Response to Reviewer 1 for AMT-2020-396

Thank you very much for agreeing to review our article. I greatly appreciate your attention to detail and your challenges to our interpretation of the results. I hope that we have responded to all of your concerns in a satisfactory manner.

This paper is the second of two manuscripts describing recent intercomparisons of the NDAAC ozone and temperature lidars. The paper is generally sound and clear, but is fairly long with lots of figures and some repetition. Since the co-submitted manuscripts will be of interest to the same set of readers, more effort could be made to reduce the overlap between the two manuscripts. Section 6 (and Figures 14-17) of this paper could also be moved to a supplement to reduce the length of the main text.

Specific comments:

The intercomparison described here has been formalized with a name: "The Hohenpeißenberg Ozone Profiling Study (HOPS)", but the name is not mentioned in either the title or abstract and doesn't even appear in the text until page 3. It should appear in both.

Title is changed to:

"Evaluation of the New DWD Ozone and Temperature Lidar during the Hohenpeißenberg Ozone Profiling Study (HOPS) and Comparison of Results with Previous NDACC Campaigns"

L7 in the abstract replaced with:

"The campaign, referred to as the Hohenpeißenberg Ozone Profiling Study (HOPS), was conducted within the larger context of NDACC validation activities for European lidar stations."

P2, L35. What do LAVANDE and HOPE stand for? Spell it out somewhere.

Added (LidAr VAlidation NDacc Experiment) to L26

Added (Hohenpeißenberg Ozone Profiling Experiment) to L36

P2, L36. The last half of this sentence is awkward.

Sentence replaced with:

"When providing context for HOPS campaign we will refer back to the 2020 LAVANDE campaign (Wing et al., 2020) and the previous validation campaign at Hohenpeißenberg called HOPE (Hohenpeißenberg Ozone Profiling Experiment) (Steinbrecht et al., 2009)."

P2, L45. "The previous NDACC campaign. . ." should be "A previous NDACC campaign. . ."

Done.

P3, L54. "During the recent NDACC validation campaign by Wing et al. . . ." should read "During the more recent LAVANDE campaign (Wing et al., 2020). . ."

Done.

P3, L59. "SABER" is defined in the abstract, but not the text.

Added definition for both SABER and MLS on L60

P3, L66 and L79. Repetitive.
Removed from L66:
“A comparison was also conducted between NASA and the OHP temperature lidar LTA. The validation exercise determined that the photomultiplier in the low gain channel of LTA was defective and the component was subsequently replaced.”

P3 ,L77. Replace “. . .35 km 2). . .” with “. . .35 km, and 2). . .”
Done.

P4,L82. This is the first appearance of “HOPS”.
Fixed in response to general comments

P4,L107. “. . .scattering cross-sections. . .” should read “. . .absorption cross sections. . .”
Done.

P4,L108. Sentence could be shortened to “The first wavelength is generated using a 308 nm XeCl excimer laser.”
Done.

P4, L114. “. . .ozone scattering targets. . .” should read “. . .ozone molecules...”
Done.

P4, L116. Awkward. Perhaps rephrase “Generating lidar temperature profiles is accomplished. . .” to “Lidar temperature profiles are derived. . .”
Done.

P4, L117. “. . .proton. . .” should read “. . .photon. . .”
Done.

P5, L123. Remove Table 4 callout, or re-order tables.
I’m using the AMT Latex template. I will remember to ask the Copy editor about this.

P5, L140. Repeats lines 122-123.
L140 removed.

P6, L170. “. . .alos. . .” should be “. . .also. . .”
Done.

P6, L177. SABER should be defined before first usage (see comment for P3, L159).
Addressed in comment for P3, L159

P7, L190. “. . .principle. . .” should be “. . .principal. . .”
Done.

P7, L208. Superfluous comma.
Sentence split to read as follows:
For HOPS there are typically between 10 and 20 coincident profiles for each of the satellites. These profiles are generally divided between one or two satellite overpasses for a given night (the following morning for OMPS).

P9, L225. Perhaps insert “(not shown)” after “both wavelengths”
Done.

P10, L241-2. Replace “An example of both. . .” with “Examples of . . .” and insert “, respectively” after “. . .Figs. 3 and 4.”
Done.

P12, L267+. I don’t see the “tight clustering” at 40 km referred to in the text. The NASA and OMPS-uv measurements are consistently low at this altitude.
Text in L269 replaced with:
“The top panel which shows the ozone number densities at 40 km, indicates that in 2019 (last 8 nights) there was tight clustering of all the measurements except for OMPS which was consistently low and the NASA lidar which was significantly lower on three of the nights. During the 2018 portion of the campaign (first two nights) there was more variation between all instruments.”

At 30 km, the OMPS-vis measurements are consistently low so I don’t think you can blame these differences on the temporal offset-particularly since the OMPS-uv measurements look OK.
Good point. Text replaced with:
“In the second panel, which shows ozone densities at 30 km, we see that there is tight clustering for all instruments except for the OMPS visible channel. Given that the OMPS UV channel is in closer agreement with all of the other measurements and that the OMPS visible channel only extends to 35 km, it is probable that the observed low bias in OMPS visible is associated with the upper measurement limits of that channel.”

Any comment on the 21 Mar HOHO measurements at 20 km? This appears to be even larger outlier than the BM measurement at 30 km that the authors do single out. What happened to the NASA-STROZ measurements on this day?
Added text:
“The NASA lidar experienced technical difficulties on the 21st of March 2019 and did not produce an ozone profile for the night. Additionally, there was a substantial delay in starting the HOHO lidar compared to the HOH lidar. As a result, the HOHO nightly average profile was more heavily influenced by a transient ozone layer which was present on this night (not shown).”

P12, L286. Fig. 8 or Fig. 6? P16, L294. Rephrase “The spread in of values. . .” as “The spread in the values. . .”
Done.

P16, L294+. The scatter plots in Figure 7 are hard to read and should be replotted with larger and different symbols (and axis labels). Perhaps use closed circles for the lidar data and open circles for the satellites?
Figure 7 and 11 are replaced.

The statement about the MLS measurements being high at low values in the 15-20 km panel is not obvious from the plot.
Hopefully with the new plot markers it is easier to see that there are more dark purple circles below the 1:1 line than above it.

The most striking feature of this panel are the very low values measured by SABER, yet there is no mention of this in the text.
Added text:
“SABER (magenta) ozone number densities are significantly larger than all other measurements below 20 km and quickly become unreliable at lower altitudes (not shown).”

As far as the scatter in the satellite measurements in the 20-30 km panel, why would fewer nights of observations necessarily lead to more scatter?
Replaced with:
“The increased scatter may be due to geophysical variability.”

Including the BM measurements in the 30-50 km panel seems inappropriate since the balloons rarely ascend past 35 km. Also, why would the wind displacements cause these points to be consistently high-particularly since these displacements are still much smaller than most of the satellite paths? Isn’t the BM pump a more likely culprit as you note below?
Including the BM data above 30 km tells us something about how the instrument bias behaves at the limit of its measurement range.

Good point. Changed to read:
“The right hand panel shows the scatter for all instruments from 30 to 50 km and we can clearly see the outlier data points in the Brewer-Mast (green) which likely arises from instrumental problems.”

P18, L325. As before, where are the NASA-STROZ measurements for 21 Mar? Were there clouds that might have affected the HOH lidar measurements leading to the low O3 at 20 km and high T at 30 km?
Addressed in general comments.

P21, L360. What exactly is meant by “due to the combination of HOH lidar data with the radiosonde mentioned in Sect. 2.2.”
Apologies this is a Typo - corrected to Sect. 2.1
The HOH lidar uses local radiosondes to correct low altitude temperatures. The lidar is not truly independent at these altitudes.

P28, L453. “lidras” should be “lidars”.
Done.

Figure 1 caption. DD-MM or MM-DD?
Corrected to DD-MM

Figure 6. I assume the red trace labelled “HOH” is actually NASA-STROZ?
Corrected.

In my opinion, ALL of the comparisons should be shown relative to the NASA-STROZ lidar and NOT the HOH lidar since it is the official NDAAC “traveling standard”.
When we wrote the LAVANDE article I chose to use the French lidar as the reference for ozone as the NASA lidar experienced technical problems with the excimer laser during a portion of the campaign and as a result had fewer overall nights of ozone measurements. In retrospect it was a mistake and I should have kept NASA as the reference for both temperature and ozone.

The authors debated the merits of correcting this mistake in HOPS (having NASA as the reference for both temperature and ozone) or keeping the same format as LAVANDE (local lidar for ozone and NASA for temperature). We decided that for ease of the intercomparison between the two campaigns we would keep the LAVANDE format. Going forward this is a lesson learned.

Figures 7 and 11. The different measurement sets are hard to discern in all of the scatter plots. The data should be replotted with different symbols and the axes labelled.
These two plots have been remade.

I assume that the HOH measurements were used as the reference in Figures 6/7 and 11/12 because of the missing NASA data on 21 Mar.
More about a poor reference decision made in LAVANDE.

To me, the missing NASA measurements and outlying HOH ozone and temperature measurements on this day are something of a red flag, particularly since there is no explanation for either.
I hope that the added text provides more context and lowers the red flag.