

The Flare Productivity of Solar Active Regions

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Flares and Active Regions

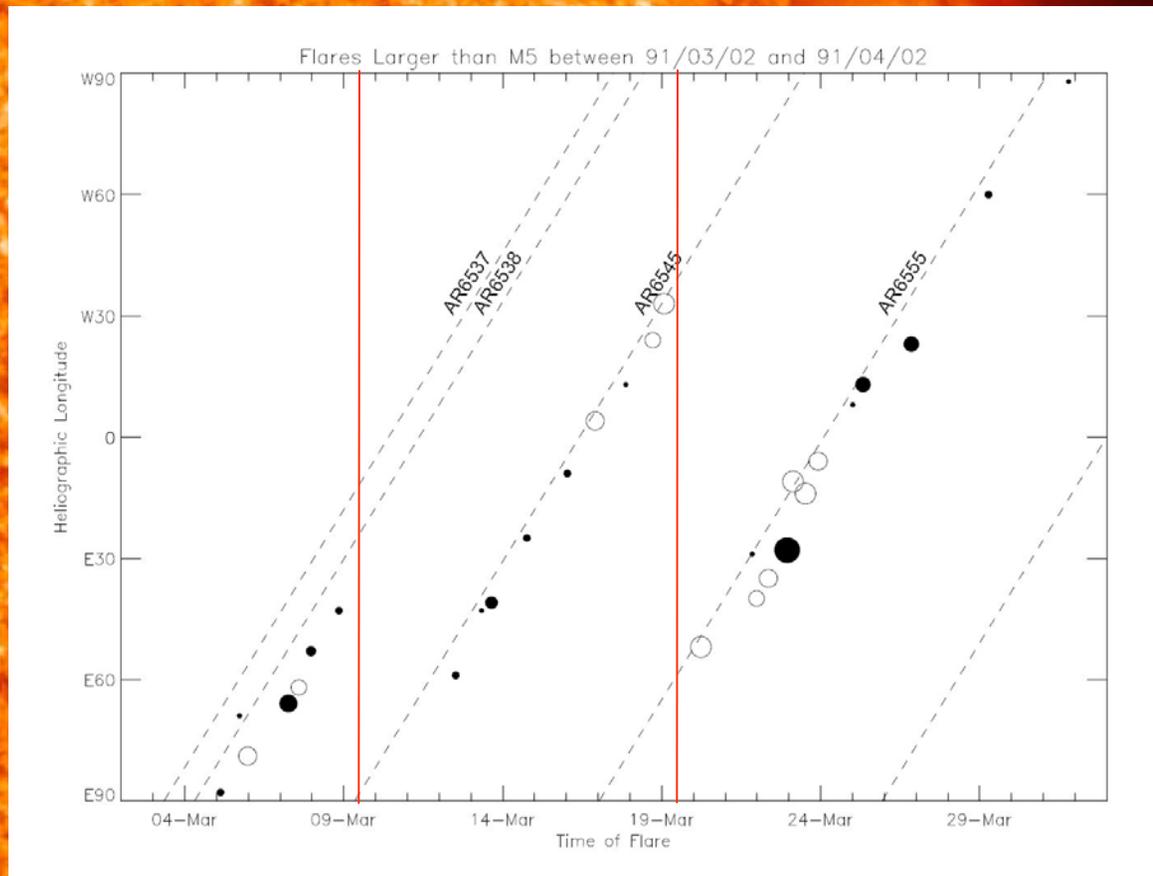
The background of the slide is a high-resolution image of the solar corona. It features a prominent, bright, and complex active region. This region is characterized by intense, swirling magnetic field lines that create a turbulent, multi-colored appearance ranging from deep red to bright yellow and white. A central, particularly bright and intense area within this region indicates the site of a solar flare. The surrounding corona is less intense, showing a more uniform, reddish-orange glow with some faint, radial structures.

Solar flares are releases of electromagnetic energy from the solar corona. They are believed to occur as a result of shedding excess magnetic energy during the process of magnetic reconnection.

Flares are produced in active regions, areas of intense, complex magnetic field in the solar corona.

Global Corona

Although flares are produced by local processes, there is some interaction between active regions. Patterns such as shown in the plot suggest the possibility that active regions can be influenced by the behavior of other active regions.



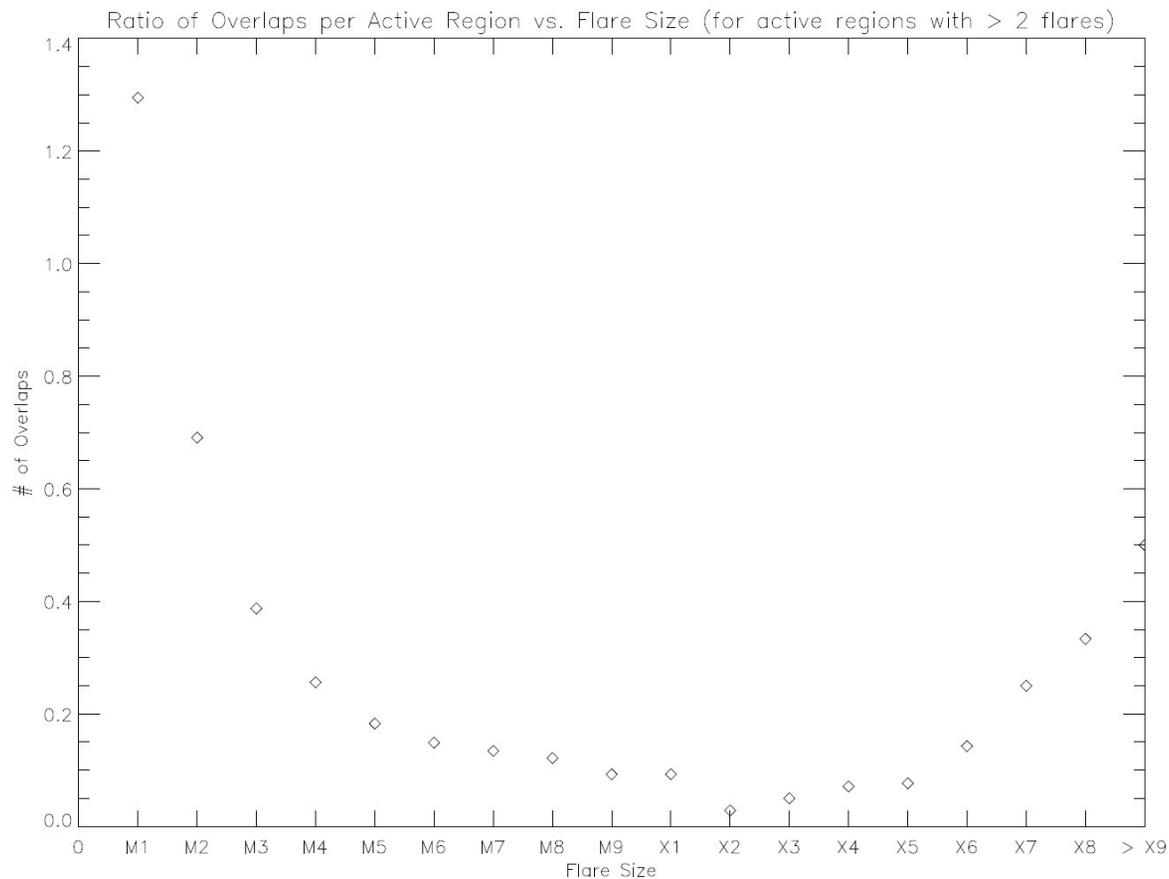
In fact, it appears in several such cases that only one active region produces large flares (here defined as $> M5$) at a particular time.

Preliminary Analysis

- Full-Sun x-ray flare data from the NOAA GOES satellite over the past 33 years was used to investigate active regions over that period
- Position, active region of origin, magnitude, and time of each flare for which all data is present was gathered to summarize solar activity
- Few periods exist in which there are multiple highly productive active regions on the disk at once; of those, some show the pattern of interest while in other cases it is broken. Whether the pattern is evident depends on the minimum flare size considered, minimum activity considered,

Flare Overlaps

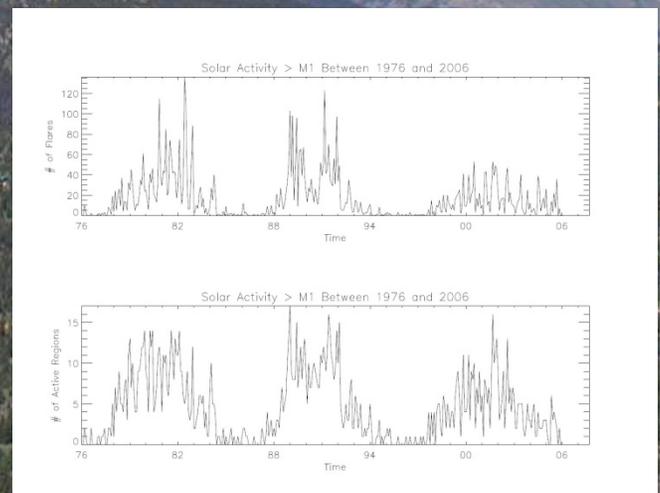
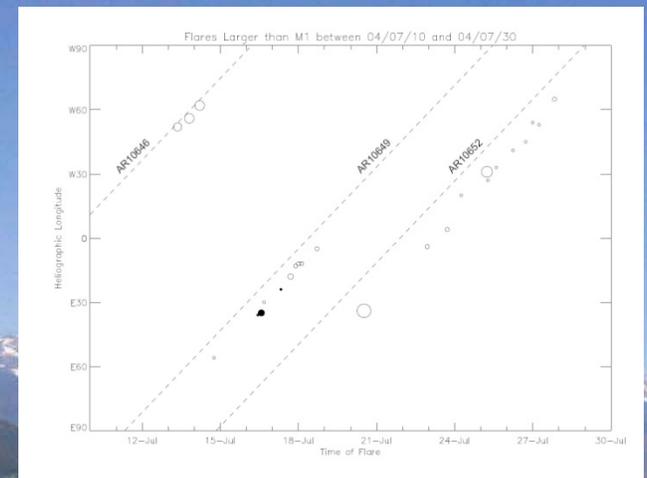
- Overlaps are defined as when an active region produces a flare after the next region has started producing



Study Outlook

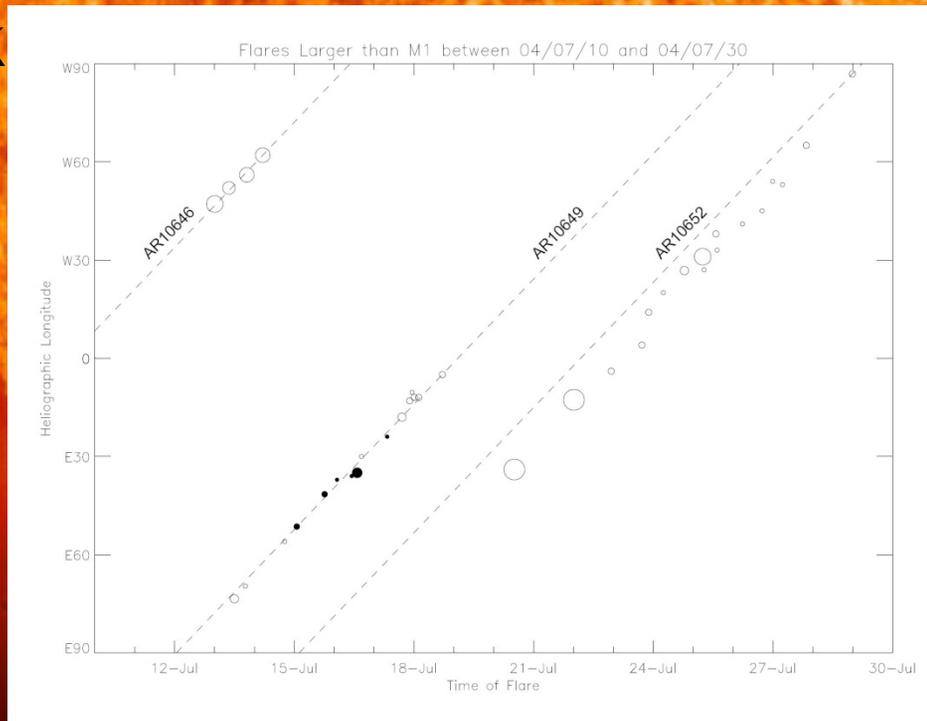
After examining the preliminary data, we have identified three potential areas for investigation

- **Statistical Study:** Use the flare data gathered to investigate the idea of a flare production pattern
- **Case Study:** Choose several interesting periods featuring multiple cotemporaral highly productive active regions and look for correlations in their behavior
- **Cycle Study:** Long-term dataset allows us to study cycle dependence of flare productivity in active regions.



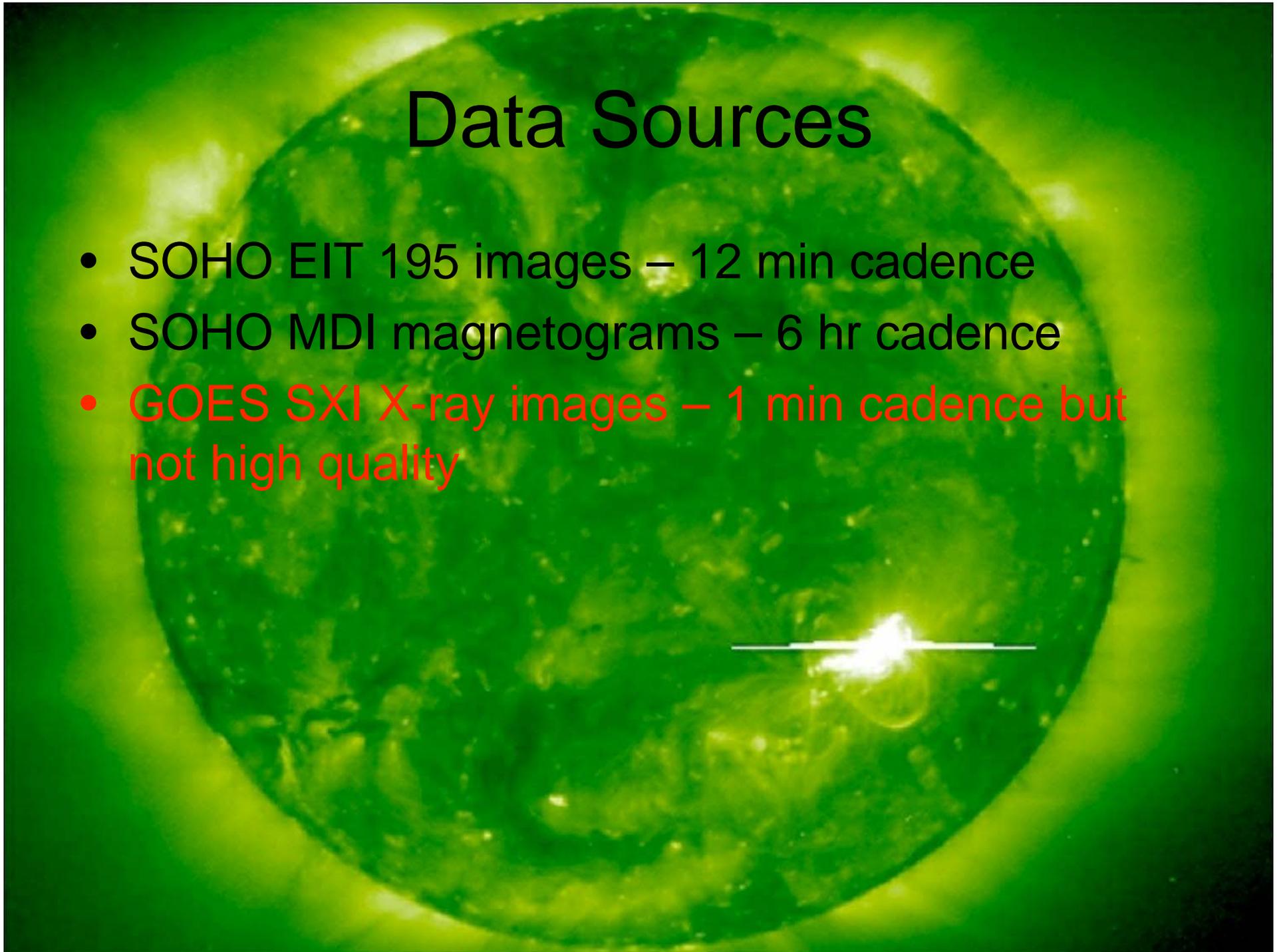
Case Study

- Set of highly productive active regions in July 2004:
 - AR 10646, 10649, 10652 (large flare producers); also 10653
- Exhibits pattern down to M1
- Look at active regions

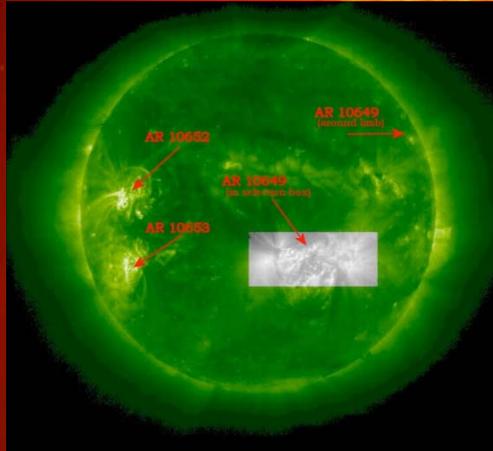


Data Sources

- SOHO EIT 195 images – 12 min cadence
- SOHO MDI magnetograms – 6 hr cadence
- GOES SXI X-ray images – 1 min cadence but not high quality

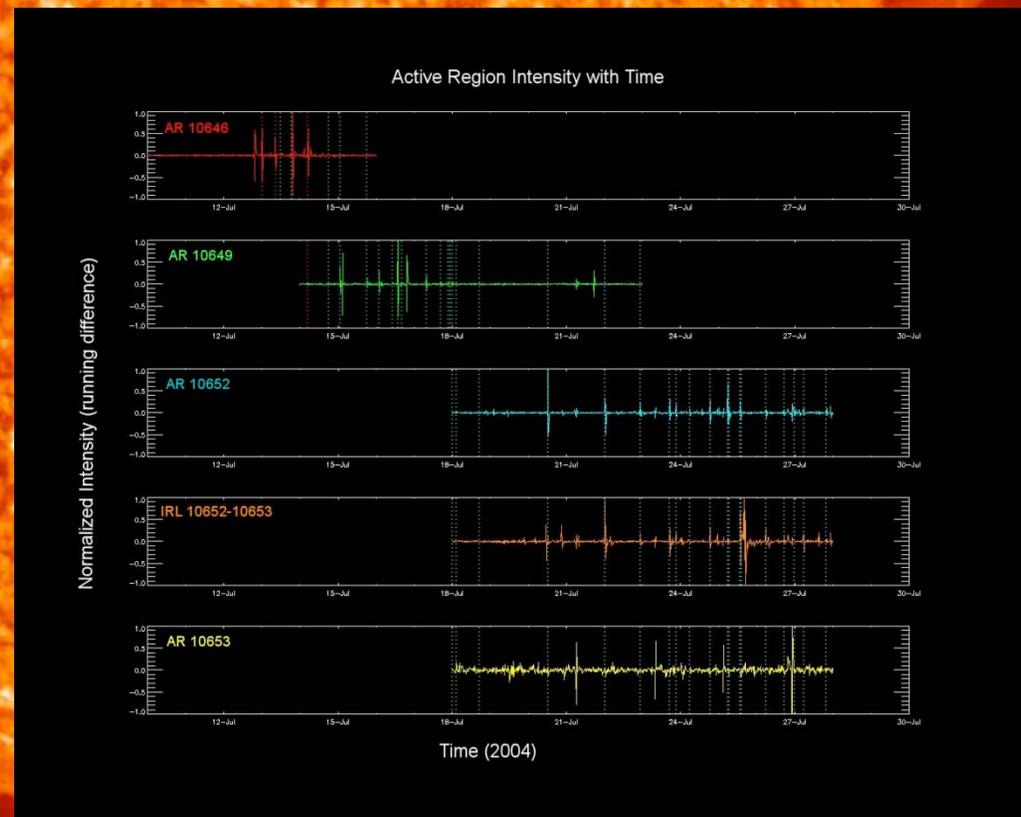


Analyzing EIT



- Rectangular ROI drawn around each active region – tracked with solar rotation and taken from each image

- Each ROI image had the previous image subtracted (running difference) and the intensity integrated over the resulting image



Correlations

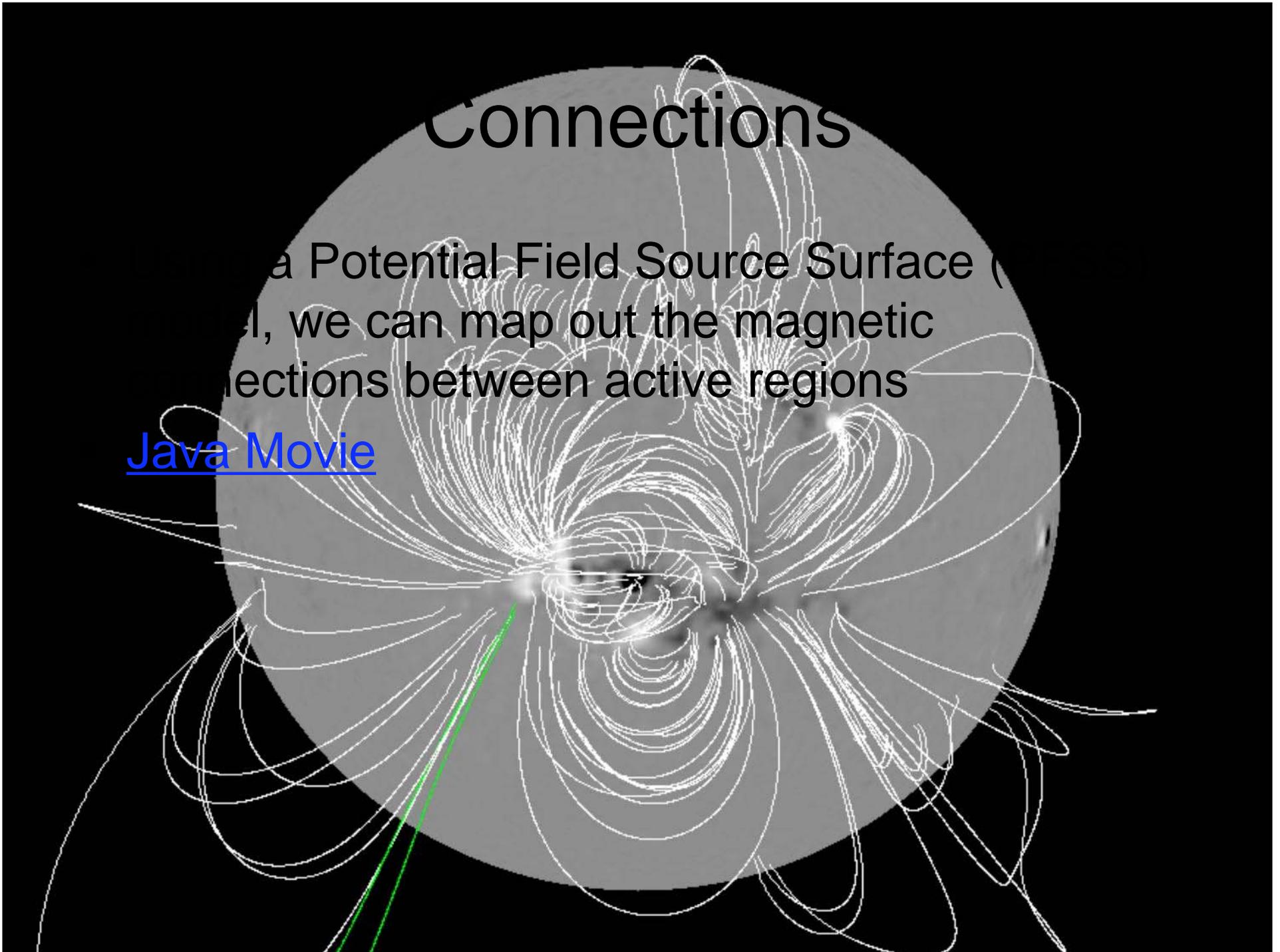
- Preliminary correlation analysis done on intensity sequences to look for responses to flaring between active regions
- Results are show low correlation but include the entire range, which has a negative influence on correlation
- From the intensity plot and from EIT images, there is definitely connection between AR 10652 and AR 10653

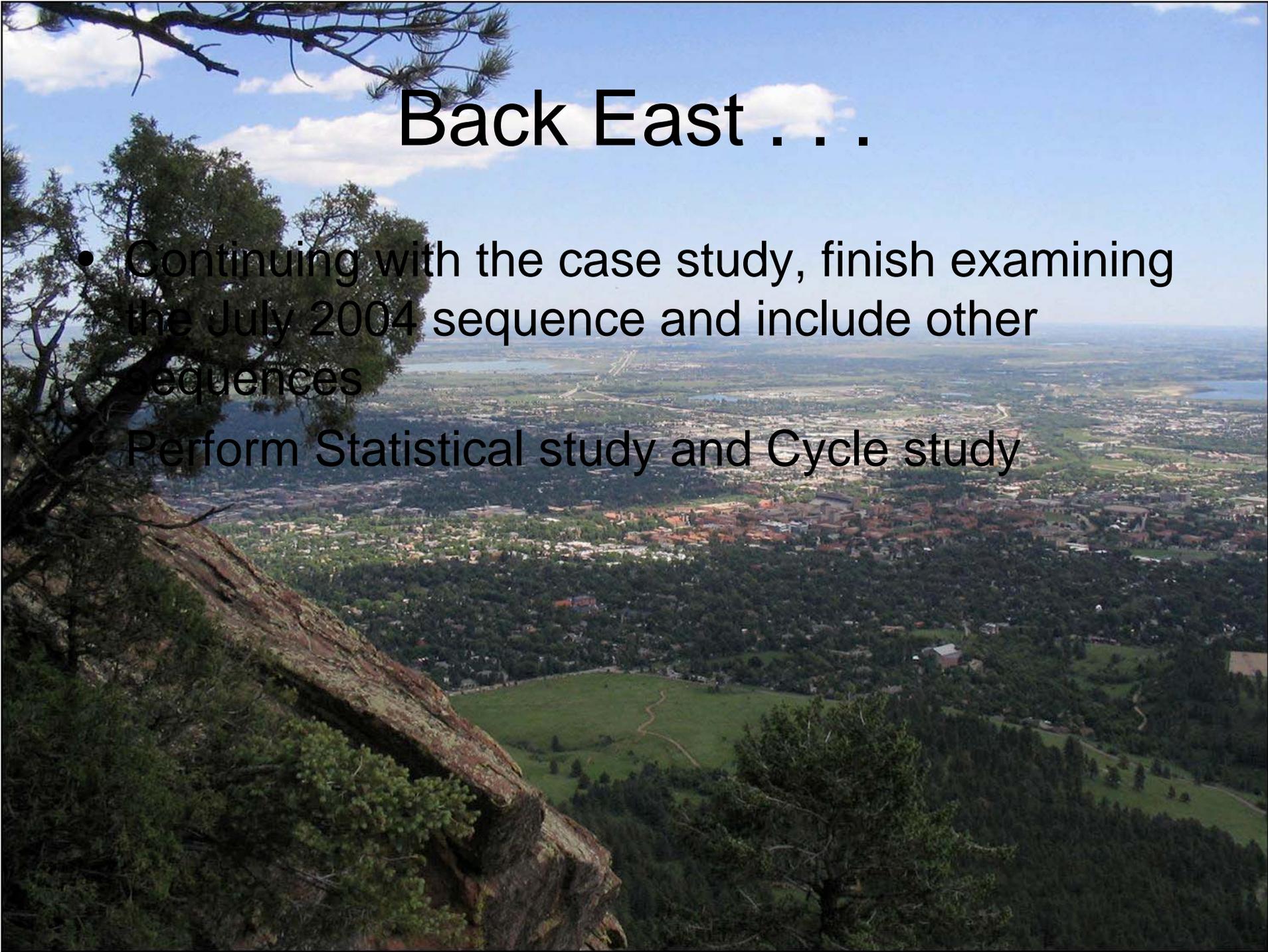
AR#	Correlation Coefficient
10646 - 10649	0.3523
10649 - 10652	0.0911
10649 - 10653	0.2467
10652 - 10653	0.3050

Connections

Using a Potential Field Source Surface (PFSS) model, we can map out the magnetic connections between active regions

[Java Movie](#)





Back East . . .

- Continuing with the case study, finish examining the July 2004 sequence and include other sequences
- Perform Statistical study and Cycle study

The End



The Beginning

