Review of "Heterogeneous Formation of Polar Stratospheric Clouds - Part 1: Nucleation of Nitric Acid Trihydrate (NAT)" by Hoyle et al.

This paper analyses a case study associated with Polar Stratospheric Cloud observations made by the CALIOP instrument in the 2009/2010 Arctic winter. In particular, a new parameterisation in a box model to include a heterogeneous nucleation mechanism for NAT on solid particles is compared with observations. Overall the relationship between the model results and the observations is rather good for this case study, though some further tuning is likely required. This paper is definitely worthy of publication, but requires some minor revisions and would benefit from some extra discussion to help the reader at a few places before it is published.

Suggestions for improvement:

General question: The current study focuses on a specific case study, how representative is this case study or was its selection only made because it was a clear example where a new formation mechanism is required. Can you make any guesses about the proportion of NAT observations linked to this mechanism from this case study?

Page 7985 Sentence starting at Line 15: A figure or some statistical information would be useful to put the statements in this sentence in context. Exactly how unlikely were undetected ice clouds based on temperature perturbations? What would be the required magnitude of these temperature perturbations?

Page 7996 Sentence starting on Line 6: I think greater referencing on the impact of temperature fluctuations might be relevant here. For example, there have been quite a few studies on the impact of orographic waves on PSC formation in both hemispheres.

Page 7998 Sentence starting on Line 2: Were the concentrations of nitric acid and water vapour representative for that period? They seem a bit high perhaps?

Page 8000 Line 1: I am not convinced about the selection of 'best' parameters. The top and bottom panels in the 2nd column of Figure 5 look like a closer match in terms of areas. Would this alternative selection make any significant difference?

Page 8001 Line 1: You indicate that Mix 2 is over-represented in your analysis, but don't really explain this phenomenon in great detail. Can you provide more information on this point?

Page 8002 Line 3: The coding system for the different orbits is not very clear. Why not just identify the start time of each orbit?

Page 8003 Sentence starting on Line 15: Could larger magnitude small-(spatial-) scale perturbations also explain the diffuse nature of the cloud of points in Figure 7 and 8?

Page 8006 Sentence starting on Line 14: Again, I think greater referencing on the impact of temperature fluctuations might be relevant here. For example, there have been many studies on the impact of gravity waves on PSC formation in both hemispheres. I assume that the perturbations examined are just small horizontal wavelength gravity waves?

Figure3/ Figure 7/ Figure 8/ Figure 9: Labels identifying the position of different categories in the diagrams of the inverse backscatter ratio versus the aerosol depolarisation would be helpful for the reader.