Solar atmosphere study using PICARD limb and spectral measurements

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OUTLINE

Limb shape: influence of the chromospheric emissions

Limb shapes predictions for the PICARD measurements

Effect of the active regions

Use of solar spectrum predictions and observations

This presentation is based on an article just submitted to Solar Physics:
« The shape of the solar limb: theory and observations « by
G. Thuillier, J. Claudel, D. Djafer, M. Haberreiter, N. Mein, S. Melo, W. Schmutz, A. Shapiro, C. I. Short, S. Sofia

LIMB SHAPE CALCULATION

The limb shape can be calculated using a solar atmosphere model.

The models use for these calculations are:

- COSI: PMOD

- PHOENIX: St Mary University

- SolMod3D: LASP

- VAL C: Vernazza

- Different limb shapes are obtained function of wavelength and function of the active regions (sunspots and faculae).

-The aim of this presentation is to apply these results to the SODISM and PREMOS data.

PICARD OBSERVED SPECTRAL DOMAINS

SODISM and PREMOS have several common spectral domains:

SODISM:

215 , 393, 535.7, 607, 782 nm

535, 607 and 782 are choosen in the solar photospheric continuum.

393 nm corresponds to the Ca II line

215 nm is a spectral domain choosen by PREMOS

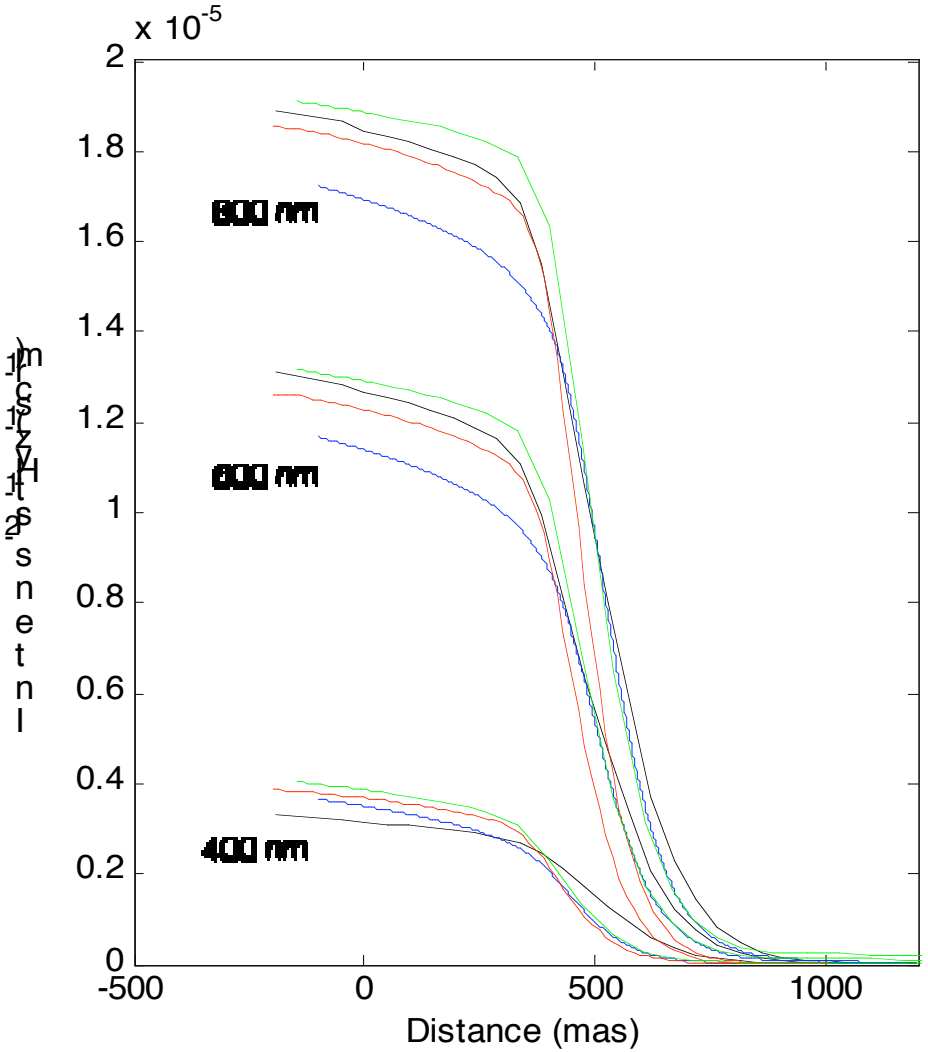
PREMOS

215 and 268 nm have been choosen by PREMOS for some specific questions relative to the ozone photochemistry. These measurements will be also used for variability studies, and the relationship radiance/irradiance.

The other channels are the same as SODISM and are synchronously observed.

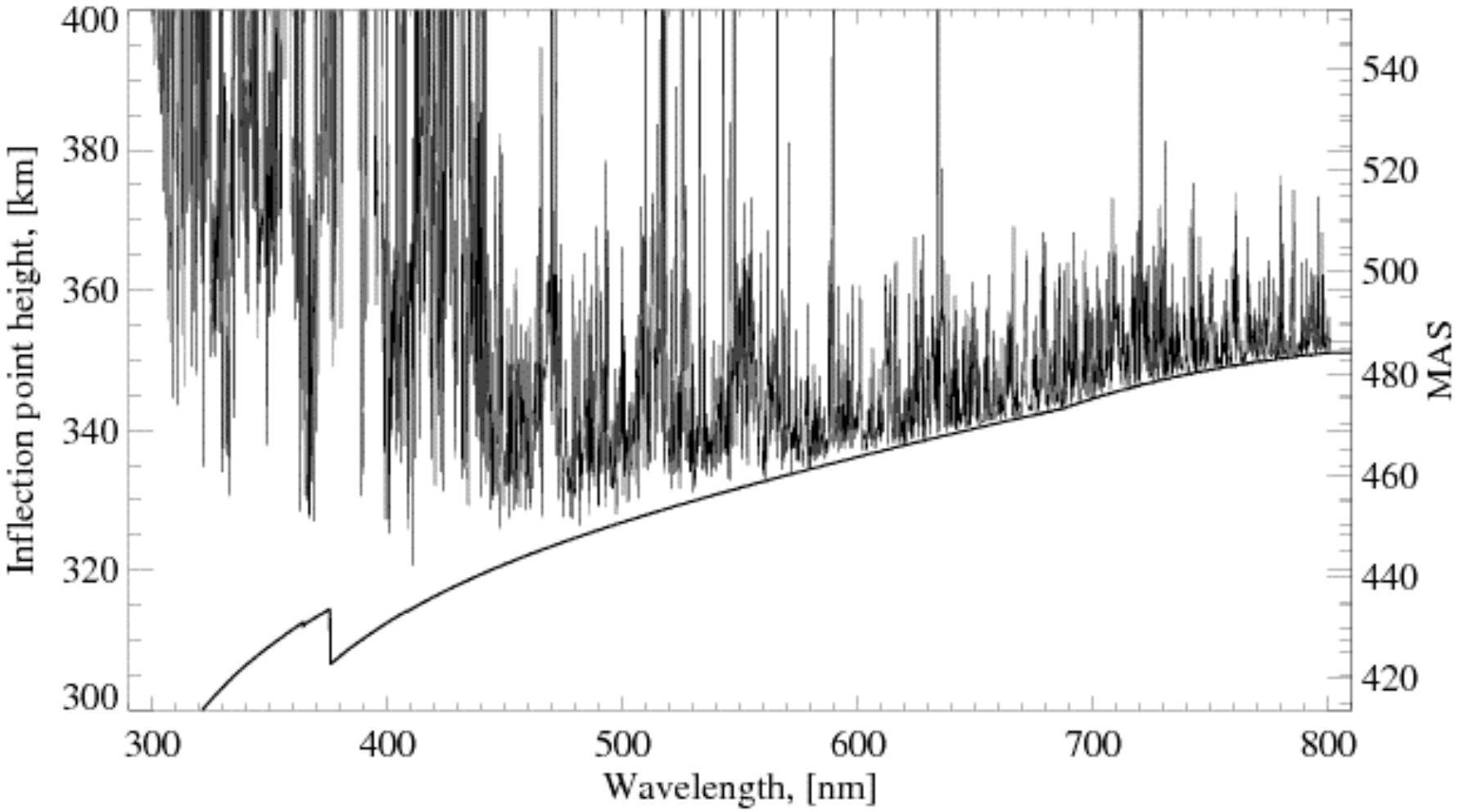
POSITION OF THE INFLECTION POINT

For a given spectral domain or for a line, the solar atmosphere models allow us to calculate the limb shape and to determine the inflection point position with or without Fraunhofer lines.



Limb shapes for three wavelengths predicted by:
SH09 (red), FCH09 (black),
VAL-C (blue), and COSI (green),
without Fraunhofer lines

EFFECT OF FRAUNHOFER LINES ON THE INFLECTION PONT POSITION



The above results are obtained by COSI.

CONSEQUENCES

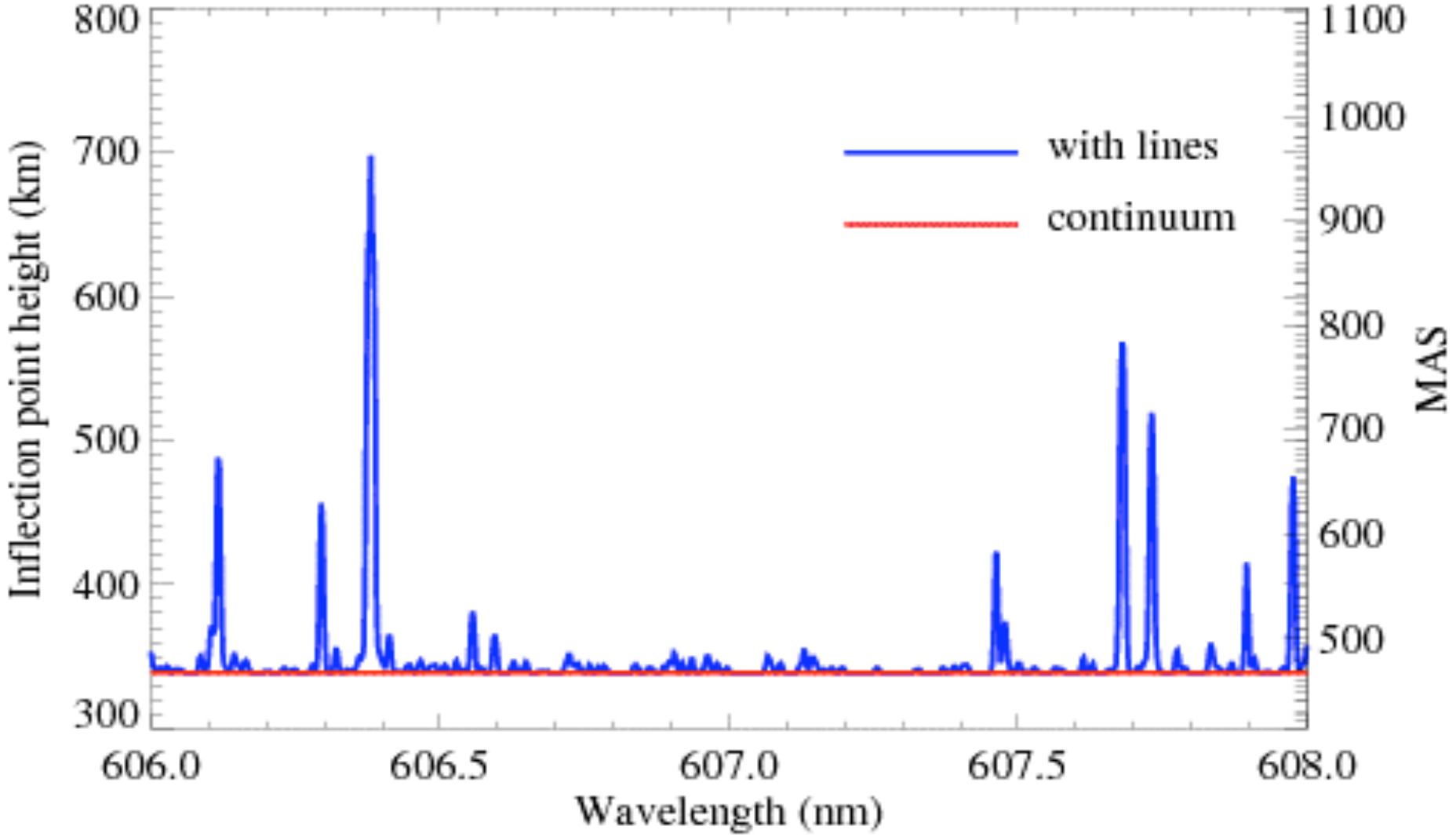
Considering all existing diameter measurements, many of the discrepancies that were attributed to the atmospheric effect, could be also due to the presence of different Fraunhofer lines within the spectral domain of measurement.

In particular, since some Fraunhofer lines are related to solar activity, this effect may explain some positive correlation between the solar diameter variation and solar activity (Ulrich and Bertello, 1995).

Furthermore, the discrepancies between the different existing solar diameter measurements, besides the different instruments and methods of analysis, are also due to the presence of Fraunhofer lines.

This dependence has been taken into account when choosing the spectral domain to measure the solar diameter by SODISM/PICARD.

SODISM WAVELENGTH DOMAIN



HOW TO SELECT AN ATMOSPHERE MODEL USING SODISM DATA?

The inflection point position calculated by the models are referred to τ_{500}=1, which is not accessible to the measurements. So, we use a position as a reference at λ = 535.7 nm.

Wavelength (nm)	607.1	782.0
VAL81	11.9	30.2
FCH09	13.6	32.8
SH09	9.4	21.2
COSI	10.0	28.0

Difference of the position of the inflection point from the position at 535.7 nm as a function of wavelength, to be observed by PICARD, for the continuum spectra calculated for the quiet Sun models VAL81, SH09, COSI and FCH09 codes. The reference is taken at 535.7 nm.

- Comparaison between the predictions shown in the previous table and observation will indicate how realistic the models are.

- Limb shape predictions and the observed limb shapre by SDS and MDI, show the same feature: calculated limb shape is always much steeper than observed limb shape

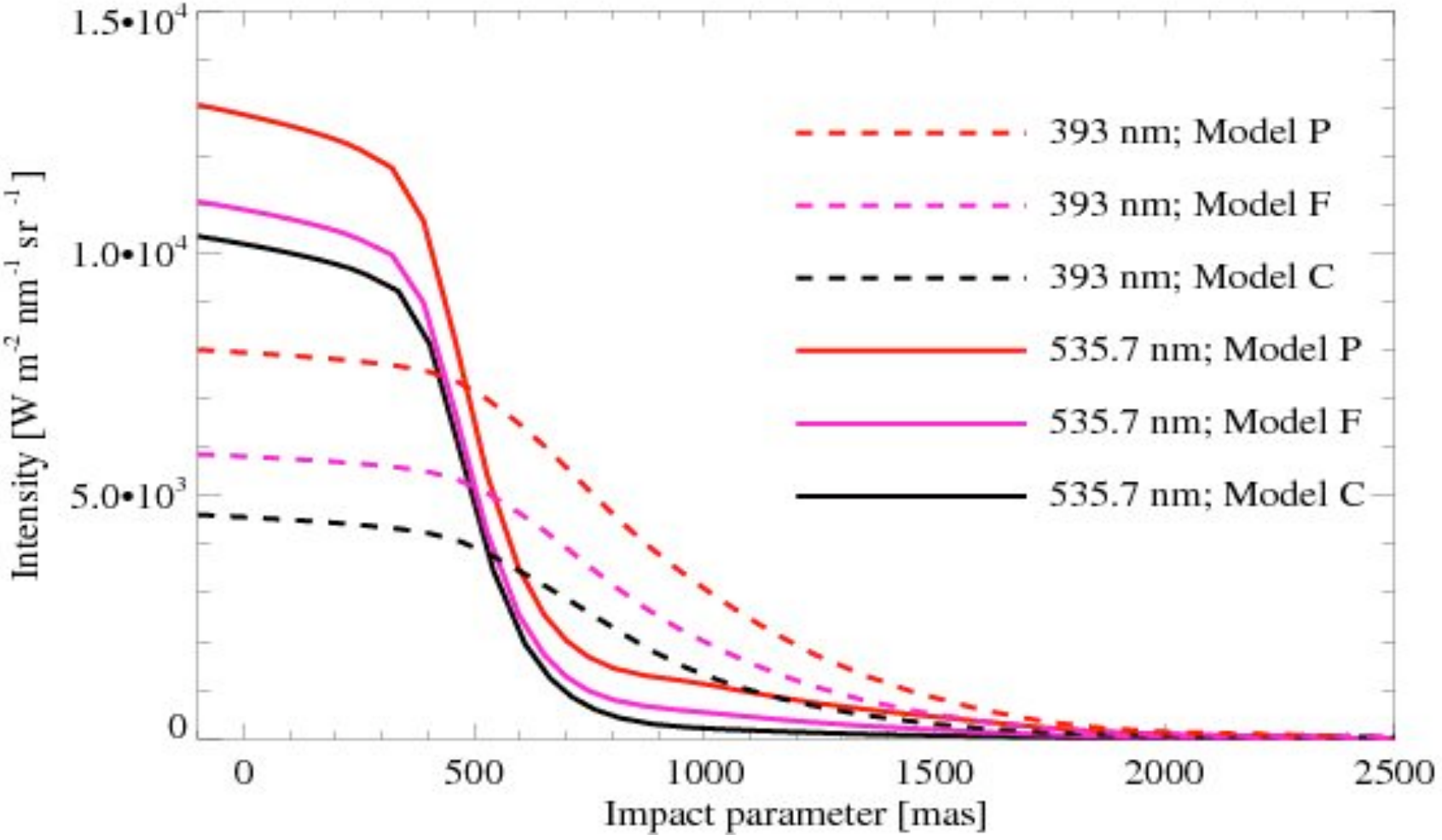
- Discrimination between models: given the differences ranging from 3 to 10 mas, efficient noise smoothing will be necessary, in particular after a very careful attention to the presence of the active regions using the Ca II images.

ACTIVE REGIONS EFFECT

As the limb shape is optically determined, in general:
-a sunspot decreases the diameter,
- a facula increases the diameter.

Chromospheric contribution may also increase the diameter.

COSI PREDICTIONS FOR CaII LINE AND CONTINUUM



This calculation will be also made at 215 nm.

USE OF SOLAR SPECTA FOR PREMOS AND SODISM

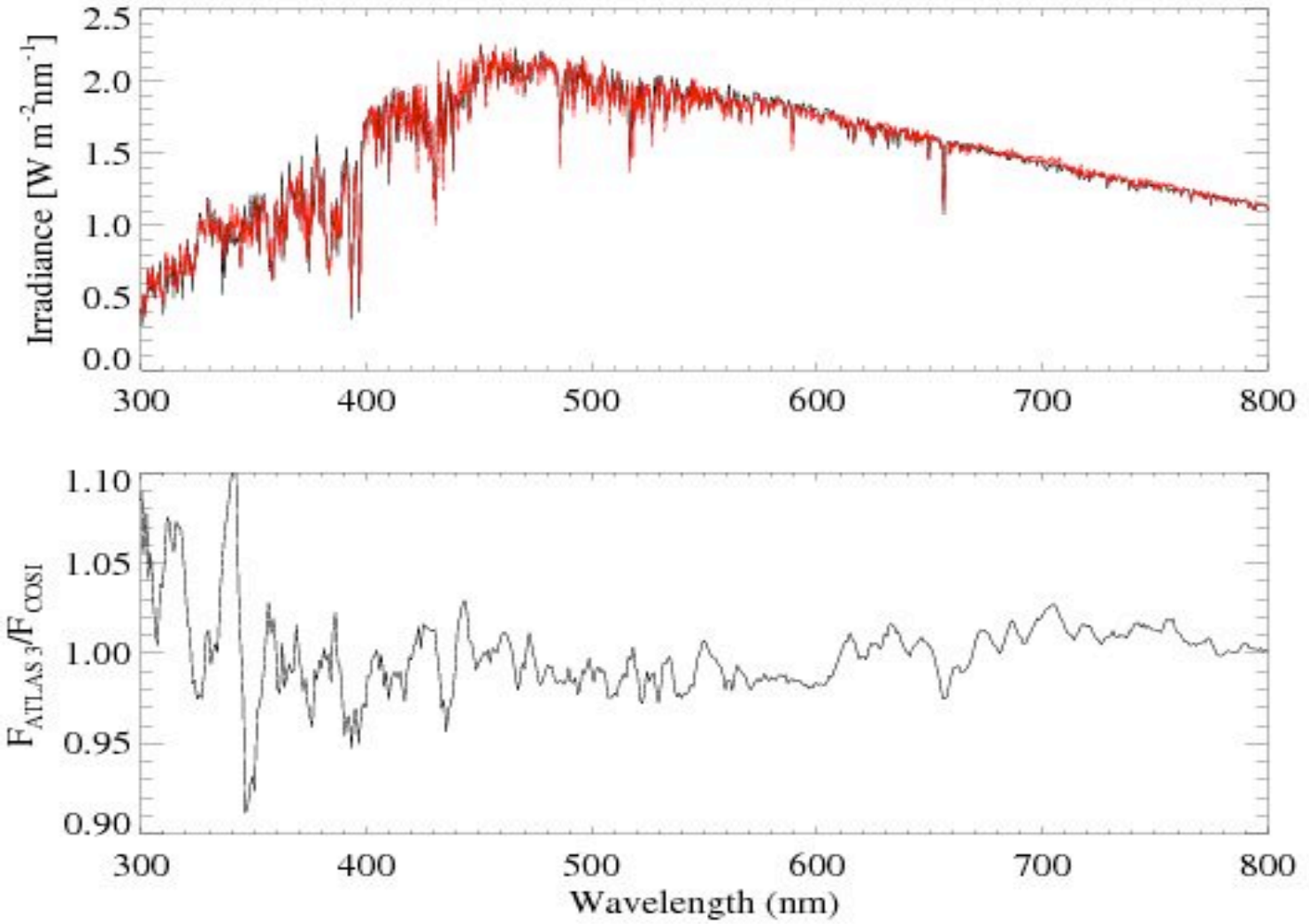
Available solar spectra:

- ATLAS 1 AND ATLAS 3 spectra at high and low solar activity, respectively.

- ISS: the running period of the *SOLAR* payload (SOL-ACES and SOLSPEC) has been extended by ESA, which will provide us with spectra during the raising phase cycle 24.

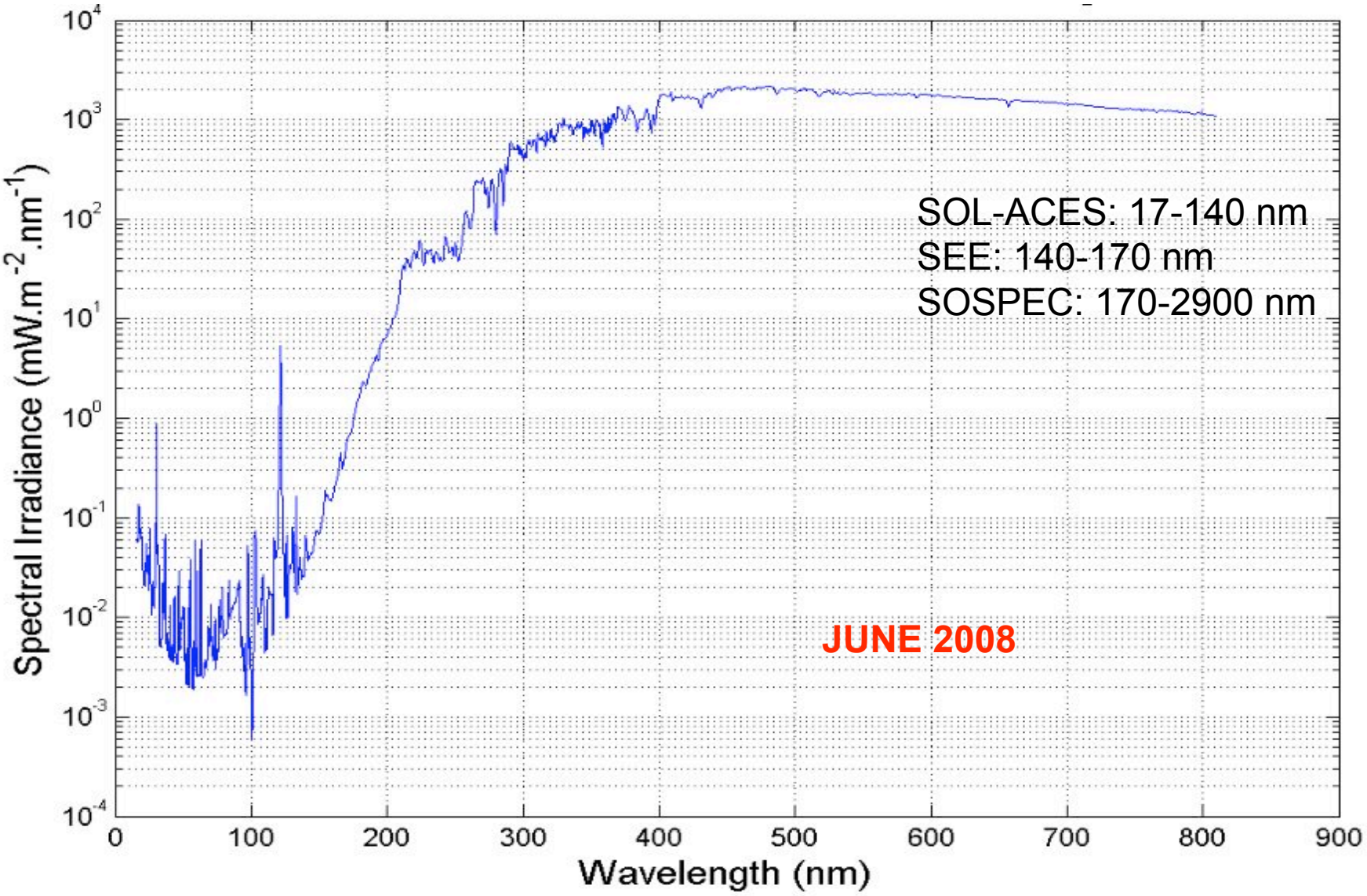
- SORCE: especially designed for detailed variability studies.

COSI CALCULATION AND ATLAS 3

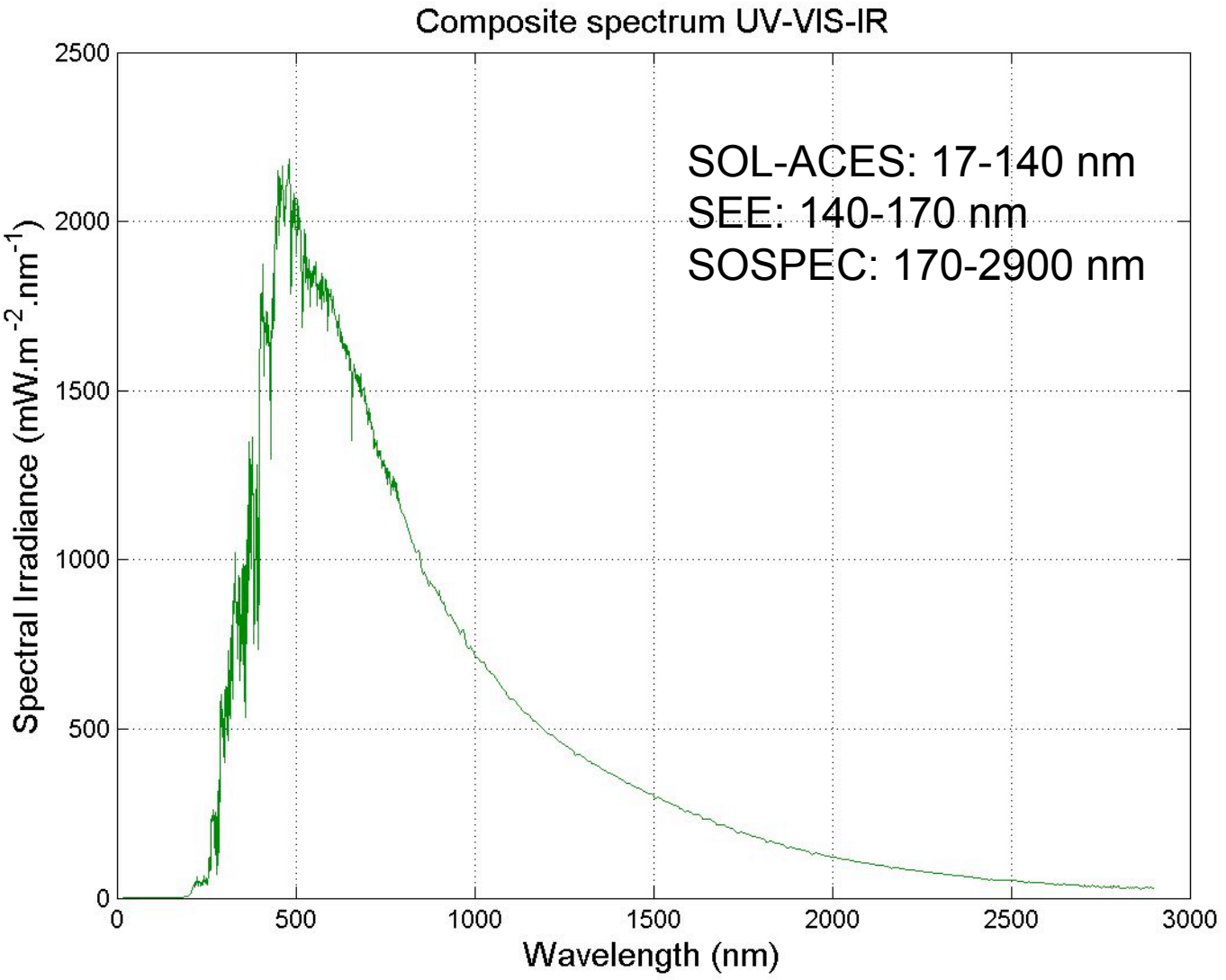


ATLAS 1 and 3 spectra: Thuillier et al, 2005

SOLAR SPECTRUM AT SOLAR ACTIVITY MINIMUM MEASURED ON BOARD THE ISS (1/2)



SOLAR SPECTRUM AT SOLAR ACTIVITY MINIMUM MEASURED ON BOARD THE ISS (2/2)



SELECTING A SOLAR ATMOSPHERE MODEL

The model predictions of limb shape and solar spectrum will have to agree

- with the limb shape measurements by SODISM as a function of wavelength, and

- with the spectral measurements provided by PREMOS and ISS as a function

of time.

CONCLUSION

As cycle 24 is just starting, PICARD mission, SDO, SORCE and ISS will provide observations at different levels of solar activity providing key observations to validate the solar modeling.

END