

Exploring the Tropospheric Response to Solar Forcing

David Rind [drind@giss.nasa.gov], NASA Goddard Institute for Space Studies; Judith Lean, NRL, Washington; and Patrick Lonergan and Jean Lerner, Columbia University.

The investigation of the influence of solar cycles on the stratosphere/troposphere system has become increasingly sophisticated in the last decade, due to a combination of empirical analyses and modeling studies. However, there is still considerable uncertainty about the actual tropospheric response to changes in solar radiative output, and the potential mechanisms involved. At least three competing theories have been proposed: surface absorption of solar radiation changes altering tropospheric dynamics directly; surface absorption changes amplifying the natural modes of ocean-atmosphere coupling; and tropospheric responses driven from the stratosphere due to changes in stability or planetary wave propagation. While not necessarily mutually exclusive, these have some opposing interpretations and cause-effect relationships which we examine with an extensive set of climate model simulations.

Spectrally-differentiated solar radiation from 1950-2005 is input to GISS Global Climate/Middle Atmosphere Model 3 in four different atmospheric configurations and in conjunction with differing oceanic conditions (some 1500 years of simulations). Simulations in which the ocean is not allowed to respond emphasize the solar “stratospheric forcing” of the troposphere, while simulations with the full ocean response illustrate the solar “surface-driving” capability. Analyses of the model simulations address the following: Do the standard runs reproduce the observed stratospheric and tropospheric temperature changes? Do the SSTs in the calculated ocean runs match those in the historical data? Do the circulation and precipitation changes match those claimed for solar forcing? Are the results dependent on the ozone change profile; or the model resolution; or the other climate forcings that have been occurring?