

Understanding Solar Flare Heating: Week Two Update

BROCK PARKER

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Background

- Solar Flares
 - Violent release of radiation
 - Related to magnetic field
- Energy
 - Magnetic field reconnection
 - Proportional to footprint

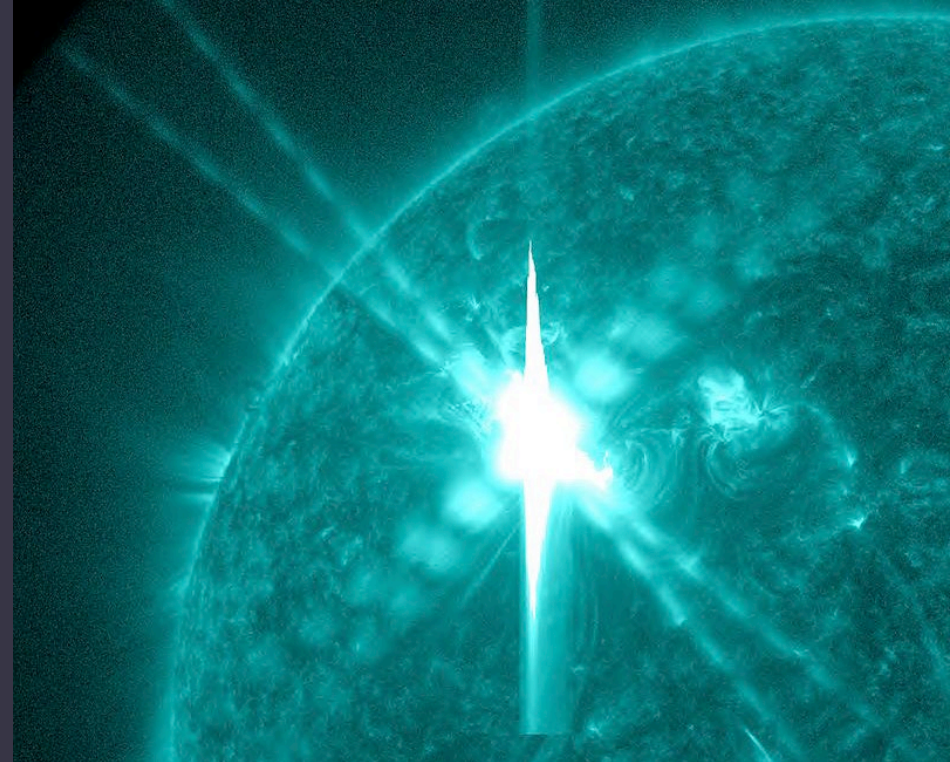


Image Credit: SDO AIA 131

Goals

- Model Synthetic Flares
 - Constrain heating functions
 - Flare loop generation
 - Synthetic light curves
 - One flare
- Synthetic Images
 - 0D and 3D combination
 - Formation insight

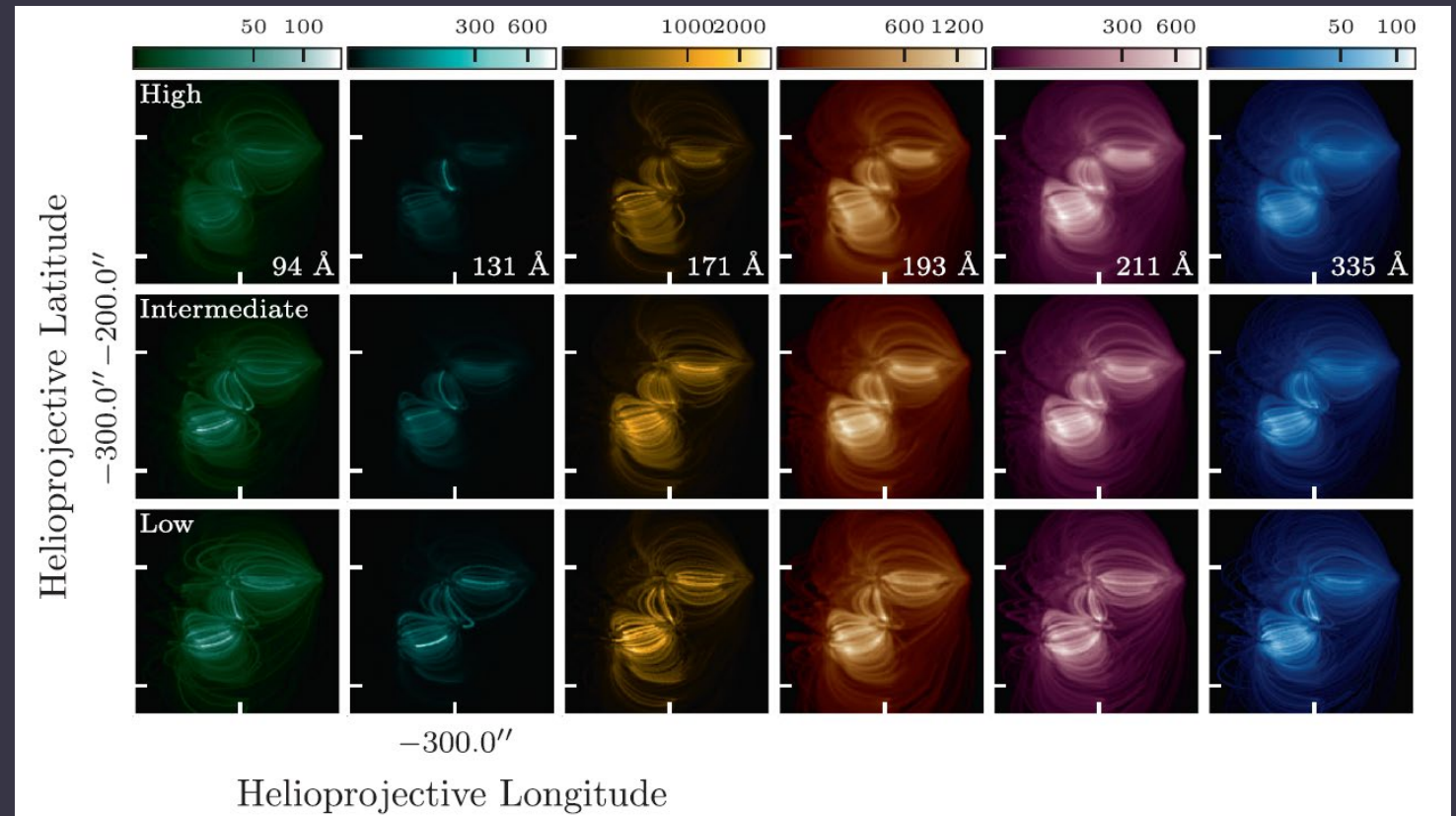
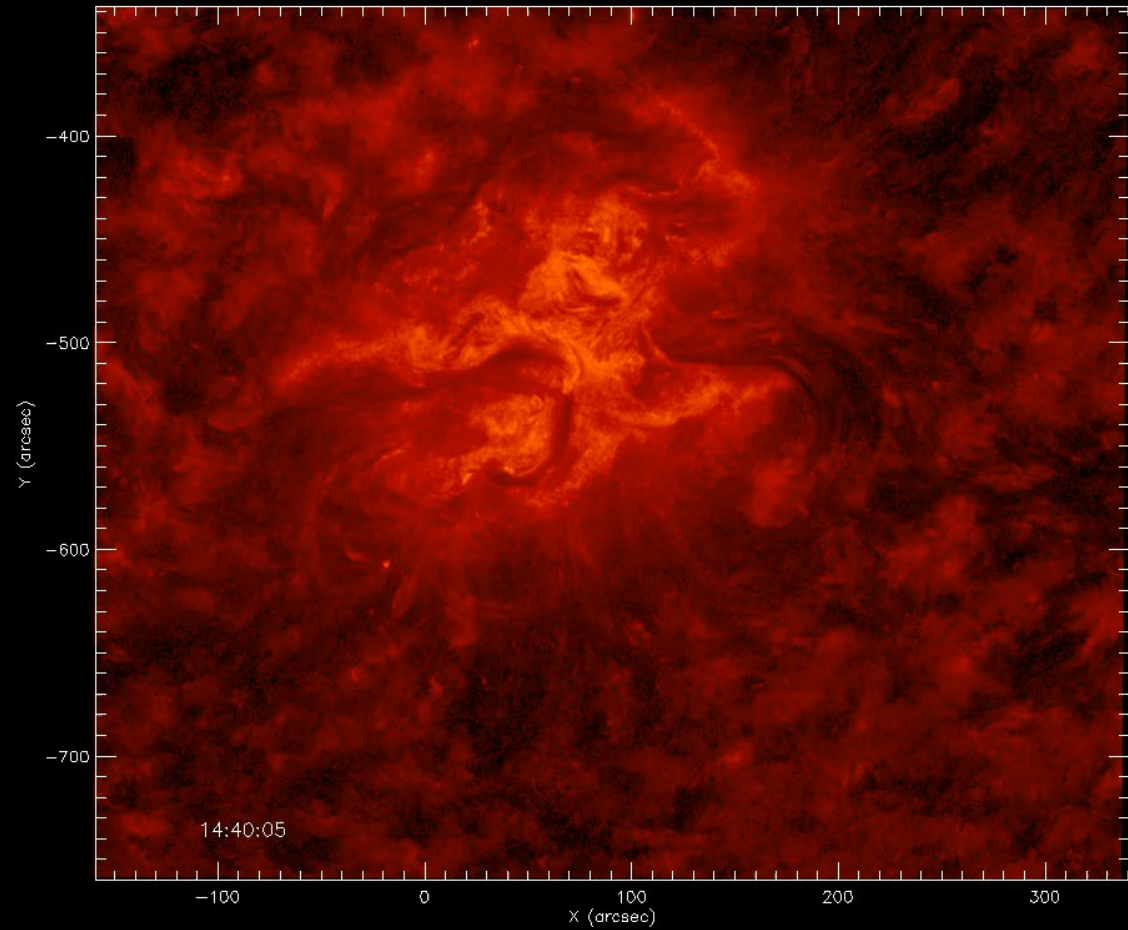


Image Credit: W. T. Barnes, et al.

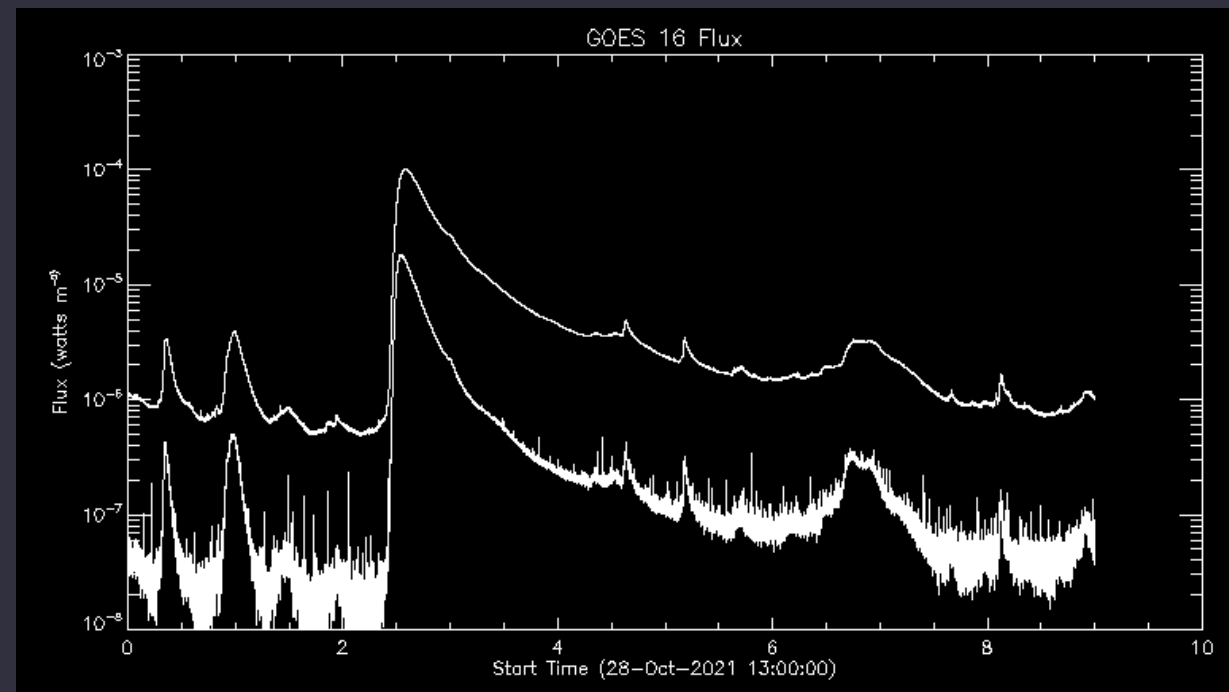
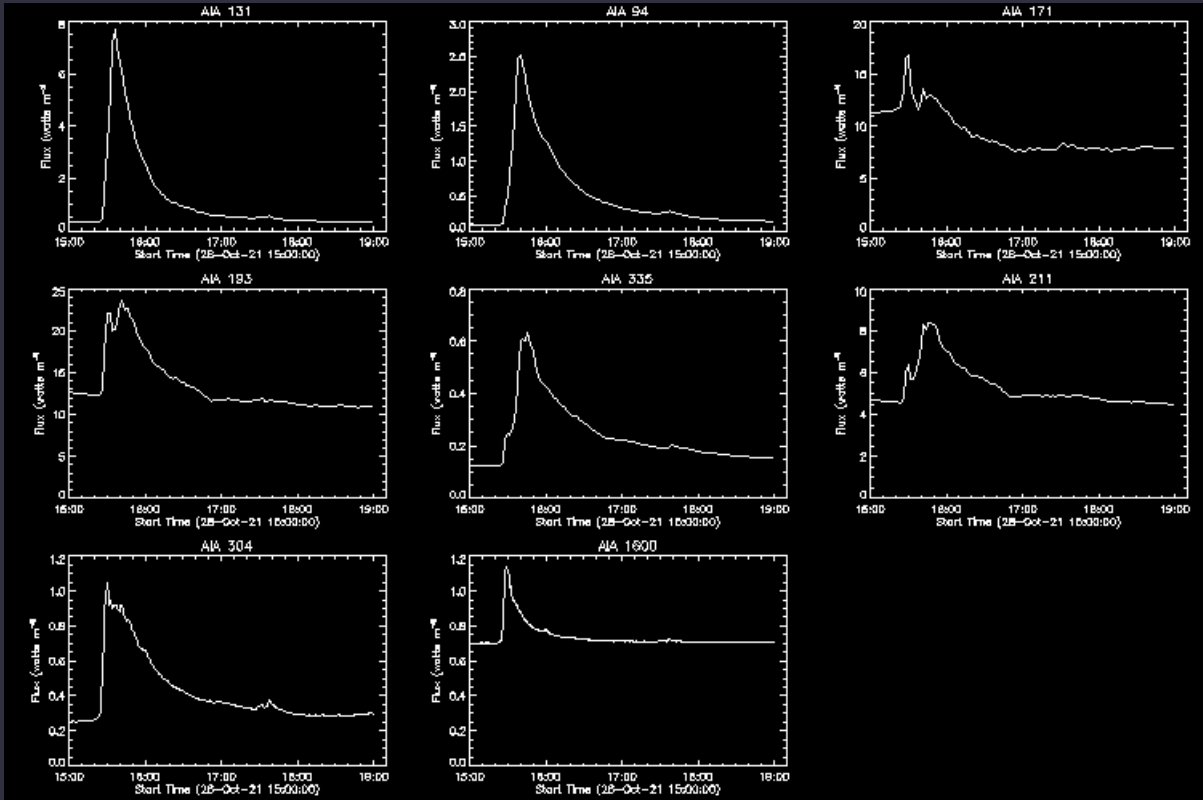
The Culprit

X1.0 Solar Flare on
2021-10-28

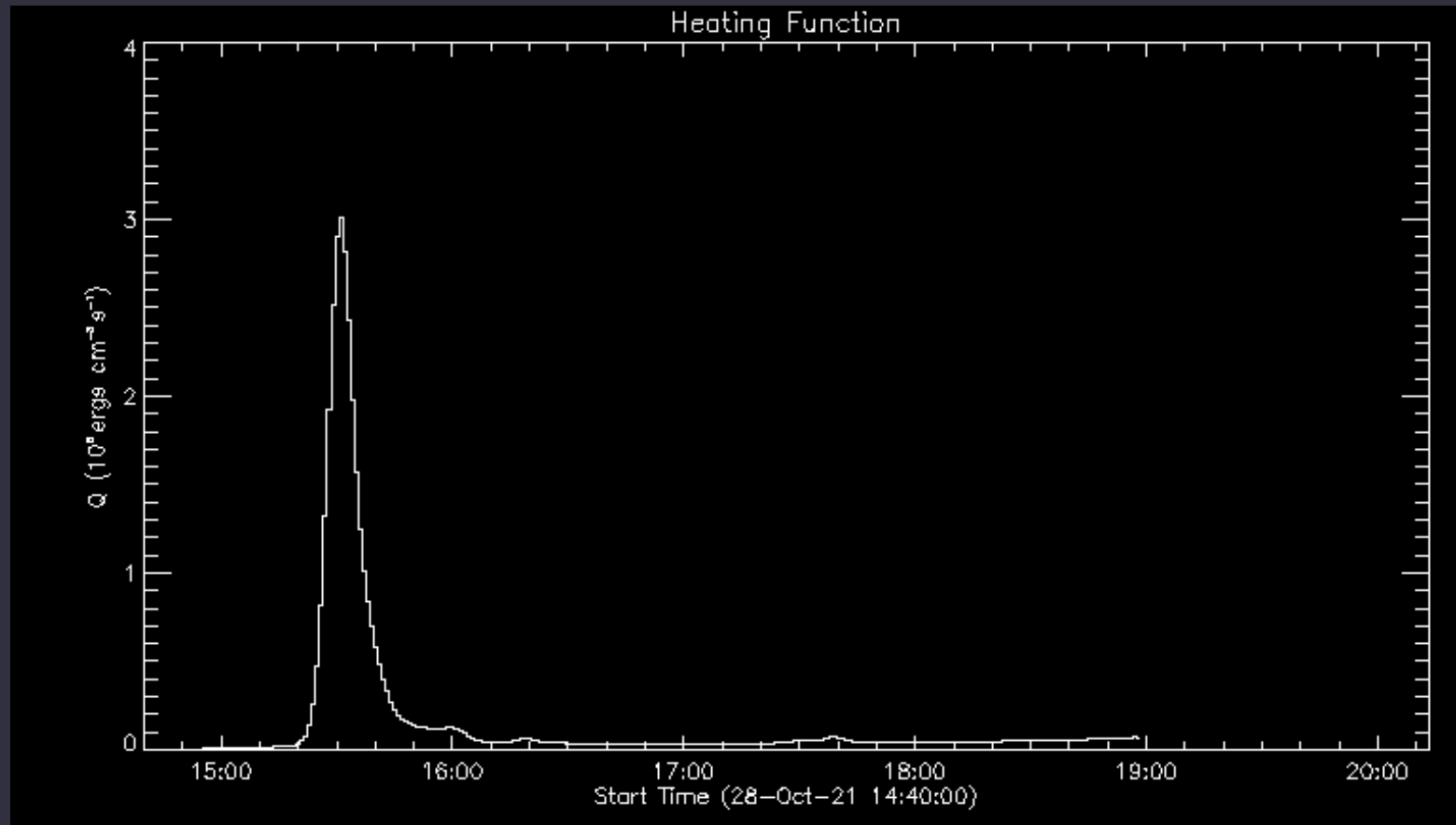


Process

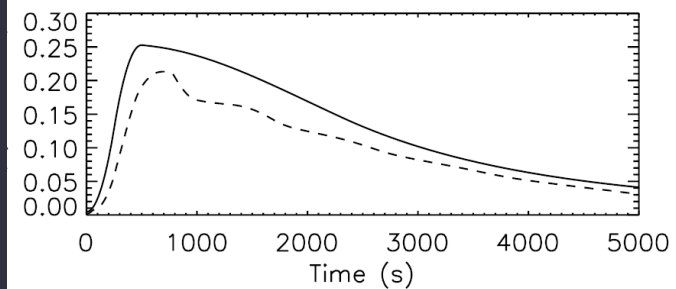
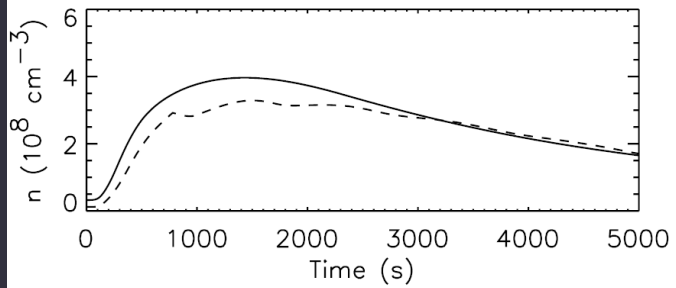
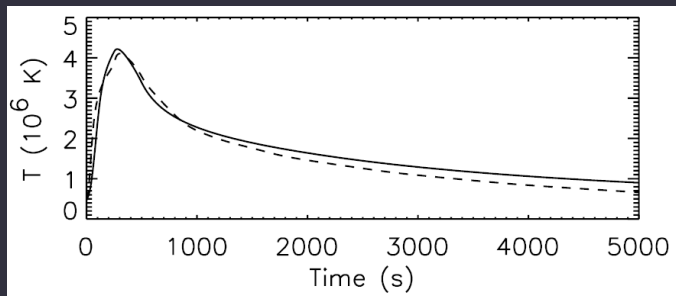
- Download and align data
- Set parameters
- Determine bright pixels
- Generate lightcurves for each separate filter
- Calculate loop lengths
- Calculate the heating function for each
- Run EBTEL - time evolution of density, pressure, and temperature for each loop
- Generate the simulated lightcurves
- Compare to observations
- Combine with EBTEL
- Generate '3d' image of full time evolved loops



Progress
Light Curves



Progress
Heating Function



$$\frac{d\bar{P}}{dt} \approx \frac{2}{3} \left[\bar{Q} - \frac{1}{L} (\mathcal{R}_c + \mathcal{R}_{tr}) - \frac{\mathcal{F}}{L} \left(1 - \frac{3 k \bar{T}}{2 \mathcal{E}} \right) \right]$$

$$\frac{d\bar{n}}{dt} = - \frac{c_2}{5c_3 k L \bar{T}} (F_0 + \mathcal{R}_{tr}) + \frac{\mathcal{F}}{\mathcal{E} L} \left(1 - \frac{c_2}{5c_3} \frac{\mathcal{E}}{k \bar{T}} \right)$$

Image Credit: J. A. Klimchuk, et al.

Process

EBTEL

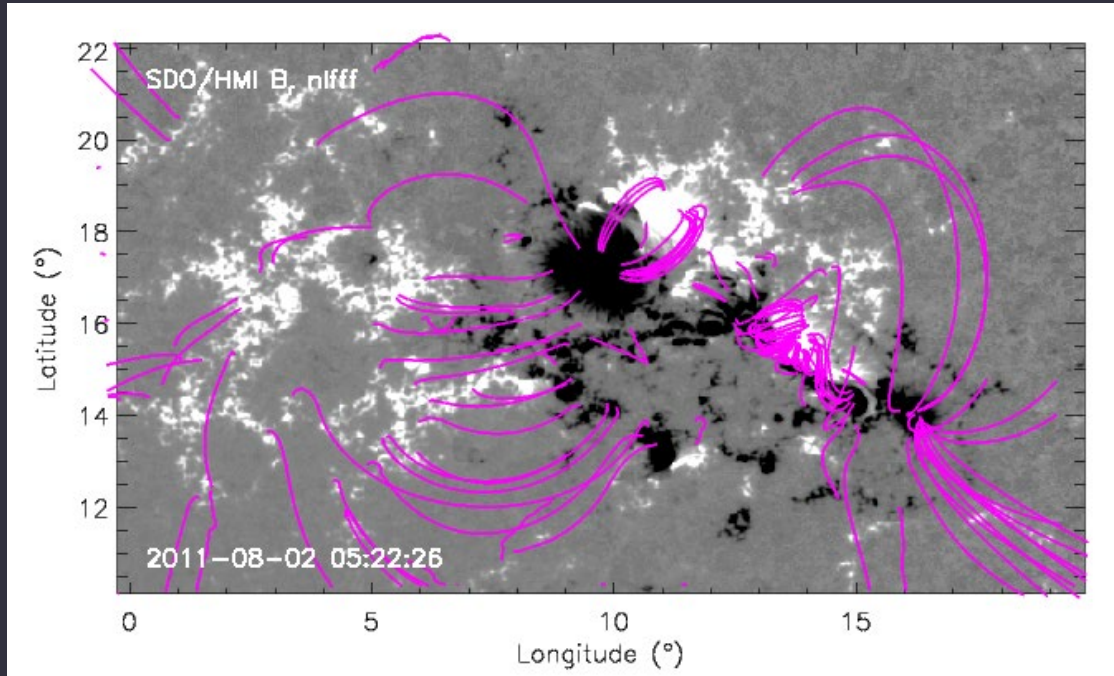


Image Credit: Chunming Zhu

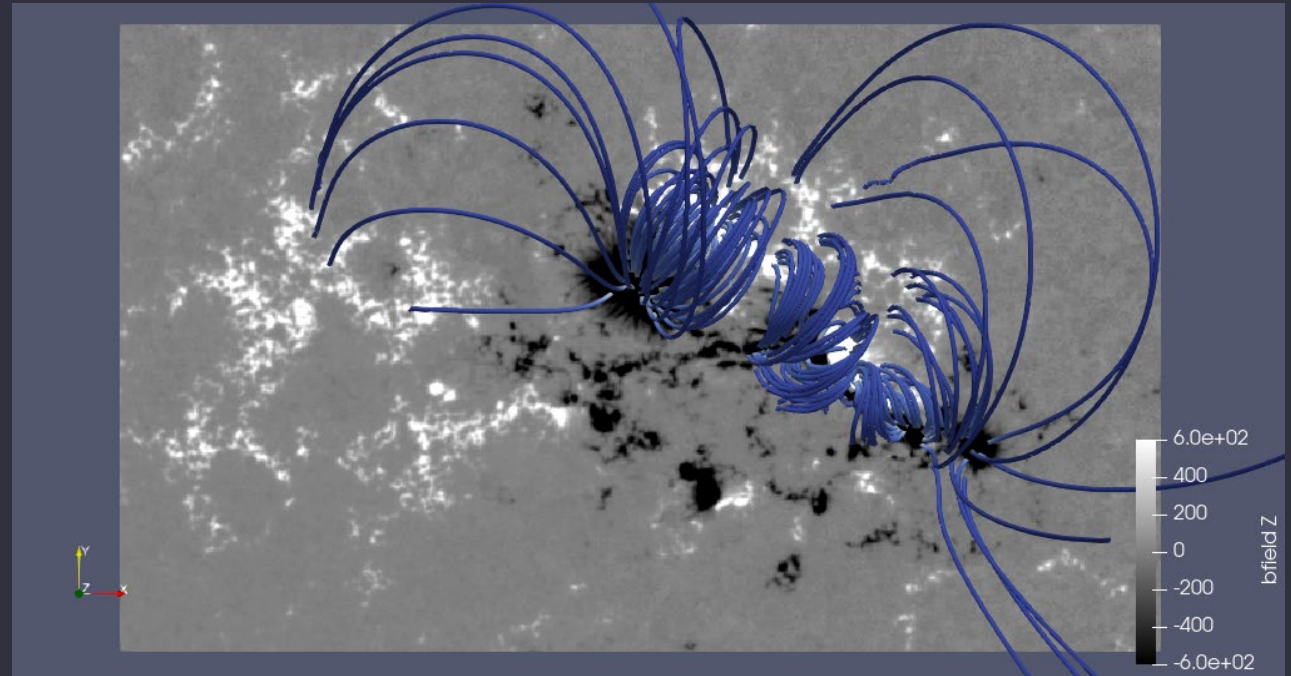


Image Credit: Chunming Zhu

Process
Extrapolation

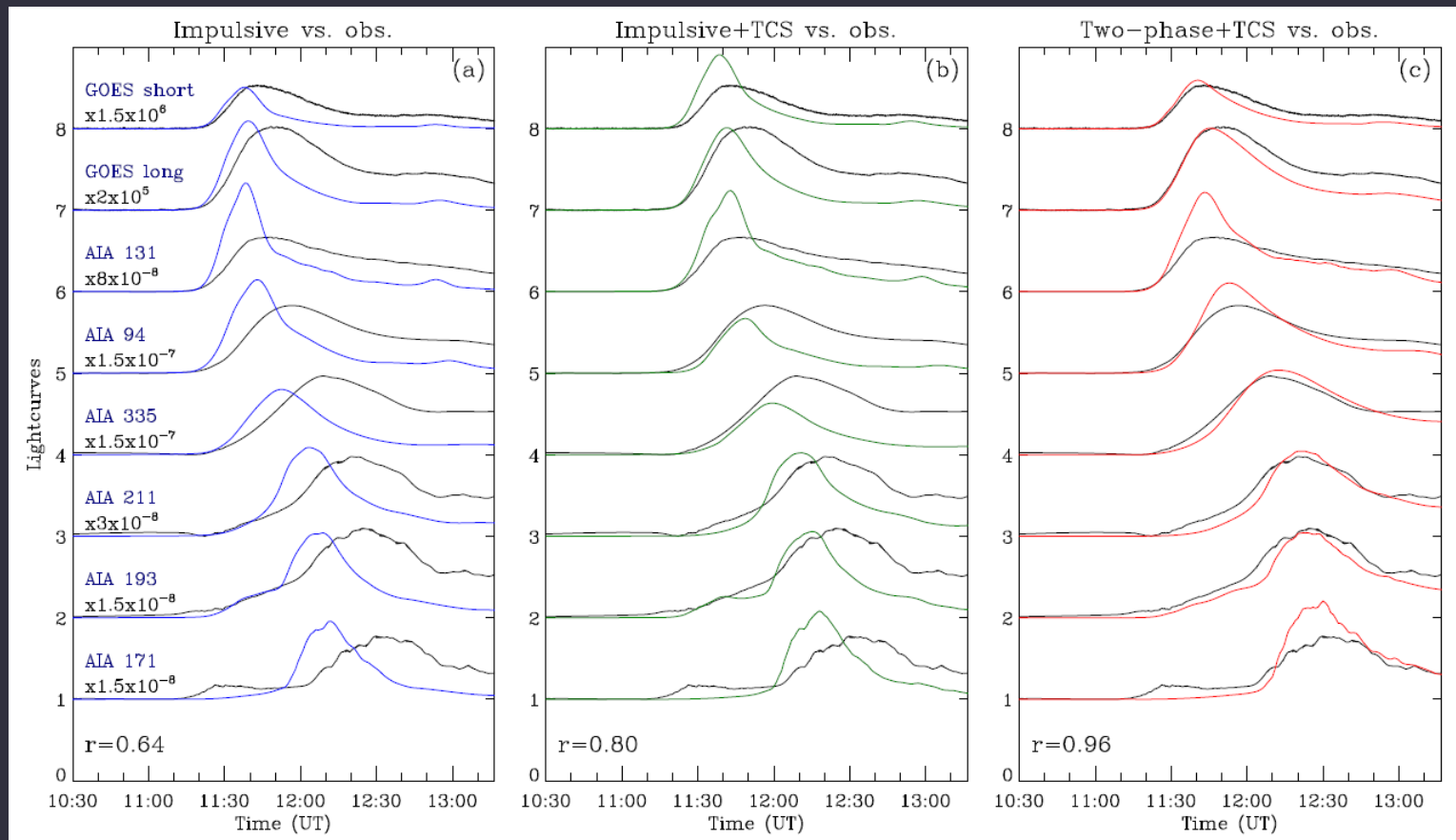


Image Credit: Chunming Zhu, et al.

Process

Simulated Light Curves

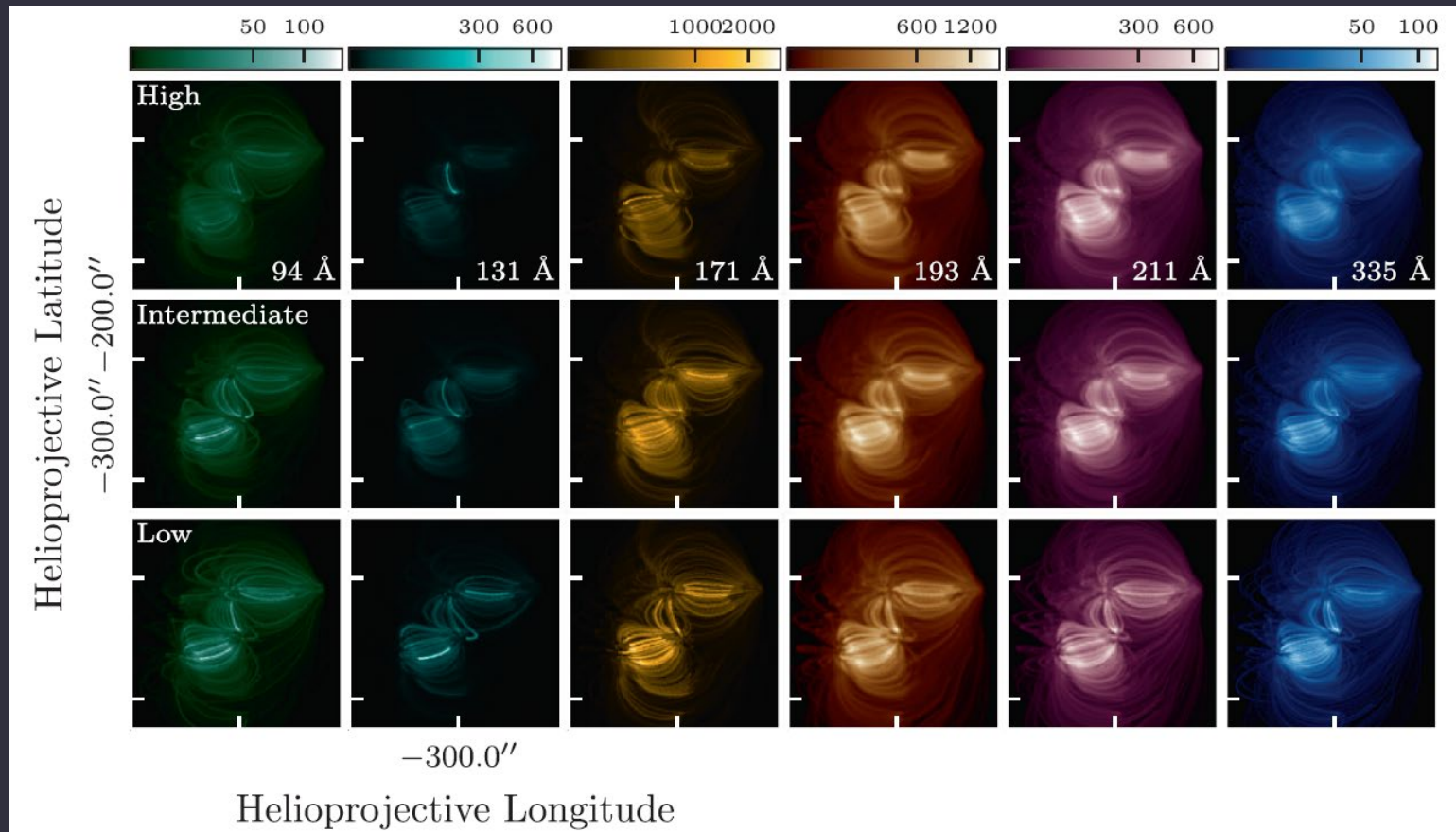


Image Credit: W. T. Barnes, et al.

Process

Images

Weeks 1-2

Week 1

Logistics

The majority of week 1 was spent getting familiar with the program, both on campus and on the computers. The first day was full of setting up task conventions, figuring out housing arrangements, and touring the campus. The second day consisted of attending our first lecture, meeting with Dr. Chatterjee to discuss the project, and completing required NSF training. The third day consisted of attending our second lecture, reading chapters out of the textbook, along with several research papers by faculty in the department. The fourth day, Friday, consisted of getting familiar with IDL, including the \$B99 commands.

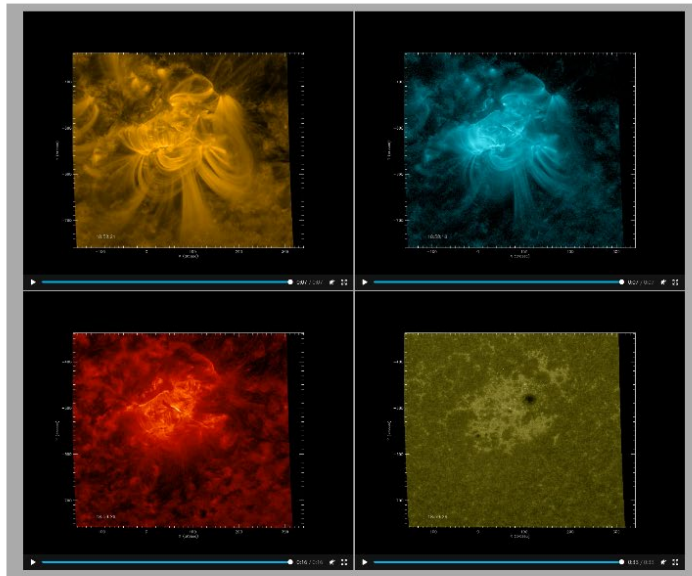
The weekend consisted of a hike to the 'W', and some pictures are included.



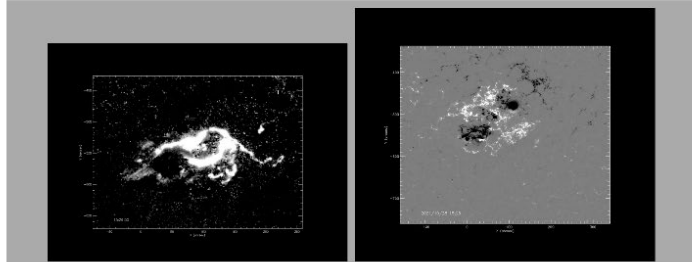
Week 2

Data Processing

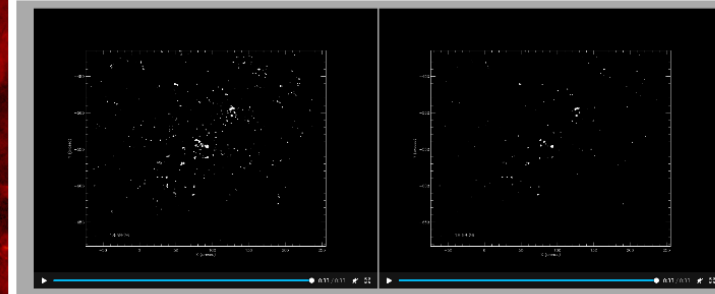
The majority of the second week was spent getting familiar with the specific IDL programs used for this venue of research. The first day consisted of downloading AIA data, aligning it with rotations in mind, plotting it, and creating an animation.



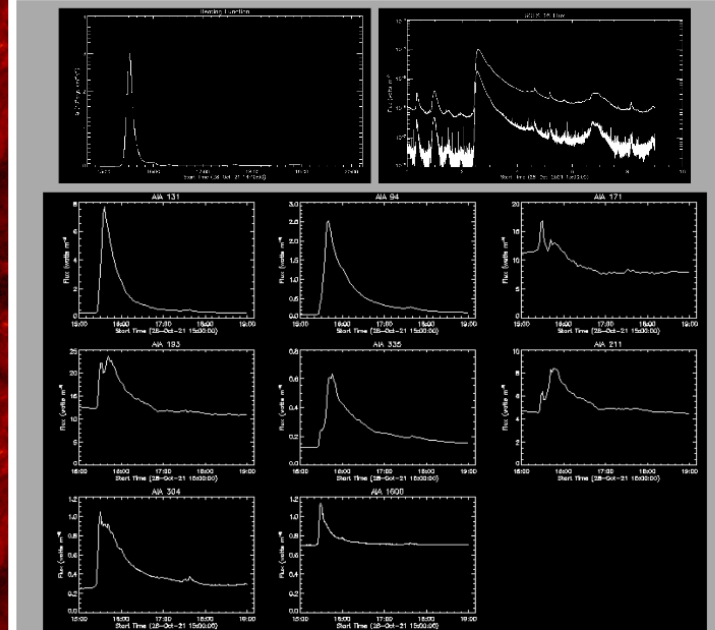
The second day consisted of doing the download, crop, rotation, and alignment of HMI data to fit perfectly with the AIA 1600 reference image data, as well as the determination of bright pixels in the AIA 5500 data.



The third day consisted of determining bright pixels in each image and then comparing their brightness to the brightness of the background image. A lot of this day was also spent determining the overall process that must be done to acquire synthetic light curves, as well as what work must get done.



The fourth day consisted of generating the light curves for different filters, as well as the overall heating function for the flaring pixels.



This Friday, we had a two-week Update presentation, and most of the fifth day was spent preparing for that. The mentioned presentation is included below.

Brock Parker

Watch My Progress!

<https://solar.physics.montana.edu/home/ww/reu/2022/bparker/index.html>

References

- J. A. Klimchuk, *et al.* 2008, *ApJ*, **682**, 1351.
- Jiong Qui, *et al.* 2012, *ApJ*, **752**, 124.
- Chunming Zhu, *et al.* 2018, *ApJ*, **856**, 27.
- W. T. Barnes, *et al.* 2019, *ApJ*, **880**, 56.