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**Article:**

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1 **Appendix 1. Supplementary tables and figures**

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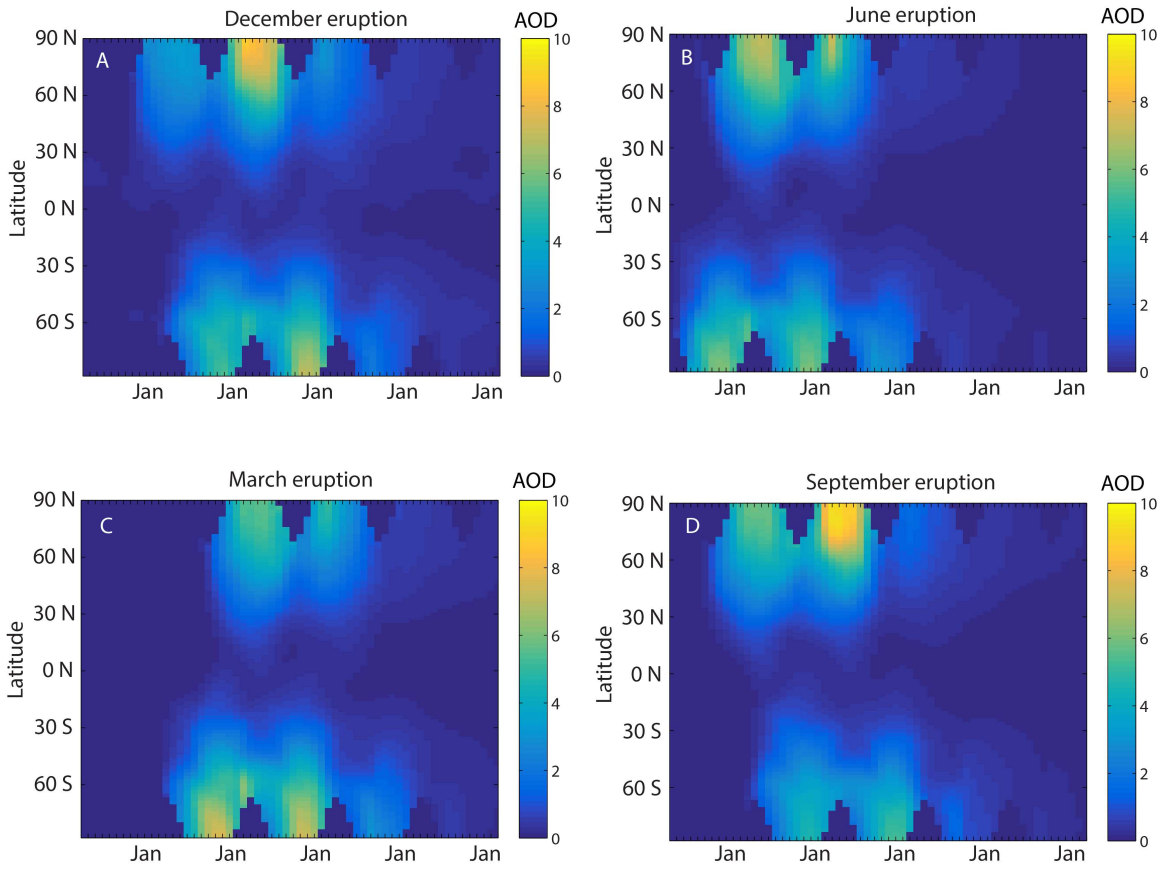
3 **Table S1.** List of simulations and boundary conditions.

<b>Run numbers</b>	<b>SO<sub>2</sub> emissions</b>	<b>Time of year</b>	<b>Emissions altitude</b>	<b>Duration</b>
Control	—	—	—	20 years
7	2000 Tg SO <sub>2</sub>	June	18-25 km	10 years
8	2000 Tg SO <sub>2</sub>	Dec.	18-25 km	10 years
9, 21-24	200 Tg SO <sub>2</sub>	June	18-25 km	10 years
25-29	200 Tg SO <sub>2</sub>	Dec.	18-25 km	10 years
16, 30-33	2000 Tg SO <sub>2</sub>	Dec.	35-40 km	10 years
35-39	2000 Tg SO <sub>2</sub>	June	35-40 km	10 years
40-44	2000 Tg SO <sub>2</sub>	Sept.	35-40 km	10 years
50-54	2000 Tg SO <sub>2</sub>	March	35-40 km	10 years
100-104	200 Tg SO <sub>2</sub>	June	35-40 km	10 years
105-109	200 Tg SO <sub>2</sub>	Dec.	35-40 km	10 years

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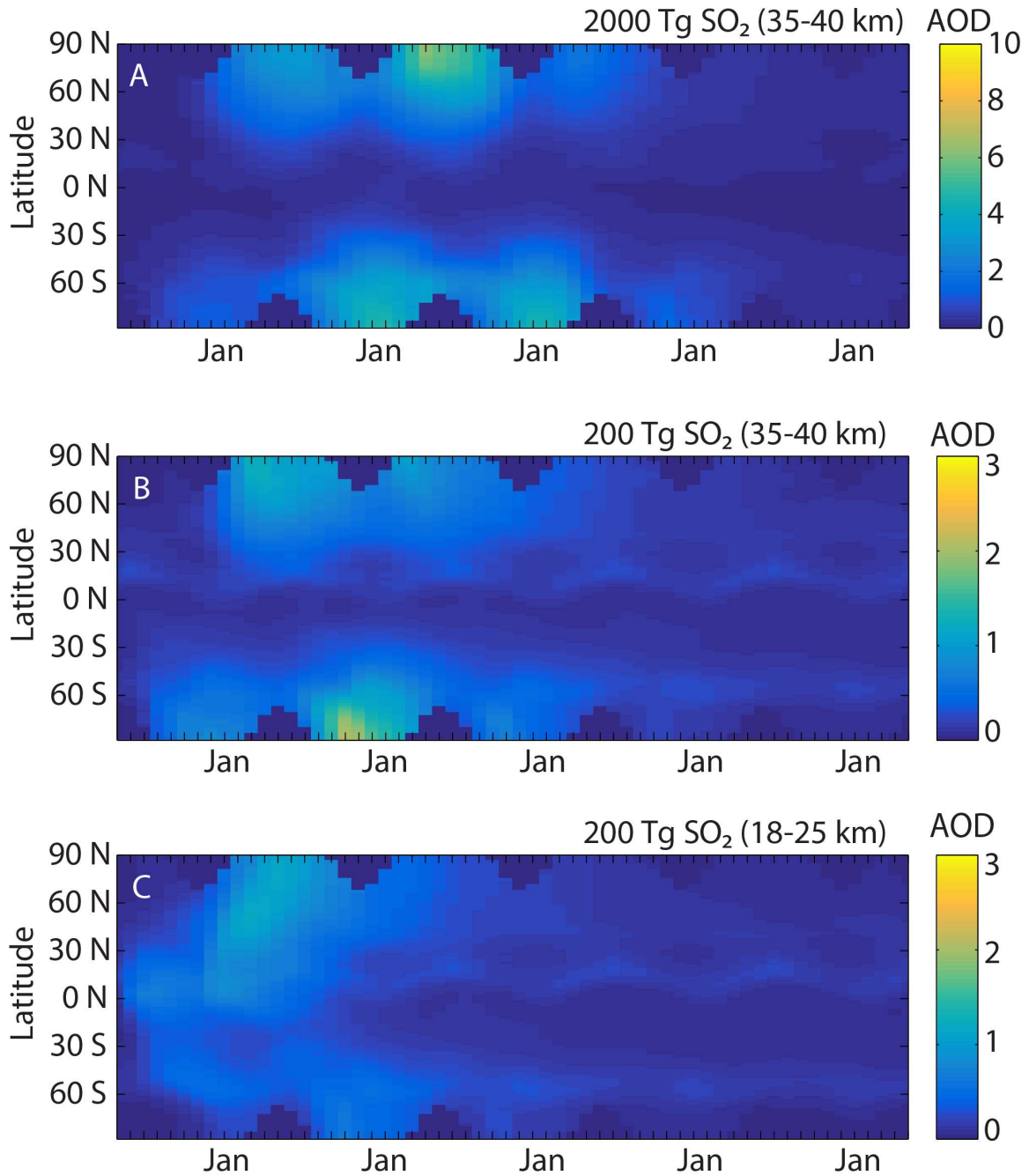
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**Figure S1.** Evolution of zonally averaged aerosol optical depth (AOD, total aerosol optical depth in the visible band) for 2000 Tg SO<sub>2</sub> eruptions at different times of year. Each panel shows the mean of five ensemble members.



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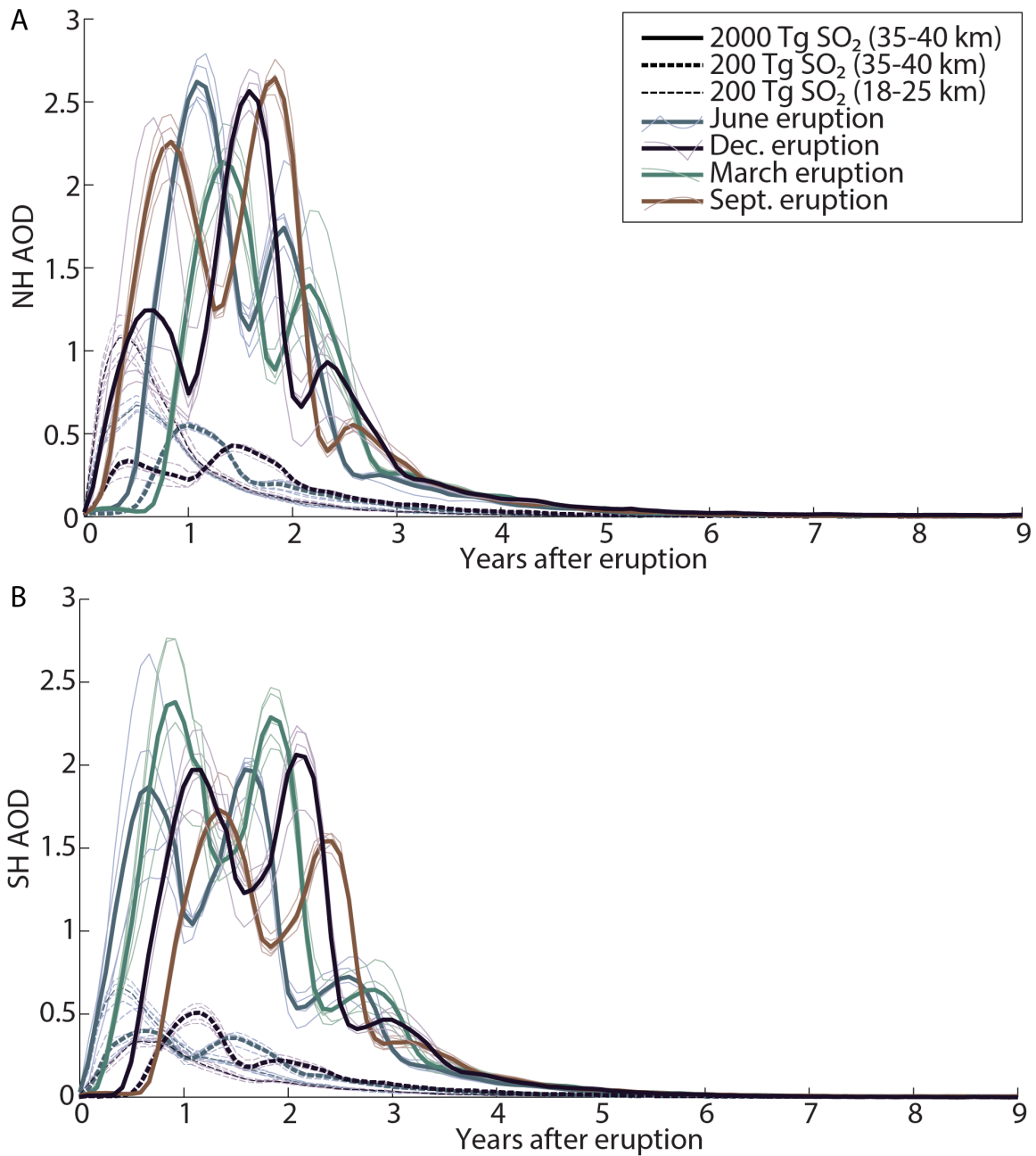
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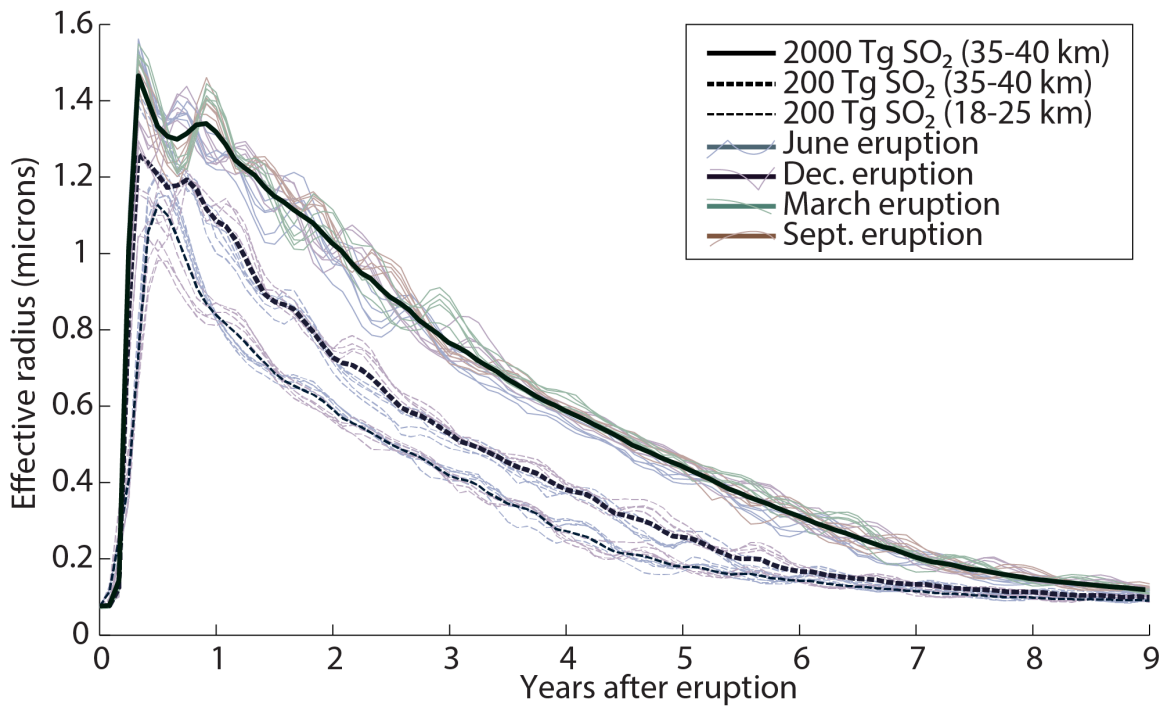
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**Figure S2.** Zonally averaged aerosol optical depth (AOD) for (A) ensemble mean of 20 members with 2000 Tg SO<sub>2</sub> B) ensemble mean of 10 members with 200 Tg SO<sub>2</sub> (35-40 km emissions), or (C) ensemble mean of 10 members with 200 Tg SO<sub>2</sub> (18-25 km emissions).



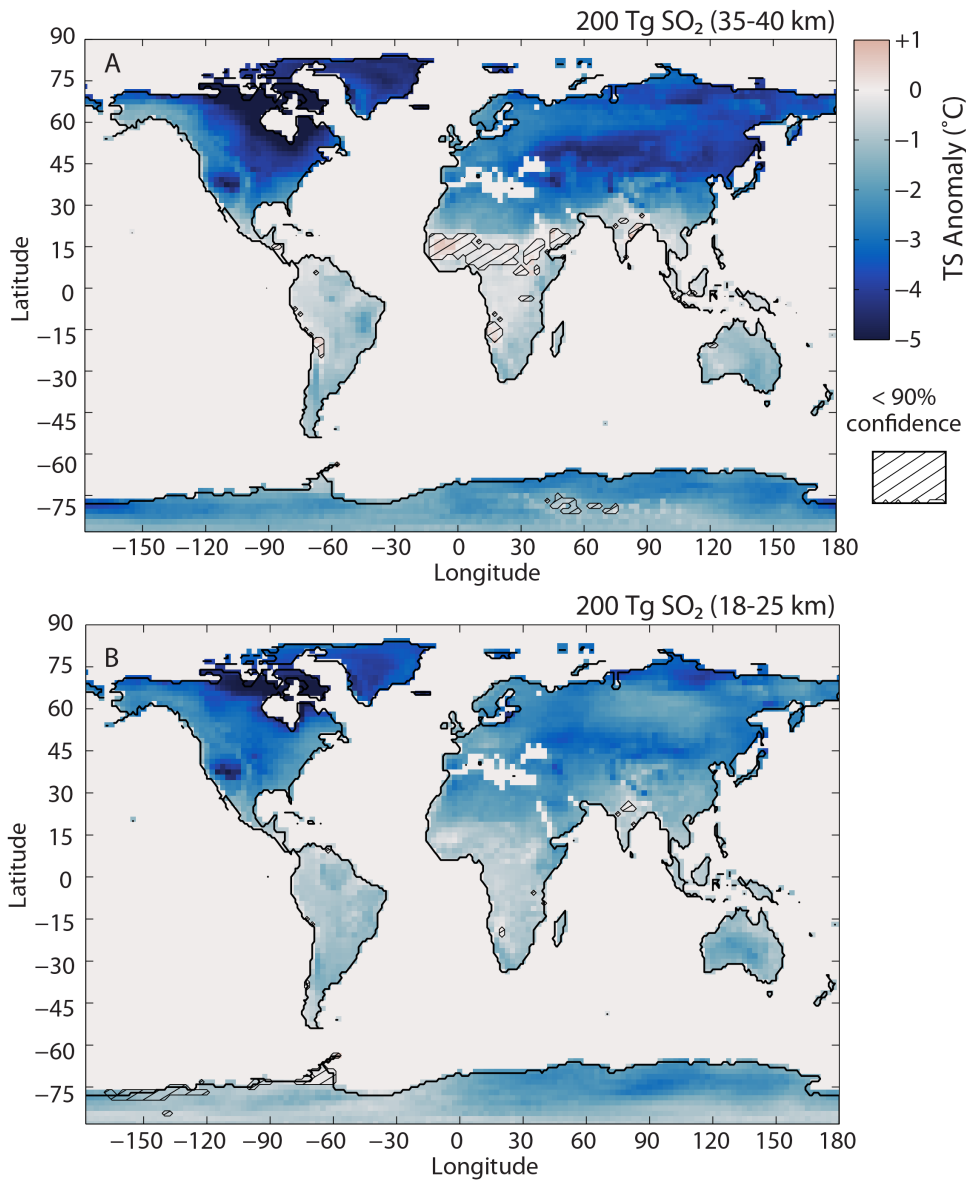
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 23 **Figure S3.** Hemispherically averaged aerosol optical depth (AOD) for 2000 Tg SO<sub>2</sub> or  
 24 200 Tg SO<sub>2</sub> emissions, sorted by eruption month. A) Northern hemisphere. B) Southern  
 25 hemisphere. Light lines represent individual simulations, heavy lines represent ensemble  
 26 means.



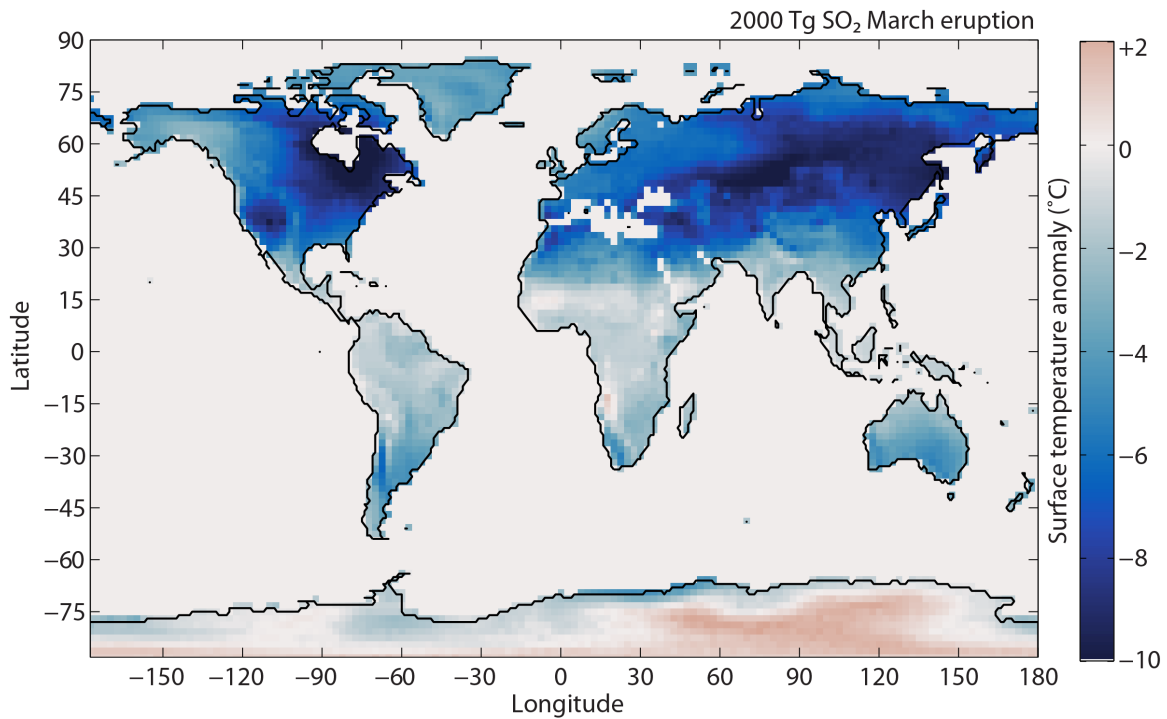
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**Figure S4.** Evolution of global mean aerosol effective radius in the lower stratosphere (at 100 hPa). See also (22) for more detailed analysis and discussion of the evolution of aerosol effective radius following a large, tropical explosive eruption.

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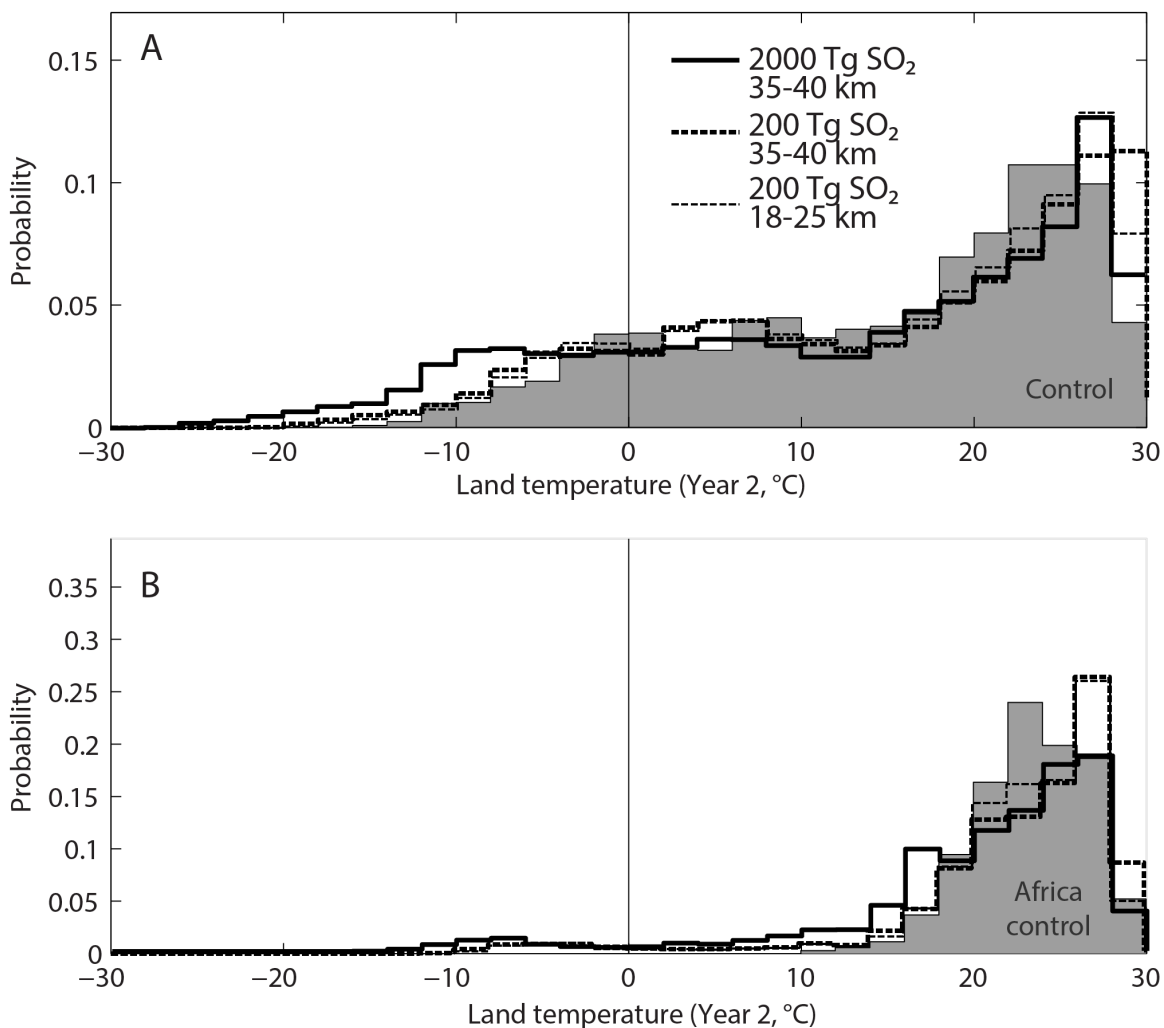
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35 **Figure S5.** Global land surface temperature anomaly following the 200 Tg SO<sub>2</sub> Toba  
36 eruption scenario represented as the mean of the second year after an eruption over 10  
37 ensemble members, which vary in the initial conditions. Cross-hatched areas indicate  
38 temperature anomalies that are not significant at the 90% level as determined with a  
39 Wilcoxon ranked sum test, compared with a monthly climatology from a 20-year control  
40 simulation. (A) shows 18-25 km altitude emissions, (B) shows 35-40 km altitude  
41 emissions.  
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 45 **Figure S6.** Surface temperature anomaly in the second year following 2000 Tg SO<sub>2</sub>  
 46 simulations with the eruption in March, the ensemble with the largest proportion of the  
 47 aerosol cloud in the southern hemisphere (Figure S3), showing that cooling in this  
 48 scenario remains stronger in the northern Hemisphere, with relatively sheltered climate in  
 49 southern Africa.

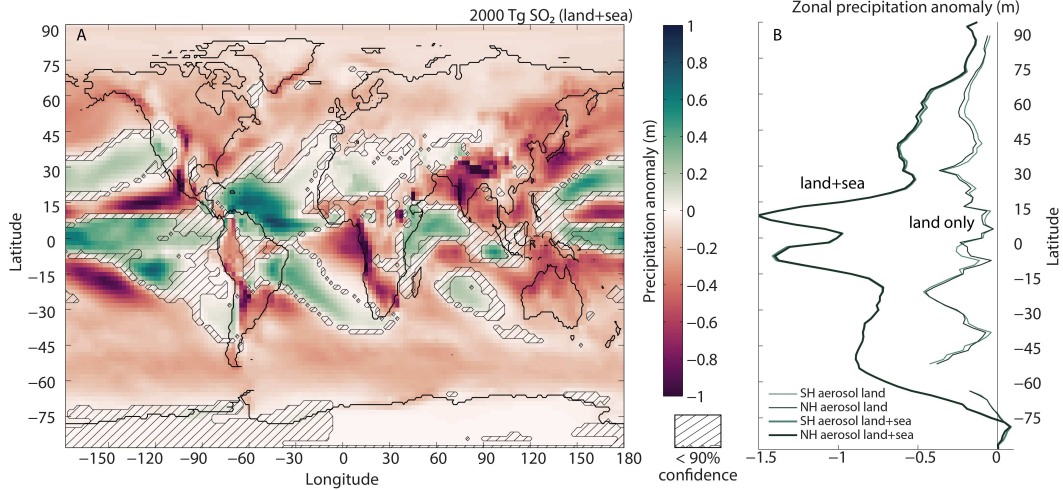


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**Figure S7.** Probability distributions for monthly land temperatures based on a climatology from a 20-year control run and Toba emissions scenarios. (A) Global land temperatures from 60 °S to 60 °N. (B) Land temperatures in Africa.



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**Figure S8.** (A) Global and (B) zonal mean precipitation anomaly in the second year following an eruption. Panel a shows mean of all 2000 Tg SO<sub>2</sub> simulations and panel B shows zonal mean of the March and December eruption ensembles, which have aerosols weighted towards the southern and northern hemispheres respectively (Figure S3).

65 **References**

66 1. English JM, Toon OB & Mills MJ (2013) Microphysical Simulations of Large  
67 Volcanic Eruptions: Pinatubo and Toba. *Journal of Geophysical Research: Atmospheres*  
68 118(4): 1880-1895.

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