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Editorial

Introduction to several papers on special section of 'The Time Varying Sun'

The Sun is at the origin of life on the Earth, and it influences all the Earth's environment, human life, climate, geomagnetism as well as many new technologies systems as, for example, navigation system. This is why the time varying Sun deserves a trans-disciplinary approach of many topics. In the following 8 papers, we will consider the Sun itself in its relation with the Earth (geomagnetism and climate).

The Sun is a nonsolid magnetized moving body under the laws of the celestial mechanics. Its time varying scales are multiple from the solar flare timescale of several seconds, to timescale of 11 years (sunspot-wolf cycle), 22 years (Schwabe cycle), century millennium, 100,000 years, millions years and more.

At the present time we are at a turning point: on the one hand there are old data on the time varying Sun recorded since centuries or more (as for example the sunspot number) or derived from Earth's magnetic field observations (as for example magnetic indices) and on the other hand there are modern data from satellite as ULYSSE, ACE, SOHO, etc. We have now to combine old and modern data of the Sun to study the various timescales of the time varying Sun.

In the following 8 papers new results are presented concerning the time varying Sun at different scales from event of several minutes (as solar flares), sunspot cycle, or long-term variations over more than one and a half century. One paper considers astronomical parameters (the solar shape) and all the other papers are devoted to electromagnetic phenomena (solar flares, sunspot cycle, long-term variations of geomagnetic activity, etc.).

Variability of the solar shape: This paper is based on a socle of what can be known today concerning the consequences of physics of the variability of solar rotation rate and of the nonuniform distribution of solar mass, on the solar limb. It emphasizes the need for new space-dedicated astrometric missions, such as SDO (HMI instrument).

Solar flares: In a first paper, effectiveness of solar flares to produce magnetic effects on Earth is analyzed according to their spectral nature and position on the solar disk using a long series of data. In a second paper the dependence on the final results on the nature of the natural external disturbances as a masking effect and the limitation of the detection method, which is highly dependent on the availability of multiple observational points, are shown, too.

Sunspot cycle: A first paper describes the study of solar activity's sudden increase and Halloween storms of 2003 and highlights that during the declining phase of the last three solar cycles, secondary peaks have been detected 2–3 years after the main peak of sunspot number.

A second paper criticizes and rejects the re-calibration of sunspot number by the observed daily range of the geomagnetic inclination proposed by other authors.

Long-term variations of the solar and geomagnetic activity: In a first paper 100–150-year-long temperature and precipitation records from 14 meteorological stations in Romania are analyzed in connection with long-term trends in solar and geomagnetic activities, in the context of other European stations and of averages on the European, northern hemisphere, and global scale. Positive correlation coefficients (temperature) and negative ones (mean precipitation) with the solar (sunspot number) and geomagnetic (aa index) parameters were found at inter-decadal timescales. Differences between local trends and average trends for larger areas are discussed. The study indicates that solar and geomagnetic activity effects are present on the 22-year Hale cycle timescale. The temperature variation on this timescale lags the solar/geomagnetic ones by 5–9 years.

In a second paper the evolution of the long-term variation of the aa index (1868–2008) is analyzed in the light of the new solar wind data obtained during the last decades. The rough ancient classification of solar geomagnetic activity, made before the existence of systematic solar wind measurements by satellite, is validated by the new in situ measurement of solar wind. Nevertheless it is now necessary to study in more details the geomagnetic activity in the light of all the new solar data from satellites as SOHO, ULYSSE, etc.

Finally a paper is devoted to Kristian Birkeland.

Kristian Birkeland addressed questions that had vexed scientists for decades:

Why do auroras appear overhead when the Earth's magnetic field is disturbed?

How are these phenomena connected to disturbances on the Sun?

To answer these questions Birkeland carried out advanced laboratory simulations—the famous terrella experiments, and daring campaigns in the polar regions. Some of Birkeland's main ideas, dismissed for decades, were confirmed by satellites observation.

Some questions remain open to debate:

Is there an influence of the solar magnetic field components (toroïdal and poloidal) on the climate? and what is it?

We know that Milankovitch's astronomical theory can explain by changes in geometric characteristics (eccentricity, precession and obliquity) of the Earth's orbit the cycles of 100,000 years, 22,000 years and 41,000 years in the global temperature, but they cannot explain the little ice age (decrease of temperature)

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observed in Europe during Maunder's minimum from 1645 to 1715 associated with a disappearance of the sunspots.

How does geomagnetic activity represent the time varying Sun? What is the real increase of geomagnetic activity?

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