Deliverable 2.1:
SOHO/MDI Continuum faculae

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Dissemination level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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ISSUE RECORD

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NOTICE

Report on the on-line publication of the SOHO/MDI facular data

Type of the deliverable:

Public on-line publication of a database.

The SOHO/MDI facular data are accessible at:

http://fenyi.solarobs.unideb.hu/SDD/SDD.html

Content of the database:

1. Formatted tables of facular area, position, and mean magnetic field data derived from SOHO/MDI observations- ASCII

Type of datasets: combined dataset (facSDD*YEAR*.txt), separated tables for disk-integrated facular data (dfacSDD*YEAR*.txt) and individual facular data (ffacSDD*YEAR*.txt).

The following data are included into numerical catalogue in text format: date and time of observation, positions of faculae (Carrington and polar coordinates), areas of faculae (both projected and corrected), mean magnetic fields of faculae, and total area of faculae.

2. Quality-filtered and time-filtered full-disk intensity images selected from Hourly Data Sets Level 1.8.– 16-bit FITS, 8-bit JPG (common part with D2.2)

3. Quality-filtered and time-filtered full-disk magnetograms selected from the recalibrated Hourly Data Sets and Daily Data Sets Level 1.8.– 32-bit FITS, 8-bit JPG (common part with D2.2)

4. User-friendly graphical presentation of the data – HTML

Time resolution:

~ 1 hour depending on the actual time resolution of the SOHO/MDI observation

Spatial resolution:

Original observations:1k x 1k pixels
Processed images:3k x 3k pixels

Time interval:

1996-05-19 - 2010-12-31

Motivation of the deliverable:

Facular data are important data of solar activity. Faculae are detectable in both the photosphere and chromosphere (on account of different mechanisms), their monitoring is equally important, but only chromospheric faculae have been observed regularly in the recent decades. It turned out from previous SOHO/MDI image processing experiences that the data of photospheric (continuum or white-light) faculae can be derived from these full disc intensity images and magnetograms.

Progress beyond the state of the art:

One of the tasks of the SOTERIA project was to produce a pioneering dataset: the first catalogue of positions and area of continuum faculae based on the SOHO/MDI full disc images for the years 1996-2010. This task provided a quite new exploitation of these observations and increased the level of the processed SOHO/MDI data significantly.

The work pursued:

To determine continuum facular areas, the software package SAM was used. SAM (Sunspot Automatic Measurement) was originally developed to automatically measure sunspot position and area, and to compile DPD catalogue (Debrecen Photohelio-graphic Data) but it was also suitable to be modified for measuring faculae.

During the project a large software development was devoted to the database of faculae. However, the measured values of feature areas depend not only on the methods used to find them but also on the qualities of the images themselves. After deriving the first preliminary results, it turned out the the area of the faculae can be determined with a large uncertainty because of the small spatial resolution of the MDI images. Thus, following the delivery of the preliminary material for 1996 the next developments focused on further calibrations and tests of the procedure.

The data were calibrated by using the independent measurements of the Helioseismic and Magnetic Imager (HMI) instrument of Solar Dynamics Observatory (SDO) spacecraft. The SOHO/MDI images have 1024x1024 pixel size while the SDO/HMI images have 4096x4096 pixel size. The MDI observes the full solar disk in the Ni I photospheric absorption line at 676.8 nm, and HMI in the Fe I absorption line at 617.3 nm . Both of them are used as proxies for the photospheric continuum intensity. The threshold parameters used in the software were set up in such a way that the results derived from the MDI images were as close as possible to the results of HMI images.

Comparison of SDD data with SDO/HMI data:

For the comparison 145 image pairs were chosen each within 2 minutes, between 1 and 31 in October 2010. Figure 1 depicts the projected area (in millionths of the solar disk) of faculae summed up on the whole disk. The equation and residual RMS of the regression line are:

$AMDI = 1.59AHMI - 224 \qquad (\chi = 184) \qquad (1).$

The result is about the same if we use 1750 image pairs, each within 2 minutes, between May 1 and December 31 in 2010:

$AMDI = 1.61AHMI - 210 \qquad (\chi = 176, \text{corr. coeff. } 0.93) \qquad (2).$

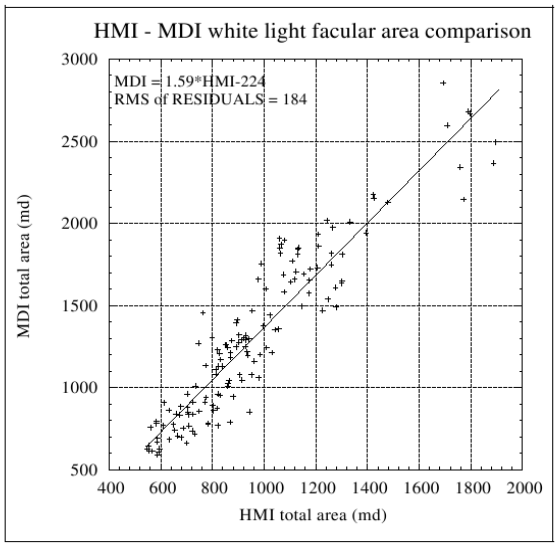

Figure 1: HMI facular area (in millionths of the solar disk) summed up on the whole disk vs MDI area (+) and the straight line (solid line) fitted to the data.

As we can see, the MDI facular areas (AMDI) are much larger than those of the HMI (AHMI). This is the consequence of the lower resolution of MDI images. The typical size of the solar facular grains is bellow 1" while the image scale of the MDI images is 2" /pixel: therefore, a resolution induced extension of the facular area happens. This effect can be well seen in Figure 3 which shows the same facular region in the HMI and the MDI images taken within 1 minute.

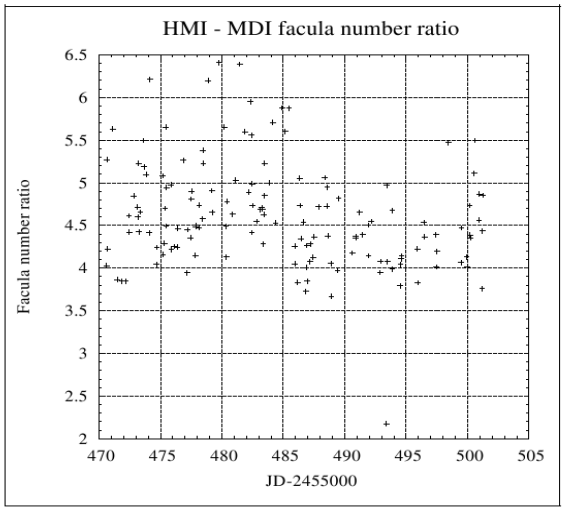

Figure 2: Julian date - 2455000 vs ratio of the number of HMI faculae to the number of MDI faculae.

The higher resolution of the HMI images also show up in the number of faculae: HMI images have about 4.5 times more facular regions than MDI as it can be seen in Figure 2. The negative additive term in the Equations 1-2. can be attributed to the large number of small single faculae outside large connected facular regions which cannot be well observed in the MDI images.

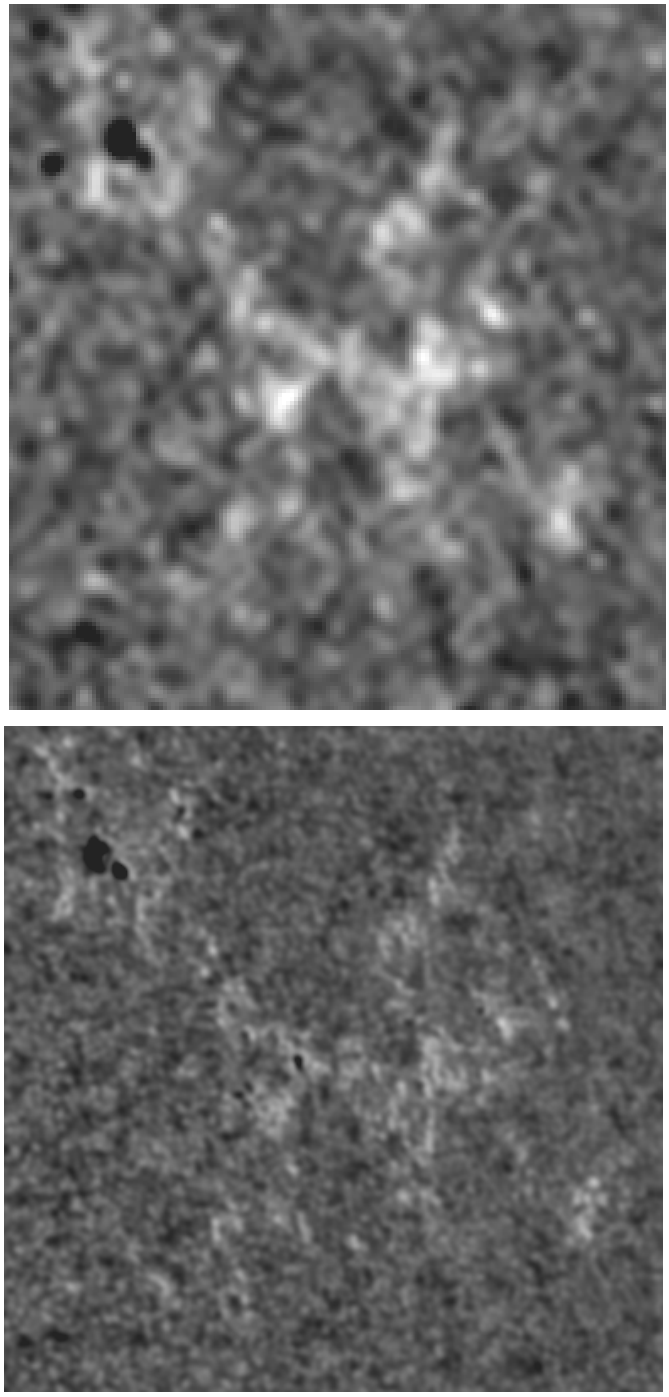

Figure 3: The same facular area in MDI (top) and HMI (bottom) images. The two images were taken within 1 minute.

Conclusion:

We calibrated the MDI facular data by using the images of HMI of larger spatial resolution. In spite of the optimized measurements, there are differences between the two datasets. The measured MDI facular areas are much higher than the HMI. But the number of faculae in the HMI images are much higher than in the MDI images. The cause of these facts can be explained by two things: the low resolution of MDI images and that the size of the facular grains are about 1". Taking into account these differences the SOHO/MDI facular data are ready to be exploited in scientific studies.