Weather Clim. Dynam. Discuss.,
https://doi.org/10.5194/wcd-2020-59-RC1, 2020

Interactive comment on "Minimal impact of model biases on northern hemisphere ENSO teleconnections" *by* Nicholas L. Tyrrell and Alexey Yu. Karpechko

Anonymous Referee #1

Received and published: 23 December 2020

Minimal impact of model biases on northern hemisphere ENSO teleconnections
Nicholas L. Tyrell and Alexey Yu Karpechko

The authors have carried out a set of bias-correction experiments in the ECHAM 6 model investigating the role of basic-state model biases on the teleconnection between ENSO and the NAO. By imposing a climatologically varying set of fixed tendencies to the temperature and divergence fields in the troposphere, stratosphere, or both, they can partially correct model biases in different regions of the model. They then impose tropical pacific SST anomalies modeled after El Nino or La Nina states and analyse the impact on the NAO, considering established pathways for the teleconnection through

Printer-friendly version

Discussion paper

the stratospheric polar vortex.

They find that while the bias correction does affect the response of the polar vortex to ENSO, the NAO response itself is largely unaffected. They conclude from this that the teleconnection between ENSO and the NAO does not depend on the stratospheric pathway. Another interesting hypothesis presented is that the response of near-tropopause heat fluxes (indicative of vertically propagating waves) to the Aleutian low may saturate at large amplitudes.

This is an interesting methodology and potentially interesting set of results. However, I find the paper to be a bit light on detailed analysis of the runs, and I am not sure that the evidence presented supports the central conclusions:

1) While Figs 2c-e show that the zonal mean zonal winds at 60 N, 10 hPa respond much more in the Control and Strat cases than in the Trop and Full cases, there are several other possible interpretations of the fact that the NAO response to ENSO does not change in a consistent fashion in 2e beyond the conclusion that the stratosphere does not play a role in the ENSO-NAO teleconnection:

(a) the lower stratospheric response may not correspond to the 10 hPa polar vortex response.

(b) there may be compensating changes: for instance, the polar vortex response might have weakened in Trop and Full BC, but the sensitivity of the NAO to stratospheric variability may have increased.

(c) there may be significant non-linearities in the response of the NAO through the stratospheric teleconnection that complicate the interpretation of a time-mean sensitivity; not all winters will see a perturbation to the polar vortex.

2) Regardless, the bias correction acheived by this methodology is only partial: the biases that remain in the full bias-corrected run are in many regions larger-amplitude than those that have been corrected. That doesn't make these results irrelevant, but it

does narrow their applicability: it is not valid to conclude, for instance, that the response of the Aleutian low to ENSO is insensitive to *all* climatological biases (l196-197), only to the ones that were corrected here. Concluding statments in lines 211-212 and 224-226 should be similiarly qualified. The results found here are really only relevant to the biases that have in fact been corrected.

3) Closely related to 1 and 2; one should be cautious about inferring too much about the observed ENSO-NAO teleconnection on the basis of a single model result, especially if the bias-corrected NAO response to ENSO does not agree well with observations.

In my opinion the paper would have greater impact if some further analyses were performed (see below for details); I believe these would constitute major revisions. At a minimum, however, these three concerns need to be addressed in the text, and conclusions should be tempered to match the level of the evidence presented.

General comments:

Nature of biases that are corrected:

There could be considerably more detail given regarding the nature of the biases that are corrected. The RMSE plots in Fig 1 give a sense of their relative magnitude, but not of their structure. What do the zonal mean biases look like? What about the stationary wave features in the upper troposphere? There has been some success in understanding the ENSO to polar vortex teleconnection in terms of linear interference ideas; this might shed a lot more light on what's happening in these runs. These details would make the results much more useful.

Details of teleconnection:

Some of the concerns listed above could be addressed by further analyses. To me the most essential to address are

1) The reanalysis results are not shown in Fig. 2. Where the bias correction does modify the quantities that have been shown here, does it move the response more

closely to observations? Fig. 3 indicates there are meaningful differences between the modelled and observed teleconnection.

2) The lower stratospheric response should be shown.

Beyond these essential points, Fig. 4 is a bit distinct from the previous figures in that it presents an event-based perspective, instead of a time-mean response. The motivation for this isn't entirely made clear in the text, but the approach could be extended to further address the concerns raised above. e.g. (a) plotting the heat fluxes against SLP anomalies might confirm the hypothesis that there is a non-linear saturation of the upward part of the teleconnection, and (b) the response of the NAO to stratospheric sudden warmings in each model run could shed light on the strength of this coupling in each run.

Specific comments

Methods: Am I correct to infer that the runs have fixed climatological SSTs in all cases?

l 110: This seems overly optimistic to me - I see meaningful improvements in mid-latitudes, but pretty the improvements over the pole are minimal except in the upper stratosphere. There is a moderate improvement in the lower polar stratosphere (200-100 hPa) in the full bc run. Arguably the tropospheric bias correction degrades the mid-stratosphere.

l145-146: 'PV response not affected by biases' this needs to be explained more carefully - the response does depend on the bias corrections, although perhaps what the authors mean is that the differences in the response can be fully explained by the differences in the heat flux anomalies?

Fig 3. Does the shading show the standard deviation, or a confidence interval? It is notable that even the bias corrected model does not capture the non-linear nature of HF teleconnection. Also, a bar chart might be more appropriate here.

l197: The HF anomalies are likely connected to the SLP anomalies, but it's not clear

that they are driven by the SLP biases, especially when the active bias correction is imposed in T and divergence.

Interactive comment on Weather Clim. Dynam. Discuss., https://doi.org/10.5194/wcd-2020-59, 2020.