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Interactive Comment

Interactive comment on "A microwave satellite water vapour column retrieval for polar winter conditions" *by* C. Perro et al.

C. Perro et al.

ch473000@dal.ca

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1 Response to Referee 1

Referee: This article describes an updated retrieval method to obtain water vapour columns in polar regions from the MHS and AMSU-B instruments. The improvements to current methods are described and the new method tested against synthetic and real data. The new method involves using a-priori information and iterating a radiative transfer model to optimise the optical depth profile by scaling the water vapour profile. The results are interesting and probably should be published I do however have some concerns.

My major question is why they do not just do a formal retrieval using an optimal estimation or other method.

Authors: We thank Referee 1 for their overall positive comments and helpful suggestions for our manuscript.

Regarding optimal estimation: it is not clear that it will provide a significant advance over what we submitted, which is conceptually clear and straight-forward to implement. It is, however, a reasonable next step, and so we have added the following to the Conclusions:

> “Given the benefits of a priori information, optimal estimation techniques (Rodgers, 2000) may further improve water vapour retrievals.”

Referee: Secondly, no indication of the relative computational burdens for the methods compared was given. I assume that this is important when processing images and presumably the reason that such parameterise methods have been developed.

Authors: We have added the following to the last paragraph in Sect. 5.1:

> “However, the MH08 retrieval is computationally faster than for PLDC16: For our unoptimized code, we found PLDC16 to take six thousand times longer than MH08. Optimizations were not performed because the PLDC16 retrieval is fast enough for our research purposes.”

Referee: A third concern is that really only the case 3 results and the comparisons to real data are a good test of the method. Since the same RT code is used to make the data as is then used in the analysis in case 1 no real conclusion can be drawn. In case 2 only random noise but no systematic effects have been applied so again the cards are weighted.

Authors: It is expected that users of our retrieval will always have reanalysis data available to serve as the a priori. As such, Case 2 is the most realistic of the simulations. We have no means of realistically introducing systematic effects. However, as pointed out by the Referee, the real data provide a good test of the retrievals. The Case 3 results are meant to provide a worst-case scenario for when the reanalyses are no better than a climatology.

To clarify the situation for the reader, we have added a new subsection (4.4 Discussion), which says:

> “Three test cases were given to theoretically evaluate the PLDC16 and MH08 retrievals. Case 1 tests their intrinsic accuracy for noiseless brightness temperatures and perfect a priori information. Both retrievals performed as expected, with the PLDC16 retrieval faithfully reproducing the model water vapour data. Case 2 included randomized noise as found in the MHS instruments. Given perfect a priori information, the PLDC16 retrieval more accurately reproduced the model water vapour. Case 3 employed a climatological a priori, which represents a worst-case scenario for PLDC16. The test yielded comparable errors for the two retrievals for most regimes.
>
> We expect that reanalysis data will always be available as the a priori. As such, the most realistic retrieval comparison is given by Case 2. Notwithstanding, there are errors in the reanalyses (Serreze et al., 2012), spatio-temporal variations (Büehler et al., 2012, Tobin et al., 2006), and systematic errors which are difficult to treat quantitatively in simulations. To address

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these concerns testing in real-world conditions is appropriate, and our results are given in Sect. 5."

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 9959, 2015.

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