



NCAR

Water vapor budgets in Track 1 and Track 5

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Motivation

- Analysis of the budget for temperature, moisture and condensate
- Climate runs:
 - understand the balance that controls the climate
- Forecast runs:
 - understand how we attain this balance

Outline

- Motivation
- Track 1 ↔ Track 5
- Water vapor budget equations
- Budget in global annual means
- Budget in specific regions
- Conclusions

What are Track 1 and Track 5 ?

- Track 1 = cam3.5.1

- Deep convection: Neale-Richter (2008)
- Microphysics: Rasch-Kristjansson (1998)
- Boundary layer: Holtslag-Boville (1993)
- Shallow convection: Hack (1993)
- Bulk Aerosol Model (BAM)
- Radiation: CAMRT



- Track 5 = cam4

- Deep convection: Neale-Ritcher (2008)
- Microphysics: Morrison and Gettelman (2008)
- Boundary layer: Bretherton and Park (2009)
- Shallow convection: Park and Bretherton (2009)
- Modal Aerosol Model (MAM): Ghan and Liu
- Radiation: RRTMG: Iacono et al (2008)



Water vapor budget

$$\frac{\partial q}{\partial t} = \underbrace{-V \cdot \nabla q - \omega \frac{\partial q}{\partial p}}_{\text{Advection tendencies}} + \underbrace{Q_{physics}}_{\text{Physics tendencies}}$$

Advection tendencies Physics tendencies

$$Q_{pbl} + Q_{deep\ convection} + Q_{shallow\ convection} + Q_{macro+micro}$$

Convective
mass flux

Evaporation
convective
precipitation

Shallow
convection
tendency

Evaporation
convective
precipitation

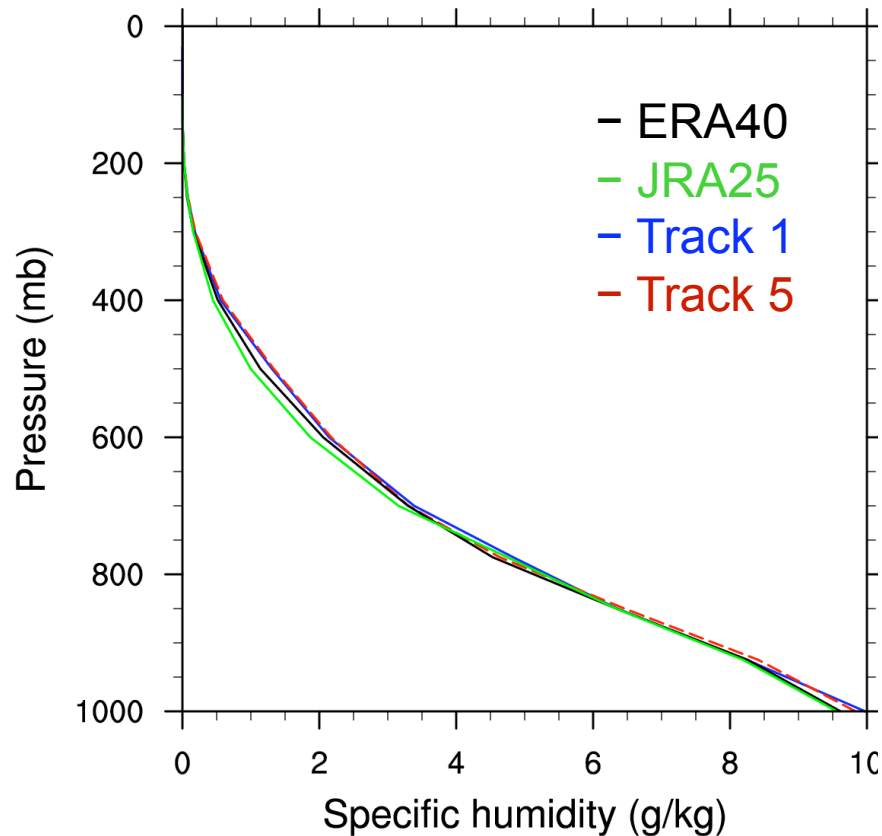
Evap-cond of
condensate

Evaporation
cloud water
sedimentation

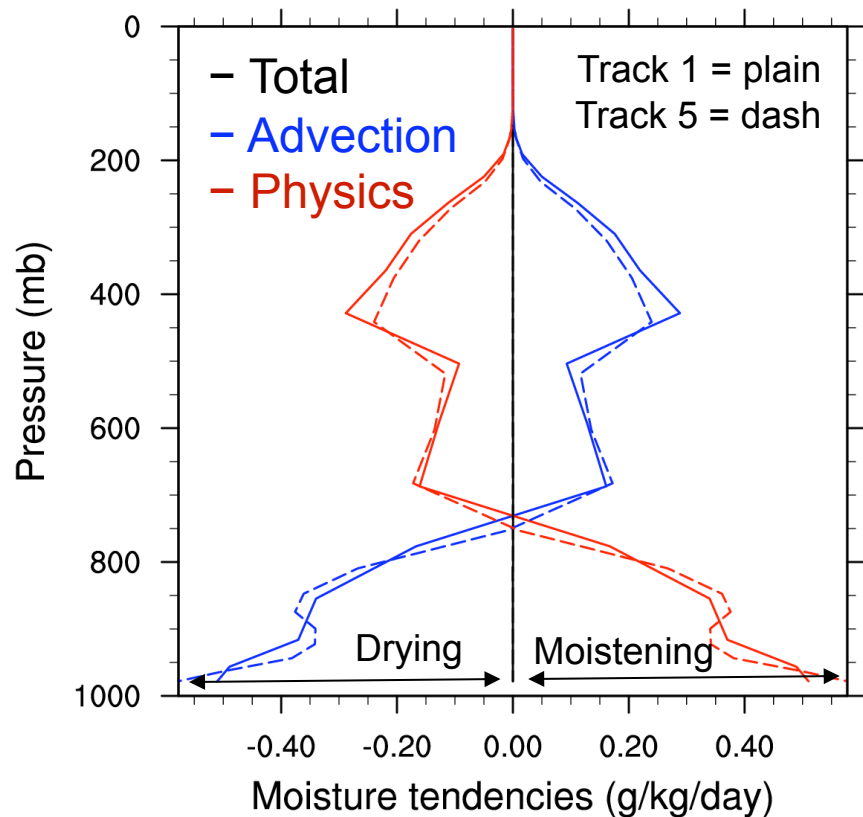
Evaporation
falling
precipitation

Global annual means: q profiles and tendencies

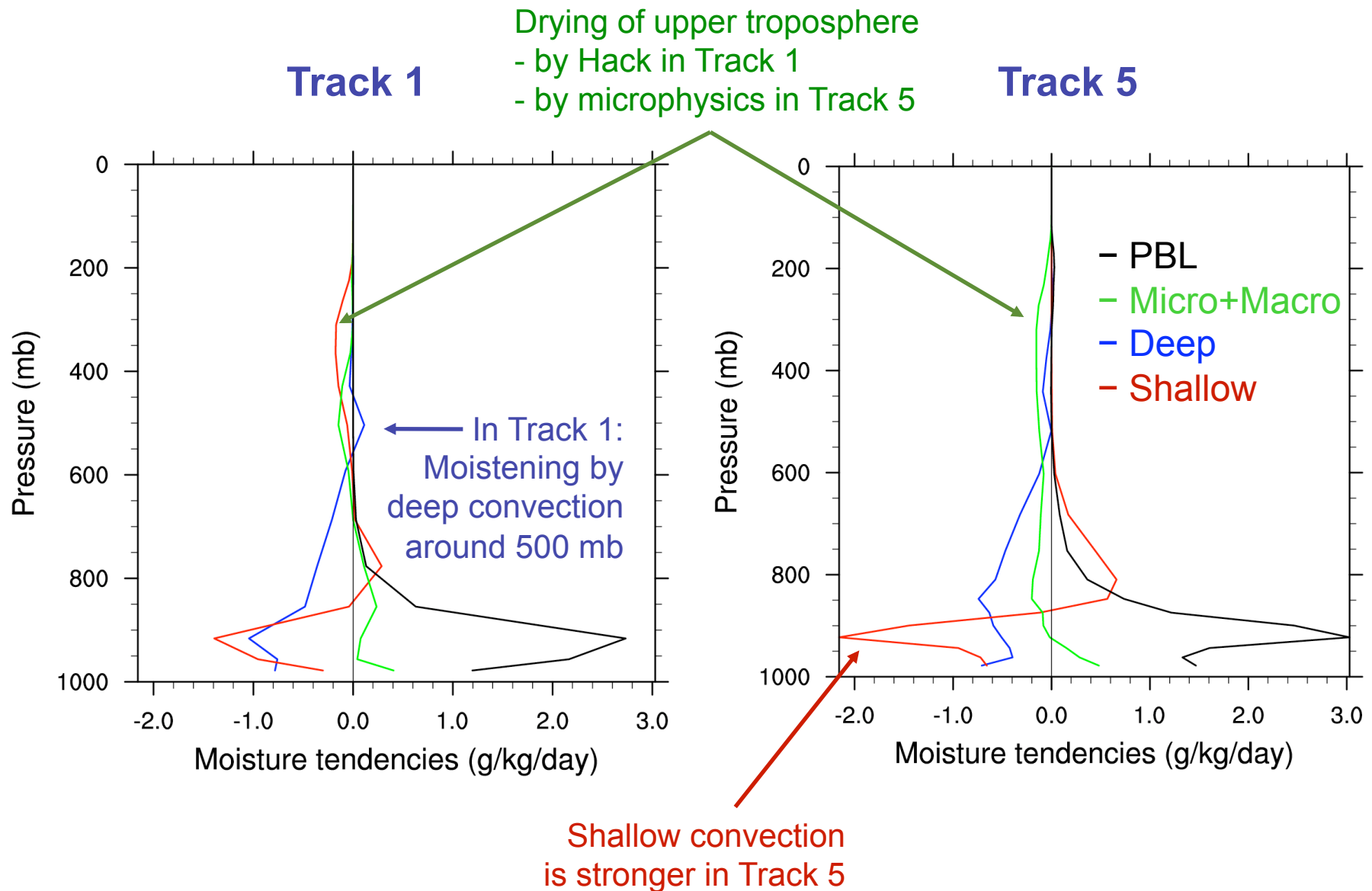
Moisture profile



Moisture tendencies

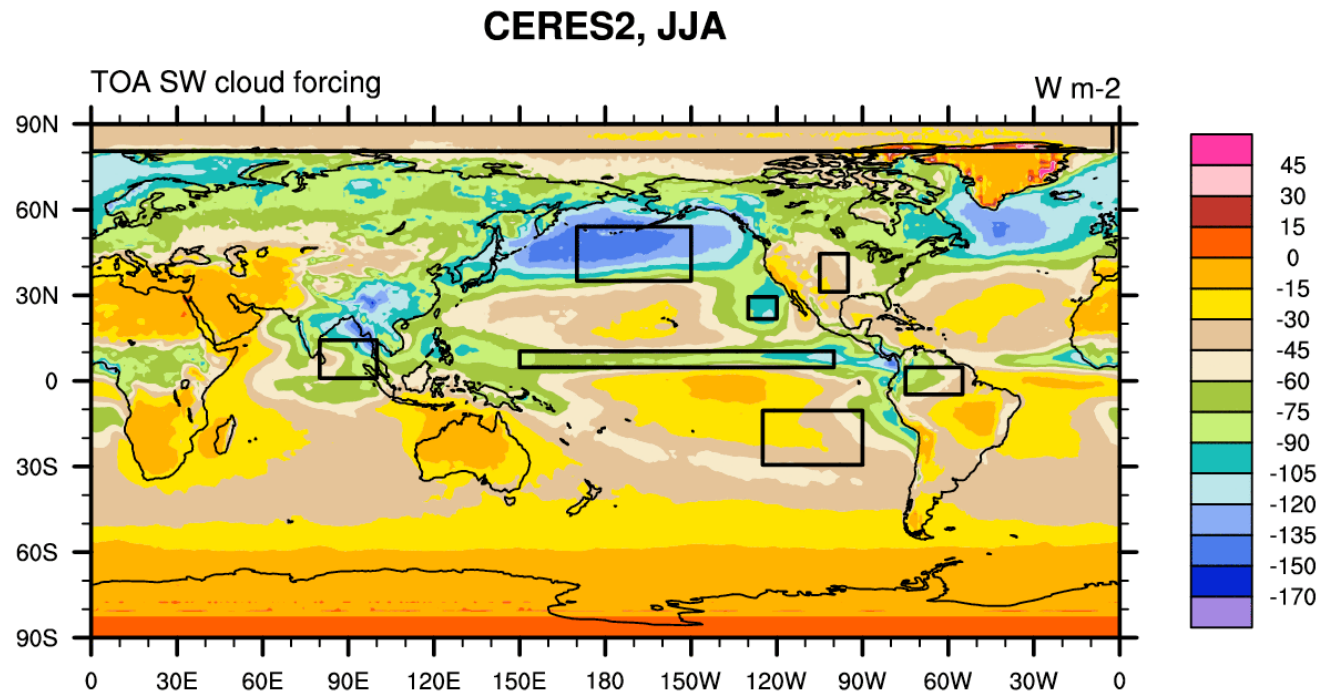


Global annual mean: physics tendencies break-up



Budget terms in various regimes

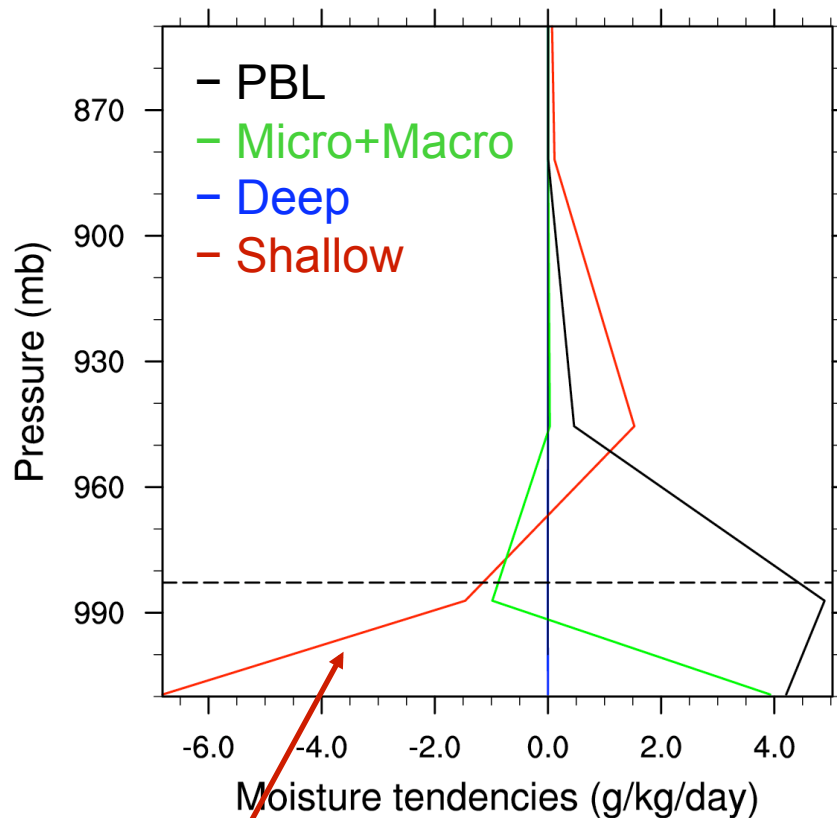
- Stratocumulus
- Transition
- ITCZ
- Bay of Bengal
- Storm Tracks
- Arctic
- Continental US
- Tropical land



http://www.cgd.ucar.edu/cms/hannay/internal/cam4_dev/budgets/t1_t5/Budget_t1_t5.html

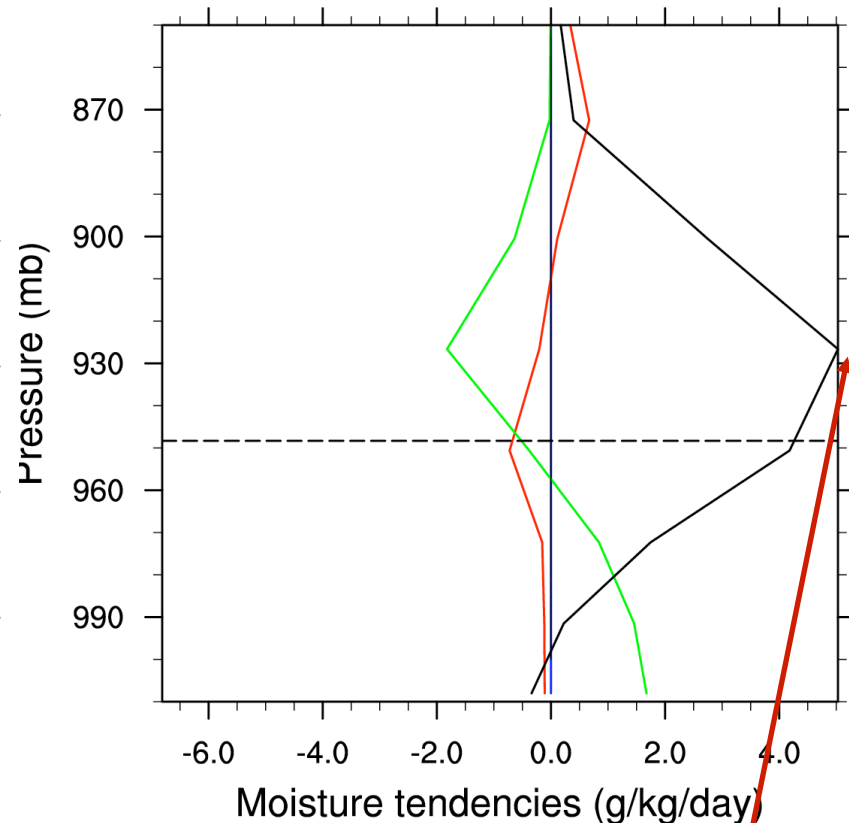
Stratocumulus

Track 1



Shallow convection is stronger in Track 1

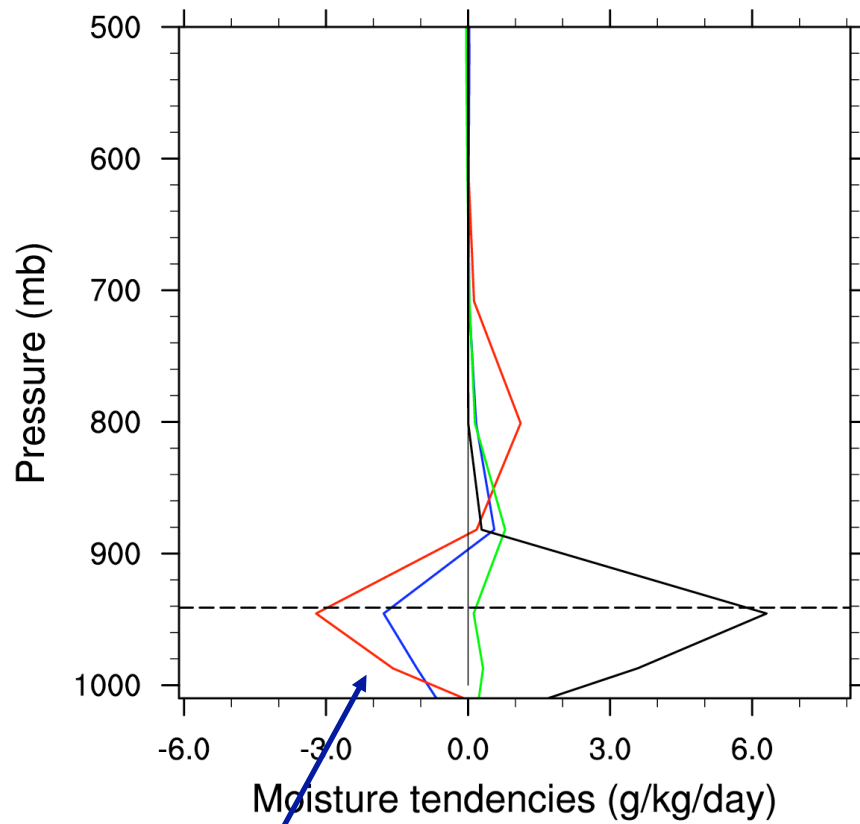
Track 5



PBL moves moisture higher in the atmosphere

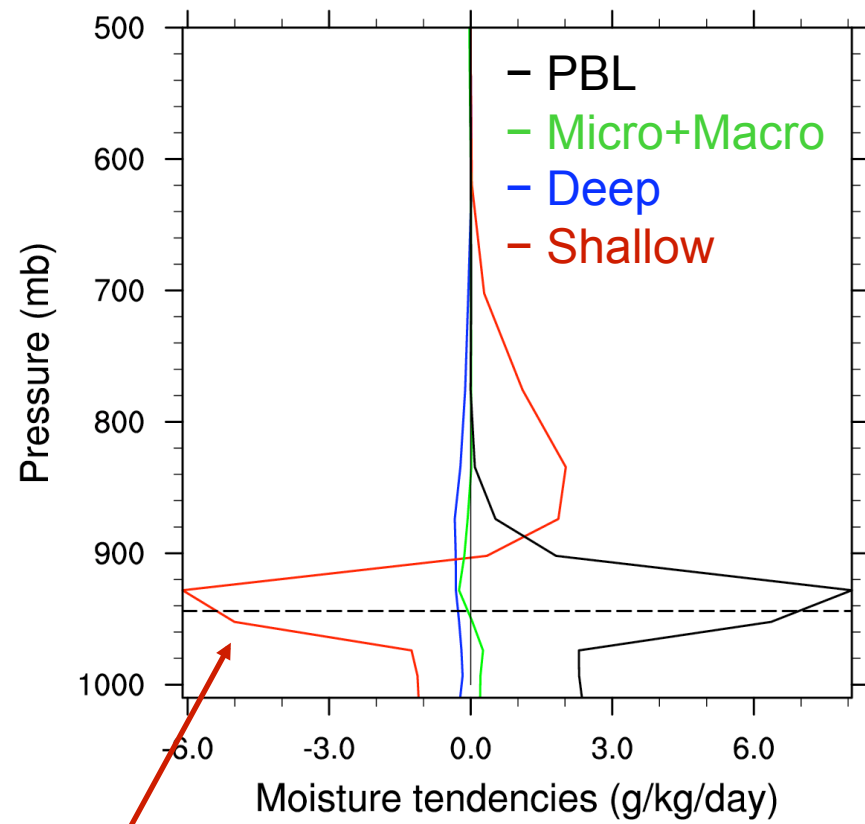
Transition region

Track 1



Deep convection is stronger in Track 1

Track 5



Shallow convection is stronger in Track 5

Conclusion and future work

- Budgets help to understand the balance that controls the climate
- Water vapor tendencies are very different in Track 1 and 5, even when the states in the two tracks are similar.

A major difference is in the shallow convective tendencies, which are globally stronger in Track 5 than Track 1

The drying of the upper troposphere is driven by different processes:

- Track1: shallow convection scheme (unrealistic)
- Track5: macro+micro (reflects new ice microphysics)

In the stratocumulus regions, there is an unrealistically large contribution from the shallow convection scheme in Track 1

Future work

Next , we will look at :

- the temperature, liquid and ice budgets
- forecast runs:
 - understand how we attain this balance
 - allows direct comparison of the parameterized variables (e.g. clouds) with observations from field campaigns