Reducing climate model systematic error in the tropical Atlantic by enhancing atmospheric resolution: implications for seasonal to interannual variability and predictability

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Sahel rainfall

Sahel rainfall July-September index

www.oecd.org

Martin et al. (2014)
tropical Atlantic bias

July-September observed climatology and model biases of SST, PR, WIND

Observations

CMIP5 mean

KCM T42L31

KCM T159L31

KCM T159L62

KCM T255L62

Harlaß et al. (2017)
Influence of atmospheric model resolution on tropical Atlantic climate

March-April-May mean latitude-height sections of wind (m/s) and total precipitation (mm/day) avg. over 40°W-10°W

Three simulations with varying atmospheric resolution; same 2° ocean:

- LR: T42L31
- MR: T159L62
- HR: T255L62

+ respective atmosphere-only simulations LR (A), MR(A) and HR (A)

Harlaß et al. (2017)
Sahel rainfall index

precipitation averaged from 20°W-10°E, 10°N-20°N

Steinig et al. (2018)

Influence of atmospheric model resolution on tropical Atlantic climate | Sebastian Steinig | 18.04.2018

Steinig et al. (2018)
West African monsoon

Total precipitation zonally averaged from 10°W-10°E

(a) OBS
(b) LR
(c) MR
(d) HR

Steinig et al. (2018)
WAM onset

<table>
<thead>
<tr>
<th>data set</th>
<th>monsoon onset (mm/dd)</th>
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<tbody>
<tr>
<td>PERSIANN</td>
<td>07/02</td>
</tr>
<tr>
<td>LR (T42L31)</td>
<td>08/04</td>
</tr>
<tr>
<td>MR (T159L62)</td>
<td>07/22</td>
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<tr>
<td>HR (T255L62)</td>
<td>07/08</td>
</tr>
</tbody>
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Atlantic Cold Tongue

\[ S_{ACT} = \int_{A(x)} H_c(25^\circ C - SST(x)) dA \]

Caniaux et al. (2011)

Steinig et al. (2018)
ACT-WAM coupling

Steinig et al. (2018)
Conclusions

- high horizontal and vertical atmospheric resolution is key to reduce climate model biases in the tropical Atlantic sector -> elimination of the westerly surface wind bias in spring (in the KCM)

- earlier and stronger development of Atlantic cold tongue (ACT) improves seasonal evolution of West African monsoon rainfall location and onset

- correct seasonal phase locking of ACT interannual variability necessary to capture observed correlation with monsoon onset