A first look at the performance of CMIP6 models in the tropical Atlantic

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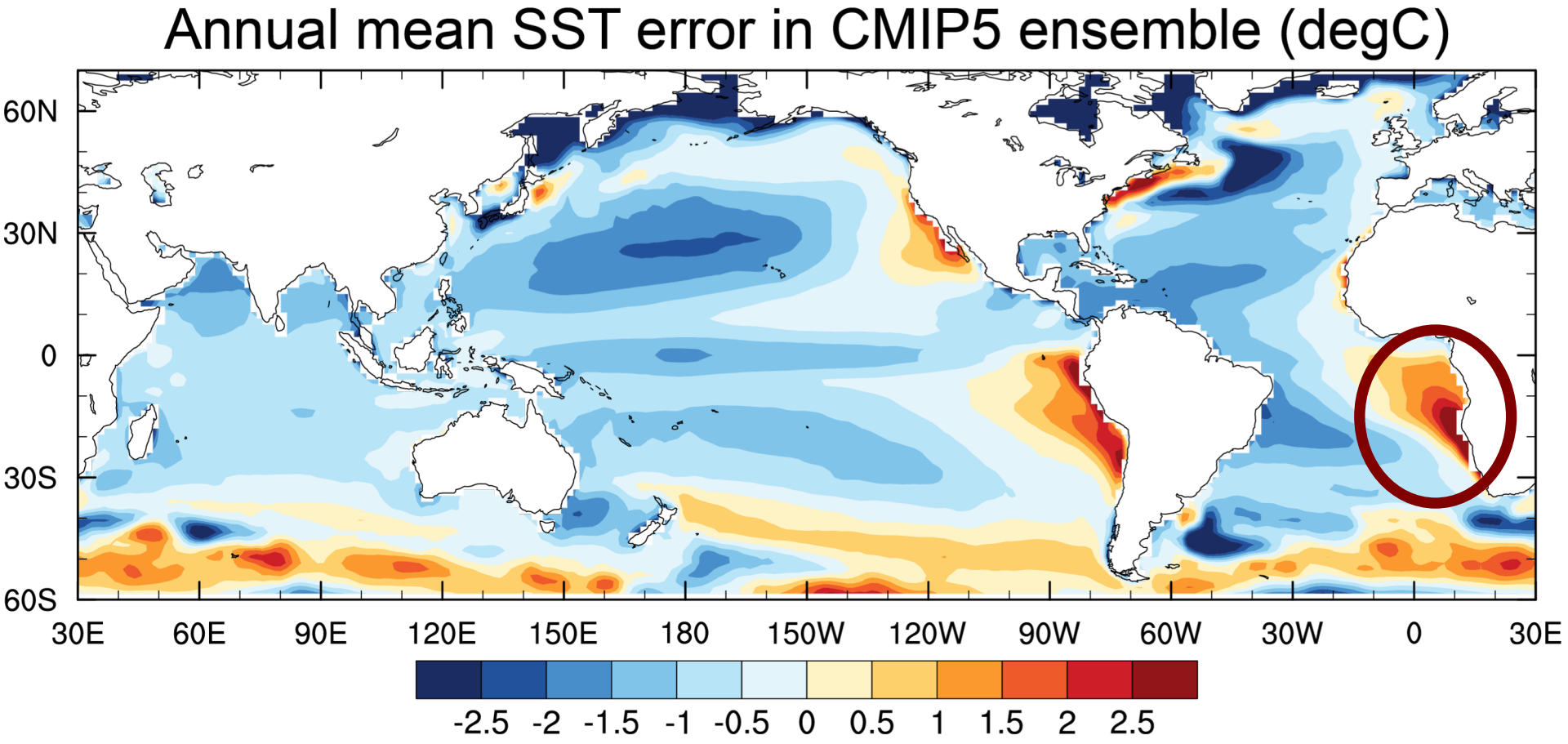
Take-home messages

- on average, CMIP6 shows little improvement in tropical Atlantic biases, relative to CMIP5
- however, a few models achieve very small bias
- many models achieve relatively realistic equatorial Atlantic variability, regardless of bias
- Atlantic Niño – Pacific Niño relation varies widely across coupled simulations

Background


Annual mean SST error in CMIP5 ensemble (degC)
60N
30N
0
30S
60S
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
30E
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5

Motivation for studying tropical Atlantic biases

- severe SST biases relative to some other regions
- potential impact on seasonal prediction skill
- impact on tropical Pacific on decadal and longer time scales (McGregor et al. 2018; see below)
- impact on global change projections

nature climate change

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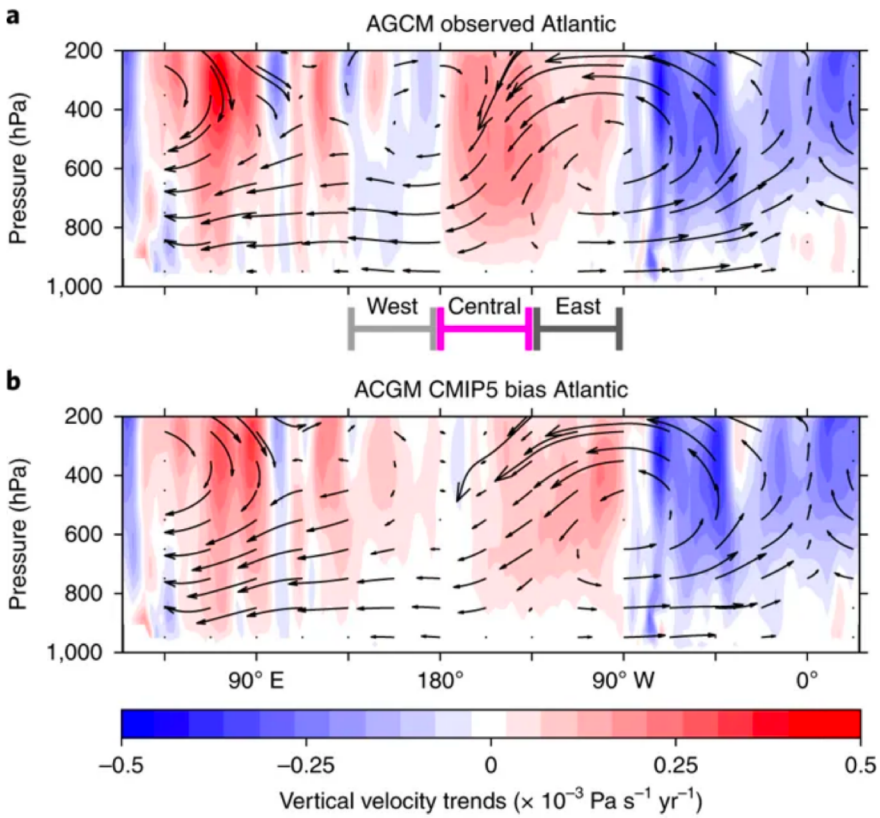
Model tropical Atlantic biases underpin diminished Pacific decadal variability

Shayne McGregor ✉, Malte F. Stuecker, Jules B. Kajtar, Matthew H. England & Mat Collins



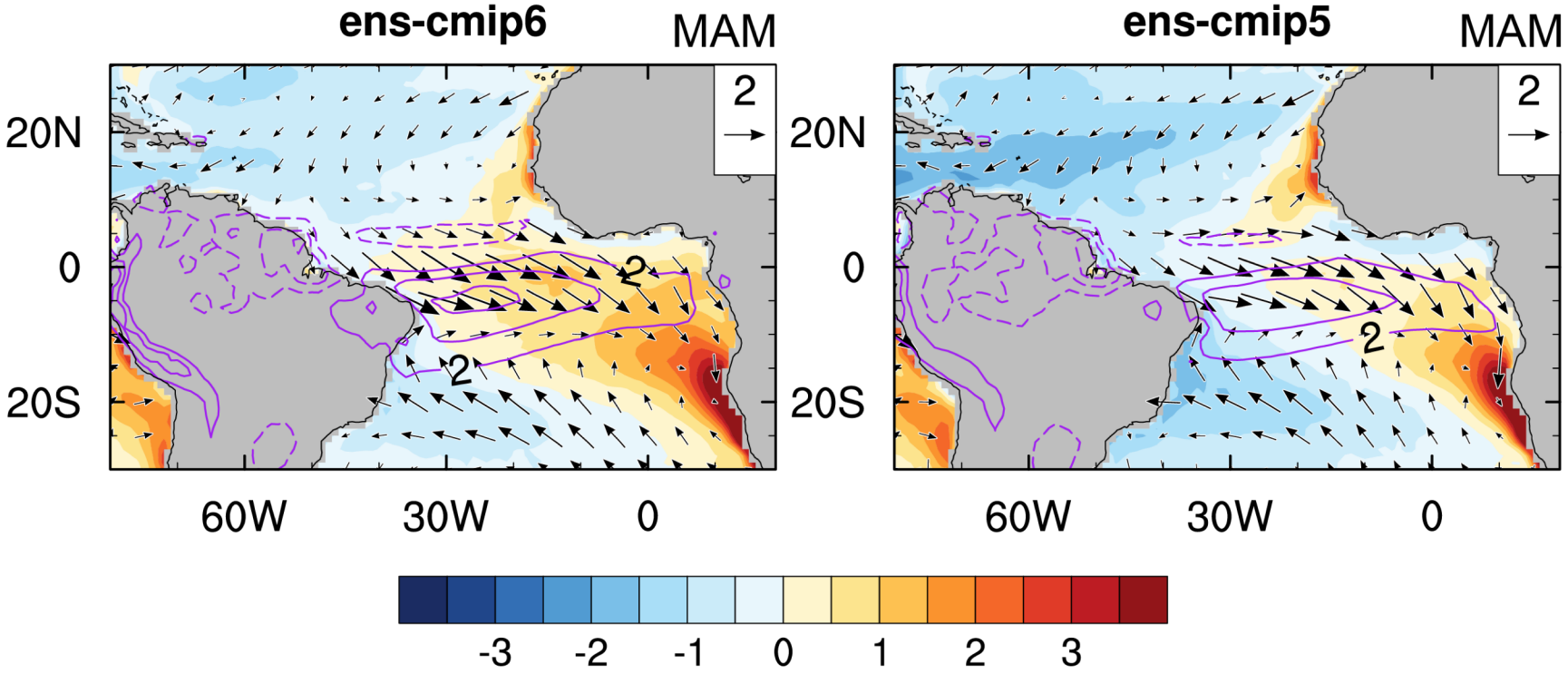
"The underestimation largely stems from a reduction and eastward shift of the atmospheric heating response to the tropical Atlantic warming trend. This result suggests that the recent Pacific trends and model decadal variability may be better captured by models with improved mean-state climatologies."

Mean state biases in piControl

- on average, little change relative to CMIP5: southward ITCZ shift and westerly bias in MAM, warm SST bias in JJA
- warm SST biases in coastal upwelling regions slightly improved
- cold SST bias in subtropics improved

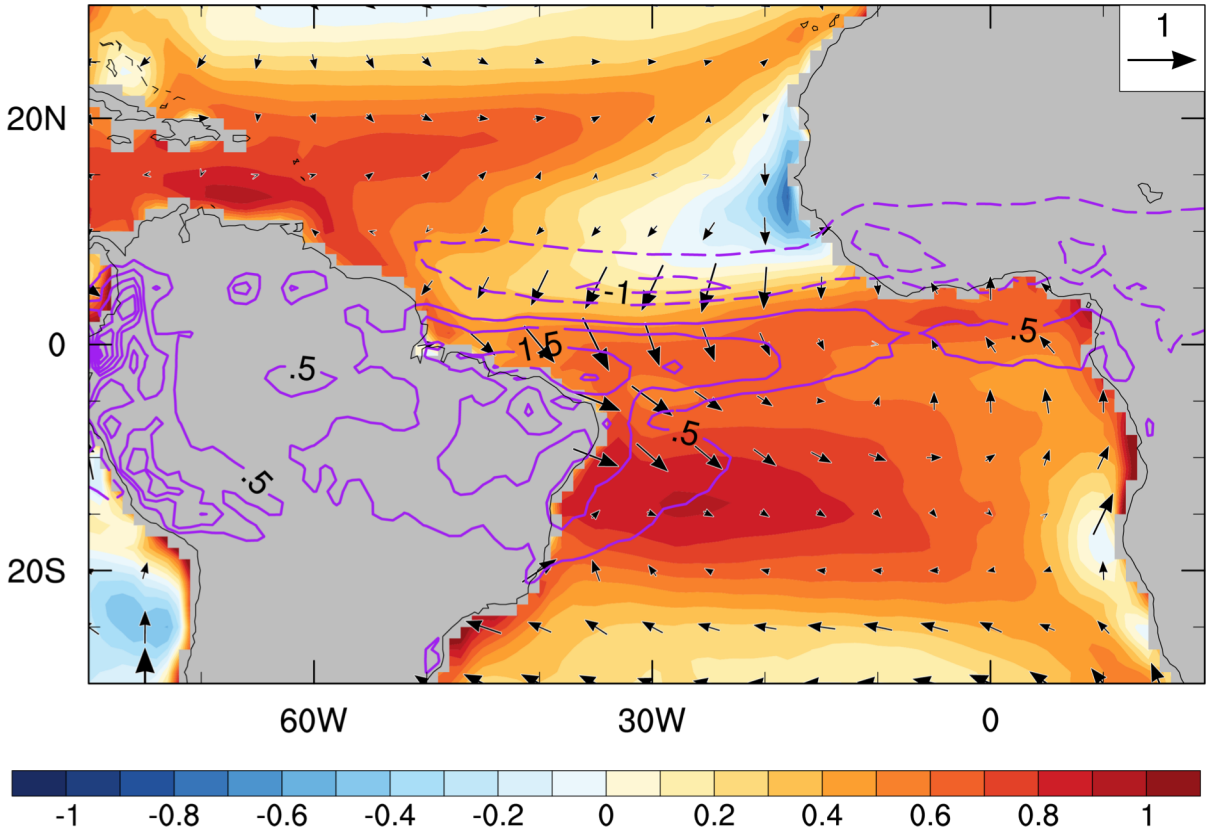
Biases in MAM

SST (shd), sfc wind (vect), precip (cnt)



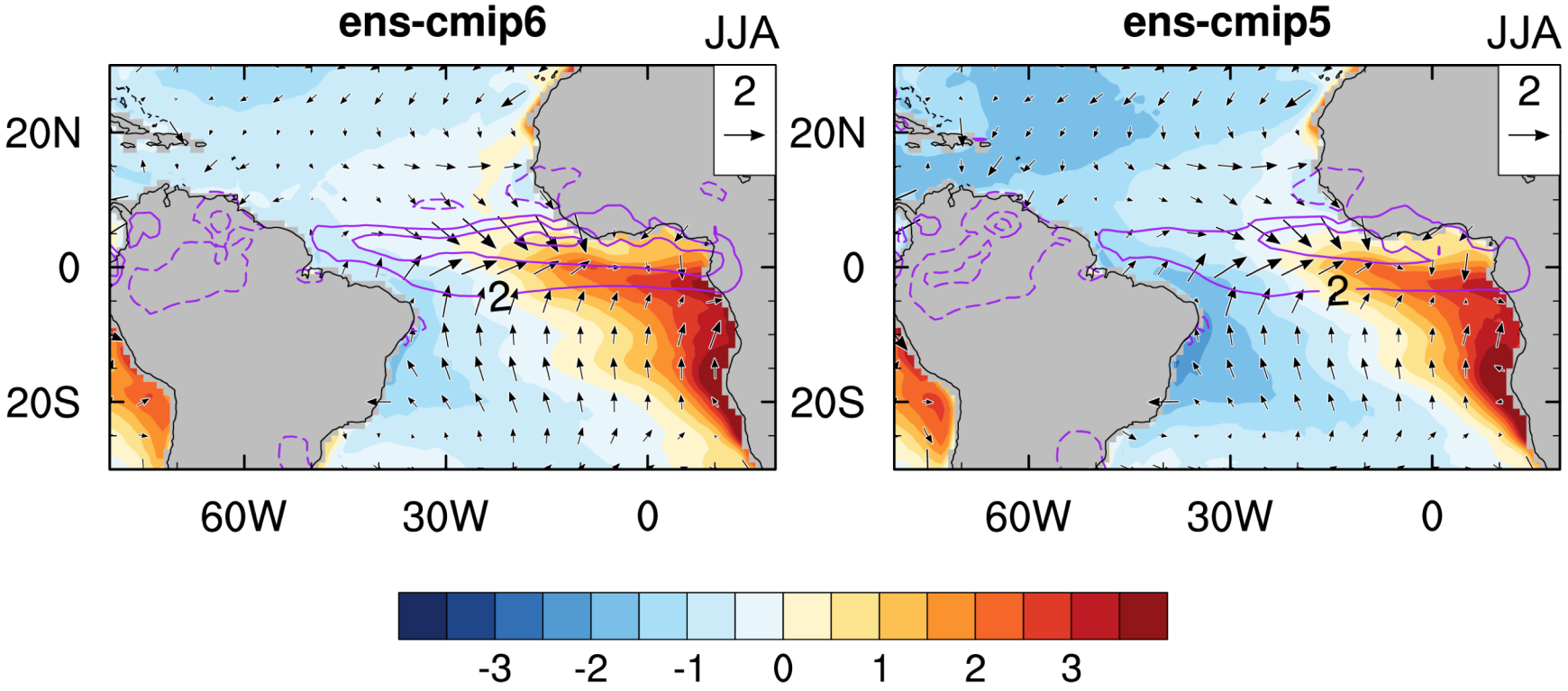
Difference CMIP6 – CMIP5; MAM

SST (shd), sfc wind (vect), precip (cnt)



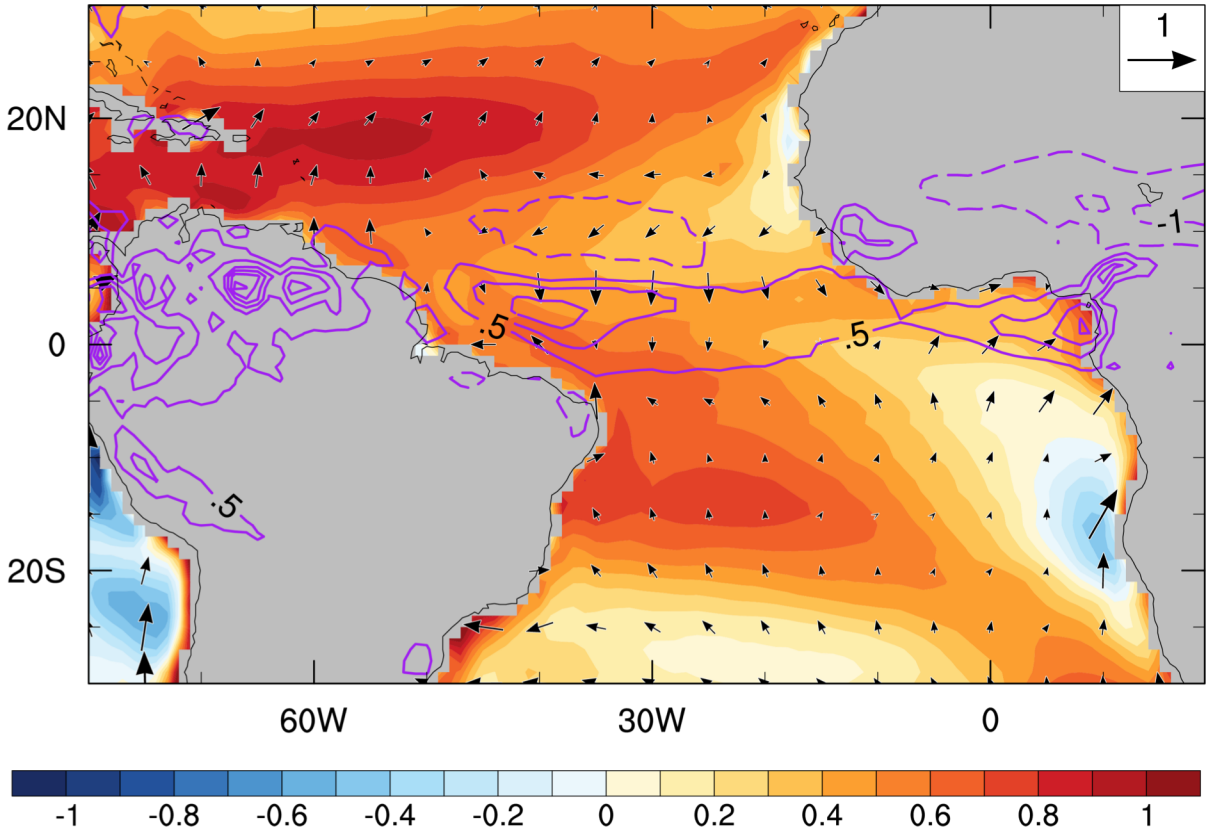
Biases in JJA

SST (shd), sfc wind (vect), precip (cnt)



Difference CMIP6 – CMIP5; JJA

SST (shd), sfc wind (vect), precip (cnt)

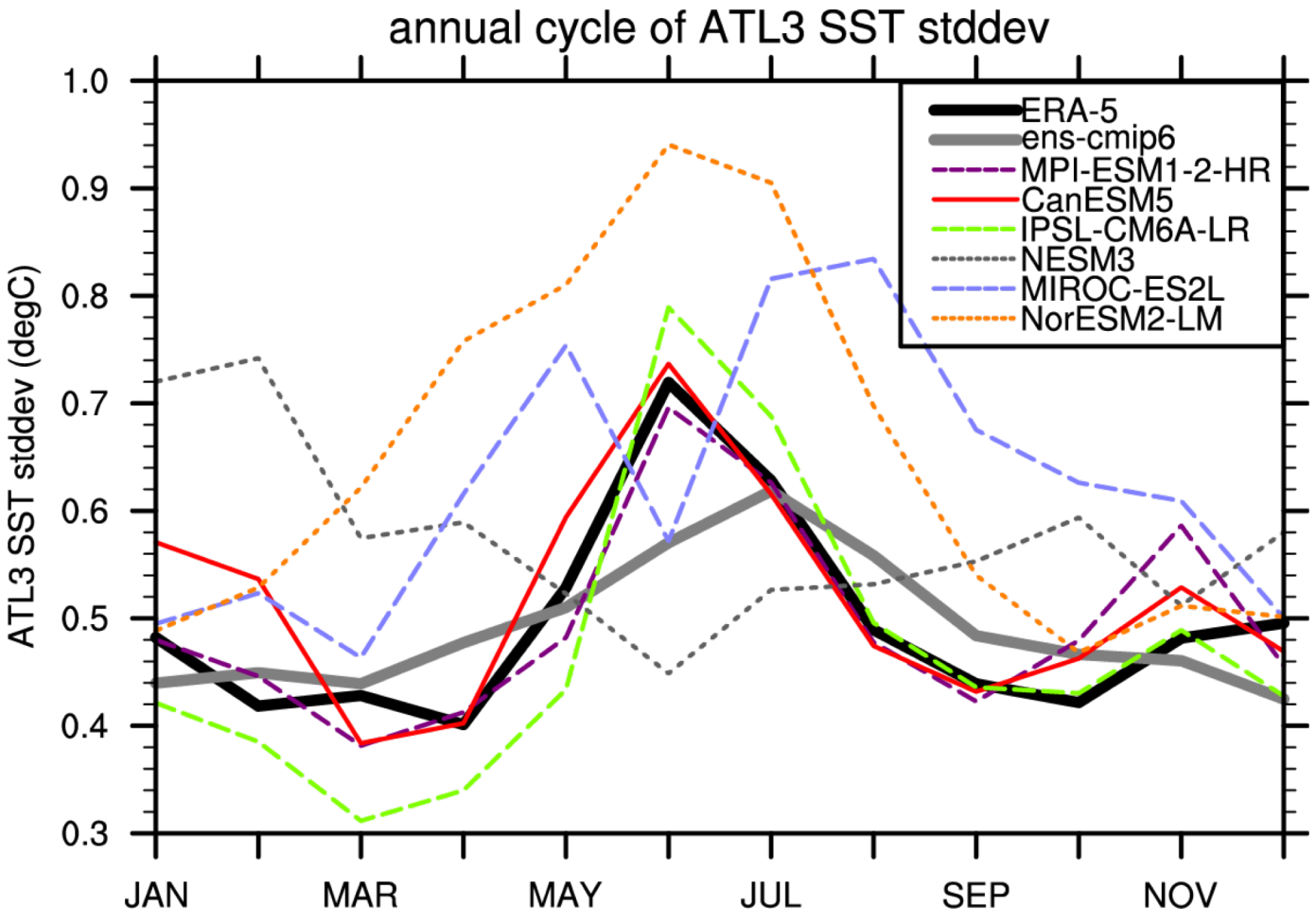


Equatorial Atlantic variability

- some models show realistic variability, both for ATL3 SST and ATL4 sfc zonal wind
- temporal evolution of the Atlantic zonal mode is also well represented in some CMIP6 models

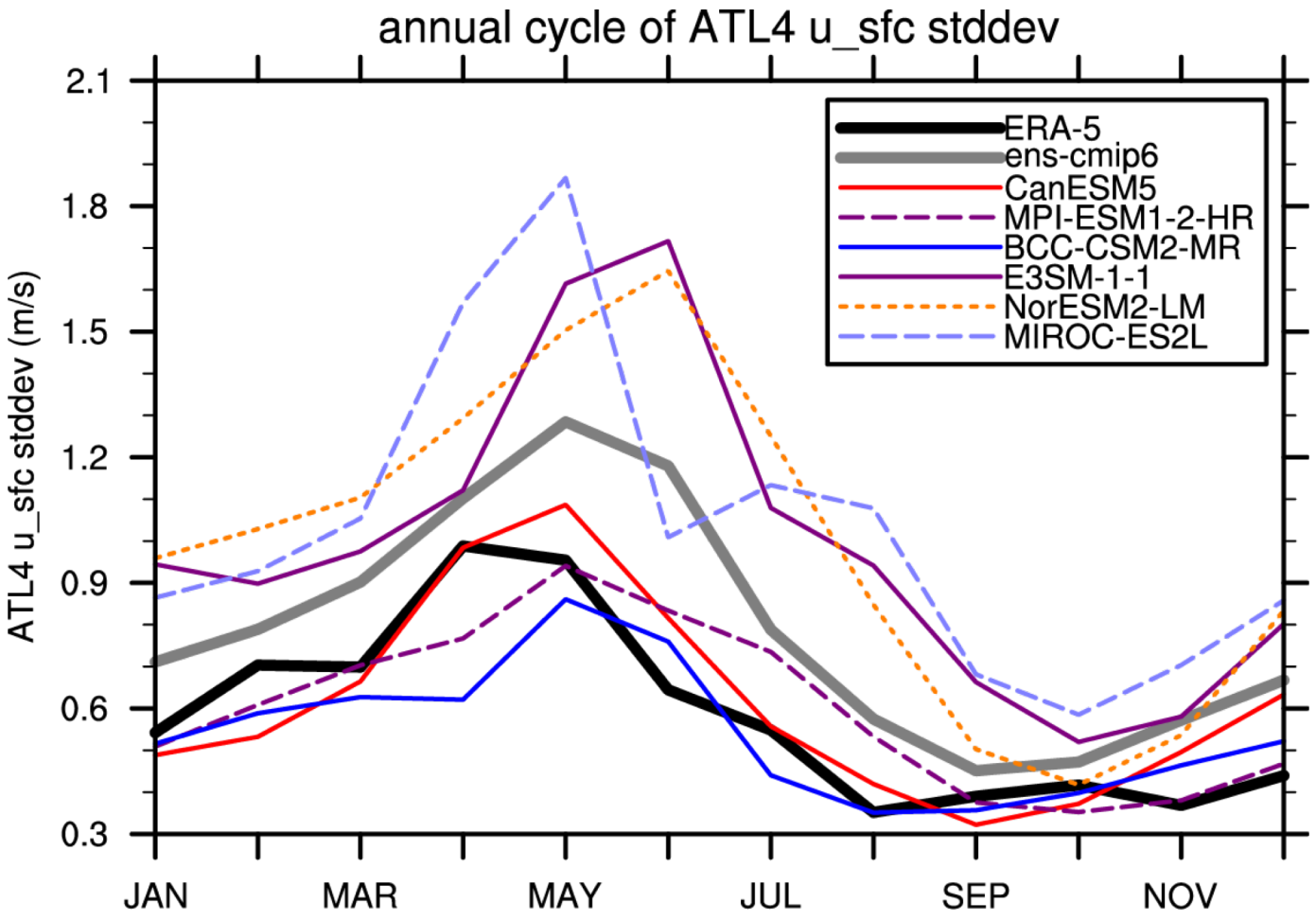
Standard deviation of SST in the ATL3

best and worst 3 models (based on RMSE)

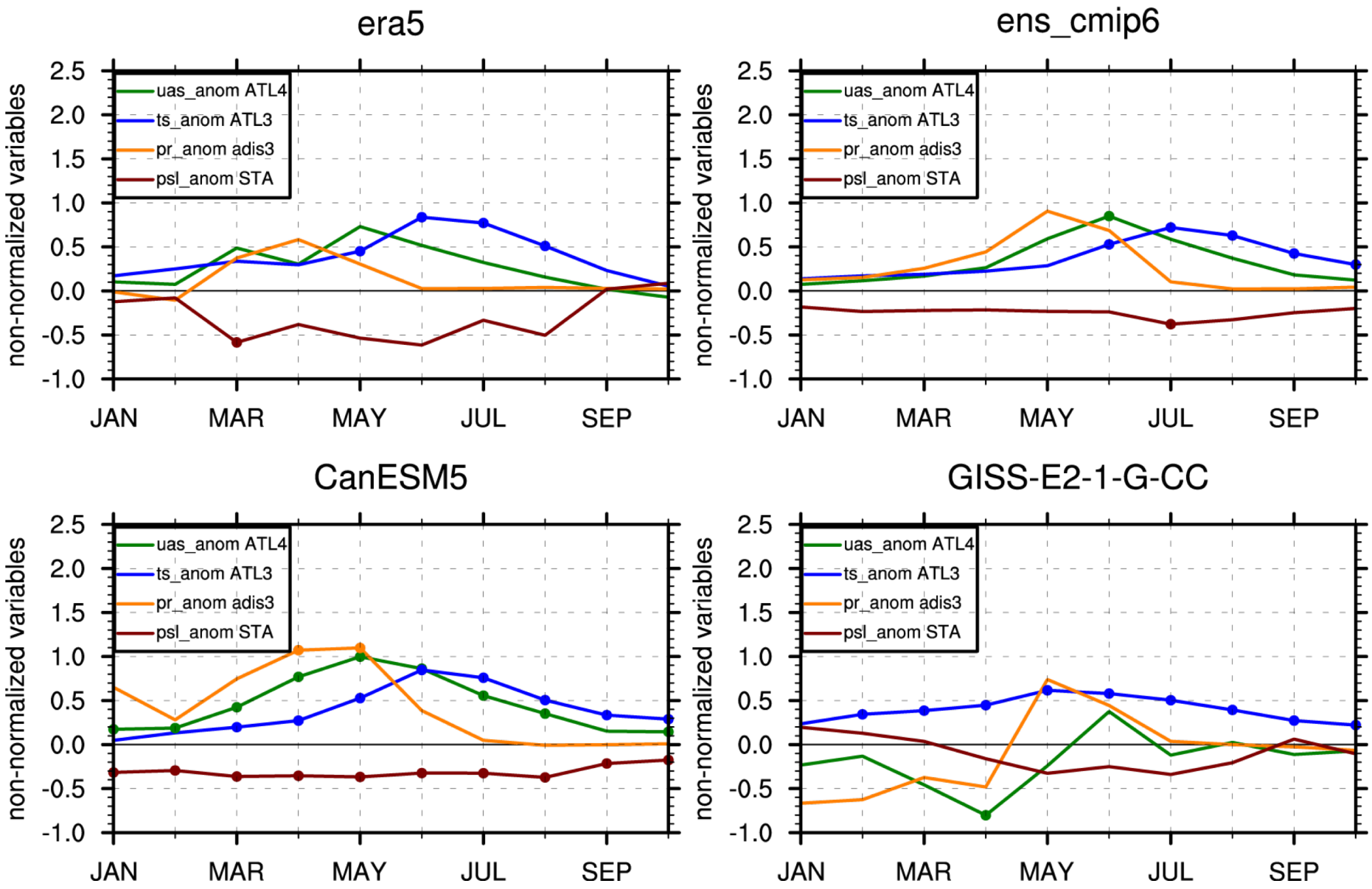


Standard deviation of u_sfc in the ATL4

best and worst 3 models (based on RMSE)



AZM+ composites: ATL4 u_sfc, ATL3 SST, SEQ precip, STA SLP



Teleconnection to the tropical Pacific

- observations show weak anti-correlation between equatorial Pacific SST in MAM and equatorial Atlantic SSTs in JJA
- CMIP6 models display widely differing behavior: from strong negative correlation, to neutral, to strong positive correlation

AZM+ composite for MAM: SST, 10m wind, precip