Is interactive ozone chemistry important to represent stratospheric temperature variability in Earth System Models?

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Climate models have become increasingly more complex over recent decades by evolving from high-end General Circulation Models to coupled Earth-System Models. The Coupled Model Intercomparison Project Phase 5 in support of the Intergovernmental Panel on Climate Change's Fifth Assessment Report included both stratosphere resolving (high-top) models and models whose model top has been below the stratopause (low-top models). One major difference in high-top and low-top models is the consideration of the stratospheric ozone layer and its variability and changes. Here we investigate the effect of interactive stratospheric chemistry on the temperature fields in the Whole Atmosphere Community Climate Model, a stratosphere-resolving version of the National Center for Atmospheric Research Community Earth System Model. We contrast two multi-decadal sensitivity simulations with perpetual year 2000 forcings, one with interactive ozone chemistry and one without. The results show a statistically significant difference in stratospheric spring-time temperatures over the Arctic (and Antarctic) polar caps. Effects are particularly pronounced for the low end of the temperature distribution and probabilistic temperature extremes (expressed as return levels). Our results ague for caution as they indicate that temperature changes/trends that are within the envelope of natural variability in simulations with interactive chemistry could be erroneously classified as significant in uncoupled model simulations.

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