Description of an alternative SSI dataset for PMIP.

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An alternative scenario of solar irradiance evolution consists of annual mean spectral solar irradiance (SSI) and total solar irradiance (TSI) dataset covering the 850-1850 time period. SSI data are available for the spectral range 120-100'000 nm with resolution 1 nm between 120 and 750 nm, 5 nm – between 750 and 5000 nm, 10 nm – between 5000 and 10000 nm, and 50 nm from 10000 nm. The spectral grid is identical to the spectral grid used for the CMIP SSI data set for the wavelength longer than 120 nm. The SSI data have been scaled to match CMIP SSI in 1850. The data are available in simple text format with the description of the file structure in the header. In addition we provide a FORTRAN routine to read the data and transform them to a user defined spectral grid.

Provided reconstruction of the spectral solar irradiance (SSI) is based on the approach of Shapiro et al. (2011, hereafter SSR11) and Judge et al. (2012). Following Krivova et al. (2003) the SSI evolution for any particular wavelength $\lambda$ is represented as the sum of four individual components:

$$I(\lambda, t) = I_q(\lambda, t) + \alpha_f(t) * (I_f(\lambda) - I_c(\lambda)) + \alpha_p(t) * (I_p(\lambda) - I_c(\lambda)) + \alpha_s(t)*(I_s(\lambda) - I_c(\lambda)), \quad (1)$$

where $t$ is the year and $I(\lambda)$ is the spectral solar irradiance calculated with the solar radiation code COSI (Shapiro et al., 2010) using solar atmosphere structure models representative for different regions or components on the Sun. These components are the quiet Sun $(I_q)$,.which in itself is variable (see below) and is equal for the present time to the present day quiet Sun $(I_c)$, faculae $(I_f)$, active network $(I_p)$, and sunspots $(I_s)$. The coefficients $\alpha_f$, $\alpha_p$, $\alpha_s$ are the filling factors, representing the projected fractional area covered by these magnetic features relative to the total surface of the Sun. These filling factors are calculated using the sunspot number instead of high resolution solar magnetograms as it was done by Krivova et al., (2003) because for the considered time interval detailed information about solar magnetic field is not available. The evolution of the sunspot number (SSN) has been taken from Wu et al. (2016, personal communication), who superposed the original data of Usoskin et al. (2016) with a 11-year cycle introducing the cyclic component of solar variability caused by the decadal scale solar activity cycle.

Our estimate of the SSI variability has higher amplitude than other available reconstructions (see Solanki et al., 2013) due to the applied treatment of the long-term variability of the quiet Sun irradiance (see detailed discussion in SSR11 and Judge et al., 2012). The hypothesis is that the long-term evolution of the quiet Sun irradiance $(I_q)$ is driven by the slowly changing content of the small scale solar magnetic fields. It is assumed that this overall magnetic activity can be well represented by a 22-year mean of the solar spot number *(SSN)* and the evolution of the quiet Sun irradiance is described by the following equation

$$I_q(\lambda, t) = I_c(\lambda) + (I_b(\lambda) - I_c(\lambda))*(SSN_{2009}-SSN(t))/(SSN_{2009}-SSN_{min}). \quad (2)$$

Where $SSN(t)$ is time evolving solar spot number, $SSN_{2009}$ is the solar spot number for the present state of the Sun and $SSN_{min}$ represents the smallest solar spot number during the considered time period (850-1850). $I_b(\lambda)$ is calculated using the atmospheric model for the minimal solar activity case. Here we applied several improvements to the original approach of SSR11. We used solar spot numbers from Usoskin et al. (2016) instead of the solar modulation potential and applied a relative scaling in the equation (2) to avoid problems with the absolute calibration of the time series. Finally, we followed Judge et al. (2012) conclusions based upon their re-analysis of sub-mm data from the James Clerk Maxwell telescope and replaced the model "A" from Fontenla et al. (1999) used by SSR11 for the quiet Sun irradiance during the minimum solar activity state by a model "B". However, the set of structures published by Fontenla et al. (1999) does not include solar structure "B", therefore, we constructed it using the requirement formulated by Judge et al. (2012) that the minimum model of the quiet sun should produce the irradiance at intermediate level between the models "A" and "C".

The evolution of TSI during the considered time period is shown in Figure 1. Figure 2 illustrates the variability of the SSI in several spectral intervals. The range of the TSI changes is up to 4 W/m$^2$, which is slightly lower than in SSR11 because the present reconstruction is based on model "B" instead of "A" for the quietest solar states. The same is true for the SSI variability.

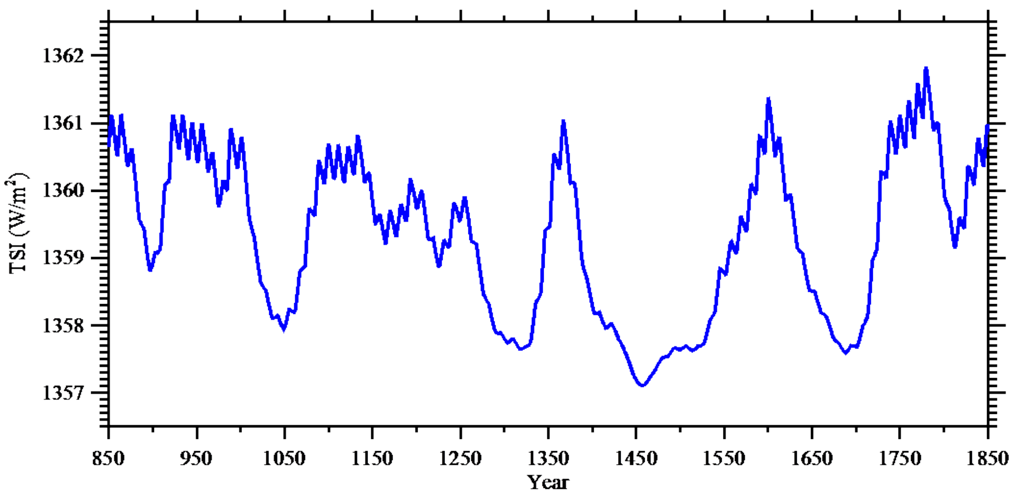


***Figure 1.*** Reconstructed evolution of the total solar irradiance (W/m$^2$) from 850 until 1850.

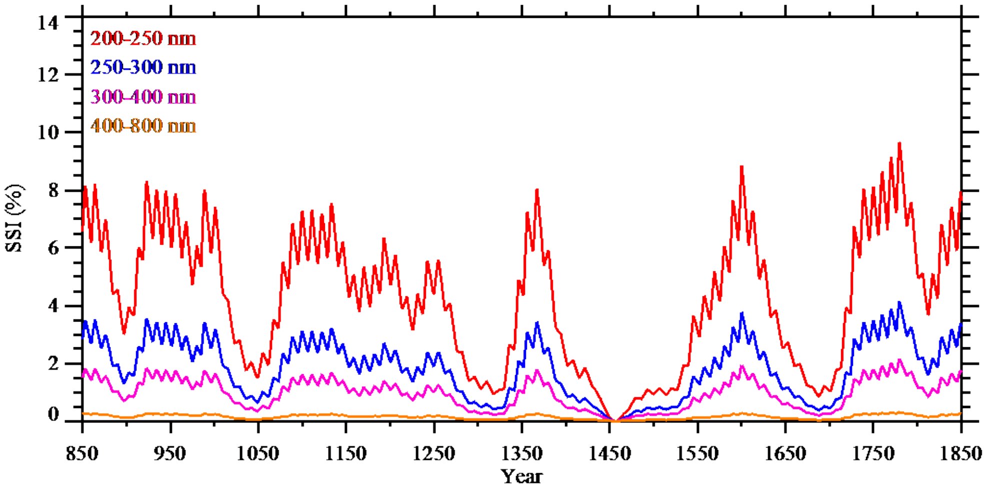


***Figure 2.*** Reconstructed evolution of the spectral solar irradiance from 850 until 1850 integrated over several spectral intervals relative to the minimum (%).

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