

Response to Anonymous Referee #2 Comment on amt-2021-229 first revision  
(Referee report submitted on 03 Dec 2021)

The authors graciously thank the reviewer for their thoughtful and detailed feedback, after which the manuscript has undoubtedly improved. Reviewer comments below are in green, while responses are in black.

**Summary:**

The submitted manuscript is a revised version of the original manuscript considered for publication. The details remain largely the same from version 1 to version 2. The manuscript presents an outline of the data processing methodology for the HALO instrument in the WV and HSRL configuration as well as needed hardware details, when relevant to the processing structure. The scope of the manuscript is largely similar to the original submission and is still well within the desired scope for AMT.

Overall, I believe the authors' revisions have been significant and positive. The revisions to this manuscript have alleviated a number of my original concerns relevant to this manuscript. The primary concern I had related to the quality of the ancillary data set have been well addressed by pivoting the scope to focus away from a validation. As a demonstration, the results and caveats with the available ancillary data set are exceptional. Second, the treatment of errors in this manuscript feels more complete and, while the changes are minor, they seem conclusive. The added elements cover more familiar issues related to DIAL measurements and answer a number of questions the original draft did not.

One lingering concern I have is how definitive this resource will be and its broader impact. Given that the content has not changed significantly from draft version 1 to draft version 2, the noted overlap with Bedka et al. 2021 is still prominent and much of the instrument's technical detail is still lacking. Said differently: the scope of the Bedka et al. 2021 paper forms a partial demonstration. Therefore, this demonstration of the instrument's capabilities is less significant than a single resource. This reduces the impact of this manuscript substantially in my opinion. In general, the authors' decision to publish the still to be written instrument paper after instrument demonstration, which itself was submitted after the full campaign description, should not be encouraged for the future. Assuming publication, there would now be 2 demonstrations of a single system, whose hardware is nowhere conclusively described, with reasonably similar author list using the same data set in the same journal in the same year. However, in my opinion, this is probably not reason to halt the publication of this work.

I would suggest that a few minor revisions would help clarify a couple of loose ends. Beyond that, it is my opinion that the manuscript should be published.

**Minor Comments:**

- 1) Page 2, Lines 52-54: This sentence currently reads "WV DIAL...only measures one species...". Suggest dropping the WV to generalize and remove redundancy.  
This change has been made.
- 2) Page 2, Lines 57-58: I take issue with this statement. This sentence suggests to me as the reader that adding multiple wavelength pairs is a general solution to limited DIAL dynamic range. This is of very limited practical benefit from ground based vertical profilers assuming somewhat canonical water vapor distributions. You need the rather special condition where WV is increasing with increasing range from the sensor that is really only possible from high-altitude flight. Please either alter this sentence to narrow the scope or remove.

This ability to leverage multiple wavelength pairs is an advantage of airborne DIAL over a ground-based DIAL. To clarify, the antecedent phrase has been added: "For nadir-pointing airborne DIAL, WV typically increases with range, and thus the challenges of signal attenuation and limited dynamic range with a single wavelength pair can be overcome by utilizing multiple wavelength pairs distributed along the side of the WV absorption line."

- 3) Page 3, Line 89: Is "n.d." "no date"? If so, should the date not be the one when the dataset's DOI was established?

The date of creation has been added (2020).

- 4) Page 3, Line 91: For context, it might be nice to give the number of flight hours here.

43 flight hours, this has been added.

- 5) Page 6, Line 182: The antecedent of "These sources of error" was, I believe, removed from version 1 to version 2. This seems unclear as it currently stands.

The antecedent phrase "These sources of error" is included in this version of the manuscript.

- 6) Page 7, Lines 201-203: I find it simpler to understand this sentence if you add the word "cumulative" to the first introduction to OD, i.e. "The maximum cumulative WV OD ...". Either way, that you have a complete profile and single range cell optical depth in the same sentence seems to me to be a point of some potential confusion.

"Cumulative" has been inserted as suggested.

- 7) Figure 1: A grid might help your reader out here on panels b and c. At first I was wondering why the Random error would increase near the bottom of the profile with increasing signal (due to the aerosol layer). I now see that I had mistakenly shifted the peak of the signal and peak of the error in my head to coincide in range. When I broke out a ruler as an altitude reference, that helped my understanding. A grid seems like a reasonable preventative measure here.

Grids have been added.

- 8) Figure 2: Do you apply the Doppler corrections at the same range spacing as the WV data? Said differently, do you use the same range resolution grid for WV and aerosol? I assume the lower resolution WV data is corrected with averaged HSRL data over the same range cell, but I don't see that stated. Did I miss that explanation?

The WV and aerosol signals and products are on the same altitude grid (with 15 m vertical spacing) as detailed around line 250.

Calculating the Doppler correction is done as the reviewer assumes, with the same range cell size used for averaging HSRL data and the DIAL calculation. This sentence has been added to Lines 467-468 to clarify: "The aerosol backscatter ratio is averaged to match the resolution of the DIAL calculation."

- 9) Page 15, Line 384-386: What is the maximum OD allowed for the transition from the second wavelength pair to the third? It is clear that the first transition occurs from OD = 1 to OD = 1.6. I would suggest that the second transition stopping point should be added for clarity.

The next sentence contains this information: "The second wavelength pair is then used alone until the OD range 1.0 to 1.5, wherein again a linearly weighted average controls the transition to the third wavelength pair."

- 10) Page 15, Line 387: This sentence might be clearer by adding that the  $\pm 0.1$  refers to optical depth. It is implied but I would suggest making it explicit.

This clarification has been added.