



Solar rotational modulations of spectral irradiance and correlations with the variability of solar proxies

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We characterize the solar rotational modulations of spectral solar irradiance (SSI) and compare them with the corresponding changes of total solar irradiance (TSI) and three solar proxies; F10.7, MgII index and Sun Spot area. Solar rotational modulations of SSI at wavelengths between 120 and 1600 nm are identified over one hundred Carrington rotational cycles during 2003–2013. The SORCE (Solar Radiation and Climate Experiment) and TIMED (Thermosphere Ionosphere Mesosphere Energetics and Dynamics)/SEE (Solar EUV Experiment) measured and SATIRE-S modeled solar irradiances are analyzed using the EEMD (Ensemble Empirical Mode Decomposition) method to determine the phase and amplitude of 27-day solar rotational variation in and SSI.

The mode decomposition clearly identifies 27-day solar rotational variations in SSI between 120 and 1600 nm, and there is a robust wavelength dependence in the phase of the rotational mode relative to those of TSI and solar proxies. The rotational modes of visible (VIS) and near infrared (NIR) are in phase with the mode of TSI, but the phase of the rotational mode of ultraviolet (UV) exhibits differences from that of TSI. While it is questionable that the VIS to NIR portion of the solar spectrum has yet been observed with sufficient accuracy and precision to determine the 11-year solar cycle variations, the temporal variations over one hundred cycles of 27-day solar rotation, independent of the two solar cycles in which they are embedded, show distinct solar rotational modulations at each wavelength.

The correlations between rotational variations of SSI and Mg II index are very high (> 0.8) in the UV region, while the correlations with sunspot area are not significant (~ 0.2). These correlations imply that brightening effect accounts for more than 60% of the rotational variance in FUV and MUV below 300 nm. Different from the Mg II index correlations, the SSI mode correlations with sunspot area mode are low in the UV region, but increase with wavelength above 300 nm and reach high negative correlation of -0.6 for SIM and over -0.8 for SATIRE near 400 nm.