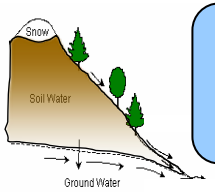
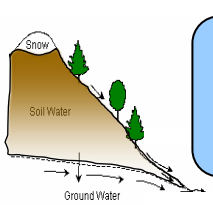


LMWG Development Activities

- Hydrology: resolve upper-soil moisture variability issue
- Snow: SCF, SBF, snow age, vertically resolved heating
- Urban model
- Fine mesh – high resolution land and downscaling
- Integration of CLM-CN with CLM-DGVM
- Ice sheet model
- Organic soil / deeper soil column / bedrock
- Irrigation (dynamic crops?)
- Roughness length, sparse and dense canopies
- Shrub vegetation type in DGVM
- Modified Richard's equation
- Dynamic wetlands (lakes)
- Prognostic canopy airspace



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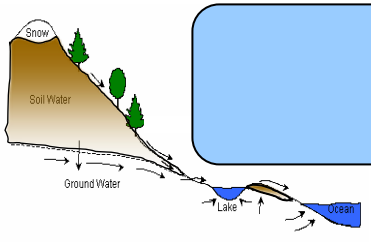
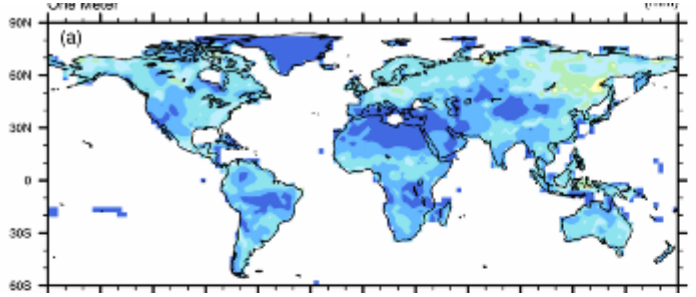


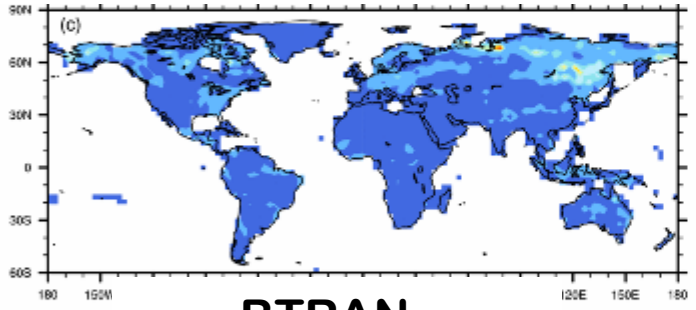
Interannual variability: July (1948-2004)

CLM3

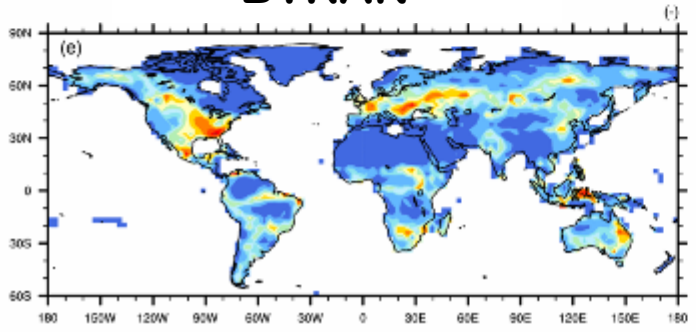
Soil water (top 1m)



Soil water (column)

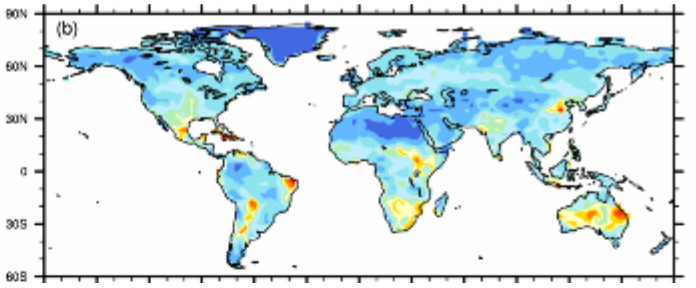


BTRAN

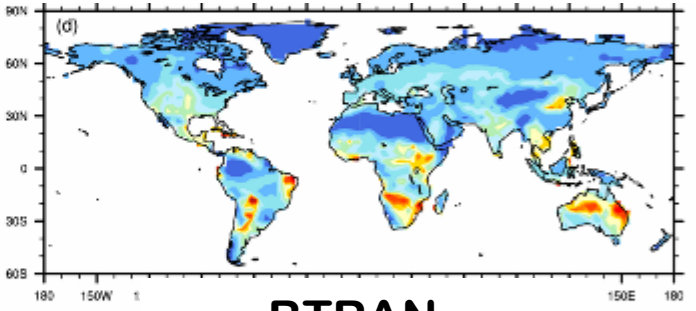


CLM3.5

Soil water (top 1m)



Soil water (column)



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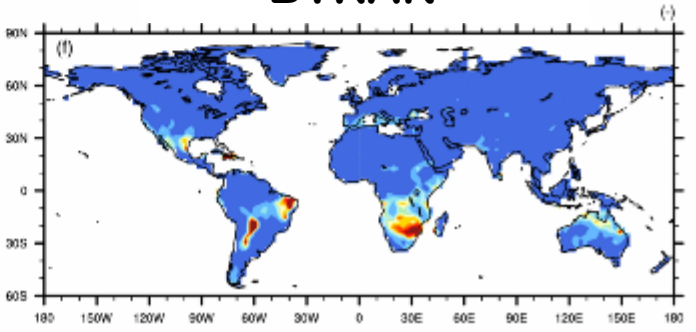
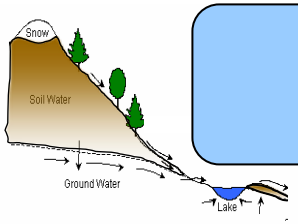


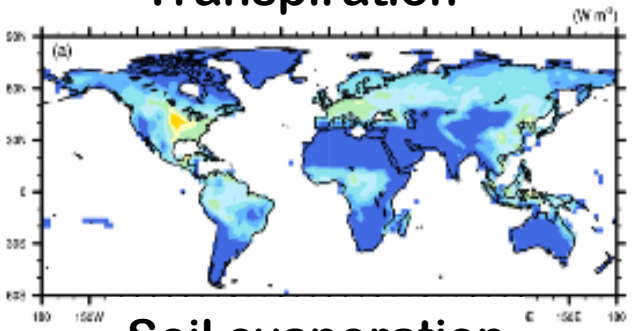
Computed from 1948-2004 monthly soil water



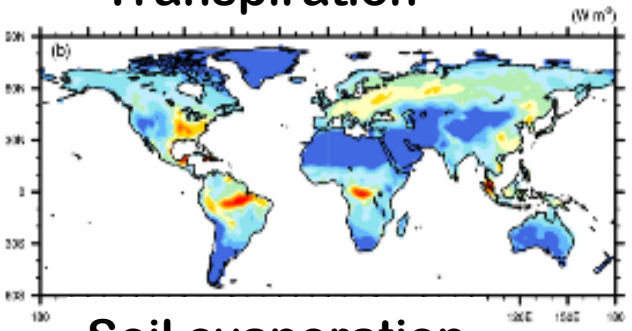
Interannual variability: July (1948-2004)

CLM3

Transpiration

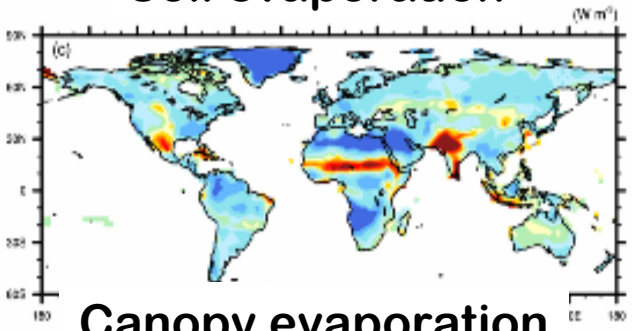


Transpiration

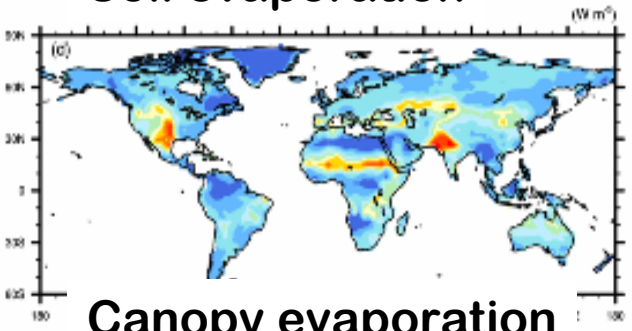


CLM3.5

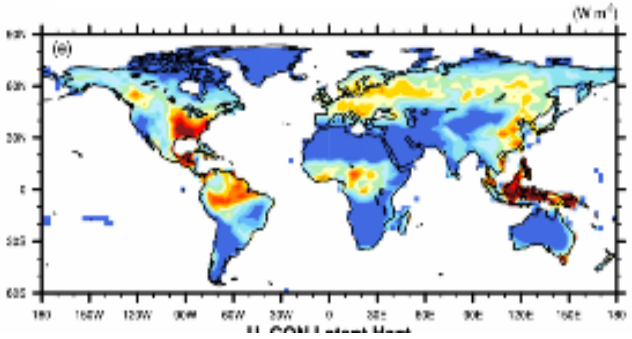
Soil evaporation



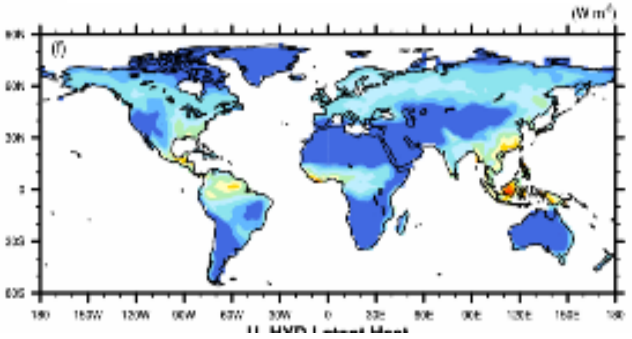
Soil evaporation

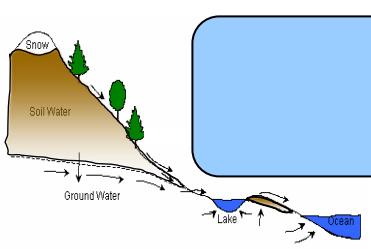


Canopy evaporation



Canopy evaporation





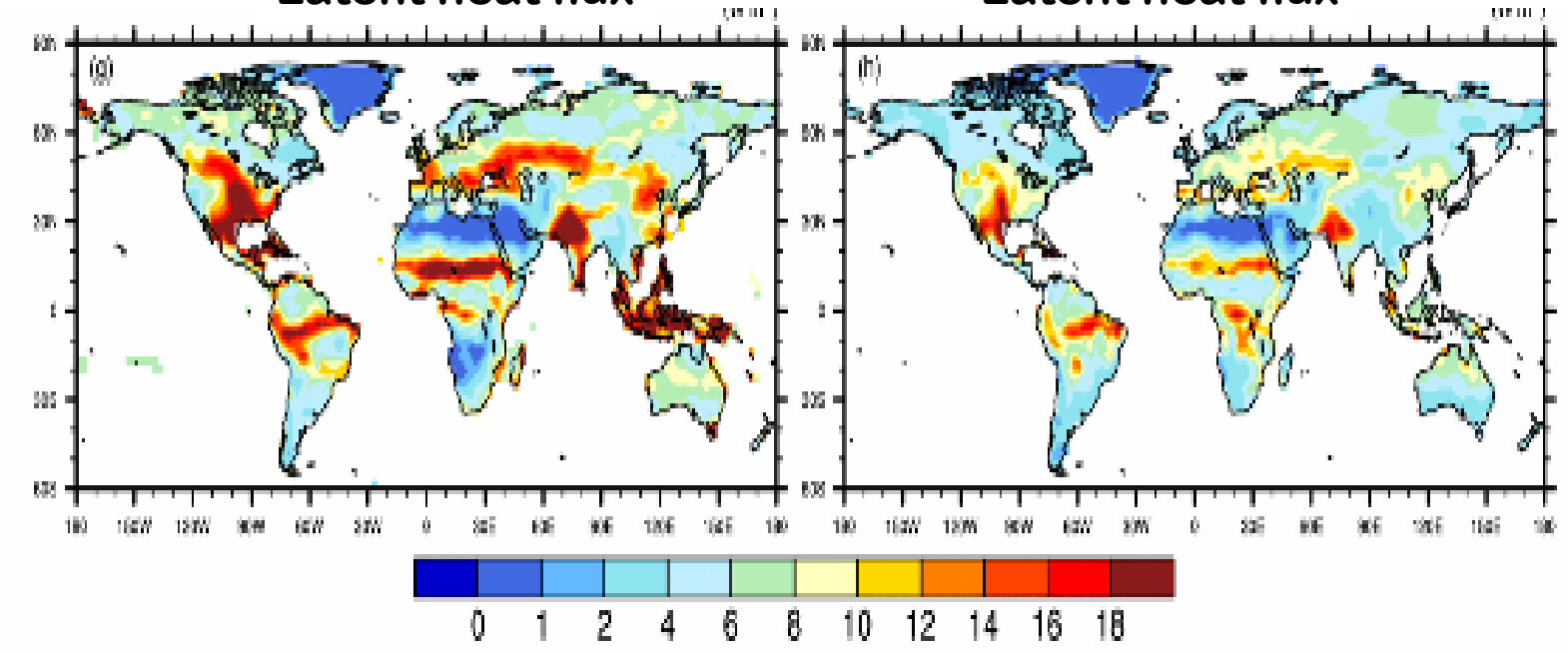
Interannual variability: July (1948-2004)

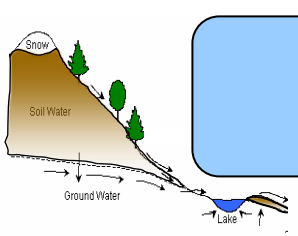
CLM3

Latent heat flux

CLM3.5

Latent heat flux

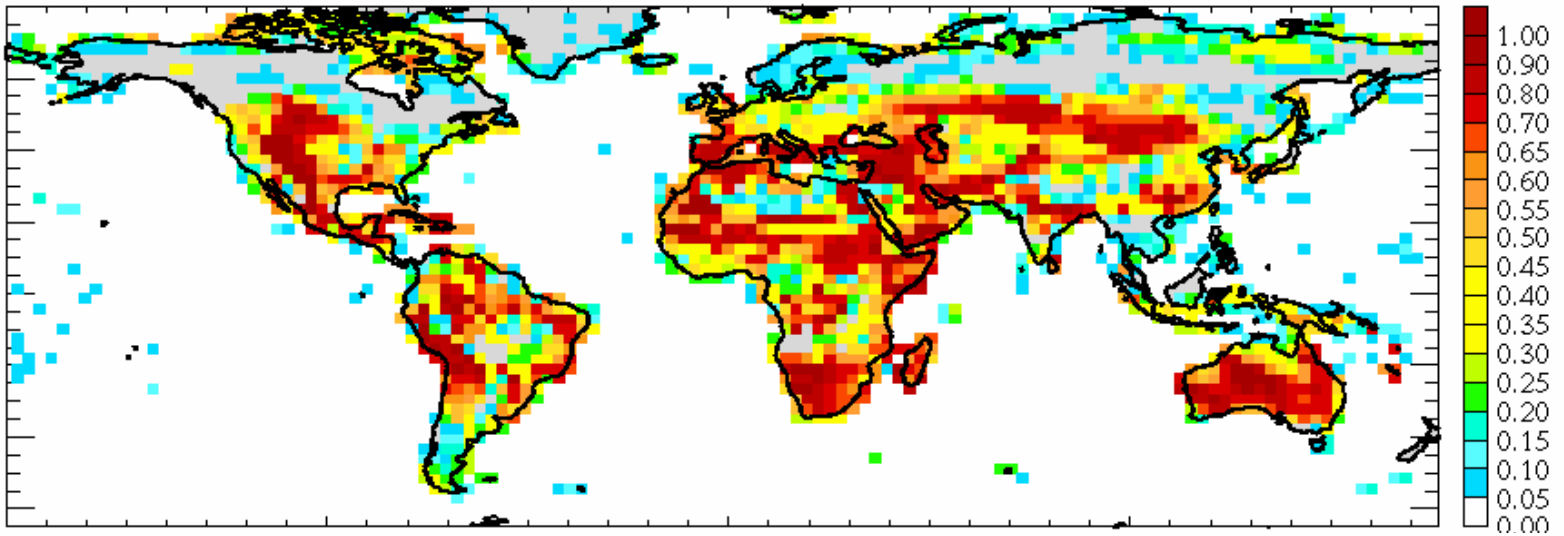




Soil moisture – evaporation relationship: JJA

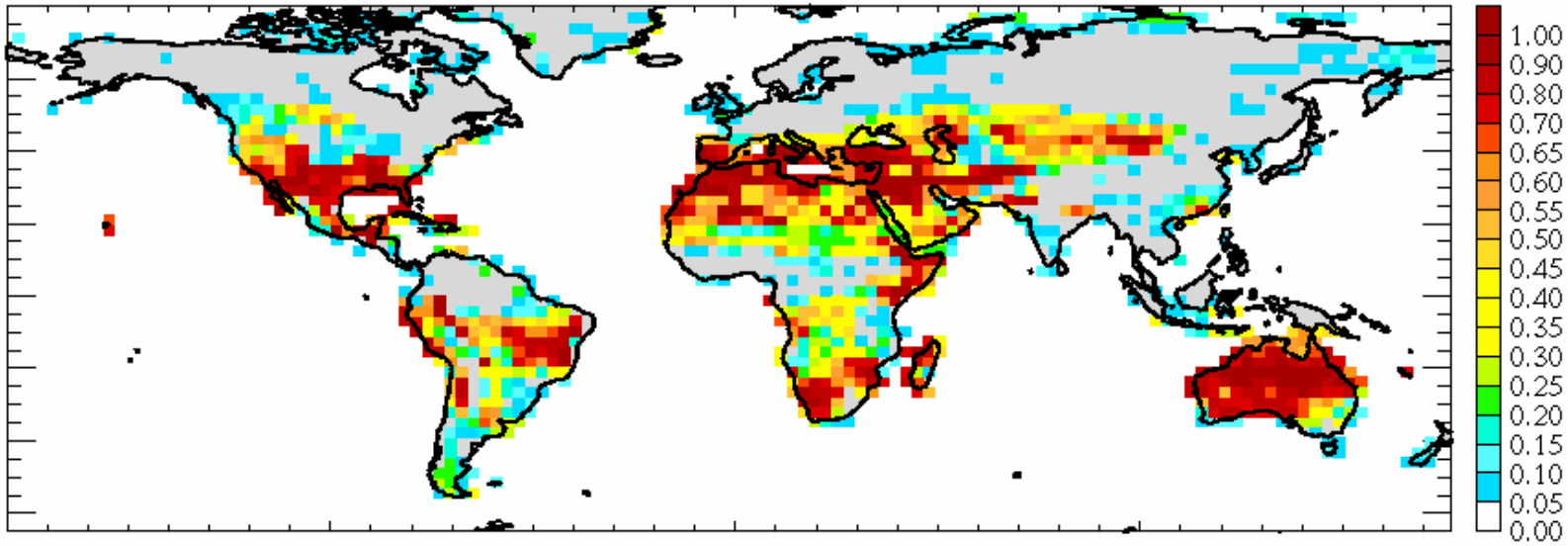
Control

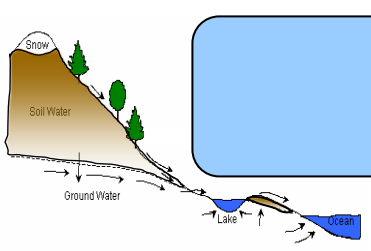
$\Omega_E[SF] - \Omega_E[W] = 0.434$



LMWG Hyd

$\Omega_E[SF] - \Omega_E[W] = 0.283$

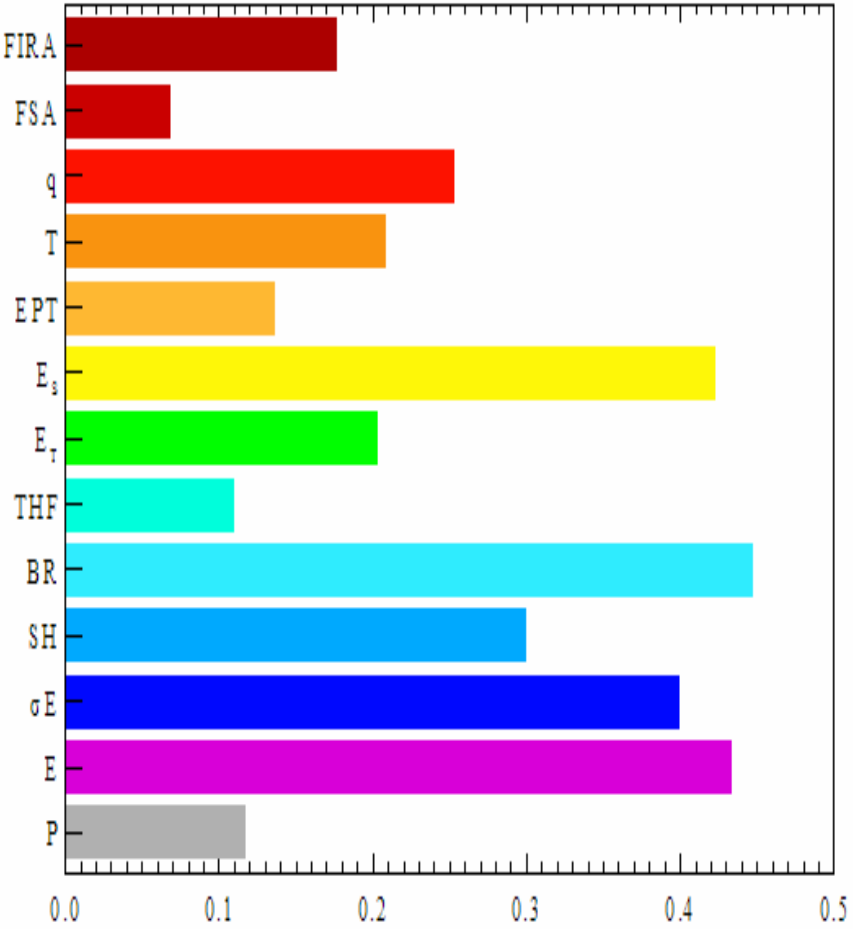




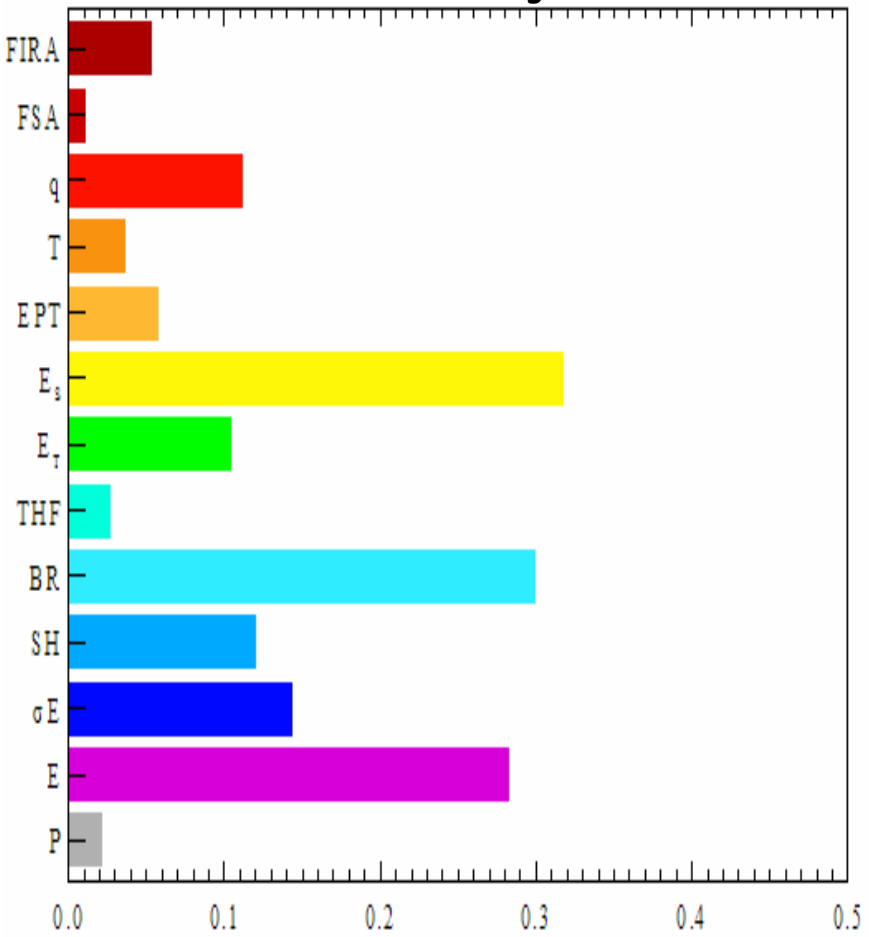
Land-atmosphere coupling strength: Influence of soil moisture on climate

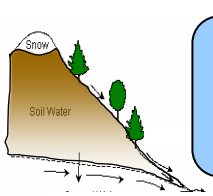
Globally averaged $\Delta\Omega$

Control



LMWG Hyd



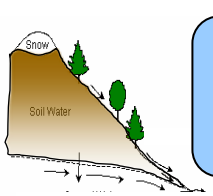


Land Model Working Group Development Activities

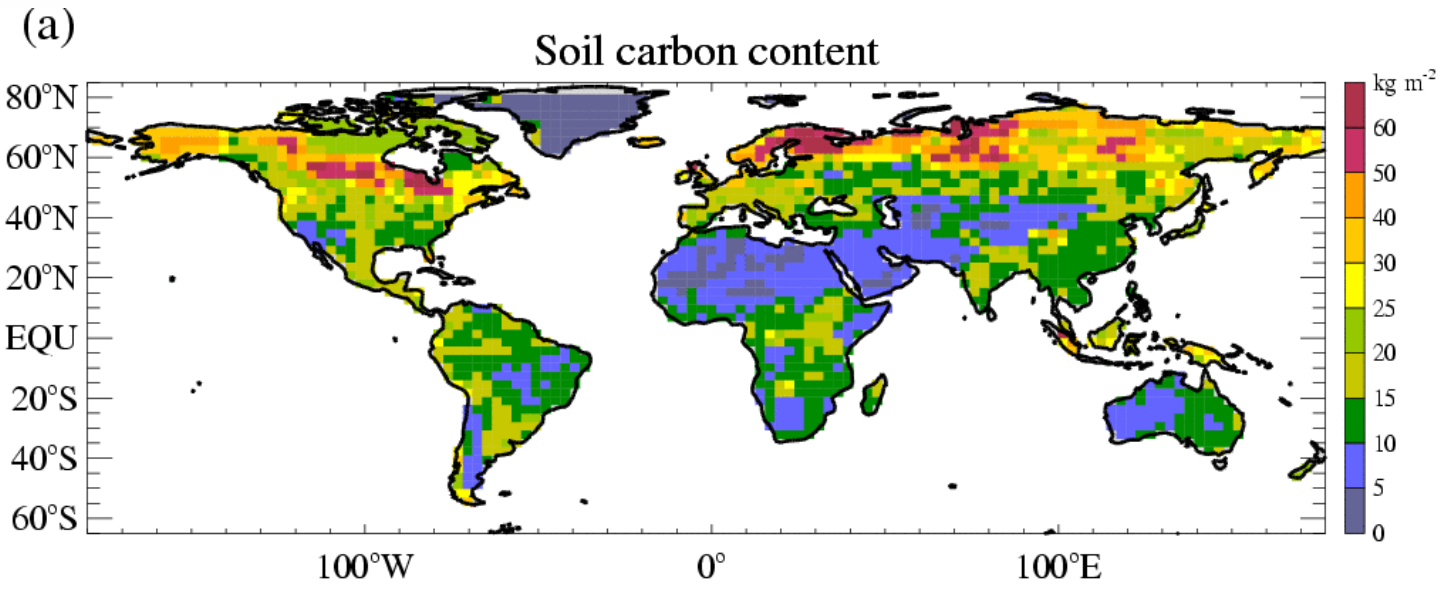
- **Organic soil / deeper soil column / bedrock**

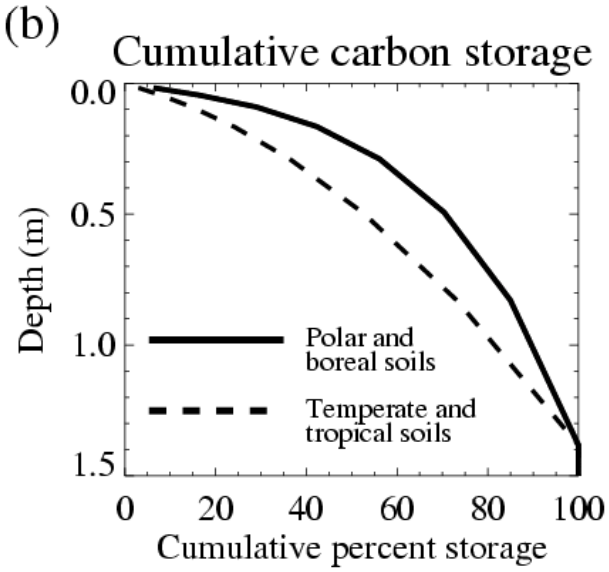
  D. Lawrence; A. Slater, CIRES; V. Romanovsky, U. Alaska

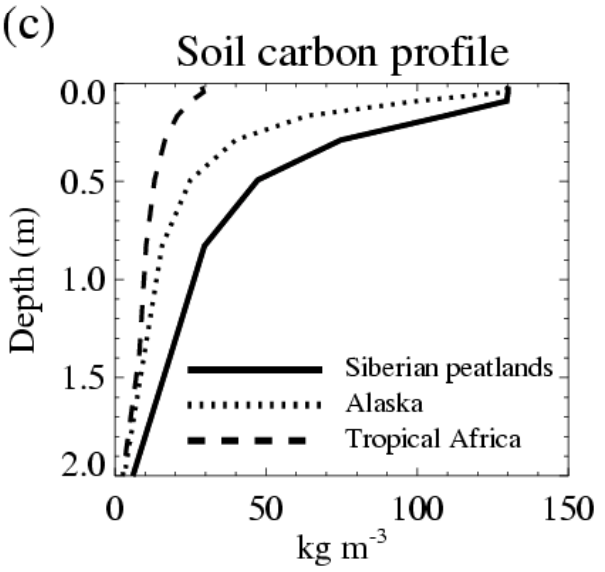
  - Improved soil temperature, permafrost simulation

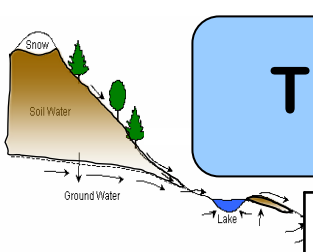


CLM soil carbon density dataset
Source data from Global Soil Data Task









Thermal and hydraulic parameters for organic soil

Soil type	λ_{sat}	λ_{dry}	Θ_{sat}	k_{sat}
Sand	**3.12**	**0.27**	**0.37**	**0.023**
Clay	**1.78**	**0.20**	**0.46**	**0.002**
Peat	**0.55**	**0.05**[a]	**0.9**[a,b]	**0.100**[b]

$f_{sc,I} = \rho_{sc,i} / \rho_{peat}$ fraction of layer *i* that is organic matter

$$\Theta_{sat,i} = (1 - f_{sc,i}) \, (\, 0.489 - 0.00126 \, \%sand_i \,) + f_{sc,i} \, \Theta_{sat,sc}$$

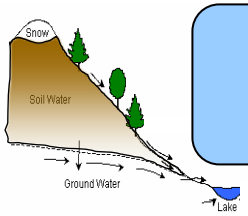
λ_{sat} sat. thermal conductivity

λ_{dry} dry thermal conductivity

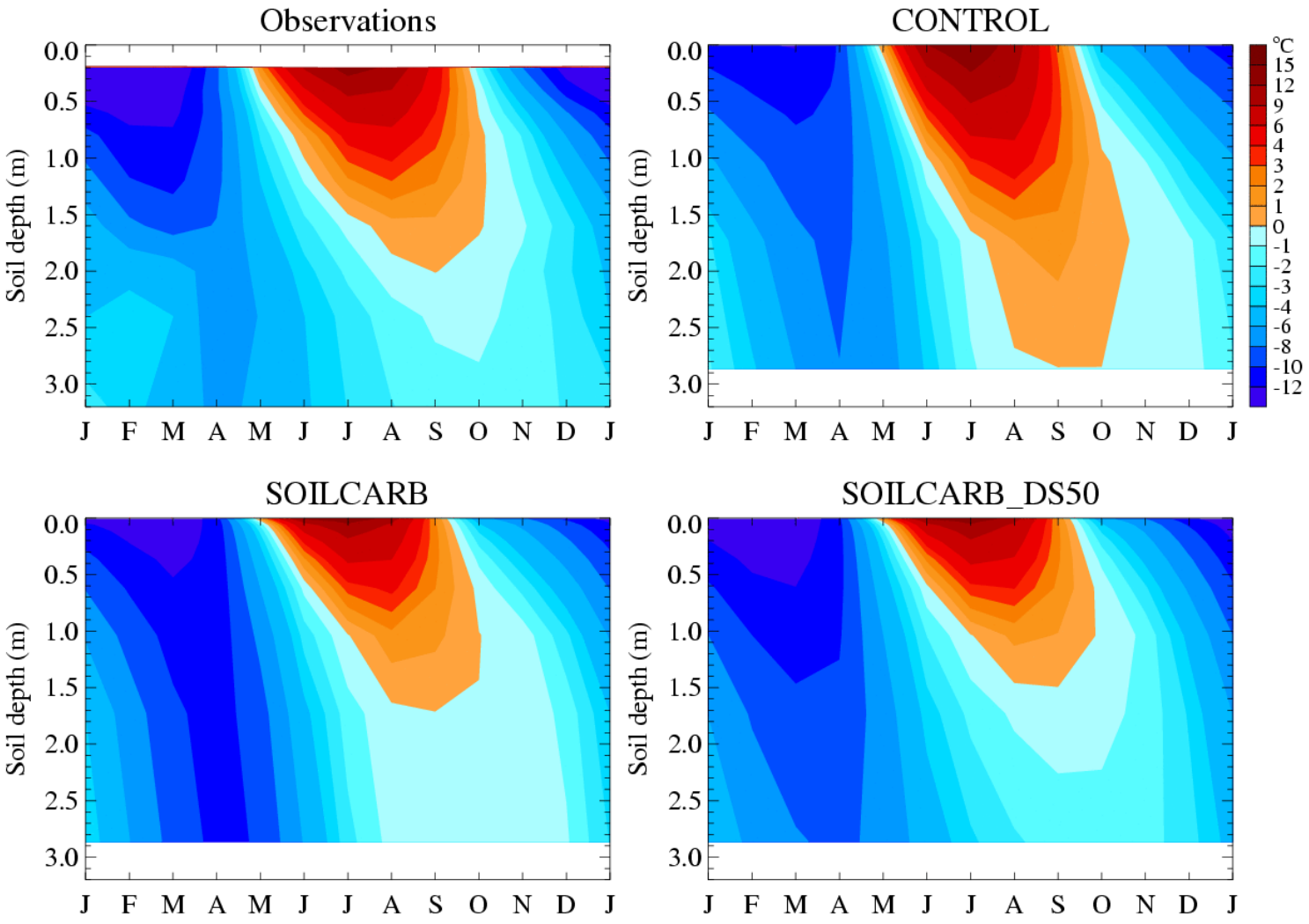
Θ_{sat} volumetric water at saturation

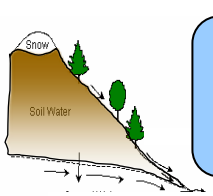
k_{sat} sat. hydraulic conductivity

[a] Farouki (1981), [b] Letts et al. (2000)



Annual cycle-depth soil temperature plots Siberia



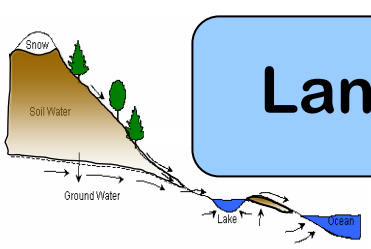


Land Model Working Group Development Activities

- **Organic soil / deeper soil column / bedrock**

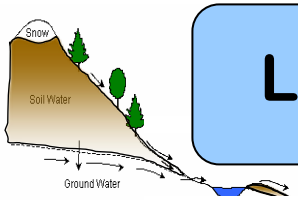
  D. Lawrence; A. Slater, CIRES; V. Romanovsky, U. Alaska

  - Improved soil temperature, permafrost simulation
  - Can be integrated with CLM-CN for 'dynamic' characterization of physical soil properties



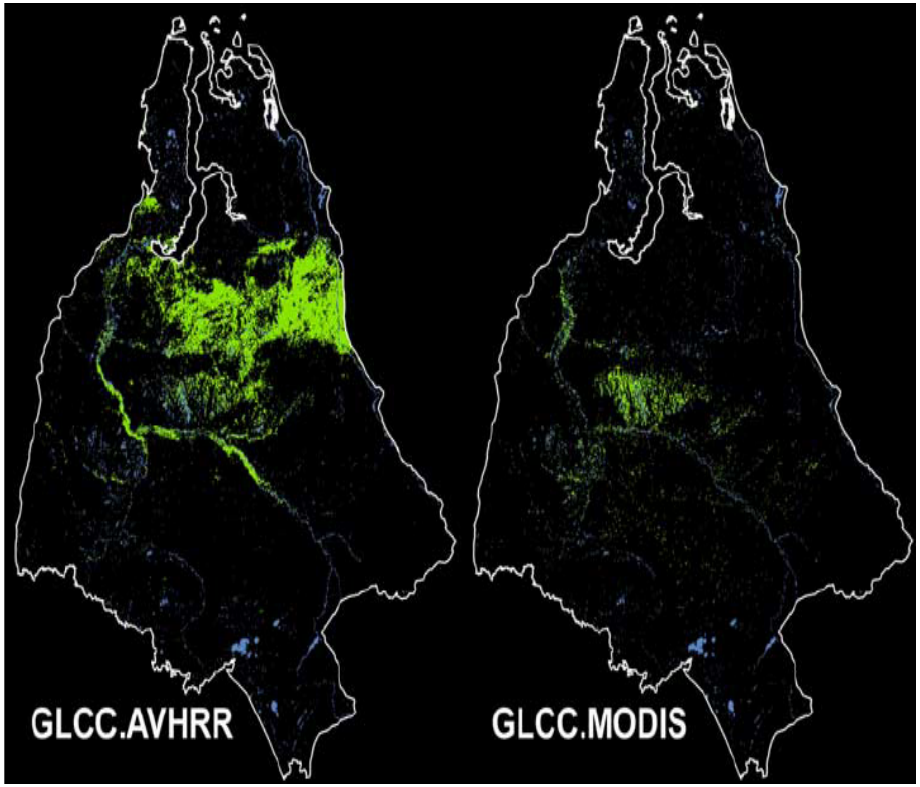
Land Model Working Group Development Activities

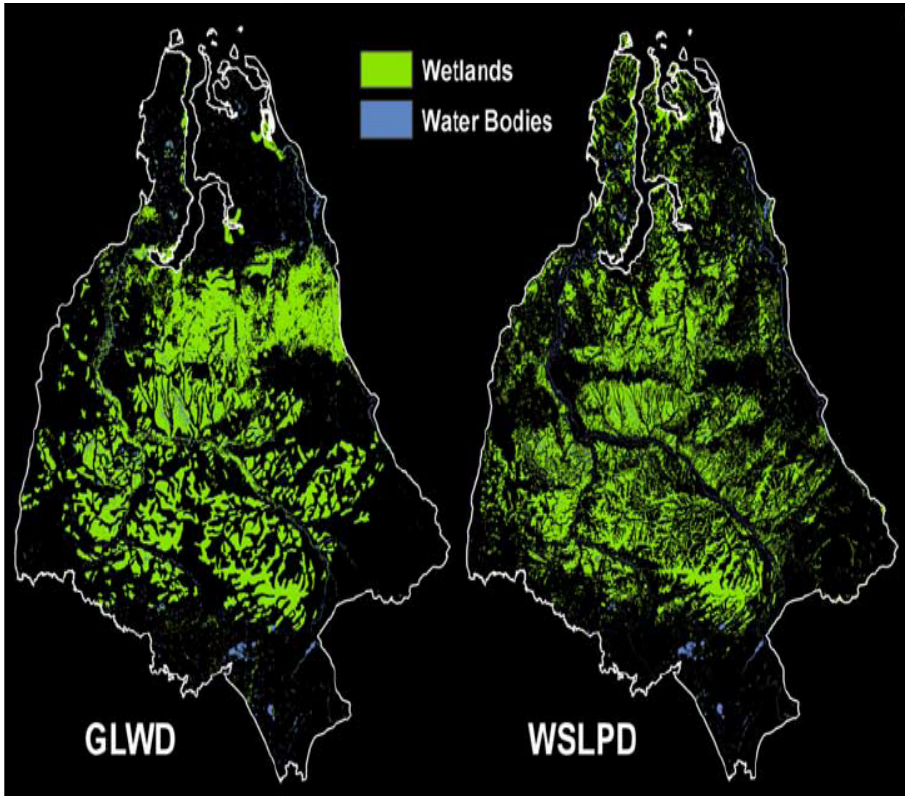
- **Irrigation** S. Levis; B. Sacks, U. Wisconsin; L. Yang, U. Texas
  - Status: research and development, identify 'best' implementation
  - Issues include source of water, spatial distribution of irrigation, how much water, time of day to irrigate, irrigate on separate landunit/column for crops
  - Dynamic crops?



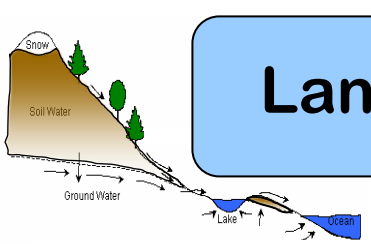
Land Model Working Group Development Activities

- **Wetlands in CLM** S. Swenson, D. Lawrence, NCAR
  - MODIS derived land cover, essentially no wetlands





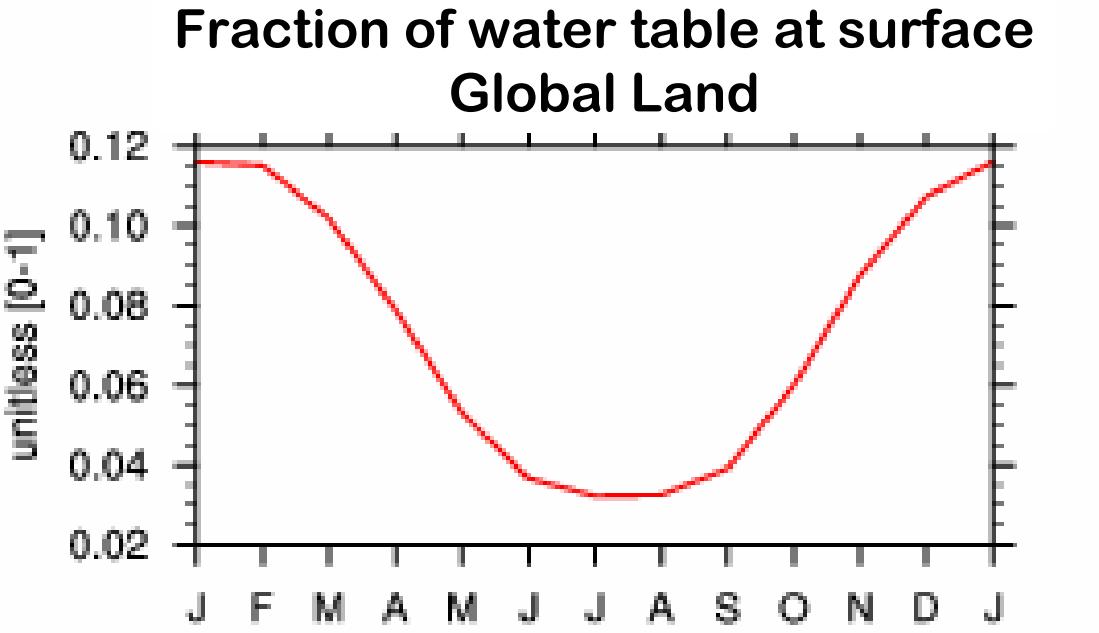
Frey et al. 2007

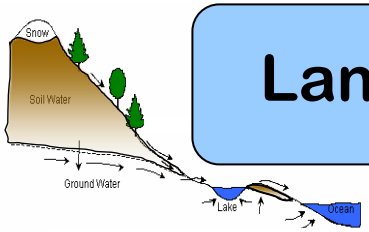


Land Model Working Group Development Activities

– **Dynamic wetlands (lakes)** S. Swenson, D. Lawrence, NCAR

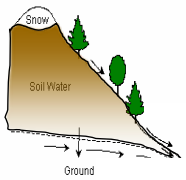
- MODIS derived land cover, essentially no wetlands
- Building block for dynamic methane sources
- Status: Research phase … can fraction water table at surface be exploited





Land Model Working Group Development Activities

- **Shrub vegetation type in DGVM** X. Zeng, M. Barlage, U. Arizona



Land-atmosphere coupling strength diagnostic
(Koster et al. 2002, 2005)

W(rite) - 16-member ensemble forced with June 1 initial conditions from each year of a 16-year climatological SST control run. Soil moisture from W1 experiment recorded at each timestep.

S(oil moisture) - 16-member ensemble where, at every timestep, simulated soil moisture is discarded and replaced with values from W1 experiment.

Ω = measure of time series similarity across ensemble members