Identifying problems with UM-convection for MJO improvement

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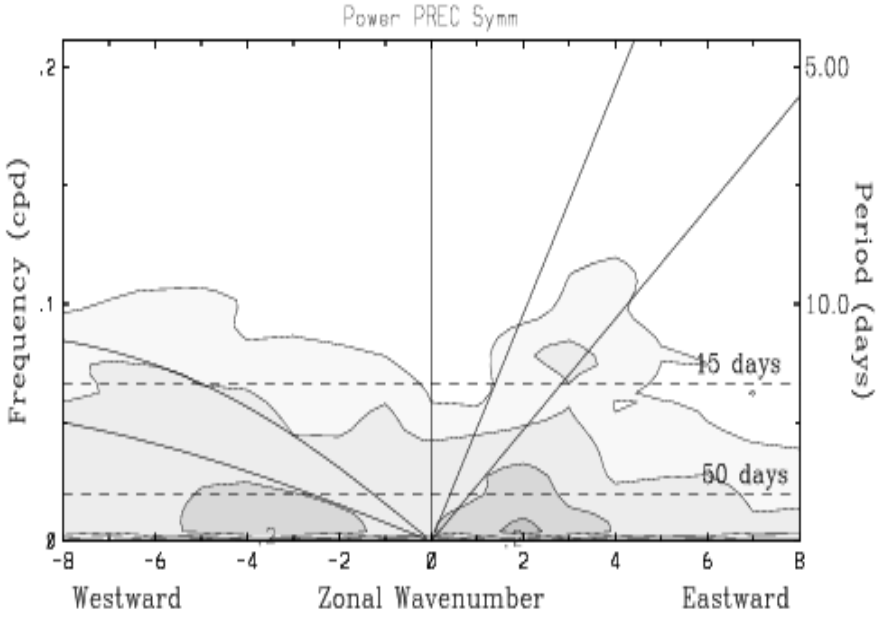
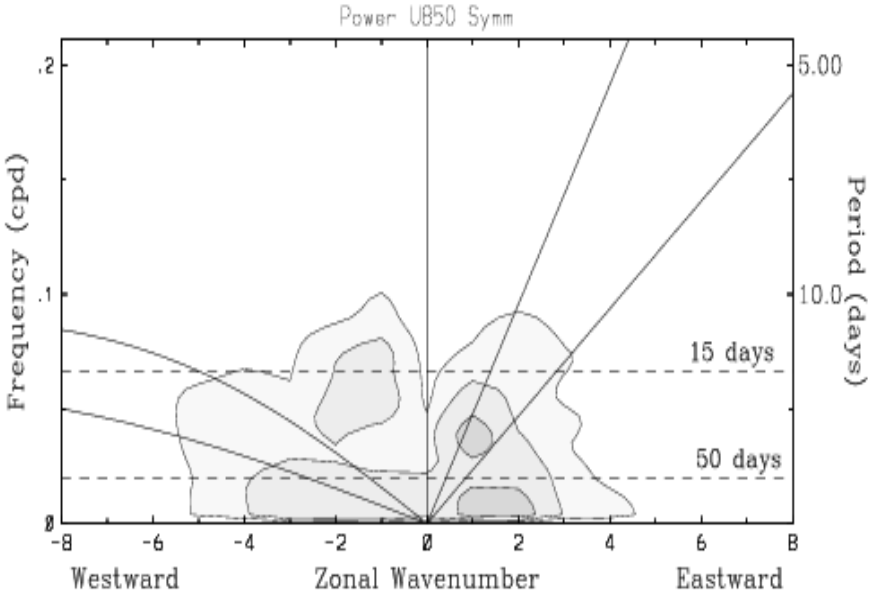
Symmetric precipitation and U850 spectral power for UM

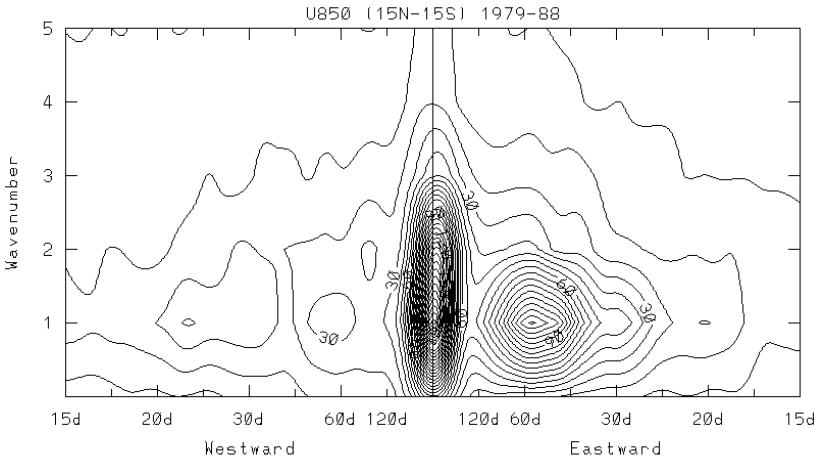




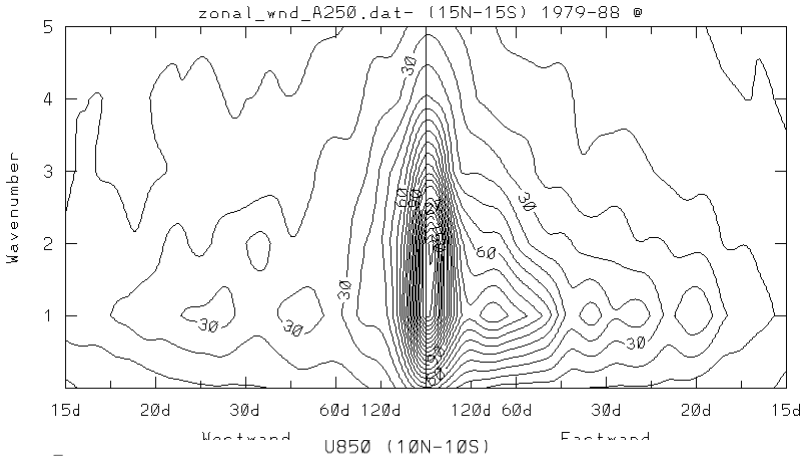
UM exhibits a weak MJO-signal in UM simulation.

U850

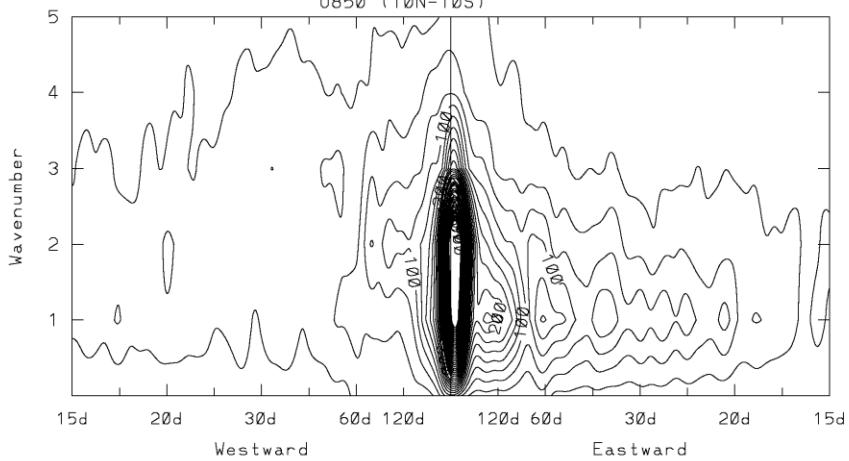
Obs



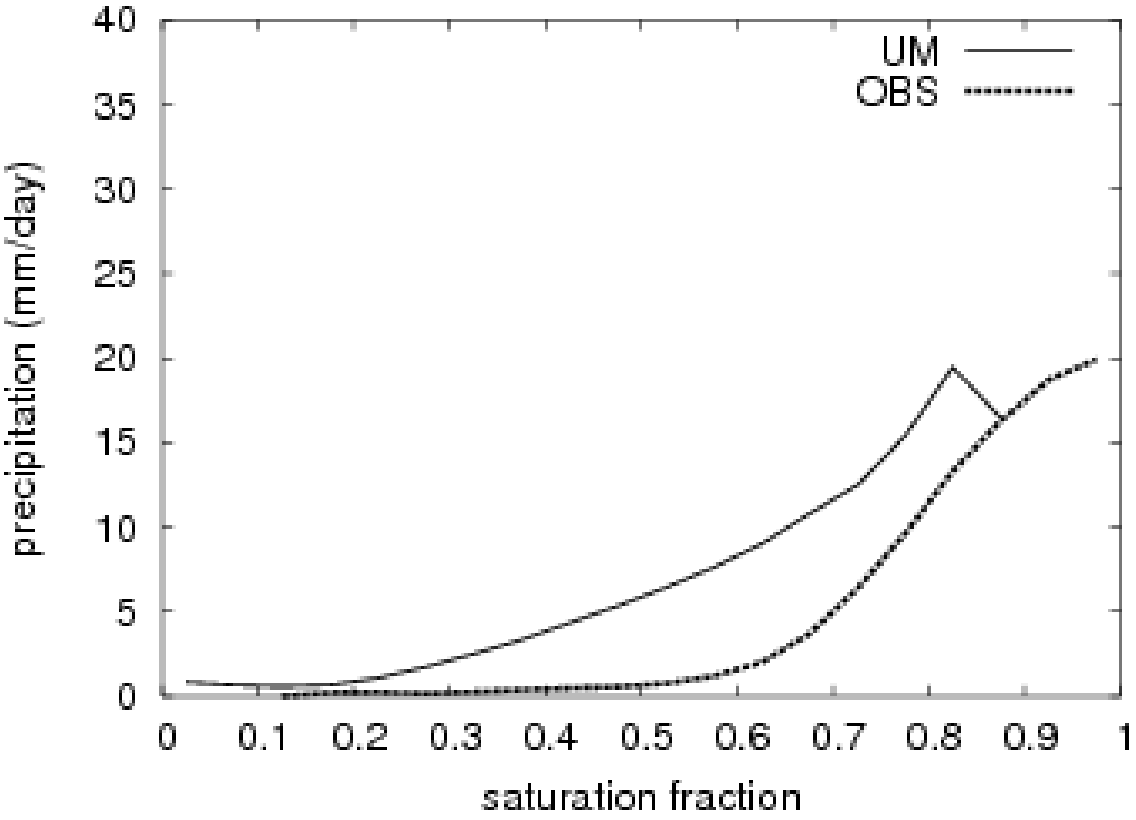
BAM4



UM

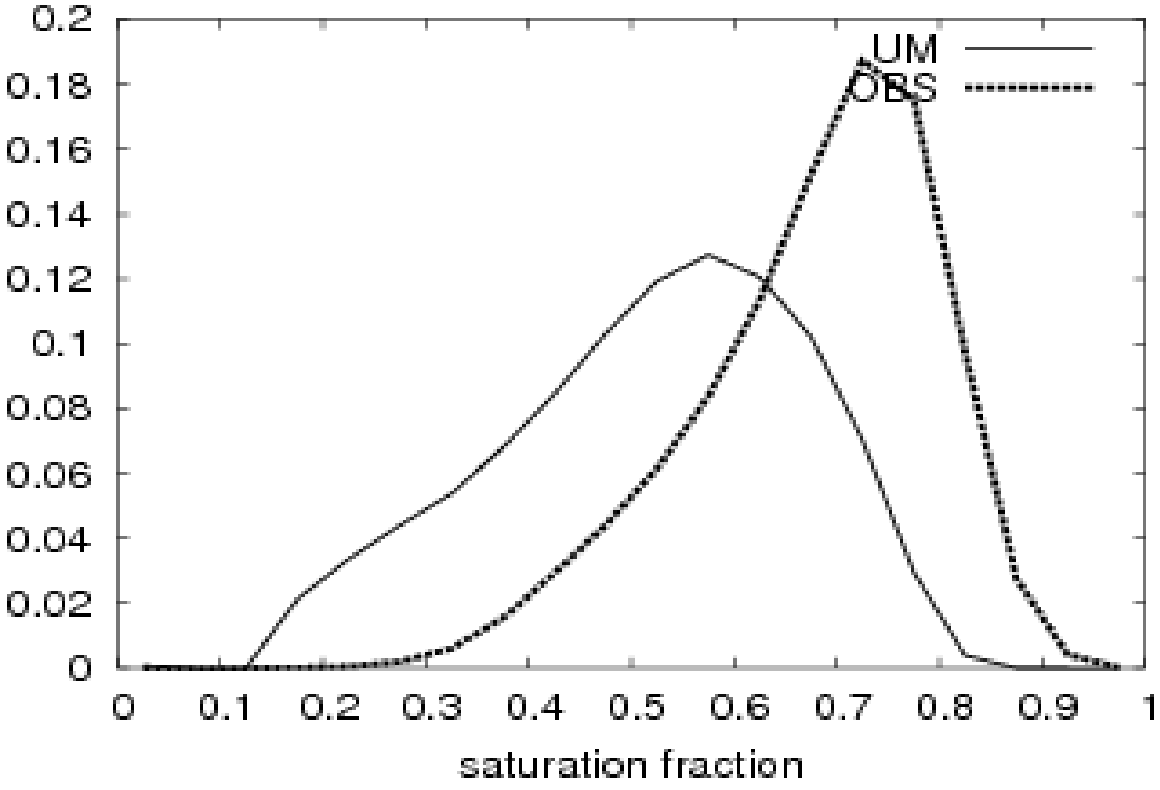


Mean daily precipitation composited into 5 % bins of saturation fraction



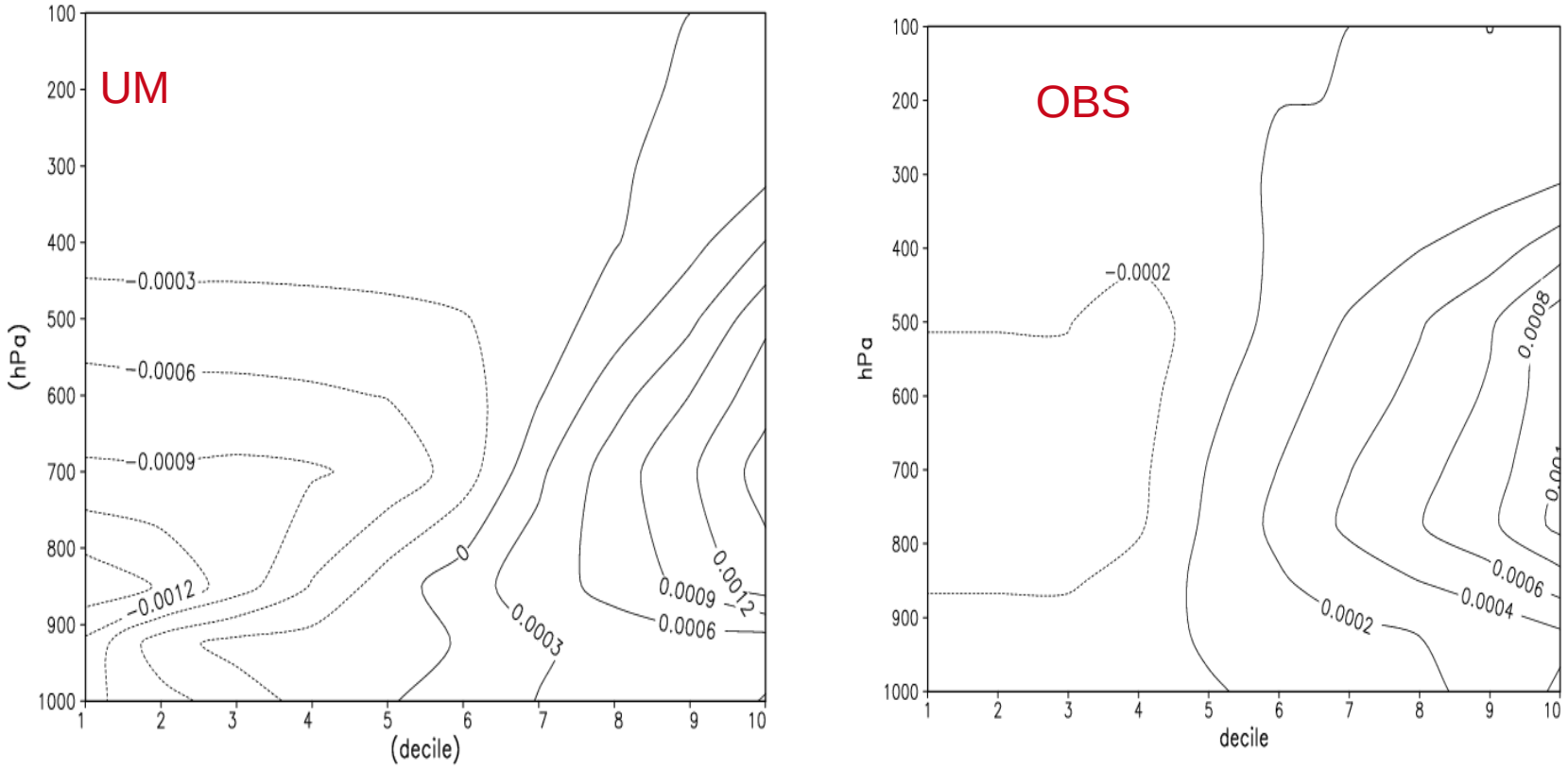
This plot shows that in UM, rains tends to occur at low column relative humidity, the rainfall rate does not further increase when the saturation fraction reaches 78%, indicating that the model can't sustain high column humidity.

Fractional number of observations in each bin of the total number of observations



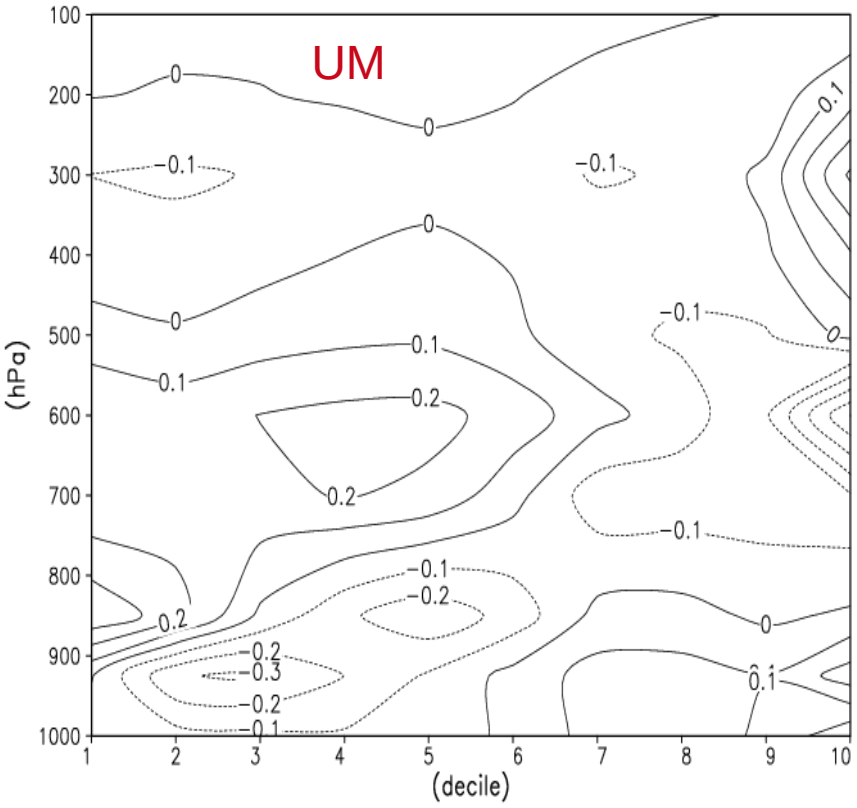
The distribution of occurrences in UM is more symmetric, peaks at 55% saturation fraction, and OBS shows more right skewed distribution.

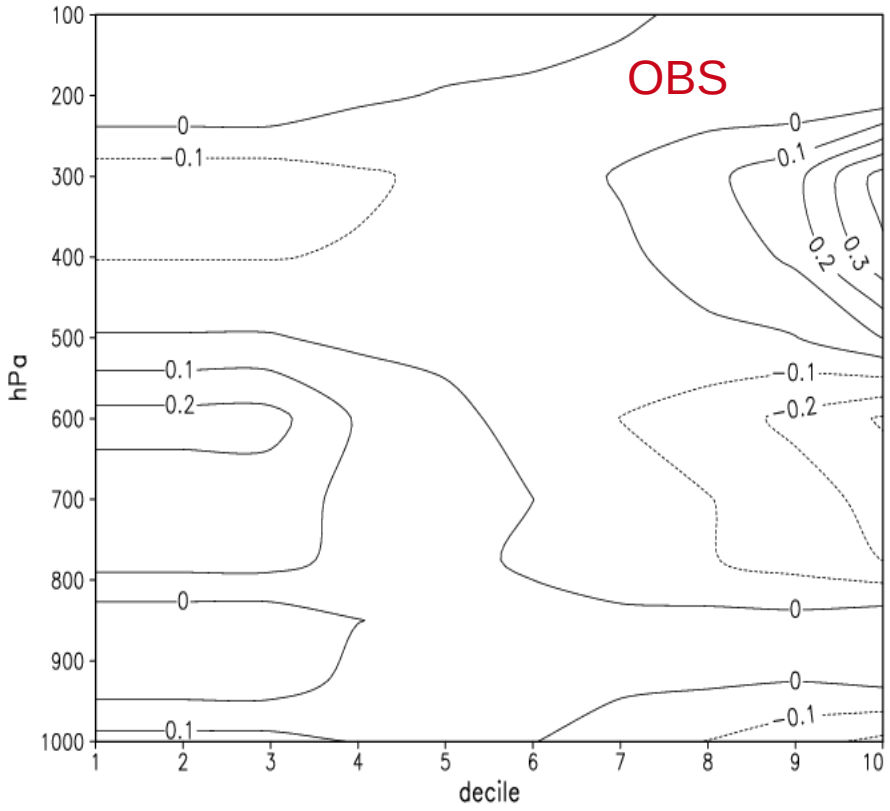
Mixing ratio anomaly (unit: kg/kg), binned by rainfall deciles for UM and OBS.



Similar to OBS, in UM precipitation is strongly related with tropospheric moisture anomaly, and humidity increases substantially over an increasingly deep layer with increasing rainfall, but less increase at higher levels in trop and more sensitivity to surface humidity.

Temperature anomaly binned by rainfall deciles for UM and OBS.

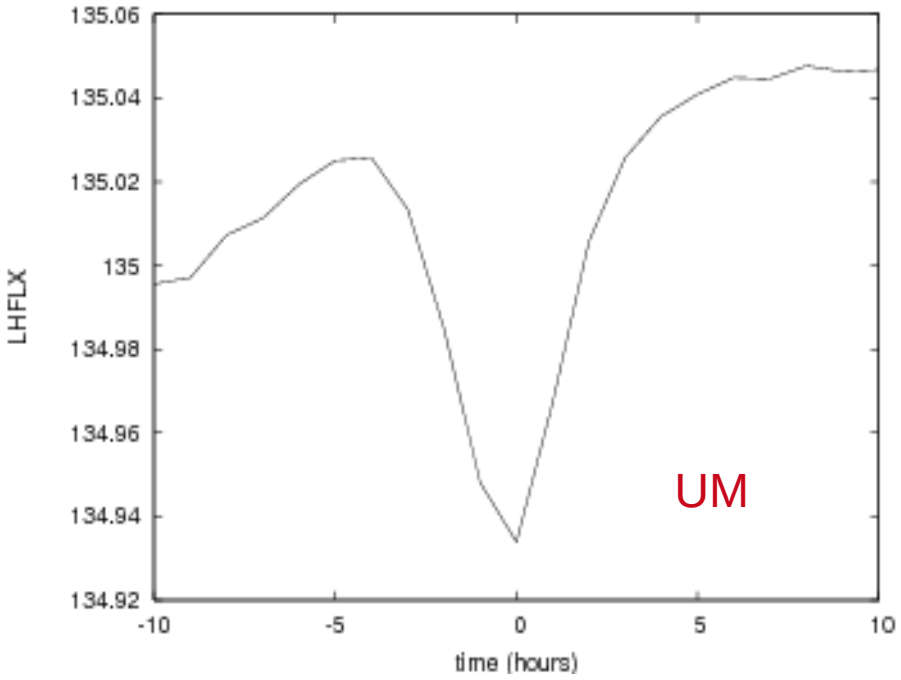


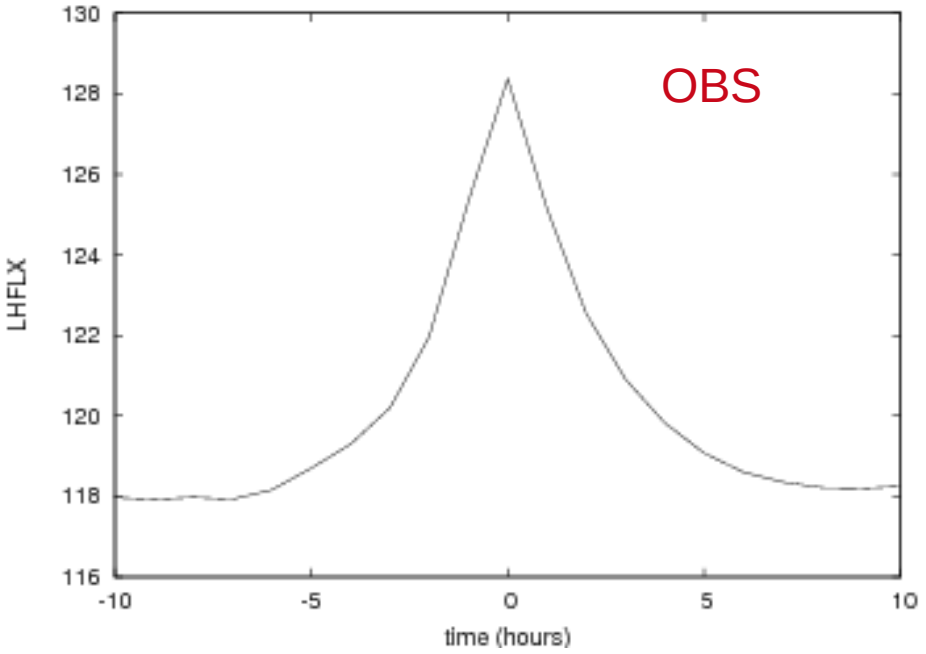


Instead of stratiform heat profile for strong rainfall as in OBS, the temperature profile in UM is indicative of a convective-dominated heating profile that should project onto faster wave modes.

The positive temperature in the BL indicates that the cooling effects of downdrafts are not obvious and the cooling center at 600 hPa might be due to the radiative effects at the frozen level in UM.

Daily mean LHFLX (W/m2) composited by the occurrence of daily mean precipitation rate greater than 8 mm d-1 for UM, and observation.





In OBS, latent heat flux increases the boundary layer entropy in phase with convection therefore promoting sustained convection; In UM, the latent heat flux doesn't vary, so does not act to sustain rainfall.

Hypothesis

1. Convection scheme may lack of self breaking mechanism which might indicate that mesoscale downdraft and unsaturated downdraft scheme needs to be implemented.

2. The precipitation tends to occur at the lower saturation fraction, which might because of less sensitivity of trigger and closure to the relative humidity (not enough entrainment/detrainment?).

3. Latent heat flux has little relationship with rainfall, which might due to a problem with boundary layer scheme or it is a consequence of convection scheme.

Weak Temperature Gradient framework of UM-SCM

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Adam Sobel

Introduction

1. Global climate models exhibit a number of major, long-standing deficiencies which caused by inadequacies in their moist physics.
2. The size and expense of AGCM simulations presents a serious obstacle to untangling the dynamics involved in producing these biases and complex sensitivities. Single column models (SCMs) have provided an economical way of examining model physics in a simpler setting.
3. SCM application in studying AGCM sensitivity is fundamentally limited by the lack of feedback between the model physics and advective tendencies of water vapor and temperature, which are typically treated as external
4. Recently a number of simple frameworks with the potential to capture dynamical (advection) feedbacks on SCM physics have been proposed

Weak Temperature Gradient (WTG) framework

$$w\partial\theta/\partial z = Q$$

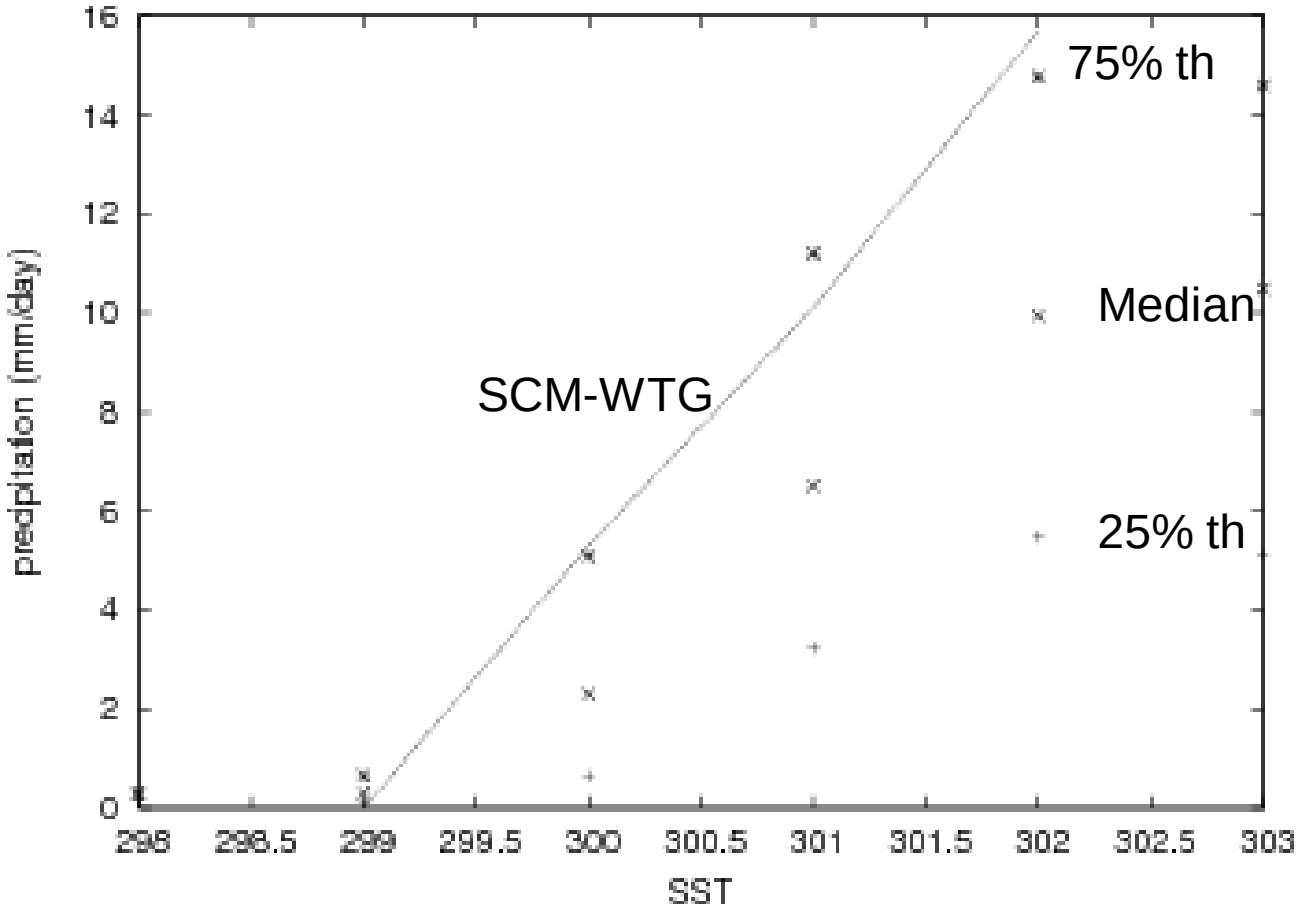
W- vertical velocity,

Z - height,

θ- potential temperature,

Q- total heating

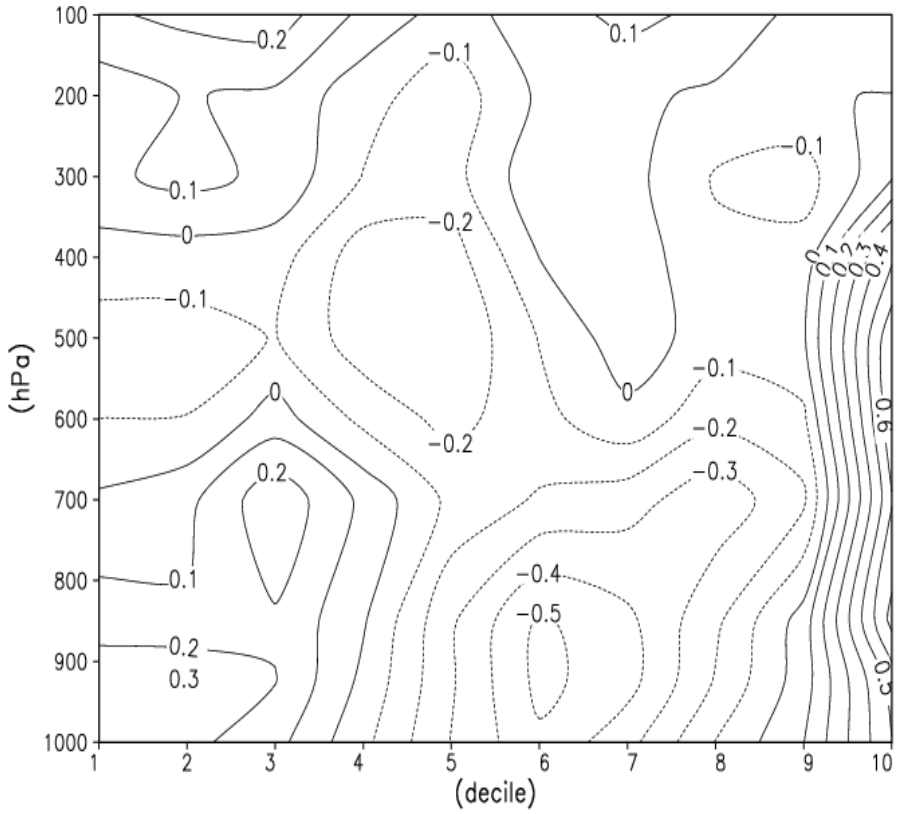
Precipitation rate relative to SST for SCM-WTG simulation and results from UM-GCM.



Future work

To understand and maximize the degree to which SCM can serve as surrogates for the full AGCM and its performance.

DU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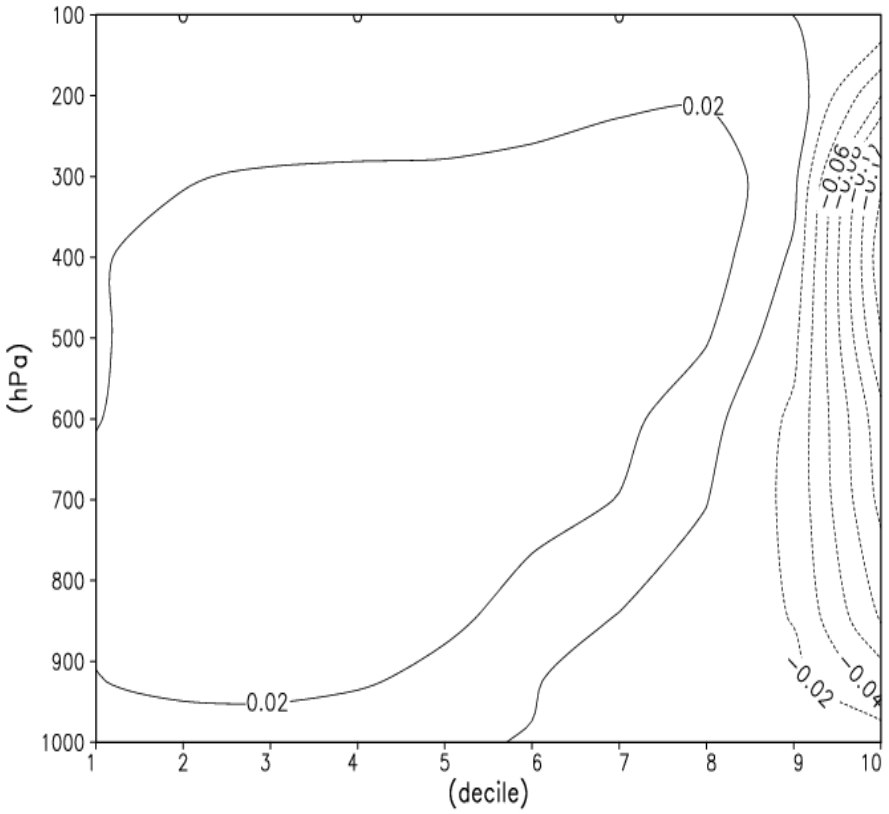
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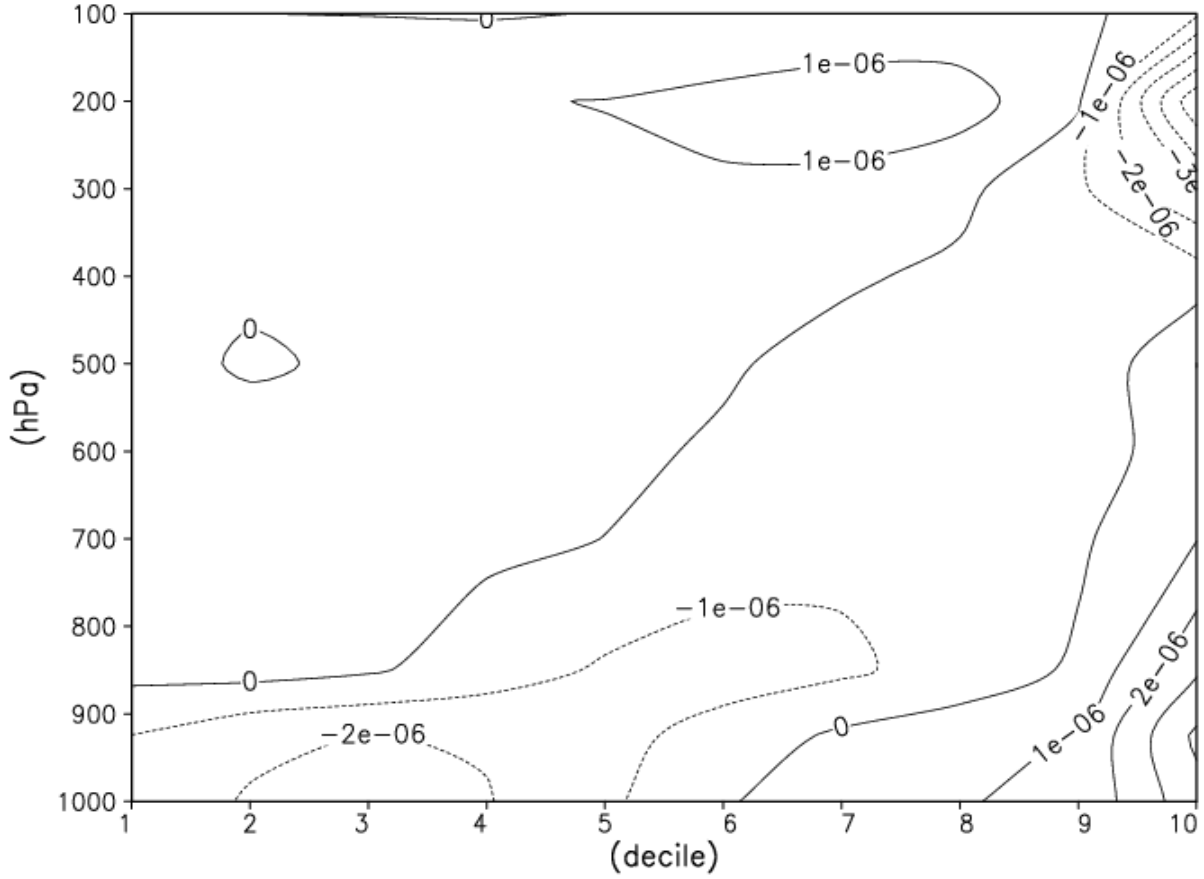
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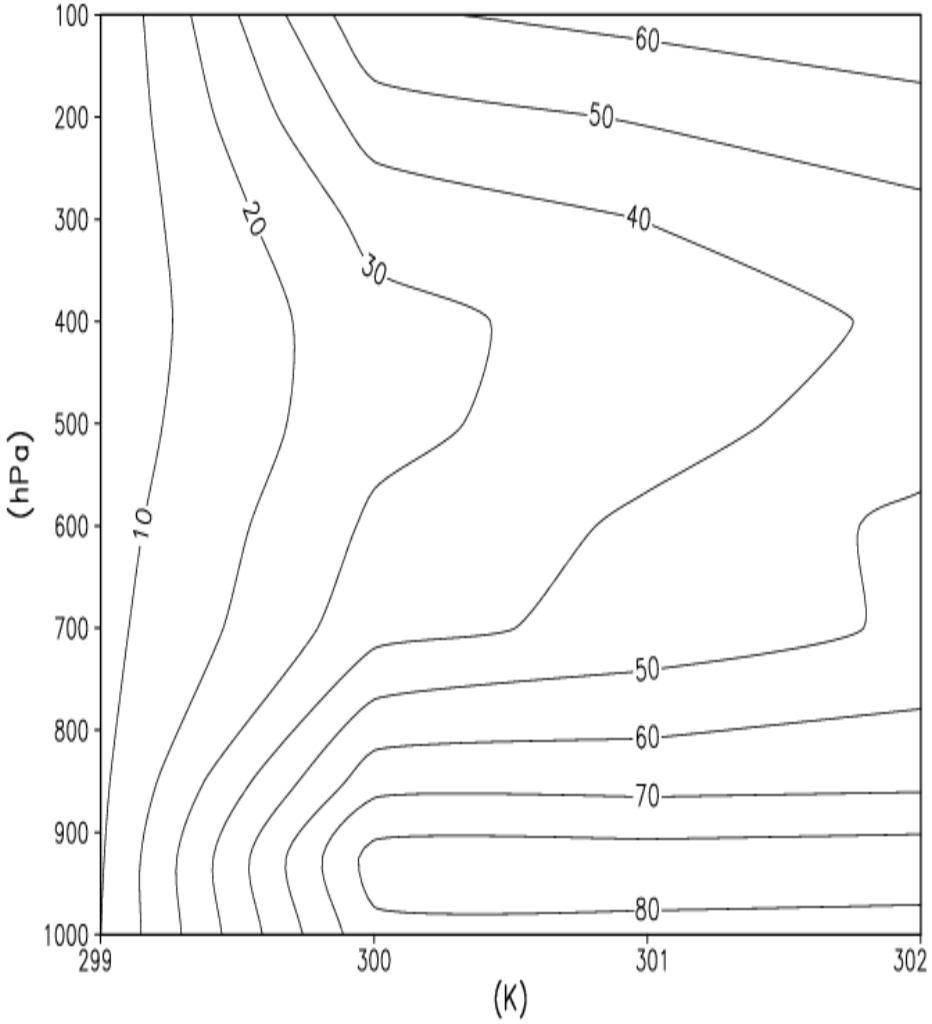

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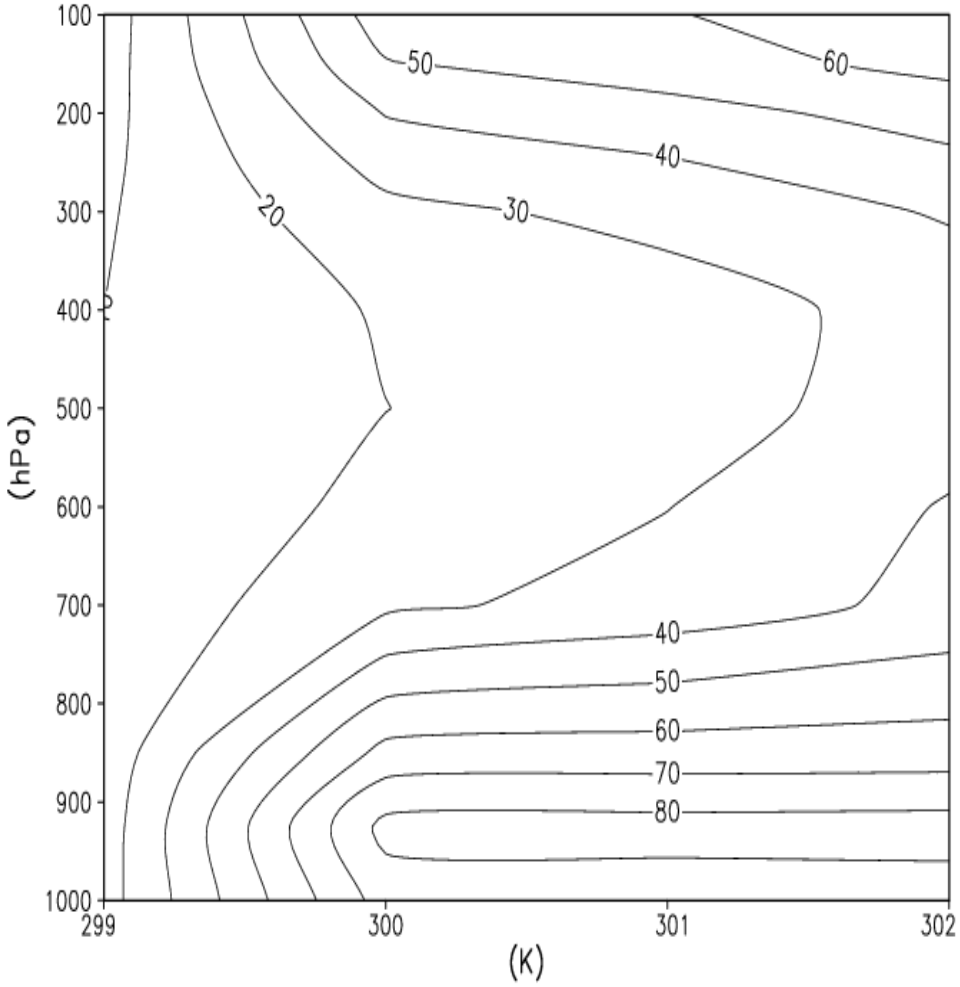

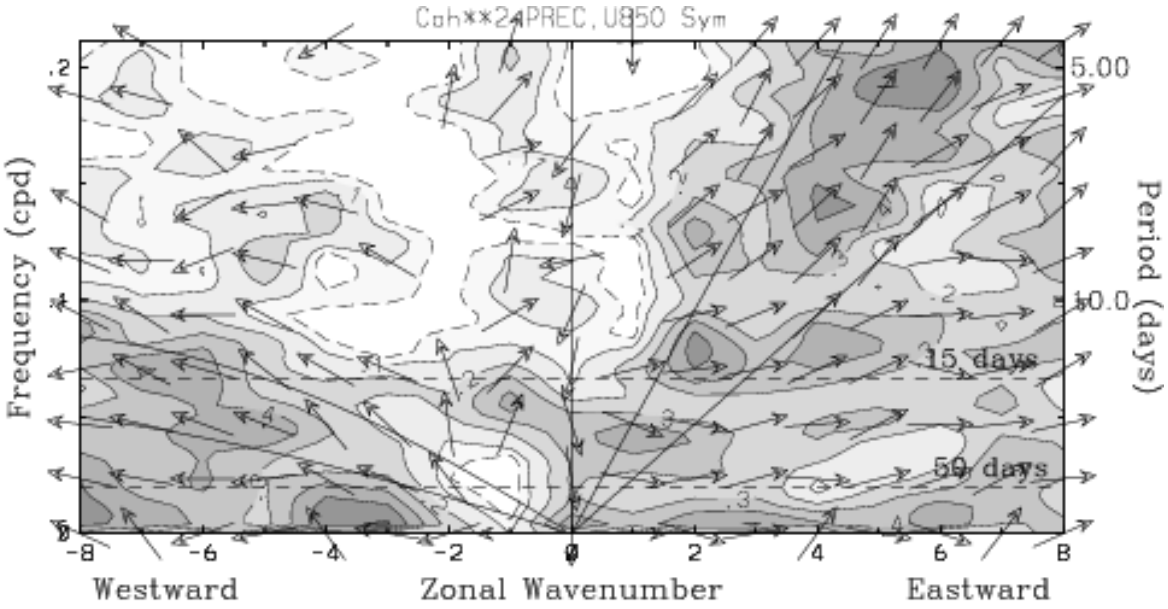

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