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Discussions

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

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Dear reviewer #2,

Thank you for your comments and suggestions regarding our manuscript. Listed below are our itemized responses, with the original comment/question displayed in italics.

1. *In The statement at line 7 and 8 in the abstract you should clearly state that this is obtained in conditions of high SNR. Also it is driven by the range of your frequency within the absorption line, this should be mentioned otherwise the reader may generalize this conclusion erroneously.*

C1

The abstract has been updated to provide this clarification regarding the quoted water vapor uncertainty.

2. *Line 14 page 2: the authors should mention the obvious caveat of attenuation in reducing the SNR (too much water content/rain drives the signal below sensitivity).*

A sentence has been added to clarify that increased reflectivity due to increased cloud water content has an associated increase in attenuation.

3. *Line 4 page 3: it would be beneficial to discuss when the assumption of negligible multiple scattering is negligible or refer to previous literature.*

Please see our detailed response to reviewer #1 on this same point.

4. *Line 4-7 page 4: I am not fully convinced by this maximum differential absorption from particulate extinction of 0.01 dB/km. I haven't tried a specific computation but liquid cloud extinction is proportional to $1/\lambda$. So (assuming that the changes in refractive indices are negligible) a change of roughly 3% in lambda should correspond to a change of 38 dB/km/(g/m³), which means that a deep cumulus cloud with 3 g/m³ could produce 0.08 dB/km (an order of magnitude larger than quoted).*

The issue of differential absorption from hydrometeors in an important one. We have added an extended discussion to the manuscript with Mie calculations for a wide range of realistic cloud and precipitation scenarios.

5. *Line 10 page 5: What is the rationale for using a ΔF_{chirp} of 60 MHz and thus a range resolution of 2.5 m (with the obvious need of averaging later on for improving the SNR?)? Why not using a smaller bandwidth in first place?*

Please see our response to reviewer #1, item #5.

6. *Line 11-12 page 7: I do not see the need of dropping the v subscript on, I would recommend to keep it for clarity (otherwise the reader may think it is the total extinction).*

We have inserted the subscript v on κ throughout the manuscript.

7. *Generally in literature SNR values are stated in dB. In Fig.4 and its discussion you use linear units. Fig6 is also confusing to me, why using an obscure value like eta in the x-axis instead of using the SNR itself?*

We have modified figures 3 and 4 and the associated discussion to express SNR in dB. While the quantity η may seem obscure, we feel it is necessary to combine the uncertainty of all the power measurements involved in the humidity extraction for the purposes of the analysis in this section. Since there are N_f different power measurements from 2 different ranges involved, all with different SNR values, the humidity extraction cannot simply be labeled by a single SNR. Due to the confusion caused by this figure, we have decided to remove it from the manuscript.

8. *Fig5: it could help the reader to have a double y axis with the plot of the relative humidity and its uncertainty as well.*

Since we do not have measurements of the coincident temperature field, we do not feel it is appropriate to report relative humidity values and errors.

9. *Fig5: A couple of points at low and far ranges from the two independent datasets in the bottom right panel seem to disagree, any comment?*

One shouldn't expect independent sample sets of the same random variable to always have error bars overlapping, as this would signify an overestimate of the distribution variance. The error bars appear representative of the variability between data sets.

10. *Fig 6: apart from the selection of the x-axis I struggle in extracting information from this figure. Why not doing a contour plot of σ_ρ/ρ using SNR vs rho e.g. for*

C3

100 200 and 400m integration? Anyhow I would ask the authors to try to rethink the figure and present it in a more understandable way.

We have decided to remove this figure from the manuscript, as well as section 4. Instead, we briefly discuss the trade-off between humidity measurement precision and resolution at the end of section 3.