5.032 Comparing the stratosphere in Specified Dynamics (nudged) and free-running simulations from the Chemistry Climate Model Initiative model intercomparison.

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Abstract:

The Specified Dynamics (SD) experiment specified for the first phase of the Chemistry Climate Model Initiative (REF-C1SD) is the first time a large group of chemistry-climate models have run a coordinated experiment where the evolution of the atmospheric dynamics is constrained by reanalysis. Constraining the dynamics is typically done by the addition of an additional tendency to the dynamical fields (nudging) and it is an open question how the model responds to this additional forcing. The existence of freely-running simulations covering the same time period and with identically specified forcings, the REF-C1 experiment, allows for a fairly direct comparison of the SD and freely-running simulations. Here we focus on the stratosphere and compare the climatology and long-term trends of dynamical and chemical fields in those CCMI models that have provided output for both the REF-C1SD and REF-C1 experiments. Comparisons of diagnostics of the Brewer-Dobson circulation, including upwelling mass flux and age of air, show that the stratospheric residual circulation in the models do not all respond in a similar fashion to the addition of an extra tendency to constrain the dynamics. While the different SD simulations show a strong correlation for the interannual variability in tropical upwelling, a large spread in the magnitude of the upwelling is not reduced as compared to the set of free-running simulations. The SD simulations do, however, show a greatly reduced spread in mixing between the tropics and extra-tropics in the lowermost stratosphere, as evidenced by the age of air, and a greatly reduced model-to-model spread in the climatological mean total column ozone. The effects of temperature and mixing on the model representation of ozone are considered as possible factors to explain differences in ozone across the free-running simulations.