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Atmospheric Measurement Techniques
Discussions
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Interactive comment on "Boundary-layer water vapor profiling using differential absorption radar" *by* Richard J. Roy et al.

Anonymous Referee #1

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This paper discusses the theoretical framework and preliminary results for in cloud absolute humidity retrievals using a new differential absorption radar technique at 183 GHz water vapor absorption line. Although mature at the optical frequencies, this is the first demonstration of range resolved differential absorption profiles of an atmospheric constituent at the microwave frequencies. The paper is generally well written and clearly organized with adequate theoretical basis to support preliminary measurements. Addressing a few general comments may strengthen the paper and provide insight into future applications of this new measurement technique.

1. Page 2, Line 9: Several references to column water vapor are made throughout the paper, this being the first one. Although the surface echo (or cloud for ground based measurements) may be exploited to directly measure the column water vapor, no dis-

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cussion is presented on the challenges associated with this measurement, specifically, to what accuracy the differential power ratio between the different sounding frequencies need to be measured. Back of the envelope calculations show a relative error of 10ˆ-4 is required in the relative transmitted power ratio, which is certainly a difficult task. A brief discussion (somewhere in the paper) on the column measurement requirements would be beneficial.

2. Page 3, Line 1: Please clarify that the column measurements do require absolute calibration.

3. Page 3, Line 4: An assumption is made that the effects of multiple scattering are negligible on the received echo within clouds. This subject is not mentioned again in the paper. It is unclear that this assumption is valid and is highly dependent on the cloud water and ice particle size distributions. At the optical frequencies, lack of quantitative knowledge of the multiple scattering limits the utility of the received signal within clouds. The effects of multiple scattering become significantly larger as the beam propagates deeper into the cloud. This effect has been quantified at the microwave frequencies such as Cloud Sat and should be more completely addressed in this paper. A discussion on the impacts of multiple scattering on the humidity retrievals for different cloud particle size distributions and viewing geometries (distance to scattering target (ground vs airborne vs space) should be presented.

4. Page 4, Lines 11-13. It should be noted that comparison on sensitivity between pulsed and FMCW is dependent on background signal levels. In high background levels with the FMCW IF bandwidth compared to the background within the gate width of a pulsed system, the advantage quickly diminishes.

5. Page 5, Line 10. The advantage of selecting such a high chirp frequency (60 MHz) is not clear, especially when the DAR retrievals are done over an equivalent bandwidth of $\sim$ 2-3 MHz. Please clarify on why the higher chirp frequency was selected.

6. Page 5, Line 16. A linear chirp results in side lobes in the power spectra which can

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contaminate the signal from the main lobe. Please discuss the logic behind choosing a linear chirp instead of a non-linear chirp such as one with a Gaussian frequency distribution which would result in a Gaussian response in the time domain. A plot showing the power spectra (and resulting side lobes) from a bright scatterer would be beneficial to the reader.

7. Page 5, Figure 2. Update the figure to accurately represent the bi-directional chirp discussed in the text

8. A single table describing the system parameters would be good in section 2.2. Of particular interest is the antenna beam width and spatial side lobes.

9. Page 8, First paragraph. Please clarify why background subtraction is done in the Fourier domain and not in the time domain.

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