Thermal Analysis of the Plasma Sheet Region

DeOndre Kittrell, Dr. Katharine Reeves
Harvard-Smithsonian Center for Astrophysics

Goals

The September 10,2017 event produced a long-lasting and intense plasma sheet

We seek to perform detailed thermal analysis of plasma sheet region by:

- Utilizing the differential emission measure to characterize plasma conditions
- Observe the thermal energy over time to determine thermal processes contributing to sustained plasma conditions.

Process

Accurately determine the length of the current sheet region (see figure 1) using AIA intensity plots of 193A wavelength.

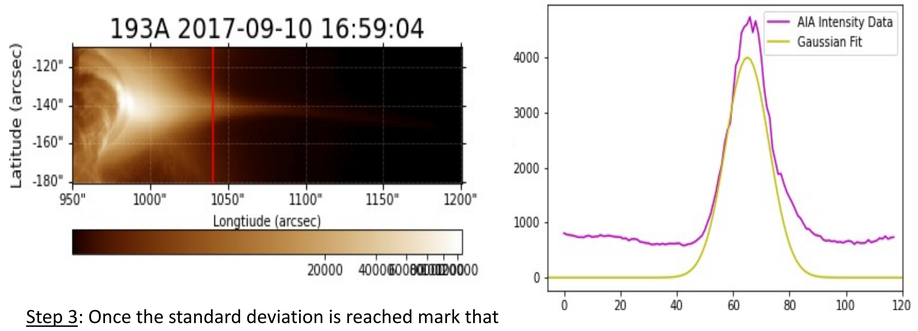
Calculate the differential emission measure using regularized DEM algorithm demonstrated in Hannah & Kontar 2012.

Derive key parameters from the differential emission measure that characterize the plasma sheet region (see figure 2).

Plot the thermal energy as a function of time. Compare to expected conductive cooling and radiative loss rates (see figure 3).

Step 1: Plot intensity along the vertical line at an x-position above the arcade loops.

Step 2: Fit a gaussian to the intensity plot and determine the width at half the height (standard deviation). The current sheet region should have an ideal width of 8 for our case.



Step 3: Once the standard deviation is reached mark that x-position as the beginning of the current region. Box out the region assuming it extends out of the field of view,

Step 4: Create submap of the current sheet region.

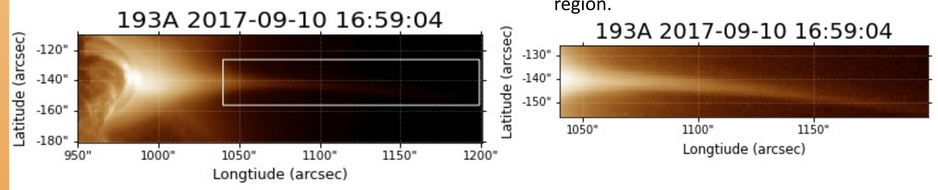


Figure 1: Sequential process of how the current region was determined using AIA 193 A intensity data.

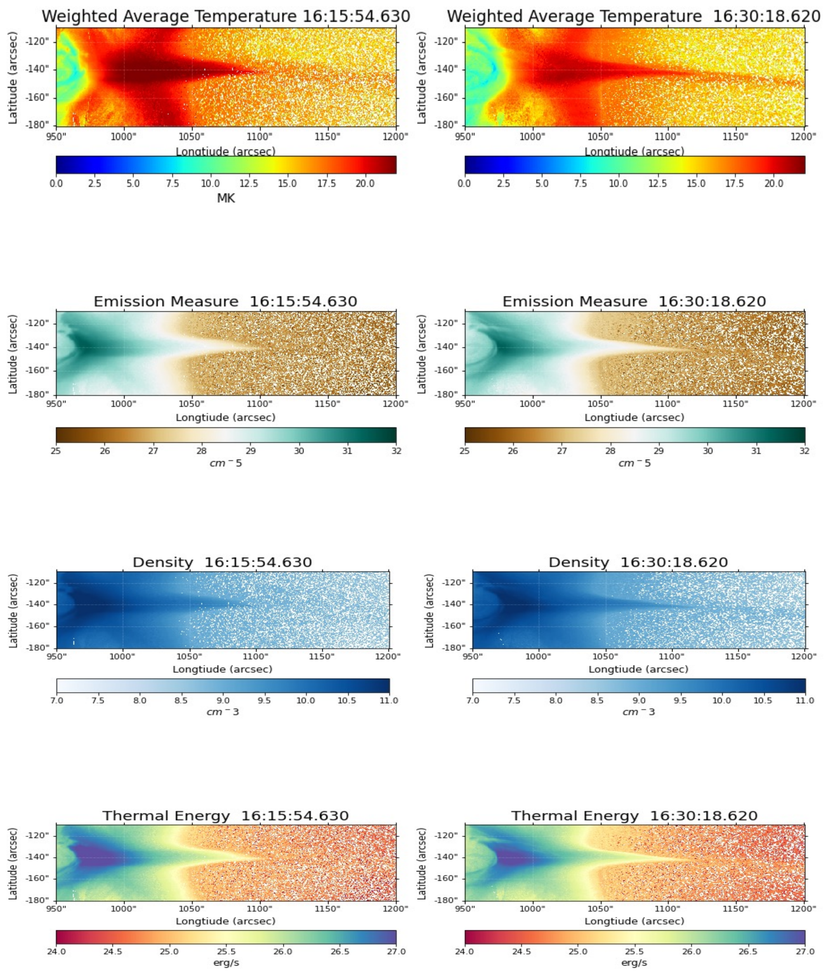


Figure 2: Maps of the emission measure, emission measure weighted average temperature, density, and thermal energy at two different timestamps.

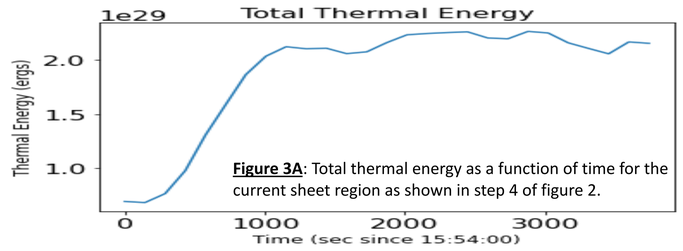


Figure 3A: Total thermal energy as a function of time for the current sheet region as shown in step 4 of figure 2.

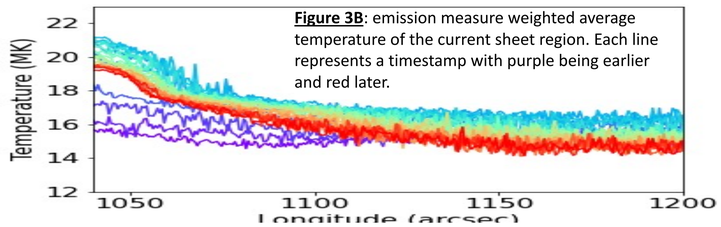


Figure 3B: emission measure weighted average temperature of the current sheet region. Each line represents a timestamp with purple being earlier and red later.

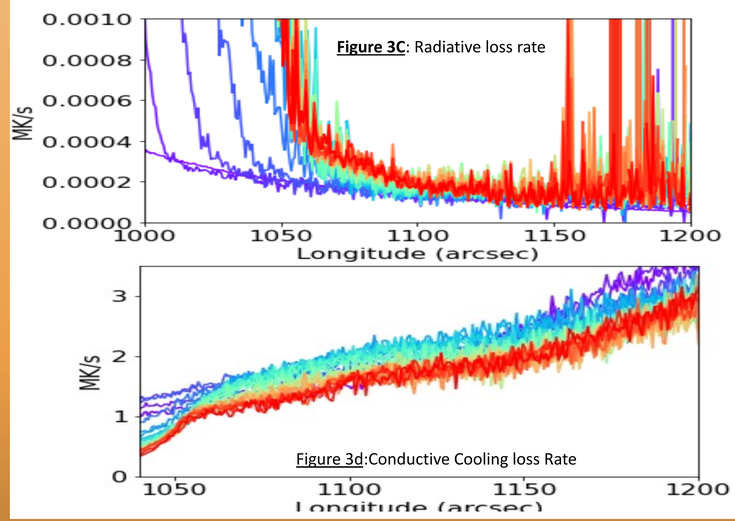


Figure 3C: Radiative loss rate

Figure 3d:Conductive Cooling loss Rate

Conclusion

- In the current sheet region, key parameters such as the emission measure and emission measure weighted average temperature remain relatively constant as a function of time.
- Results show there is no substantial decrease in the total thermal energy over time as the current sheet evolves.
- The minimal change in temperature and the thermal energy contradicts what is expected from conductive cooling and radiative loss rates.

Acknowledgements

This work supported by NSF grant #AGS-1923365 to SAO.