

Interactive comment on “Understanding and forecasting polar stratospheric variability with statistical models” by C. Blume and K. Matthes

C. Blume and K. Matthes

christian.blume@met.fu-berlin.de

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We thank this reviewer for very valuable comments that we tried to incorporate in the manuscript. We comment with a point-by-point response below.

Corrections

1) That is a good point and we made more clear that we aim at modeling and forecasting extreme polar variability. Specifically in section 6, we forecast polar variability and conclude that an SSW is an extreme event. We added another section on how the actual winter variability for 2011/12 looked like and that the prediction was at least partially correct.

2) Yes, we have now included a figure showing the nine normalized physical external
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factors in section 2 but omitted the sine, cosine and the trend term for simplicity. Please note that the normalization only changes the magnitudes, not the shape of the time series. It is true that not all factors are needed, such as BLOC2, but since we were not sure about this in the beginning, we simply included them all. The impact calculation in section 5 now tells us that BLOC2 can be omitted in future analysis. Also the other reviewer has stressed the point of selecting an optimal set of factors from a larger starting set. In this work, however, we wanted to focus on selecting an optimal model architecture (set of tuning parameters) while having a fixed set of external factors. Trying to optimize the set of external factors plus the model architecture is computationally very expensive as it entails computing an optimal architecture for EACH set of external factors. Of course, one could simply hold the model setting constant and then compute information criteria or cross-validation for each set of factors. The problem is that this would not necessarily tell us something about the importance of the factors in general but only for this specific model setting.

3) Yes, there are quite some acronyms. We have tried to make the names more obvious by, e.g., following your advice and renaming TROP1/2 to BLOC1/2. Also, we have added a table explaining the meanings of the acronyms.

4) Good point. Another blocking metric, such as potential temperature on PV2, would be one of the next steps within this framework but also how more regional blocking indices could improve a hindcast. We also expected the impact of the blocking factors to be higher. However, BLOC1 only represents blockings in both ocean basins simultaneously and should be replaced by regional indices in future analysis. A general problem with blockings is that they often appear before SSWs but they also often appear without a preceding SSW (Martius et al., 2009). We think that these challenges are the reasons why there is a lack of impact for the blocking factors. We added this information to section 5 and the conclusions.

Technical Corrections

- 1) done.
- 2) done.
- 3) done.
- 4) done.
- 5) done. We explained 'trained' in the introduction, where it first appeared.
- 6) done.
- 7) done.
- 8) Deser et al. (2010) gives a good review about SST variabilities and the corresponding indices, which we now mention in the data section. We also mention how we computed the SST indices (EOF analysis).
- 9) done.
- 10) done.
- 11) We expanded more on the MLP and gave a few references on how advanced statistical methods are used in the atmospheric science.
- 12) We were not sufficiently accurate here. What we mean is that with the current methods and the current set of external factors, this event cannot be forecasted. However, we think it will be extremely difficult to forecast this event statistically without using too much information from the internal dynamics (such as the NAM in 100hPa).
- 13) We agree, it is a problem of the sample size. For future statistical modeling, AOD should be probably left out as long as there are not more volcanic eruptions important for the stratosphere. We included this information in Section 5.

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References

- Deser, C., M. A. Alexander, S.-P. Xie, and A. S. Phillips, 2010: Sea Surface Temperature Variability: Patterns and Mechanisms. *Ann. Rev. Mar. Sci.*, 2, 115–143.
- Martius, O., Polvani, L. M., and Davies, H. C.: Blocking precursors to stratospheric sudden warming events, *Geophys. Res. Lett.*, 36, L14806, 2009.

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