Know Your Forcing

Extracting Land-Atmosphere Feedbacks Info

Ahmed Tawfik
NCAR CGD, TSS

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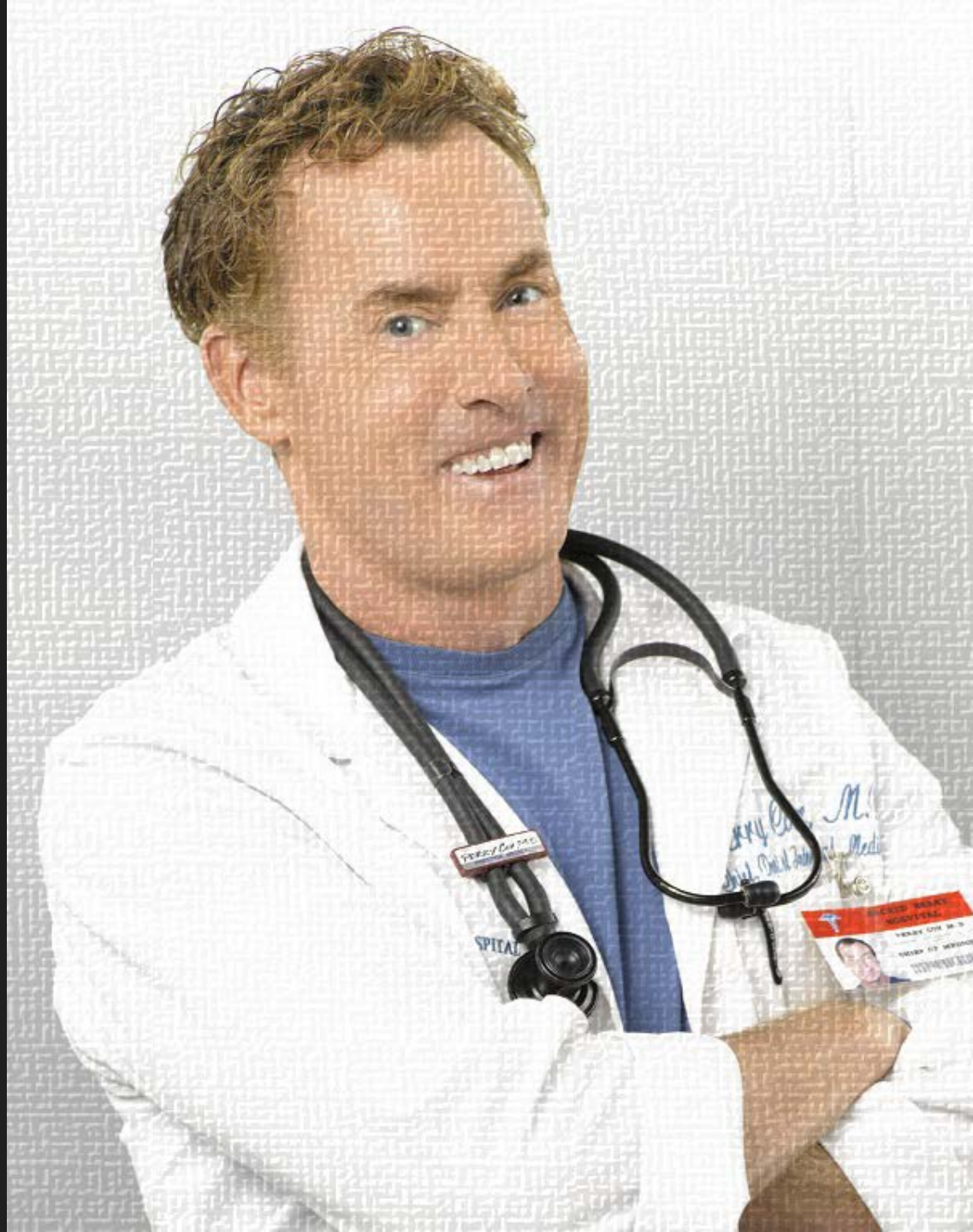

Suppose You Have Offline CLM Runs…

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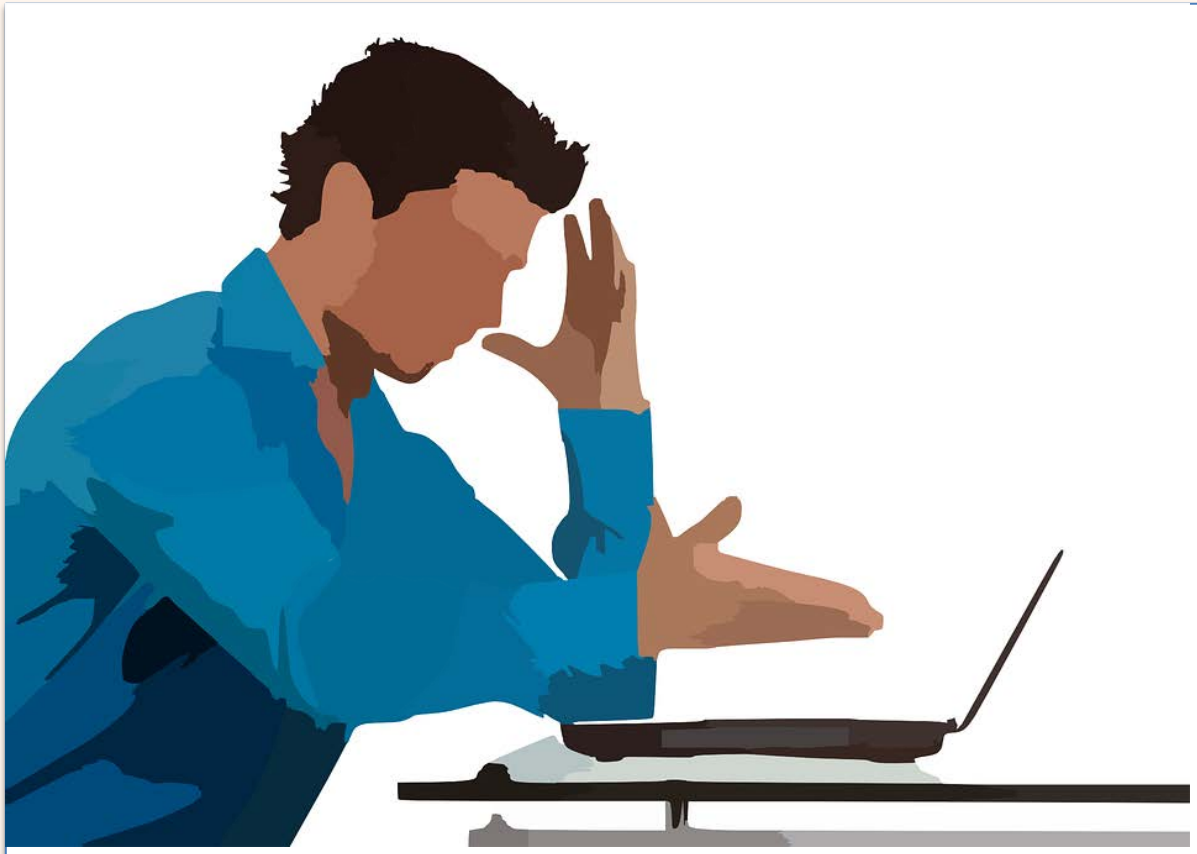

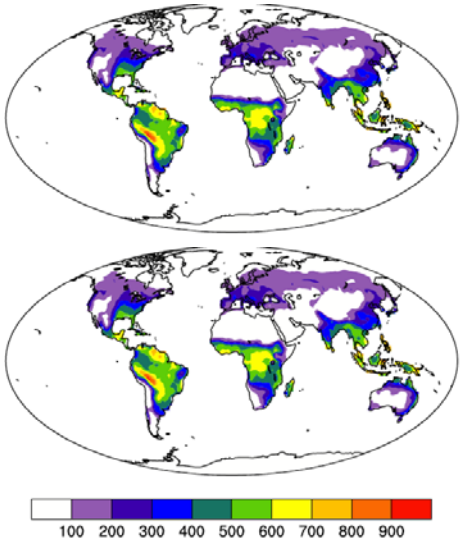

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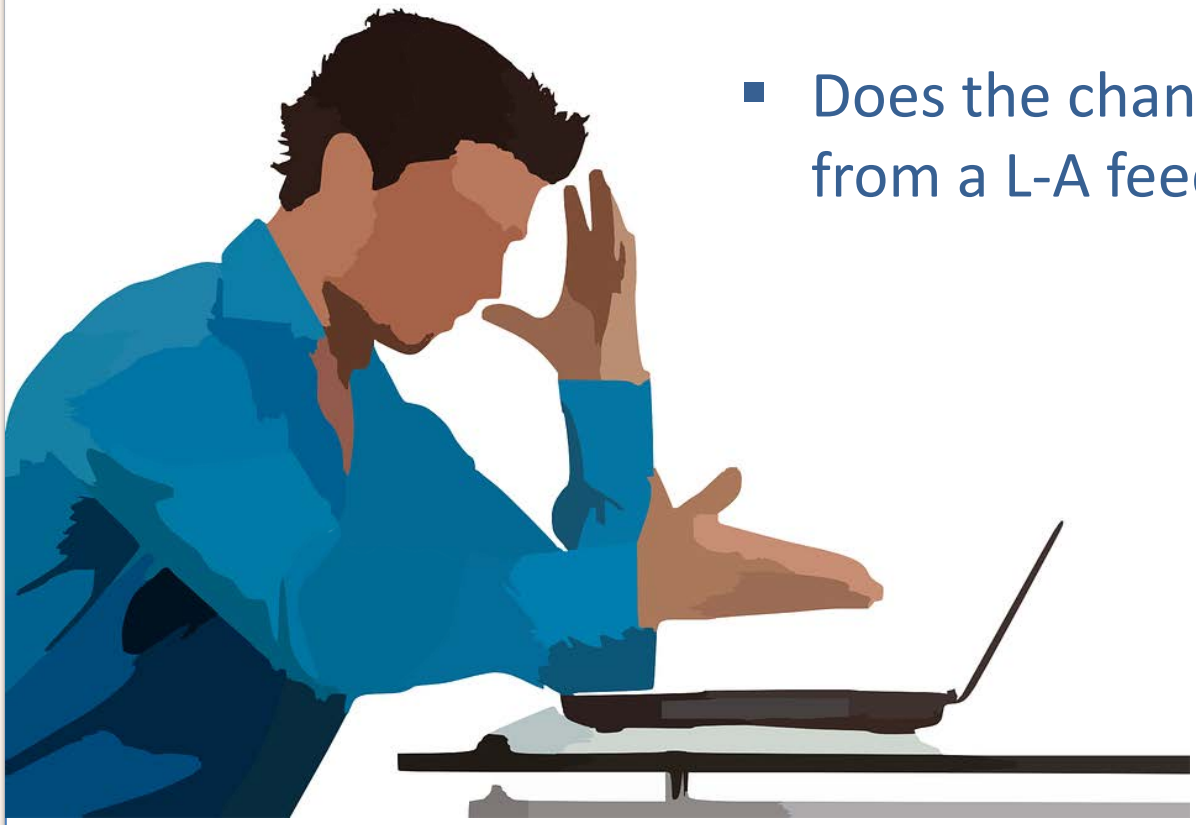

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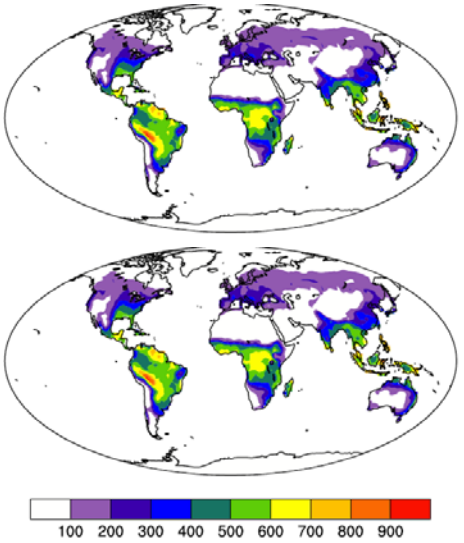

Current Approaches to Evaluate L-A Coupling

Terrestrial Coupling = ***latent heat flux*** variability controlled by ***soil moisture*** variation

Dirmeyer et al. 2011 GRL

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Terrestrial Coupling = $\sigma_{SoilM} \frac{d(Latent)}{d(SoilM)}$

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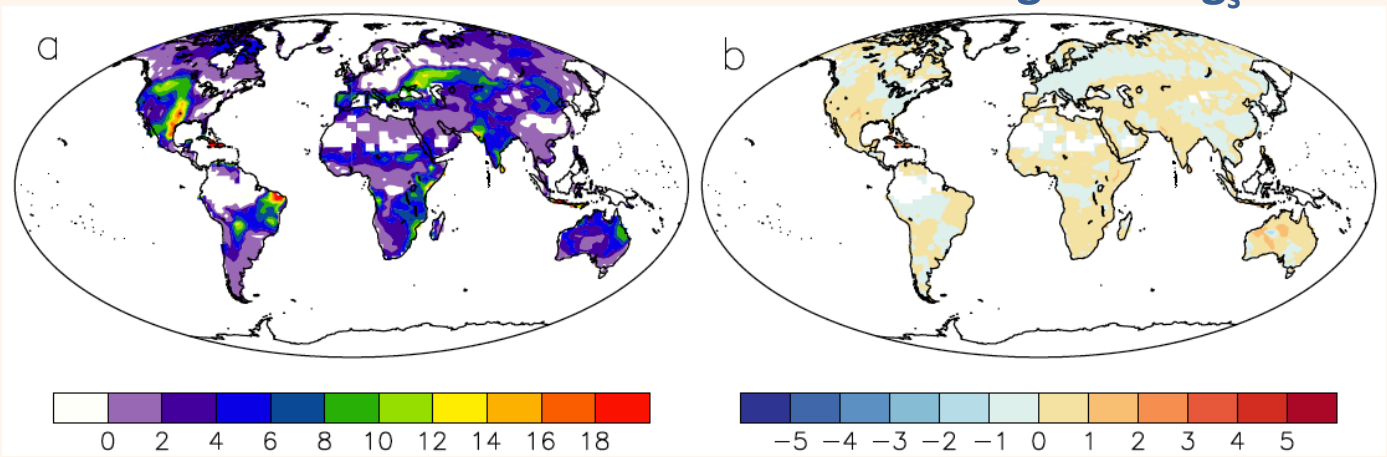
Control | **With nighttime g_s**



Dirmeyer et al. 2011 GRL; Lombardozzi et al. 2016 GMDD

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Terrestrial Coupling works well

but

only measures flux sensitivity to moisture availability

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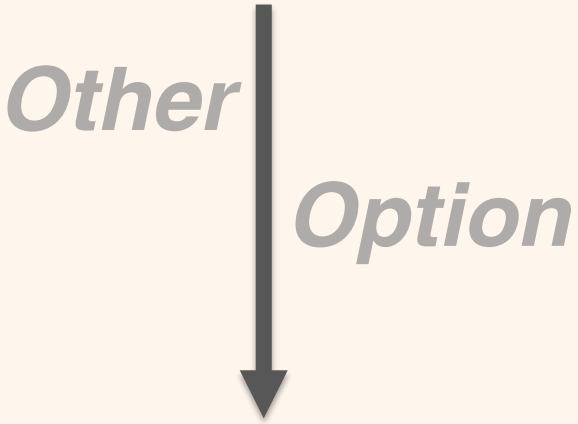

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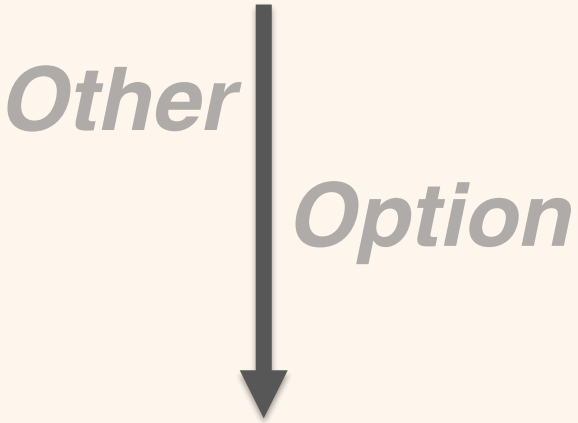

Go full CAM-CLM simulation

Current Approaches to Evaluate L-A Coupling

Terrestrial Coupling works well

but

only measures flux sensitivity to moisture availability

Is there a step in between?

Go full CAM-CLM simulation

TBOT QBOT PBOT RAIN RADIATION … etc

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Prognostic and Diagnostic Variables

TBOT QBOT PBOT RAIN RADIATION … etc

So how can we extract land-atmosphere feedback information?

Prognostic and Diagnostic Variables

DATM

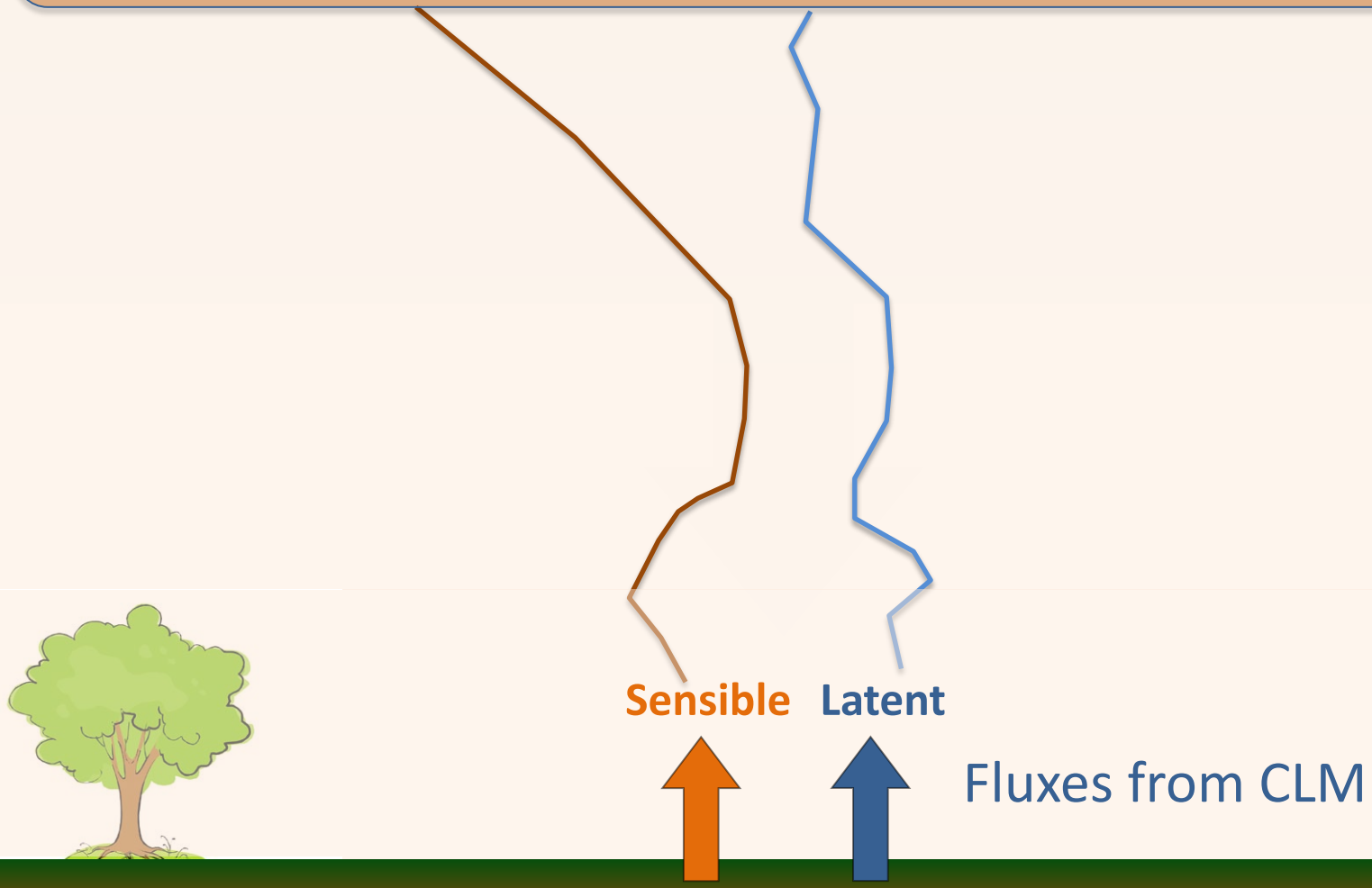
There is a structure up here!

PBOT **RAIN** **RADIATION … etc**

TBOT **QBOT**

Prognostic and Diagnostic Variables

Simple Convective Boundary Layer Model



Simple Convective Boundary Layer Model

Mixed Layer Equations

$$\frac{\partial \theta}{\partial t} = -\left(u\frac{\partial \theta}{\partial x} + v\frac{\partial \theta}{\partial y} \right) - w\frac{\partial \theta}{\partial z} + Q - \frac{\partial (w'\theta')}{\partial z}$$

$$\frac{\partial q}{\partial t} = -\left(u\frac{\partial q}{\partial x} + v\frac{\partial q}{\partial y} \right) - w\frac{\partial q}{\partial z} + Q - \frac{\partial (w'q')}{\partial z}$$

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*** Assume 1-D and no diabatic processes

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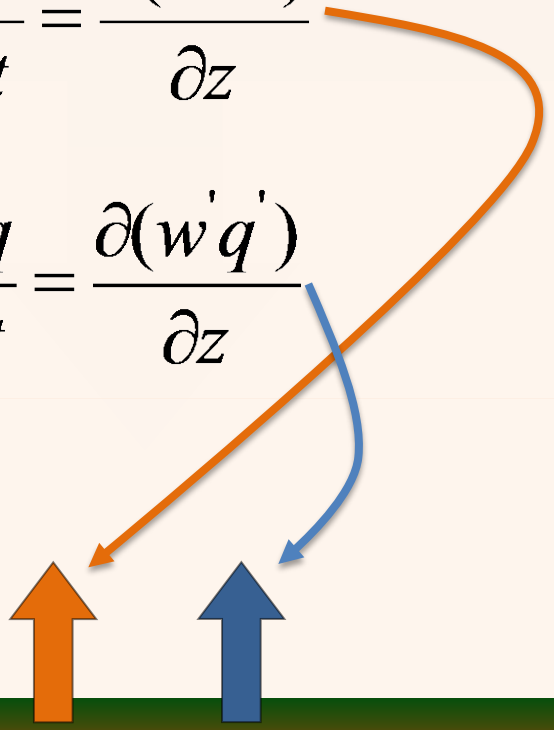

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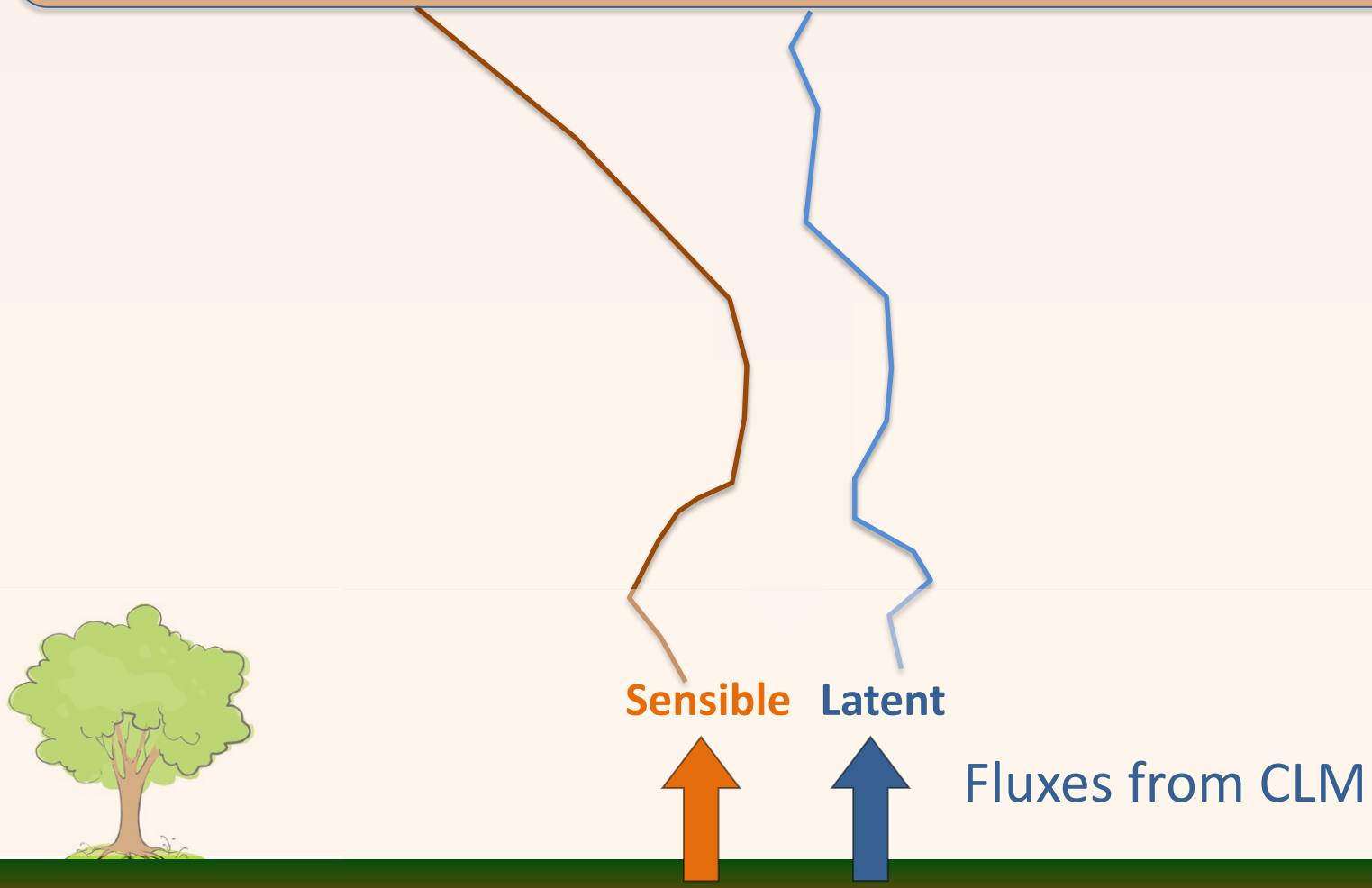

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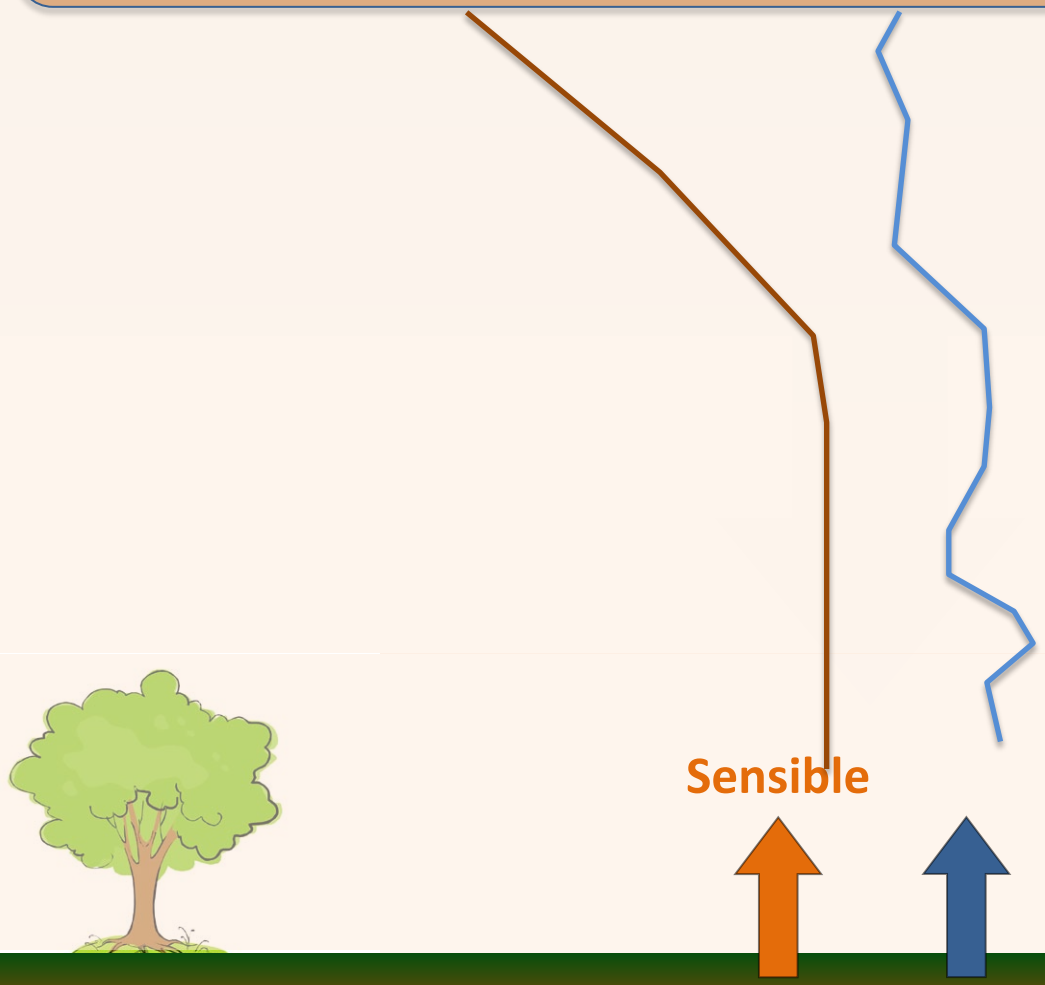

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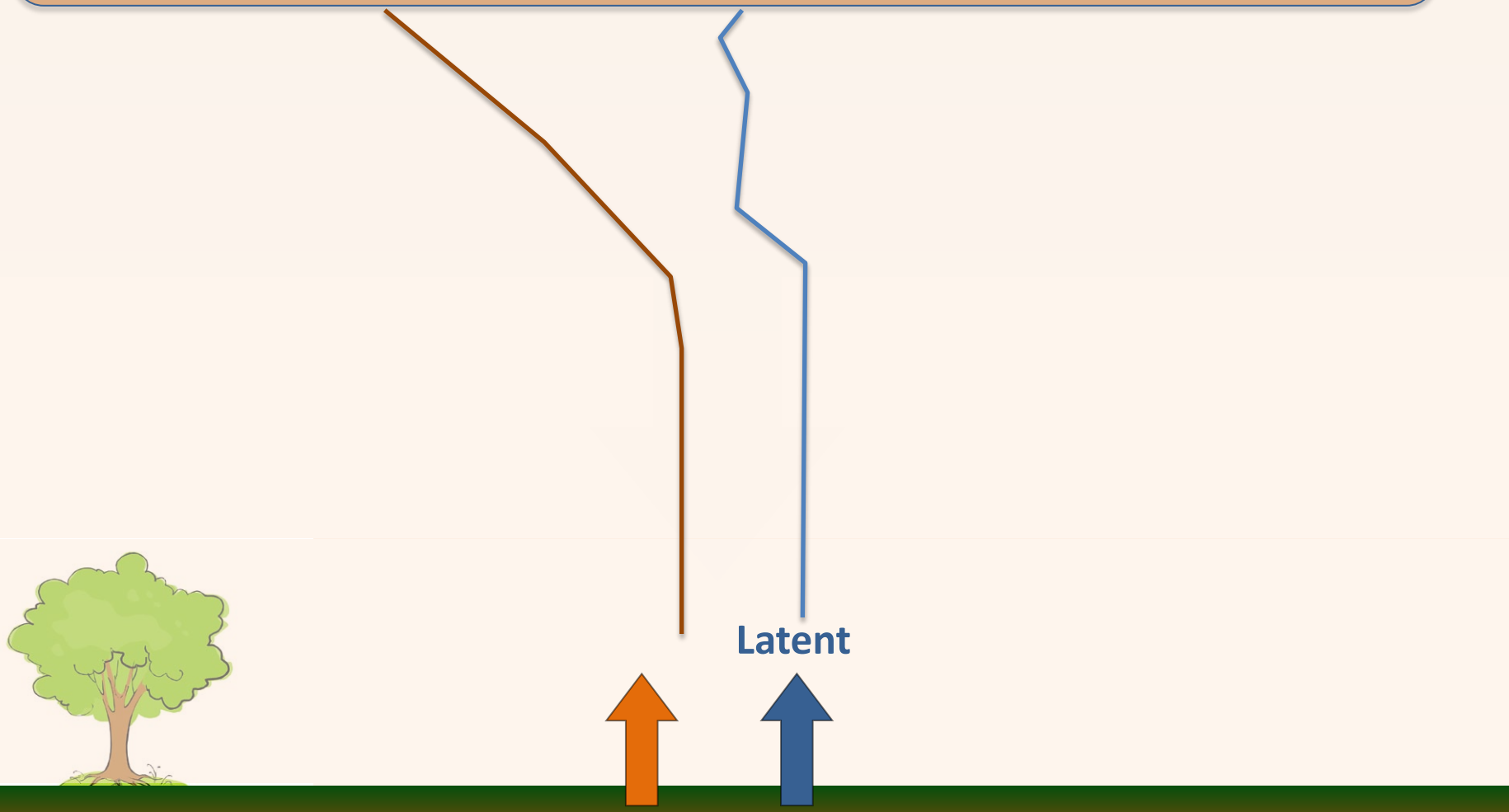

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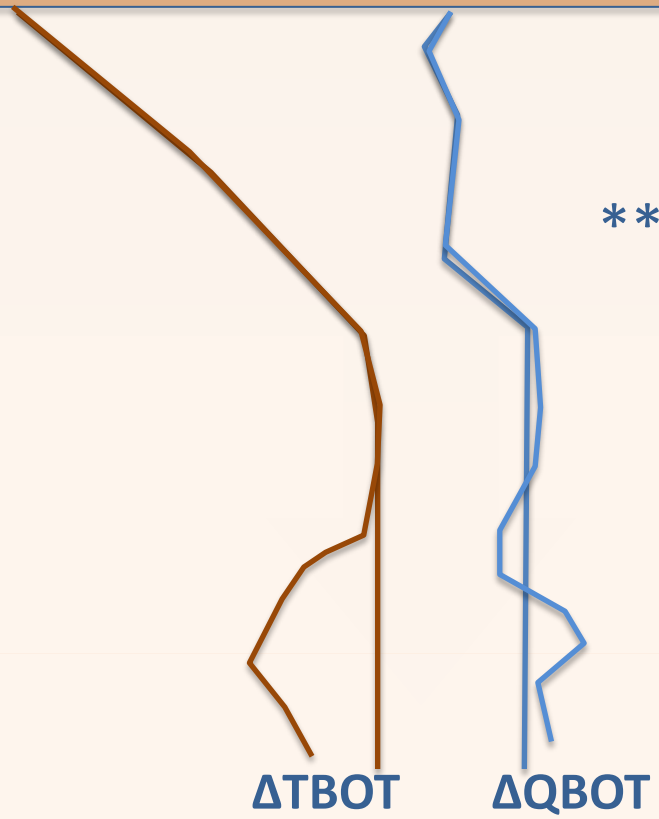
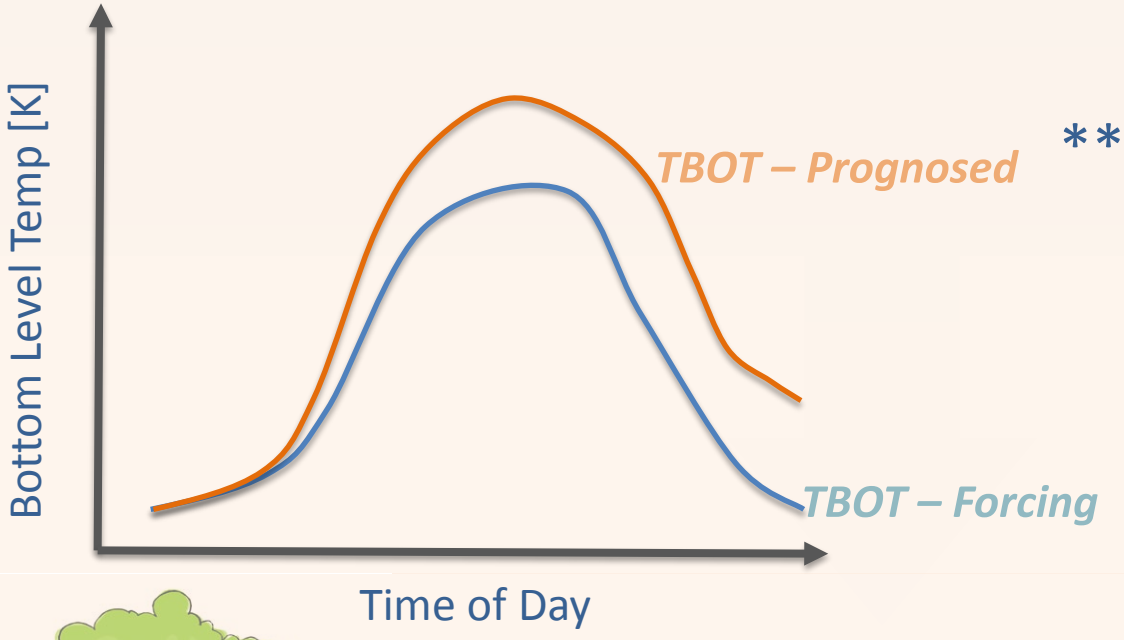


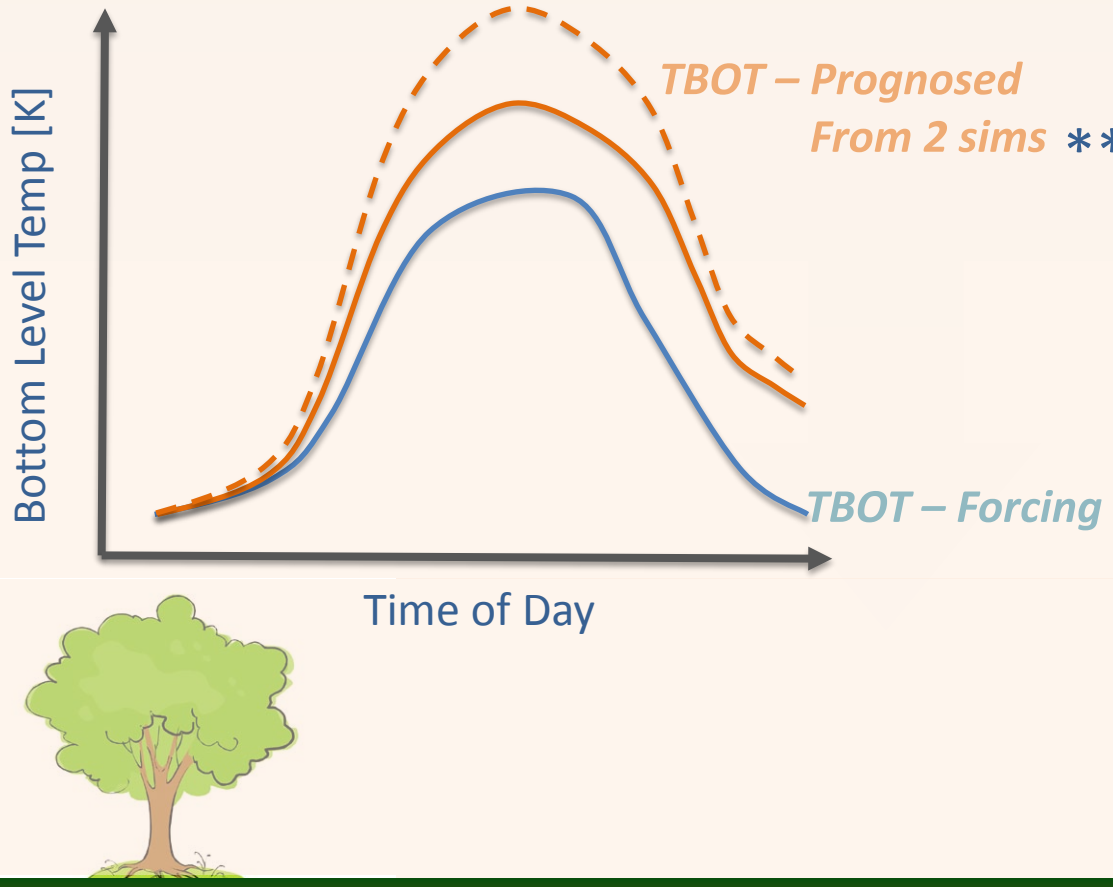
** Note that there is now a prognosed TBOT and QBOT

Simple Convective Boundary Layer Model



** Now we can compare the “drift” from the forcing over time due to the sensible and latent heat fluxes

Simple Convective Boundary Layer Model



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What the Model **DOES NOT** do…yet

- Once saturation is reached at the top of the PBL, it stops

- However a few diagnostics are calculated:
  - Convective available Potential Energy (CAPE)
  - Precipitable Water
  - Depth of Cloud

Simulation to Test

Compare:

- CLM 5.0 using ERA-Interim Forcing
- CLM 4.5 using ERA-Interim Forcing

*** Evaluate the relative “drift” and triggering potential

Simulation to Test

Compare:

- CLM 5.0 using ERA-Interim Forcing

Segmentation Fault

- CLM 4.5 using ERA-Interim Forcing

*** Evaluate the relative “drift”

Simulation to Test

Compare:

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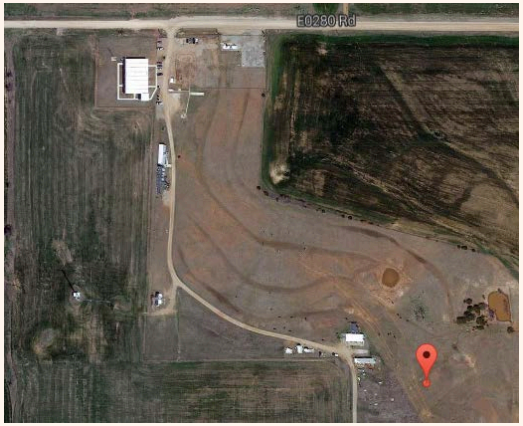
*** Evaluate the relative “drift”

Can use the forcing data itself do perform a wet-dry scenario experiments

Wetting-Drying Experiments

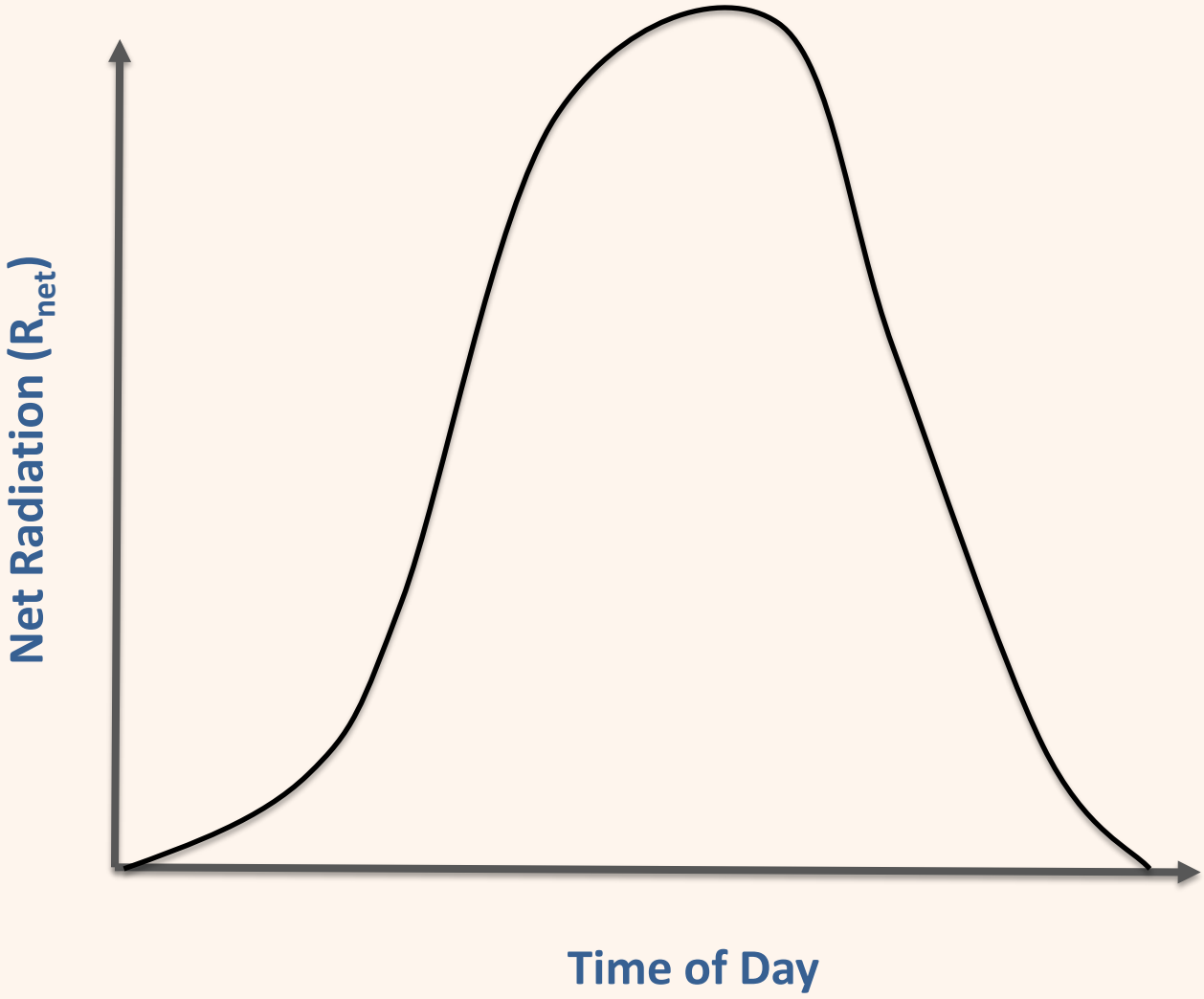
Observed Data from the:

- Atmosphere Radiation Measurement (ARM) Site in Oklahoma
- Time period: 1996-Present
- Temperature, Humidity, and Pressure vertical profiles usually 6-hourly
- Net radiation every 30-min



Weckwerth et al. 2004

Given that we have net radiation from ARM-SGP



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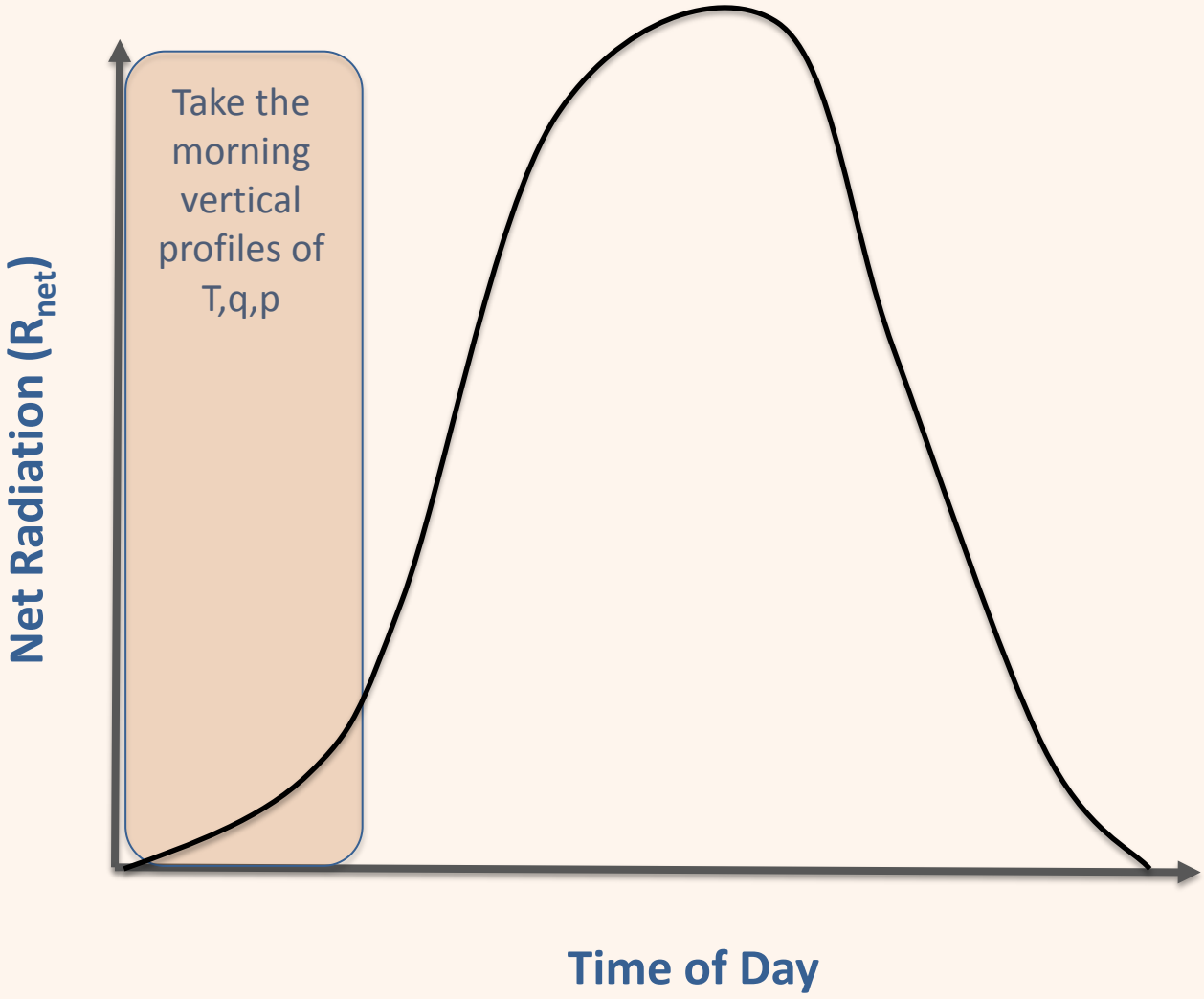

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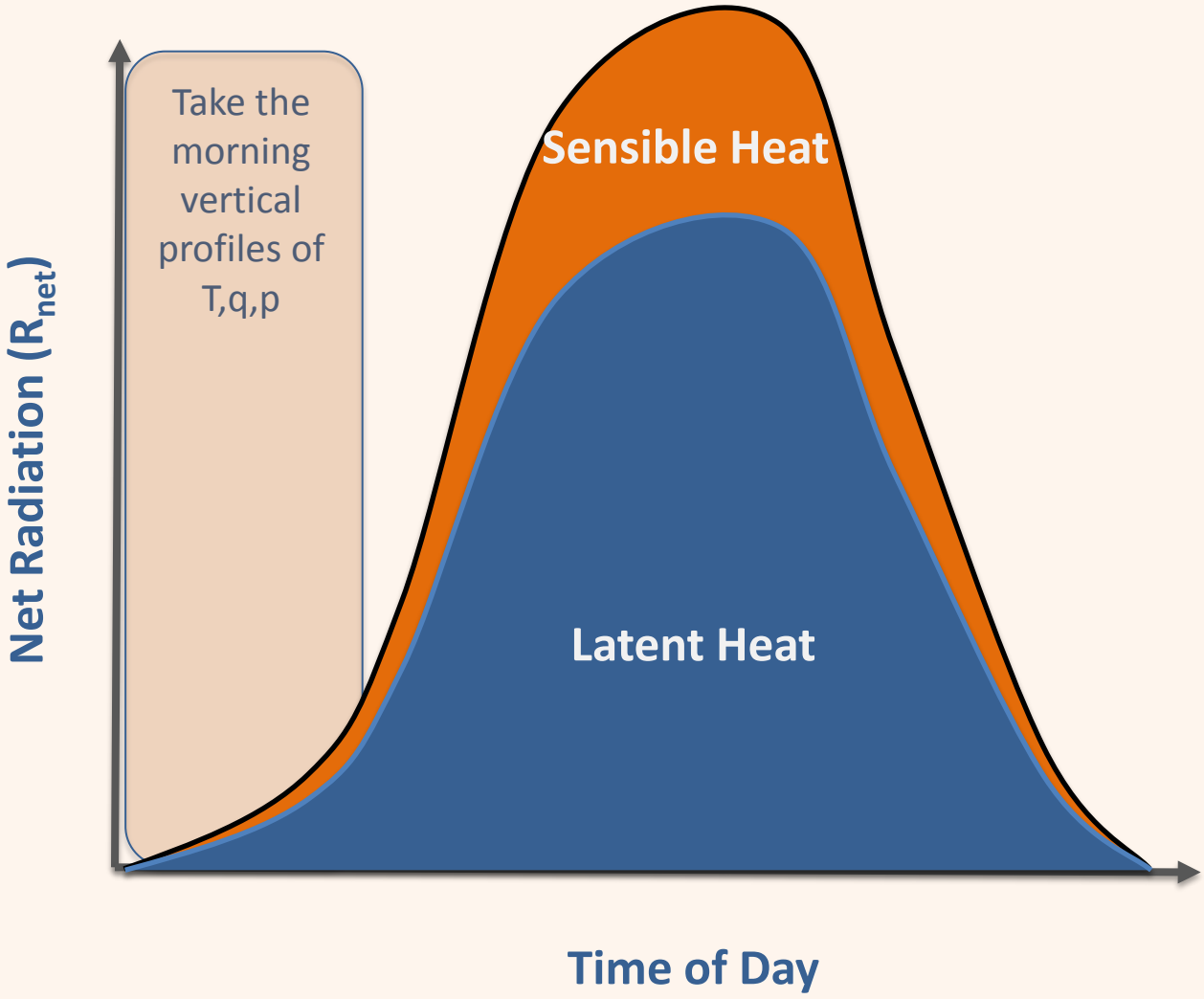
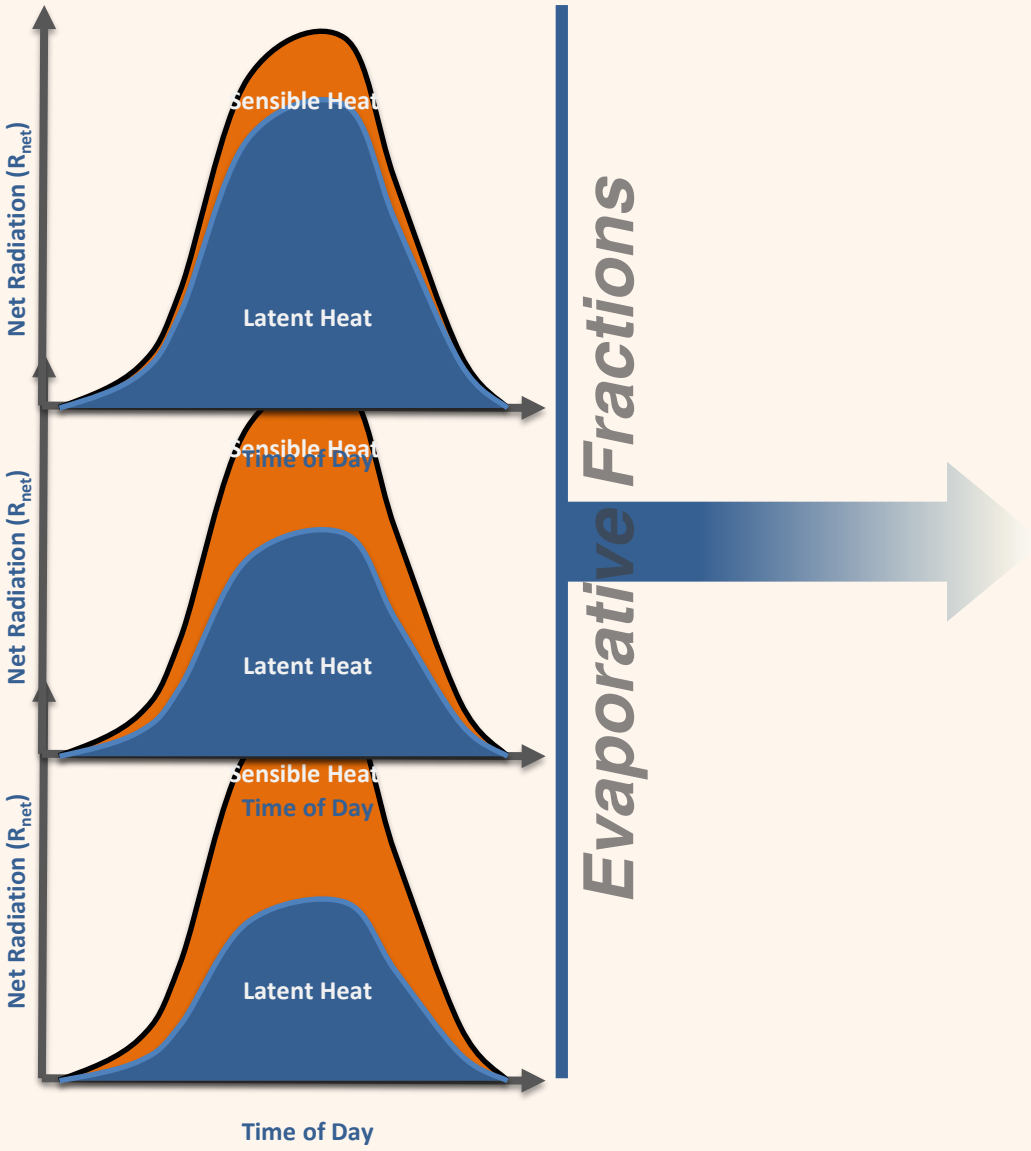


Can Explore a continuum of evaporative fraction realities

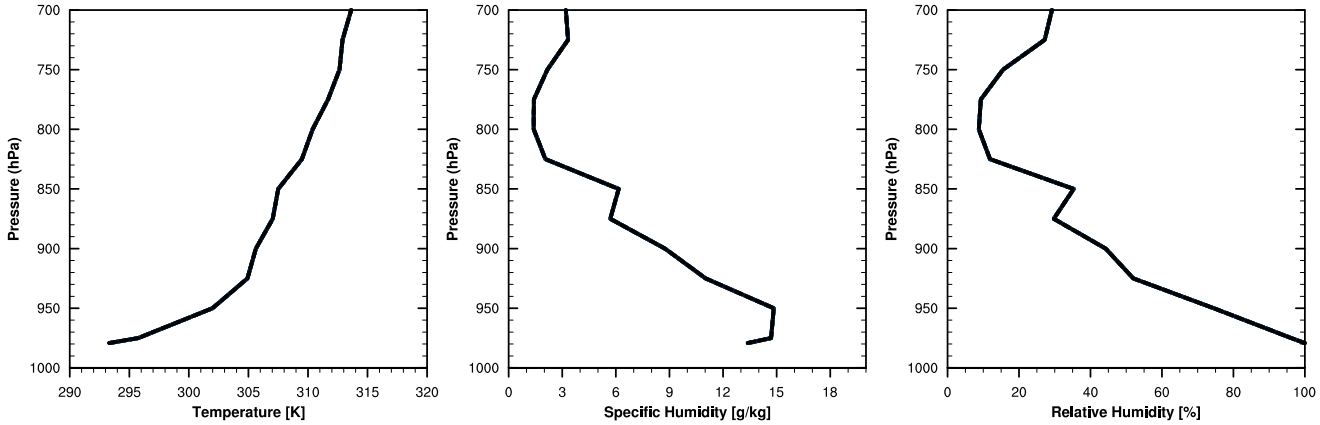


Are wet or dry surfaces more likely to trigger moist convection (negative or positive feedback)?

How do T and q evolve under various conditions?

Wetting-Drying Experiments: ARM-SGP

June 7th 2006 over Central Plains



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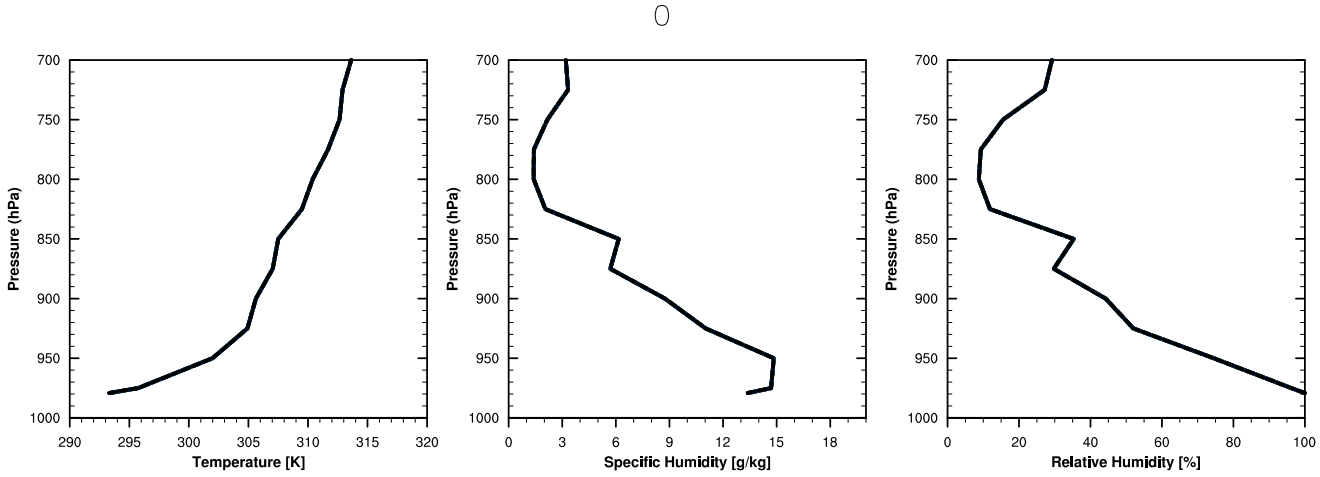

Evaporative Fractions

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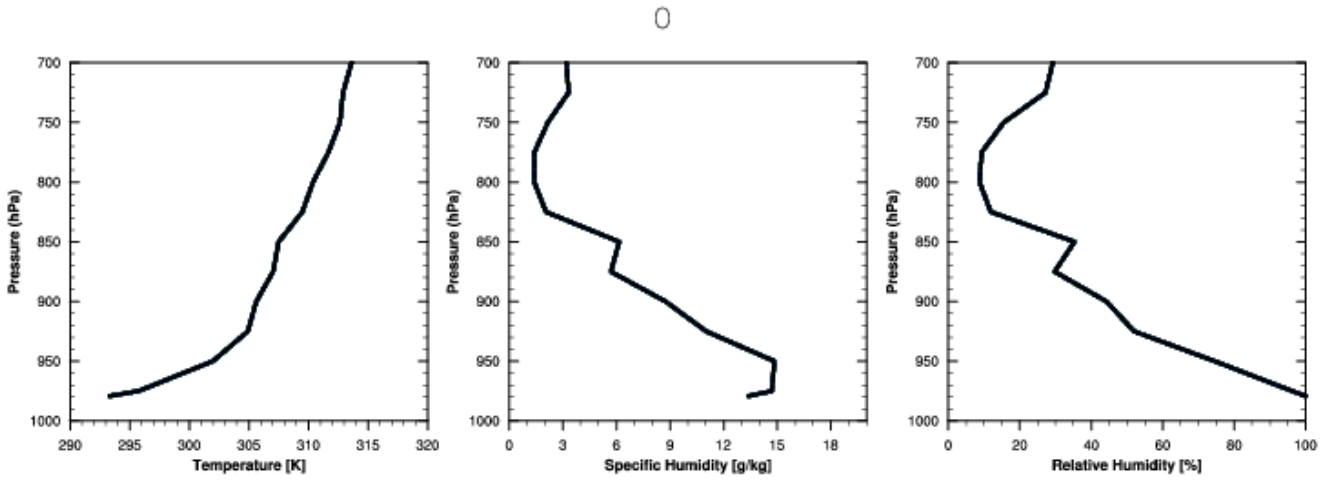

Evaporative Fractions

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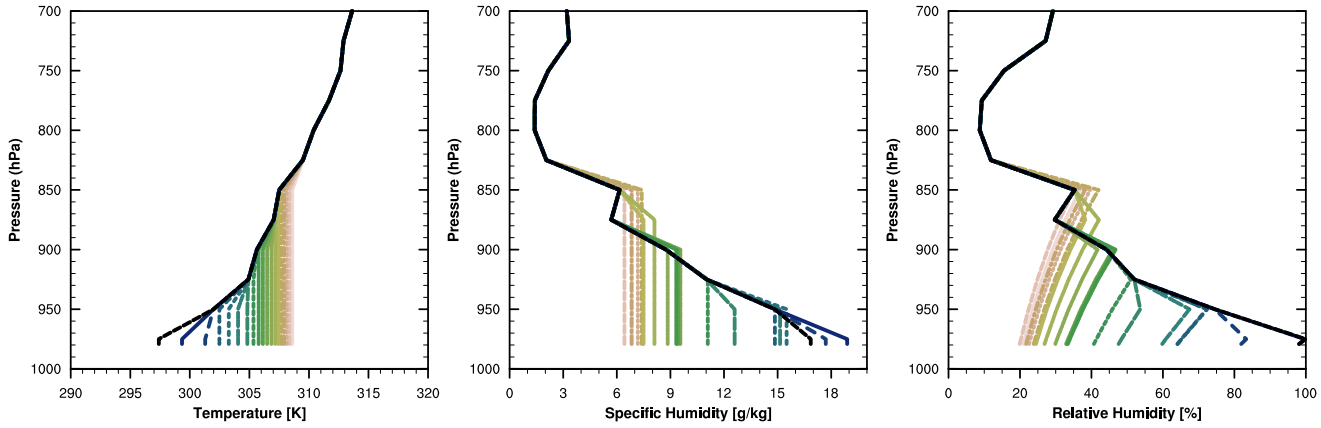
125



Dry — Wet

Evaporative Fractions

Wetting-Drying Experiments: ARM-SGP

Taking all July days from 1996-2011

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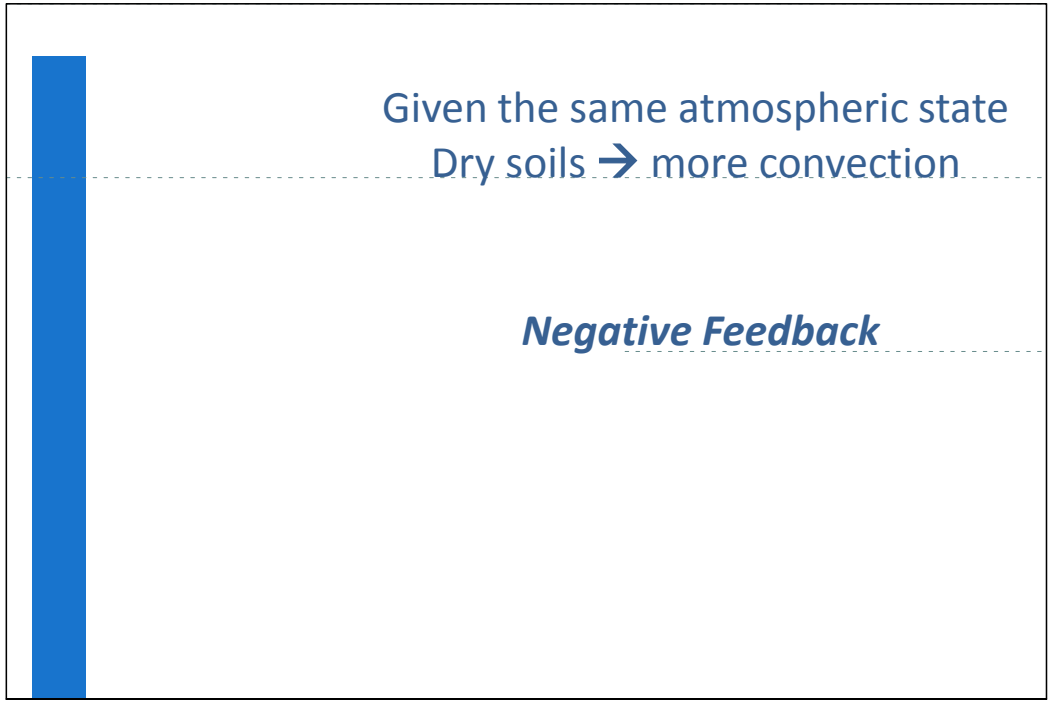
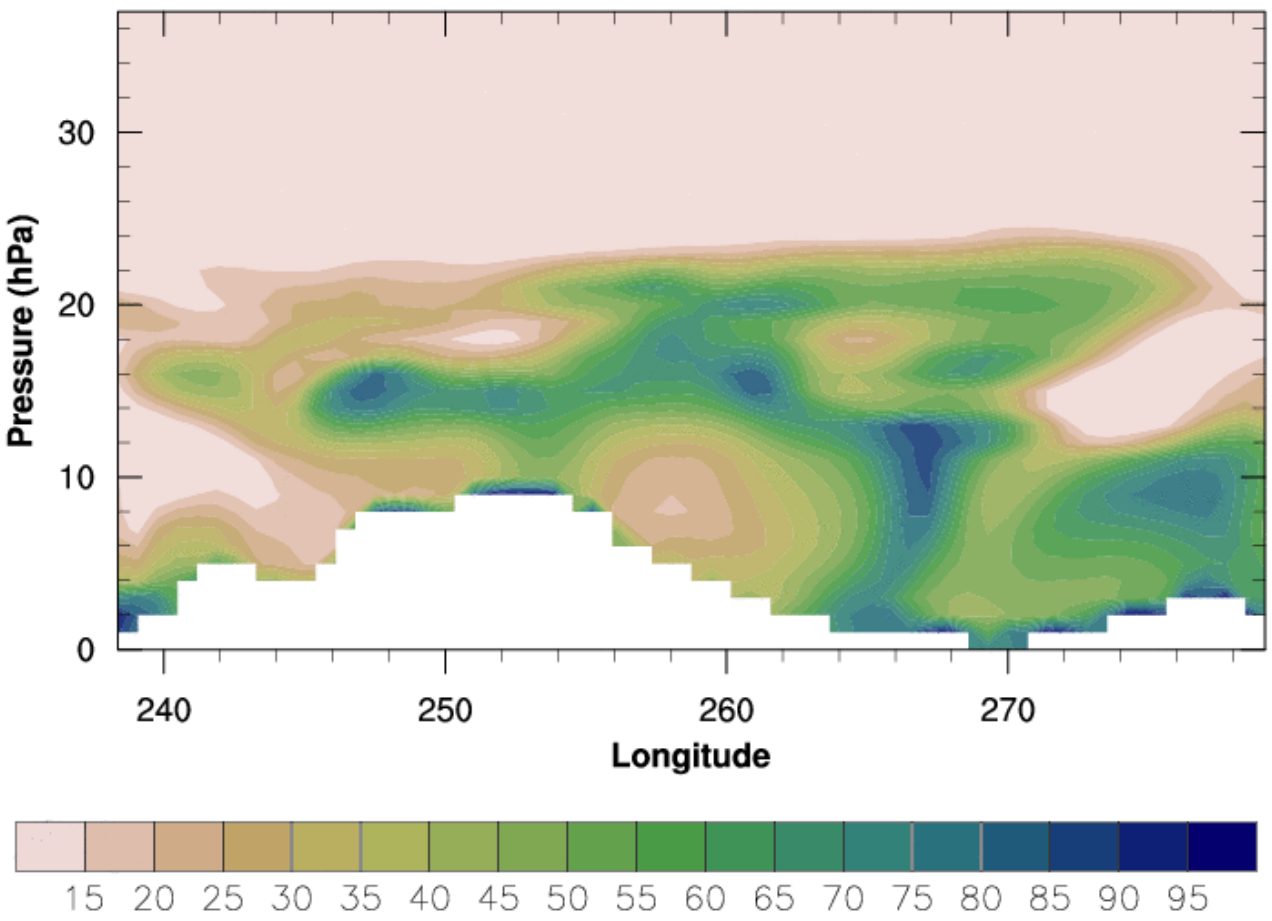
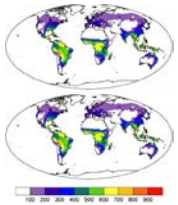


Relative Humidity Cross-Section: ERA-I



Suppose You Have Offline CLM Runs…

- Does the change I made matter from a L-A feedbacks perspective?



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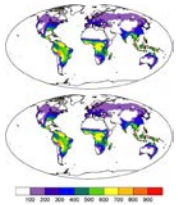
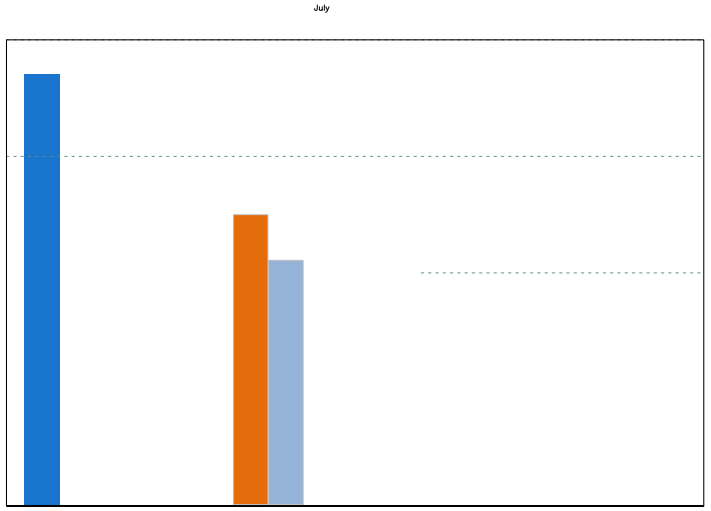


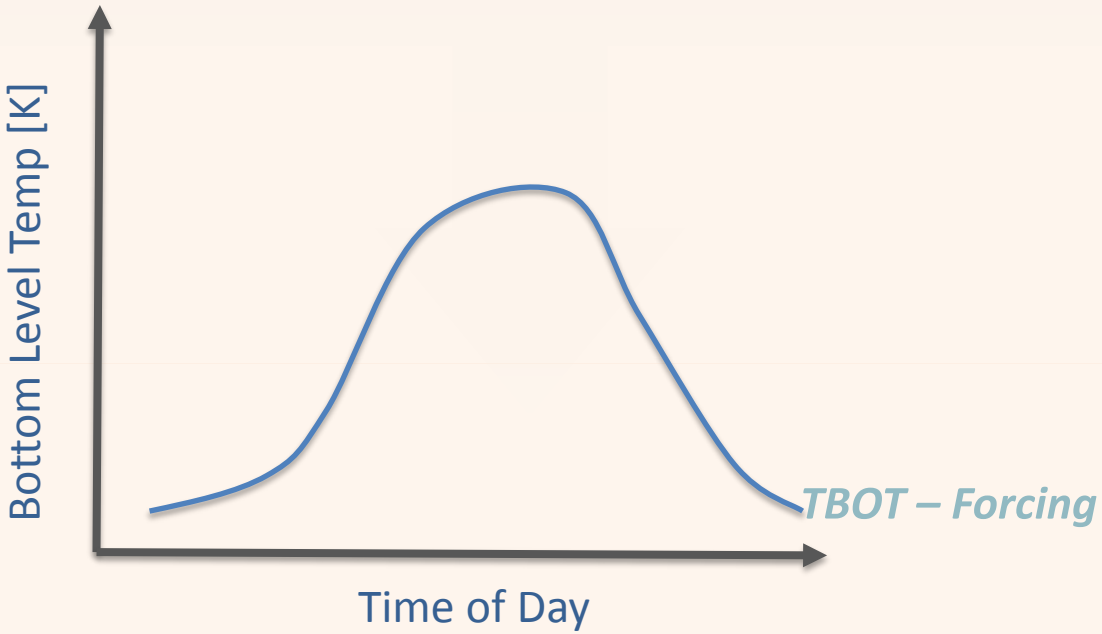


Wetting-Drying Experiments: ERA-I

Relative Humidity Profile – ERAI

Questions that can be Addressed

- What state do CLM energy fluxes nudge T and Q towards?



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