Supplemental Information

**Low Frequency (<500 cm-1) Contribution to Greenhouse Gas Radiative Efficiency**

Daniel Van Hoomissen,1,2 Vassileios C. Papadimitriou,1,2,3 and James B. Burkholder1 \*

1 Chemical Sciences Laboratory, National Oceanic and Atmospheric Administration (NOAA), Boulder, Colorado, USA 80305-3327

2 Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado, USA 80309

3 Laboratory of Photochemistry and Chemical Kinetics, Department of Chemistry, University of Crete, Vassilika Vouton, 70013, Heraklion, Crete, Greece

**Correspondence**

James B. Burkholder

Chemical Sciences Laboratory,

National Oceanic and Atmospheric Administration,

325 Broadway, Boulder, CO 80305-3327.

ORCID: [0000-0001-9532-6246](http://orcid.org/0000-0001-9532-6246)

Phone: 303-351-2739

Email: James.B.Burkholder@noaa.gov



**Figure S1.** Frequency scaling function obtained in this work by comparing DFT calculated band peak positions using the wB97X-D/def2TZVPPD level of theory with experimental spectra for molecules within the Pacific Northwest National Laboratory (PNNL) database [1]. The different colored symbols represent data from different compound classes. The line is a linear least-squares fit to the data yielding 0.95655\*x + 20.286 (cm-1).

****

**Figure S2.** Comparison of infrared absorption integrated band strengths (IBSs) calculated in this work using density functional theory with the wB97X-D/def2TZVPPD level of theory with experimental values reported in the Pacific Northwest National Laboratory (PNNL) database [1]. The comparison is broken down into wavenumber regions: lower-limit of the experimental measurement to 1000 cm-1 (green circles, 1.105), 1000 to 1500 cm-1 (blue squares, 1.096), and 1500 to 4000 cm-1 (red triangles, 1.023). The values in parenthesis are the linear least-squares to the data in that wavenumber region. The 1:1 correlation is shown as the dashed line.



**Figure S3**. Sensitivity analysis of low-frequency (<500 cm-1) absorption bands to the low-frequency contribution to RE. The results shown were obtained after increasing the low-frequency absorption band strengths by 25%. Comparison with the results given in Figure 1 and Tables 1-20 show, in general, a ~5%, or less, increase in the low-frequency contribution to a molecules total RE. .

**Table S1**. Summary of the low-frequency (<500 cm-1) contribution to radiative efficiency (RE) for the Hydrochlorofluorocarbons included in the WMO (2022) ozone assessment Annex [2].

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Hydrochlorofluorocarbon | Chemical Formula | CAS-RN | Adjusted RE(W m-2 ppb-1) a | Number of Conformers b | Low-frequency Contribution to RE(%) |
| HCFC-21 c | CHFCl2 | 75-43-4 | 0.145 | 1 | 0.02 |
| HCFC-22 c | CHF2Cl | 75‐45‐6 | 0.214 | 1 | 0.17 |
| HCFC-31 c | CH2FCl | 593-70-4 | 0.068 | 1 | 0.3 |
| HCFC-121 c | CHCl2CCl2F | 354-14-3 | 0.147 | 3 | 0.65 |
| HCFC-121a | CHClFCCl3 | 354-11-0 | 0.172 | 1 | 0.63 |
| HCFC-122 c | CHCl2CClF2 | 354-21-2 | 0.160 | 3 | 0.40 |
| HCFC-122a | CHClFCCl2F | 354-15-4 | 0.203 | 3 | 0.65 |
| HCFC-122b | CHF2CCl3 | 354-12-1 | 0.211 | 1 | 0.67 |
| HCFC-123 c | CHCl2CF3 | 306-83-2 | 0.160 | 1 | 0.16 |
| HCFC-123a | CHClFCClF2 | 354-23-4 | 0.228 | 3 | 0.24 |
| HCFC-123b | CHF2CCl2F | 812-04-4 | 0.238 | 3 | 0.59 |
| HCFC-124 c | CHClFCF3 | 2837-89-0 | 0.207 | 1 | 0.17 |
| HCFC-124a | CHF2CClF2 | 354-25-6 | 0.251 | 3 | 0.52 |
| HCFC-131 c | CHCl2CHClF | 359-28-4 | 0.097 | 3 | 1.69 |
| HCFC-131a | CH2ClCCl2F | 811-95-0 | 0.160 | 3 | 1.03 |
| HCFC-131b | CH2FCCl3 | 2366-36-1 | 0.125 | 1 | 0.52 |
| HCFC-132 c | CHClFCHClF | 25915-78-0 | 0.147 | 6 | 2.49 |
| HCFC-132a | CHCl2CHF2 | 471-43-2 | 0.129 | 3 | 1.79 |
| HCFC-132b | CH2ClCClF2 | 1649-08-7 | 0.192 | 3 | 0.57 |
| HCFC-132c | CH2FCCl2F | 1842-05-3 | 0.171 | 3 | 1.24 |
| HCFC-133 c | CHClFCHF2 | 431-07-2 | 0.173 | 3 | 3.04 |
| HCFC-133a | CH2ClCF3 | 75-88-7 | 0.150 | 1 | 0.23 |
| HCFC-133b | CH2FCClF2 | 421-04-5 | 0.206 | 3 | 0.23 |
| HCFC-141 c | CH2ClCHClF | 430-57-9 | 0.0745 | 2 | 3.65 |
| HCFC-141a | CH2FCHCl2 | 430-53-5 | 0.0573 | 3 | 3.78 |
| HCFC-141b c | CH3CCl2F | 1717‐00‐6 | 0.161 | 1 | 1.12 |
| HCFC-142 c | CH2ClCHF2 | 338-65-8 | 0.109 | 3 | 3.36 |
| HCFC-142a | CH2FCHClF | 338-64-7 | 0.111 | 3 | 2.99 |
| HCFC-142b c | CH3CClF2 | 75‐68‐3 | 0.194 | 1 | 0.46 |
| HCFC-151 c | CH2ClCH2F | 762-50-5 | 0.0295 | 3 | 5.15 |
| HCFC-151a | CH3CHClF | 1615-75-4 | 0.0617 | 1 | 2.90 |
| HCFC-221aa | CHCl2CCl2CCl2F | 422-28-6 | 0.175 | 4 | 0.33 |
| HCFC-221ab | CHClFCCl2CCl3 | 422-26-4 | 0.172 | 1 | 0.74 |
| HCFC-221ba | CHCl2CClFCCl3 | 422-40-2 | 0.168 | 2 | 0.66 |
| HCFC-221da | CCl3CHClCCl2F | 431-79-8 | 0.231 | 2 | 0.38 |
| HCFC-221ea | CCl3CHFCCl3 | – | 0.214 | 1 | 1.29 |
| HCFC-222aa | CHCl2CCl2CClF2 | 422-30-0 | 0.216 | 5 | 0.45 |
| HCFC-222ab | CHClFCCl2CCl2F | 147728-31-2 | 0.224 | 5 | 0.57 |
| HCFC-222ac | CHF2CCl2CCl3 | 422-27-5 | 0.214 | 3 | 0.51 |
| HCFC-222ba | CHCl2CClFCCl2F | 146254-26-4 | 0.204 | 2 | 0.59 |
| HCFC-222bb | CHClFCClFCCl3 | 147728-30-1 | 0.193 | 2 | 0.86 |
| HCFC-222ca | CHCl2CF2CCl3 | 422-49-1 | 0.201 | 2 | 0.86 |
| HCFC-222da | CCl2FCHClCCl2F | 431-82-3 | 0.267 | 7 | 1.05 |
| HCFC-222db | CCl3CHClCClF2 | 431-80-1 | 0.251 | 3 | 0.49 |
| HCFC-222ea | CCl3CHFCCl2F | 146254-25-3 | 0.239 | 2 | 0.90 |
| HCFC-223aa | CHCl2CCl2CF3 | 422-35-5 | 0.194 | 3 | 0.20 |
| HCFC-223ab | CHClFCCl2CClF2 | 144909-54-6 | 0.274 | 7 | 0.57 |
| HCFC-223ac | CHF2CCl2CCl2F | 422-29-7 | 0.282 | 9 | 0.38 |
| HCFC-223ba | CHCl2CClFCClF2 | 422-41-3 | 0.251 | 5 | 0.4 |
| HCFC-223bb | CHClFCClFCCl2F | 145599-91-3 | 0.230 | 6 | 0.61 |
| HCFC-223bc | CHF2CClFCCl3 | 147728-32-3 | 0.242 | 3 | 0.51 |
| HCFC-223ca | CHCl2CF2CCl2F | 422-52-6 | 0.230 | 2 | 0.76 |
| HCFC-223cb | CHClFCF2CCl3 | 422-50-4 | 0.235 | 1 | 0.98 |
| HCFC-223da | CCl2FCHClCClF2 | 431-83-4 | 0.301 | 6 | 0.48 |
| HCFC-223db | CCl3CHClCF3 | 431-81-2 | 0.229 | 1 | 0.25 |
| HCFC-223ea | CCl2FCHFCCl2F | – | 0.273 | 6 | 1.04 |
| HCFC-223eb | CCl3CHFCClF2 | 54002-59-4 | 0.254 | 2 | 0.63 |
| HCFC-224aa | CHClFCCl2CF3 | 139754-75-9 | 0.247 | 3 | 0.13 |
| HCFC-224ab | CHF2CCl2CClF2 | 422-32-2 | 0.301 | 9 | 0.48 |
| HCFC-224ba | CHCl2CClFCF3 | 422-47-9 | 0.213 | 3 | 0.42 |
| HCFC-224bb | CHClFCClFCClF2 | 422-42-4 | 0.277 | 12 | 0.55 |
| HCFC-224bc | CHF2CClFCCl2F | 139754-76-0 | 0.305 | 9 | 0.44 |
| HCFC-224ca | CHCl2CF2CClF2 | 422-54-8 | 0.259 | 5 | 0.47 |
| HCFC-224cb | CHClFCF2CCl2F | 422-53-7 | 0.244 | 5 | 0.79 |
| HCFC-224cc | CHF2CF2CCl3 | 422-51-5 | 0.310 | 3 | 0.80 |
| HCFC-224da | CClF2CHClCClF2 | 431-85-6 | 0.344 | 8 | 0.40 |
| HCFC-224db | CCl2FCHClCF3 | 431-84-5 | 0.284 | 3 | 0.30 |
| HCFC-224ea | CCl2FCHFCClF2 | 53063-53-9 | 0.308 | 5 | 0.72 |
| HCFC-224eb | CCl3CHFCF3 | 53063-52-8 | 0.234 | 1 | 0.77 |
| HCFC-225aa | CHF2CCl2CF3 | 128903-21-9 | 0.268 | 3 | 0.30 |
| HCFC-225ba | CHClFCClFCF3 | 422-48-0 | 0.254 | 6 | 0.53 |
| HCFC-225bb | CHF2CClFCClF2 | 422-44-6 | 0.315 | 9 | 0.33 |
| HCFC-225ca c | CHCl2CF2CF3 | 422-56-0 | 0.220 | 3 | 0.24 |
| HCFC-225cb c | CHClFCF2CClF2 | 507-55-1 | 0.294 | 5 | 0.51 |
| HCFC-225cc | CHF2CF2CCl2F | 13474-88-9 | 0.342 | 9 | 0.57 |
| HCFC-225da | CClF2CHClCF3 | 431-86-7 | 0.303 | 3 | 0.28 |
| HCFC-225ea | CClF2CHFCClF2 | 136013-79-1 | 0.339 | 7 | 0.38 |
| HCFC-225eb | CCl2FCHFCF3 | 51346-64-6 | 0.288 | 3 | 0.64 |
| HCFC-226ba  | CHF2CClFCF3 | 422-57-1 | 0.270 | 3 | 0.39 |
| HCFC-226ca | CHClFCF2CF3 | 422-55-9 | 0.260 | 3 | 0.60 |
| HCFC-226cb | CHF2CF2CClF2 | 431-87-8 | 0.342 | 9 | 0.37 |
| HCFC-226da | CF3CHClCF3 | 359-58-0 | 0.274 | 1 | 0.60 |
| HCFC-226ea | CClF2CHFCF3 | 51346-64-6 | 0.309 | 3 | 0.42 |
| HCFC-231aa | CHCl2CCl2CHClF | – | 0.122 | 3 | 0.73 |
| HCFC-231ab | CH2ClCCl2CCl2F | 1538604-29-3 | 0.173 | 7 | 0.93 |
| HCFC-231ac | CH2FCCl2CCl3 | – | 0.148 | 3 | 0.81 |
| HCFC-231ba | CHCl2CClFCHCl2 | – | 0.110 | 2 | 1.08 |
| HCFC-231bb | CH2ClCClFCCl3 | 421-94-3 | 0.156 | 1 | 1.14 |
| HCFC-231da | CHCl2CHClCCl2F | 1538604-31-7 | 0.130 | 3 | 0.92 |
| HCFC-231db | CHClFCHClCCl3 | 1943659-45-7 | 0.136 | 2 | 1.28 |
| HCFC-231ea | CHCl2CHFCCl3 | – | 0.127 | 2 | 1.55 |
| HCFC-231fa | CCl2FCH2CCl3 | 313696-58-1 | 0.193 | 3 | 1.22 |
| HCFC-232aa | CHClFCCl2CHClF | – | 0.170 | 9 | 0.85 |
| HCFC-232ab | CHCl2CCl2CHF2 | 872817-81-7 | 0.140 | 6 | 0.46 |
| HCFC-232ac | CH2ClCCl2CClF2 | 1538604-30-6 | 0.216 | 7 | 0.64 |
| HCFC-232ad | CH2FCCl2CCl2F | – | 0.206 | 9 | 0.73 |
| HCFC-232ba | CHCl2CClFCHClF | – | 0.157 | 8 | 1.02 |
| HCFC-232bb | CH2ClCClFCCl2F | 1943659-44-6 | 0.215 | 5 | 0.70 |
| HCFC-232bc | CH2FCClFCCl3 | – | 0.197 | 3 | 1.12 |
| HCFC-232ca | CHCl2CF2CHCl2 | 1112-14-7 | 0.125 | 2 | 1.11 |
| HCFC-232cb | CH2ClCF2CCl3 | 677-54-3 | 0.204 | 1 | 0.67 |
| HCFC-232da | CHCl2CHClCClF2 | 67879-59-8 | 0.172 | 5 | 0.62 |
| HCFC-232db | CHClFCHClCCl2F | 1943659-46-8 | 0.193 | 9 | 1.22 |
| HCFC-232dc | CHF2CHClCCl3 | – | 0.179 | 3 | 1.44 |
| HCFC-232ea | CHCl2CHFCCl2F | – | 0.159 | 3 | 2.28 |
| HCFC-232eb | CHClFCHFCCl3 | – | 0.176 | 2 | 2.87 |
| HCFC-232fa | CCl2FCH2CCl2F | 313696-57-0 | 0.256 | 4 | 1.43 |
| HCFC-232fb | CCl3CH2CClF2 | 460-89-9 | 0.236 | 1 | 0.64 |
| HCFC-233aa | CHClFCCl2CHF2 | – | 0.182 | 6 | 0.68 |
| HCFC-233ab | CH2ClCCl2CF3 | 7125-83-9 | 0.192 | 3 | 0.36 |
| HCFC-233ac | CH2FCCl2CClF2 | – | 0.250 | 9 | 0.70 |
| HCFC-233ba | CHClFCClFCHClF | – | 0.198 | 11 | 0.92 |
| HCFC-233bb | CHCl2CClFCHF2 | 13058-99-6 | 0.168 | 6 | 0.75 |
| HCFC-233bc | CH2ClCClFCClF2 | 421-95-4 | 0.254 | 7 | 0.59 |
| HCFC-233bd | CH2FCClFCCl2F | – | 0.251 | 9 | 0.85 |
| HCFC-233ca | CHCl2CF2CHClF | 131221-36-8 | 0.170 | 4 | 1.05 |
| HCFC-233cb | CH2ClCF2CCl2F | 421-99-8 | 0.246 | 5 | 0.52 |
| HCFC-233cc | CH2FCF2CCl3 | 131211-71-7 | 0.242 | 3 | 1.29 |
| HCFC-233da | CHCl2CHClCF3 | 431-51-6 | 0.142 | 3 | 0.44 |
| HCFC-233db | CHClFCHClCClF2 | 1943659-38-8 | 0.232 | 12 | 0.95 |
| HCFC-233dc | CHF2CHClCCl2F | – | 0.239 | 9 | 1.42 |
| HCFC-233ea | CHCl2CHFCClF2 | – | 0.177 | 5 | 1.68 |
| HCFC-233eb | CHClFCHFCCl2F | 54377-32-1 | 0.215 | 8 | 2.69 |
| HCFC-233ec | CHF2CHFCCl3 | 54306-56-8 | 0.230 | 3 | 3.21 |
| HCFC-233fa | CCl2FCH2CClF2 | 333-26-6 | 0.316 | 5 | 0.81 |
| HCFC-233fb | CCl3CH2CF3 | 7125-84-0 | 0.204 | 1 | 0.36 |
| HCFC-234aa | CHF2CCl2CHF2 | 17705-30-5 | 0.198 | 5 | 0.62 |
| HCFC-234ab | CH2FCCl2CF3 | 149329-24-8 | 0.215 | 3 | 0.46 |
| HCFC-234ba | CHClFCClFCHF2 | 425-94-5 | 0.212 | 14 | 0.83 |
| HCFC-234bb | CH2ClCClFCF3 | 149329-25-9 | 0.216 | 3 | 0.71 |
| HCFC-234bc | CH2FCClFCClF2 | 149329-26-0 | 0.275 | 9 | 0.66 |
| HCFC-234ca | CHClFCF2CHClF | 70341-81-0 | 0.202 | 7 | 0.76 |
| HCFC-234cb | CHCl2CF2CHF2 | 4071-01-6 | 0.196 | 6 | 0.66 |
| HCFC-234cc | CH2ClCF2CClF2 | 422-00-5 | 0.265 | 7 | 0.45 |
| HCFC-234cd | CH2FCF2CCl2F | 70192-63-1 | 0.278 | 9 | 0.92 |
| HCFC-234da | CHClFCHClCF3 | 146916-90-7 | 0.204 | 6 | 0.96 |
| HCFC-234db | CHF2CHClCClF2 | 1945188-10-2 | 0.268 | 9 | 0.90 |
| HCFC-234ea | CHCl2CHFCF3 | 53063-54-0 | 0.160 | 3 | 1.37 |
| HCFC-234eb | CHClFCHFCClF2 | 139754-77-1 | 0.236 | 12 | 2.31 |
| HCFC-234ec | CHF2CHFCCl2F | – | 0.272 | 8 | 2.84 |
| HCFC-234fa | CClF2CH2CClF2 | 76140-39-1 | 0.346 | 5 | 0.39 |
| HCFC-234fb | CCl2FCH2CF3 | 64712-27-2 | 0.267 | 3 | 0.56 |
| HCFC-235ba | CHF2CClFCHF2 | 144429-90-3 | 0.223 | 8 | 0.99 |
| HCFC-235bb | CH2FCClFCF3 | 230956-35-1 | 0.239 | 3 | 0.74 |
| HCFC-235ca | CH2ClCF2CF3 | 28103-66-4 | 0.212 | 3 | 0.45 |
| HCFC-235cb | CHClFCF2CHF2 | 422-02-6 | 0.2331 | 7 | 0.80 |
| HCFC-235cc | CH2FCF2CClF2 | 679-99-2 | 0.279 | 9 | 0.62 |
| HCFC-235da | CHF2CHClCF3 | 134251-06-2 | 0.230 | 3 | 1.19 |
| HCFC-235ea | CHClFCHFCF3 | 134251-06-2 | 0.229 | 6 | 1.75 |
| HCFC-235eb | CHF2CHFCClF2 | 162102-07-0 | 0.272 | 9 | 2.33 |
| HCFC-235fa | CClF2CH2CF3 | 677-55-4 | 0.302 | 3 | 0.34 |
| HCFC-241aa | CH2ClCCl2CHClF | – | 0.111 | 4 | 1.37 |
| HCFC-241ab | CH2FCCl2CHCl2 | – | 0.0902 | 5 | 1.15 |
| HCFC-241ac | CH3CCl2CCl2F | 7126 - 06 - 9 | 0.186 | 3 | 1.25 |
| HCFC-241ba | CH2ClCClFCHCl2 | 3175-26-6 | 0.118 | 3 | 1.15 |
| HCFC-241bb | CH3CClFCCl3 | 3175-25-5 | 0.186 | 1 | 1.10 |
| HCFC-241da | CHCl2CHClCHClF | 21981-25-9 | 0.0952 | 8 | 3.09 |
| HCFC-241db | CH2ClCHClCCl2F | 666-27-3 | 0.114 | 5 | 1.85 |
| HCFC-241dc | CH2FCHClCCl3 | 84816-05-7 | 0.110 | 3 | 3.29 |
| HCFC-241ea | CHCl2CHFCHCl2 | – | 0.0778 | 2 | 4.02 |
| HCFC-241eb | CH2ClCHFCCl3 | – | 0.119 | 1 | 1.49 |
| HCFC-241fa | CHCl2CH2CCl2F | 175897-94-6 | 0.107 | 2 | 3.46 |
| HCFC-241fb | CHClFCH2CCl3 | 23153-22-2 | 0.1417 | 1 | 1.38 |
| HCFC-242aa | CHF2CCl2CH2Cl | – | 0.128 | 5 | 1.21 |
| HCFC-242ab | CH2FCCl2CHClF | – | 0.127 | 5 | 1.71 |
| HCFC-242ac | CH3CCl2CClF2 | 7126 - 05 - 8 | 0.224 | 3 | 0.73 |
| HCFC-242ba | CHClFCClFCH2Cl | 7164-14-9 | 0.148 | 8 | 0.96 |
| HCFC-242bb | CHCl2CClFCH2F | – | 0.130 | 5 | 1.64 |
| HCFC-242bc | CH3CClFCCl2F | 7126 - 04- 7 | 0.239 | 3 | 0.71 |
| HCFC-242ca | CHCl2CF2CH2Cl | – | 0.140 | 5 | 0.96 |
| HCFC-242cb | CH3CF2CCl3 | 1112-05-6 | 0.248 | 1 | 0.55 |
| HCFC-242da | CHClFCHClCHClF | – | 0.141 | 10 | 2.55 |
| HCFC-242db | CHCl2CHClCHF2 | 1980063-50-0 | 0.116 | 6 | 3.07 |
| HCFC-242dc | CH2ClCHClCClF2 | 431-24-3 | 0.165 | 7 | 1.44 |
| HCFC-242dd | CH2FCHClCCl2F | – | 0.154 | 9 | 2.26 |
| HCFC-242ea | CHCl2CHFCHClF | 2106760-91-0 | 0.116 | 7 | 3.89 |
| HCFC-242eb | CH2ClCHFCCl2F | – | 0.161 | 5 | 1.82 |
| HCFC-242ec | CH2FCHFCCl3 | – | 0.169 | 3 | 2.30 |
| HCFC-242fa | CHCl2CH2CClF2 | 460-63-9 | 0.147 | 4 | 2.07 |
| HCFC-242fb | CHClFCH2CCl2F | 175897-95-7 | 0.195 | 4 | 1.49 |
| HCFC-242fc | CHF2CH2CCl3 | 213248-60-3 | 0.191 | 2 | 0.70 |
| HCFC-243aa | CHF2CCl2CH2F | 155329-34-3 | 0.151 | 7 | 1.81 |
| HCFC-243ab | CH3CCl2CF3 | 7126 - 01 - 4 | 0.204 | 1 | 0.39 |
| HCFC-243ba | CHF2CClFCH2Cl | – | 0.145 | 4 | 1.37 |
| HCFC-243bb | CHFClCClFCH2F | 1379241-46-9 | 0.156 | 8 | 1.63 |
| HCFC-243bc | CH3CClFCF2Cl | 7126-00-3 | 0.260 | 3 | 0.56 |
| HCFC-243ca | CH2ClCF2CHClF | 67406-68-2 | 0.180 | 6 | 1.06 |
| HCFC-243cb | CHCl2CF2CH2F | 70192-70-0 | 0.145 | 5 | 1.60 |
| HCFC-243cc | CH3CF2CFCl2 | 7125-99-7 | 0.285 | 3 | 0.47 |
| HCFC-243da | CHF2CHClCHFCl | 338-75-0 | 0.159 | 11 | 2.42 |
| HCFC-243db | CH2ClCHClCF3 | 338-75-0 | 0.139 | 3 | 1.52 |
| HCFC-243dc | CH2FCHClCF2Cl | 199171-49-8 | 0.199 | 9 | 1.28 |
| HCFC-243ea | CHFClCHFCHFCl | 151771-08-3 | 0.168 | 8 | 3.61 |
| HCFC-243eb | CHCl2CHFCHF2 | 1081835-90-6 | 0.139 | 5 | 4.10 |
| HCFC-243ec | CH2ClCHFCF2Cl | 149329-27-1 | 0.176 | 7 | 1.27 |
| HCFC-243ed | CH2FCHFCFCl2 | – | 0.209 | 9 | 1.97 |
| HCFC-243fa | CHCl2CH2CF3 | 460-69-5 | 0.122 | 2 | 1.34 |
| HCFC-243fb | CHFClCH2CF2Cl | 139754-78-2 | 0.228 | 5 | 0.98 |
| HCFC-243fc | CHF2CH2CFCl2 | 213248-61-4 | 0.259 | 8 | 0.84 |
| HCFC-244ba | CH2FCClFCHF2 | 149329-28-2 | 0.169 | 5 | 1.89 |
| HCFC-244bb | CH3CClFCF3 | 421-73-8 | 0.241 | 1 | 0.62 |
| HCFC-244ca | CH2ClCF2CHF2 | 679-85-6 | 0.172 | 7 | 1.08 |
| HCFC-244cb | CH2FCF2CHFCl | 67406-66-0 | 0.177 | 5 | 1.43 |
| HCFC-244cc | CH3CF2CF2Cl | 421-75-0 | 0.274 | 3 | 0.44 |
| HCFC-244da | CHF2CHClCHF2 | 19041-02-2 | 0.182 | 8 | 1.26 |
| HCFC-244db | CH2FCHClCF3 | 117970-90-8 | 0.164 | 3 | 1.69 |
| HCFC-244ea | CHF2CHFCHFCl | 149447-91-6 | 0.190 | 12 | 2.81 |
| HCFC-244eb | CH2ClCHFCF3 | 151771-09-4 | 0.152 | 3 | 1.33 |
| HCFC-244ec | CH2FCHFCF2Cl | 149448-09-9 | 0.223 | 9 | 1.51 |
| HCFC-244fa | CHFClCH2CF3 | 149329-29-3 | 0.187 | 2 | 0.89 |
| HCFC-244fb | CHF2CH2CF2Cl | 2730-64-5 | 0.284 | 9 | 0.55 |
| HCFC-251aa | CH2FCCl2CH2Cl | 70192-89-1 | 0.0711 | 6 | 5.26 |
| HCFC-251ab | CH3CCl2CHFCl | – | 0.106 | 3 | 2.46 |
| HCFC-251ba | CH2ClCClFCH2Cl | 7126-16-1 | 0.0927 | 4 | 3.70 |
| HCFC-251bb | CH3CClFCHCl2 | 3175-24-4 | 0.107 | 3 | 1.85 |
| HCFC-251da | CH2ClCHClCHFCl | 339202-89-0 | 0.0790 | 9 | 3.09 |
| HCFC-251db | CH2FCHClCHCl2 | – | 0.0598 | 7 | 4.27 |
| HCFC-251dc | CH3CHClCFCl2 | 421-41-0 | 0.118 | 3 | 1.39 |
| HCFC-251ea | CH2ClCHFCHCl2 | 76937-36-5 | 0.0744 | 5 | 3.69 |
| HCFC-251eb | CH3CHFCCl3 | 1448144-70-4 | 0.130 | 1 | 1.55 |
| HCFC-251fa | CHClFCH2CCl2H | 2106760-90-9 | 0.0710 | 3 | 3.12 |
| HCFC-251fb | CH2ClCH2CCl2F | 818-99-5 | 0.101 | 5 | 2.15 |
| HCFC-251fc | CH2FCH2CCl3 | 2035078-31-8 | 0.0985 | 3 | 2.62 |
| HCFC-252aa | CH2FCCl2CH2F | 154193-88-1 | 0.0978 | 3 | 6.19 |
| HCFC-252ab | CH3CCl2CHF2 | – | 0.149 | 3 | 2.23 |
| HCFC-252ba | CH2ClCClFCH2F | 70192-74-4 | 0.0960 | 4 | 4.74 |
| HCFC-252bb | CH3CClFCHClF | 362631-58-1 | 0.145 | 5 | 2.46 |
| HCFC-252ca | CH2ClCF2CH2Cl | 1112-36-3 | 0.123 | 6 | 1.46 |
| HCFC-252cb | CH3CF2CHCl2 | 1112-01-2 | 0.145 | 3 | 1.41 |
| HCFC-252da | CH2ClCHClCHF2 | 82578-00-5 | 0.0883 | 6 | 3.25 |
| HCFC-252db | CH2FCHClCHClF | – | 0.0974 | 13 | 3.73 |
| HCFC-252dc | CH3CHClCClF2 | 7126-15-0 | 0.146 | 3 | 1.01 |
| HCFC-252ea | CH2ClCHFCHClF | 111483-26-2 | 0.109 | 12 | 1.01 |
| HCFC-252eb | CH2FCHFCHCl2 | – | 0.0895 | 6 | 3.47 |
| HCFC-252ec | CH3CHFCCl2F | 151771-10-7 | 0.171 | 3 | 2.10 |
| HCFC-252fa | CHClFCH2CHClF | 1378824-14-6 | 0.139 | 9 | 2.38 |
| HCFC-252fb | CHCl2CH2CHF2 | 131404-17-6 | 0.111 | 6 | 1.72 |
| HCFC-252fc | CH2ClCH2CClF2 | 819-00-1 | 0.148 | 7 | 1.68 |
| HCFC-252fd | CH2FCH2CCl2F | 121612-64-4 | 0.151 | 9 | 2.17 |
| HCFC-253ba | CH2FCClFCH2F | 151771-11-8 | 0.126 | 5 | 5.21 |
| HCFC-253bb | CH3CClFCHF2 | 69202-10-4 | 0.183 | 3 | 2.34 |
| HCFC-253ca | CH2ClCF2CH2F | 56758-54-4 | 0.134 | 6 | 2.15 |
| HCFC-253cb | CH3CF2CHClF | 70192-76-6 | 0.182 | 3 | 1.11 |
| HCFC-253da | CH2FCHClCHF2 | – | 0.115 | 8 | 2.81 |
| HCFC-253db | CH3CHClCF3 | 421-47-6 | 0.120 | 1 | 1.35 |
| HCFC-253ea | CH2ClCHFCHF2 | 121612-65-5 | 0.112 | 7 | 3.11 |
| HCFC-253eb | CH2FCHFCHClF | 151771-12-9 | 0.123 | 11 | 3.20 |
| HCFC-253ec | CH3CHFCClF2 | 134251-05-1 | 0.180 | 3 | 1.08 |
| HCFC-253fa | CHClFCH2CHF2 | 149329-30-6 | 0.172 | 7 | 1.25 |
| HCFC-253fb | CH2ClCH2CF3 | 460-35-5 | 0.123 | 3 | 1.13 |
| HCFC-253fc | CH2FCH2CClF2 | 83124-56-5 | 0.192 | 9 | 2.50 |
| HCFC-261aa | CH3CCl2CH2F | – | 0.0687 | 3 | 3.99 |
| HCFC-261ba | CH3CClFCH2Cl | 420-97-3 | 0.0808 | 2 | 4.52 |
| HCFC-261da | CH2ClCHClCH2F | 453-01-0 | 0.0319 | 4 | 4.34 |
| HCFC-261db | CH3CHClCHClF | 7799-55-5 | 0.0600 | 5 | 2.10 |
| HCFC-261ea | CH2ClCHFCH2Cl | 816-38-6 | 0.0464 | 7 | 5.00 |
| HCFC-261eb | CH3CHFCHCl2 | 53074-31-0 | 0.0599 | 3 | 3.03 |
| HCFC-261fa | CH2ClCH2CHClF | 83124-60-1 | 0.0726 | 5 | 3.69 |
| HCFC-261fb | CH2FCH2CHCl2 | 53074-30-9 | 0.0534 | 5 | 1.59 |
| HCFC-261fc | CH3CH2CCl2F | 7799-56-6 | 0.134 | 3 | 1.48 |
| HCFC-262ba | CH3CClFCH2F | 362631-59-2 | 0.122 | 3 | 2.98 |
| HCFC-262ca | CH3CF2CH2Cl | 420-99-5 | 0.116 | 3 | 0.75 |
| HCFC-262da | CH2FCHClCH2F | 102738-79-4 | 0.0538 | 7 | 3.94 |
| HCFC-262db | CH3CHClCHF2 | 430-93-3 | 0.0788 | 3 | 2.52 |
| HCFC-262ea | CH2FCHFCH2Cl | 37161-81-2 | 0.0639 | 7 | 4.14 |
| HCFC-262eb | CH3CHFCHFCl | 430-96-6 | 0.0958 | 6 | 2.99 |
| HCFC-262fa | CH2ClCH2CHF2 | 83124-57-6 | 0.0851 | 7 | 2.57 |
| HCFC-262fb | CH2FCH2CHFCl | 151771-13-0 | 0.0960 | 7 | 3.26 |
| HCFC-262fc | CH3CH2CF2Cl | 421-02-3 | 0.165 | 3 | 1.51 |
| HCFC-271ba | CH3CClFCH3 | 420-44-0 | 0.104 | 1 | 3.20 |
| HCFC-271da | CH3CHClCH2F | 20372-78-5 | 0.0237 | 3 | 3.97 |
| HCFC-271ea | CH3CHFCH2Cl | 430-46-6 | 0.0320 | 3 | 4.98 |
| HCFC-271fa | CH2ClCH2CH2F | 462-38-4 | 0.0272 | 7 | 2.62 |
| HCFC-271fb | CH3CH2CHClF | 430-55-7 | 0.0633 | 3 | 1.87 |

a Adjusted RE value reported in WMO (2022) Annex [2]; b Number of conformers calculated to be within 3 kcal mol-1 of the lowest-energy conformer; c Molecules included in Montreal Protocol.

**Table S2**. Summary of the low-frequency (<500 cm-1) contribution to radiative efficiency (RE) for the Hydrofluorocarbons included in the WMO (2022) ozone assessment Annex [2].

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Hydrofluorocarbon | Chemical Formula | CAS-RN | Adjusted RE(W m-2 ppb-1) a | Number of Conformers b | Low-frequency Contribution to RE(%) |
| HFC-23 c | CHF3 | 75-46-7 | 0.192 | d | 0 |
| HFC-32 c | CH2F2 | 75-10-5 | 0.111 | d | 0 |
| HFC-41 c | CH3F | 593-53-3 | 0.025 | d | 0 |
| HFC-125 c | CHF2CF3 | 354-33-6 | 0.234 | d | 0.17 |
| HFC-134 c | CHF2CHF2 | 359-35-3 | 0.204 | d | 5.18 |
| HFC-134a c | CH2FCF3 | 811-97-2 | 0.167 | d | 0.30 |
| HFC-143 c | CH2FCHF2 | 430-66-0 | 0.129 | d | 1.21 |
| HFC-143a c | CH3CF3 | 420-46-2 | 0.169 | d | 0.11 |
| HFC-152 c | CH2FCH2F | 624-72-6 | 0.047 | d | 2.68 |
| HFC-152a c | CH3CHF2 | 75-37-6 | 0.101 | d | 0.06 |
| HFC-161 | CH3CH2F | 353-36-6 | 0.016 | d | 2.78 |
| HFC-227ca | CF3CF2CHF2 | 2252-84-8 | 0.265 | d | 0.47 |
| HFC-227ea c | CF3CHFCF3 | 431-89-0 | 0.273 | d | 0.19 |
| HFC-236ca | CHF2CF2CHF2 | 680-00-2 | 0.305 | d | 0.29 |
| HFC-236cb | CH2FCF2CF3 | 677-56-5 | 0.232 | d | 0.32 |
| HFC-236ea c | CHF2CHFCF3 | 431-63-0 | 0.267 | d | 0.41 |
| HFC-236fa c | CF3CH2CF3 | 690-39-1 | 0.263 | d | 4.82 |
| HFC-245ca c | CH2FCF2CHF2 | 679-86-7 | 0.266 | d | 11.52 |
| HFC-245cb | CF3CF2CH3 | 1814-88-6 | 0.249 | d | 1.54 |
| HFC-245ea | CHF2CHFCHF2 | 24270-66-4 | 0.172 | d | 7.43 |
| HFC-245eb | CH2FCHFCF3 | 431-31-2 | 0.215 | d | 5.04 |
| HFC-245fa c | CHF2CH2CF3 | 460-73-1 | 0.251 | d | 2.77 |
| HFC-254ca | CH2FCF2CH2F | 813-75-2 | 0.148 | d | 0.74 |
| HFC-254cb | CH3CF2CHF2 | 40723-63-5 | 0.205 | d | 0.66 |
| HFC-254ea | CH2FCHFCHF2 | 24270-68-6 | 0.168 | d | 0.63 |
| HFC-254eb | CH3CHFCF3 | 421-48-7 | 0.180 | d | 1.61 |
| HFC-254fa | CHF2CH2CHF2 | 66794-30-7 | 0.235 | d | 1.19 |
| HFC-254fb | CH2FCH2CF3 | 460-36-6 | 0.148 | d | 1.29 |
| HFC-263ca | CH3CF2CH2F | 811-94-9 | 0.138 | d | 1.94 |
| HFC-263ea | CH2FCHFCH2F | 66794-36-3 | 0.066 | d | 4.44 |
| HFC-263eb | CH3CHFCHF2 | 66794-35-2 | 0.114 | d | 3.52 |
| HFC-263fa | CH2FCH2CHF2 | 24270-67-5 | 0.118 | d | 1.39 |
| HFC-263fb | CH3CH2CF3 | 421-07-8 | 0.100 | d | 0.79 |
| HFC-272ca | CH3CF2CH3 | 420-45-1 | 0.085 | d | 6.57 |
| HFC-272ea | CH3CHFCH2F | 62126-90-3 | 0.054 | d | 3.07 |
| HFC-272fa | CH2FCH2CH2F | 462-39-5 | 0.036 | d | 1.03 |
| HFC-272fb | CH3CH2CHF2 | 430-61-5 | 0.069 | d | 1.66 |
| HFC-281ea | CH3CHFCH3 | 420-26-8 | 0.011 | d | 4.92 |
| HFC-281fa | CH3CH2CH2F | 460-13-9 | 0.016 | d | 3.21 |
| HFC-329p | CHF2CF2CF2CF3 | 375-17-7 | 0.325 | d | 3.94 |
| HFC-329me | CF3CHFCF2CF3 | 680-17-1 | 0.334 | d | 0.70 |
| HFC-338q | CH2FCF2CF2CF3 | 662-35-1 | 0.271 | d | 0.91 |
| HFC-338mce | CHF2CHFCF2CF3 | 119450-58-7 | 0.303 | d | 1.87 |
| HFC-338mec | CHF2CF2CHFCF3 | 35230-11-6 | 0.327 | d | 0.68 |
| HFC-338pcc | CHF2CF2CF2CHF2 | 377-36-6 | 0.328 | d | 9.24 |
| HFC-338mf | CF3CH2CF2CF3 | 2924-29-0 | 0.306 | d | 0.34 |
| HFC-338mee | CF3CHFCHFCF3 | 75995-72-1 | 0.351 | d | 0.40 |
| HFC-347mcc | CH3CF2CF2CF3 | 662-00-0 | 0.247 | d | 0.44 |
| HFC-347mce | CH2FCHFCF2CF3 | 75995-85-6 | 0.230 | d | 4.12 |
| HFC-347mec | CH2FCF2CHFCF3 | 53005-35-9 | 0.266 | d | 0.96 |
| HFC-347pcc | CH2FCF2CF2CHF2 | 119450-61-2 | 0.288 | d | 1.84 |
| HFC-347mcf | CHF2CH2CF2CF3 | 161791-36-2 | 0.323 | d | 2.69 |
| HFC-347mee | CHF2CHFCHFCF3 | 151868-61-0 | 0.303 | d | 0.29 |
| HFC-347pce | CHF2CHFCF2CHF2 | 119450-64-5 | 0.288 | d | 6.77 |
| HFC-347mfc | CHF2CF2CH2CF3 | 119450-65-6 | 0.311 | d | 0.41 |
| HFC-347mef | CF3CH2CHFCF3 | 86884-16-4 | 0.326 | d | 1.12 |
| HFC-356mce | CH3CHFCF2CF3 | 161791-32-8 | 0.196 | d | 2.99 |
| HFC-356mec | CH3CF2CHFCF3 | 76523-97-2 | 0.253 | d | 0.85 |
| HFC-356pcc | CH3CF2CF2CHF2 | 119450-66-7 | 0.264 | d | 3.84 |
| HFC-356mcf | CH2FCH2CF2CF3 | 161791-33-9 | 0.208 | d | 2.86 |
| HFC-356mee | CH2FCHFCHFCF3 | 119450-67-8 | 0.220 | d | 4.29 |
| HFC-356pce | CH2FCHFCF2CHF2 | 119450-68-9 | 0.218 | d | 4.53 |
| HFC-356mfc | CH2FCF2CH2CF3 | 76546-55-9 | 0.250 | d | 0.68 |
| HFC-356pec | CH2FCF2CHFCHF2 | 114810-03-6 | 0.226 | d | 5.17 |
| HFC-356mef | CHF2CH2CHFCF3 | 158421-88-6 | 0.265 | d | 2.44 |
| HFC-356mfe | CHF2CHFCH2CF3 | 76523-98-3 | 0.264 | d | 2.68 |
| HFC-356pcf | CHF2CH2CF2CHF2 | 119450-69-0 | 0.271 | d | 4.68 |
| HFC-356pee | CHF2CHFCHFCHF2 | 392-45-0 | 0.249 | d | 7.21 |
| HFC-356mff | CF3CH2CH2CF3 | 407-59-0 | 0.303 | d | 0.63 |
| HFC-356qcc | CH2FCF2CF2CH2F | 114810-02-5 | 0.237 | d | 5.80 |
| HFC-365mcf | CH3CH2CF2CF3 | 37826-35-0 | 0.187 | d | 0.70 |
| HFC-365mee | CH3CHFCHFCF3 | 161791-22-6 | 0.176 | d | 3.33 |
| HFC-365pce | CH3CHFCF2CHF2 | 158421-89-7 | 0.201 | d | 3.59 |
| HFC-365pec | CH3CF2CHFCHF2 | 119450-71-4 | 0.209 | d | 7.12 |
| HFC-365qcc | CH3CF2CF2CH2F | 119450-72-5 | 0.222 | d | 3.41 |
| HFC-365mfc c | CH3CF2CH2CF3 | 406-58-6 | 0.243 | d | 6.59 |
| HFC-365mef | CH2FCH2CHFCF3 | 161791-23-7 | 0.184 | d | 3.72 |
| HFC-365pcf | CH2FCH2CF2CHF2 | 161791-25-9 | 0.180 | d | 3.93 |
| HFC-365mfe | CH2FCHFCH2CF3 | 161791-24-8 | 0.165 | d | 2.35 |
| HFC-365qee | d CH2FCHFCHFCHF2 | 157016-17-6 | 0.173 | d | 8.20 |
| HFC-365pfc | CH2FCF2CH2CHF2 | 119450-76-9 | 0.207 | d | 5.11 |
| HFC-365qce | CH2FCF2CHFCH2F | 119450-75-8 | 0.162 | d | 5.57 |
| HFC-365mff | CHF2CH2CH2CF3 | 161879-85-2 | 0.246 | d | 2.86 |
| HFC-365pef | CHF2CH2CHFCHF2 | 119450-77-0 | 0.211 | d | 3.46 |
| HFC-374mef | CF3CHFCH2CH3 | 161791-15-7 | 0.136 | d | 1.46 |
| HFC-374mfe | CF3CH2CHFCH3 | 86884-13-1 | 0.125 | d | 3.03 |
| HFC-374mff | CF3CH2CH2CH2F | 83234-21-3 | 0.075 | d | 3.62 |
| HFC-374pcf | CHF2CF2CH2CH3 | 143969-51-1 | 0.132 | d | 1.01 |
| HFC-374pee | CHF2CHFCHFCH3 | 161791-16-8 | 0.122 | d | 4.31 |
| HFC-374pef | CHF2CHFCH2CH2F | 161791-17-9 | 0.135 | d | 4.15 |
| HFC-374pfc | CHF2CH2CF2CH3 | 625-09-2 | 0.177 | d | 4.59 |
| HFC-374pfe | CHF2CH2CHFCH2F | 161791-18-0 | 0.121 | d | 3.46 |
| HFC-374qce | CH2FCF2CHFCH3 | 161791-20-4 | 0.139 | d | 4.16 |
| HFC-374qec | CH2FCHFCF2CH3 | 161791-19-1 | 0.149 | d | 5.06 |
| HFC-374qcf | CH2FCF2CH2CH2F | 161791-21-5 | 0.131 | d | 4.41 |
| HFC-374qee | CH2FCHFCHFCH2F | 119382-47-7 | 0.114 | d | 7.06 |
| HFC-374scc | CH3CF2CF2CH3 | 421-74-9 | 0.215 | d | 2.93 |
| HFC-374pff | CHF2CH2CH2CHF2 | 161879-84-1 | 0.167 | d | 4.49 |
| HFC-383m | CH3CH2CH2CF3 | 460-34-4 | 0.064 | d | 0.66 |
| HFC-383pe | CHF2CHFCH2CH3 | 66675-41-0 | 0.088 | d | 2.17 |
| HFC-383pfe | CHF2CH2CHFCH3 | 66675-42-1 | 0.093 | d | 4.28 |
| HFC-383pff | CHF2CH2CH2CH2F | 66587-70-0 | 0.098 | d | 3.46 |
| HFC-383qcf | CH2FCF2CH2CH3 | 66587-71-1 | 0.106 | d | 1.31 |
| HFC-383qee | CH2FCHFCHFCH3 | 66587-72-2 | 0.064 | d | 6.25 |
| HFC-383qef | CH2FCHFCH2CH2F | 66587-73-3 | 0.069 | d | 5.19 |
| HFC-383qfc | CH2FCH2CF2CH3 | 66587-74-4 | 0.106 | d | 3.96 |
| HFC-383sce | CH3CF2CHFCH3 | 66587-75-5 | 0.116 | d | 4.19 |
| HFC-392pff | CH3CH2CH2CHF2 | 2358-38-5 | 0.034 | d | 0.59 |
| HFC-392qef | CH3CH2CHFCH2F | 686-65-7 | 0.037 | d | 3.35 |
| HFC-392qfe | CH3CHFCH2CH2F | 691-42-9 | 0.043 | d | 4.24 |
| HFC-392qff | CH2FCH2CH2CH2F | 372-90-7 | 0.026 | d | 3.78 |
| HFC-392scf | CH3CH2CF2CH3 | 353-81-1 | 0.080 | d | 0.99 |
| HFC-392see | CH3CHFCHFCH3 | 666-21-7 | 0.044 | d | 5.73 |
| HFC-3-10-1q | CH3CH2CH2CH2F | 2366-52-1 | 0.011 | d | 0.68 |
| HFC-3-10-1se | CH3CH2CHFCH3 | 359-01-3 | 0.013 | d | 4.37 |
| HFC-*b*-329my | CHF2CF(CF3)CF3 | 59571-40-3 | 0.311 | d | 0.68 |
| HFC-*b*-329mz | CF3CH(CF3)CF3 | 382-24-1 | 0.312 | d | 0.12 |
| HFC-*b*-338mz | CHF2CH(CF3)CF3 | 382-20-7 | 0.330 | d | 0.32 |
| HFC-*b*-338py | CHF2CF(CF3)CHF2 | 65781-21-7 | 0.319 | d | 4.79 |
| HFC-*b*-338mym | CH2FCF(CF3)CF3 | 65781-19-3 | 0.275 | d | 2.24 |
| HFC-*b*-347mym | CH3CF(CF3)CF3 | 662-00-0 | 0.300 | d | 0.68 |
| HFC-*b*-347mzm | CH2FCH(CF3)CF3 | 2794-16-3 | 0.271 | d | 1.73 |
| HFC-*b*-347myp | CH2FCF(CF3)CHF2 | 65781-22-8 | 0.269 | d | 1.25 |
| HFC-*b*-347mzp | CHF2CH(CF3)CHF2 | 65781-25-1 | 0.334 | d | 2.25 |
| HFC-*b*-347pyp | CHF2CF(CHF2)CHF2 | 65781-24-0 | 0.314 | d | 1.04 |
| HFC-*b*-356mzm | CH3CH(CF3)CF3 | 382-09-2 | 0.275 | d | 1.17 |
| HFC-*b*-356myp | CH3CF(CF3)CHF2 | 65781-20-6 | 0.301 | d | 2.23 |
| HFC-*b*-356mzp | CH2FCH(CF3)CHF2 | 32931-17-2 | 0.261 | d | 1.87 |
| HFC-*b*-356myq | CH2FCF(CF3)CH2F | 161791-34-0 | 0.248 | d | 2.65 |
| HFC-*b*-356pzp | CHF2CH(CHF2)CHF2 | 138507-15-0 | 0.301 | d | 1.47 |
| HFC-*b*-356pyp | CH2FCF(CHF2)CHF2 | 35274-04-5 | 0.263 | d | 1.27 |
| HFC-*b*-365mzp | CH3CH(CF3)CHF2 | 381-95-3 | 0.246 | d | 1.06 |
| HFC-*b*-365myq | CH3CF(CF3)CH2F | 119450-80-5 | 0.216 | d | 2.06 |
| HFC-*b*-365pyp | CH3CF(CHF2)CHF2 | 65781-23-9 | 0.259 | d | 0.93 |
| HFC-*b*-365mzq | CH2FCH(CF3)CH2F | 161791-30-6 | 0.144 | d | 2.42 |
| HFC-*b*-365pzp | CH2FCH(CHF2)CHF2 | 32864-57-6 | 0.238 | d | 3.27 |
| HFC-*b*-365pyq | CHF2CF(CH2F)CH2F | 65781-27-3 | 0.187 | d | 0.61 |
| HFC-*b*-374my | CF3CF(CH3)CH3 | 154381-59-6 | 0.209 | d | 1.60 |
| HFC-*b*-374mz | CF3CH(CH3)CFH2 | 161791-27-1 | 0.144 | d | 1.57 |
| HFC-*b*-374py | CHF2CF(CH3)CH2F | 65781-26-2 | 0.167 | d | 2.23 |
| HFC-*b*-374pzp | CHF2CH(CH3)CHF2 | 161791-28-2 | 0.186 | d | 3.27 |
| HFC-*b*-374qyq | CH2FCF(CH2F)CH2F | 65781-28-4 | 0.140 | d | 3.96 |
| HFC-*b*-374pzq | CHF2CH(CH2F)CH2F | 161791-29-3 | 0.145 | d | 1.93 |
| HFC-*b*-383mz | CF3CH(CH3)CH3 | 1550-49-8 | 0.136 | d | 1.01 |
| HFC-*b*-383py | CHF2CF(CH3)CH3 | 66587-76-6 | 0.146 | d | 2.54 |
| HFC-*b*-383pz | CHF2CH(CH3)CH2F | 66587-77-7 | 0.095 | d | 2.57 |
| HFC-*b*-383qy | CH2FCF(CH3)CH2F | 161791-26-0 | 0.109 | d | 2.59 |
| HFC-*b*-383qzq | CH2FCH(CH2F)CH2F | 66675-40-9 | 0.079 | d | 2.50 |
| HFC-*b*-392qy | CH2FCF(CH3)CH3 | 62126-92-5 | 0.072 | d | 3.27 |
| HFC-*b*-392qz | CH2FCH(CH3)CH2F | 62126-93-6 | 0.038 | d | 2.34 |
| HFC-*b*-392pz | CHF2CH(CH3)CH3 | 62126-91-4 | 0.069 | d | 3.32 |
| HFC-*b*-3-10-1q | CH2FCH(CH3)CH3 | 359-00-2 | 0.009 | d | 6.12 |
| HFC-*b*-3-10-1sy | CH3CF(CH3)CH3 | 353-61-7 | 0.039 | d | 6.63 |
| HFC-43-10mee c | CF3CHFCHFCF2CF3 | 138495‐42‐8 | 0.359 | 4 | 0.49 |
| HFC-458mfcf | CF3CH2CF2CH2CF3 | – | 0.508 | 3 | 0.45 |
| 1,1,2,2,3,3,4-heptafluorocyclopentane | *cyclo*-CF2CF2CF2CHFCH2- | 15290‐77‐4 | 0.253 | 1 | 2.14 |
| *trans*-1H,2H-octafluorocyclopentane | *trans*- *cyclo*-CF2CF2CF2CHFCHF- | 158389‐18‐5 | 0.266 | 1 | 2.26 |
| 1-Fluorohexane | *n*-C6H13F | 373‐14‐8 | 0.041 | 36 | 2.48 |
| Fluorobenzene  | C6H5F | 462‐06‐6 | 0.012 | 1 | 0.56 |
| HFC-55-10mcff | CF3CF2CH2CH2CF2CF3 | – | 0.557 | 3 | 0.72 |
| HFC-52-13p | CHF2CF2CF2CF2CF2CF3 | 355-37-3 | 0.582 | 22 | 0.50 |
| 1,1,2,2,3,3-hexafluorocyclopentane | *cyclo*-CF2CF2CF2CH2CH2- | 123768‐18‐3 | 0.210 | 1 | 1.60 |
| HFC-72-17p | CHF2CF2CF2CF2CF2CF2CF2CF3 | – | 0.746 | 29 | 0.64 |

a Adjusted RE value reported in WMO (2022) Annex [2]; b Number of conformers calculated to be within 3 kcal mol-1 of the lowest-energy conformer; c Molecules included in Annex F of the Kigali Amendment; d Lowest energy conformer

**References:**

[1] S.W. Sharpe, T.J. Johnson, R L. Sams, P.M. Chu, G.C. Rhoderick, and P.A. Johnson, *Appl. Spectrosc.* **58**, 1452 (2004), doi:10.1366/0003702042641281.

[2] Burkholder, J.B. and Ø. Hodenbrog (Lead Authors), B.C. McDonald, V. Orkin, V.C. Papadimitriou, D. Van Hoomissen, Summary of Abundances, Lifetimes, ODPs, REs, GWPs, and GTPs, Annex in Scientific Assessment of Ozone Depletion 2022, GAW Report No. 278, 509 pp., WMO, Geneva, 2022.