Multi-scale land-atmosphere interactions with CESM/CLM: Spatial heterogeneity and canopy turbulence

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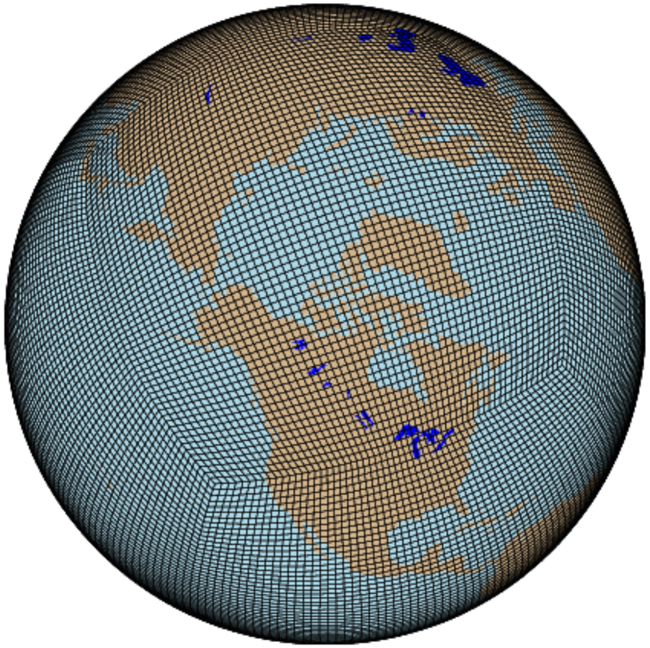
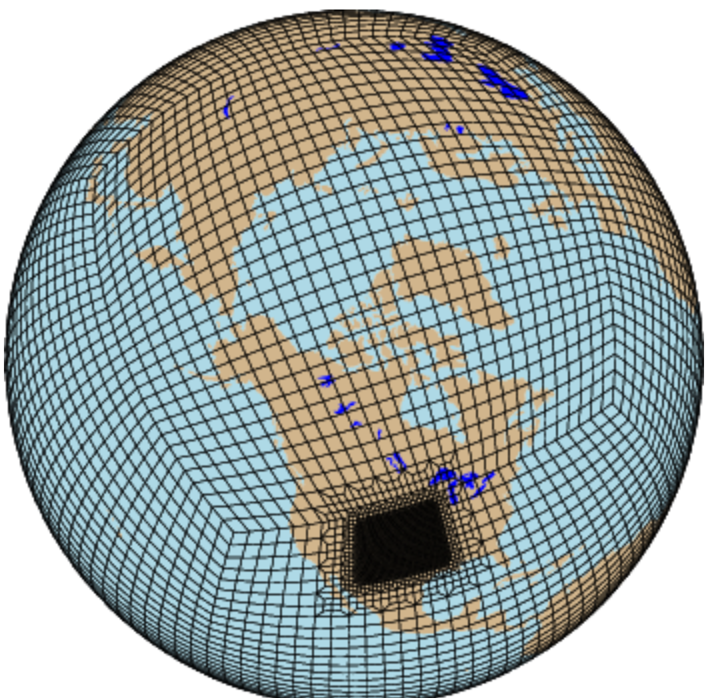
High resolution CAM5-SE and regional refinement



Global 1/8°
CAM5-SE has a very efficient, scalable and expensive 1/8° global configuration

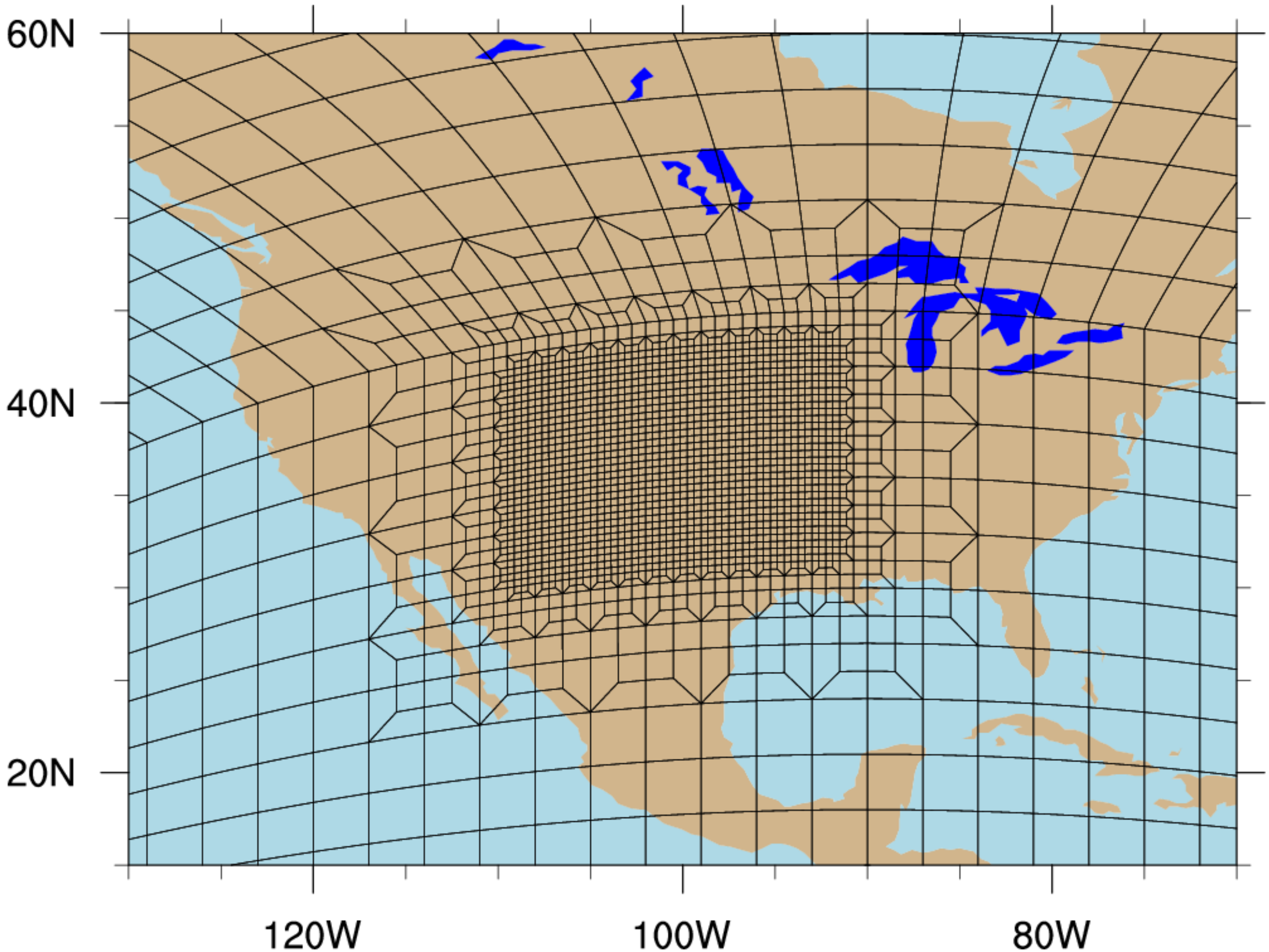


SGP 8x Regionally Refined
1° global resolution, refined to 1/8° continental sized region centered over SGP ARM site

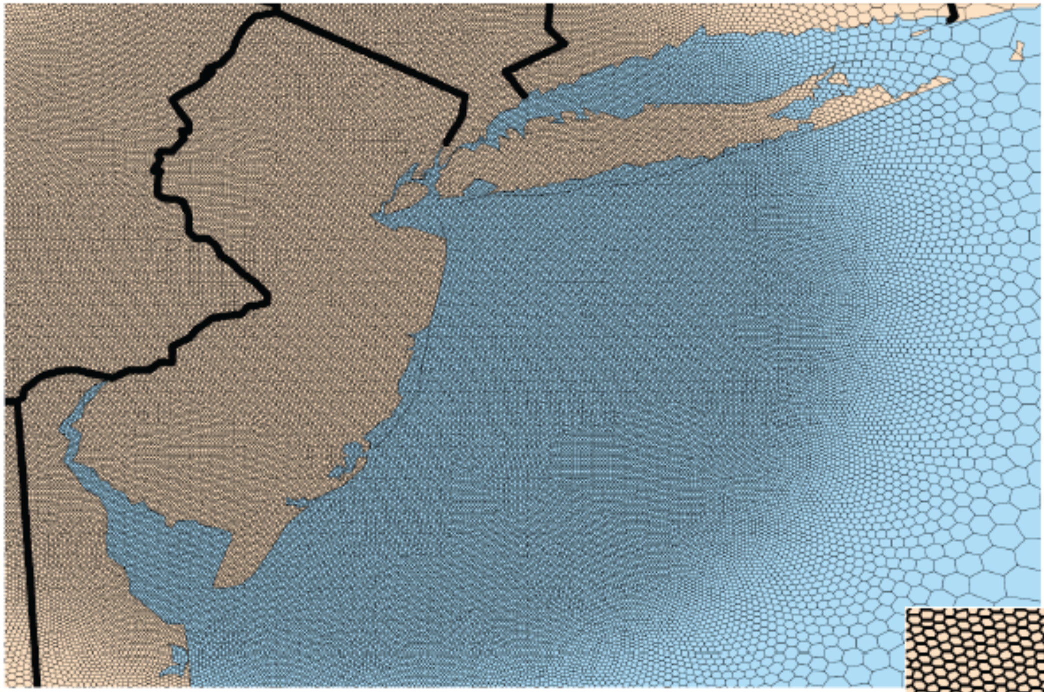
(CESM AMWG)

CAM5-SE mesh refinement over central US

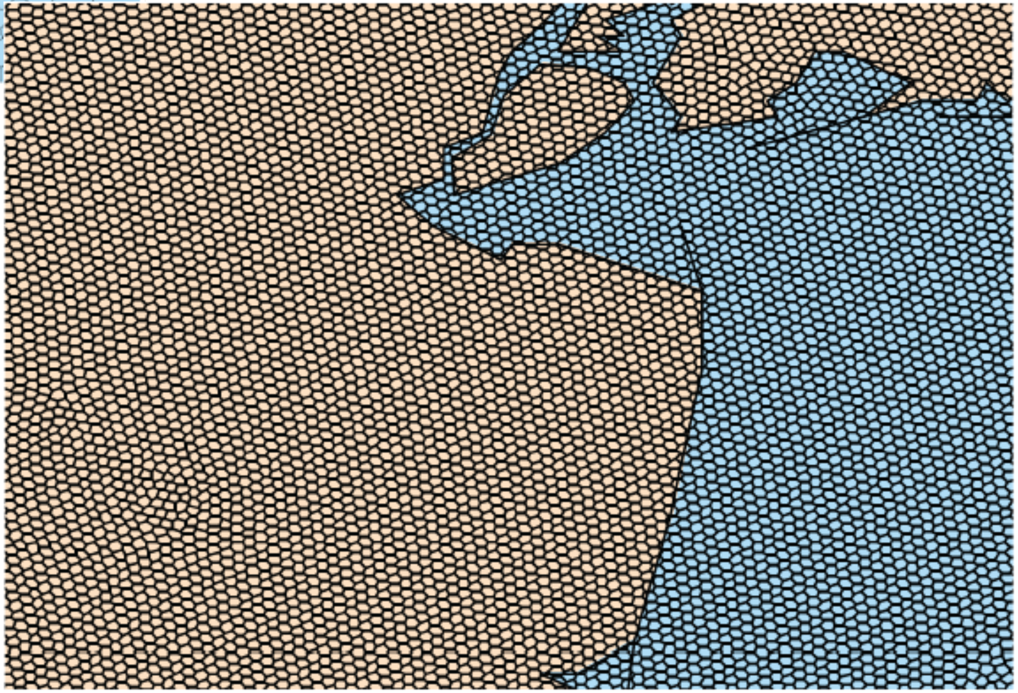
From a CAM5-SE run which is ne30 (about 1 degree globally), with regional refinement to ne240 (about 1/8 degree over the ARM SGP site)



CAM5-SE mesh refinement over New Jersey

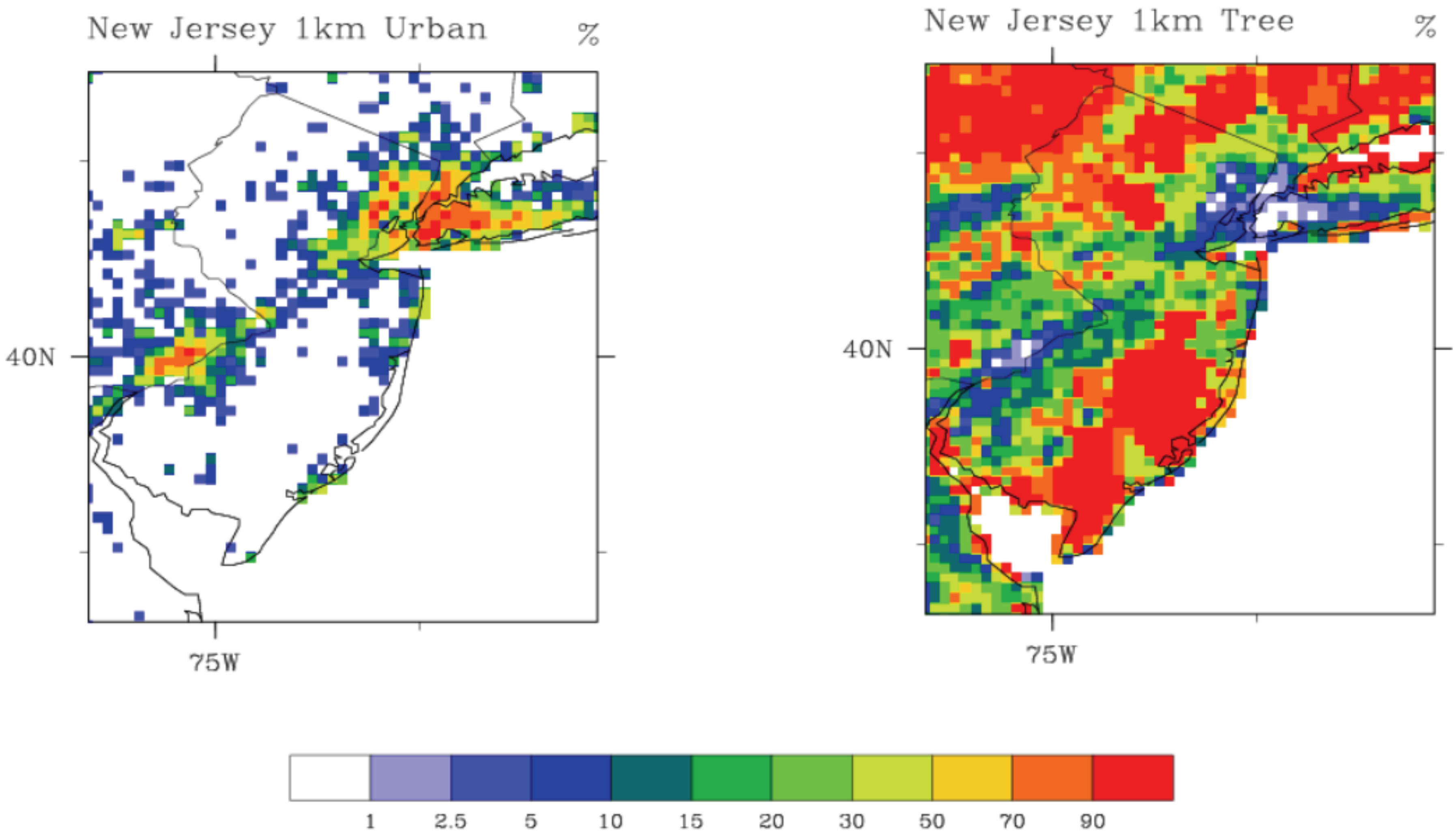


From 70 km globally to 1 km over New Jersey



(Julio Bacmeister and Peter Lawrence, NCAR)

CAM5-SE mesh refinement over New Jersey



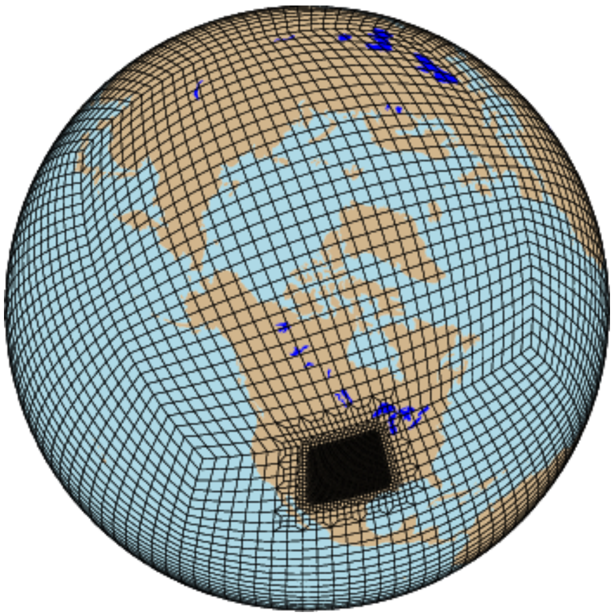
Multi-scale Land Cover Change Project

Experiments: Each set of resolutions would be run for 30 years with 1850 (potential vegetation) and again with 2000 land cover

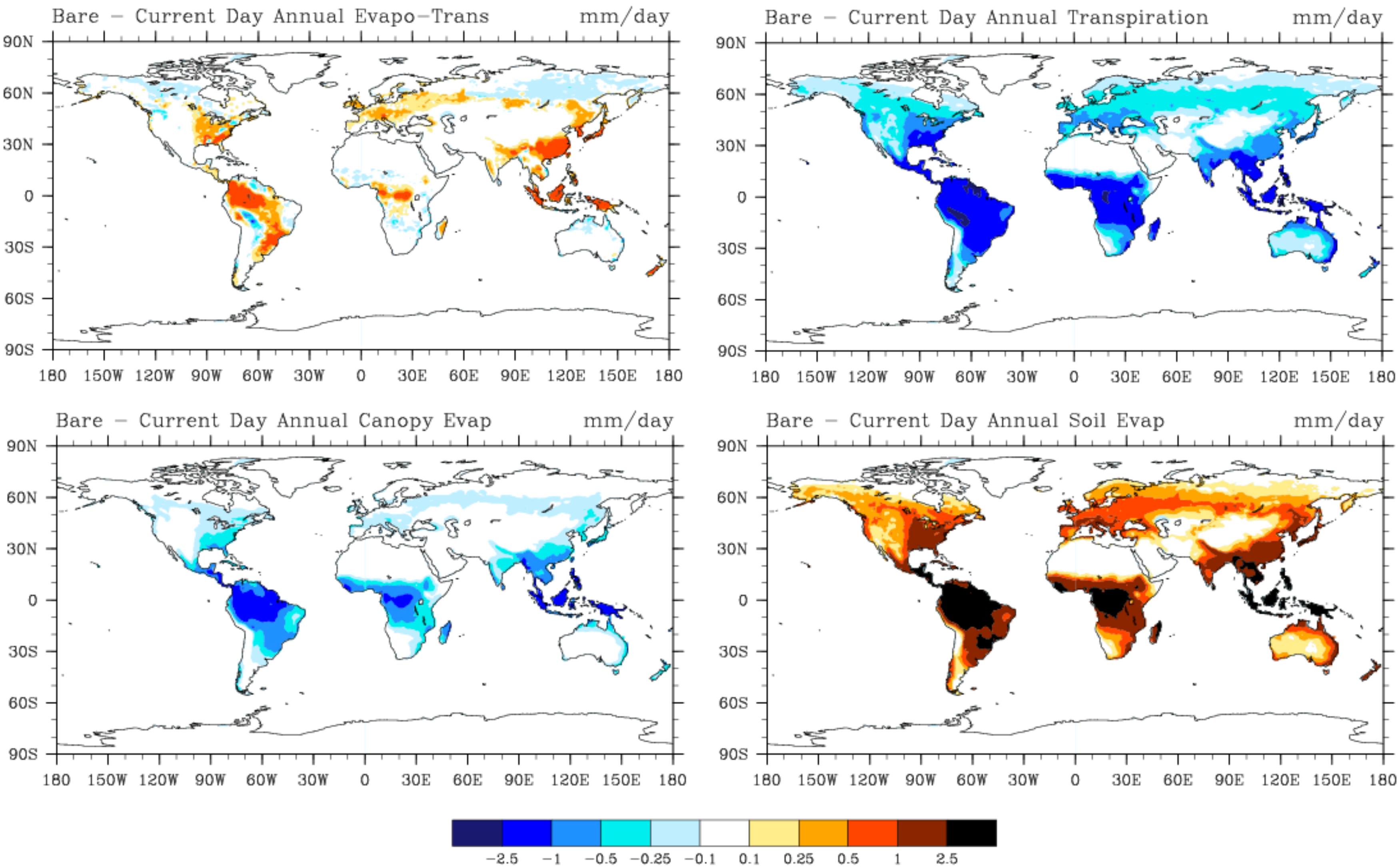
Configuration: CAM5 AMIP with present day SSTs, CO_2 and aerosol dep (CN: off; irrigation: on for 2000 land cover; high res RTM?)

Focus region: preferably centered slightly to the east of the ARM SGP grid shown below to cover midwest crop & eastern US forests

Resolution atm	Resolution lnd
ne30 (1^o)	ne30 (1^o)
ne30 (1^o) → ne240 (0.125^o)	ne30 (1^o) → ne240 (0.125^o)
ne30 (1^o)	ne30 (1^o) → ne240 (0.125^o)
ne30 (1^o) → ne240 (0.125^o)	ne30 (1^o)

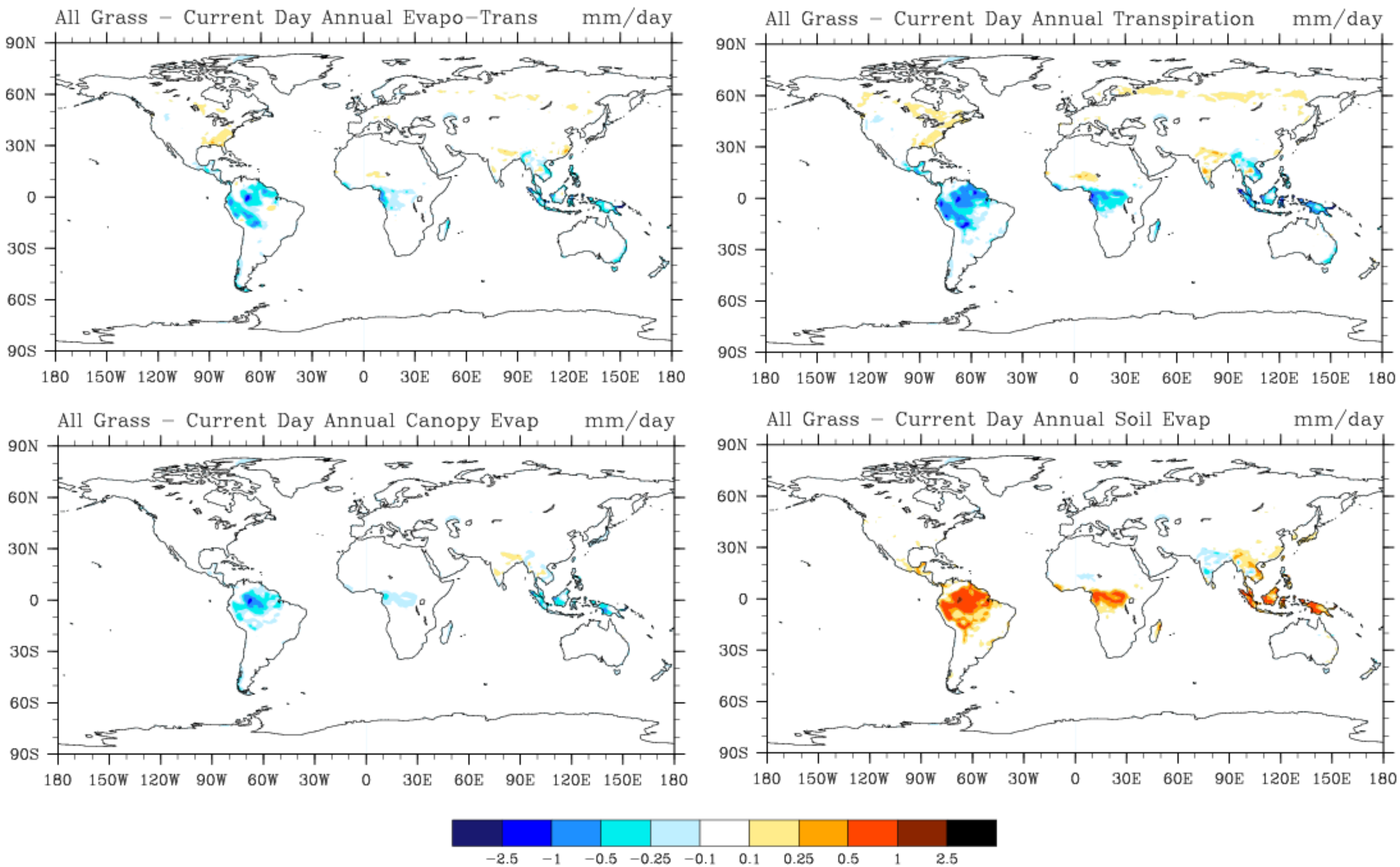


Offline CLM4: vegetation removal increases annual ET



(Peter Lawrence, NCAR)

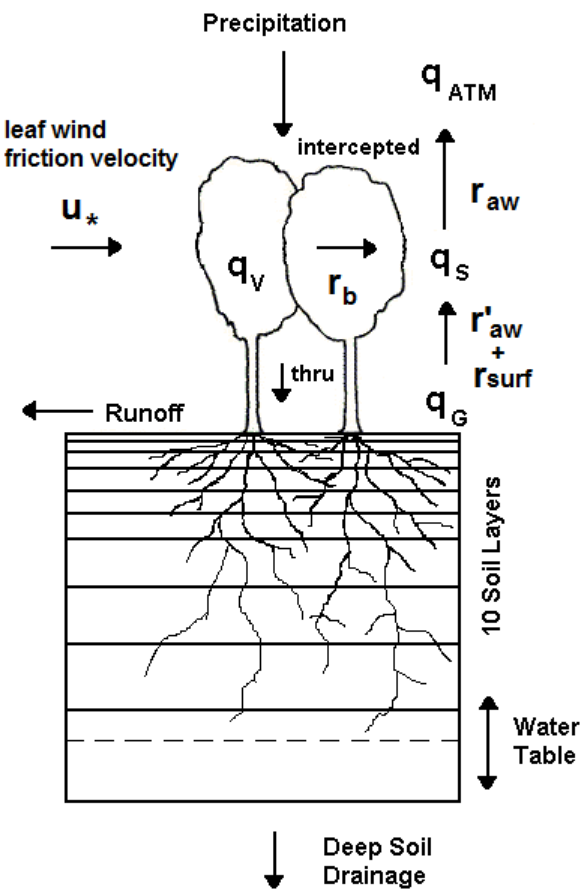
Offline CLM4: all grass also increases annual soil evaporation



(Peter Lawrence, NCAR)

Why Does CLM4 Have Higher Bare Soil Evaporation?

Soil Evaporation



$$r'_{aw} = \frac{1}{C_S\, u_*}$$ Zeng et al. (2005)

$$q_G = \exp\left(\frac{\Psi_1 g}{1\times10^3 R_{wv} T_G}\right) qsat(T_G)$$ Philip (1957)

CLM4:

$$E_g = -\rho_{ATM}\beta_{soi}\frac{q_S - q_G}{r'_{aw} + r_{litter}}$$

$$r_{litter} = \frac{1}{0.004\, u_*}\left(1 - e^{-L^{eff}_{litter}}\right) \quad L^{eff}_{litter} = 0.5 \;\; Vegetated \quad L^{eff}_{litter} = 0.0 \;\; Bare\ Soil$$

Sakaguchi and Zeng (2009)

CLM3.5:

$$E_g = -\rho_{ATM}\frac{q_S - q_G}{r'_{aw} + r_{surf}}$$

$$r_{surf} = \exp\left(8.206 - 4.255\frac{\theta_1}{\theta_{sat,1}}\right)$$

Sellers et al. (1996)

(Peter Lawrence, NCAR)