Effects of Wind-Powered Hydrogen Fuel Cell Vehicles on Stratospheric Ozone and Global Climate

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Reaction List

Gas-phase chemical kinetic reactions, reaction rate coefficients, and photoprocesses, and heterogeneous reactions treated in the model.

No.	Kinetic Reaction	F_c [a]	Rate Coefficient (s^{-1}, $cm^3\ s^{-1}$, or $cm^6\ s^{-1}$)	Ref.[b]
	Inorganic Chemistry			
1	$O + O_2 + M \rightarrow O_3 + M$		$6.00\times10^{-34}\ (300/T)^{2.3}$	A
2	$O + O_3 \rightarrow 2\ O_2$		$8.00\times10^{-12}\ e^{-2060/T}$	A
3	$O(^1D) + O_3 \rightarrow 2O_2$		1.20×10^{-10}	A
4	$O(^1D) + O_3 \rightarrow O_2 + 2O$		1.20×10^{-10}	A
5	$O(^1D) + O_2 \rightarrow O + O_2$		$3.30\times10^{-11}\ e^{55/T}$	A
6	$O(^1D) + N_2 \rightarrow O + N_2$		$2.15\times10^{-11}\ e^{110/T}$	A
7	$O(^1D) + CO_2 \rightarrow O + CO_2$		$7.50\times10^{-11}\ e^{115/T}$	A
8	$O(^1D) + N_2 + M \rightarrow N_2O + M$		$2.80\times10^{-36}\ (300/T)^{0.9}$	A
9	$O(^1D) + N_2O \rightarrow N_2 + O_2$		$4.90\times10^{-11}\ e^{20/T}$	A
10	$O(^1D) + N_2O \rightarrow NO + NO$		$6.70\times10^{-11}\ e^{20/T}$	A
11	$O(^1D) + H_2 \rightarrow OH + H$		1.10×10^{-10}	A
12	$O(^1D) + H_2O \rightarrow OH + OH$		$1.63\times10^{-10}\ e^{60/T}$	A
13	$H + O_2 \xrightarrow{M} HO_2$	(P) 0.6	$4.40\times10^{-32}\ (300/T)^{1.3}$ $4.70\times10^{-11}\ (300/T)^{0.2}$	A
14	$H + O_3 \rightarrow O_2 + OH$		$1.40\times10^{-10}\ e^{-470/T}$	A
15	$H + HO_2 \rightarrow H_2 + O_2$		5.67×10^{-12}	A
16	$H + HO_2 \rightarrow OH + OH$		7.29×10^{-11}	A
17	$H + HO_2 \rightarrow H_2O + O$		2.43×10^{-12}	A
18	$OH + O \rightarrow H + O_2$		$2.20\times10^{-11}\ e^{120/T}$	A
19	$OH + O_3 \rightarrow HO_2 + O_2$		$1.70\times10^{-12}\ e^{-940/T}$	A
20	$OH + H_2 \rightarrow H_2O + H$		$2.8\times10^{-12}\ e^{-1800/T}$	A
21	$OH + OH \rightarrow H_2O + O$		$1,80\times10^{-12}$	A
22	$OH + OH \xrightarrow{M} H_2O_2$	(P) 0.6	$6.90\times10^{-31}\ (300/T)^{0.8}$ 2.6×10^{-11}	A
23	$OH + HO_2 \rightarrow H_2O + O_2$		$4.80\times10^{-11}\ e^{250/T}$	A
24	$OH + H_2O_2 \rightarrow HO_2 + H_2O$		1.80×10^{-12}	A

25	$OH + NO \xrightarrow{M} HONO$	(P) 0.6	$7.00\times10^{-31}\ (300/T)^{2.6}$ $3.60\times10^{-11}\ (300/T)^{0.1}$	A
26	$OH + NO_2 \xrightarrow{M} HNO_3$	(P) 0.6	$1.80\times10^{-30}\ (300/T)^{3.0}$ 2.80×10^{-11}	A
27	$OH + NO_3 \rightarrow HO_2 + NO_2$		2.20×10^{-11}	A
28	$OH + HONO \rightarrow H_2O + NO_2$		$1.80\times10^{-11}\ e^{-390/T}$	A
29	$OH + HNO_3 \rightarrow H_2O + NO_3$		c	A
30	$OH + HO_2NO_2 \rightarrow H_2O + NO_2 + O_2$		$1.30\times10^{-12}\ e^{380/T}$	A
31	$OH + CO \rightarrow HO_2 + CO_2$		d	A
32	$HO_2 + O \rightarrow OH + O_2$		$3.00\times10^{-11}\ e^{200/T}$	A
33	$HO_2 + O_3 \rightarrow OH + 2O_2$		$1.40\times10^{-14}\ e^{-490/T}$	A
34	$HO_2 + HO_2 \rightarrow H_2O_2 + O_2$		e	A
35	$HO_2 + NO \rightarrow OH + NO_2$		$3.50\times10^{-12}\ e^{250/T}$	A
36	$HO_2 + NO_2 \xrightarrow{M} HO_2NO_2$	(P) 0.6	$2.00\times10^{-31}\ (300/T)^{3.4}$ $2.90\times10^{-12}\ (300/T)^{1.1}$	A
37	$HO_2NO_2 \xrightarrow{M} HO_2 + NO_2$		$k_{36} / (2.10\times10^{-27} \times e^{10900/T})$	
38	$HO_2 + NO_3 \rightarrow HNO_3 + O_2$		3.50×10^{-12}	A
39	$H_2O_2 + O \rightarrow OH + HO_2$		$1.40\times10^{-12}\ e^{-2000/T}$	A
40	$NO + O \xrightarrow{M} NO_2$	(P) 0.6	$9.00\times10^{-32}\ (300/T)^{1.5}$ 3.00×10^{-11}	A
41	$NO + O_3 \rightarrow NO_2 + O_2$		$3.00\times10^{-12} e^{-1500/T}$	A
42	$NO_2 + O \rightarrow NO + O_2$		$5.60\times10^{-12} e^{180/T}$	A
43	$NO_2 + O \xrightarrow{M} NO_3$	(P) 0.6	$2.50\times10^{-31}\ (300/T)^{1.8}$ $2.20\times10^{-11}\ (300/T)^{0.7}$	A
44	$NO_2 + O_3 \rightarrow NO_3 + O_2$		$1.20\times10^{-13}\ e^{-2450/T}$	A
45	$NO_3 + O \rightarrow NO_2 + O_2$		1.00×10^{-11}	A
46	$NO_3 + NO \rightarrow 2\ NO_2$		$1.50\times10^{-11}\ e^{170/T}$	B
47	$NO_3 + NO_2 \xrightarrow{M} N_2O_5$	(P) 0.6	$2.00\times10^{-30}\ (300/T)^{4.4}$ $1.40\times10^{-12}\ (300/T)^{0.7}$	A
48	$N_2O_5 \xrightarrow{M} NO_3 + NO_2$		$K_{47} / (3.00\times10^{-27} \times e^{10990/T})$	A
49	$N_2O_5 + H_2O \rightarrow 2\ HNO_3$		2.00×10^{-21}	B
Organic Chemistry				
Alkane, Alkene, and Aldehyde Chemistry				
50	$CH_4 + O(^1D) \rightarrow CH_3O_2 + OH$		1.50×10^{-10}	A
51	$CH_4 + O(^1D) \rightarrow CH_3O + H$		3.00×10^{-11}	B
52	$CH_4 + O(^1D) \rightarrow HCHO + H_2$		7.00×10^{-12}	B
53	$CH_4 + OH \rightarrow CH_3O_2 + H_2O$		$2.45\times10^{-12}\ e^{-1775/T}$	A
54	$CH_3O + O_2 \rightarrow HCHO + HO_2$		$3.90\times10^{-14}\ e^{-900/T}$	A
55	$CH_3O + NO \rightarrow HCHO + HO_2 + NO$		8.00×10^{-12}	A
56	$CH_3O + NO \xrightarrow{M} CH_3ONO$	(P) 0.6	$2.30\times10^{-29}\ (300/T)^{2.8}$ $3.80\times10^{-11}\ (300/T)^{0.6}$	A
57	$CH_3O + NO_2 \xrightarrow{M} CH_3ONO_2$	(P) 0.6	$5.30\times10^{-29}\ (300/T)^{4.4}$ $1.90\times10^{-11}\ (300/T)^{1.8}$	A
58	$CH_3ONO_2 + OH \rightarrow HCHO + NO_2 + H_2O$		$5.00\times10^{-13}\ e^{810/T}$	A
59	$CH_3O_2 + HO_2 \rightarrow CH_3OOH + O_2$		$4.10\times10^{-13}\ e^{750/T}$	A
60	$CH_3O_2 + NO \rightarrow CH_3O + NO_2$		$2.80\times10^{-12}\ e^{300/T}$	A
61	$CH_3O_2 + NO_2 \xrightarrow{M} CH_3O_2NO_2$	(P) 0.6	$1.00\times10^{-30}\ (300/T)^{4.8}$	A

			$7.20\times10^{-12}\ (300/T)^{2.1}$	
62	$CH_3O_2NO_2 \xrightarrow{M} CH_3O_2 + NO_2$		$k_{61} / (1.30\times10^{-28} \times e^{11200/T})$	A
63	$CH_3O_2 + CH_3O_2 \rightarrow 2\ CH_3O + O_2$		$5.90\times10^{-13}\ e^{-509/T}$	B
64	$CH_3O_2 + CH_3O_2 \rightarrow HCHO + CH_3OH$		$7.04\times10^{-14}\ e^{365/T}$	B
65	$CH_3O_2 + CH_3C(O)OO \rightarrow CH_3O_2 + CH_3O + CO_2$		$2.00\times10^{-12} e^{500/T}$	A
66	$CH_3O_2 + CH_3C(O)OO \rightarrow CH_3COOH + HCHO + O_2$		$2.20\times10^{-13} e^{500/T}$	B
67	$CH_3COOH + OH \rightarrow CH_3O_2 + CO_2 + H_2O$		$4.00\times10^{-13} e^{200/T}$	A
68	$CH_3OOH + OH \rightarrow CH_3O_2 + H_2O$		$3.80\times10^{-12}\ e^{200/T}$	A
69	$C_2H_6 + OH \rightarrow C_2H_5O_2 + H_2O$		$8.70\times10^{-12}\ e^{-1070/T}$	A
70	$C_2H_5O_2 + NO \rightarrow C_2H_5O + NO_2$		$2.60\times10^{-12}\ e^{365/T}$	A
71	$C_2H_5O_2 + NO_2 \xrightarrow{M} C_2H_5O_2NO$	(P) 0.6	$1.20\times10^{-29}\ (300/T)^{4.0}$ 9.00×10^{-12}	A
72	$C_2H_5O_2NO_2 \xrightarrow{M} C_2H_5O_2 + NO_2$	(P) 0.31	$4.80\times10^{-4}\ e^{-9285/T}$ $8.80\times10^{15}\ e^{-10440/T}$	B
73	$C_2H_5O_2 + HO_2 \rightarrow ROOH + O_2$		$7.50\times10^{-13}\ e^{700/T}$	A
74	$C_2H_5O + O_2 \rightarrow CH_3CHO + HO_2$		$6.30\times10^{-14}\ e^{-550/T}$	A
75	$C_2H_5O + NO \xrightarrow{M} C_2H_5ONO$	(P) 0.6	$2.80\times10^{-27}\ (300/T)^{4.0}$ $5.00\times10^{-12}\ (300/T)^{1.0}$	A
76	$C_2H_5O + NO \rightarrow CH_3CHO + HO_2 + NO$		1.30×10^{-11}	B
77	$C_2H_5O + NO_2 \xrightarrow{M} C_2H_5ONO_2$	(P) 0.6	$2.00\times10^{-27}\ (300/T)^{4.0}$ $2.80\times10^{-11}\ (300/T)^{1.0}$	A
78	$C_3H_8 + OH \rightarrow C_3H_7O_2 + H_2O$		$1.00\times10^{-11}\ e^{-660/T}$	A
79	$C_3H_7O_2 + NO \rightarrow C_3H_7O + NO_2$		$2.70\times10^{-12}\ e^{-660/T}$	B
80	$C_3H_7O + O_2 \rightarrow CH_3COCH_3 + HO_2$		$1.40\times10^{-14}\ e^{-210/T}$	B
81	$C_3H_7O + NO \rightarrow C_3H_7ONO$		3.40×10^{-11}	B
82	$C_3H_7O + NO \rightarrow CH_3COCH_3 + HO_2 + NO$		6.50×10^{-12}	B
83	$C_3H_7O + NO_2 \rightarrow C_3H_7ONO_2$		3.50×10^{-11}	A
84	$C_2H_4 + OH \xrightarrow{M} HOC_2H_4O_2$	(P) 0.6	$1.00\times10^{-28}\ (300/T)^{0.8}$ 8.80×10^{-12}	A
85	$HOC_2H_4O_2 + NO \rightarrow NO_2 + 2\ HCHO + H$		6.93×10^{-12}	A
86	$HOC_2H_4O_2 + NO \rightarrow NO_2 + CH_3CHO + OH$		2.07×10^{-12}	A
87	$C_2H_4 + O_3 \rightarrow HCHO + H_2COO$		$4.48\times10^{-15}\ e^{-2630/T}$	A
88	$C_2H_4 + O_3 \rightarrow HCHO + HCOOH^*$		$7.52\times10^{-15}\ e^{-2630/T}$	A
89	$H_2COO + NO \rightarrow NO_2 + HCHO$		7.00×10^{-12}	C
90	$H_2COO + H_2O \rightarrow HCOOH + H_2O$		4.00×10^{-16}	C
91	$H_2COO + HCHO \rightarrow OZD$		2.00×10^{-12}	C
92	$H_2COO + CH_3CHO \rightarrow OZD$		2.00×10^{-12}	C
93	$H_2COO + ALD2 \rightarrow OZD$		2.00×10^{-12}	C
94	$HCOOH + OH \rightarrow H + CO_2 + H_2O$		4.00×10^{-13}	A
95	$HCOOH^* \rightarrow CO_2 + H_2$		0.21	C
96	$HCOOH^* \rightarrow CO + H_2O$		0.60	C
97	$HCOOH^* \rightarrow OH + HO_2 + CO$		0.19	C
98	$C_3H_6 + OH \xrightarrow{M} HOC_3H_6O_2$	(P) 0.5	$8.00\times10^{-27}\ (300/T)^{3.5}$ 3.00×10^{-11}	B
99	$HOC_3H_6O_2 + NO \rightarrow NO_2 + CH_3CHO + HCHO + HO_2$		6.00×10^{-12}	C
100	$C_3H_6 + O_3 \rightarrow HCHO + CH_3HCOO$		$4.88\times10^{-16}\ e^{-1900/T}$	A
101	$C_3H_6 + O_3 \rightarrow HCHO + CH_3HCOO^*$		$2.76\times10^{-15}\ e^{-1900/T}$	A
102	$C_3H_6 + O_3 \rightarrow CH_3CHO + H_2COO$		$1.22\times10^{-15}\ e^{-1900/T}$	A

103	$C_3H_6 + O_3 \rightarrow CH_3CHO + H_2COO^*$	$2.03\times10^{-15}\ e^{-1900/T}$	A
104	$CH_3HCOO + NO \rightarrow NO_2 + CH_3CHO$	7.00×10^{-12}	C
105	$CH_3HCOO + H_2O \rightarrow CH_3COOH + H_2O$	4.00×10^{-16}	C
106	$CH_3HCOO + HCHO \rightarrow OZD$	2.00×10^{-12}	C
107	$CH_3HCOO + CH_3CHO \rightarrow OZD$	2.00×10^{-12}	C
108	$CH_3HCOO + ALD2 \rightarrow OZD$	2.00×10^{-12}	C
109	$CH_3COOH^* \rightarrow CH_4 + CO_2$	0.16	C
110	$CH_3COOH^* \rightarrow CH_3O_2 + CO + OH$	0.64	C
111	$CH_3COOH^* \rightarrow CH_3O + CO + HO_2$	0.20	C
120	$HCHO + OH \rightarrow HO_2 + CO + H_2O$	$9.00\times10^{-12}\ e^{20/T}$	A
113	$HCHO + O \rightarrow OH + HO_2 + CO$	$3.40\times10^{-11}\ e^{-1600/T}$	A
114	$HCHO + NO_3 \rightarrow HNO_3 + HO_2 + CO$	5.80×10^{-16}	A
115	$HCHO + HO_2 \rightarrow HOCH_2O_2$	$6.70\times10^{-15} e^{605/T}$	A
116	$HOCH_2O_2 \rightarrow HO_2 + HCHO$	$2.40\times10^{12}\ e^{-7000/T}$	B
117	$HOCH_2O_2 + HO_2 \rightarrow ROOH$	$5.60\times10^{-15}\ e^{2300/T}$	B
118	$HOCH_2O_2 + NO \rightarrow NO_2 + HO_2 + HCOOH$	7.00×10^{-12}	C
119	$CH_3CHO + O \rightarrow CH_3C(O)OO + OH$	$1.80\times10^{-11}\ e^{-1100/T}$	A
120	$CH_3CHO + OH \rightarrow CH_3C(O)OO + H_2O$	$5.60\times10^{-12}\ e^{270/T}$	A
121	$CH_3CHO + NO_3 \rightarrow CH_3C(O)OO + HNO_3$	$1.40\times10^{-12}\ e^{-1900/T}$	A
122	$ALD2 + O \rightarrow CH_3C(O)OO + OH$	$1.80\times10^{-11}\ e^{-1100/T}$	A
123	$ALD2 + OH \rightarrow CH_3C(O)OO + H_2O$	$5.60\times10^{-12}\ e^{270/T}$	A
124	$ALD2 + NO_3 \rightarrow CH_3C(O)OO + HNO_3$	$1.40\times10^{-12}\ e^{-1900/T}$	A
125	$CH_3C(O)OO + HO_2 \rightarrow ROOH + O_2$	$4.30\times10^{-13}\ e^{1040/T}$	A
126	$CH_3C(O)OO + HO_2 \rightarrow CH_3O_2 + OH + CO_2$	$3.16\times10^{-13}\ e^{1040/T}$	C
127	$CH_3C(O)OO + NO \rightarrow NO_2 + CH_3O_2 + CO_2$	$8.10\times10^{-11}\ e^{270/T}$	A
128	$CH_3C(O)OO + NO_2 \xrightarrow{M} CH_3C(O)OONO_2$ (P) 0.6	$9.70\times10^{-29}\ (300/T)^{5.6}$ $9.30\times10^{-12}\ (300/T)^{1.5}$	A
129	$CH_3C(O)OONO_2 \xrightarrow{M} CH_3C(O)OO + NO_2$	$k_{123} / (9.0\times10^{-29} \times e^{14000/T})$	A
130	$CH_3C(O)OO + CH_3C(O)OO \rightarrow 2\ CH_3O_2 + O_2$	$2.90\times10^{-12}\ e^{500/T}$	A
131	$CH_3COCH_3 + OH \rightarrow CH_3COCH_2OO + H_2O$	$1.33\times10^{-13} + 3.82\times10^{-11}\ e^{-2000/T}$	A
132	$CH_3COCH_2OO + NO \rightarrow CH_3C(O)OO + HCHO + NO_2$	8.10×10^{-12}	C
133	$CH_3OH + OH \rightarrow HCHO + HO_2 + H_2O$	$6.21\times10^{-12}\ e^{-620/T}$	A
134	$CH_3OH + OH \rightarrow CH_3O + H_2O$	$1.09\times10^{-12}\ e^{-620/T}$	A
135	$C_2H_5OH + OH \rightarrow CH_3CHO + HO_2 + H_2O$	$6.52\times10^{-12}\ e^{-230/T}$	A
136	$C_2H_5OH + OH \rightarrow HOC_2H_4O_2 + H_2O$	$3.80\times10^{-13}\ e^{-230/T}$	A
137	$PAR + OH \rightarrow RO_2 + H_2O$	9.20×10^{-14}	C
138	$PAR + OH \rightarrow RO_2R + H_2O$	7.20×10^{-13}	C
139	$RO_2 + NO \rightarrow NO_2 + HO_2 + CH_3CHO + XOP$	7.70×10^{-12}	C
140	$RO_2 + NO \rightarrow NTR$	$4.40\times10^{-11}\ e^{-1400/T}$	C
141	$RO_2R + NO \rightarrow NO_2 + ROR$	7.00×10^{-12}	C
142	$RO_2R + NO \rightarrow NTR$	$1.20\times10^{-10}\ e^{-1400/T}$	C
143	$ROR + NO_2 \rightarrow NTR$	1.50×10^{-11}	C
144	$NTR \xrightarrow{M} RO_2 + NO_2$	k_{72}	B
145	$ROR \rightarrow KET + HO_2$	1.60×10^{3}	C
146	$ROR \rightarrow KET + DOP$	$2.10\times10^{14}\ e^{-8000/T}$	C
147	$ROR \rightarrow CH_3CHO + DOP + XOP$	$4.00\times10^{14}\ e^{-8000/T}$	C
148	$ROR \rightarrow CH_3COCH_3 + DOP + 2\ XOP$	$4.40\times10^{14}\ e^{-8000/T}$	C

149	XOP + PAR →	6.80×10^{-12}	C
150	DOP + PAR → RO_2	5.10×10^{-12}	C
151	DOP + PAR → AO_2 + 2 XOP	1.50×10^{-12}	C
152	DOP + PAR → RO_2R	1.70×10^{-13}	C
153	DOP + KET → $CH_3C(O)OO$ + XOP	6.80×10^{-12}	C
154	AO_2 + NO → NO_2 + CH_3COCH_3 + HO_2	8.10×10^{-12}	C
155	OLE + O → 2 PAR	$4.10\times10^{-12}\ e^{-324/T}$	C
156	OLE + O → CH_3CHO	$4.10\times10^{-12}\ e^{-324/T}$	C
157	OLE + O → HO_2 + CO + RO_2	$1.20\times10^{-12}\ e^{-324/T}$	C
158	OLE + O → RO_2 + XOP + CO + HCHO + OH	$2.40\times10^{-12}\ e^{-324/T}$	C
159	OLE + OH → CH_3O_2 + CH_3CHO + XOP	$5.20\times10^{-12}\ e^{504/T}$	C
160	OLE + O_3 → CH_3CHO + H_2COO + XOP	$2.80\times10^{-15}\ e^{-2105/T}$	C
161	OLE + O_3 → HCHO + CH_3HCOO + XOP	$2.80\times10^{-15}\ e^{-2105/T}$	C
162	OLE + O_3 → CH_3CHO + HCOOH* + XOP	$4.30\times10^{-15}\ e^{-2105/T}$	C
163	OLE + O_3 → HCHO + CH_3COOH* + XOP	$4.30\times10^{-15}\ e^{-2105/T}$	C
164	OLE + NO_3 → PNO_2	7.70×10^{-15}	C
165	PNO_2 + NO → DNIT	6.80×10^{-13}	C
166	PNO_2 + NO → HCHO + CH_3CHO + XOP + $2NO_2$	6.80×10^{-12}	C
167	C_4H_6 + OH → CH_3O_2 + CH_3CHO	$1.48\times10^{-11}\ e^{448/T}$	D
168	C_4H_6 + O_3 → 0.5 CH_3CHO + 0.197 H_2COO + XOP + 0.5 HCHO + 0.197 CH_3HCOO + 0.303 H_2COO* + 0.303 CH_3HCOO* + OLE	$2.20\times10^{-14}\ e^{-2431/T}$	E
169	C_4H_6 + NO_3 → PNO_2 + C_2H_4	1.03×10^{-13}	D
	Aromatic Chemistry		
170	C_6H_6 + OH → 0.4 BO_2 + 0.4 H_2O + 0.6 CRES + 0.6 HO_2 + XOP	$3.10\times10^{-12}\ e^{-270/T}$	D
171	TOL + OH → BO_2 + H_2O	$1.70\times10^{-13}\ e^{322/T}$	C
172	TOL + OH → CRES + HO_2	$7.60\times10^{-13}\ e^{322/T}$	C
173	TOL + OH → TO_2	$1.20\times10^{-12}\ e^{322/T}$	C
174	BO_2 + NO → NO_2 + BZA + HO_2	8.10×10^{-12}	C
175	BZA + OH → BZO_2 + H_2O	1.30×10^{-11}	C
176	BZO_2 + NO → NO_2 + PHO_2 + CO_2	2.50×10^{-12}	C
177	BZO_2 + NO_2 → PBZN	8.40×10^{-12}	E
178	PBZN → BZO_2 + NO_2	$1.60\times10^{15}\ e^{-13033/T}$	E
179	PHO_2 + NO → NO_2 + PHO	8.10×10^{-12}	C
180	PHO + NO_2 → NPHN	$1.30\times10^{-11}\ e^{300/T}$	E
181	CRES + OH → CRO + H_2O	1.60×10^{-11}	C
182	CRES + OH → CRO_2 + H_2O	2.50×10^{-11}	C
183	CRES + NO_3 → CRO + HNO_3	2.20×10^{-11}	C
184	CRO + NO_2 → NCRE	1.40×10^{-11}	C
185	CRO_2 + NO → NO_2 + OPEN + HO_2	4.00×10^{-12}	C
186	CRO_2 + NO → NO_2 + ACID + HO_2	4.00×10^{-12}	C
187	TO_2 + NO → NO_2 + OPEN + HO_2	7.30×10^{-12}	C
188	TO_2 + NO → NTR	8.10×10^{-13}	C
189	TO_2 → HO_2 + CRES	4.20	C
190	XYL + OH → CRES + PAR + HO_2	$3.32\times10^{-12}\ e^{116/T}$	C
191	XYL + OH → XLO_2 + H_2O	$1.70\times10^{-12}\ e^{116/T}$	C
192	XYL + OH → TO_2	$5.00\times10^{-12}\ e^{116/T}$	C
193	XYL + OH → XINT	$6.60\times10^{-12}\ e^{116/T}$	C

194	$XLO_2 + NO \rightarrow NO_2 + HO_2 + BZA + PAR$	8.10×10^{-12}	C
195	$XINT + NO \rightarrow NO_2 + HO_2 + 2\ CH_3COCHO + PAR$	8.10×10^{-12}	C
196	$CH_3COCHO + OH \rightarrow MGPX + H_2O$	1.50×10^{-11}	B
197	$MGPX + NO \rightarrow NO_2 + CH_3C(O)OO + CO_2$	8.10×10^{-12}	C
198	$OPEN + OH \rightarrow OPPX + CH_3C(O)OO + HO_2 + CO$	3.00×10^{-11}	C
199	$OPEN + O_3 \rightarrow CH_3CHO + MGPX + HCHO + CO$	$1.60\times10^{-18}\ e^{-500/T}$	C
200	$OPEN + O_3 \rightarrow HCHO + CO + OH + 2\ HO_2$	$4.30\times10^{-18}\ e^{-500/T}$	C
201	$OPEN + O_3 \rightarrow CH_3COCHO$	$1.10\times10^{-17}\ e^{-500/T}$	C
202	$OPEN + O_3 \rightarrow CH_3C(O)OO + HCHO + HO_2 + CO$	$3.20\times10^{-17}\ e^{-500/T}$	C
203	$OPEN + O_3 \rightarrow$	$5.40\times10^{-18}\ e^{-500/T}$	C
204	$OPPX + NO \rightarrow NO_2 + HCHO + HO_2 + CO$	8.10×10^{-12}	C
	Terpene Chemistry		
200	$ISOP + OH \rightarrow ISOH$	$2.55\times10^{-11}\ e^{410.2/T}$	F,G
201	$ISOP + O_3 \rightarrow 0.17\ MACR + 0.378\ MVK + 0.664\ OH + 0.054 PAR + 0.054\ OLE + 0.054\ H_2COO + 0.5\ HCHO + 0.366\ HO_2 + 0.068\ CO_2 + 0.461\ CO + 0.366 RO2R + 0.121\ ACID$	$7.86\times10^{-15}\ e^{1912.9/T}$	G,H
202	$ISOP + O \rightarrow 0.22\ MACR + 0.63\ MVK + 0.08\ ISOH$	3.50×10^{-11}	F,G
203	$ISOP + NO_3 \rightarrow ISNT$	$3.02\times10^{-12}\ e^{-445.9/T}$	F,G
204	$ISOH + NO \rightarrow 0.364\ MACR + 0.477\ MVK + 0.840\ HCHO + 0.08\ ISNI1 + 0.08\ ISNI2 + 0.886\ HO_2 + 0.840\ NO_2$	$1.22\times10^{-11}\ e^{-180/T}$	F
205	$ISNT + NO \rightarrow 1.1\ NO_2 + 0.8\ HO_2 + 0.80\ ISNI1 + 0.1\ MACR + 0.15\ HCHO + 0.05\ MVK + 0.05\ DISN$	$1.39\times10^{-11}\ e^{-180/T}$	F
206	$ISNI1 + OH \rightarrow ISNIR$	3.35×10^{-11}	F
207	$ISNI2 + OH \rightarrow ISNIR$	1.88×10^{-11}	F
208	$ISNIR + NO \rightarrow 0.05\ DISN + 0.05\ HO_2 + 1.9\ NO_2 + 0.95\ CH_3CHO + 0.95\ CH_3COCH_3$	$1.39\times10^{-11}\ e^{-180/T}$	F
209	$ISNI1 + O_3 \rightarrow 0.2\ O + 0.08\ OH + 0.5\ HCHO + 0.5\ IALD1 + 0.5\ ISNI2 + 0.5\ NO_2$	5.00×10^{-18}	F
210	$ISOH + ISOH \rightarrow 0.6\ MACR + 0.6\ MVK + 1.2\ HCHO + 1.2\ HO_2$	2.00×10^{-13}	F
211	$ISOH + HO_2 \rightarrow IPRX$	$6.15\times10^{-11}\ e^{-900/T}$	F
212	$IPRX + OH \rightarrow ISOH$	2.00×10^{-11}	F
213	$IPRX + O_3 \rightarrow 0.7\ HCHO$	8.00×10^{-18}	F
214	$MACR + O_3 \rightarrow 0.8\ CH_3COCHO + 0.7\ HCHO + 0.2\ O + 0.09\ H_2COO + 0.2\ CO + 0.275\ HO_2 + 0.215\ OH + 0.16\ CO_2 + 0.15\ CH_2CCH_3CHOO$	$1.36\times10^{-15}\ e^{2113.7/T}$	F,H
215	$MVK + O_3 \rightarrow 0.5\ CH_3COCHO + 0.5\ HCHO + 0.2\ H_2O + 0.2\ CO_2 + 0.56\ CO + 0.28\ HO_2 + 0.36\ OH + 0.1\ CH_3CHO + 0.28\ CH_3CO_3 + 0.12\ ACID + 0.12\ UNR$	$7.50\times10^{-16}\ e^{-1519.9/T}$	H
216	$MACR + OH \rightarrow 0.42\ MAC1 + 0.08\ MAC2 + 0.5\ CH_2CCH_3C(O)OO$	$1.86\times10^{-11}\ e^{175/T}$	F
217	$MVK + OH \rightarrow 0.28\ MV1 + 0.72\ MV2$	$4.11\times10^{-12}\ e^{453/T}$	F
218	$MAC1 + NO \rightarrow 0.95\ HO_2 + 0.95\ CO + 0.95\ CH_3COCH_3 + 0.95\ NO_2 + 0.05\ ISNI2$	$1.39\times10^{-11}\ e^{-180/T}$	F
219	$MAC2 + NO \rightarrow 0.95\ HO_2 + 0.95\ HCHO + 0.95\ CH_3COCHO + 0.95\ NO_2 + 0.05\ ISNI2$	$1.39\times10^{-11}\ e^{-180/T}$	F
220	$MV1 + NO \rightarrow 0.95\ CH_3COCHO + 0.95\ HCHO + 0.05\ ISNI2$	$1.39\times10^{-11}\ e^{-180/T}$	F

	+ 0.95 NO_2 + 0.95 HO_2		
221	MV2 + NO → 0.95 CH_3CHO + 0.95 $CH_3C(O)OO$ + 0.05 ISNI2 + 0.95 NO_2	$1.39\times10^{-11}\ e^{-180/T}$	F
222	MV1 + HO_2 → ROOH	$6.15\times10^{-11}\ e^{-900/T}$	F
223	MV2 + HO_2 → ROOH	$6.15\times10^{-11}\ e^{-900/T}$	F
224	MAC1 + HO_2 → ROOH	$6.15\times10^{-11}\ e^{-900/T}$	F
225	MAC2 + HO_2 → ROOH	$6.15\times10^{-11}\ e^{-900/T}$	F
226	$CH_2CCH_3C(O)OO + NO_2$ → MPAN	8.40×10^{-12}	F
227	MPAN → $CH_2CCH_3C(O)OO + NO_2$	$1.58\times10^{16}\ e^{-13507/T}$	F
228	$CH_2CCH_3C(O)OO + NO$ → $C_2H_4 + CH_3O_2 + NO_2 + CO_2$	1.40×10^{-11}	F
229	TERPH + OH → RO227	1.77×10^{-10}	H
230	TERPH + O_3 → 0.445 CO + 0.055 H_2O_2 + 0.89 OH + 0.11 UNR + 0.445 RO229 + 0.445 RO230	1.40×10^{-16}	H
231	TERPH + O → UNR	8.59×10^{-11}	H
232	TERPH + NO_3 → RO228	2.91×10^{-11}	H
233	RO227 + NO → 0.38 AP8 + 0.62 NO_2 + 0.62 HO_2 + 0.62 UNR	$8.89\times10^{-13}\ e^{180.2/T}$	H
234	RO227+ RO2R → HO_2 + UNR + RO2R + O_2	1.00×10^{-15}	H
235	RO227 + HO_2 → OH + HO_2 + UNR	$3.41\times10^{-13}\ e^{800.2/T}$	H
236	RO228 + NO → 2 NO_2 + UNR	$8.89\times10^{-13}\ e^{180.2/T}$	H
237	RO228 + RO2R → NO_2 + RO2R + O_2 + UNR	1.00×10^{-15}	H
238	RO229 + HO_2 → OH + HO_2 + UNR	$3.41\times10^{-13}\ e^{800.2/T}$	H
239	RO229 + NO → 0.23 AP9 + 0.77 NO_2 + 0.77 RO240	$1.05\times10^{-12}\ e^{180.2/T}$	H
240	RO229 + RO2R → RO240 + RO2R + O_2	1.00×10^{-15}	H
241	RO230 + NO → NO_2 + CH_3CO_3 + UNR	$8.89\times10^{-13}\ e^{180.2/T}$	H
242	RO230 + RO2R → CH_3CO_3 + RO2R + O_2 + UNR	1.00×10^{-15}	H
243	RO230 + HO_2 → OH + CH_3CO_3 + UNR	$3.41\times10^{-13}\ e^{800.2/T}$	H
244	RO240 + NO → NO_2 + CH_3CO_3 + ALD2 + PAR	$1.05\times10^{-12}\ e^{180.2/T}$	H
245	RO240 + RO2R → CH_3CO_3 + ALD2 + PAR + RO2R + O_2	1.00×10^{-15}	H
246	RO240 + HO_2 → OH + CH_3CO_3 + ALD2 + PAR	$3.41\times10^{-13}\ e^{800.2/T}$	H
247	AP8 + OH → NO_2 + H_2O + UNR	1.03×10^{-10}	H
248	AP9 + OH → NO_2 + H_2O + UNR	9.07×10^{-11}	H
	Sulfur Chemistry		
249	SO_2 + OH $\xrightarrow{M}$ HSO_3 (P) 0.6	$3.00\times10^{-31}\ (300/T)^{3.3}$ 1.50×10^{-12}	A
250	$SO_2 + O + M$ → SO_3 + M	$1.30\times10^{-33}\ (300/T)^{-3.6}$	A
251	$HSO_3 + O_2$ → $SO_3 + HO_2$	$1.30\times10^{-12}\ e^{-330/T}$	A
252	$SO_3 + H_2O + H_2O$ → $H_2SO_4 + H_2O$	$8.50\times10^{-41}\ e^{6540/T}$	A
253	CH_3SCH_3 + OH → $CH_3SCH_2O_2 + H_2O$	$1.10\times10^{-11}\ e^{-240/T}$	A
254	CH_3SCH_3 + OH → $CH_3S(OH)CH_3$	f	A
255	$CH_3SCH_2O_2$ + NO → $CH_3SCH_2O + NO_2$	8.00×10^{-12}	I
256	CH_3SCH_2O → CH_3S + HCHO	1.00×10^{1}	I
257	$CH_3S + O_2$ → CH_3SOO^*	3.00×10^{-18}	A
258	CH_3SOO^* + NO → $CH_3SO + NO_2$	1.4×10^{-11}	I
259	CH_3SOO^* → $CH_3S + O_2$	6.0×10^{2}	I
260	$CH_3SO + O_3$ → $CH_3SO_2 + O_2$	6.0×10^{-13}	A
261	CH_3SO_2 → $CH_3O_2 + SO_2$	1.1×10^{1}	I
262	$CH_3S(OH)CH_3$ → $CH_3SOH + CH_3O_2$	5.0×10^{5}	I
263	CH_3SOH + OH → $CH_3SO + H_2O$	1.1×10^{-10}	I
	Chlorine Gas-Phase Chemistry		

264	$Cl + O_2 \xrightarrow{M} ClOO$	(P) 0.6	$2.20\times10^{-33}\ (300/T)^{3.1}$ 1.80×10^{-10}	A
265	$ClOO + M \rightarrow Cl + O_2 + M$		$K_{264} / (6.60\times10^{-25} \times e^{2502/T})$	A
266	$Cl + O_3 \rightarrow ClO + O_2$		$2.30\times10^{-11}\ e^{-200/T}$	A
267	$Cl + H_2 \rightarrow HCl + H$		$3.05\times10^{-11}\ e^{-2270/T}$	A
268	$Cl + HO_2 \rightarrow HCl + O_2$		$1.80\times10^{-11}\ e^{170/T}$	A
269	$Cl + HO_2 \rightarrow ClO + OH$		$4.10\times10^{-11}\ e^{-450/T}$	A
270	$Cl + H_2O_2 \rightarrow HCl + HO_2$		$1.10\times10^{-11}\ e^{-980/T}$	A
271	$Cl + NO_2 \xrightarrow{M} ClNO_2$	(P) 0.6	$1.80\times10^{-31}\ (300/T)^{2.0}$ $1.00\times10^{-10}(300/T)^{1.0}$	A
272	$Cl + HNO_3 \rightarrow HCl + NO_3$		2.00×10^{-16}	A
273	$Cl + CH_4 \rightarrow HCl + CH_3O_2$		$7.30\times10^{-12}\ e^{-1280/T}$	A
274	$Cl + HOCl \rightarrow Cl_2 + OH$		$2.50\times10^{-12}\ e^{-130/T}$	A
275	$Cl + OClO \rightarrow ClO + ClO$		$3.40\times10^{-12}\ e^{160/T}$	A
276	$Cl + ClOO \rightarrow Cl_2 + O_2$		2.30×10^{-10}	A
277	$ClO + O \rightarrow Cl + O_2$		$2.80\times10^{-11}\ e^{85/T}$	A
278	$ClO + O_3 \rightarrow ClOO + O_2$		1.40×10^{-17}	A
279	$ClO + OH \rightarrow Cl + HO_2$		$7.40\times10^{-12}\ e^{270/T}$	A
280	$ClO + OH \rightarrow HCl + O_2$		$6.00\times10^{-13}\ e^{230/T}$	A
281	$ClO + HO_2 \rightarrow HOCl + O_2$		$2.70\times10^{-12}\ e^{220/T}$	A
282	$ClO + NO \rightarrow Cl + NO_2$		$6.40\times10^{-12}\ e^{290/T}$	A
283	$ClO + NO_2 \xrightarrow{M} ClONO_2$	(P) 0.6	$1.80\times10^{-31}\ (300/T)^{3.4}$ $1.50\times10^{-11}(300/T)^{1.9}$	A
284	$ClO + ClO \rightarrow Cl + ClOO$		$3.00\times10^{-11}\ e^{-2450/T}$	A
285	$ClO + ClO \xrightarrow{M} Cl_2O_2$	(P) 0.6	$1.60\times10^{-32}\ (300/T)^{4.5}$ $2.00\times10^{-12}(300/T)^{2.4}$	A
286	$Cl_2O_2 + M \rightarrow ClO + ClO + M$		$K_{285} / (9.30\times10^{-28} \times e^{8835/T})$	A
287	$HCl + OH \rightarrow Cl + H_2O$		$2.60\times10^{-12}\ e^{-350/T}$	A
288	$ClONO_2 + O \rightarrow Cl + NO_2 + O_2$		$2.90\times10^{-12}\ e^{-800/T}$	A
289	$ClNO_2 + OH \rightarrow HOCl + NO_2$		$2.40\times10^{-12}\ e^{-1250/T}$	A
290	$OClO + O \rightarrow ClO + O_2$		$2.40\times10^{-12}\ e^{-960/T}$	A
291	$OClO + OH \rightarrow HOCl + O_2$		$4.50\times10^{-13}\ e^{800/T}$	A
292	$OClO + NO \rightarrow ClO + NO_2$		$2.50\times10^{-12}\ e^{-600/T}$	A
293	$HOCl + O \rightarrow ClO + OH$		1.70×10^{-13}	A
294	$HOCl + OH \rightarrow ClO + H_2O$		$3.00\times10^{-12}\ e^{-500/T}$	A
295	$Cl_2 + OH \rightarrow HOCl + Cl$		$1.40\times10^{-12}\ e^{-900/T}$	A
296	$CH_3Cl + OH \rightarrow HCHO + ClO + H_2O$		$2.40\times10^{-12}\ e^{-1250/T}$	A
	Bromine Gas-Phase Chemistry			
297	$Br + O_3 \rightarrow BrO + O_2$		$1.70\times10^{-11}\ e^{-800/T}$	A
298	$Br + HO_2 \rightarrow HBr + O_2$		$4.80\times10^{-12}\ e^{-310/T}$	A
299	$Br + H_2O_2 \rightarrow HBr + HO_2$		$1.00\times10^{-11}\ e^{-3000/T}$	A
300	$Br + HCHO \rightarrow HBr + CO + HO_2$		$1.70\times10^{-11}\ e^{-800/T}$	A
301	$BrO + O \rightarrow Br + O_2$		$1.90\times10^{-11}\ e^{230/T}$	A
302	$BrO + OH \rightarrow Br + HO_2$		$1.70\times10^{-11}\ e^{250/T}$	A
303	$BrO + HO_2 \rightarrow HOBr + O_2$		$4.50\times10^{-12}\ e^{460/T}$	A
304	$BrO + NO \rightarrow Br + NO_2$		$8.80\times10^{-12}\ e^{260/T}$	A
305	$BrO + NO_2 \xrightarrow{M} BrONO_2$	(P) 0.6	$5.20\times10^{-31}\ (300/T)^{3.2}$ $6.90\times10^{-12}(300/T)^{2.9}$	A

306	$BrO + ClO \rightarrow Br + OClO$	$9.50\times10^{-13}\ e^{550/T}$	A
307	$BrO + ClO \rightarrow Br + Cl + O_2$	$2.30\times10^{-13}\ e^{260/T}$	A
308	$BrO + ClO \rightarrow BrCl + O_2$	$4.10\times10^{-13}\ e^{290/T}$	A
309	$BrO + BrO \rightarrow 2Br + O_2$	$2.40\times10^{-12}\ e^{40/T}$	A
310	$BrO + BrO \rightarrow Br_2 + O_2$	$2.80\times10^{-14}\ e^{860/T}$	A
311	$BrO + O_3 \rightarrow Br + 2O_2$	$1.00\times10^{-12}\ e^{-3200/T}$	A
312	$HBr + OH \rightarrow Br + H_2O$	$5.50\times10^{-12}\ e^{200/T}$	A
313	$HOBr + O \rightarrow BrO + OH$	$1.20\times10^{-10}\ e^{-430/T}$	A
314	$BrCl + O \rightarrow BrO + Cl$	2.20×10^{-11}	A
	Heterogeneous Chemistry		
315	$N_2O_5 + H_2O(a) \rightarrow 2\ HNO_3(a)$	Aer. (J,A), ice (L), NAT (L), liq. (A)	
316	$N_2O_5 + HCl(a) \rightarrow ClNO_2 + HNO_3(a)$	Aer. (A), ice (L), NAT (L)	
317	$ClONO_2 + H_2O \rightarrow HOCl + HNO_3(a)$	Aer. (K), ice (L), NAT (L), liq. (A)	
318	$ClONO_2 + HCl(a) \rightarrow Cl_2 + HNO_3(a)$	Aer. (K), ice (L), NAT (L)	
319	$HOCl + HCl(a) \rightarrow Cl_2 + H_2O(s)$	Aer. (K), ice (L), NAT (L)	
320	$BrONO_2 + H_2O \rightarrow HOBr + HNO_3(a)$	Aer. (A), ice (A), liq. (A)	
321	$BrONO_2 + HCl(a) \rightarrow BrCl + HNO_3(a)$	Aer. (A), ice (A)	
322	$HOBr + HCl(a) \rightarrow BrCl + H_2O(s)$	Aer. (A), ice (A)	
323	$HOBr + HBr(a) \rightarrow Br_2 + H_2O(a)$	Aer. (A), ice (A)	
	Photoprocesses		
324	$O_2 + h\nu \rightarrow O + O$		A
325	$O_3 + h\nu \rightarrow O(^1D) + O_2$		A
325	$O_3 + h\nu \rightarrow O + O_2$		A
327	$HO_2 + h\nu \rightarrow OH + O(^1D)$		A
328	$H_2O + h\nu \rightarrow H + OH$		A
329	$H_2O_2 + h\nu \rightarrow 2\ OH$		A
330	$NO_2 + h\nu \rightarrow NO + O$		A
331	$NO_3 + h\nu \rightarrow NO_2 + O$		B
332	$NO_3 + h\nu \rightarrow NO + O_2$		B
333	$N_2O + h\nu \rightarrow N_2 + O(1D)$		A
334	$N_2O_5 + h\nu \rightarrow NO_2 + NO_3$		A
335	$HONO + h\nu \rightarrow OH + NO$		A
336	$HONO + h\nu \rightarrow H + NO_2$		A
337	$HNO_3 + h\nu \rightarrow OH + NO_2$		A
338	$HNO_3 + h\nu \rightarrow HONO + O(^1D)$		A
339	$HNO_3 + h\nu \rightarrow OH + NO + O$		A
340	$HO_2NO_2 + h\nu \rightarrow HO_2 + NO_2$		B
341	$HO_2NO_2 + h\nu \rightarrow OH + NO_3$		B
342	$HCHO + h\nu \rightarrow 2\ HO_2 + CO$		A
343	$HCHO + h\nu \rightarrow CO + H_2$		A
344	$CH_3OOH + h\nu \rightarrow CH_3O + OH$		B
345	$CH_3CHO + h\nu \rightarrow CH_3O_2 + HO_2 + CO$		B
346	$ALD2 + h\nu \rightarrow CH_3O_2 + HO_2 + CO$		B
347	$CH_3ONO + h\nu \rightarrow CH_3O + NO$		C
348	$CH_3ONO_2 + h\nu \rightarrow CH_3O + NO_2$		B
349	$CH_3O_2NO_2 + h\nu \rightarrow CH_3O_2 + NO_2$		B
350	$C_2H_5ONO_2 + h\nu \rightarrow C_2H_5O + NO_2$		B
351	$C_3H_7ONO_2 + h\nu \rightarrow C_3H_7O + NO_2$		B
352	$CH_3CO_3NO_2 + h\nu \rightarrow CH_3CO_3 + NO_2$		A
353	$CH_3COCH_3 + h\nu \rightarrow CH_3O_2 + CH_3C(O)OO$		B
354	$KET + h\nu \rightarrow CH_3C(O)OO + RO_2 + 2XOP$		J
355	$MVK + h\nu \rightarrow CH_3C(O)OO + C_2H_4 + HO_2$		K
356	$MACR + h\nu \rightarrow C_2H_4 + HO_2 + CO + CH_3O_2$		A

357	$CH_3COCHO + h\nu \rightarrow CH_3C(O)OO+CO+HO_2$		B
358	$BZA + h\nu \rightarrow PHO_2 + CO + HO_2$		C
359	$OPEN + h\nu \rightarrow CH_3C(O)OO + CO + HO_2$		C
360	$HCl + h\nu \rightarrow H + Cl$		A
361	$ClO + h\nu \rightarrow Cl + O$		A
362	$ClOO + h\nu \rightarrow ClO + O$		A
363	$OClO + h\nu \rightarrow ClO + O$		A
364	$HOCl + h\nu \rightarrow OH + Cl$		A
365	$ClONO_2 + h\nu \rightarrow Cl + NO_3$		A
366	$ClONO_2 + h\nu \rightarrow ClO + NO_2$		A
367	$Cl_2 + h\nu \rightarrow Cl + Cl$		A
368	$Cl_2O_2 + h\nu \rightarrow Cl + ClOO$		A
369	$ClNO_2 + h\nu \rightarrow Cl + NO_2$		A
370	$CH_3Cl + h\nu \rightarrow HCHO + ClO + HO_2$		A
371	$CFCl_3 + h\nu \rightarrow 3Cl + F + CO_2$		A
372	$CF_2Cl_2 + h\nu \rightarrow 2\ Cl + 2F + CO_2$		A
373	$BrO + h\nu \rightarrow Br + O$		A
374	$HOBr + h\nu \rightarrow Br + OH$		A
374	$BrONO_2 + h\nu \rightarrow Br + NO_3$		A
376	$BrONO_2 + h\nu \rightarrow BrO + NO_2$		A
377	$Br_2 + h\nu \rightarrow Br + Br$		A
378	$CH_3Br + h\nu \rightarrow CH_3O_2 + Br$		A
379	$HBr + h\nu \rightarrow H + Br$		A
380	$BrCl + h\nu \rightarrow Br + Cl$		A

Species names are defined in Appendix Table B.3. of Jacobson [2005b]. In addition, C_4H_6=1,3-butadiene, C_6H_6=benzene., ALD2=C_3 and higher aldehydes, TERPH = monoterpenes. Species above reaction arrows are second or third bodies included in pressure-dependent reactions (footnote *a*) or in thermal dissociation reactions in equilibrium with the forward (previous) reaction. M is total air. The "Ref." column refers to sources of data for reaction rate coefficients, absorption cross sections, and quantum yields.

a (P) indicates a pressure-dependent reaction, for which the reaction rate coefficient is

$$k_r = \frac{k_{\infty,T} k_{0,T}[\mathrm{M}]}{k_{\infty,T} + k_{0,T}[\mathrm{M}]} F_c^{\left[1+\log_{10}\left(\frac{k_{0,T}[\mathrm{M}]}{k_{\infty,T}}\right)^2\right]^{-1}}$$

where $k_{0,T}$ is the temperature-dependent three-body, low-pressure limit rate coefficient (the first rate listed), $k_{\infty,T}$ is the two-body, high-pressure limit rate coefficient (the second rate listed), [M] = [N_2] + [O_2] is the concentration (molecules cm^{-3}) of the third body, and F_c is the broadening factor.

b A, [*Sander et al*., 2006]; B, *Atkinson et al*. [1997]; C, *Gery et al*. [1988; 1989]; D, MCM Mechanism (http://mcm.leeds.ac.uk/MCM); E, *Bahta et al*. [2004] (assume products the same as OLE+O_3 plus OLE; F, *Paulson and Seinfeld* [1992]; G, *Atkinson* [1997]; H, *Griffin et al*. [2002]; G, *Yin et al*. [1990]; H, assumed the same as for acetone; I, assumed the same as for methyl ethyl ketone; J, *Robinson et al*., 1997; K, *Shi et al*. 2001; L, *Tabazadeh and Turco*, 1993.

c $k_r = k_1 + k_3[\mathrm{M}] / (1 + k_3[\mathrm{M}]/k_2)$, where $k_1 = 2.40\times10^{-14}\ e^{460/T}$, $k_2 = 2.70\times10^{-17}\ e^{2199/T}$, $k_3 = 6.50\times10^{-34}\ e^{1335/T}$, and [M] = [$N_2$] + [$O_2$] (molecules cm^{-3}).

d $k_r = 1.50\times10^{-13}(1+0.6\ p_a)(300/T)^{1.0}$, where p_a is the ambient air pressure in atmospheres.

e $k_r = (2.30\times10^{-13}\ e^{600/T} + 1.70\times10^{-33}[\mathrm{M}]e^{1000/T})(1. + 1.40\times10^{-21}[H_2O]e^{2200/T})$, where [M] = [$N_2$] + [$O_2$] and [$H_2O$] are in units of molecules cm^{-3}.

f $k_r = 1.0\times10^{-39}[\mathrm{M}]e^{5820/T}/(1+5.0\times10^{-30}[\mathrm{M}]e^{6280/T})$, where [M] = [$N_2$] + [$O_2$] (molecules cm^{-3}) .

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