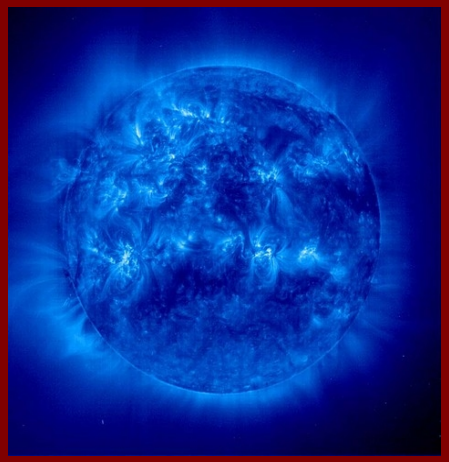
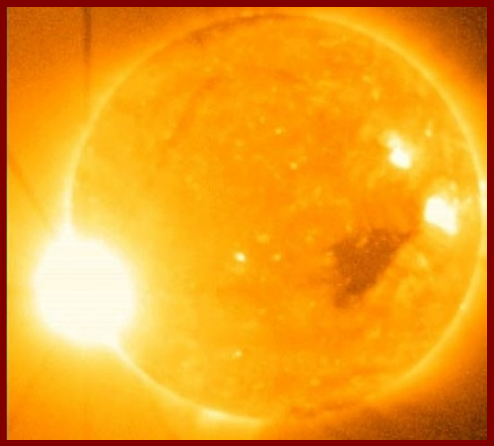
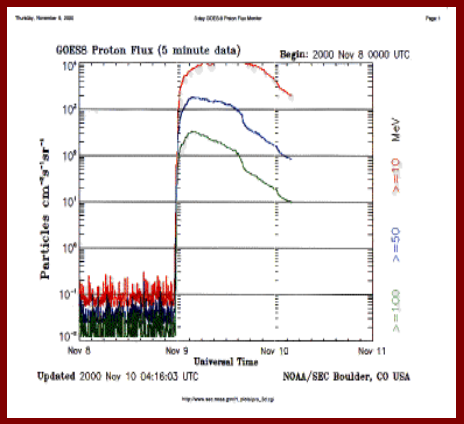






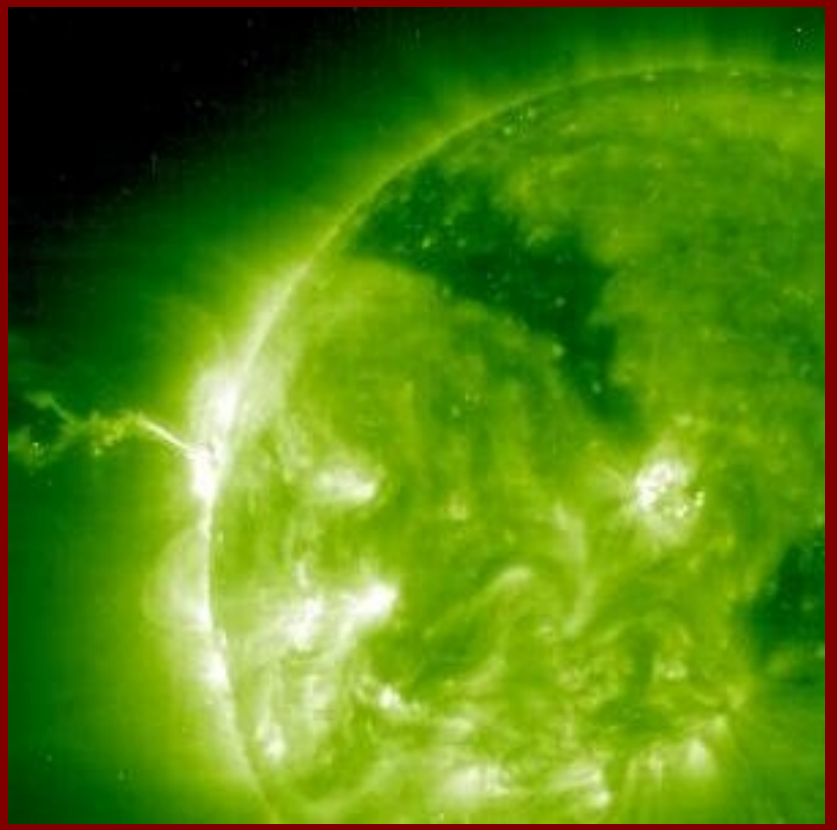
Statistical Prediction of Solar Flares Using Line of Sight (LOS) Magnetogram Data

Jacinda Knoll

Mentors: K.D. Leka and Graham Barnes

Outline

- Importance of Solar Flare Prediction
- Data and Method Used
- Special Considerations
- Data Preparation
- Results
- Summary
- Areas for Further Research



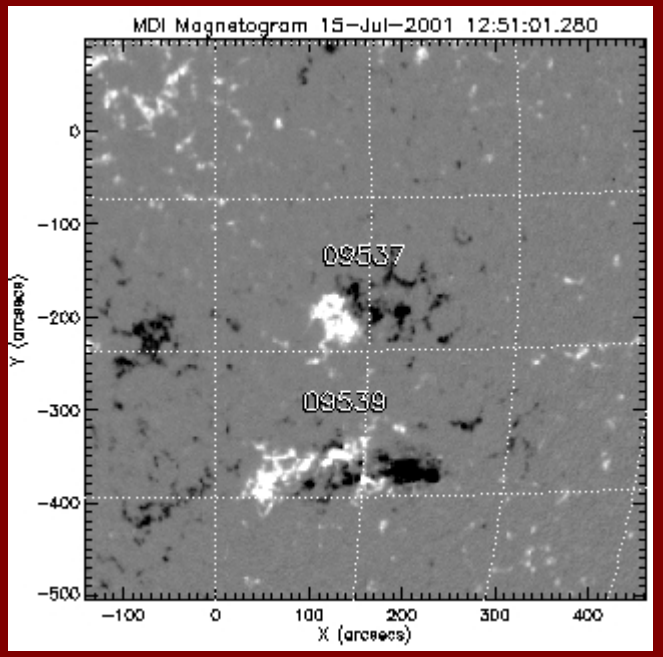
Importance of Solar Flare Prediction

- Cannot “Now-Cast” as effects travel at speed of light
  - Cause damage at same time as detection
- Satellite disruption
- Astronaut Safety
- X-Ray radiation alters ionosphere
  - Loss of communication
    - Especially in short-wave bands

Flight over the North Pole

Data and Process

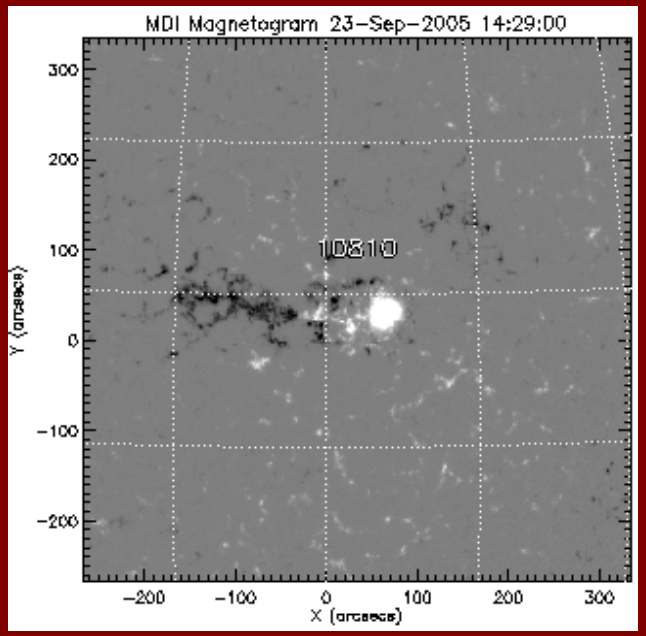
- Data Being Used
  - MDI Line of Sight (LOS) Magnetogram Data
  - Observations from 1996-2004
  - 204 x 204 pixel images centered on every active region observed
- Statistical Technique
  - Discriminant Analysis
    - Same technique being used for the IVM data

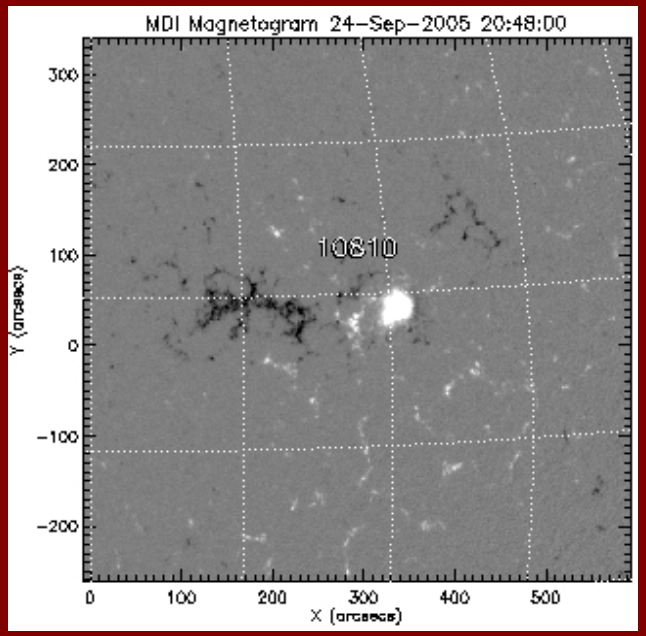


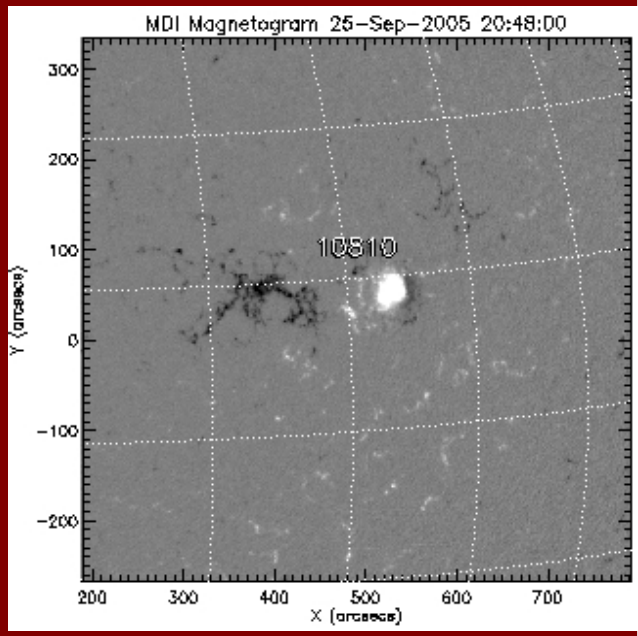
Special Considerations: LOS Data

- Advantages
  - Nearly 20,000 raw data points, with between 6,000 and 10,000 points with good data
  - Large sample sizes needed for statistics (especially non-parametric)
- Disadvantages
  - Cannot calculate many of the parameters available for vector magnetogram data (e.g. J_z, H_c, ψ_{NL})
  - Data further from disc center less reliable due to observing angle correction factor

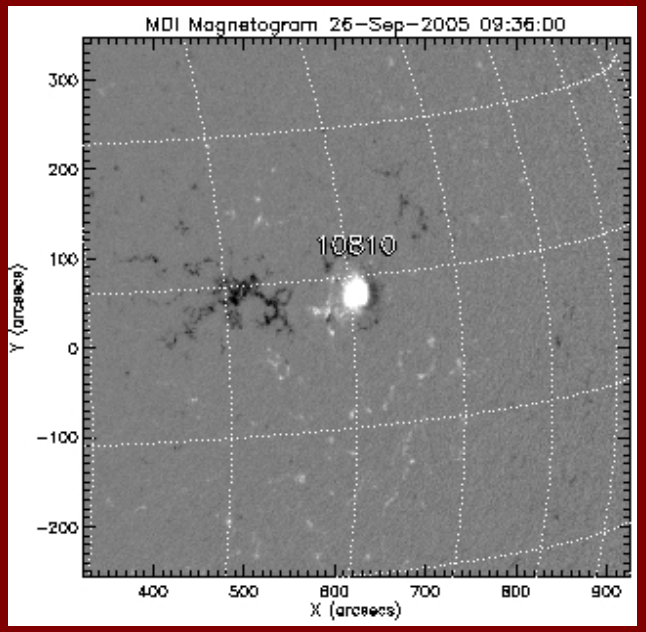
Example

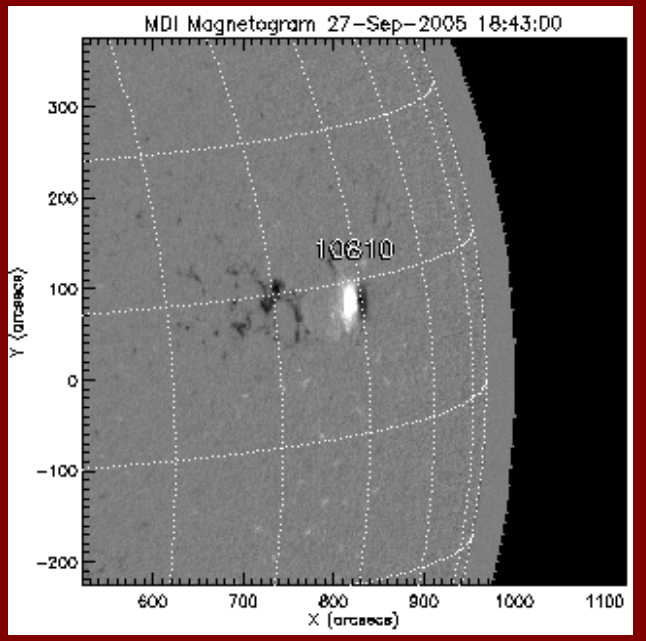


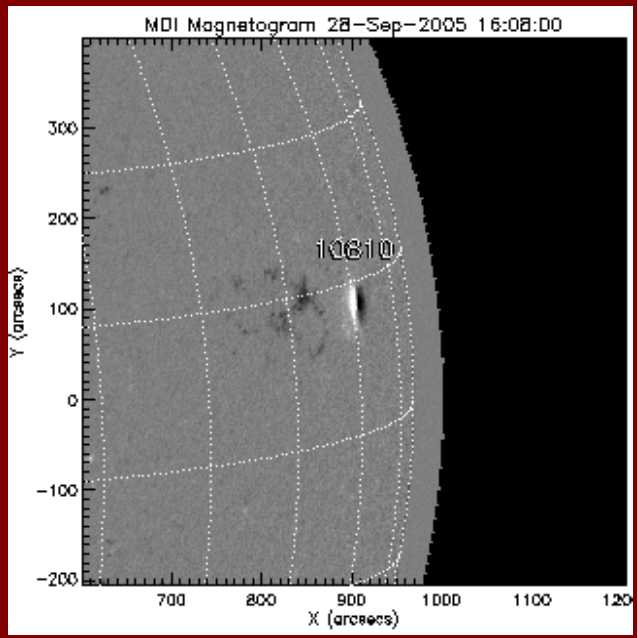




Fairly good data...



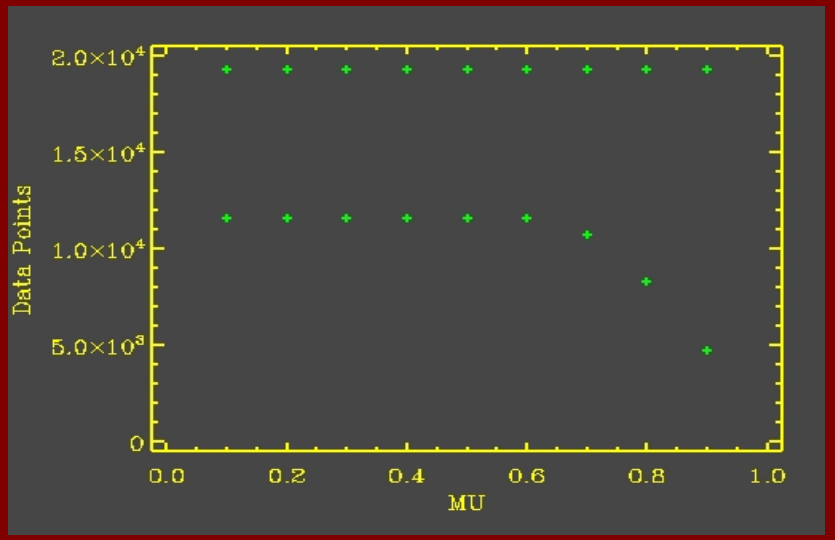




...gets worse and worse.

Data-Checking

- Data had to be pared down before analysis
  - Removal of bad instrument data
    - 11586 good points out of 19295 total points: 60% of data
  - Created IDL keywords to specify different limits to place on the data
    - Distance from disk center to throw out magnetogram
    - Distance from disk center to zero out data
  - Allows greater control over the analysis

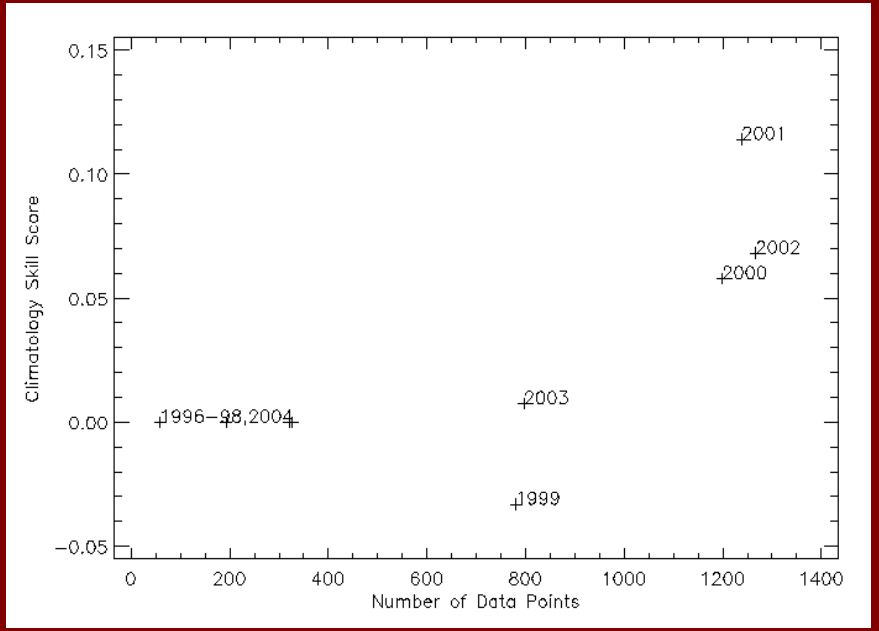


Results

- Predictive Power of DA varies year to year
  - Why?
- Quantification of Unreliability Further from Disk Center
  - Decrease of nearly 200% from Disk Center to 45 degrees out
- Potential Field Correction Does Not Improve Results
  - Although it is an improvement on observing angle correction

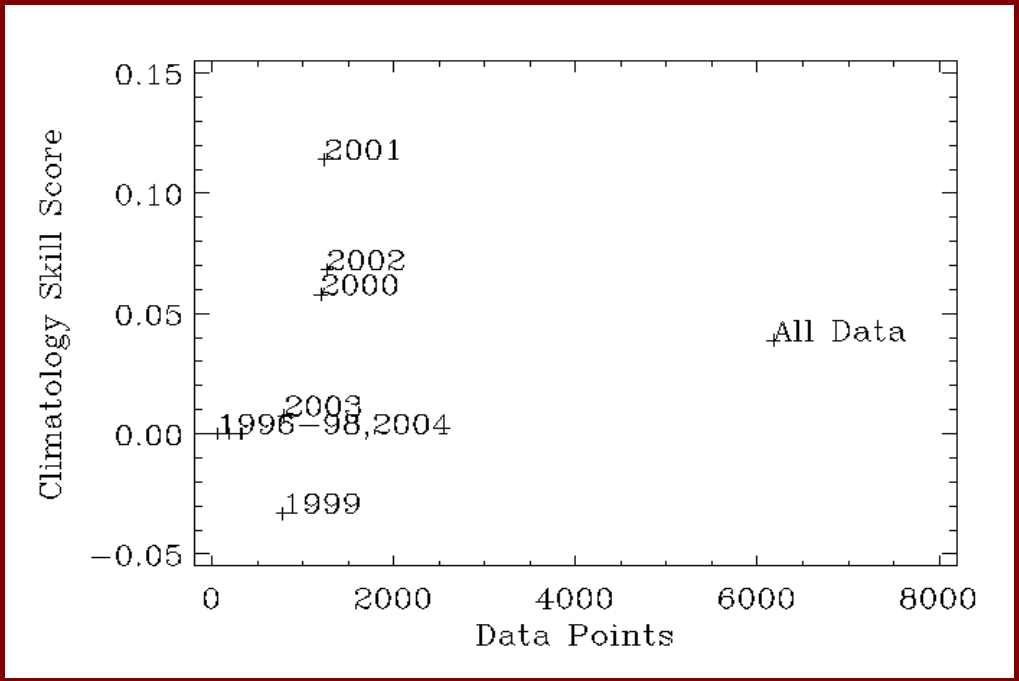
Variation with Year

- One Hypothesis
  - More magnetograms give better results
  - Weak trend to support this as more data seems to give a higher skill score
- Not the only possible explanation



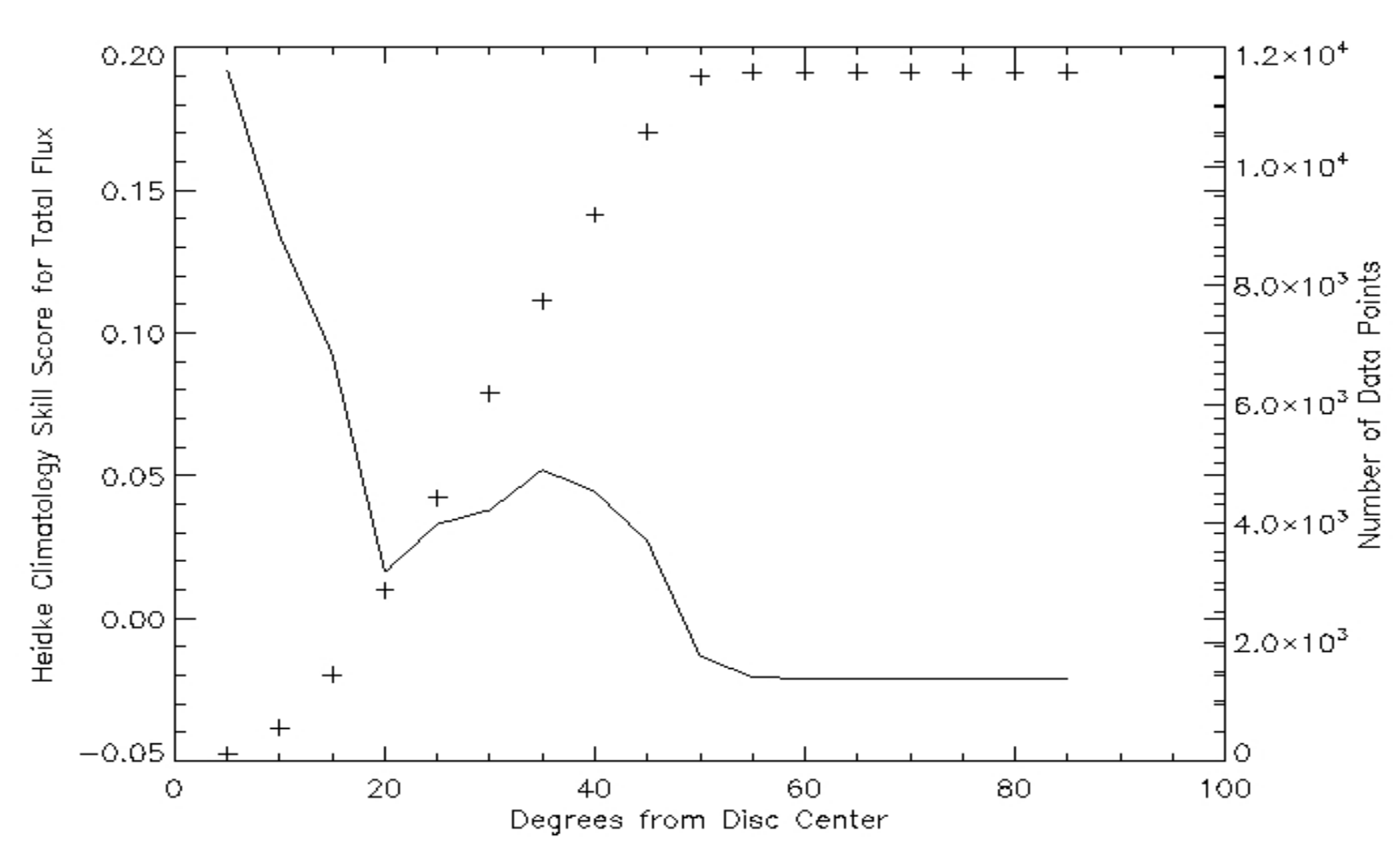
Variation with Year

- First hypothesis called into question by “All Data” anomaly
- Weak possible trend not supported

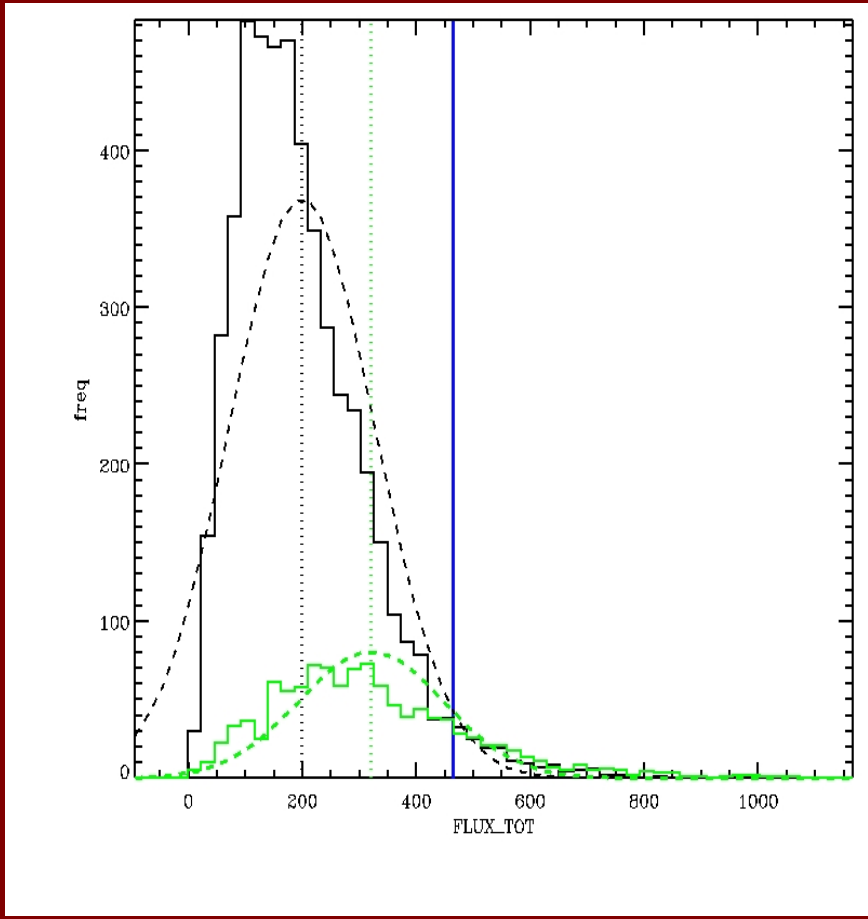


- Alternative Explanation
  - Predictive power somehow tied to solar cycle
  - Need more data to confirm

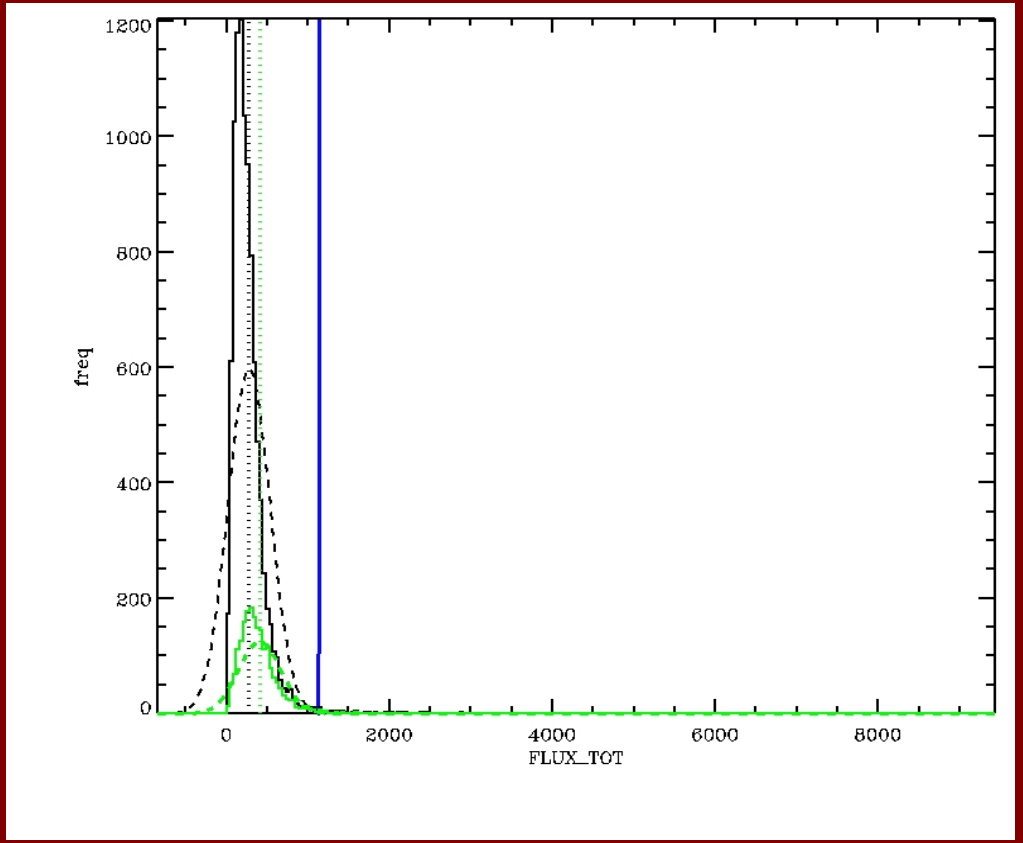
Decrease in Skill Score with Distance from Disk Center



Differences in Data



Includes data within 45° of disk center



Includes data within 60° of disk center

Who Cares?

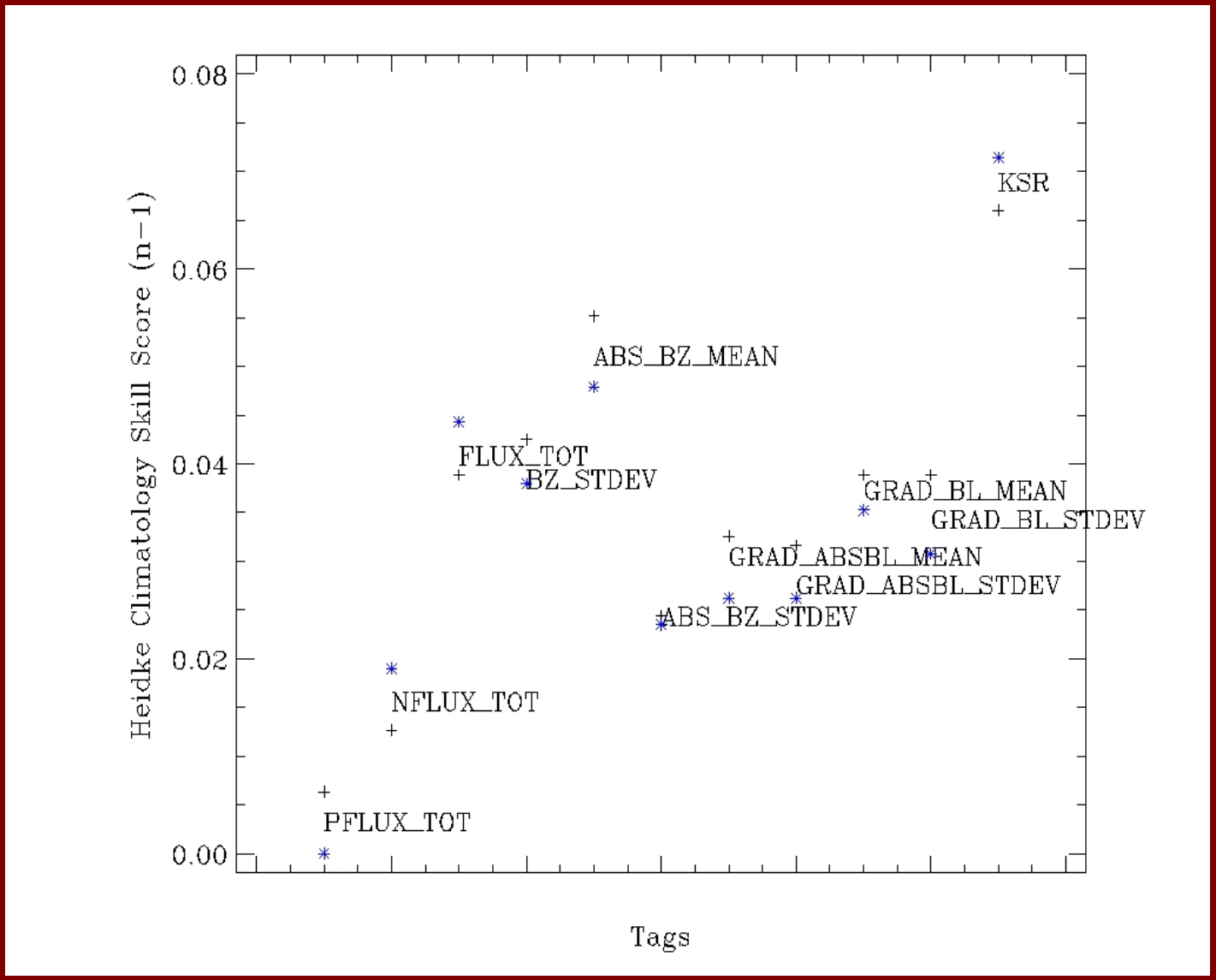
- Researchers want large datasets
  - Often try to stretch the limits with LOS data
- Many say up to 60 degrees is acceptable using observing angle correction
  - Definitely not the case
  - Even 45 degrees is questionable

Potential Field Correction

- “Mu Correction” not an accurate measure of magnetic field on the sun
- Potential field correction method models active regions as potential fields instead of assuming all magnetic field is perpendicular
- Approximation produced similar results to the mu correction

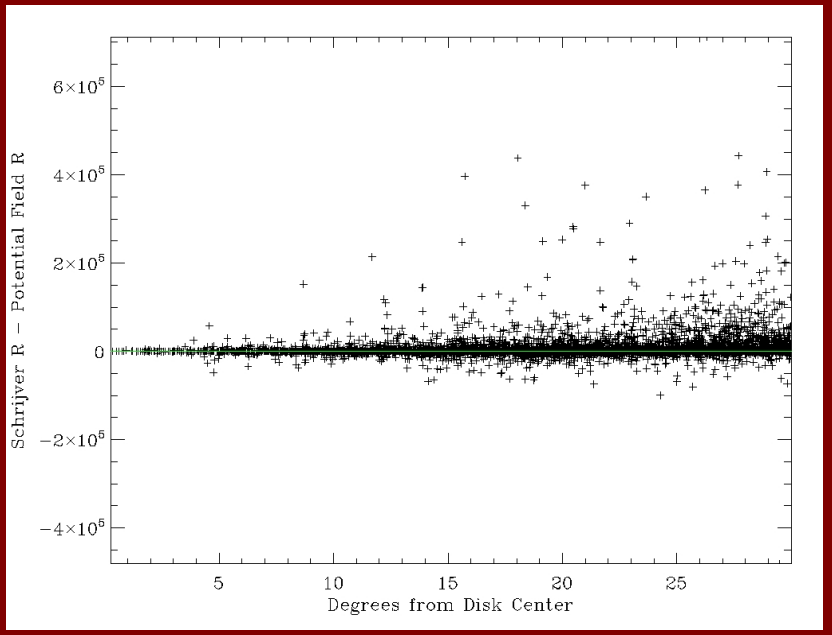
Mu Correction vs. Potential Field

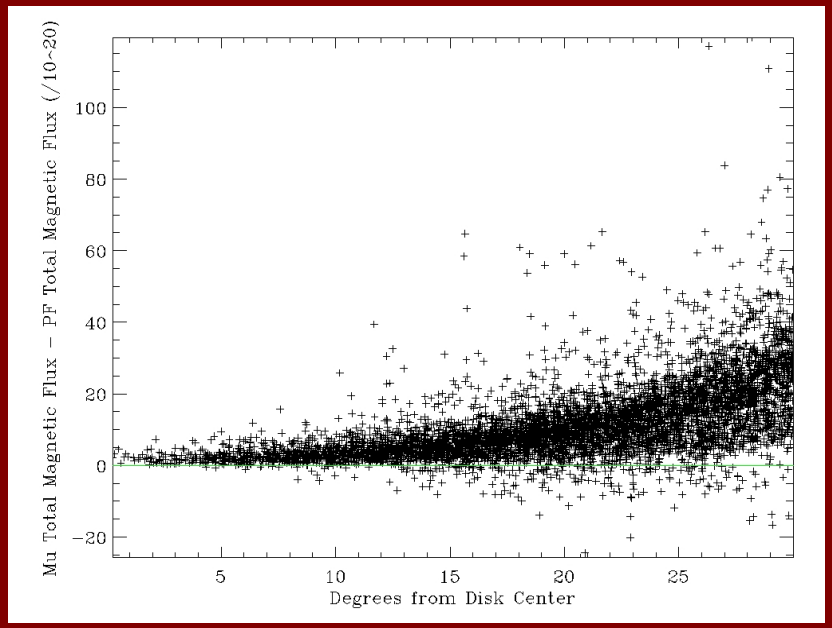
- In some cases, mu does better, in some cases, potential field does better (black crosses are mu, blue stars are PF)

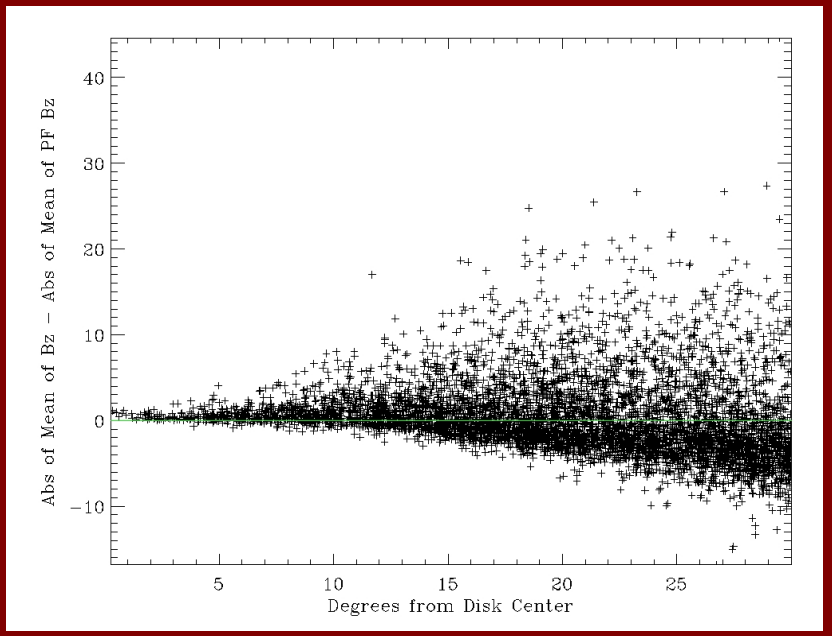


Not the Final Word

- Consistently greater difference between the potential field correction and observing angle correction further from disk center







Comparison with Peer Parameters

- R Parameter posited by Schrijver in 2007 paper
  - Locations of strong opposite-polarity magnetic fields adjacent to each other
  - Declared as proxy for photospheric electrical currents
- Uses Data Set from 1999 – 2006
- Implemented in Code, but still working out bugs
  - Unable to compare results

Summary of my Summer

- Analysis Code Edited to Allow User to Choose Data Limits
- Discovered annual variations in predictive power
- Quantitatively confirmed unreliability of data far from disk center
- Investigated difference between observing angle correction and potential field correction

Future Research Possibilities

- Add more data to flush out reason behind annual variations
- See how far potential field correction can be extended beyond observing angle correction
- Fix code for Schrijver's R parameter and investigate differences in results
- Compare four-year results for similar parameters with IVM data
- Analyze differences in results between parametric and non-parametric DA
  - LOS ideal for NPDA because of large dataset