

Sensitivity of Intensities of ~~Subtropical Jet and~~ Hadley Circulation on ~~Cumulus Parameterizations and~~ Resolutions

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AGU for APE

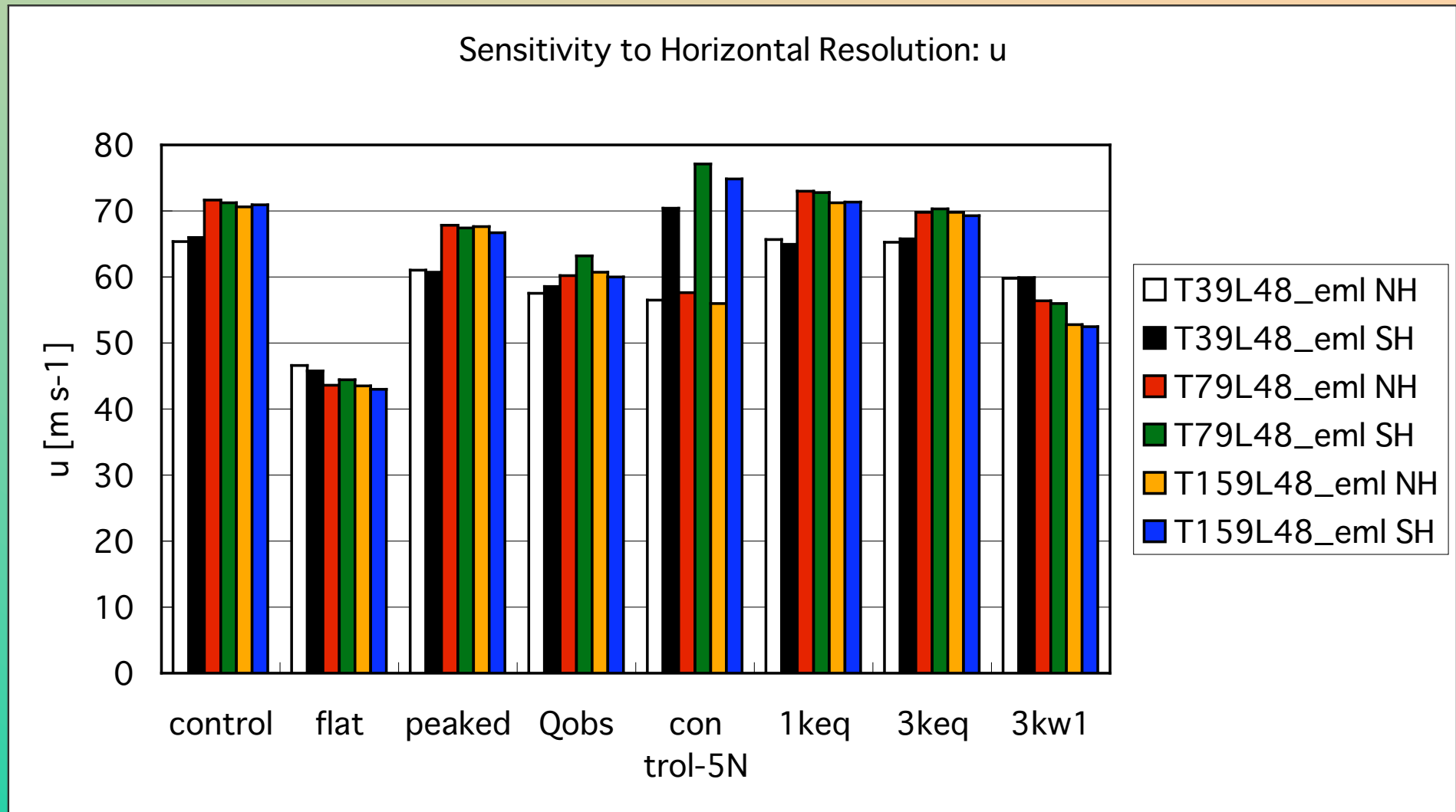
GOALS

- A Better Understanding of...
 - Sensitivity of general circulation.
 - Convergence with resolutions?
 - If any.
- Some descriptions, at least.
- Hopefully some qualitative and/or physical explanation.

This Talk

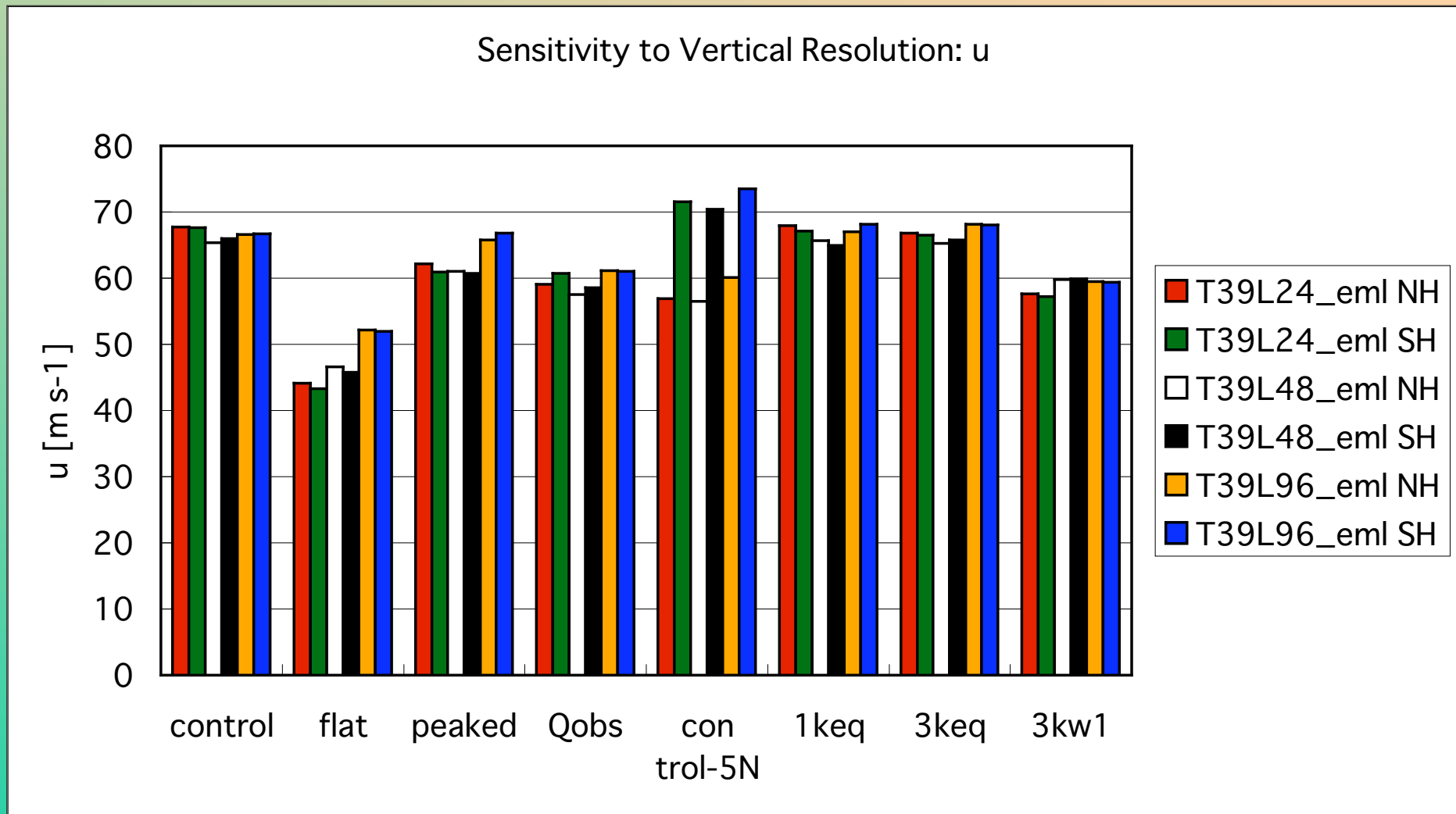
- Resolutions
 - Horizontally (with 48 levels) : T39 (~320 km), T79 (~160 km), T159 (~80 km), T319 (~40 km).
 - Vertically (with T39) : L24 (~2 km), L48 (~1 km), L96 (~500 m).
- Emanuel.
 - Others in future, hopefully.
- u (intensity of subtropical jets), Ψ (intensity of Hadley circulation).
- Descriptions.
 - Bar graphs.
- A trial for some qualitative and/or physical arguments.
- Or a trial to raise some questions at least.

Sensitivity on Horizontal Resolution: u



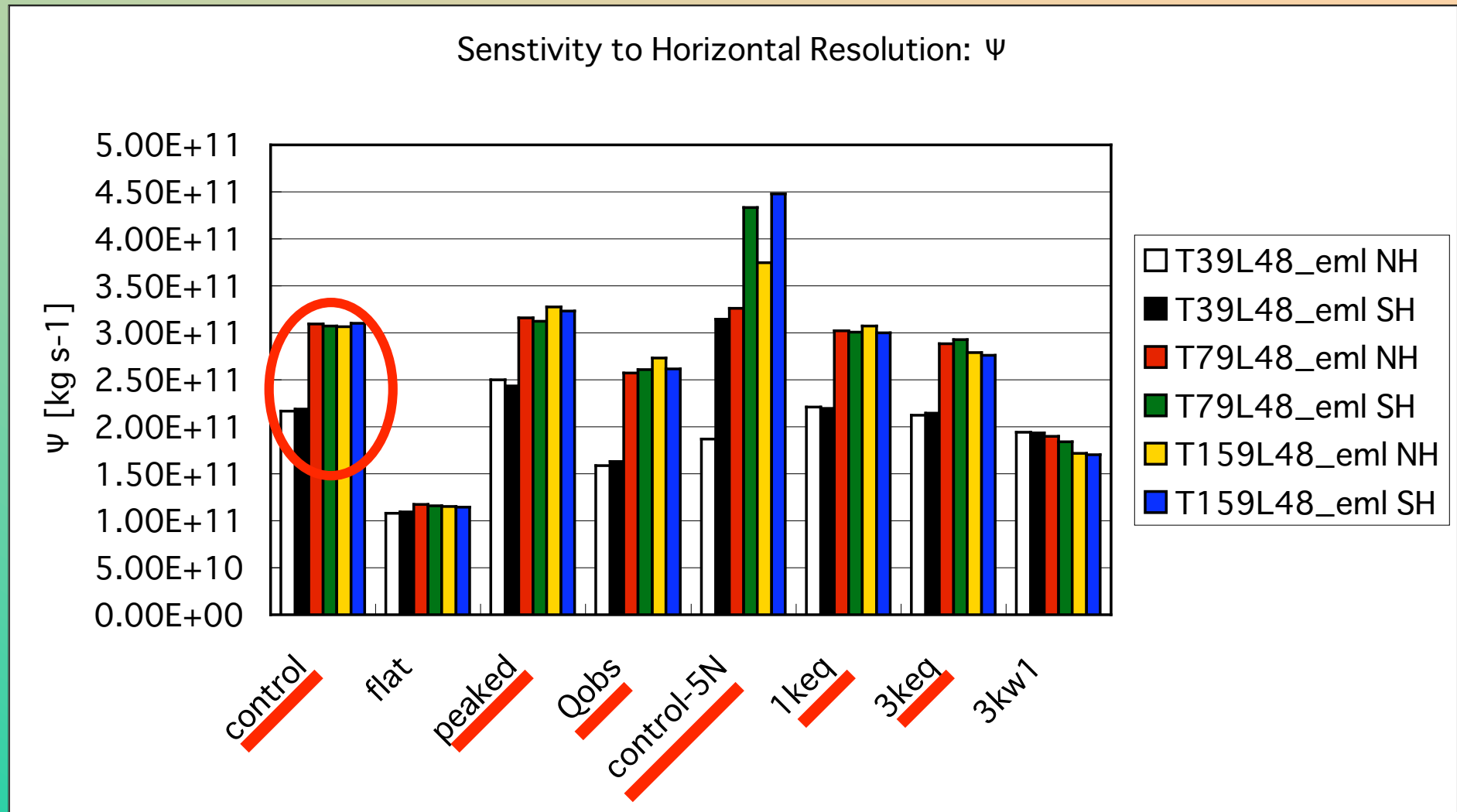
Variation of 10-20 % is normal.

Sensitivity on Vertical Resolution: u



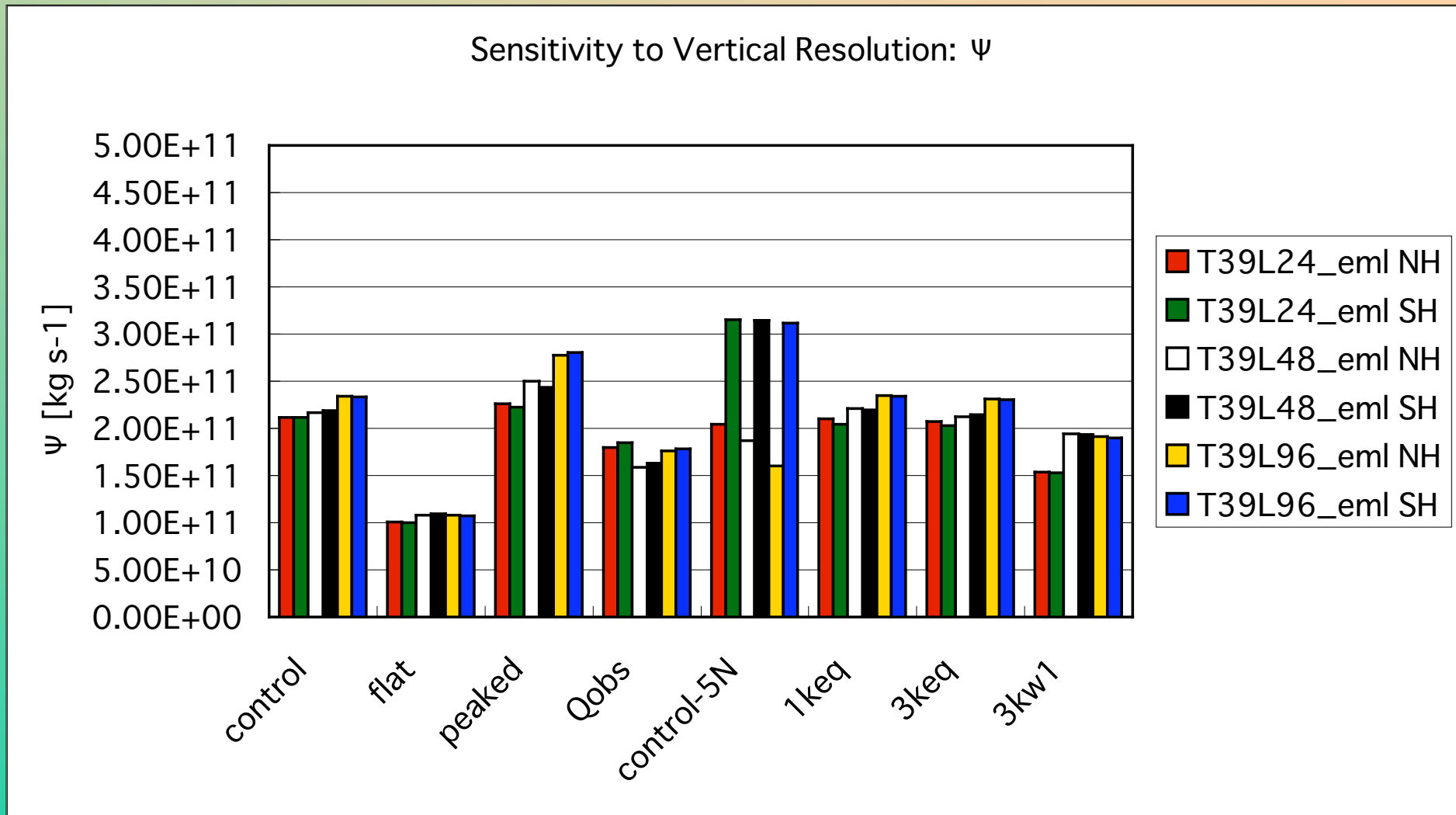
Somewhat high sensitivity for only “flat”.

Sensitivity on Horizontal Resolution: Ψ



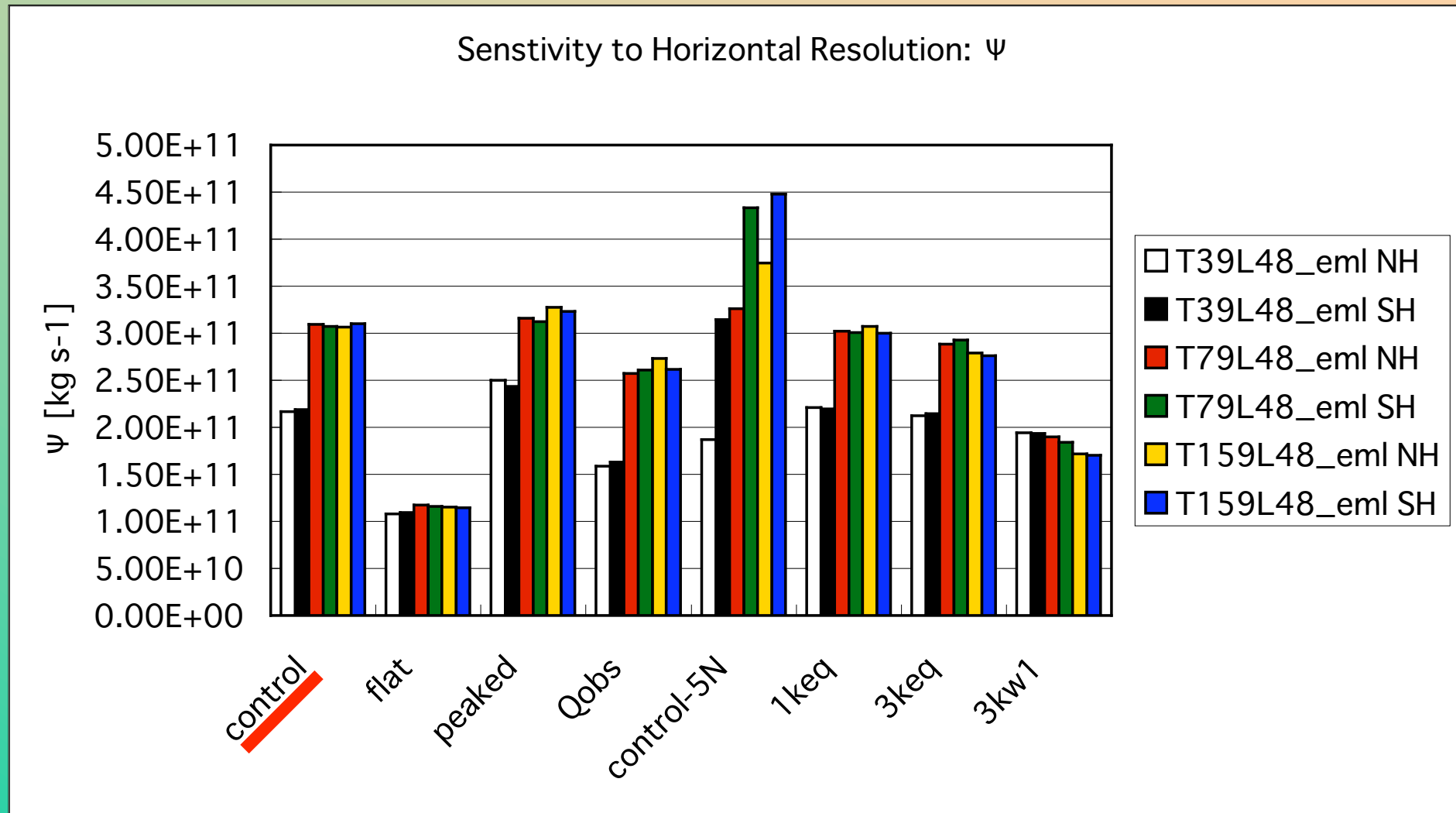
20-100 % variation is normal. A big gap between T39 and T79.

Sensitivity on Vertical Resolution: Ψ



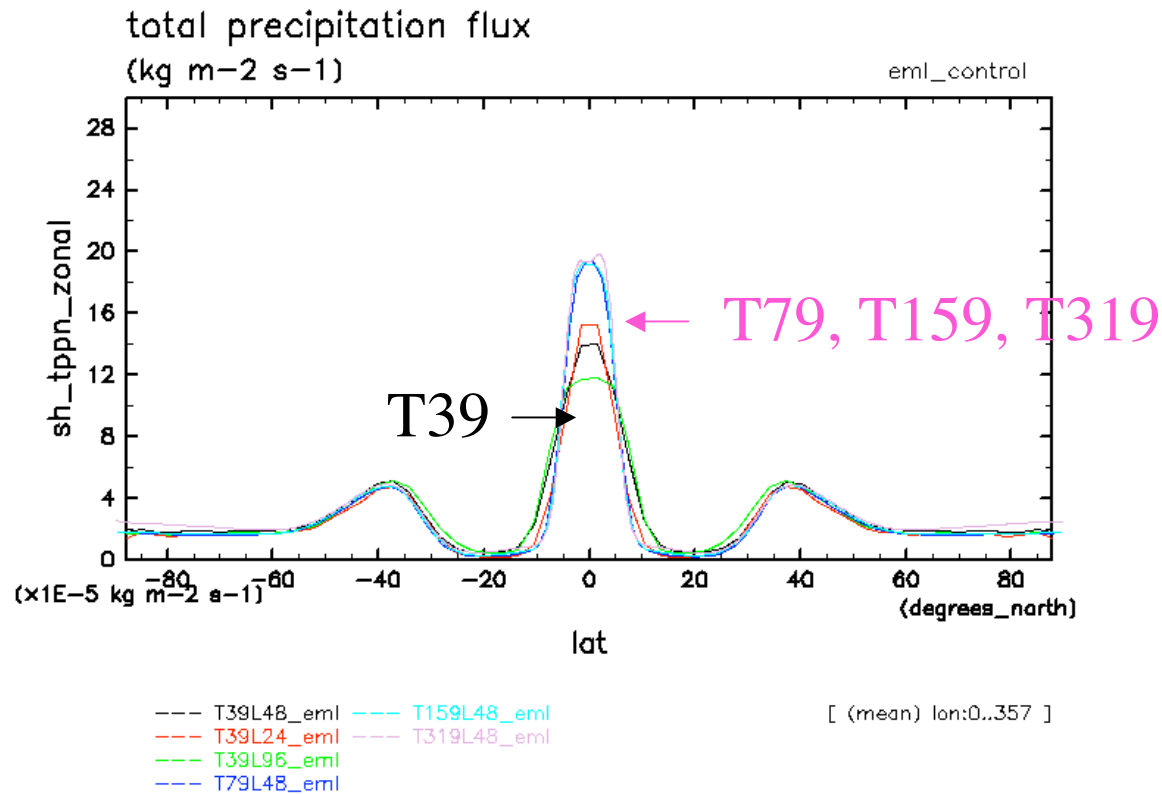
Sensitivity is but still 10-20 % variation.

Sensitivity on Horizontal Resolution: Ψ



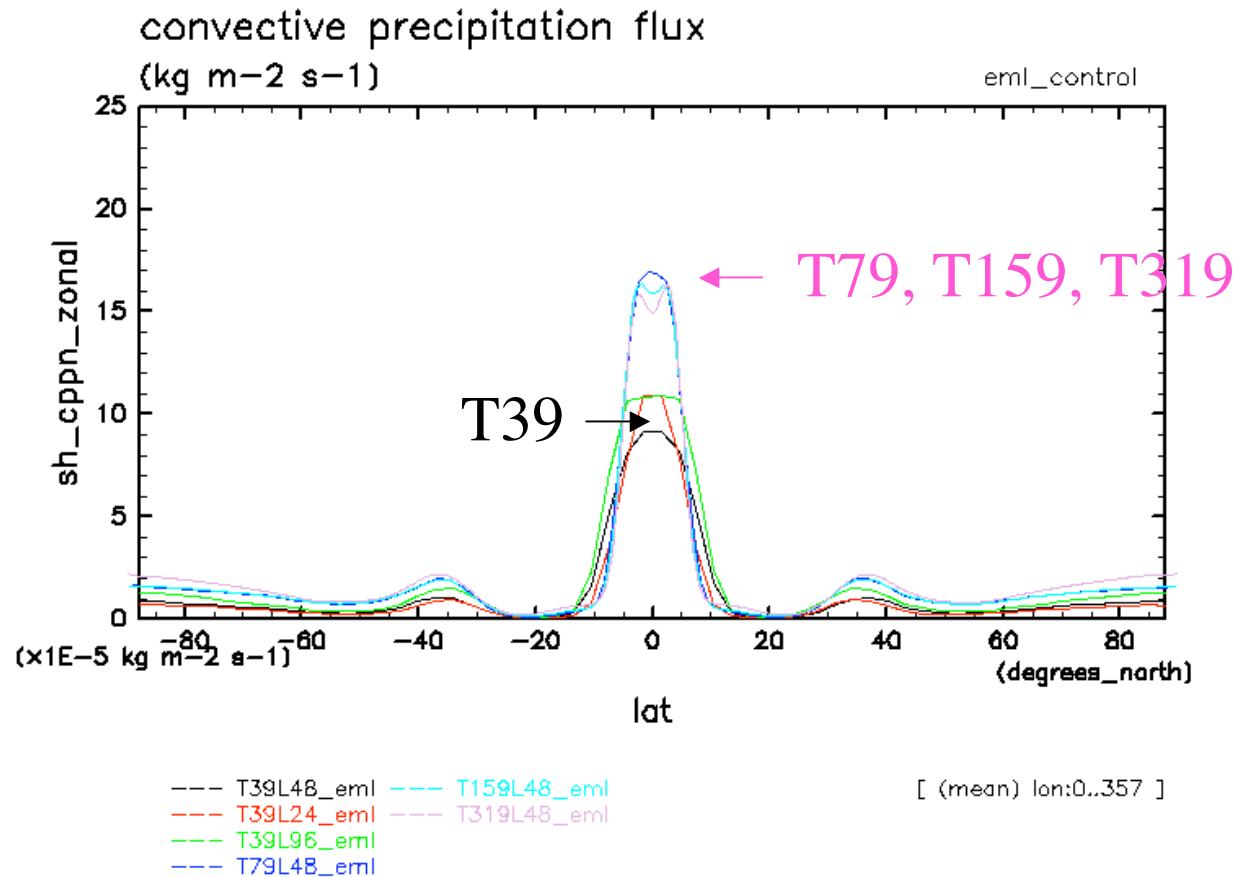
Large sensitivity for “control”.

Sensitivity on Horizontal Resolution: “control” Time-Zonal Mean Total Precipitation



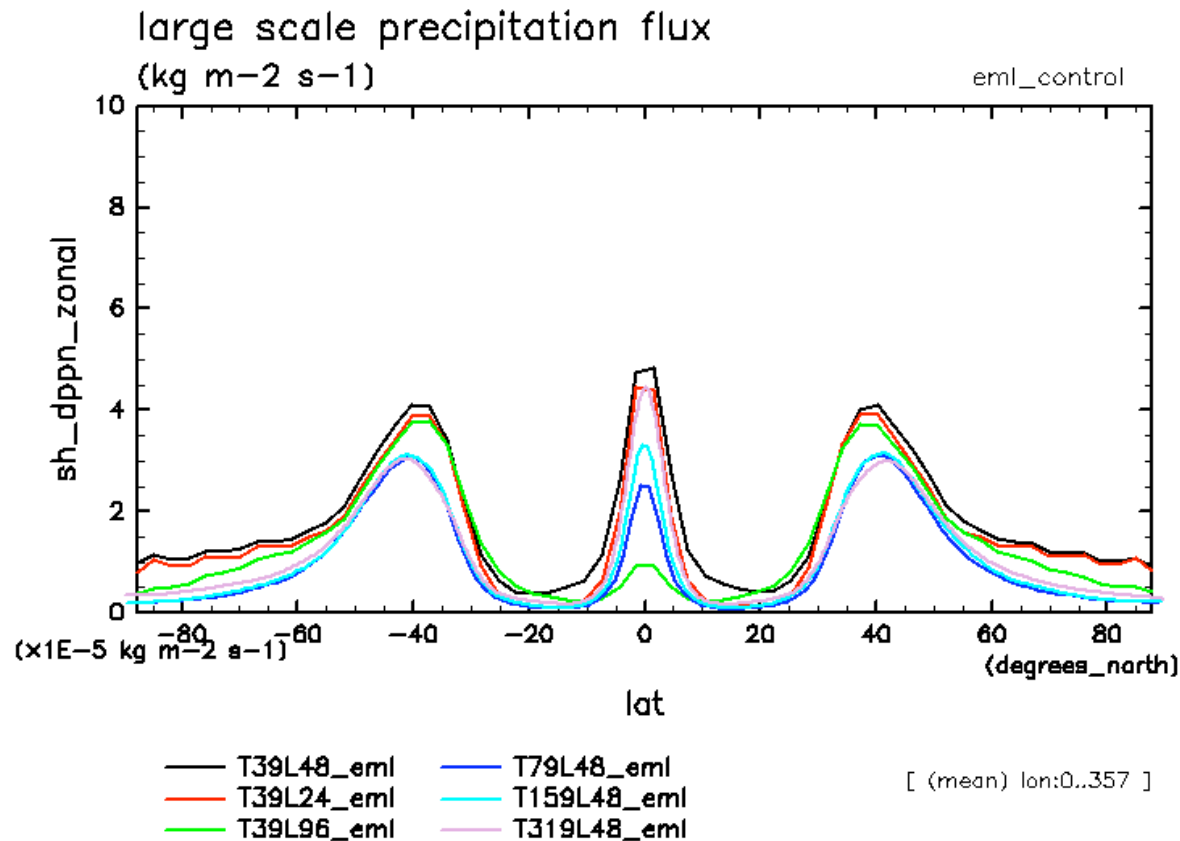
- $6 \times 10^{-5} \text{ kg m}^{-2} \text{ s}^{-1}$ (35%) gap between T39 (small) and T79 (large).
- Somewhat wider tropical precipitation for T39. Noisier?

Sensitivity on Horizontal Resolution: “control” Time-Zonal Mean Convective Precipitation



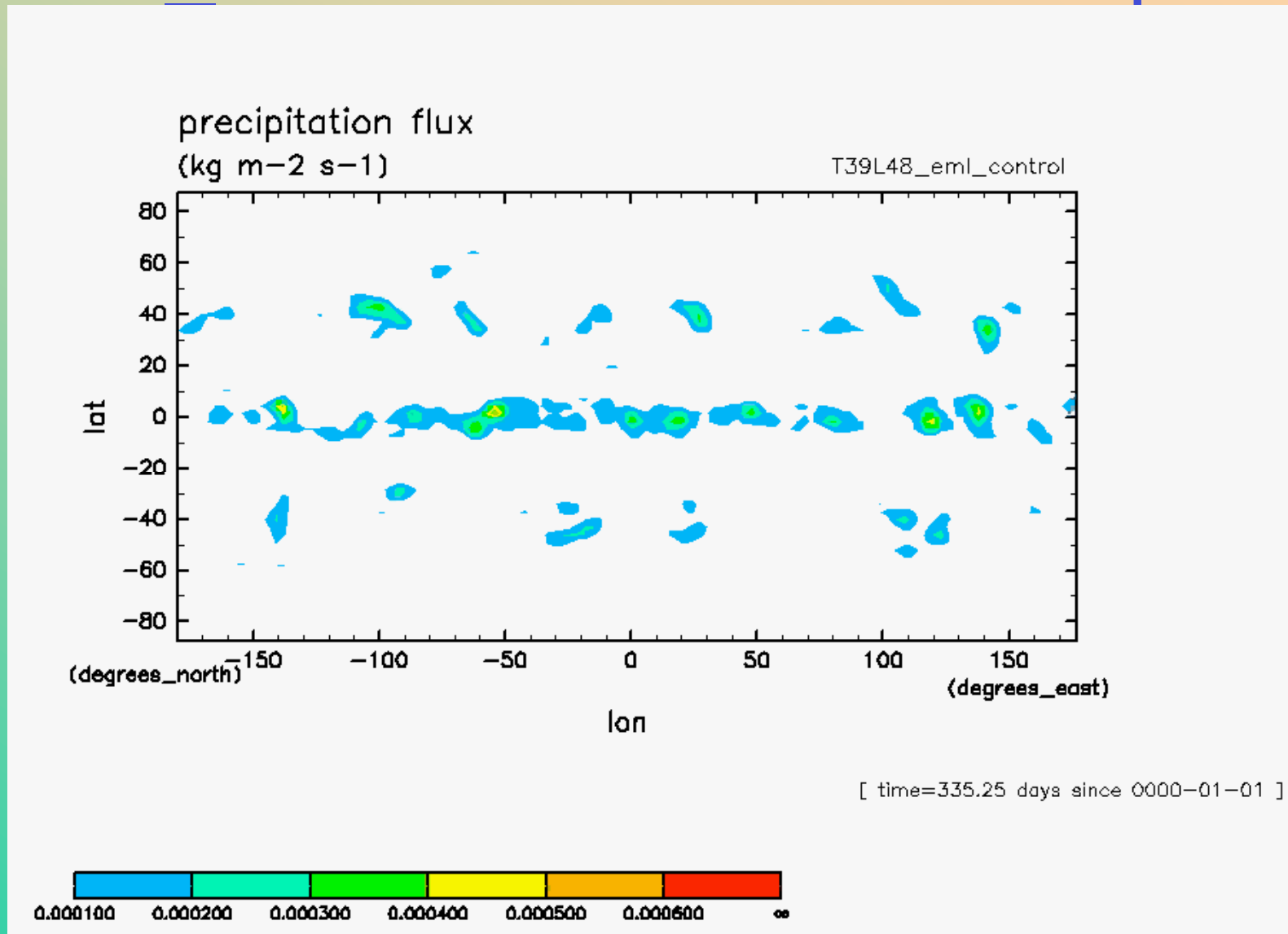
$8\text{e-}5 \text{ kg m}^{-2} \text{ s}^{-1}$ ($\sim 100\%$) T39 (small) and T79 (large).

Sensitivity on Horizontal Resolution: “control” Time-Zonal Mean Grid Precipitation



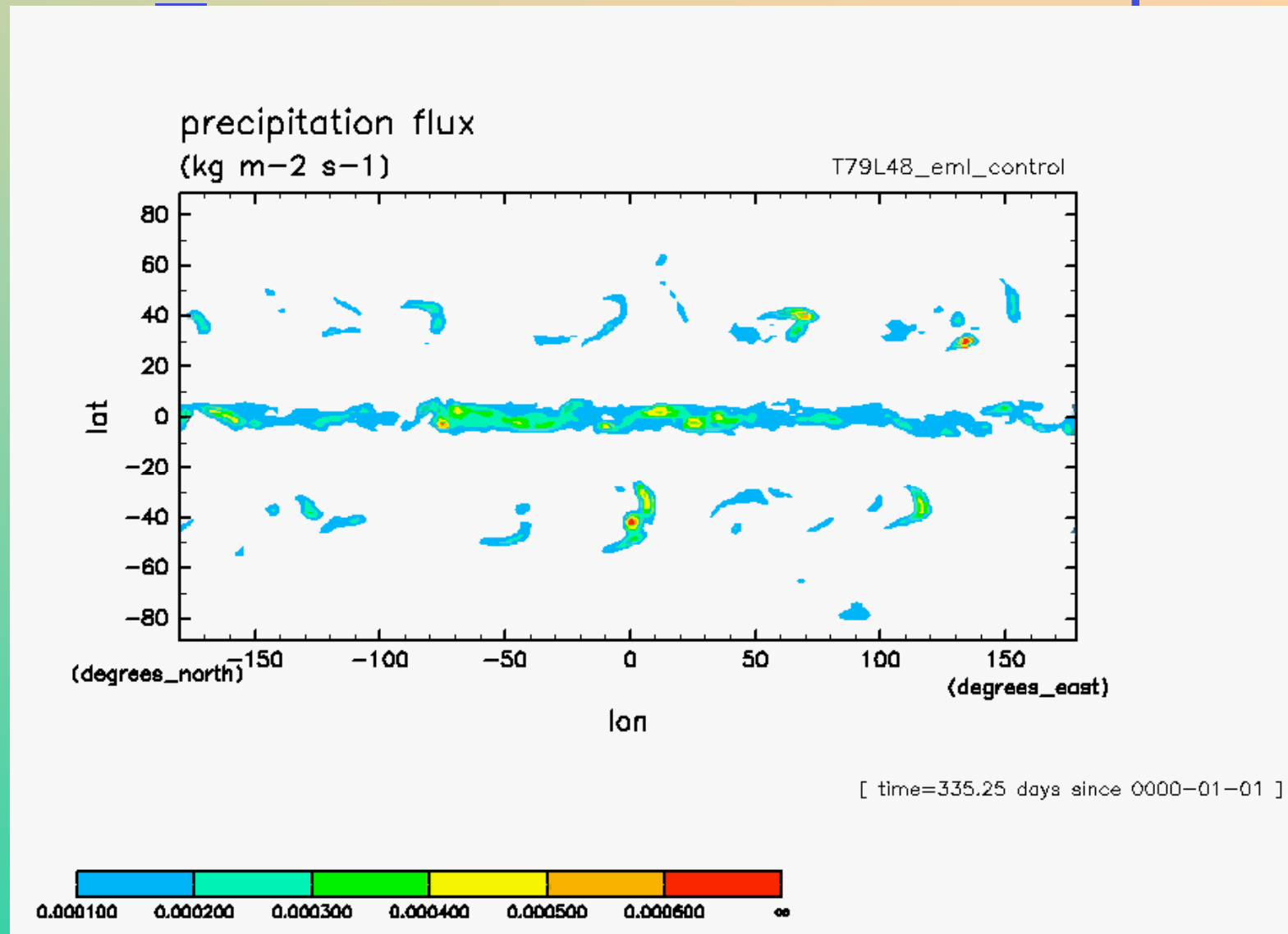
Large variation in a very complicated manner.

T39L48 eml: control: Total Precipitation



Noisier and smaller tropical precipitation. Weaker Hadley circulation.

T79L48_eml_control: Total Precipitation



More organized and larger tropical precipitation. Stronger Hadley circulation.

Somewhat More Descriptions

- Vertical motion?
- Static stability?
- Energy balance?
 - Top of the atmosphere.
 - Surface.

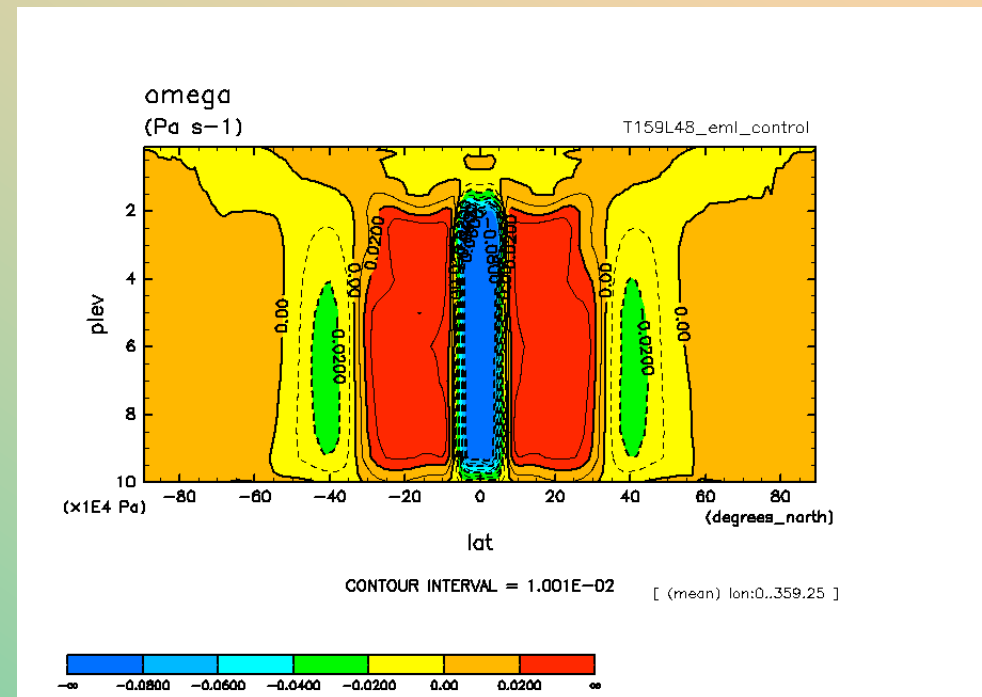
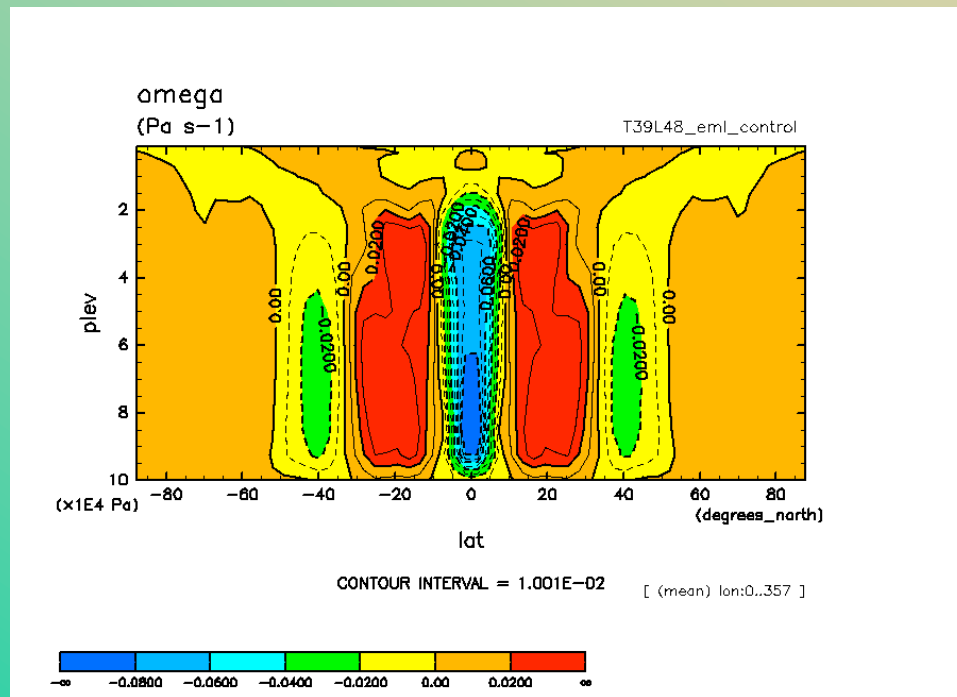
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T39

Weaker HC
Smaller Trop. Precip.

T159

Stronger HC
Larger Trop. Precip.



Somewhat stronger in somewhat larger area
when HC is stronger (T159).

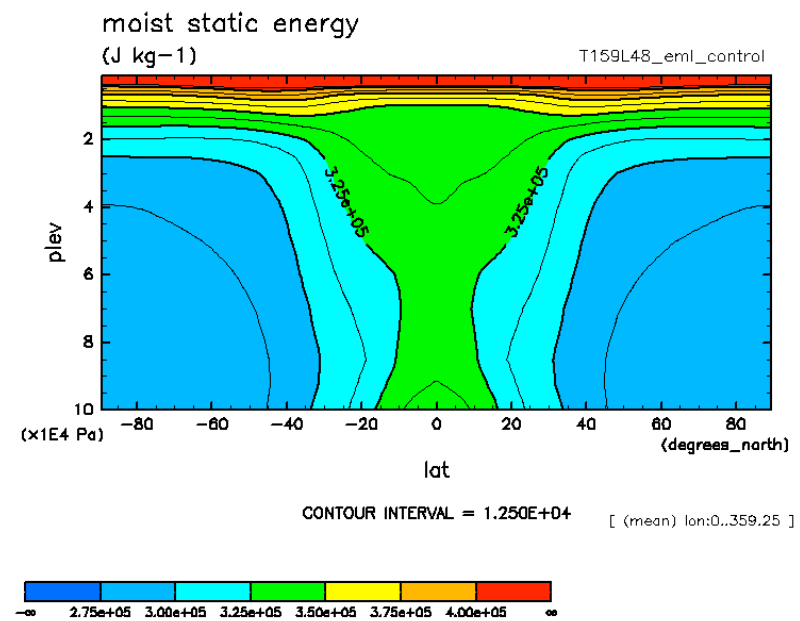
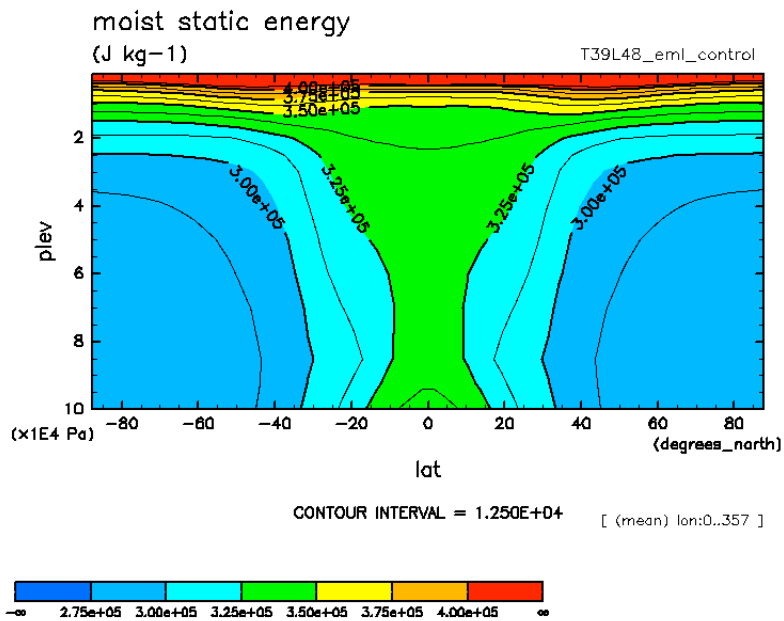
Moist Static Energy

T39

Weaker HC
Smaller Trop. Precip.

T159

Stronger HC
Larger Trop. Precip.



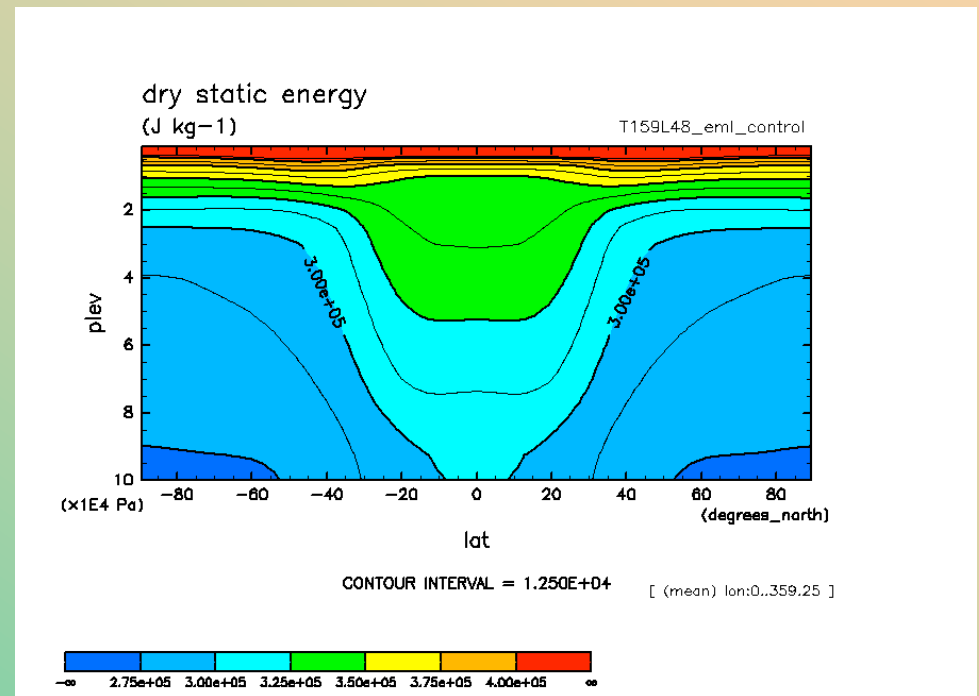
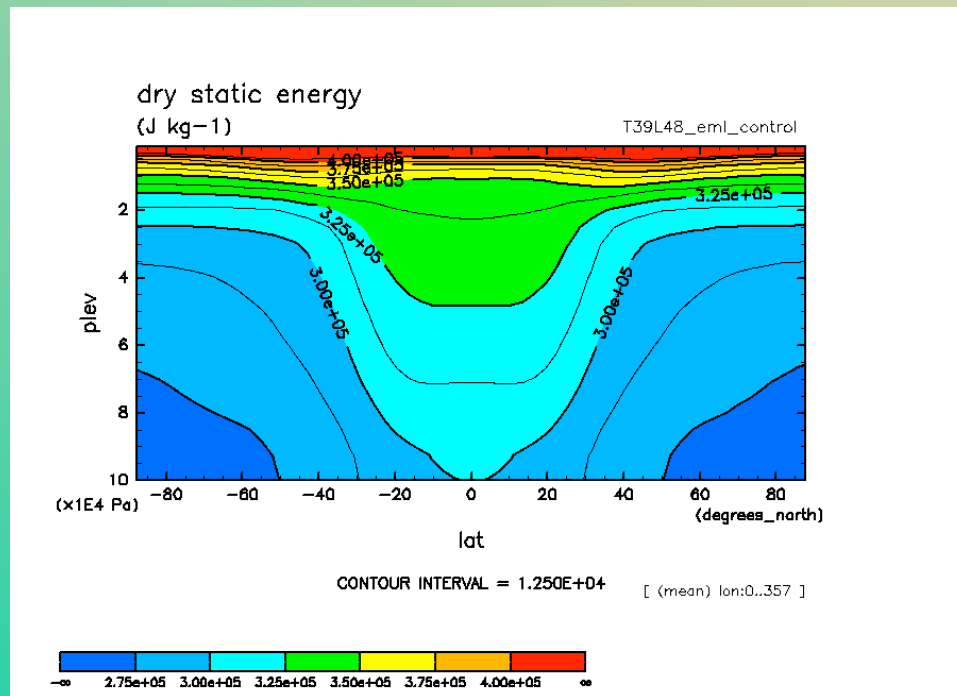
Dry Static Energy

T39

Weaker HC
Smaller Trop. Precip.

T159

Stronger HC
Larger Trop. Precip.

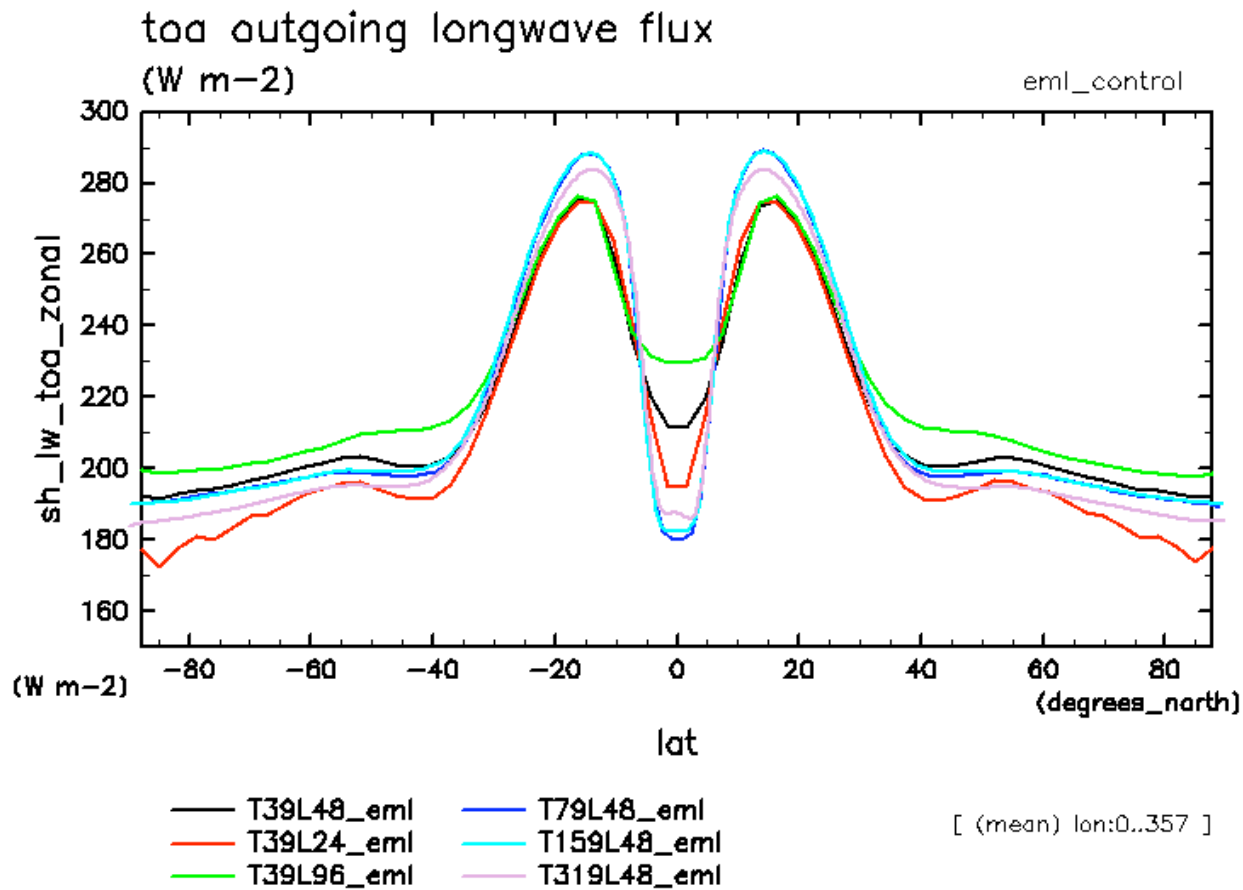


More stable in the mid-troposphere both in the tropics and subtropics when HC is stronger (T159).

Discussions

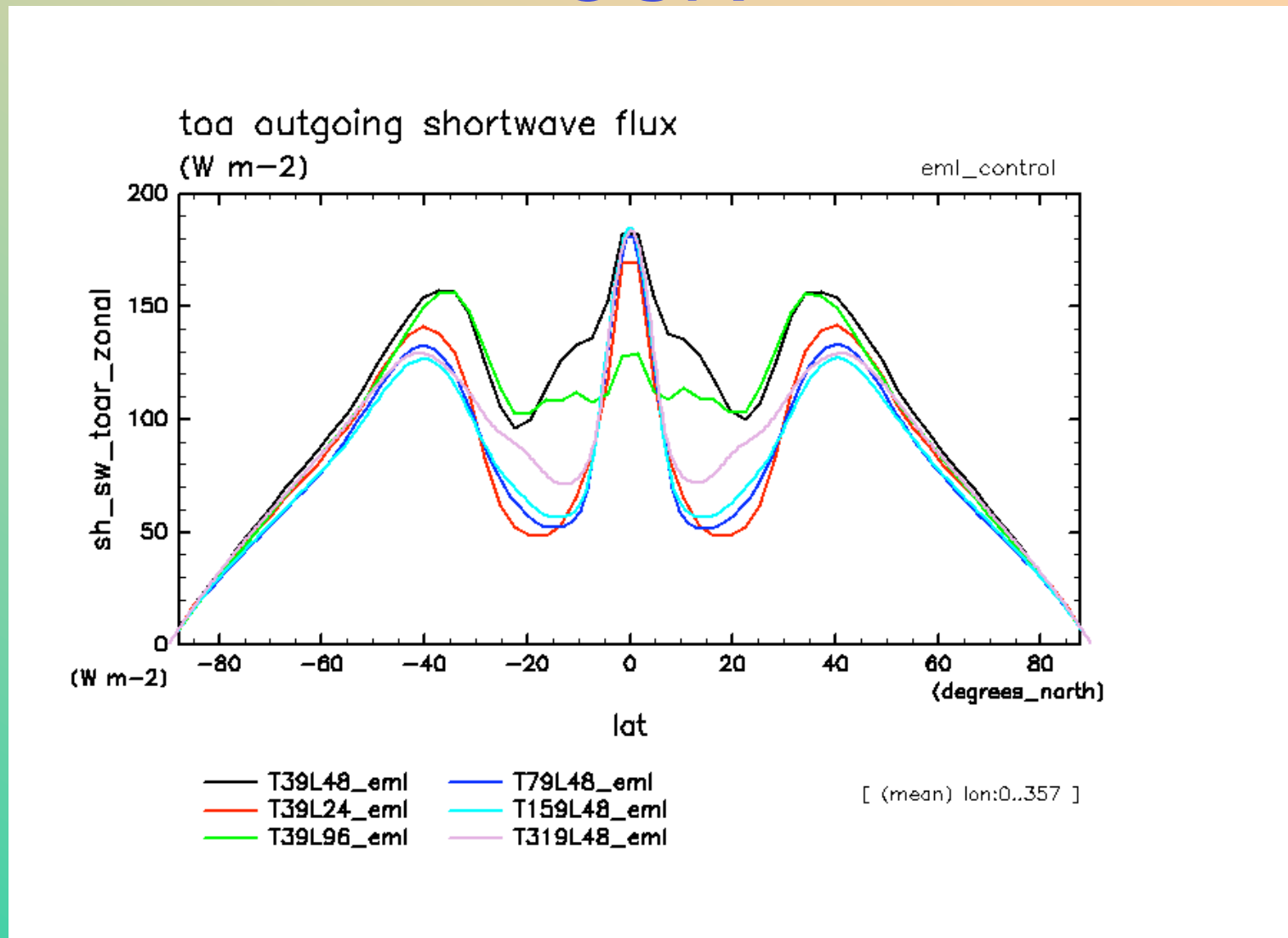
- Suppose the static stability is same.
 - The stronger the upward (downward) motion, the stronger the diabatic cooling (heating).
 - It is consistent to have more tropical precipitation when the HC is stronger (higher resolution).
 - More radiative cooling in subtropics?
 - Surely, because it's warmer.
- The change in the static stability seems to make the daiabatic cooling/heating stronger.
 - Suppose the upward (downward) motion is same, a more [less] stable condition results in more [less] daiabatic cooling (heating).
 - Hmmmm....
- The stronger (weaker) the HC, the smaller (larger) the upward (downward) motion area.
 - Hmmmm...

OLR



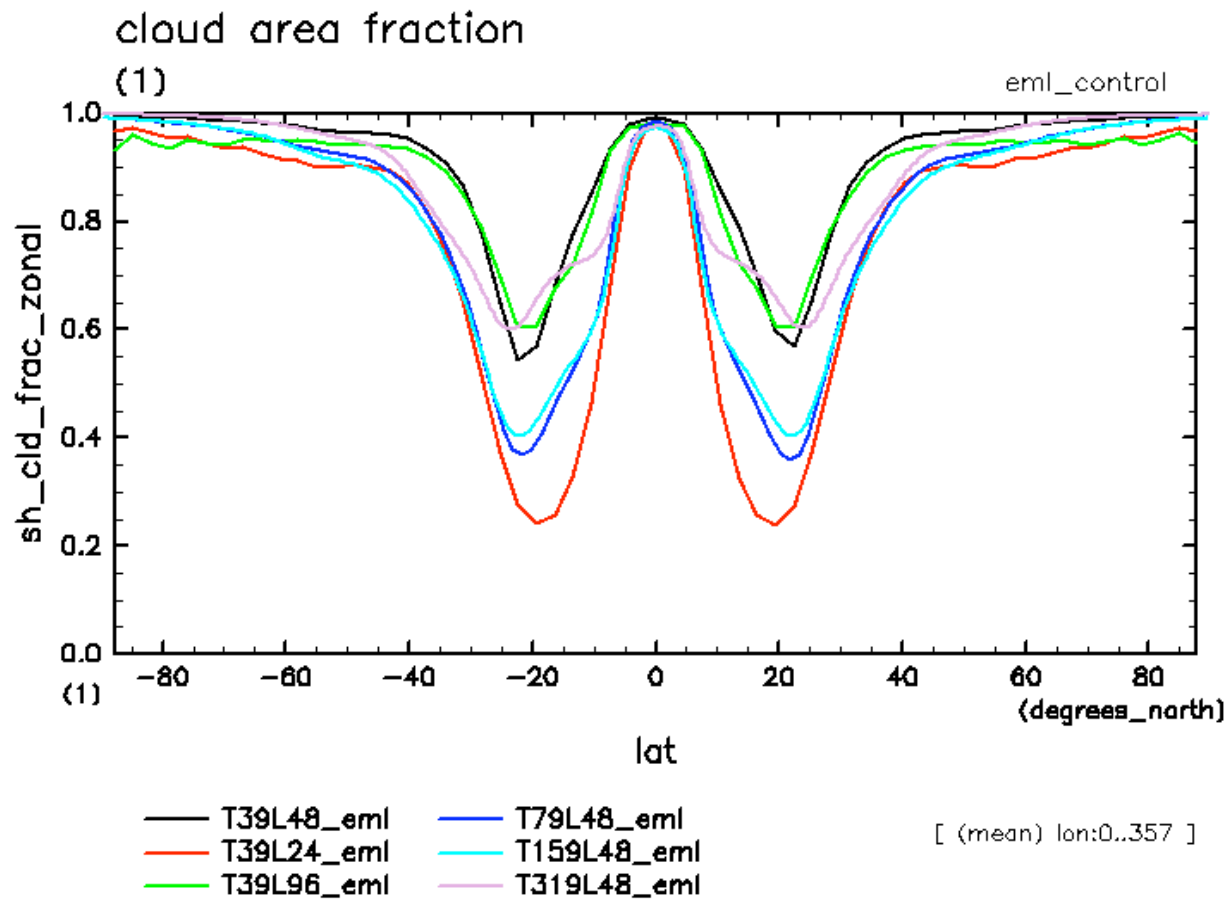
~30 $W m^{-2}$ less in the tropics and ~15 $W m^{-2}$ more in the subtropics in higher resolutions (stronger HC).

OSR



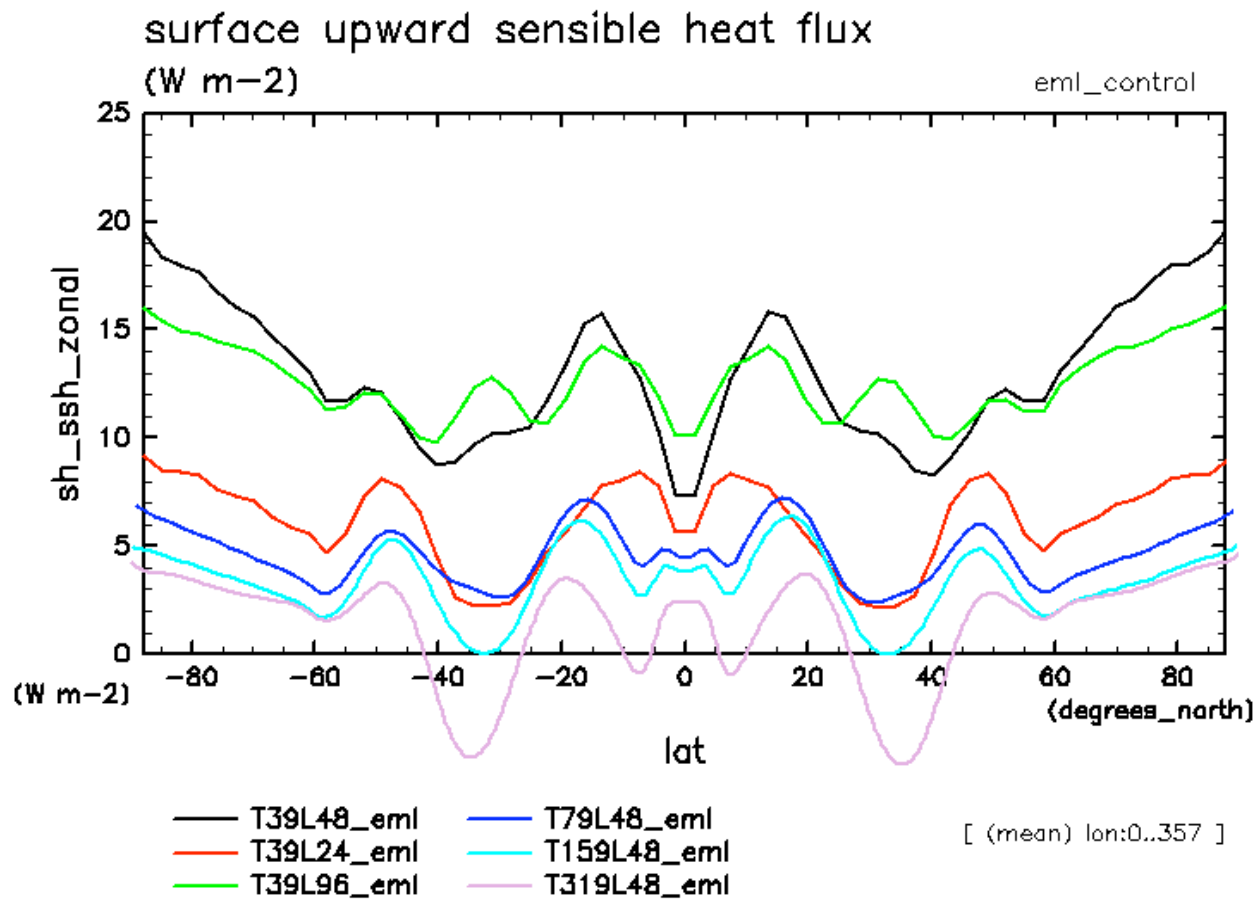
Almost same in the tropics and $\sim 50 \text{ W m}^{-2}$ less in the subtropics in higher resolutions (stronger HC).

Cloud Fraction



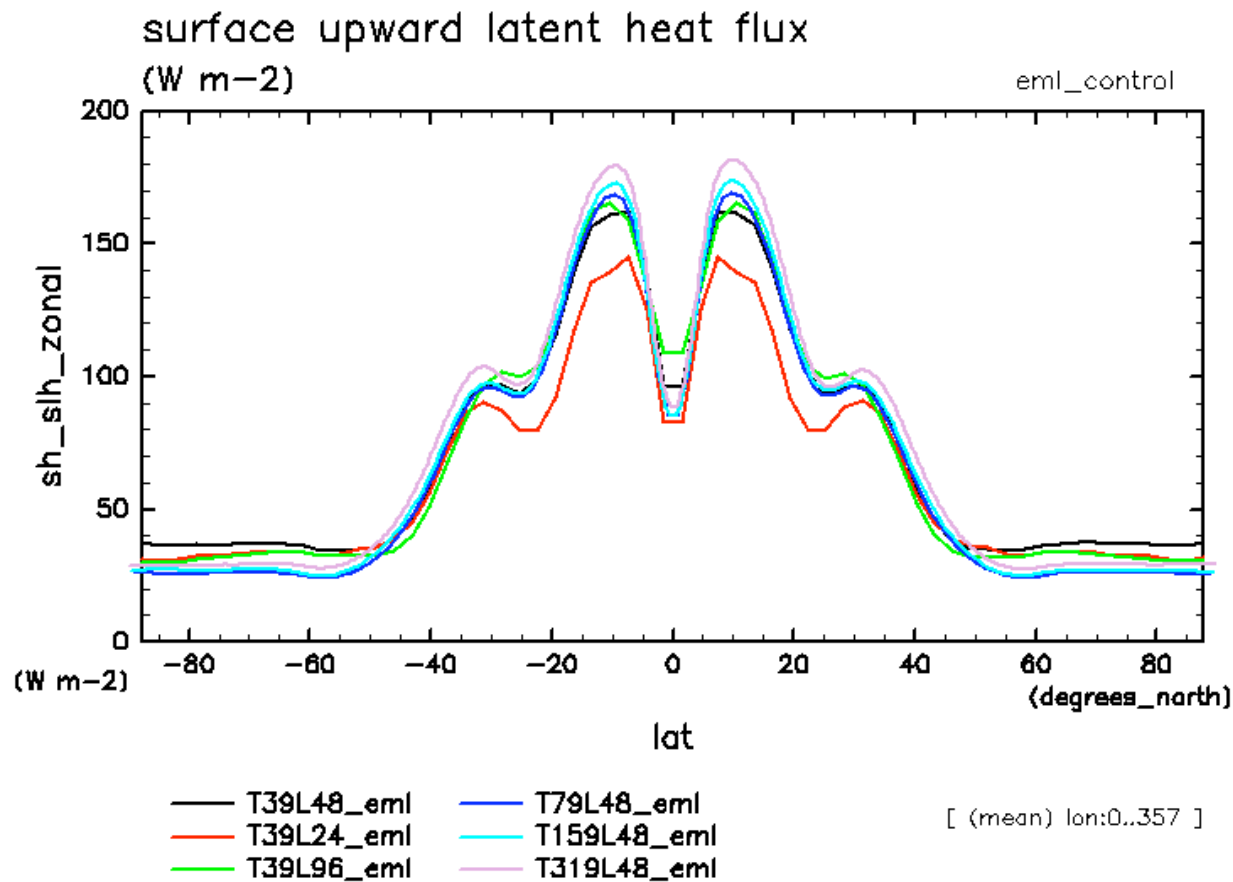
Less cloud fraction in the subtropics
in higher resolutions (stronger HC).

Surface Sensible Heat Flux



Less sensible heat flux
in higher resolutions (stronger HC).

Surface Latent Heat Flux



(OH NO!) MORE latent heat flux in higher resolutions (stronger HC).
It's consistent with larger precip.

Concluding Remarks

- I am confused.
- Fixed SST (infinite heat bath) may result in putting more responsibility to surface energy flux???
- So how about mixed-layer APE?
- We may have submitted LEAST typical result (T39L48) to PCMDI.