Observational constraints on irradiance models in UV

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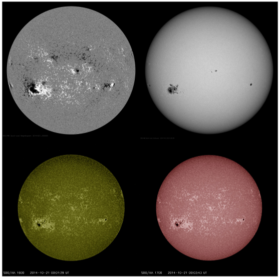
Goal of our work

- Irradiance (TSI or SSI) is essential for climate modelling and space weather
- Observations of the irradiance are difficult and recent ⇒ needs of models when there are no observations
- Two types of models are used :
  1. models using disk integrated data (like NRLSSI-2 model)
  2. models using disk resolved data (like SATIRE-S or SRPM models)
- We focus on the second type of models and we investigate some of their assumptions :
  - models use visible images to define the solar structures ⇒ Valid in the UV ?
  - models assume that the contrast of the solar structures are constant with B ⇒ Is this true ?
  - models assume that the contrast of the solar structures are constant over the time ⇒ Is this true ?

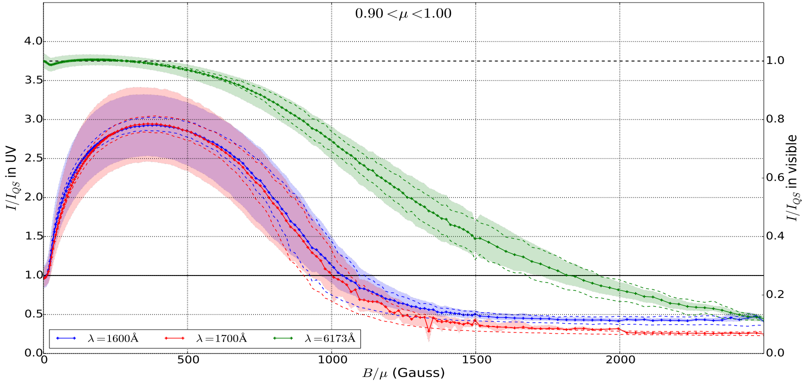
Data and processing

- HMI magnetograms and continuum images + AIA images at 160*nm* and 170*nm*.
- Data are taken between August 7, 2010 and December 31, 2016 (so that's 467 images)
- Processing :
    - Images co-alignement
    - Identification of active regions
    - Removing of the quiet-Sun centre-to-limb variation CLV_{QS}
    - Definition of the contrast like :

$$C_{pixel}(\lambda, B/\mu, \mu) = \frac{I_{pixel}(\lambda, B/\mu, \mu)}{I_{QuietSun}(\lambda, B/\mu, \mu)}$$

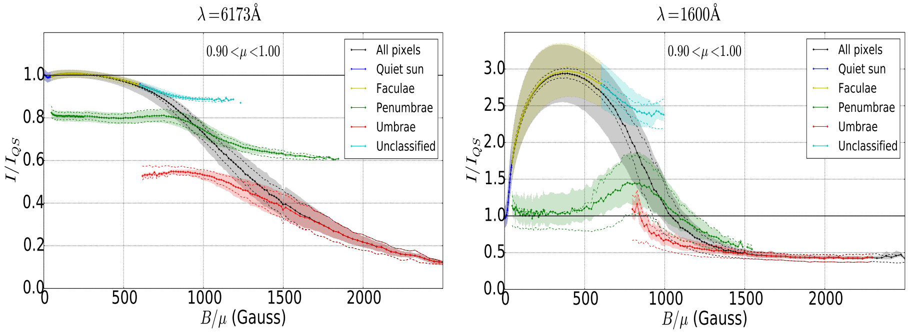


Contrast in function of magnetic field



- Contrasts in UV are 3 times larger than in the visible
- Contrast behaviour agrees very well with the flux tube model (Fligge, Solanki, JApA, 2000) and with previous studies in the visible (Ortiz et al, A&A, 2002 ; Yeo et al, A&A, 2013)

How do structures contrast vary with B/μ?

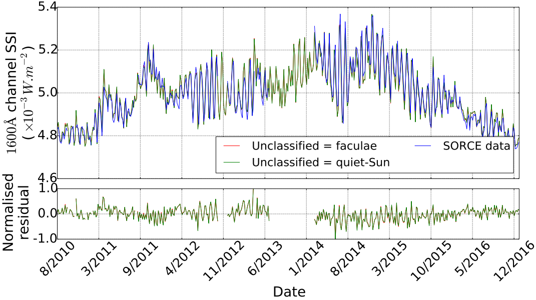


- We define solar structures like in SATIRE-S model (Yeo et al, A&A, 2014) + unclassified pixels (i.e. faculae pixels with $B > 600G$)
- Contrast of the structures show strong dependence with the magnetic field
- Unclassified pixels look like faculae in the UV

How to study the impact of unclassified pixels and magnetic dependence ?

- Unclassified pixels look like faculae in the UV and belong to this later
  - ⇒ their contrast are very close to those of faculae both in the visible and in the UV
  - ⇒ the spatial distribution of unclassified pixels follows active latitudes
  - ⇒ unclassified pixels are around 80 times closer to faculae than sunspots
- To study these impacts, we define a SSI proxy like :

$$\mathcal{P}_{SSI}(t) = \sum_{i,\mu} \alpha_i(t,\mu) C_i(\mu) \frac{I_{QS}(\mu)}{I_{QS}(\mu = 1)}$$



⇒ No strong impact of unclassified pixels on irradiance models are visible.

Impact of the contrast magnetic dependence

- To study these impacts, we define a SSI proxy like :

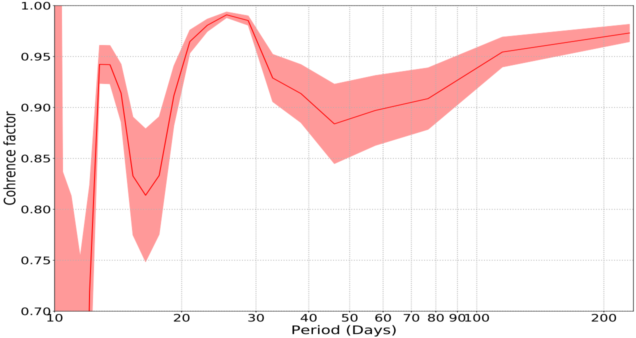
$$\mathcal{P}_{SSI}(t) = \sum_{i,\mu} \alpha_i(t,\mu) C_i(\mu, B) \frac{I_{QS}(\mu)}{I_{QS}(\mu = 1)}$$

  with C_i and α_i the contrast and the filling factor of the structure i

- Network is defined like faculae with $B < 230G$
  $\Rightarrow$ pixels partially filled by faculae
  $\Rightarrow$ we assume that

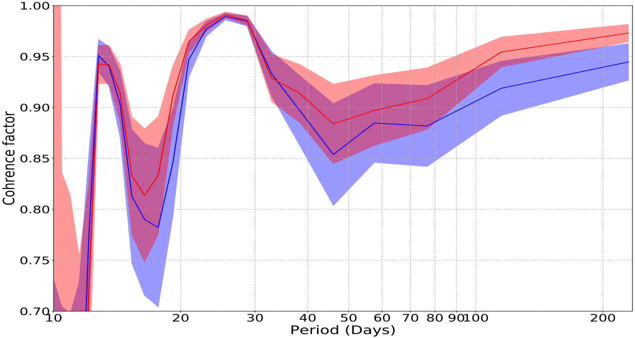
$$C_{Network} = \frac{B}{B_{sat}} \times C_{faculae} + \left(1 - \frac{B}{B_{sat}}\right) \times C_{quiet-Sun}$$

Impact of the contrast magnetic dependence



- Using magnetically dependent contrast is the best way to reconstruct the irradiance

Impact of the contrast magnetic dependence



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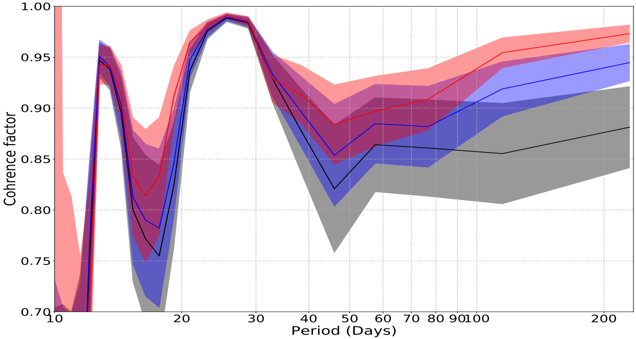
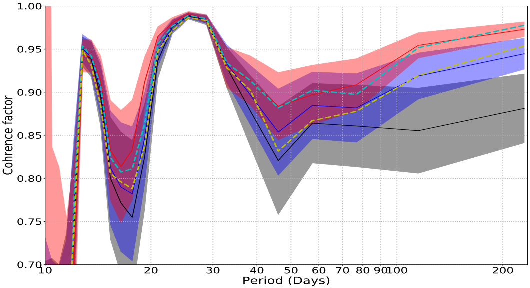
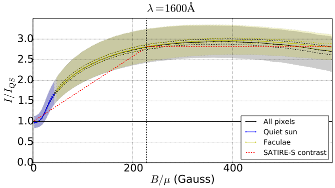
Impact of the contrast magnetic dependence



- Using magnetically dependent contrast is the best way to reconstruct the irradiance
- Separating network and faculae is essential

Impact of the contrast magnetic dependence





- Including the magnetic dependence of the network contrast is essential
  - ⇒ But linear approximation doesn't work in the UV

Summary and conclusion

- Contrast in the UV is around 3 times larger than in the visible
- Unclassified pixels look like quiet-Sun in the visible, but belongs to faculae
  - $\Rightarrow$ this misclassification doesn't impact the quality of the SSI reconstructions
- Contrasts of solar structures depend strongly on the magnetic field
  - $\Rightarrow$ this is negligible except for the network
  - $\Rightarrow$ linear relationship of the network contrast with the magnetic field is not optimal in the UV
- Contrasts of structure do not seem to vary during the solar cycle
- fall 2018 : free for a postdoc position