Coupled crop-climate variability

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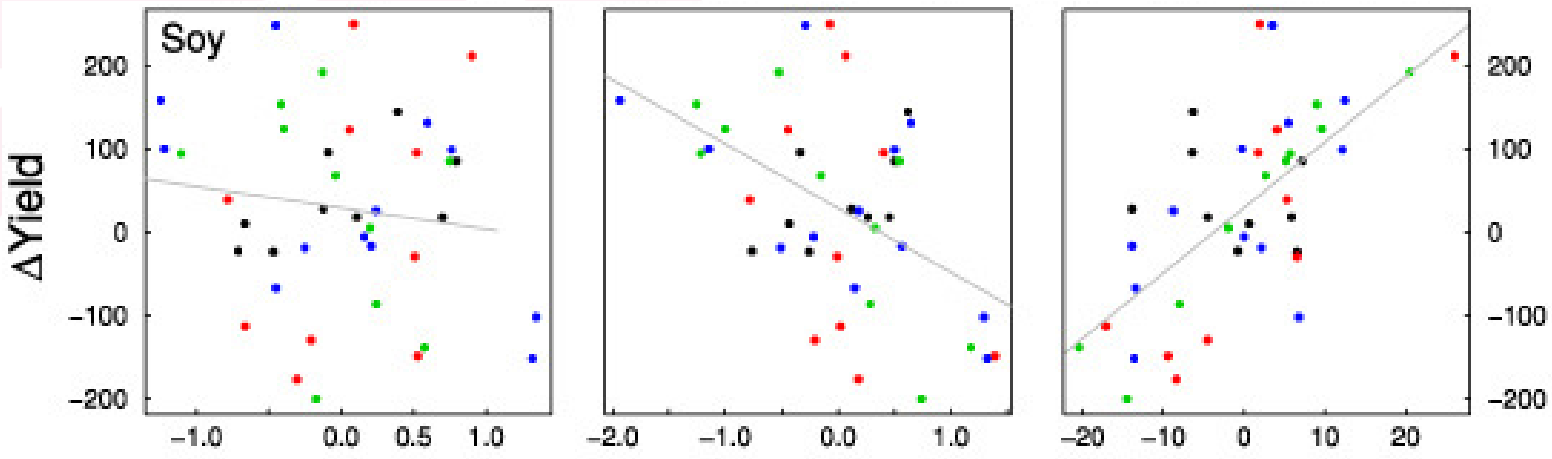
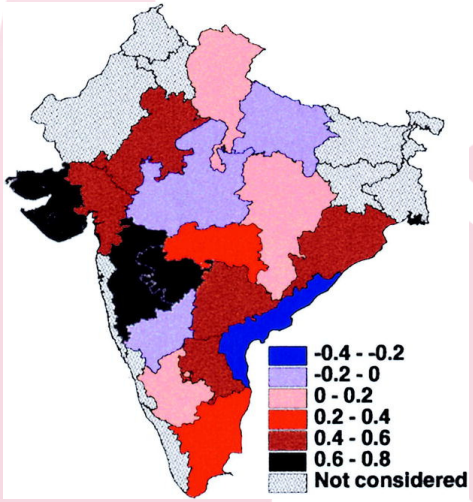
Crop yields are related to climate fluctuations

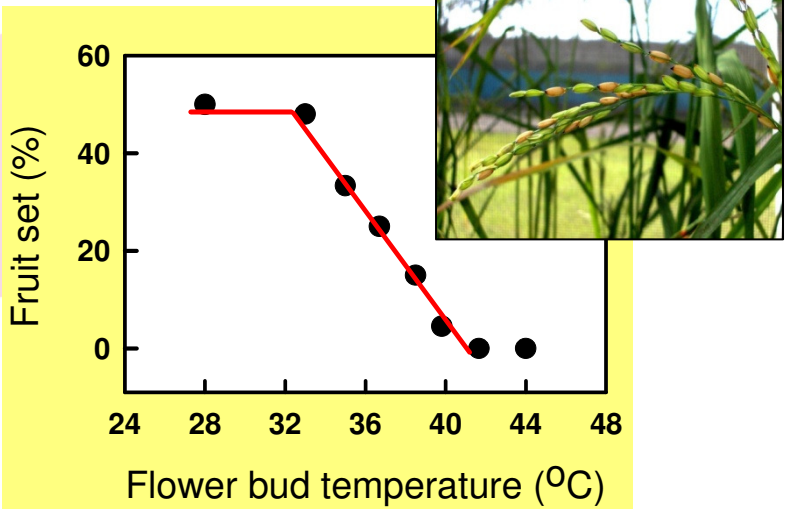
Global (Lobell and Field, 2007)



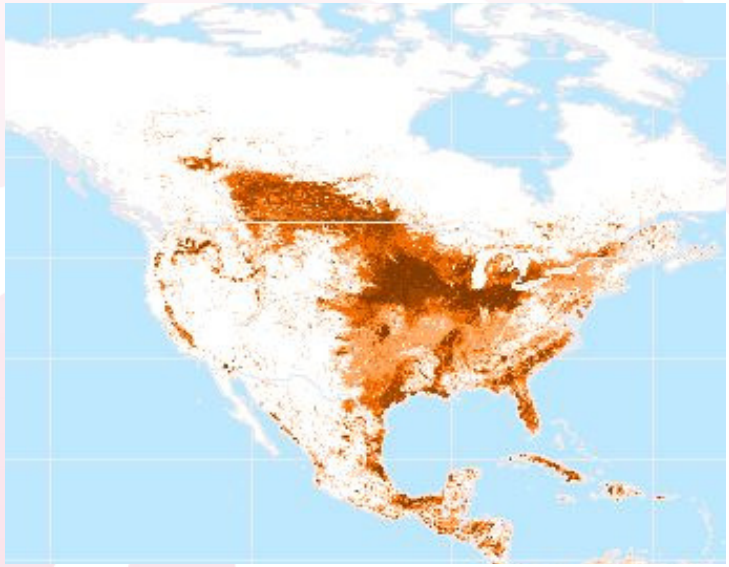
Regional (Challinor et al, 2003)

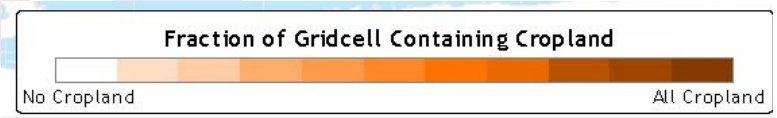


Local (Ferris et al, 1998)



Croplands now major feature of regional land cover





Hypothesis: Crop growth variations lead to variations in land surface characteristics that can influence local climate

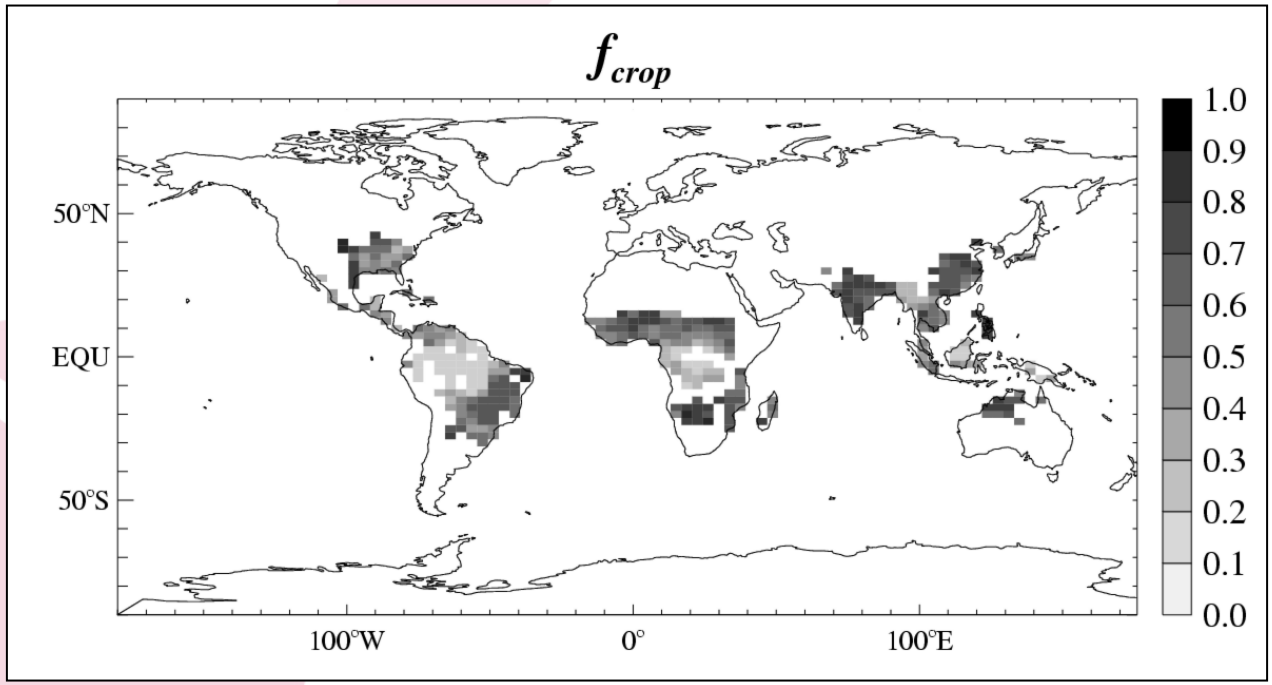
Model

- HadAM3 with GLAM-MOSES crop representation
- Prescribed SST and sea ice 1957-2001

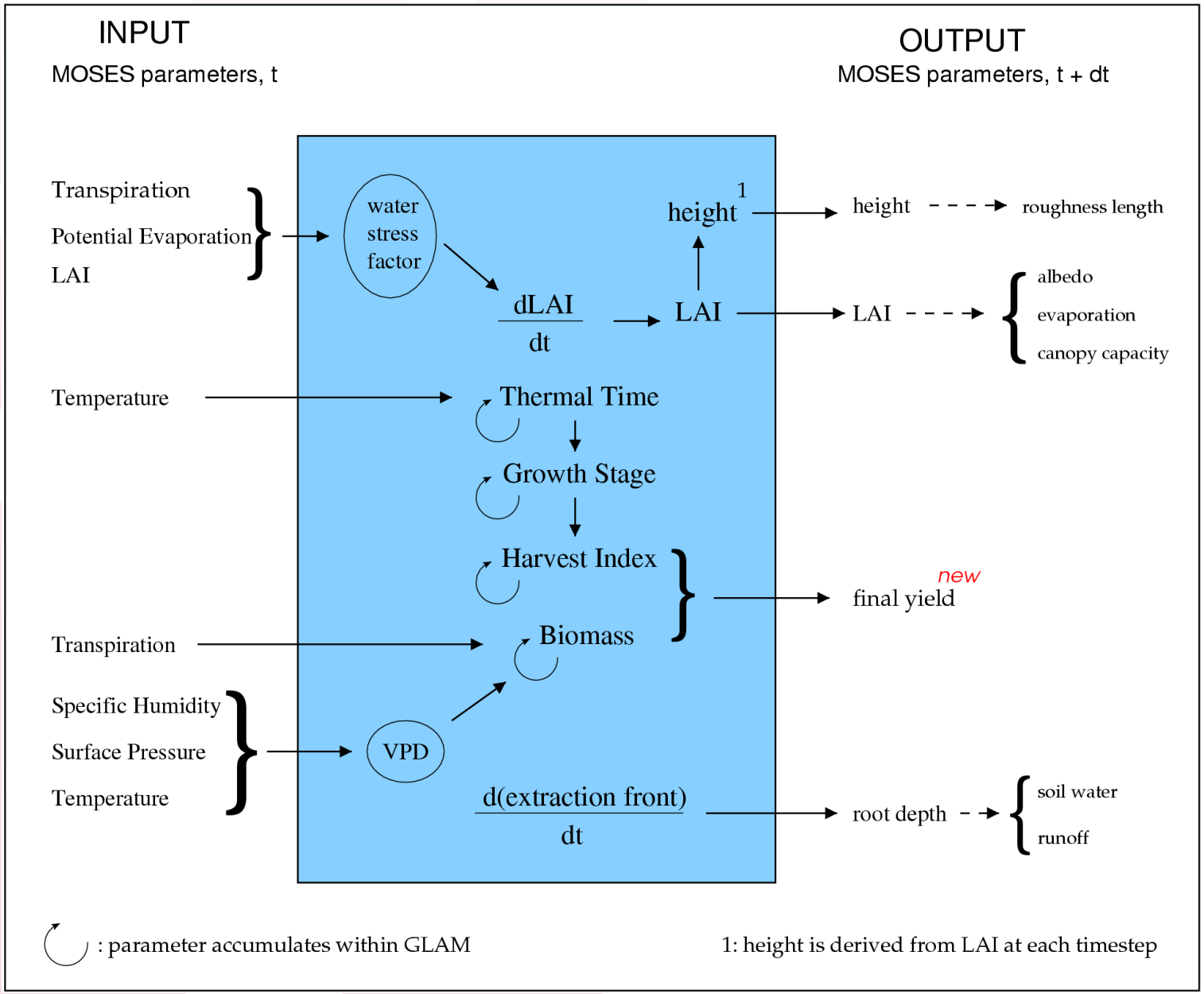
Simulations

- GROW: crop growth simulated in response to climate
- FIX: crop characteristics prescribed

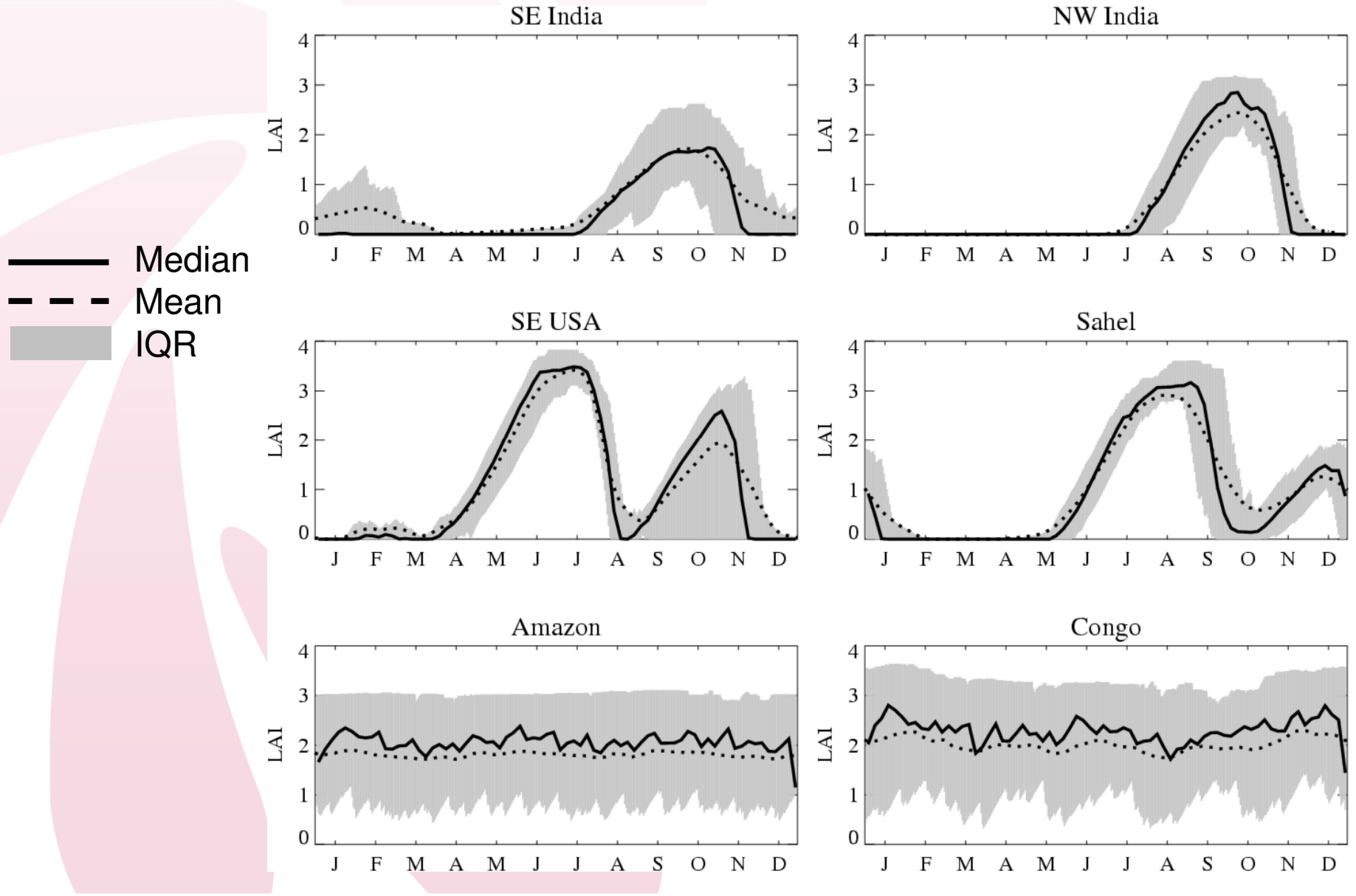
Crops occupy coverage of grasses in tropical climate



GLAM-MOSES (Osborne *et al* 2007)

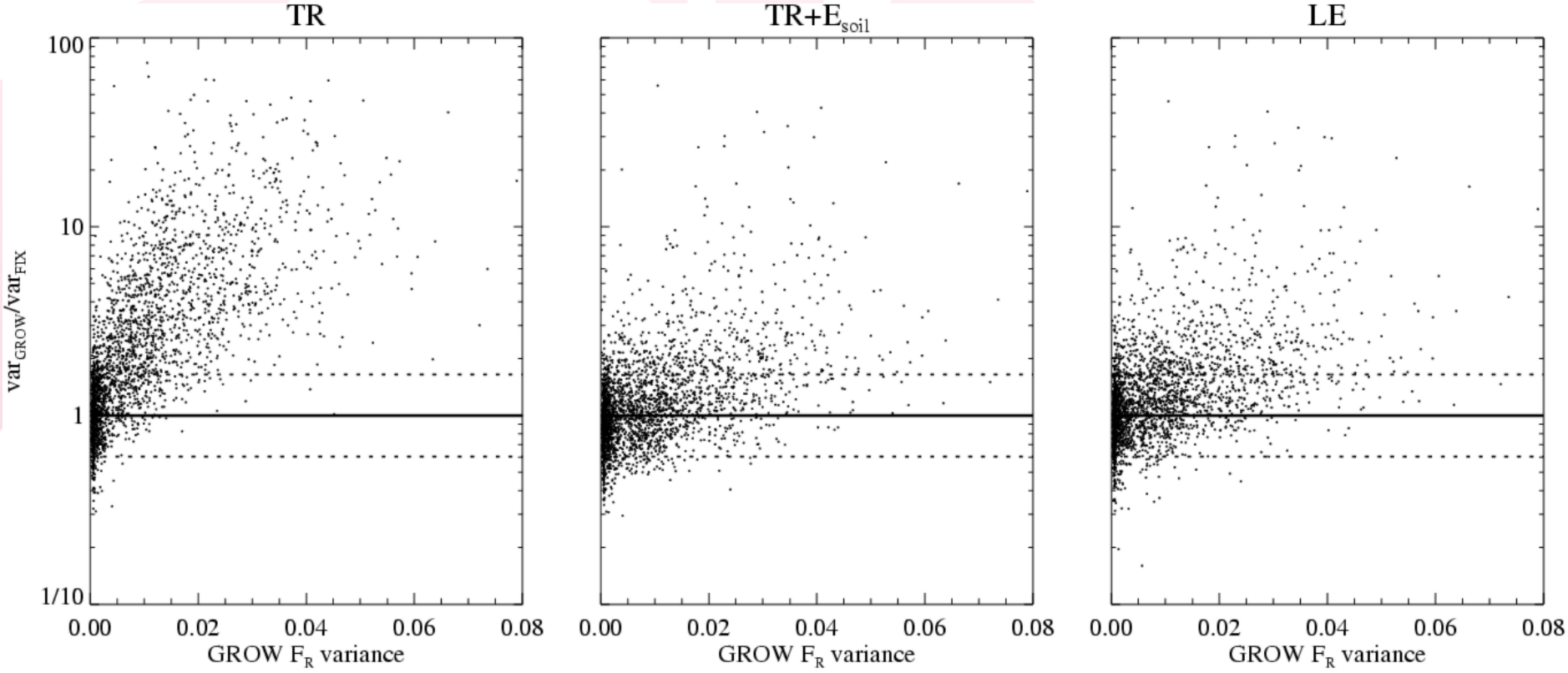


GROW: intra- and inter-annual variability of crop LAI



Evaporation

- crop variability enhances variability in transpiration
- compensated by evaporation from soil below canopy

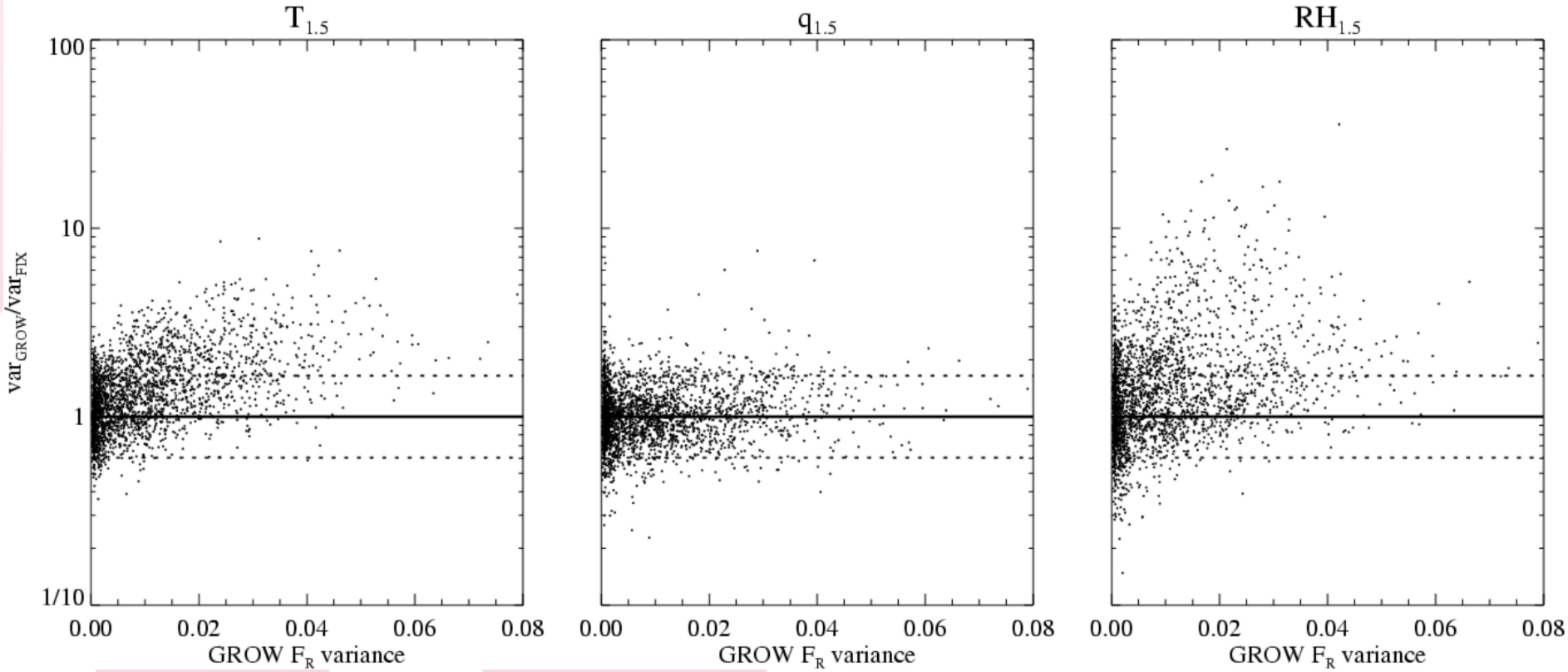


F_R = radiative fraction = $f_{crop} * (1 - e^{LAI/2})$

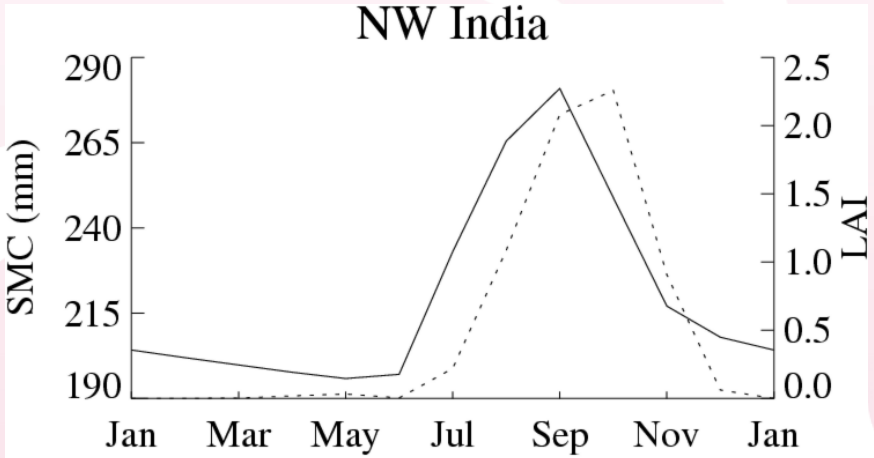
Surface climate

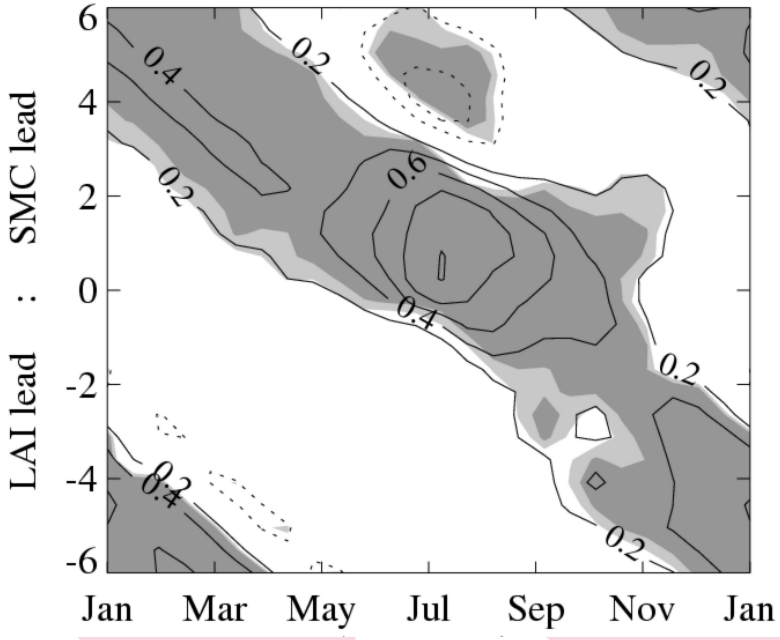
- variability of near surface temperature (and relative humidity) enhanced following change to latent heat flux

- no general response of specific humidity (or precipitation)



Regional wet/dry composite analysis





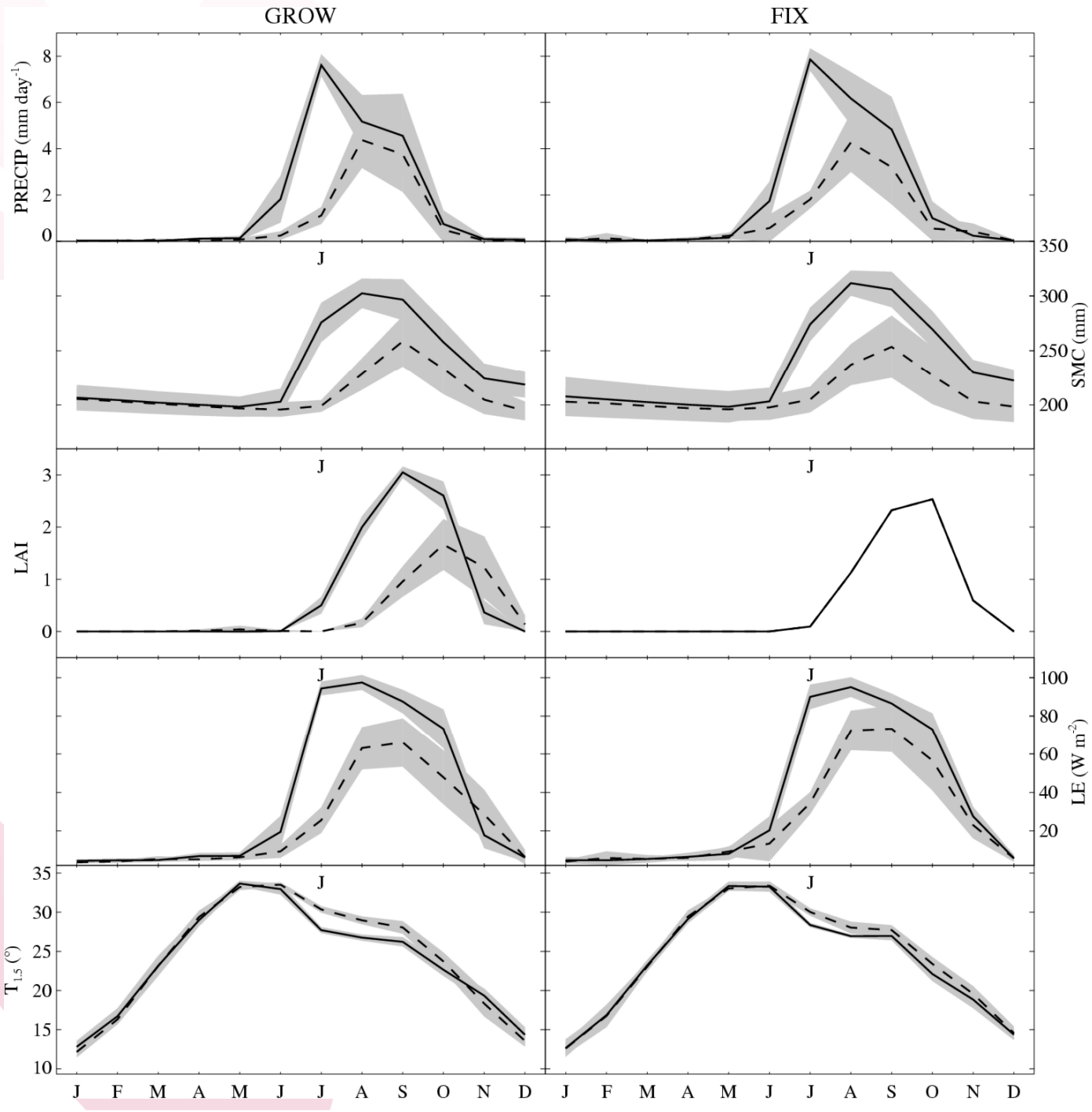
LAI variations lag soil moisture by 1 month

Wettest and driest July used for composite analysis

NW India

Wet
Dry
CI (5,95)

Crop response extends influence of anomaly into August + Sept

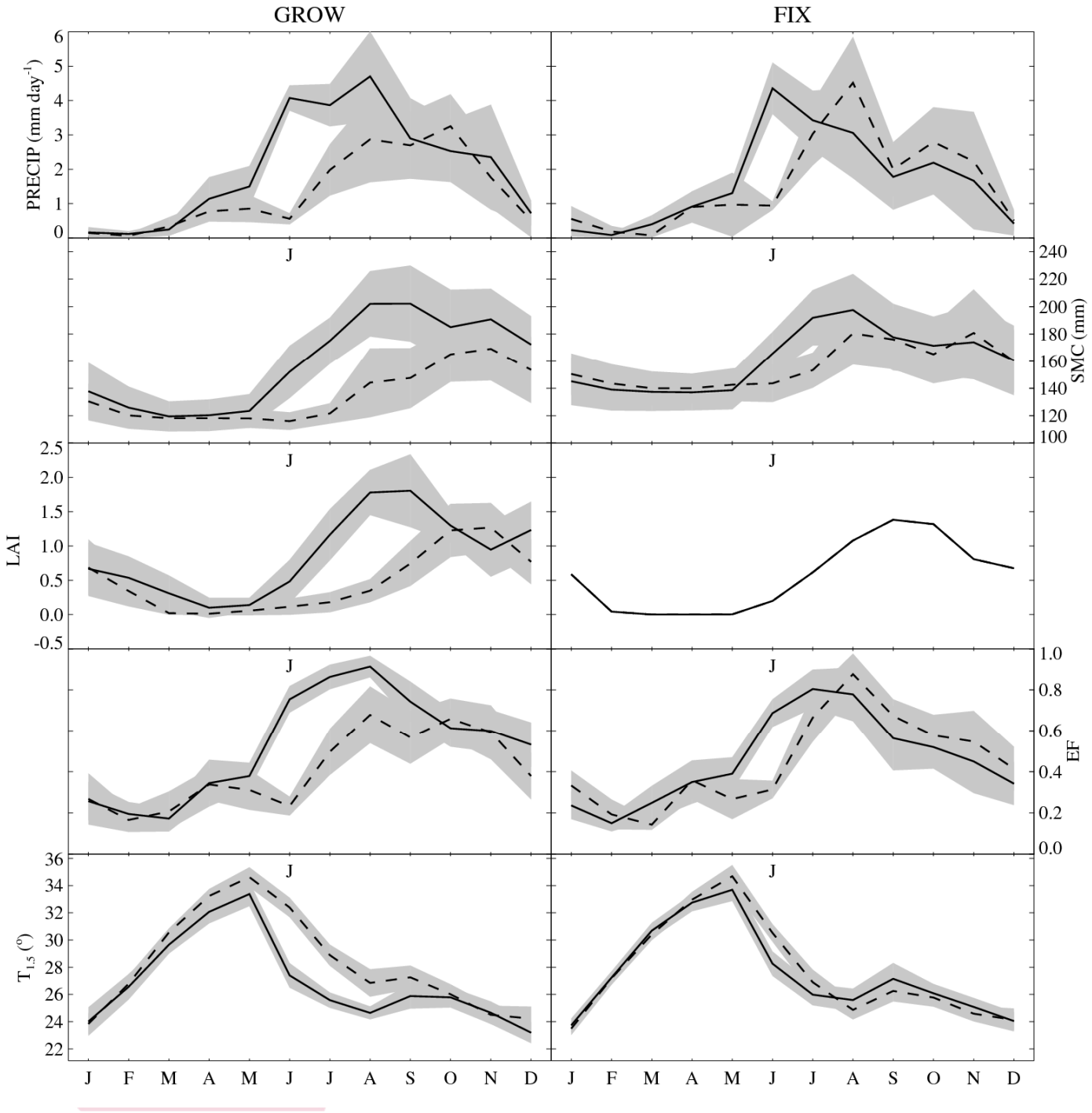


SE India

Wet
Dry
CI (5,95)

Positive feedback on rainfall leads to large soil moisture difference

Dry years drier and hotter in GROW cf. FIX



Do growing crops influence inter-annual climate variability?

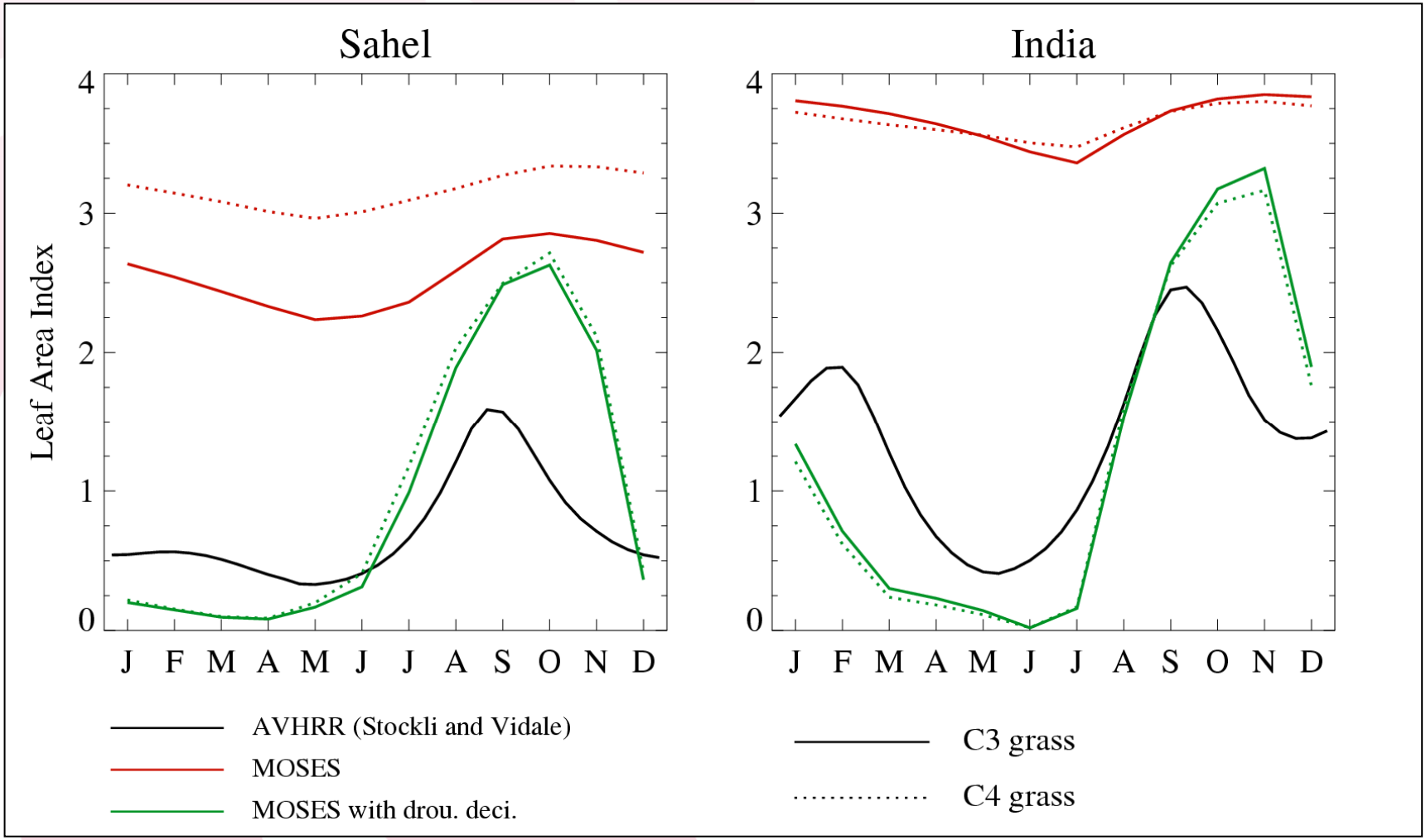
In crop-climate model:

- Increase in variability of surface fluxes and near surface T and RH, but not q,
- Weak impact on precipitation (due to HadAM3s low land-atmosphere coupling strength?),
- Growing crops introduced memory of anomalous rainfall events in surface climate,

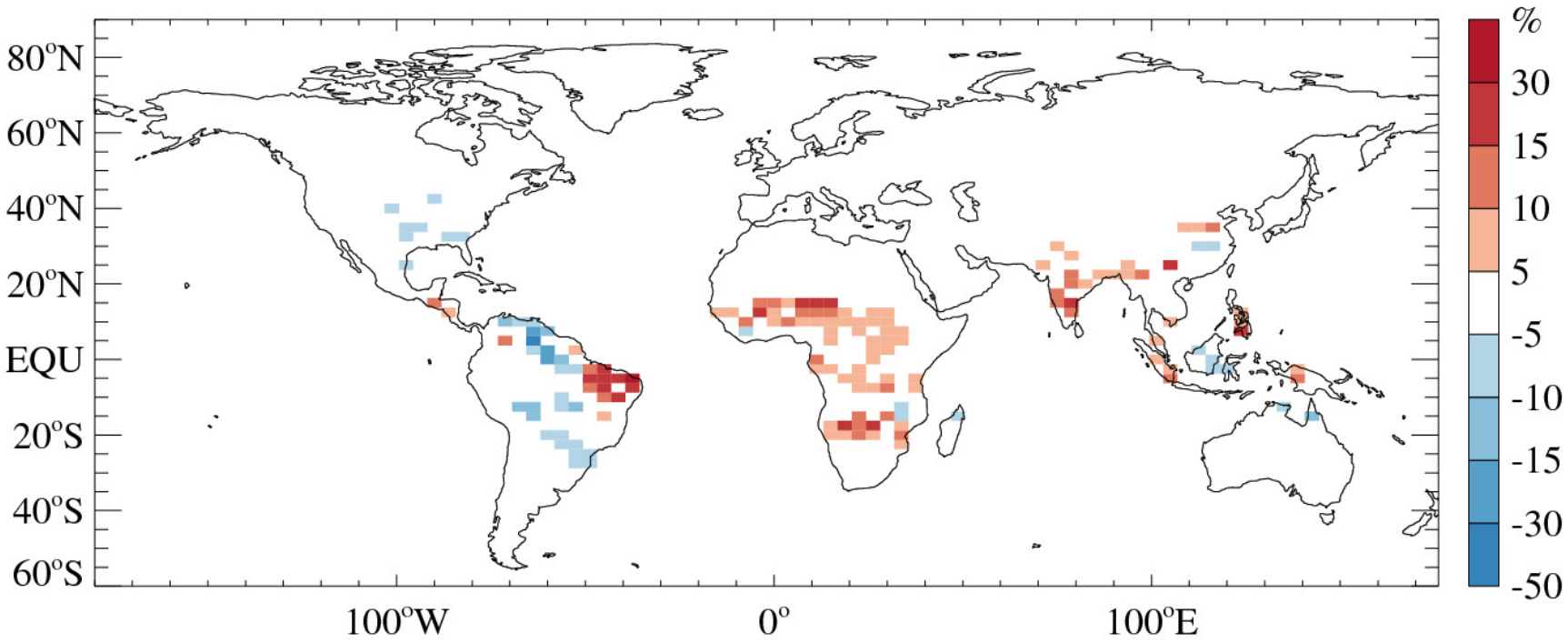
- Is influence different to that of natural vegetation?
- How important is the feedback for crop yield variability?

- Is influence different to that of natural vegetation?

Requires a representation of natural vegetation that responds to climate correctly.



- How important is the feedback for crop yield variability?



Impact of change in growing season temperature variability due to crop-climate feedback on variability of crop yield.

Walker INSTITUTE

Thanks for your time

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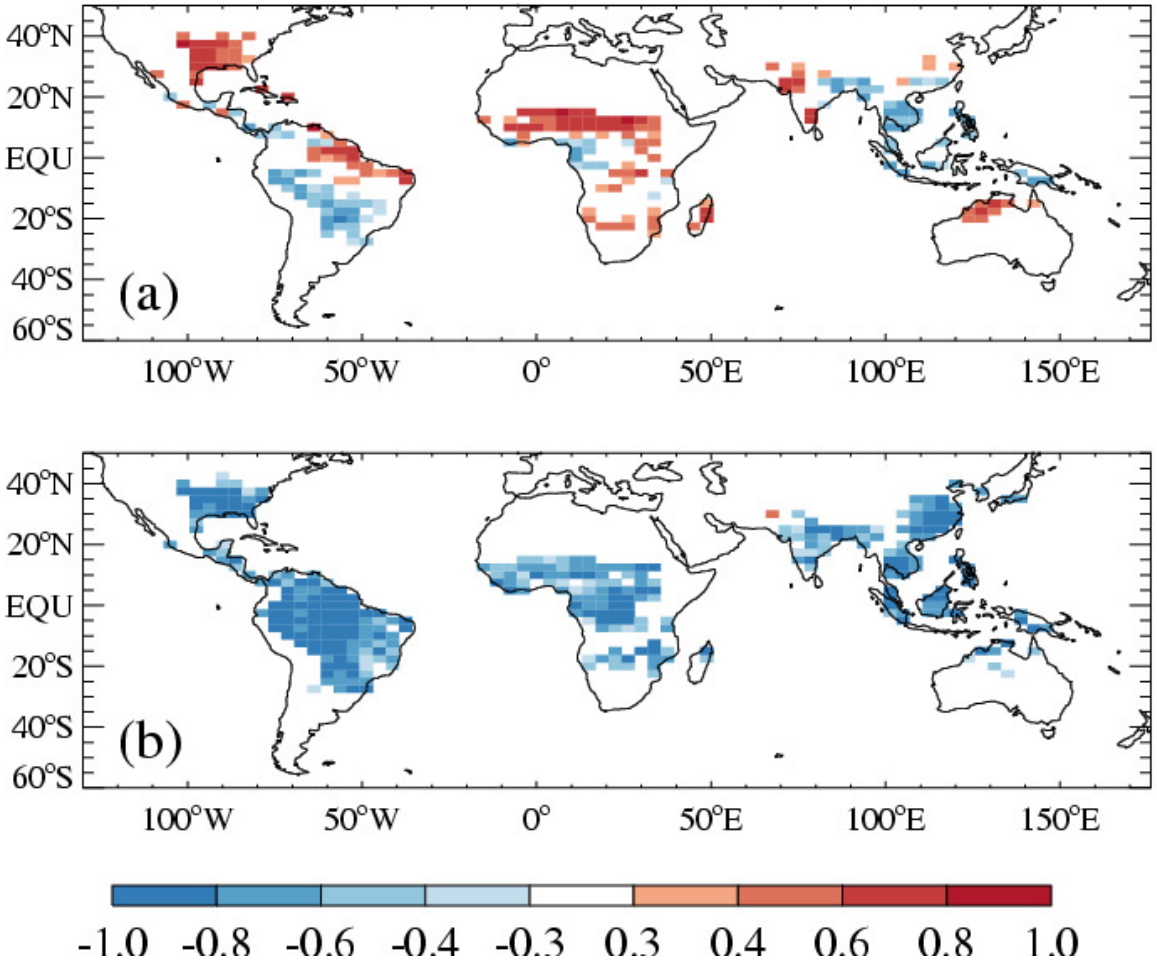
Validation: yield – climate relationships

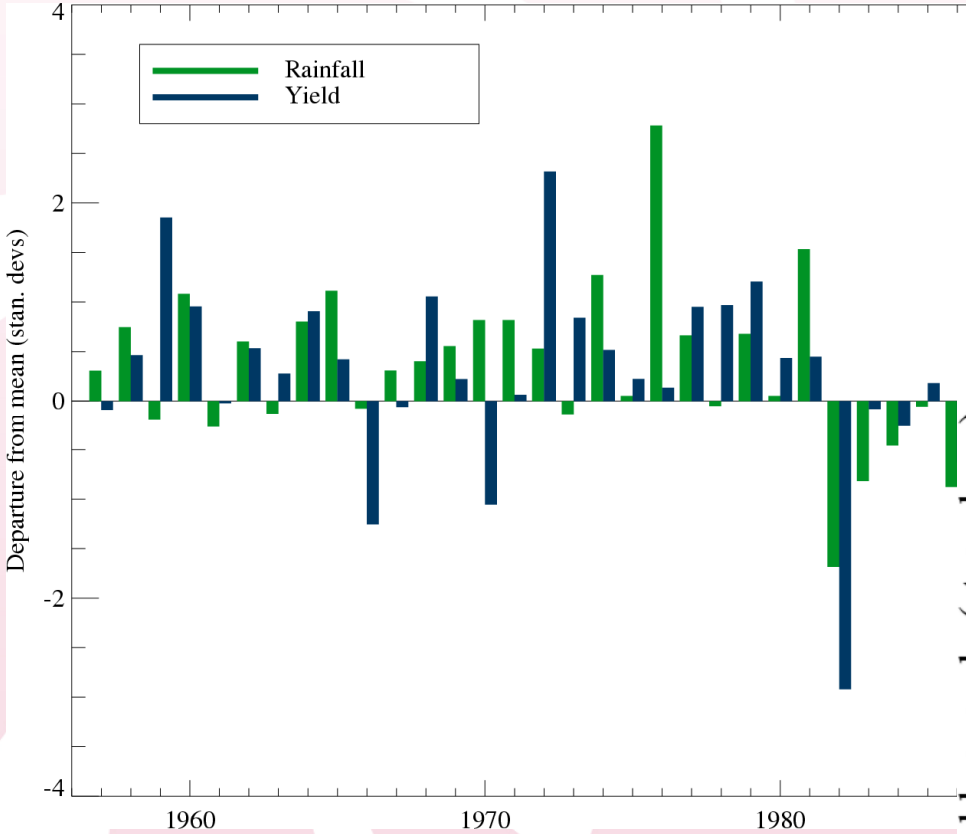
Simulated

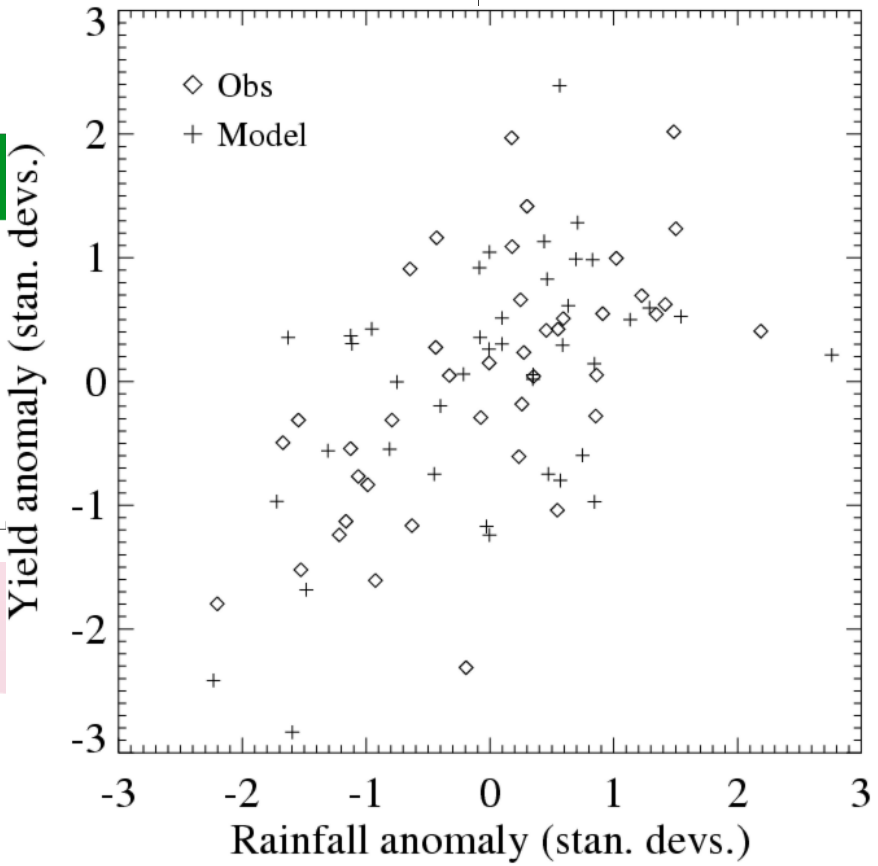


Growing season Precipitation

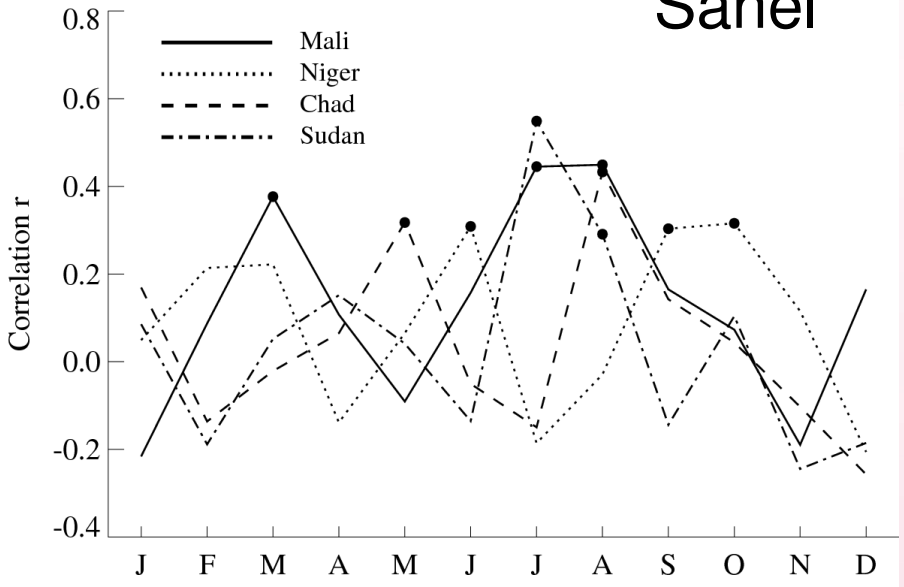
Temperature

Crop-rainfall relationships: India

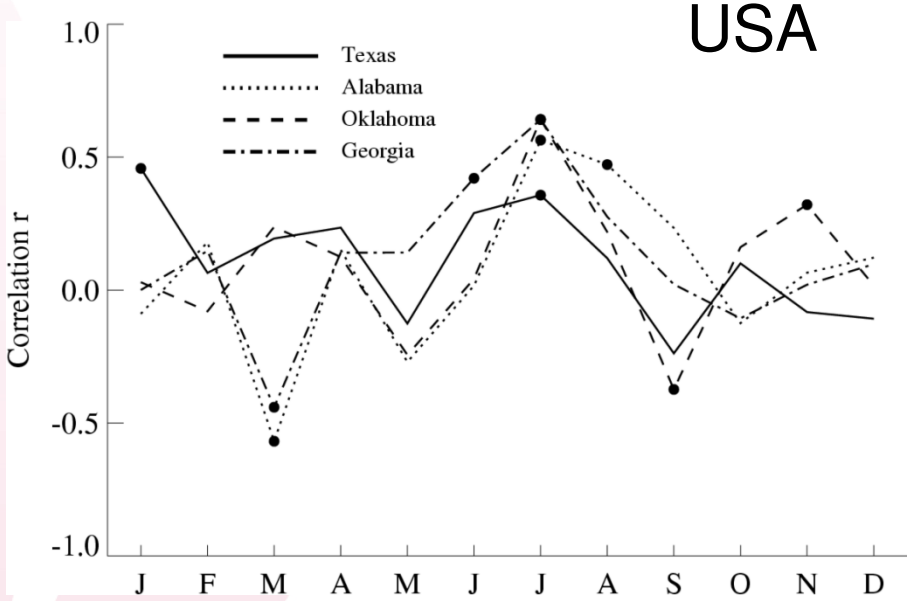




Sahel



USA



Global (Lobell and Field, 2007)