

## ***Interactive comment on “A-train CALIOP and MLS observations of early winter antarctic polar stratospheric clouds and nitric acid in 2008” by A. Lambert et al.***

### **Anonymous Referee #1**

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Lambert et al. present a careful and comprehensive study of PSC's in the Antarctic vortex based on remote sensing observations and modeling. The study integrates A-train measurements by AIRS, CALIOP, and MLS, and from MIPAS. These measurements provide information about the gas phase composition as well as particulate matter (derived from optical properties). In addition, meteorological data (temperature and winds) from GEOS-5 DAS is used to support thermodynamic arguments about cloud properties. This reviewer greatly appreciates the efforts undertaken to integrate this rich and diverse dataset to obtain a coherent description of the evolution of PSC's in the Antarctic vortex. Apart from the minor corrections/suggestions listed below, my main (and only) concern with this (long) study is that the reader (at least I did) loses the

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overview. I understand that, by virtue of being a comprehensive paper, presentation of the background information does require room. Nonetheless, I think the material could be probably streamlined and presented in an order that would make it more accessible. For example (a suggestions only), one could first briefly discuss the issues of PSC's only from a microphysical perspective. Then, one could discuss the optical properties, and possibilities and limitations to retrieve cloud microphysical parameters. This would then lead to the last step of integrating thermodynamic arguments (i.e. equilibrium modelling), and lastly, one could sketch how these aspects are integrated for this study. The discussion of the observations could then be done without replication of theory (and debates). For me, it remained difficult throughout the paper to keep the overview over 'what constrains what' - and, in essence, understanding how robust the conclusions are. For example, the thermodynamic equilibrium model calculations employed to constrain the information from the remote sensing measurements may not always valid. The manuscript mentions non-equilibrium effects in the context of fast processes, but it should be noted (and I haven't seen such a statement - perhaps I have overlooked it?) that the growth of NAT particles to sizes of several microns is also a non-equilibrium process, and the considerable fall distance (combined with wind shear) may make interpretation of co-located gas phase and particle measurements ambiguous.

Having said this, I'd like to emphasise again that I appreciated the effort undertaken, and I am looking forward to seeing the revised manuscript.

### Specific comments:

P29284/L21-24 (Abstract): The sentence is ok, but difficult to understand.

P29284/L24ff (Abstract): There is potential for confusion here; perhaps eliminate all non-essential information (e.g. reference to 2003).

P29291/L11-13: Sentence not quite clear - my interpretation is that it says that the Hoepfner et al. observations do not require a 'NAT-freezing belt'; right? Please clarify.

P29299/L25ff/Figure 1: I have difficulties seeing the importance of Figure 1.

P29304/L1: I would think that the particle shape (or lack of knowledge thereof) is a problem, and a word about uncertainties would be helpful here.

P29306/L20ff: This is one of several instances where it was not clear to me what is constrained by observations, and what by model calculations, and whether the model calculations assume thermodynamic equilibrium; and if so, whether this would not conflict with a size of 6micron (radius), which requires a long period of non-equilibrium conditions to grow to this size. And, lastly, whether the fall distance of the particle during growth is not similar, or even greater, than the 'cloud thickness', such that the local conditions (gas phase) at the position where the cloud is observed may not provide information about the cloud itself.

P29314/L12ff: This is an example where the paper is unnecessarily hard to read, as the paragraph combines information that does not belong together. Perhaps the information about H<sub>2</sub>O could be given first (page 29310)?

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