

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{O}(^1\text{D})]} = \begin{array}{ccc} -k_6^{\text{bi}}[\text{N}_2] & -k_7^{\text{bi}}[\text{O}_2] & -k_{32}^{\text{bi}}[\text{H}_2\text{O}] \\ -k_{37}^{\text{bi}}[\text{N}_2\text{O}] & -k_{39}^{\text{bi}}[\text{H}_2] & -k_{40}^{\text{bi}}[\text{CH}_4] \\ -k_{45}^{\text{bi}}[\text{CH}_4] & -k_{61}^{\text{bi}}[\text{N}_2\text{O}] & -k_{63}^{\text{bi}}[\text{CF}_2\text{Cl}_2] \\ -k_{75}^{\text{bi}}[\text{CH}_4] & -k_{76}^{\text{bi}}[\text{CH}_3\text{Br}] & -k_{77}^{\text{bi}}[\text{O}_3] \\ -k_{78}^{\text{bi}}[\text{O}_3] & -k_{92}^{\text{tri}}[\text{N}_2] & \end{array}$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{O}_3]} = -k_{77}^{\text{bi}}[\text{O}(^1\text{D})] -k_{78}^{\text{bi}}[\text{O}(^1\text{D})] +j_{145}$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{NO}_2]} = +j_{138}$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{OCIO}]} = +j_{147}$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{BrO}]} = +j_{103}$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{H}_2]} = -k_{39}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{CH}_4]} = -k_{40}^{\text{bi}}[\text{O}(^1\text{D})] -k_{45}^{\text{bi}}[\text{O}(^1\text{D})] -k_{75}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{CH}_3\text{Br}]} = -k_{76}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{CF}_2\text{Cl}_2]} = -k_{63}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{N}_2\text{O}]} = -k_{37}^{\text{bi}}[\text{O}(^1\text{D})] -k_{61}^{\text{bi}}[\text{O}(^1\text{D})] +j_{134}$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{CO}_2]} = +j_{111}$$

$$\frac{\partial[\text{O}(^1\text{D})]}{\partial[\text{H}_2\text{O}]} = -k_{32}^{\text{bi}}[\text{O}(^1\text{D})] +j_{119}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{O}(^1\text{D})]} = +k_6^{\text{bi}}[\text{N}_2] +k_7^{\text{bi}}[\text{O}_2] +2k_{78}^{\text{bi}}[\text{O}_3]$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{O}(^3\text{P})]} = \begin{array}{ccc} -k_1^{\text{bi}}[\text{O}_3] & -k_{17}^{\text{bi}}[\text{HCHO}] & -k_{21}^{\text{bi}}[\text{ClO}] \\ -k_{27}^{\text{bi}}[\text{H}_2\text{O}_2] & -k_{28}^{\text{bi}}[\text{ClONO}_2] & -k_{34}^{\text{bi}}[\text{OH}] \\ -k_{35}^{\text{bi}}[\text{HO}_2] & -k_{36}^{\text{bi}}[\text{NO}_2] & -k_{74}^{\text{bi}}[\text{BrO}] \\ -k_{82}^{\text{tri}}[\text{O}_2] & -k_{88}^{\text{tri}}[\text{NO}_2] & -k_{91}^{\text{tri}}[\text{NO}] \\ -4k_{93}^{\text{tri}}[\text{O}(^3\text{P})] & -k_{96}^{\text{tri}}[\text{CO}] & \end{array}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{O}_3]} = -k_1^{\text{bi}}[\text{O}(^3\text{P})] + 2k_{78}^{\text{bi}}[\text{O}(^1\text{D})] + j_{144}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{N}]} = +k_{16}^{\text{bi}}[\text{O}_2] + k_{38}^{\text{bi}}[\text{NO}] + k_{64}^{\text{bi}}[\text{NO}_2]$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{NO}]} = +k_{38}^{\text{bi}}[\text{N}] - k_{91}^{\text{tri}}[\text{O}(^3\text{P})] + j_{137}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{NO}_2]} = \begin{array}{ccc} -k_{36}^{\text{bi}}[\text{O}(^3\text{P})] & +k_{64}^{\text{bi}}[\text{N}] & -k_{88}^{\text{tri}}[\text{O}(^3\text{P})] \\ +j_{139} & & \end{array}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{NO}_3]} = +j_{140}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{N}_2\text{O}_5]} = +j_{135}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{ClO}]} = -k_{21}^{\text{bi}}[\text{O}(^3\text{P})] + j_{115}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{ClOO}]} = +j_{117}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{OCIO}]} = +j_{146}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{ClONO}_2]} = -k_{28}^{\text{bi}}[\text{O}(^3\text{P})]$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{BrO}]} = -k_{74}^{\text{bi}}[\text{O}(^3\text{P})] + j_{102}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{H}]} = +k_{58}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{OH}]} = -k_{34}^{\text{bi}}[\text{O}(^3\text{P})] + 2k_{47}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{HO}_2]} = -k_{35}^{\text{bi}}[\text{O}(^3\text{P})] + k_{58}^{\text{bi}}[\text{H}] + j_{126}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{H}_2\text{O}_2]} = -k_{27}^{\text{bi}}[\text{O}(^3\text{P})]$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{CH}_3\text{OOH}]} = +j_{133}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{HCHO}]} = -k_{17}^{\text{bi}}[\text{O}(^3\text{P})]$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{CO}]} = -k_{96}^{\text{tri}}[\text{O}(^3\text{P})]$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{CO}_2]} = +j_{110}$$

$$\frac{\partial[\text{O}(^3\text{P})]}{\partial[\text{H}_2\text{O}]} = +j_{118}$$

$$\frac{\partial[\text{O}_3]}{\partial[\text{O}(^1\text{D})]} = -k_{77}^{\text{bi}}[\text{O}_3] - k_{78}^{\text{bi}}[\text{O}_3]$$

$$\frac{\partial[\text{O}_3]}{\partial[\text{O}(^3\text{P})]} = -k_1^{\text{bi}}[\text{O}_3] + k_{82}^{\text{tri}}[\text{O}_2]$$

$$\frac{\partial[\text{O}_3]}{\partial[\text{O}_3]} = \begin{matrix} -k_1^{\text{bi}}[\text{O}(^3\text{P})] & -k_2^{\text{bi}}[\text{OH}] & -k_3^{\text{bi}}[\text{HO}_2] \\ -k_8^{\text{bi}}[\text{NO}] & -k_9^{\text{bi}}[\text{NO}_2] & -k_{10}^{\text{bi}}[\text{H}] \\ -k_{20}^{\text{bi}}[\text{Cl}] & -k_{65}^{\text{bi}}[\text{Br}] & -k_{77}^{\text{bi}}[\text{O}(^1\text{D})] \\ -k_{78}^{\text{bi}}[\text{O}(^1\text{D})] & -j_{144} & -j_{145} \end{matrix}$$

$$\frac{\partial[\text{O}_3]}{\partial[\text{NO}]} = -k_8^{\text{bi}}[\text{O}_3]$$

$$\frac{\partial[\text{O}_3]}{\partial[\text{NO}_2]} = -k_9^{\text{bi}}[\text{O}_3]$$

$$\frac{\partial[\text{O}_3]}{\partial[\text{Cl}]} = -k_{20}^{\text{bi}}[\text{O}_3]$$

$$\frac{\partial[\text{O}_3]}{\partial[\text{Br}]} = -k_{65}^{\text{bi}}[\text{O}_3]$$

$$\frac{\partial[\text{O}_3]}{\partial[\text{H}]} = -k_{10}^{\text{bi}}[\text{O}_3]$$

$$\frac{\partial[\text{O}_3]}{\partial[\text{OH}]} = -k_2^{\text{bi}}[\text{O}_3]$$

$$\frac{\partial[\text{O}_3]}{\partial[\text{HO}_2]} = -k_3^{\text{bi}}[\text{O}_3]$$

$$\frac{\partial[\text{N}]}{\partial[\text{N}]} = \begin{matrix} -k_{16}^{\text{bi}}[\text{O}_2] & -k_{38}^{\text{bi}}[\text{NO}] & -k_{55}^{\text{bi}}[\text{OH}] \\ -k_{64}^{\text{bi}}[\text{NO}_2] & & \end{matrix}$$

$$\frac{\partial[\text{N}]}{\partial[\text{NO}]} = -k_{38}^{\text{bi}}[\text{N}] + j_{137}$$

$$\frac{\partial[\text{N}]}{\partial[\text{NO}_2]} = -k_{64}^{\text{bi}}[\text{N}]$$

$$\frac{\partial[\text{N}]}{\partial[\text{OH}]} = -k_{55}^{\text{bi}}[\text{N}]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{O}(^1\text{D})]} = +2k_{37}^{\text{bi}}[\text{N}_2\text{O}]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{O}(^3\text{P})]} = +k_{36}^{\text{bi}}[\text{NO}_2] - k_{91}^{\text{tri}}[\text{NO}]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{O}_3]} = -k_8^{\text{bi}}[\text{NO}]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{N}]} = +k_{16}^{\text{bi}}[\text{O}_2] - k_{38}^{\text{bi}}[\text{NO}] + k_{55}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{NO}]} = \begin{matrix} -k_8^{\text{bi}}[\text{O}_3] & -k_{13}^{\text{bi}}[\text{CH}_3\text{O}_2] & -k_{24}^{\text{bi}}[\text{ClO}] \\ -k_{31}^{\text{bi}}[\text{HO}_2] & -k_{38}^{\text{bi}}[\text{N}] & -k_{53}^{\text{bi}}[\text{BrO}] \\ -k_{60}^{\text{bi}}[\text{NO}_3] & -k_{91}^{\text{tri}}[\text{O}(^3\text{P})] & -j_{137} \end{matrix}$$

$$\frac{\partial[\text{NO}]}{\partial[\text{NO}_2]} = +k_{36}^{\text{bi}}[\text{O}(^3\text{P})] + k_{79}^{\text{bi}}[\text{H}] + j_{138} + j_{139}$$

$$\frac{\partial[\text{NO}]}{\partial[\text{NO}_3]} = -k_{60}^{\text{bi}}[\text{NO}] + j_{141}$$

$$\frac{\partial[\text{NO}]}{\partial[\text{N}_2\text{O}_5]} = +j_{135}$$

$$\frac{\partial[\text{NO}]}{\partial[\text{ClO}]} = -k_{24}^{\text{bi}}[\text{NO}]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{BrO}]} = -k_{53}^{\text{bi}}[\text{NO}]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{H}]} = +k_{79}^{\text{bi}}[\text{NO}_2]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{OH}]} = +k_{55}^{\text{bi}}[\text{N}]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{HO}_2]} = -k_{31}^{\text{bi}}[\text{NO}]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{CH}_3\text{O}_2]} = -k_{13}^{\text{bi}}[\text{NO}]$$

$$\frac{\partial[\text{NO}]}{\partial[\text{N}_2\text{O}]} = +2k_{37}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{O}(^3\text{P})]} = -k_{36}^{\text{bi}}[\text{NO}_2] - k_{88}^{\text{tri}}[\text{NO}_2] + k_{91}^{\text{tri}}[\text{NO}]$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{O}_3]} = +k_8^{\text{bi}}[\text{NO}] - k_9^{\text{bi}}[\text{NO}_2]$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{N}]} = -k_{64}^{\text{bi}}[\text{NO}_2]$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{NO}]} = \begin{array}{lll} +k_8^{\text{bi}}[\text{O}_3] & +k_{13}^{\text{bi}}[\text{CH}_3\text{O}_2] & +k_{24}^{\text{bi}}[\text{ClO}] \\ +k_{31}^{\text{bi}}[\text{HO}_2] & +k_{53}^{\text{bi}}[\text{BrO}] & +2k_{60}^{\text{bi}}[\text{NO}_3] \\ +k_{91}^{\text{tri}}[\text{O}(^3\text{P})] & & \end{array}$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{NO}_2]} = \begin{array}{lll} -k_9^{\text{bi}}[\text{O}_3] & -k_{36}^{\text{bi}}[\text{O}(^3\text{P})] & -k_{64}^{\text{bi}}[\text{N}] \\ -k_{79}^{\text{bi}}[\text{H}] & -k_{85}^{\text{tri}}[\text{OH}] & -k_{86}^{\text{tri}}[\text{ClO}] \\ -k_{87}^{\text{tri}}[\text{HO}_2] & -k_{88}^{\text{tri}}[\text{O}(^3\text{P})] & -k_{89}^{\text{tri}}[\text{NO}_3] \\ -k_{94}^{\text{tri}}[\text{BrO}] & -j_{138} & -j_{139} \end{array}$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{NO}_3]} = +2k_{60}^{\text{bi}}[\text{NO}] - k_{89}^{\text{tri}}[\text{NO}_2] + j_{140}$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{N}_2\text{O}_5]} = +k_{97}^{\text{tri}}[\text{M}] + j_{136}$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{HNO}_3]} = +j_{131} + k_{187}^{\text{cr}}$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{HO}_2\text{NO}_2]} = +k_{44}^{\text{bi}}[\text{OH}] + k_{98}^{\text{tri}}[\text{M}] + j_{127}$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{ClO}]} = +k_{24}^{\text{bi}}[\text{NO}] - k_{86}^{\text{tri}}[\text{NO}_2]$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{ClNO}_2]} = +j_{114}$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{BrO}]} = +k_{53}^{\text{bi}}[\text{NO}] - k_{94}^{\text{tri}}[\text{NO}_2]$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{BrONO}_2]} = +j_{105}$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{BrONO}]} = +j_{104}$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{H}]} = -k_{79}^{\text{bi}}[\text{NO}_2]$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{OH}]} = +k_{44}^{\text{bi}}[\text{HO}_2\text{NO}_2] - k_{85}^{\text{tri}}[\text{NO}_2]$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{HO}_2]} = +k_{31}^{\text{bi}}[\text{NO}] - k_{87}^{\text{tri}}[\text{NO}_2]$$

$$\frac{\partial[\text{NO}_2]}{\partial[\text{CH}_3\text{O}_2]} = +k_{13}^{\text{bi}}[\text{NO}]$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{O}(^3\text{P})]} = +k_{28}^{\text{bi}}[\text{ClONO}_2] + k_{88}^{\text{tri}}[\text{NO}_2]$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{O}_3]} = +k_9^{\text{bi}}[\text{NO}_2]$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{NO}]} = -k_{60}^{\text{bi}}[\text{NO}_3]$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{NO}_2]} = +k_9^{\text{bi}}[\text{O}_3] + k_{88}^{\text{tri}}[\text{O}(^3\text{P})] - k_{89}^{\text{tri}}[\text{NO}_3]$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{NO}_3]} = \begin{matrix} -k_{60}^{\text{bi}}[\text{NO}] & -k_{89}^{\text{tri}}[\text{NO}_2] & -j_{140} \\ -j_{141} & & \end{matrix}$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{N}_2\text{O}_5]} = +k_{97}^{\text{tri}}[\text{M}] + j_{135} + j_{136}$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{HNO}_3]} = +k_{30}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{HO}_2\text{NO}_2]} = +j_{128}$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{ClONO}_2]} = +k_{11}^{\text{bi}}[\text{OH}] + k_{28}^{\text{bi}}[\text{O}(^3\text{P})] + j_{116}$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{BrONO}_2]} = +j_{106}$$

$$\frac{\partial[\text{NO}_3]}{\partial[\text{OH}]} = +k_{11}^{\text{bi}}[\text{ClONO}_2] + k_{30}^{\text{bi}}[\text{HNO}_3]$$

$$\frac{\partial[\text{N}_2\text{O}_5]}{\partial[\text{NO}_2]} = +k_{89}^{\text{tri}}[\text{NO}_3]$$

$$\frac{\partial[\text{N}_2\text{O}_5]}{\partial[\text{NO}_3]} = +k_{89}^{\text{tri}}[\text{NO}_2]$$

$$\frac{\partial[\text{N}_2\text{O}_5]}{\partial[\text{N}_2\text{O}_5]} = \begin{matrix} -k_{62}^{\text{bi}}[\text{H}_2\text{O}] & -k_{97}^{\text{tri}}[\text{M}] & -j_{135} \\ -j_{136} & -k_{154}^{\text{h}}[\text{H}_2\text{O}] & -k_{155}^{\text{h}}[\text{H}_2\text{O}] \\ -k_{156}^{\text{h}}[\text{H}_2\text{O}] & -k_{157}^{\text{h}}[\text{HCl}] & -k_{158}^{\text{h}}[\text{HCl}] \\ -k_{182}^{\text{h}}[\text{HBr}] & -k_{183}^{\text{h}}[\text{HBr}] & \end{matrix}$$

$$\frac{\partial[\text{N}_2\text{O}_5]}{\partial[\text{HCl}]} = -k_{157}^{\text{h}}[\text{N}_2\text{O}_5] - k_{158}^{\text{h}}[\text{N}_2\text{O}_5]$$

$$\frac{\partial[\text{N}_2\text{O}_5]}{\partial[\text{HBr}]} = -k_{182}^h[\text{N}_2\text{O}_5] - k_{183}^h[\text{N}_2\text{O}_5]$$

$$\frac{\partial[\text{N}_2\text{O}_5]}{\partial[\text{H}_2\text{O}]} = \begin{matrix} -k_{62}^{bi}[\text{N}_2\text{O}_5] & -k_{154}^h[\text{N}_2\text{O}_5] & -k_{155}^h[\text{N}_2\text{O}_5] \\ -k_{156}^h[\text{N}_2\text{O}_5] & & \end{matrix}$$

$$\frac{\partial[\text{HNO}_3]}{\partial[\text{NO}_2]} = +k_{85}^{\text{tri}}[\text{OH}]$$

$$\frac{\partial[\text{HNO}_3]}{\partial[\text{N}_2\text{O}_5]} = \begin{matrix} +2k_{62}^{bi}[\text{H}_2\text{O}] & +2k_{154}^h[\text{H}_2\text{O}] & +2k_{155}^h[\text{H}_2\text{O}] \\ +2k_{156}^h[\text{H}_2\text{O}] & +k_{157}^h[\text{HCl}] & +k_{158}^h[\text{HCl}] \\ +k_{182}^h[\text{HBr}] & +k_{183}^h[\text{HBr}] & \end{matrix}$$

$$\frac{\partial[\text{HNO}_3]}{\partial[\text{HNO}_3]} = -k_{30}^{bi}[\text{OH}] -j_{131} -k_{187}^{\text{cr}}$$

$$\frac{\partial[\text{HNO}_3]}{\partial[\text{ClONO}_2]} = \begin{matrix} +k_{148}^h[\text{HCl}] & +k_{149}^h[\text{HCl}] & +k_{150}^h[\text{HCl}] \\ +k_{151}^h[\text{H}_2\text{O}] & +k_{152}^h[\text{H}_2\text{O}] & +k_{153}^h[\text{H}_2\text{O}] \\ +k_{171}^h[\text{HBr}] & +k_{177}^h[\text{HBr}] & +k_{178}^h[\text{HBr}] \end{matrix}$$

$$\frac{\partial[\text{HNO}_3]}{\partial[\text{HCl}]} = \begin{matrix} +k_{148}^h[\text{ClONO}_2] & +k_{149}^h[\text{ClONO}_2] & +k_{150}^h[\text{ClONO}_2] \\ +k_{157}^h[\text{N}_2\text{O}_5] & +k_{158}^h[\text{N}_2\text{O}_5] & +k_{174}^h[\text{BrONO}_2] \\ +k_{175}^h[\text{BrONO}_2] & +k_{176}^h[\text{BrONO}_2] & \end{matrix}$$

$$\frac{\partial[\text{HNO}_3]}{\partial[\text{BrONO}_2]} = \begin{matrix} +k_{172}^h[\text{HBr}] & +k_{173}^h[\text{HBr}] & +k_{174}^h[\text{HCl}] \\ +k_{175}^h[\text{HCl}] & +k_{176}^h[\text{HCl}] & +k_{179}^h[\text{H}_2\text{O}] \\ +k_{180}^h[\text{H}_2\text{O}] & +k_{181}^h[\text{H}_2\text{O}] & \end{matrix}$$

$$\frac{\partial[\text{HNO}_3]}{\partial[\text{HBr}]} = \begin{matrix} +k_{171}^h[\text{ClONO}_2] & +k_{172}^h[\text{BrONO}_2] & +k_{173}^h[\text{BrONO}_2] \\ +k_{177}^h[\text{ClONO}_2] & +k_{178}^h[\text{ClONO}_2] & +k_{182}^h[\text{N}_2\text{O}_5] \\ +k_{183}^h[\text{N}_2\text{O}_5] & & \end{matrix}$$

$$\frac{\partial[\text{HNO}_3]}{\partial[\text{OH}]} = -k_{30}^{bi}[\text{HNO}_3] +k_{85}^{\text{tri}}[\text{NO}_2]$$

$$\frac{\partial[\text{HNO}_3]}{\partial[\text{H}_2\text{O}]} = \begin{matrix} +2k_{62}^{bi}[\text{N}_2\text{O}_5] & +k_{151}^h[\text{ClONO}_2] & +k_{152}^h[\text{ClONO}_2] \\ +k_{153}^h[\text{ClONO}_2] & +2k_{154}^h[\text{N}_2\text{O}_5] & +2k_{155}^h[\text{N}_2\text{O}_5] \\ +2k_{156}^h[\text{N}_2\text{O}_5] & +k_{179}^h[\text{BrONO}_2] & +k_{180}^h[\text{BrONO}_2] \\ +k_{181}^h[\text{BrONO}_2] & & \end{matrix}$$

$$\frac{\partial[\text{HO}_2\text{NO}_2]}{\partial[\text{NO}_2]} = +k_{87}^{\text{tri}}[\text{HO}_2]$$

$$\frac{\partial[\text{HO}_2\text{NO}_2]}{\partial[\text{HO}_2\text{NO}_2]} = \begin{matrix} -k_{44}^{bi}[\text{OH}] & -k_{98}^{\text{tri}}[\text{M}] & -j_{127} \\ -j_{128} & & \end{matrix}$$

$$\frac{\partial[\text{HO}_2\text{NO}_2]}{\partial[\text{OH}]} = -k_{44}^{\text{bi}}[\text{HO}_2\text{NO}_2]$$

$$\frac{\partial[\text{HO}_2\text{NO}_2]}{\partial[\text{HO}_2]} = +k_{87}^{\text{tri}}[\text{NO}_2]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{O}(^1\text{D})]} = +k_{63}^{\text{bi}}[\text{CF}_2\text{Cl}_2]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{O}(^3\text{P})]} = +k_{21}^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{O}_3]} = -k_{20}^{\text{bi}}[\text{Cl}]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{NO}]} = +k_{24}^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{Cl}]} = \begin{matrix} -k_5^{\text{bi}}[\text{H}_2\text{O}_2] & -k_{19}^{\text{bi}}[\text{H}_2] & -k_{20}^{\text{bi}}[\text{O}_3] \\ -k_{22}^{\text{bi}}[\text{CH}_4] & -k_{43}^{\text{bi}}[\text{HO}_2] & -k_{51}^{\text{bi}}[\text{HCHO}] \\ -k_{54}^{\text{bi}}[\text{HO}_2] & & \end{matrix}$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{Cl}_2]} = +2j_{112}$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{ClO}]} = \begin{matrix} +k_{21}^{\text{bi}}[\text{O}(^3\text{P})] & +k_{24}^{\text{bi}}[\text{NO}] & +k_{48}^{\text{bi}}[\text{OH}] \\ +k_{81}^{\text{bi}}[\text{CH}_3\text{O}_2] & +j_{115} & \end{matrix}$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{Cl}_2\text{O}_2]} = +j_{113}$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{ClNO}_2]} = +j_{114}$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{ClONO}_2]} = +j_{116}$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{HCl}]} = +k_{23}^{\text{bi}}[\text{OH}] + j_{125} + k_{186}^{\text{cr}}$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{HOCl}]} = +j_{130}$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{BrCl}]} = +j_{101}$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{H}_2]} = -k_{19}^{\text{bi}}[\text{Cl}]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{OH}]} = +k_{23}^{\text{bi}}[\text{HCl}] + k_{48}^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{HO}_2]} = -k_{43}^{\text{bi}}[\text{Cl}] - k_{54}^{\text{bi}}[\text{Cl}]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{H}_2\text{O}_2]} = -k_5^{\text{bi}}[\text{Cl}]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{CH}_3\text{O}_2]} = +k_{81}^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{HCHO}]} = -k_{51}^{\text{bi}}[\text{Cl}]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{CH}_4]} = -k_{22}^{\text{bi}}[\text{Cl}]$$

$$\frac{\partial[\text{Cl}]}{\partial[\text{CF}_2\text{Cl}_2]} = +k_{63}^{\text{bi}}[\text{O}(^1\text{D})] + 2j_{107}$$

$$\frac{\partial[\text{Cl}_2]}{\partial[\text{Cl}_2]} = -j_{112}$$

$$\frac{\partial[\text{Cl}_2]}{\partial[\text{ClONO}_2]} = +k_{148}^{\text{h}}[\text{HCl}] + k_{149}^{\text{h}}[\text{HCl}] + k_{150}^{\text{h}}[\text{HCl}]$$

$$\frac{\partial[\text{Cl}_2]}{\partial[\text{HCl}]} = \frac{+k_{148}^{\text{h}}[\text{ClONO}_2] + k_{149}^{\text{h}}[\text{ClONO}_2] + k_{150}^{\text{h}}[\text{ClONO}_2]}{+k_{159}^{\text{h}}[\text{HOCl}] + k_{160}^{\text{h}}[\text{HOCl}] + k_{161}^{\text{h}}[\text{HOCl}]}$$

$$\frac{\partial[\text{Cl}_2]}{\partial[\text{HOCl}]} = +k_{159}^{\text{h}}[\text{HCl}] + k_{160}^{\text{h}}[\text{HCl}] + k_{161}^{\text{h}}[\text{HCl}]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{O}(^1\text{D})]} = +k_{63}^{\text{bi}}[\text{CF}_2\text{Cl}_2]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{O}(\text{}^3\text{P})]} = -k_{21}^{\text{bi}}[\text{ClO}] + k_{28}^{\text{bi}}[\text{ClONO}_2]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{O}_3]} = +k_{20}^{\text{bi}}[\text{Cl}]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{NO}]} = -k_{24}^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{NO}_2]} = -k_{86}^{\text{tri}}[\text{ClO}]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{Cl}]} = +k_{20}^{\text{bi}}[\text{O}_3] + k_{54}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{ClO}]} = \begin{array}{ccc} -k_4^{\text{bi}}[\text{HO}_2] & -k_{21}^{\text{bi}}[\text{O}(\text{}^3\text{P})] & -k_{24}^{\text{bi}}[\text{NO}] \\ -k_{48}^{\text{bi}}[\text{OH}] & -k_{49}^{\text{bi}}[\text{OH}] & -k_{70}^{\text{bi}}[\text{BrO}] \\ -k_{71}^{\text{bi}}[\text{BrO}] & -k_{72}^{\text{bi}}[\text{BrO}] & -k_{81}^{\text{bi}}[\text{CH}_3\text{O}_2] \\ -k_{86}^{\text{tri}}[\text{NO}_2] & -4k_{95}^{\text{tri}}[\text{ClO}] & -j_{115} \end{array}$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{ClOO}]} = +j_{117}$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{OCIO}]} = +j_{146} + j_{147}$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{Cl}_2\text{O}_2]} = +k_{99}^{\text{tri}}[\text{M}]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{ClONO}_2]} = +k_{28}^{\text{bi}}[\text{O}(\text{}^3\text{P})]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{HOCl}]} = +k_{50}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{BrO}]} = -k_{70}^{\text{bi}}[\text{ClO}] - k_{71}^{\text{bi}}[\text{ClO}] - k_{72}^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{OH}]} = -k_{48}^{\text{bi}}[\text{ClO}] - k_{49}^{\text{bi}}[\text{ClO}] + k_{50}^{\text{bi}}[\text{HOCl}]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{HO}_2]} = -k_4^{\text{bi}}[\text{ClO}] + k_{54}^{\text{bi}}[\text{Cl}]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{CH}_3\text{O}_2]} = -k_{81}^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{ClO}]}{\partial[\text{CF}_2\text{Cl}_2]} = +k_{63}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{ClOO}]}{\partial[\text{ClO}]} = +k_{71}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{ClOO}]}{\partial[\text{ClOO}]} = -j_{117}$$

$$\frac{\partial[\text{ClOO}]}{\partial[\text{Cl}_2\text{O}_2]} = +j_{113}$$

$$\frac{\partial[\text{ClOO}]}{\partial[\text{BrO}]} = +k_{71}^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{OCIO}]}{\partial[\text{ClO}]} = +k_{70}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{OCIO}]}{\partial[\text{OCIO}]} = -j_{146} \quad -j_{147}$$

$$\frac{\partial[\text{OCIO}]}{\partial[\text{BrO}]} = +k_{70}^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{Cl}_2\text{O}_2]}{\partial[\text{ClO}]} = +2k_{95}^{\text{tri}}[\text{ClO}]$$

$$\frac{\partial[\text{Cl}_2\text{O}_2]}{\partial[\text{Cl}_2\text{O}_2]} = -k_{99}^{\text{tri}}[\text{M}] \quad -j_{113}$$

$$\frac{\partial[\text{ClNO}_2]}{\partial[\text{N}_2\text{O}_5]} = +k_{157}^{\text{h}}[\text{HCl}] \quad +k_{158}^{\text{h}}[\text{HCl}]$$

$$\frac{\partial[\text{ClNO}_2]}{\partial[\text{ClNO}_2]} = -j_{114}$$

$$\frac{\partial[\text{ClNO}_2]}{\partial[\text{HCl}]} = +k_{157}^{\text{h}}[\text{N}_2\text{O}_5] \quad +k_{158}^{\text{h}}[\text{N}_2\text{O}_5]$$

$$\frac{\partial[\text{ClONO}_2]}{\partial[\text{O}(^3\text{P})]} = -k_{28}^{\text{bi}}[\text{ClONO}_2]$$

$$\frac{\partial[\text{ClONO}_2]}{\partial[\text{NO}_2]} = +k_{86}^{\text{tri}}[\text{ClO}]$$

$$\frac{\partial[\text{ClONO}_2]}{\partial[\text{ClO}]} = +k_{86}^{\text{tri}}[\text{NO}_2]$$

$$\frac{\partial[\text{ClONO}_2]}{\partial[\text{ClONO}_2]} = \begin{array}{ccc} -k_{11}^{\text{bi}}[\text{OH}] & -k_{28}^{\text{bi}}[\text{O}(^3\text{P})] & -j_{116} \\ -k_{148}^{\text{h}}[\text{HCl}] & -k_{149}^{\text{h}}[\text{HCl}] & -k_{150}^{\text{h}}[\text{HCl}] \\ -k_{151}^{\text{h}}[\text{H}_2\text{O}] & -k_{152}^{\text{h}}[\text{H}_2\text{O}] & -k_{153}^{\text{h}}[\text{H}_2\text{O}] \\ -k_{171}^{\text{h}}[\text{HBr}] & -k_{177}^{\text{h}}[\text{HBr}] & -k_{178}^{\text{h}}[\text{HBr}] \end{array}$$

$$\frac{\partial[\text{ClONO}_2]}{\partial[\text{HCl}]} = -k_{148}^{\text{h}}[\text{ClONO}_2] -k_{149}^{\text{h}}[\text{ClONO}_2] -k_{150}^{\text{h}}[\text{ClONO}_2]$$

$$\frac{\partial[\text{ClONO}_2]}{\partial[\text{HBr}]} = -k_{171}^{\text{h}}[\text{ClONO}_2] -k_{177}^{\text{h}}[\text{ClONO}_2] -k_{178}^{\text{h}}[\text{ClONO}_2]$$

$$\frac{\partial[\text{ClONO}_2]}{\partial[\text{OH}]} = -k_{11}^{\text{bi}}[\text{ClONO}_2]$$

$$\frac{\partial[\text{ClONO}_2]}{\partial[\text{H}_2\text{O}]} = -k_{151}^{\text{h}}[\text{ClONO}_2] -k_{152}^{\text{h}}[\text{ClONO}_2] -k_{153}^{\text{h}}[\text{ClONO}_2]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{N}_2\text{O}_5]} = -k_{157}^{\text{h}}[\text{HCl}] -k_{158}^{\text{h}}[\text{HCl}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{Cl}]} = \begin{array}{ccc} +k_5^{\text{bi}}[\text{H}_2\text{O}_2] & +k_{19}^{\text{bi}}[\text{H}_2] & +k_{22}^{\text{bi}}[\text{CH}_4] \\ +k_{43}^{\text{bi}}[\text{HO}_2] & +k_{51}^{\text{bi}}[\text{HCHO}] & \end{array}$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{ClO}]} = +k_{49}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{ClONO}_2]} = -k_{148}^{\text{h}}[\text{HCl}] -k_{149}^{\text{h}}[\text{HCl}] -k_{150}^{\text{h}}[\text{HCl}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{HCl}]} = \begin{array}{ccc} -k_{23}^{\text{bi}}[\text{OH}] & -j_{125} & -k_{148}^{\text{h}}[\text{ClONO}_2] \\ -k_{149}^{\text{h}}[\text{ClONO}_2] & -k_{150}^{\text{h}}[\text{ClONO}_2] & -k_{157}^{\text{h}}[\text{N}_2\text{O}_5] \\ -k_{158}^{\text{h}}[\text{N}_2\text{O}_5] & -k_{159}^{\text{h}}[\text{HOCl}] & -k_{160}^{\text{h}}[\text{HOCl}] \\ -k_{161}^{\text{h}}[\text{HOCl}] & -k_{165}^{\text{h}}[\text{HOBr}] & -k_{166}^{\text{h}}[\text{HOBr}] \\ -k_{167}^{\text{h}}[\text{HOBr}] & -k_{174}^{\text{h}}[\text{BrONO}_2] & -k_{175}^{\text{h}}[\text{BrONO}_2] \\ -k_{176}^{\text{h}}[\text{BrONO}_2] & -k_{186}^{\text{cr}} & \end{array}$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{HOCl}]} = -k_{159}^h[\text{HCl}] - k_{160}^h[\text{HCl}] - k_{161}^h[\text{HCl}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{BrONO}_2]} = -k_{174}^h[\text{HCl}] - k_{175}^h[\text{HCl}] - k_{176}^h[\text{HCl}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{HOBr}]} = -k_{165}^h[\text{HCl}] - k_{166}^h[\text{HCl}] - k_{167}^h[\text{HCl}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{H}_2]} = +k_{19}^{bi}[\text{Cl}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{OH}]} = -k_{23}^{bi}[\text{HCl}] + k_{49}^{bi}[\text{ClO}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{HO}_2]} = +k_{43}^{bi}[\text{Cl}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{H}_2\text{O}_2]} = +k_5^{bi}[\text{Cl}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{HCHO}]} = +k_{51}^{bi}[\text{Cl}]$$

$$\frac{\partial[\text{HCl}]}{\partial[\text{CH}_4]} = +k_{22}^{bi}[\text{Cl}]$$

$$\frac{\partial[\text{HOCl}]}{\partial[\text{ClO}]} = +k_4^{bi}[\text{HO}_2]$$

$$\frac{\partial[\text{HOCl}]}{\partial[\text{ClONO}_2]} = \begin{matrix} +k_{11}^{bi}[\text{OH}] & +k_{151}^h[\text{H}_2\text{O}] & +k_{152}^h[\text{H}_2\text{O}] \\ +k_{153}^h[\text{H}_2\text{O}] & & \end{matrix}$$

$$\frac{\partial[\text{HOCl}]}{\partial[\text{HCl}]} = -k_{159}^h[\text{HOCl}] - k_{160}^h[\text{HOCl}] - k_{161}^h[\text{HOCl}]$$

$$\frac{\partial[\text{HOCl}]}{\partial[\text{HOCl}]} = \begin{matrix} -k_{50}^{bi}[\text{OH}] & -j_{130} & -k_{159}^h[\text{HCl}] \\ -k_{160}^h[\text{HCl}] & -k_{161}^h[\text{HCl}] & -k_{168}^h[\text{HBr}] \\ -k_{169}^h[\text{HBr}] & -k_{170}^h[\text{HBr}] & \end{matrix}$$

$$\frac{\partial[\text{HOCl}]}{\partial[\text{HBr}]} = -k_{168}^h[\text{HOCl}] - k_{169}^h[\text{HOCl}] - k_{170}^h[\text{HOCl}]$$

$$\frac{\partial[\text{HOCl}]}{\partial[\text{OH}]} = +k_{11}^{\text{bi}}[\text{ClONO}_2] - k_{50}^{\text{bi}}[\text{HOCl}]$$

$$\frac{\partial[\text{HOCl}]}{\partial[\text{HO}_2]} = +k_4^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{HOCl}]}{\partial[\text{H}_2\text{O}]} = +k_{151}^{\text{h}}[\text{ClONO}_2] + k_{152}^{\text{h}}[\text{ClONO}_2] + k_{153}^{\text{h}}[\text{ClONO}_2]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{O}(\text{1D})]} = +k_{76}^{\text{bi}}[\text{CH}_3\text{Br}]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{O}(\text{3P})]} = +k_{74}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{O}_3]} = -k_{65}^{\text{bi}}[\text{Br}]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{NO}]} = +k_{53}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{ClO}]} = +k_{70}^{\text{bi}}[\text{BrO}] + k_{71}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{Br}]} = -k_{56}^{\text{bi}}[\text{HCHO}] - k_{65}^{\text{bi}}[\text{O}_3] - k_{66}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{Br}_2]} = +2j_{100}$$

$$\frac{\partial[\text{Br}]}{\partial[\text{BrO}]} = \begin{array}{l} +k_{53}^{\text{bi}}[\text{NO}] + 4k_{67}^{\text{bi}}[\text{BrO}] + k_{70}^{\text{bi}}[\text{ClO}] \\ +k_{71}^{\text{bi}}[\text{ClO}] + k_{74}^{\text{bi}}[\text{O}(\text{3P})] + k_{80}^{\text{bi}}[\text{CH}_3\text{O}_2] \\ +j_{102} \quad +j_{103} \end{array}$$

$$\frac{\partial[\text{Br}]}{\partial[\text{BrONO}_2]} = +j_{106}$$

$$\frac{\partial[\text{Br}]}{\partial[\text{BrONO}]} = +j_{104}$$

$$\frac{\partial[\text{Br}]}{\partial[\text{HBr}]} = +k_{68}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{HOBr}]} = +j_{129}$$

$$\frac{\partial[\text{Br}]}{\partial[\text{BrCl}]} = +j_{101}$$

$$\frac{\partial[\text{Br}]}{\partial[\text{OH}]} = +k_{68}^{\text{bi}}[\text{HBr}] + k_{69}^{\text{bi}}[\text{CH}_3\text{Br}]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{HO}_2]} = -k_{66}^{\text{bi}}[\text{Br}]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{CH}_3\text{O}_2]} = +k_{80}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{HCHO}]} = -k_{56}^{\text{bi}}[\text{Br}]$$

$$\frac{\partial[\text{Br}]}{\partial[\text{CH}_3\text{Br}]} = +k_{69}^{\text{bi}}[\text{OH}] + k_{76}^{\text{bi}}[\text{O}(^1\text{D})] + j_{108}$$

$$\frac{\partial[\text{Br}_2]}{\partial[\text{Br}_2]} = -j_{100}$$

$$\frac{\partial[\text{Br}_2]}{\partial[\text{BrONO}_2]} = +k_{172}^{\text{h}}[\text{HBr}] + k_{173}^{\text{h}}[\text{HBr}]$$

$$\frac{\partial[\text{Br}_2]}{\partial[\text{HBr}]} = \frac{+k_{162}^{\text{h}}[\text{HOBr}] + k_{163}^{\text{h}}[\text{HOBr}] + k_{164}^{\text{h}}[\text{HOBr}]}{+k_{172}^{\text{h}}[\text{BrONO}_2] + k_{173}^{\text{h}}[\text{BrONO}_2]}$$

$$\frac{\partial[\text{Br}_2]}{\partial[\text{HOBr}]} = +k_{162}^{\text{h}}[\text{HBr}] + k_{163}^{\text{h}}[\text{HBr}] + k_{164}^{\text{h}}[\text{HBr}]$$

$$\frac{\partial[\text{BrO}]}{\partial[\text{O}(^3\text{P})]} = -k_{74}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{BrO}]}{\partial[\text{O}_3]} = +k_{65}^{\text{bi}}[\text{Br}]$$

$$\frac{\partial[\text{BrO}]}{\partial[\text{NO}]} = -k_{53}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{BrO}]}{\partial[\text{NO}_2]} = -k_{94}^{\text{tri}}[\text{BrO}]$$

$$\frac{\partial[\text{BrO}]}{\partial[\text{ClO}]} = -k_{70}^{\text{bi}}[\text{BrO}] - k_{71}^{\text{bi}}[\text{BrO}] - k_{72}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{BrO}]}{\partial[\text{Br}]} = +k_{65}^{\text{bi}}[\text{O}_3]$$

$$\frac{\partial[\text{BrO}]}{\partial[\text{BrO}]} = \begin{array}{ccc} -k_{53}^{\text{bi}}[\text{NO}] & -4k_{67}^{\text{bi}}[\text{BrO}] & -k_{70}^{\text{bi}}[\text{ClO}] \\ -k_{71}^{\text{bi}}[\text{ClO}] & -k_{72}^{\text{bi}}[\text{ClO}] & -k_{73}^{\text{bi}}[\text{HO}_2] \\ -k_{74}^{\text{bi}}[\text{O}(^3\text{P})] & -k_{80}^{\text{bi}}[\text{CH}_3\text{O}_2] & -k_{94}^{\text{tri}}[\text{NO}_2] \\ -j_{102} & -j_{103} & \end{array}$$

$$\frac{\partial[\text{BrO}]}{\partial[\text{BrONO}_2]} = +j_{105}$$

$$\frac{\partial[\text{BrO}]}{\partial[\text{HO}_2]} = -k_{73}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{BrO}]}{\partial[\text{CH}_3\text{O}_2]} = -k_{80}^{\text{bi}}[\text{BrO}]$$

$$\frac{\partial[\text{BrONO}_2]}{\partial[\text{NO}_2]} = +k_{94}^{\text{tri}}[\text{BrO}]$$

$$\frac{\partial[\text{BrONO}_2]}{\partial[\text{HCl}]} = -k_{174}^{\text{h}}[\text{BrONO}_2] - k_{175}^{\text{h}}[\text{BrONO}_2] - k_{176}^{\text{h}}[\text{BrONO}_2]$$

$$\frac{\partial[\text{BrONO}_2]}{\partial[\text{BrO}]} = +k_{94}^{\text{tri}}[\text{NO}_2]$$

$$\frac{\partial[\text{BrONO}_2]}{\partial[\text{BrONO}_2]} = \begin{array}{ccc} -j_{105} & -j_{106} & -k_{172}^{\text{h}}[\text{HBr}] \\ -k_{173}^{\text{h}}[\text{HBr}] & -k_{174}^{\text{h}}[\text{HCl}] & -k_{175}^{\text{h}}[\text{HCl}] \\ -k_{176}^{\text{h}}[\text{HCl}] & -k_{179}^{\text{h}}[\text{H}_2\text{O}] & -k_{180}^{\text{h}}[\text{H}_2\text{O}] \\ -k_{181}^{\text{h}}[\text{H}_2\text{O}] & & \end{array}$$

$$\frac{\partial[\text{BrONO}_2]}{\partial[\text{HBr}]} = -k_{172}^{\text{h}}[\text{BrONO}_2] - k_{173}^{\text{h}}[\text{BrONO}_2]$$

$$\frac{\partial[\text{BrONO}_2]}{\partial[\text{H}_2\text{O}]} = -k_{179}^{\text{h}}[\text{BrONO}_2] - k_{180}^{\text{h}}[\text{BrONO}_2] - k_{181}^{\text{h}}[\text{BrONO}_2]$$

$$\frac{\partial[\text{BrONO}]}{\partial[\text{N}_2\text{O}_5]} = +k_{182}^h[\text{HBr}] + k_{183}^h[\text{HBr}]$$

$$\frac{\partial[\text{BrONO}]}{\partial[\text{BrONO}]} = -j_{104}$$

$$\frac{\partial[\text{BrONO}]}{\partial[\text{HBr}]} = +k_{182}^h[\text{N}_2\text{O}_5] + k_{183}^h[\text{N}_2\text{O}_5]$$

$$\frac{\partial[\text{HBr}]}{\partial[\text{N}_2\text{O}_5]} = -k_{182}^h[\text{HBr}] - k_{183}^h[\text{HBr}]$$

$$\frac{\partial[\text{HBr}]}{\partial[\text{ClONO}_2]} = -k_{171}^h[\text{HBr}] - k_{177}^h[\text{HBr}] - k_{178}^h[\text{HBr}]$$

$$\frac{\partial[\text{HBr}]}{\partial[\text{HOCl}]} = -k_{168}^h[\text{HBr}] - k_{169}^h[\text{HBr}] - k_{170}^h[\text{HBr}]$$

$$\frac{\partial[\text{HBr}]}{\partial[\text{Br}]} = +k_{56}^{\text{bi}}[\text{HCHO}] + k_{66}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{HBr}]}{\partial[\text{BrONO}_2]} = -k_{172}^h[\text{HBr}] - k_{173}^h[\text{HBr}]$$

$$\frac{\partial[\text{HBr}]}{\partial[\text{HBr}]} = \begin{array}{ccc} -k_{68}^{\text{bi}}[\text{OH}] & -k_{162}^h[\text{HOBr}] & -k_{163}^h[\text{HOBr}] \\ -k_{164}^h[\text{HOBr}] & -k_{168}^h[\text{HOCl}] & -k_{169}^h[\text{HOCl}] \\ -k_{170}^h[\text{HOCl}] & -k_{171}^h[\text{ClONO}_2] & -k_{172}^h[\text{BrONO}_2] \\ -k_{173}^h[\text{BrONO}_2] & -k_{177}^h[\text{ClONO}_2] & -k_{178}^h[\text{ClONO}_2] \\ -k_{182}^h[\text{N}_2\text{O}_5] & -k_{183}^h[\text{N}_2\text{O}_5] & \end{array}$$

$$\frac{\partial[\text{HBr}]}{\partial[\text{HOBr}]} = -k_{162}^h[\text{HBr}] - k_{163}^h[\text{HBr}] - k_{164}^h[\text{HBr}]$$

$$\frac{\partial[\text{HBr}]}{\partial[\text{OH}]} = -k_{68}^{\text{bi}}[\text{HBr}]$$

$$\frac{\partial[\text{HBr}]}{\partial[\text{HO}_2]} = +k_{66}^{\text{bi}}[\text{Br}]$$

$$\frac{\partial[\text{HBr}]}{\partial[\text{HCHO}]} = +k_{56}^{\text{bi}}[\text{Br}]$$

$$\frac{\partial[\text{HOBr}]}{\partial[\text{HCl}]} = -k_{165}^h[\text{HOBr}] - k_{166}^h[\text{HOBr}] - k_{167}^h[\text{HOBr}]$$

$$\frac{\partial[\text{HOBr}]}{\partial[\text{BrO}]} = +k_{73}^{bi}[\text{HO}_2]$$

$$\frac{\partial[\text{HOBr}]}{\partial[\text{BrONO}_2]} = +k_{179}^h[\text{H}_2\text{O}] + k_{180}^h[\text{H}_2\text{O}] + k_{181}^h[\text{H}_2\text{O}]$$

$$\frac{\partial[\text{HOBr}]}{\partial[\text{HBr}]} = -k_{162}^h[\text{HOBr}] - k_{163}^h[\text{HOBr}] - k_{164}^h[\text{HOBr}]$$

$$\frac{\partial[\text{HOBr}]}{\partial[\text{HOBr}]} = \begin{array}{ccc} -j_{129} & -k_{162}^h[\text{HBr}] & -k_{163}^h[\text{HBr}] \\ -k_{164}^h[\text{HBr}] & -k_{165}^h[\text{HCl}] & -k_{166}^h[\text{HCl}] \\ -k_{167}^h[\text{HCl}] & & \end{array}$$

$$\frac{\partial[\text{HOBr}]}{\partial[\text{HO}_2]} = +k_{73}^{bi}[\text{BrO}]$$

$$\frac{\partial[\text{HOBr}]}{\partial[\text{H}_2\text{O}]} = +k_{179}^h[\text{BrONO}_2] + k_{180}^h[\text{BrONO}_2] + k_{181}^h[\text{BrONO}_2]$$

$$\frac{\partial[\text{BrCl}]}{\partial[\text{ClO}]} = +k_{72}^{bi}[\text{BrO}]$$

$$\frac{\partial[\text{BrCl}]}{\partial[\text{ClONO}_2]} = +k_{171}^h[\text{HBr}] + k_{177}^h[\text{HBr}] + k_{178}^h[\text{HBr}]$$

$$\frac{\partial[\text{BrCl}]}{\partial[\text{HCl}]} = \begin{array}{ccc} +k_{165}^h[\text{HOBr}] & +k_{166}^h[\text{HOBr}] & +k_{167}^h[\text{HOBr}] \\ +k_{174}^h[\text{BrONO}_2] & +k_{175}^h[\text{BrONO}_2] & +k_{176}^h[\text{BrONO}_2] \end{array}$$

$$\frac{\partial[\text{BrCl}]}{\partial[\text{HOCl}]} = +k_{168}^h[\text{HBr}] + k_{169}^h[\text{HBr}] + k_{170}^h[\text{HBr}]$$

$$\frac{\partial[\text{BrCl}]}{\partial[\text{BrO}]} = +k_{72}^{bi}[\text{ClO}]$$

$$\frac{\partial[\text{BrCl}]}{\partial[\text{BrONO}_2]} = +k_{174}^h[\text{HCl}] + k_{175}^h[\text{HCl}] + k_{176}^h[\text{HCl}]$$

$$\frac{\partial[\text{BrCl}]}{\partial[\text{HBr}]} = \begin{array}{ccc} +k_{168}^h[\text{HOCl}] & +k_{169}^h[\text{HOCl}] & +k_{170}^h[\text{HOCl}] \\ +k_{171}^h[\text{ClONO}_2] & +k_{177}^h[\text{ClONO}_2] & +k_{178}^h[\text{ClONO}_2] \end{array}$$

$$\frac{\partial[\text{BrCl}]}{\partial[\text{HOBr}]} = +k_{165}^h[\text{HCl}] + k_{166}^h[\text{HCl}] + k_{167}^h[\text{HCl}]$$

$$\frac{\partial[\text{BrCl}]}{\partial[\text{BrCl}]} = -j_{101}$$

$$\frac{\partial[\text{H}_2]}{\partial[\text{O}(^1\text{D})]} = -k_{39}^{\text{bi}}[\text{H}_2] + k_{45}^{\text{bi}}[\text{CH}_4]$$

$$\frac{\partial[\text{H}_2]}{\partial[\text{Cl}]} = -k_{19}^{\text{bi}}[\text{H}_2]$$

$$\frac{\partial[\text{H}_2]}{\partial[\text{H}_2]} = -k_{19}^{\text{bi}}[\text{Cl}] - k_{26}^{\text{bi}}[\text{OH}] - k_{39}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{H}_2]}{\partial[\text{H}]} = +k_{57}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{H}_2]}{\partial[\text{OH}]} = -k_{26}^{\text{bi}}[\text{H}_2]$$

$$\frac{\partial[\text{H}_2]}{\partial[\text{HO}_2]} = +k_{57}^{\text{bi}}[\text{H}]$$

$$\frac{\partial[\text{H}_2]}{\partial[\text{HCHO}]} = +j_{122}$$

$$\frac{\partial[\text{H}_2]}{\partial[\text{CH}_4]} = +k_{45}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{H}_2]}{\partial[\text{H}_2\text{O}]} = +j_{119}$$

$$\frac{\partial[\text{H}]}{\partial[\text{O}(^1\text{D})]} = +k_{39}^{\text{bi}}[\text{H}_2] + k_{75}^{\text{bi}}[\text{CH}_4]$$

$$\frac{\partial[\text{H}]}{\partial[\text{O}(^3\text{P})]} = +k_{34}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{H}]}{\partial[\text{O}_3]} = -k_{10}^{\text{bi}}[\text{H}]$$

$$\frac{\partial[\text{H}]}{\partial[\text{N}]} = +k_{55}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{H}]}{\partial[\text{NO}_2]} = -k_{79}^{\text{bi}}[\text{H}]$$

$$\frac{\partial[\text{H}]}{\partial[\text{Cl}]} = +k_{19}^{\text{bi}}[\text{H}_2]$$

$$\frac{\partial[\text{H}]}{\partial[\text{HCl}]} = +j_{125} + k_{186}^{\text{cr}}$$

$$\frac{\partial[\text{H}]}{\partial[\text{H}_2]} = +k_{19}^{\text{bi}}[\text{Cl}] + k_{26}^{\text{bi}}[\text{OH}] + k_{39}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{H}]}{\partial[\text{H}]} = \begin{matrix} -k_{10}^{\text{bi}}[\text{O}_3] & -k_{57}^{\text{bi}}[\text{HO}_2] & -k_{58}^{\text{bi}}[\text{HO}_2] \\ -k_{59}^{\text{bi}}[\text{HO}_2] & -k_{79}^{\text{bi}}[\text{NO}_2] & -k_{83}^{\text{tr}}[\text{O}_2] \end{matrix}$$

$$\frac{\partial[\text{H}]}{\partial[\text{OH}]} = \begin{matrix} +k_{26}^{\text{bi}}[\text{H}_2] & +k_{29}^{\text{bi}}[\text{CO}] & +k_{34}^{\text{bi}}[\text{O}(^3\text{P})] \\ +k_{55}^{\text{bi}}[\text{N}] & & \end{matrix}$$

$$\frac{\partial[\text{H}]}{\partial[\text{HO}_2]} = -k_{57}^{\text{bi}}[\text{H}] - k_{58}^{\text{bi}}[\text{H}] - k_{59}^{\text{bi}}[\text{H}]$$

$$\frac{\partial[\text{H}]}{\partial[\text{CH}_3\text{OOH}]} = +j_{133}$$

$$\frac{\partial[\text{H}]}{\partial[\text{HCHO}]} = +j_{123} + 2j_{124}$$

$$\frac{\partial[\text{H}]}{\partial[\text{CH}_4]} = +k_{75}^{\text{bi}}[\text{O}(^1\text{D})] + j_{109}$$

$$\frac{\partial[\text{H}]}{\partial[\text{CO}]} = +k_{29}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{H}]}{\partial[\text{H}_2\text{O}]} = +2j_{118} + j_{120}$$

$$\frac{\partial[\text{OH}]}{\partial[\text{O}(^1\text{D})]} = +2k_{32}^{\text{bi}}[\text{H}_2\text{O}] + k_{39}^{\text{bi}}[\text{H}_2] + k_{40}^{\text{bi}}[\text{CH}_4]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{O}(^3\text{P})]} = \frac{+k_{17}^{\text{bi}}[\text{HCHO}] + k_{27}^{\text{bi}}[\text{H}_2\text{O}_2] - k_{34}^{\text{bi}}[\text{OH}]}{+k_{35}^{\text{bi}}[\text{HO}_2]}$$

$$\frac{\partial[\text{OH}]}{\partial[\text{O}_3]} = -k_2^{\text{bi}}[\text{OH}] + k_3^{\text{bi}}[\text{HO}_2] + k_{10}^{\text{bi}}[\text{H}]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{N}]} = -k_{55}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{NO}]} = +k_{31}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{NO}_2]} = +k_{79}^{\text{bi}}[\text{H}] - k_{85}^{\text{tri}}[\text{OH}]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{HNO}_3]} = -k_{30}^{\text{bi}}[\text{OH}] + j_{131} + k_{187}^{\text{cr}}$$

$$\frac{\partial[\text{OH}]}{\partial[\text{HO}_2\text{NO}_2]} = -k_{44}^{\text{bi}}[\text{OH}] + j_{128}$$

$$\frac{\partial[\text{OH}]}{\partial[\text{Cl}]} = +k_{54}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{ClO}]} = -k_{48}^{\text{bi}}[\text{OH}] - k_{49}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{ClONO}_2]} = -k_{11}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{HCl}]} = -k_{23}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{HOCl}]} = -k_{50}^{\text{bi}}[\text{OH}] + j_{130}$$

$$\frac{\partial[\text{OH}]}{\partial[\text{HBr}]} = -k_{68}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{HOBr}]} = +j_{129}$$

$$\frac{\partial[\text{OH}]}{\partial[\text{H}_2]} = -k_{26}^{\text{bi}}[\text{OH}] + k_{39}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{H}]} = +k_{10}^{\text{bi}}[\text{O}_3] + 2k_{59}^{\text{bi}}[\text{HO}_2] + k_{79}^{\text{bi}}[\text{NO}_2]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{OH}]} = \begin{array}{ccc} -k_2^{\text{bi}}[\text{O}_3] & -k_{11}^{\text{bi}}[\text{ClONO}_2] & -k_{12}^{\text{bi}}[\text{CH}_4] \\ -k_{23}^{\text{bi}}[\text{HCl}] & -k_{25}^{\text{bi}}[\text{H}_2\text{O}_2] & -k_{26}^{\text{bi}}[\text{H}_2] \\ -k_{29}^{\text{bi}}[\text{CO}] & -k_{30}^{\text{bi}}[\text{HNO}_3] & -k_{33}^{\text{bi}}[\text{HO}_2] \\ -k_{34}^{\text{bi}}[\text{O}(^3\text{P})] & -k_{41}^{\text{bi}}[\text{HCHO}] & -k_{44}^{\text{bi}}[\text{HO}_2\text{NO}_2] \\ -k_{46}^{\text{bi}}[\text{CH}_3\text{OOH}] & -4k_{47}^{\text{bi}}[\text{OH}] & -k_{48}^{\text{bi}}[\text{ClO}] \\ -k_{49}^{\text{bi}}[\text{ClO}] & -k_{50}^{\text{bi}}[\text{HOCl}] & -k_{55}^{\text{bi}}[\text{N}] \\ -k_{68}^{\text{bi}}[\text{HBr}] & -k_{69}^{\text{bi}}[\text{CH}_3\text{Br}] & -4k_{84}^{\text{tri}}[\text{OH}] \\ -k_{85}^{\text{tri}}[\text{NO}_2] & & \end{array}$$

$$\frac{\partial[\text{OH}]}{\partial[\text{HO}_2]} = \begin{array}{ccc} +k_3^{\text{bi}}[\text{O}_3] & +k_{31}^{\text{bi}}[\text{NO}] & -k_{33}^{\text{bi}}[\text{OH}] \\ +k_{35}^{\text{bi}}[\text{O}(^3\text{P})] & +k_{54}^{\text{bi}}[\text{Cl}] & +2k_{59}^{\text{bi}}[\text{H}] \\ & +j_{126} & \end{array}$$

$$\frac{\partial[\text{OH}]}{\partial[\text{H}_2\text{O}_2]} = -k_{25}^{\text{bi}}[\text{OH}] + k_{27}^{\text{bi}}[\text{O}(^3\text{P})] + 2j_{121}$$

$$\frac{\partial[\text{OH}]}{\partial[\text{CH}_3\text{OOH}]} = -k_{46}^{\text{bi}}[\text{OH}] + j_{132}$$

$$\frac{\partial[\text{OH}]}{\partial[\text{HCHO}]} = +k_{17}^{\text{bi}}[\text{O}(^3\text{P})] - k_{41}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{CH}_4]} = -k_{12}^{\text{bi}}[\text{OH}] + k_{40}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{CH}_3\text{Br}]} = -k_{69}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{CO}]} = -k_{29}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{OH}]}{\partial[\text{H}_2\text{O}]} = +2k_{32}^{\text{bi}}[\text{O}(^1\text{D})] + j_{120}$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{O}(^3\text{P})]} = +k_{27}^{\text{bi}}[\text{H}_2\text{O}_2] - k_{35}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{O}_3]} = +k_2^{\text{bi}}[\text{OH}] - k_3^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{NO}]} = -k_{31}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{NO}_2]} = -k_{87}^{\text{tri}}[\text{HO}_2]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{HO}_2\text{NO}_2]} = +k_{98}^{\text{tri}}[\text{M}] + j_{127}$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{Cl}]} = +k_5^{\text{bi}}[\text{H}_2\text{O}_2] - k_{43}^{\text{bi}}[\text{HO}_2] - k_{54}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{ClO}]} = -k_4^{\text{bi}}[\text{HO}_2] + k_{48}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{Br}]} = -k_{66}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{BrO}]} = -k_{73}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{H}]} = \frac{-k_{37}^{\text{bi}}[\text{HO}_2] - k_{58}^{\text{bi}}[\text{HO}_2] - k_{59}^{\text{bi}}[\text{HO}_2]}{+k_{83}^{\text{tri}}[\text{O}_2]}$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{OH}]} = \frac{+k_2^{\text{bi}}[\text{O}_3] + k_{25}^{\text{bi}}[\text{H}_2\text{O}_2] - k_{33}^{\text{bi}}[\text{HO}_2]}{+k_{48}^{\text{bi}}[\text{ClO}]}$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{HO}_2]} = \begin{array}{lll} -k_3^{\text{bi}}[\text{O}_3] & -k_4^{\text{bi}}[\text{ClO}] & -4k_{15}^{\text{bi}}[\text{HO}_2] \\ -k_{18}^{\text{bi}}[\text{CH}_3\text{O}_2] & -k_{31}^{\text{bi}}[\text{NO}] & -k_{33}^{\text{bi}}[\text{OH}] \\ -k_{35}^{\text{bi}}[\text{O}(^3\text{P})] & -k_{43}^{\text{bi}}[\text{Cl}] & -4k_{52}^{\text{bi}}[\text{HO}_2] \\ -k_{54}^{\text{bi}}[\text{Cl}] & -k_{57}^{\text{bi}}[\text{H}] & -k_{58}^{\text{bi}}[\text{H}] \\ -k_{59}^{\text{bi}}[\text{H}] & -k_{66}^{\text{bi}}[\text{Br}] & -k_{73}^{\text{bi}}[\text{BrO}] \\ -k_{87}^{\text{tri}}[\text{NO}_2] & -j_{126} & \end{array}$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{H}_2\text{O}_2]} = +k_5^{\text{bi}}[\text{Cl}] + k_{25}^{\text{bi}}[\text{OH}] + k_{27}^{\text{bi}}[\text{O}(^3\text{P})]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{CH}_3\text{O}]} = +k_{14}^{\text{bi}}[\text{O}_2]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{CH}_3\text{O}_2]} = -k_{18}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{HO}_2]}{\partial[\text{HCO}]} = +k_{42}^{\text{bi}}[\text{O}_2]$$

$$\frac{\partial[\text{H}_2\text{O}_2]}{\partial[\text{O}(^3\text{P})]} = -k_{27}^{\text{bi}}[\text{H}_2\text{O}_2]$$

$$\frac{\partial[\text{H}_2\text{O}_2]}{\partial[\text{Cl}]} = -k_5^{\text{bi}}[\text{H}_2\text{O}_2]$$

$$\frac{\partial[\text{H}_2\text{O}_2]}{\partial[\text{OH}]} = -k_{25}^{\text{bi}}[\text{H}_2\text{O}_2] + 2k_{84}^{\text{tri}}[\text{OH}]$$

$$\frac{\partial[\text{H}_2\text{O}_2]}{\partial[\text{HO}_2]} = +2k_{15}^{\text{bi}}[\text{HO}_2] + 2k_{52}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{H}_2\text{O}_2]}{\partial[\text{H}_2\text{O}_2]} = \begin{matrix} -k_5^{\text{bi}}[\text{Cl}] & -k_{25}^{\text{bi}}[\text{OH}] & -k_{27}^{\text{bi}}[\text{O}(^3\text{P})] \\ -j_{121} & & \end{matrix}$$

$$\frac{\partial[\text{CH}_3]}{\partial[\text{O}(^1\text{D})]} = +k_{40}^{\text{bi}}[\text{CH}_4]$$

$$\frac{\partial[\text{CH}_3]}{\partial[\text{Cl}]} = +k_{22}^{\text{bi}}[\text{CH}_4]$$

$$\frac{\partial[\text{CH}_3]}{\partial[\text{OH}]} = +k_{12}^{\text{bi}}[\text{CH}_4]$$

$$\frac{\partial[\text{CH}_3]}{\partial[\text{CH}_3]} = -k_{90}^{\text{tri}}[\text{O}_2]$$

$$\frac{\partial[\text{CH}_3]}{\partial[\text{CH}_4]} = \begin{matrix} +k_{12}^{\text{bi}}[\text{OH}] & +k_{22}^{\text{bi}}[\text{Cl}] & +k_{40}^{\text{bi}}[\text{O}(^1\text{D})] \\ +j_{109} & & \end{matrix}$$

$$\frac{\partial[\text{CH}_3]}{\partial[\text{CH}_3\text{Br}]} = +j_{108}$$

$$\frac{\partial[\text{CH}_3\text{O}]}{\partial[\text{O}(^1\text{D})]} = +k_{75}^{\text{bi}}[\text{CH}_4] + k_{76}^{\text{bi}}[\text{CH}_3\text{Br}]$$

$$\frac{\partial[\text{CH}_3\text{O}]}{\partial[\text{NO}]} = +k_{13}^{\text{bi}}[\text{CH}_3\text{O}_2]$$

$$\frac{\partial[\text{CH}_3\text{O}]}{\partial[\text{ClO}]} = +k_{81}^{\text{bi}}[\text{CH}_3\text{O}_2]$$

$$\frac{\partial[\text{CH}_3\text{O}]}{\partial[\text{BrO}]} = +k_{80}^{\text{bi}}[\text{CH}_3\text{O}_2]$$

$$\frac{\partial[\text{CH}_3\text{O}]}{\partial[\text{CH}_3\text{O}]} = -k_{14}^{\text{bi}}[\text{O}_2]$$

$$\frac{\partial[\text{CH}_3\text{O}]}{\partial[\text{CH}_3\text{O}_2]} = +k_{13}^{\text{bi}}[\text{NO}] + k_{80}^{\text{bi}}[\text{BrO}] + k_{81}^{\text{bi}}[\text{ClO}]$$

$$\frac{\partial[\text{CH}_3\text{O}]}{\partial[\text{CH}_3\text{OOH}]} = +j_{132} + j_{133}$$

$$\frac{\partial[\text{CH}_3\text{O}]}{\partial[\text{CH}_4]} = +k_{75}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{CH}_3\text{O}]}{\partial[\text{CH}_3\text{Br}]} = +k_{76}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{CH}_3\text{O}_2]}{\partial[\text{NO}]} = -k_{13}^{\text{bi}}[\text{CH}_3\text{O}_2]$$

$$\frac{\partial[\text{CH}_3\text{O}_2]}{\partial[\text{ClO}]} = -k_{81}^{\text{bi}}[\text{CH}_3\text{O}_2]$$

$$\frac{\partial[\text{CH}_3\text{O}_2]}{\partial[\text{BrO}]} = -k_{80}^{\text{bi}}[\text{CH}_3\text{O}_2]$$

$$\frac{\partial[\text{CH}_3\text{O}_2]}{\partial[\text{OH}]} = +k_{46}^{\text{bi}}[\text{CH}_3\text{OOH}]$$

$$\frac{\partial[\text{CH}_3\text{O}_2]}{\partial[\text{HO}_2]} = -k_{18}^{\text{bi}}[\text{CH}_3\text{O}_2]$$

$$\frac{\partial[\text{CH}_3\text{O}_2]}{\partial[\text{CH}_3]} = +k_{90}^{\text{tri}}[\text{O}_2]$$

$$\frac{\partial[\text{CH}_3\text{O}_2]}{\partial[\text{CH}_3\text{O}_2]} = \begin{matrix} -k_{13}^{\text{bi}}[\text{NO}] & -k_{18}^{\text{bi}}[\text{HO}_2] & -k_{80}^{\text{bi}}[\text{BrO}] \\ -k_{81}^{\text{bi}}[\text{ClO}] & & \end{matrix}$$

$$\frac{\partial[\text{CH}_3\text{O}_2]}{\partial[\text{CH}_3\text{OOH}]} = +k_{46}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{CH}_3\text{OOH}]}{\partial[\text{OH}]} = -k_{46}^{\text{bi}}[\text{CH}_3\text{OOH}]$$

$$\frac{\partial[\text{CH}_3\text{OOH}]}{\partial[\text{HO}_2]} = +k_{18}^{\text{bi}}[\text{CH}_3\text{O}_2]$$

$$\frac{\partial[\text{CH}_3\text{OOH}]}{\partial[\text{CH}_3\text{O}_2]} = +k_{18}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{CH}_3\text{OOH}]}{\partial[\text{CH}_3\text{OOH}]} = -k_{46}^{\text{bi}}[\text{OH}] -j_{132} -j_{133}$$

$$\frac{\partial[\text{HCO}]}{\partial[\text{O}(^3\text{P})]} = +k_{17}^{\text{bi}}[\text{HCHO}]$$

$$\frac{\partial[\text{HCO}]}{\partial[\text{Cl}]} = +k_{51}^{\text{bi}}[\text{HCHO}]$$

$$\frac{\partial[\text{HCO}]}{\partial[\text{Br}]} = +k_{56}^{\text{bi}}[\text{HCHO}]$$

$$\frac{\partial[\text{HCO}]}{\partial[\text{OH}]} = +k_{41}^{\text{bi}}[\text{HCHO}]$$

$$\frac{\partial[\text{HCO}]}{\partial[\text{HCO}]} = -k_{42}^{\text{bi}}[\text{O}_2]$$

$$\frac{\partial[\text{HCO}]}{\partial[\text{HCHO}]} = \frac{+k_{17}^{\text{bi}}[\text{O}(^3\text{P})] + k_{41}^{\text{bi}}[\text{OH}] + k_{51}^{\text{bi}}[\text{Cl}]}{+k_{56}^{\text{bi}}[\text{Br}] + j_{123}}$$

$$\frac{\partial[\text{HCHO}]}{\partial[\text{O}(^1\text{D})]} = +k_{45}^{\text{bi}}[\text{CH}_4]$$

$$\frac{\partial[\text{HCHO}]}{\partial[\text{O}(^3\text{P})]} = -k_{17}^{\text{bi}}[\text{HCHO}]$$

$$\frac{\partial[\text{HCHO}]}{\partial[\text{Cl}]} = -k_{51}^{\text{bi}}[\text{HCHO}]$$

$$\frac{\partial[\text{HCHO}]}{\partial[\text{Br}]} = -k_{56}^{\text{bi}}[\text{HCHO}]$$

$$\frac{\partial[\text{HCHO}]}{\partial[\text{OH}]} = -k_{41}^{\text{bi}}[\text{HCHO}]$$

$$\frac{\partial[\text{HCHO}]}{\partial[\text{CH}_3\text{O}]} = +k_{14}^{\text{bi}}[\text{O}_2]$$

$$\frac{\partial[\text{HCHO}]}{\partial[\text{HCHO}]} = \begin{array}{ccc} -k_{17}^{\text{bi}}[\text{O}(^3\text{P})] & -k_{41}^{\text{bi}}[\text{OH}] & -k_{51}^{\text{bi}}[\text{Cl}] \\ -k_{56}^{\text{bi}}[\text{Br}] & -j_{122} & -j_{123} \\ -j_{124} & & \end{array}$$

$$\frac{\partial[\text{HCHO}]}{\partial[\text{CH}_4]} = +k_{45}^{\text{bi}}[\text{O}(^1\text{D})]$$

$$\frac{\partial[\text{CH}_4]}{\partial[\text{O}(^1\text{D})]} = \begin{array}{ccc} -k_{40}^{\text{bi}}[\text{CH}_4] & -k_{45}^{\text{bi}}[\text{CH}_4] & -k_{75}^{\text{bi}}[\text{CH}_4] \end{array}$$

$$\frac{\partial[\text{CH}_4]}{\partial[\text{Cl}]} = -k_{22}^{\text{bi}}[\text{CH}_4]$$

$$\frac{\partial[\text{CH}_4]}{\partial[\text{OH}]} = -k_{12}^{\text{bi}}[\text{CH}_4]$$

$$\frac{\partial[\text{CH}_4]}{\partial[\text{CH}_4]} = \begin{array}{ccc} -k_{12}^{\text{bi}}[\text{OH}] & -k_{22}^{\text{bi}}[\text{Cl}] & -k_{40}^{\text{bi}}[\text{O}(^1\text{D})] \\ -k_{45}^{\text{bi}}[\text{O}(^1\text{D})] & -k_{75}^{\text{bi}}[\text{O}(^1\text{D})] & -j_{109} \end{array}$$

$$\frac{\partial[\text{CH}_3\text{Br}]}{\partial[\text{O}(^1\text{D})]} = -k_{76}^{\text{bi}}[\text{CH}_3\text{Br}]$$

$$\frac{\partial[\text{CH}_3\text{Br}]}{\partial[\text{OH}]} = -k_{69}^{\text{bi}}[\text{CH}_3\text{Br}]$$

$$\frac{\partial[\text{CH}_3\text{Br}]}{\partial[\text{CH}_3\text{Br}]} = \begin{array}{ccc} -k_{69}^{\text{bi}}[\text{OH}] & -k_{76}^{\text{bi}}[\text{O}(^1\text{D})] & -j_{108} \end{array}$$

$$\frac{\partial[\text{CF}_2\text{Cl}_2]}{\partial[\text{O}(^1\text{D})]} = -k_{63}^{\text{bi}}[\text{CF}_2\text{Cl}_2]$$

$$\frac{\partial[\text{CF}_2\text{Cl}_2]}{\partial[\text{CF}_2\text{Cl}_2]} = \begin{array}{ccc} -k_{63}^{\text{bi}}[\text{O}(^1\text{D})] & & -j_{107} \end{array}$$

$$\frac{\partial[\text{CO}]}{\partial[\text{O}(^3\text{P})]} = -k_{96}^{\text{tri}}[\text{CO}]$$

$$\frac{\partial[\text{CO}]}{\partial[\text{OH}]} = -k_{29}^{\text{bi}}[\text{CO}]$$

$$\frac{\partial[\text{CO}]}{\partial[\text{HCO}]} = +k_{42}^{\text{bi}}[\text{O}_2]$$

$$\frac{\partial[\text{CO}]}{\partial[\text{HCHO}]} = +j_{122} + j_{124}$$

$$\frac{\partial[\text{CO}]}{\partial[\text{CO}]} = -k_{29}^{\text{bi}}[\text{OH}] - k_{96}^{\text{tri}}[\text{O}(^3\text{P})]$$

$$\frac{\partial[\text{CO}]}{\partial[\text{CO}_2]} = +j_{110} + j_{111}$$

$$\frac{\partial[\text{N}_2\text{O}]}{\partial[\text{O}(^1\text{D})]} = -k_{37}^{\text{bi}}[\text{N}_2\text{O}] - k_{61}^{\text{bi}}[\text{N}_2\text{O}] + k_{92}^{\text{tri}}[\text{N}_2]$$

$$\frac{\partial[\text{N}_2\text{O}]}{\partial[\text{N}]} = +k_{64}^{\text{bi}}[\text{NO}_2]$$

$$\frac{\partial[\text{N}_2\text{O}]}{\partial[\text{NO}_2]} = +k_{64}^{\text{bi}}[\text{N}]$$

$$\frac{\partial[\text{N}_2\text{O}]}{\partial[\text{N}_2\text{O}]} = -k_{37}^{\text{bi}}[\text{O}(^1\text{D})] - k_{61}^{\text{bi}}[\text{O}(^1\text{D})] - j_{134}$$

$$\frac{\partial[\text{CO}_2]}{\partial[\text{O}(^3\text{P})]} = +k_{96}^{\text{tri}}[\text{CO}]$$

$$\frac{\partial[\text{CO}_2]}{\partial[\text{OH}]} = +k_{29}^{\text{bi}}[\text{CO}]$$

$$\frac{\partial[\text{CO}_2]}{\partial[\text{CO}]} = +k_{29}^{\text{bi}}[\text{OH}] + k_{96}^{\text{tri}}[\text{O}(^3\text{P})]$$

$$\frac{\partial[\text{CO}_2]}{\partial[\text{CO}_2]} = -j_{110} - j_{111}$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{O}(\text{1D})]} = -k_{32}^{\text{bi}}[\text{H}_2\text{O}]$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{N}_2\text{O}_5]} = \begin{matrix} -k_{62}^{\text{bi}}[\text{H}_2\text{O}] & -k_{154}^{\text{h}}[\text{H}_2\text{O}] & -k_{155}^{\text{h}}[\text{H}_2\text{O}] \\ -k_{156}^{\text{h}}[\text{H}_2\text{O}] & & \end{matrix}$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{HNO}_3]} = +k_{30}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{HO}_2\text{NO}_2]} = +k_{44}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{ClONO}_2]} = \begin{matrix} -k_{151}^{\text{h}}[\text{H}_2\text{O}] & -k_{152}^{\text{h}}[\text{H}_2\text{O}] & -k_{153}^{\text{h}}[\text{H}_2\text{O}] \end{matrix}$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{HCl}]} = \begin{matrix} +k_{23}^{\text{bi}}[\text{OH}] & +k_{159}^{\text{h}}[\text{HOCl}] & +k_{160}^{\text{h}}[\text{HOCl}] \\ +k_{161}^{\text{h}}[\text{HOCl}] & +k_{165}^{\text{h}}[\text{HOBr}] & +k_{166}^{\text{h}}[\text{HOBr}] \\ +k_{167}^{\text{h}}[\text{HOBr}] & & \end{matrix}$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{HOCl}]} = \begin{matrix} +k_{50}^{\text{bi}}[\text{OH}] & +k_{159}^{\text{h}}[\text{HCl}] & +k_{160}^{\text{h}}[\text{HCl}] \\ +k_{161}^{\text{h}}[\text{HCl}] & +k_{168}^{\text{h}}[\text{HBr}] & +k_{169}^{\text{h}}[\text{HBr}] \\ +k_{170}^{\text{h}}[\text{HBr}] & & \end{matrix}$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{BrONO}_2]} = \begin{matrix} -k_{179}^{\text{h}}[\text{H}_2\text{O}] & -k_{180}^{\text{h}}[\text{H}_2\text{O}] & -k_{181}^{\text{h}}[\text{H}_2\text{O}] \end{matrix}$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{HBr}]} = \begin{matrix} +k_{68}^{\text{bi}}[\text{OH}] & +k_{162}^{\text{h}}[\text{HOBr}] & +k_{163}^{\text{h}}[\text{HOBr}] \\ +k_{164}^{\text{h}}[\text{HOBr}] & +k_{168}^{\text{h}}[\text{HOCl}] & +k_{169}^{\text{h}}[\text{HOCl}] \\ +k_{170}^{\text{h}}[\text{HOCl}] & & \end{matrix}$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{HOBr}]} = \begin{matrix} +k_{162}^{\text{h}}[\text{HBr}] & +k_{163}^{\text{h}}[\text{HBr}] & +k_{164}^{\text{h}}[\text{HBr}] \\ +k_{165}^{\text{h}}[\text{HCl}] & +k_{166}^{\text{h}}[\text{HCl}] & +k_{167}^{\text{h}}[\text{HCl}] \end{matrix}$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{H}_2]} = +k_{26}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{H}]} = +k_{58}^{\text{bi}}[\text{HO}_2]$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{OH}]} = \begin{matrix} +k_{12}^{\text{bi}}[\text{CH}_4] & +k_{23}^{\text{bi}}[\text{HCl}] & +k_{25}^{\text{bi}}[\text{H}_2\text{O}_2] \\ +k_{26}^{\text{bi}}[\text{H}_2] & +k_{30}^{\text{bi}}[\text{HNO}_3] & +k_{33}^{\text{bi}}[\text{HO}_2] \\ +k_{41}^{\text{bi}}[\text{HCHO}] & +k_{44}^{\text{bi}}[\text{HO}_2\text{NO}_2] & +k_{46}^{\text{bi}}[\text{CH}_3\text{OOH}] \\ +2k_{47}^{\text{bi}}[\text{OH}] & +k_{50}^{\text{bi}}[\text{HOCl}] & +k_{68}^{\text{bi}}[\text{HBr}] \end{matrix}$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{HO}_2]} = +k_{33}^{\text{bi}}[\text{OH}] + k_{58}^{\text{bi}}[\text{H}]$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{H}_2\text{O}_2]} = +k_{25}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{CH}_3\text{OOH}]} = +k_{46}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{HCHO}]} = +k_{41}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{CH}_4]} = +k_{12}^{\text{bi}}[\text{OH}]$$

$$\frac{\partial[\text{H}_2\text{O}]}{\partial[\text{H}_2\text{O}]} = \begin{matrix} -k_{32}^{\text{bi}}[\text{O}(^1\text{D})] & -k_{62}^{\text{bi}}[\text{N}_2\text{O}_5] & -j_{118} \\ -j_{119} & -j_{120} & -k_{151}^{\text{h}}[\text{ClONO}_2] \\ -k_{152}^{\text{h}}[\text{ClONO}_2] & -k_{153}^{\text{h}}[\text{ClONO}_2] & -k_{154}^{\text{h}}[\text{N}_2\text{O}_5] \\ -k_{155}^{\text{h}}[\text{N}_2\text{O}_5] & -k_{156}^{\text{h}}[\text{N}_2\text{O}_5] & -k_{179}^{\text{h}}[\text{BrONO}_2] \\ -k_{180}^{\text{h}}[\text{BrONO}_2] & -k_{181}^{\text{h}}[\text{BrONO}_2] & \end{matrix}$$