

Atmos. Meas. Tech. Discuss., referee comment RC1  
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## Comment on amt-2021-352

Anonymous Referee #2

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Referee comment on "Extending water vapor measurement capability of photon-limited differential absorption lidars through simultaneous denoising and inversion" by Willem J. Marais and Matthew Hayman, Atmos. Meas. Tech. Discuss.,  
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This manuscript describes a novel data analysis technique for extracting water vapor profiles from time-of-flight backscatter measurements using the MicroPulse DIAL system. The paper is very clearly written, carefully describing all the steps of the various algorithms in some detail. The results show that this new technique is superior to the standard analysis technique, particularly at high altitudes. This work is fairly specialized, being suited to photon-counting DIAL systems with pulsed lasers, and the MPD system in particular, so it may not find a wide audience. Nonetheless, it should be published so that other researchers can understand the details of the analysis. Readers may find this type of analysis could be applied to other measurement tools as well.

The authors go to some trouble to account for convolution with the relatively long laser pulses, (1 microsecond,  $\sim 300$  m), compared to the 37.5 m vertical resolution displayed in the plots. Shorter laser pulses ( $\sim$ ns) can be easily achieved, even in low-cost laser diodes. What are the tradeoffs for using longer pulses? I imagine the longer pulses allow for more backscattered photons, requiring requiring shorter acquisition times to achieve the same SNR, but at the expense of decreased vertical resolution. A detailed study of this is probably outside the scope of this paper, but a brief discussion of the qualitative tradeoffs would be nice.

There are several minor grammatical or typographical errors, but overall the manuscript is very well written. A few specific examples with line number and suggested text:

16: Great Plains

75: approach is not necessary

87: example of how

98: Table 2 lists abbreviations used throughout this paper. (Acronym is a specific type of abbreviation; most abbreviations in this paper are not acronyms.)

198: as a Gaussian  
228: in the initial atten.  
232: sequence isolates calibration  
241: that PTV-MPD employ  
249: the minimizers ... are  
257: error that indicates  
313: denoising and inverting  
315: into account  
397: and 2) at the NCAR

Abbreviations are used a little more frequently than I would prefer, but I found most of them easy to follow. I also appreciate the numbered lists that are offset from the text; these are much easier to digest than the same information would be if buried in a paragraph.

Overall, this is a solid paper. It is quite specialized but will be a valuable resource for readers trying to replicate the analysis or modify it for analyzing data taken with a different instrument. I recommend for publication in AMT after the minor technical corrections suggested above.