Chapter 6 Supplementary Material

Includes:

- 6S Supplementary Figures (6S-1 through 6S-20)
- 6S Tables (6S-1 through 6S-4)
- Photocomp 2008 Experiment

6S Supplemental Figures

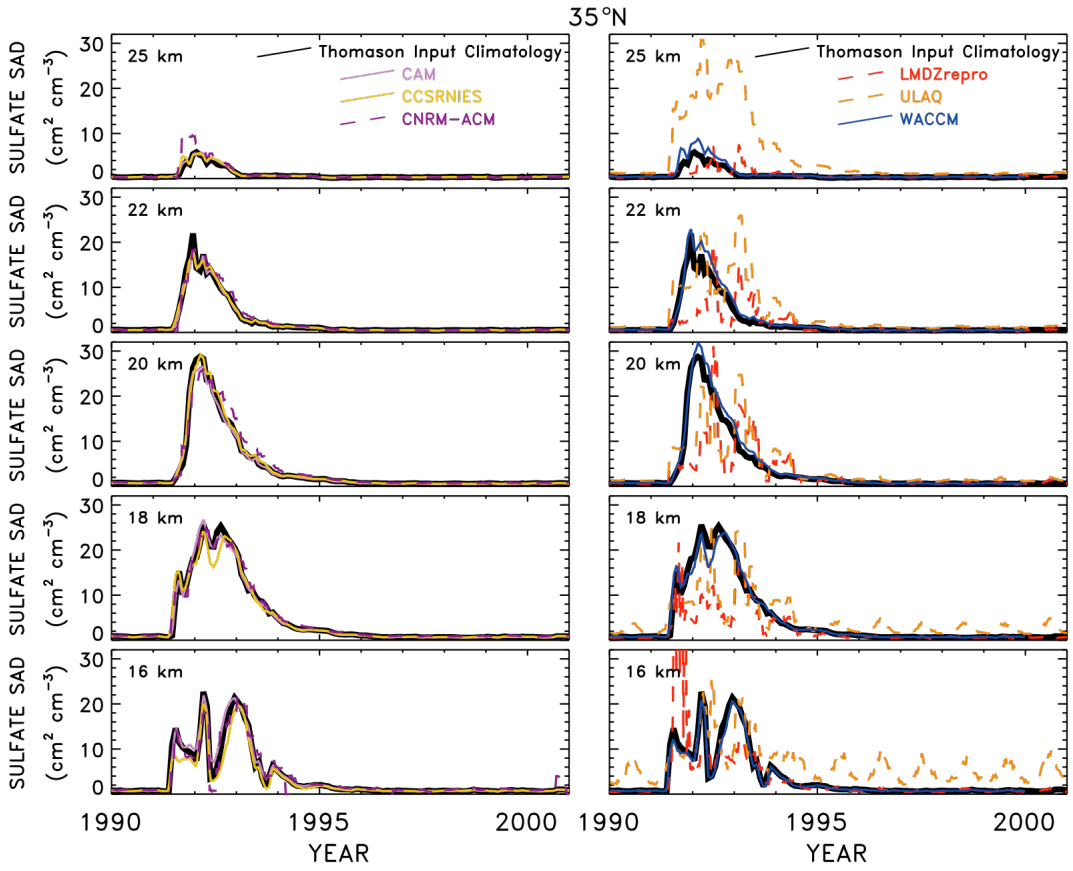


Figure 6S-1: Sulfate surface area density (cm^2 cm^{-3}) time series at 35°N and 25km, 22km, 20km, 18km, and 16km for CAM3.5, CCSRNIES, CNRM-ACM, LMDZrepro, ULAQ, and WACCM.

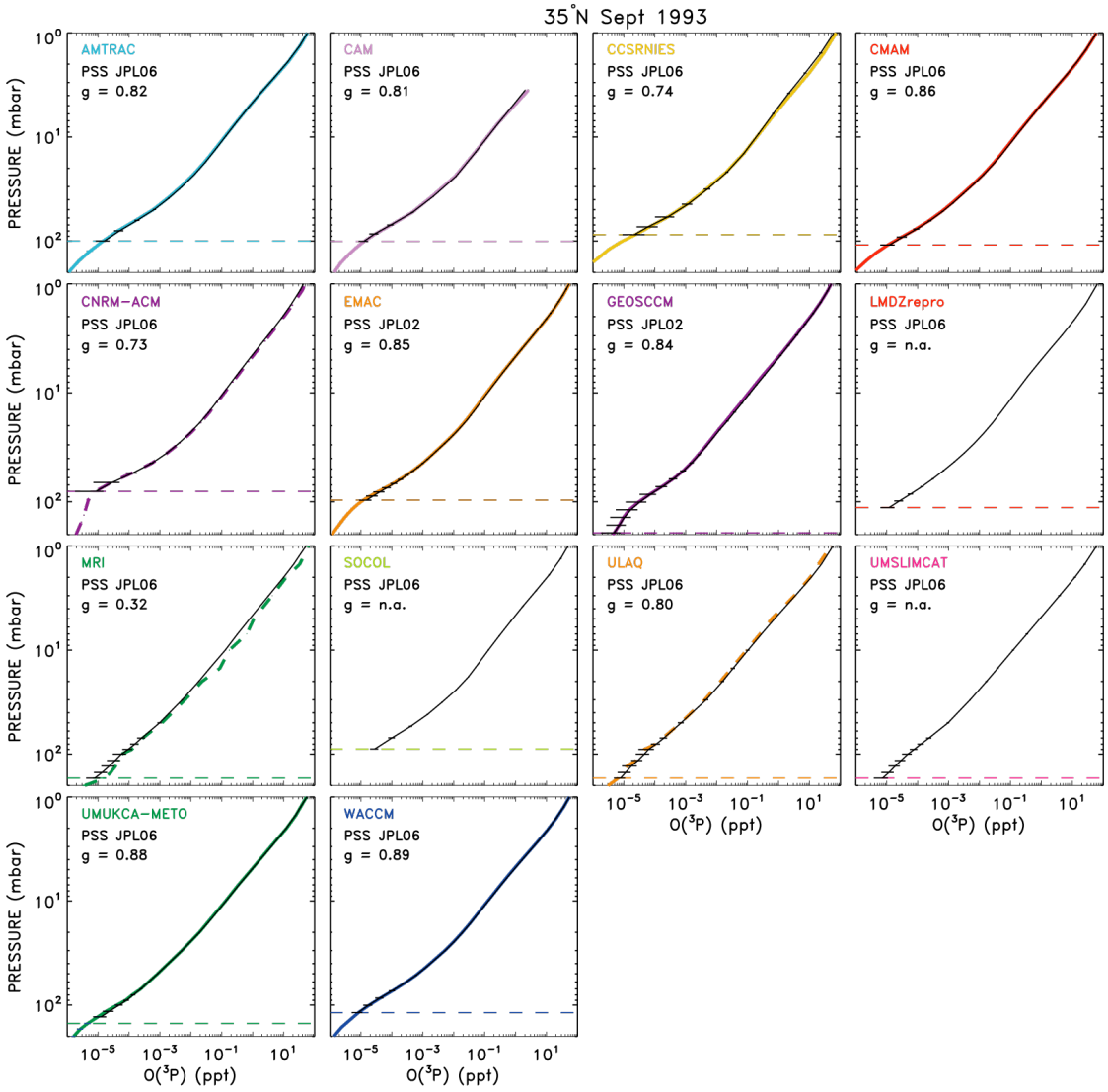


Figure 6S-2a: Comparison of zonal, monthly mean profiles of **O(^{3}P)** radicals from CCM models (coloured lines and symbols) versus 24-hour average radical profiles found using a PSS box model constrained by profiles of T, O_3, H_2O, CH_4, CO, NO_Y, Cl_Y, Br_Y, and sulfate SAD from the various CCMs for 35°N in **September 1993**. The PSS model was run for CCM model levels from the tropopause (dashed lines) to 1 hPa. The PSS model uses the latitude of the CCM output that is closest to 35°N and solar declination corresponding the the mid point of the monthly mean. Numerical values of g and the chemical kinetics in the simulation are given (see main chapter text). The coloured error bars represent the standard deviation about the zonal monthly mean for various days used to compute the mean. The black error bars represent the sensitivity of PSS output to variability in the CCM profiles of radical precursors.

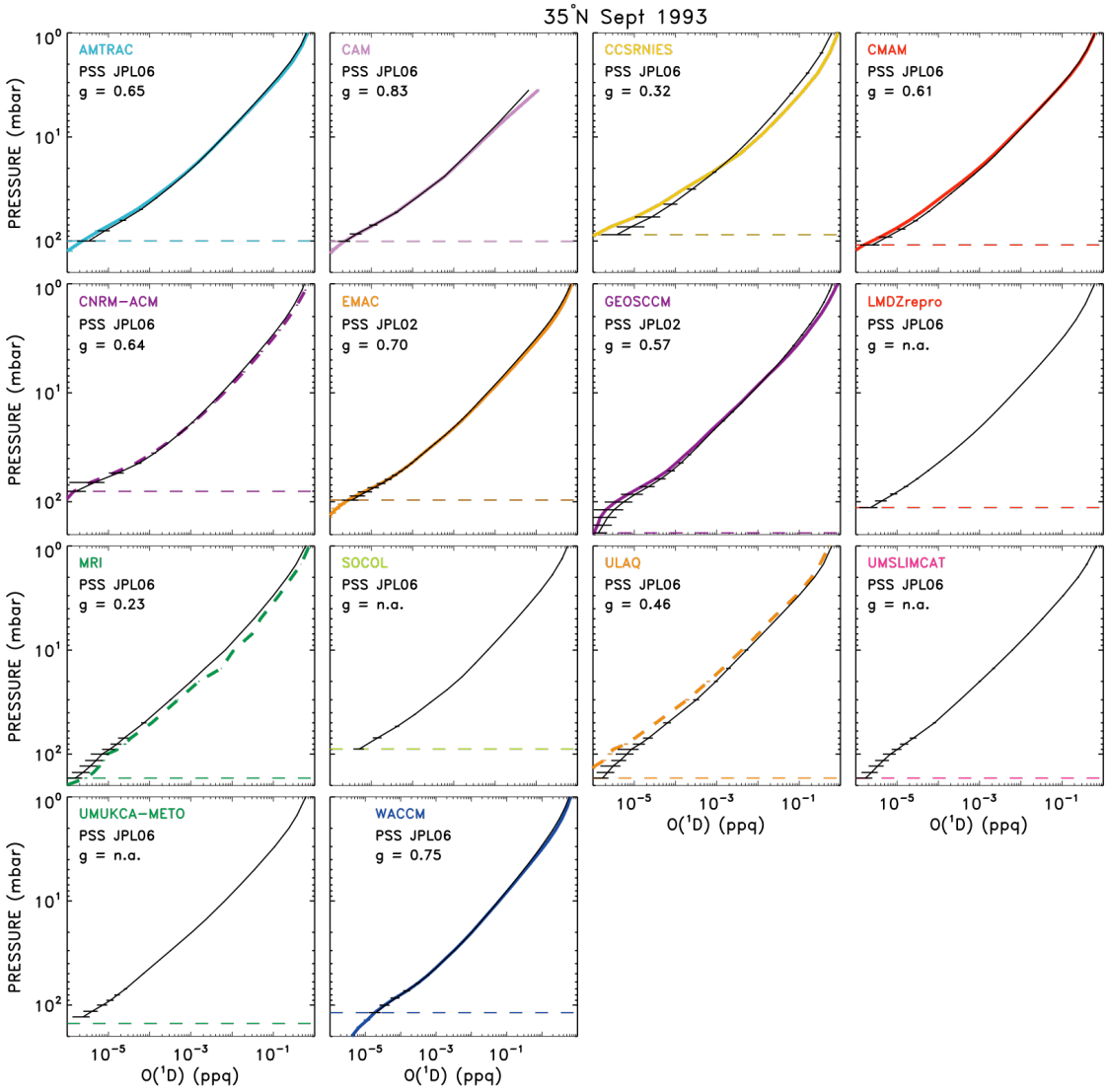


Figure 6S-2b: same as Figure 6S-2a, except **O(^{1}D)** is shown.

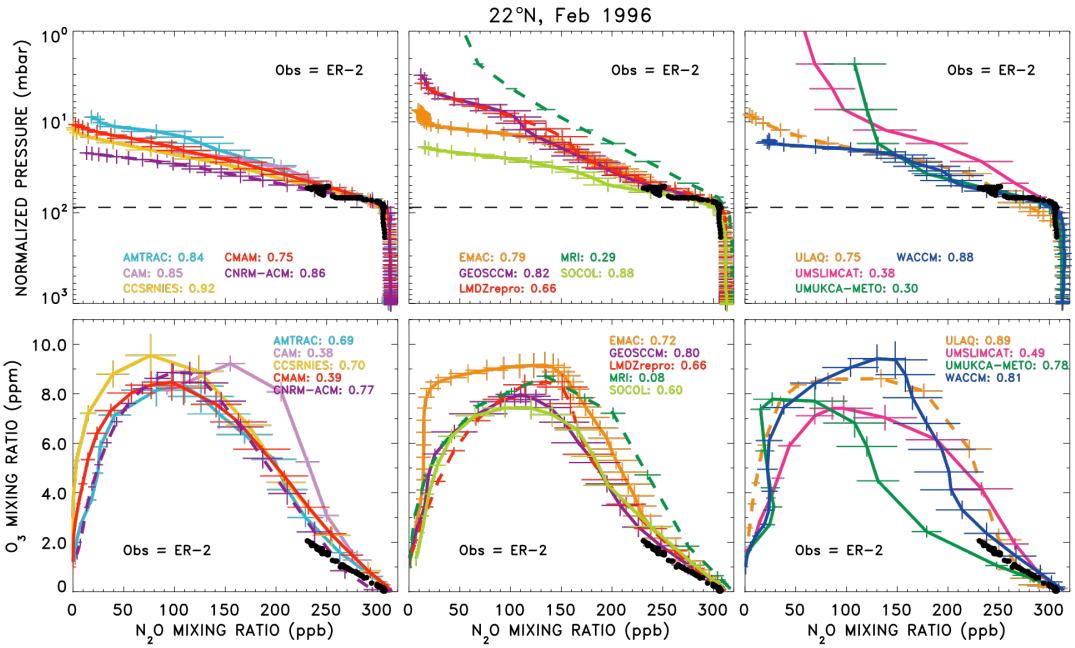


Figure 6S-3a: Comparison of N_2O profile and the relation of radical precursors versus N_2O (black) to zonal, monthly mean values from various CCM models (coloured lines and symbols, as indicated) for **February 1996**. CCM output is for the closest model latitude to 22°N, as indicated. Numerical values of g (see main chapter text) are also noted. Comparisons of N_2O vs pressure and O_3 vs N_2O are shown.

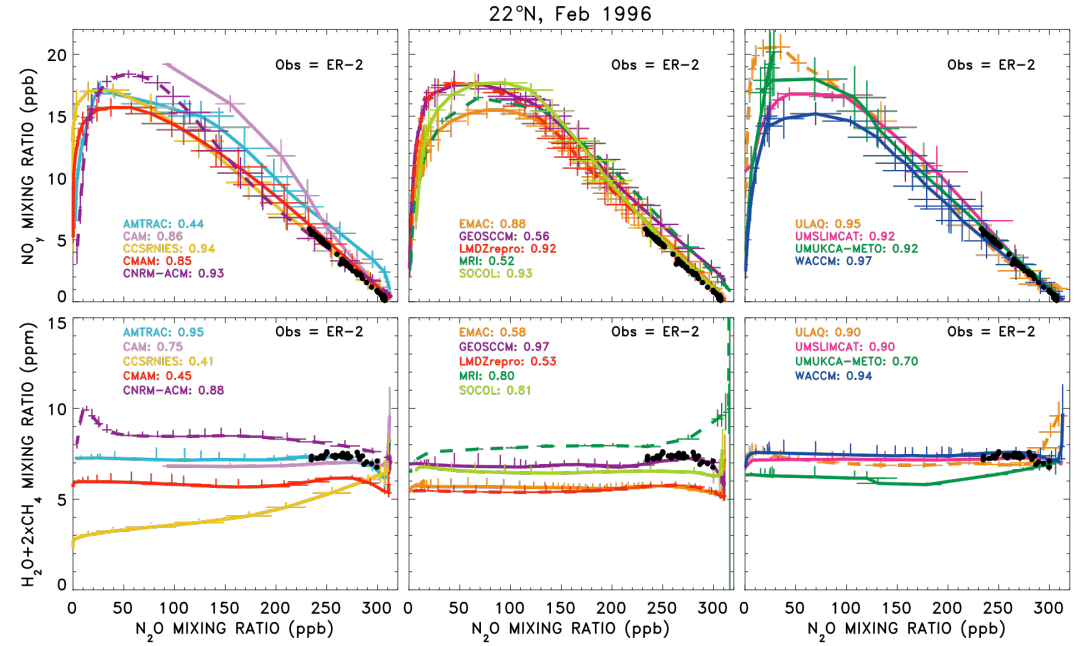


Figure 6S-3b: Same as Figure 6S-3a, except comparisons of NO_Y vs N_2O and $H_2O+2\times CH_4$ vs N_2O are shown.

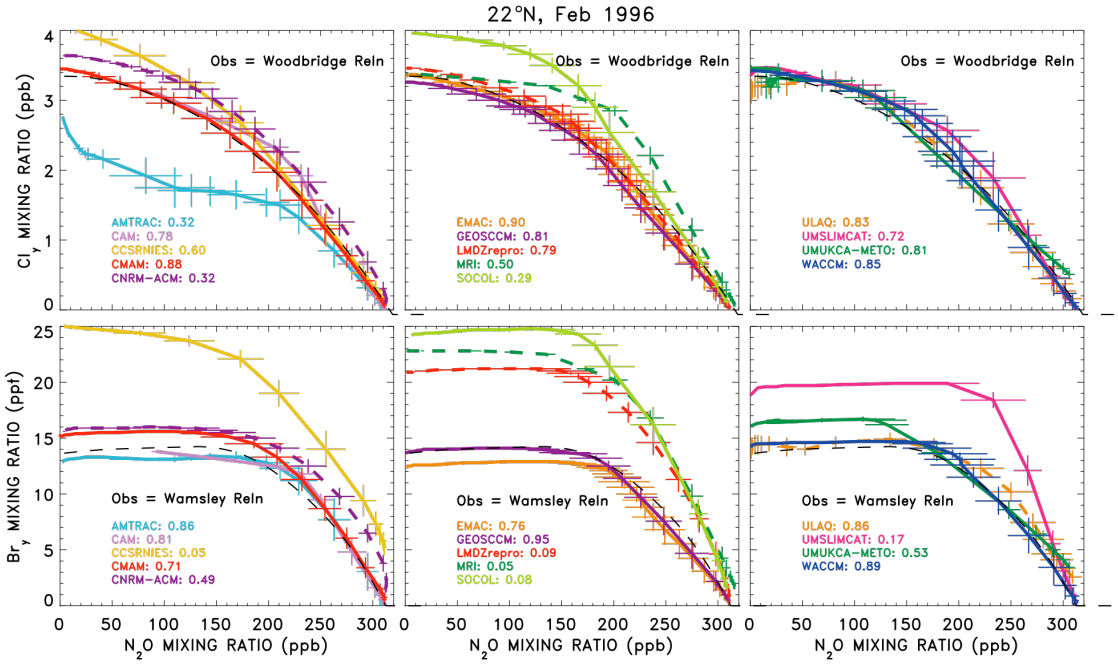


Figure 6S-3c: same as Figure 6S-3a, except comparisons of Cl_Y vs N_2O and Br_Y vs N_2O are shown.

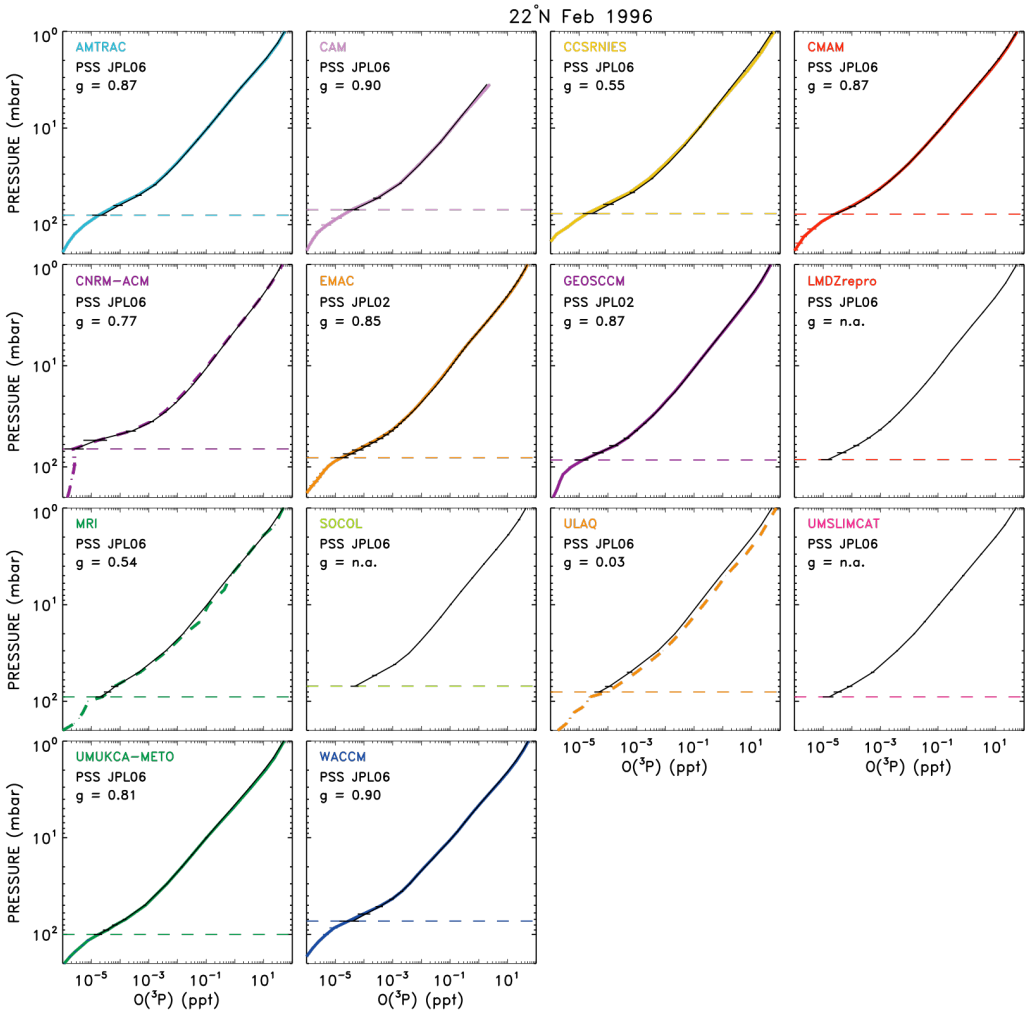


Figure 6S-4a: Comparison of zonal, monthly mean profiles of **O(^{3}P)** radicals from CCM models (coloured lines and symbols) versus 24-hour average radical profiles found using a PSS box model constrained by profiles of T, O_3, H_2O, CH_4, CO, NO_Y, Cl_Y, Br_Y, and sulfate SAD from the various CCMs for 22°N in **February 1996**. The PSS model was run for CCM model levels from the tropopause (dashed lines) to 1 hPa. The PSS model uses the latitude of the CCM output that is closest to 22°N and solar declination corresponding the the mid point of the monthly mean. Numerical values of g and the chemical kinetics in the simulation are given (see main chapter text). The coloured error bars represent the standard deviation about the zonal monthly mean for various days used to compute the mean. The black error bars represent the sensitivity of PSS output to variability in the CCM profiles of radical precursors.

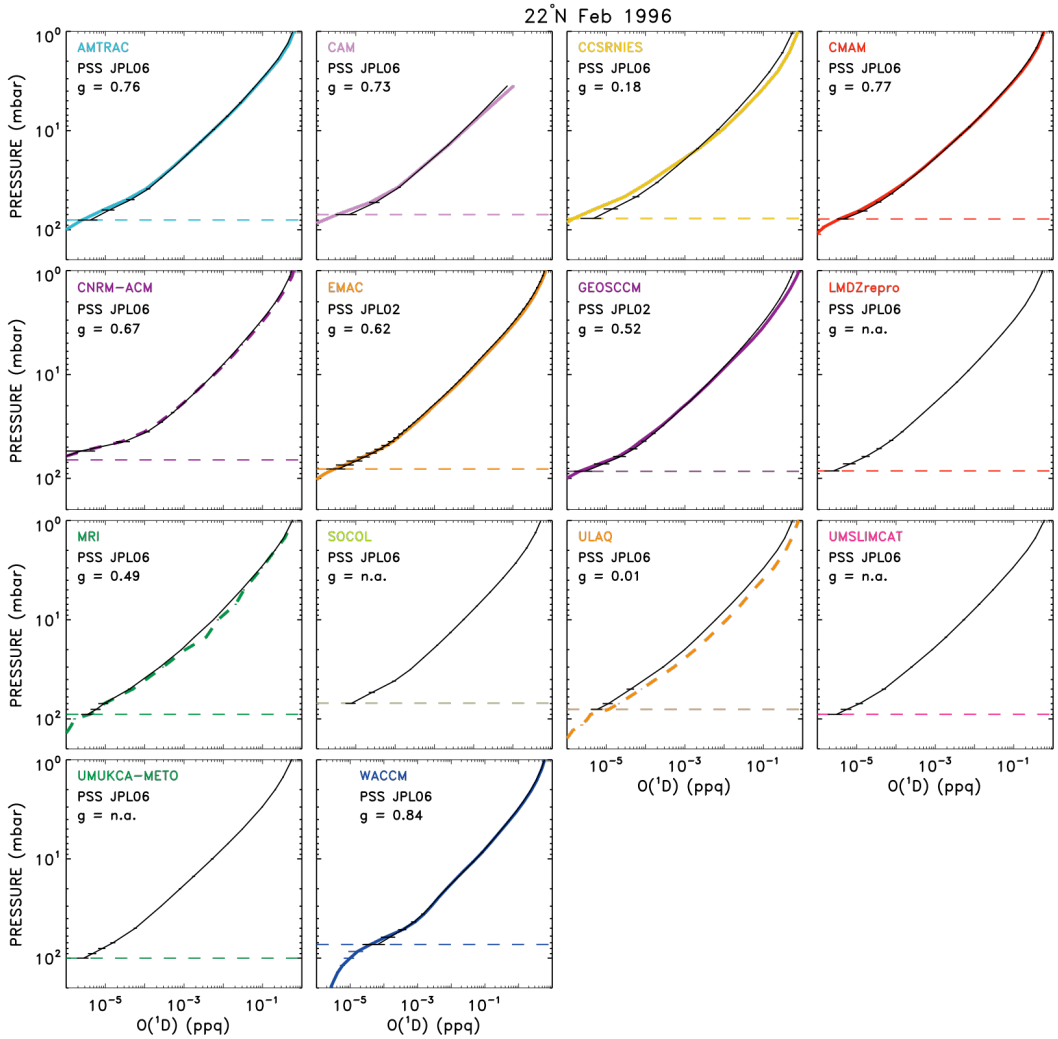


Figure 6S-4b: same as Figure 6S-4a, except **O(^{1}D)** is shown.

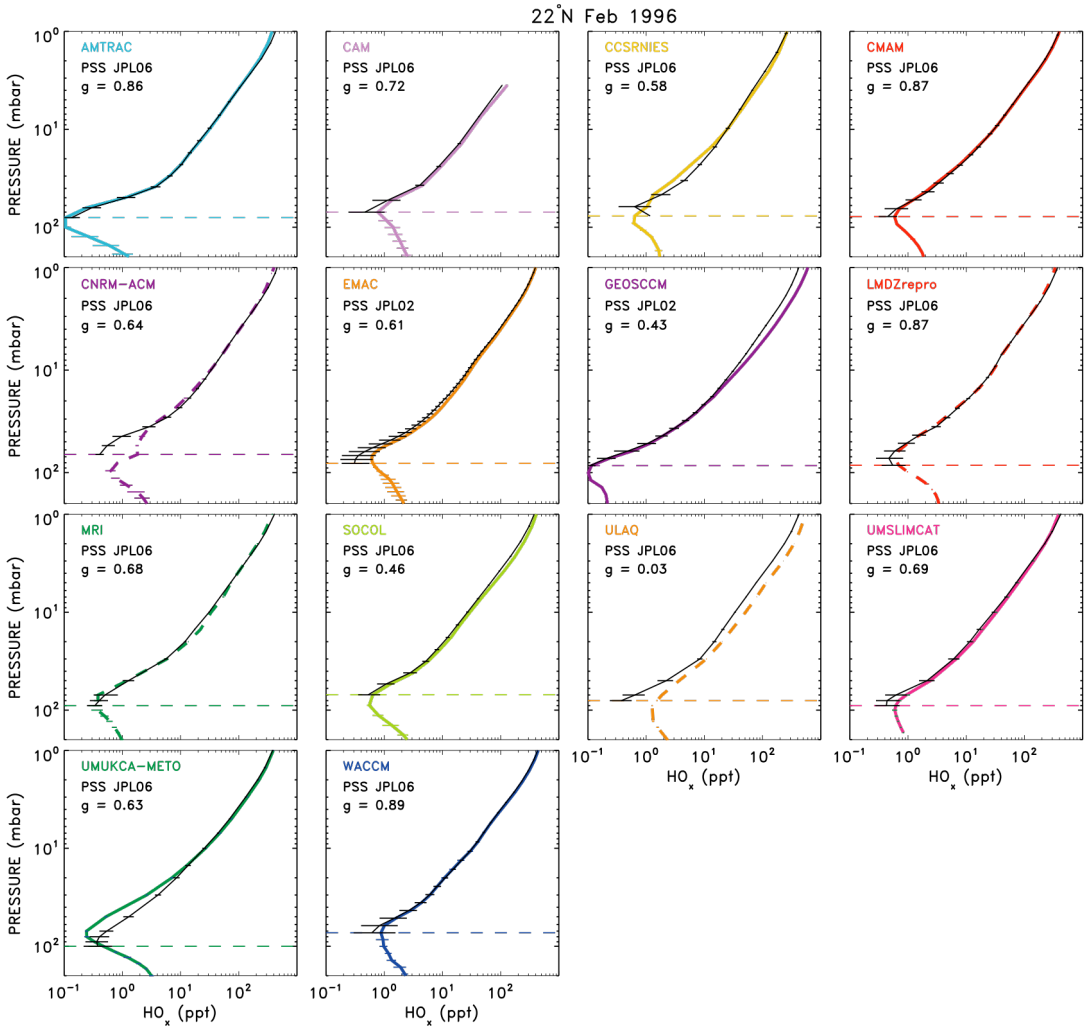


Figure 6S-4c: same as Figure 6S-4a, except **HO_X** is shown.

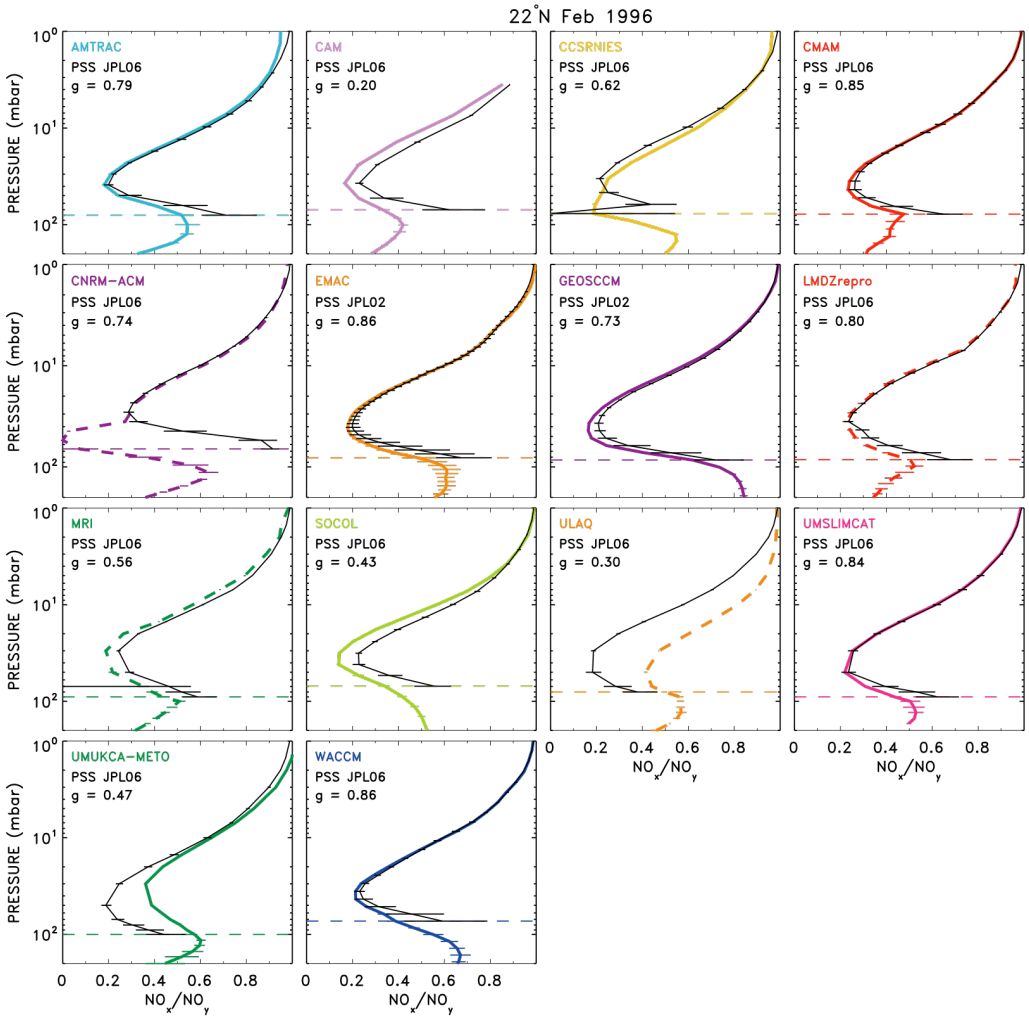


Figure 6S-4d: same as Figure 6S-4a, except **NO_X/NO_Y** is shown.

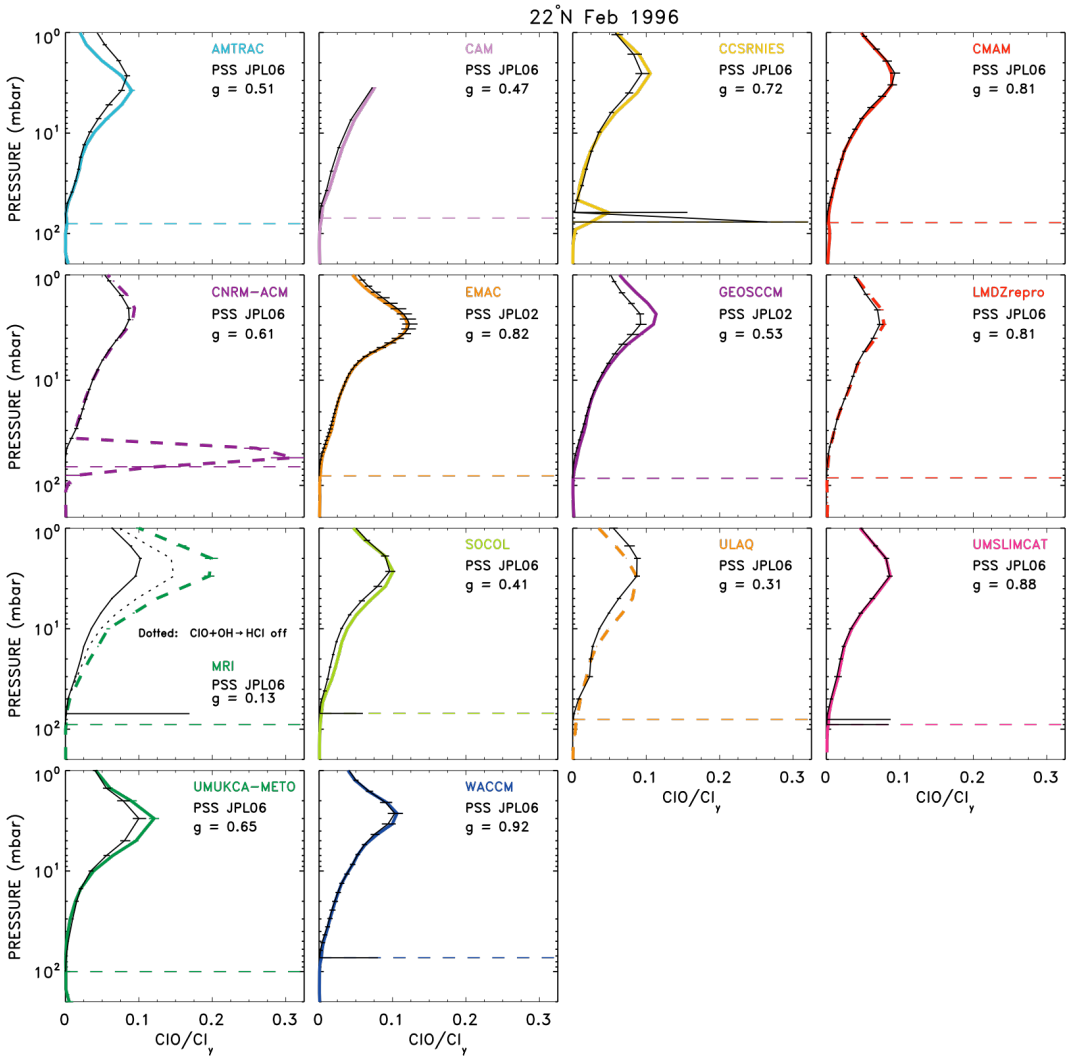


Figure 6S-4e: same as Figure 6S-4a, except **ClO/Cl_Y** is shown.

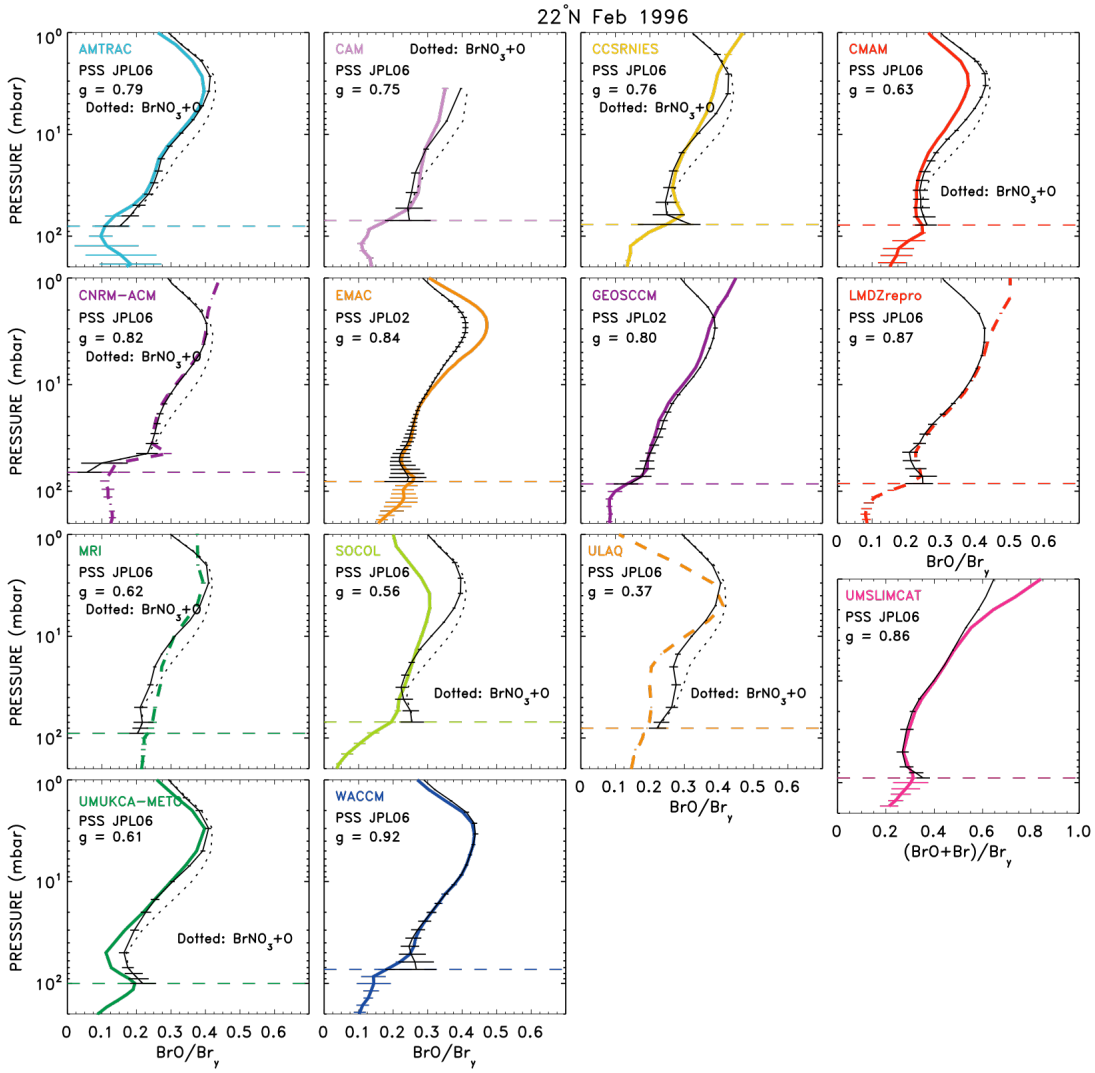


Figure 6S-4f: same as Figure 6S-4a, except **BrO/Br_Y** is shown.

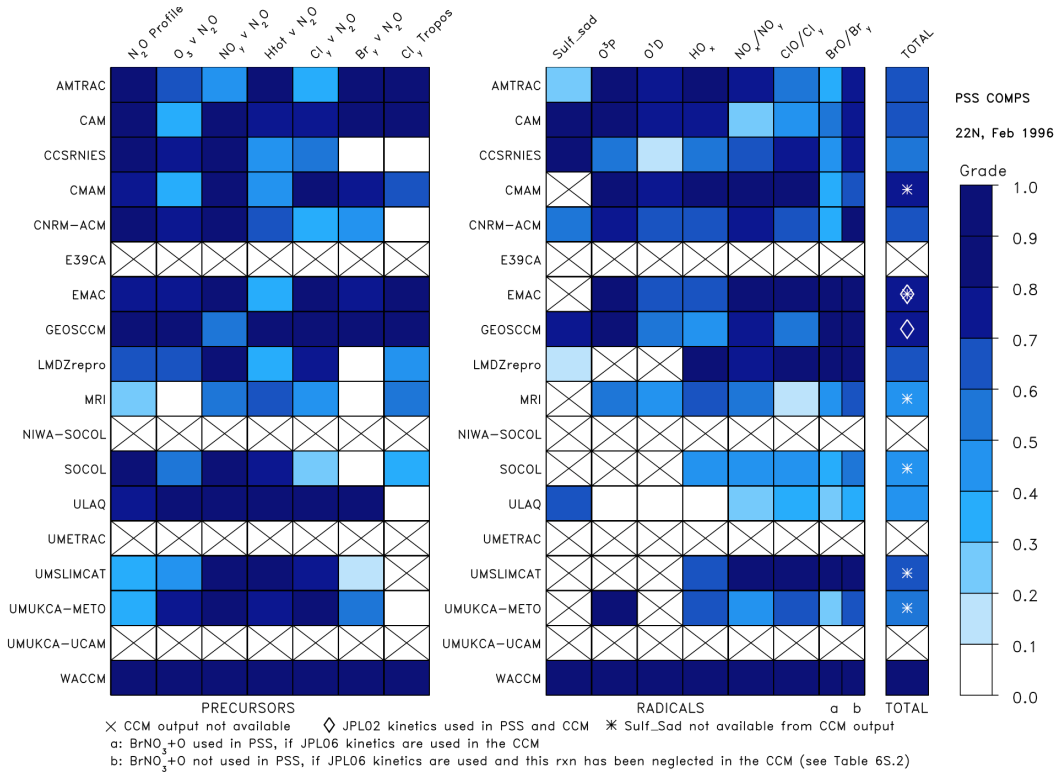


Figure S6-5: Metrics for (a, left) radical precursors and (b, right) sulfate surface area and radicals for a simulation carried out at 22°N February 1996. The same dark shade of blue is used for $0.8 < g < 1.0$, reflecting that there is little significance in differences that fall within this range of values. The symbol X denotes CCM output not archived; ◊ denotes use of JPL-2002 kinetics, and * denotes sulfate SAD not archived (see main chapter text). For models that used JPL-2006 kinetics and neglected the $BrONO_2$+O reaction, two grades are given for the evaluation of BrO/Br_Y (see text).

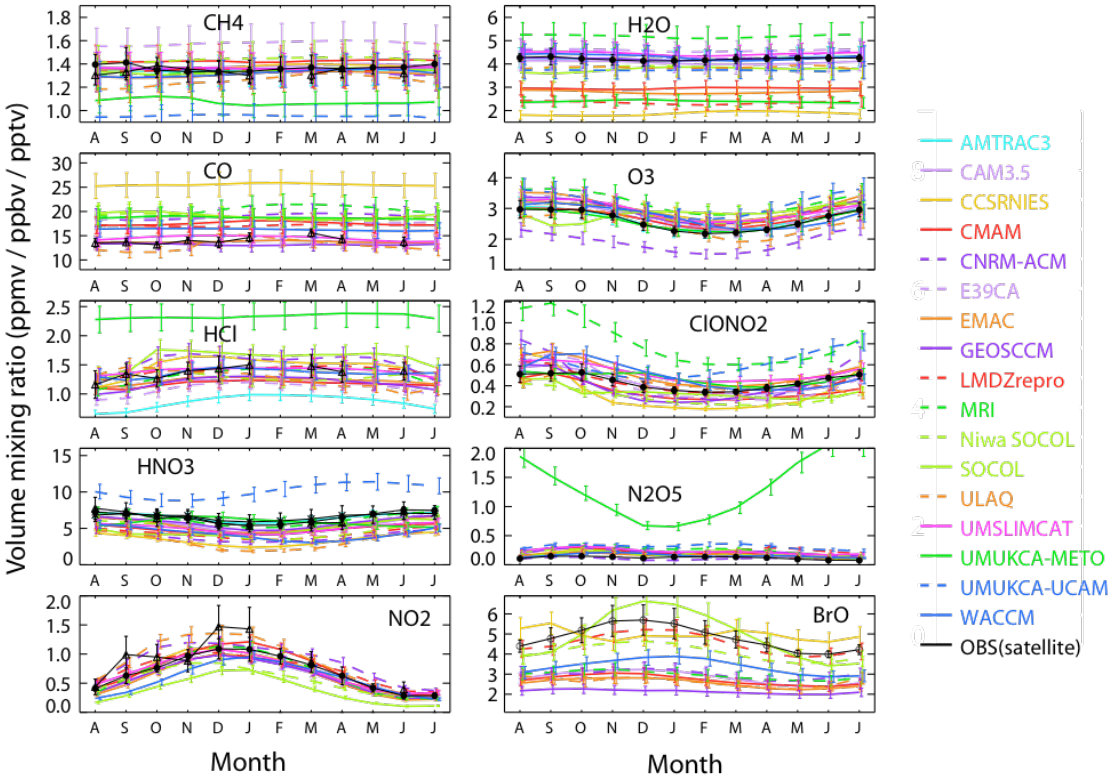


Figure 6S-6: Mean annual cycle for 30°S-60°S at 50 hPa for modelled (a) CH_4, (ppmv) (b) H_2O (ppmv), (c) CO (ppbv), (d) O_3 (ppmv), (e) HCl (ppbv), (f) $ClONO_2$ (ppbv), (g) HNO_3 (ppbv), (h) N_2O_5 (ppbv), (i) NO_2 (ppbv) and (j) BrO (pptv). The CCM data is taken from the T2Mz files (2000-2004, except E39CA model 1996-2000). Also shown are corresponding satellite observations from MIPAS (CH_4, H_2O, O_3, $ClONO_2$, HNO_3, N_2O_5, NO_2), ACE (CO, HCl), ODIN (HNO_3) and SCIAMACHY (BrO). The error bars are the standard deviations in the monthly mean values (except for ACE data).

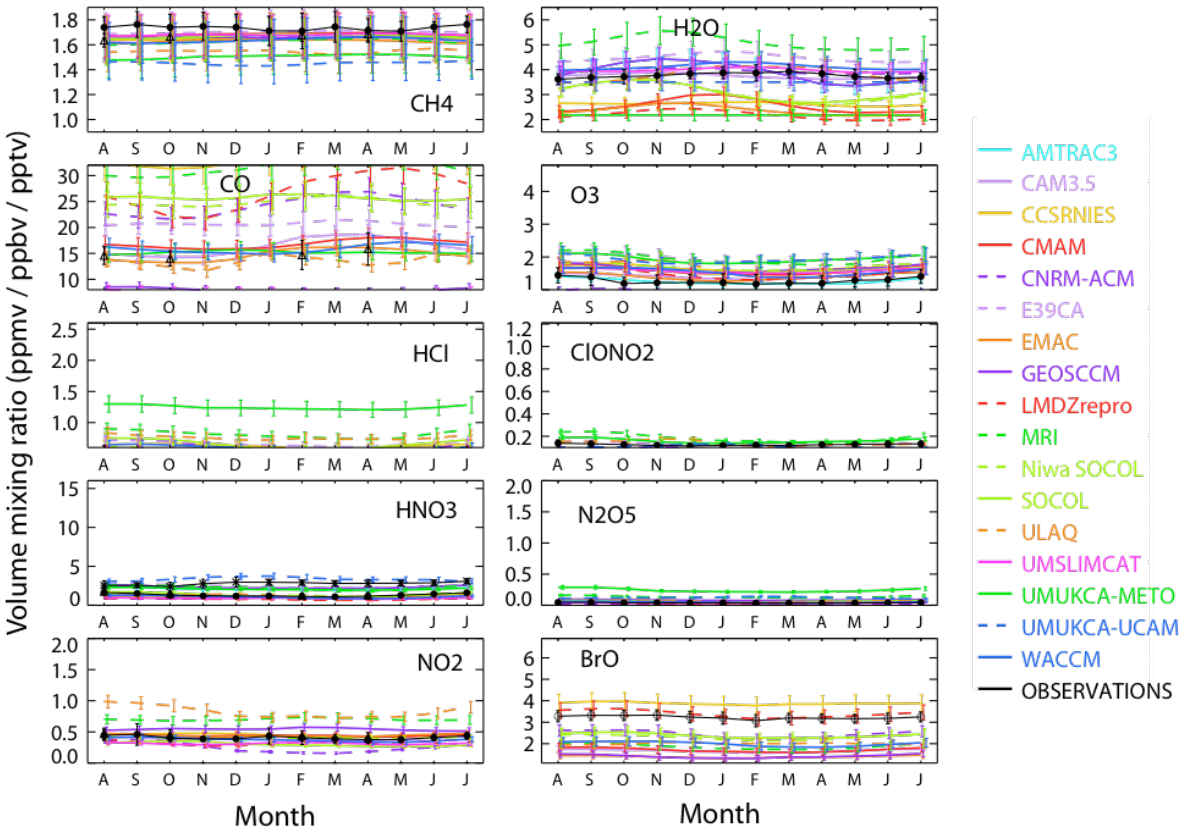


Figure 6S-7: As Figure 6S-6 but for the tropics 30°S-30°N.

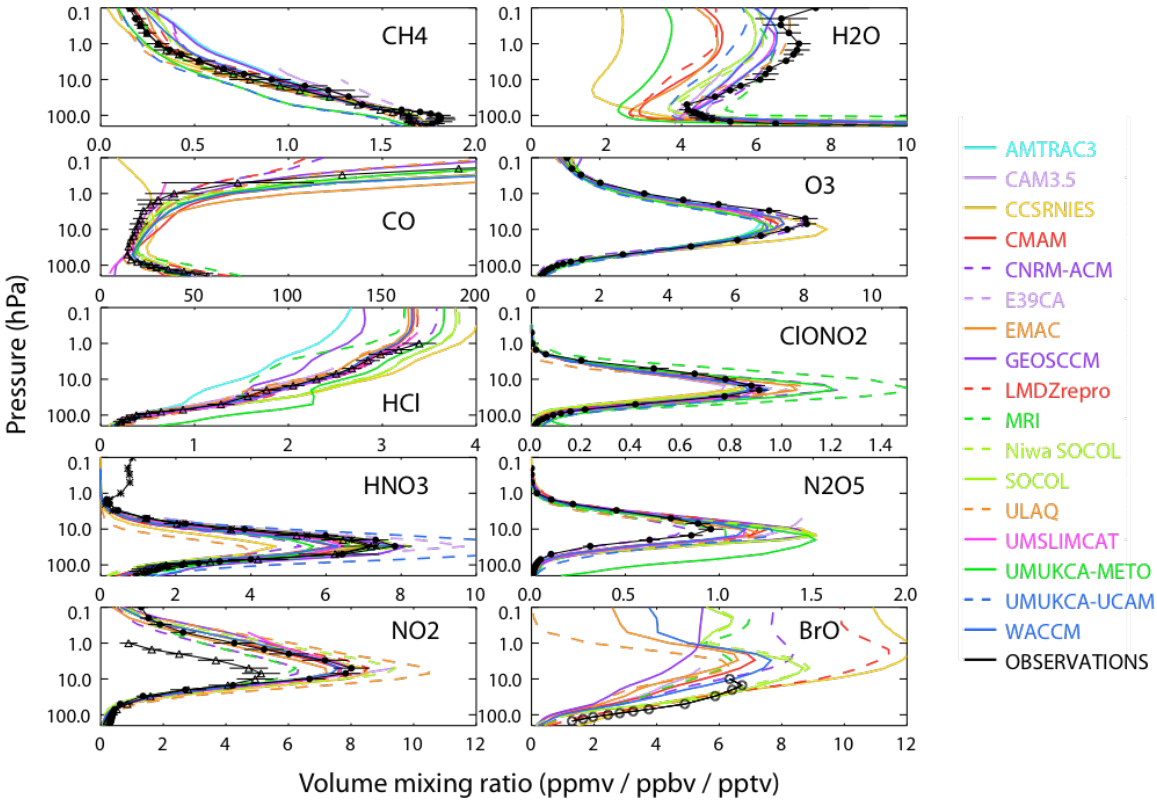


Figure 6S-8: Mean profiles for 30°N-60°N for modelled (a) CH_4, (ppmv) (b) H_2O (ppmv), (c) CO (ppbv), (d) O_3 (ppmv), (e) HCl (ppbv), (f) $ClONO_2$ (ppbv), (g) HNO_3 (ppbv), (h) N_2O_5 (ppbv), (i) NO_2 (ppbv) and (j) BrO (pptv). The CCM data is taken from the T2Mz files (2000-2004, except E39CA model 1996-2000). Also shown are corresponding satellite observations from MIPAS (CH_4, H_2O, O_3, $ClONO_2$, HNO_3, N_2O_5, NO_2), ACE (CO, HCl), ODIN (HNO_3) and SCIAMACHY (BrO). The error bars are the standard deviations in the annual mean values (except for ACE data).

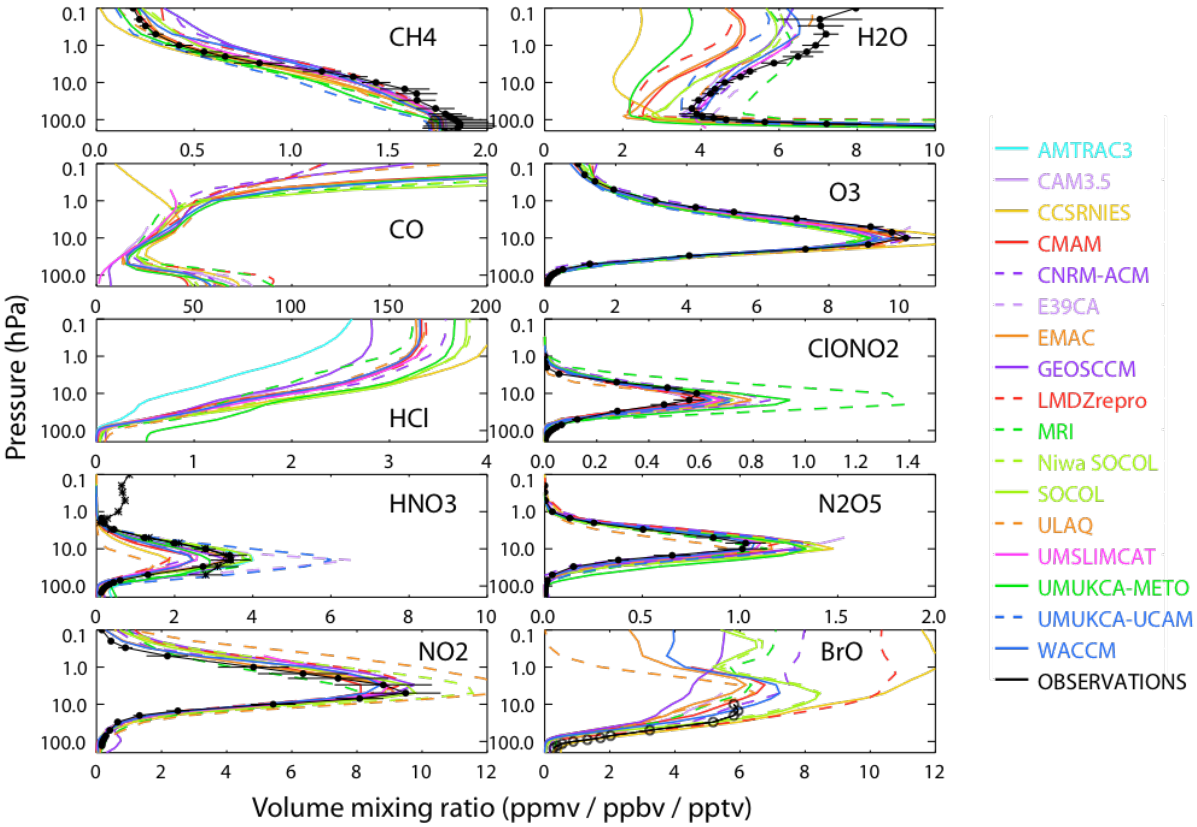


Figure 6S-9: As Figure 6S-8 but for the tropics 30°S-30°N.

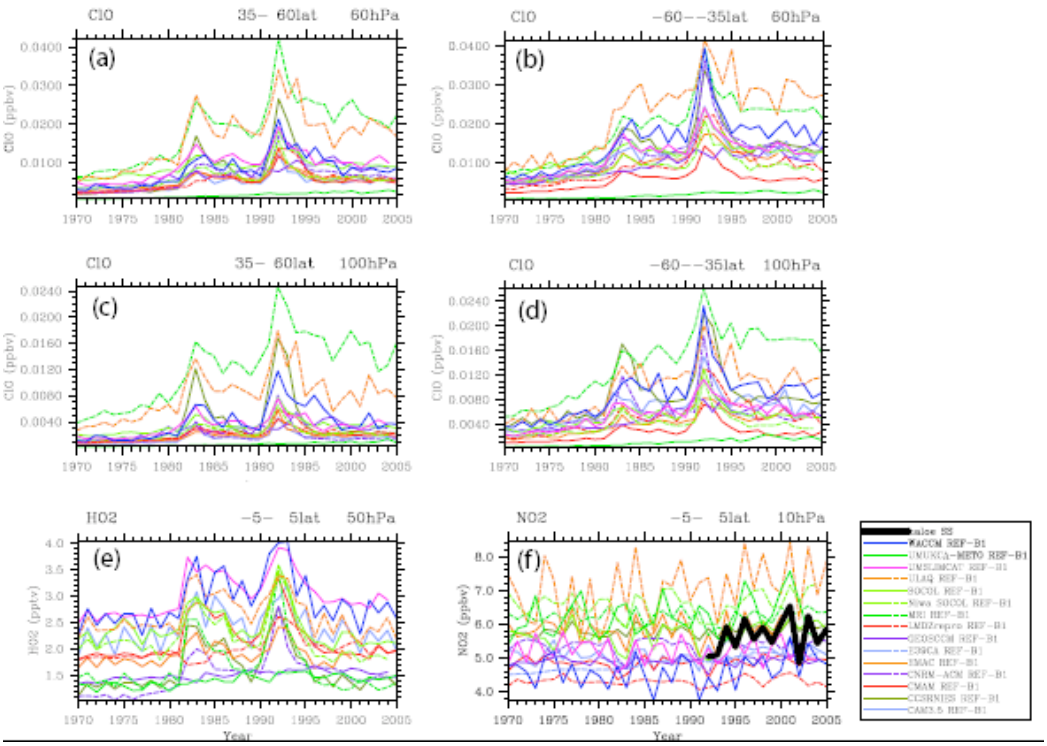


Figure 6S-10. Time series of mean tracer mixing ratios for (a) ClO (ppbv) 35°N-60°N at 60 hPa, (b) ClO (ppbv) 35°S-60°S at 60 hPa, (c) ClO (ppbv) 35°N-60°N at 100 hPa, (d) ClO (ppbv) 35°S-60°S at 100 hPa, (e) HO_2 (pptv) 5°S-5°N at 50 hPa, and (f) NO_2 (ppbv) 5°S-5°N at 10 hPa. Also shown for NO_2 are HALOE sunset observations converted to 24-hr mean using output from the EMAC model.

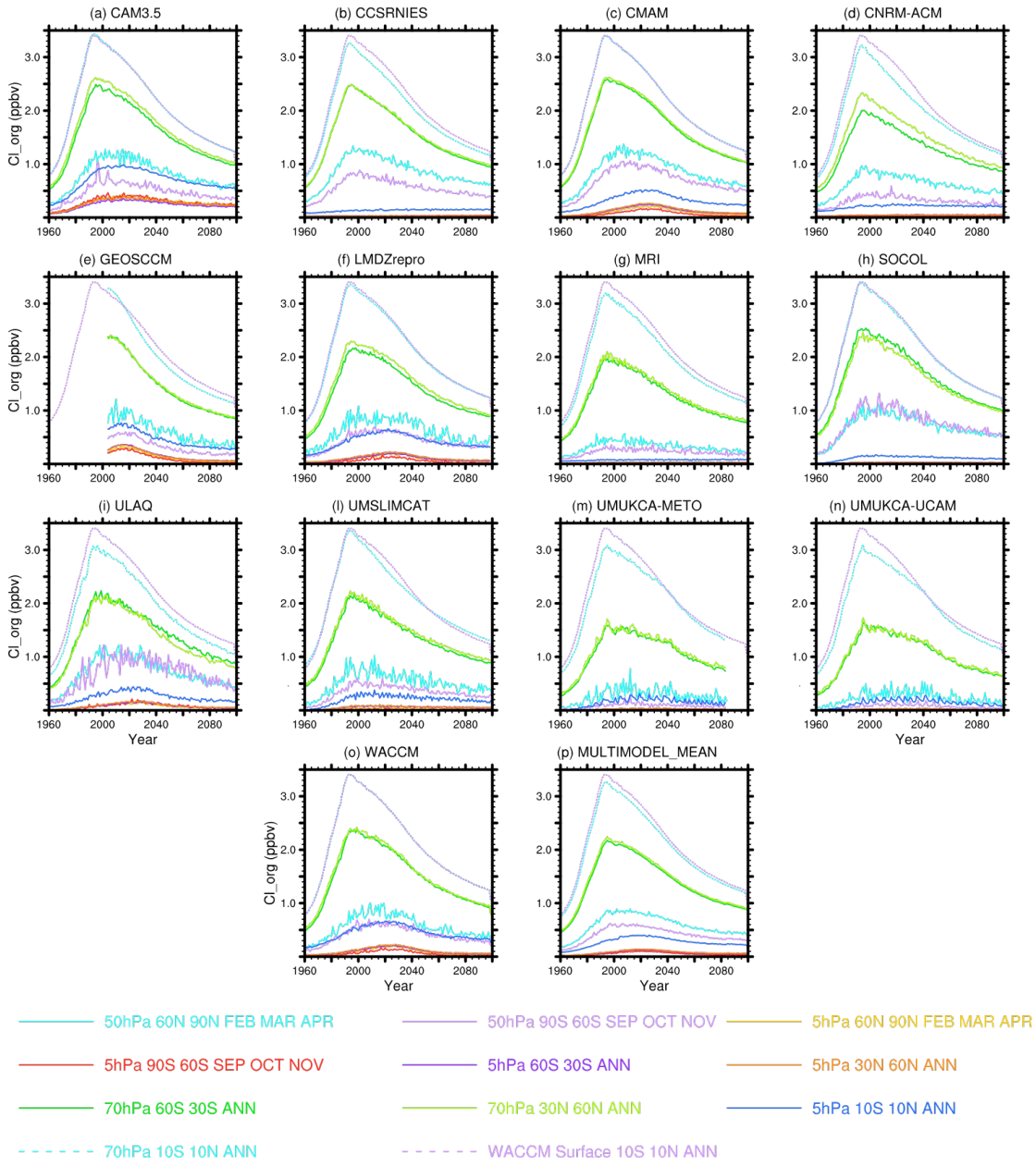


Figure 6S-11: Time series of organic chlorine volume mixing ratio (organic chlorine tracers) (ppbv) from 1960 to 2100 from 13 **REF-B2** CCM simulations and the multimodel mean. A selection of averages within different latitude bands and at different altitudes are plotted. For reference, each panel also includes the total chlorine curve from the WACCM model at the surface (black dashed line).

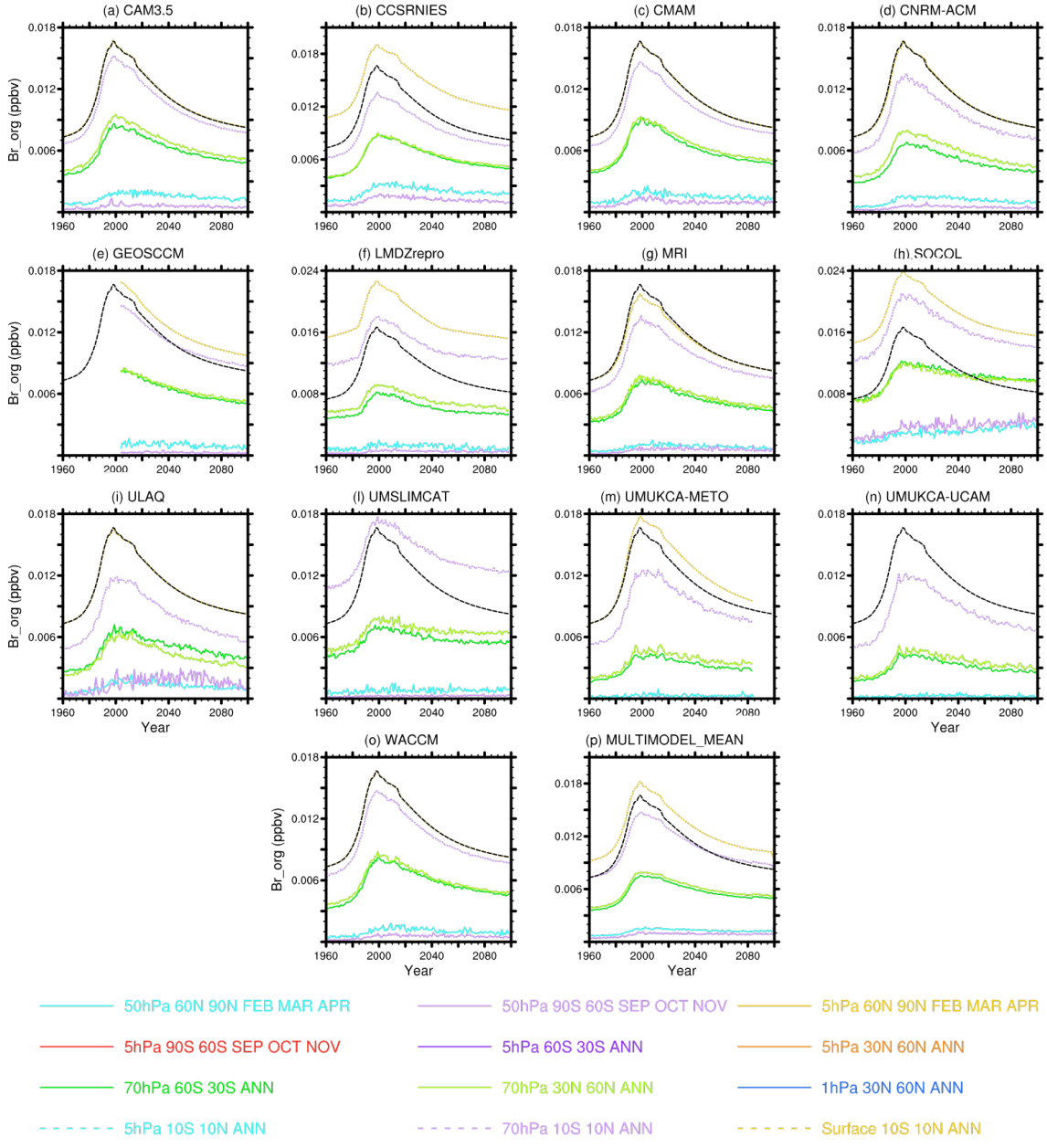
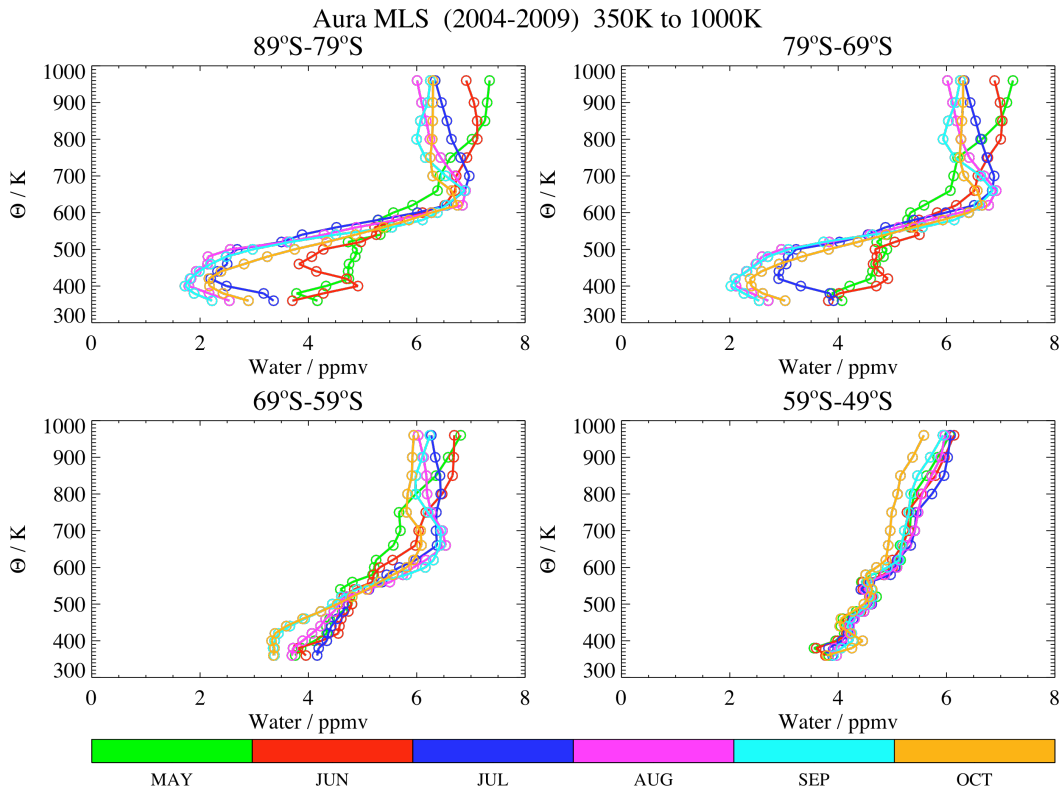


Figure 6S-12: As Figure 6S-11 but for organic bromine mixing ratio (pptv).



126
127 **Figure 6S-13.** Southern hemisphere profiles of H_2O versus θ from Aura MLS at mid-
128 month (on the 15th day of each month shown in colour bar), from May through October,
129 based on a 5-yr MLS climatology (mid-2004 to mid-2009). Profiles are averaged over the
130 EqL ranges shown above each panel.
131

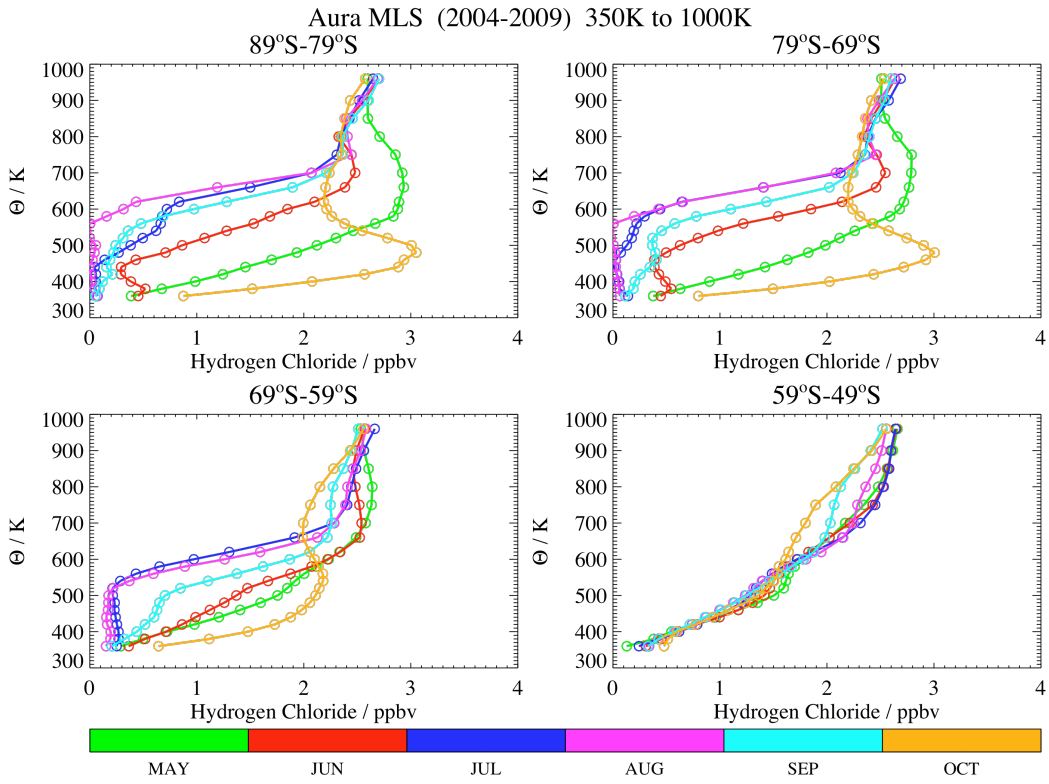


Figure 6S-14. Same as Figure 6S-13, except for HCl.

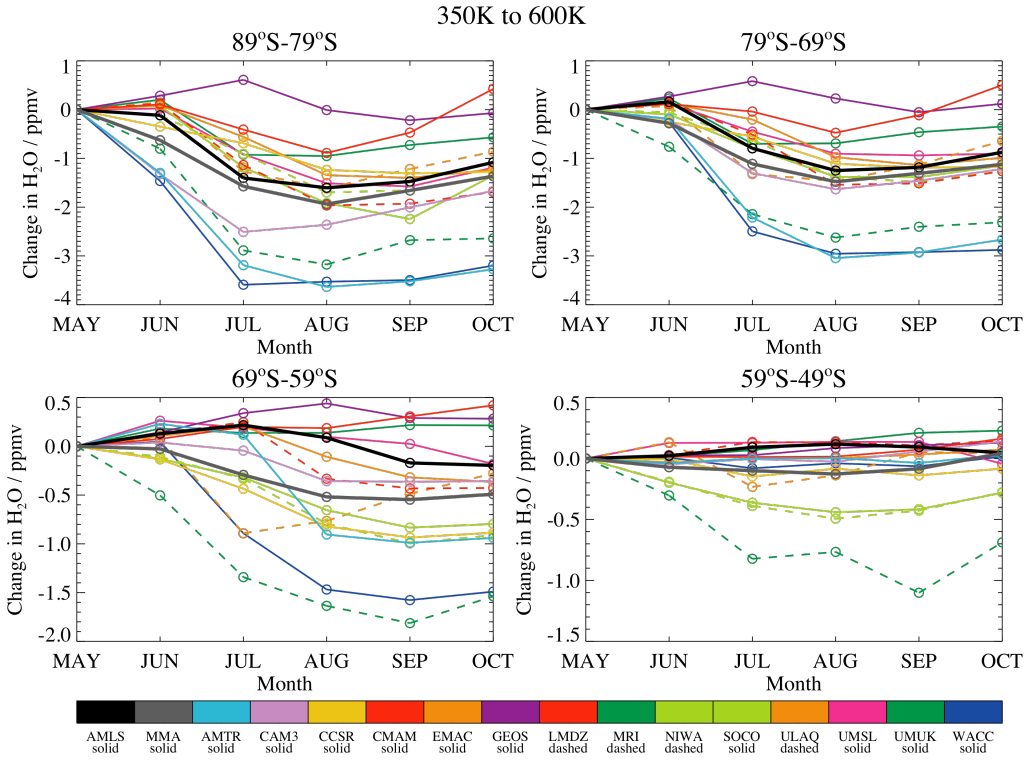


Figure 6S-15: Change in H_2O from 350K to 600K, relative to May, for Aura MLS (abbreviated as AMLS in legend) and 14 CCM climatologies (legend uses first 4 letters of each model) and multimodel mean.

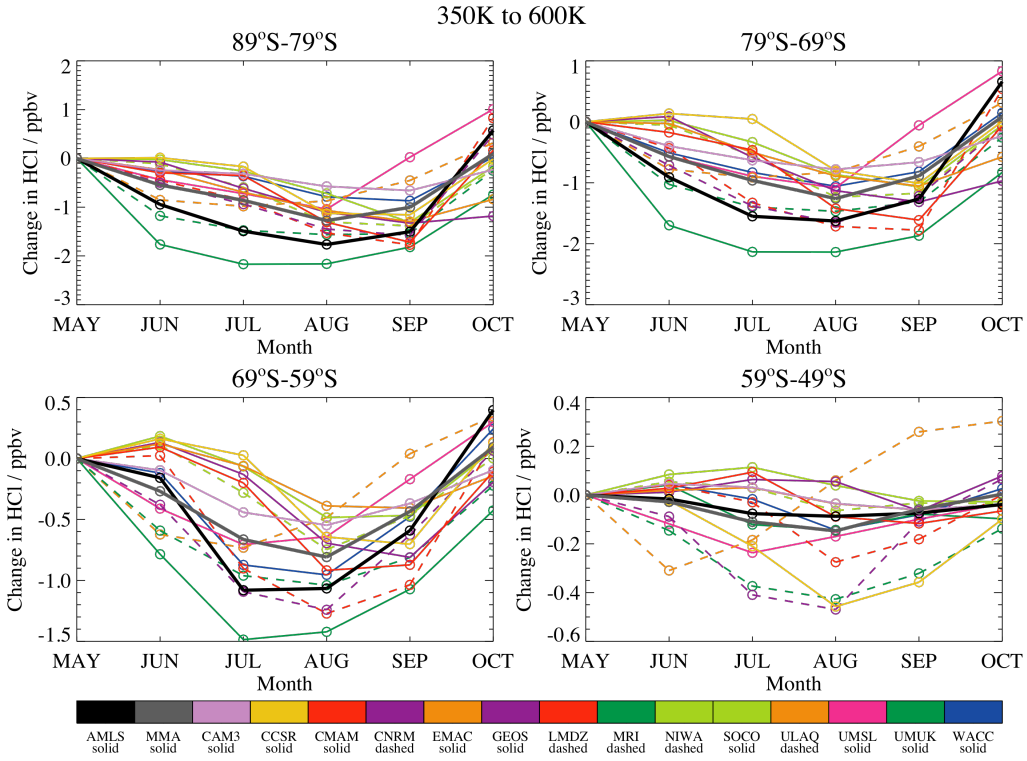
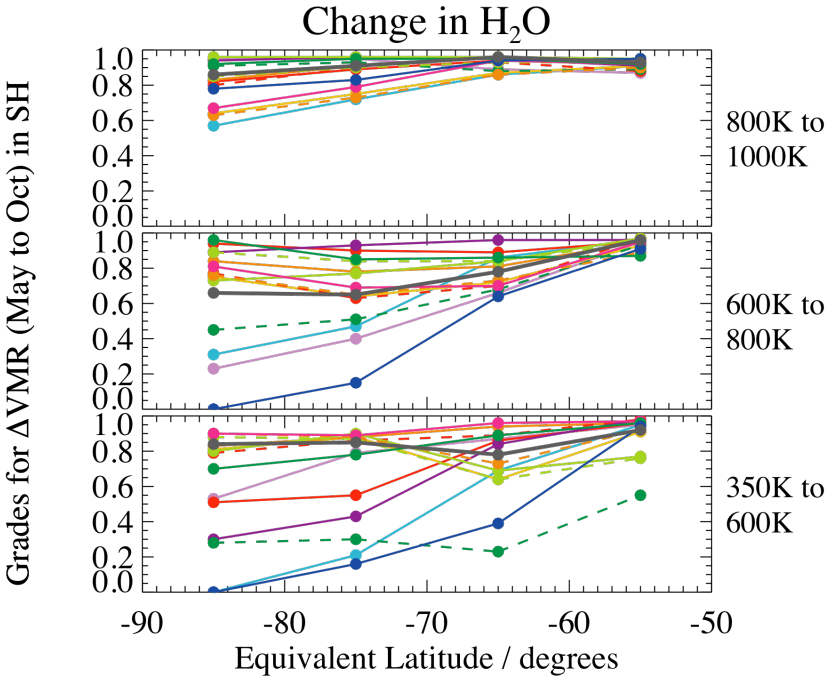
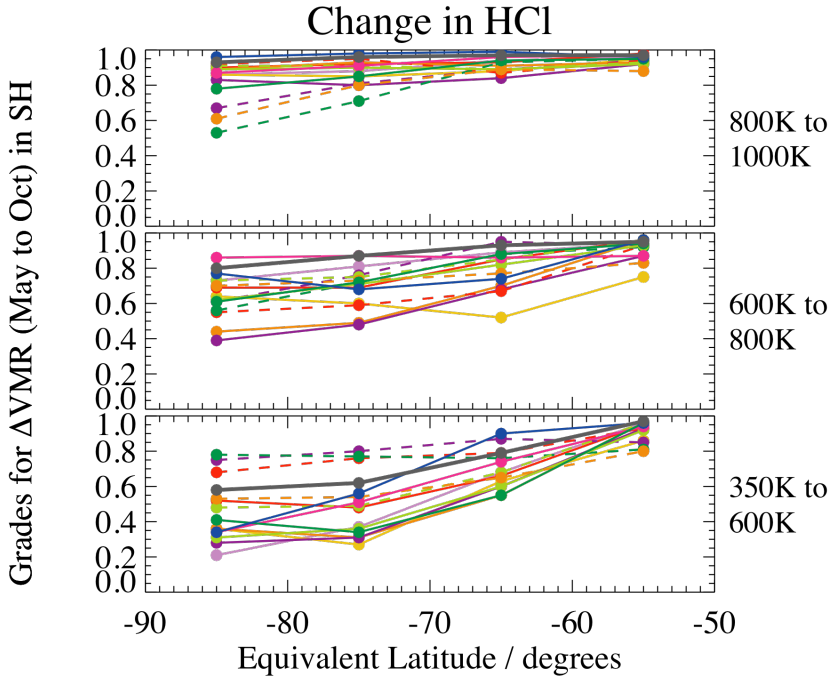


Figure 6S-16: As Figure 6S-15 but for HCl.



142
143 **Figure 6S-17:** Grades obtained for 14 CCMs from a comparison of model versus MLS-
144 derived climatological changes in H_2O (see main chapter text and Figure 6S-12). Grades
145 are calculated for 4 EqL bins and 3 ranges of θ values. Colours and linestyles correspond
146 to those shown in Figure 6S-16.
147



148
149 **Figure 6S-18:** As Figure 6S-17 but for HCl.
150

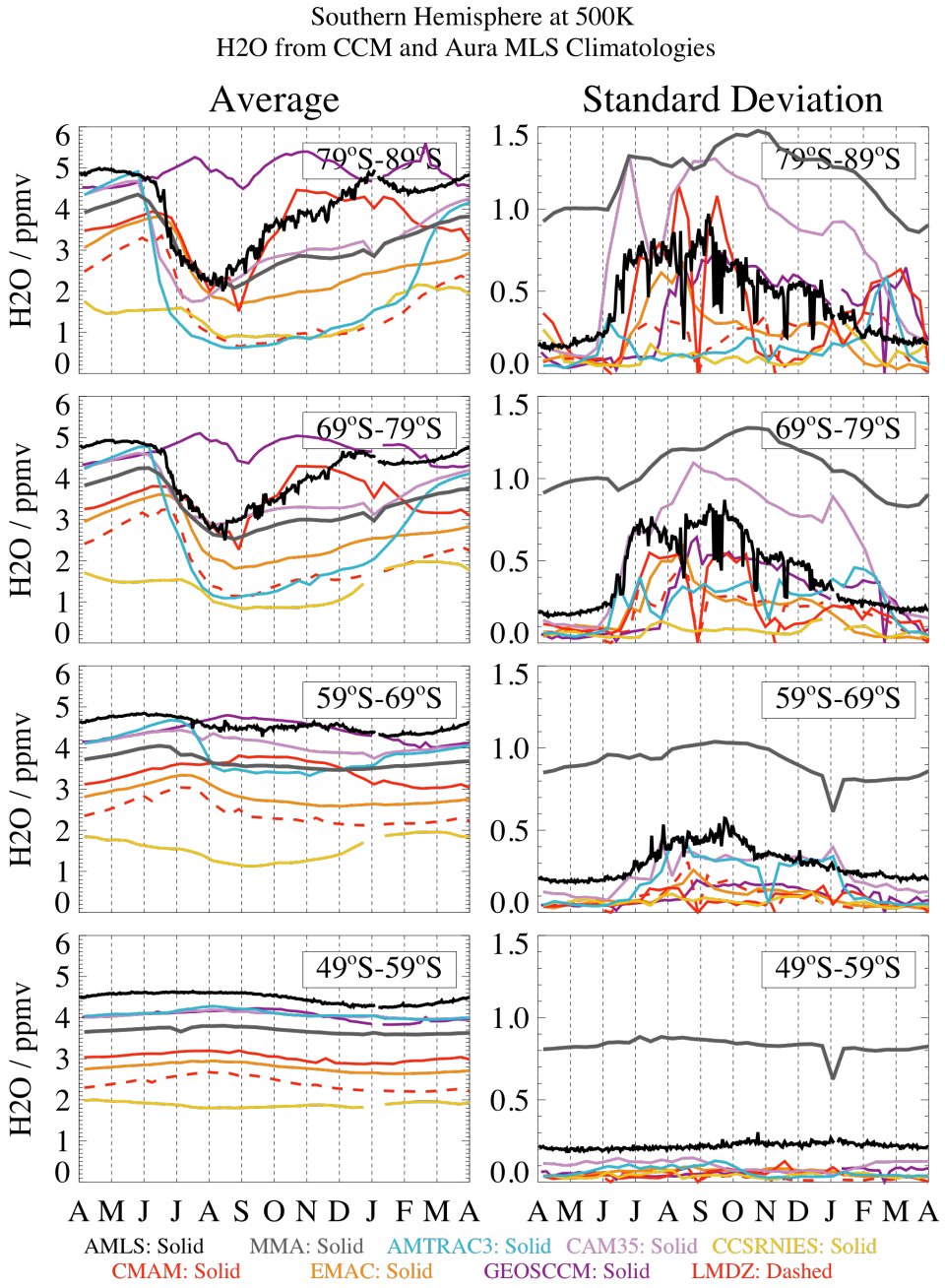


Figure 6S-19a: Left panels display variations in average H_2O at 500K during the course of a year in 4 EqL bins, based on climatologies from Aura MLS (black, solid lines) and 7 CCMs (with model sources shown in bottom legend). Right panels show the corresponding rms variability over the 5-year climatology, for each sampled day of year.

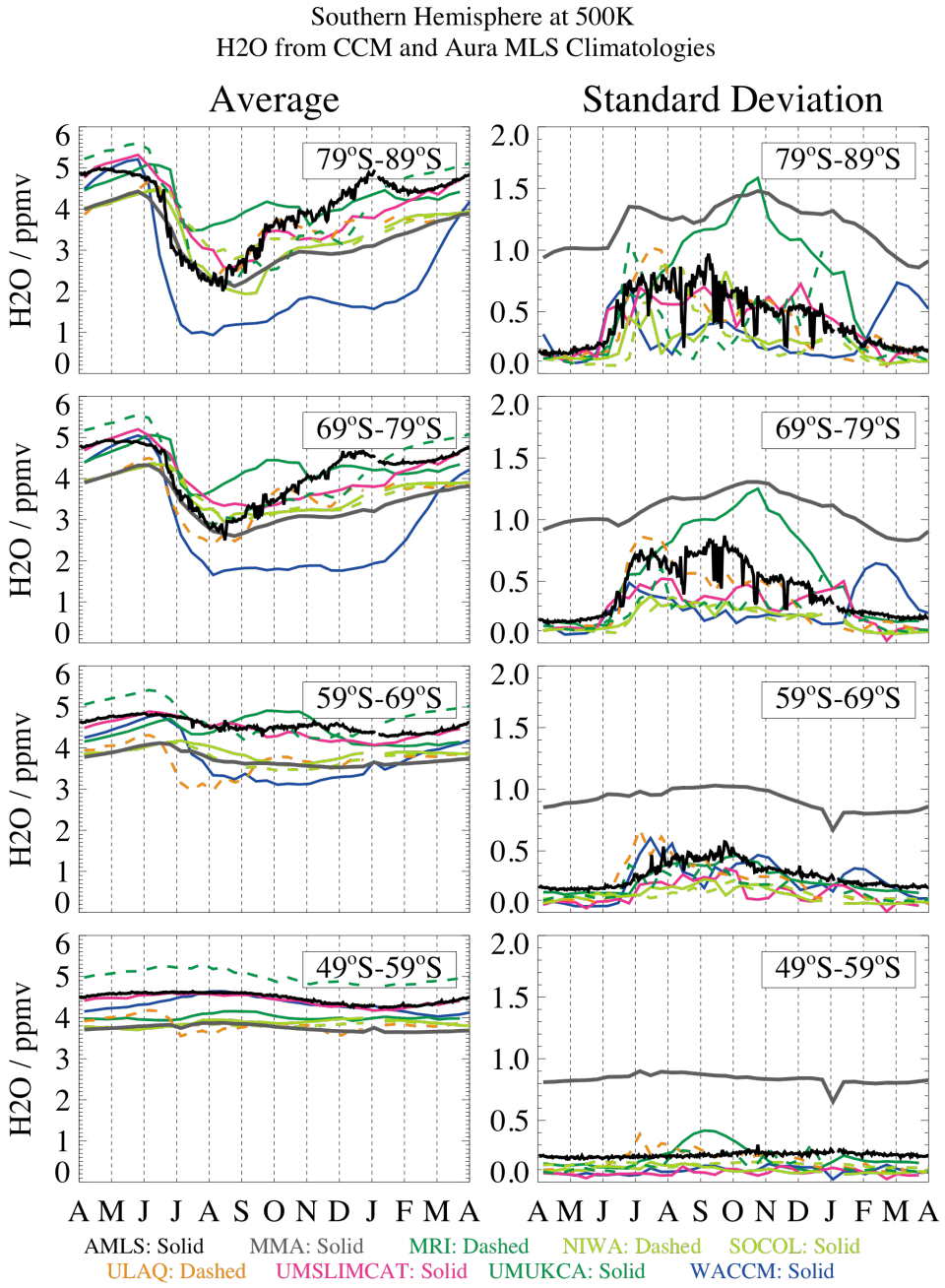


Figure 6S-19b: Same as Figure 6S-16a, but for Aura MLS H_2O (and its rms variability) compared to the 7 other available CCM distributions of H_2O versus time of year.

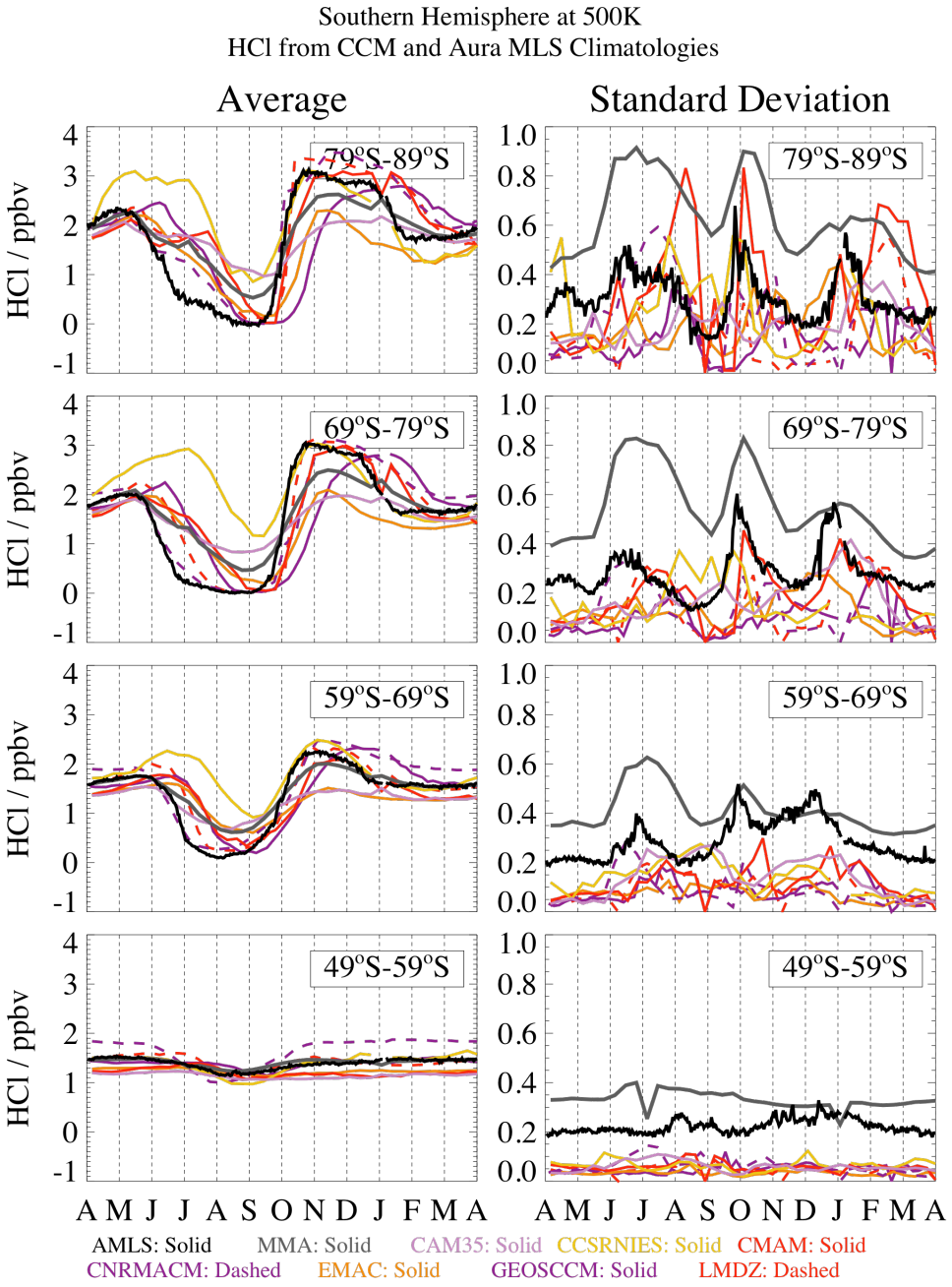


Figure 6S-20a: Left panels display variations in average HCl at 500K during the course of a year in 4 EqL bins, based on climatologies from Aura MLS (black, solid lines) and 7 CCMs (with model sources shown in bottom legend). Right panels show the corresponding rms variability over the 5-year climatology, for each sampled day of year.

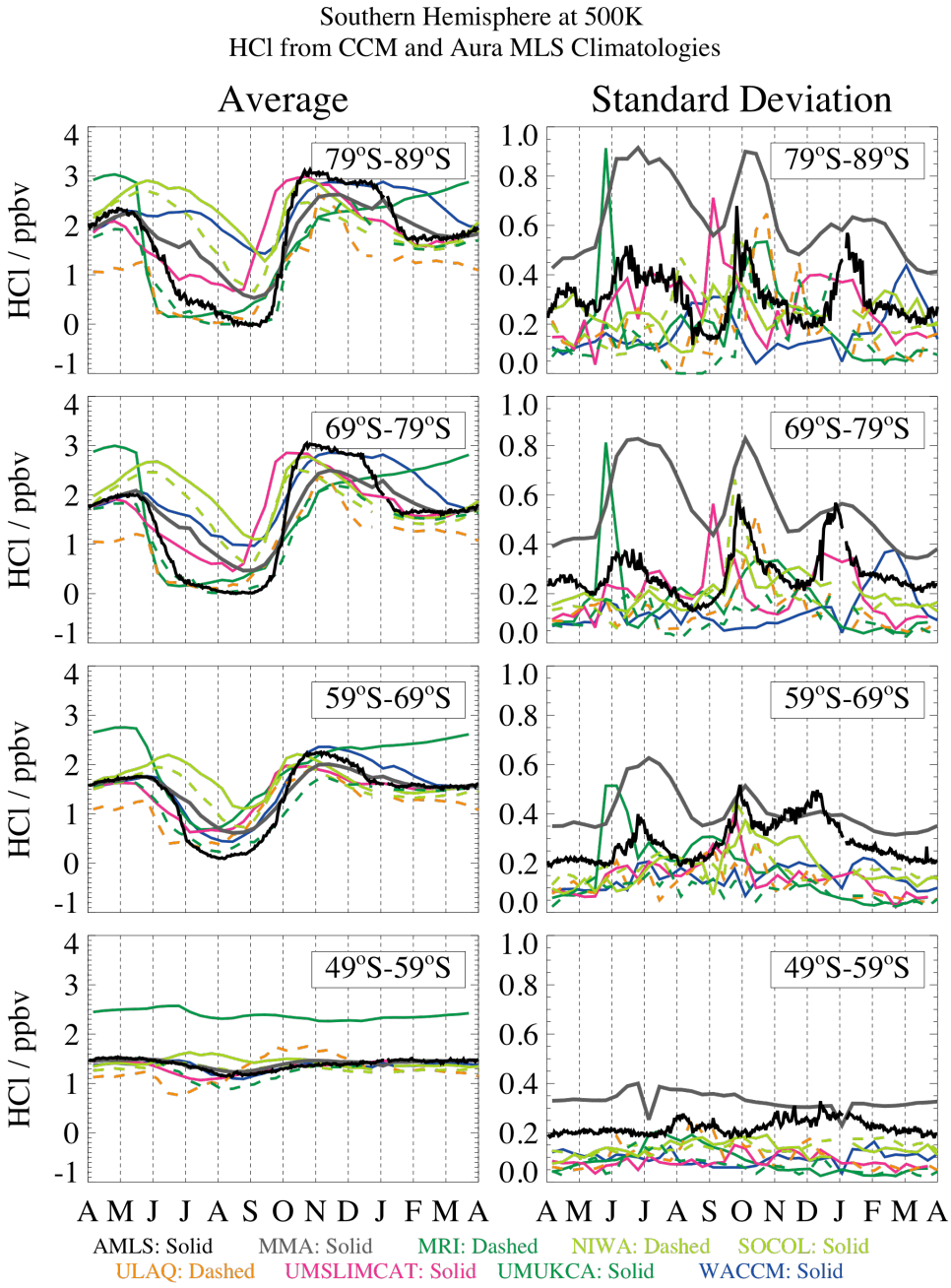


Figure 6S-20b: Same as Figure 6S-20a, but for Aura MLS HCl (and its rms variability) compared to the 7 other available CCM distributions of HCl versus time of year.