Solar Spectral Irradiance effects on tropospheric regional climate? WACCM4 preliminary results, ENSO, and volcano issues

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Solar Images, Features
Coimbra (Pt), Meudon (Fr), Udaipur (In), etc.

- Meudon 1909/7/20
- PSPT 2005/1/17
- SRPM mask 2005/1/17

Ca II K wing
Ca II K center
Red band
Ca II K 2.3 A band

Sunspot group umbra+penumbra+plage
Spotless plage
Network in quiet-Sun
Features contrasts

Continuum and lines contrast varies with $\lambda$ and viewing angle, $\mu=\cos(\theta)$. 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.


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

\[ \Sigma_\lambda(t) : \text{change in disk intensity due to features (ppm)} \]
SORCE/SIM and TSI fill the spectral gaps

*Harder et al. 2009*

Negative observed contrast

SOCE/SIM observed negative solar cycle trend over most range where $T_b > T_{eff}$. 

Sanchez Cuberes et al, Moran et al, etc

Topka et al, etc
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

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

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PSPT Ca II K intensity distribution at disk center

Intensity

Relative area

1x10^4

1x10^3

1x10^2

1x10^1

1x10^0

A B D F H P

peak

low
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

Also photo-dissociation continua of NH+OH
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”
Preliminary “nocorr” results, PS DJF anomaly (Pa)

Instances

\textbf{const} control (single) case so far

Average of 3 \textit{nocorr} instances
ENSO 3.4 temperature $\Delta$ and volcanoes
DJF zonal means

Single instance peak-min differences
End of talk
Relative and Absolute SSI changes
Bands temporal variation in simulation

200-320 nm

320 -400 nm

400-800 nm

800-1200 nm
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 ->
Visible & IR short-term

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.