

Solar activity and geomagnetic activity related to M6.0 South Sandwich Islands region earthquake recorded on March 14, 2021

Cataldi Gabriele¹, Daniele Cataldi¹⁻², Valentino Straser³

(1) Radio Emissions Project, Rome, Italy – ltpaobserverproject@gmail.com

(2) Fondazione Permanente G. Giuliani, L'Aquila, Italy – daniele77c@gmail.com

(3) Department of Science and Environment UPKL, Brussels – Valentino.straser@gmail.com

Abstract

On March 14, 2021, at 12:05:13 UTC, an M6.0 earthquake was recorded in the South region of the Sandwich Islands. The analysis of the modulation of the solar ion flux and of the Earth's geomagnetic activity showed that the M6.0 earthquake was preceded by a solar wind proton density increase and by an increase in the Earth's geomagnetic field. This type of correlation was observed for the first time by the authors in 2011 [20] [23] and currently has allowed the development of a new seismic forecasting method that is able to provide (with an average advance of 108.4 hours) when it is possible to expect a resumption of M6+ seismic activity on a global scale [24].

Keywords: solar activity, Earth's geomagnetic activity, seismic precursor, earthquake prevision, proton increase.

Introduction

On March 14, 2021, at 12:05:13 UTC, an M6.0 earthquake was recorded in the South region of the Sandwich Islands and at a depth of 10 km (**Fig. 1**). This strong seismic event was recorded after an increase in solar activity and terrestrial geomagnetic activity, as well as all potentially destructive seismic events recorded between January 1, 2012 to date [20] [23] [24]. The authors, thanks to the studies conducted on the modulation of the solar ion flux and thanks to the monitoring of the Earth's geomagnetic activity, were able to prove at the end of 2012 [1] the existence of an electromagnetic seismic precursor that always precedes potentially destructive earthquakes which are recorded on a global scale. This seismic precursor is represented by solar wind proton density increases (Interplanetary Seismic Precursors or ISPs) which can also generate increases in terrestrial geomagnetic activity (Seismic Geomagnetic Precursors or SGPs) [2-6] [11-15] [17] [18] [21-23]. In this work, the authors will present data relating to solar activity and terrestrial geomagnetic activity that have been related to the M6.0 earthquake recorded in the South region of the Sandwich Islands on March 14, 2021.

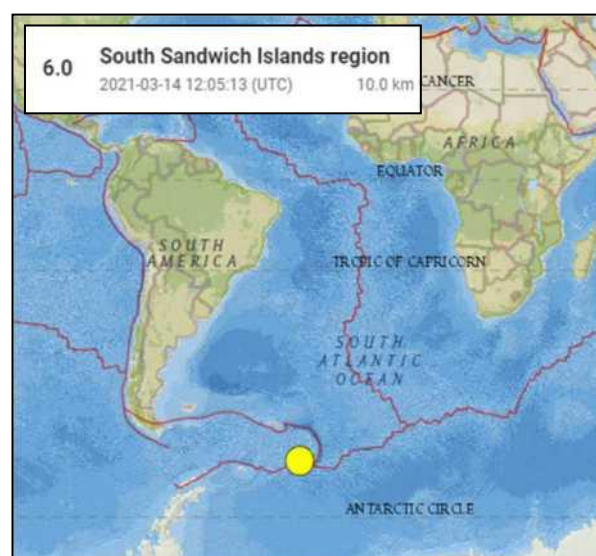


Fig. 1 – Seismic epicenter of the M6.0 earthquake recorded in the South Sandwich Islands region on March 14, 2021.

Credits: USGS

Data analysis

The confirmation of a theory in the scientific field is an extraordinary event that requires a lot of significant data. The authors, through the monitoring of solar activity and terrestrial geomagnetic activity, have managed in a few years to scientifically validate what at first seemed to be simply a series of events that repeated themselves according to a certain frequency and this suggested that they had to be connected. To confirm that every single destructive seismic event that occurs on a global scale is always preceded by a solar wind proton density increase, it was necessary to analyze the entire M6+ seismic activity that occurs on a global scale in relation to the conditions of space weather and in relation to the effects that this has on the Earth's geomagnetic field [23]. As happened for all potentially destructive seismic events recorded on Earth, also the M6.0 earthquake recorded in the South Sandwich Islands region on March 14, 2021 at 12:05 UTC was preceded by a solar wind proton density increase (Fig. 2) which subsequently produced a degree 5 increase in the Earth's geomagnetic activity (Fig. 3).

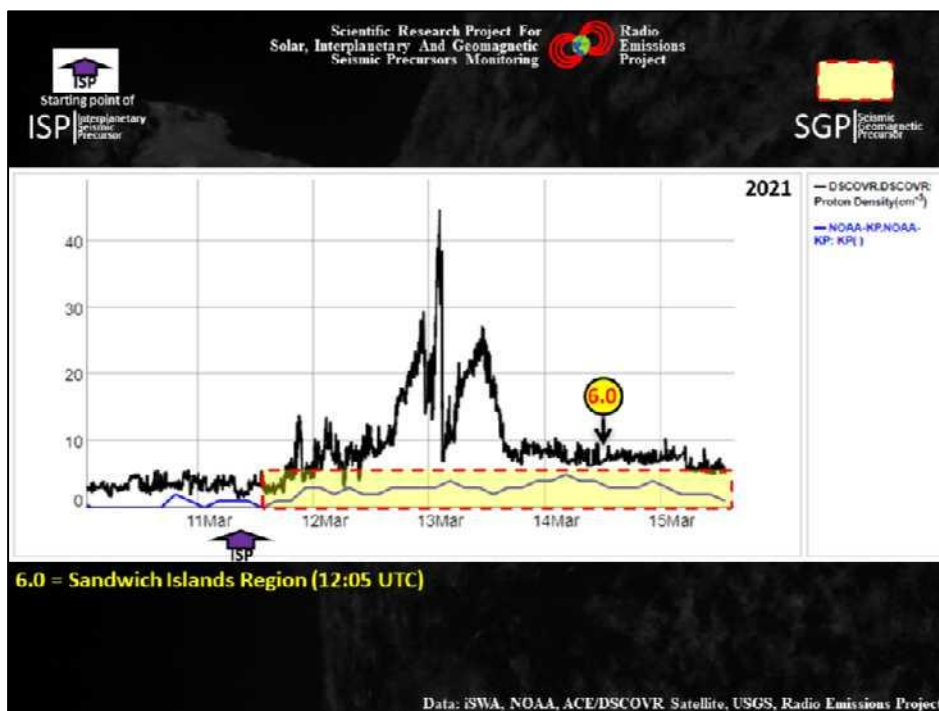


Fig. 2 – Electromagnetic seismic precursors related to the M6.0 earthquake. The graph above shows the variation curve relating to the solar wind proton density increase (black line) and the variation curve of the geomagnetic activity (Kp Index; blue line) recorded between 10 and 15 March 2021. The area yellow highlights the geomagnetic increase (Seismic Geomagnetic Precursor or SGP) that preceded the M6.0 seismic event recorded in the South Sandwich Islands region on March 14, 2021 at 12:05 UTC. The solar wind proton density increase started on 11 March 2021 at 08:50 UTC (see purple arrow) and represents the Interplanetary Seismic Precursor (ISP) related to the M6.0 earthquake. Credits: USGS, iSWA, Radio Emissions Project.

The M6.0 South Sandwich Islands region earthquake was the potentially destructive seismic event #1205 recorded after an increase in solar activity from January 1, 2012. The start of the proton increase preceded the M6.0 earthquake by 68 hours, while the peak of maximum density was recorded on March 13, 2021 at 02:21 UTC. The increase in Earth's geomagnetic activity (Kp Index) instead began on 11 March 2021 at 13:30 UTC.

By analyzing the modulation of the Earth's geomagnetic activity it was possible to observe the effects of the impact that this solar wind proton density increase had on the terrestrial magnetosphere (Fig. 4): Fig. 4 highlights that the seismic event M6.0 was preceded by an increase in the geomagnetic field measured on the vector component H (AL Index); while the DST Index shows that the earthquake was preceded by a geomagnetic storm of a weak degree which after a few hours became of moderate degree. Both of these electromagnetic phenomena can be considered geomagnetic seismic precursors (Seismic Geomagnetic Precursors or SGPs) [20] [23] [24].

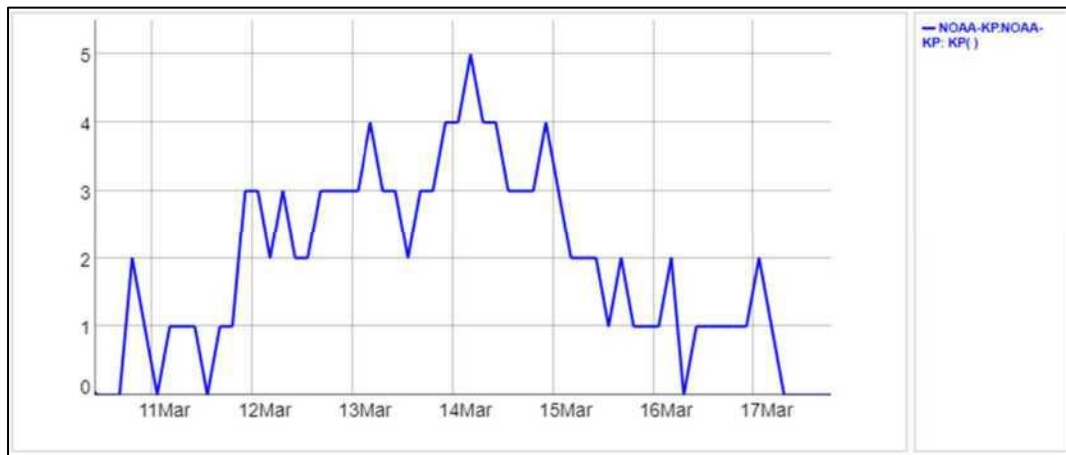


Fig. 3 – Kp Index related to M6.0 earthquake recorded on March 14, 2021. The graph above shows the Kp Index curve recorded between 10 and 17 March 2021: it is clear that the M6.0 earthquake was preceded by a geomagnetic increase that reached the degree of 5. Credits: iSWA.

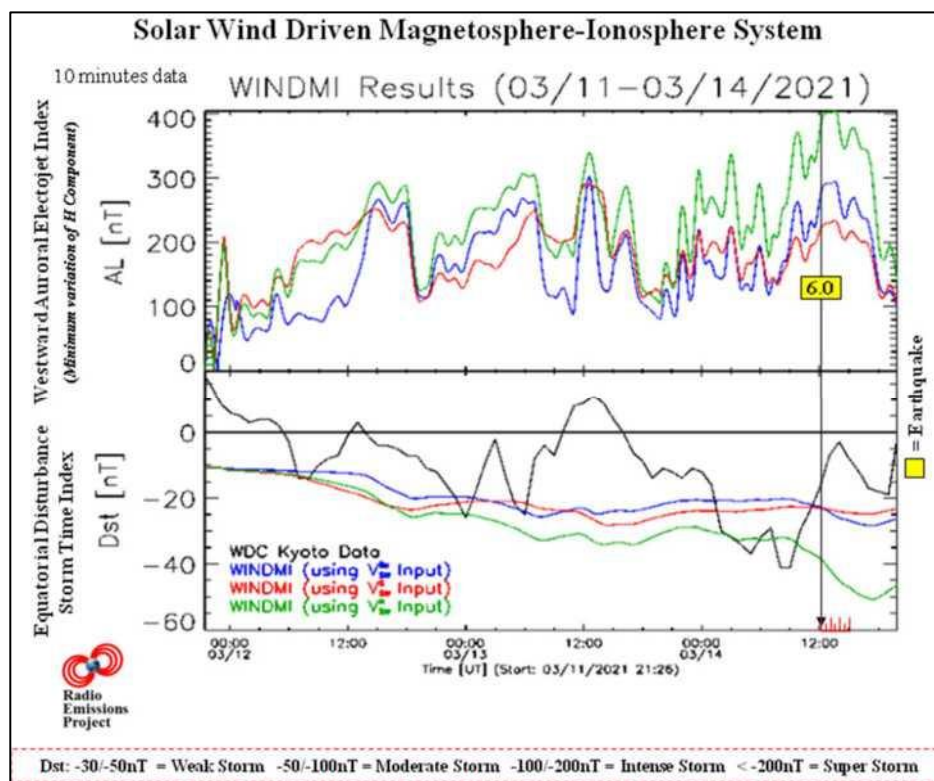


Fig. 4 – Low-dimensional model of the energy transfer from the solar wind through the magnetosphere and into the ionosphere (WINDMI). The picture shows the variation of the AL-Index (at top) and the DST-Index (at bottom) in the hours that preceded the M6.0 South Sandwich Islands region earthquake occurred on March 14, 2021 (the time marker of the earthquake is indicated by a vertical black line). The DST-Index is a direct measure of the Earth's geomagnetic horizontal (H) component variation due to the equatorial ring current, while the AL-Index (Auroral Lower) is at all times, the minimum value of the variation of the geomagnetic H component of the geomagnetic field recorded by observers of reference and provides a quantitative measure of global Westward Auroral Electrojet (WEJ) produced by increased of ionospheric currents therein present. Model developed by the Institute for Fusion Studies, Department of Physics, University of Texas at Austin. Credits: iSWA, USGS, Radio Emissions Project.

To confirm this type of correlation it is possible to observe Fig. 5 and 6: within Fig. 5 another type of Interplanetary Seismic Precursor is visible, represented by a perturbation of Interplanetary Magnetic Field (IMF): the potentially destructive seismic event was recorded after a vast disruption of IMF that began on March 12, 2021 at 12:00 UTC and ended few hours before the quake. In addition, the M6.0 earthquake occurred during a slight change in the IMF. This type of correlation was first observed by the authors between 2010 and 2011.

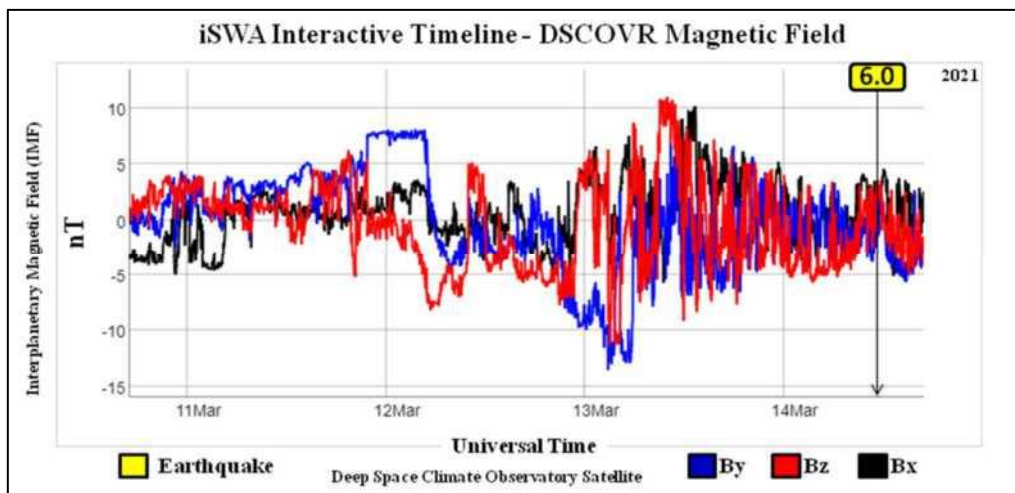


Fig. 5 – Solar wind magnetic field perturbation correlated to South Sandwich Islands region M6.0 earthquake. The chart above shows the variation of the interplanetary magnetic field (IMF) recorded through the Deep Space Climate Observatory (DSCOVR) Satellite in orbit at L1 Lagrange point. The recording was done on 3 axes (By, Bx, Bz). Analyzing the variation curves it is evident that the M6.0 earthquake occurred in South Sandwich Islands region on March 14, 2021 has been preceded by a perturbation of the interplanetary magnetic field (IMF) whose greater intensity was recorded between 02:30 UTC and 06:00 UTC of March 13, 2021. The long black vertical arrow represents the temporal markers of South Sandwich Islands region M6.0 earthquake recorded on March 14, 2021 at 12:05 UTC. Credits: iSWA, USGS, Radio Emissions Project.

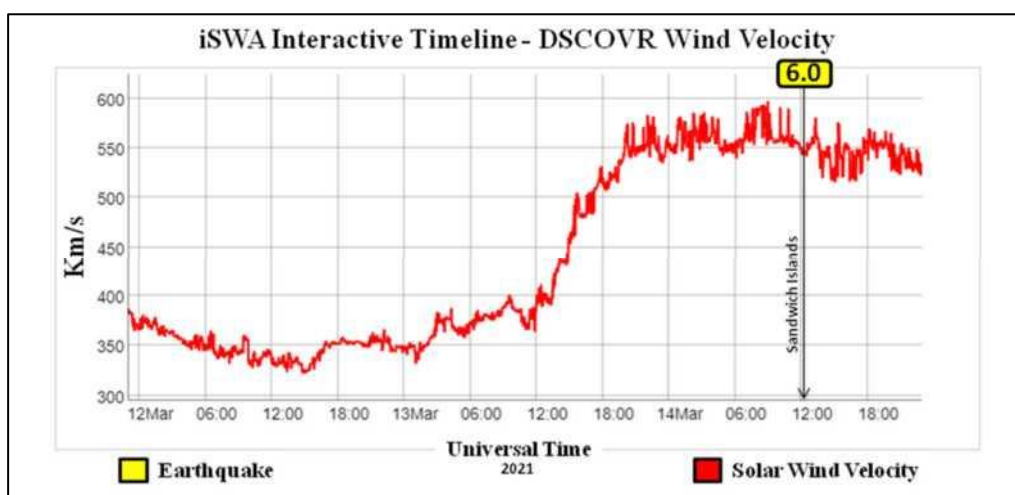


Fig. 6 – Solar wind velocity correlated to M6.0 earthquake. The graph shows the variation of solar wind velocity recorded between 12 and 14 March 2021 by Deep Space Climate Observatory (DSCOVR) Satellite, in orbit at L1 Lagrange point. Analyzing the variation curve it is possible to understand that the M6.5 South Sandwich Islands region earthquake was preceded by an increase of the solar wind speed. The black vertical arrow shows the temporal marker of the M6.0 earthquake occurred on March 14, 2021. Credits: iSWA, USGS, Radio Emissions Project.

Analyzing the curve of **Fig. 6**, however, we observe that the M6.0 earthquake recorded in the South Sandwich Islands region on March 14, 2021 was preceded by an increase in the solar wind speed which almost reached 600km/s a few hours earlier of the earthquake. The increase started on March 12, 2021 at 15:00 UTC. Also in this case we are faced with an “Interplanetary Seismic Precursor” or ISP.

Through the data that the authors presented in this work, it is evident that the M6.0 earthquake recorded in the South Sandwich Islands region was preceded by a series of clearly evident electromagnetic phenomena of a solar and geomagnetic nature that can be constantly monitored via the internet thanks to data provided by iSWA (iNTEGRATED SPACE WEATHER ANALYSIS SYSTEM). These electromagnetic phenomena occur according to a very precise modulation as they are the expression of solar activity and the impact it has on the earth’s magnetosphere [20] [23] [24].

Conclusions

The analysis of solar activity and the consequent geomagnetic activity of the Earth shows a close correlation between the density of the solar ion flux, the Earth's geomagnetic activity and the M6+ global seismic activity which is recorded on a global scale. We are therefore faced with a series of phenomena that are able to indicate when on a global scale it is possible to expect a resumption of potentially destructive seismic activity: this is the result of a study initiated by the authors in 2012 and which still continues. Today confirming each time the close correlation that exists between the solar wind proton density increase and the M6+ seismic activity. Today, through this type of analysis it is possible to understand a few days in advance when it is possible to expect a resumption of potentially destructive seismic activity on a global scale.

Credits

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