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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The effects of atmospheric waves on the amounts of polar stratospheric clouds" *by* M. Kohma and K. Sato

Anonymous Referee #1

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This study analyses observations from three satellite systems (CALIPSO, EOS MLS and COSMIC/Formosat3) along with reanalysis data to examine the impact of atmospheric waves on Polar Stratospheric Cloud (PSC) occurrence. It provides a number of interesting results which generally confirm previous work, but completes this in a more comprehensive manner than many previous studies. It also identifies some new points and is therefore a valuable contribution to the literature in my opinion. While the analysis is generally of high-quality, there are a number of minor issues which I feel should be examined or discussed in the text before publication. These issues and a set of typographical corrections are indicated below.

Minor issues:

Page 16969 Sentence starting on Line 22: Note that solar occultation satellite instru-

ments have also been used extensively for monitoring PSC (e.g. Fromm et al., 2003). Though, it is also important to note that these measurements have a significant sampling bias.

Page 16970 Line 7: I am not sure that the work of Rex et al. (2004) validates the use of the T_{NAT} threshold to identify PSC. Wouldn't the gradient between PSC volume and the ozone depletion metric just change for different temperature thresholds?

Page 16977 Paragraph 1: The difference in the propagation speed of the PSCs and the zonal mean zonal wind is very interesting. Could the explanation for this pattern be related to a lack of concentricity between the cold pool and the vortex or changes in concentricity? See Mann et al. (2002). If so, this might be related to large-scale flow rather than modulation by the planetary wave field. If not can you explain in a little more detail the modulation idea please.

Page 16978 Line 7: Would other possibilities include a hysteresis effect in the microphysics (the rate of formation and evaporation of PSC particles differ for example) or the lack of representation of gravity wave perturbations in the ERA-interim data? If the latter could this cause issues in your quantification of the impact of gravity waves?

Page 16980 Line 27: The vertical wavelength filtering scheme used to identify gravity waves uses a cutoff wavelength of 6 km. Previous studies have used longer vertical wavelength cutoffs. For example, Baumgartner and McDonald (2007) and Alexander et al. (2011) used a cutoff of 15 km. How sensitive are your results to this value?

Page 16981 Sentence starting on Line 3: References on the observational filter of the COSMIC observations would be relevant at this point.

Figure 7: Identifying the value of T_{NAT} and T_{STS} on panel (a) would be useful for the reader.

Page 16982 Paragraph 1and Figure 8: Why are the PSC areal extent values so large between 8 and 12 km? Is this really PSC or potentially a mixture of PSC and other

ACPD

11, C7505–C7509, 2011

clouds? I would be very careful of the interpretation of any data below 12 km. Do you have any comment on this point?

Figure 11 and Figure 16: I see what seems to be an anti-correlation between the ΔRSW and the ΔRGW lines in Figure 11 (a) and Figure 16. Does this suggest some difficulties in separating these two fields? See comments on conclusions.

Page 16988 Summary and concluding marks: The overall conclusion that gravity waves play a relatively minor role in PSC formation relative to the mean temperatures and planetary wave perturbations seems reasonable. But, the values presented don't match very well with previous work (Mann et al., 2005; Juarez et al., 2009; McDonald et al., 2009; Alexander et al., 2011) using very similar data. The exception is your value of 3% to ΔR which means a 30% contribution to the total in September at high latitudes (see line 26 on Page 16989). The lack of a good match is a bit surprising. In particular, Alexander et al. (2011) uses exactly the same datasets and indicates:

"During winter 2007 in the latitude range 60°S–70°S, near the edge of the vortex and where temperatures are close to PSC formation thresholds, 30% of all PSCs are attributable to orographic gravity waves."

This is a big discrepancy which needs to be considered carefully. This could be associated with differences in the way that gravity waves or temperature thresholds are identified in the two studies. In particular, could the proportions for gravity waves be small because of the process used to identify the impact of gravity waves from the COSMIC observations. To look for some consistency between methodologies used to determine the impact of different waves, how do the total PSC areas in Figure 9 (c) and (d) compare. If they are very different, does this suggest that there might be some uncertainty of the attribution of PSC area between synoptic and gravity waves?

Typographical corrections:

Page 16968 Sentence starting on Line 10: This sentence should be simplified and

ACPD

11, C7505–C7509, 2011

perhaps broken into two separate sentences.

Page 16970 Line 16: Replace ‘Arctic is rarely’ to ‘Arctic are rarely’

Page 16975 Line 1: Change ‘ as accurate as possible, the observation data of HNO_3 and H_2O from’ to ‘as accurately as possible, HNO_3 and H_2O data from’

Page 16979 Line 15: Replace ‘V is conserved’ with ‘PV is conserved’

Page 16990 Sentence starting on Line 12: This sentence should be rewritten because it is confused.

References:

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ACPD

11, C7505–C7509, 2011

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