The Role of Soil Properties on Regional Climate Simulations

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How do the soil properties affect the surface fluxes and the PBL?

Numerical Experiments

WRF Model Simulations:

- 15-km horizontal grid spacing
- 51 vertical levels (13 in the lowest 1 km)
- Period: JJA 2017

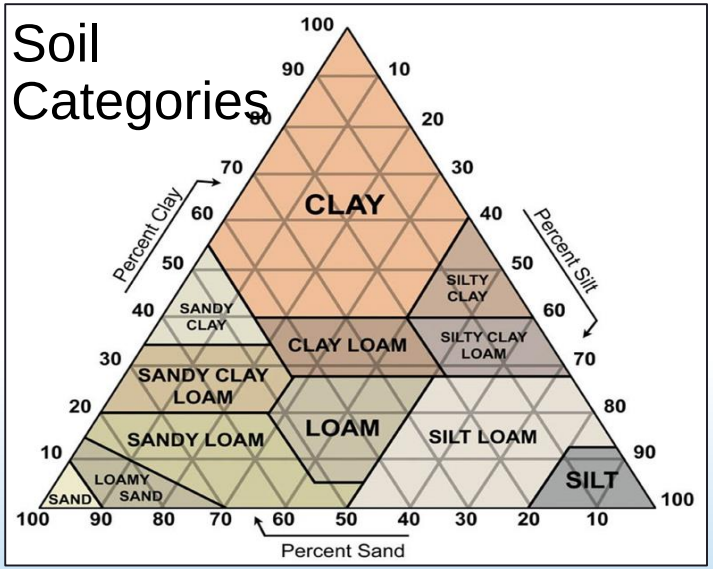
Relevant parameterizations:

- **LSM:** CLM version 4; Noah-MP
- **PBL Scheme:** MYNN2
- **Surface Layer Scheme:** MYNN (compatible with PBL Scheme)

Soil Texture Datasets:

- USDA STATSGO (WRF default)
- GSDE from Beijing Normal University

How are the hydro-physical properties represented in LSMs?



For each category, hydro-physical *parameters are defined through a table*, and they are then used for specific process parameterizations.

Soil Categories (Texture)

Look-up Table of

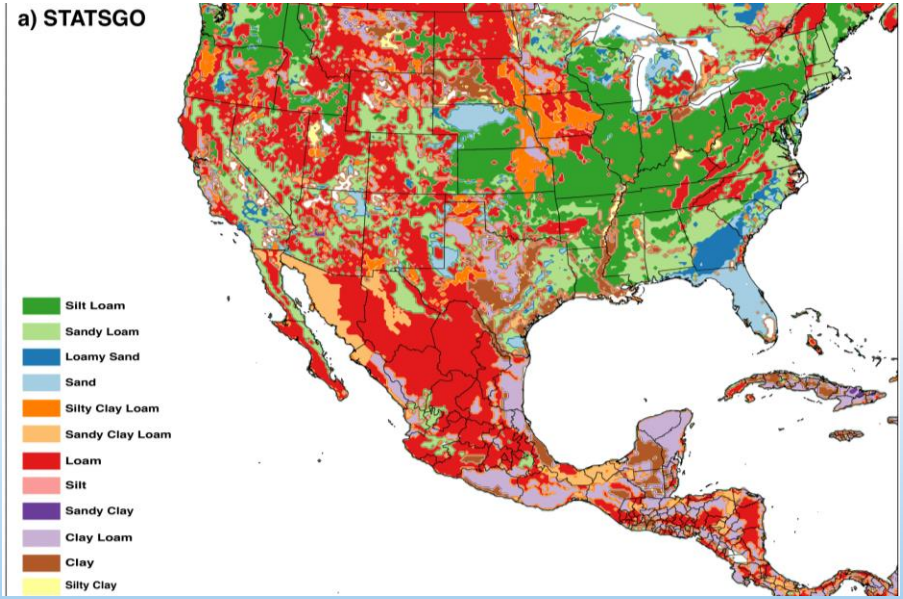
Hydraulic Parameters:
Wilting point,
Field Capacity,
…

Parameterizations:

Surface Fluxes,
Runoff,
…

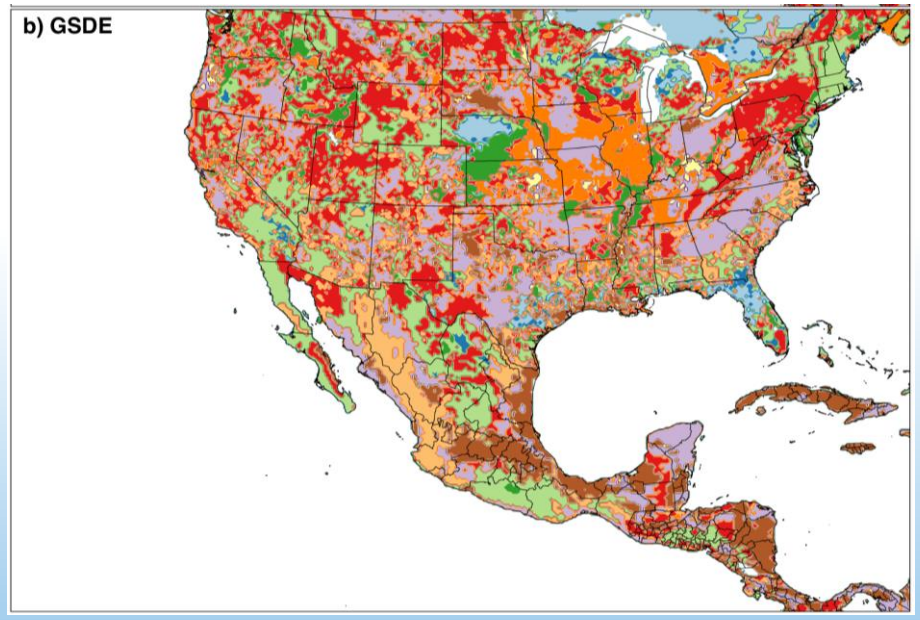
Soil Datasets

STATSGO (USDA)



STATSGO: State Soil Geographic Database

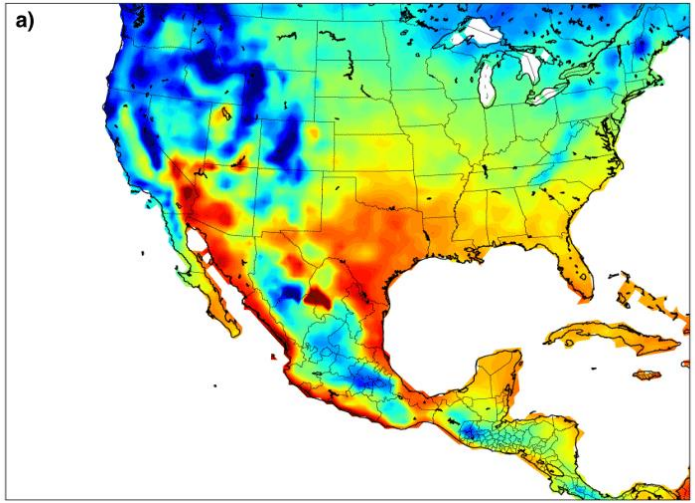
GSDE (BNU)

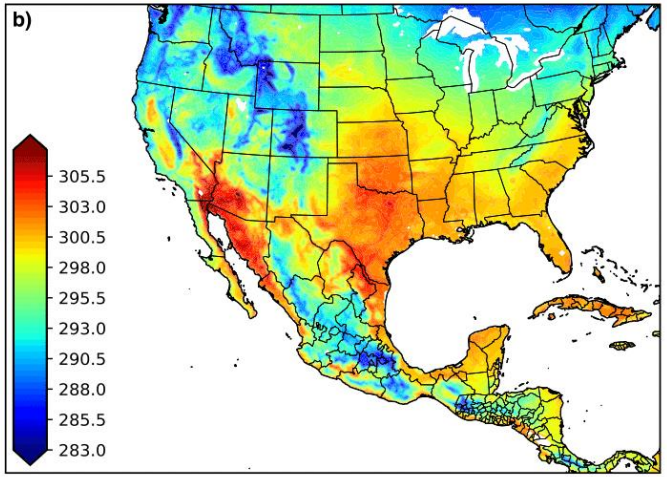


GSDE: Global Soil Dataset for use in Earth System Models

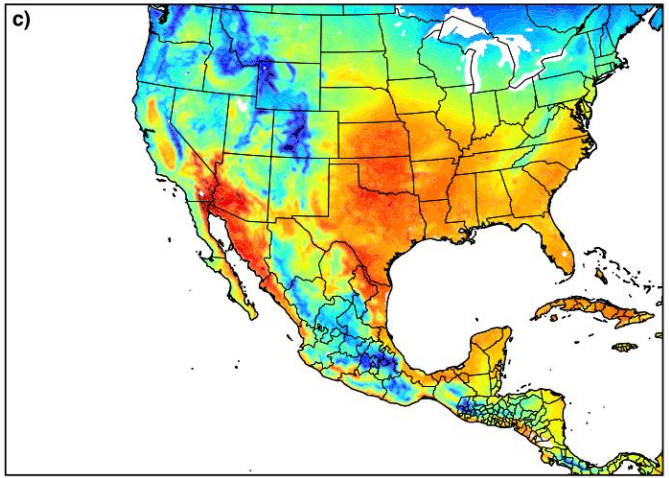
T2m

Observations



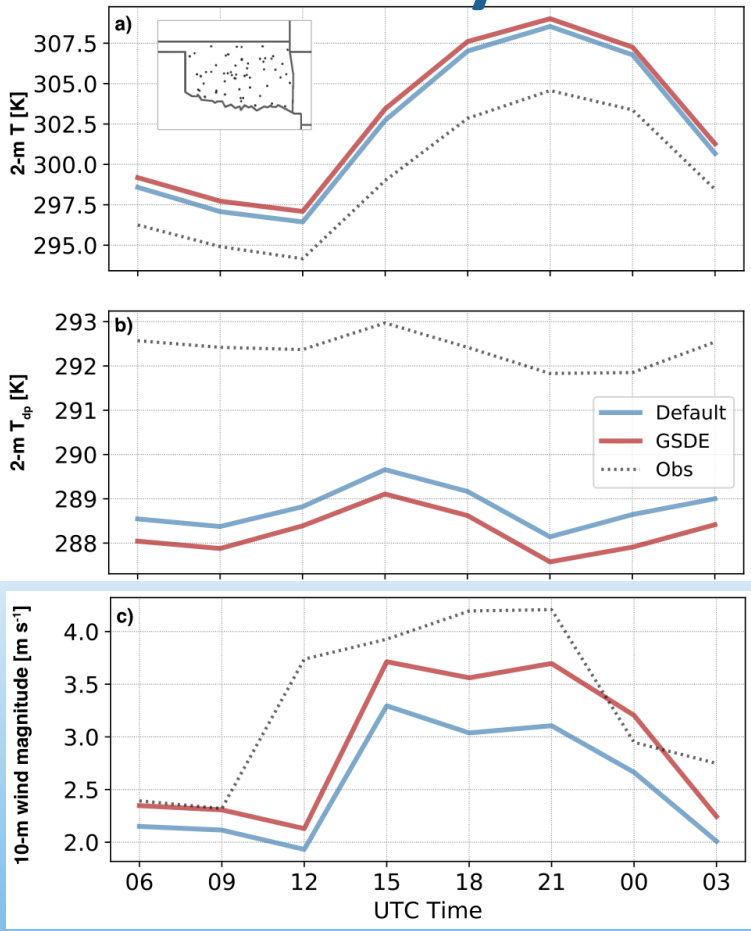


WRF/CLM with STATSGO



WRF/CLM with GSDE

Diurnal Cycle



OBS

STATSGO

GSDE

T2:

- Timing consistent with the observations
- The bias is smaller at night, larger during daytime.

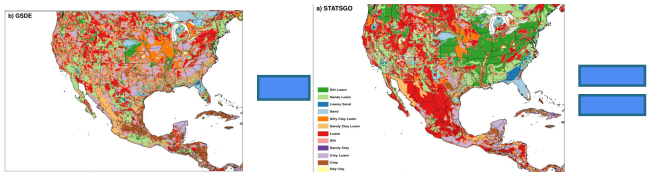
Td2:

Simulations have a slight shift (3-hr) for minimum Td min.
The timing of the Td max is with observations

Wind:

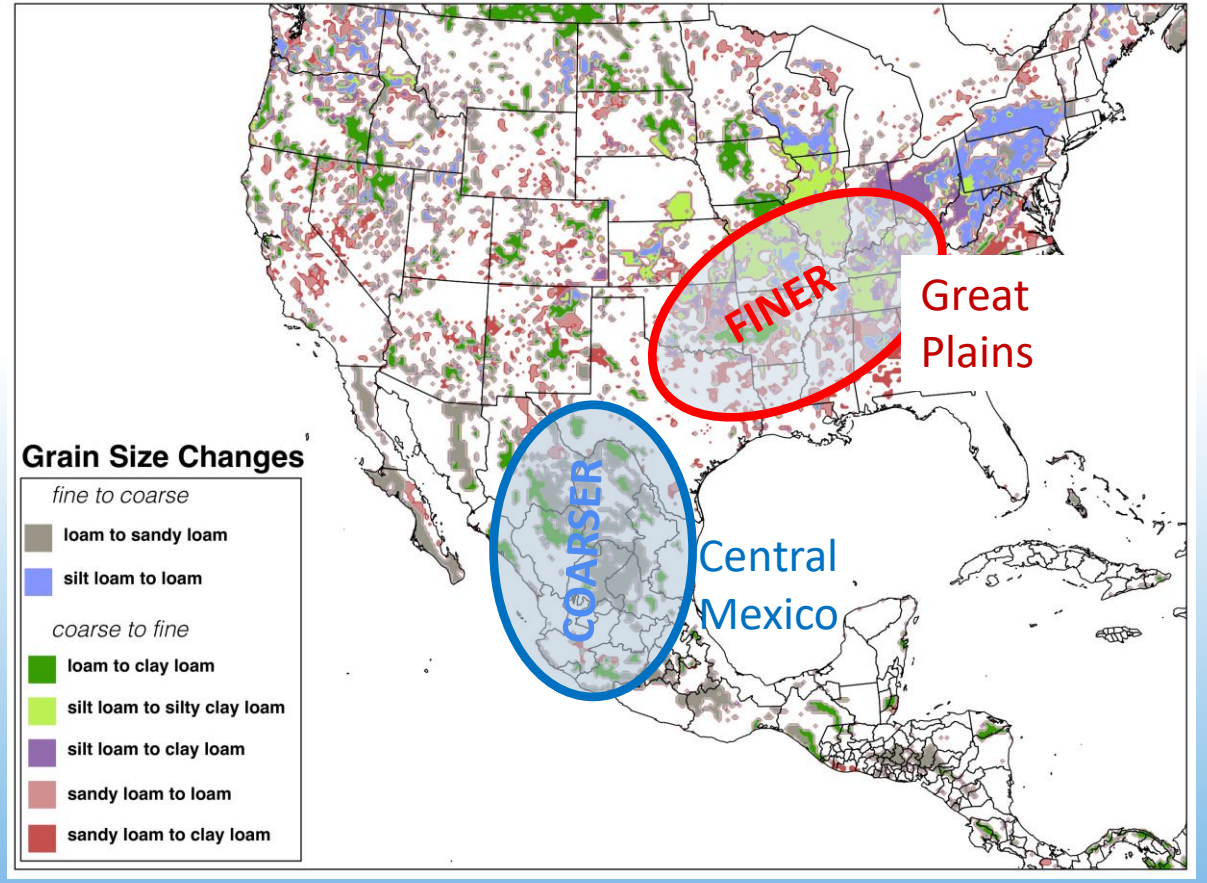
- The overall features are similar: minimum wind magnitudes at night, largest values in the afternoon/evening.
- Simulations show the Min values about 3 hs later than what is observed, while the Max tends to occur about 6 hs earlier than in observations
- Unlike T and Td, the GSDE wind biases are about 1/2 of those in STATSGO

Changes in grain size from STATSGO to GSDE

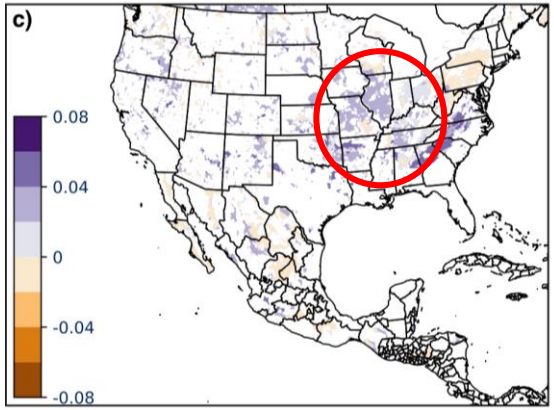


Fine to coarse

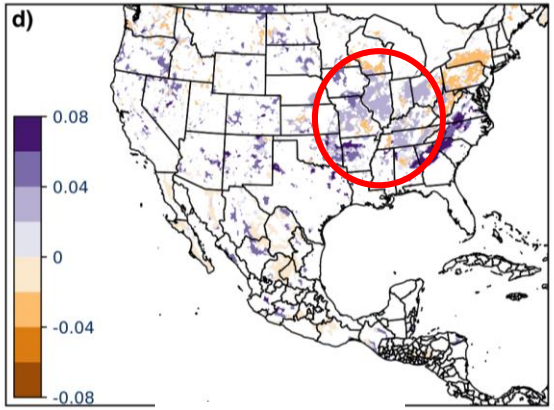
Coarse to fine



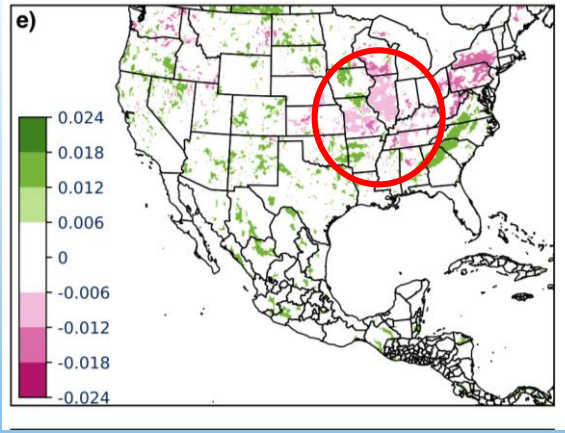
Field Capacity



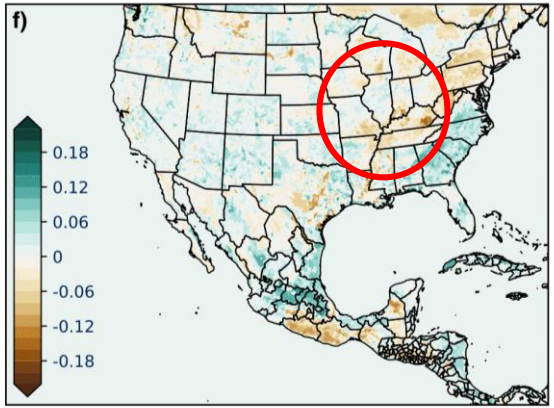
Wilting Point



Extract. Water



Soil Moisture



Changes in soil parameters from STATSGO to GSDE

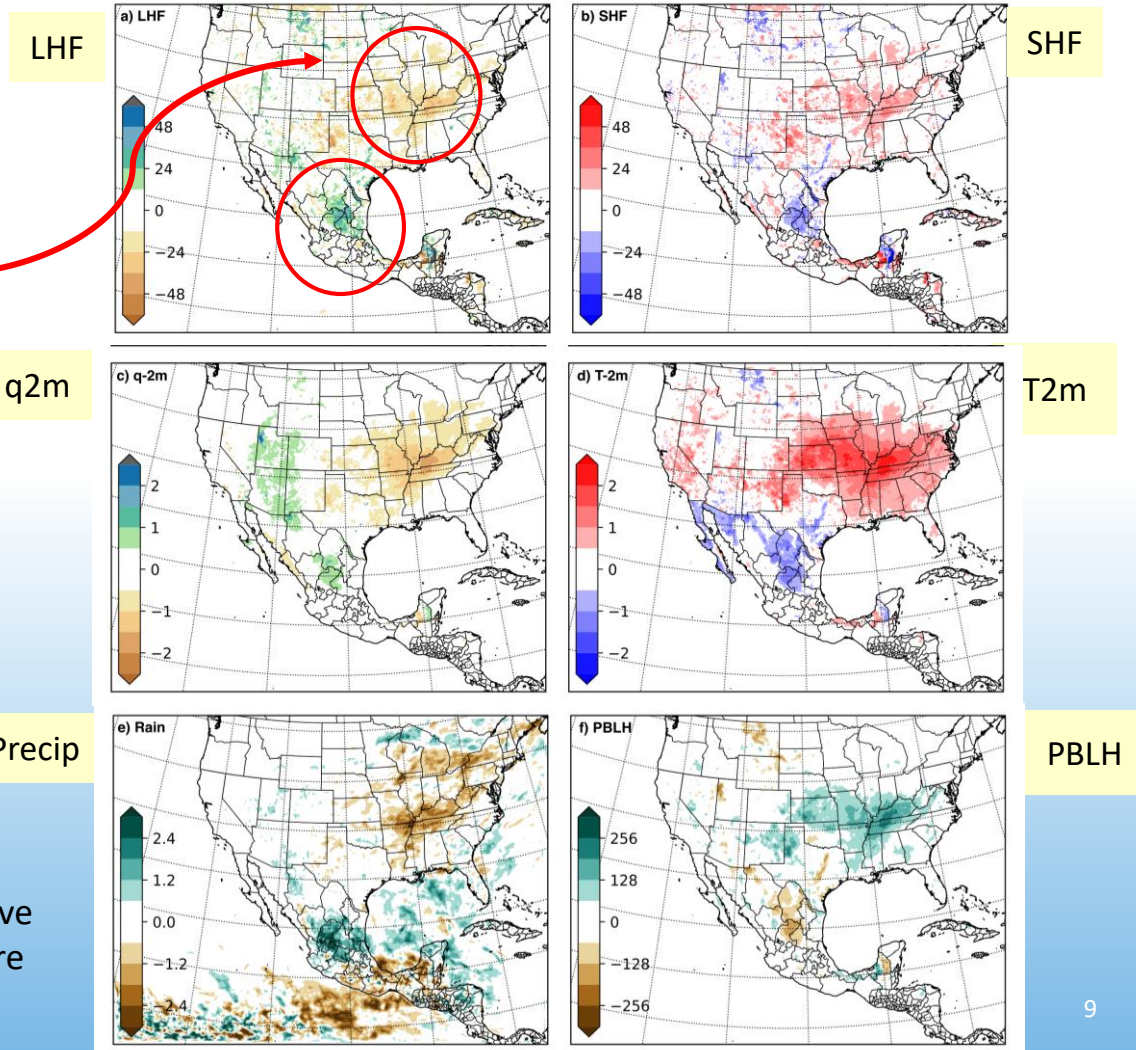
Continental Results

*The values represent **(GSDE–STATSGO)** seasonal differences*

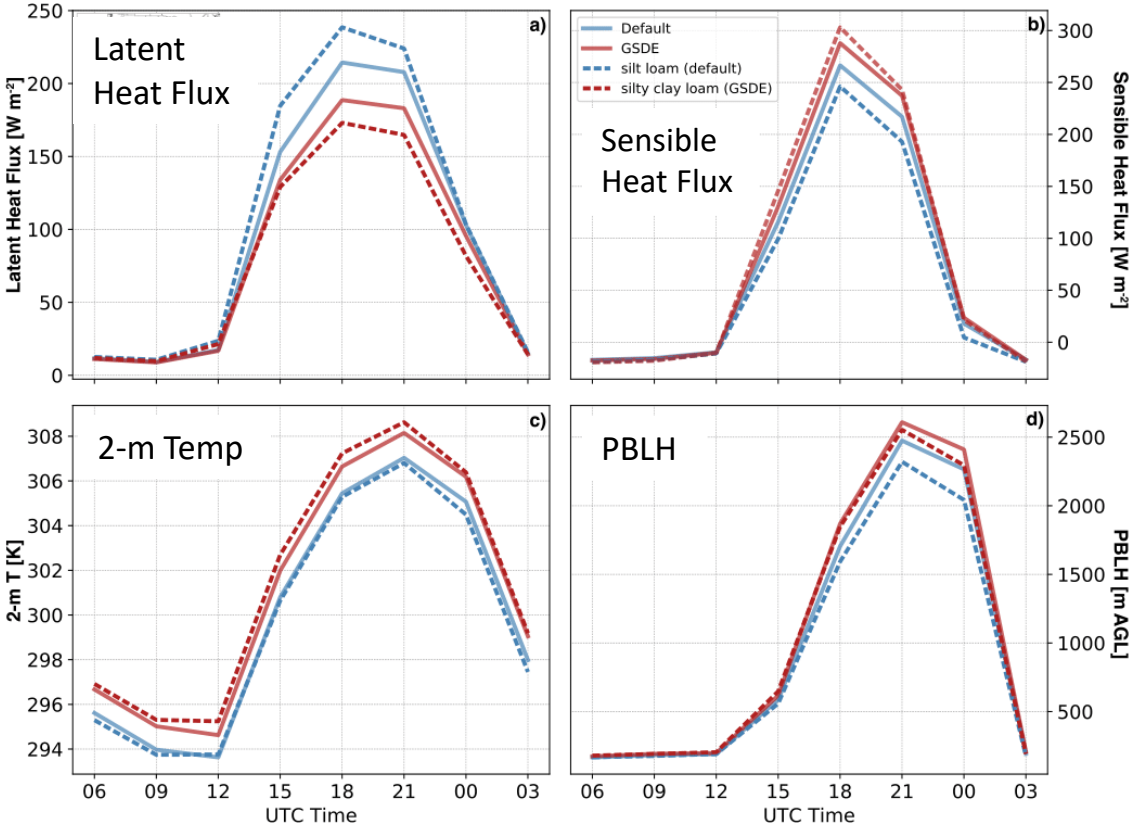
- Finer soil particles retain soil moisture more vigorously
- Energy that does not contribute to removing moisture gets partitioned into sensible heat flux

- Temperature and mixing ratio at 2-m, generally follows the pattern of the surface fluxes (though not perfectly due to advective processes)

- Integrative processes (i.e., precip and boundary layer evolution) also follow intuitive patterns, though the correspondence is more complicated.



Results: Great Plains



STATSGO (silt loam; coarser)

GSDE (silty clay loam; finer)

Solid lines: area average for all categories in GP

Conclusions (1 of 2)

- Important *differences in soil texture and degree of heterogeneity* are found over the Great Plains and Central Mexico

- Differences between simulations with the two soil texture datasets are *as large as those resulting from using different LSMs* (not shown)

- Parameters associated with soil texture control the availability of soil moisture; *soils with finer grains retain water more strongly than coarser grain soils, affecting most processes at the surface*.

Conclusions (2 of 2)

- *Surface fluxes and near surface variables respond to the changes in soil properties* and drive the boundary layer evolution facilitating feedbacks that influence the regional climate.

- Because soil hydro-physical properties influence surface fluxes, *the use of different soil texture databases will influence the local land-atmosphere (LA) coupling*.