

THE CAUSE OF THE CAM3 SENSITIVITY TO INCREASED VERTICAL RESOLUTION

David Williamson
National Center for Atmospheric Research

Aqua-planet simulations

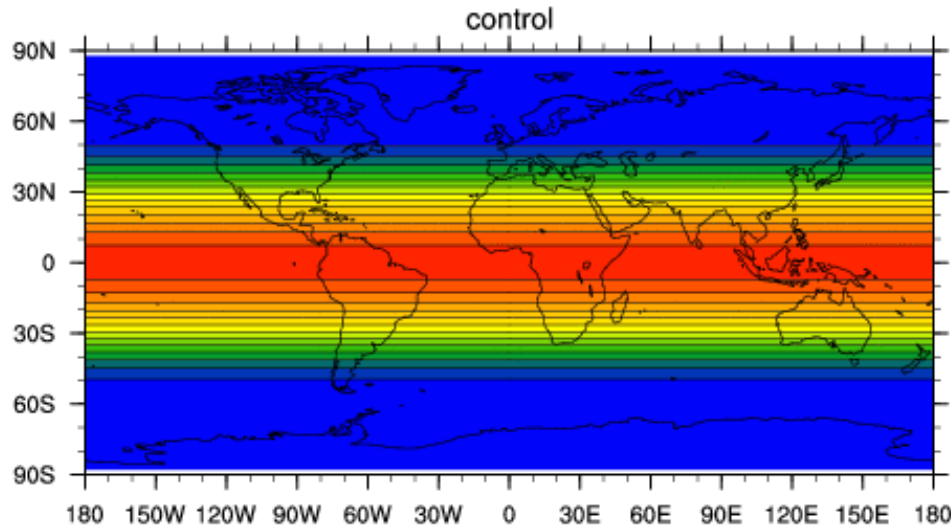
Neale, R.B. and B.J.Hoskins, 2000: A standard test for AGCMs including their physical parameterizations. I: The proposal. Atmos. Sci. Lett, Vol.1, No.2, pp. 101-107. (CONTROL experiment)

Atmospheric model with complete parameterization suite

Idealized surface

no land (or mountains), no sea ice

specified global sea surface temperatures everywhere (zonally symmetric)



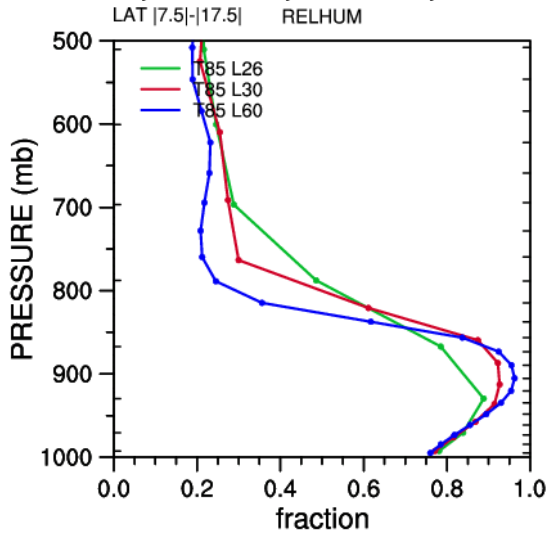
Simulations with CAM3.1

26, 30 and 60 levels

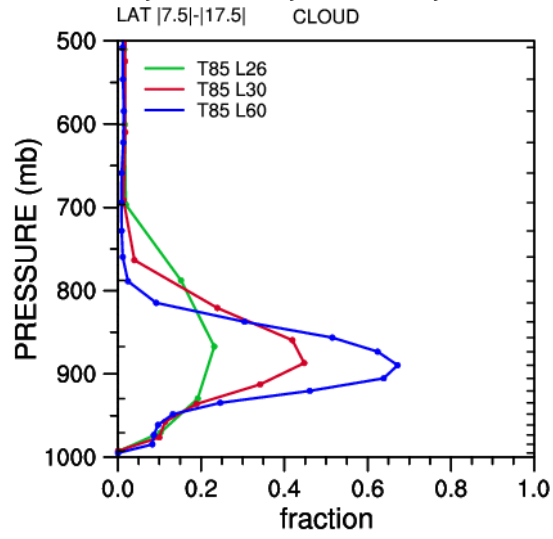
Examine averages over the subsidence region
poleward of the upward branch of the Hadley cell

Meridional average $|7.5|$ to $|17.5|$
Zonal average

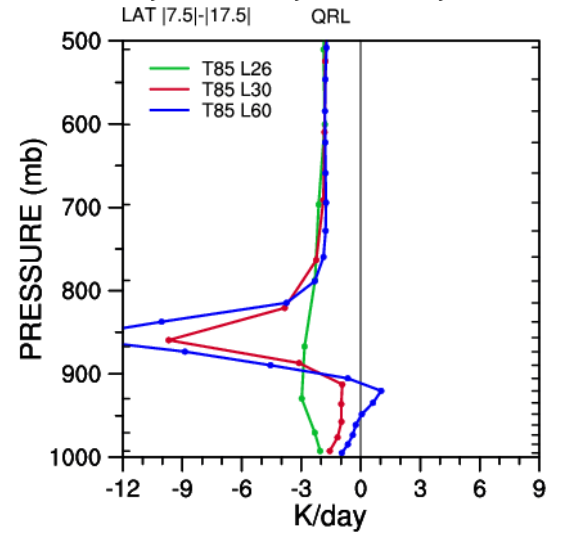
RELATIVE HUMIDITY



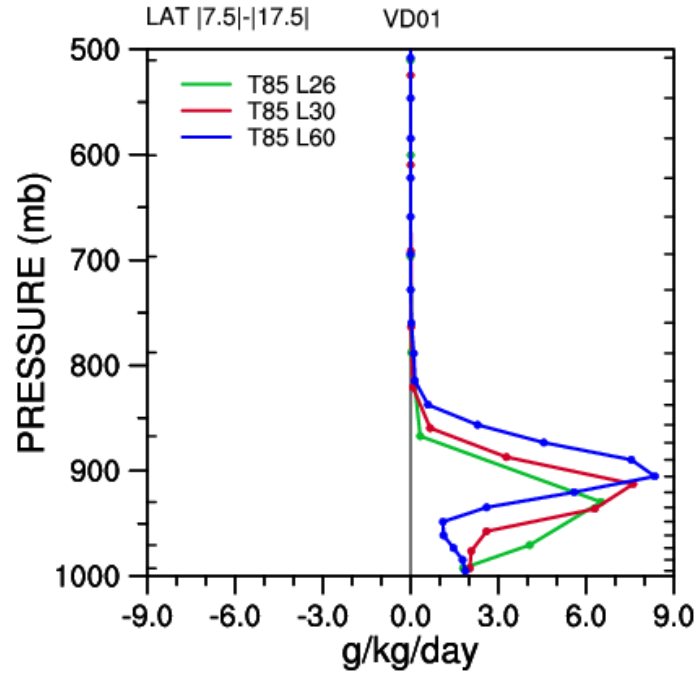
CLOUD



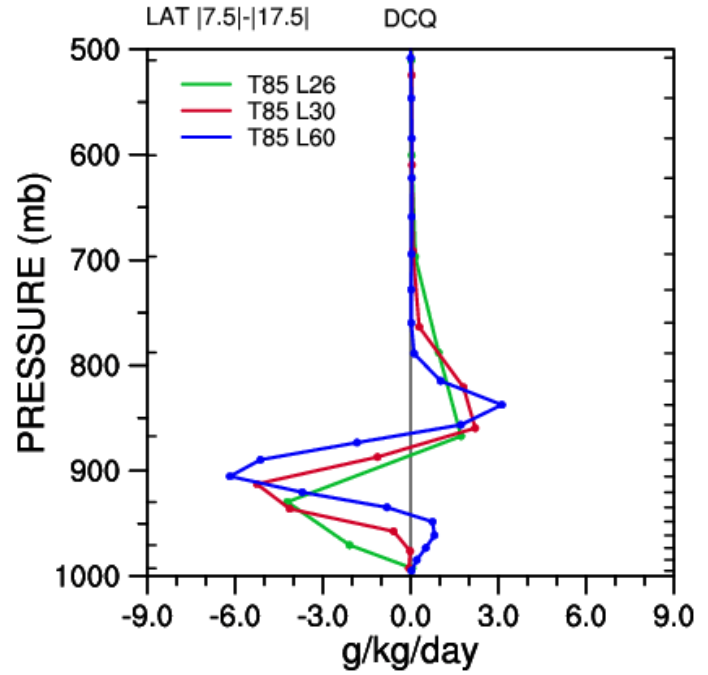
QRL



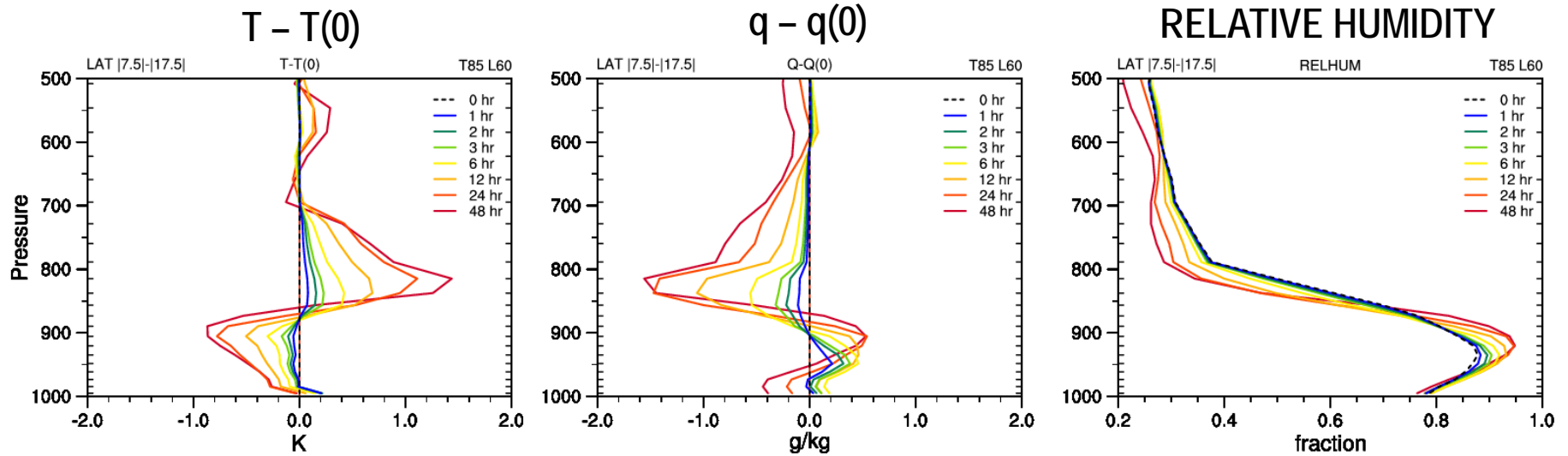
PBL



MOIST PROCESSES

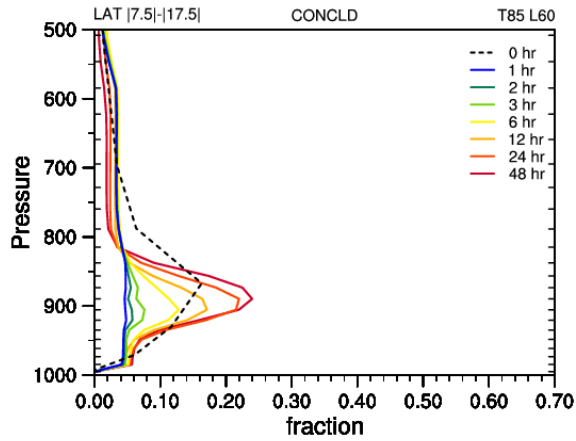


Evolution of 60-level simulation starting from a state from a 26-level simulation

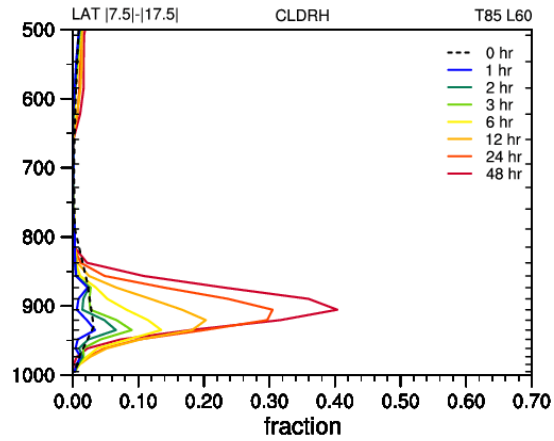


CLOUD FRACTION

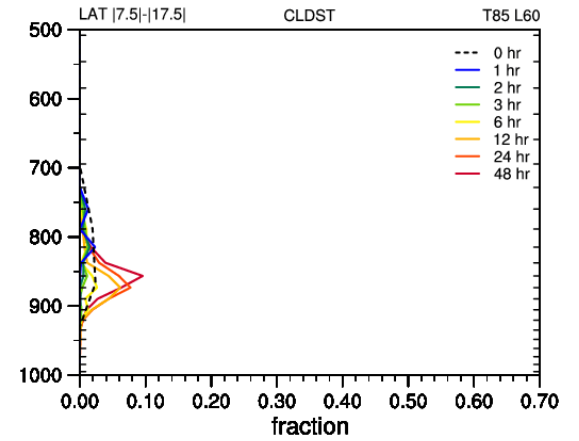
CONVECTIVE



RELATIVE HUMIDITY

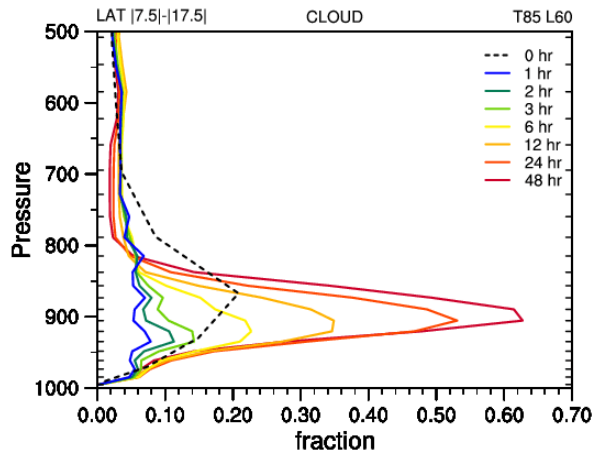


STRATUS

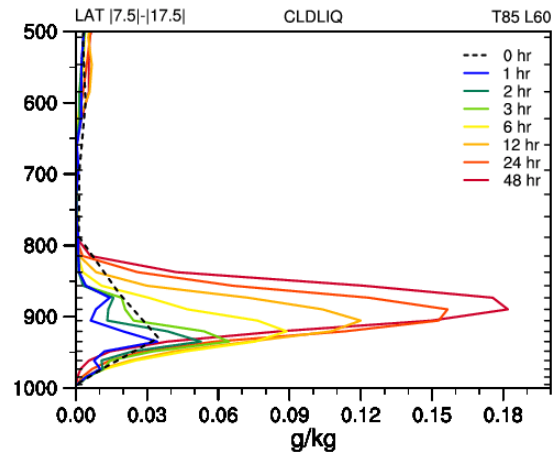


$$\text{CLOUD} = \text{CONCLD} + \max(\text{CLDRH}, \text{CLDST})$$

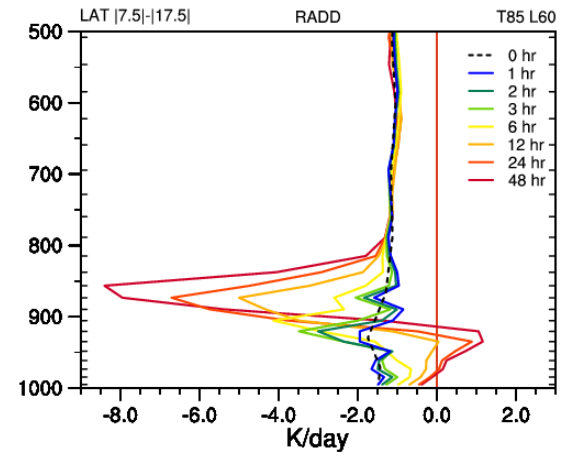
CLOUD



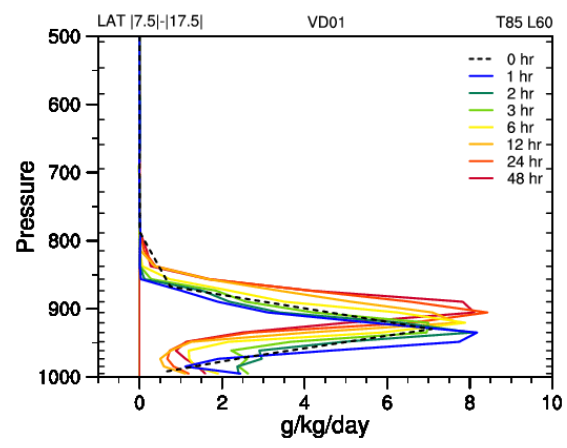
CLOUD LIQUID



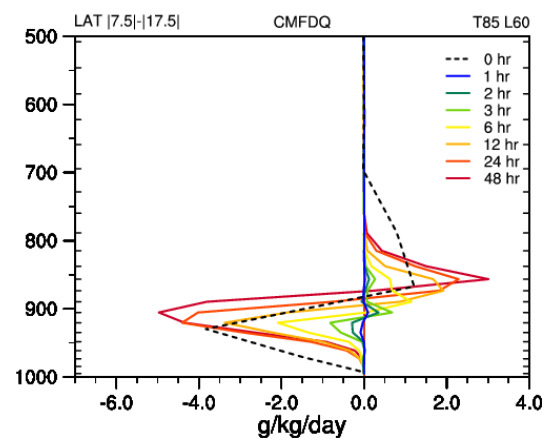
RADIATION



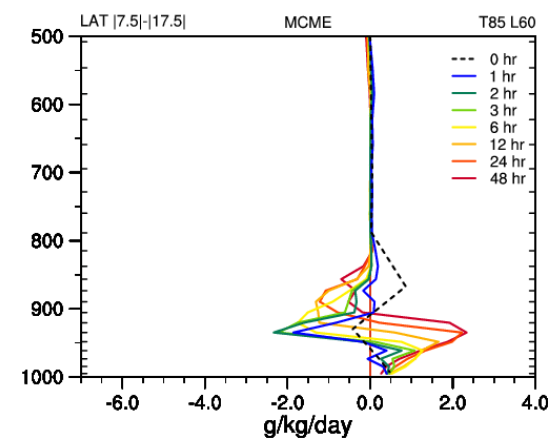
PBL



SHALLOW



PROG CLOUD WATER



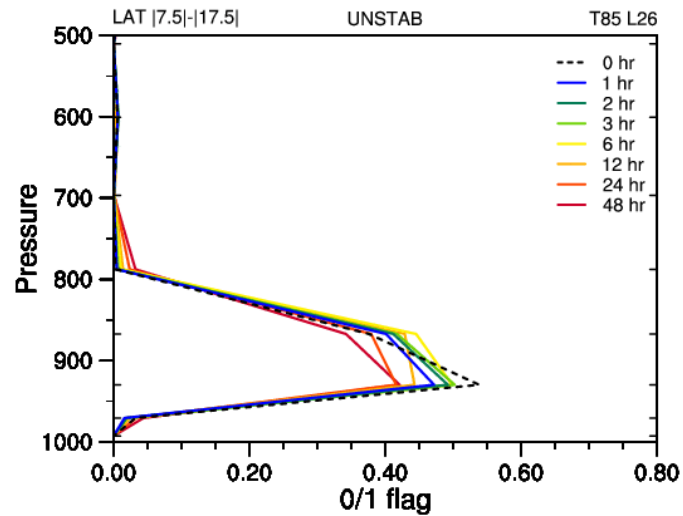
$$h_{k+1} + pert > h_k^*$$

$$h = C_p T + g + Lq, \text{ moist static energy}$$

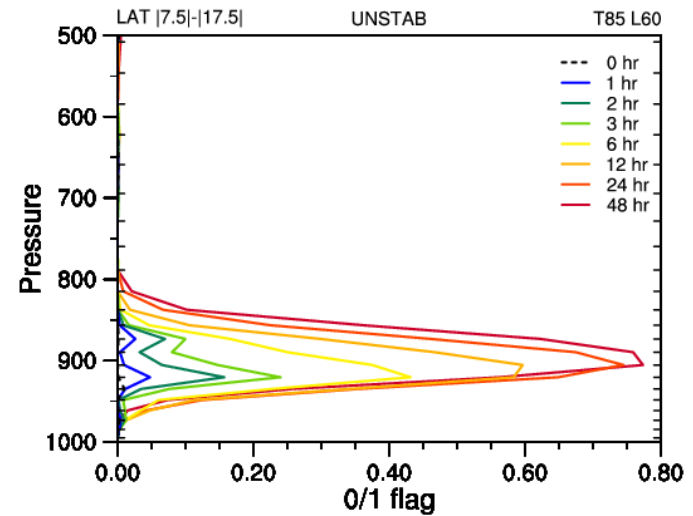
$$h^* = C_p T + g + Lq^*, \text{ saturated moist static energy}$$

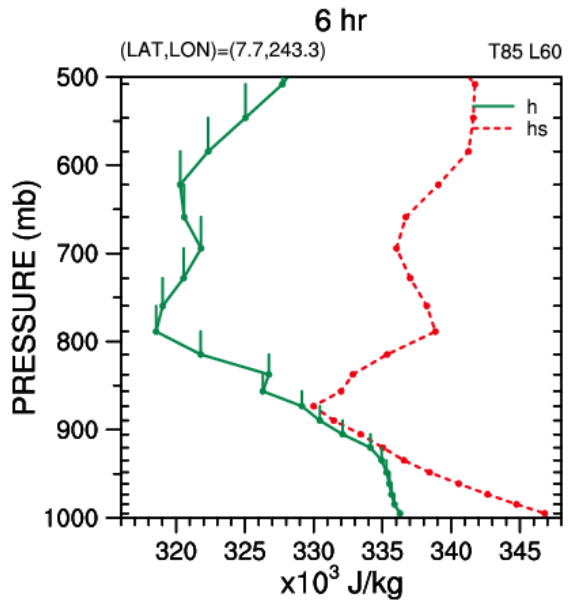
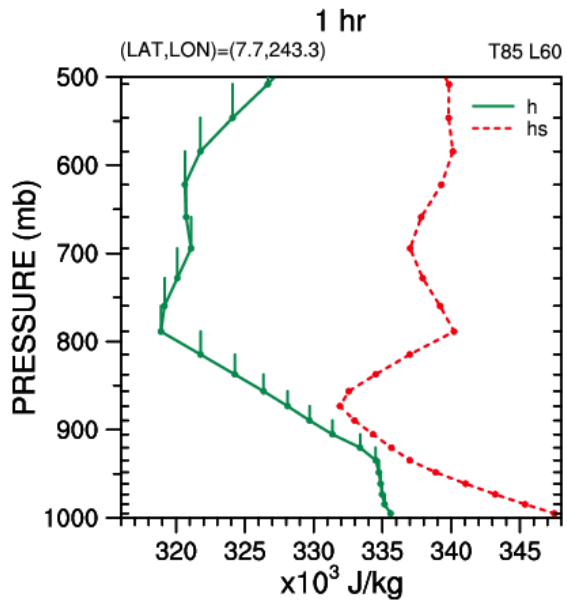
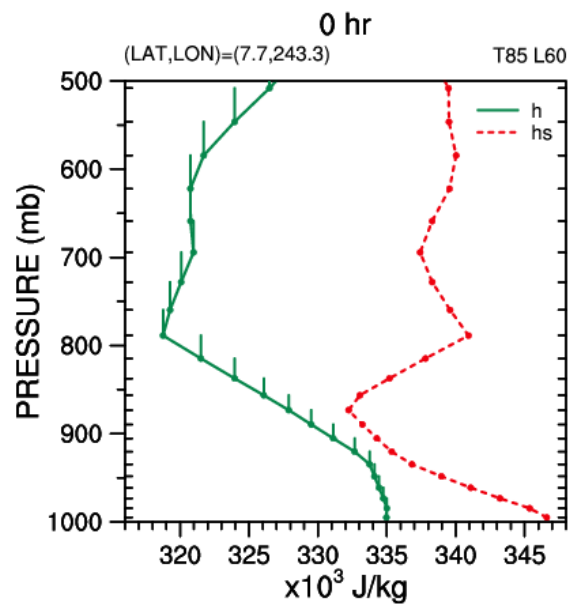
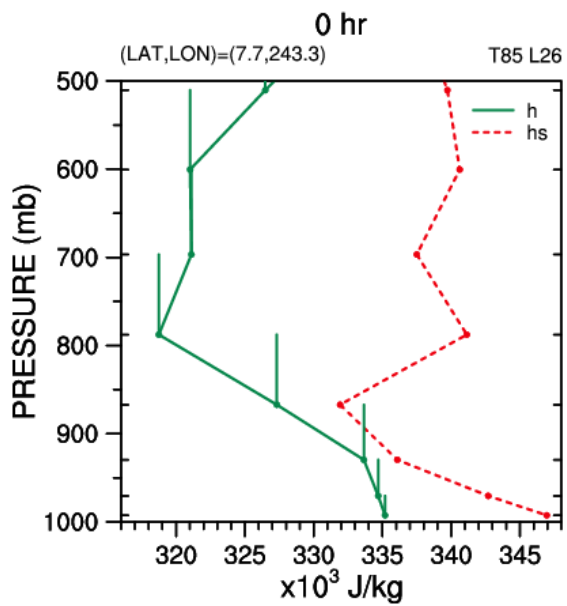
q^* is saturated specific humidity

26 levels



60 levels





Evolution of 60-level simulation from a 26-level simulation

Shallow convection initially turns off

PBL continues to deposit water vapor between 850 and 900 mb

Relative humidity clouds increase between 850 and 900 mb

Longwave radiation cooling increases and destabilizes atmosphere

Shallow convection turns back on

BUT ATMOSPHERIC STATE NOT REALISTIC

CANNOT INCREASE VERTICAL RESOLUTION

NEED PARAMETERIZATIONS NOT DEPENDENT ON GRID

