Analysis of Earth Atmospheric Temperature Response to Solar Variability

Kali Roeten
North Carolina State University, Raleigh, NC

Jerry Harder, Aimee Merkel, and Sam Liner
Laboratory for Atmospheric and Space Physics, Boulder, CO

Temperature in Earth's atmosphere is influenced by many factors on different scales, from dynamics to photochemistry. There has been much speculation and research done to determine to what extent variations in the solar cycle could influence trends in the temperature field over a length of time. Though many estimates indicate the effect would be on the order of a few degrees, solar variability is still thought to factor into variations of Earth's climate. This study attempted to identify a temperature trend in the troposphere and stratosphere induced by solar cycle variability through an analysis of satellite observations. Specifically, temperature data sets from the Atmospheric Infrared Sounder (AIRS) on the Earth observing satellite Aqua were examined for this project. The objective was to produce a method to search for an atmospheric solar cycle response looking at multiple pressure levels and latitudes over time. A Fourier analysis was conducted using the fast Fourier transform (FFT) function in the Interactive Data Language (IDL), resulting in the identification of several key frequencies including those corresponding to the annual cycle and Quasi-Biennial Oscillation (QBO). Basic Fourier sharp-cut filtering techniques were utilized to remove higher frequency signals from the AIRS temperature data in attempt to isolate longer cycles. Though there was some evidence of an approximate 10.5 year signal, close to the eleven year frequency of solar cycle activity, the signal was not definitive. As a result, it was concluded that a more sound technique than the Fourier transformation and filtering used here is necessary for this type of analysis, especially to remove what was found to be a significant dependence on the endpoints of the data set. Given these caveats, the analysis still suggests that an approximate one to two degree temperature change over the solar cycle with a temperature minimum corresponding to the 2008 solar cycle minimum may be present at some pressure levels. This analysis also included the beginning of a comparison between AIRS temperature sets and those created from a run of the Whole Atmosphere Community Climate Model (WACCM) which produced generally similar temperature records.