Geophysical Research Abstracts
Vol. 12, EGU2010-2455, 2010
EGU General Assembly 2010

Temperature Responses to Spectral Solar Variability on Decadal and Centennial Time Scales

Robert Cahalan (1), Guoyong Wen (2), Peter Pilewskie (3), and Jerald Harder (3)

(1) NASA-Goddard Space Flight Center, Greenbelt, USA (robert.f.cahalan@nasa.gov, +1 301 614-5493), (2) University of Maryland-Baltimore County, Baltimore, MD, USA (guoyong.wen-1@nasa.gov), (3) LASP, University of Colorado, Boulder, CO, USA (peter.pilewskie@lasp.colorado.edu)

We apply two scenarios of 11-year solar spectral forcing, namely SIM-based out-of-phase variations and proxy-based in-phase variations, as input to a time-dependent radiative-convective model (RCM), and also to the GISS modelE GCM. For both scenarios, and both models, we find that the maximum temperature response occurs in the upper stratosphere, and temperature responses decrease downward to the surface. The upper stratospheric temperature peak-to-peak responses to out-of-phase solar forcing are ∼0.6 K in RCM and ∼0.9 K over the tropical region in GCM simulations, a factor of ∼5 times as large as responses to in-phase solar forcing. Stratospheric responses are in-phase with TSI (Total Solar Irradiance) variations. The modeled upper stratospheric temperature response to the SORCE SIM observed SSI (Spectral Solar Irradiance) forcing resembles 11-year temperature variations observed with HALOE (Halogen Occultation Experiment). Surface responses to the two SSI scenarios are small for both RCM and GCM studies, as compared to stratospheric responses.

Though solar irradiance variations on centennial time scale are not well known, the two scenarios of reconstructed TSI time series (i.e., one based on 11-year cycles with background [Lean 2000] and the second from flux transport that has much less background change [Wang, Lean, and Sheeley, 2005]) provide a range of variations of TSI on centennial time scales. We apply phase relations among different spectral irradiance bands both from SIM observation and proxy reconstructions to the two scenarios of historical TSI. The spectral solar forcing is used to drive the RCM. The updated atmosphere and ocean mixed coupled RCM including diffusion to deep-ocean provides a first-order estimate of climate response. We report the different responses of stratosphere, troposphere, and ocean surface to these 4 scenarios of centennial spectral solar forcing. We further discuss the mechanisms for atmosphere-ocean and stratosphere-troposphere couplings responsible for the climate response to such hypothetical solar variations.