Session: C15 Poster: T102A

Evidence for changes in stratospheric transport and mixing over the past three decades based on multiple data sets and tropical leaky pipe analysis

Eric Ray[†]; Fred Moore; Karen Rosenlof; Sean Davis; Harald Boenisch; Olaf Morgenstern; Eugene Rozanov; Michaela Hegglin; Gianni Pitari; Peter Braesicke; Neal Butchart; Feng Li; Kiyotaka Shibata; David Plummer
[†] NOAA/CSD, USA
Leading author: eric.ray@noaa.gov

Variability in the strength of the stratospheric Lagrangian mean meridional or Brewer- Dobson circulation and horizontal mixing into the tropics over the past three decades are examined using observations of stratospheric mean age of air and ozone. We use a simple representation of the stratosphere, the tropical leaky pipe (TLP) model, guided by mean meridional circulation and horizontal mixing changes in several reanalyses data sets and chemistry climate model (CCM) simulations, to help elucidate reasons for the observed changes in stratospheric mean age and ozone. We find that the TLP model is able to accurately simulate multiyear variability in ozone following recent major volcanic eruptions and the early 2000s sea surface temperature changes, as well as the lasting impact on mean age of relatively short-term circulation perturbations. We also find that the best quantitative agreement with the observed mean age and ozone trends over the past three decades is found assuming a small strengthening of the mean circulation in the lower stratosphere, a moderate weakening of the mean circulation in the middle and upper stratosphere, and a moderate increase in the horizontal mixing into the tropics. The mean age trends are strongly sensitive to trends in the horizontal mixing into the tropics, and the uncertainty in the mixing trends causes uncertainty in the mean circulation trends. Comparisons of the mean circulation and mixing changes suggested by the measurements with those from a recent suite of CCM runs reveal significant differences that may have important implications on the accurate simulation of future stratospheric climate.