

# Modeling South Asian monsoon precipitation climatology: Representation of air-sea interactions over the tropical Indian Ocean

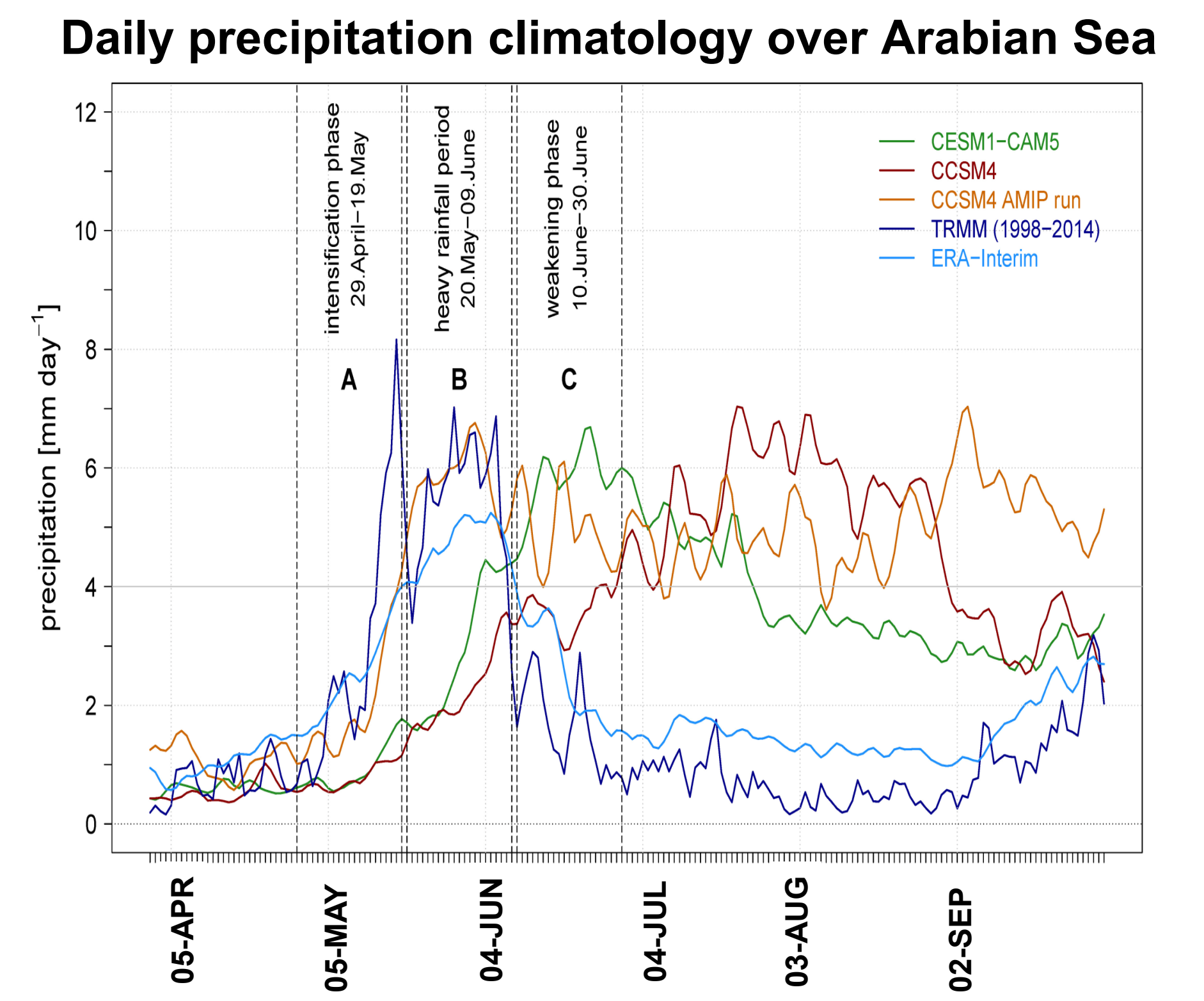
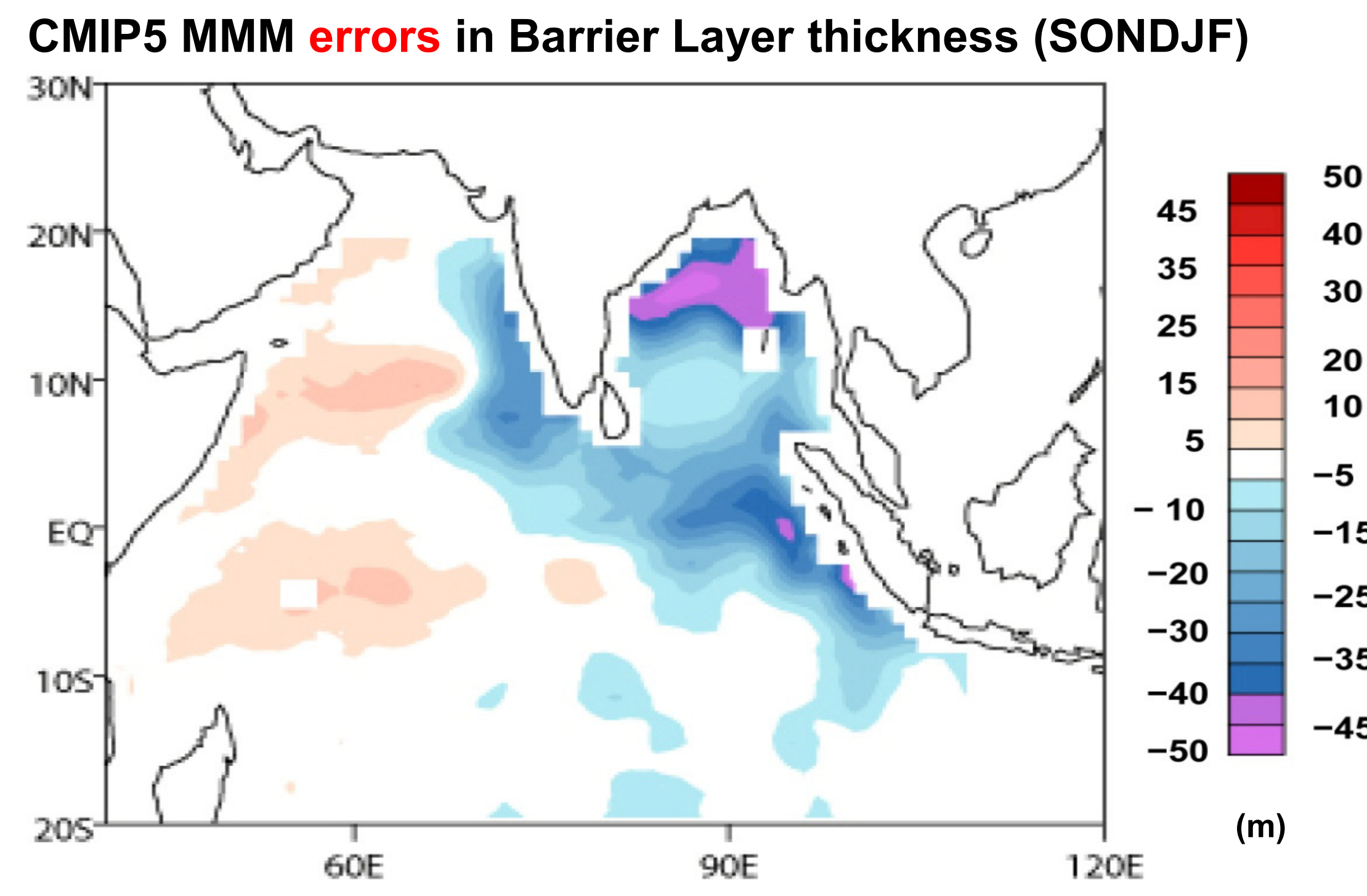
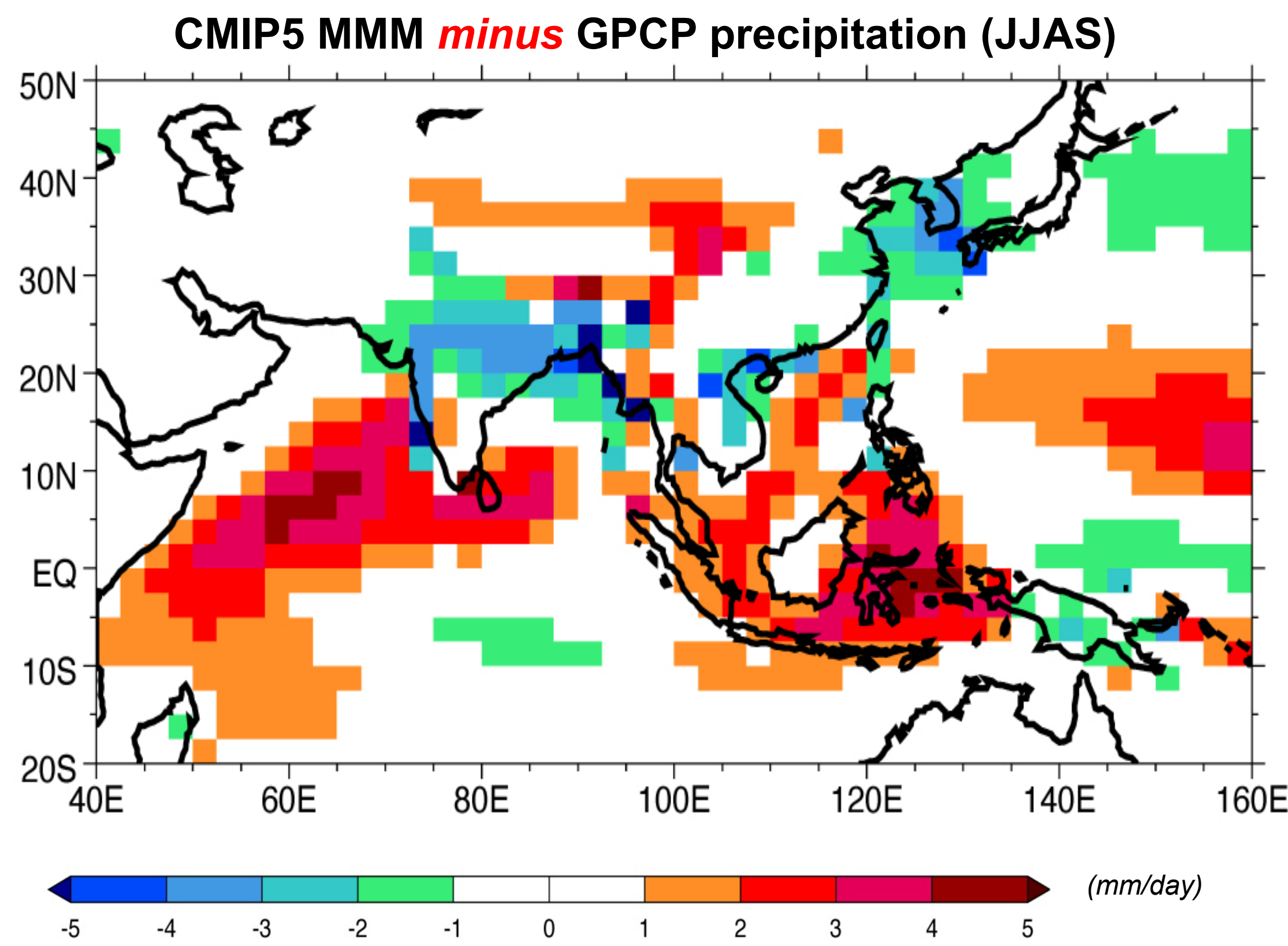
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## Motivation

Relative to observations, multi-model-mean errors for the Asian monsoon precipitation climatology shows little improvement in the last few decades. Here, with a focus on air-sea interactions and their impact on monsoon convection, the nature and dynamical causes of the models' biases are investigated by performing process-based diagnostics and sensitivity experiments with CFES (Coupled model For Earth Simulator).

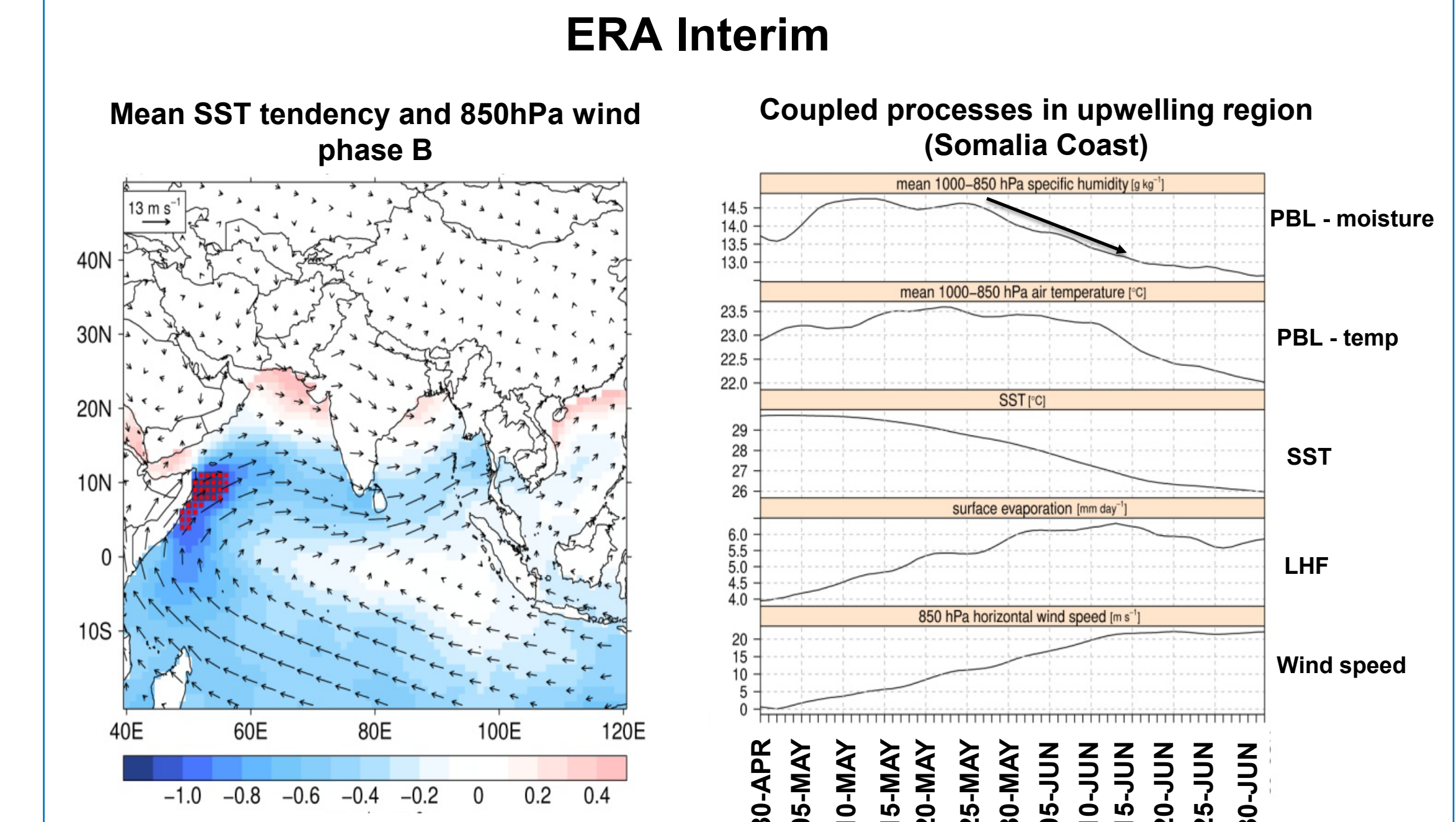
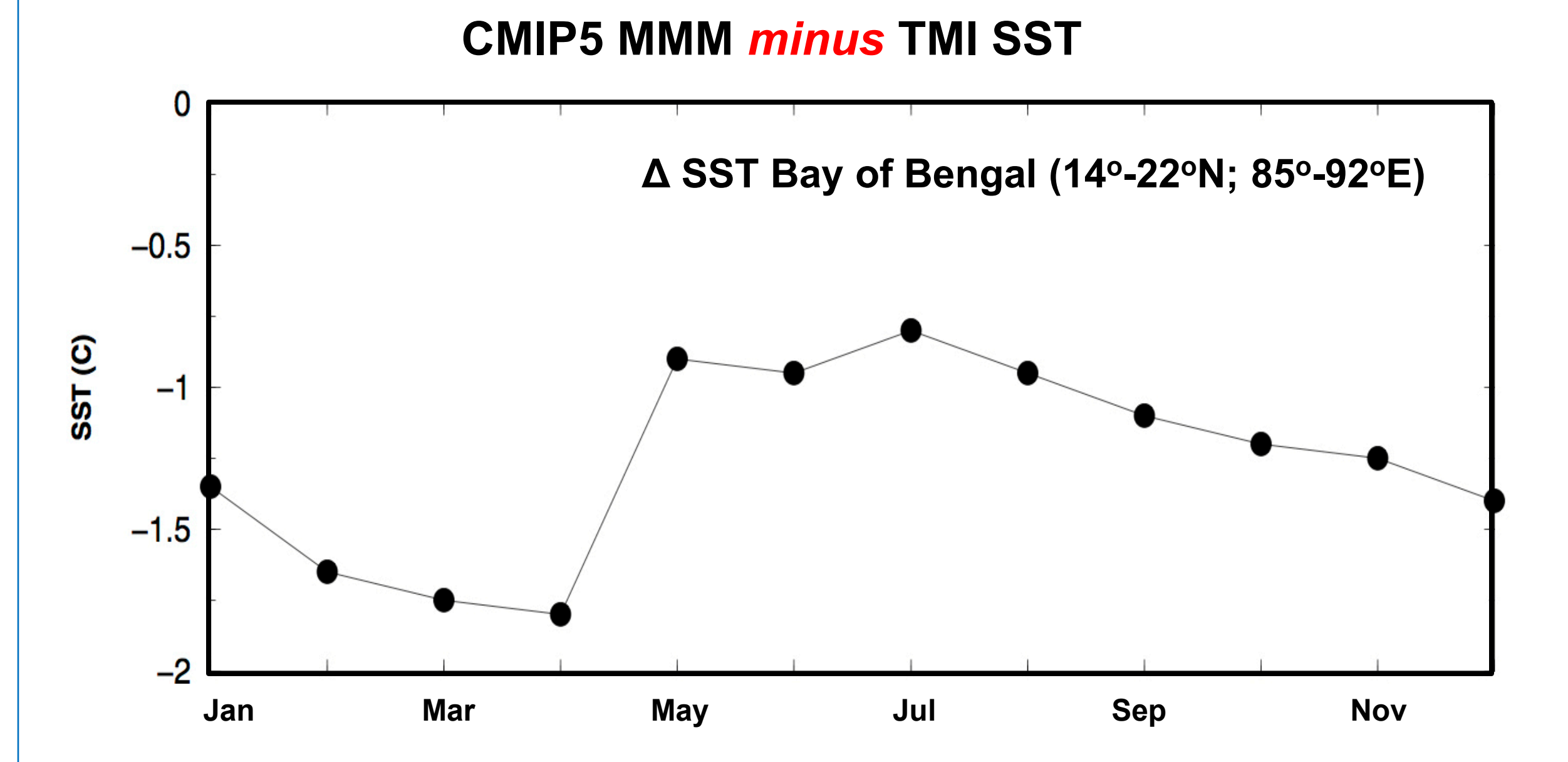
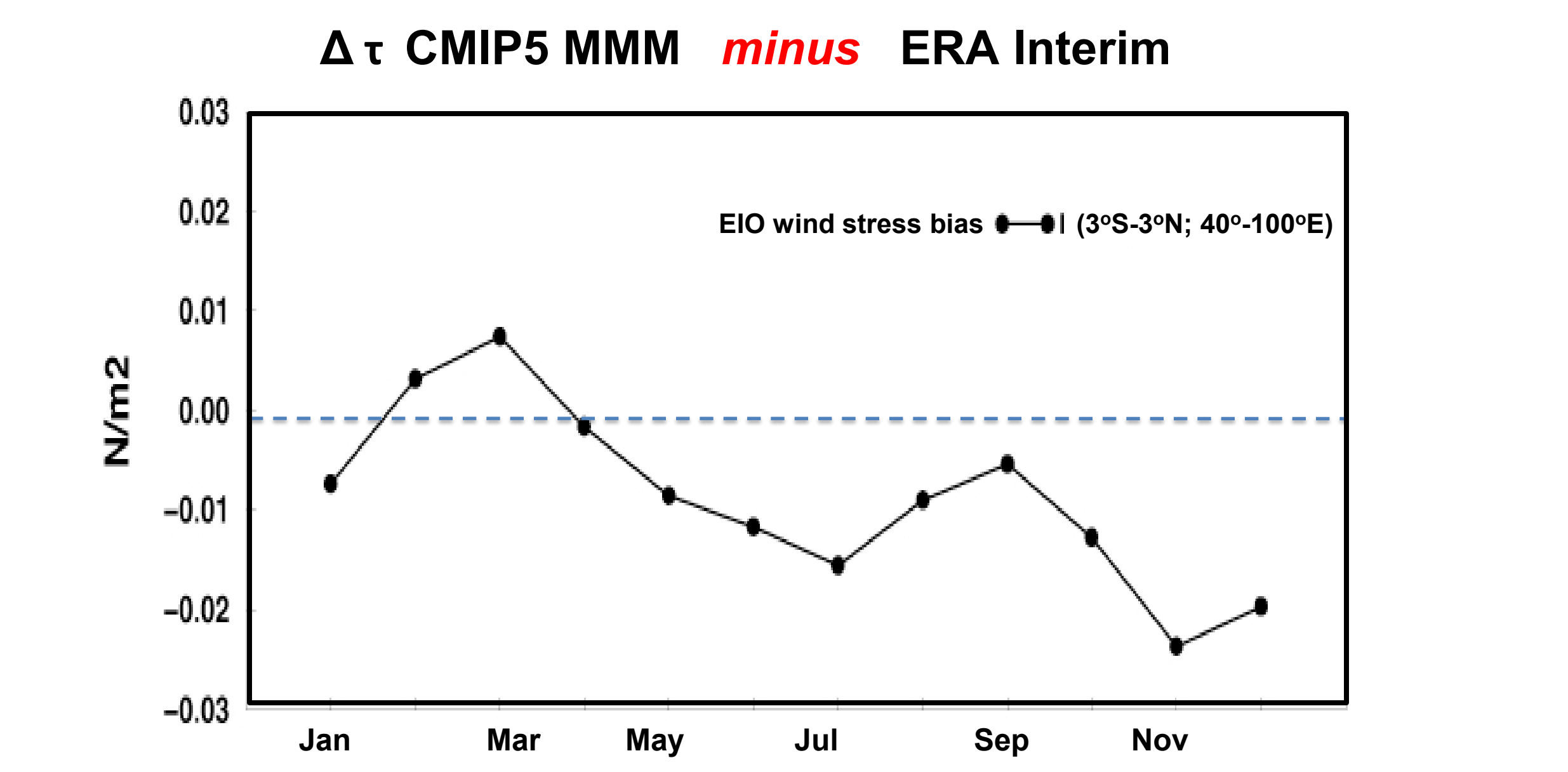
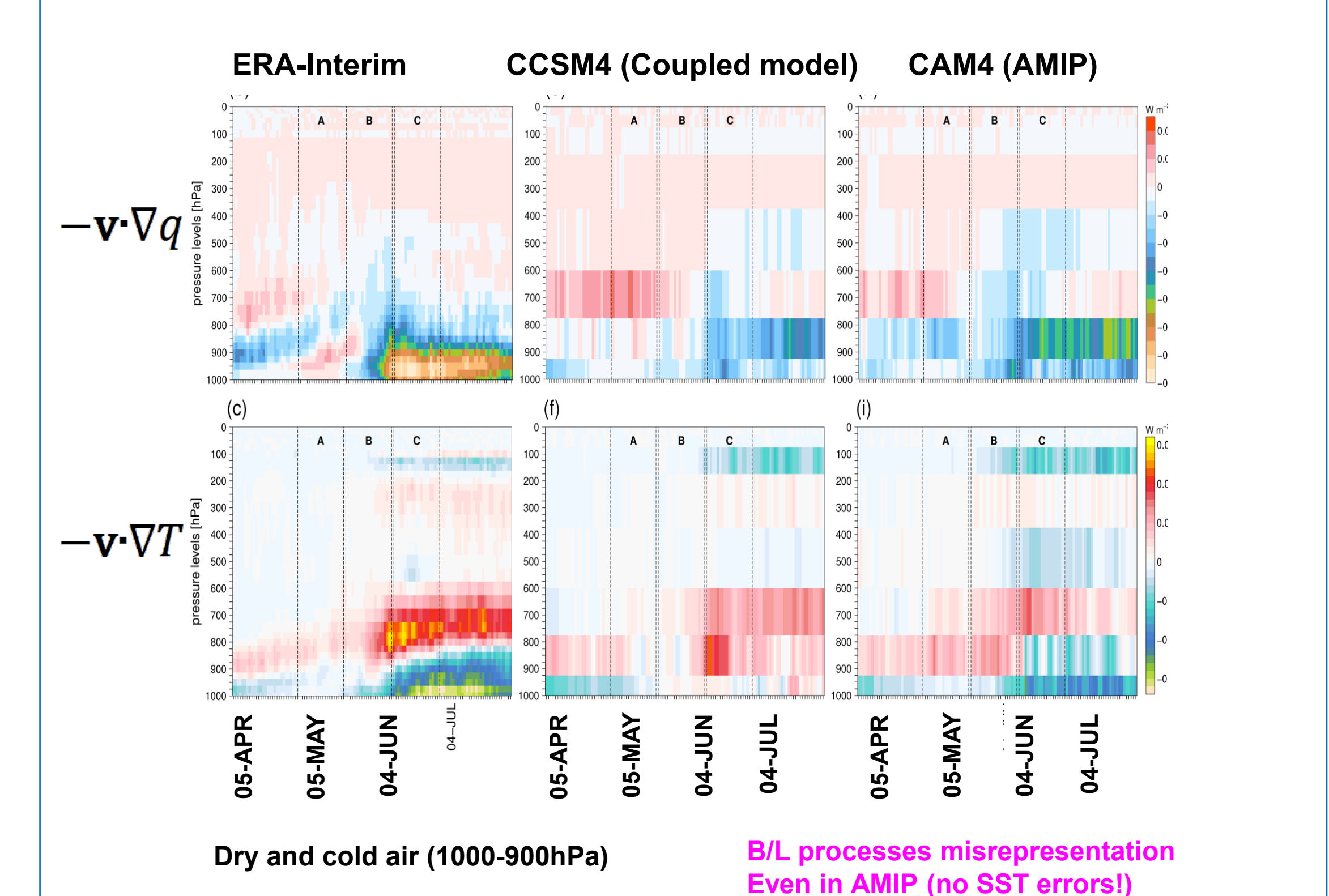
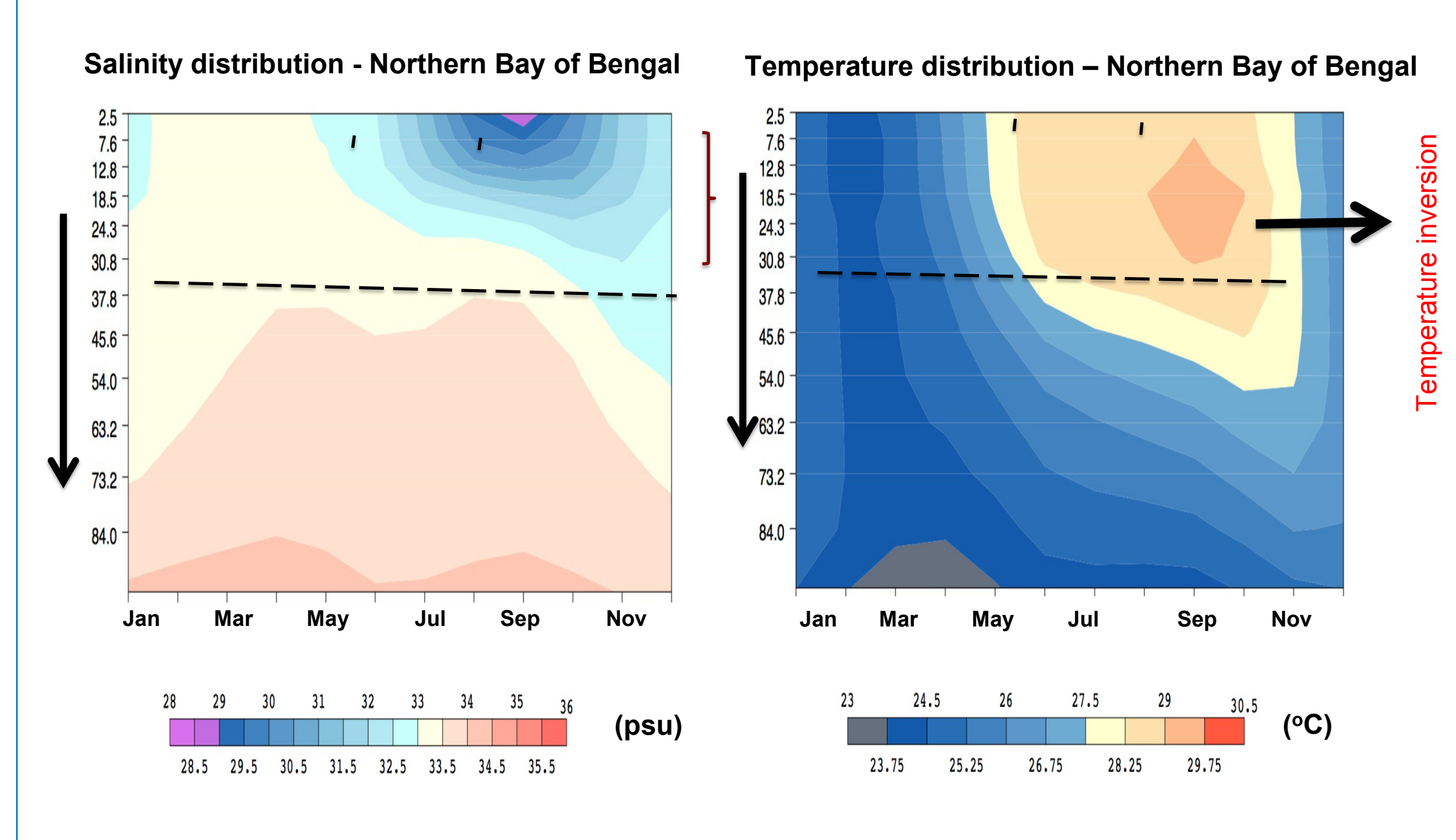
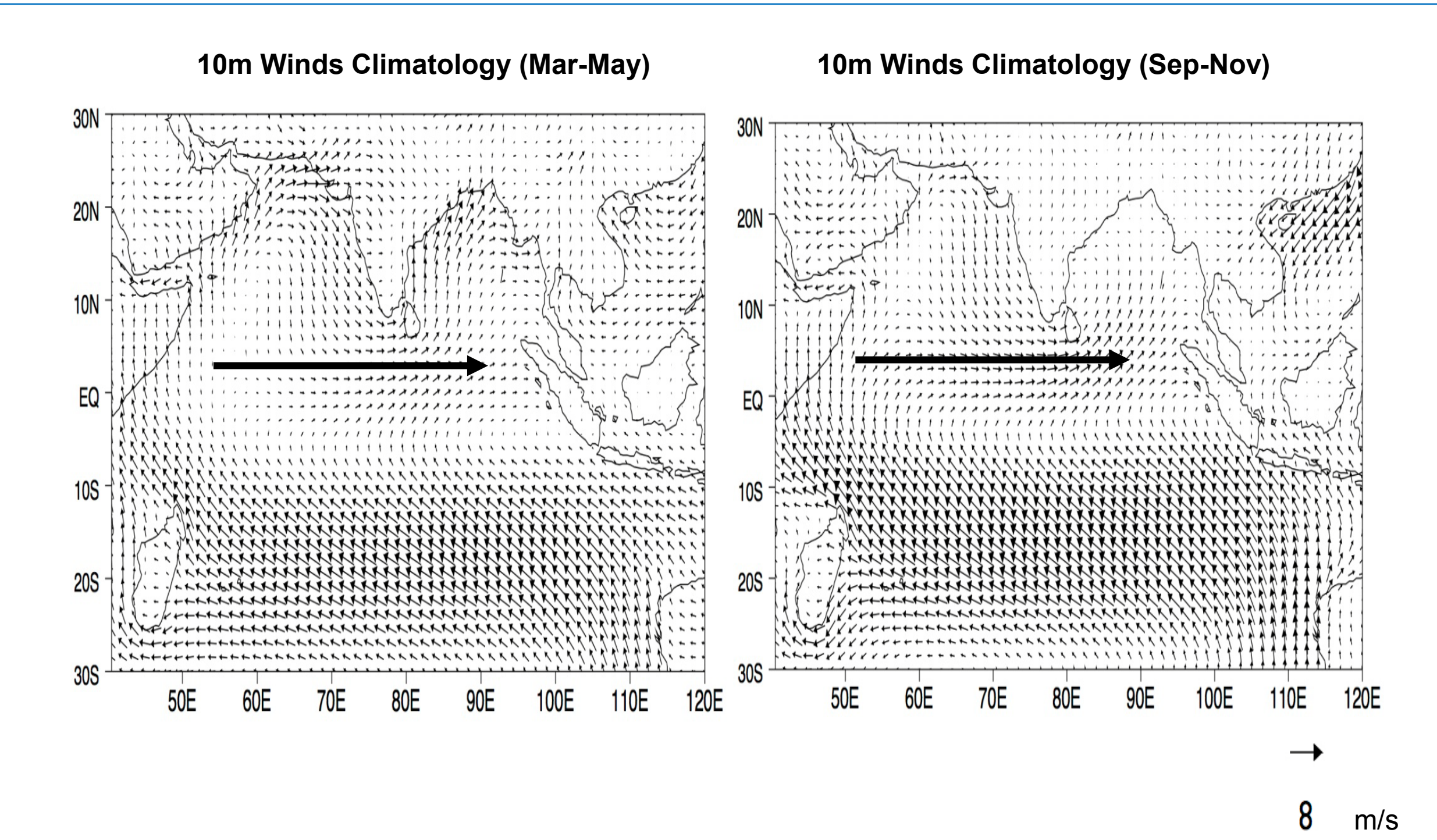
- (i) **Equatorial Indian Ocean:** Model errors indicate for an easterly wind stress bias with consequences to elimination of Wyrki Jets with implications to erroneous SST gradient. The structure of the errors indicates that they arise from a strong Bjerknes' feedback.
- (ii) **Bay of Bengal:** Model errors indicate that salinity-induced upper-ocean stratification is very weakly represented with consequences to cold SST bias.
- (iii) **Somali-Oman coasts:** Model errors indicate for a very weak representation of boundary-layer processes with consequences to wet bias.



## Equatorial Indian Ocean

## Bay of Bengal

## Somali upwelling region



Compared to climatology :in May 40-50% weaker and in November 70% weaker

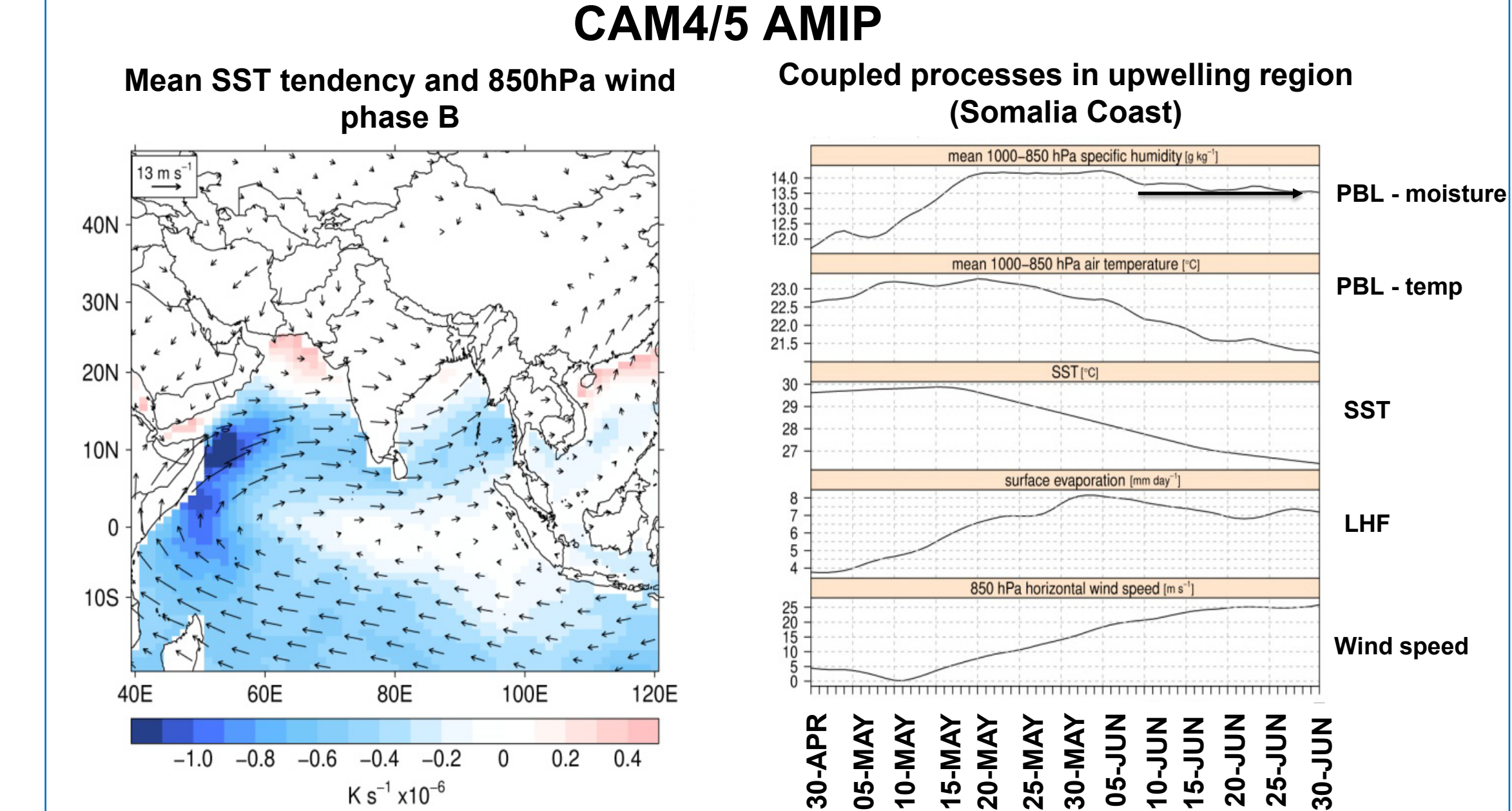
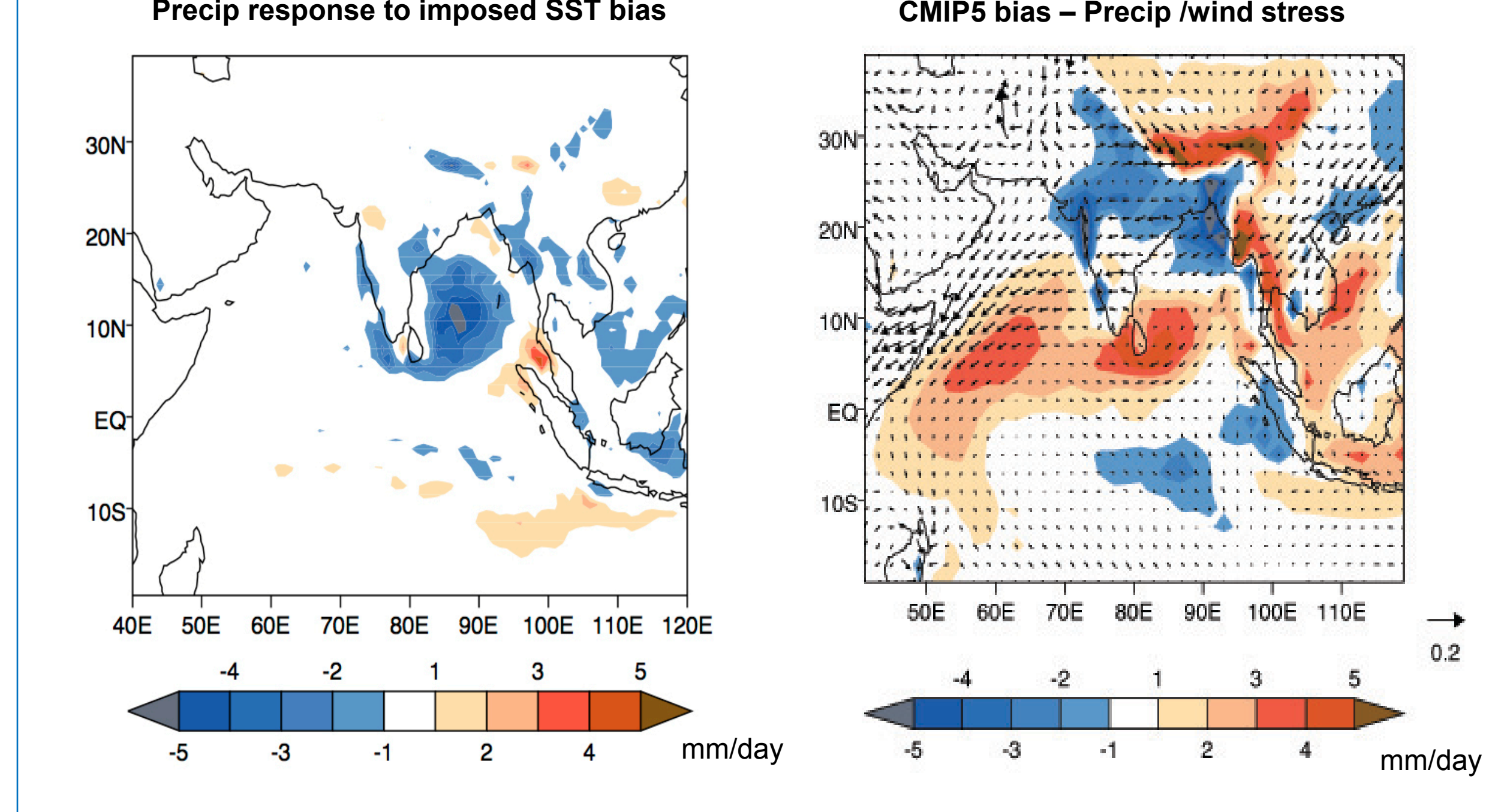
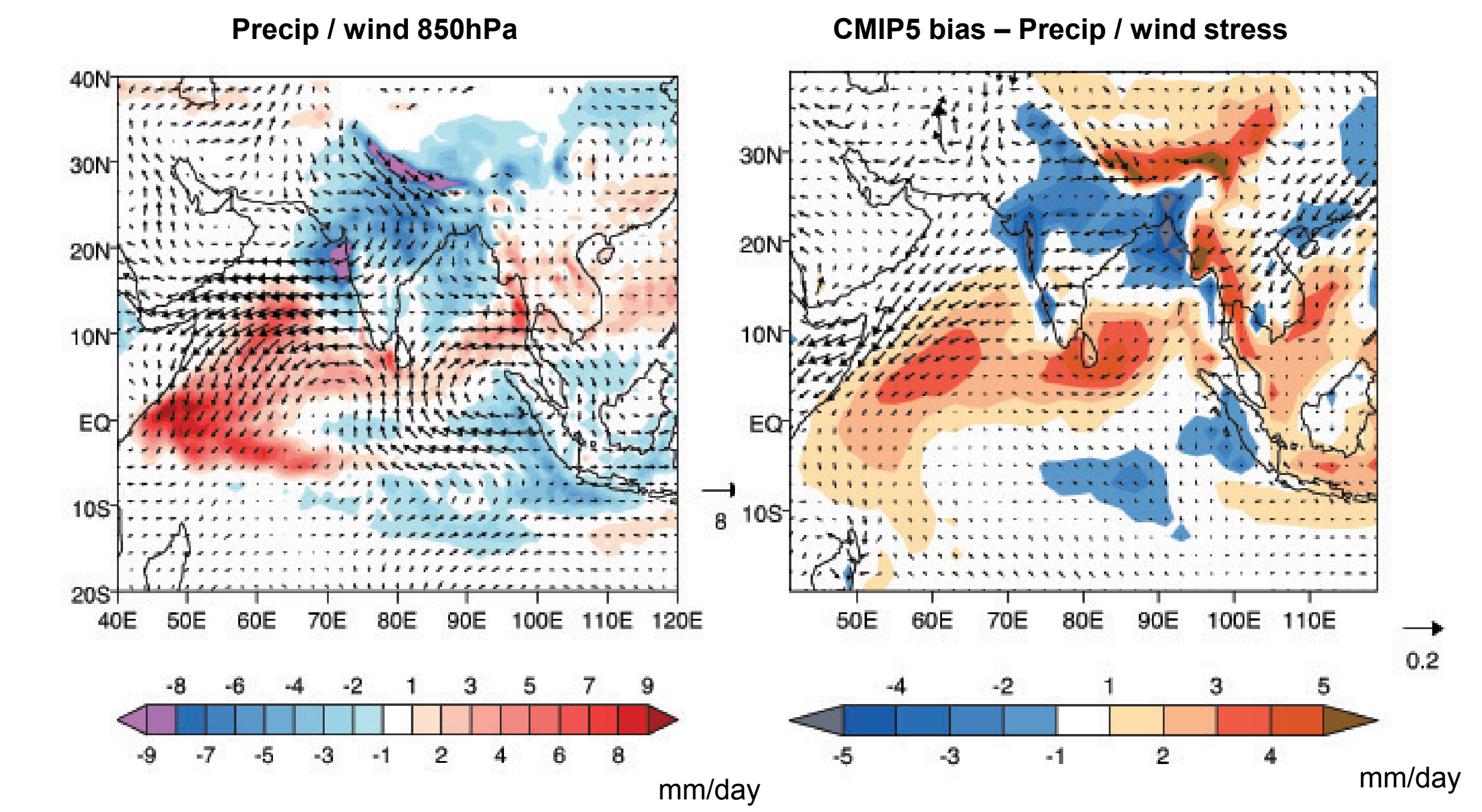
Persistence of cold SST biases – over Bay of Bengal

Dry and cold air (1000-900hPa) B/L processes misrepresentation Even in AMIP (no SST errors)

$\Delta \tau$  a measure of Bjerkens' feedback in the Equatorial Indian Ocean

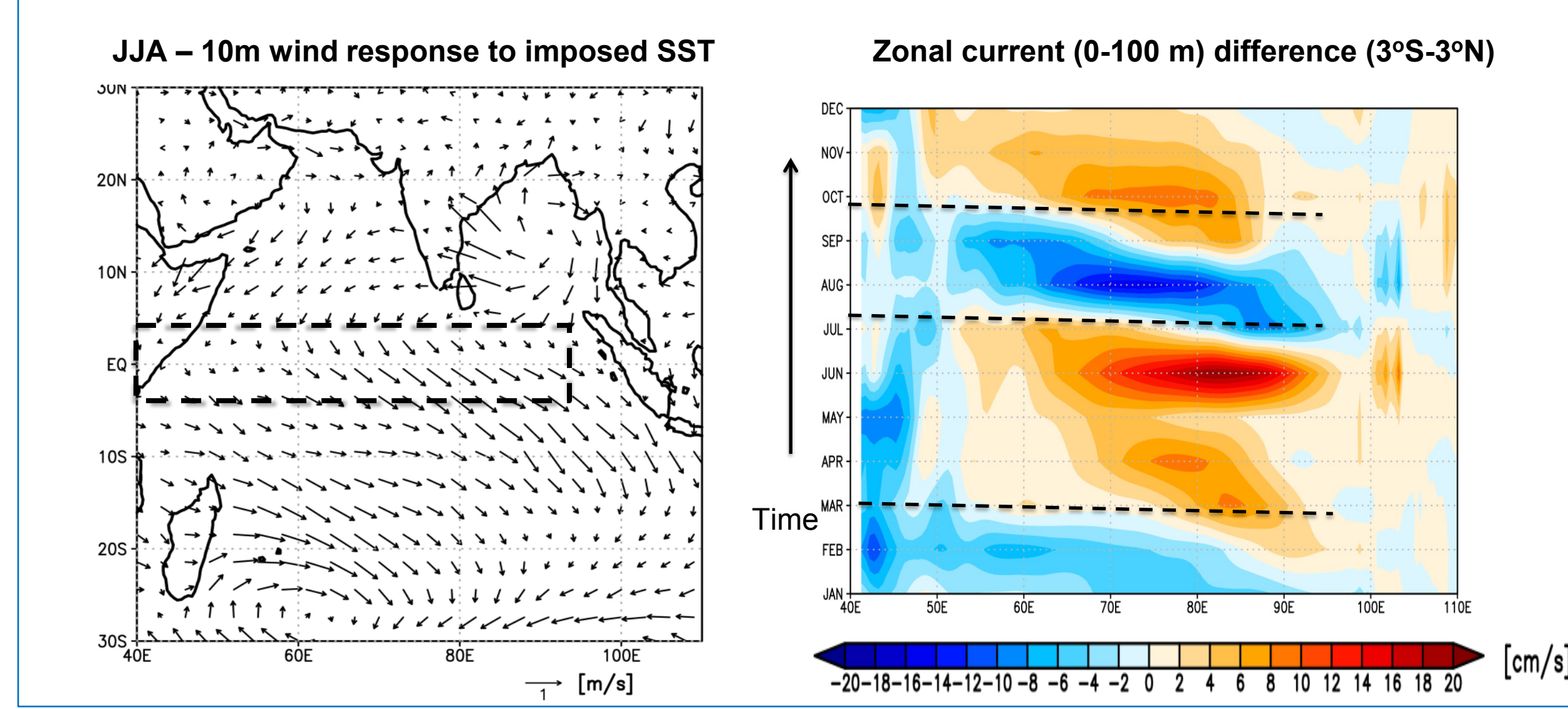
## CFES response to $\Delta \tau$

## CFES response to $\Delta$ SST



Misrepresentation of EIO coupled processes leads to monsoon precipitation errors in CMIP models.

Inadequate representation of boundary layer processes over the Arabian Sea leads to a wet bias there.



SST cold bias over Bay of Bengal impacts *in-situ* precipitation but enhances equatorial Wyrki Jets unlike CMIP5 model bias.

### References

H. Annamalai, B. Taguchi, J.P. McCreary, M. Nagura and T. Miyama, 2017: Systematic Errors in South Asian Monsoon Simulation: Importance of Equatorial Indian Ocean Processes. *J. Climate*, 30, 8159-8178

F. Hanf and H. Annamalai, 2019: Systematic errors in South Asian monsoon precipitation: Process-based diagnostics and sensitivity to entrainment in NCAR models. *J. Climate* (revised)

H. Annamalai, B. Taguchi and J.P. McCreary, 2019: Systematic errors in South Asian monsoon simulation in coupled models: role of Bay of Bengal upper-ocean processes (in preparation)

