

Modeling the Solar Atmosphere: Spectral Irradiance Synthesis for the Period 2010-2015

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Recent progress has been made in constructing atmospheric models that reproduce the observed center-to-limb solar spectra emitted from the various components of both quiet and active regions. We use these results to calculate the solar spectral irradiance (SSI) at any time, given the state of the solar disk, i.e., given by the observed components of quiet and active regions located at various heliocentric angles. These components are determined directly from images at various wavelengths, and in the current decomposition scheme 9 feature types are considered.

The analysis of many images obtained by the Solar Dynamics Explorer/Atmospheric Imaging Assembly (SDO/AIA) produced daily masks of the solar disk, indicating the location of regions of various activity. From these we have computed the relative area and position on the disk occupied by the features that describe the state of the solar disk at any time during the current solar cycle.

Using the spectra of the key solar surface features produced by detailed models of these features by the Solar-Stellar Radiation Physical Modeling system version 2 (SRPMv2), together with the masks, we computed the SSI during the period 2010-2015. We show the resulting SSI as function of time in several wavelength bands, from the UV to the far-IR. We also show how the various solar features contribute to the SSI and to its variation over the current solar cycle 24.

Recent progress in the understanding of molecular photo-dissociation UV opacity solved the outstanding issues in the previous models and calculations, and now the SSI results are fully consistent with the observations. These results include the significant variation of the near-UV spectrum that affects ozone photo-dissociation in the Hartley band, and the overall opposite trends with the solar cycle of the visible and UV SSI variations.

The current methods and models are the culmination of the project Radiative Inputs from the Sun to the Earth started in 1995 by a collaborative team led by O. R. White. Longer-term reconstructions can now be carried out using extensive imaging data that exists from early in the 20th century to the present.