PROPERTIES OF NETWORK AND FACULAE DERIVED FROM HMI DATA COMPENSATED FOR SCATTERED-LIGHT

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From Fontenla et al. 2011

Solar Radiation Physical Modeling - SRPM

Irradiance variations
- Network contrast is smaller than facular one
- Network contrast shows shallower CLV than faculae

Ermolli et al. 2003
Ortiz et al. 2002
Ermolli et al 2007
1) Models based on proxies: difference is not taken into account (e.g. NRLSSI).
2) SATIRE and SRPM: photometric contrast of Network lower than Facular. CLV flatter

![Graph showing contrast vs mu]

- Bright Fac.
- Fac.
- Active Net.
- Faint Net.
For a given magnetic field intensity, the contrast of magnetic elements is higher in Network than in AR regions.

These observations are typically restricted to disk center, so no information is available about CLV.
HMI is an excellent instrument!

4096x4096px
0.5 arcsec/pixel
1 arcsec
617.3 nm
HMI Yeo et al. 2014

Black: original
Red: restored
45-s Data acquired in 10 days, from 2011 to 2015
- Intensitygrams, Magnetograms and HARP masks
- Intensitygrams and Magnetograms were also compensated for instrumental scattered light (Richardson-Lucy algorithm, is standard in HMI pipeline)
Original data...
Restored data

- 0.250 ≤ μ < 0.300
- 0.350 ≤ μ < 0.400
- 0.450 ≤ μ < 0.500
- 0.500 ≤ μ < 0.600
- 0.650 ≤ μ < 0.700
- 0.750 ≤ μ < 0.800
- 0.850 ≤ μ < 0.900
- 0.950 ≤ μ < 1.000

Faculae Network
What is the error in the estimate of Total irradiance variations if Network and Faculae are not considered separately?

Facular excess (Lean et al. 1998; Foukal et al. 1991)

\[
\frac{\Delta F}{F} = \sum_k \sum_j \frac{5\mu_j N(\mu_j, B_k) C(\mu_j, B_k) \Psi(\mu)}{2}
\]

300 G < B_k < 1500 G; 0.2 < \mu_j < 1

N: Area of features at position \(\mu_j\) and magnetic field \(B_k\), normalized to solar disk

\(\Psi(\mu)\): \((3\mu+2)/5\) quiet Sun limb-darkening function

\(C(\mu, B)\): contrast derived from surface fit to HMI data
$N(\mu,B)$ was estimated using daily HMI 45-s data acquired between April 2010 and October 2015

Faculae and Network area discriminated using HARP regions

Model 1) Facular excess computed without discrimination (BLACK)

Model 2) Facular excess computed discriminating between faculae and Network (RED)

In Model 1) the facular excess is overestimated by 11%
For $B > 300$ G the Network is brighter than facula. At the limb it is up to twice the facular one.
- For $B < 300$ G the network is Darker than Faculae
- These results are in agreement with high-res obs. and simulations, but extend the results to the whole disk.

The magnetic flux alone is not a good discriminant for irradiance modeling purposes

The facular excess is overestimated by about 11% if faculae and network are not considered separately. This is in agreement with uncertainties estimated in NRL and EMPIRE.

Models, at least those that distinguish between faculae and network, should take these new results into account.
Thank you!

In kind memory of
Juan Fontenla
1) Use of magnetograms to distinguish between Faculae and Network

2) What is the error in the estimate of Total irradiance variations if Network and Faculae are not considered separately?
1) Use of magnetograms to distinguish between Faculae and Network

**SATIRE, MDI** (Ortiz et al. 2007, Foukal et al. 2011); **HMI** (Yeo et al. 2013)

- B< 180 G network
- B>180 G Facula

Triangle: Network
Diamond: Faculae
Star: no discrimination

Red: B=200G
Black: B=600G

- For B = 400 G photometric properties of Network are well defined
- For B > 400 G properties of Faculae are statistically affected by Network, and Facular contrast is overestimated!