Solar wind can provoke earthquakes: Possible magnetosphere-solid earth tornado

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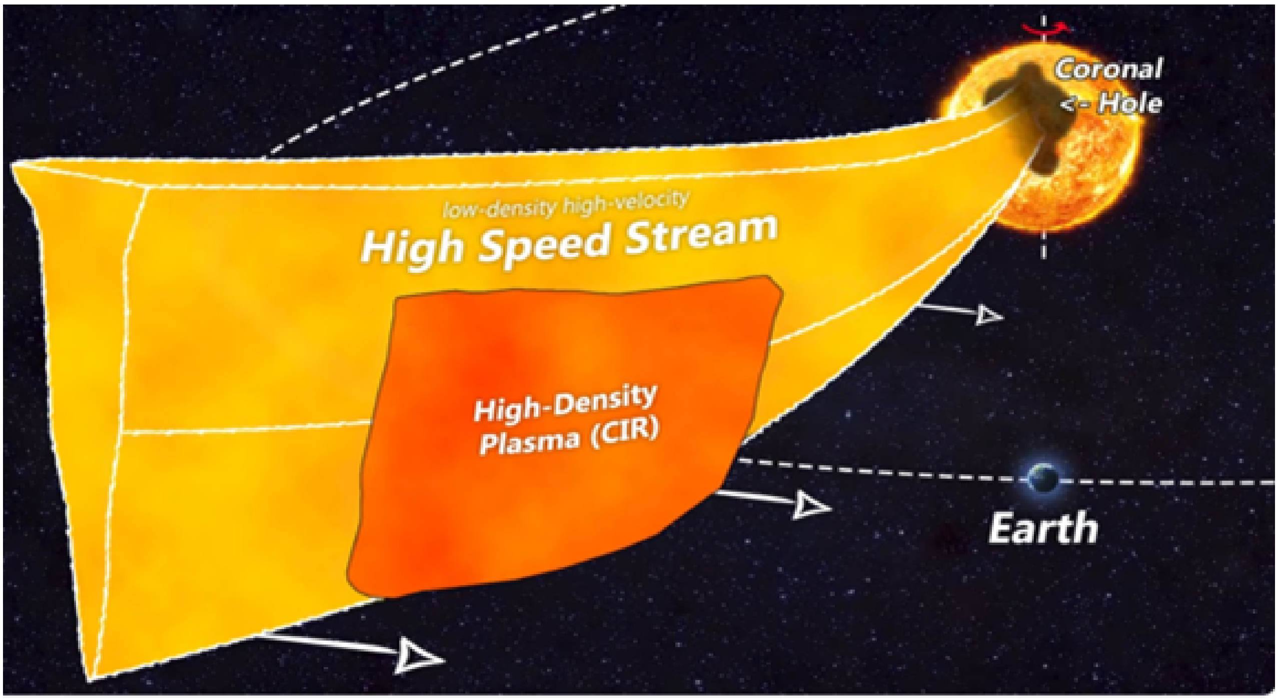

Fig. 1 Schematic diagram of the CHHSS as adopted from (10).

This article explores the potential influence of solar wind on earthquake occurrences, drawing on findings that show a correlation between strong earthquakes and geomagnetic storms, particularly in areas beneath the polar cusp during storm events

Over the last 30 years, cooperation within the international community has led to the introduction of the concept of lithosphere–atmosphere–ionosphere coupling (LAIC), suggesting that electromagnetic disturbances in the lithosphere are linked to the earthquake process and can alter the electric field in the global electric circuit (GEC). [1,2,3] By studying geo-space weather and its potential impact on Earth, scientists have established that solar wind activity and geomagnetic storms result not only in stunning auroras but also in negative consequences, such as increased radiation levels in space, disruptions to satellite electronics, GPS failures, and induced electrical currents in power lines, which can lead to overloads, transformer failures, and large-scale power outages.

The solar wind, a stream of charged particles released from the Sun's active regions or coronal holes, was discovered in 1959. [4] Fig. 1 presents a schematic representation of the Coronal Hole High Speed Stream (CHHSS). On Earth, geomagnetic storms are the most obvious manifestations of solar wind activity. [5] Since earthquake generation is influenced by a broad range of geophysical and tectonic variables, it is very difficult to isolate the influence of solar wind and geomagnetic storms from other factors. Nevertheless, it is currently believed that they may be seen as potential agents that provoke earthquakes. [6]

We have discussed these results in [7-9], which clearly demonstrate the influence of solar wind energy and geomagnetic storms on intra-terrestrial processes we perceive as earthquakes, including catastrophic events.

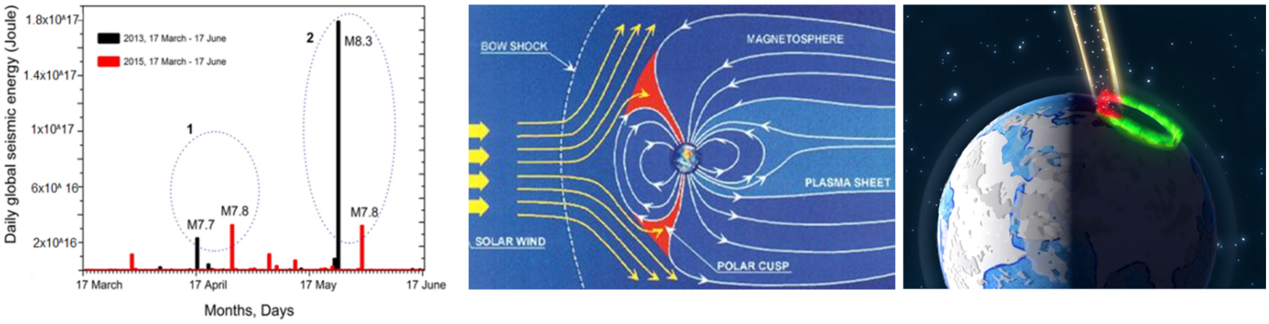

Fig. 2(A) The histogram of released seismic energy at the globe per day from March 17 to June 17 in 2013 and 2015 (black and red columns, respectively) is adopted from [8]; B – schematic drawing of the Earth's magnetosphere, with polar cusps shown in red [https://www.megakastro.gr/weather_agro/solar_modulation.htm] C – A conceptual snapshot from an animation showing solar wind interacting with the Earth's magnetic field and causing atmospheric loss within the cusp aurora at the polar cusps (NASA GSFC) (Full animation is available here – [https://svs.gsfc.nasa.gov/13506/]).

Strong earthquakes occur following geomagnetic storms in the longitudinal regions that were positioned beneath the polar cusp at the time of the storm's onset

The efficiency of solar wind energy penetration into Earth's environment varies with the season and time. [11] Therefore, the pattern of seismic response to different geomagnetic storms may differ; however, it could be similar for comparable geomagnetic storms, and this is one such case. Two nearly identical geomagnetic storms on March 17 in 2013 and 2015 (St. Patrick's Day Geomagnetic Storms), which started at relatively close times of 06:04 UTC and 04:48 UTC, respectively, were followed by a remarkably similar pattern of strong earthquake occurrences over a time interval of approximately 2.5 months (Fig.2A). Specifically, with delays of 30 and 39 days, crustal earthquakes of M7.7 in Iran and M7.8 in Nepal occurred, followed by deep-focused earthquakes of M8.3 and M7.8 beneath the Sea of Okhotsk (Russia) and the Pacific Ocean (Japan) after delays of 68 and 74 days.

It seems that a possible reason for the similarity in seismicity patterns is that during the onset of geomagnetic storms, the longitudinal regions of future epicenters were located under the polar cusps, [8] where solar wind plasma has direct access to the Earth's environment (Fig. 2B). This pattern applies to all M7.5+ earthquakes in 2013 and 2015, as well as to the Turkish M7.8/M7.5 events of February 6, 2023. [9] It also pertains to events in 2025 (Fig. 3). Specifically, on December 29, 2024, a coronal mass ejection (CME) took place.

A geomagnetic storm began on December 31, 2024, at 16:37 UTC (black text in Fig. 3). At this point, the American longitudinal region was under the cusp. On February 8, 2025, the M7.6 Cayman Islands earthquake (17.651°N, 82.395°W) occurred with a delay of 39 days. Another CME erupted from the [Sun on January 1, 2025, impacting Earth on January 4.] The geomagnetic storm initiated on January 4, 2025, at 02:55 UTC (red text in Fig. 3). At that time, the longitudinal region 75°E-195°E was under the cusp. The M7.7 Myanmar earthquake (22.013°N, 95.922°E) happened on March 28, 2025, with a delay of 83 days.

Fig. 3 presents one-minute data on the geomagnetic SYM/H index from December 24 to March 29, 2025. The black line indicates the M7.6 earthquake in South America on February 8, 2025, while the red line denotes the M7.7 earthquake in Myanmar on March 28, 2025. Black text highlights the onset of geomagnetic storms that met the criteria for the occurrence of the American earthquake, whereas the red text refers to the occurrence of the Myanmar earthquake.

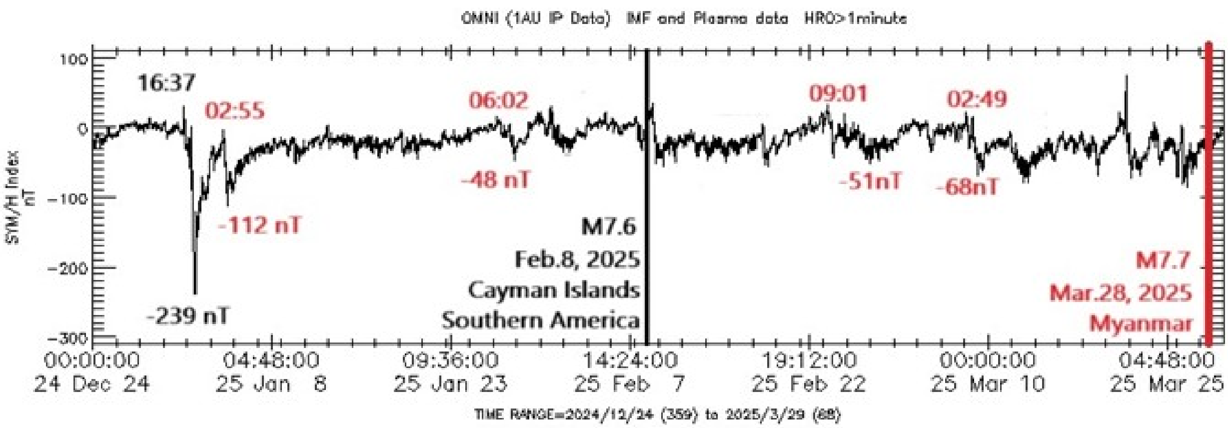

Fig. 3

A possible mechanism of solar-lithosphere connections

Long-anticipated periods of earthquakes following geomagnetic storms suggest that space weather does not trigger earthquakes immediately. Instead, solar wind stimulates lithospheric processes, which then result in earthquakes. We believe a delay could occur if solar wind influences the upward movement of fluids, which actively participate in tectonic earthquakes. [12] In exceptional cases, upwelling fluids may manifest at the surface: a sharp emanation of radon occurred before the M=6.9 earthquake in Kobe, Japan, on January 16, 1995. [13] The next question could be: ‘How is it possible that fluid uplift occurs efficiently only during times of cusp and is ineffective in other longitudinal sectors?’ We believe that processes in the cusp could provide a hint. The CHAMP and DMSP satellites discovered that the density of the neutral atmosphere in the cusp funnel is always increased relative to neighboring areas. [14-15]

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