

## ***Interactive comment on “First Odin sub-mm retrievals in the tropical upper troposphere: ice cloud properties” by P. Eriksson et al.***

**P. Eriksson et al.**

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A short answer to this comment is that we simply forgot to include a discussion of the inhomogeneity effect, and we regret this.

Cory Davis points out that horizontal inhomogeneities (that can be denoted as a 3D effect) of the ice cloud field cause an additional retrieval error. We took an early decision to limit this paper to "pure 1D" issues. The mistake that we made was not to remind ourselves about this simplification when writing the manuscript. We thank Cory Davis for identifying this oversight.

Our main justification for leaving a more detailed investigation of the effect for future work is that we lack the data necessary to allow the relevant calculations and that these would be very demanding. The upcoming release of CloudSat data will make it

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possible to study this issue in more detail, and it is part of our plans to perform such a study. Alternatively, we could use CloudSat data to include the effect of inhomogeneities along the viewing direction already when mapping brightness temperature depression values to ice water contents. A Bayesian retrieval method must then be applied, instead of the direct regression used now. The fundamental limitation to 1D retrievals can not be overcome, but an estimation of the inhomogeneity effect will then be an intrinsic part of the retrieval error characterisation.

Cory Davis has made the most detailed calculations around the discussed effect and we are fully aware of this work. In fact, we are presently involved in an ESA-led study where Cory Davis has provided input on exactly these matters. We could then, for example, follow the internal email exchange discussing the results presented at the EGU general assembly 2006 by Davis, Buehler and Evans, which are more elaborate results than those presented in Davis et al. 2005. The experience from these studies will be incorporated in the final manuscript.

It is clear that the effect is important, but we do not see any clear grounds for the following statement by Cory Davis: "I believe that cloud inhomogeneity will provide at least as much error as the PSD assumption". As we see it, no good overall estimate exist for any of the effects, simply some test calculations for particular conditions. In fact, the test calculations performed point at a similar impact for the two effects.

The most recent and comprehensive results by Davis on inhomogeneity effects are found at <http://xweb.geos.ed.ac.uk/cdavis/mindmaps/mm3Dpol.html>. Different combinations of observation geometry, frequency and particle aspect ratio are considered. A detailed discussion of these results is outside the scope here, but it could be commented that not all results are relevant with respect to Odin-SMR. First, due to the polarisation response of Odin-SMR, results for Q (Stokes component 2) are of limited interest. In addition, the retrieval algorithm presented uses only low tangent altitudes, where clouds solely cause a negative change in intensity ( $\Delta I$ ). The results for EOS MLS and 10 km tangent altitude are thus ignored here. Further, the geometry of the obser-

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vations gives a relatively small footprint for the Odin-SMR retrievals. It is approximately 2 x 50 km, which may decrease the sensitivity to inhomogeneities somewhat. Using remaining results, we find a maximum difference between 1D and 3D calculations of about 100 %. We can take this as an estimate of "worst case". The calculations of Cory Davis are however made for mid-latitude conditions and higher errors could be found for the tropical conditions valid for Odin-SMR.

Our paper gives several examples on retrieval errors exceeding 100 % when different PSD are assumed. These are worst case estimates, but unfortunately no tighter error bounds can be given today.

Anyhow, worst case estimates are less interesting than mean errors, which in neither case are known. We have very recent results from the ESA study mentioned above (Carlos Jiménez and Stefan Buehler, private communication), indicating an error for the PSD effect of at least 20-50 % (depending on IWP), but these results are for down-looking geometry and mid-latitude conditions, and can only be used as a general indication for the Odin-SMR results. However, the found values are in general consistency with the value adopted in the paper of 50 %.

It is clear that we and Cory Davis have here similar research interests and we would be very happy to coordinate further studies of these questions.

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Interactive comment on Atmos. Chem. Phys. Discuss., 6, 8681, 2006.

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