A new observational solar irradiance composite

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1. Abstract

Variations of the spectral solar irradiance (SSI) are an important driver for the chemistry, temperature and dynamics of the Earth's atmosphere and ultimately the Earth's climate. Due to the sparce and scattered SSI data sets it is important to establish tools to derive a consistent SSI dataset, including realistic uncertainties. We present a new SSI composite based on the face values of SSI observations and applying a probabilistic method that takes into account the uncertainty of the data set scale-wise. We will present the data set and discuss its effects on the Earth's atmosphere in relation to SSI reconstruction models.

2. Approach

***Table 1:** List of the instruments used for making the com- posite. See Paper I for more details, and a few more instru- ments that were not used for the composite. The dates corre- sponds to the dates of available data in the SOLID database (see Schöll et al., 2016; Haberreiter et al., 2016).*

Name of the instrument	Wavelength range [nm]	Observation Period
GOES13/EUVS	11.7–123.2	07/2006–10/2014
GOES14/EUVS	11.7–123.2	07/2009–11/2012
GOES15/EUVS	11.7–123.2	04/2010–10/2014
ISS/SolACES	16.5–57.5	01/2011–03/2014
NIMBUS7/SBUV	170.0–399.0	11/1978–10/1986
NOAA9/SBUV2	170.0–399.0	03/1985–05/1997
NOAA11/SBUV2	170.0–399.0	12/1988–10/1994
NOAA16/SBUV2	170.0–406.2	10/2000–04/2003
SDO/EVE	5.8–106.2	04/2010–10/2014
SME/UV	115.5–302.5	10/1981–04/1989
SNOE/SXP	4.5	03/1998–09/2000
SOHO/CDS	31.4–62.0	04/1998–06/2010
SOHO/SEM	25.0–30.0	01/1996–06/2014
SORCE/SIM	240.0–2412.3	04/2003–05/2015
SORCE/SOLSTICE	115.0–309.0	04/2003–05/2015
SORCE/XPS	0.5–39.5	04/2003–05/2015
TIMED/SEE-EGS	27.1–189.8	02/2002–02/2013
TIMED/SEE-XPS	1.0–9.0	01/2002–11/2014
UARS/SOLSTICE	119.5–419.5	10/1991–09/2001
UARS/SUSIM	115.5–410.5	10/1991–08/2005

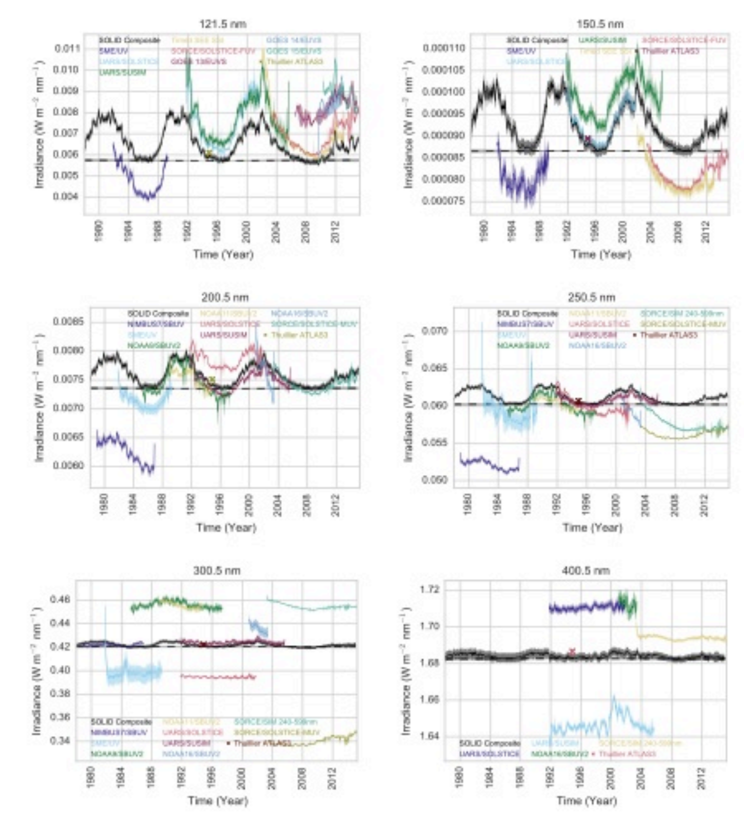

Figure 1: SOLID composite along with the individual irradiance datasets used to produce it for: top panels 121.5 nm (left), 150 nm (right); second row 200.5 nm (left) and 250 nm (right); third row 300 nm (left) and 400 nm (right).

The making of such a composite involves several steps: first, the raw data are preprocessed (Schöll et al., 2016). Next, each individual time series is decomposed into different time scales (typically, from daily to annual). For each time scale, their uncertainty is estimated. All these records are then merged scale-wise, by computing their average, weighted by their scale-dependent uncertainties. Finally, the composite is obtained by adding up the average obtained for each time scale. Let us stress that the foremost aim has been to keep the observations, and ultimately the composite fully independent from existing models. This means that no SSI models have been used to correct the observational data, which were taken at their face value, without any correction.

2. The SOLID observational composite

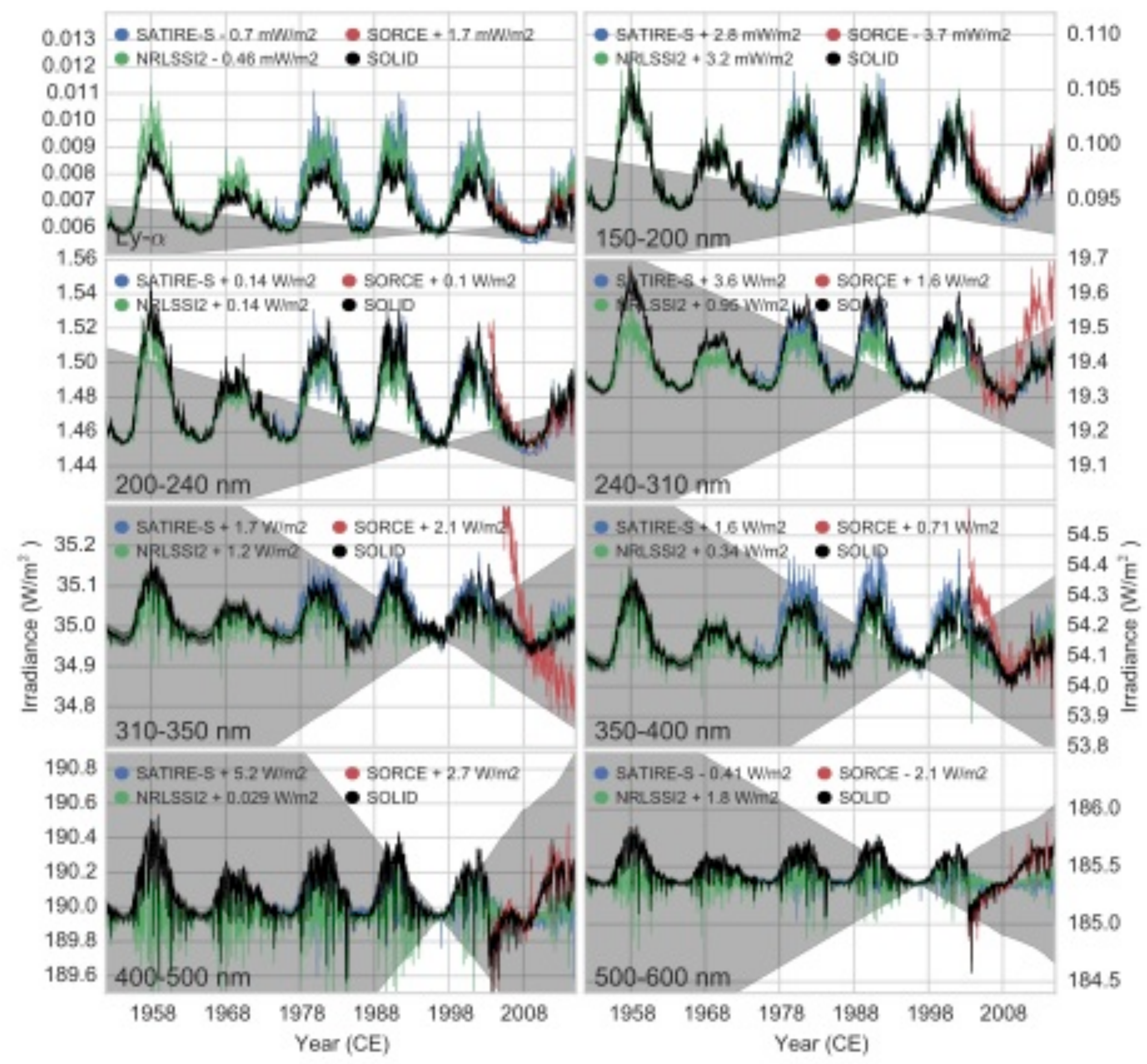

Figure 2: Shown are the observational composite (black line), NRLSSI2 (green line), SATIRE-S (blue line), and the SORCE composite (red line) integrated over the following spectral intervals. Top row: 120–122 nm (left) and 150–200 nm (right); second row: 200–240 nm (left) and 240–310 nm (right); third row: 310–350 nm (left) and 350–400 nm (right); bottom row: 400–500 nm (left) and 500–600 nm (right). The numbers in the legend given after the name of each dataset give the value for the absolute scaling of each of the datasets to the SOLID composite.

5. Relative variation of the SSI

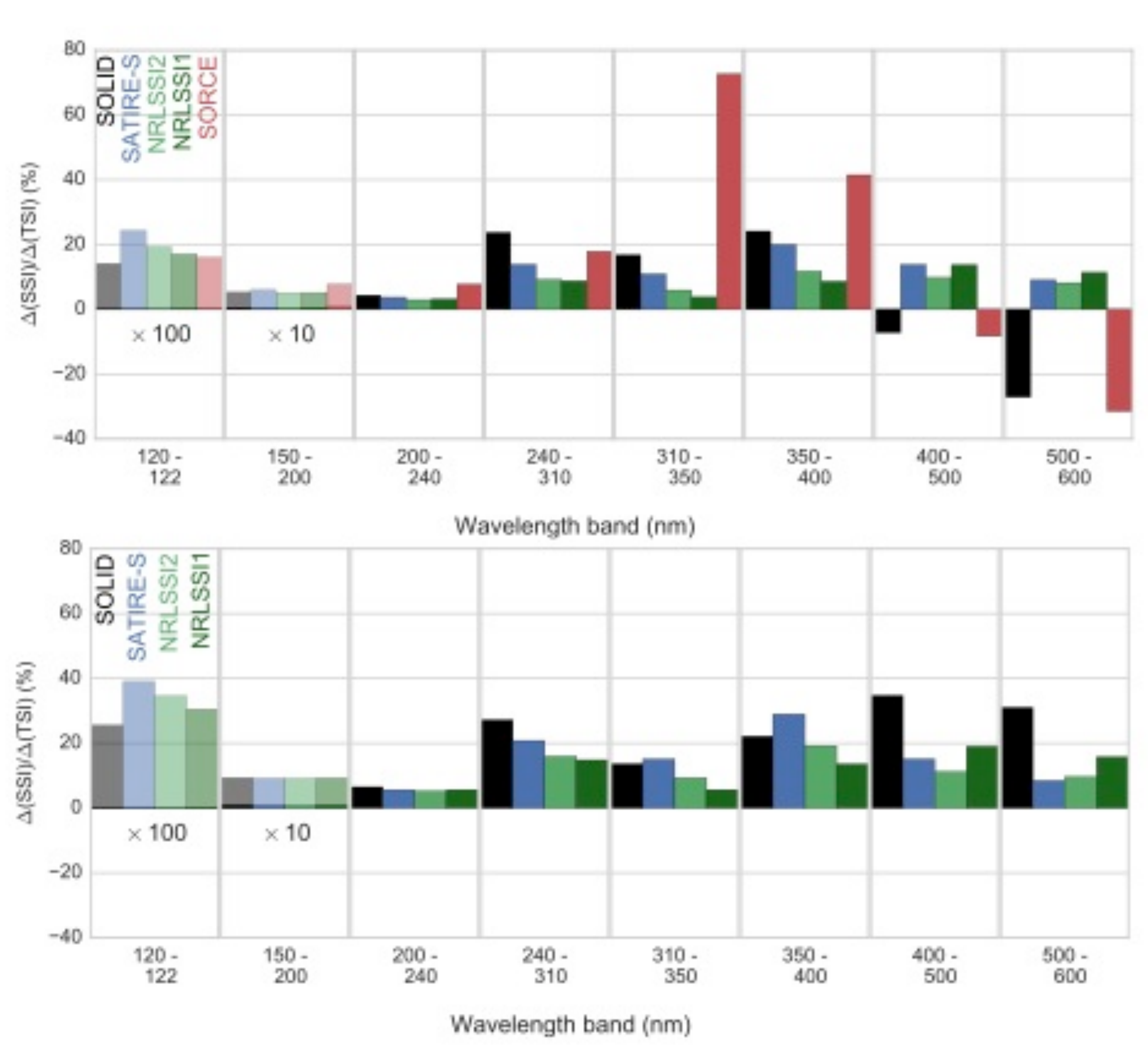

Figure 3. Upper Panel: Change of the annual mean of SSI in different spectral bins from 2003 to 2008 with respect to the variation in TSI for the same time interval. Shown are the relative changes for SOLID (black), SATIRE-S (blue), NRLSSI1 and NRLSSI2 (dark and light green), and the SORCE composite (red). For better illustration, the first and second spectral bin, i.e. for 121–122nm and 150–200nm is multiplied by a factor of 100 and 10, respectively, additionally shown in partly transparent color. Lower panel: Same as upper panel, but for the annual means of 1989 and 1994, for which no SORCE data is available.

6. Atmospheric Response to the radiative forcing

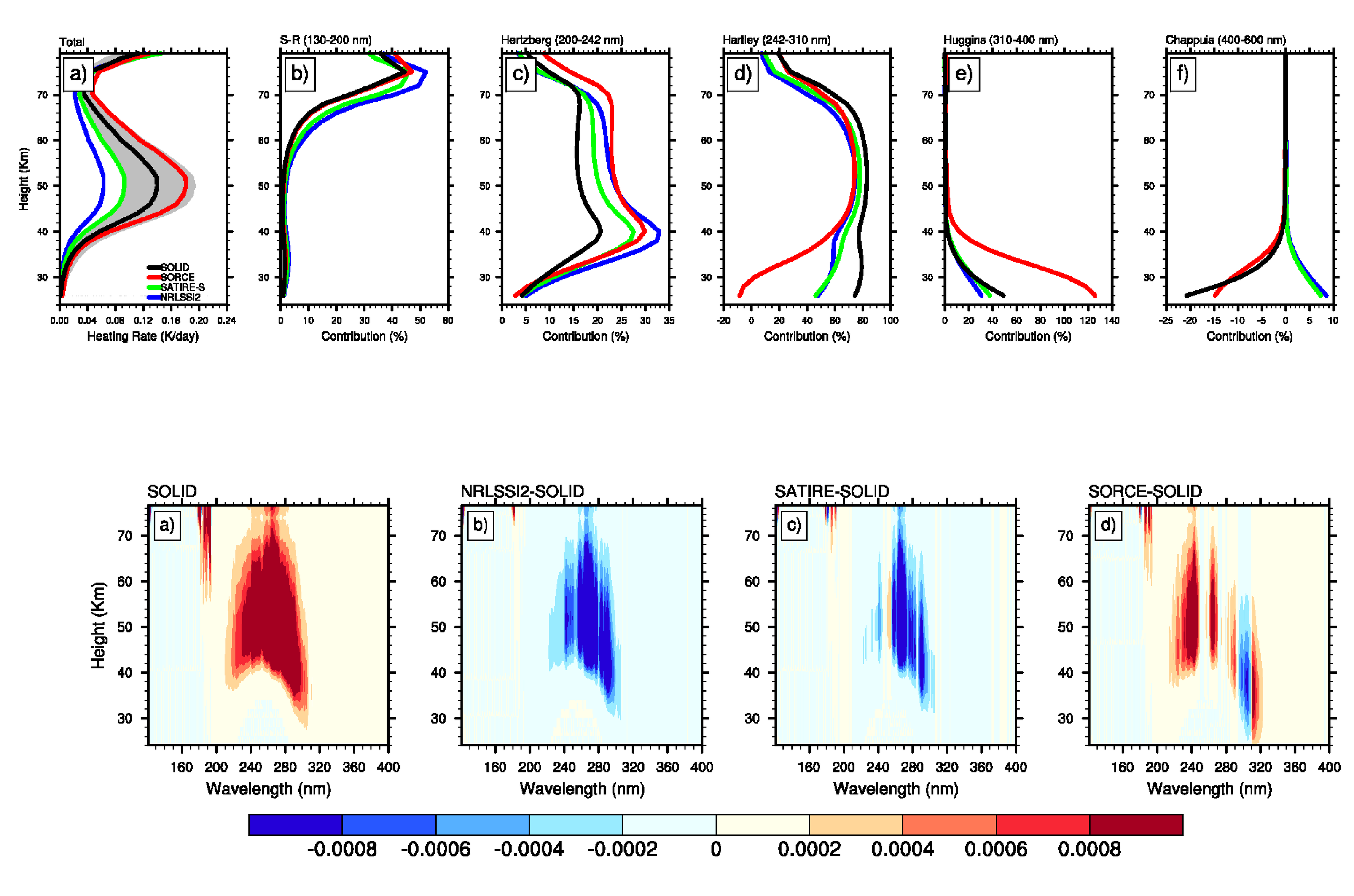

Figure 4. Top Panels: Comparison of solar heating rate differences (K/day) between solar minimum (2008) and maximum (2003) for the SOLID composite, NRLSSI2, SATIRE-S and SORCE. Panel a) shows the integrated (120-700 nm) heating rate anomalies whereas panels b)-d) show the relative contribution (%) of the 200–300 nm, 300–400 nm and 400–500 nm spectral bands to the integral. Grey shading indicates a 2-σ uncertainty of the SOLID dataset. Bottom Panels: a) Solar spectral heating rate anomalies (K/day/nm) between solar minimum (2008) and maximum (2003) for SOLID. Panels (b–d): Differences in solar cycle spectral heating rate anomalies between SOLID and NRLSSI2, SATIRE-S and SORCE.

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References:

Haberreiter, M., Schöll, M., Dudok de Wit, T., Kretzschmar, M., Misios, S., Tourpali, T., and Schmutz, W., 2016, A new observational solar irradiance composite, to be submitted to JGR
Schöll, M., Dudok de Wit, T., Kretzschmar, M., Haberreiter, M., 2016, Making of a solar spectral irradiance dataset I: observations, uncertainties, and methods, J. Space Weather Space Clim., 6, A14.