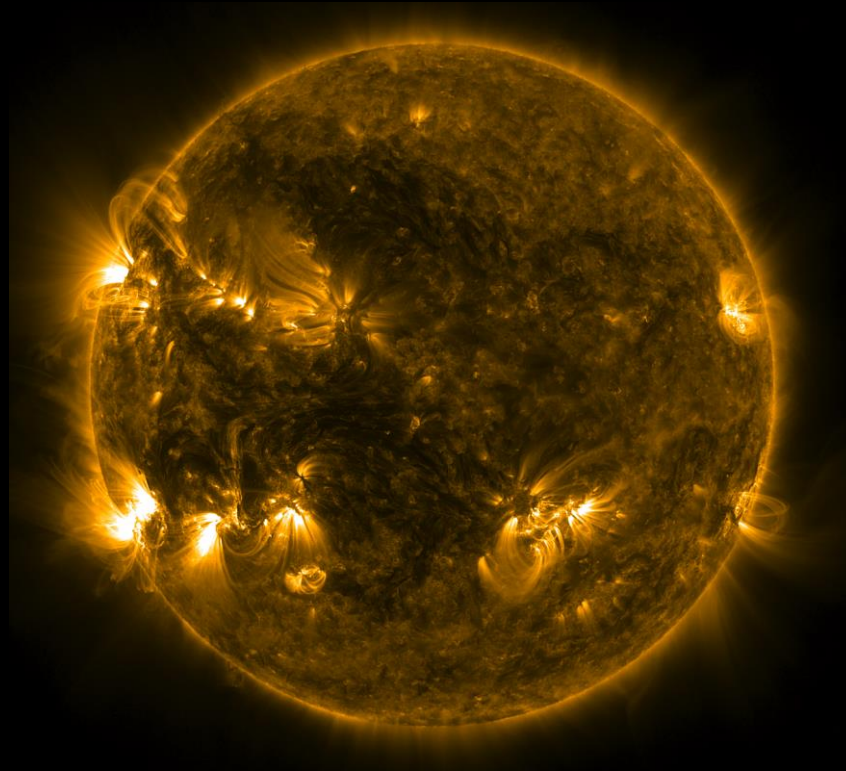


Scott Lucchini

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2012 Solar REU Program

Mentor: Steve Saar



From Blankets into Ropes

Active Region Canopies
and their Filaments

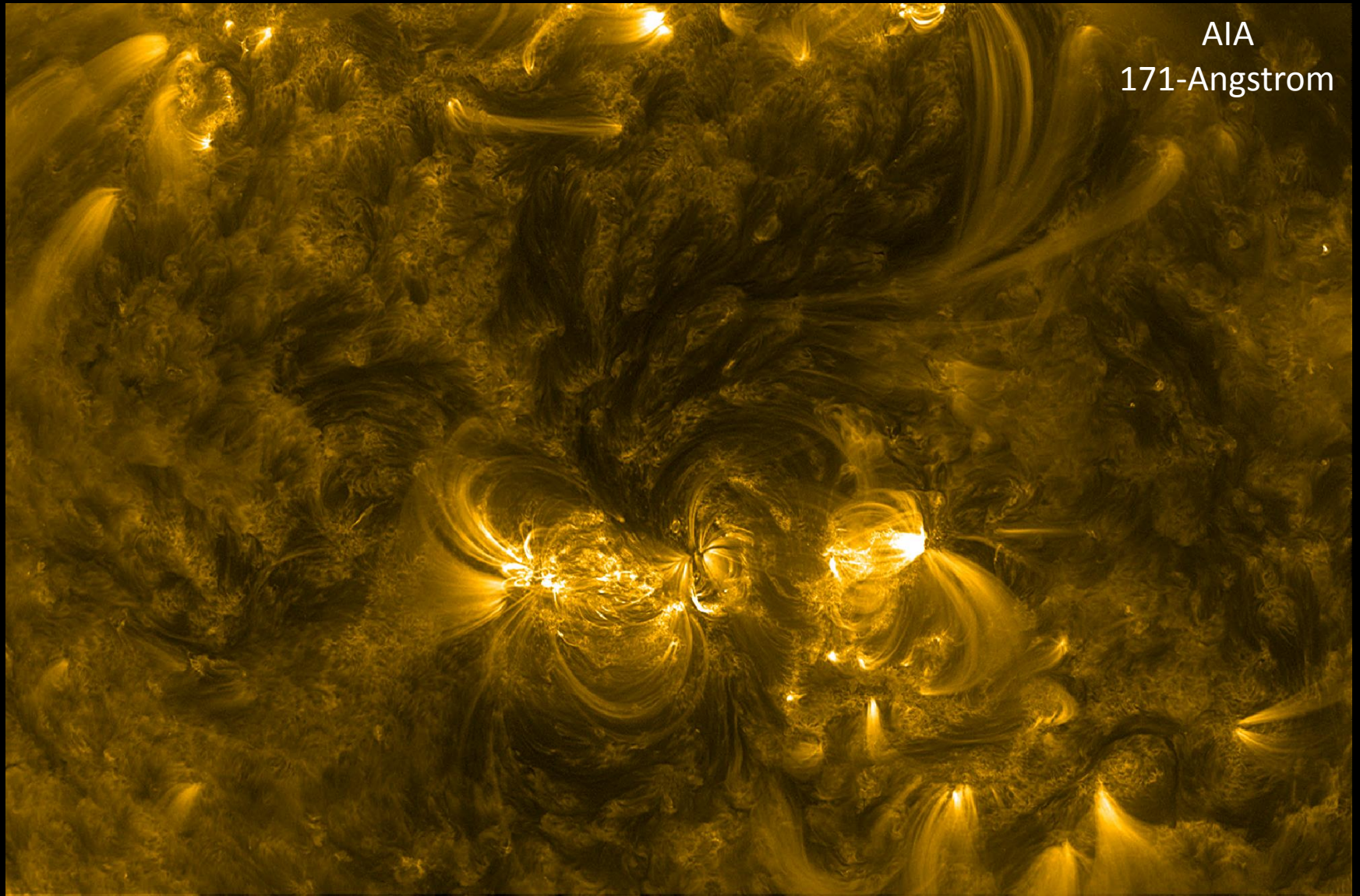
Outline

- What are Canopies?
- How to Find Them
- Problems we Encountered
- Some Results
 - Evolution of Canopies into Filaments
 - Temperature Mappings from DEM Analysis
- Future Work

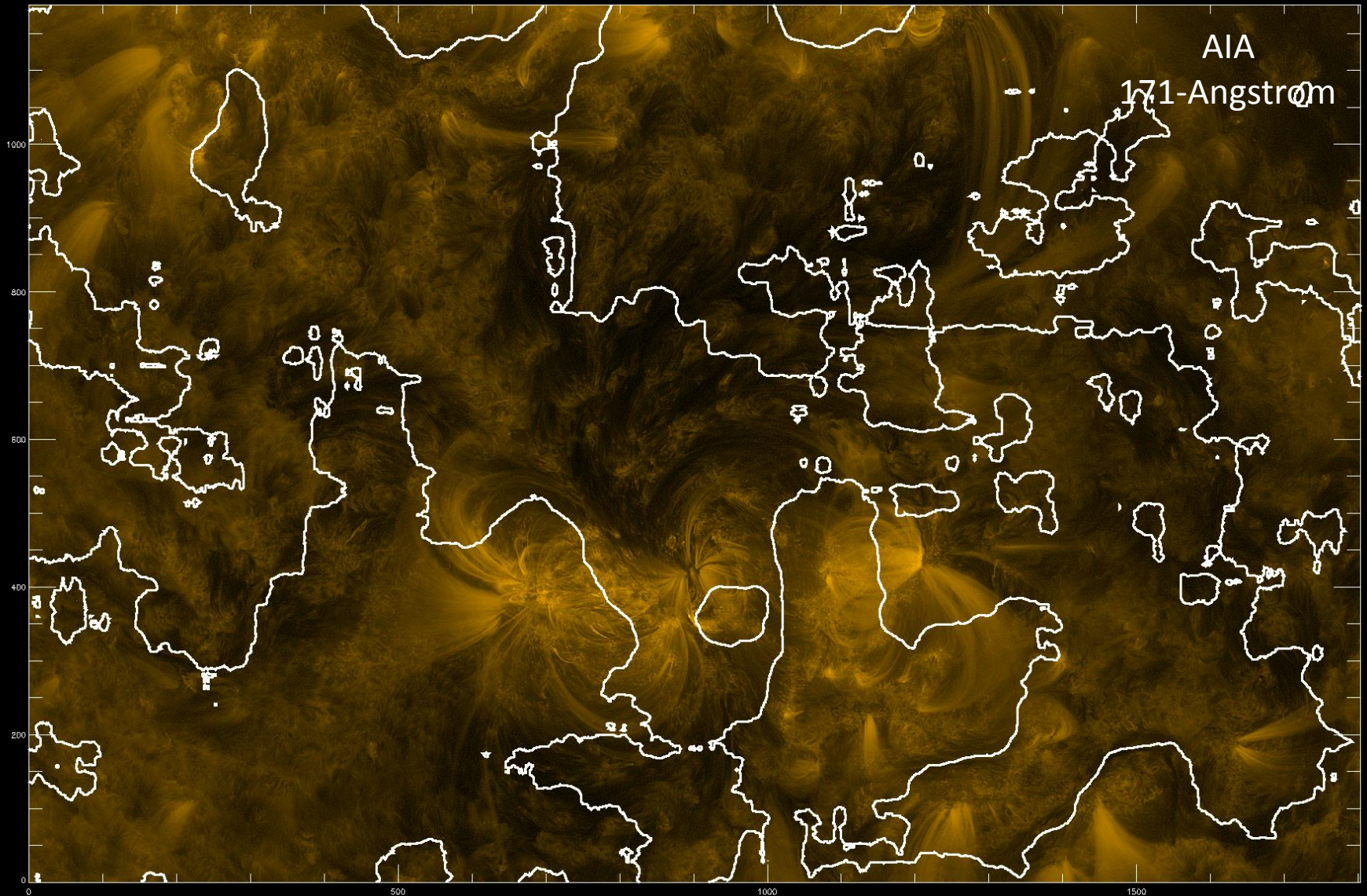
What are Canopies?

- Active Regions have large extending loops
- These loops reconnect to form low-lying, horizontal field lines
- These field lines cover the Canopy regions
- They contain fibril structures surrounding Active Regions
- Line up with Polarity Inversion Lines (PILs)

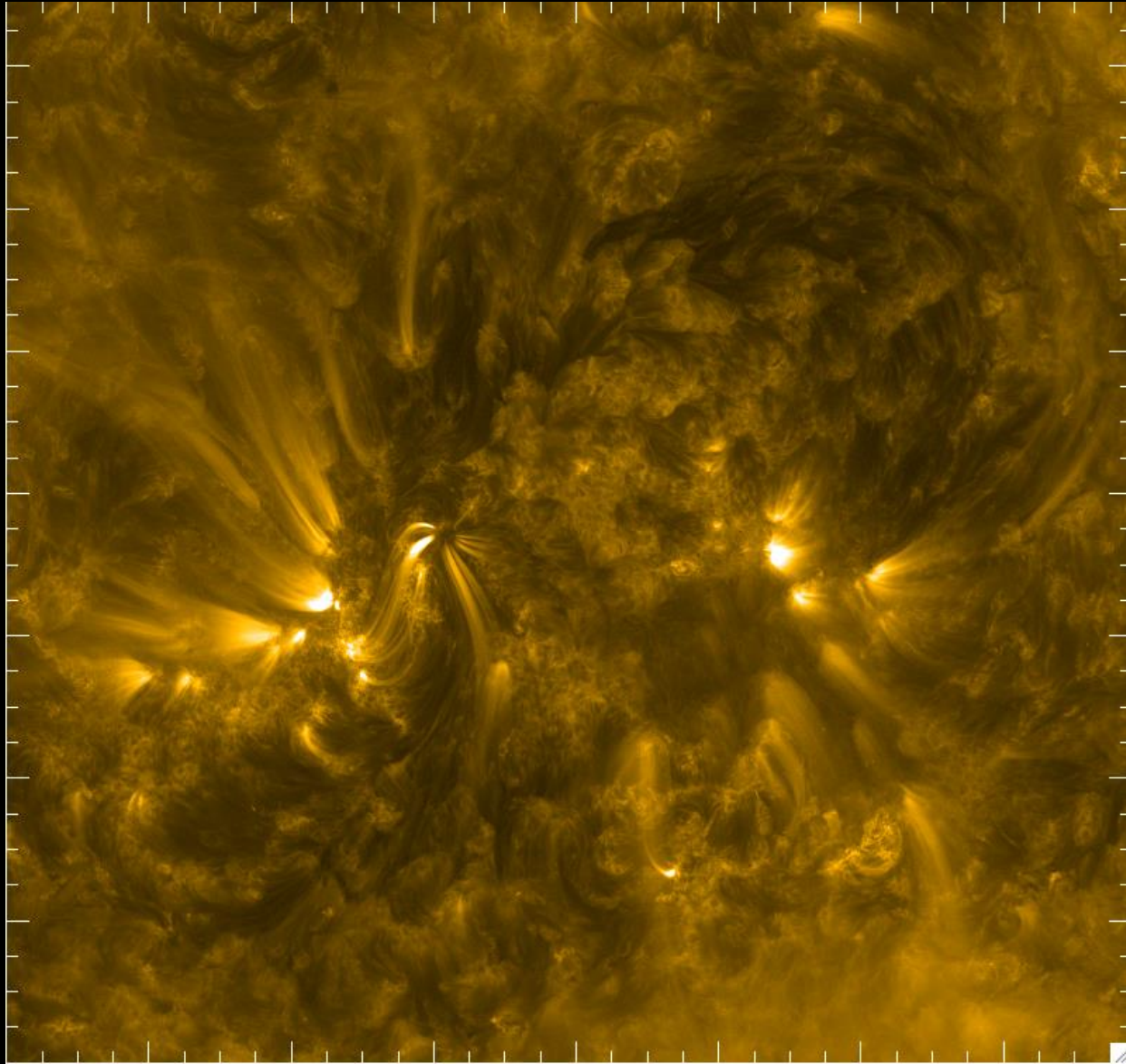
What are Canopies?



What are Canopies?

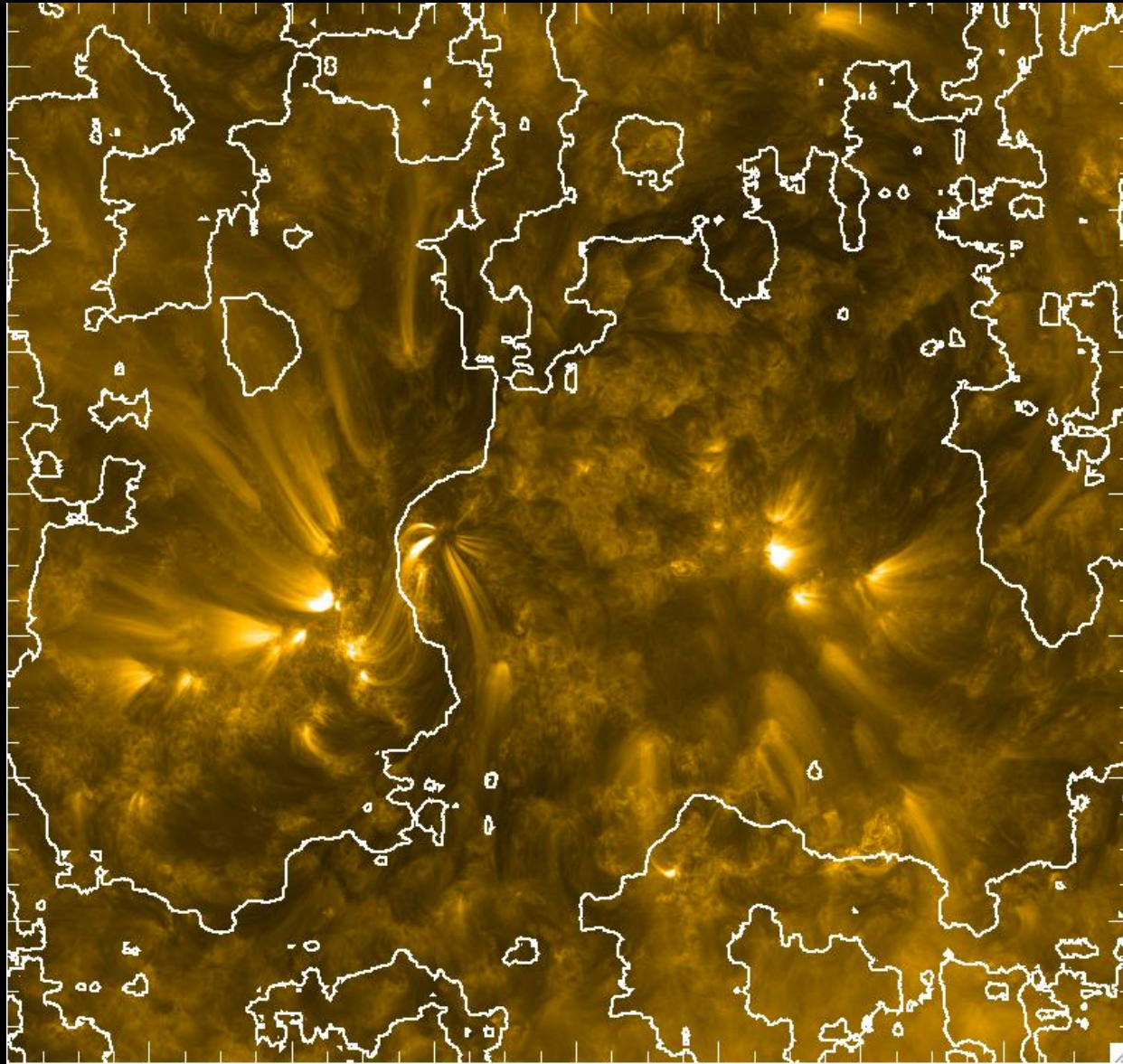


What are Canopies?



AIA
171-Angstrom

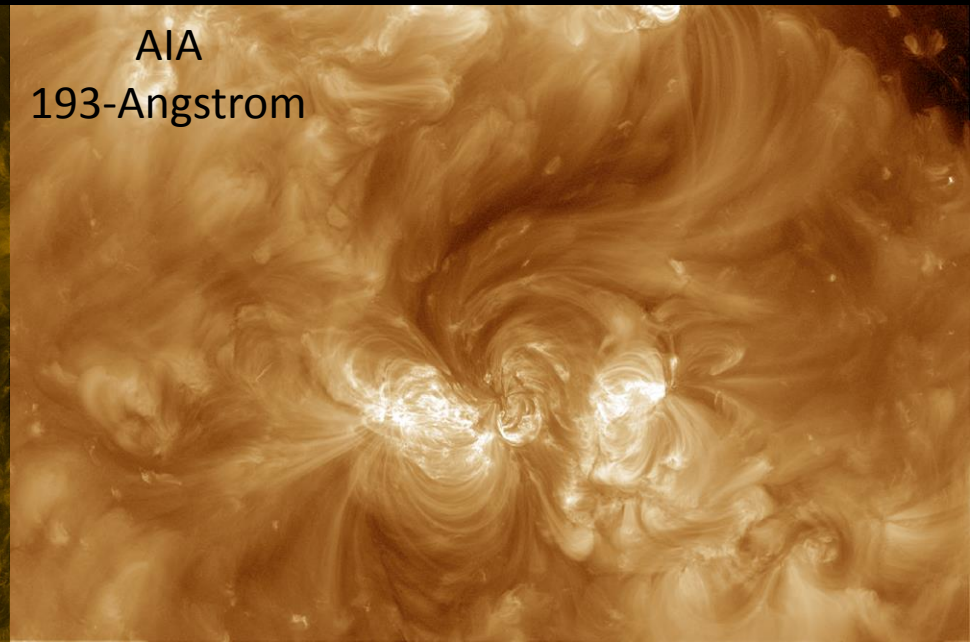
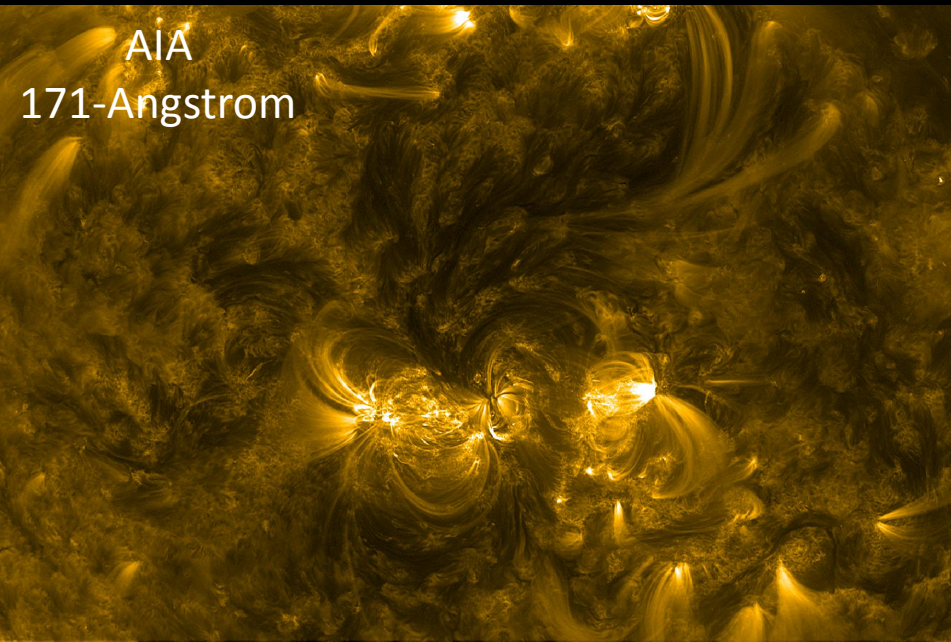
What are Canopies?



AIA
171-Ångstrom

How to Find Them!

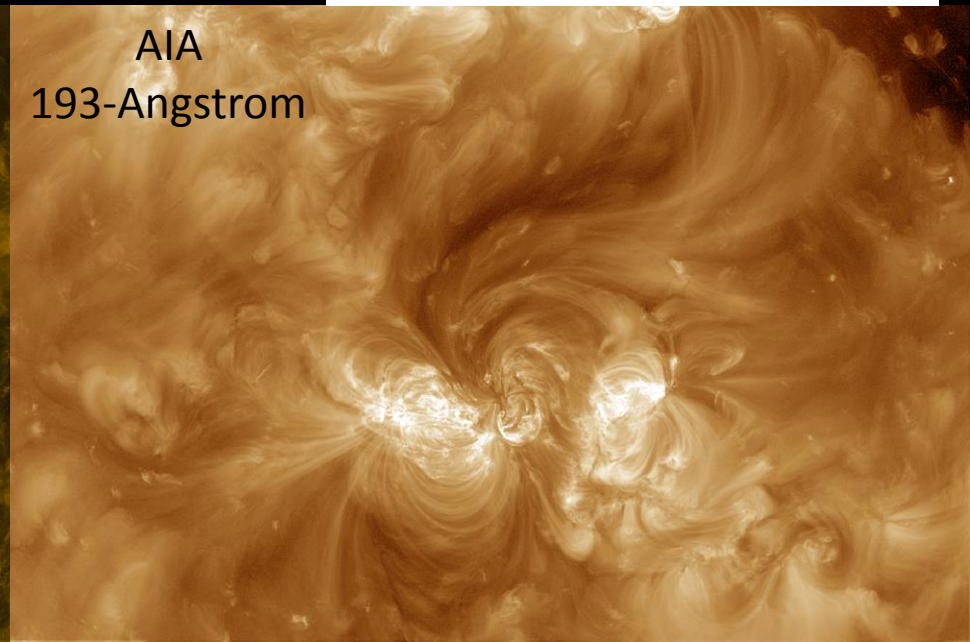
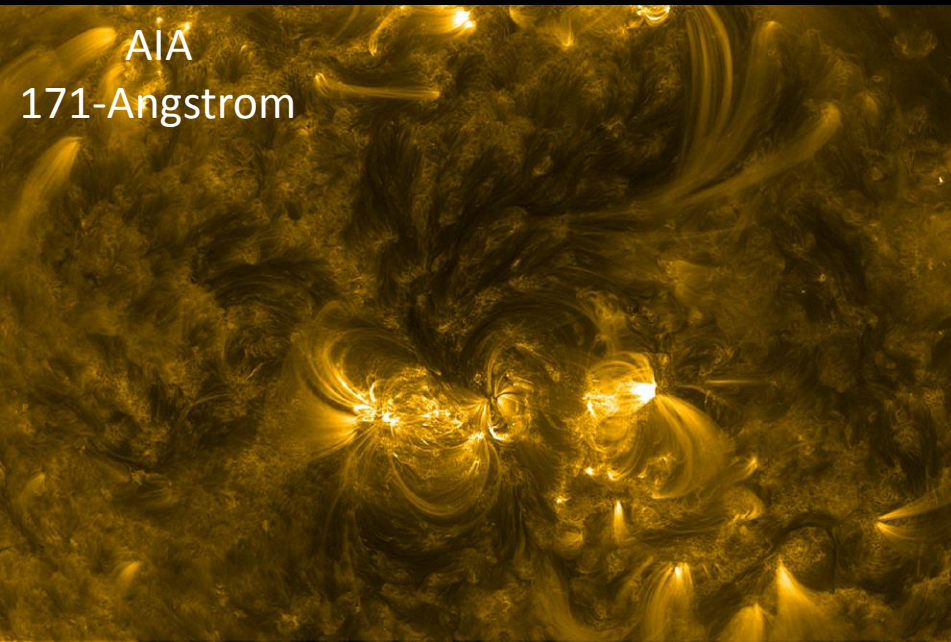
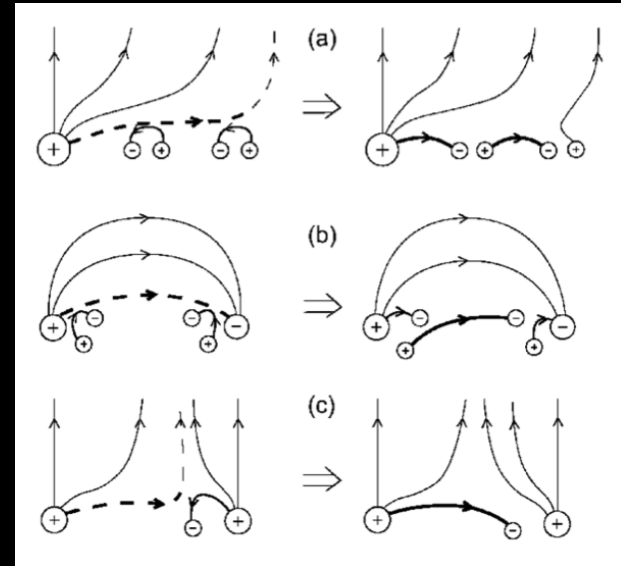
- Decreased emission from lower temperature lines (AIA Fe IX 17.1 nm)
- Normal emission from higher temperature lines (AIA Fe XII 19.3 nm)

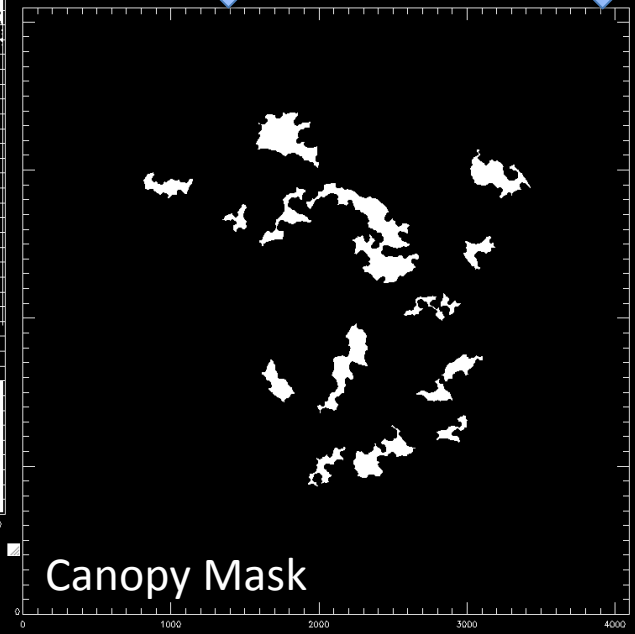
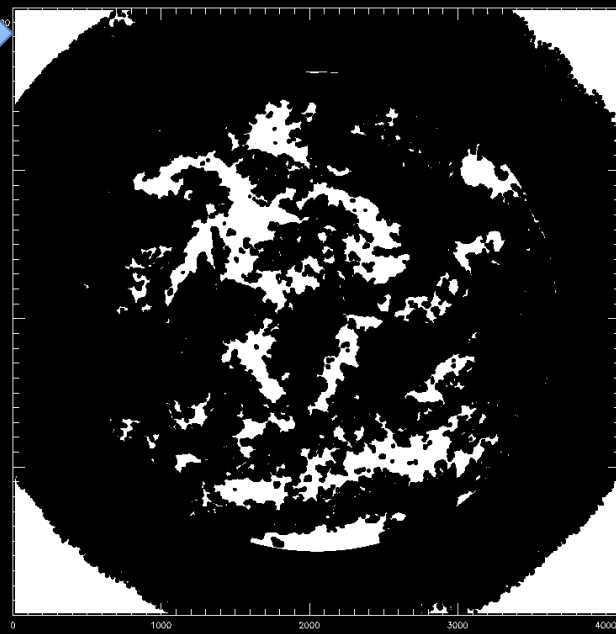
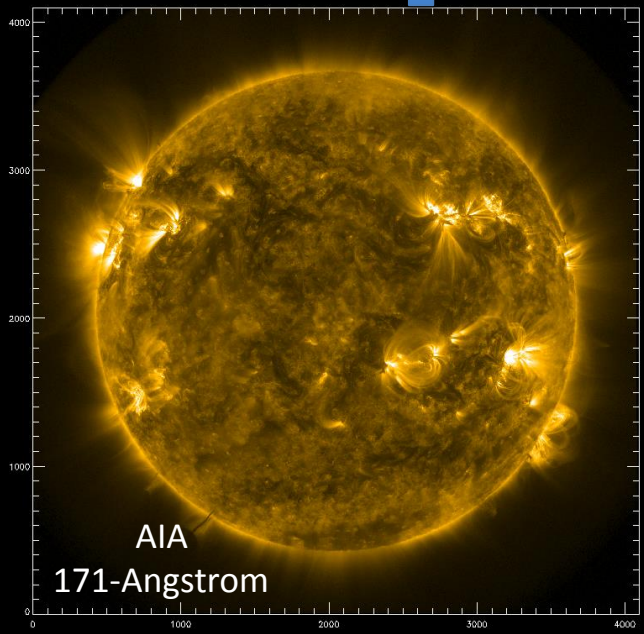
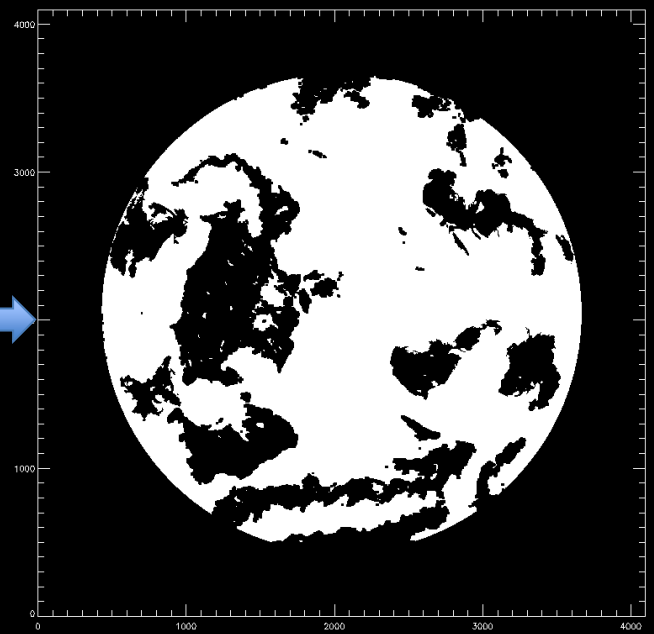
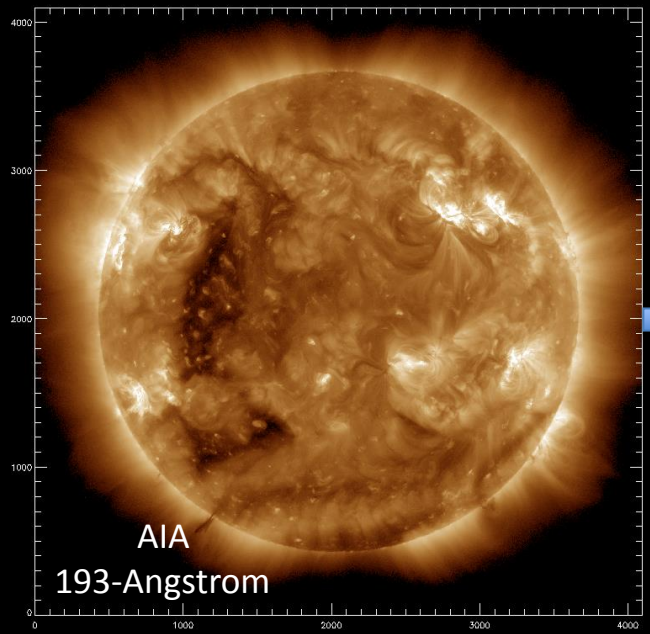


How to Find Them!

Image Source: Wang et al, 2011

- Rosner, Tucker & Vaiana, 1978
- $T \propto (PL)^{1/3}$
- Constant pressure
- $T \propto L^{1/3}$

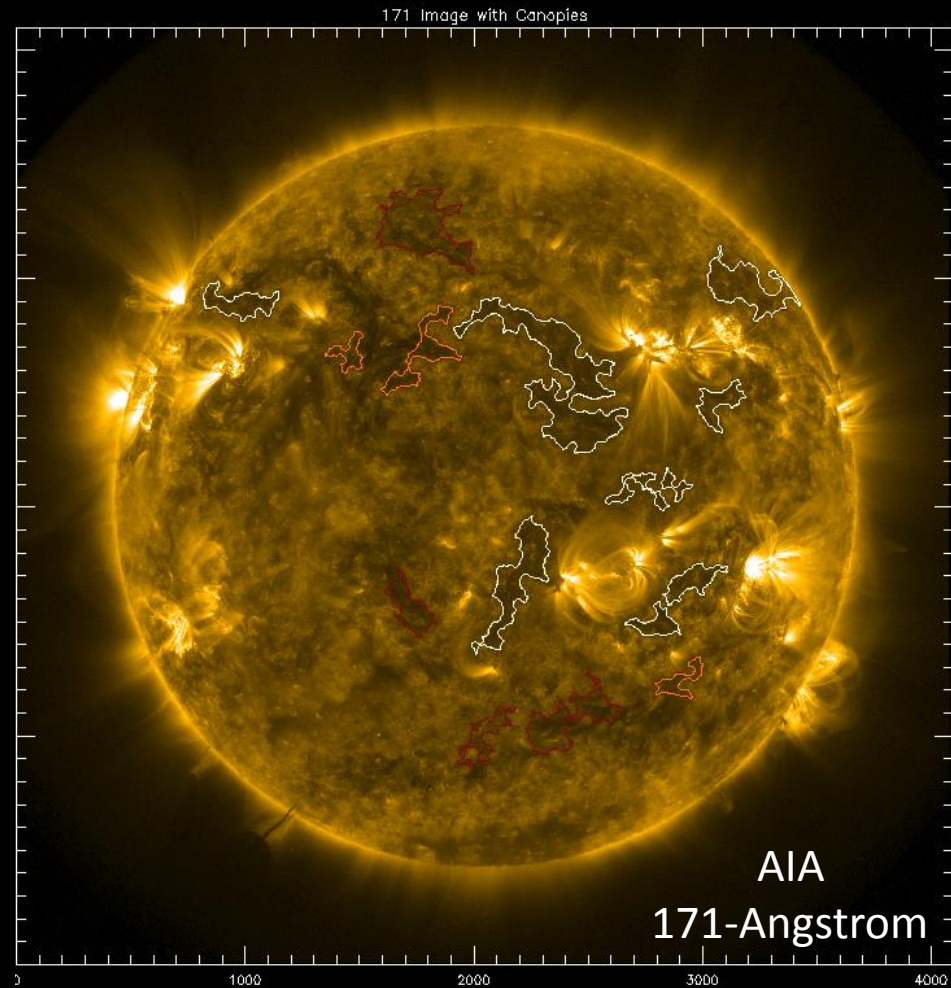
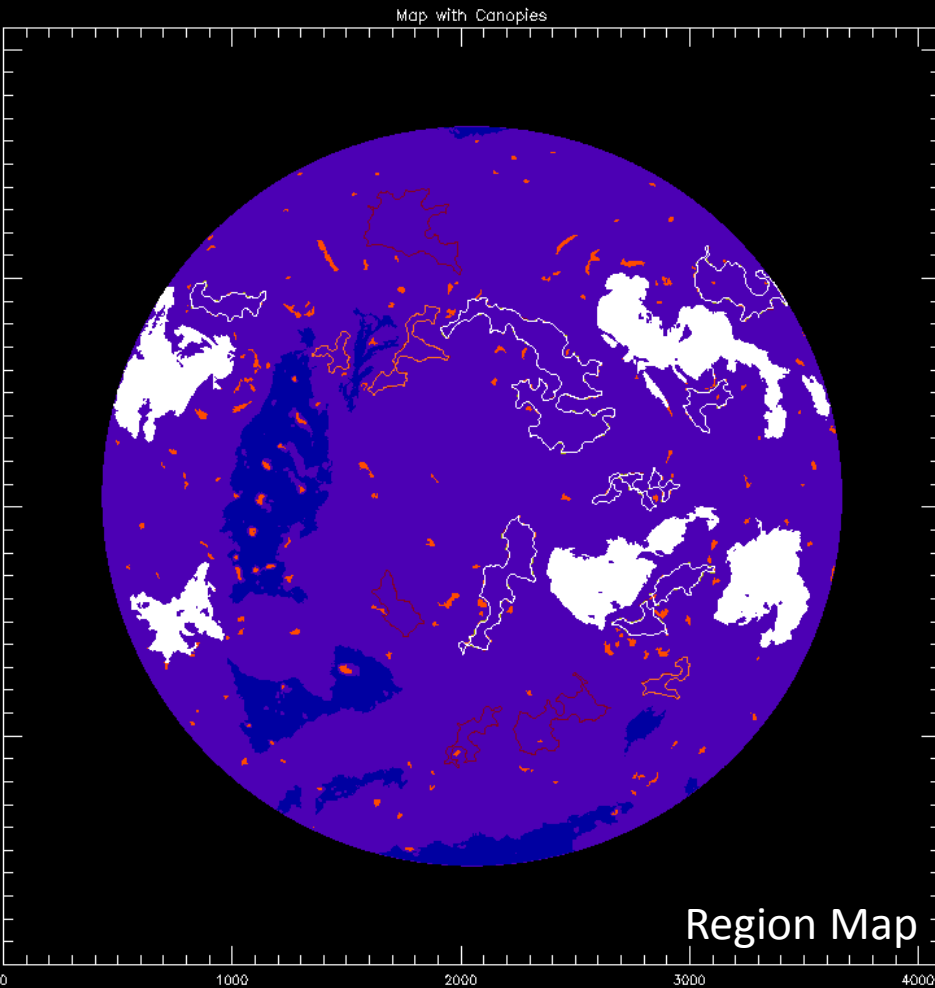




Ranking the Canopies

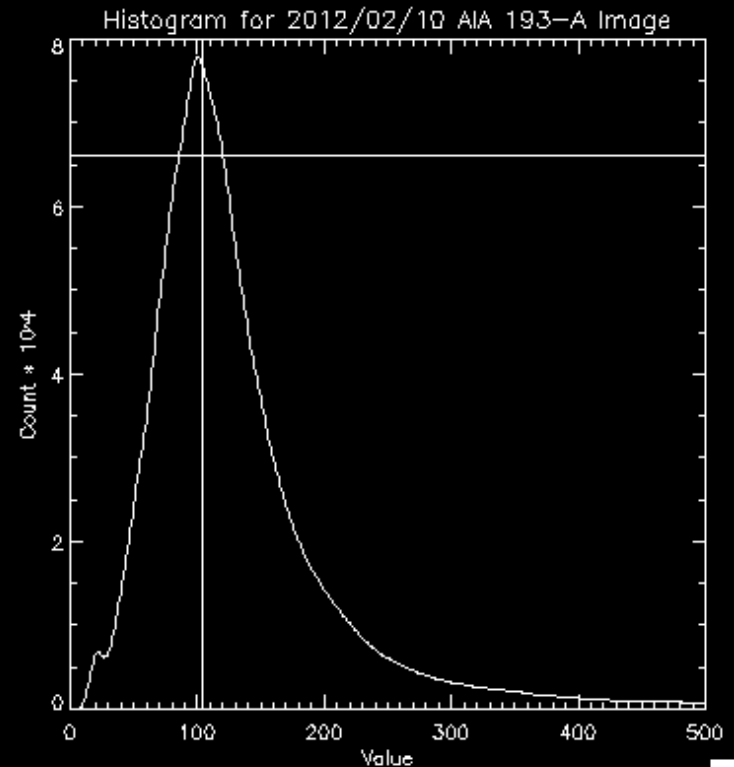
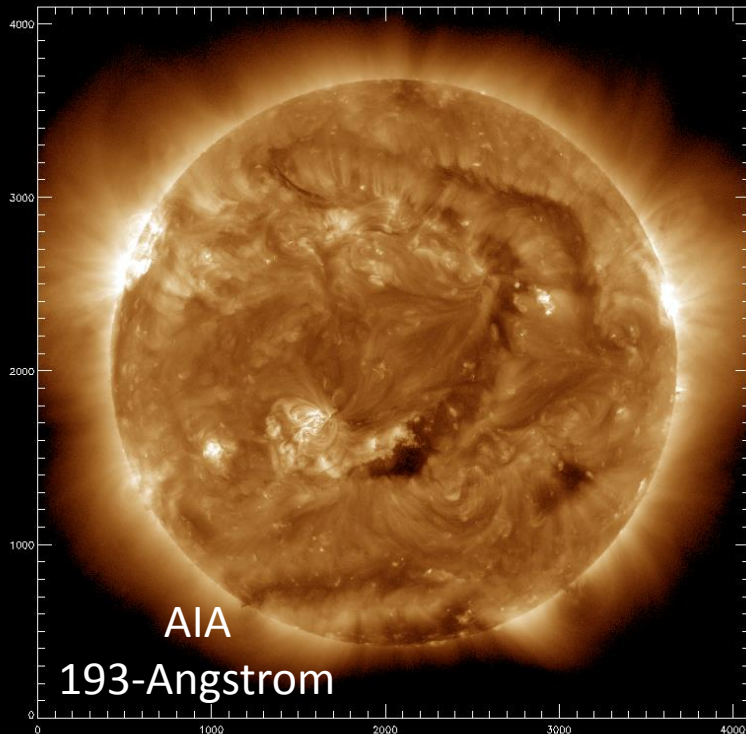
- Not all canopies are created equal
- Ranking
 - Active Regions
 - Bright Points
 - Coronal Holes
 - Quiet Sun

Ranking the Canopies



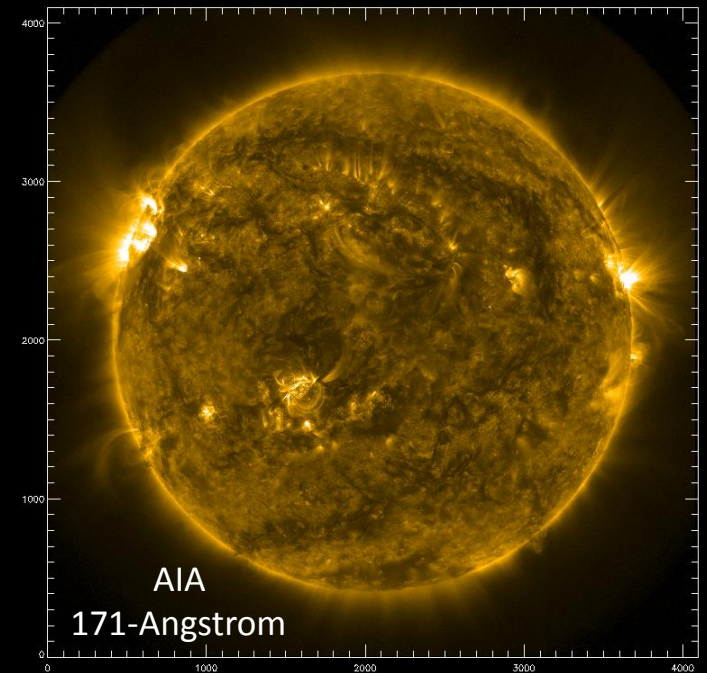
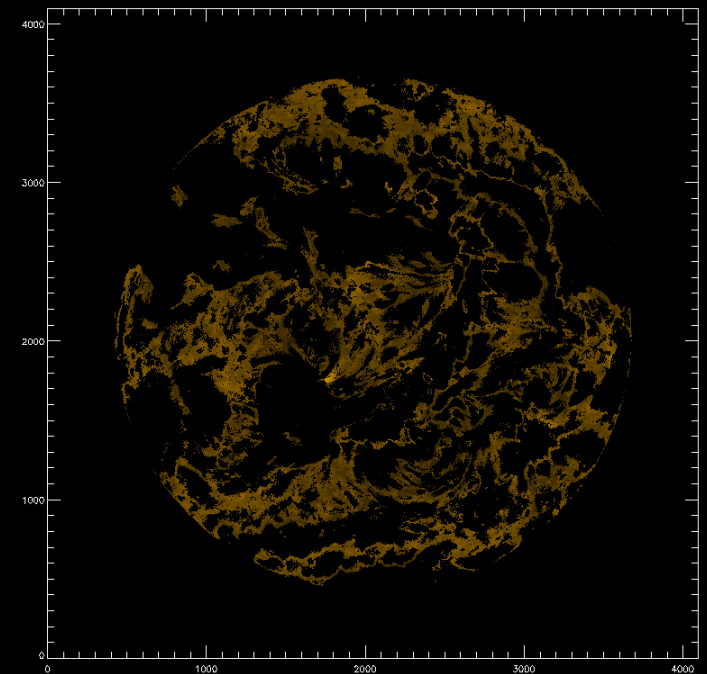
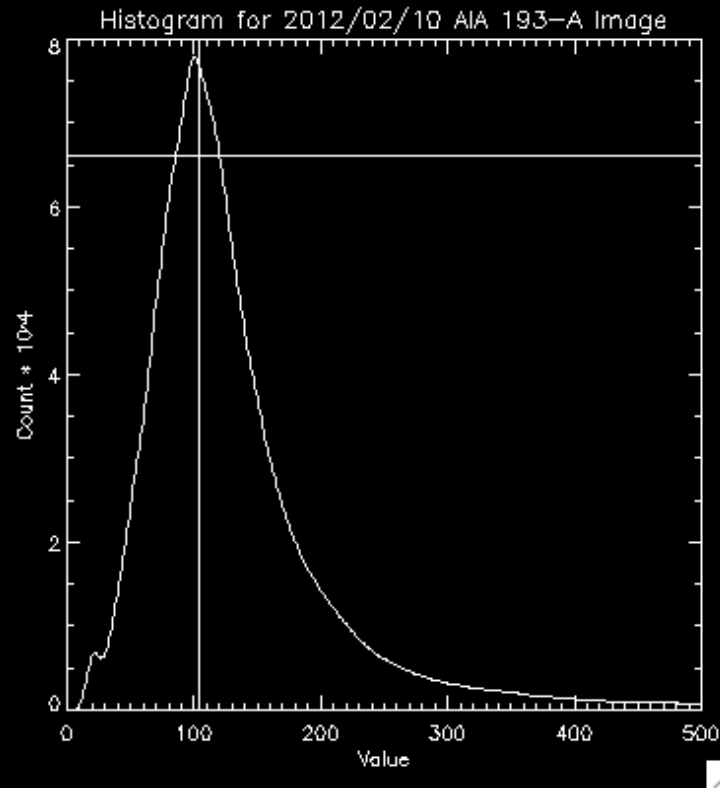
Problems

- All images are different
 - Each requires different levels to define QS, ARs, CHs, Canopies
- Found peak of histogram to determine baseline for all levels



Problems

- Used 193-defined QS to find base level for 171 QS

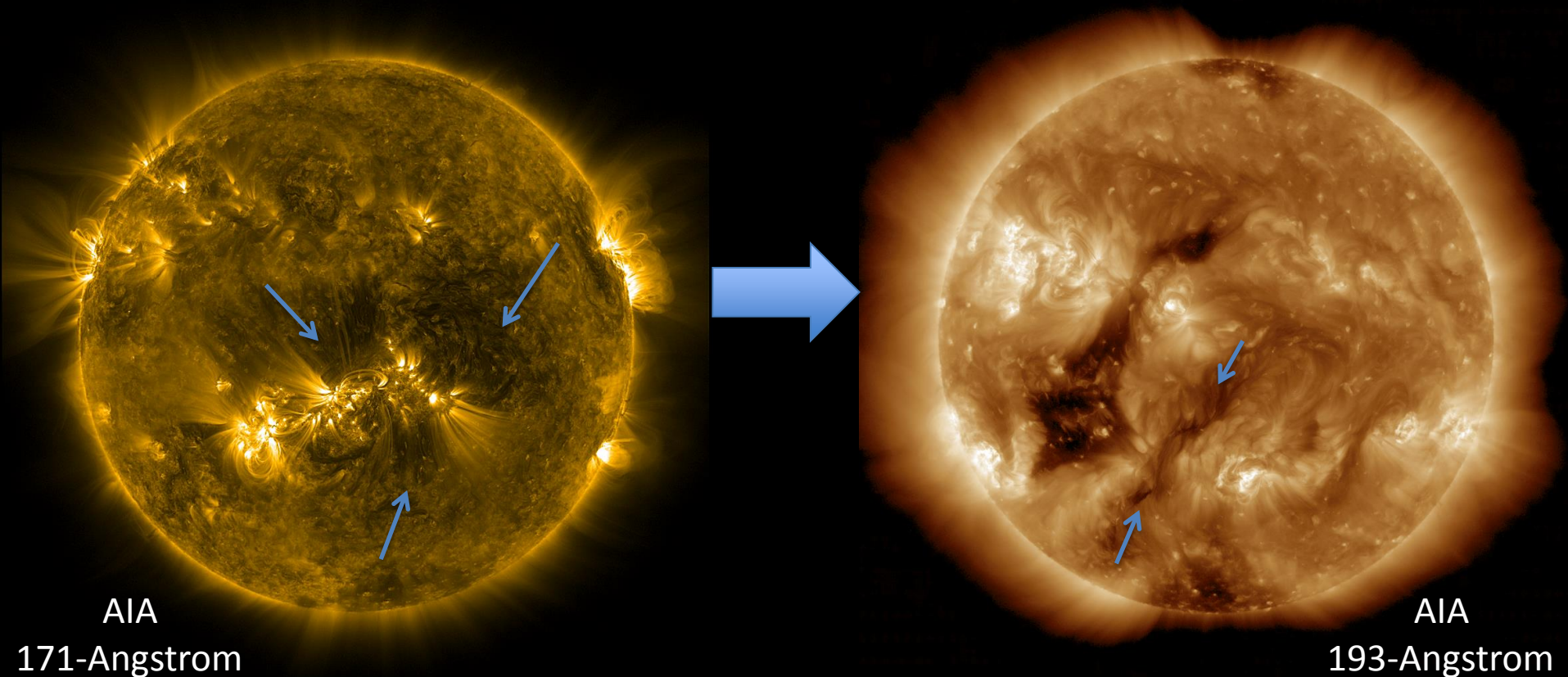


Results

- We have lots of info on canopies for any image
 - Locations, AIA fluxes, Physical Properties, etc.
- Used these programs over time to track regions and Canopies
- Learn about the properties and evolution of Canopies

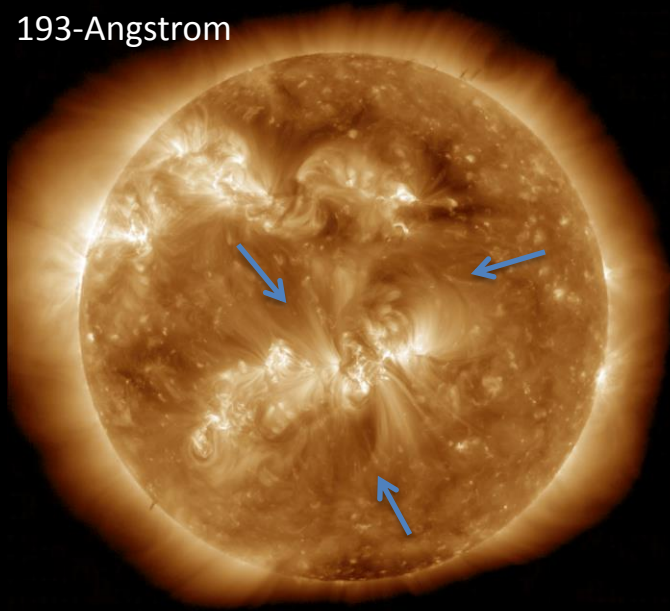
Evolution

- Noticed a few clear cases of transformation from canopy to quiescent filament
- Programs show this as well!

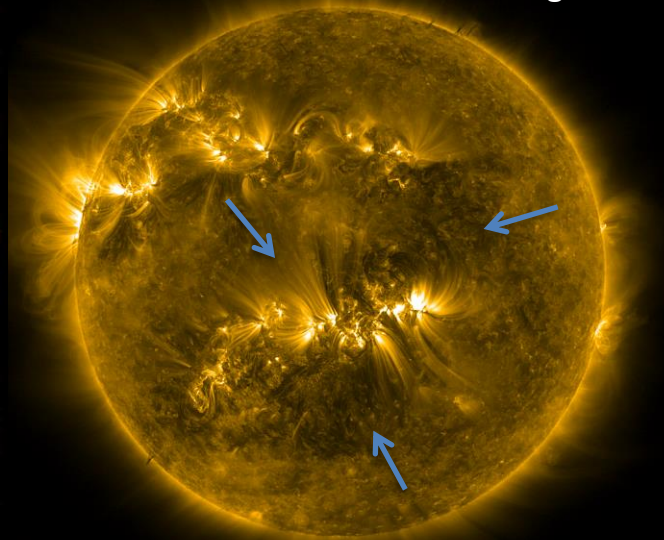


March 29, 2011

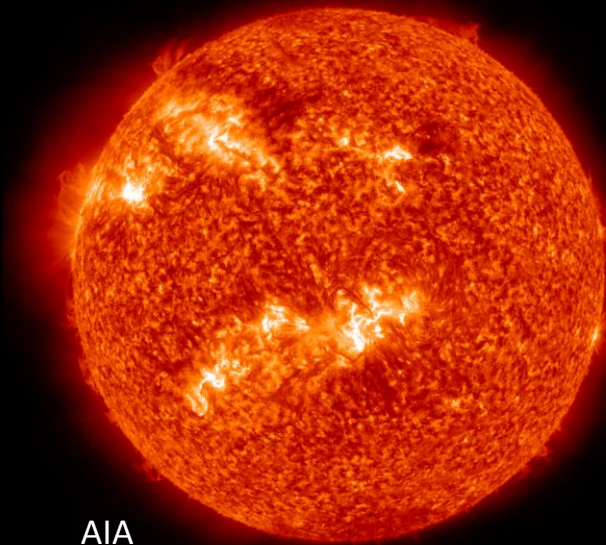
AIA
193-Angstrom



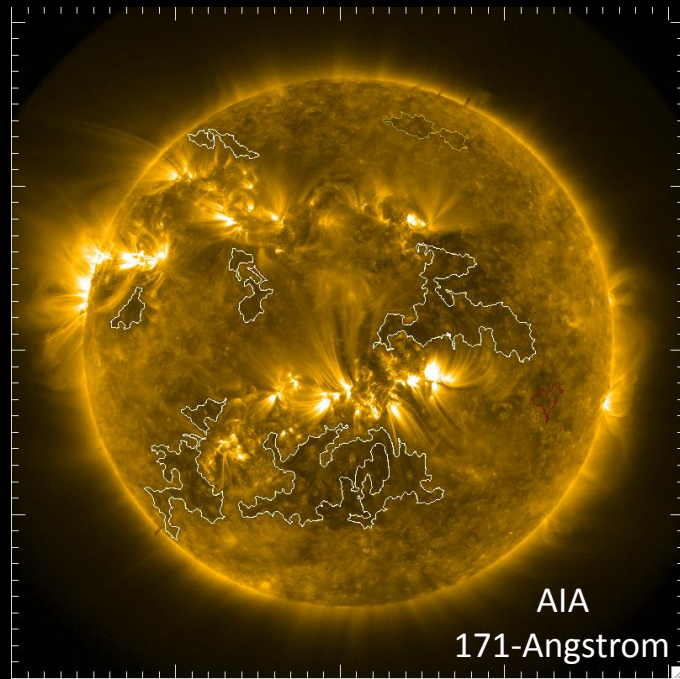
AIA
171-Angstrom



AIA
304-Angstrom

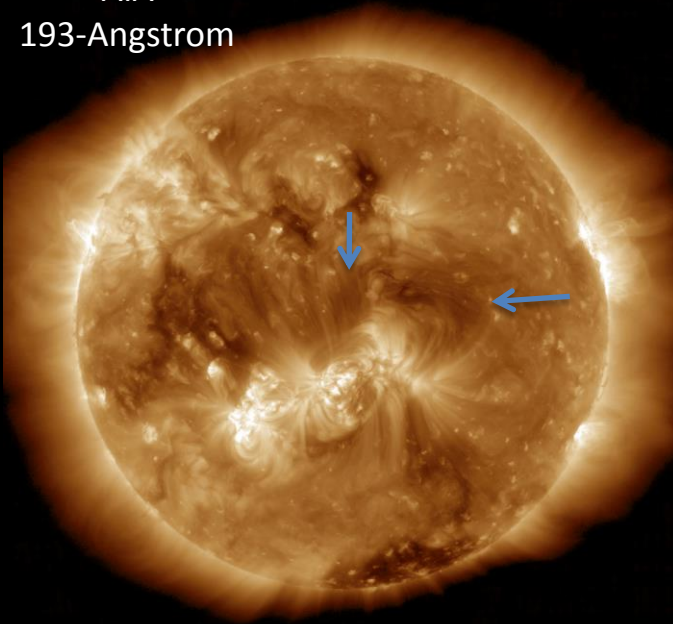


AIA
171-Angstrom

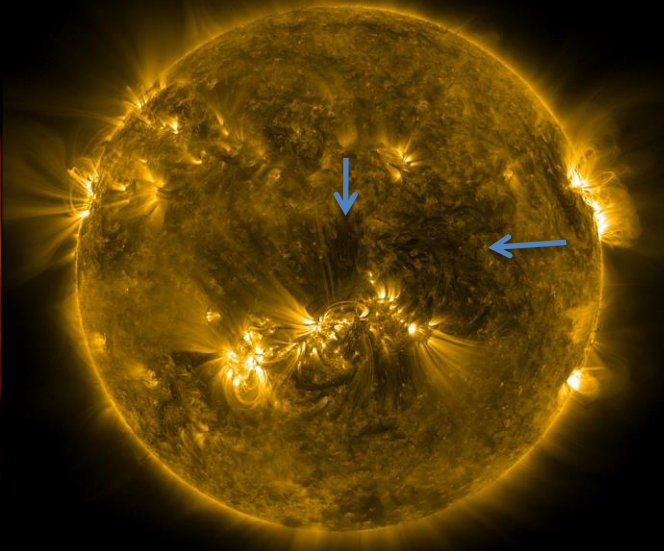


April 25, 2011

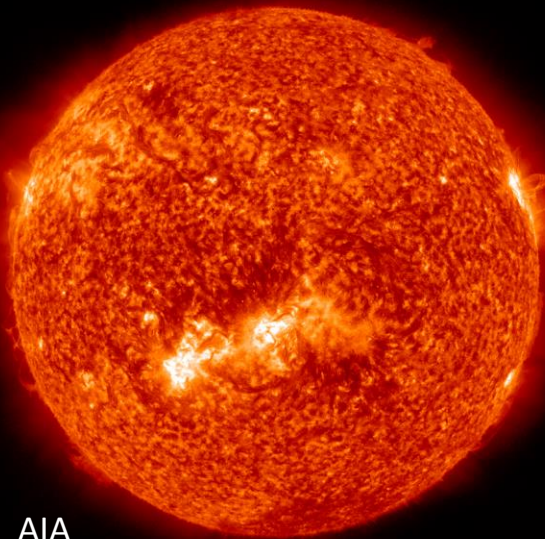
AIA
193-Angstrom



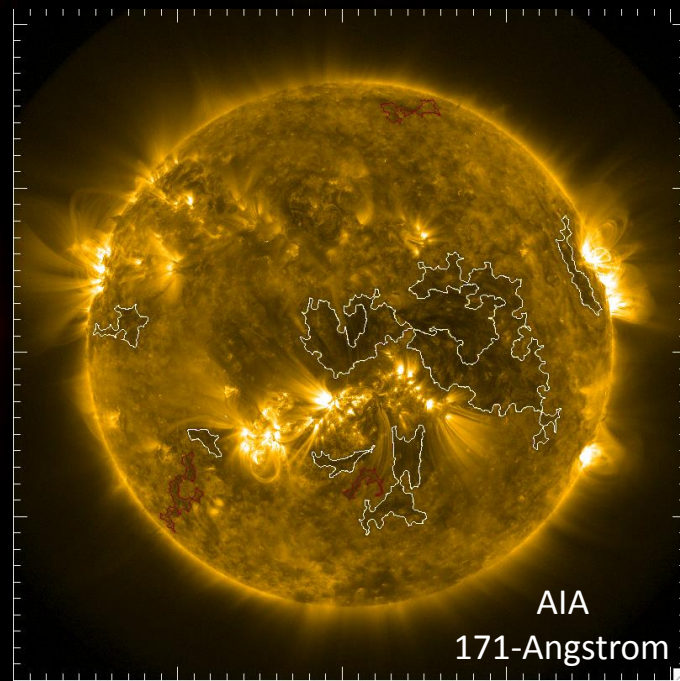
AIA
171-Angstrom



AIA
304-Angstrom

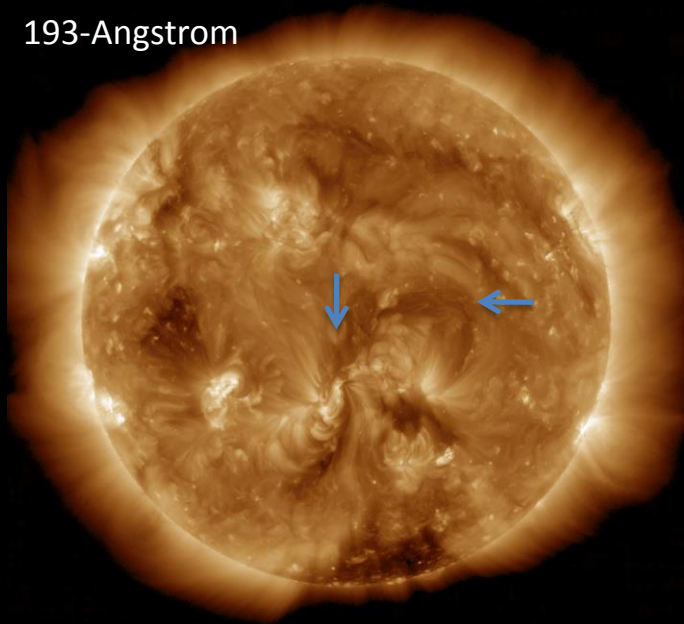


AIA
171-Angstrom

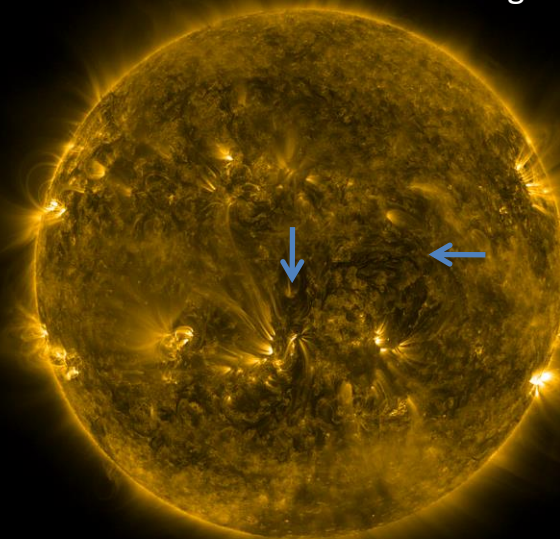


May 22, 2011

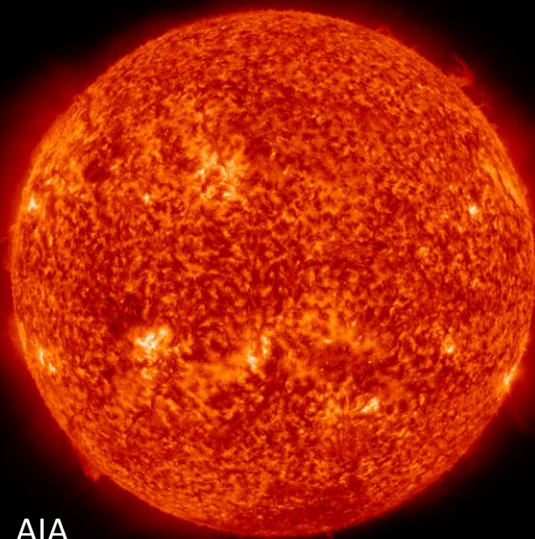
AIA
193-Angstrom



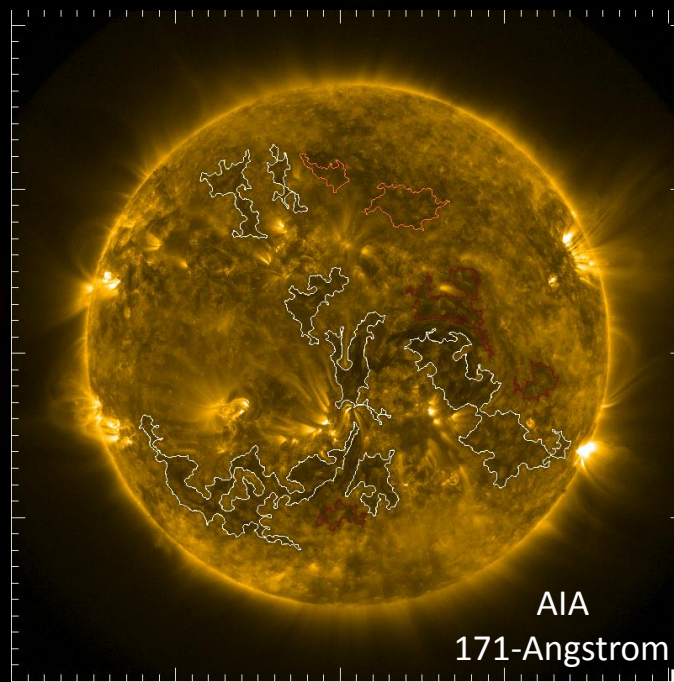
AIA
171-Angstrom



AIA
304-Angstrom

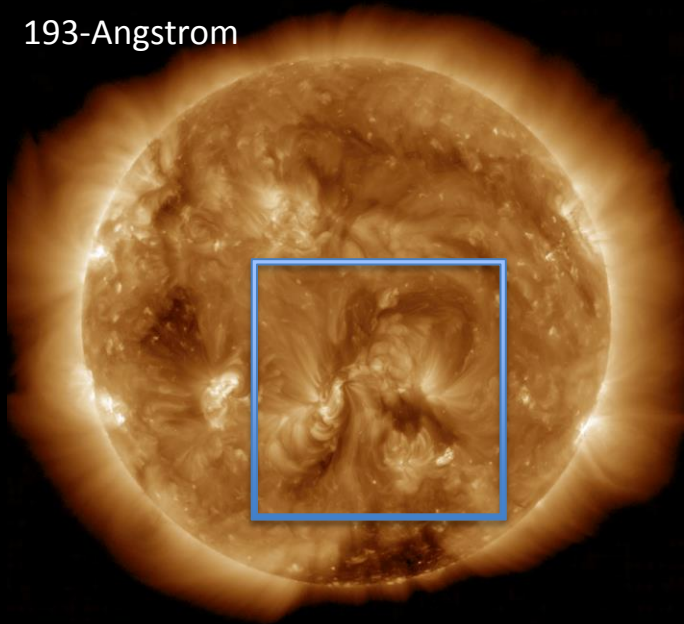


AIA
171-Angstrom

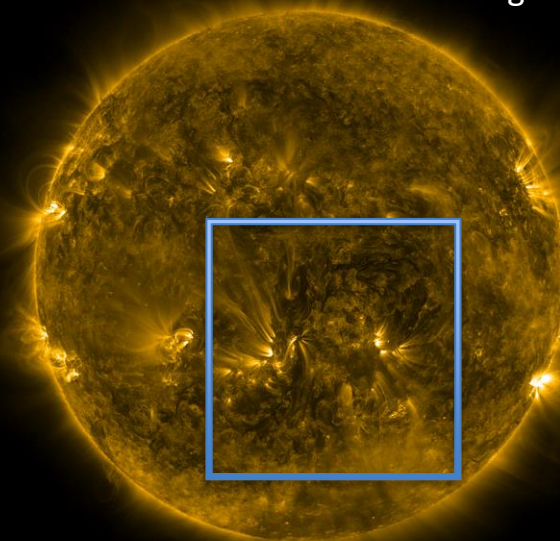


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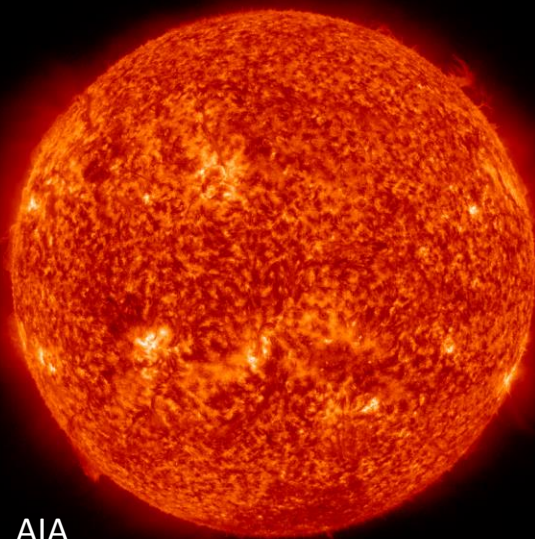
AIA
193-Angstrom



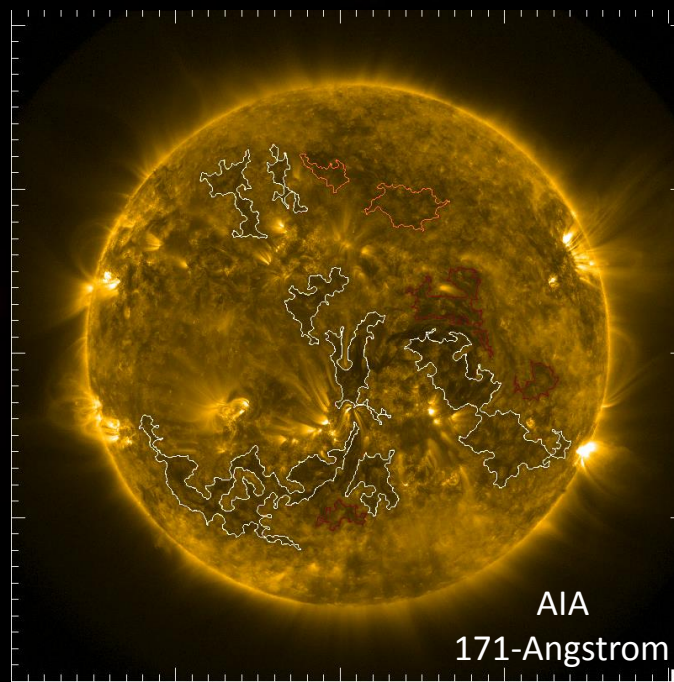
AIA
171-Angstrom



AIA
304-Angstrom

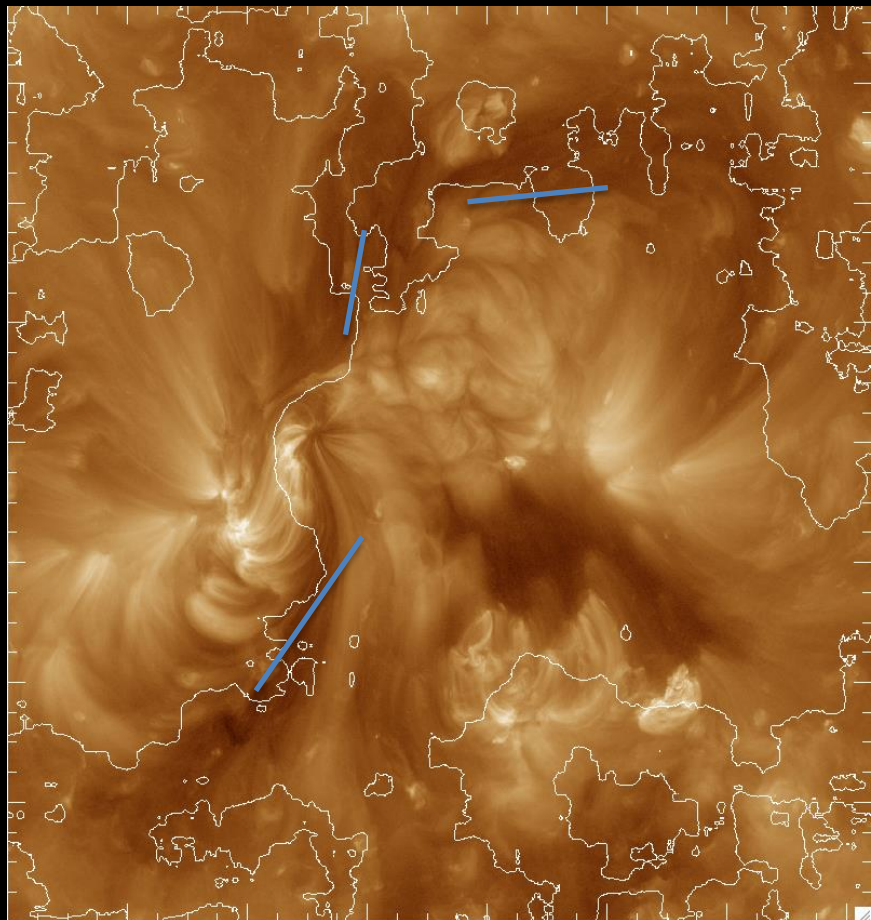


AIA
171-Angstrom

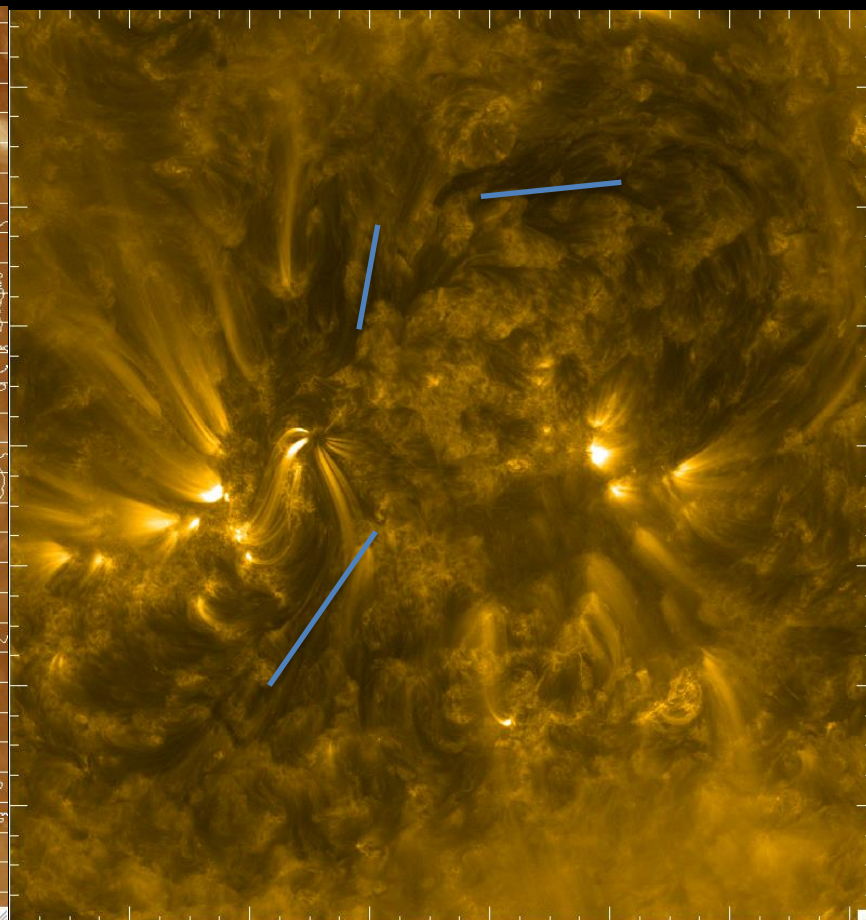


May 22, 2011

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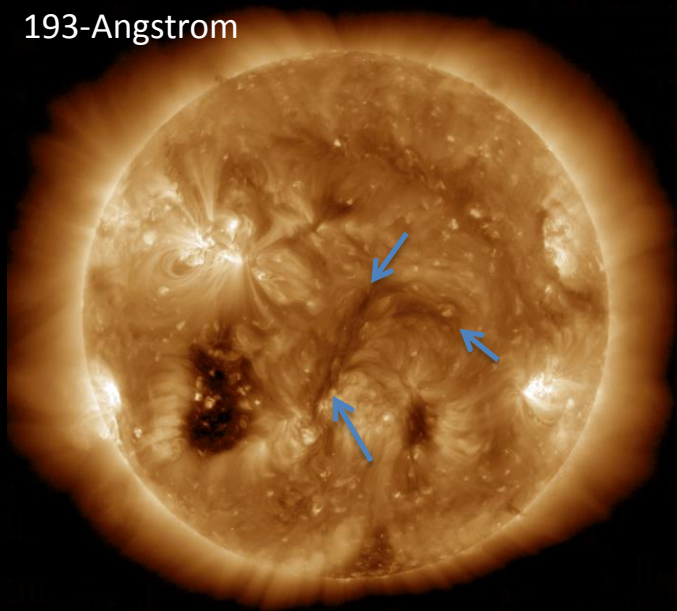


AIA
171-Angstrom

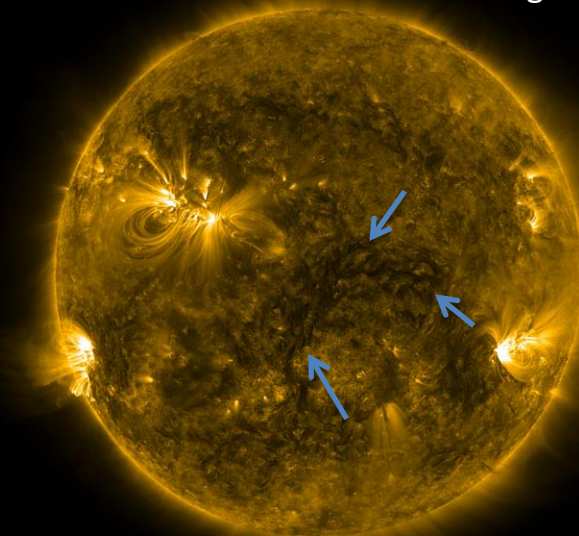


June 18, 2011

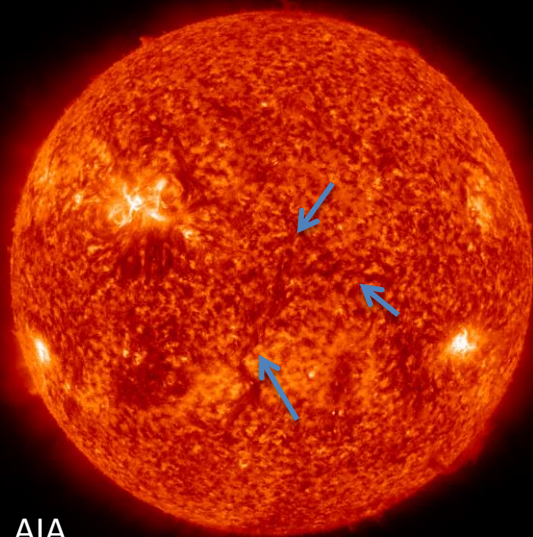
AIA
193-Angstrom



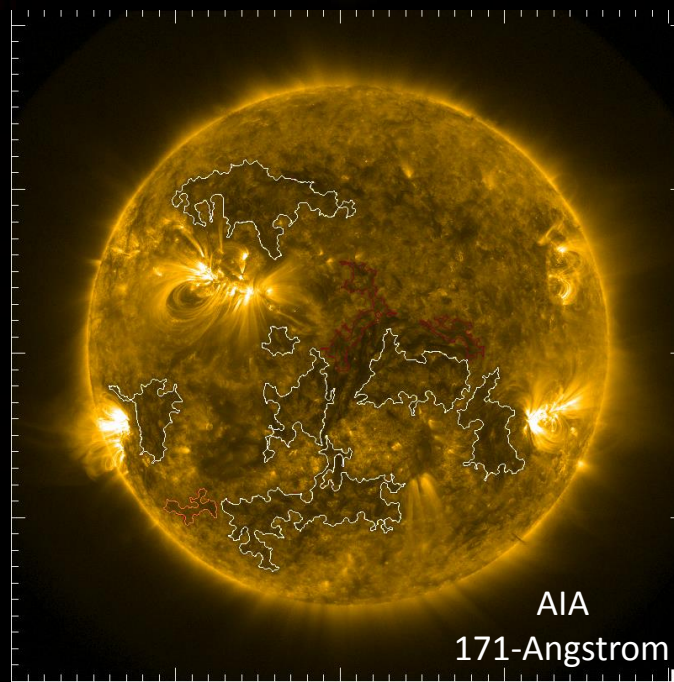
AIA
171-Angstrom



AIA
304-Angstrom

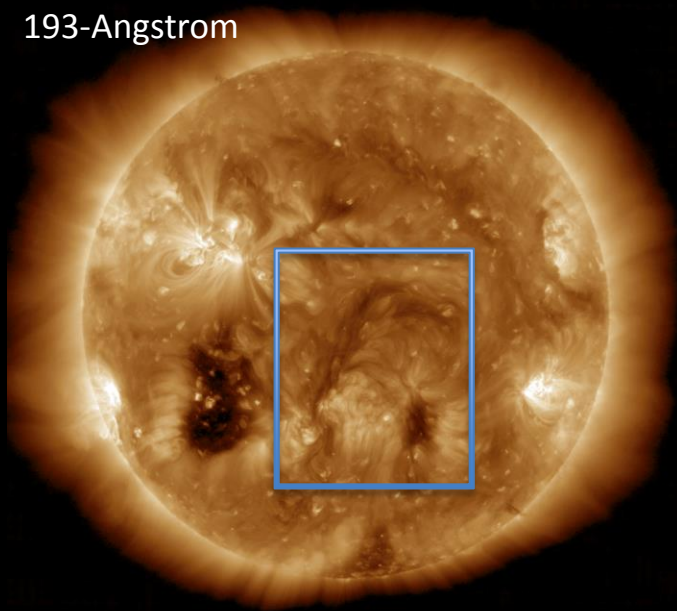


AIA
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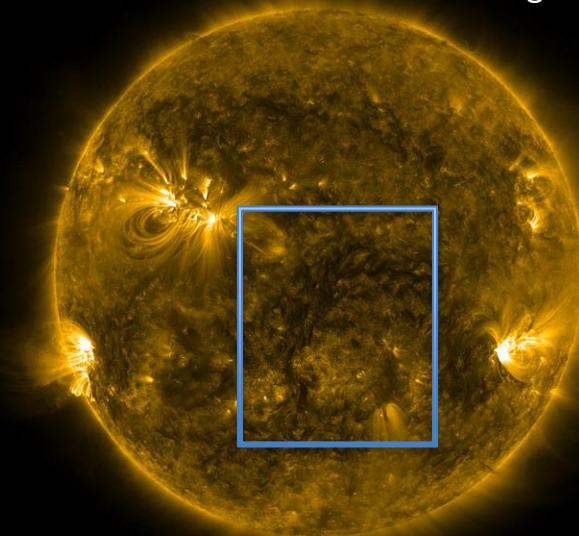


June 18, 2011

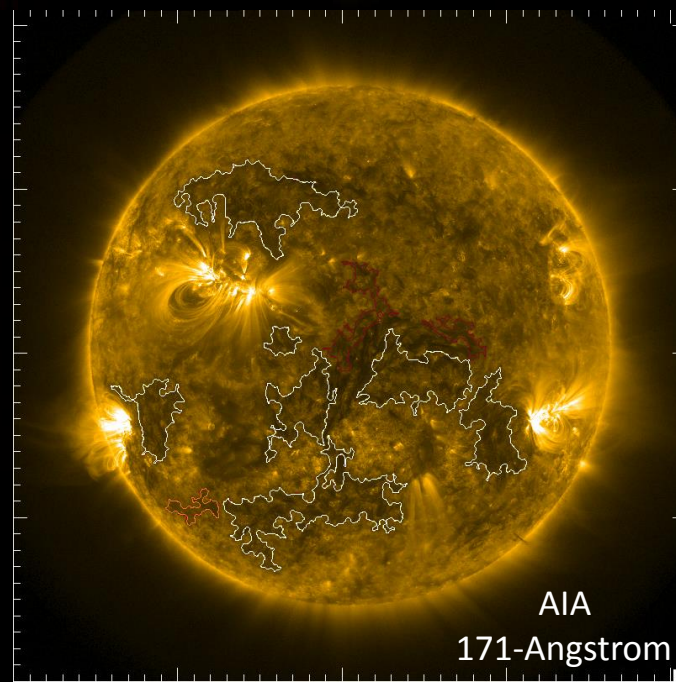
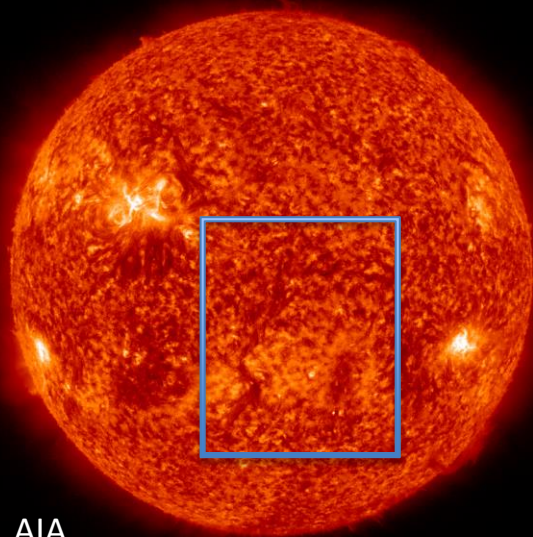
AIA
193-Angstrom



AIA
171-Angstrom



AIA
304-Angstrom



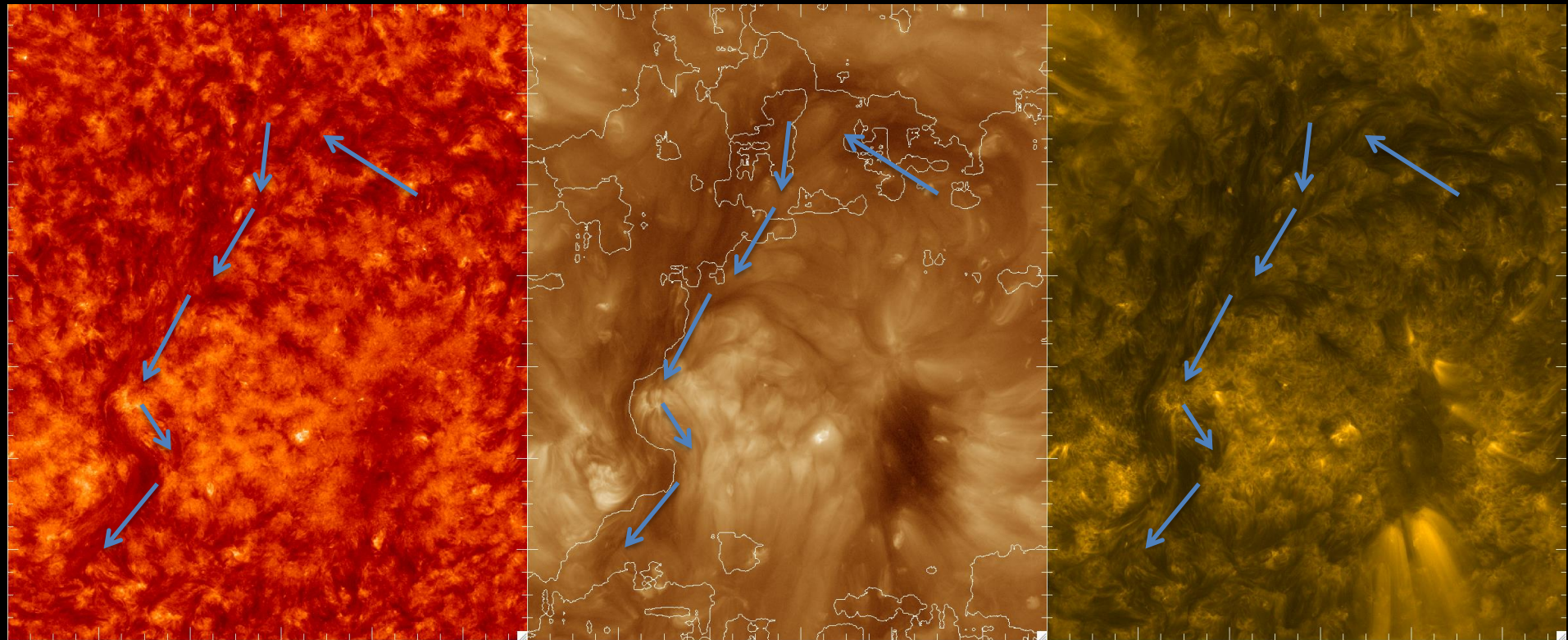
AIA
171-Angstrom

June 18, 2011

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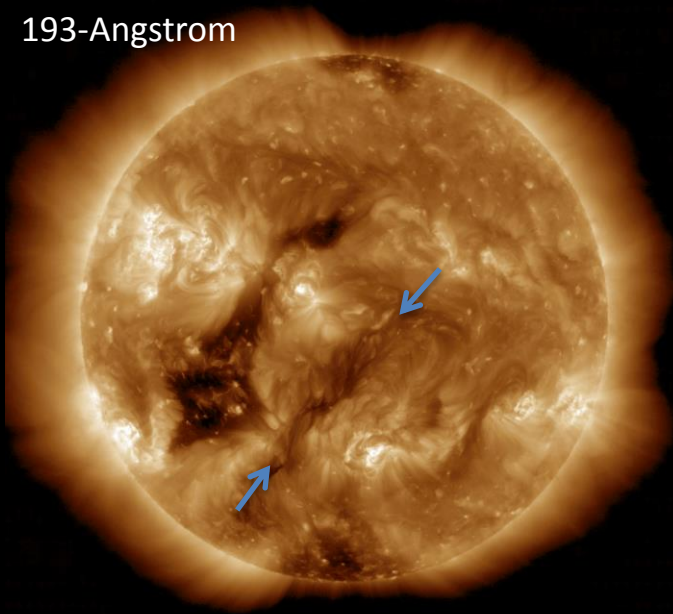
AIA
193-Angstrom

AIA
171-Angstrom

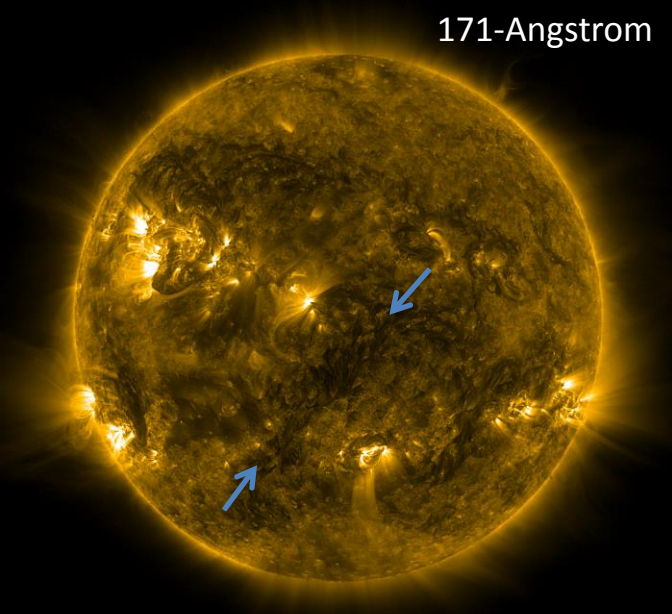


July 15, 2011

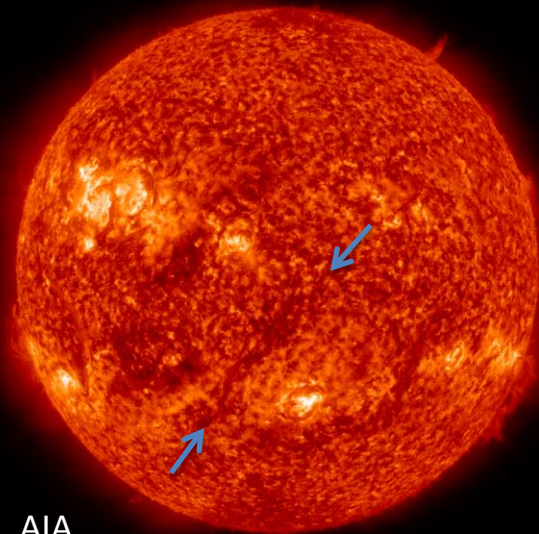
AIA
193-Angstrom



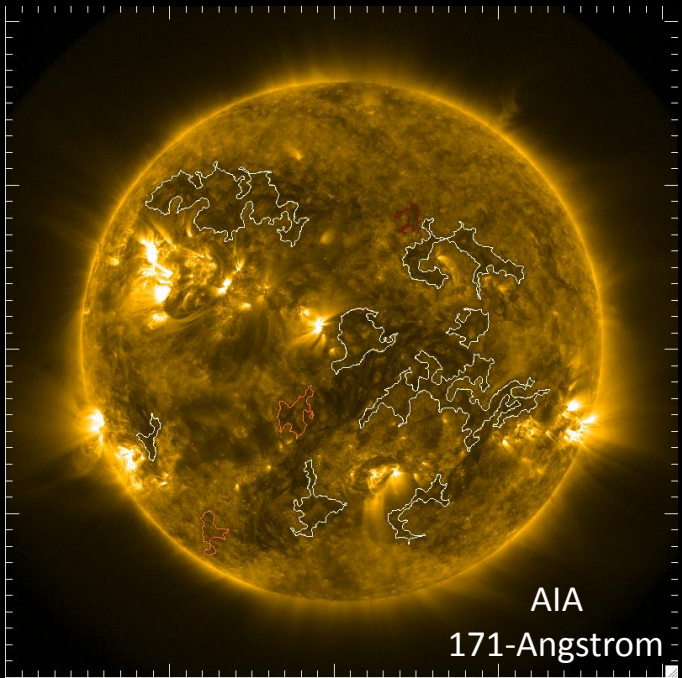
AIA
171-Angstrom



AIA
304-Angstrom

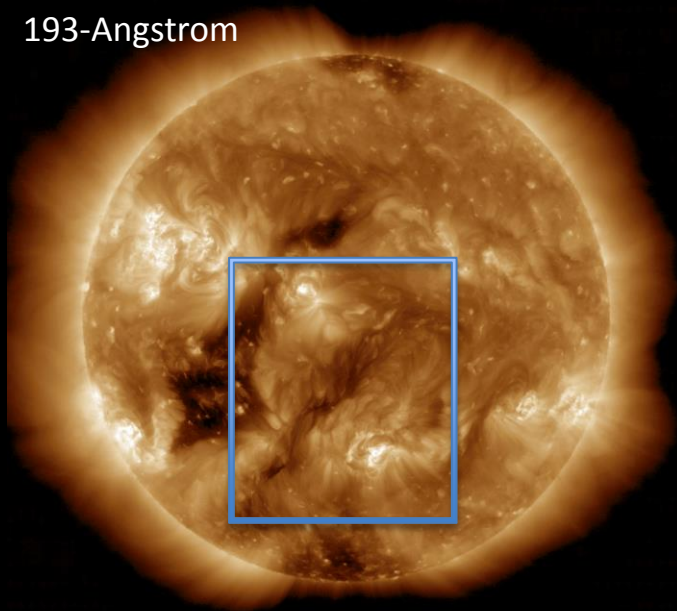


AIA
171-Angstrom

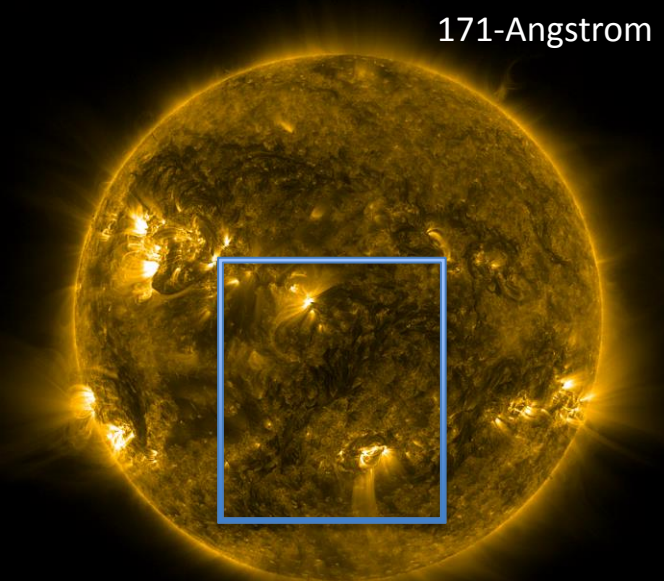


July 15, 2011

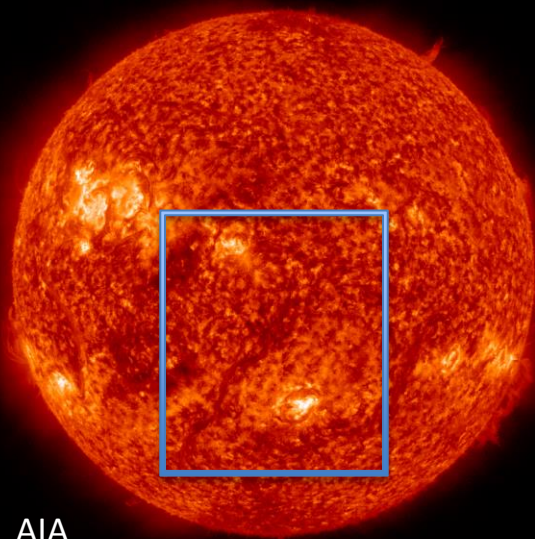
AIA
193-Angstrom



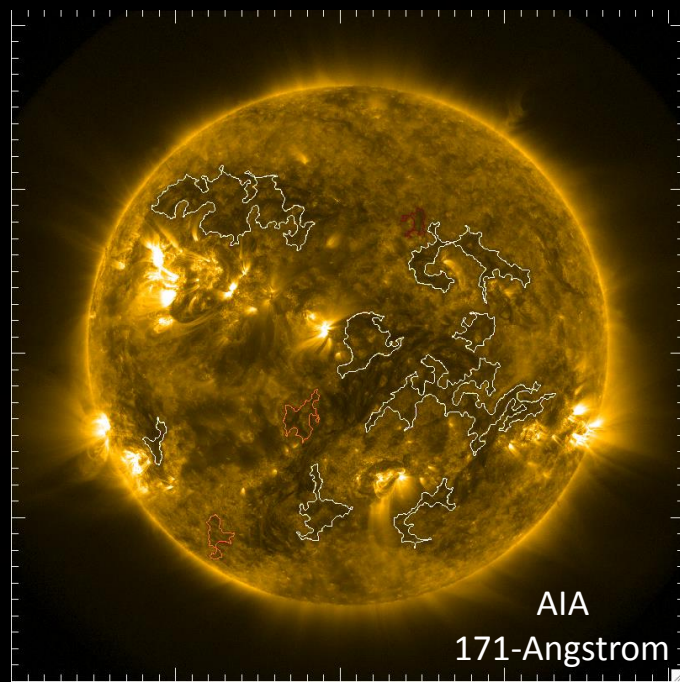
AIA
171-Angstrom



AIA
304-Angstrom



AIA
171-Angstrom

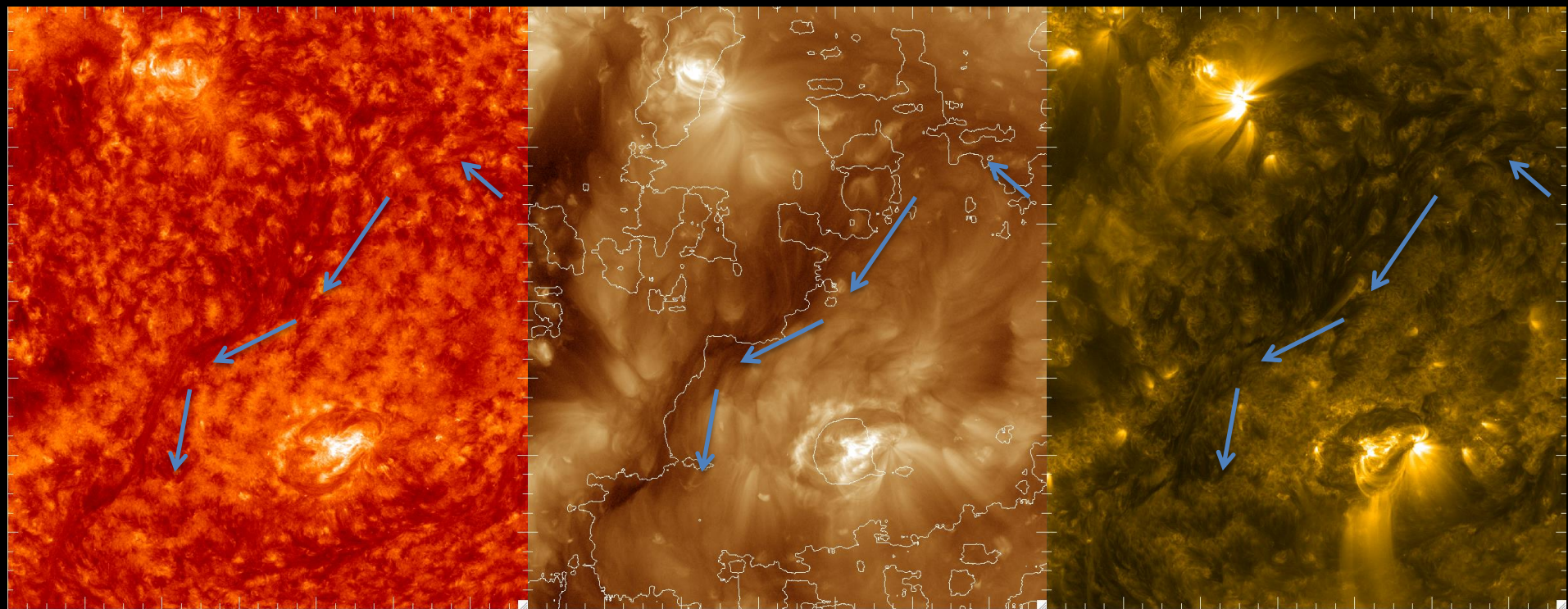


July 15, 2011

AIA
304-Angstrom

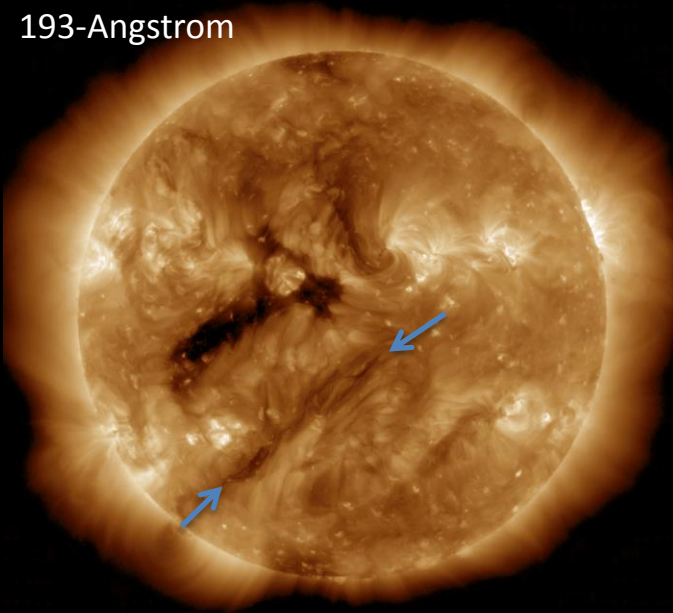
AIA
193-Angstrom

AIA
171-Angstrom

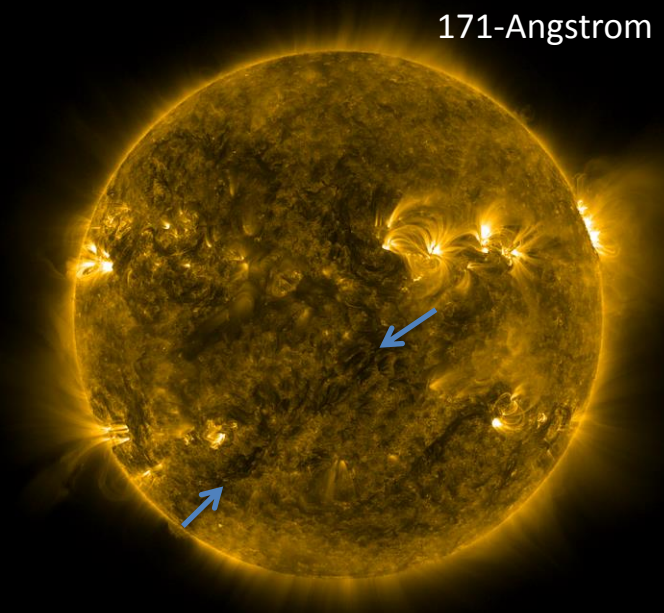


August 11, 2011

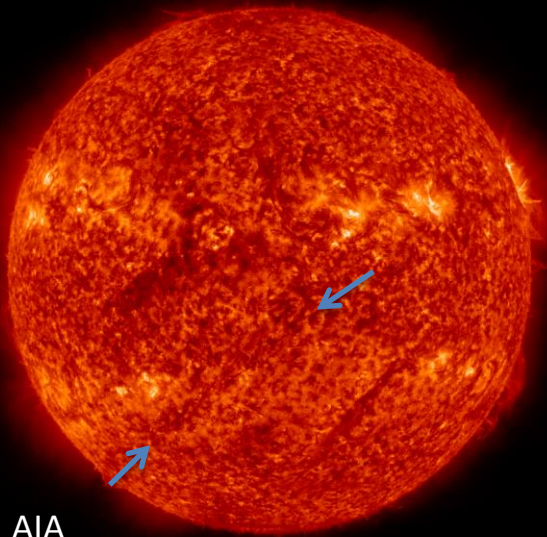
AIA
193-Angstrom



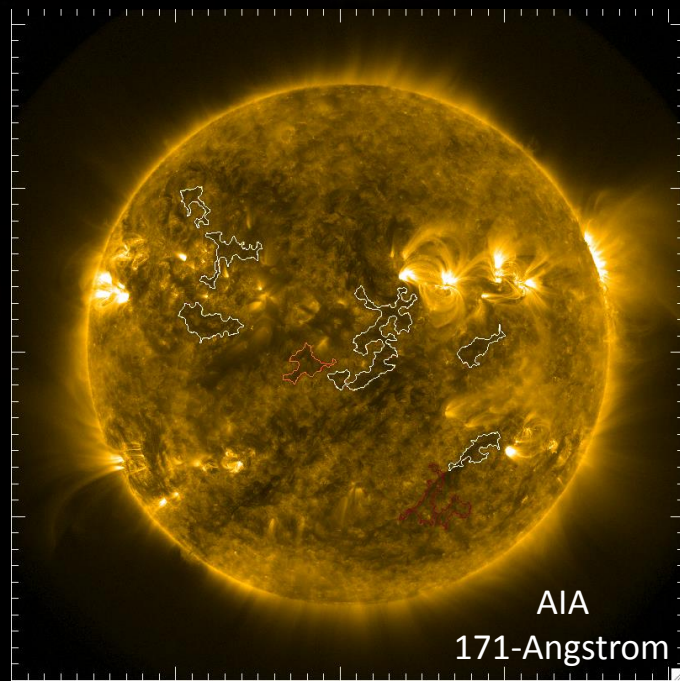
AIA
171-Angstrom



AIA
304-Angstrom



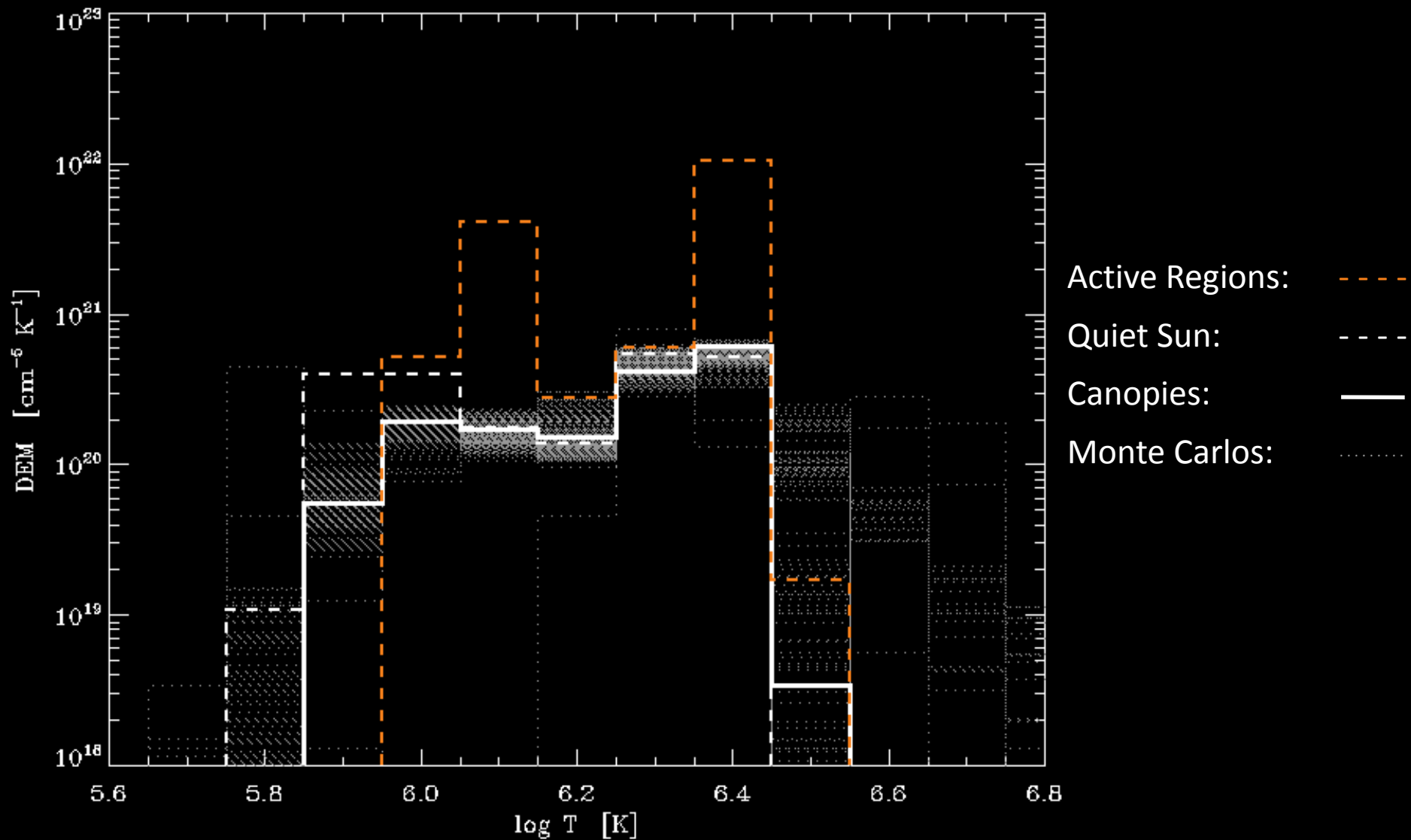
AIA
171-Angstrom



DEM

- Differential Emission Measure (DEM)
- Uses flux values (average intensities) in multiple wavelengths to determine the amount of emission at each temperature
- Issues due to abundances and response functions
- But, we got preliminary results

DEM



Conclusions

- Canopies are regions of low-lying horizontal magnetic field
 - Fibril structures seen in Fe IX (17.1 nm) AIA images
- Wrote programs to find them using discrepancies in luminosity between low and high temperature wavelength images
- Tracked evolution of canopies into filaments
- By using DEM analysis, we found that canopies seem to be a combination of QS and ARs.
 - Showing hot AR loops with cool fibrils underneath

Future Work

- More analysis of the data looking for more examples of canopy evolution
- Use Stereo A/B for full sun 360 degree canopy tracking
- Use SoHO EIT to look much further back in time
- Get correct temperature response functions for DEM and try to get more accurate temperature mappings

References



Wang, Y.-M., Robbrecht, E., & Muglach, K., 2011, ApJ, 733, 20

Rosner, R., Tucker, W. H., & Vaiana, G.S., 1978, ApJ, 220, 643

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Kathy Reeves

All of the CfA Scientists and Staff

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Thank you