Review of amt-2016-72

Title: A Differential Absorption Radar Techniques: Water Vapor Retrievals
Authors: Millán et al.

1 Summary

In this work, water vapor retrieval from satellite-based radar measurements was first described and further demonstrated and investigated with simulations. The ideal is to exploit the differential water absorption from two distinct radar frequencies at on and off the absorption line (183 GHz). As a result, the total column water vapor as well as water vapor profile can be estimated. The feasibility of the retrieval was investigated under different weather conditions including clear sky, cloudy, and rainy. It is also very valuable to assess the performance of different frequency combinations and contributions from various error sources. In summary, this is a well organized and written paper with significant scientific contribution to the community. I recommend to publish this work after those relatively minor comments/concerns in the following two sections are addressed.

2 General Comments

As pointed out by the authors, it is important to measure water vapor with adequate resolution, accuracy, and coverage to characterize the atmosphere. The proposed satellite-based retrieval method exploits differential absorption at two radar frequencies at around water vapor absorption. The overall structure of the paper is well organized and clear. However, there are some parts of the paper can be explained in a more clear way. For example, the theoretical basis is easy to understand. However, the forward model for simulation is not clearly explained. Even though the reference paper provided does not have enough detail to understand the basic idea of the simulation. I suggest to include a flow chart outlining the important steps in the simulation, which can be provided in the appendix. Specifically, what are the outputs of the simulations, reflectivity at two assigned frequencies? How are the reflectivity from each gate generated? When the noise is added, is it added in the dB scale or linear scale? Additionally, it is not clear to how the sensitivity of -30 dBZ, instrument precision of 0.16 dBZ, and spatial resolution were incorporated in the simulations, or were they ever incorporated in the simulation?

Moreover, the retrieval of total CWV and profile of water vapor needs to be elaborated. For example, in line 21 page 5, it is stated that "The retrieval algorithm used was a linear least square fit ..." It is not clear what variables the least square fit are applied to. Do you mean reflectivity from multiple frequencies? In the profiling case, more detail for the optimal estimation algorithm is desired. Do you mean the problem is postulated as a constraint optimization? What is the mathematical representation of it and how exactly are the measurement and a priori information used in this method?

3 Specific Comments

The comments here are relatively minor and mostly editorial.

1. *Line 1, page 2 and line 27, page 3*: change "asses" to "assess".
2. *Line 3, page 2*: change "retrieved" to "retrieve"
3. *equation (6)*: need dr
4. *Line 15, page 3*: "same similar"?
5. *Line 23, page 5*: change "there" to "these"
6. *Line 26, page 5*: need a space before "Not only ..."
7. *Line 8, page 7*: What is the role of these kernels? Please elaborate.