Comparison of ERA-Interim and ERA-40 reanalyses with observations over river basins

Alan K. Betts

Atmospheric Research, Pittsford, VT

akbetts@aol.com

M. Kőhler (ECMWF)

Y. Zhang (NASA GISS)

23rd AMS Conference on Hydrology

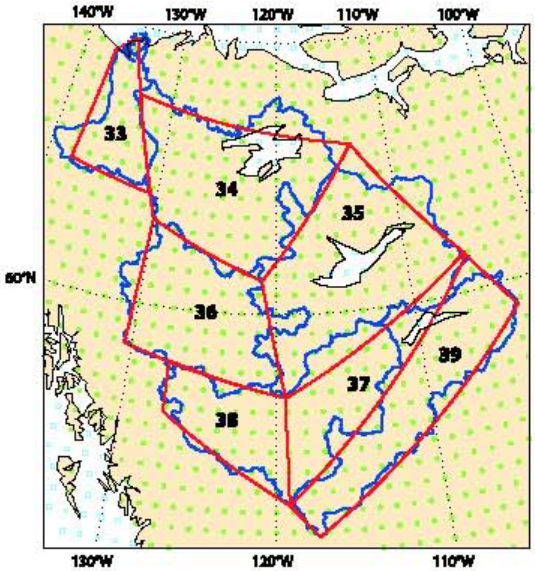
Phoenix, AZ, Jan 12-15, 2009

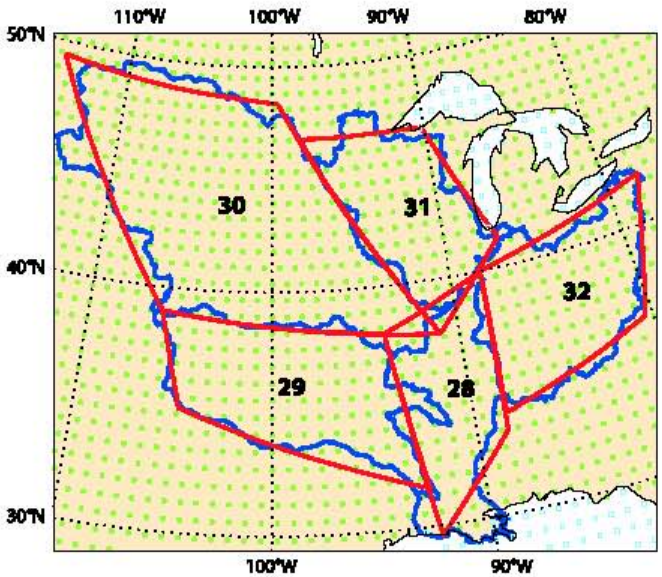
Themes

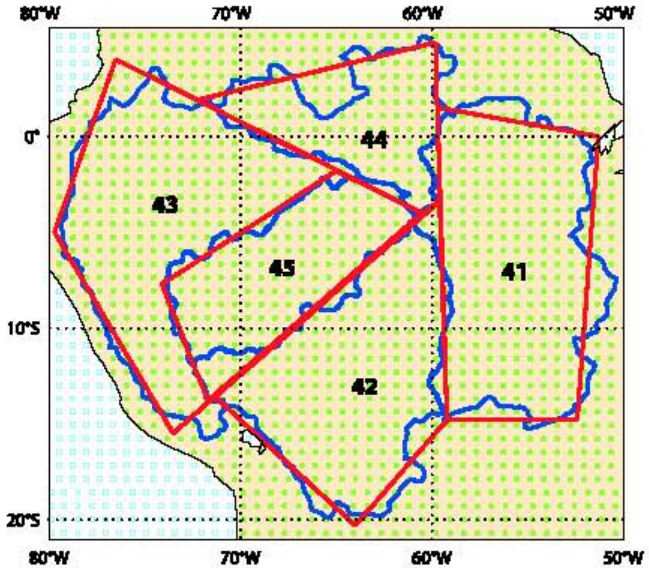
- **Evaluating reanalyses**
  - against independent data
- Annual cycle, diurnal cycle, daily mean
- *Temperature and humidity*
- *Precipitation and evaporation*
- *SW Cloud radiative impacts*
- *Betts, A. K., M. Köhler and Y-C. Zhang, 2008: Comparison of river basin hydrometeorology in ERA-Interim and ERA-40 with observations. J. Geophys. Res. In press. [ECMWF tm568.pdf]*

River basin archive

ERA-40 and ERA-Interim





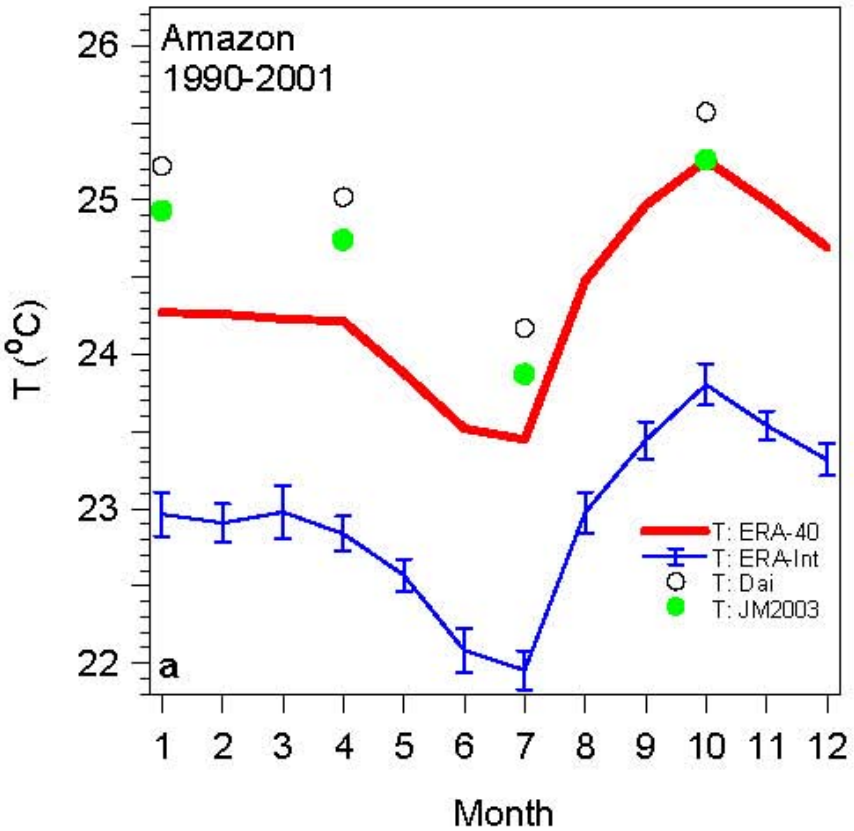


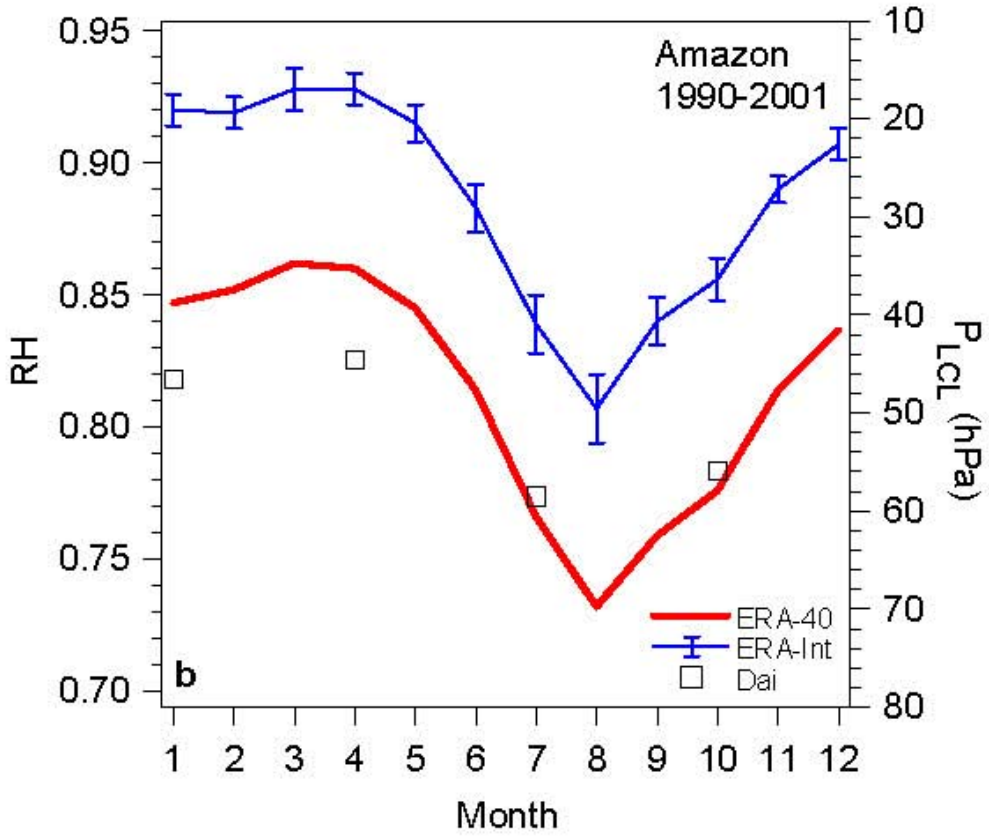
Mackenzie **Mississippi** **Amazon**

Evaluation on river basin scale, starting from **hourly archive**

Amazon: ERA-40 & ERA-Int

Annual T, RH and LCL





- ERA-Interim has
  - larger cold bias
  - high bias of RH and low bias of cloud-base

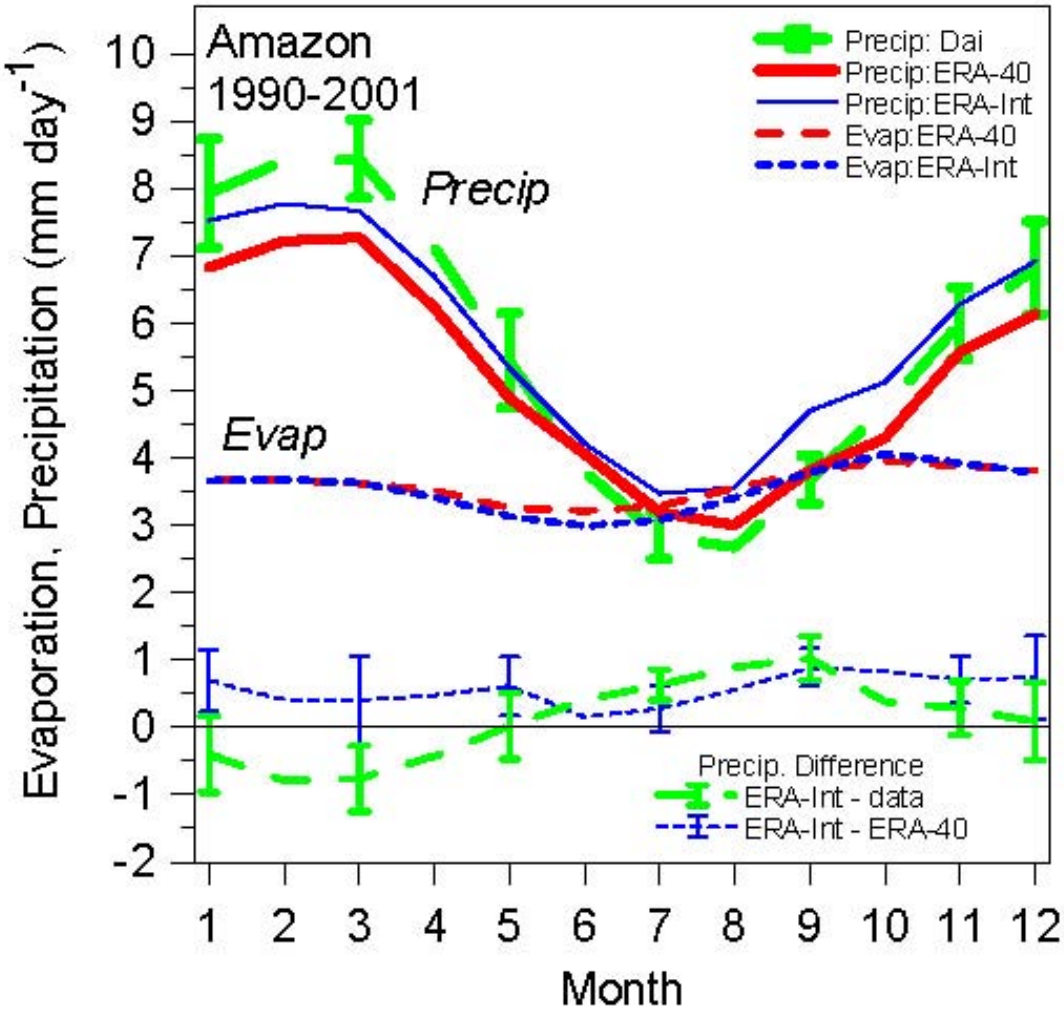
Amazon

Precipitation & Evaporation

Data

ERA-Int

ERA-40

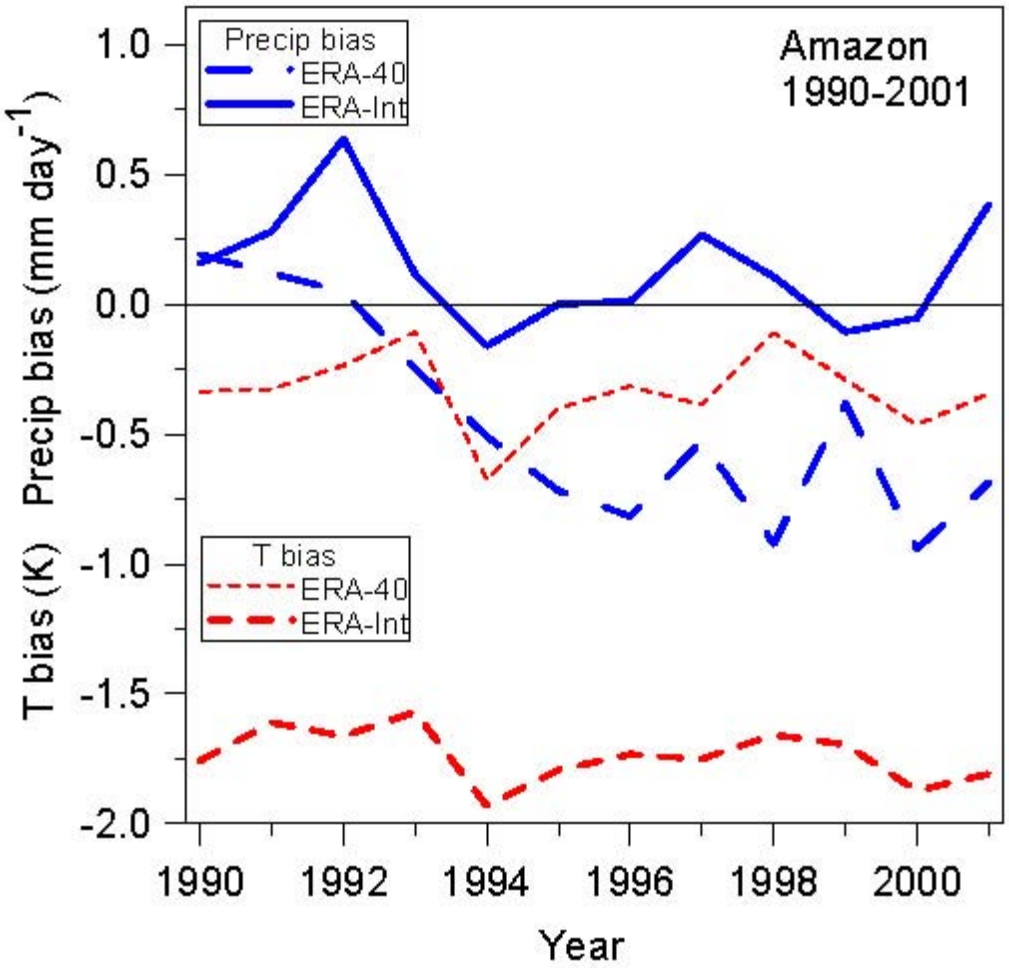


- ERA-Interim precipitation increased
- Seasonal amplitude remains too small

Annual biases

Precip

Temp



- Interannual drift of precipitation reduced
  - annual precipitation largely unbiased
  - from improved humidity analysis *[Uppala et al., 2008]*
- Cold temperature bias increased substantially

Clouds & Surface SW_{net}

$$SW_{net} = SW_{down} - SW_{up} = (1 - \alpha_{surf})(1 - \alpha_{cloud})\, SW_{down}(clear)$$

- *surface albedo*

$$\alpha_{surf} = SW_{up} / SW_{down}$$

- ***effective cloud albedo***

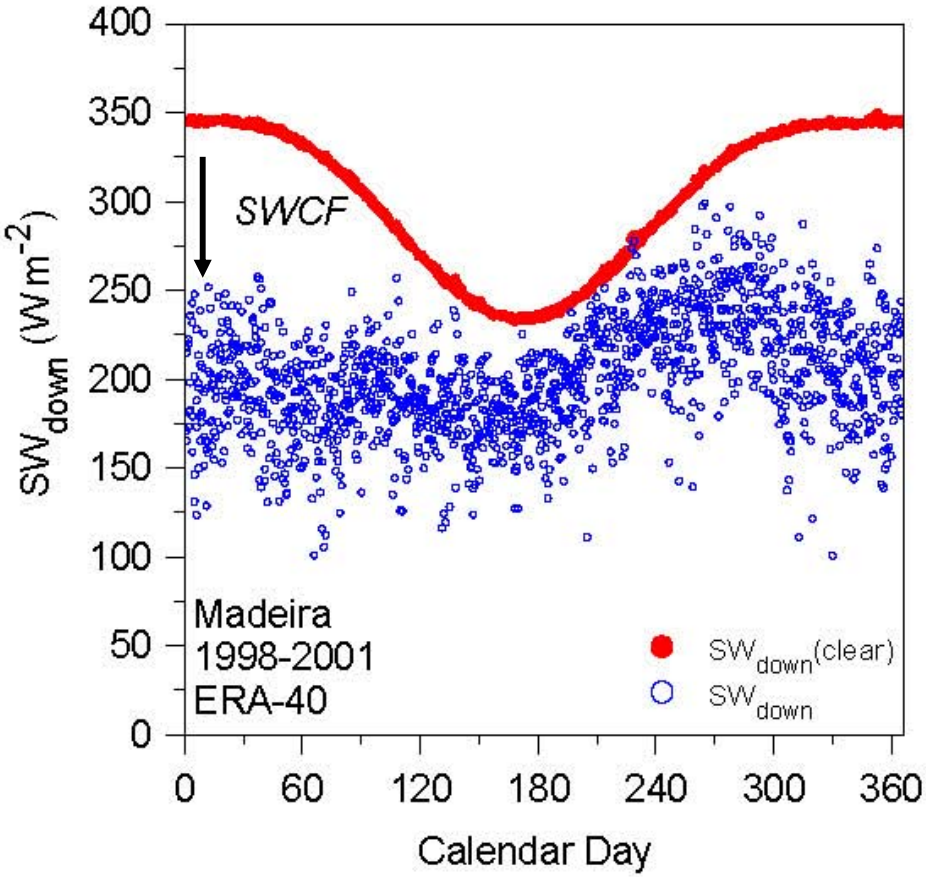
  - scaled surface **short-wave cloud forcing, SWCF**

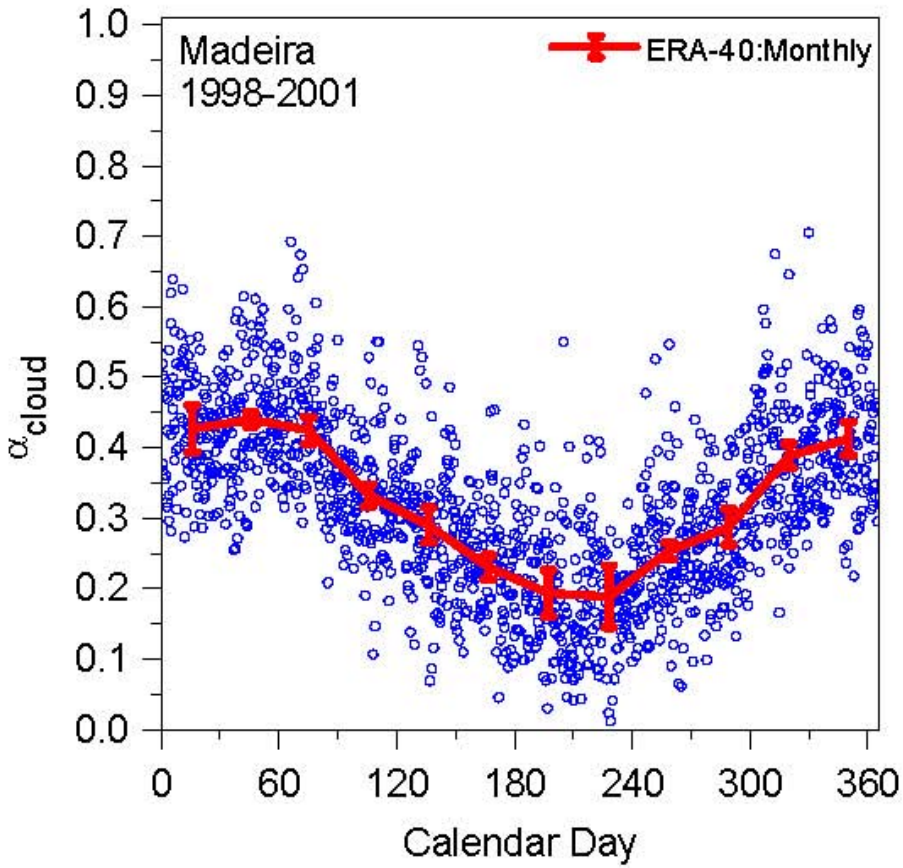
$$SWCF = SW_{down} - SW_{down}(clear)$$

$$\boldsymbol{\alpha_{cloud} = - SWCF / SW_{down}(clear)}$$

[Betts and Viterbo, 2005; Betts, 2007]

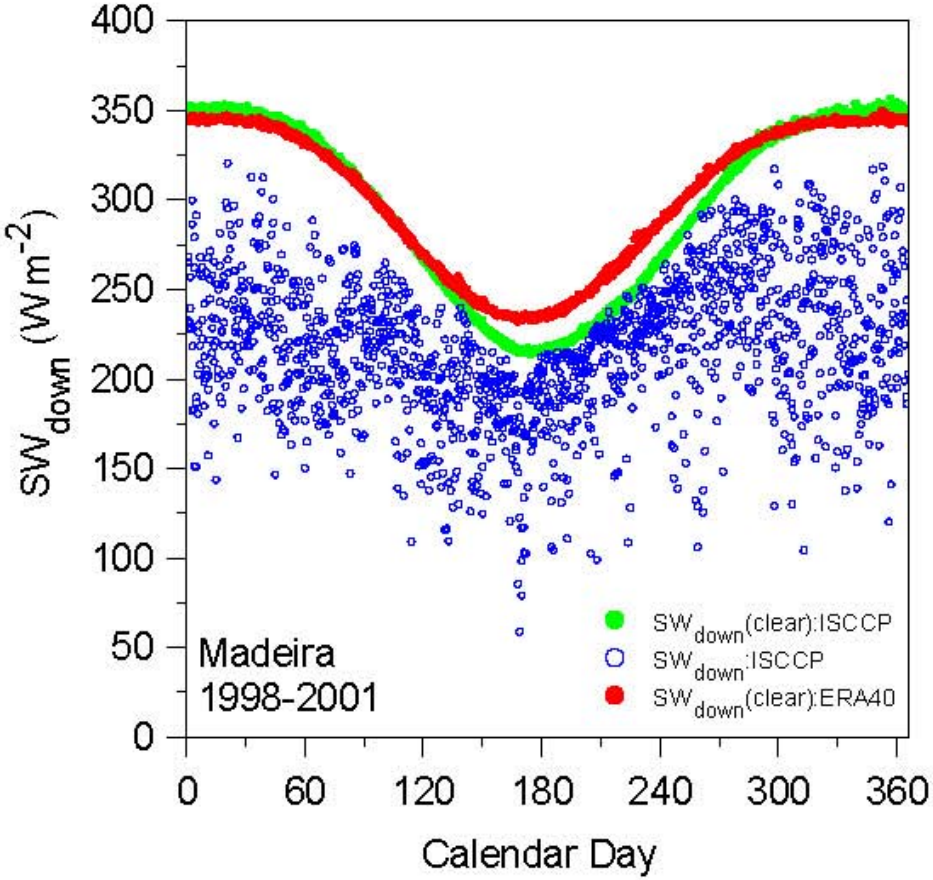
“Cloud albedo”: *ERA-40 data*

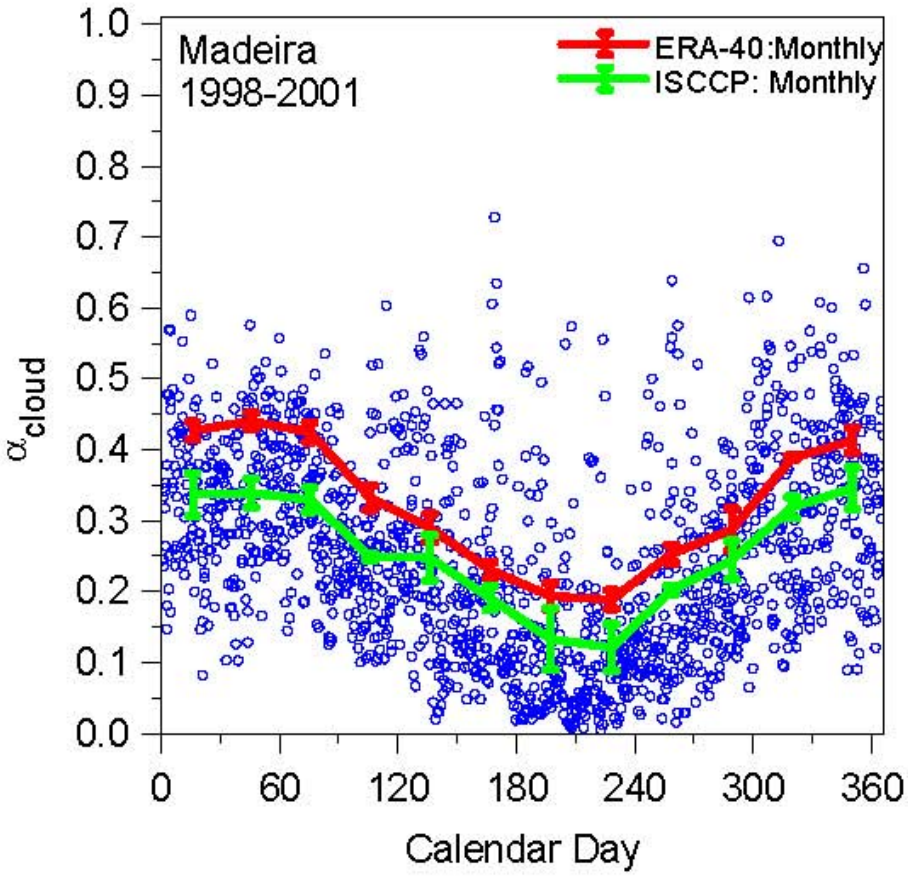




- Transformation: α_{cloud} = SWCF/ SW$_{down}$(clear)
- Seasonal cycle OK: small daily variability: Is it biased?

Cloud albedo: *ISCCP data*

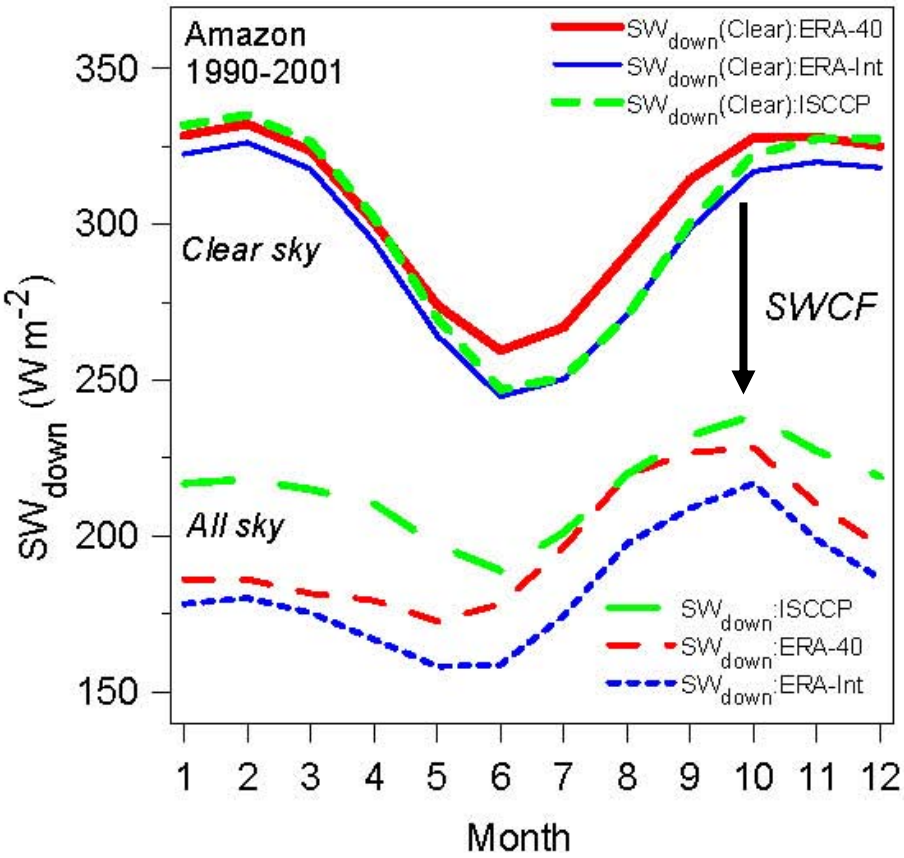




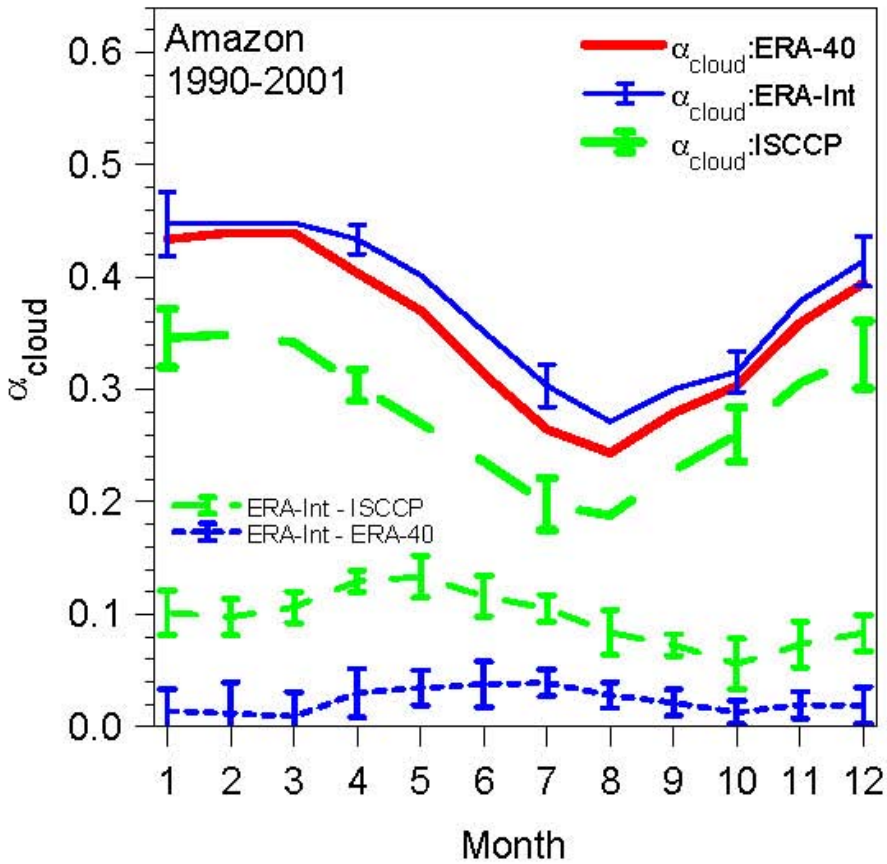
- Different clear-sky flux: Aerosol differences
- ERA-40 systematic high bias in α_{cloud} ≈ +7%
- ISCCP has more daily variability

Amazon – *Shortwave & α_{cloud}*

SW_{down}



Cloud albedo

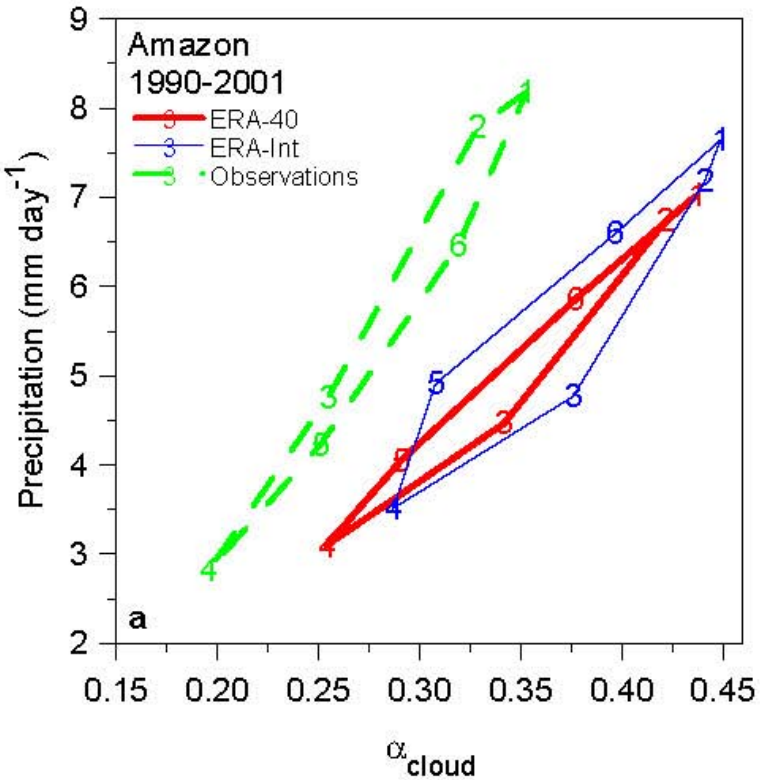


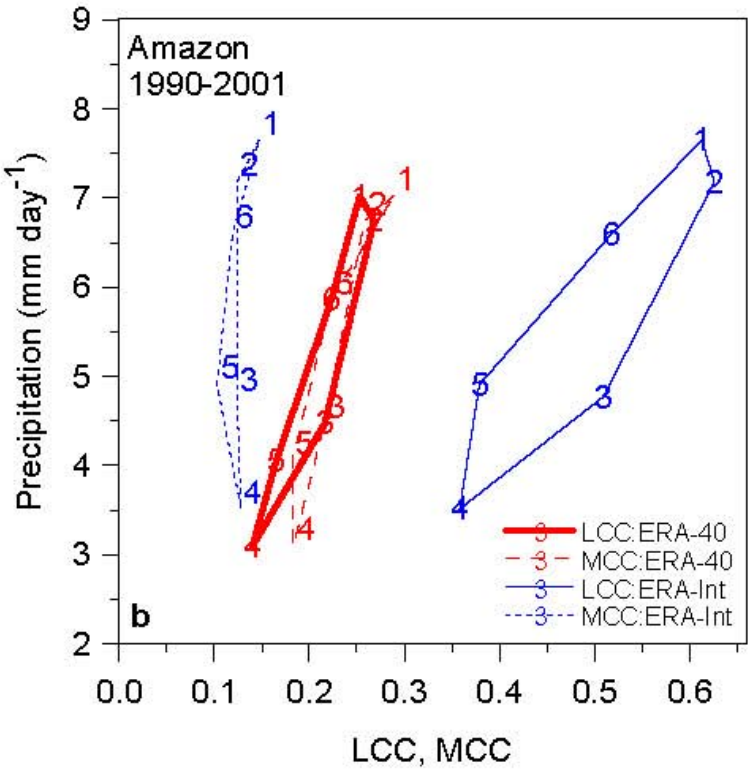
Clear-sky differences

All-sky differences are larger

ERA-Int > ERA-40 > ISCCP

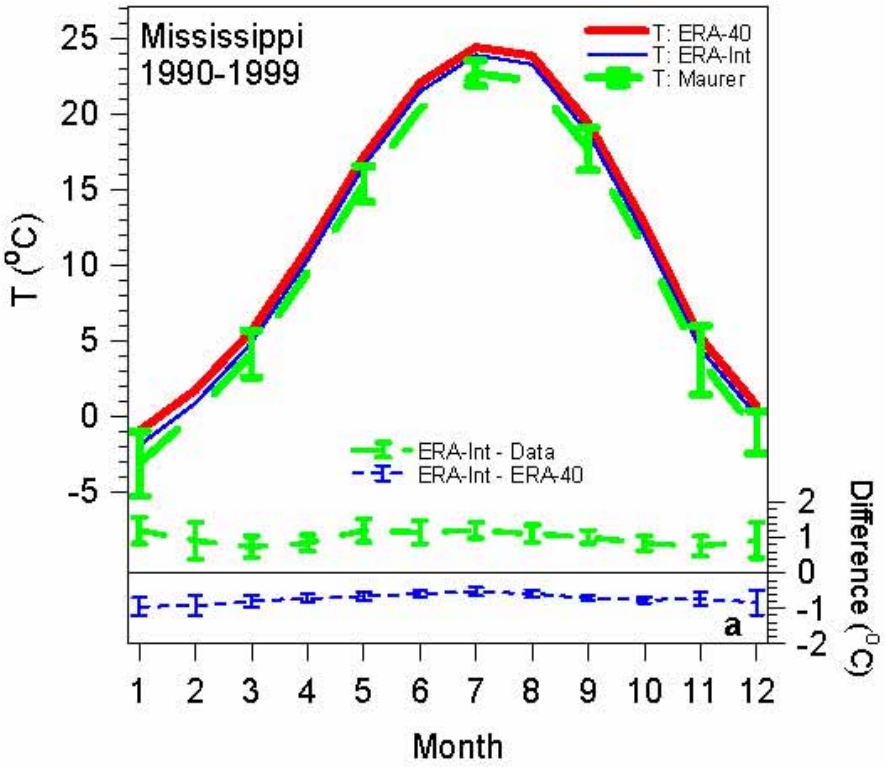
Cloud differences

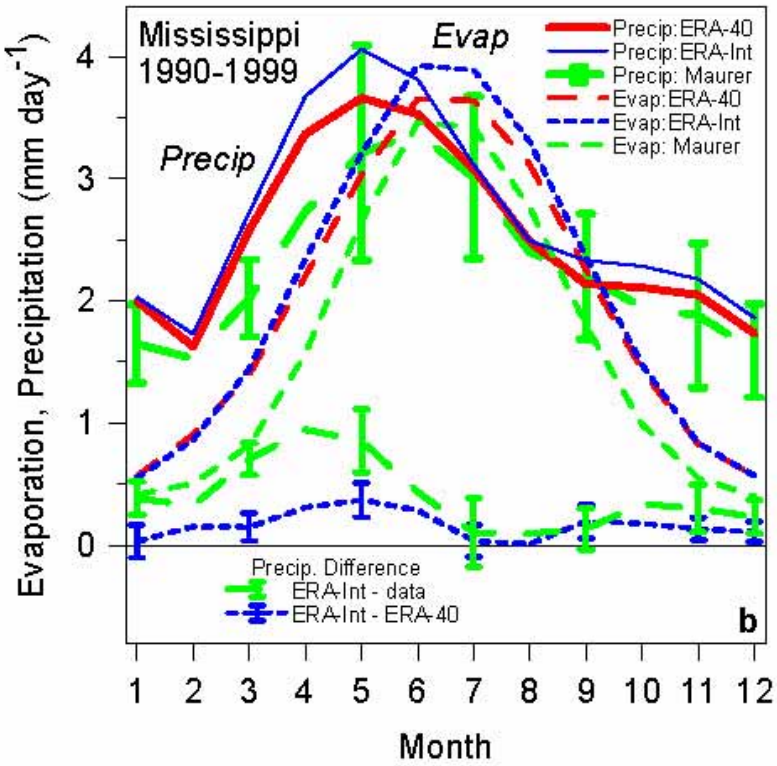




- More cloud in reanalyses for same precip.
- Much more low cloud in ERA-Interim

Mississippi: *T, Precip & Evap*

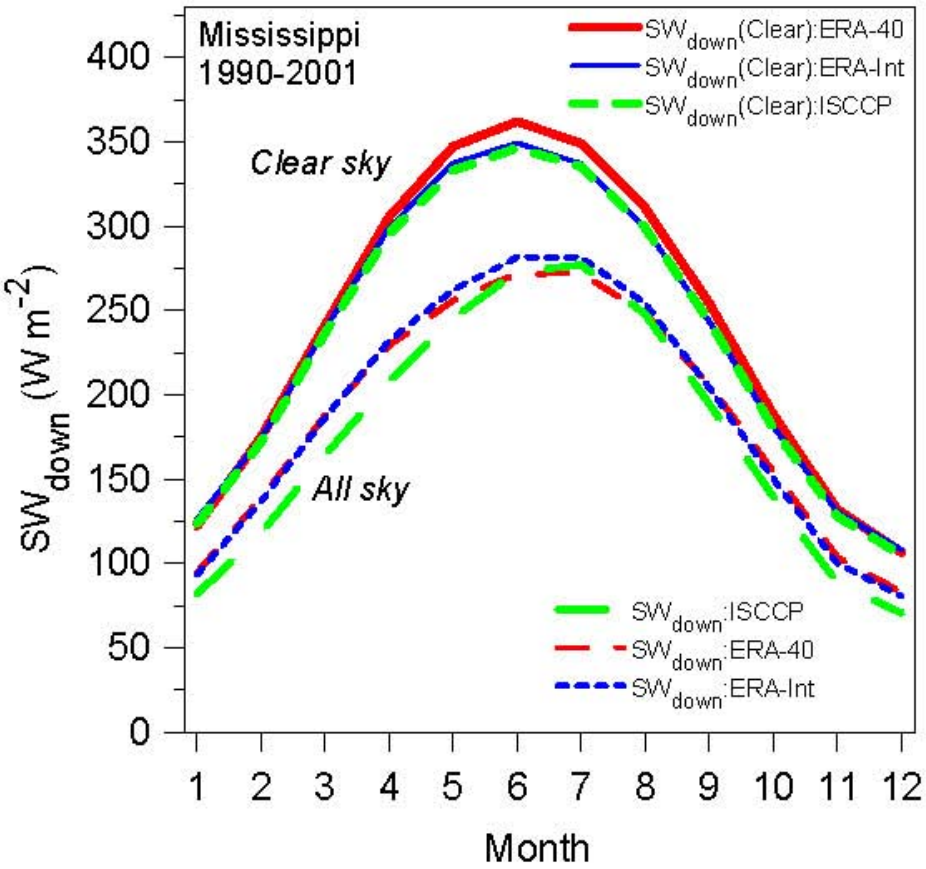




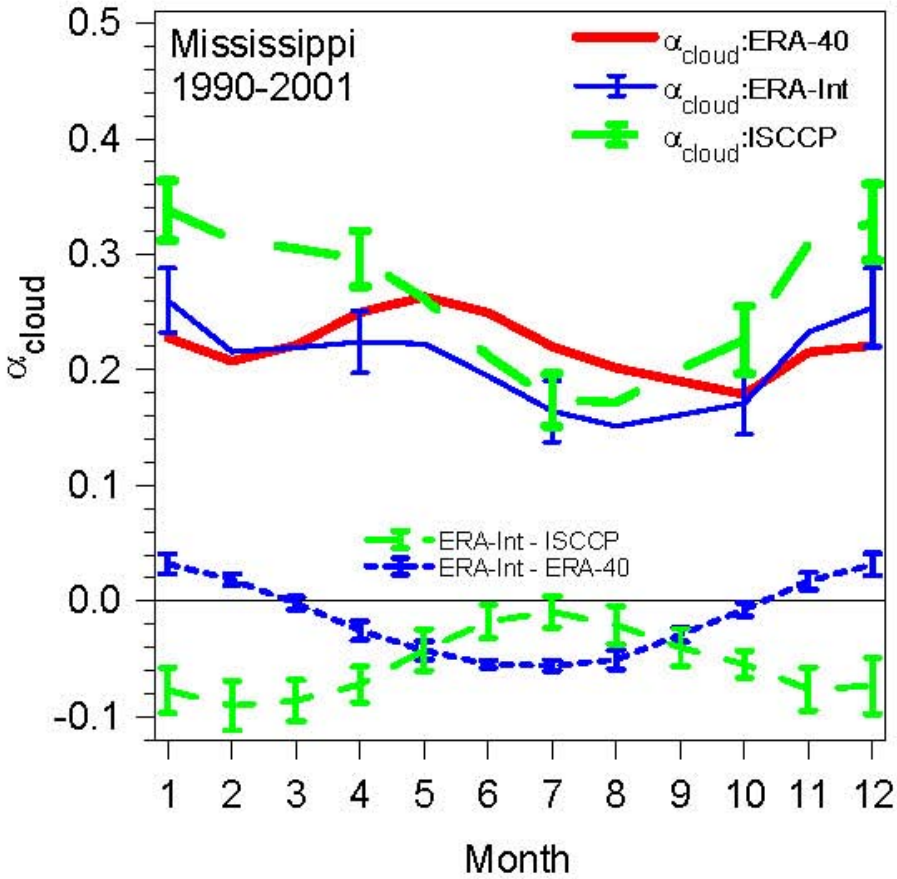
- ERA-Int a little cooler: still warm bias
- ERA-Int more precip. & evap: larger wet bias

Mississippi – *Shortwave & α_{cloud}*

SW_{down}



Cloud albedo

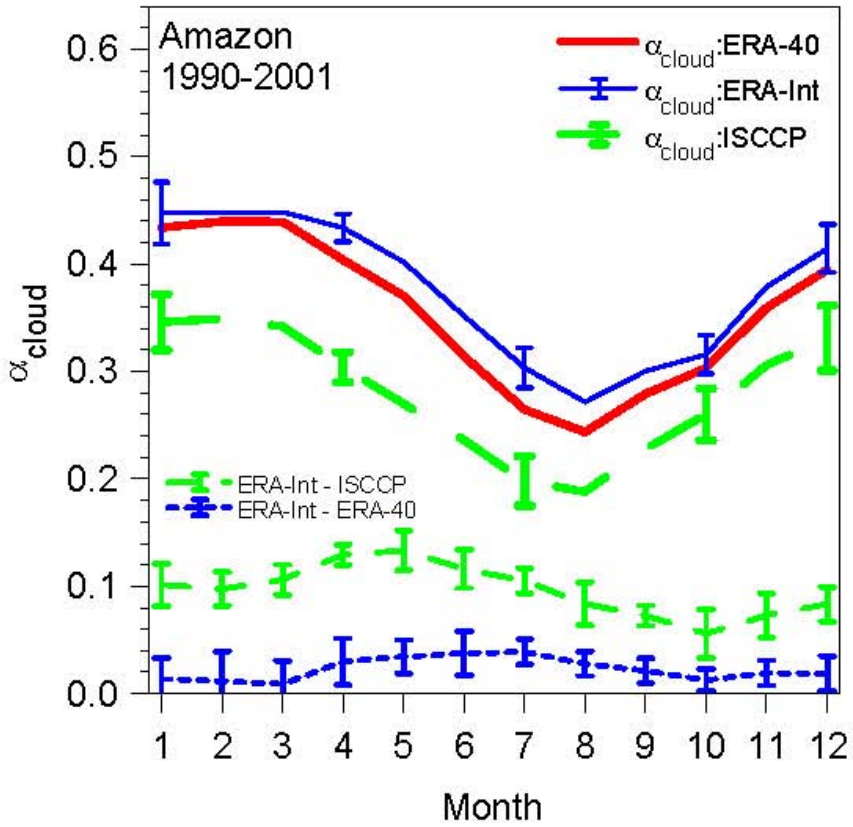


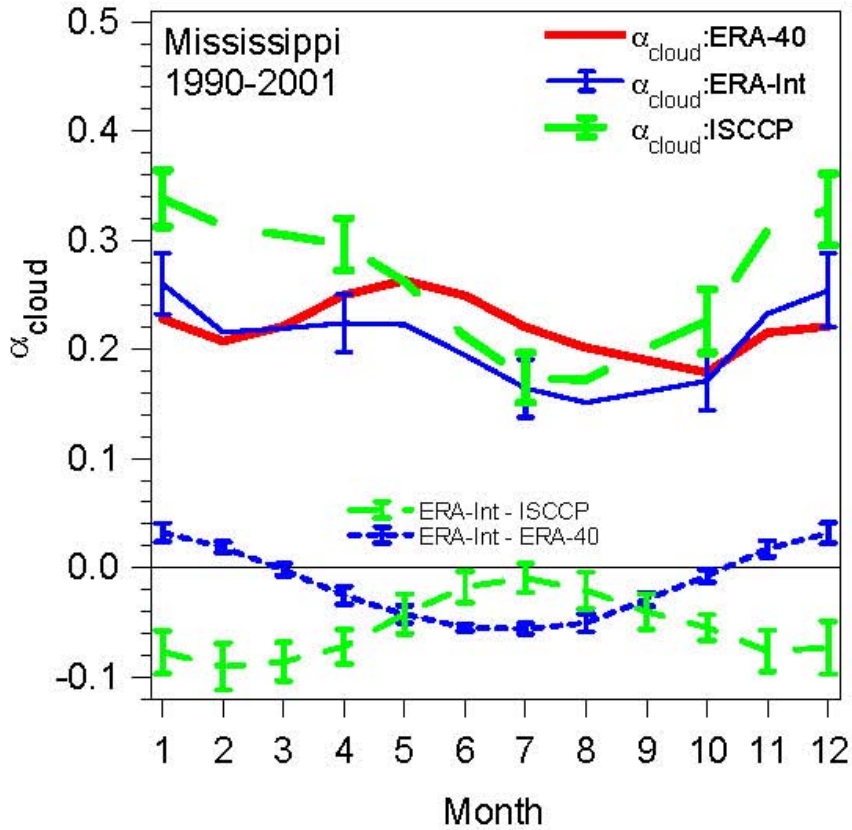
ERA-Int Clear-sky closer to ISCCP

ERA-Int closer to ISCCP

All-sky differences are small

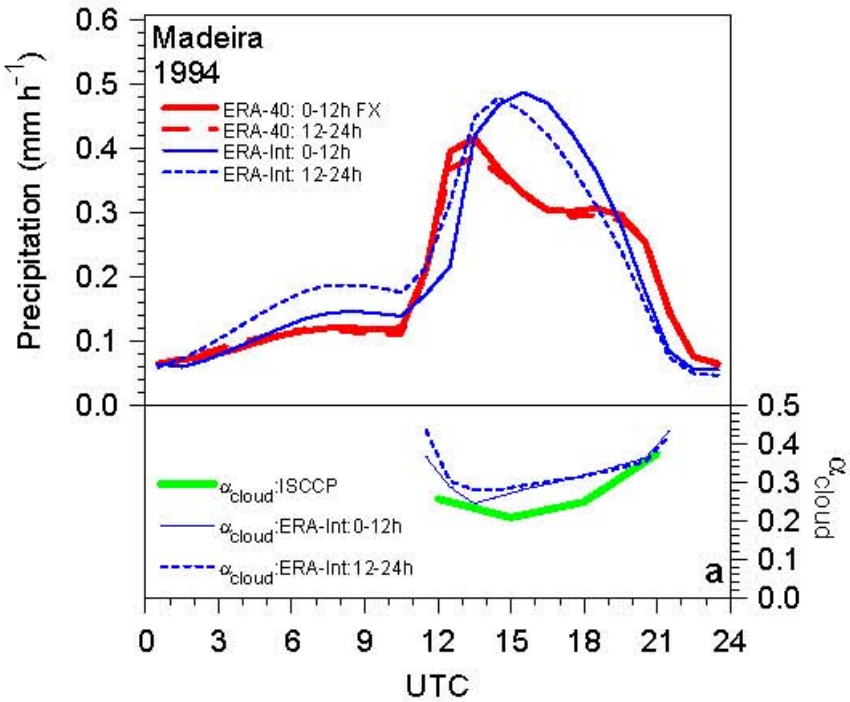
Tropics *vs.* mid-latitudes

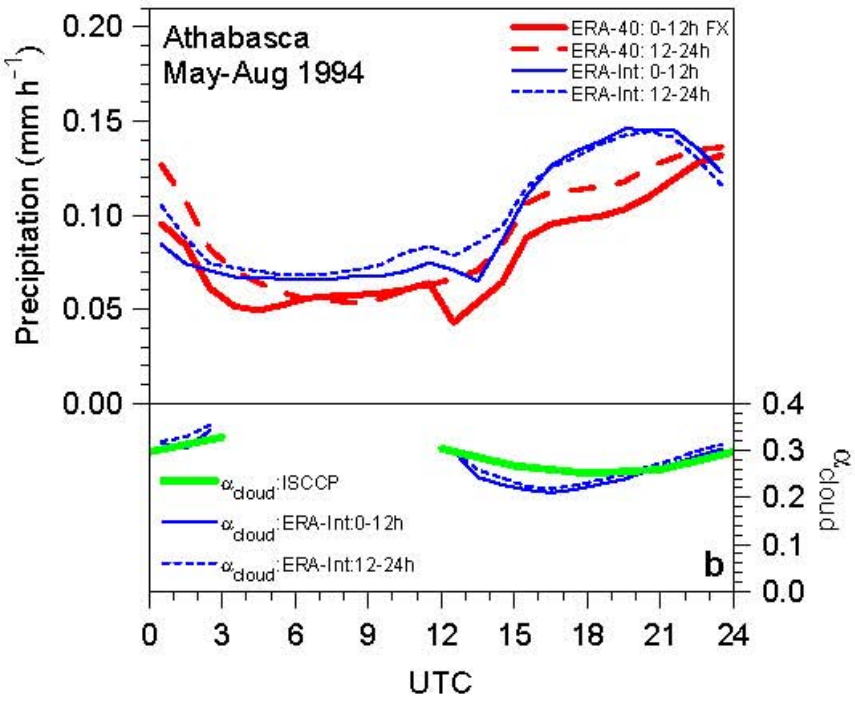




- Amazon: reanalyses α_{cloud} biased high
- Mississippi: different bias signature

Diurnal cycle: reanalyses



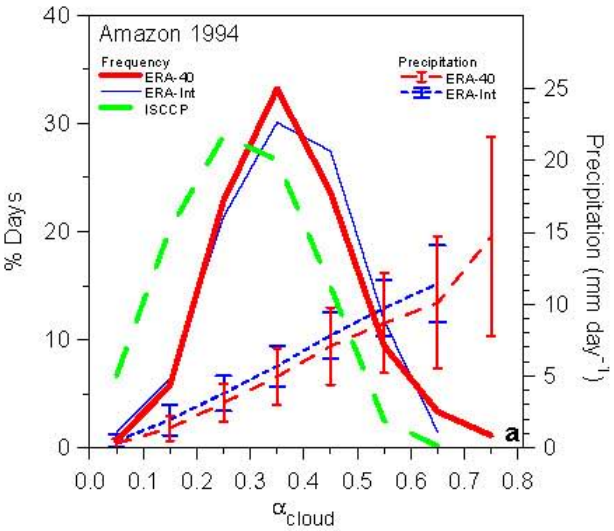


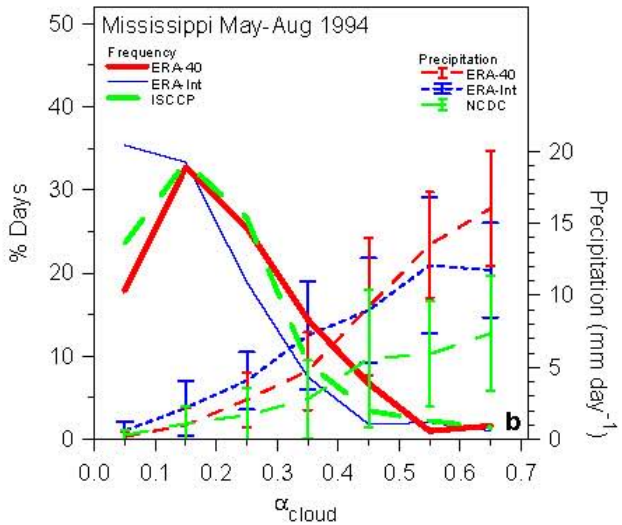
- ERA-Int has lost spurious early morning tropical peak, but precip. still too early
- ERA-Int has near-noon peak at all latitudes

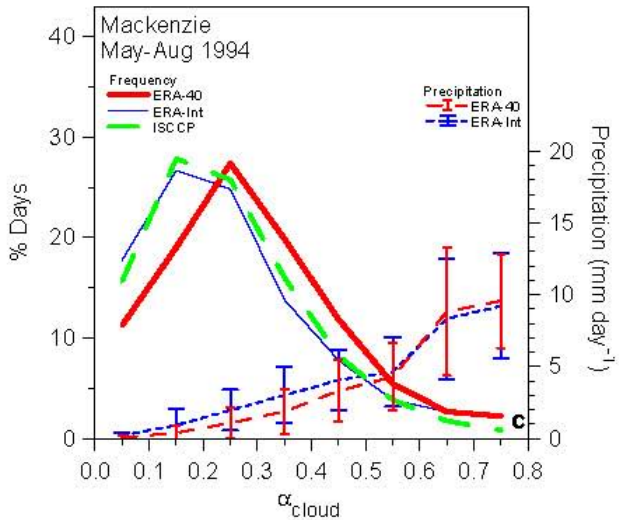
α_{cloud} distribution

- coupling to precipitation

Amazon **Mississippi** **Mackenzie**







Shift to more cloud **Summer shift to less cloud**

- **Increase in ratio precip. forcing/cloud forcing in ERA-Int**

  tropics too low **mid-lats too high**

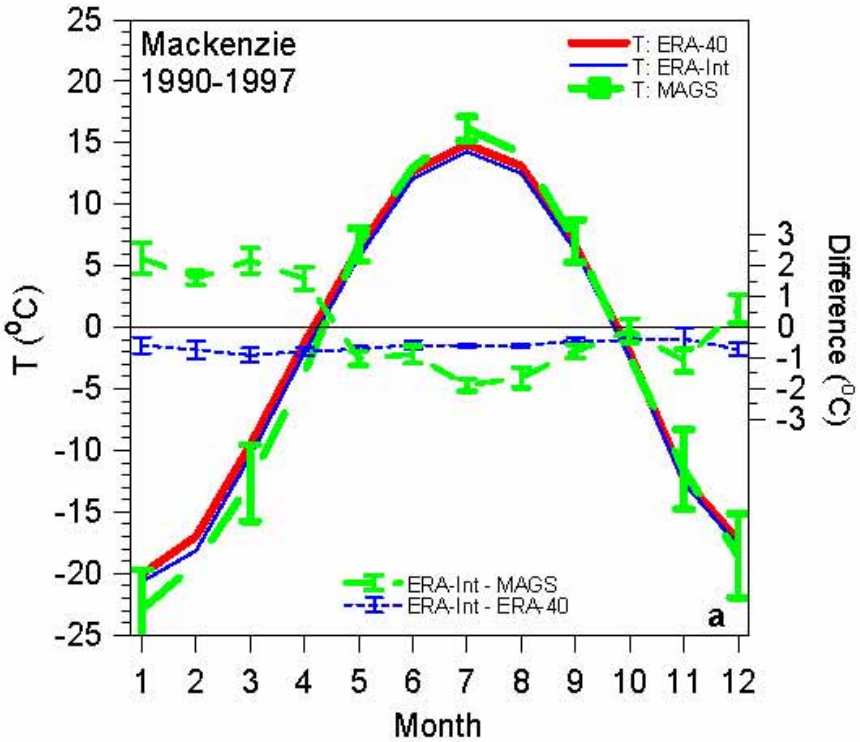
Conclusions

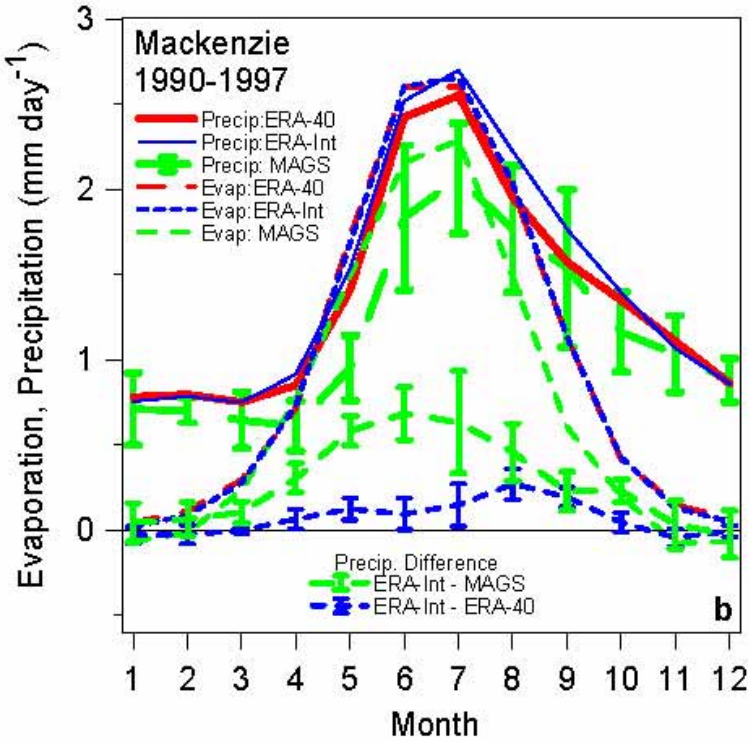
- **Tropics**
  - Amazon: interannual drift of precipitation reduced In ERA-Interim
  - Annual precipitation improved: seasonal amplitude of precipitation remains too small.
  - ERA-Interim has increased low cloud and large cold 2-m temperature bias [Positive bias in SWCF is worse]
  - Diurnal cycle of precipitation better, but still rains too early in day

- **Mississippi** (& Mackenzie)
  - Temperature biases are small in both reanalyses
  - Summer precipitation and evaporation too high
  - ERA-Interim has less reflective cloud cover in summer and more in winter – an improvement
  - Spinup of precipitation in 24h forecasts greatly reduced in ERA-Int

- *[More recent model cycles have improved Amazon seasonal precipitation, and cloud cover]*

Mackenzie: *T, Precip & Evap*





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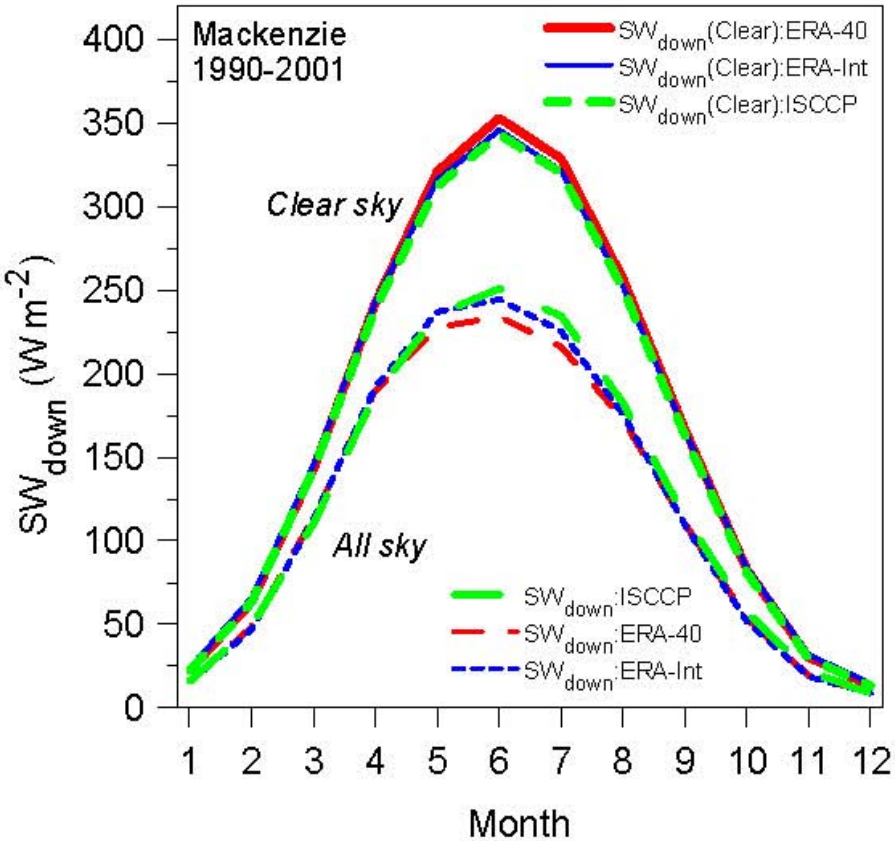
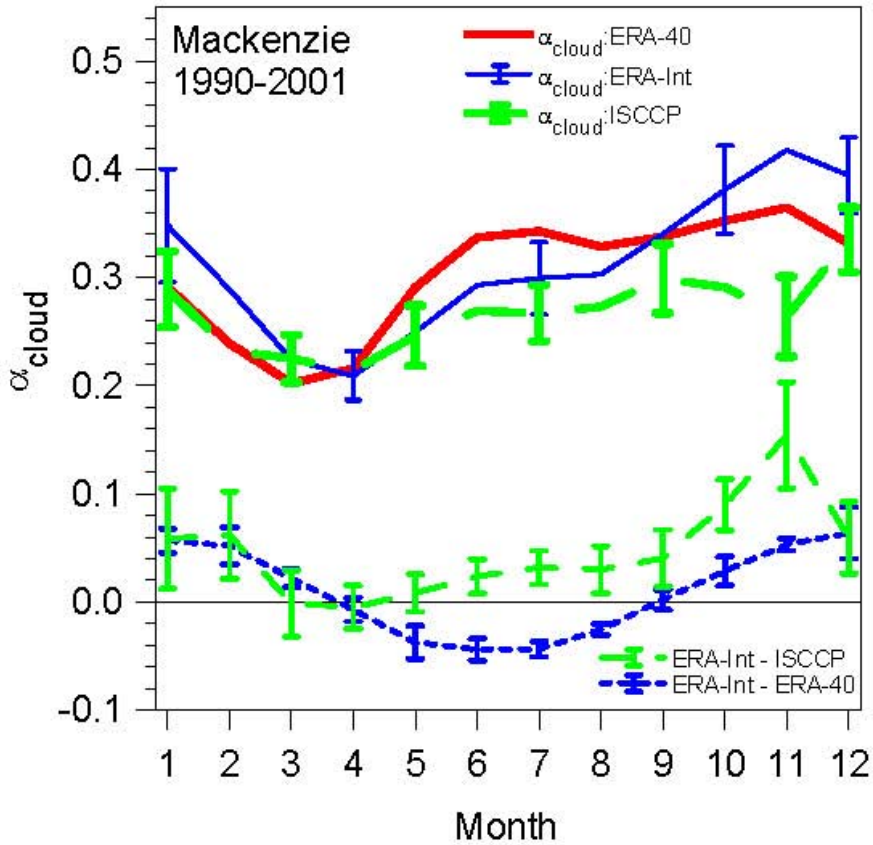
Mackenzie – Shortwave & α_{cloud}

SW_{down}



Cloud Albedo



ERA-Int Clear-sky closer to ISCCP

ERA-Int closer to ISCCP in summer

All-sky differences are small