processes are negligible except for very long-lived compounds as noted in the footnotes.

$$\frac{1}{\tau_{Total}^{Atm}} = \frac{1}{\tau_{Trop}} + \frac{1}{\tau_{Strat}} + \frac{1}{\tau_{Meso}}$$

$$\frac{1}{\tau_{Trop}} = \frac{1}{\tau_{OH}^{Trop}} + \frac{1}{\tau_{hv}^{Trop}}$$

$$\frac{1}{\tau_{Strat}} = \frac{1}{\tau_{OH}^{Strat}} + \frac{1}{\tau_{O(^1D)}^{Strat}} + \frac{1}{\tau_{hv}^{Strat}}$$

$$\frac{1}{\tau_{Total}} = \frac{1}{\tau_{Total}^{Atm}} + \frac{1}{\tau_{Ocean}} + \frac{1}{\tau_{Soil}}$$

- d The tropospheric partial lifetime due reaction with the OH radical was calculated relative to the lifetime for CH<sub>3</sub>CCl<sub>3</sub> (6.1 years) using a temperature of 272 K. OH reaction rate coefficients are taken from Burkholder et al. (2015) unless stated otherwise in the footnote. Lifetimes for very short-lived substances (VSLs) are reported, although their local lifetimes will depend on the time and location of their emission. A representative range of VSLs local lifetimes taken from WMO (2014) Chapter 1 (Tables 1-5, 1-11) are given in parenthesis where available. The tropospheric OH partial lifetime for CH<sub>3</sub>CCl<sub>3</sub> (6.1 years) was calculated from an overall lifetime of 5.0 years derived from the AGAGE and NOAA networks using a stratospheric partial lifetime of 38 years and an ocean partial lifetime of 94 years (Prinn et al., 2005).
- e The stratospheric partial lifetime was estimated based on atmospheric model calculations, where available, and empirical relationships for the OH, O(<sup>1</sup>D), and photolysis partial lifetimes. Stratospheric lifetimes are not reported for very short-lived substances (VSLs). The minimum stratospheric partial lifetime was taken to be 20 years.
- \* Stratospheric OH reactive loss partial lifetimes were estimated based on the empirical correlation derived using 2-D model results reported in Ko et al. (2013):  $\log_{10}(\tau_{OH}^{Strat}) = 1.528 + 0.901 \times \log_{10}(\tau_{OH}^{Trop})$ .
  - \* The O(<sup>1</sup>D) lifetime was based on measured or estimated reaction rate coefficients ( $k_{reactive}$ , cm<sup>3</sup> molecule<sup>-1</sup> s<sup>-1</sup>) and estimated using the empirical lifetime relationship;  $\tau(years) = 3.7 \times 10^{-8}/k_{reactive}$ . Where experimental data were not available, the O(<sup>1</sup>D) reactivity was estimated using the activity relationship for H atom and Cl atom abstraction given in Baasandorj et al. (2013).
  - \* Stratospheric photolysis partial lifetimes were taken from model calculations or based on the empirical estimates given in Orkin et al. (2013) or for the HCFCs from Papanastasiou et al. (2018).

- f Atmospheric model calculated and semi-empirical values as cited in the footnotes.
- g Radiative efficiency (RE) values were calculated using the empirical approach given in Hodgenbrog et al. (2013). The values reported in this table are lifetime adjusted using the exponential expression reported in Hodgenbrog et al., (2013) for compounds primarily removed by UV photolysis in the stratosphere and the S shaped curve for compounds primarily removed by reaction with the OH radical. The values also include a +10% stratospheric temperature change adjustment.
- h Global warming potentials (GWPs) are calculated relative to CO<sub>2</sub>.
- i Global temperature change potentials (GTPs) calculated relative to CO<sub>2</sub> using the parameterization given in Supplementary Material Section S8.12 and references therein in IPCC (2013).

### Abundance Footnotes

- A1. See Chapter 6.
- A2. See Chapter 1, Section 1.5.2 and Table 1-8.
- A3. See Chapter 1, Section 1.5.1 and Table 1-8.
- A4. See Chapter 1, Section 1.2.1 and Table 1-1.
- A5. See Chapter 1, Section 1.2.5 and Table 1-1.
- A6. See Chapter 2, Section 2.3 and Table 2-3.
- A7. See Chapter 2, Section 2.3.5.
- A8. See Chapter 1, Section 1.2 and Tables 1-1, 1-2, 1-3 and 1-4.
- A9. See Chapter 1, Section 1.2 and 1.3 and Tables 1-1 and 1-4.
- A10. See Chapter 1, Section 1.5 and Table 1-8.
- A11. See Chapter 1, Section 1.5.
- A12. See Chapter 1, Section 1.3 and Table 1-4.

### Lifetime Footnotes

- L1. Total lifetime reported in WMO (2014).
- L2. Tropospheric photolysis partial lifetimes

| Molecule             | Formula                                                 | Lifetime (years) | Reference                                  |
|----------------------|---------------------------------------------------------|------------------|--------------------------------------------|
| Nitrous oxide        | N <sub>2</sub> O                                        | 14,600           | SPARC Lifetime Report (Ko et al., 2013) *  |
| Carbon tetrachloride | CCl <sub>4</sub>                                        | 1,230            | SPARC Lifetime Report (Ko et al., 2013) *  |
| CFC-11               | CCl <sub>3</sub> F                                      | 1,770            | SPARC Lifetime Report (Ko et al., 2013) *  |
| CFC-12               | CCl <sub>2</sub> F <sub>2</sub>                         | 12,500           | SPARC Lifetime Report (Ko et al., 2013) *  |
| CFC-112              | CCl <sub>2</sub> FCCl <sub>2</sub> F                    | 2,280            | Davis et al. (2016)                        |
| CFC-112a             | CCl <sub>3</sub> CClF <sub>2</sub>                      | 1,190            | Davis et al. (2016)                        |
| CFC-113              | CCl <sub>2</sub> FCClF <sub>2</sub>                     | 8,120            | SPARC Lifetime Report (Ko et al., 2013) *  |
| CFC-113a             | CCl <sub>3</sub> CF <sub>3</sub>                        | 1,480            | Davis et al. (2016)                        |
| CFC-114              | CClF <sub>2</sub> CClF <sub>2</sub>                     | 19,600           | SPARC Lifetime Report (Ko et al., 2013) *  |
| CFC-114a             | CCl <sub>2</sub> FCF <sub>3</sub>                       | 8,300            | Davis et al. (2016)                        |
| (E)-R316c            | (E)-1,2-c-C <sub>4</sub> F <sub>6</sub> Cl <sub>2</sub> | 3,600            | Papadimitriou et al. (2013b)               |
| (Z)-R316c            | (Z)-1,2-c-C <sub>4</sub> F <sub>6</sub> Cl <sub>2</sub> | 10,570           | Papadimitriou et al. (2013b)               |
| Bromodichloromethane | CHBrCl <sub>2</sub>                                     | 222 days         | WMO (2014) Table 1-5                       |
| Dibromochloromethane | CHBr <sub>2</sub> Cl                                    | 160 days         | WMO (2014) Table 1-5                       |
| Methylene bromide    | CH <sub>2</sub> Br <sub>2</sub>                         | 13.7             | WMO (2014) Table 1-5                       |
| Bromoform            | CHBr <sub>3</sub>                                       | ~23 days         | Papanastasiou et al. (2014)                |
| Halon-1202           | CBr <sub>2</sub> F <sub>2</sub>                         | 2.74             | Papanastasiou et al. (2013)                |
| Halon-1211           | CBrClF <sub>2</sub>                                     | 27.2             | Papanastasiou et al. (2013)                |
| Halon-1301           | CBrF <sub>3</sub>                                       | 4,050            | SPARC Lifetime Report (Ko et al., 2013) ** |
| Halon-2402           | CBrF <sub>2</sub> CBrF <sub>2</sub>                     | 85.5             | Papanastasiou et al. (2013)                |

\* Model mean given in SPARC Table 5.6 scaled to recommended total lifetime.

\*\* Model mean given in SPARC Table 5.6 scaled to CBrF<sub>3</sub> UV cross section reported by Bernard et al. (2015).

- L3. Atmospheric lifetimes recommended in the SPARC Lifetime report (Ko et al., 2013). Note, in some cases there are slight differences between the combination of the partial lifetimes and the recommended total atmospheric lifetime, which was derived from multi-model results and field observations.
- L4. OH rate coefficient taken from Atkinson (2003).
- L5. OH rate coefficient taken from Le Calve et al. (1997).
- L6. Room temperature OH rate coefficient taken from Wallington et al. (1997) and *E/R* assumed to be 1000 K.
- L7. Total lifetime is the best estimate taken from Ravishankara et al. (1993) that includes mesospheric loss due to Lyman- $\alpha$  (121.567 nm) photolysis. Electron reactive loss was included for SF<sub>6</sub>.
- L8. Stratospheric partial lifetime was taken from the 2-D model calculations in Davis et al. (2016). These values are in agreement with the values reported in Laube et al. (2014) [59 (43–95) years for CFC-112, 51 (32–113) years for CFC-112a, and 59 (31–305) years for CFC-113a (scaled to a CFC-11 lifetime of 52 years)], but of higher precision.
- L9. The total lifetime includes mesospheric loss due to Lyman- $\alpha$  (121.567 nm) photolysis.
- L10. Lifetime taken from Kloss et al. (2014).
- L11. Stratospheric partial lifetime taken from 2-D model calculations in Papadimitriou et al. (2013b).
- L12. *k*(OH) in the NASA/JPL (Burkholder et al., 2015) data evaluation was updated since the previous assessment resulting in a slight change in the OH tropospheric loss partial lifetime from that given in WMO (2014).
- L13. Ocean and soil loss partial lifetimes

| Molecule             | Formula                             | Soil Lifetime (years) | Reference                              | Ocean Lifetime (years) | Reference                    |
|----------------------|-------------------------------------|-----------------------|----------------------------------------|------------------------|------------------------------|
| Methyl chloride      | CH <sub>3</sub> Cl                  | 4.2                   | Hu et al. (2012)                       | 12                     | Hu et al. (2013)             |
| Methyl bromide       | CH <sub>3</sub> Br                  | 3.35                  | Montzka and Reimann et al. (WMO, 2014) | 3.1                    | Hu et al. (2012)             |
| Carbon tetrachloride | CCl <sub>4</sub>                    | 375 (288–536)*        | Rhew and Happell (2016), SPARC (2016)  | 183 (147–241)*         | Butler et al. (2016)         |
| HCFC-21              | CHCl <sub>2</sub> F                 | –                     |                                        | 673                    | Yvon-Lewis and Butler (2002) |
| HCFC-22              | CHClF <sub>2</sub>                  | –                     |                                        | 1,174                  | Yvon-Lewis and Butler (2002) |
| HCFC-124             | CHClF-CF <sub>3</sub>               | –                     |                                        | 1,855                  | Yvon-Lewis and Butler (2002) |
| HCFC-141b            | CH <sub>3</sub> C-Cl <sub>2</sub> F | –                     |                                        | 9,190                  | Yvon-Lewis and Butler (2002) |
| HCFC-142b            | CH <sub>3</sub> C-ClF <sub>2</sub>  | –                     |                                        | 122,200                | Yvon-Lewis and Butler (2002) |
| HFC-41               | CH <sub>3</sub> F                   | –                     |                                        | 1,340                  | Yvon-Lewis and Butler (2002) |
| HFC-125              | CHF <sub>2</sub> CF <sub>3</sub>    | –                     |                                        | 10,650                 | Yvon-Lewis and Butler (2002) |
| HFC-134a             | CH <sub>2</sub> FCF <sub>3</sub>    | –                     |                                        | 5,909                  | Yvon-Lewis and Butler (2002) |
| HFC-152a             | CH <sub>3</sub> CHF <sub>2</sub>    | –                     |                                        | 1,958                  | Yvon-Lewis and Butler (2002) |
| Methyl chloroform    | CH <sub>3</sub> CCl <sub>3</sub>    | –                     |                                        | 94                     | Yvon-Lewis and Butler (2002) |
| Sulfuryl fluoride    | SO <sub>2</sub> F <sub>2</sub>      | –                     |                                        | 40                     | Mühle et al. (2009)          |

\* Possible range of lifetime given in parenthesis.

- L14. Lifetimes taken from Papanastasiou et al. (2018) where *k*(OH) was calculated using the structure activity relationship (SAR) of DeMore (1996) and stratospheric lifetime estimated as described in footnote e.
- L15. 2-D model calculated stratospheric lifetime reported in McGillen et al. (2015).
- L16. OH reactivity assumed the same as CHF<sub>2</sub>CF<sub>3</sub> (HFC-125).
- L17. Stratospheric partial lifetime calculated using 2-D model with OH and O(<sup>1</sup>D) rate coefficients recommended in SPARC lifetime report, Chapter 3 (Ko et al., 2013).

- L18. OH reactivity calculated using the structure activity relationships of DeMore (1996) with an assumed  $E/R$  of 1700 K.
- L19. OH reactivity calculated using the room temperature rate coefficient reported by Young et al. (2009a) with an assumed  $E/R$  of 1700 K.
- L20. OH reactivity taken from IUPAC evaluation (Ammann et al., 2017).
- L21. OH reactivity taken from Chen et al. (2011).
- L22. The OH rate coefficient data were taken from Baasandorj and Burkholder (2016).
- L23. No experimental data available for the OH reaction and the lifetimes were estimated based on reactivity trends of fluorinated ethenes and propenes.
- L24. The OH rate coefficient was taken from Jia et al. (2013).
- L25. The OH rate coefficient data were taken from Baasandorj et al. (2018).
- L26. Assumed to be the same as HFO-1336mzz(E).
- L27. OH reactivity was calculated using the room temperature rate coefficient reported by Sulbaek Andersen et al. (2005) with the  $E/R$  obtained for the  $\text{OH} + \text{CH}_2=\text{CHCF}_3$  reaction, -170 K.
- L28. OH reactivity was calculated using the rate coefficient data from Papadimitriou and Burkholder (2016).
- L29. Lifetimes recommended in the SPARC  $\text{CCl}_4$  report (2016).
- L30. Lifetime due to reaction with Cl-atom of 259 years taken from the SPARC lifetime report, Chapter 5 model-mean (Ko et al., 2013).
- L31. Local lifetime estimated as similar to that of  $(E)\text{-CF}_3\text{CH}=\text{CHCl}$ .
- L32. Local lifetime estimated as similar to that of  $\text{CF}_3\text{CF}=\text{CF}_2$ .
- L33. Stratospheric photolysis lifetime was estimated using the empirical relationship given in Orkin et al. (2013).
- L34. Lifetime estimated to be similar to that of  $\text{CBr}_2\text{F}_2$ .
- L35. OH rate coefficient taken from Orkin et al. (2017).
- L36. Tropospheric (84,150 years) and mesospheric (2,531 years) lifetimes taken from 2-D model calculations in Papadimitriou et al. (2013a).
- L37. Estimated total lifetime lower-limit.
- L38. Total lifetime range taken from Takahashi et al. (2002) including mesospheric loss due to Lyman- $\alpha$  (121.567 nm) photolysis, dissociative electron attachment, and solar proton event loss processes.
- L39. Total lifetime estimate based on the increase in Lyman- $\alpha$  (121.567 nm) absorption cross section (increased photolysis rate) with increasing number of  $-\text{CF}_2-$  groups in the perfluorocarbon.
- L40. OH rate coefficient taken from Zhang et al. (2017).
- L41. Room temperature OH rate coefficient taken from Young et al. (2009b) with the  $E/R$  assumed to be the same as for the  $\text{OH} + \text{CF}_3\text{CF}=\text{CF}_2$  reaction, -415 K.
- L42. Tropospheric OH partial lifetime estimated from that for  $\text{CF}_3\text{CH}_2\text{OCF}_2\text{CHF}_2$  by adjusting for the reactivity contribution of  $-\text{CF}_2\text{CHF}_2$  determined from the reactivity of  $\text{CF}_3\text{CF}_2\text{OCF}_2\text{CHF}_2$ .
- L43. Tropospheric OH partial lifetime estimated from those for  $\text{CF}_3\text{OCH}_3$  and  $\text{CHF}_2\text{CH}_2\text{CF}_3$ .
- L44. Room temperature OH rate coefficient taken from Oyaro et al. (2005) with an assumed  $E/R$  of 500 K.
- L45. Estimated OH reactivity.
- L46. Tropospheric OH partial lifetime estimated to be greater than that of  $\text{CHF}_2\text{CF}_2\text{OCHF}_2$  and less than that of  $\text{CHF}_2\text{CF}_2\text{CF}_2\text{CF}_3$ .
- L47. Tropospheric OH partial lifetime estimated to be the same as for  $\text{CF}_3\text{OCH}_2\text{CF}_3$ .
- L48. Tropospheric OH partial lifetime estimated to be the same as for  $\text{CH}_3\text{OCF}_2\text{CHF}_2$ .
- L49. Tropospheric OH partial lifetime estimated from the sum of the OH partial lifetimes of  $\text{CF}_3\text{CF}_2\text{OCF}_2\text{CHF}_2$  and  $\text{CF}_3\text{CF}_2\text{OCH}_2\text{CHF}_2$ .
- L50. Room temperature OH rate coefficient taken from Oyaro et al. (2004) with an assumed  $E/R$  of 500 K.
- L51. Tropospheric OH partial lifetime estimated in Bravo et al. (2011b).
- L52. Tropospheric OH partial lifetime calculated using the OH rate coefficient from Chen et al. (2005).
- L53. Tropospheric OH partial lifetime calculated using the room temperature OH rate coefficient from Christensen et al. (1998) with an assumed  $E/R$  of 1000 K.
- L54. OH reactivity assumed to be similar to that of  $\text{HCF}_2\text{OCF}_2\text{H}$ .
- L55. OH reactivity assumed to be similar to HG-10.
- L56. OH reactivity assumed to be similar to HG-01.
- L57. Tropospheric OH partial lifetime calculated using the room temperature OH rate coefficient from Javadi et al. (2007) with an assumed  $E/R$  of 1000 K.

- L58. Tropospheric OH partial lifetime calculated using the structure activity relationship estimated OH rate coefficient in Urata et al. (2003).
- L59. OH rate coefficient calculated theoretically in Blowers et al. (2008).
- L60. Tropospheric OH partial lifetime calculated using the room temperature OH rate coefficient from Sulbaek Andersen et al. (2004) with an assumed  $E/R$  of 1000 K.
- L61. Tropospheric OH partial lifetime calculated using the room temperature OH rate coefficient from Wallington et al. (2004) with an assumed  $E/R$  of 1000 K.
- L62. Tropospheric OH partial lifetime calculated using the OH rate coefficient from Tokuhashi et al. (1999).
- L63. Lifetime estimated in Young et al. (2006).
- L64. Tropospheric OH partial lifetime calculated using the room temperature OH rate coefficient from Mashino et al. (2000) with an assumed  $E/R$  of -400 K.
- L65. Tropospheric OH partial lifetime calculated using the OH rate coefficient from Chen et al. (2004a).
- L66. Tropospheric OH partial lifetime calculated using the OH rate coefficient from Chen et al. (2004b). There is no experimental data available for perfluorobutyl formate and it is assumed to be similar to perfluoropropyl formate.
- L67. Tropospheric OH partial lifetime calculated using the room temperature OH rate coefficient from Oyaro et al. (2004) with an assumed  $E/R$  of 500 K.
- L68. Lifetime estimated in Bravo et al. (2011a).
- L69. Tropospheric OH partial lifetime calculated using the OH rate coefficient from Chen et al. (2006).
- L70. Tropospheric OH partial lifetime estimated in Christensen et al. (1998) based on comparison with Cl atom reactivity.
- L71. OH reactivity assumed to be the same as for perfluorobutyl acetate.
- L72. OH reactivity assumed to be the same as for  $\text{CF}_3\text{C}(\text{O})\text{OCH}_2\text{CH}_3$ .
- L73. Tropospheric OH partial lifetime calculated using the room temperature OH rate coefficient from Blanco and Teruel (2007) with an assumed  $E/R$  of 1000 K.
- L74. Tropospheric OH partial lifetime calculated using the room temperature OH rate coefficient from Oyaro et al. (2005) with an assumed  $E/R$  of 1500 K.
- L75. Tropospheric OH partial lifetime calculated using the room temperature OH rate coefficient from Oyaro et al. (2004) with an assumed  $E/R$  of 1000 K.
- L76. Tropospheric OH partial lifetime calculated using the OH rate coefficient from Antiñolo et al. (2010).
- L77. OH rate coefficient taken from Antiñolo et al. (2011).
- L78. OH reactivity estimated by comparison with other fluoroalcohols.
- L79. OH reactivity calculated using the room temperature rate coefficient reported by Ellis et al. (2003) with an assumed  $E/R$  of 1000 K.
- L80. OH rate coefficient taken from Bravo et al. (2010).
- L81. OH rate coefficient taken from Antiñolo et al. (2012).
- L82. Tropospheric photolysis is the dominant loss process for perfluoroketones (Jackson et al., 2011; Taniguchi et al., 2003).
- L83. OH reactivity assumed to be similar to that of NOVEC-1230.
- L84. Lifetime primarily determined by UV photolysis with a decreasing local lifetime with increasing altitude.
- L85. Lifetime estimates taken from the 3-D model simulations of Youn et al. (2010).
- L86. Lifetime range is representative of the variation in local photolysis partial lifetime with time and location of emission.
- L87. Photolysis lifetimes taken from Mössinger et al. (1998) for  $\text{CH}_2\text{BrI}$  and Roehl et al. (1997) for  $\text{CH}_2\text{ClI}$ ,  $\text{CH}_3\text{CH}_2\text{I}$ ,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{I}$ ,  $\text{CH}_3\text{CHICH}_3$ .
- L88. OH reactivity assumed to be similar to that of  $\text{CH}_2\text{Br}_2$ .
- L89. OH reactivity taken from Zhang et al. (2011).
- L90. OH reactivity taken from Zhang et al. (2012)
- L91. Photolysis and OH reactivity assumed the same as for  $\text{CF}_3\text{I}$ .
- L92. Heterogeneous processing is the predominate removal process.
- L93. Lifetime reported in Brühl et al. (2012).
- L94. Lifetimes taken from Papadimitrou et al. (2008) and Mühle et al. (2009).

## ODP Footnotes

- O1. See Chapter 1, Section 1.5.1.

- O2. Negligible and assigned a value of zero.
- O3. ODP taken from WMO (2014) Table 5.2.
- O4. A greater ODP value was reported from the 2-D model calculations in Davis et al. (2016): 0.95 (CFC-113), 0.78 (CFC-114), 0.44 (CFC-115), 1.01 (CFC-12), and 1.06 (CCl<sub>4</sub>).
- O5. Taken from Montreal Protocol.
- O6. ODP taken from the 2-D model calculations in Davis et al. (2016). The semi-empirical ODP reported in Laube et al. (2014) is consistent with the latter Davis et al. (2016) value, but has a larger uncertainty range.
- O7. ODP taken from Kloss et al. (2014).
- O8. ODP taken from the 2-D model calculations in Papadimitriou et al. (2013b).
- O9. Semi-empirical ODP calculated using empirical relationship of the fractional release factor with stratospheric lifetime given in Papanastasiou et al. (2018).
- O10. Taken from Papanastasiou et al. (2018).
- O11. ODP taken from WMO (2011).
- O12. Upper-limit of ODPs of short-lived substances reported in the studies of Brioude et al. (2010) (C<sub>2</sub>H<sub>5</sub>Br, CH<sub>2</sub>CBrCF<sub>3</sub>, n-C<sub>3</sub>H<sub>7</sub>Br, C<sub>2</sub>HCl<sub>3</sub>, CCl<sub>3</sub>CHO, CH<sub>3</sub>I, CF<sub>3</sub>I, C<sub>3</sub>F<sub>7</sub>I, CH<sub>2</sub>ClI, CHBr<sub>3</sub>), Wuebbles and co-workers (Patten et al., 2011; Patten and Wuebbles, 2010; Wuebbles et al., 2011; Wuebbles et al., 2009; Youn et al., 2010) (C<sub>3</sub>H<sub>7</sub>Br, C<sub>2</sub>HCl<sub>3</sub>, C<sub>2</sub>Cl<sub>4</sub>, HFO-1233zd, (E)-CHCl=CHCl, CF<sub>3</sub>I, and CH<sub>3</sub>I), and Tegtmeier et al. (2012) (CH<sub>2</sub>Br<sub>2</sub>, CHBr<sub>3</sub>). The derived ODPs in these studies were shown to be strongly dependent on the region and season of the substance emission with the greatest values obtained for emissions in the Indian subcontinent.
- O13. Taken from Langbein et al. (1999).
- O14. Value not available.
- O15. Assumed to be <0.02 for surface emission.
- O16. Assumed to be the same as for CF<sub>3</sub>I.

### RE, GWP, and GTP Footnotes

- R1. Radiative metrics taken from IPCC (2013).
- R2. RE calculated using the room temperature infrared absorption spectrum reported in the Pacific Northwest National Laboratory (PNNL) database, <https://secure2.pnl.gov/nsd/nsd.nsf> (Sharpe et al., 2004).
- R3. RE taken from recommendation given in Hodnebrog et al. (2013), which was based on a combination of literature review of experimental data and re-analysis.
- R4. Radiative metrics calculated using the infrared absorption spectrum reported in Davis et al. (2016) and the lifetime reported here.
- R5. Radiative metrics calculated using the infrared absorption spectrum reported in Papadimitriou et al. (2013b) and the lifetime reported here.
- R6. Radiative metrics calculated using the theoretically calculated infrared absorption spectrum in Papanastasiou et al. (2018) and lifetimes given here.
- R7. Radiative metrics calculated using the theoretically calculated infrared absorption spectrum and lifetimes reported in Papanastasiou et al. (2018).
- R8. Radiative metrics calculated using the infrared spectrum and lifetimes reported in McGillen et al. (2015).
- R9. Radiative efficiency not available.
- R10. Radiative metrics calculated using the RE reported in Le Bris et al. (2018) and the lifetime reported here.
- R11. Radiative metrics calculated using the infrared spectrum in Baasandorj and Burkholder (2016).
- R12. Radiative metrics calculated using the RE reported in Jai et al. (2013) with lifetime and stratospheric temperature corrections applied here using the lifetimes reported here.
- R13. Radiative metrics calculated using the infrared spectrum in Baasandorj et al. (2018).
- R14. Radiative metrics calculated using the infrared spectrum in Papadimitriou and Burkholder (2016).
- R15. Radiative metrics calculated using the infrared spectrum in Wallington et al. (2016).
- R16. Radiative metrics calculated using the infrared spectrum in Gierczak et al. (2014).
- R17. Radiative metrics calculated using the infrared spectrum in Orkin et al. (2017).
- R18. Infrared absorption spectrum taken from Bernard et al. (2018).
- R19. RE taken from recommendation given in Hodnebrog et al. (2013), which was based on theoretically calculated infrared absorption spectra and analysis.

- R20. Radiative metrics calculated using the RE reported in Zhang et al. (2017) and the lifetime reported here.  
 R21. Assumed to be similar to NOVEC-1230.  
 R22. Assumed negligible.  
 R23. Assumed to be similar to that of CF<sub>3</sub>I.

## REFERENCES

- Ammann, M., R.A. Cox, J.N. Crowley, H. Herrmann, M.E. Jenkin, V.F. McNeil, A. Mellouki, M.J. Rossi, J. Troe, and T.J. Wallington, IUPAC Task Group on Atmospheric Chemical Kinetic Data Evaluation, 2017.
- Antiñolo, M., E. Jiménez, A. Notario, E. Martínez, and J. Albaladejo, Tropospheric photooxidation of CF<sub>3</sub>CH<sub>2</sub>CHO and CF<sub>3</sub>(CH<sub>2</sub>)<sub>2</sub>CHO initiated by Cl atoms and OH radicals, *Atmos. Chem. Phys.*, **10**, 1911–1922, doi:10.5194/acp-10-1911-2010, 2010.
- Antiñolo, M., E. Jiménez, and J. Albaladejo, Temperature effects on the removal of potential HFC replacements, CF<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH and CF<sub>3</sub>(CH<sub>2</sub>)<sub>2</sub>CH<sub>2</sub>OH, initiated by OH radicals, *Environ. Sci. Technol.*, **45**, 4323–4330, doi:10.1021/es103931s, 2011.
- Antiñolo, M., S. González, B. Ballesteros, J. Albaladejo, and E. Jiménez, Laboratory studies of CHF<sub>2</sub>CF<sub>2</sub>CH<sub>2</sub>OH and CF<sub>3</sub>CF<sub>2</sub>CH<sub>2</sub>OH: UV and IR absorption cross sections and OH rate coefficients between 263 and 358 K, *J. Phys. Chem. A*, **116**, 6041–6050, doi:10.1021/jp2111622, 2012.
- Atkinson, R., Kinetics of the gas-phase reactions of OH radicals with alkanes and cycloalkanes, *Atmos. Chem. Phys.*, **3**, 2233–2307, doi:10.5194/acp-3-2233-2003, 2003.
- Baasandorj, M., and J.B. Burkholder, Rate coefficient for the gas-phase OH + CHF=CF<sub>2</sub> reaction between 212 and 375 K, *Int. J. Chem. Kinet.*, **48**, 714–723, doi:10.1002/kin.21027, 2016.
- Baasandorj, M., E.L. Fleming, C.H. Jackman, and J.B. Burkholder, O(<sup>1</sup>D) kinetic study of key ozone depleting substances and greenhouse gases, *J. Phys. Chem. A*, **117**, 2434–2445, doi:10.1021/j312781c, 2013.
- Baasandorj, M., P. Marshall, A.R. Ravishankara, and J.B. Burkholder, Rate coefficient measurements and theoretical analysis of the OH + (E)-CF<sub>3</sub>CH=CHCF<sub>3</sub> reaction, *J. Phys. Chem. A*, **122**, doi:10.1021/acs.jpca.8b02771, 2018.
- Bernard, F., M.R. McGillen, E.L. Fleming, C.H. Jackman, and J.B. Burkholder, CBrF<sub>3</sub> (Halon-1301): UV absorption spectrum between 210 and 320 K, atmospheric lifetime, and ozone depletion potential, *J. Photochem. Photobiol.*, **306**, 13–20, doi:10.1016/j.jphotochem.2015.03.012, 2015.
- Bernard, F., D.K. Papanastasiou, V.C. Papadimitriou, and J.B. Burkholder, Infrared absorption spectra of N(C<sub>x</sub>F<sub>2x+1</sub>)<sub>3</sub>, x = 2–5 perfluoroamines, *J. Quant. Spectrosc. Rad. Trans.*, **211**, 166–171, doi:10.1016/j.jqsrt.2018.02.039, 2018.
- Blanco, M.B., and M.A. Teruel, Atmospheric degradation of fluoroesters (FESs): Gas-phase reactivity study towards OH radicals at 298 K, *Atmos. Environ.*, **41**, 7330–7338, doi:10.1016/j.atmosenv.2007.05.013, 2007.
- Blowers, P., K.F. Tetrault, and Y. Trujillo-Morehead, Global warming potential predictions for hydrofluoroethers with two carbon atoms, *Theor. Chem. Acc.*, **119**, 369–381, doi:10.1007/s00214-007-0394-3, 2008.
- Bravo, I., Y. Díaz-de-Mera, A. Aranda, K. Smith, K.P. Shine, and G. Marston, Atmospheric chemistry of C<sub>4</sub>F<sub>9</sub>OC<sub>2</sub>H<sub>5</sub> (HFE-7200), C<sub>4</sub>F<sub>9</sub>OCH<sub>3</sub> (HFE-7100), C<sub>3</sub>F<sub>7</sub>OCH<sub>3</sub> (HFE-7000) and C<sub>3</sub>F<sub>7</sub>H<sub>2</sub>OH: Temperature dependence of the kinetics of their reactions with OH radicals, atmospheric lifetimes and global warming potentials, *Phys. Chem. Chem. Phys.*, **12**, 5115–5125, doi:10.1039/b923092k, 2010.
- Bravo, I., Y. Diaz-de-Mera, A. Aranda, E. Moreno, D.R. Nutt, and G. Marston, Radiative efficiencies for fluorinated esters: indirect global warming potentials of hydrofluoroethers, *Phys. Chem. Chem. Phys.*, **13**, 17185–17193, doi:10.1039/c1cp21874c, 2011a.
- Bravo, I., G. Marston, D.R. Nutt, and K.P. Shine, Radiative efficiencies and global warming potentials using theoretically determined absorption cross-sections for several hydrofluoroethers (HFEs) and hydrofluoropolyethers (HFPEs), *J. Quant. Spectrosc. Rad. Trans.*, **112**, 1967–1977, doi:10.1016/j.jqsrt.2011.05.001, 2011b.

- Brioude, J., R.W. Portmann, J.S. Daniel, O.R. Cooper, G.J. Frost, K.H. Rosenlof, C. Granier, A.R. Ravishankara, S.A. Montzka, and A. Stohl, Variations in ozone depletion potentials of very short-lived substances with season and emission region, *Geophys. Res. Lett.*, **37**, L19804, doi:10.1029/2010GL044856, 2010.
- Brühl, C., J. Lelieveld, P.J. Crutzen, and H. Tost, The role of carbonyl sulphide as a source of stratospheric sulphate aerosol and its impact on climate, *Atmos. Chem. Phys.*, **12**, 1239–1253, doi:10.5194/acp-12-1239-2012, 2012.
- Burkholder, J.B., S.P. Sander, J. Abbatt, J.R. Barker, R.E. Huie, C.E. Kolb, M.J. Kurylo, V.L. Orkin, D.M. Wilmouth, and P.H. Wine, *Chemical Kinetics and Photochemical Data for Use in Atmospheric Studies, Evaluation No. 18*, JPL Publication 15-10, Jet Propulsion Laboratory, Pasadena, California, <http://jpldataeval.jpl.nasa.gov>, 2015.
- Butler, J.H., S.A. Yvon-Lewis, J.M. Lobert, D.B. King, S.A. Montzka, J.L. Bullister, V. Koropalov, J. Elkins, B.D. Hall, L. Hu, and Y. Liu, A comprehensive estimate for loss of atmospheric carbon tetrachloride ( $\text{CCl}_4$ ) to the ocean, *Atmos. Chem. Phys.*, **16**, 10899–10910, doi:10.5194/acp-16-10899-2016, 2016.
- Chen, L., S. Kutsuna, K. Tokuhashi, and A. Sekiya, Kinetics of the gas-phase reaction of  $\text{CF}_3\text{OC(O)H}$  with OH radicals at 242–328 K, *Int. J. Chem. Kinet.*, **36**, 337–344, doi:10.1002/kin.20004, 2004a.
- Chen, L., S. Kutsuna, K. Tokuhashi, and A. Sekiya, Kinetics study of the gas-phase reactions of  $\text{C}_2\text{F}_5\text{OC(O)H}$  and  $n\text{-C}_3\text{F}_7\text{OC(O)H}$  with OH radicals at 253–328 K, *Chem. Phys. Lett.*, **400**, 563–568, doi:10.1016/j.cplett.2004.11.019, 2004b.
- Chen, L., S. Kutsuna, K. Tokuhashi, and A. Sekiya, Kinetics study of the gas-phase reactions of  $\text{CHF}_2\text{CF}_2\text{OCHF}_2$  and  $\text{CF}_3\text{CHFCF}_2\text{OCH}_2\text{CF}_2\text{CF}_3$  with OH radicals at 253–328 K, *Chem. Phys. Lett.*, **403**, 180–184, doi:10.1016/j.cplett.2005.01.002, 2005.
- Chen, L., S. Kutsuna, K. Tokuhashi, and A. Sekiya, Kinetics and mechanisms of  $\text{CF}_3\text{CHFOCH}_3$ ,  $\text{CF}_3\text{CHFOC(O)H}$ , and  $\text{FC(O)OCH}_3$  reactions with OH radicals, *J. Phys. Chem. A*, **110**, 12845–12851, doi:10.1021/jp064917h, 2006.
- Chen, L., T. Uchimaru, S. Kutsuna, K. Tokuhashi, A. Sekiya, and H. Okamoto, Kinetics and mechanism of gas-phase reaction of  $\text{CF}_3\text{CF}_2\text{CF}_2\text{CF}_2\text{CF}_2\text{CF}_2\text{CF}_2\text{H}$  with OH radicals in an environmental reaction chamber at 253–328 K, *Chem. Phys. Lett.*, **501**, 263–266, doi:10.1016/j.cplett.2010.12.009, 2011.
- Christensen, L.K., J. Sehested, O.J. Nielsen, M. Bilde, T.J. Wallington, A. Guschin, L.T. Molina, and M.J. Molina, Atmospheric chemistry of HFE-7200 ( $\text{C}_4\text{F}_9\text{OC}_2\text{H}_5$ ): Reaction with OH radicals and fate of  $\text{C}_4\text{F}_9\text{OCH}_2\text{CH}_2\text{O}(\bullet)$  and  $\text{C}_4\text{F}_9\text{OCHO}(\bullet)\text{CH}_3$  radicals, *J. Phys. Chem. A*, **102**, 4839–4845, doi:10.1021/jp981128u, 1998.
- Davis, M.E., F. Bernard, M.R. McGillen, E.L. Fleming, and J.B. Burkholder, UV and infrared absorption spectra, atmospheric lifetimes, and ozone depletion and global warming potentials for  $\text{CCl}_2\text{FCF}_2$  (CFC-112),  $\text{CCl}_3\text{CCF}_2$  (CFC-112a),  $\text{CCl}_3\text{CF}_3$  (CFC-113a), and  $\text{CCl}_2\text{FCF}_3$  (CFC-114a), *Atmos. Chem. Phys.*, **16**, 8043–8052, doi:10.5194/acp-16-8043-2016, 2016.
- DeMore, W.B., Experimental and estimated rate constants for the reactions of hydroxyl radicals with several halocarbons, *J. Phys. Chem.*, **100**, 5813–5820, doi:10.1021/jp953216%2B, 1996.
- Ellis, D.A., J.W. Martin, S.A. Mabury, M.D. Hurley, M.P. Sulbaek Andersen, and T.J. Wallington, Atmospheric lifetime of fluorotelomer alcohols, *Environ. Sci. Technol.*, **37**, 3816–3820, doi:10.1021/es034136j, 2003.
- Gieczak, T., M. Baasandorj, and J.B. Burkholder, OH + (E)- and (Z)-1-chloro-3,3,3-trifluoropropene-1 ( $\text{CF}_3\text{CH}=\text{CHCl}$ ) reaction rate coefficients: Stereoisomer-dependent reactivity, *J. Phys. Chem. A*, **118**, 11,015–11,025, doi:10.1021/jp509127h, 2014.
- Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer, Twelfth Edition, Ozone Secretariat, Secretariat of the Vienna Convention for the Protection of the Ozone Layer and of the Montreal Protocol on Substances the Deplete the Ozone Layer, United Nations Environment Programme, Nairobi, Kenya, 2018. [http://ozone.unep.org/sites/default/files/MP\\_handbook-english-2018.pdf](http://ozone.unep.org/sites/default/files/MP_handbook-english-2018.pdf)
- Hodnebrog, Ø., M. Etminan, J.S. Fuglestad, G. Marston, G. Myhre, C.J. Nielsen, K.P. Shine, and T.J. Wallington, Global warming potentials and radiative efficiencies of halocarbons and related compounds: A comprehensive review,

- Rev. Geophys.*, 51, 300–378, doi:10.1002/rog.20013, 2013.
- Hu, L., S.A. Yvon-Lewis, Y. Liu, and T.S. Bianchi, The ocean in near equilibrium with atmospheric methyl bromide, *Global Biogeochem. Cycles*, 26, GB3016, doi:10.1029/2011GB004272, 2012.
- Hu, L., S.A. Yvon-Lewis, J.H. Butler, J.M. Lobert, and D.B. King, An improved oceanic budget for methyl chloride, *J. Geophys. Res.*, 118, 715–725, doi:10.1029/2012JC008196, 2013.
- IPCC, *Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midgley, 1535 pp., Cambridge University Press, Cambridge, United Kingdom, 2013.
- Jackson, D.A., C.J. Young, M.D. Hurley, T.J. Wallington, and S.A. Mabury, Atmospheric degradation of perfluoro-2-methyl-3-pentanone: Photolysis, hydrolysis and hydration, *Environ. Sci. Technol.*, 45, 8030–8036, doi:10.1021/es104362g, 2011.
- Javadi, M.S., O.J. Nielsen, T.J. Wallington, M.D. Hurley, and J.G. Owens, Atmospheric chemistry of 2-ethoxy-3,3,4,4,5-pentafluorotetrahydro-2,5-bis[1,2,2,2-tetrafluoro-1-(trifluoromethyl)ethyl]-furan: Kinetics, mechanisms, and products of Cl atom and OH radical initiated oxidation, *Environ. Sci. Technol.*, 41, 7389–7395, doi:10.1021/es071175c, 2007.
- Jia, X., L. Chen, J. Mizukado, S. Kutsuna, and K. Tokuhashi, Rate constants for the gas-phase reactions of cyclo-CX=CXCF<sub>2</sub>CF<sub>2</sub> (X = H, F) with OH radicals at a temperature range of 253–328 K, *Chem. Phys. Lett.*, 572, 21–25, doi:10.1016/j.cplett.2013.04.020, 2013.
- Kloss, C., M.J. Newland, D.E. Oram, P.J. Fraser, C.A.M. Brenninkmeijer, T. Röckmann, and J.C. Laube, Atmospheric abundances, trends and emissions of CFC-216ba, CFC-216ca and HCFC-225ca, *Atmos.*, 5, 420–434, doi:10.3390/atmos5020420, 2014.
- Ko, M.K.W., P.A. Newman, S. Reimann, S.E. Strahan, R.A. Plumb, R.S. Stolarski, J.B. Burkholder, W. Mellouki, A. Engel, E.L. Atlas, M. Chipperfield, and Q. Liang, Lifetimes of stratospheric ozone-depleting substances, their replacements, and related species, *SPARC Report No. 6*, WCRP-15/2013, 2013.
- Langbein, T., H. Sonntag, D. Trapp, A. Hoffmann, W. Malms, E.-P. Röth, V. Mörs, and R. Zellner, Volatile anaesthetics and the atmosphere: Atmospheric lifetimes and atmospheric effects of halothane, enflurane, isoflurane, desflurane and sevoflurane, *Br. J. Anaesth.*, 82, 66–73, doi:10.1093/bja/82.1.66, 1999.
- Laube, J.C., M.J. Newland, C. Hogan, C.A.M. Brenninkmeijer, P.J. Fraser, P. Martinerie, D.E. Oram, C.E. Reeves, T. Röckmann, J. Schwander, E. Witrant, and W.T. Sturges, Newly detected ozone-depleting substances in the atmosphere, *Nat. Geosci.*, 7, 266–269, doi:10.1038/ngeo2109, 2014.
- Le Bris, K., J. DeZeeuw, P.J. Godin, and K. Strong, Infrared absorption cross-sections, radiative efficiency and global warming potential of HFC-43-10mee, *J. Mol. Spectrosc.*, 348, 64–67, doi:10.1016/j.jms.2017.06.004, 2018.
- Le Calve, S., G. Le Bras, and A. Mellouki, Temperature dependence for the rate coefficients of the reactions of the OH radical with a series of formates, *J. Phys. Chem. A*, 101, 5489–5493, doi:10.1021/jp970554x, 1997.
- Mashino, M., Y. Ninomiya, M. Kawasaki, T.J. Wallington, and M.D. Hurley, Atmospheric chemistry of CF<sub>3</sub>CF=CF<sub>2</sub>: Kinetics and mechanism of its reactions with OH radicals, Cl atoms, and ozone, *J. Phys. Chem. A*, 104, 7255–7260, doi:10.1021/jp000498r, 2000.
- McGillen, M.R., F. Bernard, E.L. Fleming, and J.B. Burkholder, HCFC-133a (CF<sub>3</sub>CH<sub>2</sub>Cl): OH rate coefficient, UV and infrared absorption spectra, and atmospheric implications, *Geophys. Res. Lett.*, 42, 6098–6105, doi:10.1002/2015GL064939, 2015.
- Mössinger, J.C., D.E. Shallcross, and R.A. Cox, UV-VIS absorption cross-sections and atmospheric lifetimes of CH<sub>2</sub>Br<sub>2</sub>, CH<sub>2</sub>I<sub>2</sub> and CH<sub>2</sub>BrI, *J. Chem. Soc. Faraday Trans.*, 94, 1391–1396, doi:10.1039/A709160E, 1998.
- Mühle, J., J. Huang, R.F. Weiss, R.G. Prinn, B.R. Miller, P.K. Salameh, C.M. Harth, P.J. Fraser, L.W. Porter, B.R. Grealley, S.

- O'Doherty, and P.G. Simonds, Sulfuryl fluoride in the global atmosphere, *J. Geophys. Res.*, 114, D05306, doi:10.1029/2008JD011162, 2009.
- Orkin, V.L., V.G. Khamaganov, E.E. Kasimovskaya, and A.G. Guschin, Photochemical properties of some Cl containing halogenated alkanes, *J. Phys. Chem. A*, 117, 5483–5490, doi:10.1021/jp400408y, 2013.
- Orkin, V.L., L.E. Martynova, and M.J. Kurylo, Photochemical properties of  $\text{CH}_2=\text{CH}-\text{CFCl}-\text{CF}_2\text{Br}$  (4-bromo-3-chloro-3,4,4-trifluoro-1-butene) and  $\text{CH}_3-\text{O}-\text{CH}(\text{CF}_3)_2$  (Methyl Hexafluoroisopropyl Ether): OH reaction rate constants and UV and IR absorption spectra, *J. Phys. Chem. A*, 121 (30), 5675–5680, doi:10.1021/acs.jpca.7b04256, 2017.
- Oyaro, N., S.R. Sellevåg, and C.J. Nielsen, Study of the OH and Cl-initiated oxidation, IR absorption cross-section, radiative forcing, and global warming potential of four  $\text{C}_4$ -hydrofluoroethers, *Environ. Sci. Technol.*, 38, 5567–5576, doi:10.1021/es0497330, 2004.
- Oyaro, N., S.R. Sellevåg, and C.J. Nielsen, Atmospheric chemistry of hydrofluoroethers: Reaction of a series of hydrofluoroethers with OH radicals and Cl atoms, atmospheric lifetimes, and global warming potentials, *J. Phys. Chem. A*, 109, 337–346, doi:10.1021/jp047860c, 2005.
- Papadimitriou, V.C., and J.B. Burkholder, OH radical reaction rate coefficients, infrared spectrum, and global warming potential of  $(\text{CF}_3)_2\text{CFCH}=\text{CHF}$  (HFO-1438ez(E)), *J. Phys. Chem. A*, 120, 6618–6628, doi:10.1021/acs.jpca.6b06096, 2016.
- Papadimitriou, V.C., R.W. Portmann, D.W. Fahey, J. Mühle, R.F. Weiss, and J.B. Burkholder, Experimental and theoretical study of the atmospheric chemistry and global warming potential of  $\text{SO}_2\text{F}_2$ , *J. Phys. Chem. A*, 112, 12657–12666, doi:abs/10.1021/jp806368u, 2008.
- Papadimitriou, V.C., M.R. McGillen, E.L. Fleming, C.H. Jackman, and J.B. Burkholder,  $\text{NF}_3$ : UV absorption spectrum temperature dependence and the atmospheric and climate forcing implications, *Geophys. Res. Lett.*, 40, 1–6, doi:10.1002/grl.50120, 2013a.
- Papadimitriou, V.C., M.R. McGillen, S.C. Smith, A.M. Jubb, R.W. Portmann, B.D. Hall, E.L. Fleming, C.H. Jackman, and J.B. Burkholder, 1,2-Dichlorohexafluoro-cyclobutane (1,2-c- $\text{C}_4\text{F}_6\text{Cl}_2$ , R-316c) a potent ozone depleting substance and greenhouse gas: Atmospheric loss processes, lifetimes, and ozone depletion and global warming potentials for the (E) and (Z) stereoisomers, *J. Phys. Chem. A*, 117, 11,049–11,065, doi:10.1021/jp407823k, 2013b.
- Papanastasiou, D.K., N. Rontu Carlon, J.A. Neuman, E.L. Fleming, C.H. Jackman, and J.B. Burkholder, Revised UV absorption spectra, ozone depletion potentials, and global warming potentials for the ozone-depleting substances  $\text{CF}_2\text{Br}_2$ ,  $\text{CF}_2\text{ClBr}$ , and  $\text{CF}_2\text{BrCF}_2\text{Br}$ , *Geophys. Res. Lett.*, 40, doi:10.1002/GRL.50121, 2013.
- Papanastasiou, D.K., S.A. McKeen, and J.B. Burkholder, The very short-lived ozone depleting substance  $\text{CHBr}_3$  (bromoform): Revised UV absorption spectrum, atmospheric lifetime and ozone depletion potential, *Atmos. Chem. Phys.*, 14, 3017–3025, doi: 10.5194/acpd-13-32963-2013, 2014.
- Papanastasiou, D.K., A. Beltrone, P. Marshall, and J.B. Burkholder, Global warming potential estimates for  $\text{C}_1$ - $\text{C}_3$  hydrochlorofluorocarbons (HCFCs) included in the Kigali amendment to the Montreal Protocol, *Atmos. Chem. Phys.*, 18, 6317–6330, doi:10.5194/acp-18-6317-2018, 2018.
- Patten, K.O., and D.J. Wuebbles, Atmospheric lifetimes and Ozone Depletion Potentials of trans-1-chloro-3,3,3-trifluoropropylene and trans-1,2-dichloroethylene in a three-dimensional model, *Atmos. Chem. Phys.*, 10, 10867–10874, doi:10.5194/acp-10-10867-2010, 2010.
- Patten, K.O., V.G. Khamaganov, V.L. Orkin, S.L. Baughcum, and D.J. Wuebbles, OH reaction rate constant, IR absorption spectrum, ozone depletion potentials and global warming potentials of 2-bromo-3,3,3-trifluoropropene, *J. Geophys. Res.*, 116, D24307, doi:10.1029/2011JD016518, 2011.
- Prinn, R.G., J. Huang, R.F. Weiss, D.M. Cunnold, P.J. Fraser, P.G. Simmonds, A. McCulloch, C. Harth, S. Reimann, P. Salam, S. O'Doherty, R.H.J. Wang, L.W. Porter, B.R. Miller, and P.B. Krummel, Evidence for variability of atmospheric hydroxyl radicals over the past quarter century, *Geophys. Res. Lett.*, 32, L07809, doi:10.1029/2004GL022228, 2005.

- Ravishankara, A.R., S. Solomon, A.A. Turnipseed, and R.F. Warren, Atmospheric lifetimes of long-lived halogenated species, *Science*, 259, 194–199, doi:10.1126/science.259.5092.194, 1993.
- Rhew, R.C., and J.D. Happell, The atmospheric partial lifetime of carbon tetrachloride with respect to the global soil sink, *Geophys. Res. Lett.*, 43, 2889–2895, doi:10.1002/2016GL067839, 2016.
- Roehl, C.M., J.B. Burkholder, G.K. Moortgat, A.R. Ravishankara, and P.J. Crutzen, Temperature dependence of UV absorption cross sections and atmospheric implications of several alkyl iodides, *J. Geophys. Res.*, 102, 12,819–12,829, doi:10.1029/97JD00530, 1997.
- Sharpe, S.W., T.J. Johnson, R.L. Sams, P.M. Chu, G.C. Rhoderick, and P.A. Johnson, Gas-phase databases for quantitative infrared spectroscopy, *Appl. Spectrosc.*, 58, 1452–1461, doi:10.1366/0003702042641281, 2004.
- SPARC, *Report on the Mystery of Carbon tetrachloride*, edited by Q. Liang, P.A. Newman, and S. Reimann, *SPARC Report No. 7*, WCRP-13/2016, 2016.
- Sulbaek Andersen, M.P., M.D. Hurley, T.J. Wallington, F. Blandini, N.R. Jensen, V. Librando, J. Hjorth, G. Marchionni, M. Avataneo, M. Visca, F.M. Nicolaisen, and O.J. Nielsen, Atmospheric chemistry of  $\text{CH}_3\text{O}(\text{CF}_2\text{CF}_2\text{O})_n\text{CH}_3$  ( $n=1-3$ ): Kinetics and mechanism of oxidation initiated by Cl atoms and OH radicals, IR spectra, and global warming potentials, *J. Phys. Chem. A*, 108, 1964–1972, doi:10.1021/jp036615a, 2004.
- Sulbaek Andersen, M.P., O.J. Nielsen, A. Toft, T. Nakayama, Y. Matsumi, R.L. Waterland, R.C. Buck, M.D. Hurley, and T.J. Wallington, Atmospheric chemistry of  $\text{C}_x\text{F}_{2x+1}\text{CH}=\text{CH}_2$  ( $x=1, 2, 4, 6$ , and  $8$ ): Kinetics of gas-phase reactions with Cl atoms, OH radicals, and  $\text{O}_3$ , *J. Photochem. Photobio.*, 176, 124–128, doi:10.1016/j.jphotochem.2005.06.015, 2005.
- Takahashi, K., T. Nakayama, Y. Matsumi, S. Solomon, T. Gejo, E. Shigemasa, and T.J. Wallington, Atmospheric lifetime of  $\text{SF}_5\text{CF}_3$ , *Geophys. Res. Lett.*, 29, doi:10.1029/2002GL015356, 2002.
- Taniguchi, N., T.J. Wallington, M.D. Hurley, A.G. Guschin, L.T. Molina, and M.J. Molina, Atmospheric chemistry of  $\text{C}_2\text{F}_5\text{C}(\text{O})\text{CF}(\text{CF}_3)_2$ : Photolysis and reaction with Cl atoms, OH radicals, and ozone, *J. Phys. Chem. A*, 107, 2674–2679, doi:10.1021/jp0220332, 2003.
- Tegtmeier, S., K. Krüger, B. Quack, E.L. Atlas, I. Pisso, A. Stohl, and X. Yang, Emission and transport of bromocarbons: From the West Pacific ocean into the stratosphere, *Atmos. Chem. Phys.*, 12, 10,633–10,648, doi:10.5194/acp-12-10633-2012, 2012.
- Tokuhashi, K., A. Takahashi, M. Kaise, and S. Kondo, Rate constants for the reactions of OH radicals with  $\text{CH}_3\text{OCF}_2\text{CHFCl}$ ,  $\text{CHF}_2\text{OCF}_2\text{CHFCl}$ ,  $\text{CHF}_2\text{OCHClCF}_3$ , and  $\text{CH}_3\text{CH}_2\text{OCF}_2\text{CHF}_2$ , *J. Geophys. Res.*, 104, 18,681–18,688, doi:10.1029/1999JD900278, 1999.
- UNEP (United Nations Environment Programme), Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer, Ozone Secretariat, Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer, 895 pp., Nairobi, Kenya, 2018.
- Urata, S., A. Takada, T. Uchimaru, and A.K. Chandra, Rate constants estimation for the reaction of hydrofluorocarbons and hydrofluoroethers with OH radicals, *Chem. Phys. Lett.*, 368, 215–223, 2003.
- Wallington, T.J., M.D. Hurley, J.C. Ball, A.M. Straccia, J. Platz, L.K. Christensen, J. Sehested, and O.J. Nielsen, Atmospheric chemistry of dimethoxymethane ( $\text{CH}_3\text{OCH}_2\text{OCH}_3$ ): Kinetics and mechanism of its reaction with OH radicals and fate of the alkoxy radicals  $\text{CH}_3\text{OCHO}(\bullet)\text{OCH}_3$  and  $\text{CH}_3\text{OCH}_2\text{OCH}_2\text{O}(\bullet)$ , *J. Phys. Chem. A*, 101, 5302–5308, doi:10.1021/jp9631184, 1997.
- Wallington, T.J., M.D. Hurley, O.J. Nielsen, and M.P. Sulbaek Andersen, Atmospheric chemistry of  $\text{CF}_3\text{CFHCF}_2\text{OCF}_3$  and  $\text{CF}_3\text{CFHCF}_2\text{OCF}_2\text{H}$ : Reaction with Cl atoms and OH radicals, degradation mechanism, and global warming potentials, *J. Phys. Chem. A*, 108, 11,333–11,338, doi:10.1021/jp046454q, 2004.
- Wallington, T.J., B.P. Pivesso, A.M. Lira, J.E. Anderson, C.J. Nielsen, N.H. Andersen, and Ø. Hodnebrog,  $\text{CH}_3\text{Cl}$ ,  $\text{CH}_2\text{Cl}_2$ ,  $\text{CHCl}_3$ , and  $\text{CCl}_4$ : Infrared spectra, radiative efficiencies, and global warming potentials, *J. Quant. Spectrosc. Rad. Trans.*, 174, 56–64, doi:10.1016/j.jqsrt.2016.01.029, 2016.

- WMO (World Meteorological Organization), *Scientific Assessment of Ozone Depletion: 2014*, Global Ozone Research and Monitoring Project–Report No. 55, World Meteorological Organization, Geneva, Switzerland, 2014.
- Wuebbles, D.J., D. Youn, K. Patten, D. Wang, and M. Martinez-Aviles., Metrics for ozone and climate: Threedimensional modeling studies of ozone depletion potentials and indirect global warming potentials, in *Twenty Years of Ozone Decline*, in *Proceedings of the Symposium for the 20th Anniversary of the Montreal Protocol*; edited by C. Zerefos, G. Contopoulos, and G. Skalkas, 297–326, Springer, Netherlands, 2009.
- Wuebbles, D.J., K.O. Patten, D. Wang, D. Youn, M. Martínez-Avilés, and J.S. Francisco, Three-dimensional model evaluation of the ozone depletion potentials for n-propyl bromide, trichloroethylene and perchloroethylene, *Atmos. Chem. Phys.*, *11*, 2371–2380, doi:10.5194/acp-11-2371-2011, 2011.
- Youn, D., K.O. Patten, D.J. Wuebbles, H. Lee, and C.-W. So, Potential impact of iodinated replacement compounds  $\text{CF}_3\text{I}$  and  $\text{CH}_3\text{I}$  on atmospheric ozone: A three-dimensional modeling study, *Atmos. Chem. Phys.*, *10*, 10,129–10,144, doi:10.5194/acp-10-10129-2010, 2010.
- Young, C.J., M.D. Hurley, T.J. Wallington, and S.A. Mabury, Atmospheric lifetime and global warming potential of a perfluoropolyether, *Environ. Sci. Technol.*, *40*, 2242–2246, doi:10.1021/es052077z, 2006.
- Young, C.J., M.D. Hurley, T.J. Wallington, and S.A. Mabury, Atmospheric chemistry of  $\text{CF}_3\text{CF}_2\text{H}$  and  $\text{CF}_3\text{CF}_2\text{CF}_2\text{CF}_2\text{H}$ : Kinetics and products of gas-phase reactions with Cl atoms and OH radicals, infrared spectra, and formation of perfluorocarboxylic acids, *Chem. Phys. Lett.*, *473*, 251–256, doi:10.1016/j.cplett.2009.04.001, 2009a.
- Young, C.J., M.D. Hurley, T.J. Wallington, and S.A. Mabury, Atmospheric chemistry of perfluorobutenes ( $\text{CF}_3\text{CF}=\text{CFCF}_3$  and  $\text{CF}_3\text{CF}_2\text{CF}=\text{CF}_2$ ): Kinetics and mechanisms of reactions with OH radicals and chlorine atoms, IR spectra, global warming potentials, and oxidation to perfluorocarboxylic acids, *Atmos. Environ.*, *43*, 3717–3724, doi:10.1016/j.atmosenv.2009.04.025, 2009b.
- Yvon-Lewis, S.A., and J.H. Butler, Effect of oceanic uptake on atmospheric lifetimes of selected trace gases, *J. Geophys. Res.*, *107* (D20), doi:10.1029/2001JD001267, 2002.
- Zhang, N., T. Uchimaru, Q. Guo, F. Qing, L. Chen, and J. Mizukado, Atmospheric chemistry of perfluorocyclopentene ( $\text{cyc-CF}_2\text{CF}_2\text{CF}_2\text{CF}=\text{CF}-$ ): Kinetics, products and mechanism of gas-phase reactions with OH radicals, and atmospheric implications, *Atmos. Environ.*, *160*, 46–54, doi:10.1016/j.atmosenv.2017.04.012, 2017.
- Zhang, S., R. Strekowski, L. Bosland, A. Monod, and C. Zetzsch, Kinetic study of the reaction of OH with  $\text{CH}_2\text{I}_2$ , *Phys. Chem. Chem. Phys.*, *13*, 11,671–11,677, doi:10.1039/c1cp20885c, 2011.
- Zhang, S., R. Strekowski, A. Monod, L. Bosland, and C. Zetzsch, Temperature-dependent kinetics study of the reactions of OH with  $\text{C}_2\text{H}_5\text{I}$ ,  $n\text{-C}_3\text{H}_7\text{I}$ , and  $\text{iso-C}_3\text{H}_7\text{I}$ , *J. Phys. Chem. A*, *116*, 9497–9506, doi:10.1021/jp300575f, 2012.