Space weather and geomagnetic activity related to M6+ earthquakes recorded between 17 and 19 July 2017

Gabriele Cataldi[1], Daniele Cataldi[1-2], Valentino Straser[3]

(1) Radio Emissions Project (I). ltpaobserverproject@gmail.com
(2) Fondazione Permanente G. Giuliani - Onlus (I). daniele77c@hotmail.it
(3) Department of Science and Environment UPKL Brussel (B). valentino.straser@gmail.com

Abstract

Between 17 and 19 July 2017, four potentially destructive seismic events were recorded (M6.3 Russia earthquake, recorded on July 17, 2017 at 11:05:19 UTC; M7.7 Russia earthquake, recorded on July 17, 2017 at 23: 34:13 UTC; M6.4 Peru earthquake, recorded on July 18, 2017 at 02:05:19 UTC and M6.0 Mauritius earthquake, recorded on July 19, 2017 at 12:16:23 UTC). The authors, analyzing the modulation of the "near Earth" solar activity and the terrestrial geomagnetic activity between 13 and 19 July 2017, found that the four M6+ seismic events were preceded by a solar wind proton density increase and by a series of intense geomagnetic increases.

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

Introduction

On our planet, almost 130 M6+ seismic events are recorded on average per month (2012-2020). All this activity is closely related to solar activity that affects the Earth's geomagnetic field [1-25]. In this work, the authors will present the correlation results they obtained by analyzing the modulation of the solar ion flux and the Earth's geomagnetic activity between 13 and 19 July 2017: temporal interval in which four high intensity seismic events were recorded (**Fig. 1**).

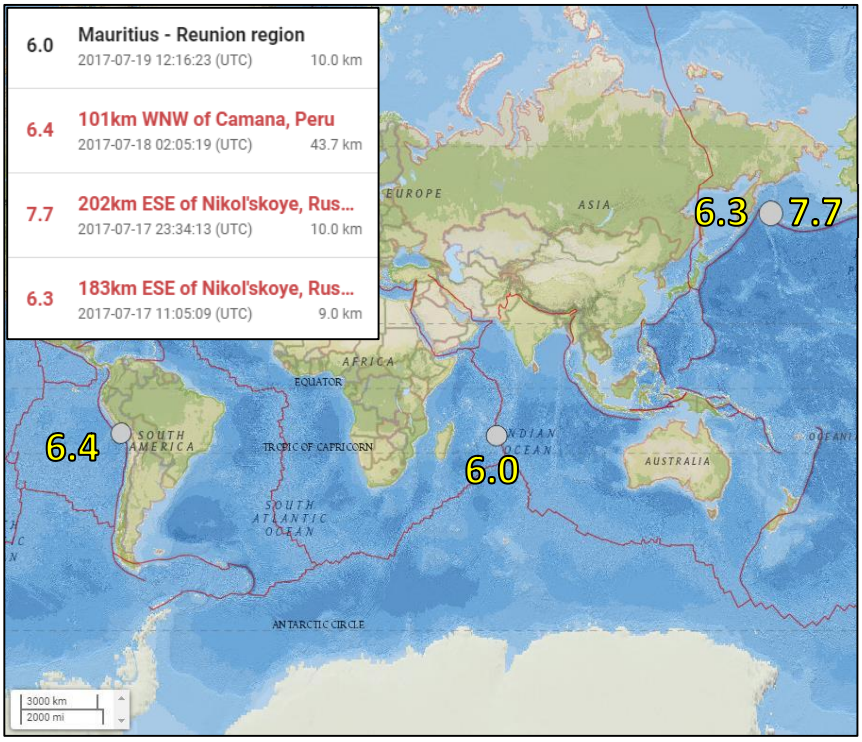

Fig. 1 – Seismic epicenter of M6+ earthquakes recorded between 17 and 19 July 2017. The map above shows the seismic epicenter of four M6+ earthquakes recorded between 17 and 19 July 2017: M6.3 Russia earthquake, recorded on July 17, 2017 at 11:05:19 UTC; M7.7 Russia earthquake, recorded on July 17, 2017 at 23:34:13 UTC; M6.4 Peru earthquake, recorded on July 18, 2017 at 02:05:19 UTC and M6.0 Mauritius earthquake, recorded on July 19, 2017 at 12:16:23 UTC.
Credits: USGS, Radio Emissions Project.

Data analysis

Between July 14, 2017 at 00:00 and July 21, 2017 at 12:00 UTC the Advanced Composition Explorer (ACE) satellite (located in Lagrangian point L1) detected a wide solar wind proton density increase. This very dense ion flux produced a geomagnetic increment which lasted 3 days and reached grade G1-G2 on July 16, 2017 and grade G2 on July 17, 2017 (**Fig. 2**).

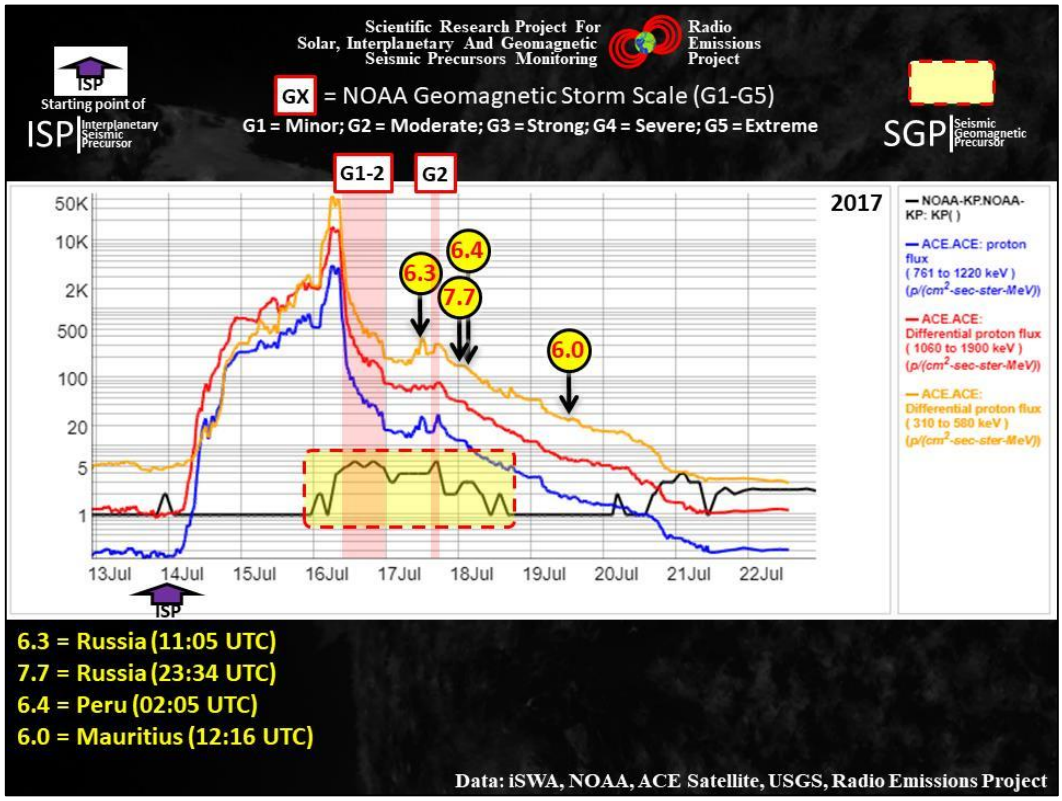

Fig. 2 – Variation in solar ion flux and Earth's geomagnetic activity related to the M6+ global seismic activity recorded between 17 and 19 July 2017. Graph contains the data on the variation of solar wind proton density (blu, red and yellow lines) recorded between 13 and 22 July 2017 recorded at the 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 in the same period. 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, Radio Emissions Project.

During this state of spatial and geomagnetic critical issues on our planet we were recorded four of high intensity seismic events:

1) M6.3 Russia earthquake, recorded on July 17, 2017 at 11:05:19 UTC (9km depth);
2) M7.7 Russia earthquake, recorded on July 17, 2017 at 23:34:13 UTC (10km depth);
3) M6.4 Peru earthquake, recorded on July 18, 2017 at 02:05:19 UTC (43,7km depth);
4) M6.0 Mauritius earthquake, recorded on July 19, 2017 at 12:16:23 UTC (10km depth).

The first seismic event (M6.3) was recorded after the geomagnetic perturbation of class G1-G2 occurred immediately after the maximum density increase of the solar proton flux recorded between 05:15 UTC and 08:15 UTC on July 16, 2017 (**Fig. 3**). The second and third M6+ seismic events (M6.4 and M7.7) were recorded immediately after the second geomagnetic perturbation of class G2 recorded on July 17, 2017 (**Fig. 3**), while the fourth seismic event (M6.3) was recorded on July 19, 2017 during a geomagnetic condition of rest and during the progressive reduction of the proton increase started on July 14, 2017: a series of electromagnetic phenomena (we can consider them as "seismic precursors") closely related to the M6+ global seismic activity that the authors observed for the first time between 2010 and 2011 and which today (2021)

are used by the authors as prodromal physical phenomena capable of establishing, from predictive a point of view, when a resumption of M6+ global seismic activity can be expected with an average warning of 108 hours [3-16] [18-25]. The analysis of solar activity, combined with the analysis of the Earth's geomagnetic activity [1-4] [9] [11-13] [15] [16] [18] [22-25], therefore represents a method of seismic prediction that has proved more reliable than other methods developed over the last few decades by the international scientific community.

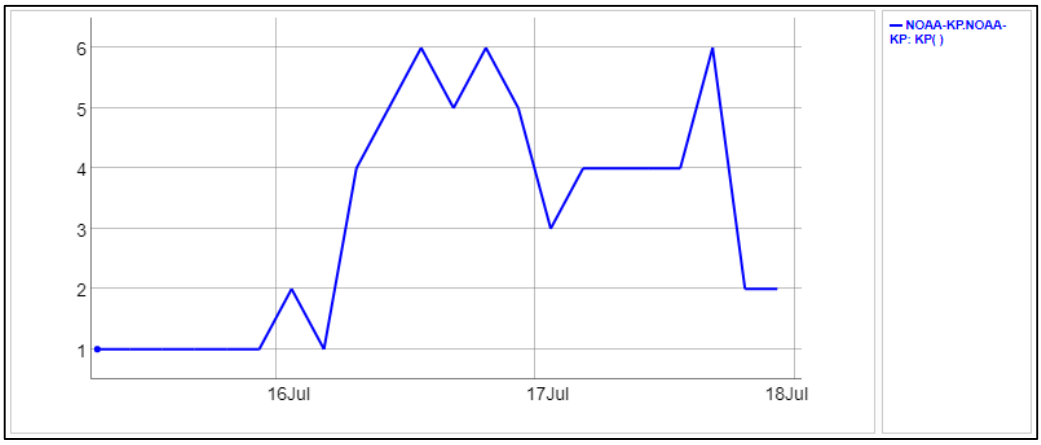

Fig. 3 – Kp Index related to M6+ global seismic activity recorded between 17 and 19 July 2017. The graph shows the trend of the Kp Index recorded between 15 and 18 July 2017. Credits: iSWA, Radio Emissions Project.

Another electromagnetic phenomenon of solar origin related to the four M6+ seismic events recorded between 17 and 19 July 2017 is visible in the **Fig. 4**.

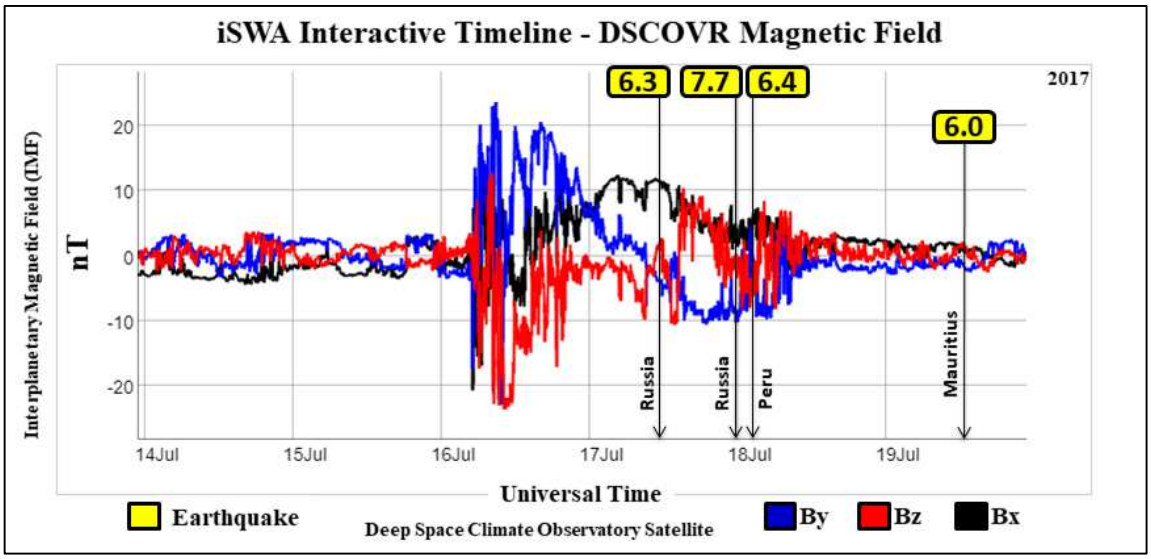

Fig. 4 – Solar wind magnetic field perturbation correlated to M6+ earthquakes recorded between 17 and 19 July 2017. The chart above shows the variation of the interplanetary magnetic field (IMF) recorded through the Deep Space Climate Observatory (DSCOVR) Satellite in orbit at L1 Lagrange point. The recording was done on 3 axes (By, Bx, Bz). Analyzing the variation curves it is evident that the four M6+ earthquakes recorded between 17 and 19 July 2017 has been preceded by a perturbation of the interplanetary magnetic field (IMF). The long black vertical arrow represents the temporal markers of M6+ earthquakes. Credits: iSWA, USGS, Radio Emissions Project.

The curve, in agreement with the data relating to the variation of the proton density (**Fig. 2**), suggests that the Earth's magnetosphere was reached by an ion flux that also carried with it an important variation of Interplanetary Magnetic Field (IMF): a phenomenon that contributed to generate the two geomagnetic perturbations visible in **Fig. 2** and **3**. Added to this is also an increase in the speed of the solar wind (**Fig. 5**) which has increased the dynamic pressure of the solar wind directed towards the Earth.

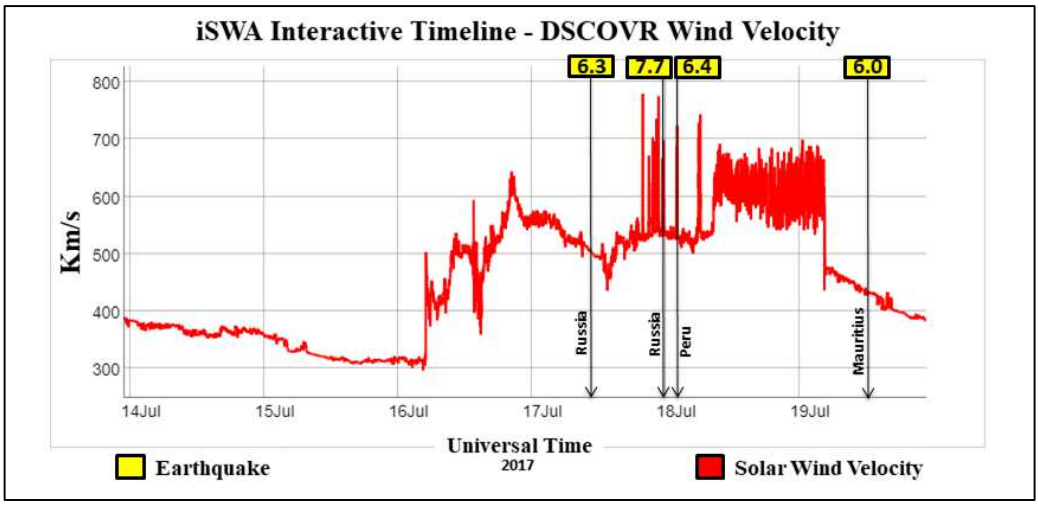

Fig. 5 – Solar wind velocity correlated to M6+ earthquakes recorded between 17 and 19 July 2017. The graph shows the variation of solar wind velocity recorded between 14 and 19 July 2017 by Deep Space Climate Observatory (DSCOVR) Satellite, in orbit at L1 Lagrange point. Analyzing the variation curve, it is possible to understand that the four 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.

Conclusions

By analyzing all the data presented in this work, it is clear that there is a relationship between solar activity, Earth's geomagnetic activity and M6+ global seismic activity. This relationship is not yet known, but the authors are trying to understand what form of electromagnetic interaction is capable of connecting everything. Today we can however affirm that every single potentially destructive seismic event that is recorded on Earth is always preceded by an increase in the proton density of the solar wind [21] [22]: the average time interval calculated on the basis of 1213 M6+ seismic events recorded on a global scale between January 1, 2012 and April 5, 2021 corresponds to 108 hours.

Credits

[1] G. Cataldi, D. Cataldi, V. Straser. (2013). Variations Of Terrestrial Geomagnetic Activity Correlated To M6+ Global Seismic Activity. EGU (European Geosciences Union) 2013, General Assembly, Seismology Section (SM3.1), Earthquake precursors, bio-anomalies prior to earthquakes and prediction, Geophysical Research Abstracts, Vol. 15. EGU2013-2617, Vienna, Austria. Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[2] G. Cataldi, D. Cataldi and V. Straser. (2014). Earth's magnetic field anomalies that precede the M6+ global seismic activity. European Geosciences Union (EGU) General Assembly 2014, Geophysical Research Abstract, Vol. 16, EGU2014-1068, Vienna, Austria. Natural Hazard Section (NH4.3), Electro-magnetic phenomena and connections with seismo-tectonic activity, Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[3] T. Rabeh, G. Cataldi, V. Straser. (2014). Possibility of coupling the magnetosphere–ionosphere during the time of earthquakes. European Geosciences Union (EGU) General Assembly 2014, Geophysical Research Abstract, Vol. 16, EGU2014-1067, Vienna, Austria. Natural Hazard Section (NH4.3), Electro-magnetic phenomena and connections with seismo-tectonic activity. Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[4] V. Straser, G. Cataldi. (2014). Solar wind proton density increase and geomagnetic background anomalies before strong M6+ earthquakes. Space Research Institute of Moscow, Russian Academy of Sciences, MSS-14. 2014. Moscow, Russia. pp280-286.

[5] V. Straser, G. Cataldi. (2015). Solar wind ionic variation associated with earthquakes greater than magnitude M6.0. New Concepts in Global Tectonics Journal, V. 3, No. 2, June 2015, Australia. P.140-154.

[6] G. Cataldi, D. Cataldi, V. Straser. (2015). Solar wind proton density variations that preceded the M6+ earthquakes occurring on a global scale between 17 and 20 April 2014. European Geosciences Union (EGU) General Assembly 2015, Vienna, Austria. Natural Hazard Section (NH5.1), Sea & Ocean Hazard - Tsunami, Geophysical Research Abstract, Vol. 17, EGU2015-4157-2, Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[7] G. Cataldi, D. Cataldi, V. Straser. (2015). Solar wind ion density variations that preceded the M6+ earthquakes occurring on a global scale between 3 and 15 September 2013. European Geosciences Union (EGU) General Assembly 2015, Geophysical Research Abstract, Vol. 17, EGU2015-4581, Vienna, Austria. Natural Hazard Section (NH5.1), Sea & Ocean Hazard - Tsunami, Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[8] G. Cataldi, D. Cataldi, V. Straser. (2015). Solar wind proton density variations that preceded the M6,1 earthquake occurred in New Caledonia on November 10, 2014. European Geosciences Union (EGU) General Assembly 2015, Geophysical Research Abstract, Vol. 17, EGU2015-4167, Vienna, Austria. Natural Hazard Section (NH5.1), Sea & Ocean Hazard - Tsunami, Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[9] V. Straser, G. Cataldi, D. Cataldi. (2015). Solar wind ionic and geomagnetic variations preceding the Md8.3 Chile Earthquake. New Concepts in Global Tectonics Journal, V. 3, No. 3, September 2015, Australia. P.394-399.

[10] G. Cataldi, D. Cataldi, V. Straser. (2016). Solar activity correlated to the M7.0 Japan earthquake occurred on April 15, 2016. New Concepts in Global Tectonics Journal, V. 4, No. 2, pp202-208, June 2016.

[11] G. Cataldi, D. Cataldi, V. Straser. (2016). Tsunami related to solar and geomagnetic activity. European Geosciences Union (EGU) General Assembly 2016, Natural Hazard Section (NH5.6), Complex modeling of earthquake, landslide, and volcano tsunami sources. Geophysical Research Abstract, Vol. 18, EGU2016-9626, Vienna, Austria. Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[12] G. Cataldi, D. Cataldi, V. Straser. (2017). SELF-VLF electromagnetic signals and solar wind proton density variations that preceded the M6.2 Central Italy earthquake on August 24, 2016. International Journal of Modern Research in Electrical and Electronic Engineering, Vol. 1, No. 1, 1-15. DOI: 10.20448/journal.526/2017.1.1/526.1.1.15.Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[13] G. Cataldi, D. Cataldi, V. Straser. (2017). Solar and Geomagnetic Activity Variations Correlated to Italian M6+ Earthquakes Occurred in 2016. European Geosciences Union (EGU), General Assembly 2017. Geophysical Research Abstracts Vol. 19, EGU2017-3681, 2017. Seismology (SM1.2)/Natural Hazards (NH4.7)/Tectonics & Structural Geology (TS5.5) The 2016 Central Italy Seismic sequence: overview of data analyses and source models.Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[14] G. Cataldi, D. Cataldi, V. Straser. (2017). Solar wind proton density increase that preceded Central Italy earthquakes occurred between 26 and 30 October 2016. European Geosciences Union (EGU), General Assembly 2017. Geophysical Research Abstracts Vol. 19, EGU2017-3774, 2017. Seismology (SM1.2)/Natural Hazards (NH4.7)/Tectonics & Structural Geology (TS5.5) The 2016 Central Italy Seismic sequence: overview of data analyses and source models. Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[15] V. Straser, G. Cataldi, D. Cataldi. (2017). Solar and electromagnetic signal before Mexican Earthquake M8.1, September 2017. New Concepts in Global Tectonics Journal, V. 5, No. 4, December 2017. pp600-609.

[16] G. Cataldi, D. Cataldi, V. Straser. (2017). Solar and Geomagnetic Activity Variations Correlated to Italian M6+Earthquakes Occurred in 2016. EGU General Assembly 2017. EGU2017-3681, Vol. 19.

[17] G. Cataldi, D. Cataldi, V. Straser. (2019). Solar wind ionic density variations related to M6+ global seismic activity between 2012 and 2018. European Geosciences Union (EGU) General Assembly 2019, Short-term Earthquake Forecast (StEF) and multy-parametric time-Dependent Assessment of Seismic Hazard (t-DASH) (NH4.3/AS4.62/EMRP2.40/ESSI1.7/Gi2.13/SM3.9), General Contribution on Earthquakes, Earth Structure, Seismology (SM1.1), Geophysical Research Abstract, Vol. 21, EGU2019-3067, 2019, Vienna, Austria. Harvard-Smithsonian Center for Astrophysics, High Energy Astrophysics Division, SAO/NASA Astrophysics Data System.

[18] G. Cataldi. (2020). Precursori Sismici – Monitoraggio Elettromagnetico. Kindle-Amazon, ISNB: 9798664537970. ASIN Code: B08CPDBGX9.

[19] G. Cataldi, D. Cataldi, V. Straser. (2019). Wolf Number Related To M6+ Global Seismic Activity. New Concepts in Global Tectonics Journal, Volume 7, Number 3, December 2019, pp. 178-186.

[20] V. Straser, G. Cataldi, D. Cataldi. (2020). The Space Weather Related to the M7+ Seismic Activity Recorded on a Global Scale between 28 January and 25 March 2020. Acta Scientific Agriculture 4.12 (2020): 55-62.

[21] G. Cataldi, V. Straser, D. Cataldi. (2020). Space Weather related to potentially destructive seismic activity recorded on a global scale. New Concepts in Global Tectonics Journal. Vol.8, No.3, pp.233-253, December 2020. ISSN 2202-0039.

[22] G. Cataldi. (2021). Radio Emissions Project – A new approach to seismic prediction. Kindle-Amazon, ISNB: 9798709593411.

[23] G. Cataldi, D. Cataldi, V. Straser. (2021). Space weather and geomagnetic activity related to the Japan M7.1 earthquake recorded on February 13, 2021. New Concepts in Global Tectonics Journal, Vol. 9, No. 1, pp.16-23. March 2021.

[24] G. Cataldi, D. Cataldi, V. Straser. (2021). Space weather and geomagnetic activity related to the Chilean M6.7 earthquake recorded on February 3, 2021. New Concepts in Global Tectonics Journal, Vol. 9, No. 1, pp.3-9. March 2021.

[25] G. Cataldi, D. Cataldi, V. Straser. (2021). Space weather and geomagnetic activity related to M6+ global seismic activity recorded on February 7, 2021. New Concepts in Global Tectonics Journal, Vol. 9, No. 1, pp.24-30. March 2021.