SORCE Science Meeting

Jan. 28-31, 2014

Cocoa Beach, Florida

The PREMOS/PICARD Radiometer: An Overview after 3 Years of Observations

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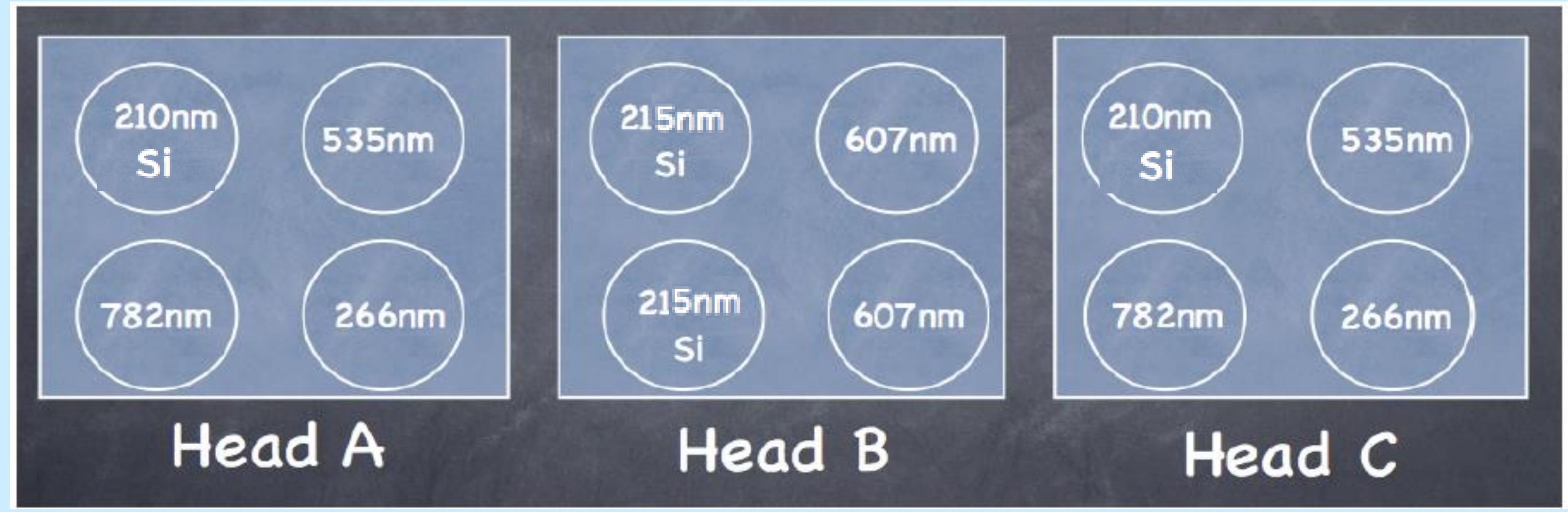
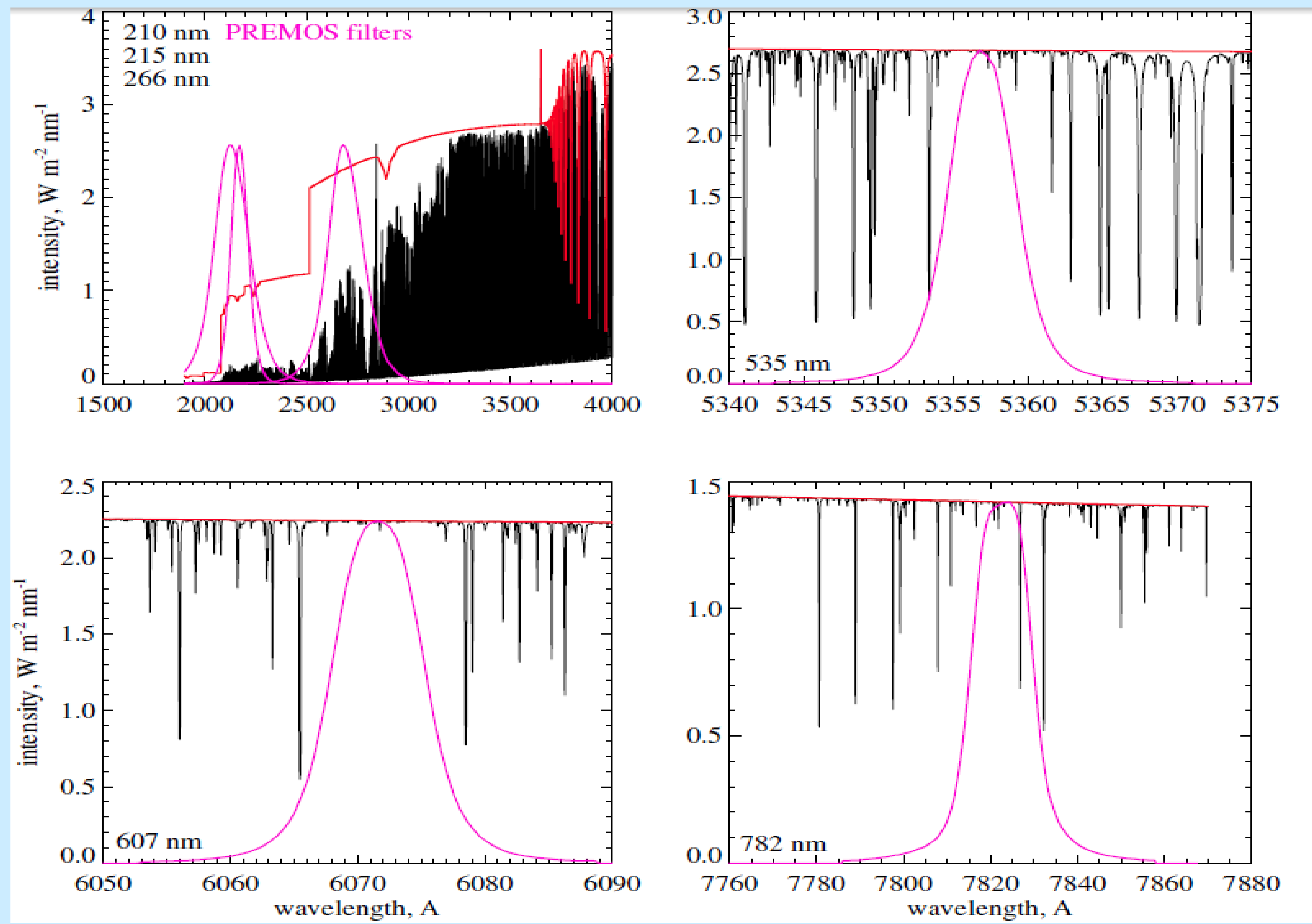
PMOD/WRC, Switzerland

PREMOS instrument

pmod wrc

SSI irradiance at 6 wavelengths





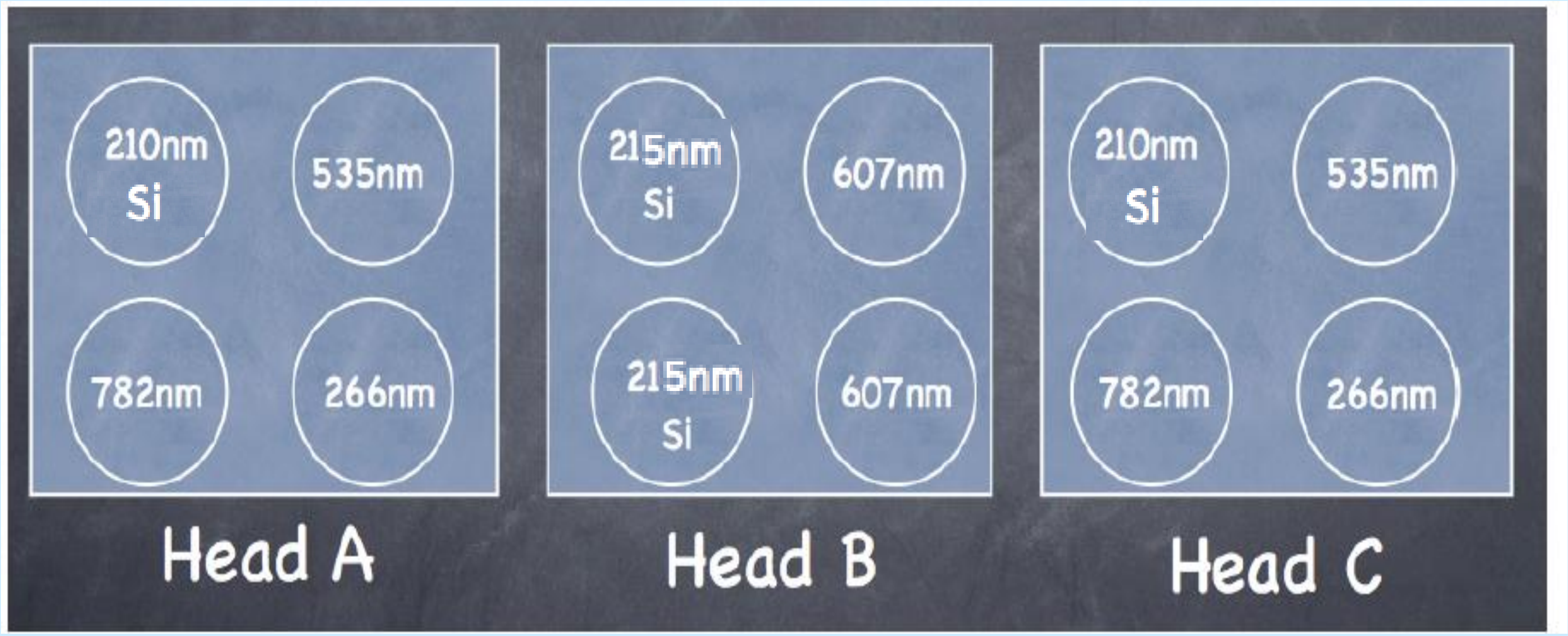
Behind the measure…

… the observation strategy

An attempt to assess instrument degradation in a self consistent way by

- referring operational measurements to occasional backup operations
- correcting the backup channel by initial ageing of operational channel

Redundancy strategies



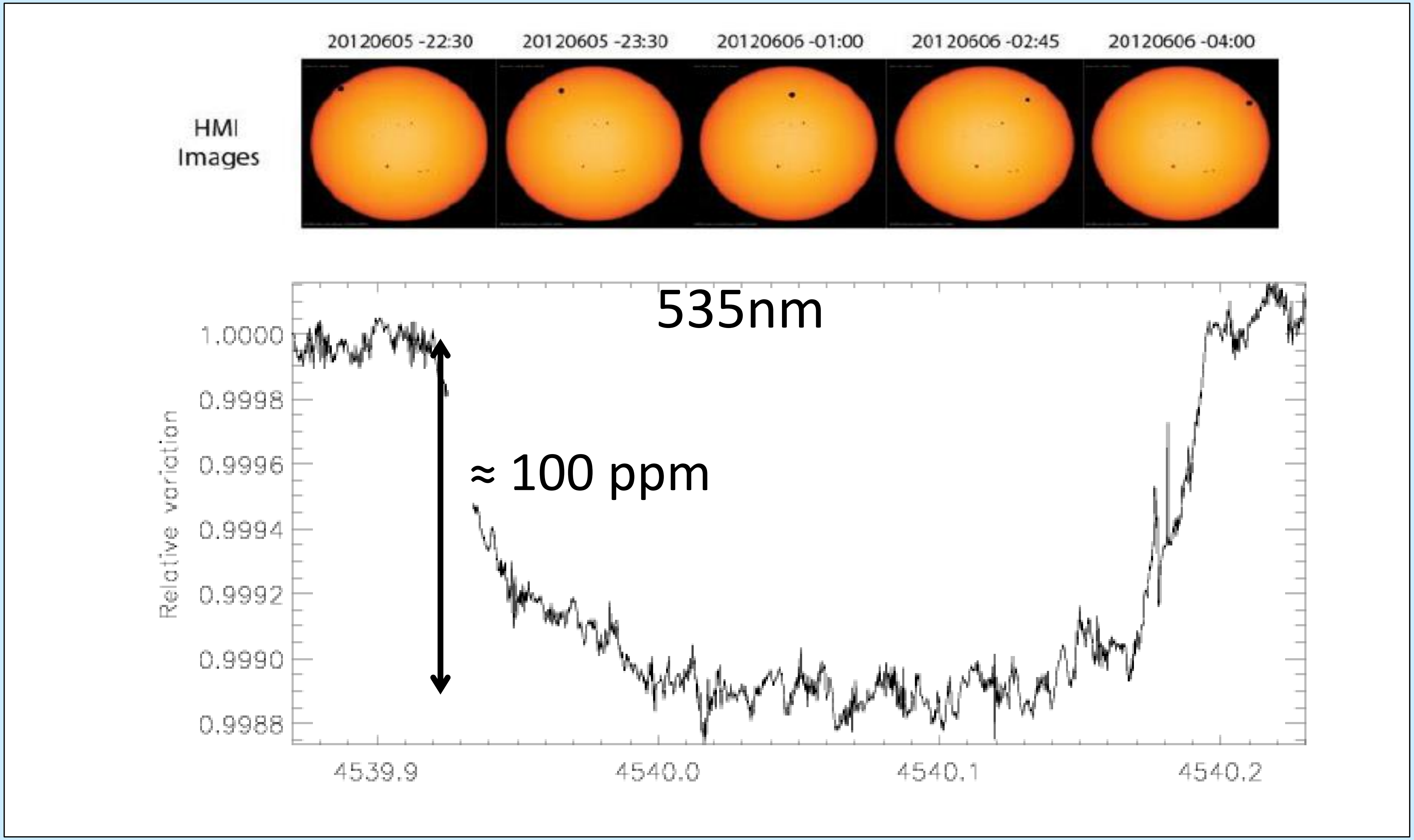
Head A: operational channel (1 measure every 10s)
Head C: backup channel of Head A (1 measure every day)
Head-B C1,C2 measure during 1 minute (6 samples), about every second orbit
Head-B C3,C4 measure during 2 minutes (12 samples), about once a week

PREMOS-VIS ‘First Light’

ATLAS & SIM spectra convoluted with actual filter transmittance

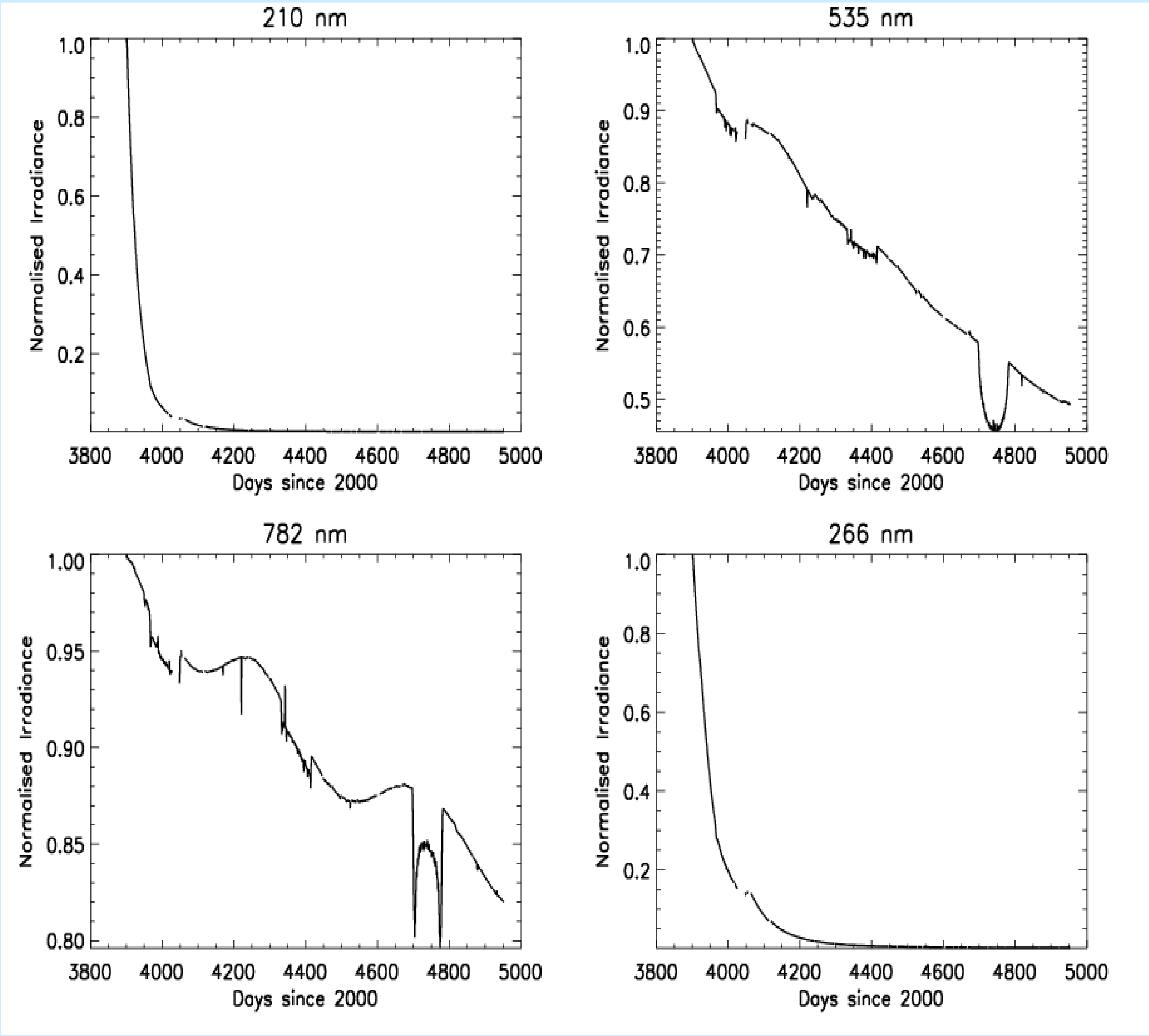
PREMOS FR	535nm	607nm	782nm
First Light @1AU	1.913	1.858	1.174
@ T=20°	**1.961**	**1.858**	**1.203**
ATLAS	1.983	1.772	1.188
SORCE/SIM	1.918	1.731	1.169
	0.5%	**+6%**	**+2%**

Venus Transit as seen by PREMOS



- Similar results at 782 nm (and for SIM data), no signature in the UV

Degradation Issues

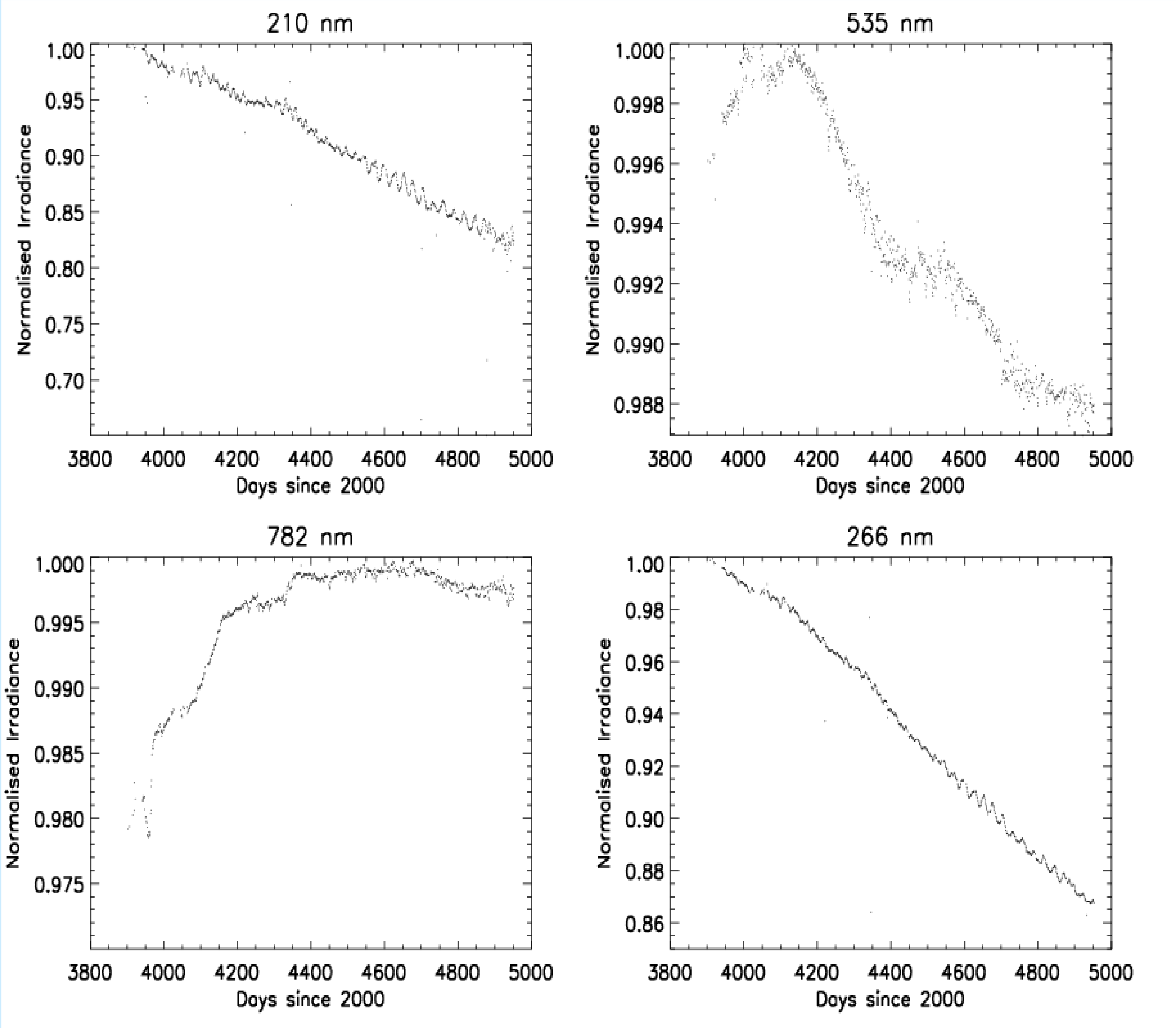


Head-A, continuous operation

- Strong degradation:
  - UV channels <1% after 300 days
  - VIS channel : 50 % left
  - IR channel > 80 %

- Contamination under solar UV exposure

Degradation Issues

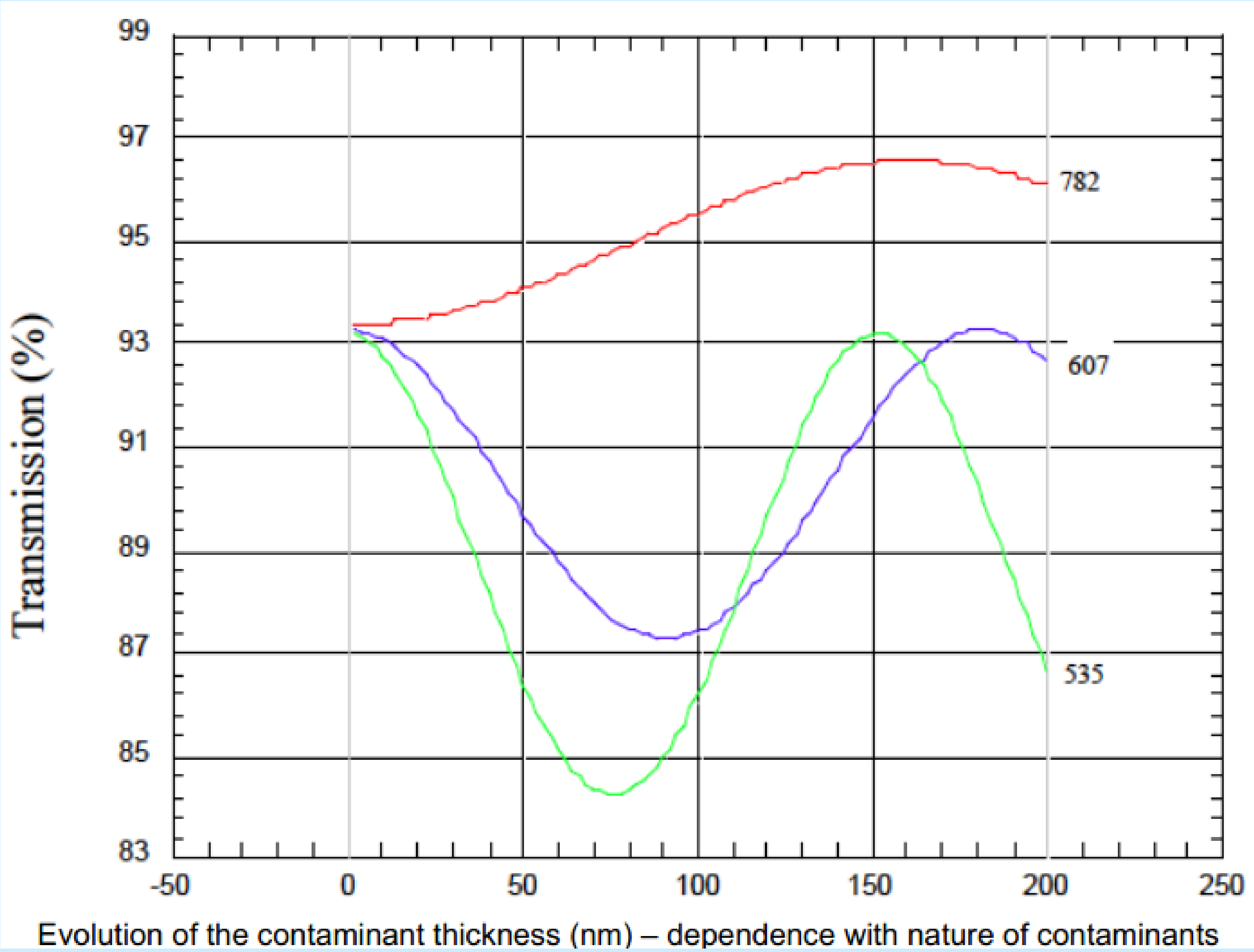


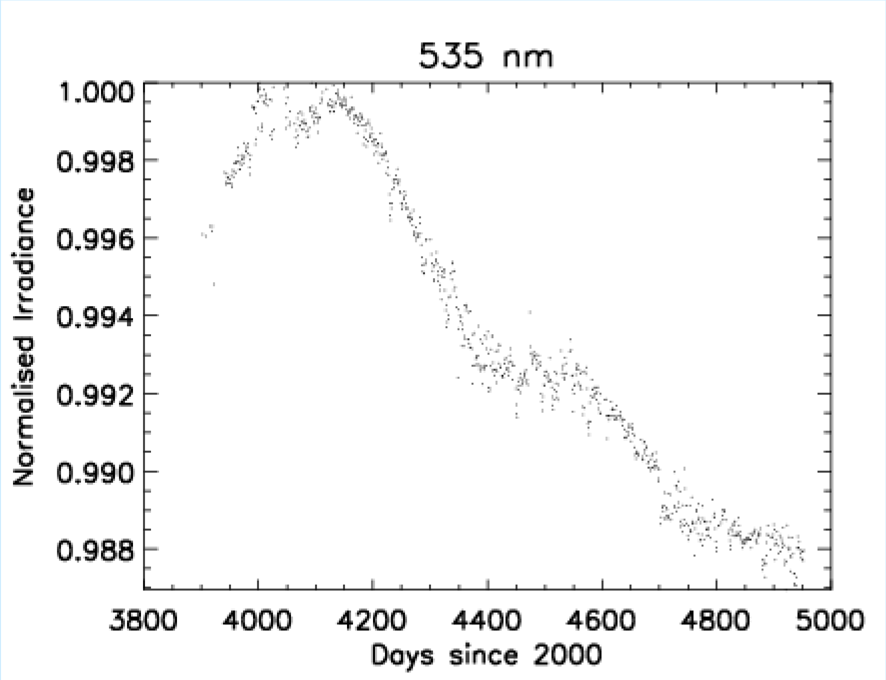
Head-C, backup for Head-A

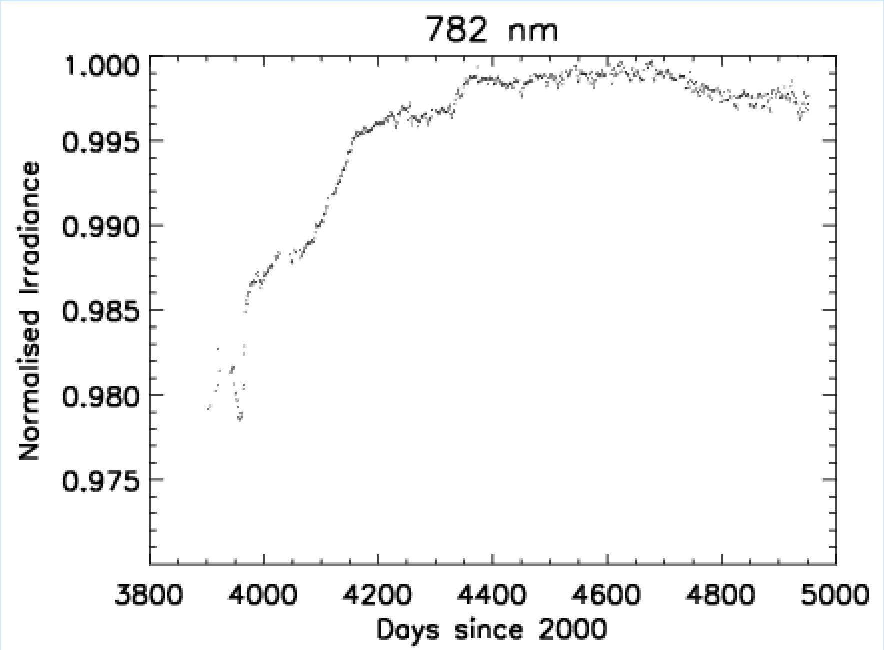
- UV channels
  - 210nm – 20%
  - 266nm – 14 %
- VIS-NIR channels
  - 535nm ≈ -1%
  - 782nm +2%

Degradation issues

VIS and IR channels: contamination under solar UV exposure ?



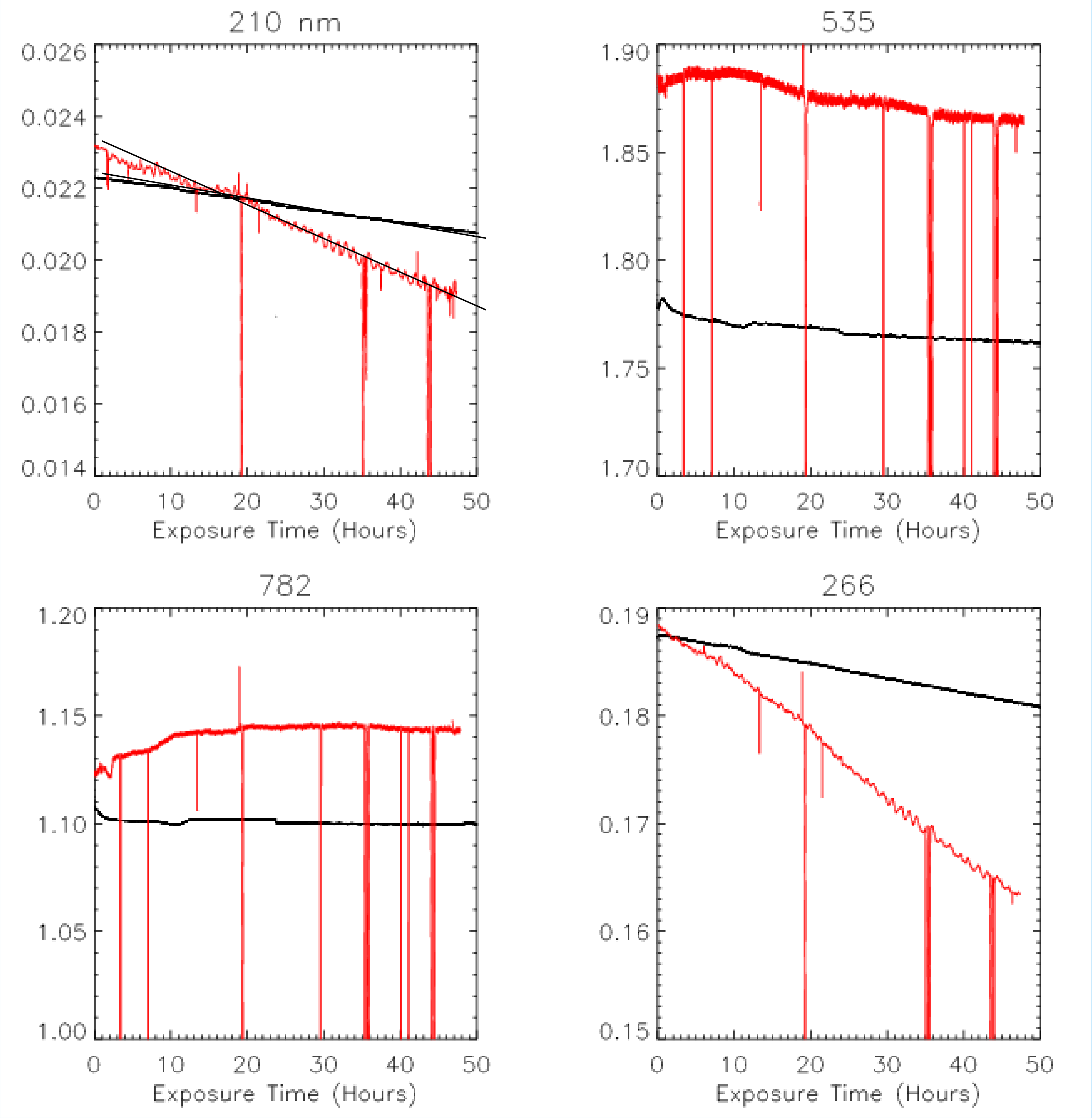




Collaboration with the LYRA team (Brussels) and the SODISM team

Degradation Issues

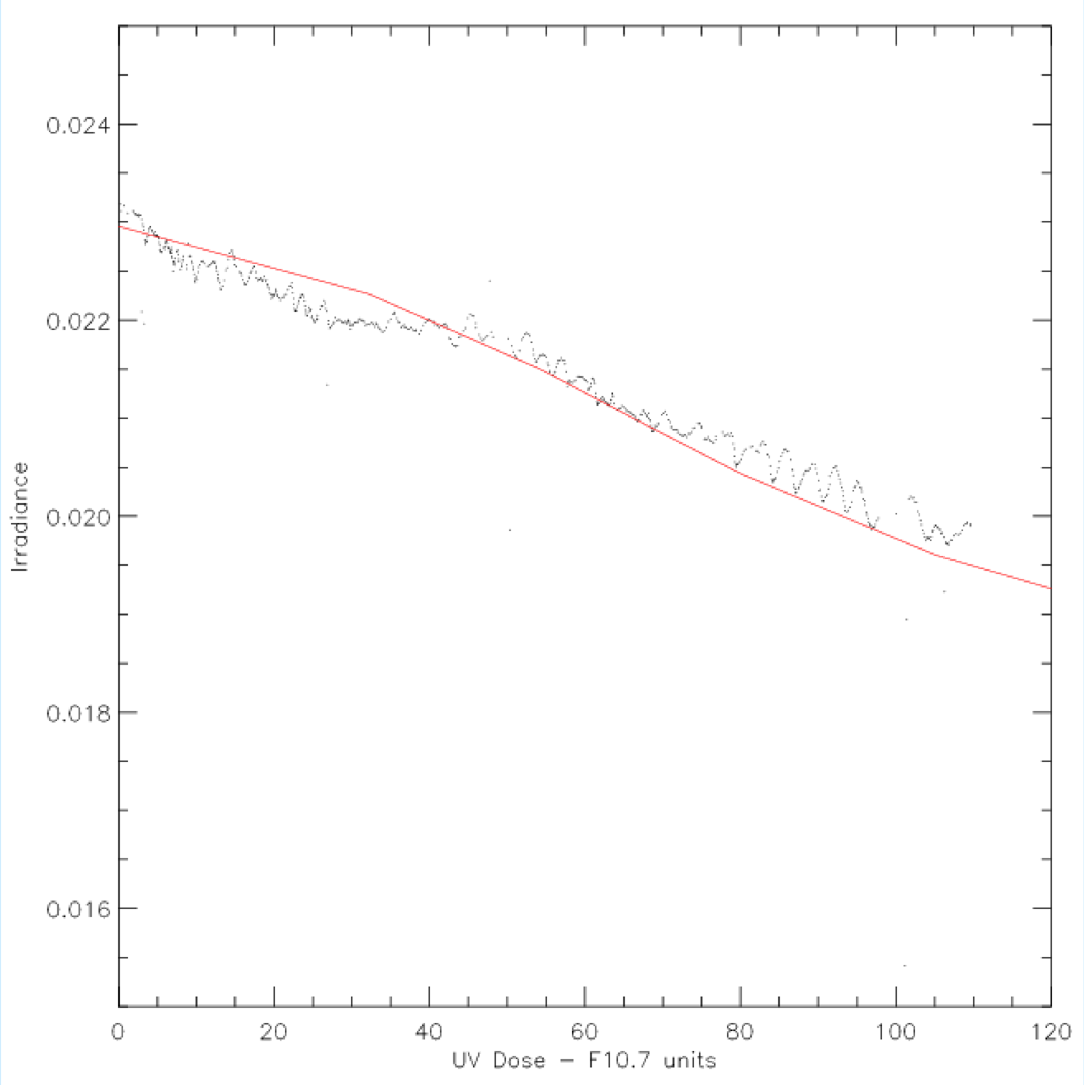
Exposure time: Operational vs. Backup



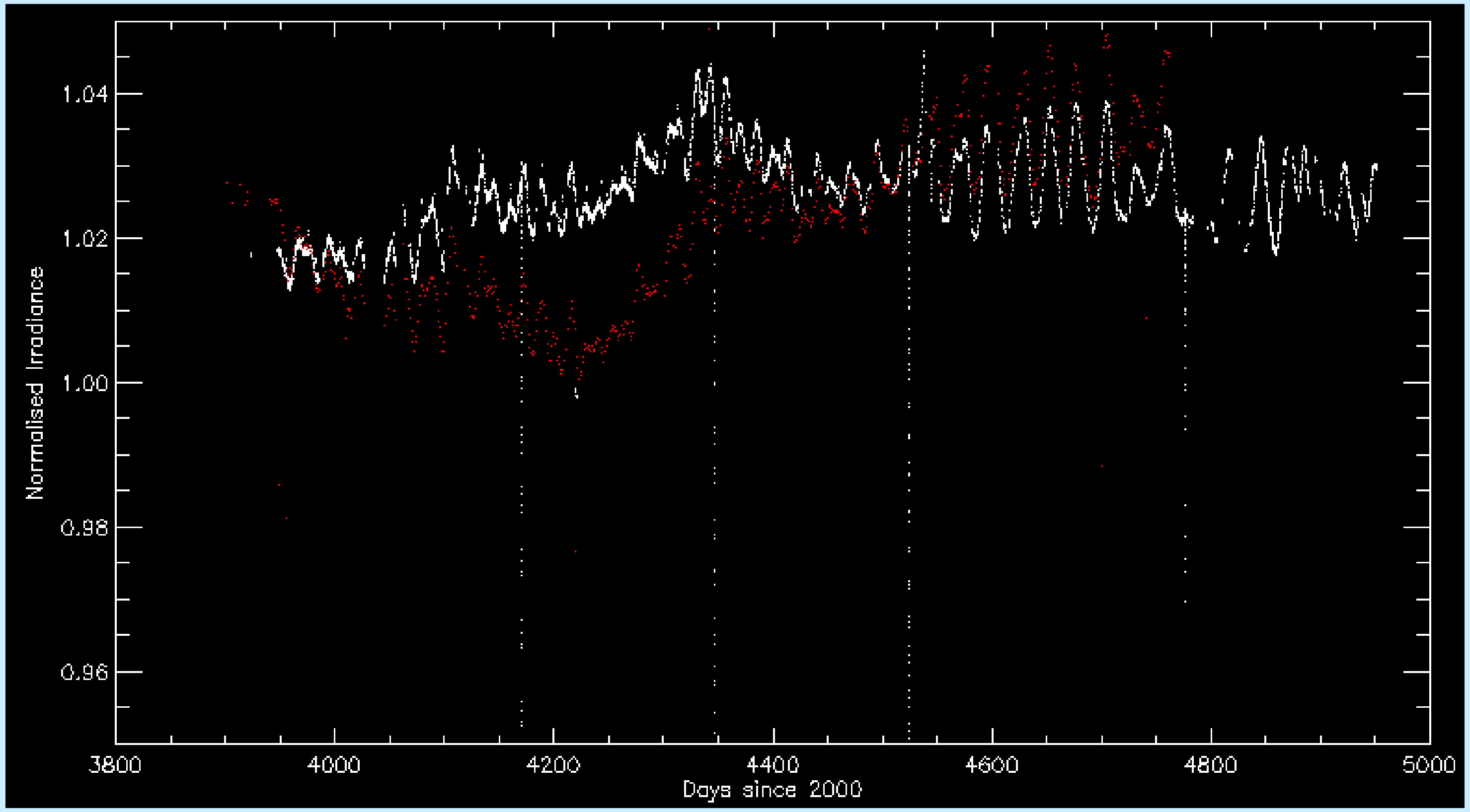
- Different behaviour according the time exposure
- Degradation of filters according the exposure time (contamination)
- Degradation of filters according real time
(structural change, increasing of filters' width,...)

Degradation Issues

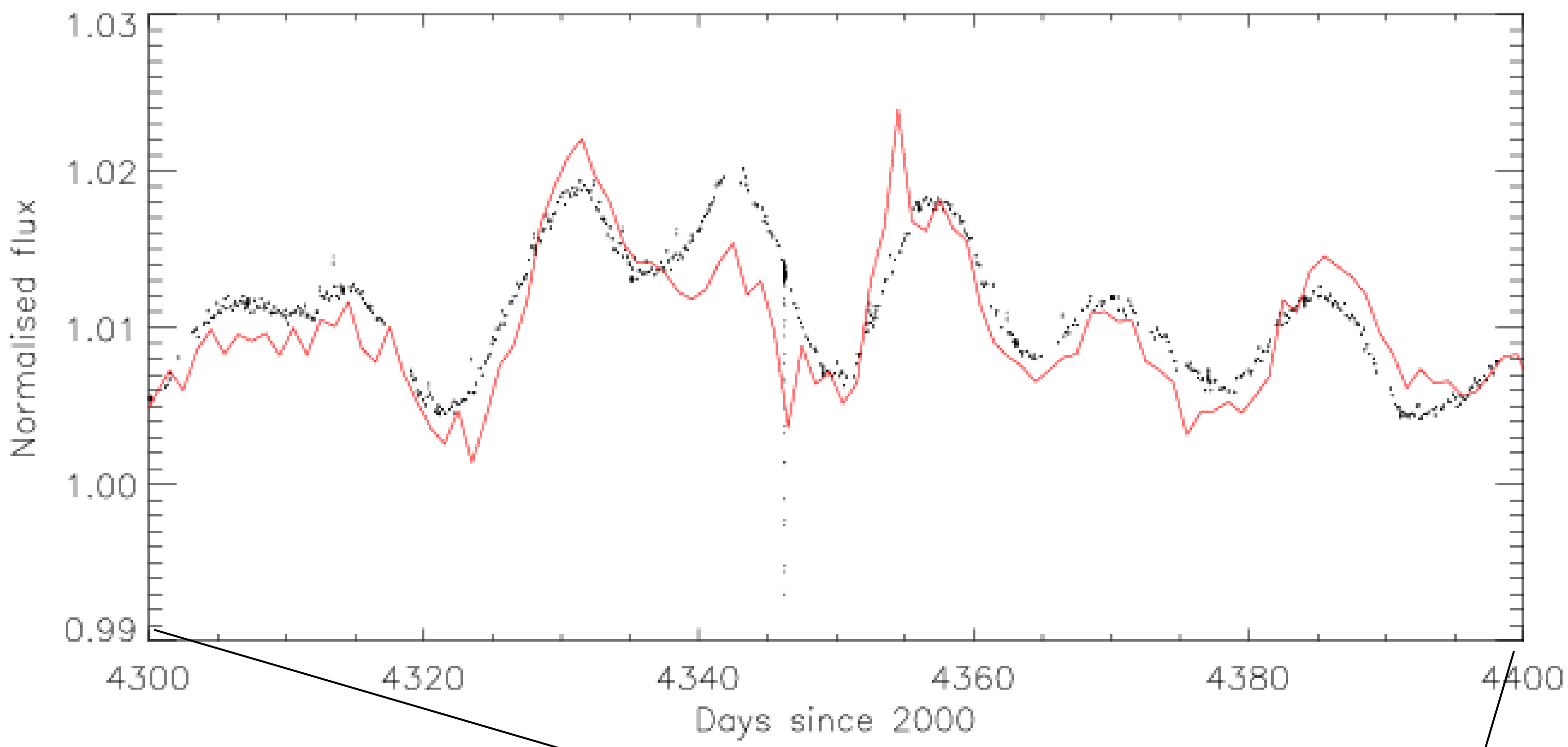
UV Dose: Operational vs. Backup

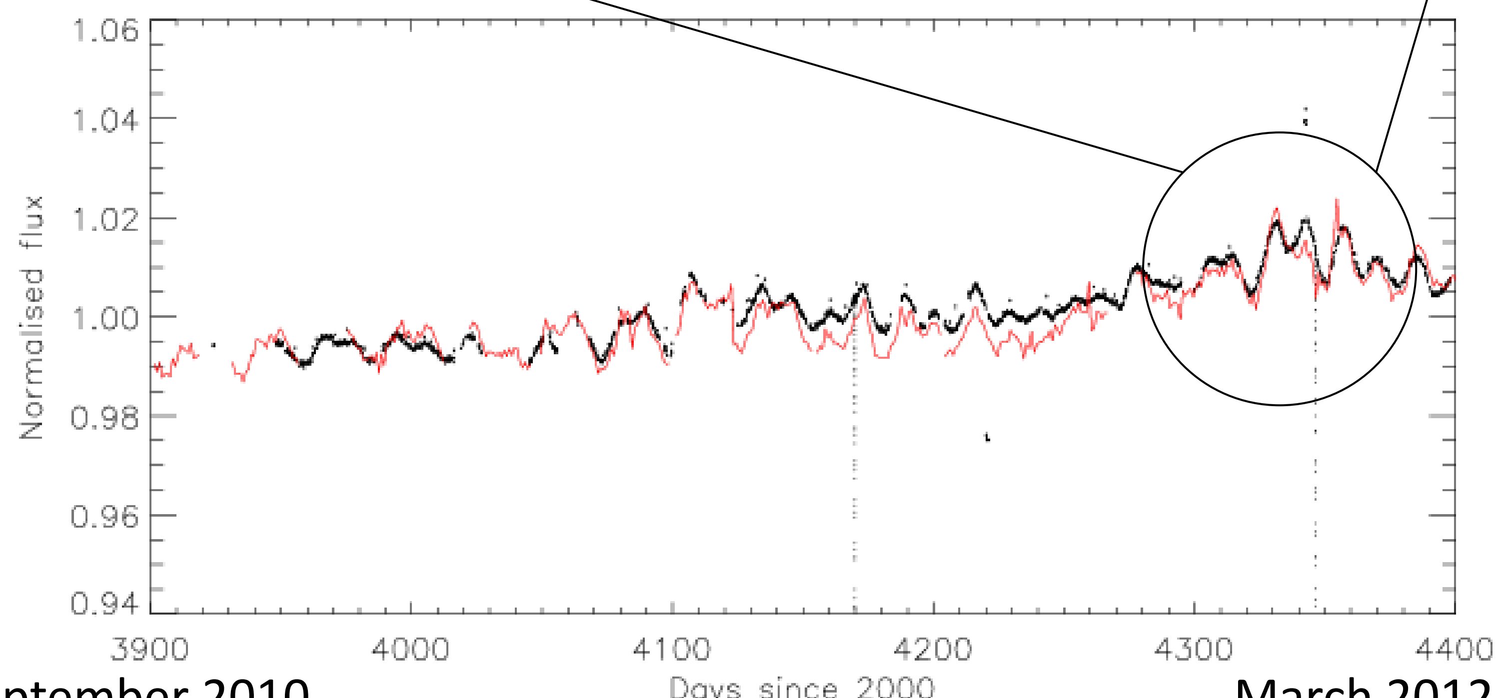


- Still an ongoing project for assessing the degradation for the UV channels (210 and 266 nm)



PREMOS investigations at 215 nm





September 2010

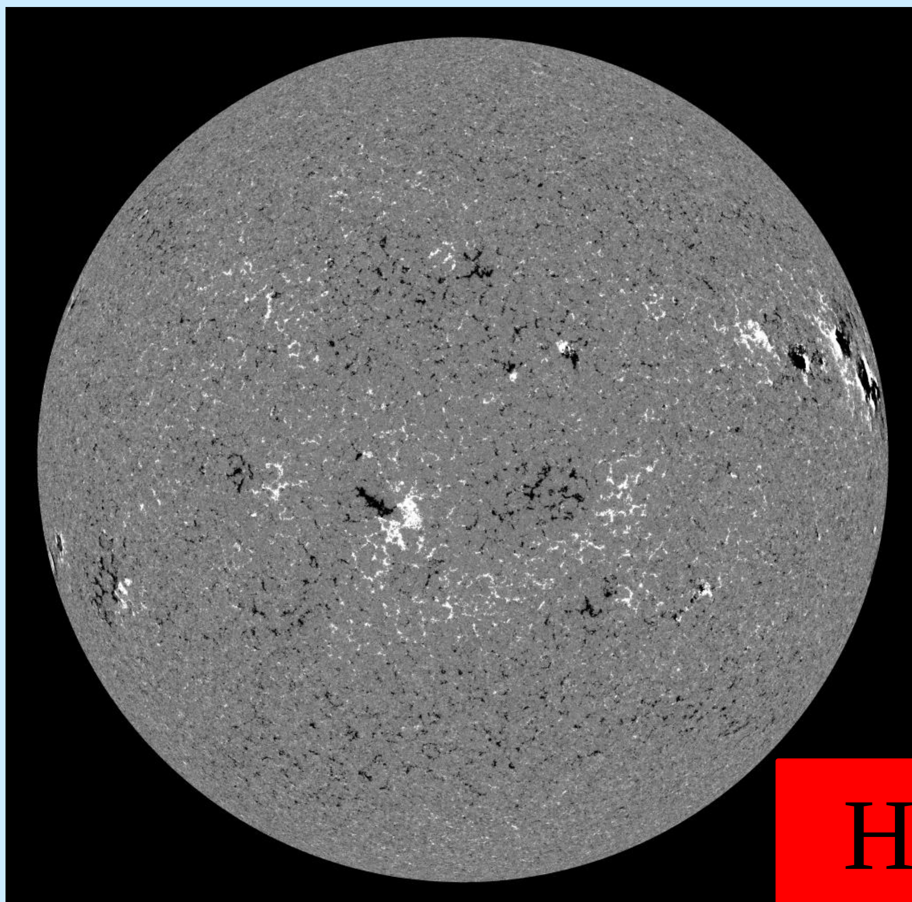
March 2012

- ✓ Independant correction
- ✓ Strong correlation

  13.5 and 27 days modulation
- ✓ **Rotational modulation more accurate**
- ✓ Solar modeling
- ✓ Similar paper with PROBA2/LYRA data (Shapiro et al, Solar Physics, 2012)

Solar modeling

Main assumption: Variations in the solar irradiance are directly related to the evolution of surface magnetic flux



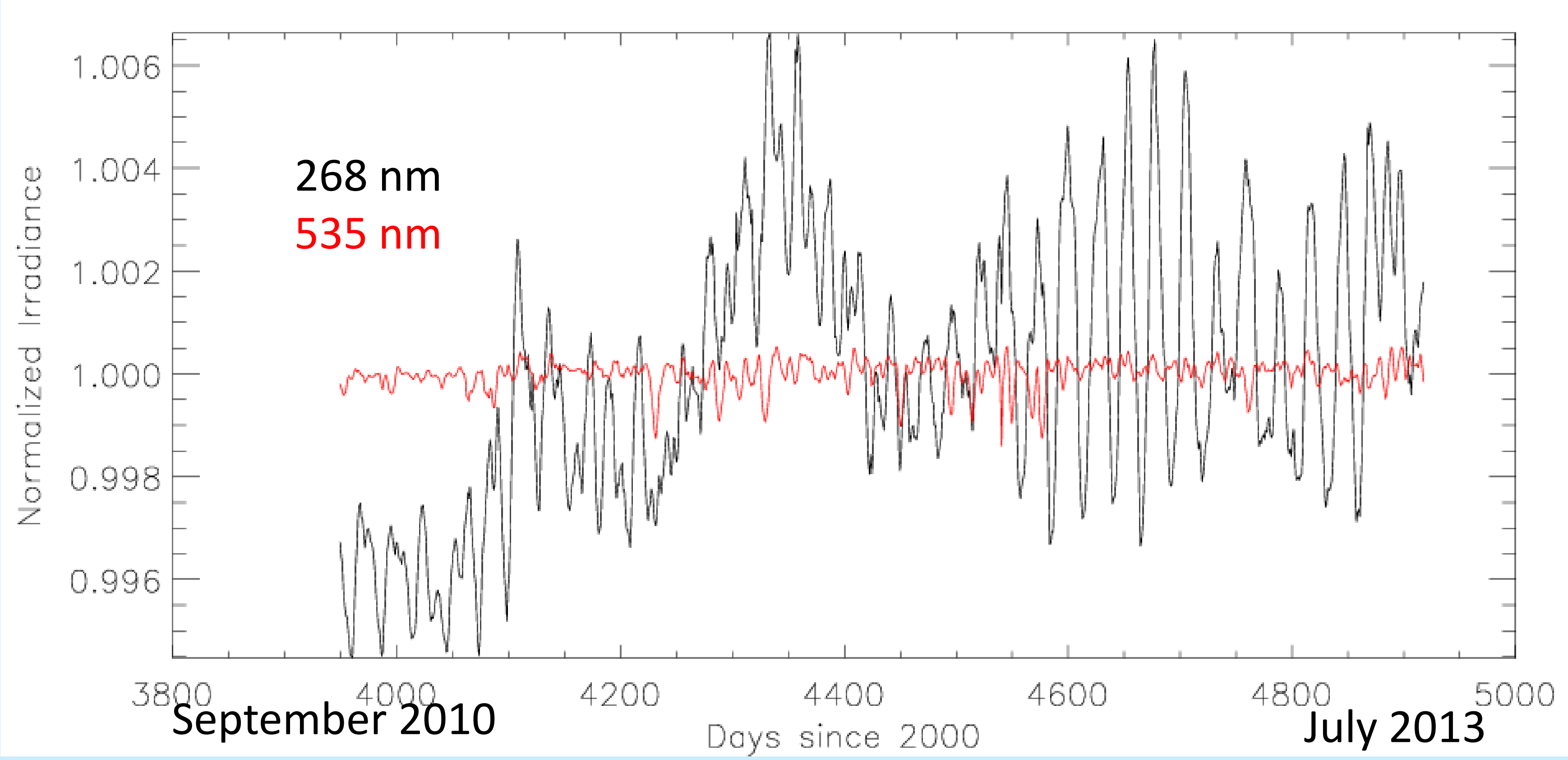
Sunspot (umbra and penumbra) S
Faculae P
Network F
Quiet Sun C

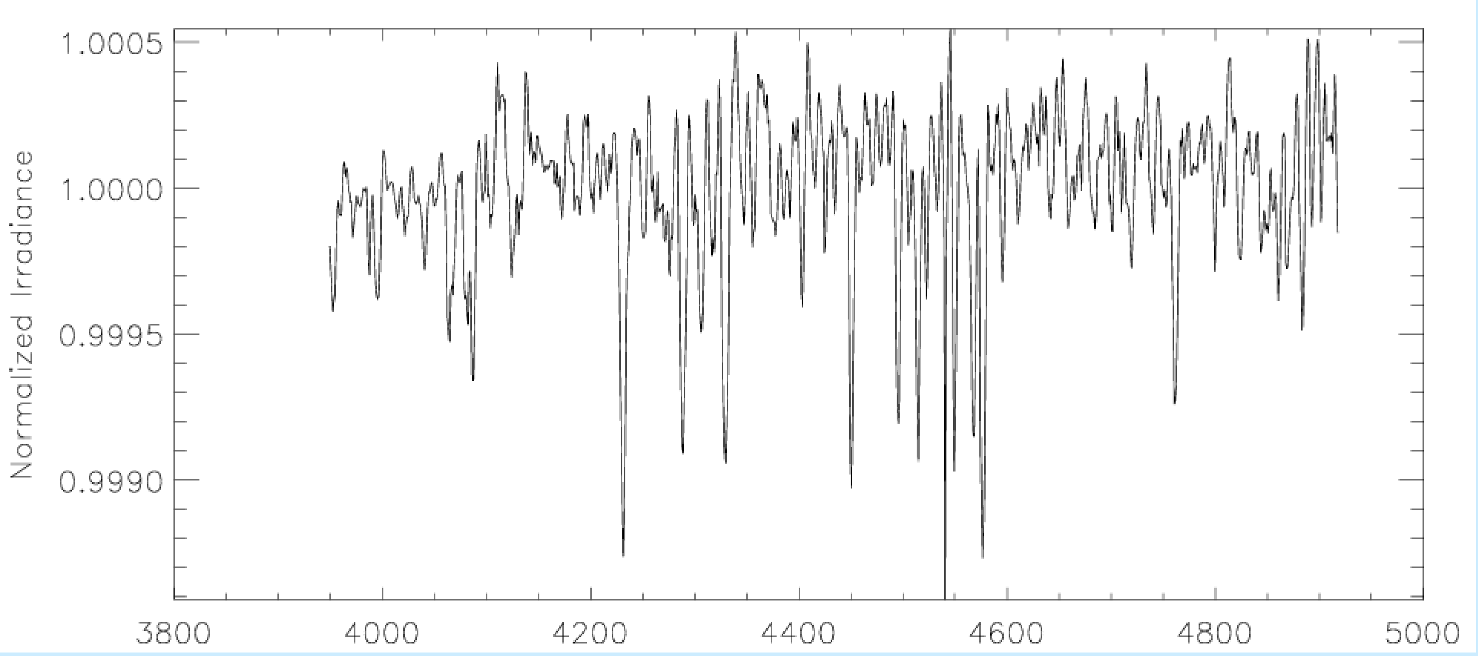
HMI data for calculating the area for each different feature

$$
\begin{aligned}
I(\lambda,t) &= \sum_k \left(\alpha_{\mathrm{QS}}(\mu_k,t) I_{\mathrm{QS}}(\lambda,\mu_k) + \alpha_{\mathrm{S}}(\mu_k,t) I_{\mathrm{S}}(\lambda,\mu_k) + \right. \\
&\quad + \left. \alpha_{\mathrm{AN}}(\mu_k,t) I_{\mathrm{AN}}(\lambda,\mu_k) + \alpha_{\mathrm{P}}(\mu_k,t) I_{\mathrm{P}}(\lambda,\mu_k)\right),
\end{aligned}
$$

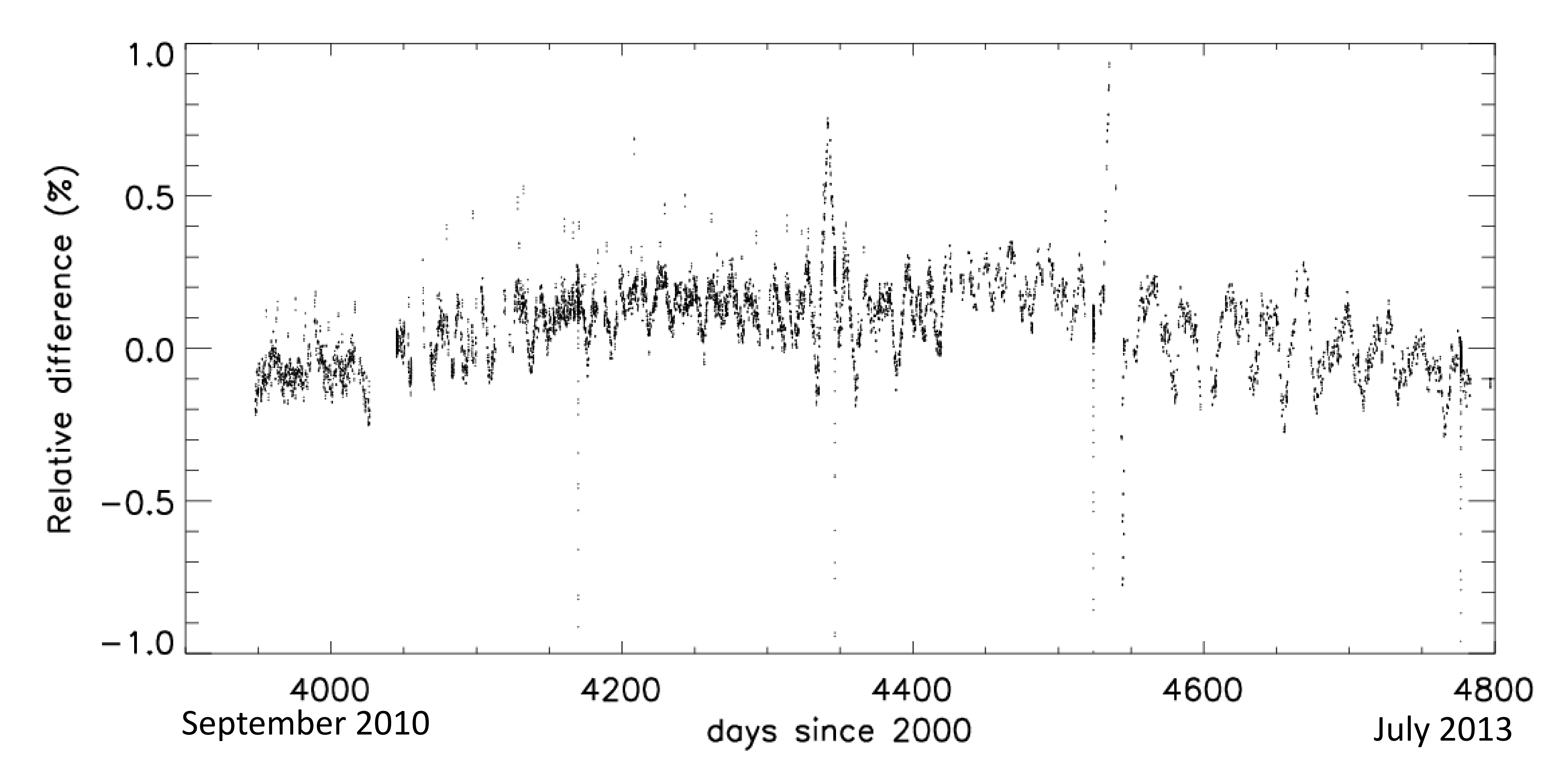
Solar modeling

COCOSIS: Combination of COSI Spectra





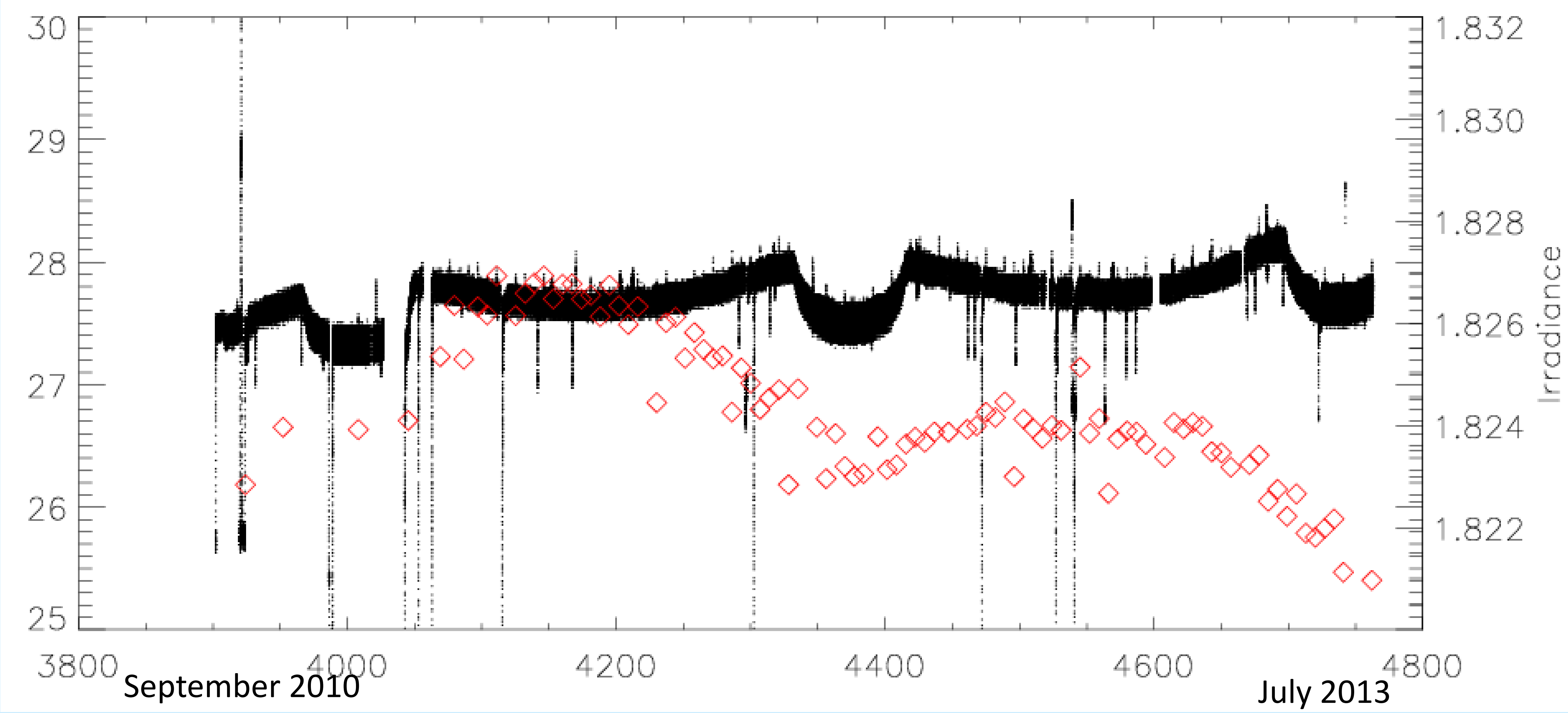
Irradiance at 215 nm



- Similar results for irradiance at 210 and 266 nm
- PREMOS data could be **considered as reference** instead of SORCE data ?
- Calibrated data available over 3 years

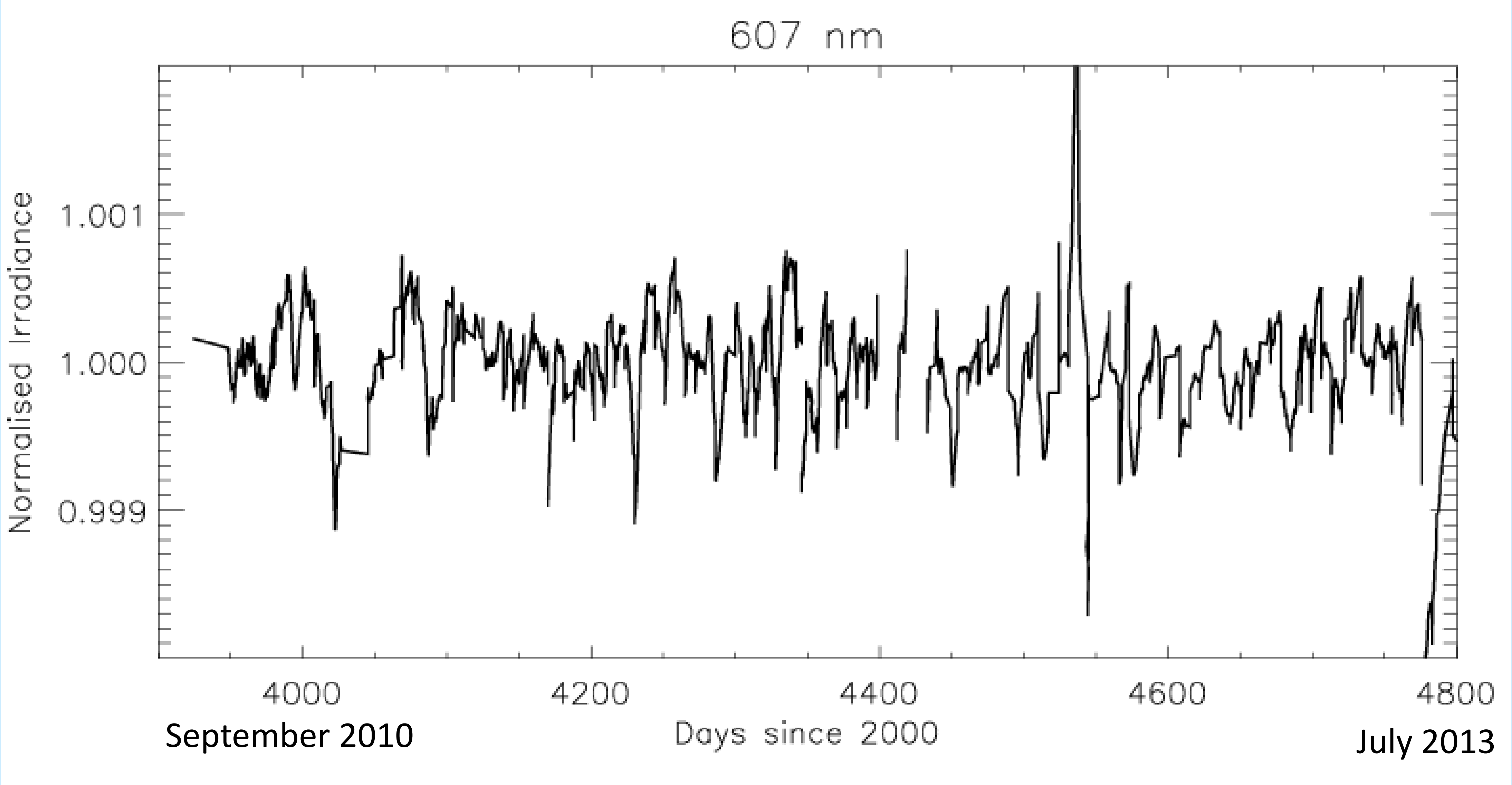
PREMOS investigations

Irradiance at 607 nm: influence of the temperature



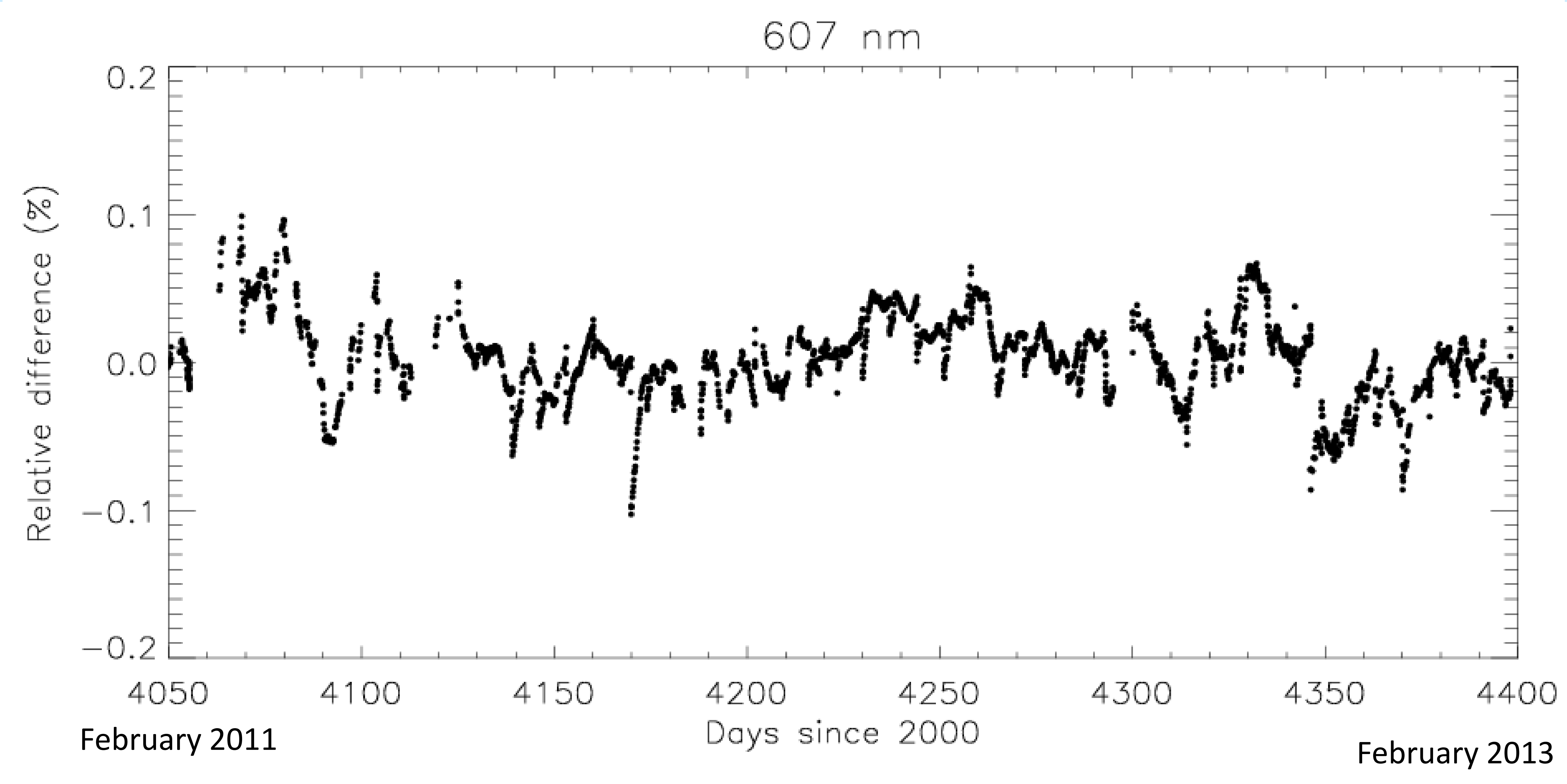
PREMOS investigations

Irradiance at 607 nm



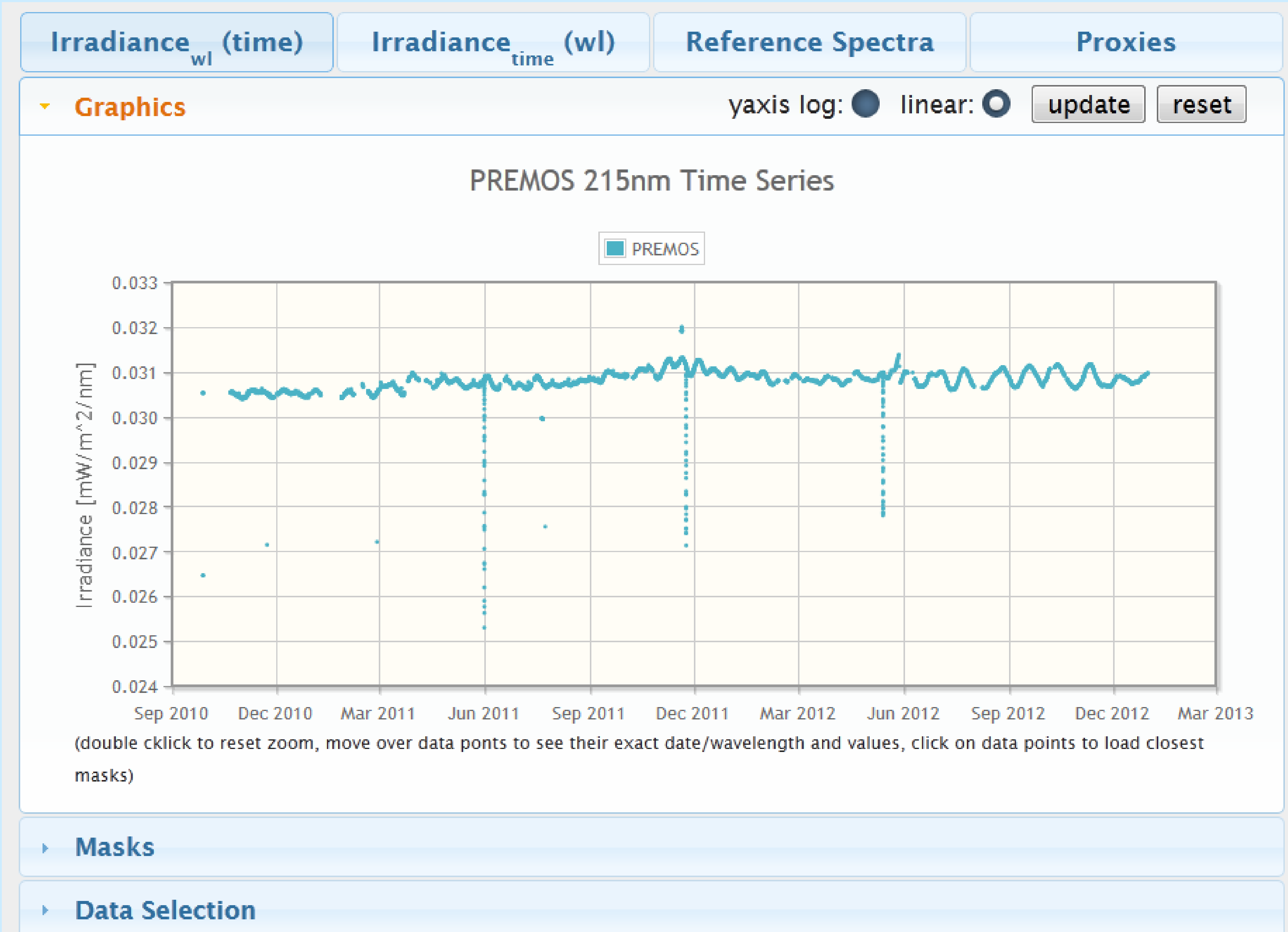
- No trend over 3 years because of the degradation correction process

Irradiance at 607 nm



- Strong correlation for solar rotational variations

Irradiance at 215nm available (soon 607 nm)



Others channels

- UV channels (210 and 266 nm): Degradation effect soon corrected; time series soon available.
- Visible channel (535 nm): similar results as for 607 nm.
- Infrared (782 nm): still working on degradation issues
- Every irradiance time series will be distributed on the SOLID database

Conclusions & Perspectives

- PREMOS/PICARD is successfully operating after 3 years in space
- Strong correlation between SORCE and PREMOS instruments, but we still have to attach the correct W/m^2 to the curves.
- We are still working on the radiometric calibration; Comparison with SODISM degradation
- PREMOS data might be used as reference instead of SORCE for solar modeling purposes
- PREMOS as a spectrometer: empirical model using the spectral dynamic coherency

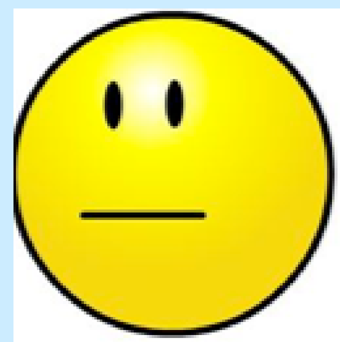
Thank you

Our understanding of the solar variability

1. Rotational cycle

~500 cycles

2. 11-year activity cycle

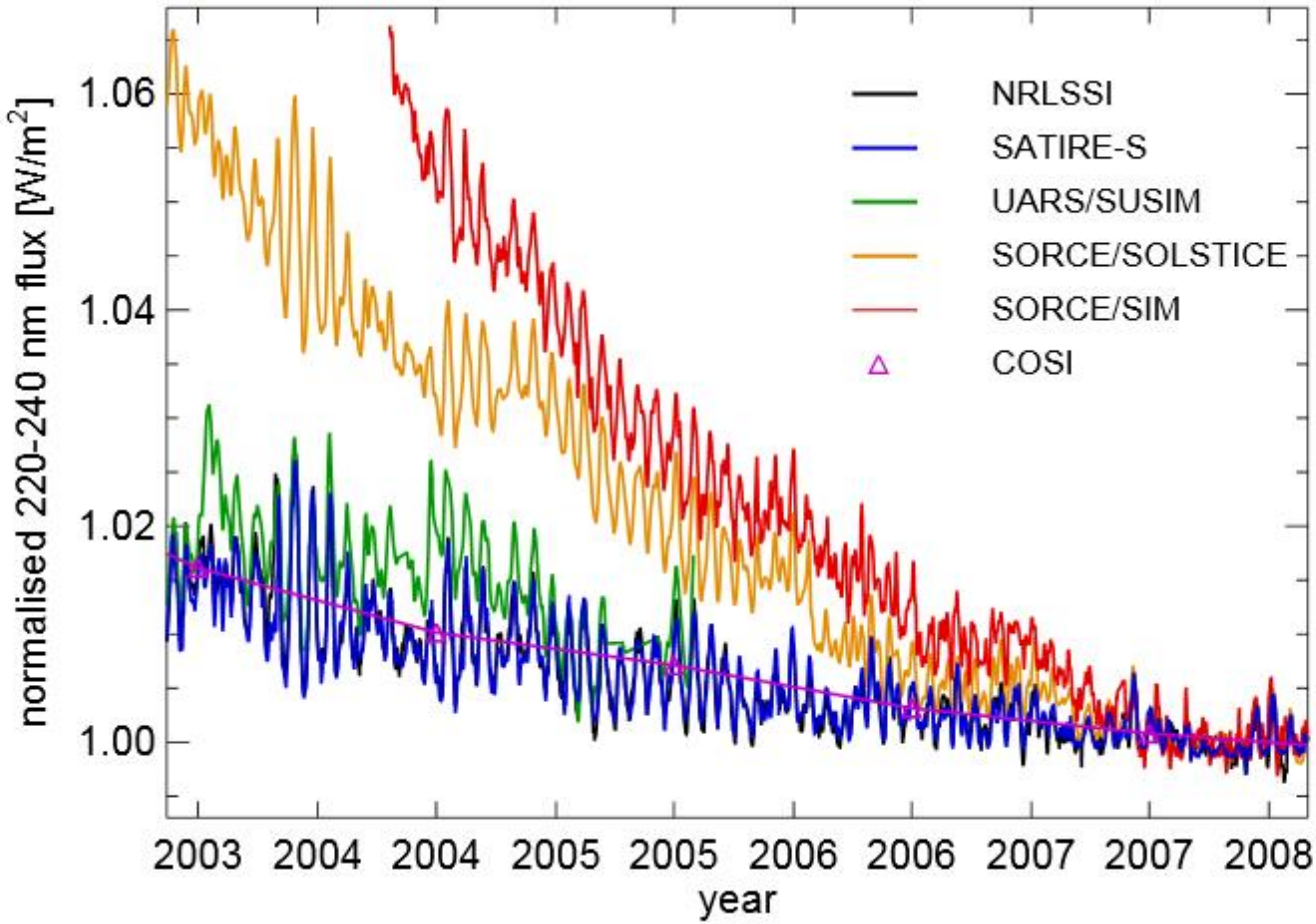


~3 cycles

3. Long-term trend

very difficult to detect (Ermolli et al. 2012)

We measure TSI and SSI only during the last 30 years

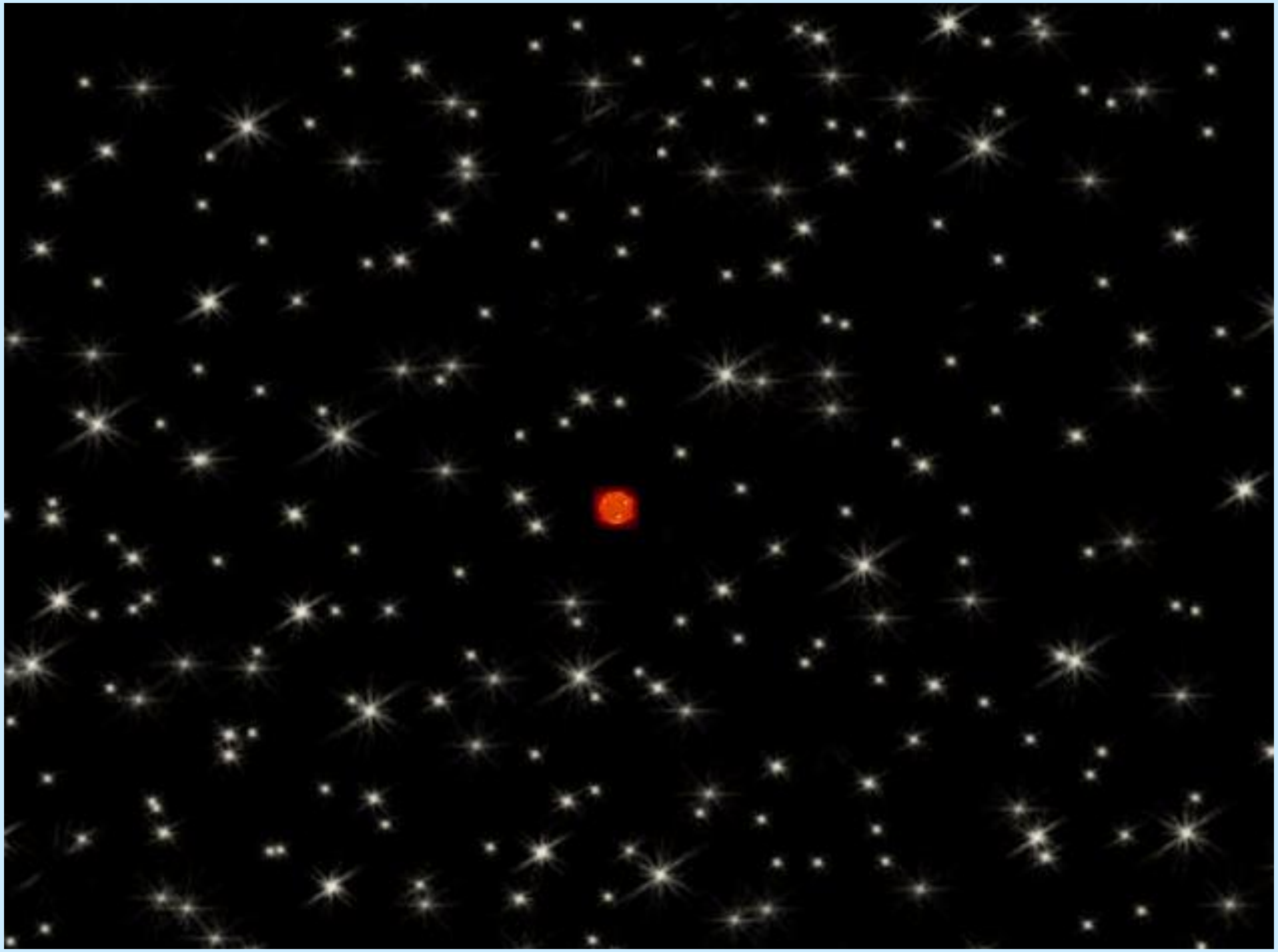


(Ermolli et al. 2012)

The Sun amongst its stellar cohort

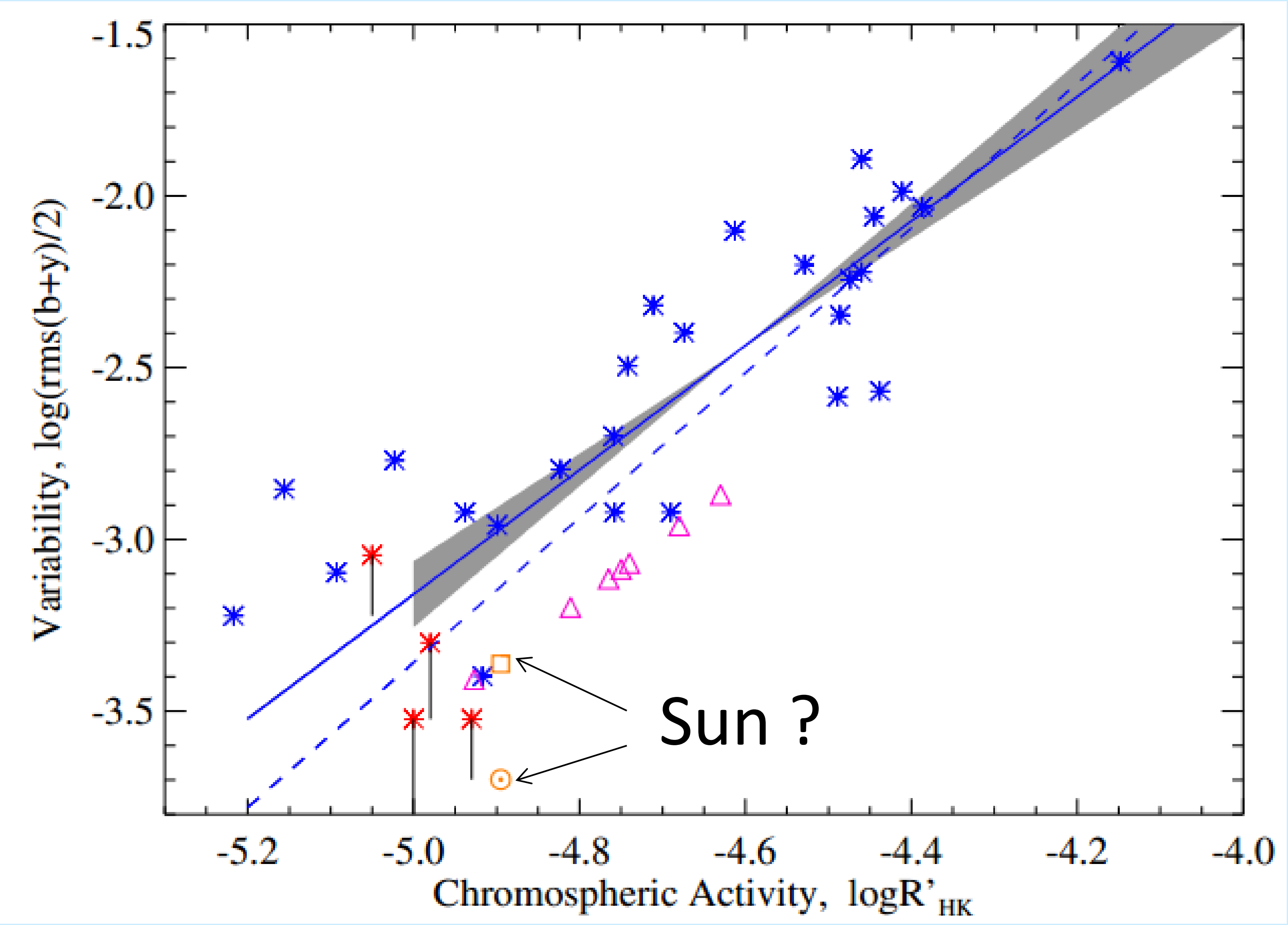
The Sun: 30 years of observations

25 Sun analogues * 25 years of observations: 500 years !



The Sun amongst its stellar cohort

pmod wrc



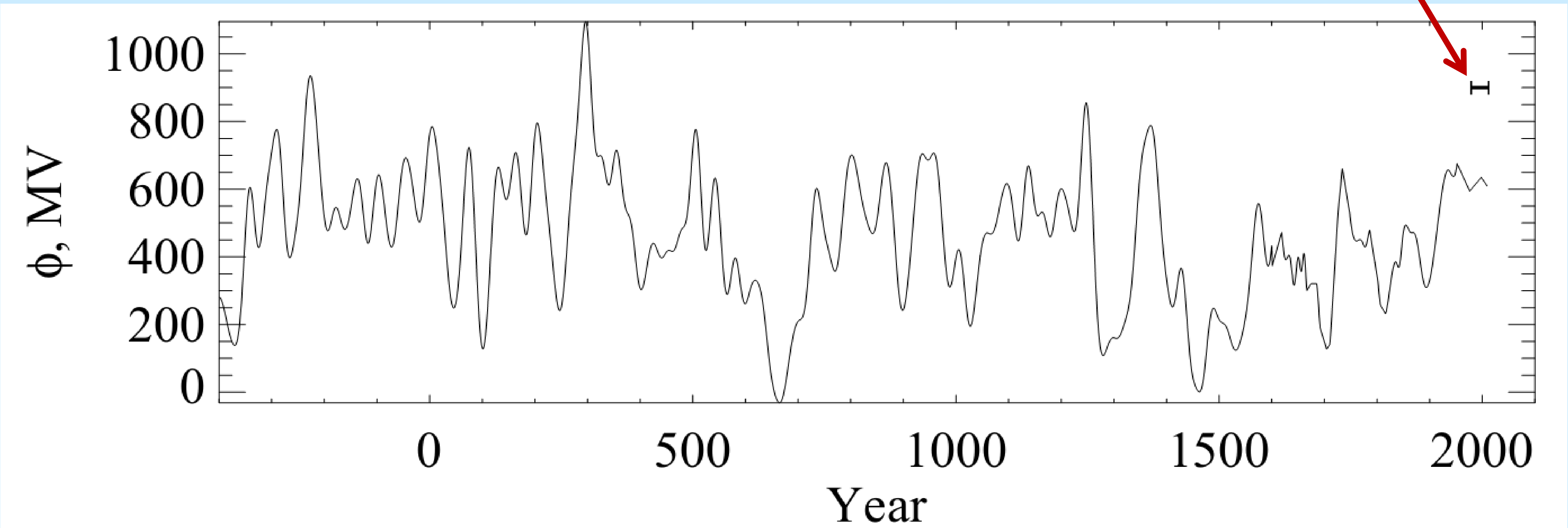
Photometric variability (Visible) against chromospheric activity (Ca II K)

- ✓ Position of the Sun ?
- ✓ Many possibilities according to the model (SIM, SATIRE,…)
- ✓ Unique position ?
- ✓ Irradiance computation out of ecliptic

The Sun amongst its stellar cohort

Present solar location is rather peculiar

satellite epoch



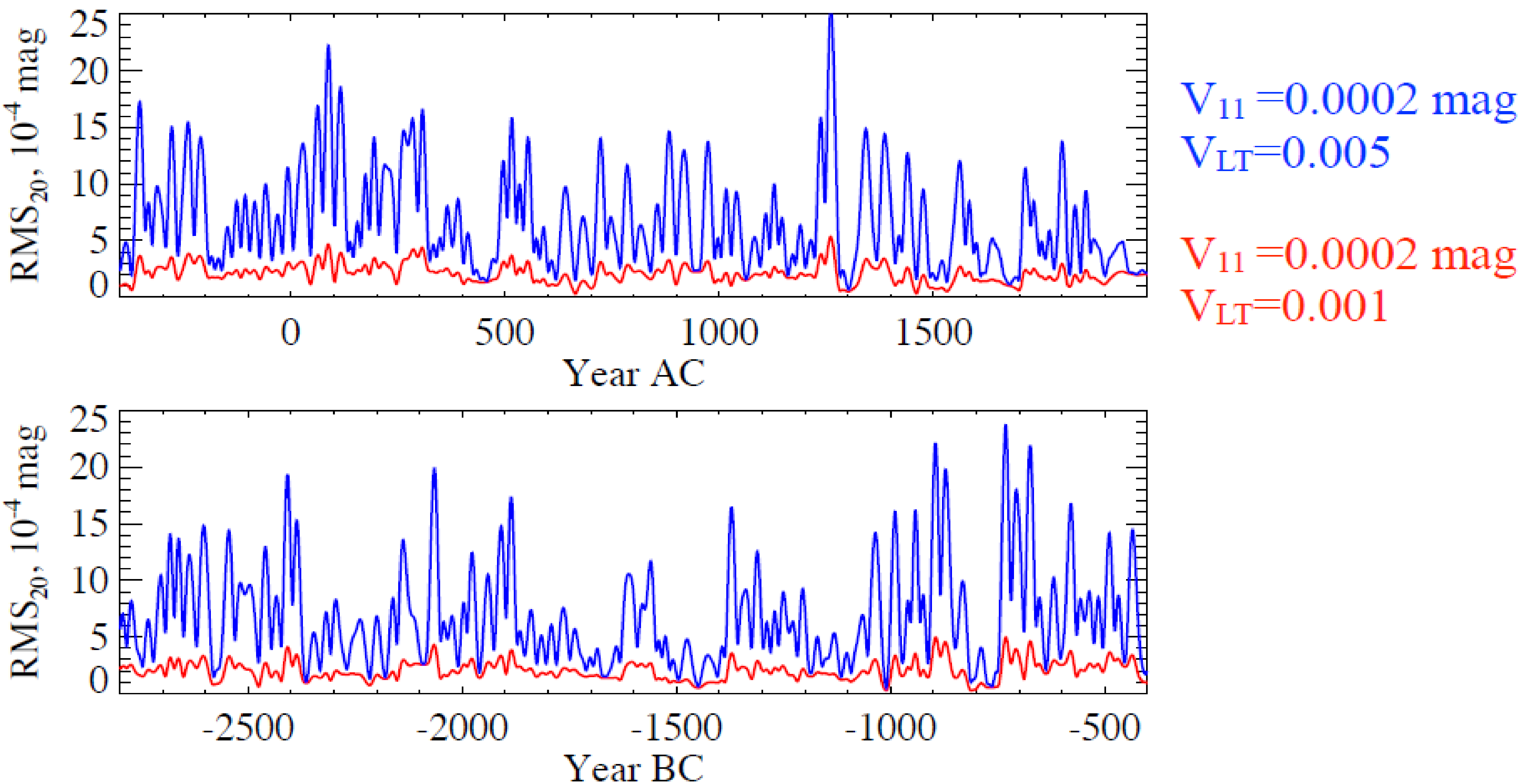
Mean solar activity over the past 2500 years are twice more less than the present value: the Sun probably follows a trajectory

Solar Variability back in time

two free parameters

amplitude of the 11-year cycle, V_{11}

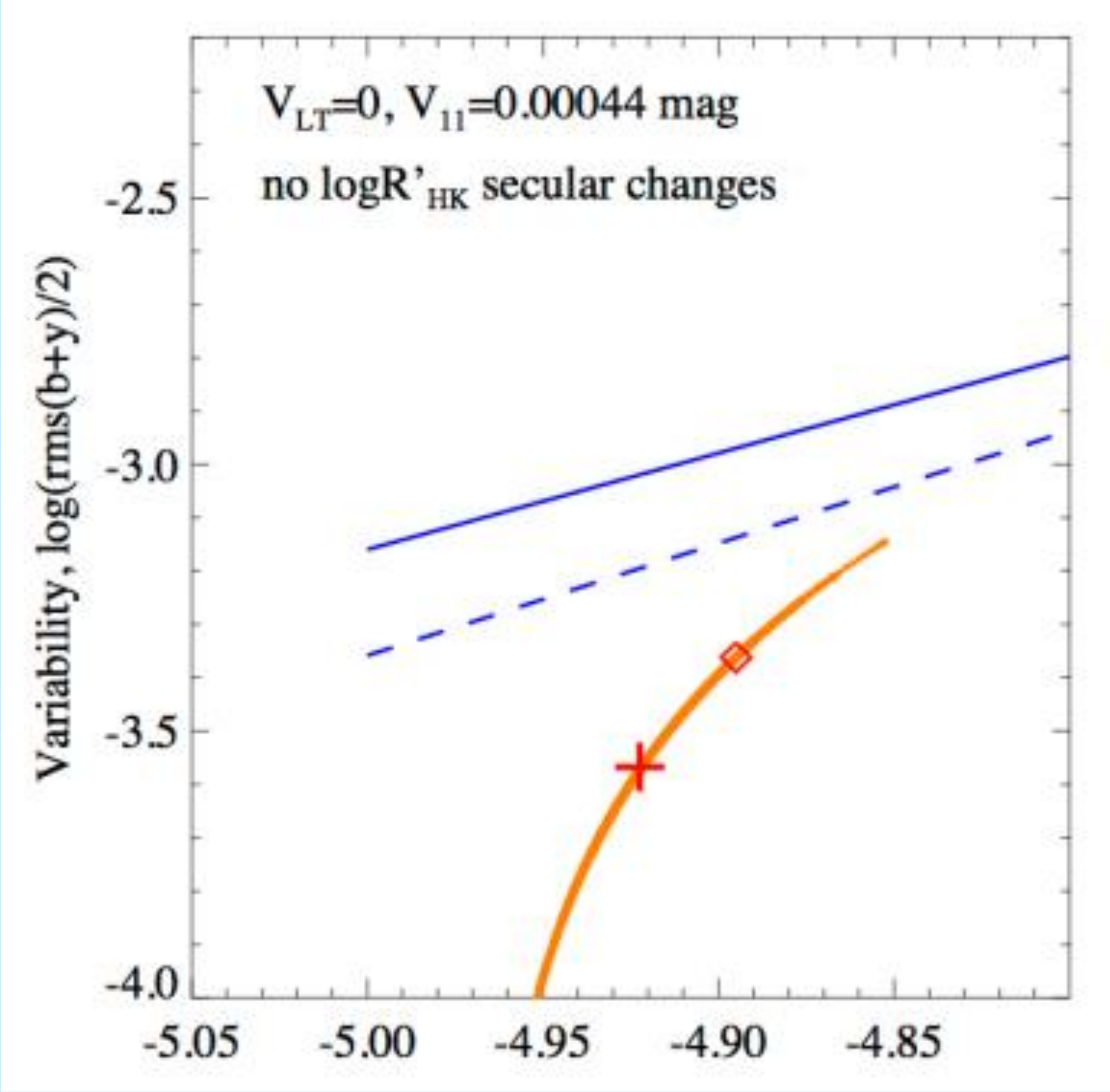
amplitude of the long-term trend, V_{LT}

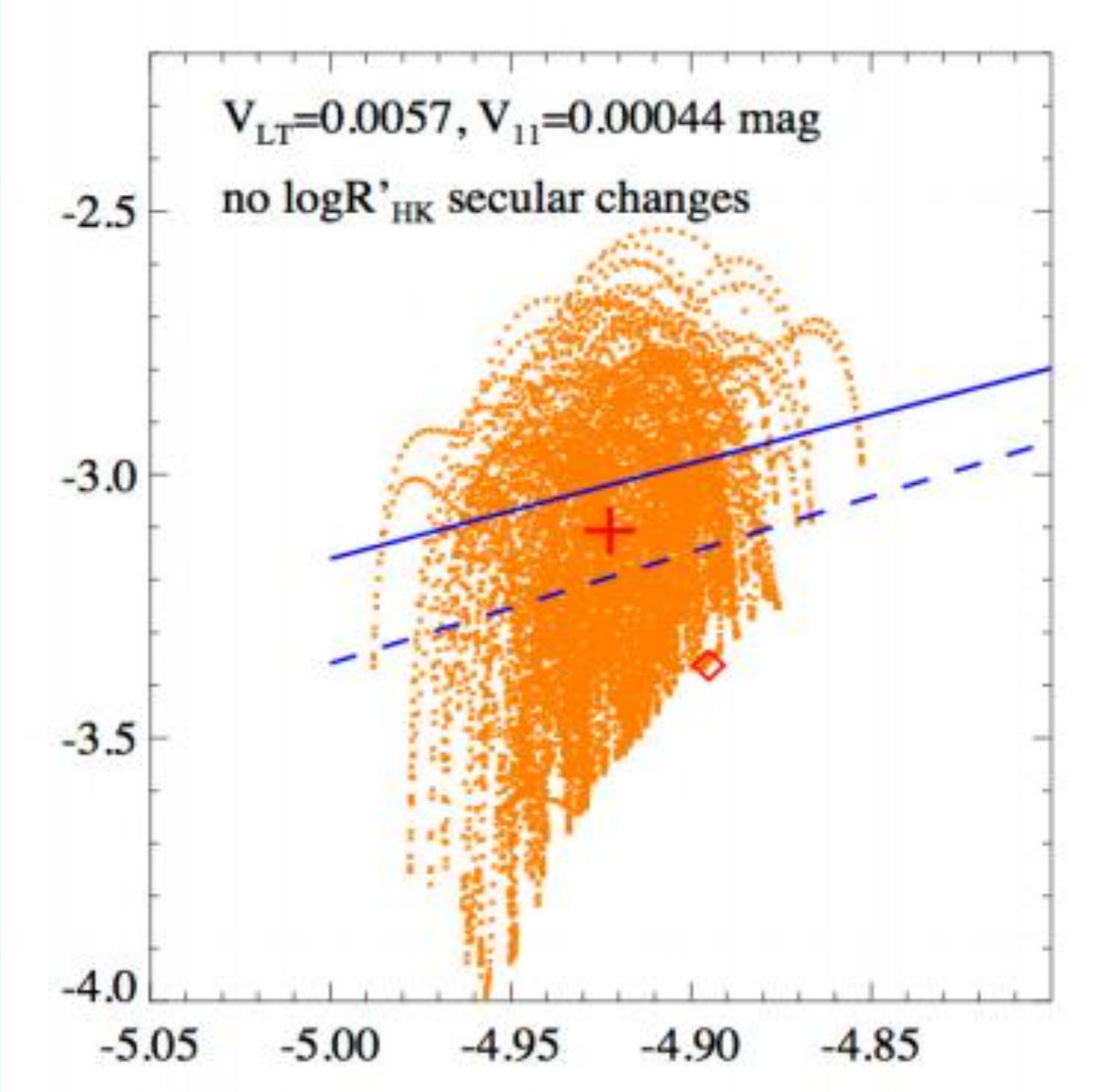


The Sun amongst its stellar cohort

Two free parameters

V11 : 11-years cycle amplitude
VLT : long term cycle amplitude (300 years)





Which implications for the stellar magntic activity for the long term ? (Shapiro, Schmutz, Cessateur et al, A&A, 2013)

Comparison with SOLSTICE