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A mechanism for biologically induced iodine emissions from sea ice

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Table 1. Gas Phase Reactions and Rate Constants

#	Bimolecular Reactions	Rate Constants	References
1.	$O(^1D) + N_2 \rightarrow O + N_2$	$1.8 \times 10^{-11} e^{(110 / T)}$	2
2.	$O(^1D) + O_2 \rightarrow O + O_2$	$3.2 \times 10^{-11} e^{(70 / T)}$	2
3.	$O(^1D) + H_2O \rightarrow OH + OH$	2.2×10^{-10}	2
4. (0.05)	$O(^1D) + CH_4 \rightarrow CH_3 + OH$ (0.75),$CH_3O + H$ (0.2),$HCHO + H_2$	1.5×10^{-10}	2
5.	$O(^1D) + H_2 \rightarrow OH + H$	1.1×10^{-10}	2
6.	$OH + CO \rightarrow H + CO_2$	$1.5 \times 10^{-13} \times (1 + 0.6 \times P_{atm})$	2
7.	$HO_2 + NO \rightarrow NO_2 + OH$	$3.5 \times 10^{-12} e^{(250 / T)}$	2
8.	$O_3 + HO_2 \rightarrow OH + 2O_2$	$1.1 \times 10^{-14} e^{(-500 / T)}$	2
9.	$HO_2 + HO_2 \rightarrow H_2O_2 + O_2$	$2.3 \times 10^{-13} e^{(600 / T)}$	2
10.	$OH + H_2 \rightarrow H_2O + H$	$5.5 \times 10^{-12} e^{(-2000 / T)}$	2
11.	$O_3 + OH \rightarrow HO_2 + O_2$	$1.6 \times 10^{-12} e^{(-940 / T)}$	2
12.	$OH + HNO_3 \rightarrow H_2O + NO_3$	$k_0 = 7.2 \times 10^{-15} e^{(785 / T)}$ $k_2 = 4.1 \times 10^{-16} e^{(1440 / T)}$ $k_3 = 1.9 \times 10^{-33} e^{(725 / T)}$ $k = k_0 + (k_3 \times [M] / (1 + k_3 \times [M] / k_2))$	2
13.	$H_2O_2 + OH \rightarrow H_2O + HO_2$	$2.9 \times 10^{-12} e^{(-160 / T)}$	2
14.	$OH + HO_2NO_2 \rightarrow NO_2 + HO_2 + OH$	$1.3 \times 10^{-12} e^{(380 / T)}$	2
15.	$OH + HO_2 \rightarrow H_2O + O_2$	$4.8 \times 10^{-11} e^{(250 / T)}$	2
16.	$OH + HONO \rightarrow H_2O + NO_2$	$1.8 \times 10^{-11} e^{(390 / T)}$	2
17.	$C_2H_5 + O_2 \rightarrow C_2H_4 + HO_2$	2×10^{-14}	2,b
18.	$OH + CH_4 \rightarrow CH_3 + H_2O$	$2.45 \times 10^{-12} e^{(-1775 / T)}$	2
19.	$O(^3P) + CH_3 \rightarrow CH_3O$	1.1×10^{-10}	2
20.	$CH_3O_2 + HO_2 \rightarrow CH_3OOH + O_2$	$3.8 \times 10^{-13} e^{(800 / T)}$	2
21.	$CH_3OOH + OH \rightarrow CH_3(O)O + H_2O$	$0.7 \times 3.8 \times 10^{-12} e^{(200 / T)}$	2
22.	$CH_3O + O_2 \rightarrow CH_2O + HO_2$	$3.9 \times 10^{-14} e^{(-900 / T)}$	2
23.	$OH + HCHO \rightarrow H_2O + HCO$	$8.8 \times 10^{-12} e^{(25 / T)}$	2
24.	$HCO + O_2 \rightarrow CO + HO_2$	$3.5 \times 10^{-12} e^{(140 / T)}$	2
25.	$CH_3O_2 + CH_3O_2 \rightarrow 2CH_3O + O_2$ 29%	$0.29 \times 2.5 \times 10^{-13} e^{(190 / T)}$	2
26.	$NO + CH_3O_2 \rightarrow NO_2 + CH_3O$	$3 \times 10^{-12} e^{(280 / T)}$	2
27.	$NO + O_3 \rightarrow NO_2 + O_2$	$2 \times 10^{-12} e^{(-1400 / T)}$	2
28.	$NO + NO_3 \rightarrow 2NO_2$	$1.5 \times 10^{-11} e^{(170 / T)}$	2
29.	$NO_3 + HCHO \rightarrow$ Products	5.8×10^{-16}	2,b
30.	$HO_2 + SO_2 \rightarrow$ Products	1×10^{-18}	2,b
31.	$N_2O_5 + H_2O \rightarrow 2HNO_3$	2.5×10^{-22}	2,b
32.	$NO_2 + O_3 \rightarrow NO_3 + O_2$	$1.2 \times 10^{-13} e^{(-2450 / T)}$	2
33.	$OH + O(^3P) \rightarrow H + O_2$	$2.2 \times 10^{-11} e^{(120 / T)}$	2
34.	$O(^3P) + HO_2 \rightarrow OH + O_2$	$3 \times 10^{-11} e^{(200 / T)}$	2

35.	$H_2O_2 + O(^3P) \rightarrow OH + HO_2$	$1.4 \times 10^{-12} e^{(-2000 / T)}$	2
36.	$OH + OH \rightarrow H_2O + O(^3P)$	$4.2 \times 10^{-12} e^{(-240 / T)}$	2
37.	$O_3 + Alkenes \rightarrow Products$	$1.2 \times 10^{-14} e^{(-2630 / T)}$	2,b
38.	$NO_3 + CO \rightarrow Products$	4×10^{-19}	2,b
39.	$OH + CH_3OOH \rightarrow CH_2OOH + H_2O \rightarrow CH_2O + OH + H_2O$	$0.3 \times 3.8 \times 10^{-12} e^{(200 / T)}$	2
40.	$O(^3P) + HCHO \rightarrow OH + HCO$	$3.4 \times 10^{-11} e^{(-1600 / T)}$	2
41.	$HCHO + HO_2 \rightarrow HO_2CH_2O$	$6.7 \times 10^{-15} e^{(600 / T)}$	2
42.	$H + O_3 \rightarrow OH + O_2$	$1.4 \times 10^{-10} e^{(-470 / T)}$	2
43.	$HO_2 + H \rightarrow 2OH$	$0.9 \times 8.1 \times 10^{-11}$	2
44.	$O(^3P) + HO_2NO_2 \rightarrow Products$	$7.8 \times 10^{-11} e^{(-3400 / T)}$	2
45.	$O(^1D) + O_3 \rightarrow 2O_2$	1.2×10^{-10}	2
46.	$O(^1D) + O_3 \rightarrow O_2 + 2O$	1.2×10^{-10}	2
47.	$CH_3O_2 + SO_2 \rightarrow Products$	5×10^{-17}	1,b
48.	$NO_3 + HO_2 \rightarrow OH + NO_2 + O_2$	3.5×10^{-12}	2
49.	$CH_3 + O_3 \rightarrow Products$	$5.4 \times 10^{-12} e^{(-220 / T)}$	2
50.	$SO_2 + O_3 \rightarrow SO_3 + O_2$	$3 \times 10^{-12} e^{(-7000 / T)}$	2,b
51.	$NO_3 + OH \rightarrow NO_2 + HO_2$	2.2×10^{-11}	2
52.	$O_3 + O(^3P) \rightarrow 2O_2$	$8 \times 10^{-12} e^{(-2060 / T)}$	2
53.	$O_3 + HONO \rightarrow O_2 + HNO_3$	5×10^{-19}	2,b
54.	$CH_3O_2 + O_3 \rightarrow Products$	3×10^{-17}	2,b
55.	$NO_3 + Alkenes \rightarrow HOCH_2CH_2 + NO_2$	3×10^{-14}	1
56.	$SO_2 + NO_2 \rightarrow Products$	2×10^{-26}	1,b
57.	$NO_3 + Alkanes \rightarrow C_2H_5 + HNO_3$	3.6×10^{-17}	1
58.	$CH_3O_2 + CH_3O_2 \rightarrow CH_2O + CH_3OH + O_2$	$0.71 \times 2.5 \times 10^{-13} e^{(190 / T)}$	2
59.	$NO_2 + NO_3 \rightarrow NO + NO_2 + O_2$	$4.5 \times 10^{-14} e^{(-1260 / T)}$	2
60.	$OH + Alkanes \rightarrow C_2H_5 + H_2O$	$1.1 \times 10^{-11} e^{(-1100 / T)}$	1
61.	$C_2H_5O_2 + NO \rightarrow NO_2 + C_2H_5O$	$2.6 \times 10^{-12} e^{(365 / T)}$	2
62.	$CH_3CHO + NO_3 \rightarrow HNO_3 + CH_3CO (\rightarrow CH_3C(O)O_2)$	$1.4 \times 10^{-12} e^{(-1900 / T)}$	2
63.	$CH_3CHO + O(^3P) \rightarrow OH + CH_3CO (\rightarrow CH_3C(O)O_2)$	$1.8 \times 10^{-11} e^{(-1100 / T)}$	2
64.	$CH_3CHO + OH \rightarrow H_2O + CH_3CO (\rightarrow CH_3C(O)O_2)$	$5.6 \times 10^{-12} e^{(270 / T)}$	2
65.	$O(^3P) + H_2 \rightarrow OH + H$	4.11×10^{-18}	1
66.	$NO + CH_3C(O)O_2 \rightarrow NO_2 + CH_3 + CO_2$	$5.3 \times 10^{-12} e^{(360 / T)}$	2
67.	$OH + C_2H_5OOH \rightarrow C_2H_4OOH + H_2O$	3.64×10^{-12}	1
68.	$OH + C_2H_5OOH \rightarrow C_2H_5O_2 + H_2O$	5.95×10^{-12}	1
69.	$NO_2 + O(^3P) \rightarrow NO + O_2$	$6.5 \times 10^{-12} e^{(120 / T)}$	2
70.	$NO_3 + O(^3P) \rightarrow NO_2 + O_2$	1×10^{-11}	2
71.	$HNO_3 + O(^3P) \rightarrow NO_3 + OH$	3×10^{-17}	2,b
71.	$C_2H_5O + O_2 \rightarrow CH_3CHO + HO_2$	$6.3 \times 10^{-14} e^{(-550 / T)}$	2
73.	$HO_2CH_2O \rightarrow HO_2 + CH_2O$	$2.4 \times 10^{12} e^{(-7000 / T)}$	1
74.	$HO_2CH_2O + HO_2 \rightarrow HCOOH + O_2 + H_2O$	$5.6 \times 10^{-15} e^{(2300 / T)}$	1
	Halogen chemistry		
75.	$I + O_3 \rightarrow IO + O_2$	$2 \times 10^{-11} e^{(-890 / T)}$	2
76.	$I + HO_2 \rightarrow HI + O_2$	$1.5 \times 10^{-11} e^{(-1190 / T)}$	2
77.	$IO + NO \rightarrow I + NO_2$	$7.3 \times 10^{-12} e^{(330 / T)}$	2
78.	$IO + HO_2 \rightarrow HOI + O_2$	5.8×10^{-11}	2

79.	$IO + IO \rightarrow OIO + I / I_2O_2$	8.6×10^{-11}	3
80.	$IO + OIO (+M) \rightarrow I_2O_3$	1.5×10^{-11}	3
81.	$IONO_2 \rightarrow IO + NO_2$	$2.07 \times 10^{15} e^{(-11859 / T)}$	2
82.	$OH + HI \rightarrow I + H_2O$	3×10^{-11}	2
83.	$HOI + OH \rightarrow IO + H_2O$	2×10^{-13}	2
84.	$IO + DMS \rightarrow$ Products	1.2×10^{-14}	2
85.	$INO_2 \rightarrow I + NO_2$	$(2.4 / 0.005) \times 2.07 \times 10^{15} e^{(-11859 / T)}$	2
86.	$Br + O_3 \rightarrow BrO + O_2$	$1.7 \times 10^{-11} e^{(-800/T)}$	2
87.	$HBr + OH \rightarrow Br + H_2O$	1.1×10^{-11}	2
88.	$Br + HO_2 \rightarrow HBr + O_2$	$1.5 \times 10^{-11} e^{(-600/T)}$	2
89.	$Br + HCHO \rightarrow HBr + HCO$	$7.7 \times 10^{-13} e^{(-580/T)}$	2
90.	$Br + CH_3CHO \rightarrow HBr\ CH_3CO$	$1.8 \times 10^{-12} e^{(-460/T)}$	2
91.	$BrO + HO_2 \rightarrow HOBr + O_2$	$3.4 \times 10^{-12} e^{(540/T)}$	2
92.	$BrO + NO \rightarrow Br + NO_2$	$8.8 \times 10^{-12} e^{(260/T)}$	2
93.	$BrO + CH_3SCH_3 \rightarrow CH_3SOCH_3 + Br$	$1.5 \times 10^{-14} e^{(850/T)}$	2
94.	$BrO + BrO \rightarrow 2Br + O_2$	$2.4 \times 10^{-12} e^{(40/T)}$	2
95.	$BrO + BrO \rightarrow Br_2 + O_2$	$2.8 \times 10^{-14} e^{(860/T)}$	2
96.	$BrONO_2 \rightarrow BrO + NO_2$	$2.8 \times 10^{13} e^{-(12360/T)}$	4
97.	$BrO + IO \rightarrow Br + I + O_2 / Br + OIO$	$1.5 \times 10^{-12} e^{(510/T)}$	2
98.	$Cl + CH_4 \rightarrow HCl + CH_3$	$1.1 \times 10^{-11} e^{(-1400/T)}$	2
99.	$HCl + OH \rightarrow H_2O + Cl$	$2.6 \times 10^{-12} e^{(-350/T)}$	2
100.	$Cl + O_3 \rightarrow ClO + O_2$	$2.9 \times 10^{-11} e^{(-260/T)}$	2
101.	$ClO + HO_2 \rightarrow HOCl + O_2$	$5.0 \times 10^{-12} e^{(700/T)}$	2
102.	$ClO + NO \rightarrow Cl + NO_2$	$6.4 \times 10^{-12} e^{(290/T)}$	2
103.	$ClO + IO \rightarrow 0.2 (I + Cl + O_2)$	$1.3 \times 10^{-12} e^{(280/T)}$	2
104.	$Cl + Alkanes \rightarrow HCl + CH_3OO$	$5.7 \times 10^{-11} e^{(-90/T)}$	2,1
105.	$Cl + Alkenes \rightarrow HCl + CH_3OO$	1.0×10^{-10}	2,1
106.	$Cl + HCHO \rightarrow HCl + HO_2 + CO$	$7.3 \times 10^{-11} e^{(-30/T)}$	2
107.	$ClO + CH_3OO \rightarrow Cl + HCHO + HO_2$	$2.2 \times 10^{-12} e^{(-115/T)}$	2
108.	$ClO + ClO \rightarrow Cl_2O_2$	3.5×10^{-13}	2
109.	$Cl_2O_2 \rightarrow ClO + ClO$	50	2
110.	$ClONO_2 \rightarrow ClO + NO_2$	0.0022	2
111.	$Cl + ClONO_2 \rightarrow Cl_2 + NO_3$	$9.6 \times 10^{-12} e^{(140/T)}$	2
112.	$Cl + H_2O_2 \rightarrow HCl + HO_2$	$4.1 \times 10^{-13} e^{(-980/T)}$	2
113.	$Br_2 + Cl \rightarrow BrCl + Br$	$1.2 \times 10^{-10} e^{(-260/T)}$	2,1
114.	$BrCl + Br \rightarrow Br_2 + Cl$	3.3×10^{-15}	2,1
115.	$Cl_2 + Br \rightarrow BrCl + Cl$	1.1×10^{-15}	2,1
116.	$BrCl + Cl \rightarrow Cl_2 + Br$	1.5×10^{-11}	2,1
117.	$ClO + BrO \rightarrow Br + OClO$	$6.0 \times 10^{-12} e^{(550/T)}$	2,1
118.	$ClO + BrO \rightarrow Br + Cl + O_2$	$5.6 \times 10^{-12} e^{(260/T)}$	2,1
119.	$ClO + BrO \rightarrow BrCl + O_2$	$1.1 \times 10^{-12} e^{(290/T)}$	2,1
	Recombination Reactions		
1.	$O(^1D) + N_2 (+M) \rightarrow N_2O (+M)$	$[M] \times 3.5 \times 10^{-37} \times (T / 300)^{-0.6}$	2
2.	$HO_2 + HO_2 (+M) \rightarrow H_2O_2 (+M)$	$[M] \times 1.7 \times 10^{-33} e^{(1000 / T)}$	2
3.	$H + O_2 (+ M) \rightarrow HO_2 (+ M)$	$k_0 = 5.7 \times 10^{-32} \times (T / 300)^{-1.6}$	2

		$k_\infty = 7.5 \times 10^{-11}$	
4.	$O_2 + O(^3P) \rightarrow O_3$	$[M] \times 6 \times 10^{-34} \times (T / 300)^{-2.3}$	2
5.	$NO_2 + OH \rightarrow HNO_3$	$k_0 = 2.5 \times 10^{-30} \times (T / 300)^{-4.4}$ $k_\infty = 1.6 \times 10^{-11} \times (T / 300)^{-1.7}$	2
6.	$NO + OH (+ M) \rightarrow HONO (+ M)$	$k_0 = 7 \times 10^{-31} \times (T / 300)^{-2.6}$ $k_\infty = 1.5 \times 10^{-11} \times (T / 300)^{-0.5}$	2
7.	$HO_2 + NO_2 (+ M) \rightarrow HO_2NO_2 (+ M)$	$k_0 = 1.8 \times 10^{-31} \times (T / 300)^{-3.2}$ $k_\infty = 4.7 \times 10^{-12} \times (T / 300)^{-1.4}$	2
8.	$HO_2NO_2 \rightarrow HO_2 + NO_2$	$k_R = k_F / k_{EQ}$ $k_R = k_F / (2.1 \times 10^{-27} e^{(10900 / T)})$	2
9.	$O_2 + CH_3 (+ M) \rightarrow CH_3O_2 (+ M)$	$k_0 = 4.5 \times 10^{-31} \times (T / 300)^{-3}$ $k_\infty = 1.8 \times 10^{-12} \times (T / 300)^{-1.7}$	2
10.	$NO_2 + NO_3 (+ M) \rightarrow N_2O_5 (+ M)$	$k_0 = 2.2 \times 10^{-30} \times (T / 300)^{-3.9}$ $k_\infty = 1.5 \times 10^{-12} \times (T / 300)^{-0.7}$	2
11.	$N_2O_5 (+ N_2) \rightarrow NO_2 + NO_3 (+ N_2)$	$k_R = k_F / k_{EQ}$ $k_R = k_F / (2.7 \times 10^{-27} e^{(11000 / T)})$	2
12.	$OH + OH (+ M) \rightarrow H_2O_2 (+ M)$	$k_0 = 6.2 \times 10^{-31} \times (T / 300)^{-1}$ $k_\infty = 2.6 \times 10^{-11}$	2
13.	$NO + O(^3P) (+ M) \rightarrow NO_2 (+ M)$	$k_0 = 9 \times 10^{-32} \times (T / 300)^{-1.5}$ $k_\infty = 3 \times 10^{-11}$	2
14.	$NO_2 + O(^3P) (+ M) \rightarrow NO_3 (+ M)$	$k_0 = 9 \times 10^{-32} \times (T / 300)^{-2}$ $k_\infty = 2.2 \times 10^{-11}$	2
15.	$SO_2 + OH (+ M) \rightarrow HOSO_2 (+ M)$	$k_0 = 3 \times 10^{-31} \times (T / 300)^{-3.3}$ $k_\infty = 1.5 \times 10^{-12}$	2
16.	$CH_3C(O)O_2 + NO_2 (+ M) \rightarrow PAN (+ M)$	$k_0 = 9.7 \times 10^{-29} \times (T / 300)^{-5.6}$ $k_\infty = 9.3 \times 10^{-12} \times (T / 300)^{-1.5}$	2
17.	$PAN (+ M) \rightarrow CH_3C(O)O_2 + NO_2 (+ M)$	$k_R = k_F / k_{EQ}$ $k_R = k_F / (9 \times 10^{-29} e^{(14000 / T)})$	2
18.	$OH + Alkenes (+ M) \rightarrow HOCH_2CH_2 (+ M)$	$k_0 = 1.5 \times 10^{-28} \times (T / 300)^{-0.8}$ $k_\infty = 8.8 \times 10^{-12}$	2,1
19.	$C_2H_5 + O_2 (+ M) \rightarrow C_2H_5O_2 (+ M)$	$k_0 = 1.5 \times 10^{-28} \times (T / 300)^{-3.8}$ $k_\infty = 8 \times 10^{-12}$	2
20.	$NO_2 + CH_3O_2 (+ M) \rightarrow CH_3O_2NO_2 (+ M)$	$k_0 = 1.5 \times 10^{-30} \times (T / 300)^{-4}$ $k_\infty = 6.5 \times 10^{-12} \times (T / 300)^{-2}$	2
21.	$CH_3O_2NO_2 \rightarrow CH_3O_2 + NO_2$	$k_R = k_F / k_{EQ}$ $k_R = k_F / (1.3 \times 10^{-28} e^{(11200 / T)})$	2
22.	$I + NO_2 (+ M) \rightarrow INO_2 (+ M)$	$k_0 = 3 \times 10^{-31} \times (T / 300)^{-1}$ $k_\infty = 6.6 \times 10^{-11}$	2
23.	$IO + NO_2 (+ M) \rightarrow IONO_2 (+ M)$	$F_c = e^{(-T / 650)} + e^{(-2600 / T)}$ $k_0 = 7.7 \times 10^{-31} \times (T / 300)^{-5}$ $k_\infty = 1.6 \times 10^{-11}$ $F_c = 0.4$	2
24.	$Br + NO_2 + M \rightarrow BrNO_2$	$k_0 = 4.2 \times 10^{-31} \times (T / 300)^{-2.4}$ $k_\infty = 2.7 \times 10^{-11} \times (T / 300)^{-0}$	2
25.	$BrO + NO_2 + M \rightarrow BrONO_2$	$k_0 = 5.2 \times 10^{-31} \times (T / 300)^{-3.2}$	2

25.	$ClO + NO_2 + M \rightarrow ClONO_2$	$k_o = 6.9 \times 10^{-12} \times (T / 300)^{-2.9}$ $k_0 = 1.6.2 \times 10^{-31} \times (T / 300)^{-3.4}$ $k_\infty = 1.5 \times 10^{-11}$	2

	Photochemical Reactions	References
J1.	$O_3 + h\nu \rightarrow O_2 + O(^1D)$	2,1,c
J2.	$H_2O_2 + h\nu \rightarrow 2OH$	2,1,c
J3.	$HNO_3 + h\nu \rightarrow OH + NO_2$	2,1,c
J4.	$HO_2NO_2 + h\nu \rightarrow OH + NO_3$	2,1,c
J5.	$HONO + h\nu \rightarrow OH + NO$	2,1,c
J6.	$CH_3OOH + h\nu \rightarrow CH_3O + OH$	2,1,c
J7.	$CH_2O + h\nu \rightarrow HCO + H$	2,1,c
J8.	$CH_2O + h\nu \rightarrow CO + H_2$	2,1,c
J9.	$NO_2 + h\nu \rightarrow NO + O$	2,1,c
J10.	$NO_3 + h\nu \rightarrow NO_2 + O$	2,1,c
J11.	$N_2O_5 + h\nu \rightarrow NO_2 + NO_3$	2,1,c
J12.	$C_2H_5O_2H + h\nu \rightarrow OH + C_2H_5O$	2,1,c
J13.	$CH_3CHO + h\nu \rightarrow CH_3 + HCO$	2,1,c
J15.	PAN ($CH3C(O)O_2NO_2$) + $h\nu \rightarrow CH_3C(O)O_2 + NO_2$	2,1,c
J16.	$NO_3 + h\nu \rightarrow NO + O_2$	2,1,c
J17.	$CH_3I + h\nu \rightarrow CH_3 + I$	2,1,c
J18.	$CH_2I_2 + h\nu \rightarrow CH_2I + I \rightarrow CH_2 + 2I$	2,1,c
J19.	$CH_2IBr + h\nu \rightarrow CH_2Br + I$	2,1,c
J20.	$I_2 + h\nu \rightarrow 2I$	2,1,c
J21.	$INO_2 + h\nu \rightarrow I + NO_2$ / IO + NO	2,1,c
J22.	$IO + h\nu \rightarrow I + O$	2,1,c
J23.	$OIO + h\nu \rightarrow I + O_2$	2,1,c
J24.	$IONO_2 + h\nu \rightarrow I + NO_3$	2,1,c
J25.	$HOI + h\nu \rightarrow I + OH$	2,1,c
J26.	$BrO + h\nu \rightarrow Br + O$	2,1,c
J27.	$Br_2 + h\nu \rightarrow 2Br$	2,1,c
J28.	$IBr + h\nu \rightarrow Br + I$	2,1,c
J29.	$BrCl + h\nu \rightarrow Br + Cl$	2,1,c
J30.	$BrNO_2 + h\nu \rightarrow Br + NO_2$	2,1,c
J31.	$BrONO_2 + h\nu \rightarrow 0.7 (BrO + NO_2) / 0.3 (Br + NO_3)$	2,1,c
J32.	$HOBr + h\nu \rightarrow Br + OH$	2,1,c
J33.	$Cl_2 + h\nu \rightarrow 2Cl$	2,1,c
J34.	$ICl + h\nu \rightarrow I + Cl$	2,1,c
J35.	$ClO + h\nu \rightarrow Cl + O$	2,1,c
J36.	$HOCl + h\nu \rightarrow Cl + OH$	2,1,c
J37.	$ClNO_2 + h\nu \rightarrow Cl + NO_2$	2,1,c
J38.	$ClONO_2 + h\nu \rightarrow 0.9 (Cl + NO_3) / 0.1 (ClO + NO_2)$	2,1,c

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Species	Deposition velocities, cm s^{-1}	References
HOI	1.0	5
HOBr	1.0	d
HOCl	1.0	d
HBr	2.0	d
HCl	2.0	d
HI	1.0	5
$BrONO_2$	1.0	d
$IONO_2$	1.0	5
$ClONO_2$	1.0	d
INO_2	1.0	d

[a]Units: unimolecular reactions, s^{-1}; photolysis rate constants, s^{-1}; bimolecular reactions, cm^3 $molecule^{-1}$ s^{-1}; termolecular reactions, cm^6 $molecule^{-2}$ s^{-1}, calculated using the formalism of *Sander et al.* (2006), where $k = ((k_o [M]/(1 + k_o[M]/k_\infty)) \times F_c^n)$, $F_c = 0.6$ (unless otherwise noted) and $n = (1 + (\log_{10}(k_o[M]/k_\infty))^2)^{-1}$.

[b]set as upper limit.

[c]absorption cross-sections taken from *Atkinson et al*., 2000.

[d]deposition velocities estimated.

Table 2. QLL Reactions and Rate Constants

#	Reactions	Rate Constants	References
1.	$HOI + I^- + H^+ \rightarrow I_2 + H_2O$	4.4×10^{12} M^{-2} s^{-1}/(volumetric)^2	6
2.	$I_2 + H_2O \rightarrow HOI + I^- + H^+$	0 s^{-1}	
3.	$HOI + Br^- + H^+ \rightarrow IBr + H_2O$	3.3×10^{12} M^{-2} s^{-1}/(volumetric)^2	7
4.	$IBr + H_2O \rightarrow HOI + Br^- + H^+$	8.0×10^5 s^{-1}	7
5.	$HOI + Cl^- + H^+ \rightarrow ICl + H_2O$	2.9×10^{10} M^{-2} s^{-1}/(volumetric)^2	8
6.	$ICl + H_2O \rightarrow HOI + Cl^- + H^+$	2.4×10^6 s^{-1}	8
7.	$HOBr + Br^- + H^+ \rightarrow Br_2 + H_2O$	1.6×10^{10} M^{-2} s^{-1}/(volumetric)^2	9
8.	$Br_2 + H_2O \rightarrow HOBr + Br^- + H^+$	9.7×10^1 s^{-1}	9
9.	$HOBr + Cl^- + H^+ \rightarrow BrCl + H_2O$	5.6×10^9 M^{-2} s^{-1}/(volumetric)^2	10
10.	$BrCl + H_2O \rightarrow HOBr + Cl^- + H^+$	1.0×10^5 s^{-1}	10
11.	$BrCl + Br^- \rightarrow Br_2Cl^-$	5.0×10^9 M^{-1} s^{-1}/(volumetric)	10
12.	$Br_2Cl^- \rightarrow BrCl + Br^-$	2.8×10^5 s^{-1}	10
13.	$Br_2Cl^- \rightarrow Br_2 + Cl^-$	3.8×10^9 s^{-1}	10
14.	$Br_2 + Cl^- \rightarrow Br_2Cl^-$	5.0×10^9 M^{-1} s^{-1}/(volumetric)	10
15.	$BrCl + Cl^- \rightarrow BrCl_2^-$	5.0×10^9 M^{-1} s^{-1}/(volumetric)	11

16.	$BrCl_2^- \rightarrow BrCl + Cl^-$	$1.3 \times 10^9\ s^{-1}$	11
17.	$HOBr + I^- \rightarrow IBr + OH^-$	$5.0 \times 10^9\ M^{-1}\ s^{-1}$/(volumetric)	12
18.	$HOCl + Cl^- + H^+ \rightarrow Cl_2 + H_2O$	$2.2 \times 10^4\ e^{(-3508\ /\ T)}\ M^{-2}\ s^{-1}$/(volumetric)^2	13
19.	$Cl_2 + H_2O \rightarrow HOCl + Cl^- + H^+$	$2.2 \times 10^1\ e^{(-8012\ /\ T)}\ s^{-1}$	13
20.	$HOCl + Br^- + H^+ \rightarrow BrCl + H_2O$	$3.5 \times 10^{11}\ M^{-2}\ s^{-1}$/(volumetric)^2	14
21.	$BrCl + H_2O \rightarrow HOCl + Br^- + H^+$	$0\ s^{-1}$	
22.	$HOCl + I^- + H^+ \rightarrow ICl + H_2O$	$3.9 \times 10^{-14}\ e^{(-900\ /\ T)}\ M^{-2}\ s^{-1}$/(volumetric)^2	15
23.	$ICl + H_2O \rightarrow HOCl + I^- + H^+$	$0\ s^{-1}$	

Table 3. Henry Constants

Species	Henry Constants	References
IO	$4.5 \times 10^2\ e^{(5862(1/T - 1/To))}$ M atm^{-1}	16
HOI	$4.5 \times 10^2\ e^{(5862(1/T - 1/To))}$ M atm^{-1}	16,17
I_2	$3.0 \times 10^0\ e^{(4431(1/T - 1/To))}$ M atm^{-1}	18
ICl	$1.1 \times 10^2\ e^{(5600(1/T - 1/To))}$ M atm^{-1}	19
IBr	$2.4 \times 10^1\ e^{(5600(1/T - 1/To))}$ M atm^{-1}	20
HOBr	$9.3 \times 10^1\ e^{(5862(1/T - 1/To))}$ M atm^{-1}	16,20
Br_2	$7.6 \times 10^{-1}\ e^{(4094(1/T - 1/To))}$ M atm^{-1}	21
BrCl	$9.4 \times 10^{-1}\ e^{(5600(1/T - 1/To))}$ M atm^{-1}	17
HOCl	$6.7 \times 10^2\ e^{(5862(1/T - 1/To))}$ M atm^{-1}	17
Cl_2	$9.1 \times 10\text{-}^2\ e^{(2500(1/T - 1/To))}$ M atm^{-1}	22

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