SUPPLEMENT to Froidevaux et al. (2018 manuscript submitted to ACPD)

Evaluation of CESM1 (WACCM) free-running and specified-dynamics atmospheric composition simulations using global multi-species satellite data records

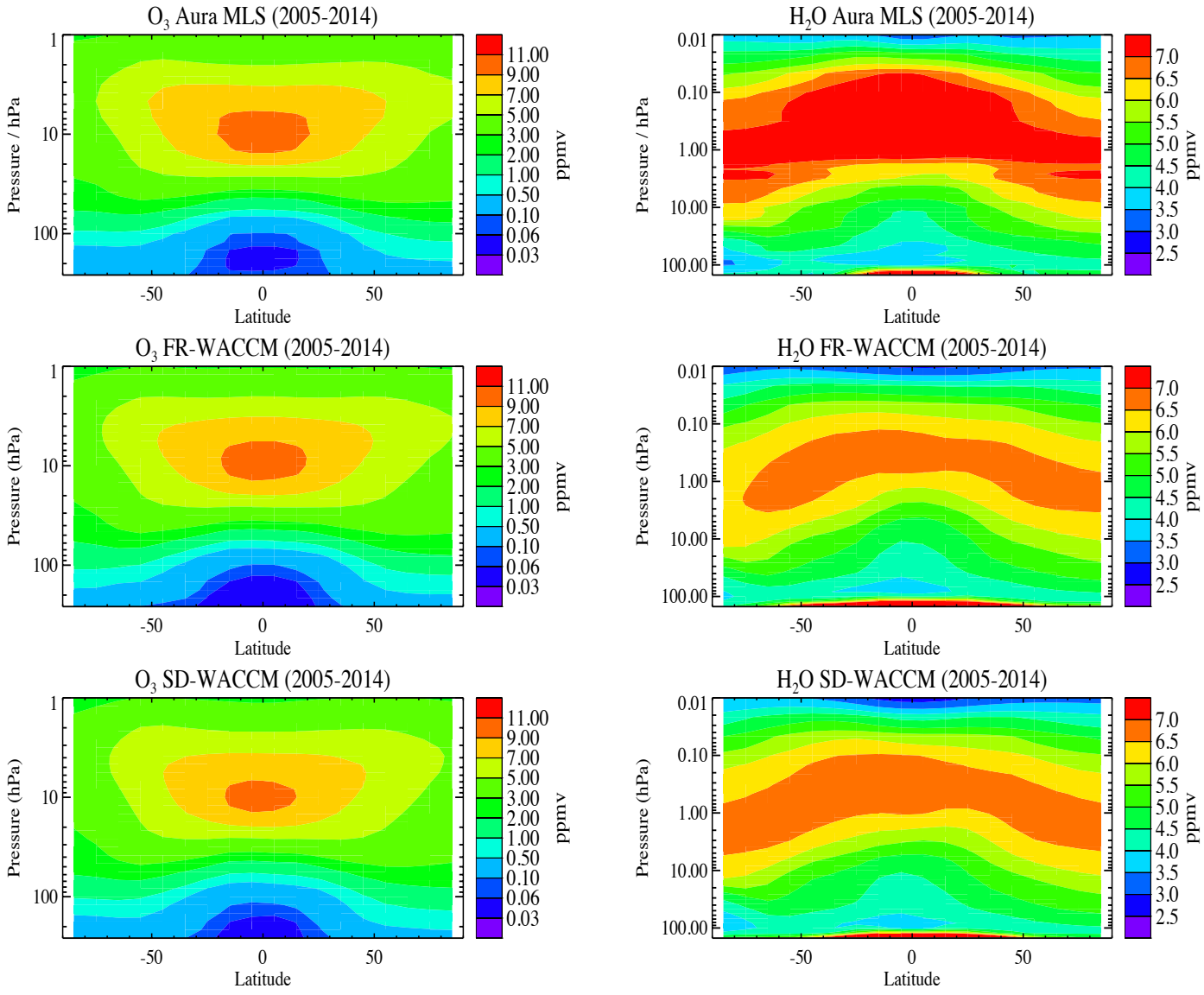

Figure S1. Latitude/pressure contour plots of the average climatological abundances of O_3 (left panels) and H_2O (right panels) for 2005 through 2014. Results are shown for Aura MLS data (top panels), the WACCM free running model (FR-WACCM), and the WACCM specified dynamics version (SD-WACCM).

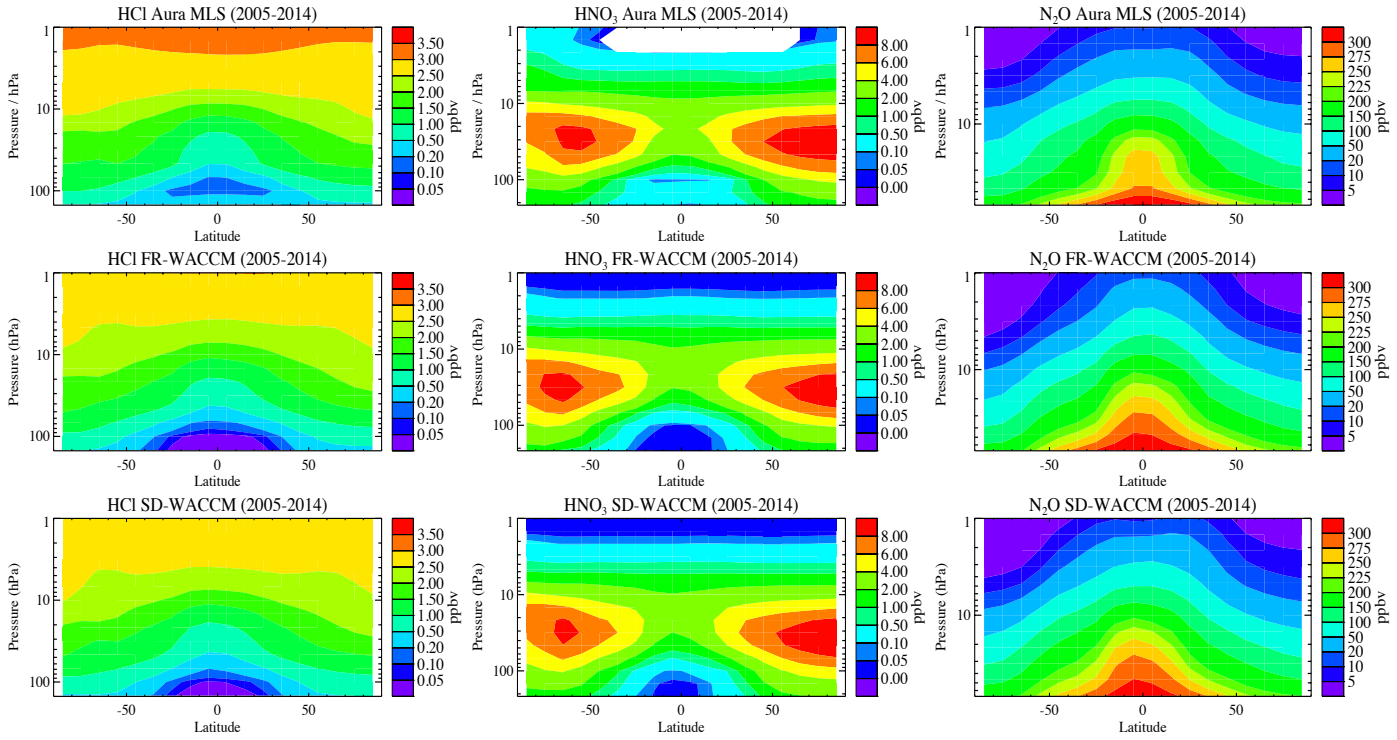

Figure S2. Same as Fig. S1, but for the 2005-2014 climatologies (from Aura MLS, FR-WACCM and SD-WACCM) of three other species: HCl (left panels), HNO_3 (center panels), and N_2O (right panels).

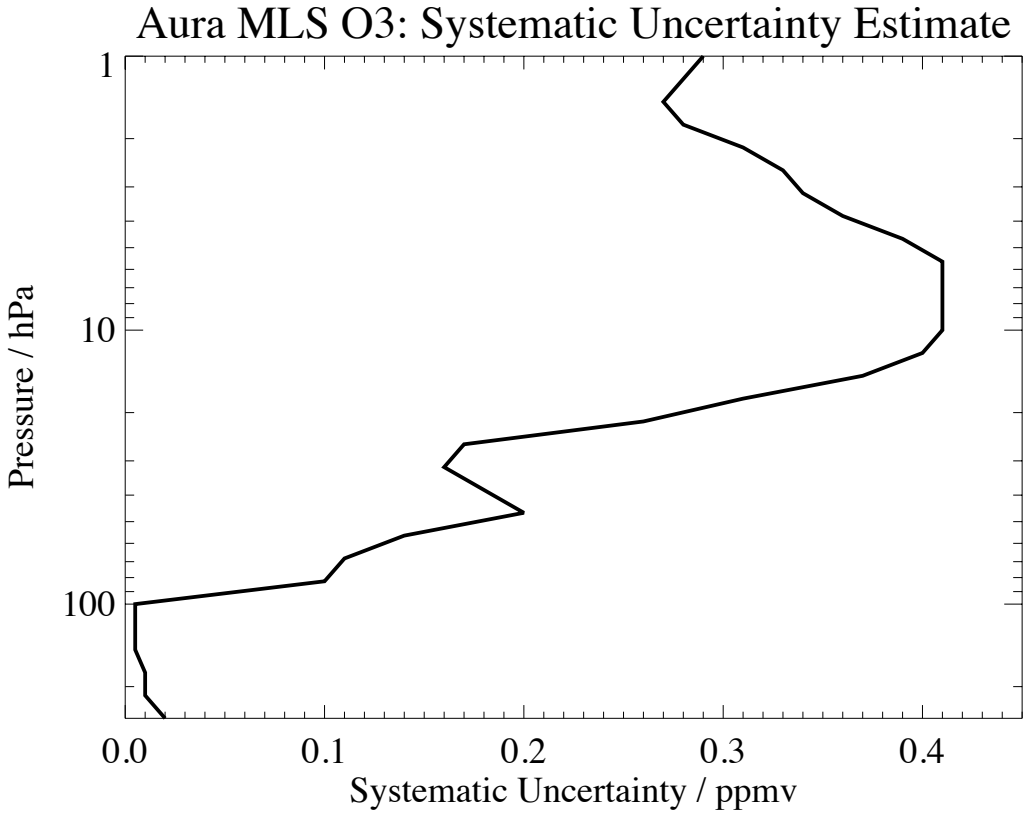

Figure S3. Profile of globally-averaged systematic uncertainties (2σ estimates) in Aura MLS ozone, based on the MLS team's characterization of the likely (known) error sources and their calculated impact on Level 2 retrievals, coupled with validation results (see text).

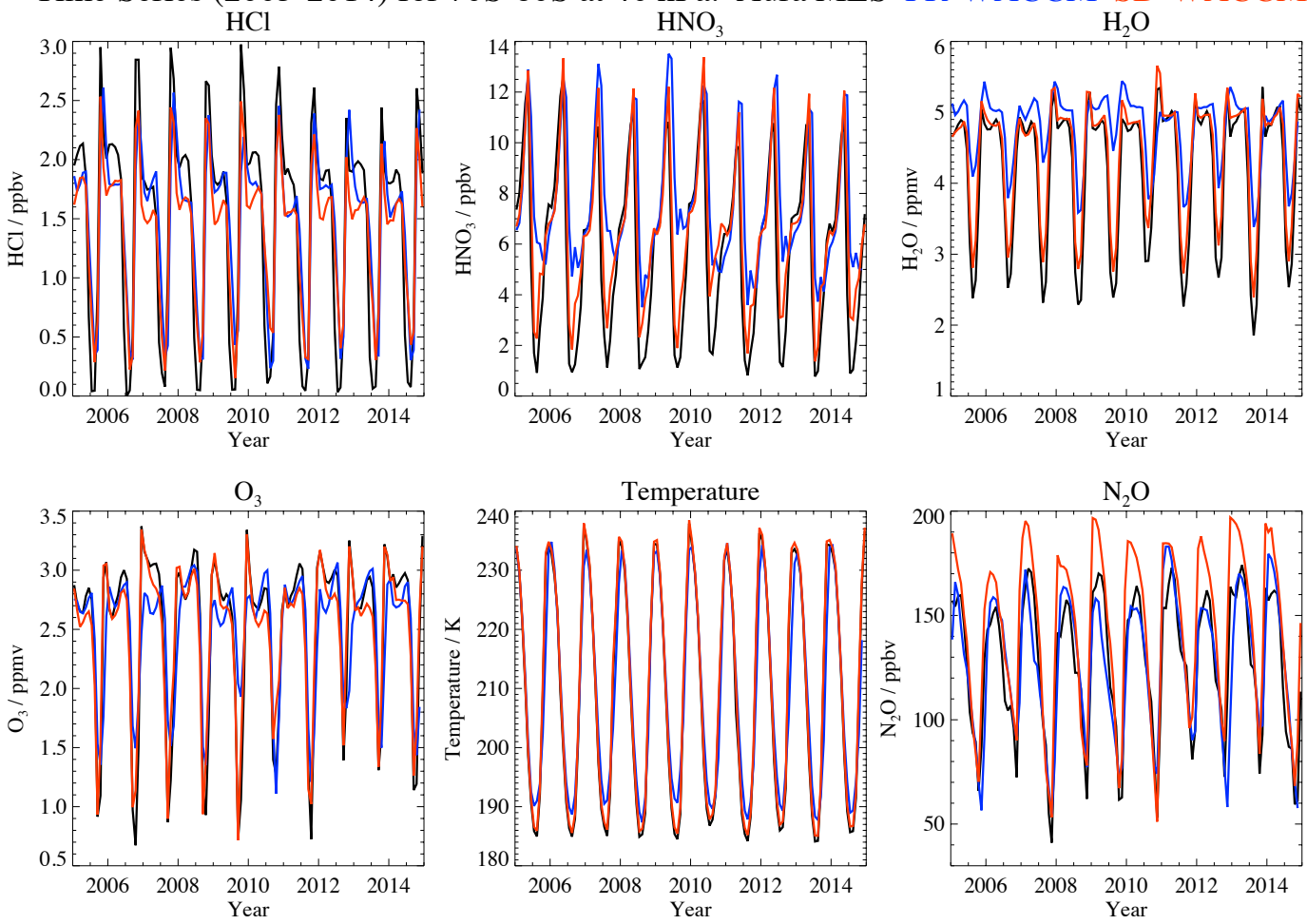

Figure S4. These plots provide the time series for all years (2005 through 2014) from both data (MLS) and models (FR-WACCM in blue, SD-WACCM in red) in the 70°S-80°S latitude range at 46 hPa. The averaged values of these time series are provided in the main text, with emphasis on the slope of the early winter decline in HCl over the Antarctic region, where we see consistently that the model HCl values do not decline as fast as indicated in the data, even though SD-WACCM tracks the interannual variability better, overall, than FR-WACCM.

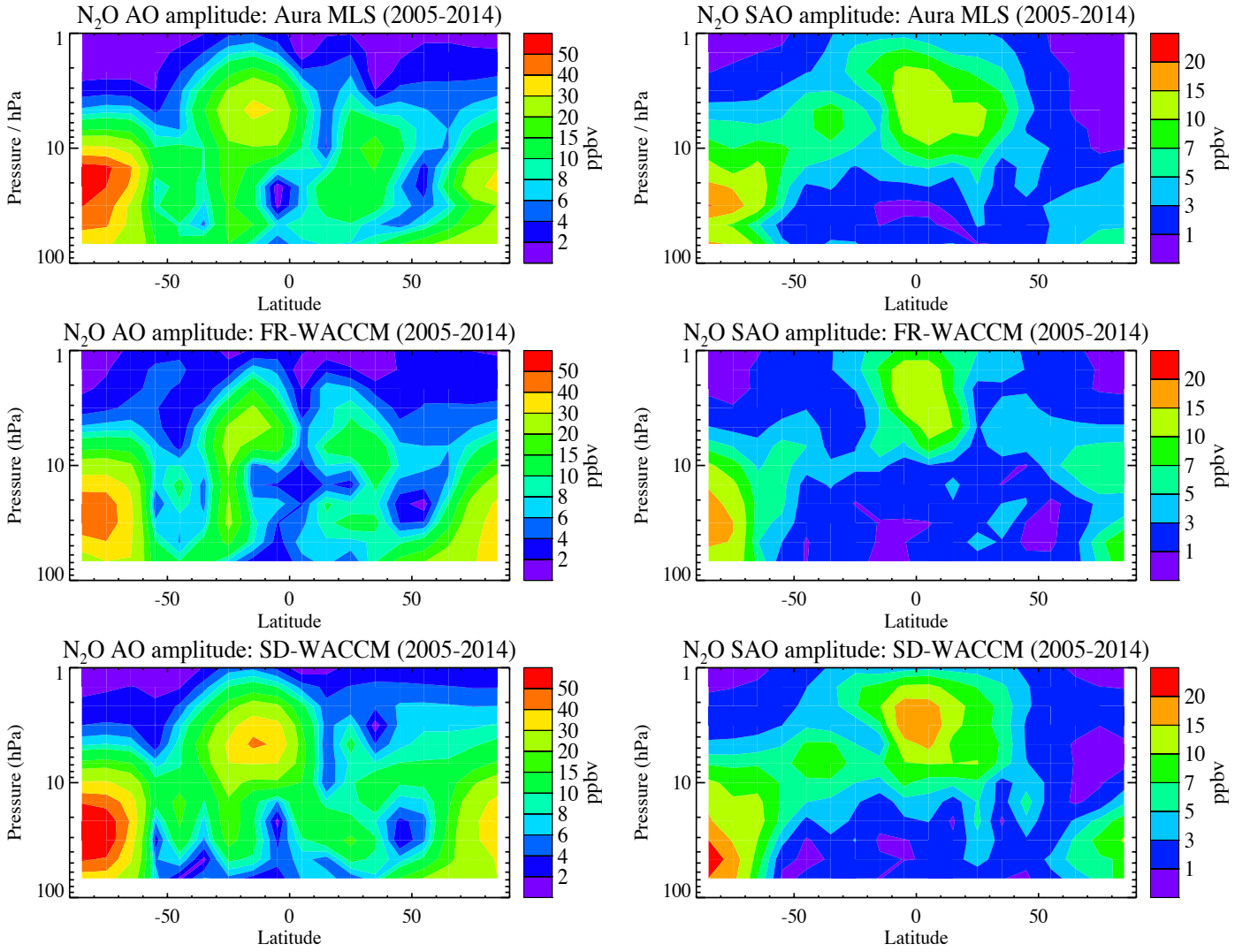

Figure S5. Amplitudes of the annual oscillation (AO, left panels) and semi-annual oscillation (SAO, right panels) for N_2O, based on fits to the 2005-2014 time series from Aura MLS (top panels), FR-WACCM (middle panels), and SD-WACCM (bottom panels). The product used here is N2O-190 (from the 190 GHz MLS retrievals), since the N2O-640 retrievals had to be discontinued in 2013, as a result of an instrument degradation issue affecting that band.

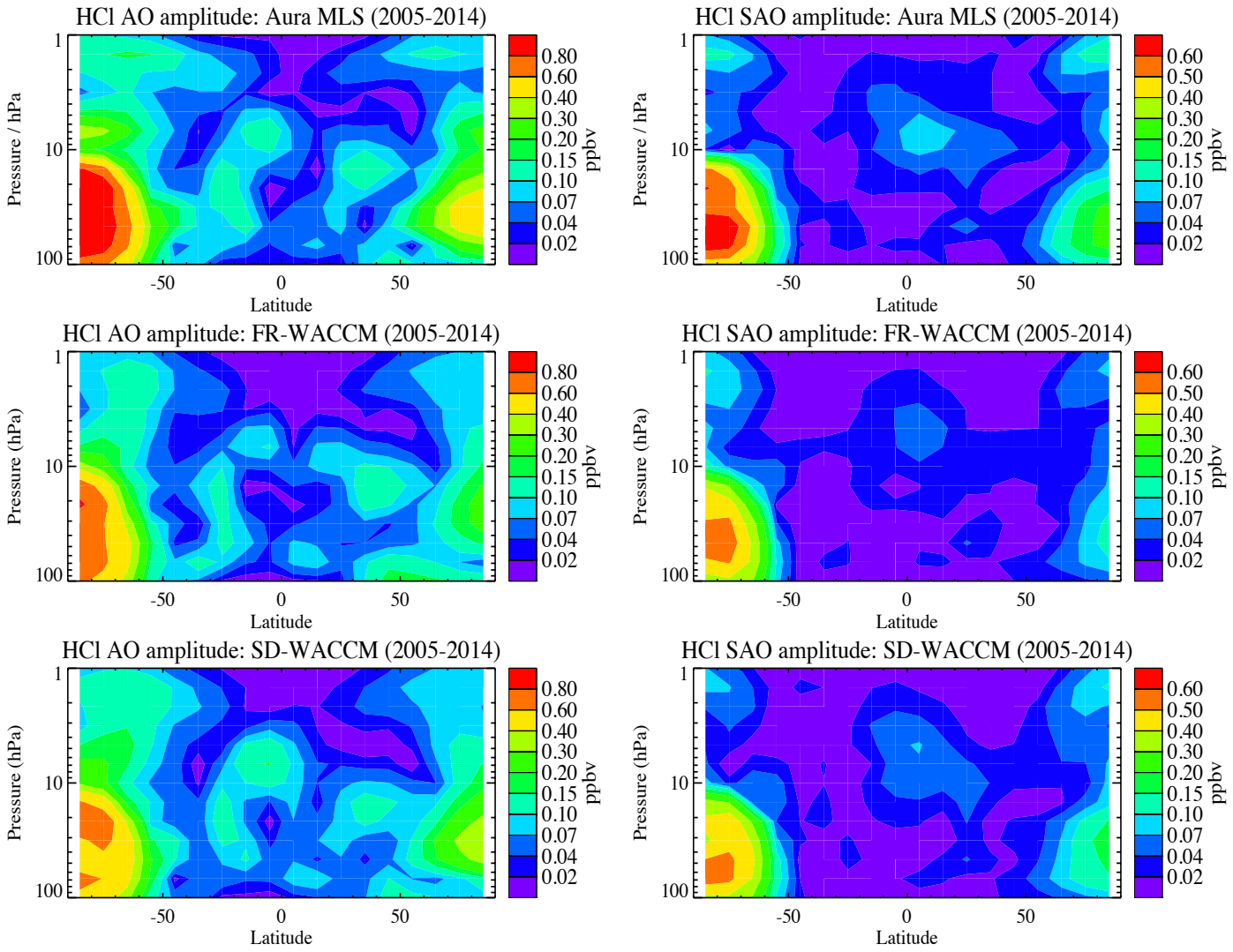

Figure S6. Amplitudes of the annual oscillation (AO, left panels) and semi-annual oscillation (SAO, right panels) for HCl, based on fits to the 2005-2014 time series from Aura MLS (top panels), FR-WACCM (middle panels), and SD-WACCM (bottom panels).

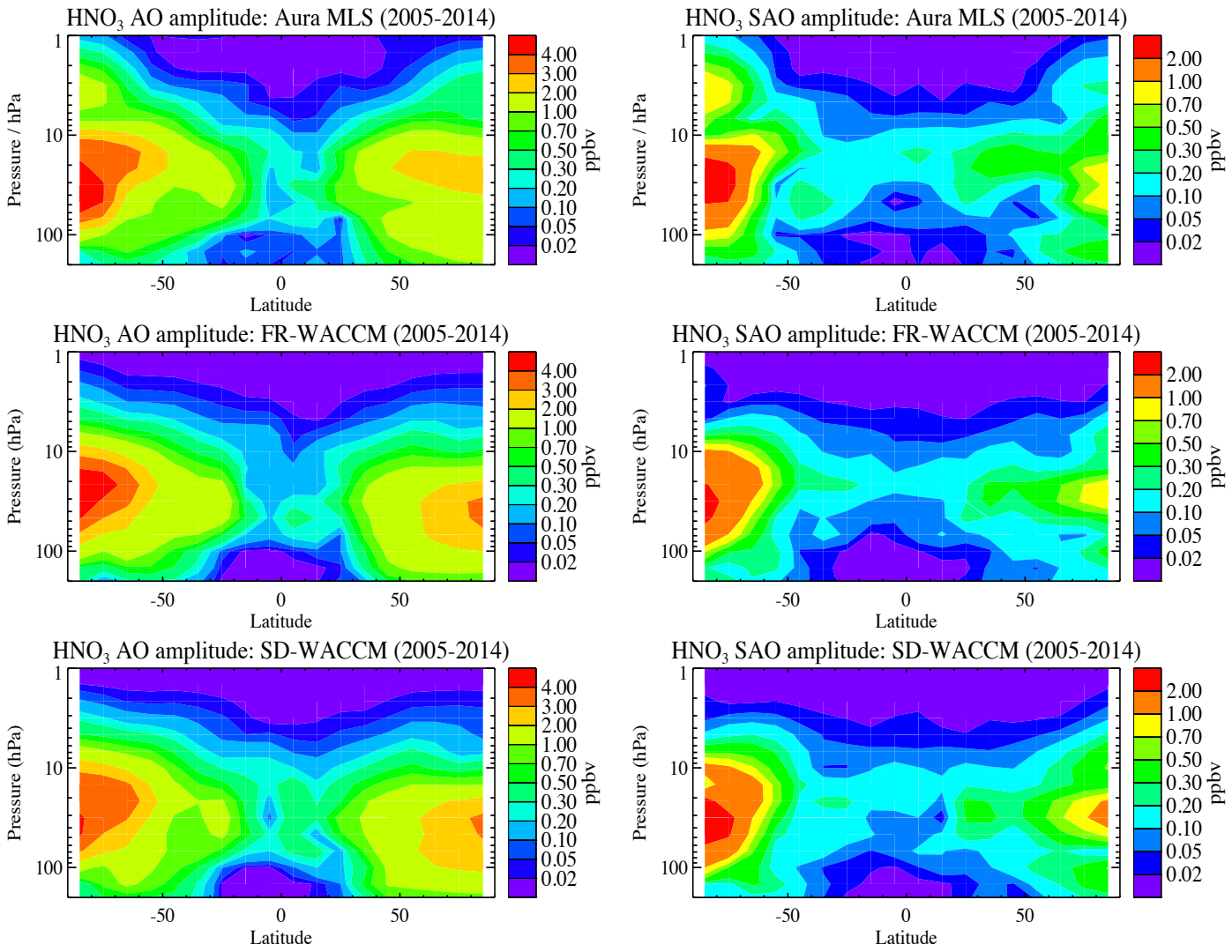

Figure S7. Amplitudes of the annual oscillation (AO, left panels) and semi-annual oscillation (SAO, right panels) for HNO_3, based on fits to the 2005-2014 time series from Aura MLS (top panels), FR-WACCM (middle panels), and SD-WACCM (bottom panels).

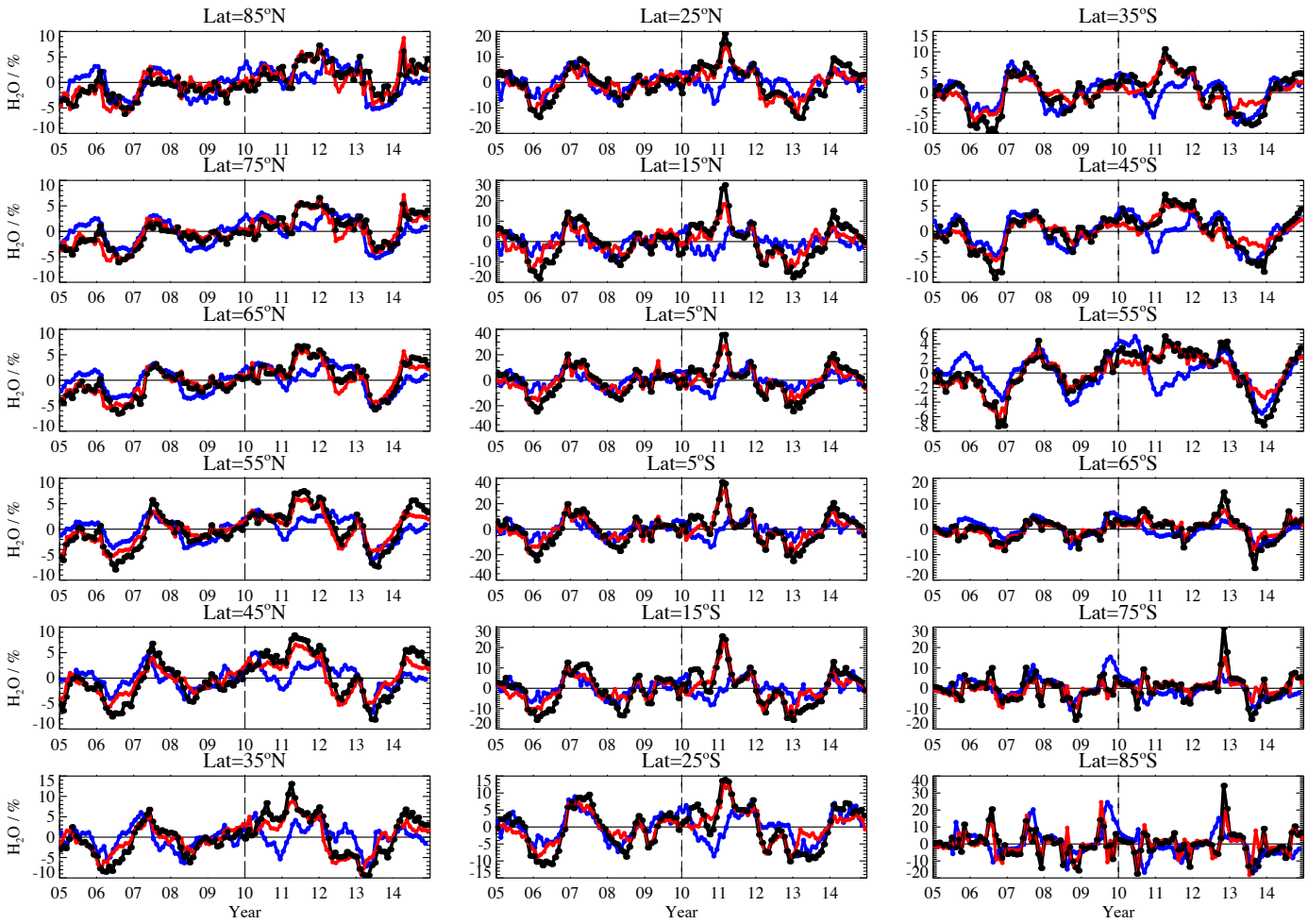

Figure S8. This shows H_2O model and data series comparisons at 83 hPa, as percent deseasonalized anomalies for 2005 through 2014 for all latitude bins from 85°S to 85°N, for Aura MLS data (black), FR-WACCM (blue), and SD-WACCM (red).

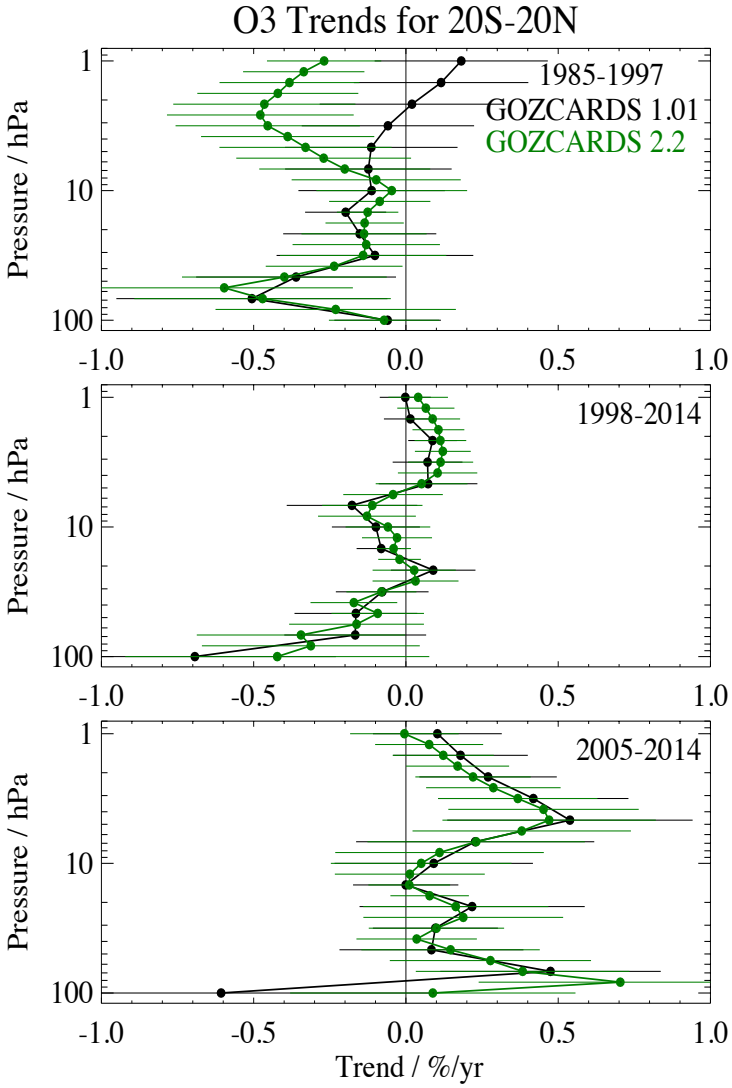

Figure S9. Stratospheric ozone trends in the 20°S-20°N latitude range from two different GOZCARDS data versions (2.20 versus 1.01) for three time periods, as labeled above. The tropical region for the early time period (see top panel) shows the largest differences between the two GOZCARDS merged ozone data sets (as explained in the text).

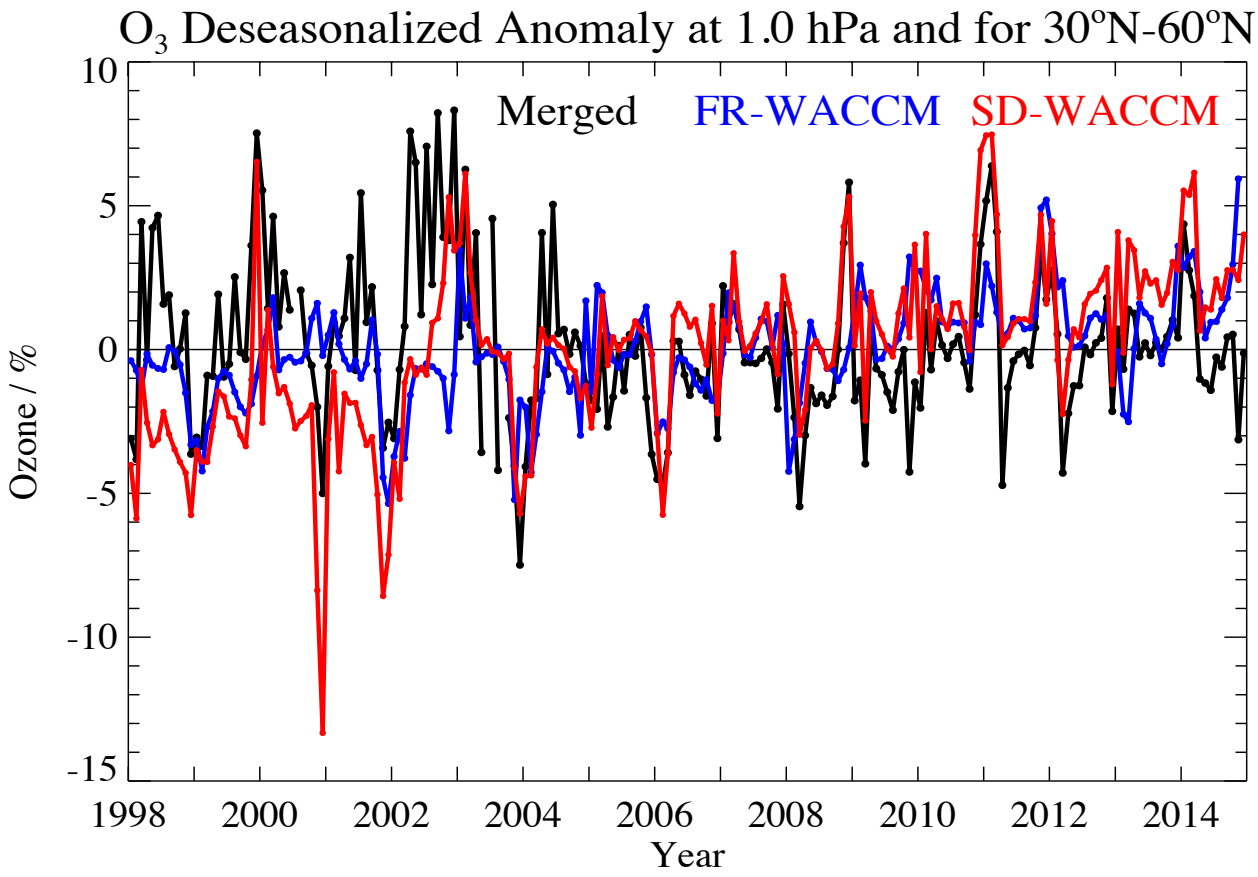

Figure S10. Percent anomalies in deseasonalized time series (1998 through 2014) from GOZCARDS merged O_3 at 1 hPa for 30°N-60°N are compared to the corresponding model anomalies from FR-WACCM and SD-WACCM, as labeled above.

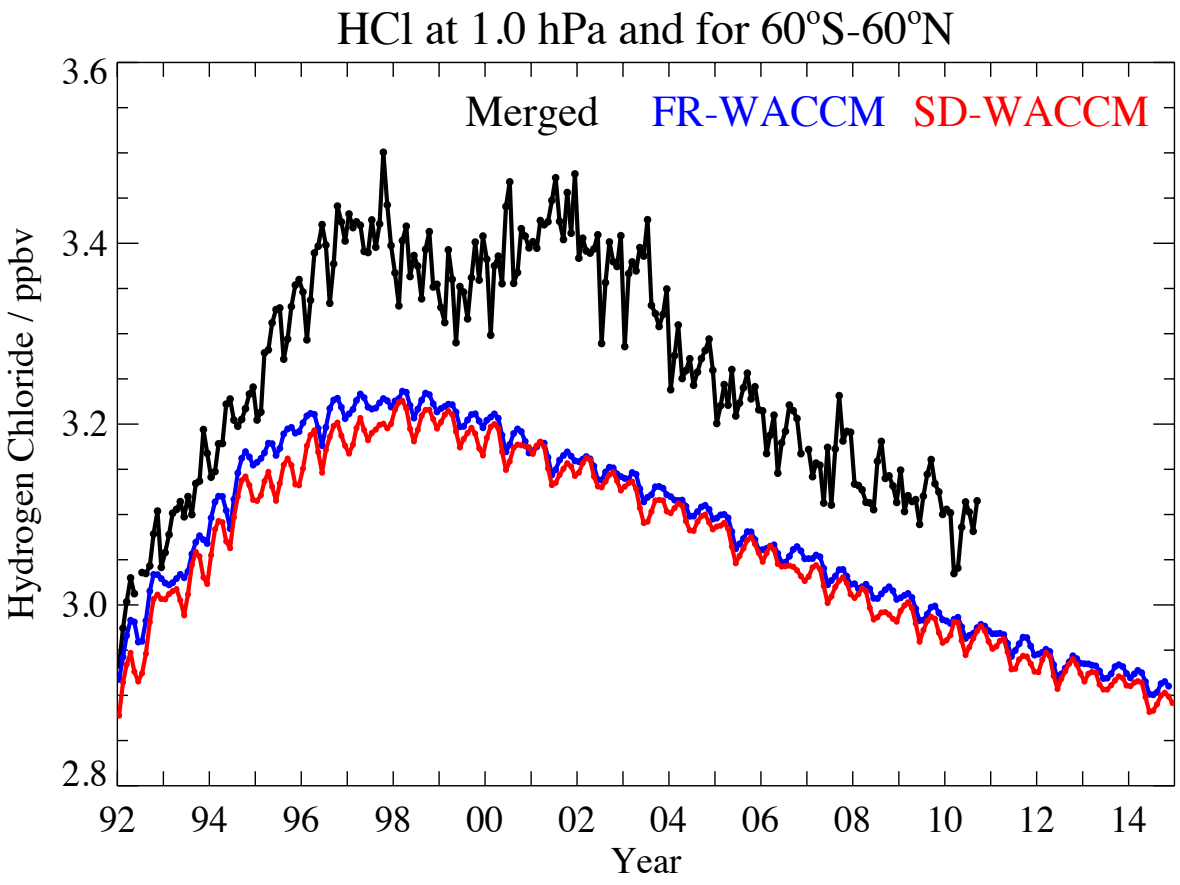

Figure S11. Time series for average near-global (60ºS-60ºN) HCl from the GOZCARDS merged data record (black), compared to the FR-WACCM (blue) and SD-WACCM (red) model series. The GOZCARDS data (version 1.01) for HCl stopped at the end of 2010, after some issues with ACE-FTS data processing; while a new ACE-FTS data version now exists, this has not yet been replaced into the GOZCARDS merged data record.

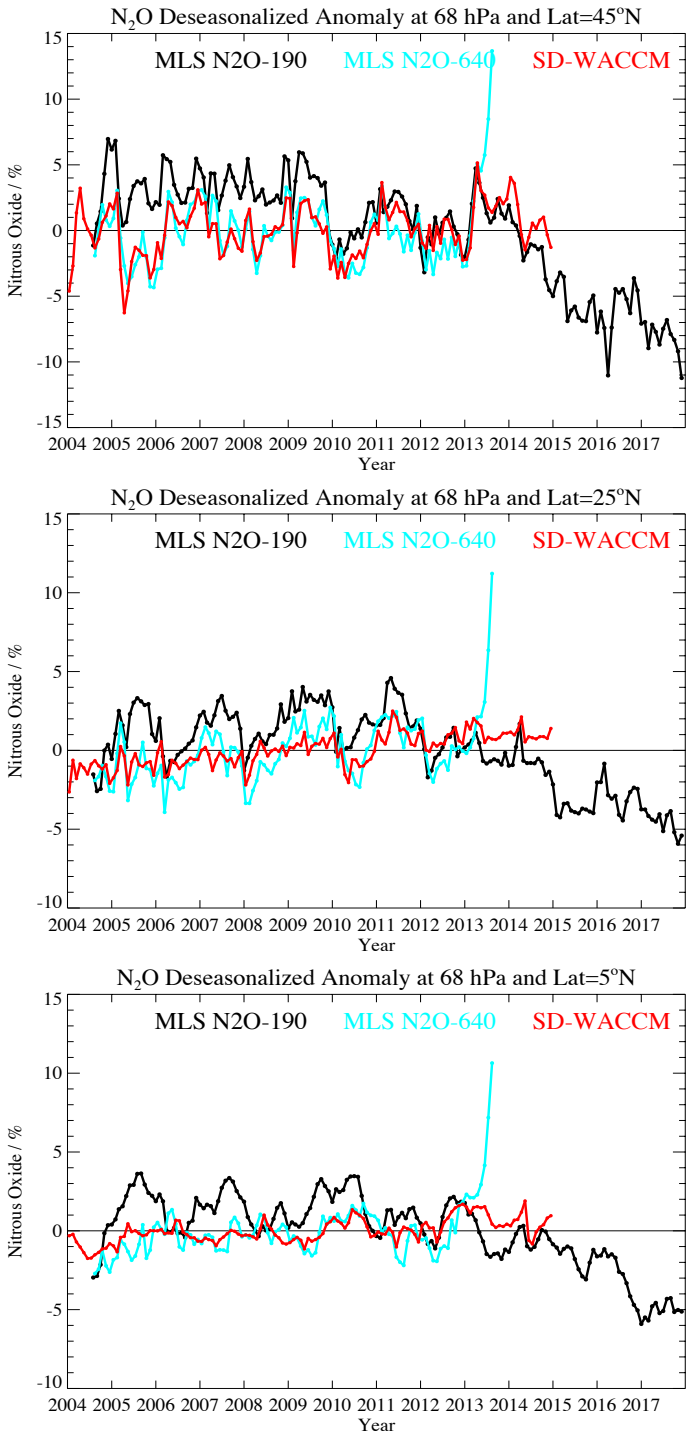

Figure S12. Percent anomalies (deseasonalized) for N_2O from the 2 MLS retrieval bands (N2O-190 and N2O-640) in 3 northern hemisphere latitude bins (labeled above) are compared to SD-WACCM anomalies, which are only through the end of 2014. While results from the standard MLS N_2O product at launch came from the 640 GHz radiometer band, these retrievals had to be discontinued in 2013, as a result of a hardware degradation issue affecting that particular N_2O band as early as April 2013.

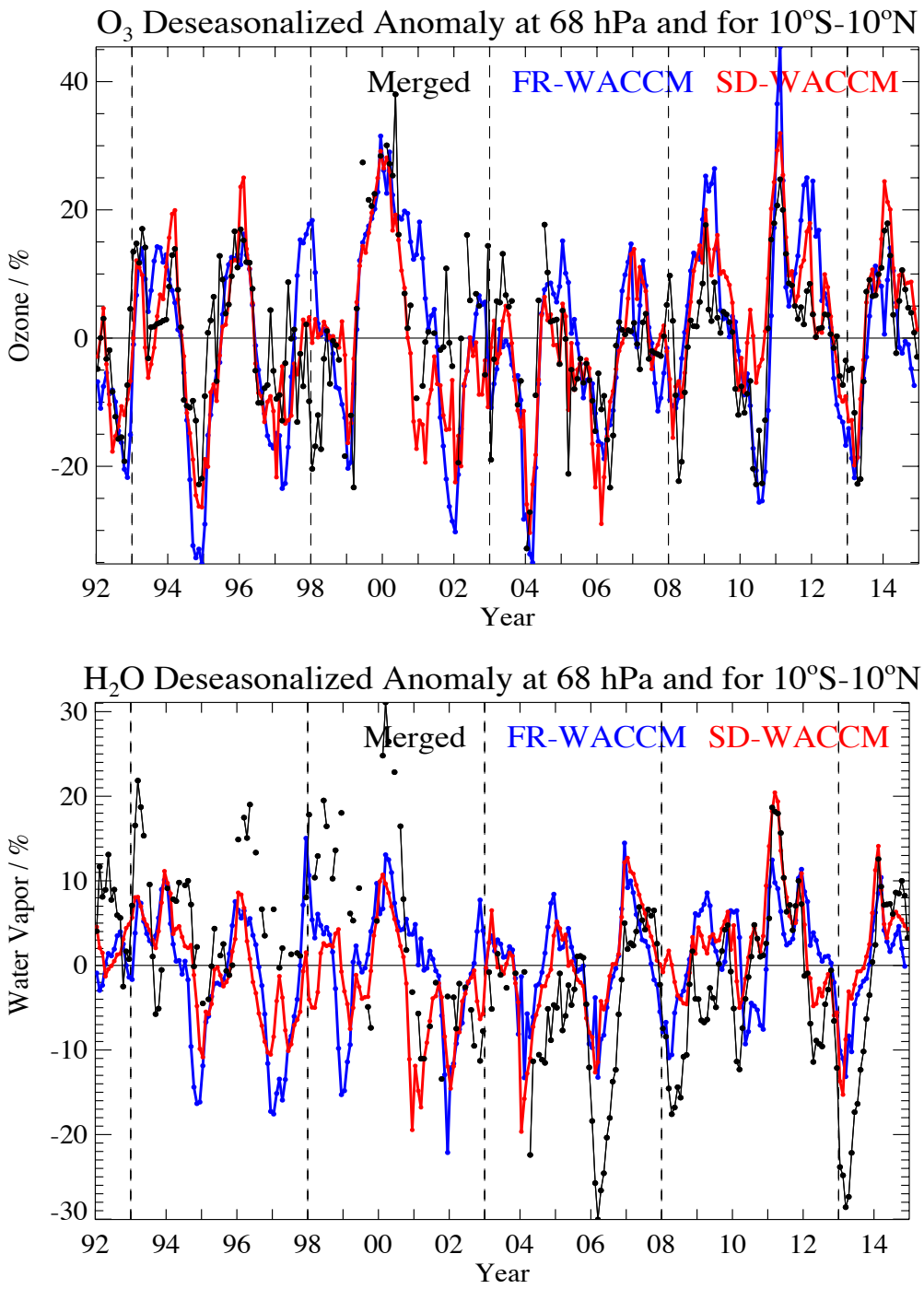

Figure S13. Percent anomalies at 68 hPa for 1992-2014 from both models (FR-WACCM and SD-WACCM), compared to the GOZCARDS anomalies for the 10°S-10°N latitude region. Ozone is shown in the top panel, and water vapor in the bottom panel.