MAX PLANCK INSTITUTE
FOR SOLAR SYSTEM RESEARCH

SOLAR IRRADIANCE VARIABILITY IN THE NEAR-UV
CA II H & K LINES


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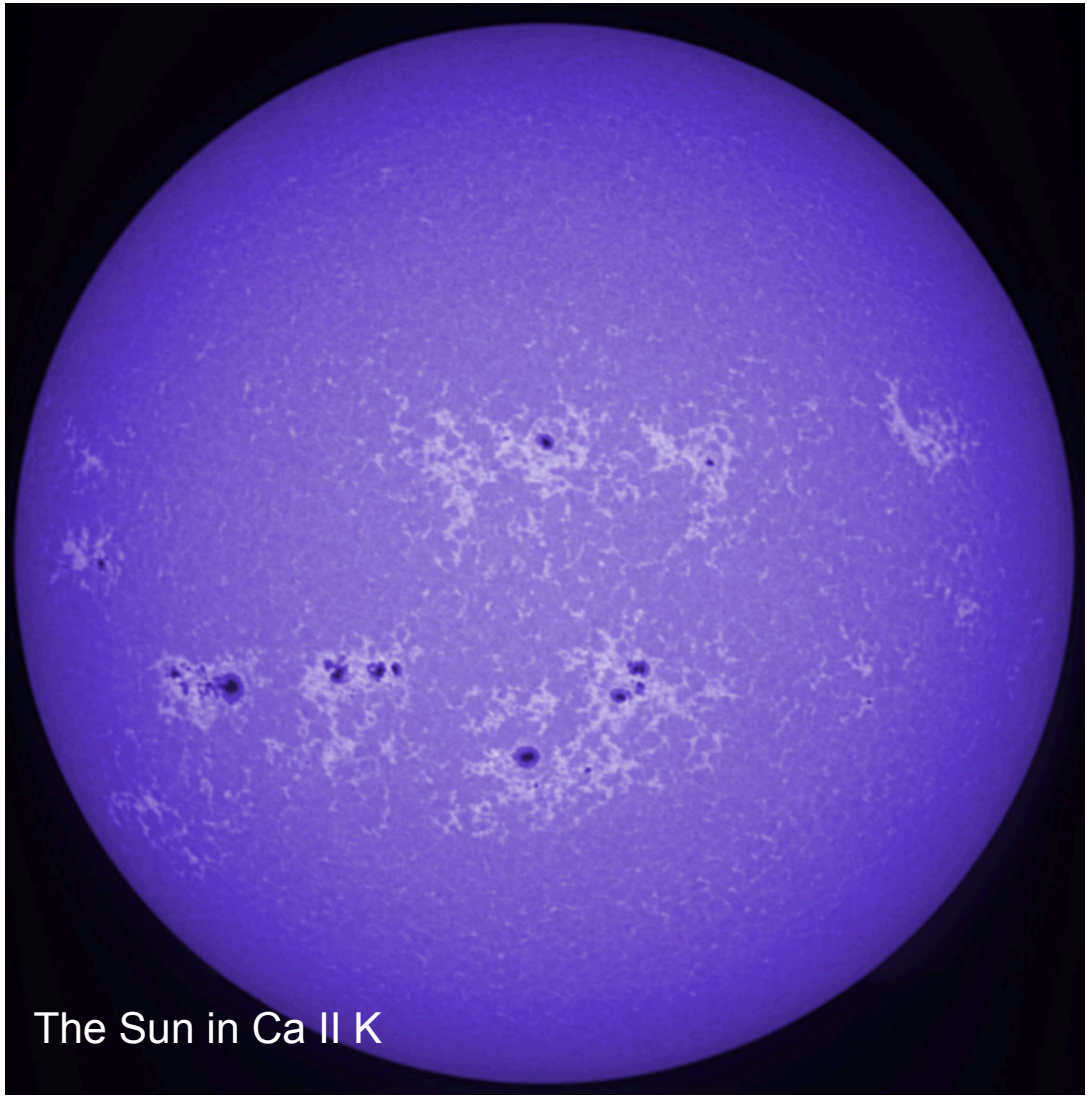
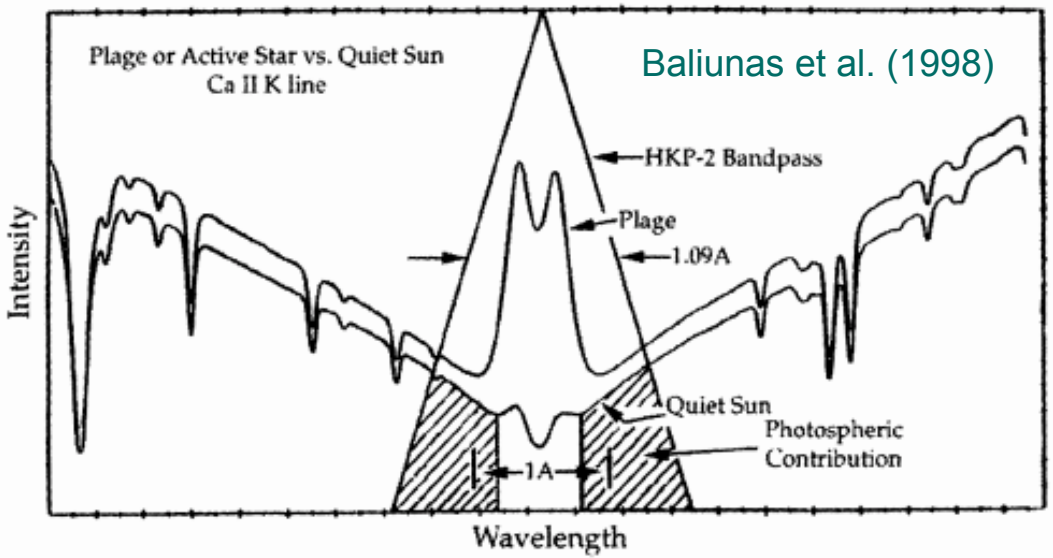
SOLAR MAGNETISM IN CA II H & K

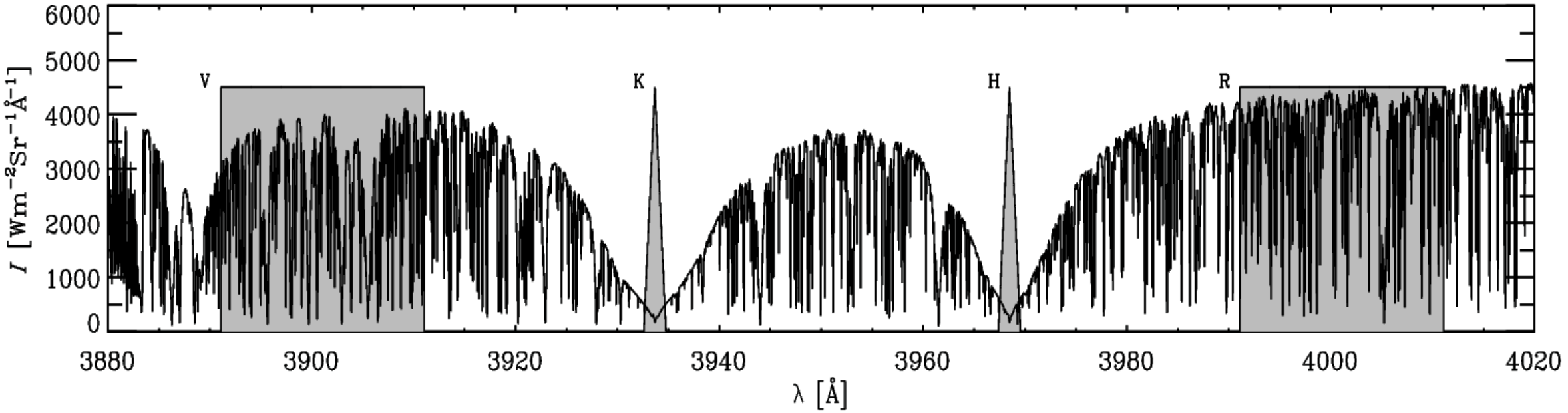


The emission in the near-UV Ca II H & K lines is modulated by magnetic activity



Source: An Introduction to Stellar Magnetic Activity by Gibor Basri

S-INDEX



$$S(t) = \alpha_c \frac{N_H(t) + N_K(t)}{N_R(t) + N_V(t)}$$

S-index is one of the main proxies for stellar magnetic activity

Vaughan et al. (1978)

Many aspects of the complex relation between stellar magnetism and *S*-index remain largely unexplored (e.g. dependence on the inclination, stellar metallicity)

OUTLINE

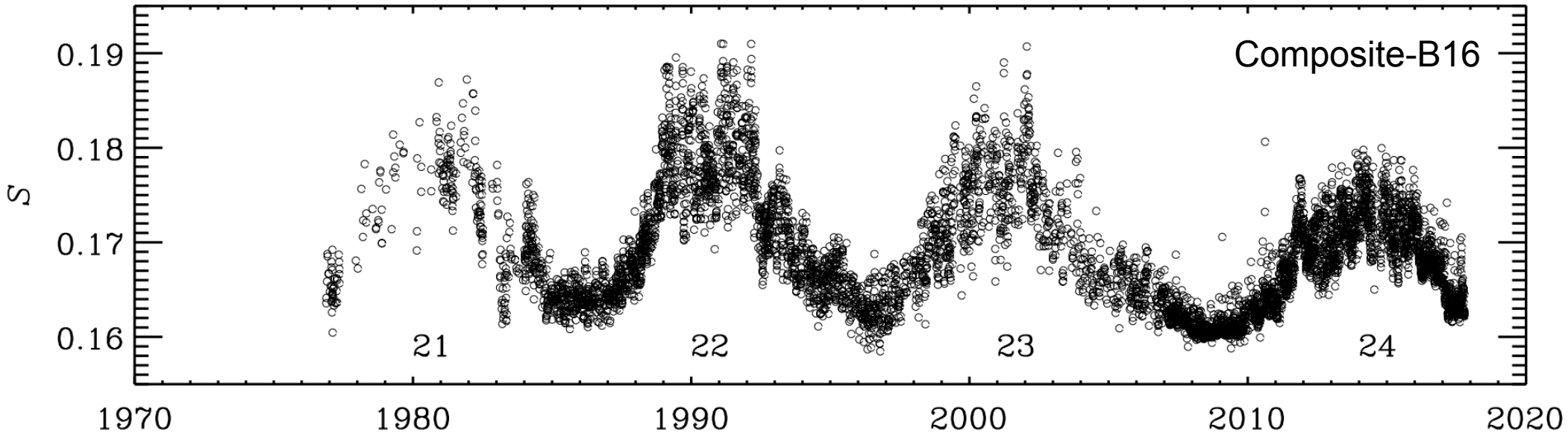
Model to compute *S*-index
(based on SATIRE* approach)

Reconstruction of the solar *S*-index variability

Effect of inclination on the *S*-index
(for solar-stellar comparison studies)

*Spectral And Total Irradiance REconstruction (Fligge et al. 2000, Krivova et al. 2003)

OBSERVED SOLAR *S*-INDEX VARIABILITY



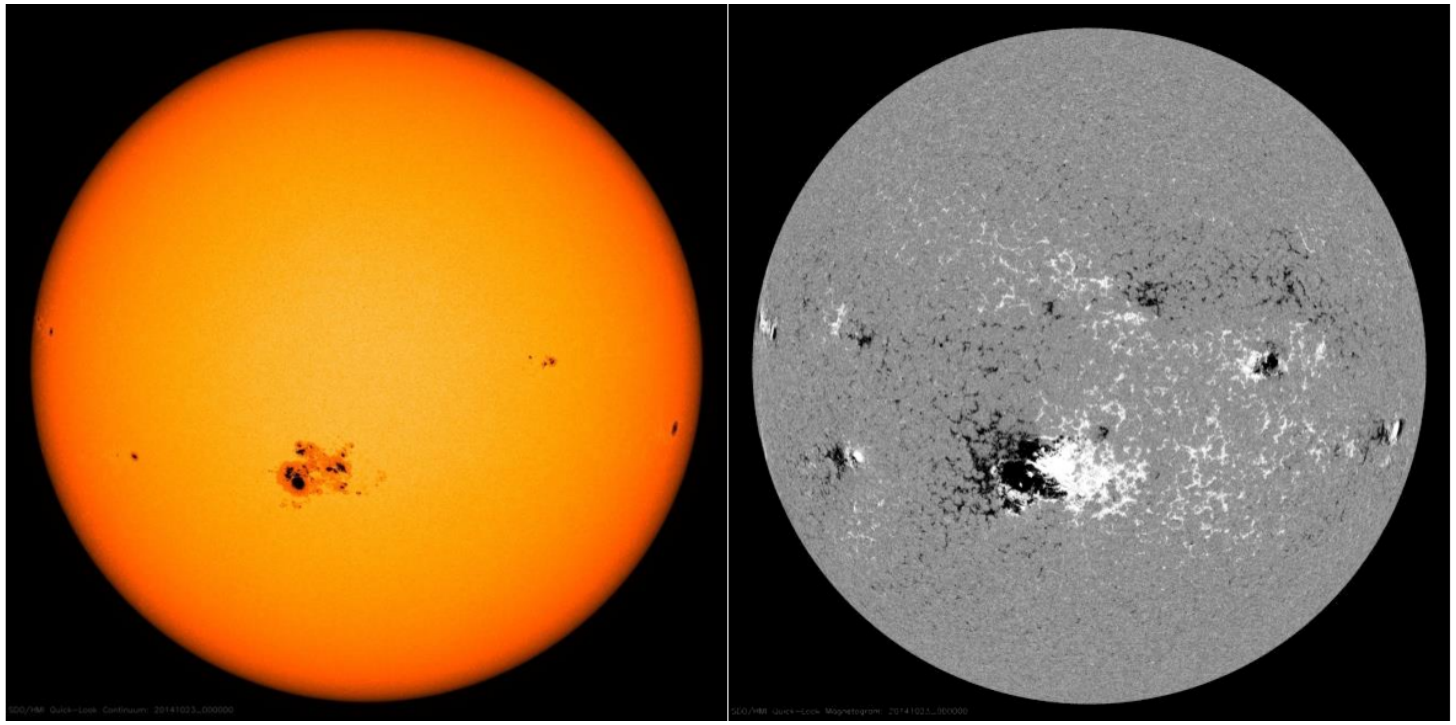
Bertello et al. (2016), Egeland et al. (2017)

For the reconstruction using SATIRE approach:

Area coverages of the magnetic features

Spectra of the quiet and magnetic features

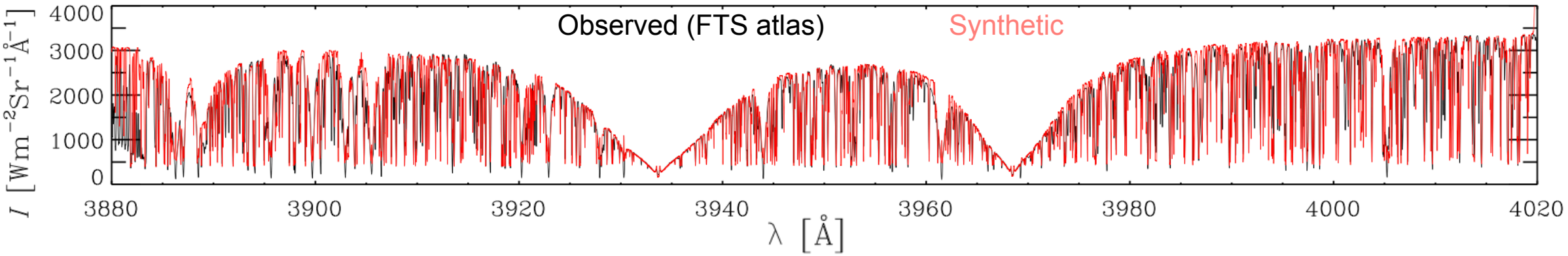
AREA COVERAGES OF MAGNETIC FEATURES



The disk area coverages of spots and faculae are computed from the observed intensity images and magnetograms (Yeo et al. 2014)

SPECTRAL SYNTHESIS

Disk averaged quiet Sun spectra

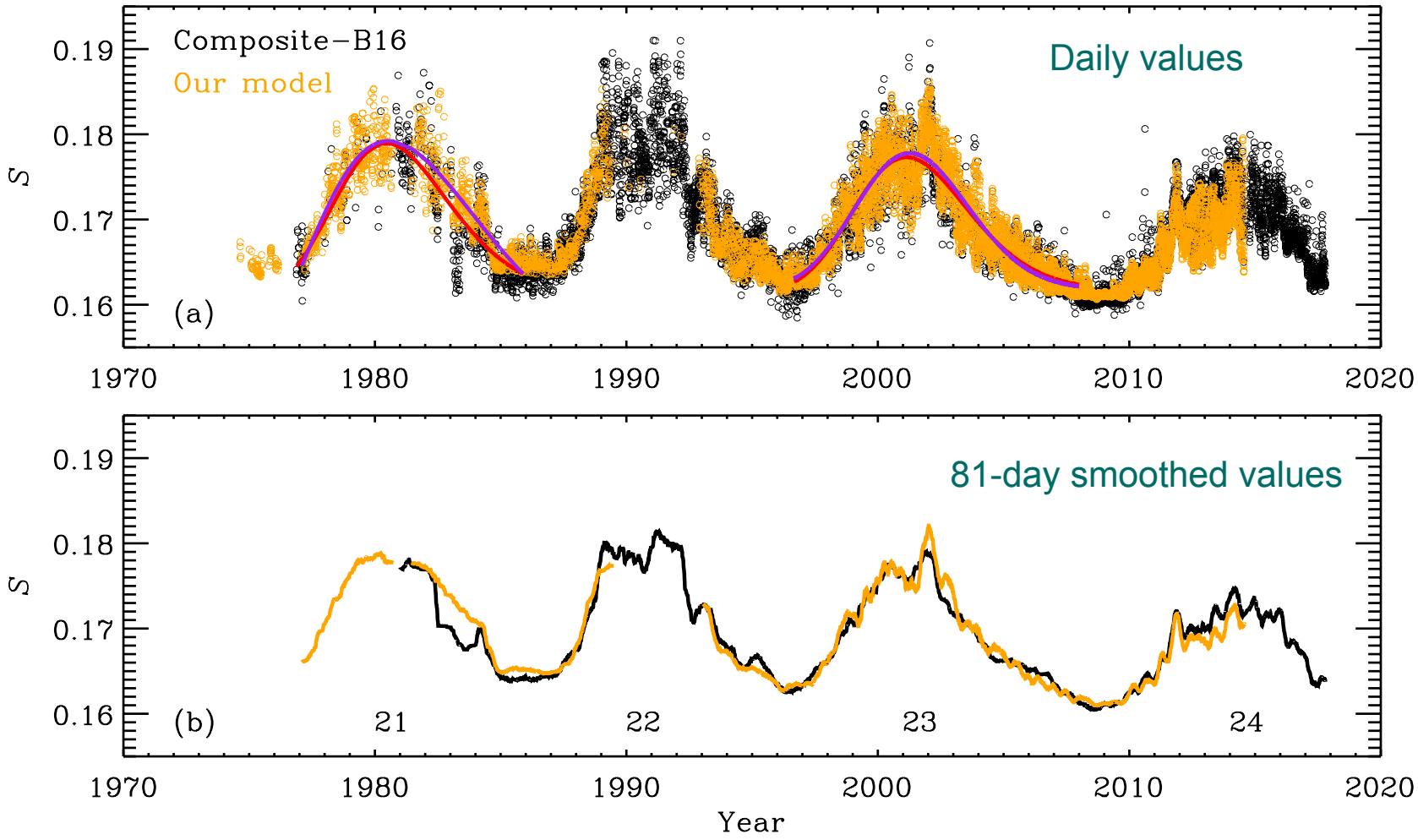


Radiative transfer code **RH**
(Uitenbroek 2001)

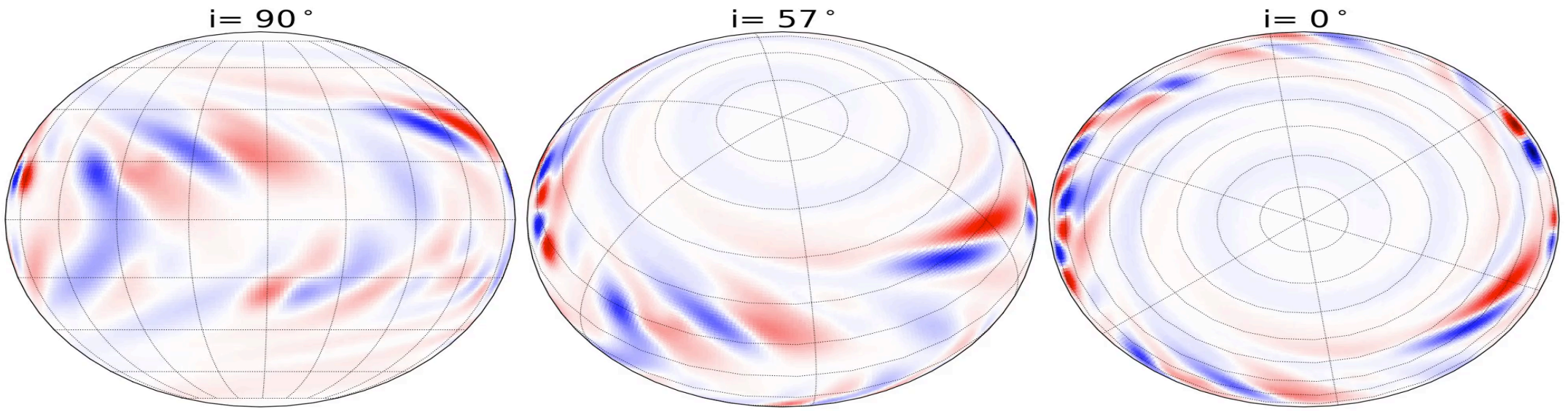
1D semi-empirical model atmospheres
(Fontenla et al. 1999)

Neglect the contribution from spots

SOLAR *S*-INDEX RECONSTRUCTION



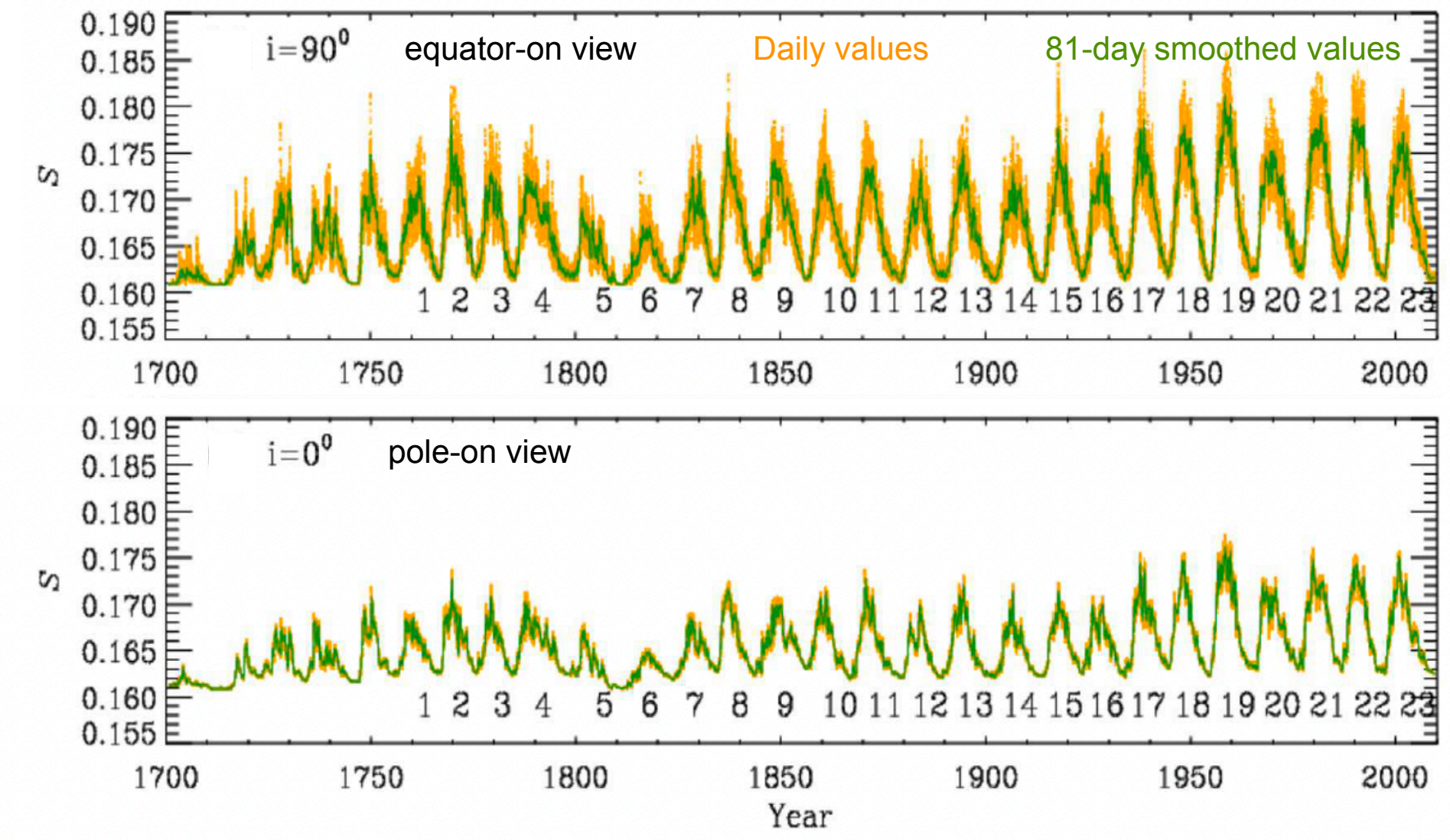
AREA COVERAGES AT DIFFERENT INCLINATIONS



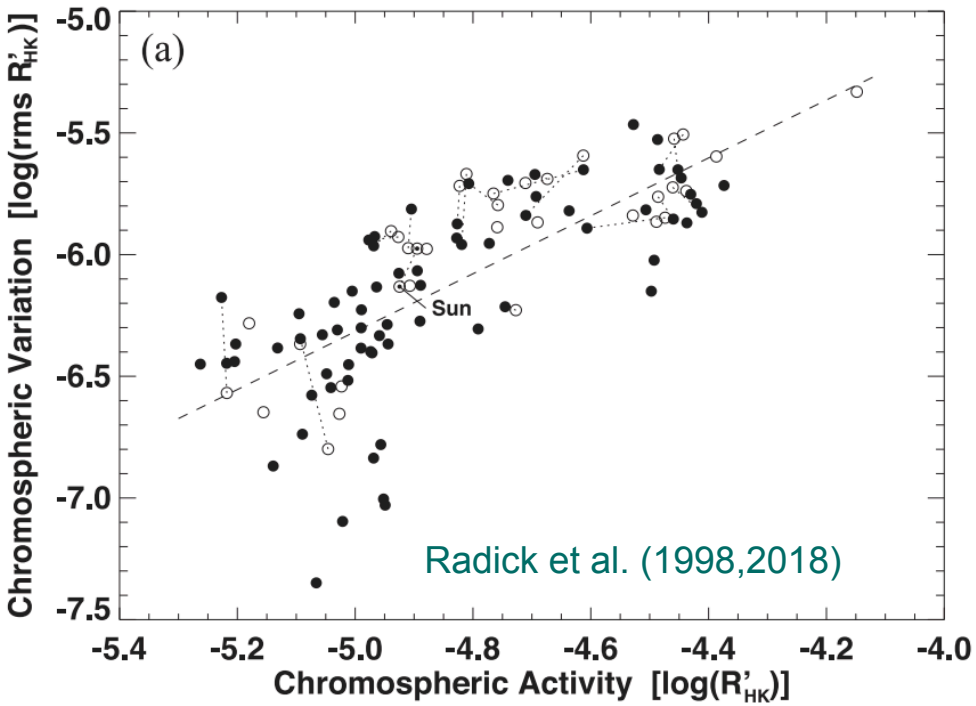
Courtesy of Nina Nèmec

Obtained using the magnetograms synthesised from surface flux transport model
(Cameron et al. 2010; Nèmec et al. 2020)

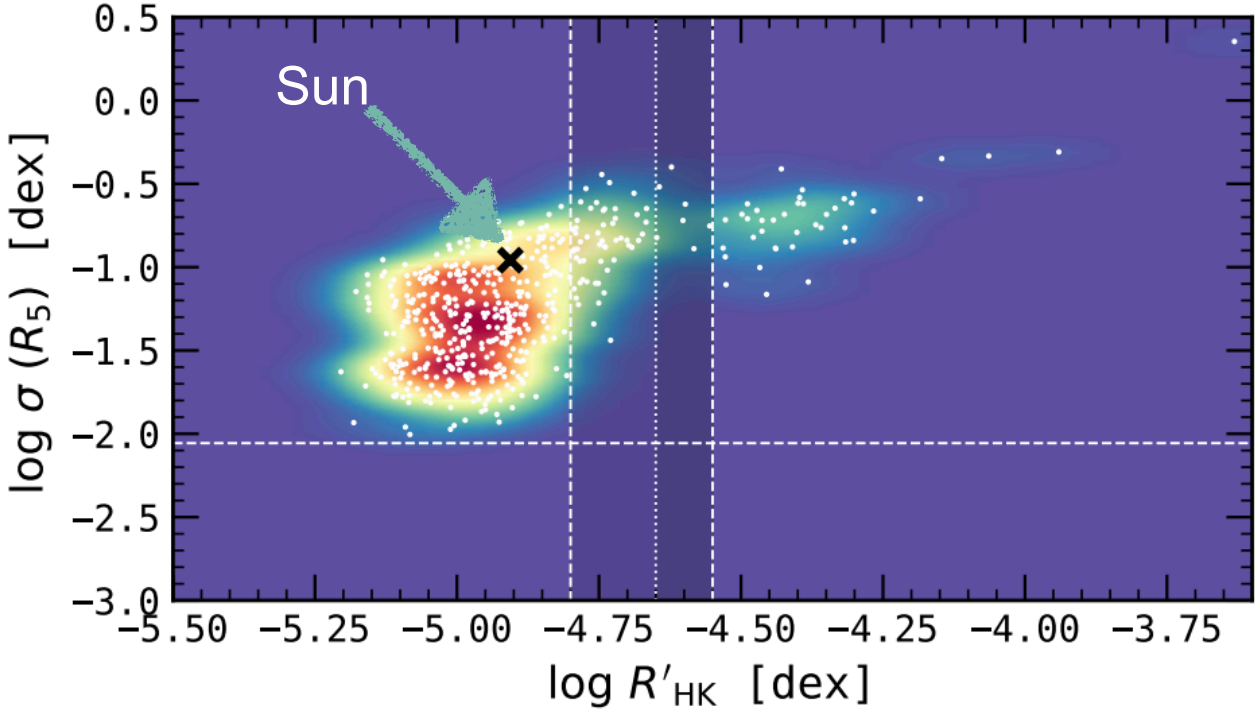
EFFECT OF INCLINATION



IS THE CA II VARIABILITY OF THE SUN TOO STRONG?



Radick et al. (1998,2018)



Gomes da Silva et al. (2021)

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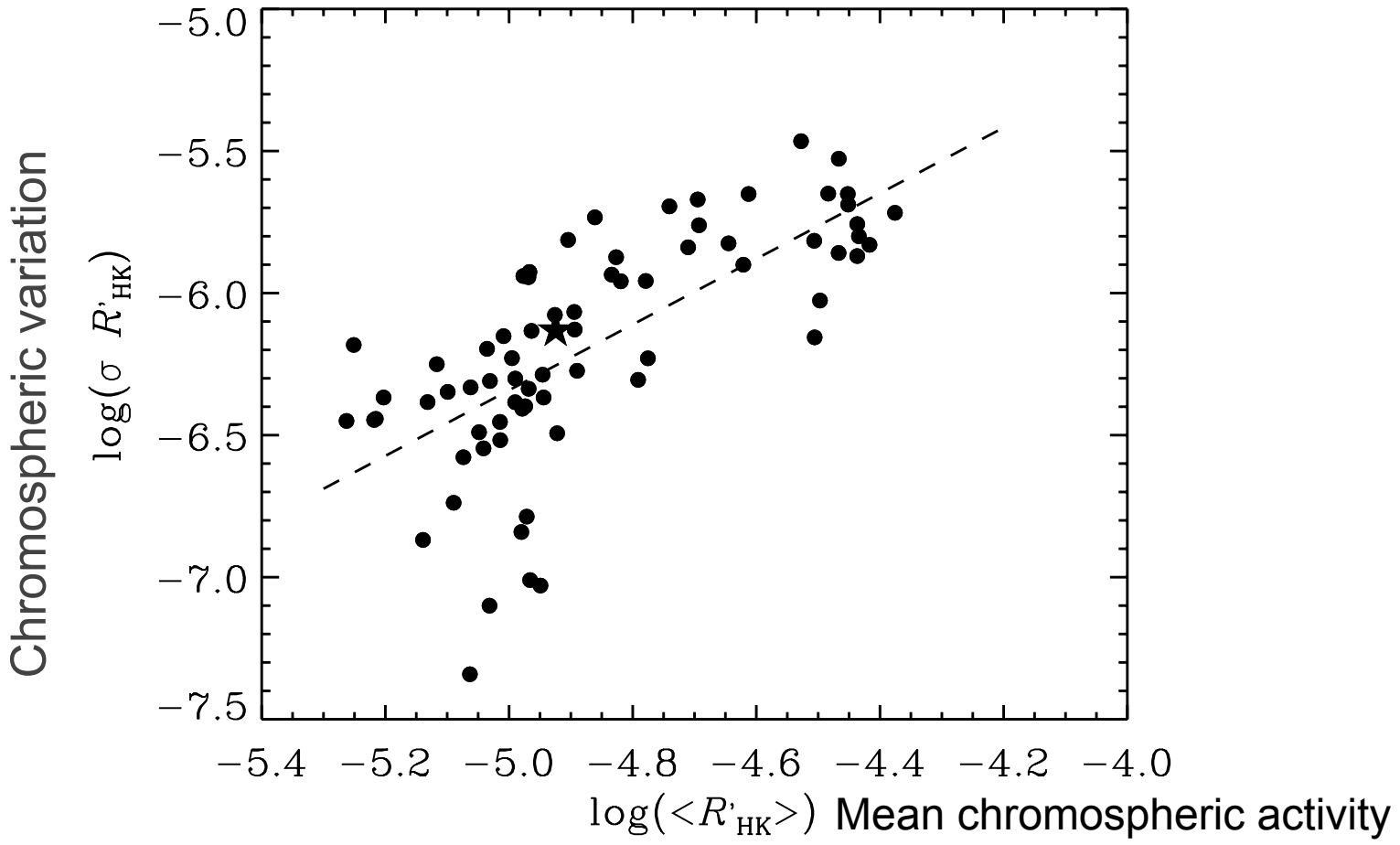

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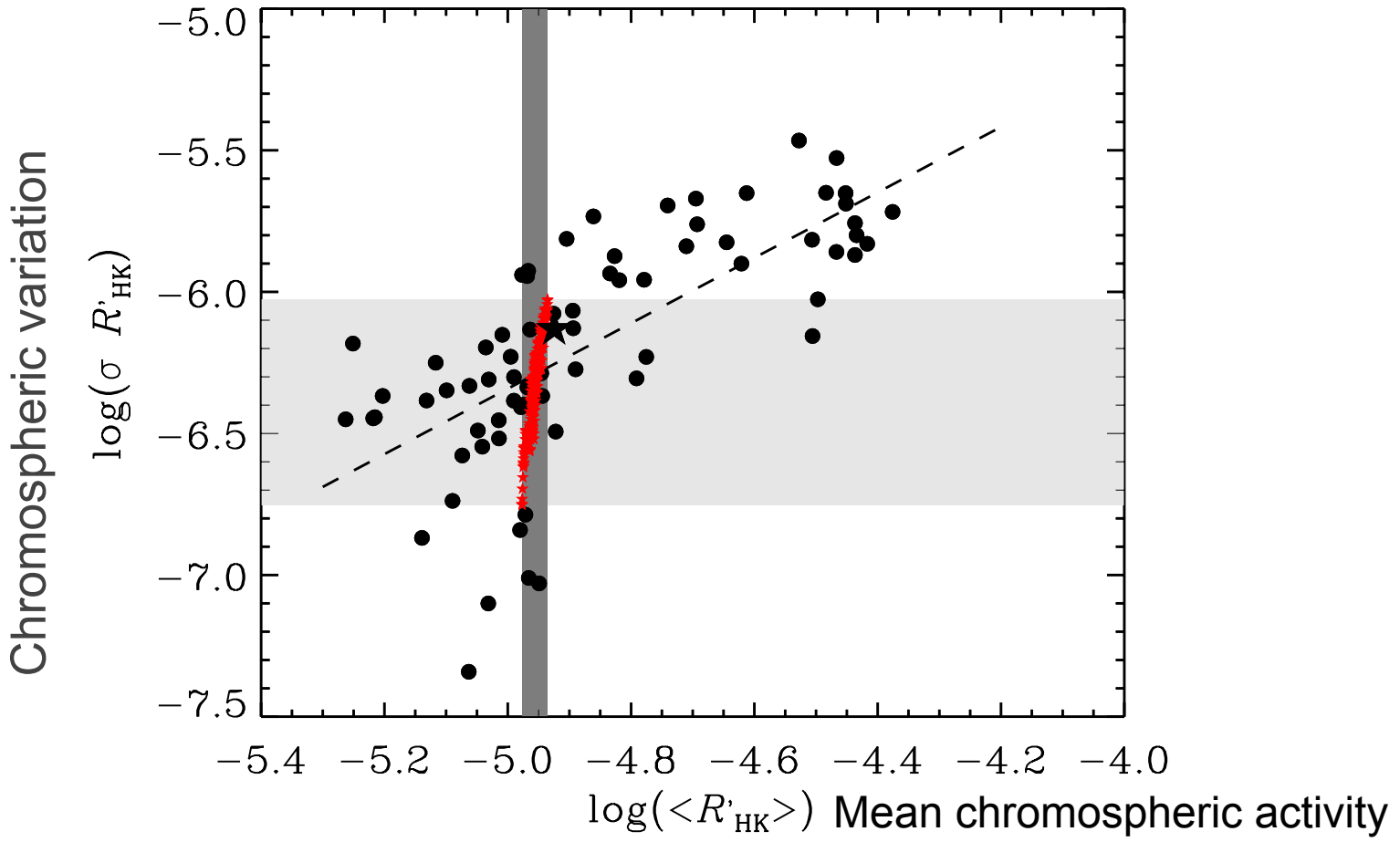

Solar Ca II H & K emission variation is absolutely normal in comparison to stars with near-solar magnetic activity

SUMMARY

- For a proper comparison of solar activity with those of other sun-like stars, it is crucial to quantitatively asses the dependence of Ca II H & K emissions on stellar inclination and stellar intrinsic properties.

- We developed a first physics-based model to reconstruct solar *S*-index variability and extended it to explore the dependence of *S*-index on inclination.

- With decreasing inclination the amplitude of *S*-index variations decrease.

- The solar Ca II H & K emission variations are normal in comparison to its peers.

THANK YOU FOR YOUR ATTENTION!

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