Geophysical Research Abstracts
Vol. 16, EGU2014-4438, 2014
EGU General Assembly 2014

The Surface Climate Response to 11-Yr Solar Forcing During Northern Winter: Tests of the Stratospheric (UV-Ozone) Mechanism

Lon Hood (1), Semjon Schimanke (2), Thomas Spangehl (3), Sourabh Bal (4), and Ulrich Cubasch (5)

(1) University of Arizona, Lunar and Planetary Laboratory, Tucson, Arizona, United States (lon@lpl.arizona.edu), (2) Swedish Meteorological and Hydrological Institute, Norrkoping, Sweden, (3) German Weather Service, Offenbach am Main, Germany, (4) Department of Physics, Dream Institute of Technology, Kolkata, India, (5) Institute for Meteorology, Free University of Berlin, Berlin, Germany

We have previously reported comparisons of observational estimates of the surface climate response to 11-yr solar forcing during northern winter with a series of GCM simulations that differed only in the assumed solar cycle variation of stratospheric ozone (Hood et al., J. of Climate, 2013). Here, we test further whether the most successful model simulation was primarily a consequence of stratospheric (solar UV-ozone) forcing by carrying out multiple linear regression analyses of model zonal wind and temperature data, and then comparing the results to similar analyses of observed zonal wind, temperature, and ozone data. It is found that the GCM simulation that produced a qualitative agreement with the observationally estimated surface climate response is characterized by an unusually strong zonal wind anomaly in the northern midlatitude upper stratosphere during early winter at solar maximum relative to solar minimum (about 5.5 m/s). The centennial period of this simulation that produced the best agreement yielded an even larger anomaly (7.5 m/s). This zonal wind anomaly is similar to (but smaller than) that derived from observations and is a consequence of the stronger latitudinal gradient of ozone and radiative heating in the upper stratosphere during early winter for this simulation. It propagates poleward and downward during the winter, perturbing tropospheric circulation and initiating ocean-atmosphere feedbacks that lead to the observed surface climate response. However, a major remaining uncertainty is the true magnitude of the solar forcing in the upper stratosphere that ultimately leads to the surface climate response. In addition to uncertainties in the solar spectral irradiance variation, there are also uncertainties in the true 11-year variation of ozone in the upper stratosphere that contribute indirectly to the radiative forcing. In particular, current observational evidence indicates that the 11-year variation of upper stratospheric ozone is considerably larger than is simulated in most existing models with interactive chemistry. Possible reasons for this difference will be discussed.