

# modeling stratocumulus in GFS

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# NCEP GFS

- \* The shallow convection parameterization is applied wherever the deep convective parameterization is not active
- \* Shallow convection is enhanced vertical diffusion in the cloud layers
- \* Cloud top is defined as the layer above the highest positive buoyant layer below  $P_t$  ( $P_t = 0.7 * P_{sfc}$ )
- \* Background diffusion

# A simple method to improve stratocumulus representation

- \* The background vertical diffusion coefficient is set to zero above inversion (ZeroBD)
- \* If the condition for cloud top entrainment instability (CTEI) is not satisfied the top of the shallow convection is set to just below inversion. If satisfied operational method is used to determine cloud top (CTEI)

\* CTEI condition:  $C_p \Delta \bar{\theta}_e < 0.7 L \Delta \bar{q}_t$

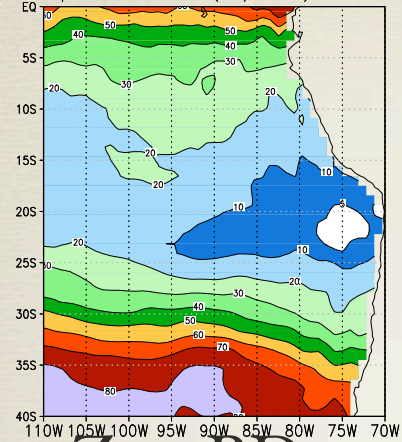
# Experiments

- \* **Ctl** (operational GFS with RAS)
- \* **New** (CTEI + zeroBD)
- \* **ZeroBD** (Ctl + zeroBD)
- \* **CTEI** (CTEI)
- General settings used in all experiments:
  1. resolution: T126 and 64 levels
  2. observed SST
  3. two-month simulations started at 2008061300

# Total cloud (July)

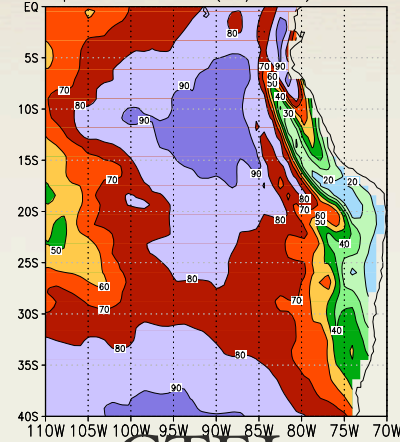
## Ctl

set31p1 GFS tot cld (07/2008)



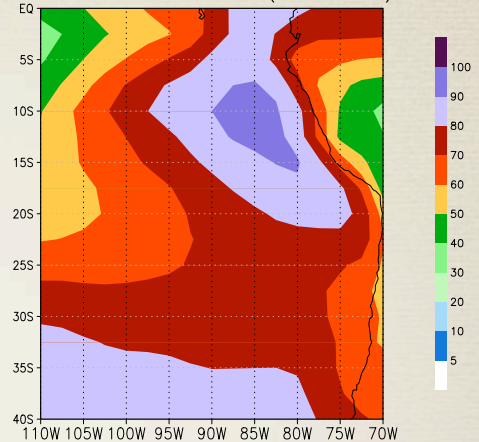
## New

set31p1 GFS tot cld (07/2008)



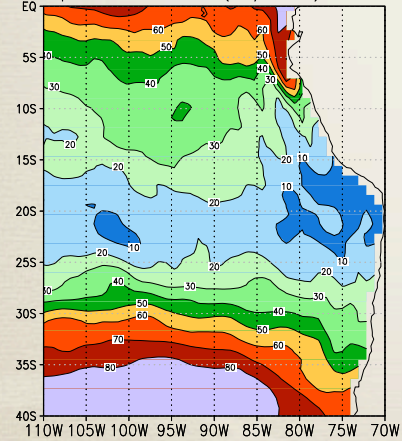
## ISCCP

ISCCP JUL tcdclm CLM (1985-1993)



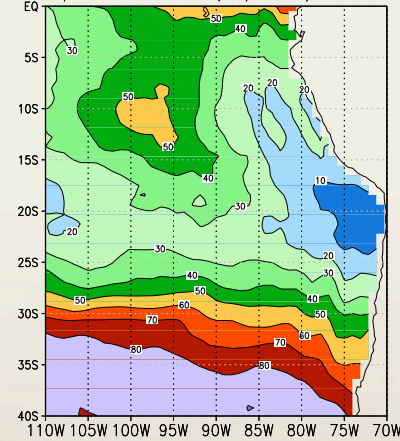
## ZeroBD

set31p0 GFS tot cld (07/2008)



## CTEI

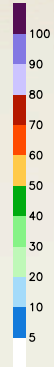
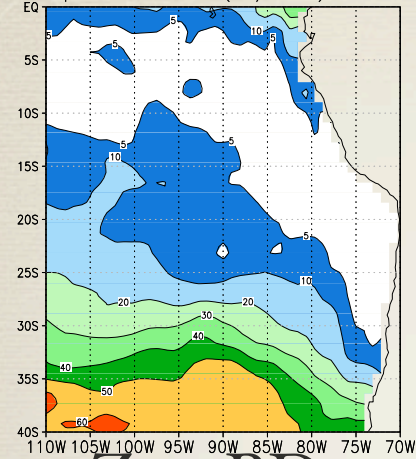
set31p3 GFS tot cld (07/2008)



# Low cloud

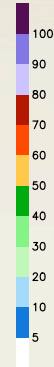
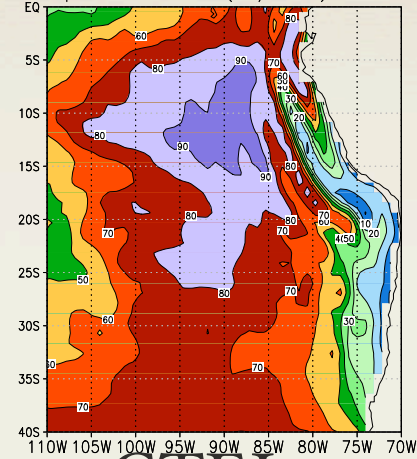
## Ctl

set31pc GFS low cld (07/2008)



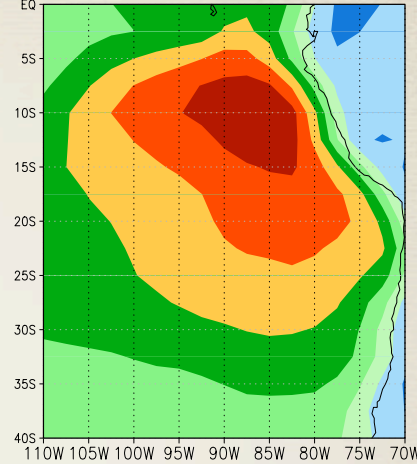
## New

set31p1 GFS low cld (07/2008)



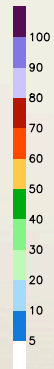
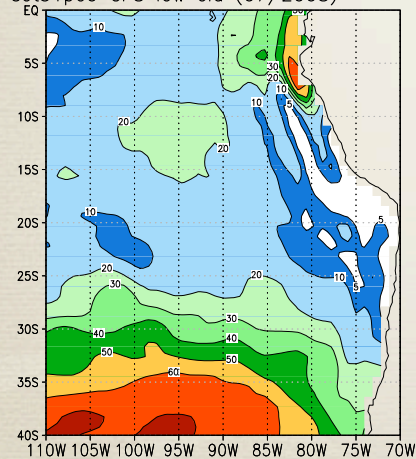
## ISCCP

ISCCP JUL tcdcl CLM (1985-1993)



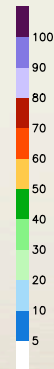
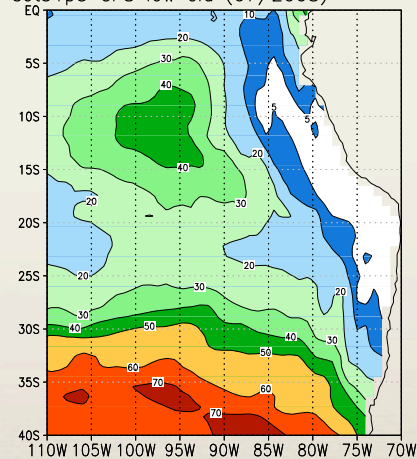
## ZeroBD

set31pc0 GFS low cld (07/2008)



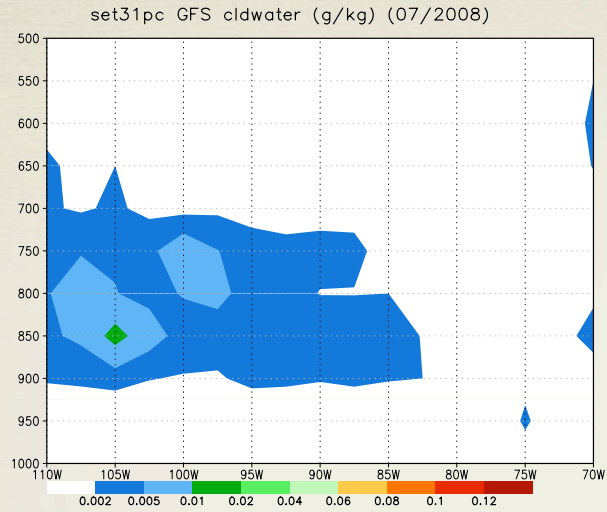
## CTEI

set31p3 GFS low cld (07/2008)

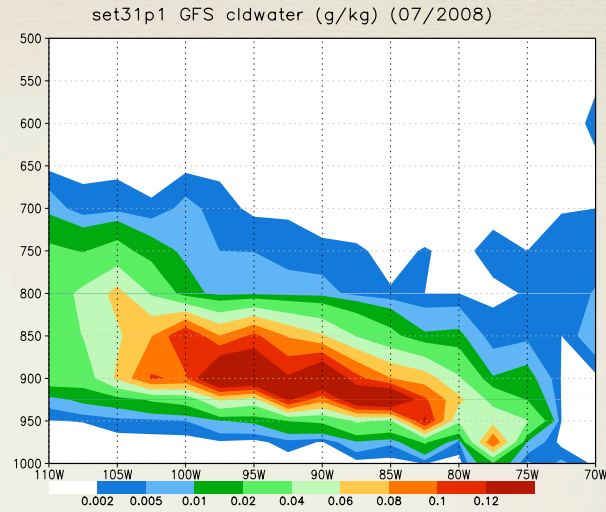


# xz cloud water (20S)

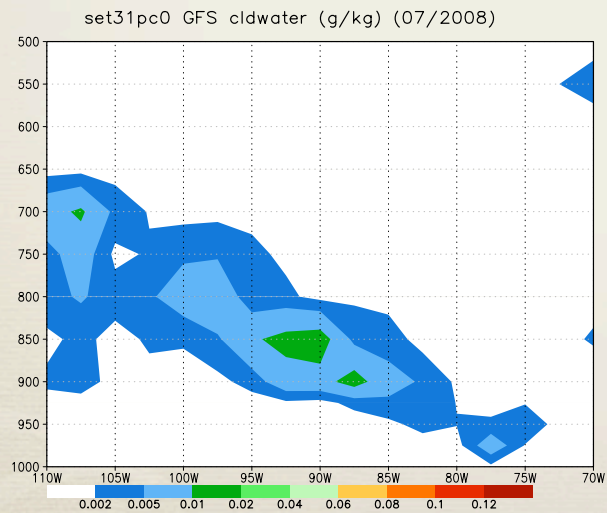
Ctl



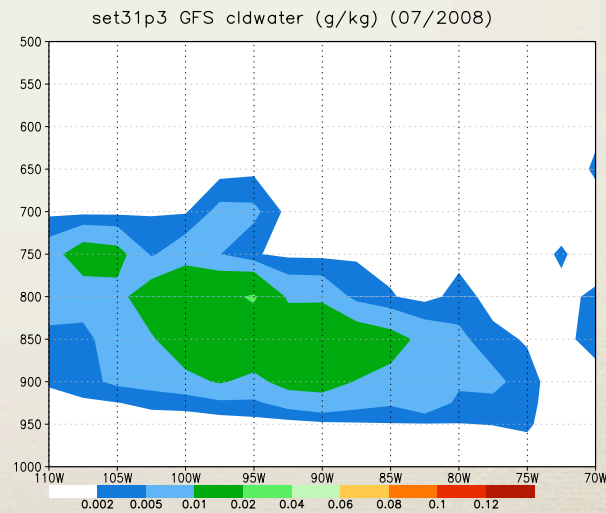
New



ZeroBD

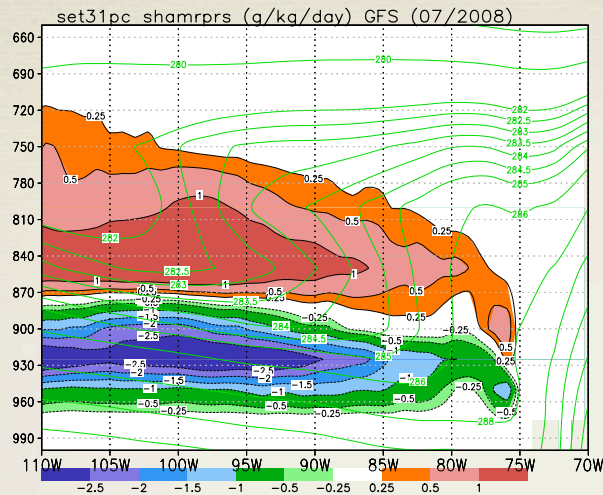


CTEI

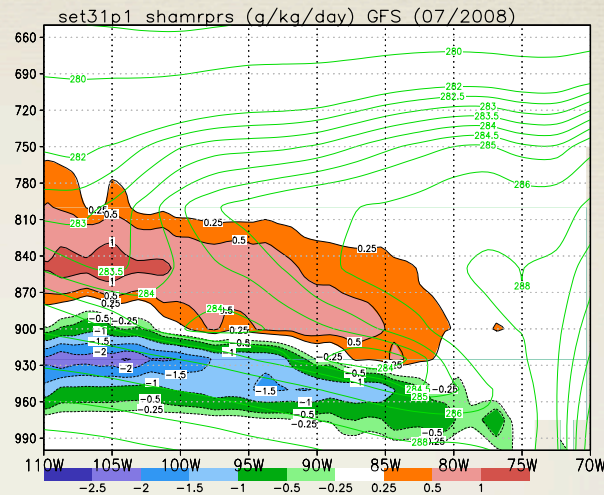


# xz shallow moistening (20S)

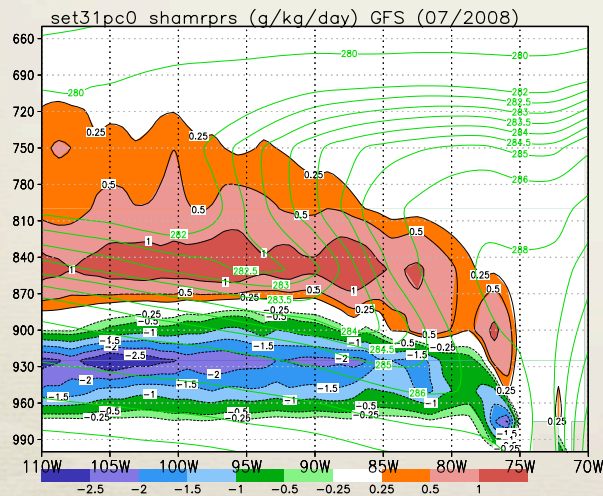
Ctl



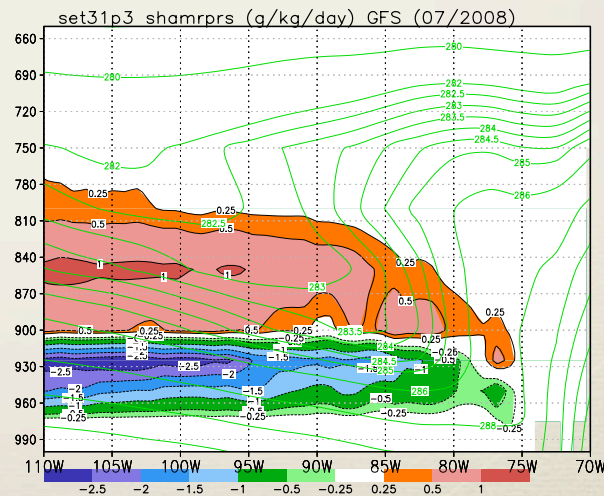
New



ZeroBD



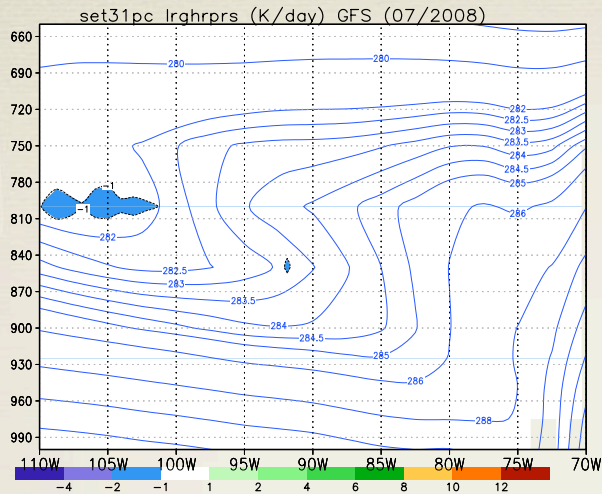
CTEI



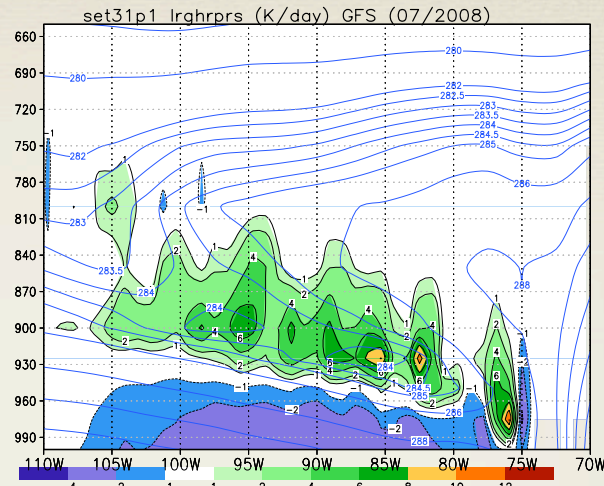


# xz LS condensation (20S)

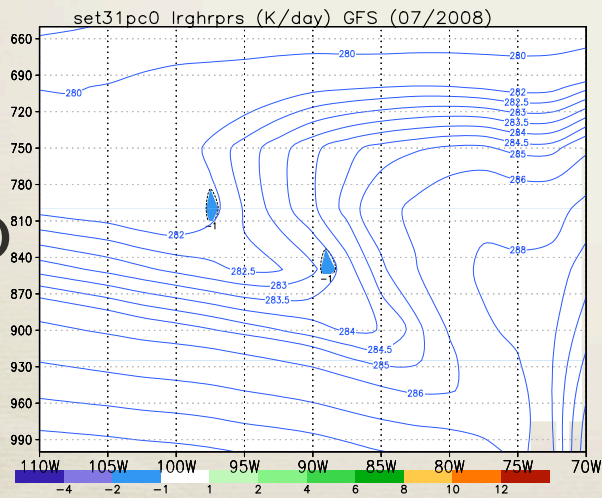
Ctl



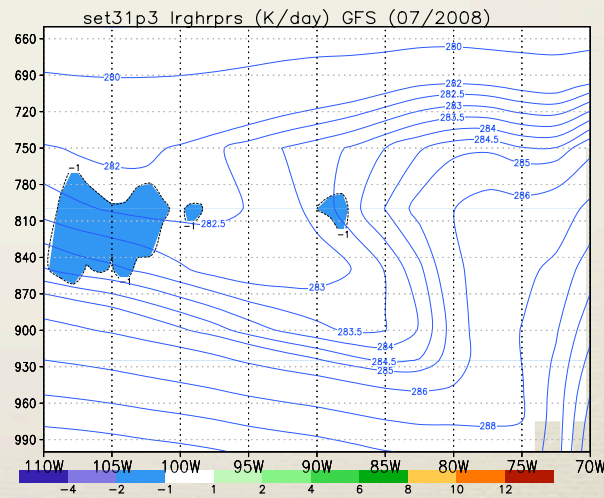
New



ZeroBD

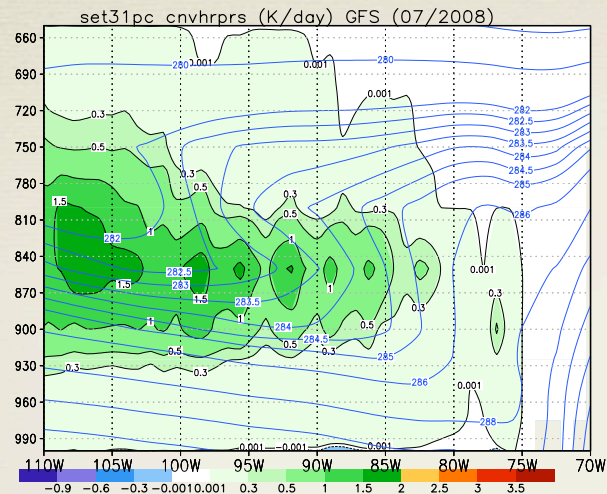


CTEI

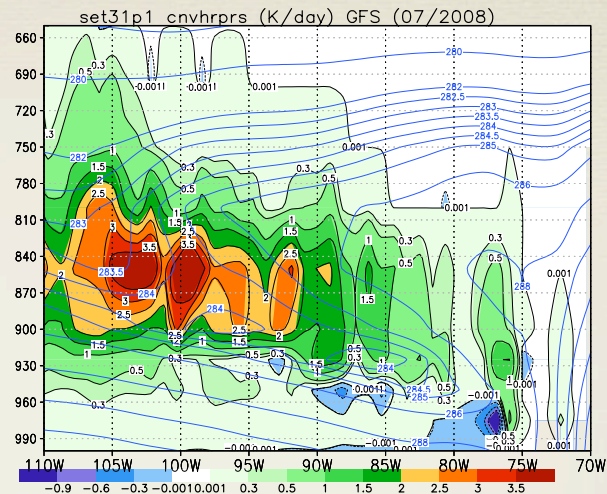


# xz conv heating RAS (20S)

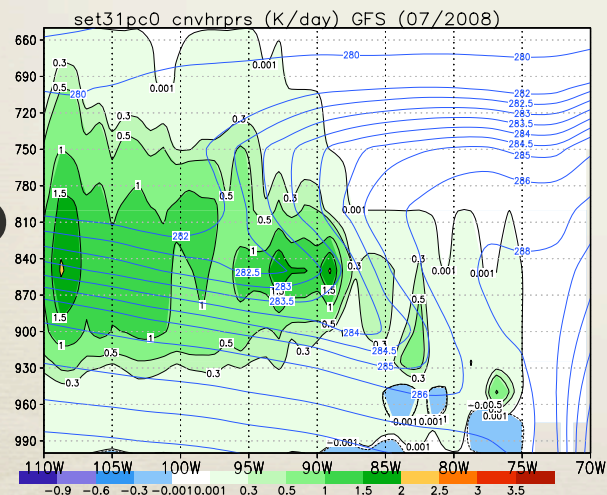
Ctl



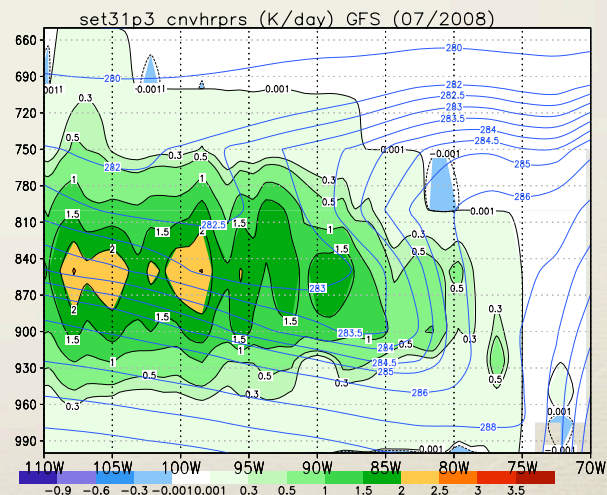
New



ZeroBD

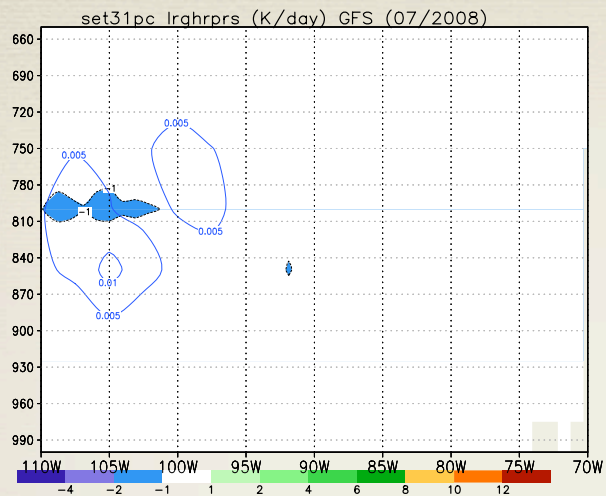


CTEI

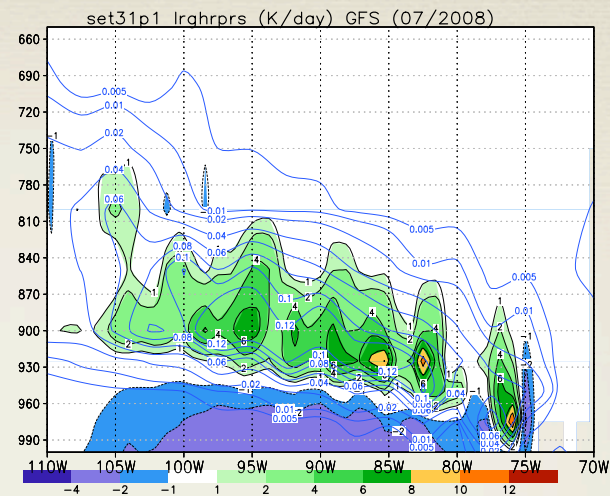


# xz LS condensation (20S)

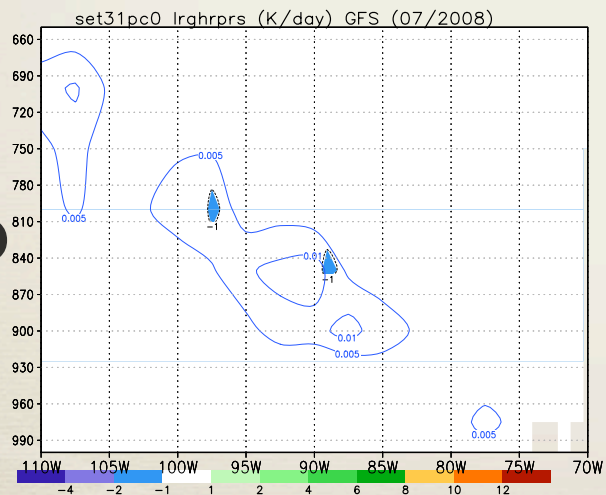
Ctl



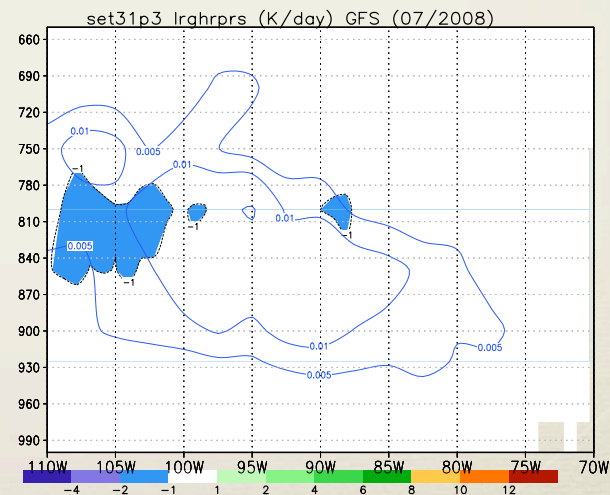
New



ZeroBD

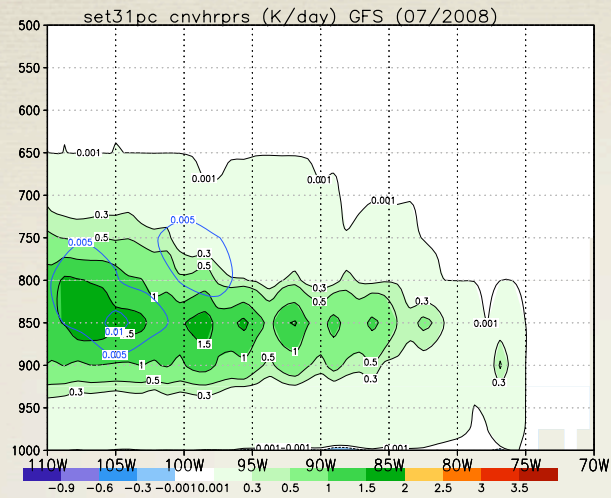


CTEI

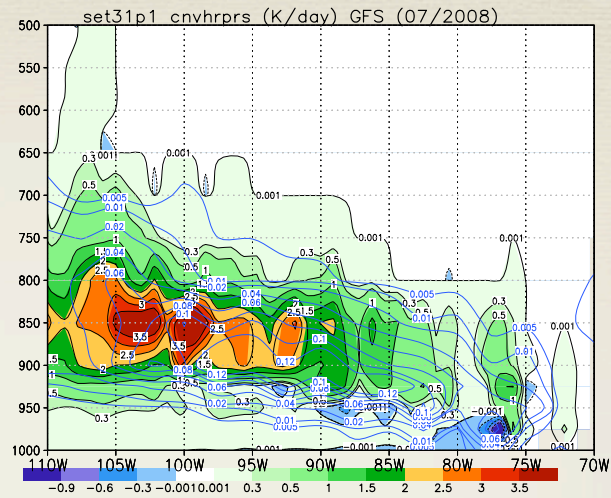


# xz conv heating (20S)

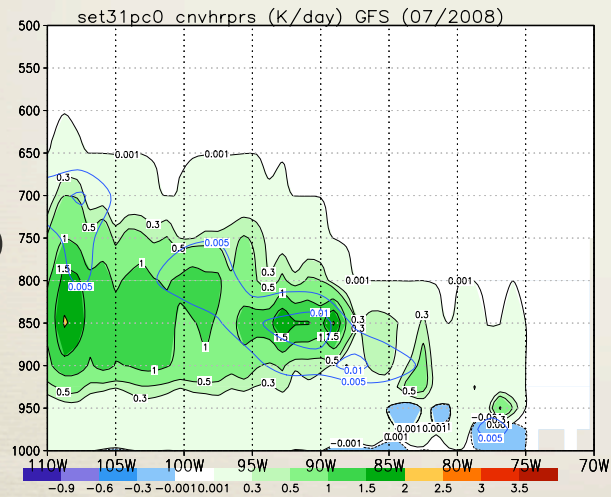
Ctl



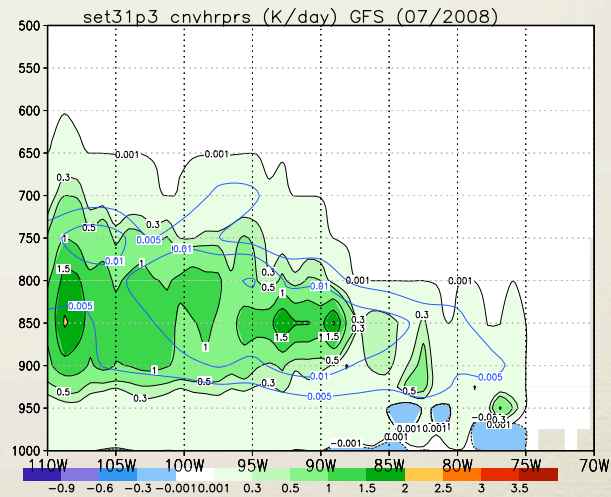
New



ZeroBD



CTEI

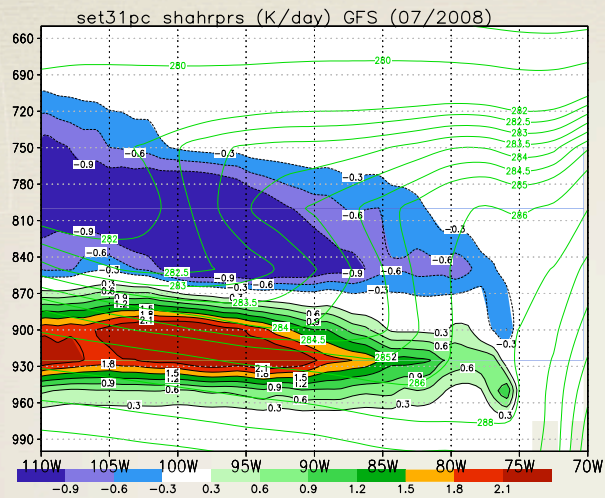


# Summary

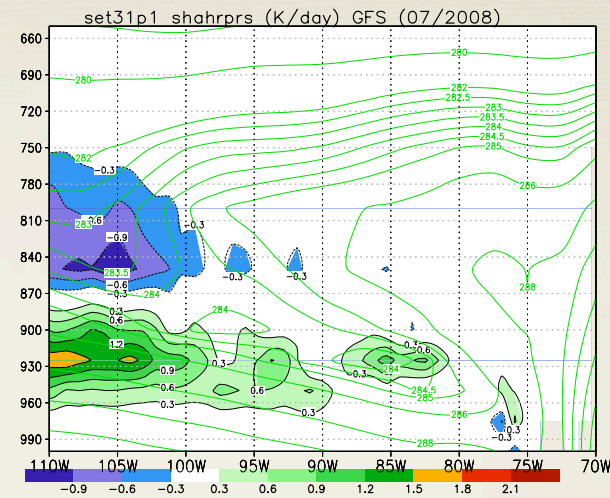
- \* Zero background diffusion above inversion is important in producing the stratocumulus clouds
- \* The method of determining cloud top in the current operational shallow convection scheme tends to set the cloud tops too high and hence produce too thick mixing layers and destroy the stratocumulus
- \* Large scale condensation is the main process to produce stratocumulus clouds
- \* RAS takes care of some shallow convection and produce shallow clouds

# xz shallow heating (20S)

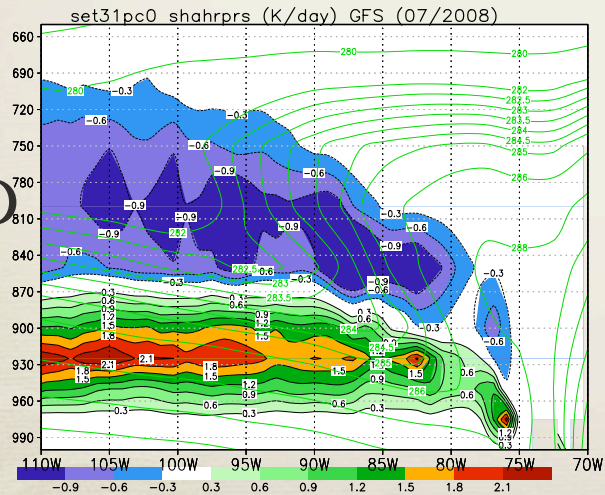
Ctl



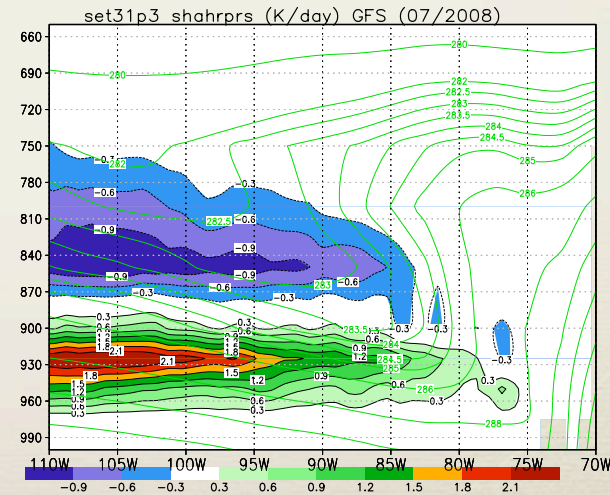
New



ZeroBD

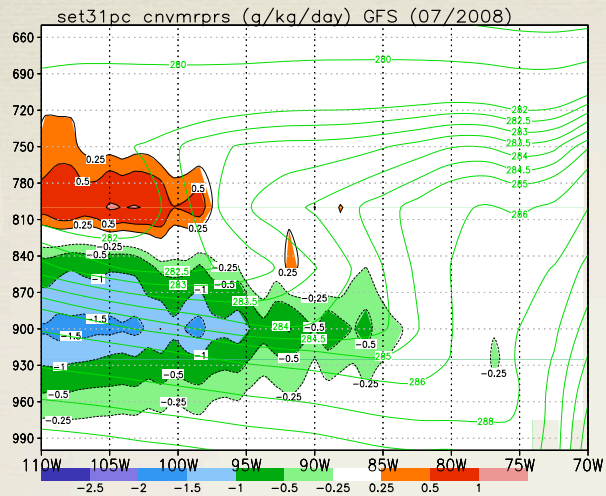


CTEI

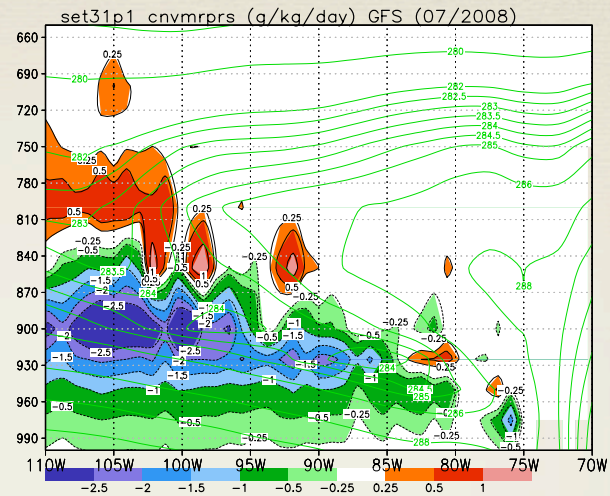


# xz conv moistening (20S)

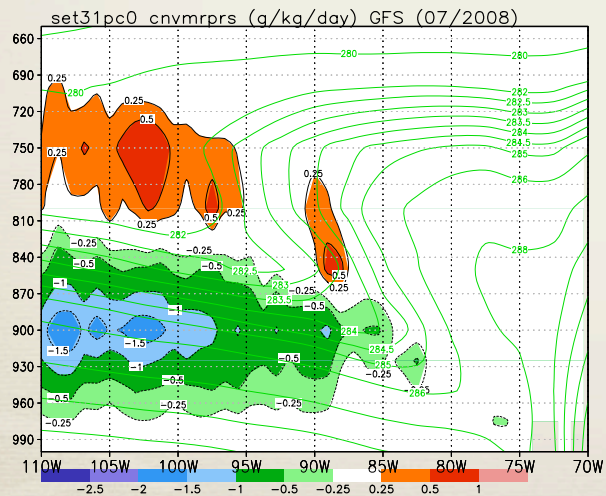
Ctl



New



ZeroBD



CTEI

