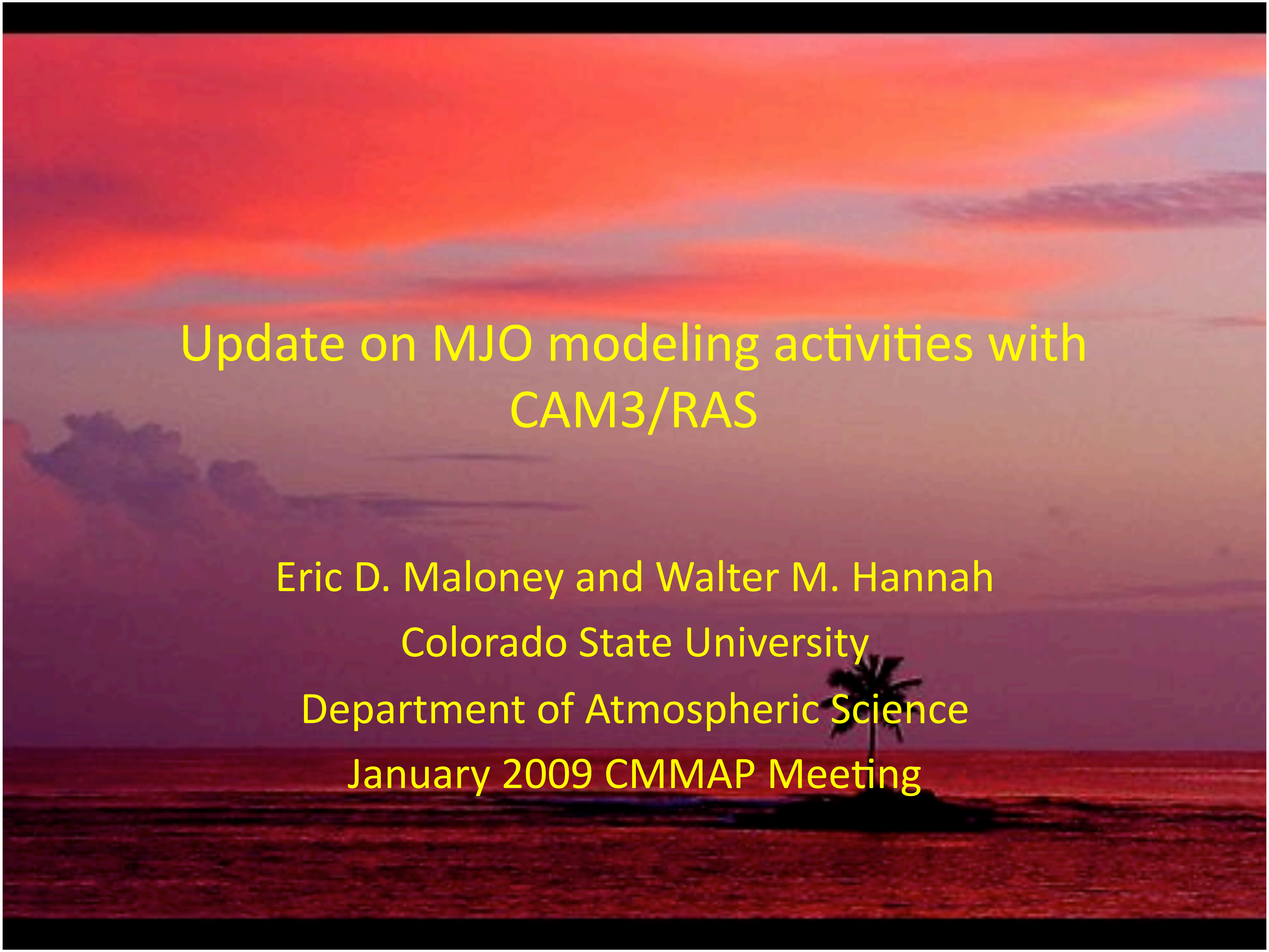

Update on MJO modeling activities with CAM3/RAS

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Outline

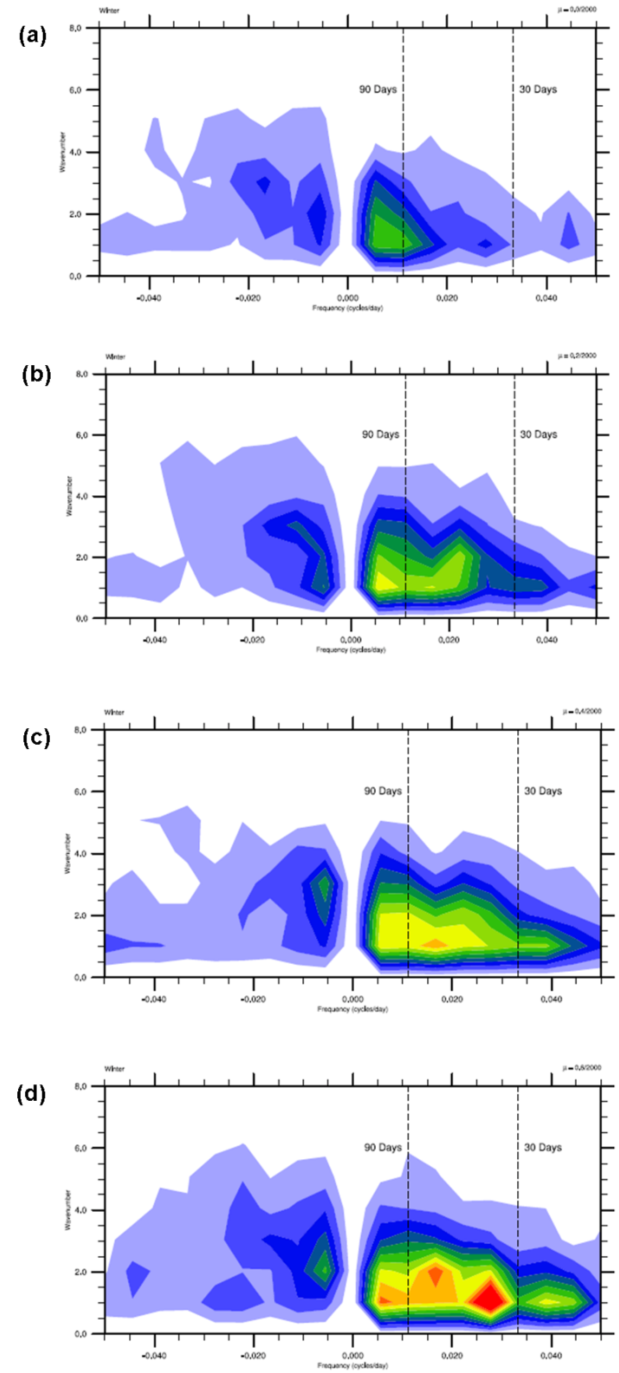
- Series of sensitivity tests with the CAM3.1 conventional GCM
- Building toward understanding why Tokioka et al (1988)-type modifications to convection schemes produce realistic MJOs
- Some work in progress, and some results from a recent paper: Maloney (2009)

Details of Experiments

- NCAR Community Atmosphere Model (CAM) Version 3.1, Relaxed Arakawa-Schubert (RAS) convection parameterization (with Tokioka-like minimum entrainment).
- Cloud members are defined by an entrainment parameter, with the lowest entrainment rates for the highest clouds
- We impose a series of minimum entrainment thresholds, below which cloud members are not allowed to exist (0, 0.2/2000, 0.4/2000, 0.6/2000 m^{-1})
- We build towards understanding why the model produces a reasonable MJO with imposition of a minimum entrainment threshold

850 hPa Wind Spectra

- Intraseasonal variance monotonically increases as minimum entrainment parameter is increased
- Consistent with previous studies using Tokioka-like parameterization modifications
- May begin to saturate?



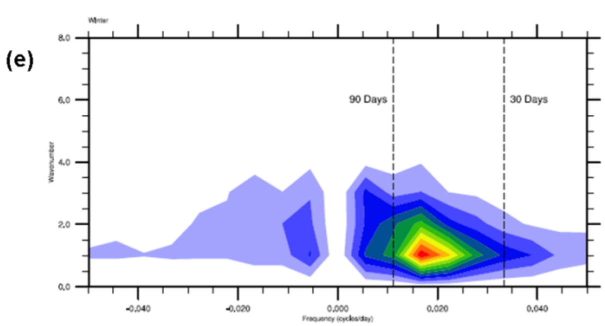
μ=0.0

μ=0.2

μ=0.4

μ=0.6

Observations (NCEP)



Variance Ratios

Eastward vs. westward

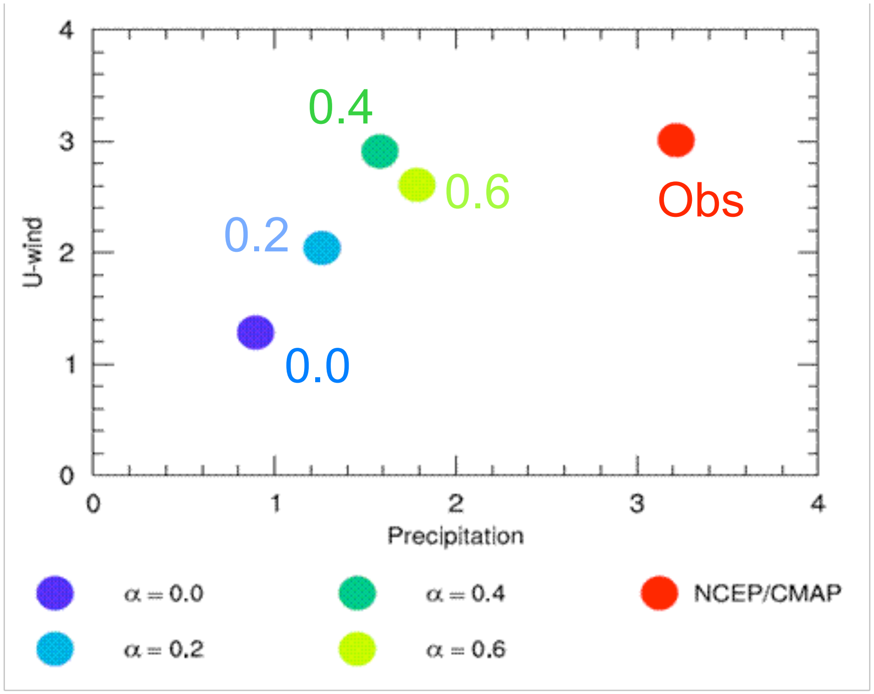


Figure 4. Ratios of boreal winter eastward to westward spectral power for wavenumbers 1-4 and 30-90 day periods.

Eastward vs. observations

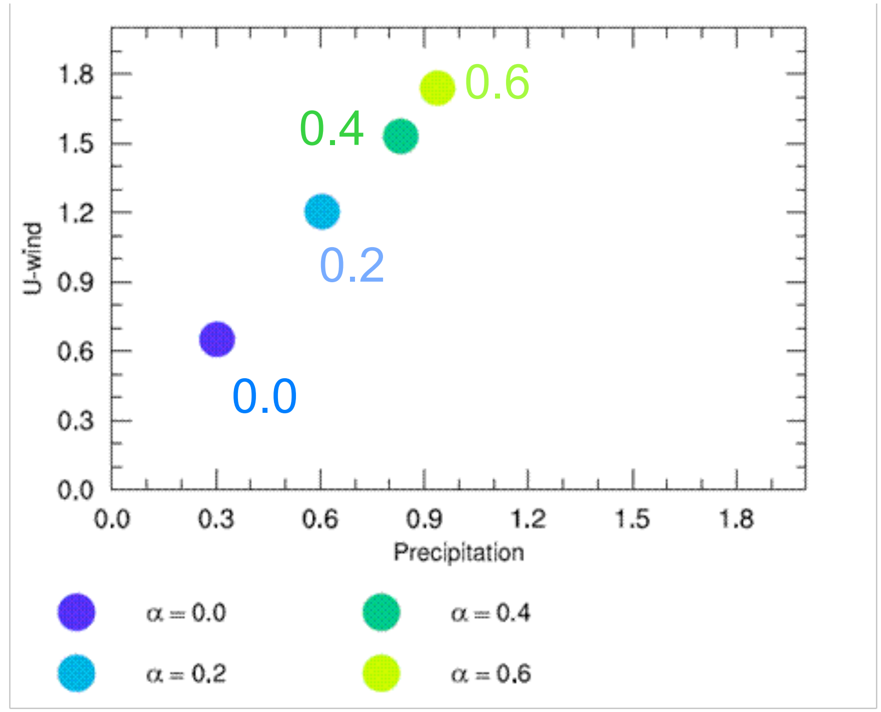
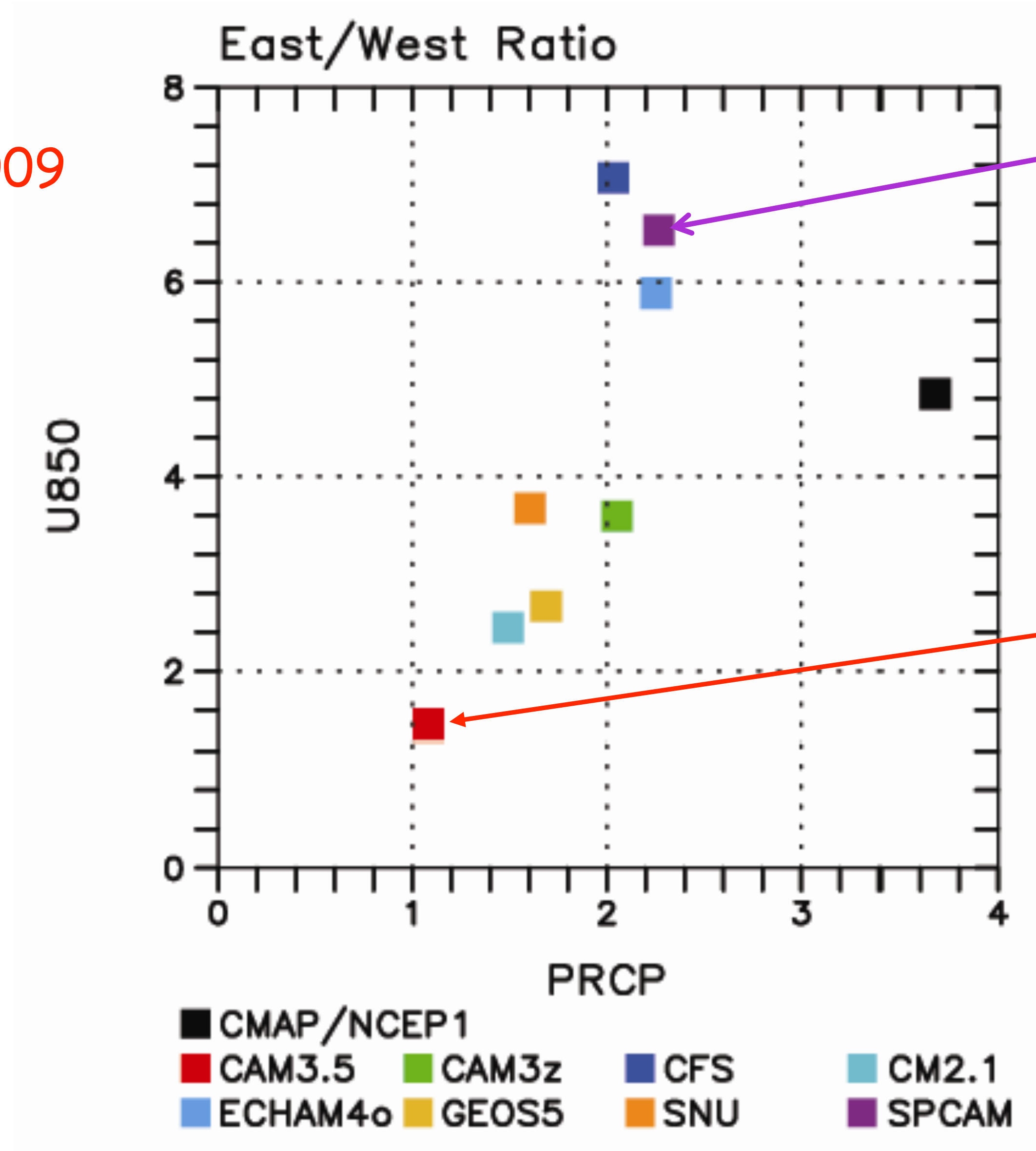


Figure 5. Ratios of boreal winter model eastward spectral power to observed for wavenumbers 1-4 and 30-90 day periods.

Variance Ratios in Other Models

Kim et al. 2009



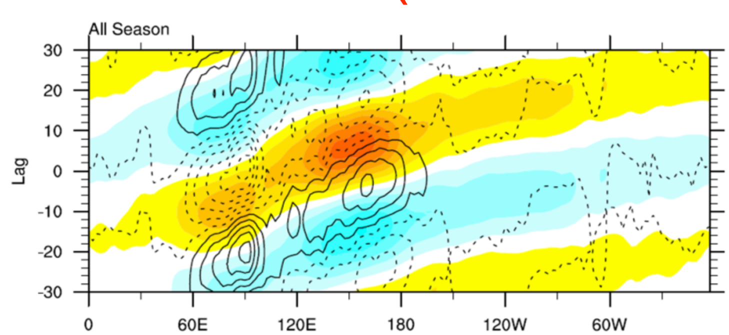
SPCAM

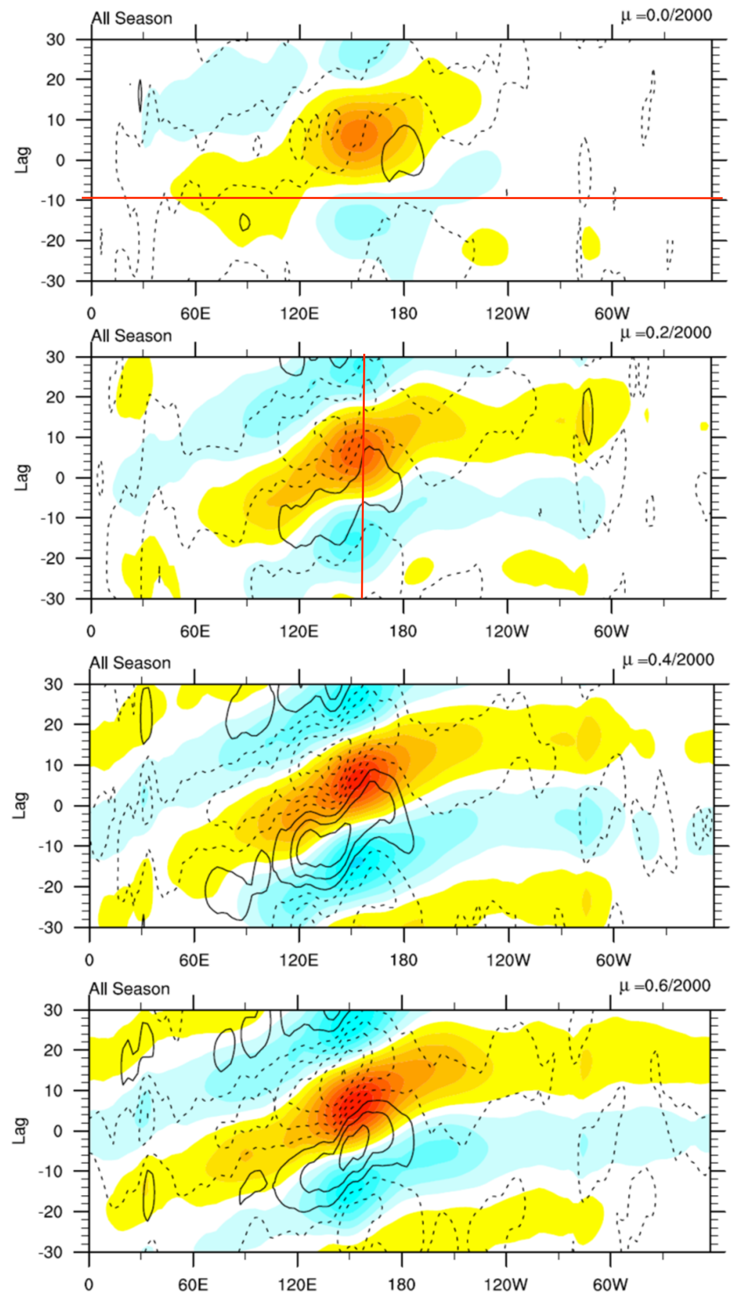
CAM3.5

Composite 850 hPa Wind, Precip

- With exceptions of continued weaknesses in the Indian Ocean, composite winds and precipitation in the models with stronger minimum entrainment thresholds are most realistic

Observations (NCEP/CMAP)





μ=0.0

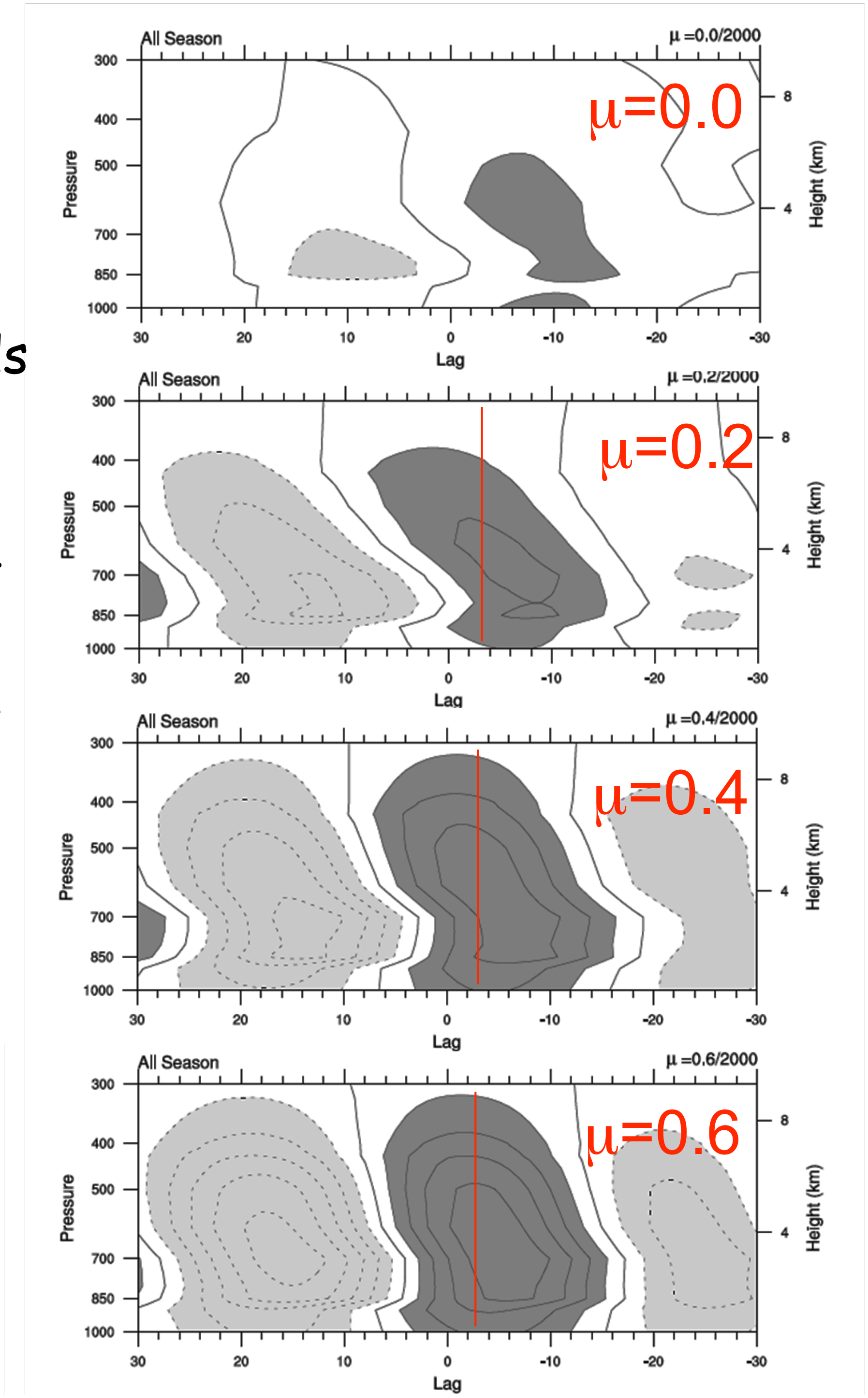
μ=0.2

μ=0.4

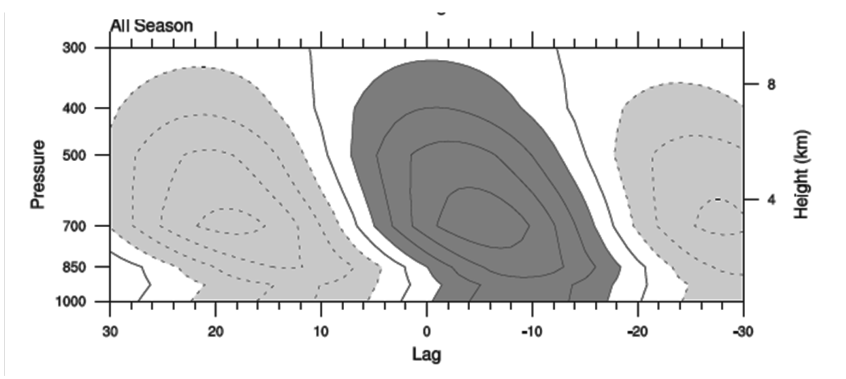
μ=0.6

Specific Humidity Composites

- Hypothesis is that higher minimum entrainment thresholds allow higher sensitivity of the scheme to free trop. humidity
- Results seems to bear out that lower tropospheric humidity accumulates in the scheme with higher thresholds

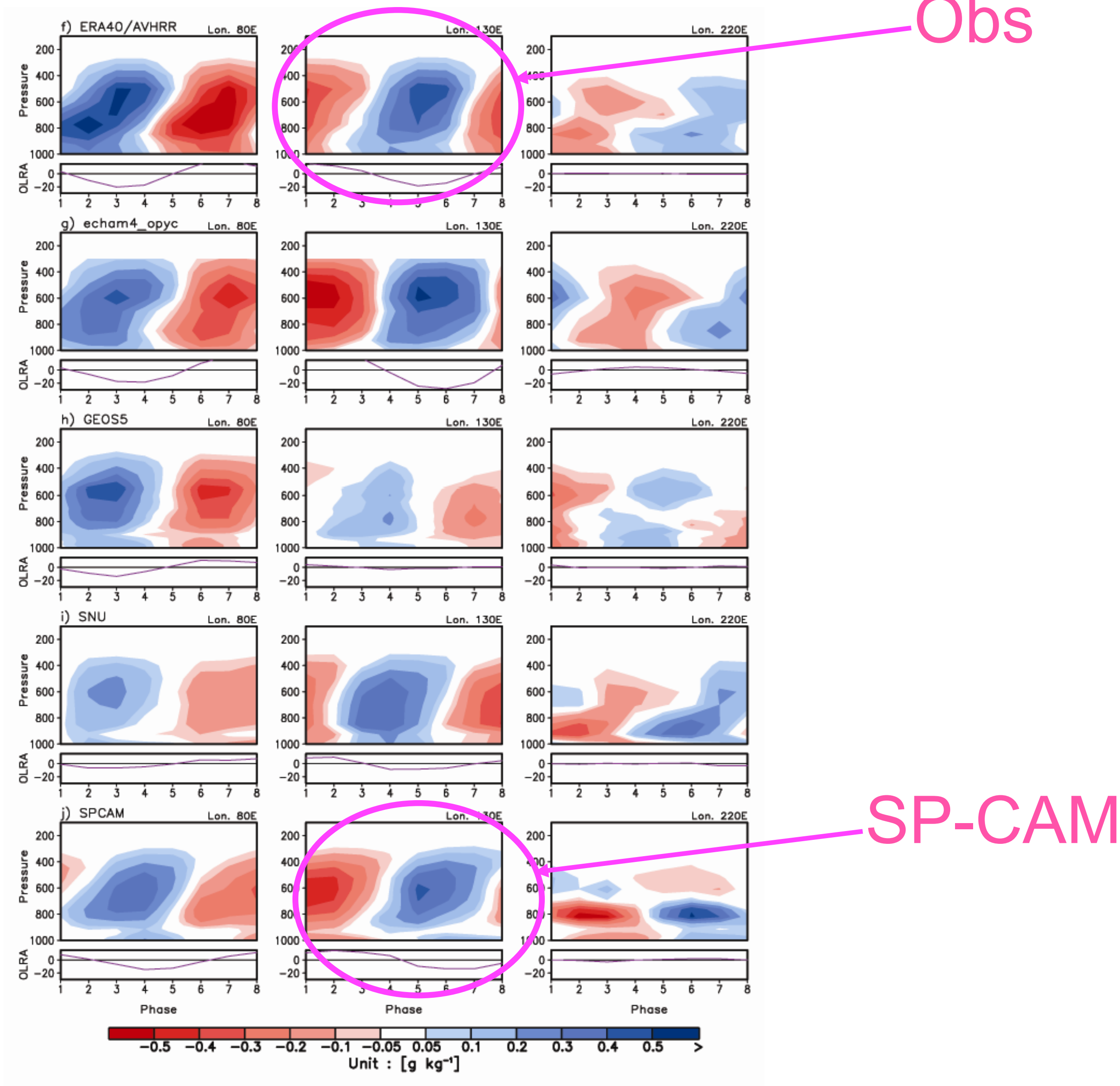


Observations (ERA40)



Models Typically Have a Difficult Time Capturing this Moisture Structure

Kim et al. 2009



What's Causing the Moistening? Partitioning of Moist Static Energy Budget (Vertical Integral)

Vertical Integral

$$\left\langle \frac{\partial m}{\partial t} \right\rangle_{ISO} = -\left\langle \omega \frac{\partial m}{\partial p} \right\rangle_{ISO} - \left\langle \vec{v} \cdot \nabla m \right\rangle_{ISO} + LH_{ISO} + SH_{ISO} + \Delta SW_{ISO} + \Delta LW_{ISO}$$

30-90 Day Anom.

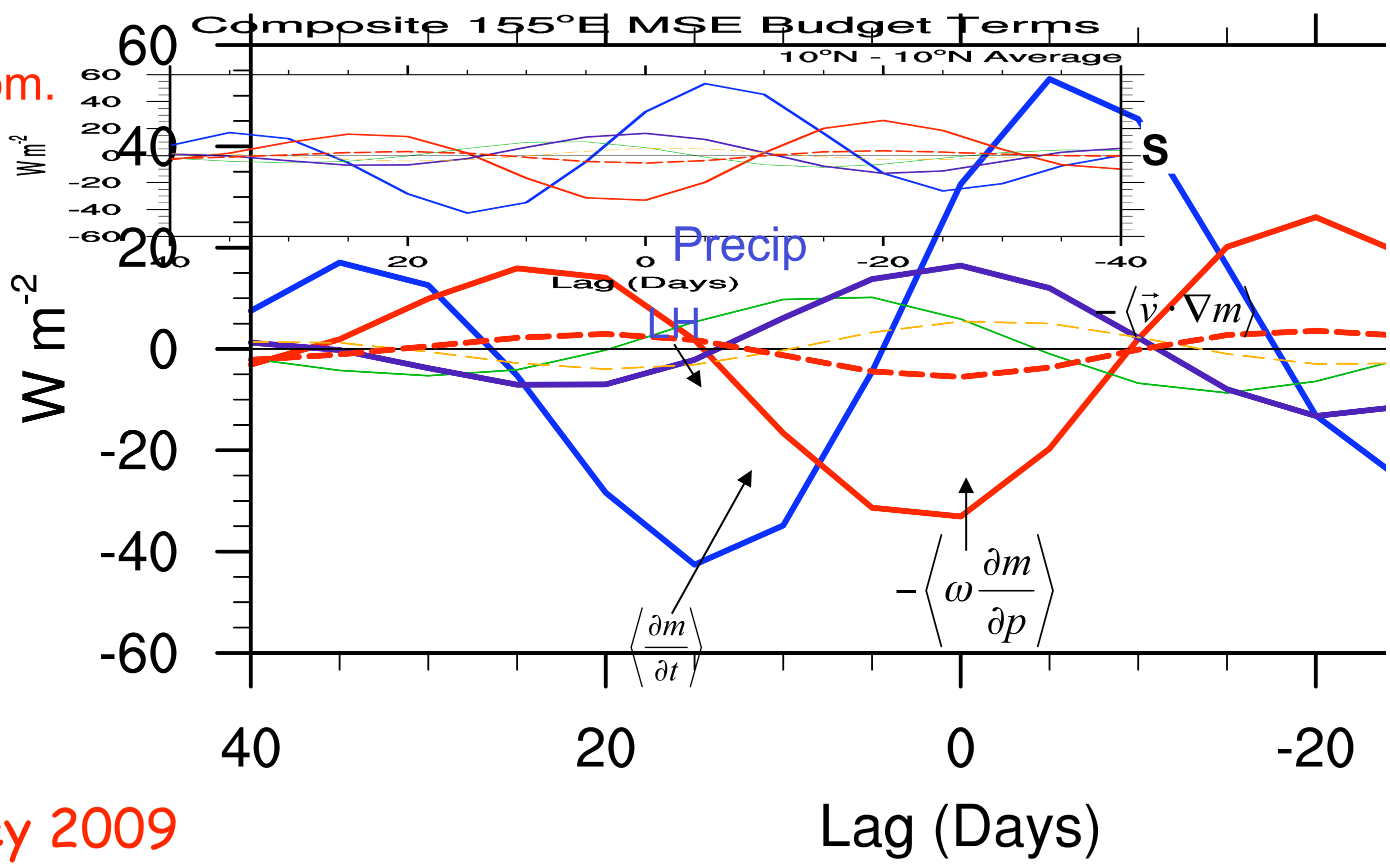
Vertical advection

Horizontal advection

Surface Latent and Sensible Heat Flux

Shortwave Flux Convergence

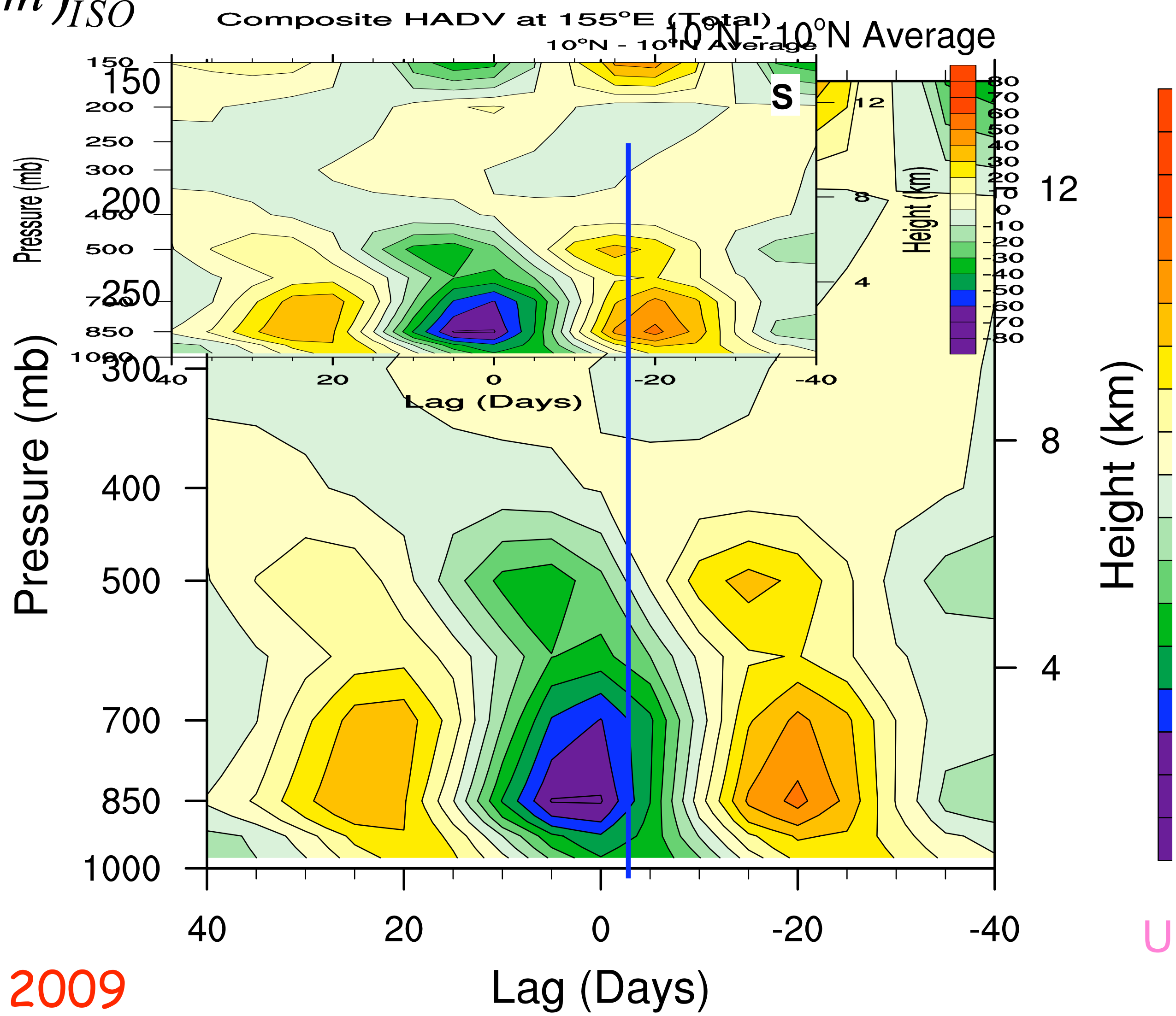
Longwave Flux Convergence



Maloney 2009

Vertical Distribution of Horizontal Advection Anomalies

$$-\left(\vec{v}\cdot\nabla m\right)_{ISO}$$



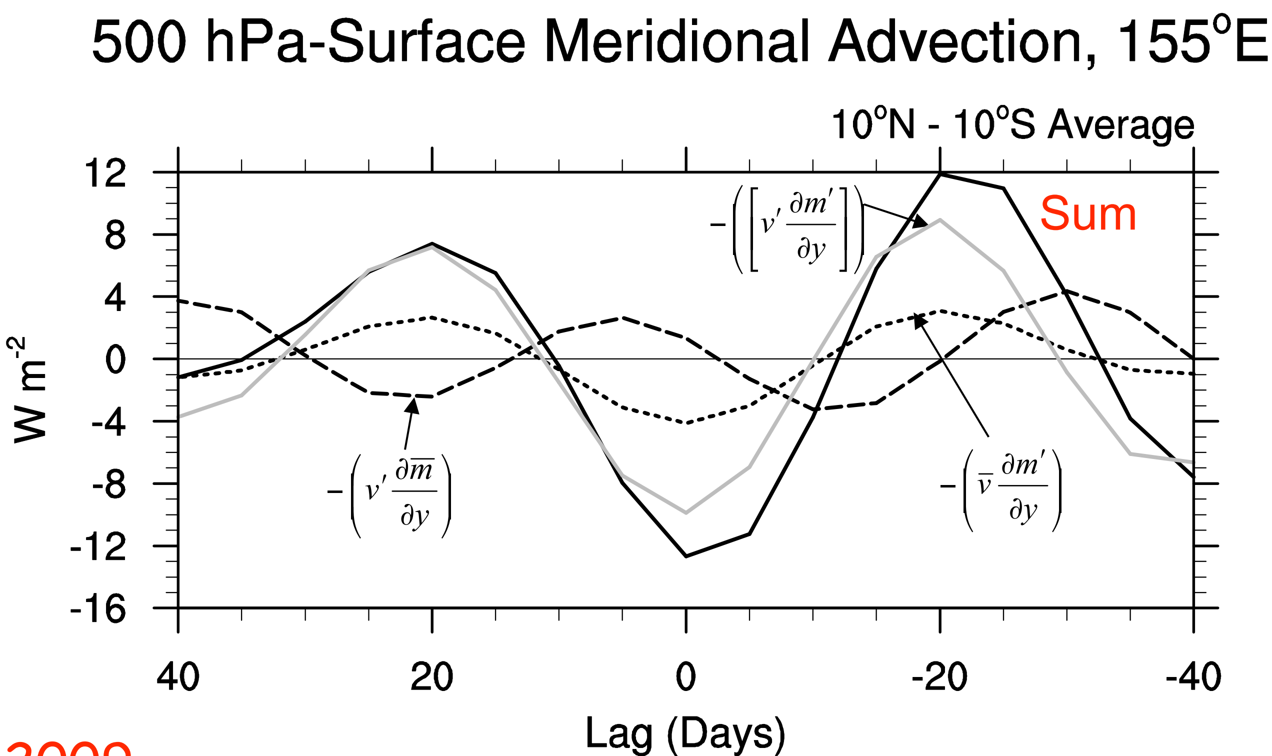
Units: 10^{-4} W kg^{-1}

Maloney 2009

Partitioning of Meridional Component of HADV

$$-\left(v\frac{\partial m}{\partial y}\right)_{ISO} \approx -\left(\overline{v}\frac{\partial m'}{\partial y}\right)_{ISO} -\left(v'\frac{\partial \overline{m}}{\partial y}\right)_{ISO} -\left(\left[v'\frac{\partial m'}{\partial y}\right]\right)_{ISO}$$

$\overline{a}$ = 50-day avg. a' is the deviation from the 50-day avg.

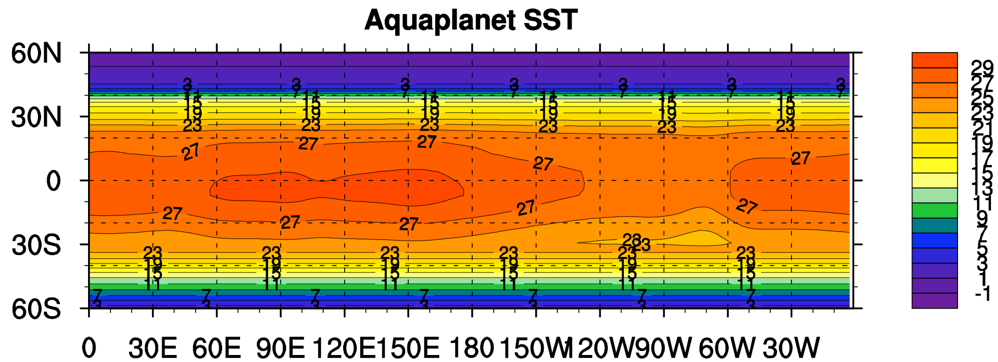


Maloney 2009

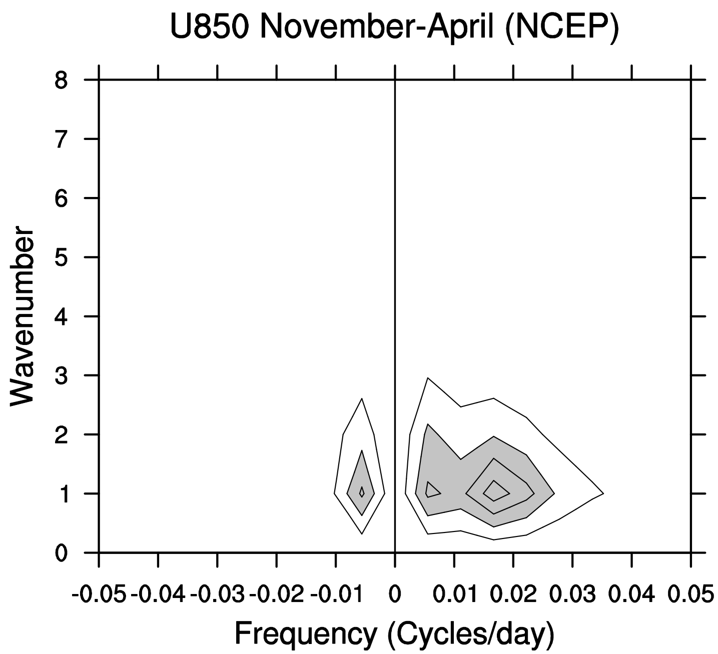
Future Work

- Advanced diagnosis
  - Moisture versus temperature regulation of model entrainment rates
  - Evolution of cloud populations, convective mass flux, cloud work functions versus MJO phase
  - How convective suppression might regulate phase relationships between convection and thermodynamic fields and thus energetics (e.g. WISHE)
  - More general diagnosis of convection versus tropopsheric humidity and comparisons to SP-CAM
  - Aquaplanet

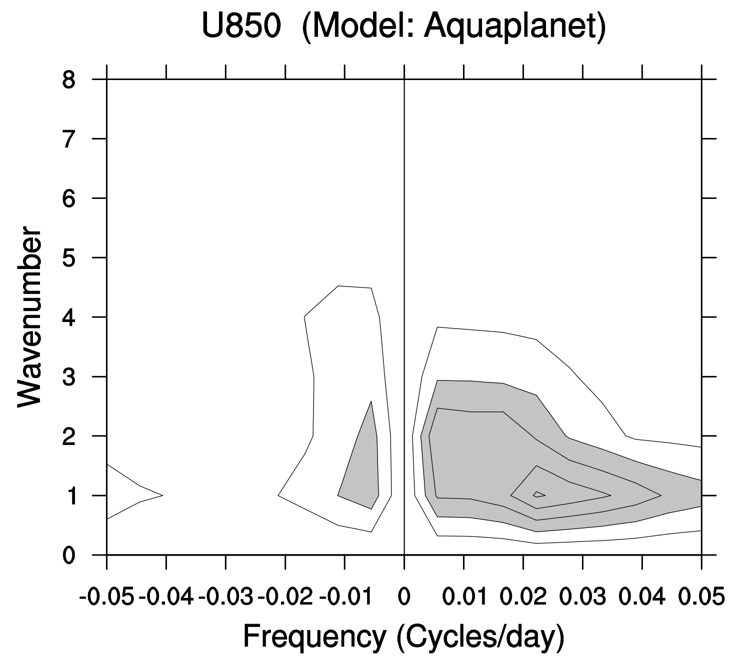
Aquaplanet Simulations



Observations (NCEP/CMAP)



Model




Thanks!