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Interactive stratospheric aerosol models' response to different amounts and altitudes of SO_2 injection during the 1991 Pinatubo eruption

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1 Tables

S 1: Models overview

Model	Horizontal resolution (lat x lon)	Vertical resolution (model top, # levels)	Reference
ECHAM6-SALSA	1.9°x 1.9°(T63)	0.01 hPa, 95 levels	Kokkola et al. (2018) and Laakso et al. (2017)
ECHAM5-HAM	2.8°x 2.8°(T42)	0.01 hPa, 90 levels	Niemeier et al. (2009) and Toohey et al. (2013b)
EMAC*	1.9°x1.9°(T63)	0.01 hPa, 90 levels	Jöckel et al, (2010), Brühl et al. (2018)
SOCOL-AERv2	2.8°x 2.8°(T42)	0.01 hPa, 39 levels	Sheng et al. (2015) and Sukhodolov et al. (2018)
ULAQ-CCM	5°x 6°(T21)	0.04 hPa, 126 levels	Pitari et al. (2016) and Visioni et al. (2018)
UM-UKCA	1.25°x 1.875°(N96)	80 km, 85 levels	Marshall et al. (2019) and Dhomse et al. (2020)

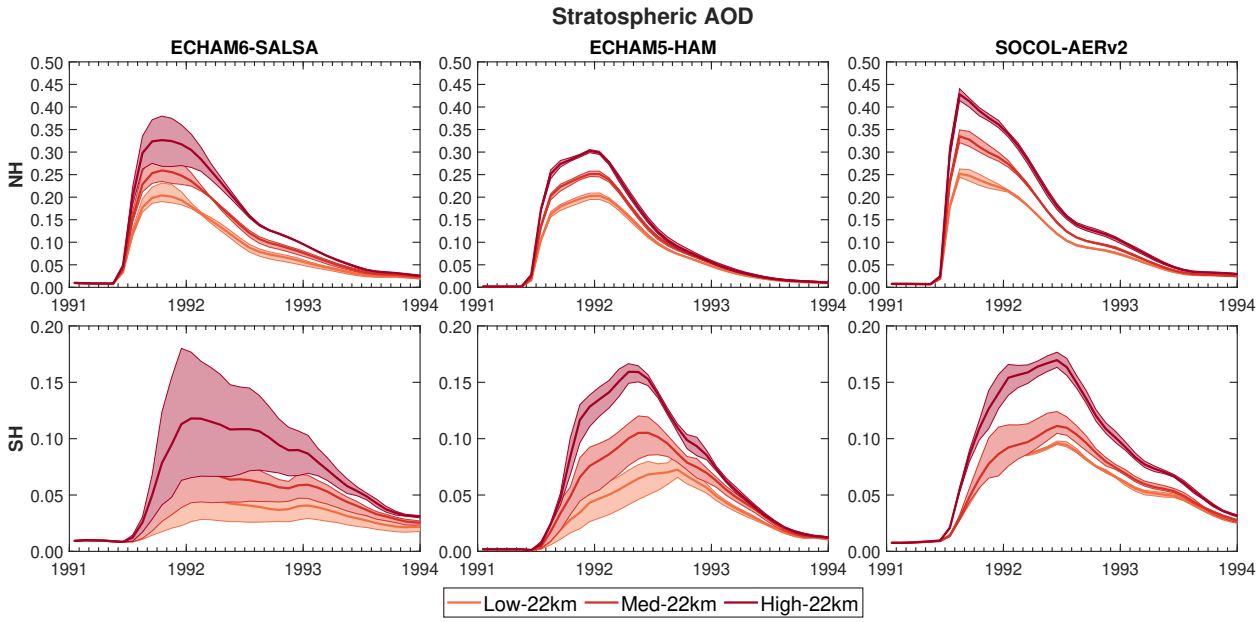
* highlights models with spatially distributed SO_2 injections.

S 2: Peak value of the global stratospheric sulfate burden (in Tg-S), month in which it is reached since January 1991 and e-folding time for each model and experiment.

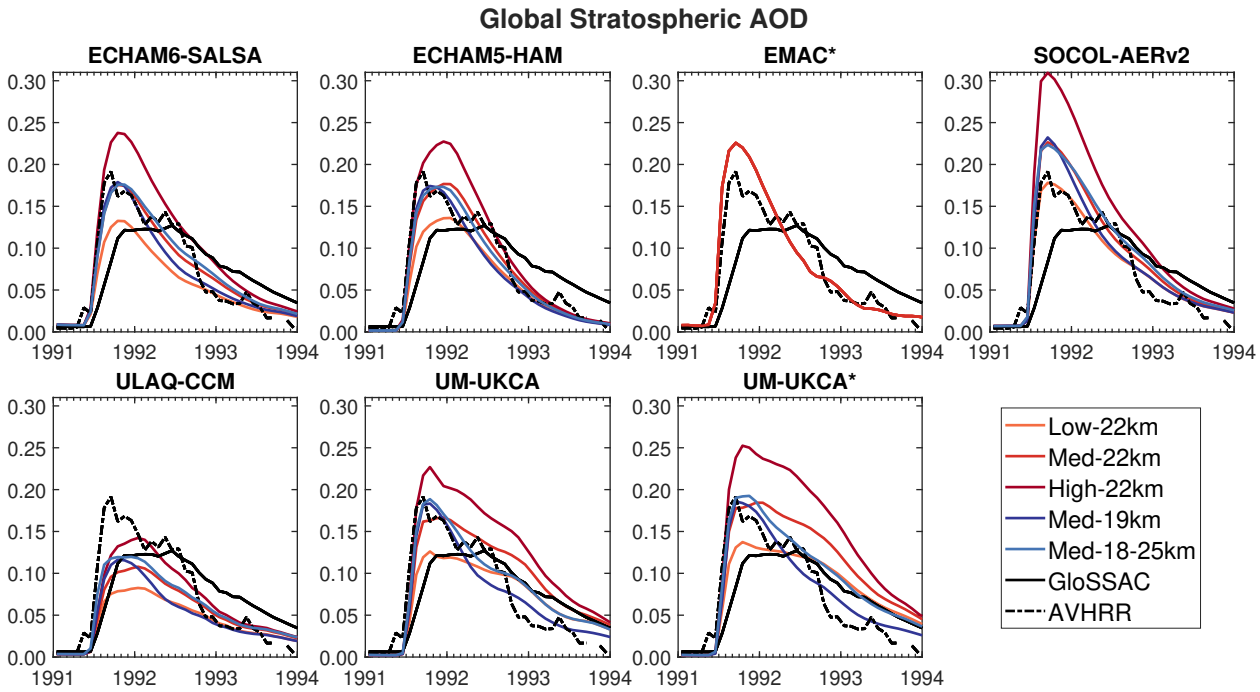
	Low-22km			Med-22km			High-22km			Med-19km			Med-18-25km		
Model	Peak	Month	e-fold	Peak	Month	e-fold	Peak	Month	e-fold	Peak	Month	e-fold	Peak	Month	e-fold
ECHAM6-SALSA	4.8	10	10	6.7	10	11	9.5	11	12	6.1	10	9	6.7	10	13
ECHAM5-HAM	5.0	12	11	7.0	12	10	9.9	12	9	6.0	10	11	6.5	11	11
EMAC*				7.0	9	8									
SOCOL-AERv2	4.8	10	14	6.6	10	13	9.4	10	13	5.4	9	13	6.6	10	14
ULAQ-CCM	5.0	11	13	7.0	11	13	9.8	11	12	6.6	11	10	6.9	11	13
UM-UKCA	4.2	11	21	5.9	11	19	8.4	11	18	5.4	10	14	5.7	11	17
UM-UKCA*	4.2	11	23	6.0	11	21	8.6	11	20	5.3	10	15	5.6	11	19

* highlights models with spatially distributed SO_2 injections.

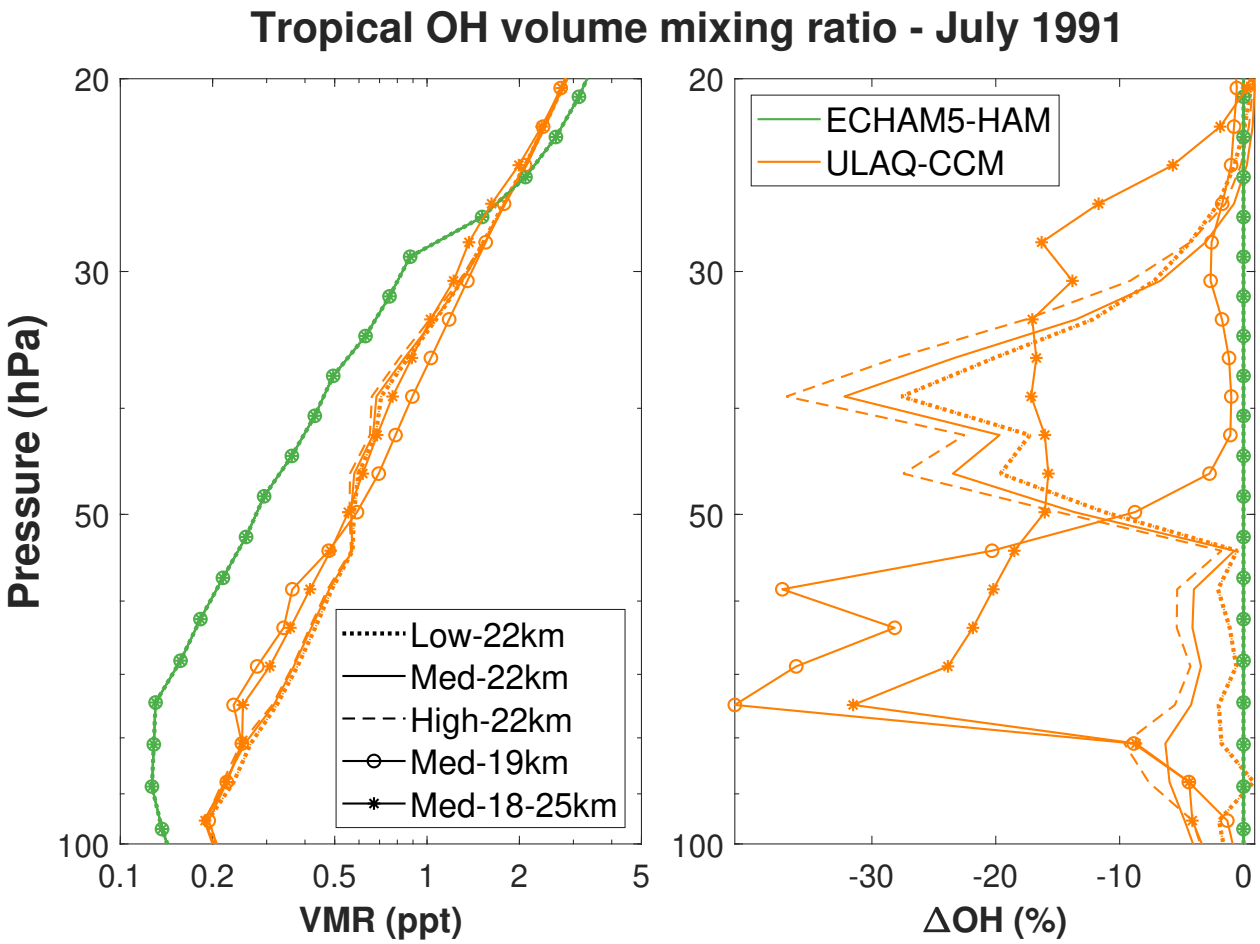
2 Figures



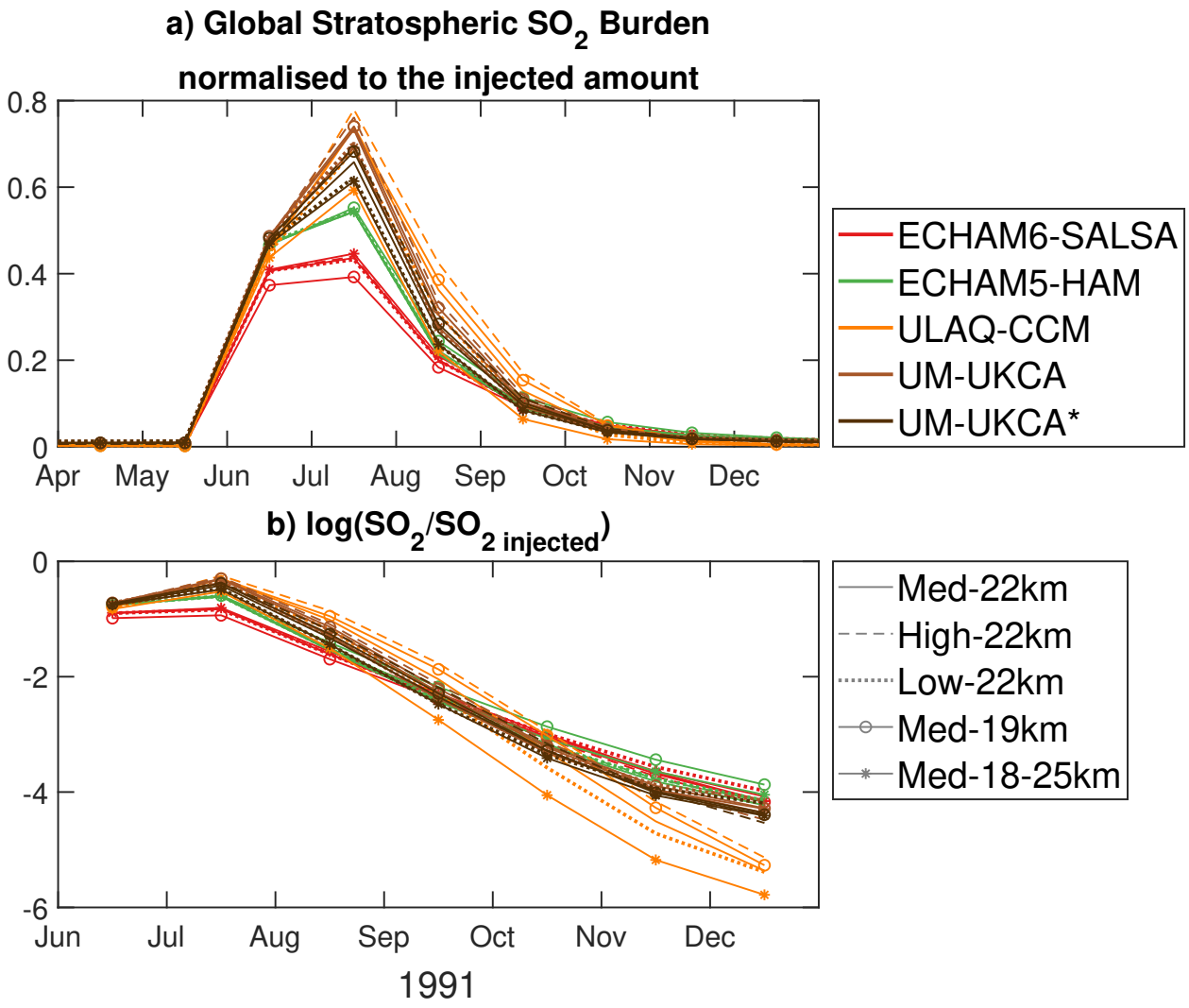
S 1: Time evolution of the stratospheric AOD in the northern (NH) and southern hemisphere (SH) simulated by ECHAM6-SALSA, ECHAM5-HAM and SOCOL-AERv2 for the experiments with different amounts of SO_2 injected at about 22 km altitude. The thick line represents the ensemble mean, the shaded area the region between the minimum and maximum values between the ensemble members (thin lines).



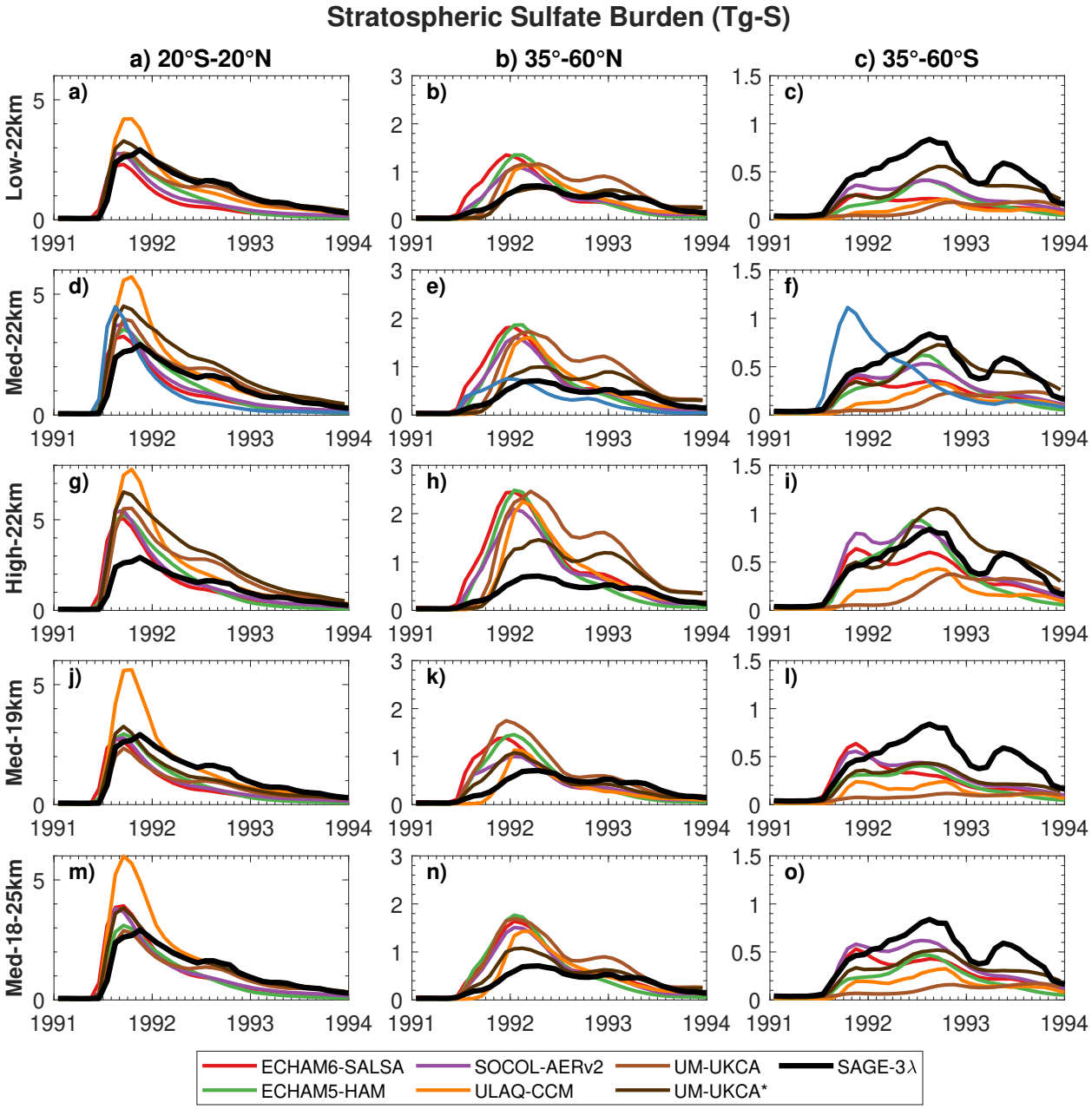
S 2: Temporal evolution of monthly global stratospheric AOD values. Each panel refers to the respective model in which the results of the different experiments (coloured lines) are compared with GloSSAC and AVHRR measurements (black lines). * Models with spatially spread SO_2 injections.



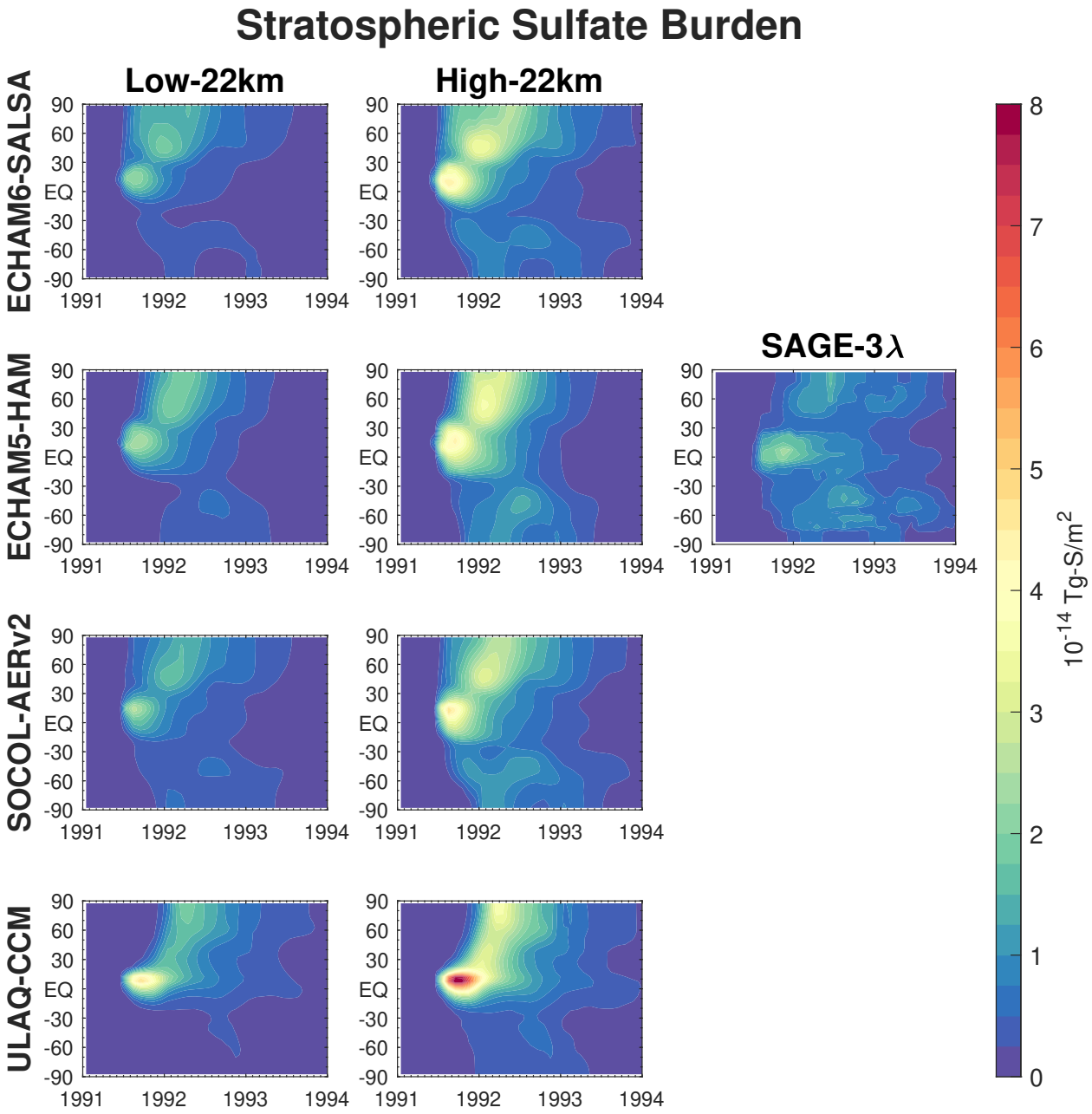
S 3: Vertical distribution of OH mixing ratio in July 1991 and its change from the background conditions (July 1991 without eruption) in ECHAM5-HAM (prescribed OH) and ULAQ-CCM (interactive OH). Experiments are identified here with different line styles, the different colors refer to the models.



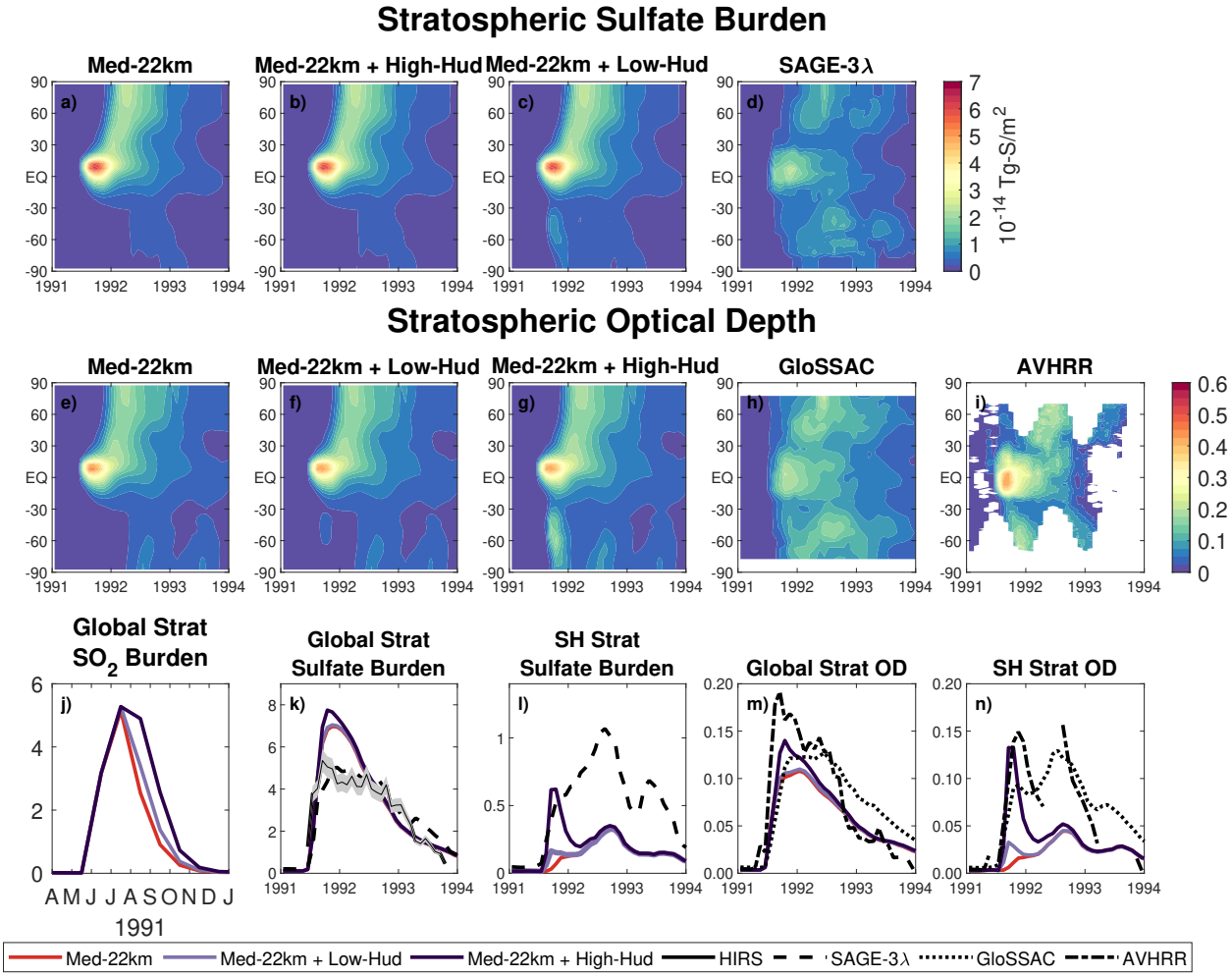
S 4: Time evolution of global stratospheric SO_2 burden in Tg-S (a) and logarithm of SO_2 burden divided by the amount of SO_2 injected (b) in all model experiments. The models are identified by the different colours (top legend), the different scenarios by the different line styles (bottom legend). * Models with spatially spread SO_2 injections.



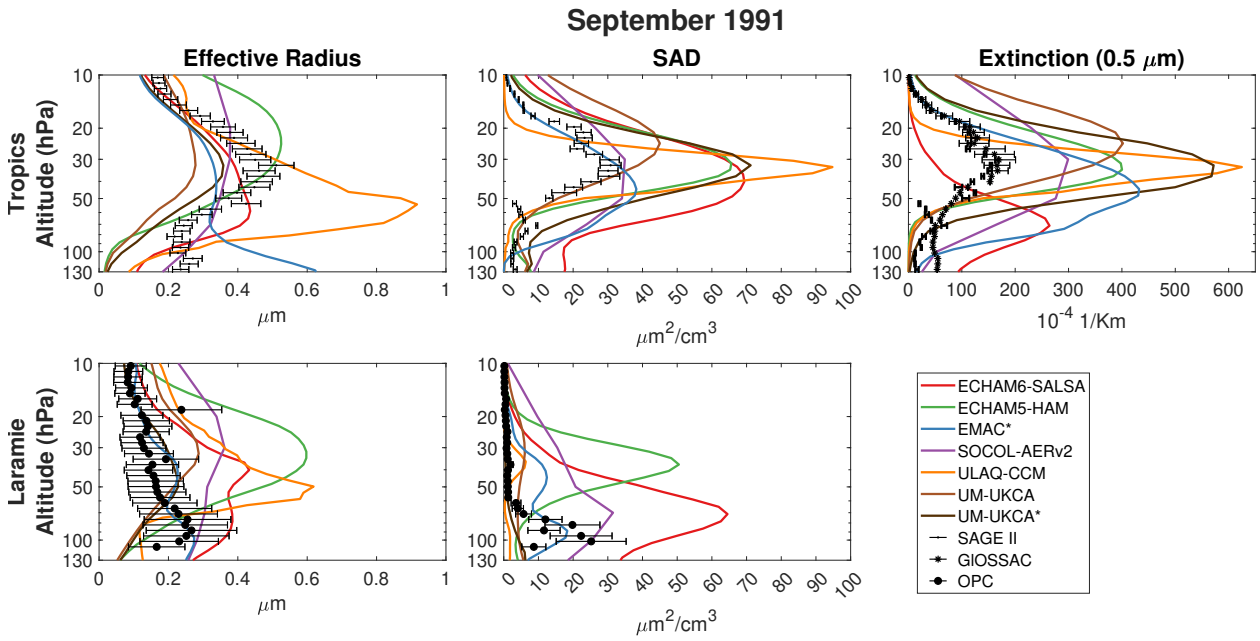
S 5: Time evolution of stratospheric sulfate burden in Tg-S in the tropics (first column), in the NH (second column) and SH mid-latitudes (third column) simulated by models and compared with observations. Each row identifies a different experiment.



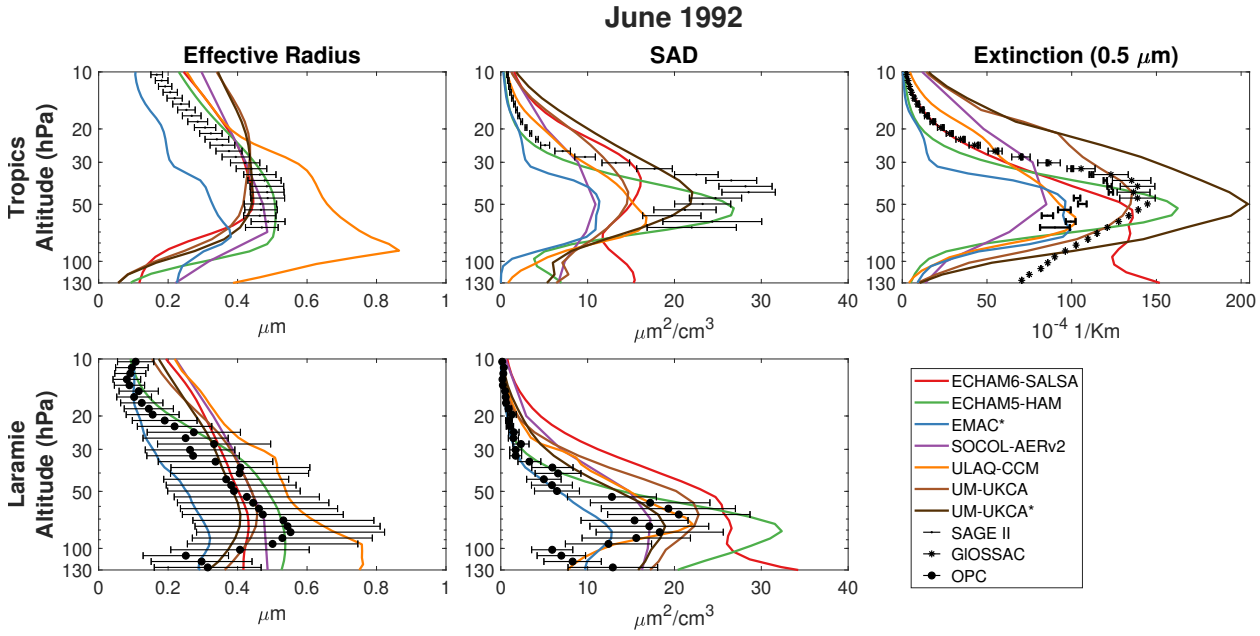
S 6: Time evolution of zonal stratospheric sulfate burden (in 10^{-14} Tg-S/m^2) in Low-22km (first column) and High-22km (second column) for all models, and zonal stratospheric sulfate burden of SAGE-3λ (third column).



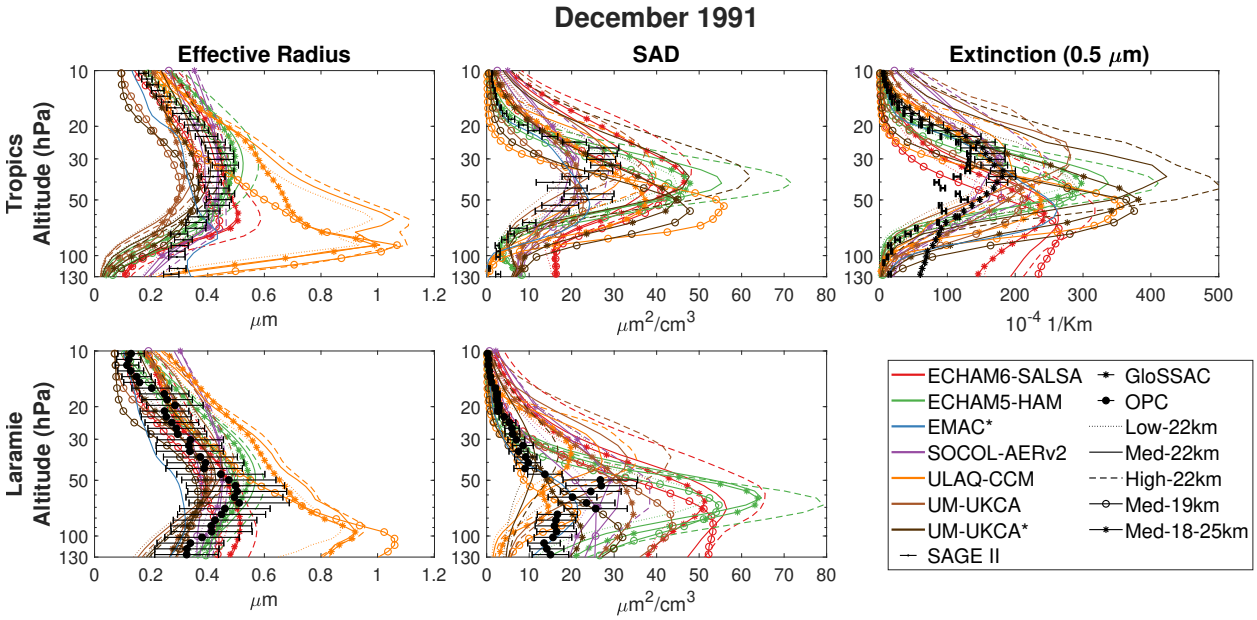
S 7: Time evolution of zonal stratospheric sulfate burden (in 10^{-14} Tg-S/m^2) and optical depth (first and second row, respectively) for Med-22km (a, e), Med-22km with Cerro Hudson lower-end emission (b, f) and with the upper-end emission (c, g). Observations for stratospheric sulfate burden are form SAGE-3λ (d), and for optical depth from GloSSAC and AVHRR (h and i). The third row includes the global mean of stratospheric SO_2 (j), global and SH mean of stratospheric sulfate burden (k and l), global and SH mean of optical depth (m and n) for the same simulations and observations as panels a-i.



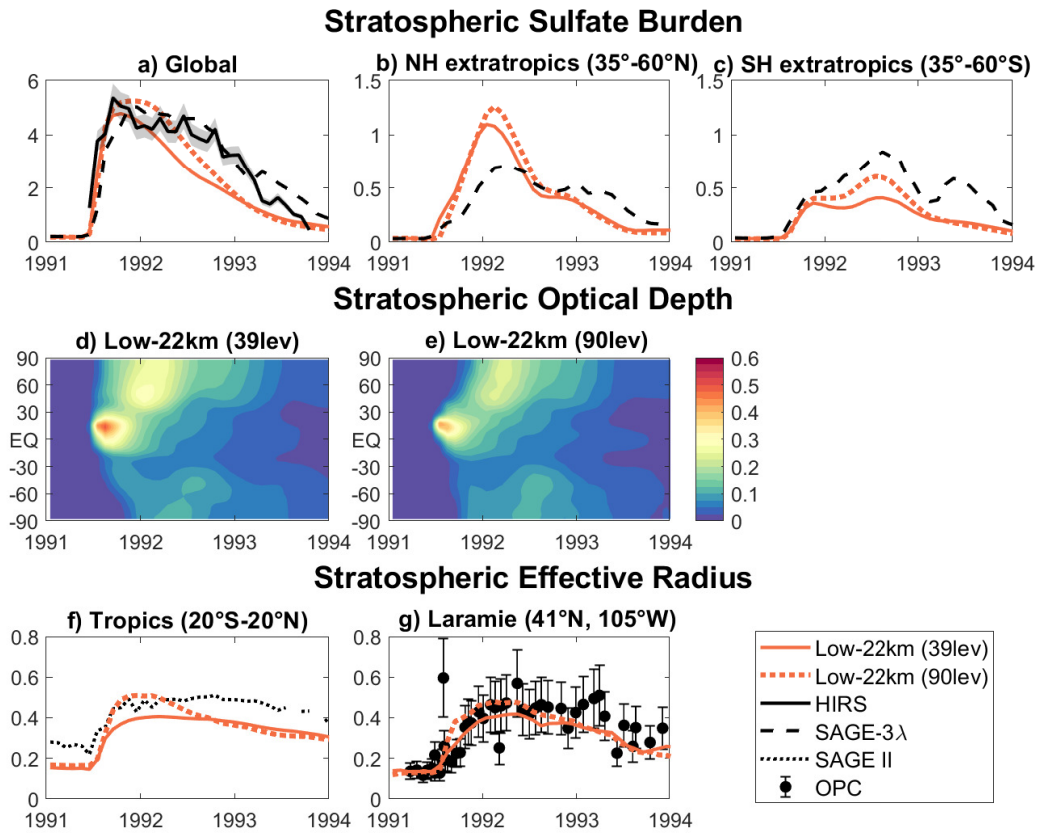
S 8: Vertical profile of the effective radius in μm (left panels), surface area density (SAD) in $\mu m^2/cm^3$ (middle panels), and extinction at 0.5 μm in 1/km (right panel) in the tropics (first row) and over Laramie (second row) for Med-22km in September 1991. Model results are compared with SAGE II and GloSSAC in the tropics and with OPC over Laramie. * Models with spatially spread SO_2 injections.



S 9: Vertical profile of the effective radius in μm (left panels), surface area density (SAD) in $\mu m^2/cm^3$ (middle panels), and extinction at 0.5 μm in 1/km (right panel) in the tropics (first row) and over Laramie (second row) for Med-22km in June 1992. Model results are compared with SAGE II and GloSSAC in the tropics and with OPC over Laramie. * Models with spatially spread SO_2 injections.



S 10: Vertical profile of the effective radius in μm (left panels), surface area density (SAD) in $\mu m^2/cm^3$ (middle panels), and extinction at 0.5 μm in 1/km (right panel) in the tropics (first row) and over Laramie (second row) for all experiments in December 1991. Model results are compared with SAGE II and GloSSAC in the tropics and with OPC over Laramie. Experiments are identified here with different line styles, the different colors refer to the models. * Models with spatially spread SO_2 injections.



S 11: Time evolution of the monthly averages of global stratospheric sulfate burden (a), in extratropical NH, and extratropical SH (c) for Low-22km performed in SOCOL-AERv2 with 39 and 90 vertical levels (light orange lines, different line style) compared with the observations (black lines, different line style). Panels d and e show the time evolution of zonal stratospheric AOD for Low-22km performed in SOCOL-AERv2 with the two vertical resolutions. Panels f and g are the same as panels a-c but for the stratospheric effective radius in the tropics and over Laramie. The legend is common to panels a-c and f-g.