Solar Radiative Forcing

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For the past twenty-five years, space-based radiometers have continuously monitored the Sun's total radiative output, unanimously detecting an 11-year cycle of amplitude about 0.08%, as a result of changing magnetic sunspot and facular features on the Sun's surface. An array of empirical evidence suggests that climate responds to the solar activity cycle by some combination of direct surface heating, indirect processes involving UV radiation and the stratosphere, and modulation of internal climate system circulation patterns. Empirical data also suggest longer-term Sun-climate associations but evidence for significant secular irradiance change is ambiguous. Calibration offsets between the solar radiometers and in-flight sensitivity drifts thus far preclude the direct determination of whether longer-term irradiance trends are occurring in addition to the 11 year cycle. Simulations of the evolution of magnetic flux on the Sun's surface suggest a secular total irradiance increase of order 0.08% during the past three centuries, which is less than the increase of 0.2-0.4% inferred from earlier studies of variations in Sun-like stars and cosmogenic isotopes. The Solar Radiation and Climate Experiment (SORCE) commences a new generation of solar irradiance measurements with much expanded capabilities. Relative to historical solar observations SORCE monitors both total and spectral irradiance with significantly reduced uncertainty and increased repeatability, especially on long time scales. Spectral coverage expands beyond UV wavelengths to encompass the visible and near infrared regions that dominate the Sun's radiative output. The space-based irradiance record, augmented now with the spectrum of the changes, facilitates improved characterization of magnetic sources of irradiance variability, and the detection of additional mechanisms. This understanding provides a scientific basis for estimating past and future irradiance variations, needed for detecting and predicting climate change.

Essential for future progress are reliable, extended observations of the solar radiative output changes beyond the SORCE mission, into the indefinite future.