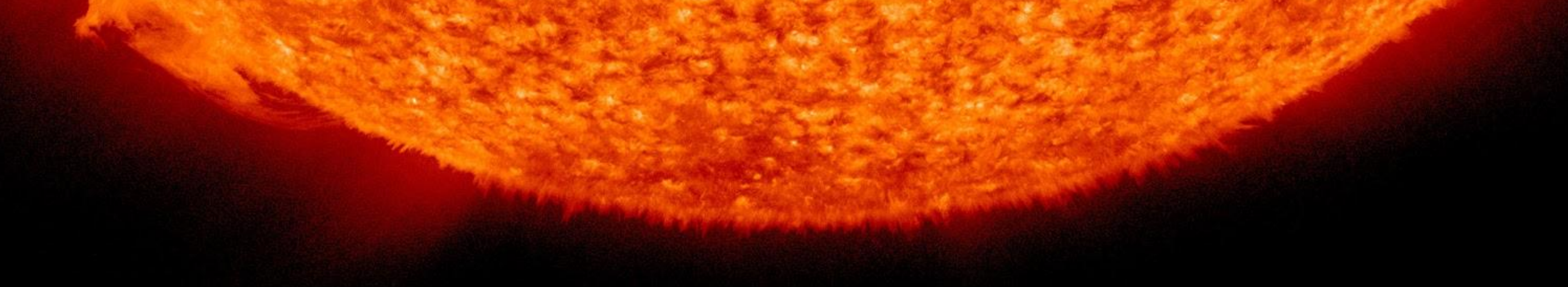
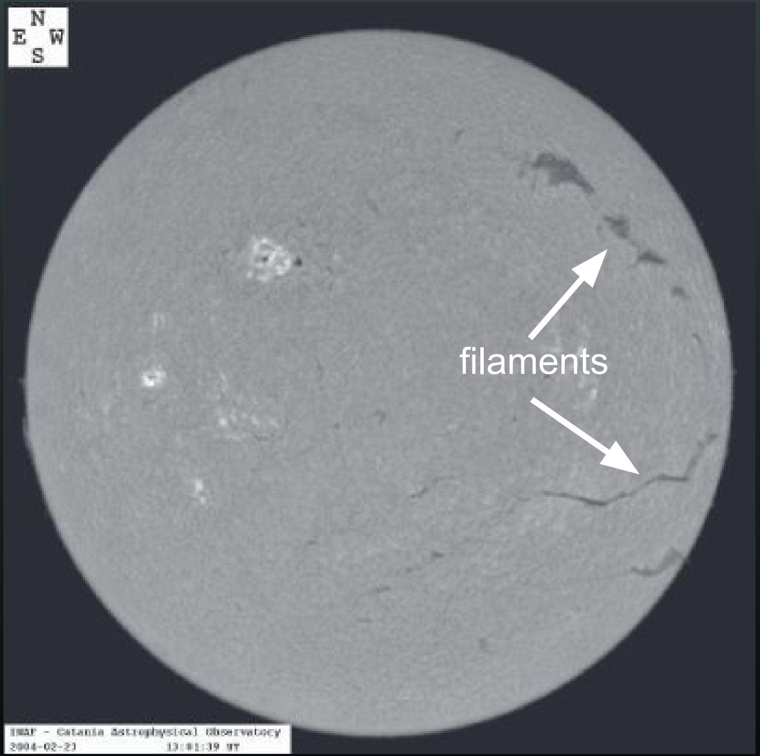


The Connection Between Solar Coronal Cavities and Solar Filaments

Brianna Zawadzki, Lycoming College

Advisors: Kathy Reeves, SAO; Nishu Karna, SAO; and Jakub Prchlik, SAO

Filaments



(Parenti 2014)

- Easily viewed in H alpha
- Strands of relatively cool, dense, partially ionized plasma suspended in corona
- Referred to as prominences when viewed on the limb
- Located above polarity inversion lines (PIL)

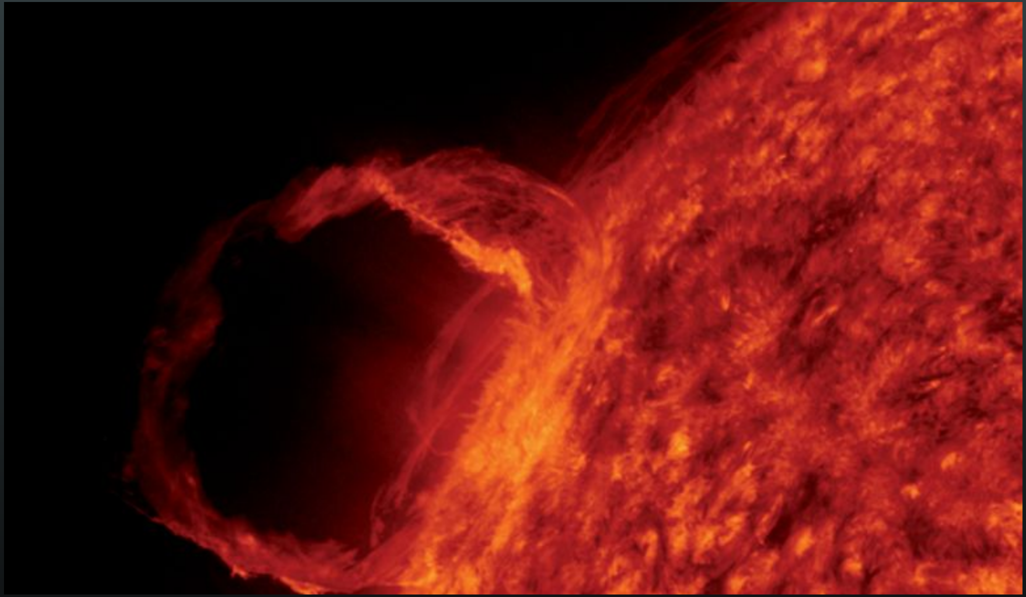
Cavities

(Karna et al. 2017)

- Viewed in EUV and white light coronal images
- Circular/elliptical regions of low density
- Viewed on solar limb
- Observed above prominences

Why are these structures important?

- Cavities and filaments are often associated with one another
- Why are cavities observed above some filaments and not others?
- Filament eruptions often lead to CMEs
- Learning more about cavities and filaments can help us learn more about space weather

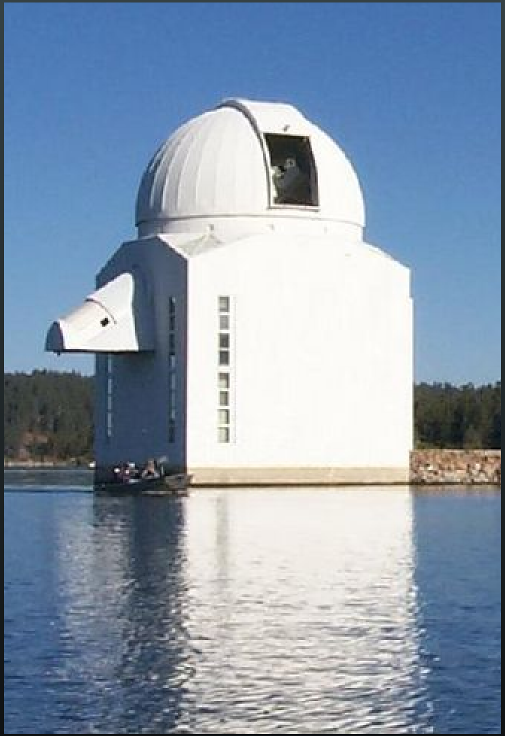


A filament eruption
(Parenti 2014)

Project Overview

Analyze filament and cavity metadata in Python

- H alpha images: GONG (Global Oscillation Network Group) H alpha telescopes
  - Six telescopes around the world to take 24/7 solar data
- Filament metadata: HEK (Heliophysics Events Knowledgebase)
  - Big Bear Solar Observatory and Kanzelhöhe Solar Observatory
  - Filaments given as individual instances (12 hour cadence)
  - Georgia State Tracking algorithm (developed by Dustin Kempton and Rafal Angryk, and improved by Jakub Prchlik) ties instances together to create a filament track
  - Includes information such as date, latitude, length, tilt, number of barbs, and more



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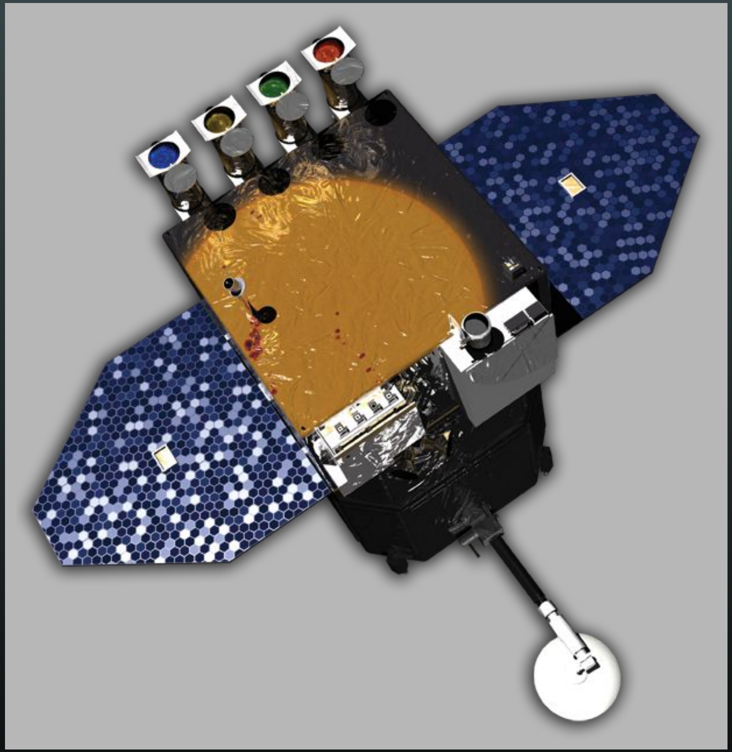
Project Overview

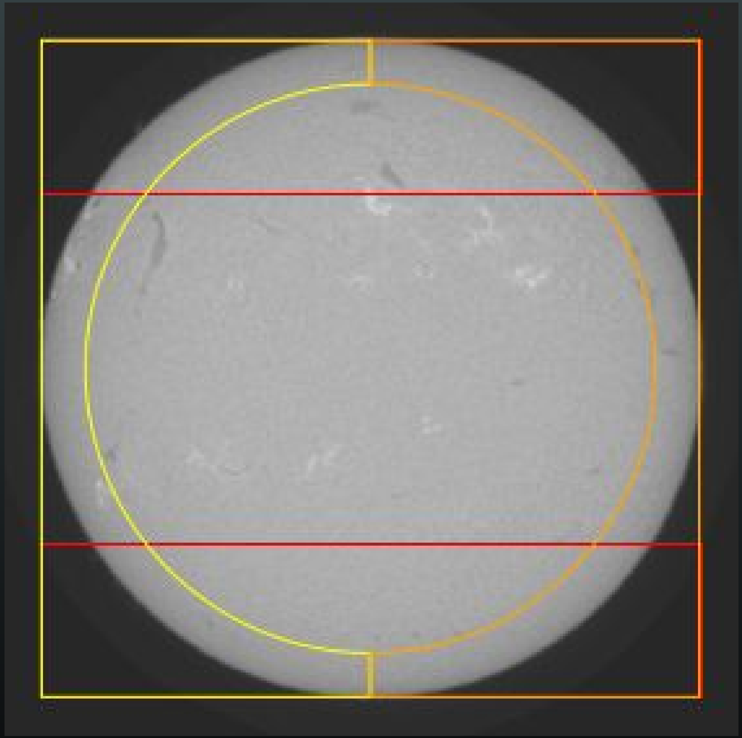
Analyze cavity and filament metadata in Python

- SDO: Solar Dynamics Observatory
- AIA: Atmospheric Imaging Assembly
  - Observes the Sun in 10 different wavelengths every 10 seconds
- Cavity metadata: SDO AIA
  - Cavity catalog developed by Nishu Karna
  - http://spaceweather.gmu.edu/projects/synop/
  - Used cavities that appeared on the Eastern Limb



Project Overview

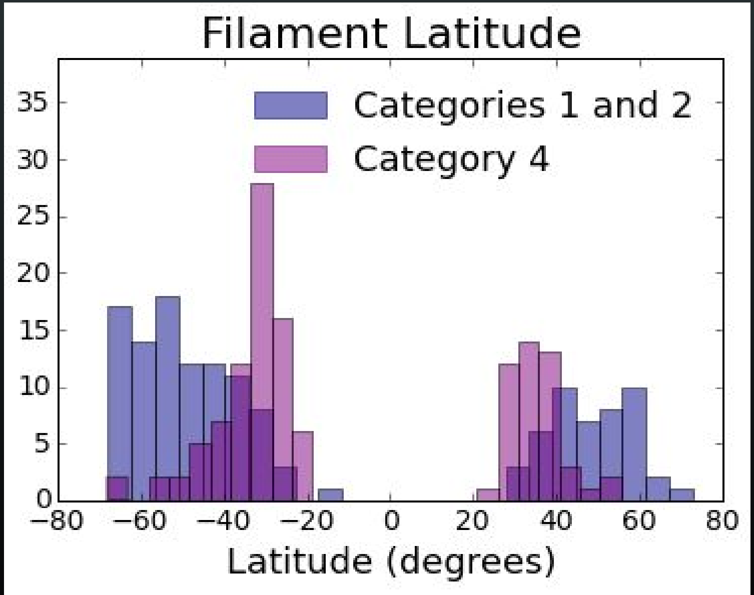
- Find corresponding cavities and filament tracks
- Categorize filament tracks based on stability
- Within each category, analyze qualities such as length and tilt
- Perform a statistical study to find meaningful connections

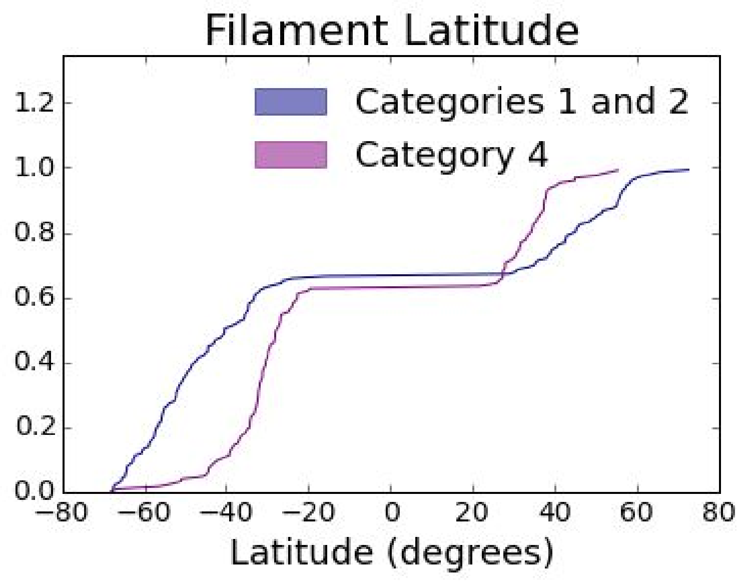


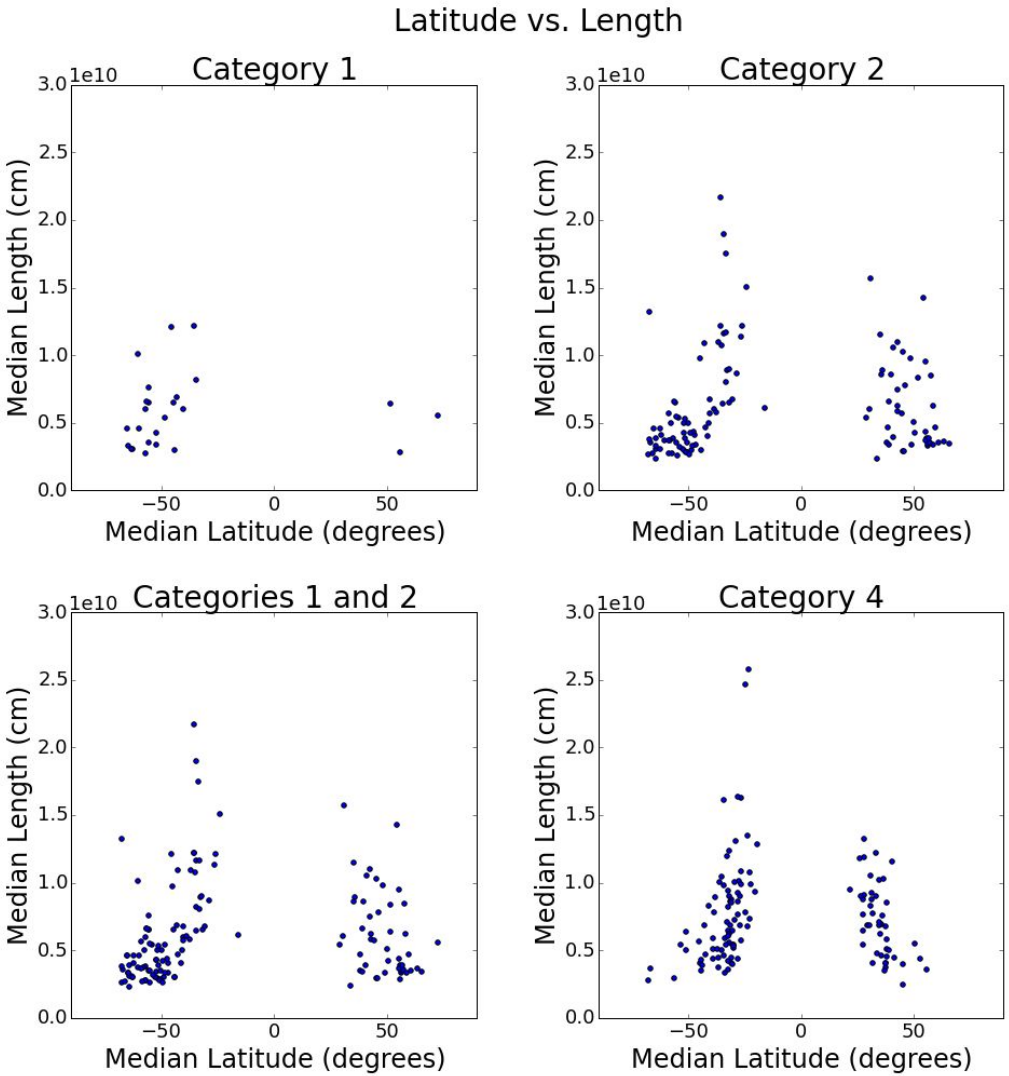
Category	Qualities	Number of Filament Tracks
1	In a cavity-filament match, both the cavity and filament track fully across the solar disk	25
2	In a cavity-filament match, only the filament tracks fully across solar disk	119
3	In a cavity-filament match, neither the cavity nor the filament track fully across solar disk	95
4	Stable filaments that exist with no matching cavities and lie poleward of ± 30° latitude	129
5	Cavities that exist with no matching filaments (in H alpha)	N/A

Statistical Study: Latitudes of Stable Filament Tracks

- Cavities tend to be observed at high latitudes
- It follows that filaments with cavities are also observed at high latitudes
- This is reflected in the latitude histogram and cumulative distribution function



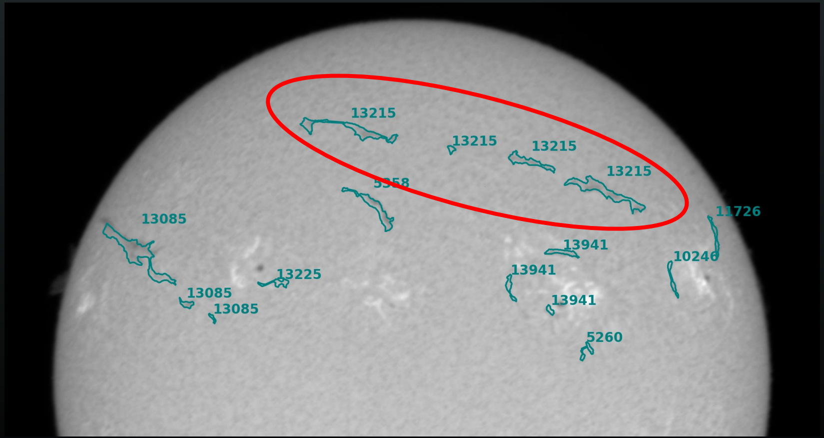




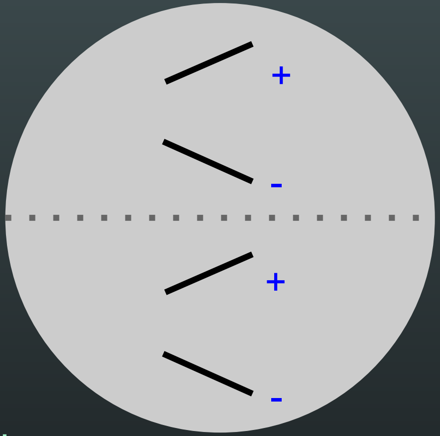
Latitude and Length of Stable Filament Tracks

Scatter plots show that filaments near the poles tend to be shorter

This is likely the result of the filament detecting algorithm



Statistical Study: Tilt of Stable Filament Tracks



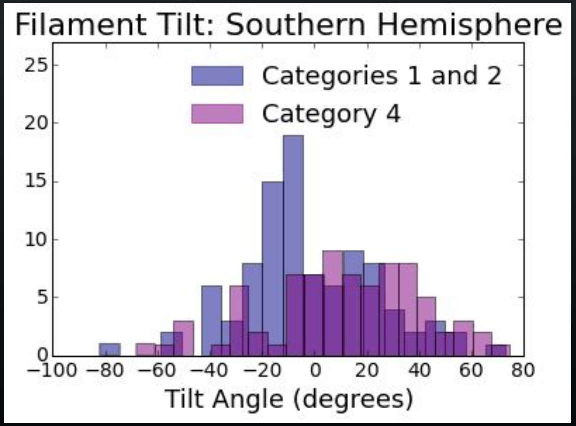
Positive tilt means the leading end of the filament points north.

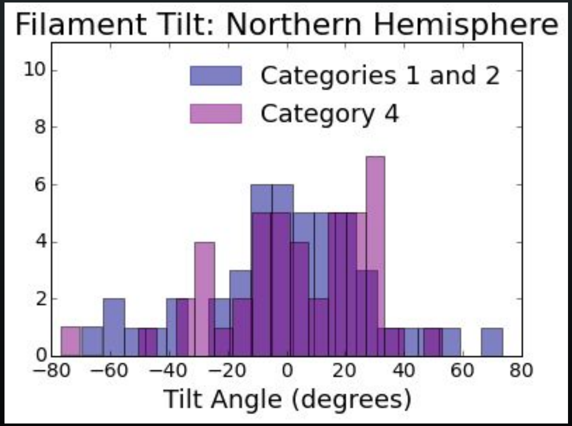
Negative tilt means the leading end of the filament points south.

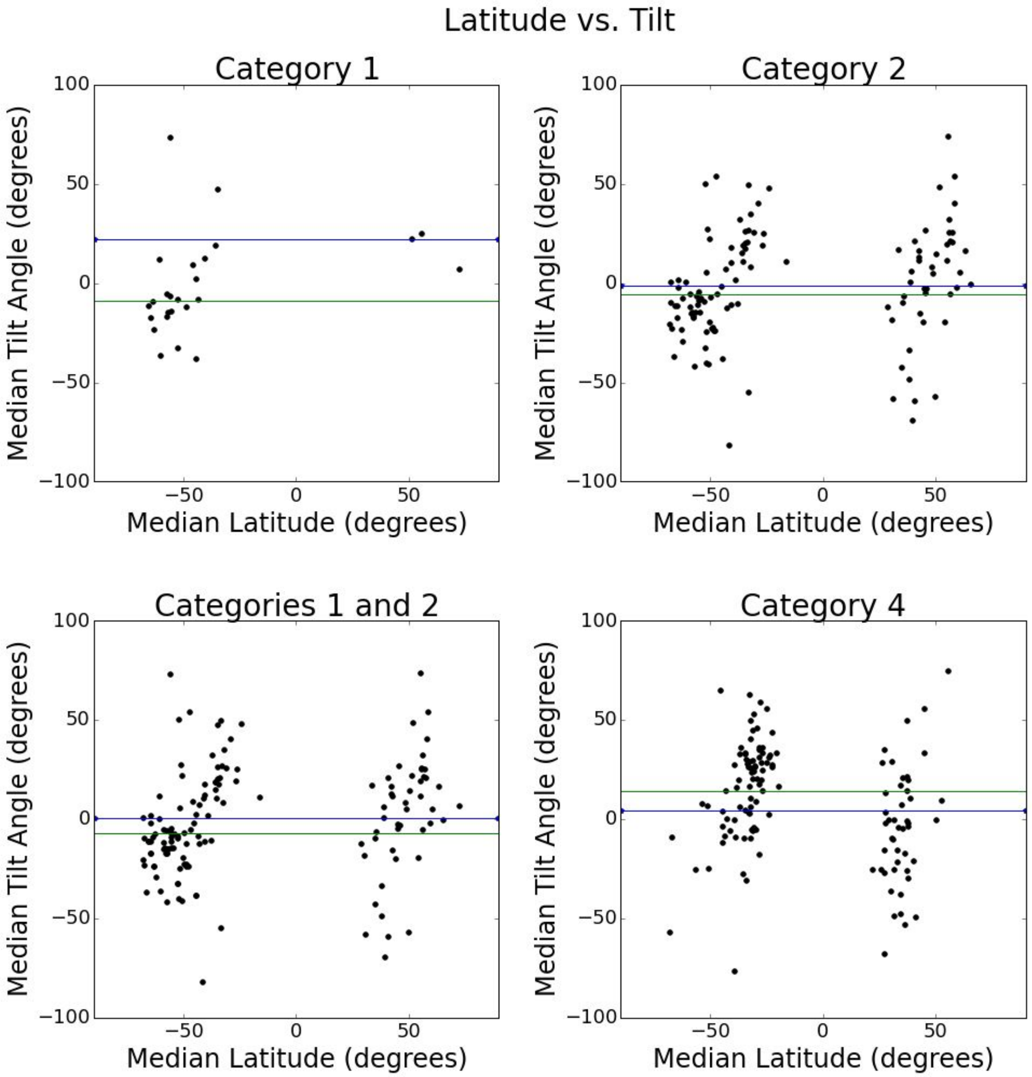
Southern Hemisphere:

- Filaments associated with a cavity tend to have more negative tilts
- Those with no associated cavity tend to have more positive tilts

The result in the northern hemisphere is less clear due to a smaller sample size







Latitude and Tilt of Stable Filament Tracks

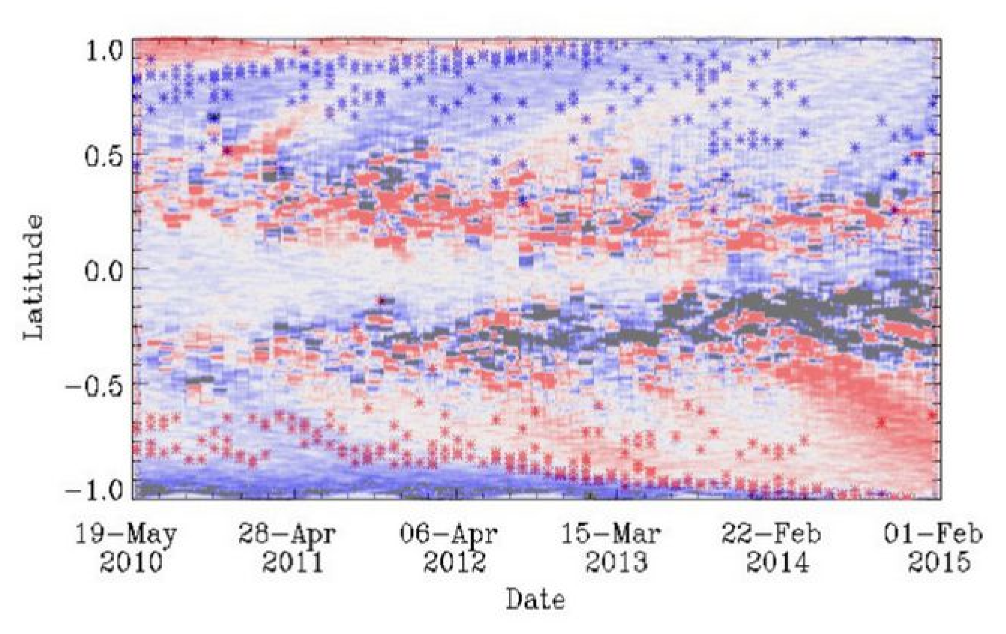
In the southern hemisphere, filament tracks with cavities tend to have negative tilts while those without cavities tend to have positive tilts

This is less clear in the northern hemisphere, likely due to magnetic pole reversal

Median tilt of filaments in the northern hemisphere

Median tilt of filaments in the southern hemisphere

Latitude and Tilt of Stable Filament Tracks



(Karna et al. 2017)

In the southern hemisphere, filament tracks with cavities tend to have negative tilts while those without cavities tend to have positive tilts

This is less clear in the northern hemisphere, likely due to magnetic pole reversal

The butterfly diagram above shows average cavity latitudes (marked by asterisks) and magnetic polarity (positive in blue, negative in red) with respect to time

The data we analyzed ranges from 2012 to 2015, which includes a pole reversal

Conclusions and Future Work

- Filaments with associated cavities tend to appear closer to the poles than filaments without cavities
- Filaments tend to appear more “broken up” near the poles
- Tilt, or the orientation of the filament, may have an influence on whether or not a cavity is likely to be observed

In the future

- Examine cavities with both stable and unstable filament tracks
- Use data from a full solar cycle
- Examine other filament qualities

Acknowledgements

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