CLM-Related Research at COLA

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COLA AGCM - Multi-LSM Coupling

- Couple COLA AGCM v3.2 to SSiB, CLM3.5 and Noah, individually and <u>in combination</u> (tiled LSSs at each grid box with equal weights).
- Questions:
  - How does the choice of LSS affect simulated climate (PILPS 3 revisited)?
  - Does a multi-LSS coupling produce better simulations (like we see for offline modeling)?
  - What can we learn about LSS difference by comparing these coupled runs?

Impact of LSS on AGCM

AMIP-type integration

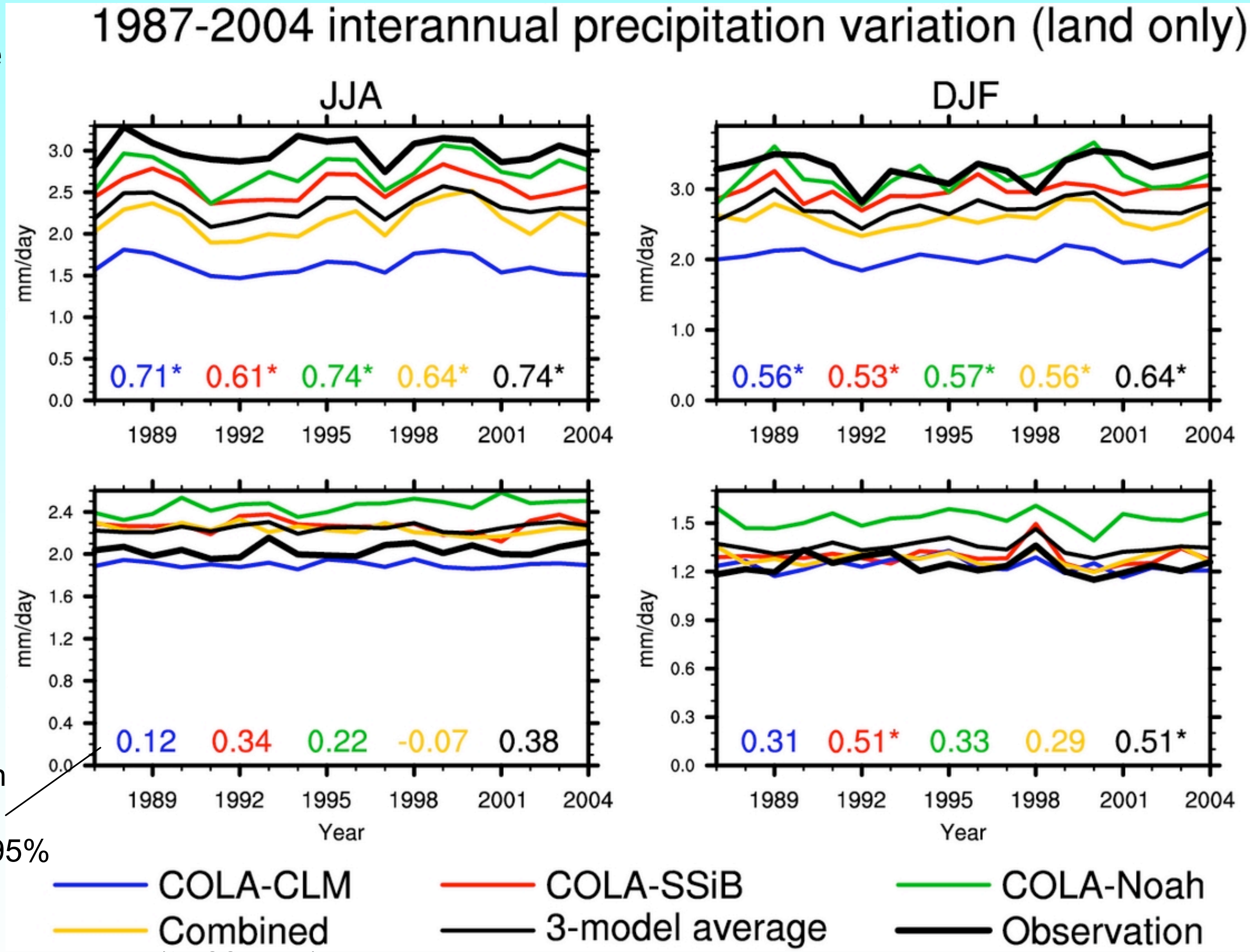
Tropical land

(25°S-25°N)

Northern land

(25°N-70°N)

Correlation with observations (* = significant at 95% confidence)

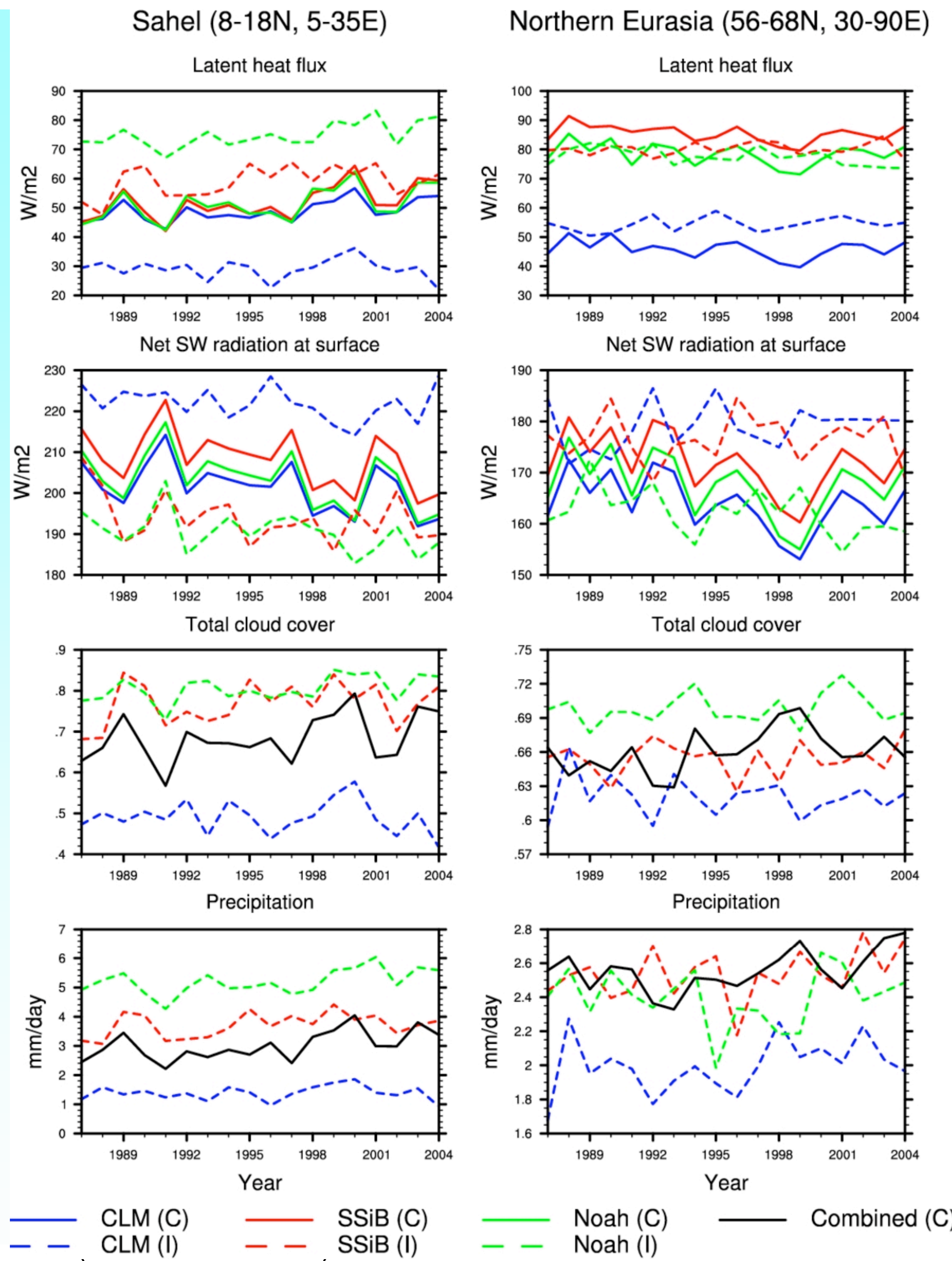


(3 LSSs tiled)

(Blue+Green+Red)/3

Surfaces Fluxes

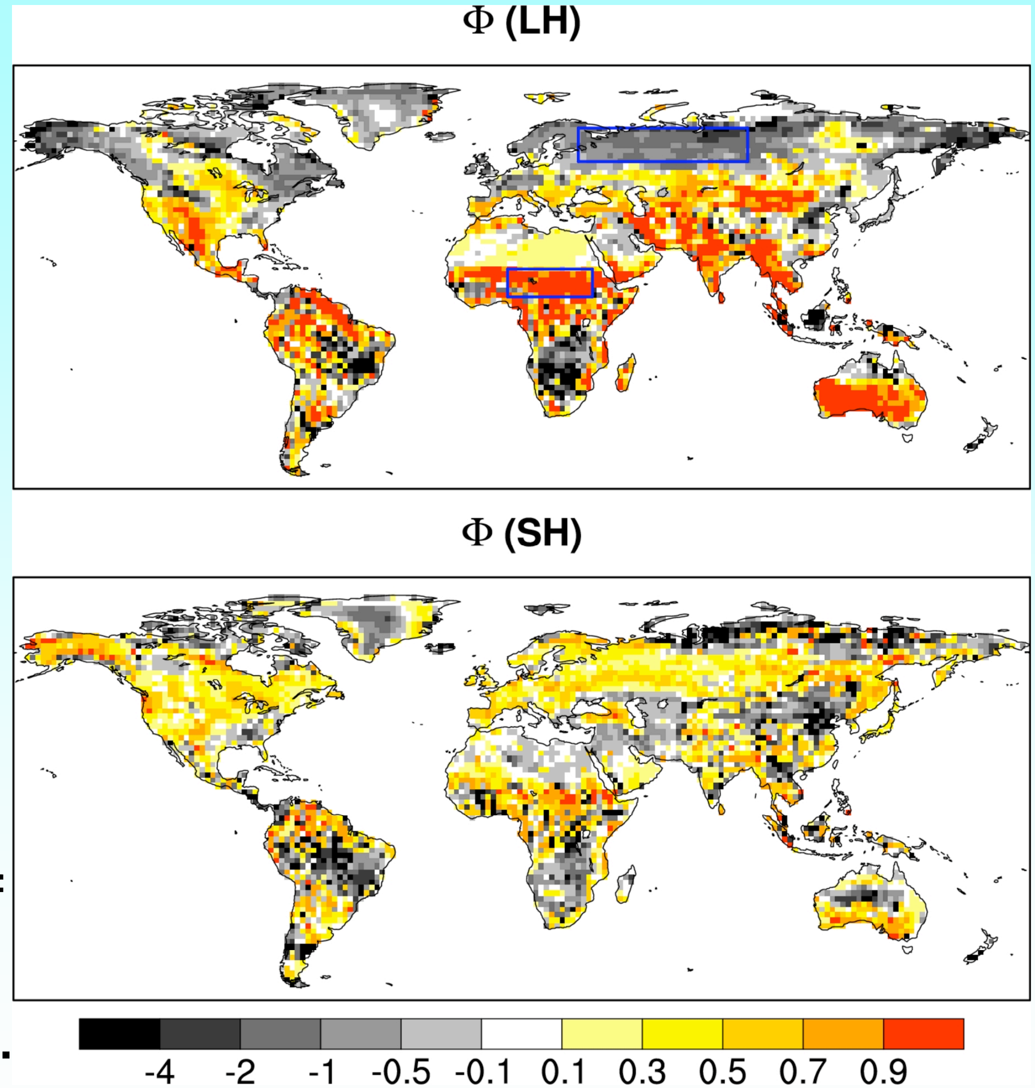
- CLM3.5 has significantly lower ET, leads to a dry feedback with atmosphere.
- This can be canceled in multi-LSS run (but not always - next slide)



Impact on Inter-model Variances

$$\Phi = \frac{Var(I) - Var(C)}{Var(I)}$$

- We expect that multi-LSS coupling (C) will reduce variance in fluxes among LSSs, compared to running each separately (I).
- In fact, sometimes variance increases ($\Phi<0$). When this happens, we cannot estimate the strength of L-A feedbacks in contributing to variance.

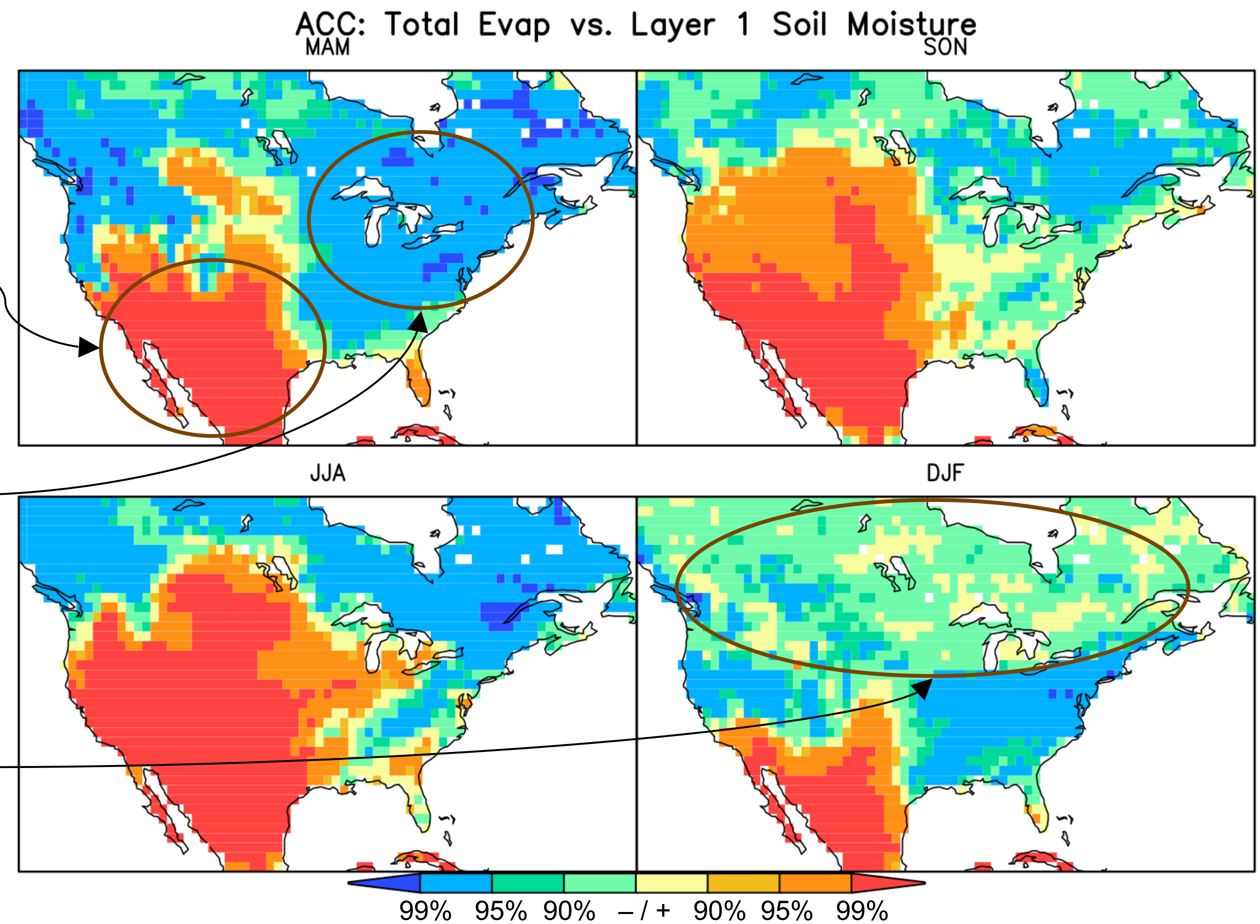


ΔP ⇒ ΔSM → ΔE → ΔP

Moisture limited: SM controls E

Sufficient moisture: E controls SM

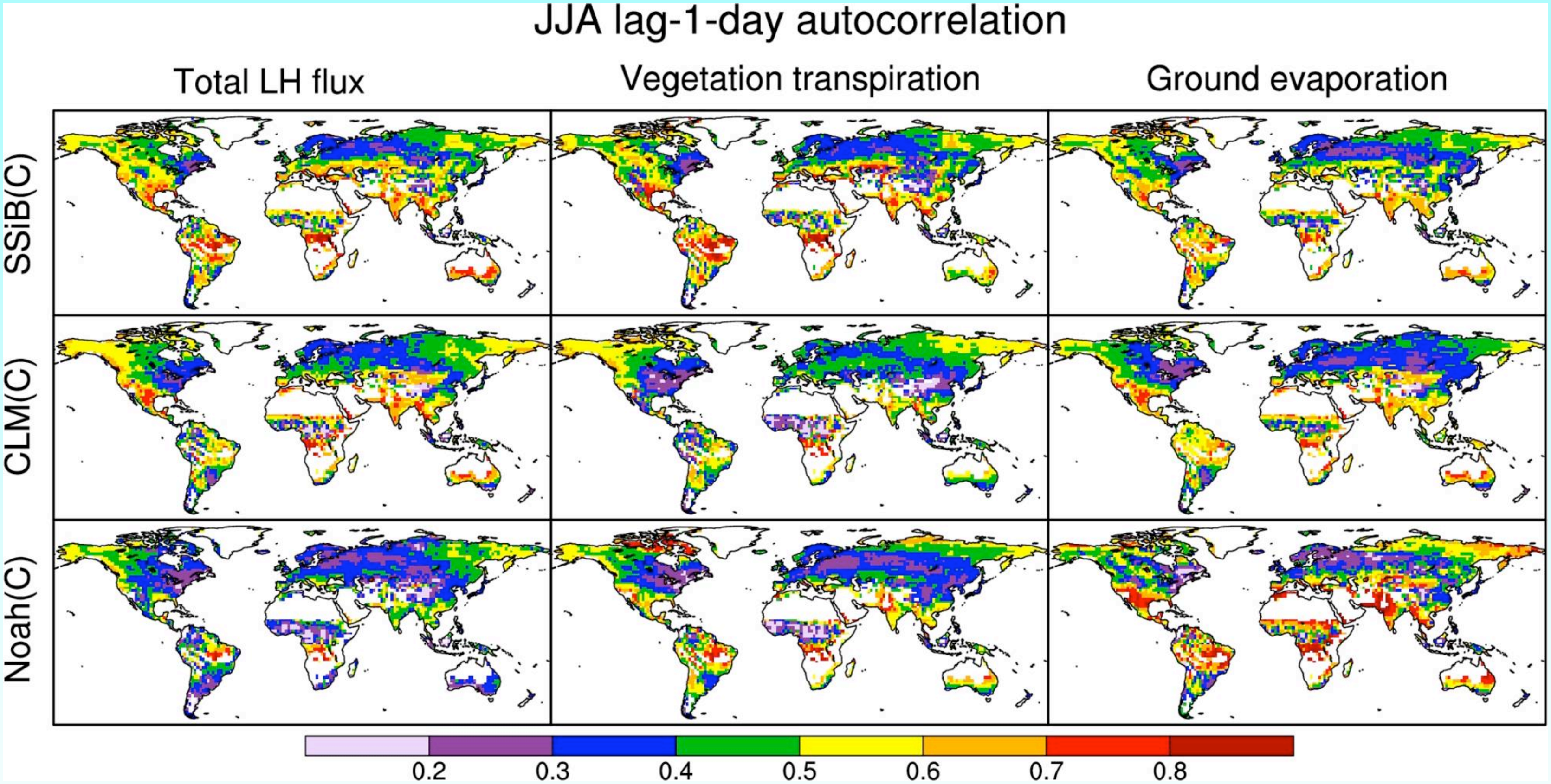
Snow cover cuts connection between SM & E



So we can have: ΔSM ← ΔE

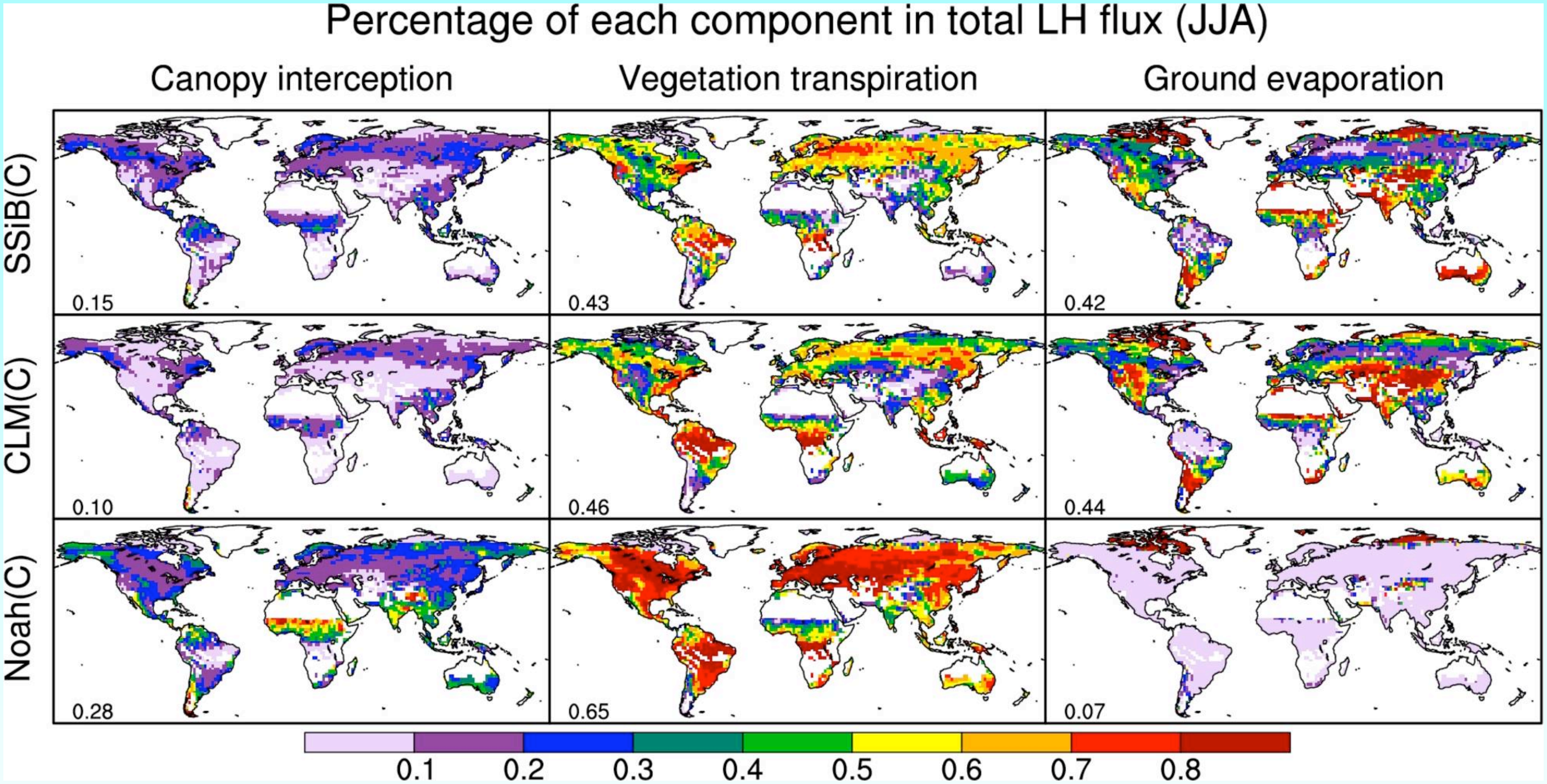
Dirmeyer, P. A., C. A. Schlosser, and K. L. Brubaker, 2009: Precipitation, recycling and land memory: An integrated analysis. *J. Hydrometeor*. **10**, 278-288.

Memory of Land Models



Noah model has lower memory of LH than the other two LSSs

Distribution of ET components

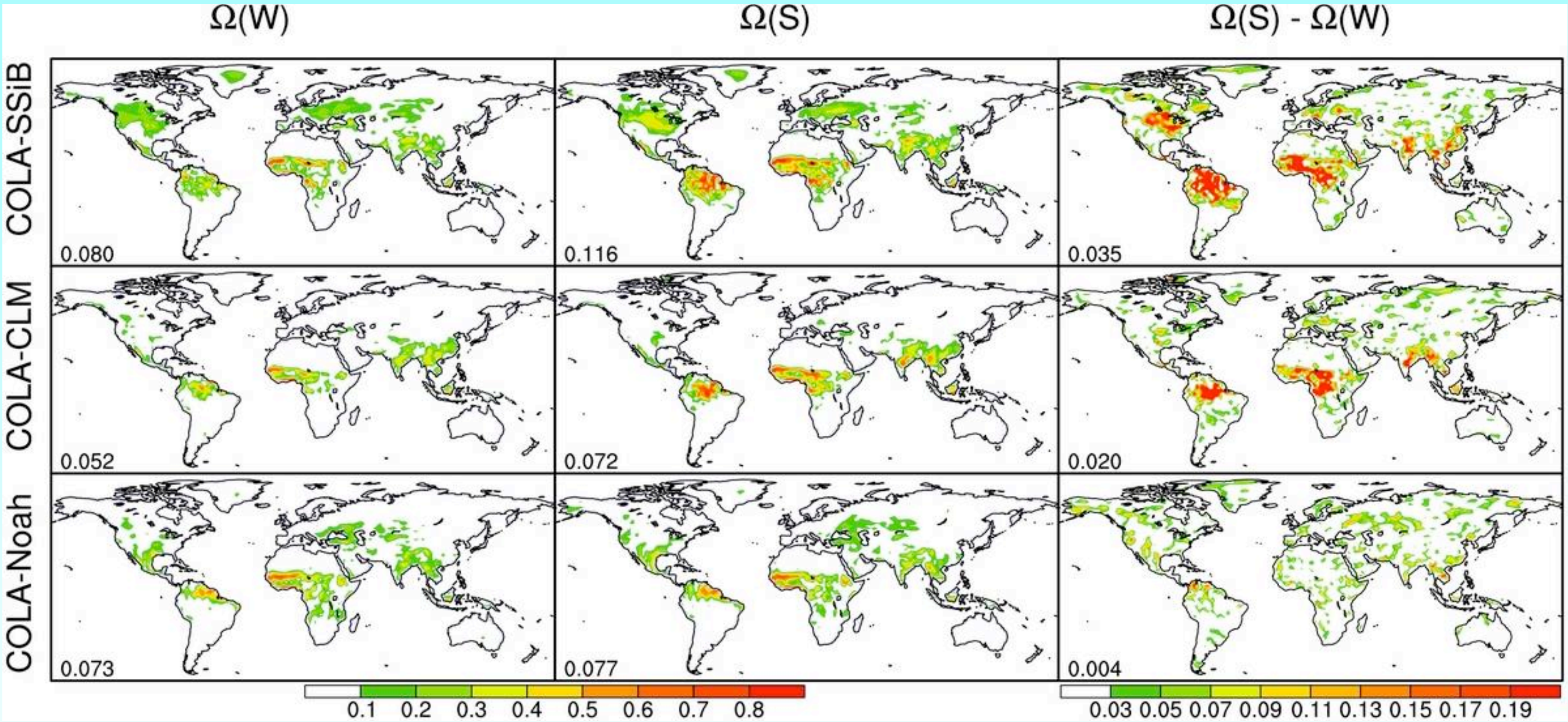


Causes of low LH memory in Noah model:

tropics: percentage of canopy interception is too high

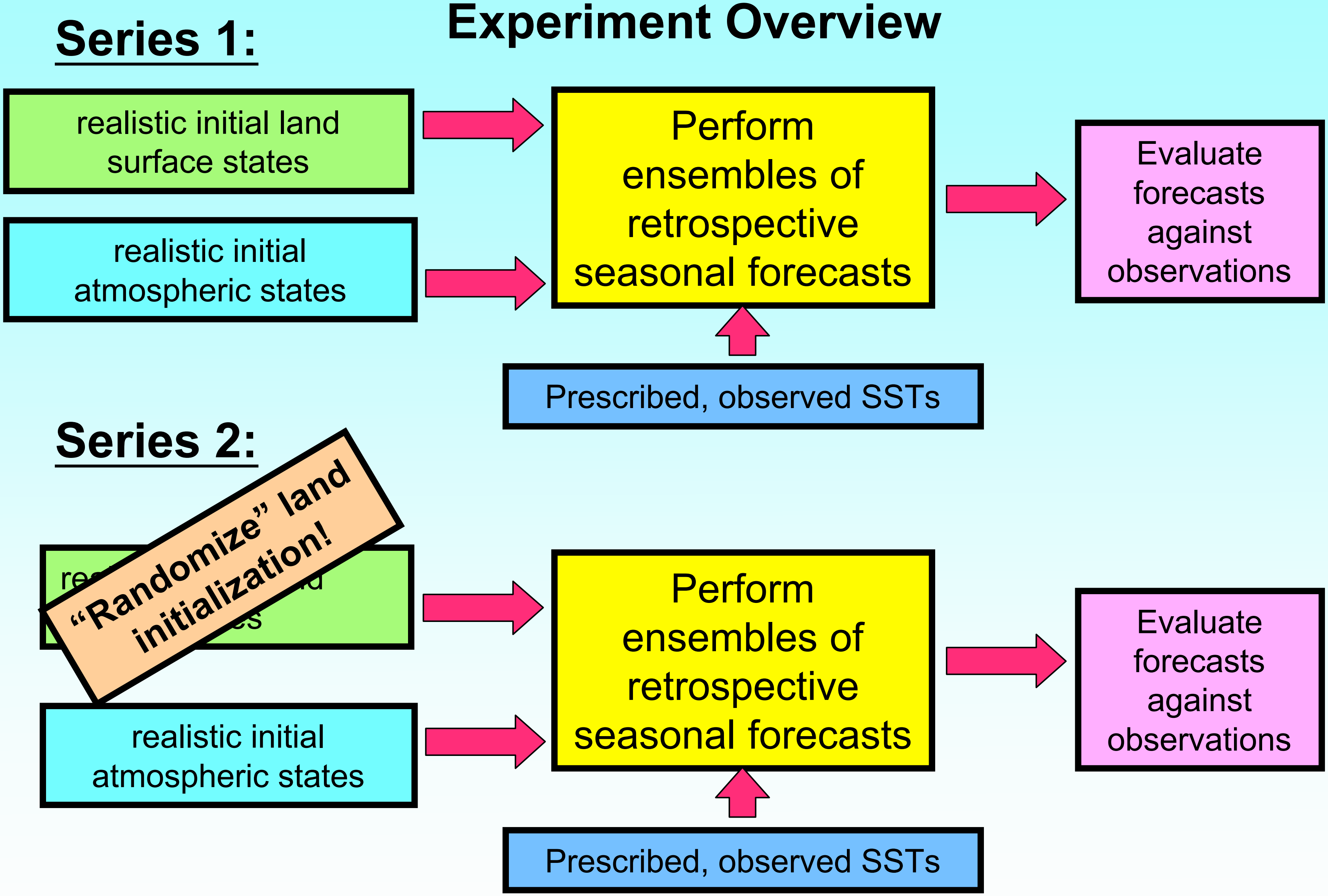
middle to high latitudes: high percentage of interception and low memory of vegetation transpiration

GLACE Coupling Index



- Ω shows similar patterns for 3 models, with largest values in the tropical rain belt where the SST forcing has strongest influence.
- The patterns of W and S are very close, with large differences (Ω(S)- Ω(W)) mainly over the regions with high Ω values. This indicates that the land-atmosphere coupling strength is strongly influenced by external forcing.
- COLA-Noah has very weak land-atmosphere coupling. SSiB and CLM similar.

GLACE-2:
Experiment Overview



FORECAST START DATES

	Apr 1	Apr 15	May 1	May 15	Jun 1	Jun 15	Jul 1	Jul 15	Aug 1	Aug 15
1986	●	●	●	●	●	●	●	●	●	●
1987	●	●	●	●	●	●	●	●	●	●
1988	●	●	●	●	●	●	●	●	●	●
1989	●	●	●	●	●	●	●	●	●	●
1990	●	●	●	●	●	●	●	●	●	●
1991	●	●	●	●	●	●	●	●	●	●
1992	●	●	●	●	●	●	●	●	●	●
1993	●	●	●	●	●	●	●	●	●	●
1994	●	●	●	●	●	●	●	●	●	●
1995	●	●	●	●	●	●	●	●	●	●

→ 100 (10 years x 10 start dates) different 10-member forecast ensembles, each running for 2 months.

GLACE2 Experiments with NCAR CAM

Model version: CAM V3.4.10 + CLM 3.5

Resolution: T85

Atmosphere initialization:

ERA-40 reanalysis. Initialization at 00Z from 10 days around the start dates.

Land surface initialization:

GSWP-type offline simulations with CLM3.5 driven by Princeton meteorological forcing data (1948-2006). *Soil moisture has been scaled to the CAM/CLM climatology*.

Series 1 (“realistic”), same initial field for 10 ensembles at each starting date.

Series 2 (“unrealistic”), initial fields from 10 different years (1986-1995) at each starting date are used for 10 ensembles at that starting date.

GLACE2 Experiments with NCAR CAM (Cont.)

SST (poor-man's forecast):

based on Hadley observed SST.

Daily climatology + persistent anomaly (excluding polar regions)

Scaling of soil moisture states:

CAM/CLM simulations for 32 years (1975-2006).

Scale offline simulated soil moisture states to the climatology of CAM/CLM forecast system.

Anticipated Schedule for model runs:

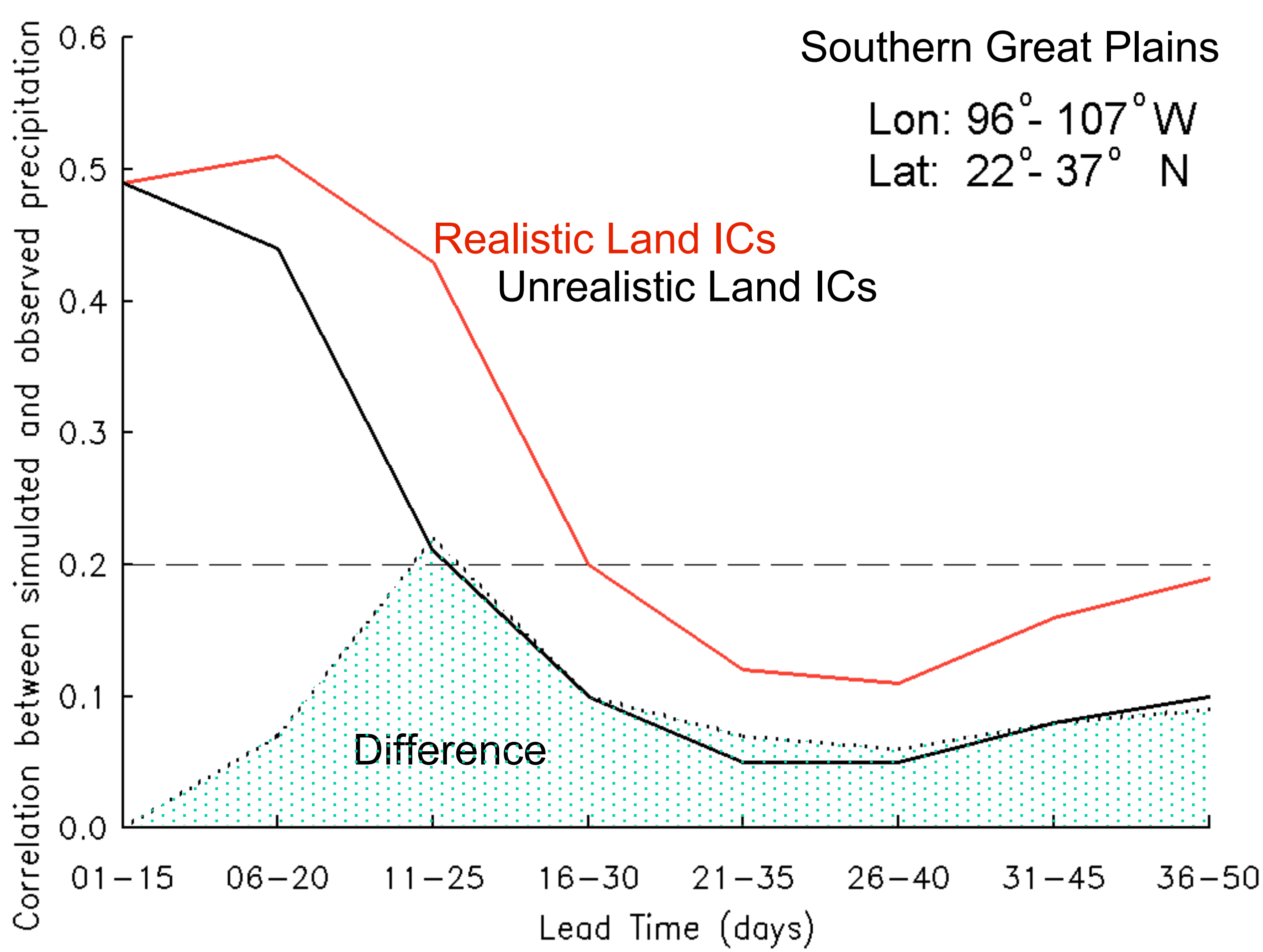
March 20, 2009 - July 1, 2009

Hope to have preliminary results at Breckenridge.

GLACE-2 Initialization and Precipitation

COLA AGCM runs

- Little impact at short lead times (deterministic forecast range) - atmospheric initial states dominate.
- Peak in impact around 3-weeks lead time.
- Positive impacts persist throughout forecast period



Land Initial State and Temperature

- Impact is immediate and continues to grow with time.
- The gain in lead time for various levels of skill is much greater than for precipitation.