This work basically documents an algorithm that is now being used to produce aerosol column optical depth over oceans from CALIPSO surface returns and MERRA-2 10m wind speed. The first part that describes the method is really more suited as an ATBD (Algorithm Theoretical Basis Document) than a research paper. In general, it is a well written and thought-out paper. A strength is that they present comparisons with MODIS, HSRL, SODA and CALISPO layer optical depths. Also important is their treatment of the CALIOP surface return, realizing that it can be saturated and using a fitting method to the instrument impulse response function to retrieve a more accurate measurement of the surface return magnitude. The filtering of suspect data based on surface signal magnitude, depolarization and wind speed is well done.
However, I think the paper is too long. At around 50 pages it becomes a very tedious read. I would suggest breaking the paper into two parts. The first would present the ODCOD algorithm and the uncertainty analysis and the second part would present results and comparisons. This would allow a better and more in-depth description of the surface return fitting to the IRF (which I think at present is confusing and the results paper to include more examples and comparisons. A comparison that should be added are some island-based or costal AERONET comparisons of column optical depth.

Thank you for the thorough review and for the encouraging words. It has been the practice of the CALIPSO team to introduce new as well as changes to existing data products via papers submitted to journals rather than changes to the CALIPSO ATBDs. See Getzewich et al. 2018, Hu et al. 2009, Kim et al. 2018, Omar et al. 2009, Powell et al. 2009, Vaughan et al. 2004, Vaughan et al. 2019, Winker et al. 2009, etc. and we hope with the changes we are proposing based on the reviewer's comments that this paper is now less ATBD-like and will be a fitting addition to the AMT journal.

We agree with the assessment that the paper is long. We also recognize that there is a need for a full validation of the ODCOD algorithm however, this manuscript is not attempting to fulfill that need. Instead, this paper intends to describe the technique and its inputs, to quantify the random uncertainties and describe their estimation, and then to finally provide only an initial assessment for the performance of the ODCOD algorithm by considering global systematic differences to other established datasets. We specifically chose the airborne HSRL for its accuracy, MODIS for its well validated and long running global aerosol optical depth record, and SODA for its nighttime data, matched footprint, and similar retrieval technique. While AERONET comparisons are crucial to validating ODCOD, this paper is already long, and additional analysis would delay publication of the algorithm technique further from the already released data product. Also, Thorsen et al. 2024 in preparation is currently working on presenting an AERONET validation of the ODCOD data product.

To address the comments specifically, we have re-written the abstract to better state the goal of the paper and deemphasize "results," instead framing them more as what they are intended to be which is an assessment of performance and a characterization of the systematic differences to other datasets. To address the paper length, we have made the decision to remove Section 4 completely and reduced the body of the text by over 900 words. Section 4, while interesting and good to promote discussion, doesn't further the purpose of the manuscript enough to retain it. Some portions of Section 4 fit well in the introduction and we have moved important parts there. However, this along with the numerous edits based on reviewer comments has not successfully shortened the overall length of the paper. We feel that providing the algorithm to readers with no analysis into how the algorithm performs would generally not be well received. Breaking the current work into two parts would leave the analysis underwhelming without additional and more detailed validation. To perform the necessary validation work would take some time to perform and separate the release of the algorithm and validation papers by an undesirable amount of time. The length of the paper is unfortunate but with the removal of section 4 we hope each section now is an important and necessary part of the paper.

The fitting of the CALIOP response model (CRM previously called IRM) is a difficult procedure to describe succinctly but in short is done by finding the measurement time of a reference measurement by taking the ratio of that measurement and the next downlinked measurement which we are confident are part of the surface return. That ratio is unique for any time within the surface return. Since the reference measurement time is unique, it allows us to identify where within the surface return each measurement is taken. Once the positioning is known, it is possible to iteratively solve the scale of the CRM by minimizing the error between the measured points of the CALIOP surface return and points on the CRM but averaged in the same way the CALIOP measurements are averaged onboard the spacecraft. We call this mapping of the CRM to the downlink averaged samples the DCRM (downlinked CALIOP response model). We have completely re-written section 2.1to attempt to make the procedure clearer.

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