Empirical, Semi-Empirical, and Physical Models of Solar Irradiance Variability

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The solar irradiance at soft X-ray, EUV, and UV wavelengths plays a central role in determining the state of the Earth's upper atmosphere. The accurate specification and forecasting of the solar irradiance and its variability at these wavelengths is critical to problems ranging from modeling stratospheric ozone to predicting collisions between orbital debris and operational satellites. In this talk we review three approaches to irradiance modeling: empirical - the regression of observations with proxies for solar irradiance, semi-empirical - coupling computed radiance spectra with solar images, and physical - first principles calculations of the density and temperature structure of the solar atmosphere. We discuss the advantages and limitations of each approach. We also show how each approach can be tied to measurements of solar magnetic fields, which are ultimately responsible for driving almost all aspects of solar variability. Finally, we describe the future breakthroughs that are needed to improve our understanding of the sun's radiative output.