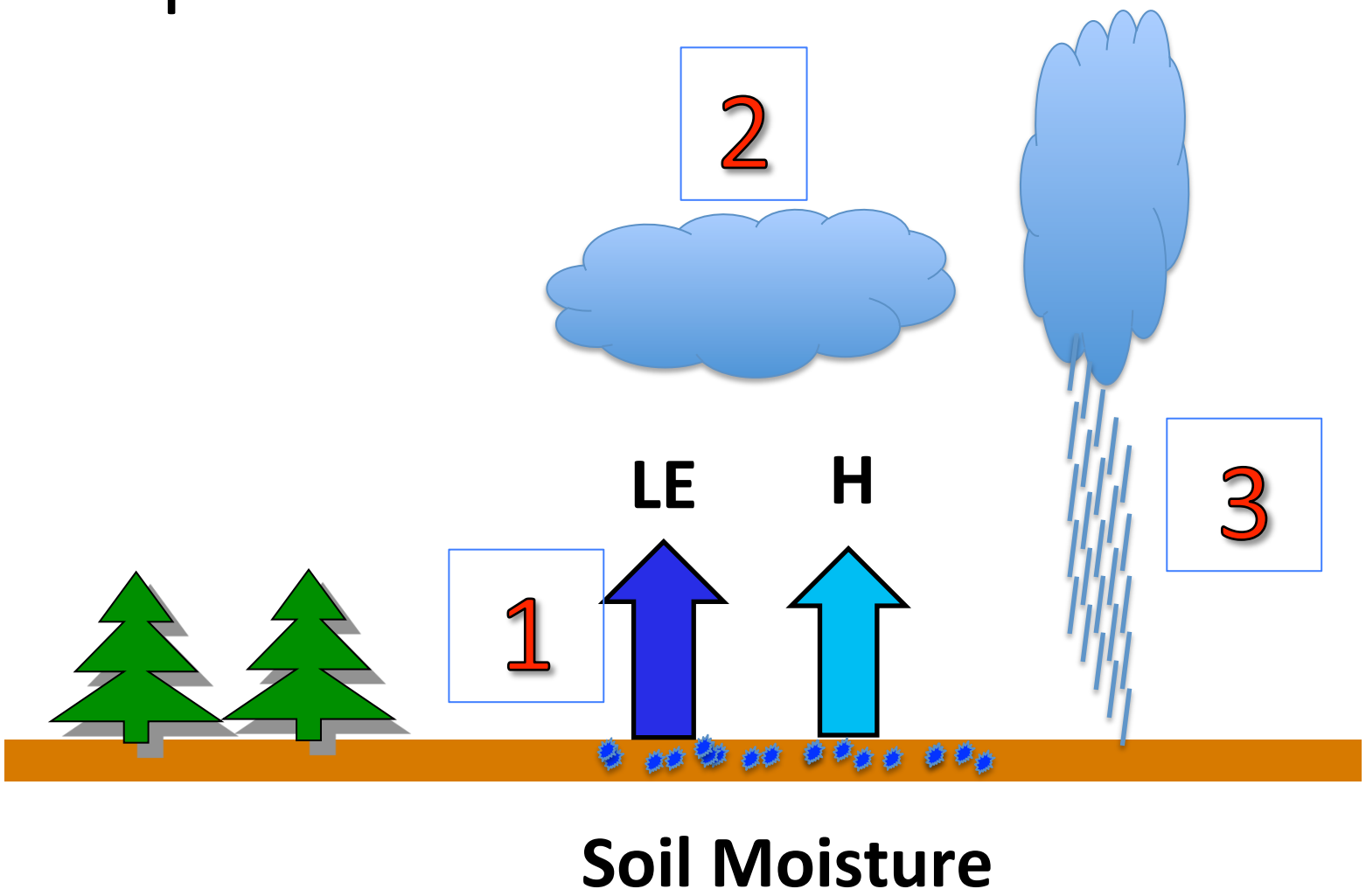
Some thoughts about L-A coupling using ARM observations

Stephen A. Klein

Searching for Land Forcing the Atmosphere in ARM SGP Observations

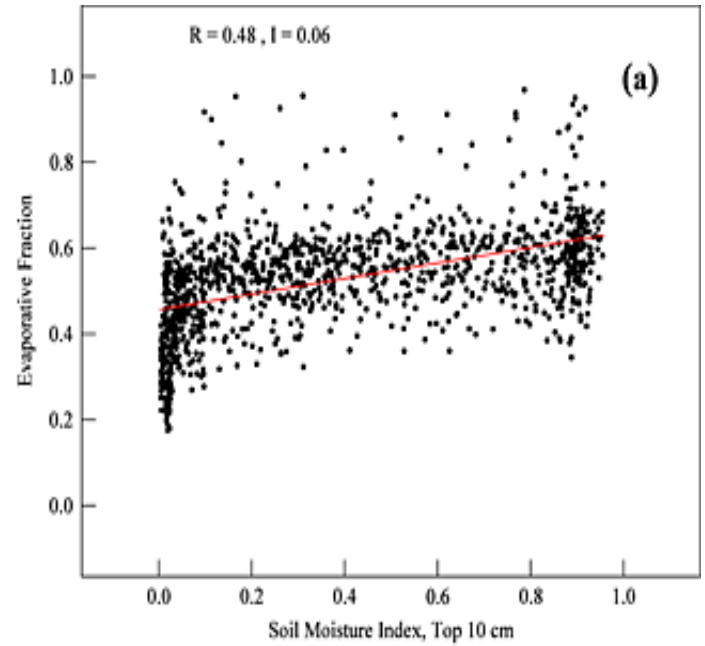


1

Controls on Surface Flux Partitioning

- Some control is apparent
- But how good are our observations?
- Soil moisture:
  - Lack of sensitivity over whole range of soil moisture
  - Sensitivity to instrument choice (SWATS vs. EBBR)
  - Sensitivity to number of stations (one point vs. multiple stations)
- Surface fluxes
  - Sensitivity to instrument (EBBR vs. ECOR)
  - Sensitivity to land surface type

Evaporative Fraction LE/(LE+H))



Phillips and Klein (JGR-Atmos., 2014)

Land-atmosphere coupling manifested in warm-season observations on the U.S. southern great plains

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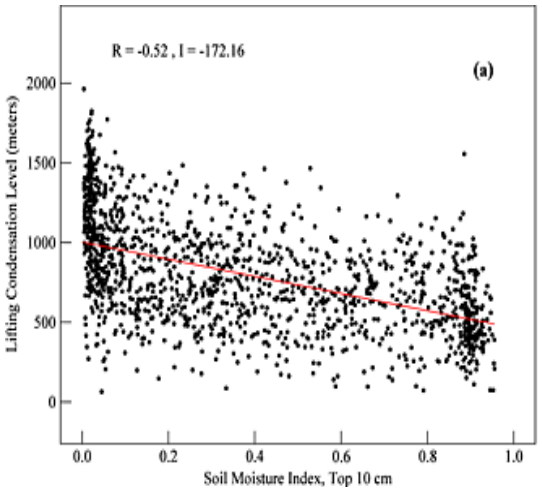
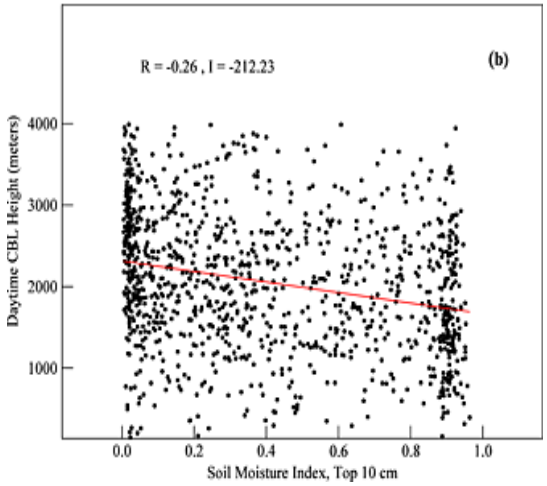
2 Controls on Boundary Layer Cloud

- Some control on near surface humidity and thus lifting condensation level
- Actual cloud base shows a weaker correlation
  - Not all clouds are formed from convection from the surface
- Depth of shallow convection shows a weak positive correlation to soil moisture *(Zhang and Klein 2013)*
  - Other factors (RH in atmosphere) show stronger control on convective cloud depth

Lifting Condensation Level



Cloud Base Height

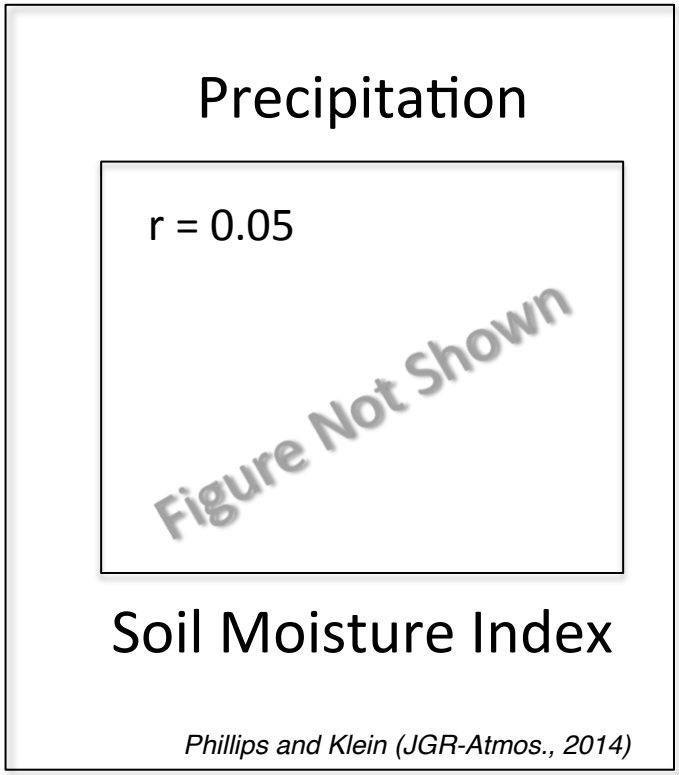


Phillips and Klein (JGR-Atmos., 2014)

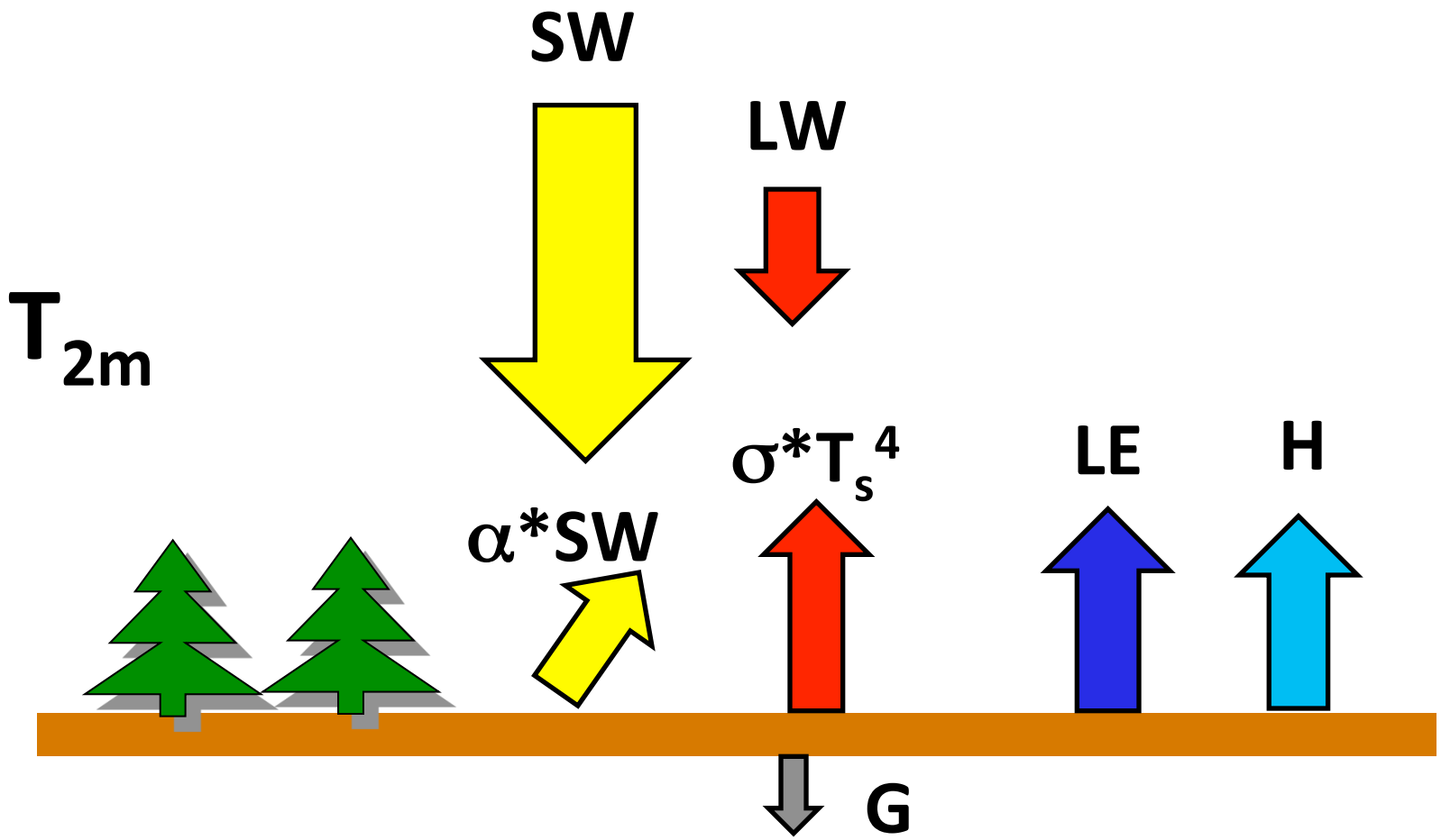
3

Controls on Precipitation

- Little evidence for local control of soil moisture on precipitation. *Why?*
- Moisture recycling is not that important
  - Horizontal advection of moisture (via LLJ) is more important
  - Convective systems originate remotely
- SGP is NOT moisture limited
  - Other regions (e.g. Sahel) could show stronger relationships
- Scale of interaction is important
  - At mesoscales, the surface can influence the sites that convection originates both through orographic and surface buoyancy control via surface fluxes *(Taylor et al. 2012)*

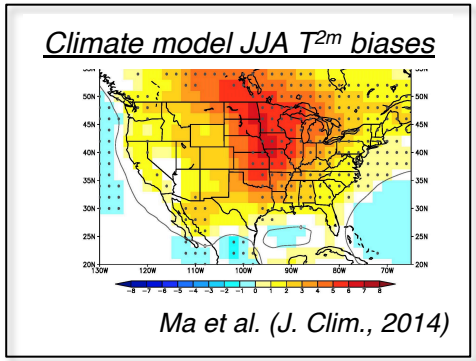


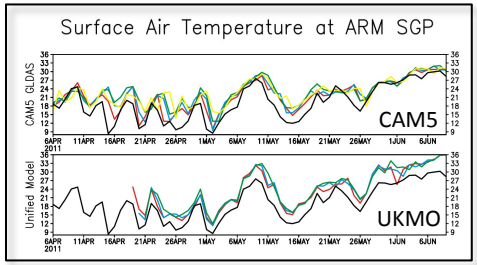
Surface Air Temperature and the Surface Energy Budget

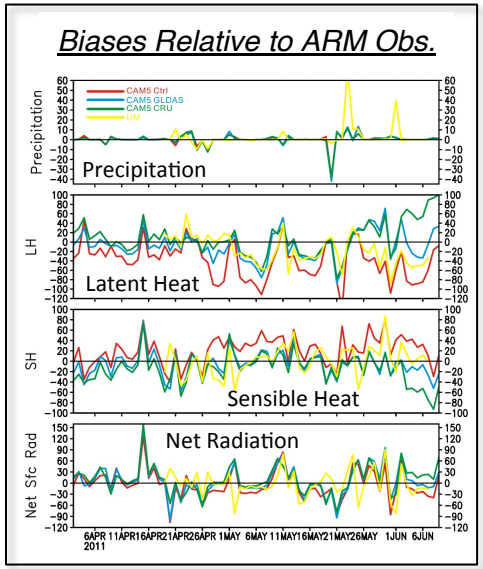


Why do models have a significant warm bias in summer time T_{2m}?

1. Atmosphere forcing land : radiation (~hours)
2. Land forcing atmosphere: flux partitioning (~hours)
3. Feedbacks: too little precipitation leads underestimated soil moisture and hence bad flux partitioning (~days to weeks)







CAUSES Warm bias project

Cyril Morcrette (UKMetOffice) and Hsi-Yen Ma (LLNL)

Please join!

- Hindcast model intercomparison project for MC3E period
- Surface energy budget evaluation with ARM obs.
- Partitioning radiation errors by cloud regime
- Do errors growth with time? And do the processes causing errors change with time?
- Initial culprits:
  - Lack of solar reflection by daytime deep convection
  - Too many clouds at night (LW)
  - Surface albedo error