

Weather Clim. Dynam. Discuss., referee comment RC1  
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## Comment on wcd-2021-62

Ronald Kwan Kit Li (Referee)

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Referee comment on "Sudden stratospheric warmings during El Niño and La Niña: sensitivity to atmospheric model biases" by Nicholas L. Tyrrell et al., Weather Clim. Dynam. Discuss., <https://doi.org/10.5194/wcd-2021-62-RC1>, 2021

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General comments:

This study investigates whether atmospheric bias correction in a climate model can improve the representation of SSWs, in particular during ENSO. Detailed analyses were performed on both reanalysis and model runs. The authors were able to demonstrate the benefits of a more realistic atmospheric climatology in better SSW simulations. This study also stressed again the uncertainty in the ENSO-SSW relationship based on limited reanalysis data. I have just a few major concerns. In addition, the way information is conveyed can be clearer at times, which I have also suggested below.

Specific comments:

L155-162: In ERA5, the ENSO SST anomaly varies seasonally. But in the experiments, the ENSO SST anomalies "were kept constant in time i.e. the anomaly did not vary seasonally (L85)". Is this the reason why the experiments do not show enough seasonal variation in SSWs compared to ERA5 (L157)?

L170: But there are clearly regions of red in the troposphere in Fig 5(e,h,k,n), so I am unsure why the authors say that "this corresponds to a slightly weaker tropospheric response".

L180-181: I agree that "the negative AO pattern is stronger in La Nina experiments for the FullBC and StratBC runs", but I am unsure about the next sentence "which relates to the stronger stratospheric Zcap response in Figure (5) i and o". The stratospheric Zcap response in CTRL\_LN (Fig5f) is also stronger, yet the projection onto the AO pattern is weak (Fig6f). So I am unsure if the AO response is related to the stratospheric response in a simple way. Meanwhile, the tropospheric response in CTRL\_LN (fig5f) 30 days after SSW is weaker than that in FullBC\_LN (fig5i) and StratBC\_LN (fig5o), which is consistent with the results in Fig6(f,i,o), as it should be because these are two ways of looking at the same picture.

L253: But as concluded in L215, "there is a smaller improvement (in the number of SSWs) in the StratBC runs, despite the improvement in the strength of the vortex being similar to FullBC". So I am not completely convinced that the authors have shown that "improvements to the strength of the polar vortex can improve the SSW statistics of a model in relation to the number of SSWs per year" in L253. Similarly in L13-14.

Technical comments:

L1: Can be more specific about what kind of model bias is being investigated e.g. "sensitivity to model atmospheric biases" instead of, for example, bias in the ocean which is not investigated.

L55 and L242: heat flux

L82: maybe briefly explain why only the Pacific SST anomalies are chosen, whereas ENSO is associated with SST anomalies in other ocean basins too.

L93: statistical significance

L148-150: the values do not agree exactly with those in the third column in table 1.

L164 and subsequent lines: Should be figure 5 instead of 4. Similarly in L181 and L182.

L218: Any examples of parameterisation?

L370 Fig1: it should be (d) not (c). Also, maybe include a description of the dotted and bold lines in the caption as in L118.

L390 Fig4: Are there no SSWs in November in ERA5?