

# Drift, bias, variability and skill in the Tropical Atlantic

## IC3 contribution to PREFACE

C. Prodhomme, E. Exarchou, D. Volpi, V. Guemas,  
F. Doblas-Reyes

Preface General Assembly, Cape Town, 27/08/2015



# How is the SST drifting in seasonal hindcasts?

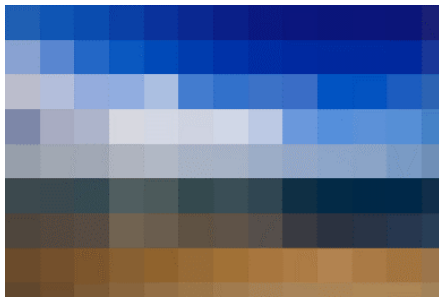
E. Exarchou, V. Guemas, C. Prodhomme, F.  
Doblas-Reyes



# EC-Earth seasonal hindcasts

Seasonal retrospective hindcasts performed with **EC-Earth 3.0.1**

**SRes** (T255/ORCA1)



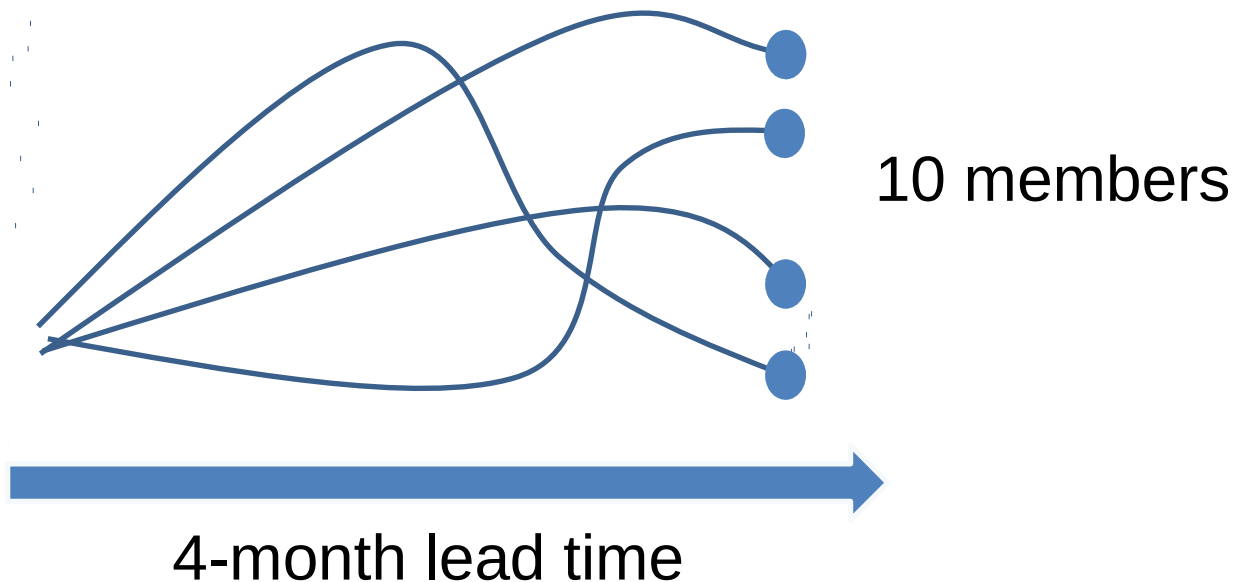
Oceanic ICs:  
- GLORYS  
- ORAS4

**HRes** (T511/ORCA025)



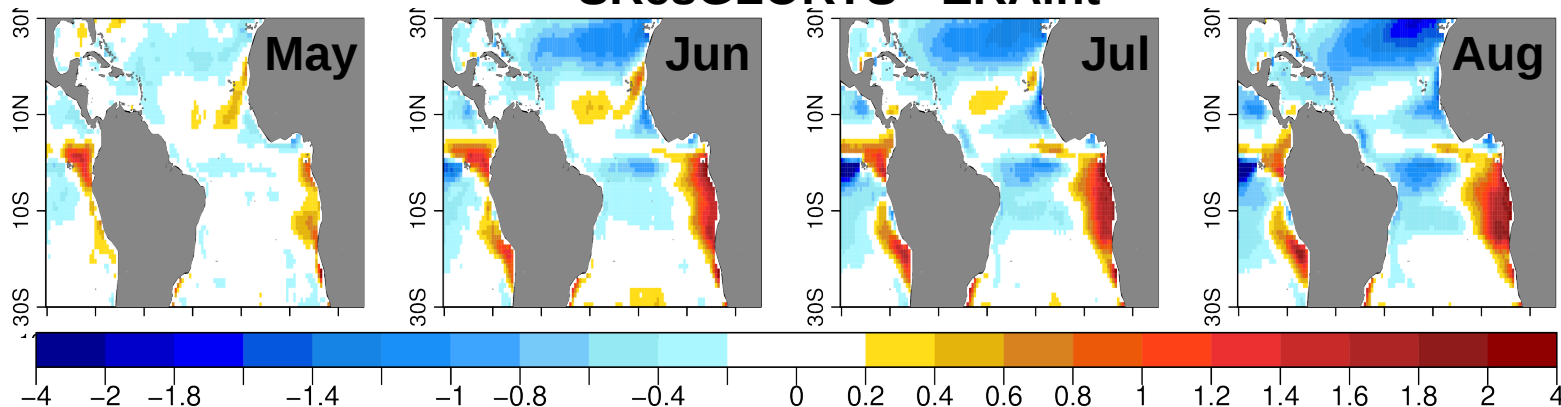
Oceanic IC: GLORYS

32 start dates: May and November every year between 1993 and 2009



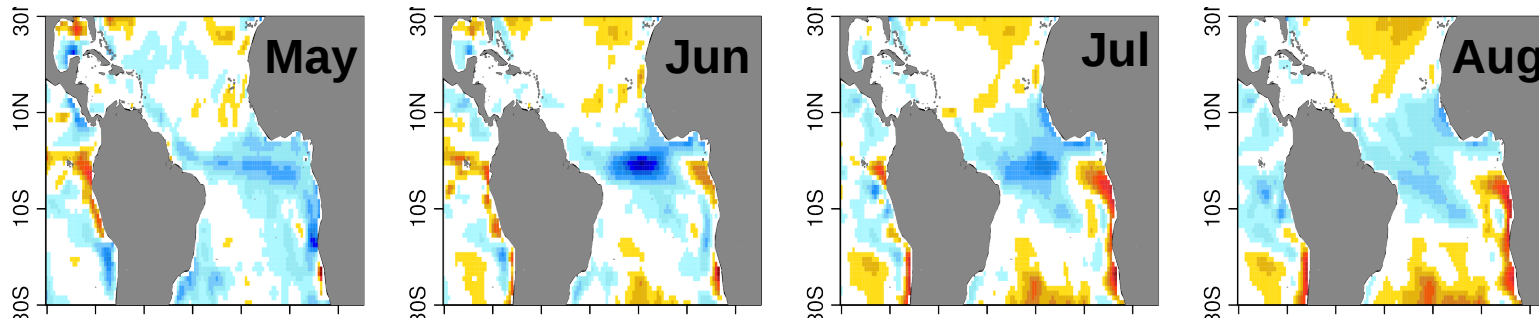
# SST biases

**SResGLORYS - ERAint**



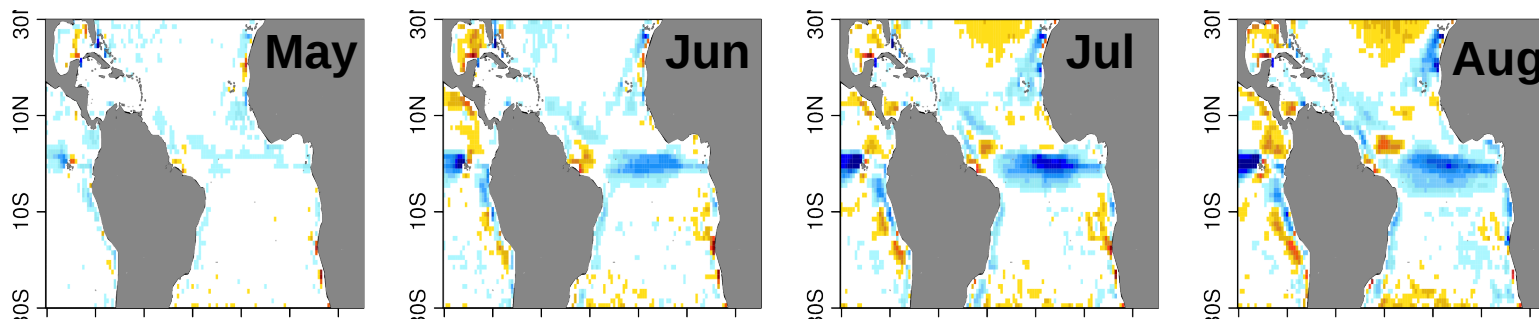
- The bias remains similar in all experiments

**SResGLORYS - SResORAS4**



- The bias is slightly reduced when using ORAS4 IC  
- Error growing faster with ORAS4

**SresGLORYS - HRes**

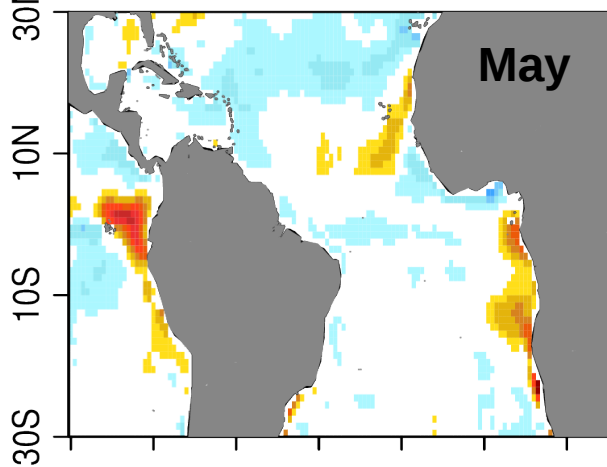


- The bias is reduced in the equatorial region in high resolution forecast

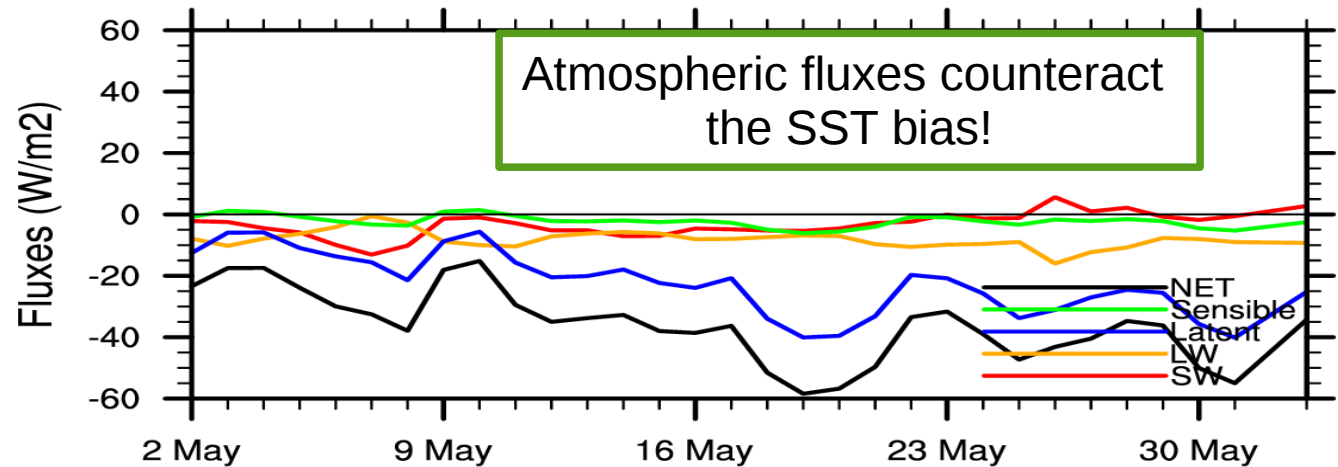


# Fast development of the error in ABA

SResGLORYS – ERAint: SST



SF biases ABA, May, EXP-ORAS4

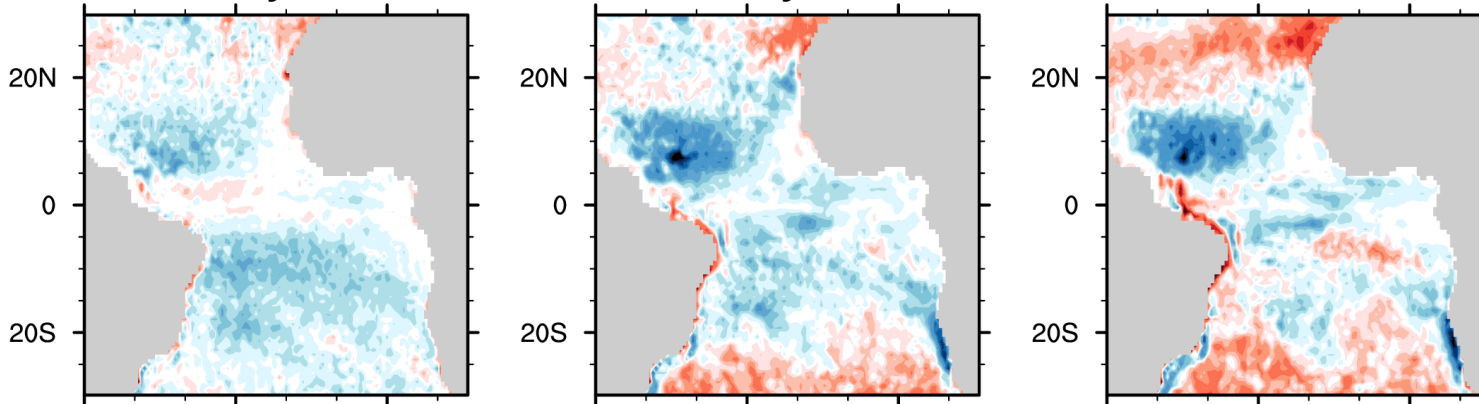


SResGLORYS – ERAint: Mix Layer Depth

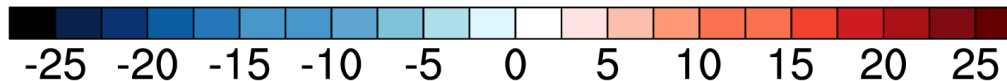
May 1st

May 15th

May 30th

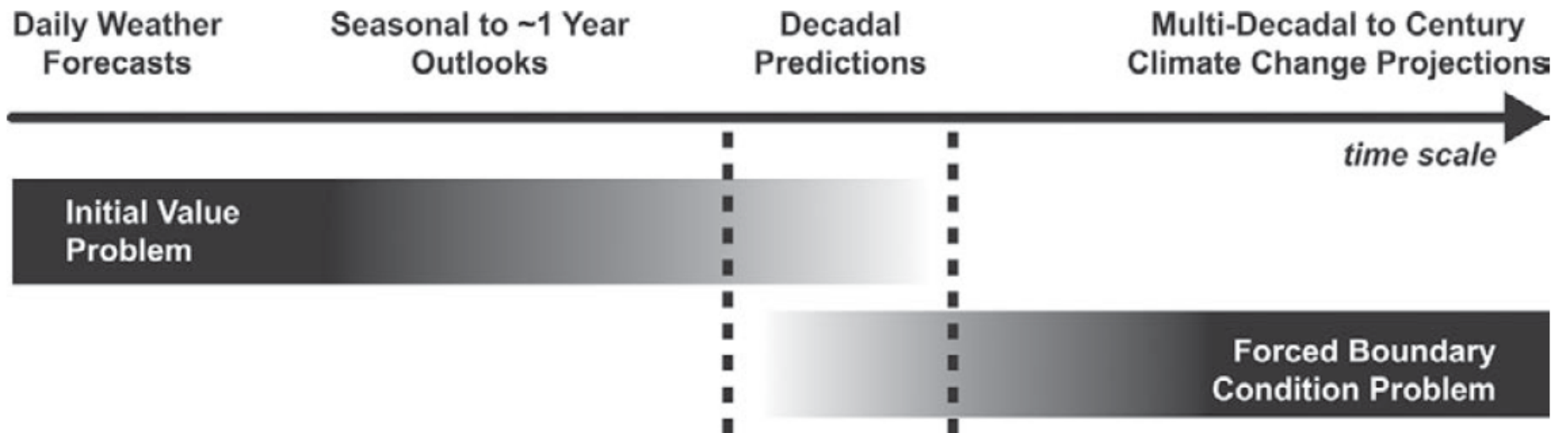


The mix layer is too thin  
→ not enough mixing



# CMIP5 decadal hindcasts skill and bias in the tropical Atlantic

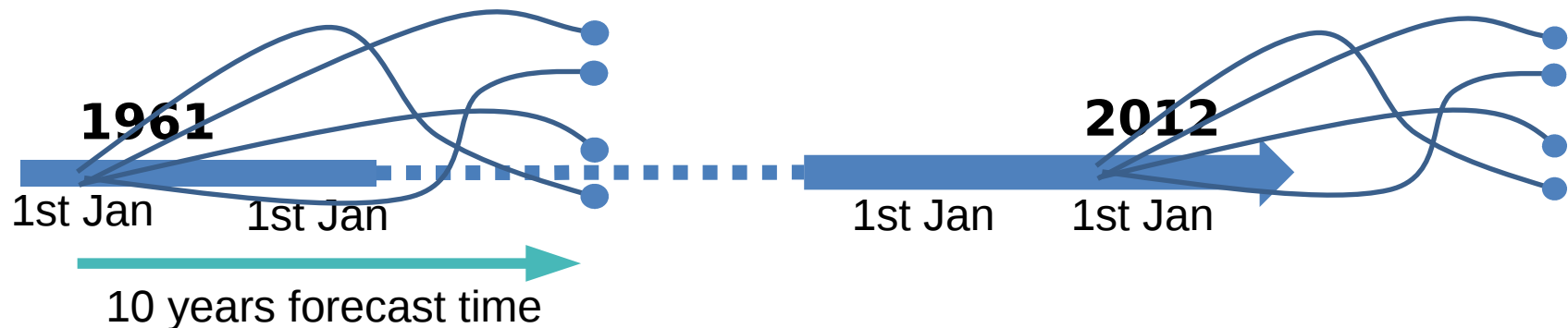
D. Volpi, E. Exarchou, C. Prodhomme, V. Guemas,  
F. Doblas-Reyes



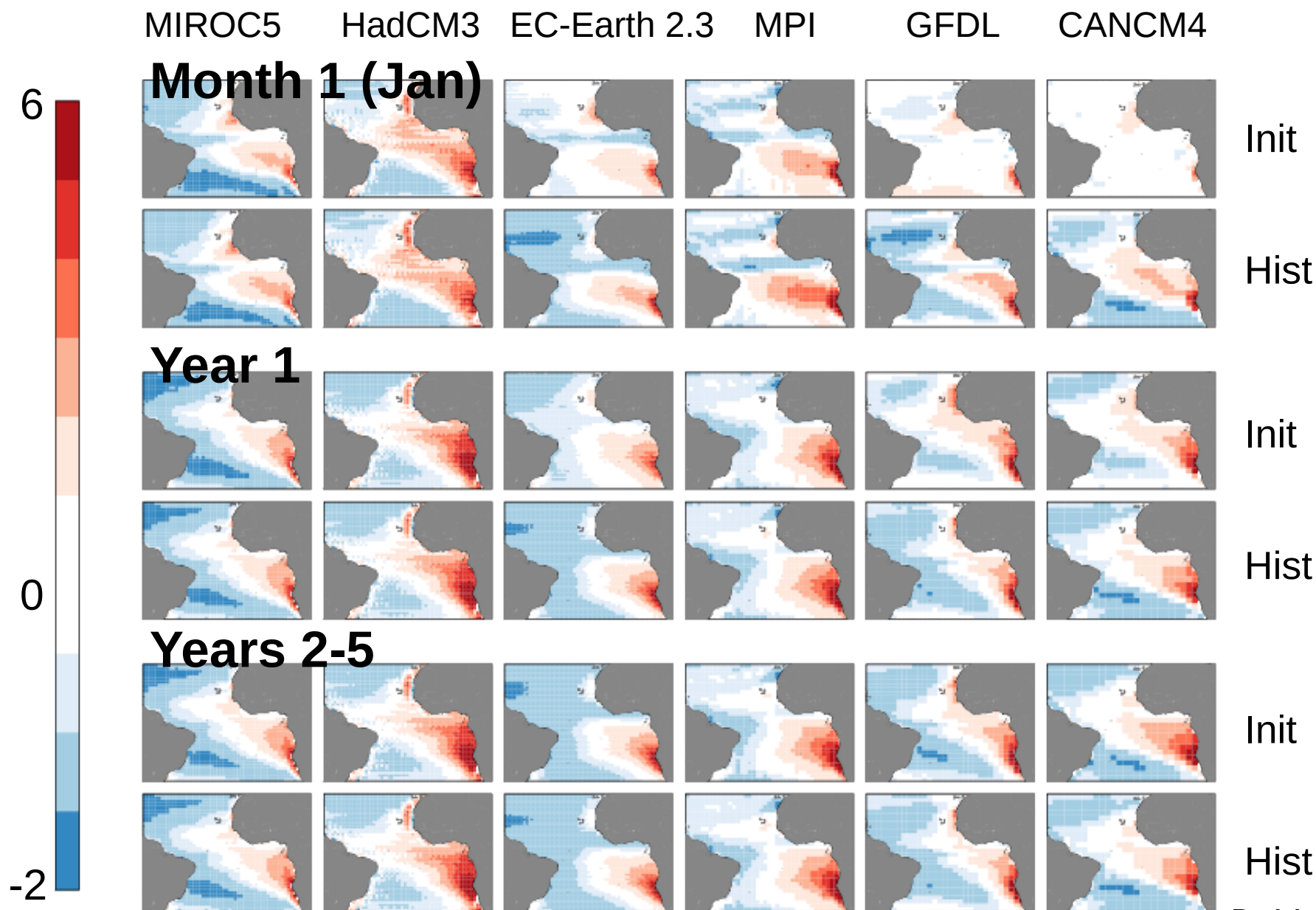
# CMIP5 decadal/historical experiments

	Member prediction	Members historical	Period
MIROC5	6	1	1961-2011
HadCM3	10	10	1961-2010
EC-Earth v2.3	10	10	1961-2006
MPI	5	3	1961-2012
GFDL-CM2	10	10	1961-2012
CANCM4	10	10	1961-2012

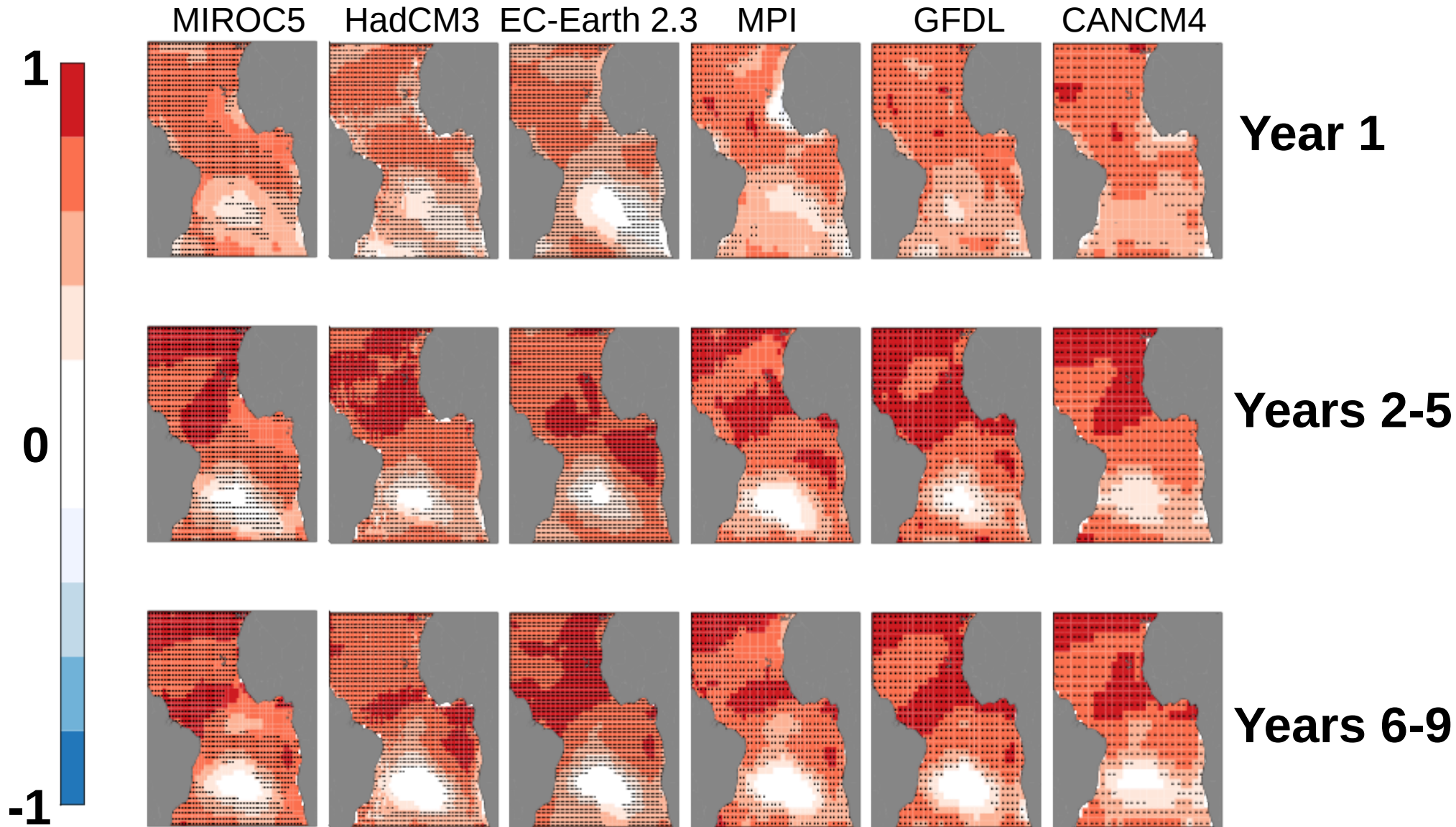
Between 46 and 52 stardate:  
1st of January of every years



# CMIP5 decadal/historical experiments



# SST correlation in the decadal hindcasts





# SST skill decadal hindcasts vs historical

MIROC5

HadCM3

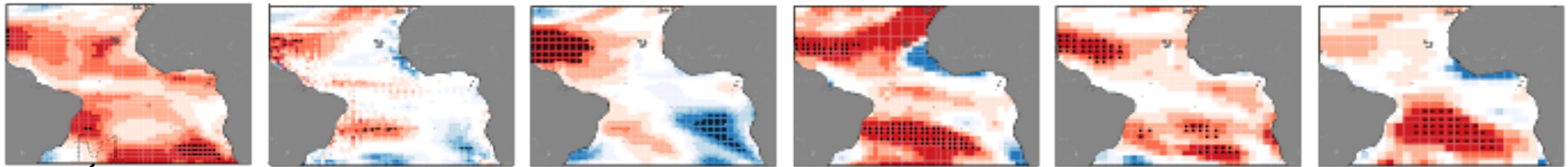
EC-Earth 2.3

MPI

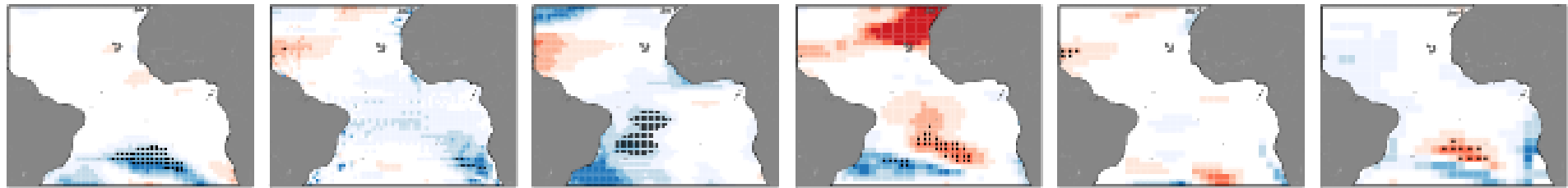
GFDL

CANCM4

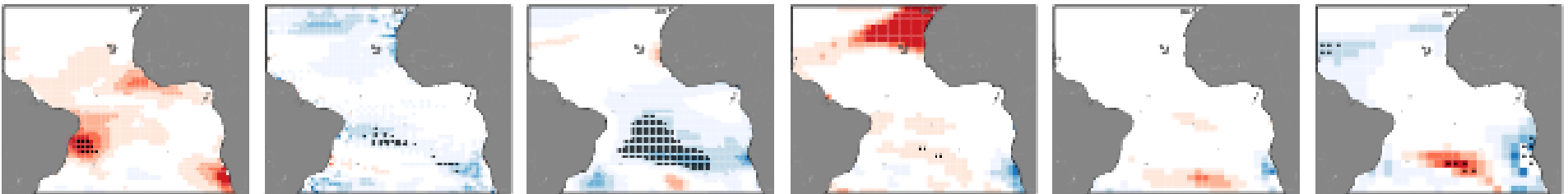
**Year 1**



**Years 2-5**



**Years 6-9**



-1

0

1



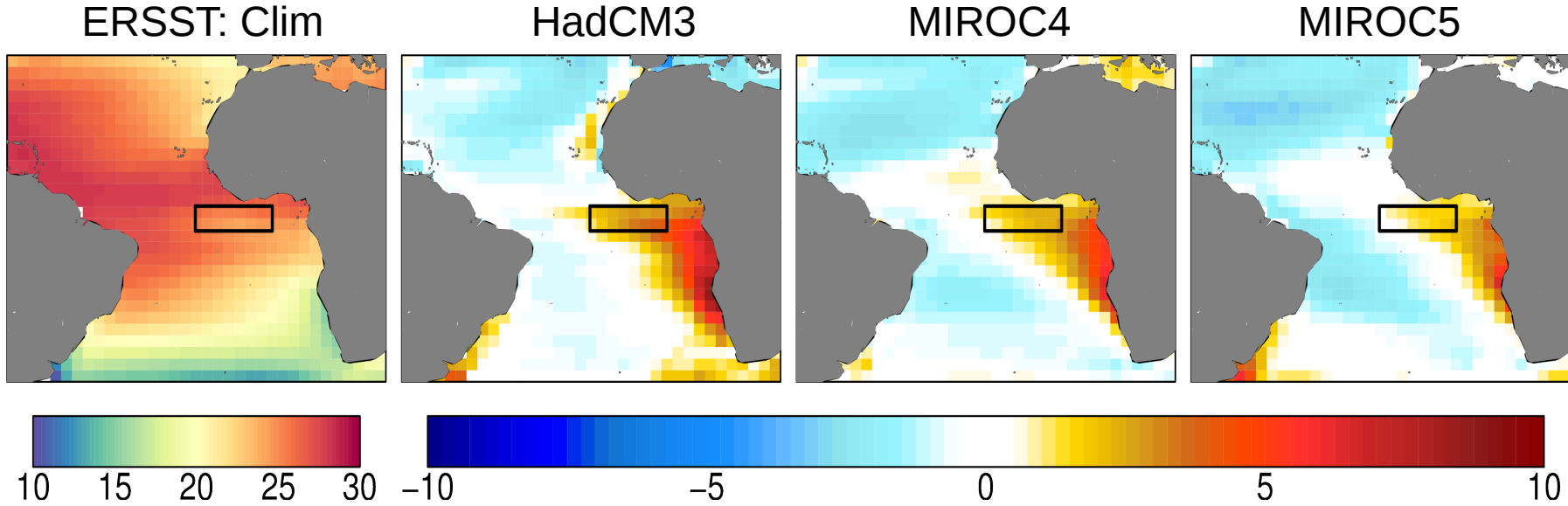


# How the bias affects the variability in CMIP5 historical simulation?

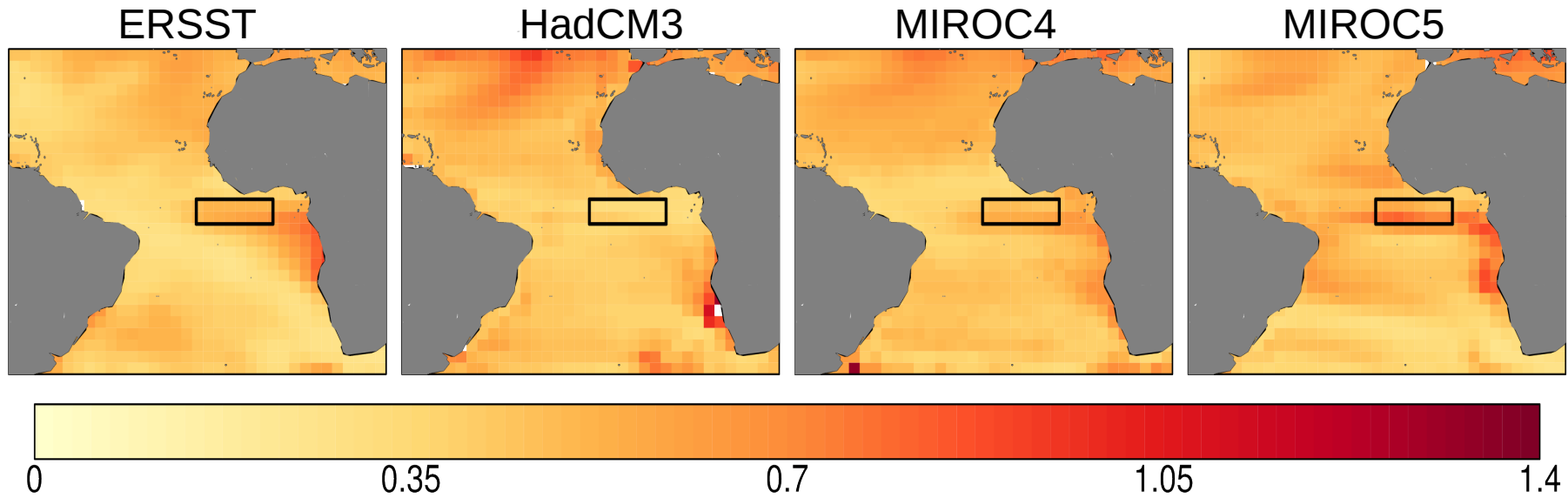
C. Prodhomme, J. Garci-Serrano, V. Guemas, F. Doblas-Reyes

# Bias and variability in Summer (JJA)

## SST: Bias



## Standard Deviation

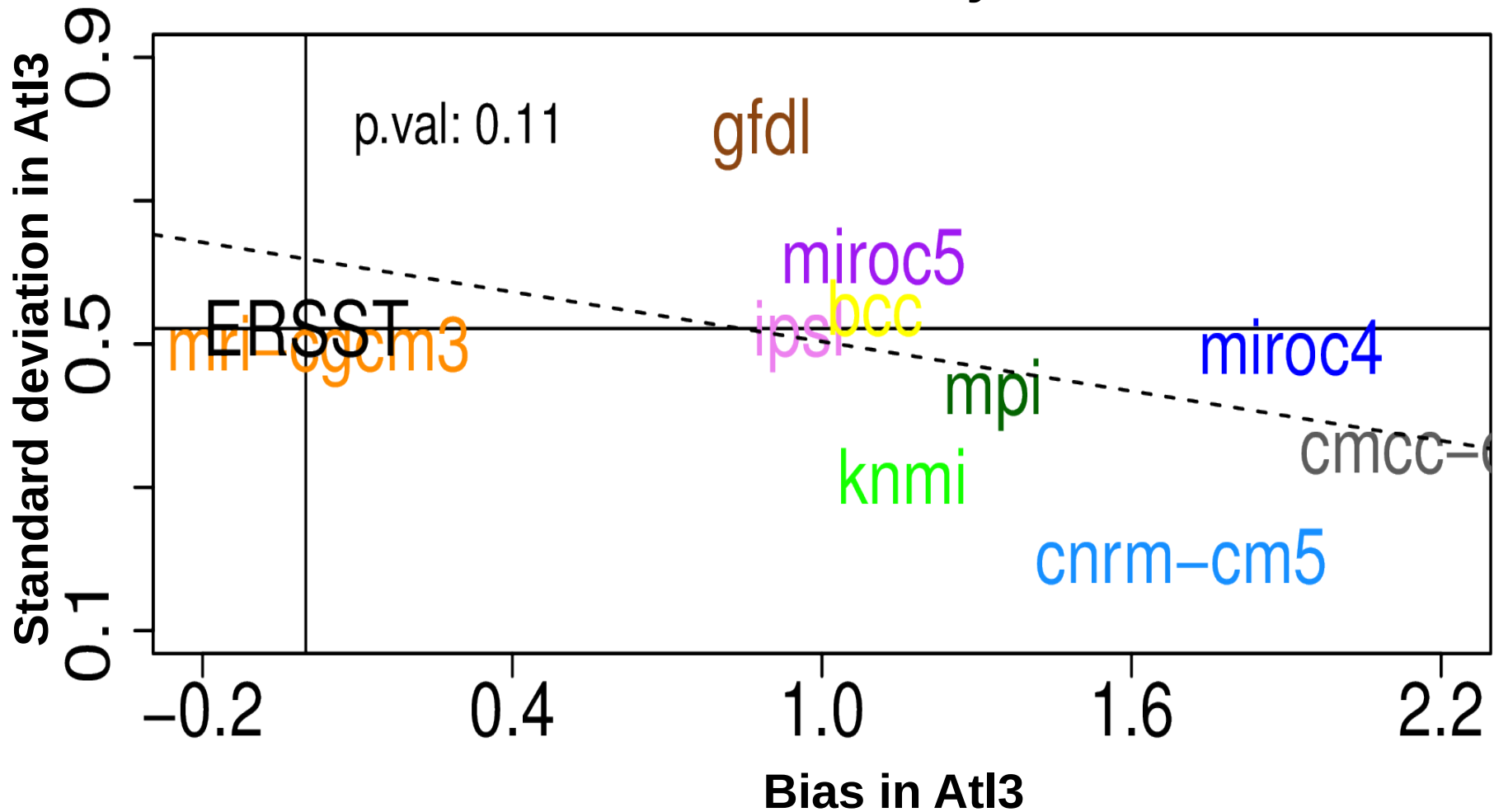






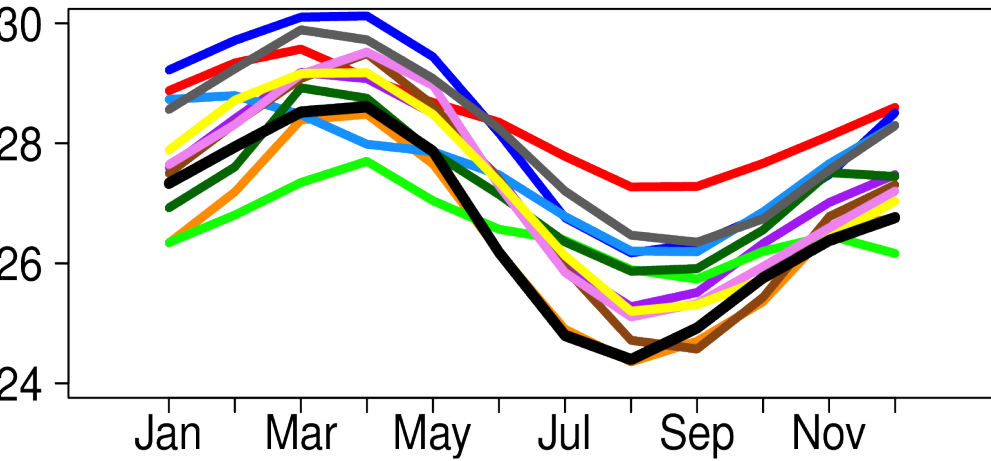
# Bias and variability in Summer (JJA)

### Bias vs variability in Atl3

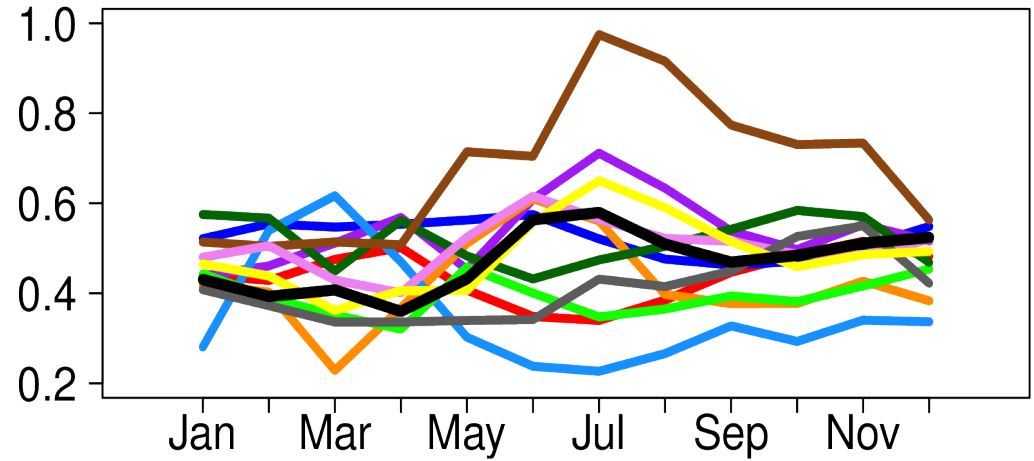


# Bias and variability seasonal cycle

**Climatology Atl3**

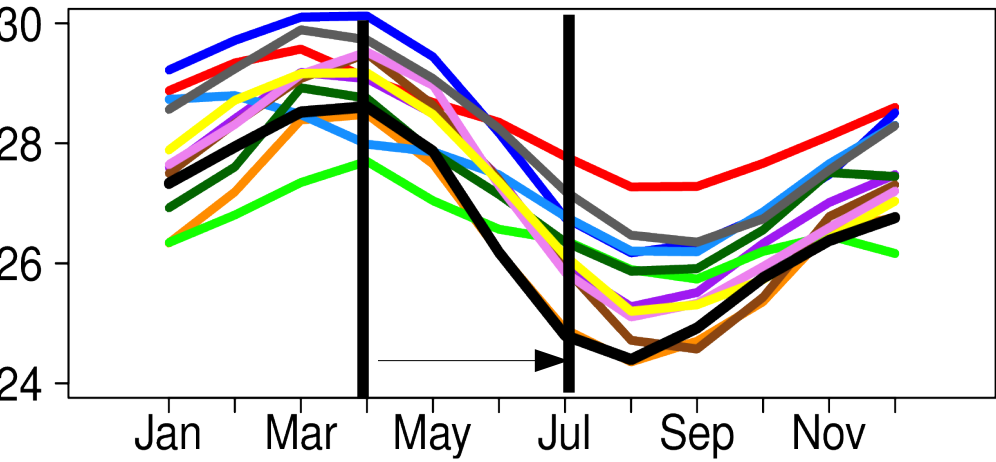


**Standard Deviation Atl3**

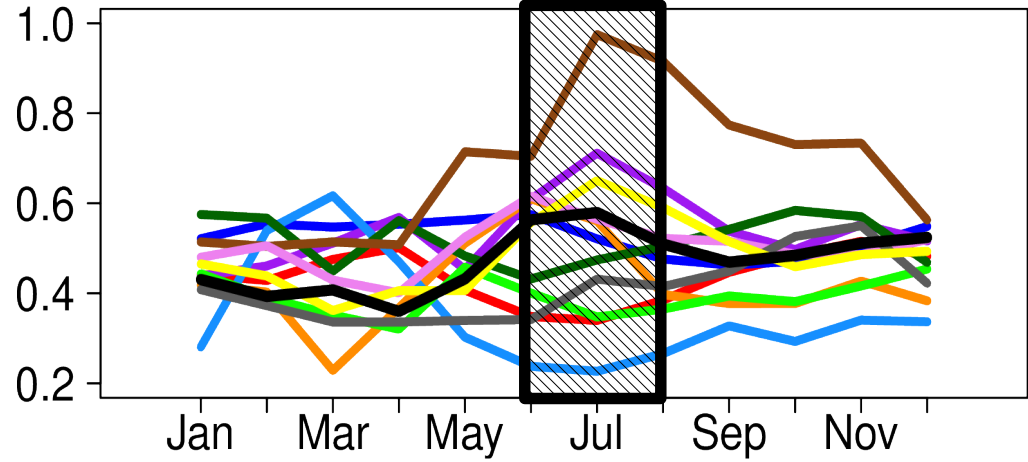


# Bias and variability seasonal cycle

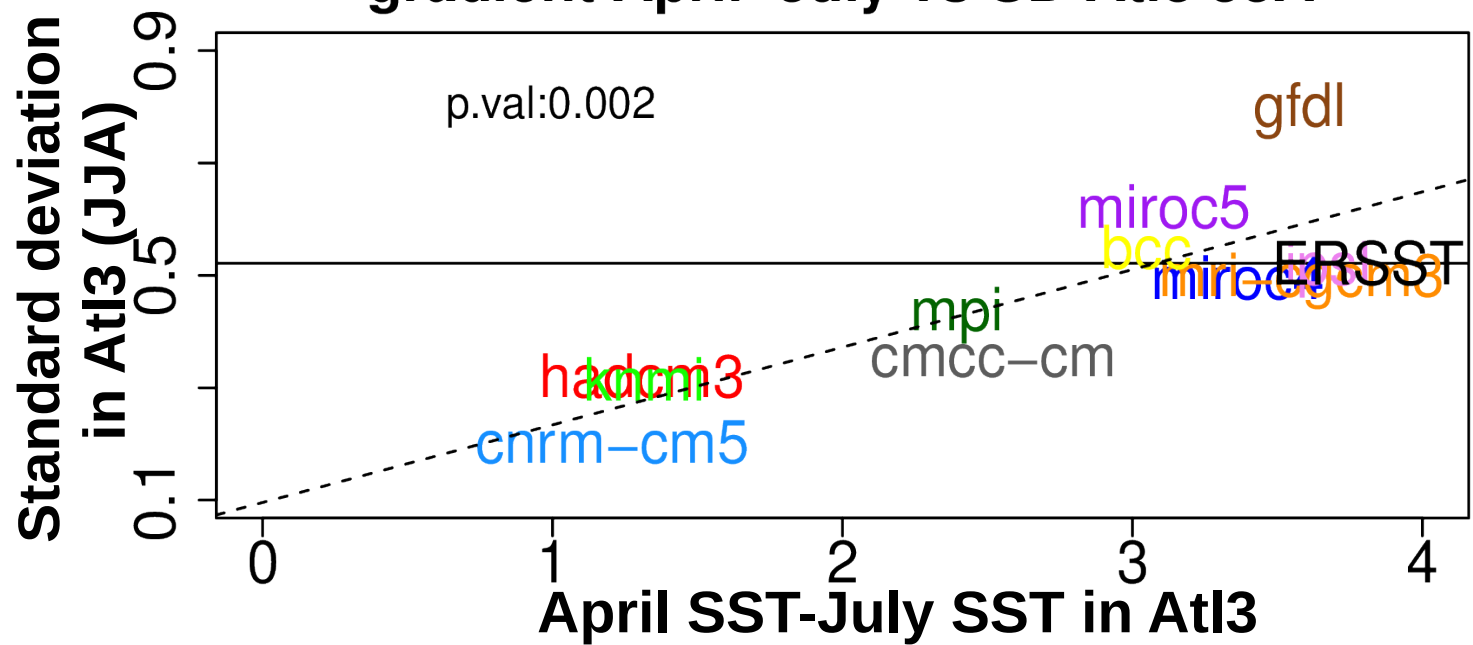
Climatology Atl3



Standard Deviation Atl3



gradient April–July vs SD Atl3 JJA



## Conclusions

- The bias in tropical Atlantic (TA) is developing **very fast** (during the first year).
- Results suggest an **oceanic origin** of the bias.
- Both decadal hindcasts and historical simulation have **skill up to 10 years** in the TA.
- The initialization does not affect much the skill in the TA after the first year.
- The **interannual variability** in the equatorial Atlantic is linked with the ability of the model to reproduce a **correct seasonal cycle** in the TA.

## Prospects

- Investigate the daily time series of oceanic variables in the seasonal hindcasts (temperature and density profiles, MLD...).
- Investigate the robustness and the processes underlying the relationship between interannual variability and seasonal cycle representation.

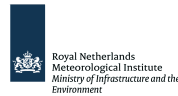
# Not shown...



## The Influence of Wind Stress on Tropical Atlantic SST Bias

Sensitivity experiments with EC-Earth 3.1

Anna-Lena Deppenmeier (anna-lena.deppenmeier@wur.nl), Chloé Prod'homme, Eleftheria Exarchou, Francisco J. Doblas-Reyes, Rein Haarsma, and Wilco Hazeleger



**THE STATUS QUO IN THE TROPICAL ATLANTIC**

Sea surface temperatures in the tropical Atlantic ocean is still heavily biased in most state-of-the-art GCMs.

EC-Earth3.1 displays the typical warm bias off the coast of Angola. On the equator itself the bias is small (zonal winds, which are too weak in most GCMs, cold, northward). The Benguela region shows a strong wind stress component, but it is too weak.

**EXPERIMENTAL SETUP**

We investigate the influence of wind stress on the tropical Atlantic SST bias with sensitivity experiments. The model is run in coupled mode, but over indicated boxes we force the ocean with ERA-Interim wind stress, instead of model wind stress.

The first box covers the whole tropical Atlantic including the Angola-Benguela region where the SST bias is especially large (TA forcing).

The second box applies ERA-Interim wind stress only in the Benguela region (EA forcing).

A possible reason for the warm bias are the (equator-coast of Angola). On the equator itself the bias is small (zonal winds, which are too weak in most GCMs, cold, northward). The Benguela region shows a strong wind stress component, but it is too weak.

**FURTHER INVESTIGATION**

a) **Quantitative change of SST bias**

- Gridpoint analysis
- Dependence on box

b) **Wind stress variability & SST bias**

- Compare internal variability ERA-Interim to EC-Earth3.1

- variability of forcing field

c) **SST bias in ABA region**

- $\tau$  seems to have little influence on SST bias in EC-Earth3.1
- Investigate connection bias - heat fluxes

**THE SST BIAS THROUGH THE EXPERIMENTS**

We show the SST bias of the wind stress driven by the wind stress (TA and EA) in the center panel for comparison. Results from forcing over two different boxes, EA and TA, and with two different forcing leads of hourly (EA<sub>dir</sub>, TA<sub>dir</sub>) and monthly (EA<sub>24h</sub>, TA<sub>24h</sub>) are shown.

Top panel: EA  $\tau_{dir}$ , bottom panel: TA  $\tau_{dir}$ .

• Direct forcing cools SST around equator

• Cooling TA<sub>dir</sub> > EA<sub>dir</sub> to bias pattern

• Localised cooling also on eq. coast

• Combine EA &  $\tau_{24h}$ : drastic worsening of bias

• Importance of forcing variability? Different effects per box?

• No cooling in ABA

	trop. Atlantic	eq. Atlantic	ABA (not shown)
$\tau_{dir}$	↓	↓	—
$\tau_{24h}$	↓↓	↑↑	—

**REFERENCES**

EC-Earth:  
 W. Hazeleger et al., *Bull. Amer. Meteor. Soc.*, 91, (2010)  
 ORAS4 ocean reanalysis:  
 M. A. Balmaseda, K. Morigensen, A. T. Weaver  
*Q.J.R. Meteorol. Soc.*, 139 (2013)  
 ERA-Interim atmosphere reanalysis:  
 D. Dee, S. Uppala et al., *Q.J.R. Meteorol. Soc.*, 137 (2011)

And lot of details.....

So questions....?

Thanks for your attention!

