Supplementary material

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**	**Ref.**	**Ice core**	**LAT**	**LON**	**Ref.**
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	19.90	*Sigl et al. (2014)*	GITS	77.14	-61.095	*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	-44.00	*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)*				
W10k	-66.75	112.83	*Sigl et al. (2014)*				
DIV2010	-77.95	-95.96	*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	-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 pre-industrial 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	-66.3	112.83	ACT11d	66.47	-46.3
DIV	-76.77	-101.73	D4	71.4	-43.9
WD	-79.47	-112.68	Zoe	72.6	-38.3
NUS Site8_7	-74.88	1.6	NEEMS3	77.43	-51.05
NUS Site8_5	-82.63	17.87	Tunu	78.00	-33.98
NUS Site7_7	-82.07	54.88	McCall	69.3	-143.8
NUS Site7_5	-78.65	35.63	Akademmi Nauk	80.52	94.82
NUS Site7_2	-76.07	22.47	Flade Isblink	81.58	-15.7
NUS Site7_1	-73.72	7.98			

Table S3: Mean polar (60°-90°) cumulative deposited sulfate [kg SO_4 km^{-2}] and revised BTD factors [* 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 [10^9 km^{-2}]	Antarctic deposition [kg SO_4 km^{-2}]	SH_BTD [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

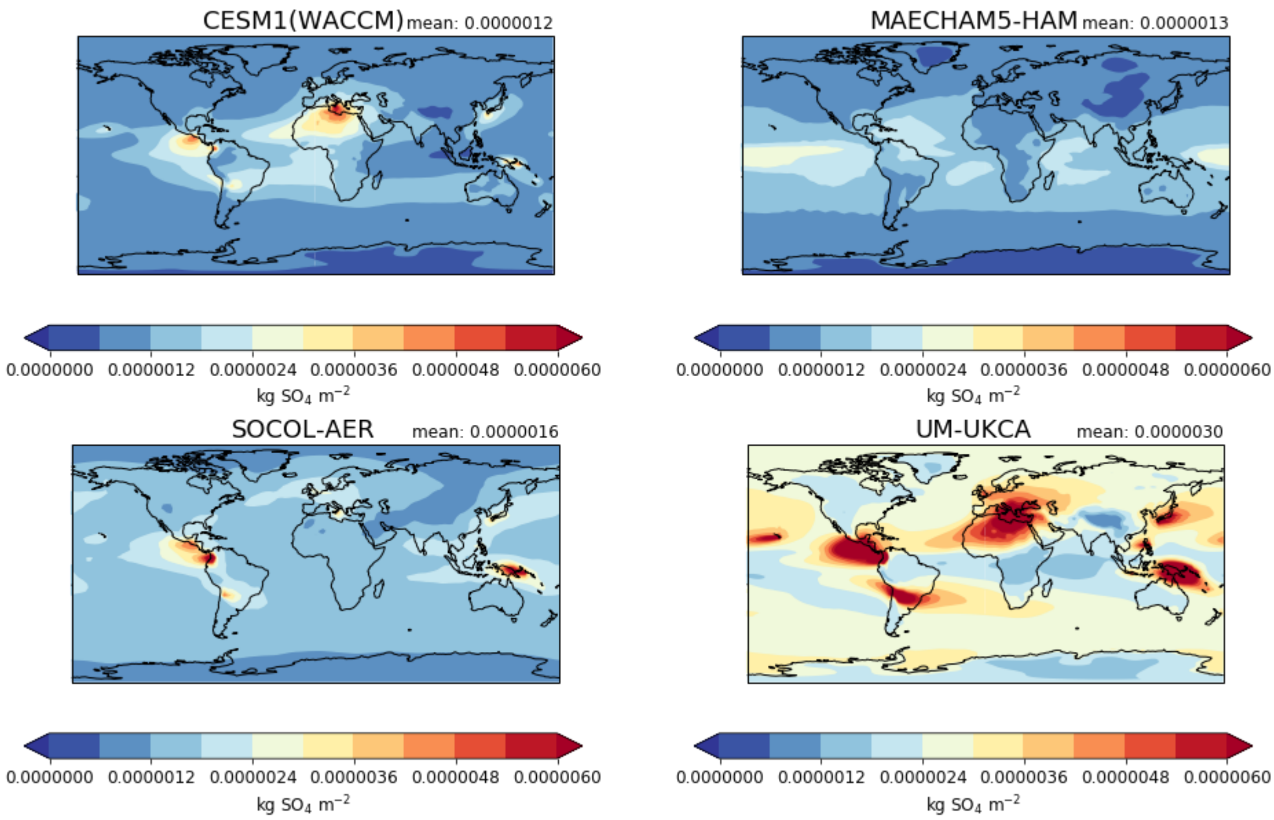

Figure S1: Pre-industrial background (no Tambora) global atmospheric sulfate burdens in the model control simulations (year average).

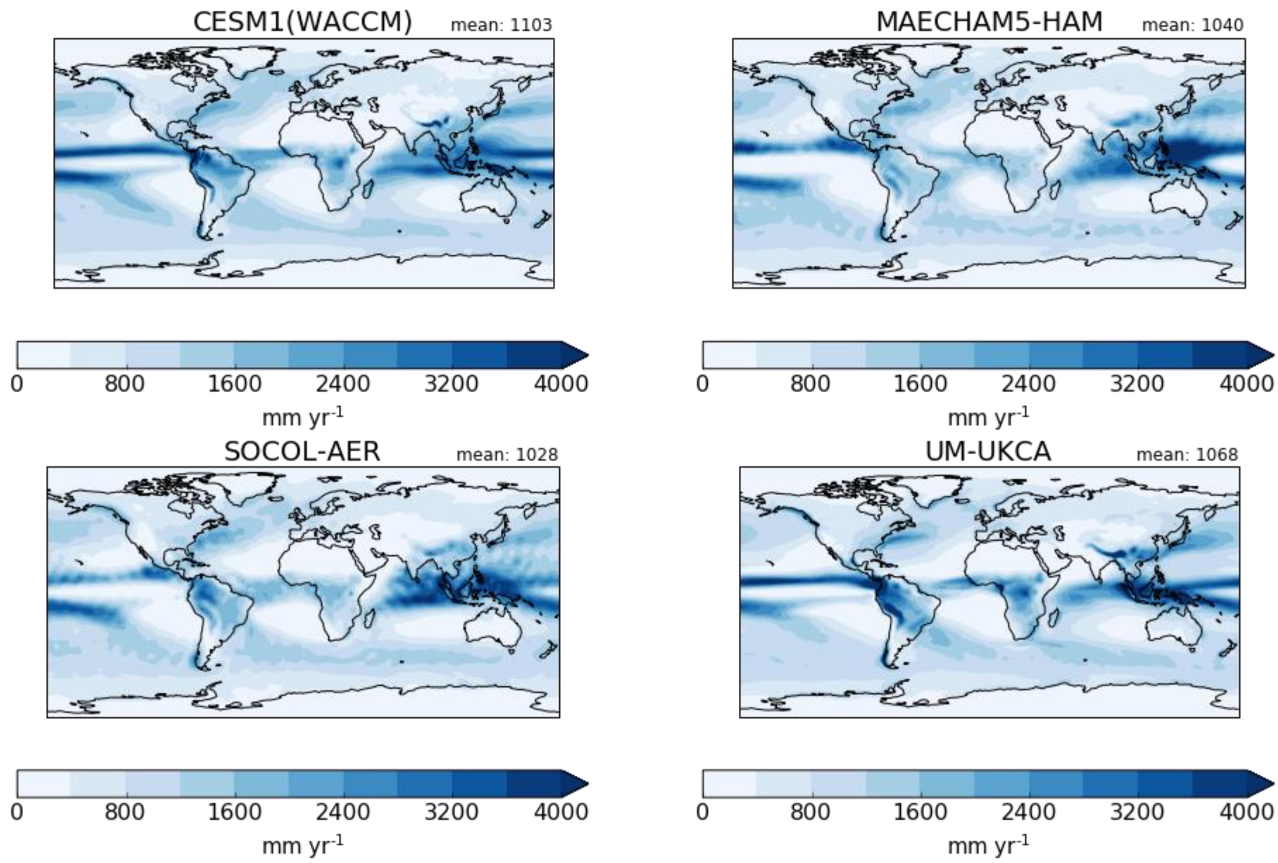

Figure S2: Pre-industrial background global precipitation in each model control simulation (year average). SOCOL-AER is included here for reference but deposition in SOCOL-AER is not connected to the precipitation.

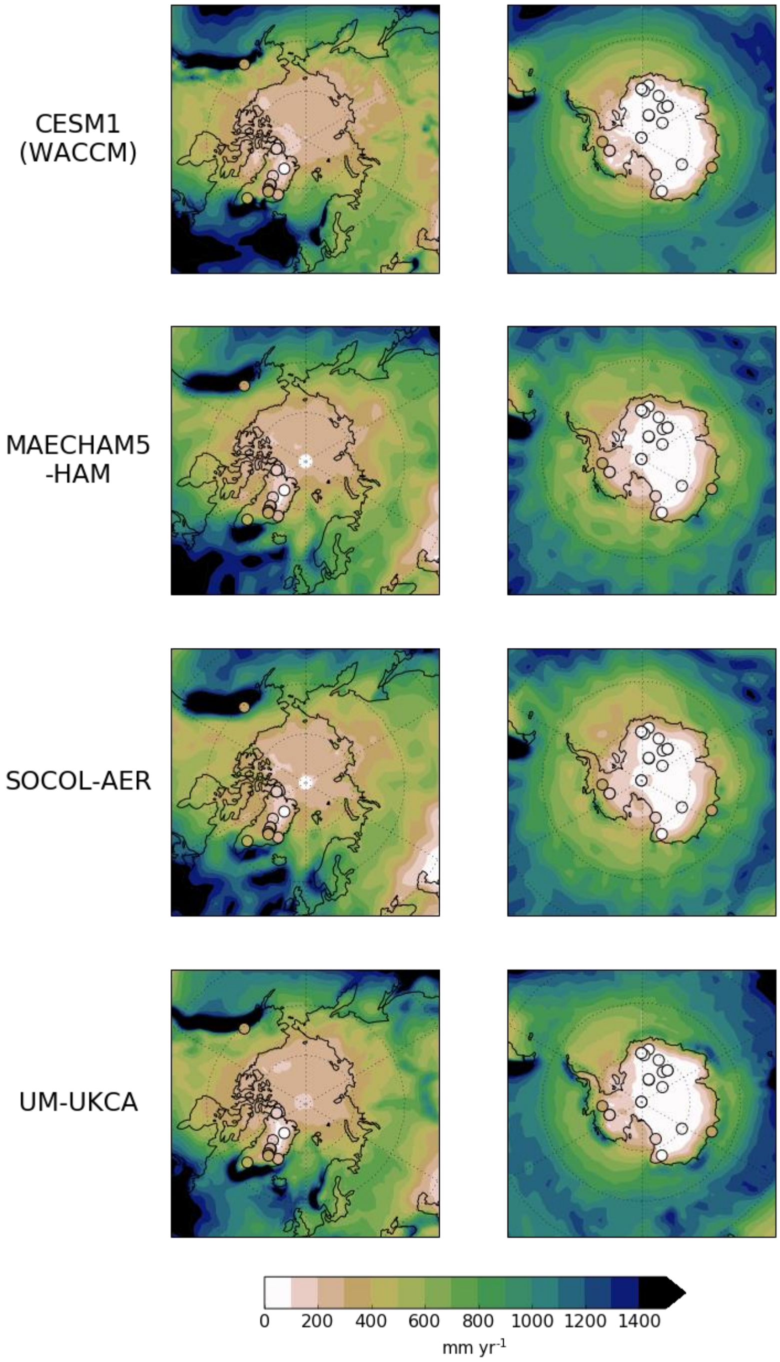

Figure S3: Pre-industrial background polar precipitation in each model control simulation (year average) (shading) and ice core accumulation (mm liquid water equivalent yr^{-1}) in ice cores (filled circles) (Sigl et al., 2014). Antarctic ice core accumulation rates are an average of annual ice core 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.

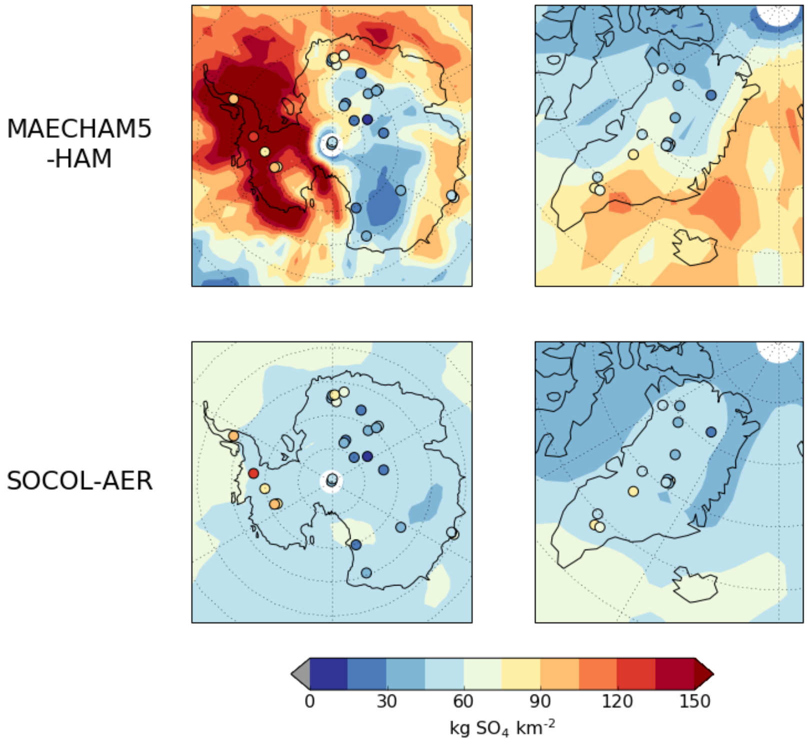

Figure S4: Cumulative deposited sulfate [kg SO_4 km^{-2}] for MAECHAM5-HAM and SOCOL-AER (ensemble mean). Results have been reduced by a factor of 3 (for MAECHAM5-HAM the slope of the regression line between simulated deposited sulfate and ice core records in Antarctica was 3.7 and 1.7 in Greenland. 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, but the magnitude is too large.

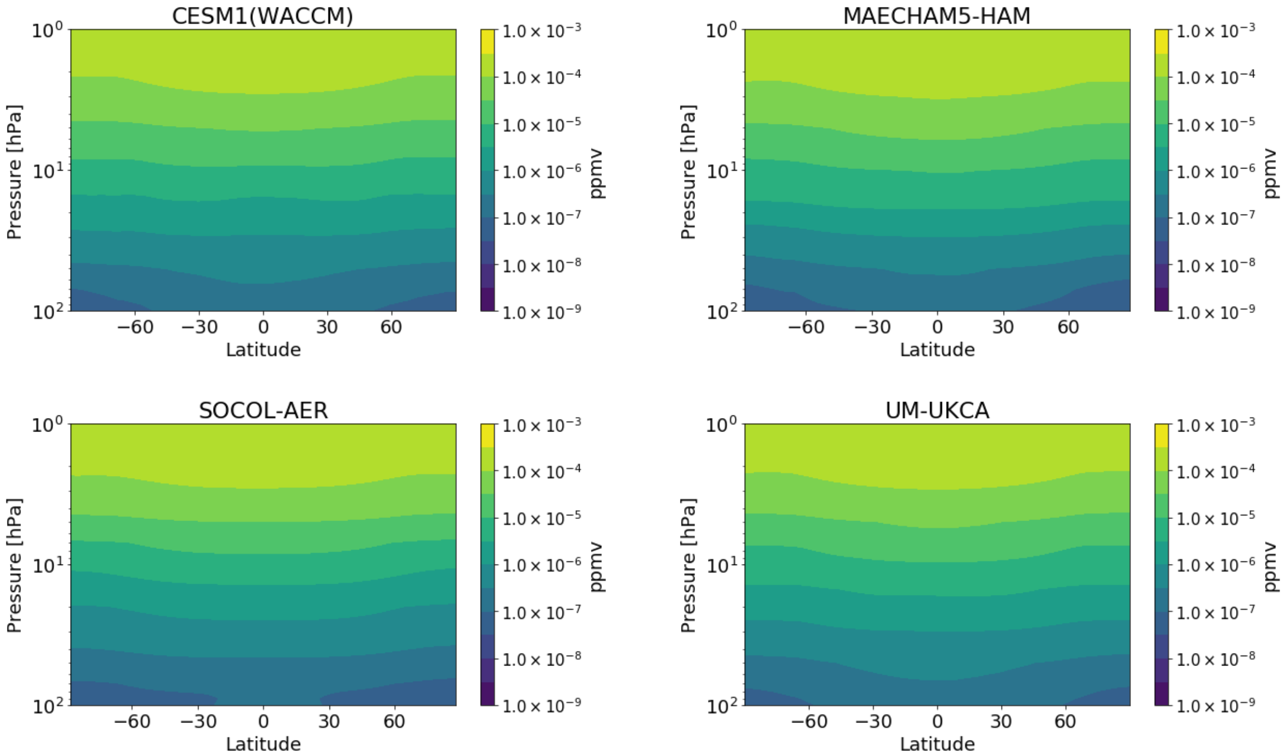

Figure S5: Annual-mean zonal-mean OH [ppmv] in each model's pre-industrial background control simulations. In MAECHAM5-HAM the OH is prescribed.

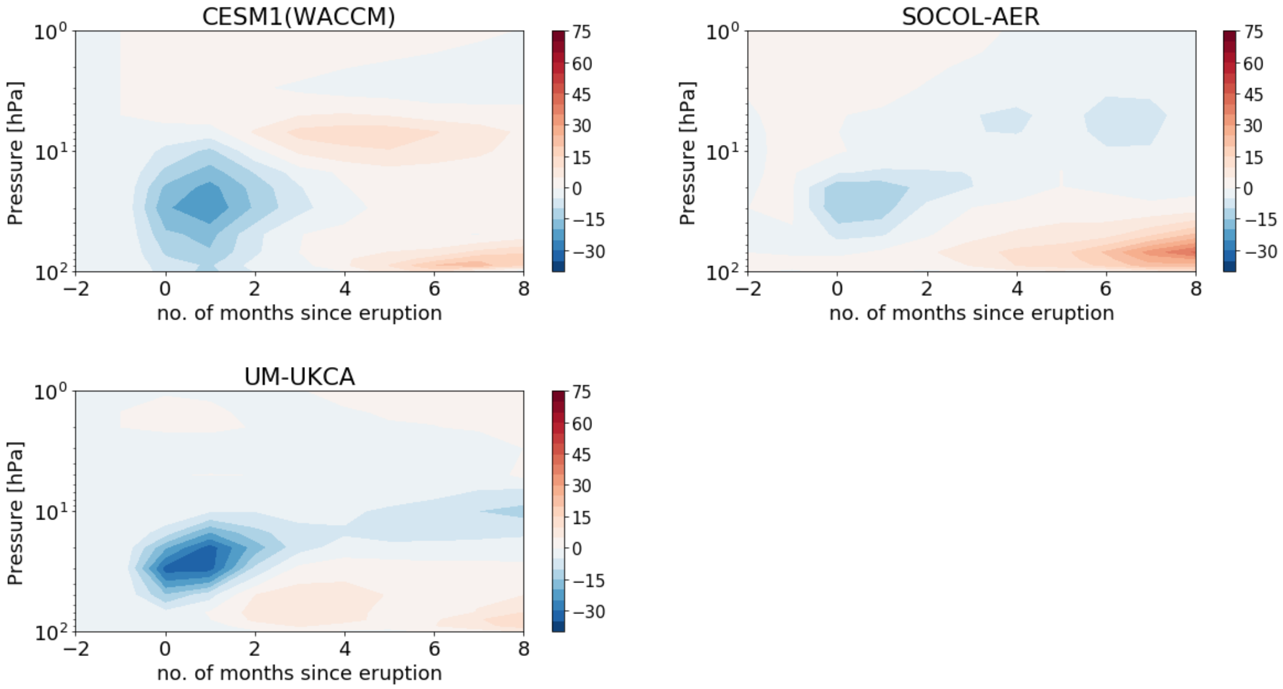

Figure S6: Percentage change in tropical (15°S - 15°N) OH in the first 8 months after the eruption (ensemble mean) for each model including interactive OH chemistry.

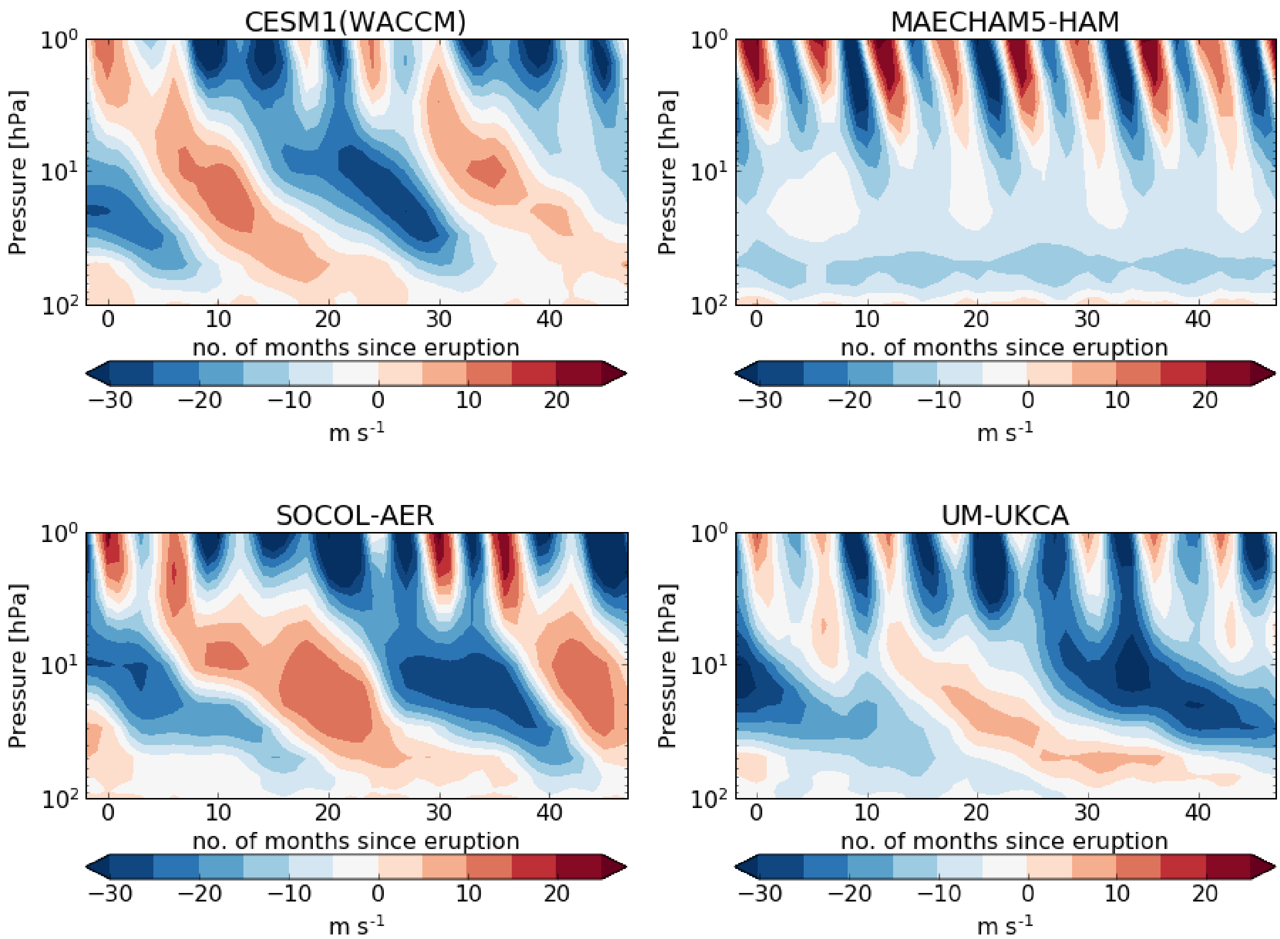

Figure S7: Tropical mean (15°S - 15°N) zonal wind for the volcanic simulations in each model (ensemble mean). Tropical winds in UM-UKCA, SOCOL-AER and CESM1(WACCM) oscillate, exhibiting characteristics of the QBO, with downward propagating easterly and westerly winds, but length of phase differs. QBO 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.

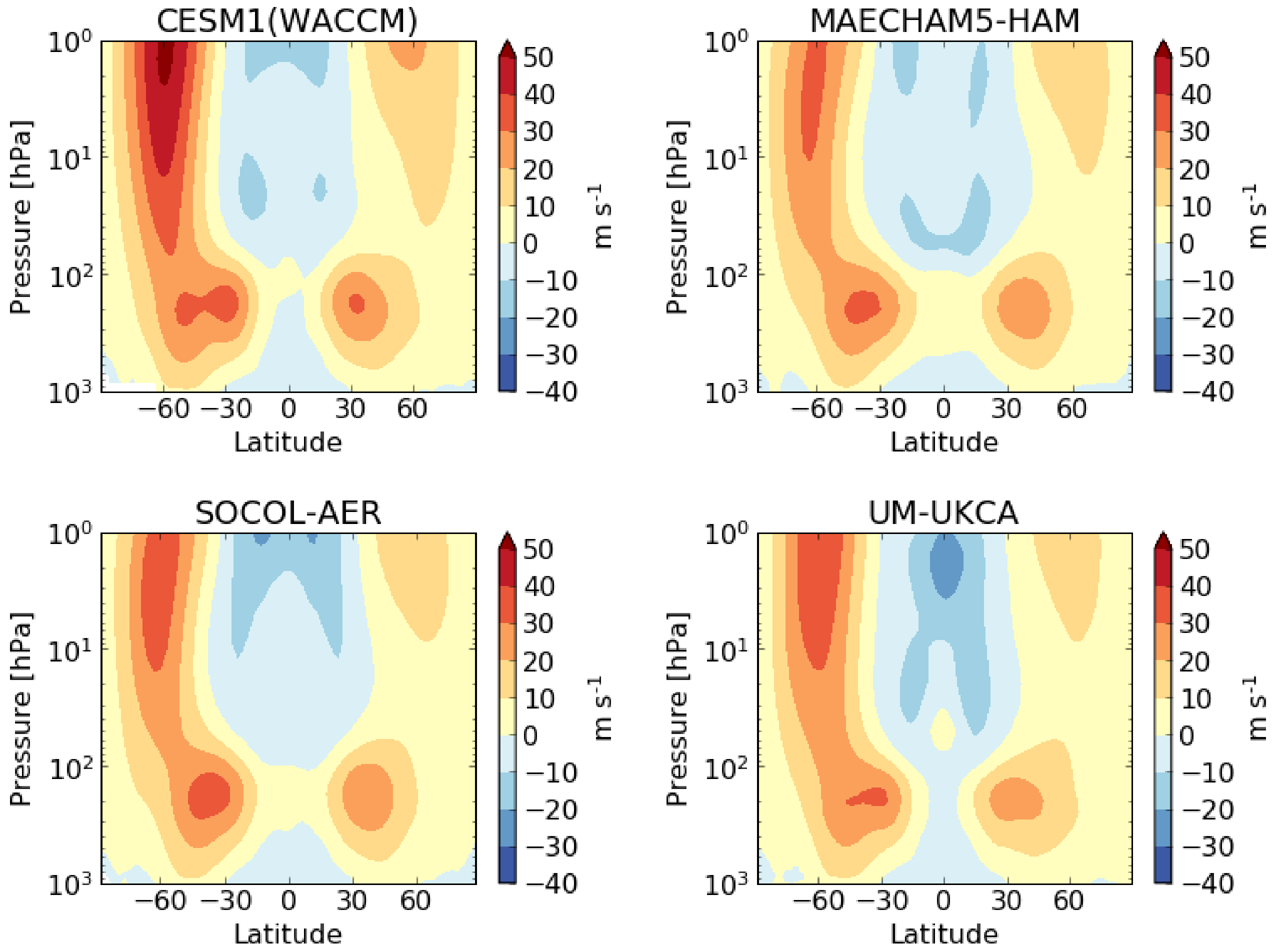

Figure S8: Zonal mean zonal wind (year average) in each model's pre-industrial background control simulations [m s^{-1}]. Zonal wind is output on 36 pressure levels in UM-UKCA, 33 pressure levels in MAECHAM5-HAM and 32 pressure levels in SOCOL-AER. Zonal wind in CESM1(WACCM) is output on an atmosphere hybrid sigma pressure coordinate and has been interpolated to the pressure levels used in UM-UKCA.

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