	Heliophysics Integrated Observatory

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Feature Description
SMART

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CAPACITIES

e-infrastructure

Revision History

Version	Date	Released by	Detail
1.0	2010-11-18	D. Pérez-Suárez and P. Higgins	First version. Description and properties of the code.

Note: This document will continue to undergo revisions during the implementation phase of HELIO to incorporate changes and improvements.

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Feature description

The code described in this document is the SolarMonitor Active Region Tracker (SMART, Higgins et al., 2010).

Solar active regions (ARs) are concentrations of magnetic flux that have emerged through the solar surface and are thus a manifestation of solar magnetic activity. They appear different when observed at different wavelengths. Figure 1 shows an example of AR NOAA 11124 and 11125 from SolarMonitor.org (Gallagher et al., 2002).

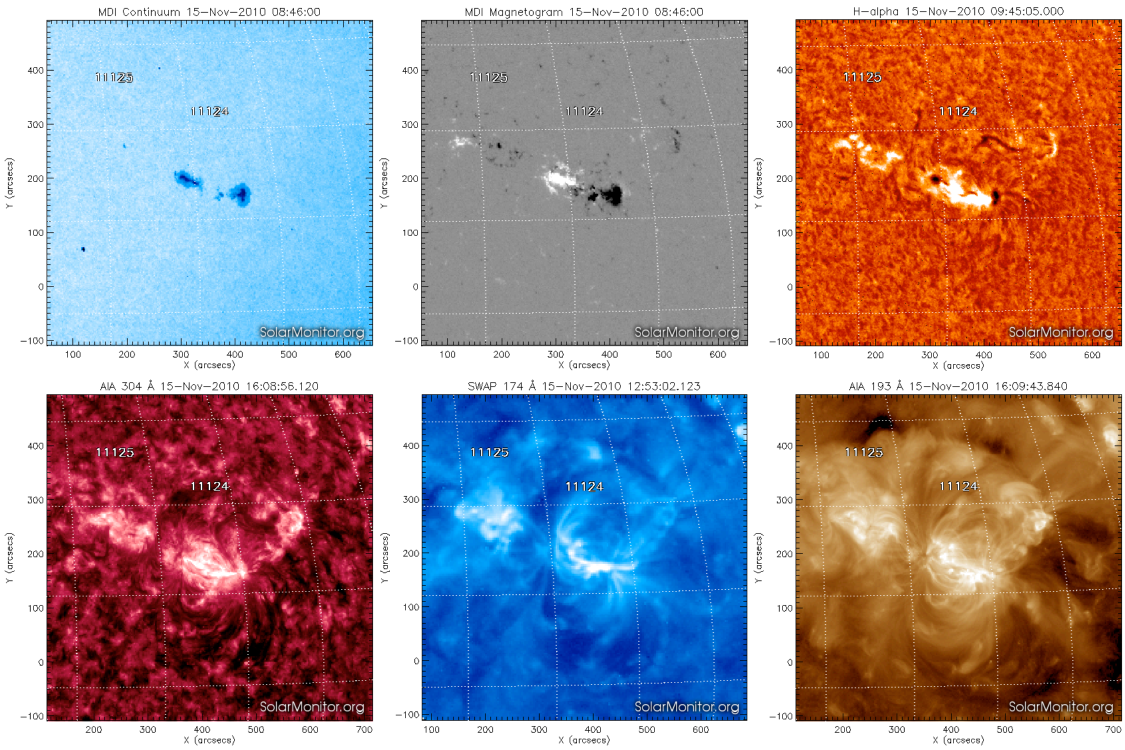

Fig 1. These six images show NOAA AR 11124 and 11125 as viewed in (a) continuum (photosphere, ~6,000 K) from MDI, (b) magnetogram from MDI, (c) H-alpha (chromosphere, ~8,000 K) from Big Bear Solar Observatory and d) 304 Å (higher chromosphere, ~10,000 K) from Solar Dynamics Observatory (SDO), e) 174 Å (corona ,1 MK) from SWAP and f) 193 Å (corona, 1.2 MK) from SDO. From http://www.solarmonitor.org (Gallagher et al., 2002)

The detection of ARs is essential because they are the source of several forms of solar activity, such as flares and coronal mass ejections (CMEs).

Because SMART only uses line-of-sight magnetograms, we only describe the appearance of ARs in that channel.

The ARs appear as concentrations of kilo-gauss magnetic field (positive and/or negative) that emerge, evolve and decay. They do not show any characteristic shape, since their magnetic field is the only property that differentiates it from the quiet sun.

Feature Code Characteristics

SMART is an algorithm for detecting, tracking, and cataloging active regions throughout their emergence, evolution, and subsequent decay. It extracts magnetic properties such as active region size, total magnetic flux, flux imbalance, growth or decay rate, and measurements of magnetic morphology. The SMART code operates in four main steps. First, the magnetograms are segmented into individual feature masks. Second, a characterization algorithm is run on each extracted region to determine its physical properties. Third, extracted regions are classified using a simple scheme. An extended description of the code can be found in the documentation provided in Higgins et al. (2010).

Output of the Feature Recognition Code

Smart produces for the HELIO Feature Catalogue (HFC) four files each time it is run. This may change to better fit the grid processing and could be standardised to the nomenclature used by the filament code. The actual files are:

yyymmdd_hhmm_ar_frc.csv
yyymmdd_hhmm_ar_observatory.csv
yyymmdd_hhmm_ar_observation.csv
yyymmdd_hhmm_ar_results.csv

where, yyyymmdd_hhmm is the time when the code was run.
yyymmdd_hhmm_ar_frc.csv describes the version and the name of the code.
yyymmdd_hhmm_ar_observatory.csv describes the instruments used.
yyymmdd_hhmm_ar_observation.csv contain information of the originals files used for the detetion.
yyymmdd_hhmm_ar_results.csv properties of the ARs detected.

On the successive subsections some examples and the information related to each of the columns are shown.

Feature Recogition Code table (ar_frc.csv)

FRC table contain the information of the code following the HFC specifications. It shouldn't change unless the code has some changes in the way it proceeds to detect the features. The file is as follows:

#ID;INSTITUT;NAME_CODE;VERSION_CODE;FEATURE;PERSON
2;TCD;SMART;1.0;ACTIVE REGIONS;PAUL HIGGINS

Observatory table (ar_observatory.csv)

The Observatory file follows the HFC specifications too. It has as many entries as the number of instruments used. SMART just uses, so far, magnetograms from MDI, so it only has one entry. An example of the file is shown below.

#ID;OBSERVAT;INSTRUMENT;TELESCOPE;UNITS;WAVELNTH;WAVENAME;WAVEUNIT;OBS_TYPE;COMMENT
2;SoHO;MDI;Magnetogram;Gauss;676.800;Ni I;nm;line_of_sight magnetic field;96-min fd

Observation table (ar_observation.csv)

The Observation files follow the HFC standards as to how the table is populated with each code. The first three lines of one of the files are shown below.

#ID; OBSERVATORY_ID; DATE_OBS; DATE_END; JDINT; JDFRAC; EXP_TIME; C_ROTATION; BSCALE; BZERO; BITPIX; NAXIS1; NAXIS2; R_SUN; CENTER_X; CENTER_Y; CDELT1; CDELT2; QUALITY; FILENAME; DATE_OBS_STRING; DATE_END_STRING; COMMENT; LOC_FILENAME; ID2
1;2;2007-05-01T00:03:01.353;2007-05-01T00:03:01.353;2454221.0;0.502095;0;2056.12;1;0;-32;1024;1024;483.882;512.608;512.557;1.98590;1.98590;;fd_M_96m_01d.5233.0000.fits;2007-05-01T00:03:01.353Z;2007-05-01T00:03:01.353Z;;http://soi.Stanford.EDU/magnetic/mag//fd_M_96m_01d.005233/fd_M_96m_01d.5233.0000.fits;" "
2;2;2007-05-01T01:39:01.352;2007-05-01T01:39:01.352;2454221.0;0.568762;0;2056.12;1;0;-32;1024;1024;483.873;512.605;512.554;1.98590;1.98590;;fd_M_96m_01d.5233.0001.fits;2007-05-01T01:39:01.352Z;2007-05-01T01:39:01.352Z;;http://soi.Stanford.EDU/magnetic/mag//fd_M_96m_01d.005233/fd_M_96m_01d.5233.0001.fits;" "
3;2;2007-05-01T03:12:01.351;2007-05-01T03:12:01.351;2454221.0;0.633345;0;2056.12;1;0;-32;1024;1024;483.864;512.605;512.545;1.98590;1.98590;;fd_M_96m_01d.5233.0002.fits;2007-05-01T03:12:01.351Z;2007-05-01T03:12:01.351Z;;http://soi.Stanford.EDU/magnetic/mag//fd_M_96m_01d.005233/fd_M_96m_01d.5233.0002.fits;" "

ARs results table (ar_results.csv)

The description of the columns from the three previous files are explained in the HFC document. The ARs results table is corresponds to the SMART code output and its description is detailed below.

ID	FRC_INFO	MDI_FILE	MDI_FILE_T	RUN_DATE	OBS_DATE	OBS_DATE_T
1	2	2	1	2010-10-29T11:03:45.000	2007-05-01T01:39:01.352	2007-05-01T00:03:01.353
2	2	2	1	2010-10-29T11:03:45.000	2007-05-01T01:39:01.352	2007-05-01T00:03:01.353
3	2	2	1	2010-10-29T11:03:45.000	2007-05-01T01:39:01.352	2007-05-01T00:03:01.353

ARC_ARC_X	ARC_ARC_Y	ARC_CAR_LAT	ARC_CAR_LON	AR_NPIX	AR_AREA	BR_ARC_X_Y
437.554	457.477	-10.6814	307.098	11207	156.898	-280,-32,-216,32
288.942	496.21	-5.60816	288.329	3603	50.442	-514,-361,-81,14
615.7	590.558	5.32102	328.727	676	9.464	188,218,129,171

BR_PIX_X_Y	AR_MAX_INT	AR_MIN_INT	AR_MEAN_INT	AR_LNL	AR_LSG	AR_GRAD_MAX
371,496,403,528	1222.61	-3051.95	-5.09547	87.7298	8.48998	255.001
253,330,471,519	1383.46	-941.008	3.03148	2.82999	1.415	83.7599
607,622,577,598	343.67	-511.735	-31.1342	0	0	0

AR_GRAD_MEAN	AR_GRAD_MEDIAN	AR_RVAL	AR_WLSG	ENC_MET	CC_PIX_X	CC_PIX_Y
70.6097	63.449	3.71E+11	632.346	CHAIN CODE	422	396
54.143	83.7599	1.72E+10	83.7599	CHAIN CODE	276	466
0	0	0	0	CHAIN CODE	616	577

CC_ARC_X	CC_ARC_Y	CHAIN_CODE	CC_LENGTH	SNAPSHOT_FILENAME	SNAPSHOT_PATH
-178.56	-230.144	444445....443	451	smart_20070501_0139.png	http://solarmonitor.org/phiggins/smart_plots/
-468.224	-91.264	424112…151	212	smart_20070501_0139.png	http://solarmonitor.org/phiggins/smart_plots/
206.336	128.96	454423…556	82	smart_20070501_0139.png	http://solarmonitor.org/phiggins/smart_plots/

Description of Fields

NAME	FORMAT	DESCRIPTION	NOTES
ID	INT(11)	Result index.	
FRC_INFO	INT(4)	Ref. to FR code information.	
OBSERVATION_ID	INT(11)	Pointing to the observation image where detection was done.	
OBSERVATION_ID_T	INT(11)	Pointing to the previous image used for the detection.	
RUN_DATE	DATETIME	Date when FR code was run.	
AR_DATE	DATETIME	Date of the AR detected.	In principle, the same than: OBSERVATION_ID
AR_DATE_T	DATETIME	Date of the previous image used for the detection.	Same than: OBSERVATION_ID_T
SC_ARC_X	DOUBLE	Gravity centre in arcsec (X).	
SC_ARC_Y	DOUBLE	Gravity centre in arcsec (Y).	
SC_CAR_LAT	DOUBLE	Gravity centre in Heliographic, degrees (lat).	
SC_CAR_LON	DOUBLE	Gravity centre in Heliographic, degrees (lon).	
FEAT_NPIX	INT(11)	Number of pixels included in the feature.	
FEAT_AREA	DOUBLE	Area of the feature in degrees square	Need some testing!
BR_ARC	VARCHAR(150)	Bounding rectangle coord in arcs	
BR_PIX	VARCHAR(150)	Bounding rectangle coord in pixels	
FEAT_MAX_INT	FLOAT	Feature max. value in Gauss	
FEAT_MIN_INT	FLOAT	Feature min. value in Gauss	
FEAT_MEAN_INT	FLOAT	Feature mean value in Gauss	
FEAT_LNL	FLOAT	Feature length of the neutral line	
FEAT_LSG	FLOAT	Feature length of the strong gradient of neutral line above 50 G/Mm	
FEAT_GRAD_MAX	FLOAT	Maximum of the horizontal gradient	
FEAT_GRAD_MEAN	FLOAT	Mean of the horizontal gradient	
FEAT_GRAD_MEDIAN	FLOAT	Median of the horizontal gradient	
FEAT_RVAL	FLOAT	R schridver value	
FEAT_WLSG	FLOAT	Falconer's WLSG value	
ENC_MET	VARCHAR(50)	Encoding method	
CC_PIX_X	INT(8)	X coordinate of chain code start position (pixels)	
CC_PIX_Y	INT(8)	Y coordinate of chain code start position (pixels)	
CC_ARC_X	FLOAT	X coordinate of chain code start position (arcsec)	
CC_ARC_Y	FLOAT	Y coordinate of chain code start position (arcsec)	
CHAIN_CODE	TEXT	Boundary chain code	
CCODE_LNTH	INT(11)	Length of the chain code	
SNAPSHOT_FN	VARCHAR(200)	Snapshot of the AR in solarmonitor.org	
SNAPSHOT_PATH	VARCHAR(200)	Full URL path for the snapshot.	