Heliophysics Integrated Observatory

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Feature Description
CHARM

Title:	**Feature Description: CHARM**
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Editor:	**D. Pérez-Suárez**, TCD
Contributors:	**L.D. Krista**, TCD
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Revision History

Version	Date	Released by	Detail
1.0	2010-11-19	D. Pérez-Suárez	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

Coronal holes (CHs) are low density regions of the solar corona that exhibit reduced EUV and X-ray emission when compared to the quiet Sun. The magnetic field distribution in CHs is believed to be dominated by a single polarity due to the predominantly open nature of the magnetic field lines that extend beyond the corona and into the interplanetary medium. As a result, CHs give rise to the high-speed solar wind streams (Altschuler et al., 1972), causing recurring magnetic disturbances at Earth on time scales of days to months as these streams sweep past. CHs appear dark in EUV and X-ray observations due to reduced emission caused by lower densities, and bright in He I chromospheric images caused by the lower absorption due to reduced population of the atomic state required for radiative absorption. Figure 1 shows the signature of a CH in He I and a Fe XII image.

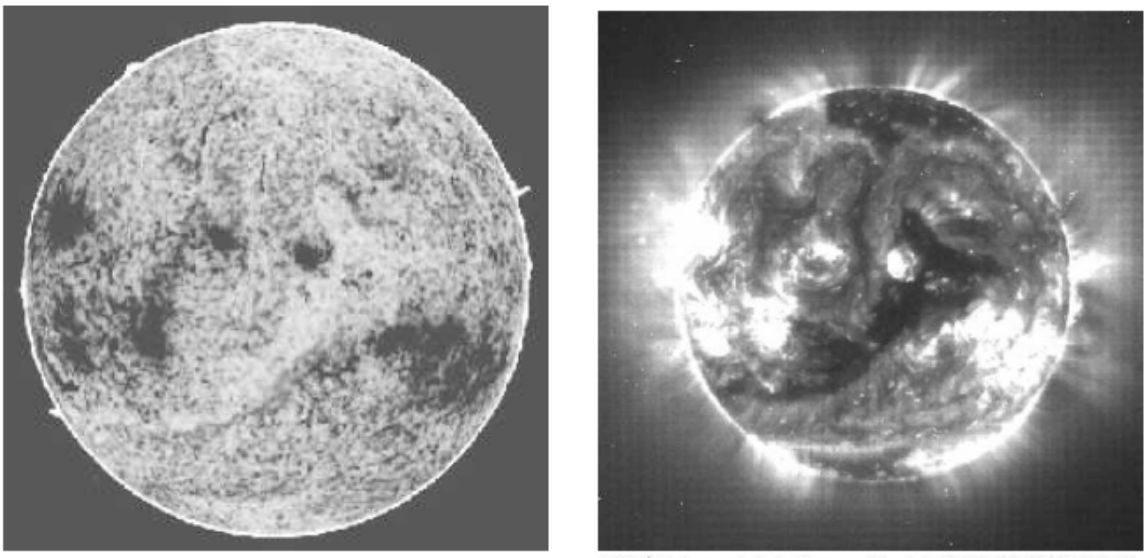

Fig 1. KPVT He I 10830 Å spectroheliogram (left), EIT 195 Å Fe XII emission line image (right) for July 14, 2003 (extracted from Henney and Harvey, 2007).

Feature Code Characteristics

The CH detection tool used in HELIO is the Coronal Hole Automated Recognition and Monitoring algorithm-package (CHARM). CHARM uses SOHO/EIT 195 Å and SOHO/MDI line-of-sight magnetograms to detect CHs and has the ability to provide real-time high-speed solar wind forecasts at Earth and compare the predictions with in-situ solar wind data. The technique used is based on local intensity thresholding. Each EIT image is partitioned and the local intensity minimum between the quiet Sun and the low intensity regions is extracted. The low intensity regions are distinguished from other regions based on the magnetic field information obtained from MDI magnetograms. An extended description of the code can be found in the documentation provided in Krista and Gallagher, 2009.

Output of the Feature Recognition Code

With each run CHARM produces four files for the HELIO Feature Catalogue (HFC). This may change to according to the grid process and could be standardised to the nomenclature used by the filaments code. The actual files are:

yyymmdd_hhmm_ch_frc.csv
yyymmdd_hhmm_ch_observatory.csv
yyymmdd_hhmm_ch_observation.csv
yyymmdd_hhmm_ch_results.csv

where, yyyymmdd_hhmm is the time when the code was run.
yyymmdd_hhmm_ch_frc.csv describes the version and the name of the code.
yyymmdd_hhmm_ch_observatory.csv describes the instruments used.
yyymmdd_hhmm_ch_observation.csv contain information of the originals files used for the detetion.
yyymmdd_hhmm_ch_results.csv properties of the CHs detected.

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

Feature Recogition Code table (ch_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
3;TCD;CHARM;1.0;CORONAL HOLES;LARISZA KRISTA

Observatory table (ch_observatory.csv)

The Observatory file follows the HFC specifications. It has as many entries as instruments used. CHARM uses EIT 195 images and MDI magnetograms. An example of the file is shown below.

#ID;OBSERVAT;INSTRUMENT;TELESCOPE;UNITS;WAVELNTH;WAVENAME;WAVEUNIT;OBS_TYPE;COMMENT
2;SoHO; MDI;Magnetogram;Gauss;676.8;Ni I;nm;Magnetic field;96-min fd
3;SoHO; SoHO;EIT;Counts;19.5;Fe XII;nm;Extreme Ultraviolet;12-min fd

Observation table (ar_observation.csv)

The Observation files follows the HFC standards as such table is populated with all the different codes. The first three lines of one of the files is 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
29; 3; 2009-01-15T01:13:45.998; 2009-01-15T01:13:45.998; 2454846.0; 0.551215; 12; 2079.04; 1; 0; 16; 1024; 1024; 375.040; 507.840; 518.270; 2.63000; 2.63000; ; efz20090115.011345; 2009-01-15T01:13:45.998Z; 2009-01-15T01:13:45.998Z; ; http://sohodata.nascom.nasa.gov//archive/soho/private/data/processed/eit/lz/2009/01/efz20090115.011345; " "
30; 2; 2009-01-15T01:39:02.139; 2009-01-15T01:39:02.139; 2454846.0; 0.568773; 0; 2079.04; 1; 0; -32; 1024; 1024; 496.562; 512.527; 511.986; 1.98559; 1.98559; ; fd_M_96m_01d.5858.0001.fits; 2009-01-15T01:39:02.139Z; 2009-01-15T01:39:02.139Z; ; http://soi.Stanford.EDU/magnetic/mag//fd_M_96m_01d.5858.0001.fits; " "

CHs group table (ch_groups.csv)

The description of the columns from the three previous files are explained on the HFC document. All CHs are grouped and the properties are stored as shown below.

#ID	CH_NUMS	CHGR_BR_PIX	CHGR_BR_DEG	CHGR_BR_ARC
1	1	163.282,0.750903,969.819,80.6153	-55,-79,70,-50	589.47,-735.18,-152.53,-950.98
2	2,3,6	567.384,191.231,591.550,207.842	8,-28,11,-25	168.76,-365.88,119.92,-412.33
3	3	651.346,167.622,732.645,227.504	21,-32,33,-22	492.82,-323.34,296.59,-473.93

CHGR_BR_PIX	CHGR_BR_DEG	CHGR_BR_ARC	CHGR_CBR_PIX	CHGR_CBR_DEG
163.282,0.750903,969.819,80.6153	-55,-79,70,-50	589.47,-735.18,-152.53,-950.98	566.550,40.6831	7.50000,-64.5000
567.384,191.231,591.550,207.842	8,-28,11,-25	168.76,-365.88,119.92,-412.33	579.467,199.537	9.50000,-26.5000
651.346,167.622,732.645,227.504	21,-32,33,-22	492.82,-323.34,296.59,-473.93	691.995,197.563	27.0000,-27.0000

CHGR_CBR_ARC	CHGR_LAT_WIDTH_DEG	CHGR_LON_WIDTH_DEG	CHGR_LAT_WIDTH_ARC
126.29,178.00	125	29	215.802
158.86,211.12	3	3	46.4516
394.77,484.95	12	10	150.588

CHGR_LON_WIDTH_ARC	CHGR_AREA_PIX	CHGR_MEAN_BZ
742.015	22061	1
48.8439	345	0.9
196.227	2933	0.8

Description of Fields (groups)

NAME	FORMAT	DESCRIPTION	NOTES
ID	INT(11)	Group index.	
CH_NUMS	VARCHAR(150)	CHs belonging to that group numbered as in the image	
BR_PIX	VARCHAR(150)	Bounding rectangle coord in px	
BR_DEG	VARCHAR(150)	Bounding rectangle coord in heliographic degrees	
BR_ARC	VARCHAR(150)	Bounding rectangle coord in arcsec	
SC_PIX	VARCHAR(150)	Bounding rectangle center coord in px	
SC_DEG	VARCHAR(150)	Bounding rectangle center coord in heliographic degrees	
SC_ARC	VARCHAR(150)	Bounding rectangle center coord in arcsec	
GROUP_LAT_WIDTH_DEG	DOUBLE	Max Width of feature in lat axis (deg)	
GROUP_LON_WIDTH_DEG	DOUBLE	Max Width of feature in lon axis (deg)	
GROUP_LAT_WIDTH_ARC	DOUBLE	Max Width of feature in lat axis (arc)	
GROUP_LAT_WIDTH_ARC	DOUBLE	Max Width of feature in lon axis (arc)	
GROUP_NPIX	INT(11)	Number pixels included within the group	
GROUP_MEAN_BZ	FLOAT	Mean Bz value in Gauss of the group.	

CHs results table (ch_results.csv)

The CHs results table is detailed below.

#ID	CHG_NUM	CH_NUMI	CHG_NUMI	CH_THRESH	CH_BR_PIX	CH_BR_DEG
1	1	1	1	25	163,1,970,81	-54.82,-79.00,69.80,-50.00
2	2	2	2	25	601,186,654,255	12.81,-29.00,21.00,-17.00
3	2	3	2	25	665,167,696,205	22.77,-32.00,27.49,-26.00

CH_BR_DEG	CH_BR_ARC	CHC_PIX	CHC_DEG
-54.82,-79.00,69.80,-50.00	588.758,-735.089,-152.213,-950.963		16,-61
12.81,-29.00,21.00,-17.00	334.513,-238.779,189.372,-428.397		16,-20
22.70,-32.00,27.49,-26.00	404.893,-386.078,319.423,-476.008		25,-26

CHC_ARC	CH_LAT_WIDTH_DEG	CH_LON_WIDTH_DEG	CH_LAT_WIDTH_ARC
130.41366,-828.27549	124.633	29	215.882
252.77710,-286.63262	8.18533	12	189.605
370.69971,-385.11603	4.78765	6	89.9917

CH_LON_WIDTH_ARC	CH_NPIX	CH_MIN_INT	CH_MAX_INT	CH_MEAN_INT	CH_MEAN2QSUN	CH_MIN_BZ
740.964	22061	5.08184	152.854	21.5784	0.362217	-31.1196
145.141	1704	-12.577	456.882	22.497	0.377635	-49.8496
85.4698	782	12.2064	44.3899	22.9995	0.386071	-22.9879

CH_MAX_BZ	CH_MEAN_BZ	CH_BZ_SKEW	ENC_MET	CC_PIX_XY	CHAIN_CODE	CC_LENGTH
69.5642	1	0	CHAIN CODE	173,001	4444444444444….000	2175
90.0495	0.7	0	CHAIN CODE	624,186	546675554…..3321590	191
67.0664	0.9	0	CHAIN CODE	683,168	34444….21546855	96
50.2124	0.9	0	CHAIN CODE	572,192	344454651…..65465462	63

FRC_INFO	EIT_FILE	MDI_FILE	RUN_DATE	OBS_DATE
3	1	2	2009-01-01T00:00:08.531	2010-07-26T13:21:05.000
3	1	2	2009-01-01T00:00:08.531	2010-07-26T13:21:05.000
3	1	2	2009-01-01T00:00:08.531	2010-07-26T13:21:05.000

Description of Fields (results)

NAME	FORMAT	DESCRIPTION	NOTES
ID	INT(11)	Result index.	
CHGROUPS_ID	INT(11)	Pointing to group index number	
IMAGE_ID	INT(11)	Number on the daily image	
IMAGE_GROUP_ID	INT(11)	Group number on the daily image	
CH_THRESHOLD	DOUBLE	Threshold value used on the image	
BR_PIX	VARCHAR(150)	Bounding rectangle coordinates in px	
BR_DEG	VARCHAR(150)	Bounding rectangle coordinates in heliographic degerees	
BR_ARC	VARCHAR(150)	Bounding rectangle coordinates in arcsec	
CHC_PIX	VARCHAR(150)	CH centre coordinates in px	
CHC_DEG	VARCHAR(150)	CH centre coordinates in heliographic deg	
CHC_ARC	VARCHAR(150)	CH centre coordinates in arc	
LAT_WIDTH_DEG	DOUBLE	Latitude width of the CH in HG deg	
LON_WIDTH_DEG	DOUBLE	Longitude width of the CH in HG deg	
LAT_WIDTH_ARC	DOUBLE	Latitude width of the CH in arc	
LON_WIDTH_ARC	DOUBLE	Longitude width of the CH in arc	
FEAT_NPIX	INT(11)	Number of pixels of the CH.	
FEAT_MIN_INT	FLOAT	Feature min. intensisty	
FEAT_MAX_INT	FLOAT	Feature max. intensisty	
FEAT_MEAN_INT	FLOAT	Feature mean intensisty	
FEAT_MEAN2QSUN	DOUBLE	Mean of the feature to QS intensity ratio	
FEAT_MIN_BZ	FLOAT	Feature min. line-of-sight magnetic field	
FEAT_MAX_BZ	FLOAT	Feature max. line-of-sight magnetic field	
FEAT_MEAN_BZ	FLOAT	Feature mean line-of-sight magnetic field	
FEAT_SKEW_BZ	DOUBLE	Feature skewness of the line-of-sight magnetic field	
ENC_MET	VARCHAR(50)	Encoding method	
CC_PIX_XY	VARCHAR(50)	X and Y coordinates of chain code start position (pixels)	
CHAIN_CODE	TEXT	Boundary chain code	
CCODE_LNTH	INT(11)	Length of the chain code	
FRC_INFO_ID	INT(11)	Ref to FR code information	
OBSERVATION_ID_EIT	INT(11)	Pointing to observation in EIT	
OBSERVATION_ID_MDI	INT(11)	Pointing to observation in MDI	
OBS_DATE	DATETIME	Date when CH was observed	
RUN_DATE	DATETIME	Date when FR code was run	