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Inter-model comparison of global hydroxyl radical (OH) distributions and their impact on atmospheric methane over the 2000–2016 period

Yuanhong Zhao et al.

Correspondence to: Yuanhong Zhao (yuanhong.zhao@lsce.ipsl.fr)

S1 OH fields from CCMI REF-C1 experiments.

We compare spatial and vertical distributions of OH fields from REF-C1 (main text) with that from REF-C1SD to access influences from dynamic biases. Of CCMI models included in this study, 7 models conducted REF-C1SD experiments (EMAC offers fields at two different model resolutions). Fig. S1 shows the spatial distributions of volume-weighted tropospheric mean [OH] averaged from 2000 to 2010 simulated by REF-C1SD experiments, Table S1 summarizes their inter-hemispheric ratios and mean values over four latitudinal bands. The volume-weighted mean [OH] averaged over the troposphere and over three pressure latitudinal intervals are calculated in Table S2. By comparing Fig. S1, table S1, and table S2 with Fig. 2, table 3, and table 4, respectively, we find that OH fields from REF-C1 and REF-C1SD experiments show similar spatial and vertical distributions. Only CESM and MOCAGE simulated recognizable different N/S ratios (small differences within 0.1-0.2) by REF-C1 and REF-C1SD experiments, and the differences in mean OH over four latitudinal bands and latitudinal intervals are within 10%.

Table S1. Inter-hemispheric ratios (N/S) of hemispheric mean OH and volume-weighted tropospheric mean [OH] for four latitude bands (in 10^5 molec.cm^{-3}) averaged over the years 2000 to 2010 from CCMI REF-C1SD experiment.

OH fields	**N/S ratio**	**90 °S-30 °S** (10^5 molec.cm^{-3})	**30 °S-0 °** (10^5 molec.cm^{-3})	**0 °-30 °N** (10^5 molec.cm^{-3})	**30 °N-90 °N** (10^5 molec.cm^{-3})
CESM1-CAM4Chem	1.3	6.3	13.3	15.9	8.7
CESM1-WACCM	1.2	6.6	13.3	15.9	9
CMAM	1.2	5.8	12.8	13.7	8.1
EMAC-L47MA	1.2	6.4	14.1	15.6	8.5
EMAC-L90MA	1.2	6.2	13.5	15.1	8.4
MOCAGE	1.3	6.1	12.1	14.5	8.9
MRI-ESM1r1	1.2	4.7	14.2	15.7	6.9
UMUKCA-UCAM	1.3	5.6	13.9	15.2	10.1

Table S2. Global mean [OH] averaged over the troposphere and three vertical pressure levels (in 10^5 molec cm^{-3}) over the years 2000 to 2010 from CCMI REF-C1SD experiment.

	Tp[1]	**750**	**500**	**250**
CESM1-CAM4Chem	11.1	12.1	13.1	11.5
CESM1-WACCM	11.2	12.3	13.4	11.8
CMAM	10.1	14.3	10.9	10.8
EMAC-L47MA	11.2	12.4	12.4	11.1
EMAC-L90MA	10.9	12.3	12.1	10.2
MOCAGE	10.4	19.2	15	7.3
MRI-ESM1r1	10.5	12.4	10.8	9.7
UMUKCA-UCAM	11.2	16.0	12.4	10.6

[1] Tp refers to the volume-weighted tropospheric mean [OH], 750 refers to the volume-weighted average from the surface to 750hPa, 500 refers to the volume-weighted average from 750hPa to 500 hPa, and 250 refers to the volume-weighted average from 500 to 250hPa.

Table S3. Lightning NOx emission (Tg N yr^{-1}) over pressure altitude levers of CCMI models over 2000-2010.

	Surfce-800hPa	800-600hPa	600-400hPa	400-300hPa	300-200hPa	200-100hPa	100-1hPa	tp
CMAM	0.6	0.3	0.4	0.8	1.1	1.1	0	4.2
EMAC-L90MA	0.1	0.3	0.6	0.5	1	1.2	0.1	3.7
CESM1-WACCM	0.2	0.3	1.1	1.3	1.2	0.2	0	4.2
GEOSCCM	0.1	0.7	2	1.4	1.1	0.3	0	5.6
MOCAGE	0.2	0.4	1.9	0.9	0.9	0.6	0	4.8
MRI-ESM1r1	1.3	0.5	0.9	1.4	2.9	3.5	0.1	10.2
SOCOL3	0.1	0.4	1.1	0.9	1.2	0.8	0	4.4

Table S4. Global volume-weighted mean $O(^1D)$ photolysis rate and Specific humidity averaged over the whole troposphere and three pressure altitude levels for CCMI models over 2000 to 2010.[1] Multi-model means and standard deviations (Mean ± stand. dev.) are also shown.

	$O(^1D)$ **photolysis rate 10^{-5} s^{-1}**				**Specific humidity (g/kg)**			
	750	500	250	Tp[2]	750	500	250	Tp
CESM1-CAM4Chem	0.9	1.3	1.5	1.3	7.3	2.6	0.6	2.9
CESM1-WACCM	1.0	1.3	1.6	1.3	7.2	2.6	0.6	2.9
CMAM	0.9	1.2	1.3	1.1	6.3	2.1	0.5	2.5
EMAC-L47MA	0.7	1	1.3	1.1	7.3	2.5	0.5	2.9
EMAC-L90MA	0.7	1	1.3	1.1	7.2	2.6	0.5	2.9
GEOSCCM	0.6	0.8	0.9	0.8	7.1	2.8	0.7	3
MOCAGE	/	/	/	/	6.8	2.3	0.5	2.7
MRI-ESM1r1	0.7	0.9	1.1	0.9	7.4	2.6	0.5	3
SOCOL3	0.7	0.8	0.9	0.8	7.2	2.8	0.6	3
Mean ± stand. dev.	0.8±0.1	1.0±0.2	1.2±0.3	1.1±0.2	7.1±0.3	2.5±0.2	0.6±0.1	2.9±0.2

[1] HadGEM3-ES and UMUKCA-UCAM are not analyzed since model output has been regridded to too coarse vertical pressure levels.
[2] Tp refers to the total tropospheric average, 750 refers to the average from the surface to 750hPa, 500 refers to the average from 750hPa to 500hPa, and 250 refers to the average from 500hPa to 250hPa.

Table S5. Tropospheric mean stratosphere ozone and $O(^1D)$ photolysis rate for four latitudinal bands averaged from 2000 to 2010. Multi-model means and standard deviations (Mean ± stand. dev.) are also shown.

	Stratosphere ozone				$O(^1D)$ photolysis rates (10^{-5} s^{-1})			
	90°S-30°S	30°S-0°	0°-30°N	30°N-90°N	90°S-30°S	30°S-0°	0°-30°N	30°N-90°N
CESM1-CAM4Chem	272	222	225	300	0.8	1.8	1.8	0.7
CESM1-WACCM	261	219	223	286	0.8	1.9	1.8	0.7
CMAM	269	228	230	293	0.8	1.6	1.6	0.6
EMAC-L47MA	298	232	232	299	0.6	1.5	1.5	0.6
EMAC-L90MA	291	233	233	293	0.7	1.5	1.5	0.6
GEOSCCM	249	216	219	286	0.6	1.2	1.1	0.4
HadGEM3-ES	282	245	248	297	/	/	/	/
MOCAGE	212	224	245	280	/	/	/	/
MRI-ESM1r1	280	238	238	301	0.6	1.3	1.3	0.5
SOCOL3	277	238	238	297	0.6	1.1	1.1	0.5
UMUKCA-UCAM	241	236	236	256	/	/	/	/
Mean ± stand. dev.	267±25	230±9	233±9	289±13	0.7±0.1	1.5±0.3	1.5±0.3	0.6±0.1

Table S6. CH_4 loss by OH oxidation (unit: Tg yr^{-1}) as simulated by LMDz using different OH fields and repeating year 2000 over 30 times.

Run name		**TransCom**	**INVSAT**	**INCA**	**CESM1-WACCM**	**CMAM**	**EMAC-L90MA**	**GEOSCCM**	**MOCAGE**	**MRI-ESM1r1**	**SOCOL3**
Surface-750hPa	30-90°N	42.9	58	53.1	56	56	51	50.2	70.2	54.2	79.7
	0-30°N	90.5	106.5	105.1	101.9	115	106.2	93.8	123.7	111.6	112.9
	0-30°S	77.9	85.1	83.5	74.6	89.9	79.6	75.2	91.7	85.4	77.4
	30-90°S	16.7	16.3	18.6	18.5	18.2	18.1	17.7	24.3	16.5	20.7
750-500hPa	30-90°N	25.8	25.9	25.7	28	22.9	26.8	26.4	26.1	22.6	31.1
	0-30°N	66.8	56.4	57.5	59.5	49.5	57.9	63.5	51.1	54.4	49.1
	0-30°S	61	45.6	46.3	45	38.9	44.4	49.9	34.6	42.8	35.5
	30-90°S	15.1	10.6	12.2	11.2	9.6	13	11.7	9.2	9	10.5
500-250hPa	30-90°N	9.9	11.5	11.9	13.8	11.9	12.3	12.6	8.8	11.2	12.8
	0-30°N	26.1	21.9	23.3	27.4	26.4	25.7	31	16.7	26.9	19.7
	0-30°S	24.7	17.7	19.2	20.7	21.5	20.2	23.6	11.5	20.8	14.4
	30-90°S	7	5.6	6.2	5.8	5.4	6.1	6	3	4.8	4.5

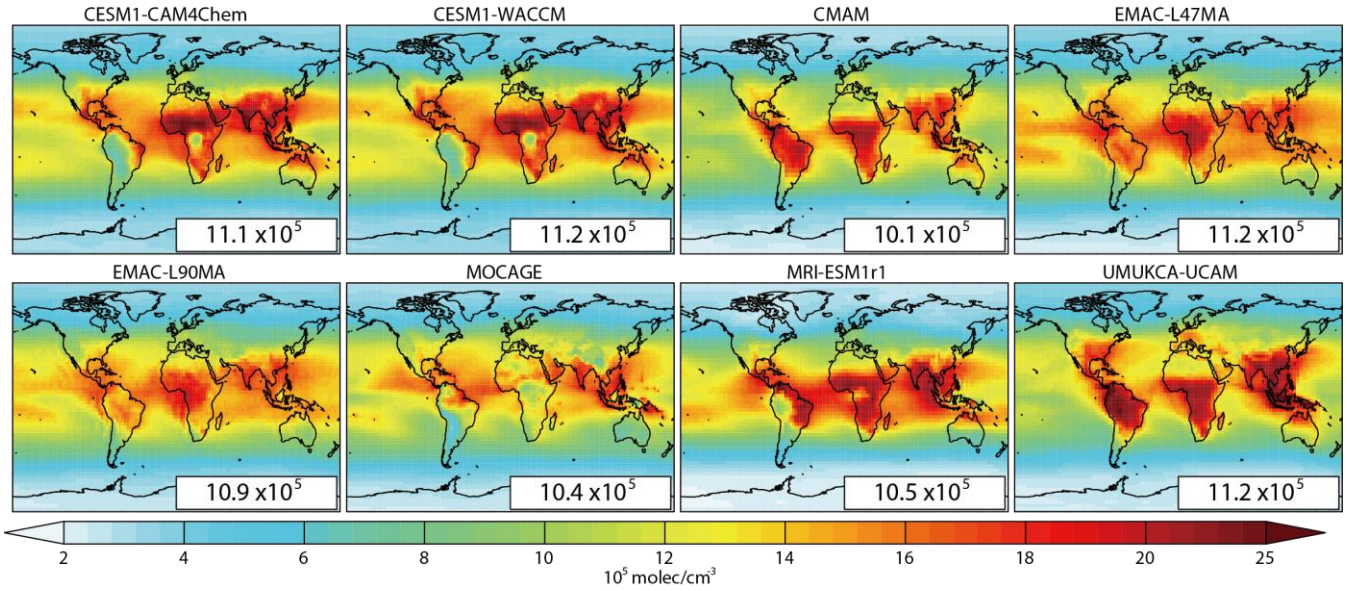

Figure S1. The spatial distributions of volume-weighted tropospheric mean OH fields CCMI REF-C1SD experiments averaged for 2000-2010 . Global mean values (105 molec cm-3) are shown as insets.

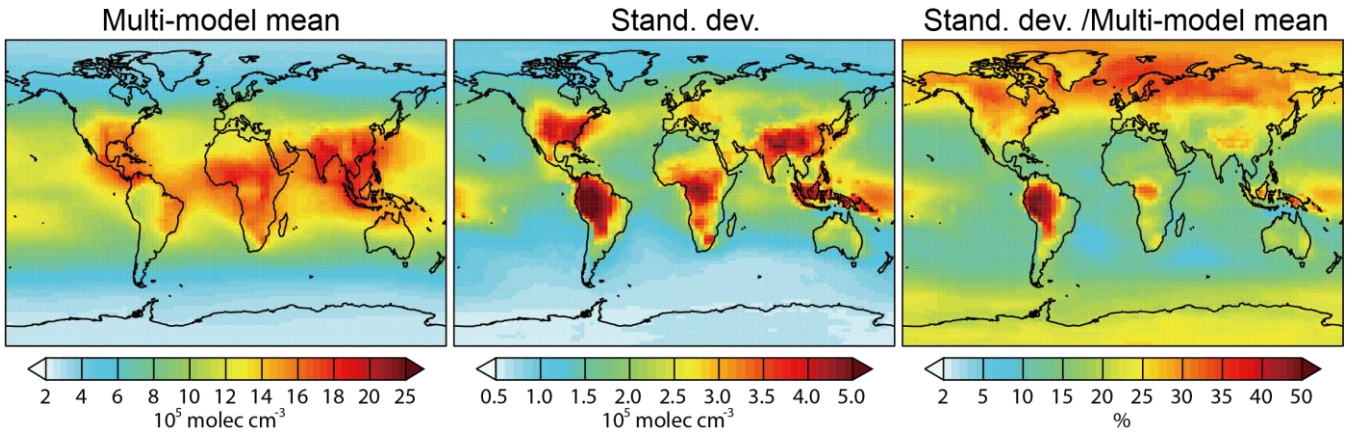

Figure S2. Multi-model mean (left), standard deviation(middle). and standard deviation relative to multi-model mean of tropospheric mean OH fields shown in figure 2.

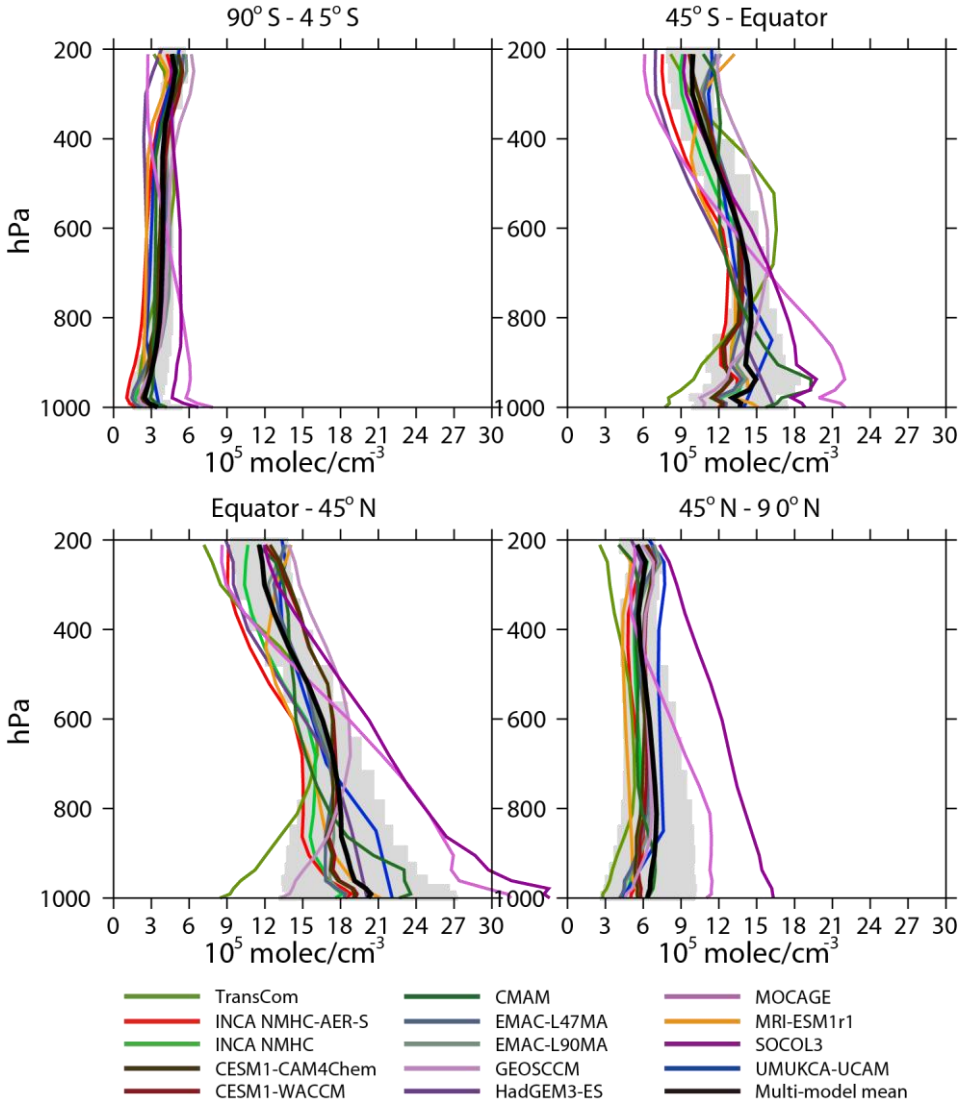

Figure S3. Vertical distribution of [OH] averaged over four latitude bands and over the years 2000 to 2010. Color lines represent [OH] from individual model simulations, black lines represent multi-model mean values and grey shades represent the standard deviations.

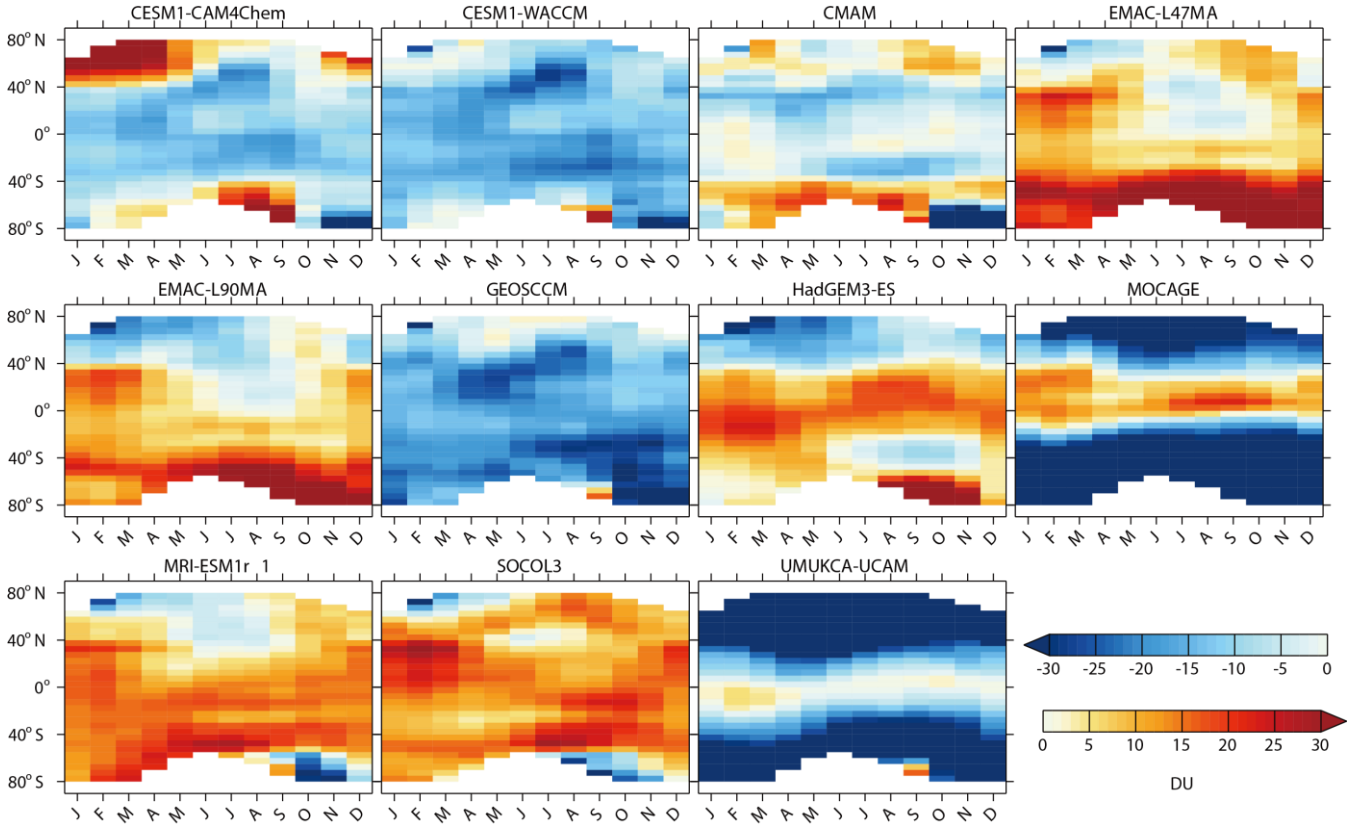

Figure S4. Monthly total column ozone bias from CCMI simulations averaged over 2000-2010 compared to satellite measurements from Total Ozone Mapping Spectrometer/solar backscatter ultraviolet (TOMS/SBUV) (model minus measurement).

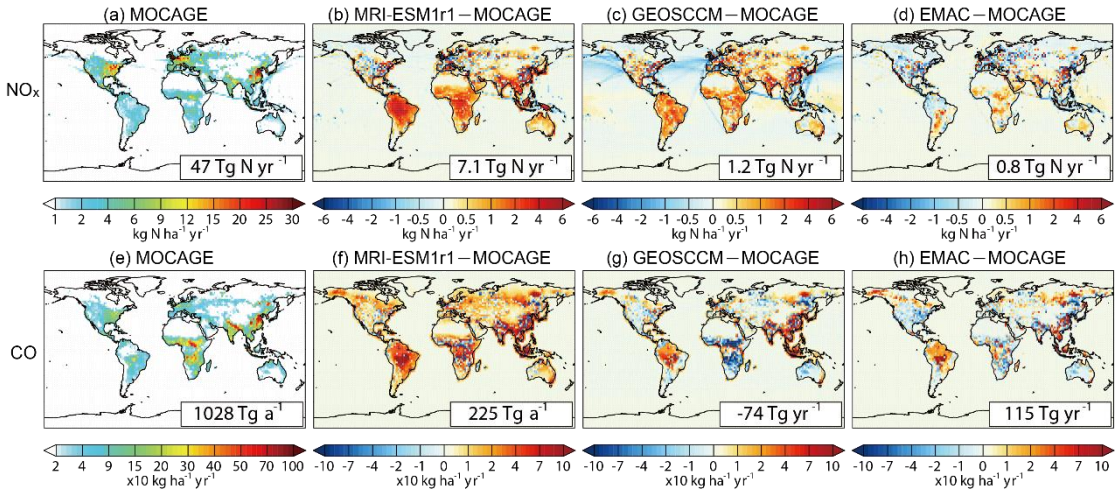

Figure S5. Spatial distributions of NO_x and CO emissions inputted to MOCAGE (a, e) REF-C1 experiments averaged from 2000 to 2009 and differences of MOCAGE with MRI-ESM1r1 (b, f), GEOSCCM(c, g) and EMAC (d, h).

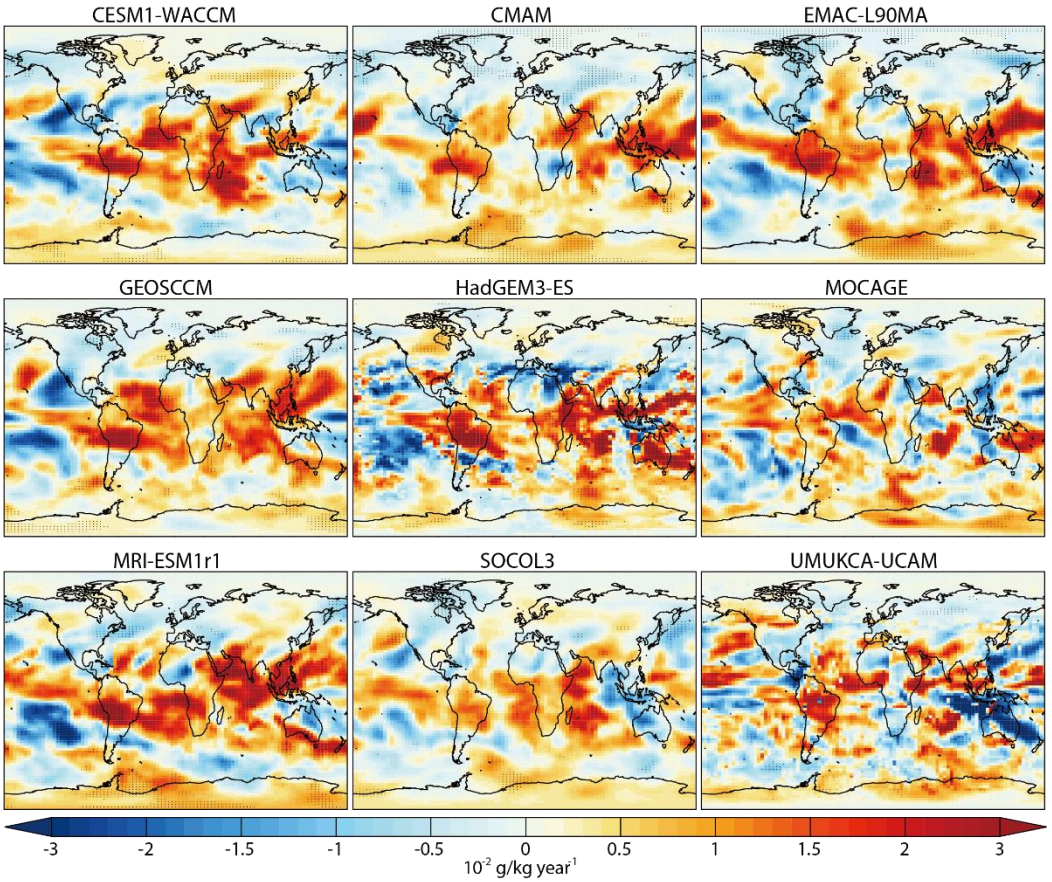

Figure S6a. Spatial distribution of tropospheric specific humidity trends from 2000 to 2010 (in 10^{-2} g/kg $year^{-1}$). Black dots denote model grid-cells with statistically significant trends (p-value < 0.05).

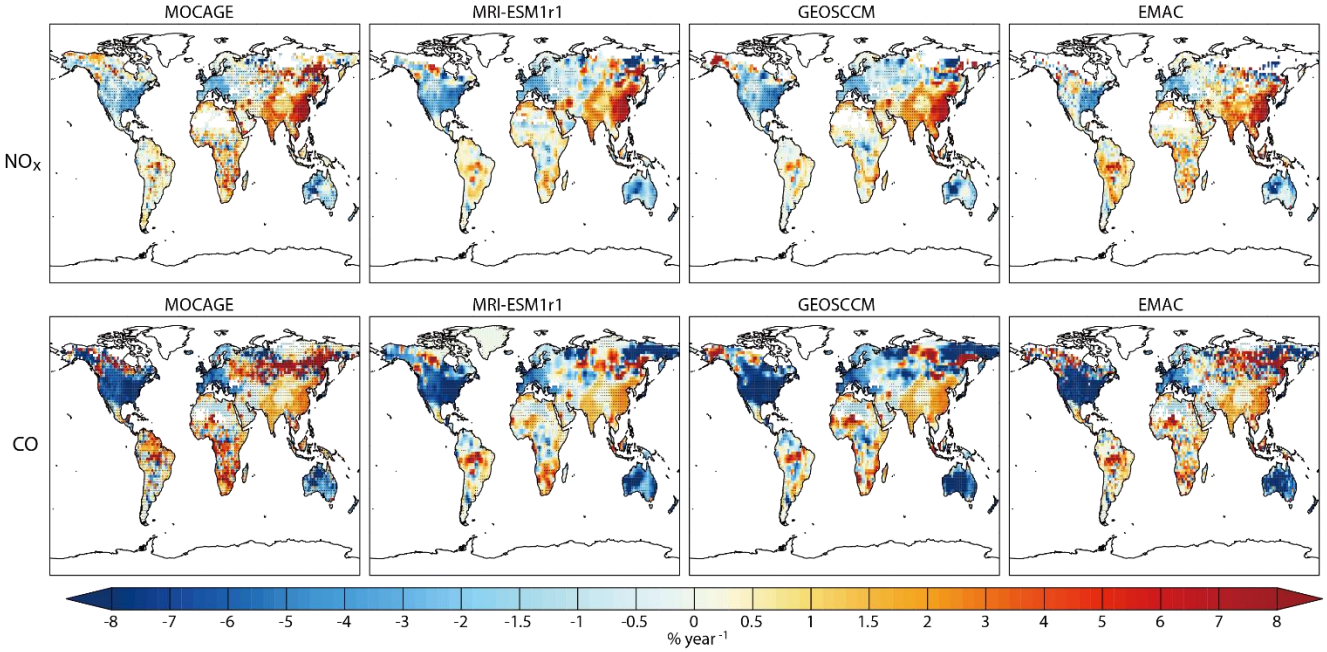

Figure S6b. Spatial distribution of NO_x (top panels) and CO (bottom panels) trend from 2000 to 2010 (in %). Black dots denote model grid-cells with statistically significant trends (p-value < 0.05).

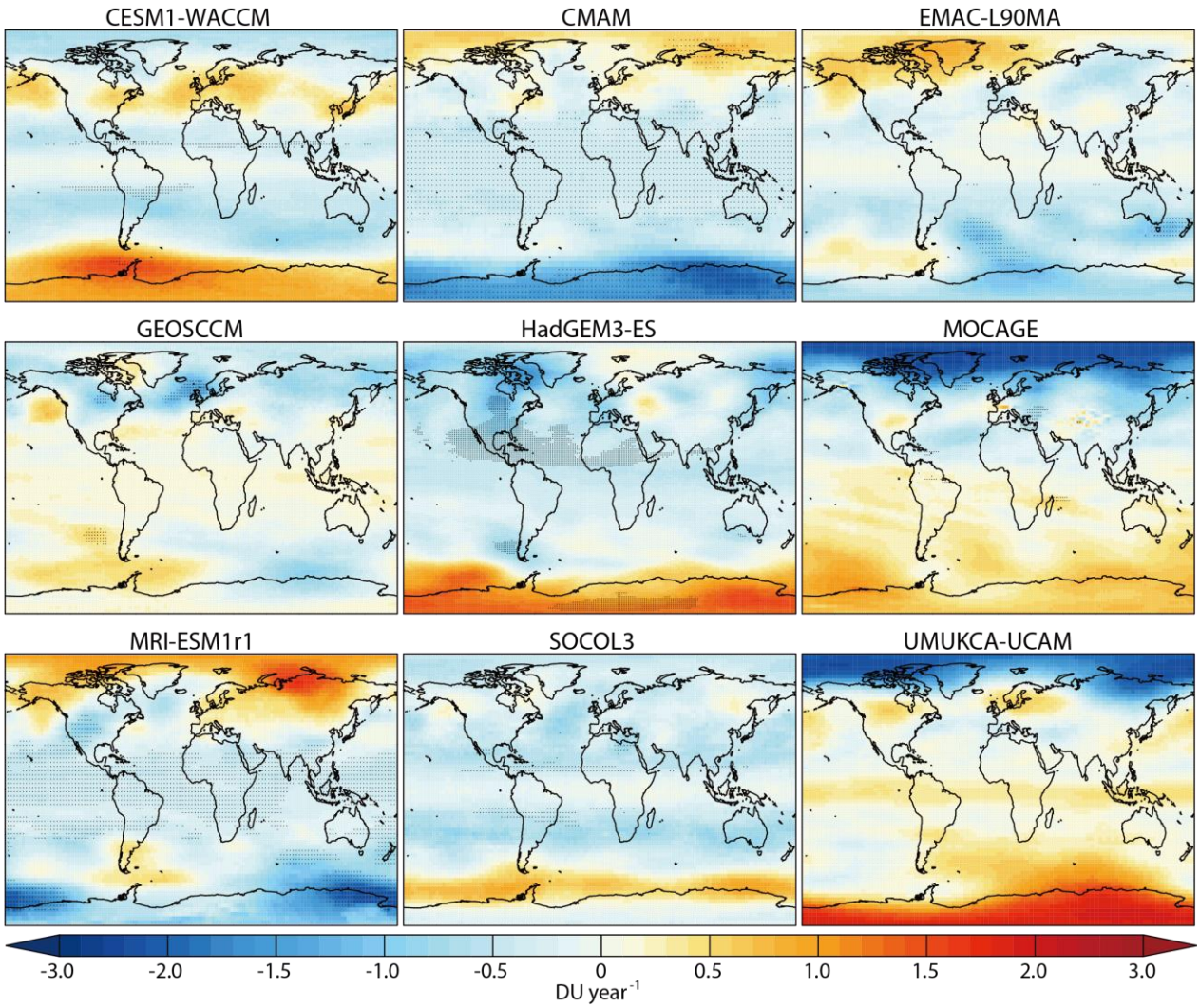

Figure S6c. Spatial distribution of stratosphere O_3 column trends from 2000 to 2010 (in DU year^{-1}). Black dots denote model grid-cells with statistically significant trends (p-value < 0.05).