

Supplement of Atmos. Chem. Phys., 19, 3589–3620, 2019
<https://doi.org/10.5194/acp-19-3589-2019-supplement>
© Author(s) 2019. This work is distributed under
the Creative Commons Attribution 4.0 License.



Supplement of

Characterising the seasonal and geographical variability in tropospheric ozone, stratospheric influence and recent changes

Ryan S. Williams et al.

Correspondence to: Ryan S. Williams (r.s.williams@pgr.reading.ac.uk)

The copyright of individual parts of the supplement might differ from the CC BY 4.0 License.

DJF	OMI	EMAC-OMI	CMAM-OMI	EMAC-OMI (AK)	CMAM-OMI (AK)	Δ EMAC-OMI	Δ CMAM-OMI
60°N-90°N	26.47	-6.92	-9.92	-3.58	-3.71	3.34	6.21
30°N-60°N	20.78	0.04	-3.24	1.41	-0.09	1.36	3.15
0°N-30°N	16.51	5.32	-0.03	4.55	-0.70	-0.86	-0.68
30°S-0°N	14.13	2.16	-0.76	1.91	-0.82	-0.25	-0.06
60°S-30°S	13.96	-0.51	-2.14	1.45	1.16	1.96	3.31
90°S-60°S	9.60	-2.86	-3.83	-0.46	0.57	2.40	4.40
MAM	OMI	EMAC-OMI	CMAM-OMI	EMAC-OMI (AK)	CMAM-OMI (AK)	Δ EMAC-OMI	Δ CMAM-OMI
60°N-90°N	28.44	-3.65	-8.22	1.07	0.14	4.72	8.36
30°N-60°N	25.03	1.71	-3.37	3.70	0.58	2.00	3.95
0°N-30°N	18.10	5.58	-0.94	4.83	-1.21	-0.75	-0.27
30°S-0°N	13.33	2.48	-0.63	2.29	-0.61	-0.19	0.02
60°S-30°S	14.11	0.55	-0.66	1.90	2.22	1.35	2.88
90°S-60°S	13.06	-2.89	-3.26	-1.18	0.34	1.71	3.59
JJA	OMI	EMAC-OMI	CMAM-OMI	EMAC-OMI (AK)	CMAM-OMI (AK)	Δ EMAC-OMI	Δ CMAM-OMI
60°N-90°N	25.88	-4.93	-7.96	-1.10	-1.22	4.08	6.73
30°N-60°N	24.09	0.29	-3.55	1.36	-1.55	1.32	2.00
0°N-30°N	15.22	3.73	-0.72	3.20	-1.85	-0.64	-1.12
30°S-0°N	16.54	2.76	-0.54	1.97	-1.35	-0.63	-0.81
60°S-30°S	17.07	-0.25	-0.50	1.21	2.78	2.71	3.28
90°S-60°S	16.48	-2.76	-2.42	-1.74	-1.23	1.68	1.19
SON	OMI	EMAC-OMI	CMAM-OMI	EMAC-OMI (AK)	CMAM-OMI (AK)	Δ EMAC-OMI	Δ CMAM-OMI
60°N-90°N	22.99	-4.04	-6.95	-2.17	-2.08	2.44	4.87
30°N-60°N	20.14	1.71	-2.34	2.02	-1.37	0.50	0.97
0°N-30°N	14.83	4.56	-0.85	4.06	-2.09	-0.64	-1.24
30°S-0°N	17.60	2.80	-1.02	2.21	-1.75	-0.60	-0.73
60°S-30°S	17.28	-0.07	-1.61	2.12	2.02	2.19	3.63
90°S-60°S	11.52	-1.93	-2.58	-1.54	-1.87	0.39	0.71

Table S1 – Seasonal mean 1000-450 hPa (0-5.5 km) subcolumn O₃ (DU) for 2005-2010 from OMI and differences with respect to both EMAC and CMAM both with and without AKs, together with the change (Δ) in bias through applying the OMI AKs on a zonal mean 30° latitude band basis.

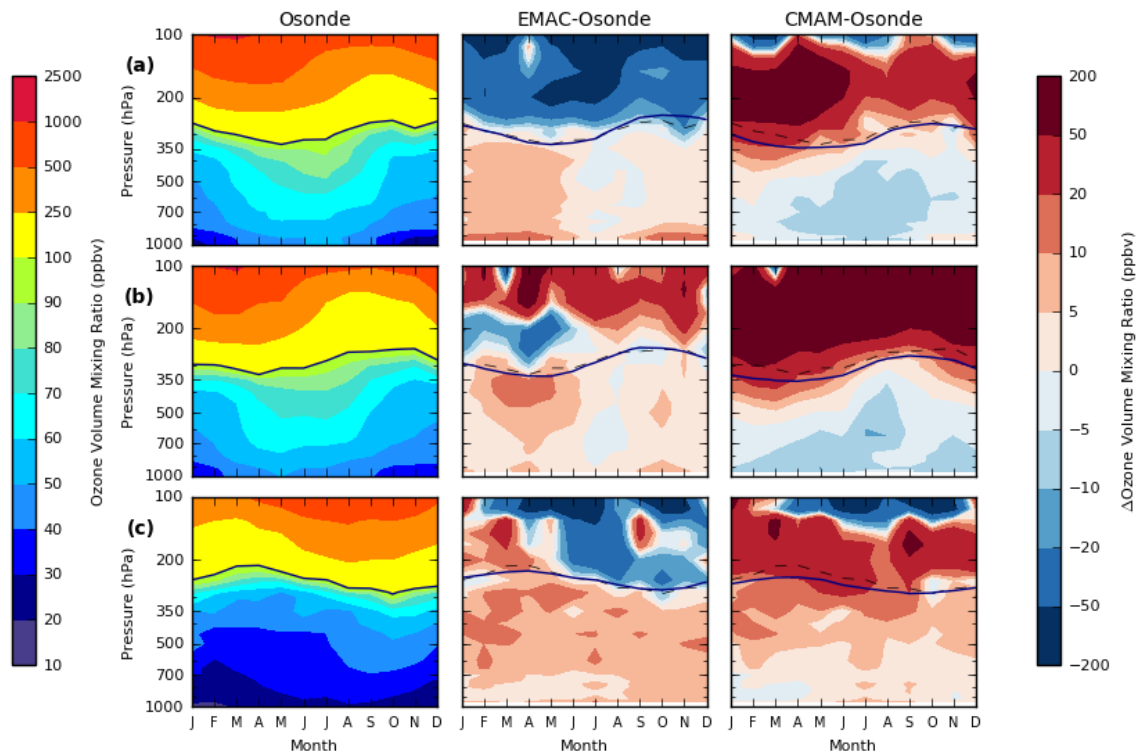


Figure S1 – Monthly evolution of the vertical distribution of mean O_3 volume mixing ratio (VMR) (ppbv) derived from ozonesonde measurements (left column); EMAC minus ozonesonde differences (ppbv) (middle column) and CMAM minus ozonesonde differences (ppbv) (right column) over the period 1980-2010 inclusive for three different world regions: (a) Europe ($n = 18$), (b) eastern North America ($n = 14$) and (c) Tasman Sea ($n = 6$). The ozonesonde/model 100 ppbv contour (the ozone defined extratropical tropopause as identified in Bethan et al. (1996)) is additionally highlighted in bold (ozonesonde 100 ppbv contour indicated again by dashed line – middle and right column).

Pressure (hPa)	DJF			MAM		
	Osonde (ppbv)	EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)	Osonde (ppbv)	EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)
100	958.1	-86.7 (-9.1 %)	-47.6 (-4.9 %)	1009.8	-60.2 (-5.9%)	-28.3 (-2.7 %)
200	591.4	-48.5 (-8.3 %)	+28.6 (+4.9 %)	677.2	-27.3 (-4.0 %)	+48.9 (+7.3 %)
350	62.3	+4.9 (+7.7 %)	+10.8 (+17.1 %)	83.7	+5.8 (+7.1 %)	+11.8 (+14.6 %)
500	51.2	+5.4 (+10.6 %)	+0.8 (+1.5 %)	67.0	+7.1 (+10.5 %)	-1.8 (-2.7 %)
850	45.6	+4.5 (+9.9 %)	-2.3 (-5.0 %)	57.8	+5.9 (+10.2 %)	-6.1 (-10.5 %)
1000	27.4	+12.2 (+45.3 %)	+1.4 (+5.6 %)	44.7	+10.6 (+24.1 %)	-5.2 (-11.5 %)
Pressure (hPa)	JJA			SON		
	Osonde (ppbv)	EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)	Osonde (ppbv)	EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)
100	738.3	-85.6 (-11.7 %)	-34.6 (-4.7 %)	712.7	-86.7 (-12.1 %)	-6.6 (-0.7 %)
200	453.5	-60.0 (-13.6 %)	+16.2 (+3.3 %)	377.0	-41.5 (-10.8 %)	+30.2 (+8.4 %)
350	88.0	+1.2 (+1.3 %)	+2.0 (+2.3 %)	65.9	+1.6 (+2.6 %)	+0.1 (+0.2 %)
500	75.2	-1.0 (-1.2 %)	-6.8 (-8.9 %)	57.9	+2.0 (+3.7 %)	-5.3 (-8.9 %)
850	59.4	-0.2 (-0.3%)	-8.6 (-14.4 %)	48.2	+3.9 (+8.3 %)	-4.9 (-10.2 %)
1000	50.1	+1.7 (+3.4 %)	-8.8 (-17.4 %)	33.3	+11.0 (+37.0 %)	-1.8 (-3.3 %)

Table S2a – Seasonally averaged ozone VMR (ppbv) values for six pressure levels between the surface (1000 hPa) and the lower stratosphere (100 hPa) derived from available ozonesondes measurements across Europe (30° N - 65° N, 15° W - 35° E) (n = 18) over the period 1980-2010 inclusive, together with the differences with respect to both EMAC and CMAM (also expressed in percentage terms).

Pressure (hPa)	DJF			MAM		
	Osonde (ppbv)	EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)	Osonde (ppbv)	EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)
100	939.5	+35.0 (+3.8 %)	+56.6 (+6.2 %)	906.6	+27.6 (+3.8 %)	+57.9 (+7.6 %)
200	608.0	+16.5 (+2.4 %)	+81.7 (+13.3 %)	615.5	+32.4 (+5.7 %)	+104.1 (+17.7 %)
350	67.1	+4.0 (+6.0 %)	+17.5 (+25.9 %)	80.8	+11.3 (+14.1 %)	+19.7 (+25.0 %)
500	52.9	+3.1 (+5.8 %)	+0.6 (+1.0 %)	65.5	+8.7 (+13.3 %)	+1.3 (+2.2 %)
850	46.6	+2.8 (+6.0 %)	-3.8 (-8.2 %)	58.5	+4.4 (+7.5 %)	-5.8 (-9.9 %)
1000	33.5	+4.6 (+13.6 %)	-7.6 (-22.6 %)	47.0	+4.8 (+10.2 %)	-8.1 (-17.3 %)
Pressure (hPa)	JJA			SON		
	Osonde (ppbv)	EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)	Osonde (ppbv)	EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)
100	611.1	+23.5 (+3.7 %)	+96.0 (+15.8 %)	581.8	+24.4 (+4.0 %)	+99.4 (+17.2 %)
200	330.5	+34.0 (+10.8 %)	+125.6 (+39.3 %)	299.7	+33.1 (+10.8 %)	+97.2 (+32.4 %)
350	83.5	+2.1 (+2.5 %)	+0.7 (+0.7 %)	63.8	+4.1 (+6.5 %)	+3.5 (+5.8 %)
500	70.4	+1.8 (+2.6 %)	-5.1 (-7.3 %)	54.8	+4.6 (+8.5 %)	-1.9 (-3.5 %)
850	58.4	-1.4 (-2.5 %)	-6.8 (-11.7 %)	49.5	+2.9 (+5.9 %)	-4.8 (-9.8 %)
1000	46.4	+2.1 (+4.4 %)	-4.6 (-9.9 %)	36.2	+6.2 (+17.2 %)	-6.6 (-18.6 %)

Table S2b – Same as for table 2a but for eastern North America (32.5° N - 60° N, 92.5° W - 55° W) (n = 14).

Pressure (hPa)	Osonde (ppbv)	DJF		Osonde (ppbv)	MAM	
		EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)		EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)
100	485.3	+13.2 (+3.0 %)	+36.5 (+7.9 %)	544.0	-44.7 (-8.1 %)	-13.2 (-2.1 %)
200	294.1	-9.4 (-2.7 %)	+19.4 (+7.2 %)	270.3	+6.3 (+3.4 %)	+41.0 (+16.3 %)
350	52.7	+7.8 (+15.0 %)	+9.3 (+17.9 %)	42.5	+11.1 (+26.5 %)	+10.5 (+25.1 %)
500	40.1	+9.1 (+22.9 %)	+6.6 (+16.6 %)	36.2	+9.6 (+26.6 %)	+5.9 (+16.4 %)
850	26.9	+6.0 (+22.5 %)	+0.5 (+2.1 %)	29.5	+4.9 (+17.6 %)	+1.0 (+3.8 %)
1000	18.6	+6.1 (+32.9 %)	+1.2 (+6.8 %)	22.7	+5.7 (+25.0 %)	+2.0 (+8.5 %)
Pressure (hPa)	Osonde (ppbv)	JJA		Osonde (ppbv)	SON	
		EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)		EMAC-Osonde (ppbv)	CMAM-Osonde (ppbv)
100	807.3	-72.7 (-9.1 %)	-84.7 (-10.5 %)	848.8	-64.9 (-7.6 %)	-83.3 (-9.7 %)
200	486.1	-45.6 (-9.5 %)	-20.0 (-4.1 %)	463.9	-5.8 (-1.2 %)	+5.4 (+1.3 %)
350	50.4	+6.5 (+13.7 %)	+8.9 (+18.5 %)	61.2	+6.1 (+10.2 %)	+7.7 (+12.9 %)
500	40.8	+7.8 (+19.3 %)	+5.0 (+12.2 %)	46.6	+8.8 (+18.9 %)	+5.3 (+11.5 %)
850	36.6	+3.3 (+8.9 %)	+2.2 (+5.9 %)	35.5	+6.7 (+18.8 %)	+2.6 (+7.1 %)
1000	25.8	+8.0 (+31.5 %)	+6.9 (+27.3 %)	26.3	+7.8 (+29.7 %)	+3.1 (+11.3 %)

Table S2c – Same as for table 2a/2b but for the Tasman Sea region (15° S - 55° S, 140° E - 180° E) (n = 6).

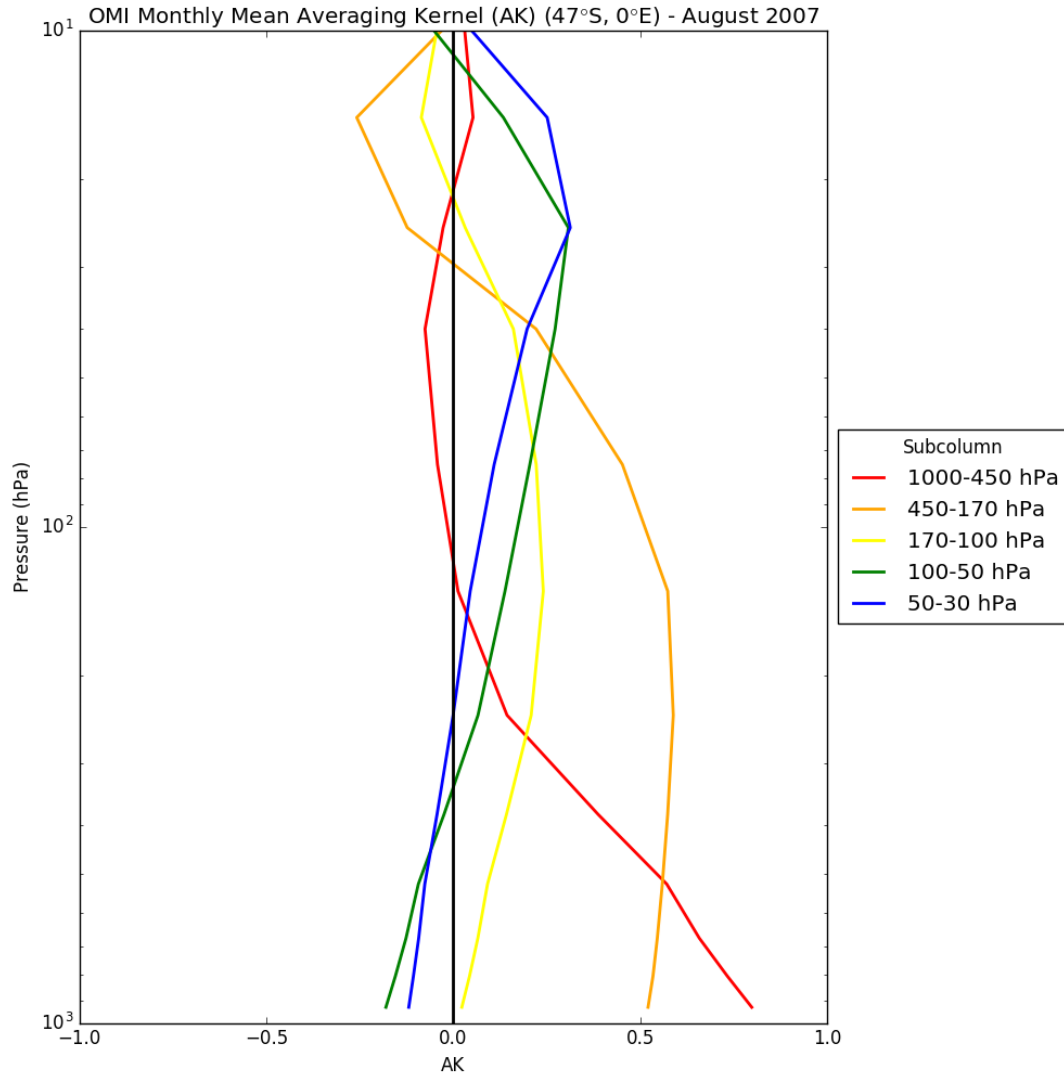


Figure S2 – Example of monthly mean OMI Averaging Kernels (AKs) used to convolve model and ozonesonde subcolumn profiles to ensure a like-for-like comparison with OMI. The red line (AK for the 1000-450 hPa subcolumn) for instance, shows sensitivity to influence from ~ 150-450 hPa. Application of this AK leads to a systematic increase in 1000-450 hPa subcolumn ozone in mid- to high-latitudes due to smearing of higher ozone above the tropopause (which is typically within this pressure range).

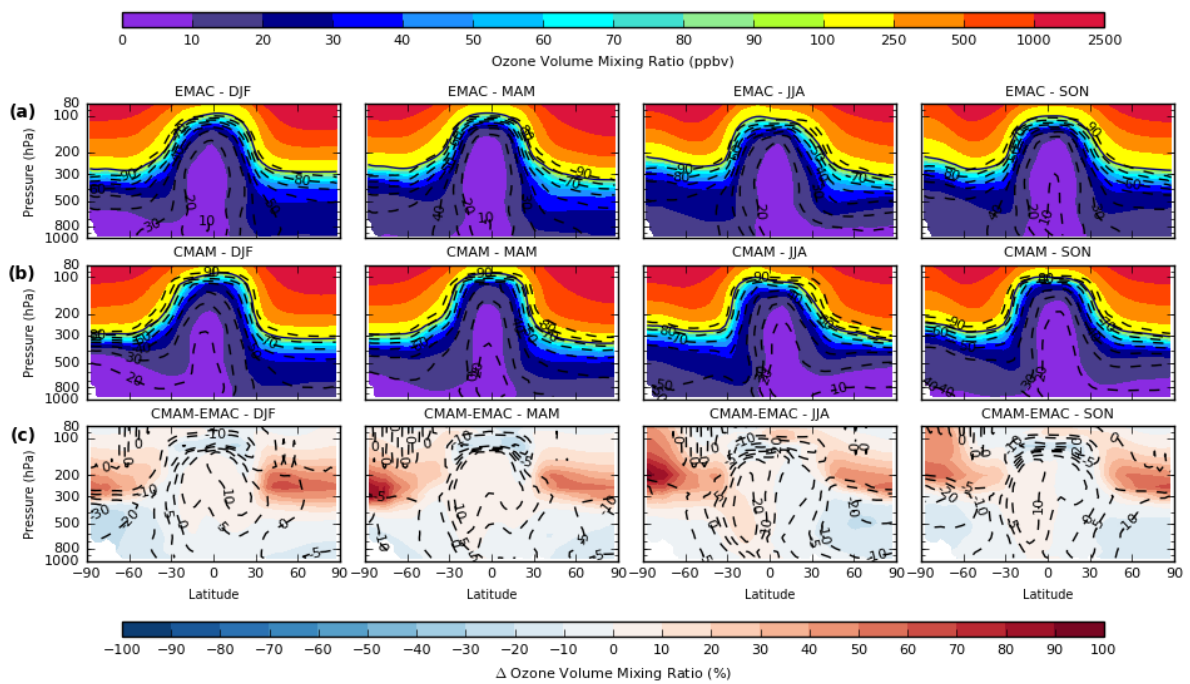


Figure S3 – Zonal mean seasonal composites of monthly mean O_3S concentration (ppbv) for the troposphere and lower stratosphere (1000-80 hPa) from (a) EMAC, (b) CMAM and (c) CMAM and EMAC (CMAM-EMAC) percentage differences over the period 1980-2010. Dashed lines indicate the stratospheric contribution (%) calculated using both ozone tracers in each model: O_3F (%) = $(O_3S / O_3) \times 100$. The 100 ppbv contour (bold line) is included as a reference for the tropopause altitude (top and middle row).

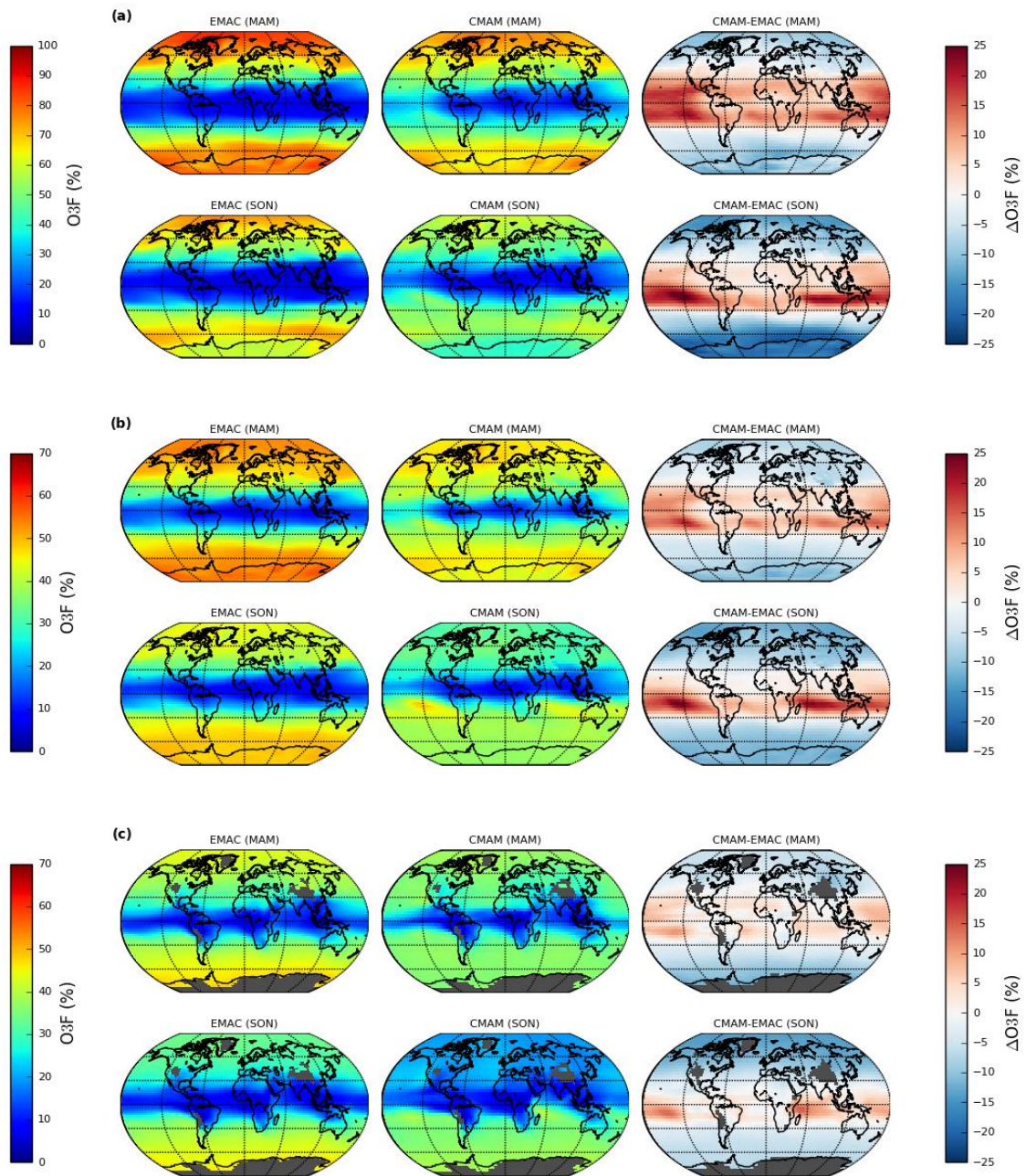


Figure S4 – Seasonal (MAM/SON) composites of (a) 350 hPa, (b) 500 hPa and (c) 850 hPa monthly mean stratospheric ozone fraction (O_3F) for EMAC (left), CMAM (middle) and CMAM-EMAC (right) over the period 1980-2010. Note the scale difference between (a) and (b-c). Grey shaded regions represent regions where the surface pressure is lower than the plotted pressure level.

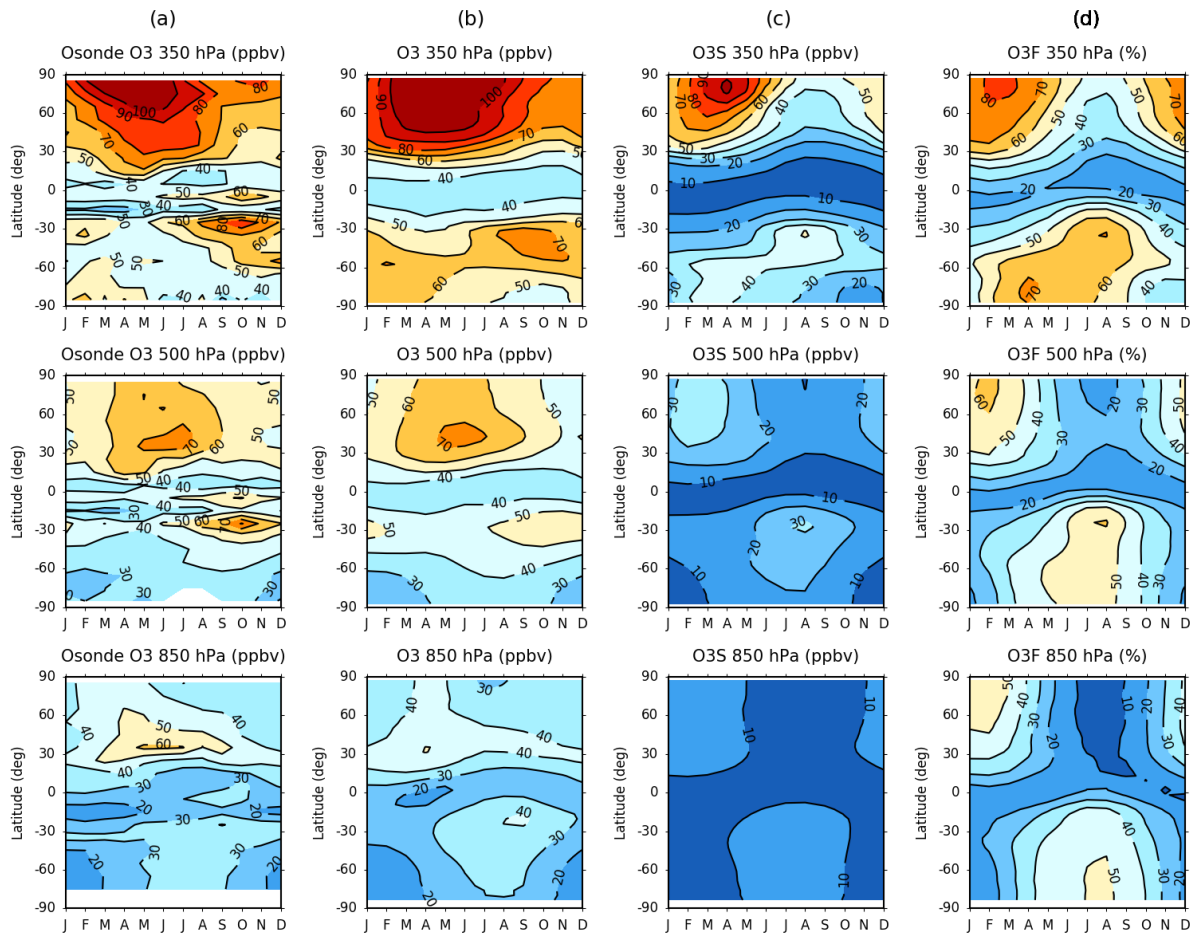


Figure S5 – Zonal-mean monthly mean evolution of O_3 VMR concentration (ppbv) derived from (a) ozonesondes and (b) CMAM O_3 model tracer. The evolution of the (c) CMAM stratospheric O_3S tracer and (d) O_3F stratospheric fraction (%) are additionally included over the period 1980-2010 for 350 hPa (top row), 500 hPa (middle row) and 850 hPa (bottom row).

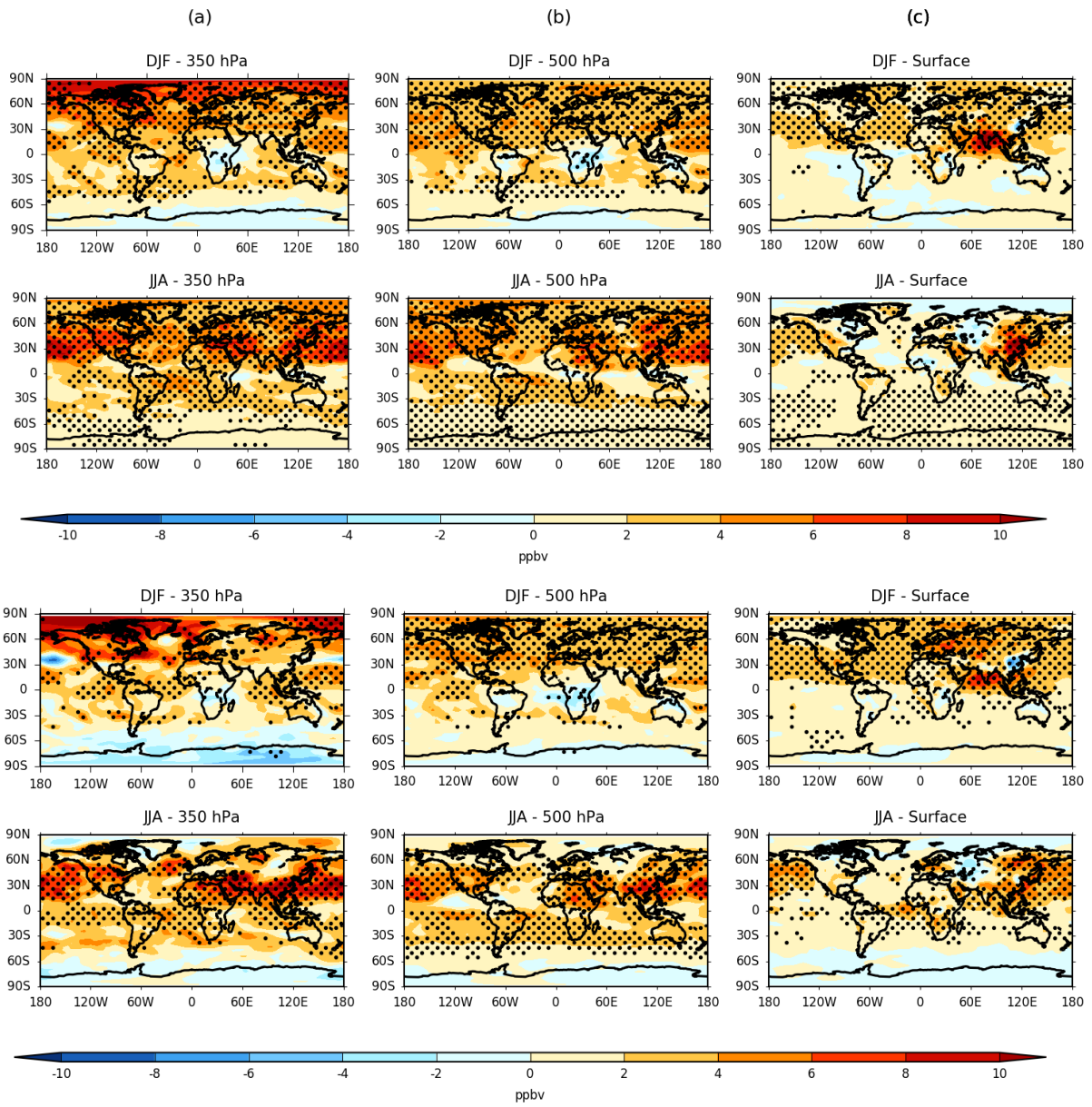


Figure S6 – Seasonal change in EMAC (top) and CMAM (bottom) ozone (O₃) VMR concentration (ppbv) between 1980-89 and 2001-10 for DJF and JJA at (a) 350 hPa, (b) 500 hPa and (c) the surface model level. Stippling denotes regions of statistical significance according to a paired two-sided t-test ($p < 0.05$).

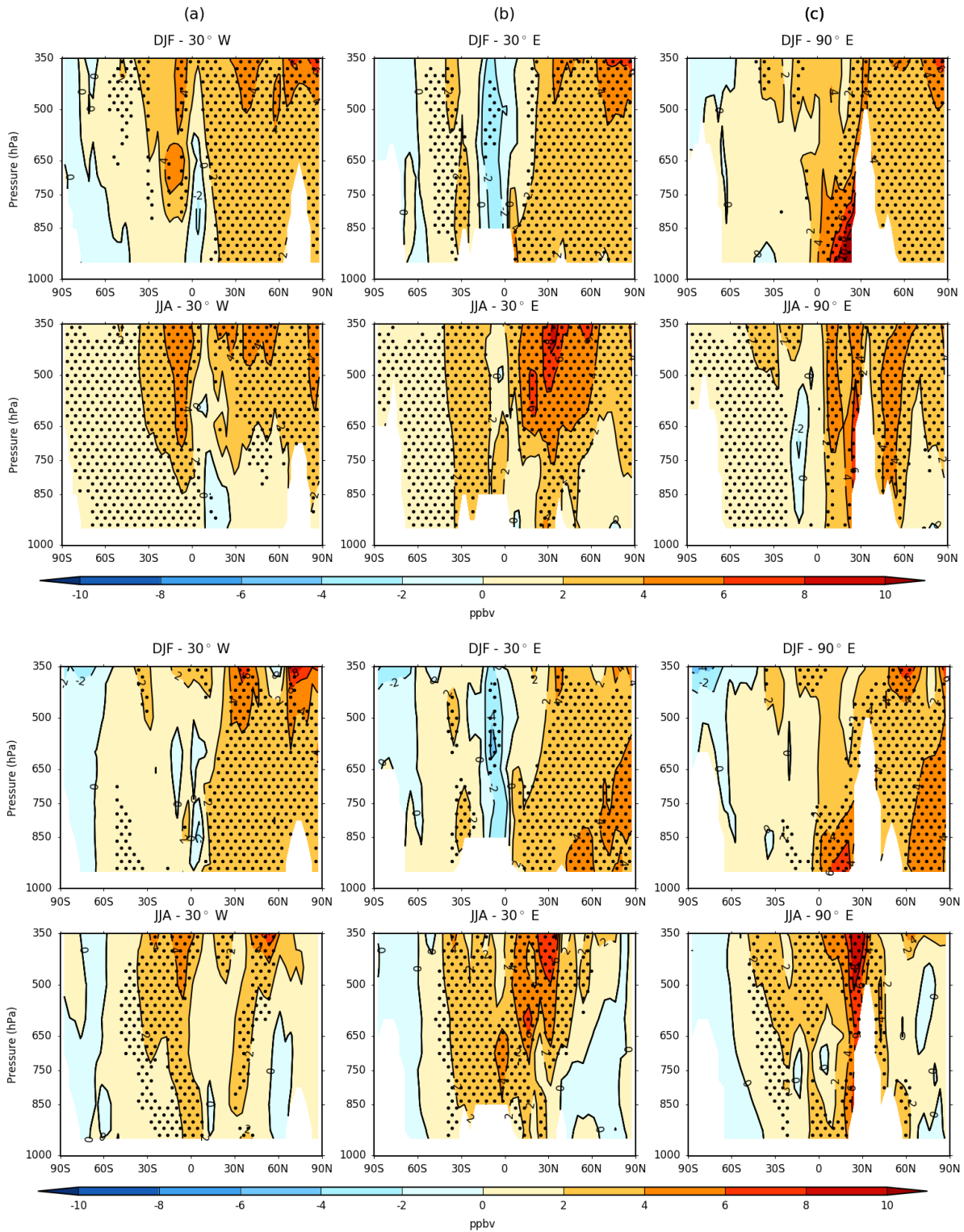


Figure S7 – Longitudinal cross-sections of the seasonal change in the vertical distribution of ozone (O_3) VMR (ppbv) from EMAC (top) and CMAM (bottom) between 1980-89 and 2001-10 for DJF and JJA at (a) 30° W, (b) 30° E and (c) 90° E. Stippling denotes regions of statistical significance according to a paired two-sided t -test ($p < 0.05$).

DJF	EMAC O3			CMAM O3		
	350 hPa	500 hPa	Surface	350 hPa	500 hPa	Surface
60°N-90°N	+7.0 (+11.3 %)*	+3.6 (+7.4 %)*	+2.0 (+7.0 %)*	+7.1 (+8.7 %)	+3.6 (+7.5 %)*	+2.7 (+13.3 %)*
30°N-60°N	+4.4 (+6.6 %)*	+3.7 (+6.8 %)*	+2.0 (+5.8 %)*	+3.6 (+4.9 %)	+3.5 (+6.9 %)*	+2.8 (+13.4 %)*
0°N-30°N	+2.7 (+5.4 %)	+2.7 (+5.4 %)	+2.7 (+6.4 %)	+2.5 (+6.4 %)	+2.1 (+5.1 %)	+2.6 (+8.0 %)
30°S-0°N	+1.9 (+3.9 %)	+1.5 (+3.1 %)	+0.7 (+2.7 %)	+1.5 (+4.0 %)	+0.9 (+2.4 %)	+0.8 (+4.0 %)
60°S-30°S	+1.7 (+2.9 %)	+1.3 (+3.0 %)	+0.2 (+1.0 %)	+0.4 (+0.8 %)	+0.9 (+2.0 %)	+0.4 (+2.4 %)
90°S-60°S	-0.4 (-0.9 %)	+0.1 (+0.3 %)	+0.1 (+0.9 %)	-2.3 (-3.5 %)	-0.2 (-0.9 %)	+0.1 (+0.7 %)
MAM	EMAC O3			CMAM O3		
	350 hPa	500 hPa	Surface	350 hPa	500 hPa	Surface
60°N-90°N	+3.4 (+3.7 %)	+3.4 (+5.2 %)*	+1.6 (+4.5 %)	+1.6 (+1.4 %)	+3.0 (+4.8 %)	+1.9 (+6.8 %)*
30°N-60°N	+4.8 (+5.4 %)*	+3.7 (+5.2 %)*	+1.8 (+3.6 %)	+5.0 (+5.3 %)	+4.1 (+6.4 %)*	+2.4 (+6.7 %)
0°N-30°N	+3.2 (+5.3 %)	+3.4 (+5.7 %)	+2.1 (+4.8 %)	+2.9 (+6.6 %)	+3.0 (+6.4 %)	+2.7 (+8.7 %)
30°S-0°N	+1.6 (+3.3 %)	+1.3 (+2.8 %)	+1.0 (+3.6 %)	+1.5 (+4.3 %)	+0.9 (+2.7 %)	+0.9 (+4.3 %)
60°S-30°S	+1.2 (+2.4 %)	+1.2 (+2.8 %)	+0.4 (+1.7 %)	-0.6 (-0.9 %)	+0.1 (+0.1 %)	-0.0 (-0.2 %)
90°S-60°S	+1.0 (+2.4 %)	+0.8 (+2.8 %)	+0.5 (+2.4 %)	-2.2 (-3.4 %)	-0.5 (-1.4 %)	-0.3 (-1.5 %)
JJA	EMAC O3			CMAM O3		
	350 hPa	500 hPa	Surface	350 hPa	500 hPa	Surface
60°N-90°N	+4.0 (+4.7 %)*	+3.7 (+6.1 %)*	+0.3 (+0.9 %)	+1.8 (+1.7 %)	+1.1 (+1.9 %)	+0.2 (+0.8 %)
30°N-60°N	+5.4 (+6.5 %)*	+4.5 (+6.5 %)*	+1.8 (+5.0 %)	+4.6 (+5.7 %)	+3.2 (+5.1 %)	+2.0 (+6.6 %)
0°N-30°N	+3.9 (+6.9 %)	+3.5 (+6.5 %)	+1.7 (+5.6 %)	+4.3 (+10.1 %)	+3.2 (+7.9 %)	+2.1 (+8.5 %)
30°S-0°N	+2.3 (+4.2 %)	+2.1 (+4.0 %)	+0.9 (+2.8 %)	+2.5 (+6.7 %)	+2.6 (+6.4 %)	+1.3 (+4.7 %)
60°S-30°S	+1.9 (+3.5 %)	+1.7 (+3.8 %)*	+0.7 (+2.4 %)*	+1.9 (+3.0 %)	+1.5 (+3.4 %)	+0.1 (+0.4 %)
90°S-60°S	+1.0 (+2.4 %)	+1.1 (+3.1 %)*	+0.8 (+3.2 %)*	-0.7 (-1.3 %)	-0.1 (-0.3 %)	-0.2 (-0.9 %)
SON	EMAC O3			CMAM O3		
	350 hPa	500 hPa	Surface	350 hPa	500 hPa	Surface
60°N-90°N	+4.4 (+7.3 %)*	+3.7 (+7.3 %)*	+2.0 (+7.1 %)*	+4.1 (+5.4 %)	+3.0 (+6.1 %)*	+2.1 (+10.5 %)*
30°N-60°N	+4.5 (+6.9 %)*	+4.4 (+7.7 %)*	+2.1 (+5.7 %)	+5.3 (+8.4 %)*	+4.8 (+9.4 %)*	+2.7 (10.7 %)*
0°N-30°N	+3.4 (+6.7 %)	+3.3 (+6.6 %)	+2.3 (+6.6 %)	+3.8 (+10.2 %)*	+3.2 (+8.9 %)	+2.7 (+10.3 %)*
30°S-0°N	+2.6 (+4.6 %)	+2.3 (+4.2 %)	+0.8 (+2.6 %)	+2.6 (+6.6 %)	+2.3 (+5.5 %)	+1.3 (+5.3 %)
60°S-30°S	+2.0 (+3.1 %)	+1.7 (+3.6 %)	+0.4 (+1.6 %)	+1.7 (+2.4 %)	+1.9 (+4.1 %)*	+0.7 (+2.7 %)*
90°S-60°S	+1.4 (+3.3 %)	+0.9 (+2.6 %)	+0.6 (+2.5 %)	+2.4 (+4.7 %)	+1.3 (+3.8 %)	+0.5 (+2.1 %)

Table S3 - 30° latitude band changes in seasonal mean ozone (O₃) VMR (ppbv) (also expressed in percentage (%) terms) between 1980-89 and 2001-10 at 350 hPa, 500 hPa and the surface (left to right for each model). Values denoted with an asterisk () represent statistical significance at the 95% confidence level ($p < 0.05$) as determined by a two-sided paired t -test.*

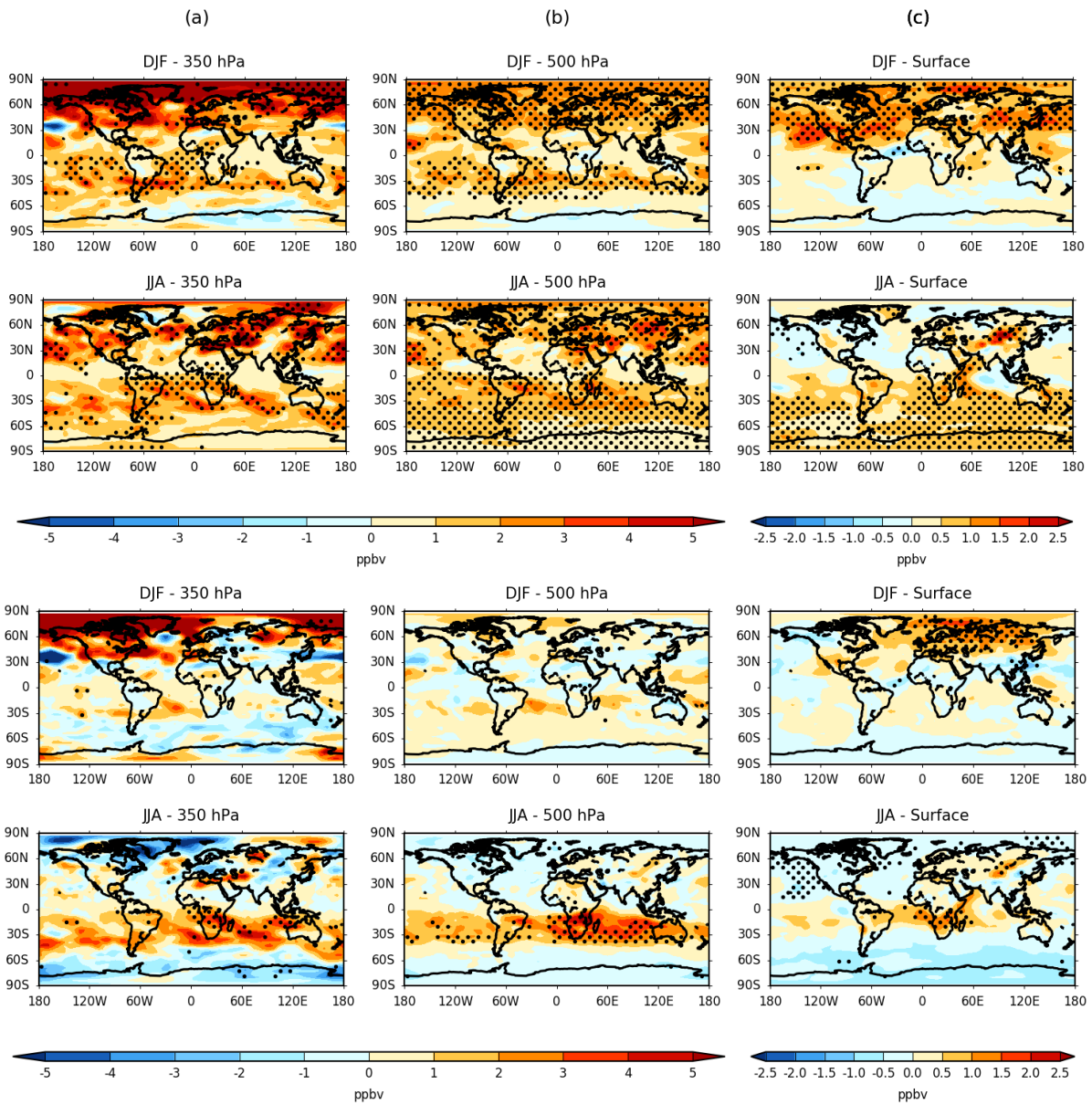


Figure S8 – Seasonal change in EMAC (top) and CMAM (bottom) stratospheric ozone (O_3S) VMR concentration (ppbv) between 1980-89 and 2001-10 for DJF and JJA at (a) 350 hPa, (b) 500 hPa and (c) the surface model level. Stippling denotes regions of statistical significance according to a paired two-sided t -test ($p < 0.05$). Note the scale difference between (a-b) and (c).

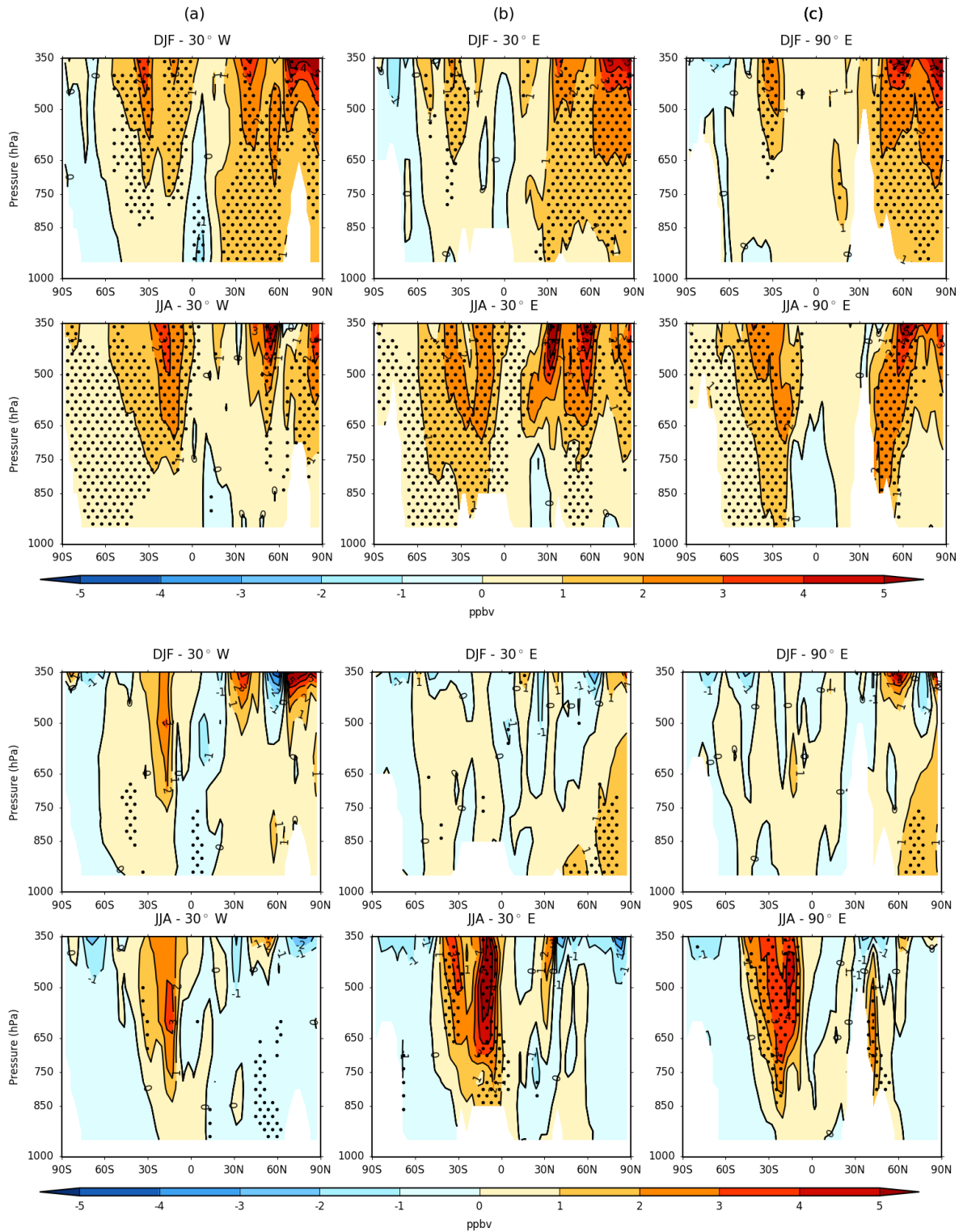


Figure S9 – Longitudinal cross-sections of the seasonal change in the vertical distribution of stratospheric ozone (O_3S) VMR (ppbv) from EMAC (top) and CMAM (bottom) between 1980-89 and 2001-10 for DJF and JJA at (a) 30° W, (b) 30° E and (c) 90° E. Stippling denotes regions of statistical significance according to a paired two-sided t-test ($p < 0.05$).

DJF	EMAC O3S			CMAM O3S		
	350 hPa	500 hPa	Surface	350 hPa	500 hPa	Surface
60°N-90°N	+6.9 (+14.0 %)	+2.4 (+8.4 %)*	+0.9 (+6.1 %)	+5.3 (+8.1 %)	+0.5 (+1.8 %)	+0.5 (+5.9 %)
30°N-60°N	+2.8 (+6.2 %)	+1.9 (+6.7 %)*	+1.0 (+5.9 %)	+0.7 (+1.5 %)	+0.0 (+0.1 %)	+0.3 (+3.4 %)
0°N-30°N	+0.9 (+8.1 %)	+1.0 (+7.9 %)	+0.5 (+5.1 %)	+0.2 (+2.1 %)	-0.0 (-0.1 %)	-0.1 (-1.3 %)
30°S-0°N	+1.2 (+13.2 %)	+1.1 (+11.6 %)	+0.1 (+4.2 %)	+0.3 (+3.0 %)	+0.3 (+2.7 %)	+0.0 (+0.8 %)
60°S-30°S	+1.2 (+4.4 %)	+0.9 (+5.1 %)	-0.0 (-0.0 %)	-0.5 (-1.4 %)	+0.2 (+2.0 %)	+0.0 (+0.2 %)
90°S-60°S	+0.1 (+0.1 %)	-0.0 (-0.2 %)	+0.0 (-0.4 %)	+0.1 (+0.2 %)	-0.1 (-1.0 %)	-0.1 (-2.9 %)
MAM	EMAC O3S			CMAM O3S		
	350 hPa	500 hPa	Surface	350 hPa	500 hPa	Surface
60°N-90°N	+1.8 (+2.5 %)	+1.9 (+5.5 %)	+0.8 (+5.1 %)	-2.7 (-2.4 %)	+0.2 (+0.7 %)	+0.7 (+6.7 %)
30°N-60°N	+3.3 (+6.2 %)	+2.1 (+6.4 %)	+0.8 (+4.5 %)	+1.6 (+2.7 %)	+0.8 (+2.9 %)	+0.5 (+5.0 %)
0°N-30°N	+1.6 (+11.7 %)	+1.6 (+12.5 %)	+0.5 (+7.4 %)	+0.4 (+2.1 %)	+0.4 (+1.7 %)	+0.2 (+2.0 %)
30°S-0°N	+1.1 (+13.1 %)	+1.0 (+11.6 %)	+0.3 (+5.0 %)	+0.4 (+4.0 %)	+0.2 (+1.8 %)	+0.0 (+0.2 %)
60°S-30°S	+1.3 (+4.7 %)	+1.1 (+6.2 %)*	+0.4 (+4.0 %)	-0.9 (-2.3 %)	-0.3 (-1.5 %)	-0.2 (-2.5 %)
90°S-60°S	+1.5 (+5.0 %)	+0.9 (+5.9 %)*	+0.5 (+5.5 %)*	-0.9 (-2.0 %)	-0.3 (-1.9 %)	-0.1 (-1.7 %)
JJA	EMAC O3S			CMAM O3S		
	350 hPa	500 hPa	Surface	350 hPa	500 hPa	Surface
60°N-90°N	+2.1 (+3.5 %)	+1.8 (+7.3 %)	+0.0 (+0.2 %)	-1.4 (-2.7 %)	-0.5 (-3.9 %)	-0.1 (-6.0 %)
30°N-60°N	+2.5 (+6.3 %)	+1.8 (+6.5 %)	+0.1 (+0.7 %)	-0.2 (-0.3 %)	-0.2 (-1.1 %)	-0.1 (-2.4 %)
0°N-30°N	+1.1 (+9.9 %)	+0.9 (+9.4 %)	+0.1 (+2.9 %)	+0.1 (+1.5 %)	+0.0 (+0.0 %)	+0.0 (-0.6 %)
30°S-0°N	+1.4 (+11.2 %)	+1.5 (+12.3 %)	+0.5 (+4.4 %)	+1.5 (+8.7 %)	+1.8 (+8.9 %)	+0.3 (+3.6 %)
60°S-30°S	+1.7 (+5.0 %)	+1.4 (+6.1 %)*	+0.6 (+3.7 %)*	+1.0 (+2.4 %)	+0.7 (+2.8 %)	-0.4 (-2.5 %)
90°S-60°S	+0.8 (+3.0 %)	+0.9 (+4.2 %)*	+0.6 (+4.3 %)*	-1.5 (-4.2 %)	-0.7 (-3.3 %)	-0.5 (-3.9 %)
SON	EMAC O3S			CMAM O3S		
	350 hPa	500 hPa	Surface	350 hPa	500 hPa	Surface
60°N-90°N	+2.8 (+6.6 %)	+1.5 (+7.0 %)*	+0.5 (+5.9 %)	+0.3 (+0.8 %)	+0.0 (+0.1 %)	+0.2 (+4.9 %)
30°N-60°N	+1.7 (+5.2 %)	+1.5 (+6.8 %)	+0.4 (+4.0 %)	+0.5 (+2.0 %)	+0.3 (+2.3 %)	+0.1 (+1.9 %)
0°N-30°N	+0.7 (+8.9 %)	+0.6 (+8.2 %)	+0.1 (+3.7 %)	+0.1 (+2.4 %)	+0.1 (+1.8 %)	+0.1 (+1.7 %)
30°S-0°N	+1.2 (+11.8 %)	+1.2 (+11.5 %)	+0.1 (+2.4 %)	+1.2 (+9.7 %)	+1.5 (+10.0 %)	+0.3 (+4.2 %)
60°S-30°S	+1.1 (+2.7 %)	+0.8 (+3.5 %)	+0.0 (+0.2 %)	+0.2 (+0.6 %)	+0.6 (+3.1 %)	-0.1 (-0.5 %)
90°S-60°S	+1.2 (+4.3 %)	+0.4 (+2.5 %)	+0.2 (+1.8 %)	+1.2 (+5.2 %)	+0.1 (+1.0 %)	-0.1 (-0.8 %)

Table S4 - 30° latitude band changes in seasonal mean stratospheric ozone (O₃S) VMR (ppbv) (also expressed in percentage (%) terms) between 1980-89 and 2001-10 at 350 hPa, 500 hPa and the surface (left to right for each model). Values denoted with an asterisk () represent statistical significance at the 95% confidence level (p < 0.05) as determined by a two-sided paired t-test.*