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Multi-model comparison of the volcanic sulfate deposition from the 1815 eruption of Mt. Tambora

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Table S1: Ice cores used for volcanic sulfate deposition fluxes after the 1815 eruption of Mt. Tambora and their metadata. Antarctica ice core details taken from Table S1, Sigl et al. (2014).

Antarctica ice cores				Greenland ice cores			
Ice core	**Lat**	**Lon**	**Reference**	**Ice core**	**Lat**	**Lon**	**Reference**
WDC06A	-79.47	-112.09	*Sigl et al. (2013)*	B20	79	-36.5	*Bigler et al. (2002), Gao et al. (2006)*
WDC05Q	-79.47	-112.08	*Sigl et al. (2013)*	GISP2	72.6	-38.5	*Gao et al. (2006), Zielinski et al. (1994)*
SP04	-89.95	17.67	*Budner & Cole-Dai, (2003)*	20D	65	-45	*Gao et al. (2006), Mayewski et al. (1990)*
SP01	-89.95	17.67	*Ferris et al. (2011)*	NGRIP	75.1	-42.3	*Plummer et al. (2012)*
DML05	-75.00	0.02	*Traufetter et al. (2004)*	NEEM-2011-S1	77.45	-51.06	*Sigl et al. (2013)*
DML07	-75.58	3.43	*Traufetter et al. (2004)*	Humboldt	78.53	-56.83	*Sigl et al. (2013)*
B40	-75.00	0.06	*Sigl et al. (2014)*	Site T	72.58	-38.45	*Mosley-Thompson et al. (2003)*
NUS08-4	-82.82	18.90	*Sigl et al. (2014)*	GITS	77.14	-61.10	*Mosley-Thompson et al. (2003)*
NUS08-5	-82.63	17.87	*Sigl et al. (2014)*	D2	71.75	-46.33	*Mosley-Thompson et al. (2003)*
NUS07-2	-76.07	22.47	*Sigl et al. (2014)*	D3	69.8	-44.0	*Mosley-Thompson et al. (2003)*
NUS07-5	-78.65	35.63	*Sigl et al. (2014)*	Raven	65.9	-46.3	*Mosley-Thompson et al. (2003)*
NUS07-7	-82.07	54.88	*Sigl et al. (2014)*	Dye 3	65.18	-43.83	*Larsen et al. (2008)*
EDC96	-75.10	123.35	*Castellano et al. (2005)*	GRIP	72.58	-37.64	*Larsen et al. (2008)*
DFS10	-77.40	39.62	*Sigl et al. (2014)*	SU07	72.5	-38.5	*Cole-Dai et al. (2009)*
DF01	-77.37	39.70	*Motizuki et al. (2014)*	D4	71.4	-43.9	*McConnell et al. (2007)*
W10k	-66.75	112.83	*Sigl et al. (2014)*				
DIV2010	-76.77	-101.74	*Sigl et al. (2014)*				
NUS08-7	-74.88	1.60	*Sigl et al. (2014)*				
NUS07-1	-73.72	7.98	*Sigl et al. (2014)*				
TalosDome	-72.48	159.06	*Stenni et al. (2002)*				
Taylor Dome	-77.81	158.72	*Mayewski et al. (1996)*				
DomeA	-80.37	77.22	*Jiang et al. (2012)*				
DSS	-66.77	112.80	*Plummer et al. (2012)*				
Siple Station	-75.91	-83.91	*Cole-Dai et al. (1997)*				
Dyer	-70.66	-64.87	*Cole-Dai et al. (1997)*				
PlatRemote	-84.00	43.00	*Cole-Dai et al. (2000)*				

Table S2: Ice cores used for preindustrial background sulfate deposition fluxes (1850–1860 mean) taken from Lamarque et al. (2013).

Antarctic ice cores			Arctic ice cores		
Ice core	**Lat**	**Lon**	**Ice core**	**Lat**	**Lon**
W10	-66.73	112.83	ACT11d	66.48	-46.31
DIV	-76.77	-101.74	D4	71.4	-43.9
WD	-79.47	-112.07	Zoe	72.6	-38.3
NUS08-7	-74.88	1.60	NEEMS3	77.45	-51.06
NUS08-5	-82.63	17.87	Tunu	78.02	-33.99
NUS07-7	-82.07	54.88	McCall	69.3	-143.8
NUS07-5	-78.65	35.63	Akademii Nauk	80.52	94.82
NUS07-2	-76.07	22.47	Flade Isblink	81.58	-15.7
NUS07-1	-73.72	7.98			

Table S3: Mean polar (60°–90°) cumulative deposited sulfate [kg SO_4 km^{-2}] and revised BTD factors [$\times 10^9$ km^2] calculated from mean polar deposited sulfate and hemispheric peak atmospheric sulfate burden as opposed to ice sheet deposited sulfate (ensemble mean).

Model	**Arctic deposition [kg SO_4 km^{-2}]**	**NH_BTD [$\times 10^9$ km^2]**	**Antarctic deposition [kg SO_4 km^{-2}]**	**SH_BTD [$\times 10^9$ km^2]**
CESM1(WACCM)	125	0.27	100	0.58
MAECHAM5-HAM	175	0.21	287	0.17
SOCOL-AER	131	0.25	168	0.33
UM-UKCA	77	0.38	53	1.07

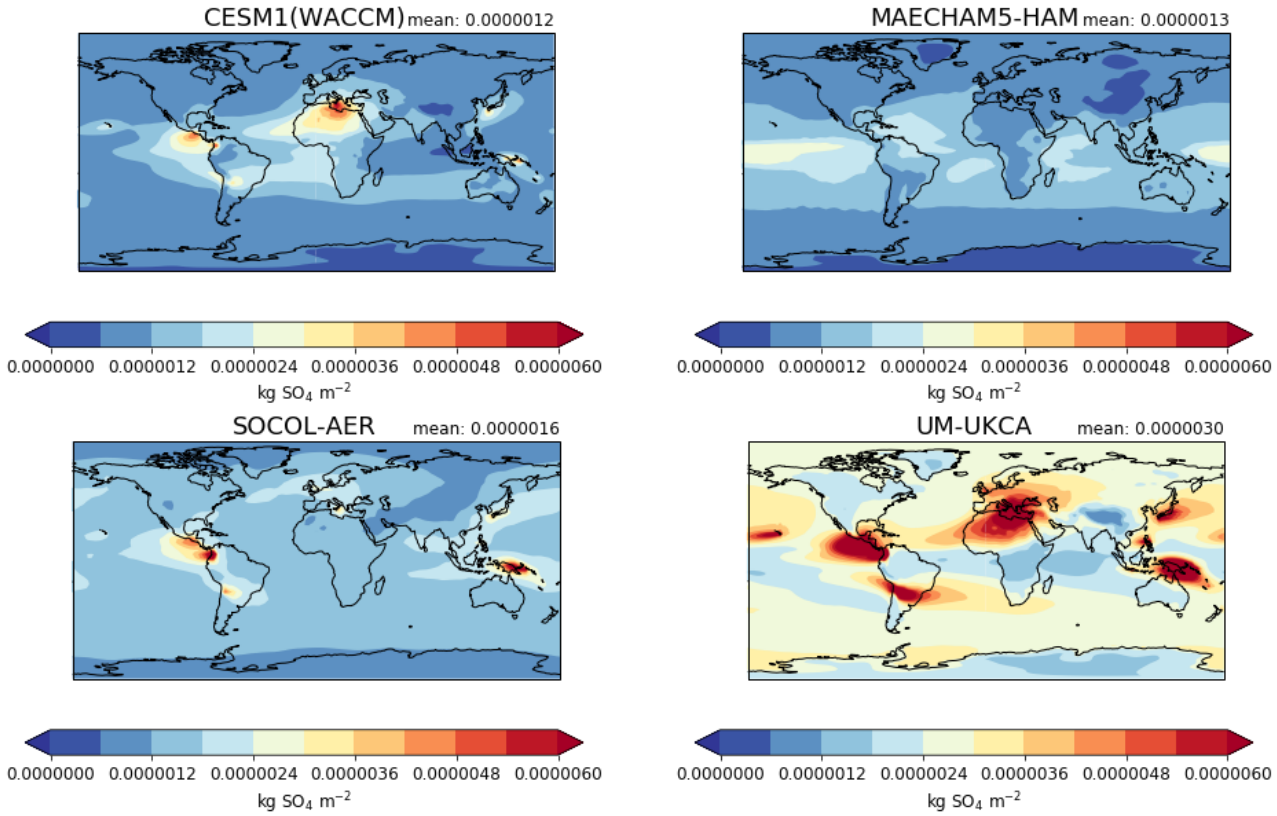

Figure S1: Preindustrial background (no Tambora) global atmospheric sulfate burdens in the control simulations [kg SO_4 m^{-2}]. The value shown in the top right-hand corner of each plot refers to the global mean sulfate burden. Background values are averages of the monthly mean model output from 5 control simulations each with 48 months of data for UM-UKCA, 3 controls each with 60 months of data for CESM1(WACCM), and 1 control with 60 months of data for MAECHAM5-HAM and SOCOL-AER.

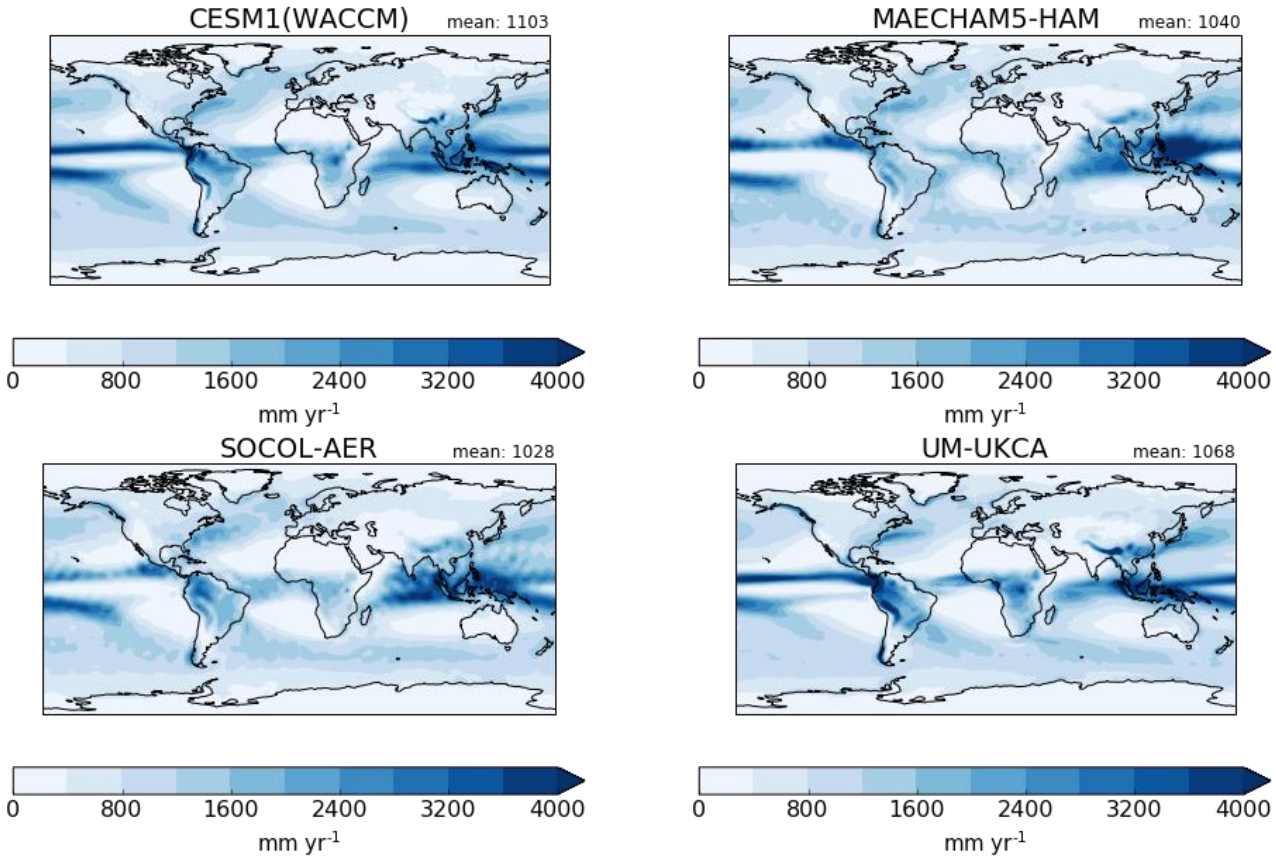

Figure S2: Preindustrial background global precipitation in the control simulations [mm yr^{-1}]. SOCOL-AER is included here for reference but deposition in SOCOL-AER is not connected to the precipitation. The value shown in the top right-hand corner of each plot refers to the global mean precipitation. Background values are averages of the monthly mean model output from 5 control simulations each with 48 months of data for UM-UKCA, 3 controls each with 60 months of data for CESM1(WACCM), and 1 control with 60 months of data for MAECHAM5-HAM and SOCOL-AER.

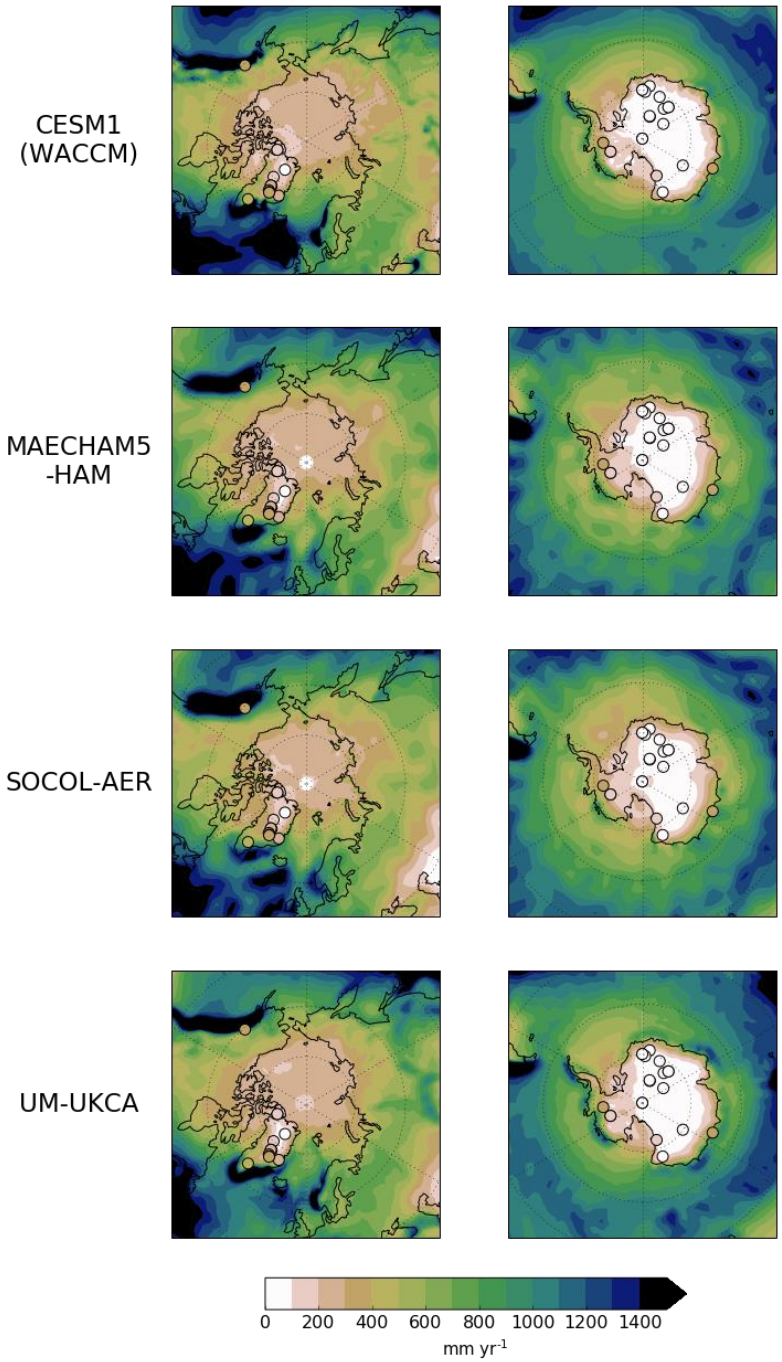

Figure S3: Preindustrial background polar precipitation in the control simulations [mm yr^{-1}] (shading) and ice core accumulation [mm liquid water equivalent yr^{-1}] in ice cores (filled circles) (Sigl et al., 2014). Antarctic ice core accumulation rates are an average of annual ice core accumulation from 1850–1860 taken from Sigl et al. (2014). Greenland ice core accumulation rates are taken from Gao et al. (2006) (their Table 1). SOCOL-AER is included here for reference but deposition in SOCOL-AER is not connected to the precipitation. Background values are averages of the monthly mean model output from 5 control simulations each with 48 months of data for UM-UKCA, 3 controls each with 60 months of data for CESM1(WACCM), and 1 control with 60 months of data for MAECHAM5-HAM and SOCOL-AER.

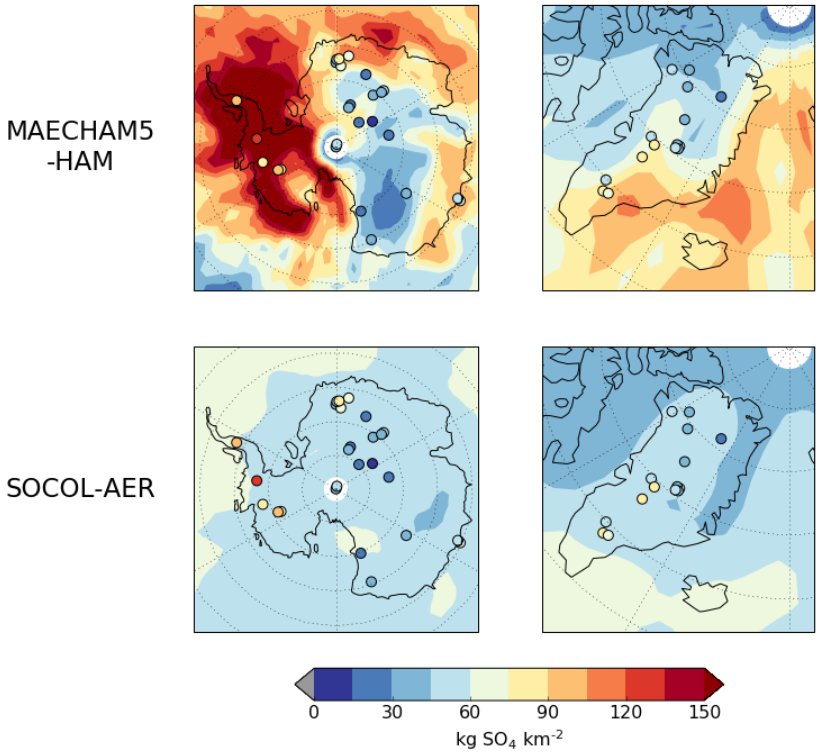

Figure S4: Cumulative deposited sulfate [kg SO_4 km^{-2}] for MAECHAM5-HAM and SOCOL-AER (ensemble mean). Model results have been reduced by a factor of 3 (for MAECHAM5-HAM the slope of the regression line between simulated deposited sulfate and ice core records in Antarctica was 3.7 and 1.7 in Greenland. SOCOL-AER is reduced by the same factor for comparison). MAECHAM5-HAM is able to simulate the spatial pattern of ice sheet deposited sulfate when compared to ice cores (circles), but the magnitude is too large.

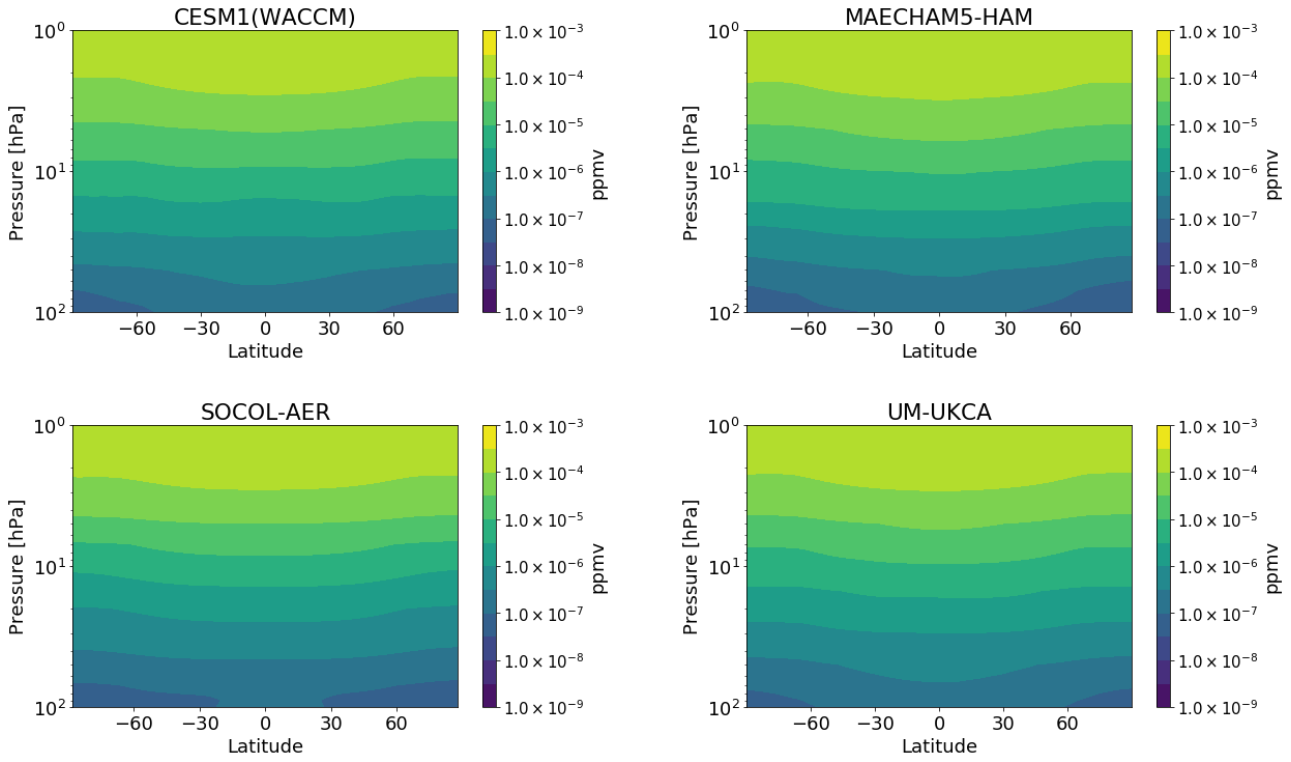

Figure S5: Preindustrial background zonal mean OH in the control simulations [ppmv]. Background values are averages of the monthly mean model output from 5 control simulations each with 48 months of data for UM-UKCA, 3 controls each with 60 months of data for CESM1(WACCM), and 1 control with 60 months of data for SOCOL-AER. In MAECHAM5-HAM the OH is prescribed and plotted here is the 12-month average.

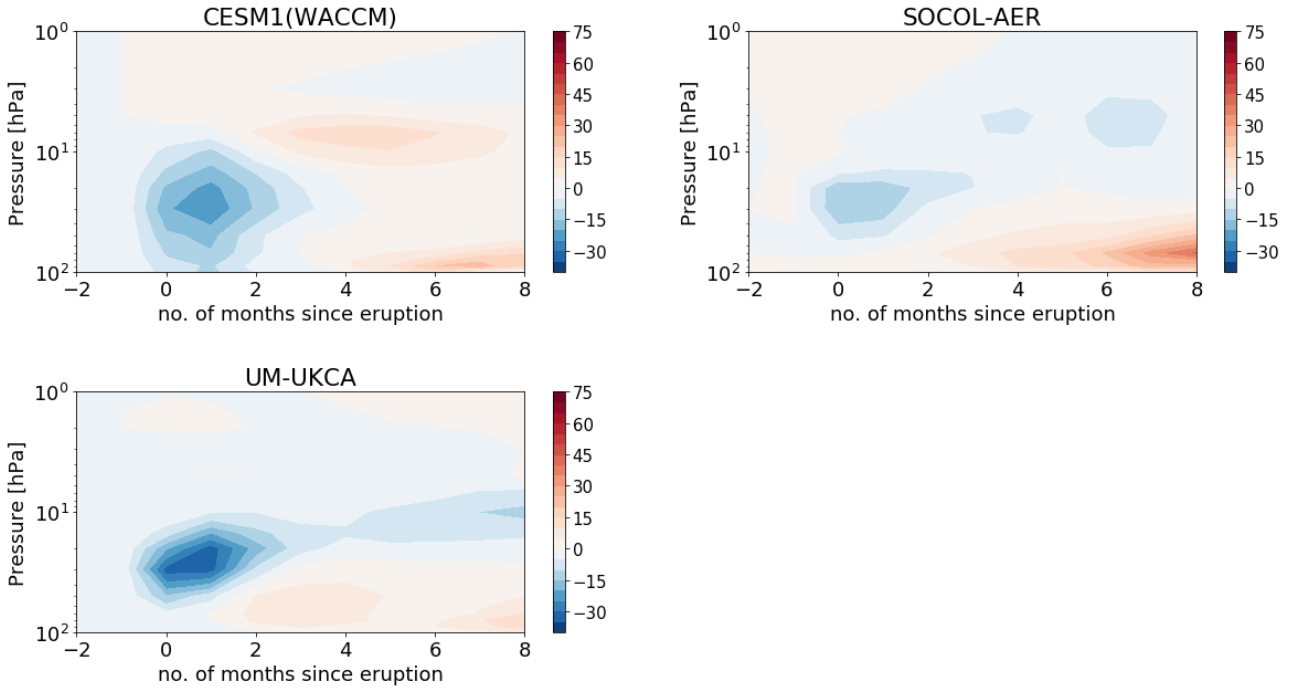

Figure S6: Percentage change in tropical (15°S–15°N) OH in the first 8 months after the eruption (ensemble mean) for each model that includes interactive OH chemistry.

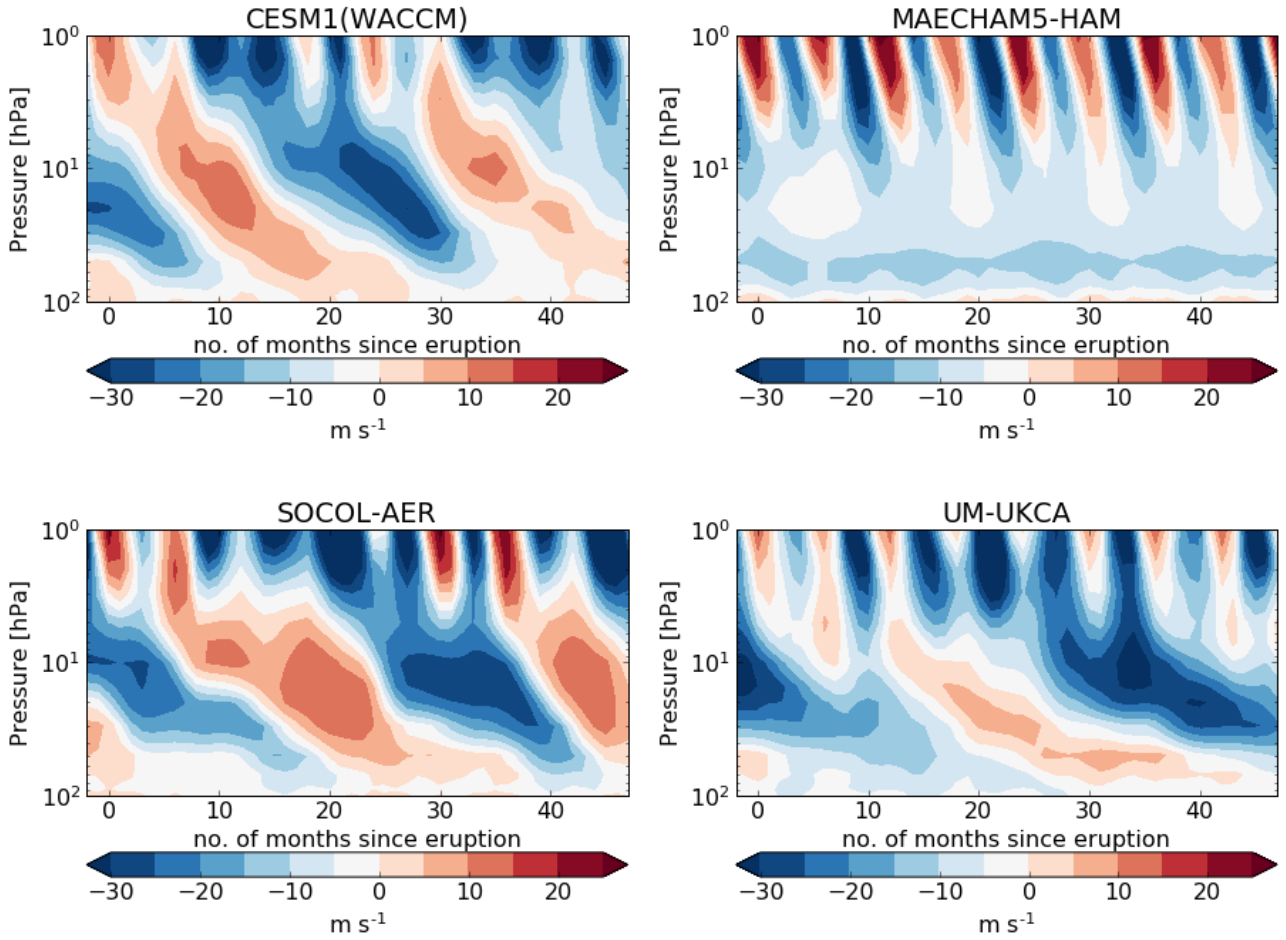

Figure S7: Tropical mean (15°S–15°N) zonal wind for the volcanic simulations in each model (ensemble mean). Tropical winds in UM-UKCA, SOCOL-AER and CESM1(WACCM) oscillate, exhibiting characteristics of the QBO, with downward propagating easterly and westerly winds, but length of phase differs. QBO easterly phase is longer in UM-UKCA; ~2.5 years compared to ~1.5 years in CESM1(WACCM) and SOCOL-AER. MAECHAM5-HAM does not include representation of the QBO and winds remain easterly in the lower stratosphere throughout the simulations.

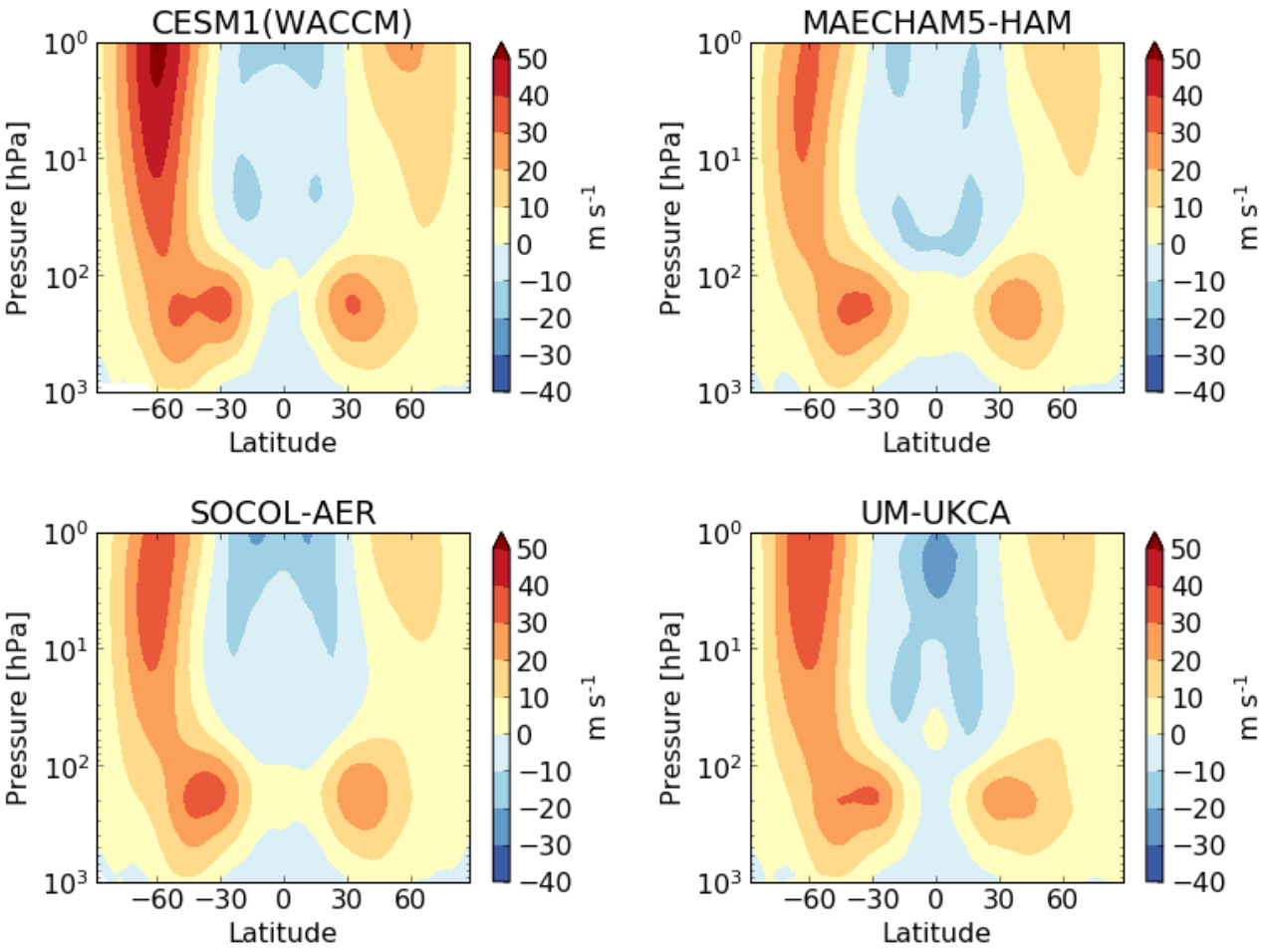

Figure S8: Preindustrial background zonal mean zonal wind in the control simulations [m s^{-1}]. Background values are averages of the monthly mean model output from 5 control simulations each with 48 months of data for UM-UKCA, 3 controls each with 60 months of data for CESM1(WACCM), and 1 control with 60 months of data for MAECHAM5-HAM and SOCOL-AER. Zonal wind is output on 36 pressure levels in UM-UKCA, 33 pressure levels in MAECHAM5-HAM and 32 pressure levels in SOCOL-AER. Zonal wind in CESM1(WACCM) is output on an atmosphere hybrid sigma-pressure coordinate and has been interpolated to the pressure levels used in UM-UKCA.

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