Solar Spectral Irradiance effects on tropospheric regional climate?

WACCM4 preliminary results, ENSO, and volcano issues

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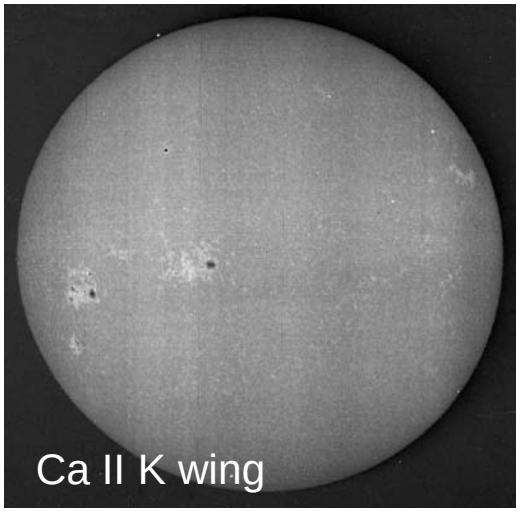
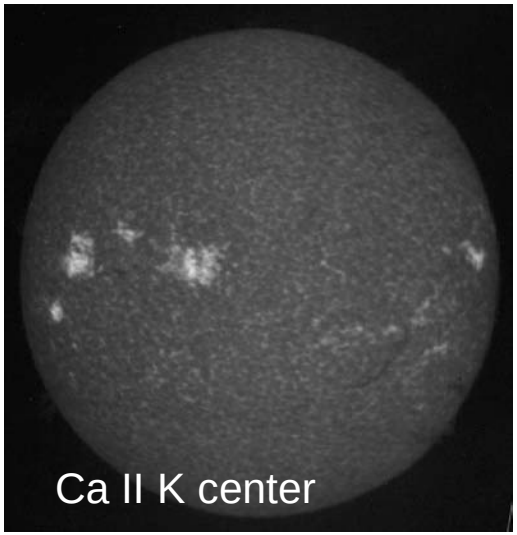
Boulder, 2013

Solar Images, Features

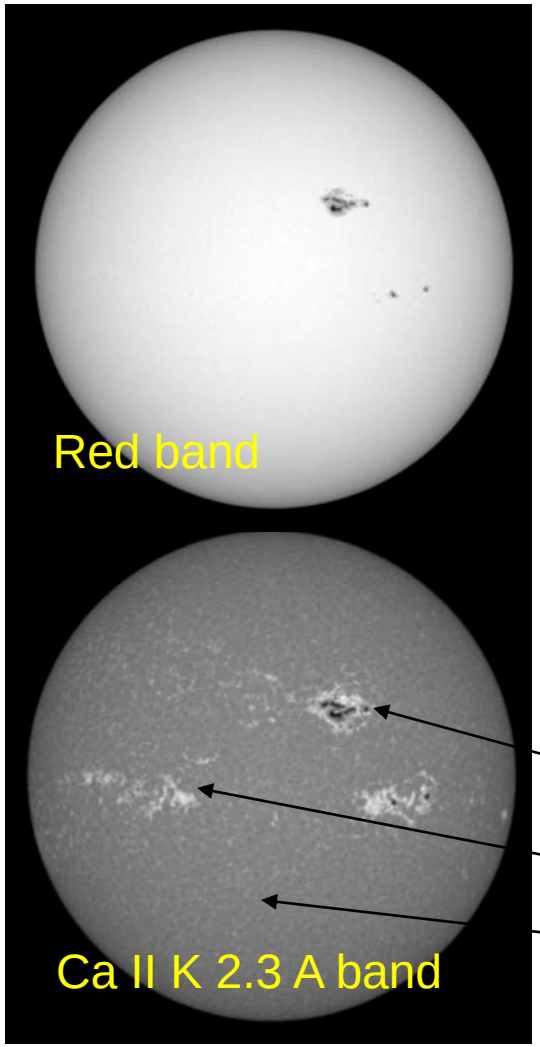
Coimbra (Pt), Meudon (Fr), Udaipur (In), etc.

Meudon 1909/7/20

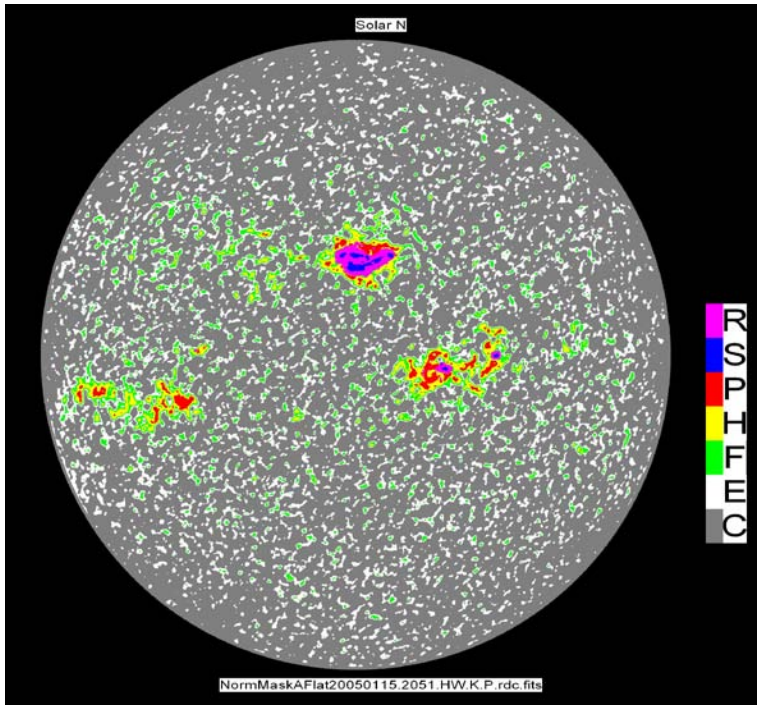




PSPT 2005/1/17



SRPM mask 2005/1/17



Sunspot group umbra+penumbra+plage

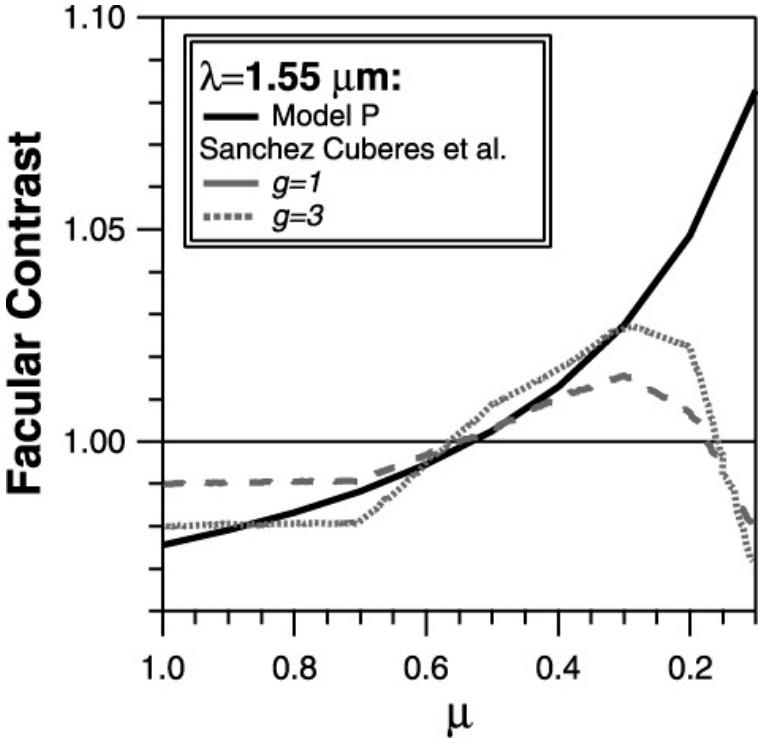
Spotless plage

Network in quiet-Sun

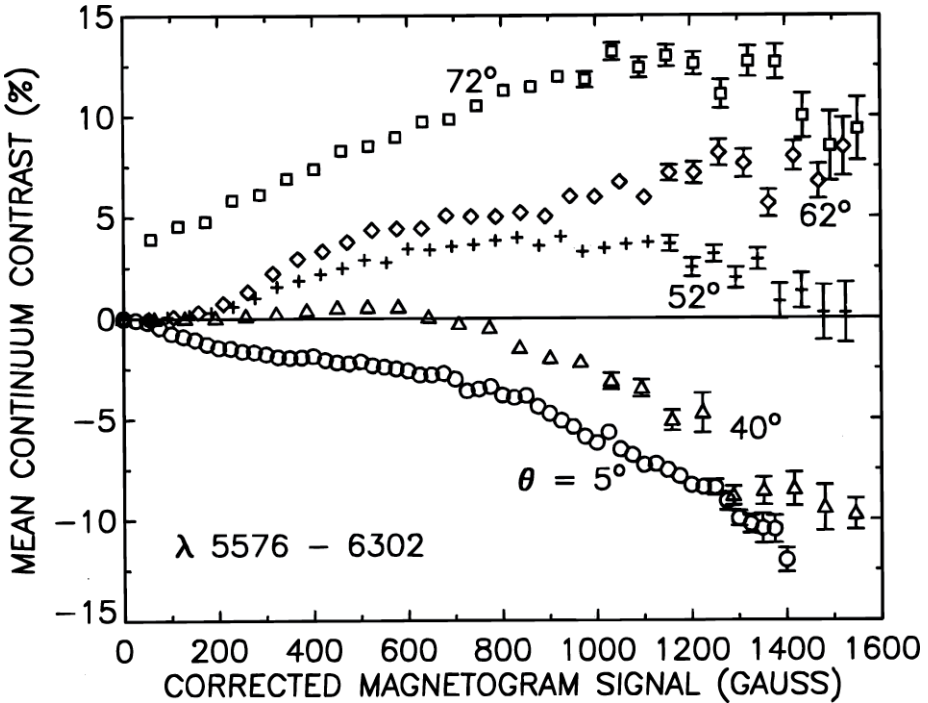
Features contrasts

Continuum and lines contrast varies with λ and viewing angle, μ=cos(θ).
Because of the slope of T(p) and geometric effects.
Non-LTE effects are very important in the many deep absorption lines of the visible, IR, and UV.

Sanchez Cuberes et al. 2002, The Astrophysical Journal, 570:886–899

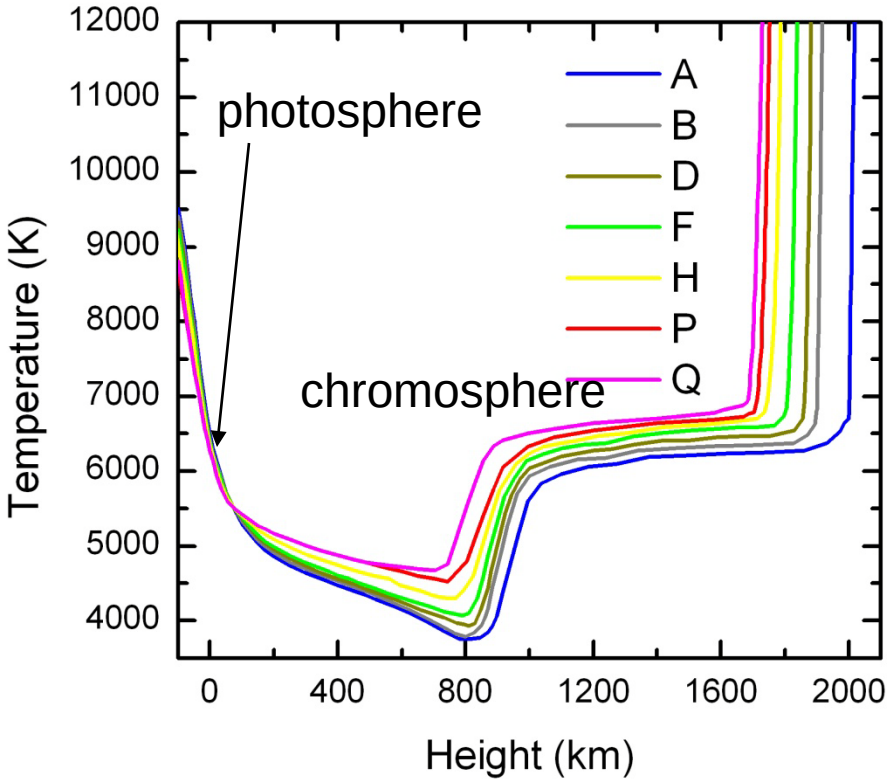


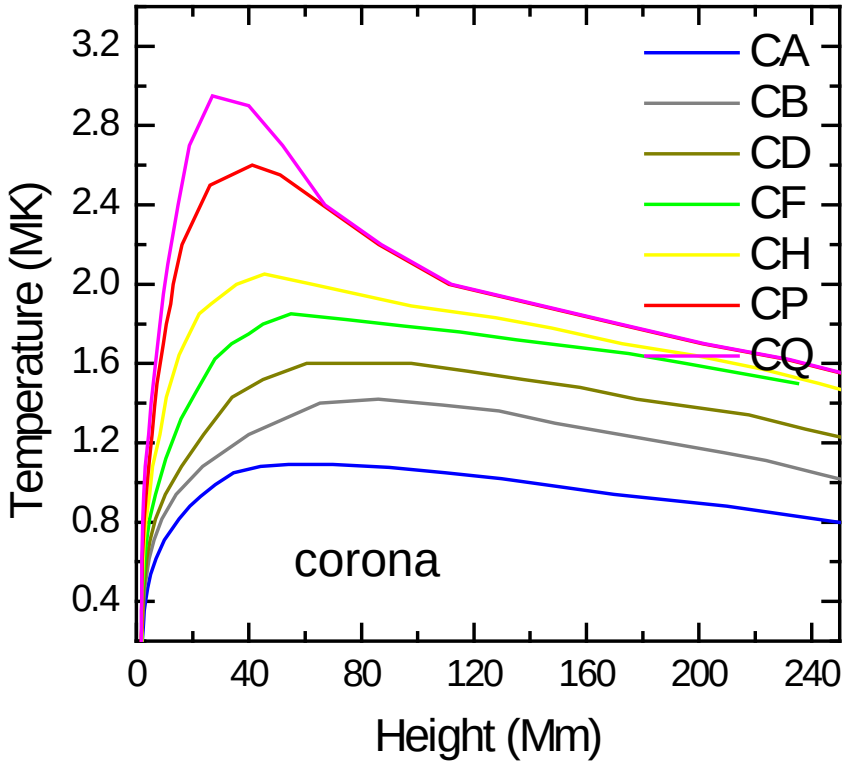
Topka et al. 1997, The Astrophysical Journal, 484:479-486



Solar Radiation Physical Modeling

(SRPM) *Fontenla et al. 2011, JGR, 116, D20108*





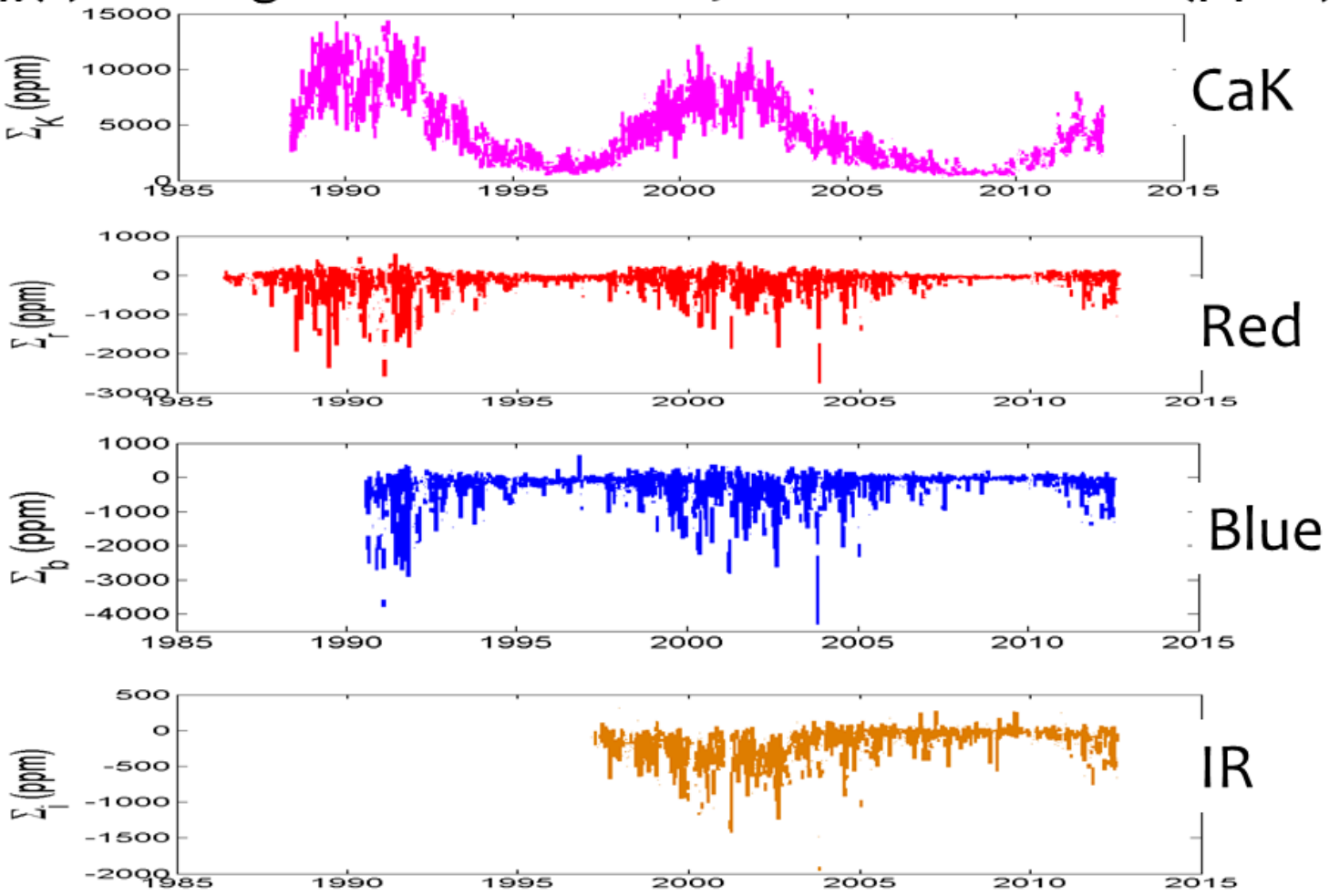
Contributions to quiet-Sun TSI (1360 W m^{-2}, Δ~+1 W m^{-2}):

- Photosphere: ~1350 W m^{-2} (Δ~-1 W m-2)
- Chromosphere: ~10 W m^{-2} (Δ~+2 W m^{-2})
- Corona+Transition-region: ~70 mW m^{-2} (Δ~+100 mW m^{-2})

Solar Spectral Irradiance ground observations

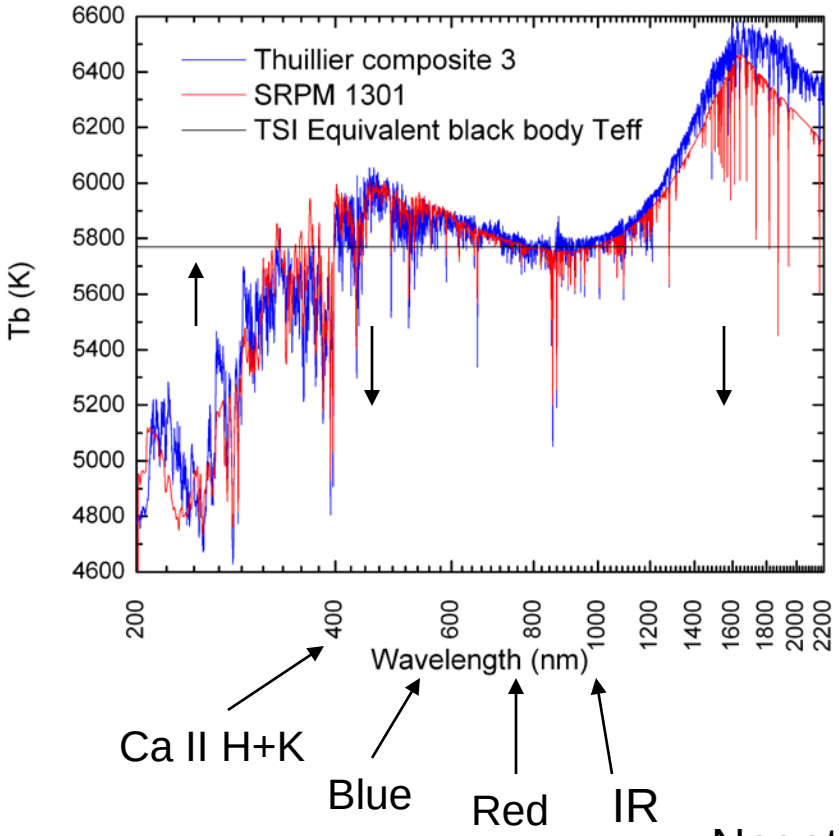
Preminger, Chapman and Cookson, San Fernando Observatory

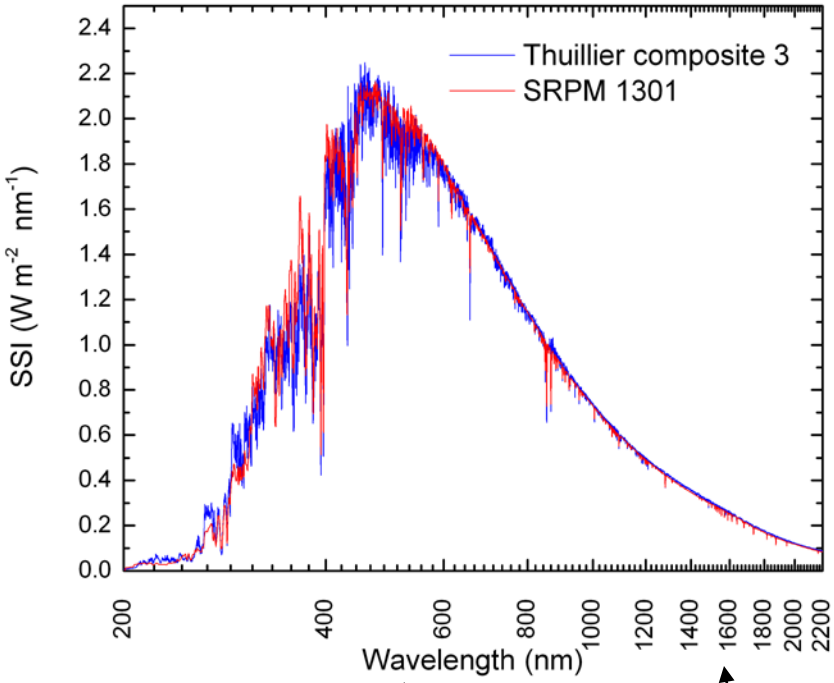
$\Sigma_\lambda(t)$: change in disk intensity due to features (ppm)



SORCE/SIM and TSI fill the spectral gaps

Harder et al. 2009





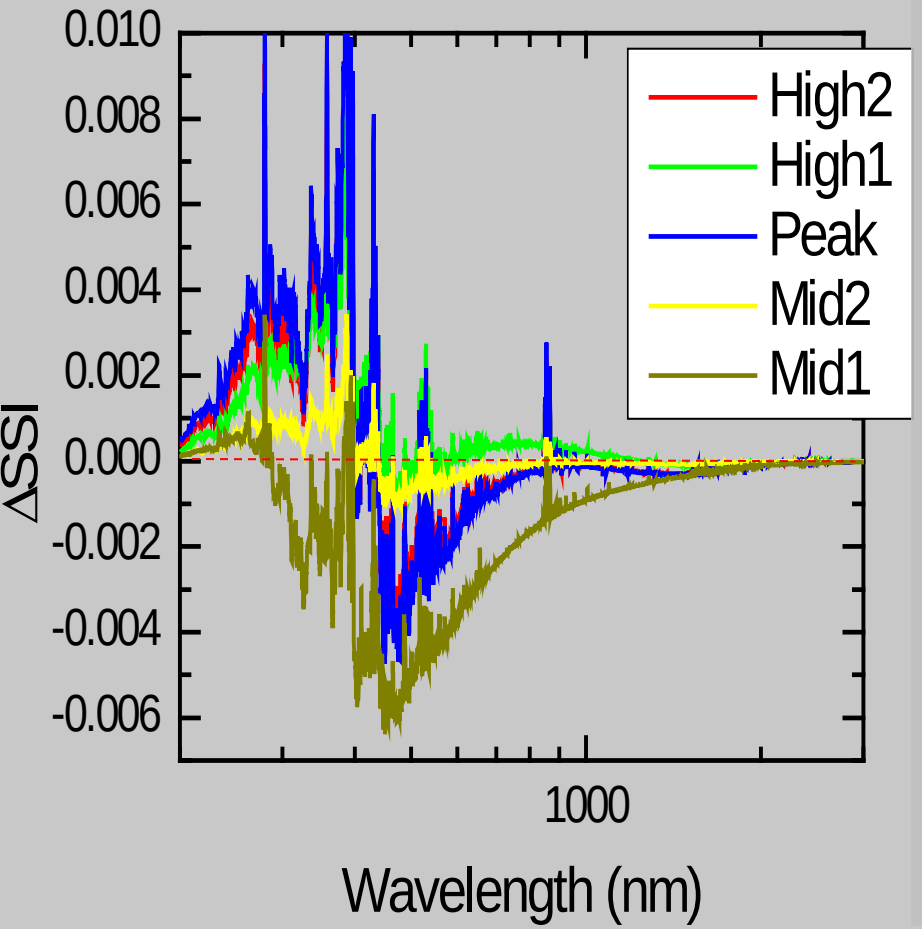
Sanchez Cuberes et al, Moran et al, etc

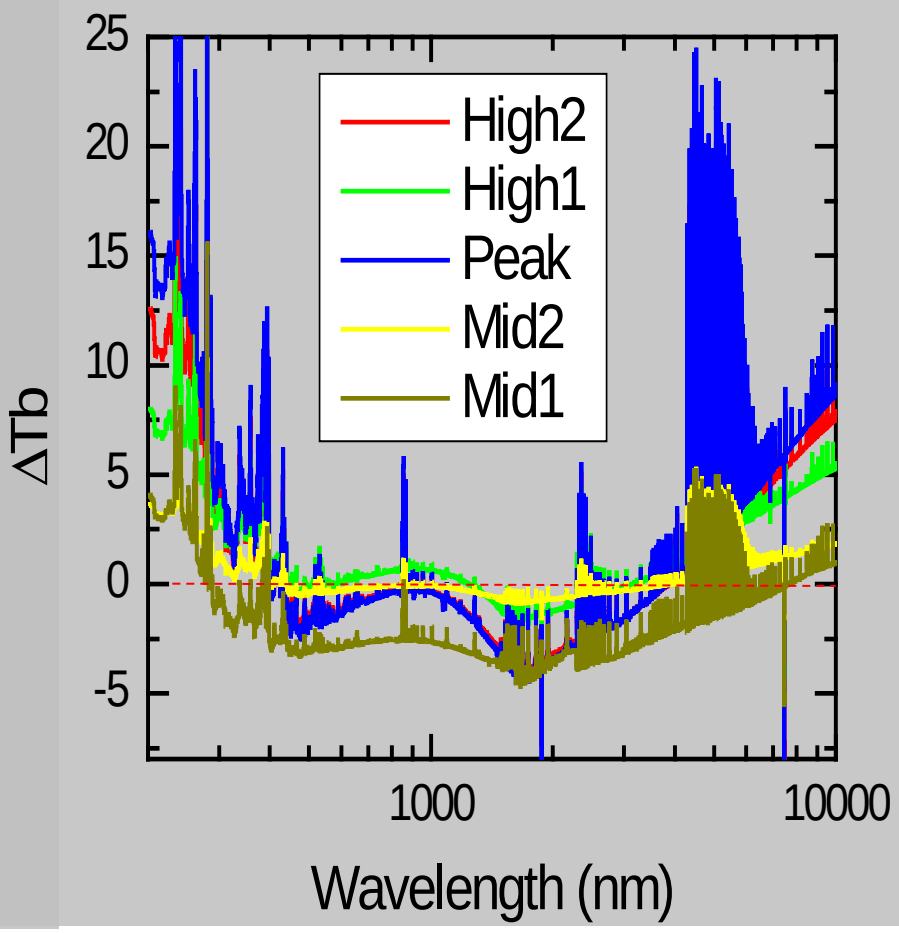
Topka et al, etc

Negative observed contrast

SOCE/SIM observed negative solar cycle trend over most range where Tb > Teff.

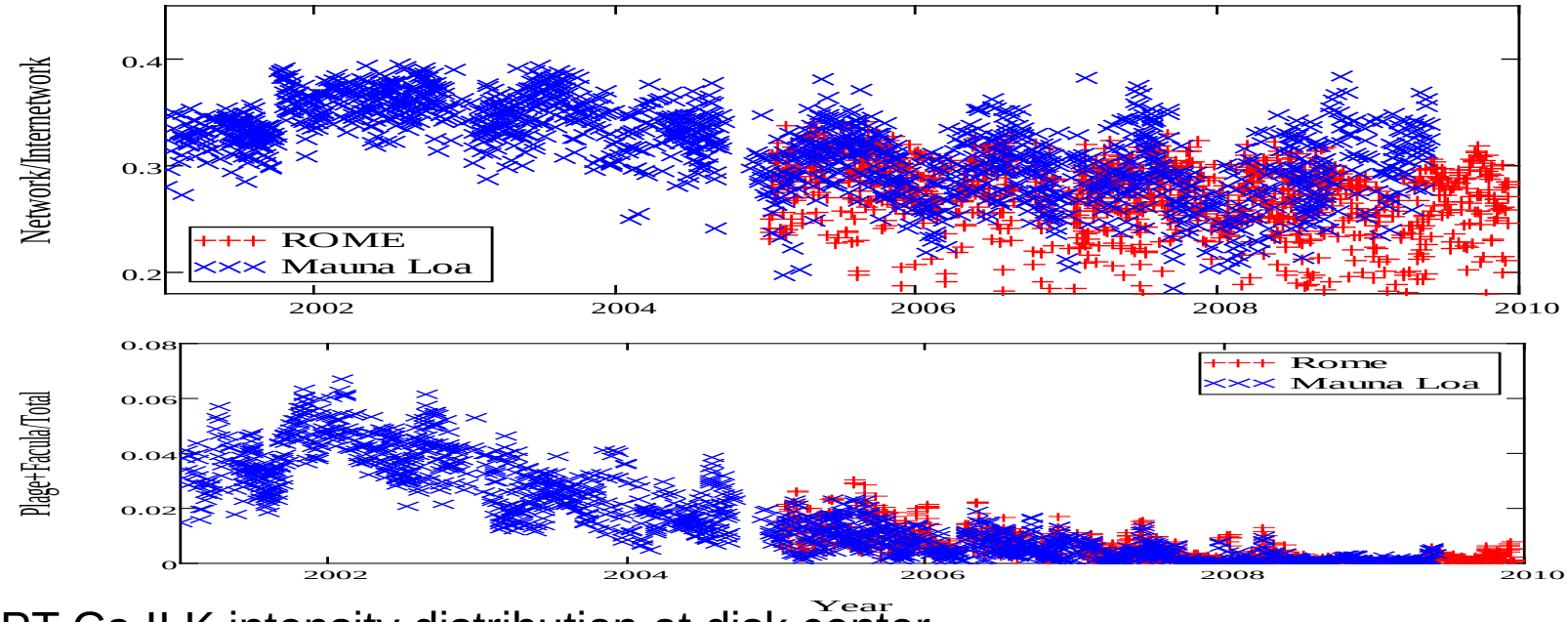
SSI Variation Detail



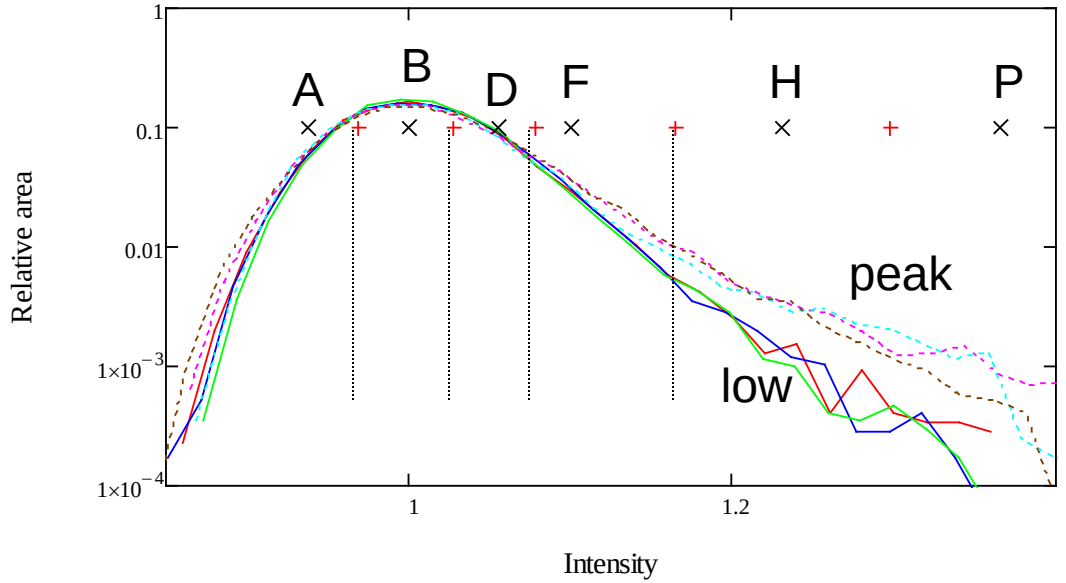


The spectral variation is complex but in general the visible is negative and the near UV (shorter than ~ 400 nm) is positive with high activity. Part of the spectral variations cancel in the total because of their opposite sign.

SRPM matching of TSI by network changes



PSPT Ca II K intensity distribution at disk center



Available ground images lack reliable absolute calibration. Day to day matching is done either by median (nocorr) or by TSI (corr).

TSI before -1.6 % scale

A	1101	1374.60
B	1001	1382.19
D	1002	1388.15
F	1003	1391.44
H	1004	1400.86
P	1005	1419.14
S	1006	265.97
R	1007	1103.82
Q	1008	1428.82

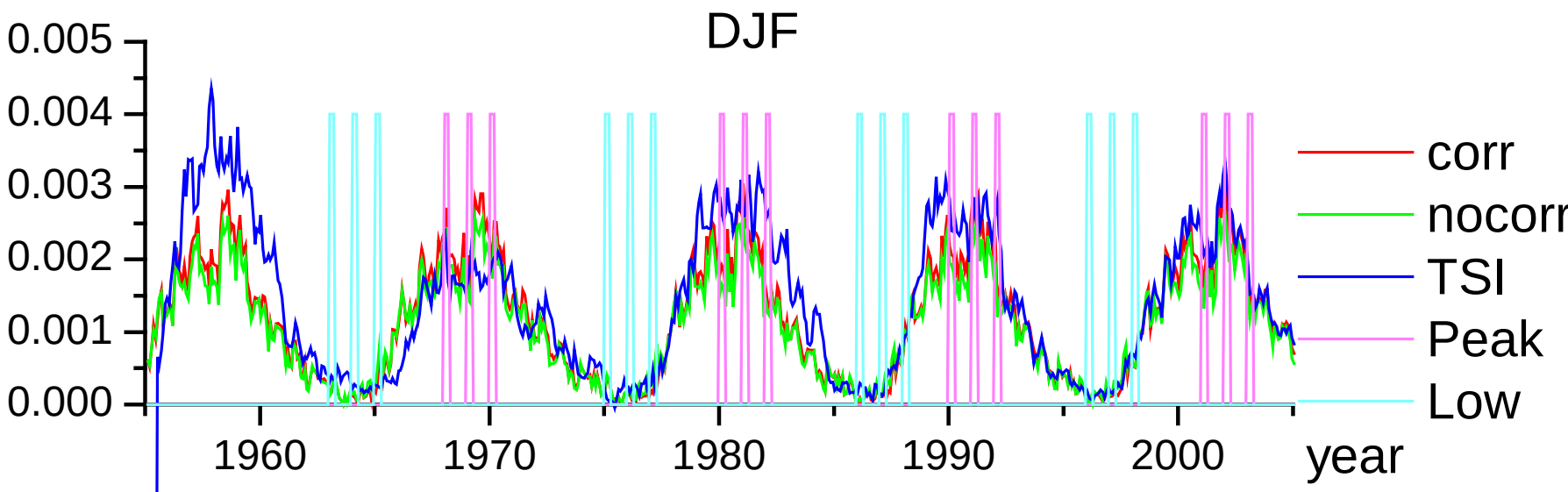
SRPM SSI for current WACCM4 runs

- "**const**" The SSI and TSI are assumed constant with time at the solar cycle min level. (Control case.)

- "**nocorr**" Variations are calculated by SRPM from SC23 images with the median method. TSI is only well matched for rotational modulation, but does not show the solar cycle increase. (Low < ~300 nm.)

- "**corr**" Variations are calculated by SRPM from SC23 images with the TSI matching method. TSI is perfectly well matched at all times. (High < ~300 nm.)

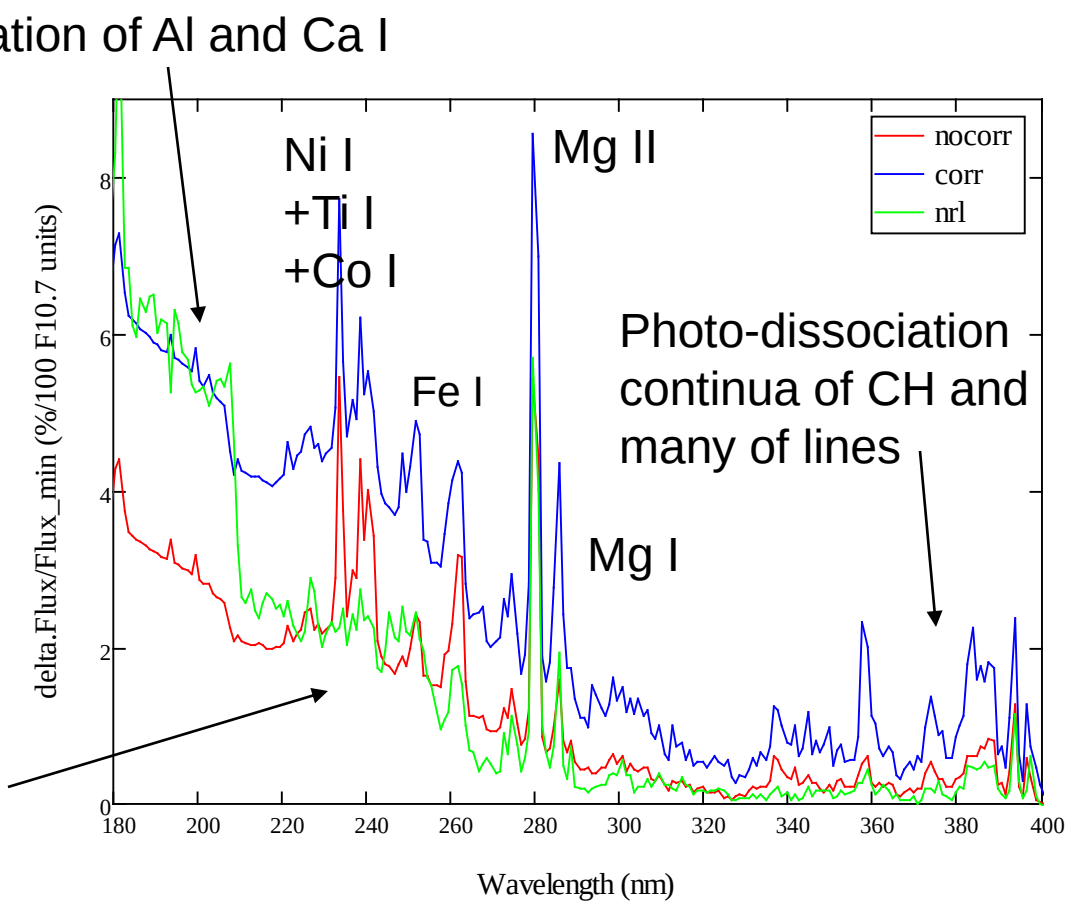
Fully interactive ocean and ice but forced QBO.
Studied data 4*3 years average near SC peak – similar near min.



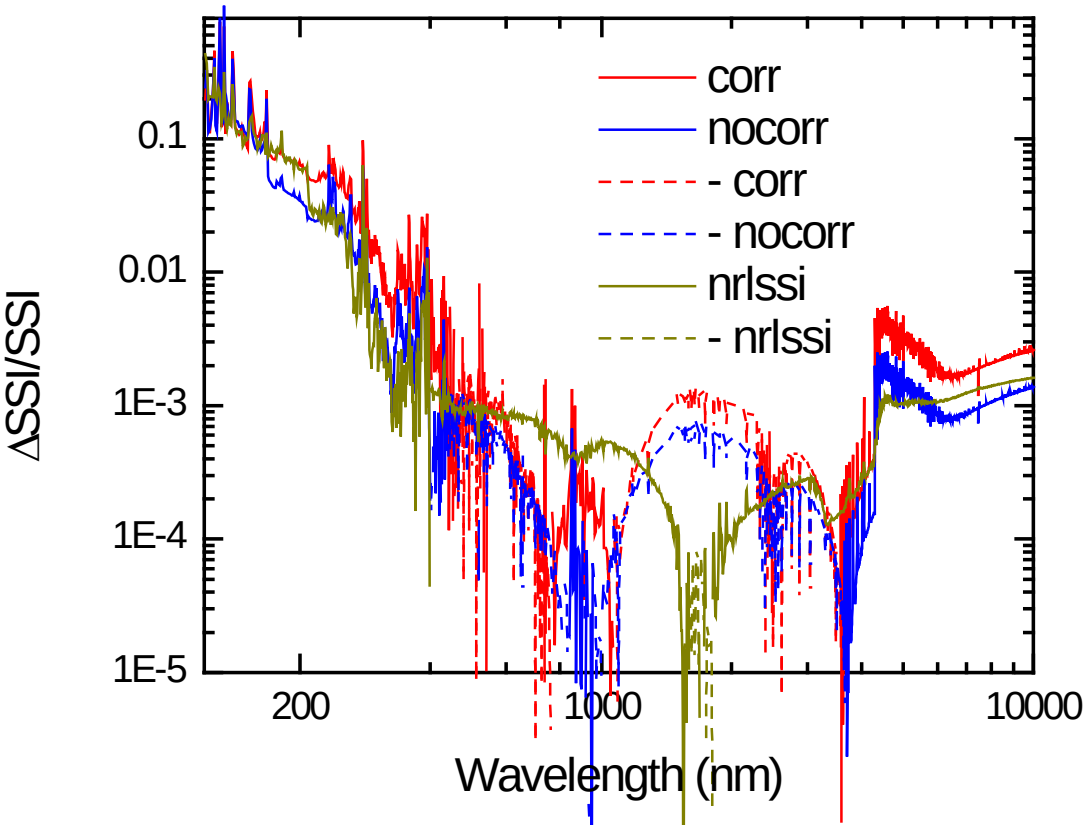
NUV effects on O3

Calculations were carried out by Merkel et al (see GRL38, L13802 2011), using SORCE data extrapolated in time. These were done with WACCM3 in static SSI runs. Other authors also made simplified calculations showing important differences.

Variability Spectrum from various models

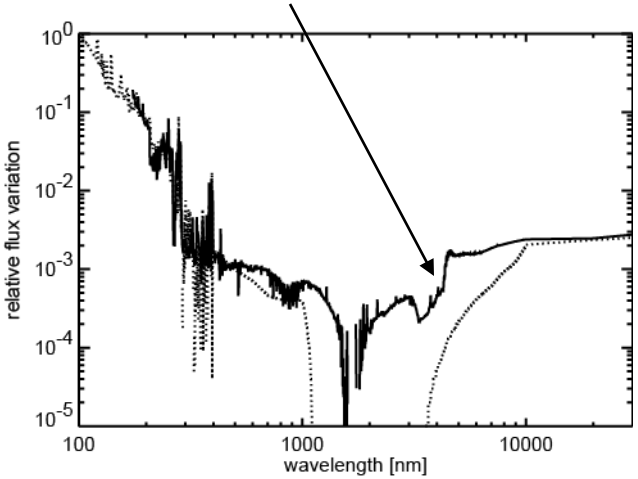


SSI comparison between models



Relative changes between Solar Cycle 23 peak/min that I am using for WACCM4 simulation runs.
Nocorr – Fontenla et al 2011, SRPM + PSPT images
Corr - same as above with a correction to match TSI
NRLSSI – WACCM4 default.
"Lean_1610-2140_ann_c100405"

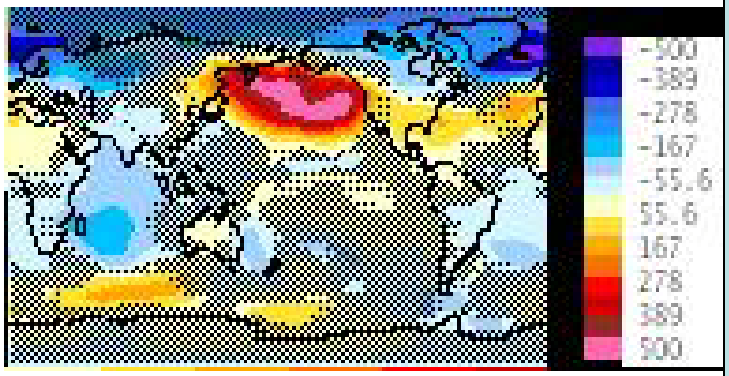
Solanki & Unruh 1998, Astron. Astrophys. 329, 747-753

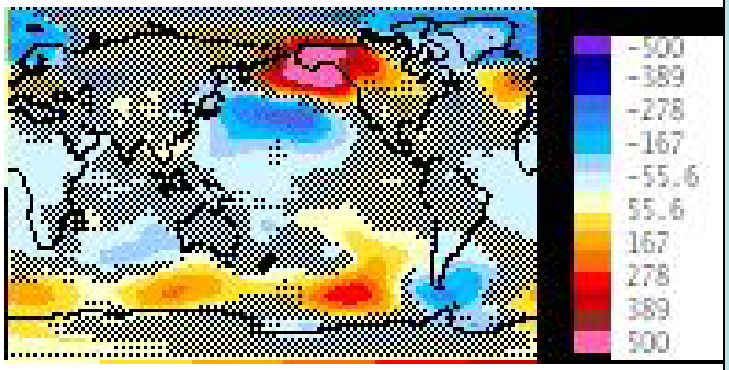


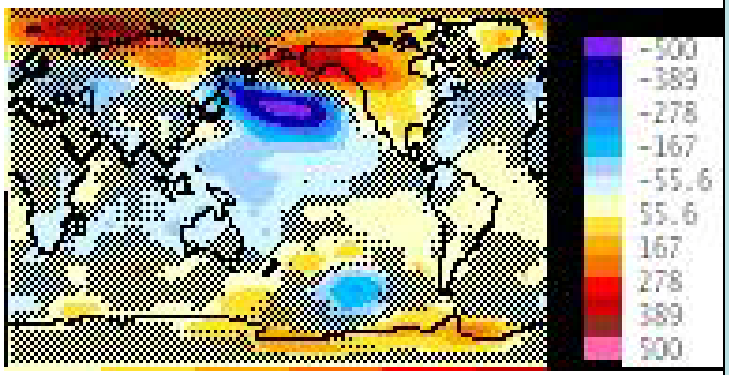
According to this paper: « The dotted curve shows the observed relative irradiance variation for λ < 400 nm between solar activity minimum and maximum vs. wavelength, compiled by Lean et al. (1997) and extrapolated to longer wavelengths by Lean (1991). »

Preliminary “nocorr” results, PS DJF anomaly (Pa)

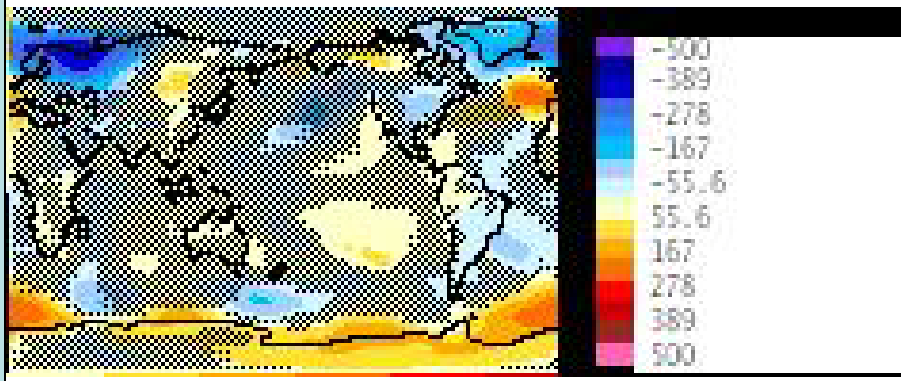
Instances



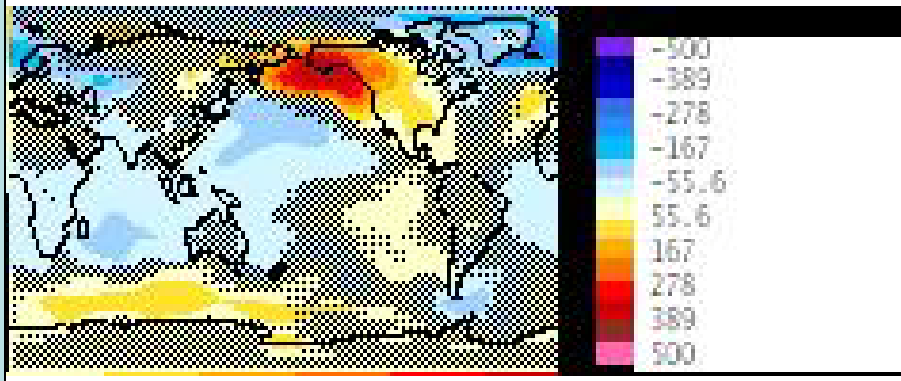




const control (single) case so far

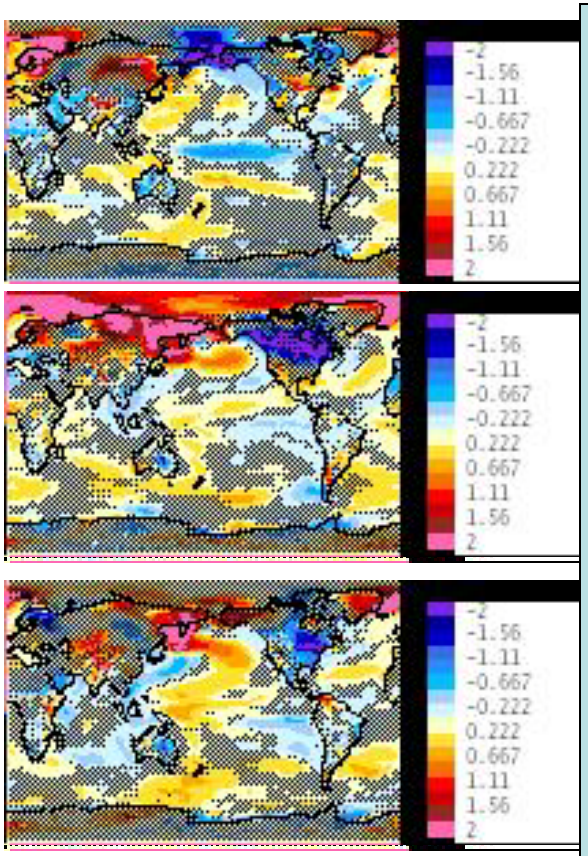


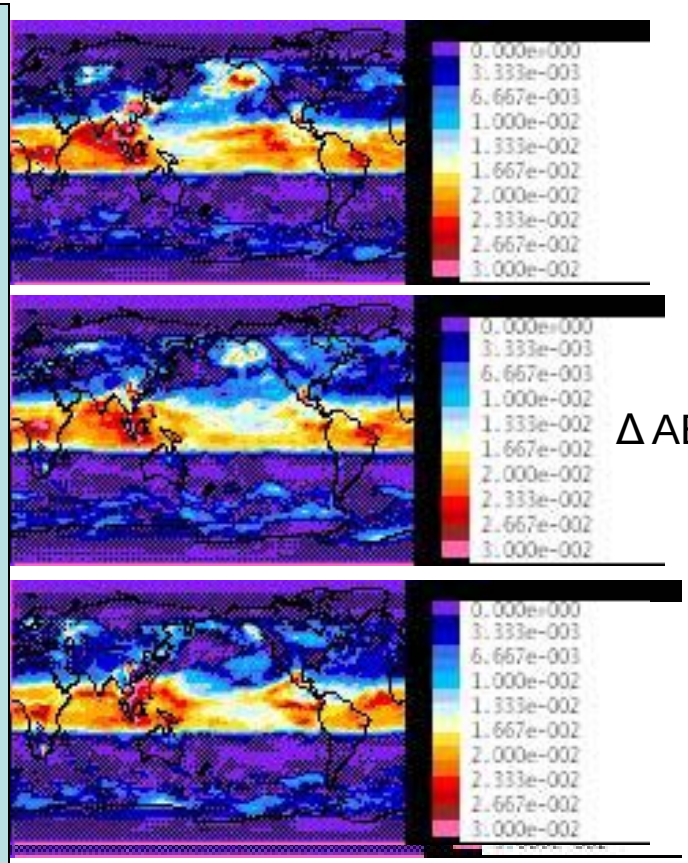
Average of 3 **nocorr** instances



ENSO 3.4 temperature Δ and volcanoes

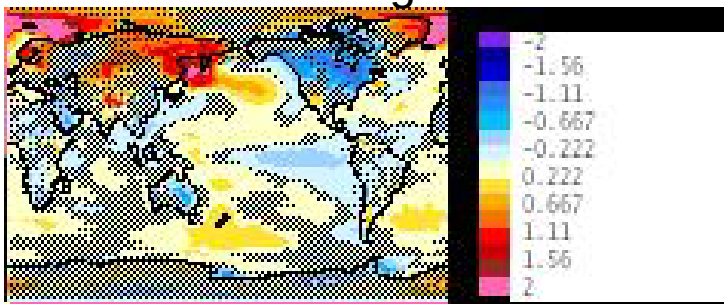
ΔTS



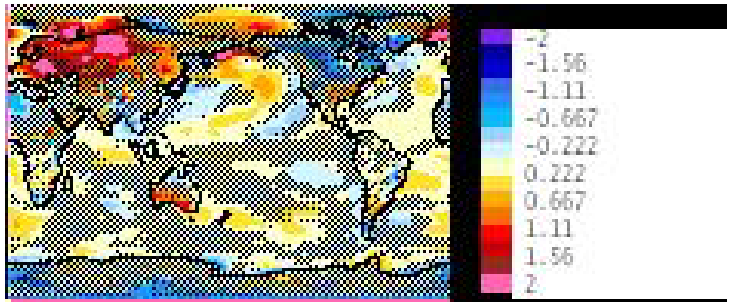


Δ AEROD_v

nocorr Average ΔTS

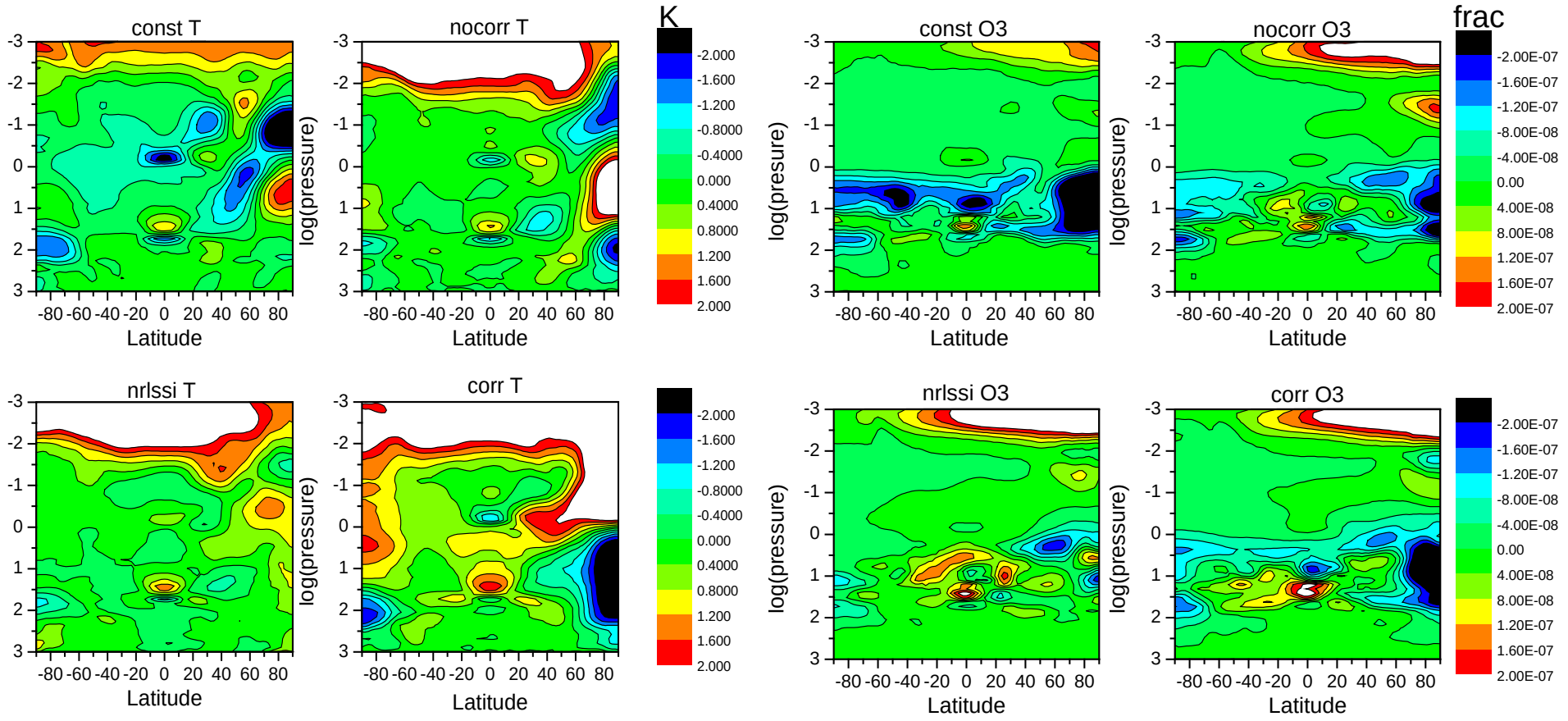


const Δ TS



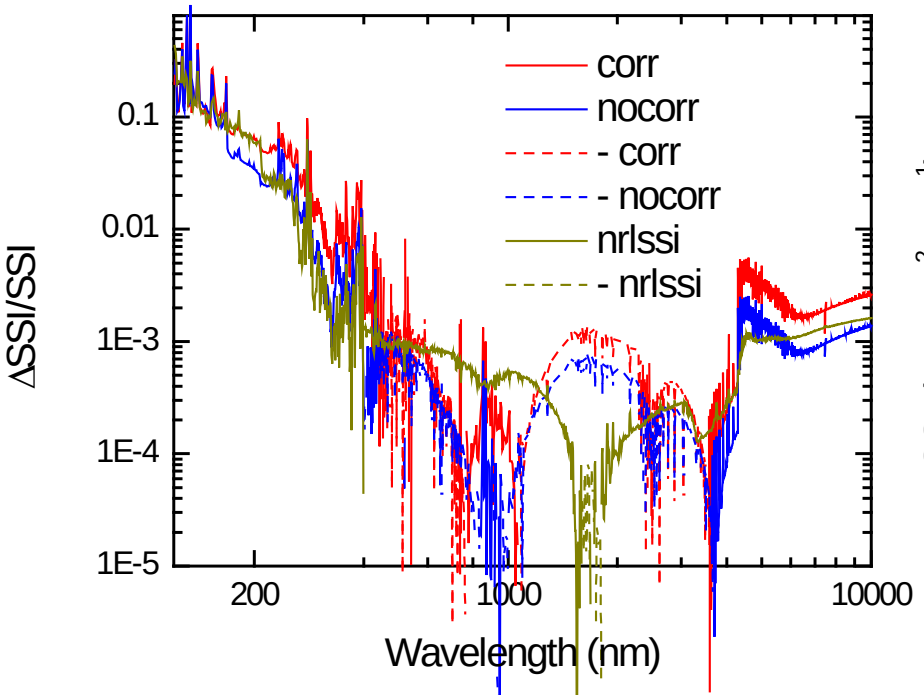
DJF zonal means

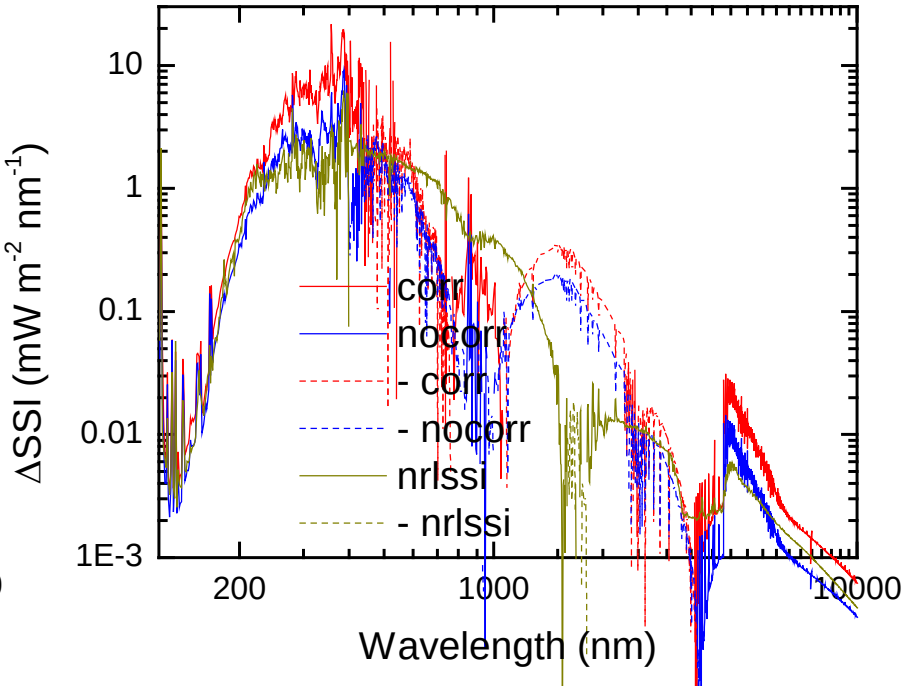
Single instance peak-min differences



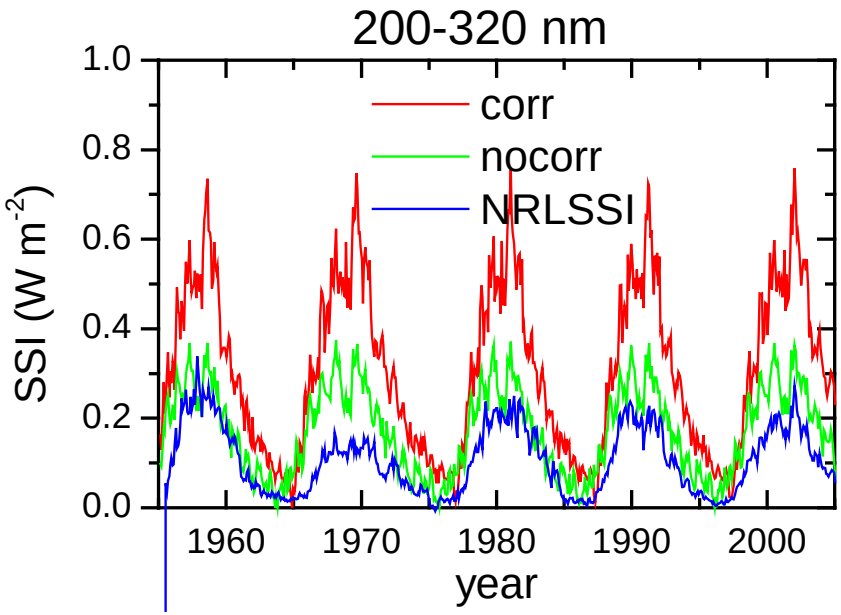
End of talk

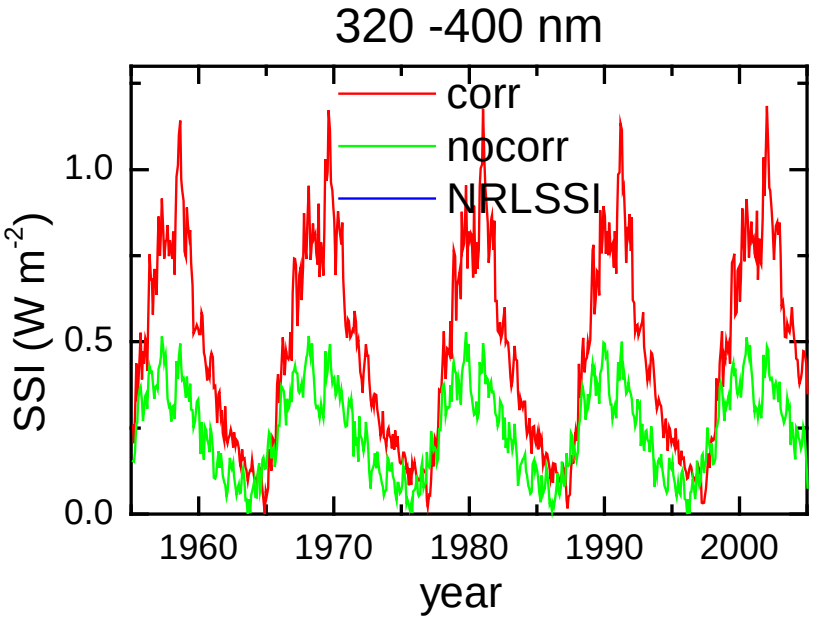
Relative and Absolute SSI changes

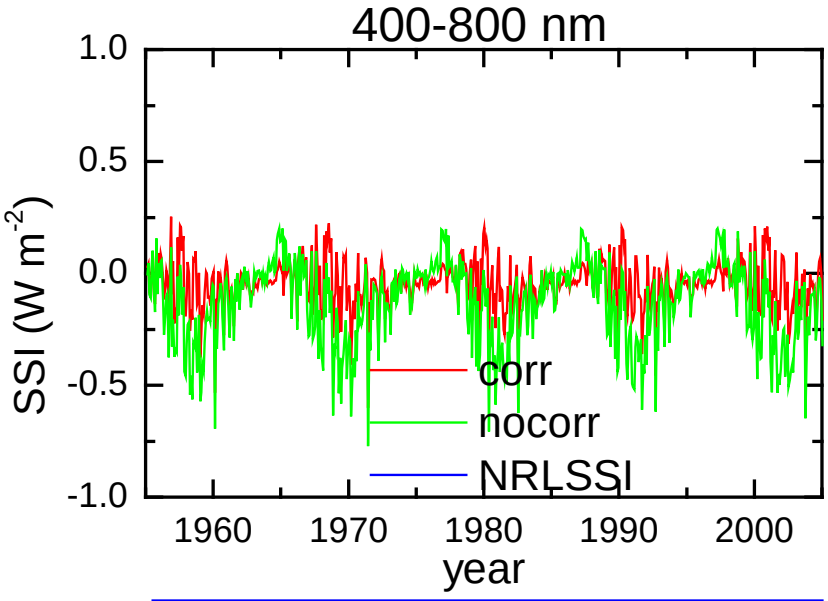


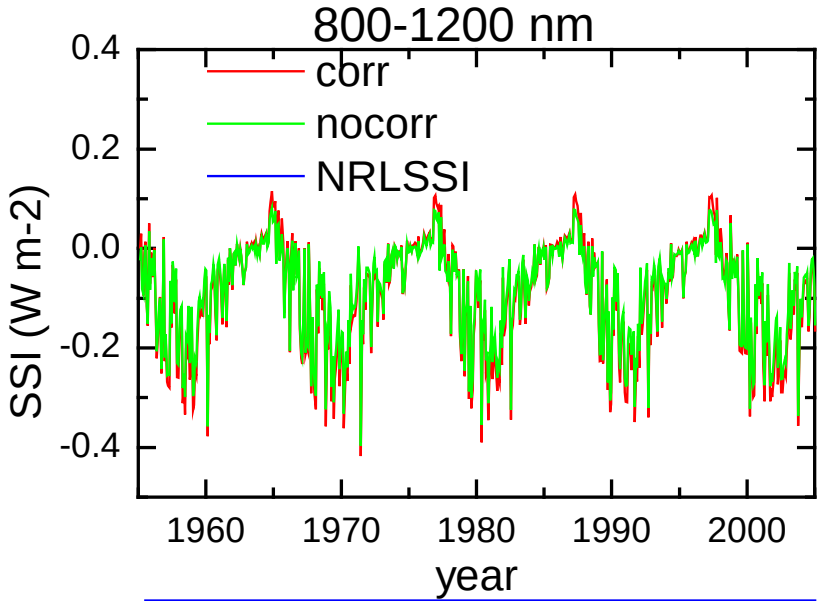


Bands temporal variation in simulation

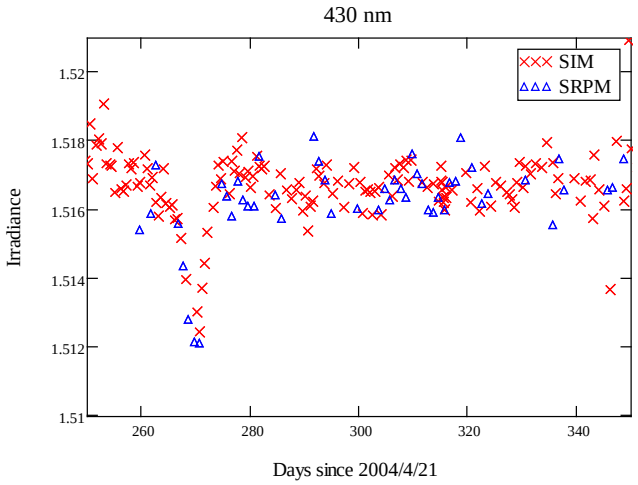




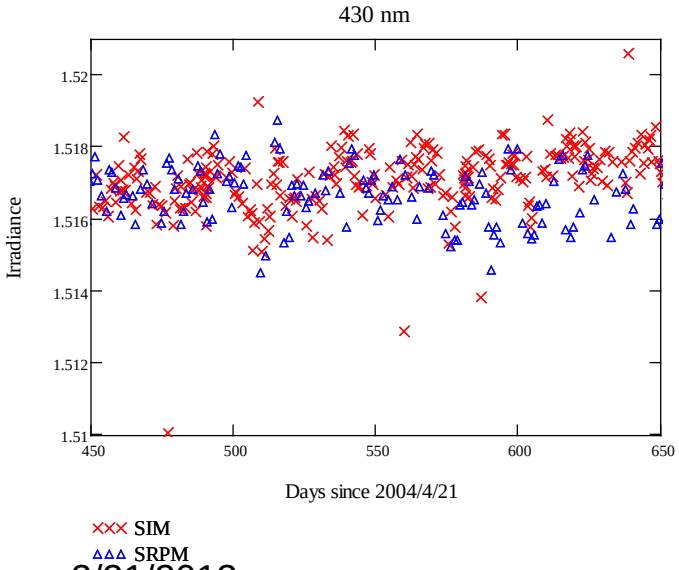




Visible & IR short-term

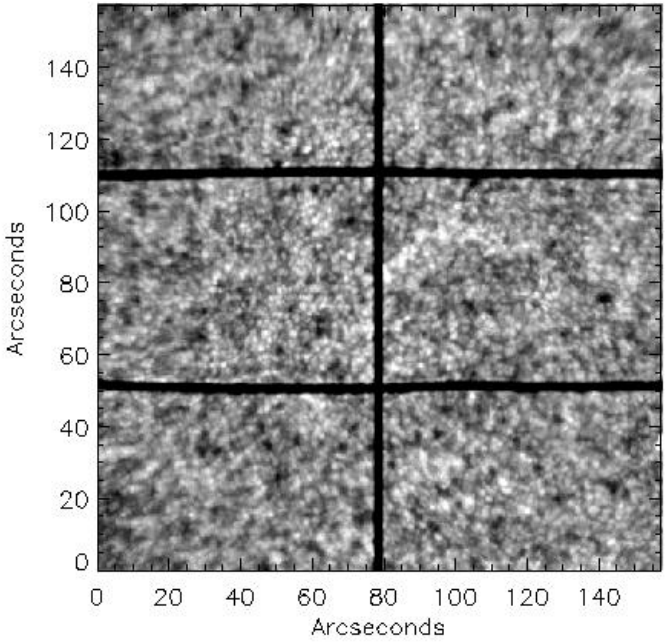


(Top panel) On the big things ARs effects are well understood. SRPM and the PSPT masks do a fairly good job.
(Bottom panel) On the small things this is not so good because the discrimination of the network is very dependent on seeing. Better images would help, perhaps from space.



Also, the lower layers of network models are not well constrained by observations.

Remember what the models try to discretely represent the “quiet-” and active-Sun. (Quiet ->



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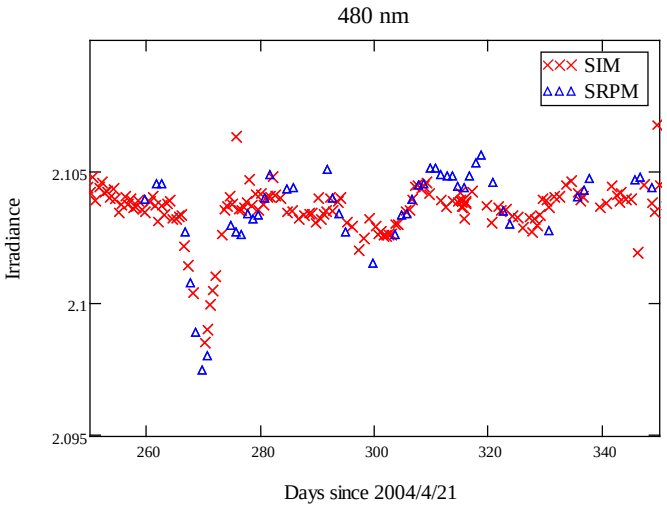
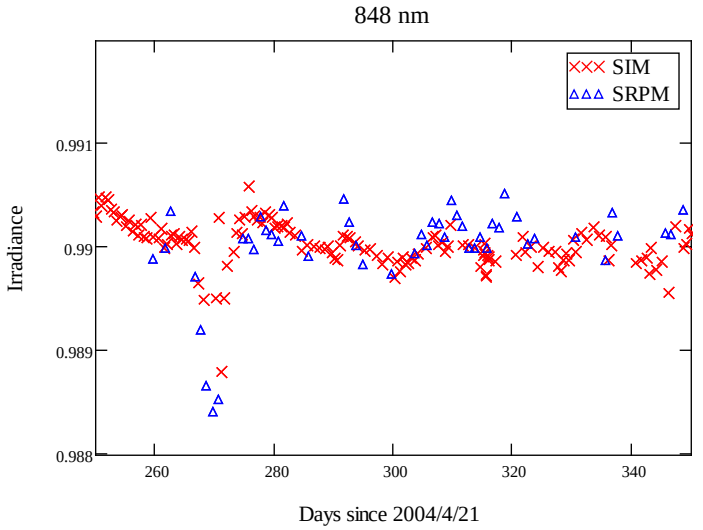
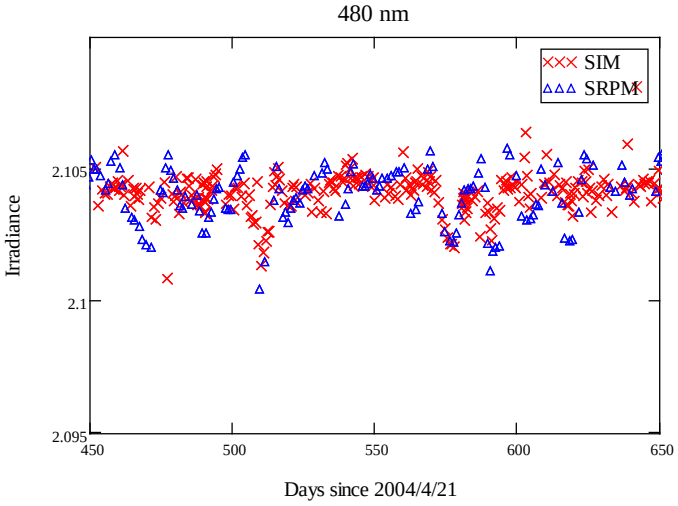


At all wavelengths rotational modulation is well explained by these set of models. Of course the models can also be improved but until better images are available this is not an issue.





The issues about image quality can be solved by images from space and in bandpasses with larger contrast that better display the network.