

TRIATLAS



An assessment of marine biogeochemical processes in the tropical Atlantic in NorESMs

Shunya Koseki¹, Lander R. Crespo¹, Jerry Tjiputra², Noel Keenleyside¹

1: Geophysical Institute, University of Bergen, NORWAY

2: NORCE Norwegian Research Centre, NORWAY

EGU21, Apr 19-30

A common issue in ESMs: tropical Atlantic bias (SST, wind, precipitation....)
⇒ How is the marine biogeochemical (BGC) process biased?
⇒ With physical bias reduction, BGC is also improved?

1. Implementing physical bias correction (wind stress and SST) by anomaly coupling technique (Toniazzo and Koseki, 2018, *JAMES*) to **NorESM1-ME**,

In addition to alleviate the climatological physical bias,

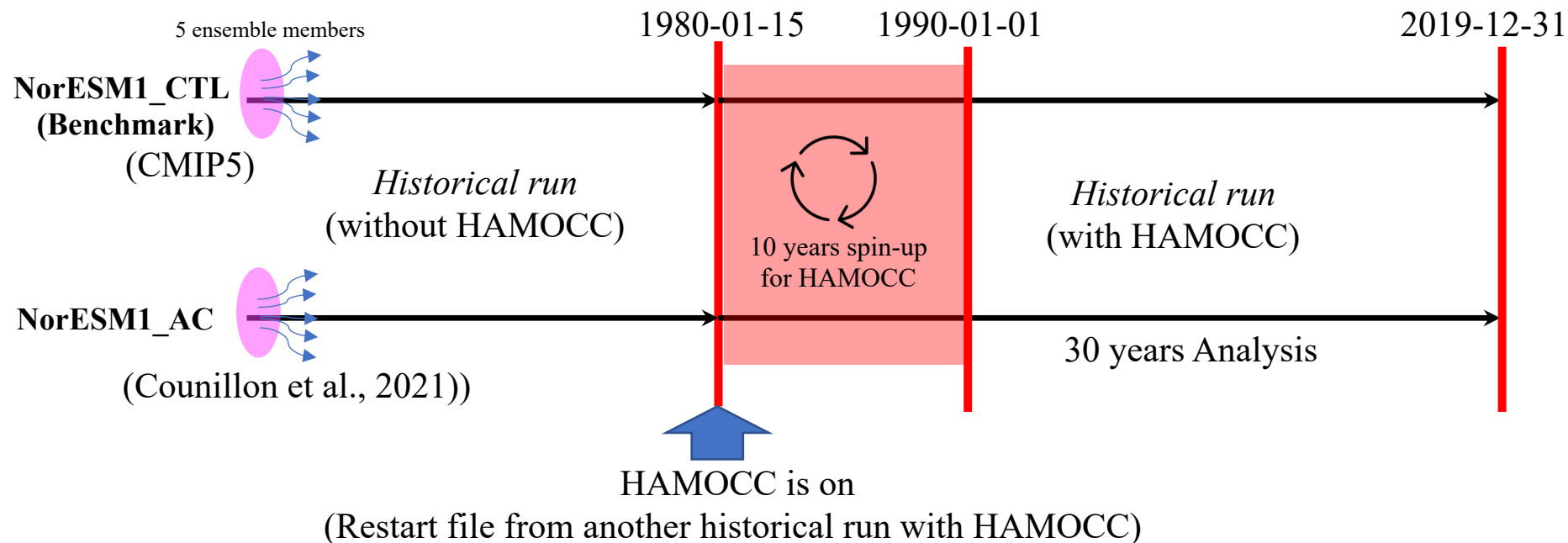
Seasonal prediction skill in the tropical Atlantic is improved, especially, winter (Nov-Dec) Atlantic Niño (Counillon et al., 2021, *Clim. Dyn.*)

Such physical bias correction leads to improve the marine biogeochemical process in simulation of earth system model ?

2. A new generation of NorESM, **NorESM2** has been released (e.g., Seland et al., 2020; Tjiputra et al., 2020) and modeling of physical and biogeochemical processes are updated.

Important to explore the difference in BGC in the tropical Atlantic among different model versions. How better is the new version of ESM?

Experimental Design



For anomaly coupling (AC)....

Observed Climatology: ERA-Interim (wind stress) and HadiSST (SST) for 1980-2000

Model Climatology: 50 years run with 90's fixed external emission (Toniazzo and Koseki, 2018)

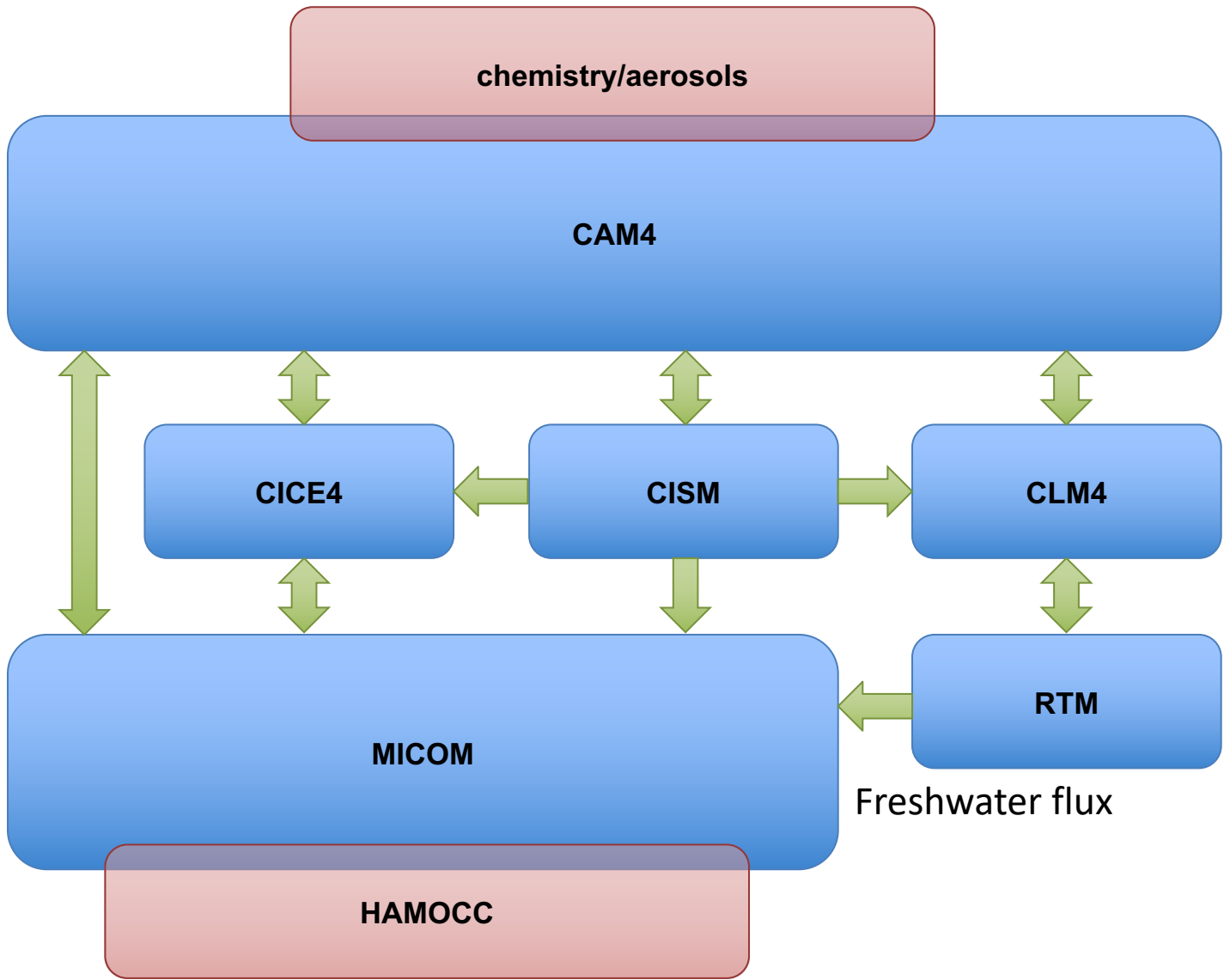
AC: Atmospheric (Ocean) component sees **the climatologically-corrected SST (surface wind)**

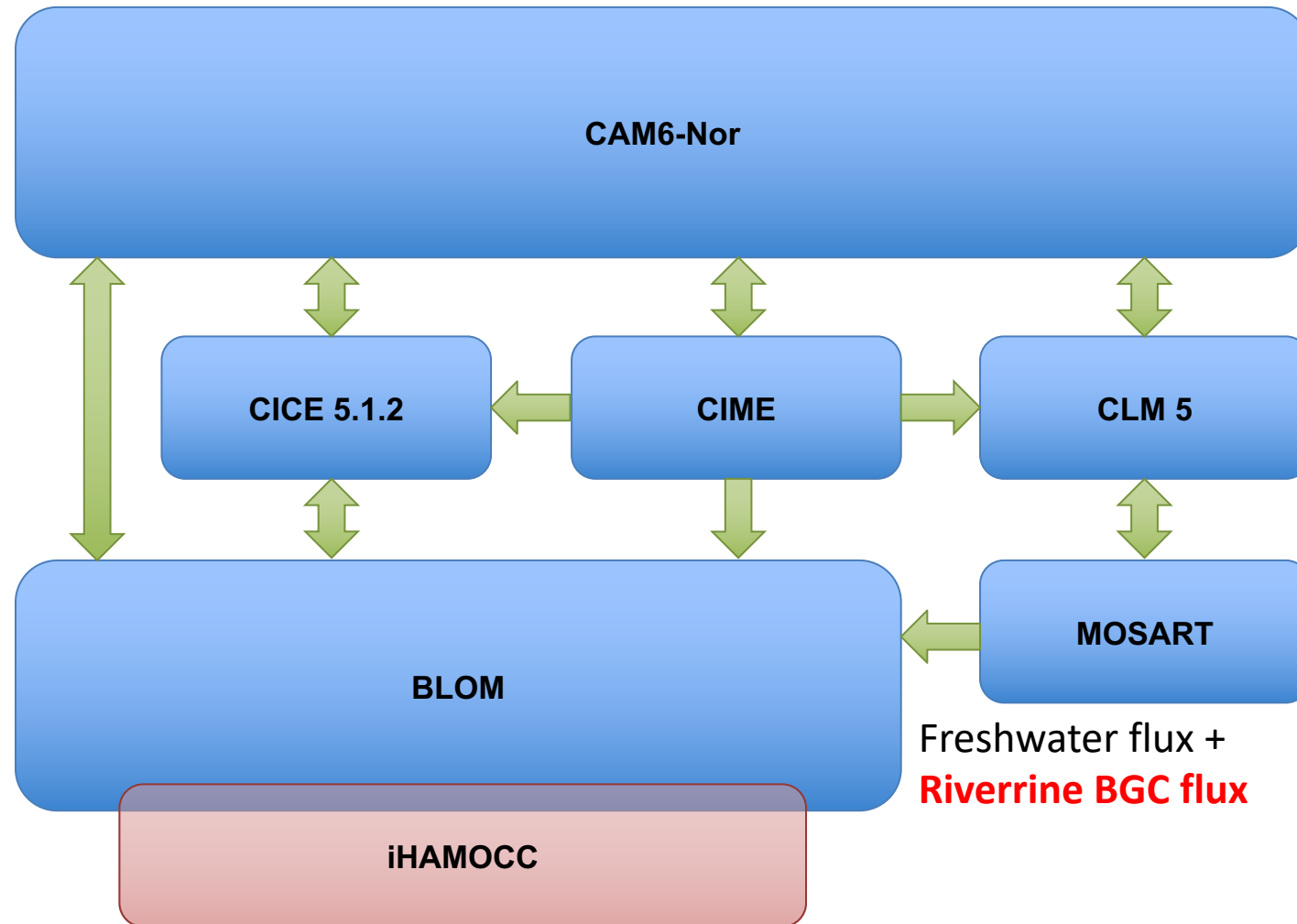
NorESM2_LM: Coarse resolution of CAM and intermediate resolution of BLOM

NorESM2_MM: Both intermediate resolution of CAM and BLOM

=> Historical run of 1990-2014 available (3 member)

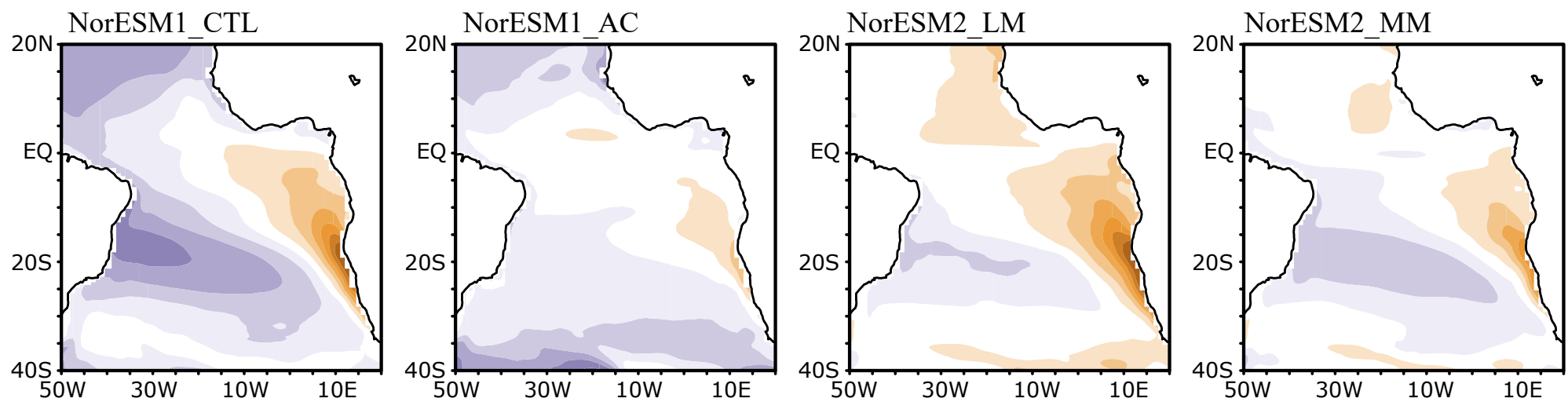
NorESM1-ME



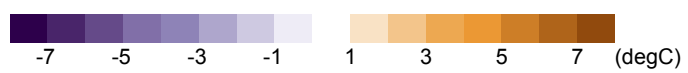
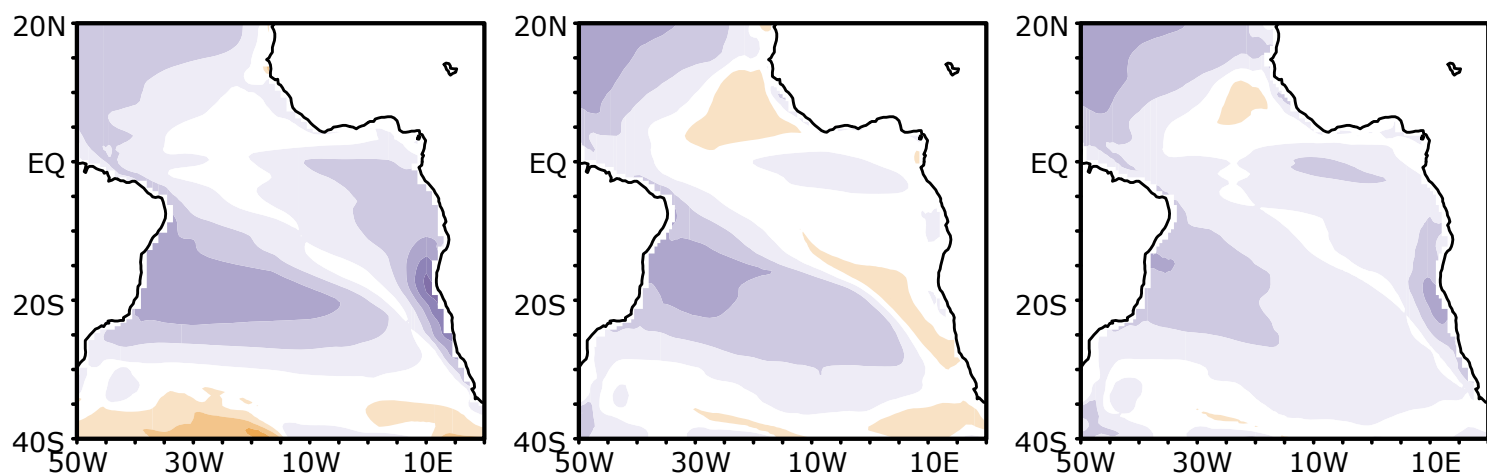


Tuned biological parameters (Tjiputra et al., 2020)

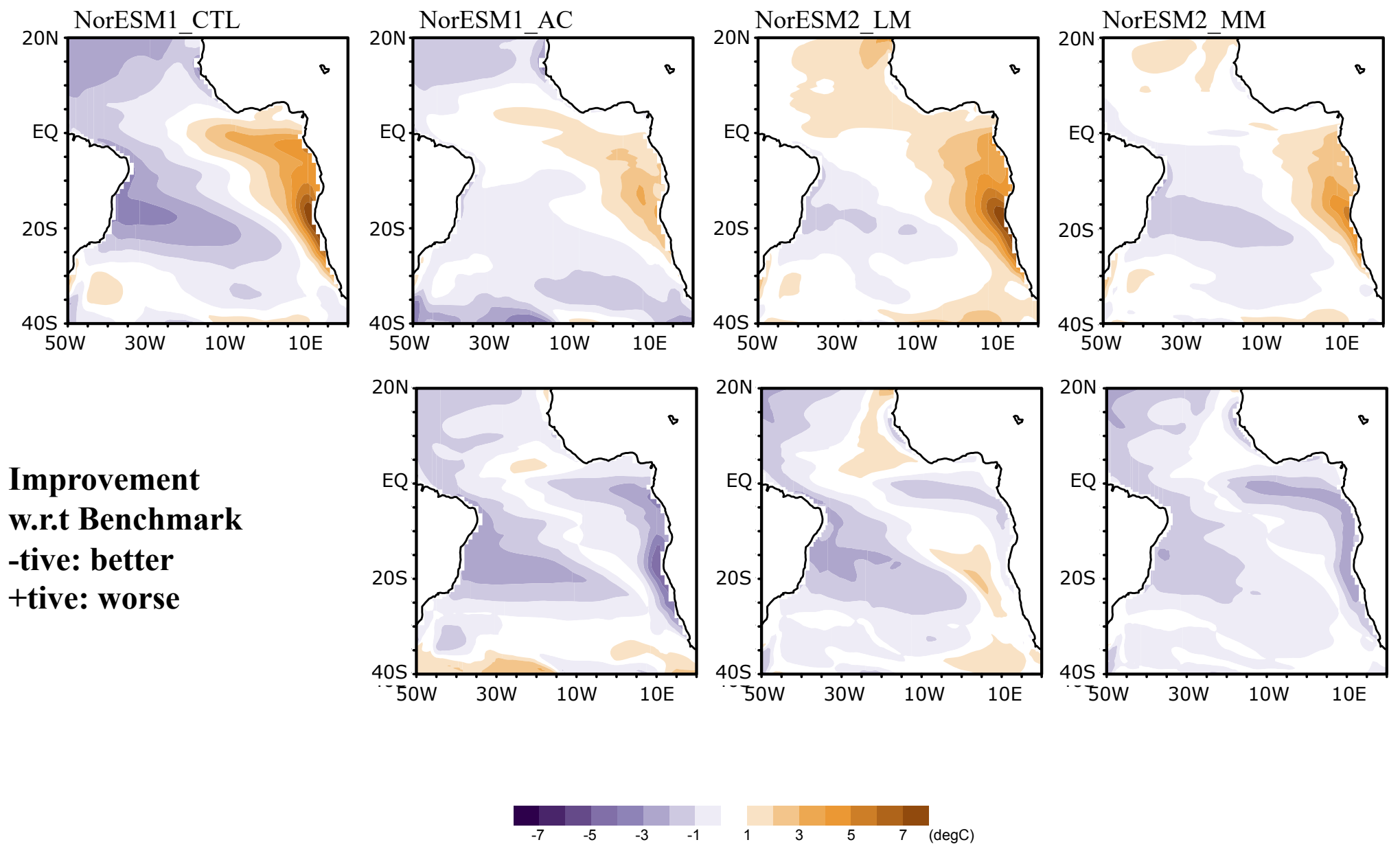
SST Bias (annual-mean)



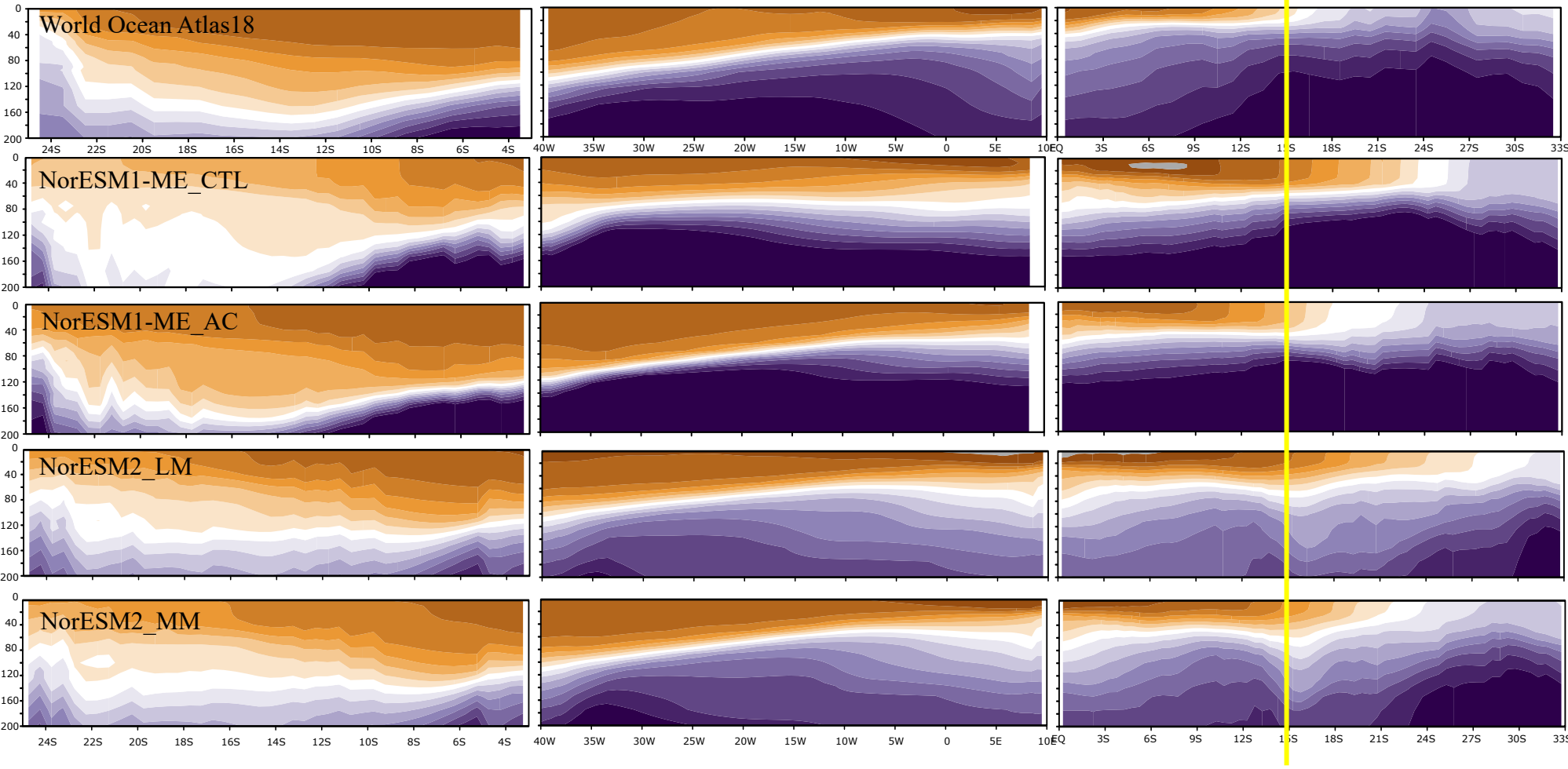
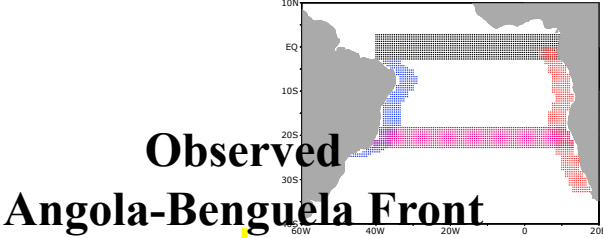
**Improvement
w.r.t Benchmark**
-tive: better
+tive: worse



SST Bias (June-July-August)



Temperature Bias Reduction (annual-mean climatology)



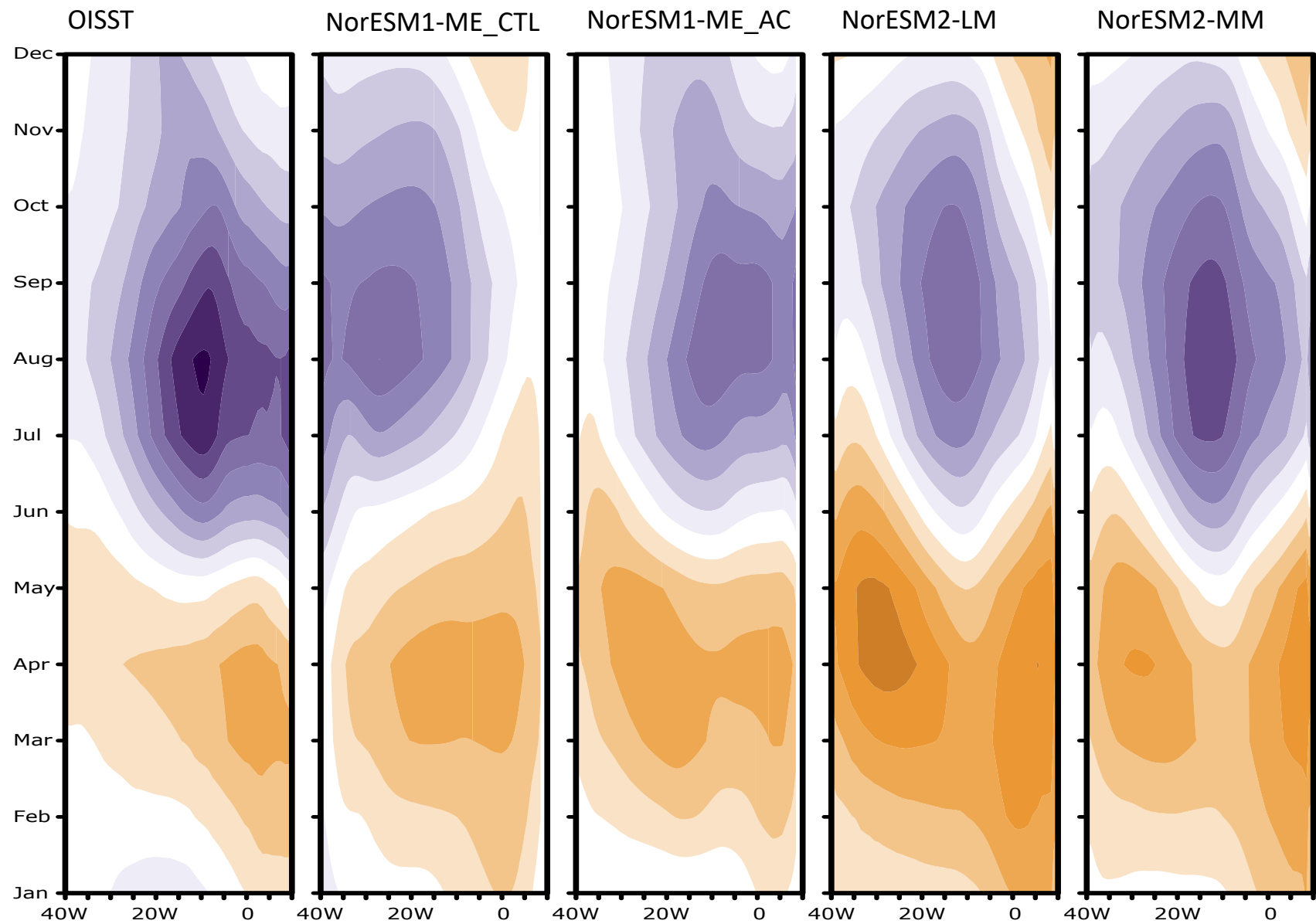
Brazilian Coast

Equatorial Atlantic

African Coast

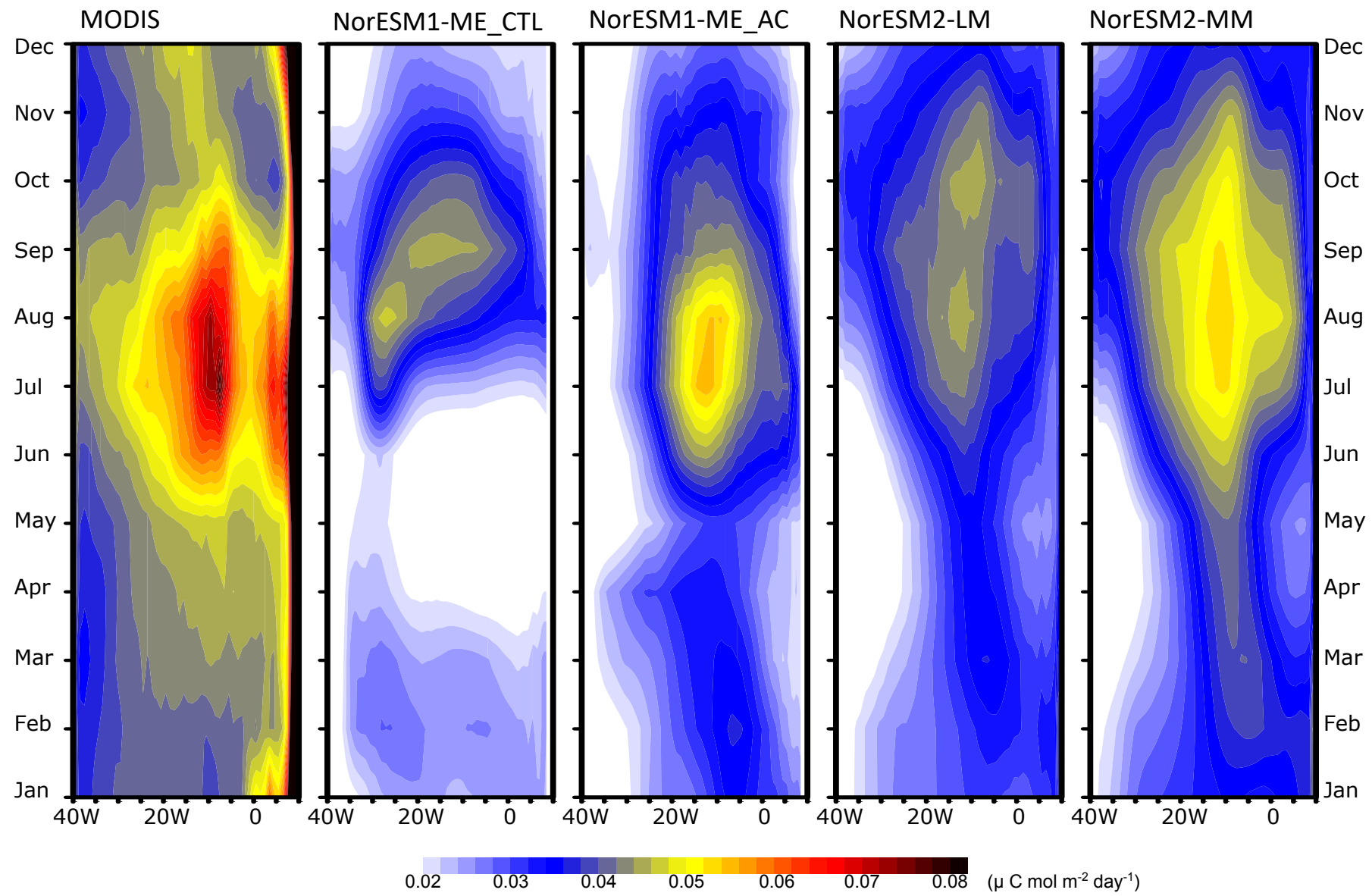


Seasonal Cycle of SST in the Equatorial Atlantic (3S-3N)

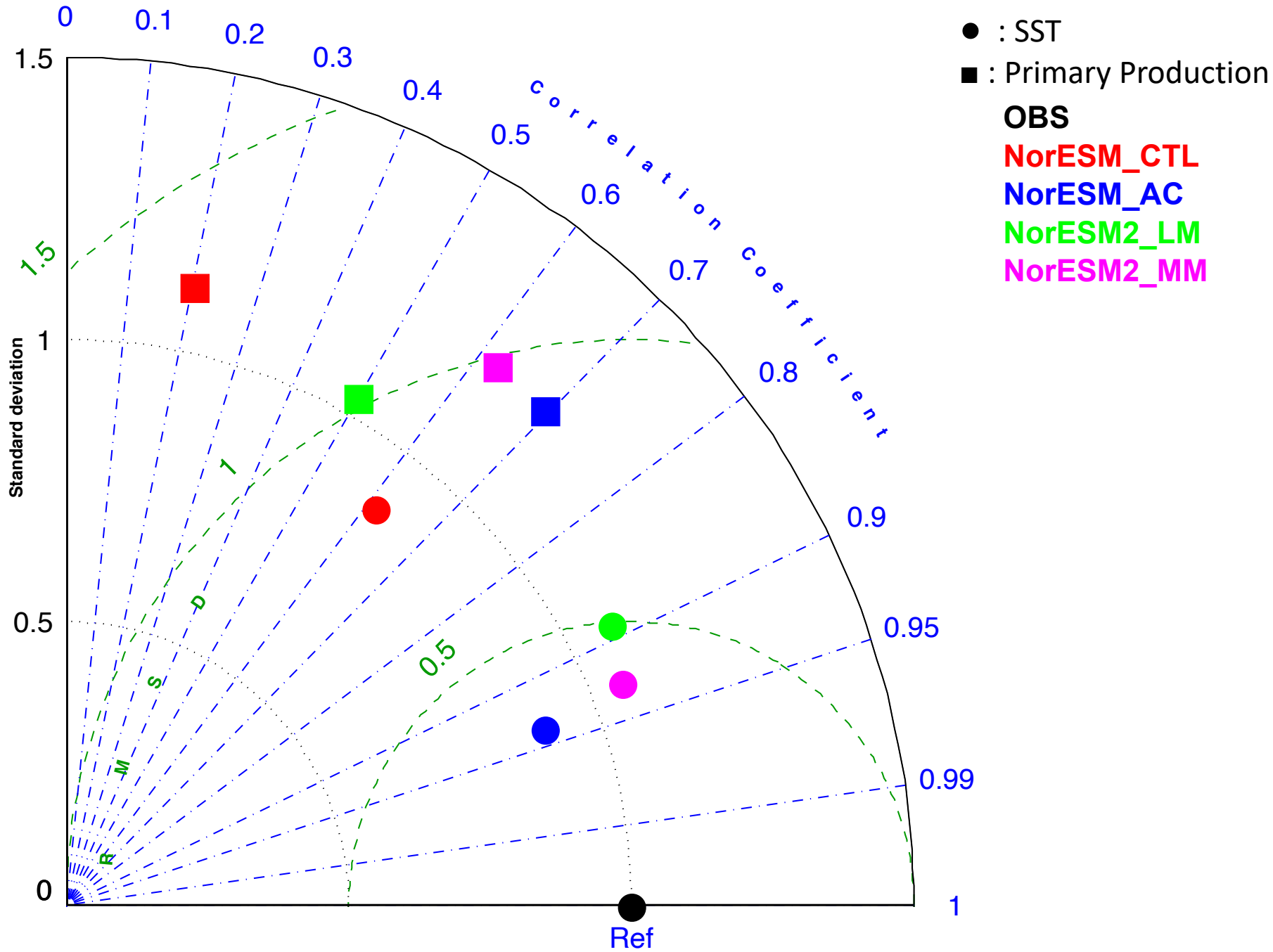


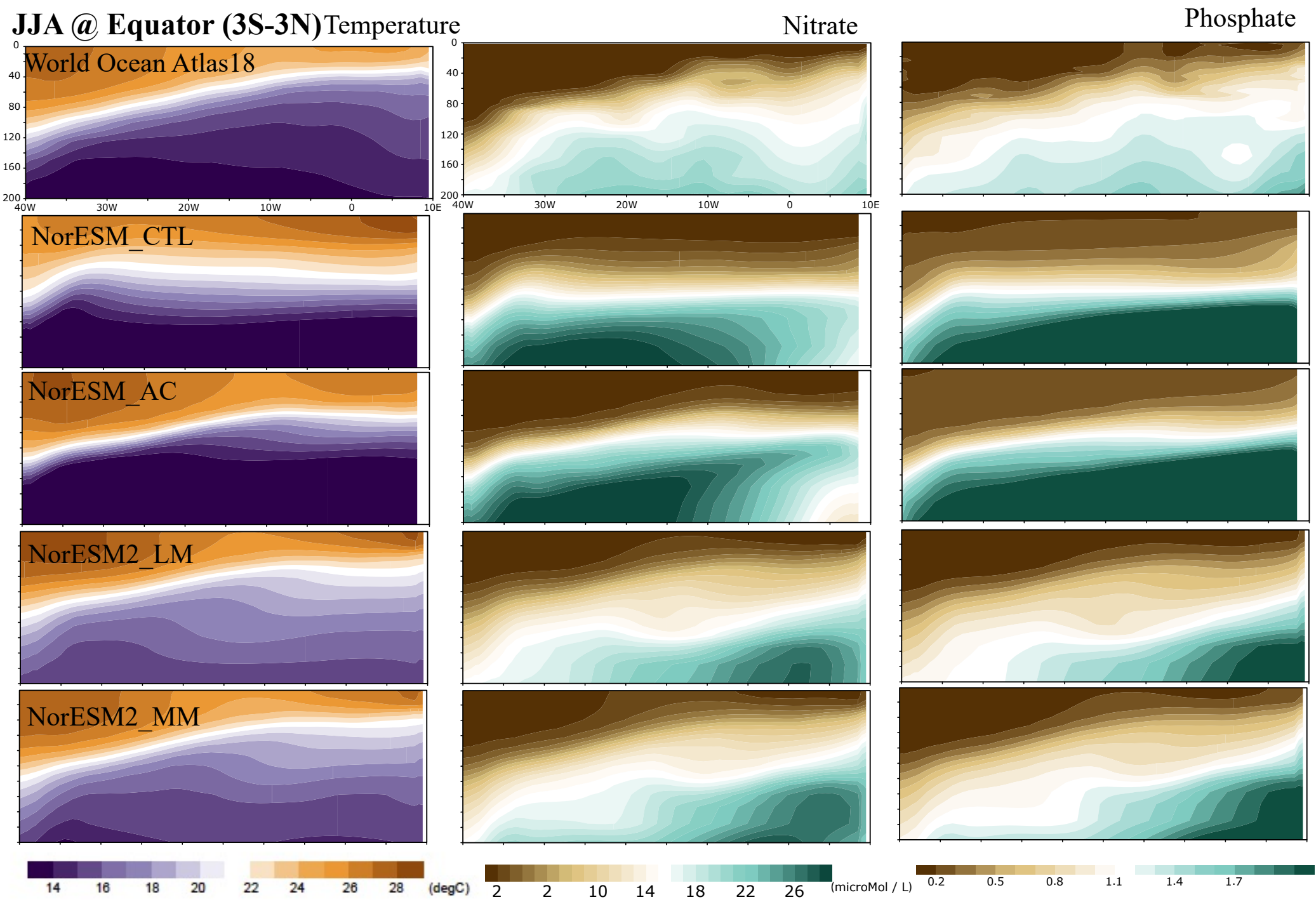
Seasonal Cycle of Primary Production in the Equatorial Atlantic (3S-3N)

Primary Production: CO₂ uptake by phytoplankton due to photosynthesis.

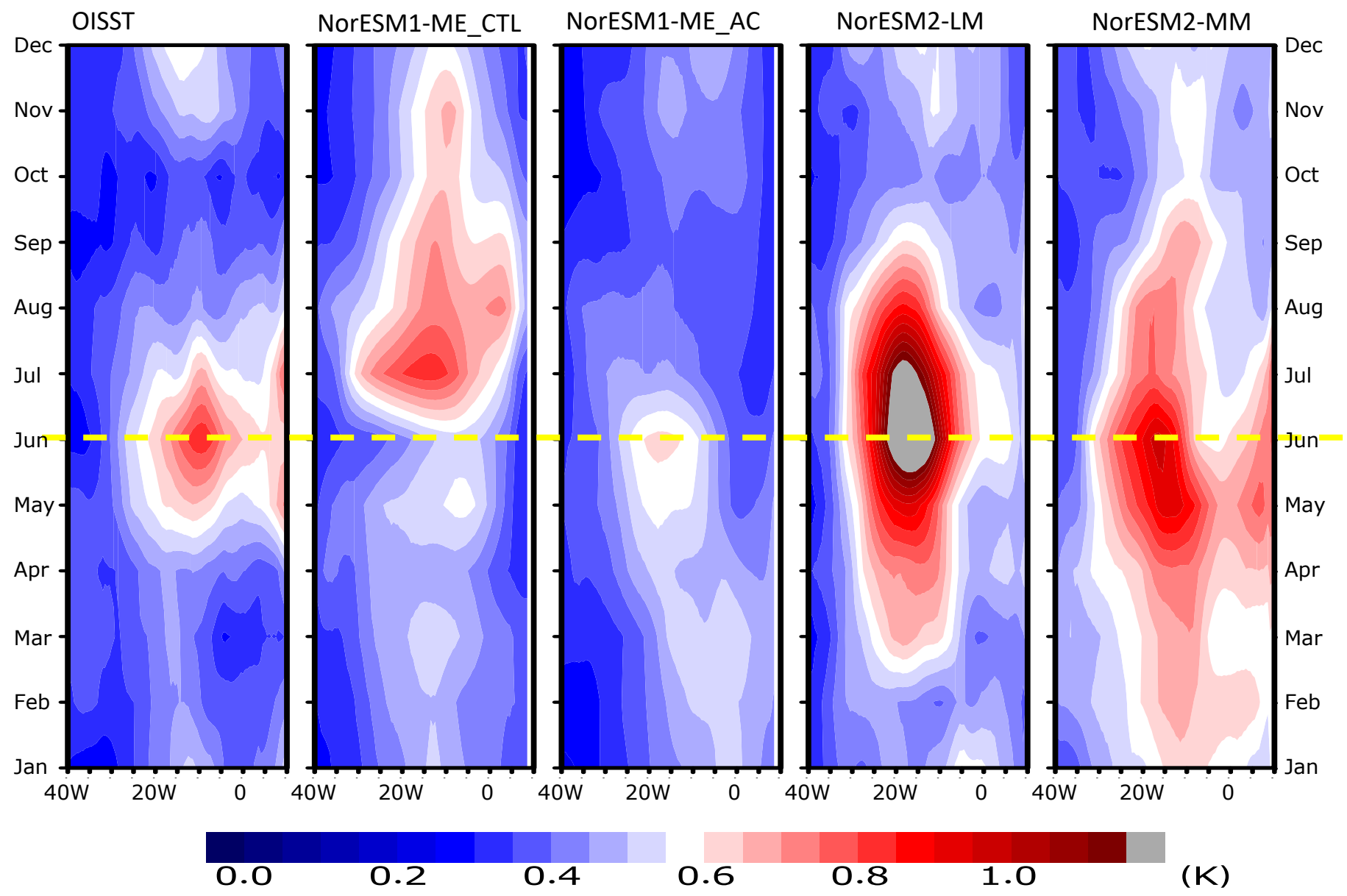


Metrics: Seasonal Cycle in the Equatorial Atlantic (3S-3N)

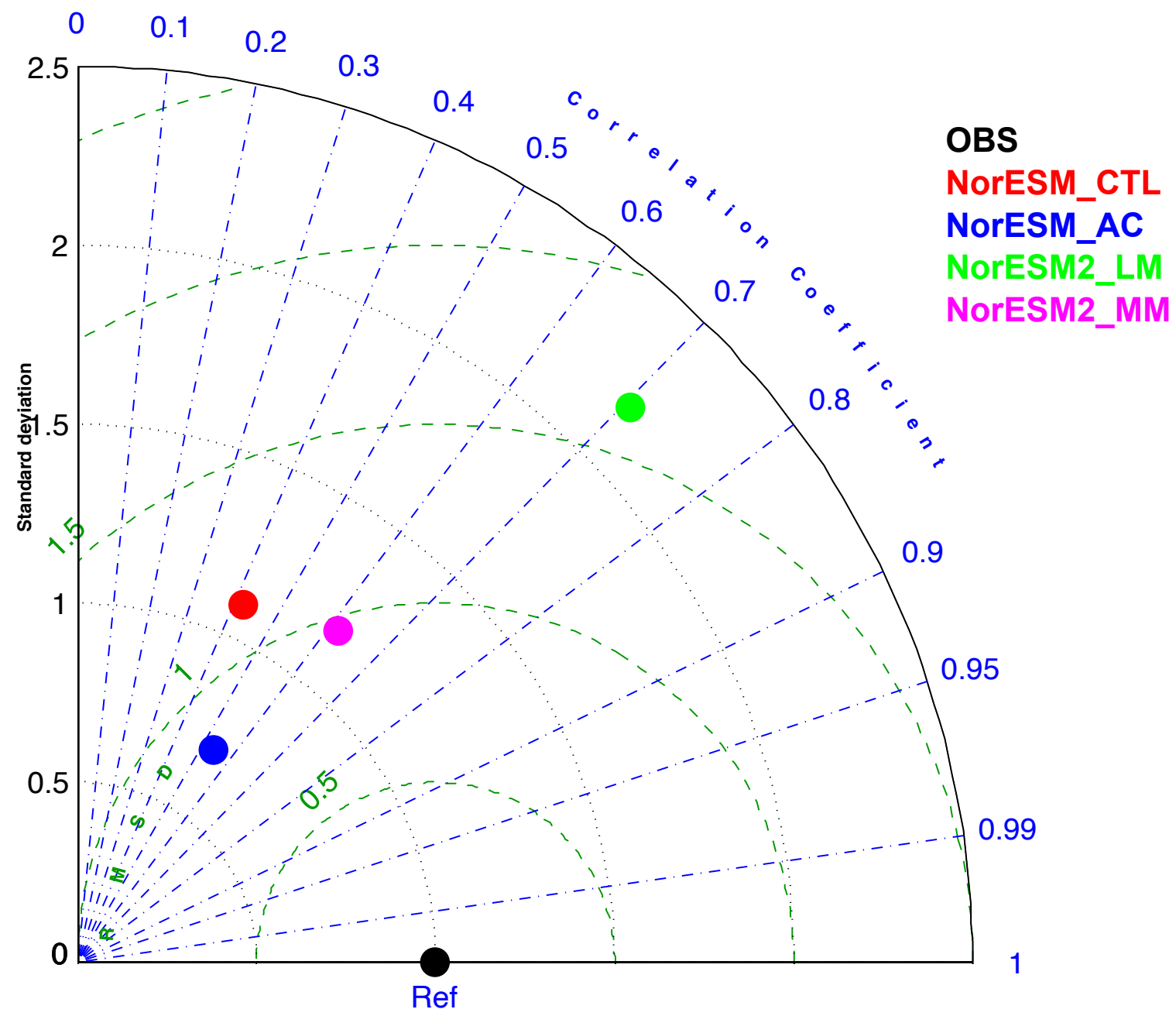




SST Variability in the equatorial Atlantic



Metrics: Seasonal Cycle in the Equatorial Atlantic Variability (3S-3N)

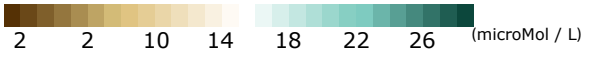
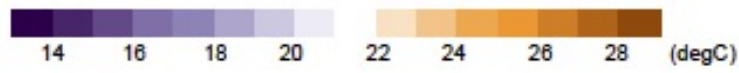
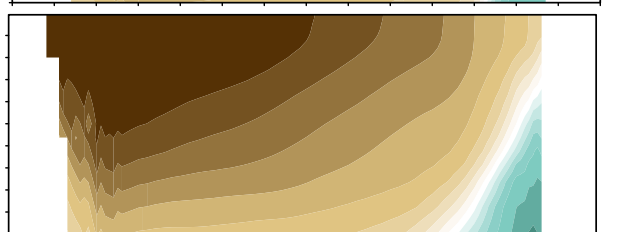
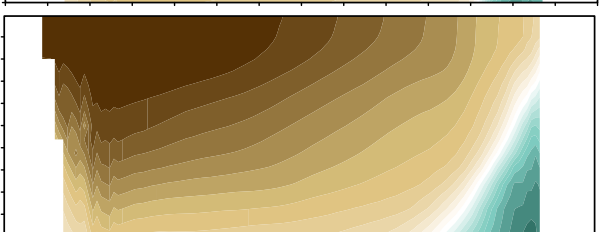
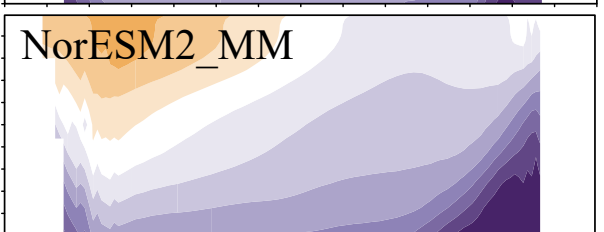
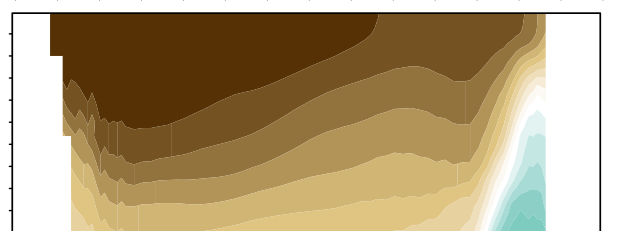
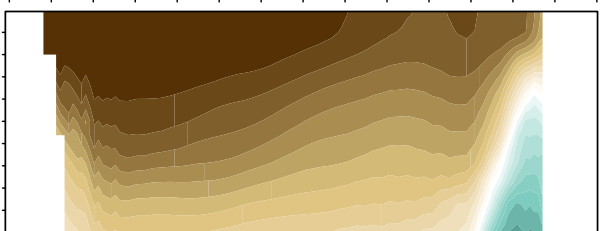
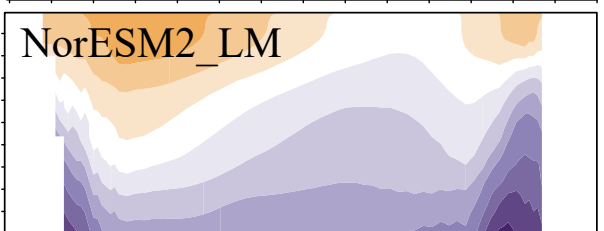
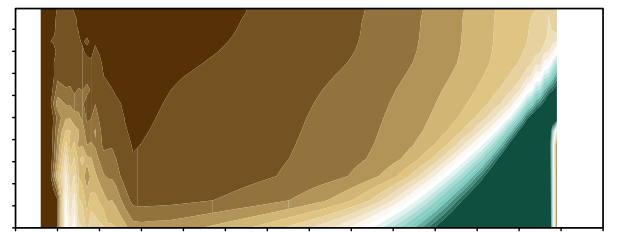
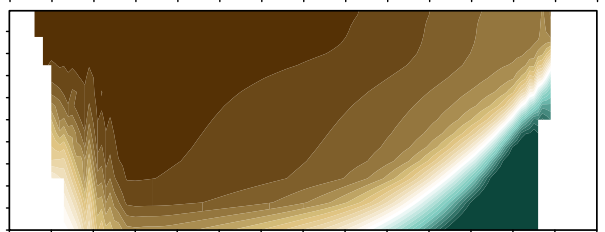
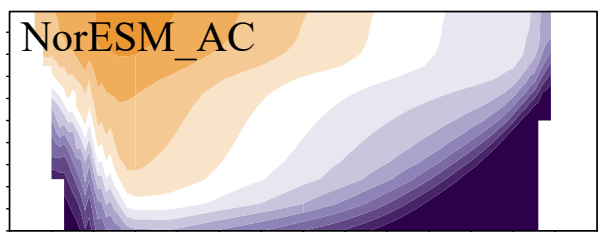
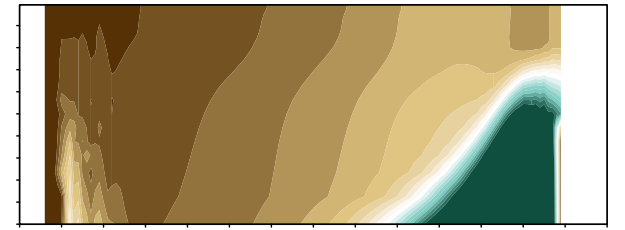
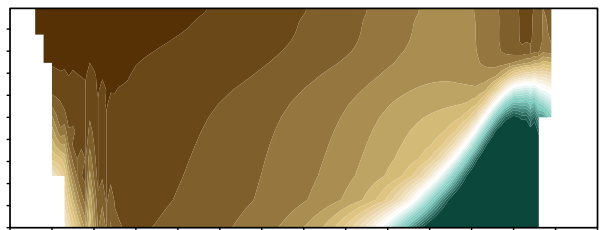
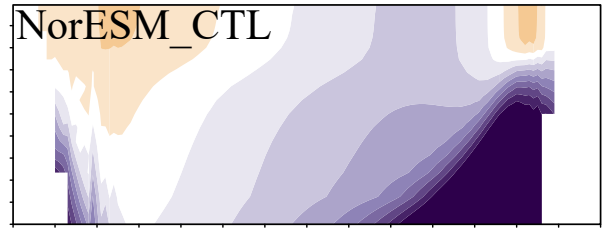
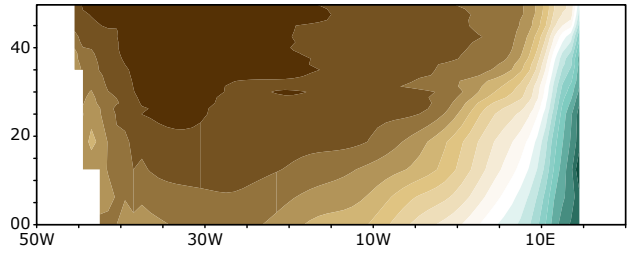
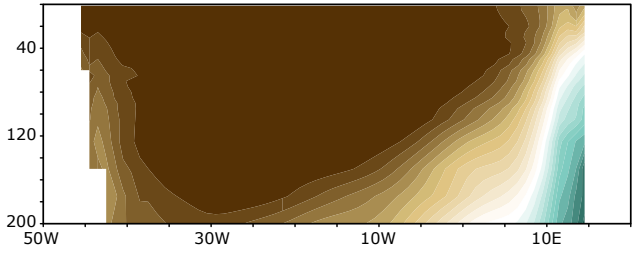
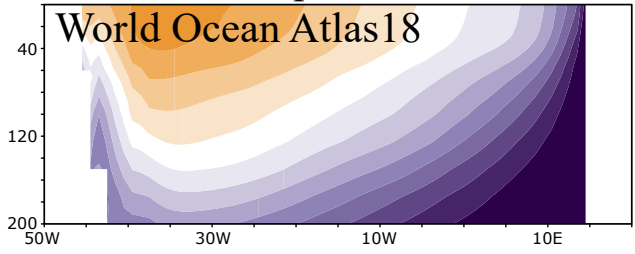


South Atlantic Sector (25S to 18S), annual-mean

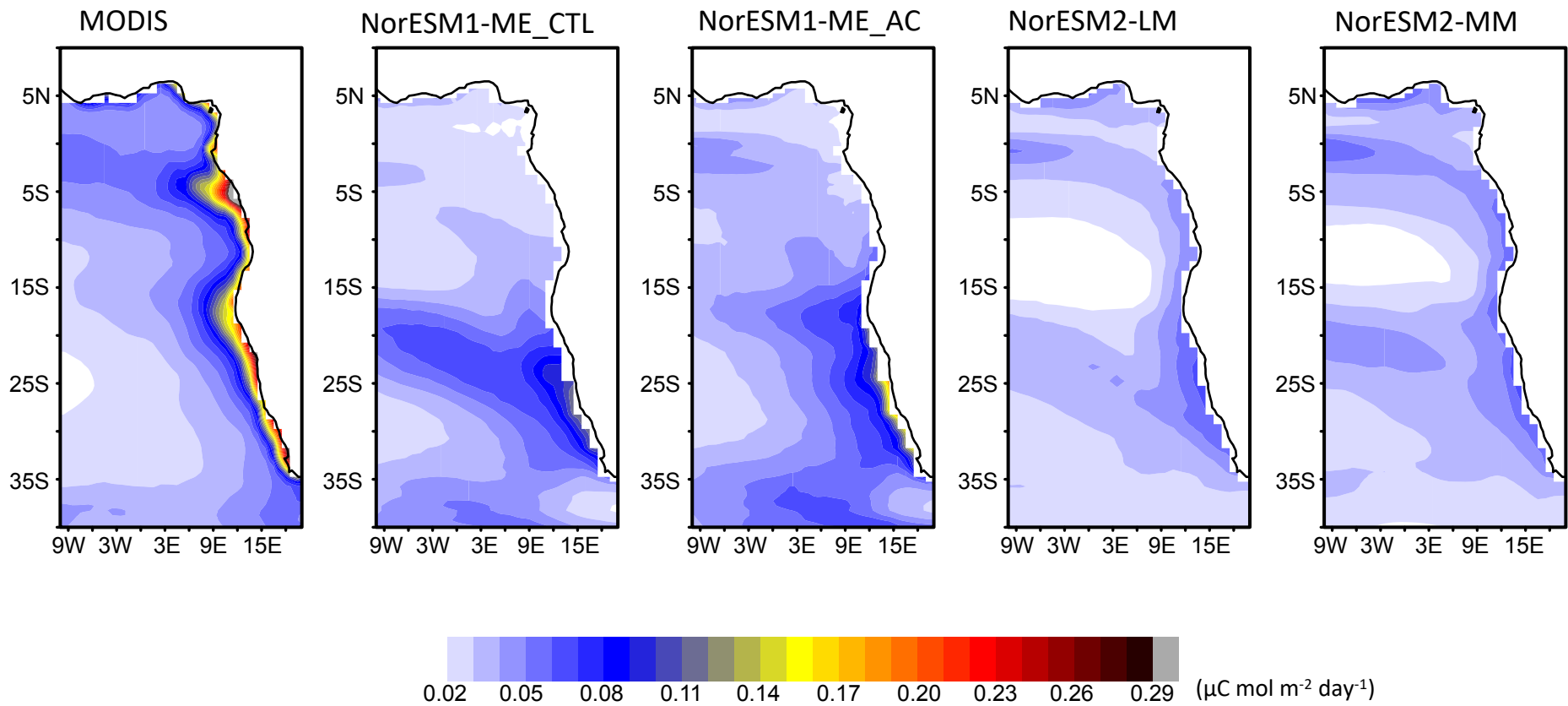
Temperature

Nitrate

Phosphate



Primary Production along the west African coast



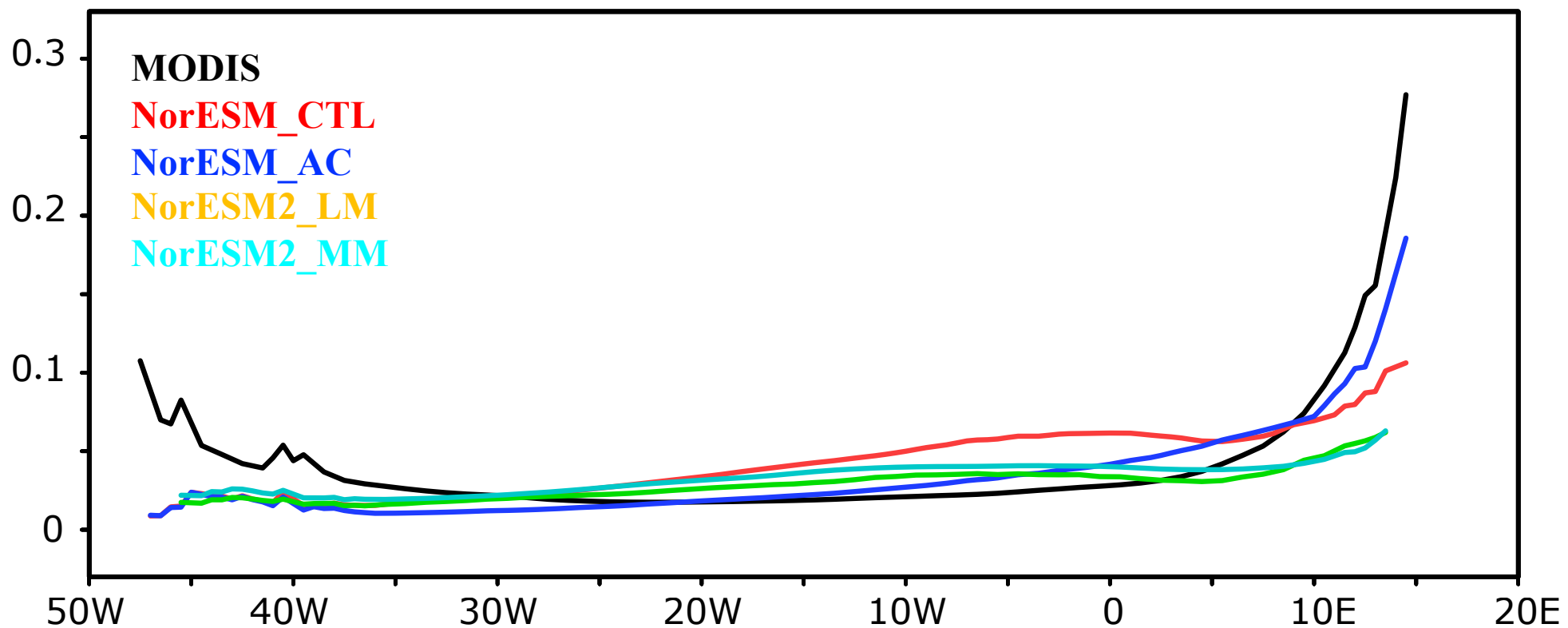
Physical bias correction has large impacts on the marine BGC in the tropical Atlantic;

1. Seasonal cycle of primary production (Summer Atlantic Bloom) is well-represented.
2. Summer nutrients upwelling in the equator
3. Primary production and nutrients due to Benguela upwelling

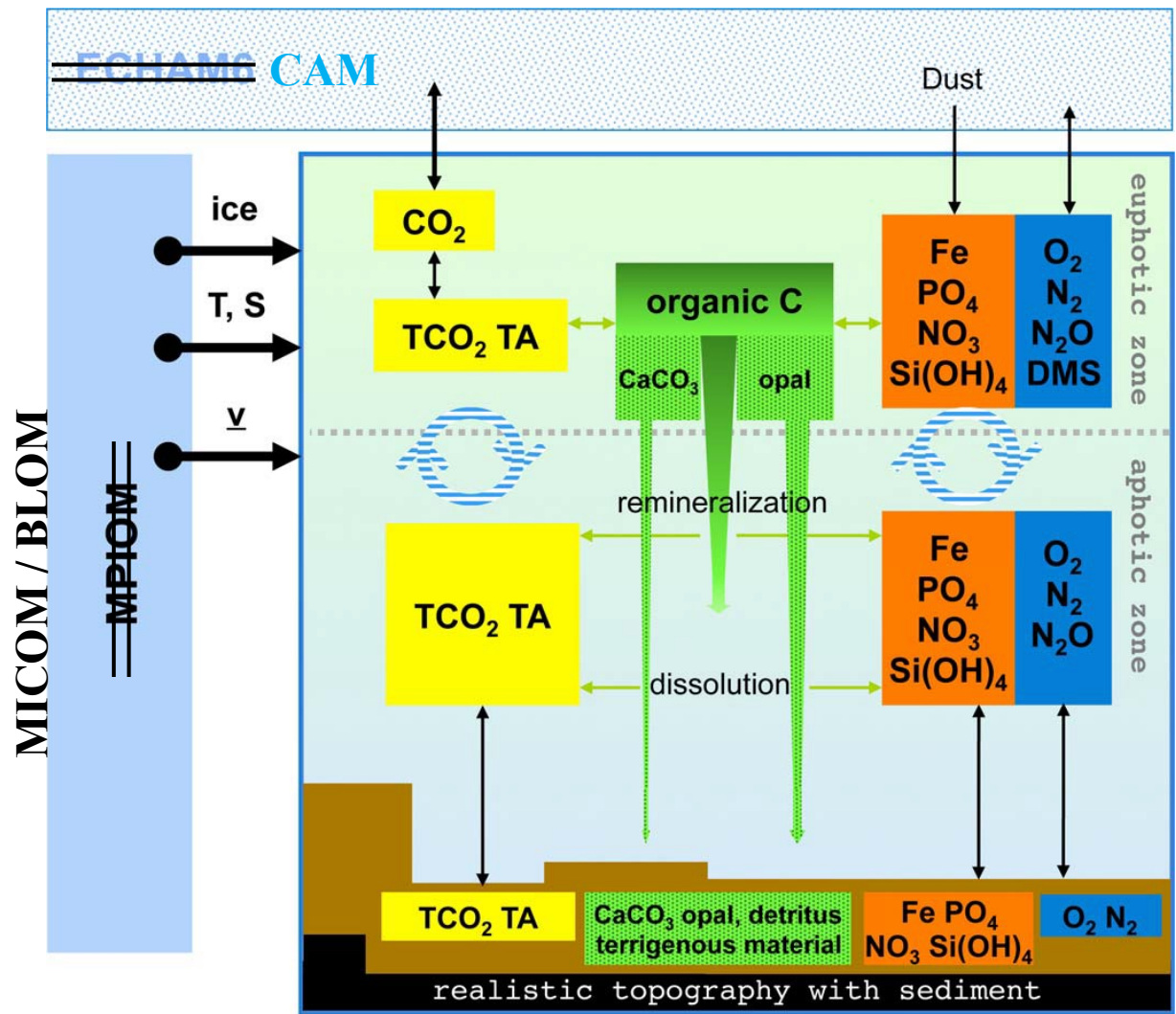
Benefits of new version of NorESM;

1. Better seasonal cycle of SST and primary production
2. Summer nutrients upwelling in the equator
3. Weakened primary production and better nutrients in the Benguela upwelling
⇒ Some biological parameters have been tuned (Tjiputra et al., 2020). This may affect the productivity along the upwelling region
4. Some improvements of primary production in near-equator coastal region (5S)
⇒ due to riverine flux input in NorESM2?
5. Finer atmospheric component is more beneficial

Primary Production in South Atlantic (25S to 18S)



!! NorESM's PP is vertically-integrated through the entire layer



HAMOCC

$$\frac{\partial C^i}{\partial t} + \nabla \nabla C^i - DC^i = \sum_k \Psi_k^i(C^i, C_k) + \Psi_{air-sea} + \Psi_{sedflux}$$