

Early Observable Events in Correlation with Geomagnetic Storms





Victoria Strait¹, Robert Rutledge², Christopher Balch² ¹ Furman University, Dept. of Physics, Greenville, SC ² National Oceanic and Atmospheric Association/Space Weather Prediction Center, Boulder, CO



Abstract

Coronal Mass Ejections are associated with several solar events including large flares, high and low energy proton events, and Types II and IV radio bursts. The purpose of this project is to uncover what correlations exist between several of these CME-associated events and their resulting geomagnetic effects on Earth.

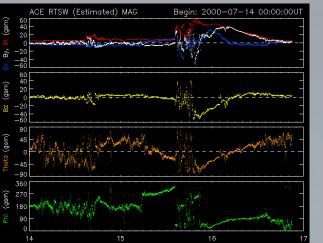
With data from the Space Weather Prediction Center's Weekly Space Weather Reports, EPAM, and LASCO, we recorded several properties of most significant flares associated with a maximum observed Ap index of greater than 100 including duration, brightness, location, proton fluence, radio flux, and peak values of the 47-65 and 115-195 keV proton channels. These were used as parameters for correlating causative solar events with numerical indices Ap, ap, and Kp. While finding very little correlation between the maximum Ap of a geomagnetic storm and most of these variables, and little more between those variables and maximum ap, the number of specific Kps observed produced the most significant results. We also concluded that while geomagnetic activity depends heavily on the frequency at which the low energy proton channels' peaks occur, it depends very little on the magnitude of the maximum flux values. A large part of error in these results comes from the lack of reliable data that was available in the Weekly Reports. Further studies are needed in order to investigate the relationship between geomagnetic activity and event duration and location on the solar disk.

Data/Methods:

MAG (Magnetometer)

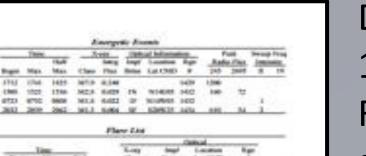
Also located on ACE, the magnetometer measures the magnitude and direction of the local interplanetary magnetic field. Using the time from peak low energy proton flux channels, I recorded the corresponding MAG information.

Weekly Reports

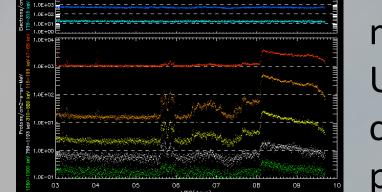


EPAM (Electron, Proton and Alpha Monitor)

Located on ACE (Advanced Composition Explorer), EPAM has two telescope apertures on EPAM that measure low energy proton flux channels, and it has been thought that the peaks of these channels are a decent way to predict the magnitude of a geomagnetic storm. Using the 47-65 keV and 115-195 keV channels, I identified the closest previous peak to the activity in question.



Dating back to the 1940s, each Weekly Report includes a summary of flares, proton events,

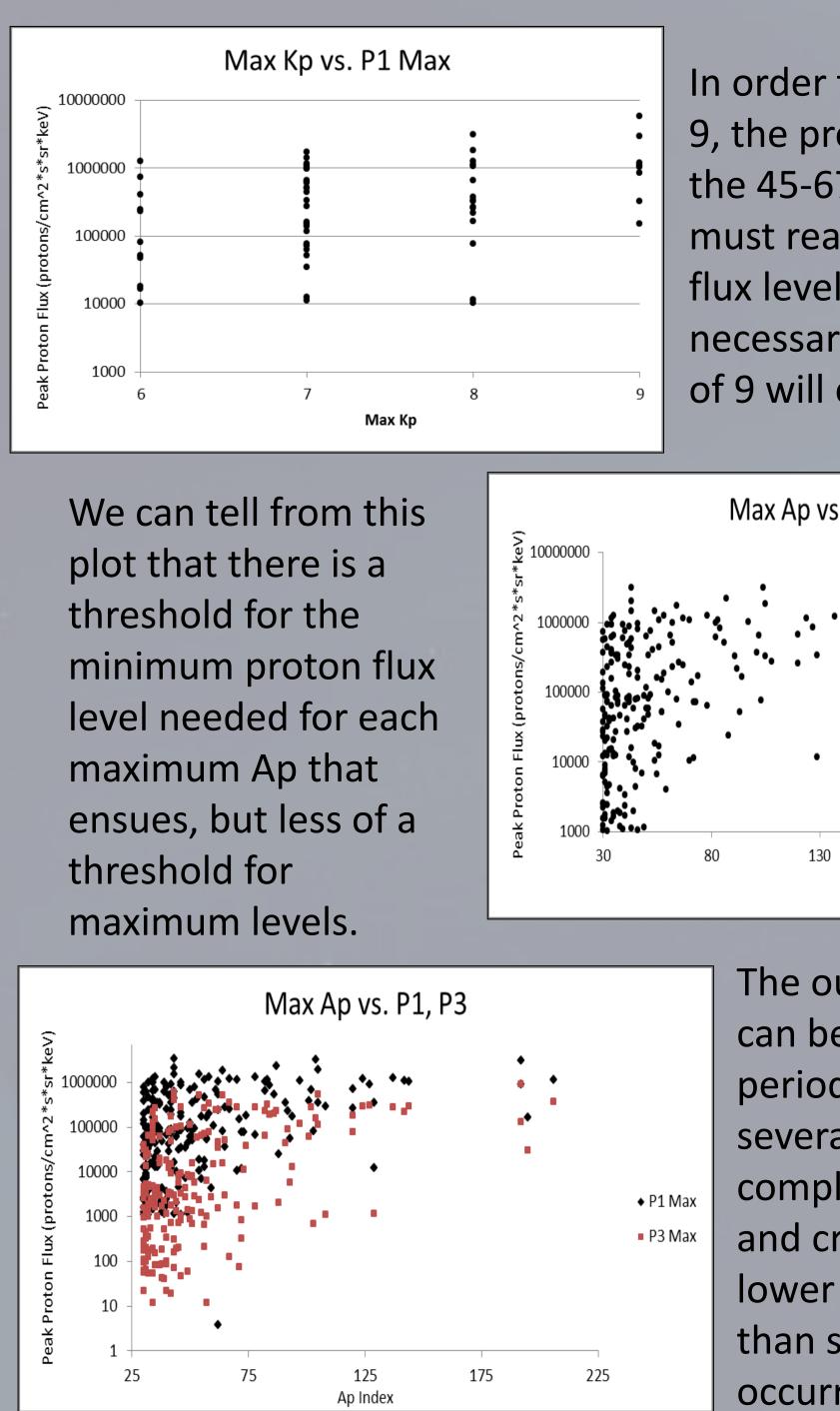


solar wind and coronal activity, geomagnetic activity, region and sunspot summaries, and alerts and warnings for that week.

The most useful information included the forecaster's guess at causative events for geomagnetic activity, and

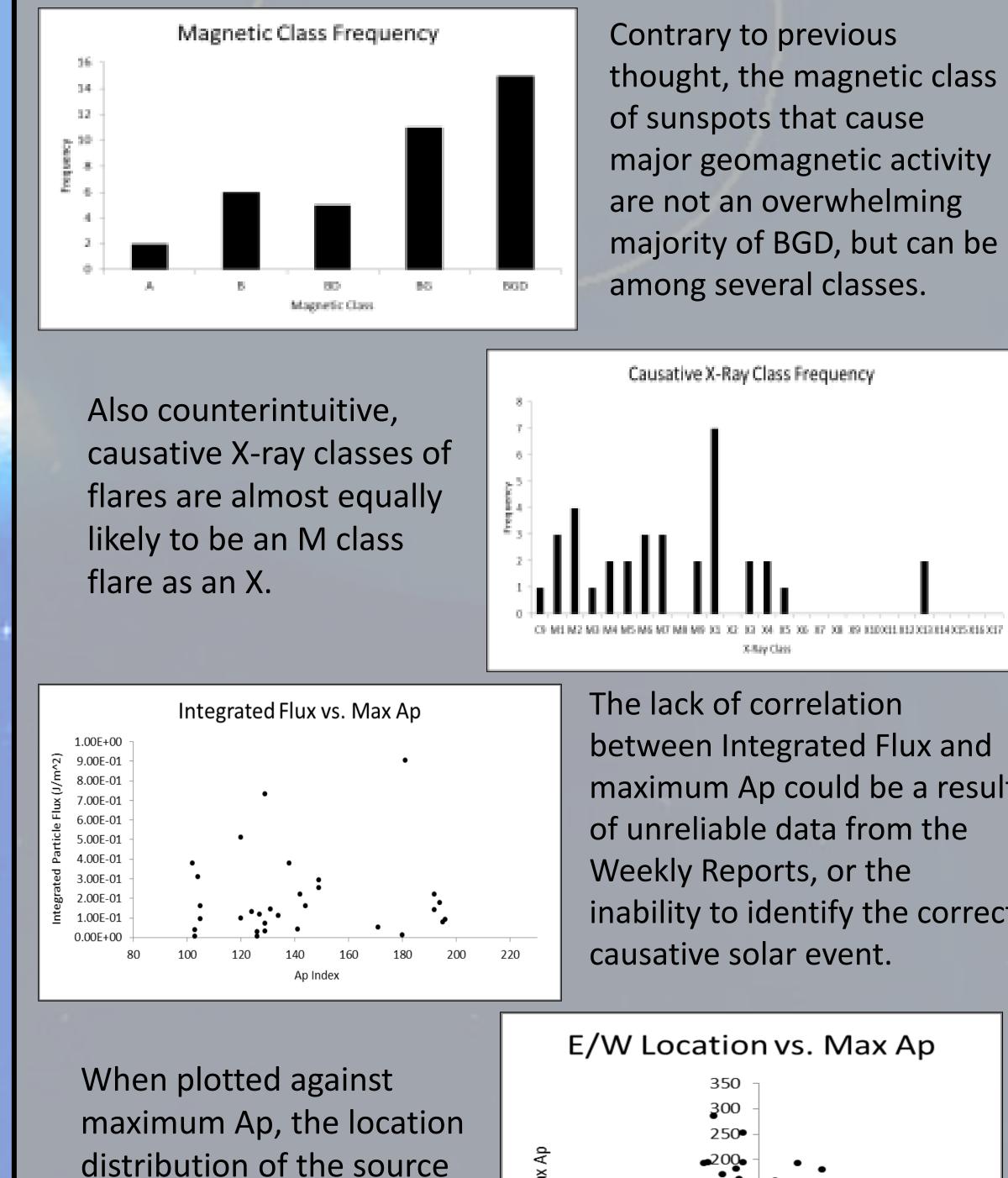
energetic events information such as integrated flux, sunspot number, proton fluences, radio fluxes, and source locations.

Observations/Results:



In order to observe a Kp of 9, the proton flux level for the 45-67 keV channel must reach 1x10⁵, but a flux level of 1x10⁵ does not necessarily mean that a Kp of 9 will ensue.

Observations/Results (Cont.):



region is slightly biased

disk.

toward the East side of the

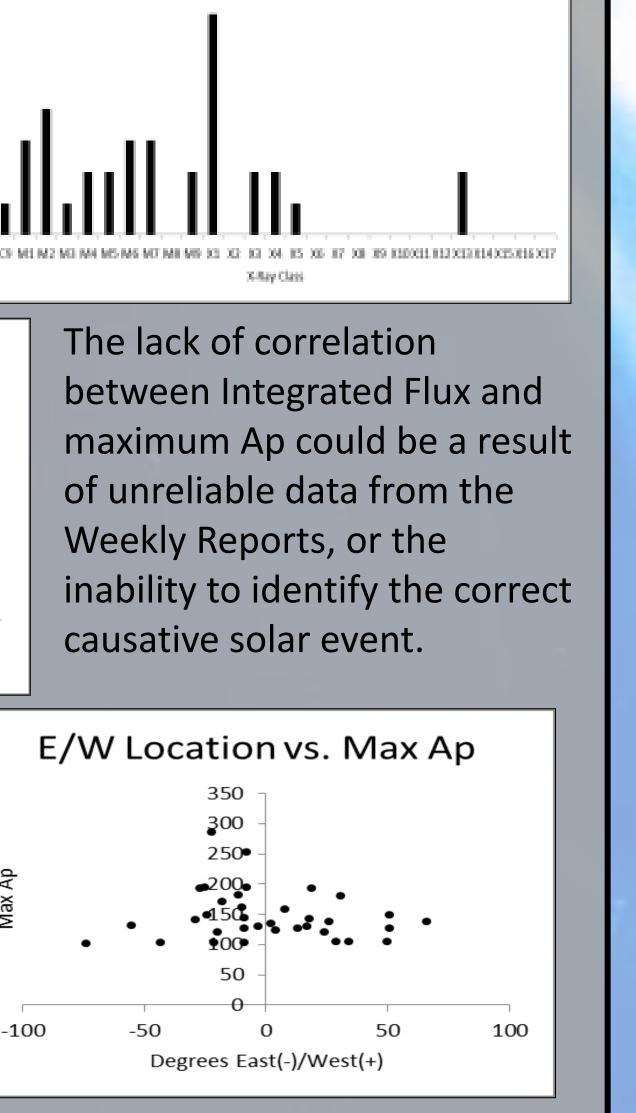
Conclusions:

Based on what was found with the EPAM data, it is necessary for a proton flux of 1x10⁵ to occur in order for a Kp of 9 to be observed, but it cannot necessarily be said that if this level is observed that a Kp of 9 will absolutely ensue. We can also infer that there is a lower threshold that the 45-67 keV and 115-195 keV proton channels must reach in order to produce higher Kps.

Some information is washed out by Ap and ap indices,

Max Ap vs. P1 Max The outliers in this plot can be attributed to a period of time in which several events occurred, complicating EPAM data, and creating a much lower proton flux peak than should have occurred.

Max ap vs. P3 Max •••••



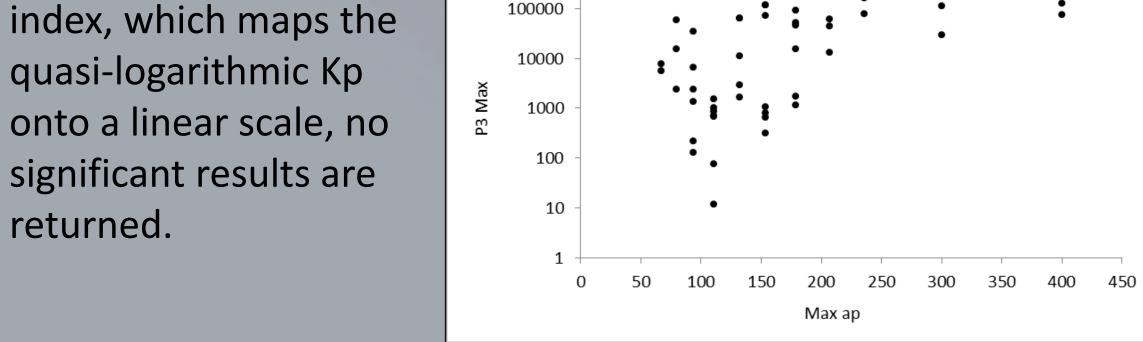
- producing counterintuitive results. Further investigation is needed in order to know which index provides the most useful information.
- Information received from the Weekly Reports, especially prior to 1995, is for the most part unreliable when speaking of causative event predictions.

Future Studies:

More detailed EPAM study:

References:

- Use more data, derive more specific probabilities
- Look further into advantages of specific Kps vs. other indices
- Find more reliable sources for variables such as event duration, xray class, magnetic class, and identified source events
- Is using frequency of Kp 5-9 most helpful?
- Is observing one particular Kp more insightful than observing another?



When using the ap



• Smith, Z.K., Murtagh, W.J., 2009, Solar wind low-energy energetic ion enhancements: A tool to forecast large geomagnetic storms, http://www.sciencedirect.com/science/article/pii/S0273117709004384/(July 30, 2013) www.swpc.noaa.gov <u>http://science.nasa.gov/heliophysics/</u>