Big Flare Hunting

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Solar Flares and Coronal ejections (CMEs) are one of the most explosive events in the solar system, and thus have a major impact on what is called space weather. Space weather influences the performance and reliability of space-borne and ground-based technological systems and can endanger human life and/or health.

The first step is to prevent and estimate the impact that these powerful space weather events can have is to try to understand the processes deep inside the Solar interior that drives them. We use data from the Solar Dynamics Observatory (SDO) spacecraft (especially the Helioseismic and Magnetic Imager - SDO/HMI) to study the evolution of the photospheric magnetic field in the build-up to the most powerful solar flares and CME's of the current solar cycle.

The signature of the emergence of new magnetic flux, which we think is a vital component of the biggest flares, was harder to detect than expected and more work is needed to understand the formation of these energetic events.

The results of the project could provide a breakthrough in our understanding of these explosive events.

MOTIVATION

. Solar Flares and Coronal Mass ejections (CMEs) are one of the most explosive events in the solar system, and the main drivers of Space Weather
. Modern Society is dependent on technologies that can be vulnerable to space weather

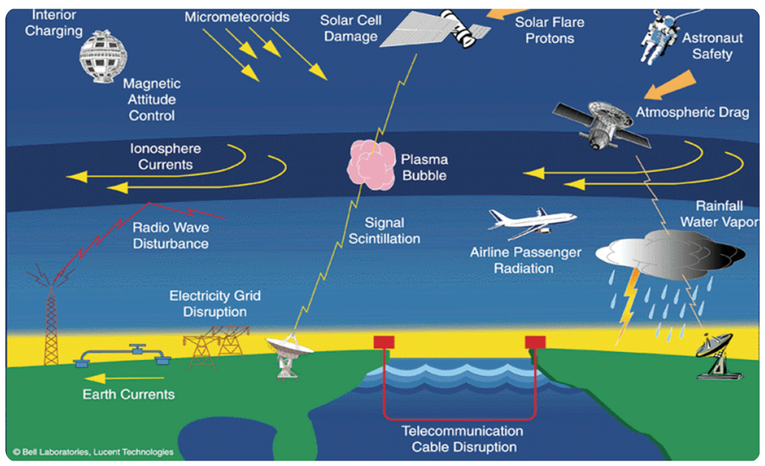

Fig. 1. Shows the various negative effects space weather can have on Earth

MROI

. The Magnetic Range of Influence (MROI) is the radial distance required to balance the integrated magnetic field contained in a 25 Mm^2 circular area centered at any pixel in the HMI magnetogram
. Small values represent locally "closed" magnetic regions
. Large Values represent unbalanced and "open" magnetic regions

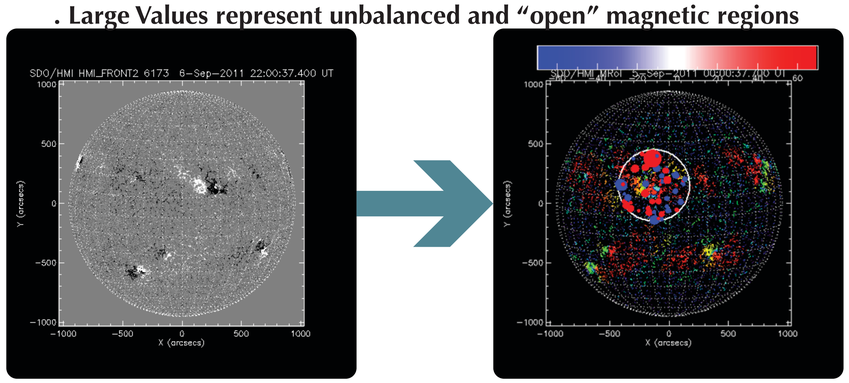

Fig. 2. MROI found from the magnetogram data and the Solar Dynamics Observatory (SDO) along with the active region and the gnodes found in that region. Red and Blue color bar indicates the sum of the parallel B field defined by the G-nodes radius

G-nodes

. G-nodes represent the magnetic elements of a very large (and potentially deep) scale of maegneto-convection (150-250 Mm MROI scale).
. G-nodes, being tied to deep rooted magnetism, are likely to be related to the Solar cycle and Coronal Holes. Here we are investigating their relation to solar flares

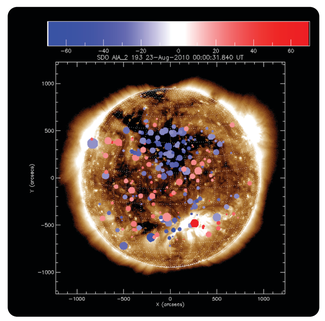

Fig. 3. AIA image of the Sun superimposed with the G-nodes found. Notice the agglomeration of G-nodes around te Coronal Hole

Method

. Track active region where 3 major flares (M53, X21, X18) happened from September 05 to September 08, 2011
. Pick radius of 300″ centered on the active region, and on other 3 test regions with no significant flare event
. 76 hours of data at 30 min cadence

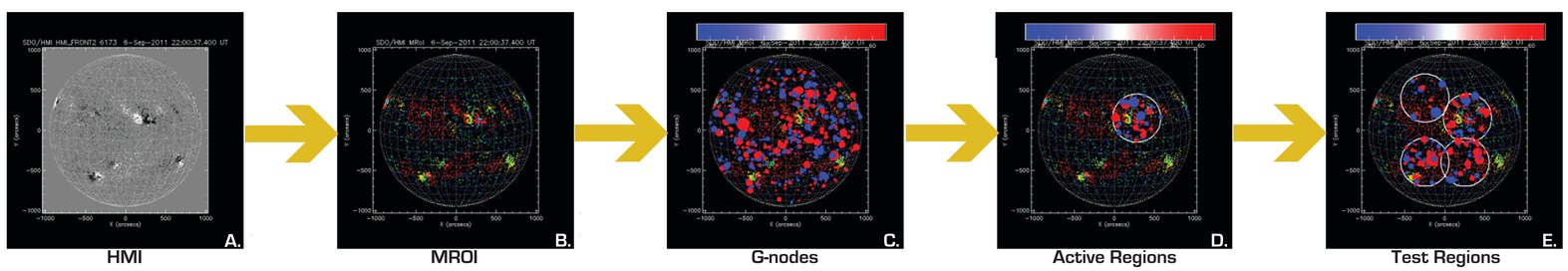

Fig. 4. Summary of the steps used to study the pre-eruption magnetism before X-class Flare

Future Work

. Different background subtraction for the MROI
. Extend observation period before flare event
. Decrease time steps
. Examine other X-Class Flares
. Analyze other possible indicators

Acknowledgments

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RESULTS

. No significant correlation between G-node count and Flare events (Fig. 5)
. Magnetic Field as a possible indicator (Fig. 6.)

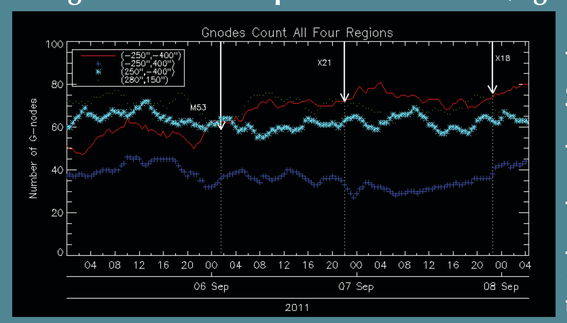

Fig. 5. shows the number of G-nodes as a function of time for the active region and three test regions. Arrows denote the time of the flares.

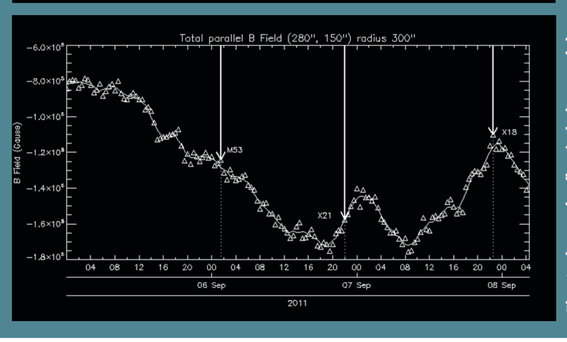

Fig. 6. shows the flux imbalance of the active region as a function of time.