Modelling stellar brightness variations

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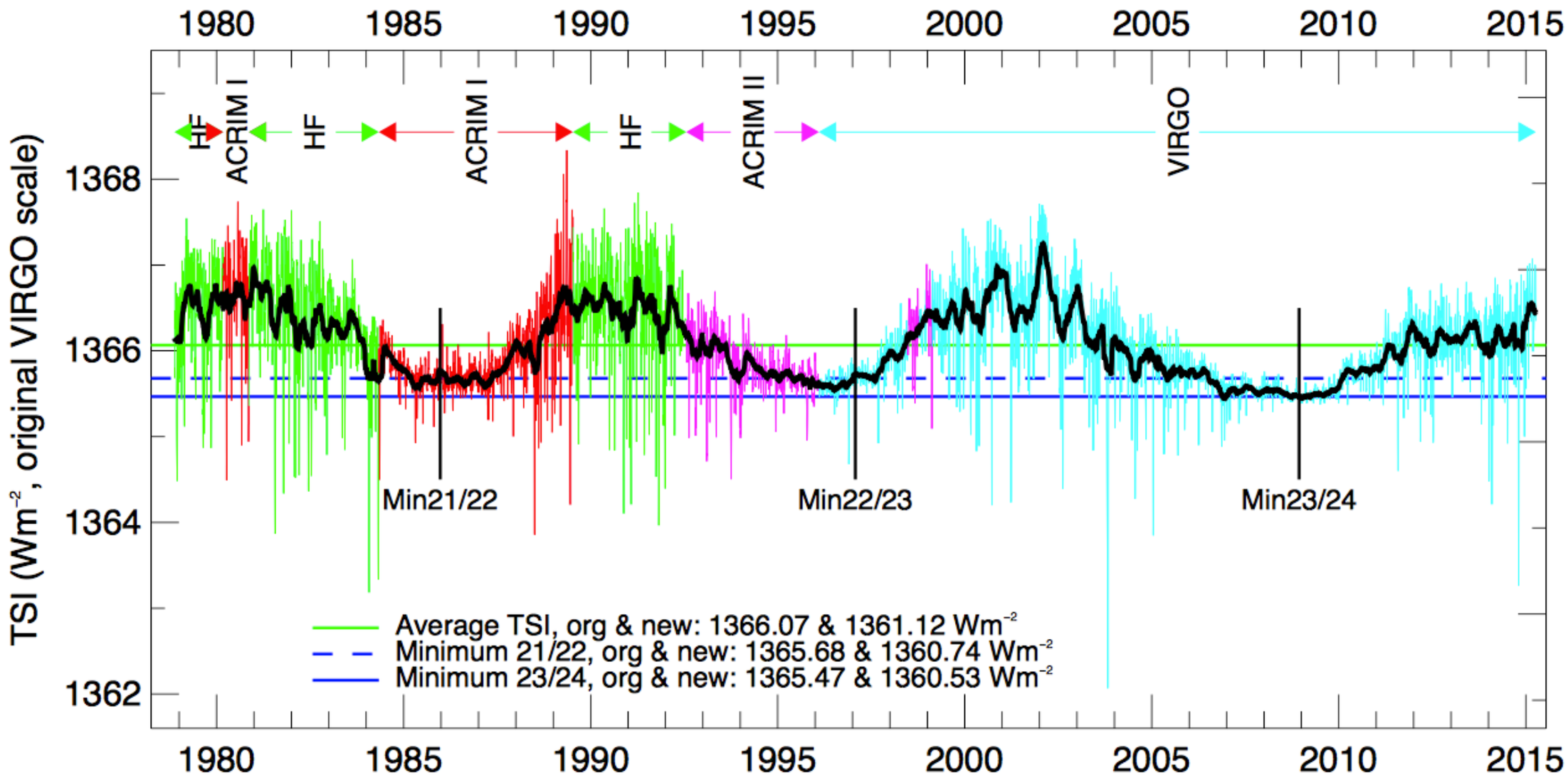
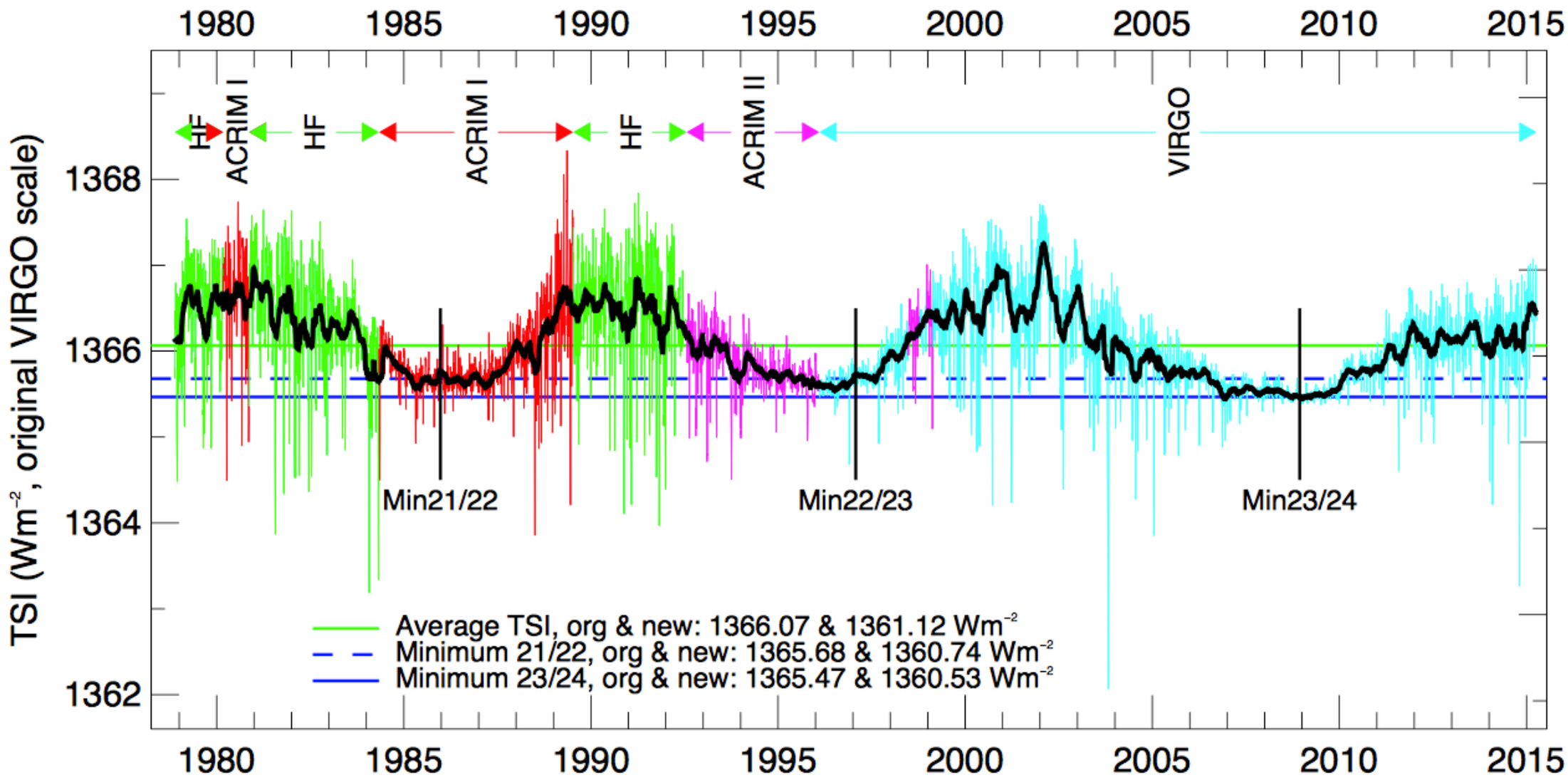
Variations of solar brightness



from Fröhlich (2013)

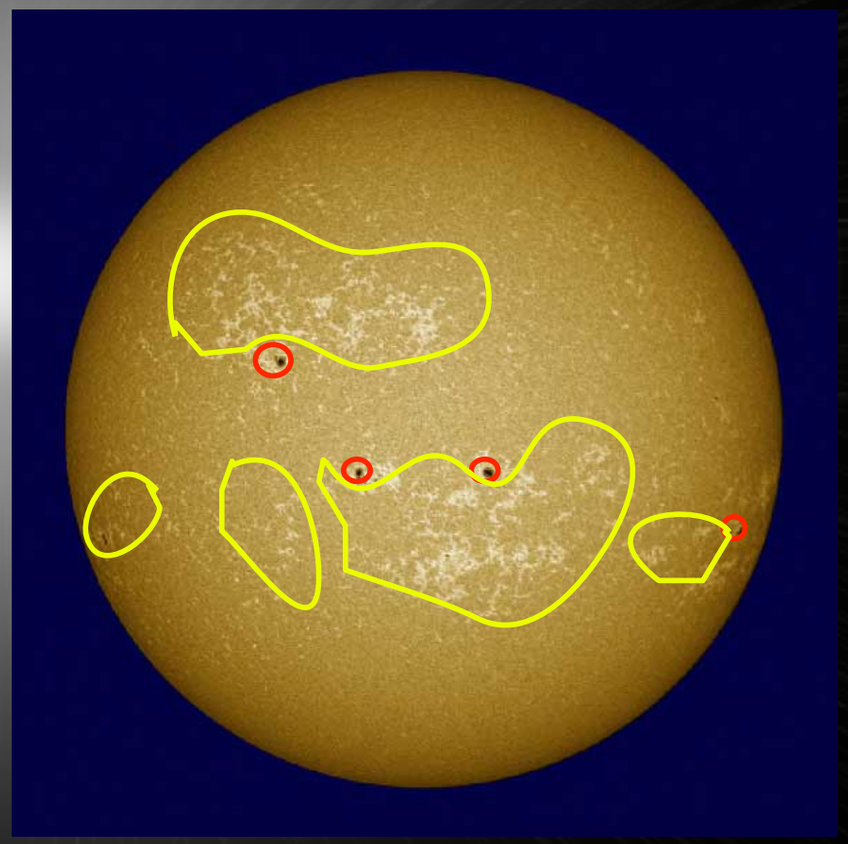
Variations of solar brightness



from Fröhlich (2013)

We do understand these variations

MECHANISM OF IRRADIANCE VARIATION

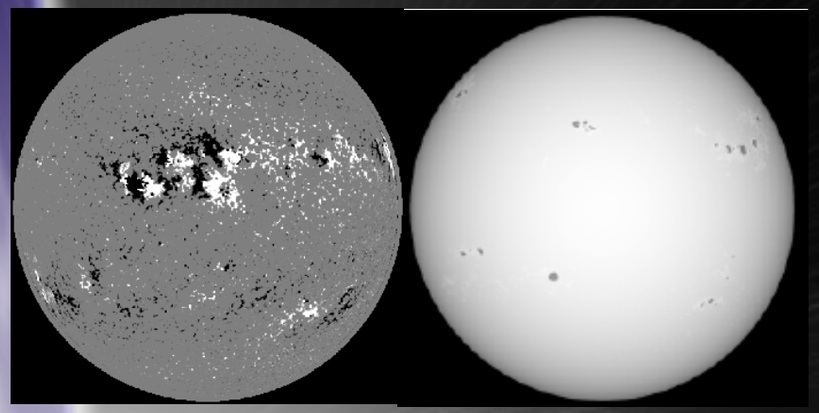


Photospheric magnetic fields (changes in surface structure):

darkening due to sunspots and brightening due to faculae and the network:

$$\Delta S_{tot}(t) = \Delta S_s(t) + \Delta S_f(t)$$

SATIRE
(Spectral And Total Irradiance REconstructions)



Unruh et al. 1999, 2008; Fligge et al. 2000; Krivova et al. 2003, 2006, 2009a,b, 2011a,b; Wenzler et al. 2004, 2005, 2006, 2009; Ball et al. 2014; Yeo et al. 2014

Magnetograms and continuum images

Semi-empirical model atmospheres

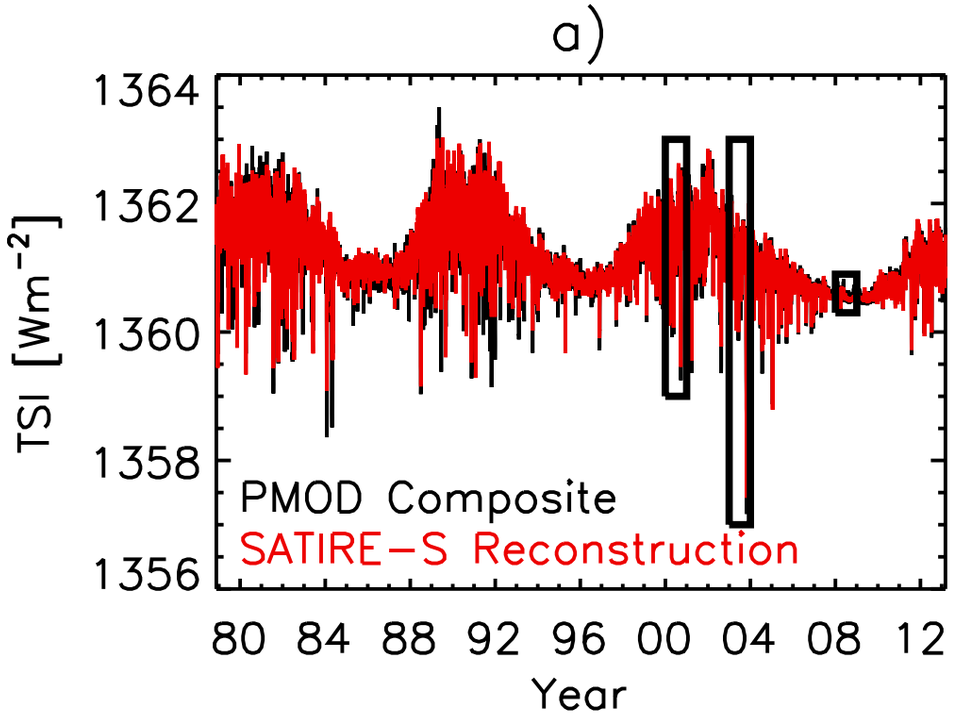
Distribution of features on the solar surface

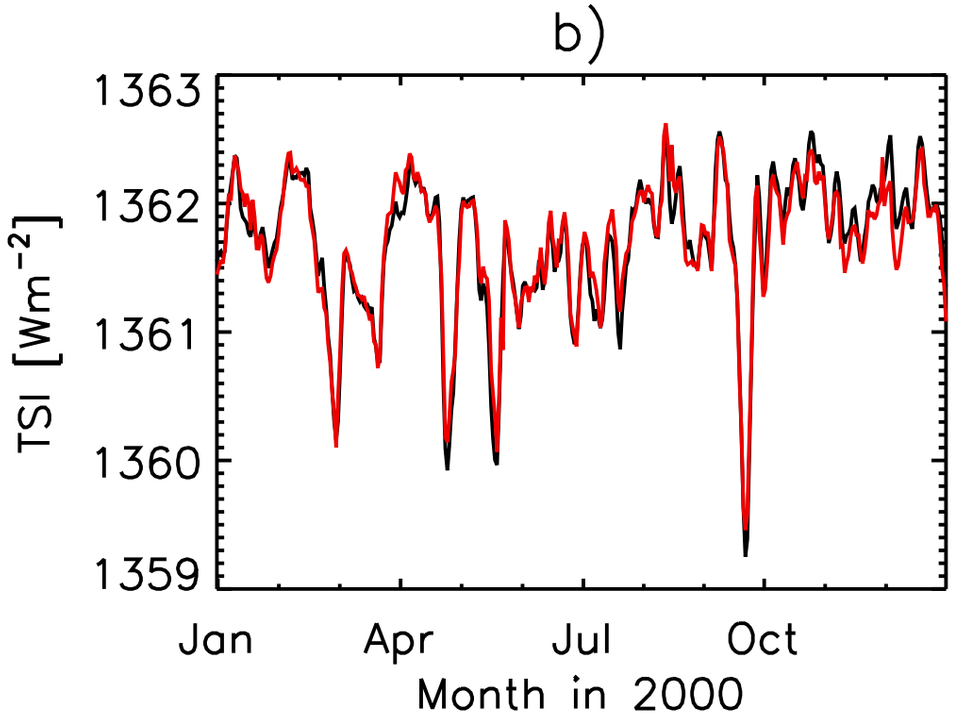
\+

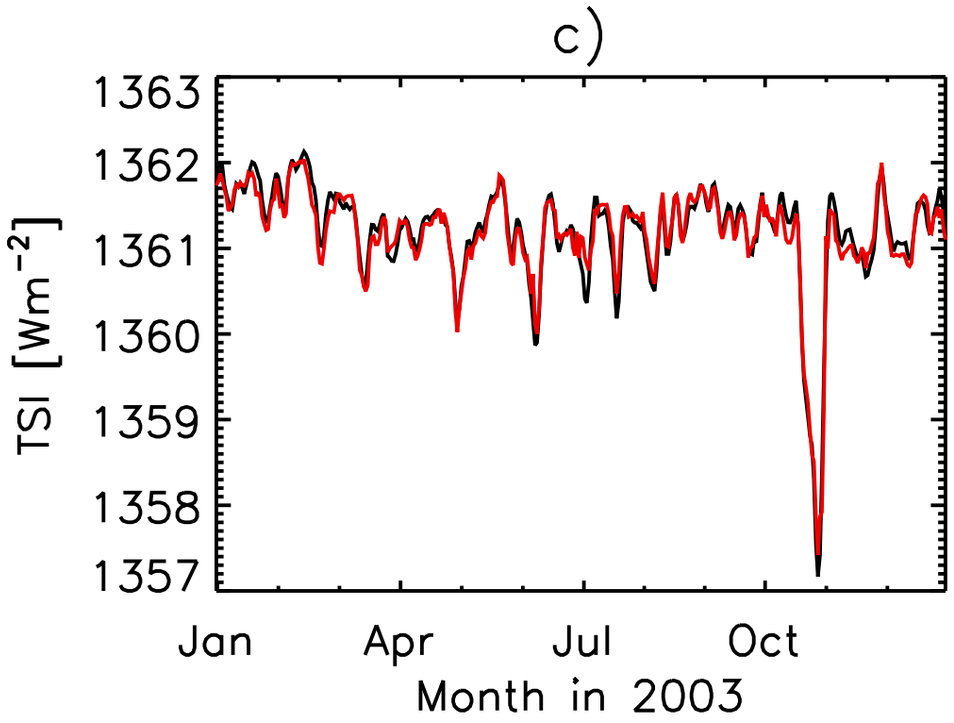
Brightness of features

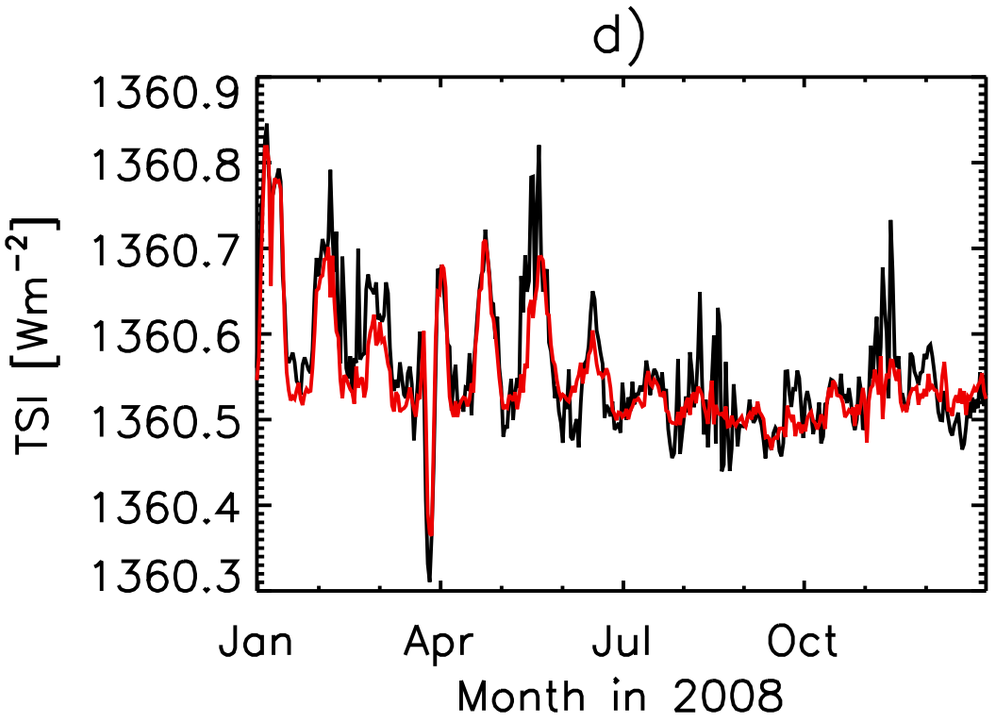
IRRADIANCE

SATIRE-S vs PMOD composite

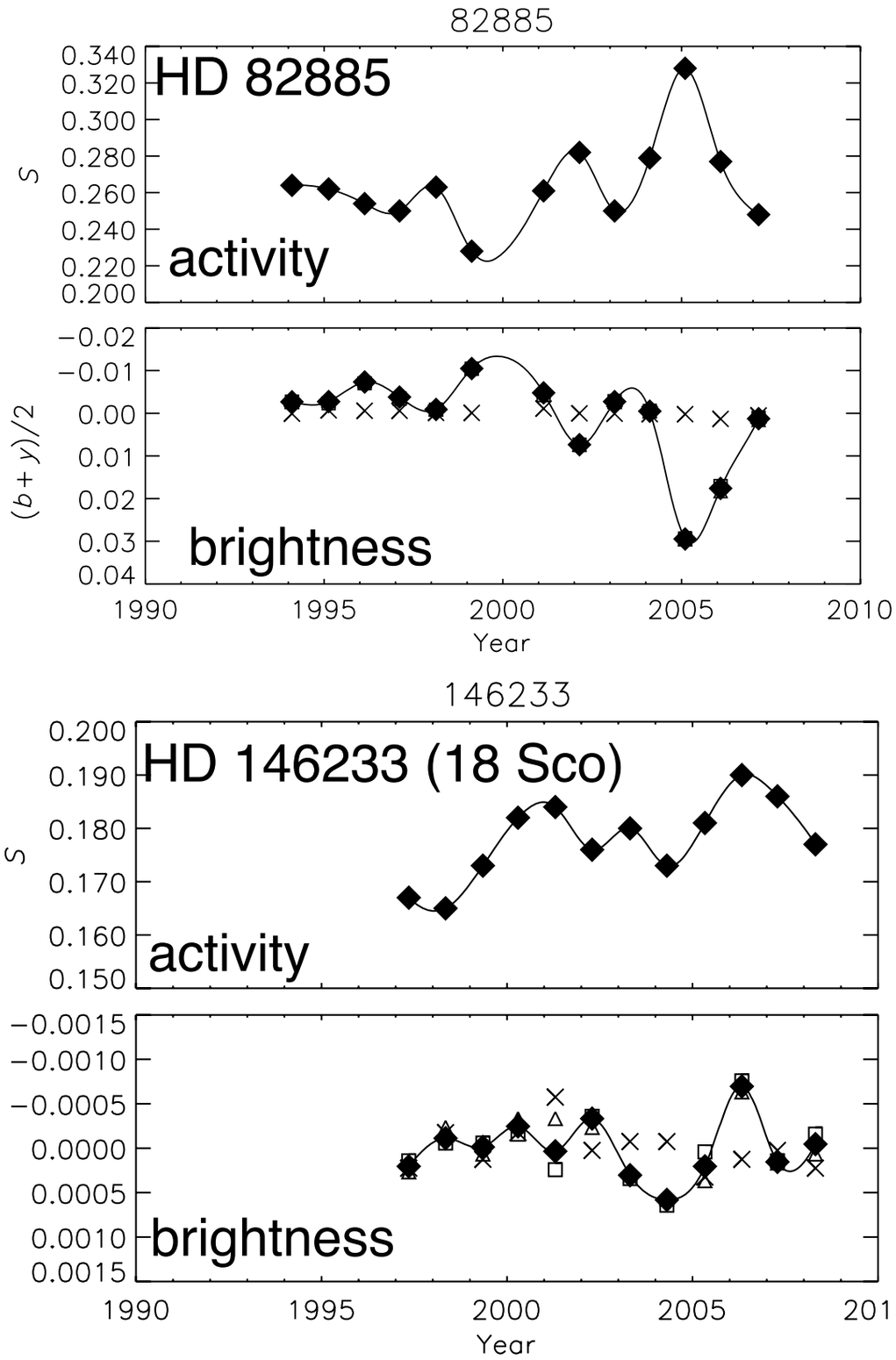








Variation of stellar brightness



from Hall et al. (2009)

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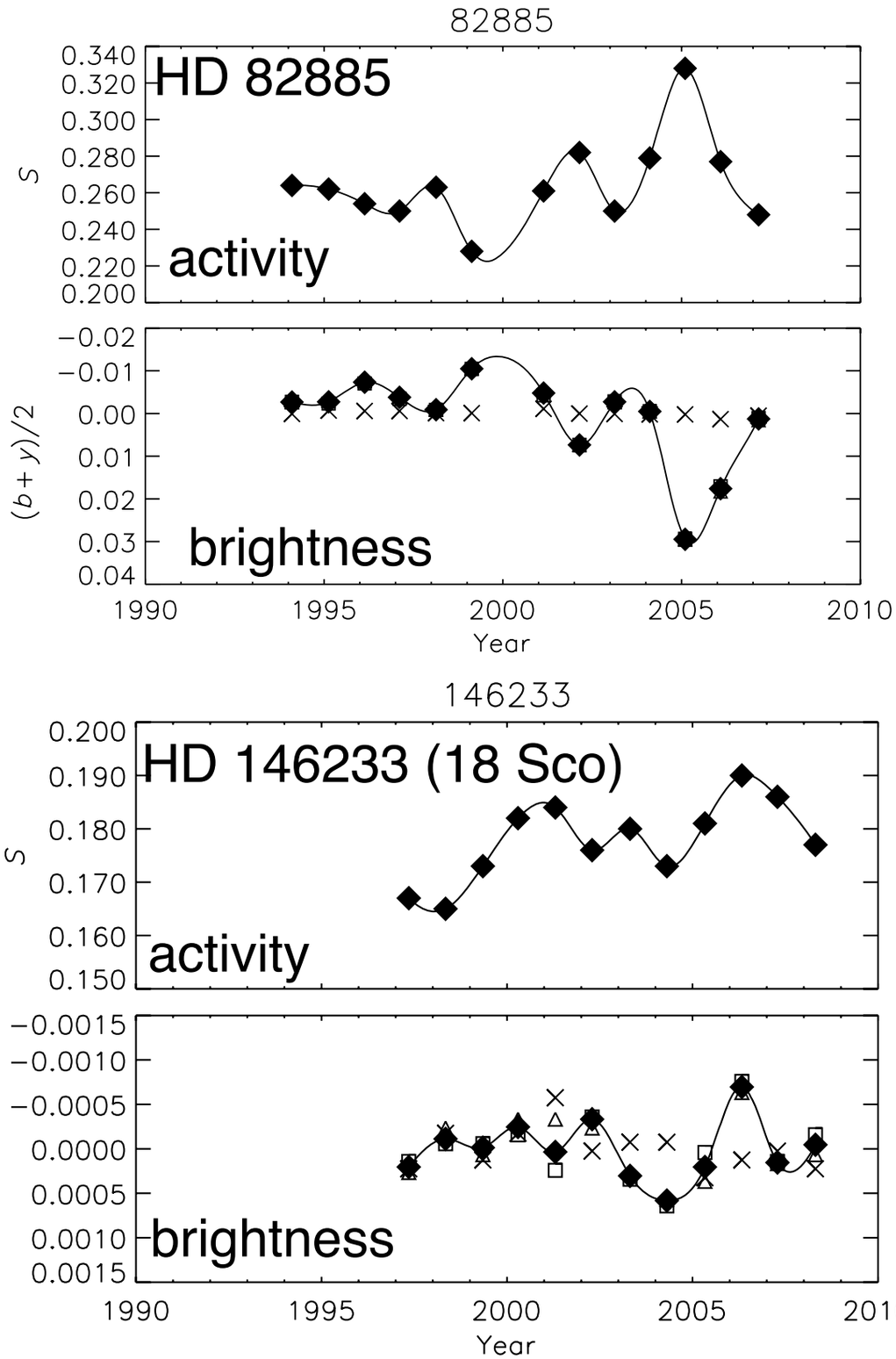
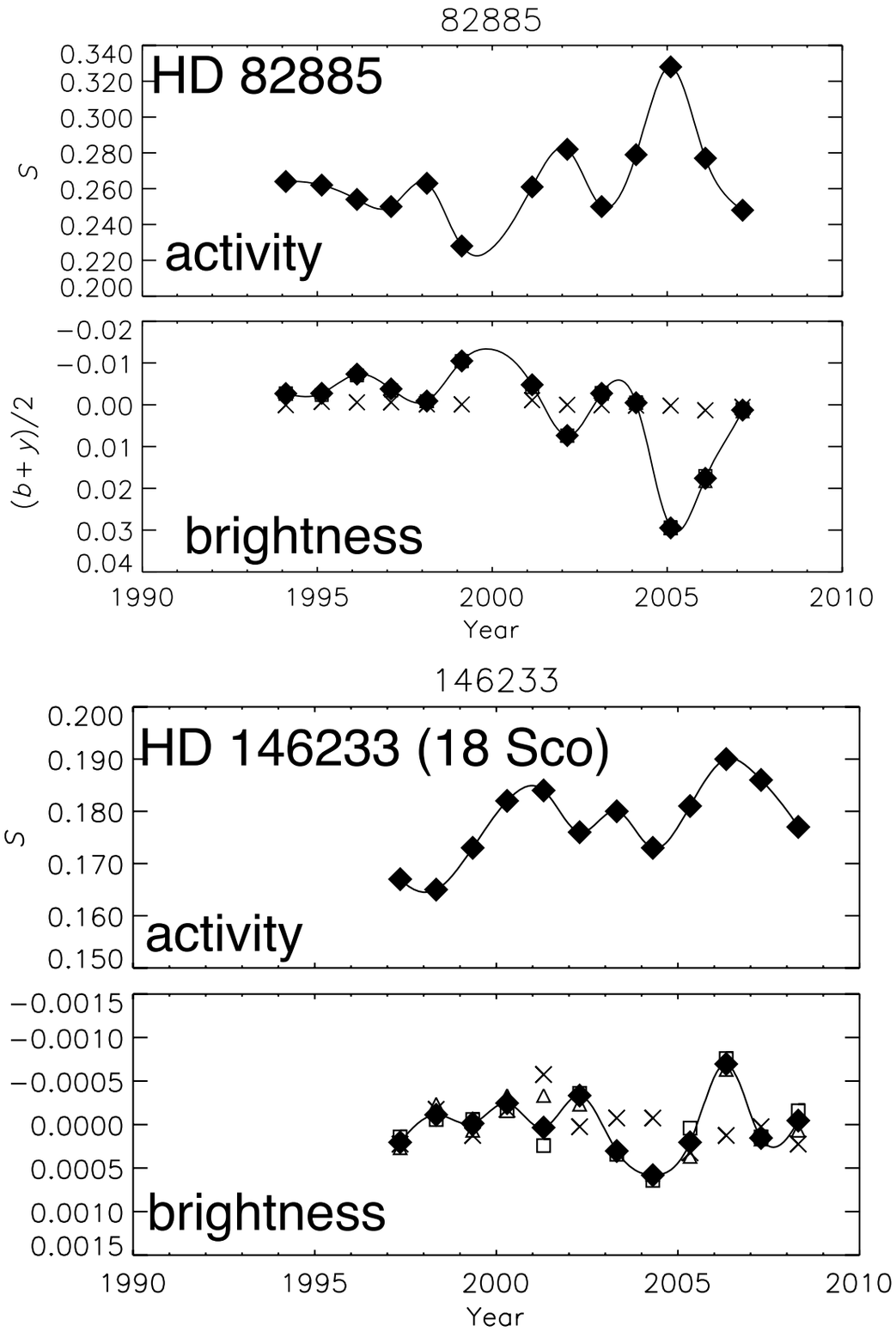


anticorrelation

correlation

from Hall et al. (2009)

Variation of stellar brightness



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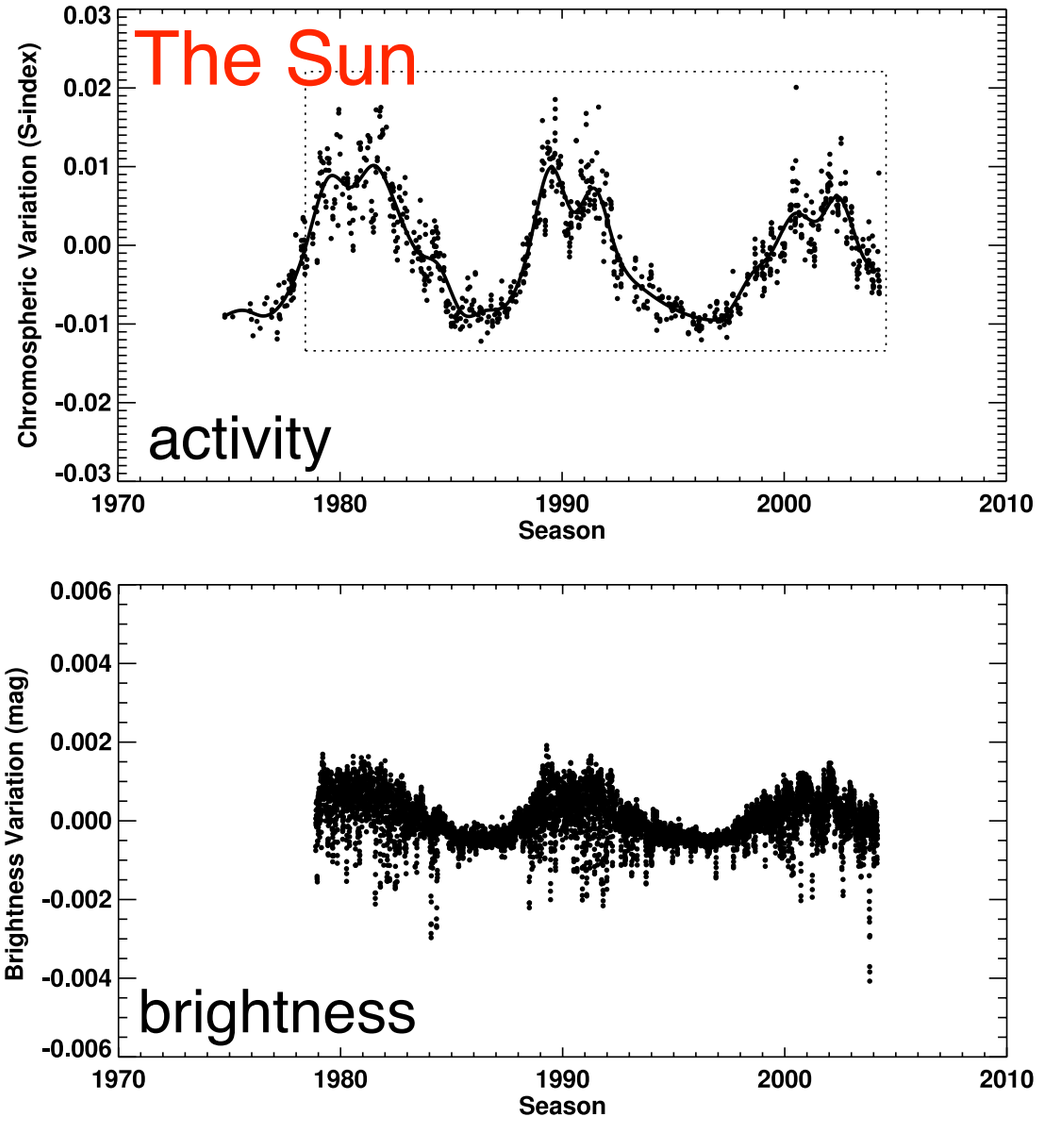
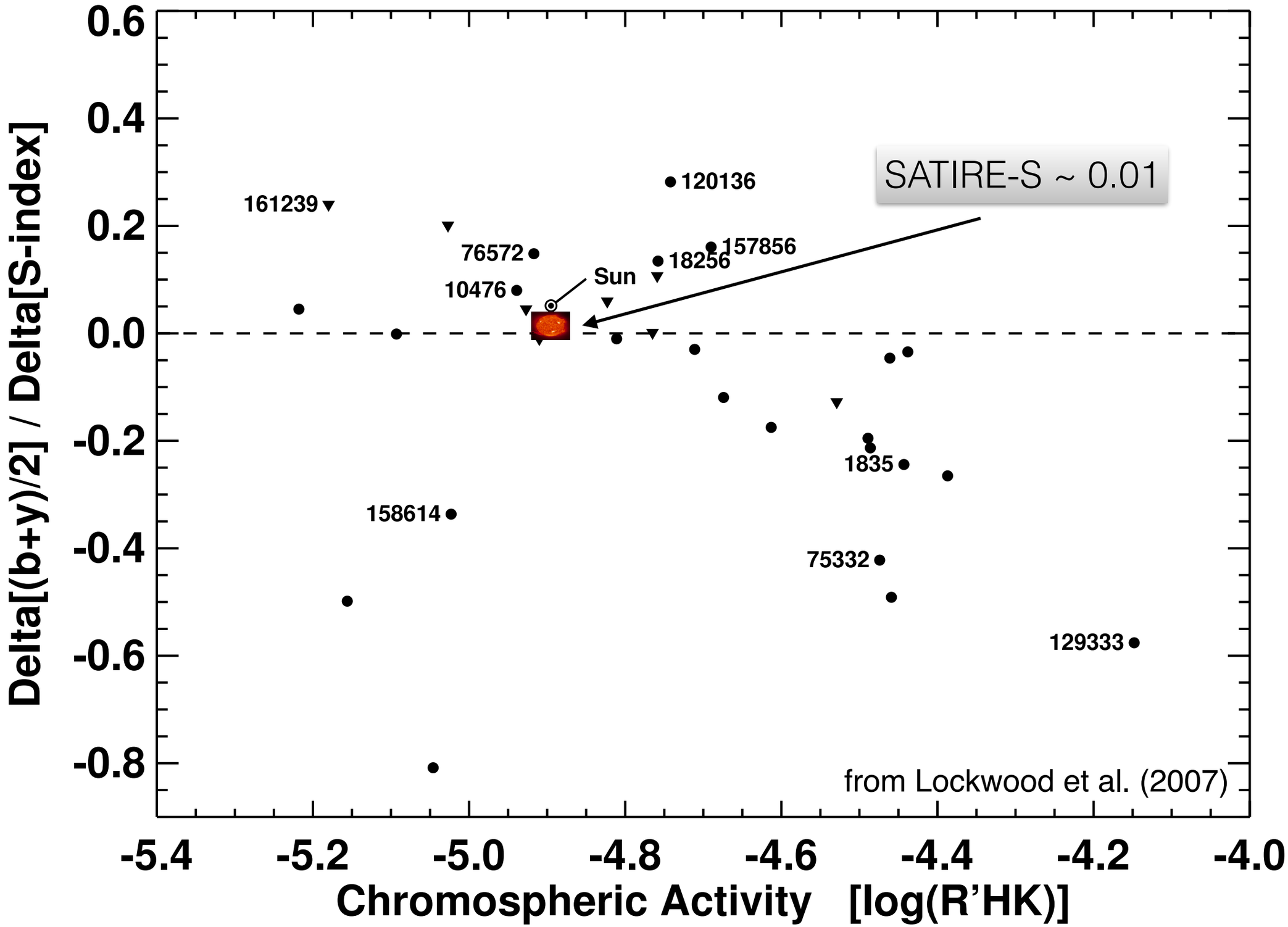
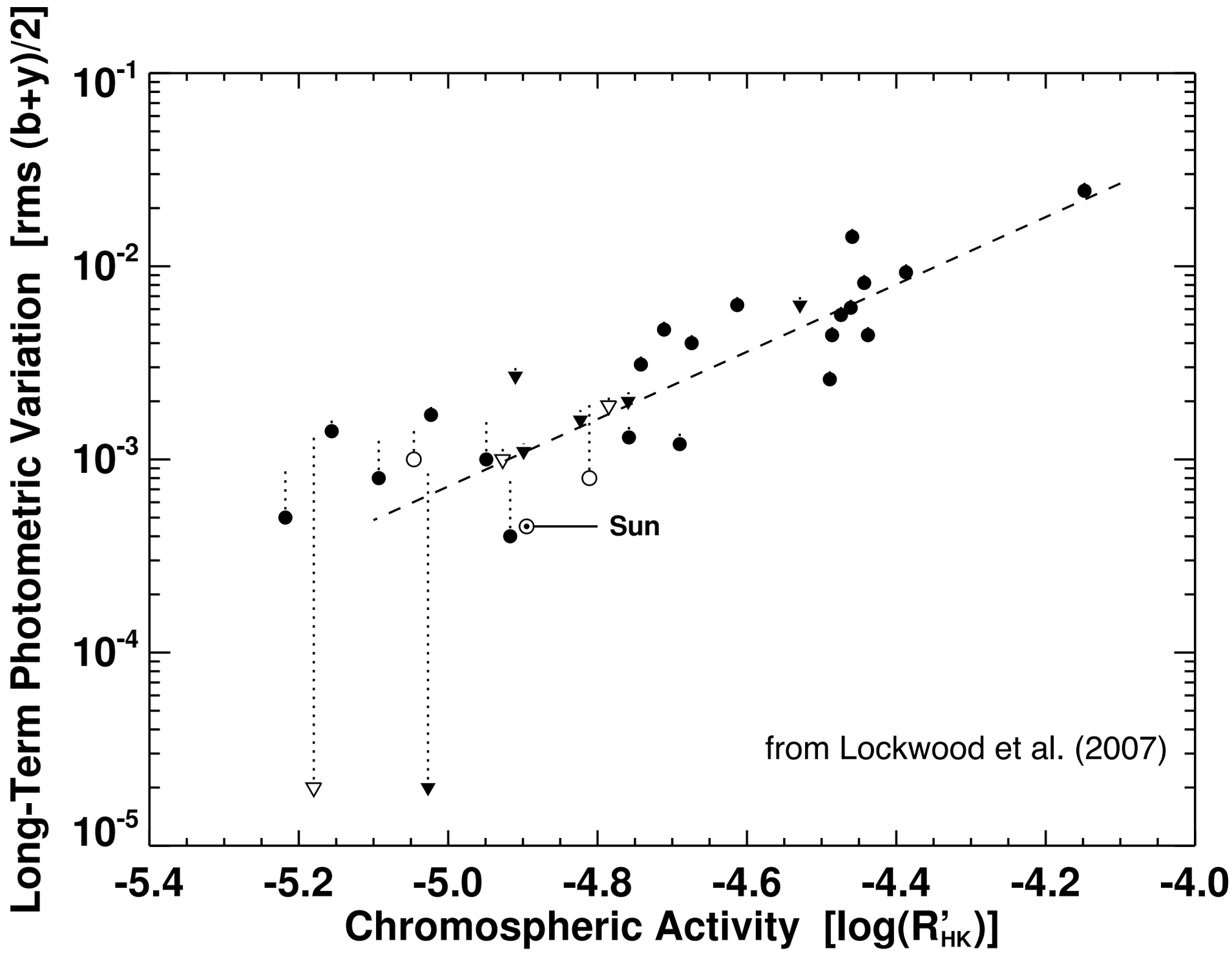


from Lockwood et al. (2007)

Spot- vs. faculae-dominated variability



Variability as a function of activity



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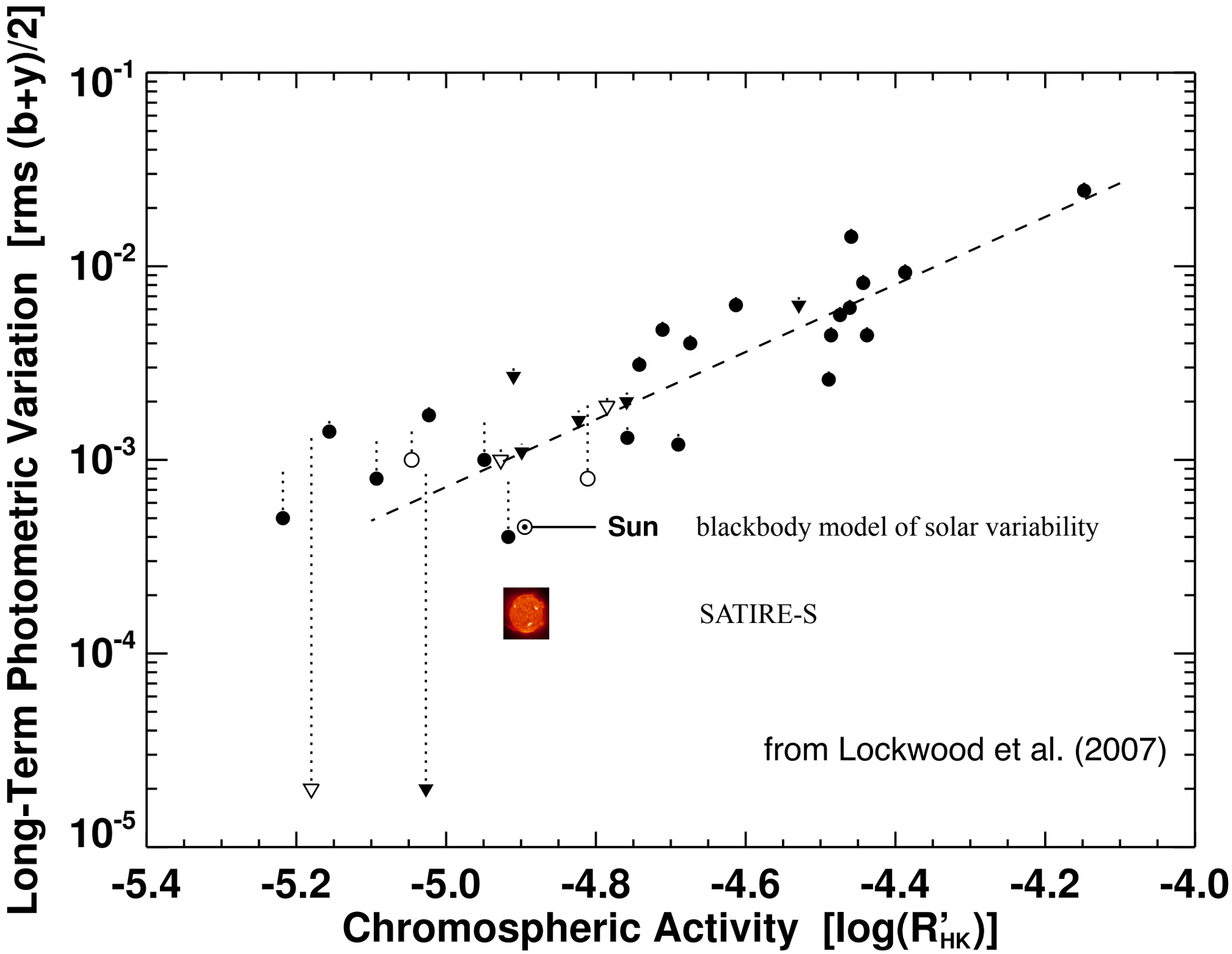
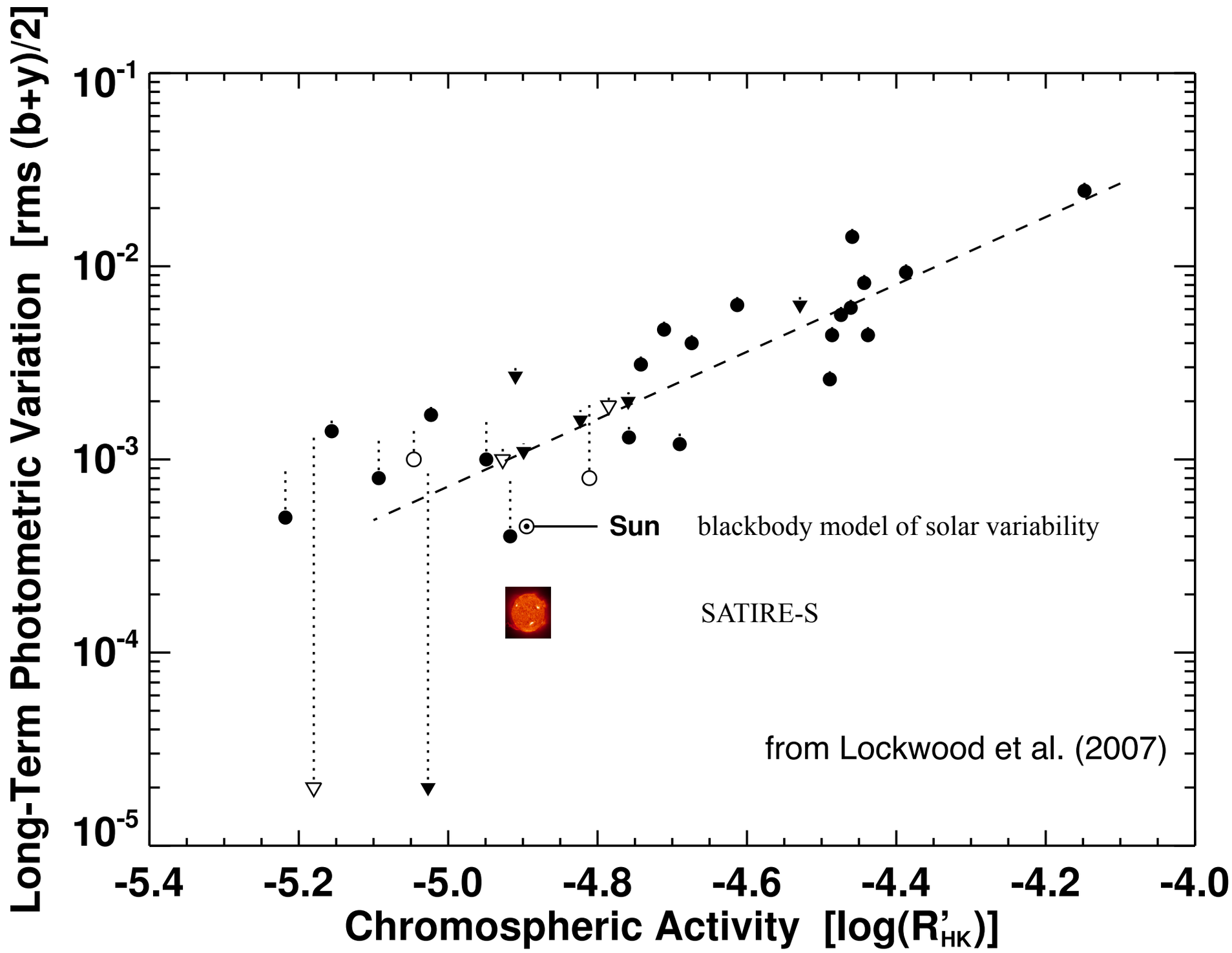


Variability as a function of activity

Is something wrong with the solar dynamo?

Is the Sun a Sun-like star?



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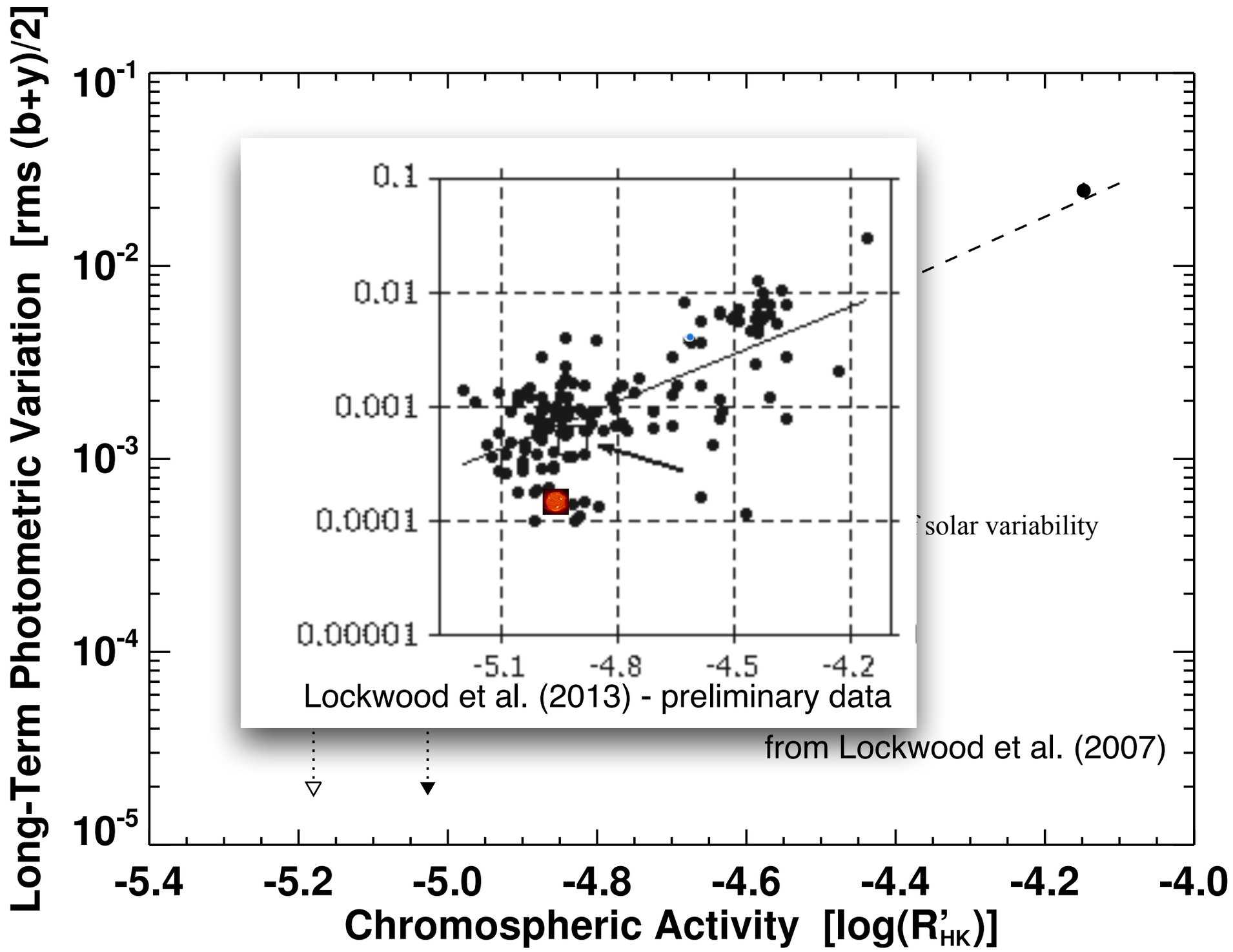

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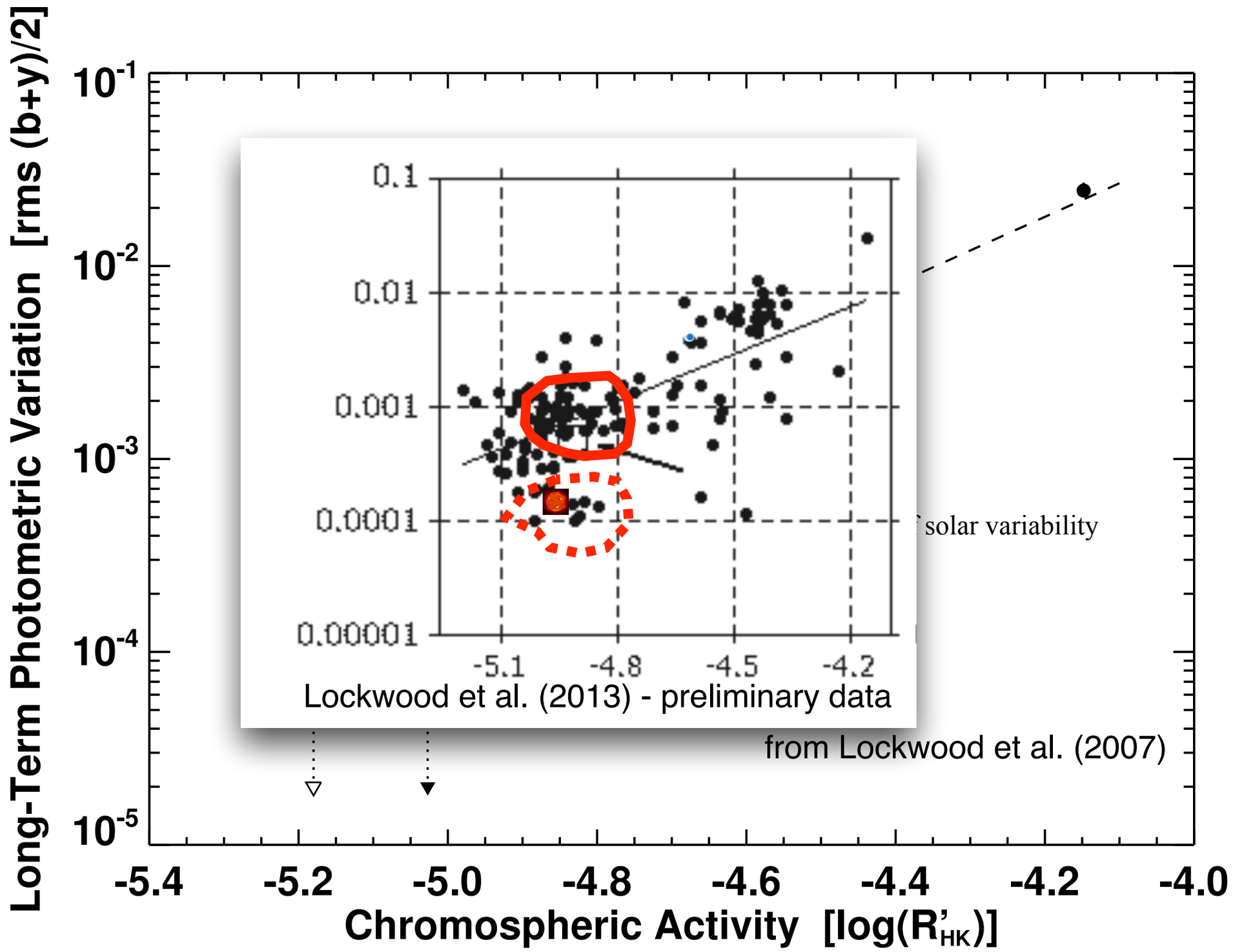

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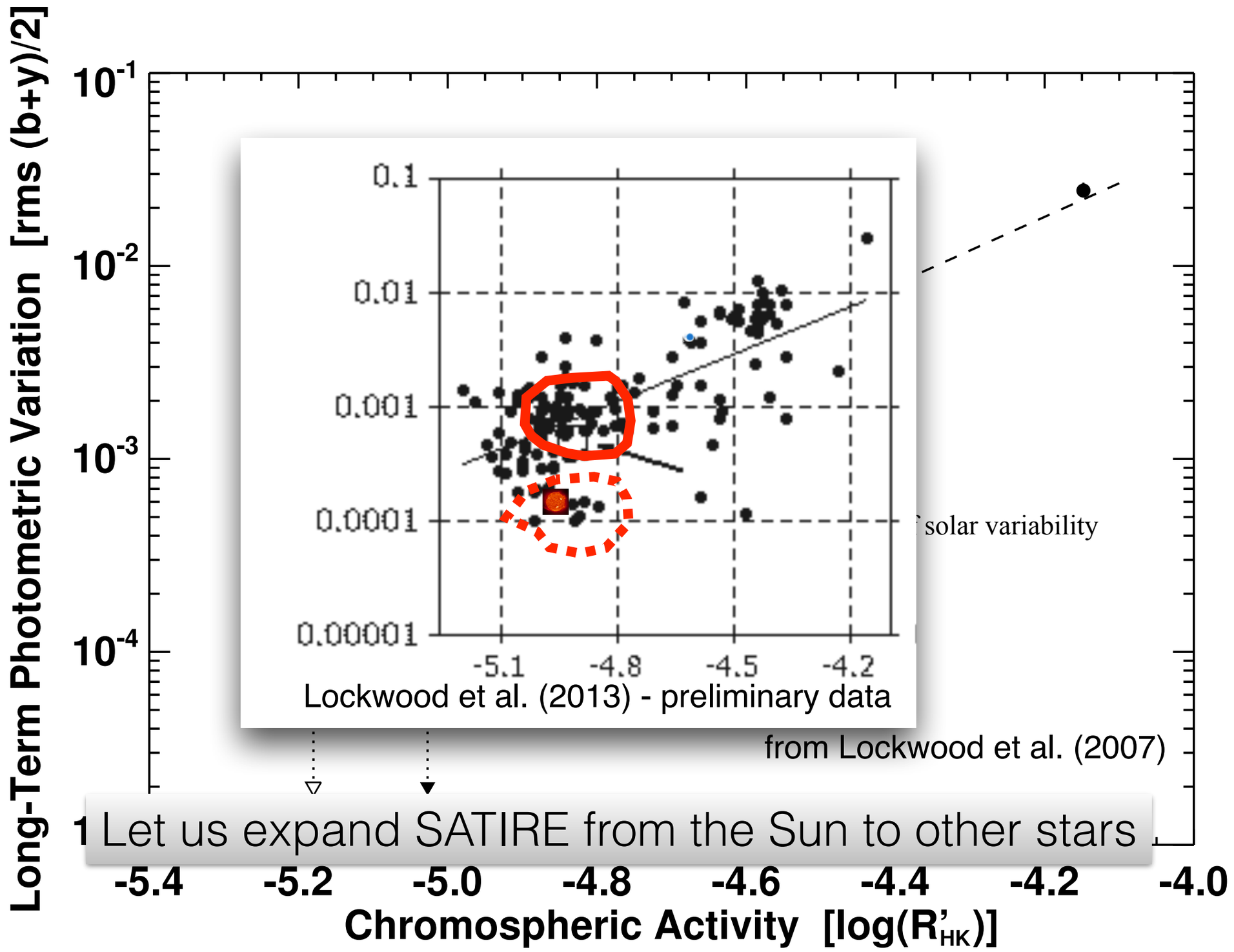
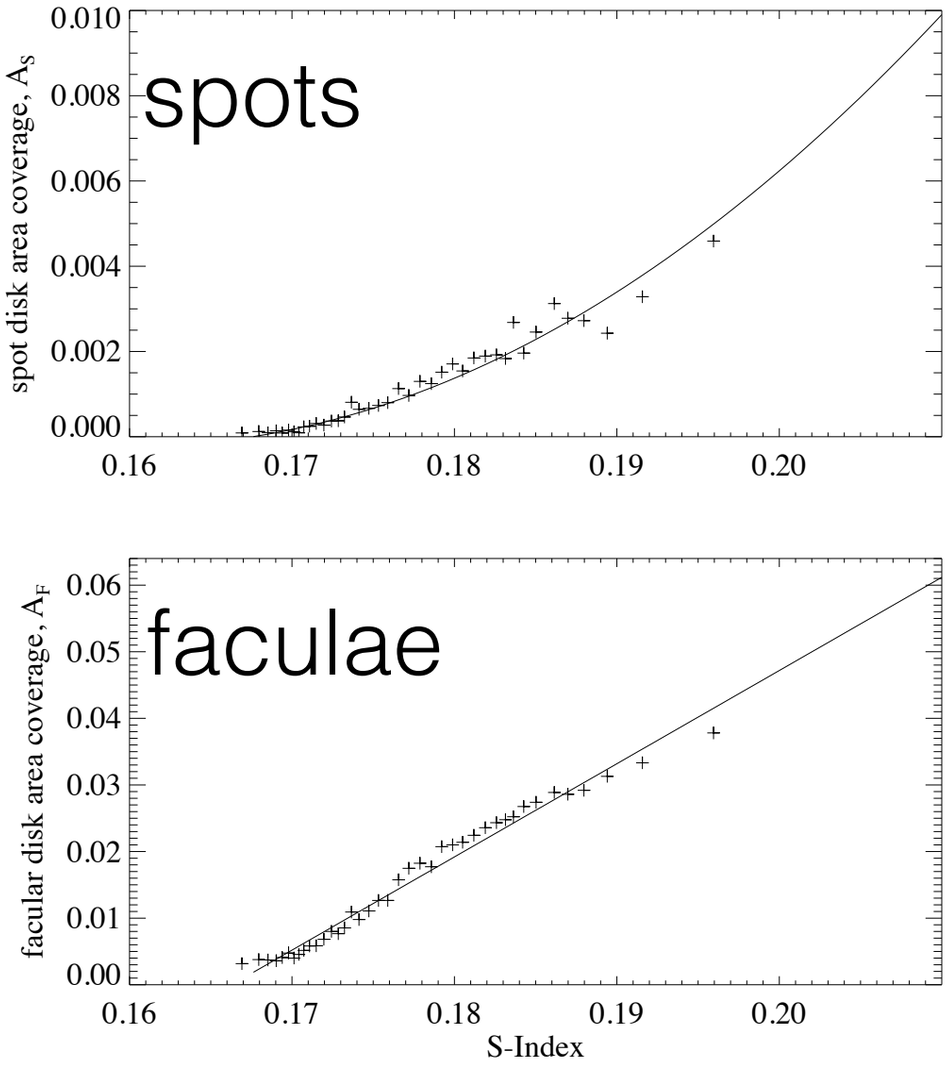
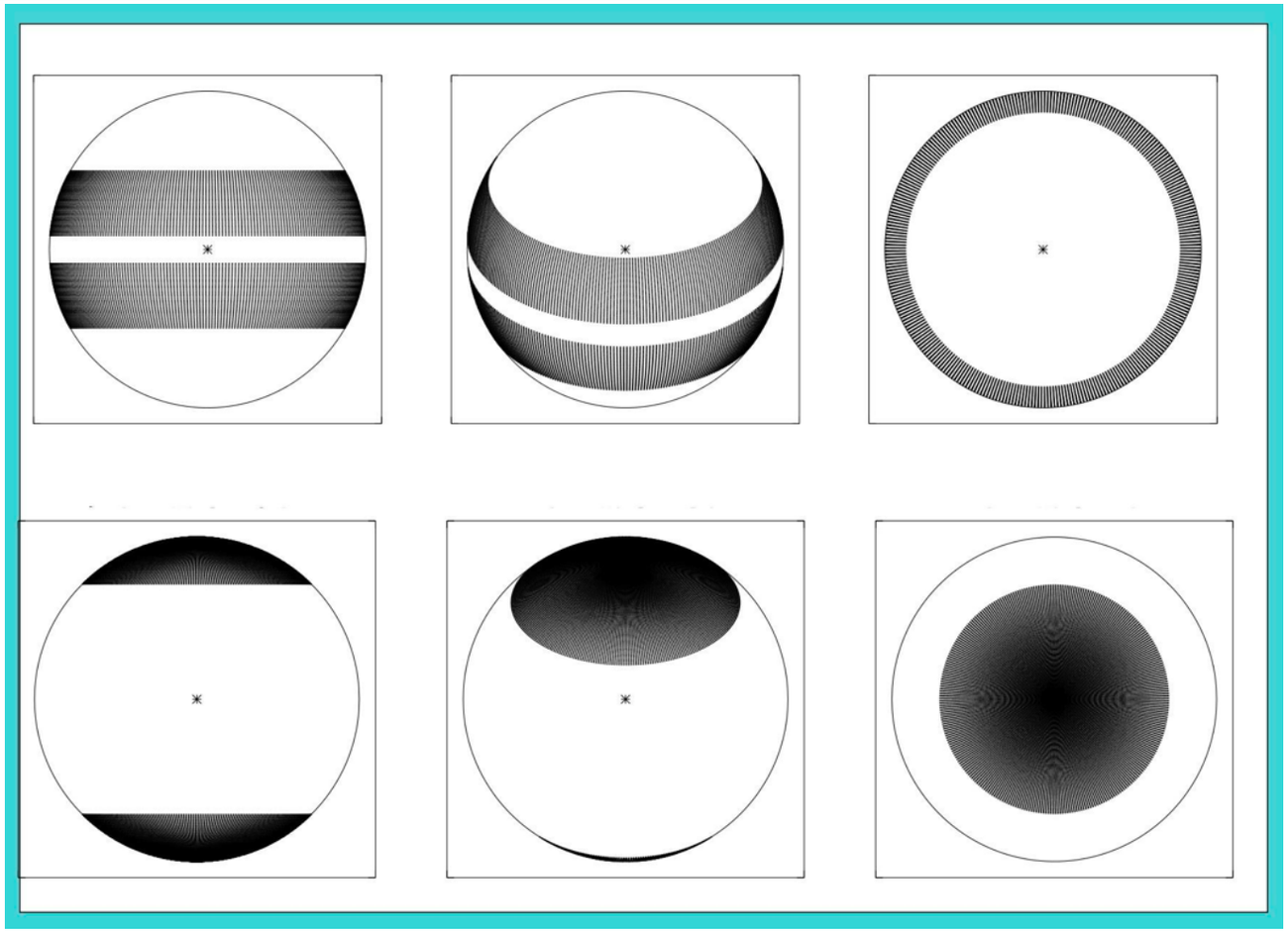


Our approach

SATIRE is extrapolated to stars by treating them as hypothetical Suns with coverage by magnetic features different from that of the Sun





slow-rotator

fast-rotator

equator

intermediate

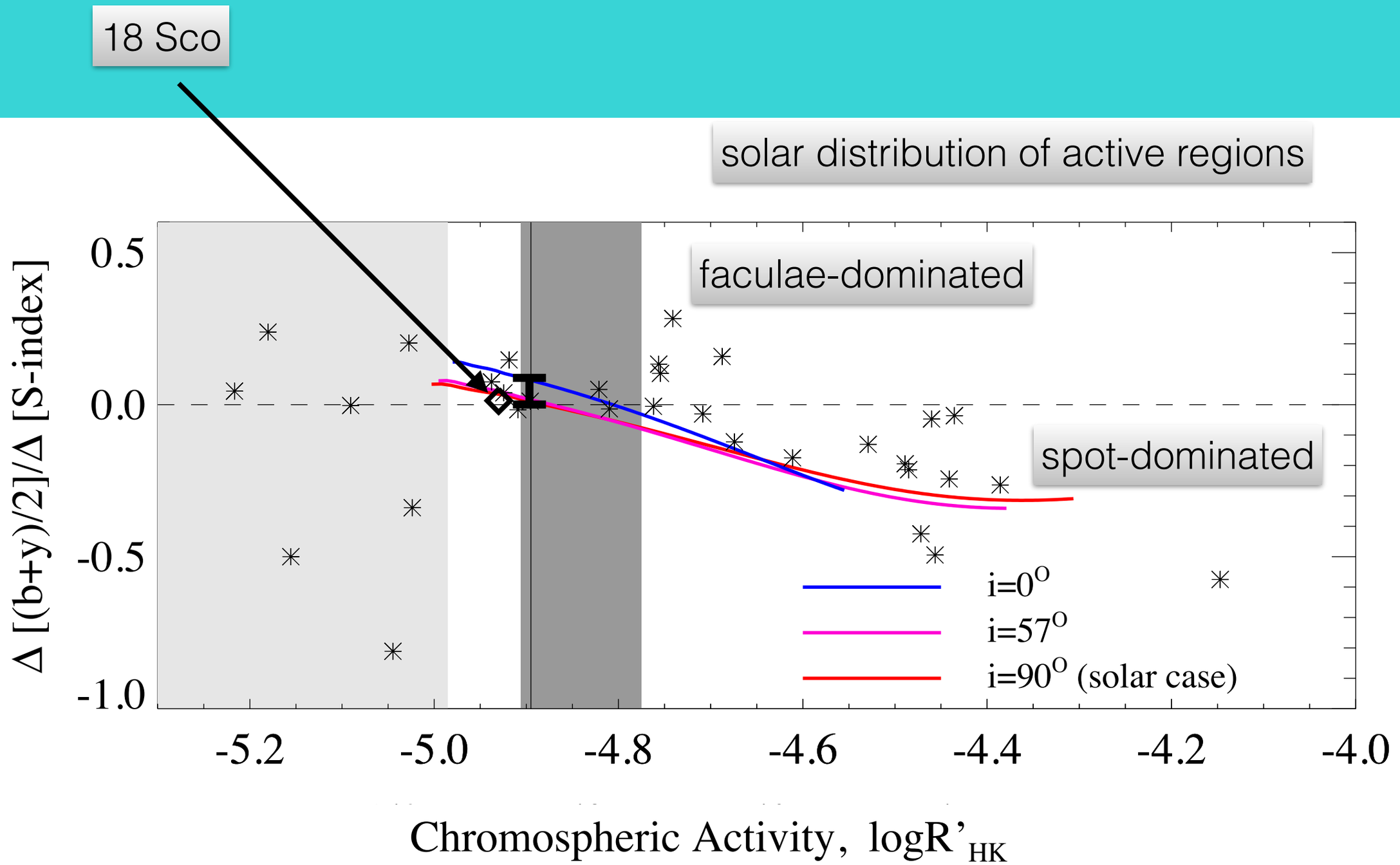
polar

i=90° (solar case)

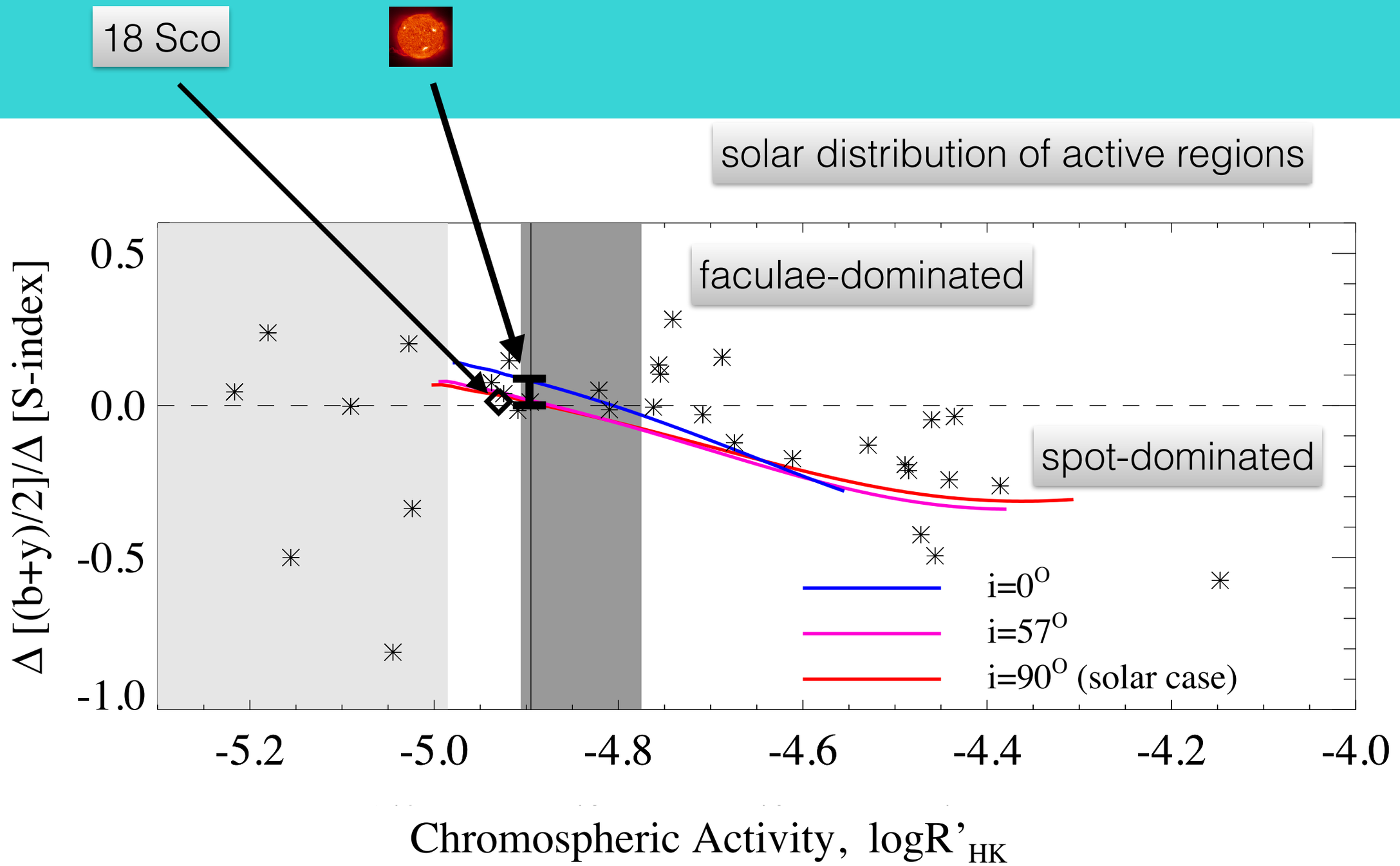
i=57°

i=0°

Spot- vs faculae- dominated regimes

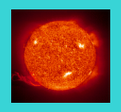


Spot- vs faculae- dominated regimes

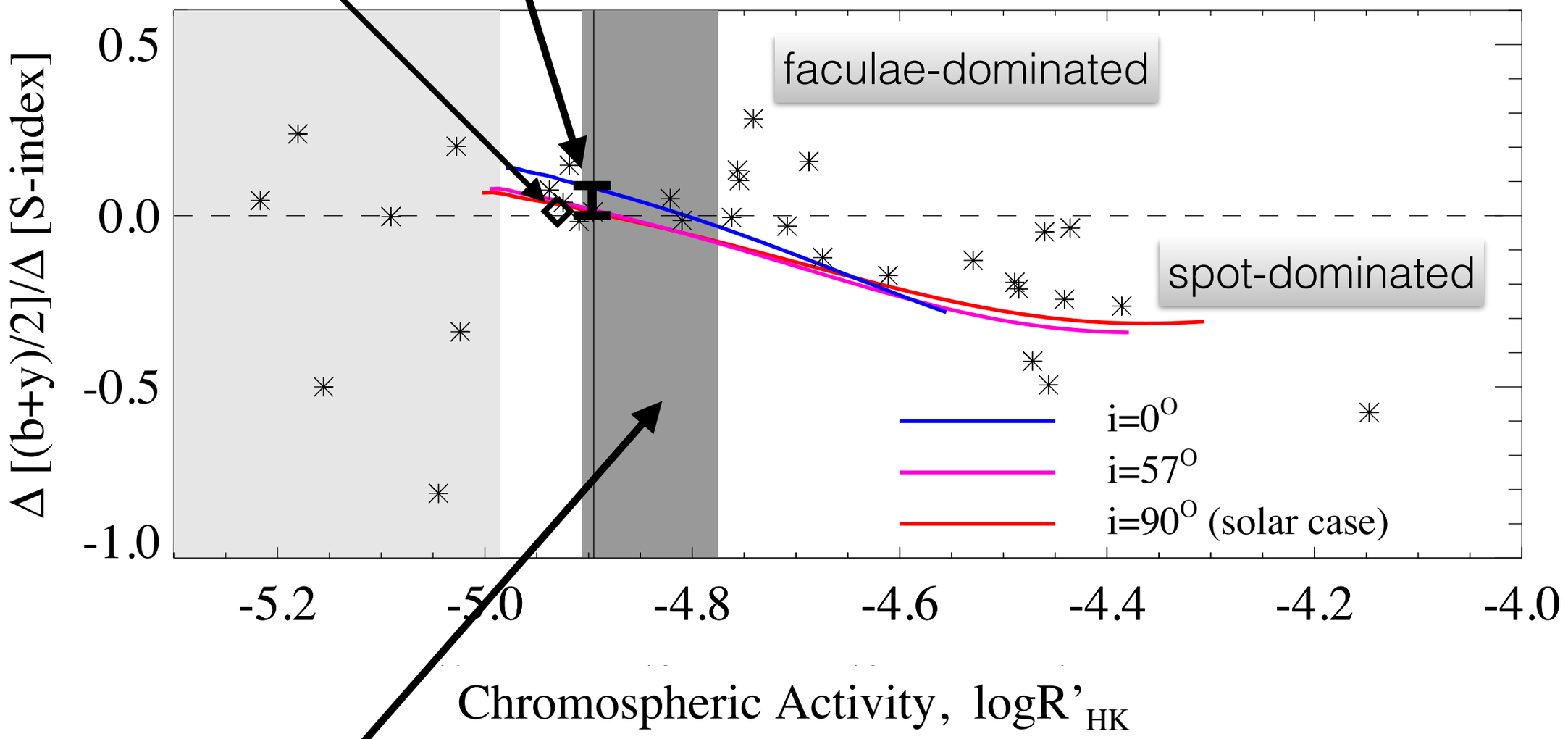


Spot- vs faculae- dominated regimes

18 Sco



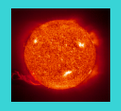
solar distribution of active regions



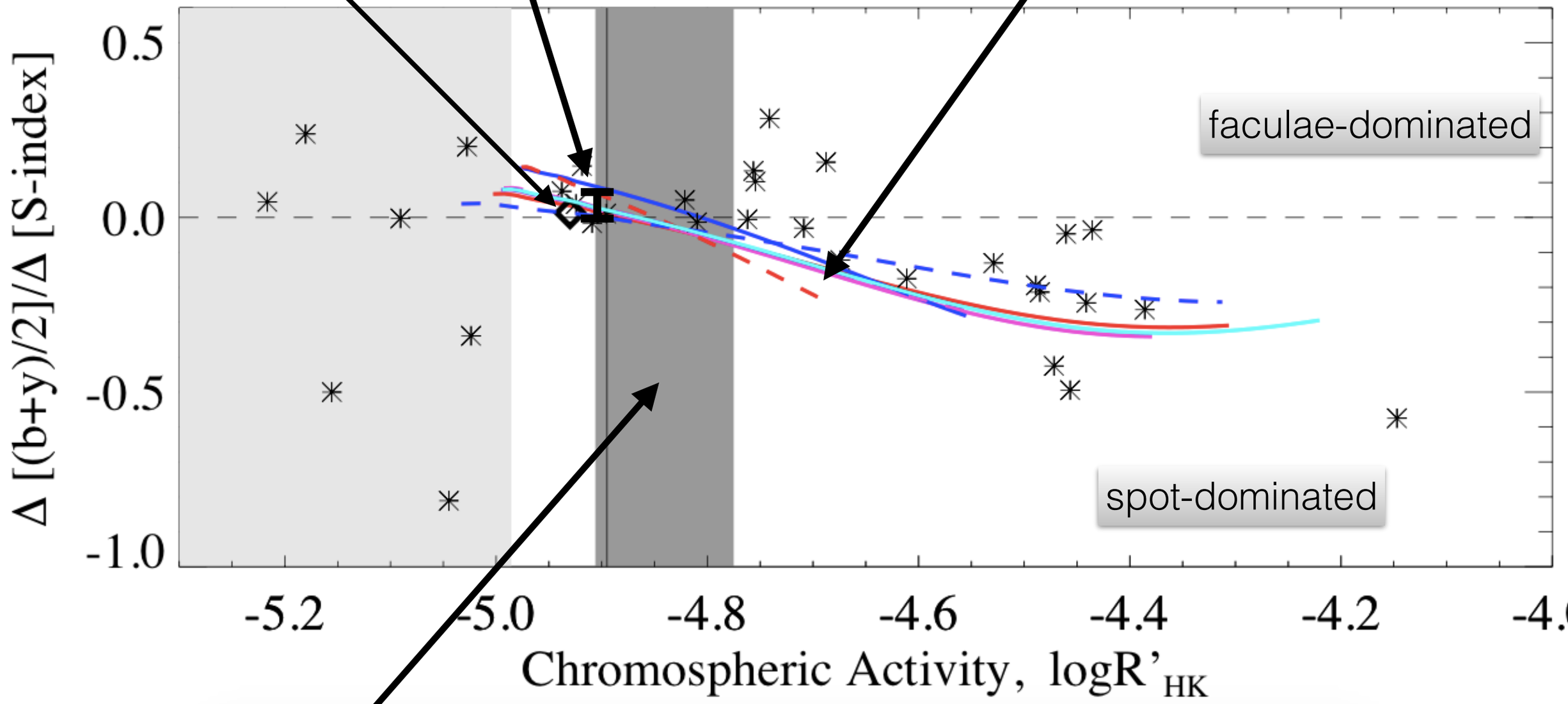
spot-dominated around maxima of activity
faculae-dominated around minima of activity

Spot- vs faculae- dominated regimes

18 Sco



different inclinations and distributions of magnetic features



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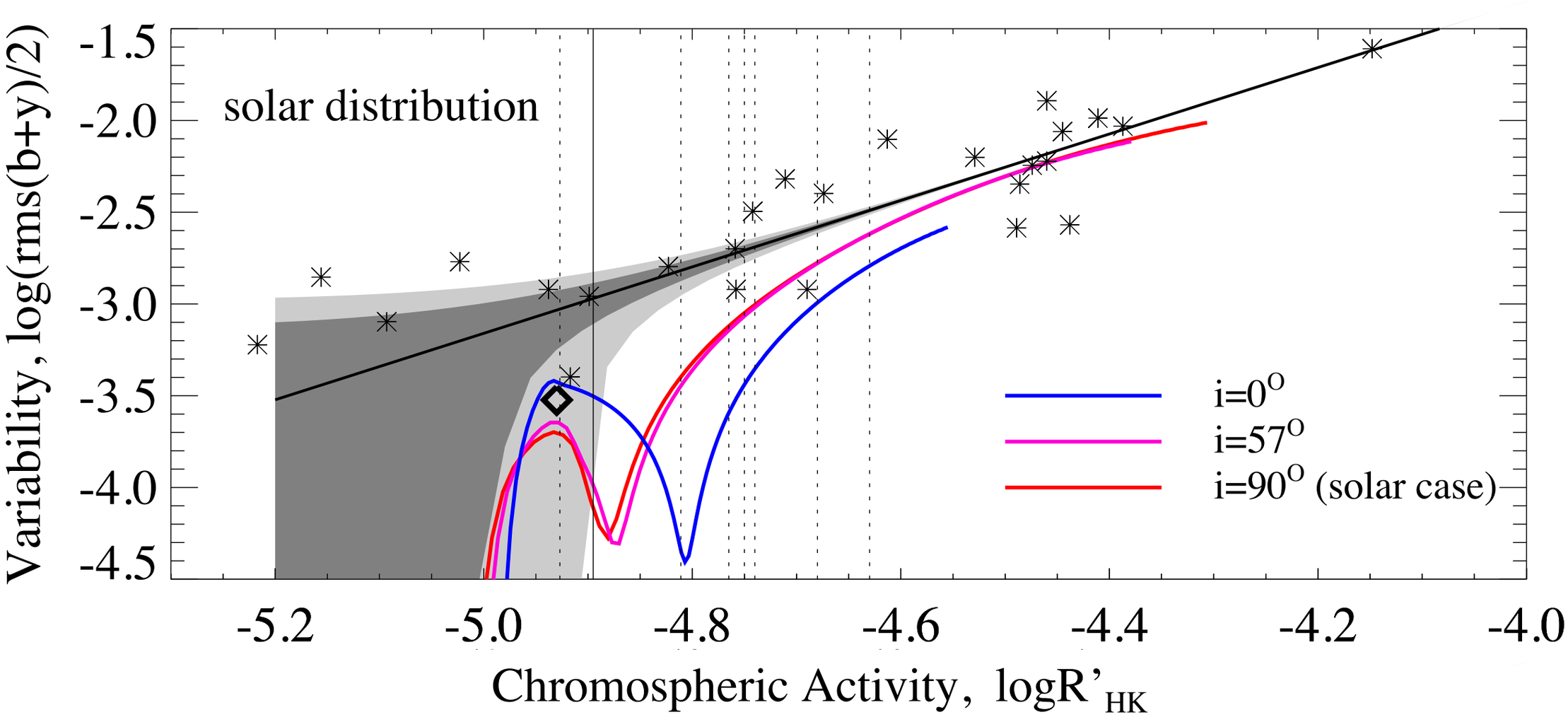
Variability vs. magnetic activity



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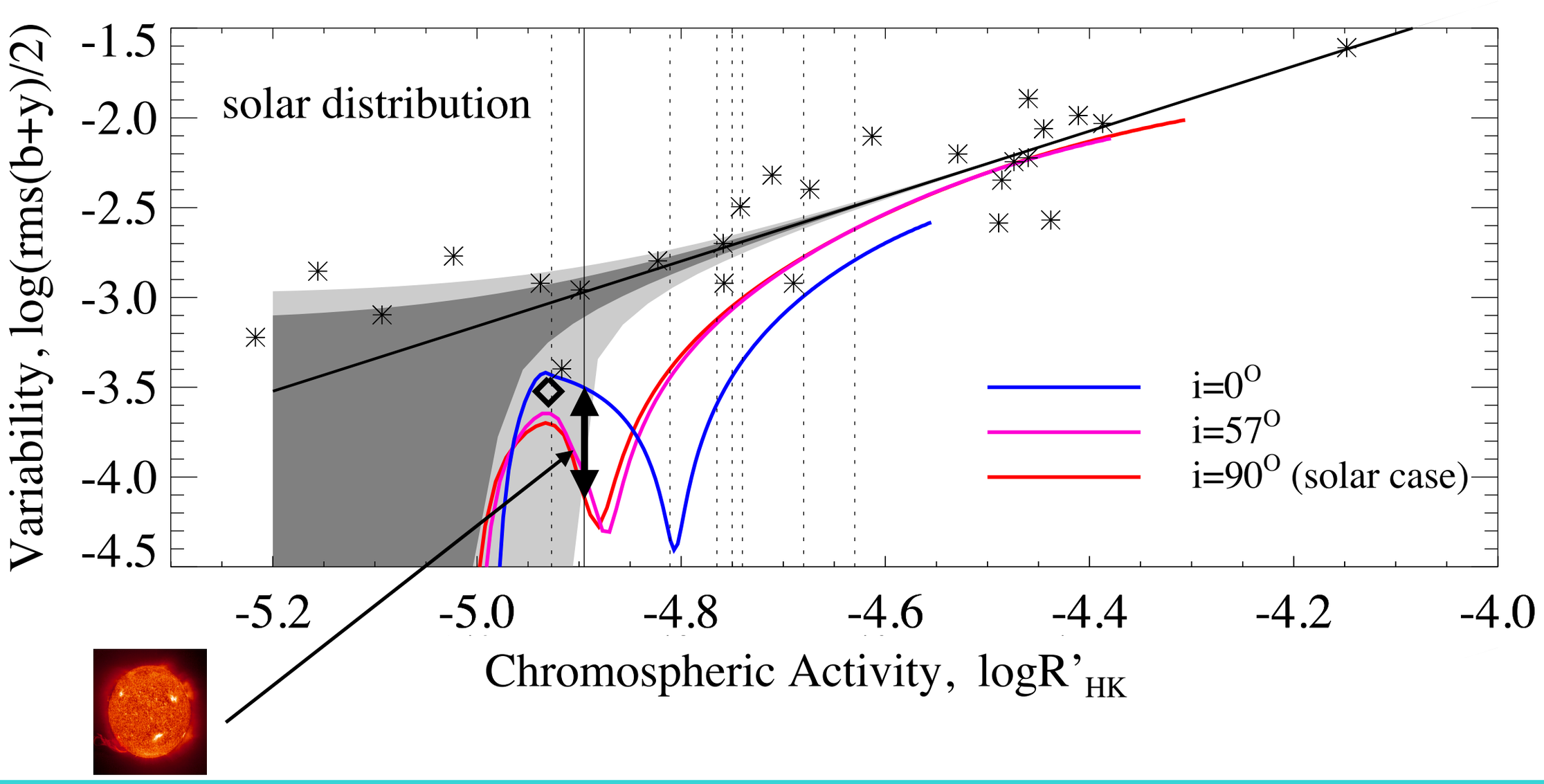

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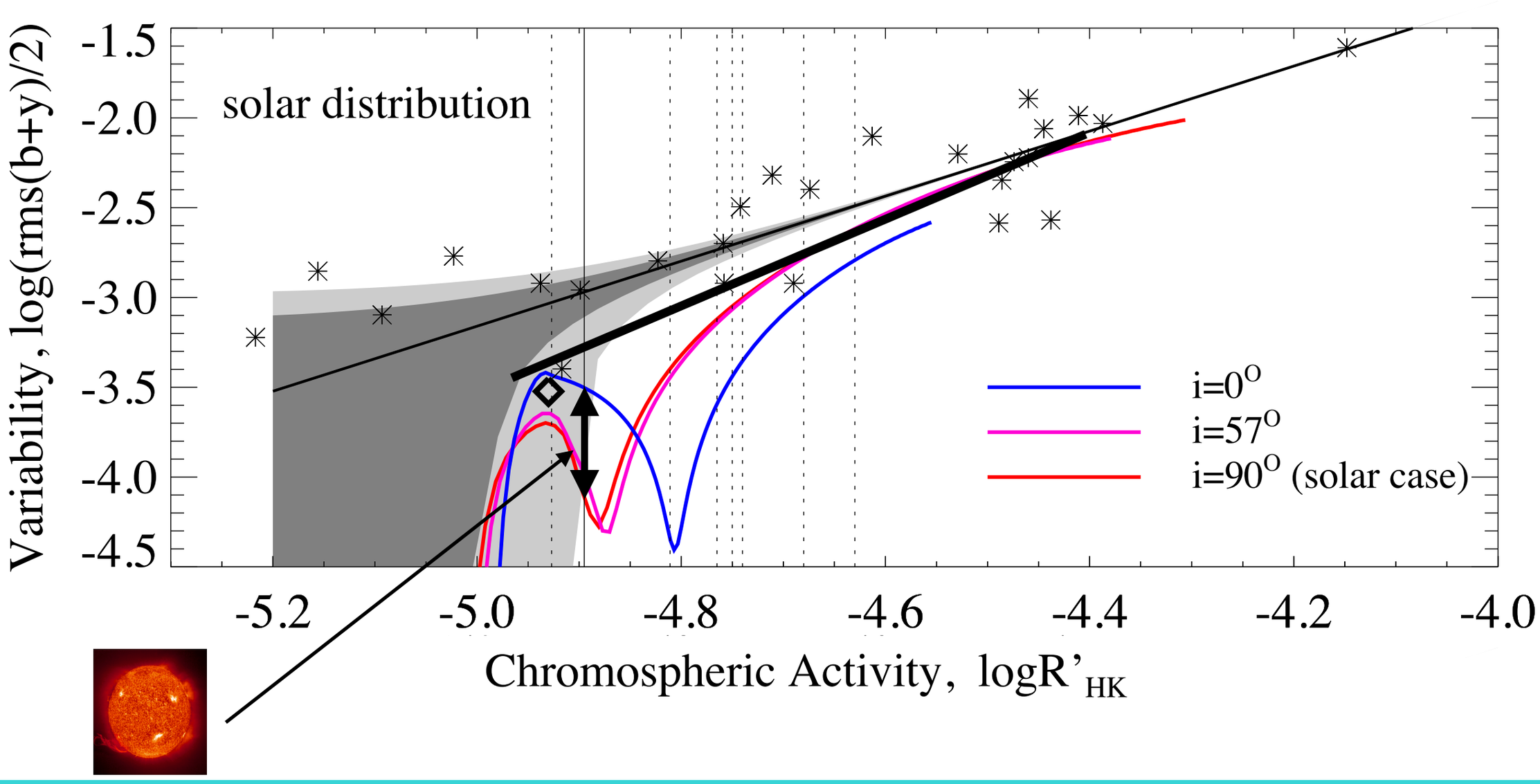

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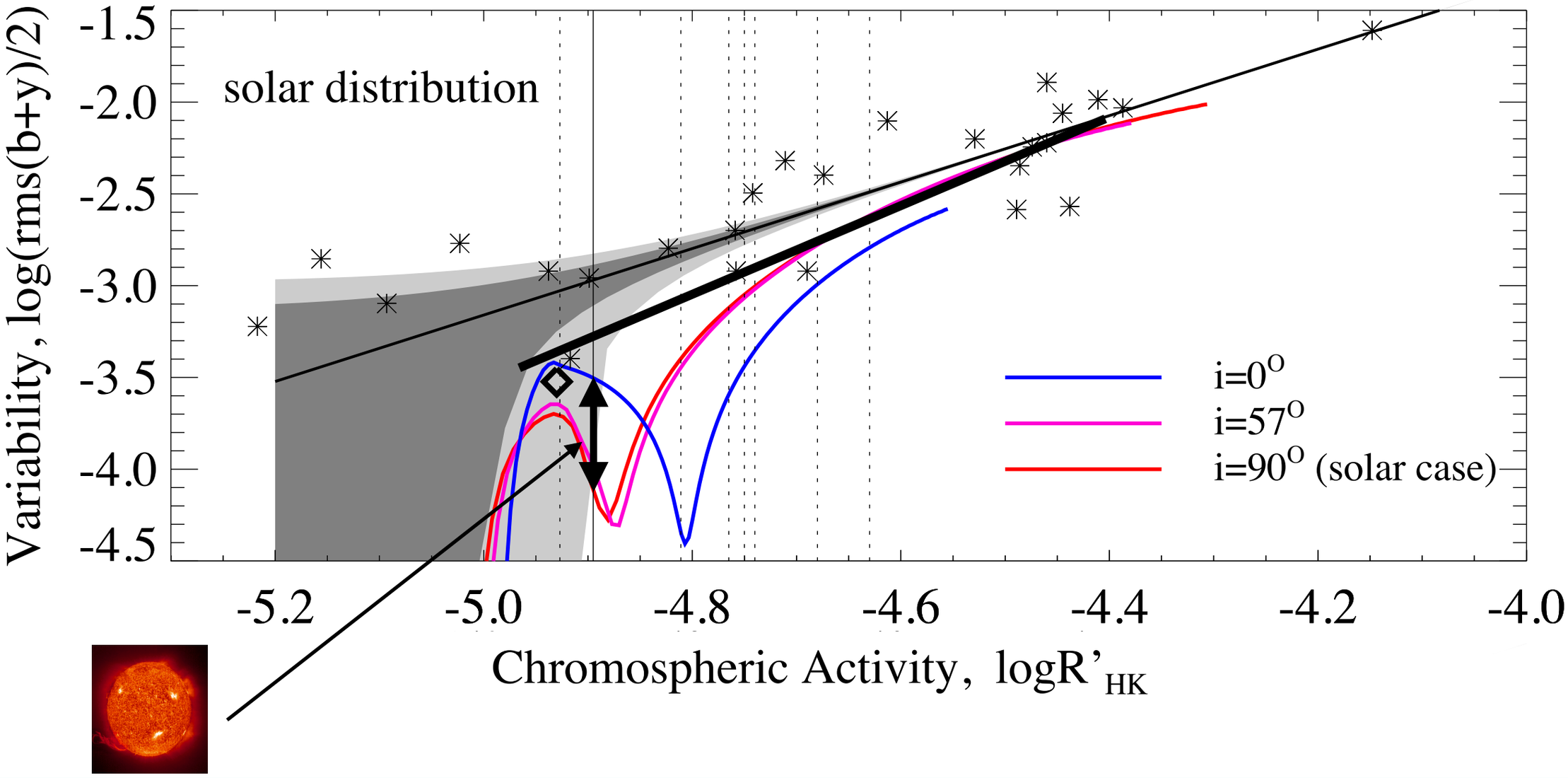
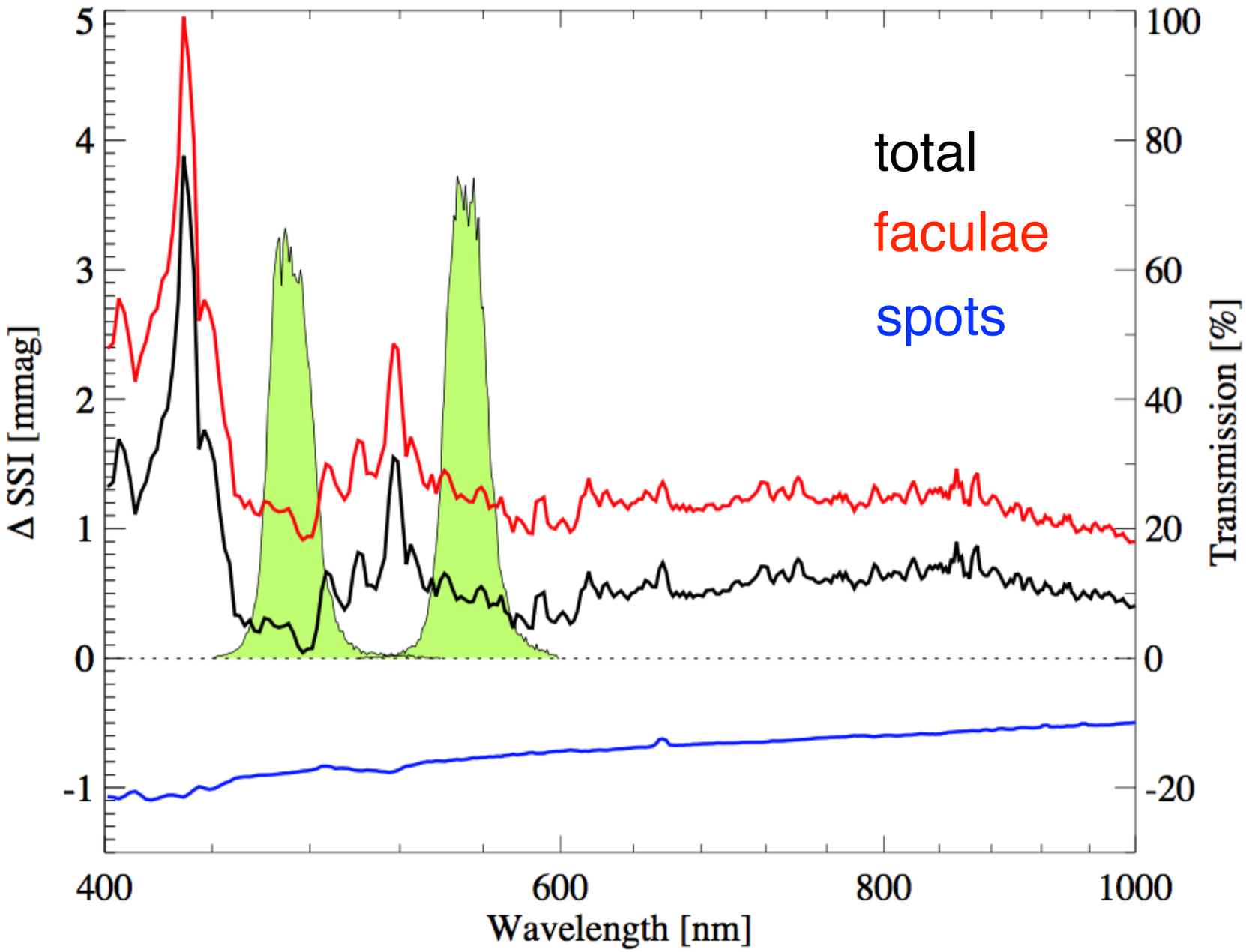


no variability gap in stellar data

Origin of the variability gap



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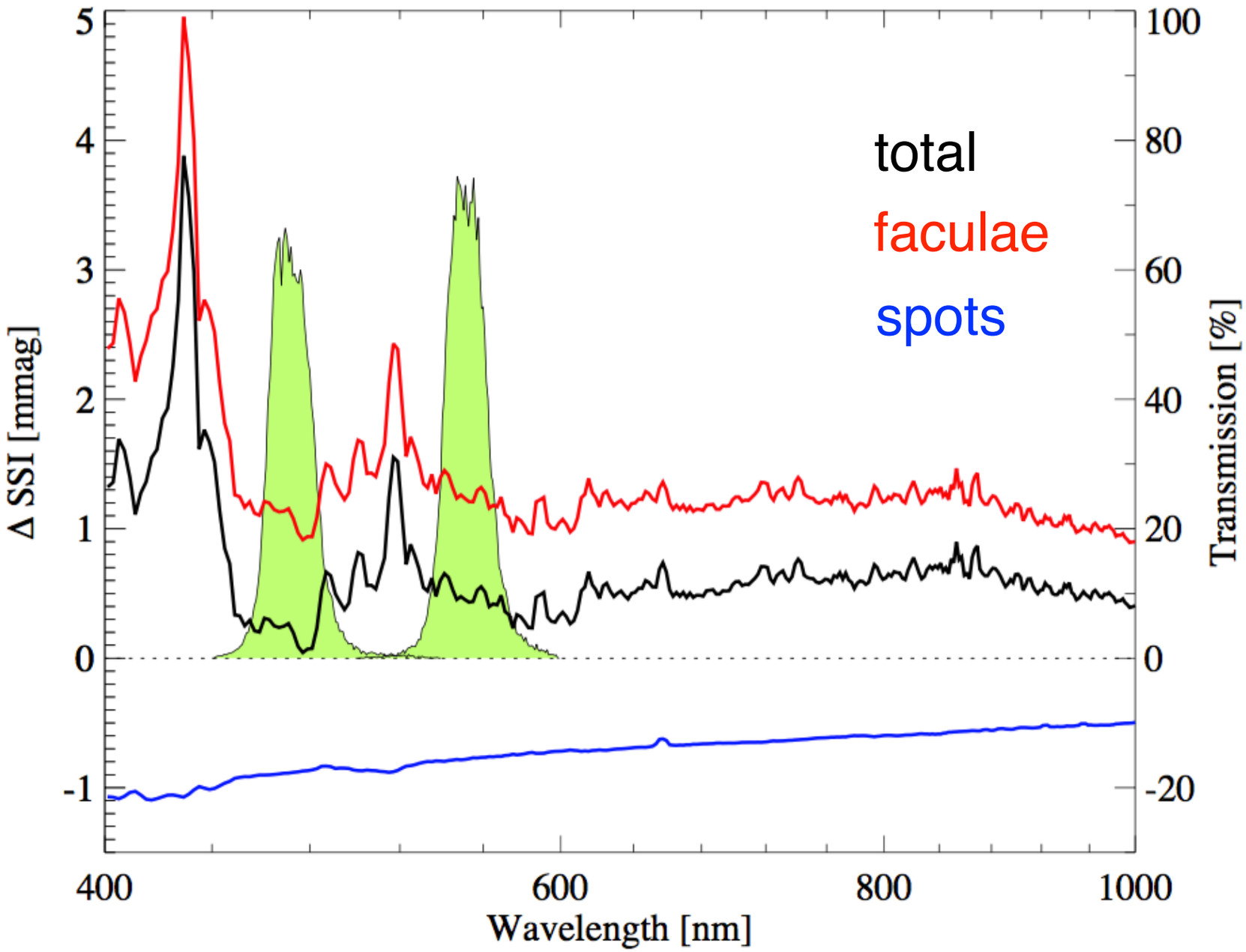

the Sun is just in an unlucky place

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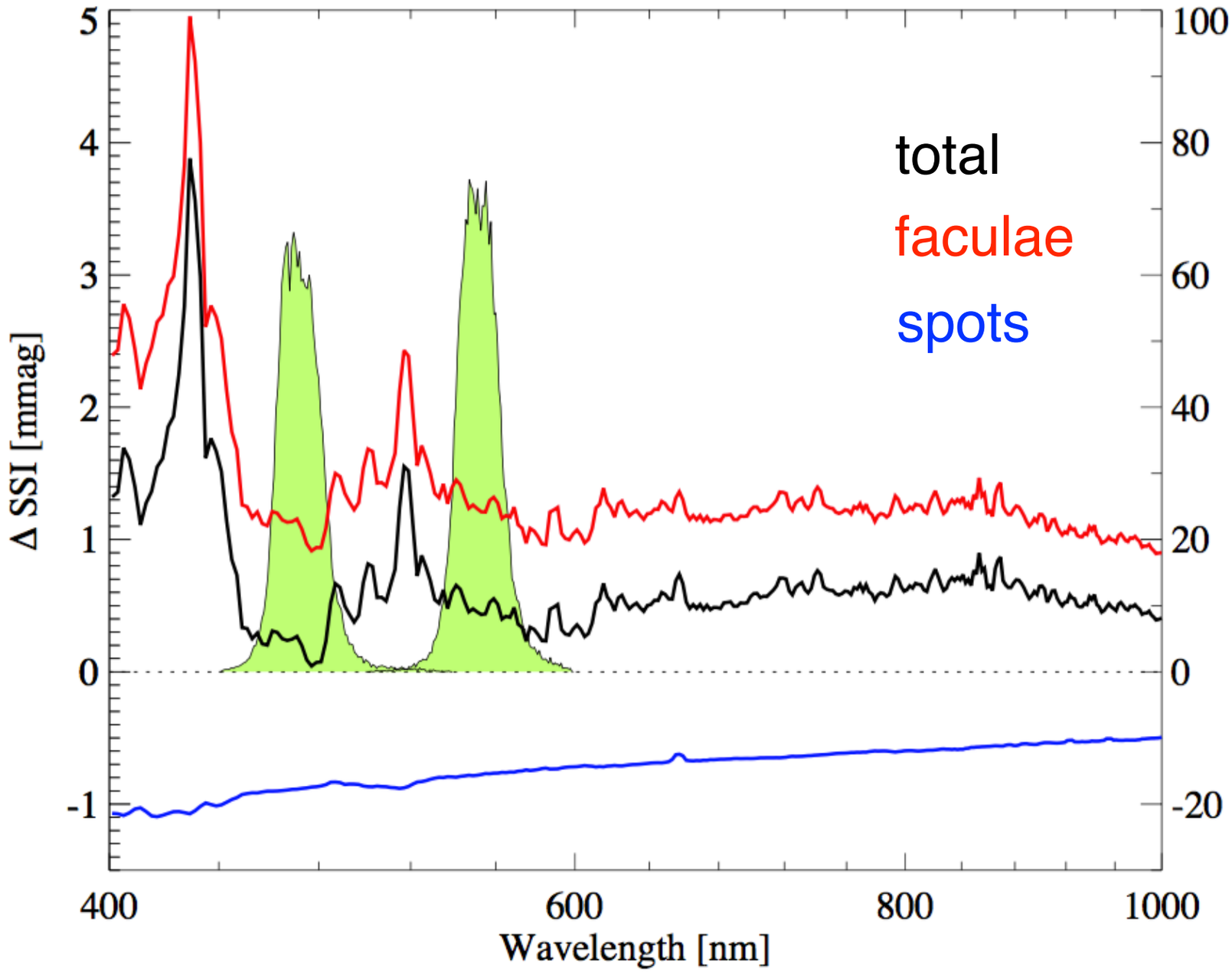

B-V?

[Fe/H]?

log g?

variability on different timescales ?

the Sun is just in an unlucky place

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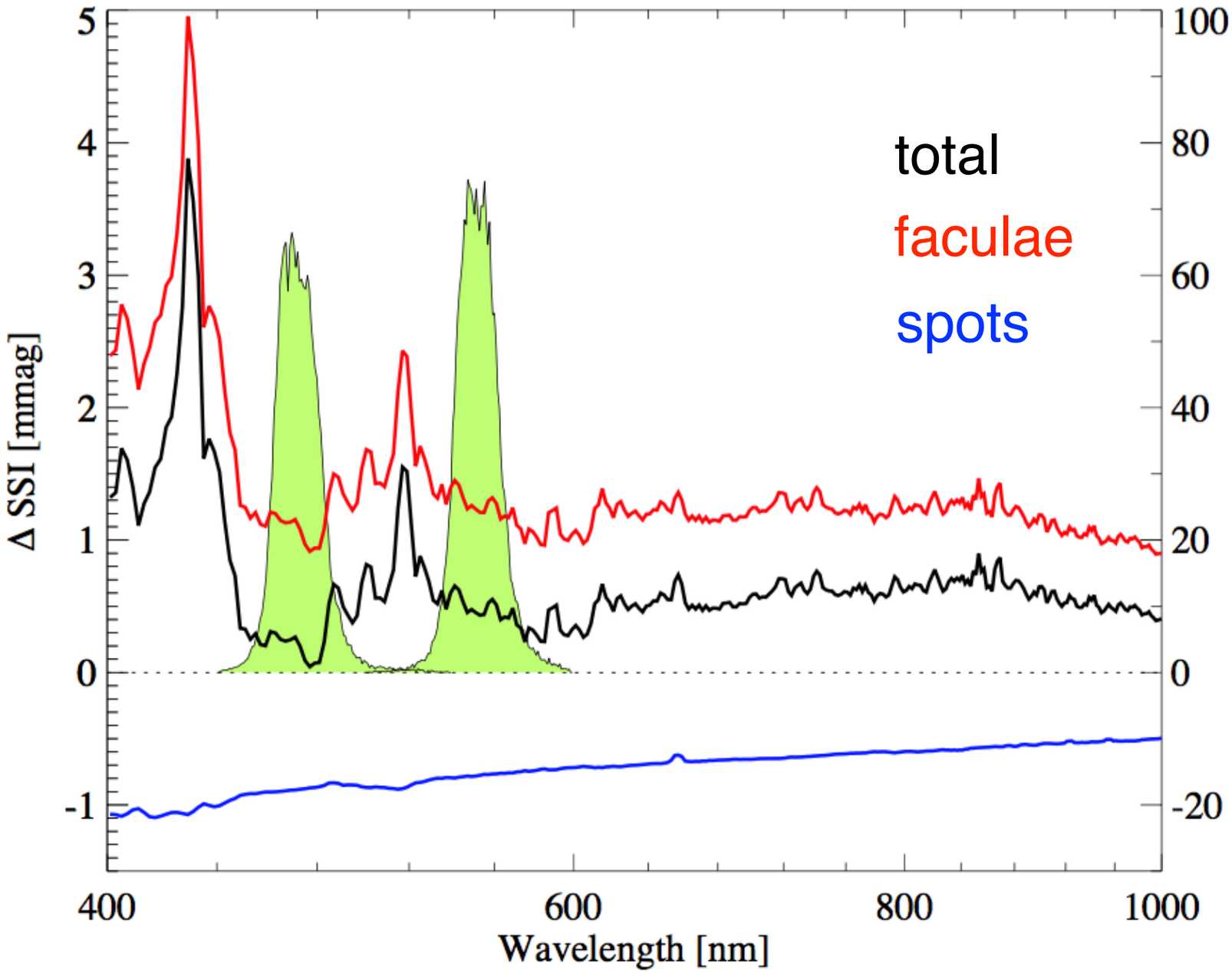

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THANK YOU!