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The Influence of solar spectral variations on climate

JD Haigh
Imperial College London, Physics, London, United Kingdom (j.haigh@imperial.ac.uk, +44 (0)20 7594 7900)

Reliable measures of solar activity, together with records of atmospheric and oceanographic parameters, have enabled considerable progress to be made in establishing statistical evidence of solar-climate links over a range of timescales. Some of these (e.g. large impacts on upper atmospheric temperature, in-phase signals in ozone column and global mean surface temperature) can be broadly interpreted in terms of known changes in solar output. It is increasingly clear, however, that there are a number of aspects of the solar signal in climate records that pose some challenges to interpretation. These include, inter alia, a double-peaked structure in the vertical profile of stratospheric ozone, largest signals in tropospheric temperatures found in mid-latitudes, large signals in the winter polar lower stratosphere which vary with the (tropical) quasi-biennial oscillation and, possibly, ENSO-like variations in tropical sea surface temperatures.

In this talk I will review measurements and estimates of variations of the solar spectrum and discuss the processes whereby they might be related to the apparent climate signals. These processes include the direct radiative impact on temperature and composition and also indirect effects through changes in atmospheric circulations. I will focus on recent research into the impact of changes in UV radiation in four main areas:

1. Sensitivity of stratospheric ozone and temperature to variations in solar ultraviolet radiation: Subtle changes in the spectrum can produce quite different responses in the vertical profile.

2. Solar radiative forcing (RF) of surface climate: Using the IPCC definition (with stratospheric adjustment) variations in UV can moderate the value of solar RF so that it depends on details of the solar spectrum, not just on total irradiance.

3. Stratosphere-troposphere dynamical coupling: Solar-induced changes to stratospheric temperatures and winds may influence the troposphere by downward coupling.

4. Direct radiative impacts on tropospheric photochemistry and heating rates: An investigation into the sensitivity to variations in the solar spectrum.