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Atmospheric Measurement Techniques Discussions

Interactive comment on "Non-Gaussian Bayesian retrieval of tropical upper tropospheric cloud ice and water vapour from Odin-SMR measurements" *by* B. Rydberg et al.

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Reviewer 1

1. Typically, simulation of a 3-D system will be much more time-consuming than that of a 1-D system. How much does the computational time increase when the inhomogeneity is considered in the retrieval algorithm?

Reply

Clearly, simulating a 3-d system is more time consuming than simulating a 1-d system. However, it is not trivial how to best represent a 3-d system with a 1-d system. We

found it necessary to simulate a 3-d system in order to deal with beam-filling problems. The most time consuming part of the presented retrieval approach is the generation of the retrieval database, including generation of atmospheric states and simulations of radiative transfer. However, once the retrieval database is created the retrievals are fast, and the retrieval computation time does not depend on the dimensionality of the retrievals. As a radiative transfer model we used a Monte Carlo model, which can not be run in a strict 1-D mode, so it is hard to say how much time it would have taken to simulate a 1-D system. We did not measure the exact computer time required to complete the database, but approximately a few thousand computer hours were used. That is probably about a factor of 10 longer computation time than a 1-d system would have required.

Reviewer 1

2. Fairly large systematic errors are seen in the retrieved relative humidity (Fig. 7). The authors explained (page 1596, line 24) that "This is an effect of that the measurements do not provide complete information and the BMCI method favours more likely states". Is it possible to remove or to reduce the errors coming from these sources?

Reply

For an individual retrieval the retrieved values are the most likelihood solution. The two dominant effects generating the systematic errors are that the measured signal saturates for high relative humidity and the measurement noise, including calibration errors, is approximately as high as the variation between the signal at 70 and 150% RHi. So in order to reduce the systematic errors one has to reduce the Odin-SMR calibration errors. Ideally this can be done, but it is to date not known why there are such high random calibration errors for Odin-SMR. As this seems to have been unclear, we will add this to the discussion of the figure. A simple correction for geographical averaged retrievals, taking into account the biases in Fig.7, is discussed (page 1599 line 21) and applied in Fig. 10.

Reviewer 1

3. To explain the systematic errors in the retrieved IWC (Fig. 9), the authors stated that (page 1597, line 28) they are "caused by incomplete measurement information in the same manner as for RHi". However, one can see that for the RHi, the 15-16.5 layers has the largest error, but for the IWC the 10.5-12 layer has the largest error. Is there a reason for this?

Reply

Yes. At the considered frequency channels Odin-SMR measures upwelling thermal emission where the main part of this emission is originating from water vapour in the altitude region between approximately 10-15 km. Thus, the measured signal is only slightly affected by water vapour above 15 km. Therefore, the layer between 15-16.5 km is expected to have larger retrieval errors than the lower layers. Cloud ice mass, on the other hand, mainly interact with the radiation by scattering effects. This reduces the intensity as compared to cloud free scene. For a hypothetical cloud, which can be moved in altitude but with all other properties constant, the decrease in intensity would increase with increasing the cloud altitude. Thus a "low" altitude cloud is not as "visible" as a "high" altitude cloud due to water vapour screening effects. A low cloud can also be partly hidden by a higher cloud. Thus ice water content retrieval errors are expected to be largest for the lowest layer. This is partly discussed(page 1598 line 4), but a more throughout explanation will be added.

Reviewer 1

4. To compare the retrieved RHi from the improved algorithm with that from previous algorithm, the authors showed the retrievals from both algorithms in Fig. 10. However, in this figure, it is not obvious that "the v2 results give a fairer representation of the actual measurement information found in Odin-SMR spectra" (page 1599, line 19) compared with the previous algorithm. It would be helpful if the authors can plot the RHi retrieved from the previous algorithm against the "True RHi", and then compare these plots with

Fig. 7.

Reply

We agree that it is not obvious from the figure that "the v2 results give a fairer representation of the actual measurement information found in Odin-SMR spectra", and we do not refer to the figure when we are saying so. As the statement "the v2 results give a fairer representation of the actual measurement information found in Odin-SMR spectra" is a bit vague we will rewrite it. What is meant is that v2 retrievals are more general and uses the measurement information in a more optimal estimation method manner than the v1 retrievals. The measurement is combined with a priori information, in order to retrieve the maximum likelihood solution. The complete statement says in fact that "it is judged that the v2 results give a fairer representation of the actual measurement information found in Odin-SMR spectra". Thus, we judge that it is more fair to combine data with a priori information in order to be able to handle cloudy situations, than using a questionable ad hoc method, as in the v1 retrieval. Clearly, as the measurement information is not "complete" the use of a priori data in the v2 retrievals, will give rise to a bias towards more likely states. This is not a unique situation, as this will be the case for all retrievals where a priori information is used. This type of bias will not be seen for v1 retrievals, as no a priori information is used. On the other hand, the v1 retrievals can introduce other type of biases. It seems like the reviewer thinks that we state that the v2 retrievals have a higher accuracy than the v1 retrievals. That we do not state, and we do not think it is necessary to include such a figure as the reviewer suggests. We judge that it is enough to present the characteristics of the v2 retrieval version in this paper. The v1 retrieval characteristics is already presented in Ekström et al. 2007.

Interactive comment on Atmos. Meas. Tech. Discuss., 2, 1575, 2009.