The flare productivity of active regions

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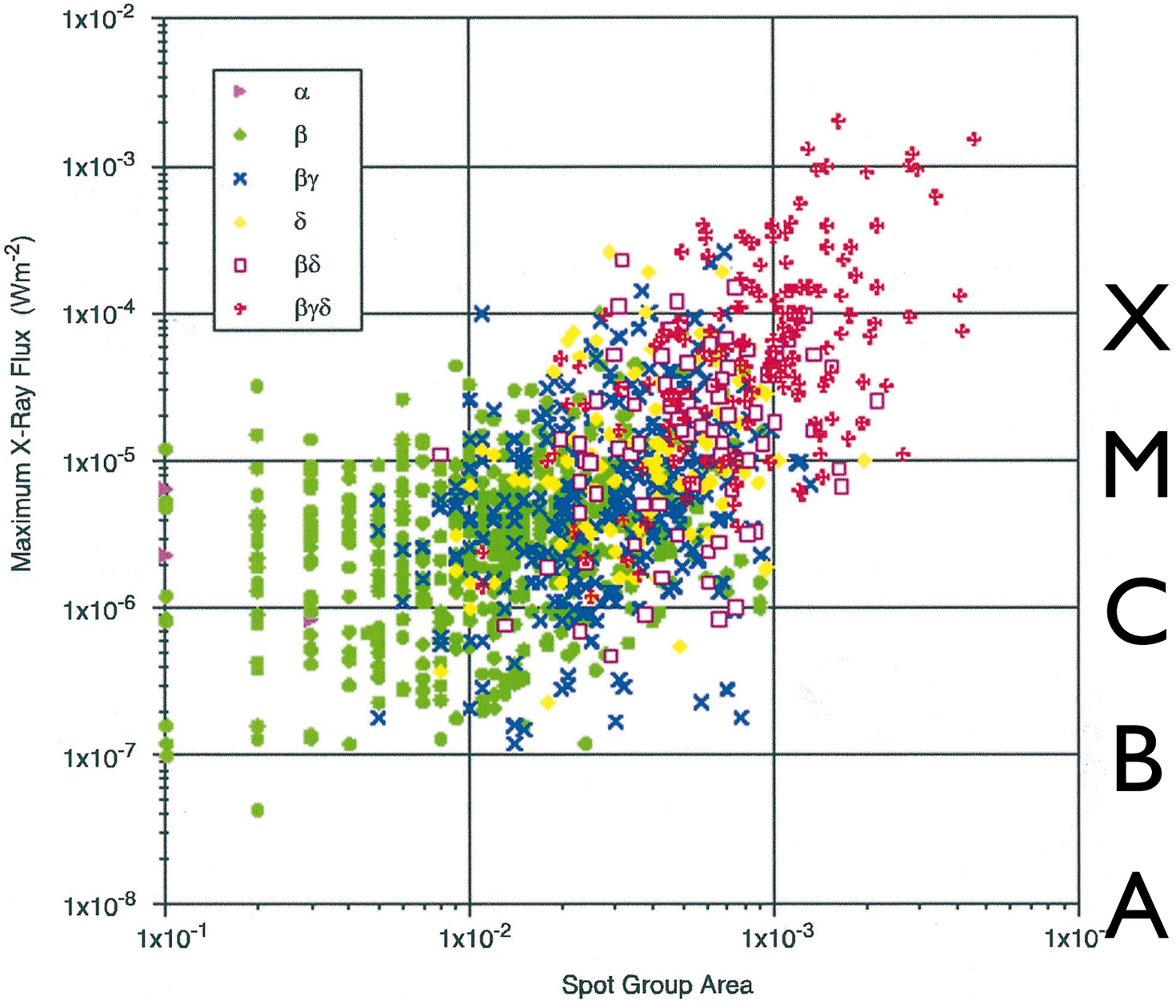
Motivation



X

M

C

B

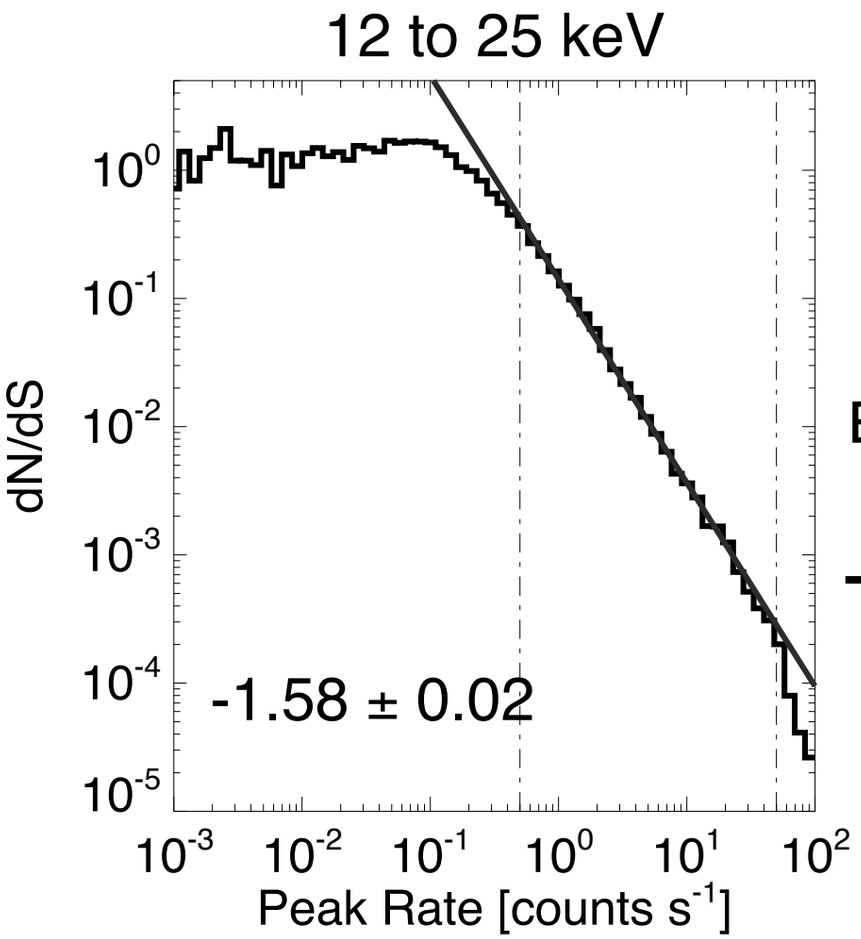
A

(Sammis et al., 2000)

- Regions of higher magnetic complexity are known to produce large flares
- More than 80% of X class events occurred in βγδ and δ spots
- The magnetic complexity of a region plays important role in flare production

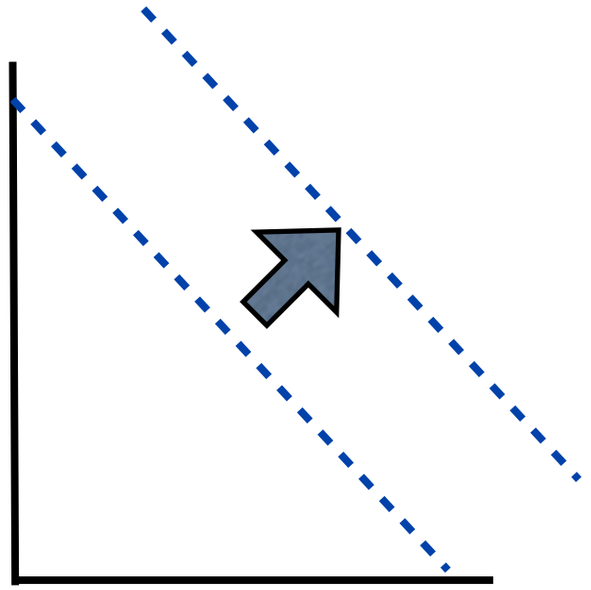
Goal

- How could regions with higher magnetic complexity produce more large flares?

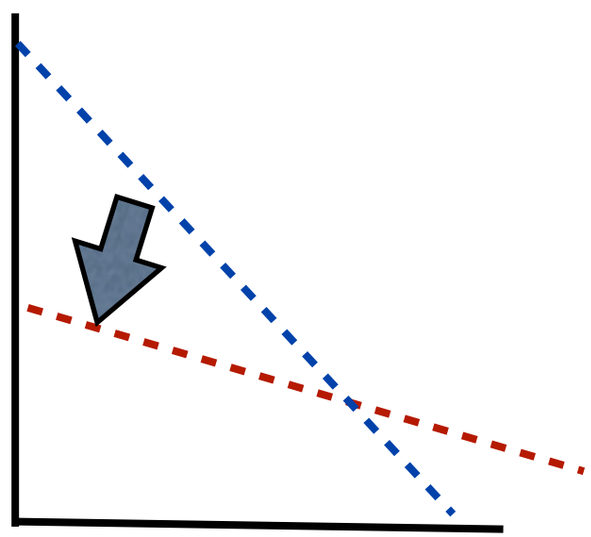


Combined plot

Bin by magnetic properties...



"Parent distribution"?

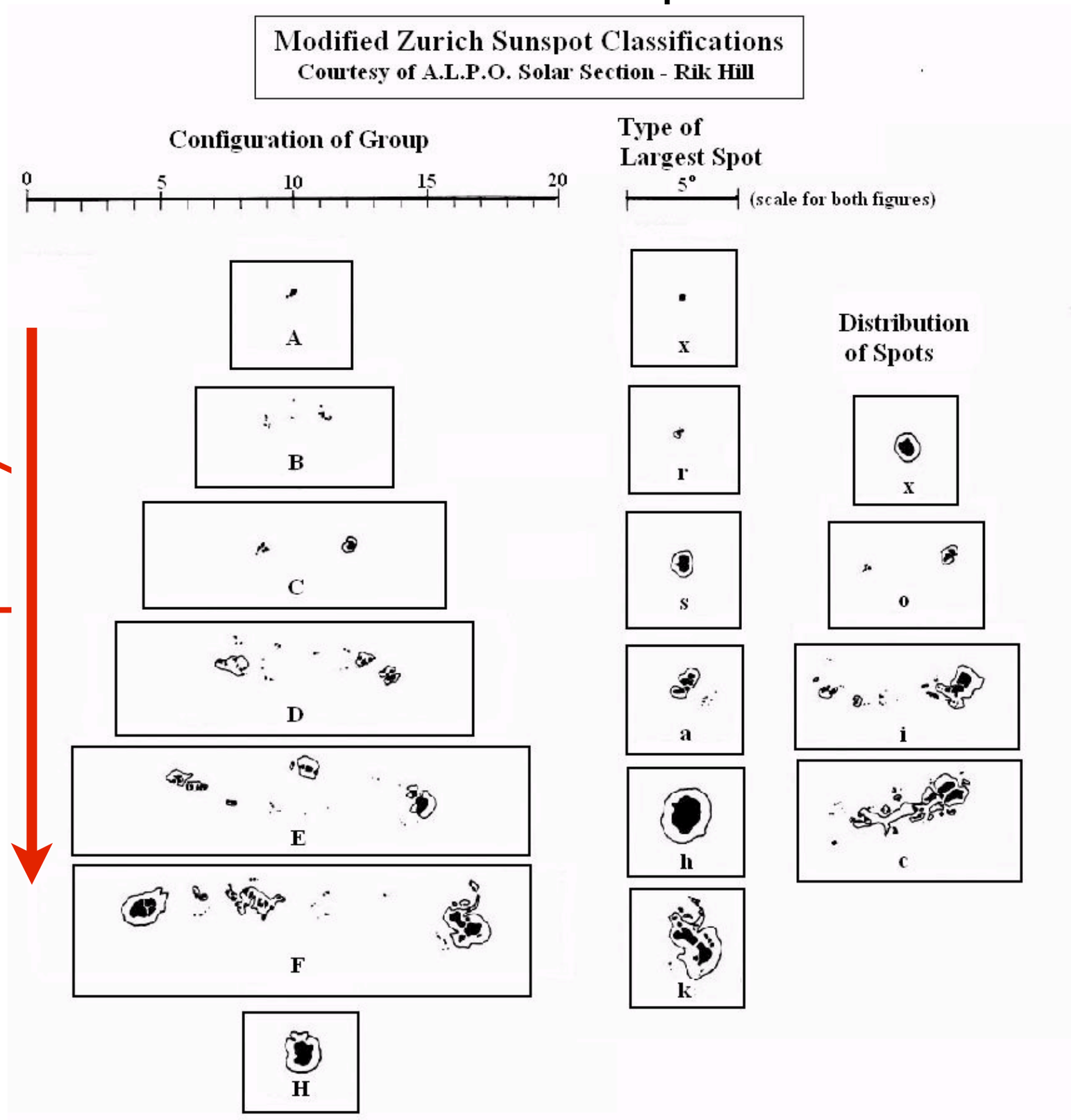


Change in the slope?

Data

- RHESSI microflare list (below GOES C class, 25,006 events): flare start time, end time, peak time, position (arcsec), peak count rate (background subtracted)
- Active region information(Solar Region Summary by NOAA/SWPC): NOAA number, location, area (μ-hs), Zurich/ McIntosh Sunspot Classification, Mount Wilson Magnetic Classification

AR magnetic properties:
Zurich/McIntosh Sunpost Classification (McIntosh, 1990)



- **Configuration of Group**: whether penumbra is present, how penumbra is distributed, the length of the group

- **Type of Largest Spot**: type of penumbra, size of penumbra, symmetry of penumbra and umbrae within that penumbra

- **Sunspot Distribution**: the relative spottedness in the interior of a sunspot group

AR magnetic properties:
Mount Wilson Magnetic Classification

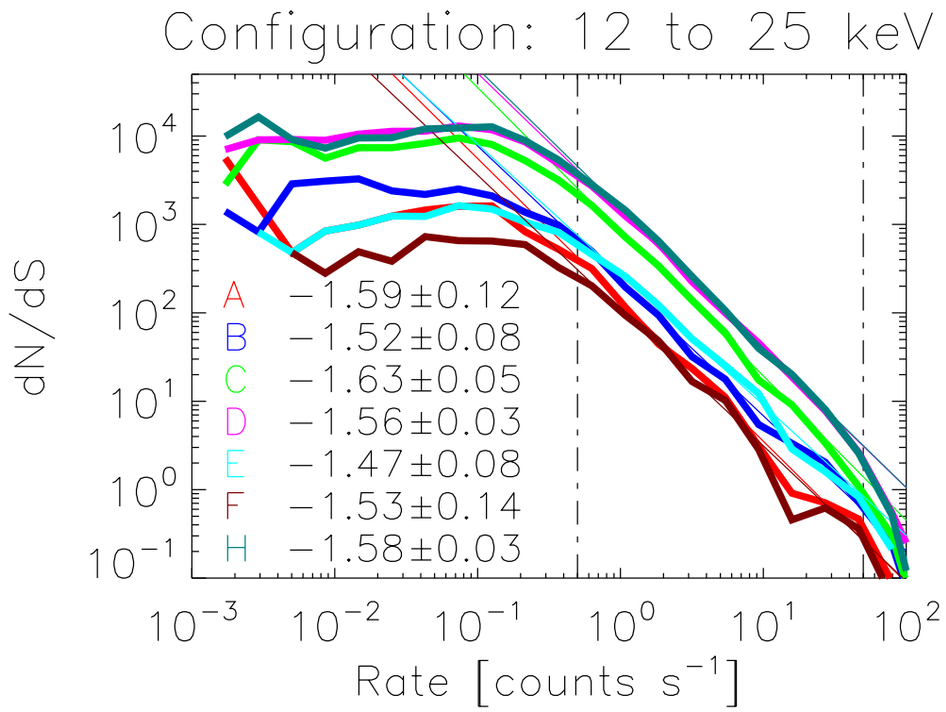
Complexity

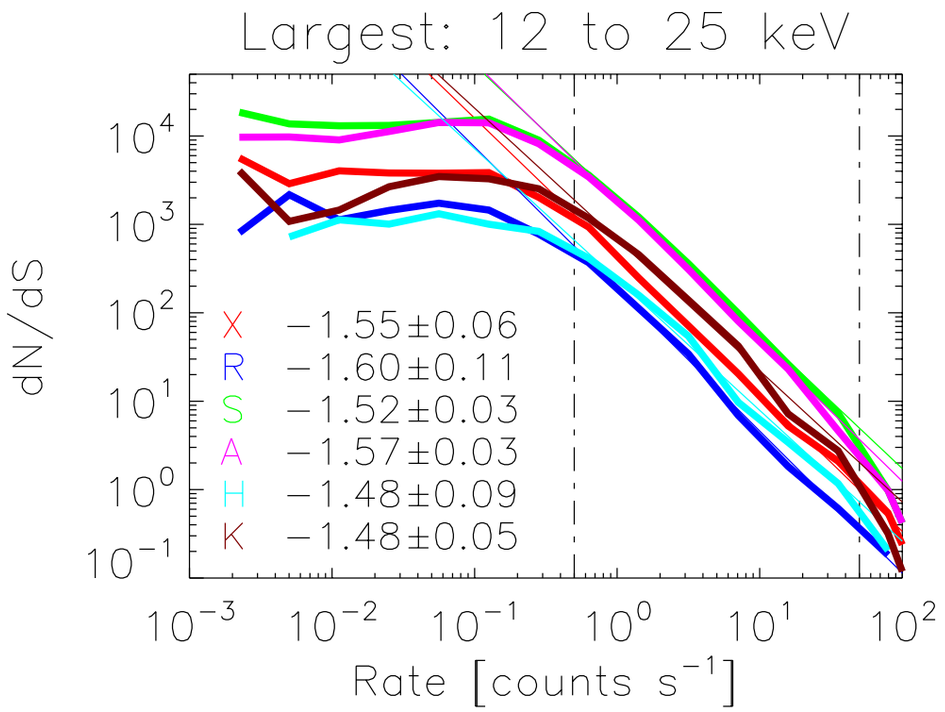
- α: A unipolar sunspot group
- β: A bipolar group with a simple and distinct division between the polarities
- γ: A complex AR in which the positive and negative polarities are so irregularly distributed as to prevent classification as a bipolar group
- βγ: A sunspot group that is bipolar but in which no continuous line can be drawn separating spots of opposite polarities
- δ: A complex magnetic configuration of a sunspot group consisting of opposite polarity umbrae within the same penumbra
- βγδ: A sunspot group of βγ but containing one or more δ spot

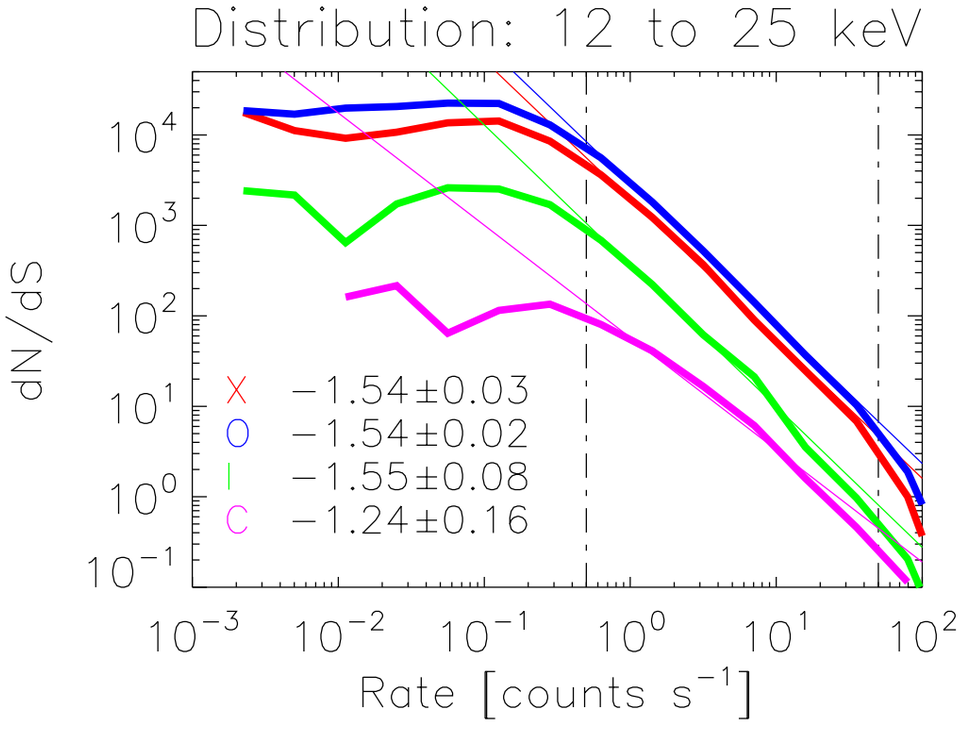
Methodology

- Find the closest AR for each flare (778 AR)
- Plot & fit slopes for the frequency distribution of peak count rate in 12-25 keV range, binning by AR magnetic classification

Results: Frequency distribution vs. Zurich/McIntosh Sunspot Classification

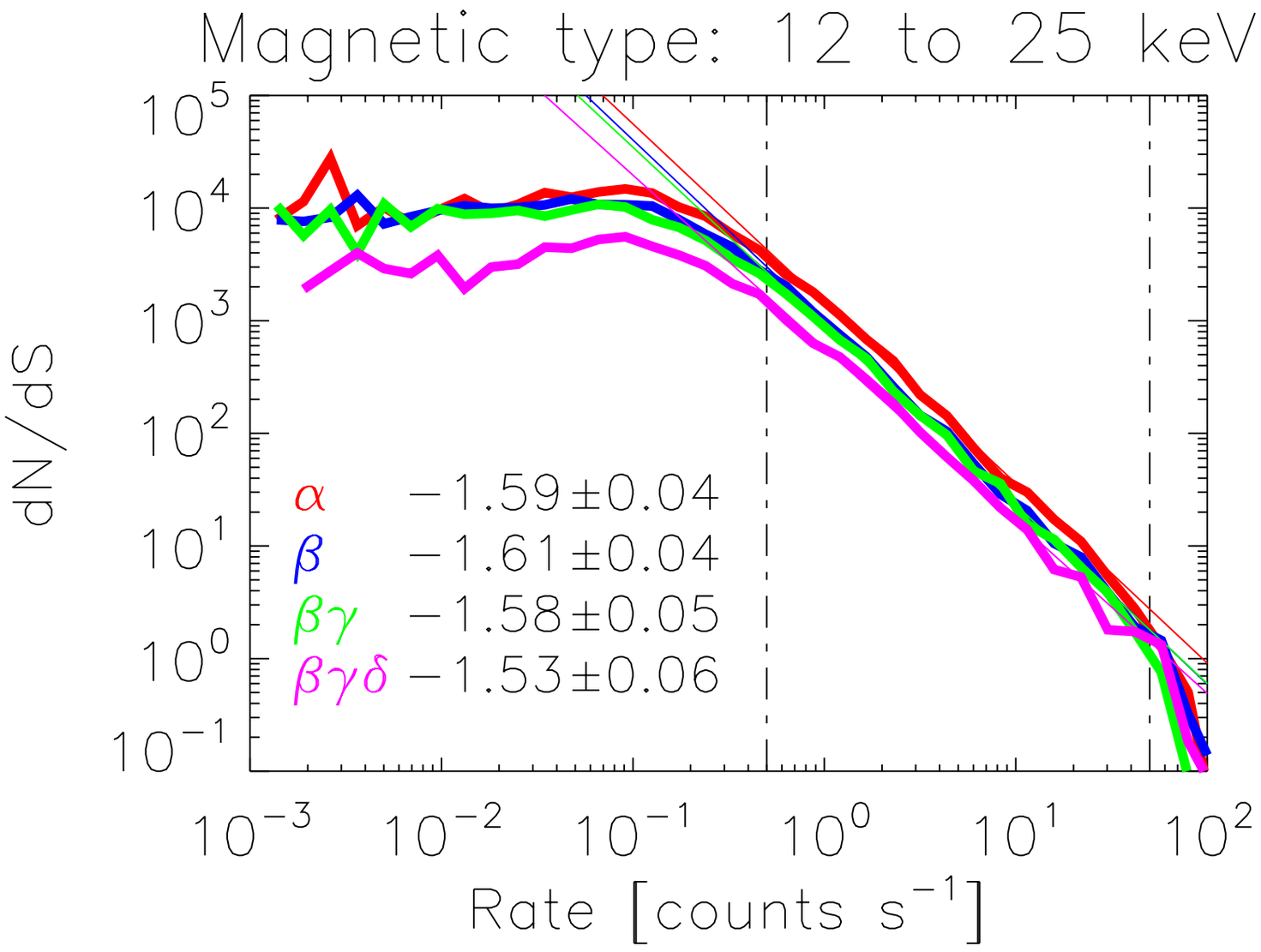






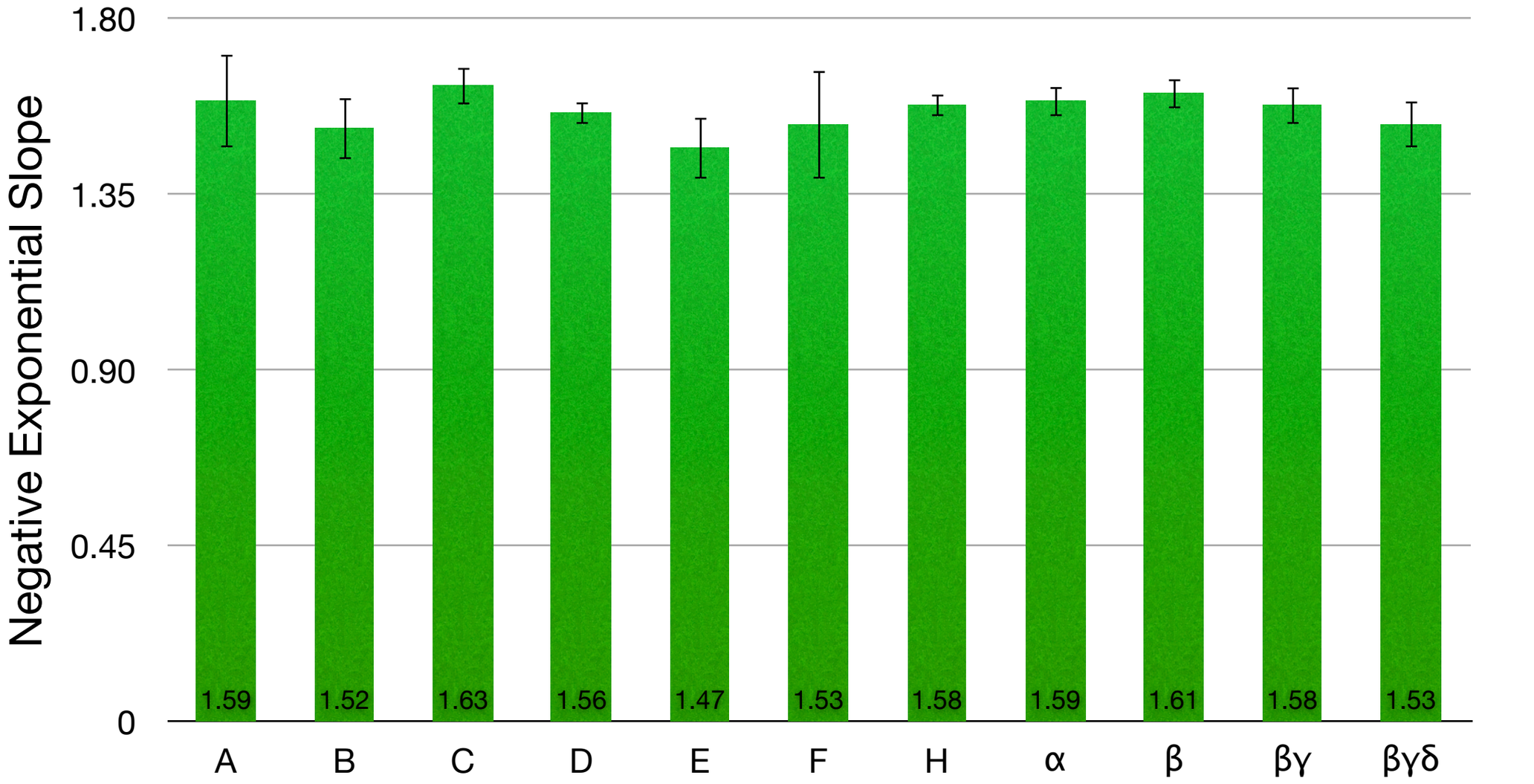
No significant changes in slopes

Results: Frequency distribution vs. Mount Wilson Magnetic Classification



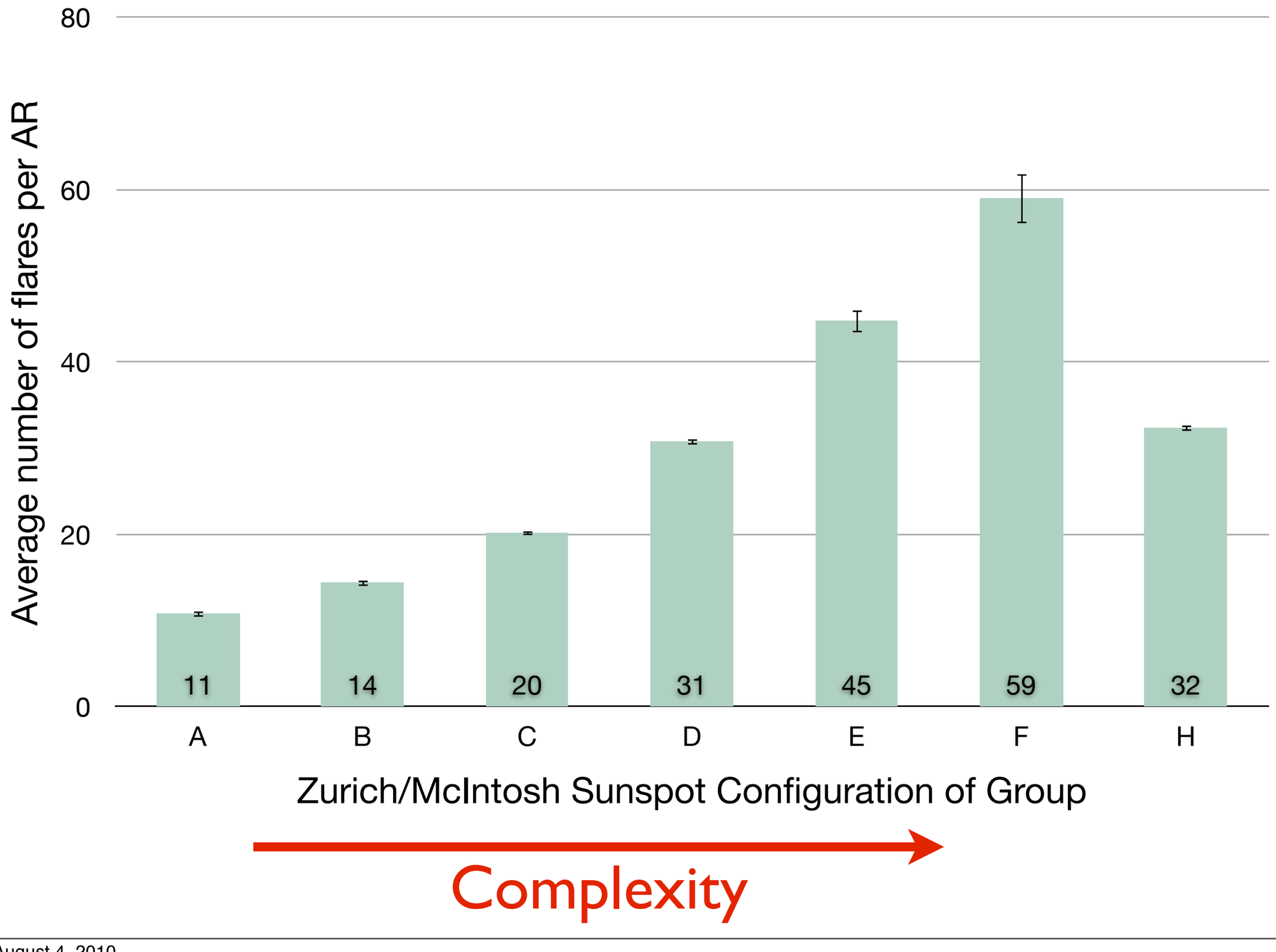
Again, no significant changes in slopes

Slope comparison & Summary



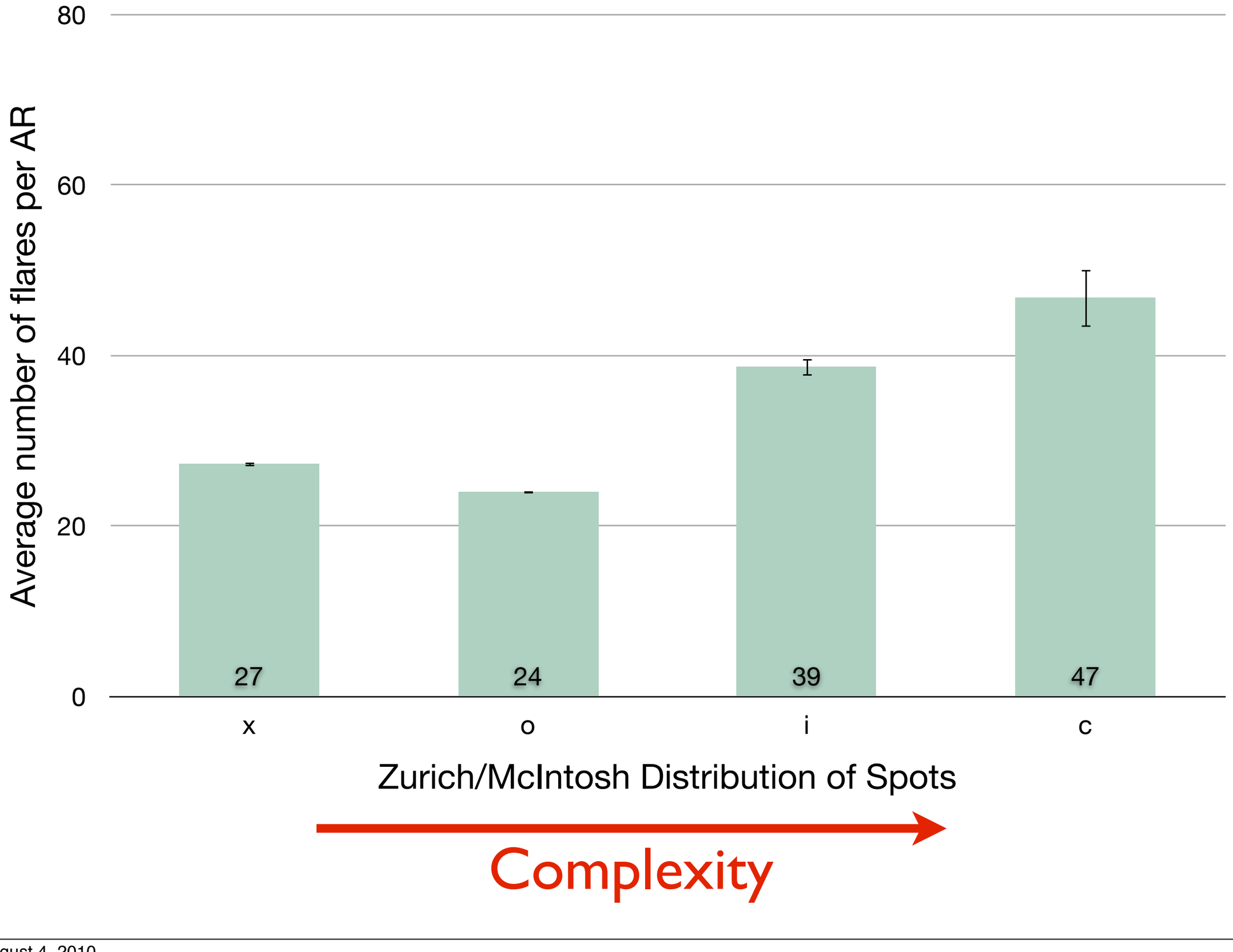
AR magnetic class does NOT affect the shape of flare frequency distribution

Results: Flare productivity vs. Zurich/McIntosh Sunspot Configuration of Group

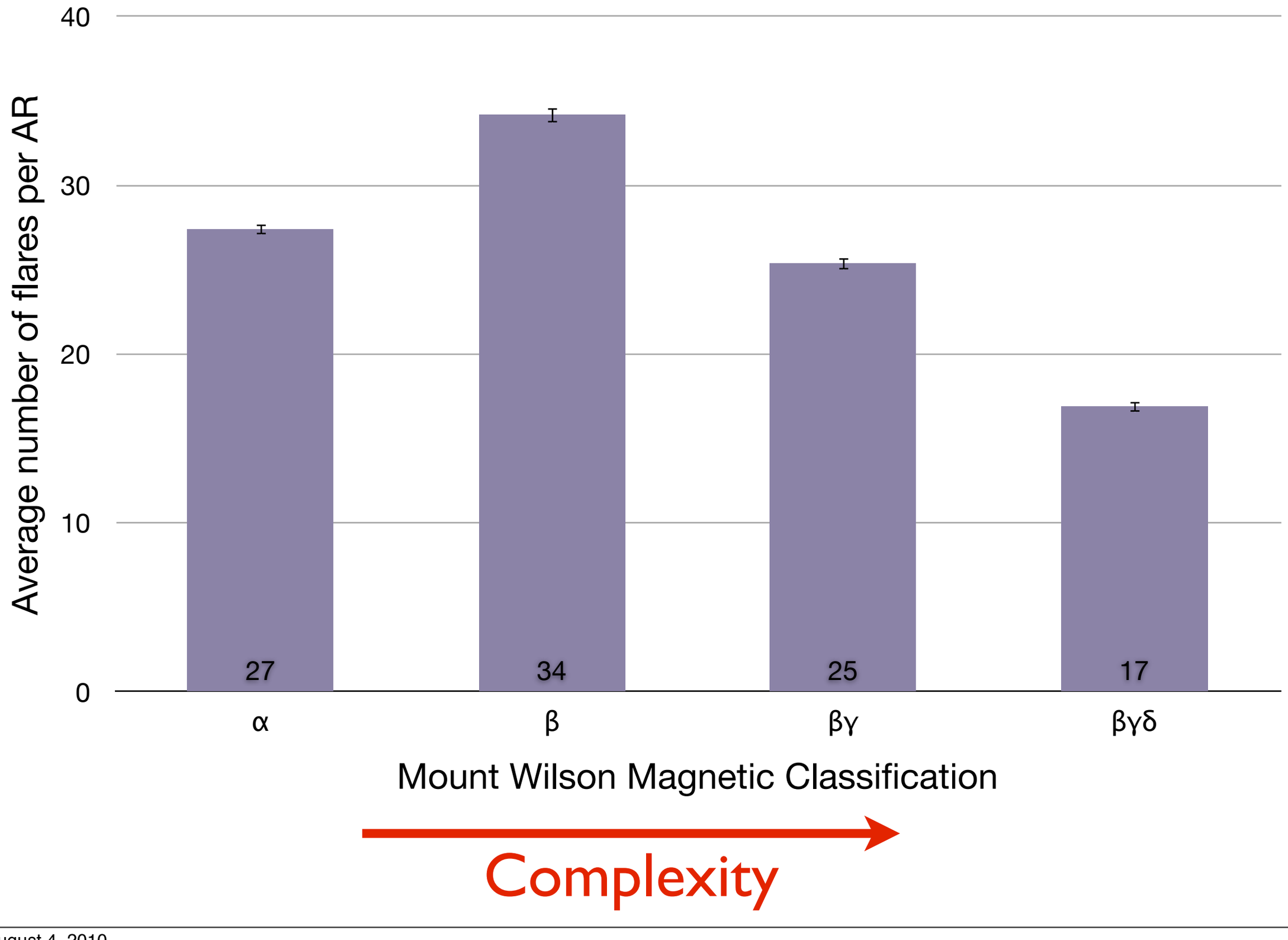


Results: Flare productivity vs. Zurich/McIntosh Type of Largest Spot

Results: Flare productivity vs. Zurich/McIntosh Distribution of Spots



Results: Flare productivity vs. Mount Wilson Magnetic Classification



Conclusions

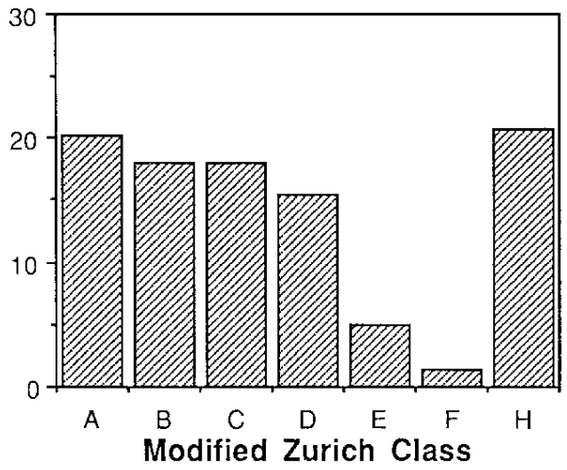
- There is no change in the slope as a function of magnetic complexity: there may be "parent distribution" of flare frequency that is a fundamental property for every AR
- It is still possible but unlikely that there is a break up in flare distribution for flares larger than C class
- Zurich/McIntosh Classification may be more appropriate measure of magnetic complexity for microflare productive regions

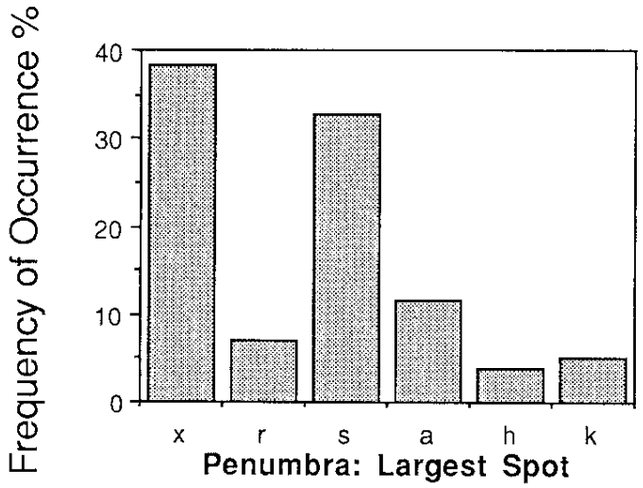
Next step

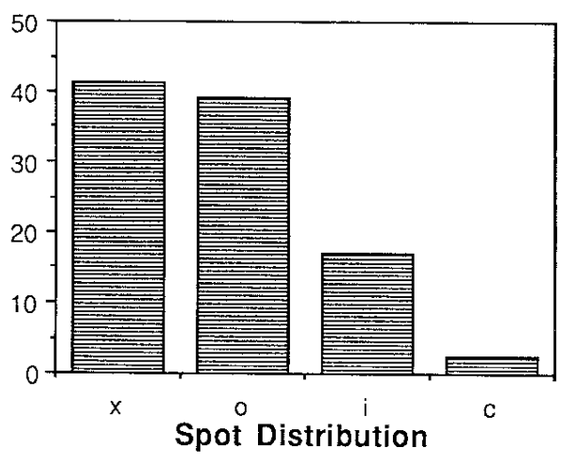
- Investigate further by using MDI magnetograms: total unsigned flux, average AR magnetic field strength, Schrijver's R value, potential magnetic energy

Additional slides

Frequency of AR Occurrence







McIntosh, 1989