Using solar images in irradiance studies: an overview

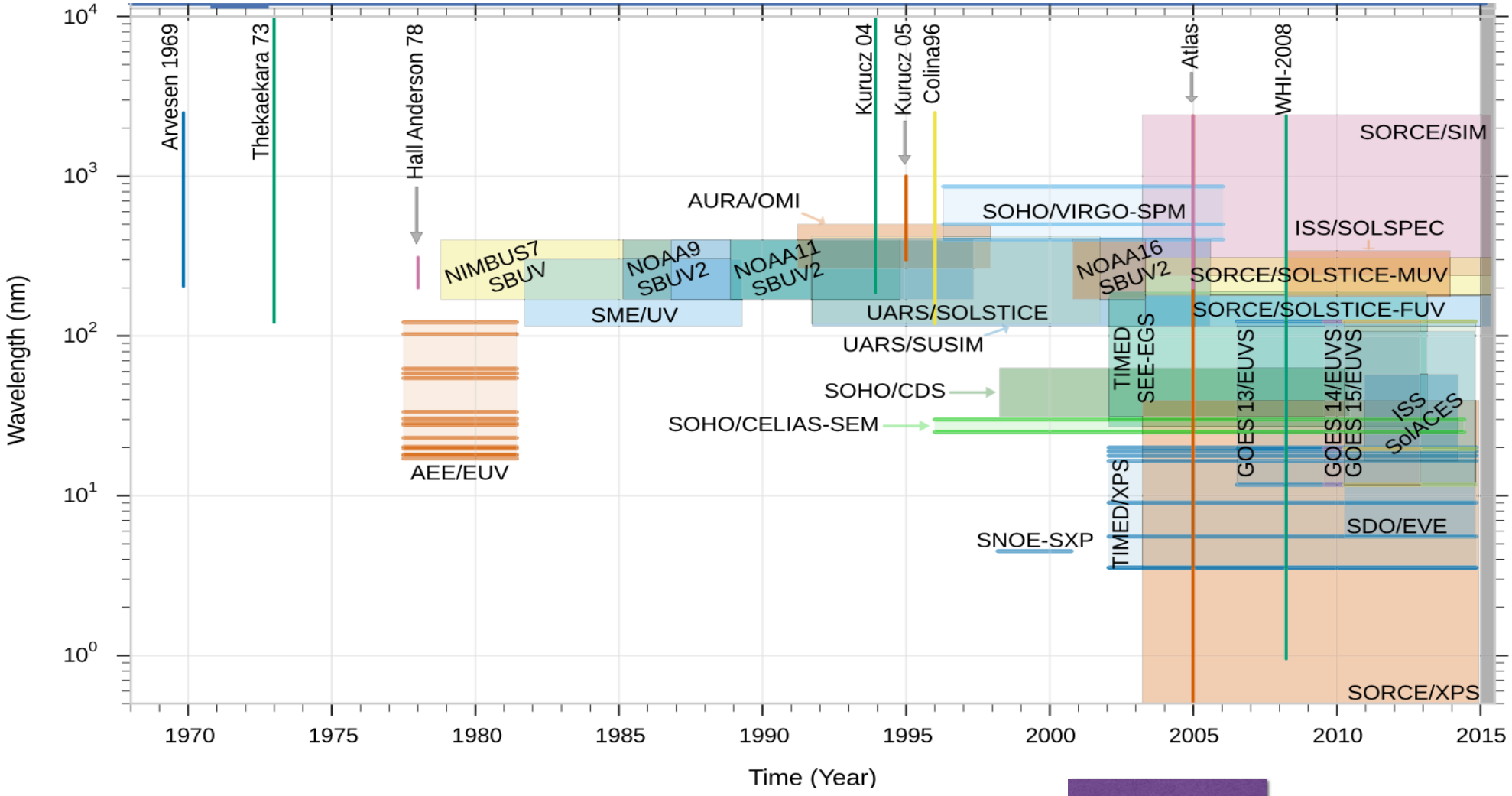
Matthieu Kretzschmar
LPC2E, CNRS & University of Orléans

Contents

- Solar irradiance status: observations and models.
- Using images for solar irradiance studies.

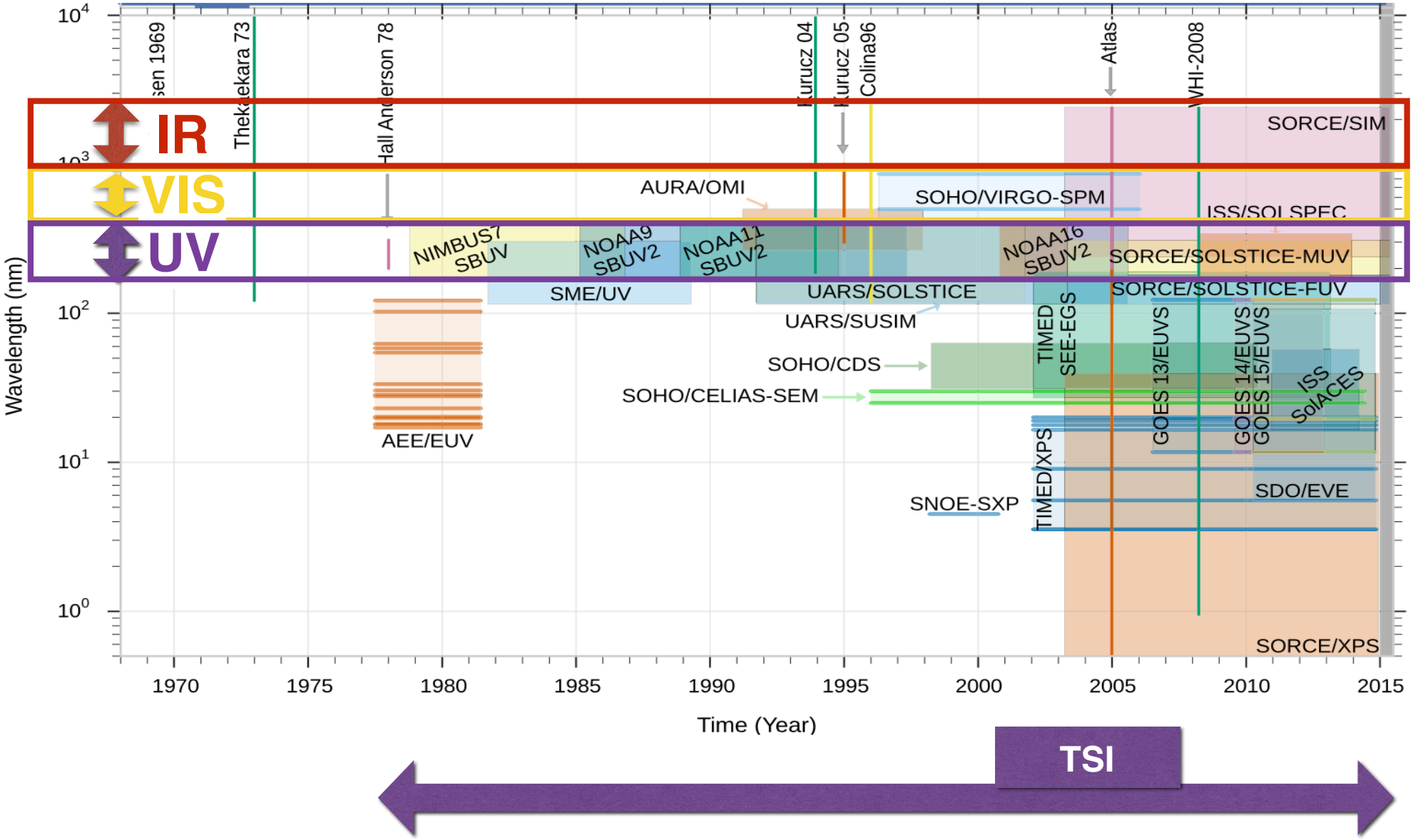
Solar irradiance observations

Schöll et al., 2015



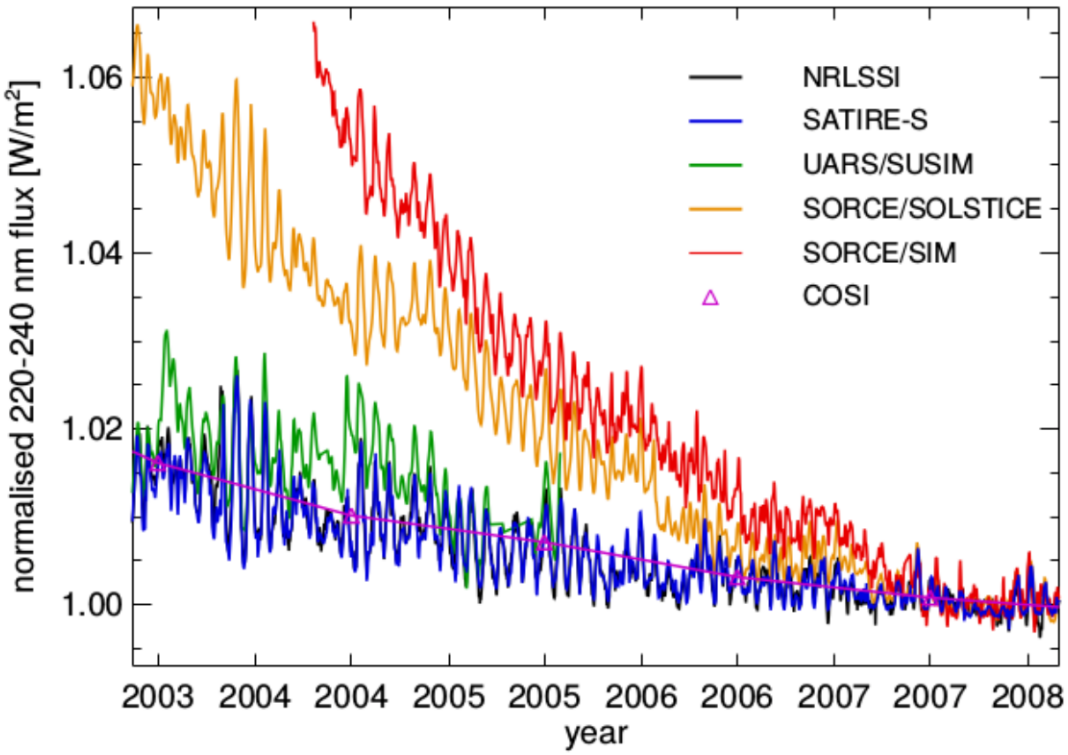
Solar irradiance observations

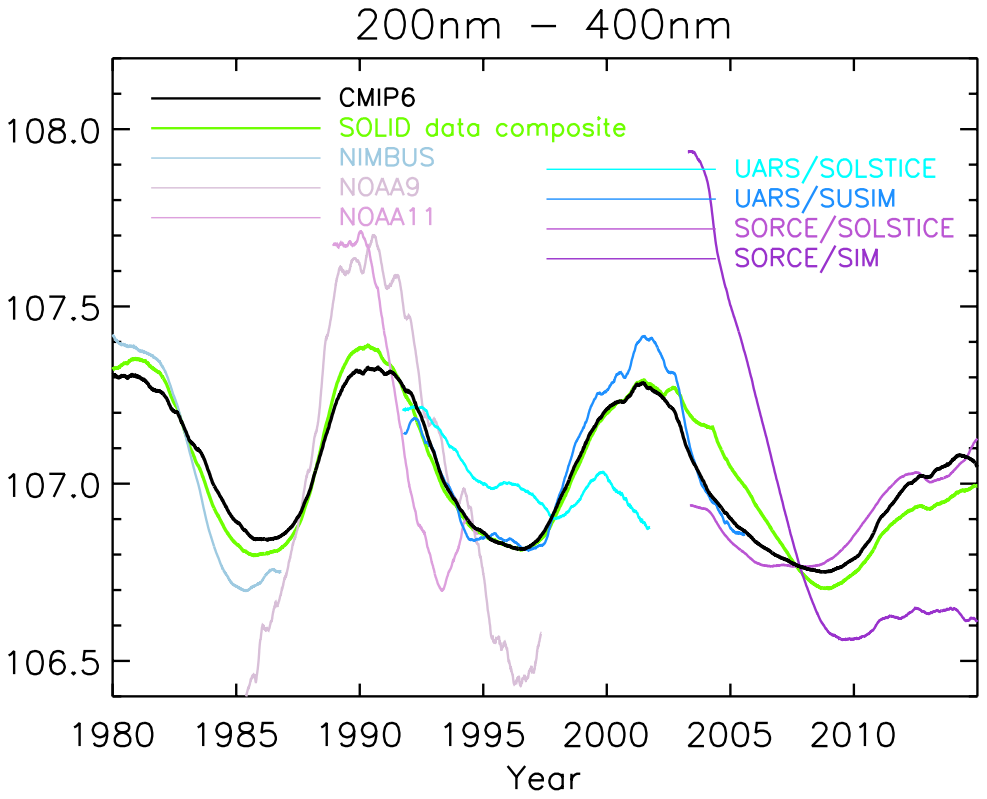
Schöll et al., 2015



Solar cycle variability

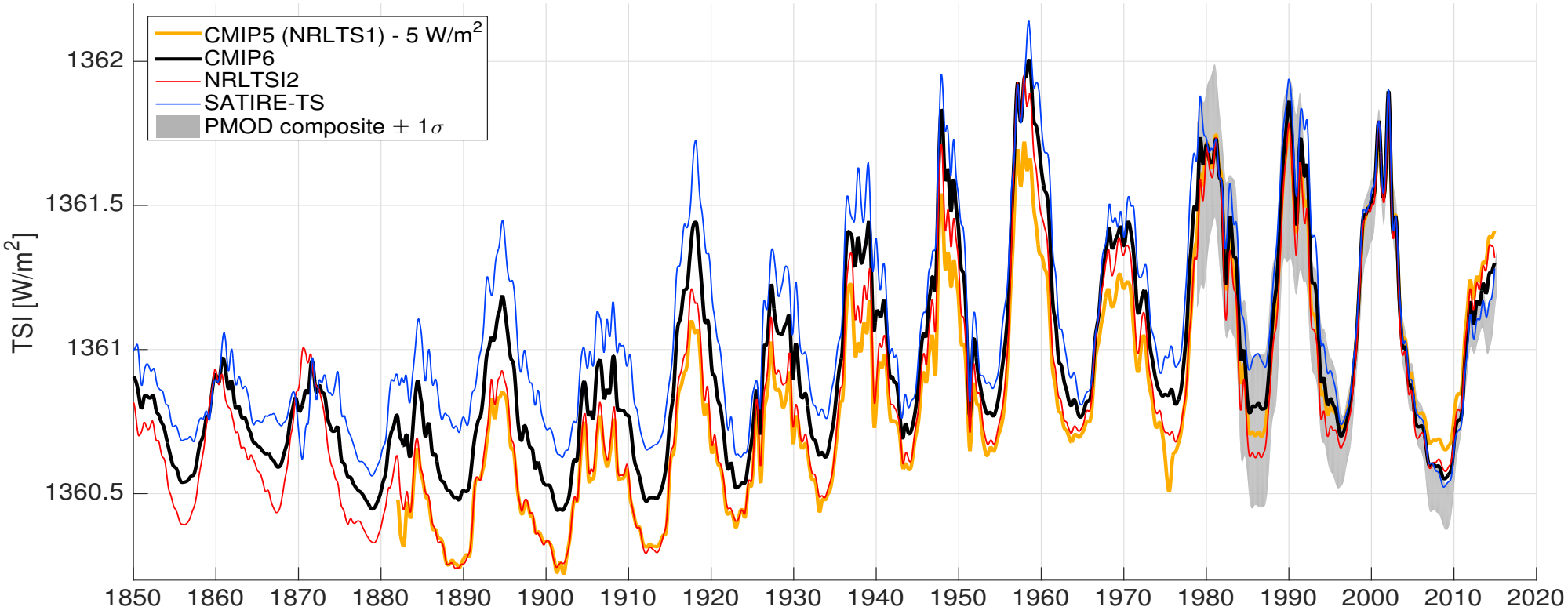
Ermolli et al., 2013





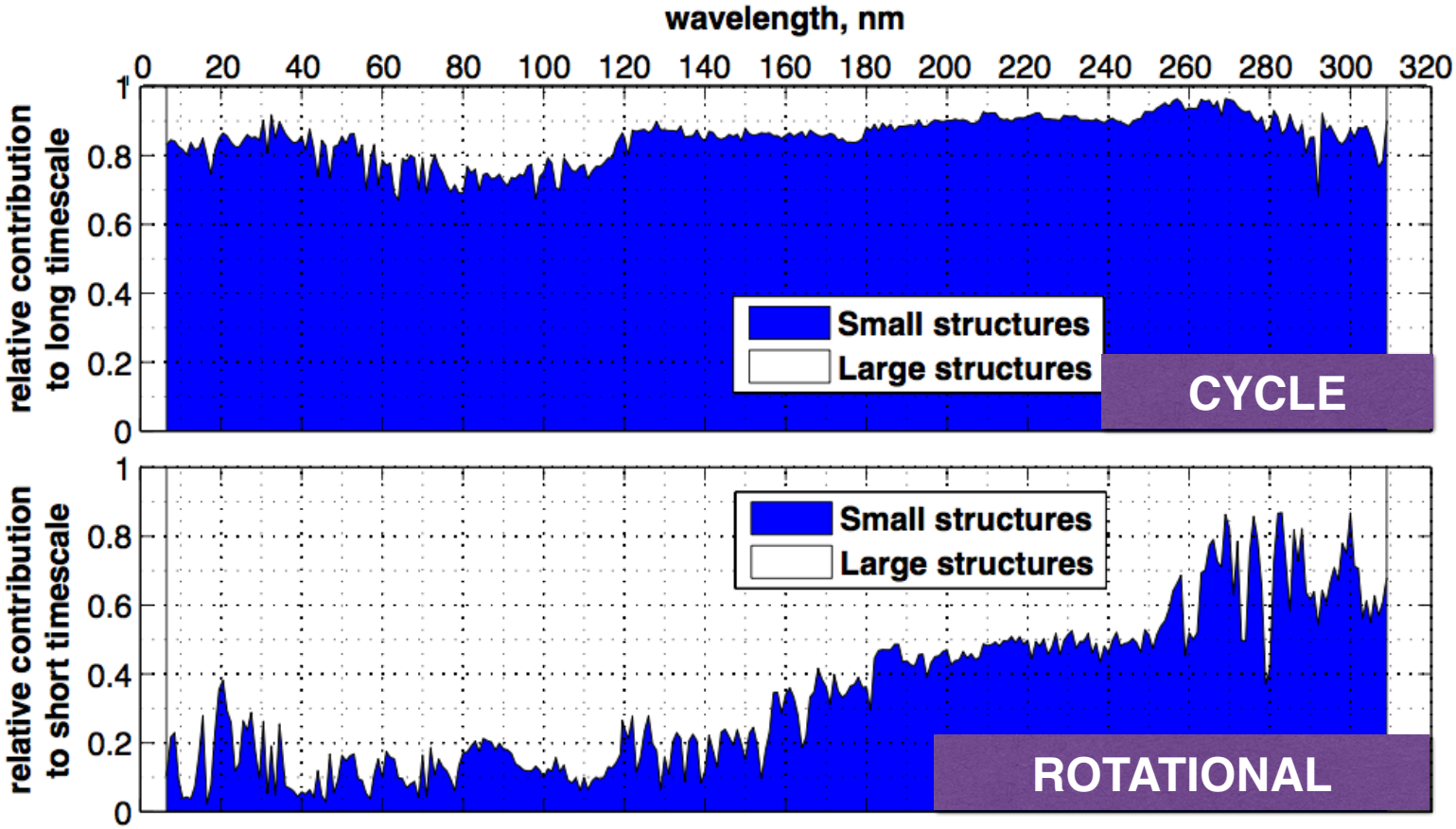
- Cycle variability is badly known above about 220nm
- Good agreement between data and models on rotational time scale
- Models should be used to constrain observations and vice versa…

Solar cycle variability



Matthes et al., sub.

Contributions of network and faculae to cycle variability



Vuets et al., 2016

Solar irradiance models

empirical models (NRLSSI2)

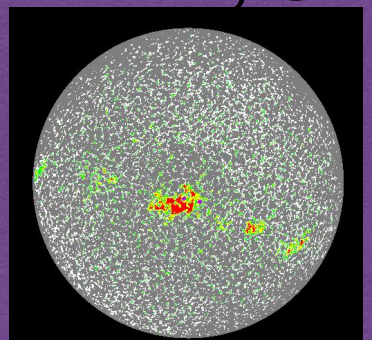
- Use full Sun proxies: sunspot area, Mg II index, f10.7cm, etc…
- make **linear regression** at rotational timescale and use these relations at cycle timescale.

Lean et al. 1998; Coddington et al., 2016

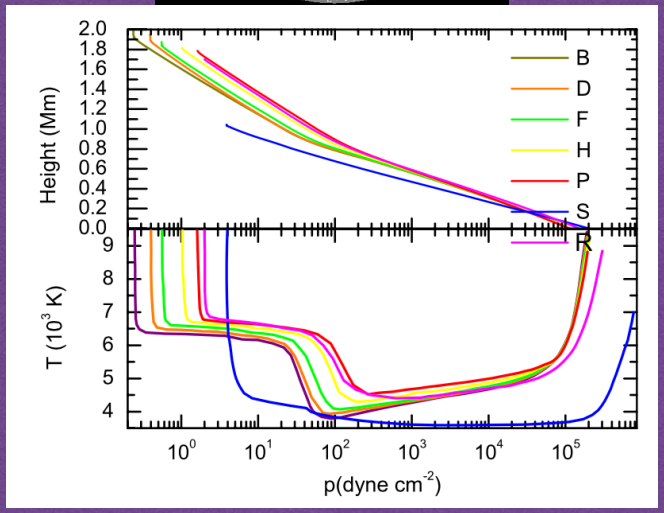
semi-empirical models (SATIRE, SRPM)

Krivova et al., 2010; Fontenla et al., 2015

- daily spatial distribution of magnetic structures



- Assigned spectrum to each structures/ pixels



- Sum up contribution from each pixel

radiative transfert

spectrum

Assumptions in semi-empirical models

- Constant contrast in time.
- Constant contrast in one structure (including QS).
- Structure definition.
- Radial model atmosphere, 1D radiative transfer, + all the assumptions in radiative transfert code.
- CLV
- Faculae filling factor.
- Ephemeral regions.

SOLAR IRRADIANCE SUDIES

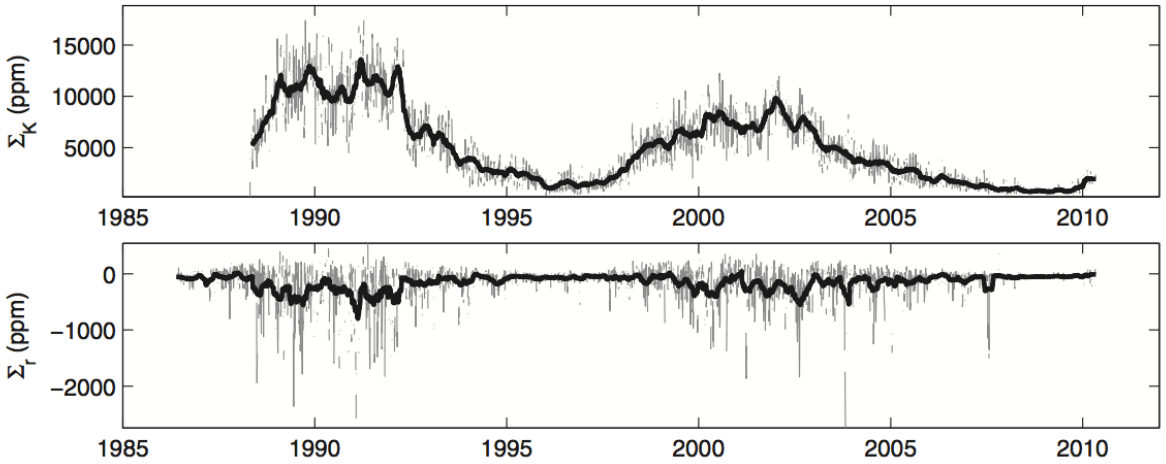
- **Photometry**
  - Conversion to physical units (see CLIMSO talk)
  - need UNCERTAINTY and STABILITY
  - usually very difficult from ground.

- **Magnetic field**

- **Contrast**
  - Contrast images as proxy.
  - Characterization of contrast vs Magnetic field.
  - Contrast variations in Time and Space (CLV).
  - Constraint on model atmosphere and radiative transfer code (magnetic structure spectrum).

Contrast images as proxy

- San Fernando Observatory:
  - **393.4 nm** with a 1 nm bandpass (Ca II **K**)
  - 672.3 nm with a 10 nm bandpass (red)



$$\Sigma = \sum_i C_i \phi(\mu_i)$$

Contrast CLV

Preminger et al., 2011

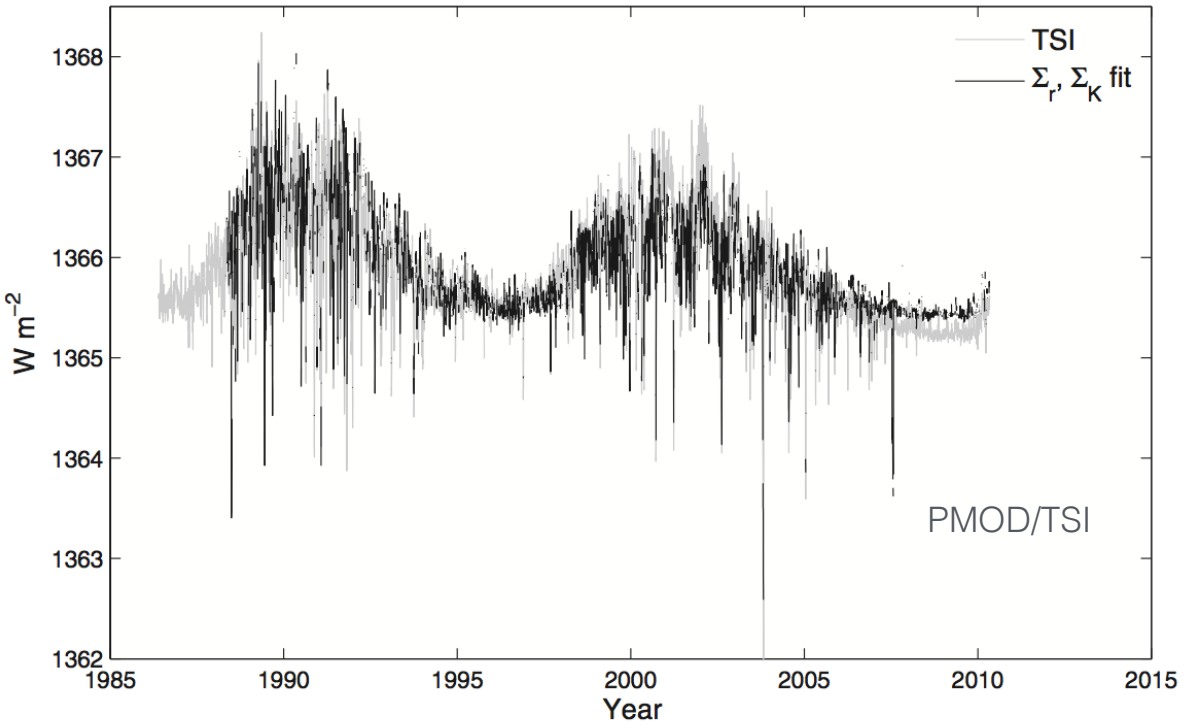
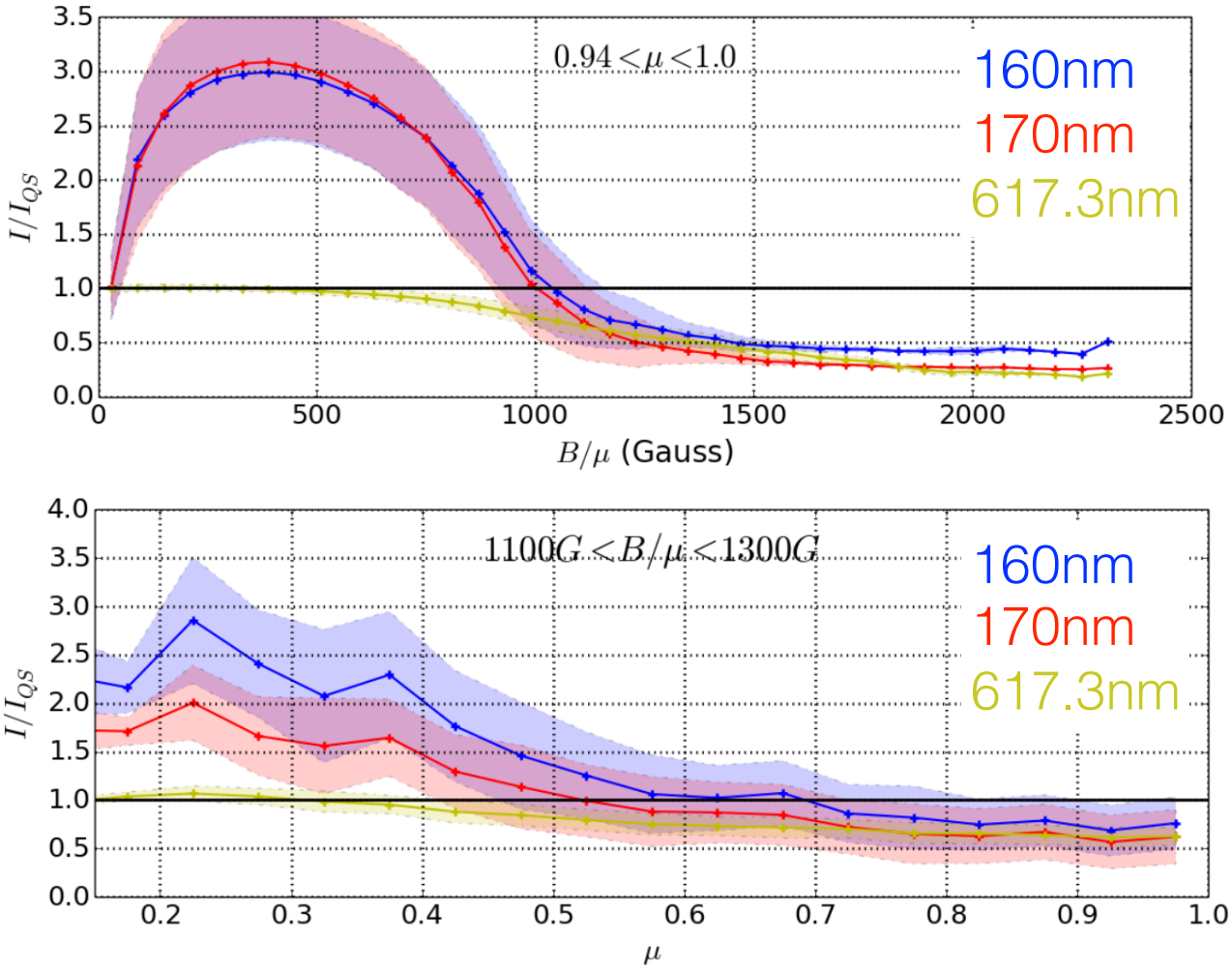
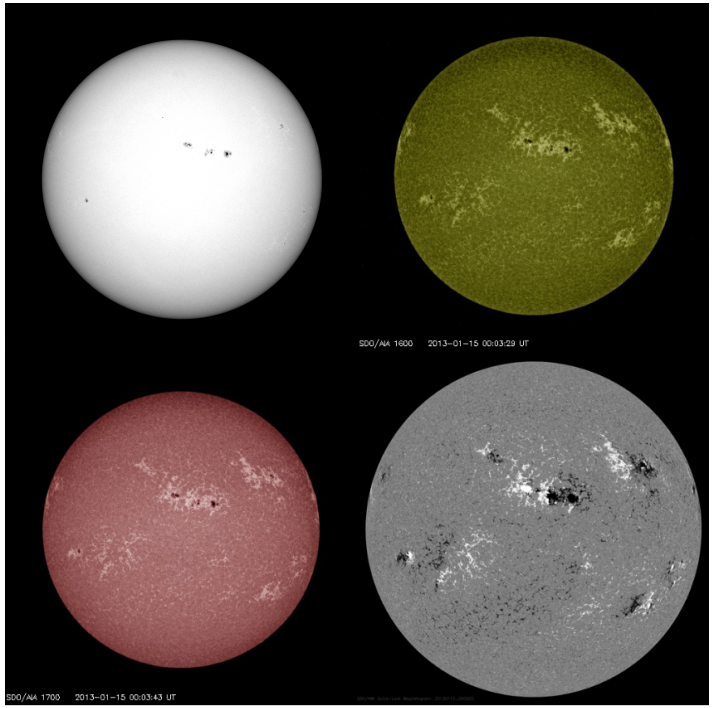


Figure 3. TSI and model fit using SFO data, $R^2 = 0.85$ (1988–2010).

Contrast vs B and μ

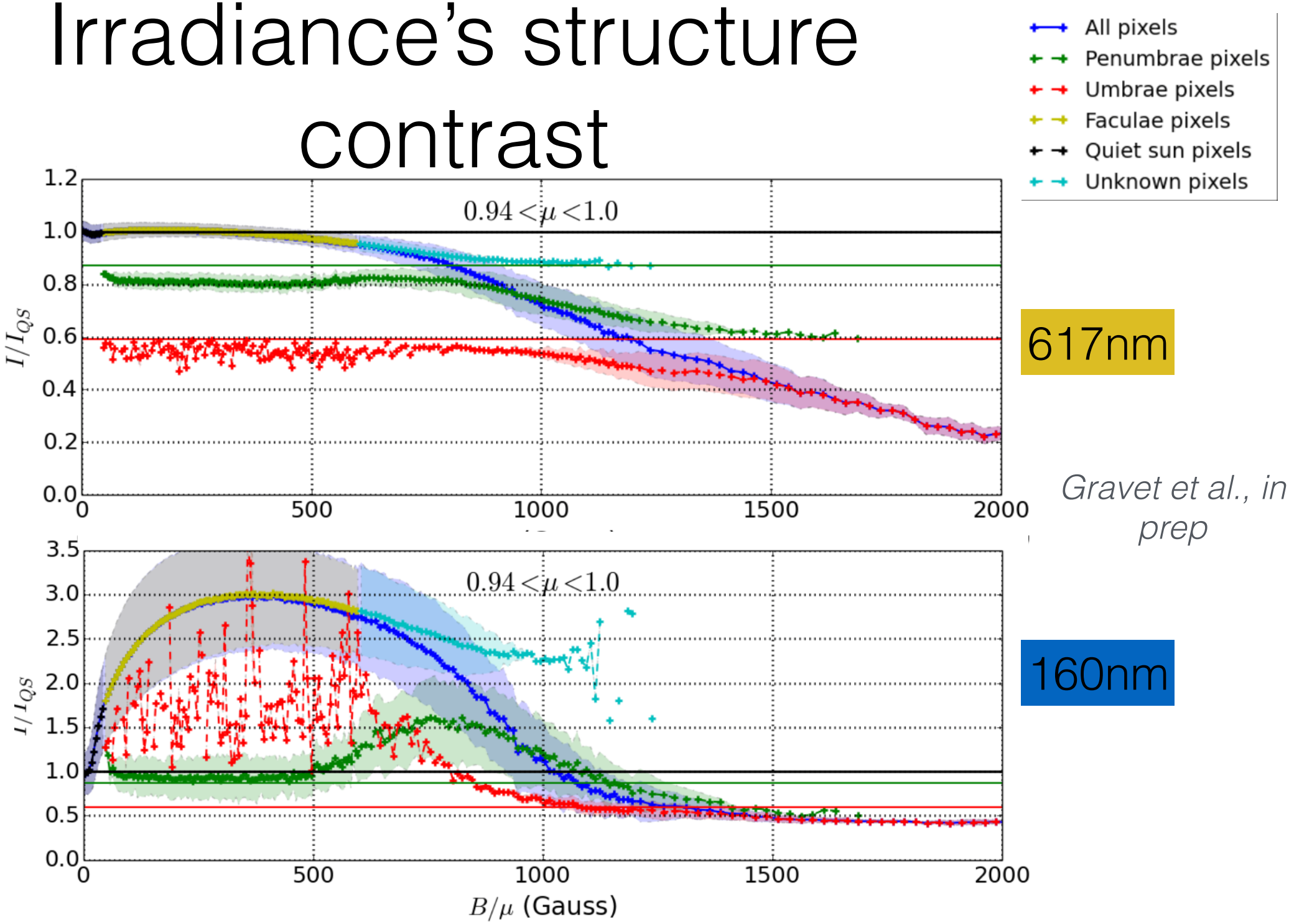




Gravet et al., in prep

Which wavelengths and sensitivity on ground for similar studies ?

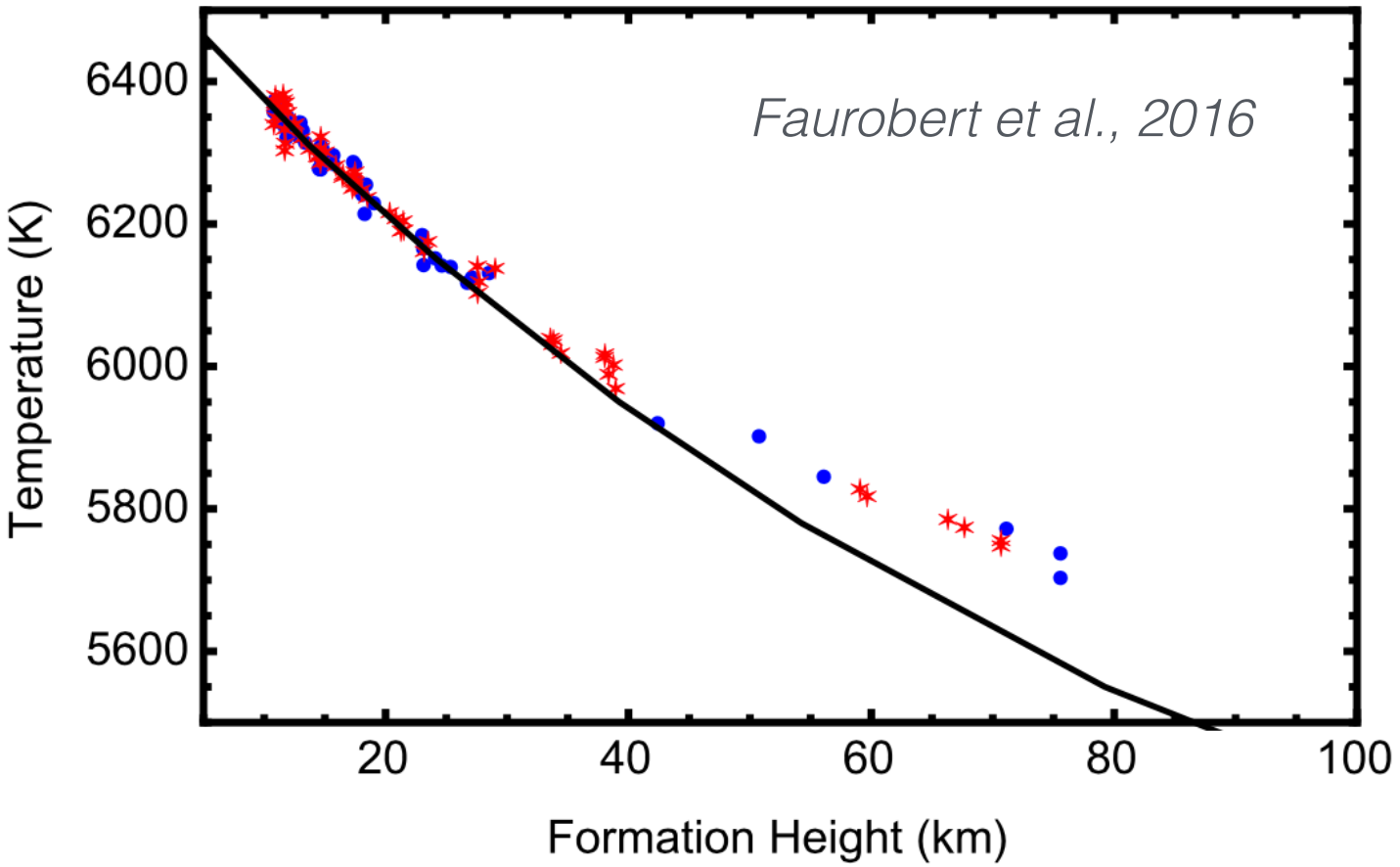
Irradiance's structure contrast



Gravet et al., in prep

Which wavelengths and sensitivity on ground for similar studies ?

Using images to test atmospheric profiles and their variability



Can this be done from ground based observations ?

Conclusion

- **Contrast**
  - Contrast images as proxy.
  - Characterization of contrast vs Magnetic field.
  - Contrast variations in Time and Space.
  - Constraint on model atmosphere and radiative transfer code (magnetic structure spectrum).

  ➡ Better if at « new » wavelength.

- Structure area, ratio, distribution, variability,

Thank you