A first look at wind stress sensitivity experiments with CNRM-CM5.2 within the framework of PREFACE WP6 coordinated experiments

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Introduction

- Coupled general circulation models have systematic biases in the tropical Atlantic.
- Most research so far has focused on the equatorial Atlantic, however biases in this region are strongly model dependent. For example, in the CNRM model the bias is strongly linked to the missing spring cooling.
- The biases in the South-East tropical Atlantic have been poorly studied so far, even though they are very robust among models.
- The aim of PREFACE WP6 is to identify possible sources of bias development and to assess similarities and differences between different models by performing coordinated sensitivity experiments in order to try to improve our understanding of the formation of SST biases, especially focussing on the South-East tropical Atlantic.

Box average monthly mean biases

Figure 3: Monthly mean SSTs for the hindcast experiments (ensemble mean) compared to ORAS4 (K).

Figure 4: Monthly mean zonal wind stress over the ATL3 region and meridional wind stress over the SETA region for the hindcast experiments (ensemble mean) compared to ORAS4 [hPa].

Figure 5: Monthly mean wind energy flux (WEF) for the hindcast experiments (ensemble mean) compared to ORAS4 [m/s].

Figure 6: Monthly mean zonal surface current for the hindcast experiments (ensemble mean) compared to ORAS4 [m/s].

Figure 7: Monthly mean current at 56m depth for the hindcast experiments (ensemble mean) compared to ORAS4 [m/s].

Figure 8: Monthly mean mixed layer depths (MLD) for the hindcast experiments (ensemble mean) compared to ORAS4 [m].

Figure 9: Daily mean SST evolution for the hindcast experiments (ensemble mean) compared to ORAS4 [K].

Figure 10: Daily mean surface zonal current evolution for the hindcast experiments (ensemble mean) compared to Glorys [m/s].

Conclusion

- Prescribing the wind stress over the equatorial Atlantic reduces the bias in this region and greatly improves the spring cooling in the ATL3 region for the experiments starting in May.
- For the February starts not so clear picture → need to run the experiments for longer.
- In the SETA region improvements when prescribing wind stress over the region, but no remote impacts from correcting the wind stress over the equatorial Atlantic.
- The bias directly off the African coast around 15°S is only weakly impacted by the wind stress forcing.

Outlook

- Complete the experiment set for all the years from 1993-2009.
- Increase the length of the experiments to 6 months?
- Perform additional experiments initialized from GLORYS to study possible impacts of different initial conditions.
- In addition to the experiments presented here additional CTL experiments with SST restoring to observations are planned to study the role of the coupling.
- A further possible experiment is the same as CTL but with a solar heat flux correction over the SETA region.

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Box average daily bias evolution

Figure 11: Climatological mean bias and annual cycles of SST in the ATL3 and SETA regions for the coupled model CNRM-CM5.2 (HIST) compared to HadISST [K].

Figure 12: Monthly mean SST biases with respect to HadISST [K].

Figure 13: Daily mean SST evolution for the hindcast experiments (ensemble mean) compared to Glorys [K]. Please note that the SETA box size is reduced to 20S-30S [N/(ms)].

Figure 14: Daily mean mixed layer depths (MLD) for the hindcast experiments (ensemble mean) compared to ORAS4 [m].

Figure 15: Daily mean zonal surface current evolution for the hindcast experiments (ensemble mean) compared to Glorys [m/s].

Experiment setup

- Model: CNRM-CM5.2 (1.4° horizontal resolution in the atmosphere, ocean on ORCA 1° grid)
- Initialization: Atmosphere – ERA-Interim, Ocean – ORAS4
- Forcing: ERA-Interim daily wind stress data
- Experiments: initialized hindcast experiments starting on the 1st of February and 1st of May for the years 2005-2007, 3 members, 3 months

<table>
<thead>
<tr>
<th>Experiment</th>
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<tbody>
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<td>CTL</td>
<td>Control experiments</td>
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<tr>
<td>WATL30</td>
<td>Wind stress prescribed over the whole Atlantic from 30S-30N with a 5° tapering zone</td>
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<tr>
<td>WATL5</td>
<td>Wind stress prescribed over the whole Atlantic from 30S-5N with a 5° tapering zone</td>
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<tr>
<td>WSETA</td>
<td>Wind stress prescribed over the South-East tropical Atlantic from 30S-10S, 0E-coast with a 5° tapering zone</td>
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Monthly mean SST biases 2007

Figure 16: Monthly mean SST biases with respect to HadISST [K].