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The 1986–1989 ENSO cycle in a chemical climate model

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Abstract. A pronounced ENSO cycle occurred from 1986 to 1989, accompanied by distinct dynamical and chemical anomalies in the global troposphere and stratosphere. Reproducing these effects with current climate models not only provides a model test but also contributes to our still limited understanding of ENSO's effect on stratosphere-troposphere coupling. We performed several sets of ensemble simulations with a chemical climate model (SOCOL) forced with global sea surface temperatures. Results were compared with observations and with large-ensemble simulations performed with an atmospheric general circulation model (MRF9). We focus our analysis on the extratropical stratosphere and its coupling with the troposphere. In this context, the circulation over the North Atlantic sector is particularly important. Relative to the La Niña winter 1989, observations for the El Niño winter 1987 show a negative North Atlantic Oscillation index with corresponding changes in temperature and precipitation patterns, a weak polar vortex, a warm Arctic middle stratosphere, negative and positive total ozone anomalies in the tropics and at middle to high latitudes, respectively, as well as anomalous upward and poleward Eliassen-Palm (EP) flux in the midlatitude lower stratosphere. Most of the tropospheric features are well reproduced in the ensemble means in both models, though the amplitudes are underestimated. In the stratosphere, the SOCOL simulations compare well with observations with respect to zonal wind, temperature, EP flux, meridional mass streamfunction, and ozone, but magnitudes are underestimated in the middle stratosphere. With respect to the mechanisms relating ENSO to stratospheric circulation, the results suggest that both, upward and poleward components of anomalous EP flux are important for obtaining the stratospheric signal and that an increase in strength of the Brewer-Dobson circulation is part of that signal.

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