

Weather Clim. Dynam. Discuss., referee comment RC2
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Comment on wcd-2021-77

Anonymous Referee #2

Referee comment on "Stratospheric modulation of Arctic Oscillation extremes as represented by extended-range ensemble forecasts" by Jonas Spaeth and Thomas Birner, Weather Clim. Dynam. Discuss., <https://doi.org/10.5194/wcd-2021-77-RC2>, 2022

Review of manuscript WCD-2021-77: "**Stratospheric Modulation of Arctic Oscillation Extremes as Represented by Extended-Range Ensemble Forecasts**", by Jonas Spaeth and Thomas Birner.

The authors used a large set of extended-range ensemble forecasts within the sub seasonal-to-seasonal (S2S) framework (namely ECWMF and UKMO models) to obtain an improved characterization of the modulation of AO extremes due to stratosphere-troposphere coupling. Within this framework, they investigated how much stratospheric polar vortex extremes increase the probability of persistently AO phases and their extremes. They found that following potential SSW events, persistently negative AO states (> 1 week duration) are 16% more likely, and the likelihood for extremely negative AO states ($< -3\sigma$) is enhanced by at least 35%. How the stratospheric polar vortex extremes can be considered as the cause of the subsequent AO extremes was also quantified and discussed. Despite the straightforward analysis presented in this paper, I still found the results are interesting and the diagnostics can be useful for the forecast model assessment. The main issue I have is a lack of dynamical analysis to explain the differences in the two models in representing the AO extremes followed by stratospheric events (SSWs and SPVs) and the results regarding causal relationships between AO extreme and stratospheric polar vortex extremes. Hence my suggestion is major revisions. Once my points below are answered, I can recommend this work to be published in WCD.

General Comments:

- Two S2S forecast models (ECMWF and UKMO) used in this study showed some quantitative disagreement (i.e., the results diverge significantly e.g., Figs. 5, 6, 7, 8 etc). However, there is no dynamical analysis and explanations to address the issue rather than simply comparing the results in a statistical sense. It would make the results clearer if you could address this issue in the paper.
- I am not convinced about the causal analysis in this paper. As you are aware, the

extreme AO events are not only preceded by extreme stratospheric events, but also by mid-latitude winter circulation such sea-level pressure, sea-ice and remote forcing from the tropics. How can you isolate the possible stratospheric influence alone from these other factors (since this may not direct/linear statistical relationship)? I believe that not all stratospheric polar vortex extremes lead to AO extremes. You probably need to revise your methodology to address this question.

Other Comments:

L143: Will be the results sensitive to the WMO's definition that includes the reversal of the meridional temperature gradient?

Figure 3. Please also add a similar histogram for UKMO model next to this figure. Also please add the uncertainty in this plot.

L175: Please delete this and just mention the number. Otherwise, please provide a full equation before inserting the number.

Figure 4. Do you have a similar figure for ERA5? How does it look like compared to UKMO and ECMWF models? It's hard to get definitive quantitative statements since both the model are probably not right.

L429: I dont think you will get a definite answer for this rather than a spread of the quantification of the probability of extreme AO events following extreme strat. events in different model configuration.