Land surface latent heat estimations using surface radiation data: Preliminary results

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Goals

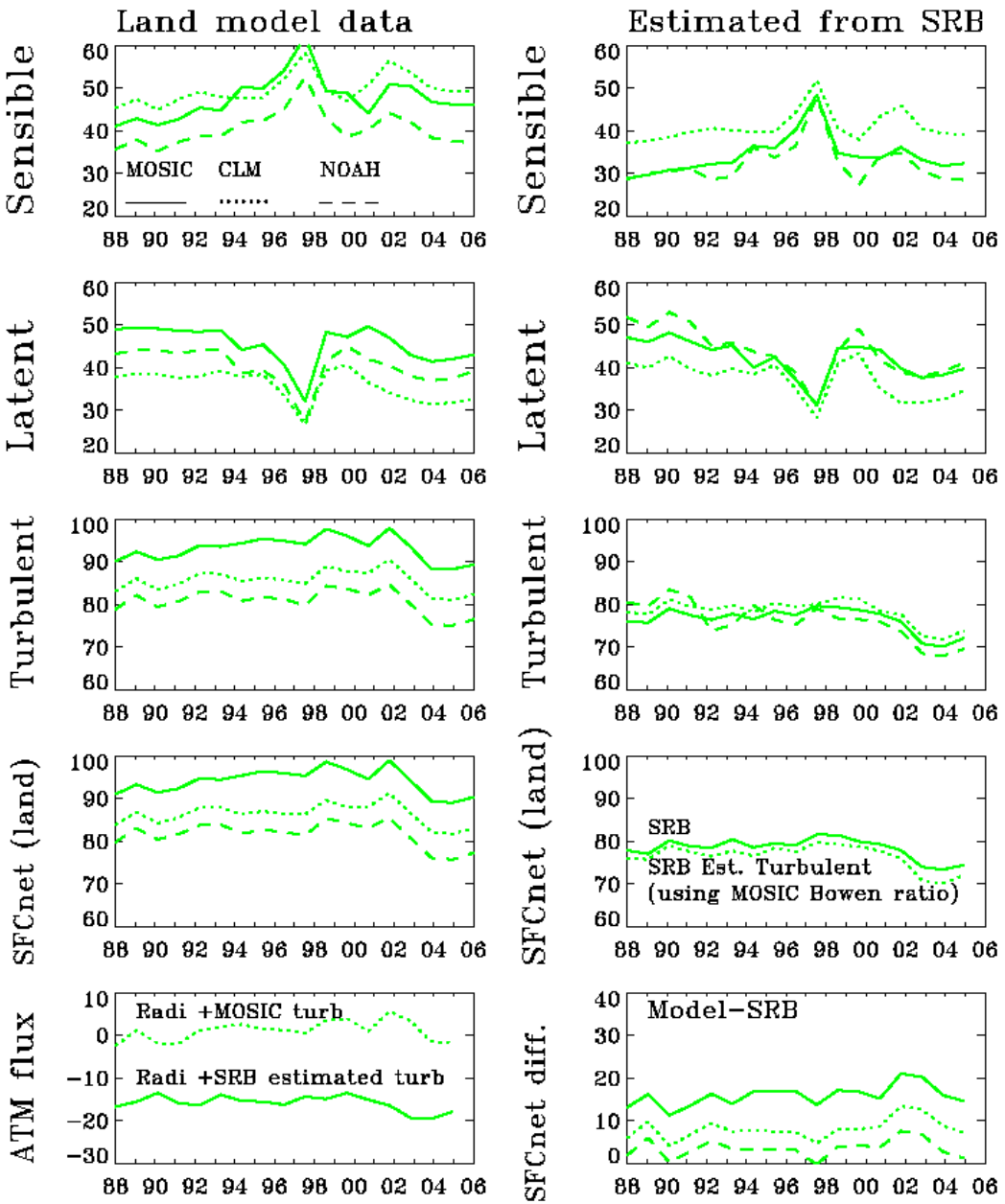
- Improve land surface heat estimates
  - combined approach
    surface radiation data + model results

- Cross-exam satellite radiation estimates
  - water budget over land
  - river discharge

No large scale direct observations of land surface turbulent heat fluxes

Land surface fluxes

differences among models are about 15 W/m^2: all larger than surface radiation estimates.



Background

- Model results:

  large bias errors for heat budget in global/large scales

- Observations:

  surface radiation -- surface site val/cal

  may need large scale examinations

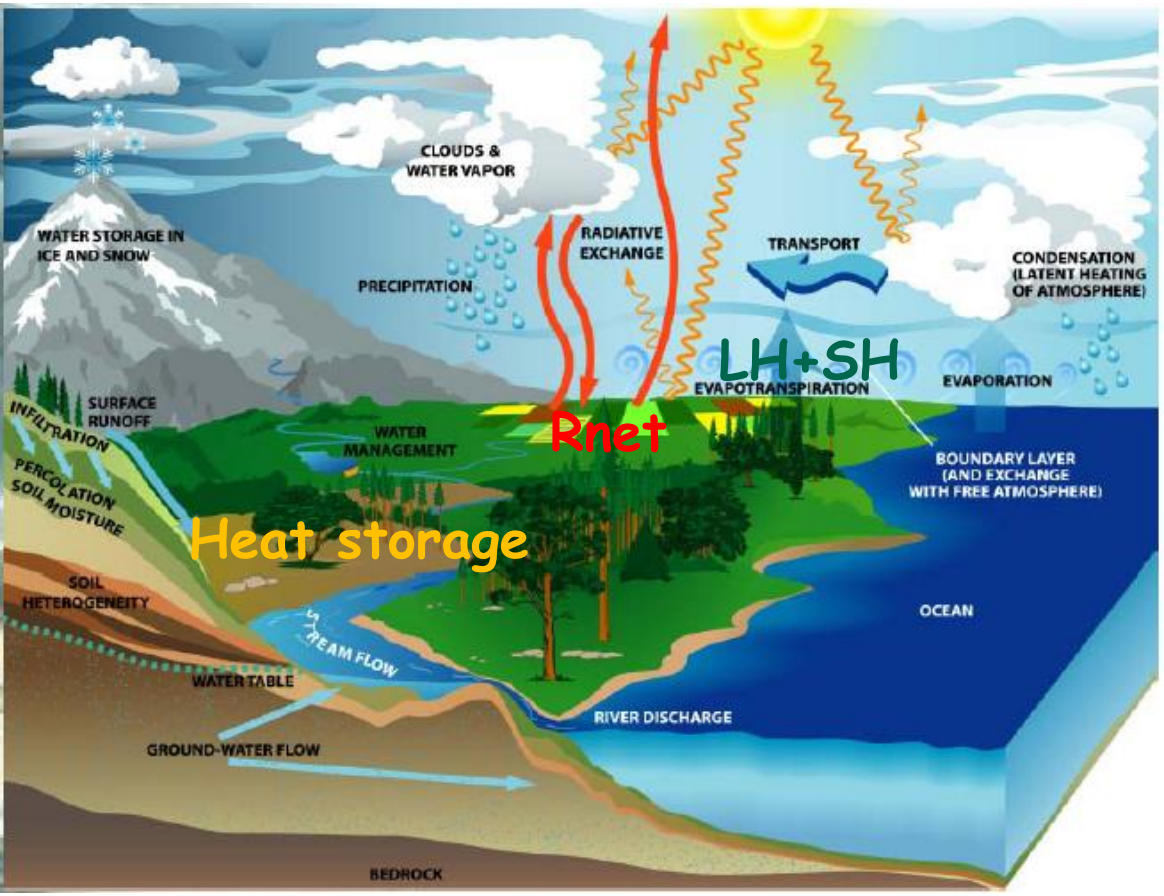
- Radiation: refine modeled energy balance

  examined by water balance

Current study (88-06)

- Radiation:
  - TOA & sfc -- CERES, SRB, ISCCP-FD
  - errors: ~ 10 W/m^2
- Precipitation: GPCP
  - atmospheric latent heat (water balance)
  - annual mean errors: 5% or ~4 W/m^2
- River discharges: ?? 10 ~ 20 % ??
- Model results: surface fluxes
  - interrelationships (Bowen ratio)

Land heat budget

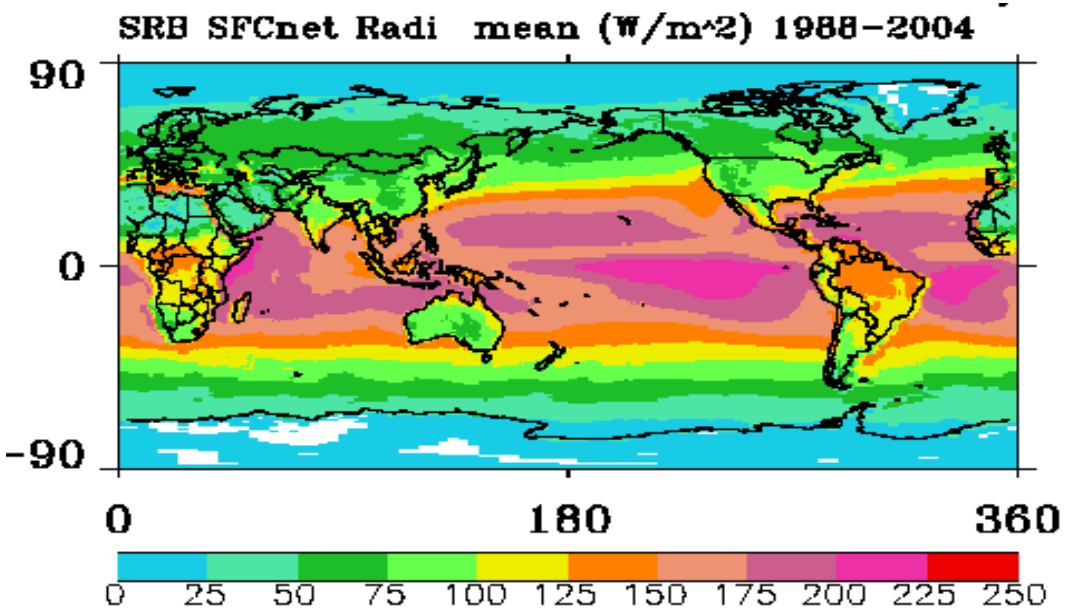


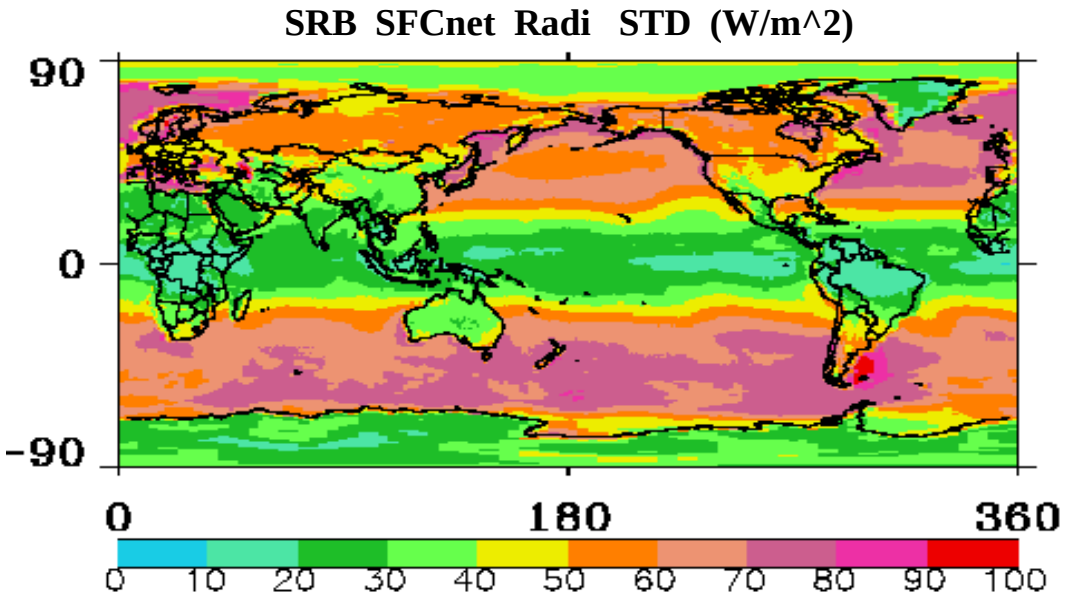
- heat storage S
- Bowen ratio B
- forced by Rnet
  daily ~ monthly
  time scales

$$Rnet = LH + SH + S \qquad (1)$$

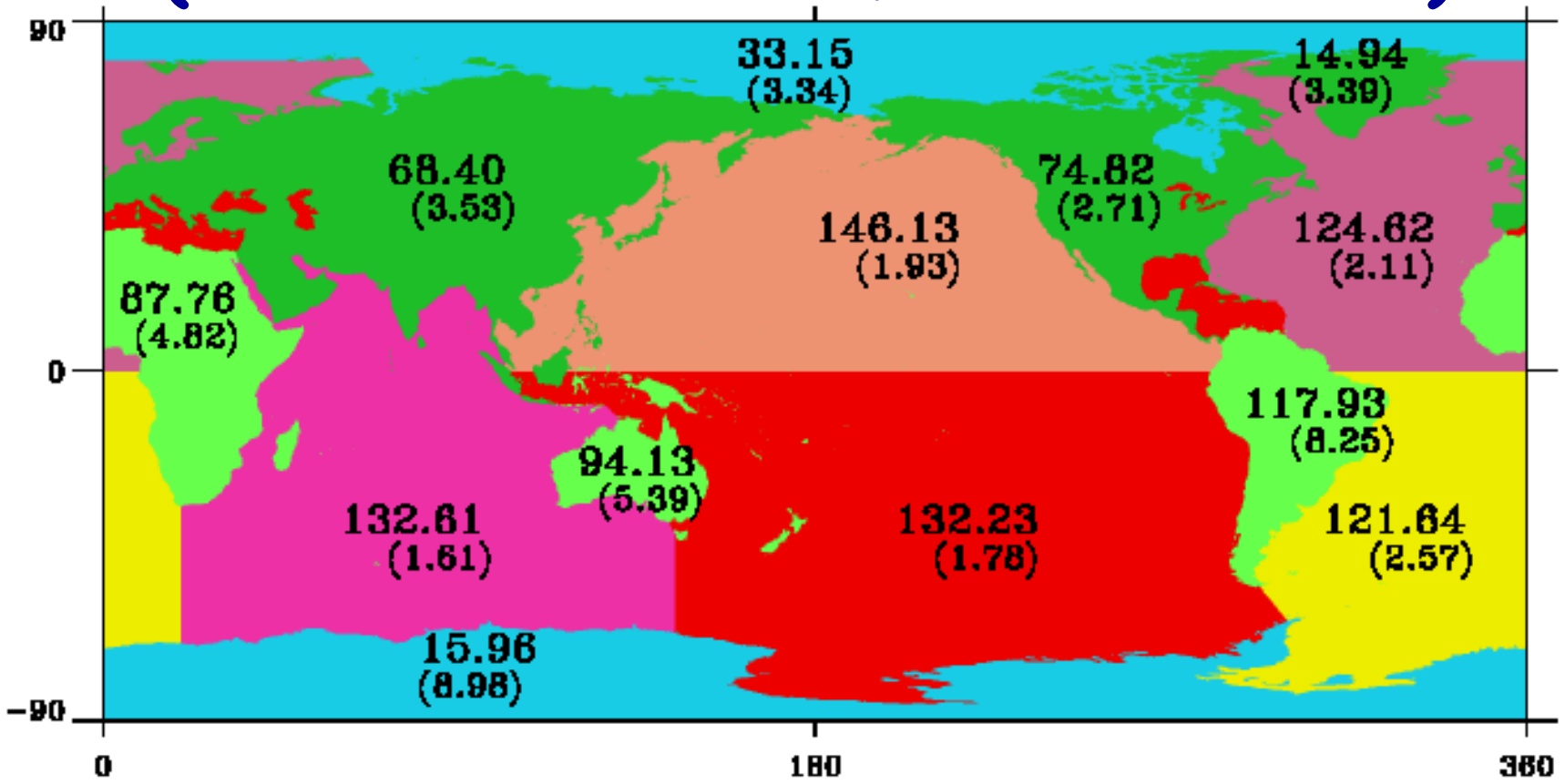
$$B = LH/(LH+SH) \qquad (2)$$

Large variability



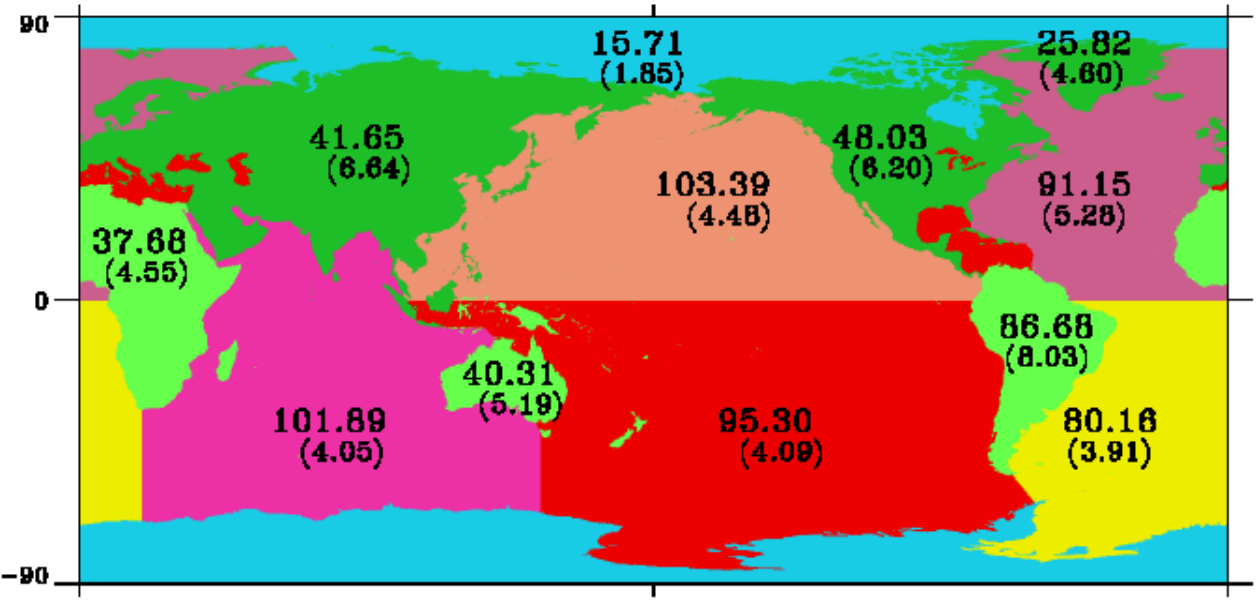


surface net radiation
(-115 ± 1.7 W/m²; 1988 ~ 2004)



significant net radiative heating over the surface:
energy source for latent and sensible heat

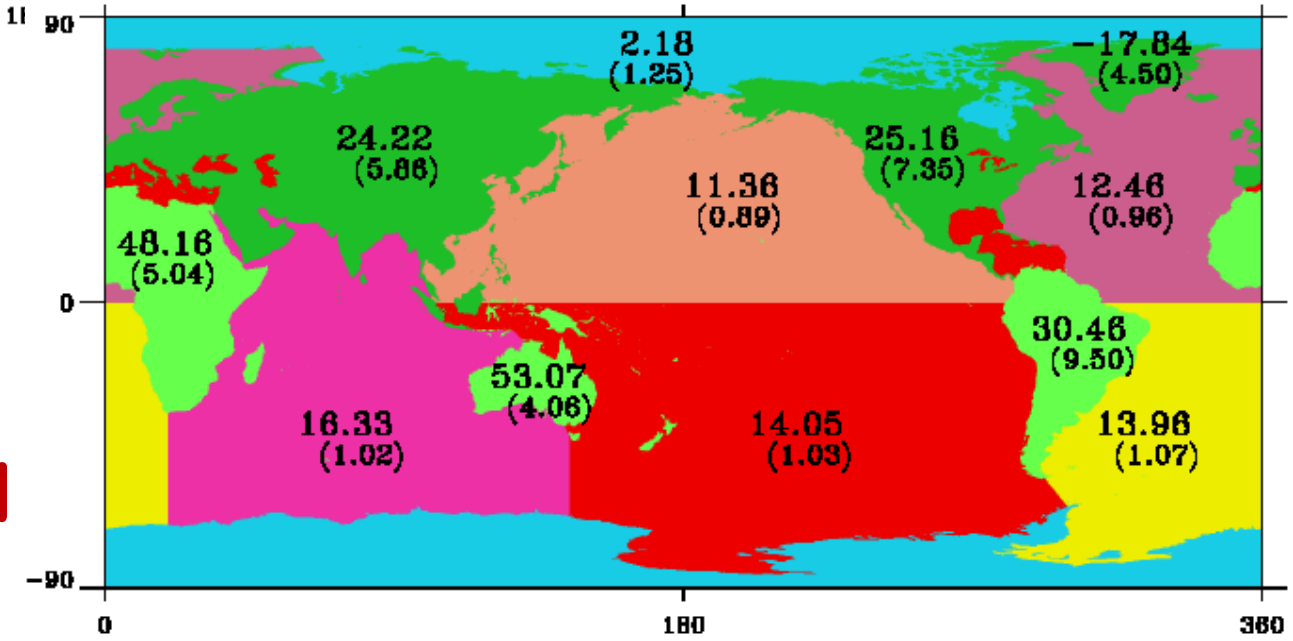
surface turbulent fluxes



Ocean: HOAPS
Land: Noah

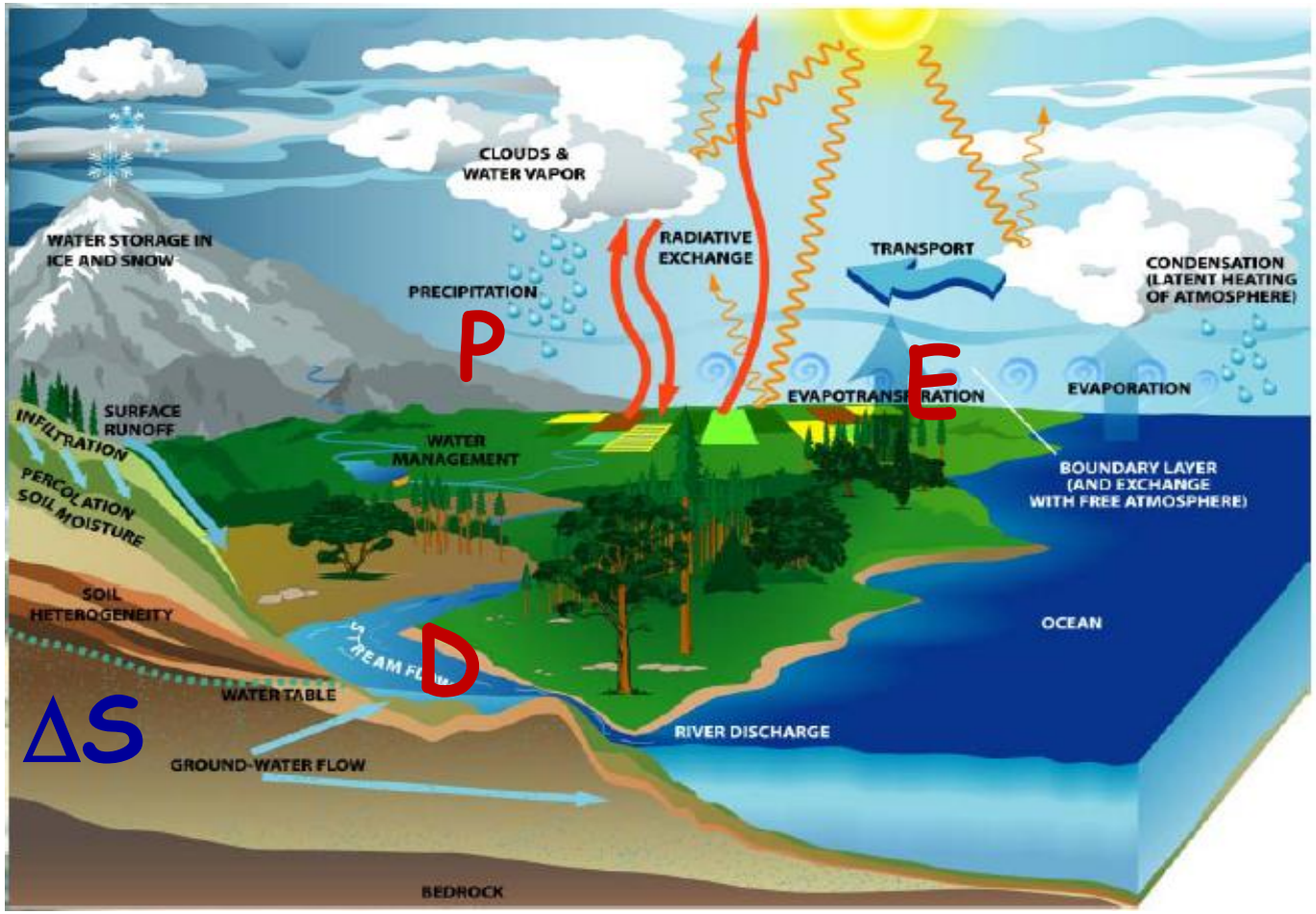
sensible heat
(18 ± 1.9 W/m²)

latent heat
(82.2 ± 2.5 W/m²)



small variability
at long temporal
scales!

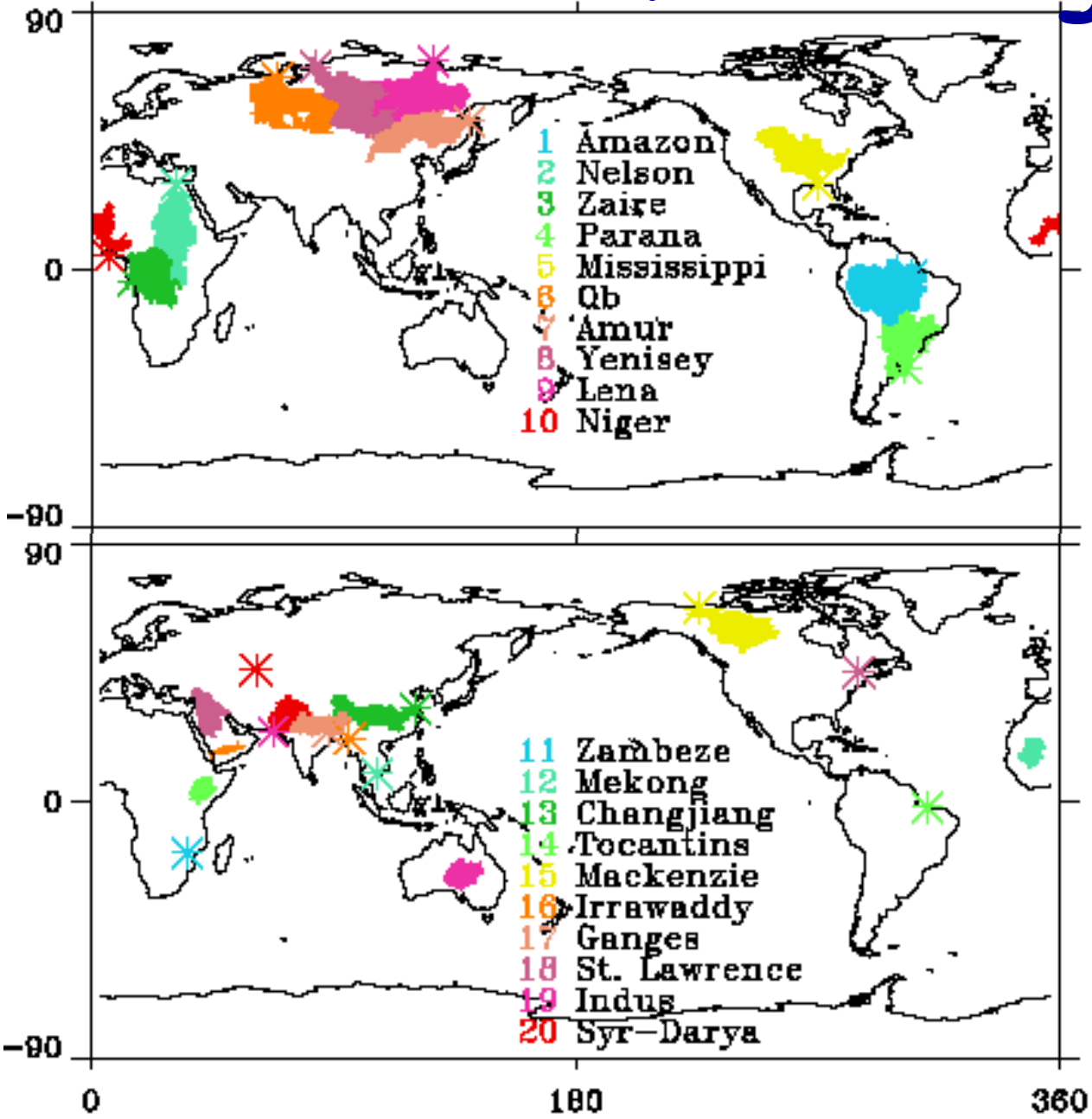
consistency and validation

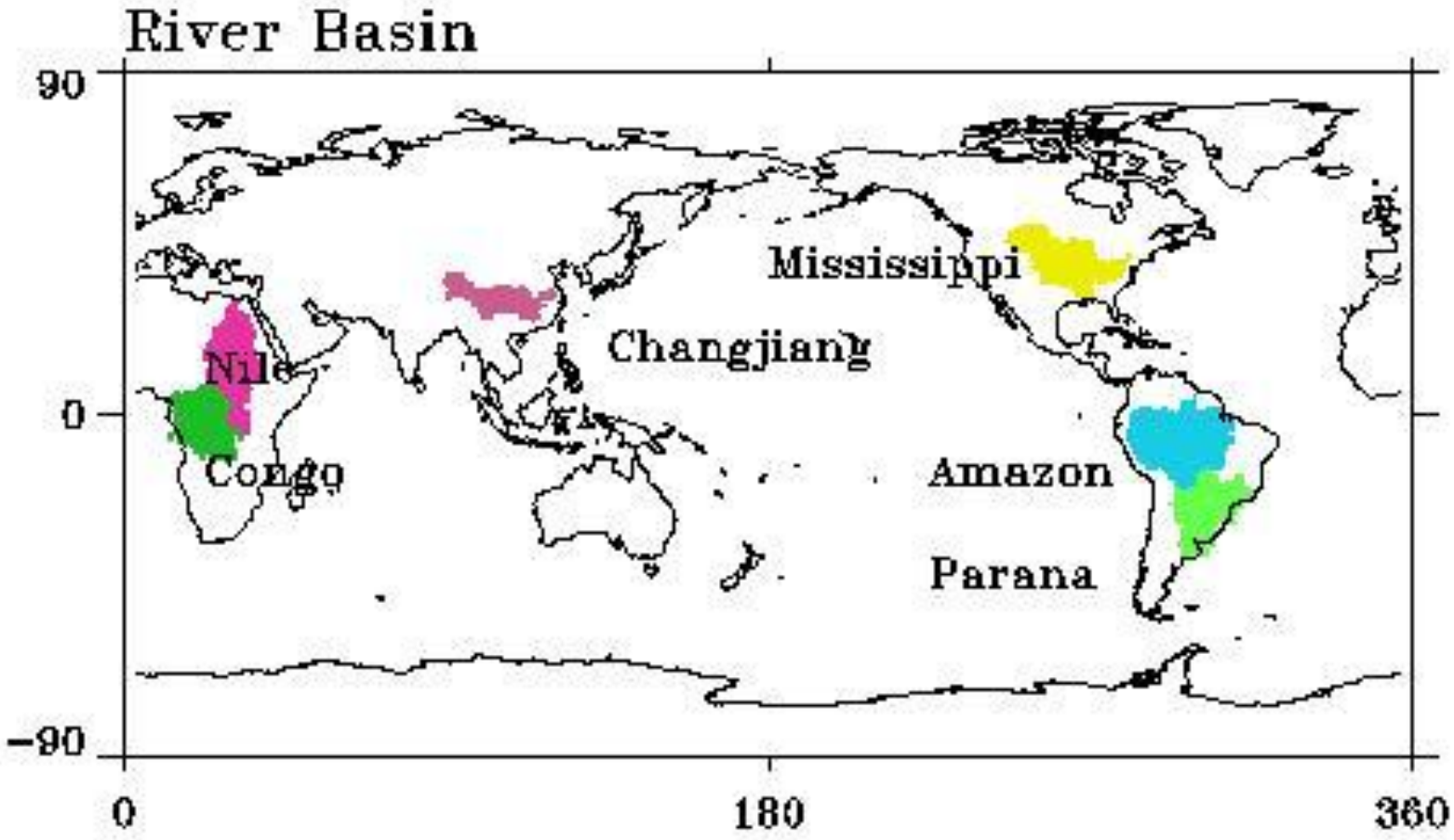


$$P - E = D + \Delta S \qquad (3)$$

long term: $\Delta S \approx 0$ (4)

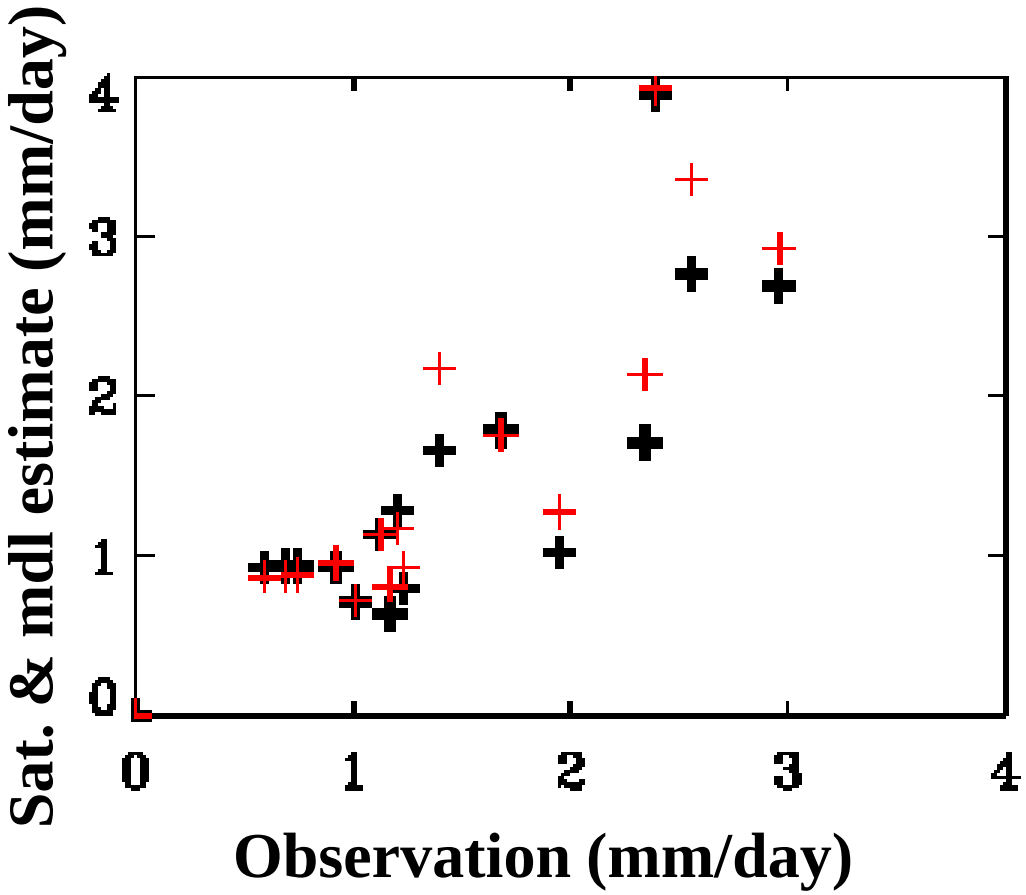
river basin & discharge





focus on Mississippi & Changjiang

basin scale comparison
(climatology)



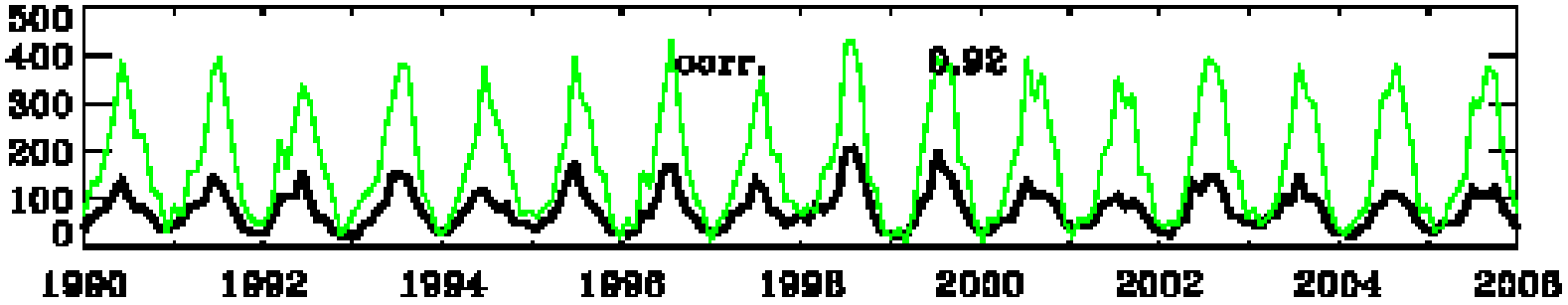
Obs: 1.50 mm/day
Sat: 1.49 mm/day
Mdl: 1.62 mm/day

Obs =
GPCP - Discharge

basin scale comparison

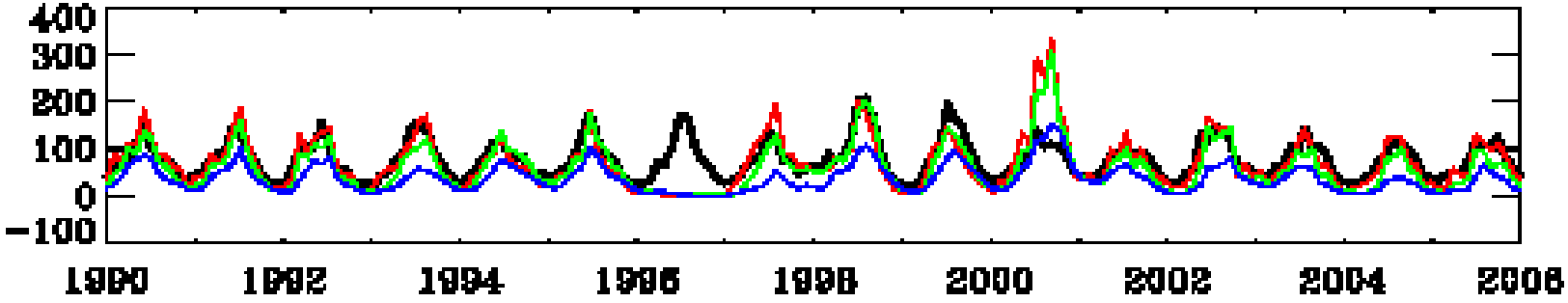
Changjiang River Basin (km^3/yr)

GPCP	Datong	Dai&Trenberth	Chen
2102.5	934.5	907	914

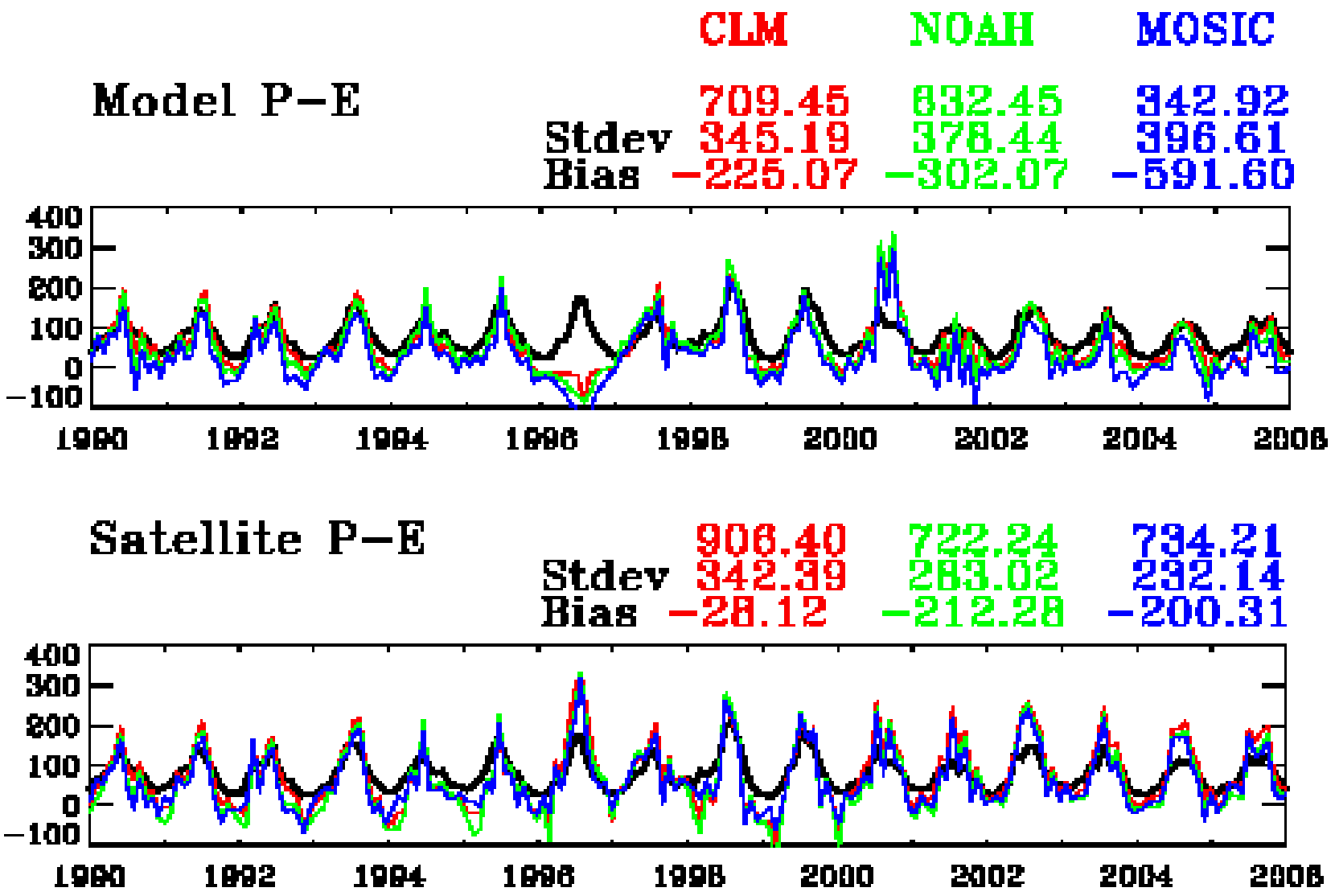


Model runoff

	850.74	716.20	440.80
Stdev	329.25	267.91	184.01
Bias	−83.76	−218.32	−493.72

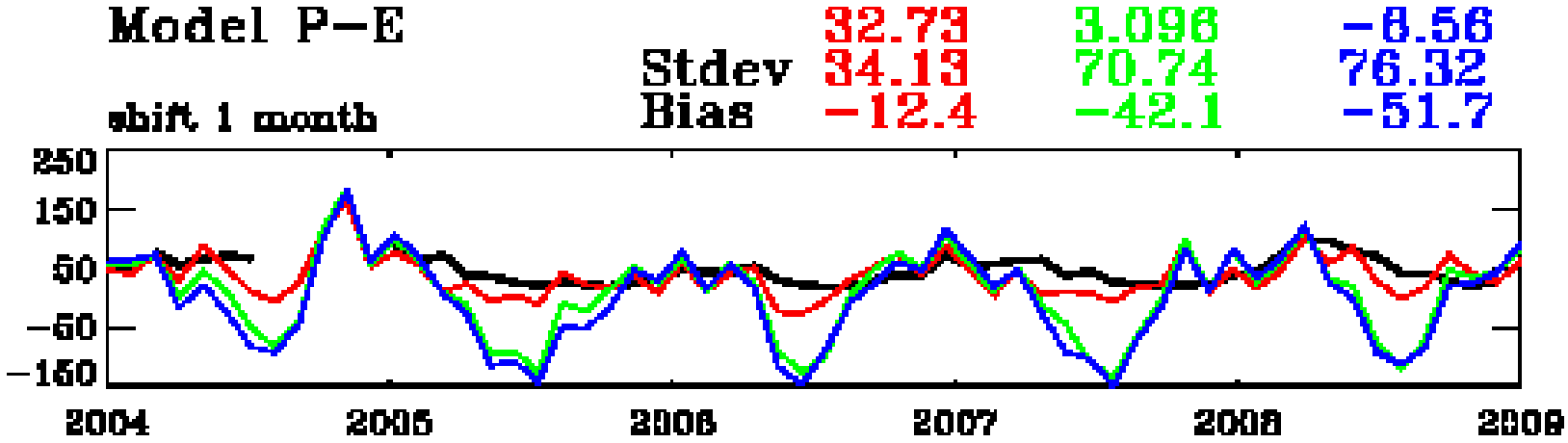


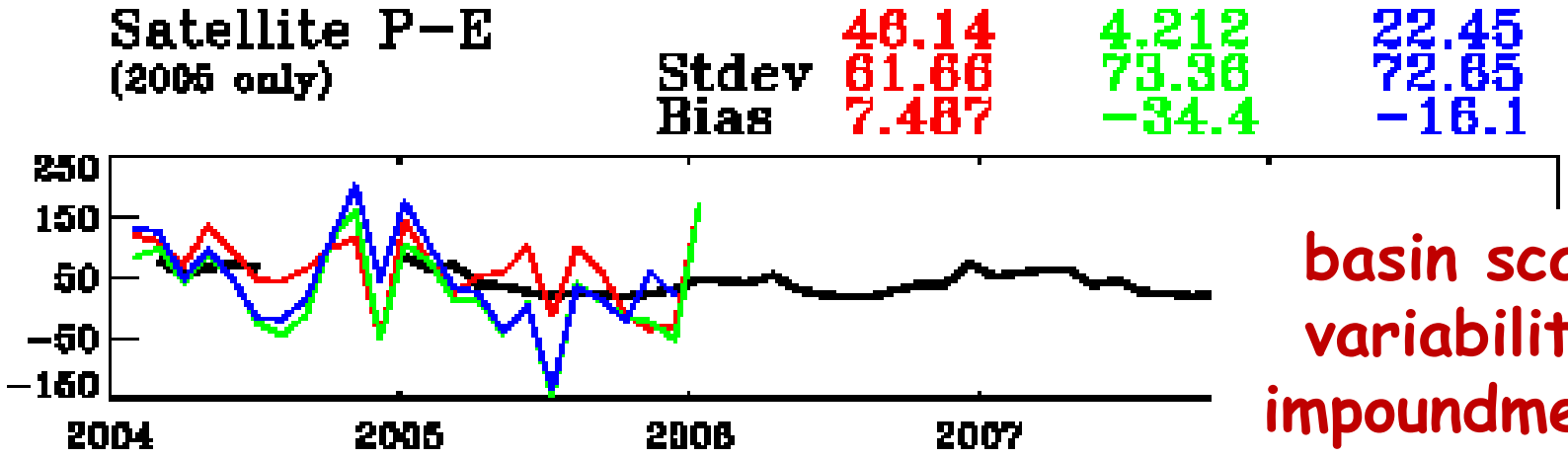
basin scale comparison



basin scale comparison

Mississippi River Basin- Baton Rouge
Gauge: 45.2 (km^3/mo)





basin scale variability: impoundments

Summary

- Although satellites can provide invaluable estimates of latent heat fluxes over oceans, there are significant observational gaps of the fluxes over land surfaces and cold regions.

- Current model results of land surface latent heat are considerably biased when observed radiation, precipitation and river discharge are considered. That is, modeled latent heat fluxes result in much larger imbalances in the energy and water cycles over continental or basin scales than those from observations.

Summary (conti.)

- Based on a combination of satellite surface radiation estimates and assimilation model results of land surface properties, land surface latent heat is estimated. This hybrid technique, at least, generates a consistent picture between radiative heat into land surface and the heat removed by turbulent processes.

- Comparison of estimated latent heat fluxes with satellite precipitation and river discharge observations over certain big river basins indicates that current technique may remove large bias errors. Encourage (??)