A total of 81 bimolecular reactions were selected and they are given in Table 1. A total of 18 trimolecular reactions were selected and they are given in Table 2. The low and high pressure limits are combined as described in the 2003 JPL report available online at `http://jpldataeval.jpl.nasa.gov/download.html`. A total of 48 photolysis reactions were selected and they are given in Table 3. A total of 36 heterogeneous reactions were selected and they are given in Table 4.

References

[1] D.E. Anderson. The troposphere-stratosphere radiation-field at twilight - A spherical model. *Planet. Space Sci.*, 31(12):1517–1523, 1983.

[2] G. Becker, J.U. Grooss, D.S. McKenna, and R. Muller. Stratospheric photolysis frequencies: Impact of an improved numerical solution of the radiative transfer equation. *J. Atmos. Chem.*, 37:217–229, 2000.

[3] D.J. Lary and J.A. Pyle. Diffuse-radiation, twilight, and photochemistry: 1. *J. Atmos. Chem.*, 13(4):373–392, 1991.

[4] D.J. Lary and J.A. Pyle. Diffuse-radiation, twilight, and photochemistry: 2. *J. Atmos. Chem.*, 13(4):393–406, 1991.

[5] R.R. Meier, D.E. Anderson, and M. Nicolet. Radiation-field in the troposphere and stratosphere from 240-1000 nm. 1., General-analysis. *Planet. Space Sci.*, 30(9):923–933, 1982.

[6] M. Nicolet, R.R. Meier, and D.E. Anderson. Radiation-field in the troposphere and stratosphere .2. Numerical-analysis. *Planet. Space Sci.*, 30(9):935–983, 1982.

[7] W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery. *Numerical Recipes in Fortran - The Art of Scientific Computing*. Cambridge Univ. Press, New York, 2nd edition, 1992.

[8] WMO. Scientific assessment of stratospheric ozone: 1985. Technical Report 16, Global Ozone Res. and Monitor. Proj., Geneva, Switzerland, 1986.

#	Reactants		Products	Rate coefficient
1	$O(^3P) + O_3$	$\longrightarrow$	$2\ O_2$	$k_1^{bi} = 8.000x10^{-12}\ e^{-\frac{2060.}{T}}$
2	$OH + O_3$	$\longrightarrow$	$HO_2 + O_2$	$k_2^{bi} = 1.700x10^{-12}\ e^{-\frac{940.0}{T}}$
3	$HO_2 + O_3$	$\longrightarrow$	$OH + 2\ O_2$	$k_3^{bi} = 1.000x10^{-14}\ e^{-\frac{490.0}{T}}$
4	$ClO + HO_2$	$\longrightarrow$	$HOCl + O_2$	$k_4^{bi} = 2.700x10^{-12}\ e^{\frac{220.0}{T}}$
5	$Cl + H_2O_2$	$\longrightarrow$	$HCl + HO_2$	$k_5^{bi} = 1.100x10^{-11}\ e^{-\frac{980.0}{T}}$
6	$O(^1D) + N_2$	$\longrightarrow$	$O(^3P) + N_2$	$k_6^{bi} = 1.800x10^{-11}\ e^{\frac{110.0}{T}}$
7	$O(^1D) + O_2$	$\longrightarrow$	$O(^3P) + O_2$	$k_7^{bi} = 3.200x10^{-11}\ e^{\frac{70.00}{T}}$
8	$NO + O_3$	$\longrightarrow$	$NO_2 + O_2$	$k_8^{bi} = 3.000x10^{-12}\ e^{-\frac{1500.}{T}}$
9	$NO_2 + O_3$	$\longrightarrow$	$NO_3 + O_2$	$k_9^{bi} = 1.200x10^{-13}\ e^{-\frac{2450.}{T}}$
10	$H + O_3$	$\longrightarrow$	$OH + O_2$	$k_{10}^{bi} = 1.400x10^{-10}\ e^{-\frac{470.0}{T}}$
11	$OH + ClONO_2$	$\longrightarrow$	$HOCl + NO_3$	$k_{11}^{bi} = 1.200x10^{-12}\ e^{-\frac{330.0}{T}}$
12	$CH_4 + OH$	$\longrightarrow$	$CH_3 + H_2O$	$k_{12}^{bi} = 2.450x10^{-12}\ e^{-\frac{1775.}{T}}$
13	$CH_3O_2 + NO$	$\longrightarrow$	$CH_3O + NO_2$	$k_{13}^{bi} = 2.800x10^{-12}\ e^{\frac{300.0}{T}}$
14	$CH_3O + O_2$	$\longrightarrow$	$HCHO + HO_2$	$k_{14}^{bi} = 3.900x10^{-14}\ e^{-\frac{900.0}{T}}$
15	$HO_2 + HO_2$	$\longrightarrow$	$H_2O_2 + O_2$	$k_{15}^{bi} = 2.300x10^{-13}\ e^{\frac{600.0}{T}}$
16	$N + O_2$	$\longrightarrow$	$NO + O(^3P)$	$k_{16}^{bi} = 1.500x10^{-11}\ e^{-\frac{3600.}{T}}$
17	$HCHO + O(^3P)$	$\longrightarrow$	$HCO + OH$	$k_{17}^{bi} = 3.400x10^{-11}\ e^{-\frac{1600.}{T}}$
18	$CH_3O_2 + HO_2$	$\longrightarrow$	$CH_3OOH + O_2$	$k_{18}^{bi} = 4.100x10^{-13}\ e^{\frac{750.0}{T}}$
19	$Cl + H_2$	$\longrightarrow$	$HCl + H$	$k_{19}^{bi} = 3.700x10^{-11}\ e^{-\frac{2300.}{T}}$
20	$Cl + O_3$	$\longrightarrow$	$ClO + O_2$	$k_{20}^{bi} = 2.300x10^{-11}\ e^{-\frac{200.0}{T}}$
21	$ClO + O(^3P)$	$\longrightarrow$	$Cl + O_2$	$k_{21}^{bi} = 3.000x10^{-11}\ e^{\frac{70.00}{T}}$
22	$Cl + CH_4$	$\longrightarrow$	$HCl + CH_3$	$k_{22}^{bi} = 9.600x10^{-12}\ e^{-\frac{1360.}{T}}$
23	$HCl + OH$	$\longrightarrow$	$Cl + H_2O$	$k_{23}^{bi} = 2.600x10^{-12}\ e^{-\frac{350.0}{T}}$
24	$ClO + NO$	$\longrightarrow$	$Cl + NO_2$	$k_{24}^{bi} = 6.400x10^{-12}\ e^{\frac{290.0}{T}}$
25	$OH + H_2O_2$	$\longrightarrow$	$H_2O + HO_2$	$k_{25}^{bi} = 2.900x10^{-12}\ e^{-\frac{160.0}{T}}$
26	$H_2 + OH$	$\longrightarrow$	$H_2O + H$	$k_{26}^{bi} = 5.500x10^{-12}\ e^{-\frac{2000.}{T}}$
27	$O(^3P) + H_2O_2$	$\longrightarrow$	$OH + HO_2$	$k_{27}^{bi} = 1.400x10^{-12}\ e^{-\frac{2000.}{T}}$
28	$O(^3P) + ClONO_2$	$\longrightarrow$	$ClO + NO_3$	$k_{28}^{bi} = 2.900x10^{-12}\ e^{-\frac{800.0}{T}}$
29	$CO + OH$	$\longrightarrow$	$CO_2 + H$	$k_{29}^{bi} = 1.500x10^{-13}$
30	$HNO_3 + OH$	$\longrightarrow$	$NO_3 + H_2O$	$k_{30}^{bi} = 2.410x10^{-14}\ e^{-\frac{460.0}{T}}$
31	$NO + HO_2$	$\longrightarrow$	$OH + NO_2$	$k_{31}^{bi} = 3.500x10^{-12}\ e^{\frac{250.0}{T}}$
32	$H_2O + O(^1D)$	$\longrightarrow$	$OH + OH$	$k_{32}^{bi} = 2.200x10^{-10}$
33	$OH + HO_2$	$\longrightarrow$	$H_2O + O_2$	$k_{33}^{bi} = 4.800x10^{-11}\ e^{\frac{250.0}{T}}$
34	$OH + O(^3P)$	$\longrightarrow$	$H + O_2$	$k_{34}^{bi} = 2.200x10^{-11}\ e^{\frac{120.0}{T}}$
35	$HO_2 + O(^3P)$	$\longrightarrow$	$OH + O_2$	$k_{35}^{bi} = 3.000x10^{-11}\ e^{\frac{200.0}{T}}$
36	$NO_2 + O(^3P)$	$\longrightarrow$	$NO + O_2$	$k_{36}^{bi} = 5.600x10^{-12}\ e^{\frac{180.0}{T}}$
37	$N_2O + O(^1D)$	$\longrightarrow$	$2\ NO$	$k_{37}^{bi} = 6.700x10^{-11}$
38	$N + NO$	$\longrightarrow$	$N_2 + O(^3P)$	$k_{38}^{bi} = 2.100x10^{-11}\ e^{\frac{100.0}{T}}$
39	$H_2 + O(^1D)$	$\longrightarrow$	$OH + H$	$k_{39}^{bi} = 1.100x10^{-10}$

Table 1: Bimolecular reactions.

#	Reactants		Products	Rate coefficient
40	$CH_4 + O(^1D)$	$\longrightarrow$	$CH_3 + OH$	$k^{bi}_{40} = 1.250x10^{-11}$
41	$HCHO + OH$	$\longrightarrow$	$H_2O + HCO$	$k^{bi}_{41} = 9.000x10^{-12}$
42	$HCO + O_2$	$\longrightarrow$	$CO + HO_2$	$k^{bi}_{42} = 5.200x10^{-12}$
43	$Cl + HO_2$	$\longrightarrow$	$HCl + O_2$	$k^{bi}_{43} = 1.800x10^{-11}\ e^{\frac{170.0}{T}}$
44	$OH + HO_2NO_2$	$\longrightarrow$	$H_2O + O_2 + NO_2$	$k^{bi}_{44} = 1.300x10^{-12}\ e^{\frac{380.0}{T}}$
45	$CH_4 + O(^1D)$	$\longrightarrow$	$H_2 + HCHO$	$k^{bi}_{45} = 7.500x10^{-12}$
46	$OH + CH_3OOH$	$\longrightarrow$	$H_2O + CH_3O_2$	$k^{bi}_{46} = 3.800x10^{-12}\ e^{\frac{200.0}{T}}$
47	$OH + OH$	$\longrightarrow$	$H_2O + O(^3P)$	$k^{bi}_{47} = 4.200x10^{-12}\ e^{-\frac{240.0}{T}}$
48	$ClO + OH$	$\longrightarrow$	$Cl + HO_2$	$k^{bi}_{48} = 7.400x10^{-12}\ e^{\frac{270.0}{T}}$
49	$ClO + OH$	$\longrightarrow$	$HCl + O_2$	$k^{bi}_{49} = 6.000x10^{-13}\ e^{\frac{230.0}{T}}$
50	$HOCl + OH$	$\longrightarrow$	$H_2O + ClO$	$k^{bi}_{50} = 3.000x10^{-12}\ e^{-\frac{500.0}{T}}$
51	$Cl + HCHO$	$\longrightarrow$	$HCl + HCO$	$k^{bi}_{51} = 8.100x10^{-11}\ e^{-\frac{30.00}{T}}$
52	$HO_2 + HO_2$	$\longrightarrow$	$H_2O_2 + O_2$	$k^{bi}_{52} = 1.700x10^{-33}\ e^{\frac{1000.}{T}}$
53	$BrO + NO$	$\longrightarrow$	$Br + NO_2$	$k^{bi}_{53} = 8.800x10^{-12}\ e^{\frac{260.0}{T}}$
54	$Cl + HO_2$	$\longrightarrow$	$OH + ClO$	$k^{bi}_{54} = 4.100x10^{-11}\ e^{-\frac{450.0}{T}}$
55	$N + OH$	$\longrightarrow$	$NO + H$	$k^{bi}_{55} = 5.000x10^{-11}$
56	$Br + HCHO$	$\longrightarrow$	$HBr + HCO$	$k^{bi}_{56} = 1.700x10^{-11}\ e^{-\frac{800.0}{T}}$
57	$H + HO_2$	$\longrightarrow$	$H_2 + O_2$	$k^{bi}_{57} = 6.500x10^{-12}$
58	$H + HO_2$	$\longrightarrow$	$H_2O + O(^3P)$	$k^{bi}_{58} = 1.600x10^{-12}$
59	$H + HO_2$	$\longrightarrow$	$OH + OH$	$k^{bi}_{59} = 7.300x10^{-11}$
60	$NO + NO_3$	$\longrightarrow$	$NO_2 + NO_2$	$k^{bi}_{60} = 1.500x10^{-11}\ e^{\frac{170.0}{T}}$
61	$N_2O + O(^1D)$	$\longrightarrow$	$N_2 + O_2$	$k^{bi}_{61} = 4.900x10^{-11}$
62	$N_2O_5 + H_2O$	$\longrightarrow$	$2\ HNO_3$	$k^{bi}_{62} = 2.000x10^{-21}$
63	$O(^1D) + CF_2Cl_2$	$\longrightarrow$	$ClO + Cl$	$k^{bi}_{63} = 1.400x10^{-10}$
64	$N + NO_2$	$\longrightarrow$	$N_2O + O(^3P)$	$k^{bi}_{64} = 5.800x10^{-12}\ e^{\frac{220.0}{T}}$
65	$Br + O_3$	$\longrightarrow$	$BrO + O_2$	$k^{bi}_{65} = 1.700x10^{-11}\ e^{-\frac{800.0}{T}}$
66	$Br + HO_2$	$\longrightarrow$	$HBr + O_2$	$k^{bi}_{66} = 1.500x10^{-11}\ e^{-\frac{600.0}{T}}$
67	$BrO + BrO$	$\longrightarrow$	$2\ Br + O_2$	$k^{bi}_{67} = 1.500x10^{-12}\ e^{\frac{230.0}{T}}$
68	$OH + HBr$	$\longrightarrow$	$H_2O + Br$	$k^{bi}_{68} = 1.100x10^{-11}$
69	$CH_3Br + OH$	$\longrightarrow$	Br	$k^{bi}_{69} = 2.350x10^{-12}\ e^{-\frac{1300.}{T}}$
70	$BrO + ClO$	$\longrightarrow$	$Br + OClO$	$k^{bi}_{70} = 9.500x10^{-13}\ e^{\frac{550.0}{T}}$
71	$BrO + ClO$	$\longrightarrow$	$Br + ClOO$	$k^{bi}_{71} = 2.300x10^{-12}\ e^{\frac{260.0}{T}}$
72	$BrO + ClO$	$\longrightarrow$	$BrCl + O_2$	$k^{bi}_{72} = 4.100x10^{-13}\ e^{\frac{290.0}{T}}$
73	$BrO + HO_2$	$\longrightarrow$	$HOBr + O_2$	$k^{bi}_{73} = 3.400x10^{-12}\ e^{\frac{540.0}{T}}$
74	$BrO + O(^3P)$	$\longrightarrow$	$Br + O_2$	$k^{bi}_{74} = 1.900x10^{-11}\ e^{\frac{230.0}{T}}$
75	$CH_4 + O(^1D)$	$\longrightarrow$	$H + CH_3O$	$k^{bi}_{75} = 3.000x10^{-11}$
76	$O(^1D) + CH_3Br$	$\longrightarrow$	$Br + CH_3O$	$k^{bi}_{76} = 1.800x10^{-10}$
77	$O(^1D) + O_3$	$\longrightarrow$	$O_2 + O_2$	$k^{bi}_{77} = 1.200x10^{-10}$
78	$O(^1D) + O_3$	$\longrightarrow$	$O_2 + O(^3P) + O(^3P)$	$k^{bi}_{78} = 1.200x10^{-10}$
79	$H + NO_2$	$\longrightarrow$	$OH + NO$	$k^{bi}_{79} = 4.000x10^{-10}$
80	$BrO + CH_3O_2$	$\longrightarrow$	$O_2 + Br + CH_3O$	$k^{bi}_{80} = 3.230x10^{-11}\ e^{-\frac{965.0}{T}}$
81	$ClO + CH_3O_2$	$\longrightarrow$	$O_2 + Cl + CH_3O$	$k^{bi}_{81} = 3.300x10^{-12}\ e^{-\frac{965.0}{T}}$

Table 1: (continued) Bimolecular reactions.

#	Reactants		Products	Rate coefficient
1	$O(^3P) + O_2$	$\xrightarrow{M}$	O_3	k_1^o=[M] $6.000\text{x}10^{-34}$ $\left(\frac{T}{300.0}\right)^{2.400}$ f_1^c= 0.6000
2	$H + O_2$	$\xrightarrow{M}$	HO_2	k_2^o=[M] $5.700\text{x}10^{-32}$ $\left(\frac{T}{300.0}\right)^{1.600}$ k_2^∞= $7.500\text{x}10^{-11}$ f_2^c= 0.6000
3	$OH + OH$	$\xrightarrow{M}$	H_2O_2	k_3^o=[M] $6.900\text{x}10^{-31}$ $\left(\frac{T}{300.0}\right)^{1.000}$ k_3^∞= $2.600\text{x}10^{-11}$ f_3^c= 0.6000
4	$OH + NO_2$	$\xrightarrow{M}$	HNO_3	k_4^o=[M] $2.000\text{x}10^{-30}$ $\left(\frac{T}{300.0}\right)^{3.000}$ k_4^∞= $2.500\text{x}10^{-11}$ f_4^c= 0.6000
5	$ClO + NO_2$	$\xrightarrow{M}$	$ClONO_2$	k_5^o=[M] $1.800\text{x}10^{-31}$ $\left(\frac{T}{300.0}\right)^{3.400}$ k_5^∞= $1.500\text{x}10^{-11}$ $\left(\frac{T}{300.0}\right)^{1.900}$ f_5^c= 0.6000
6	$HO_2 + NO_2$	$\xrightarrow{M}$	HO_2NO_2	k_6^o=[M] $1.800\text{x}10^{-31}$ $\left(\frac{T}{300.0}\right)^{3.200}$ k_6^∞= $4.700\text{x}10^{-12}$ $\left(\frac{T}{300.0}\right)^{1.400}$ f_6^c= 0.6000
7	$NO_2 + O(^3P)$	$\xrightarrow{M}$	NO_3	k_7^o=[M] $2.500\text{x}10^{-31}$ $\left(\frac{T}{300.0}\right)^{1.800}$ k_7^∞= $2.200\text{x}10^{-11}$ $\left(\frac{T}{300.0}\right)^{0.7000}$ f_7^c= 0.6000
8	$NO_2 + NO_3$	$\xrightarrow{M}$	N_2O_5	k_8^o=[M] $2.000\text{x}10^{-30}$ $\left(\frac{T}{300.0}\right)^{4.400}$ k_8^∞= $1.400\text{x}10^{-12}$ $\left(\frac{T}{300.0}\right)^{0.7000}$ f_8^c= 0.6000
9	$CH_3 + O_2$	$\xrightarrow{M}$	CH_3O_2	k_9^o=[M] $4.500\text{x}10^{-31}$ $\left(\frac{T}{300.0}\right)^{3.000}$ k_9^∞= $1.800\text{x}10^{-12}$ $\left(\frac{T}{300.0}\right)^{1.700}$ f_9^c= 0.6000
10	$NO + O(^3P)$	$\xrightarrow{M}$	NO_2	k_{10}^o=[M] $9.000\text{x}10^{-31}$ $\left(\frac{T}{300.0}\right)^{1.500}$ k_{10}^∞= $3.000\text{x}10^{-11}$ f_{10}^c= 0.6000

Table 2: Trimolecular reactions.

#	Reactants		Products	Rate coefficient
11	$O(^1D) + N_2$	$\xrightarrow{M}$	N_2O	k_{11}^o=[M] $3.500x10^{-37}$ $\left(\frac{T}{300.0}\right)^{0.6000}$ f_{11}^c= 0.6000
12	$O(^3P) + O(^3P)$	$\xrightarrow{M}$	O_2	k_{12}^o=[M] $1.400x10^{-33}$ $\left(\frac{T}{300.0}\right)^{-408.0}$ f_{12}^c= 0.6000
13	$BrO + NO_2$	$\xrightarrow{M}$	$BrONO_2$	k_{13}^o=[M] $5.200x10^{-31}$ $\left(\frac{T}{300.0}\right)^{3.200}$ k_{13}^∞= $6.900x10^{-12}$ $\left(\frac{T}{300.0}\right)^{2.900}$ f_{13}^c= 0.6000
14	$ClO + ClO$	$\xrightarrow{M}$	Cl_2O_2	k_{14}^o=[M] $1.600x10^{-32}$ $\left(\frac{T}{300.0}\right)^{4.500}$ k_{14}^∞= $2.000x10^{-12}$ $\left(\frac{T}{300.0}\right)^{2.400}$ f_{14}^c= 0.6000
15	$CO + O(^3P)$	$\xrightarrow{M}$	CO_2	k_{15}^o=[M] $2.000x10^{-37}$ f_{15}^c= 0.6000
16	N_2O_5	$\xrightarrow{M}$	$NO_2 + M + NO_3$	k_{16}^o=[M] $1.3000E-03$ $\left(\frac{T}{300.0}\right)^{-3.500}$ $e^{-\frac{1.1000E+04}{T}}$ k_{16}^∞= $9.700x10^{14}$ $\left(\frac{T}{300.0}\right)^{0.1000}$ $e^{-\frac{1.1080E+04}{T}}$ f_{16}^c= 0.3500
17	HO_2NO_2	$\xrightarrow{M}$	$HO_2 + M + NO_2$	k_{17}^o=[M] $4.100x10^{-5}$ $e^{-\frac{1.0650E+04}{T}}$ k_{17}^∞= $4.800x10^{15}$ $e^{-\frac{1.1170E+04}{T}}$ f_{17}^c= 0.6000
18	Cl_2O_2	$\xrightarrow{M}$	$ClO + ClO$	k_{18}^o=[M] $1.000x10^{-6}$ $e^{-\frac{8000.}{T}}$ k_{18}^∞= $4.800x10^{15}$ $e^{-\frac{8820.}{T}}$ f_{18}^c= 0.6000

Table 2: (continued) Trimolecular reactions.

#	Reactants		Products
1	$Br_2 + h\nu$	$\longrightarrow$	$Br + Br$
2	$BrCl + h\nu$	$\longrightarrow$	$Cl + Br$
3	$BrO + h\nu$	$\longrightarrow$	$O(^3P) + Br$
4	$BrO + h\nu$	$\longrightarrow$	$Br + O(^1D)$
5	$BrONO + h\nu$	$\longrightarrow$	$Br + NO_2$
6	$BrONO_2 + h\nu$	$\longrightarrow$	$NO_2 + BrO$
7	$BrONO_2 + h\nu$	$\longrightarrow$	$Br + NO_3$
8	$CF_2Cl_2 + h\nu$	$\longrightarrow$	$Cl + Cl$
9	$CH_3Br + h\nu$	$\longrightarrow$	$Br + CH_3$
10	$CH_4 + h\nu$	$\longrightarrow$	$H + CH_3$
11	$CO_2 + h\nu$	$\longrightarrow$	$O(^3P) + CO$
12	$CO_2 + h\nu$	$\longrightarrow$	$CO + O(^1D)$
13	$Cl_2 + h\nu$	$\longrightarrow$	$Cl + Cl$
14	$Cl_2O_2 + h\nu$	$\longrightarrow$	$Cl + ClOO$
15	$ClNO_2 + h\nu$	$\longrightarrow$	$Cl + NO_2$
16	$ClO + h\nu$	$\longrightarrow$	$O(^3P) + Cl$
17	$ClONO_2 + h\nu$	$\longrightarrow$	$Cl + NO_3$
18	$ClOO + h\nu$	$\longrightarrow$	$O(^3P) + ClO$
19	$H_2O + h\nu$	$\longrightarrow$	$H + H + O(^3P)$
20	$H_2O + h\nu$	$\longrightarrow$	$H_2 + O(^1D)$
21	$H_2O + h\nu$	$\longrightarrow$	$H + OH$
22	$H_2O_2 + h\nu$	$\longrightarrow$	$OH + OH$
23	$HCHO + h\nu$	$\longrightarrow$	$H_2 + CO$
24	$HCHO + h\nu$	$\longrightarrow$	$H + HCO$
25	$HCHO + h\nu$	$\longrightarrow$	$H + H + CO$
26	$HCl + h\nu$	$\longrightarrow$	$H + Cl$
27	$HO_2 + h\nu$	$\longrightarrow$	$O(^3P) + OH$
28	$HO_2NO_2 + h\nu$	$\longrightarrow$	$NO_2 + HO_2$
29	$HO_2NO_2 + h\nu$	$\longrightarrow$	$OH + NO_3$
30	$HOBr + h\nu$	$\longrightarrow$	$OH + Br$
31	$HOCl + h\nu$	$\longrightarrow$	$Cl + OH$
32	$HNO_3 + h\nu$	$\longrightarrow$	$OH + NO_2$
33	$CH_3OOH + h\nu$	$\longrightarrow$	$OH + CH_3O$
34	$CH_3OOH + h\nu$	$\longrightarrow$	$O(^3P) + H + CH_3O$
35	$N_2O + h\nu$	$\longrightarrow$	$N_2 + O(^1D)$
36	$N_2O_5 + h\nu$	$\longrightarrow$	$O(^3P) + NO + NO_3$
37	$N_2O_5 + h\nu$	$\longrightarrow$	$NO_2 + NO_3$
38	$NO + h\nu$	$\longrightarrow$	$O(^3P) + N$
39	$NO_2 + h\nu$	$\longrightarrow$	$NO + O(^1D)$

Table 3: photolysis reactions. A key part of the chemical model is the calculation of photolysis rates. In this study they are calculated using full spherical geometry and multiple scattering [1, 3, 4, 5, 6] corrected after [2]. The photolysis rate used for each time step is obtained by ten point Gaussian-Legendre integration of the photolysis rate over the time step [7]. The photolysis rates are looked up in a photolysis rate tabulation which is updated every day for each latitude band to ensure that the current ozone and temperature profiles are used to calculate the photolysis rates. A total of 203 wavelength intervals are used from 116.7 to 850 nm [8]. Daily solar irradiances are used for each of the 203 wavelength intervals. The surface albedo used for each latitude band is the median albedo observed by TOMS for that month.

#	Reactants		Products
40	$NO_2 + h\nu$	$\longrightarrow$	$O(^3P) + NO$
41	$NO_3 + h\nu$	$\longrightarrow$	$O(^3P) + NO_2$
42	$NO_3 + h\nu$	$\longrightarrow$	$O_2 + NO$
43	$O_2 + h\nu$	$\longrightarrow$	$O(^3P) + O(^1D)$
44	$O_2 + h\nu$	$\longrightarrow$	$O(^3P) + O(^3P)$
45	$O_3 + h\nu$	$\longrightarrow$	$O(^3P) + O_2$
46	$O_3 + h\nu$	$\longrightarrow$	$O_2 + O(^1D)$
47	$OClO + h\nu$	$\longrightarrow$	$O(^3P) + ClO$
48	$OClO + h\nu$	$\longrightarrow$	$ClO + O(^1D)$

Table 3: (continued) photolysis reactions.

#	Reactants		Products	Reaction Probability
1	$HCl + ClONO_2$	$\xrightarrow{SA}$	$Cl_2 + HNO_3$	
2	$HCl + ClONO_2$	$\xrightarrow{NAT}$	$Cl_2 + HNO_3$	γ= 0.3000
3	$HCl + ClONO_2$	$\xrightarrow{Ice}$	$Cl_2 + HNO_3$	γ= 0.3000
4	$H_2O + ClONO_2$	$\xrightarrow{SA}$	$HOCl + HNO_3$	
5	$H_2O + ClONO_2$	$\xrightarrow{NAT}$	$HOCl + HNO_3$	γ= 6.0000E − 03
6	$H_2O + ClONO_2$	$\xrightarrow{Ice}$	$HOCl + HNO_3$	γ= 0.3000
7	$H_2O + N_2O_5$	$\xrightarrow{SA}$	$HNO_3 + HNO_3$	γ= 0.1000
8	$H_2O + N_2O_5$	$\xrightarrow{NAT}$	$HNO_3 + HNO_3$	γ= 6.000x10^{-4}
9	$H_2O + N_2O_5$	$\xrightarrow{Ice}$	$HNO_3 + HNO_3$	γ= 3.0000E − 02
10	$HCl + N_2O_5$	$\xrightarrow{NAT}$	$ClNO_2 + HNO_3$	γ= 3.0000E − 03
11	$HCl + N_2O_5$	$\xrightarrow{Ice}$	$ClNO_2 + HNO_3$	γ= 3.0000E − 02
12	$HCl + HOCl$	$\xrightarrow{SA}$	$Cl_2 + H_2O$	γ= 0.1000
13	$HCl + HOCl$	$\xrightarrow{NAT}$	$Cl_2 + H_2O$	γ= 0.1000
14	$HCl + HOCl$	$\xrightarrow{Ice}$	$Cl_2 + H_2O$	γ= 0.3000
15	$HBr + HOBr$	$\xrightarrow{SA}$	$Br_2 + H_2O$	γ= 6.0000E − 02
16	$HBr + HOBr$	$\xrightarrow{NAT}$	$Br_2 + H_2O$	γ= 0.1200
17	$HBr + HOBr$	$\xrightarrow{Ice}$	$Br_2 + H_2O$	γ= 0.1200
18	$HCl + HOBr$	$\xrightarrow{SA}$	$BrCl + H_2O$	γ= 0.1000
19	$HCl + HOBr$	$\xrightarrow{NAT}$	$BrCl + H_2O$	γ= 0.2500
20	$HCl + HOBr$	$\xrightarrow{Ice}$	$BrCl + H_2O$	γ= 0.2500
21	$HBr + HOCl$	$\xrightarrow{SA}$	$BrCl + H_2O$	γ= 0.1000
22	$HBr + HOCl$	$\xrightarrow{NAT}$	$BrCl + H_2O$	γ= 0.1000
23	$HBr + HOCl$	$\xrightarrow{Ice}$	$BrCl + H_2O$	γ= 0.3000
24	$HBr + ClONO_2$	$\xrightarrow{SA}$	$BrCl + HNO_3$	
25	$HBr + BrONO_2$	$\xrightarrow{NAT}$	$Br_2 + HNO_3$	γ= 0.3000
26	$HBr + BrONO_2$	$\xrightarrow{Ice}$	$Br_2 + HNO_3$	γ= 0.3000
27	$HCl + BrONO_2$	$\xrightarrow{SA}$	$BrCl + HNO_3$	
28	$HCl + BrONO_2$	$\xrightarrow{NAT}$	$BrCl + HNO_3$	γ= 0.3000
29	$HCl + BrONO_2$	$\xrightarrow{Ice}$	$BrCl + HNO_3$	γ= 0.3000
30	$HBr + ClONO_2$	$\xrightarrow{NAT}$	$BrCl + HNO_3$	γ= 0.3000
31	$HBr + ClONO_2$	$\xrightarrow{Ice}$	$BrCl + HNO_3$	γ= 0.3000
32	$H_2O + BrONO_2$	$\xrightarrow{SA}$	$HOBr + HNO_3$	γ= 0.9000
33	$H_2O + BrONO_2$	$\xrightarrow{NAT}$	$HOBr + HNO_3$	γ= 6.0000E − 03
34	$H_2O + BrONO_2$	$\xrightarrow{Ice}$	$HOBr + HNO_3$	γ= 0.3000
35	$HBr + N_2O_5$	$\xrightarrow{NAT}$	$BrONO + HNO_3$	γ= 5.0000E − 03
36	$HBr + N_2O_5$	$\xrightarrow{Ice}$	$BrONO + HNO_3$	γ= 5.0000E − 03

Table 4: Heterogeneous reactions. When no value is given for γ the temperature and any other relevant dependencies of γ are calculated in a subroutine.