

The challenges of reducing systematic biases in the Indian Ocean

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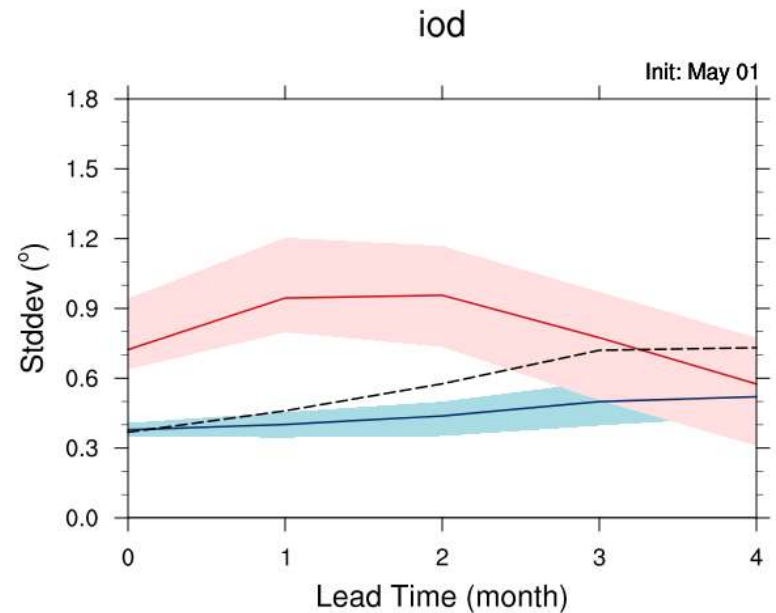
Plan

The problem – Indian Ocean Biases

Atmospheric convection sensitivity Study

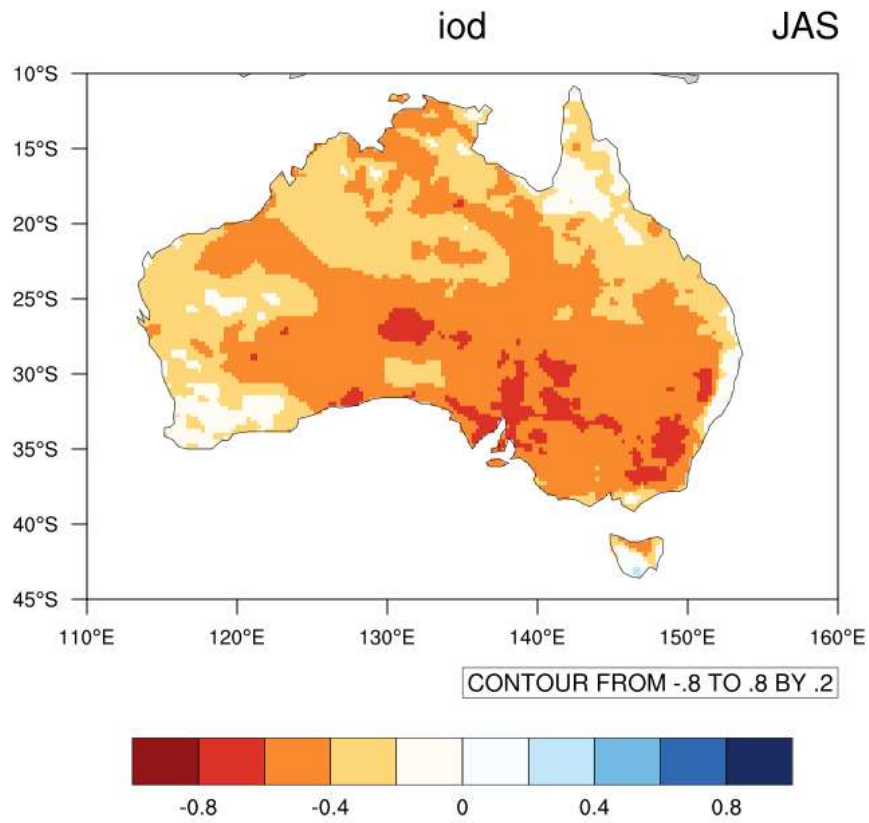
Can ocean data assimilation impact atmospheric biases

Conclusions

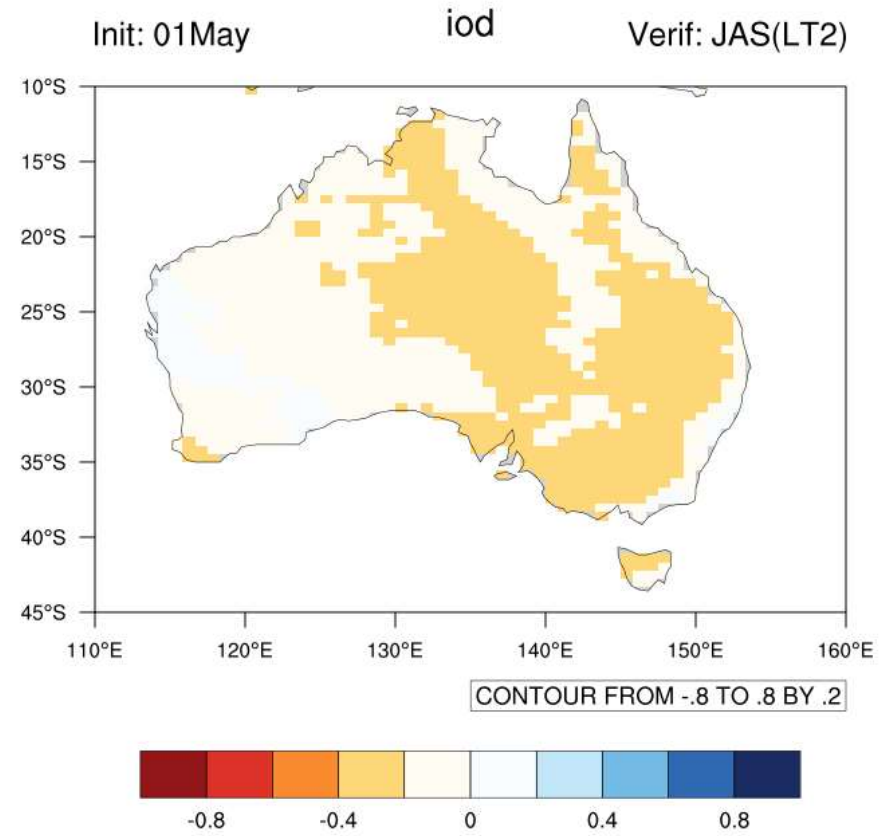


IOD Teleconnections to Australia

Obs - correlation



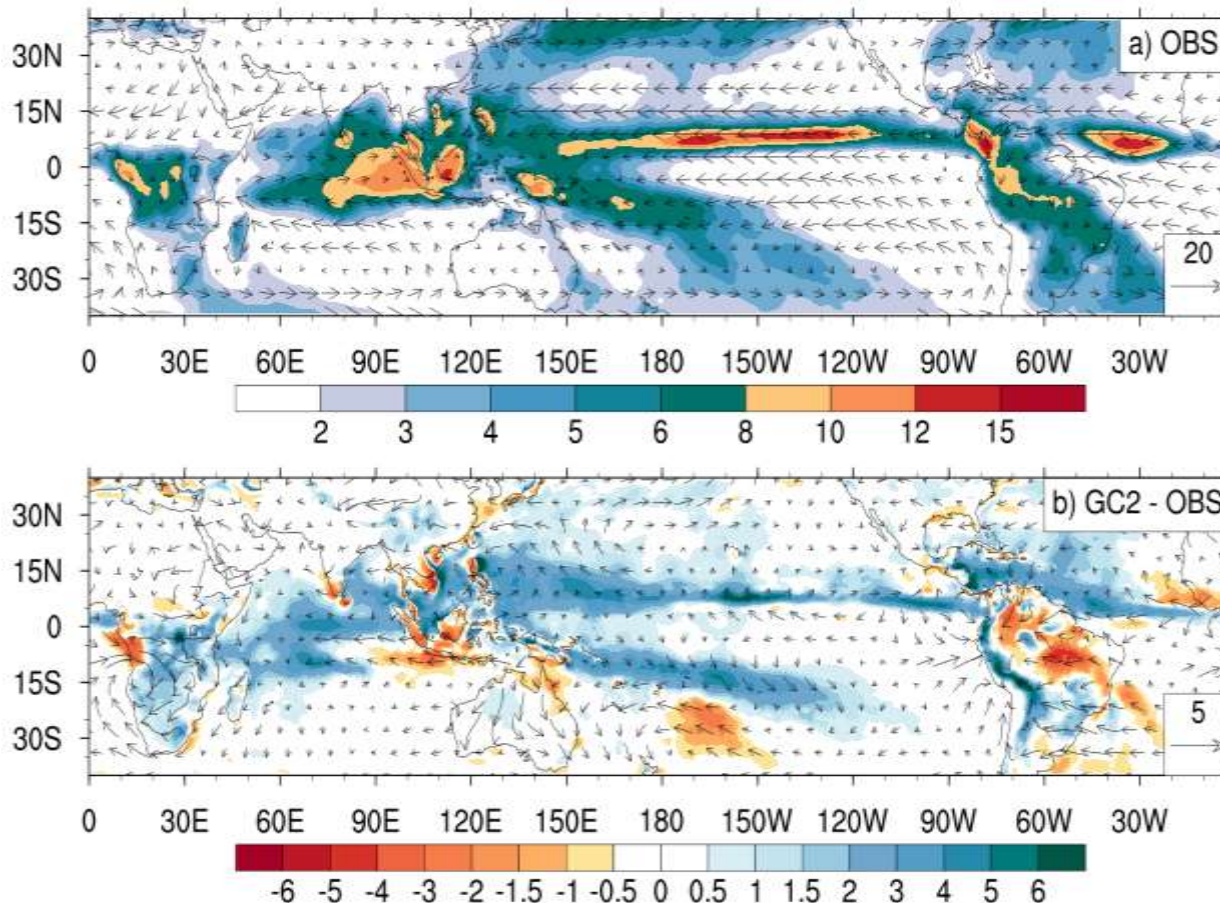
Model - correlation



Rainfall/Surface Wind Coupled Model Forecast Bias

DJF based on 1st Nov Forecasts over 23 years

UKMO GC2 used for seasonal at UKMO
and BoM



Indian Ocean

Too dry east, wet west

Enhanced easterlies along
equator

Pacific – enhanced
convection in west +
enhanced easterlies along
equator

Too dry northern Australia

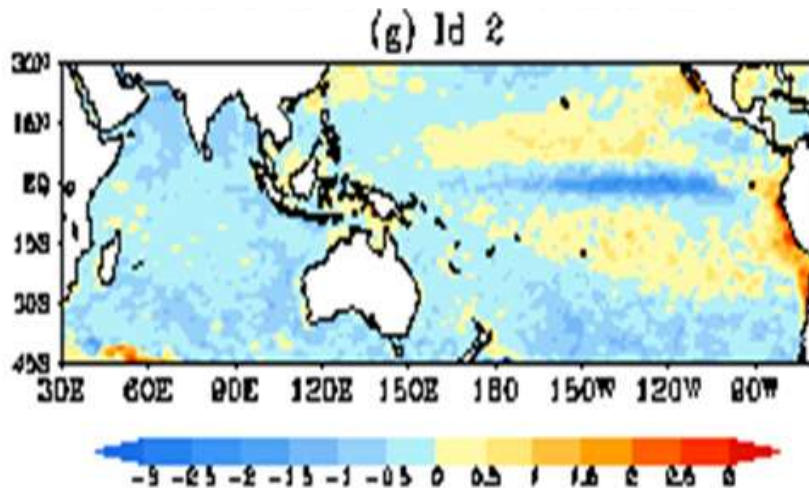
Same issues in AMIP run

Atmospheric problem ?

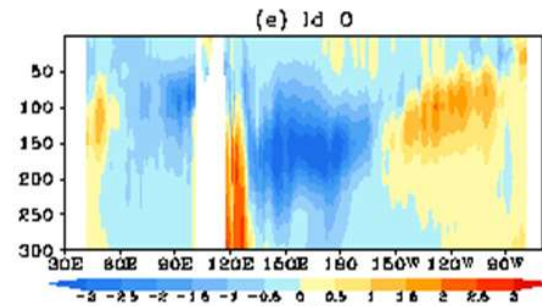
Impact of biases on ocean

Model – obs mean

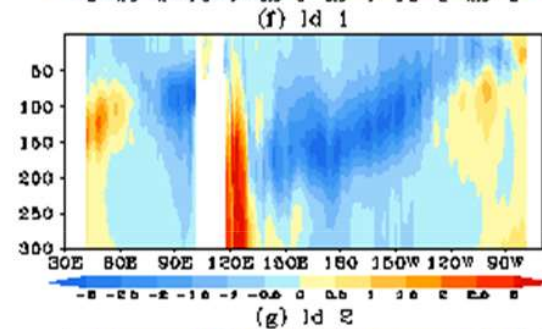
SST Month 3



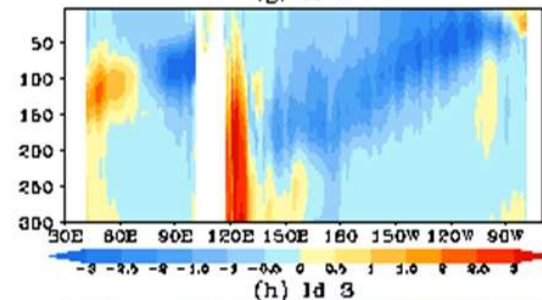
Temperature section
along equator



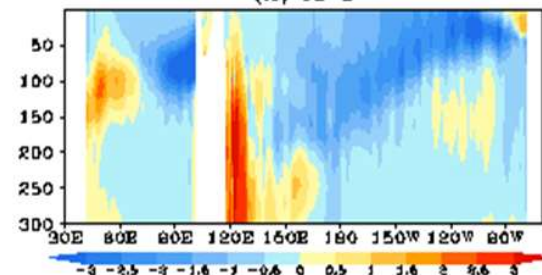
Month 1



Month 2



Month 3



Month 4

Blame the atmosphere

Especially atmospheric
convection

Experiment Strategy

Tried several changes e.g. Enhanced convective entrainment, changes to precip melting – little impact on Indian Ocean and dry bias due to compensating effects e.g. between convective and large scale precip.

Experiment here – look at impact of increased convection over maritime continent by artificially enhancing convection over land

EXPT: 2K temperature perturbation is added to the updraft parcel over all land points

Table 1. Convective diagnosis in 10-day SCM simulation (total 1200 time-steps)				
	Total	Deep	Shallow	No Convection
CTRL	1200	142	67	991
Experiment	1200	84	1028	88

AMIP Style Forecasts

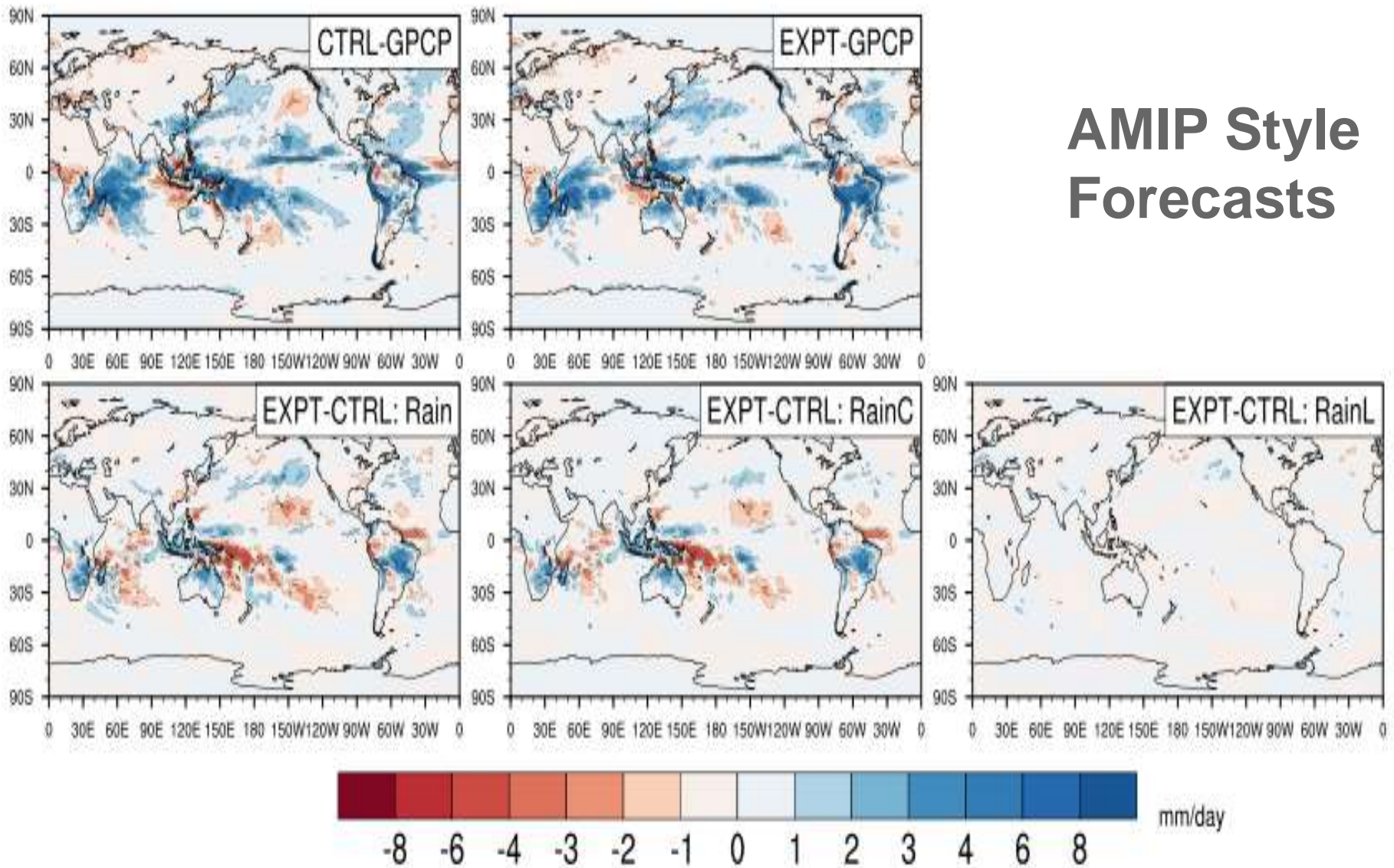
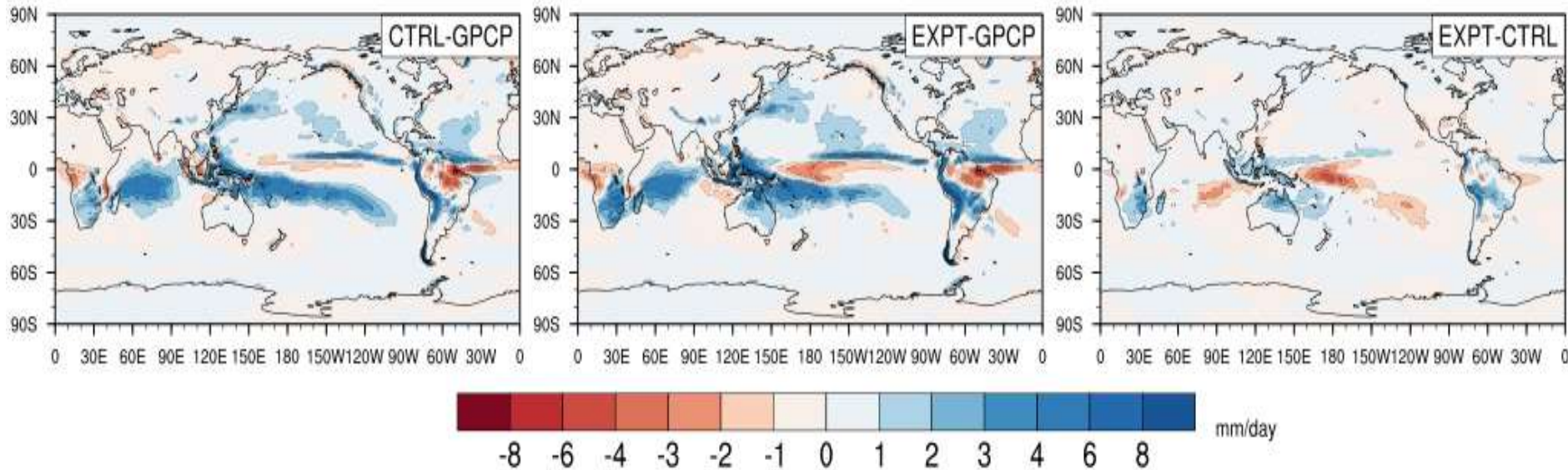


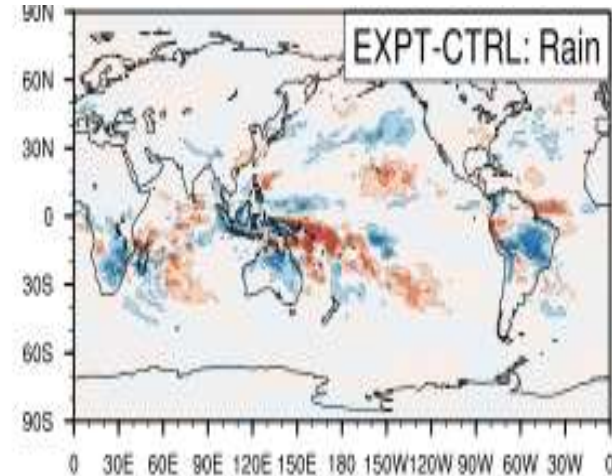
Fig.2: DJF mean rainfall from GPCP and total, convective and large-scale rainfall from CTRL and the experiment in AGCM. The lower two rows show their bias relative to GPCP and CTRL, respectively.

Coupled Forecast Results

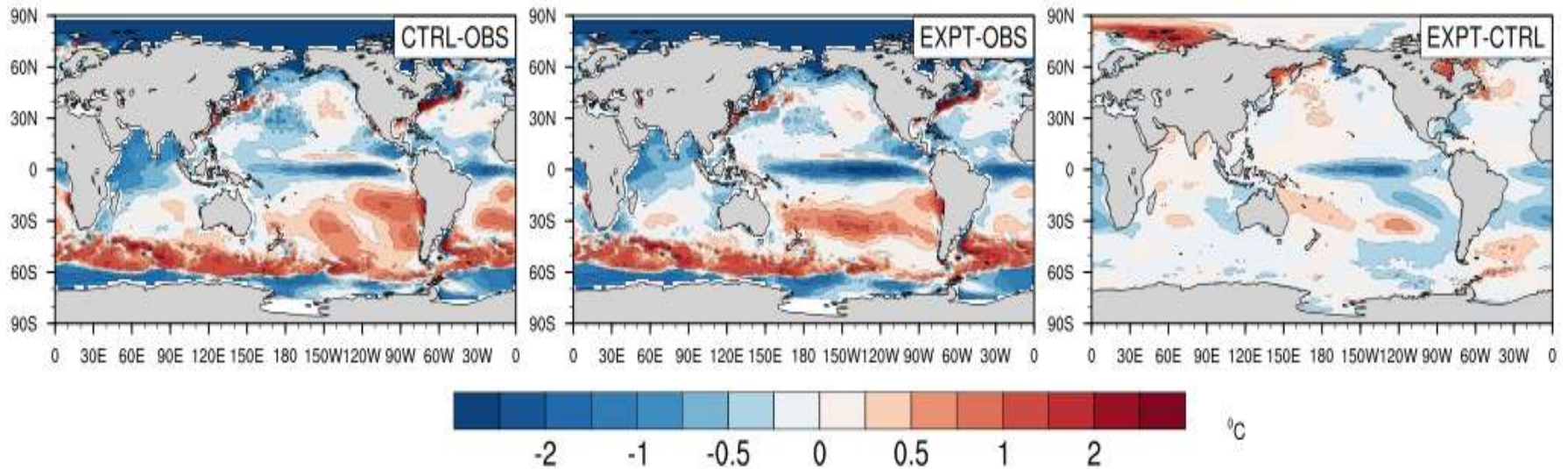
Coupled DJF Precip fc starting 1 Nov (1990-2012)



Uncoupled



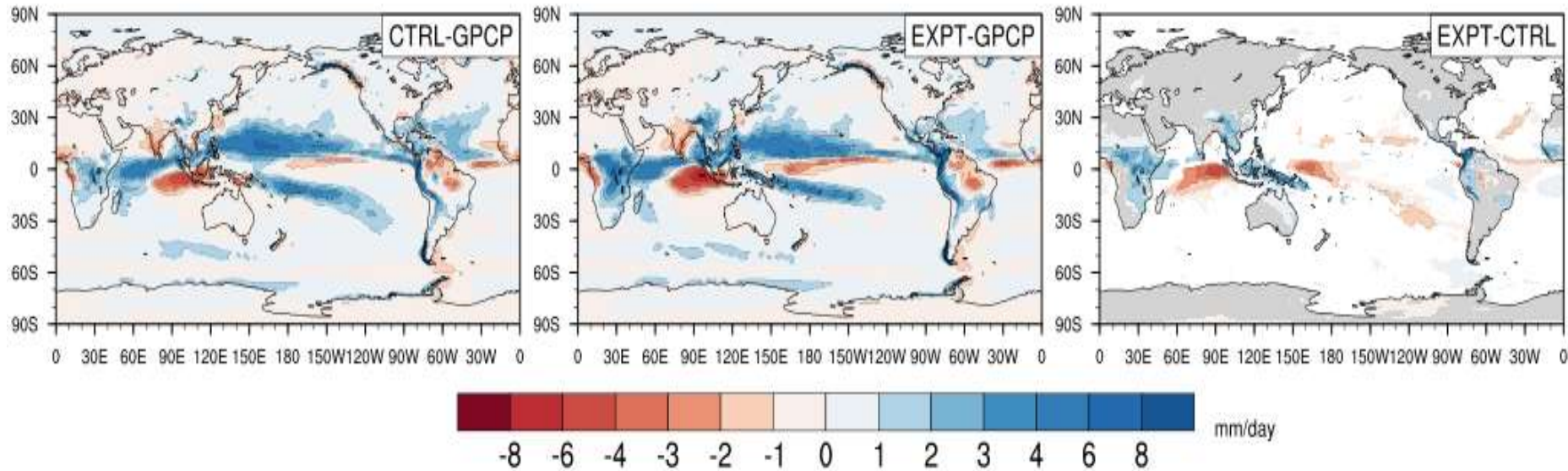
Impact of SST biases for DJF



Indian Ocean cold bias is slightly reduced. But cold tongue issue is amplified in EXPT.

Repeat Coupled Experiment for 1st Aug Start – for IOD

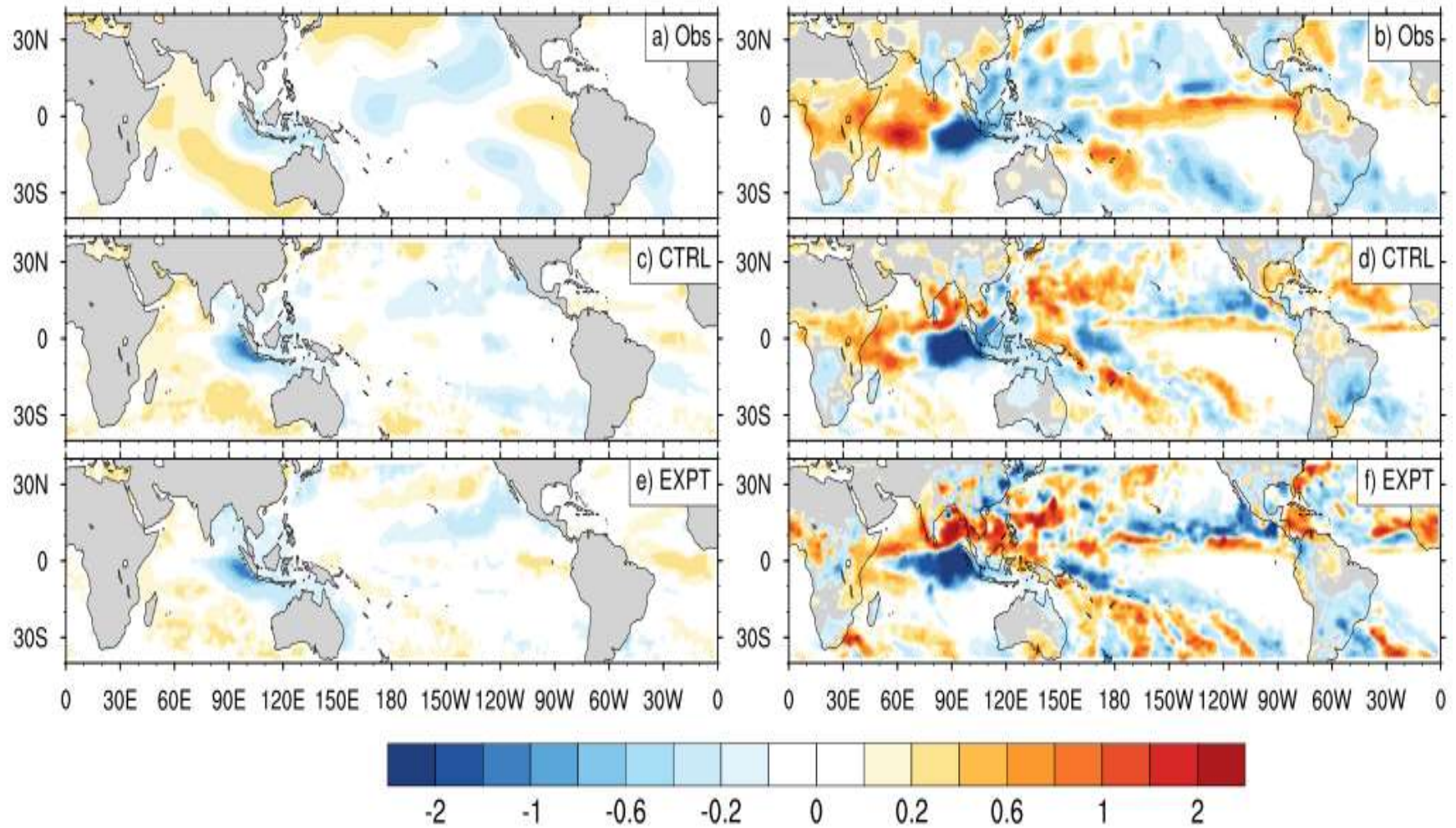
Results for SON Season



It makes the rainfall bias worse. Positive IOD type SST bias is also enhanced. Not lucky this time!

Regression of SST/Rain onto IOD SST index

1st Aug Start for SON Season



EXPT is not an improvement in terms of IOD

Let's look at something
completely different

Ocean assimilation
impact

10 – Year Re-Analyses and Hindcasts

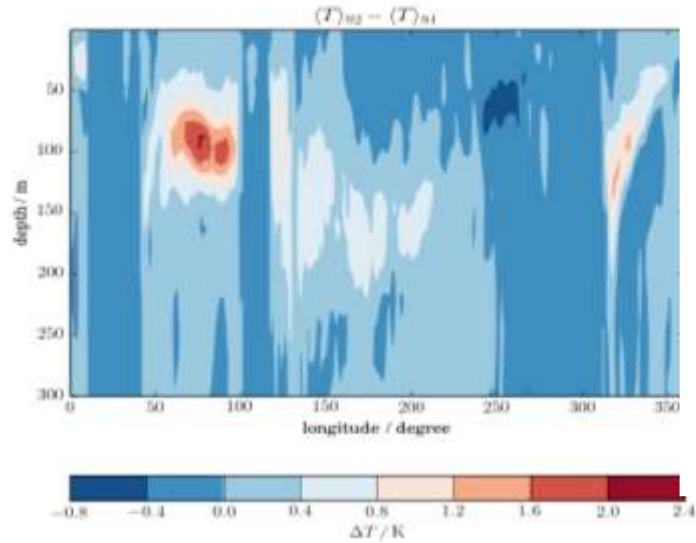
ACCESS-S1: Uses UKMO Initial Conditions from UKMO ocean assimilation scheme (The control experiment in the convection study)

ACCESS-S2: Uses BoM coupled assimilation scheme (very different to UKMO scheme)

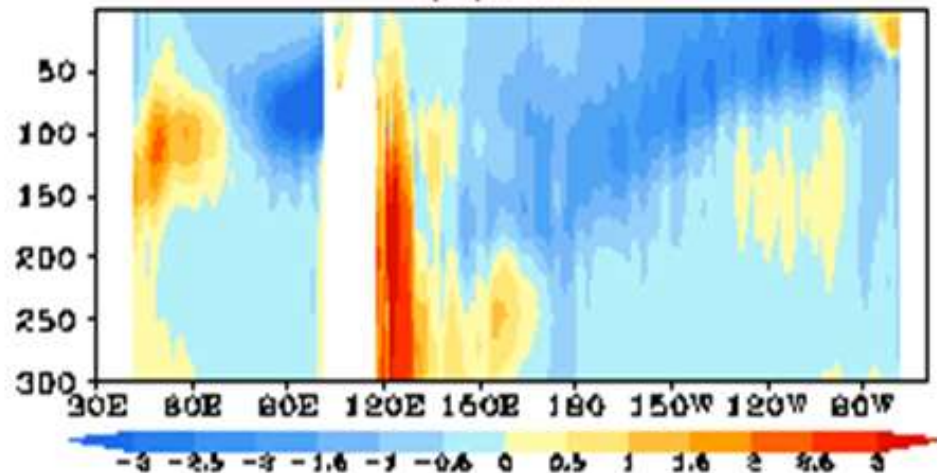
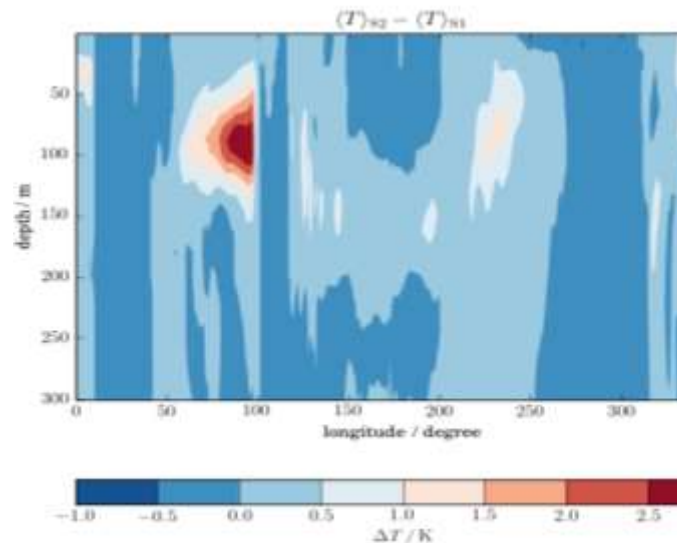
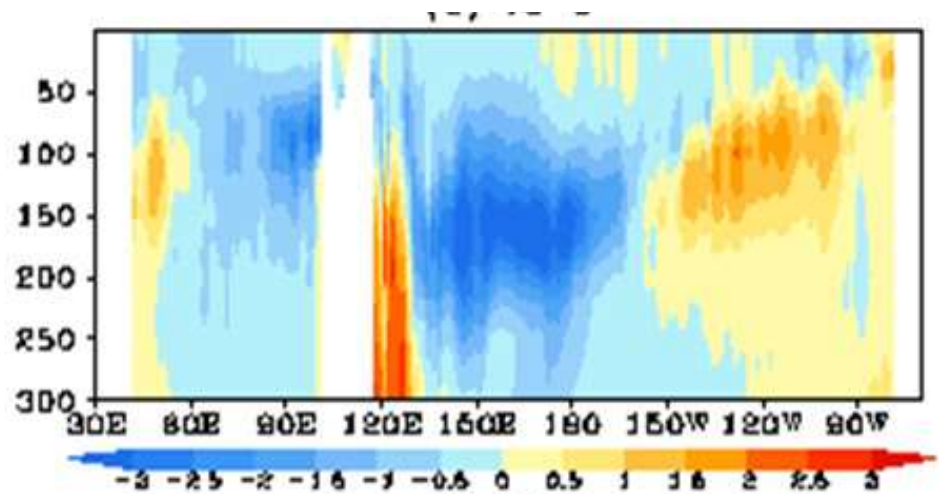
- 10 Coupled Re-analyses
- 3 months lead hindcasts every 3 months (5-11 members)
- Preliminary view of impact on ENSO/IOD

Assimilation impact: Equator ocean temperature bias

ACCESS-S2-ACCESS-S1



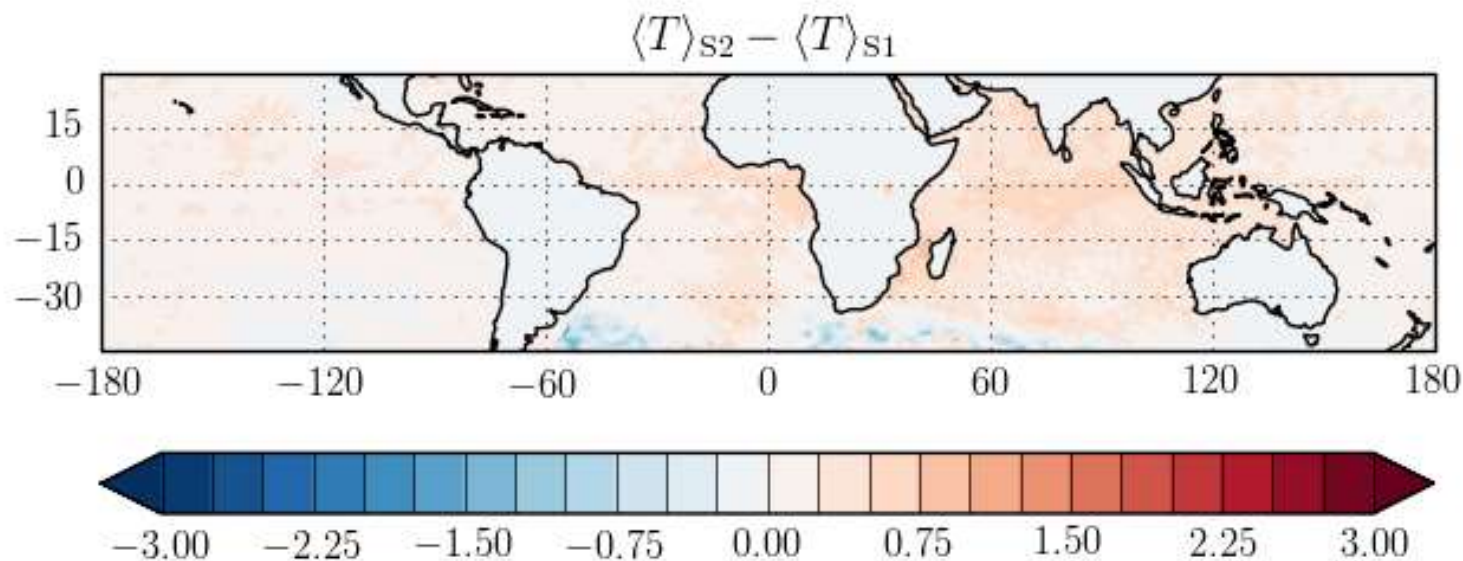
ACCESS-S1 Bias



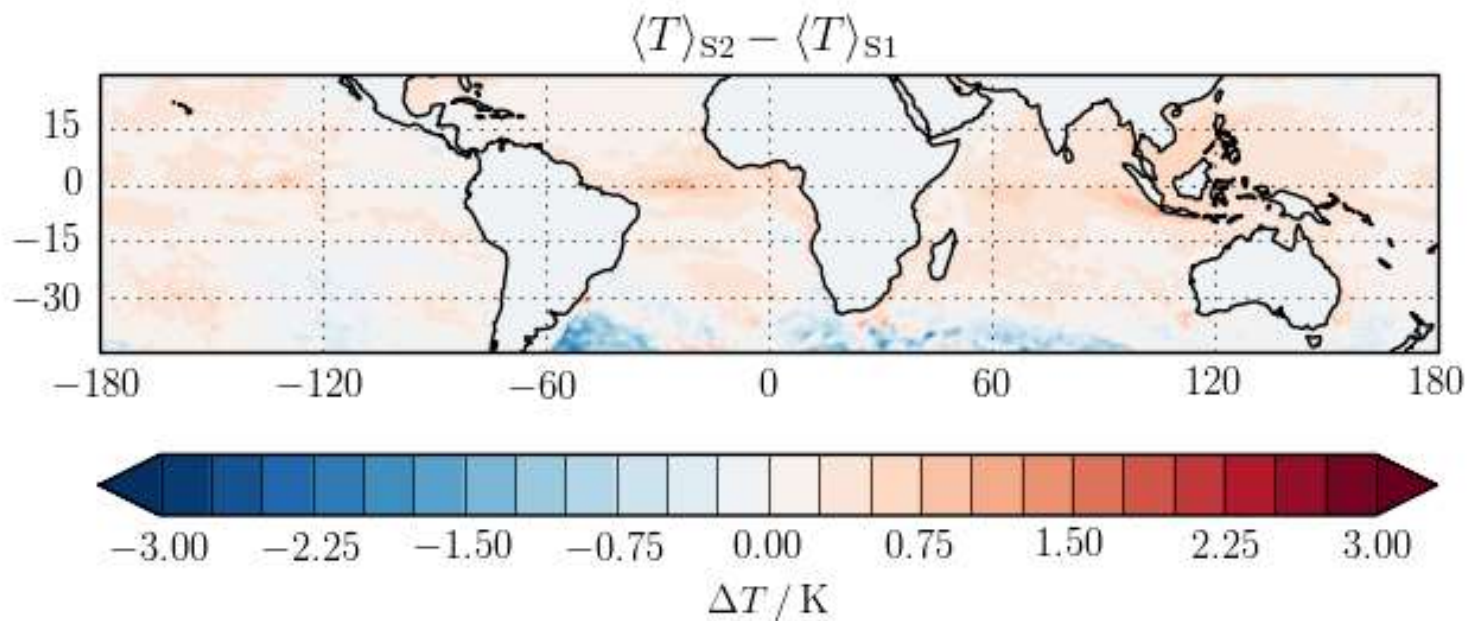
Assimilation impact: Ocean SST bias

SST : ACCESS-S2-ACCESS-S1

Month 1



Month 3



Assimilation differences

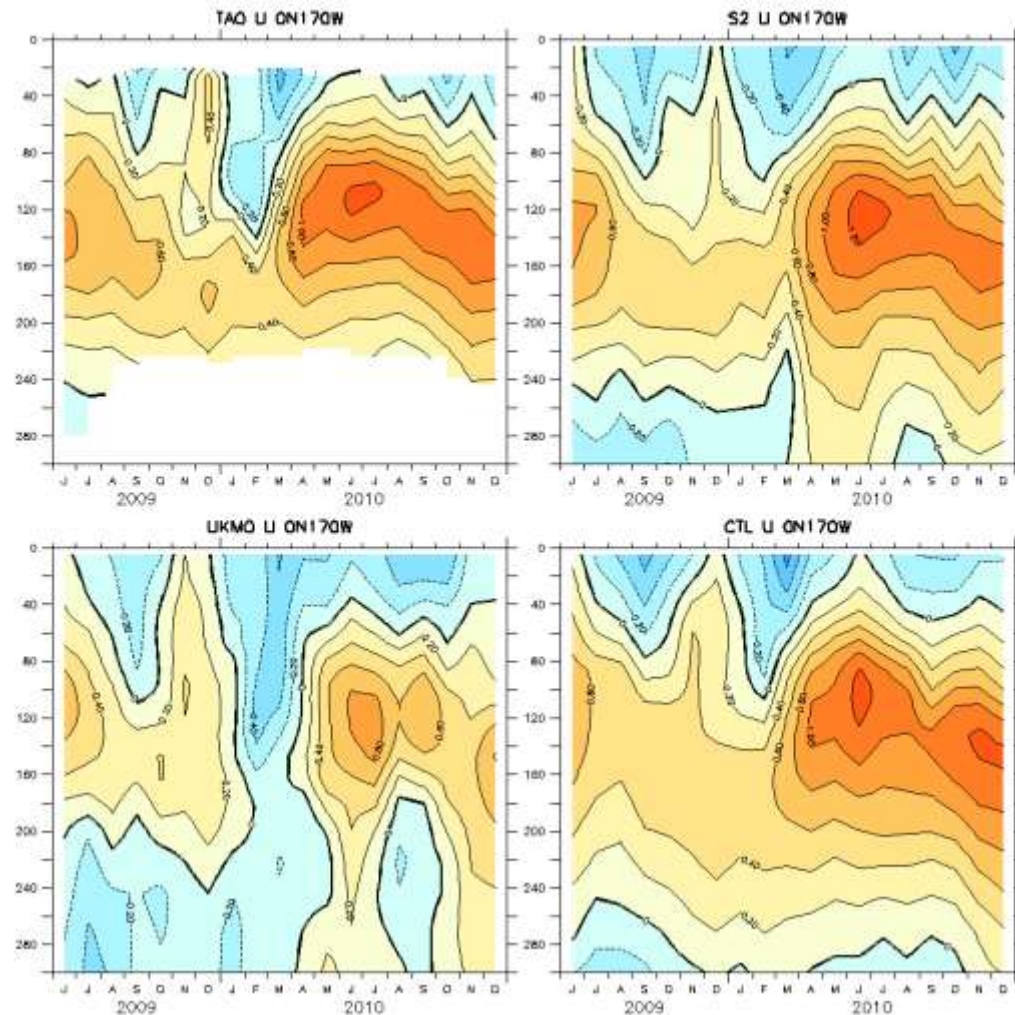
Compared 2 year ocean re-analyses

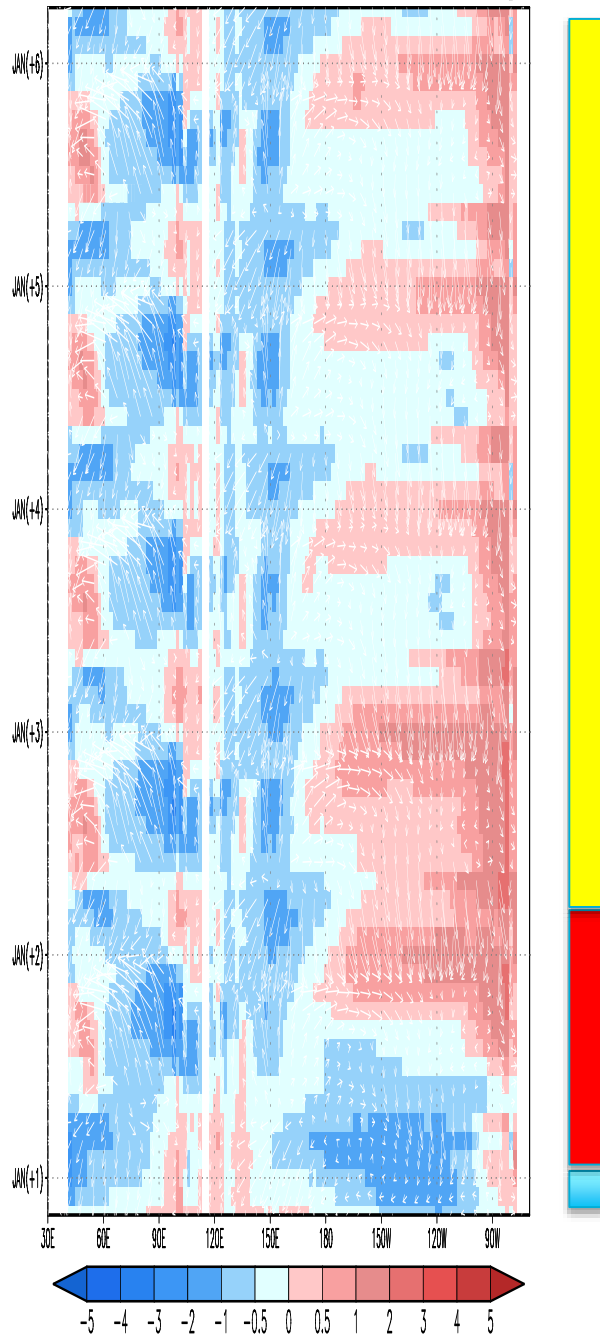
Temperature/Salinity very similar

Velocities very different – better in ACCESS-S1

Could have significant positive impact on ENSO/IOD skill (and SST biases)

Equatorial currents important for oceanic Kelvin wave mode





Conclusions

Coupled model error –
model mean state bias

Coupled model + all initialisation contribute to
model bias – difficult area to work in

Atmos model error + Atmos
Initialisation (~days ?)

What Next

Measure how much ocean initialisation errors can impact model bias (both ocean and atmosphere)

The only difference in ACCESS-S1 and ACCESS-S2 is the ocean assimilation

Conducting large hindcast set of ACCESS-S2