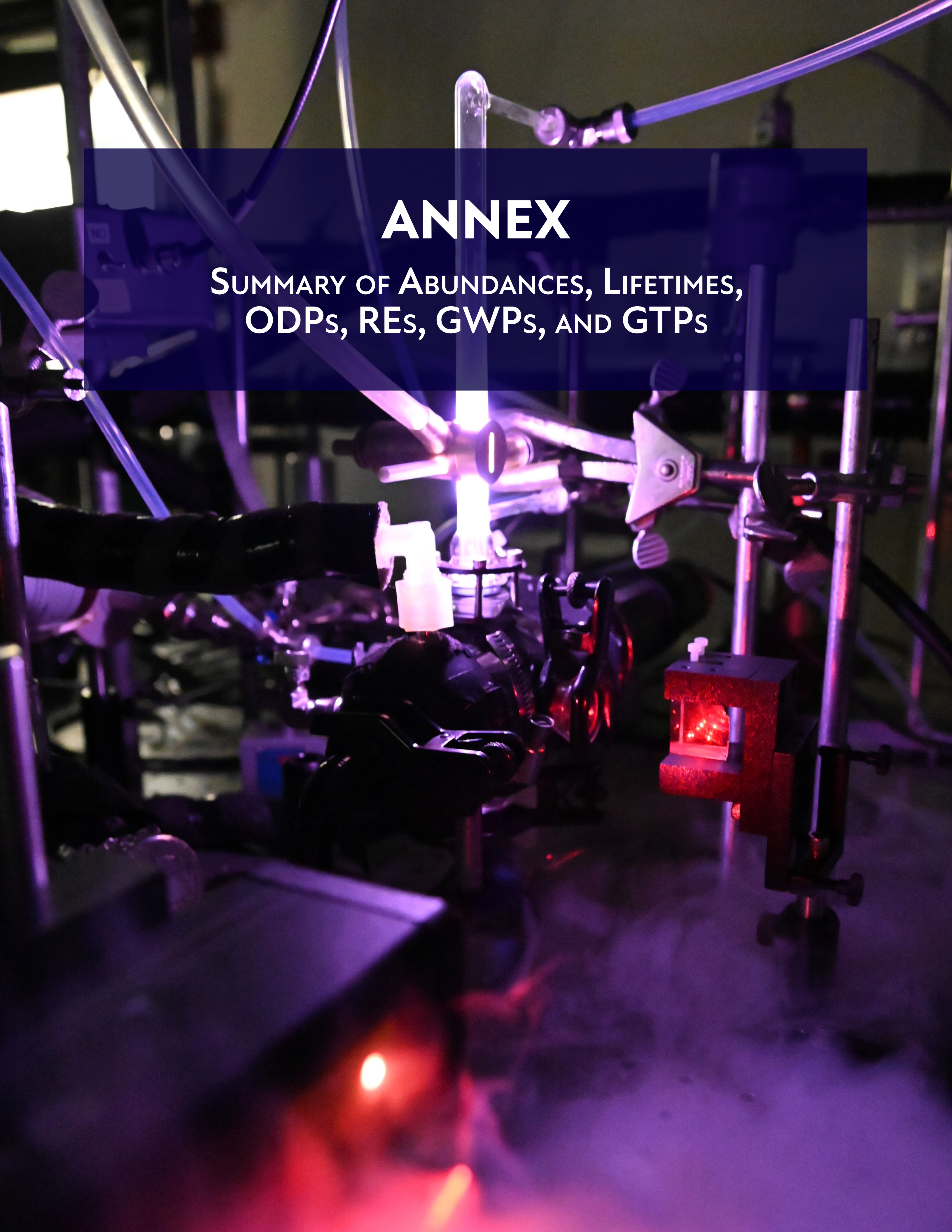
ANNEX

Summary of Abundances, Lifetimes, ODPs, REs, GWPs, and GTPs



About the cover image:
Laboratory studies of the chemical and physical properties of atmospheric trace species are essential to understand the fundamental processes that affect stratospheric ozone and climate.

Photo credit: Daniel Van Hoomissen, NOAA CSL / CIRES

ANNEX

Summary of Abundances, Lifetimes, ODPs, REs, GWPs, and GTPs

Lead Authors : James B. Burkholder
Øivind Hodnebrog

Contributors : Brian C. McDonald
Vladimir Orkin
Vassilis C. Papadimitriou
Daniel Van Hoomissen

CONTENTS

Annex: Summary of Abundances, Lifetimes, ODPs, REs, GWPs, and GTPs

SCIENTIFIC SUMMARY

- The present analysis has updated climate metrics that reflect 2019 CO_2 forcing.
- The hydrocarbon, hydrofluorocarbon (HFC), and chlorinated molecule sections were expanded.
- A new halogenated aldehyde section has been included.
- Climate metric values have been updated using a recently improved method for calculating radiative efficiencies with stratospheric temperature adjustment included. For carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), CFC-11, and CFC-12, the reported radiative efficiencies also include tropospheric adjustments.
- Climate-carbon feedbacks have been included for all compounds, consistent with the methods of the Intergovernmental Panel on Climate Change Sixth Assessment Report (AR6, 2022). Differences between climate metrics reported here and those in AR6 are due to total lifetime and radiative efficiency updates included here.
- The low wavenumber, usually <500 cm^{-1}, contribution to radiative efficiencies is usually not determined by experimental infrared absorption spectra. The low wavenumber contribution was evaluated using theoretically calculated spectra for all molecules. The contributions are typically a small positive adjustment, 0–5%, but need to be evaluated on a molecule basis.
- Theoretically calculated infrared absorption spectra have been added for molecules previously lacking experimental and theoretical values.

A.1 INTRODUCTION

The *Annex* 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 Ozone Assessment. The table builds upon the metrics reported in previous assessments from the Intergovernmental Panel on Climate Change (2013; 2022) and the World Meteorological Organization (WMO) (2014; 2018) and United Nations Environment Programme (UNEP). The *Annex* provides updates based on new studies and refined methods for evaluating climate metrics. The *Annex* content has been expanded from Appendix A of the previous Ozone Assessment (WMO, 2018) to include an expanded coverage of potential replacement compounds, e.g. hydrofluorocarbons (HFCs), as well as several prominent hydrocarbons observed in urban environments and commercially used chlorinated compounds. A summary is provided below that is broken into the following categories and/or classes of molecules.

The ozone depletion potentials (ODPs) and global warming potentials (GWPs) given in **Table A-5** may differ in some cases from the metrics for controlled substances reported in the Montreal Protocol and subsequent Amendments due to consideration of recent experimental data, methods of analysis, and/or assessment recommendations, e.g. recommendation given in Burkholder et al. (2019), SPARC (2013), and WMO (2014; 2018).

The following subsections describe the methods applied to derive the recommendations provided in **Table A-5**. An extensive set of table footnotes provide the literature source, parameters, or method used to derive the reported metric. The table contains both long- and short-lived (lifetimes <~0.5 years) compounds. Metrics given for short-lived molecules are dependent on the time and location of their emissions, as they are not expected to be well-mixed in the atmosphere. Hence, the abundances and metrics reported are to be considered representative values but are most likely not valid for all spatial and temporal emissions scenarios.

Index	Category	Number of Compounds
1	CO_2, CH_4, and N_2O	
2	Hydrocarbons	13
3	Oxygenated Hydrocarbons	7
4	Chlorofluorocarbons (CFCs)	13
5	Hydrochlorofluorocarbons (HCFCs)	274
6	Hydrofluorocarbons (HFCs)	162
7	Unsaturated Hydrofluorocarbons	32
8	Chlorocarbons and Hydrochlorocarbons	20
9	Unsaturated Hydrochlorocarbons and Chlorocarbons	23
10	Unsaturated Chlorofluorocarbons and Hydrochlorofluorocarbons	19

Index	Category	Number of Compounds
11	Bromocarbons, Hydrobromocarbons, and Halons	18
12	Unsaturated Bromocarbons	9
13	Unsaturated Bromochlorofluorocarbons	1
14	Fully Fluorinated Species	34
15	Halogenated Ethers	74
16	Fluoroesters	25
17	Halogenated Alcohols	15
18	Halogenated Ketones	9
19	Halogenated Aldehydes	10
20	Iodocarbons	11
21	Special Compounds	10

A.2 EVALUATION METHODOLOGY

A.2.1 Compound Name, Chemical Formula, and CAS RN

Table A-5 has a row for each compound that contains the compound name and/or abbreviation, the chemical formula, and the compound's Chemical Abstracts Service registry number (CAS RN), which provides for effective searching of the table. Some compounds, however, do not have assigned CAS RNs.

A.2.2 Atmospheric Abundance

The data provided for atmospheric abundances were taken from *Chapters 1* and *2* of this report for the year 2020, where possible, or from the last WMO Ozone Assessment, as noted in the footnotes. A compound's abundance typically falls into one of the following categories: 1) compounds with known emissions sources for which global observations are available, 2) compounds with known sources but with only local or regional observations, and 3) compounds with no known sources or observations. The abundances provided in the table are only intended to provide a snapshot of a molecule's atmospheric abundance, in particular for short-lived compounds. *Chapters 1* and *2* in this report and in the previous Assessment provide an analysis of reported abundances and trends, as well as the most relevant citations.

A.2.3 Total and Atmospheric Lifetimes

Total lifetime (τ_{Total}) includes tropospheric OH reactive and photolysis loss, stratospheric loss due to reaction (OH and O(^{1}D)) and photolysis, and ocean, soil, aerosol, and cloud uptake. Atmospheric lifetimes do not include heterogeneous loss processes such as ocean uptake.

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

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

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

Note that loss due to Cl-atom reaction is not included here but may represent a significant loss process for some molecules under certain spatial and temporal conditions, e.g. urban coastal regions. Mesospheric loss processes are negligible except for very long-lived compounds, as noted in the **Table A-5** footnotes. Total lifetimes reported in the last Assessment are included for comparison with the 2022 updates.

The tropospheric partial lifetime due to reaction with the OH radical, τ_{OH}^{Trop}, was calculated relative to the lifetime for methyl chloroform (CH_3CCl_3; 6.1 years) using a temperature of 272 K. OH reaction rate coefficients are taken from Burkholder et al. (2019) unless stated otherwise in the footnote. Lifetimes for very short-lived substances (VSLSs) are reported using the same method and are considered representative lifetimes, because their local lifetimes will depend on the time and location of their emissions. A representative range of 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_3CCl_3 (6.1 years) was calculated from an overall lifetime of 5.0 years derived from the Advanced Global Atmospheric Gases Experiment (AGAGE) and National Oceanic and Atmospheric Administration (NOAA) monitoring networks using a stratospheric partial lifetime of 38

Table A-1. Tropospheric photolysis lifetimes for key ozone depleting substances (ODSs) reported in the literature.

Molecule	Formula	Lifetime (years)	Reference
Nitrous oxide	N_2O	14,600	SPARC (2013)*
Carbon tetrachloride	CCl_4	1230	SPARC (2013)*
CFC-11	CCl_3F	1770	SPARC (2013)*
CFC-12	CCl_2F_2	12,500	SPARC (2013)*
CFC-112	CCl_2FCCl_2F	2280	Davis et al. (2016)
CFC-112a	CCl_3CClF_2	1190	Davis et al. (2016)
CFC-113	CCl_2FCClF_2	8120	SPARC (2013)*
CFC-113a	CCl_3CF_3	1480	Davis et al. (2016)
CFC-114	$CClF_2CClF_2$	19,600	SPARC (2013)*
CFC-114a	CCl_2FCF_3	8300	Davis et al. (2016)
(*E*)-R316c	(*E*)-1,2-c-$C_4F_6Cl_2$	3600	Papadimitriou et al. (2013b)
(*Z*)-R316c	(*Z*)-1,2-c-$C_4F_6Cl_2$	10,570	Papadimitriou et al. (2013b)
Bromodichloromethane	$CHBrCl_2$	222 days	WMO Table 1-5 (2014)
Dibromochloromethane	$CHBr_2Cl$	160 days	WMO Table 1-5 (2014)
Methylene bromide	CH_2Br_2	13.7	WMO Table 1-5 (2014)
Bromoform	$CHBr_3$	~23 days	Papanastasiou et al. (2014)
Halon-1202	CBr_2F_2	2.74	Papanastasiou et al. (2013)
Halon-1211	$CBrClF_2$	27.2	Papanastasiou et al. (2013)
Halon-1301	$CBrF_3$	4050	SPARC (2013)**
Halon-2402	$CBrF_2CBrF_2$	85.5	Papanastasiou et al. (2013)

* Model mean given in SPARC (2013) Table 5.6, scaled to recommended lifetime.
** Model mean given in SPARC (2013) Table 5.6, scaled to $CBrF_3$ UV cross section reported by Bernard et al. (2015)

years and an ocean partial lifetime of 94 years, see Prinn et al. (2005).

Ultraviolet (UV) photolysis loss has been included as a molecule loss process in the total lifetime analysis. The evaluation of photolysis lifetimes typically requires atmospheric model calculations to derive global annually averaged lifetimes. Photolysis lifetimes in the troposphere and stratosphere are taken from the literature whenever possible. Tropospheric photolysis lifetimes for key ODSs are given in **Table A-1**. In the absence of literature values, molecular properties and the similarity with other molecules were used to estimate photolysis lifetimes.

The stratospheric partial lifetime is not a directly observable molecular property and was estimated based on atmospheric model calculations, where available, and empirical relationships for the OH, O(^{1}D), and photolysis partial lifetimes. Stratospheric lifetimes are not reported for VSLSs. The minimum transport limited 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 SPARC (2013): $\log_{10}(\tau_{Strat})=1.528+0.901 \times \log_{10}(\tau_{OH}^{Trop})$. The O(^{1}D) lifetime was based on the measured or estimated reaction rate coefficient, i.e., reactant loss ($k_{reactive}$, cm^3 molecule^{-1} s^{-1}), and the empirical lifetime relationship reported in Bernard et al. (2018): $\tau_{O(^1D)}$(years) = $3.7 \times 10^{-8}/k_{reactive}$. Where experimental data were not available, the O(^{1}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 hydrochlorofluorocarbons (HCFCs) from Papanastasiou et al. (2018).

Heterogeneous losses include uptake to the ocean, soil, aerosol, and cloud droplets. Partial lifetimes for these processes are included in the evaluation of a molecule's total lifetime where possible. The available literature and recommended lifetimes for soil and ocean loss are given in **Table A-2**. Aerosol and cloud uptake is an important loss process for certain highly soluble molecules, e.g. halogenated aldehydes, which may also hydrolyze or form hydrates in solution. In these cases, an uptake lifetime of ~1 week was assumed representative of this loss process and is noted in the footnote for each of those molecules.

A.2.4 Ozone Depletion Potential (ODP)

The ODPs reported here are obtained from atmospheric model simulations or via a semiempirical relationship, e.g. for a chlorinated ODS:

$$ODP_i = \frac{n_{Cl}}{3} \times \frac{f_i}{f_{CFC\text{-}11}} + \frac{\tau_i}{\tau_{CFC\text{-}11}} + \frac{m_{CFC\text{-}11}}{m_i}$$

where n_{Cl} is the number of chlorine atoms in the molecule, f_i is the fractional release factor for the molecule (see *Chapter 7*), τ_i is the total lifetime, and m_i is the molecular mass of the molecule. For brominated and iodine molecules, the number of halogen atoms is adjusted, and enhancement factors of 60 (see *Chapter 7*) and ~250, respectively, are included as multiplicative factors.

A.2.5 Radiative Efficiency (RE)

A.2.5.1 Spectral Radiative Efficiency Curve

Radiative efficiency (RE) values were calculated using the empirical approach given in Shine and Myhre (2020) and based on the same experimental absorption cross sections as in Hodnebrog et al. (2020a), unless noted otherwise. This approach involves a spectral RE curve, also known as the "Pinnock curve," where the instantaneous radiative forcing for a weak absorber is given per unit cross section as a function of wavenumber. The RE, in units of W m^{-2} ppb^{-1}, is obtained by multiplying the curve with the absorption spectrum of a compound and integrating over all wavenumbers. The Pinnock curve was first established by Pinnock et al. (1995) using a narrow-band radiative transfer model with 10 cm^{-1} spectral resolution. Hodnebrog et al. (2013) provided an updated curve, that was used in WMO (2018), by using a

Table A-2. Ocean and soil loss partial lifetimes reported in the literature.*

Molecule	Formula	Soil Lifetime (years)	Reference	Ocean Lifetime (years)	Reference
Methyl chloride	CH_3Cl	4.2	Hu (2012)	12	Hu et al. (2013)
Methyl bromide	CH_3Br	3.35	Montzka and Reimann (2011)	3.1	Hu et al. (2012)
Carbon tetrachloride	CCl_4	375 (288–536)	Rhew and Happel (2016), SPARC (2016)	124 (110–150)	Suntharalingam et al. (2019)
HCFC-21	$CHCl_2F$	–		673	Yvon-Lewis and Butler (2002)
HCFC-22	$CHClF_2$	–		1174	Yvon-Lewis and Butler (2002)
HCFC-124	$CHClFCF_3$	–		1855	Yvon-Lewis and Butler (2002)
HCFC-141b	CH_3CCl_2F	–		9190	Yvon-Lewis and Butler (2002)
HCFC-142b	CH_3CClF_2	–		122,200	Yvon-Lewis and Butler (2002)
HFC-41	CH_3F	–		1340	Yvon-Lewis and Butler (2002)
HFC-125	CHF_2CF_3	–		10,650	Yvon-Lewis and Butler (2002)
HFC-134a	CH_2FCF_3	–		5909	Yvon-Lewis and Butler (2002)
HFC-152a	CH_3CHF_2	–		1958	Yvon-Lewis and Butler (2002)
Methyl chloroform	CH_3CCl_3	–		94	Yvon-Lewis and Butler (2002)
Sulfuryl fluoride	SO_2F_2	–		40	Mühle et al. (2009)

* Possible range of lifetime given in parenthesis.

line-by-line (LBL) model run at 0.02 cm^{-1} spectral resolution and with more refined atmospheric profiles of temperature, clouds, and greenhouse gas abundances. Shine and Myhre (2020) generated a new curve (see also *Section A.2.5.2*) based on the same LBL model but with changes in the representation of clouds and the water vapor continuum.

A.2.5.2 Infrared Absorption Spectra

REs were calculated using a compound's room temperature infrared absorption spectrum. Absorption spectra were taken from the literature where possible. The Hodnebrog et al. (2020a) database of RE values, based on experimental literature infrared spectra, provides the reference for many of the RE values presented here.

In the absence of experimentally measured infrared absorption spectra, REs were determined based on theoretically calculated spectra, e.g. for HCFCs by Papanastasiou et al. (2018), HFCs by Burkholder et al. (2020), and fluoroesters by Bravo et al. (2011a). Theoretical methods have been applied to provide spectra for the compounds lacking RE values listed in Appendix A of the previous Assessment.

A.2.5.3 Stratospheric Temperature Adjustment

In the last Assessment, a generic 10% increase of the instantaneous radiative forcing was assumed for all compounds to account for stratospheric temperature adjustment, as in Hodnebrog et al. (2013). Here, the improved method of Shine and Myhre (2020) has been used. In contrast to the previous spectral RE curves, which yield instantaneous REs, Shine and Myhre (2020) included stratospheric temperature adjustment in the spectral RE curve by calculating the adjustment using a narrow-band model and applying this adjustment to the instantaneous RE curve derived using the LBL model. The magnitude of the stratospheric temperature adjustment is dependent on the infrared absorption spectrum of the compound and, in general, is in the 10 ± 5% range.

A.2.5.4 Lifetime Adjustment

The RE value calculations assume the compound is well mixed in the atmosphere. However, most compounds have a nonuniform vertical and horizontal distribution in the atmosphere. As in the last Assessment, the adjusted RE values reported in the summary table are lifetime adjusted using the approximate fractional correction (f) factors derived in Hodnebrog et al. (2013).

For compounds primarily removed by UV photolysis in the stratosphere, $f(\tau)=1-0.1826\tau^{-0.3339}$ (applicable for lifetimes of $10 < \tau < 10^4$ years). For compounds primarily removed by reaction with the OH radical, $f(\tau)=\frac{a\tau^b}{1+c\tau^d}$, where $a = 2.962$, $b = 0.9312$, $c = 2.994$, $d = 0.9302$ (applicable for $10^{-4} < \tau < 10^4$ years). Different factors were used for CFC-11 (0.927), CFC-12 (0.970), and halon-1211 (0.937) because explicit radiative transfer calculations are available for these compounds, for details see Hodnebrog et al. (2013). Note that OH radical fractional correction factors are particularly approximate for very short-lived compounds (VSLCs) due to the spatial and temporal dependence on their emissions.

A.2.5.5 Low-Frequency Infrared Absorption Adjustment

The vast majority of experimentally measured infrared absorption spectra do not provide data below ~500 cm^{-1}. There is, however, a component of the radiative forcing profile in this region. The larger molecules in particular that are included in **Table A-5** have low-frequency vibrations or torsions that would contribute a positive adjustment to their REs. We have performed a theoretically based survey of the molecules in the summary table to evaluate the low-frequency contribution. The adjustment needs to be considered on a molecule-by-molecule basis but is relatively small (0–5%) for the majority of the molecules in the table. The adjustment is generally larger for the larger (more carbon atoms) and heavier (higher molecular weight) molecules. The adjustments have been applied to the molecules in **Tables A-3** and **A-5**.

A.2.5.6 Tropospheric Adjustments and Effective Radiative Efficiency

In the last Assessment, stratospheric temperature adjustment was included in the radiative efficiencies while tropospheric adjustments were not. However, radiative efficiencies that also include tropospheric adjustments better represent the climate change response, e.g. the temperature response due to a perturbation in halocarbon concentrations. REs with tropospheric adjustments are denoted here as effective radiative efficiencies and are based on the concept of effective radiative forcing (ERF). IPCC AR6 defines ERF as the change in net downward radiative flux at the top of the atmosphere (TOA) following adjustments in both tropospheric and stratospheric temperature, water vapor, clouds, and some surface properties that are uncoupled to changes in global surface air temperature, see Forster et al. (2021). While REs without tropospheric adjustments can be calculated in offline radiation codes with high spectral resolution, calculations of effective REs typically rely on computationally expensive simulations with global climate models (GCMs), and this is currently not feasible for a large number of compounds. However, recent studies have quantified tropospheric adjustments: for CO_2, see Vial et al. (2013), Zhang and Huang (2014), and Smith et al. (2020; 2018); for CH_4 see Smith et al. (2018) and Modak et al. (2018), and for

Table A-3. Comparison between radiative efficiencies (RE) and effective radiative efficiencies, which include tropospheric adjustments. Here, stratospheric temperature adjustment, lifetime adjustment, and low-frequency infrared absorption adjustment are included for both RE and effective RE. Uncertainties are given as 5–95% confidence intervals.

	CO_2	CH_4	N_2O	CFC-11	CFC-12
RE ($W\ m^{-2}\ ppb^{-1}$)	$(1.27 \pm 0.13) \times 10^{-5}$	$(4.52 \pm 0.63) \times 10^{-4}$	$(2.98 \pm 0.30) \times 10^{-3}$	0.267 ± 0.037	0.320 ± 0.045
Effective RE ($W\ m^{-2}\ ppb^{-1}$)	$(1.33 \pm 0.16) \times 10^{-5}$	$(3.89 \pm 0.78) \times 10^{-4}$	$(3.19 \pm 0.51) \times 10^{-3}$	0.299 ± 0.057	0.358 ± 0.068

N_2O, CFC-11, and CFC-12 see Hodnebrog et al.(2020b), and effective REs for these compounds have been assessed in Forster et al. (2021). Specifically, tropospheric adjustments were estimated as +5 ± 5%, –14 ± 15%, +7 ± 13%, +13 ± 10%, and +12 ± 14%, respectively, of the REs (uncertainties are given as 5–95% confidence intervals), but an adjustment of 12% was used for both CFC-11 and CFC-12. For other halogenated compounds, tropospheric adjustments are assumed to be 0 ± 13% due to lack of calculations. The assessed tropospheric adjustments from AR6 are adopted here to calculate effective REs in **Tables A-3** and **A-5**.

Table A-3 shows a comparison of REs and effective REs for compounds where estimates of tropospheric adjustments are available. It is important to note that uncertainties associated with effective RE are larger than for RE, and magnitudes of tropospheric adjustments are generally associated with low confidence in AR6 (Forster et al., 2021). GCMs have less sophisticated radiation schemes than offline radiative transfer models, and unrealistically strong perturbations in concentrations are often needed to avoid noise caused by natural variability dominating the climate change signal, thus not accounting for possible nonlinear effects. The magnitudes of tropospheric adjustments, particularly for clouds, vary between different GCMs and between the different radiative kernel methods needed to separate individual adjustments from the instantaneous radiative forcing, see Smith et al. (2018) and Hodnebrog et al. (2020b). Another source of uncertainty arises because tropospheric adjustments are based on GCM simulations with fixed sea surface temperatures while, ideally, temperatures over land should also have been held fixed, see Andrews et al. (2021). In the effective RE estimates here, the radiative response to land surface temperature change is only partially accounted for, see Section 7.3.1 in Forster et al. (2021) for further discussion.

The total radiative forcing uncertainty for halogenated compounds is estimated to be ~14% for compounds with lifetimes >~5 years and ~24% for compounds with lifetimes <~5 years, see Hodnebrog et al. (2020a). These numbers increase to 19% and 26%, respectively, for effective RE uncertainty. For CO_2, CH_4, and N_2O, the effective RE uncertainty is 12%, 20%, and 16%, respectively, from Forster et al. (2021).

A.2.6 Global Warming Potential (GWP)

Absolute Global Warming Potentials (AGWPs). Radiative metrics reported here (GWPs and global temperature change potentials [GTPs]) are calculated relative to CO_2 and based on a 2019 CO_2 abundance of 409.9 ppm. The response of the carbon cycle to an instantaneous pulse of CO_2 emissions, known as the impulse response function, is unchanged from the last Assessment and taken from Joos et al. (2013). The CO_2 AGWPs for the 20-, 100-, and 500-year time horizons are 2.434×10^{-14}, 8.947×10^{-14}, and 3.138×10^{-13} W m^{-2} yr kg^{-1}, respectively, and are consistent with the values reported in IPCC AR6 (Forster et al., 2021).

A.2.7 Global Temperature Change Potential (GTP)

Absolute Global Temperature Change Potentials (AGTPs). The CO_2 AGTPs for the 50- and 100-year time horizons are 4.277×10^{-16} and 3.946×10^{-16} K kg^{-1}, respectively, and are consistent with the values reported in IPCC AR6 (Forster et al., 2021). These values are approximately 30% smaller than those used in the last Assessment, and this is mainly because of updates to

Table A-4. Comparison of GWP and GTP values for a selection of compounds when climate-carbon feedback is: included for CO_2 only as in WMO (2018), excluded for all compounds as in Hodnebrog et al. (2020a), and included for both CO_2 and non-CO_2 compounds. The impulse response function is from Gasser et al. (2017) instead of Joos et al. (2013), to be able to exclude the climate-carbon feedback for CO_2, and the contribution from low-frequency wavenumbers to the RE is not included here. Thus, the GWP and GTP values with climate-carbon feedback included for all compounds are slightly different from the recommended values in **Table A-5**.

	Climate-Carbon Feedback						
	CO_2	Compound	GWP (20)	GWP (100)	GWP (500)	GTP (50)	GTP (100)
CFC-11							
	✓	–	8110	5910	1980	5950	3270
	–	–	8370	6360	2230	6450	3620
	✓	✓	8290	6210	2100	6340	3520
CFC-12							
	✓	–	12,400	11,900	5400	12,500	9700
	–	–	12,800	12,800	6080	13,600	10,800
	✓	✓	12,700	12,500	5720	13,200	10,300
HCFC-22							
	✓	–	5440	1800	516	633	334
	–	–	5610	1940	581	687	370
	✓	✓	5580	1900	546	742	366
CH_3CCl_3							
	✓	–	549	152	44	30	27
	–	–	566	164	49	33	30
	✓	✓	565	161	46	37	30

the global surface temperature response function, see Section 7.6.1.2 in Forster et al. (2021) for details, affecting both the AGTP for CO_2 and the AGTPs for the non-CO_2 compounds.

A.3 CLIMATE-CARBON FEEDBACK

Compounds that warm the surface due to their direct radiative forcing also influence climate indirectly through perturbations of carbon fluxes. When the surface warms, a net flux of CO_2 goes into the atmosphere and leads to further warming, known as the climate-carbon feedback, for example see Gasser et al. (2017). In the previous Assessment, climate-carbon feedbacks were included for CO_2, while no climate feedbacks were included for the other compounds. Here, climate-carbon feedbacks are included for all components, consistent with IPCC AR6 Section 7.6.1.3 (Forster et al., 2021). **Table A-4** shows metric values for different combinations of climate-carbon feedback and illustrates the bias introduced when this feedback is included only for CO_2 and not for the non-CO_2 compounds. Excluding the climate-carbon feedback completely generally leads to smaller differences against values with the feedback included for both CO_2 and non-CO_2 compounds.

A.4 INDIRECT EFFECTS

The climate metric values presented in **Table A-5** are due to the direct radiative effect only. This means that the negative radiative forcing resulting from stratospheric ozone depletion by ODSs is not included in these estimates. In some cases, these can be large and potentially offset the direct effect, see *Section 7.3.2* and **Table 7A-1** for further information. Indirect effects of methane (e.g., through production of ozone and stratospheric water vapor) and nitrous oxide (through methane lifetime reduction and stratospheric ozone depletion) are also not included here. Non-methane hydrocarbons generally have small direct radiative effects, and it is important to note that their indirect effects, mainly through tropospheric ozone production and changes in methane lifetime, can be significant as reported by Collins et al. (2002) and Hodnebrog et al. (2018). There are also indirect effects caused by degradation of halogenated compounds, see Burkholder et al. (2015), where some breakdown products have high GWP values as reported in Jubb et al. (2015) and Bravo et al. (2011a) and discussed in *Section 7.2.5*.

A.5 METRIC UNCERTAINTIES

Uncertainties in GWP and GTP values for halogenated compounds depend on several factors: lifetime, radiative efficiency, global surface temperature response function (for GTP), and the radiative efficiency and impulse response function for CO_2. Contributions from these factors to the radiative metrics were explored for four halogenated compounds (CFC-11, PFC-14, HFC-134a, and HFC-32) in IPCC AR6, and the total uncertainty in GWP and GTP values typically range from 30% to 60% (5–95% confidence interval) for the metrics and time horizons considered here, see Supplementary Tables 7.SM.10–7.SM.13 in Smith et al. (2021) for details. Note that metrics based solely on theoretically calculated infrared absorption spectra will, in general, have even greater uncertainties.

Table A-5. Atmospheric abundances; lifetimes; radiative efficiencies (REs); direct effect Global Warming Potentials (GWPs) for 20-, 100-, and 500-year time horizons; and Global Temperature Change Potentials (GTPs) for 50- and 100-year time horizons

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
Carbon dioxide	CO_2	124-38-9	412.5 ppm			
Methane, non-fossil	CH_4	74-82-8	1879 ppb	12.4	11.8	
Methane, fossil	CH_4	74-82-8		12.4	11.8	
Nitrous oxide	N_2O	10024-97-2	333.0 ppb	123	109	
Hydrocarbons						
Ethane	CH_3CH_3	74-84-0			76 days	76 days
Ethene	$CH_2{=}CH_2$	74-85-1			1.7 days	1.7 days
Acetylene	HCCH	74-86-2			0.1 days	0.1 days
Propene	$CH_2{=}CHCH_3$	115-07-1		0.4 days (0.27–0.50 days)	0.4 days (0.27–0.50 days)	0.4 days
Propane, R-290	$CH_3CH_2CH_3$	74-98-6		15 days (9.9–27 days)	15 days (9.9–27 days)	15 days
n-butane	$CH_3CH_2CH_2CH_3$	106-97-8			6.5 days	6.5 days
Isobutane, R-600a	$(CH_3)_2CHCH_3$	75-28-5		7 days (5.2–10.7 days)	7.0 days (5.2–10.7 days)	7.0 days
Isobutene	$(CH_3)_2C{=}CH_2$	115-11-7		0.2 days (0.15–0.29 days)	0.2 days (0.15–0.29 days)	0.2 days
n-pentane	$CH_3CH_2CH_2CH_2CH_3$	109-66-0		3 days (2.7–6.5 days)	4.0 days (2.7–6.5 days)	4.0 days
Isopentane	$(CH_3)_2CHCH_2CH_3$	78-78-4		4 days (2.9–6.0 days)	3.9 days (2.9–6.0 days)	3.9 days
Cyclopentane	$c\text{-}CH_2CH_2CH_2CH_2CH_2$	287-92-3		3 days (2.2–5.3 days)	3.2 days (2.2–5.3 days)	3.2 days
Benzene	C_6H_6	71-43-2			~10.0 days	10.0 days
Toluene	C_7H_8	108-88-3			~29 days	29 days
Oxygenated Hydrocarbons						
Formaldehyde	CH_2O	50-00-0		–	0.08 days	1.6 days
Ethanol	CH_3CH_2OH	64-17-5		–	4.1 days	4.1 days
Acetaldehyde	CH_3CHO	75-07-0		–	0.7 days	0.8 days
Methyl formate	CH_3OCHO	107-31-3		87 days (60–143 days)	86 days	87 days
Acetone	$CH_3C(O)CH_3$	67-64-1		–	26 days	87 days
Isopropanol	$(CH_3)_2CHOH$	67-63-0		2 days (1.5–2.9 days)	2.4 days (1.5–2.9 days)	2.4 days
Methylal	$CH_3OCH_2OCH_3$	109-87-5		2 days (1.5–2.8 days)	2.6 days (1.5–2.8 days)	2.6 days
Chlorofluorocarbons						
CFC-11	CCl_3F	75-69-4	224 ppt	52	52	–
CFC-12	CCl_2F_2	75-71-8	497.2 ppt	102	102	–
CFC-13	$CClF_3$	75-72-9	3.32 ppt	640	640	–
CFC-112	CCl_2FCCl_2F	76-12-0	0.39 ppt	63.6	63.6	–
CFC-112a	$CClF_2CCl_3$	76-11-9	0.08 ppt	52	52	–
CFC-113	CCl_2FCClF_2	76-13-1	68.9 ppt	93	93	–
CFC-113a	CCl_3CF_3	354-58-5	0.95 ppt	55	55	–
CFC-114	$CClF_2CClF_2$	76-14-2	16.3 ppt	189	189	–
CFC-114a	CCl_2FCF_3	374-07-2	1.11 ppt	105	105	–
CFC-115	$CClF_2CF_3$	76-15-3	8.7 ppt	540	540	–
CFC-216ba	$CClF_2CClFCF_3$	–	38 ppq	135	135	–
CFC-216ca	$CClF_2CF_2CClF_2$	–	20 ppq	~135	~135	–
(E)-R316c ((E)-1,2-dichlorohexa-fluoro-cyclobutane)	(E)-1,2-c-$C_4F_6Cl_2$	3832-15-3		75	75	–
(Z)-R316c ((Z)-1,2-dichlorohexa-fluoro-cyclobutane)	(Z)-1,2-c-$C_4F_6Cl_2$	3934-26-7		114	114	–
1,2,3,4-Tetrachlorohexafluoro-butane (TCHFB)	$C_4Cl_4F_6$	375-45-1			>50	–
Hydrochlorofluorocarbons						
HCFC-21	$CHFCl_2$	75-43-4		1.7	1.71	1.82

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) (W m^{-2} ppb^{-1}) [b]	Recommended Adjusted Effective Radiative Efficiency (W m^{-2} ppb^{-1}) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance* *L: Lifetime* *O: Ozone Depletion Potential* *R: Radiative Metrics*
	0		1.33E-05	1	1	1	1	1	A1, O1, R1
	0		3.89E-04	79.7	27	7.25	10.4	4.72	A1, L1, O1, R1
	0		3.89E-04	82.5	29.8	9.99	13.2	7.46	O1, R1
	0.017		3.20E-03	273	273	130	290	233	A1, L1, O2, R1
–	0	0.004	1.61E-03	3	<1	<1	<1	<1	L2, R2
–	0	0.039	7.75E-04	<<1	<<1	<<1	<<1	<<1	L2, R2
–	0	0.041	5.91E-05	<<1	<<1	<<1	<<1	<<1	L2, R2
–	0	0.031	1.65E-04	<<1	<<1	<<1	<<1	<<1	L2, O1, R3
–	0	0.003	3.96E-04	<<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.004	2.60E-04	<<1	<<1	<<1	<<1	<<1	L2
–	0	0.004	2.87E-04	<<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.023	7.38E-05	<<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.023	2.11E-04	<<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.006	2.57E-04	<<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.006	1.41E-04	<<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.003	2.82E-04	<<1	<<1	<<1	<<1	<<1	L3, O1, R2
–	0	0.014	1.54E-03	<1	<<1	<<1	<<1	<<1	L3, O1, R2
–	0	0.004	4.60E-06	<<1	<<1	<<1	<<1	<<1	L2, O1, R3
–	0	0.044	2.20E-03	<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.017	1.80E-04	<<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.108	4.90E-02	46	13	4	3	2	L2, O1, R2
–		0.027	6.10E-03	2	<1	<1	<1	<<1	L2, R2
–	0	0.06	1.80E-03	<<1	<<1	<<1	<<1	<<1	L2, O1, R3
–	0	0.169	6.40E-03	<1	<<1	<<1	<<1	<<1	L2, O1, R2
55	1	0.28	0.299	8560	6410	2150	6540	3640	A2, L4, L5, R4
103	0.75	0.33	0.358	12,700	12,500	5710	13,200	10,400	A2, L4, L5, O3, O4, R4
–	0.3	0.284	0.279	12,400	16,300	17,600	17,100	18,900	A2, L6, O5, R2
65.4	0.98	0.295	0.281	5600	4600	1670	4800	3010	A2, L4, L7, O6, R5
53.8	0.86	0.258	0.246	4750	3550	1190	3620	2020	A2, L4, L7, O6, R5
94.5	0.82	0.314	0.302	6870	6530	2840	6920	5220	A2, L4, L5, O3, O4, R2
57.5	0.73	0.253	0.241	5110	3930	1350	4030	2320	A2, L4, L7, O6, R5
191	0.53	0.325	0.315	8280	9450	6160	10,000	9430	A2, L4, L5, O3, O4, R2
106.7	0.72	0.309	0.297	7490	7410	3440	7870	6230	A2, L4, L7, O6, R5
664	0.45	0.252	0.247	7430	9630	9910	10,100	11,000	A2, L5, L8, O3, R2
135	0.35	0.42	0.406	8090	8580	4610	9110	7860	A2, L9, O7, R6
~135	~0.35	0.37	0.357	7110	7540	4050	8010	6910	A2, L9, O7, R6
76	0.46	0.282	0.273	4870	4290	1670	4510	3080	L10, O8, R7
115	0.54	0.311	0.302	5630	5710	2780	6060	4940	L10, O8, R7
–	–	0.46	0.439	5640	4140	1370	4200	2280	L3, R6
29.8	0.036	0.176	0.145	578	161	46	36	29	L2, L11, O9, R2

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HCFC-22	CHF_2Cl	75-45-6	247.8 ppt	11.9	11.6	13
HCFC-31	CH_2FCl	593-70-4	0.11 ppt	1.2	1.29	1.33
HCFC-121	$CHCl_2CCl_2F$	354-14-3		1.11	1.1	1.17
HCFC-121a	$CHClFCCl_3$	354-11-0		2.67	2.67	2.96
HCFC-122	$CHCl_2CClF_2$	354-21-2		0.9	0.912	0.955
HCFC-122a	$CHClFCCl_2F$	354-15-4		3.1	3.11	3.43
HCFC-122b	CHF_2CCl_3	354-12-1		9.31	9.3	12.6
HCFC-123	$CHCl_2CF_3$	306-83-2		1.3	1.31	1.38
HCFC-123a	$CHClFCClF_2$	354-23-4		4	4.03	4.31
HCFC-123b	CHF_2CCl_2F	812-04-4		11.8	11.8	15.1
HCFC-124	$CHClFCF_3$	2837-89-0	1.1 ppt	5.9	5.9	6.28
HCFC-124a	CHF_2CClF_2	354-25-6		17	17	19
HCFC-131	$CHCl_2CHClF$	359-28-4		0.76	0.756	0.786
HCFC-131a	CH_2ClCCl_2F	811-95-0		2.57	2.57	2.8
HCFC-131b	CH_2FCCl_3	2366-36-1		2.33	2.324	2.55
HCFC-132	CHClFCHClF	25915-78-0		1.73	1.73	1.81
HCFC-132a	$CHCl_2CHF_2$	471-43-2		1.12	1.12	1.18
HCFC-132b	$CH_2ClCClF_2$	1649-08-7	0.14 ppt	3.5	3.5	3.73
HCFC-132c	CH_2FCCl_2F	1842-05-3		4.1	4.08	4.52
HCFC-133	$CHClFCHF_2$	431-07-2		3.1	3.06	3.21
HCFC-133a	CH_2ClCF_3	75-88-7	0.45 ppt	4.6	4.48	4.74
HCFC-133b	CH_2FCClF_2	421-04-5		7.2	7.2	7.71
HCFC-141	$CH_2ClCHClF$	430-57-9		1.14	1.14	1.19
HCFC-141a	CH_2FCHCl_2	430-53-5		0.5	0.497	0.51
HCFC-141b	CH_3CCl_2F	1717-00-6	24.5 ppt	9.4	8.81	10.7
HCFC-142	CH_2ClCHF_2	338-65-8		2.6	2.61	2.73
HCFC-142a	$CH_2FCHClF$	338-64-7		1.58	1.58	1.64
HCFC-142b	CH_3CClF_2	75-68-3	21.7 ppt	18	17.1	19.3
HCFC-151	CH_2ClCH_2F	762-50-5		0.49	0.488	0.5
HCFC-151a	CH_3CHClF	1615-75-4		1.16	1.16	1.2
HCFC-221aa	$CHCl_2CCl_2CCl_2F$	422-28-6		0.93	0.933	0.979
HCFC-221ab	$CHClFCCl_2CCl_3$	422-26-4		2.67	2.67	2.96
HCFC-221ba	$CHCl_2CClFCCl_3$	422-40-2		1.11	1.1	1.17
HCFC-221da	$CCl_3CHClCCl_2F$	431-79-8		3.29	3.29	3.71
HCFC-221ea	$CCl_3CHFCCl_3$	–		3.52	3.51	3.99
HCFC-222aa	$CHCl_2CCl_2CClF_2$	422-30-0		1.11	1.1	1.17
HCFC-222ab	$CHClFCCl_2CCl_2F$	147728-31-2		2.67	2.67	2.96
HCFC-222ac	$CHF_2CCl_2CCl_3$	422-27-5		9.29	9.28	12.6
HCFC-222ba	$CHCl_2CClFCCl_2F$	146254-26-4		1.11	1.1	1.17
HCFC-222bb	$CHClFCClFCCl_3$	147728-30-1		3.15	3.15	3.54
HCFC-222ca	$CHCl_2CF_2CCl_3$	422-49-1		1.38	1.38	1.47
HCFC-222da	$CCl_2FCHClCCl_2F$	431-82-3		4.48	4.48	5.23
HCFC-222db	$CCl_3CHClCClF_2$	431-80-1		4.62	4.62	5.42
HCFC-222ea	$CCl_3CHFCCl_2F$	146254-25-3		4.68	4.67	5.49
HCFC-223aa	$CHCl_2CCl_2CF_3$	422-35-5		1.11	1.1	1.17
HCFC-223ab	$CHClFCCl_2CClF_2$	144909-54-6		3.18	3.18	3.54
HCFC-223ac	$CHF_2CCl_2CCl_2F$	422-29-7		9.29	9.28	12.6
HCFC-223ba	$CHCl_2CClFCClF_2$	422-41-3		1.39	1.38	1.47
HCFC-223bb	$CHClFCClFCCl_2F$	145599-91-3		3.18	3.18	3.54

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W m^{-2} ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W m^{-2} ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance* *L: Lifetime* *O: Ozone Depletion Potential* *R: Radiative Metrics*
120	0.038	0.223	0.214	5610	1910	546	744	368	A2, L5, L11, O3, R2
36.7	0.019	0.088	0.068	307	85	24	19	15	A2, L2, O9, R8
20	0.03	0.193	0.147	209	58	17	13	10	L12, O10, R2
27.4	0.066	0.197	0.172	592	165	47	37	30	L12, O10, R9
20	0.022	0.22	0.16	207	57	16	13	10	L12, O9, R2
33.8	0.067	0.227	0.203	891	248	71	56	45	L12, O9, R2
35.5	0.17	0.221	0.211	2440	772	220	239	145	L12, O10, R9
25.7	0.02	0.203	0.16	329	91	26	20	17	L2, O3, R2
62.9	0.039	0.25	0.228	1430	400	114	91	73	L2, O9, R2
53.8	0.124	0.248	0.238	3570	1220	349	485	236	L12, O10, R9
105	0.022	0.222	0.207	2060	596	170	143	110	A3, L2, O3, R2
161	0.026	0.258	0.251	5140	2080	595	1220	450	L12, O10, R2
20	0.019	0.14	0.097	116	32	9	7	6	L12, O10, R9
31.4	0.056	0.184	0.16	650	181	52	41	33	L12, O10, R9
26.2	0.054	0.145	0.125	460	128	36	29	23	L12, O10, R9
39.1	0.025	0.174	0.147	452	126	36	28	23	L12, O10, R2
23.9	0.02	0.167	0.129	257	71	20	16	13	L12, O10, R2
57.5	0.038	0.214	0.192	1190	332	95	75	61	A2, L2, O10, R9
41.8	0.062	0.186	0.171	1230	345	98	79	63	L2, O9, R2
67.8	0.017	0.195	0.173	1070	298	85	67	54	L12, O10, R9
82.6	0.019	0.164	0.15	1340	378	108	87	69	A2, L13, O9, R10
110	0.024	0.218	0.206	2800	834	238	215	155	L12, O10, R9
29.5	0.022	0.094	0.0745	174	48	14	11	9	L12, O10, R2
20	0.011	0.095	0.0573	58	16	5	4	3	L12, O10, R9
49.4	0.102	0.168	0.161	2590	808	231	239	152	A2, L5, L11, O3, R2
60.1	0.019	0.125	0.109	678	189	54	42	34	L12, O10, R9
42.3	0.015	0.136	0.111	419	116	33	26	21	L12, O10, R9
148	0.057	0.199	0.194	5400	2190	628	1300	477	A2, L5, L11, O3, R2
20	0.008	0.049	0.0295	42	12	3	3	2	L12, O10, R9
33.2	0.015	0.08	0.0617	208	58	16	13	10	L12, O10, R9
20	0.027	0.24	0.175	146	41	12	9	7	L12, O10, R9
27.4	0.069	0.197	0.172	409	114	32	26	21	L12, O10, R9
20	0.032	0.221	0.168	165	46	13	10	8	L12, O10, R9
29	0.083	0.259	0.231	675	189	54	43	34	L12, O10, R9
29.5	0.088	0.238	0.214	666	186	53	42	34	L12, O10, R9
20	0.028	0.285	0.216	226	63	18	14	11	L12, O10, R9
27.4	0.061	0.257	0.224	567	158	45	35	29	L12, O10, R9
35.2	0.191	0.224	0.214	1660	525	150	162	99	L12, O10, R9
20	0.028	0.268	0.204	213	59	17	13	11	L12, O10, R9
28.6	0.071	0.217	0.193	576	161	46	36	29	L12, O10, R9
21.6	0.034	0.253	0.201	264	73	21	16	13	L12, O10, R9
31.2	0.097	0.292	0.267	1120	316	90	73	58	L12, O10, R9
31.4	0.1	0.273	0.251	1080	306	87	71	56	L12, O10, R9
31.4	0.101	0.26	0.239	1040	295	84	68	54	L12, O10, R9
20	0.024	0.256	0.194	217	60	17	13	11	L12, O10, R9
31.4	0.059	0.308	0.274	883	246	70	56	45	L12, O10, R9
35.2	0.164	0.297	0.282	2340	739	211	229	139	L12, O10, R9
23.1	0.029	0.316	0.251	352	98	28	22	18	L12, O10, R9
31.4	0.059	0.258	0.23	741	207	59	47	38	L12, O10, R9

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HCFC-223bc	$CHF_2CClFCCl_3$	147728-32-3		10.6	10.6	15.1
HCFC-223ca	$CHCl_2CF_2CCl_2F$	422-52-6		1.38	1.38	1.47
HCFC-223cb	$CHClFCF_2CCl_3$	422-50-4		3.88	3.88	4.45
HCFC-223da	$CCl_2FCHClCClF_2$	431-83-4		6.48	6.48	7.86
HCFC-223db	$CCl_3CHClCF_3$	431-81-2		6.47	6.47	8.02
HCFC-223ea	$CCl_2FCHFCCl_2F$	–		6.28	6.28	7.74
HCFC-223eb	$CCl_3CHFCClF_2$	54002-59-4		6.46	6.47	8.02
HCFC-224aa	$CHClFCCl_2CF_3$	139754-75-9		3.15	3.15	3.54
HCFC-224ab	$CHF_2CCl_2CClF_2$	422-32-2		11.3	11.3	15.1
HCFC-224ba	$CHCl_2CClFCF_3$	422-47-9		1.39	1.39	1.47
HCFC-224bb	$CHClFCClFCClF_2$	422-42-4		4.1	4.09	4.45
HCFC-224bc	$CHF_2CClFCCl_2F$	139754-76-0		11.3	11.3	15.1
HCFC-224ca	$CHCl_2CF_2CClF_2$	422-54-8		1.79	1.8	1.92
HCFC-224cb	$CHClFCF_2CCl_2F$	422-53-7		1.57	1.57	1.64
HCFC-224cc	$CHF_2CF_2CCl_3$	422-51-5		12.5	12.5	19
HCFC-224da	$CClF_2CHClCClF_2$	431-85-6		10.4	10.4	12.3
HCFC-224db	$CCl_2FCHClCF_3$	431-84-5		9.39	9.4	12
HCFC-224ea	$CCl_2FCHFCClF_2$	53063-53-9		9.16	9.15	11.6
HCFC-224eb	CCl_3CHFCF_3	53063-52-8		8.88	8.9	11.9
HCFC-225aa	$CHF_2CCl_2CF_3$	128903-21-9		11.8	11.8	15.1
HCFC-225ba	$CHClFCClFCF_3$	422-48-0		4.2	4.2	4.45
HCFC-225bb	$CHF_2CClFCClF_2$	422-44-6		15.9	16	19
HCFC-225ca	$CHCl_2CF_2CF_3$	422-56-0		1.9	1.9	2.03
HCFC-225cb	$CHClFCF_2CClF_2$	507-55-1		5.9	5.77	6.26
HCFC-225cc	$CHF_2CF_2CCl_2F$	13474-88-9		14.1	14.1	19
HCFC-225da	$CClF_2CHClCF_3$	431-86-7		16.3	16.3	19.5
HCFC-225ea	$CClF_2CHFCClF_2$	136013-79-1		15.3	15.3	18.1
HCFC-225eb	$CCl_2FCHFCF_3$	51346-64-6		13.4	13.4	17.7
HCFC-226ba	$CHF_2CClFCF_3$	422-57-1		17	17	19
HCFC-226ca	$CHClFCF_2CF_3$	422-55-9		5.47	5.48	5.8
HCFC-226cb	$CHF_2CF_2CClF_2$	431-87-8		21.6	21.6	24.7
HCFC-226da	$CF_3CHClCF_3$	359-58-0		27.7	27.7	32.6
HCFC-226ea	$CClF_2CHFCF_3$	51346-64-6		24.9	24.8	28.8
HCFC-231aa	$CHCl_2CCl_2CHClF$	–		0.799	0.805	0.839
HCFC-231ab	$CH_2ClCCl_2CCl_2F$	1538604-29-3		1.61	1.61	1.73
HCFC-231ac	$CH_2FCCl_2CCl_3$	–		2.33	2.32	2.55
HCFC-231ba	$CHCl_2CClFCHCl_2$	–		0.56	0.569	0.586
HCFC-231bb	$CH_2ClCClFCCl_3$	421-94-3		2.54	2.54	2.8
HCFC-231da	$CHCl_2CHClCCl_2F$	1538604-31-7		0.54	0.542	0.557
HCFC-231db	$CHClFCHClCCl_3$	1943659-45-7		1.34	1.34	1.43
HCFC-231ea	$CHCl_2CHFCCl_3$	–		0.76	0.768	0.799
HCFC-231fa	$CCl_2FCH_2CCl_3$	313696-58-1		6.26	6.26	7.71
HCFC-232aa	$CHClFCCl_2CHClF$	–		1.65	1.65	1.77
HCFC-232ab	$CHCl_2CCl_2CHF_2$	872817-81-7		1.01	1.02	1.07
HCFC-232ac	$CH_2ClCCl_2CClF_2$	1538604-30-6		2.56	2.56	2.8
HCFC-232ad	$CH_2FCCl_2CCl_2F$	–		2.33	2.32	2.55
HCFC-232ba	$CHCl_2CClFCHClF$	–		0.99	0.989	1.04
HCFC-232bb	$CH_2ClCClFCCl_2F$	1943659-44-6		2.56	2.56	2.8
HCFC-232bc	$CH_2FCClFCCl_3$	–		3.64	3.63	4.14

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W\ m^{-2}\ ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W\ m^{-2}\ ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance L: Lifetime O: Ozone Depletion Potential R: Radiative Metrics*
35.7	0.185	0.254	0.242	2200	725	207	256	138	L12, O10, R9
21.6	0.029	0.29	0.23	323	90	26	20	16	L12, O10, R9
30.2	0.073	0.259	0.235	919	258	73	59	47	L12, O10, R9
37.1	0.111	0.321	0.301	1880	551	157	136	102	L12, O10, R9
33.4	0.117	0.245	0.229	1430	419	119	103	78	L12, O10, R9
33.2	0.114	0.292	0.273	1660	485	138	118	90	L12, O10, R9
33.4	0.117	0.271	0.254	1590	464	132	114	86	L12, O10, R9
28.9	0.049	0.278	0.247	847	236	67	53	43	L12, O10, R9
44.6	0.141	0.314	0.301	3060	1030	295	390	198	L12, O10, R9
24.5	0.023	0.268	0.213	324	90	26	20	16	L12, O10, R9
51.2	0.047	0.304	0.277	1230	344	98	79	63	L12, O10, R9
44.6	0.141	0.318	0.305	3100	1050	299	396	201	L12, O10, R9
27.5	0.028	0.312	0.259	509	142	40	32	26	L12, O10, R9
35	0.022	0.301	0.244	419	116	33	26	21	L12, O10, R9
36.7	0.174	0.322	0.31	3350	1180	336	498	229	L12, O10, R9
67.1	0.096	0.36	0.344	3310	1090	310	376	206	L12, O10, R9
43.4	0.119	0.298	0.284	2550	811	231	254	153	L12, O10, R9
43.3	0.117	0.324	0.308	2710	856	244	261	161	L12, O10, R9
35.3	0.126	0.247	0.234	2020	633	180	189	119	L12, O10, R9
53.8	0.094	0.279	0.268	3030	1040	296	412	200	L12, O10, R9
74.3	0.025	0.279	0.254	1250	350	100	80	64	L12, O10, R9
99.5	0.069	0.326	0.315	4210	1650	472	915	347	L12, O10, R9
31.5	0.025	0.262	0.22	494	137	39	31	25	L5, O3, R2
73.3	0.033	0.314	0.294	1930	557	159	133	103	L5, O3, R2
55.2	0.11	0.355	0.342	4280	1580	452	766	318	L12, O10, R9
100	0.071	0.313	0.303	4090	1620	463	914	343	L12, O10, R9
98.7	0.068	0.35	0.339	4430	1700	486	900	351	L12, O10, R9
54.8	0.105	0.299	0.288	3500	1270	362	579	251	L12, O10, R9
161	0.019	0.278	0.27	4040	1630	468	963	354	L12, O10, R9
98	0.013	0.28	0.26	1780	509	145	120	94	L12, O10, R9
174	0.022	0.351	0.342	5680	2610	753	1890	665	L12, O10, R9
185	0.025	0.28	0.274	4960	2630	774	2230	842	L12, O10, R9
180	0.023	0.317	0.309	5400	2680	782	2140	773	L12, O10, R9
20	0.022	0.173	0.122	101	28	8	6	5	L12, O10, R9
23	0.042	0.212	0.173	285	79	23	18	14	L12, O10, R9
26.2	0.058	0.173	0.148	351	98	28	22	18	L12, O10, R9
20	0.015	0.174	0.11	64	18	5	4	3	L12, O10, R9
26.9	0.063	0.18	0.156	405	113	32	25	21	L12, O10, R9
20	0.015	0.209	0.13	72	20	6	4	4	L12, O10, R9
21.3	0.036	0.172	0.136	187	52	15	11	9	L12, O10, R9
20	0.021	0.184	0.127	100	28	8	6	5	L12, O10, R9
33.2	0.143	0.206	0.193	1180	344	98	84	64	L12, O10, R9
245	0.036	0.208	0.17	309	86	24	19	16	L12, O10, R9
20	0.024	0.188	0.14	157	44	12	10	8	L12, O10, R9
29.4	0.053	0.248	0.216	608	169	48	38	31	L12, O10, R9
26.2	0.05	0.24	0.206	526	146	42	33	27	L12, O10, R9
20	0.023	0.213	0.157	171	48	14	10	9	L12, O10, R9
29.4	0.053	0.247	0.215	605	168	48	38	31	L12, O10, R9
29.7	0.075	0.219	0.197	782	219	62	50	40	L12, O10, R9

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HCFC-232ca	$CHCl_2CF_2CHCl_2$	1112-14-7		0.7	0.711	0.737
HCFC-232cb	$CH_2ClCF_2CCl_3$	677-54-3		4.47	4.46	5.21
HCFC-232da	$CHCl_2CHClCClF_2$	67879-59-8		0.82	0.824	0.859
HCFC-232db	$CHClFCHClCCl_2F$	1943659-46-8		1.51	1.51	1.61
HCFC-232dc	$CHF_2CHClCCl_3$	–		2.83	2.83	3.15
HCFC-232ea	$CHCl_2CHFCCl_2F$	–		0.83	0.836	0.872
HCFC-232eb	$CHClFCHFCCl_3$	–		2.04	2.04	2.22
HCFC-232fa	$CCl_2FCH_2CCl_2F$	313696-57-0		9.23	9.22	12.5
HCFC-232fb	$CCl_3CH_2CClF_2$	460-89-9		10.2	10.2	14.4
HCFC-233aa	$CHClFCCl_2CHF_2$	–		2.63	2.63	2.87
HCFC-233ab	$CH_2ClCCl_2CF_3$	7125-83-9		2.57	2.57	2.8
HCFC-233ac	$CH_2FCCl_2CClF_2$	–		3.71	3.7	4.14
HCFC-233ba	$CHClFCClFCHClF$	–		2.1	2.11	2.23
HCFC-233bb	$CHCl_2CClFCHF_2$	13058-99-6		1.27	1.27	1.34
HCFC-233bc	$CH_2ClCClFCClF_2$	421-95-4		4.75	4.75	5.21
HCFC-233bd	$CH_2FCClFCCl_2F$	–		3.71	3.7	4.14
HCFC-233ca	$CHCl_2CF_2CHClF$	131221-36-8		1.27	1.27	1.34
HCFC-233cb	$CH_2ClCF_2CCl_2F$	421-99-8		4.57	4.57	5.21
HCFC-233cc	$CH_2FCF_2CCl_3$	131211-71-7		6.26	6.26	7.71
HCFC-233da	$CHCl_2CHClCF_3$	431-51-6		0.896	0.897	0.939
HCFC-233db	$CHClFCHClCClF_2$	1943659-38-8		2.37	2.37	2.52
HCFC-233dc	$CHF_2CHClCCl_2F$	–		3.55	3.56	3.96
HCFC-233ea	$CHCl_2CHFCClF_2$	–		0.982	0.981	1.03
HCFC-233eb	$CHClFCHFCCl_2F$	54377-32-1		2.32	2.32	2.51
HCFC-233ec	$CHF_2CHFCCl_3$	54306-56-8		4.13	4.13	4.77
HCFC-233fa	$CCl_2FCH_2CClF_2$	333-26-6		15.4	15.4	23.3
HCFC-233fb	$CCl_3CH_2CF_3$	7125-84-0		16.4	16.4	29.3
HCFC-234aa	$CHF_2CCl_2CHF_2$	17705-30-5		6.51	6.51	7.54
HCFC-234ab	$CH_2FCCl_2CF_3$	149329-24-8		3.76	3.76	4.14
HCFC-234ba	$CHClFCClFCHF_2$	425-94-5		3.39	3.4	3.61
HCFC-234bb	$CH_2ClCClFCF_3$	149329-25-9		4.84	4.83	5.21
HCFC-234bc	$CH_2FCClFCClF_2$	149329-26-0		7.01	7.01	7.71
HCFC-234ca	$CHClFCF_2CHClF$	70341-81-0		2.74	2.74	2.9
HCFC-234cb	$CHCl_2CF_2CHF_2$	4071-01-6		1.65	1.64	1.74
HCFC-234cc	$CH_2ClCF_2CClF_2$	422-00-5		9.46	9.43	10.6
HCFC-234cd	$CH_2FCF_2CCl_2F$	70192-63-1		6.64	6.64	7.71
HCFC-234da	$CHClFCHClCF_3$	146916-90-7		2.67	2.67	2.82
HCFC-234db	$CHF_2CHClCClF_2$	1945188-10-2		5.69	5.69	6.18
HCFC-234ea	$CHCl_2CHFCF_3$	53063-54-0		1.06	1.06	1.11
HCFC-234eb	$CHClFCHFCClF_2$	139754-77-1		2.88	2.87	3.04
HCFC-234ec	$CHF_2CHFCCl_2F$	–		5.32	5.33	6.04
HCFC-234fa	$CClF_2CH_2CClF_2$	76140-39-1		31	31	43.4
HCFC-234fb	$CCl_2FCH_2CF_3$	64712-27-2		45	37	97.8
HCFC-235ba	$CHF_2CClFCHF_2$	144429-90-3		8.8	8.81	9.5
HCFC-235bb	$CH_2FCClFCF_3$	230956-35-1		7.21	7.2	7.71
HCFC-235ca	$CH_2ClCF_2CF_3$	28103-66-4		9.82	9.78	10.6
HCFC-235cb	$CHClFCF_2CHF_2$	422-02-6		4.45	4.45	4.7
HCFC-235cc	$CH_2FCF_2CClF_2$	679-99-2		14.2	14.2	15.7
HCFC-235da	$CHF_2CHClCF_3$	134251-06-2		7.55	7.55	8.09

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) (W m^{-2} ppb^{-1}) [b]	Recommended Adjusted Effective Radiative Efficiency (W m^{-2} ppb^{-1}) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance L: Lifetime O: Ozone Depletion Potential R: Radiative Metrics*
20	0.017	0.185	0.125	98	27	8	6	5	L12, O10, R9
31.2	0.09	0.223	0.204	987	278	79	64	51	L12, O10, R9
20	0.019	0.244	0.172	156	43	12	10	8	L12, O10, R9
24	0.033	0.24	0.193	321	89	25	20	16	L12, O10, R9
27.8	0.06	0.204	0.179	556	155	44	35	28	L12, O10, R9
20	0.019	0.224	0.159	146	41	12	9	7	L12, O10, R9
25.1	0.045	0.209	0.176	395	110	31	25	20	L12, O10, R9
35.2	0.176	0.269	0.256	2280	722	206	222	136	L12, O10, R9
35.6	0.194	0.247	0.236	2260	736	210	250	140	L12, O10, R9
31.6	0.043	0.208	0.182	569	158	45	36	29	L12, O10, R9
31.4	0.042	0.221	0.192	587	163	47	37	30	L12, O10, R9
35.2	0.057	0.277	0.25	1090	306	87	69	56	L12, O10, R9
37.8	0.031	0.233	0.198	497	138	39	31	25	L12, O10, R9
23.3	0.023	0.216	0.168	254	71	20	16	13	L12, O10, R9
53.3	0.057	0.276	0.254	1410	399	114	92	73	L12, O10, R9
35.2	0.057	0.278	0.251	1100	307	88	70	56	L12, O10, R9
23.3	0.023	0.218	0.17	257	71	20	16	13	L12, O10, R9
37.3	0.069	0.268	0.246	1320	372	106	86	68	L12, O10, R9
33.2	0.1	0.258	0.242	1720	501	143	122	93	L12, O10, R9
20	0.017	0.196	0.142	152	42	12	9	8	L12, O10, R9
40.1	0.034	0.269	0.232	654	182	52	41	33	L12, O10, R9
34.8	0.055	0.266	0.239	1010	282	80	64	51	L12, O10, R9
20.4	0.019	0.239	0.177	207	57	16	13	10	L12, O10, R9
30.2	0.038	0.25	0.215	593	165	47	37	30	L12, O10, R9
30.6	0.068	0.254	0.23	1120	314	90	72	58	L12, O10, R9
45.7	0.207	0.327	0.316	4170	1610	459	856	333	L12, O10, R9
37.3	0.247	0.21	0.204	2780	1100	316	628	235	L12, O10, R9
47.4	0.062	0.211	0.198	1590	464	132	115	86	L12, O10, R9
40.8	0.039	0.238	0.215	1040	291	83	66	53	L12, O10, R9
56.9	0.028	0.237	0.212	930	260	74	59	47	L12, O10, R9
67	0.035	0.234	0.216	1330	376	107	87	69	L12, O10, R9
77.3	0.045	0.292	0.275	2340	695	198	177	129	L12, O10, R9
51	0.025	0.23	0.202	716	199	57	45	36	L12, O10, R9
29.2	0.02	0.24	0.196	417	116	33	26	21	L12, O10, R9
85.1	0.054	0.278	0.265	2830	900	257	283	170	L12, O10, R9
47.6	0.063	0.297	0.278	2260	665	190	166	123	L12, O10, R9
50.3	0.024	0.234	0.204	705	196	56	44	36	L12, O10, R9
71.6	0.039	0.289	0.268	1910	550	157	131	101	L12, O10, R9
23.1	0.014	0.213	0.16	220	61	17	14	11	L12, O10, R9
52.4	0.026	0.268	0.236	876	244	70	55	44	L12, O10, R9
45.1	0.052	0.293	0.272	1830	522	149	123	96	L12, O10, R9
108	0.132	0.353	0.346	6540	3700	1100	3300	1320	L12, O10, R9
59.7	0.35	0.272	0.267	5290	3310	1020	3140	1400	L2, O9, R9
121	0.018	0.235	0.223	2490	777	222	230	146	L12, O10, R9
110	0.017	0.254	0.239	2280	681	194	176	127	L12, O10, R9
126	0.018	0.223	0.212	2550	820	234	266	155	L12, O10, R9
85.2	0.014	0.255	0.2331	1450	410	117	94	75	L12, O10, R9
146	0.021	0.289	0.279	4220	1560	447	764	315	L12, O10, R9
112	0.017	0.244	0.23	2280	687	196	182	128	L12, O10, R9

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HCFC-235ea	$CHClFCHFCF_3$	134251-06-2		7.36	7.36	7.88
HCFC-235eb	$CHF_2CHFCClF_2$	162102-07-0		3.18	3.18	3.33
HCFC-235fa	$CClF_2CH_2CF_3$	677-55-4		61.7	61.8	88.6
HCFC-241aa	CH_2ClCCl_2CHClF	–		1.43	1.43	1.52
HCFC-241ab	$CH_2FCCl_2CHCl_2$	–		0.77	0.772	0.803
HCFC-241ac	$CH_3CCl_2CCl_2F$	7126-06-9		5.18	5.18	6.18
HCFC-241ba	$CH_2ClCClFCHCl_2$	3175-26-6		0.79	0.793	0.826
HCFC-241bb	$CH_3CClFCCl_3$	3175-25-5		7.76	7.74	10
HCFC-241da	$CHCl_2CHClCHClF$	21981-25-9		0.56	0.565	0.581
HCFC-241db	$CH_2ClCHClCCl_2F$	666-27-3		0.53	0.534	0.549
HCFC-241dc	$CH_2FCHClCCl_3$	84816-05-7		0.75	0.756	0.786
HCFC-241ea	$CHCl_2CHFCHCl_2$	–		0.42	0.42	0.429
HCFC-241eb	$CH_2ClCHFCCl_3$	–		1.05	1.05	1.11
HCFC-241fa	$CHCl_2CH_2CCl_2F$	175897-94-6		0.53	0.54	0.555
HCFC-241fb	$CHClFCH_2CCl_3$	23153-22-2		1.48	1.48	1.59
HCFC-242aa	$CHF_2CCl_2CH_2Cl$	–		2.13	2.12	2.29
HCFC-242ab	CH_2FCCl_2CHClF	–		1.78	1.78	1.91
HCFC-242ac	$CH_3CCl_2CClF_2$	7126-05-8		8.09	8.08	10
HCFC-242ba	$CHClFCClFCH_2Cl$	7164-14-9		1.99	2	2.11
HCFC-242bb	$CHCl_2CClFCH_2F$	–		1.03	1.04	1.09
HCFC-242bc	$CH_3CClFCCl_2F$	7126-04-7		8.09	8.08	10
HCFC-242ca	$CHCl_2CF_2CH_2Cl$	–		1.09	1.09	1.15
HCFC-242cb	$CH_3CF_2CCl_3$	1112-05-6		12.3	12.3	18.7
HCFC-242da	$CHClFCHClCHClF$	–		1.32	1.32	1.38
HCFC-242db	$CHCl_2CHClCHF_2$	1980063-50-0		0.73	0.733	0.761
HCFC-242dc	$CH_2ClCHClCClF_2$	431-24-3		1.2	1.2	1.25
HCFC-242dd	$CH_2FCHClCCl_2F$	–		0.83	0.835	0.871
HCFC-242ea	$CHCl_2CHFCHClF$	2106760-91-0		0.72	0.728	0.756
HCFC-242eb	$CH_2ClCHFCCl_2F$	–		1.24	1.24	1.31
HCFC-242ec	$CH_2FCHFCCl_3$	–		1.7	1.71	1.84
HCFC-242fa	$CHCl_2CH_2CClF_2$	460-63-9		0.74	0.74	0.768
HCFC-242fb	$CHClFCH_2CCl_2F$	175897-95-7		1.61	1.6	1.71
HCFC-242fc	$CHF_2CH_2CCl_3$	213248-60-3		4.14	4.14	4.78
HCFC-243aa	$CHF_2CCl_2CH_2F$	155329-34-3		2.99	2.99	3.25
HCFC-243ab	$CH_3CCl_2CF_3$	7126-01-4		8.33	8.32	10
HCFC-243ba	$CHF_2CClFCH_2Cl$	–		3.63	3.64	3.88
HCFC-243bb	$CHFClCClFCH_2F$	1379241-46-9		2.67	2.67	2.82
HCFC-243bc	$CH_3CClFCF_2Cl$	7126-00-3		15.6	15.6	18.7
HCFC-243ca	CH_2ClCF_2CHClF	67406-68-2		2.89	2.96	3.14
HCFC-243cb	$CHCl_2CF_2CH_2F$	70192-70-0		1.46	1.46	1.54
HCFC-243cc	$CH_3CF_2CFCl_2$	7125-99-7		18	18.2	27.1
HCFC-243da	$CHF_2CHClCHFCl$	338-75-0		1.97	1.97	2.07
HCFC-243db	$CH_2ClCHClCF_3$	338-75-0		1.44	1.45	1.51
HCFC-243dc	$CH_2FCHClCF_2Cl$	199171-49-8		2.03	2.03	2.13
HCFC-243ea	$CHFClCHFCHFCl$	151771-08-3		1.57	1.57	1.64
HCFC-243eb	$CHCl_2CHFCHF_2$	1081835-90-6		0.9	0.898	0.938
HCFC-243ec	$CH_2ClCHFCF_2Cl$	149329-27-1		1.7	1.7	1.78
HCFC-243ed	$CH_2FCHFCFCl_2$	–		2.03	2.03	2.17
HCFC-243fa	$CHCl_2CH_2CF_3$	460-69-5		0.78	0.781	0.813

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W m^{-2} ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W m^{-2} ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance* *L: Lifetime* *O: Ozone Depletion Potential* *R: Radiative Metrics*
111	0.017	0.244	0.229	2230	667	190	174	124	L12, O10, R9
69.4	0.012	0.305	0.272	1230	342	98	77	62	L12, O10, R9
204	0.051	0.306	0.302	7250	5880	2110	6120	3770	L12, O10, R9
23.5	0.035	0.139	0.111	190	53	15	12	10	L12, O10, R9
20	0.02	0.13	0.0902	84	23	7	5	4	L12, O10, R9
32.1	0.112	0.201	0.186	1130	321	92	75	59	L12, O10, R9
20	0.02	0.168	0.118	112	31	9	7	6	L12, O10, R9
34.3	0.163	0.197	0.186	1590	480	137	129	90	L12, O10, R9
20	0.014	0.151	0.0952	65	18	5	4	3	L12, O10, R9
20	0.014	0.184	0.114	73	20	6	4	4	L12, O10, R9
20	0.019	0.159	0.11	100	28	8	6	5	L12, O10, R9
20	0.011	0.138	0.0778	39	11	3	2	2	L12, O10, R9
20	0.027	0.159	0.119	150	42	12	9	8	L12, O10, R9
20	0.014	0.173	0.107	69	19	5	4	3	L12, O10, R9
22.2	0.037	0.176	0.1417	252	70	20	16	13	L12, O10, R9
29.3	0.039	0.151	0.128	355	99	28	22	18	L12, O10, R9
27.2	0.034	0.153	0.127	296	82	23	18	15	L12, O10, R9
41.9	0.125	0.236	0.224	2150	658	188	182	123	L12, O10, R9
36.7	0.033	0.176	0.148	387	108	31	24	20	L12, O10, R9
21	0.021	0.174	0.13	177	49	14	11	9	L12, O10, R9
41.9	0.125	0.252	0.239	2300	702	200	194	131	L12, O10, R9
21.6	0.022	0.185	0.14	200	55	16	12	10	L12, O10, R9
36.3	0.206	0.258	0.248	3180	1110	316	460	215	L12, O10, R9
29.2	0.024	0.179	0.141	243	68	19	15	12	L12, O10, R9
20	0.015	0.169	0.116	111	31	9	7	6	L12, O10, R9
27.6	0.023	0.214	0.165	259	72	21	16	13	L12, O10, R9
20	0.017	0.217	0.154	168	47	13	10	8	L12, O10, R9
20	0.015	0.17	0.116	111	31	9	7	6	L12, O10, R9
23	0.025	0.207	0.161	261	73	21	16	13	L12, O10, R9
23.5	0.034	0.205	0.169	378	105	30	23	19	L12, O10, R9
20	0.015	0.214	0.147	142	40	11	9	7	L12, O10, R9
26.1	0.031	0.239	0.195	408	113	32	25	21	L12, O10, R9
30.6	0.075	0.21	0.191	1020	287	82	66	53	L12, O10, R9
37.3	0.036	0.171	0.151	647	180	51	41	33	L12, O10, R9
49.3	0.085	0.216	0.204	2200	677	193	191	127	L12, O10, R9
58	0.033	0.161	0.145	753	211	60	48	39	L12, O10, R9
49.7	0.027	0.179	0.156	597	166	47	37	30	L12, O10, R9
94.2	0.088	0.269	0.26	4170	1620	462	873	336	L12, O10, R9
52.4	0.035	0.204	0.18	763	213	61	48	39	L12, O10, R9
27.3	0.02	0.181	0.145	304	85	24	19	15	L12, O10, R9
55.3	0.19	0.293	0.285	4920	2060	591	1300	464	L2, O9, R9
41.9	0.022	0.189	0.159	450	125	36	28	23	L12, O10, R9
34.5	0.018	0.174	0.139	290	80	23	18	15	L12, O10, R9
42.6	0.023	0.236	0.199	580	161	46	36	29	L12, O10, R9
36.3	0.019	0.207	0.168	379	105	30	23	19	L12, O10, R9
20.8	0.014	0.192	0.139	179	50	14	11	9	L12, O10, R9
38.3	0.02	0.214	0.176	430	119	34	27	22	L12, O10, R9
31.9	0.026	0.248	0.209	609	169	48	38	31	L12, O10, R9
20	0.012	0.174	0.122	137	38	11	8	7	L12, O10, R9

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HCFC-243fb	$CHFClCH_2CF_2Cl$	139754-78-2		2.24	2.24	2.36
HCFC-243fc	$CHF_2CH_2CFCl_2$	213248-61-4		5.07	5.07	5.73
HCFC-244ba	$CH_2FCClFCHF_2$	149329-28-2		5.17	5.18	5.49
HCFC-244bb	$CH_3CClFCF_3$	421-73-8		16.6	16.6	18.7
HCFC-244ca	$CH_2ClCF_2CHF_2$	679-85-6		6.39	6.39	6.82
HCFC-244cb	CH_2FCF_2CHFCl	67406-66-0		4.02	4.02	4.24
HCFC-244cc	$CH_3CF_2CF_2Cl$	421-75-0		31.2	31.2	38.1
HCFC-244da	$CHF_2CHClCHF_2$	19041-02-2		3.88	3.88	4.09
HCFC-244db	$CH_2FCHClCF_3$	117970-90-8		2.44	2.43	2.54
HCFC-244ea	$CHF_2CHFCHFCl$	149447-91-6		2.39	2.39	2.5
HCFC-244eb	$CH_2ClCHFCF_3$	151771-09-4		2.04	2.04	2.12
HCFC-244ec	$CH_2FCHFCF_2Cl$	149448-09-9		2.88	2.88	3.01
HCFC-244fa	$CHFClCH_2CF_3$	149329-29-3		2.37	2.38	2.48
HCFC-244fb	$CHF_2CH_2CF_2Cl$	2730-64-5		7.76	7.76	8.35
HCFC-251aa	$CH_2FCCl_2CH_2Cl$	70192-89-1		1.26	1.27	1.34
HCFC-251ab	CH_3CCl_2CHFCl	–		1.73	1.73	1.85
HCFC-251ba	$CH_2ClCClFCH_2Cl$	7126-16-1		1.34	1.34	1.4
HCFC-251bb	$CH_3CClFCHCl_2$	3175-24-4		1.02	1.02	1.07
HCFC-251da	$CH_2ClCHClCHFCl$	339202-89-0		0.69	0.694	0.719
HCFC-251db	$CH_2FCHClCHCl_2$	–		0.4	0.408	0.416
HCFC-251dc	$CH_3CHClCFCl_2$	421-41-0		0.52	0.521	0.535
HCFC-251ea	$CH_2ClCHFCHCl_2$	76937-36-5		0.47	0.477	0.489
HCFC-251eb	$CH_3CHFCCl_3$	1448144-70-4		0.68	0.685	0.709
HCFC-251fa	$CHClFCH_2CCl_2H$	2106760-90-9		0.33	0.333	0.339
HCFC-251fb	$CH_2ClCH_2CCl_2F$	818-99-5		0.45	0.456	0.467
HCFC-251fc	$CH_2FCH_2CCl_3$	2035078-31-8		0.65	0.654	0.676
HCFC-252aa	$CH_2FCCl_2CH_2F$	154193-88-1		1.94	1.94	2.07
HCFC-252ab	$CH_3CCl_2CHF_2$	–		4.41	4.41	4.93
HCFC-252ba	$CH_2ClCClFCH_2F$	70192-74-4		2.19	2.2	2.31
HCFC-252bb	$CH_3CClFCHClF$	362631-58-1		2.87	2.87	3.04
HCFC-252ca	$CH_2ClCF_2CH_2Cl$	1112-36-3		2.47	2.47	2.61
HCFC-252cb	$CH_3CF_2CHCl_2$	1112-01-2		1.19	1.19	1.25
HCFC-252da	$CH_2ClCHClCHF_2$	82578-00-5		1	1	1.04
HCFC-252db	$CH_2FCHClCHClF$	–		1.15	1.15	1.2
HCFC-252dc	$CH_3CHClCClF_2$	7126-15-0		0.77	0.771	0.799
HCFC-252ea	$CH_2ClCHFCHClF$	111483-26-2		1.02	1.02	1.06
HCFC-252eb	$CH_2FCHFCHCl_2$	–		0.65	0.648	0.67
HCFC-252ec	$CH_3CHFCCl_2F$	151771-10-7		0.84	0.845	0.882
HCFC-252fa	$CHClFCH_2CHClF$	1378824-14-6		1.15	1.14	1.19
HCFC-252fb	$CHCl_2CH_2CHF_2$	131404-17-6		0.66	0.661	0.684
HCFC-252fc	$CH_2ClCH_2CClF_2$	819-00-1		0.94	0.936	0.972
HCFC-252fd	$CH_2FCH_2CCl_2F$	121612-64-4		0.7	0.706	0.732
HCFC-253ba	$CH_2FCClFCH_2F$	151771-11-8		3.66	3.67	3.86
HCFC-253bb	$CH_3CClFCHF_2$	69202-10-4		7.85	7.85	8.46
HCFC-253ca	$CH_2ClCF_2CH_2F$	56758-54-4		4.23	4.23	4.47
HCFC-253cb	CH_3CF_2CHClF	70192-76-6		3.48	3.48	3.66
HCFC-253da	$CH_2FCHClCHF_2$	–		1.67	1.67	1.74
HCFC-253db	$CH_3CHClCF_3$	421-47-6		1.02	1.02	1.06
HCFC-253ea	$CH_2ClCHFCHF_2$	121612-65-5		1.44	1.44	1.5

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) (W m⁻² ppb⁻¹) [b]	Recommended Adjusted Effective Radiative Efficiency (W m⁻² ppb⁻¹) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes A: Atmospheric Abundance L: Lifetime O: Ozone Depletion Potential R: Radiative Metrics
45.1	0.024	0.266	0.228	733	204	58	46	37	L12, O10, R9
44	0.056	0.281	0.259	1840	524	150	122	96	L12, O10, R9
90.5	0.017	0.183	0.169	1360	388	111	91	71	L12, O10, R9
148	0.027	0.249	0.241	4420	1770	505	1020	378	L12, O10, R9
101	0.018	0.184	0.172	1670	487	139	119	90	L12, O10, R9
78.6	0.015	0.195	0.177	1120	315	90	72	58	L12, O10, R9
173	0.039	0.28	0.274	6370	3620	1080	3240	1300	L12, O10, R9
77	0.015	0.201	0.182	1120	313	89	71	57	L12, O10, R9
57.4	0.012	0.19	0.164	634	177	50	40	32	L12, O10, R9
56.6	0.012	0.22	0.19	723	201	57	45	37	L12, O10, R9
50.8	0.011	0.18	0.152	494	137	39	31	25	L12, O10, R9
64	0.013	0.254	0.223	1020	284	81	64	52	L12, O10, R9
56.3	0.012	0.217	0.187	708	197	56	44	36	L12, O10, R9
111	0.02	0.301	0.284	3220	976	278	263	182	L12, O10, R9
23.3	0.028	0.091	0.0711	131	36	10	8	7	L12, O10, R9
26.9	0.037	0.129	0.106	266	74	21	16	13	L12, O10, R9
29.4	0.027	0.118	0.0927	180	50	14	11	9	L12, O10, R9
20.8	0.023	0.143	0.107	158	44	13	10	8	L12, O10, R9
20	0.016	0.117	0.079	80	22	6	5	4	L12, O10, R9
20	0.009	0.107	0.0598	35	10	3	2	2	L12, O10, R9
20	0.012	0.192	0.118	89	25	7	5	4	L12, O10, R9
20	0.011	0.125	0.0744	52	14	4	3	3	L12, O10, R9
20	0.016	0.194	0.13	129	36	10	8	6	L12, O10, R9
20	0.008	0.138	0.071	34	10	3	2	2	L12, O10, R9
20	0.011	0.173	0.101	67	19	5	4	3	L12, O10, R9
20	0.015	0.149	0.0985	93	26	7	6	5	L12, O10, R9
31	0.029	0.117	0.0978	305	85	24	19	15	L12, O10, R9
41.9	0.056	0.163	0.149	1040	294	84	67	54	L12, O10, R9
44	0.027	0.112	0.096	340	95	27	21	17	L12, O10, R9
50.9	0.032	0.164	0.145	668	186	53	42	34	L12, O10, R9
47	0.029	0.142	0.123	488	136	39	30	25	L12, O10, R9
24.4	0.019	0.188	0.145	278	77	22	17	14	L12, O10, R9
26.7	0.016	0.119	0.0883	142	40	11	9	7	L12, O10, R9
29.4	0.017	0.127	0.0974	180	50	14	11	9	L12, O10, R9
22.2	0.013	0.211	0.146	181	50	14	11	9	L12, O10, R9
27.2	0.016	0.146	0.109	179	50	14	11	9	L12, O10, R9
20	0.011	0.136	0.0895	93	26	7	6	5	L12, O10, R9
20	0.015	0.24	0.171	233	65	18	14	12	L12, O10, R9
29.4	0.017	0.182	0.139	255	71	20	16	13	L12, O10, R9
20	0.011	0.168	0.111	118	33	9	7	6	L12, O10, R9
25.5	0.015	0.203	0.148	223	62	18	14	11	L12, O10, R9
20	0.012	0.223	0.151	172	48	14	11	9	L12, O10, R9
72.9	0.017	0.139	0.126	831	233	66	53	43	L12, O10, R9
108	0.024	0.194	0.183	2380	722	206	196	135	L12, O10, R9
79.3	0.018	0.147	0.134	1010	285	81	65	52	L12, O10, R9
70.8	0.017	0.204	0.182	1140	319	91	72	58	L12, O10, R9
43.6	0.012	0.14	0.115	348	97	28	21	18	L12, O10, R9
30.2	0.009	0.16	0.12	222	62	18	14	11	L12, O10, R9
39.2	0.011	0.14	0.112	292	81	23	18	15	L12, O10, R9

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HCFC-253eb	$CH_2FCHFCHClF$	151771-12-9		1.5	1.5	1.56
HCFC-253ec	$CH_3CHFCClF_2$	134251-05-1		1.13	1.13	1.17
HCFC-253fa	$CHClFCH_2CHF_2$	149329-30-6		1.83	1.82	1.9
HCFC-253fb	$CH_2ClCH_2CF_3$	460-35-5		1.05	1.05	1.09
HCFC-253fc	$CH_2FCH_2CClF_2$	83124-56-5		1.48	1.48	1.54
HCFC-261aa	$CH_3CCl_2CH_2F$	–		1.06	1.06	1.11
HCFC-261ba	$CH_3CClFCH_2Cl$	420-97-3		2.19	2.19	2.31
HCFC-261da	$CH_2ClCHClCH_2F$	453-01-0		0.45	0.452	0.462
HCFC-261db	$CH_3CHClCHClF$	7799-55-5		0.47	0.467	0.478
HCFC-261ea	$CH_2ClCHFCH_2Cl$	816-38-6		0.54	0.539	0.554
HCFC-261eb	$CH_3CHFCHCl_2$	53074-31-0		0.31	0.31	0.315
HCFC-261fa	CH_2ClCH_2CHClF	83124-60-1		0.57	0.574	0.591
HCFC-261fb	$CH_2FCH_2CHCl_2$	53074-30-9		0.33	0.333	0.339
HCFC-261fc	$CH_3CH_2CCl_2F$	7799-56-6		0.61	0.618	0.638
HCFC-262ba	$CH_3CClFCH_2F$	362631-59-2		3.4	3.41	3.59
HCFC-262ca	$CH_3CF_2CH_2Cl$	420-99-5		3.2	3.17	3.33
HCFC-262da	$CH_2FCHClCH_2F$	102738-79-4		0.92	0.924	0.956
HCFC-262db	$CH_3CHClCHF_2$	430-93-3		0.64	0.642	0.662
HCFC-262ea	$CH_2FCHFCH_2Cl$	37161-81-2		0.83	0.828	0.856
HCFC-262eb	$CH_3CHFCHFCl$	430-96-6		0.66	0.664	0.685
HCFC-262fa	$CH_2ClCH_2CHF_2$	83124-57-6		0.8	0.801	0.828
HCFC-262fb	CH_2FCH_2CHFCl	151771-13-0		0.87	0.872	0.902
HCFC-262fc	$CH_3CH_2CF_2Cl$	421-02-3		1.2	1.2	1.24
HCFC-271ba	$CH_3CClFCH_3$	420-44-0		5	5.04	5.37
HCFC-271da	$CH_3CHClCH_2F$	20372-78-5		0.27	0.274	0.278
HCFC-271ea	CH_3CHFCH_2Cl	430-46-6		0.3	0.298	0.302
HCFC-271fa	$CH_2ClCH_2CH_2F$	462-38-4		0.34	0.339	0.345
HCFC-271fb	CH_3CH_2CHClF	430-55-7		0.49	0.494	0.506
Hydrofluorocarbons						
HFC-23	CHF_3	75-46-7	33.7 ppt	228	228	243
HFC-32	CH_2F_2	75-10-5	23.2 ppt	5.4	5.27	5.47
HFC-41	CH_3F	593-53-3		2.8	2.8	2.92
HFC-125	CHF_2CF_3	354-33-6	32.6 ppt	30	30.7	32.3
HFC-134	CHF_2CHF_2	359-35-3		10	10	10.5
HFC-134a	CH_2FCF_3	811-97-2	113.0 ppt	14	13.5	14.1
HFC-143	CH_2FCHF_2	430-66-0		3.6	3.57	3.7
HFC-143a	CH_3CF_3	420-46-2	25.6 ppt	51	51.8	57.2
HFC-152	CH_2FCH_2F	624-72-6		172 days (114–335 days)	0.473 (114–335 days)	0.485
HFC-152a	CH_3CHF_2	75-37-6	7.1 ppt	1.6	1.5	1.55
HFC-161	CH_3CH_2F	353-36-6		80 days (51–154 days)	0.217 (51–154 days)	0.219
HFC-227ca	$CF_3CF_2CHF_2$	2252-84-8		30	32.2	33.7
HFC-227ea	CF_3CHFCF_3	431-89-0	1.7 ppt	36	35.8	37.5
HFC-236ca	$CHF_2CF_2CHF_2$	680-00-2			11.4	11.8
HFC-236cb	$CH_2FCF_2CF_3$	677-56-5		13.4	13.4	14
HFC-236ea	CHF_2CHFCF_3	431-63-0		11.4	11.4	11.9
HFC-236fa	$CF_3CH_2CF_3$	690-39-1	0.20 ppt	213	213	253
HFC-245ca	$CH_2FCF_2CHF_2$	679-86-7		6.6	6.61	6.88
HFC-245cb	$CF_3CF_2CH_3$	1814-88-6		39.9	39.8	42.9
HFC-245ea	$CHF_2CHFCHF_2$	24270-66-4		3.2	3.26	3.37

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W\ m^{-2}\ ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W\ m^{-2}\ ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance* *L: Lifetime* *O: Ozone Depletion Potential* *R: Radiative Metrics*
40.4	0.011	0.153	0.123	334	93	26	21	17	L12, O10, R9
32.7	0.009	0.237	0.18	368	102	29	23	19	L12, O10, R9
46.4	0.012	0.207	0.172	566	157	45	35	29	L12, O10, R9
30.8	0.009	0.164	0.123	234	65	19	14	12	L12, O10, R9
39.9	0.011	0.239	0.192	514	143	41	32	26	L12, O10, R9
22.7	0.02	0.092	0.0687	133	37	11	8	7	L12, O10, R9
43.6	0.031	0.095	0.0808	324	90	26	20	16	L12, O10, R9
20	0.009	0.055	0.0319	26	7	2	2	1	L12, O10, R9
20	0.009	0.102	0.06	51	14	4	3	3	L12, O10, R9
20	0.01	0.075	0.0464	46	13	4	3	2	L12, O10, R9
20	0.006	0.121	0.0599	34	9	3	2	2	L12, O10, R9
20	0.011	0.114	0.0726	76	21	6	5	4	L12, O10, R9
20	0.006	0.104	0.0534	33	9	3	2	2	L12, O10, R9
20	0.012	0.206	0.134	152	42	12	9	8	L12, O10, R9
68.6	0.02	0.136	0.122	867	242	69	55	44	L12, O10, R9
65.6	0.019	0.131	0.116	767	214	61	48	39	L12, O10, R9
27.7	0.009	0.074	0.0538	104	29	8	6	5	L12, O10, R9
20.8	0.007	0.12	0.0788	106	29	8	6	5	L12, O10, R9
25.4	0.009	0.09	0.0639	111	31	9	7	6	L12, O10, R9
21.3	0.007	0.144	0.0958	133	37	11	8	7	L12, O10, R9
24.8	0.008	0.121	0.0851	143	40	11	9	7	L12, O10, R9
26.5	0.009	0.134	0.096	175	49	14	11	9	L12, O10, R9
33.7	0.011	0.214	0.165	415	115	33	26	21	L12, O10, R9
83.4	0.028	0.113	0.104	1270	362	103	84	67	L12, O10, R9
20	0.004	0.051	0.0237	16	4	1	<1	<1	L12, O10, R9
20	0.004	0.066	0.032	24	7	2	1	1	L12, O10, R9
20	0.004	0.053	0.0272	23	6	2	1	1	L12, O10, R9
20	0.007	0.105	0.0633	78	22	6	5	4	L12, O10, R9
3,636	0	0.193	0.192	12,400	14,700	10,600	15,500	15,200	A4, L5, O1, R2
146	0	0.12	0.111	2620	749	214	175	138	A4, L5, O1, R2
68.5	0	0.028	0.025	492	137	39	31	25	L2, L11, O1, R2
665	0	0.239	0.234	6790	3820	1140	3400	1350	A4, L5, L11, O1, R2
243	0	0.203	0.204	4110	1330	380	443	252	L2, O1, R2
313	0	0.173	0.167	4060	1470	420	679	292	A4, L5, L11, O1, R2
101	0	0.142	0.129	1310	365	104	83	67	L2, O1, R2
548	0	0.171	0.169	7900	5900	1980	6020	3340	A4, L5, O1, R2
20	0	0.077	0.047	81	22	6	5	4	L2, O1, R2
44.3	0	0.125	0.101	550	153	44	34	28	A4, L5, L11, O1, R2
20	0	0.038	0.016	17	5	1	1	<1	O1, R2
694	0	0.269	0.265	5500	3180	955	2890	1180	L14, O1, R2
754	0	0.278	0.273	5830	3580	1090	3370	1470	A4, L5, L15, O1, R2
268		0.318	0.305	4500	1520	435	581	293	L14, O1, R11
304	0	0.24	0.232	3770	1360	389	623	270	L14, O1, R2
268	0	0.277	0.267	3940	1330	381	509	256	L14, O1, R12
136	0	0.253	0.263	7820	9120	6340	9650	9310	L14, O1, R2
166	0	0.255	0.266	2980	874	249	217	162	L14, O1, R13
551	0	0.255	0.249	6920	4510	1410	4370	2050	L14, O1, R2
93.2	0	0.18	0.172	999	279	80	63	51	L14, O1, R14

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HFC-245eb	$CH_2FCHFCF_3$	431-31-2		3.2	3.2	3.32
HFC-245fa	$CHF_2CH_2CF_3$	460-73-1	3.2 ppt	7.9	7.74	8.16
HFC-254ca	$CH_2FCF_2CH_2F$	813-75-2			2.56	2.65
HFC-254cb	$CH_3CF_2CHF_2$	40723-63-5			10.8	11.4
HFC-254ea	$CH_2FCHFCHF_2$	24270-68-6			1.94	2.01
HFC-254eb	CH_3CHFCF_3	421-48-7			2.25	2.33
HFC-254fa	$CHF_2CH_2CHF_2$	66794-30-7			3.99	4.14
HFC-254fb	$CH_2FCH_2CF_3$	460-36-6			1.38	1.43
HFC-263ca	$CH_3CF_2CH_2F$	811-94-9			3.67	3.81
HFC-263ea	$CH_2FCHFCH_2F$	66794-36-3			0.533	0.547
HFC-263eb	$CH_3CHFCHF_2$	66794-35-2			1.09	1.12
HFC-263fa	$CH_2FCH_2CHF_2$	24270-67-5			1.07	1.1
HFC-263fb	$CH_3CH_2CF_3$	421-07-8		1.1	1.12	1.16
HFC-272ca	$CH_3CF_2CH_3$	420-45-1		9	9.21	9.7
HFC-272ea	CH_3CHFCH_2F	62126-90-3			0.374	0.381
HFC-272fa	$CH_2FCH_2CH_2F$	462-39-5			0.186	0.188
HFC-272fb	$CH_3CH_2CHF_2$	430-61-5			0.706	0.727
HFC-281ea	CH_3CHFCH_3	420-26-8		27 days (19–46 days)	0.075 (19–46 days)	0.076
HFC-281fa	$CH_3CH_2CH_2F$	460-13-9			0.131	0.132
HFC-329p	$CHF_2CF_2CF_2CF_3$	375-17-7		32	31.5	33
HFC-329me	$CF_3CHFCF_2CF_3$	680-17-1			48.2	50.9
HFC-338q	$CH_2FCF_2CF_2CF_3$	662-35-1			14.6	15.3
HFC-338mce	$CHF_2CHFCF_2CF_3$	119450-58-7			9.27	9.66
HFC-338mec	$CHF_2CF_2CHFCF_3$	35230-11-6			11.7	12.2
HFC-338pcc	$CHF_2CF_2CF_2CHF_2$	377-36-6		13.5	13.5	14
HFC-338mf	$CF_3CH_2CF_2CF_3$	2924-29-0			184	214
HFC-338mee	$CF_3CHFCHFCF_3$	75995-72-1			11.4	11.9
HFC-347mcc	$CH_3CF_2CF_2CF_3$	662-00-0			36.8	39.5
HFC-347mce	$CH_2FCHFCF_2CF_3$	75995-85-6			3.35	3.47
HFC-347mec	$CH_2FCF_2CHFCF_3$	53005-35-9			4.22	4.38
HFC-347pcc	$CH_2FCF_2CF_2CHF_2$	119450-61-2			8.7	9.08
HFC-347mcf	$CHF_2CH_2CF_2CF_3$	161791-36-2			8.64	9.02
HFC-347mee	$CHF_2CHFCHFCF_3$	151868-61-0			5	5.2
HFC-347pce	$CHF_2CHFCF_2CHF_2$	119450-64-5			6.43	6.7
HFC-347mfc	$CHF_2CF_2CH_2CF_3$	119450-65-6			14.6	15.4
HFC-347mef	$CF_3CH_2CHFCF_3$	86884-16-4			8.53	8.9
HFC-356mce	$CH_3CHFCF_2CF_3$	161791-32-8			2.25	2.33
HFC-356mec	$CH_3CF_2CHFCF_3$	76523-97-2			13.8	14.6
HFC-356pcc	$CH_3CF_2CF_2CHF_2$	119450-66-7			10.8	11.4
HFC-356mcf	$CH_2FCH_2CF_2CF_3$	161791-33-9		1.2	1.22	1.26
HFC-356mee	$CH_2FCHFCHFCF_3$	119450-67-8			2.21	2.28
HFC-356pce	$CH_2FCHFCF_2CHF_2$	119450-68-9			2.87	2.98
HFC-356mfc	$CH_2FCF_2CH_2CF_3$	76546-55-9			4.84	5.03
HFC-356pec	$CH_2FCF_2CHFCHF_2$	114810-03-6			2.83	2.93
HFC-356mef	$CHF_2CH_2CHFCF_3$	158421-88-6			2.71	2.81
HFC-356mfe	$CHF_2CHFCH_2CF_3$	76523-98-3			3.05	3.16
HFC-356pcf	$CHF_2CH_2CF_2CHF_2$	119450-69-0			5.43	5.66
HFC-356pee	$CHF_2CHFCHFCHF_2$	392-45-0			3.17	3.29
HFC-356mff	$CF_3CH_2CH_2CF_3$	407-59-0			8.47	8.86

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) (W m^{-2} ppb^{-1}) [b]	Recommended Adjusted Effective Radiative Efficiency (W m^{-2} ppb^{-1}) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance L: Lifetime O: Ozone Depletion Potential R: Radiative Metrics*
91.9	0	0.23	0.215	1230	342	98	77	62	L14, O1, R13
153.8	0	0.259	0.251	3190	966	276	260	180	A4, L5, O1, R13
74.5	0	0.17	0.148	782	218	62	49	40	L14, O1, R11
227	0	0.214	0.205	3830	1270	363	457	242	L14, O1, R11
59.2	0	0.201	0.168	673	187	53	42	34	L14, O1, R11
67.1	0	0.211	0.18	836	233	66	52	42	L14, O1, R11
107	0	0.259	0.235	1920	538	154	123	99	L14, O1, R11
44.3	0	0.186	0.148	422	117	33	26	21	L14, O1, R11
97.8	0	0.153	0.138	1230	344	98	78	63	L14, O1, R11
20	0	0.107	0.066	86	24	7	5	4	L14, O1, R11
35.7	0	0.15	0.114	304	84	24	19	15	L14, O1, R11
35.1	0	0.157	0.118	309	86	24	19	16	L14, O1, R11
36.7	0	0.13	0.1	274	76	22	17	14	L14, O1, R14
183	0	0.084	0.085	2060	651	186	200	123	L16, O1, R2
20	0	0.101	0.054	61	17	5	4	3	L14, O1, R11
20	0	0.094	0.036	20	6	2	1	1	L14, O1, R11
24.3	0	0.102	0.069	146	41	12	9	7	L14, O1, R11
20	0	0.054	0.011	3	<1	<1	<1	<1	L14, O1, R11
20	0	0.051	0.016	8	2	<1	<1	<1	L14, O1, R11
714	0	0.319	0.325	5180	2960	885	2660	1080	L17, O1, R2
886	0	0.339	0.334	5890	4240	1390	4280	2270	L14, O1, R11
325	0	0.28	0.271	3470	1300	372	656	265	L14, O1, R11
228	0	0.319	0.303	2930	926	264	286	174	L14, O1, R11
274	0	0.341	0.327	3690	1260	360	495	243	L14, O1, R11
360	0	0.341	0.328	4020	1460	417	673	289	L14, O1, R11
1289	0	0.309	0.306	6790	7720	4950	8180	7650	L14, O1, R11
269	0	0.366	0.351	3900	1320	377	503	253	L14, O1, R11
529	0	0.252	0.247	4910	3060	939	2910	1290	L14, O1, R11
95.4	0	0.257	0.23	999	279	80	63	51	L14, O1, R11
116	0	0.292	0.266	1450	406	116	93	75	L14, O1, R11
205	0	0.304	0.288	2920	907	259	265	170	L14, O1, R11
204	0	0.341	0.323	3250	1010	288	294	189	L14, O1, R11
133	0	0.328	0.303	1930	549	156	127	101	L14, O1, R11
162	0	0.308	0.288	2290	671	191	165	124	L14, O1, R11
300	0	0.322	0.311	4370	1640	469	826	333	L14, O1, R11
202	0	0.344	0.326	3250	1010	287	290	189	L14, O1, R11
67.1	0	0.229	0.196	636	177	50	40	32	L14, O1, R11
268	0	0.262	0.253	3820	1400	400	662	279	L14, O1, R11
227	0	0.276	0.264	3440	1140	326	412	218	L14, O1, R11
39.6	0	0.268	0.208	367	102	29	23	18	L14, O1, R11
65.9	0	0.258	0.22	701	195	56	44	35	L14, O1, R11
82.1	0	0.247	0.218	901	251	72	56	46	L14, O1, R11
125	0	0.272	0.25	1710	486	139	112	89	L14, O1, R11
81	0	0.257	0.226	921	257	73	58	47	L14, O1, R11
78.3	0	0.303	0.265	1030	288	82	65	52	L14, O1, R11
86.4	0	0.298	0.264	1160	323	92	73	59	L14, O1, R11
137	0	0.293	0.271	2060	591	168	139	109	L14, O1, R11
89.1	0	0.28	0.249	1140	317	90	71	58	L14, O1, R11
191	0	0.32	0.303	3330	1030	294	295	193	L14, O1, R11

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HFC-356qcc	$CH_2FCF_2CF_2CH_2F$	114810-02-5			7.03	7.34
HFC-365mcf	$CH_3CH_2CF_2CF_3$	37826-35-0			1.64	1.69
HFC-365mee	$CH_3CHFCHFCF_3$	161791-22-6			1.09	1.12
HFC-365pce	$CH_3CHFCF_2CHF_2$	158421-89-7			4.35	4.52
HFC-365pec	$CH_3CF_2CHFCHF_2$	119450-71-4			5.44	5.67
HFC-365qcc	$CH_3CF_2CF_2CH_2F$	119450-72-5			10.1	10.6
HFC-365mfc	$CH_3CF_2CH_2CF_3$	406-58-6	1.1 ppt	8.9	8.86	9.3
HFC-365mef	$CH_2FCH_2CHFCF_3$	161791-23-7			1.07	1.1
HFC-365pcf	$CH_2FCH_2CF_2CHF_2$	161791-25-9			1.26	1.3
HFC-365mfe	$CH_2FCHFCH_2CF_3$	161791-24-8			0.841	0.867
HFC-365qee	$CH_2FCHFCHFCHF_2$	157016-17-6			1.96	2.03
HFC-365pfc	$CH_2FCF_2CH_2CHF_2$	119450-76-9			3.28	3.4
HFC-365qce	$CH_2FCF_2CHFCH_2F$	119450-75-8			2.07	2.15
HFC-365mff	$CHF_2CH_2CH_2CF_3$	161879-85-2			3.32	3.44
HFC-365pef	$CHF_2CH_2CHFCHF_2$	119450-77-0			2.14	2.22
HFC-374mef	$CF_3CHFCH_2CH_3$	161791-15-7			0.629	0.648
HFC-374mfe	$CF_3CH_2CHFCH_3$	86884-13-1			0.492	0.504
HFC-374mff	$CF_3CH_2CH_2CH_2F$	83234-21-3			0.212	0.214
HFC-374pcf	$CHF_2CF_2CH_2CH_3$	143969-51-1			0.788	0.812
HFC-374pee	$CHF_2CHFCHFCH_3$	161791-16-8			0.908	0.936
HFC-374pef	$CHF_2CHFCH_2CH_2F$	161791-17-9			0.862	0.889
HFC-374pfc	$CHF_2CH_2CF_2CH_3$	625-09-2			3	3.119
HFC-374pfe	$CHF_2CH_2CHFCH_2F$	161791-18-0			0.75	0.772
HFC-374qce	$CH_2FCF_2CHFCH_3$	161791-20-4			1.54	1.59
HFC-374qec	$CH_2FCHFCF_2CH_3$	161791-19-1			2.29	2.37
HFC-374qcf	$CH_2FCF_2CH_2CH_2F$	161791-21-5			1.07	1.11
HFC-374qee	$CH_2FCHFCHFCH_2F$	119382-47-7			1.2	1.24
HFC-374scc	$CH_3CF_2CF_2CH_3$	421-74-9			17.6	18.8
HFC-374pff	$CHF_2CH_2CH_2CHF_2$	161879-84-1			1.38	1.43
HFC-383m	$CH_3CH_2CH_2CF_3$	460-34-4			0.192	0.194
HFC-383pe	$CHF_2CHFCH_2CH_3$	66675-41-0			0.483	0.495
HFC-383pfe	$CHF_2CH_2CHFCH_3$	66675-42-1			0.445	0.455
HFC-383pff	$CHF_2CH_2CH_2CH_2F$	66587-70-0			0.198	0.2
HFC-383qcf	$CH_2FCF_2CH_2CH_3$	66587-71-1			1.22	1.26
HFC-383qee	$CH_2FCHFCHFCH_3$	66587-72-2			0.365	0.372
HFC-383qef	$CH_2FCHFCH_2CH_2F$	66587-73-3			0.491	0.503
HFC-383qfc	$CH_2FCH_2CF_2CH_3$	66587-74-4			1.1	1.14
HFC-383sce	$CH_3CF_2CHFCH_3$	66587-75-5			1.19	1.23
HFC-392pff	$CH_3CH_2CH_2CHF_2$	2358-38-5			0.166	0.167
HFC-392qef	$CH_3CH_2CHFCH_2F$	686-65-7			0.275	0.279
HFC-392qfe	$CH_3CHFCH_2CH_2F$	691-42-9			0.311	0.316
HFC-392qff	$CH_2FCH_2CH_2CH_2F$	372-90-7			0.106	0.106
HFC-392scf	$CH_3CH_2CF_2CH_3$	353-81-1			0.779	0.803
HFC-392see	$CH_3CHFCHFCH_3$	666-21-7			0.279	0.283
HFC-3-10-1q	$CH_3CH_2CH_2CH_2F$	2366-52-1			0.081	0.081
HFC-3-10-1se	$CH_3CH_2CHFCH_3$	359-01-3			0.103	0.104
HFC-b-329my	$CHF_2CF(CF_3)CF_3$	59571-40-3			23.7	24.8
HFC-b-329mz	$CF_3CH(CF_3)CF_3$	382-24-1			589	740
HFC-b-338mz	$CHF_2CH(CF_3)CF_3$	382-20-7			15.2	15.9

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W m^{-2} ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W m^{-2} ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance L: Lifetime O: Ozone Depletion Potential R: Radiative Metrics*
167	0	0.252	0.237	2250	669	191	171	124	L14, O1, R11
50.4	0	0.229	0.187	497	138	39	31	25	L14, O1, R11
35.6	0	0.233	0.176	311	86	25	19	16	L14, O1, R11
112	0	0.22	0.201	1400	394	112	90	72	L14, O1, R11
132	0	0.226	0.209	1790	512	146	120	94	L14, O1, R11
205	0	0.233	0.222	3110	1010	288	339	191	L14, O1, R11
188	0	0.24	0.243	3100	969	276	288	182	A4, L14, O1, R2
35	0	0.244	0.184	319	89	25	20	16	L14, O1, R11
40.3	0	0.231	0.18	367	102	29	23	18	L14, O1, R11
28.5	0	0.232	0.165	225	62	18	14	11	L14, O1, R11
58.8	0	0.206	0.173	549	153	44	34	28	L14, O1, R11
89.4	0	0.232	0.207	1090	306	87	69	56	L14, O1, R11
61.6	0	0.192	0.162	543	151	43	34	27	L14, O1, R11
90.3	0	0.276	0.246	1320	368	105	83	67	L14, O1, R11
63.2	0	0.248	0.211	731	203	58	45	37	L14, O1, R11
22	0	0.209	0.136	158	44	12	10	8	L14, O1, R11
20	0	0.209	0.125	113	32	9	7	6	L14, O1, R11
20	0	0.182	0.075	29	8	2	2	1	L14, O1, R11
26.8	0	0.189	0.132	192	53	15	12	10	L14, O1, R11
30.2	0	0.169	0.122	204	57	16	13	10	L14, O1, R11
28.9	0	0.189	0.135	215	60	17	13	11	L14, O1, R11
81.6	0	0.201	0.177	976	272	78	61	50	L14, O1, R11
25.6	0	0.176	0.121	167	47	13	10	8	L14, O1, R11
47.2	0	0.171	0.139	395	110	31	24	20	L14, O1, R11
65.7	0	0.174	0.149	628	175	50	39	32	L14, O1, R11
34.8	0	0.174	0.131	259	72	20	16	13	L14, O1, R11
38.4	0	0.147	0.114	252	70	20	16	13	L14, O1, R11
268	0	0.221	0.215	4690	1930	553	1180	426	L14, O1, R11
43.3	0	0.21	0.167	425	118	34	26	21	L14, O1, R11
20	0	0.166	0.064	26	7	2	2	1	L14, O1, R11
20	0	0.147	0.088	91	25	7	6	5	L14, O1, R11
20	0	0.16	0.093	89	25	7	5	4	L14, O1, R11
20	0	0.248	0.098	42	12	3	3	2	L14, O1, R11
38.4	0	0.137	0.106	277	77	22	17	14	L14, O1, R11
20	0	0.119	0.064	50	14	4	3	3	L14, O1, R11
20	0	0.115	0.069	73	20	6	4	4	L14, O1, R11
35.3	0	0.14	0.106	250	69	20	15	13	L14, O1, R11
37.8	0	0.151	0.116	295	82	23	18	15	L14, O1, R11
20	0	0.094	0.034	14	4	1	<1	<1	L14, O1, R11
20	0	0.078	0.037	26	7	2	2	1	L14, O1, R11
20	0	0.087	0.043	34	9	3	2	2	L14, O1, R11
20	0	0.098	0.026	7	2	<1	<1	<1	L14, O1, R11
26.1	0	0.114	0.08	159	44	13	10	8	L14, O1, R11
20	0	0.094	0.044	31	9	2	2	2	L14, O1, R11
20	0	0.05	0.011	3	<1	<1	<1	<1	L14, O1, R11
20	0	0.051	0.013	4	1	<1	<1	<1	L14, O1, R11
523	0	0.319	0.311	4530	2200	637	1700	606	L14, O1, R11
2879	0	0.313	0.312	6600	8600	9080	9010	9890	L14, O1, R11
334	0	0.342	0.33	4320	1650	472	868	340	L14, O1, R11

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HFC-b-338py	$CHF_2CF(CF_3)CHF_2$	65781-21-7			11.4	11.8
HFC-b-338mym	$CH_2FCF(CF_3)CF_3$	65781-19-3			14.6	15.3
HFC-b-347mym	$CH_3CF(CF_3)CF_3$	662-00-0			36.8	39.5
HFC-b-347mzm	$CH_2FCH(CF_3)CF_3$	2794-16-3			4.66	4.83
HFC-b-347myp	$CH_2FCF(CF_3)CHF_2$	65781-22-8			8.7	9.08
HFC-b-347mzp	$CHF_2CH(CF_3)CHF_2$	65781-25-1			7.04	7.33
HFC-b-347pyp	$CHF_2CF(CHF_2)CHF_2$	65781-24-0			7.39	7.71
HFC-b-356mzm	$CH_3CH(CF_3)CF_3$	382-09-2			12	12.6
HFC-b-356myp	$CH_3CF(CF_3)CHF_2$	65781-20-6			10.8	11.4
HFC-b-356mzp	$CH_2FCH(CF_3)CHF_2$	32931-17-2			3.52	3.65
HFC-b-356myq	$CH_2FCF(CF_3)CH_2F$	161791-34-0			7.03	7.34
HFC-b-356pzp	$CHF_2CH(CHF_2)CHF_2$	138507-15-0			4.58	4.76
HFC-b-356pyp	$CH_2FCF(CHF_2)CHF_2$	35274-04-5			6.15	6.41
HFC-b-365mzp	$CH_3CH(CF_3)CHF_2$	381-95-3			3.52	3.65
HFC-b-365myq	$CH_3CF(CF_3)CH_2F$	119450-80-5			3.67	3.81
HFC-b-365pyp	$CH_3CF(CHF_2)CHF_2$	65781-23-9			6.25	6.53
HFC-b-365mzq	$CH_2FCH(CF_3)CH_2F$	161791-30-6			0.698	0.718
HFC-b-365pzp	$CH_2FCH(CHF_2)CHF_2$	32864-57-6			2.6	2.69
HFC-b-365pyq	$CHF_2CF(CH_2F)CH_2F$	65781-27-3			4.01	4.17
HFC-b-374my	$CF_3CF(CH_3)CH_3$	154381-59-6			6.42	6.72
HFC-b-374mz	$CF_3CH(CH_3)CFH_2$	161791-27-1			0.969	1
HFC-b-374py	$CHF_2CF(CH_3)CH_2F$	65781-26-2			2.92	3.03
HFC-b-374pzp	$CHF_2CH(CH_3)CHF_2$	161791-28-2			1.93	2
HFC-b-374qyq	$CH_2FCF(CH_2F)CH_2F$	65781-28-4			4.59	4.78
HFC-b-374pzq	$CHF_2CH(CH_2F)CH_2F$	161791-29-3			1.64	1.7
HFC-b-383mz	$CF_3CH(CH_3)CH_3$	1550-49-8			0.988	1.02
HFC-b-383py	$CHF_2CF(CH_3)CH_3$	66587-76-6			3.8	3.96
HFC-b-383pz	$CHF_2CH(CH_3)CH_2F$	66587-77-7			0.678	0.699
HFC-b-383qy	$CH_2FCF(CH_3)CH_2F$	161791-26-0			2.36	2.44
HFC-b-383qzq	$CH_2FCH(CH_2F)CH_2F$	66675-40-9			1.02	1.05
HFC-b-392qy	$CH_2FCF(CH_3)CH_3$	62126-92-5			1.2	1.24
HFC-b-392qz	$CH_2FCH(CH_3)CH_2F$	62126-93-6			0.33	0.336
HFC-b-392pz	$CHF_2CH(CH_3)CH_3$	62126-91-4			0.308	0.313
HFC-b-3-10-1q	$CH_2FCH(CH_3)CH_3$	359-00-2			0.088	0.089
HFC-b-3-10-1sy	$CH_3CF(CH_3)CH_3$	353-61-7			1.2	1.25
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	138495-42-8	0.30 ppt	17	17	17.9
HFC-458mfcf	$CF_3CH_2CF_2CH_2CF_3$	–		23.8	23.8	25.4
1,1,2,2,3,3,4-heptafluorocyclo-pentane	cyclo-$CF_2CF_2CF_2CHFCH_2$-	15290-77-4			3.15	3.26
trans-1H,2H-octafluorocyclopen-tane	trans- cyclo-$CF_2CF_2CF_2CHFCHF$-	158389-18-5			3.69	3.82
1-Fluorohexane	n-$C_6H_{13}F$	373-14-8			28.5	33
Fluorobenzene	C_6H_5F	462-06-6			0.059	0.059
HFC-55-10mcff	$CF_3CF_2CH_2CH_2CF_2CF_3$	–		7.7	7.66	8
HFC-52-13p	$CHF_2CF_2CF_2CF_2CF_2CF_3$	355-37-3		35.2	35.1	37
1,1,2,2,3,3-hexafluorocyclopen-tane	cyclo-$CF_2CF_2CF_2CH_2CH_2$-	123768-18-3			1.79	1.85
HFC-72-17p	$CHF_2CF_2CF_2CF_2CF_2CF_2CF_2CF_3$	–		23.8	23.8	24.9
Unsaturated Hydrofluorocarbons						
HFO-1141	$CH_2{=}CHF$	75-02-5		2.5 days (1.4–3.1 days)	2.5 days (1.4–3.1 days)	2.5 days

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W m^{-2} ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W m^{-2} ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance L: Lifetime O: Ozone Depletion Potential R: Radiative Metrics*
268	0	0.333	0.319	3540	1200	342	458	230	L14, O1, R11
325	0	0.285	0.275	3520	1320	378	665	268	L14, O1, R11
529	0	0.306	0.3	5960	3720	1140	3530	1570	L14, O1, R11
125	0	0.295	0.271	1620	457	130	105	84	L14, O1, R11
205	0	0.24	0.269	2720	847	242	248	159	L14, O1, R11
174	0	0.356	0.334	2870	851	243	217	158	L14, O1, R11
181	0	0.333	0.314	2800	840	240	220	156	L14, O1, R11
244	0	0.287	0.275	3830	1320	378	535	256	L14, O1, R11
227	0	0.315	0.301	3930	1300	372	469	249	L14, O1, R11
96.9	0	0.291	0.261	1320	369	105	84	67	L14, O1, R11
167	0	0.264	0.248	2360	700	200	178	130	L14, O1, R11
120	0	0.328	0.301	1960	553	158	127	102	L14, O1, R11
151	0	0.281	0.263	2230	649	185	157	120	L14, O1, R11
94.5	0	0.275	0.246	1390	390	111	88	71	L14, O1, R11
97.8	0	0.24	0.216	1270	357	102	81	65	L14, O1, R11
147	0	0.278	0.259	2500	729	208	177	135	L14, O1, R11
24.2	0	0.214	0.144	163	45	13	10	8	L14, O1, R11
74.1	0	0.273	0.238	1000	279	79	62	51	L14, O1, R11
105	0	0.206	0.187	1200	338	96	77	62	L14, O1, R11
144	0	0.224	0.209	2350	687	196	169	127	L14, O1, R11
32	0	0.195	0.144	257	71	20	16	13	L14, O1, R11
79.7	0	0.189	0.167	896	250	71	56	46	L14, O1, R11
57.2	0	0.222	0.186	661	184	52	41	33	L14, O1, R11
13	0	0.152	0.14	1170	329	94	76	60	L14, O1, R11
49.9	0	0.177	0.145	438	122	35	27	22	L14, O1, R11
32.2	0	0.184	0.136	288	80	23	18	14	L14, O1, R11
95.4	0	0.162	0.146	1180	330	94	75	60	L14, O1, R11
23.3	0	0.142	0.095	138	38	11	8	7	L14, O1, R11
66	0	0.127	0.109	550	153	44	34	28	L14, O1, R11
33.1	0	0.105	0.079	172	48	14	11	9	L14, O1, R11
37.5	0	0.093	0.072	220	61	17	14	11	L14, O1, R11
20	0	0.075	0.038	32	9	3	2	2	L14, O1, R11
20	0	0.139	0.069	54	15	4	3	3	L14, O1, R11
20	0	0.039	0.009	2	<1	<1	<1	<1	L14, O1, R11
37.4	0	0.05	0.039	147	41	12	9	7	L14, O1, R11
360	0	0.369	0.359	3980	1610	460	948	348	A4, L2, O1, R2
372	0	0.521	0.508	7550	3670	1060	2850	1020	L2, O1, R6
90.7	0	0.28	0.253	971	271	77	61	49	L18, O1, R15
106	0	0.29	0.266	1090	306	87	69	56	L18, O1, R15
209	0	0.041	0.041	1340	723	213	622	238	L19, O1, R2
20	0	0.065	0.012	2	<1	<1	<1	<<1	L3, O1, R2
178	0	0.59	0.557	3540	1070	305	286	199	L2, O1, R6
659	0	0.593	0.582	6570	3990	1210	3730	1610	L2, O1, R6
55.2	0	0.248	0.21	506	141	40	31	26	L20, O1, R16
525	0	0.765	0.746	5700	2770	804	2150	768	L2, O1, R6
–	0	0.089	2.47E-03	<<1	<<1	<<1	<<1	<<1	L2, O1, R2

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
(E)-HFO-1132, (E)-1,2-difluoro-ethene	(E)-CHF=CHF	–			1.3 days	1.3 days
(Z)-HFO-1132, (Z)-1,2-difluoro-ethene	(Z)-CHF=CHF	–			1.6 days	1.6 days
HFO-1132a	$CH_2=CF_2$	75-38-7		4.6 days (3–5.7 days)	4.6 days (3–5.7 days)	4.6 day
HFO-1123	$CHF=CF_2$	359-11-5		1.4 days	1.5 days	1.5 days
HFO-1261yf	$CH_2=CFCH_3$	–			0.7 days	0.7 days
HFO-1261zf, 3-fluoro-1-propene	$CH_2FCH=CH_2$	818-92-8		0.8 days (0.5–1.0 days)	0.9 days (0.5–1.0 days)	0.9 days
HFO-1243zf	$CF_3CH=CH_2$	677-21-4		9 days (5.5–11 days)	9 days (5.5–11 days)	9 days
(E)-HFO-1234ye	(E)-$CHF=CFCHF_2$	–		<5 days	19 days	19 days
(Z)-HFO-1234ye	(Z)-$CHF=CFCHF_2$	–		<5 days	10 days	10 days
(E)-HFO-1234ze	(E)-$CF_3CH=CHF$	29188-24-9	0.023 ppt	19 days (12.8–24 days)	19 days (12.8–24 days)	19 days
(Z)-HFO-1234ze	(Z)-$CF_3CH=CHF$	29118-25-0		10.0 days	9.6 days	9.6 days
HFO-1234zc	$CF_2=CHCHF_2$	–		<5 days	5 days	5 days
HFO-1234yf	$CF_3CF=CH_2$	754-12-1	0.026 ppt	12 days (8.4–16 days)	12 days (8.4–16 days)	12 days
HFO-1234yc	$CF_2=CFCH_2F$	–		~2 days	2 days	2 days
3,3,4,4-tetrafluorocyclobutene	c-$CH=CHCF_2CF_2$-	2714-38-7		84 days	83 days	83 days
2,3,3,4,4-pentafluorocyclo-but-1-ene	c-$CH=CFCF_2CF_2$-	374-31-2		270 days	258 days	268 days
(E)-HFO-1225ye	(E)-$CF_3CF=CHF$	5595-10-8		5.7 days (3.7–6.9 days)	5.7 days (3.7–6.9 days)	5.7 days
(Z)-HFO-1225ye	(Z)-$CF_3CF=CHF$	5528-43-8		10 days (6.2–12 days)	10 days (6.2–12 days)	10 days
HFO-1225yc	$CF_2=CFCHF_2$	–			1.6 days	1.6 days
HFO-1225zc	$CF_2=CHCF_3$	690-27-7		~2 days	2 days	2 days
HFO-1345zfc	$C_2F_5CH=CH_2$	374-27-6		9 days (5.8–11.4 days)	9 days (5.8–11.4 days)	9 days
(E)-HFO-1336mzz	(E)-$CF_3CH=CHCF_3$	–		122 days	121 days	121 days
(Z)-HFO-1336mzz	(Z)-$CF_3CH=CHCF_3$	692-49-9		27 days (16.3–32 days)	27 days (16.3–32 days)	27 days
3,3,3-trifluoro-2-(trifluoromethyl)-1-propene	$(CF_3)_2C=CH_2$	382-10-5			17 days	17 days
HFO-1447fz	$CH_2=CHCF_2CF_2CF_3$	355-08-8		9 days (6–10 days)	33 days	33 days
1,3,3,4,4,5,5-heptafluorocyclo-pentene	cyclo-$CF_2CF_2CF_2CF=CH$-	1892-03-1			254 days	263 days
(E)-HFO-1438mzz	(E)-$CF_3CH=CHCF_2CF_3$	–		122 days	120 days	122 days
(E)-HFO-1438ezy	(E)-$(CF_3)_2CFCH=CHF$	14149-41-8		43 days	43 days	43 days
3,3,4,4,5,5,6,6,6-nonafluoro-hex-1-ene	$C_4F_9CH=CH_2$	19430-93-4		9 days	9 days	9 days
3,3,4,4,5,5,6,6,7,7,8,8,8-trideca-fluorooct-1-ene (HFO-174-13fz)	$C_6F_{13}CH=CH_2$	25291-17-2		9 days	9 days	9 days
3,3,4,4,5,5,6,6,7,7,8, 8,9,9, 10,10,10-heptadecafluoro-dec-1-ene (HFO-194-17fz)	$C_8F_{17}CH=CH_2$	21652-58-4		9 days	9 days	9 days
Chlorocarbons and Hydrochlorocarbons						
Methyl chloroform	CH_3CCl_3	71-55-6	1.4 ppt	5	5	6.1
Carbon tetrachloride	CCl_4	56-23-5	77.6 ppt	32	30	–
Methyl chloride	CH_3Cl	74-87-3	549.4 ppt	0.9	0.9	1.57
Methylene chloride	CH_2Cl_2	75-09-2	45.7 ppt	180 days (95–1070 days)	176 days (95–1070 days)	181 days
Chloroform	$CHCl_3$	67-66-3	8.7 ppt	183 days (97–1145 days)	178 days (97–1145 days)	183 days
1,2-dichloroethane	CH_2ClCH_2Cl	107-06-2	12.8 ppt (10.4–18.3)	82 days (41–555 days)	81.3 days (41–555 days)	82.1 days
Chloroethane	CH_3CH_2Cl	75-00-3		48 days (26–280 days)	47.6 days (26–280 days)	47.8 days
1,1-dichloroethane	CH_3CHCl_2	75-34-3			134 days	134 days
1,1,2-trichloroethane	$CH_2ClCHCl_2$	79-00-5			83 days	84 days
1,1,1,2-tetrachloroethane	CH_2ClCCl_3	630-20-6			3.39	3.85
1,1,2,2-tetrachloroethane	$CHCl_2CHCl_2$	79-34-5			145 days	148 days

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W\ m^{-2}\ ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W\ m^{-2}\ ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance* *L: Lifetime* *O: Ozone Depletion Potential* *R: Radiative Metrics*
–	0	0.157	2.46E-03	<<1	<<1	<<1	<<1	<<1	L21, O1, R6
–	0	0.115	2.09E-03	<<1	<<1	<<1	<<1	<<1	L21, O1, R6
–	0	0.09	4.32E-03	<1	<<1	<<1	<<1	<<1	L2, O1, R17
–	0	0.117	2.10E-03	<<1	<<1	<<1	<<1	<<1	L2, O1, R18
–	0	0.093	8.32E-04	<<1	<<1	<<1	<<1	<<1	L22, O1, R6
–	0	0.059	6.75E-04	<<1	<<1	<<1	<<1	<<1	L22, O1, R2
–	0	0.177	0.0152	<1	<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.242	0.0399	4	1	<1	<1	<1	L23, O1, R6
–	0	0.204	0.0187	1	<1	<<1	<<1	<<1	L23, O1, R6
–	0	0.284	0.0459	5	1	<1	<1	<1	A4, L2, O1, R2
–	0	0.209	0.0191	1	<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.231	0.0121	<1	<<1	<<1	<<1	<<1	L24, O1, R6
–	0	0.238	0.0268	2	<1	<1	<1	<<1	A4, L2, O1, R2
–	0	0.202	4.61E-03	<<1	<<1	<<1	<<1	<<1	L24, O1, R6
–	0	0.231	0.101	44	12	3	3	2	L2, O1, R19
20	0	0.297	0.205	241	67	19	15	12	L2, O1, R19
–	0	0.259	0.0152	<1	<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.265	2.48E-02	1	<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.207	3.79E-03	<<1	<<1	<<1	<<1	<<1	L25, O1, R6
–	0	0.371	8.47E-03	<<1	<<1	<<1	<<1	<<1	L24, O1, R6
–	0	0.356	0.0168	<1	<1	<<1	<<1	<<1	L2, O1, R6
–	0	0.376	0.193	94	26	7	6	5	L2, O1, R20
–	0	0.393	0.0809	9	2	<1	<1	<1	L2, O1, R21
–	0	0.341	0.0509	3	<1	<1	<1	<1	L26, O1, R2
–	0	0.396	0.0962	11	3	<1	<1	<1	L27, O1, R22
20	0	0.33	0.224	193	54	15	12	10	L28, O1, R23
–	0	0.564	0.289	107	30	8	7	5	L29, O1, R6
–	0	0.325	0.0931	12	3	<1	<1	<1	L30, O1, R24
–	0	0.354	0.0314	<1	<1	<<1	<<1	<<1	L31, O1, R2
–	0	0.396	0.0354	<1	<1	<<1	<<1	<<1	L31, O1, R2
–	0	0.444	0.0397	<1	<1	<<1	<<1	<<1	L31, O1, R2
38	0.12	0.07	0.0655	576	164	47	38	30	A2, L5, L11, O3, R2
44	0.87	0.176	0.172	3870	2150	638	1890	744	A2, L11, L32, O3, O4, R2
30.4	0.015	0.00645	4.66E-03	20	6	2	1	1	A2, L5, L11, O3, R2
–	–	0.048	0.0287	39	11	3	2	2	A2, L2, R2
–	–	0.122	0.0731	72	20	6	4	4	A2, L2, R2
–	–	0.02	8.64E-03	5	1	<1	<1	<1	A3, L2, R2
–	–	0.011	3.43E-03	2	<1	<1	<1	<<1	L2, R2
–	–	0.028	0.0154	14	4	1	<1	<1	L3, R2
–	–	0.05	0.0219	9	2	<1	<1	<1	L33, R2
28	–	0.103	0.0953	459	128	37	29	23	L34, R2
–	–	0.096	0.0543	31	9	2	2	2	L34, R2

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
1-chloropropane	$CH_3CH_2CH_2Cl$	540-54-5		16 days (10–80 days)	16.5 days (10–80 days)	16.5 days
2-chloropropane	$CH_3CHClCH_3$	75-29-6		22 days (13–95 days)	22 days (13–95 days)	22 days
1,3-dichloropropane	$CH_2ClCH_2CH_2Cl$	142-28-9			17.5 days	17.5 days
1-chloro-2-methylpropane	$(CH_3)_2CHCH_2Cl$	513-36-0			7.0 days	7.0 days
1-chlorobutane	$CH_3(CH_2)_2CH_2Cl$	109-69-3			5.9 days	5.9 days
1-chloropentane	$CH_3(CH_2)_3CH_2Cl$	543-59-9			0.8 days	0.8 days
Unsaturated Chlorocarbons and Hydrochlorocarbons						
Chloroethene (vinyl chloride)	CH_2=CHCl	75-01-4		1.7 days (0.9–2.2 days)	1.7 days (0.9–2.2 days)	1.7 days
1,1-dichloroethene	CH_2=CCl_2	75-35-4		1 days (0.5–1.3 days)	1 day (0.5–1.3 days)	1 day
(E)-1,2-dichloroethene	(E)-CClH=CClH	156-60-5		5.5 days (3.2–6.7 days)	5.5 days (3.2–6.7 days)	5.5 day
(Z)-1,2-dichloroethene	(Z)-CClH=CClH	156-59-2		5.2 days (3.2–6.7 days)	5.2 days (3.2–6.7 days)	5.2 days
Trichloroethene	CHCl=CCl_2	79-01-6	0.3 ppt	5.6 days (3.3–7.1 days)	5.6 days (3.3–7.1 days)	5.6 days
Perchloroethene	CCl_2=CCl_2	127-18-4	1.13 ppt	110 days (66–245 days)	109 days (66–245 days)	110 days
3-chloro-1-propene	CH_2=$CHCH_2Cl$	107-5-1			1.4 days	1.4 days
3-chloro-1-propyne	CH_2ClC€H	624-65-7			1.4 days	1.4 days
2,3-dichloropropene	CH_2ClCCl=CH_2	78-88-6			1.0 day	1.0 day
1,2-dichloropropene	CHCl=$CClCH_3$	563-54-2			1.4 days	1.4 days
1,3-dichloropropene (E)	(E)-CHCl=$CHCH_2Cl$	10061-02-6			1.6 days	1.6 days
1,3-dichloropropene (Z)	(Z)-CHCl=$CHCH_2Cl$	10061-01-5			0.95 days	0.95 days
3,4-dichloro-1-butene	CH_2ClCHClCH=CH_2	760-23-6			0.94 days	0.94 days
Hexachloro-1,3-butadiene	CCl_2=CClCCl=CCl_2	87-68-3			1.4 days	1.4 days
Hexachloro-1,3-cyclopentadiene	C_5Cl_6	77-47-4			1.4 days	1.4 days
Chlorobenzene	C_6H_5-Cl	108-90-7			22.8 days	22.8 days
1,4-dichlorobenzene	p-Cl-C_6H_4-Cl	106-46-7			42 days	43 days
1,3-dichlorobenzene	m-Cl-C_6H_4-Cl	541-73-1			18.9 days	19 days
1,2-dichlorobenzene	o-Cl-C_6H_4-Cl	95-50-1			32.4 days	32.5 days
1-chloro-4-methylbenzene	p-Cl-C_6H_4-CH_3	106-43-4			27.2 days	27.3 days
1-chloro-3-methylbenzene	m-Cl-C_6H_4-CH_3	108-41-8			27.2 days	27.3 days
1-chloro-2-methylbenzene	o-Cl-C_6H_4-CH_3	95-49-8			27.2 days	27.3 days
Benzyl chloride	C_6H_5-CH_2Cl	100-44-7			45.2 days	45.6 days
1,2-dichloro-3-(trichloromethyl)-benzene (DCTCB)	$C_7H_3Cl_5$	84613-97-8			134 days	136 days
Unsaturated Chlorofluorocarbons and Hydrochlorofluorocarbons						
CFO-1113 Chlorotrifluoroethene	CF_2=CFCl	79-38-9		1.5 days (0.8–2.1 days)	1.5 days (0.8–2.1 days)	1.5 days
(E)-1,2-fluorochloroethene	(E)-CHCl=CHF	2268-32-8			2.2 days	2.2 days
(Z)-1,2-fluorochloroethene	(Z)-CHCl=CHF	2268-31-7			2.2 days	2.2 days
1,2-dichloro-1,2-difluoroethylene (E)	(E)-CFCl=CFCl	598-88-9			4.9 days	4.9 days
1,2-dichloro-1,2-difluoroethylene (Z)	(Z)-CFCl=CFCl	598-88-9			4.7 days	4.7 days
1,1-dichloro-2,2-difluoro-ethene	CCl_2=CF_2	79-35-6			2.7 days	2.7 days
fluorotrichloroethylene	CCl_2=CClF	359-29-5			2.7 days	2.7 days
3-chloro-1,1,3-trifluoro propene (E)	(E)-CHF_2CF=CHCl	–			5.0 days	5.1 days
3-chloro-1,1,3-trifluoro propene (Z)	(Z)-CHF_2CF=CHCl	–			2.7 days	2.7 days
(E)-HCFO-1233zd	(E)-CF_3CH=CHCl	102687-65-0	0.047 ppt	42.5 days (34–64 days)	41.9 days (34–64 days)	41.9 days
(Z)-HCFO-1233zd	(Z)-CF_3CH=CHCl	99728-16-2		13 days	13 days	13 days
1-chloro-2,3,3,3-tetrafluoropropene (E); (E)-HCFO-1224yd	(E)-CF_3CF=CHCl	3110-38-1			10 days	10 days
1-chloro-2,3,3,3-tetrafluoropropene (Z); (Z)-HCFO-1224yd	(Z)-CF_3CF=CHCl	3110-38-1			12 days	12 days

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) (W m⁻² ppb⁻¹) [b]	Recommended Adjusted Effective Radiative Efficiency (W m⁻² ppb⁻¹) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance L: Lifetime O: Ozone Depletion Potential R: Radiative Metrics*
–	–	0.0195	2.83E-03	<1	<1	<<1	<<1	<<1	L2, R6
–	–	0.0293	3.67E-03	<1	<1	<<1	<<1	<<1	L2, R6
–	–	0.02	4.40E-03	<1	<1	<<1	<<1	<<1	L35, R2
–	–	0.029	1.42E-03	<<1	<<1	<<1	<<1	<<1	L36, R2
–	–	0.02	9.83E-04	<<1	<<1	<<1	<<1	<<1	L36, R2
–		0.016	1.66E-04	<<1	<<1	<<1	<<1	<<1	L37, R2
–	–	0.041	7.91E-04	<<1	<<1	<<1	<<1	<<1	L2, R2
–	–	0.086	1.17E-03	<<1	<<1	<<1	<<1	<<1	L2, R6
–	<0.0003	0.091	5.15E-03	<1	<<1	<<1	<<1	<<1	L2, O11, R2
–	<0.0003	0.043	2.63E-03	<<1	<<1	<<1	<<1	<<1	L2, O11, R3
–	<0.004	0.099	5.77E-03	<1	<<1	<<1	<<1	<<1	A3, L2, O11, R2
–	–	0.107	0.0522	23	6	2	1	1	A2, L2, R2
–		0.046	7.44E-04	<<1	<<1	<<1	<<1	<<1	L3, R2
–		0.024	4.22E-04	<<1	<<1	<<1	<<1	<<1	L3, R2
–		0.052	6.37E-04	<<1	<<1	<<1	<<1	<<1	L38, R2
–		0.025	4.15E-04	<<1	<<1	<<1	<<1	<<1	L3, R2
–		0.056	1.11E-03	<<1	<<1	<<1	<<1	<<1	L39, R2
–		0.061	7.15E-04	<<1	<<1	<<1	<<1	<<1	L39, R2
–		0.055	6.40E-04	<<1	<<1	<<1	<<1	<<1	L38, R2
–		0.144	2.31E-03	<<1	<<1	<<1	<<1	<<1	L3, R2
–		0.11	1.77E-03	<<1	<<1	<<1	<<1	<<1	L3, R2
–		0.039	7.71E-03	1	<1	<<1	<<1	<<1	L40, R2
–		0.075	0.0226	4	1	<1	<1	<1	L41, R2
–		0.08	0.013	1	<1	<<1	<<1	<<1	L42, R2
–		0.046	0.0115	2	<1	<1	<1	<<1	L42, R2
–		0.05	0.0115	2	<1	<1	<<1	<<1	L3, R2
–		0.054	0.0117	2	<1	<1	<1	<<1	L3, R2
–		0.036	8.02E-03	1	<1	<<1	<<1	<<1	L3, R2
–		0.024	7.32E-03	2	<1	<1	<1	<<1	L3, R2
–		0.134	0.0743	25	7	2	2	1	R6
–	–	0.114	2.03E-03	<<1	<<1	<<1	<<1	<<1	L43, R2
–		0.044	1.08E-03	<<1	<<1	<<1	<<1	<<1	L43, R25
–		0.044	1.11E-03	<<1	<<1	<<1	<<1	<<1	L44, R25
–		0.013	5.99E-03	<1	<<1	<<1	<<1	<<1	L43, L44, R25
–		0.013	5.74E-03	<1	<<1	<<1	<<1	<<1	L44, R25
–		0.007	2.65E-03	<<1	<<1	<<1	<<1	<<1	L43, R25
–		0.13	3.92E-03	<<1	<<1	<<1	<<1	<<1	L3, R2
–		0.232	0.0124	<1	<<1	<<1	<<1	<<1	L45, R6
–		0.174	0.0052	<<1	<<1	<<1	<<1	<<1	L45, R6
–	<0.0004	0.229	0.0651	14	4	1	<1	<1	L2, O11, R26
–	<0.0004	0.213	0.0254	2	<1	<1	<1	<<1	L2, O11, R26
–		0.366	0.0357	2	<1	<1	<<1	<<1	L45, R6
–		0.31	0.0335	2	<1	<1	<1	<<1	L45, R6

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HCFO-1233xf (2-chloro-3,3,3-fluoro-1-propene)	$CF_3CCl{=}CH_2$	–		42.5 days (34–64 days)	42.3 days (34–64 days)	42.5 days
CFO-1215yc (3-chloro-1,1,2,3,3-fluoro-1-propene)	$CF_2{=}CFCF_2Cl$	–		~5 days ~(3–7 days)	~5 days ~(3–7 days)	~5 days
3,3-dichloro-1,1,1,2-tetrafluoro-propene	$CCl_2{=}CFCF_3$	–			14 days	14 days
1,2-dichloro-3,3,3-trifluoro-propene (Z)	(Z)-$CF_3CCl{=}CHCl$	431-27-6			28.4 days	28.4 days
CFO-1316yff (4,4-dichloro-1,1,2,3,3,4-fluoro-1-butene)	$CF_2{=}CFCF_2CFCl_2$	–		~5 days ~(3–7 days)	~6 days ~(3–7 days)	~6 days
p-chlorobenzotrifluoride	$ClC_6H_4CF_3$	98-56-6			60 days	60.7 days
Bromocarbons, Hydrobromocarbons, and Halons						
Methyl bromide	CH_3Br	74-83-9	6.68 ppt	0.8	0.8	1.8
Methylene bromide	CH_2Br_2	74-95-3	0.9 ppt (0.6–1.7)	150 days (80–890 days)	147 days (80–890 days)	150 days
Bromoform	$CHBr_3$	75-25-2	1.2 ppt (0.4–4.0)	16 days (8–23 days)	13 days (8–23 days)	57 days (15–88 days)
Halon-1201	$CHBrF_2$	1511-62-2		4.9	4.85	5.68
Halon-1202	CBr_2F_2	75-61-6	0.009 ppt	2.5	2.5	122
Halon-1211	$CBrClF_2$	353-59-3	3.11 ppt	16	16	1.45E+04
Halon-1301	$CBrF_3$	75-63-8	3.32 ppt	72	72	2.10E+04
Bromochloromethane	CH_2BrCl	74-97-5	0.10 ppt (0.07–0.12)	165 days (89–1050 days)	162 days (89–1050 days)	165 days
Bromodichloromethane	$CHBrCl_2$	75-27-4	0.3 ppt (0.1–0.9)	66 days (38–250 days)	66 days (38–250 days)	95 days (56–460 days)
Dibromochloromethane	$CHBr_2Cl$	124-48-1	0.3 ppt (0.1–0.8)	59 days (28–225 days)	49 days (28–225 days)	71 days (45–325 days)
Bromoethane	CH_3CH_2Br	74-96-4		50 days (30–260 days)	50 days (30–260 days)	50 days
1,2-dibromoethane	CH_2BrCH_2Br	106-93-4		89 days (44–590 days)	89 days (44–590 days)	89 days
n-bromopropane	$CH_3CH_2CH_2Br$	106-94-5		15 days (9–65 days)	15 days (9–65 days)	15 days
Iso-bromopropane	$CH_3CHBrCH_3$	75-26-3		20 days (12–88 days)	20 days (12–88 days)	20 days
Halon-2301	CH_2BrCF_3	421-06-7		3.2	2.9	3.25
Halon-2311 / Halothane	$CHBrClCF_3$	151-67-7	0.010 ppt	1	1	1.08
Halon-2401	$CHFBrCF_3$	124-72-1		2.9	2.83	3.15
Halon-2402 isomer	CF_3CFBr_2	–		2.5	28	2.10E+04
Halon-2402	$CBrF_2CBrF_2$	124-73-2	0.40 ppt	28	28	2.10E+04
Unsaturated Bromofluorocarbons						
Bromoethene	$CH_2{=}CHBr$	593-60-2			34 days	35 days
Bromothrifluoroethene	$CFBr{=}CF_2$	598-73-2		1.6 days (0.9–2.0 days)	1.6 days (0.9–2.0 days)	1.6 days
1-bromo-2,2-fluoroethene	$CHBr{=}CF_2$	359-08-0		2.7 days (1.5–3.4 days)	2.7 days (1.5–3.4 days)	2.7 days
3-bromo-1-propene	$CH_2{=}CHCH_2Br$	106-95-6			20 days	20 days
2-bromo-3,3,3-fluoro-1-propene	$CH_2{=}CBrCF_3$	1514-82-5		3.2 days (1.8–3.9 days)	3.2 days (1.8–3.9 days)	3.2 days
2-bromo-3,3,4,4,4-fluoro-1-butene	$CH_2{=}CBrCF_2CF_3$	68318-95-6		3.7 days (2.0–4.6 days)	3.7 days (2.0–4.6 days)	3.7 days
4-bromo-3,3,4,4-fluoro-1-butene	$CH_2{=}CHCF_2CF_2Br$	18599-22-9		7.5 days (4.7–9.5 days)	7.5 days (4.7–9.5 days)	7.5 days
Benzyl bromide	C_6H_5-CH_2Br	100-39-0			14 days	14 days
Unsaturated Bromochlorofluorocarbons						
4-bromo-3-chloro-3,4,4-trifluoro-1-butene	$CH_2{=}CHCClFCBrF_2$	374-25-4		4.5 days	4.4 days	4.4 days
Fully Fluorinated Species						
Nitrogen trifluoride	NF_3	7783-54-2	2.3 ppt	569	569	–
Perfluorotriethylamine	$N(C_2F_5)_3$	359-70-6		>1000	>3000	–
Perfluorotripropylamine	$N(C_3F_7)_3$	338-83-0		>1000	>3000	–

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W\ m^{-2}\ ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W\ m^{-2}\ ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance* *L: Lifetime* *O: Ozone Depletion Potential* *R: Radiative Metrics*
–	–	0.263	0.075	16	4	1	<1	<1	L46, R6
–	–	0.362	0.021	<1	<1	<<1	<<1	<<1	L47, R6
–		0.343	0.0419	2	<1	<1	<1	<1	L3, R6
–		0.318	0.0684	8	2	<1	<1	<1	L48, R6
–	–	0.399	0.0231	<1	<1	<<1	<<1	<<1	L47, R6
–		0.314	0.115	25	7	2	2	1	L49
26.3	0.57	0.006	4.21E-03	9	2	<1	<1	<1	A2, L5, L11, O3, R2
–	3–4	0.017	9.33E-03	5	1	<1	<1	<1	A3, L2, O11, R2
–	1–5	0.018	2.13E-03	<<1	<<1	<<1	<<1	<<1	A3, L2, O11, R2
34		0.165	0.152	1320	375	107	87	69	L2, R2
36	1.8	0.313	0.271	773	215	61	48	39	A2, L2, L5, O3, R2
41	7.1	0.32	0.31	5080	1990	570	1110	420	A2, L2, L5, O3, R4
73.5	17	0.313	0.309	8580	7430	2840	7800	5220	A2, L2, L5, O3, R2
–	–	0.035	0.0202	17	5	1	1	<1	A3, L2, R2
–	–	0.061	0.023	6	2	<1	<1	<1	A3, L2, R6
–	–	0.04	0.0125	2	<1	<1	<1	<<1	A3, L2, R6
–	<0.46	0.018	5.67E-03	2	<1	<1	<1	<<1	L2, O11, R2
–	–	0.027	1.20E-02	4	1	<1	<1	<1	L2, R2
–	<0.17	0.018	2.43E-03	<1	<<1	<<1	<<1	<<1	L2, O11, R2
–	–	0.026	4.32E-03	<1	<1	<<1	<<1	<<1	L2, R2
–	–	0.152	0.135	575	160	46	36	29	L2, R2
–	~1.6	0.18	0.134	163	45	13	10	8	A3, L2, O12, R2
28	–	0.214	0.189	707	197	56	44	36	L2, R2
32	–	0.346	0.339	4420	2360	695	2010	763	L2, L50, R6
41	15.6	0.332	0.325	4240	2260	666	1930	732	A2, L5, L11, O3, R2
–	–	0.041	0.01	2	<1	<1	<1	<1	L51, R2
–	–	0.161	0.003	<<1	<<1	<<1	<<1	<<1	L2, R6
–	–	0.123	0.004	<<1	<<1	<<1	<<1	<<1	L2, R6
–		0.04	0.007	<1	<1	<<1	<<1	<<1	L52, R2
–	<0.05	0.246	0.009	<1	<<1	<<1	<<1	<<1	L2, O11, R6
–	–	0.334	0.013	<1	<<1	<<1	<<1	<<1	L2, R6
–	–	0.348	0.026	<1	<1	<<1	<<1	<<1	L2, R6
–	–	0.032	0.004	<1	<<1	<<1	<<1	<<1	L3, R2
	–	0.329	0.015	<1	<<1	<<1	<<1	<<1	L2, R6
740	0	0.209	0.208	13,600	17,700	18,500	18,600	20,300	A2, L5, L53, O1, R2
>3000	0	0.686	0.69	8770	12,100	16,300	12,500	14,600	L3, O1, R27
>3000	0	0.809	0.816	7390	10,200	13,700	10,600	12,300	L3, O1, R27

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
Perfluorotributylamine	$N(C_4F_9)_3$	311-89-7		>1000	>3000	–
Perfluorotripentylamine	$N(C_5F_{11})_3$	338-84-1		>1000	>3000	–
Sulfur hexafluoride	SF_6	2551-62-4	10.3 ppt	3200	850–1280	–
(Trifluoromethyl)sulfur penta-fluoride	SF_5CF_3	373-80-8	0.155 ppt	650–950	650–950	–
PFC-14 (Perfluoromethane)	CF_4	75-73-0	86.4 ppt	50,000	50,000	–
PFC-116 (Perfluoroethane)	C_2F_6	76-16-4	4.94 ppt	10,000	10,000	–
PFC-c216 (Perfluorocyclopropane)	$c\text{-}C_3F_6$	931-91-9		3000	3000	–
PFC-218 (Perfluoropropane)	C_3F_8	76-19-7	0.7 ppt	2600	2600	–
PFC-c316 (Perfluorocyclobutene)	$c\text{-}C_4F_6$	697-11-0		1.2	1.2	1.205
PFC-c318 (Perfluorocyclobutane)	$c\text{-}C_4F_8$	115-25-3	1.82 ppt	3200	3200	–
PFC-31-10 (Perfluorobutane)	$n\text{-}C_4F_{10}$	355-25-9		2600	2600	–
PFC-c418 (Perfluorocyclopentene)	$c\text{-}C_5F_8$	559-40-0		1.1	1.06	1.063
PFC-41-12 (Perfluoropentane)	$n\text{-}C_5F_{12}$	678-26-2	0.148 ppt	4100	4100	–
PFC-51-14 (Perfluorohexane)	$n\text{-}C_6F_{14}$	355-42-0	0.22 ppt	3100	3100	–
PFC-61-16 (Perfluoroheptane)	$n\text{-}C_7F_{16}$	335-57-9		3000	3000	–
PFC-71-18 (Perfluorooctane)	$n\text{-}C_8F_{18}$	307-34-6		3000	3000	–
PFC-91-18 (isomer mixture)	$C_{10}F_{18}$	306-94-5		2000	2000	–
PFC-c91-18(Z) (Perfluorodecalin(Z))	$(Z)\text{-}C_{10}F_{18}$	60433-12-7		2000	2000	–
PFC-c91-18(E) (Perfluorodecalin(E))	$(E)\text{-}C_{10}F_{18}$	60433-11-6		2000	2000	–
PFC-1114	$CF_2{=}CF_2$	116-14-3		1.2 days (0.7–1.6 days)	1.2 days (0.7–1.6 days)	1.2 days
PFC-1216	$CF_3CF{=}CF_2$	116-15-4		5.5 days (3.3–7.1 days)	5.5 days (3.3–7.1 days)	5.5 days
Perfluorobuta-1,3-diene	$CF_2{=}CFCF{=}CF_2$	685-63-2		1.1 days	1.1 days	1.1 days
Perfluorobut-1-ene	$CF_3CF_2CF{=}CF_2$	357-26-6		6 days	6.6 days	6.6 days
Perfluoroisobutene	$(CF_3)_2C{=}CF_2$	382-21-8			14 days	14 days
(E)-Perfluoro-2-butene	$(E)\text{-}CF_3CF{=}CFCF_3$	360-89-4		22 days	22 days	22 days
(Z)-Perfluoro-2-butene	$(Z)\text{-}CF_3CF{=}CFCF_3$	1516-15-9		35 days	35 days	35 days
Perfluoro(2-methyl-2-pentene)	$(CF_3)_2C{=}CFCF_2CF_3$	1584-03-8		192 days	0.527	0.527
Hexafluorobenzene	C_6F_6	392-56-3			115 days	115 days
PFPHP- Perfluoroperhydrophen-anthrene (Vitreon, Flutec PP 11)	$C_{14}F_{24}$	306-91-2			>1000	–
Halogenated Ethers						
HFE-125	CHF_2OCF_3	3822-68-2		135	101.7	147
HFE-134 (HG-00)	CHF_2OCHF_2	1691-17-4		26.9	25.4	28.4
HFE-143a	CH_3OCF_3	421-14-7		4.9	4.82	5.05
HFE-152a	CH_3OCHF_2	359-15-9		1.8	1.78	1.85
HFE-227ea	$CF_3CHFOCF_3$	2356-62-9		54.8	48.4	58.1
1,1,2,2-tetrafluoro-1-(trifluoro-methoxy)ethane	$CF_3OCF_2CF_2H$	2356-61-8			15.3	16.6
HCFE-235ca2 (enflurane)	CHF_2OCF_2CHFCl	13838-16-9		4.42	4.38	4.58
HCFE-235da2 (isoflurane)	$CHF_2OCHClCF_3$	26675-46-7	0.11 ppt	3.5	3.48	3.7
HFE-236ca	$CHF_2OCF_2CHF_2$	32778-11-3		22	18.9	23.2
HFE-236ea2 (desflurane)	$CHF_2OCHFCF_3$	57041-67-5	0.37 ppt	14.1	13.7	14.8
HFE-236fa	$CF_3CH_2OCF_3$	20193-67-3		~7.5	7.56	8
HFE-245cb2	$CF_3CF_2OCH_3$	22410-44-2		5	4.99	5.24
HFE-245fa1	$CHF_2CH_2OCF_3$	84011-15-4		~6.7	6.64	7
HFE-245fa2	$CHF_2OCH_2CF_3$	1885-48-9		5.5	5.49	5.77
HFE-254cb1	$CH_3OCF_2CHF_2$	425-88-7		2.5	2.52	2.62
HFE-254eb2	$CH_3OCHFCF_3$	–		110 days (69–200 days)	107 days (69–200 days)	110 days
HFE-263mf	$CF_3CH_2OCH_3$	460-43-5		28 days (19–47 days)	28 days (19–47 days)	29 days

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) (W m⁻² ppb⁻¹) [b]	Recommended Adjusted Effective Radiative Efficiency (W m⁻² ppb⁻¹) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance* *L: Lifetime* *O: Ozone Depletion Potential* *R: Radiative Metrics*
>3000	0	0.924	0.938	6590	9070	12,200	9430	11,000	L3, O1, R2
>3000	0	1.05	1.06	6090	8370	11,300	8710	10,200	L3, O1, R27
–	0	0.574	0.574	18,400	24,700	29,800	25,800	29,300	A2, L54, O1, R2
650–950	0	0.596	0.594	14,200	18,800	21,400	19,600	22,000	A2, L55, O1, R2
50,000	0	0.099	0.1	5380	7490	10,700	7770	9180	A2, L6, O1, R2
10,000	0	0.263	0.264	9040	12,600	17,700	13,000	15,400	A2, L6, O1, R2
3000	0	0.74	0.747	23,500	32,300	43,600	33,600	39,200	L56, O1, R6
2600	0	0.274	0.276	6920	9500	12,700	9880	11,500	A2, L56, O1, R2
1.2	0	0.33	0.255	453	126	36	28	23	L57, O1, R19
3200	0	0.318	0.328	7740	10,600	14,400	11,100	12,900	A2, L6, O1, R2
2600	0	0.374	0.375	7430	10,200	13,600	10,600	12,300	L56, O1, R2
>1000	0	0.363	0.275	330	92	26	20	17	L58, O1, R28
4100	0	0.412	0.415	6800	9390	12,900	9760	11,400	A3, L6, O1, R2
3100	0	0.455	0.459	6410	8810	11,900	9160	10,700	A2, L6, O1, R2
3000	0	0.51	0.515	6260	8610	11,600	8950	10,400	L56, O1, R2
3000	0	0.565	0.572	6160	8470	11,400	8810	10,300	L56, O1, R2
2000	0	0.545	0.547	5580	7620	9950	7930	9170	L56, O1, R2
2000	0	0.519	0.536	5460	7460	9750	7770	8990	L56, O1, R2
2000	0	0.569	0.583	5940	8120	10,600	8450	9780	L56, O1, R2
–	0	0.126	0.002	<<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.239	0.014	<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.244	0.003	<<1	<<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.307	0.021	<1	<1	<<1	<<1	<<1	L2, O1, R2
–	0	0.336	0.041	2	<1	<1	<1	<<1	L3, O1, R2
–	0	0.304	0.055	4	1	<1	<1	<1	L2, O1, R2
–	0	0.304	0.076	9	2	<1	<1	<1	L2, O1, R2
–	0	0.774	0.478	202	56	16	12	10	L2, O1, R6
–	0	0.153	0.077	31	9	2	2	2	L59, O1, R2
>1000	0	0.961	0.984	7390	9900	11,800	10,300	11,700	L3, O1, R6
330	0	0.42	0.416	13,100	12,900	5880	13,700	10,700	L2, O1, R2
241	0	0.459	0.454	12,600	6370	1860	5150	1880	L2, O1, R2
104	0	0.205	0.189	2140	607	173	140	112	L2, O1, R2
50.6	0	0.201	0.168	874	243	69	54	44	L2, O1, R2
288	0	0.466	0.46	9600	6930	2280	7000	3720	L2, O1, R2
197	0	0.687	0.665	9480	3640	1040	1920	751	L60, O1, R6
96.6	0.04	0.448	0.415	2330	657	187	151	120	L2, O12, R2
58.4	0.03	0.475	0.426	1920	536	153	121	98	A2, L2, O12, R2
103	0	0.654	0.638	11,100	4750	1360	3090	1100	L2, O1, R6
188	0	0.482	0.466	6930	2530	722	1190	504	A2, L2, O1, R2
138	0	0.393	0.378	3770	1,30	323	300	211	L3, O1, R2
107	0	0.365	0.34	2650	754	215	175	139	L2, O1, R2
128	0	0.335	0.322	3230	950	271	236	176	L3, O1, R2
113	0	0.388	0.361	3070	880	251	208	162	L2, O1, R2
66	0	0.3	0.262	1200	333	95	75	61	L2, O1, R2
–	0	0.362	0.176	94	26	7	6	5	L2, O1, R6
–	0	0.216	0.046	7	2	<1	<1	<1	L61, O1, R2

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HFE-263m1	$CF_3OCH_2CH_3$	690-22-2		~145 days	143 days	0.4
1,1,2-trifluoro-2-(trifluoromethoxy)-ethane	$CHF_2CHFOCF_3$	84011-06-3		9	8.75	9.3
Perfluoro ethyl vinyl ether	$C_2F_5OCF{=}CF_2$	–			3.9 days	0.011
HFE-329mcc2	$CHF_2CF_2OCF_2CF_3$	134769-21-4		~25	22.6	25
1,1,1,3,3,3-hexafluoro trifluoro-methoxy	$CF_3OC(CF_3)_2H$	–			84.6	114.8
HFE-338mmz1	$(CF_3)_2CHOCHF_2$	26103-08-2		22.3	21.3	23.5
HFE-338mcf2	$CF_3CH_2OCF_2CF_3$	156053-88-2		~7.5	7.56	8
HFE-338mec3	$CF_3CFHCF_2OCF_2H$	56860-85-6			9.4	10
HFE-347mmz1 (Sevoflurane)	$(CF_3)_2CHOCH_2F$	28523-86-6	0.16 ppt	1.9	1.41	1.46
HFE-347mcc3 (HFE-7000)	$CH_3OCF_2CF_2CF_3$	375-03-1		5.1	5.07	5.32
HFE-347mcf2	$CHF_2CH_2OCF_2CF_3$	171182-95-9		~6.7	6.64	7
HFE-347pcf2	$CHF_2CF_2OCH_2CF_3$	406-78-0		6.1	5.99	6.31
HFE-347mmy1	$(CF_3)_2CFOCH_3$	22052-84-2		3.7	3.66	3.83
HFE-347mcf	$CHF_2OCH_2CF_2CF_3$	56860-81-2		5.8	5.73	6.03
HFE-356mec3	$CH_3OCF_2CHFCF_3$	382-34-3		2.5	2.87	3
HFE-356mff2	$CF_3CH_2OCH_2CF_3$	333-36-8		128 days (79–270 days)	126 days (79–270 days)	128 days
HFE-356pcf2	$CHF_2CH_2OCF_2CHF_2$	50807-77-7		~6	5.7	6
HFE-356pcf3	$CHF_2OCH_2CF_2CHF_2$	35042-99-0		3.5	3.52	3.67
HFE-356pcc3	$CH_3OCF_2CF_2CHF_2$	160620-20-2		2.5	2.87	3
HFE-356mmz1	$(CF_3)_2CHOCH_3$	13171-18-1		65 days (49–128 days)	67 days (49–128 days)	66 days
HFE-365mcf3	$CF_3CF_2CH_2OCH_3$	378-16-5		25 days (17–42 days)	25 days (17–42 days)	26 days
HFE-365mcf2	$CF_3CF_2OCH_2CH_3$	22052-81-9		219 days	0.573	0.59
HFE-374pc2	$CHF_2CF_2OCH_2CH_3$	512-51-6		76 days (49–128 days)	76 days (49–128 days)	77 days
1,1,2,2-tetrafluoro-3-methoxy-propane	$CHF_2CF_2CH_2OCH_3$	60598-17-6		26 days	26 days	26 days
HFE-43-10pccc124 (H-Galden 1040x, HG-11)	$CHF_2OCF_2OC_2F_4OCHF_2$	188690-77-9		14.1	13.7	14.7
HFE-449s1 (HFE-7100)	$C_4F_9OCH_3$	219484-64-7		4.8	5.05	5.3
n-HFE-7100	n-$C_4F_9OCH_3$	163702-07-6		4.8	5.05	5.3
i-HFE-7100	i-$C_4F_9OCH_3$	163702-08-7		4.8	5.05	5.3
1-ethoxy-1,1,2,3,3,3-hexafluoro-propane	$CF_3CHFCF_2OCH_2CH_3$	380-34-7		147 days	147 days	150 days
1,1,1,2,2,3,3-Heptafluoro-3-(1,2,2,2-tetrafluoroethoxy)-propane	$CF_3CF_2CF_2OCHFCF_3$	3330-15-2		59.4	51.1	62
HFE-54-11mecf	$CF_3CHFCF_2OCH_2CF_2CF_3$	1000-28-8		9.1	0.95	0.98
HFE-569sf2 (HFE-7200, isomer mix)	$C_4F_9OC_2H_5$	–		0.8	0.784	0.808
n-HFE-7200	n-$C_4F_9OC_2H_5$	163702-05-4		0.8	0.784	0.808
i-HFE-7200	i-$C_4F_9OC_2H_5$	163702-06-5		0.63	0.63	0.649
n-HFE-7300	n-$C_2F_5CF(OCH_3)CF(CF_3)_2$	132182-92-4			4.99	5.23
n-HFE-7500	n-$C_3F_7CF(OC_2H_5)CF(CF_3)_2$	297730-93-9			0.348	0.354
HFE-236ca12 (HG-10)	$CHF_2OCF_2OCHF_2$	78522-47-1		26.5	25.1	28
HFE-338pcc13 (HG-01)	$CHF_2OCF_2CF_2OCHF_2$	188690-78-0		13.4	13	14
HG-02 (1,1'-oxybis[2-(difluoro-methoxy)-1,1,2,2-tetrafluoro-ethane)	$HF_2C(OCF_2CF_2)_2OCF_2H$	205367-61-9		26.9	25.4	28.4
HG-03 (1,1,3,3,4,4, 6,6,7,7,9,9, 10,10,12,12-hexadecafluoro-2,5,8,11-tetraoxadodecane)	$HF_2C(OCF_2CF_2)_3OCF_2H$	173350-37-3		26.9	25.4	28.4

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W m^{-2} ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W m^{-2} ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance L: Lifetime O: Ozone Depletion Potential R: Radiative Metrics*
–	0	0.227	0.125	103	29	8	6	5	L3, O1, R2
150	0	0.371	0.356	3970	1240	352	363	232	L62, O1, R2
–	0	0.596	0.025	<1	<<1	<<1	<<1	<<1	L63, O1, R6
241	0	0.559	0.555	7410	3490	1010	2620	925	L3, O1, R2
321	0	0.692	0.686	12,300	11,300	4670	11,900	8630	L64, O1, R6
226	0	0.464	0.458	6470	2950	851	2120	743	L2, O1, R2
138	0	0.481	0.461	3540	1070	304	282	198	L65, O1, R2
156	0	0.712	0.682	6170	1960	559	613	369	L3, O1, R6
41.9	0	0.369	0.299	505	140	40	31	25	A2, L2, O1, R2
108	0	0.367	0.343	2040	579	165	135	107	L2, O1, R2
128	0	0.46	0.44	3310	973	278	242	180	L66, O1, R2
120	0	0.516	0.483	3330	964	275	232	178	L2, O1, R13
86.6	0	0.353	0.321	1400	391	112	89	72	L2, O1, R2
116	0	0.55	0.517	3430	987	282	235	182	L2, O1, R6
66	0	0.333	0.297	1120	312	89	70	57	L67, O1, R2
–	0	0.363	0.19	87	24	7	5	4	L2, O1, R2
116	0	0.406	0.388	2810	810	231	192	149	L68, O1, R2
84	0	0.421	0.393	1810	506	144	115	93	L2, O1, R2
66	0	0.349	0.314	1180	330	94	74	60	L67, O1, R2
–	0	0.336	0.127	31	9	2	2	2	L2, O1, R2
–	0	0.294	0.058	6	2	<1	<1	<1	L69, O1, R2
–	0	0.486	0.309	259	72	21	16	13	L2, O1, R6
–	0	0.325	0.132	45	13	4	3	2	L70, O1, R2
–	0	0.256	0.052	6	2	<1	<1	<1	L71, O1, R2
188	0	1.068	1.03	8580	3130	894	1470	624	L2, O1, R2
108	0	0.391	0.362	1710	487	139	113	90	L2, O1, R2
108	0	0.462	0.428	2020	576	164	134	106	L2, O1, R2
108	0	0.371	0.343	1620	462	132	107	85	L2, O1, R2
–	0	0.347	0.195	96	27	8	6	5	L62, O1, R2
292	0	0.6	0.594	8140	6040	2020	6150	3390	L62, O1, R2
30.4	0	0.778	0.575	437	121	35	27	22	L2, O1, R6
25.9	0	0.653	0	<<1	<<1	<<1	<<1	<<1	L72, O1, R6
25.9	0	0.429	0.3	214	59	17	13	11	L72, O1, R2
21.5	0	0.33	0.216	124	34	10	8	6	L72, O1, R2
107	0	0.572	0.536	1790	509	145	118	94	L73, O1, R29
–	0	0.616	0.332	67	19	5	4	3	L73, O1, R29
240	0	0.663	0.669	11,900	5950	1740	4780	1730	L2, O1, R2
183	0	0.904	0.92	9540	3400	972	1500	669	L2, O1, R2
241	0	1.18	1.167	10,900	5520	1610	4460	1630	L74, O1, R30
241	0	1.46	1.451	10,200	5160	1500	4170	1520	L74, O1, R30

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
HG-04 (1,1,3,3,4,4,6,6,7,7,9,9, 10,10,12,12,13,13,15,15-eicosa-fluoro-2,5,8,11,14-pentaoxa-pentadecane)	$HCF_2O(CF_2CF_2O)_4CF_2H$	173350-38-4		26.9	25.4	28.4
HG-20	$HF_2C(OCF_2)_2OCF_2H$	249932-25-0		26.5	25.1	28
HG-21	$HF_2COCF_2CF_2OCF_2OCF_2OCF_2H$	249932-26-1		13.4	13	14
HG-30	$HF_2C(OCF_2)_3OCF_2H$	–		26.5	25.1	28
1-ethoxy-1,1,2,2,3,3,3-heptafluoro-propane	$CF_3CF_2CF_2OCH_2CH_3$	22052-86-4		0.75	0.728	0.75
Fluoroxene	$CF_3CH_2OCH{=}CH_2$	406-90-6		3.6 days	3.6 days	3.6 days
1,1,2,2-tetrafluoro-1-(fluorometh-oxy)ethane	$CH_2FOCF_2CF_2H$	37031-31-5		6.2	5.89	6.2
2-ethoxy-3,3,4,4,5-pentafluoro-tetrahydro-2,5-bis[1,2,2,2-tetra-fluoro-1-(trifluoromethyl)ethyl]-furan	$C_{12}H_5F_{19}O_2$	920979-28-8		0.81	0.806	0.83
Fluoro(methoxy)methane	CH_3OCH_2F	460-22-0		73 days	72 days	73 days
Fluoro(fluoromethoxy)methane	CH_2FOCH_2F	462-51-1		0.9	0.872	0.9
Difluoro(fluoromethoxy)methane	CH_2FOCHF_2	461-63-2		3.2	3.17	3.3
Trifluoro(fluoromethoxy)methane	CH_2FOCF_3	2261-01-0		4.2	4.2	4.4
HG'-01	$CH_3OCF_2CF_2OCH_3$	73287-23-7		1.7	1.68	1.74
HG'-02	$CH_3O(CF_2CF_2O)_2CH_3$	485399-46-0		1.7	1.68	1.74
HG'-03	$CH_3O(CF_2CF_2O)_3CH_3$	485399-48-2		1.7	1.68	1.74
HFE-329me3	$CF_3CFHCF_2OCF_3$	428454-68-6		33.6	31	35.3
2-chloro-1,1,2-trifluoro-1-methoxy-ethane	CH_3OCF_2CHFCl	425-87-6		1.43	1.44	1.49
Octafluorooxolane	$c\text{-}C_4F_8O$	773-14-8	0.074 ppt	–	>3000	–
PFPMIE (perfluoropolymethyl-isopropyl ether)	$CF_3OCF(CF_3)CF_2OCF_2OCF_3$	1309353-34-1		800	370	–
HFE-216	$CF_3OCF{=}CF_2$	1187-93-5		1.6 days	4.7 days	4.7 days
Fluoroesters						
Trifluoromethyl formate	$HC(O)OCF_3$	85358-65-2		<3.5	3.55	3.71
Perfluoroethyl formate	$HC(O)OCF_2CF_3$	313064-40-3		<3.6	3.57	3.73
Perfluoropropyl formate	$HC(O)OCF_2CF_2CF_3$	271257-42-2		<2.6	2.62	2.73
Perfluorobutyl formate	$HC(O)OCF_2CF_2CF_2CF_3$	197218-56-7		<2.6	2.6	2.7
2,2,2-trifluoroethyl formate	$HC(O)OCH_2CF_3$	32042-38-9		200 days	0.54	0.56
3,3,3-trifluoropropyl formate	$HC(O)OCH_2CH_2CF_3$	1344118-09-7		99 days	108 days	110 days
1,2,2,2-tetrafluoroethyl formate	$HC(O)OCHFCF_3$	481631-19-0		3.1	3.12	3.25
1,1,1,3,3,3-hexafluoropropan-2-yl-formate	$HC(O)OCH(CF_3)_2$	856766-70-6		3.1	3.07	3.2
Perfluorobutyl acetate	$CH_3C(O)OCF_2CF_2CF_2CF_3$	209597-28-4		22 days	22 days	22 days
Perfluoropropyl acetate	$CH_3C(O)OCF_2CF_2CF_3$	1344118-10-0		22 days	22 days	22 days
Perfluoroethyl acetate	$CH_3C(O)OCF_2CF_3$	343269-97-6		22 days	22 days	22 days
Trifluoromethyl acetate	$CH_3C(O)OCF_3$	74123-20-9		22 days	22 days	22 days
Methyl carbonofluoridate	$FCOOCH_3$	1538-06-3		1.8	1.74	1.81
1,1-difluoroethyl carbonofluoridate	$FC(O)OCF_2CH_3$	1344118-11-1		110 days	108 days	110 days
1,1-difluoroethyl 2,2,2-trifluoro-acetate	$CF_3C(O)OCF_2CH_3$	–		110 days	119 days	120 days
Ethyl 2,2,2-trifluoroacetate	$CF_3C(O)OCH_2CH_3$	383-63-1		22 days	69 days	70 days
2,2,2-trifluoroethyl 2,2,2-trifluoro-acetate	$CF_3C(O)OCH_2CF_3$	–		180 days	176 days	180 days
Methyl 2,2,2-trifluoroacetate	$CF_3C(O)OCH_3$	431-47-0		1	0.98	1.01
Methyl 2,2-difluoroacetate	$HCF_2C(O)OCH_3$	433-53-4		124 days	122 days	124 days

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W\ m^{-2}\ ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W\ m^{-2}\ ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance* *L: Lifetime* *O: Ozone Depletion Potential* *R: Radiative Metrics*
241	0	1.5	1.493	8420	4250	1240	3430	1250	L74, O1, R30
240	0	1.181	1.159	15,200	7590	2210	6090	2210	L75, O1, R6
183	0	1.822	1.763	11,700	4170	1190	1840	820	L74, O1, R6
240	0	1.601	1.572	16,300	8150	2370	6540	2370	L75, O1, R6
24.3	0	0.516	0.354	289	80	23	18	14	L70, O1, R6
–	0	0.3	0.012	<1	<<1	<<1	<<1	<<1	L70, O1, R31
119	0	0.468	0.44	3980	1150	328	276	213	L70, O1, R6
26.5	0	0.66	0.467	167	46	13	10	8	L76, O1, R32
–	0	0.191	0.076	56	16	4	3	3	L77, O1, R6
28.3	0	0.191	0.222	566	157	45	35	28	L78, O1, R6
78	0	0.25	0.315	2380	665	190	150	121	L78, O1, R6
95	0	0.308	0.389	3280	923	263	211	169	L78, O1, R6
48	0	0.352	0.291	723	201	57	45	36	L79, O1, R2
48	0	0.683	0.563	816	227	65	50	41	L79, O1, R2
48	0	0.927	0.763	780	217	62	48	39	L79, O1, R2
256	0	0.499	0.5	7400	4190	1250	3740	1500	L80, O1, R2
43	0	0.313	0.251	584	162	46	36	29	L81, O1, R6
>3000	0	0.469	0.469	10,200	14,100	19,000	14,600	17,100	A5, L82, O1, R32
370	0	0.653	0.656	7830	9830	8860	10,300	10,900	L83, O1, R2
–	0	0.491	0.024	<1	<1	<<1	<<1	<<1	L84, O1, R6
110	0	0.347	0.313	2320	650	185	147	119	L85, O1, R34
110	0	0.504	0.456	2370	662	189	150	121	L86, O1, R34
83	0	0.222	0.194	569	158	45	36	29	L86, O1, R34
83	0	0.613	0.54	1270	354	101	79	65	L87, O1, R34
–	0	0.278	0.176	178	49	14	11	9	L88, O1, R34
–	0	0.277	0.138	69	19	5	4	3	L89, O1, R34
77	0	0.396	0.354	1810	504	144	114	92	L90, O1, R34
76	0	0.373	0.335	1250	350	100	79	64	L89, O1, R34
–	0	0.706	0.125	7	2	<1	<1	<1	L91, O1, R34
–	0	0.571	0.101	6	2	<1	<1	<1	L92, O1, R34
–	0	0.572	0.101	8	2	<1	<1	<1	L92, O1, R34
–	0	0.404	0.071	8	2	<1	<1	<1	L92, O1, R34
50	0	0.085	0.071	380	106	30	23	19	L90, O1, R34
–	0	0.352	0.171	95	26	8	6	5	L93, O1, R34
–	0	0.533	0.271	119	33	9	7	6	L89, O1, R34
–	0	0.315	0.122	39	11	3	2	2	L94, O1, R2
–	0	0.428	0.257	152	42	12	9	8	L94, O1, R34
31	0	0.267	0.201	369	103	29	23	19	L94, O1, R35
–	0	0.193	0.101	74	20	6	4	4	L94, O1, R34

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
Difluoromethyl 2,2,2-trifluoro-acetate	$CF_3C(O)OCHF_2$	2024-86-4		110 days	108 days	110 days
Vinyl 2,2,2-trifluoroacetate	$CF_3C(O)OCH{=}CH_2$	433-28-3			1.7 days	1.7 days
Allyl 2,2,2-trifluoroacetate	$CF_3C(O)OCH_2CH{=}CH_2$	383-67-5			1.5 days	1.5 days
Halogenated Alcohols						
3,3,3-trifluoropropan-1-ol	$CF_3CH_2CH_2OH$	2240-88-2		15 days	16 days	16 days
2,2,3,3,3-pentafluoropropan-1-ol	$CF_3CF_2CH_2OH$	422-05-9		172 days	168 days	172 days
4,4,4-trifluorobutan-1-ol	$CF_3(CH_2)_2CH_2OH$	461-18-7		5.4 days	5.4 days	5.4 days
2,2,3,3,4,4,5,5-octafluorocyclo-pentanol	$-(CF_2)_4CH(OH)-$	16621-87-7		110 days	19.5 days	19.5 days
1,1,1,3,3,3-hexafluoropropan-2-ol	$(CF_3)_2CHOH$	920-66-1		1.9	1.88	1.95
3,3,4,4,5,5,6,6,7,7,7-undeca-fluoroheptan-1-ol	$CF_3(CF_2)_4CH_2CH_2OH$	185689-57-0		17 days	17 days	17.4 days
3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-pentadecafluorononan-1-ol	$CF_3(CF_2)_6CH_2CH_2OH$	755-02-2		17 days	17 days	17.4 days
3,3,4,4,5,5,6,6,7,7,8,8,9,9,10, 10,11,11,11-nonadecafluoro-undecan-1-ol	$CF_3(CF_2)_8CH_2CH_2OH$	87017-97-8		17 days	13 days	12.8 days
2,2,3,3,4,4,4-heptafluoro-butan-1-ol	$CF_3CF_2CF_2CH_2OH$	375-01-9		0.55	0.46	0.472
2,2,3,3-tetrafluoro-1-propanol	$CHF_2CF_2CH_2OH$	76-37-9		93 days	92.4 days	93.6 days
2,2,3,4,4,4-hexafluoro-1-butanol	$CF_3CHFCF_2CH_2OH$	382-31-0		134 days (85–280 days)	132 days (85–280 days)	134 days
2-fluoroethanol	CH_2FCH_2OH	371-62-0		16 days	16.2 days	16.2 days
2,2-difluoroethanol	CHF_2CH_2OH	359-13-7		61 days	60.8 days	61.4 days
2,2,2-trifluoroethanol	CF_3CH_2OH	75-89-8		167 days	163 days	167 days
2,2-3,3,4,4,5,5,5-fluoro-1-pentanol	$CF_3CF_2CF_2CF_2CH_2OH$	–		172 days (111–330 days)	168 days (111–330 days)	172 days
Halogenated Ketones						
1-fluoropropan-2-one	$CH_3C(O)CH_2F$	430-51-3			16 days	136 days
1,1,1-trifluoropropan-2-one	$CF_3C(O)CH_3$	421-50-1			16 days	136 days
1,1,1,3,3,3-hexafluoropropan-2-one	$CF_3C(O)CF_3$	684-16-2			18 days	–
1,1,1-trifluorobutan-2-one	$CF_3C(O)CH_2CH_3$	381-88-4			0.8 days	13.5 days
NOVEC-1230, FK-5-1-12 (Perfluoro -(2-methyl-3-pentanone))	$CF_3CF_2C(O)CF(CF_3)_2$	756-13-8		7 days (7–14 days)	7 days (7–14 days)	–
NOVEC-774 (Tetradecafluoro-2,4-dimethylpentan-3-one)	$(CF_3)_2CFC(O)CF(CF_3)_2$	–		–	7 days	–
Perfluoro(2-methyl-3-hexanone)	$CF_3CF_2CF_2C(O)CF(CF_3)_2$	–		–	7 days	–
Chloroacetone	$CH_3C(O)CH_2Cl$	78-95-5			1 day	32 days
Bromoacetone	$CH_3C(O)CH_2Br$	598-31-2			<2 hours	15 days
Halogenated Aldehydes						
Trifluoroacetaldehyde	CF_3CHO	75-90-1			2.7 days	31 days
Trifluoroacetyl fluoride	CF_3CFO	354-34-7			6.9 days	–
Oxalyl fluoride	FC(O)C(O)F	359-40-0			5.1 days	–
3,3,3-trifluoro-propanal	CF_3CH_2CHO	460-40-2		5 days	2.7 days	5.5 days
2,2,3,3,3-pentafluoropropanal	CF_3CF_2CHO	422-06-0			1.4 days	13.5 days
Difluoromalonyl fluoride	$FC(O)CF_2C(O)F$	5930-67-6			6.9 days	–
4,4,4-trifluorobutanal	$CF_3CH_2CH_2CHO$	406-87-1			1.8 days	2.6 days
2,2,3,3,4,4,4-heptafluorobutanal	$CF_3CF_2CF_2CHO$	375-02-0			1.1 days	13.5 days
Tetrafluorosuccinyl fluoride	$FC(O)CF_2CF_2C(O)F$	679-13-0			6.9 days	–
2,2,3,3,4,4,5,5,5-nonafluoro-petanal	$CF_3CF_2CF_2CF_2CHO$	375-53-1			1.1 days	13.5 days

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W m^{-2} ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W m^{-2} ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance* *L: Lifetime* *O: Ozone Depletion Potential* *R: Radiative Metrics*
–	0	0.471	0.23	100	28	8	6	5	L89, O1, R34
–	0	0.261	0.009	<<1	<<1	<<1	<<1	<<1	L95, O1, R2
–	0	0.334	0.008	<<1	<<1	<<1	<<1	<<1	L95, O1, R2
–	0	0.221	0.032	3	<1	<1	<1	<1	L2, O1, R2
–	0	0.289	0.17	125	35	10	8	6	L2, O1, R2
–	0	0.116	0.007	<1	<<1	<<1	<<1	<<1	L96, O1, R2
–	0	0.319	0.054	3	<1	<1	<1	<1	L97, O1, R2
53	0	0.334	0.294	789	219	63	49	40	L97, O1, R2
–	0	0.371	0.058	2	<1	<1	<1	<1	L98, O1, R2
–	0	0.412	0.065	2	<1	<1	<1	<<1	L98, O1, R2
–	0	0.312	0.04	<1	<1	<<1	<<1	<<1	L98, O1, R2
–	0	0.321	0.197	109	30	9	7	5	L99, O1, R2
–	0	0.257	0.122	56	16	4	3	3	L100, O1, R2
–	0	0.424	0.227	108	30	9	7	5	L2, O1, R2
–	0	0.087	0.012	2	<1	<1	<1	<<1	L2, O1, R2
–	0	0.127	0.045	22	6	2	1	1	L2, O1, R2
–	0	0.202	0.1	107	30	8	7	5	L2, O1, R2
–	0	0.529	0.045	20	6	2	1	<1	L2, O1, R6
–	0	0.046	0.026	4	<1	<1	<1	<1	L3, O1, R2
–	0	0.205	0.099	9	3	<1	<1	<1	L3, O1, R2
–	0	0.289	0.147	10	3	<1	<1	<1	L3, O1, R2
–	0	0.205	0.0994	<1	<1	<<1	<<1	<<1	L3, O1, R2
–	0	0.407	0.133	2	<1	<1	<1	<<1	L101, O1, R2
–	0	0.802	0.264	3	<1	<1	<1	<1	L101, L102, O1, R6
–	0	0.768	0.253	3	<1	<1	<1	<1	L101, L102, O1, R6
–		0.038	4.60E-04	<<1	<<1	<<1	<<1	<<1	L103, O1, R2
–		0.045	5.00E-05	<<1	<<1	<<1	<<1	<<1	L104, O1, R6
–	0	0.167	0.00481	<<1	<<1	<<1	<<1	<<1	L105, L106, O1, R2
–	0	0.274	0.0188	<1	<1	<<1	<<1	<<1	L106, O1, R6
–	0	0.188	0.00988	<1	<<1	<<1	<<1	<<1	L106, O1, R6
–	0	0.173	0.00515	<<1	<<1	<<1	<<1	<<1	L106, L107, O1, R2
–	0	0.202	0.00331	<<1	<<1	<<1	<<1	<<1	L3, L106, O1, R2
–	0	0.29	0.0198	<1	<1	<<1	<<1	<<1	L106, O1, R6
–	0	0.163	0.00336	<<1	<<1	<<1	<<1	<<1	L3, L106, O1, R2
–	0	0.25	0.00328	<<1	<<1	<<1	<<1	<<1	L3, L106, O1, R2
–	0	0.375	0.0257	<1	<1	<<1	<<1	<<1	L106, O1, R6
–	0	0.286	0.00376	<<1	<<1	<<1	<<1	<<1	L3, L106, O1, R2

Industrial Designation or Chemical Name	Chemical Formula	CAS RN	Atmospheric Abundance[a]	WMO (2018) Total Lifetime (years)	WMO (2022) Total Lifetime (years)	Tropospheric (OH Reactive Loss) Lifetime 2022 (years)
Iodocarbons						
Methyl iodide	CH_3I	74-88-4	0.8 ppt (0.3–2.1)	<14 days (3.5–14 days)	<14 days (3.5–14 days)	269 days
Bromoiodomethane	CH_2BrI	557-68-6		≤60 mins	≤60 mins	150 days
Chloroiodomethane	CH_2ClI	593-71-5		<100 mins	<100 mins	150 days
Diiodomethane	CH_2I_2	75-11-6		≤5 mins	≤5 mins	3.8 days
Trifluoroiodomethane	CF_3I	2314-97-8		<5 days (0.7–5 days)	<5 days (0.7–5 days)	3
Iodoethane	CH_3CH_2I	75-03-6		<4 days (2.4–13.9 days)	<4 days (2.4–13.9 days)	52 days (13–94 days)
n-iodopropane	$CH_3CH_2CH_2I$	107-08-4		<2 days	<2 days	14.6 days
i-iodopropane	CH_3CHICH_3	75-30-9		<1 day	<1 day	12.7 days
3-iodo-1-propene	$CH_2{=}CHCH_2I$	556-56-9			<1.2 days	1.4 days
1-iodo-heptafluoropropane	$CF_3CF_2CF_2I$	754-34-7		<2 days	<2 days	3
Tert-butyl iodide	$(CH_3)_3CI$	558-17-8			<5 days	13.6 days
Special Compounds						
Carbonyl fluoride	COF_2	353-50-4		7 days (5–10 days)	7 days (5–10 days)	
Phosphorus tribromide	PBr_3	7789-60-8		<0.01 days	<0.1 day	
Ammonia	NH_3	7664-41-7		(few days)	(few days)	110 days
Carbonyl Sulfide	COS	463-58-1	505 ppt	2	2	–
Sulfuryl fluoride	SO_2F_2	699-79-8	2.6 ppt	36	36	>300
Trifluoroacetic acid (TFA)	$CF_3C(O)OH$	76-05-1			5 days	116 days
3,5-dichloro-2,4,6-trifluoro-pyridine (DCTFP)	$C_5Cl_2F_3N$	1737-93-5			–	–
Heptafluorobutyronitrile	$(CF_3)_2CFCN$	375-00-8			32.7	58.3
Chlorine nitrate	$ClONO_2$	14545-72-3			14 days	–
Bromine nitrate	$BrONO_2$	40423-14-1			~2 hours	–

Table Heading Footnotes:

[a] Atmospheric abundances were taken from *Chapter 1*, *Chapter 2*, and WMO (2018) for the year 2020 or 2016, as noted in the footnotes.

[b] Values in this column include molecule dependent stratospheric temperature adjustment (see *Section A.2.5.2*) and assumes that compounds are well mixed in the atmosphere (note that this assumption leads to overestimation of RE for molecules that have an inhomogeneous atmospheric distribution).

[c] Values in this column include molecule dependent stratospheric temperature adjustment (see *Section A.2.5.2*), lifetime adjustment (*Section A.2.5.3*), low-frequency infrared absorption adjustment (*Section A.2.5.4*), and tropospheric adjustments when relevant (*Section A.2.5.5*).

Abundance Footnotes:

A1 Year 2020 value was taken from the Global Monitoring Laboratory (GML) database (gml.noaa.gov/ccgg/trends).

A2 Taken from Chapter 1 for the year 2020.

A3 Taken from WMO (2018) for the year 2016. Values in parentheses represent a potential range of values.

A4 Taken from Chapter 2 for the year 2020.

A5 Taken from Chapter 1.

Lifetime Footnotes:

L1 Perturbation total lifetime reported in IPCC (2022) used to evaluate climate metrics. The lifetime for CH_4 based on a budget analysis is 9.1 years.

L2 OH rate coefficient was taken from Burkholder et al. (2019).

L3 Estimated OH radical rate coefficient and/or total lifetime.

L4 Tropospheric photolysis partial lifetimes have been included in the total lifetime analysis; see *Section A.1 Introduction*.

L5 Atmospheric lifetimes taken from the recommendations given in the SPARC (2013) lifetime report. Note that 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.

L6 Total lifetime is the best estimate taken from Ravishankara et al. (1993) that includes mesospheric loss due to Lyman-α (121.567 nm) photolysis.

L7 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.

L8 The total lifetime includes mesospheric loss due to Lyman-α (121.567 nm) photolysis.

L9 Lifetime was taken from Kloss et al. (2014).

Stratospheric Lifetime 2022 (years)	ODP	Radiative Efficiency (well mixed) ($W\ m^{-2}\ ppb^{-1}$) [b]	Recommended Adjusted Effective Radiative Efficiency ($W\ m^{-2}\ ppb^{-1}$) [c]	GWP 20-yr	GWP 100-yr	GWP 500-yr	GTP 50-yr	GTP 100-yr	Footnotes *A: Atmospheric Abundance* *L: Lifetime* *O: Ozone Depletion Potential* *R: Radiative Metrics*
–	<0.42	0.009	0.004	<1	<<1	<<1	<<1	<<1	A3, L2, L108, L109, L110, O11, R2
–	<0.02	0.031	2.00E-05	<<1	<<1	<<1	<<1	<<1	L108, L111, L112, O14, R6
–	<0.07	0.035	4.00E-05	<<1	<<1	<<1	<<1	<<1	L108, L111, L112, O11, R6
–	<0.02	0.038	2.00E-06	<<1	<<1	<<1	<<1	<<1	L108, L111, L113, O14, R2
–	<0.09	0.283	0.067	1	<1	<<1	<<1	<<1	L108, L109, L110, O11, R6
–	<0.02	0.021	0.004	<<1	<<1	<<1	<<1	<<1	L108, L110, L111, L114, O14, R2
–	<0.02	0.0248	5.60E-04	<<1	<<1	<<1	<<1	<<1	L108, L111, L114, O14, R6
–	>0.02	0.043	5.20E-04	<<1	<<1	<<1	<<1	<<1	L108, L114, O14, R2
–	–	0.042	6.00E-04	<<1	<<1	<<1	<<1	<<1	L3, L115, R2
–	<0.09	0.427	9.69E-03	<<1	<<1	<<1	<<1	<<1	L108, L116, O15, R6
–	–	0.032	0.008	<1	<<1	<<1	<<1	<<1	L3, L115, R6
–	–	0.123	0.008	<1	<1	<<1	<<1	<<1	L106, R2
–	–	0.038	<0.001	<<1	<<1	<<1	<<1	<<1	L106, R6
–	–	0.061	0.0014	<1	<<1	<<1	<<1	<<1	L2, L106, R2
60	–	0.016	0.0137	109	30	9	7	6	A3, L117, R2
630	0	0.203	0.2	7130	4390	1340	4140	1820	A2, L2, L118, O1, R2
–	0	0.359	0.019	<1	<1	<<1	<<1	<<1	L106, L119, O1, R2
–	–	0.118	–	–	–	–	–	–	R6
74	0	0.223	0.221	4020	2350	705	2140	884	L120, O1, R37
–	–	0.086	0.0108	1	<1	<<1	<<1	<<1	L121, R2
–	–	0.102	1.09E-04	<<1	<<1	<<1	<<1	<<1	L121, R2

L10 Stratospheric partial lifetime was taken from 2-D model calculations in Papadimitriou et al. (2013b).

L11 Ocean and soil loss partial lifetimes have been included in the total lifetime analysis; see *Section A.1 Introduction*.

L12 Lifetimes were 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 the *Section A.1 Introduction*.

L13 Stratospheric lifetime was taken from the 2-D model simulation reported in McGillen et al. (2015).

L14 OH radical rate coefficient was taken from Burkholder et al. (2020).

L15 Stratospheric partial lifetime was calculated using a 2-D model with OH and $O(^1D)$ rate coefficients recommended in SPARC (2013) lifetime report, see *Chapter 3*.

L16 OH radical reactivity was calculated using the structure activity relationships of DeMore (1996) with an assumed E/R of 1700 K.

L17 OH radical reactivity calculated using the room temperature rate coefficient reported by Young et al. (2009) with an assumed E/R of 1700 K.

L18 OH radical rate coefficient was taken from Zhang et al. (2015).

L19 OH radical rate coefficient was assumed to be the same as for HFC-329p.

L20 OH radical rate coefficient was taken from Guo et al. (2019).

L21 OH radical rate coefficient data were taken from Tokuhashi et al. (2018a).

L22 OH radical rate coefficient data were taken from Tokuhashi et al. (2021).

L23 OH radical rate coefficient was assumed to be similar to that of HFO-1234ze.

L24 A lifetime upper limit was estimated based on reactivity trends.

L25 OH radical rate coefficient was taken from Tokuhashi et al. (2021).

L26 OH radical rate coefficient was taken from Papadimitriou et al. (2015).

L27 OH radical rate coefficient was taken from Jiménez et al. (2016).

L28 OH radical rate coefficient was taken from Liu et al. (2016).

L29 The lifetime estimated to be similar to that of (*E*)-$CF_3CH{=}CHCF_3$.

L30 OH radical rate coefficient was taken from Papadimitriou and Burkholder (2016).

L31 OH radical rate coefficient was calculated using the room temperature rate coefficient reported by Sulbaek Andersen et al. (2005a) with an E/R of –170 K.

L32 Partial lifetimes, other than ocean uptake (see *Section A.1 Introduction*), were taken from recommendations in the SPARC (2016) CCl_4 report.

L33 OH radial rate coefficient was taken from Taylor et al. (1992).
L34 OH radial rate coefficient was taken from Jiang et al. (1993).
L35 OH radial rate coefficient was taken from Donaghy et al. (1993).
L36 OH radial rate coefficient was taken from Loison et al. (1998).
L37 OH radial rate coefficient was taken from Markert and Nielsen (1992).
L38 OH radial rate coefficient was taken from Zhang et al. (2017).
L39 OH radial rate coefficient was taken from Tuazon et al. (1988).
L40 OH radial rate coefficient was taken from Bryukov et al. (2009).
L41 OH radial rate coefficient was taken from the studies of Arnts et al. (1989) and Wahner and Zetzsch (1983).
L42 OH radial rate coefficient was taken from Wahner and Zetzsch (1983).
L43 OH radial rate coefficient was taken from Barrera et al. (2015).
L44 OH radial rate coefficient was taken from the studies of Tokuhashi et al. (2019) and Barrera et al. (2015).
L45 OH radial rate coefficient was taken from Tokuhashi et al. (2018b).
L46 Local lifetime was estimated to be similar to that of (*E*)-$CF_3CH=CHCl$.
L47 Local lifetime was estimated to be similar to that of $CF_3CF=CF_2$.
L48 OH radical rate coefficient was taken from Tokuhashi et al. (2021).
L49 OH radical rate coefficient was taken from the studies of Atkinson (1985) and Young et al. (2008).
L50 Lifetime was estimated to be similar to that of CBr_2F_2.
L51 OH radical rate coefficient was taken from Perry et al. (1977).
L52 OH radical rate coefficient was taken from Albaladejo et al. (2003).
L53 Tropospheric (84,150 years) and mesospheric (2531 years) lifetimes were taken from the 2-D model calculations in Papadimitriou et al. (2013a).
L54 Lifetime range derived from the modeling studies of Kovacs et al. (2017), with a reported lifetime of 1278 years, and Ray et al. (2017), with a reported lifetime of 850 years.
L55 Total lifetime range was taken from Takahashi et al. (2002), which included mesospheric loss due to Lyman-α (121.567 nm) photolysis, dissociative electron attachment, and solar proton event loss processes.
L56 Total lifetime was estimate based on the increase in Lyman-α (121.567 nm) absorption cross section (increased photolysis rate) with increasing number of $-CF_2-$ groups in the perfluorocarbon.
L57 OH radical rate coefficient was taken from Jia et al. (2013).
L58 OH radical rate coefficient was taken from Zhang et al. (2017).
L59 OH radical rate coefficient was taken from McIlroy and Tully (1993).
L60 OH radical reaction rate coefficient was taken from Sulbaek Andersen et al. (2005b).
L61 OH radical rate coefficient was taken from the room temperature value from Oyaro et al. (2005) with an assumed E/R of 500 K.
L62 OH radical rate coefficient was taken from the room temperature value from Oyaro et al. (2005) with an assumed E/R of 1500 K.
L63 OH radical reaction rate coefficient was taken from Srinivasulu et al. (2018).
L64 OH radical reaction rate coefficient was taken from Sulbaek Andersen et al. (2005b).
L65 The OH radical reactive loss partial lifetime was estimated to be the same as for $CF_3OCH_2CF_3$.
L66 OH radical reaction rate coefficient was assumed to be the same as $CHF_2CH_2OCF_3$.
L67 The OH radical reactive loss partial lifetime was estimated to be the same as for $CH_3OCF_2CHF_2$.
L68 The OH radical reactive loss partial lifetime was estimated from the sum of the OH partial lifetimes of $CF_3CF_2OCF_2CHF_2$ and $CF_3CF_2OCH_2CHF_2$.
L69 OH radical rate coefficient was taken from the room temperature value from Oyaro et al. (2004) with an assumed E/R of 500 K.
L70 The OH radical partial lifetime was taken from the value in Bravo et al. (2011b).
L71 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Oyaro et al. (2004) with an assumed E/R of 1000 K.
L72 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Christensen et al. (1998) with an assumed E/R of 1000 K.
L73 OH radical reaction rate coefficient was taken from Rodriguez et al. (2014).
L74 OH radical reaction rate coefficient was taken from Sulbaek Andersen et al. (2010).
L75 OH radical reaction rate coefficient was assumed to be similar to HG-10.
L76 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Javadi et al. (2007) with an assumed E/R of 1000 K.
L77 The OH radical reactive loss partial lifetime was calculated using the structure activity relationship estimated OH rate coefficient in Urata et al. (2003).
L78 OH radical rate coefficient was taken from the theoretically calculated value in Blowers et al. (2008).
L79 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Sulbaek Andersen et al. (2004) with an assumed E/R of 1000 K.
L80 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Wallington et al. (2004) with an assumed E/R of 1000 K.
L81 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Tokuhashi et al. (1999).
L82 Total lifetime estimated in Vollmer et al. (2019).
L83 Total lifetime estimated in Young et al. (2006).
L84 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Mashino et al. (2000) with an assumed E/R of −400 K.

L85 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Chen et al. (2004b).
L86 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Chen et al. (2004a).
L87 OH radical rate coefficient was assumed to be similar to that of perfluoropropyl formate ($HC(O)OCF_2CF_2CF_3$).
L88 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Oyaro et al. (2004) with an assumed E/R of 500 K.
L89 Total lifetime was taken from the estimate in Bravo et al. (2011a).
L90 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Chen et al. (2006).
L91 The OH radical reactive loss partial lifetime was taken from the estimate in Christensen et al. (1998), which was based on comparison with Cl atom reactivity.
L92 OH radical rate coefficient was assumed to be the same as for perfluorobutyl acetate ($CH_3C(O)OCF_2CF_2CF_2CF_3$).
L93 OH radical rate coefficient was assumed to be the same as for ethyl 2,2,2-trifluoroacetate ($CF_3C(O)OCH_2CH_3$).
L94 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Blanco and Teruel (2007) with an assumed E/R of 1000 K.
L95 OH radical reaction rate coefficient was taken from Rodriguez et al. (2016).
L96 OH radical reaction rate coefficient was taken from Antiñolo et al. (2011).
L97 OH radical reaction rate coefficient was estimated by comparison with other fluoroalcohols; see Ellis et al. (2003).
L98 The OH radical reactive loss partial lifetime was calculated using the room temperature OH rate coefficient from Ellis et al. (2003) with an assumed E/R of 1000 K.
L99 OH radical rate coefficient was assumed to be the same as $CF_3CF_2CH_2OH$.
L100 OH radical rate coefficient was taken from Antiñolo et al. (2012).
L101 Tropospheric photolysis is the dominant loss process for perfluoroketones; see Taniguchi et al. (2003)and Jackson et al. (2011).
L102 OH radical rate coefficient was assumed to be similar to that of NOVEC-1230.
L103 OH radical reaction rate coefficient was taken from Carr et al. (2003); UV photolysis is the primary loss process, and the lifetime was taken from Burkholder et al. (2002).
L104 UV photolysis is the primary loss process, and the lifetime was taken from Burkholder et al. (2002).
L105 OH radical reaction rate coefficient was taken from Sellevåg et al. (2004).
L106 Heterogeneous uptake is most likely the predominant loss process.
L107 OH radical reaction rate coefficient was taken from Antiñolo et al. (2010).
L108 Total lifetime is primarily determined by UV photolysis with a decreasing local lifetime with increasing altitude.
L109 Lifetime estimates were taken from the 3-D model simulations of Youn et al. (2010).
L110 Lifetime range represents a likely variation in local photolysis partial lifetime with time and location of emissions.
L111 Photolysis lifetimes were taken from Mössinger et al. (1998) for CH_2BrI and Roehl et al. (1997) for CH_2ClI, CH_3CH_2I, $CH_3CH_2CH_2I$, and CH_3CHICH_3.
L112 OH radical reaction rate coefficient was assumed to be similar to that of CH_2Br_2.
L113 OH radical reaction rate coefficient was taken from Zhang et al. (2011).
L114 OH radical reaction rate coefficient was taken from Zhang et al. (2012).
L115 UV photolysis rate coefficient was assumed to be the same as for CF_3I.
L116 Photolysis and OH reactivity assumed the same as for CF_3I.
L117 Lifetime was taken from Brühl et al. (2012).
L118 Lifetimes were taken from Papadimitriou et al. (2008) and Mühle et al. (2009).
L119 OH radical reaction rate coefficient was taken from Carr et al. (1994).
L120 OH radical reaction rate coefficient was taken from Blázquez et al. (2017).
L121 Formed in the stratosphere with a predominant UV photolysis loss. UV absorption spectra are recommended in Burkholder et al. (2019).

ODP Footnotes:

O1 Negligible and assigned a value of zero.
O2 Value was taken from Ravishankara et al. (2009).
O3 Value was taken from *Chapter 7*.
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), 1.01 (CFC-12), and 1.06 (CCl_4).
O5 Value was taken from the Montreal Protocol.
O6 ODP was taken from the 2-D model calculations in Davis et al. (2016). The semiempirical ODP reported in Laube et al. (2014) is consistent with the Davis et al. (2016) value but has a larger uncertainty range.
O7 ODP was taken from Kloss et al. (2014).
O8 ODP was taken from the 2-D model calculations in Papadimitriou et al. (2013b).
O9 Semiempirical ODP was calculated using an empirical relationship of the fractional release factor with stratospheric lifetime given in Papanastasiou et al. (2018).
O10 ODP was taken from Papanastasiou et al. (2018).
O11 Upper limit of ODPs of short-lived substances reported in the studies of Brioude et al. (2010) for C_2H_5Br, CH_2CBrCF_3, n-C_3H_7Br, C_2HCl_3, CCl_3CHO, CH_3I, CF_3I, C_3F_7I, CH_2ClI, and $CHBr_3$; Wuebbles et al. (2009) for C_3H_7Br, C_2HCl_3, and C_2Cl_4; Patten et al. (2010) for HFO-1233zd and *E*-CHCl=CHCl; Youn et al. (2010) for CF_3I and CH_3I; and Tegtmeier et al. (2012) for CH_2Br_2 and $CHBr_3$. The derived ODPs in these studies were shown to be strongly dependent on the region and season of the substance emissions, with the greatest values obtained for emissions in the Indian subcontinent.

O12 ODP was taken from Langbein et al. (1999).

O14 ODP was assumed to be <0.02 for surface emissions.

O15 ODP was assumed to be the same as for CF_3I.

RE, GWP, and GTP Footnotes:

GWP and GTP values that are less then 0.1 are reported as "<<1" in the table. GWP and GTP values that are between 0.1 and 1 are reported as "<1" in the table.

R1 Radiative efficiency and climate metrics were taken from IPCC (2022).

R2 Radiative efficiency was taken from the recommendation given in Hodnebrog et al. (2020a), which was based on a combination of literature review of experimental data and reanalysis. Climate metrics were calculated here.

R3 Radiative efficiency was calculated using the room temperature infrared absorption spectrum reported in the Pacific Northwest National Laboratory (PNNL) database (secure2.pnl.gov/nsd/nsd.nsf). Sharpe et al. (2004).

R4 Radiative efficiency was taken from the recommendation given in Hodnebrog et al. (2020a) with +12% added due to tropospheric adjustments.

R5 Radiative efficiency and climate metrics were calculated using the infrared absorption spectrum reported in Davis et al. (2016) and the lifetime reported here.

R6 Radiative efficiency and climate metrics were calculated using the theoretically calculated infrared absorption spectrum and lifetimes given here.

R7 Radiative efficiency and climate metrics were calculated using the infrared absorption spectrum reported in Papadimitriou et al. (2013b) and the lifetime reported here.

R8 An instantaneous radiative efficiency was reported in Charmet et al. (2013), which was increased by +10% here to approximately account for the stratospheric temperature adjustment.

R9 Radiative efficiency and climate metrics were calculated using the theoretically calculated infrared absorption spectrum in Papanastasiou et al. (2018) and lifetimes given here.

R10 Radiative efficiency metrics were calculated using the infrared spectrum reported in McGillen et al. (2015).

R11 Radiative efficiency and climate metrics were calculated using the theoretically calculated infrared absorption spectrum reported in Burkholder et al. (2020).

R12 Radiative efficiency and climate metrics were calculated using the infrared absorption spectrum reported in Gierczak et al. (1996) and the lifetime reported here.

R13 Radiative efficiency was taken from recommendation given in Hodnebrog et al. (2013), which was based on a combination of literature review of experimental and theoretical data and reanalysis.

R14 Radiative efficiency and climate metrics were calculated using the infrared absorption spectrum reported in Rajakumar et al. (2006) and the lifetime reported here.

R15 Zhang et al. (2015) reported an instantaneous radiative efficiency value, using the Oslo LBL–Pinnock method. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R16 Guo et al. (2019) reported an "instantaneous radiative efficiency" value, using the Pinnock method. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R17 Radiative efficiency and climate metrics were calculated using the infrared absorption spectrum reported in Baasandorj et al. (2010) and the lifetime reported here.

R18 Radiative efficiency and climate metrics were calculated using the infrared absorption spectrum reported in Baasandorj et al. (2016) and the lifetime reported here.

R19 Radiative efficiency and climate metrics were calculated using the instantaneous radiative efficiency reported in Jai et al. (2013), which was calculated using the Pinnock method, and the lifetimes reported here. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied to obtain the radiative efficiency here.

R20 Radiative efficiency and climate metrics were based on the infrared spectrum reported in Baasandorj et al. (2018).

R21 Radiative efficiency and climate metrics were based on an average of the instantaneous radiative efficiencies reported in Baasandorj et al. (2011) and Østerstrøm et al. (2017), which were calculated using the Pinnock method, and the lifetimes reported here. In the absence of experimental spectra, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R22 Radiative efficiency and climate metrics were calculated using the instantaneous radiative efficiency reported in Jiménez et al. (2016), which was calculated using the Pinnock method, and the lifetimes reported here. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R23 Radiative efficiency and climate metrics were calculated using the instantaneous radiative efficiency reported in Liu et al. (2016), which was calculated using the Pinnock method, and the lifetimes reported here. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R24 Radiative efficiency and climate metrics were calculated using the infrared spectrum from Papadimitriou and Burkholder (2016).

R25 Radiative efficiency and climate metrics were calculated using the instantaneous radiative efficiency reported in Barrera et al. (2015), which was calculated using the Pinnock method, and the lifetimes reported here. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R26 Radiative efficiency and climate metrics were calculated using the infrared spectrum in Gierczak et al. (2014).

R27 Radiative efficiency and climate metrics were calculated using the infrared spectrum in Bernard et al. (2018).

R28 Radiative efficiency and climate metrics were calculated using the instantaneous radiative efficiency reported in Zhang et al. (2017), which was calculated using the Pinnock method, and the lifetimes reported here. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R29 Radiative efficiency and climate metrics were calculated using the instantaneous radiative efficiency reported in Rodríguez et al. (2014), which was calculated using the Pinnock method, and the lifetimes reported here. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R30 Radiative efficiency and climate metrics were calculated using the instantaneous radiative efficiency reported in Sulbaek Andersen et al. (2010), which was calculated using the Pinnock method, and the lifetimes reported here. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R31 Radiative efficiency and climate metrics were calculated using the instantaneous radiative efficiency reported in Bravo et al. (2013), which was calculated using the Pinnock method, and the lifetimes reported here. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R32 Radiative efficiency and climate metrics were calculated using the infrared spectrum in Vollmer et al. (2019).

R33 Radiative efficiency and climate metrics were calculated using the instantaneous radiative efficiency reported in Javadi et al. (2007), which was calculated using the Pinnock method, and the lifetimes reported here. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R34 Radiative efficiency and climate metrics were calculated using the recommendation given in Hodnebrog et al. (2013), which was based on the Bravo et al. (2011a) theoretically calculated infrared absorption spectra.

R35 Radiative efficiency and climate metrics were calculated using the instantaneous radiative efficiency reported in Østerstrøm et al. (2015), which was calculated using the Pinnock method, and the lifetimes reported here. In the absence of an experimental spectrum, a +10% stratospheric temperature adjustment was applied here to obtain the radiative efficiency.

R36 An OH radical reaction vertical profile lifetime adjustment was applied for very short-lived compounds lost by UV photolysis.

R37 Radiative efficiency and climate metrics were calculated using the radiative efficiency reported in Sulbaek Andersen (2017), which was calculated using the Pinnock method, with a +10% stratospheric temperature adjustment applied, and the lifetimes reported here.

REFERENCES

Albaladejo, J., B. Ballesteros, E. Jiménez, Y. Díaz de Mera, and E. Martínez, Gas-Phase OH Radical-Initiated Oxidation of the 3-halopropenes studied by PLP-LIF in the temperature range 228-388 K, ***Atmos. Environ.***, ***37***, 2919–2926, doi:10.1016/S1352-2310(03)00297-8, 2003.

Andrews, T., C.J. Smith, G. Myhre, P.M. Forster, R. Chadwick, and D. Ackerley, Effective radiative forcing in a GCM with fixed surface temperatures, ***J. Geophys. Res.***, ***126***, doi:10.1029/2020JD033880, 2021.

Antiñolo, M., S. González, B. Ballesteros, J. Albaladejo, and E. Jiménez, Laboratory studies of $CHF_2CF_2CH_2OH$ and $CF_3CF_2CH_2OH$: 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.

Antiñolo, M., E. Jiménez, and J. Albaladejo, Temperature effects on the removal of potential HFC replacements, $CF_3CH_2CH_2OH$ and $CF_3(CH_2)_2CH_2OH$, initiated by OH radicals, ***Environ. Sci. Technol.***, ***45***, 4323–4330, doi:10.1021/es103931s, 2011.

Antiñolo, M., E. Jiménez, A. Notario, E. Martínez, and J. Albaladejo, Tropospheric photooxidation of CF_3CH_2CHO and $CF_3(CH_2)_2CHO$ initiated by Cl atoms and OH radicals, ***Atmos. Chem. Phys.***, ***10***, 1911–1922, doi.org/10.5194/acp-10-1911-2010, 2010.

Arnts, R.R., R.L. Seila, and J.J. Bufalini, Determination of room temperature OH rate constants for acetylene, ethylene dichloride, ethylene dibromide, p-dichlorobenzene and carbon disulfide, ***J. Air Pollut. Control Assoc.***, ***39***, 453–460, doi:10.1080/08940630.1989.10466544, 1989.

Atkinson, R., S.M. Aschmann, A.M. Winer, and J.N. Pitts, Atmospheric gas phase loss processes for chlorobenzene, benzotrifluoride, and 4-chlorobenzotrifluoride, and generalization of predictive techniques for atmospheric lifetimes of aromatic compounds, ***Arch. Environ. Contam. Tox.***, ***14***, 417–425, doi:10.1007/BF01055527, 1985.

Baasandorj, M., and J.B. Burkholder, Rate coefficient for the gas-phase OH + $CHF{=}CF_2$ 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, $O(^1D)$ kinetic study of key ozone depleting substances and greenhouse gases, ***J. Phys. Chem. A***, ***117***, 2434–2445, doi:10.1021/j312781c, 2013.

Baasandorj, M., G. Knight, V.C. Papadimitriou, R.K. Talukdar, A.R. Ravishankara, and J.B. Burkholder, Rate coefficients for the gas-phase reaction of the hydroxyl radical with $CH_2{=}CHF$ and $CH_2{=}\ CF_2$ ***J. Phys. Chem. A***, ***114***, 4619–4633, doi:10.1021/jp100527z, 2010.

Baasandorj, M., P. Marshall, A.R. Ravishankara, and J.B. Burkholder, Rate coefficient measurements and theoretical analysis of the OH + (*E*)-$CF_3CH{=}CHCF_3$ reaction, ***J. Phys. Chem. A***, ***122***, 4635–4646, doi:10.1021/acs.jpca.8b02771, 2018.

Baasandorj, M., A.R. Ravishankara, and J.B. Burkholder, Atmospheric chemistry of (*Z*)-$CF_3CH{=}CHCF_3$: OH radical reaction rate coefficient and global warming potential, ***J. Phys. Chem. A***, ***115***, 10539–10549, doi:10.1021/jp206195g, 2011.

Barrera, J.A., P.R. Dalmasso, J.P.A. Abrate, R.A. Taccone, and S.I. Lane, Kinetic study of the OH and Cl-initiated oxidation, lifetimes and atmospheric acceptability indices of three halogenated ethenes, ***RSC Advances***, ***5***, 73501, doi:10.1039/c5ra13589c, 2015.

Bernard, F., M.R. McGillen, E.L. Fleming, C.H. Jackman, and J.B. Burkholder, $CBrF_3$ (Halon-1301): UV absorption spectrum between 210 and 320 K, atmospheric lifetime, and ozone depletion potential, ***J. Photochem. and Photobio. A: Chem.***, ***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 $N(C_xF_{2x+1})_3$, 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.

Blázquez, S., M. Antiñolo, O.J. Nielsen, J. Albaladejo, and E. Jiménez, Reaction kinetics of $(CF_3)_2CFCN$ with OH radicals as a function of temperature (278-358 K): A good replacement for greenhouse SF_6?, ***Chem. Phys. Lett.***, ***687***, 297–302, doi:10.1016/j.cplett.2017.09.039, 2017.

Blowers, P., K.F. Tetrault, and Y. Trujilo-Morehead, Global warming potential predictions for hydrofluoroethers with two carbon atoms, *Theor. Chem. Account*, *119*, 369–381, doi:10.1007/s00214-007-0394-3, 2008.

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.

Bravo, I., A. Rodríguez, D. Rodríguez, Y. Diaz-de-Mera, A. Notario, and A. Aranda, Atmospheric chemistry and environmental assessment of inhalational fluroxene, ***ChemPhysChem***, ***14***, 3834–3842, doi:10.1002/cphc.201300559, 2013.

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 suphide 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.

Bryukov, M.G., V.D. Knyazev, W.M. Gehling, and B. Dellinger, Kinetics of the gas-phase reaction of OH with chlorobenzene, ***J. Phys. Chem. A***, ***113***, 10452–10459, doi:10.1021/jp9049186, 2009.

Burkholder, J.B., R.A. Cox, and A.R. Ravishankara, Atmospheric Degradation of Ozone Depleting Substances, Their Substitutes, and Related Species, ***Chem. Rev.***, ***115***, 3704–3759, doi:10.1021/cr5006759, 2015.

Burkholder, J.B., M.K. Gilles, T. Gierczak, and A.R. Ravishankara, The atmospheric degradation of 1-bromopropane ($CH_3CH_2CH_2Br$): The photochemistry of bromoacetone, ***Geophys. Res. Lett.***, ***29***, doi:10.1029/2002GL014712, 2002.

Burkholder, J.B., P. Marshall, P.P. Bera, J.S. Francisco, and T.J. Lee, Climate metrics for C1-C4 hydrofluorocarbons (HFCs), ***J. Phys. Chem. A***, ***124***, 4793–4800, doi:10.1021/acs.jpca.0c02679, 2020.

Burkholder, J.B., S.P. Sander, J. Abbatt, J.R. Barker, C. Cappa, J.D. Crounse, T.S. Dibble, R.E. Huie, C.E. Kolb, M.J. Kurylo, V.L. Orkin, C.J. Percival, D.M. Wilmouth, and P.H. Wine, "Chemical Kinetics and Photochemical Data for Use in Atmospheric Studies, Evaluation No. 19," JPL Publication 19-5, Jet Propulsion Laboratory, Pasadena, 2020 http://jpldataeval.jpl.nasa.gov., 2019.

Carr, S., D.E. Shallcross, C.E. Canosa-Mas, J.C. Wenger, H.W. Sidebottom, J.J. Treacy, and R.P. Wayne, A kinetic and mechanistic study of the gas-phase reactions of OH radicals and Cl atoms with some halogenated acetones and their atmospheric implications, ***Phys. Chem. Chem. Phys.***, ***5***, 3874–3883, doi:10.1039/b304298g, 2003.

Carr, S., J.J. Treacy, H.W. Sidebottom, R.K. Connell, C.E. Canosa-Mass, R.P. Wayne, and J. Franklin, Kinetics and mechanisms for the reaction of hydroxyl radicals with trifluoroacetic acid under atmospheric conditions, ***Chem. Phys. Lett.***, ***227***, 39–44, doi:10.1016/0009-2614(94)00802-7, 1994.

Charmet, A.P., P. Stoppa, N. Tasinato, S. Giorgianni, V. Barone, M. Biczysko, J. Bloino, C. Cappelli, I. Carnimeo, and C. Puzzarini, An integrated experimental and quantum-chemical investigation on the vibrational spectra of chlorofluoromethane, ***J. Chem. Phys.***, ***139***, 15, doi: 10.1063/1.4825380, 2013.

Chen, L., S. Kutsuna, K. Tokuhashi, and A. Sekiya, Kinetics study of the gas-phase reactions of $C_2F_5OC(O)H$ and ***n***-$C_3F_7OC(O)H$ with OH radicals at 253-328 K, ***Chem. Phys. Lett.***, ***400***, 563–568, doi:10.1016/j.cplett.2004.11.019, 2004a.

Chen, L., S. Kutsuna, K. Tokuhashi, and A. Sekiya, Kinetics of the gas-phase reaction of $CF_3OC(O)H$ with OH radicals at 242-328 K, ***Int. J. Chem. Kinet.***, ***36***, 337–344, doi:10.1002/kin.20004, 2004b.

Chen, L., S. Kutsuna, K. Tokuhashi, and A. Sekiya, Kinetics and mechanisms of $CF_3CHFOCH_3$, $CF_3CHFOC(O)H$, and $FC(O)OCH_3$ reactions with OH radicals, ***J. Phys. Chem. A***, ***110***, 12845–12851, doi:10.1021/jp064917h, 2006.

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 ($C_4F_9OC_2H_5$): Reaction with OH radicals and fate of $C_4F_9OCH_2CH_2O(\bullet)$ and $C_4F_9OCHO(\bullet)CH_3$ radicals, ***J. Phys. Chem. A***, ***102***, 4839–4845, doi:10.1021/jp981128u, 1998.

Collins, W.J., R.G. Derwent, C.E. Johnson, and D.S. Stevenson, The oxidation of organic compounds in the troposphere and their global warming potentials, ***Climatic Change***, ***52***, 453–479, doi:10.1023/a:1014221225434, 2002.

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 CCl_2FCCl_2F (CFC-112), CCl_3CClF_2 (CFC-112a), CCl_3CF_3 (CFC-113a), and CCl_2FCF_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+, 1996.

Donaghy, T., I. Shanahan, M. Hande, and S. Fitzpatrick, Rate constants and atmospheric lifetimes for the reactions of OH radicals and Cl atoms with haloalkanes, ***Int. J. Chem. Kinet.***, ***25***, 273–284, doi:10.1002/kin.550250407, 1993.

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.

Forster, P., T. Storelvmo, K. Armour, W. Collins, J.-L. Dufresne, D. Frame, D.J. Lunt, T. Mauritsen, M.D. Palmer, M. Watanabe, M. Wild, and H. Zhang, The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity, Chapter 7 In Climate Change 2021: ***The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change***, edited by Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou, Cambridge University Press, United Kingdom and New York, NY, USA, 131 pp., doi:10.1017/9781009157896.009, 2021.

Gasser, T., G.P. Peters, J.S. Fuglestvedt, W.J. Collins, D.T. Shindell, and P. Ciais, Accounting for the climate–carbon feedback in emission metrics, ***Earth Syst. Dynam.***, ***8***, 235–253, doi:10.5194/esd-8-235-2017, 2017.

Gierczak, T., M. Baasandorj, and J.B. Burkholder, OH + (*E*)- and (*Z*)-1-chloro-3,3,3-trifluoropropene-1 ($CF_3CH=CHCl$) reaction rate coefficients: Stereoisomer-dependent reactivity, ***J. Phys. Chem. A***, ***118***, 11015–11025, doi:10.1021/jp509127h, 2014.

Gierczak, T., R.K. Talukdar, J.B. Burkholder, R.W. Portmann, J.S. Daniel, S. Solomon, and A.R. Ravishankara, Atmospheric fate and greenhouse warming potentials of HFC 236fa and HFC 236ea, ***J. Geophys. Res.***, ***101***, 12905–12911, doi:10.1029/96jd00059, 1996.

Guo, Q., N. Zhang, T. Uchimaru, L. Chen, H. Quan, and J. Mizukado, Atmospheric chemistry for gas-phase reactions of cyc-$CF_2CF_2CF_2CH_XCH_X$- (X = H or F) with OH radicals in the temperature range of 253-328 K, ***Atmos. Environ.***, ***215***, 8, doi:10.1016/j.atmosenv.2019.116895, 2019.

Hodnebrog, Ø., B. Aamaas, J.S. Fuglestvedt, G. Marston, G. Myhre, C.J. Nielsen, M. Sandstad, K.P. Shine, and T.J. Wallington, Updated global warming potentials and radiative efficiencies of halocarbons and other weak atmospheric absorbers, ***Rev. Geophys.***, ***58***, 30, doi:10.1029/2019rg000691, 2020a.

Hodnebrog, Ø., S.B. Dalsoren, and G. Myhre, Lifetimes, direct and indirect radiative forcing, and global warming potentials of ethane (C_2H_6), propane (C_3H_8), and butane (C_4H_{10}), ***Atmos. Sci. Lett.***, ***19***, 7, doi:10.1002/asl.804, 2018.

Hodnebrog, Ø., M. Etminan, J.S. Fuglestvedt, 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.

Hodnebrog, Ø., G. Myhre, R.J. Kramer, K.P. Shine, T. Andrews, G. Faluvegi, M. Kasoar, A. Kirkevåg, J.-F. Lamarque, J. Mülmenstädt, D. Olivié, B.H. Samset, D. Shindell, C.J. Smith, T. Takemura, and A. Voulgarakis, The effect of rapid adjustments to halocarbons and N_2O on radiative forcing, ***Clim. Atmos. Sci.***, ***3***, 43, doi:10.1038/s41612-020-00150-x, 2020b.

Hu, L. The role of the ocean in the atmospheric budgets of methyl bromide, methyl chloride and methane. Doctoral dissertation, Texas A&M University, College Station, TX, U.S.A., 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.

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.

IPCC (Intergovernmental Panel on Climate Change), ***Climate Change 2013: The Physical Science Basis, ontribution 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, Cambridge University Press, Cambridge, United Kingdom, 1535 pp., 2013.

IPCC (Intergovenmental Panel on Climate Change), ***Climate Change 2021: The Physical Science Basis, Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change***, edited by V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press, doi:10.1017/9781009157896, 2022.

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-$CX=CXCF_2CF_2$- (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.

Jiang, Z., P.H. Taylor, and B. Dellinger, Laser photolysis/laser-induced fluorescence studies of the reaction of OH with 1,1,1,2- and 1,1,2,2-tetrachloroethane over an extended temperature range, ***J. Phys. Chem.***, ***97***, 5050–5053, doi:10.1021/j100121a033, 1993.

Jiménez, E., S. González, M. Cazaunau, H. Chen, B. Ballesteros, V.r. Daële, J. Albaladejo, and A. Mellouki, Atmospheric degradation initiated by OH radicals of the potential foam expansion agent, $CF_3(CF_2)_2CH=CH_2$ (HFC-1447fz): Kinetics and formation of gaseous products and secondary organic aerosols, ***Environ. Sci. Technol.***, ***50***, 1234–1242, doi:10.1021/acs.est.5b04379, 2016.

Joos, F., R. Roth, J.S. Fuglestvedt, G.P. Peters, I.G. Enting, W. von Bloh, V. Brovkin, E.J. Burke, M. Eby, N.R. Edwards, T. Friedrich, T.L. Frölicher, P.R. Halloran, P.B. Holden, C. Jones, T. Kleinen, F. Mackenzie, K. Matsumoto, M. Meinshausen, G.K. Plattner, A. Reisinger, J. Segschneider, G. Shaffer, M. Steinacher, K. Strassmann, K. Tanaka, A. Timmermann, and A.J. Weaver, Carbon dioxide and climate impulse response functions for the computation of greenhouse gas metrics: a multi-model analysis, ***Atmos. Chem. Phys.***, ***13***, 2793–2825, doi:10.5194/acp-13-2793-2013, 2013.

Jubb, A.M., M.R. McGillen, R.W. Portmann, J.S. Daniel, and J.B. Burkholder, An atmospheric photochemical source of the persistent greenhouse gas CF_4, ***Geophys. Res. Lett.***, ***42***, doi:10.1002/2015GL066193, 2015.

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, ***Atmosphere***, ***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, 2013.

Kovács, T., W. Feng, A. Totterdill, J.M.C. Plane, S. Dhomse, J.C. Gómez-Martín, G.P. Stiller, F.J. Haenel, C. Smith, P.M. Forster, R.R. García, D.R. Marsh, and M.P.

Chipperfield, Determination of the atmospheric lifetime and global warming potential of sulfur hexafluoride using a three-dimensional model, ***Atmos. Chem. Phys.***, ***17***, 883–898, doi:10.5194/acp-17-883-2017, 2017.

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, ***Brit. 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 detetecd ozone-depleting substances in the atmosphere, ***Nature Geoscience***, ***7***, 266–269, doi:10.1038/ngeo2109, 2014.

Liu, D., S. Qin, W. Li, D. Zhang, and Z. Guo, Atmospheric chemistry of 1H-Heptafluorocyclopentene (cyc-$CF_2CF_2CF_2CF$=CH−): Rate constant, products, and mechanism of gas-phase reactions with OH radicals, IR absorption spectrum, photochemical ozone creation potential, and global warming potential, ***J. Phys. Chem. A***, ***120***, 9557–9563, doi:10.1021/acs.jpca.6b10348, 2016.

Loison, J.C., L. Ley, and R. Lesclaux, Kinetic study of OH radical reactions with chlorobutane isomers at 298 K, ***Chem. Phys. Lett.***, ***296***, 350–356, doi:10.1016/S0009-2614(98)01058-6, 1998.

Markert, F., and O.J. Nielsen, The reactions of OH radicals with chloralkanes in the temperature range 295-360 K, ***Chem. Phys. Lett.***, ***194***, 123–127, doi:10.1016/0009-2614(92)85753-W, 1992.

Mashino, M., Y. Ninomiya, M. Kawasaki, T.J. Wallington, and M.D. Hurley, Atmospheric chemistry of $CF_3CF=CF_2$: 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_3CH_2Cl): OH rate coefficient, UV and infrared absorption spectra, and atmospheric implications, ***Geophys. Res. Lett.***, ***42***, 6098–6105, doi:10.1002/2015GL064939, 2015.

McIlroy, A., and F.P. Tully, Kinetic study of OH reactions with perfluoropropene and perfluorobenzene, ***J. Phys. Chem.***, ***97***, 610–614, doi:10.1021/j100105a013, 1993.

Modak, A., G. Bala, K. Caldeira, and L. Cao, Does shortwave absorption by methane influence its effectiveness?, ***Climate Dynamics***, 1–20, doi:10.1007/s00382-018-4102-x, 2018.

Montzka, S.A., S. Reimann, (Coordinating Lead Authors) A. Engel, K. Krüger, S. O`Doherty, and W.T. Sturges, , Ozone-Depleting Substances (ODSs) and Related Chemicals, Chapter 1 in Scientific Assessment of Ozone Depletion: 2010, Global Ozone Research and Monitoring Project–Report No. 52, World Meteorological Organization, Geneva, Switzerland, 2011.

Mössinger, J.C., D.E. Shallcross, and R.A. Cox, UV-VIS absorption cross-sections and atmospheric lifetimes of CH_2Br_2, CH_2I_2 and CH_2BrI, ***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. Greally, 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.

Østerstrøm, F.F., S.T. Andersen, T.I. Solling, O.J. Nielsen, and M.P.S. Andersen, Atmospheric chemistry of ***Z***- and ***E***-$CF_3CH=CHCF_3$, ***Phys. Chem. Chem. Phys.***, ***19***, 735–750, doi:10.1039/C6CP07234H, 2017.

Østerstrøm, F.F., T.J. Wallington, M.P.S. Andersen, and O.J. Nielsen, Atmospheric chemistry of $(CF_3)_2CHOCH_3$, $(CF_3)_2CHOCHO$, and $CF_3C(O)OCH_3$, ***J. Phys. Chem. A***, ***119***, 10540–10552, doi:10.1021/acs.jpca.5b08204, 2015.

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 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 $(CF_3)_2CFCH$=CHF (HFO-1438ezy(***E***)), ***J. Phys. Chem. A***, ***120***, 6618–6628, doi:10.1021/acs.jpca.6b06096, 2016.

Papadimitriou, V.C., M.R. McGillen, E.L. Fleming, C.H. Jackman, and J.B. Burkholder, 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-Dichlorohexafluorocyclobutane (1,2-c-$C_4F_6Cl_2$, R-316c) a potent ozone depleting substance and greenhous gas: Atmospheric loss processes, lifetimes, and ozone depletion and global warming potentials for the (***E***) and (***Z***) stereoisomers, ***J. Phys. Chem. A***, ***117***, 11049–11065, doi:10.1021/jp407823k, 2013b.

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 SO_2F_2, ***J. Phys. Chem. A***, ***112***, 12657–12666, doi:10.1021/jp806368u, 2008.

Papadimitriou, V.C., C.S. Spitieri, P. Papagiannakopoulos, M. Cazaunau, M. Lendar, V. Daëleb, and A. Mellouki, Atmospheric chemistry of $(CF_3)_2C=CH_2$: OH radicals, Cl atoms and O_3 rate coefficients, oxidation end-products and IR spectra, ***Phys. Chem. Chem. Phys.***, ***17***, 25607, doi:10.1039/c5cp03840e, 2015.

Papanastasiou, D.K., A. Beltrone, P. Marshall, and J.B. Burkholder, Global warming potential estimates for C_1-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.

Papanastasiou, D.K., S.A. McKeen, and J.B. Burkholder, The very short-lived ozone depleting substance $CHBr_3$ (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., 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 CF_2Br_2, CF_2ClBr, and CF_2BrCF_2Br, ***Geophys. Res. Lett.***, ***40***, doi:10.1002/GRL.50121, 2013.

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.

Perry, R.A., R. Atkinson, and J.N. Pitts, Rate constants for the reaction of OH radicals with CH_2=CHF, CH_2=CHCl, and CH_2=CHBr over the temperature range 299-426 °K, ***J. Chem. Phys.***, ***67***, 458–462, doi:10.1063/1.434889, 1977.

Pinnock, S., M.D. Hurley, K.P. Shine, T.J. Wallington, and T.J. Smyth, Radiative forcing of climate by hydrochlorofluorocarbons and hydrofluorocarbons, ***J. Geophys. Res.***, ***100***, 23227–23238, doi:10.1029/95jd02323, 1995.

Prinn, R.G., J. Huang, R.F. Weiss, D.M. Cunnold, P.J. Fraser, P.G. Simmonds, A. McCulloch, C. Harth, S. Reimann, P. Salameh, 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.

Rajakumar, B., R. W. Portmann, J. B. Burkholder, and A. R. Ravishankara, Rate coefficients for the reactions of OH with $CF_3CH_2CH_3$ (HFC-263fb), CF_3CHFCH_2F (HFC-245eb), and $CHF_2CHFCHF_2$ (HFC-245ea) between 238 and 375 K, ***J. Phys. Chem. A***, ***110***, 6724–6731, doi:10.1021/jp056248y, 2006.

Ravishankara, A.R., J.S. Daniel, and R.W. Portmann, Nitrous oxide (N_2O): The dominant ozone-depleting substance emitted in the 21st century, ***Science***, ***326***, 123–125, doi: 10.1126/science.1176985, 2009.

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.

Ray, E.A., F.L. Moore, J.W. Elkins, K.H. Rosenlof, J.C. Laube, T. Röckmann, D.R. Marsh, and A.E. Andrews, Quantification of the SF_6 lifetime based on mesospheric loss measured in the stratospheric polar vortex, ***J. Geophys. Res.***, ***122***, doi:10.1002/2016JD026198., 2017.

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.

Rodriguez, A., I. Bravo, D. Rodriguez, M. Tajuelo, Y. Diaz-de-Mera, and A. Aranda, The environmental impact of unsaturated fluoroesters: atmospheric chemistry towards OH radicals and Cl atoms, radiative behavior and cumulative ozone creation, ***RSC Advances***, ***6***, 21833–21843, doi:10.1039/C6RA00630B, 2016.

Rodríguez, A., D. Rodríguez, A. Moraleda, I. Bravo, E. Moreno, and A. Notario, Atmospheric chemistry of HFE-7300 and HFE-7500: Temperature dependent kinetics, atmospheric lifetimes, infrared spectra and global warming potentials, ***Atmos. Environ.***, ***96***, 145–153, doi:10.1016/j.atmosenv.2014.07.033, 2014.

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***, 12819–12829, doi:10.1029/97JD00530, 1997.

Sellevåg, S.R., T. Kelly, H. Sidebottom, and C.J. Nielsen, A study of the IR and UV-Vis absorption cross sections, photolysis and OH-initiated oxidation of CF_3CHO and CF_3CH_2CHO, ***Phys. Chem. Chem. Phys.***, ***6***, 1243–1252, doi:10.1039/b315941h, 2004.

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, ***Applied Spectrosc.***, ***58***, 1452–1461, 2004.

Shine, K.P., and G. Myhre, The spectral nature of stratospheric temperature adjustment and its application to halocarbon radiative forcing, ***J. Adv. in Model. Earth Syst.***, ***12***, 16, doi:10.1029/2019ms001951, 2020.

Smith, C.J., R.J. Kramer, G. Myhre, K. Alterskjær, W. Collins, A. Sima, O. Boucher, J.-L. Dufresne, P. Nabat, M. Michou, S. Yukimoto, J. Cole, D. Paynter, H. Shiogama, F.M. O'Connor, E. Robertson, A. Wiltshire, T. Andrews, C. Hannay, R. Miller, L. Nazarenko, A. Kirkevåg, D. Olivié, S. Fiedler, A. Lewinschal, C. Mackallah, M. Dix, R. Pincus, and P.M. Forster, Effective radiative forcing and adjustments in CMIP6 models, ***Atmos. Chem. Phys.***, ***20***, 9591–9618, doi:10.5194/acp-20-9591-2020, 2020.

Smith, C.J., R.J. Kramer, G. Myhre, P.M. Forster, B.J. Soden, T. Andrews, O. Boucher, G. Faluvegi, D. Flaschner, Ø. Hodnebrog, M. Kasoar, V. Kharin, A. Kirkevag, J.F. Lamarque, J. Mulmenstadt, D. Olivié, T. Richardson, B.H. Samset, D. Shindell, P. Stier, T. Takemura, A. Voulgarakis, and D. Watson-Parris, Understanding rapid adjustments to diverse forcing agents, ***Geophys. Res. Lett.***, ***45***, 12023–12031, doi:10.1029/2018gl079826, 2018.

Smith, C., Z.R.J. Nicholls, K. Armour, W. Collins, P. Forster, M. Meinshausen, M.D. Palmer, and M. Watanabe, The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity Supplementary Material. In ***Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*** [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Available from https://www.ipcc.ch/, 2021.

SPARC (Stratosphere-troposphere Processes And their Role in Climate), ***SPARC Report on the Lifetimes of Stratospheric Ozone-Depleting Substances, Their Replacements, and Related Species***, edited by M.K.W. Ko, P.A. Newman, S. Reimann, and S.E. Strahan, SPARC Report No. 6, WCRP-15/2013, [available at: https://www.sparc-climate.org/fileadmin/customer/6_Publications/SPARC_reports_PDF/6_SPARC_LifetimeReport_Web.pdf], 2013.

SPARC (Stratosphere-troposphere Processes And their Role in Climate), ***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, [available at: https://www.wcrp-climate.org/WCRP-publications/2016/SPARC_Report7_2016.pdf], 2016.

Srinivasulu, G., A.J.C. Bunkan, D. Amedro, and J.N. Crowley, Absolute and relative-rate measurement of the rate coefficient for reaction of perfluoro ethyl vinyl ether ($C_2F_5OCF=CF_2$) with OH, ***Phys. Chem. Chem. Phys.***, ***20***, 3761–3767, doi:10.1039/c7cp08056e, 2018.

Sulbaek Andersen, M.P., V.F. Andersen, O.J. Nielsen, S.P. Sander, and T.J. Wallington, Atmospheric chemistry of $HCF_2O(CF_2CF_2O)_xCF_2H$ (x = 2-4): Kinetics and mechanisms of the chlorine-atom-initiated oxidation, ***ChemPhysChem***, ***11***, 4035–4041, doi:10.1002/cphc.201000438, 2010.

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 $CH_3O(CF_2CF_2O)_nCH_3$ (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., M. Kyte, S.T. Andersen, C.J. Nielsen, and O.J. Nielsen, Atmospheric chemistry of $(CF_3)_2CFCN$: A replacement compound for the most potent industrial greenhouse gas, SF_6, ***Environ. Sci. Technol.***, ***51***, 1321–1329, doi:10.1021/acs.est.6b03758, 2017.

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 $C_xF_{2x+1}CH=CH_2$ (x=1, 2, 4, 6, and 8): Kinetics of gas-phase reactions with Cl atoms, OH radicals, and O_3, ***J. Photochem. and Photobio. A: Chem.***, ***176***, 124–128, doi:10.1016/j.jphotochem.2005.06.015, 2005a.

Sulbaek Andersen, M.P., O.J. Nielsen, T.J. Wallington, M.D. Hurley, and W.B. DeMore, Atmospheric chemistry of $CF_3OCF_2CF_2H$ and $CF_3OC(CF_3)_2H$: Reaction with Cl atoms and OH radicals, degradation mechanism, global warming potentials, and empirical relationship between *k*(OH) and *k*(Cl) for organic compounds, ***J. Phys. Chem. A***, ***109***, 3926–3934, doi:10.1021/jp044635m, 2005b.

Suntharalingam, P., E. Buitenhuis, L.J. Carpenter, J.H. Butler, M.J. Messias, S.J. Andrews, and S.C. Hackenberg, Evaluating oceanic uptake of atmospheric CCl_4: A combined analysis of model simulations and observations, ***Geophys. Res. Lett.***, ***46***, 472–482, doi:10.1029/2018GL080612, 2019.

Takahashi, K., T. Nakayama, Y. Matsumi, S. Solomon, T. Gejo, E. Shigemasa, and T.J. Wallington, Atmospheric lifetime of SF_5CF_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 $C_2F_5C(O)CF(CF_3)_2$: Photolysis and reaction with Cl atoms, OH radicals, and ozone, ***J. Phys. Chem. A***, ***107***, 2674–2679, doi:10.1021/jp0220332, 2003.

Taylor, P.H., Z. Jiang, and B. Dellinger, Laser photolysis/laser-induced fluorescence studies of the reaction of hydroxyl with 1,1,2-trichloroethane over an extended temperature range, ***J. Phys. Chem.***, ***96***, 1293–1296, doi:10.1021/j100182a050, 1992.

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***, 10633–10648, doi:10.5194/acp-12-10633-2012, 2012.

Tokuhashi, K., A. Takahashi, M. Kaise, and S. Kondo, Rate constants for the reactions of OH radials with CH_3OCF_2CHFCl, CHF_2OCF_2CHFCl, $CHF_2OCHClCF_3$, and $CH_3CH_2OCF_2CHF_2$, ***J. Geophys. Res.***, ***104***, 18681–18688, doi:10.1029/1999JD900278, 1999.

Tokuhashi, K., K. Takizawa, and S. Kondo, Rate constants for the reactions of OH radicals with fluorinated ethenes: Kinetic measurements and correlation between structure and reactivity, ***J. Phys. Chem. A***, ***122***, 4593–4600, doi:10.1021/acs.jpca.7b11653, 2018a.

Tokuhashi, K., K. Takizawa, and S. Kondo, Rate constants for reactions of OH radials with (*Z*)-$CF_3CCl=CHCl$, $CHF_2CF=CF_2$, (*E*)-$CF_3CH=CHF$, (*Z*)-$CF_3CH=CHF$, $CH_3CF=CH_2$, and $CH_2FCH=CH_2$, ***Atmos. Environ.***, ***255***, 118428, doi:10.1016/j.atmosenv.2021.118428, 2021.

Tokuhashi, K., T. Uchimaru, K. Takizawa, and S. Kondo, Rate constants for the reactions of OH radical with the (*E*)/(*Z*) isomers of $CF_3CF=CHCl$ and $CHF_2CF=CHCl$, ***J. Phys. Chem. A***, ***122***, 3120–3127, doi:10.1021/acs.jpca.7b11923, 2018b.

Tokuhashi, K., T. Uchimaru, K. Takizawa, and S. Kondo, Rate constants for the reactions of OH radicals with the (*E*)/(*Z*) isomers of $CFCl=CFCl$ and (*E*)-$CHF=CHF$, ***J. Phys. Chem. A***, ***123***, 4834–4843, doi:10.1021/acs.jpca.9b02454, 2019.

Tuazon, E.C., R. Atkinson, S.M. Aschmann, M.A. Goodman, and A.M. Winer, Atmospheric reactions of chloroethenes with the OH radical, ***Int. J. Chem Kinet.***, ***20***, 241–265, doi:10.1002/kin.550200305, 1988.

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, doi:10.1016/S0009-2614(02)01718-9, 2003.

Vial, J., J.-L.L. Dufresne, and S. Bony, On the interpretation of inter-model spread in CMIP5 climate sensitivity estimates, ***Climate Dynamics***, ***41***, 3339–3362, doi:10.1007/s00382-013-1725-9, 2013.

Vollmer, M.K., F. Bernard, B. Mitrevski, L.P. Steele, C.M. Trudinger, S. Reimann, R.L. Langenfelds, P.B. Krummel, P.J. Fraser, D.M. Etheridge, M.A.J. Curran, and J.B. Burkholder, Abundances, emissions, and loss processes of the long-lived and potent greenhouse gas octafluorooxolane (octafluorotetrahydrofuran, c-C_4F_8O) in the atmosphere, ***Atmos. Chem. Phys.***, ***19***, 3481–3492, doi:10.5194/acp-19-3481-2019, 2019.

Wahner, A., and C. Zetzsch, Rate constants for the addition of OH to aromatics (benzene, p-chloroaniline, and o-, m-, and p-dichlorobenzene) and the unimolecular decay of the adduct. Kinetics into a quasi-equilibrium. 1, ***J. Phys. Chem.***, ***87***, 4945–4951, doi:10.1021/j150642a036, 1983.

Wallington, T.J., M.D. Hurley, O.J. Nielsen, and M.P. Sulbaek Andersen, Atmospheric chemistry of $CF_3CFHCF_2OCF_3$ and $CF_3CFHCF_2OCF_2H$: Reaction with Cl atoms and OH radicals, degradation mechanism, and global warming potentials, ***J. Phys. Chem. A***, ***108***, 11333–11338, doi:10.1021/jp046454q, 2004.

WMO (World Meteorological Organization), ***Scientific Assessment of Ozone Depletion: 2014***, Global Ozone Research and Monitoring Project–Report No. 55, 416 pp., Geneva, Switzerland, 2014.

WMO (World Meteorological Organization), ***Scientific Assessment of Ozone Depletion: 2018***, Global Ozone Research and Monitoring Project–Report No. 58, 588 pp., Geneva, Switzerland, 2018.

Wuebbles, D.J., D. Youn, K. Patten, D. Wang, and M. Martinez-Aviles, Metrics for Ozone and Climate: Three-Dimensional Modeling Studies of Ozone Depletion Potentials and Indirect Global Warming Potentials, in ***Twenty Years of Ozone Decline: Proceedings of the Symposium for the 20th Anniversary of the Montreal Protocol***, edited by C. Zerefos, G. Contopoulos, and G. Skalkeas, Springer, Dordrecht, Netherlands, 297–326 pp., doi:10.1007/978-90-481-2469-5_23, 2009.

Youn, D., K.O. Patten, D.J. Wuebbles, H. Lee, and C.-W. So, Potential impact of iodinated replacement compounds CF_3I and CH_3I on atmospheric ozone: a three-dimensional modeling study, ***Atmos. Chem. Phys.***, ***10***, 10129–10144, doi:10.5194/acp-10-10129-2010, 2010.

Young, C.J., R.F. Gómez Biagi, M.D. Hurley, T.J. Wallington, and S.A. Mabury, Paint solvent to food additive: An environmental route of dehalgenation for 4-chlorobenzotrifluoride, ***Environ. Tox. Chem.***, ***27***, 2233–2238, doi:10.1897/08-051.1, 2008.

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 CF_3CF_2H and $CF_3CF_2CF_2CF_2H$: 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, 2009.

Yvon-Lewis, S.A., and J.H. Butler, Effect of oceanic uptake on atmospheric lifetimes of selected trace gases, ***J. Geophys. Res.***, ***107***, 4414, doi:10.1029/2001JD001267, 2002.

Zhang, M., and Y. Huang, Radiative forcing of quadrupling CO_2, ***J. Climate***, ***27***, 2496–2508, doi:10.1175/jcli-d-13-00535.1, 2014.

Zhang, N., L. Chen, T. Uchimaru, F. Qing, J. Mizukado, H. Quan, and H. Suda, Kinetics of gas-phase reactions of cyc-$CF_2CF_2CF_2CHFCH_2$ and trans-cyc-CF_2CF-$_2CF_2CHFCHF$ with OH radicals between 253 and 328 K, ***Chem. Phys. Lett.***, ***639***, 199–204, doi:10.1016/j.cplett.2015.09.020, 2015.

Zhang, N., T. Uchimaru, Q. Guo, F. Qing, L. Chen, and J. Mizukado, Atmospheric chemistry of perfluorocyclopentene (cyc-$CF_2CF_2CF_2CF$=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, Q., C. Y., S. Tong, M. Ge, J. Shenolikar, M.S. Johnson, Y. Wang, N.T. Tsona, A. Mellouki, and L. Du, Atmospheric oxidation of selected chlorinated alkenes by O_3, OH, NO_3 and Cl, ***Atmos. Environ.***, ***170***, 12–21, doi:10.1016/j.atmosenv.2017.09.031, 2017.

Zhang, S., R. Strekowski, L. Bosland, A. Monod, and C. Zetzsch, Kinetic study of the reaction of OH with CH_2I_2, ***Phys. Chem. Chem. Phys.***, ***13***, 11671–11677, 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 C_2H_5I, *n*-C_3H_7I, and *iso*-C_3H_7I, ***J. Phys. Chem. A***, ***116***, 9497–9506, doi:10.1021/jp300575f, 2012.