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Atmospheric Chemistry and Physics Discussions

Interactive comment on "First Odin sub-mm retrievals in the tropical upper troposphere: humidity and cloud ice signals" *by* M. Ekström et al.

Anonymous Referee #1

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General:

The paper describes a retrieval strategy to derive relative humidity and cloud ice signals from Odin observations. Since upper tropospheric humidity observations are sparse this is an important contribution to data availability and characterization. I appreciate especially the thorough analysis of systematic and random error contributions.

A major concern is the handling and characterisation of the retrieval in presence of clouds. It is not clear how far the quantity applied for cloud detection is independent of the retrieval parameter and how these interact. Further, the comparison with the MOZAIC dataset should be elaborated more quantitatively.

Specific:

p. 8652, l. 4: 'The retrieval of UTH requires that the influence of cloud scattering can be quantified, and this can now be achieved with recent development in the area of radiative transfere calculations.'

-> This sentence implies that in the paper detailed radiative trasfer calculation of clouds are used to help the retrieval of UTH in presence of clouds. However, this is not the case since a pure empirical method (the 'T_B depression') is applied to detect clouds and correct UTH.

-> Second, throughout the paper the influence of clouds is denoted as 'cloud scattering'. However, since the index of refraction of ice is not zero in the sub-mm range, for ice clouds with small particles (<30-40 μm radius) absorption may dominate scattering. (In case of liquid water clouds, absorption even dominates up to radii of 150 μm.) Thus, I propose to replace 'cloud scattering' with something like 'cloud influence' or 'cloud extinction'.

p. 8654, l.6: 'but with the important differences that in this case the surface and clouds interact much less with the retrieval'

-> As shown further on, clouds have a large impact on the retrieval. So I don't understand this sentence.

p. 8655, l.14: 'only on the amount of water vapour and temperature.'

-> 'and clouds' (I have not found an indication that in this chapter only clear-sky conditions are described).

p. 8655, l.27: 'Simulations have revealed that the sounding altitude throughout is found at more or less the same optical depth τ, however at different τ for the different bands.

-> Could you specify which τ is meant. I assume vertical from the satellite downwards? Or along the line of sight? Does this τ depend on the actual tangent height?

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p. 8656, l.3: 'These values have been determined empirically by simulations of different humidity profiles, tangent altitudes and temperature profiles.'

-> Summarising in a plot the performed tests to derive the applied values of τ would support the statement.

p. 8656, l.27: 'From the measured spectra a band of 100 MHz is averaged.'

-> Please give the exact boundaries of the ranges used.

p. 8657, l. 9: 'Clouds in the upper troposphere act to both scatter away the up-welling radiation from the lower warmer atmosphere and to scatter into the line-of-sight the radiation from the region surrounding the ice cloud.'

-> Note also the possible absorption I've mentioned above.

p. 8657, l. 15 and below:

-> The 'T_B depression' is introduced as a means to detect cloud influence. Can you explain why this quantity has been introduced? Is it really an independent measure for ice clouds? Isn't it strongly correlated with the retrieved RHi? I would expect that increasing cloud extinction has the same effect on the spectrum as increasing humidity since both leads to a decrease of the measured radiances. Could you make e.g. a plot of 'T_B depression' against retrieved (assumed clear-sky) RHi (also to explain the chosen weighting more clearly)? In case both quantities are highly correlated a cloud correction on basis of one of them seems to be quite arbitrary.

p. 8662, l. 1: 'The precision in ECMWF temperatures was assumed to be 1K'

-> From Table 2 the resulting error is about 10% at 501 GHz for a 1K ECMWF error. However, a 0.5 K thermal noise error makes 8% and a 2K calibration error results in 30% RHi error. How does this fit to the ECMWF error?

p. 8662, l. 5: 'The result was an average deviation of 2% RHi.'

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-> Is it really the 'average deviation' calculated here or do you mean the 'standard deviation' which should be used?

p. 8662, l. 15...: 'A conservative estimate of the overall precision of the cloud correction is also 20% RHi, and this value is applied generally. An interesting consequence of the assumptions around the cloud correction is that the retrieval error is relatively small for cases with strong scattering. The retrieval error is then equal to the a priori uncertainty for humidity inside ice clouds (20%).'

-> However, for not so thick ice clouds the error on RHi may be even higher since the ice cloud signal can perhaps not be distinguished from the RHi signal.

-> A further problem might be the relative position of the cloud with respect to the sounding altitude. Has this been investigated?

p. 8663, l. 6: 'but with notable differences for $<$20%RHi and $>$120%RHi. However, simulations showed that the differences at both ends of the distribution can be explained as an effect of the established random calibration uncertainty.'

-> However, the differences between 60 and 80% are comparable to those $>$120%.

-> How many data went into these distributions?

-> Can you show these simulations or, better, make a statistical test on the compatibility of both distributions.

p. 8663, l. 24:

-> How have the 200hPa values been selected? Are these all values from the 501 GHz channel or has there been a post-selection on basis of the optical depth criterion?

-> Same question for the 130 hPa values.

Technical:

p. 8655, l. 2: ' 557 H2O line'

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-> ’557 GHz H2O line’

p. 8658, l. 17: ’rely’

-> ’relies’

p. 8659, l. 17: ’of current’

-> ’of the current’

p. 8659, l. 28: ’consist’

-> ’consists’

p. 8660, l. 25: ’Table 5’

-> ’Table 1’

p. 8661, l. 20: ’is pointing off-sets’

-> ’are pointing off-sets’

p. 8663, l. 27: ’centra’

-> ’centre’

p. 8665, l. 6: ’be low’

-> ’to be low’

p. 8673, Fig. 2: ’maxima’

-> ’maximum’

p. 8673, Fig. 3: ’lines shows’

-> ’lines show’

p. 8675, Fig. 4: ’that has’

-> ’that have’

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