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Interactive comment on "Demonstration of an off-axis parabolic receiver for near-range retrieval of lidar ozone profiles" *by* Betsy M. Farris et al.

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Both reviewers have provided very helpful insights and we concur with all of the reviewers suggestions. A complete point-by-point reply is provided below, along with changes to the manuscript where appropriate. The authors graciously thank the reviewers for the time and effort in enhancing the quality of this work.

Reviewer #1: General Comments: The manuscript describes a substantial improvement in the return of the Langley ozone lidar system. The manuscript discusses the improvement of the LMOL data retrieval in the lowest 1km by using an OAP (off axis parabolic) reflector. The article describes the technical make-up and design change to the system to incorporate the OAP then justifies the changes by showing robust results

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Discussion paper

from the OWLETS (southeast VA) campaign. The lidar showed higher ozone on average than ozonesondes, but lower than the insitu measurements provided by a UAV holding a POM. The low level return is an important improvement in the information gathered by the system. The vertical transport and evolution of ozone in the lowest levels of the atmosphere is most pertinent to the evolution of surface concentrations, which most directly impact human health, monitoring, and ultimately policy. While the overall evolution of the boundary layer provides important information to the evolution of surface ozone the ability to properly resolve the near-surface layer is imperative for fine scale dynamics which transpire near the ground. This manuscript provides a technically driven discussion on the set-up of the near-field retrieval, and then displays its practicality in an operational environment, demonstrating the usefulness of the improvement. The manuscript itself seems well written, quite technical for those unfamiliar with the intricacies of the lidar design, but otherwise well structured with good flow with only minor science questions/suggestions and a few technical corrections.

Sciences Questions/Suggestions: Page 2 line 24: “(F#=1)” Does this mean the fnumber of the OAP is 1? The notation caught me a bit off-guard as f-number hadn’t been discussed prior to this.

Thank you for the suggested change, for better clarity text changed to “f-number 1.0”.

Page 4 line 5: Where does the background value come from?

Added for clarity, the background subtraction is obtained from above 6km for the near-field receiver data, where residual signal effects are insignificant. (Page 4 line 7)

Page 4 line 9: How do you know pressure and temperature at altitude? Do you use a rawinsonde?

Text was added to better explain the pressure and temperature sources: Ozone cross sections along with pressure and temperature information are used as part of the process to extract ozone mixing ratio as a function of altitude. Pressure and temperature

are determined as a function of altitude using a radiosonde; each ozonesonde launch includes a radiosonde. The ozonesonde launches associated with the present data are frequent enough (> 2 per day) to have a better than 3% error due to pressure and temperature uncertainties. In general, LMOL uses the GEOS-5, near real time data product (Putman et. al, 2011)to retrieve pressure and temperature when no radiosonde data can be used. (Page 4, Line 10)

Page 5, lines 8-15: This section shows the capability of the OAP and ozone lidar well. However, there are a lot of assumptions, so the interpretation should be handled with care. Overall questions and suggestions in this section do not change the conclusion that the new OAP adds incredible value to the lidar, but that additional instrumentation complimenting the lidar can add huge explanatory value to the ozone observed.

We agree with the reviewer that a correct interpretation requires complementary data. We modified the text (see next answer), to provide additional context.

line 8: It is not entirely clear on the figure how the boundary layer collapses. Are you referring to a collapsing of ozone to the surface or collapsing in total depth? If the former, is that collapse hidden behind the UAV observations rectangles near the surface and ozone has mixed down from 400m to the surface around 20UTC? From the surface observations at the bottom of the figure, it looks like ozone has increased by 18UTC thus more likely the collapse refers the PBL total depth decreasing, to the drop in ozone concentrations above 500m, and the enhancement in ozone centered around 400m at the same time. Is that enhancement at 400m due to this collapse or is it possibly due to advection? Did ceilometers capture a PBLH decrease? These questions are beyond the scope of this paper's purpose, but important to recognize.

As the reviewer noted, these questions are beyond the defined scope of the paper, however, we have added some sentences to provide some additional context on the convective boundary layer collapse. A collapse in boundary layer can be seen at $\sim$20 UTC (4 pm local time) which contributes to the formation of a more defined enhanced

ozone layer (up to 95ppbv) approximately 400 meters above the surface. This remains as a residual layer into the evening, possibly contributing to some marginal ozone enhancement at the surface until 4 UTC. The sonde wind speed data were stagnant at this time, a significant rapid reduction in surface temperature was noted, and the ceilometer reported a corresponding layer height change, with its PBL height product significantly dropping at 20 UTC to 500 meters above the surface, consistent with the ozone layer height change. Further study would be needed to determine if the ozone enhancement at 400 meters is due solely to the mixed layer collapse or other complex changes over short spatial scales, such as effects from the adjacent shipping channel or other nearby sources. (Page 5 line 13)

Figures 4 & Table 1: It was not initially clear that the flights listed in table 1 were the same as those in figure 4. Matching the times and/or titling the profiles in Figure 4 as "Flight #" could help the reader.

Changed titles to date and time in Figure 4. Table 1 changed due to Reviewer #2's suggestions.

Page 7 line 3: Does "all-profile" mean 120m – 1.0 km? Connecting table 1 to figure 4 would help clarify that.

Changed wording and updated table and figure to better represent profiles differences. Please see additional comments under reviewer #2 for additional response.

Page 8 line 9: Flight 4 is also closest to dawn, when heterogeneity is typically greatest. That, plus any low level jet could create large spatial differences reflected in differences between sonde and lidar.

Thank you for the observationâĂŤthis comment will be included in this paragraph. (Page 9 line 11)

Technical concerns: Page 2 line 28: "Sheer Plate". "Shear Plate" seems to be another possible spelling.

Correct, changed to “shear”. (Page 2 line 31)

Page 3: Figures 1 and 2. Are the figure captions switched under the figures? At the very least, it may be prudent to have “Figure 1” first (on the left) and “Figure 2” (on the right of the page).

Figure #s incorrect, switched to make more accurate.

Page 3 line 16: Comma necessary after FOV? Also, I assume FOV means field of view, but this hasn’t been defined in the text.

Changed to field of view and no comma.

Page 3 line 21-23: Strangely worded or missing a word...maybe meant to say “. . .optimized ËĘforËĘ the near field. . .” ?

Erased last few works. “alignment was refined” explains that the alignment was optimized.

Page 4 line 11: Unclear if this was meant to be a new paragraph.

Formatting error. Combined correct paragraphs.

Page 5, line 13 – 14: Is that supposed to be Aug 2?

Yes, thank you. We have correct that sentence to say Aug. 2.

Page 8, line 14: “. . .larger than the than the. . .”

Corrected.

Page 8, line 15: “. . .but could be potentially be. . .”

Corrected.

Page 8, line 21 - more efficient to eliminate "in another paper" and take "Gronoff et al., 2018" out of parentheses?

Corrected.

Page 8, line 34 - I think there is a word missing: "measurements due use of"

Due to the use of, correct. âĂČ

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