

Author's final response: “The influence of future changes in springtime Arctic ozone on stratospheric and surface climate”

Chiodo, Friedel, Seeber et al.

[RC 1.1] Ar1.7 response: I had suggested being careful with the calculation of EOF1 in a future climate (currently the EOF loading pattern is calculated over the entire period 2005-2099). The authors argue that the IPCC report uses a simpler definition that involves the zonal mean surface pressure differences between 35N and 65N without removing any trends ahead of time. However, I think my point was missed (partly my fault; I suggested removing global-mean height value for each day but I think the easier solution is to base the EOF loading pattern on the 2005-2020 period rather than the full period as is currently done). Per Gerber et al. 2010, the EOF method applied to geopotential heights will at some point stop picking up the NAM as the dominant mode of variability, and instead pick up the climate change-related height increases everywhere as the dominant mode. Thus, EOF1 stops being the NAM if some care is not taken in its calculation in future climate scenarios. Note that the EOF1 calculated per Gerber et al. 2010 will still reflect long term changes in the NAM (because the data projected onto the loading pattern will still contain the trend). The IPCC report method likely worked because in that case they are using a difference between the regions where the NAM centers of action maximize, so the relative differences still reflect the NAM pattern. I would suggest using the EOF loading pattern calculated for the 2005-2020 period rather than the full period and then this may ensure there are no issues. As mentioned in the Gerber paper “When long data sets are used, however, one must be careful to define the annular mode patterns and indices in such a way that they always reflect internal variability. McLandress and Shepherd [2009] and Morgenstern et al. [2010a] address this concern in long integrations (similar CCMVal-2 REF-B2 simulations as considered here) by computing the NAM relative to shorter 40 year periods at the beginning and/or end of the integration.”

AR 1.1 We have implemented the changes requested by the referee, by using the 2005-2020 period for the EOF loading pattern calculation. The results are almost identical, as one can see from the revised Fig. 4a. We have added the following in the methods section near L75 accordingly: “...spatial loading pattern is then calculated based on the same time period (2005-2020)” and near L77 “Subsequently, geopotential height anomalies for the whole time period (2005-2099) are...”.

RC 1.2 Line 15-16: here, it says “In the stratosphere,” but then goes on to refer to the springtime Northern Annular Mode. Are you referring to the stratospheric NAM here, or the surface NAM?

AR 1.2 We are referring to the stratospheric NAM. We have now explicitly stated this in the abstract.

RC 1.3 Line 55: could change “ozone depletion trends over the recent past” to just “ozone depletion” to avoid duplicate phrase in the next sentence.

Line 59: suggest “a shift towards the negative phase of the Southern Annular Mode (SAM)” – it could also be made more apparent that this sentence is referring to future ozone recovery.

Line 324: there are two erroneous “are”s here and two “a”s

AR 1.3 We have adopted all these minor changes. Thank you.