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Interactive Comment

Interactive comment on “The feasibility of water vapor sounding of the cloudy boundary layer using a differential absorption radar technique” *by* M. D. Lebsock et al.

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Comment:

1) It is rarely that a satellite will see the boundary layer un-interrupted by high clouds. I believe that ice clouds and the attenuation due to them will also affect your retrievals of water vapor. Moreover the backscatter cross-section from ice clouds will be highly different for the frequencies in consideration (140-170 GHz), making it tougher to retrieve water vapor. This issue need to explored or at least discussed in the article.

Response:

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It is true that the radar field of view will frequently be obscured by high clouds. Mace et al. (2009) show that the fraction of high topped clouds can exceed 60% at the equator and is roughly 30% over the subtropics using CloudSat/CALIPSO data. However most of these high clouds in this region are thin and are as such misdetected by passive algorithms like ISCCP and MODIS as mid-level cloud (Mace et al., 2009). Attenuation of microwaves due to ice is generally very small. At 183 GHz the absorption due to ice clouds is greater than 2 orders of magnitude less than that of water clouds (Burrows et al., Figure 4.3). Furthermore these thin clouds contain little ice to begin with so it is unlikely that the ice attenuation will greatly limit the ability of DAR to see through them to the boundary layer. The backscattering cross section of ice clouds is only consequential in the sense that it attenuates some of the signal before it reaches the boundary layer. However once again this attenuation is small. Ice clouds are not the focus of this paper however if one wanted to design a DAR for water vapor sounding in ice clouds ideally one would use channels closer the 183 GHz absorption line. Because the measurement that is related to the water vapor is the differential reflectivity (difference between two frequencies) it is not the differences between water and ice backscattering that are relevant but rather the spectral variation in reflectivity and its dependence on the cloud drop size and shape that matter. Much of the uncertainty in backscattering cross sections related to ice crystal habit would cancel out in the construction of the differential reflecticvity. A dedicated study is needed to quantify this effect however and it is not the focus of this paper.

Comment:

2) You have used a sophisticated forward model that takes in to account Mie effects. Now in the article, you knew the micro-physics from the LES model simulations, while in reality they will be unknown. There are significant undulations in the backscatter cross-section in the Mie regime due to slight changes in microphysics. What if the microphysics causes the backscatter to increase at one frequency and to decrease in the other frequency? The Mie undulations especially for precipitating cloud conditions

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can be quite significant.

Response:

The reviewer is correct that Mie effects can obscure the water vapor signal in the presence of precipitation, however we have already quantified this effect. In particular, Figure 7 shows this. Panel (A) shows the RICO simulation that contains precipitation while Panel (B) shows the non-precipitating DYCOMS simulation. The large amount of scatter in the RICO simulation that is not present in the DYCOMS simulation is due to a combination of the microphysics and the NUBF. The scatter about the linear fit in figure 7 is used to estimated the uncertainty due to natural variability that enters into the uncertainty characterization in Figure 10. Here it is obvious that the uncertainty in inhomogeneous precipitating cumulus (RICO) is much greater than that in homogenous stratus (DYCOMS). In effect the difference in error between the two panels shows what the reviewer is asking for, and in fact shows more because it also includes the NUBF effects that must be overcome.

Comment:

Minor Points: 1) Figure 9: I believe the y-label should be g/m2 not g/m3? 2) Table 3: One of the columns (probably the third and the fifth) should be delz/delp * delta(p). Currently columns 2 to 5 have the same denominator. 3) The terms “integrated vapor path” and “column vapor path” have been used in the article, I think maybe the authors should just use one of them for clarity.

Response:

1) the units are correct but the axis labels were incorrect causing the confusion. We have addressed this. 2) The labels are correct as they are. 3) We have changed to CWV throughout.

References:

Mace, G. G., Q. Zhang, M. Vaughan, R. Marchand, G. Stephens, C. Trepte, and D.

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Winker (2009), A description of hydrometeor layer occurrence statistics derived from the first year of merged Cloudsat and CALIPSO data, J. Geophys. Res., 114, D00A26, doi:10.1029/2007JD009755.

J.P. Burrows et al. (eds.), The Remote Sensing of Tropospheric Composition from Space, Physics of Earth and Space Environments, DOI 10.1007/978-3-642-14791-3_4, # Springer-Verlag Berlin Heidelberg 2011

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 5973, 2015.