Space weather and geomagnetic activity related to Ecuadorean M7.5 earthquake recorded on February 22, 2019

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Abstract

On February 22, 2019 at 10:17:23 UTC, an M7.5 earthquake was recorded in Ecuador. The authors, by monitoring in real time solar activity and terrestrial geomagnetic activity, identified a solar wind proton density increase and an increase in terrestrial geomagnetic activity that preceded the Ecuadorian seismic event of 72 hours (respect to solar wind ionic flux) and 48 hours (respect to geomagnetic perturbation). This type of correlation was first observed by the authors in 2011. To date, all destructive seismic events that are recorded on a global scale are always preceded by a solar wind proton density increase.

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

Introduction

Since the late 1800s, many studies have been conducted on the so-called seismic precursors of the electromagnetic type and much evidence has been collected (both from the ground and from space) on the existence of these natural radio emissions. Despite this, among researchers, there are still those who even claim that electromagnetic seismic precursors do not exist or that it is not worth spending economic and intellectual resources on a class of electromagnetic phenomena that will not produce any advancement in research. The authors of this work, on the other hand, think, because they have demonstrated it, that scientific research on pre-seismic radiofrequency will represent the methodological substrate on which a new seismic forecasting methodology will be built, capable of freeing itself from historical seismometric data; but provided that the electromagnetic monitoring will also be accompanied by the monitoring of solar activity [19] [23].

Fig. 1 – Seismic epicenter of the Ecuadorean M7.5 earthquake recorded on February 22, 2019. The map above shows the seismic epicenter of the Ecuadorean M7.5 earthquake recorded on February 22, 2019. Credits: USGS, Radio Emissions Project.

There is no longer any doubt that there is a close correlation between solar activity and global seismic activity [1] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23]. The first studies that investigated this type of correlation were conducted between 1960 and 1970 but only in recent years, thanks to the work carried out by the authors, it was possible to understand that all potentially destructive seismic activity is always preceded by an increase the density of the solar ion flux. This work will present the results of a study conducted on the Ecuadorian M7.5 earthquake recorded On February 22, 2019 at 10:17:23 UTC (**Fig. 1**).

Data analysis

Between February 19, 2019 at 10:00 UTC and February 23, 2019 at 24:00 UTC, the DSCOVR Satellite (located in Lagrangian orbit L1) detected a solar wind proton density increase whose maximum peak was recorded on February 20, 2019 at 20:02 UTC (**Fig. 2**). 72 hours after the start of the proton increase (and 38 hours after the maximum peak) the Ecuadorean M7.5 earthquake was recorded. (**Fig. 2**).

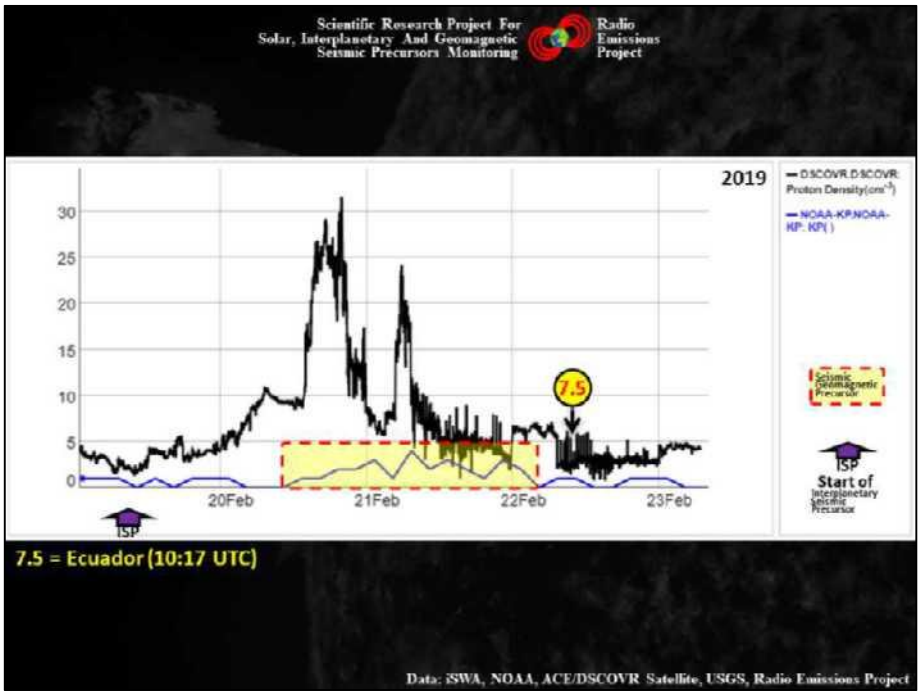

Fig. 2 – Variation in solar ion flux and Earth's geomagnetic activity related to the M7.5 Equadorean earthquake recorded on February 22, 2019. The graph above shows the time marker of the Ecuadorean M6.7 earthquake recorded on February 22, 2019 at 10:17 UTC (black vertical arrow). Analyzing the data in the graph it is evident that the Ecuadorean 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 graph visible in **Fig. 2** condenses the data relating to solar wind proton density increase and those on Earth's geomagnetic activity. From the integration of the data, it is evident that the proton increase has generated a geomagnetic perturbation: phenomena of an electromagnetic nature that preceded the Ecuadorian seismic event. Geomagnetic activity reached its maximum value on February 21, 2019 at 07:30 UTC: Kp Index = 4 (**Fig. 3**).

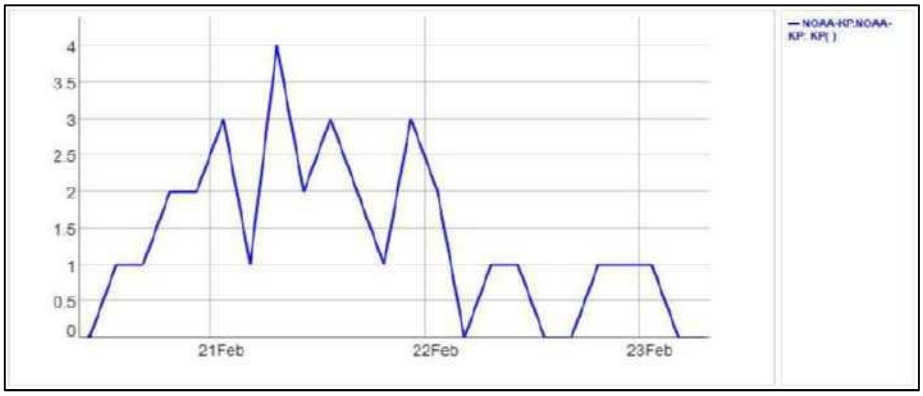

Fig. 3 – Earth's geomagnetic activity related to M7.5 Equadorean earthquake recorded on February 22, 2019. The graph above shows the modulation of Kp Index in the hours preceding the Ecuadorian earthquake recorded on February 22, 2019 at 10:17 UTC. Credits: iSWA, USGS, Radio Emissions Project.

Confirmations on the correlation between Earth's geomagnetic activity and M6+ global seismic activity have been obtained by the authors in many cases: [2] [3] [5] [10] [12] [14] [17] [19] [23]. Since the intensity of the geomagnetic variation depends substantially on the density and the velocity of the solar ion flux reaching the Earth's magnetosphere, not always the potentially destructive seismic activity is correlated to geomagnetic storms of class G1-G5: the authors observed that also increases more modest of Kp Index may be related to the M6+ seismic activity, just like in the case of the Ecuadorian M7.5 earthquake. (**Fig. 2** and **4**)

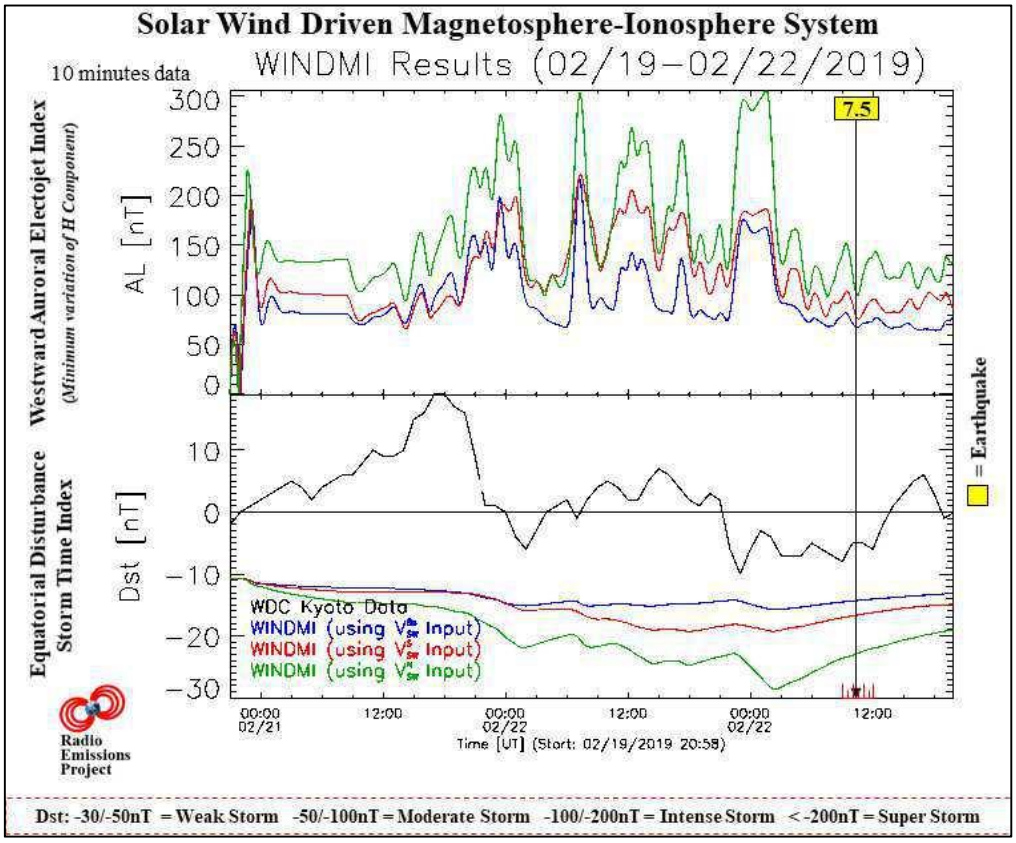

Fig. 4 – Low-dimensional model of the energy transfer from the solar wind through the magnetosphere and into the ionosphere (WINDMI). The picture shows the variation of the AL-Index (at top) and the DST-Index (at bottom) in the hours that preceded the Ecuadorean M6.7 earthquake recorded on February 22, 2019 (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.

The graph in **Fig. 4** confirms what has just been stated: a geomagnetic perturbation measured through the "H" component of the geomagnetic field (AL Index, which reached 300nT) preceded the Ecuadorian earthquake by about 48 hours, while the DST Index almost reached the degree of "weak geomagnetic storm" about 8 hours before the earthquake. The variations in the density of the ion flux of the interplanetary medium and the variations in the Earth's geomagnetic field that precede potentially destructive earthquakes are phenomena of an electromagnetic nature that can be classified within the so-called "seismic precursors of the electromagnetic type" according to the classification developed by the authors in 2013 (**Fig. 5**) [1] [19] [23]. This classification is the result of years of solar activity and natural electromagnetic background monitoring, and currently represents the only electromagnetic model capable of supporting both the theory of microfractures (electromagnetic emission generated as a result of tectonic stress - piezoelectricity) [1] [23], and the correlations observed between seismic activity and space weather (geomagnetic radio emissions) [22].
According to this new classification, pre-seismic radio emissions can be divided into two main families:

1. "Local" seismic precursors.
2. "Non local" seismic precursors.

The first are represented by local electromagnetic emissions, generated in the earthquake preparation area following the accumulation of tectonic stress (through the phenomenon of piezoelectricity); while the latter are generated by solar electromagnetic activity, i.e. that visible on the photosphere, chromosphere and in the solar corona (solar flare, sunspots, coronal hole, coronal mass ejection or CME, magnetic loops) responsible for the increase in the speed and density of the solar ion flux [19] [23].

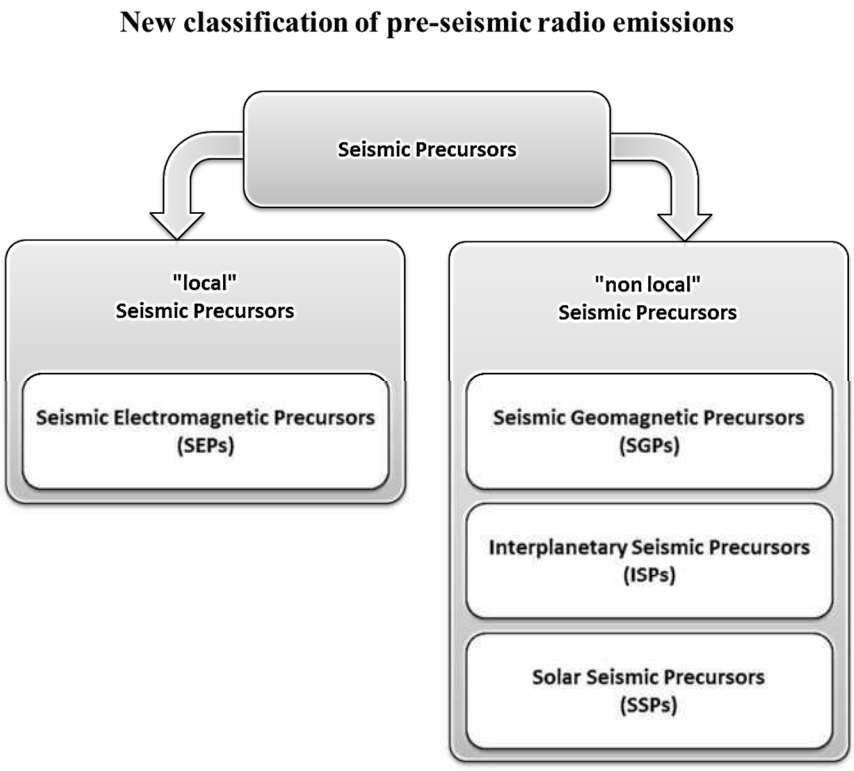

Fig. 5 – New classification of pre-seismic radio emissions. Above it is visible the new classification of pre-seismic radio emissions created by the authors following the studies conducted on environmental electromagnetic monitoring and on seismic activity monitoring starting from 2012. Credits: Radio Emissions Project.

Conclusions

The potentially destructive seismic activity is closely related to solar activity and, consequently, to the Earth's geomagnetic activity. This is the conclusion the authors came to after ten years of observing. What remains to be done is to expand the current electromagnetic monitoring network created by the authors (Radio Emissions Project network) and implemented with Radio Direction Finding (RDF) technology that allows to perform a crustal diagnosis thanks to the identification of pre-seismic radiofrequency through the triangulation technique. According to the authors, this is currently the best way forward for the scientific community to develop a better seismic forecasting method than the current one. [24-39].

Credits

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