Project Details

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Project Title:
Climate Response to Solar Forcing, Observational Analysis, Theory and Modeling

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Summary:
We study the effect of the variation of the spectral irradiance of the sun over the 11-year solar cycle on the terrestrial climate. On the forcing side, we will use the latest satellite data to quantify the spectral variations over a solar cycle. This will impact the radiative forcing for the climate system, especially on energy absorbed at different levels in the atmosphere and on the fraction of the top of the atmosphere radiation that reaches the surface land and ocean. On the response side, the observational analysis will focus on statistical methods that are capable of separating out the small solar signal from the climate noise and other components of climate signal, such as El Nino and Southern Oscillation(ENSO) and Quasi-Biennial Oscillation (QBO). Lack of rigorous statistical tests of the solar signal has in the past been a criticism of this Sun-Climate field. The observational analysis will concentrate on the global and, to some extent, the wide regional, response in temperature, zonal wind and circulation in the lower atmosphere, to yield a clearer picture of the spatial pattern of the climate response at the surface, with polar amplification of the warming during solar max. Methods used for data analysis include previously used methods :Empirical Mode Decomposition (EMD), Composite Mean Difference Projection (CMD Projection) and Linear Discriminant Analysis (LDA), and new methods in this application, such as Singular Spectrum Analysis (SSA). On the theory side, we attempt to quantify the effectiveness of various pathways through which solar forcing is transmitted from the upper atmosphere to the lower atmosphere. In the stratosphere, we seek to understand how the enhanced UV component of the solar radiation variability affects the distribution of ozone, and how that filters the amount of radiation reaching the troposphere. The long-wave downward radiation by a warmed stratosphere will also be taken into account. Possible effects of solar cycle heating in the stratosphere affecting the propagation of planetary waves will also be considered, although it is not clear at this time how much this mechanism can contribute to the surface warming on a global basis. These effects will be studied using a radiative transfer code and a 2.5-dimensional model with interactive radiation, chemistry and dynamical transport(involving the planetary waves) previously co-developed by the PI. The tropospheric research focuses on understanding how the net radiative forcing (RF) reaching the top of the troposphere (after stratosphere adjustment in ozone and temperature) forces directly and indirectly the surface temperature, with an aim to quantifying the climate-gain factor due to the feedback processes, such as water-vapor feedback, ice albedo feedback and cloud feedback. The time scale considered range from seasonal to 150 years, the length of the instrumented observational record. The proposed research attempts to address the objective of the solicitation to "deliver the understanding of how and to what degree variations in the solar radiative output contribute to changes in global and regional climate over a wide range of timescales."

Publication References:

no references