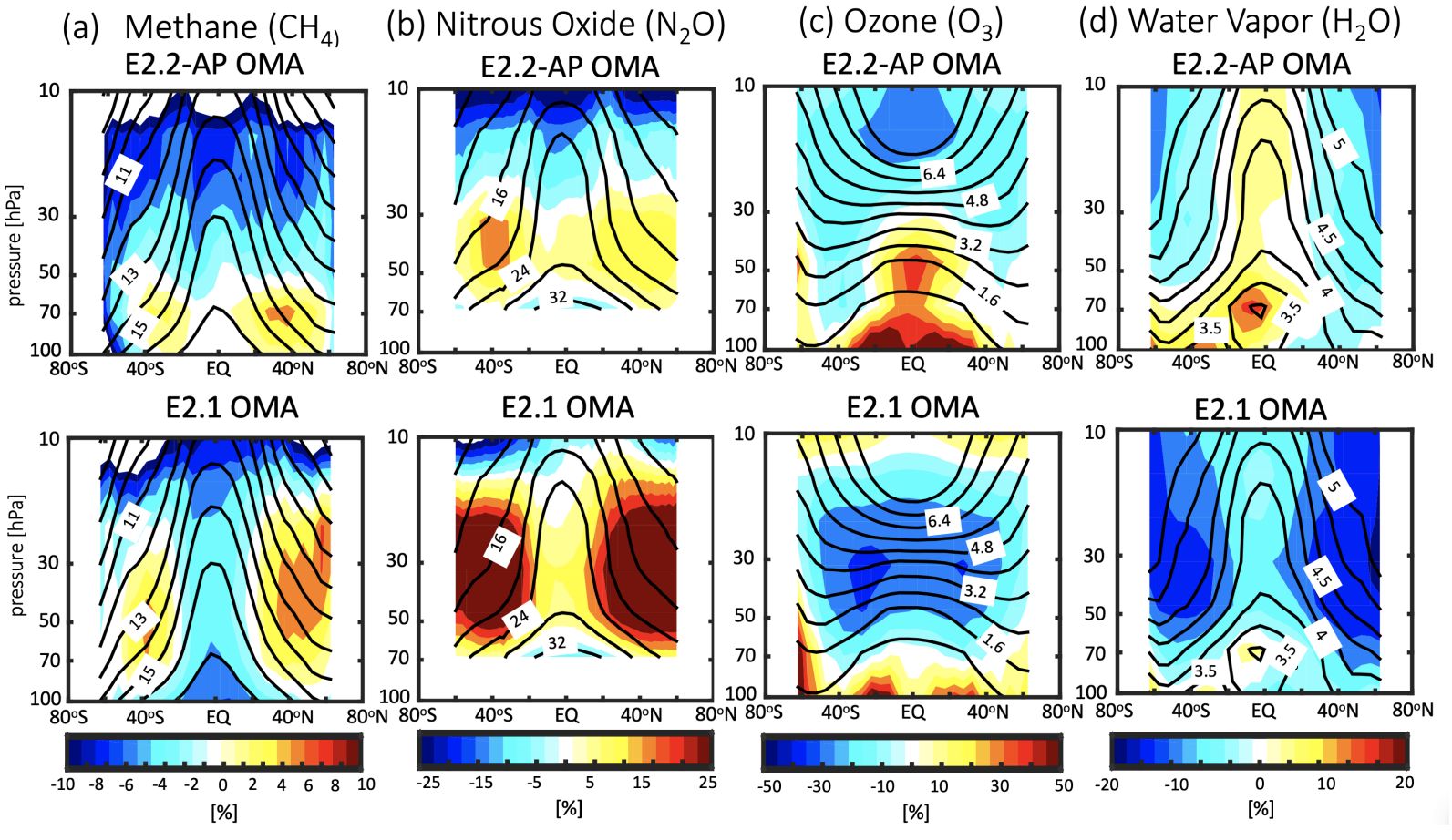

FIG. 1: Climatological annually and zonally averaged methane (a) (CH_4), (b) nitrous oxide (N_2O), (c) ozone (O_3) and (d) water vapor (H_2O) as in Figure 1, except now showing percent differences relative to observations. Color contours shows the percent difference for the three-member mean of the E2.2-AP OMA Historical ensemble (top) and the two-member mean of the E2.1 OMA Historical ensemble (bottom). Black contours show observed values from HALOE (a,c,d) and MLS (b). Climatologies have been performed over years 1991-2002 when comparing to HALOE (a,c,d) and over 2005-2014 when comparing to MLS (b).

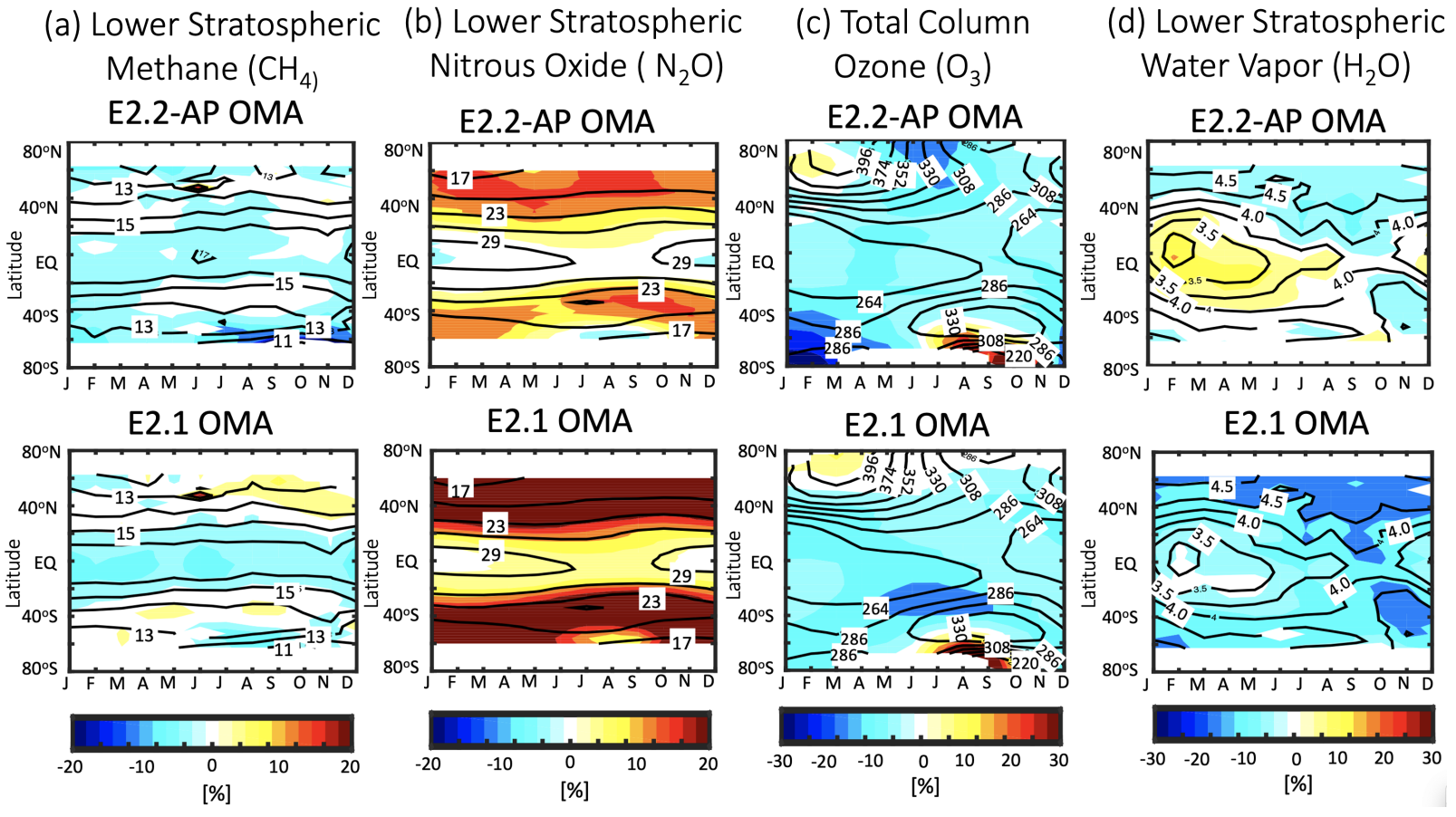

FIG. 2: Percent differences in the seasonal cycle of simulated zonally averaged methane (a) (CH_4), (b) nitrous oxide (N_2O), (c) ozone (O_3) and (d) water vapor (H_2O), relative to observations. Averaging has been performed over the middle-to-lower stratosphere (30-100 hPa) as in Figure 4. Percent differences are shown. For the case of ozone (c) the total column is shown. Color contours shows the three-member mean of the E2.2-AP OMA Historical ensemble (top) and one member of the E2.1 OMA Historical simulation (bottom). Black contours denote observed values from HALOE (a,d), AURA-MLS (b) and TOMS/OMI (c). Climatologies have been performed over years 1991-2002 when comparing to HALOE (a,d), over 2005-2014 when comparing to MLS (b) and over 2000-2010 when comparing to TOMS/OMI (c).

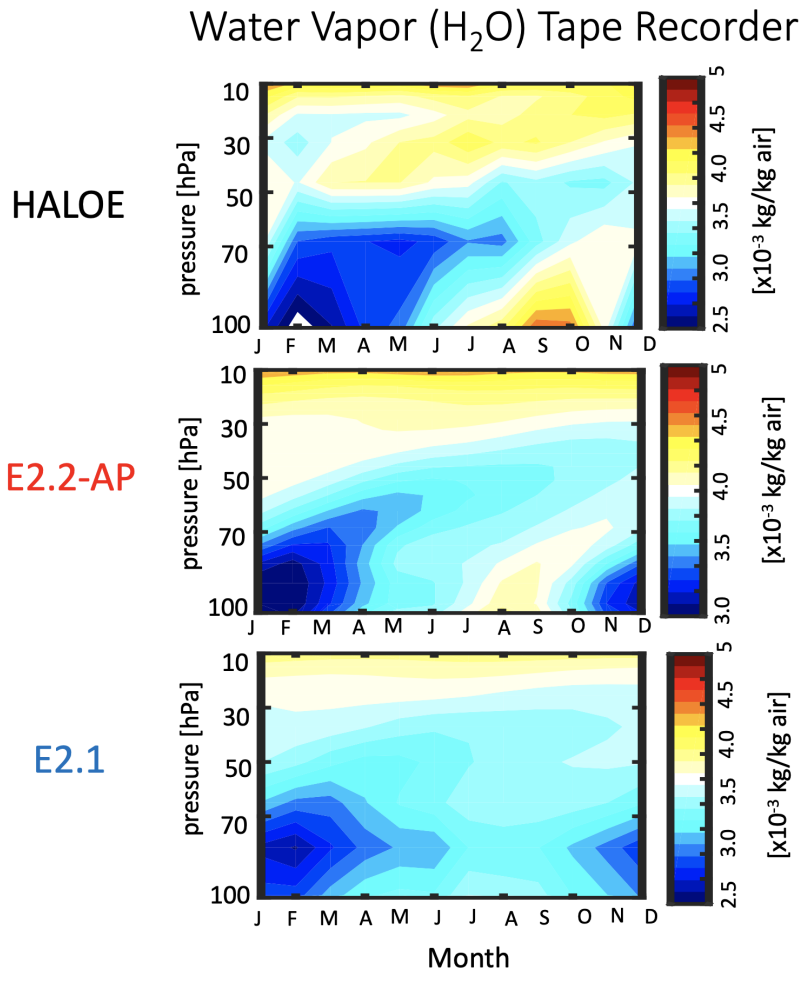

FIG. 3: Seasonal evolution of water vapor (H_2O), averaged over 10°S-10°N, for observed values from HALOE (top) as well as simulated values from E2.2-AP (middle) and E2.1 (bottom). The three-member mean of the E2.2-AP OMA Historical ensemble and one member of the E2.1 OMA Historical simulation are shown. Model annual climatologies have been performed over years 1991-2002 in order to best compare with HALOE.

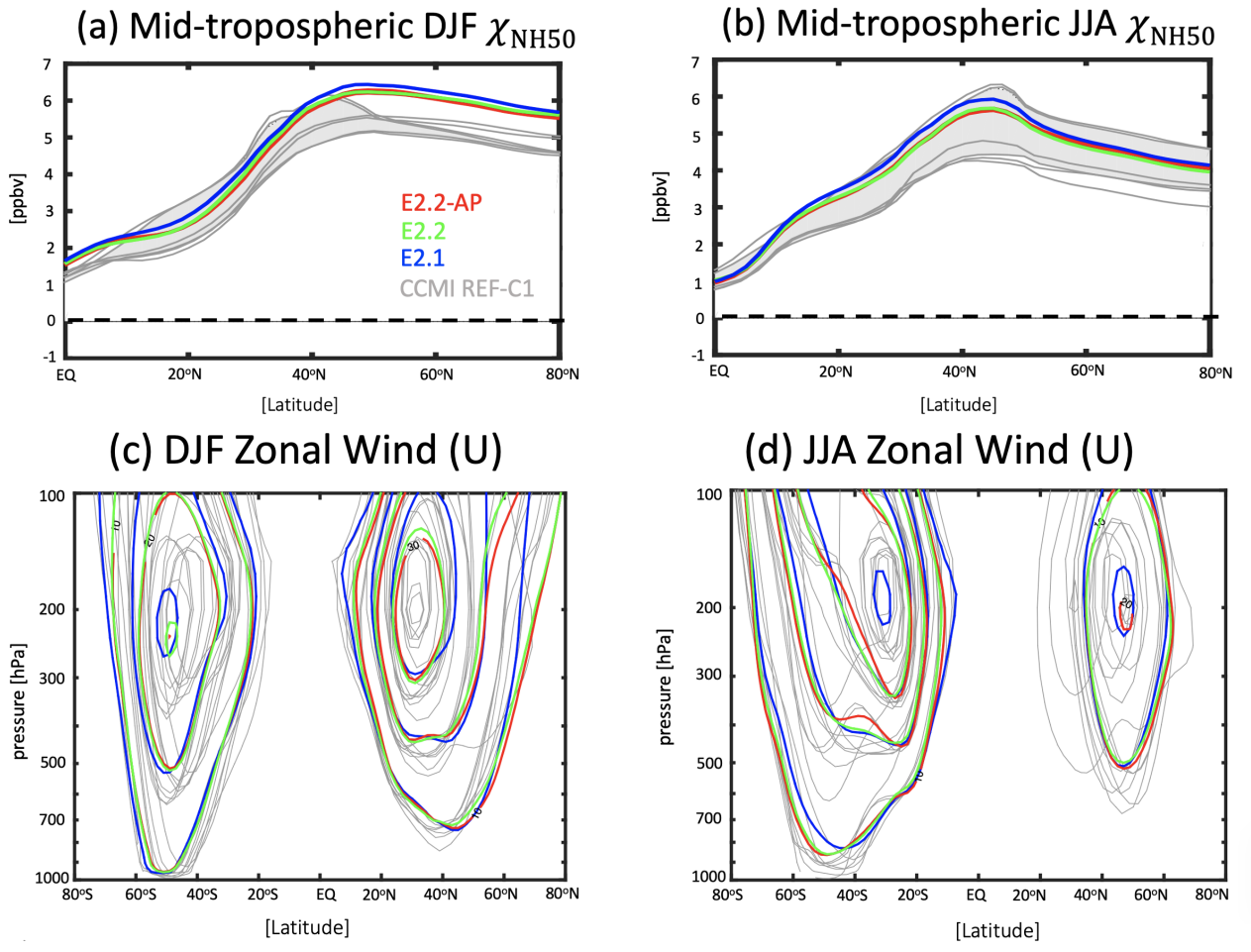

FIG. 4: Climatological meridional profiles of the 50-day NH midlatitude surface loss tracer (χ_{50}) at 500 mb for boreal winter (DJF) (a) and boreal summer (JJA) (b). Boreal winter (c) and summer (d) climatological mean zonal winds. Red, green and blue lines/contours denote E2.2-AP, E2.2, and E2.1, respectively, while grey lines/contours denote the individual CCMI models.

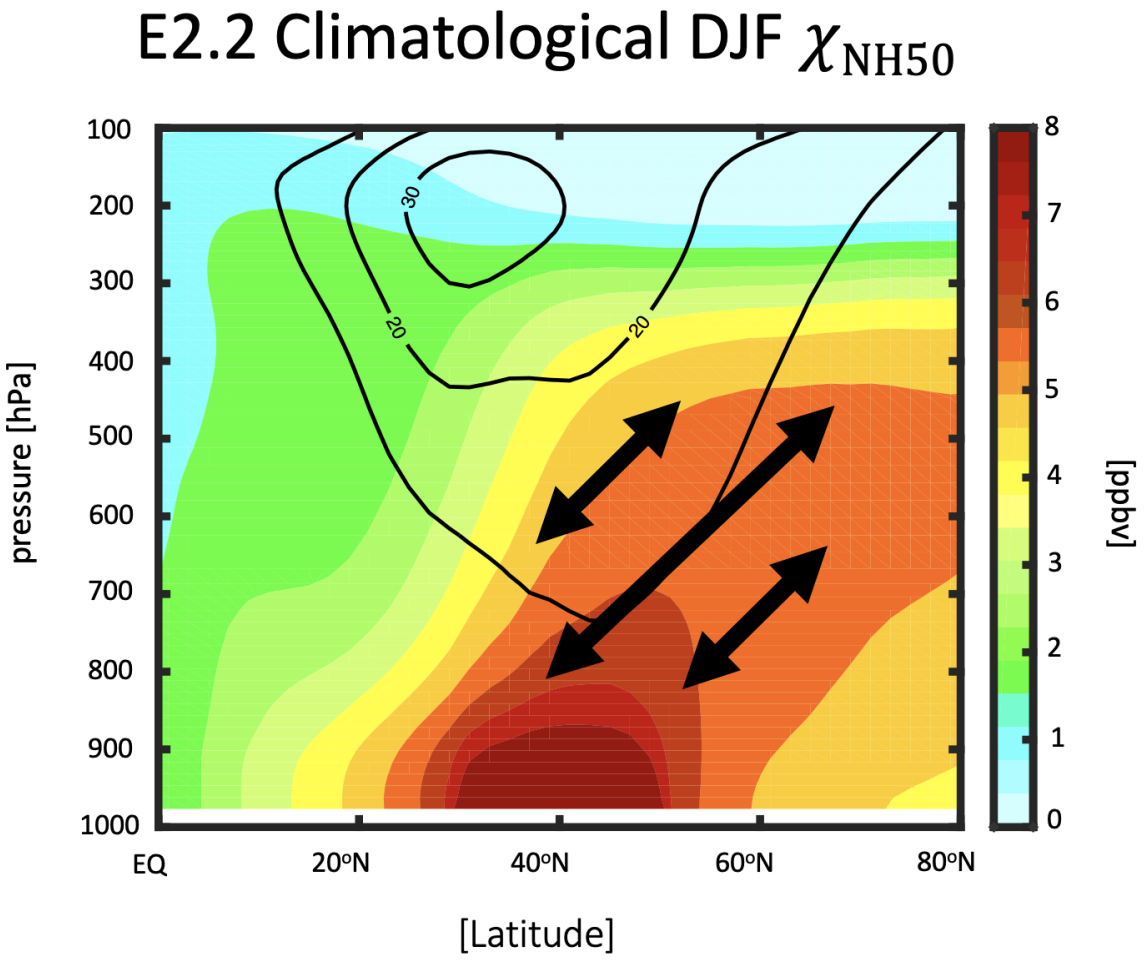

FIG. 5: Annual mean climatological tropopause pressure, compared among E2.2-AP, E2.2, and E2.1 (red, green and blue) and the CCMI models (grey lines).

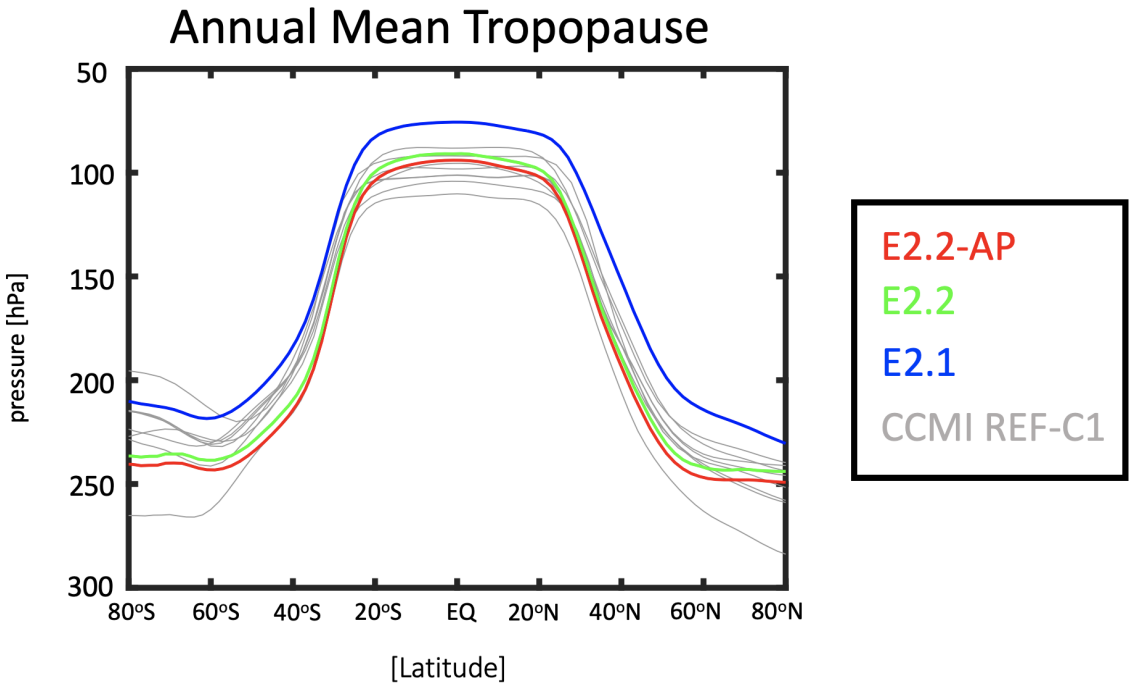

FIG. 6: Color contours denotes climatological boreal winter concentrations of the 50-day NH midlatitude surface loss tracer (χ_{50}), as represented in E2.2-AP. Black thick contours denote the boreal winter zonal mean climatological winds (only 10/20/30 m/s are shown). Thick arrows (schematically) refer to along-isentropic mixing.

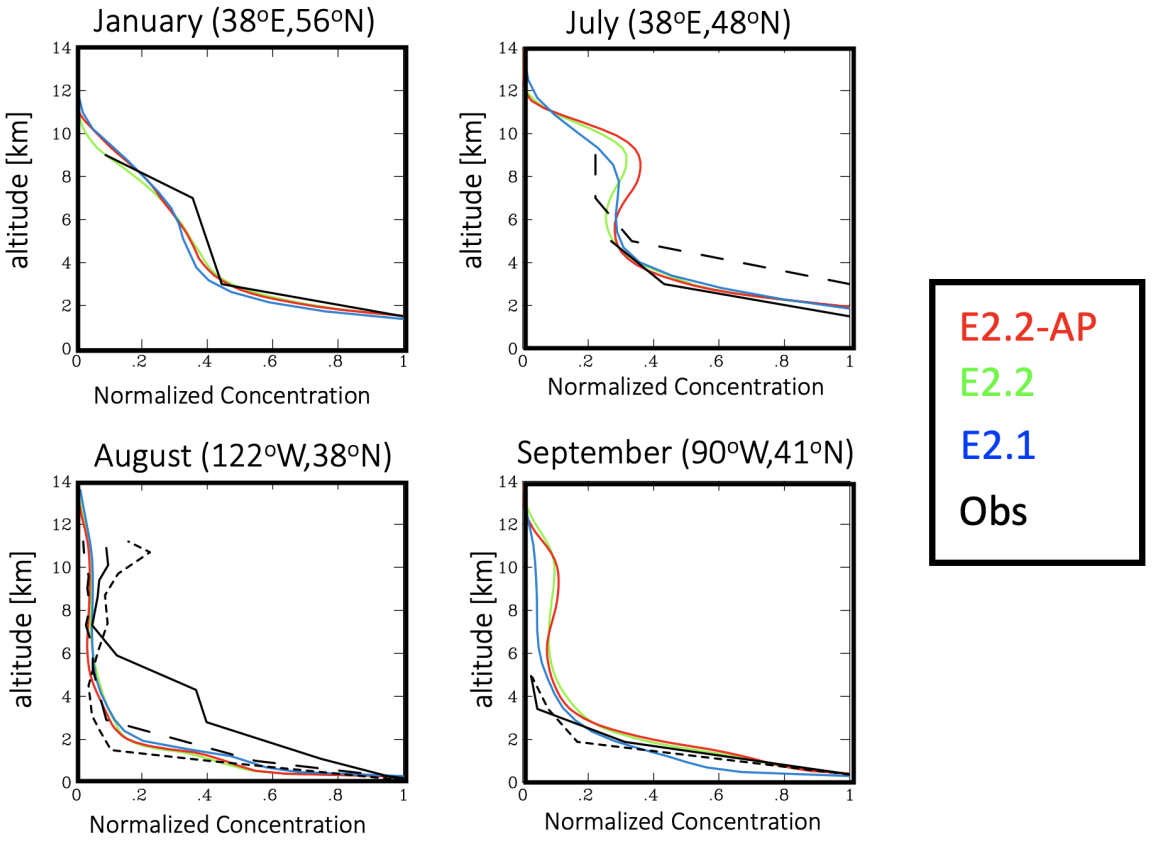

FIG. 7: Profiles of the idealized radon tracer (Rn-222), normalized by values at the surface, and evaluated at different locations over northern midlatitudes during January (top left), July (top right), August (bottom left) and September (bottom right). Red, green and blue lines correspond to ensemble mean values of E2.2-AP, E2.2, and E2.1, respectively, sampled at the closest gridpoint to the observed locations. Observed profiles are a subset of those presented in Murray et al. (2014)

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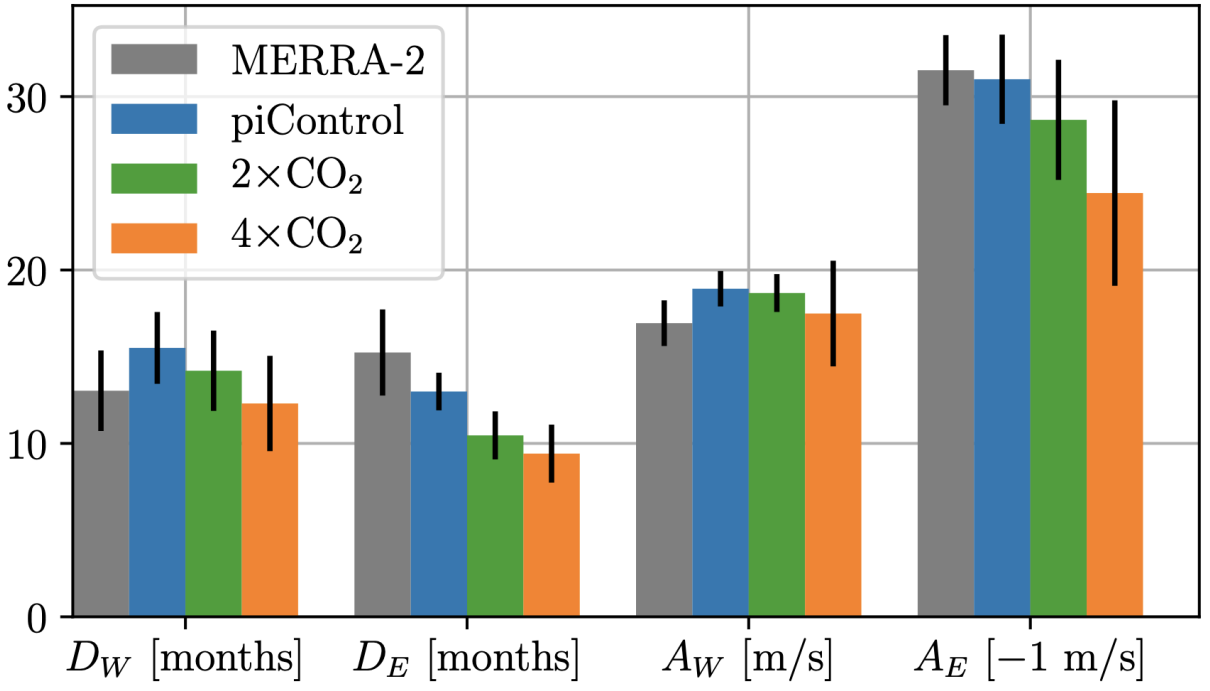

FIG. 8: Changes in the duration (D) and amplitude (A) of the westerly and easterly phases of the QBO between the PI control (blue), 2xCO_2 (green) and 4xCO_2 (orange) experiments utilizing E2.2-AP. MERRA-2 (grey) is shown for comparison.