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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Sensitivity of polar stratospheric cloud formation to changes in water vapour and temperature" *by* F. Khosrawi et al.

Anonymous Referee #1

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This study examines the impact of changes in the concentration of stratospheric water vapour (increases up to 1ppmv) and temperature (decreases of 1K) on the time that air parcels might be below various PSC existence thresholds in the Northern hemisphere. This study also examines a range of satellite datasets to identify trends in the temperature and water vapour concentrations over the period 2000-2014 at high equivalent latitudes. While the central premise of the work is interesting, the amount of analysis shown seems to be too cursory for major conclusions to be drawn with certainty. In particular, Section 5 which examines the trends in the water vapour concentration and temperature over the period 2000 to 2014 lacks sufficient depth in my opinion. Thus, I think this work needs major revision before it is accepted for publication. I identify a number of key points below that concern me about the analysis and suggestions for

further analysis which might help the authors tune this work for publication.

Sampling issue and interpretation of track statistics: The authors use trajectories derived from data in the 2010/2011 which they argue is sensible to use because there was a significant amount of PSC in this year. They then argue that this means that the statistics derived are effectively more robust because of the larger number of cases possible to derive back trajectories from. However, I would argue that this selection likely means that this study represents a worst-case scenario. Essentially a year with high PSC occurrence is used as the baseline to examine how even cooler temperatures and more water vapour will impact PSC formation. Whether the resultant statistics of an average year would be similar is not clear to me and not tested. The number of trajectories tracked (738) also seems rather small to me given the nature of the question that the authors wish to examine. Thus, I think this work would greatly benefit from analysis of at least some tracks in another year to identify whether the enhancement in the time below the PSC thresholds is comparable in a relative sense. However, to significantly improve this study, I would suggest doing this type of analysis over a number of years to get a representative set of statistics.

Another issue with the analysis is the use of absolute values of time is somewhat meaningless given the arbitrary number of tracks selected. Thus, I would suggest identifying increases in relative terms (percentage increase relative to the base state). This relative analysis would also allow the trajectories from other years to be directly compared – though obviously with less certainty given the likely fewer number of tracks to be calculated.

Small-scale processes and errors in the reanalyses: A number of studies have shown that the reanalyses temperature can be rather biased (e.g. Boccara et al., 2008) and this means that the temperature values derived from NCEP can have uncertainties which might be comparable to the temperature variations considered. In addition, while it is mentioned that several studies have identified the impact of small-scale wave temperature perturbations on PSC occurrence this also builds uncertainty into the impact

of the prescribed temperature decrease. Without consideration of these factors the uncertainty on the results from the trajectory analysis is unknown, but I would guess from previous studies might be sizable. Thus, some type of uncertainty analysis – perhaps using Monte-Carlo analysis would add real value to the study in my opinion.

Linear trend analysis: This analysis seems like an afterthought and given the difficulty in inter-calibrating the various satellite datasets to the level required to observe a small trend makes me wonder whether this portion of the analysis is an unnecessary distraction. I would advise thinking seriously about whether this analysis really adds value. In particular, I would suggest that a rigorous trend analysis using this many satellite datasets is a large paper in its own right.

Reference: Boccara, G., et al. (2008). "Accuracy of NCEP/NCAR reanalyses and ECMWF analyses in the lower stratosphere over Antarctica in 2005." Journal of Geophysical Research-Atmospheres 113(D20): 15.

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