# CHAPTER 3 – SUPPLEMENT 5

## Evaluation of Atmospheric Loss Processes: 2-D Modeling Supplement

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This supplement provides a summary of the gas-phase atmospheric loss processes and uncertainties obtained from the steady-state 2-D model simulations for year 2000 conditions that are presented in Chapter 3. A summary is provided for each molecule where the left-hand panels contain model results obtained using the JPL10-6 kinetic and photochemical recommendations and uncertainties (where available) and the right-hand panels contain results obtained using the recommendations given in the SPARC Lifetimes report. For each molecule, the baseline global lifetime and range in lifetime computed using the parameters and uncertainties, taken from Table 3.7 in Chapter 3, also are provided.

The top pair of panels present the global annually averaged model calculated total first-order loss coefficients as a function of altitude ($Z$), $k'(Z)$, for molecule X as well as the contributions from the individual loss process (reactive and photolytic)

$$k'(Z) = \left(k_{OH}(T)[OH]_Z + k_O(T)[O(^1D)]_Z + k_{Cl}(T)[Cl]_Z\right) + \int \sigma(\lambda,T)\ \Phi\ F(\lambda,Z,\chi)\ d\lambda$$

where $k_{OH}$, $k_O$, and $k_{Cl}$, are the temperature-dependent bimolecular rate coefficients, $[OH]_Z$, $[O(^1D)]_Z$, and $[Cl]_Z$ are the atmospheric concentration profiles of OH, $O(^1D)$, and Cl, $\sigma(\lambda,T)$ is the absorption cross section of molecule X as a function of wavelength ($\lambda$) and temperature (T), $\Phi$ is the photolysis quantum yield (taken to be unity for all molecules in this assessment), and $F(\lambda,Z,\chi)$ is the solar flux that is a function of wavelength, altitude, and solar zenith angle ($\chi$). The photolytic loss term has been further sub-divided into contributions from Lyman-$\alpha$, (121.567 nm) and the wavelength ranges 169-190, 190-230, 230-286, and >286 nm in the graphs to more clearly identify the most critical wavelength ranges for each molecule. The local lifetime, $1/k'(Z)$, in years is given on the top axes. Overall the first-order losses from the JPL10-6 and SPARC recommendations are generally similar. One key difference is that Lyman-$\alpha$ cross sections were not included in JPL10-6 ($N_2O$ is the exception), but were evaluated in the present SPARC recommendations and included in the SPARC model calculations.

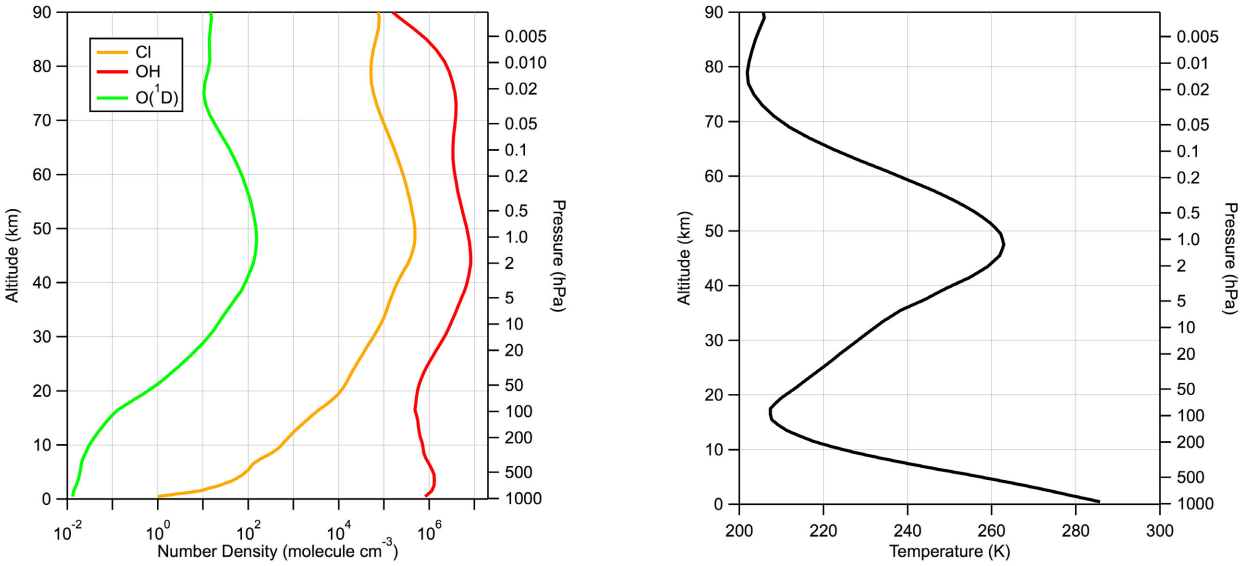
The middle pair of panels show the contributions of the uncertainty in the individual loss processes, as a function of altitude, to the total overall $2\sigma$ uncertainty in $k'(Z)$ from the baseline and slow/fast model calculations. The uncertainties are generally significantly reduced in the SPARC recommendations, as discussed in Chapter 3. In particular, uncertainties in the absorption cross-section data and its temperature dependence are quantitatively defined in the SPARC evaluation. For CFC-113, CFC-114, CFC-115, HCFCs, HFCs, $N_2O$, $CH_3Cl$, $NF_3$, and $CH_4$ Lyman-$\alpha$ photolysis is the primary loss process in the mesosphere, altitudes above ~60 km.

The bottom pair of panels show the molecular loss rate (in units of molecule $cm^{-3}$ $s^{-1}$), along with the molecules mixing ratio vertical profile. The solid (black) lines depict the baseline simulation, with the $2\sigma$ slow and $2\sigma$ fast uncertainty simulations shown by the dotted (green) and dashed (red) curves, respectively. The slow/fast limiting calculated loss rates include the ozone feedback effect, as the loss rates were allowed to interact with the model constituents, as discussed in Chapter 3. Including the ozone feedback, however, in general, has a small effect on the calculated globally averaged lifetimes, <5%.

The differences between the JPL10-6 and SPARC based calculations due primarily to differences in the estimated uncertainties in the model input parameters are readily apparent, with the overall uncertainty generally smaller when the SPARC recommendations are used for most, but not all,

molecules. One aspect of the molecular loss rate profiles is that for most of the molecules the 2σ slow and 2σ fast profiles tend to "cross-over" in the stratosphere, i.e., in the troposphere-lower stratosphere the molecular loss rates in the slow simulation are less than those of the fast simulation, with the opposite occurring in the upper stratosphere and above. The "cross-over" is due to the fact that the changes in the model input parameters alters the vertical concentration profiles, as shown in the mixing ratio figures, i.e., the 2σ slow calculation shifts the profile to higher altitude, while the 2σ fast calculation shifts the profile toward lower altitude. Cross-over behavior was not observed for molecules that have relatively weak losses such that the concentration profiles change very little between the slow and fast uncertainty simulations (e.g. CFC-115, HFC-134a, HFC-143a, HFC-23, HFC-125, and HFC-227ea).

The globally annually averaged vertical profiles for the Cl atom, OH radical, and O($^1$D) atom number densities from the 2-D model (see Chapter 3 text for details) as well as the temperature profile are given in the figures below.




Section 3.6 in Chapter 3 discusses the lifetime sensitivity to uncertainties in the $O_2$ and $O_3$ absorption cross sections. These cross sections are used in the APL radiative transfer code to compute the incident solar flux and $O_2$ photolysis for use in the 2-D model. The baseline $O_2$ and $O_3$ cross sections are given in the table and figure below.

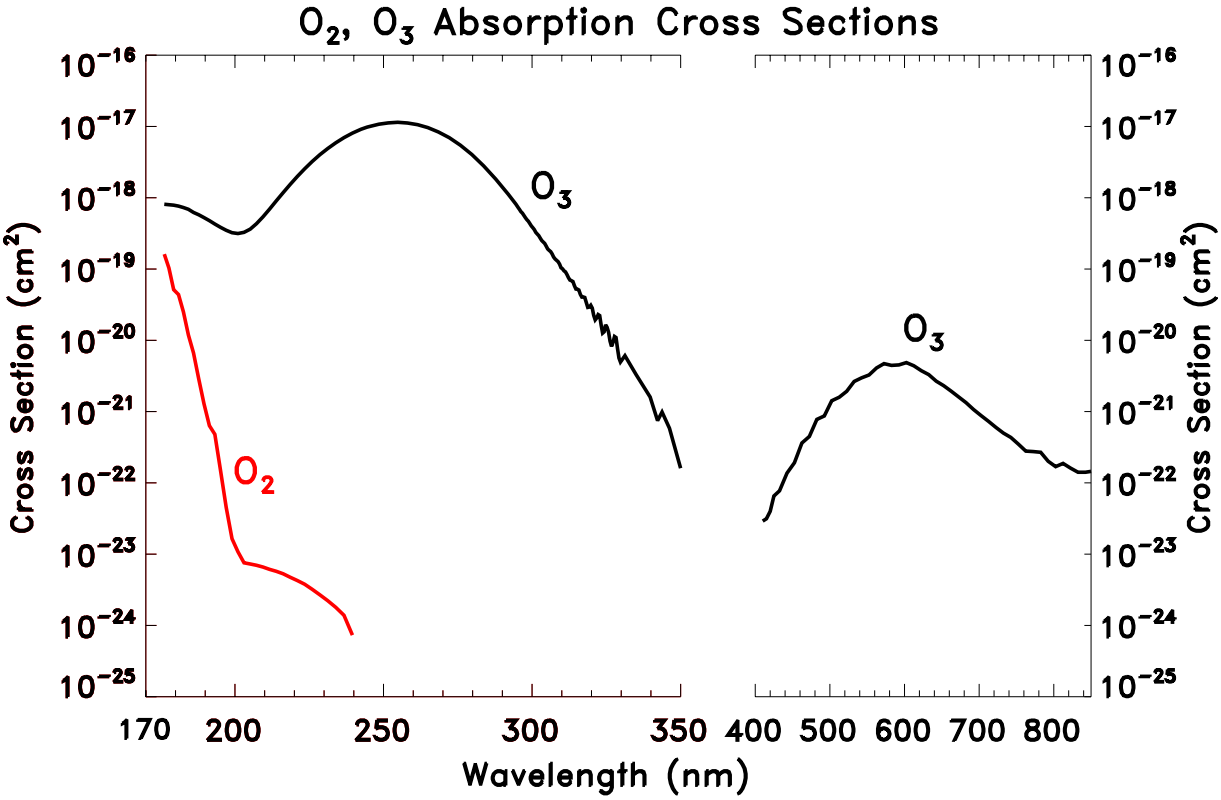
Wavelength ranges and $O_2$ and $O_3$ absorption cross sections (298 K) used in the APL radiative transfer code (see text for details).

| Bin | Wavelength Range (nm) | $O_2$ cross section $10^{-24}$ $cm^2$ | $O_3$ cross section $10^{-20}$ $cm^2$ |
|---|---|---|---|
| 1 | 175.439 - 176.991 | 161800 | 81.10 |
| 2 | 176.991 - 178.571 | 103100 | 79.90 |
| 3 | 178.571 - 180.180 | 51370 | 78.60 |
| 4 | 180.180 - 181.818 | 43840 | 76.30 |
| 5 | 181.818 - 183.486 | 25040 | 72.90 |
| 6 | 183.486 - 185.185 | 11860 | 68.80 |
| 7 | 185.185 - 186.916 | 6642 | 62.17 |
| 8 | 186.916 - 188.679 | 2880 | 57.67 |
| 9 | 188.679 - 190.476 | 1289 | 52.62 |
| 10 | 190.476 - 192.308 | 635.1 | 47.70 |
| 11 | 192.308 - 194.175 | 480.4 | 42.78 |
| 12 | 194.175 - 196.078 | 151.3 | 38.53 |
| 13 | 196.078 - 198.020 | 45.34 | 34.94 |
| 14 | 198.020 - 200.000 | 16.46 | 32.31 |
| 15 | 200.000 - 202.020 | 10.81 | 31.48 |
| 16 | 202.020 - 204.082 | 7.557 | 32.70 |
| 17 | 204.082 - 206.186 | 7.277 | 36.26 |
| 18 | 206.186 - 208.333 | 6.984 | 43.26 |
| 19 | 208.333 - 210.526 | 6.602 | 53.94 |
| 20 | 210.526 - 212.766 | 6.125 | 69.22 |
| 21 | 212.766 - 215.054 | 5.745 | 90.40 |
| 22 | 215.054 - 217.391 | 5.304 | 118.0 |
| 23 | 217.391 - 219.780 | 4.749 | 153.6 |
| 24 | 219.780 - 222.222 | 4.268 | 199.0 |
| 25 | 222.222 - 224.719 | 3.784 | 255.0 |
| 26 | 224.719 - 227.273 | 3.214 | 322.4 |
| 27 | 227.273 - 229.885 | 2.687 | 401.6 |
| 28 | 229.885 - 232.558 | 2.223 | 490.4 |
| 29 | 232.558 - 235.294 | 1.795 | 589.6 |
| 30 | 235.294 - 238.095 | 1.388 | 697.0 |
| 31 | 238.095 - 240.964 | 0.7318 | 807.1 |
| 32 | 240.964 - 243.902 | | 914.4 |
| 33 | 243.902 - 245.018 | | 978.4 |
| 34 | 245.018 - 246.914 | | 1016 |
| 35 | 246.914 - 250.000 | | 1076 |
| 36 | 250.000 - 253.165 | | 1122 |
| 37 | 253.165 - 256.410 | | 1144 |
| 38 | 256.410 - 259.740 | | 1119 |
| 39 | 259.740 - 263.158 | | 1059 |
| 40 | 263.158 - 266.667 | | 963.3 |
| 41 | 266.667 - 270.270 | | 836.4 |
| 42 | 270.270 - 273.973 | | 696.3 |
| 43 | 273.973 - 277.778 | | 545.4 |
| 44 | 277.778 - 281.690 | | 404.1 |
| 45 | 281.690 - 285.714 | | 279.7 |
| 46 | 285.714 - 289.855 | | 182.4 |
| 47 | 289.855 - 294.118 | | 111.9 |
| 48 | 294.118 - 295.000 | | 81.13 |
| 49 | 295.000 - 295.500 | | 73.59 |
| 50 | 295.500 - 296.000 | | 68.71 |

| Bin | Wavelength Range (nm) | $O_2$ cross section $10^{-24}$ $cm^2$ | $O_3$ cross section $10^{-20}$ $cm^2$ |
|---|---|---|---|
| 51 | 296.000 - 296.500 | | 63.76 |
| 52 | 296.500 - 297.000 | | 60.80 |
| 53 | 297.000 - 297.500 | | 56.51 |
| 54 | 297.500 - 298.000 | | 52.46 |
| 55 | 298.000 - 298.500 | | 49.24 |
| 56 | 298.500 - 299.000 | | 46.83 |
| 57 | 299.000 - 299.500 | | 43.39 |
| 58 | 299.500 - 300.000 | | 40.23 |
| 59 | 300.000 - 300.500 | | 38.03 |
| 60 | 300.500 - 301.000 | | 35.69 |
| 61 | 301.000 - 301.500 | | 32.72 |
| 62 | 301.500 - 302.000 | | 30.95 |
| 63 | 302.000 - 302.500 | | 29.38 |
| 64 | 302.500 - 303.000 | | 27.10 |
| 65 | 303.000 - 303.500 | | 25.10 |
| 66 | 303.500 - 304.000 | | 23.95 |
| 67 | 304.000 - 304.500 | | 22.87 |
| 68 | 304.500 - 305.000 | | 20.98 |
| 69 | 305.000 - 305.500 | | 19.14 |
| 70 | 305.500 - 306.000 | | 18.26 |
| 71 | 306.000 - 306.500 | | 17.57 |
| 72 | 306.500 - 307.000 | | 16.30 |
| 73 | 307.000 - 307.500 | | 14.74 |
| 74 | 307.500 - 308.000 | | 13.82 |
| 75 | 308.000 - 308.500 | | 13.25 |
| 76 | 308.500 - 309.000 | | 12.68 |
| 77 | 309.000 - 309.500 | | 11.71 |
| 78 | 309.500 - 310.000 | | 10.42 |
| 79 | 310.000 - 310.500 | | 10.06 |
| 80 | 310.500 - 311.000 | | 9.424 |
| 81 | 311.000 - 311.500 | | 9.104 |
| 82 | 311.500 - 312.000 | | 8.351 |
| 83 | 312.000 - 312.500 | | 7.566 |
| 84 | 312.500 - 313.000 | | 6.994 |
| 85 | 313.000 - 313.500 | | 6.860 |
| 86 | 313.500 - 314.000 | | 6.674 |
| 87 | 314.000 - 314.500 | | 5.832 |
| 88 | 314.500 - 315.000 | | 5.235 |
| 89 | 315.000 - 315.500 | | 5.209 |
| 90 | 315.500 - 316.000 | | 5.073 |
| 91 | 316.000 - 316.500 | | 4.403 |
| 92 | 316.500 - 317.000 | | 4.039 |
| 93 | 317.000 - 317.500 | | 4.048 |
| 94 | 317.500 - 318.000 | | 3.987 |
| 95 | 318.000 - 318.500 | | 3.392 |
| 96 | 318.500 - 319.000 | | 2.897 |
| 97 | 319.000 - 319.500 | | 2.926 |
| 98 | 319.500 - 320.000 | | 3.101 |
| 99 | 320.000 - 320.500 | | 2.827 |
| 100 | 320.500 - 321.000 | | 2.241 |
| 101 | 321.000 - 321.500 | | 1.934 |
| 102 | 321.500 - 322.000 | | 2.058 |
| 103 | 322.000 - 322.500 | | 2.295 |
| 104 | 322.500 - 323.000 | | 2.222 |
| 105 | 323.000 - 323.500 | | 1.624 |

| Bin | Wavelength Range (nm) | $O_2$ cross section $10^{-24}$ $cm^2$ | $O_3$ cross section $10^{-20}$ $cm^2$ |
|---|---|---|---|
| 106 | 323.500 - 324.000 | | 1.263 |
| 107 | 324.000 - 324.500 | | 1.317 |
| 108 | 324.500 - 325.000 | | 1.649 |
| 109 | 325.000 - 325.500 | | 1.520 |
| 110 | 325.500 - 326.000 | | 1.293 |
| 111 | 326.000 - 326.500 | | 0.974 |
| 112 | 326.500 - 327.000 | | 0.821 |
| 113 | 327.000 - 327.500 | | 0.941 |
| 114 | 327.500 - 328.000 | | 1.131 |
| 115 | 328.000 - 328.500 | | 1.094 |
| 116 | 328.500 - 329.000 | | 0.765 |
| 117 | 329.000 - 329.500 | | 0.5641 |
| 118 | 329.500 - 330.000 | | 0.4959 |
| 119 | 330.000 - 332.500 | | 0.6085 |
| 120 | 332.500 - 337.500 | | 0.3309 |
| 121 | 337.500 - 341.981 | | 0.1599 |
| 122 | 341.981 - 342.500 | | 0.07461 |
| 123 | 342.500 - 345.000 | | 0.09854 |
| 124 | 345.000 - 347.500 | | 0.05837 |
| 125 | 347.500 - 352.500 | | 0.01599 |
| 126 | 352.500 - 357.500 | | 0.0000 |
| 127 | 357.500 - 362.500 | | 0.0000 |
| 128 | 362.500 - 367.500 | | 0.0000 |
| 129 | 367.500 - 372.500 | | 0.0000 |
| 130 | 372.500 - 377.500 | | 0.0000 |
| 131 | 377.500 - 382.500 | | 0.0000 |
| 132 | 382.500 - 387.500 | | 0.0000 |
| 133 | 387.500 - 392.500 | | 0.0000 |
| 134 | 392.500 - 397.500 | | 0.0000 |
| 135 | 397.500 - 402.500 | | 0.0000 |
| 136 | 402.500 - 407.500 | | 0.0000 |
| 137 | 407.500 - 412.500 | | 0.002910 |
| 138 | 412.500 - 417.500 | | 0.003140 |
| 139 | 417.500 - 422.500 | | 0.003990 |
| 140 | 422.500 - 427.500 | | 0.006540 |
| 141 | 427.500 - 437.500 | | 0.007745 |
| 142 | 437.500 - 447.500 | | 0.01370 |
| 143 | 447.500 - 457.500 | | 0.01915 |
| 144 | 457.500 - 467.500 | | 0.03625 |
| 145 | 467.500 - 477.500 | | 0.04475 |
| 146 | 477.500 - 487.500 | | 0.0777 |
| 147 | 487.500 - 497.500 | | 0.08685 |
| 148 | 497.500 - 507.500 | | 0.0868 |
| 149 | 507.500 - 517.500 | | 0.1420 |
| 150 | 517.500 - 527.500 | | 0.1590 |
| 151 | 527.500 - 537.500 | | 0.1925 |
| 152 | 537.500 - 547.500 | | 0.2645 |
| 153 | 547.500 - 557.500 | | 0.2975 |
| 154 | 557.500 - 567.500 | | 0.3265 |
| 155 | 567.500 - 577.500 | | 0.4095 |
| 156 | 577.500 - 587.500 | | 0.4710 |
| 157 | 587.500 - 597.500 | | 0.4450 |
| 158 | 597.500 - 607.500 | | 0.4515 |
| 159 | 607.500 - 617.500 | | 0.4865 |
| 160 | 617.500 - 627.500 | | 0.4390 |

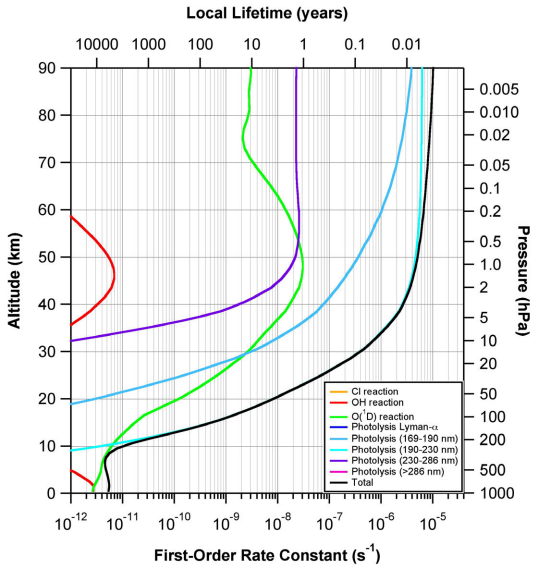
| Bin | Wavelength Range (nm) | $O_2$ cross section $10^{-24}$ $cm^2$ | $O_3$ cross section $10^{-20}$ $cm^2$ |
|---|---|---|---|
| 161 | 627.500 - 637.500 | | 0.3750 |
| 162 | 637.500 - 647.500 | | 0.3300 |
| 163 | 647.500 - 657.500 | | 0.2675 |
| 164 | 657.500 - 667.500 | | 0.2310 |
| 165 | 667.500 - 677.500 | | 0.1935 |
| 166 | 677.500 - 687.500 | | 0.1605 |
| 167 | 687.500 - 697.500 | | 0.1335 |
| 168 | 697.500 - 707.500 | | 0.1070 |
| 169 | 707.500 - 717.500 | | 0.0730 |
| 170 | 717.500 - 727.500 | | 0.0600 |
| 171 | 727.500 - 737.500 | | 0.0500 |
| 172 | 737.500 - 747.500 | | 0.0433 |
| 173 | 747.500 - 757.500 | | 0.0350 |
| 174 | 757.500 - 767.500 | | 0.0279 |
| 175 | 767.500 - 777.500 | | 0.0275 |
| 176 | 777.500 - 787.500 | | 0.0269 |
| 177 | 787.500 - 797.500 | | 0.0201 |
| 178 | 797.500 - 807.500 | | 0.0169 |
| 179 | 807.500 - 817.500 | | 0.0187 |
| 180 | 817.500 - 827.500 | | 0.0161 |
| 181 | 827.500 - 837.500 | | 0.0141 |
| 182 | 837.500 - 847.500 | | 0.0141 |
| 183 | 847.500 - 852.500 | | 0.0145 |

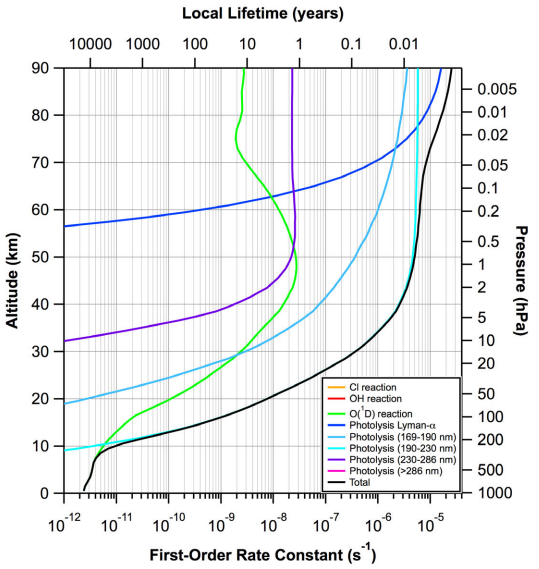


# 1. $CFCl_3$ (CFC-11)

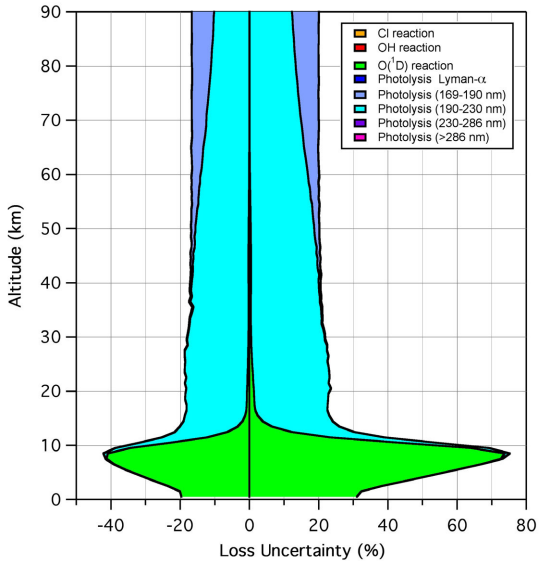
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 58.6 (54.5-62.8) yrs | 60.2 (54.3-66.3) yrs |

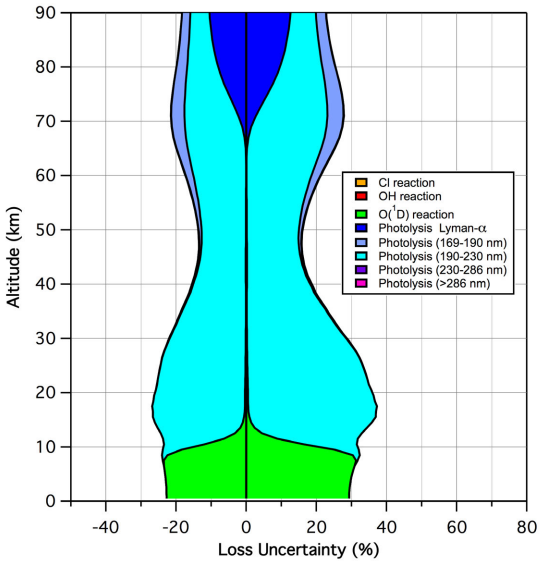
## Gas-Phase Loss Processes



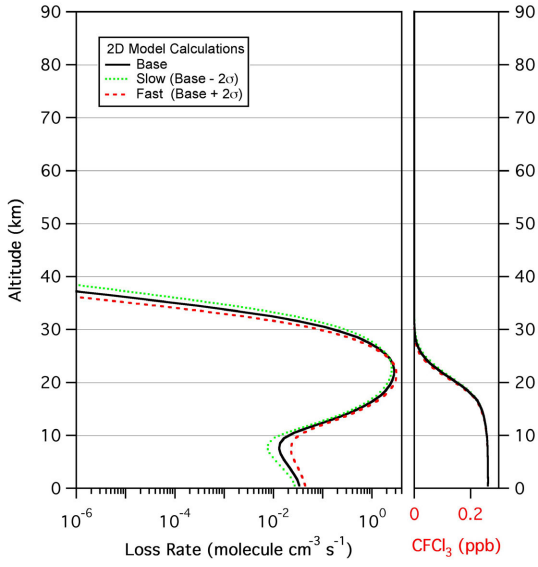



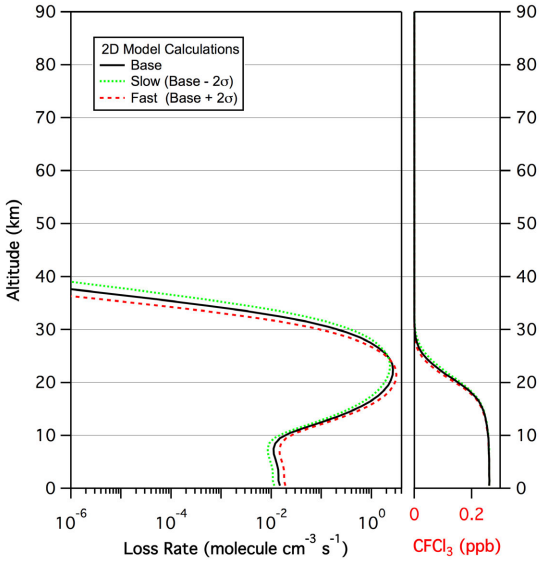

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

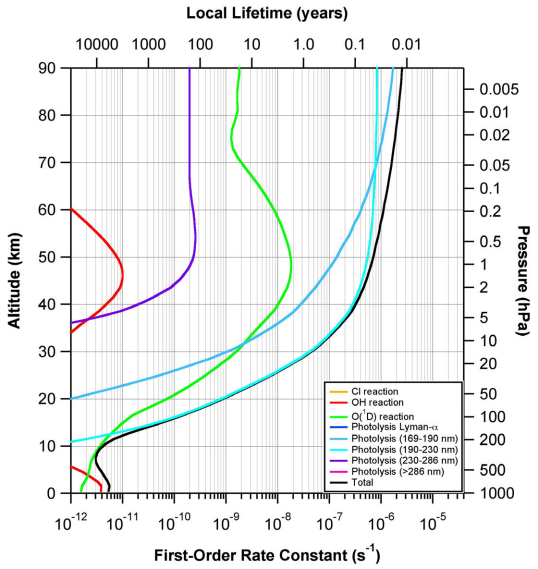


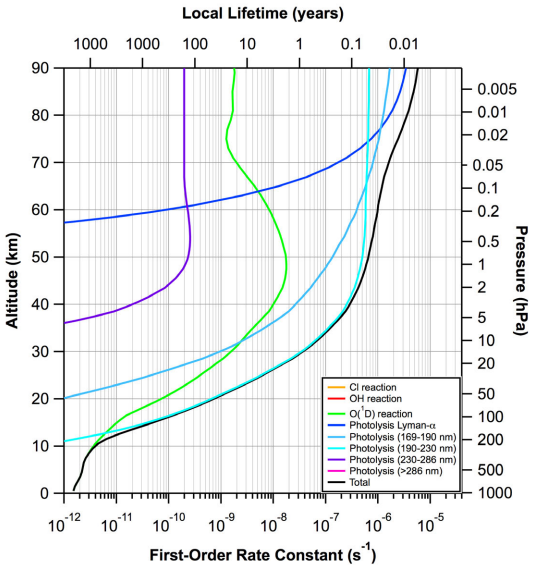



# 2. $CF_2Cl_2$ (CFC-12)

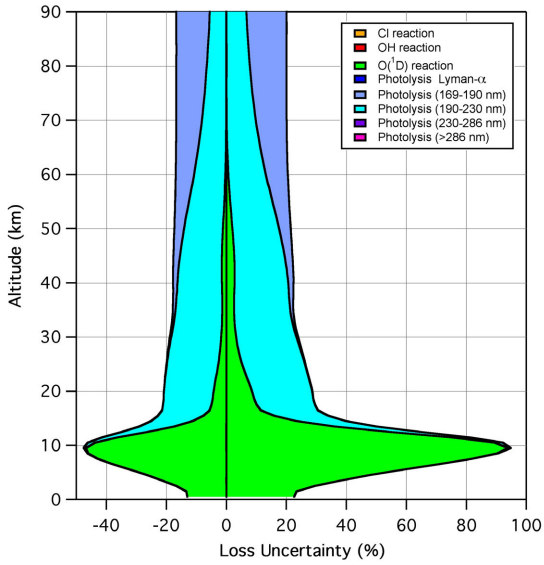
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 103.7 (96.6-110.7) yrs | 109.5 (102.9-116.1) yrs |

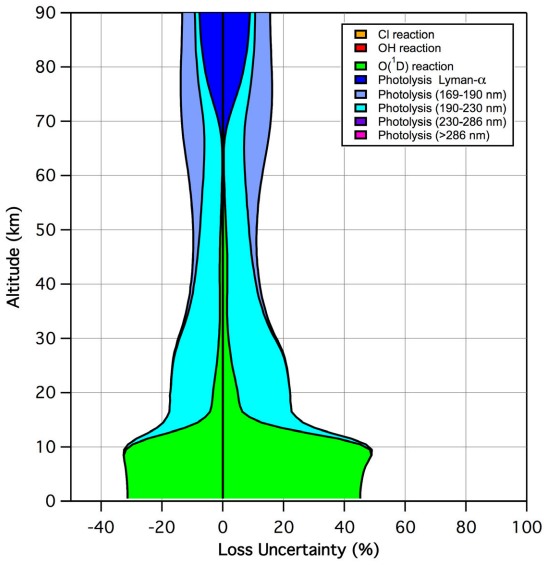
## Gas-Phase Loss Processes



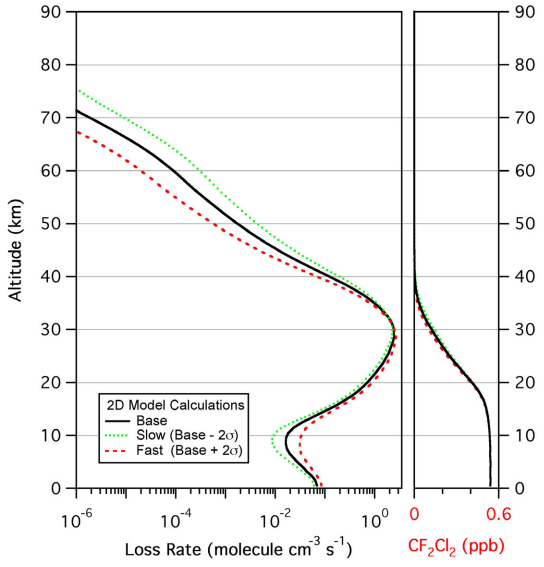



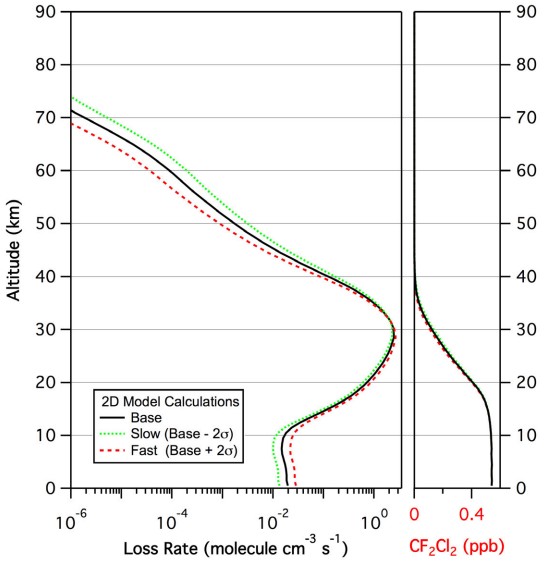

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

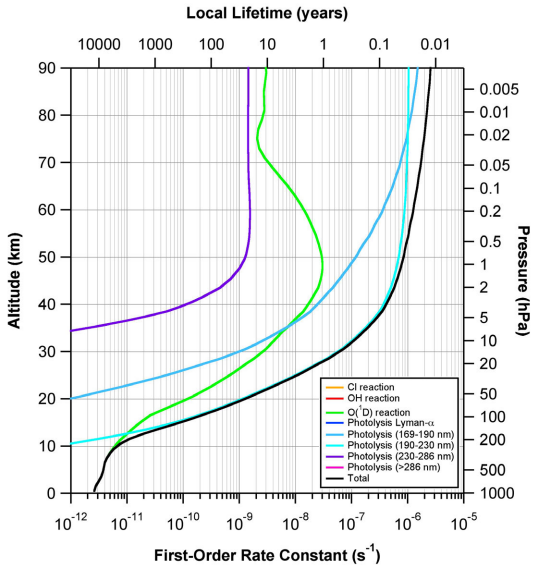


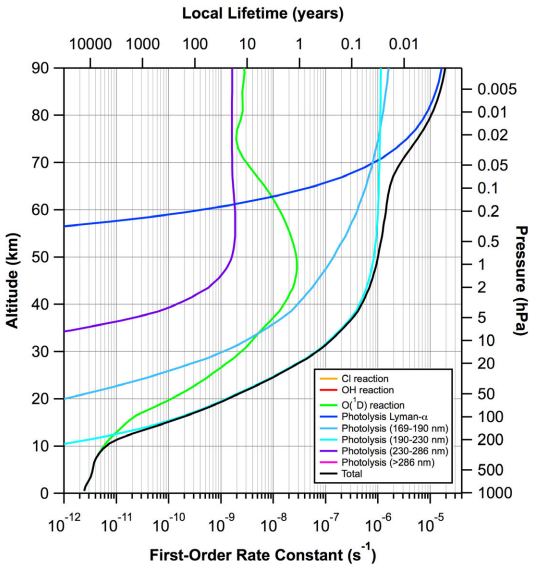



# 3. $CF_2ClCFCl_2$ (CFC-113)

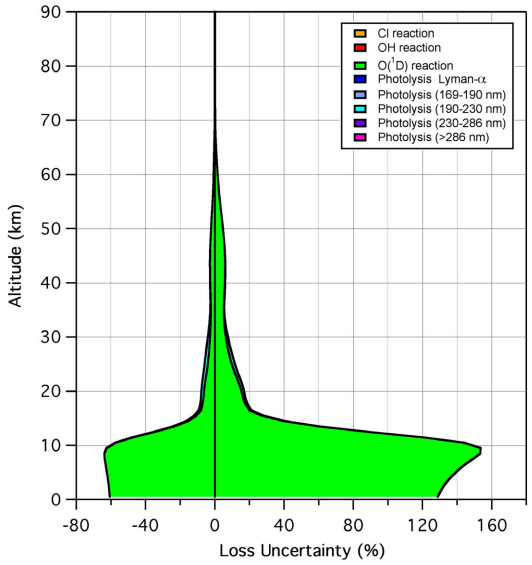
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 95.4 (90.4-98.4) yrs | 93.6 (86.6-100.7) yrs |

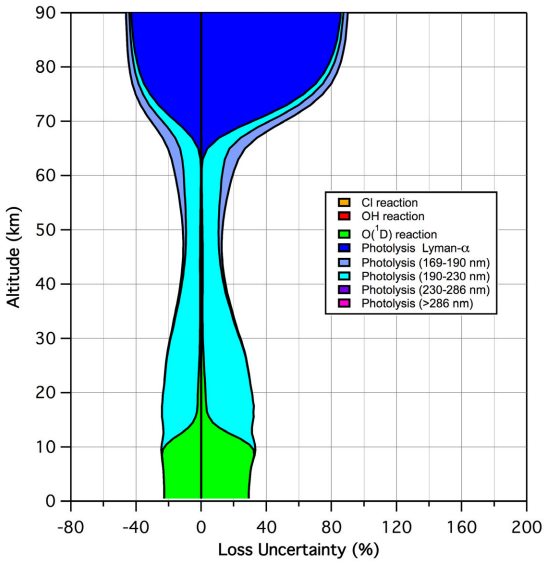
## Gas-Phase Loss Processes



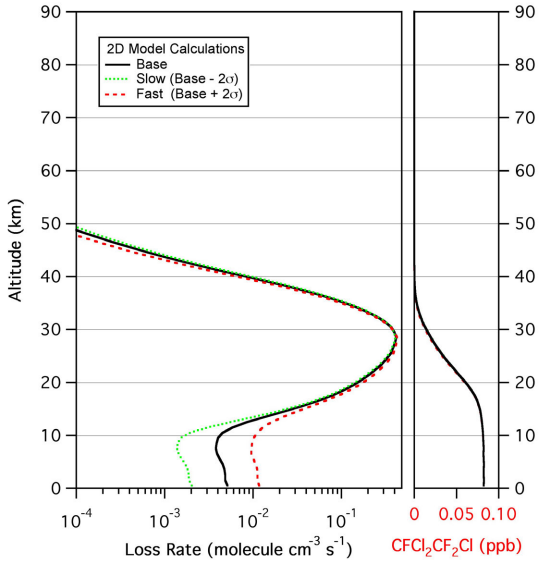



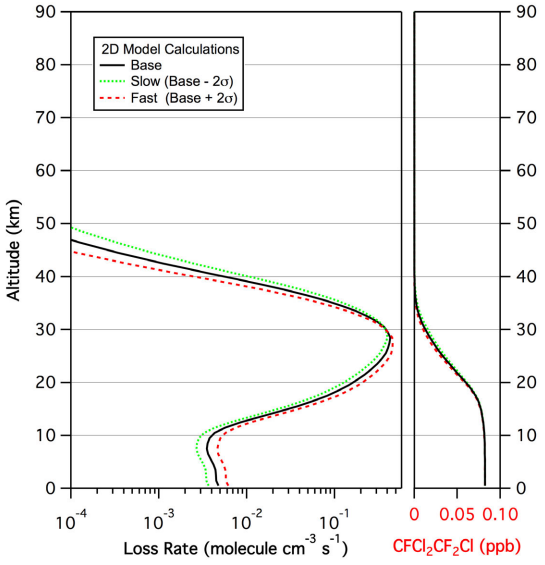

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

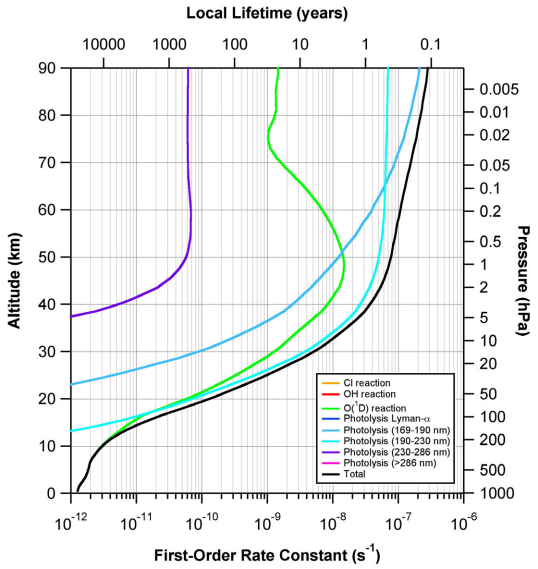


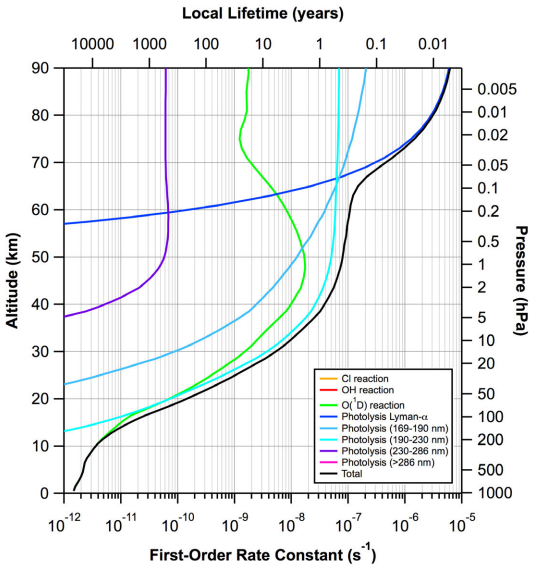



# 4. $CF_2ClCF_2Cl$ (CFC-114)

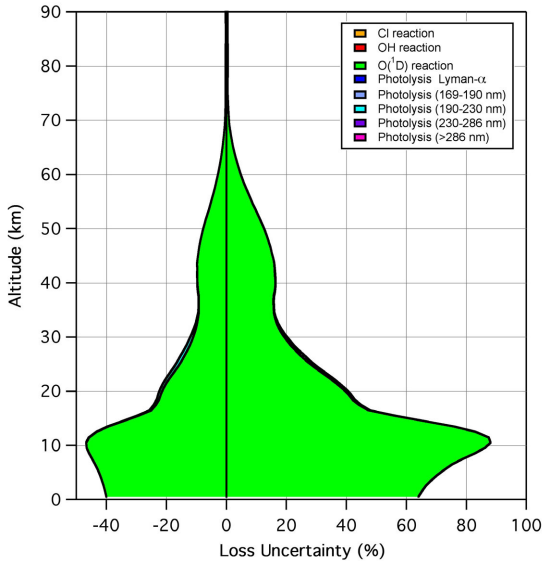
| JPL10-6 Parameters | SPARC Parameters |
|---|---|
| $\tau_{Global}$ 204.2 (186.1-217.8) yrs | 199.7 (178.3-223.9) yrs |

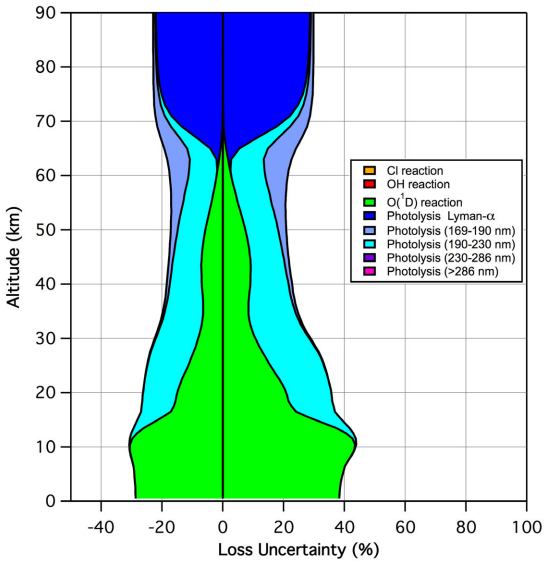
## Gas-Phase Loss Processes



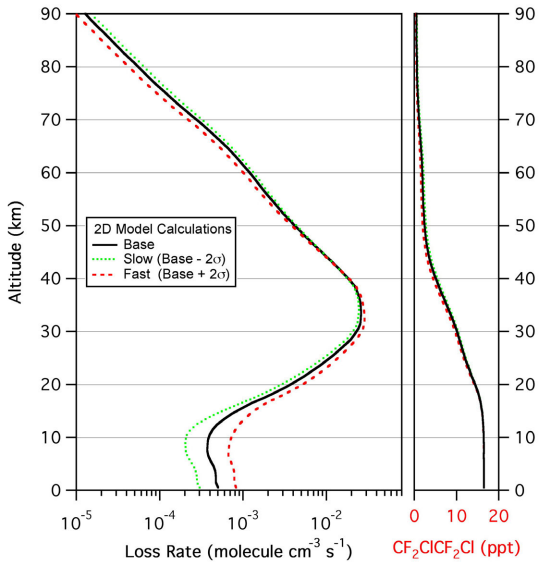



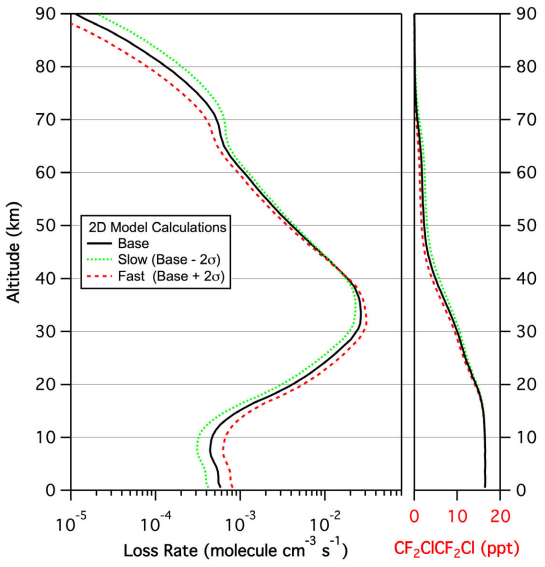

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

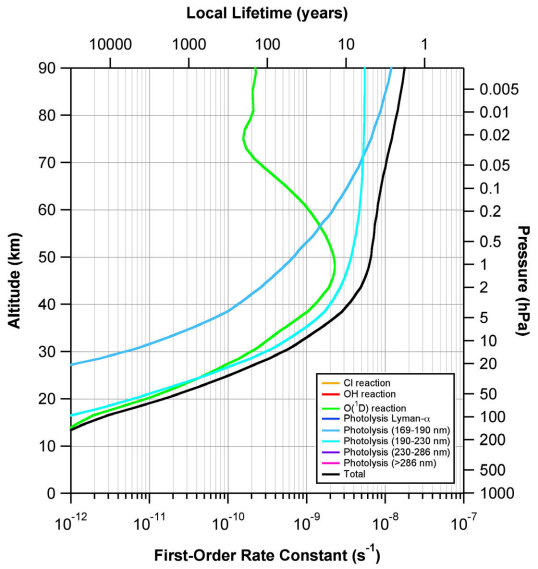


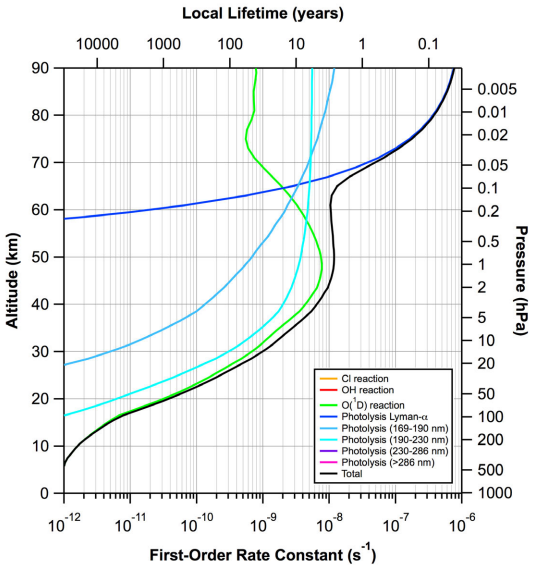



# 5. $CF_3CF_2Cl$ (CFC-115)

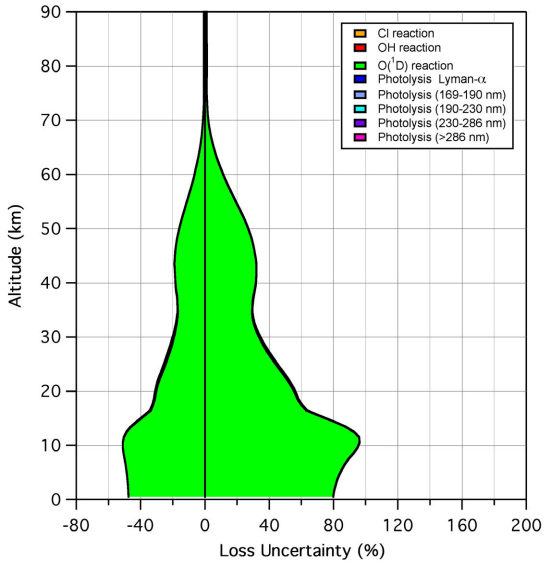
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 960.7 (762-1144) yrs | 539.9 (414.8-717.1) yrs |

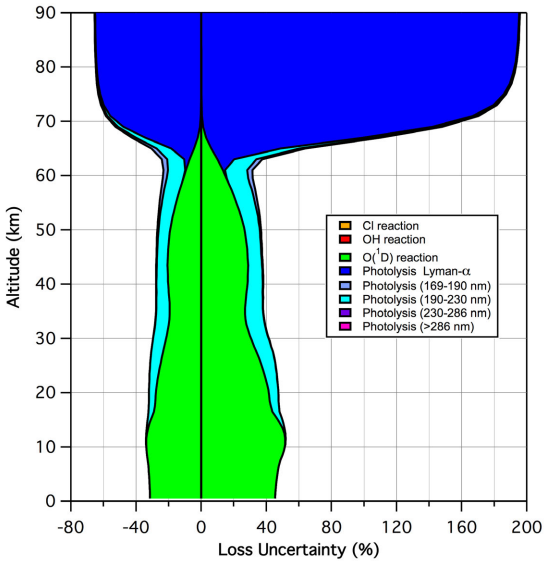
## Gas-Phase Loss Processes



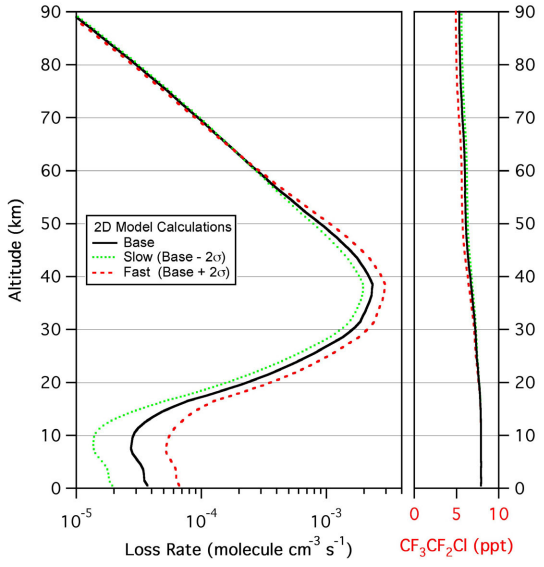



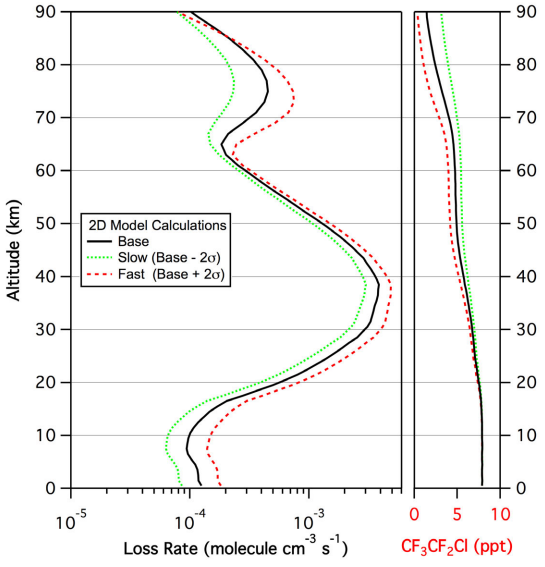

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

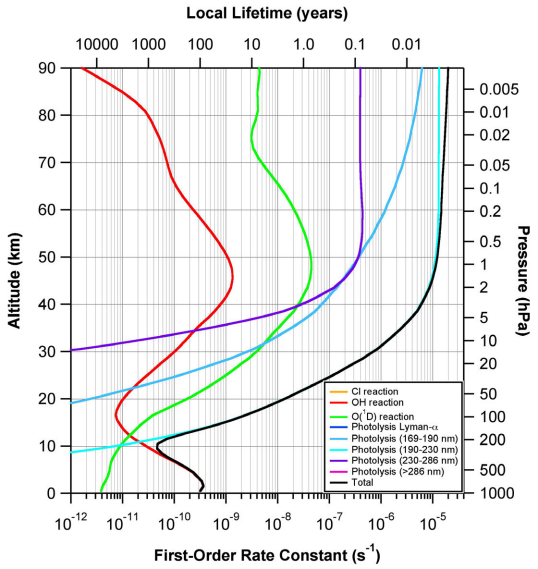


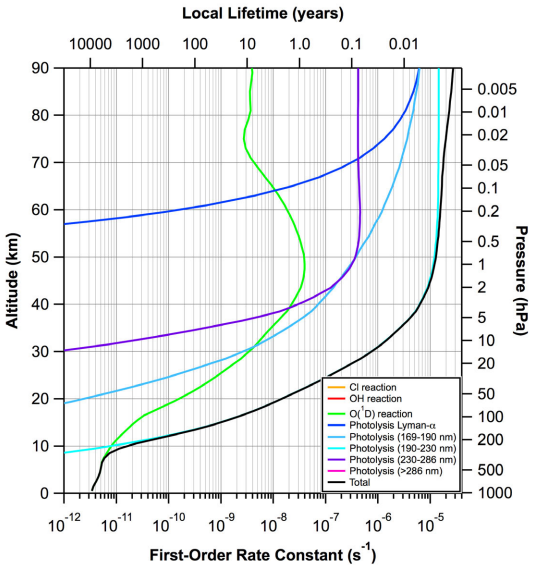



# 6. $CCl_4$ (Carbon Tetrachloride)

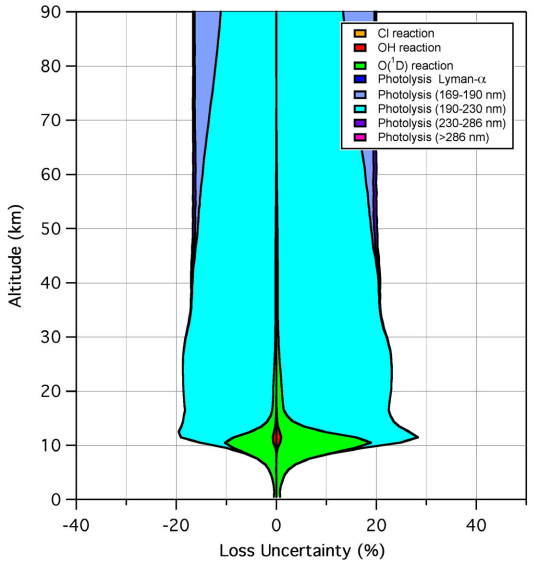
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 38.0 (35.6-40.3) yrs | 48.7 (45.2-52.3) yrs |

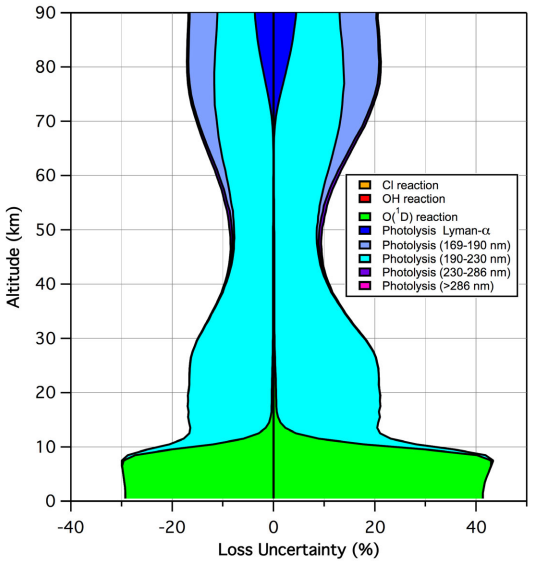
## Gas-Phase Loss Processes



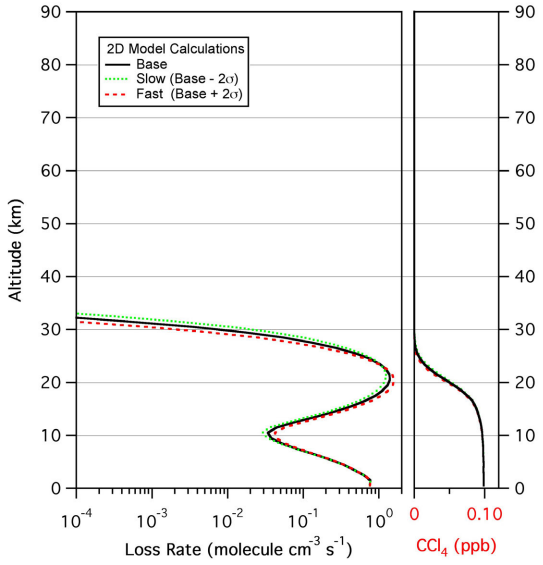



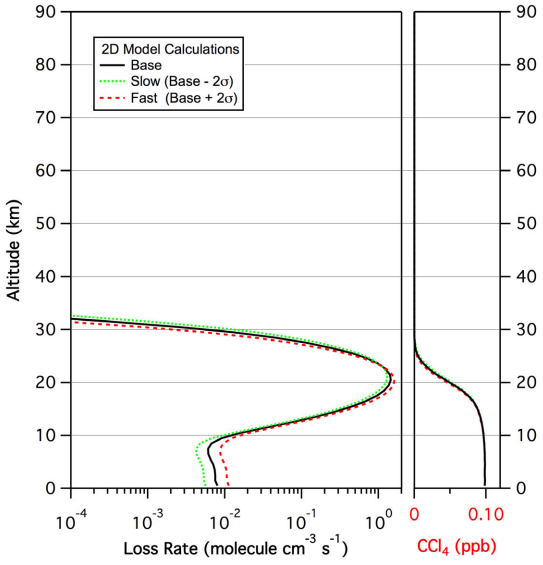

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles



# 7. $N_2O$

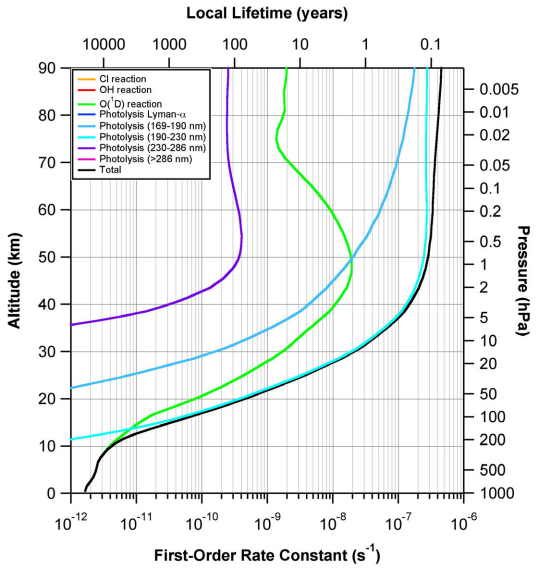
## JPL10-6 Parameters

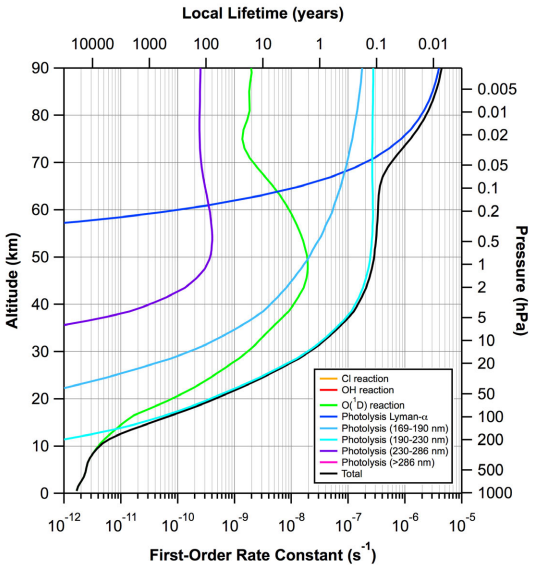
$\tau_{Global}$ 125.2 (113.0-139.6) yrs

## SPARC Parameters

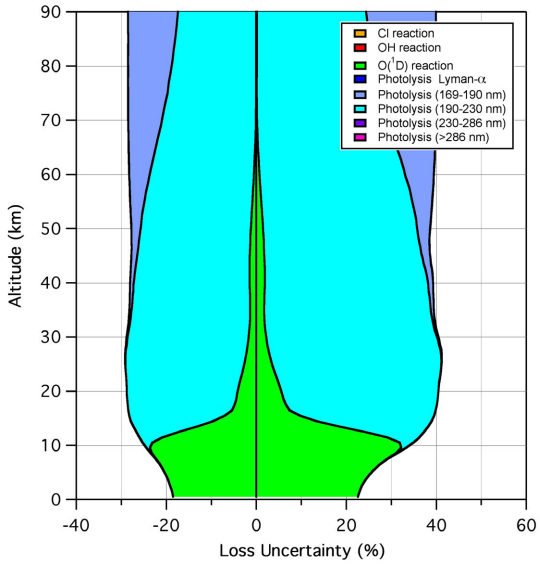
125.2 (118.1-132.3) yrs

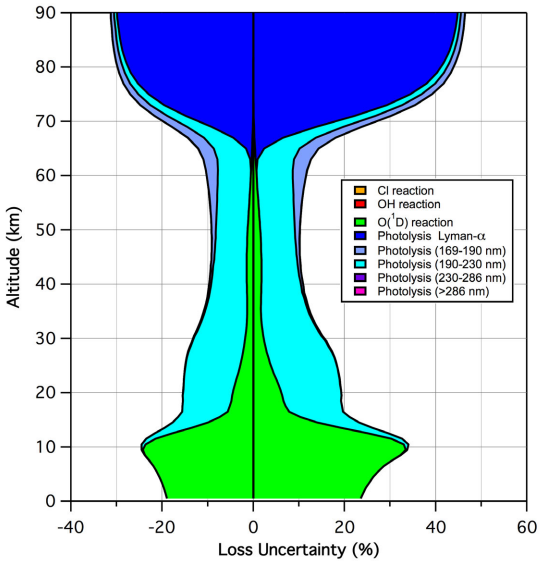
### Gas-Phase Loss Processes



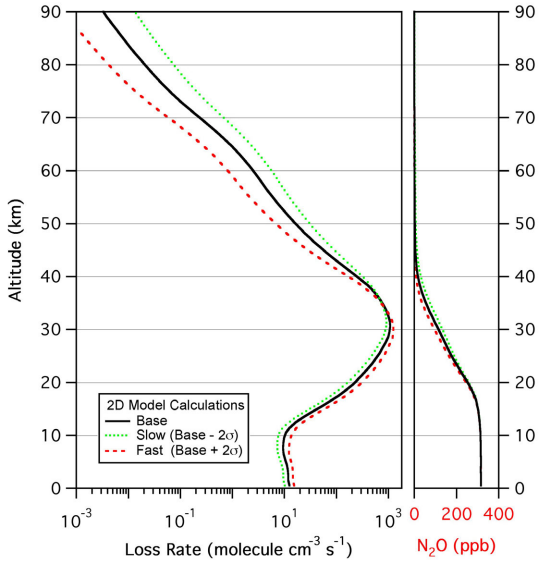



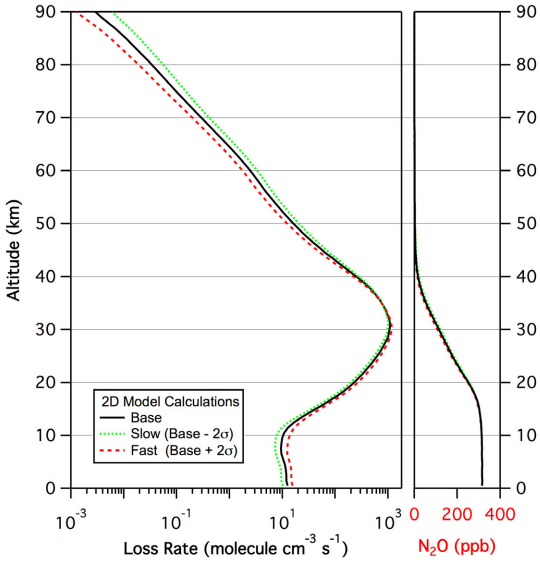

### Estimated Uncertainties




### Molecular Loss Rates, Uncertainties, and Profiles

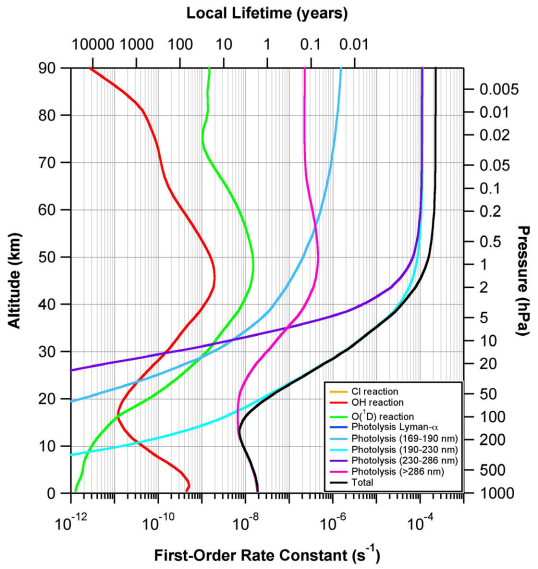


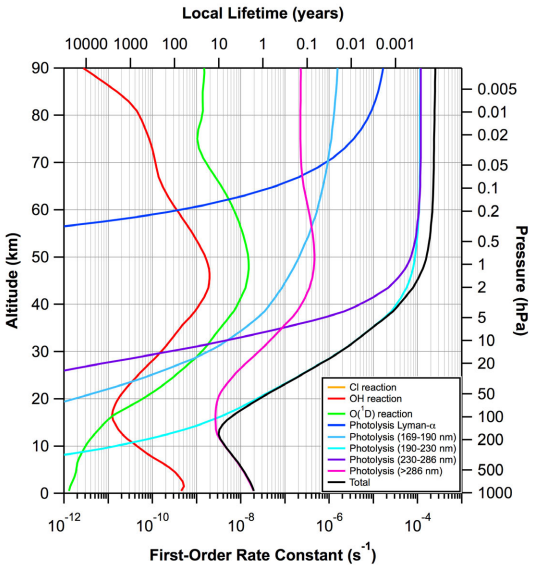



# 8. $CF_2Br_2$ (Halon-1202)

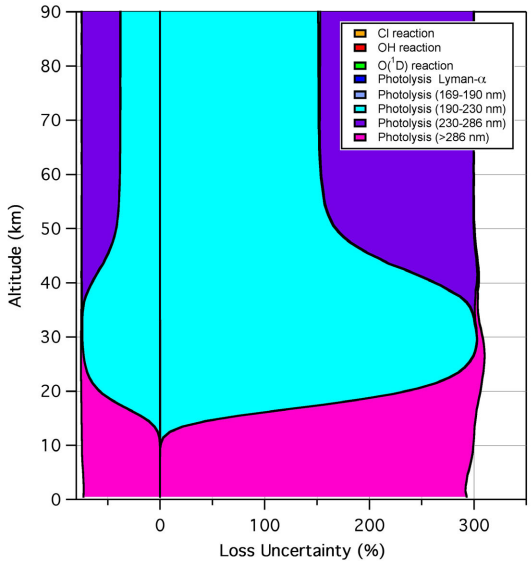
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 2.09 (0.53-7.50) yrs | 2.54 (1.96-3.26) yrs |

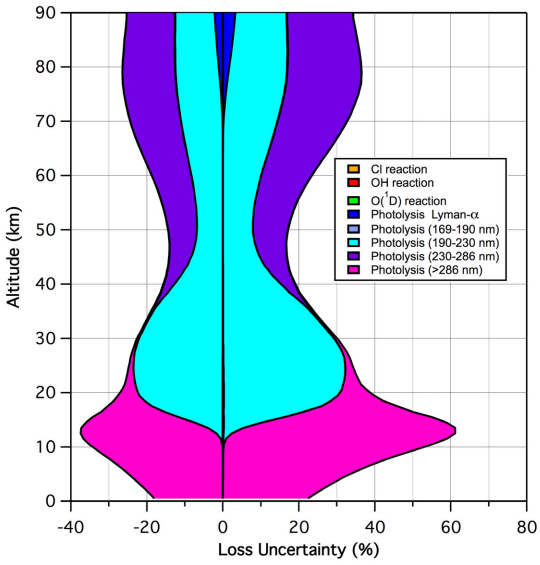
## Gas-Phase Loss Processes



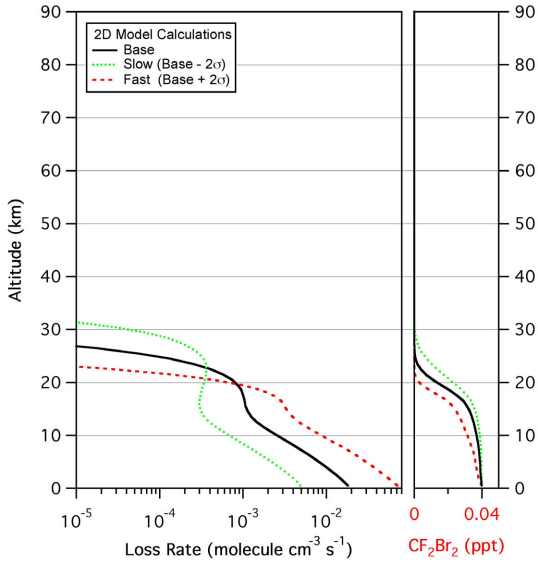



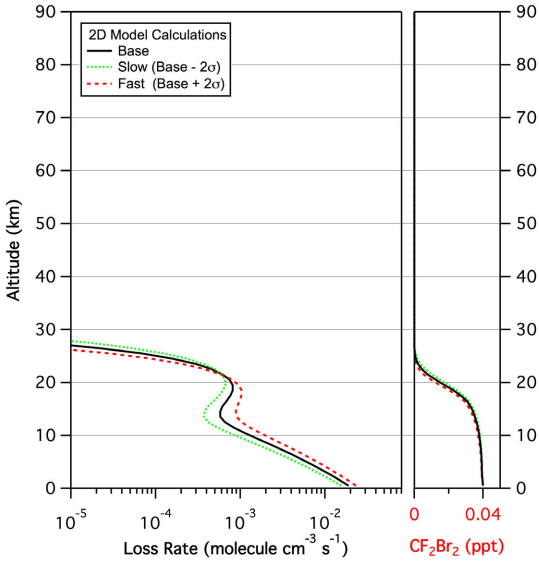

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

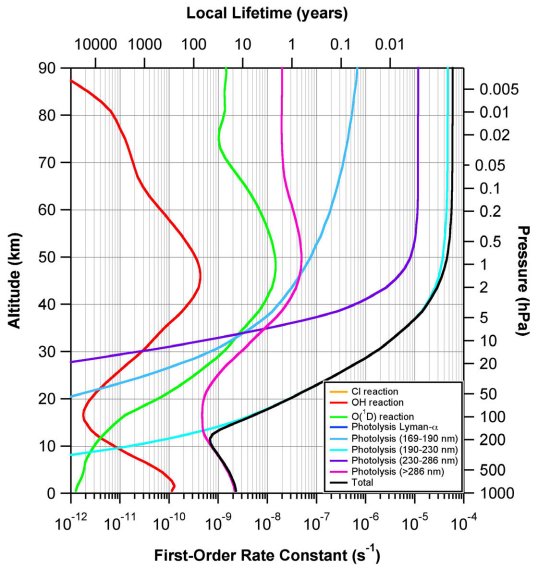


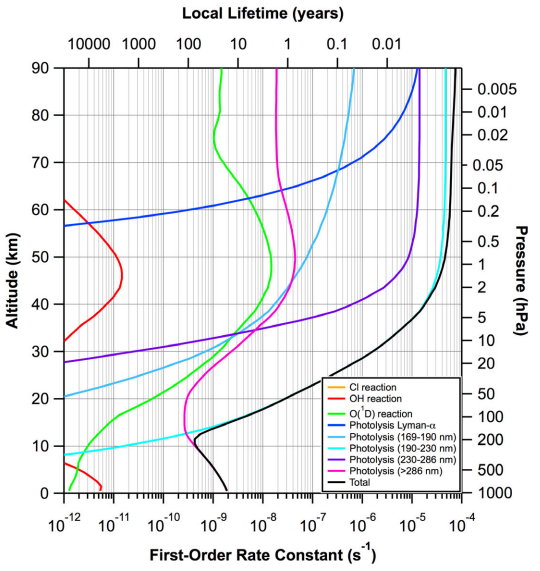



# 9. $CF_2ClBr$ (Halon-1211)

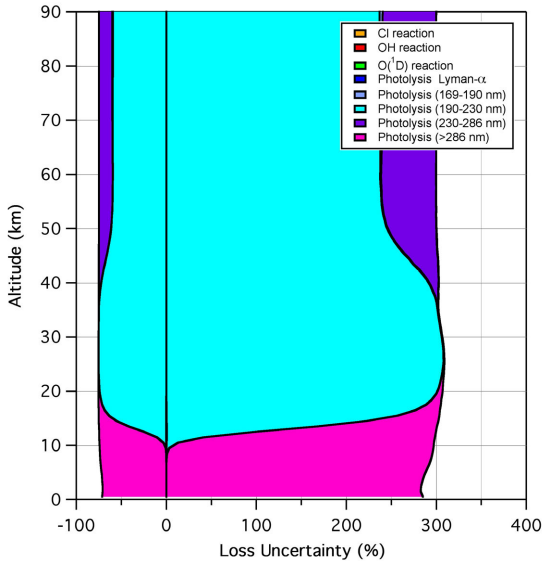
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 13.5 (4.18-34.0) yrs | **16.3 (10.8-23.8) yrs** |

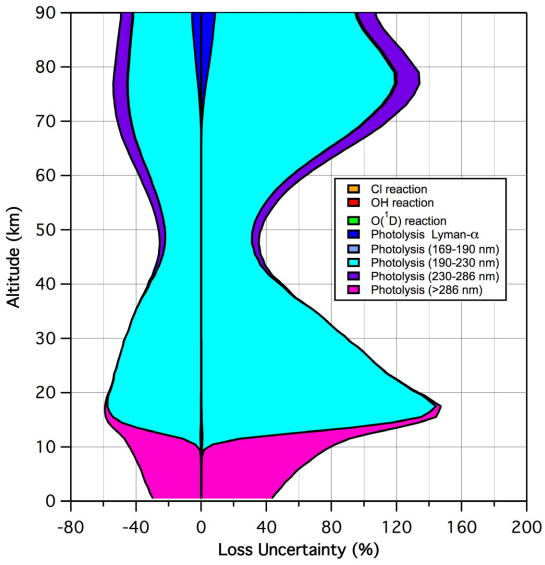
## Gas-Phase Loss Processes



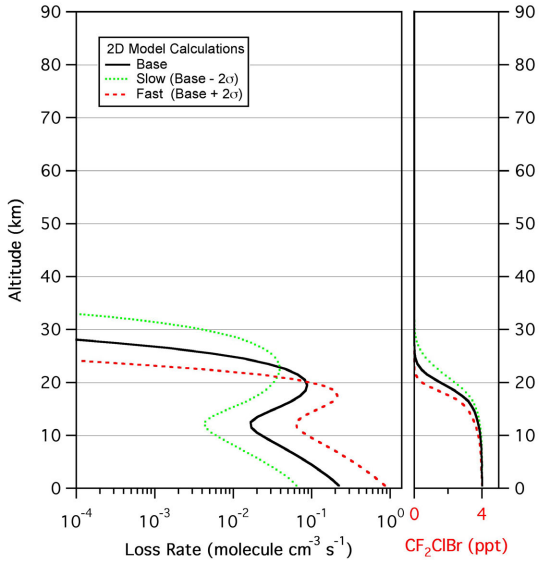



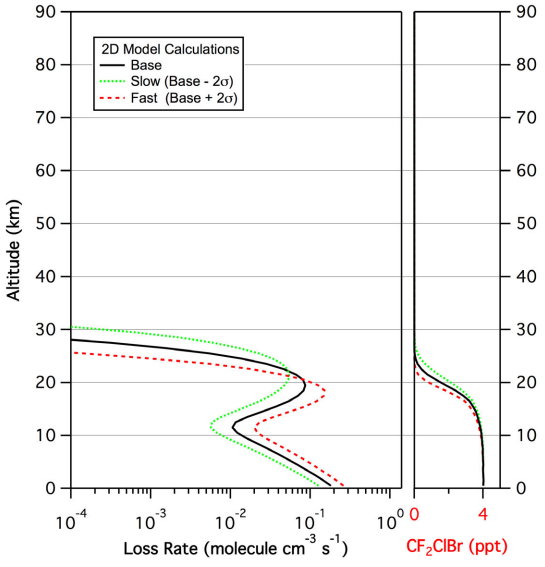

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

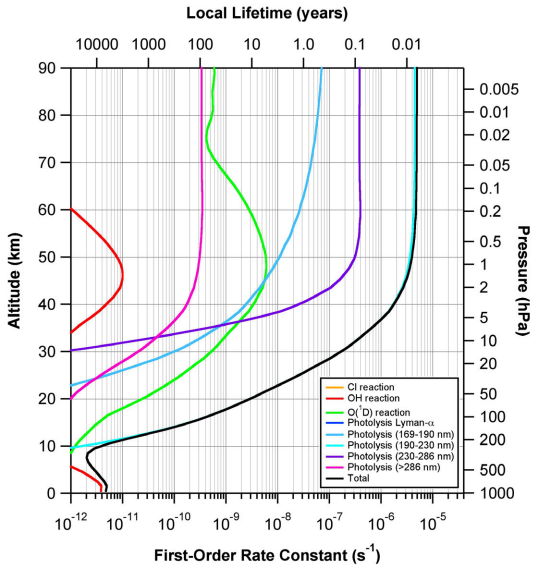


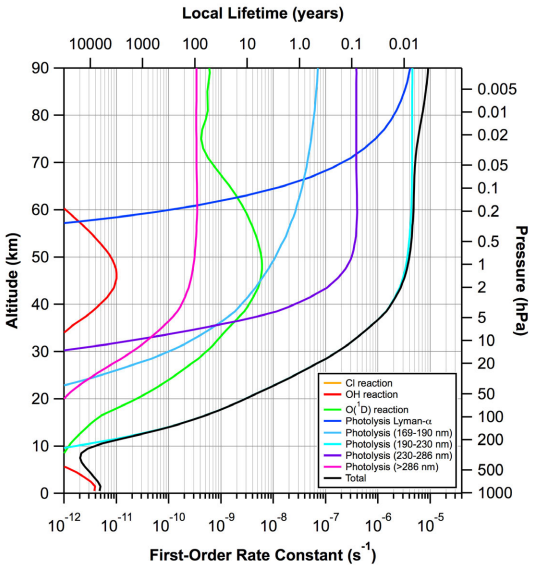



# 10. $CF_3Br$ (Halon-1301)

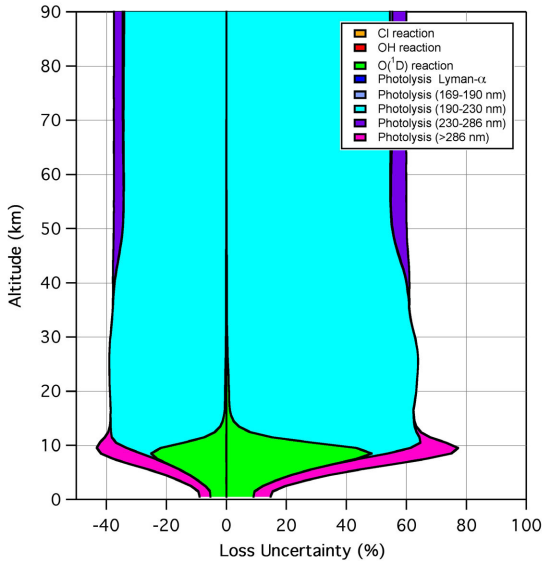
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 77.4 (67.7-87.9) yrs | 77.4 (70.9-84.0) yrs |

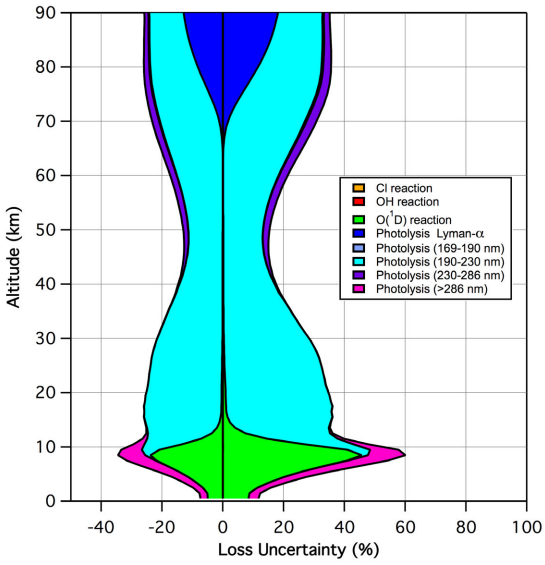
## Gas-Phase Loss Processes



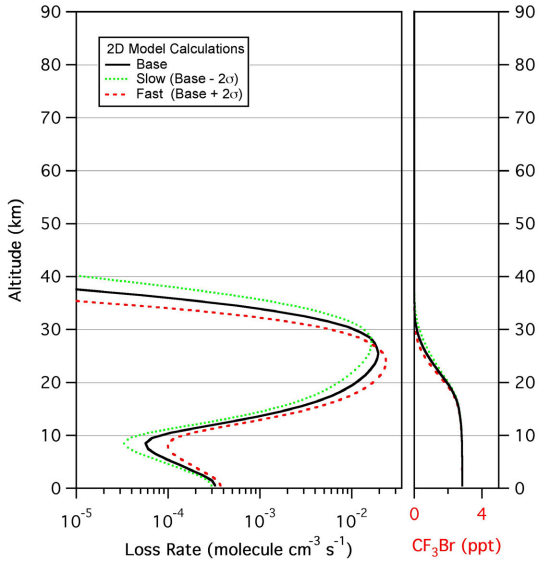



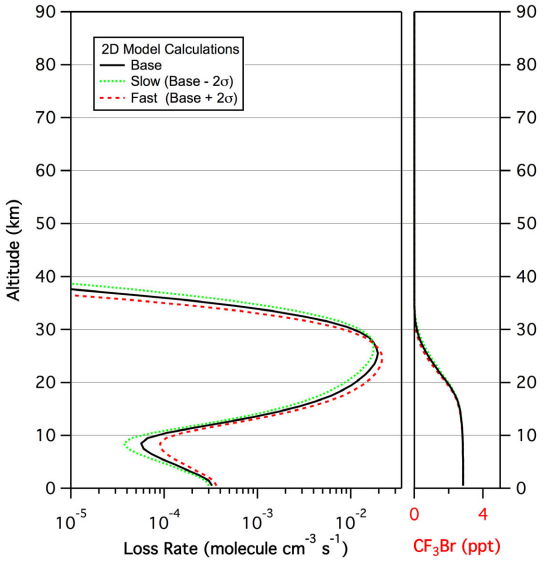

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

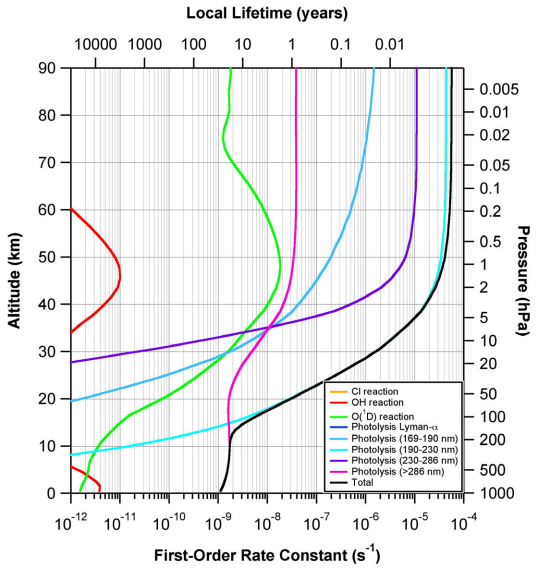


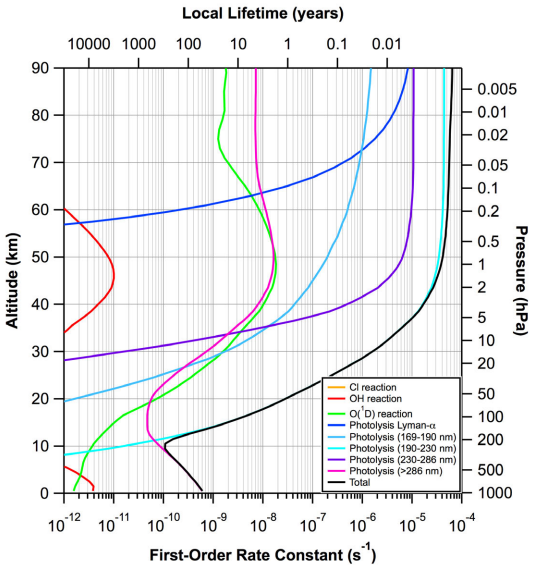



# 11. $CF_2BrCF_2Br$ (Halon-2402)

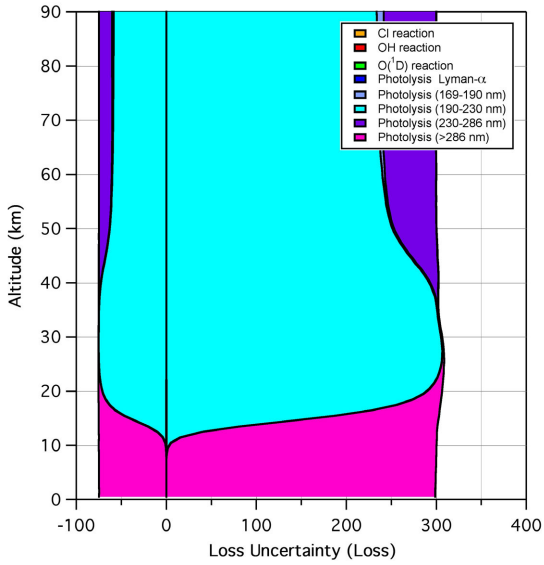
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 13.9 (4.32-36.4) yrs | 27.8 (22.9-33.3) yrs |

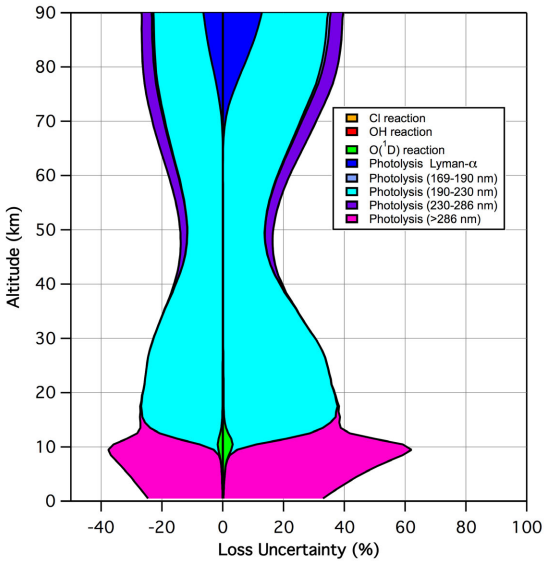
## Gas-Phase Loss Processes



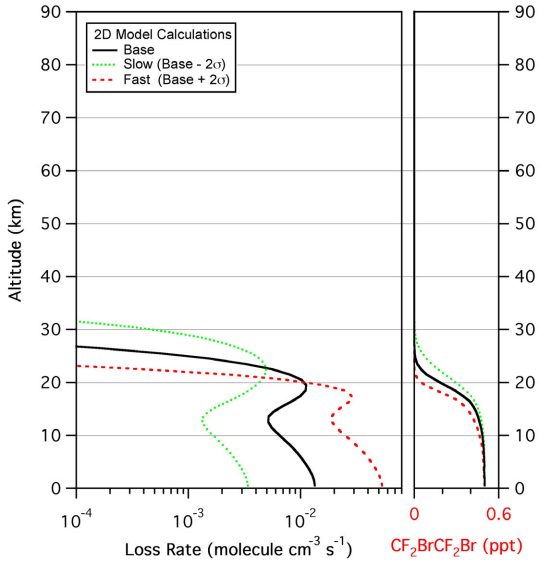



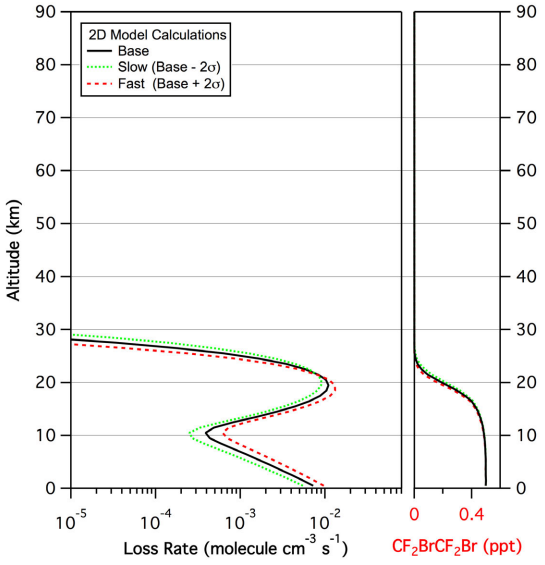

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

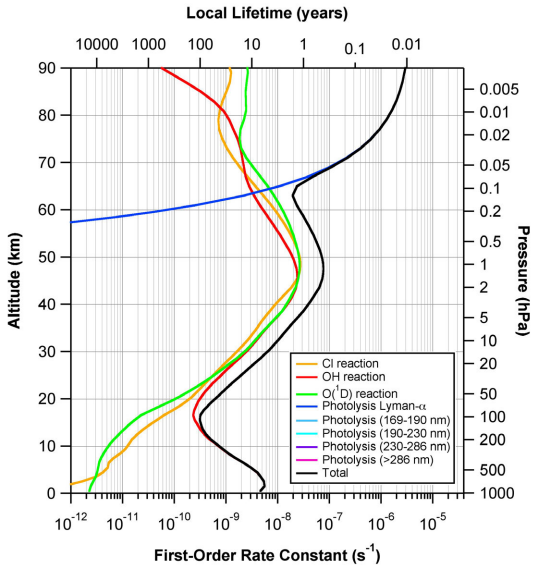


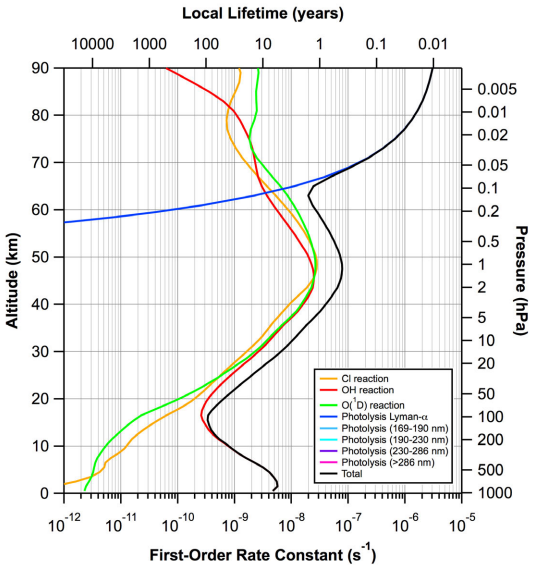



# 12. $CH_4$ (Methane)

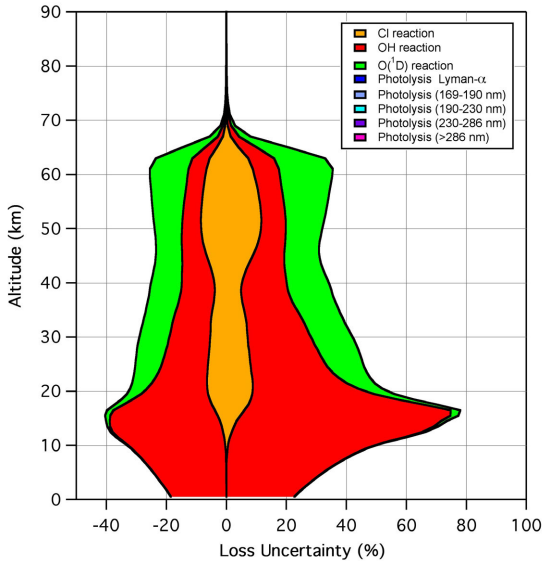
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 9.56 (7.43-12.2) yrs | 9.32 (8.17-10.6) yrs |

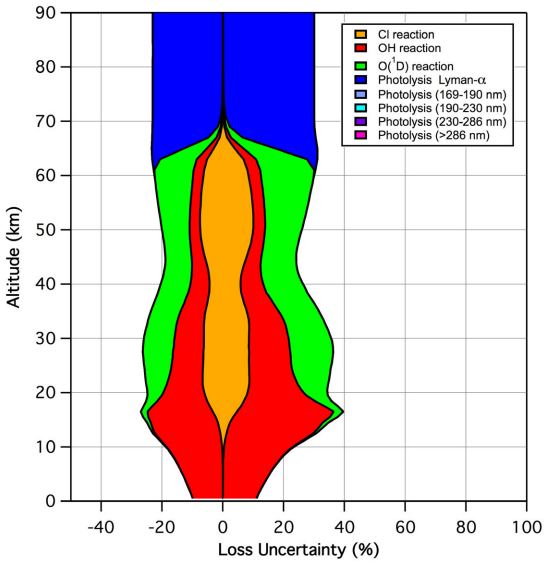
## Gas-Phase Loss Processes



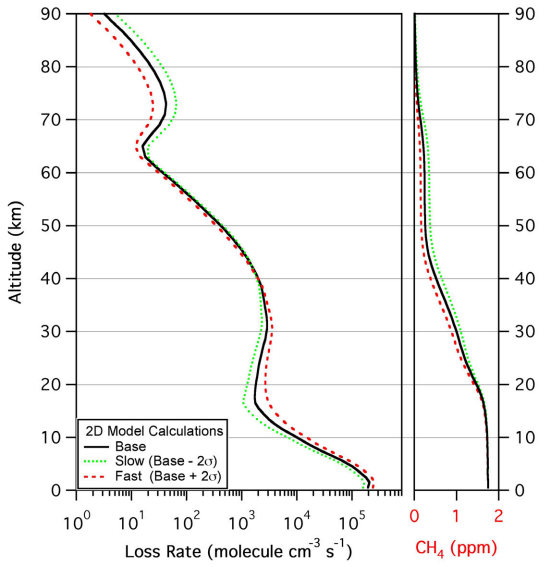



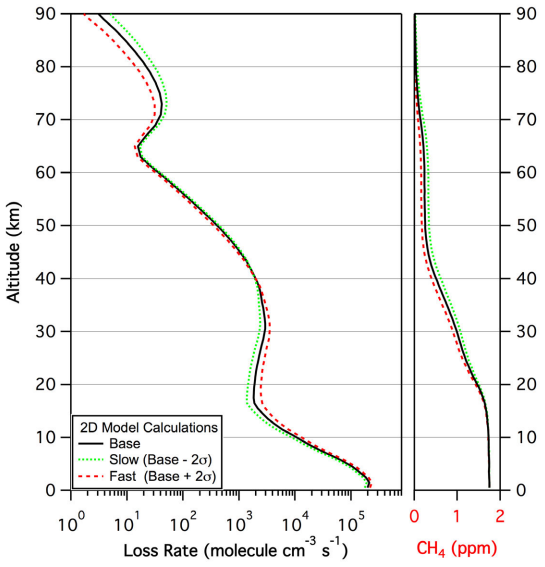

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

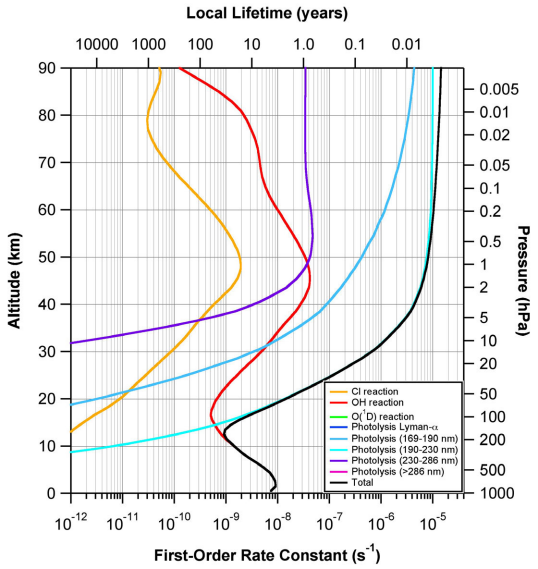


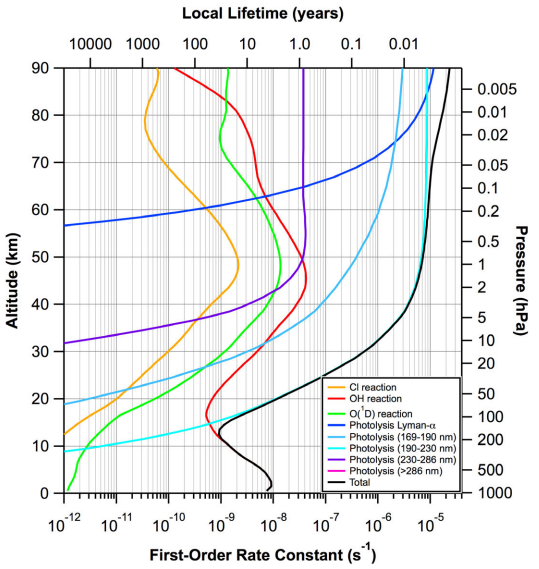



# 13. $CH_3CCl_3$ (Methyl Chloroform)

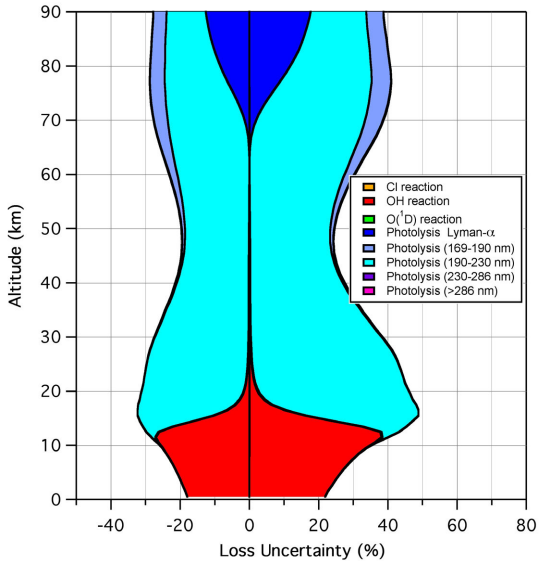
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 5.15 (3.76-6.97) yrs | **5.19 (4.17-6.44) yrs** |

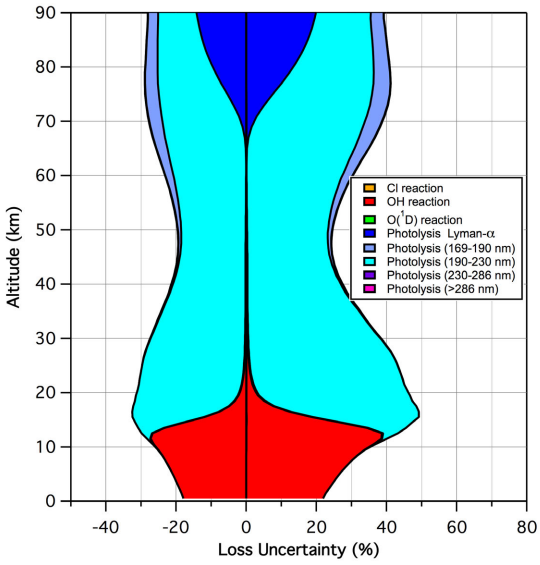
## Gas-Phase Loss Processes



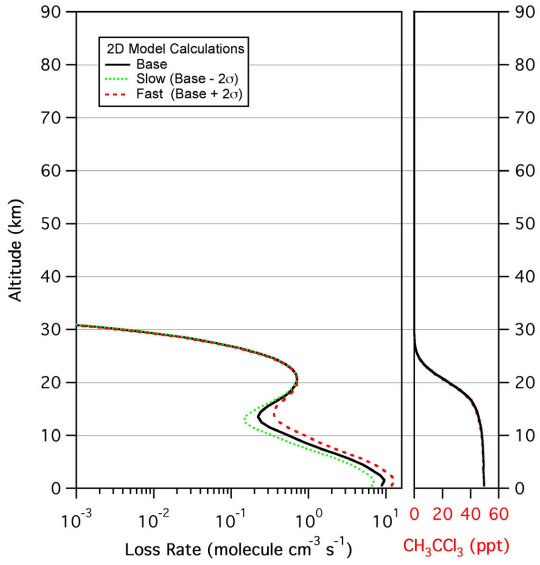



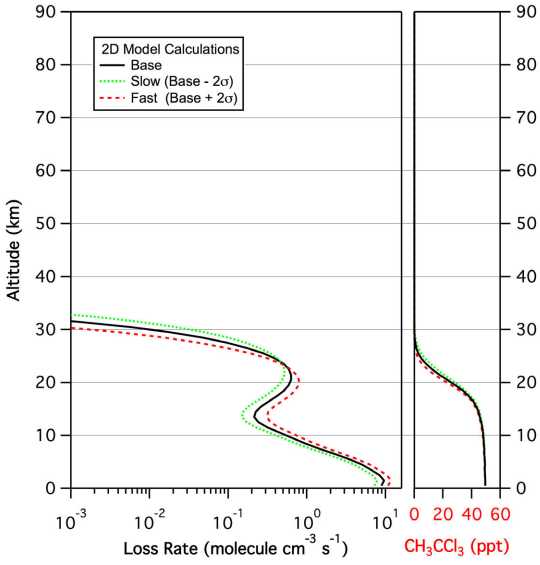

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

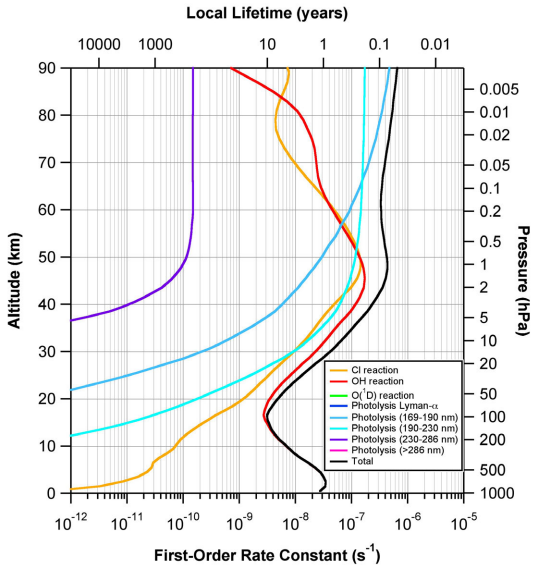


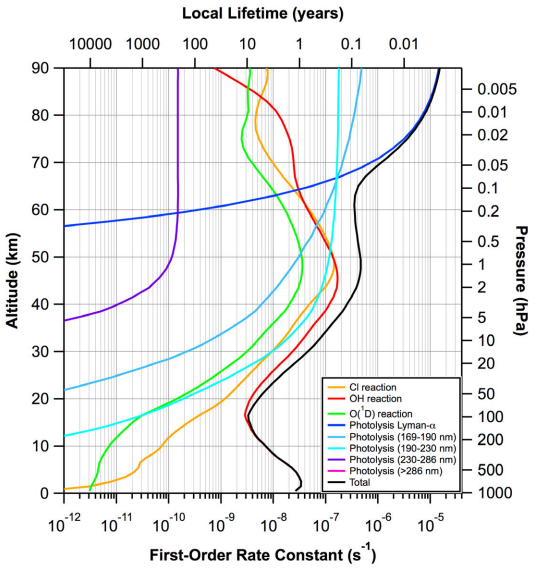



# 14. $CH_3Cl$ (Methyl Chloride)

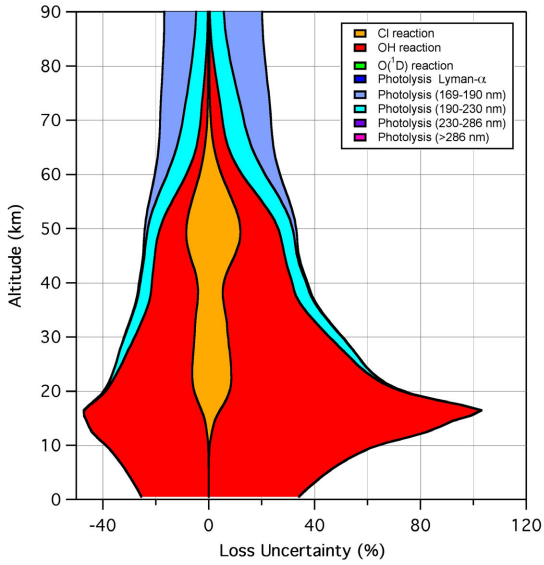
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 1.45 (1.02-2.05) yrs | **1.47 (1.17-1.85) yrs** |

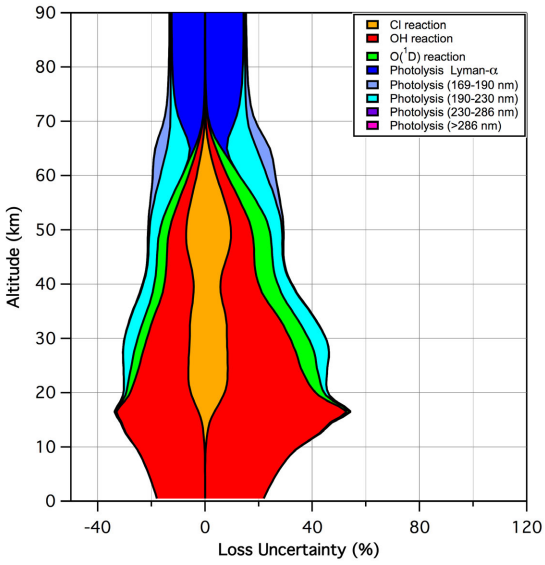
## Gas-Phase Loss Processes



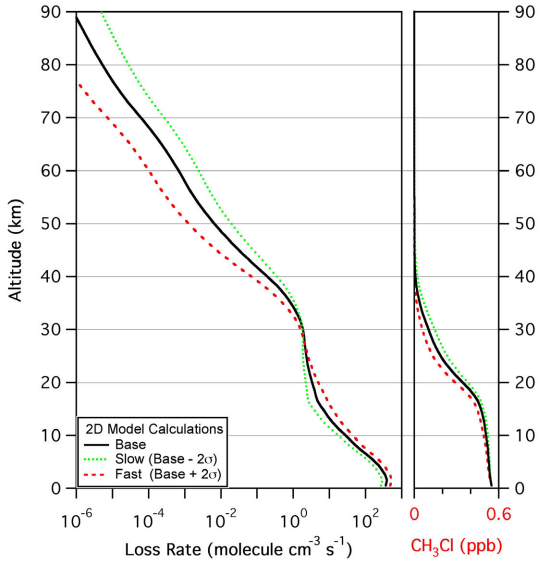



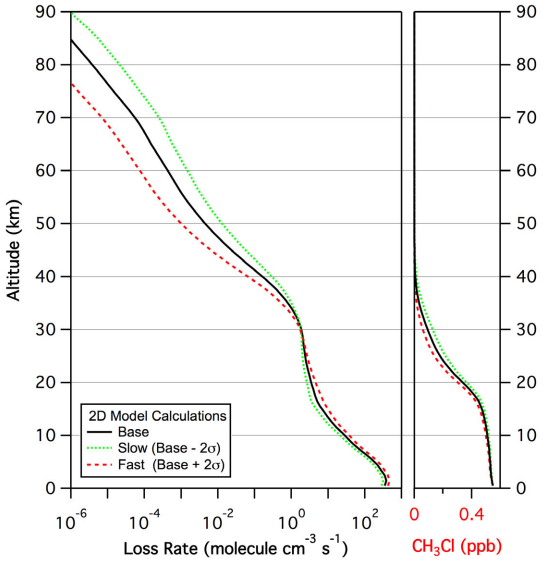

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

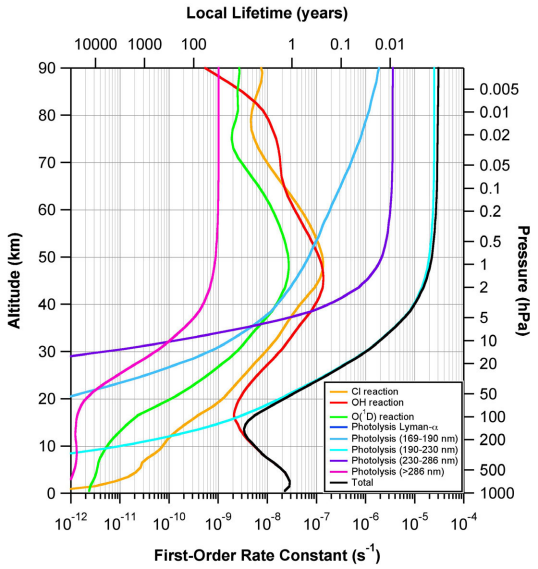


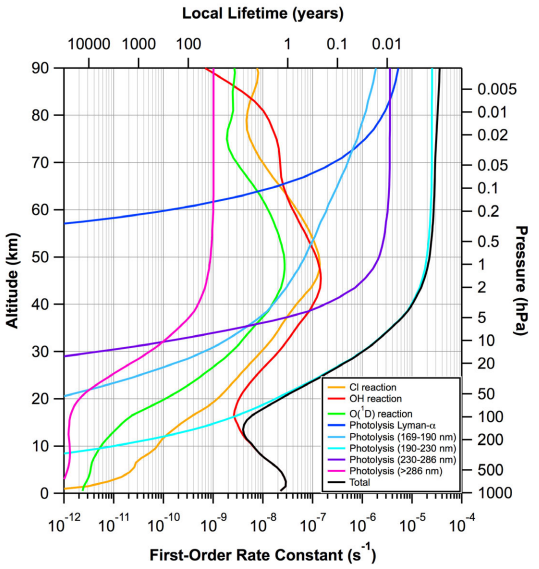



# 15. $CH_3Br$ (Methyl Bromide)

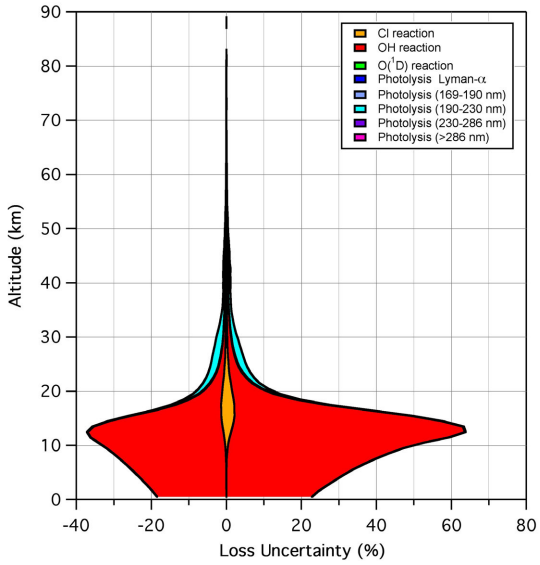
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 1.70 (1.32-2.18) yrs | **1.65 (1.34-2.01) yrs** |

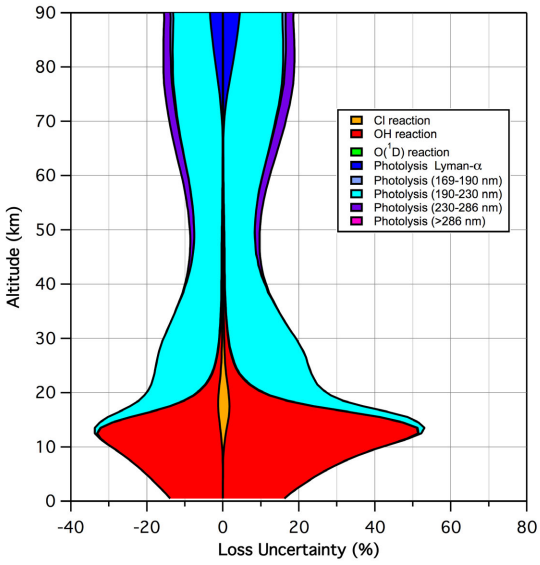
## Gas-Phase Loss Processes



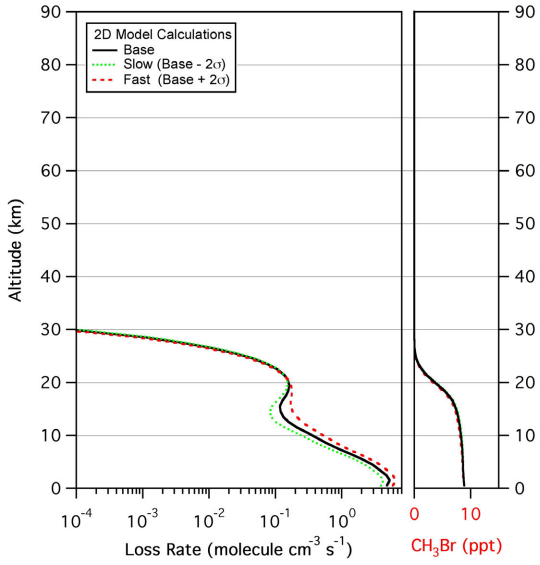



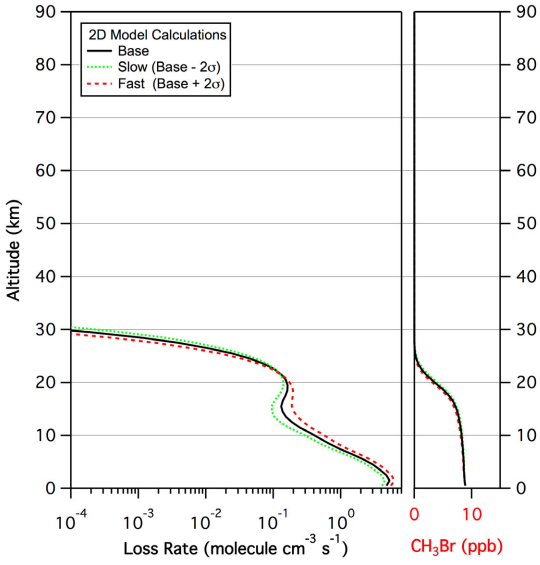

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

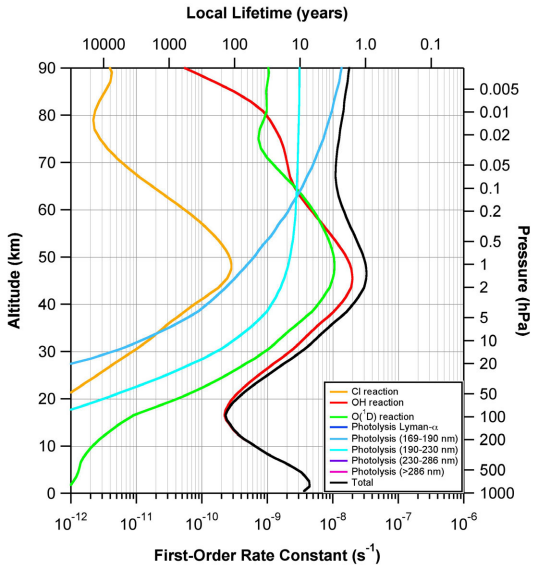


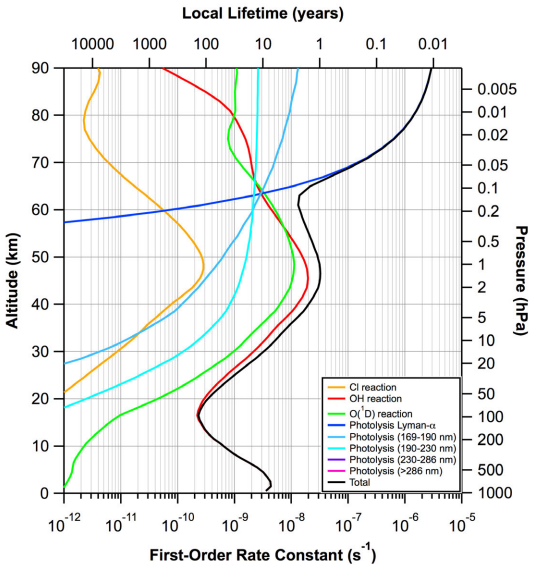



# 16. $CHF_2Cl$ (HCFC-22)

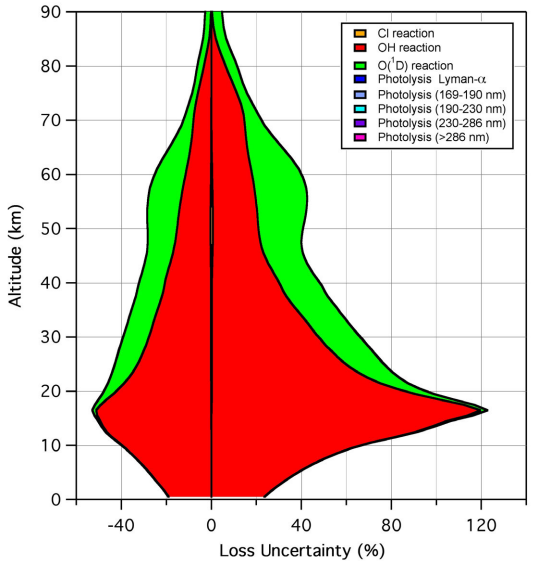
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 12.0 (9.00-16.0) yrs | 12.2 (10.0-14.9) yers |

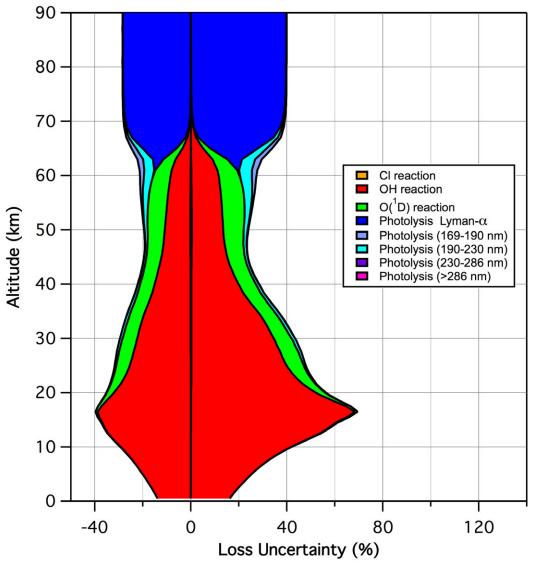
## Gas-Phase Loss Processes



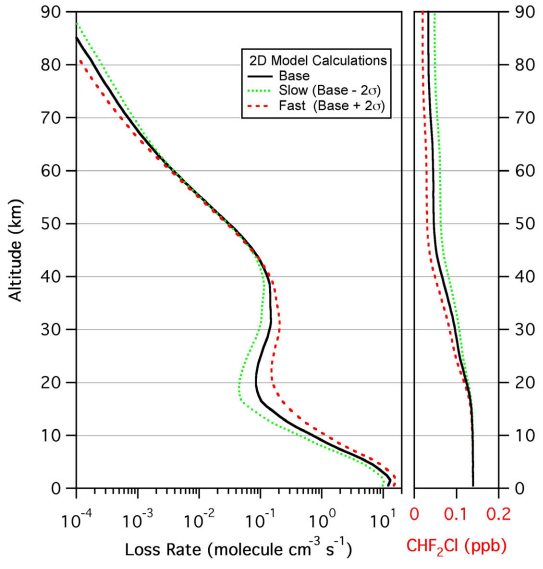



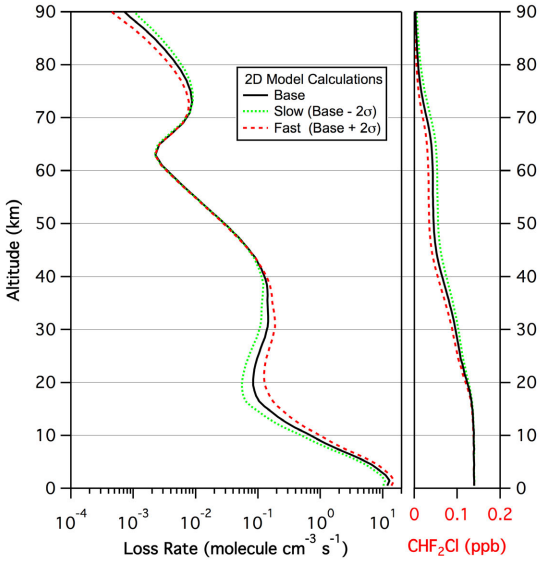

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

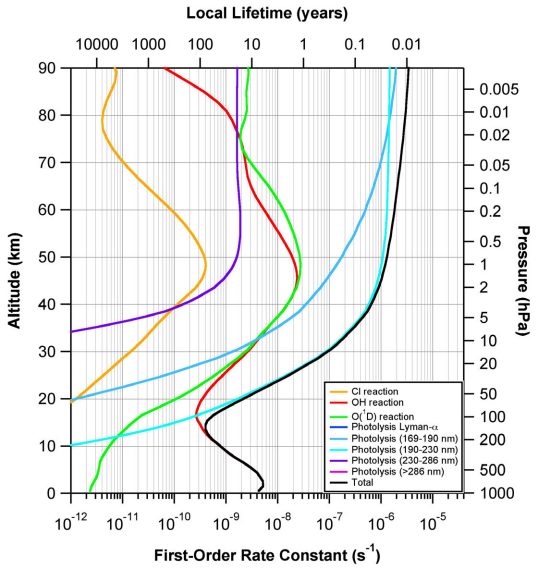


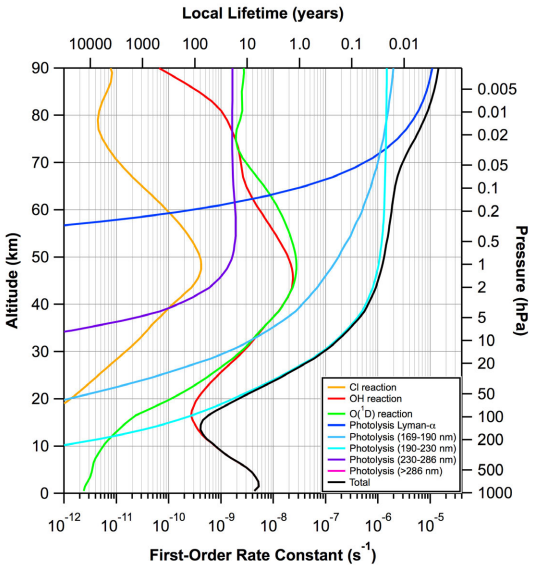



# 17. $CH_3CFCl_2$ (HCFC-141b)

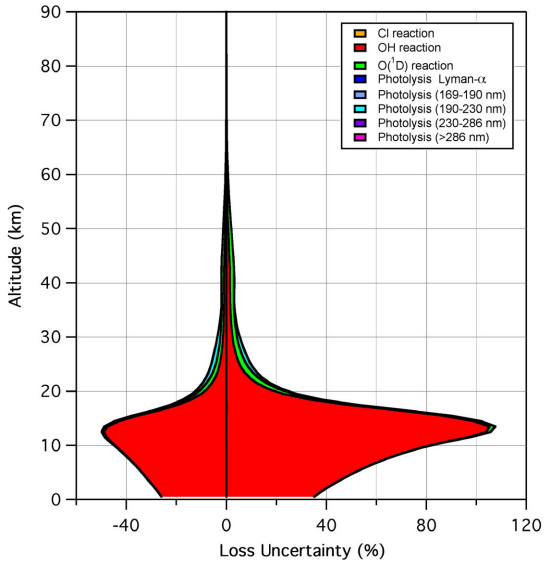
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 9.20 (6.51-12.8) yrs | 9.2 (7.6-11.1) yrs |

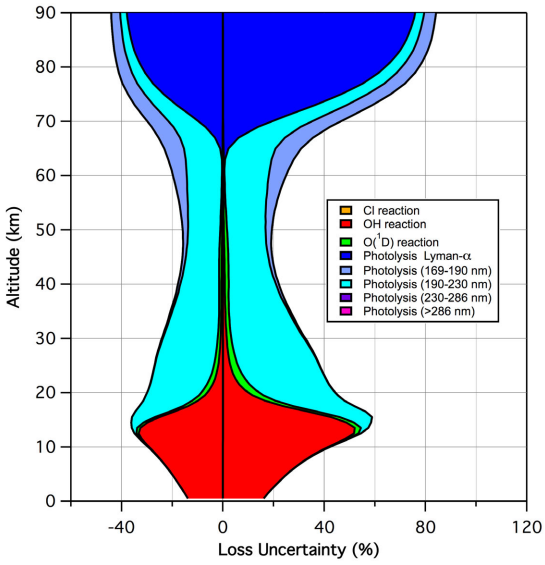
## Gas-Phase Loss Processes



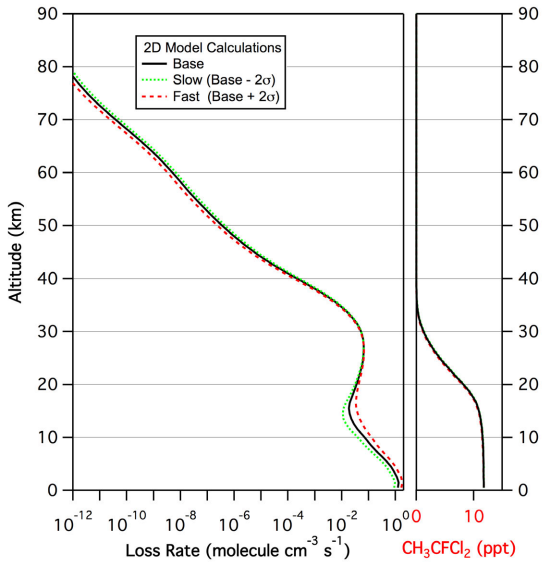



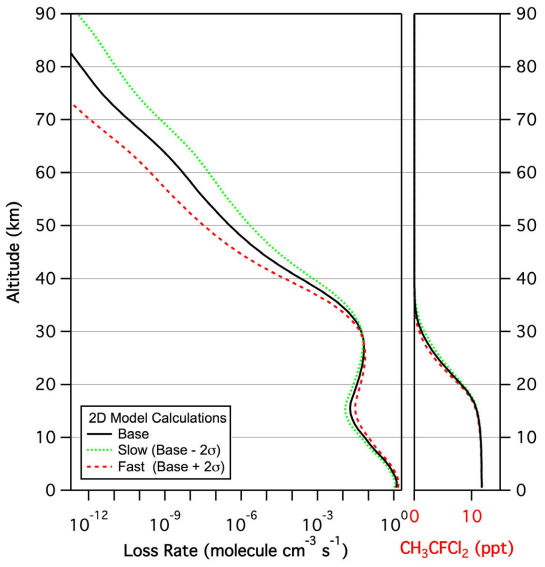

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

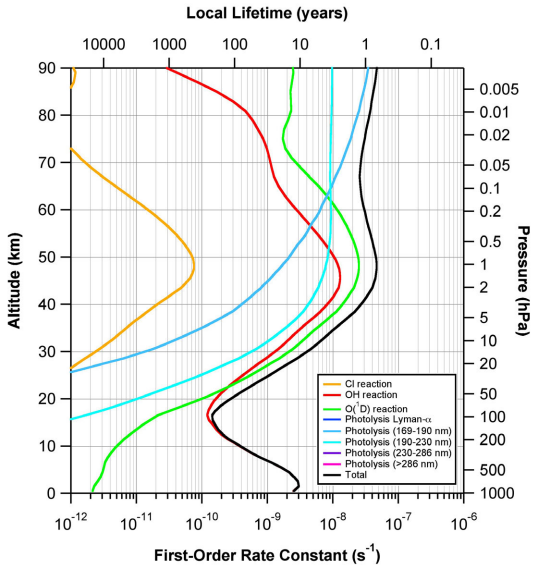


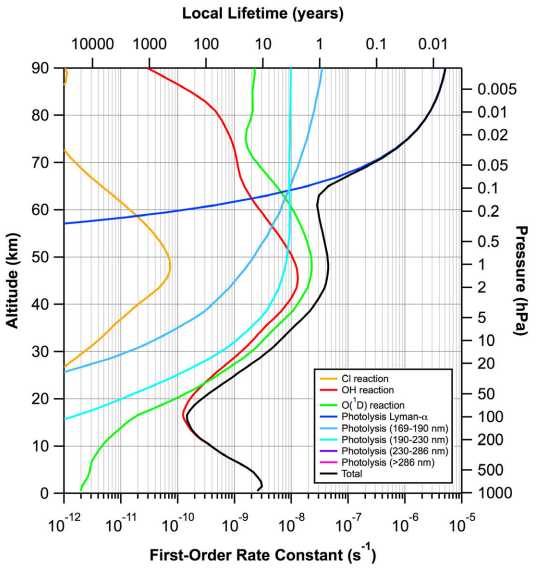



# 18. $CH_3CF_2Cl$ (HCFC-142b)

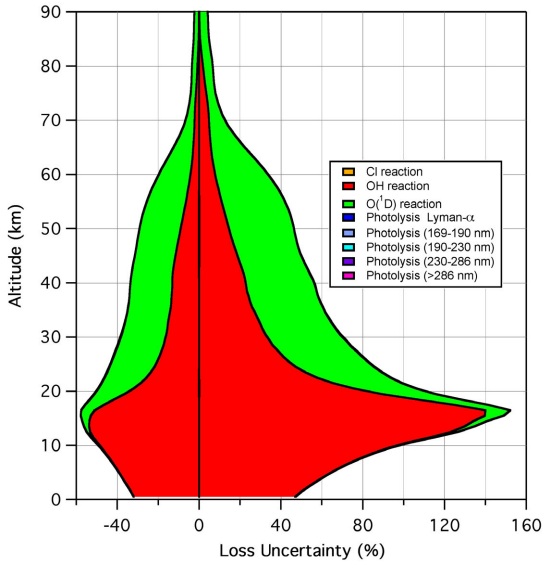
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 17.5 (11.2-27.0) yrs | 17.5 (12.9-23.6) yrs |

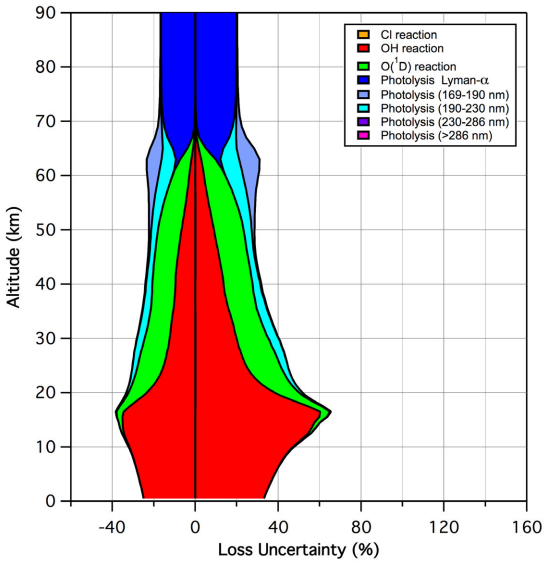
## Gas-Phase Loss Processes



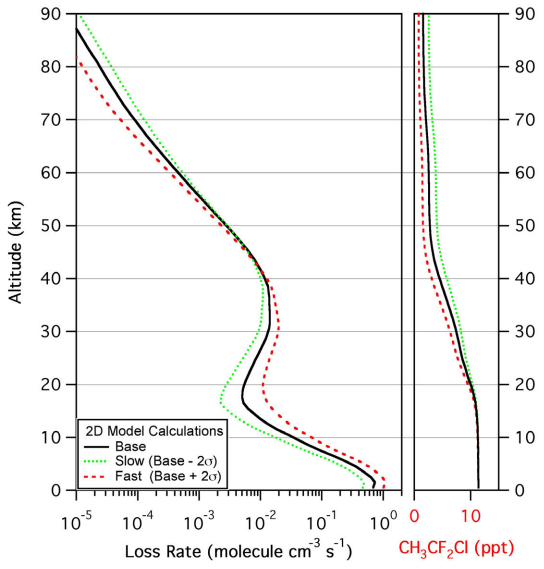



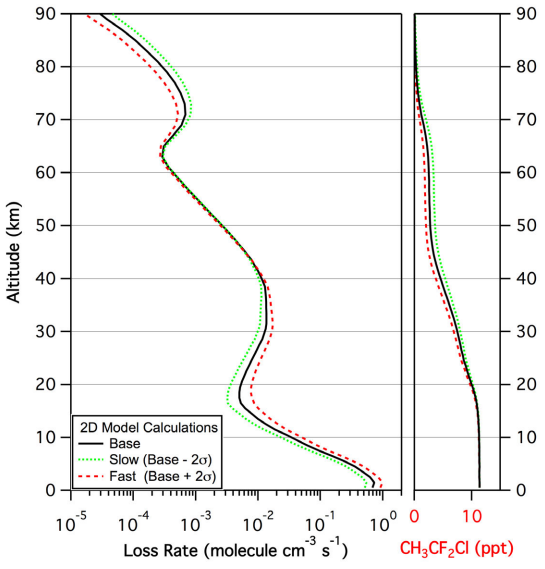

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

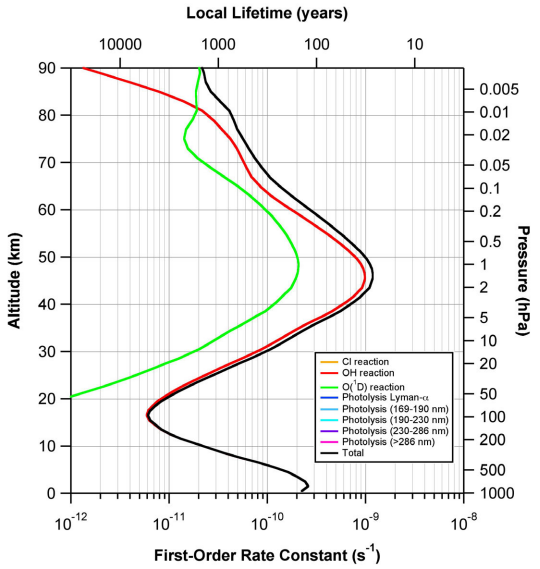


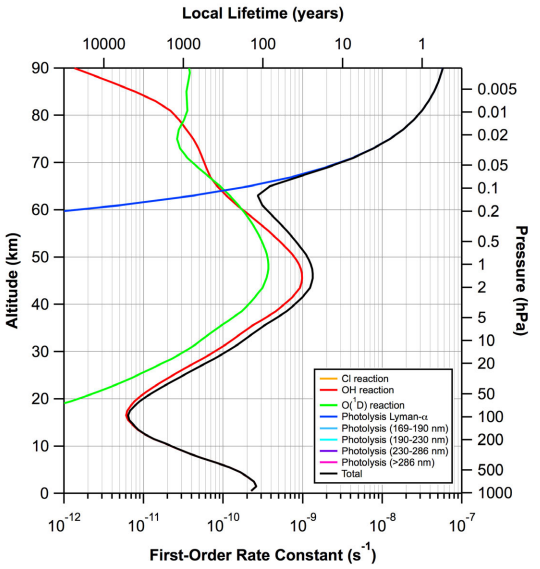



# 19. $CHF_3$ (HFC-23)

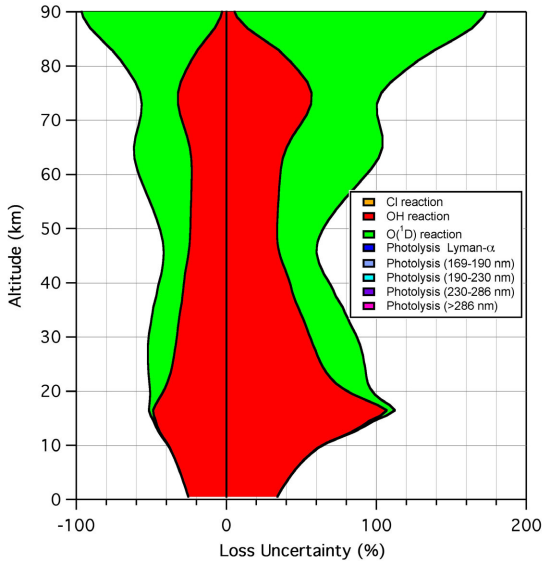
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 226.4 (160.2-319.5) yrs | 223.8 (159.4-313.3) yrs |

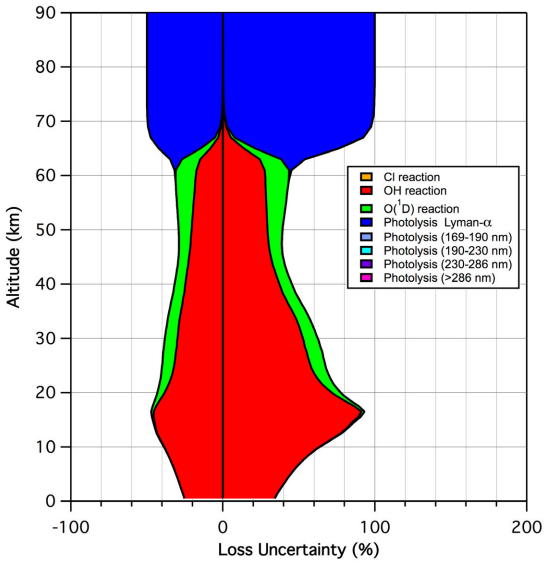
## Gas-Phase Loss Processes



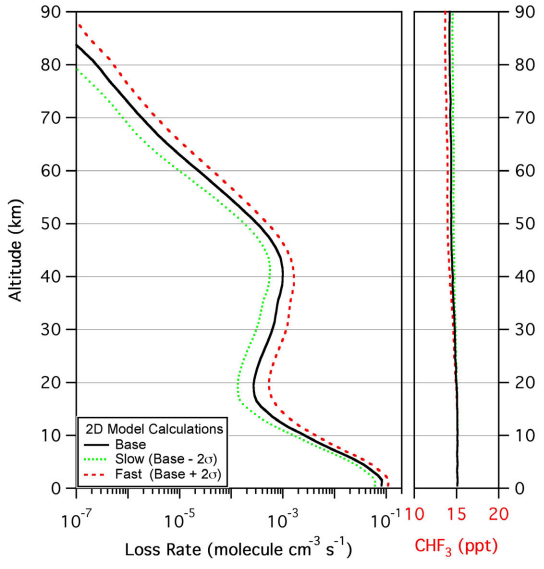



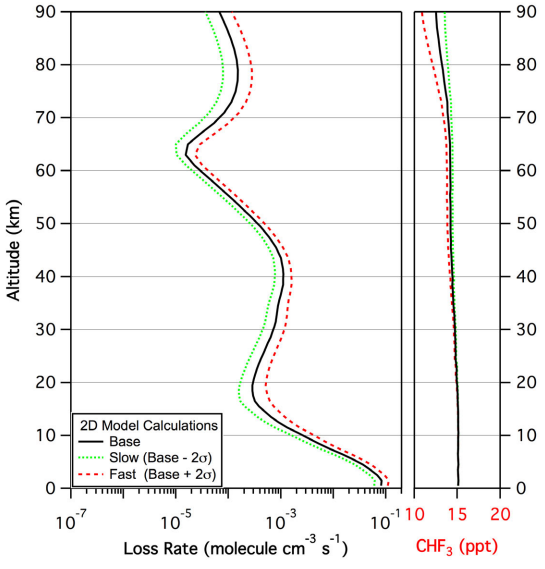

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

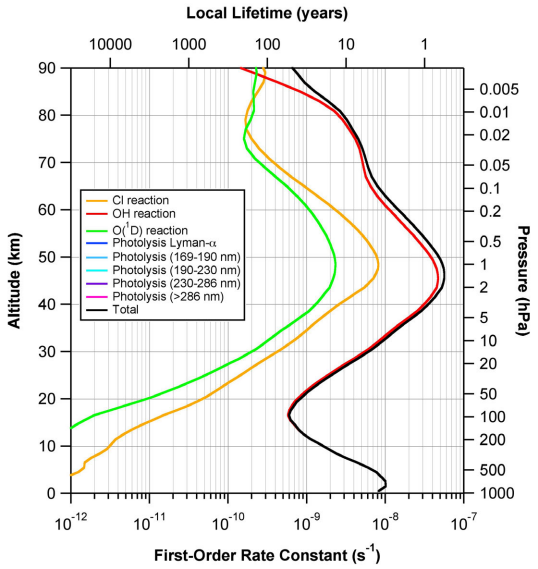


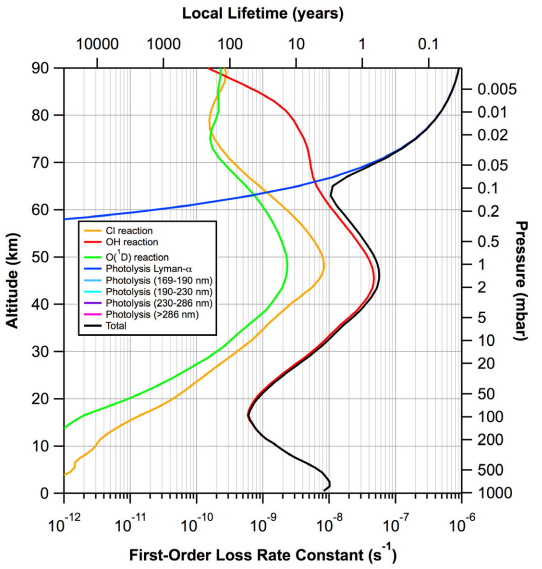



# 20. $CH_2F_2$ (HFC-32)

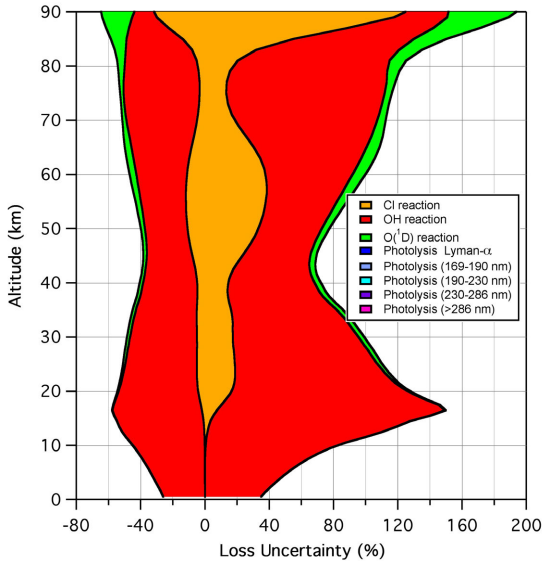
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 5.21 (3.54-7.60) yrs | 5.21 (4.24-6.37) yrs |

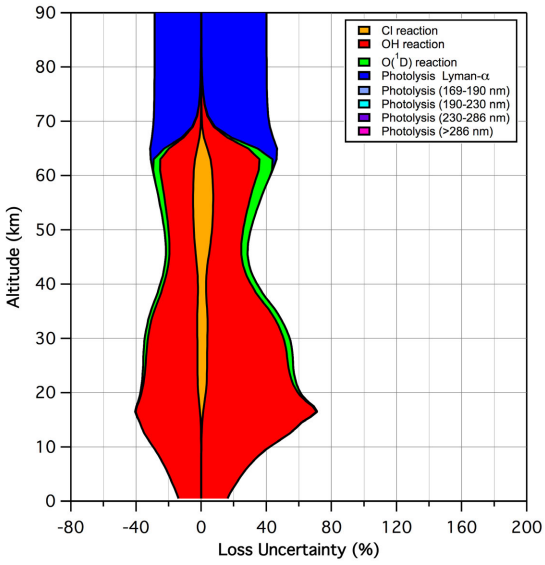
## Gas-Phase Loss Processes



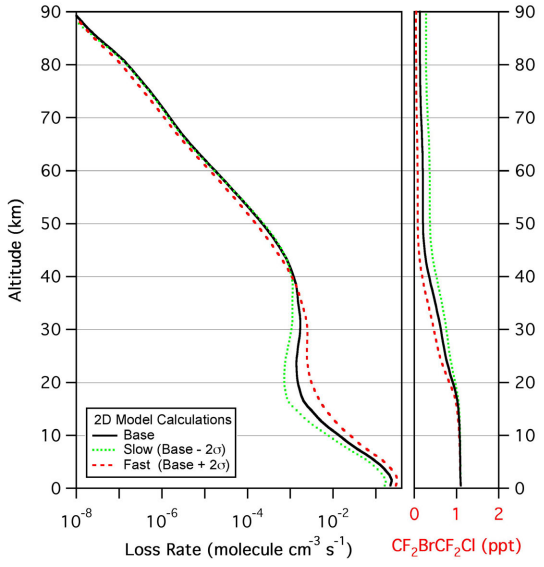



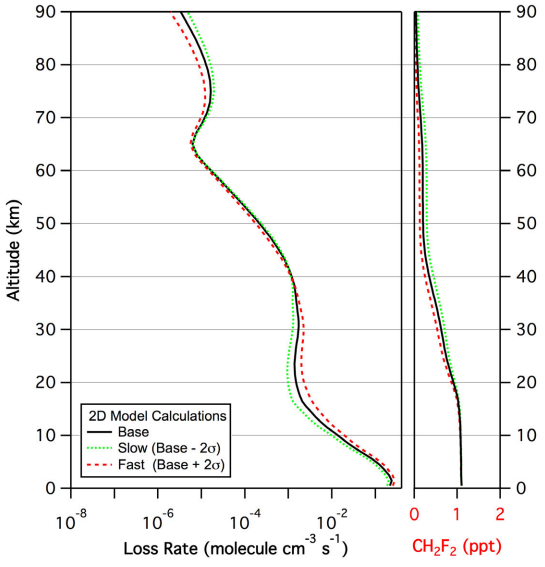

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

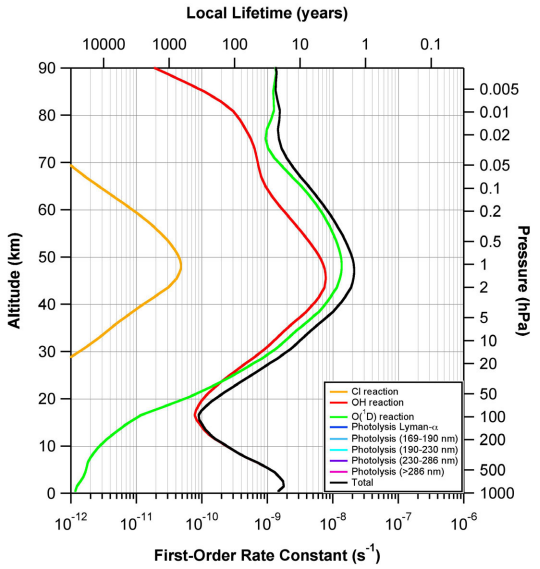


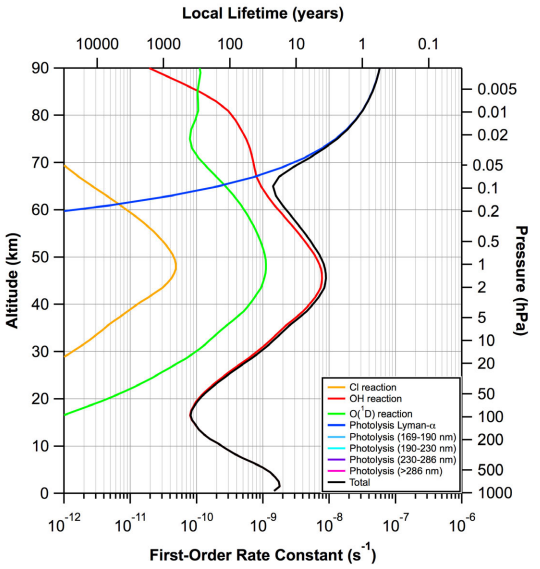



# 21. $CHF_2CF_3$ (HFC-125)

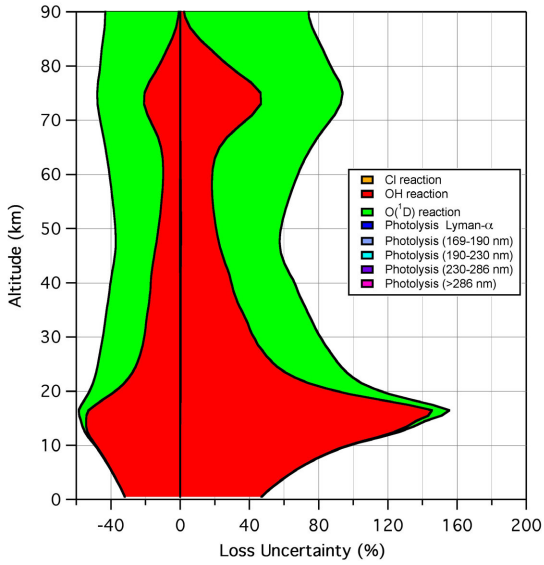
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 29.3 (18.6-46.0) yrs | **30.6 (23.7-39.5) yrs** |

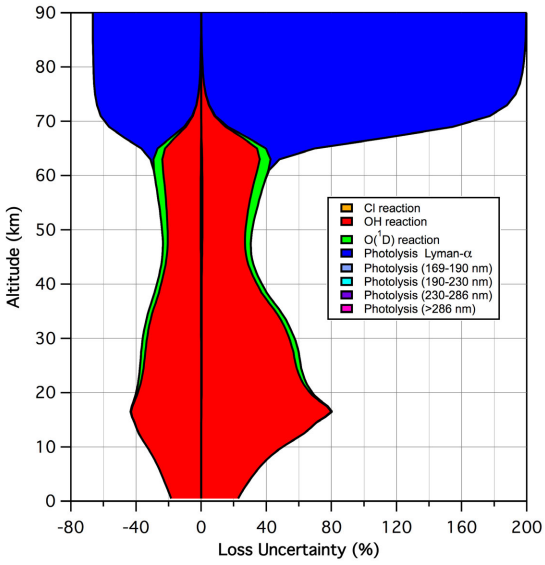
## Gas-Phase Loss Processes



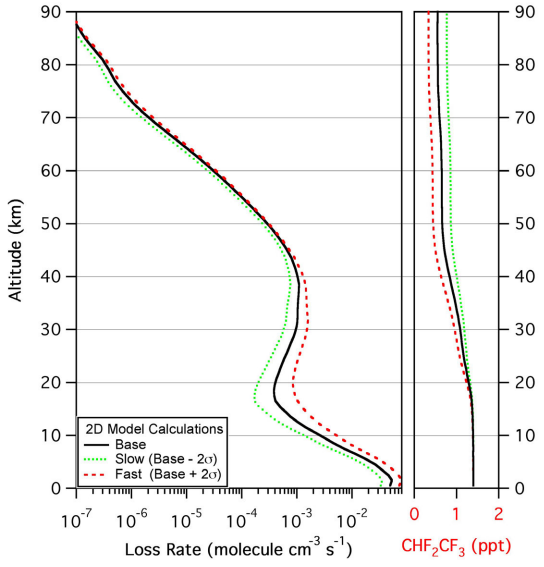



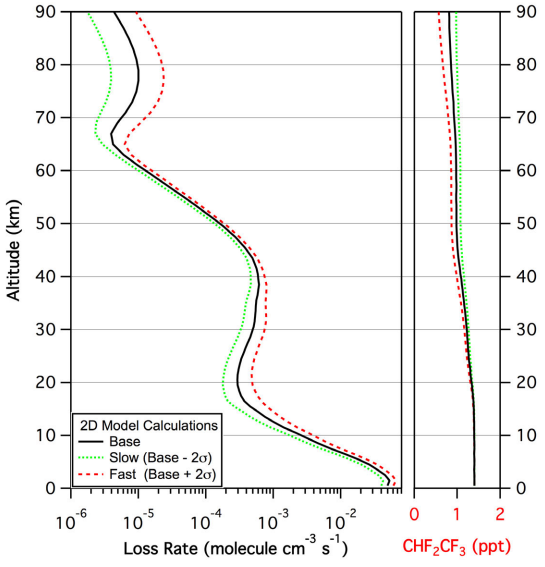

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

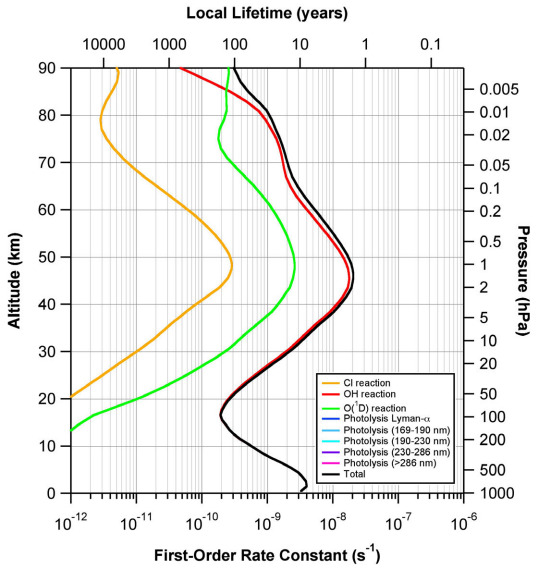


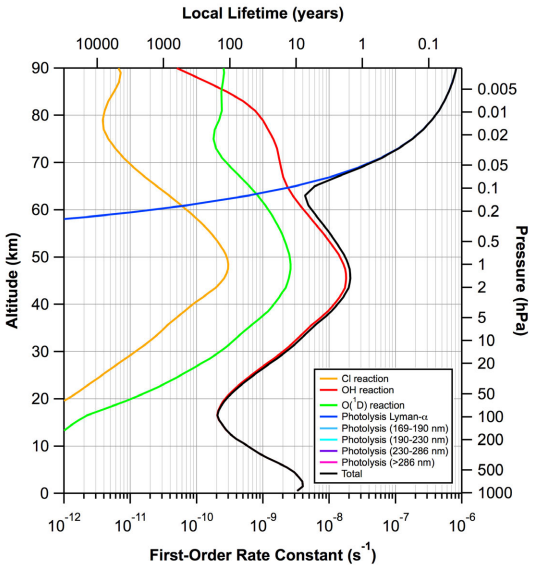



# 22. $CH_2FCF_3$ (HFC-134a)

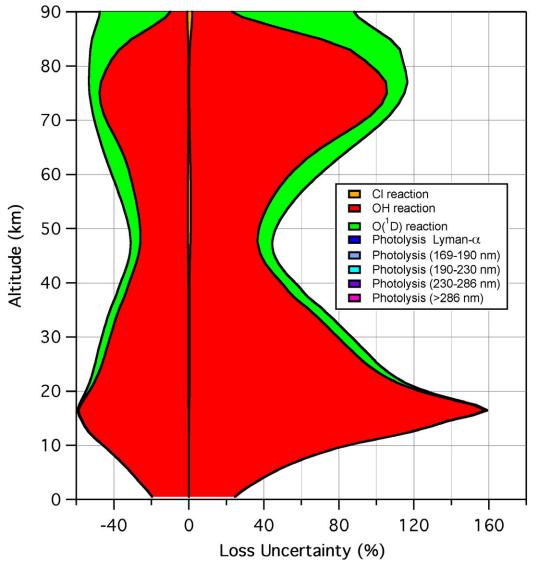
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 13.6 (9.80-18.6) yrs | 13.4 (10.4-17.3) yrs |

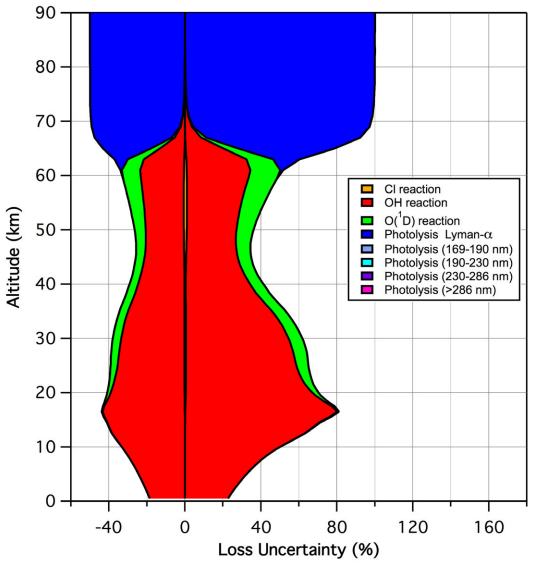
## Gas-Phase Loss Processes



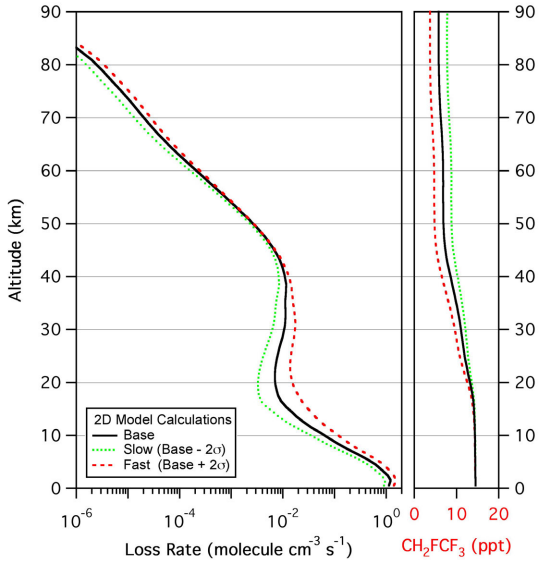



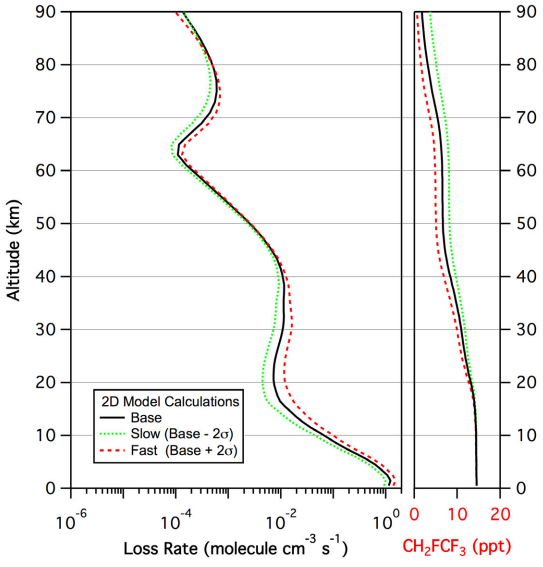

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

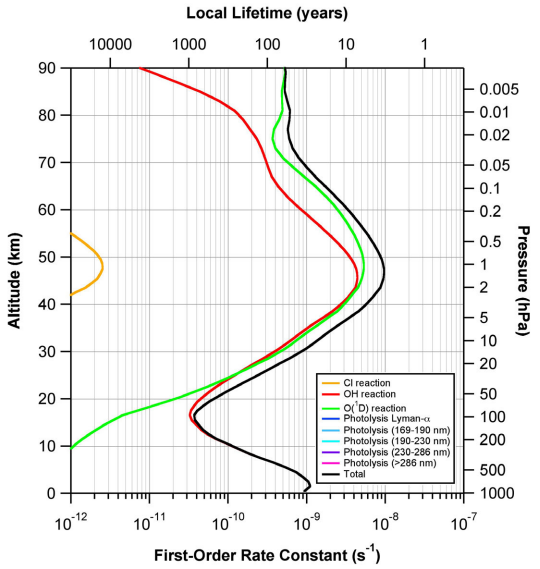


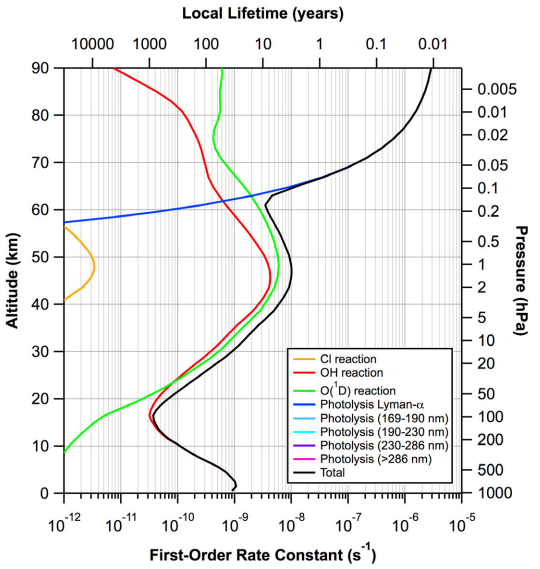



# 23. $CH_3CF_3$ (HFC-143a)

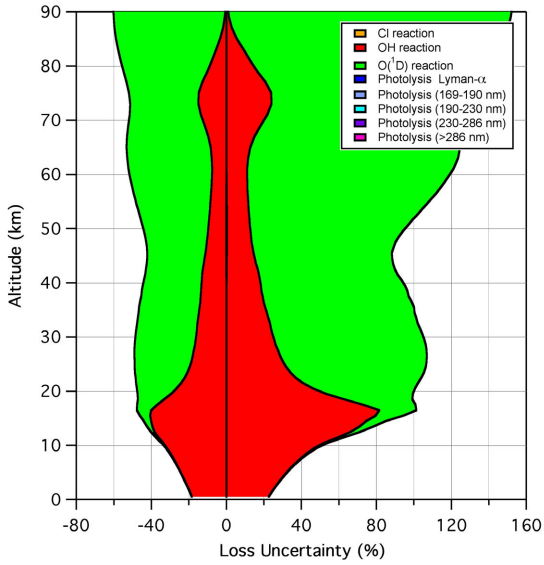
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 50.1 (38.0-65.4) yrs | 51.0 (38.9-65.7) yrs |

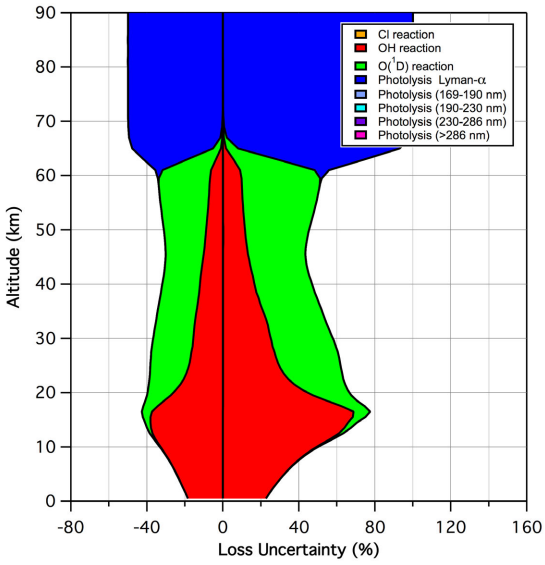
## Gas-Phase Loss Processes



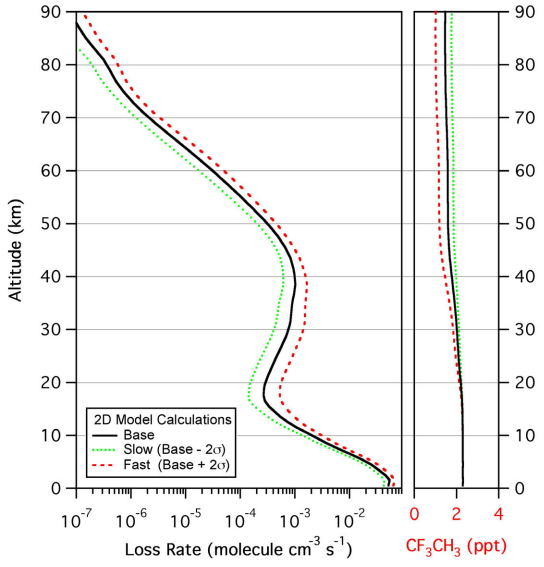



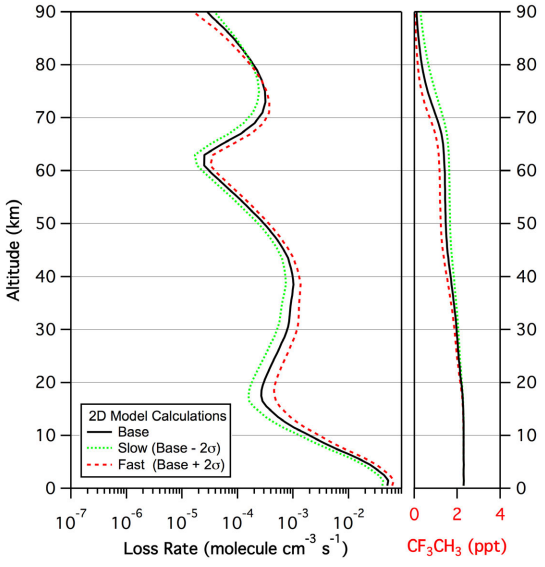

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

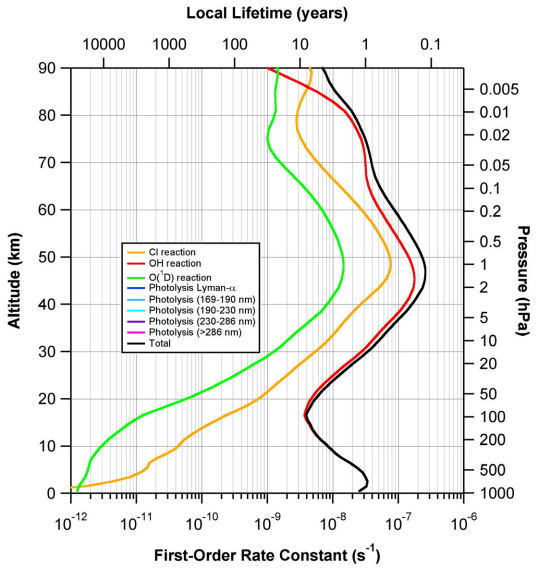


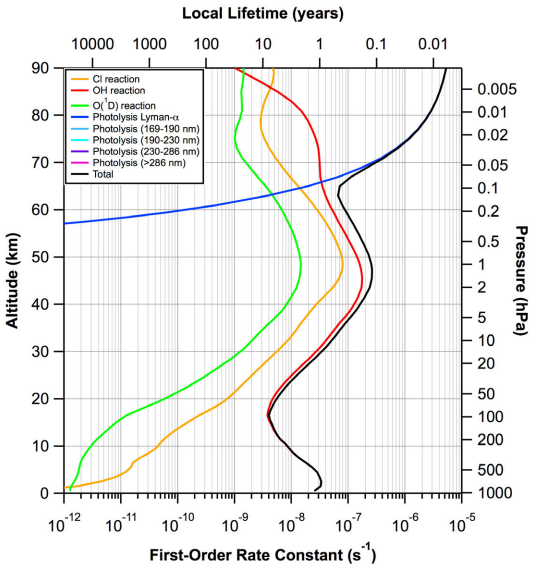



# 24. $CH_3CHF_2$ (HFC-152a)

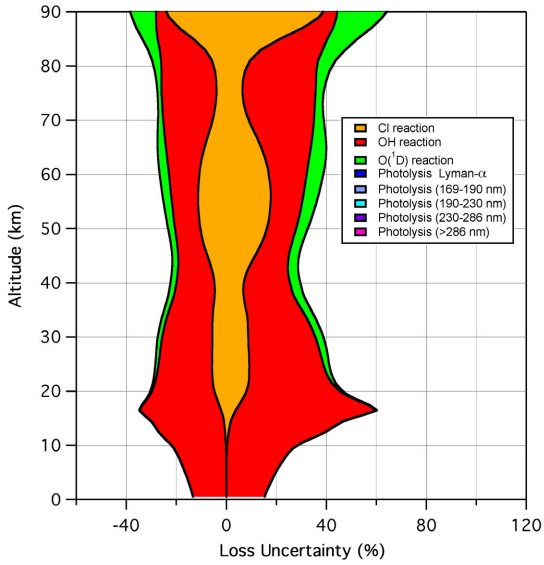
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 1.45 (1.21-1.73) yrs | **1.45 (1.26-1.67) yrs** |

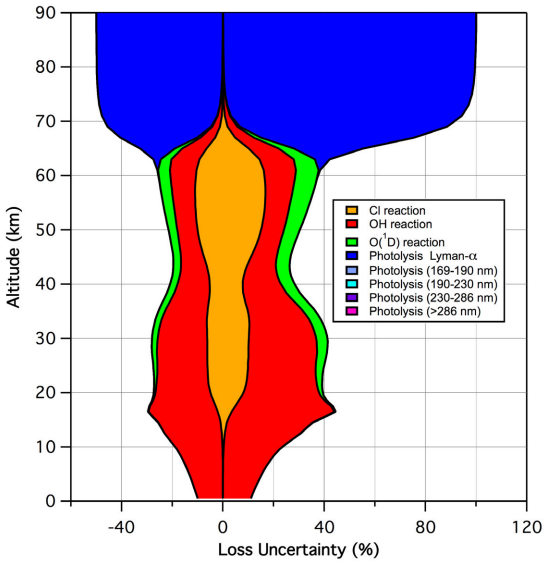
## Gas-Phase Loss Processes



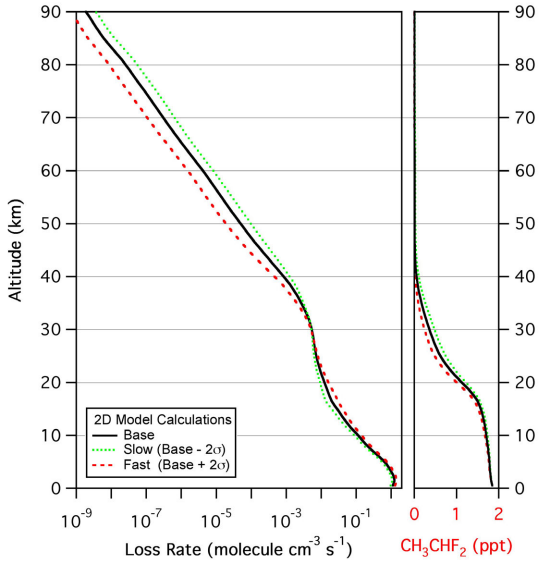



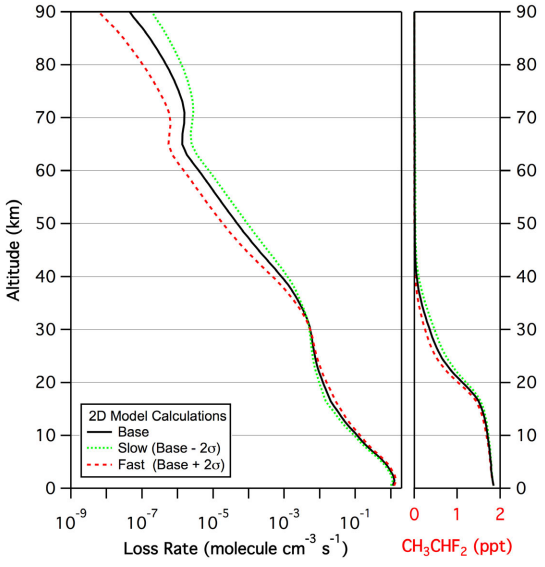

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

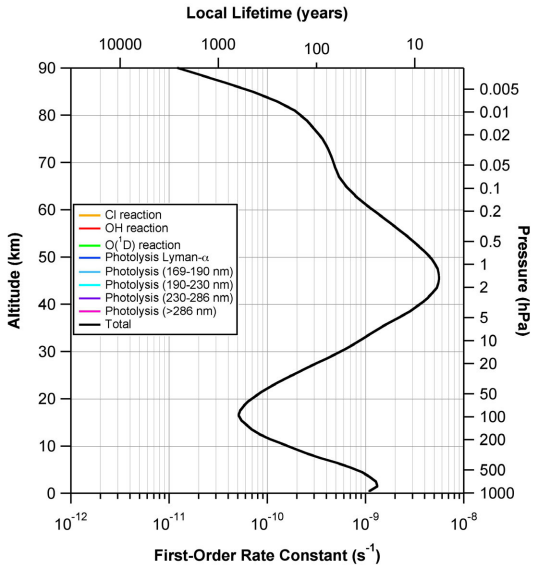


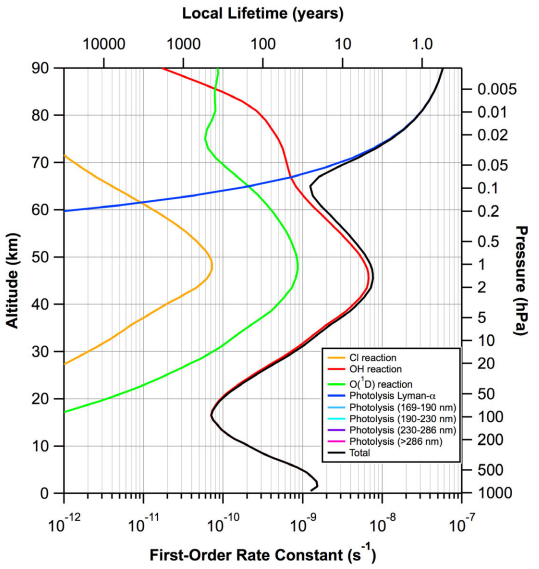



# 25. $CF_3CHFCF_3$ (HFC-227ea)

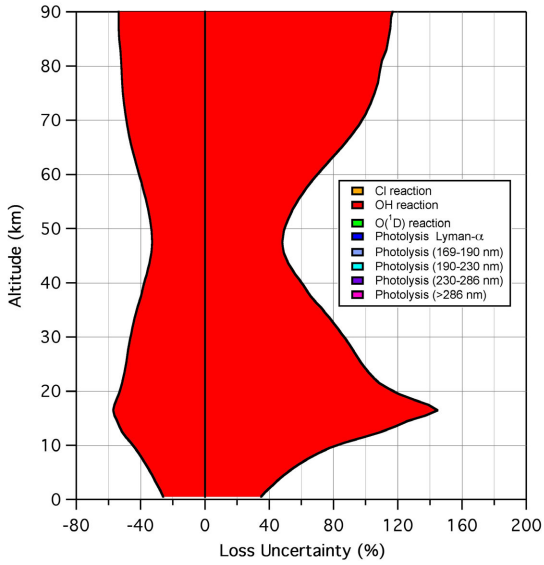
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 42.3 (29.0-61.3) yrs | 35.6 (25.6-49.4) yrs |

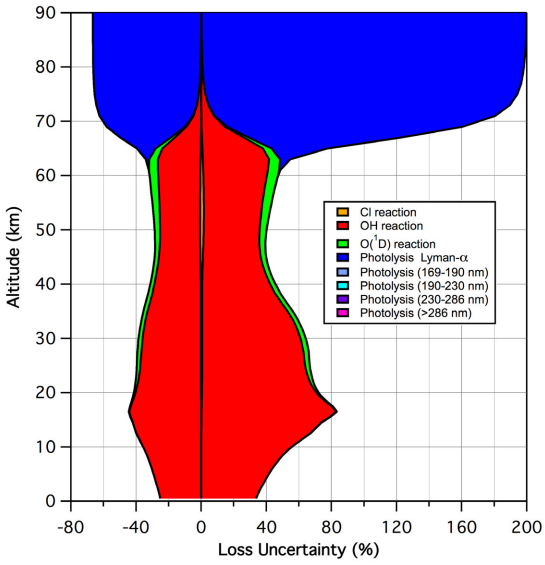
## Gas-Phase Loss Processes



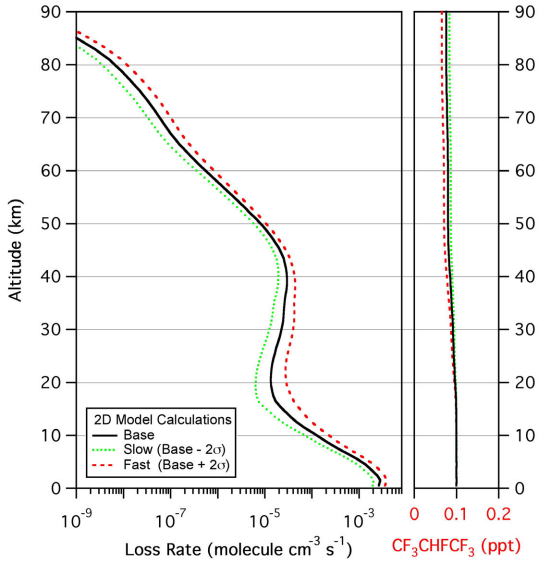



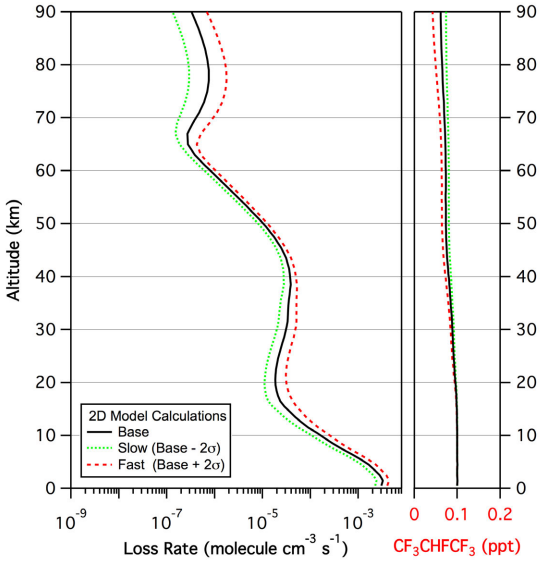

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

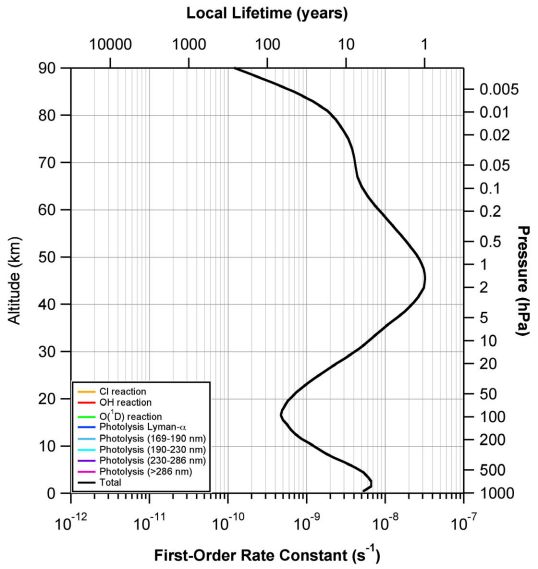


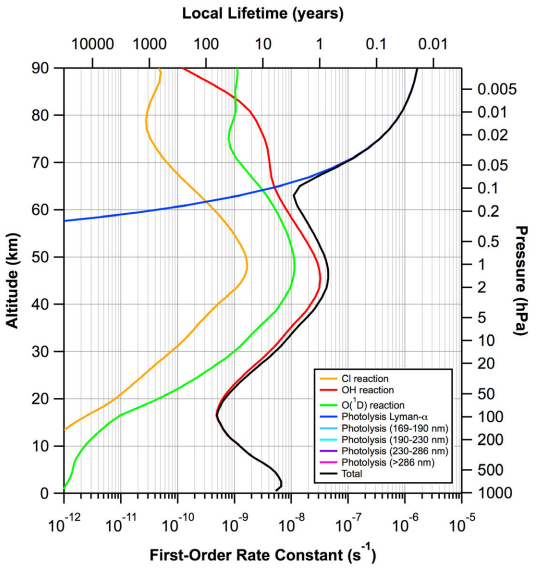



# 26. $CHF_2CH_2CF_3$ (HFC-245fa)

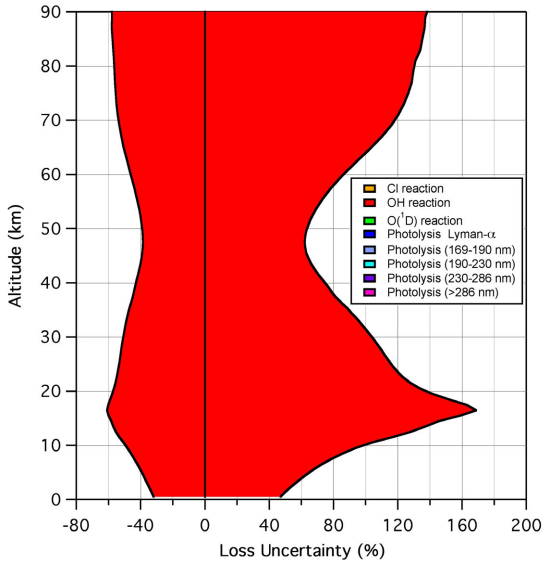
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 7.79 (4.85-12.4) yrs | 7.73 (5.44-10.9) yrs |

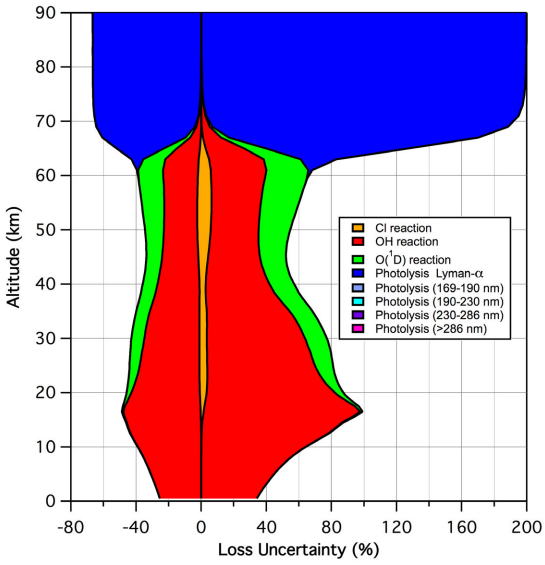
## Gas-Phase Loss Processes



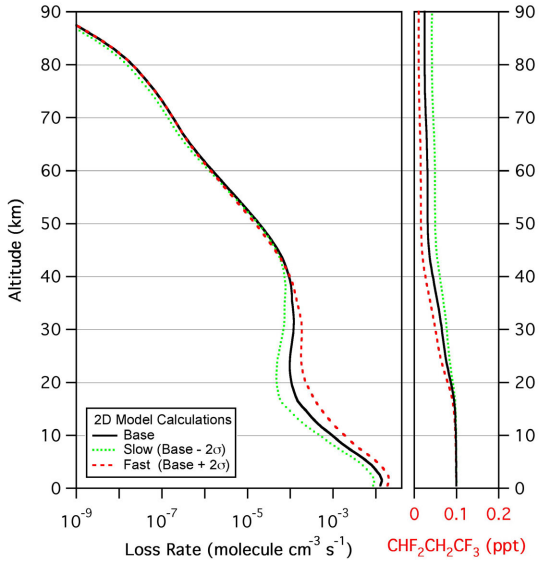



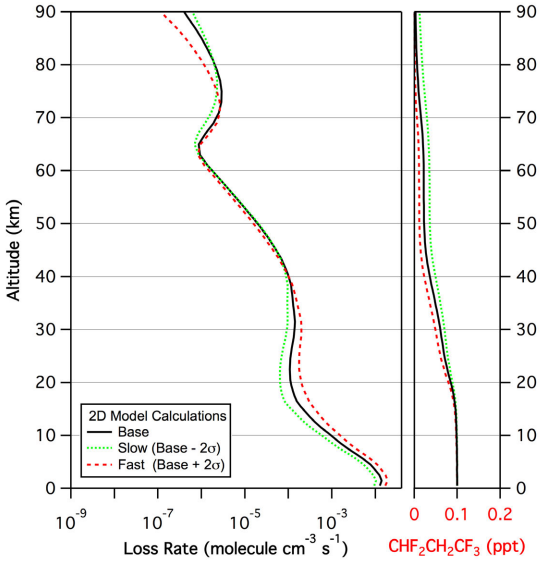

## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles

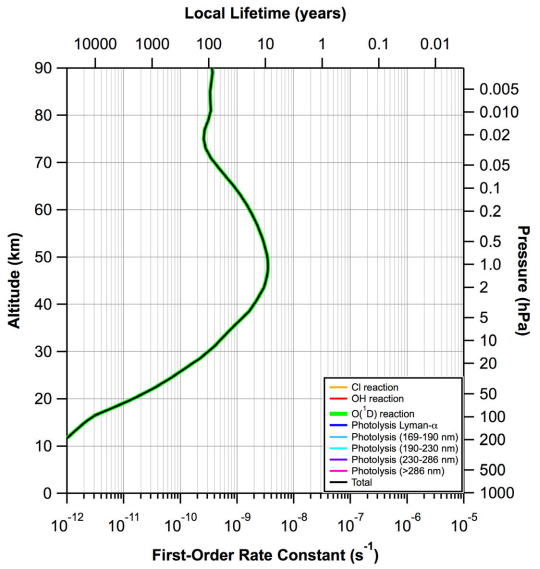


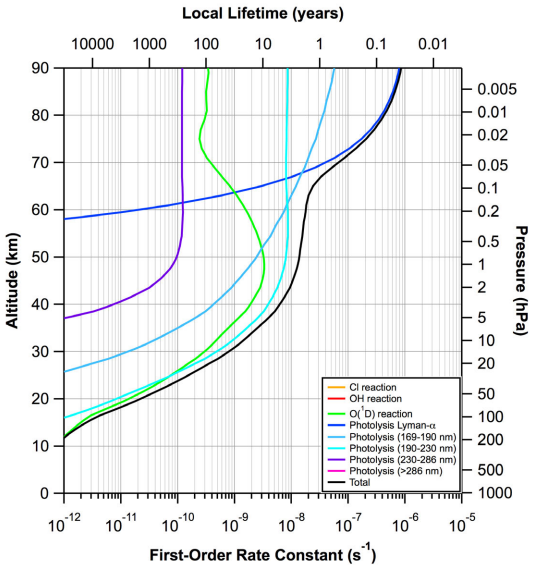



# 27. $NF_3$

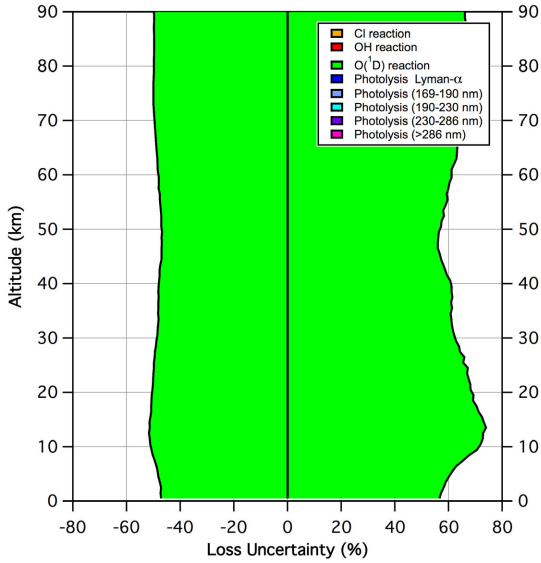
| | JPL10-6 Parameters | SPARC Parameters |
|---|---|---|
| $\tau_{Global}$ | 1588 (1031-2951) yrs | 569.2 (493.8-679.2) yrs |

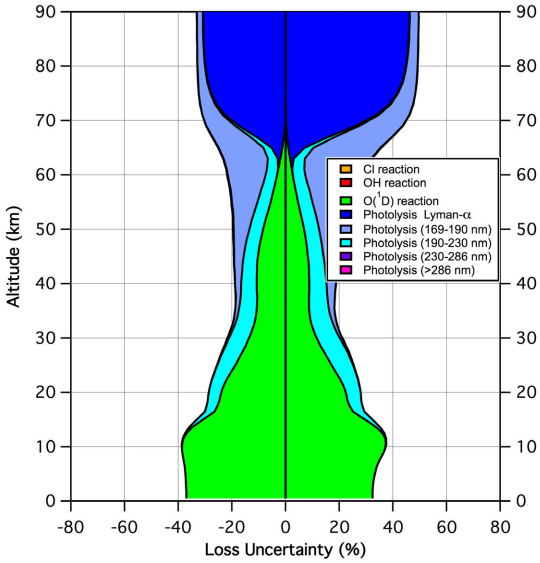
## Gas-Phase Loss Processes




## Estimated Uncertainties




## Molecular Loss Rates, Uncertainties, and Profiles