Calculations of Solar Spectral Irradiance (daily from 1950 to 2006)

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The overall approach for calculating the solar spectral irradiance involves the parameterization of an observed irradiance time series at a given wavelength in terms of the proxy indicators needed to represent the known sources of variability at that wavelength. For wavelengths longer than 300 nm there are two main sources of variability, the dark sunspots and the bright faculae, which are represented by, respectively, the sunspot blocking function and the Mg index. For wavelengths from about 30 to 300 nm, the variations are primarily causes by emission from bright plages, approximately overlying the visible faculae, and the Mg index is used as a proxy for the sources of these variations. For the parameterizations of the shortest EUV and X-ray emissions (mainly at wavelengths below about 27 nm) the 10.7 cm radio flux is also used, in addition to the Mg index, to account for emission from hot coronal plasma overlying the bright plage.

Because the measurements of the solar spectral irradince have traditionally suffered from wavelength dependent degradation, the multiple regression that determines the association of the proxies with the observations is undertaken using detrended time series (both the proxies and the irradiance). In essence, this means that the associations are determined from a subset of the range of possible variations. The reconstruction of the irradiance from the proxy indicators (using the proxies themselves, i.e.., not detrended) therefore assumes that the proxies and the irradiance behave in similar ways over both rotational and solar cycle time scales. This direct multiple regression approach is applied to the wavelength range 120 to 300 nm using the UARS/SOLSTICE data and to the wavelength range 0 to 120 nm using the TIMED/SEE data. For wavelengths longer than 300 nm, the spectral dependence of the variability is determined from the spectral dependence of the sunspot blocking and facular brightening. The total flux from 120 to 100000 nm is constrained in absolute magnitude such that the total equals the actual bolometric observations of total solar irradince (modeled separately).

The approach is documented in detail in:

J.L. Lean, G.J. Rottman, H.L. Kyle, T.N. Woods, J.R. Hickey, and L.C. Puga, Detection and parameterization of variations in solar mid and near ultraviolet radiation (200 to 400 nm), J. Geophys. Res., 102, 29939-29956, 1997.

Judith Lean, Evolution of the Sun's Spectral Irradiance since the Maunder Minimum, Geophys. Res. Lett., 27, 2425-2428, 2000.

J. Lean, G. Rottman, J. Harder and G Kopp, SORCE contributions to new understanding of global change and solar variability, Solar Phys., 230:27-53, 2005.