Influence of the Change in Total Ozone Column (TOC) on the Occurrence of Tropospheric Ozone Depletion Events (ODEs) in the Antarctic: Supplement

Le Cao¹,*, Linjie Fan¹,²,*, Simeng Li¹, and Shuangyan Yang²

¹Key Laboratory for Aerosol-Cloud-Precipitation of China Meteorological Administration, Nanjing University of Information Science and Technology, Nanjing 210044, China
²Key Laboratory of Meteorological Disaster, Ministry of Education (KLME)/Joint International Research Laboratory of Climate and Environmental Change (ILCEC)/Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disasters (CIC-FEMD), Nanjing University of Information Science and Technology, Nanjing 210044, China

*These authors contributed equally to this work.

Correspondence: L. Cao (le.cao@nuist.edu.cn)
Table S1. Correlation coefficients of the change in TOC between stations in the Antarctic.

|                | Halley | Arrival Heights | Dumont D’Urville | South Pole | Belgrano II | Faraday-Vernadsky |
|----------------|--------|-----------------|------------------|------------|-------------|-------------------|
| Halley         | 1      | 0.87            | 0.78             | 0.70       | 0.76        | 0.39              |
| Arrival Heights| 0.87   | 1               | 0.79             | 0.64       | 0.64        | 0.33              |
| Dumont D’Urville| 0.78  | 0.79            | 1                | 0.73       | 0.82        | 0.31              |
| South Pole     | 0.70   | 0.64            | 0.73             | 1          | 0.87        | 0.63              |
| Belgrano II    | 0.76   | 0.64            | 0.82             | 0.87       | 1           | 0.52              |
| Faraday-Vernadsky| 0.39 | 0.33            | 0.31             | 0.63       | 0.52        | 1                 |
Table S2. The complete chemical reaction mechanism with an implementation of a constant temperature $T = 258$ K, and the rate of third-body reactions is estimated as $k = k_\infty \times \frac{k_0/k_\infty}{1 + k_0/k_\infty}$ $F_{1+1}(\log(10(k_0/k_\infty)))^2$ (Atkinson et al., 2006).

| Reaction Number | Reaction | $k$ [(molec. cm$^{-3}$)$^{1-n}$s$^{-1}$] | Order | Reference |
|-----------------|----------|------------------------------------------|-------|-----------|
| (SR1)           | $O_3 + h\nu \rightarrow O(1D) + O_2$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR2)           | $O(1D) + O_3 \rightarrow O_5$ | $3.20 \times 10^{-11}$ exp(67/T) | 2     | Atkinson et al. (2006) |
| (SR3)           | $O(1D) + N_2 \rightarrow O_3 + N_2$ | $1.80 \times 10^{-11}$ exp(107/T) | 2     | Atkinson et al. (2006) |
| (SR4)           | $O(1D) + H_2O \rightarrow 2OH$ | $2.20 \times 10^{-10}$ | 2     | Atkinson et al. (2006) |
| (SR5)           | $Br + O_3 \rightarrow BrO + O_2$ | $1.70 \times 10^{-11}$ exp(-800/T) | 2     | Atkinson et al. (2006) |
| (SR6)           | $Br_2 + h\nu \rightarrow Br$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR7)           | $BrO + h\nu \rightarrow BrO + Br + O_3$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR8)           | $BrO + BrO \rightarrow 2Br + O_2$ | $2.70 \times 10^{-12}$ | 2     | Atkinson et al. (2006) |
| (SR9)           | $BrO + BrO \rightarrow Br_2 + O_2$ | $2.90 \times 10^{-12}$ exp(840/T) | 2     | Atkinson et al. (2006) |
| (SR10)          | $BrO + HO_2 \rightarrow HOBr + O_2$ | $4.5 \times 10^{-12}$ exp(500/T) | 2     | Atkinson et al. (2006) |
| (SR11)          | $HOBr + h\nu \rightarrow Br + OH$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR12)          | $CO + OH (+M) \rightarrow HO_2 + CO_2 (+M)$ | $1.44 \times 10^{-11}(1 + \frac{[N_2]}{[O_2]})^{-1}$ | 2     | Atkinson et al. (2006) |
| (SR13)          | $Br + HO_2 \rightarrow HBr + O_2$ | $7.70 \times 10^{-12}$ exp(-450/T) | 2     | Atkinson et al. (2006) |
| (SR14)          | $HOBr + HBr_{aero} \rightarrow Br_2 + H_2O$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR15)          | $HOBr + H^+ + Br^- \rightarrow Br_2 + H_2O$ | $(r_a + r_b + r_c)^{-1}$ $\alpha_{eff,ice}$ | 2     | Atkinson et al. (2006) |
| (SR16)          | $Br + HCHO \rightarrow HBr + CO + HO_2$ | $7.70 \times 10^{-12}$ exp(-580/T) | 2     | Atkinson et al. (2006) |
| (SR17)          | $Br + CH_2CHO \rightarrow HBr + CH_3CO_3$ | $1.80 \times 10^{-11}$ exp(-460/T) | 2     | Atkinson et al. (2006) |
| (SR18)          | $Br_2 + OH \rightarrow HOBr + Br$ | $2.0 \times 10^{-11}$ exp(240/T) | 2     | Atkinson et al. (2006) |
| (SR19)          | $HBr + OH \rightarrow H_2O + Br$ | $5.5 \times 10^{-12}$ exp(205/T) | 2     | Atkinson et al. (2006) |
| (SR20)          | $Br + C_2H_2 \rightarrow 2CO + 2H_2O + Br$ | $4.20 \times 10^{-14}$ | 2     | Borken (1996) |
| (SR21)          | $Br + C_2H_2 \rightarrow 2CO + H_2O + HBr$ | $8.92 \times 10^{-14}$ | 2     | Borken (1996) |
| (SR22)          | $Br + C_2H_4 \rightarrow 2CO + 2H_2O + Br + H_2O$ | $2.52 \times 10^{-13}$ | 2     | Barnes et al. (1993) |
| (SR23)          | $Br + C_2H_4 \rightarrow 2CO + HO_2 + HBr + H_2O$ | $5.34 \times 10^{-13}$ | 2     | Barnes et al. (1993) |
| (SR24)          | $CH_4 + OH \rightarrow \Delta Br$ CO_2 + H_2O + Br + H_2O | $1.85 \times 10^{-12}$ exp(-1690/T) | 2     | Atkinson et al. (2006) |
| (SR25)          | $BrO + CH_2O \rightarrow Br + HCHO + HO_2$ | $1.60 \times 10^{-12}$ | 2     | Aranda et al. (1997) |
| (SR26)          | $BrO + CH_3O_2 \rightarrow HOBr + HCHO + 0.5O_2$ | $4.10 \times 10^{-12}$ | 2     | Aranda et al. (1997) |
| (SR27)          | $OH + O_3 \rightarrow HO_2 + O_2$ | $1.70 \times 10^{-12}$ exp(-940/T) | 2     | Atkinson et al. (2006) |
| (SR28)          | $OH + HO_2 \rightarrow H_2O + O_2$ | $4.80 \times 10^{-12}$ exp(250/T) | 2     | Atkinson et al. (2006) |
| (SR29)          | $OH + HO_2 \rightarrow H_2O + O_2$ | $2.90 \times 10^{-12}$ exp(-160/T) | 2     | Atkinson et al. (2006) |
| (SR30)          | $OH + OH \rightarrow H_2O + O_3$ | $6.20 \times 10^{-13}(T/298)^{2.6}$ exp(945/T) | 2     | Atkinson et al. (2006) |
| (SR31)          | $HO_2 + O_3 \rightarrow OH + HO_2$ | $2.03 \times 10^{-12}(T/300)^{1.57}$ exp(693/T) | 2     | Atkinson et al. (2006) |
| (SR32)          | $HO_2 + HO_2 \rightarrow O_2 + H_2O_2$ | $2.20 \times 10^{-12}$ exp(600/T) | 2     | Atkinson et al. (2006) |
| (SR33)          | $C_2H_5 + OH \rightarrow C_2H_4 + H_2O$ | $6.90 \times 10^{-12}$ exp(-1000/T) | 2     | Atkinson et al. (2006) |
| (SR34)          | $C_2H_5 + O_2 \rightarrow C_2H_4 + HO_2$ | $3.80 \times 10^{-15}$ | 2     | Atkinson et al. (2006) |
Table S2. (continued).

| Reaction Number | Reaction | $k$ \( ([\text{molec. cm}^{-3}]^{1-n} \cdot \text{s}^{-1}) \) | Order | Reference |
|-----------------|----------|------------------------------------------------|-------|-----------|
| (SR35)          | $C_2H_5 + O_2(M) \rightarrow C_2H_5O_2(M)$ | $k_a = 5.90 \times 10^{-29}(T/300)^{-1.8}[N_2]$ \( k_a = 7.80 \times 10^{-13} \) | 2     | Atkinson et al. (2006) |
|                 |          | $F_i = 0.58 \exp(-T/1250)$ \( +0.42 \exp(-T/183) \) |       |           |
| (SR36)          | $C_2H_4 + OH(M) \rightarrow ^{1,5}CH_2O_2 + CO + H_2O(M)$ | $k_a = 8.60 \times 10^{-29}(T/300)^{-3.1}[N_2]$ \( k_a = 9.00 \times 10^{-12}(T/300)^{-0.85} \) | 2     | Atkinson et al. (2006) |
| (SR37)          | $C_2H_4 + O_3 \rightarrow HCHO + CO + H_2O$ | $4.33 \times 10^{-10}$ | 2     | Sander et al. (1997) |
| (SR38)          | $C_2H_2 + OH(M) \rightarrow HCHO + CO + HO_2(M)$ | $k_a = 5.00 \times 10^{-30}(T/300)^{-1.5}[N_2]$ \( k_a = 1.00 \times 10^{-12} \) | 2     | Atkinson et al. (2006) |
|                 |          | $F_i = 0.37$ |       |           |
| (SR39)          | $C_2H_4 + OH + \rightarrow C_2H_2O_2 + CO + 2H_2O$ | $7.60 \times 10^{-12} \exp(-585/T)$ | 2     | Atkinson et al. (2006) |
| (SR40)          | $CHO + OH + \rightarrow CO + H_2O + HO_2$ | $5.40 \times 10^{-12} \exp(135/T)$ | 2     | Atkinson et al. (2006) |
| (SR41)          | $CH_2CHO + OH \rightarrow CH_2O + CO + H_2O$ | $4.40 \times 10^{-12} \exp(365/T)$ | 2     | Atkinson et al. (2006) |
| (SR42)          | $C_2H_4 + HO_2 \rightarrow CH_2O_2 + CO + O_2$ | $3.42 \times 10^{-12} \exp(780/T)$ | 2     | Atkinson et al. (2006) |
| (SR43)          | $C_2H_5 + HO_2 \rightarrow HCHO + H_2O + O_2$ | $3.79 \times 10^{-14} \exp(780/T)$ | 2     | Atkinson et al. (2006) |
| (SR44)          | $CH_2O + OH \rightarrow CH_2O_2 + H_2O$ | $1.00 \times 10^{-12} \exp(190/T)$ | 2     | Atkinson et al. (2006) |
| (SR45)          | $CHO + CH_2O + HCHO + OH + H_2O$ | $1.90 \times 10^{-12} \exp(190/T)$ | 2     | Atkinson et al. (2006) |
| (SR46)          | $CHO + Br \rightarrow CH_2O_2 + HBr$ | $2.66 \times 10^{-12} \exp(-1610/T)$ | 2     | Mallard et al. (1993) |
| (SR47)          | $CH_2O + CH_2O + CH_2OH + HCHO + CO_2$ | $6.29 \times 10^{-11} \exp(365/T)$ | 2     | Atkinson et al. (2006) |
| (SR48)          | $CH_2O + CH_2O \rightarrow C_2H_2O_2 + 2H_2O$ | $3.71 \times 10^{-14} \exp(365/T)$ | 2     | Atkinson et al. (2006) |
| (SR49)          | $CH_2O + OH \rightarrow \rightarrow 2HO_2 + H_2O$ | $2.42 \times 10^{-12} \exp(-345/T)$ | 2     | Atkinson et al. (2006) |
| (SR50)          | $C_2H_5 + C_2H_2O_2 \rightarrow C_2H_6O + C_2H_2O + O_2$ | $6.40 \times 10^{-14}$ | 2     | Atkinson et al. (2006) |
| (SR51)          | $C_2H_5 + O_2 \rightarrow CH_2CHO + HO_2$ | $7.44 \times 10^{-15}$ | 2     | Sander et al. (1997) |
| (SR52)          | $C_2H_5O + O_2 \rightarrow C_2H_2O_2 + HCHO$ | $7.51 \times 10^{-17}$ | 2     | Sander et al. (1997) |
| (SR53)          | $C_2H_5O_2 + HO_2 \rightarrow C_2H_2O_2 + HCHO$ | $3.80 \times 10^{-12} \exp(900/T)$ | 2     | Atkinson et al. (2006) |
| (SR54)          | $C_2H_5O + O_2 \rightarrow C_2H_2O_2 + HCHO$ | $8.21 \times 10^{-12}$ | 2     | Atkinson et al. (2006) |
| (SR55)          | $C_2H_5O + Br \rightarrow C_2H_2O_2 + HBr$ | $5.19 \times 10^{-15}$ | 2     | Sander et al. (1997) |
| (SR56)          | $OH + OH(M) \rightarrow H_2O_2(M)$ | $k_a = 6.90 \times 10^{-31}(T/300)^{-0.8}[N_2]$ \( k_a = 2.60 \times 10^{-11} \) | 2     | Atkinson et al. (2006) |
|                 |          | $F_i = 0.30$ |       |           |
| (SR57)          | $H_2O + h_\nu \rightarrow 2OH$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR58)          | $HCHO + h_\nu \rightarrow 2H_2O + CO$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR59)          | $HCHO + h_\nu \rightarrow H_2 + CO$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR60)          | $C_2H_4 + h_\nu \rightarrow CH_2O + CO + H_2O$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR61)          | $C_2H_5 + h_\nu \rightarrow CH_2O_2 + CO + + H_2O$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR62)          | $C_2H_5O_2 + h_\nu \rightarrow C_2H_2O_2 + HCHO$ | calculated by TUV model | 1     | Madronich and Flocke (1997, 1999) |
| (SR63)          | $NO + O_3 \rightarrow NO_2 + O_2$ | $1.40 \times 10^{-12} \exp(-1310/T)$ | 2     | Atkinson et al. (2006) |
| (SR64)          | $NO + NO_2 \rightarrow NO_2 + OH$ | $3.60 \times 10^{-12} \exp(270/T)$ | 2     | Atkinson et al. (2006) |
| (SR65)          | $NO_2 + O_3 \rightarrow NO_3 + O_2$ | $1.40 \times 10^{-12} \exp(-2470/T)$ | 2     | Atkinson et al. (2006) |
| (SR66)          | $NO_2 + OH(M) \rightarrow HNO_3(M)$ | $k_a = 3.30 \times 10^{-30}(T/300)^{-1.0}[N_2]$ \( k_a = 4.10 \times 10^{-11} \) | 2     | Atkinson et al. (2006) |
|                 |          | $F_i = 0.40$ |       |           |
| (SR67)          | $NO + NO_3 \rightarrow 2NO_2$ | $1.80 \times 10^{-11} \exp(110/T)$ | 2     | Atkinson et al. (2006) |
| (SR68)          | $HONO + OH \rightarrow NO_2 + H_2O$ | $2.50 \times 10^{-12} \exp(260/T)$ | 2     | Atkinson et al. (2006) |
| (SR69)          | $HO_2 + NO_2(M) \rightarrow HNO_3(M)$ | $k_a = 1.80 \times 10^{-31}(T/300)^{-1.2}[N_2]$ \( k_a = 4.70 \times 10^{-12} \) | 2     | Atkinson et al. (2006) |
|                 |          | $F_i = 0.60$ |       |           |
| (SR70)          | $HNO_3(M) \rightarrow NO_2 + HO_2(M)$ | $k_a = 4.10 \times 10^{-5} \exp(-10650/T)[N_2]$ \( k_a = 4.80 \times 10^{-13} \exp(-11170/T) \) | 1     | Atkinson et al. (2006) |
| Reaction Number | Reaction | \( k \) \([\text{molec. cm}^{-3} \cdot \text{s}^{-1}]\) | Order | Reference |
|-----------------|----------|----------------|-------|-----------|
| (SR71) HNO\(_2\) + OH → NO\(_2\) + H\(_2\)O + O\(_2\) | 3.20 \times 10^{-13} \text{exp}(690/T) | 2 | Atkinson et al. (2006) |
| (SR72) NO + OH(+M) → HONO(+M) | \( k_0 = 7.40 \times 10^{-33} \left(\frac{T}{300}\right)^{-2.4}[\text{N}_2] \) \( k_{\infty} = 3.30 \times 10^{-11} \left(\frac{T}{300}\right)^{-0.3} \) | 2 | Atkinson et al. (2006) |
| (SR73) OH + NO\(_3\) → NO\(_2\) + HO\(_2\) | 2.00 \times 10^{-11} | 2 | Atkinson et al. (2006) |
| (SR74) HNO\(_3\) + hv → NO\(_3\) + OH | calculated by TUV model | 1 | Madronich and Flocke (1997, 1999) |
| (SR75) NO\(_2\) + hv → NO + O\(_3\) | calculated by TUV model | 1 | Madronich and Flocke (1997, 1999) |
| (SR76) NO\(_3\) + hv → NO\(_2\) + O\(_3\) | calculated by TUV model | 1 | Madronich and Flocke (1997, 1999) |
| (SR77) NO\(_3\) + hv → NO + O\(_2\) | calculated by TUV model | 1 | Madronich and Flocke (1997, 1999) |
| (SR78) NO\(_3\) + H\(_2\)O → HCHO + HO\(_2\) + NO\(_2\) | 2.30 \times 10^{-12} \text{exp}(360/T) | 2 | Atkinson et al. (2006) |
| (SR79) NO\(_3\) + Cl + H\(_2\)O → HCHO + HO\(_2\) + HNO\(_3\) | 9.40 \times 10^{-13} \text{exp}(2650/T) | 2 | Atkinson et al. (2006) |
| (SR80) NO\(_3\) + HCHO → CO + HO\(_2\) + HNO\(_3\) | 5.60 \times 10^{-16} | 2 | Atkinson et al. (2006) |
| (SR81) NO + C\(_2\)H\(_2\)O → CH\(_3\)CHO + NO\(_2\) + HO\(_2\) | 2.60 \times 10^{-12} \text{exp}(380/T) | 2 | Atkinson et al. (2006) |
| (SR82) NO + C\(_2\)H\(_4\)O → CH\(_3\)\(_2\)CHO + NO\(_2\) + CO\(_2\) | 7.50 \times 10^{-12} \text{exp}(290/T) | 2 | Atkinson et al. (2006) |
| (SR83) NO\(_2\) + C\(_2\)H\(_4\)O(+M) → PAN(+M) | \( k_0 = 2.70 \times 10^{-29}(T/300)^{-7.1}[\text{N}_2] \) \( k_{\infty} = 1.20 \times 10^{-11}(T/300)^{-4} \) | 2 | Atkinson et al. (2006) |
| (SR84) Br + NO\(_2\) (+M) → BrNO\(_2\) (+M) | \( k_0 = 4.20 \times 10^{-33}(T/300)^{-2.4}[\text{N}_2] \) \( k_{\infty} = 2.70 \times 10^{-11} \) | 2 | Atkinson et al. (2006) |
| (SR85) Br + NO\(_2\) → BrO + NO\(_2\) | 1.60 \times 10^{-11} | 2 | Atkinson et al. (2006) |
| (SR86) BrO + NO\(_2\) (+M) → BrNO\(_2\) (+M) | \( k_0 = 4.70 \times 10^{-33}(T/300)^{-3.1}[\text{N}_2] \) \( k_{\infty} = 1.80 \times 10^{-11} \) | 2 | Atkinson et al. (2006) |
| (SR87) BrO + NO → Br + NO\(_2\) | 8.70 \times 10^{-12} \text{exp}(260/T) | 2 | Atkinson et al. (2006) |
| (SR88) BrO + NO\(_2\) + hv → NO\(_2\) + BrO | calculated by TUV model | 1 | Madronich and Flocke (1997, 1999) |
| (SR89) BrNO\(_2\) + hv → NO\(_2\) + Br | calculated by TUV model | 1 | Madronich and Flocke (1997, 1999) |
| (SR90) BrNO\(_2\) + H\(_2\)O → BrOH + NO\(_3\) | \( \frac{\tau_2}{\tau_1} + \frac{r_4}{r_3} + \frac{r_6}{r_5} \) | 1 | Cao et al. (2014) |
| (SR91) PAN + NO\(_2\) + C\(_2\)H\(_2\)O | calculated by TUV model | 1 | Madronich and Flocke (1997, 1999) |
| (SR92) BrNO\(_2\) + H\(_2\)O → BrOH + NO\(_3\) | \( \tau_3 + \tau_4 \) \( \tau_6 \) \( \text{air} \) | 1 | Atkinson et al. (2006) |
| (SR93) C\(_2\)H\(_2\)O + Cl → C\(_2\)H\(_2\)O + HCl | 5.70 \times 10^{-11} | 2 | Sander et al. (1997) |
| (SR94) C\(_2\)H\(_2\)O + Cl → C\(_2\)H\(_2\)O + HCl | 3.61 \times 10^{-11} | 2 | Atkinson et al. (2006) |
| (SR95) CI + HO\(_2\) → HCl + O\(_2\) | 6.30 \times 10^{-11} \text{exp}(-570/T) | 2 | Atkinson et al. (2006) |
| (SR96) CI + HO\(_2\) → ClO + HO\(_2\) | 1.10 \times 10^{-11} \text{exp}(-980/T) | 2 | Atkinson et al. (2006) |
| (SR97) CI + O\(_3\) → ClO + O\(_2\) | 2.80 \times 10^{-11} \text{exp}(-250/T) | 2 | Atkinson et al. (2008) |
| (SR98) CI + H\(_2\)O → Cl + H\(_2\)O | 6.60 \times 10^{-12} \text{exp}(-1240/T) | 2 | Atkinson et al. (2008) |
| (SR99) CI + C\(_2\)H\(_4\)O → Cl + C\(_2\)H\(_4\) | 2.00 \times 10^{-11} | 2 | Borken (1996) |
| (SR100) CI + C\(_2\)H\(_4\)O → Cl + 2C\(_2\)H\(_4\)O + HCl | 4.24 \times 10^{-11} | 2 | Borken (1996) |
| (SR101) CI + C\(_2\)H\(_4\)O → Cl + 2CO + H\(_2\)O + HCl | \( k_0 = 0.59 \times 10^{-29}(T/300)^{-3.3}[\text{air}] \) \( k_{\infty} = 6.00 \times 10^{-10} \) | 2 | Atkinson et al. (2006) |
| (SR102) CI + C\(_2\)H\(_4\)O → Cl + 2CO + 2H\(_2\)O + Cl + H\(_2\)O(+M) | \( k_0 = 1.26 \times 10^{-29}(T/300)^{-3.3}[\text{air}] \) \( k_{\infty} = 6.00 \times 10^{-10} \) | 2 | Atkinson et al. (2006) |
| (SR103) CI + C\(_2\)H\(_4\)O → Cl + 2CO + H\(_2\)O + Cl + H\(_2\)O(+M) | \( k_0 = 1.80 \times 10^{-12} \text{exp}(-240/T) \) | 2 | Atkinson et al. (2006) |

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Table S2. (continued).
| Reaction Number | Reaction | $k$ \([\text{molec. cm}^{-3}\text{s}^{-1}]\) | Order $n$ | Reference |
|-----------------|----------|---------------------------------|------------|-----------|
| (SR110)         | OH + HOCl $\rightarrow$ ClO + H$_2$O | $5.00 \times 10^{-13}$ | 2          | Atkinson et al. (2006) |
| (SR111)         | OH + ClO $\rightarrow$ Cl + HO$_2$ | $6.86 \times 10^{-12}\exp(300/T)$ | 2          | Atkinson et al. (2006) |
| (SR112)         | OH + ClO $\rightarrow$ HCl + O$_2$ | $4.37 \times 10^{-13}\exp(300/T)$ | 2          | Atkinson et al. (2006) |
| (SR113)         | ClO + ClO $\rightarrow$ Cl$_2$ + O$_2$ | $1.00 \times 10^{-12}\exp(-1590/T)$ | 2          | Atkinson et al. (2006) |
| (SR114)         | ClO + ClO $\rightarrow$ 2Cl + O$_2$ | $3.00 \times 10^{-11}\exp(-2450/T)$ | 2          | Atkinson et al. (2006) |
| (SR115)         | ClO + ClO $\rightarrow$ Cl + OClO | $3.50 \times 10^{-13}\exp(-1370/T)$ | 2          | Atkinson et al. (2006) |
| (SR116)         | ClO + ClO($+M$) $\rightarrow$ Cl$_2$O$_2$(+M) | $k_0 = 2.00 \times 10^{-12}(T/300)^{-1}[N_2]$ | 2          | Atkinson et al. (2006) |
|                 |                                                   | $k_{\infty} = 1.00 \times 10^{-11}$ |            |           |
|                 |                                                   | $F_r = 0.45$ |            |           |
| (SR117)         | Cl$_2$O$_2$(+M) $\rightarrow$ 2ClO(+M) | $k_0 = 3.70 \times 10^{-7}\exp(-7690/T)[N_2]$ | 1          | Atkinson et al. (2006) |
|                 |                                                   | $k_{\infty} = 1.80 \times 10^{-4}\exp(-7690/T)$ |            |           |
|                 |                                                   | $F_r = 0.45$ |            |           |
| (SR118)         | ClO + HO$_2$ $\rightarrow$ HOCI + O$_2$ | $2.20 \times 10^{-12}\exp(340/T)$ | 2          | Atkinson et al. (2006) |
| (SR119)         | ClO + CH$_3$O$_2$ $\rightarrow$ Cl + CH$_3$O + HO$_2$ | $2.40 \times 10^{-12}\exp(-20/T)$ | 2          | Atkinson et al. (2006) |
| (SR120)         | ClO + NO $\rightarrow$ Cl + NO$_2$ | $6.20 \times 10^{-12}\exp(295/T)$ | 2          | Atkinson et al. (2006) |
| (SR121)         | ClO + NO$_2$(+M) $\rightarrow$ ClONO$_2$(+M) | $k_0 = 1.60 \times 10^{-33}(T/300)^{-3.4}[N_2]$ | 2          | Atkinson et al. (2006) |
|                 |                                                   | $k_{\infty} = 7.00 \times 10^{-11}$ |            |           |
|                 |                                                   | $F_r = 0.40$ |            |           |
| (SR122)         | Cl + ClONO$_2$ $\rightarrow$ Cl$_2$ + NO$_3$ | $6.20 \times 10^{-12}\exp(145/T)$ | 2          | Atkinson et al. (2006) |
| (SR123)         | OCIO + NO $\rightarrow$ NO$_2$ + ClO | $1.10 \times 10^{-13}\exp(350/T)$ | 2          | Atkinson et al. (2006) |
| (SR124)         | OH + ClONO$_2$ $\rightarrow$ HOCI + NO$_3$ | $1.20 \times 10^{-13}\exp(-330/T)$ | 2          | Atkinson et al. (2006) |
| (SR125)         | ClO + BrO $\rightarrow$ Br + ClO | $1.60 \times 10^{-12}\exp(430/T)$ | 2          | Atkinson et al. (2006) |
| (SR126)         | ClO + BrO $\rightarrow$ Br + Cl + O$_2$ | $2.90 \times 10^{-12}\exp(220/T)$ | 2          | Atkinson et al. (2006) |
| (SR127)         | ClO + BrO $\rightarrow$ BrCl + O$_2$ | $5.80 \times 10^{-13}\exp(170/T)$ | 2          | Atkinson et al. (2006) |
| (SR128)         | Br + OCIO $\rightarrow$ BrO + ClO | $2.70 \times 10^{-11}\exp(-1300/T)$ | 2          | Atkinson et al. (2006) |
| (SR129)         | Br + Cl$_2$O$_2$ $\rightarrow$ BrCl + ClO | $3.00 \times 10^{-12}$ | 2          | Atkinson et al. (2006) |
| (SR130)         | Br$_2$ + Cl $\rightarrow$ BrCl + Br | $1.20 \times 10^{-10}$ | 2          | Sander and Crutzen (1996) |
| (SR131)         | BrCl + Br $\rightarrow$ Br$_2$ + Cl | $3.30 \times 10^{-15}$ | 2          | Sander and Crutzen (1996) |
| (SR132)         | Br + Cl$_2$ $\rightarrow$ BrCl + Cl | $1.10 \times 10^{-15}$ | 2          | Sander and Crutzen (1996) |
| (SR133)         | BrCl + Cl $\rightarrow$ Br + Cl$_2$ | $1.50 \times 10^{-11}$ | 2          | Sander and Crutzen (1996) |
| (SR134)         | HOBr + H$^+$ + Cl$^-$ $\rightarrow$ BrCl + H$_2$O | $3.03 \times 10^{-5}$ \((r_a + r_b + r_c)^{-1}\alpha_{\text{eff.aerosol}}\) | Cao et al. (2014) |
| (SR135)         | BrCl + hv $\rightarrow$ Br + Cl | calculated by TUV model | 1          | Madronich and Flocke (1997, 1999) |
| (SR136)         | Cl$_2$ + hv $\rightarrow$ Cl | calculated by TUV model | 1          | Madronich and Flocke (1997, 1999) |
| (SR137)         | ClO + hv $\rightarrow$ Cl + O$_3$ | calculated by TUV model | 1          | Madronich and Flocke (1997, 1999) |
| (SR138)         | HOCI + hv $\rightarrow$ HO + Cl | calculated by TUV model | 1          | Madronich and Flocke (1997, 1999) |
| (SR139)         | ClONO$_2$ + hv $\rightarrow$ NO$_3$ + Cl | calculated by TUV model | 1          | Madronich and Flocke (1997, 1999) |
| (SR140)         | OCIO + hv $\rightarrow$ O$_3$ + ClO | calculated by TUV model | 1          | Madronich and Flocke (1997, 1999) |
| (SR141)         | HOBr + HCl $\rightarrow$ BrCl + H$_2$O | \((\frac{1}{J_k} + \frac{1}{J_{\text{aerosol}}} + \alpha_{\text{aerosol}})^{-1}\) | Cao et al. (2014) |
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