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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "A decadal satellite record of gravity wave activity in the lower stratosphere to study polar stratospheric cloud formation" *by* Lars Hoffmann et al.

**Anonymous Referee #1**

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This paper is technically very strong, was written extremely well and provides new information. But, I think that the title is misleading given that the vast amount of work in this document discusses the gravity wave activity satellite record and its comparison with the ECMWF operational analysis. I do understand that when presenting a new dataset that it is vitally important to understand its strengths and weaknesses and this has been done very well in this work. But, the connection of the gravity wave activity data derived from AIRS to the formation of polar stratospheric clouds (observed by MIPAS) is extremely qualitative and appears to have been added to demonstrate future application possibilities rather than being a central part of the work. Thus, I would suggest that this paper be re-focussed so that the title and introduction better reflect



the main focus of the work or extra analysis is completed which helps to strengthen the relationship between the AIRS wave activity data and the MIPAS PSC observations. I should state that I do think this is a strong paper and is definitely worthy of publication, but at present I feel needs major revision because of this point. I identify a number of suggestions for potential improvements below.

**Suggestions: Figure 5 and 6 and corresponding discussion on Page 6 and 7:** I thought that there was a significant opportunity here to talk about the interannual and intraseasonal variability in more detail and perhaps extend the analysis. Given the discussion on temperature and wind dependencies in the rest of the work, I think adding corresponding time series of the mean 30hPa winds from ERA-interim and brightness temperatures from AIRS might be useful in aiding the interpretation of these variations. These additions might also help shows how the temperature variance varies relative to the potential timing of temperatures below PSC thresholds. The impact of features such as Sudden Stratospheric Warmings on the linkage of PSC formation to gravity waves in the Northern hemisphere might also be highlighted/explored.

**Figure 7 and 8:** Is the 2004-2012 monthly mean really representative? I would guess that variability would be rather high in the Northern hemisphere (also supported in paper) and wondered whether displaying a sample of individual years might be instructive?

**Figure 10 and corresponding text:** I understand that the operational ECMWF analyses varies, but I wondered whether some colour coding related to major changes, such as large changes in spatial resolution within the analyses might help the interpretation of Figure 10.

**Identification of PSC impacted by gravity waves:** The examples in Figure 11 seem to identify PSC using MIPAS and highlights them as anomalous when they exist in a region where the temperature is above the corresponding temperature threshold and also occur where they are co-located with sizable gravity wave temperature variance.

If this is not the method used this should be stated more clearly in the document and some statistics presented. If this is the methodology, then I would suggest some statistics would still be useful. In particular, what is the quantity of PSCs identified using MIPAS that exist in regions where temperature data would identify that they should not exist (i.e. temperatures above $T_{NAT}$ formation threshold or similar) and what is the corresponding AIRS temperature variance distribution for these cases. By comparing the distribution from that subset with the distribution data in Figure 6 you could provide a nice quantification of the importance of gravity wave activity on PSC formation.

**Minor points: Page 2 Line 16:** Earlier work by Wu and Jiang (2002), Shibata et al. (2003) and Baumgaertner and McDonald (2007) might be worthwhile additions to your list.

**Page 10 Sentence starting on Line 21:** I think Alexander et al. (2011) and Alexander et al. (2013) might be worthwhile citing at this point since they highlighted the importance of advection of PSCs away from the region where the temperature perturbations were observed.

**Figure 11:** I think this figure (as the major proof of the connection between anomalous PSC formation and wave activity) could be improved. At present, it is complex enough that I have to squint to see what is happening and is overall rather busy.First, I think the coloured markers are not used effectively. It would be helpful to colour code the markers based on whether the corresponding temperatures are above or below the corresponding temperature thresholds and use only the shape to identify different PSC types (or perhaps vice versa). I would also remove the 'no detection' dots as they do not really add value and clutter the diagram. I also think that the streamlines, while useful, crowd the diagram – so perhaps using less of them. I would also make the black boxes highlighting the areas of interest more defined.

**References:**

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