The Impulse Response of the Solar Spectral Irradiance: What does it tell us about the solar spectral variability?

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Many empirical solar spectral irradiance (SSI) models assume that there is a static relation between solar proxies and the SSI. This approximation breaks down when one takes into account the different time-evolutions of solar structures such as sunspots, extended active regions, their remnants, etc. Preminger et al. [GRL, 2005] were among the first to show that the connection between them is correctly described by a transfer function rather than by some static (non)-linear relation.

Here, we bring this concept further by considering time scales of 27 days and more, and by using a system identification approach to estimate the impulse response of the SSI. This response reveals how the SSI would evolve after a major sunspot that would last for a few days, without any remnants. The main advantage of having timescales longward of 27 days is that geometrical projection effects can be ignored. The system identification approach used here more sensitive than standard methods, thereby allowing the signature of sunspots to be tracked during 5 solar rotations and more, even with noisy measurements.

We consider SSI measurements from SORCE and TIMED to estimate the impulse response from the XUV to the Visible. Significant differences are observed in the relaxation times, and this will be discussed in the light of known solar variability results. Most importantly, these results show how important it is to use a convolutive (i.e. non-static) model when connecting proxies to the SSI, even on long time-scales.

Here, we bring this concept further by considering time scales of 27 days and more, and by using a system identification approach to estimate the impulse response of the SSI. This response reveals how the SSI at specific wavelengths would evolve after a major sunspot that would last for a few days, with not remnants at all. The main advantage of having timescales longward of 27 days is that geometrical projection effects can be ignored. The system identification approach is much more sensitive than the methods used so far in the literature, thereby allowing the signature from sunspots to be tracked during 5 solar rotations and more.

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