



Soil Moisture Memory and Its Impacts on Intraseasonal and Seasonal Forecasts over Australia: *a coupled model study*

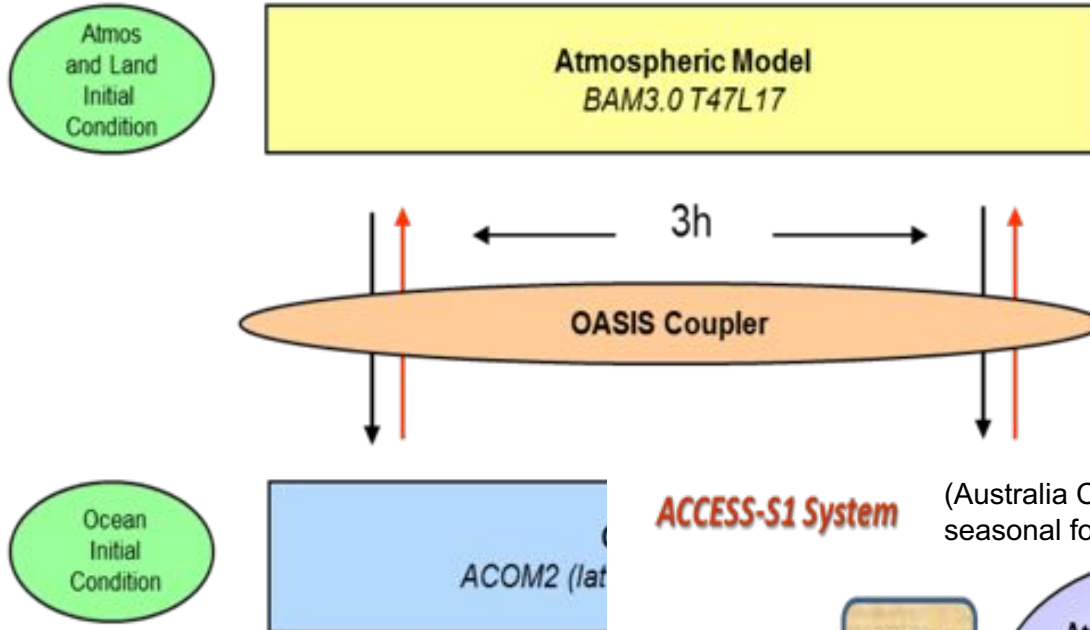
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Australian Bureau of Meteorology

Reference: Zhao M., Zhang H., and Dharssi I (2018) *On the Soil Moisture Memory and Influence on Seasonal Forecasts over Australia: a coupled forecast model study. Climate Dynamics (submitted)*

POAMA System

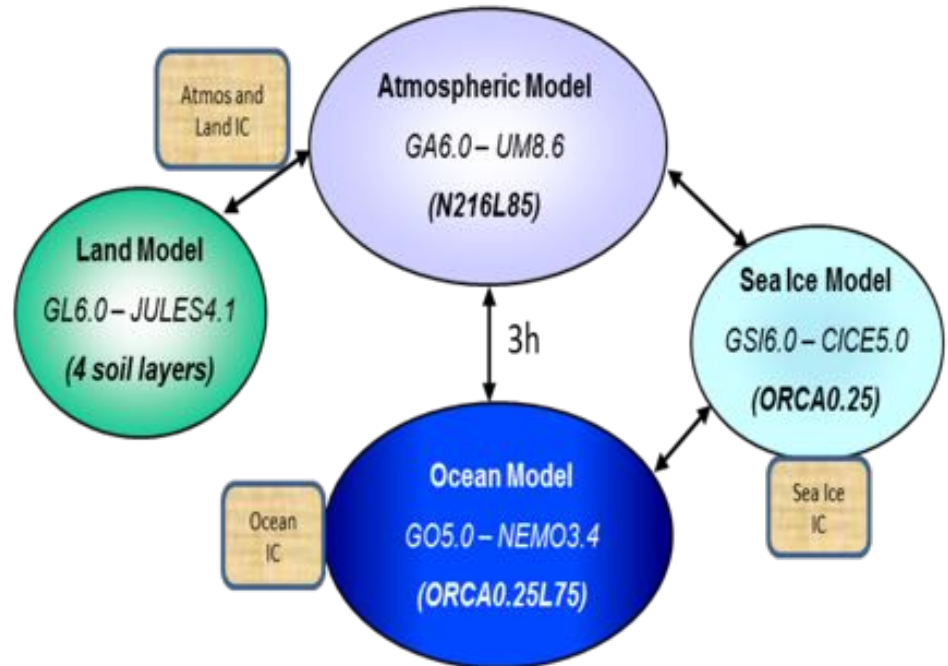
(Predictive Ocean Atmosphere Model for Australia)



POAMA: old BoM model (bucket land model) & low resolution (~200km)

ACCESS-S1 System

(Australia Community Climate Earth-System Simulator – seasonal forecast version)



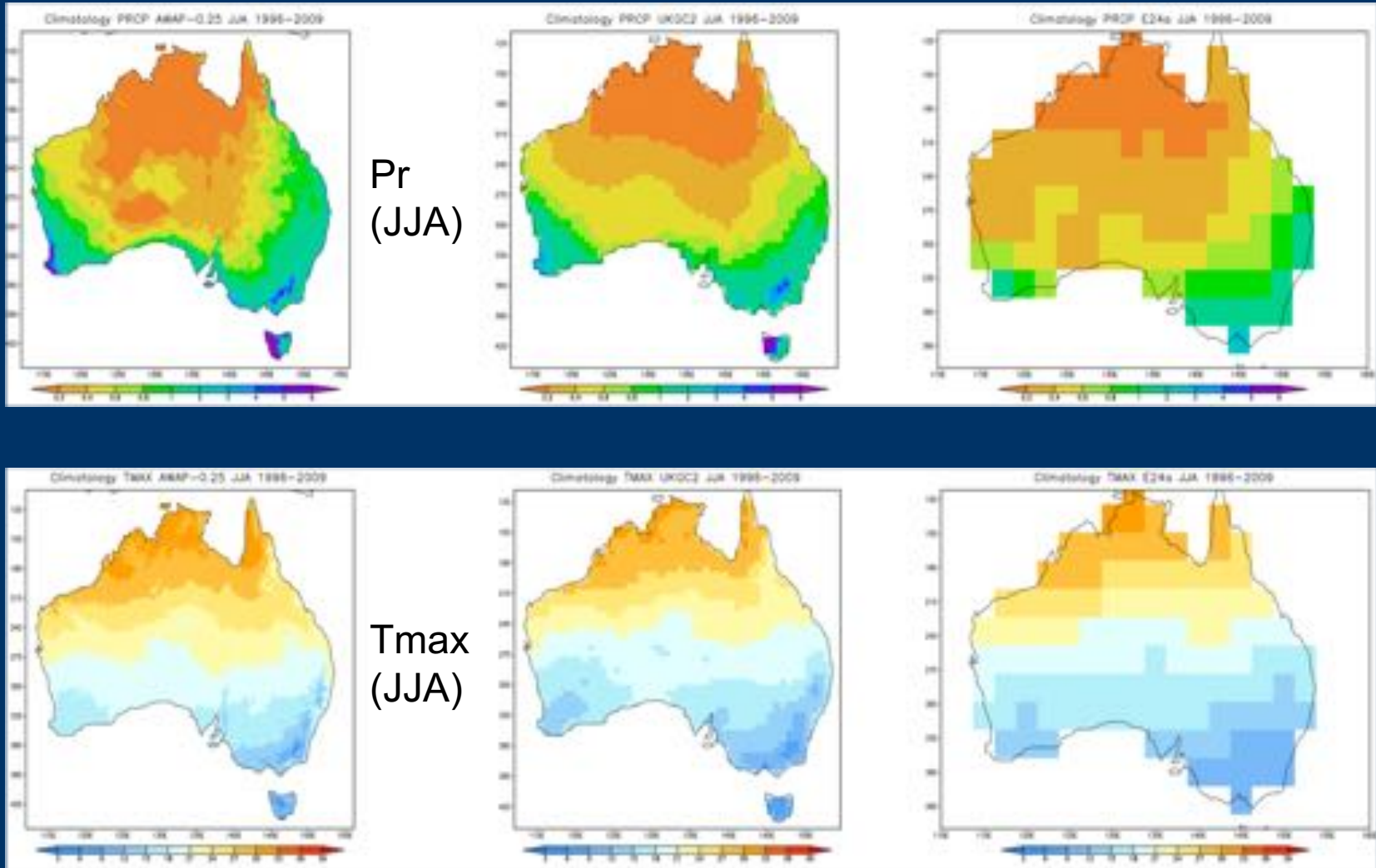
ACCESS-S1: UK GC2-based (advanced physics) & higher resolution (~60km)

Improved mean climate

Obs

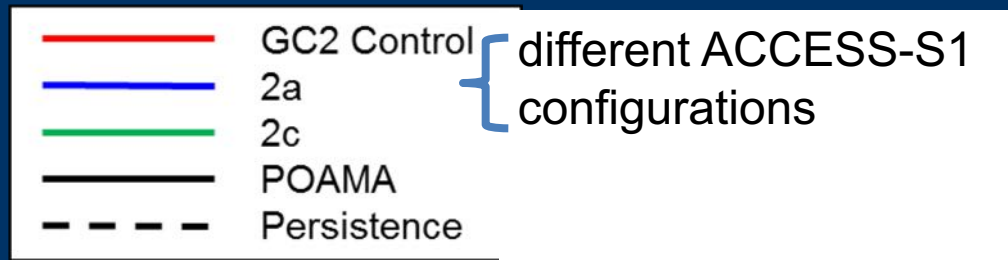
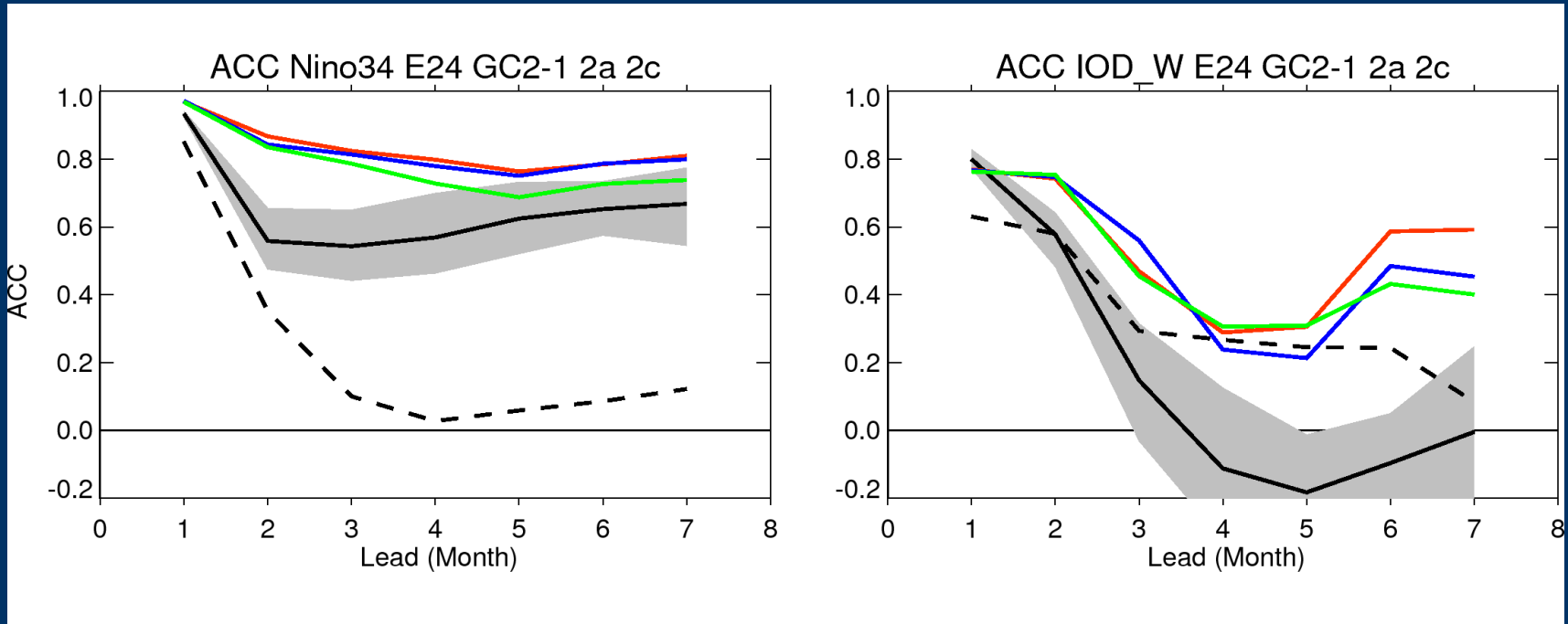
ACCESS-S1(GC2)

POAMA



Source: Li Shi (ACCESS-S meeting 18/12/2015)

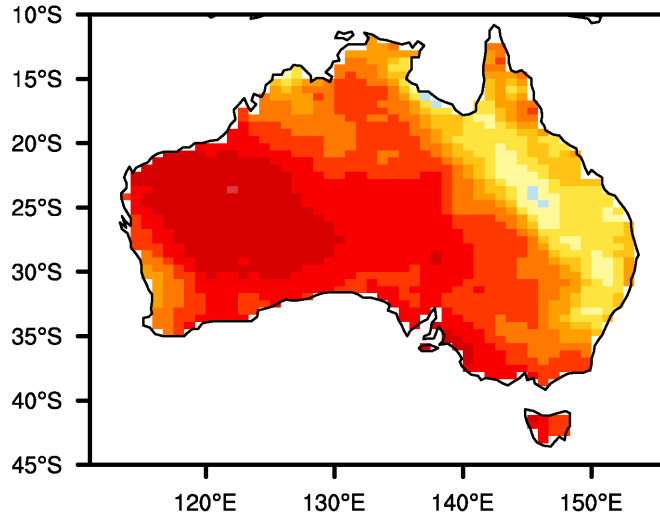
Improved tropical SST prediction skill



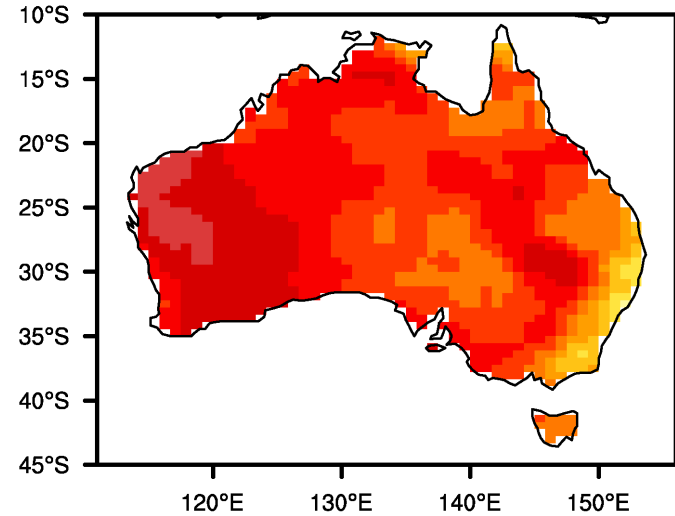
Source: Guomin Wang (ACCESS-S meeting 18/12/2015)

BUT

(b) ACCESS-S1,CTL



(c) POAMA e24a

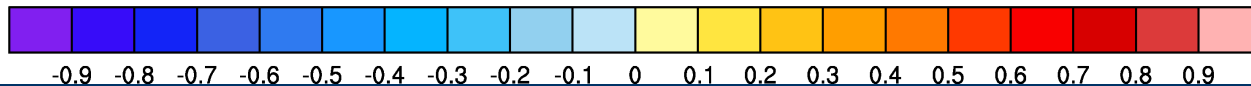
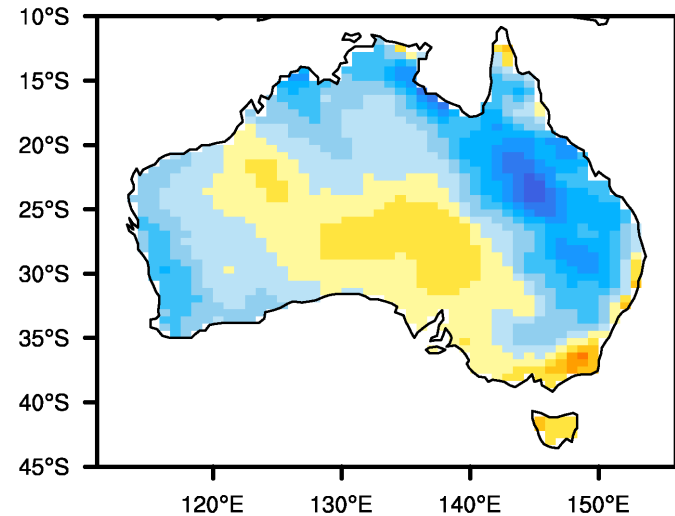


T_{max} hindcast skill
(anomaly correlation)
degraded

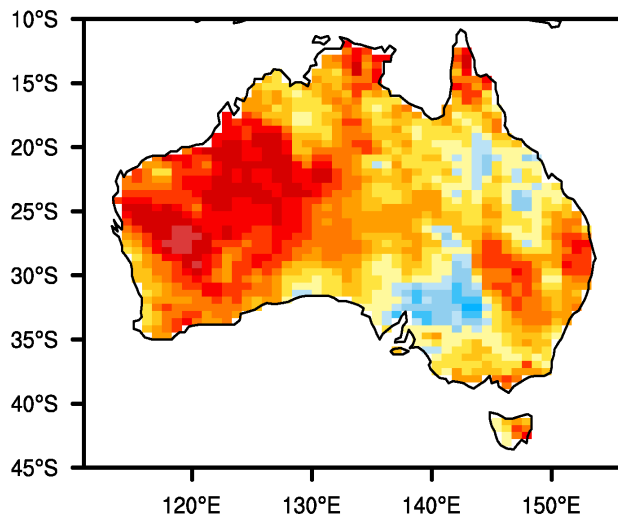
hindcast period: 1990-2012

Lead time (LT) zero: starting
1st May and forecasting for
May-Jun-Jul

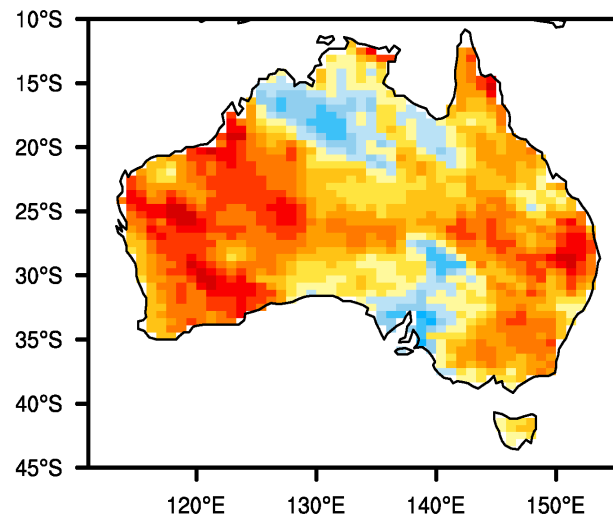
(f) Diff CTL-E24a



(b) ACCESS-S1,CTL



(c) POAMA e24a

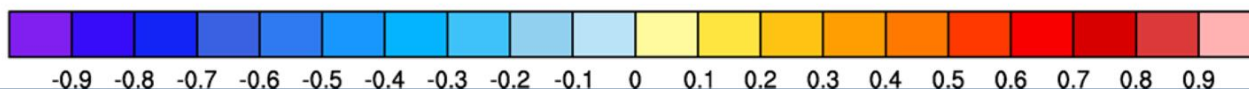
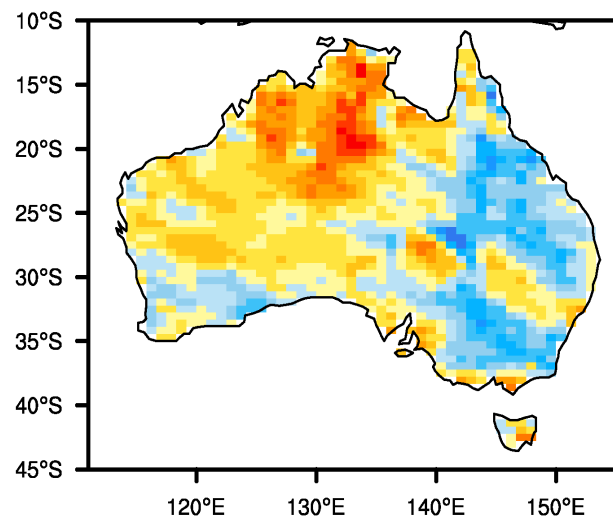


Prec hindcast skill (anomaly correlations) for 1st May start time

Hindcast period: 1990-2012

Lead time (LT) zero: starting 1st May and forecasting for May-Jun-Jul

(f) Diff CTL-E24a



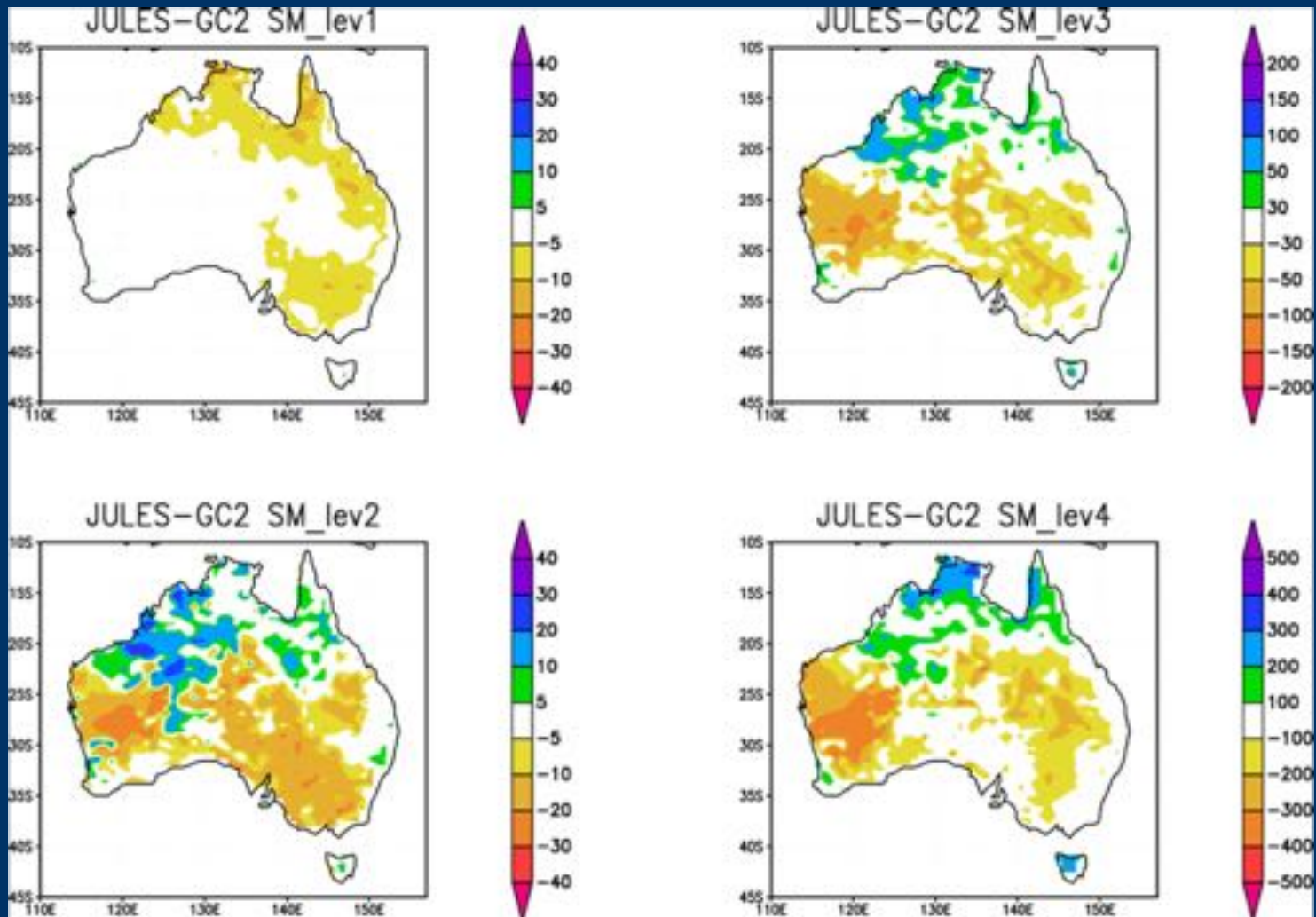
Focus of this study: contribution of soil moisture initialisation to the lack of translation of good tropical SST forecast skill into surface climate forecasts

Experiments (1st May, 3-mon, 11 members, 1990-2012)

- **CTL:** standard ACCESS-S1 configuration (as GloSea5/GC2) with an *invariant* climatological soil moisture used ;
- **LIC:** using interannually varying soil moisture from its land model JULES offline run (Era-interim forcing +GPCP rainfall correction);
- **LICC:** climatological soil moisture from JULES offline run

LICC~CTL → impacts due to different soil moisture climatology

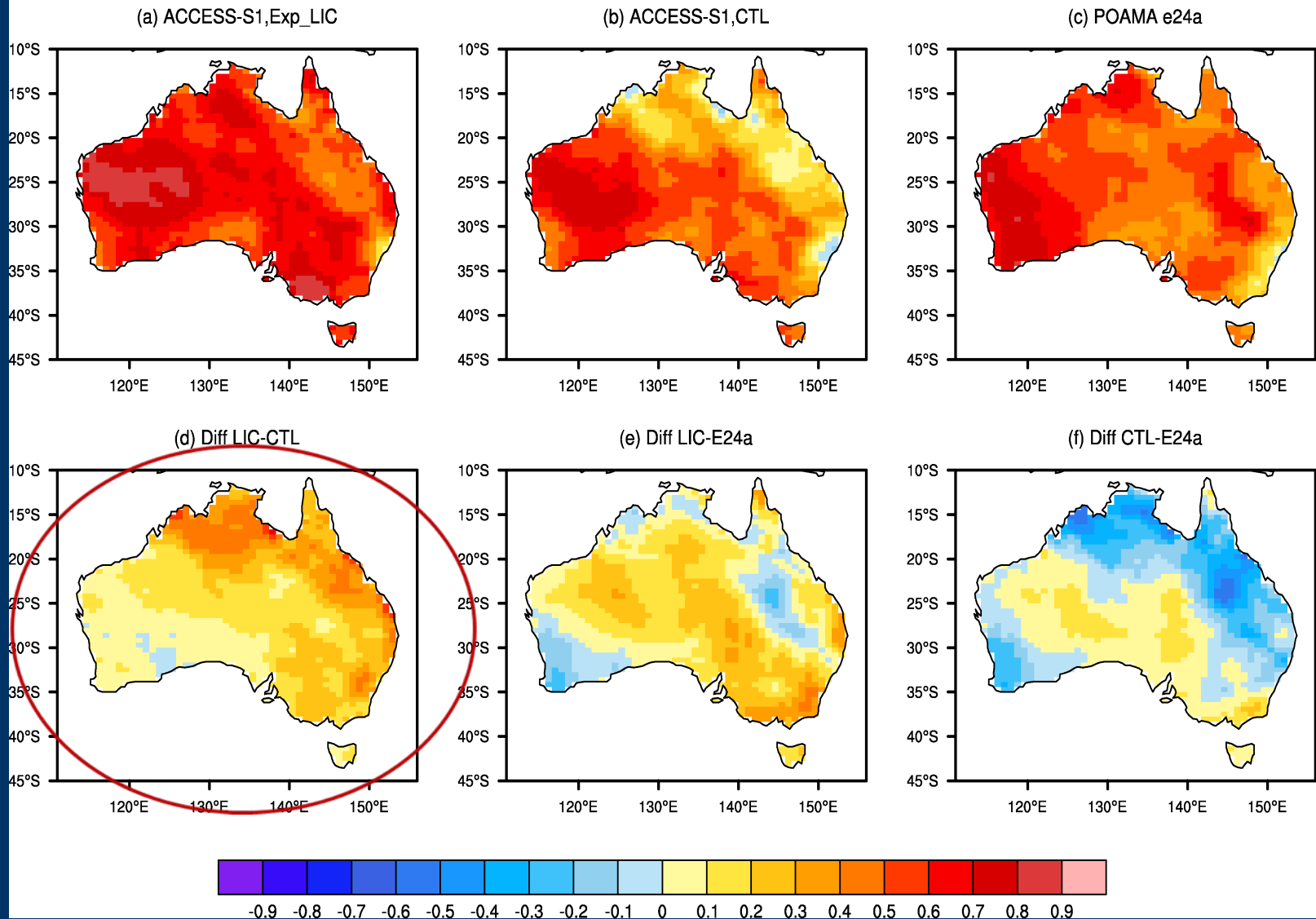
LIC~LICC → impacts due to varying soil moisture initial conditions



Different soil moisture initial conditions: soil moisture difference (May) at each soil layer between results from JULES offline run and that used in GC2/ACCESS-S1 (the differences are ~40-50% of the means)

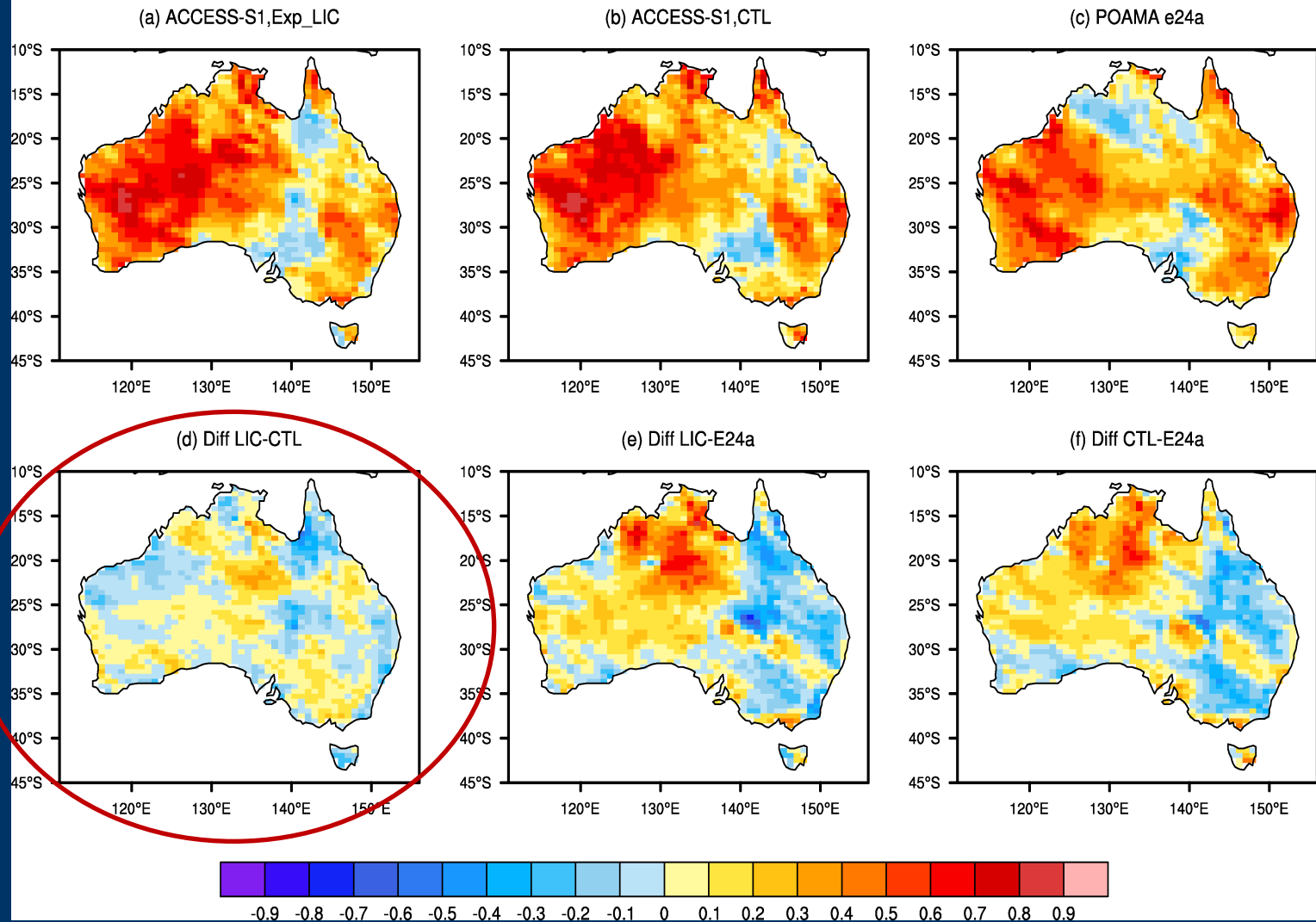
Seasonal forecast skill (anomaly correlation) gain from using "realistic" soil moisture initial condition: **Tmax**:

Tmax ACC with AWAP: 1990-2012, MJJ

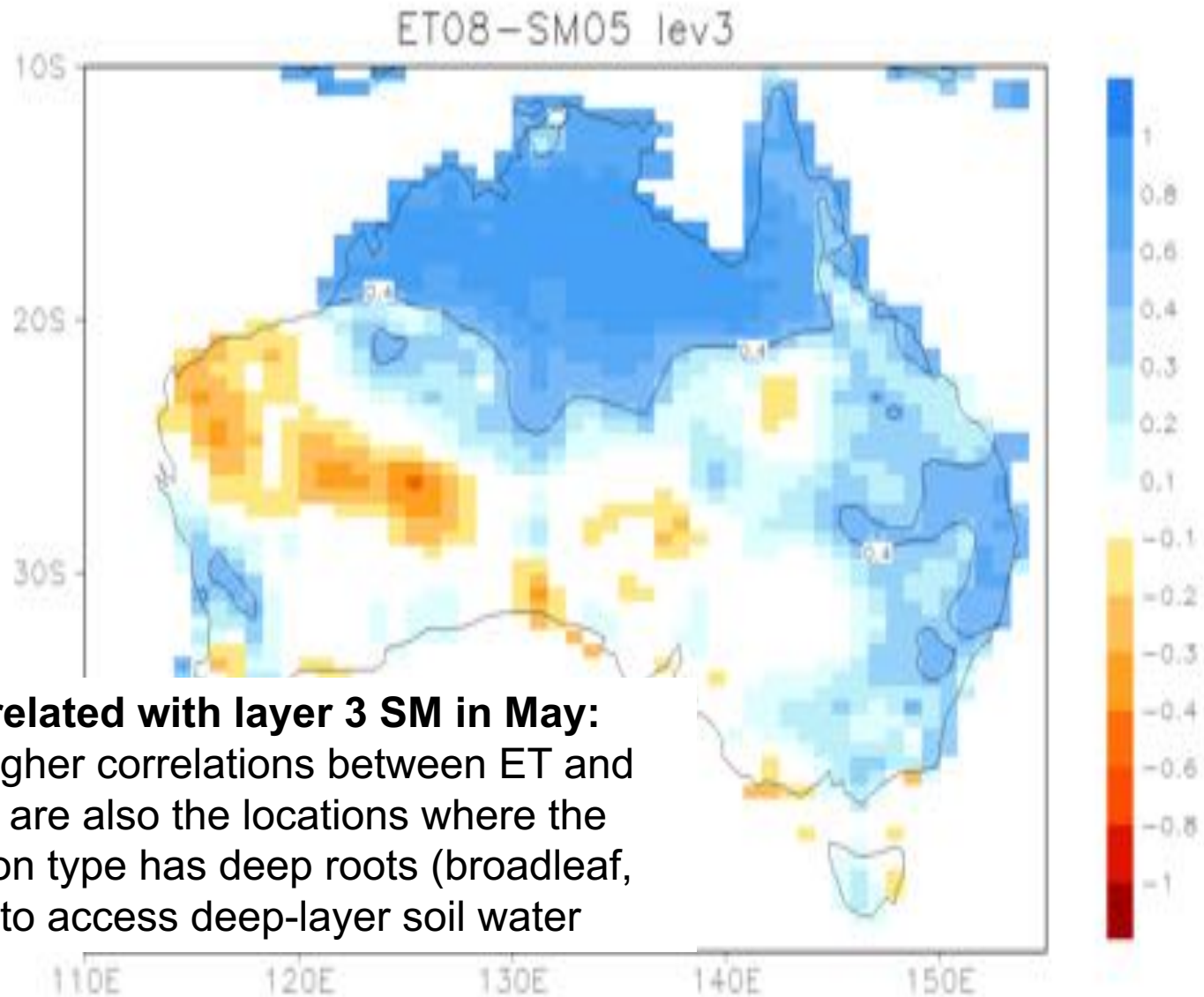


Seasonal forecast skill (anomaly correlation) gain from using "realistic" soil moisture initial condition: **Pr**

Prec ACC with AWAP: 1990-2012, MJJ



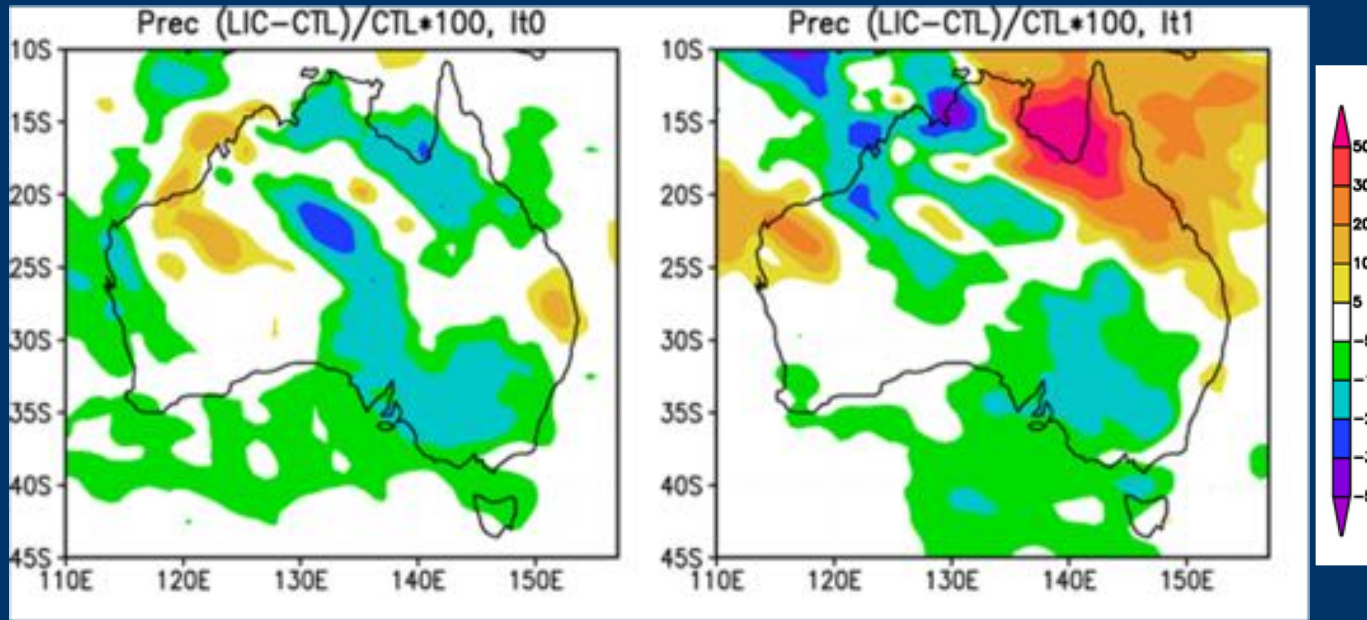
Q1: How strong is soil moisture memory (modelled and observed) in this dry continent?



ET in Aug correlated with layer 3 SM in May:

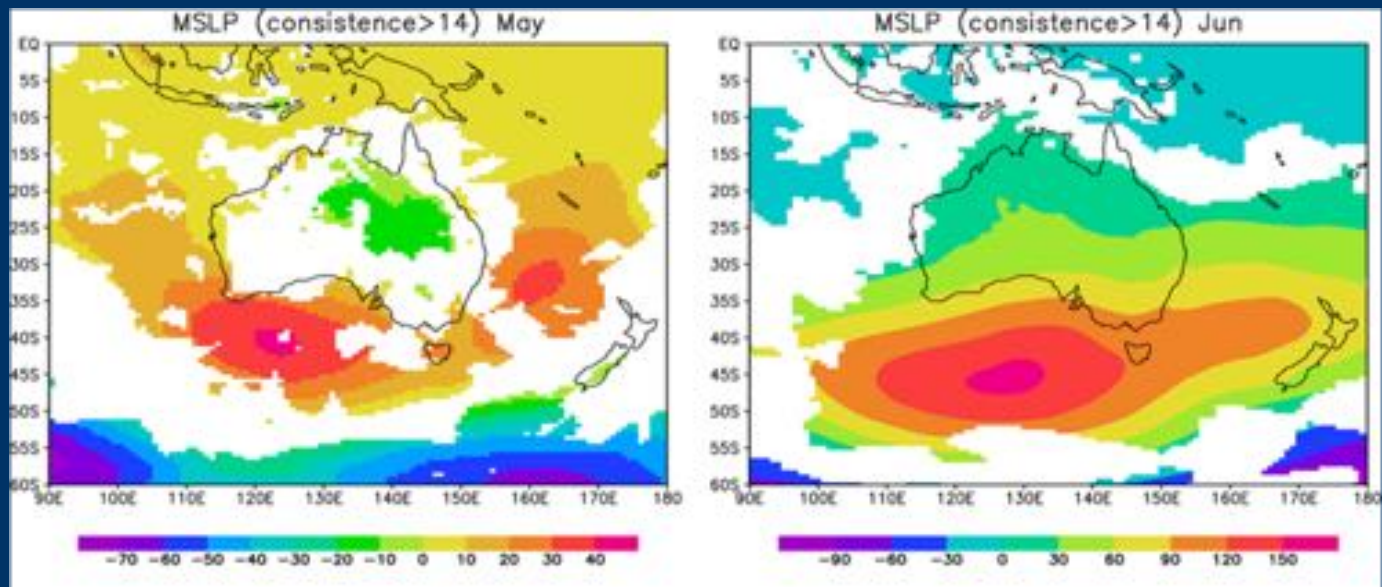
Regions with higher correlations between ET and preceding SM are also the locations where the model vegetation type has deep roots (broadleaf, 3m root depth) to access deep-layer soil water

Q2: Any circulation responses to support the model skill gain?



Difference (%) in model rainfall climatology from 23-yr hindcasts

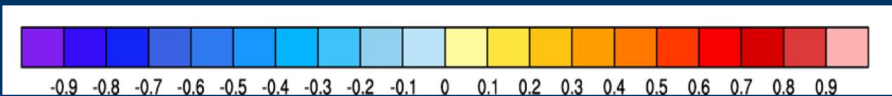
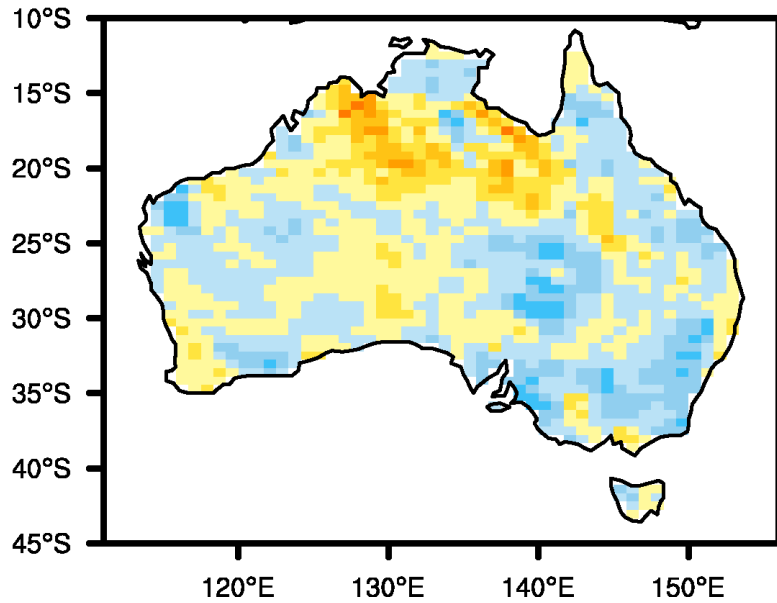
Difference in model MSLP climatology (hPa)



Summary:

- Impacts of land-surface initial conditions on ACCESS-S1 seasonal forecast skill are evident over Australia region;
- Even in this dry continent, both observations and modelled results showed notable soil moisture memory and its impacts on surface fluxes and land-sea thermal contrast;
- The model skill gain is supported by regional circulation responses to different land surface conditions;
- Model skill improvement expected in ACCESS-S2 in which better LIC is being implemented.

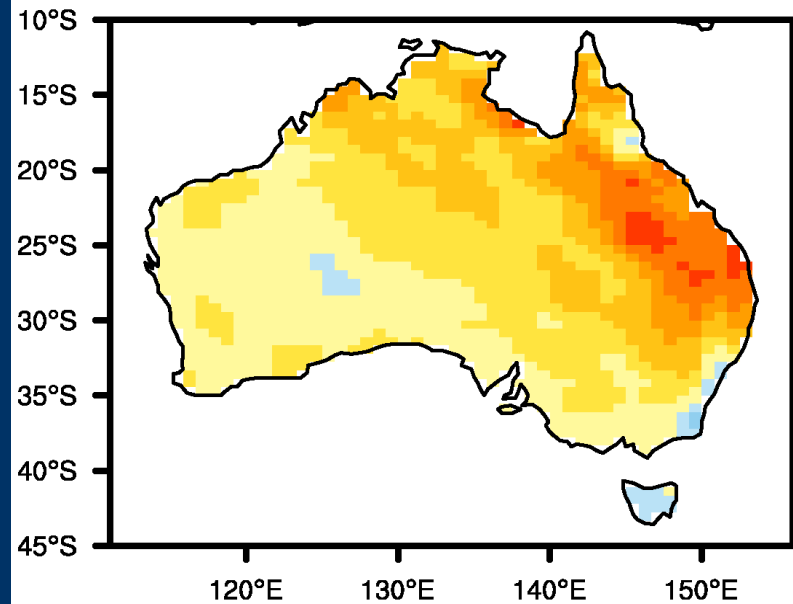
(d) Diff LIC-LICC , Prec



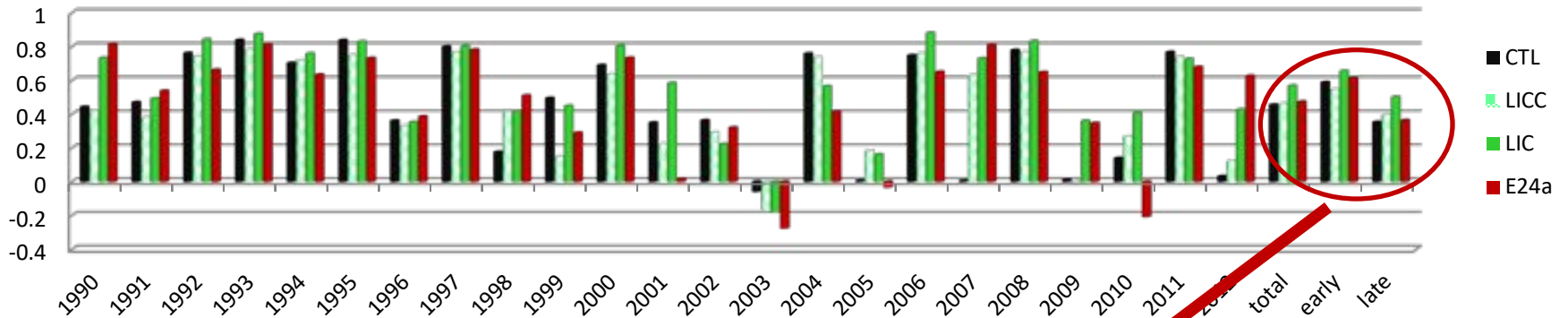
LIC against LICC:

climatological soil
moisture ~ "realistic" soil
moisture)

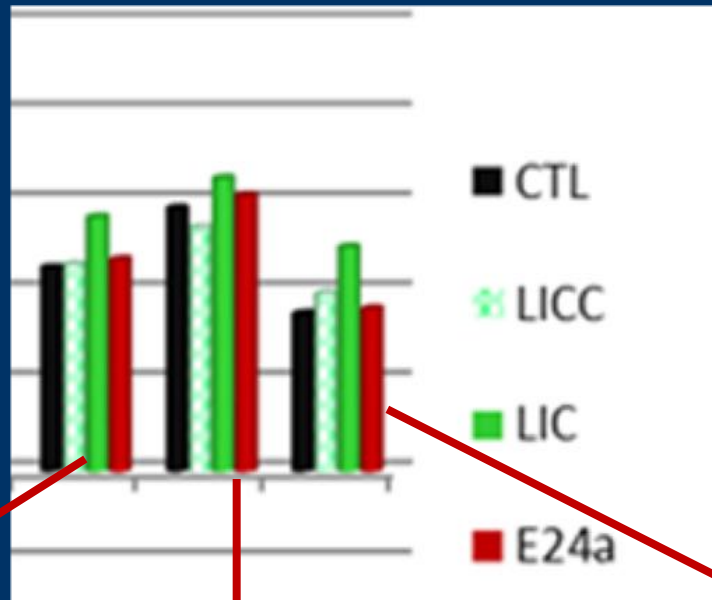
(g) Diff LIC-LICC , Tmax



Pattern Corr with AWAP Tmax_oz, 0501, It0



Spatial correlation of May Tmax monthly anomalies over Australia



total period (1990-2012)

early period (1990-1999)
IPO warm phase

late period (2000-2012)
IPO cold phase