Space weather and geomagnetic activity related to M6+ earthquakes recorded between 13 and 16 April, 2016

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Abstract

Between 13 and 16 April 2016, eight potentially destructive seismic events were recorded on a global scale (M6.9 Burma earthquake, recorded on April 13, 2016 at 13:55:17 UTC; 6.0 Philippines earthquake, recorded on April 13, 2016 at 18:21:35 UTC; M6.2 Japan earthquake, recorded on April 14, 2016 at 12:26:35 UTC; M6.0 Japan earthquake, recorded on April 14, 2016 at 15:03:47 UTC; M6.4 Vanuatu earthquake, recorded on April 14, 2016 at 21:50:27 UTC; M6.1 Guatemala earthquake, recorded on April 15, 2016 at 14:11:26 UTC; M7.0 Japan earthquake, recorded on April 15, 2016 at 16:25:06 UTC; M7.8 Ecuador earthquake, recorded on April 16, 2016 at 23:58:36 UTC). The authors verified the existence of a close correlation between this seismic train and the solar activity recorded between 12 and 17 April 2016.

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

Introduction

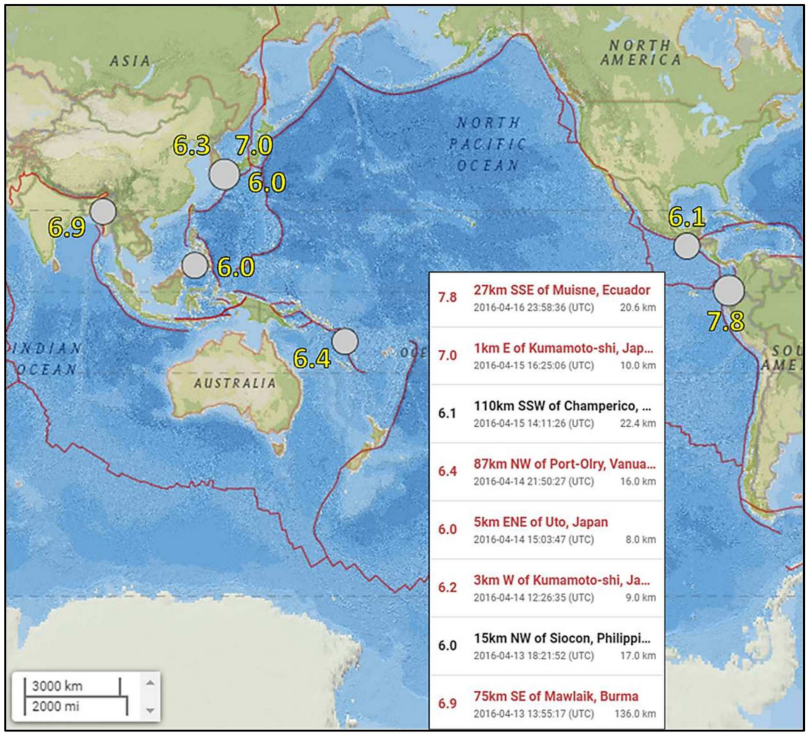

Fig. 1 – Seismic epicenter of M6+ earthquakes recorded between 12 and 17 April 2016. The map above shows the seismic epicenter of four M6+ earthquakes recorded between 12 and 17 April 2016: M6.9 Burma earthquake, recorded on April 13, 2016 at 13:55:17 UTC; 6.0 Philippines earthquake, recorded on April 13, 2016 at 18:21:35 UTC; M6.2 Japan earthquake, recorded on April 14, 2016 at 12:26:35 UTC; M6.0 Japan earthquake, recorded on April 14, 2016 at 15:03:47 UTC; M6.4 Vanuatu earthquake, recorded on April 14, 2016 at 21:50:27 UTC; M6.1 Guatemala earthquake, recorded on April 15, 2016 at 14:11:26 UTC; M7.0 Japan earthquake, recorded on April 15, 2016 at 16:25:06 UTC; M7.8 Ecuador earthquake, recorded on April 16, 2016 at 23:58:36 UTC.
Credits: USGS, Radio Emissions Project.

The first large study conducted on the correlation between potentially destructive seismic events, seismic activity and geomagnetic activity was carried out by the authors starting from 2012 [1] based on observations conducted between 2010 and 2011. From 2012 to today the authors have collected a large amount of data that allows us to establish without doubt that the potentially destructive seismic activity that is recorded on our planet is always preceded by a solar wind proton density increase [1-25]. In this work the authors will present the correlation results obtained by analyzing the M6+ seismic train recorded between 12 and 17 April 2016 (**Fig. 1**). Looking at the map of the seismic epicenters visible on the left, it is evident that most of the M6+ seismic events recorded between 12 and 17 April 2016 occurred in the Pacific Ocean's fire belt.

Data analysis

Between 12 and 17 April 2016 the Advanced Composition Explorer (ACE) satellite (located in Lagrangian point L1) detected a wide solar wind proton density increase (**Fig. 2**) which generated two geomagnetic storms of

class G1 (NOAA G Scale): the first it was recorded between 12 and 13 April 2016; the second was recorded on April 14, 2016 at 10:30 UTC (**Fig. 2** and **3**).

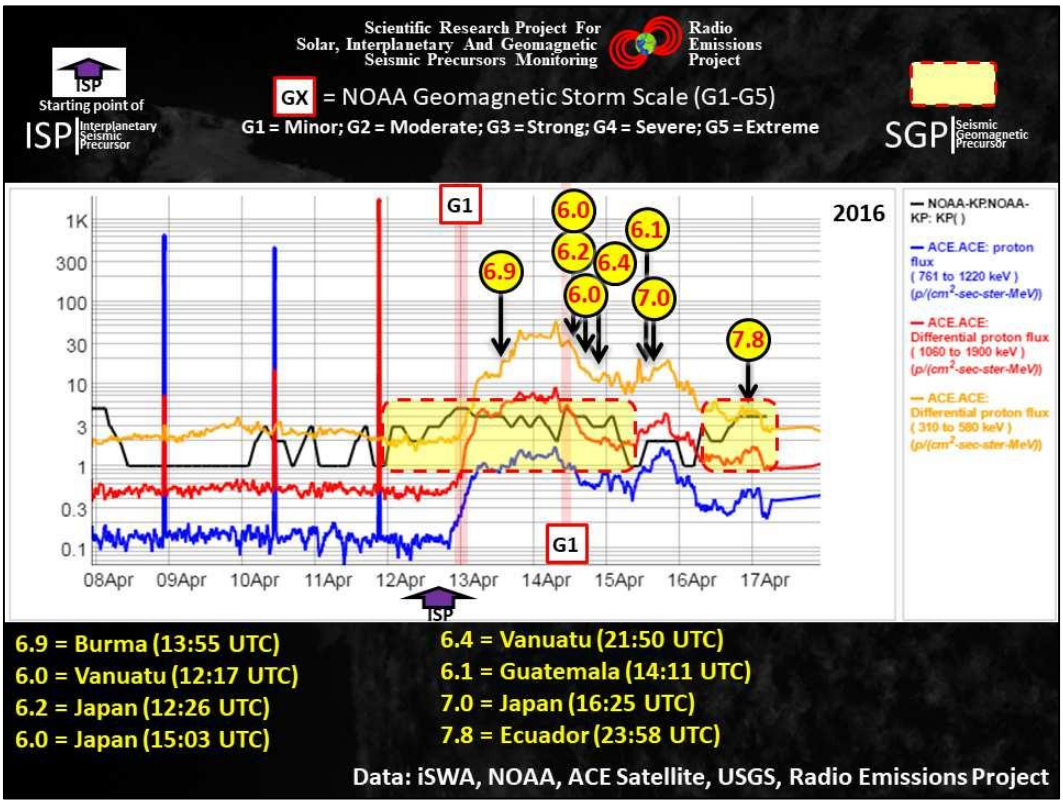

Fig. 2 – Variation in solar ion flux and Earth's geomagnetic activity related to the M6+ global seismic activity recorded between 12 and 17 April 2016. Graph contains the data on the variation of solar wind proton density (blu, red and yellow lines) recorded between 12 and 17 April 2016 recorded at the L1 Lagrange point by Advanced Composition Explorer (ACE) satellite; the variation of Kp-Index and the temporal markers (black vertical arrows) of M6+ earthquakes recorded between 13 and 17 April 2016. The vertical purple arrow represents the beginning of the "gradual" proton density increase (beginning of Interplanetary Seismic Precursor). The yellow areas surrounded by the red dashed line indicates increases of Kp-Index (black line) that preceded the M6+ earthquakes (Geomagnetic Seismic Precursor). The data on the proton density variation and the Kp-Index were provided by iSWA. iSWA is a flexible, turn-key, Web-based dissemination system for NASA-relevant space weather information that combines forecasts based on the most advanced space weather models with concurrent space environment information. The data on seismic activity were provided by United States Geological Survey (USGS). Credits: iSWA, USGS, NOAA, Radio Emissions Project.

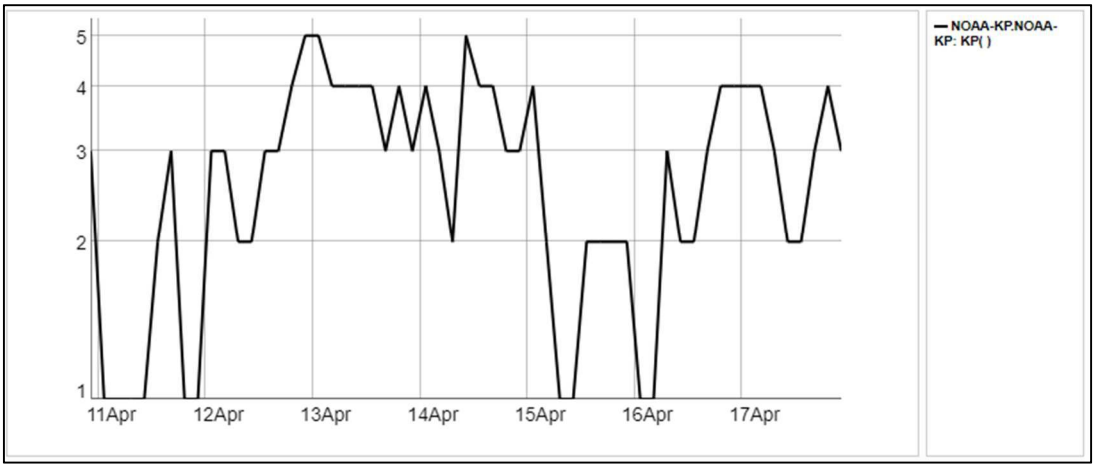

Fig. 3 – Kp Index related to M6+ global seismic activity recorded between 13 and 16 April 2016. The graph shows the trend of the Kp Index recorded between 11 and 17 April 2016. Credits: iSWA, Radio Emissions Project.

The first seismic event (M6.9) was recorded approximately 12 hours after the first geomagnetic storm of class G1 (recorded between 12 and 13 April 2016; **Fig. 3**); the second (M6.0), third (M6.2), fourth (M6.0) and fifth (M6.4) seismic events were recorded immediately after and no later than 12 hours after the second geomagnetic storm od class G1 (recorded on April 14, 2016 at 10:30 UTC; **Fig. 3**); the sixth (M6.1) and the seventh (M7.0) seismic events were recorded during a small flexion of the Kp Index and during a second slight proton increase; the eighth (M7.8) seismic event has been recorded during the progressive deflection of the proton density but in the course of a second increase of Kp Index, which has reached the level of 4 (**Fig. 2** and **3**). All these electromagnetic events are the direct and indirect expression of solar activity.
To confirm what has been stated, it is interesting to observe the graph on the variation of the solar wind speed (**Fig. 4**): the maximum speed was reached on April 13, 2016 at 06:14 UTC. After this peak, seven of the eight M6+ seismic events occurred while the eighth was recorded after a second increase in speed (much more modest than the main one) but which explains why this latest earthquake was recorded during a resumption of the Kp Index.

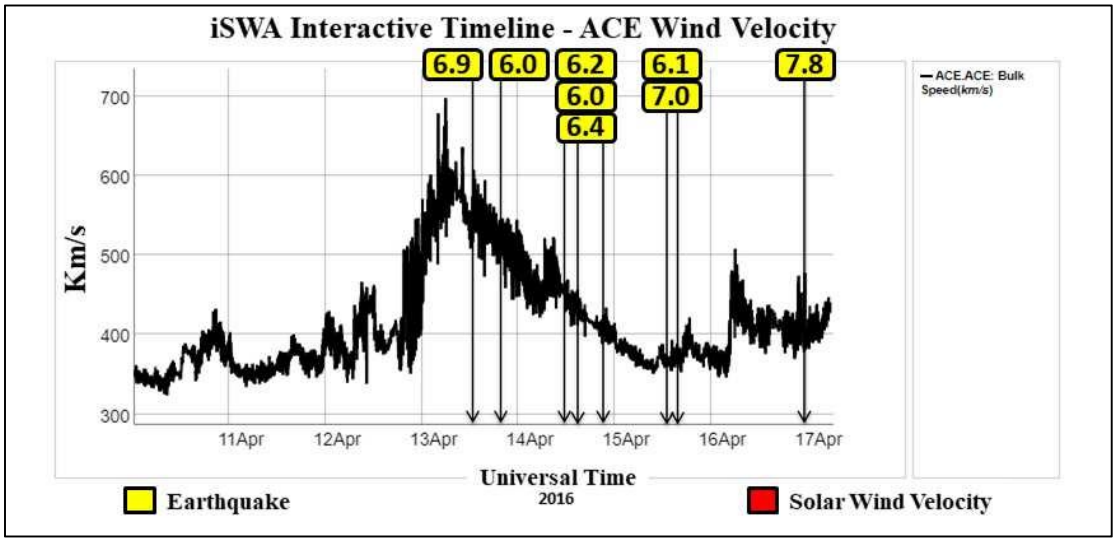

Fig. 4 – Solar wind velocity correlated to M6+ earthquakes recorded between 17 and 19 July 2016. The graph shows the variation of solar wind velocity recorded between 10 and 17 April 2016 by Advanced Composition Explorer (ACE) satellite, in orbit at L1 Lagrange point. Analyzing the variation curve, it is possible to understand that the eight M6+ earthquakes was preceded by an increase of the solar wind speed. The black vertical arrow shows the temporal marker of the M6+ earthquakes.
Credits: iSWA, Radio Emissions Project.

As has already been stated several times by the authors over the last 9 years, the increase in the speed of the solar wind and the increase in the density of the solar proton flux are in all respects the "Interplanetary Seismic Precursors" (ISPs) since they precede potentially destructive seismic events [3-16] [18-25]. For the same reason, the increases in the Earth's geomagnetic field are considered "Seismic Geomagnetic Precursors" (SGPs) [1-4] [9] [11-13] [15] [16] [18] [22-25]. However, the increases in the density of the solar ion flux remain the type of electromagnetic seismic precursor with the highest correlation index (= 1) since the M6+ seismic activity is always preceded by solar wind proton density increase [1-25].

Conclusions

The conclusions on this type of study are partly obvious: the authors say since 2013 that there is a very close correlation between solar activity and the potentially destructive seismic activity that is recorded on our planet [1]. This type of correlation could be used today as a seismic forecasting method dedicated to M6+ global seismic activity: a method that is certainly not able to identify the seismic epicenters but is absolutely capable of establishing (on average with 108 hours of notice) when a resumption of M6+ global seismic activity is expected on Earth. This is, in effect, a very important scientific achievement that is unprecedented and which should find fertile ground within the international scientific community. The authors believe that the international scientific community can no longer afford to wait: it must reconsider some misconceptions about the possibility of predicting strong earthquakes.

Credits

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