The Influence of Wind Stress on Tropical Atlantic SST Bias

Sensitivity experiments with EC-Earth 3.1

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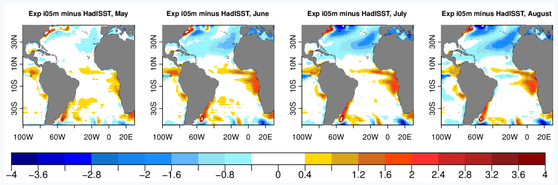
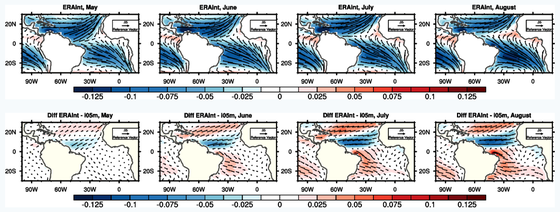
The status quo in the tropical Atlantic

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



Ensemble mean SST bias of EC-Earth3.1 initialised hind casts from year 2000-2009.



ERA-Interim and Δ(ERA-Interim - EC-Earth) wind stress vectors and zonal wind stress in shading.

EC-Earth3.1 displays the typical warm bias off the coast of Angola. On the equator itself the bias is cold, north of it warm.

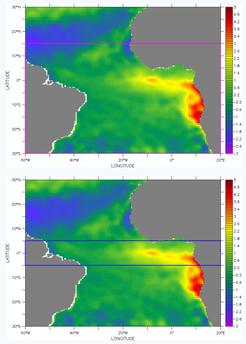
A possible reason for the warm bias are the (equatorial zonal) winds, which are too weak in most GCMs. This is the case for EC-Earth3.1 as well.

- **SST bias in equatorial Atlantic and Angola–Benguela region**
- **Zonal and meridional wind stress components too weak**

Hypothesis:
stronger wind stress cools SST

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 on the equator region (EA forcing). The forcing is tapered linearly over a range of 5^o.

Further investigation

a) **Quantitative change of SST bias**

- Gridpoint analysis
- Dependence on box

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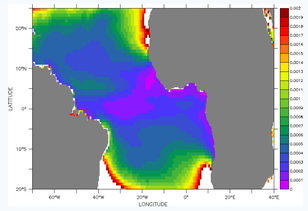
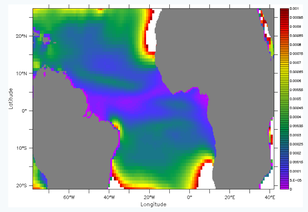
b) **Wind stress variability & SST bias**

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



Variability of τ_v in ERA-Interim



Variability of τ_v in EC-Earth3.1 contol.

- variability of forcing field

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c) **SST bias in ABA region**

- τ seems to have little influence on SST bias in EC-Earth3.1
- Investigate connection bias – heat fluxes

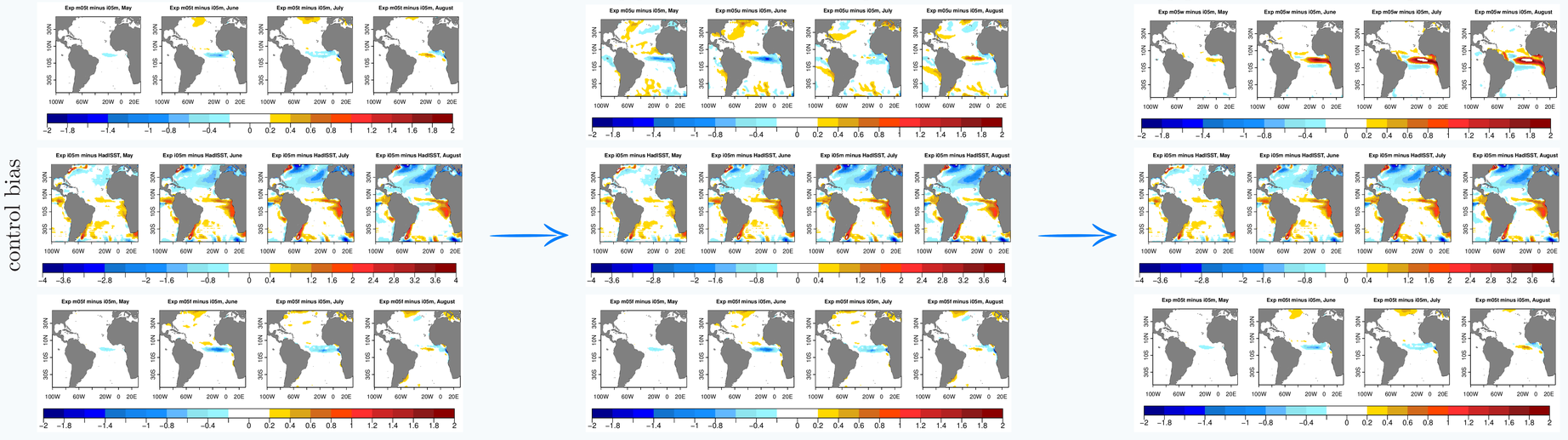
The SST bias through the experiments

We show the SST bias of the wind stress driven experiments with respect to the control bias. The latter is shown in the center panels for comparison. Results from forcing over two different boxes, EA and TA, and with two different forcing fields (3 hourly unsmoothed stress, τ_{dir}, and forcing smoothed with a 24 h running mean, τ_{24h}) are shown.

Top panel: EA τ_{dir}, bottom panel: TA τ_{dir}.

Top panel: TA τ_{24h}, bottom panel: TA τ_{dir}.

Top panel: EA τ_{dir}, bottom panel: EA τ_{24h}.



	trop. Atlantic	eq. Atlantic	ABA (not shown)
τ_{dir}	↓	↓	–
τ_{24h}	↓↓	↑↑	

- Direct forcing cools SST around equator
- Localised cooling also on eq. coast
- Cooling $\mathrm{TA}_{dir} > \mathrm{EA}_{dir}$
- Cooling pattern EA closer to bias pattern
- No cooling in ABA
- Combine EA & τ_{24h}: drastic worsening of bias
- Importance of forcing variability? Different effects per box?

References

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M. A. Balmaseda, K. Morgensen, A. T. Weaver *Q.J.R.Meteorol.Soc. 139* (2013)
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