Space weather and geomagnetic activity related to Chilean M6.7 earthquake recorded on February 3, 2021

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Abstract

On February 3, 2021, at 05:23:44 UTC, an M6.7 earthquake was recorded off the west coast of Chile. The monitoring of solar activity and terrestrial geomagnetic activity allowed the authors to highlight that the Chilean seismic event was preceded by a solar wind proton density increase (Interplanetary Seismic Precuror) and by an increase in terrestrial geomagnetic activity (Seismic Geomagnetic Precursor), confirming also this time that all potentially destructive earthquakes that are recorded on a global scale are always preceded by an increase in solar activity.

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

Introduction

Electromagnetic monitoring, intended as a scientific method capable of monitoring electromagnetic phenomena of solar origin and those produced through the coupling function between the solar ion flux and the terrestrial magnetosphere, has allowed the authors to establish that the M6+ seismic activity that is recorded on our planet is always preceded by an increase in the solar ion flux [1] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23]. This type of correlation has been scientifically ascertained over a long period (from 1 January 2012 to date) thanks to the studies conducted by the authors in this research area. This work will present the results of solar activity monitoring and terrestrial geomagnetic activity monitoring related to the Chilean M6.7 earthquake recorded on February 3, 2021 at 05:23:44 UTC (**Fig. 1**).

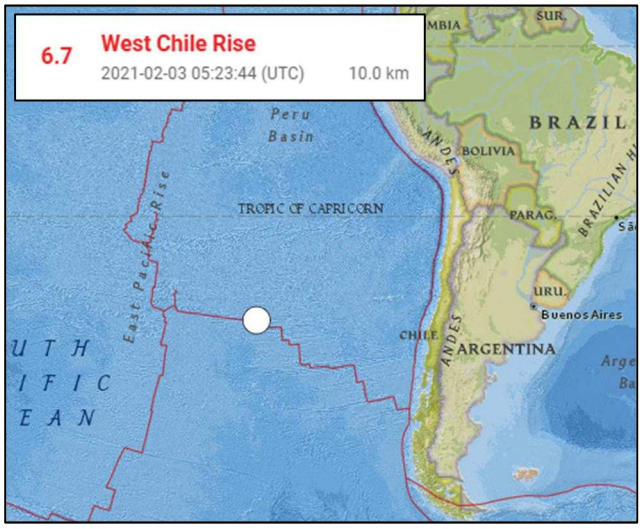

Fig. 1 – Seismic epicenter of the Chilean earthquake recorded on February 3, 2021. The map above shows the seismic epicenter of the Chilean earthquake recorded on February 3, 2021 off the west coast of Chile.
Credits: USGS, Radio Emissions Project.

Data analysis

Between January 30, 2021 at 00:00 UTC and February 6, 2021 at 04:30 UTC the DSCOVR Satellite (located in Lagrangian orbit L1) detected a solar wind proton density increase whose maximum peak was recorded on February 1 at 23:31 UTC (**Fig. 2**). 77 hours after the start of the proton increase (and 66 hours after the maximum peak) the Chilean M6.7 earthquake was recorded. (**Fig. 2**).

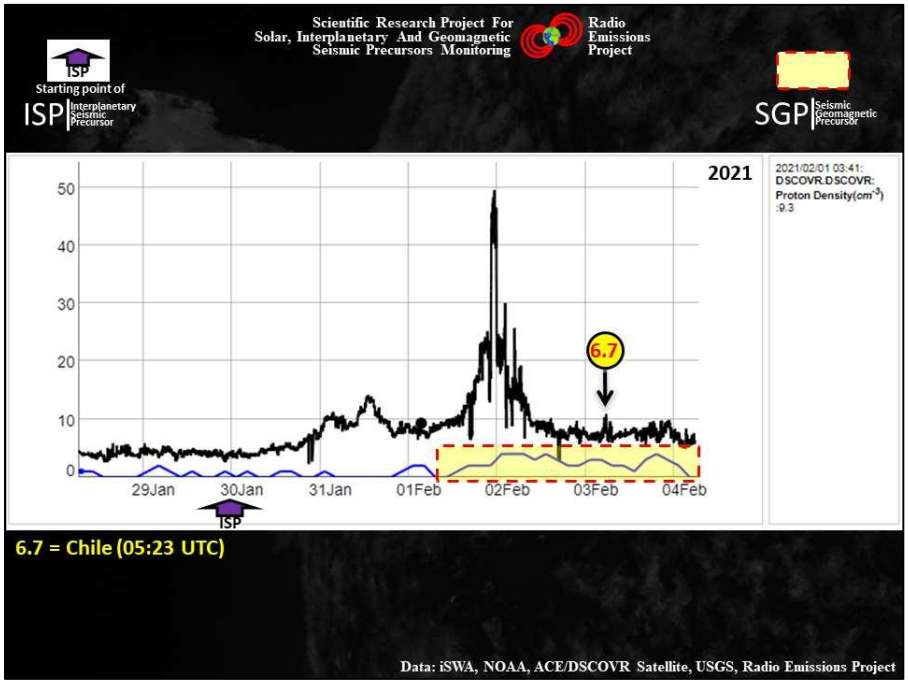

Fig. 2 – Variation in solar ion flux and Earth's geomagnetic activity related to the M6.7 Chilean earthquake recorded on February 3, 2021. The graph above shows the time marker of the Chilean M6.7 earthquake recorded on February 3, 2021 at 05:23 UTC (black vertical arrow). Analyzing the data in the graph it is evident that the Chilean earthquake was preceded by a solar wind proton density increase (Interplanetary Seismic Precursor; black curve) and by an increase of Kp Index (Seismic Geomagnetic Precursor; blue curve highlighted by the yellow area). The purple arrow indicates the start of solar wind proton density increase. Credits: iSWA, USGS, Radio Emissions Project.

The authors have not yet been able to identify the related seismogenic mechanism at solar wind proton density increase but it is known that when the solar ion flux is dense and/or fast has a significant impact on the terrestrial magnetosphere causing one or more perturbations of the terrestrial geomagnetic field, also related to seismic activity [2] [3] [5] [10] [12] [14] [17] [19] [23]. It is therefore conceivable that the seismogenic mechanism could be represented by a form of electromagnetic interaction [19] [22] [23]. An example of the impact that solar activity has on the Earth's geomagnetic field can be observed through **Fig. 3**; that is through what is defined as "Solar Wind Driven Magnetosphere-Ionosphere System" (WINDMI). Analyzing the WINDMI graph it is possible to observe the presence of an intense and vast geomagnetic perturbation (AL Index) which reached 400nT in intensity: this perturbation was highlighted on February 2, 2021 at 00:00 UTC and ended at 20:00 UTC. During this disturbance the DST Index reached -40nT indicating that a low degree geomagnetic storm was in progress. But that is not all. On February 3, 2021 at 00:00 UTC the AL Index suddenly began to increase again and during this second increase the Chilean M6.7 earthquake was recorded. The increases in the solar ion flux and, subsequently, the perturbations of the geomagnetic field are in effect electromagnetic seismic precursors closely linked to each other due to the coupling function between the solar ion flux and the terrestrial magnetosphere: however, being closely related to seismic activity, the authors defined the first as "Interplanetary seismic Precursors" or ISPs, the second as "Seismic Geomagnetic Precursors" or SGPs as they precede the seismic activity [1-23].

Further confirmation of the correlation existing between solar activity and potentially destructive seismic activity that is recorded on a global scale is highlighted through the graph relating to the modulation of the Interplanetary Magnetic Field (IMF) (**Fig. 4**) and that relating to the speed of the solar wind (**Fig. 5**). The first "electromagnetic anomaly" of Interplanetary Seismic Precursors (IMF) that the authors correlated to the M6+ global seismic activity was observed in 2011: the authors defined it as "Italic S" as the variation curve related to the anomaly resembled a Italic "S". It was thanks to the studies conducted in 2011 on Interplanetary Magnetic Field (IMF) that it was later possible to identify what the authors themselves define today as "the most important known electromagnetic precursor": that is, the solar wind proton density increase.

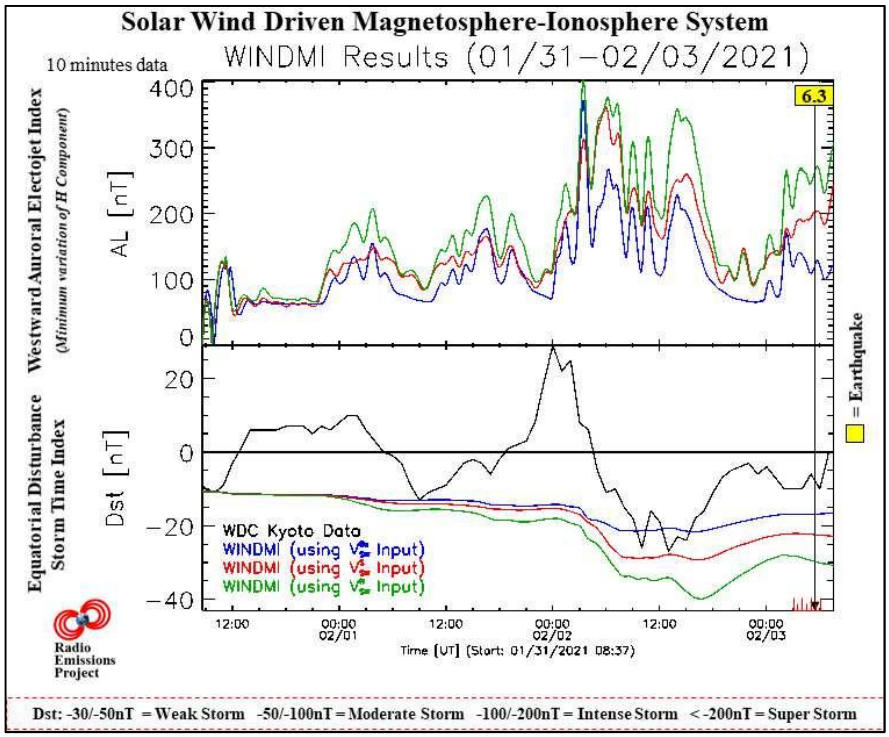

Fig. 3 – Low-dimensional model of the energy transfer from the solar wind through the magnetosphere and into the ionosphere (WINDMI). The picture shows the variation of the AL-Index (at top) and the DST-Index (at bottom) in the hours that preceded the Chilean M6.7 earthquake recorded on February 3, 2021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

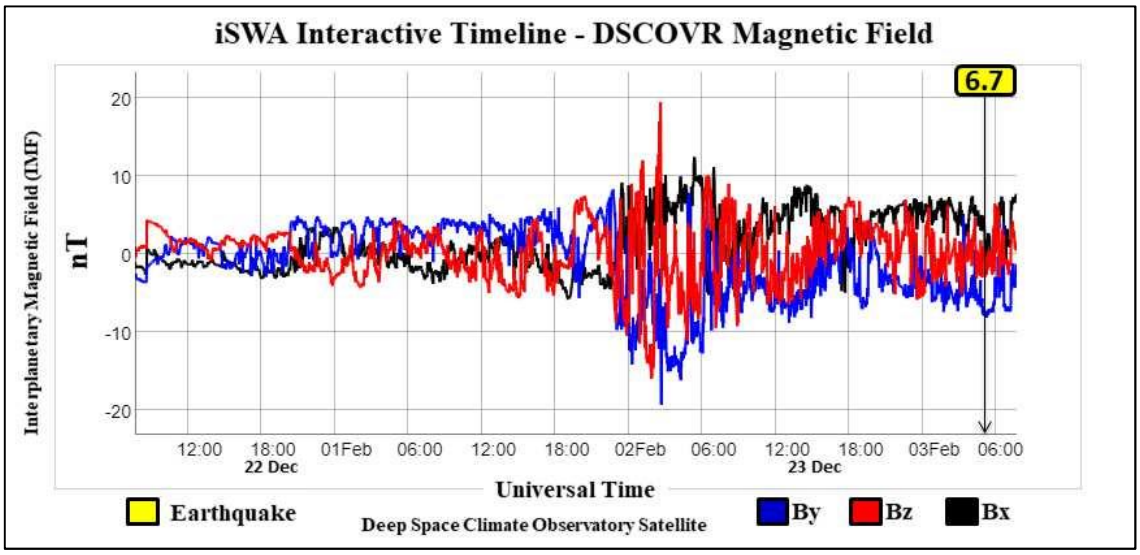

Fig. 4 – Interplanetary Magnetic Field (IMF) related to Chilean M6.7 earthquake recorded on February 3, 2021. The graph above shows a disturbance of Interplanetary Magnetic Field (IMF) which preceded the Chilean M6.7 earthquake recorded on February 3, 2021 (black vertical arrow) by almost 36 hours. Credits: iSWA, USGS, Radio Emissions Project.

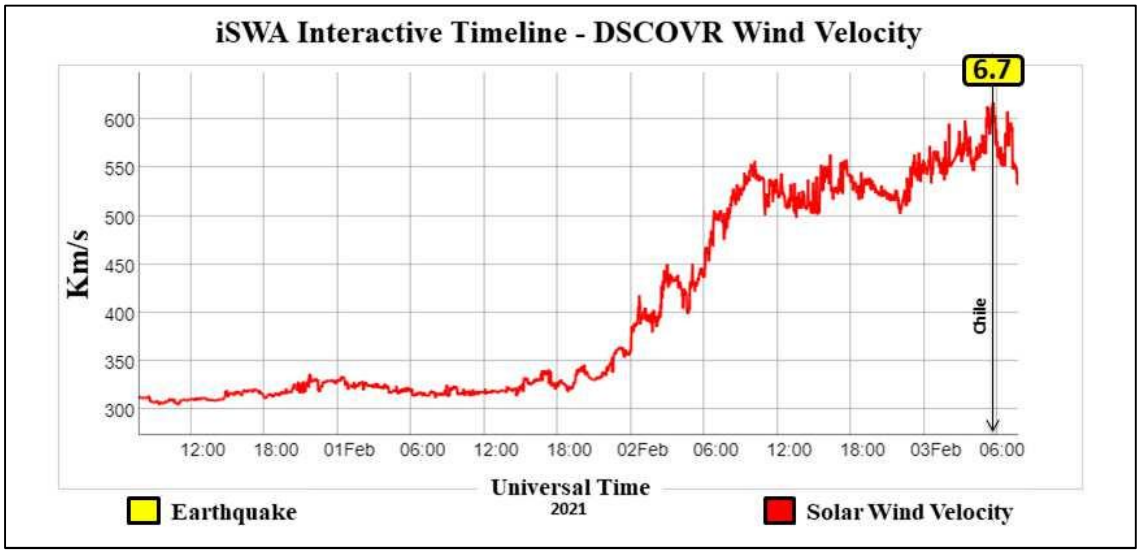

Fig. 5 – Solar wind velocity related to Chilean M6.7 earthquake recorded on February 2, 2021. The graph above shows an increase in solar wind speed that preceded the Chilean M6.7 earthquale recorded on February 3, 2021 (black vertical arrow) by almost 42 hours. Credits: iSWA, USGS, Radio Emissions Project.

Conclusions

This work has once again highlighted the existence of a close and evident correlation between electromagnetic phenomena of solar origin, terrestrial geomagnetic perturbations and M6+ global seismic activity. This type of correlation was first observed by the authors in 2011 by analyzing the modulation of Interplanetary Magnetic Field (IMF). The authors have already presented this important result to the international scientific community but this has not been followed by a constructive debate capable of creating a new unanimously shared point of view in the seismological field and above all in scientific research dedicated to the prediction of potentially destructive earthquakes that are recorded on a global scale. The authors are convinced that this is a serious mistake. The future of seismic prediction research is set to reconsider the old beliefs that many scientists and researchers hold about electromagnetic seismic precursors.

Credits

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