

Improvement of CLM4 Soil Hydrology by Introducing Micropores/Macropores to the Soil/Aquifer Coupling

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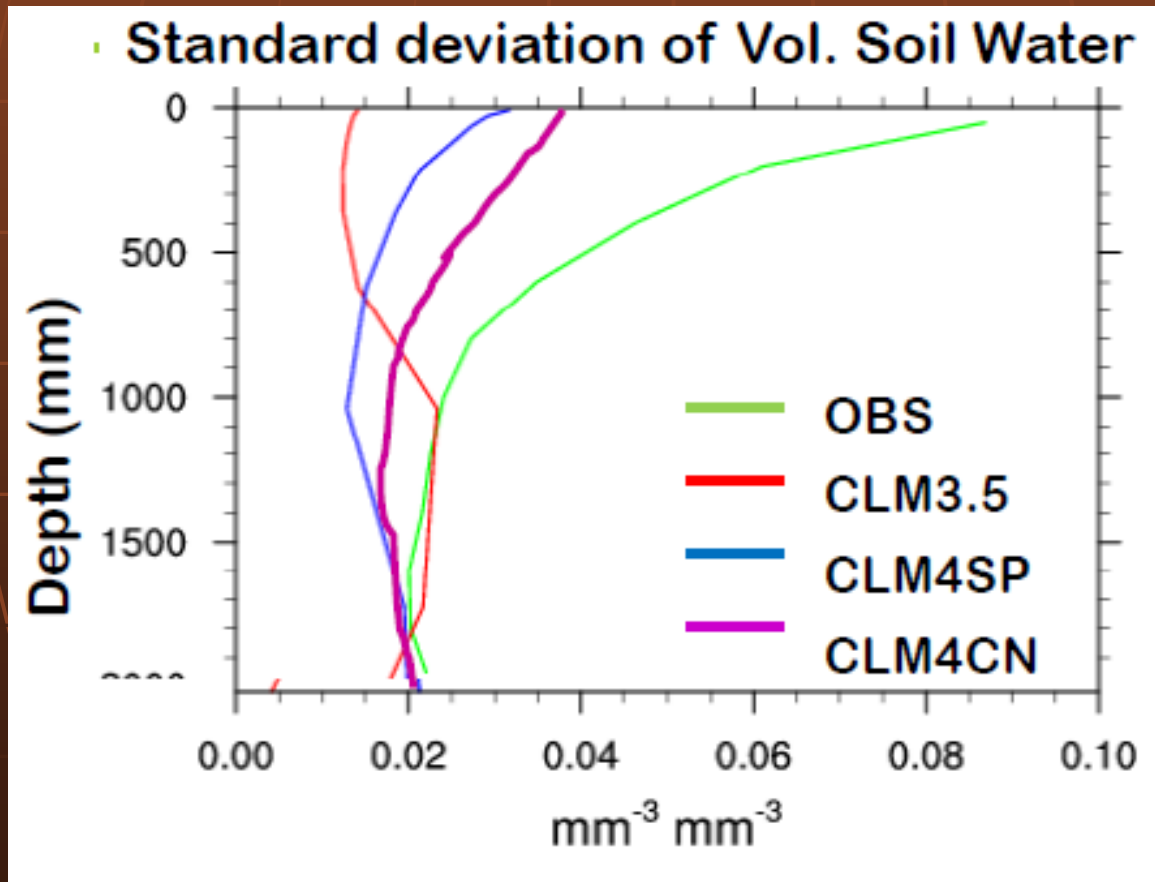
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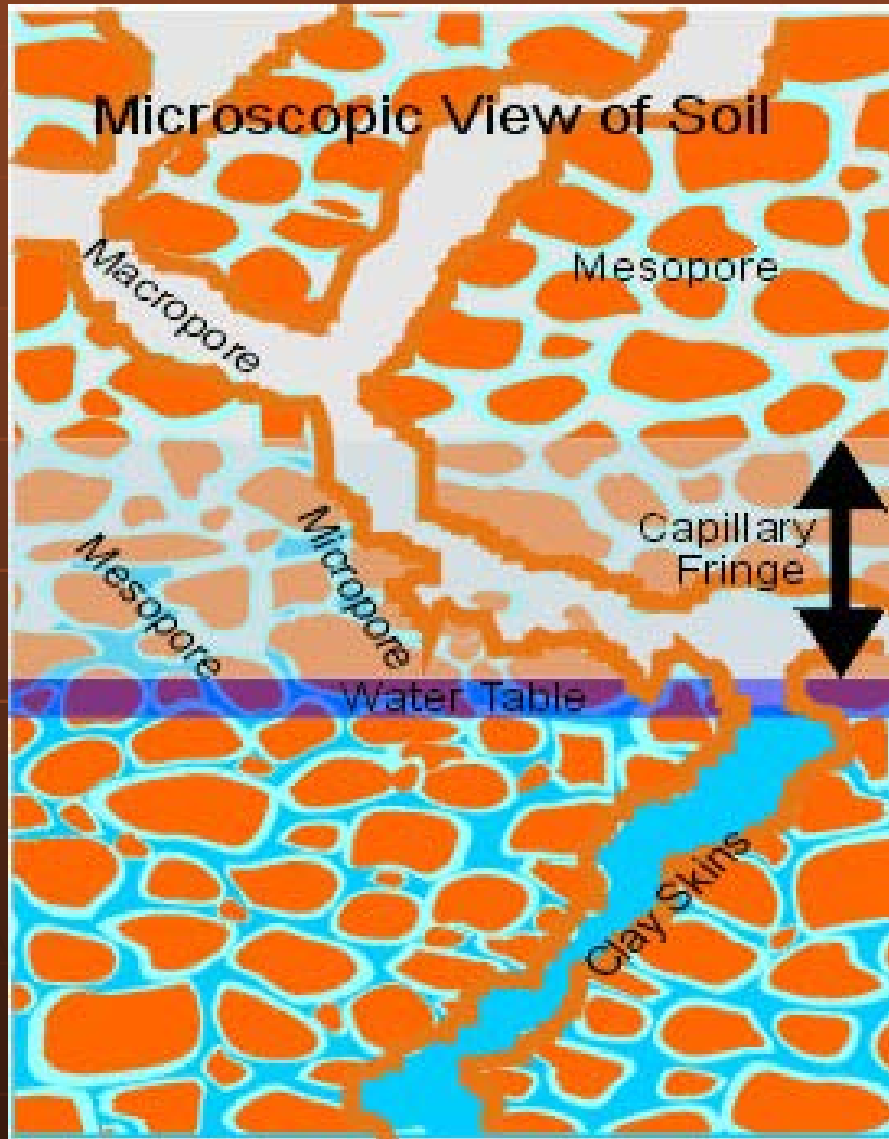
SCHOOL OF GEOSCIENCES

Motivation

CLM soil moisture seasonal to interannual variability is weaker than observed.



Water in the Soil Profile



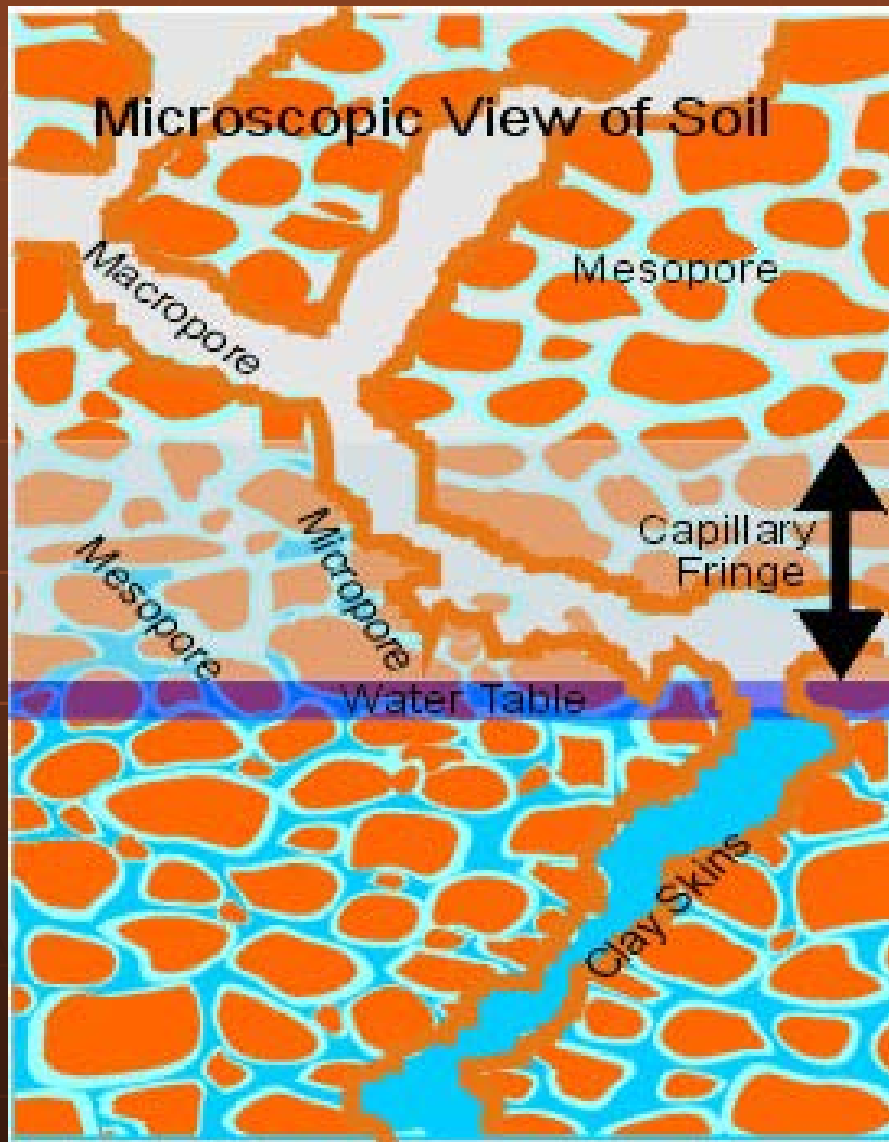
Unsaturated zone
(vadose zone)

Capillary Fringe: immediately
above the water table
At the base, soil is saturated
for all pores; at the top,
saturation is limited to
micropores.

Water Table

Saturated zone

Water in the Soil Profile

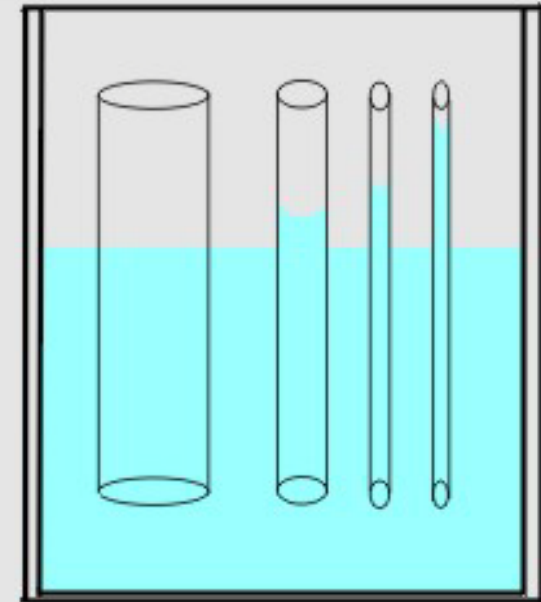


The soil pores are analogous to water pipes; small pore (small diameter pipe) → great rise.

Capillary Tubes

Capillary rise is related to the diameter of the tube: the smaller the tube diameter the greater the rise of the water column

Capillarity is due to adhesion of water to a surface and cohesion of the adhered water to and among other water molecules

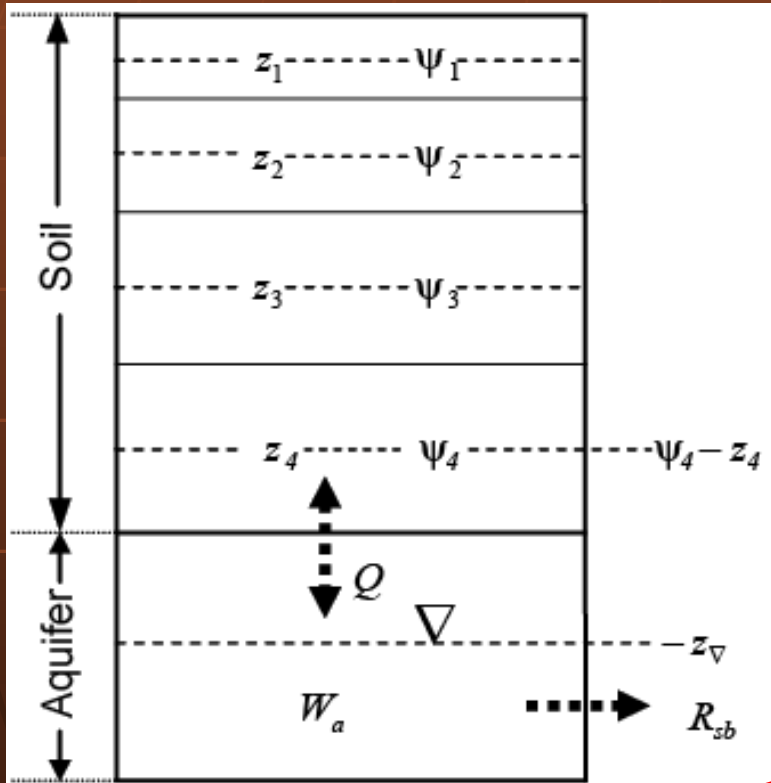


**How to compute the capillary fringe
in CLM4?**

**Do we have distributions of
micropores, mesopores, and
macropores?**

**How to compute groundwater
recharge in relation to soil/aquifer
coupling?**

A Simple Groundwater Model (SIMGM)



Water storage in an unconfined aquifer:

$$\frac{dW_a}{dt} = Q - R_{sb}$$

$$z_\nabla = W_a / S_y$$

Recharge Rate:

$$Q = -K_a \frac{-z_\nabla - (\psi_{bot} - z_{bot})}{z_\nabla - z_{bot}}$$

$$= K_a \left(1 + \frac{\psi_{bot}}{z_\nabla - z_{bot}} \right)$$

Modified to consider micropore/macropore effects:

$C_{mic} * \psi_{bot}$

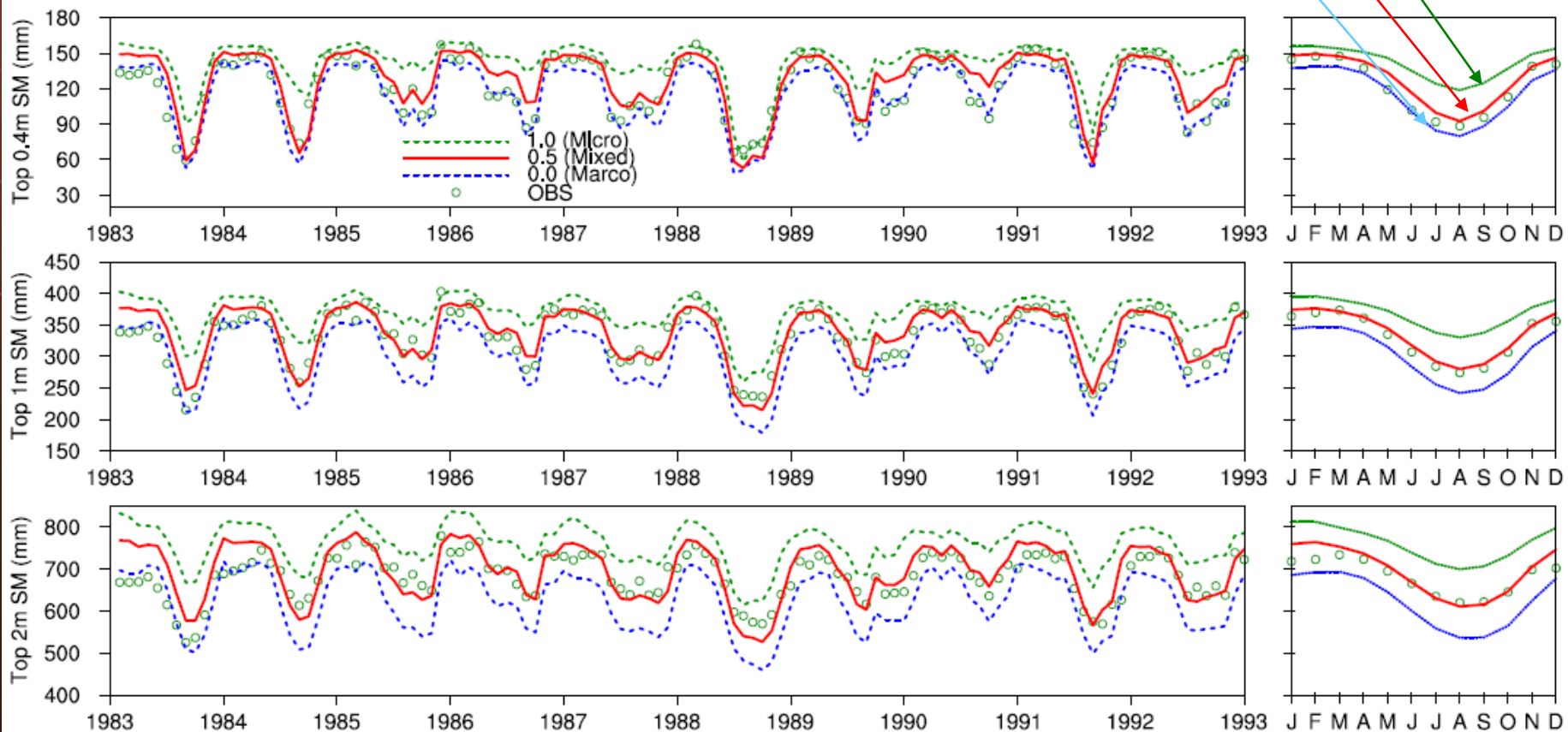
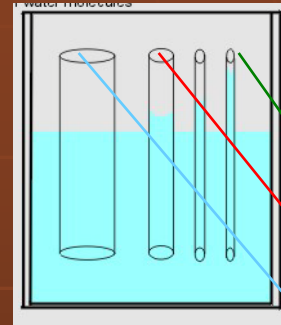
$C_{mic} \rightarrow$ fraction of micropore content

0–1 (0 macropore \rightarrow free drainage;

1 micropore \rightarrow strong capillary rise)

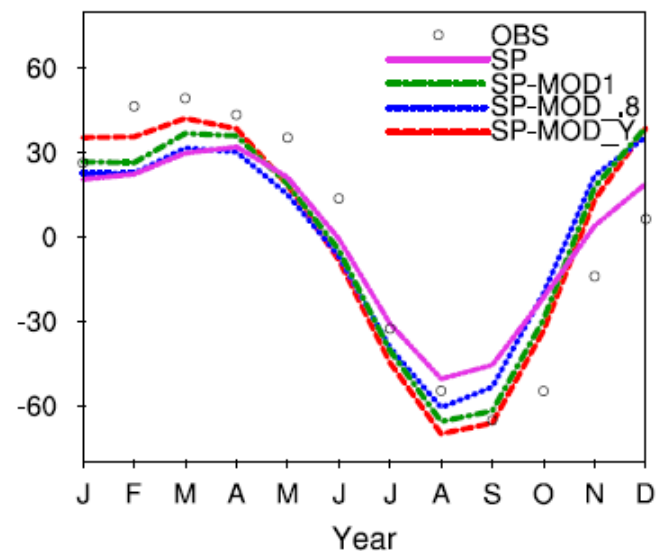
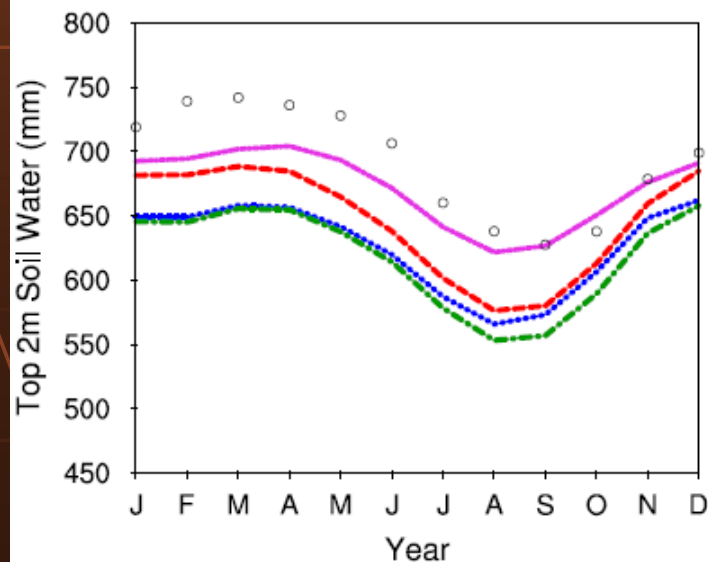
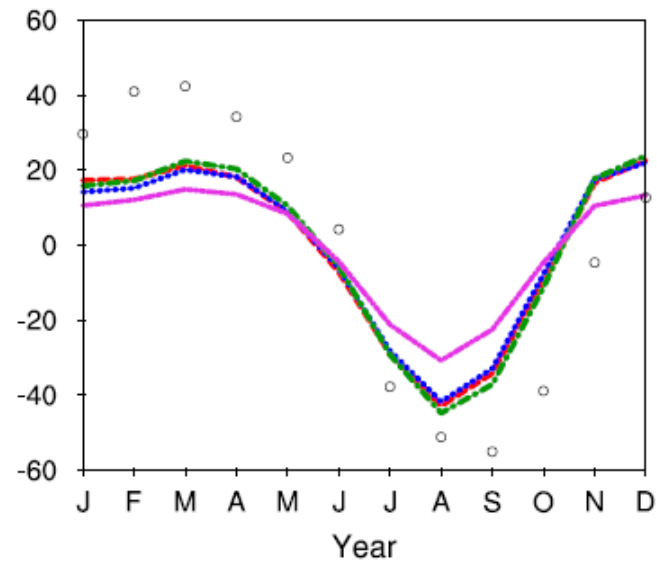
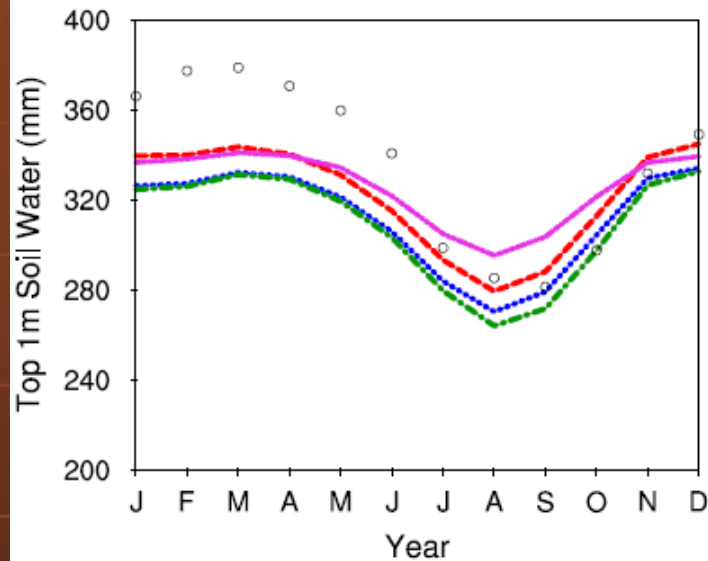
Effects in the Noah LSM

Micropore fraction: $C_{mic} = 0.5$

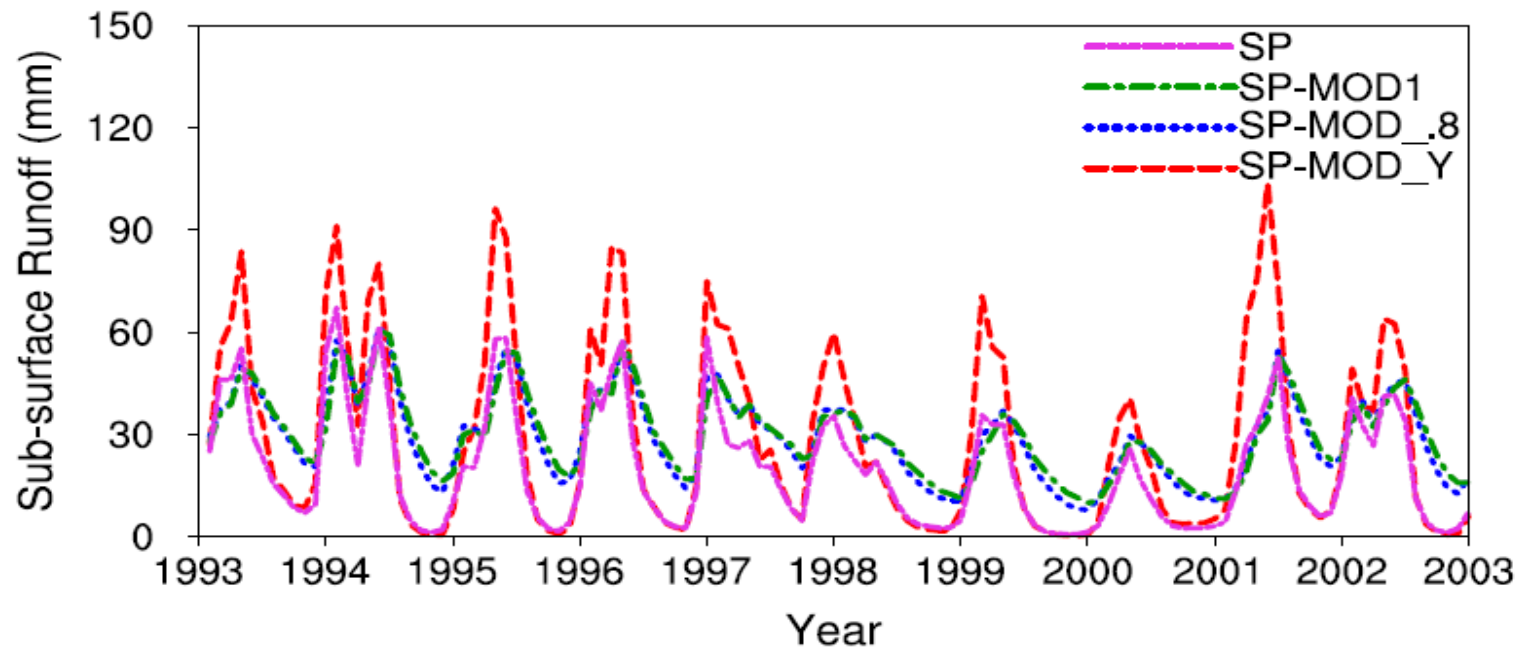
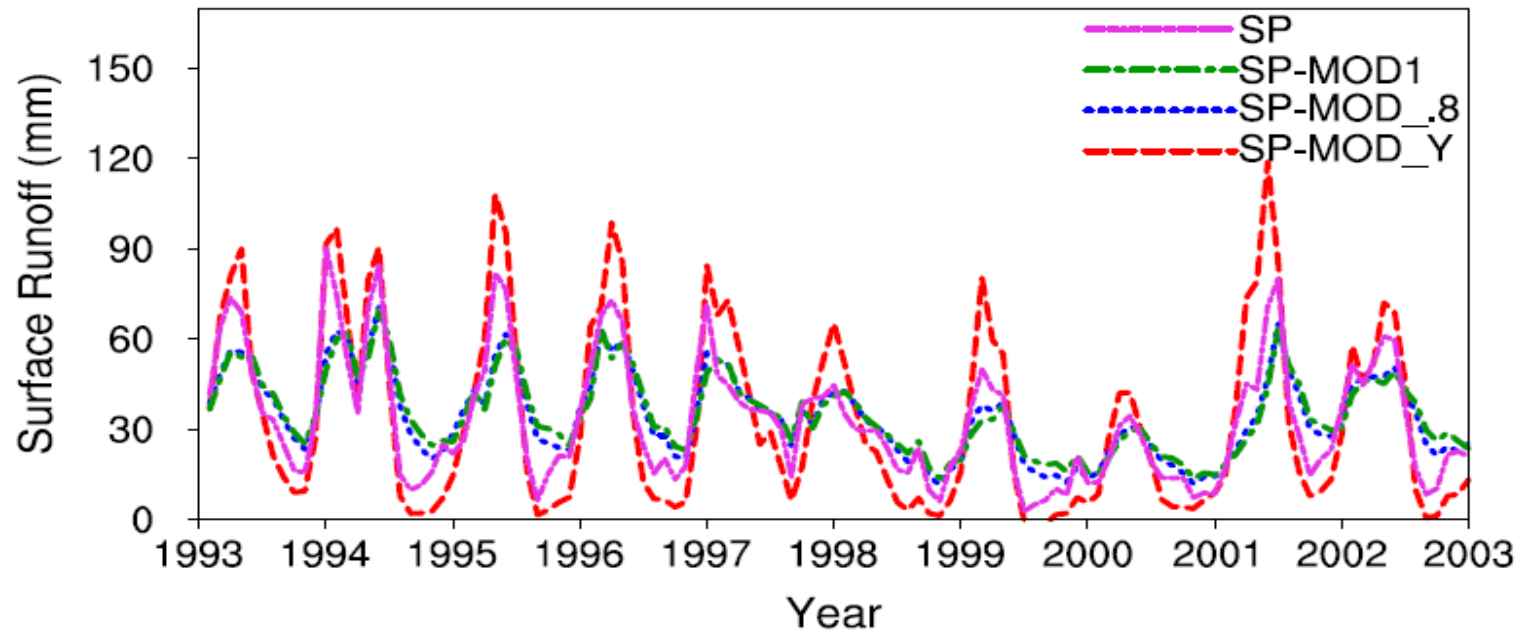


Effects in CLM4SP

Illinois (37-44N, 94-86W)

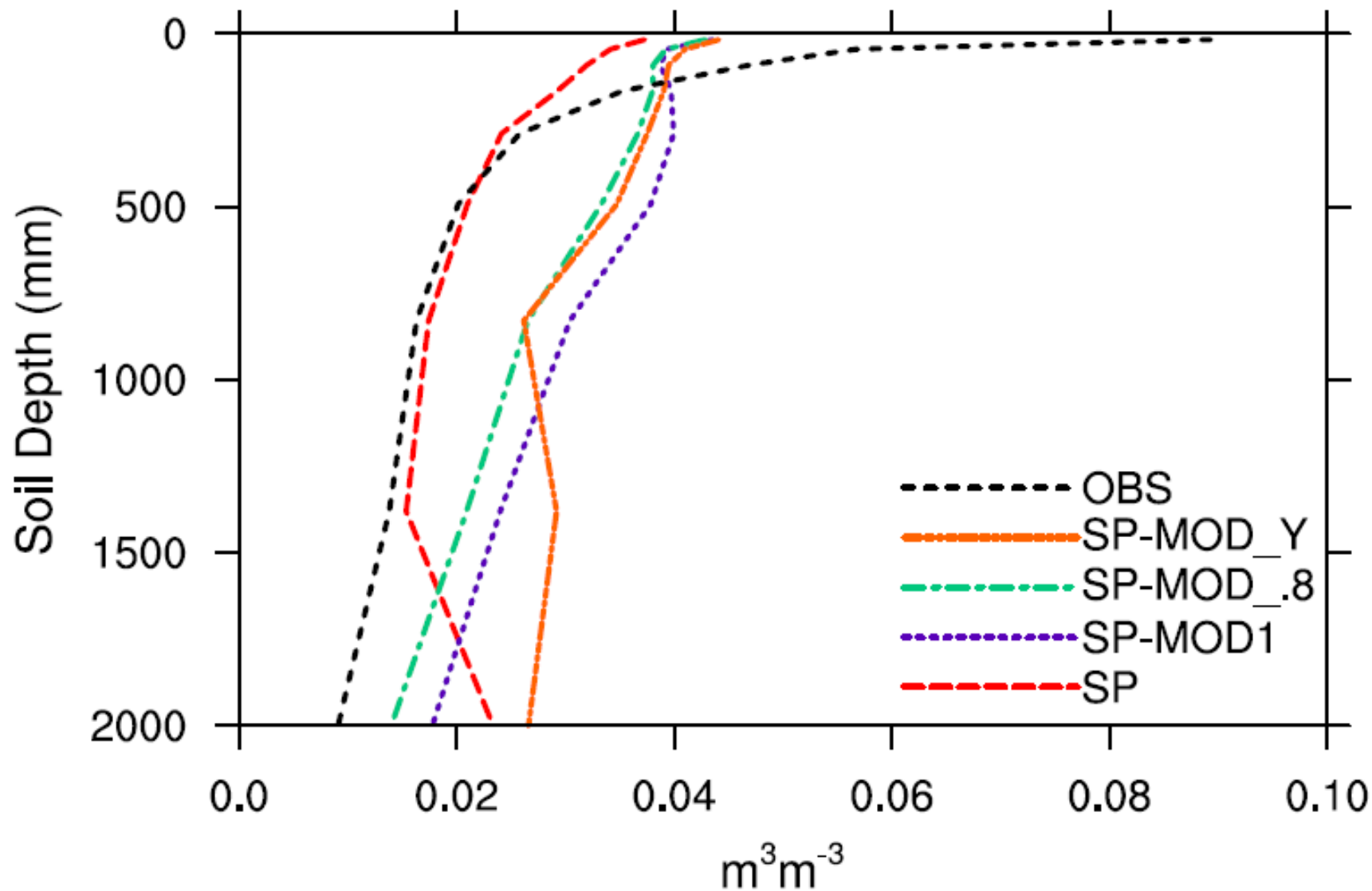


Illinois (37-44N, 94-86W)



Illinois (37-44N, 94-86W)

Standard Deviation of Volumetric Soil Water



Summary

Preliminary results show that a simple consideration of micropores/macropores in the soil/aquifer coupling enhances soil moisture variability.

More tests with observed data are warranted.