Millennial solar irradiance forcing (Hallstatt’s cycle) in the terrestrial temperature variations

Valentina Zharkova¹, Simon Shepherd², and Elena Popova³
¹University of Northumbria, MPEE, Faculty of Engineering and Environment, Newcastle upon Tyne, UK (valentina.zharkova@northumbria.ac.uk)
²VSS Enterprise Ltd., Bradford, West Yorkshire, UK
³National Research University, Higher School of Economics, 101000, Moscow, Russia

In this paper we explore the millennial oscillations (or Hallstatt cycle) of the baseline solar magnetic field, total solar irradiance and baseline terrestrial temperature detected from Principal Component Analysis of the observed solar background magnetic field. We confirm the existence of these oscillations with a period of 2100-2200 years with the similar oscillations detected in carbon 14C isotope abundances and with wavelet analysis of solar irradiance in the past 12 millennia indicating the presence of this millennial period among a few others. We also test again the idea expressed in our paper Zharkova et al, 2019 that solar inertial motion (SIM) can cause these millennial variations because of a change of the distance between the Sun and Earth. In this paper we use the S-E distance derived from the current JPL ephemeris, finding that currently starting from the Maunder minimum the Sun-Earth distance is reducing by 0.00025 au per 100 years, or by 0.0025 au per 1000 years. We present the estimation of variations of solar irradiance caused by this variation of the S-E distance caused by solar inertial motion (SIM) demonstrating these variations to be closely comparable with the observed variations of the solar irradiance measured by the SATIRE payload. We also estimate the baseline temperature variations since Maunder Minimum caused by the increase of solar irradiance caused by the recovery from grand solar minimum and by reduction of the S-E distance caused by SIM. These estimations show that the Sun will still continue moving towards the Earth in the next 700 years that will result in the increase of the baseline terrestrial temperature by up to 2.5°C in 2700. These variations of solar irradiance will be over-imposed by the variations of solar activity of 11 cycles and the two grand solar minima occurring in 2020-2053 and 2370-2415 caused by the double dynamo actions inside the Sun.