

Space weather and geomagnetic activity related to M6+ global seismic activity recorded on February 7, 2021

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Abstract

On February 7, 2021 two M6+ seismic events were recorded on our planet (M6.0 Philippines earthquake, recorded at 04:22:56 UTC; M6.3 Papua New Guinea earthquake, recorded at 05:45:52 UTC). The authors, analyzing the characteristics of solar ion flux and terrestrial geomagnetic activity, verified that the two potentially destructive seismic events were preceded by a solar wind proton density increase and by an increase in terrestrial geomagnetic activity. This type of correlation is already known to the international scientific community thanks to the studies conducted by the authors in this field of research since 2011.

Keywords: proton density increase, seismic precursors, solar activity, geomagnetic activity, solar ion flux.

Introduction

Every year on our planet are recorded on average 129 potentially destructive earthquakes (average calculated on the period 2012-2020) which does not follow a random modulation distribution: the studies conducted by the authors from 2011 to date [1] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23] made it possible to highlight that potentially destructive seismic events are always preceded by an increase in solar activity, and precisely by an increase in the density of the solar ion flux (especially of the proton type) which also influences the terrestrial geomagnetic activity [2] [3] [5] [10] [12] [14] [17] [19] [23]. This work will present some of the results obtained by the authors in this research area: attention will be focused on potentially destructive seismic events recorded on February 7, 2021 (**Fig. 1**):

1. M6.0 Philippines earthquake, recorded on February 7, 2021 at 04:22 UTC;
2. M6.3 Papua New Guinea earthquake, recorded on February 7, 2021 at 05:45 UTC.



Fig. 1 – Seismic epicenters of potentially destructive earthquakes recorded on February 7, 2021. The map above shows the seismic epicenters of the two potentially destructive earthquakes recorded on February 7, 2021.

Credits: USGS, Radio Emissions Project.

Data analysis

On February 6, 2021 at 04:40 UTC the DSCOVR Satellite, located in Lagrangian orbit L1, provided the first data of a solar wind proton density increase which ended on February 8, 2021 at 12:00 UTC. The peak of this increase was recorded on February 6, 2021 at 16:30 UTC after which two potentially destructive earthquakes were recorded. (**Fig. 1** and **2**):

1. M6.0 Philippines earthquake, recorded on February 7, 2021 at 04:22 UTC;
2. M6.3 Papua New Guinea earthquake, recorded on February 7, 2021 at 05:45 UTC.

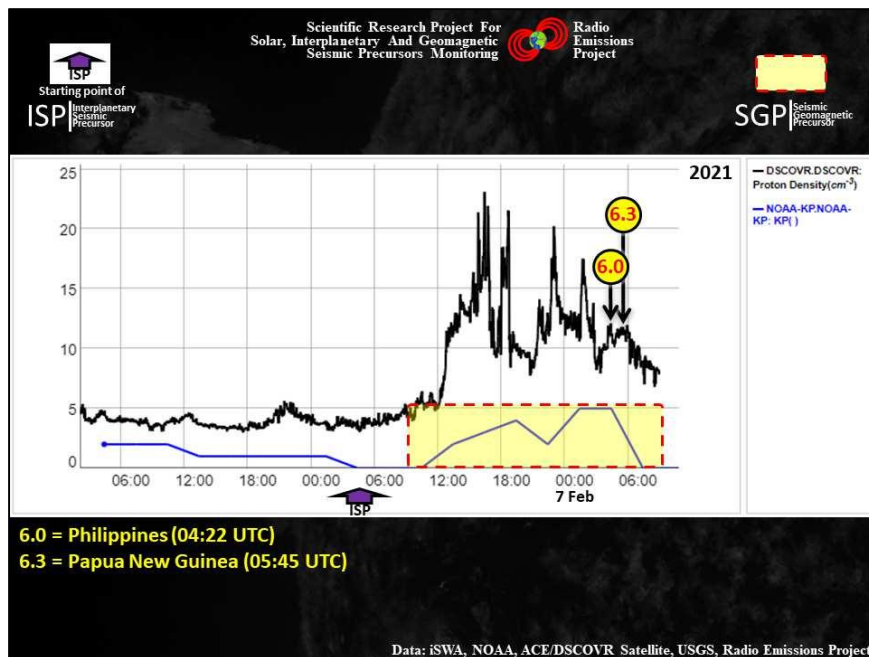


Fig. 2 – Variation in solar ion flux and Earth’s geomagnetic activity related to potentially destructive seismic events recorded on February 7, 2021. The graph above shows the time markers of the two M6+ earthquakes recorded on February 7, 2021 and which are correlated to the variation of solar wind proton density (black curve) and a subsequent increase in the Earth’s geomagnetic activity (blue curve highlighted by the yellow area). The purple arrow indicates the beginning of the solar wind proton density increase. Credits: iSWA, USGS, Radio Emissions Project.

Analyzing the temporal data of the two seismic events with the space weather data provided by DSCOVR Satellite between 6 and 8 February 2021, the authors were able to calculate the time intervals recorded between the start of the proton increment (Interplanetary Seismic Precursor) and the two M6+ seismic events:

1. M6.0 Philippines earthquake, recorded on February 7, 2021 at 04:22 UTC \approx **25** hours
2. M6.3 Papua New Guinea earthquake, recorded on February 7, 2021 at 05:45 UTC \approx **26** hours

The average time interval calculated by analyzing the seismic activity and the solar activity that occurred between January 1, 2012 and February 18, 2021 is equal to 108.8 hours: the average was calculated by analyzing 1192 M6+ seismic events that occurred in the same period (the 100% of M6+ seismic events recorded on a global scale).

Since the increases in solar ion flux also have a significant impact on the Earth’s magnetosphere following the coupling function between solar activity and terrestrial geomagnetic activity, the two seismic events analyzed in this work were preceded by an evident increase in the Kp Index which has reached the value of 5 (a level very close to the first degree of geomagnetic storm: G1, Kp=6) (**Fig. 2**).

What has just been stated is evident by analyzing the data on solar wind driven Magnetosphere-Ionosphere system (WINDMI) (**Fig. 3**): the two M6+ seismic events recorded on February 7, 2021 occurred right behind a strong increase in the H component of the Earth’s geomagnetic field which has reached 440nT (AL Index). Furthermore, at the same time the DST Index showed that a weak geomagnetic storm was in progress. These perturbations of the Earth’s geomagnetic field have been defined by the authors as “Seismic Geomagnetic Precursors” or SGPs.

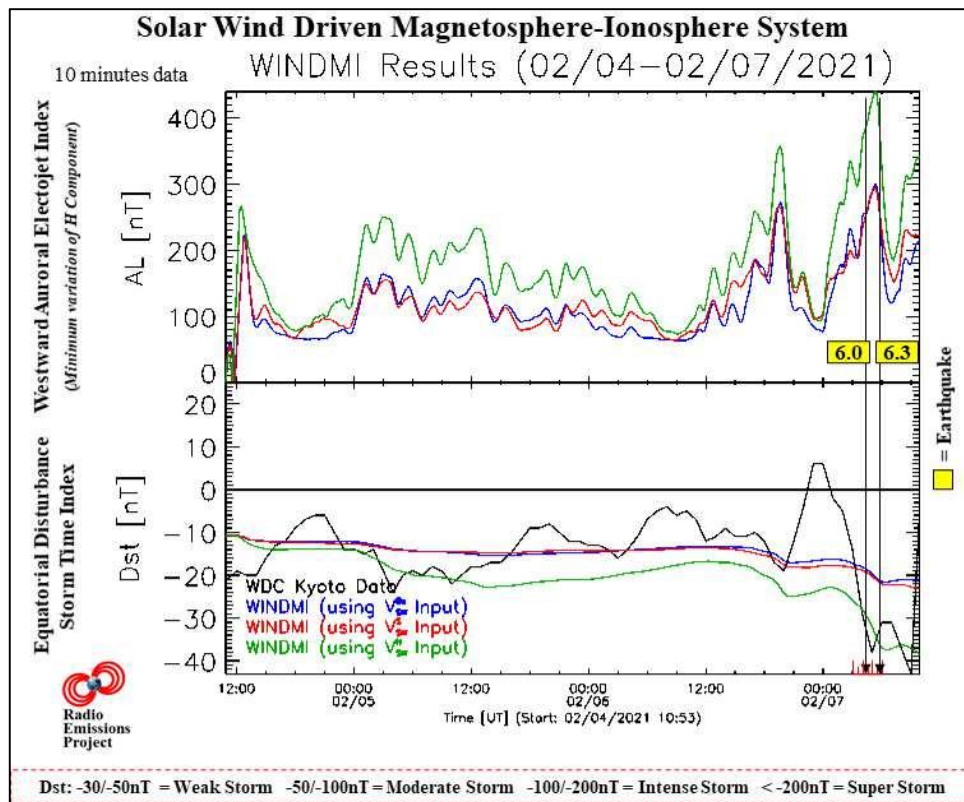


Fig. 3 – Low-dimensional model of the energy transfer from the solar wind through the magnetosphere and into the ionosphere (WINDMI). The picture shows the variation of the AL-Index (at top) and the DST-Index (at bottom) in the hours that preceded the M6+ earthquakes recorded on February 7, 2021 (the time marker of the earthquakes 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.

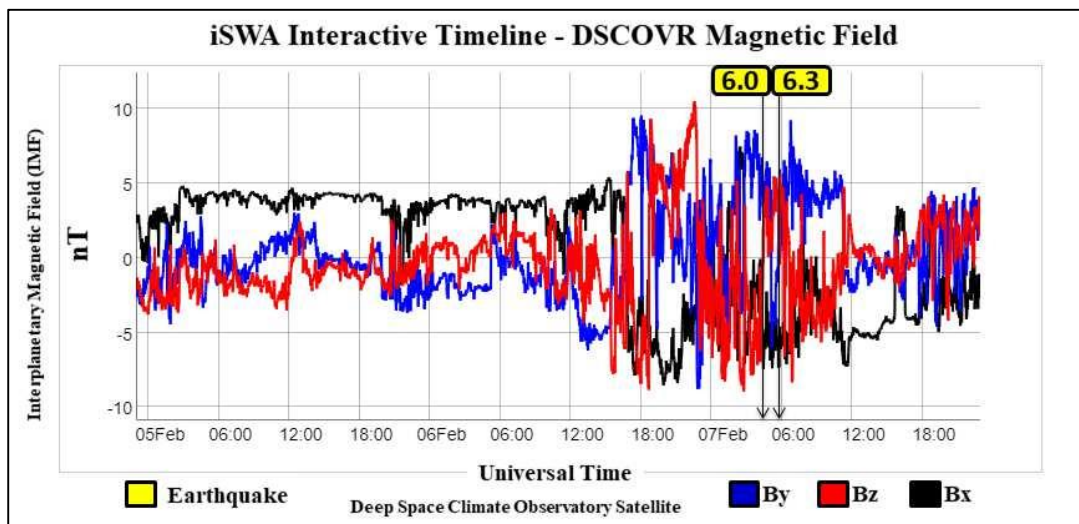


Fig. 4 – Interplanetary Magnetic Field (IMF) related to M6+ seismic events recorded on February 7, 2021. The graph above shows a perturbation of Interplanetary Magnetic Field (IMF) which preceded the two M6+ seismic events recorded on February 7, 2021 (black vertical arrows) by 18 hours. Credits: iSWA, USGS, Radio Emissions Project.

This type of correlation confirms the clear and close relationship that solar activity and terrestrial geomagnetic activity have with respect to the M6+ seismic activity that is recorded on our planet. From a predictive point of view, it is possible to use this type of analysis to predict in advance when to expect a resumption of M6+ global seismic activity and to issue a state of general alert useful to all those countries that are located in

seismically active areas with a high seismic risk to prepare for a possible high intensity earthquake. This is possible thanks to the results that the authors have obtained from 2012 to today [19] [22] [23], that is, since they ascertained that every potentially destructive seismic event that is recorded on our planet is always preceded by an increase in solar ion flux density (Interplanetary Seismic Precursor or ISP). Over the last eight years, the authors have had the opportunity to present these results several times to the international scientific community but the discovery has not had the right media echo and the right scientific recognition which, it is right to reiterate, is unprecedented in the history of scientific research dedicated to seismic prediction.

To confirm the correlation that the authors found between solar activity and the two potentially destructive seismic events recorded on February 7, 2021, you can see the next two graphs (**Fig. 4** and **5**).

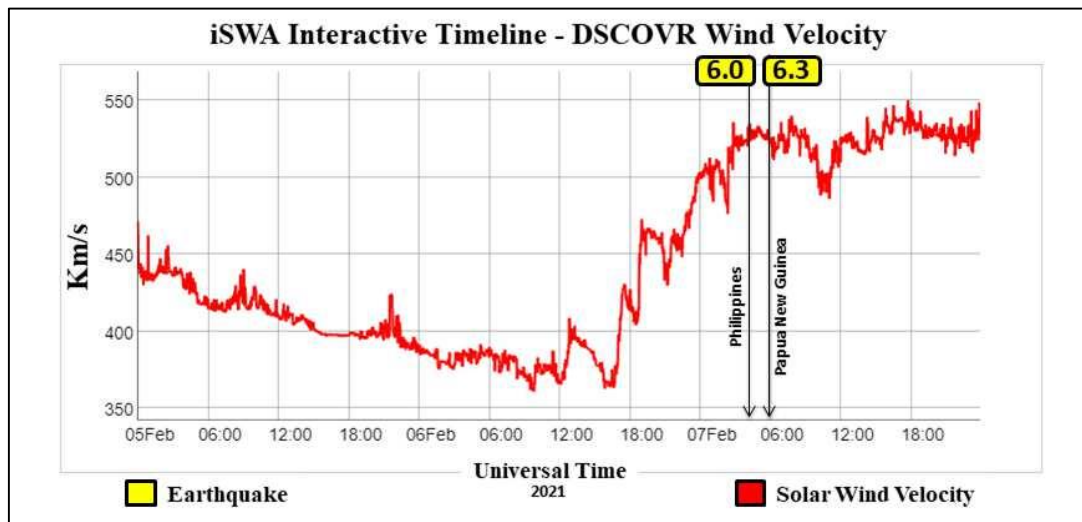


Fig. 5 – Solar wind velocity related to M6+ seismic events recorded on February 7, 2021. The graph above shows a rapid increase in the solar wind speed that preceded the two potentially destructive seismic events recorded on February 7, 2021 (vertical black arrows).

Credits: iSWA, USGS, Radio Emissions Project.

The perturbation of the Interplanetary Magnetic Field (IMF) visible in **Fig. 4** confirms that the Earth has been reached by a dense solar ion flux; while **Fig. 5** confirms that this flow had a high speed. In both cases, both the perturbation of the Interplanetary Magnetic Field and the increase in the speed of the solar wind have been defined by the authors as “Interplanetary Seismic Precursors” or ISPs. The “Interplanetary Seismic Precursors” always precede the “Seismic Geomagnetic Precursors” (**Fig. 3**) [19] [22] [23]: in both cases it is always a direct or indirect expression of solar activity, and is therefore we must turn our attention to the Sun if we want to create an innovative seismic forecasting method.

Conclusions

The term “Seismic Prediction” has evolved so much over the decades that it has undergone a conceptual split through the word “Forecast” and the word “Prevision”. When we talk about “Seismic Forecast” we refer to a series of scientific methods through which it is possible to make seismic predictions by analyzing statistical data (for example, historical seismometric data); otherwise, when we talk about “Seismic Prevision” we refer to a scientific method through which it is possible to make seismic prediction using one or more physical phenomena that precede the expected seismic event. Today, research on earthquake prediction is focused on the term “Prevision” rather than the word “Forecast” and we can say it seems beyond doubt that the authors have shown many times that have identified a physical phenomenon that allows us to understand (on average well in advance) when a resumption of M6+ seismic activity can occur on Earth [19] [22] [23].

Credits

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