Introduction of the ASGARD code

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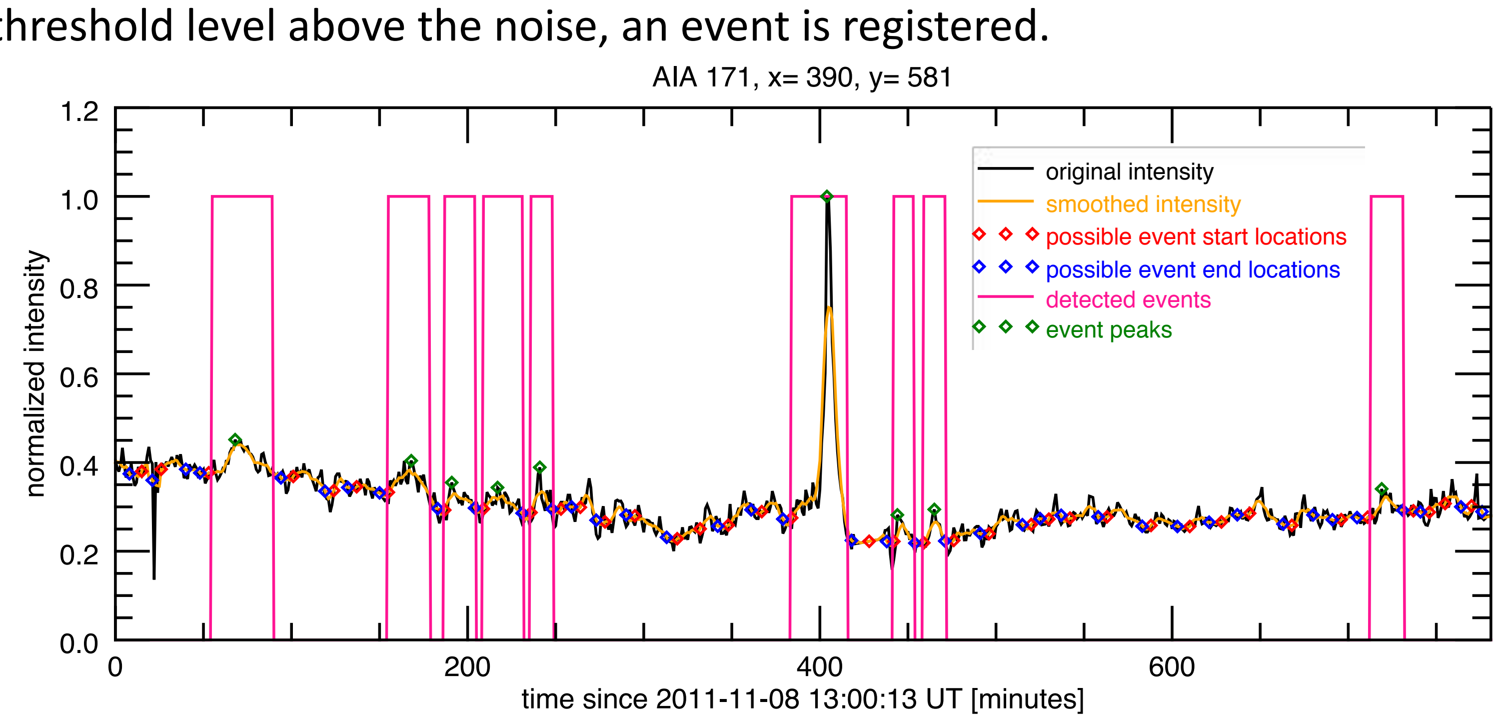
Overview

ASGARD stands for *"Automated Selection and Grouping of events in AIA Regional Data"*. The code is a refinement of the event detection method in Ugarte-Urra & Warren (2014)[1]. It is intended to automatically detect and group brightenings ("events") in the AIA EUV channels, to record event parameters, and to find related events over multiple channels. Ultimately, the goal is to automatically determine heating and cooling timescales in the corona and to significantly increase statistics in this respect. The code is written in IDL and requires the SolarSoft library. It is parallelized and can run with multiple CPUs. Input files are regions of interest (ROIs) in time series of AIA images from the JSOC cutout service (http://jsoc.stanford.edu/ajax/exportdata.html). The ROIs need to be tracked, co-registered, and limited in time (typically 12 hours).

[1]Ugarte-Urra, I., & Warren, H. P. 2014, ApJ, 783, 12

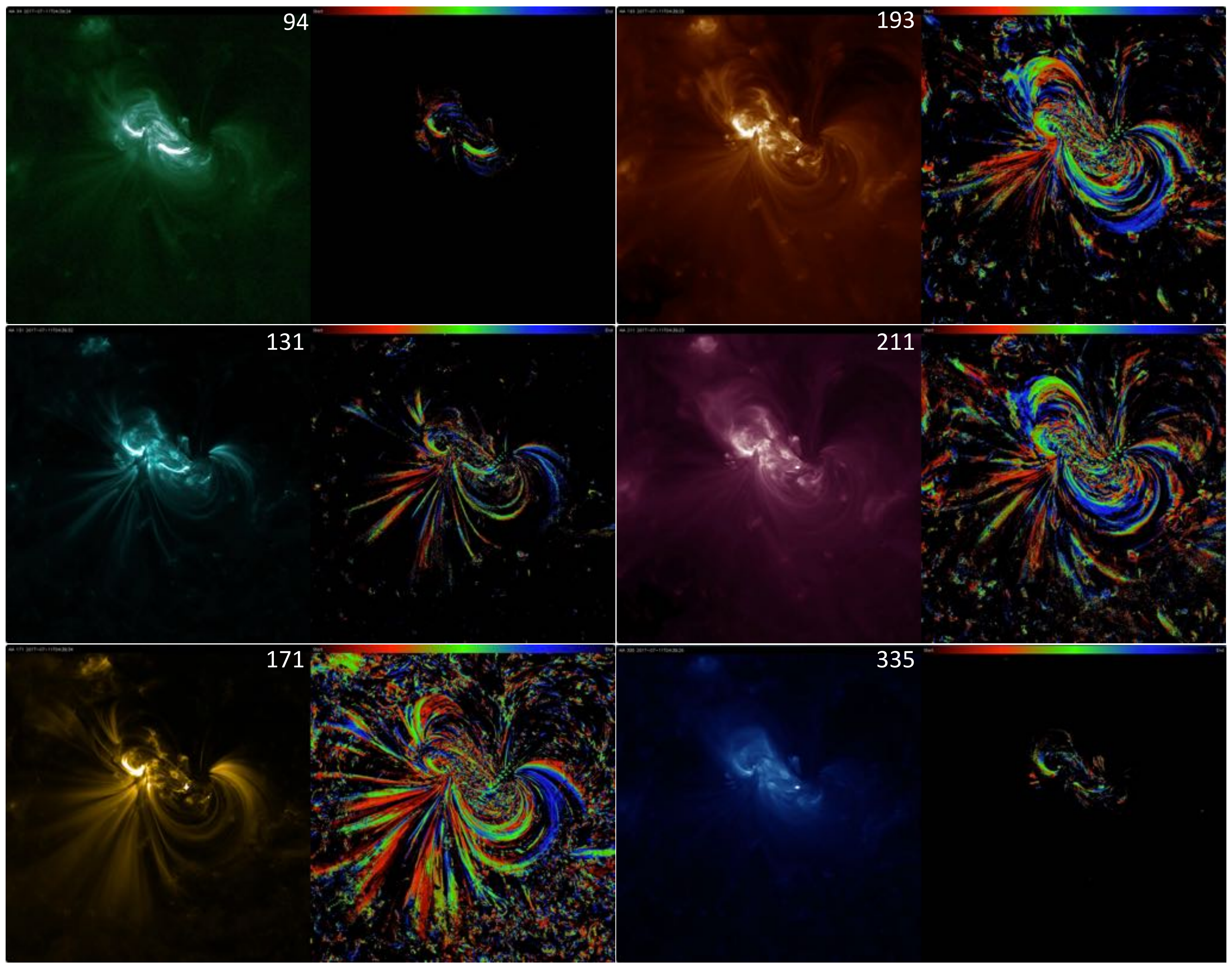
Event detection

Events are detected in each pixel independently. First, the intensity over time is smoothed to compensate for small scale variations due to noise. A moving mean window then first moves forward in time and marks rising intensity levels ("possible event start locations") and then does the same backwards in time ("possible event end locations"). Whenever the intensity between a possible start and end location rises above a selectable threshold level above the noise, an event is registered.



Event visualization and grouping

An "event progress" parameter is assigned to each registered event: two linear ramps, one from the start to the peak, and a second one from the peak to the end. Snapshots below from event detection movies illustrate that this parameter facilitates the ability to pick out simultaneous brightenings (red=start, green=peak, blue=end). This parameter (among others) can be used afterwards to influence which structures are being grouped together. The fact that spatially coherent structures show similar progress with the event detection being performed on a pixel-by-pixel basis indicates that the underlying method is reliable. Ask me about the movies and the current grouping algorithm!



The goal

The plots below show light curves in the AIA EUV channels at a single location as a function of time *(middle)* and the AIA temperature response functions (TRF, *bottom*). The light curves are from an averaged 3x3 pixel region indicated by the red box and arrow in the co-aligned AIA ROI *(top)*. Assuming that the bulk of the emission in each channel is coming from the peaks in the TRFs labeled with the numbers 1-6 in the bottommost plot, the light curves paint a picture of a coronal loop structure cooling from about 7.1 MK to 5.9 MK in about 20 minutes. With the ASGARD code automatically registering the start, peak, and end times of events, a correlation of events over multiple channels can be used to automatically determine heating and cooling timescales. With a grouping algorithm that consolidates spatially and temporally related structures, the determined timescales can then be extended from single pixels to coherent coronal structures. We are currently working on refined algorithms for the grouping and correlation of events across channels to study the thermal evolution of loops in flaring active regions.