Land-surface, boundary layer and cloud-field coupling over the Amazon in ERA-40.

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Using ERA-40 to understand coupling of processes

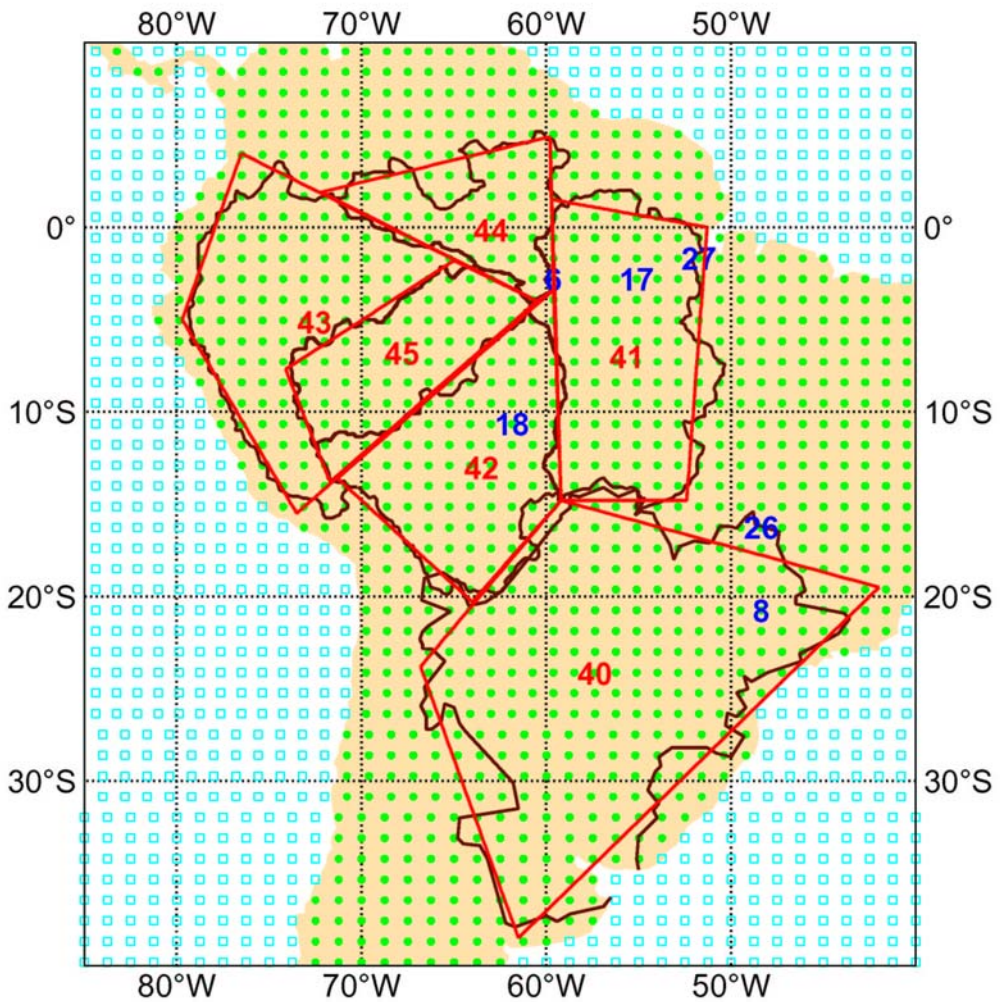
- Land-surface processes
- BL processes
- SW and LW fluxes: coupling to clouds
- Coupling to precipitation and dynamics

- *Evaluate models; compare with data*
- *Betts (BAMS,2004, Nov)*

Madeira River basin : 42

- Hourly archive: basin mean
- Generate daily means

- [*Hydrometeorology of the Amazon in ERA-40, Betts et al. 2005*]



Cloud forcing; Cloud albedos

- SWCF:TOA = SW:TOA - SW:TOA(clear)
- LWCF:TOA = LW:TOA - LW:TOA(clear)
- SWCF:SRF = SW:SRF - SW:SRF(clear)
- LWCF:SRF = LW:SRF - LW:SRF(clear)

Atmosphere cloud radiative forcing are the differences

- SWCF:ATM = SWCF:TOA - SW:SRF
- LWCF:ATM = LWCF:TOA - LW:SRF

Define TOA and SRF cloud albedos

ALB:TOA = 1 - SW:TOA/SW:TOA(clear)

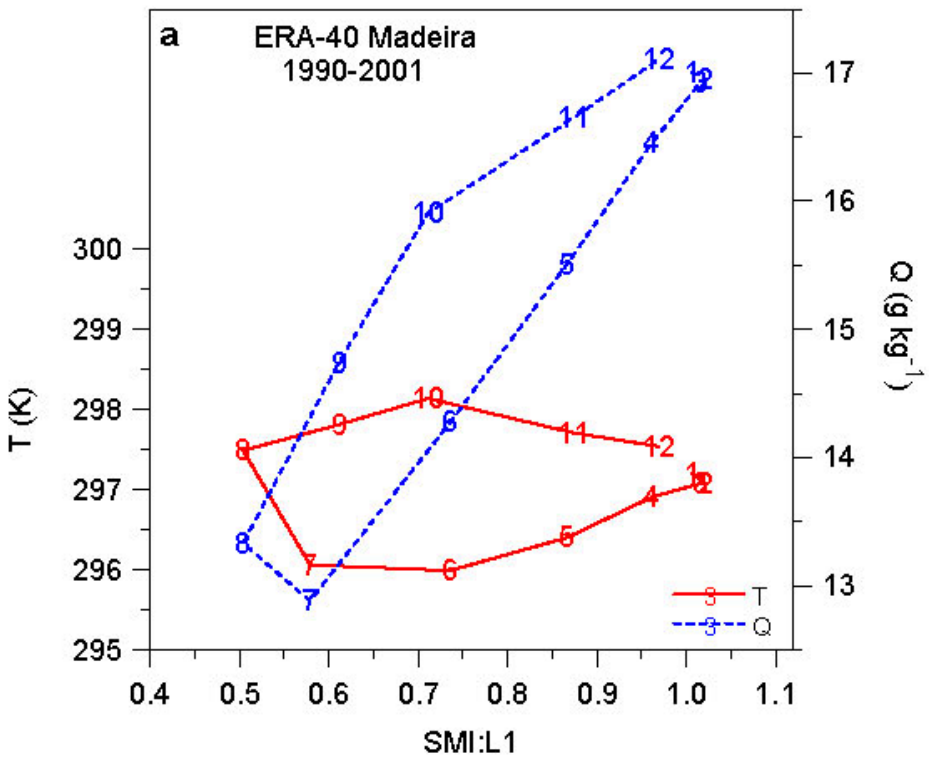
ALB:SRF = 1 - SW:SRF/SW:SRF(clear)

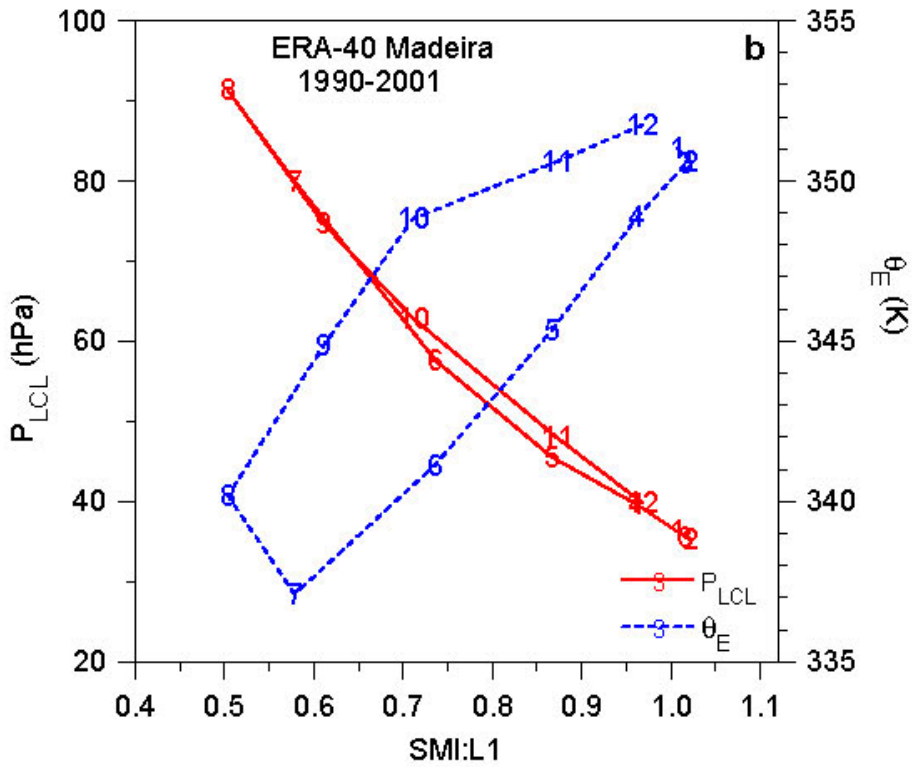
Soil moisture indices

- 0 < SMI < 1 as PWP<SM<FC

- SMI:L1 -- 0-7cm
- SMI:root -- 0-100cm [L123]

Seasonal Cycle and SMI -1

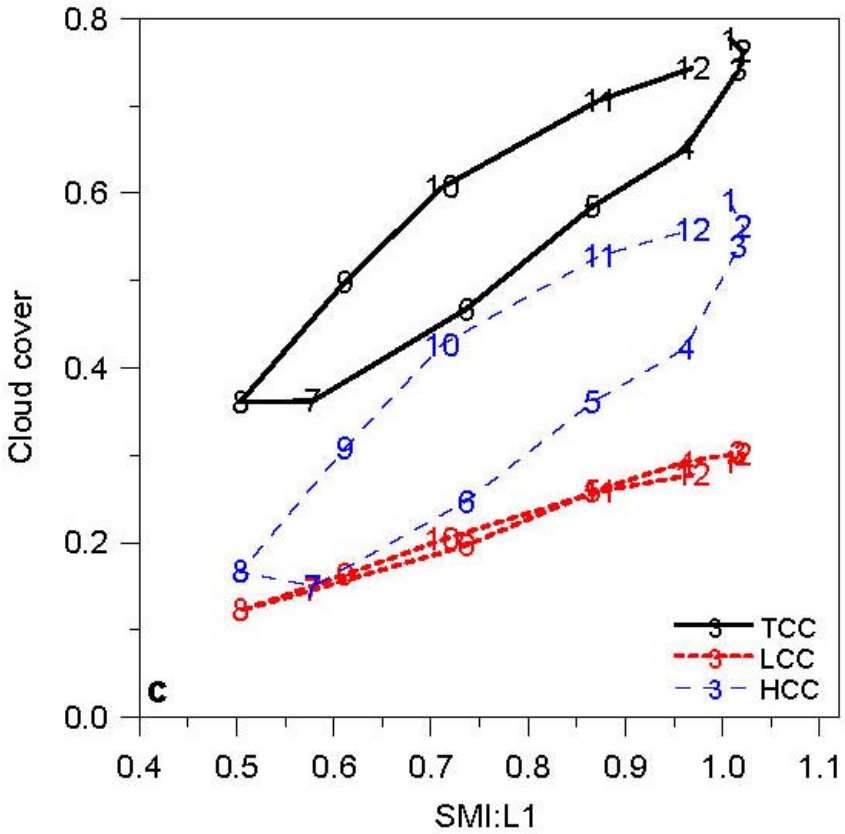


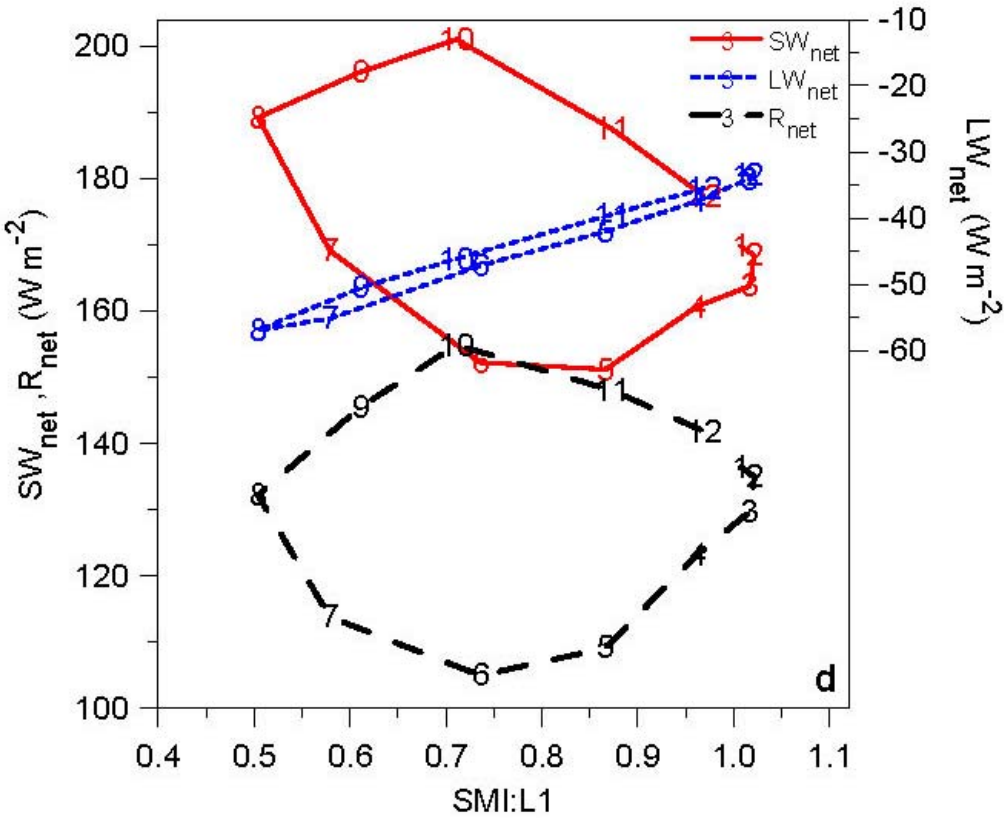


- T and Q

LCL and θ_E

Seasonal Cycle and SMI -2

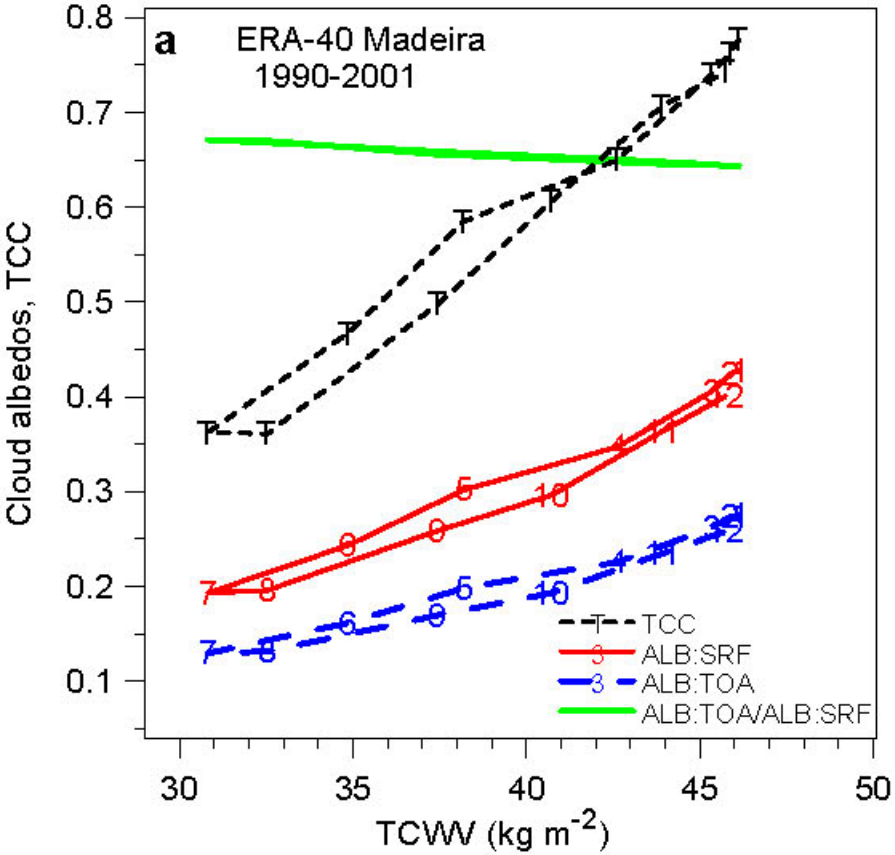


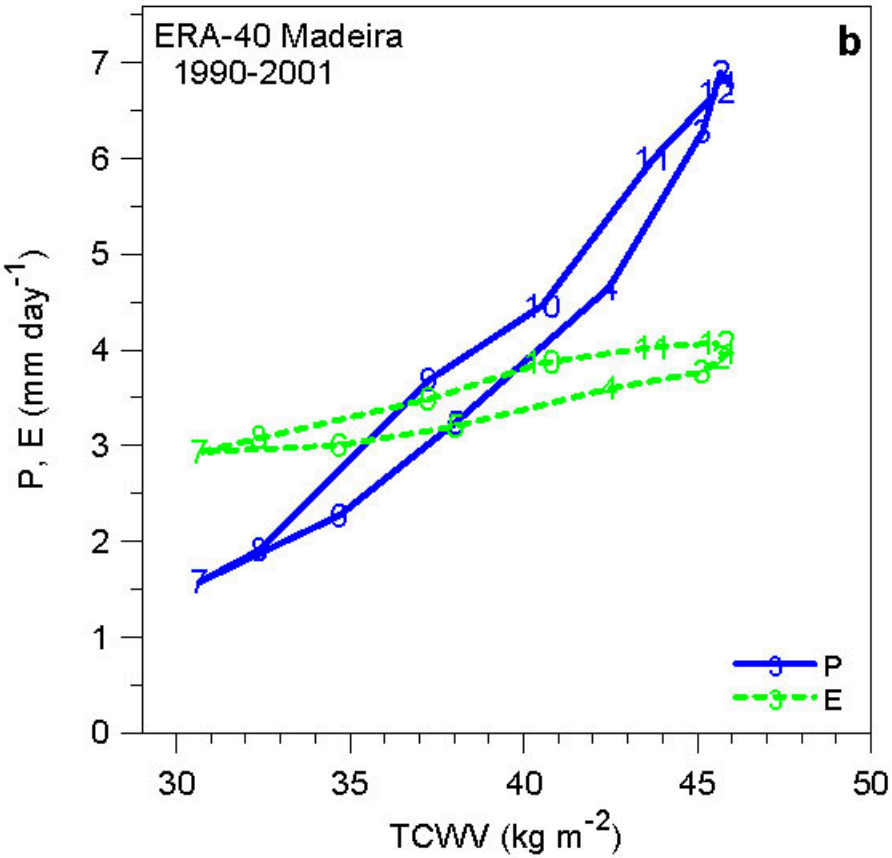


- TCC, HCC, LCC

SW_{net}, LW_{net}, R_{net}

Seasonal Cycle and TCWV

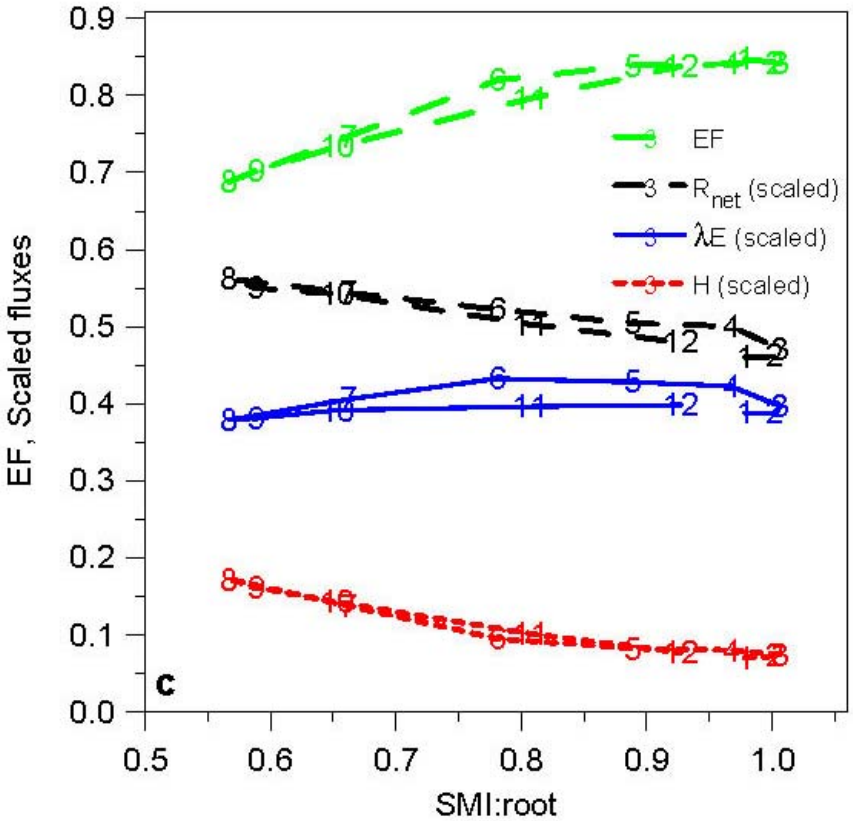


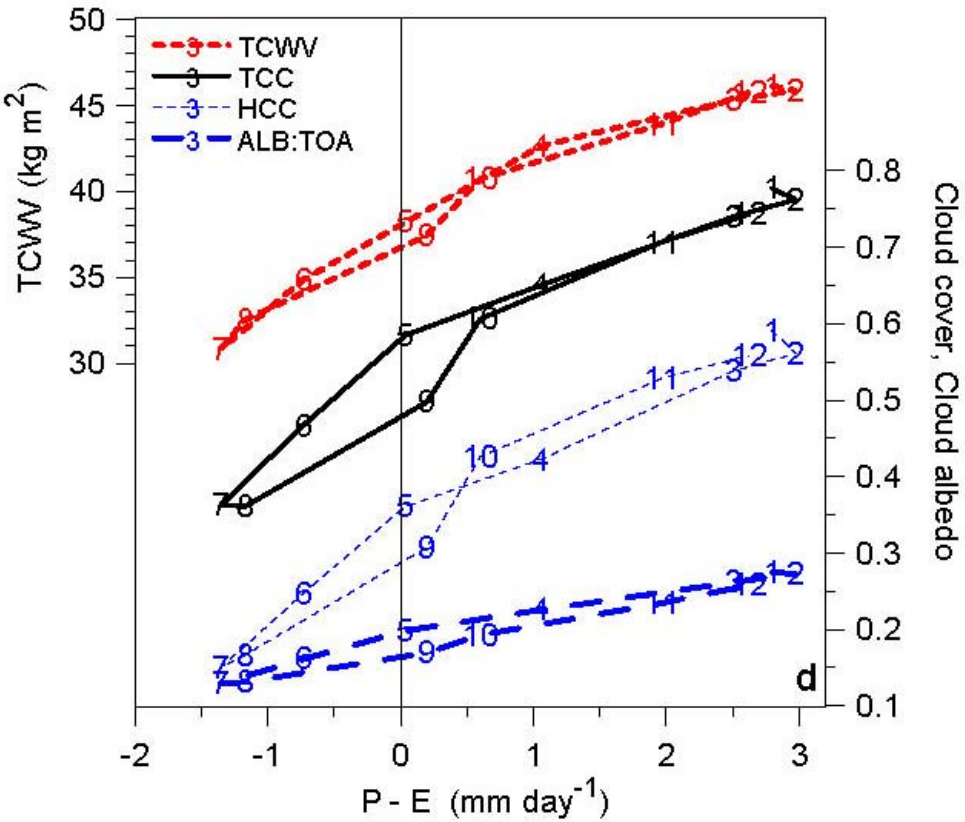


Note TCC,ALB and TCWV
-ratio of ALBs

Seasonal cycle of P-E
-zero in May/Sept

Seasonal Cycle - 4

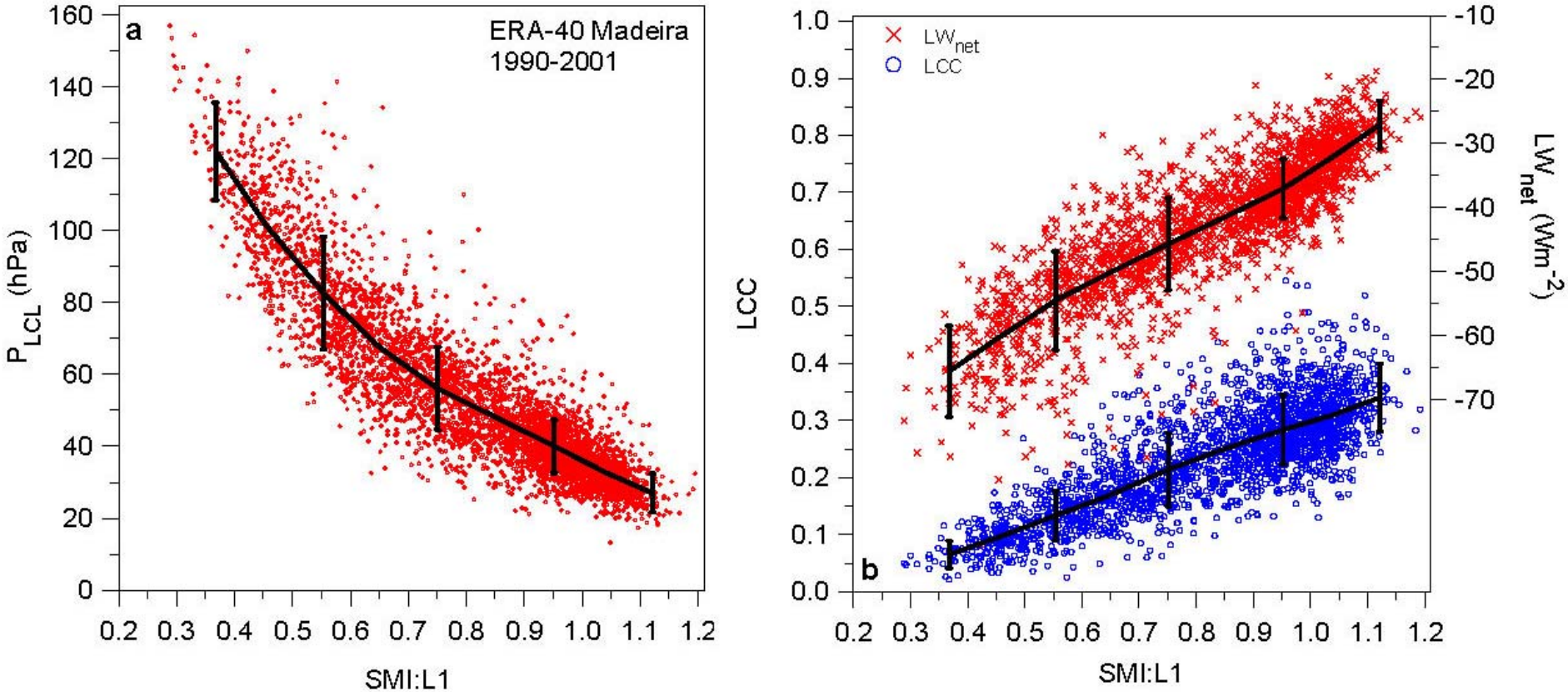




- Scaled SEB
  R_{net} falls, E flat

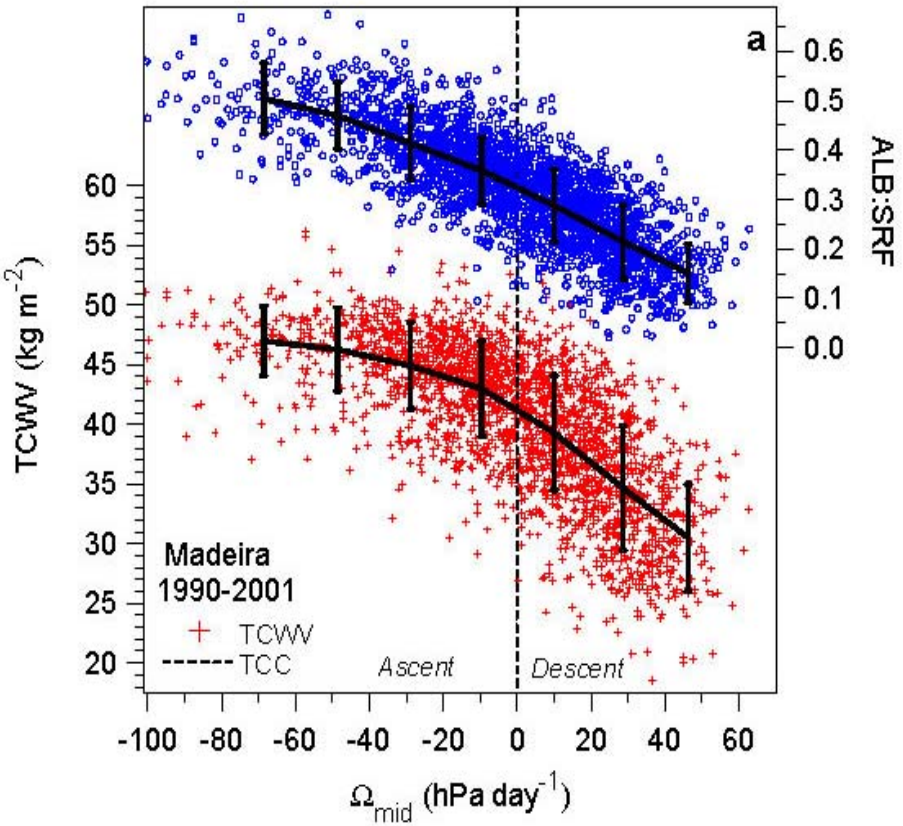
Convergence → TCWV, cloud

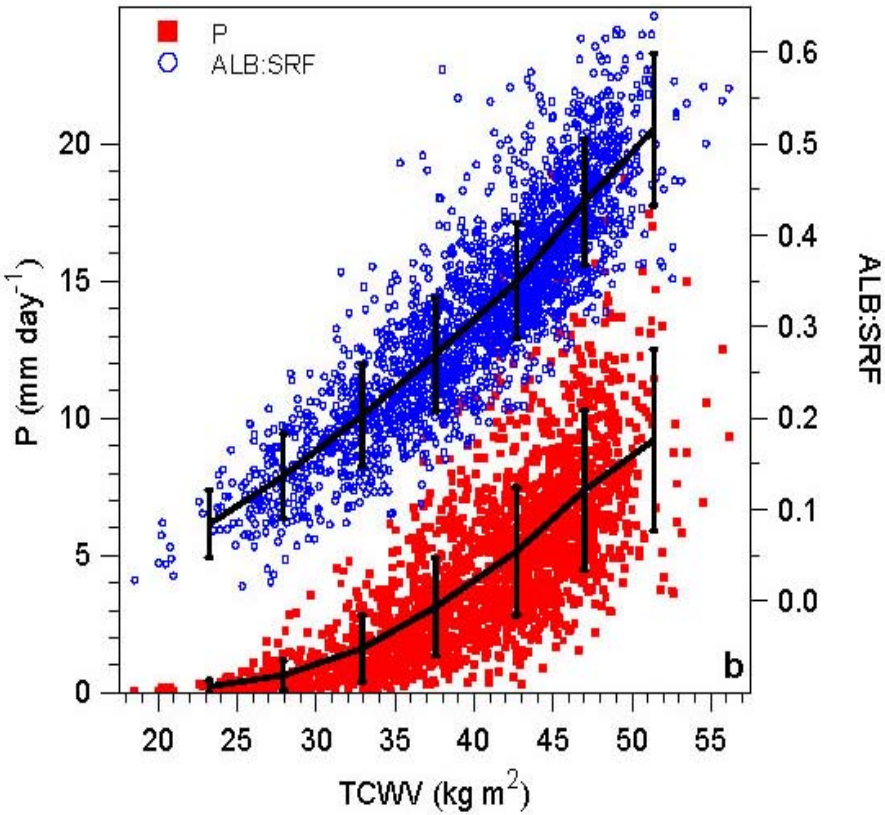
Coupling of soil moisture to P_{LCL},LCC, LW_{net}



- Cloud-base, LCC and LW_{net} tightly linked to soil moisture

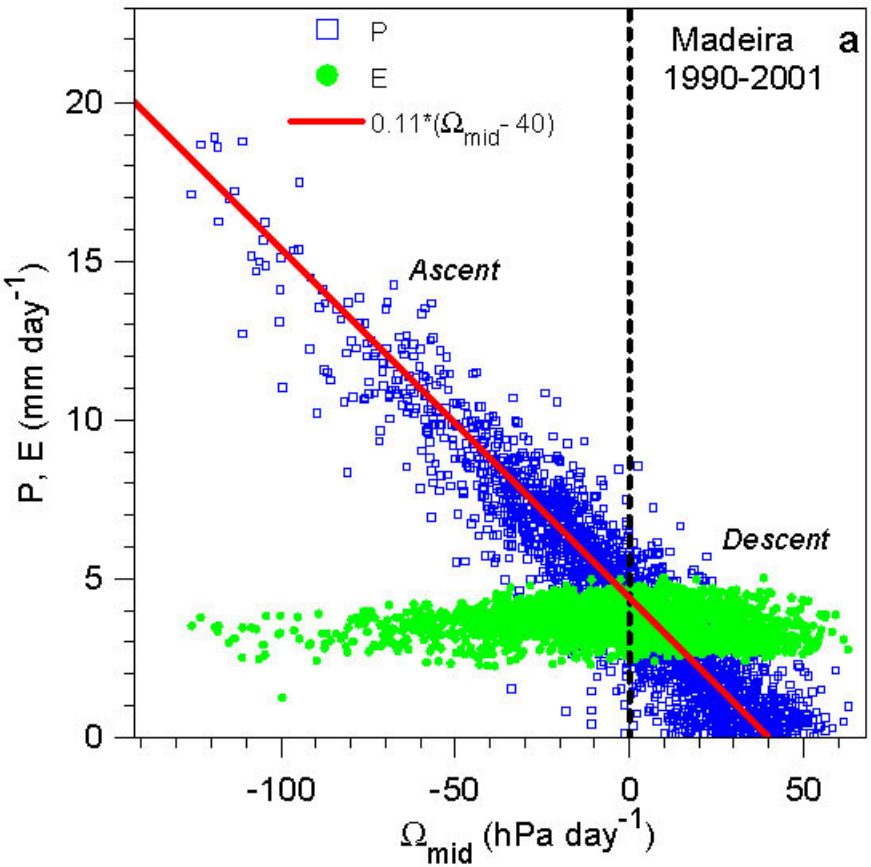
Omega, TCWV, and albedo
TCWV, albedo and P

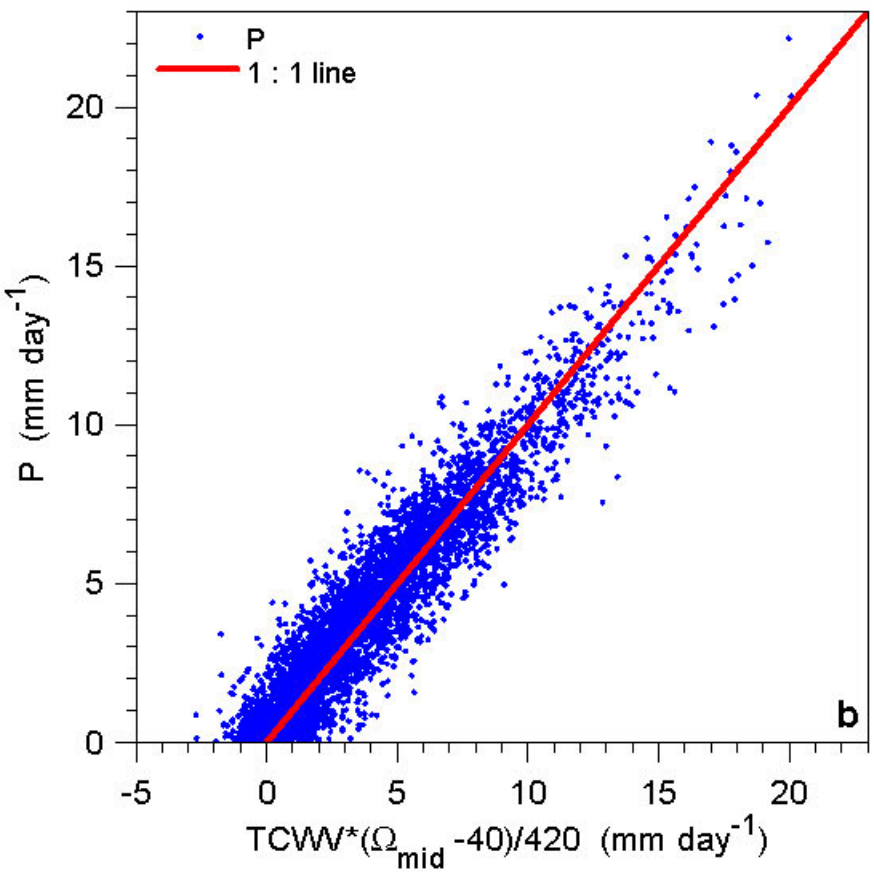




- TCWV, ALB driven by omega
- P, ALB linked to TCWV

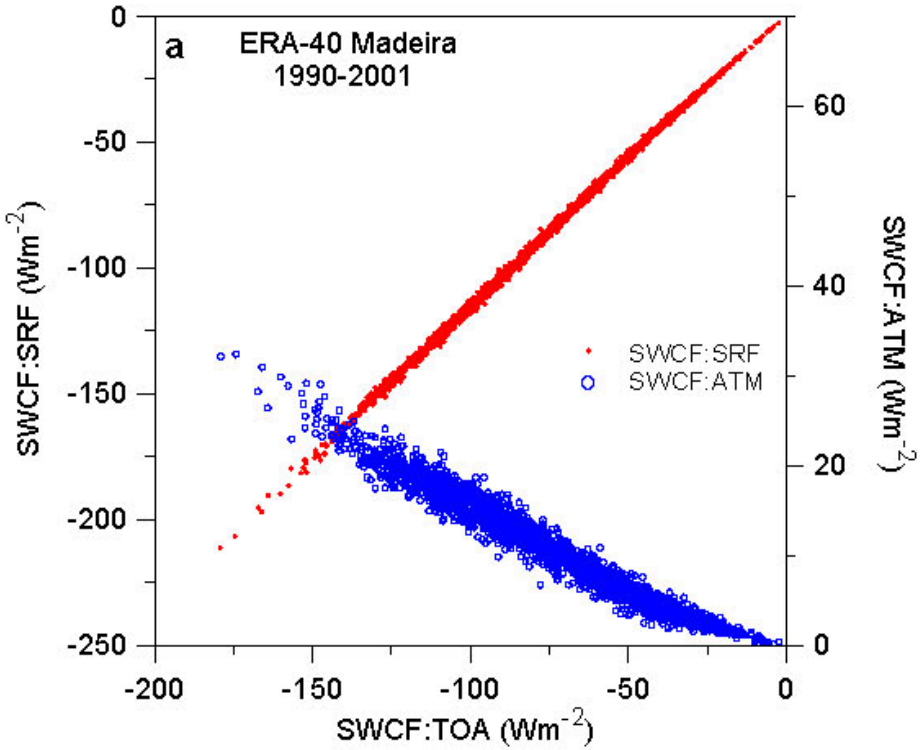
Omega, P, E and TCWV

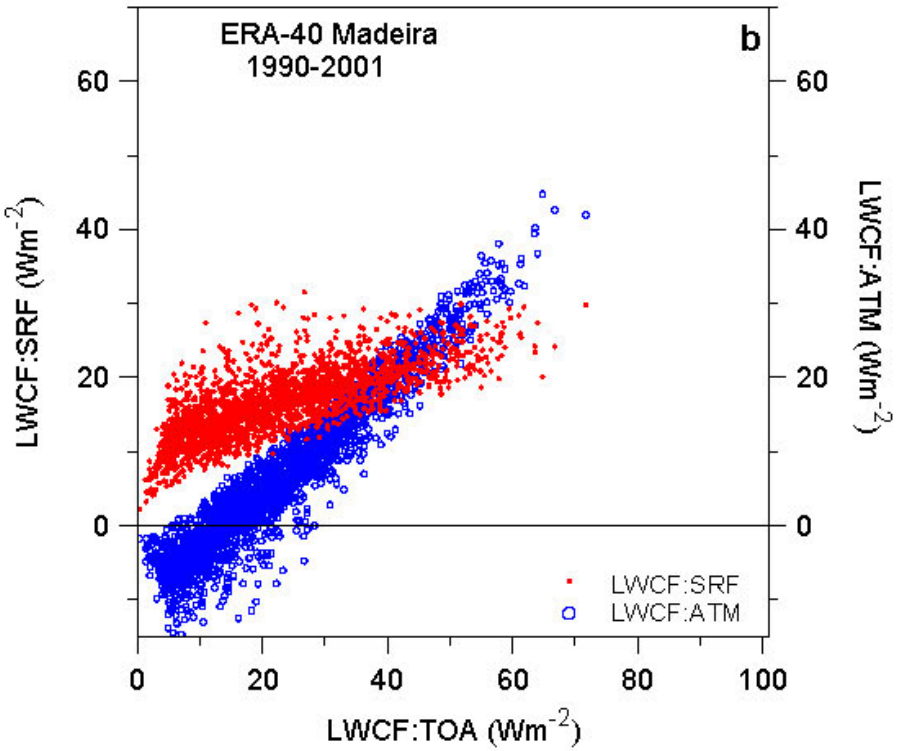




- Linear relationship P with omega

SW and LW cloud forcing



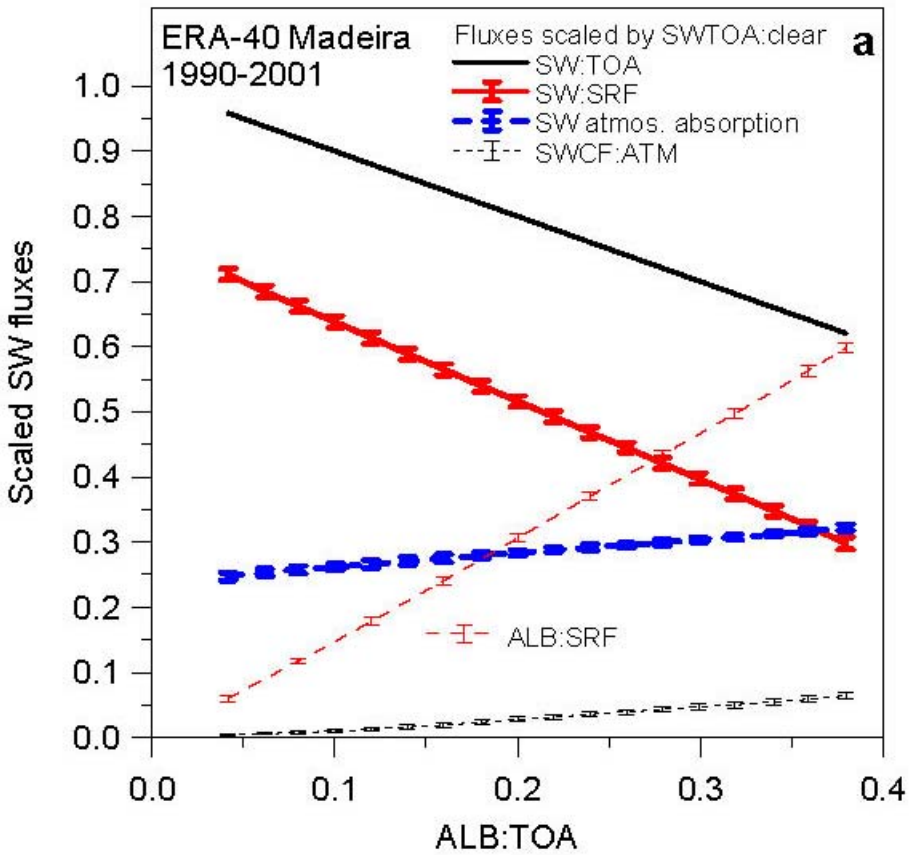


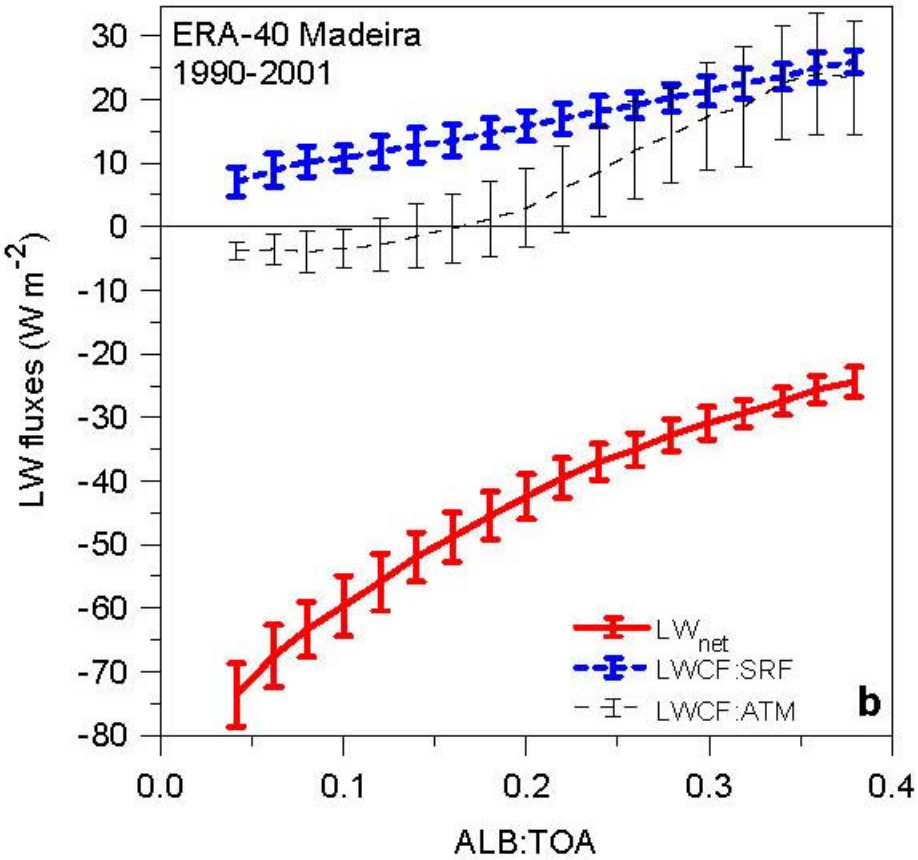
- Tight relation of TOA and SRF SWCF

TOA and ATM LWCF - linked

Albedo, SW and LW coupling

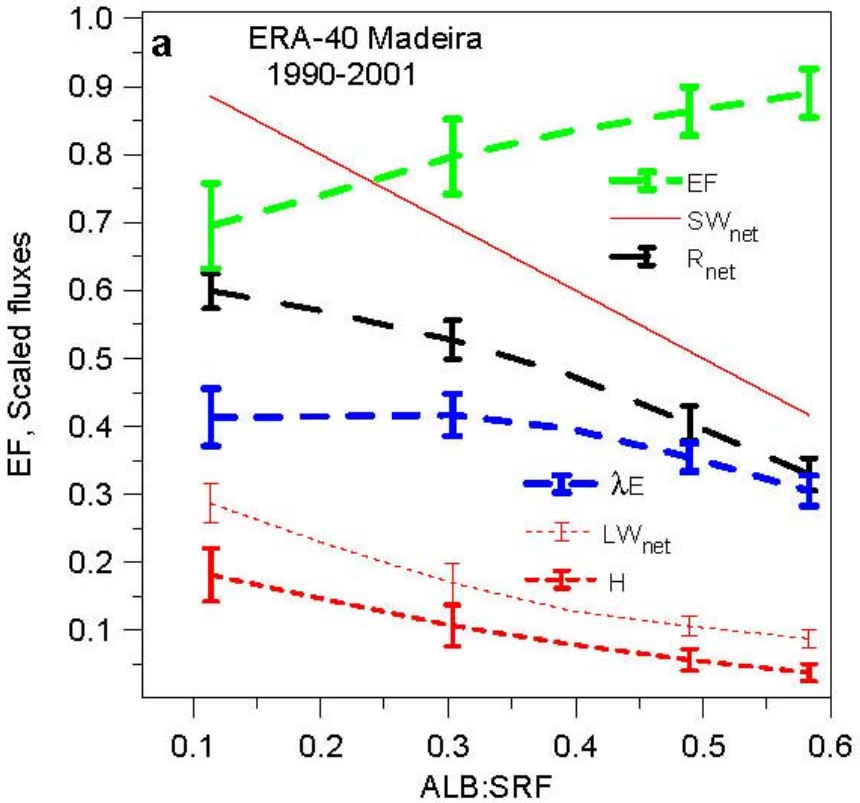
SW very tight

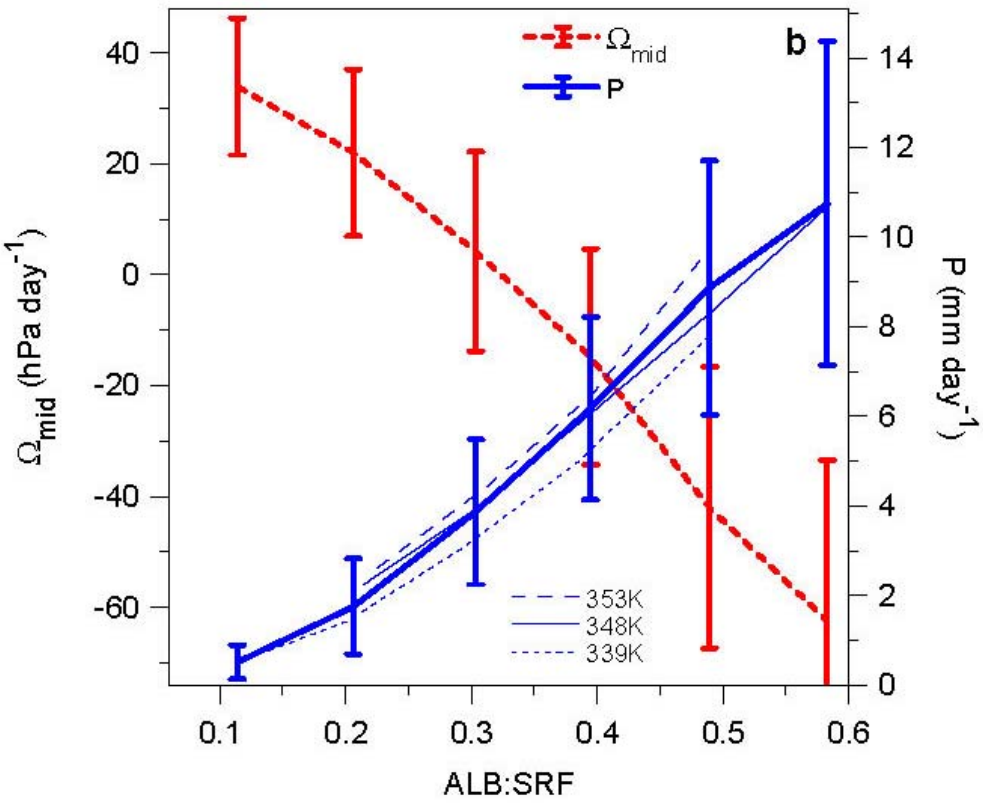




- *ALB:SRF = 1.45*ALB:TOA + 0.35*(ALB:TOA)^2*

Scaled fluxes, P and omega binned by albedo

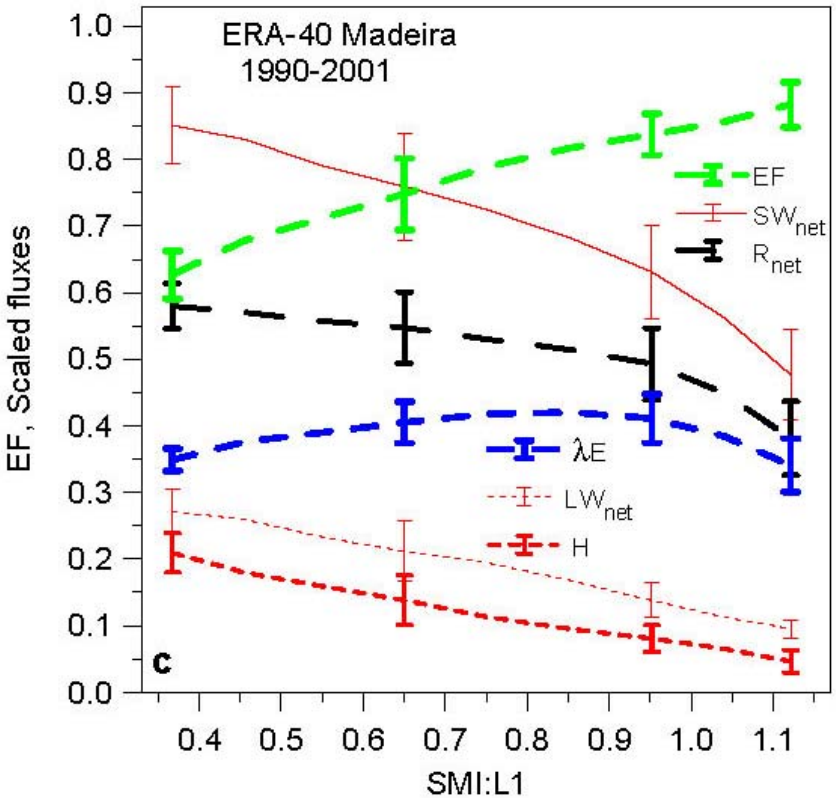


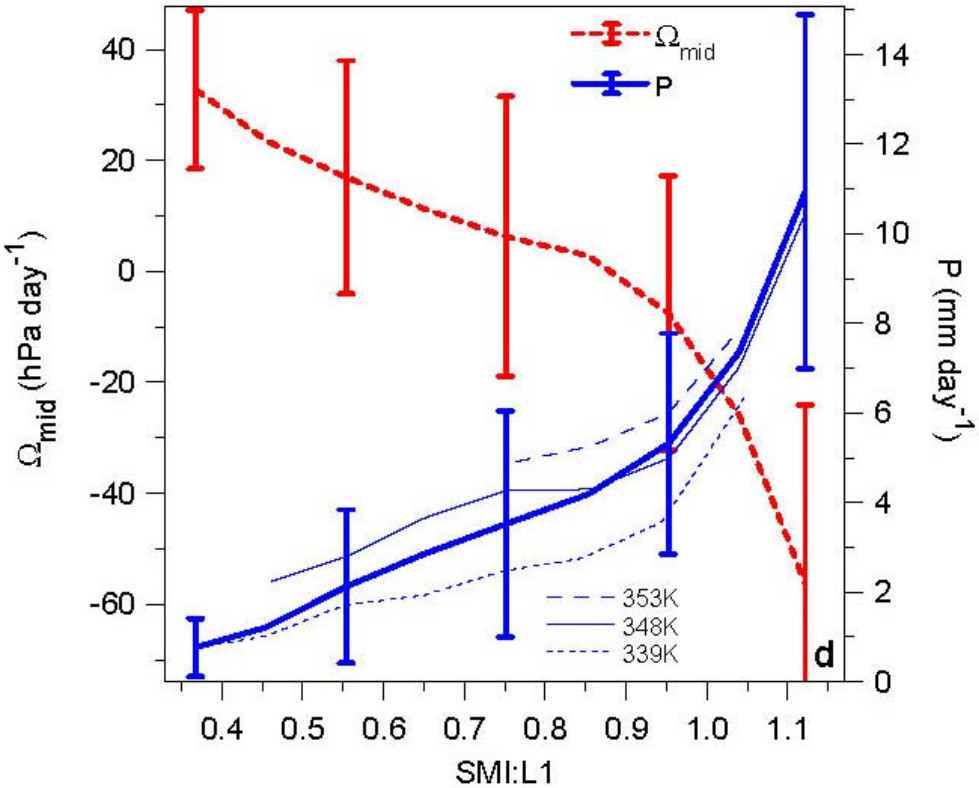


- Flat λE, unlike H, LW$_{net}$
- EF increases with SMI

- ALB is fair measure of omega and P

Scaled fluxes, P and omega binned by Soil moisture



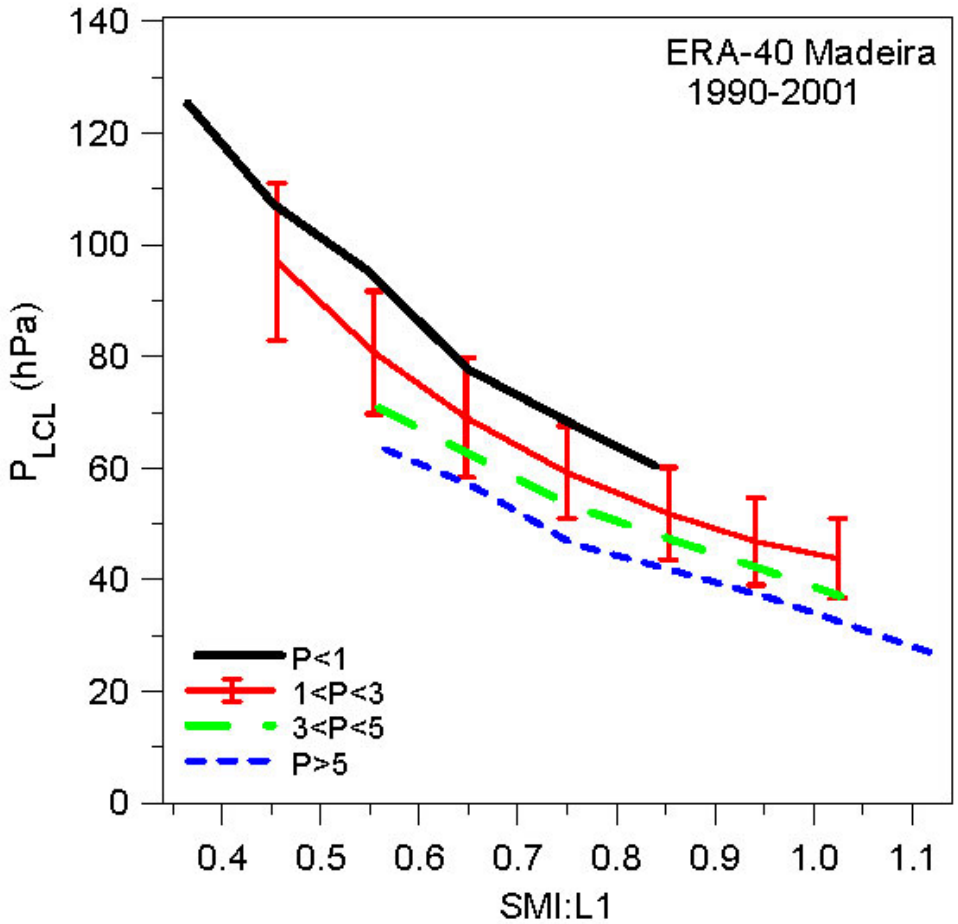


- λE weak max.
- linear H and LW$_{net}$

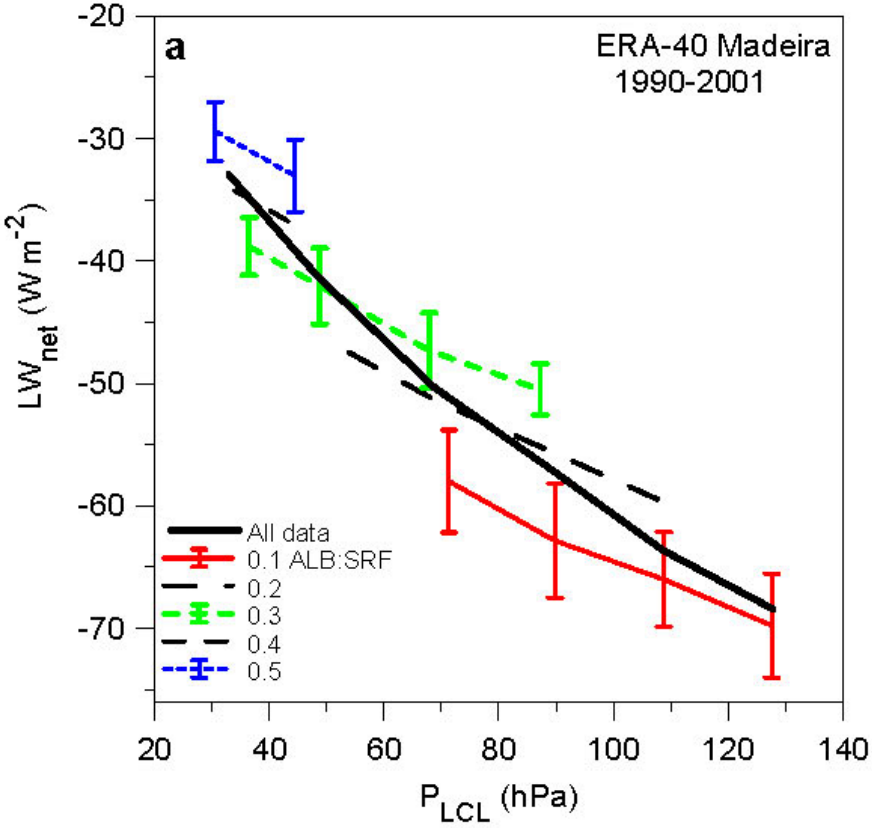
- P has θ_E dependence as well as SMI

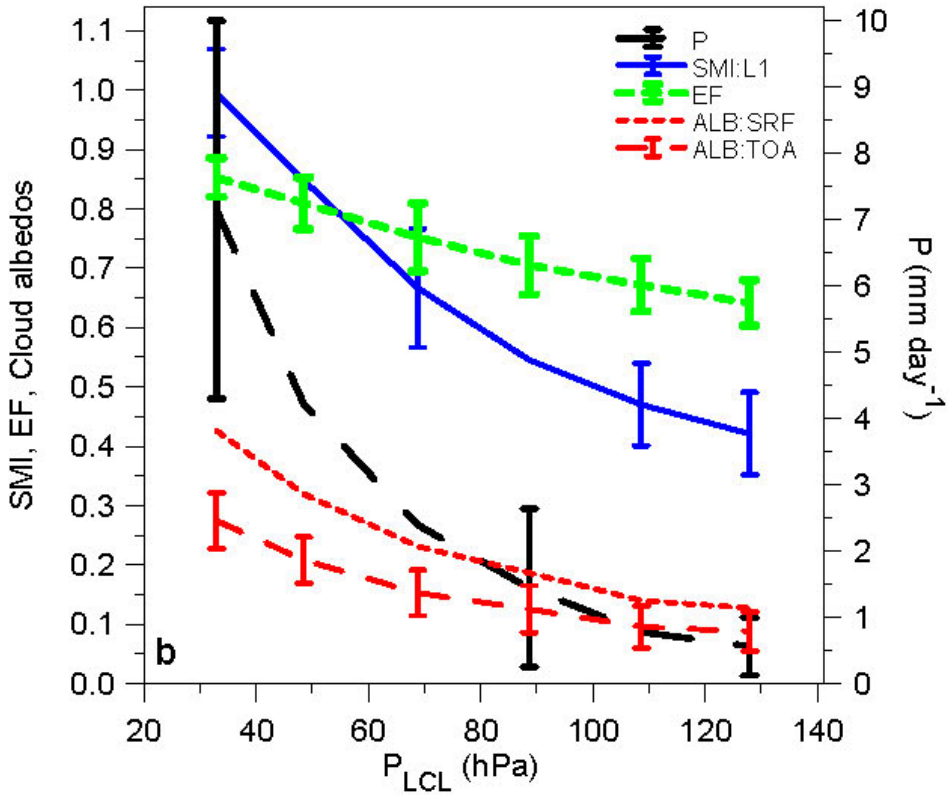
SMI to cloud-base

- LCL falls with SMI
- Precipitation into the sub-cloud layer lowers LCL



Binned by P_{LCL}



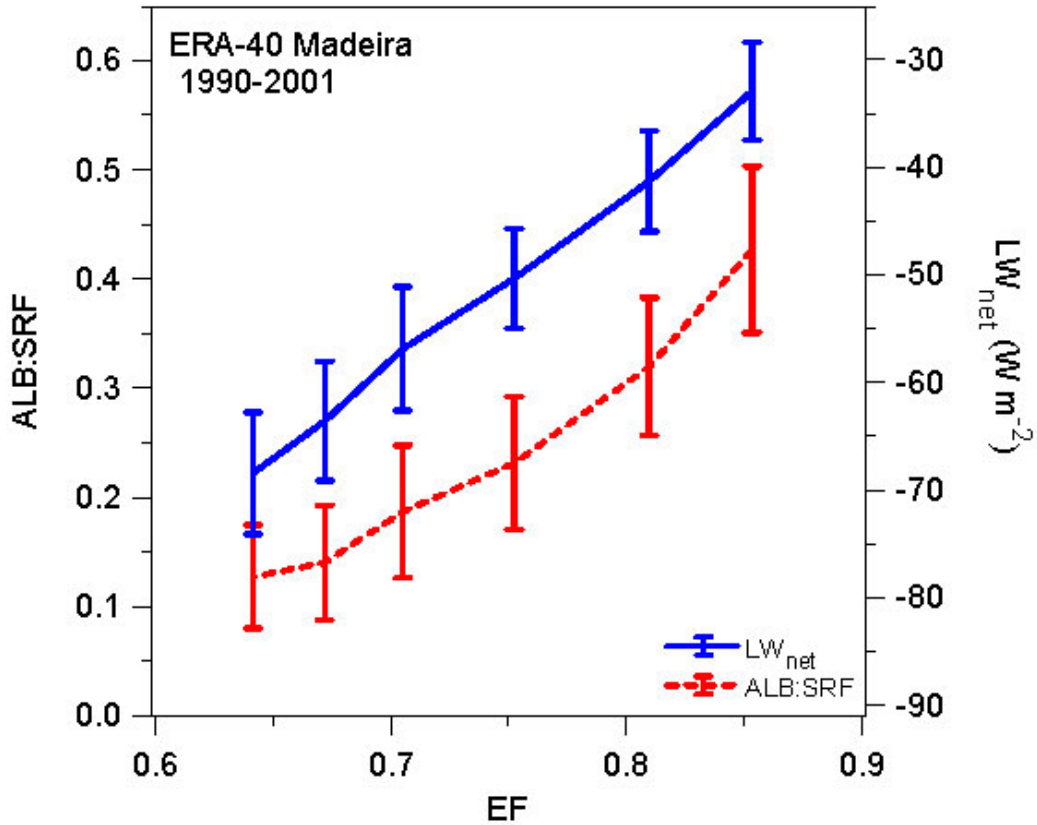


- LW_{net} and ALB

P, EF, SMI, ALBs
- all decrease with LCL

SW and LW feedback of EF

- Greater EF
- reduces outgoing LW
- increases surface cloud albedo



Conclusions-1

- Models are powerful tool for understanding coupling of processes
- At the land surface, soil moisture, evaporation, precipitation, surface energy budget, LCL and cloud field are tightly coupled
- Omega field, precipitation, TCWV and cloud field are tightly coupled
- Daily mean data sufficient to describe the states and the transition between them

Conclusions-2

- Soil moisture directly impacts P_{LCL}, LCC, LW_{net}
- Surface LW_{net} is tightly controlled by BL depth and cloud albedo (3 W/m^2)

- Omega field linked to TCC, ALB, P
- The TOA SW ‘cloud albedo’ is sufficient to determine surface (<0.5%) and atmospheric cloud forcing on basin scales

Conclusion-3

- How good is the coupling between processes in ERA-40, knowing that the diurnal cycle of precipitation is poor over land in the tropics? *Check Cy 28R1*
- Can we evaluate any of these relationships directly from satellite data or at surface flux sites?
- Can we use these relationships in our data assimilation methodology?