Temperature and Ozone Response to the 11-year Solar Cycle in the Tropical Stratosphere as Revealed by Ensemble Simulation of Chemistry-Climate Model

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Ensemble simulation of five members was made with the chemistry-climate model of Meteorological Research Institute (MRI-CCM) under the CCMVal REF1 scenario, in which observed forcings of SST, sea-ice, greenhouse gases, halogens, the 11-year solar cycle, and volcanic aerosols are given. The integration period covers 25 years from November 1979 to December 2004. Multiple linear regression analysis is used to isolate specific signals from the anomalies in temperature and ozone data using reference variables of the mean value, the linear trend, the QBOs at 20 and 50 hPa, the volcanic aerosols of El Chichón and Mount Pinatubo, El Niño/Southern Oscillation (ENSO), and the 11-year solar cycle. As an ensemble average of the annual-mean solar signals, MRI-CCM reproduced observed feature of ozone in the tropical stratosphere: the first maximum in the lower stratosphere and the second one in the upper stratosphere. Analysis of temperature and ozone solar signal for each member reveals that the first ozone maximum comes from a chemical effect of intensified UV radiation and cooling due to upwelling and that the second one is a dynamical effect due to transport of ozone-rich air accompanying downwelling.