Final Report for the SDO Feature Finding Team, NASA Grant NNX09AB03G, January 1 2009 - December 31 2013

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FFT Website: http://solar.physics.montana.edu/sol_phys/fft/
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1 Summary

The SDO Feature Finding Team has operated for five years (2009-2013), the last year with a no cost extension. Our brief final report describes the current status of each of the originally proposed 16 modules, and lists the key papers and presentations. We believe extended funding is needed for maintenance, monitoring, and documentation of the software.

Four modules are currently producing metadata that are not ingested by the HEK. For a fifth module the HEK only accepts part of the metadata. These metadata are available from separate websites as described below. The emerging flux detection module has produced an updated version that is not run on the LMSAL Event Detection System. Most other modules operate as planned, or are close to operational status.

2 Individual Module Final Reports

2.1 Filament Detection (Bernasconi)

The filaments module (AAFDCC) is fully operational at SAO.

Key scientific publications:


2.2 Sigmoid Sniffer (Georgoulis)

The sigmoid module v1.0 is fully operational at the LMSAL pipeline, with VOEvents recorded regularly. v2.0 is currently in preparation and it implements the following revisions over v1.0: a robust Ramer-Douglas-Peucker algorithm to simplify the sigmoids’ contour, chaincode information, and a revised aspect-ratio calculation. v2.0 further envisions to include a surface area and sigmoid brightness reported into the VOEevent, as well.

The module paper is still to come out and the tentative planning was to complete v2.0 of the code first and then work on the paper.

The sigmoid sniffer is supported by European resources. As this work does not incur any NASA cost, Dr. Georgoulis plans to continue working on these revisions and upload v2.0 to HEK for implementation.
2.3 Flare Detective (Winter)

The Flare Detection Module is running in real time in the EDS system at LMSAL. The Flare Detection Module detects flares of all size scales and creates and initial IVO event file which is then entered into the HEK.

The Flare Characterization Module performs a posteriori analysis on event files generated by the Flare Detection Module. The characterization module generates light curves, area estimates, associations with NOAA active regions, association to GOES class, two filter ratio temperature estimates, and emission measure estimates of each flare. This database will be made public at the 2014 AAS/SPD Meeting.

Key Module Presentations:

“Mining Solar Big Data with the Flare Detective”, Invited Presentation, Henry “Trae” Winter III, 2014 Joint Statistical Meeting, American Statistical Association, Section on Statistical Learning and Data Mining.


2.4 CORIMP, the CME Detection Module (Byrne)

The CORIMP CME detection module has been finalized for the LASCO data, and almost all the data from 2000 onwards has been processed, with an easy-to-navigate website of current results at:

http://alshamess.ifa.hawaii.edu/CORIMP/

As the results have been generated, so too have the XML outputs for the VOEvent uploads to the HEK, though the HEK still only has the capacity for accepting the parameters that were introduced for CACTus, while CORIMP can offer much more information.

The processing for SECCHI images has been difficult due to discrepancies across some dataset intervals and possible inconsistencies in the header information. It is still intended that a catalog of STEREO CME detections be generated, as progress is still being made.

A realtime implementation of the codes is in development, with the aim of providing alerts as new CME detections are made.


2.5 SWAMIS (Lamb)

SWAMIS-EF is fully operational. An early test version is producing prototype HEK flux-emergence events in the LMSAL pipeline. There are some bugs in the deployed prototype version, and the prototype events should not be used for catalog generation. We delivered a full production grade final version of SWAMIS-EF to LMSAL in 2013 January, but LMSAL has to date refused to install it, citing lack of funding from NASA to do so. Since we have no large-scale feed of the HMI magnetograms, this has prevented us from analyzing large blocks of HMI data with the production code, although we have been able to improve SWAMIS and to disseminate some science results with it (Lamb et al. 2014 in press). SWAMIS-EF has been described in several conference talks and proceedings, and a refereed description paper is planned for submission in Summer 2014.


2.6 Dimming Region Detection (Davey)

The dimmings module is fully functional and running at SAO. It has complete data for 2013-2014/03/21. A new interface to the data can now be seen at:

http://helio.cfa.harvard.edu/FFT/modules/dimmings/

Back filling to the beginning of the mission has been started. That will probably take the rest of this year to complete.

Work on a further improved algorithm to find fainter dimmings that are part of a larger dimming and not just thermal events on disk of which there are a large number has started.

No pertinent publications have been submitted yet.

2.7 SPoCA: Active Regions and Coronal Holes (Delouille)

SPoCA-AR and SPoCA-CH are fully operational at LMSAL pipeline.


SPoCA development is supported with European funds.
2.8 Bright Point Detector (Saar)

An “over-capable” version of the BP module runs at SAO. This version finds and tracks XBP at a 10 minute cadence.

This is more than accepted by the HEK, so a simpler version which has a daily cadence and does not track has been implemented and is going through final debugging and tests. Progress has been slow due to zero funding.


Key scientific presentations:

“A Preliminary Study of Active Region Canopies With AIA”, Lucchini, Scott; Saar, S.; Muglach, K. 2013, AAS 221, 159.05.


2.9 Polarity Inversion Line Mapping (Engell)

The PIL module is being run in near-real-time at LMSAL utilizing the bounding boxes for ARs provided by Stanford. Since LMSAL does not want to store the module’s output, the save file and image products are available through MSU:

http://cbsir.cs.montana.edu/pil


2.10 Non-Linear Force-Free Field (NLFFF) Extrapolation Tools (Wiegelmann)

The NLFFF-codes run on several local computers in different universities besides Max Planck Göttingen, e.g., the spherical code version is also installed at Goddard Space Flight Center (Tilaye Tadesse) and the Cartesian code at Graz University (Julia Thalmann).

Key scientific papers:


The work on the NLFFF in Germany is supported by local sources and will continue.

2.11 Jet Detection (Savcheva)

The work on the Jet Module will be completed by the end of the year. The Jets Module will be tested and run at SAO.

Dr. Savcheva currently leads the LWS Jet Focused Science Team that will fully utilize the metadata from the Jet Module.


2.12 CorPITA, EIT Wave Detection (Long)

The Coronal Pulse identification and Tracking Algorithm (CorPITA) has been successfully tested using a series of events and is now running on an event-by-event basis at MSSL due to local constraints with regard to data flow and storage. Development of the code is continuing and it continues to be used for scientific analysis (cf. Long et al., 2013). Larger scale implementation and more systematic output of events into the HEK will begin in the next couple of months.

Module paper:


Key scientific papers:


The development of CorPITA has been supported by European and UK funding and as a result, Dr. Long will continue development of the code and uploading of metadata to the HEK.
2.13 Sunspot Module (Zharkov)

The Sunspot Module is fully operational at the LMSAL pipeline.

There are no recent related publications.

The sunspot module is supported by European funds.

2.14 Oscillations Module (McAteer)

The code is operational at NMSU and runs on a case by case basis. The code has been made available to SAO for routine operations.


2.15 Trainable Module (Angryk, Banda)

The Trainable Module for Content Based Image Retrieval (CBIR) is fully operational at MSU.

Two user sites are operational at MSU, one for full-disk CBIR:

http://cbsir.cs.montana.edu/sdocbir/php/index.php

and one for region based CBIR querying:

http://cbsir.cs.montana.edu/sdoregion-demo/php/rrt-sdoRegion-demo.php

The trainable module has been published extensively in the computer science and solar physics literature. The key module paper is:


A key scientific result has been the comparison between the results of the filament detection module AAFDCC and the CBIR module:

2.16 Event Detection System (Timmons)

The following Feature Finding Team modules have been integrated and supported as part of the Event Detection System (EDS) at the Lockheed Martin Advanced Technology Center (LM-ATC) Solar and Astrophysics Laboratory (LMSAL) within the last year:

2. Coronal Holes and Active Regions (SPoCA); CH first operational since Jan. 2012. AR since October 2010 with data coverage as far back as July 21, 2010.
3. Sigmoid Detection, operational since Nov. 2011
5. Flare module (trigger portion), operational since June 2010.

2.17 Support Activities at SAO (Davey)

SAO maintains an AIA data archive and runs or will run six FFT modules:

1. Filaments,
2. Dimmings,
3. Jets,
4. Bright Points,
5. EIT waves,
6. Oscillations.

The other three modules are operating at various locations as described above: CME’s at IfA, NLFFF at Max Planck, trainable at MSU.

3 Co-Investigators and Institutional Responsibilities

3.1 USA

1. SAO: Alisdair Davey, Ed Deluca (Project Manager), Steve Saar, Trae Winter, Antonia Savcheva, Jonathan Sattelberger, Yingna Su, Patrick McCauly
   Responsibilities: Flares, Coronal Dimmings, Bright Points, Jets, SAO Archive runs several modules, Project Management
2. MSU: Piet Martens (PI), Rafal Angryk, Juan Banda, Ricky Egeland, Alexander Engell, Karthik Pillai, Jason Scott, Michael Schuh
   Responsibilities: Trainable Module, Polarity Inversion Lines, Principal Investigator

3. JH-APL: Pietro Bernasconi, Nour-Eddine Raouafi
   Responsibilities: Filaments, Sigmoids

4. SwRI: Craig DeForest, Derek Lamb
   Responsibility: SWAMIS Module (magnetic feature and emerging flux detection)

5. LMSAL: Ryan Timmons, Neal Hurlburt
   Event Detection System (EDS; includes several modules), Heliophysics Events Knowledgebase (HEK; repository for solar metadata)

6. NMSU: James McAteer, Brandon Calabra, Alex Pevtsov Jr., Aleksandra Andic
   Responsibility: Oscillations Module

7. IfA: Jason Byrne, Shadia Habbal, Huw Morgan
   Responsibility: CME Module

3.2 Europe

1. Royal Observatory of Belgium: Veronique Delouille, Benjamin Mampaey, Cis Verbeek
   Responsibility: SPoCA: Module for Active Regions and Coronal Holes

2. Academy of Athens: Manolis Georgoulis
   Responsibility: Sigmoid Module

3. Max Planck - Göttingen: Thomas Wiegelmann, Tilaye Tadesse, Julia Thalmann
   Responsibility: Non-Linear Force-Free Magnetic Field Extrapolation

4. Mullard Space Sciences Lab: David Long, Sergei Zharkov
   Responsibilities: EIT Waves Module and Sunspot Module

5. Bradford University: Valentina Zharkova
   Responsibility: Sunspot Module