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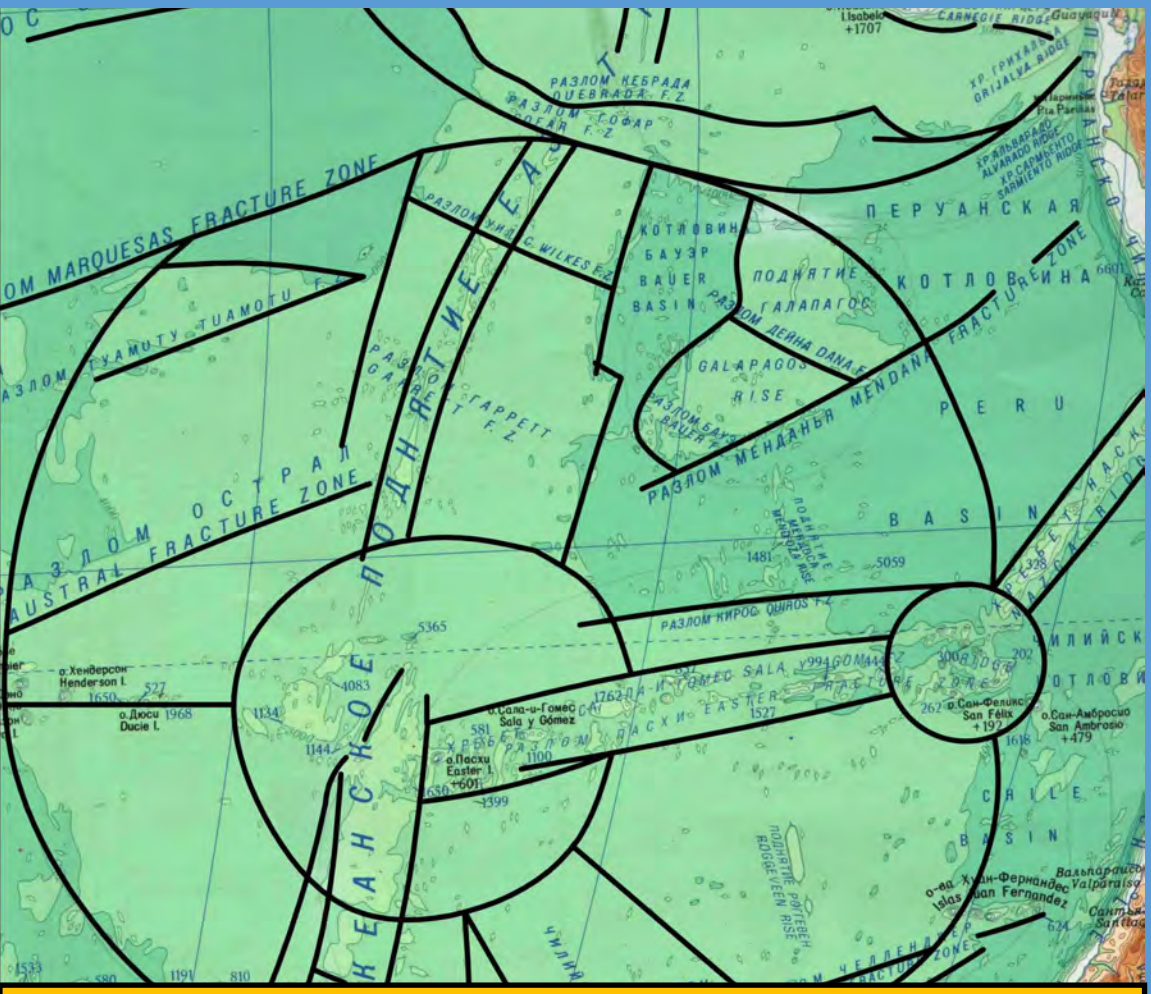

Fig. 7.2. Scheme of the main morphostructural elements of the East Pacific over-plume mega-arch (Gavrilov, 2018). It is made on the basis of data (International Geological and Geophysical Atlas..., 2003). Black lines show arc, ring and rectilinear lineaments with known and conjectural fault zones - A.A. Gavrilov

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Magnitude of potentially destructive earthquakes recorded in Mexico correlated to the extent of the solar proton flux

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Abstract

Between 2012 and 2023, the authors analyzed solar activity and potentially destructive global seismic activity (1594 seismic events), identifying a close correlation between these earthquakes and increases in solar proton flux density. The data obtained from this study also highlighted a correlation between the magnitude of the recorded earthquakes and the extent of the observed protonic increase. To confirm this, in this study the authors will present the results obtained by analyzing seismic events recorded in Mexico during two different periods: those recorded between September 19 and 22, 2022, and the one recorded on September 8, 2017.

Keywords: space weather, seismic precursors, Mexico, M6+, magnitude.

Introduction

Over the years, experimentation with new methodologies in the context of earthquake prediction has allowed for the identification of a new series of geomagnetic seismic precursors never considered before. Studies in this regard have focused on space weather, namely the effects of solar activity on Planet Earth. [1] These studies, for the first time undertaken by the Radio Emissions Project, an Italian scientific research project, have identified a direct correlation between the increase in proton density measured outside of space and the occurrence of earthquakes. [2-5]

This has provided indications that allow us to seriously consider the increase in ions present outside of space, near Earth, as an interplanetary seismic precursor (ISP – Interplanetary Seismic Precursors). [6] [7] These data have enabled the authors to make a series of short-term global seismic predictions, by analyzing the modulation of the solar ionic flux density in real time through data provided by some artificial satellites located in the L1 Lagrangian orbit:

- DSCOVR (Deep Space Climate Observatory) Satellite.
- Advanced Composition Explorer (ACE) Satellite.

Method and Data

The data used for this study were provided by the iSWA – Integrated Space Weather Analysis System. To confirm the working hypothesis, the authors analyzed the modulation of the solar ionic flux of three different energetic proton fractions (1060-1900 keV; 310-580 keV; 115-195 keV) between September 8 and 23, 2022, to understand whether the seismic sequence recorded between September 9 and 22, 2022, had been preceded and sustained by an increase in the density of the solar proton flux: a correlation first observed by the authors in 2012 [8] and reconfirmed every year [9] until December 31, 2023.

Scientific Research Project For Solar, Interplanetary And Geomagnetic Seismic Precursors Monitoring — Radio Emissions Project

M6+ seismic sequence related to the proton increase recorded between 9 and 22 September 2022

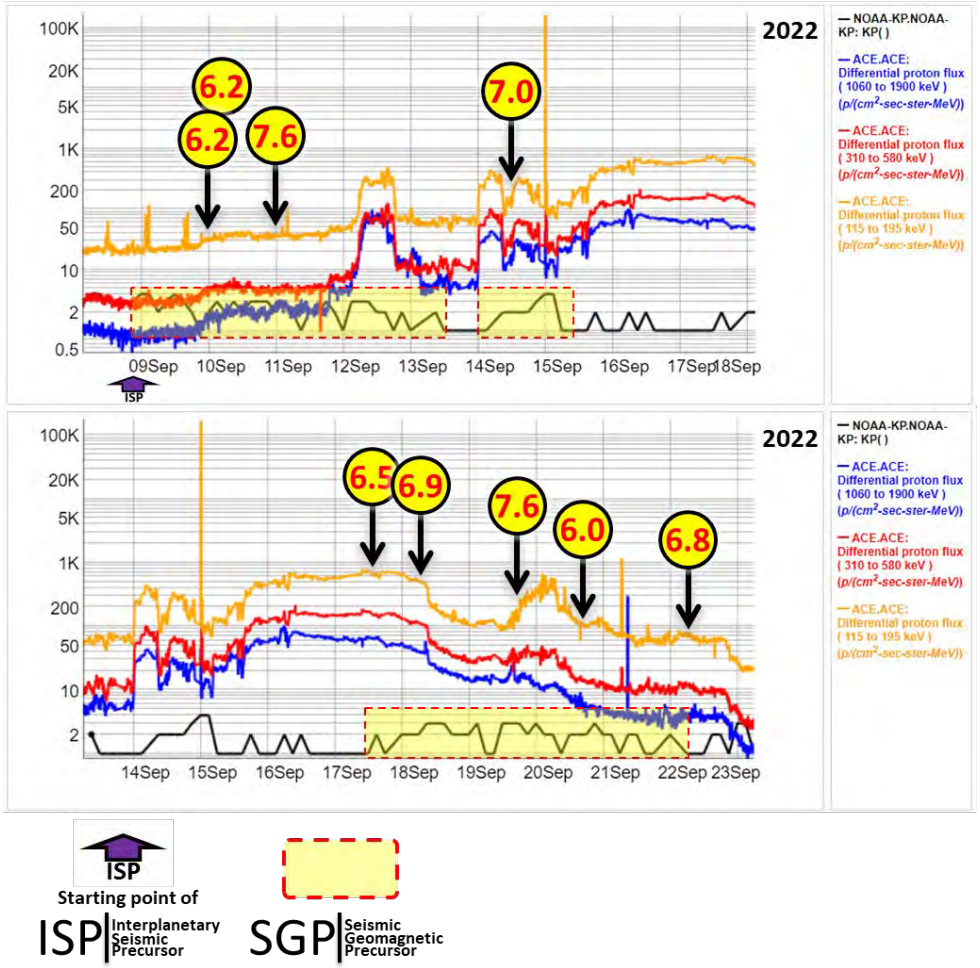

Fig. 1 – M6+ seismic sequence correlated to the protonic increase recorded between September 9 and 23, 2022. *In the upper graph, the distribution of potentially destructive seismic events recorded between September 9 and 21, 2022, correlated to the increase in solar proton flux density recorded between September 9 and 23, 2022, is visible. The yellow areas bordered by the dashed red line highlight the increase in the Kp-Index correlated to the seismic sequence. The vertical black arrows identify the time markers of the potentially destructive events recorded between September 9 and 21, 2022. Credits: iSWA, Radio Emissions Project.*

On September 8, 2022, at 21:15 UTC, the Advanced Composition Explorer (ACE) Satellite recorded the beginning of a protonic increase in the solar wind, which was followed by a seismic sequence of 9 potentially destructive earthquakes (M6+) (**Fig. 1**).:

- M6.2 = Indonesia (recorded on September 9, 2022 at 23:31 UTC);
- M6.2 = Indonesia (recorded on September 10, 2022, at 00:05 UTC);
- M7.6 = Papua New Guinea (recorded on September 10, 2022 at 23:46 UTC);
- M7.0 = Vanuatu (recorded on September 14, 2022 at 11:04 UTC);
- M6.5 = Taiwan (recorded on September 17, 2022 at 13:41 UTC);

- M6.9 = Taiwan (recorded on September 18, 2022 at 06:44 UTC);
- M7.6 = Mexico (recorded on September 19, 2022 at 18:05 UTC);
- M6.0 = Russia (recorded on September 20, 2022 at18:23 UTC);
- M6.8 = Mexico (recorded on September 22, 2022 at 06:16 UTC).

Two of these seismic events were recorded in Mexico:

- M7.6 = Mexico (recorded on September 19, 2022 at 18:05 UTC);
- M6.8 = Mexico (recorded on September 22, 2022 at 06:16 UTC).

Analyzing the potentially destructive seismic activity recorded in Mexico in recent years, the authors have identified an interesting coincidence: on September 8, 2017, at 04:49 UTC, an M8.1 earthquake was recorded in Mexico. This seismic event was preceded by an increase in the proton density of the solar wind that began on September 4, 2022. (**Fig. 2**).

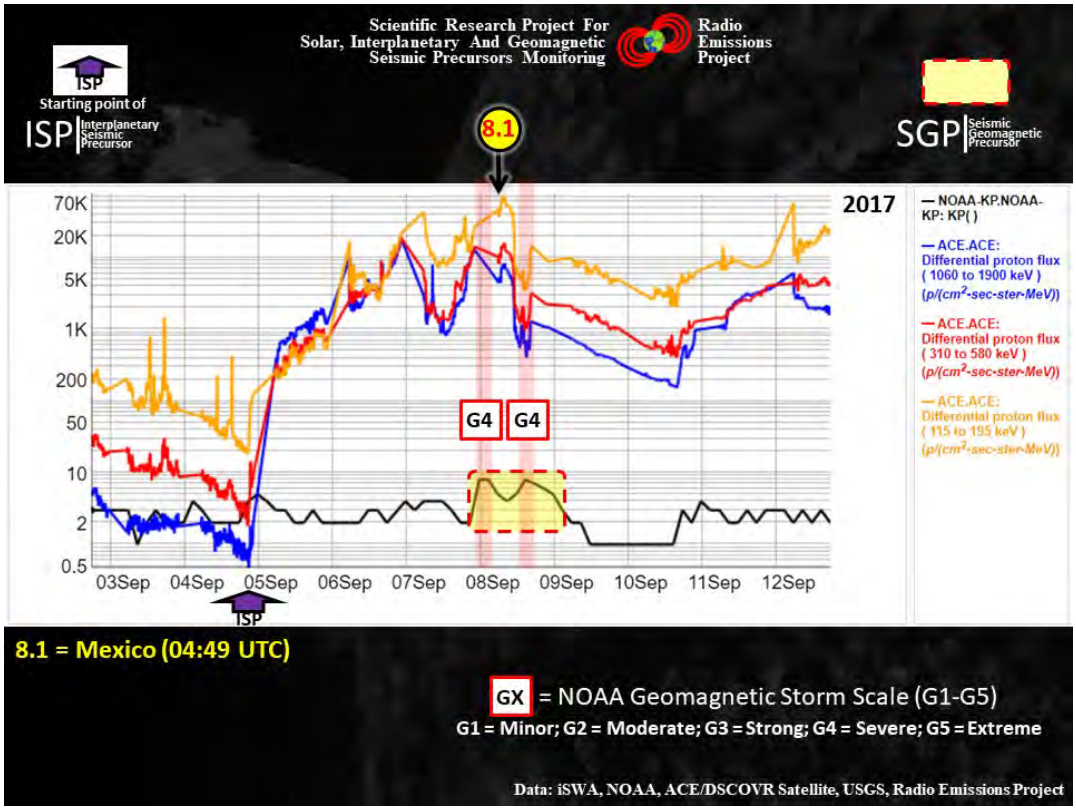

Fig. 2 – Mexican Earthquake correlated to the protonic increase of September 4, 2022. *In the upper graph, the time marker of the M8.1 earthquake recorded in Mexico on September 8, 2017, is visible. This is correlated to an intense protonic increase that began on September 4, 2017, at 21:05 UTC. Moreover, the graph shows that the strong Mexican seismic event was preceded by a G4-grade geomagnetic storm. Credits: iSWA, Radio Emissions Project.*

On September 4, 2017, at 21:05 UTC, the Advanced Composition Explorer (ACE) Satellite recorded the beginning of a protonic increase in the solar wind, which was followed by the M8.1 earthquake recorded in Mexico on September 8, 2022, at 04:49 UTC. This seismic event was preceded by several hours and by a G4-class (strong) geomagnetic storm that reappeared several hours after the earthquake.

Observing the timing of the onset of protonic increases that preceded the earthquakes:

- M8.1 = Mexico (recorded on September 8, 2017 at 04:49 UTC);
- M7.6 = Mexico (recorded on September 19, 2022 at 18:05 UTC);
- M6.8 = Mexico (recorded on September 22, 2022 at 06:16 UTC);

It has been established that the protonic increase correlated with the 2017 Mexican M8.1 earthquake began at 21:05 UTC, while that correlated with the 2022 Mexican M7.6 and M6.8 earthquakes began at 21:15 UTC. However, the time intervals recorded between the onset of the protonic increase and the Mexican earthquakes are different:

- M8.1 = Mexico (recorded on September 8, 2017 at 04:49 UTC) = 70 hours;
- M7.6 = Mexico (recorded on September 19, 2022 at 18:05 UTC) = 261 hours;
- M6.8 = Mexico (recorded on September 22, 2022 at 06:16 UTC) = 297 hours.

Instead, the hypothesis proposed by the authors over the years seems to be gaining acceptance, namely that the magnitude of the destructive seismic event appears to be correlated with the extent of the protonic increase that precedes the seismic events themselves: the Mexican M8.1 earthquake was preceded by a protonic increase that led to a G4-grade geomagnetic storm, while the two Mexican earthquakes M7.6 and M6.8 recorded in September 2022 were preceded by a less intense protonic increase that did not produce geomagnetic storms.

Discussion

Such data indicate that the hypotheses put forward by the authors seem to be gaining acceptance, namely that within the short-term temporal context in which increases in the ionic density of the solar wind are observed in Lagrangian orbit, destructive earthquakes are recorded on Earth whose magnitude (but also the number of earthquakes) appears to be correlated with the extent and duration of the increase in solar proton flux. [10-14].

Conclusion

In conclusion, the data obtained from this study have confirmed that potentially destructive seismic activity recorded on a global scale is always preceded by an increase in the solar ionic flux (proton density), and that the extent and duration of the protonic increase seem to be directly proportional to both the magnitude and the number of recorded seismic events.

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