A SURGE AND SHORT-TERM PEAK IN NORTHERN SOLAR POLAR FIELD MAGNETISM PRIOR TO THE M8.3 EARTHQUAKE NEAR CHILE ON SEPTEMBER 16, 2015

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Abstract: The Sun's northern polar magnetic fields experienced a significant increase in magnetism, as evidenced by a sharp increase in solar wind speed associated with the coronal holes containing those interplanetary magnetic fields. This surge in magnetism peaked the day of the M8.3 earthquake in Chile, and matches a signal identified in Davidson 2015 as being proliferative of Earth's largest seismic events.

Keywords: *solar polar fields, earthquakes, coronal holes, interplanetary magnetic fields*

The solar polar magnetic fields (SPF) have been studied and correlated with the largest seismic events on Earth; the peaks in magnetism and the reversals of magnetism of the individual solar poles and the total North/South field structure itself (Davidson et al., 2015) appear to trigger many of the largest earthquakes. The Earth-facing position, and valid date of the graphic, is the 2nd date from the left.

On September 16th, 2015, a magnitude 8.3 earthquake struck off the coast of Chile, producing a deadly tsunami. During this event, a tremendous surge occurred in the northern SPF magnetism, and in the magnetism of the interplanetary magnetic fields of a connected, positively polarized, Earth-facing coronal hole.

In **Fig. 1** we have solar wind speed (SWS) graphics from the National Solar Observatory's Global Oscillation Network Group (NSO GONG) measuring the SWS coming from all points on the Sun, flattened to fit on one graphic. From first to last shown: Six SWS graphics taken from September 12, 13, 14, 16, 17 and 18, 2015. The colors represent the SWS, black to red being slow (~250km/sec) to fast (700+km/sec). The faster SWS is associated with stronger magnetism in the associated fields and therefore we can use these charts as a short-term, qualitative stand-in for the SPF data. This is important because the SPF data is on a multi-week delay, eliminating predictive use, and the data is averaged over ten-day periods which may not capture short-term variation in SPF magnetism.

Starting with the first graphic and coming down through all six images, we find a strong surge in SWS near northern SPF and interplanetary magnetic fields (IMF) of the nearby coronal hole. The largest patch of red at the north appears on the 4th graphic, September 16th, 2015. Over a period of six days the northern SPF and other nearby IMF increased their magnetism to a peak on the day of the M8.3 in Chile. Then, as seen in the last two graphics, September 17th and 18th, 2015, the surge in magnetism associated with the northern SPF stopped, reversed its trend, and began to decline once the earthquake occurred. However, this surge in magnetism was not confined to the SPF

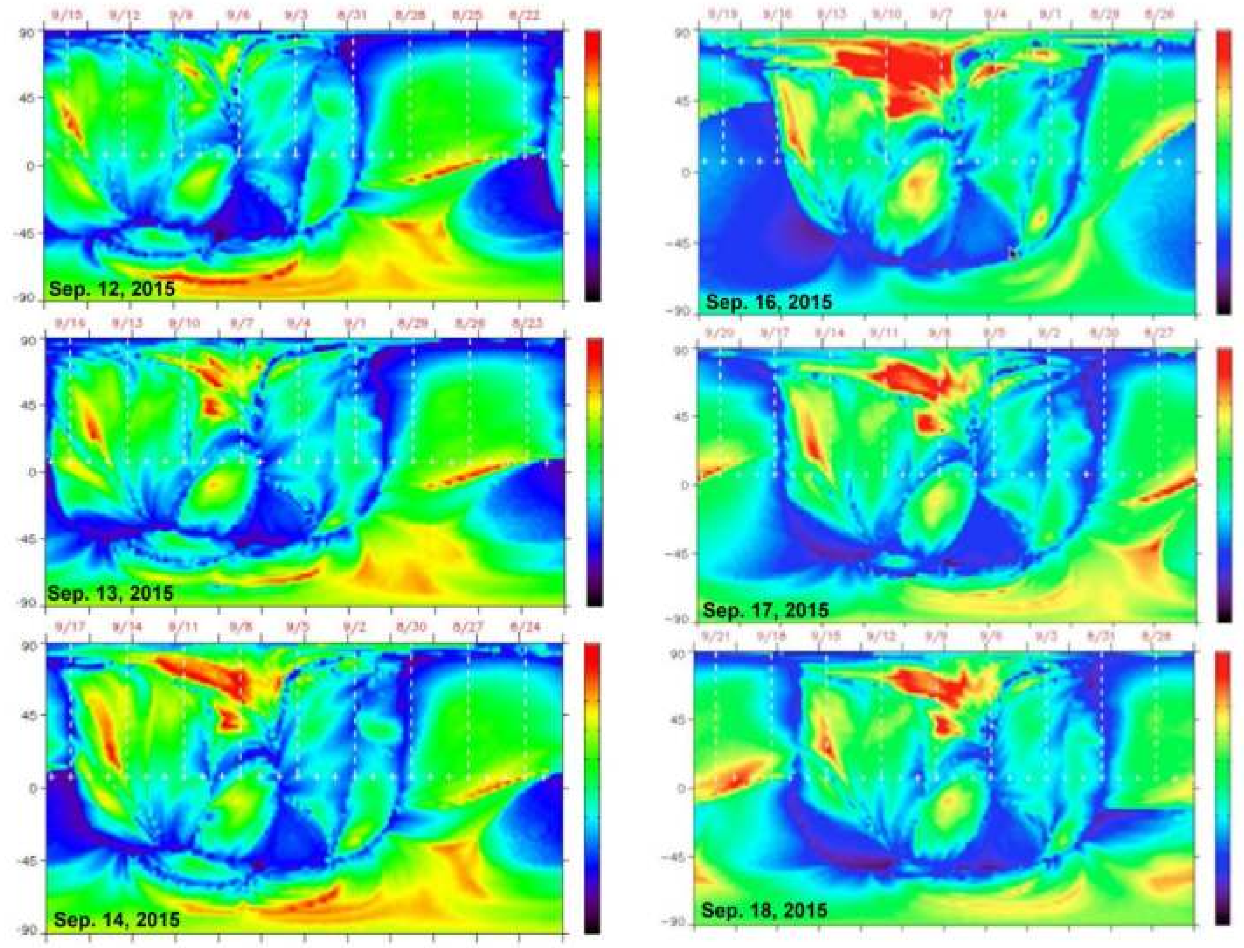

Fig. 1. Solar wind speed graphs from September 12 to 18, 2015.

Coronal holes

The SPF are measured from solar latitudes higher than 55 degrees while adjoining fields at the 54th latitude would be considered IMF from a connected coronal hole. The distinction between SPF and coronal hole IMF may be illusory for the purposes of gauging their effect on earthquake triggering processes associated with changes in the geoeffective solar wind and sector boundaries in the heliospheric current sheet, and in the magnetic flux connections between Earth and Sun.

The coronal hole associated with the SPF and lower-latitude IMF in question can be seen as the dark patch on the top right, with a trans-equatorial tail in the Earth-facing position, **Fig. 2**. The surge in magnetism was not confined to the SPF north of the 55th latitude, but included lower areas of the coronal hole and the Earth-facing trans-equatorial portion, which can be seen as the north-south oriented sliver of red in the September 15th/16th position throughout the six days covered by the SWS graphics. This indicates that the entire coronal hole area, and the associated IMF, experienced an increase in magnetism leading up to the Chile earthquake, not simply those associated with the SPF.

Although the 10-day averaged SPF data used in Davidson et al. (2015), which is made public three to five weeks after the valid time period, may not capture this event, there was a short-term surge in the solar magnetism. One of the events that Davidson et al. identified as being likely to trigger large earthquakes is a peak in the magnetism of one of the solar poles; here we saw exactly that, but also the Earth-facing portion of the coronal hole IMF experienced as rapid and severe change in magnetism as the SPF, specifically those in ‘center disk’ position (center of the circle representing the Earth-facing half of the Sun) during the earthquake. Traditionally, the Earth’s magnetic connection to the Sun appears near the departing limb, at a coronal hole, and the Earth was likely connected to the coronal hole structure in question for this study.

For these reasons, I conclude that it is possible the surge in magnetism of the Sun’s northern SPF and coronal hole IMF may have contributed to the severity of the M8.3 earthquake near Chile on September 16, 2015.

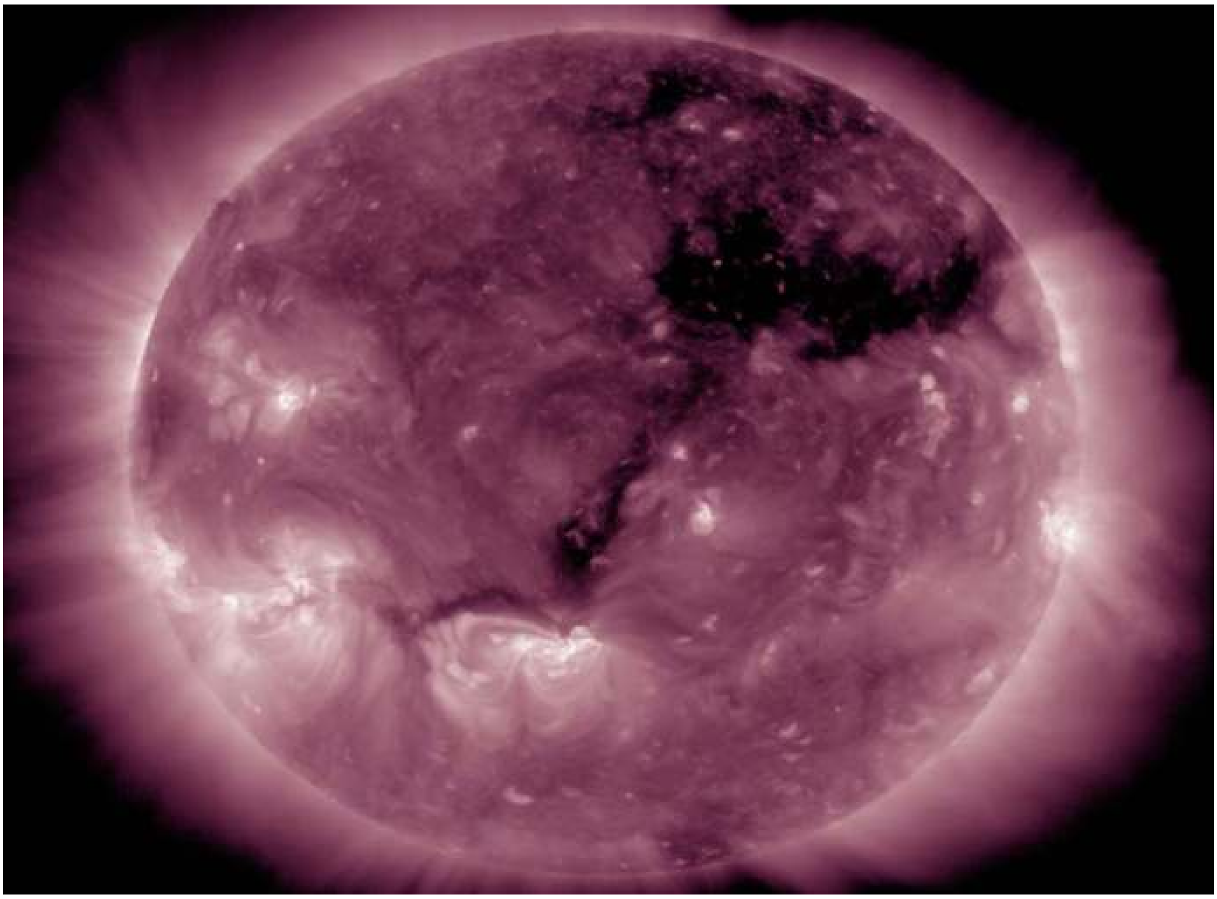

Fig. 2. The Sun in 211 angstroms of light via NASA's Solar Dynamics Observatory from September 16, 2015. The dark areas represent the coronal holes.

References

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