Constraining the JULES water budget over the Amazon basin & its impact on future projections

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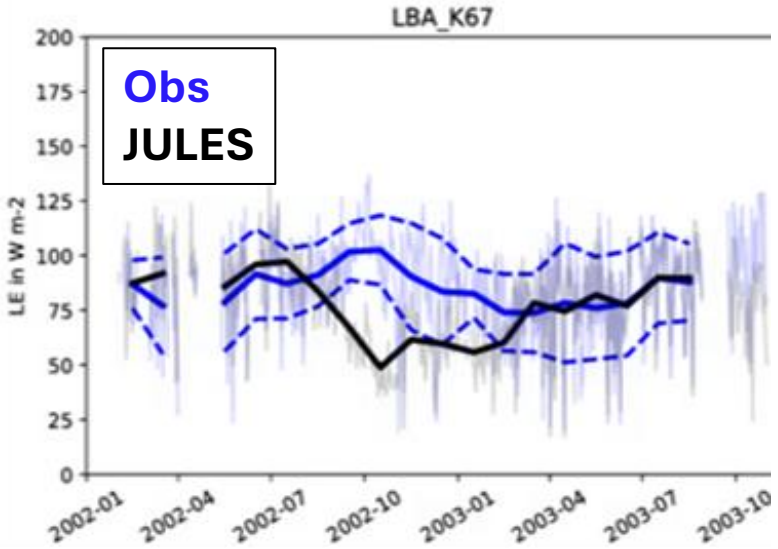
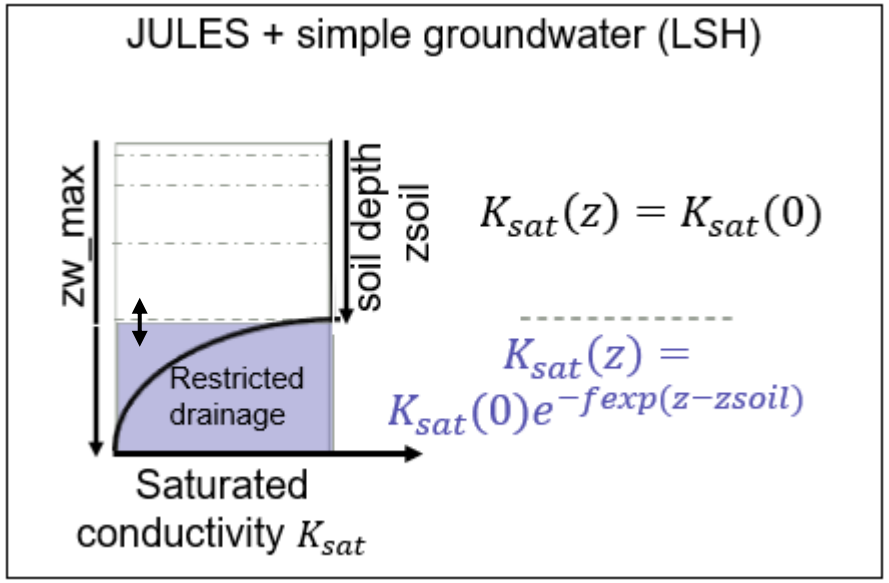
JULES – too *seasonally* water stressed (Harper et al., 2021) especially in South and East of basin

Large-Scale Biosphere-Atmos Expt in Amazonia (LBA) K67

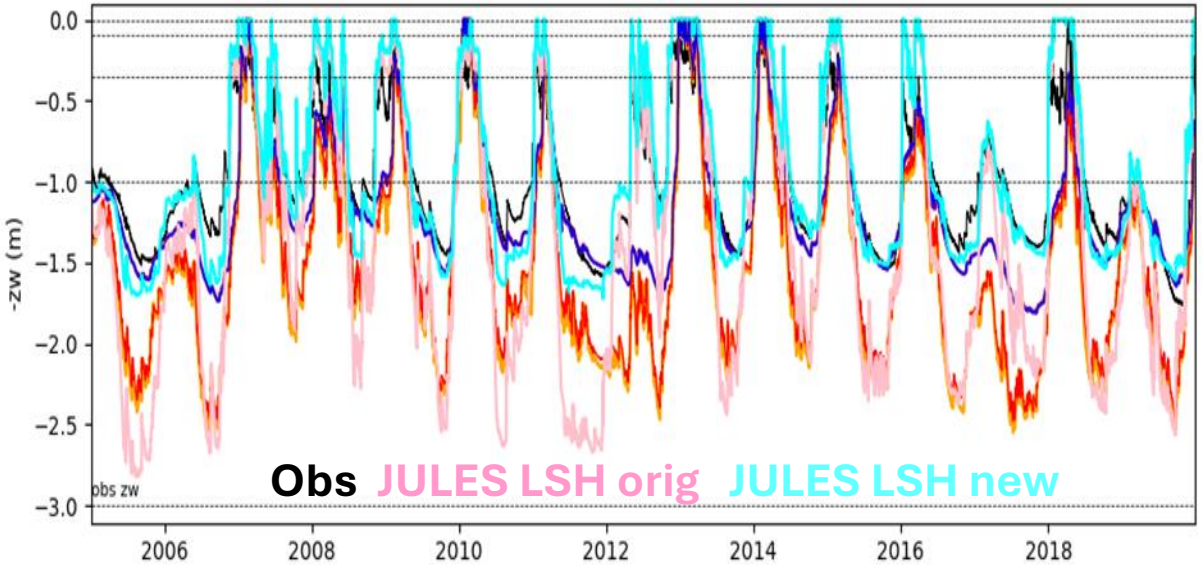


- Improve hydrological representation
- Constrain parameters - data assimilation tool LAVENDAR
- Impact of optimised JULES

JULES-LSH developments



Cardington water table



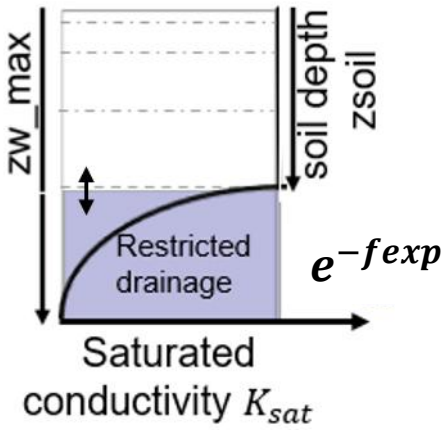
Recent developments:

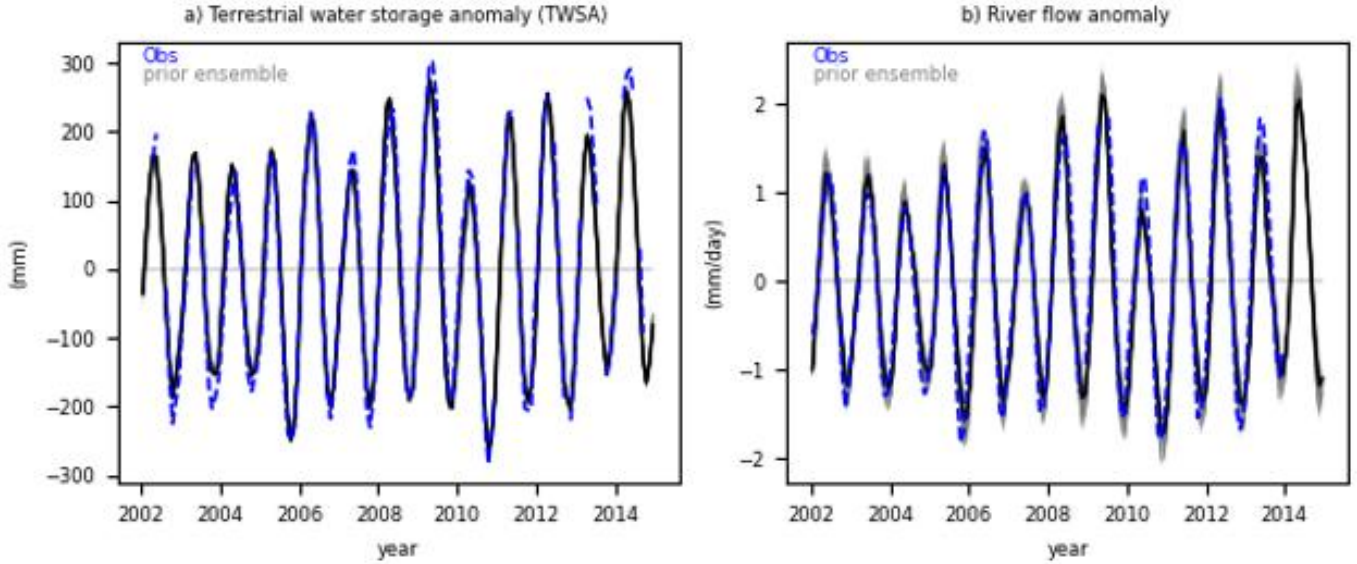
- full hydraulic connectivity between layers (soon in trunk)
- new water table calculation (soon in trunk)
- Soil ancils include oxisols and ultisols
  (some uncertainty in saturated hydraulic conductivity)

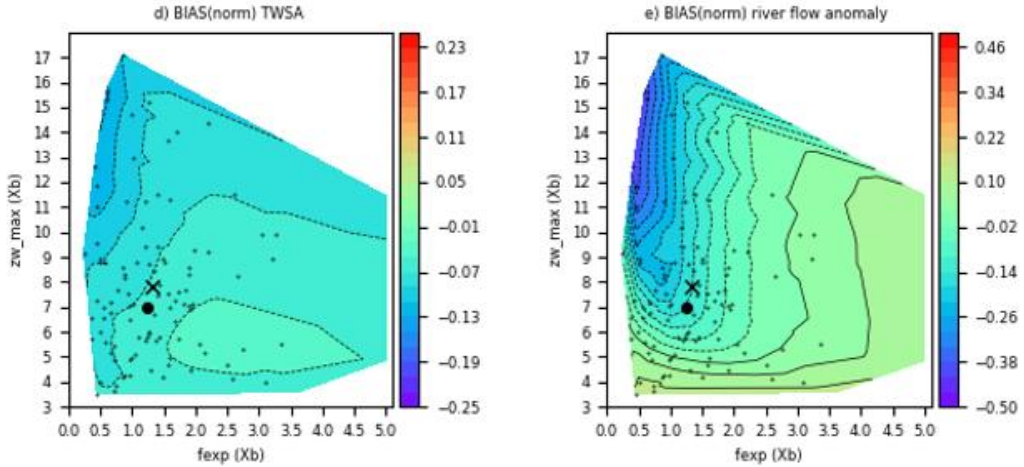
Constraining JULES-LSH with LAVENDAR

Constrain (basin mean) **zw_max** & **fexp** (impact soil water storage):

- Ensemble of off-line JULES simulations (obs meteorology) with varying **zw_max** & **fexp** (priors)
- Apply LAVENDAR (Land Variational Ensemble Data Assimilation; Pinnington et al., 2020)
- Terrestrial water storage (GRACE) & river flow anomalies (Dai et al.,2014)
- => Updated (posterior) estimates of **zw_max** & **fexp** and their uncertainties

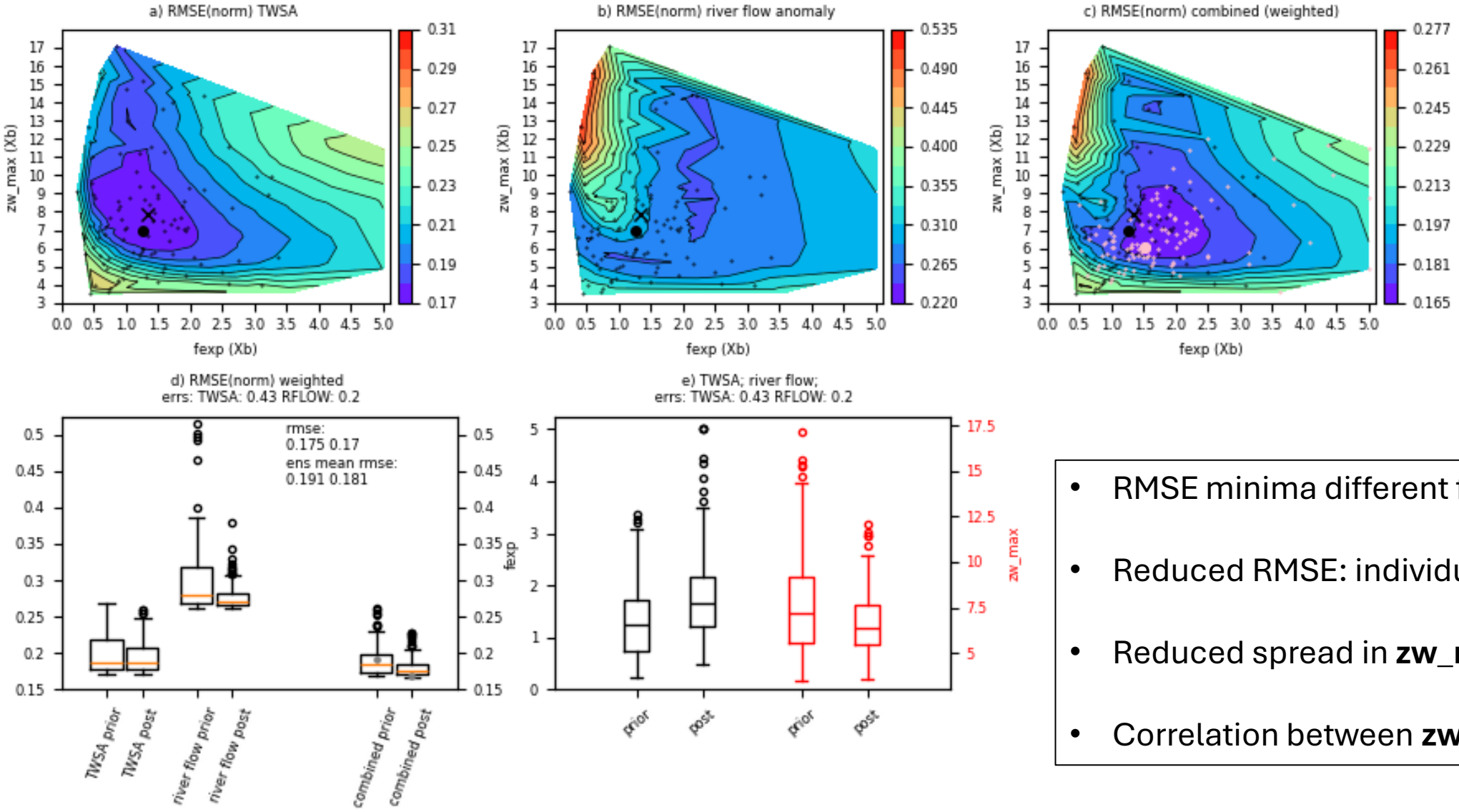






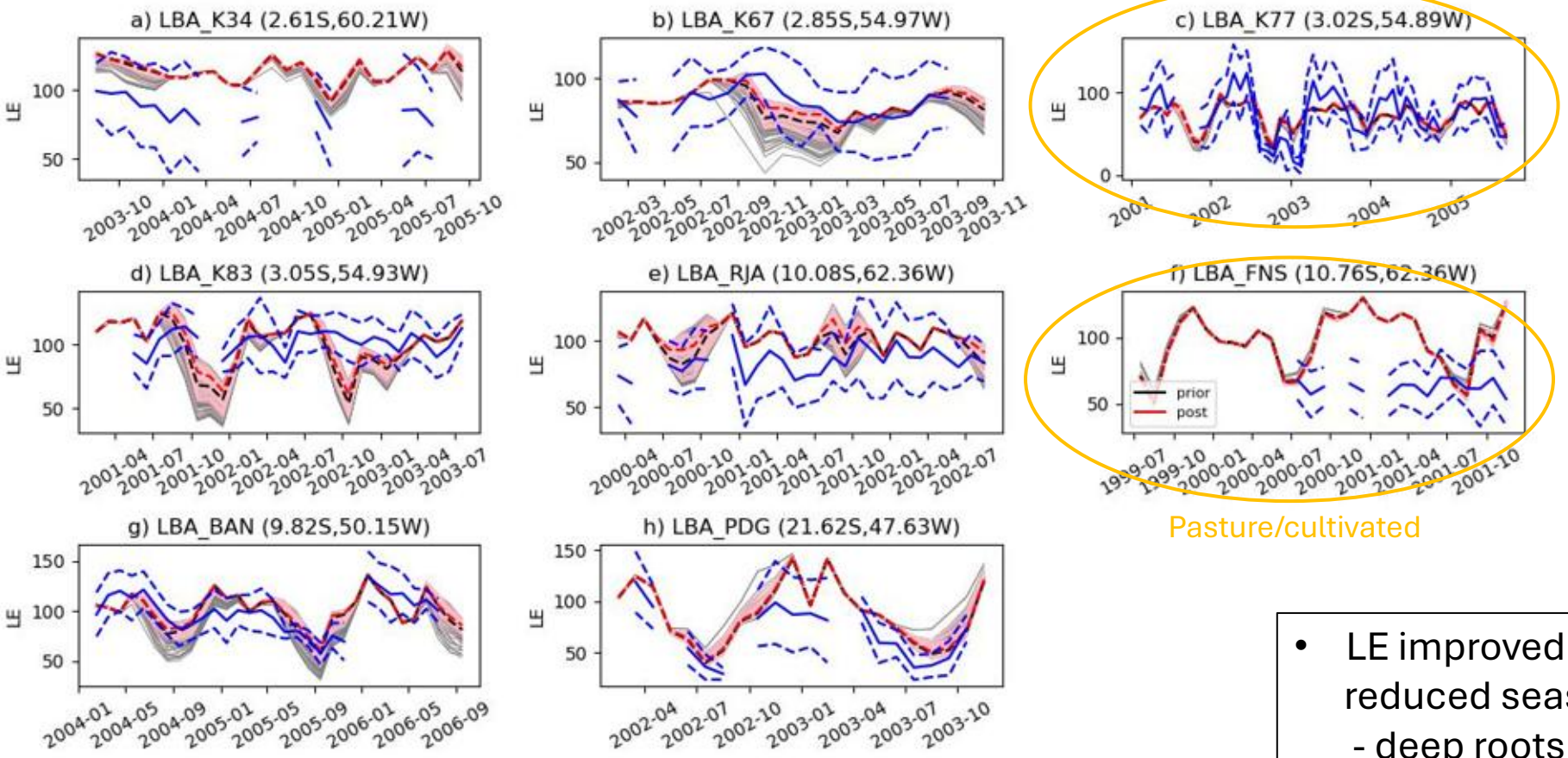
River flow more sensitive to parameter values than TWSA

Impact of constrained parameters on contemporary basin-mean water budget

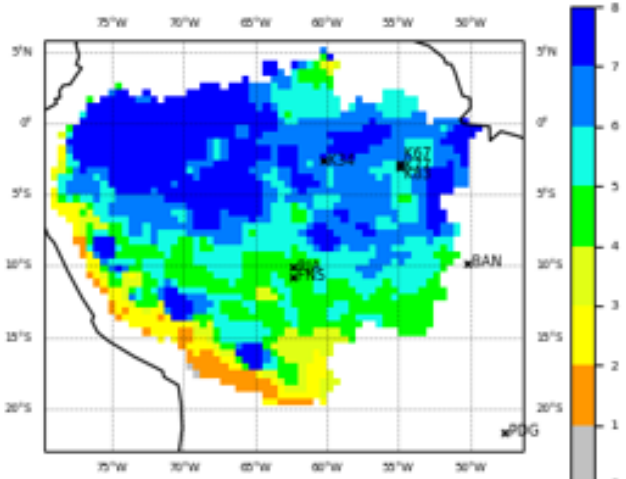


- RMSE minima different for TWSA & river flow
- Reduced RMSE: individual & combined fields
- Reduced spread in **zw_max**
- Correlation between **zw_max** & **f**

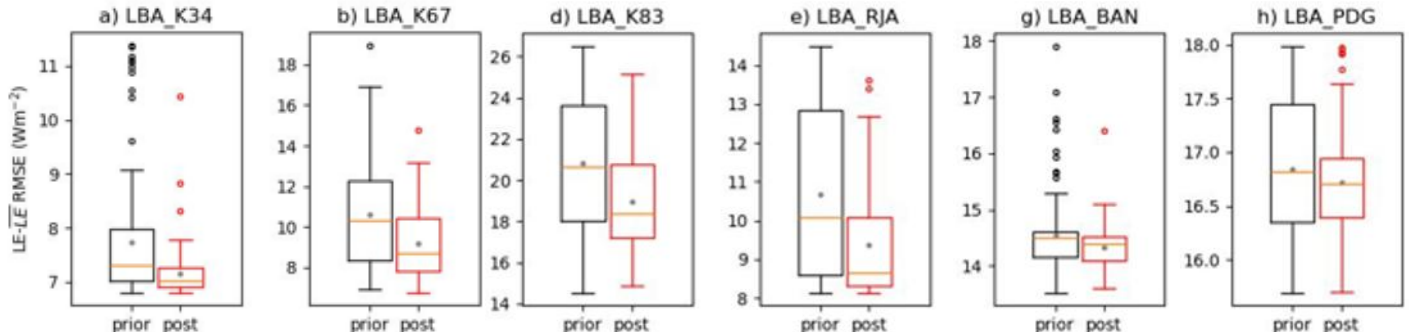
Impact of optimisation on LBA (Large-Scale Biosphere-Atmos Expt in Amazonia) flux site simulations



Pasture/cultivated

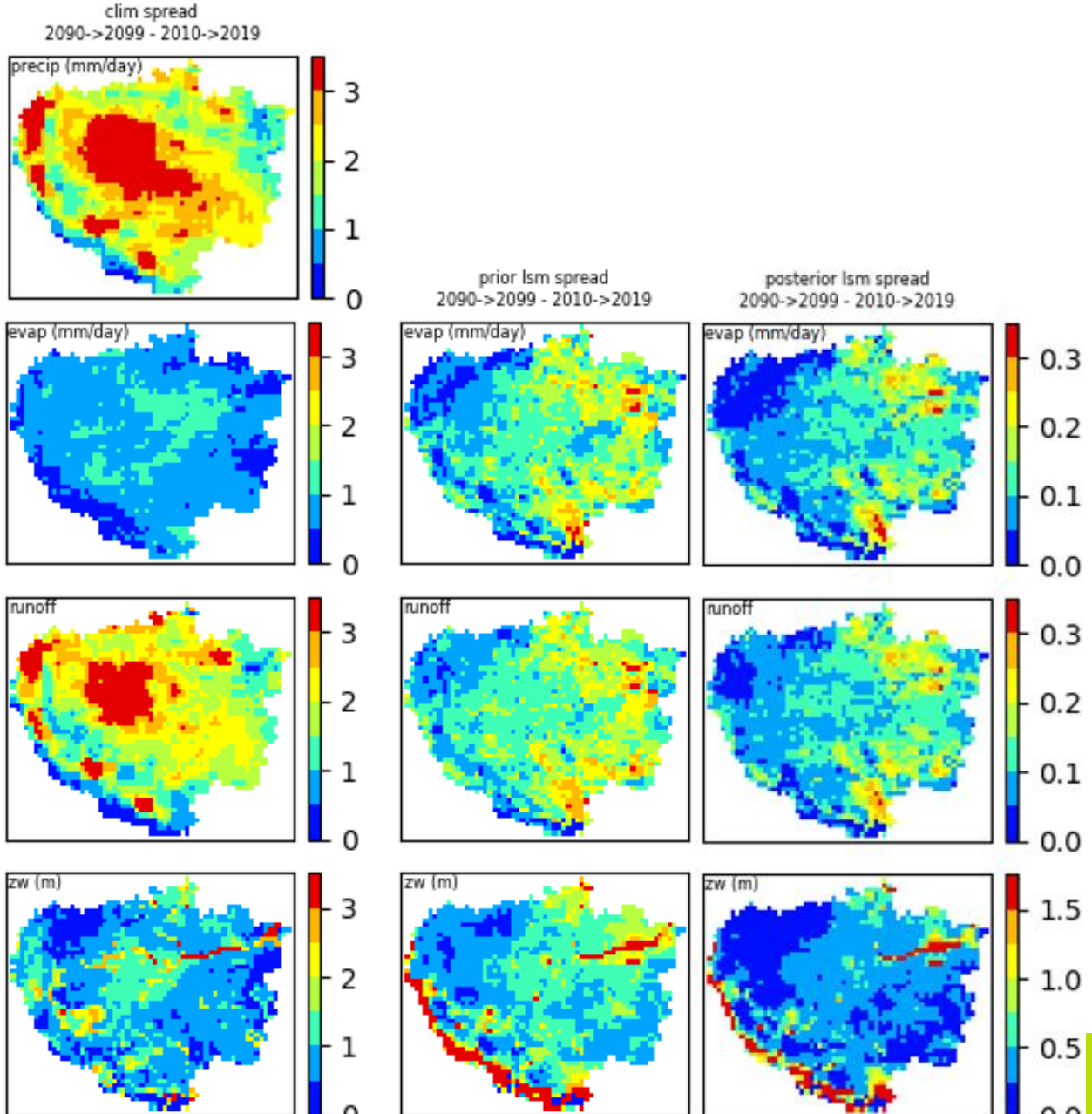


Annual mean precip (mm/day)



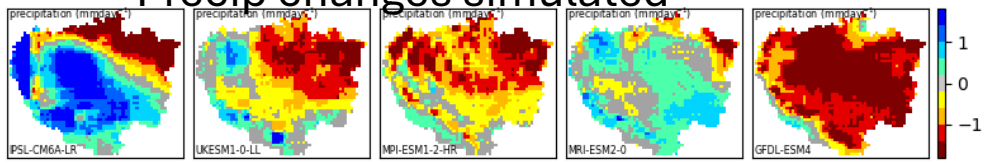
- LE improved over non-grass LBA sites due to reduced seasonal water stress
  - deep roots access deeper water stores?
- Optimisation at coarse scale also improves site-scale simulation

Impact of optimisation on off-line future projections



ISIMIP3b (5 ESM-based meteorology)
high emissions offline runs with
prior and posterior parameter values

Precip changes simulated



- Large spread in projected precip change (mostly drier NE)
- Largest spread in land water (flux) change is in East:
  - stressed South (and East) in present day
  - stressed North East in future projections
- Posterior: considerable drop in projected land spread
  - especially in East
- Climate spread dominates (even) in prior simulations
  - (unsurprisingly)

Conclusions & Future work

- Applying LAVENDAR constrains 2 parameters important in JULES land water budget
- over the Amazon basin
- Results in improved simulations at basin and site scale
- In off-line future projections this reduces simulated spread in land water budget

Future:

- Consider other JULES parameters & regions.
- Compare JULES against other observations e.g. inundation extent, water table depth