Supplementary Information: Sulfur monoxide dimer chemistry as a possible source of polysulfur in the upper atmosphere of Venus

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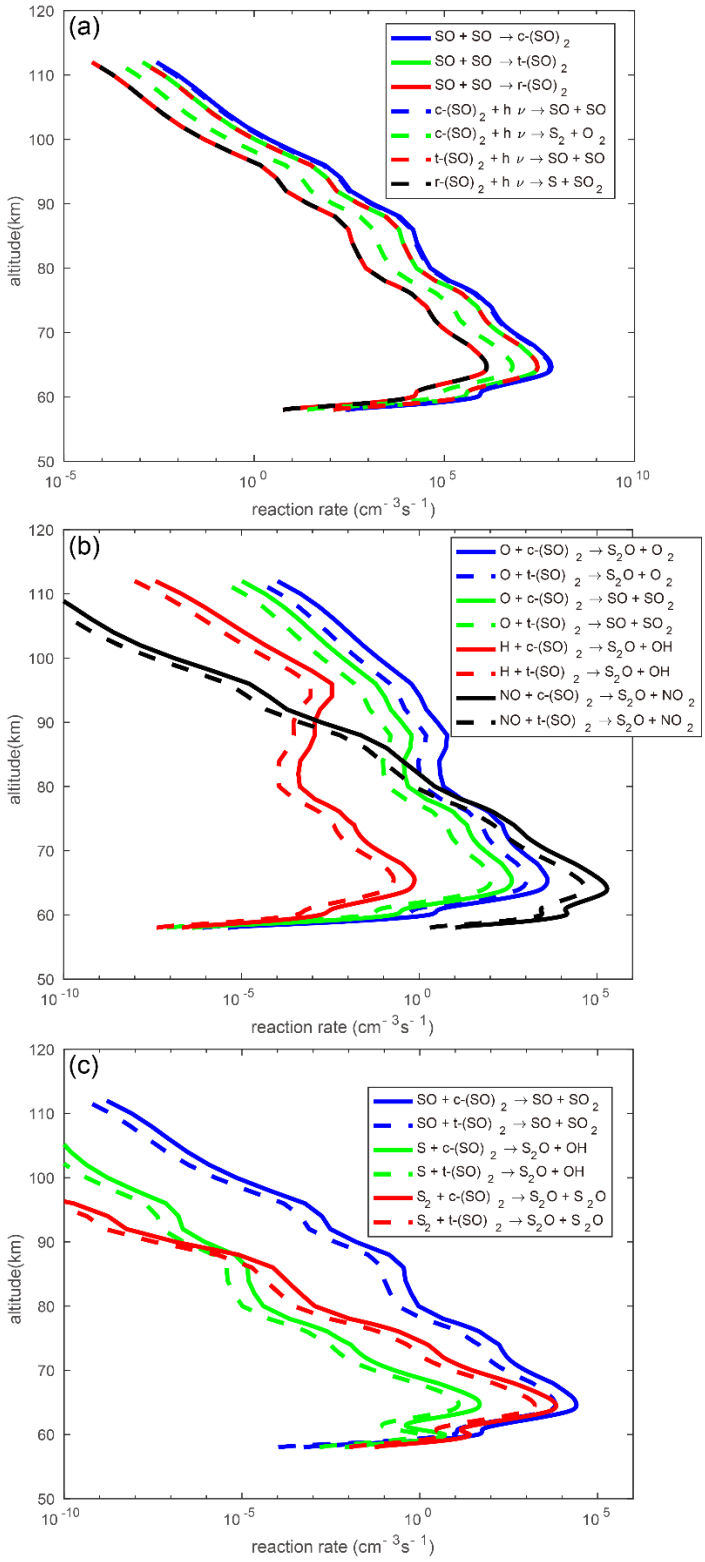
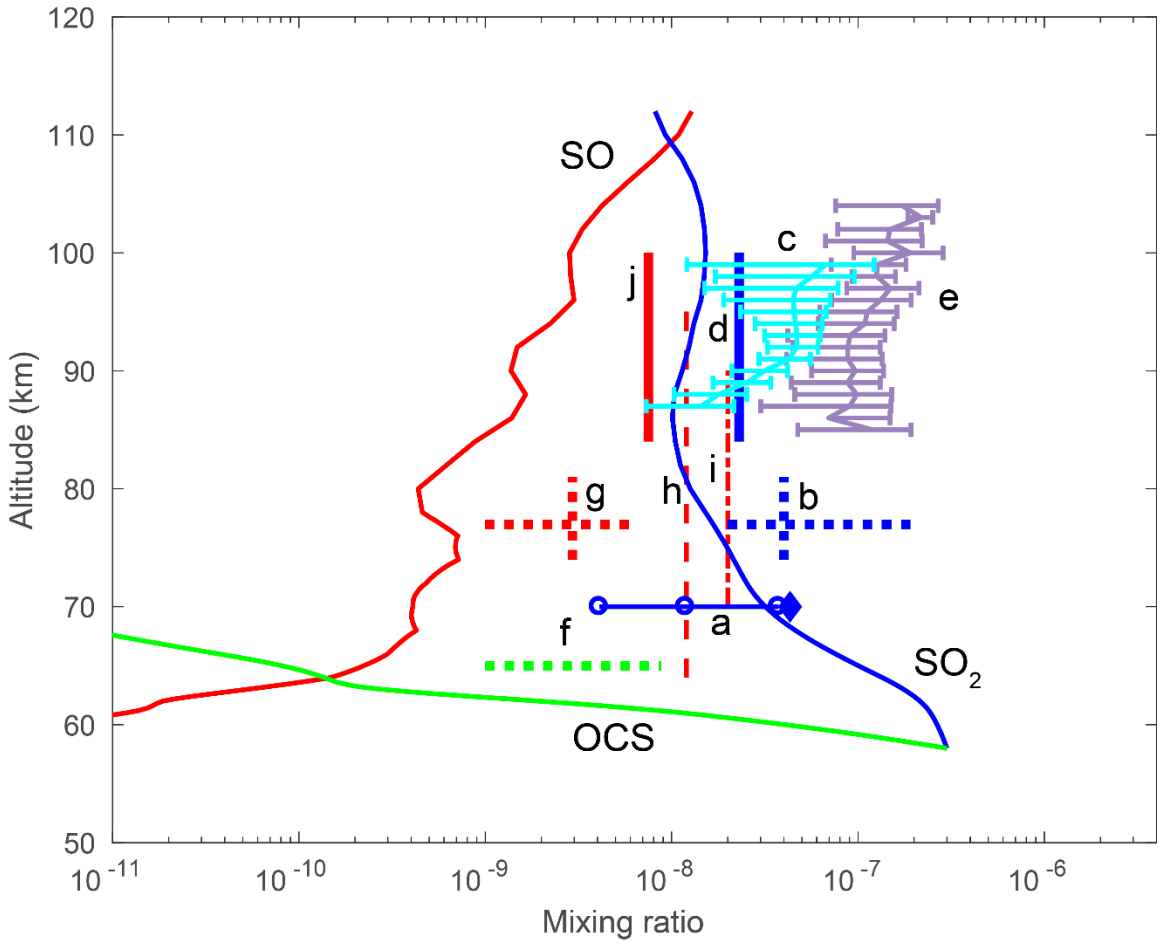
Supplementary Table 1. Reactions involving the SO dimer in the photochemical model.

Reactions	Photolysis Rate, J Rate Coefficients, k*	References
1. SO + SO + M → c-(SO)$_2$ + M	k = 2.15×10^{-31}; 1.00×10^{-11}	a
2. SO + SO + M → t-(SO)$_2$ + M	k = 2.15×10^{-31}; 1.00×10^{-11}	a
3. SO + SO + M → r-(SO)$_2$ + M	k = 8.80×10^{-33}; 1.00×10^{-11}	a
4. c-(SO)$_2$ + hν → SO + SO	J = 9.30×10^{-2}	a
5. c-(SO)$_2$ + hν → S$_2$ + O$_2$	J = 9.30×10^{-3}	a
6. t-(SO)$_2$ + hν → SO + SO	J = 9.30×10^{-2}	a
7. r-(SO)$_2$ + hν → S + SO$_2$	J = 1.20×10^{-1}	a
8. O + c-(SO)$_2$ → S$_2$O + O$_2$	k = 3.00×10^{-14}	a
9. O + c-(SO)$_2$ → SO + SO$_2$	k = 3.00×10^{-15}	a
10. O + t-(SO)$_2$ → S$_2$O + O$_2$	k = 3.00×10^{-14}	a
11. O + t-(SO)$_2$ → SO + SO$_2$	k = 3.00×10^{-15}	a
12. H + c-(SO)$_2$ → S$_2$O + OH	k = 3.00×10^{-14}	b
13. H + t-(SO)$_2$ → S$_2$O + OH	k = 3.00×10^{-14}	b
14. NO + c-(SO)$_2$ → S$_2$O + NO$_2$	k = 3.00×10^{-14}	b
15. NO + t-(SO)$_2$ → S$_2$O + NO$_2$	k = 3.00×10^{-14}	b
16. SO + c-(SO)$_2$ → S$_2$O + SO$_2$	k = 3.00×10^{-14}	b
17. SO + t-(SO)$_2$ → S$_2$O + SO$_2$	k = 3.00×10^{-14}	a
18. S + c-(SO)$_2$ → S$_2$O + SO	k = 3.00×10^{-14}	a
19. S + t-(SO)$_2$ → S$_2$O + SO	k = 3.00×10^{-14}	a
20. S$_2$ + c-(SO)$_2$ → 2S$_2$O	k = 3.00×10^{-14}	a
21. S$_2$ + t-(SO)$_2$ → 2S$_2$O	k = 3.00×10^{-14}	a

*Low and high pressure rate coefficients given for SO dimer formation; J values given at 112 km, units are $cm^{-3}s^{-1}$ for J and $cm^3s^{-1}molec^{-1}$, $cm^6s^{-1}molec^{-2}$ for k. References: (a) ref. 1 and references therein; (b) estimated based on ref. 1.



Supplementary Figure 1. Reaction rate profiles of the reactions in Table S1.



Supplementary Figure 2. Comparison of modeled profiles of SO_2, OCS and SO with observations for SO_2 = 0.3 ppm and OCS = 0.3 ppm at 58 km, the lower boundary of the model. Model profiles are shown as thin solid lines; (blue) SO_2, (green) OCS, (red) SO. Model SO_2 and SO profiles considering new H_2SO_4 cross sections from ref. 2 are shown as thin dotted lines. Model OCS profile using 100 ppm at 58 km shown as dotted line. Data sources: (a) SO_2, interquartile range from 2010 through 2014, diamond shows mean of distribution, ref. 3; (b) SO_2, ref. 4; (c) SO_2, ref. 5 solar occultation with 1-σ error bars; (d) SO_2, ref. 6; (e) SO_2, ref. 5 stellar occultation with 1-σ error bars; (f) OCS, ref. 7; (g) SO, ref. 4; (h) SO, ref. 8; (i) SO, ref. 9; (j) SO, ref. 6.

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