EPSC Abstracts
Vol. 13, EPSC-DPS2019-2071, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Solar irradiance variability over last four billion years

Anna V. Shapiro (1), Alexander I. Shapiro (1), Laurent Gizon (1,2,3), Natalie A. Krivova (1), and Sami K. Solanki (1,4)

(1) Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen (shapiro@mps.mpg.de)
(2) Institut für Astrophysik, Georg-August-Universität, Friedrich-Hund-Platz 1, 37077 Göttingen
(3) Center for Space Science, NYUAD Institute, New York University Abu Dhabi, PO Box 129188, Abu Dhabi, UAE
(4) School of Space Research, Kyung Hee University, Yongin, 446-701 Gyeonggi, Korea

Abstract

The action of dynamo generates magnetic field in the solar interior. This field then travels through the convective zone and emerges on the solar surface, leading to a various manifestations of solar magnetic activity. One of the most appealing among them is the variations of Spectral Solar Irradiance (SSI). There is an evidence that these variations have substantial effect on the Earth's climate system. The faster rotation of the Sun in the past led to a more vigorous dynamo and consequently larger amplitude of solar spectral irradiance variability. This could led to a stronger effect of the SSI variability on the Earth.

The main goal of our study is to calculate the amplitude of the SSI variability over the course of the solar activity cycle (which presently lasts 11 years but could have different duration in the past) as a function of solar age. We utilize recently published relation between the stellar chromospheric activity and stellar age to reconstruct solar chromospheric activity back in time. It is used to calculate solar disk coverages by magnetic features, i.e. solar spots and faculae. Corresponding brightness variations are then computed using the SATIRE (which stands for Spectral And Total Irradiance Reconstruction) approach.

Our study shows that the facular component of the irradiance variability over the solar activity cycle decreases slower with the solar age than the spot component. This makes the dependence of the amplitude of the solar variability on the age non-monotonic. The amplitude decreases for the young Sun till it reaches minimum value and then gradually increases again. The variability of the Total Solar Irradiance (TSI, i.e. irradiance integrated over the entire spectral domain) changes from being spot- to facular-dominated at the solar age of about 2.8 Gyr. Our calculations show that the amplitude of the TSI variability of 600-Myr Sun was one order of magnitude larger than the present-day value. We have found that the age of the transition between spot- and facular-dominated regimes of the variability depends on the wavelength. For example, it is about 1.3 Gyr for the 210-400 nm spectral domain and becomes approximately 3.7 Gyr for the 400-700 nm spectral range.

Our calculations of the past solar irradiance variability on the activity cycle timescale might be of interest for paleoclimate researchers as well as for modelling of atmospheres of exoplanets.