Evaluating and Improving Representation of Soil Knowledge in the Noah-MP

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Background

- "A 95% inclusion of available information on soil capability in model-based decision making by 2030." Global Soil Security Conference (2015)
- <u>Noah-MP</u>

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! Options for dynamic vegetation:
! 1 -> off (use table LAI; use FVEG = SHDFAC from input)
! 2 -> on (together with OPT_CRS = 1)
! 3 -> off (use table LAI; calculate FVEG)
! 4 -> off (use table LAI; use maximum vegetation fraction)

  INTEGER :: DVEG    != 4    !

! Options for canopy stomatal resistance
! 1-> Ball-Berry; 2->Jarvis

  INTEGER :: OPT_CRS != 1     !(must 1 when DVEG = 2)

! Options for soil moisture factor for stomatal resistance
! 1-> Noah (soil moisture)
! 2-> CLM  (matric potential)
! 3-> SSiB (matric potential)

  INTEGER :: OPT_BTR != 1     !(suggested 1)

! Options for runoff and groundwater
! 1 -> TOPMODEL with groundwater (Niu et al. 2007 JGR) ;
! 2 -> TOPMODEL with an equilibrium water table (Niu et al. 2005 JGR) ;
! 3 -> original surface and subsurface runoff (free drainage)
! 4 -> BATS surface and subsurface runoff (free drainage)
! 5 -> Miguez-Macho&Fan groundwater scheme (Miguez-Macho et al. 2007 JGR, lateral flow: Fan et al. 2007
JGR)
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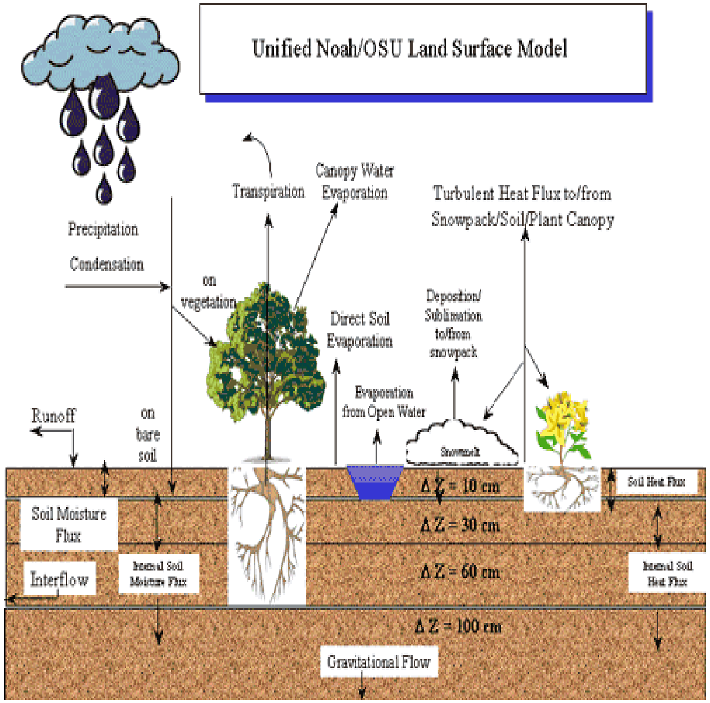
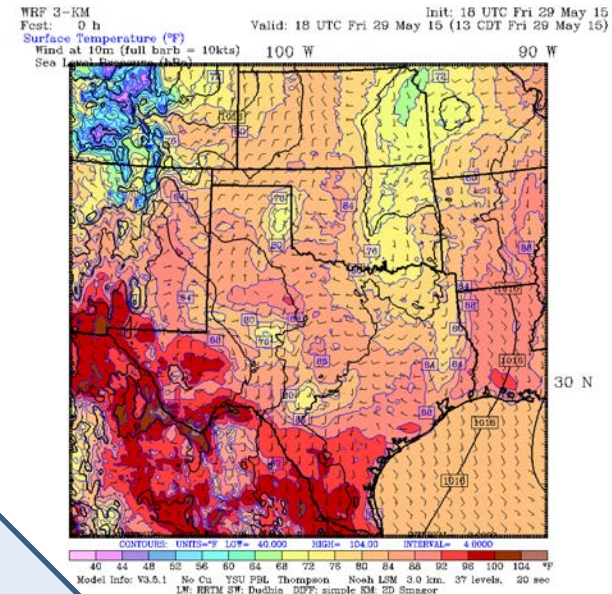
Thousands of combinations!!

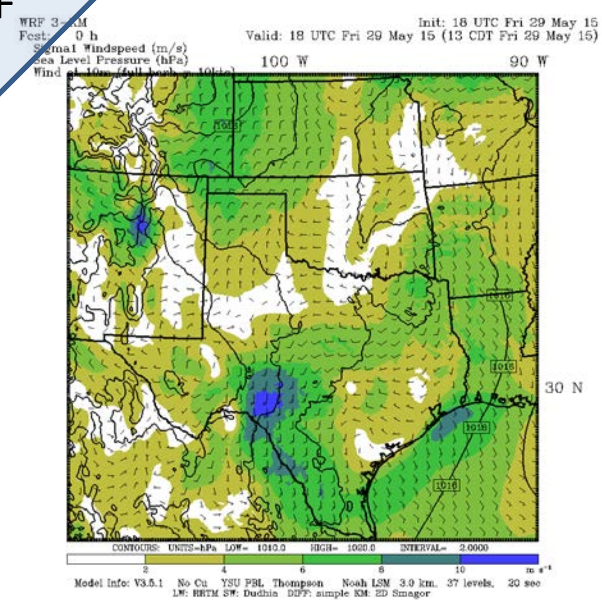
Background



Coupled Noah-MP_WRF

WRF Predictions



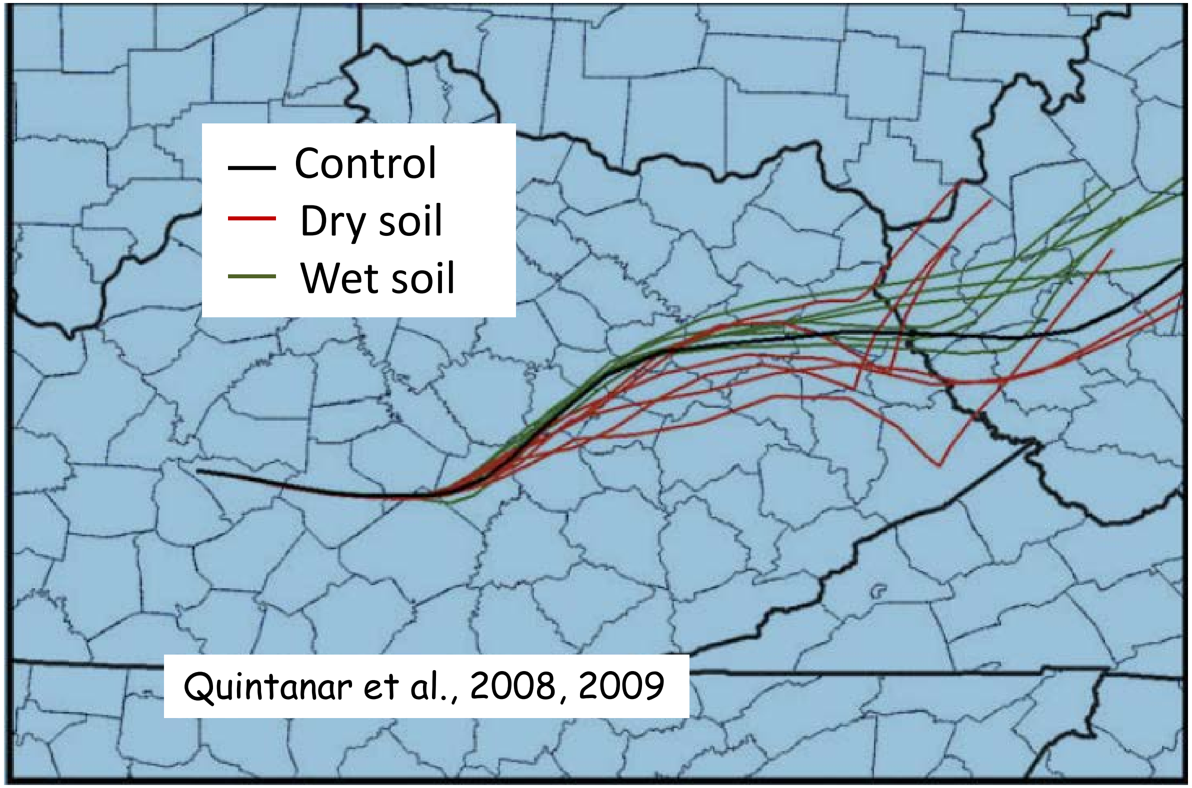


http://www.atmo.ttu.edu/bancell/real_time_WRF

- Land surface variables → important lower boundary conditions of the atmospheric system
- Surface sensible and latent heat fluxes → input for atmospheric models

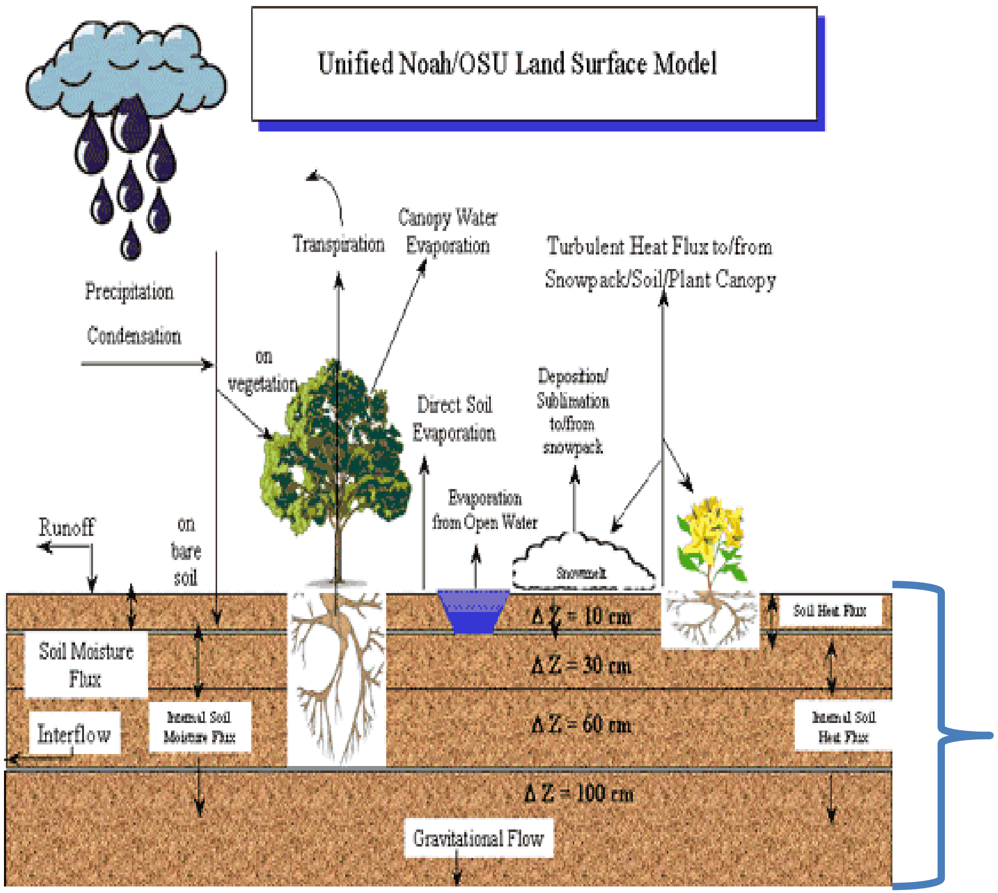
Background

- Effect of soil moisture on the trajectory of air pollution



Limitations

NOAH-MP Land Surface Model



1. The model uses a look up table for important soil properties and the values were not representative for Texas
2. Assumes 2-m deep uniform soil texture

Revised Soil Parameter Table

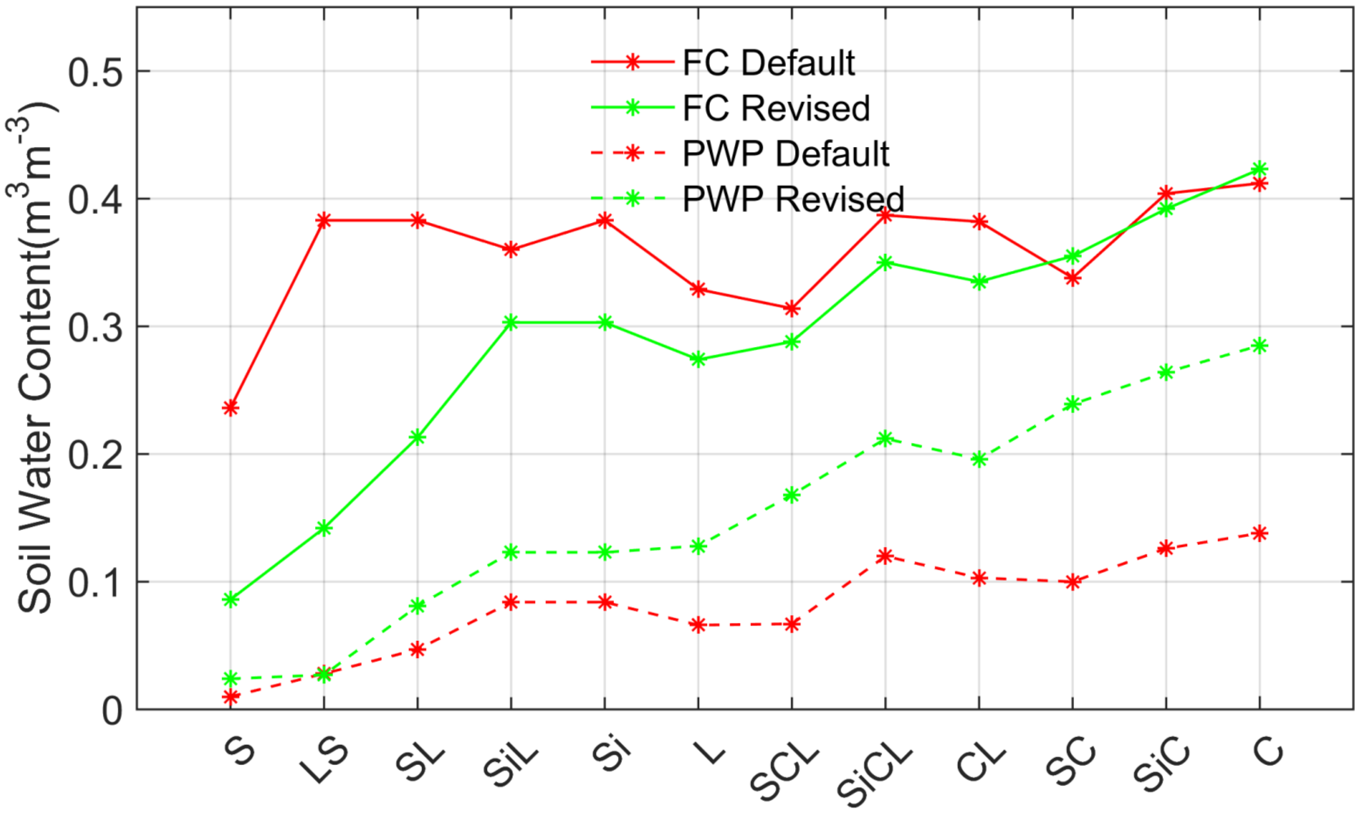
	BB	DRYSMC	F11	SATSMC	REFSMC	SATPSI	SATDK	SATDW	WLTSMC	QTZ	Category Type
		m^3m^{-3}		m^3m^{-3}	m^3m^{-3}	m	$m\ s^{-1}$	$m^2\ s^{-1}$	m^3m^{-3}	%	
											'SAND'
											'LOAMY SAND'
											'SANDY LOAM'
											'SILT LOAM'
											'SILT'
											'LOAM'
											'SANDY CLAY LOAM'
											'SILTY CLAY LOAM'
											'CLAY LOAM'
											'SANDY CLAY'
											'SILTY CLAY'
											'CLAY'
											'ORGANIC MATERIAL'
											'WATER'
											'BEDROCK'
											'OTHER(land-ice)'
											'PLAYA'
											'LAVA'
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	'WHITE SAND'

118 out of 190 (62%) were significantly different for soils from Texas

Morgan and Kishné (2013)

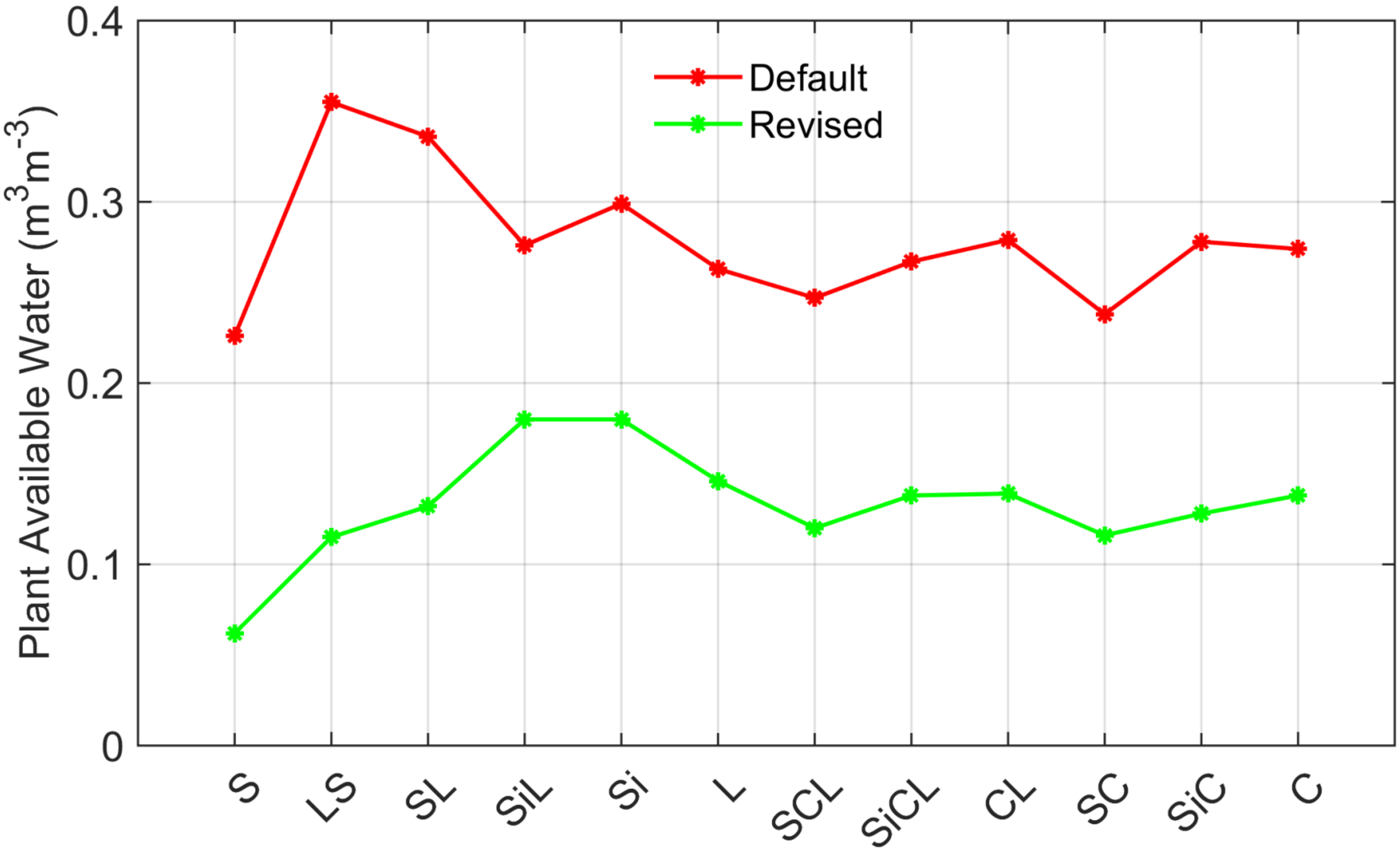
Default vs. Revised

- Example: Field Capacity and Permanent Wilting Point



Default vs. Revised

- Potential Plant Available Water



Simulation Comparisons

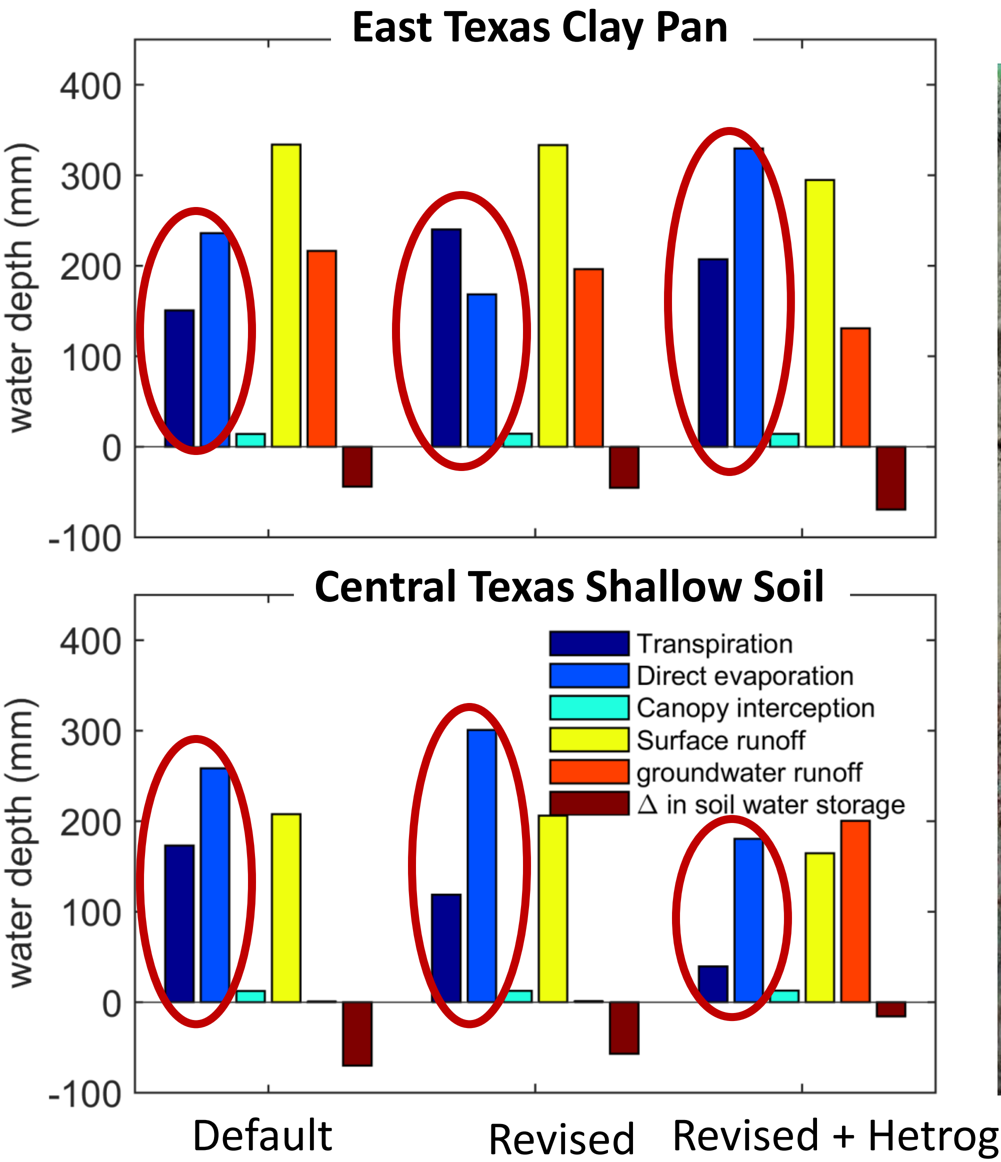
Current Practice

1. Default + Uniform 2-m deep soil
2. Revised + Uniform 2-m deep soil
3. Revised + Soil layering information

- Water Balance
- Energy Partitioning
- Soil water content

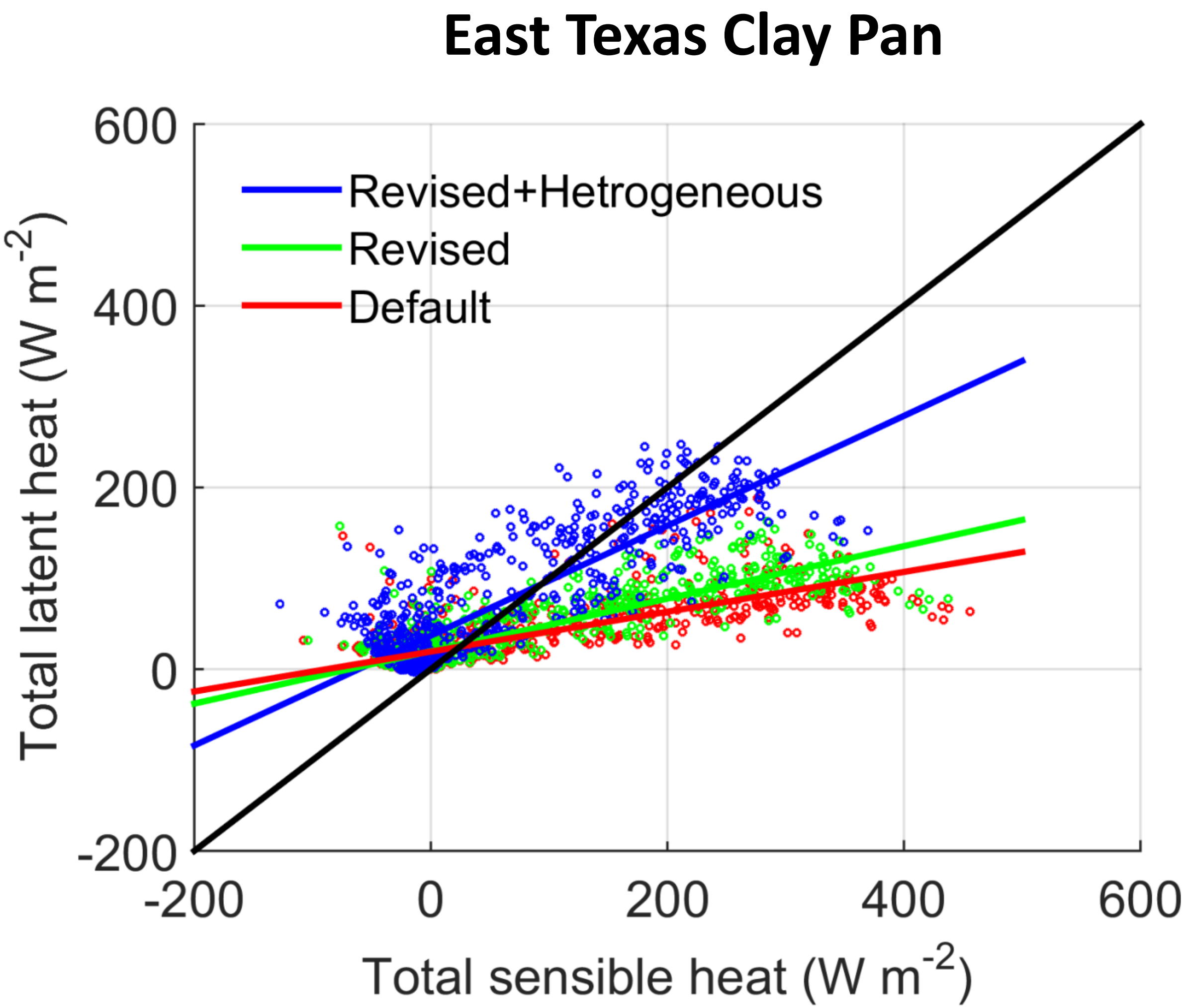
- Two Locations
  - East Texas (deep clay pan)
  - Central Texas (shallow soil)

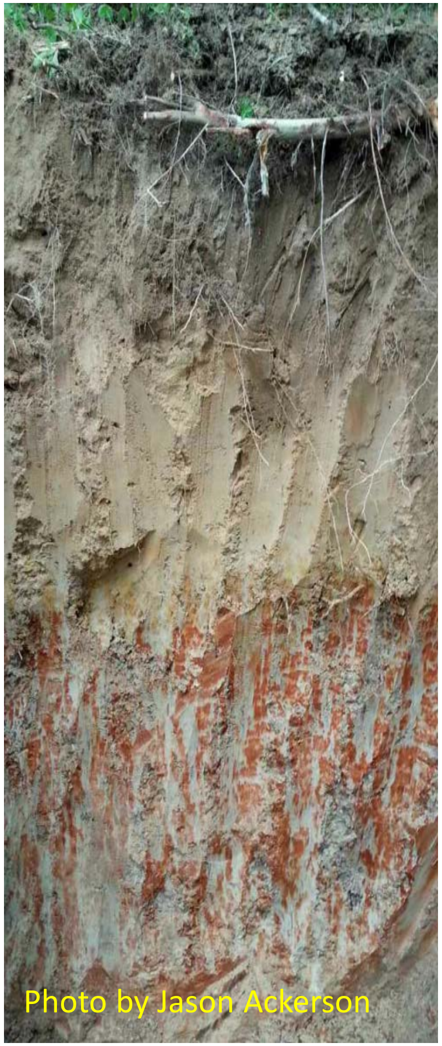
Change in Water Balance



www.cals.uidaho.edu/soilorders/i/Incept_03b.jpg

ENERGY: Latent vs. Sensible Heat





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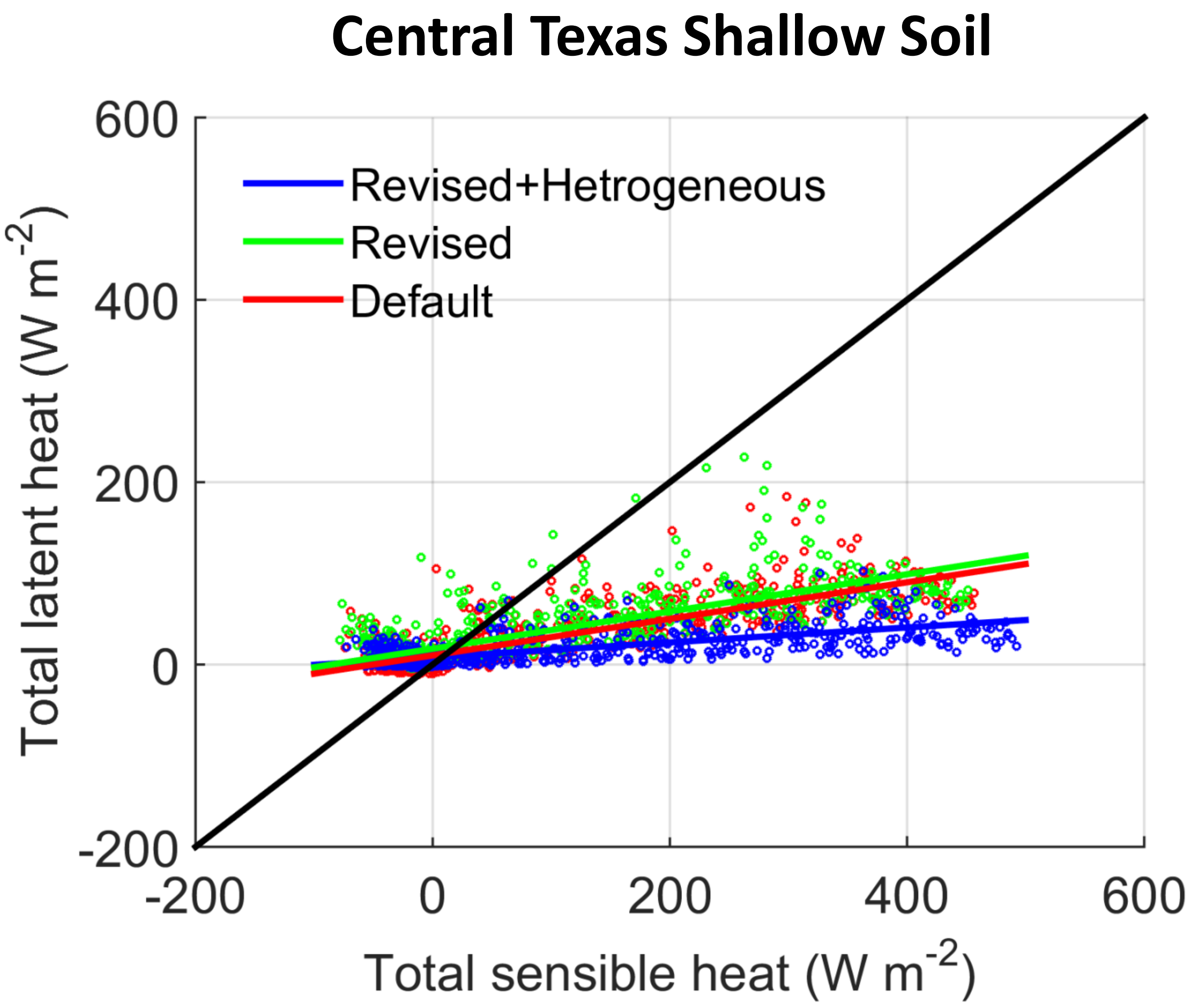

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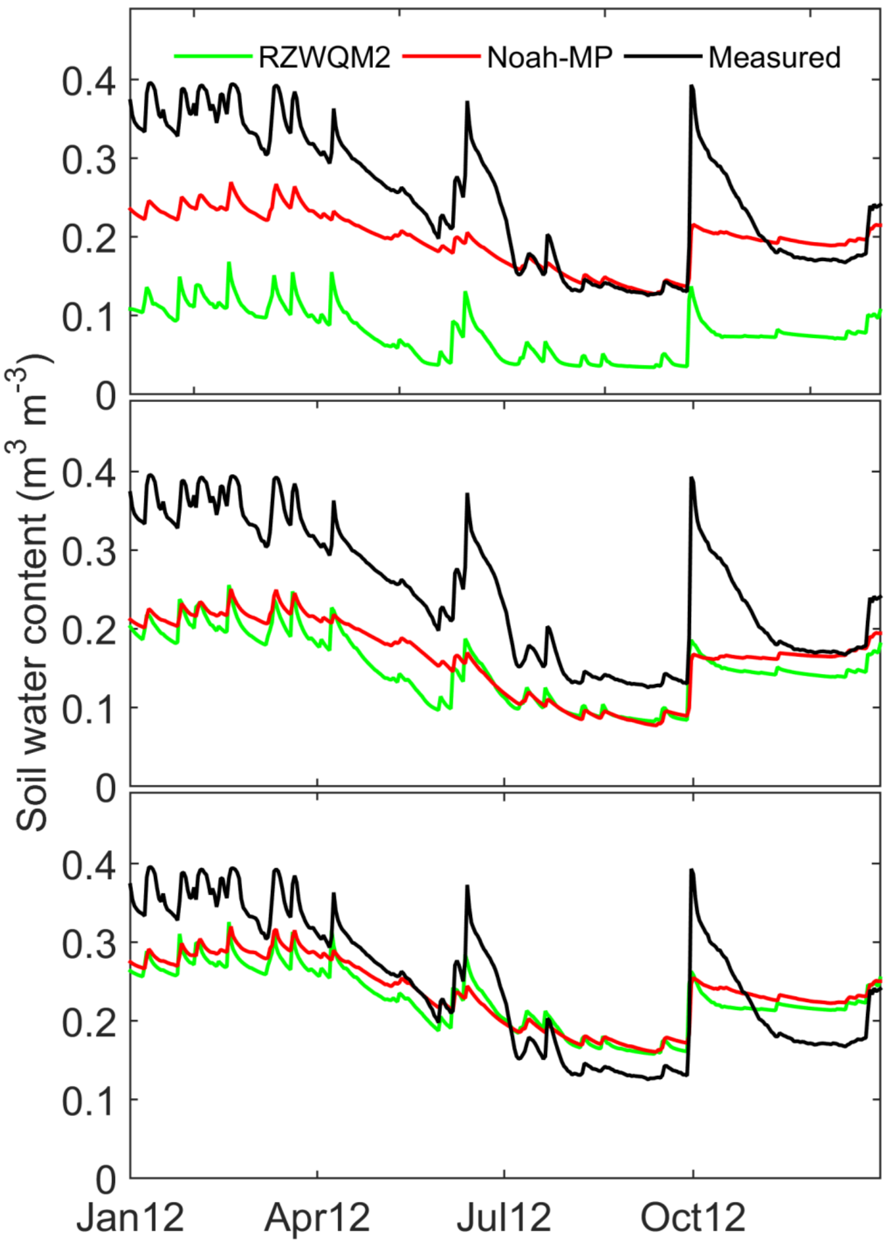
Soil water content for the top 1m – East Texas



Default + Homogeneous

Noah-MP vs.	RMSE	NSE
measurement	0.076	0.20

Revised + Homogeneous

Noah-MP vs.	RMSE	NSE
measurement	0.098	-0.32

Revised + Heterogeneous

Noah-MP vs.	RMSE	NSE
measurement	0.051	0.64

Conclusion

- Improving soil parameter table and considering soil heterogeneity significantly changes simulations of the water balance and energy partitioning
- Incorporating better soil information improved model prediction of soil water content
- Soil water content simulations by different models were comparable for an improved soil information case
- To achieve the goal of 95% inclusion of soil information in models, continuous communication between soil scientists and modelers is crucial
    - Continue field observations and improve mapping
    - Physics of many equations need to be updated

Research in-progress

and questions for the group

- ❑ Extend the enhancement to a more spatially-explicit description of the surface energy and water fluxes.

→ Validation dataset?

- ❑ Quality of dataset from observatory systems

→ Include soil type in the QAQC algorithms to bound observations?