DEM Temperature Analysis of Eruptive Events Using the XRT on Hinode

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Abstract. The X-Ray Telescope (XRT) on Hinode has unprecedented temperature coverage with 9 X-Ray filters in the focal plane. This temperature coverage is especially useful in determining the temperatures of flaring plasma. In this work, we use DEM techniques to analyze the temperature structures in some small eruptive events.

1. Introduction

The X-Ray Telescope (XRT) on Hinode has nine X-Ray filters in the focal plane, and thus has the best temperature coverage of any solar X-Ray telescope ever flown. In this work, we use this capability to construct differential emission measures (DEMs) of post flare loops to determine their temperatures.

2. Observations and Analysis

On July 10, 2007 XRT observed a C8.2 flare in AR 10963 that peaked around 12:40 UT. Sets of the following seven filter combinations were taken every 10 minutes: Al-poly, Ti-poly, thin-Be, med-Be, Al-poly/Ti-poly, thick-Al, C-poly, thick-Al. We will concentrate on observations taken 30-40 minutes after the peak of the flare, since at these times there is no saturation in any of the filters.

The data were calibrated using the standard xrt_prep routine provided in SolarSoft. Additionally, the average of the off-limb intensity was subtracted in order to correct for the CCD read noise. The data were spatially smoothed with a boxcar function with a width of 3 pixels (1 pixel = 1.0286") to further decrease the noise level in each pixel. Errors in the data are assumed to be due to photon noise at 16 Å (since the thin filters are most sensitive to the iron lines between 15-17 Å) and an additional error of 5 DN due to CCD read noise.

The routine xrt_dem_iterative (provided in SolarSoft) is used to calculate DEMs in each pixel. It is a forward fitting routine - a solution is guessed and iterated upon until the $\chi^2$ between the actual and model observations is minimized (Golub 2004). Monte Carlo runs on the data using values varied normally by the sigma error gives an estimate of the error in the DEM.

3. Results

For each pixel, we calculate a DEM for the observations and 100 Monte Carlo runs. Out of this set, we find the DEM that is closest to the median in each
temperature bin, and construct emission measure maps (shown in Figure 1) for each pixel by integrating the DEM over a specified temperature range.

![Figure 1. DEM-weighted emission measure maps constructed from from the post-flare loops taken at 13:10 UT (Top) and 13:20 UT (Bottom).]

4. Conclusions

In the emission measure maps from 13:10 UT, a prominent loop-like structure is seen in the 3-5 MK map. Ten minutes later, this structure appears in the 2-3 MK map. Thus clear evidence of cooling is seen in the post flare loop system using this method of determining temperatures with XRT.

Acknowledgments. Hinode is a Japanese mission developed and launched by ISAS/ JAXA, with NAOJ as domestic partner and NASA and STFC (UK) as international partners. It is operated by these agencies in cooperation with ESA and NSC (Norway). US members of the XRT team are supported by NASA contract NNM07AA02C to SAO.

References