The paper by Toth et al. describes the creation of regional and seasonal lidar ratio tables for CALIPSO's final data release (V5). The study focuses on marine aerosol and for the creation of the lidar ratio tables passive and active remote sensing measurements were used, in particular MODIS AOD constrained CALIOP backscatter profiles in addition to GOCART model simulations of sea salt volume fraction (SSVF). This is a great step beyond the single globally-constant lidar ratio value that was used in earlier versions.

In addition to the well described methodology, differences between V4.51 and the new V5 CALIPSO extinction and AOD were also presented together with a preliminary validation using the CALIPSO ODCOD algorithm for seven study regions by utilizing four months from 2015. Improvements due to the new seasonal maps are demonstrated in a case study, focusing on one of the aforementioned regions. Validation using AERONET retrievals was also performed and the results suggest that the lidar ratio tables for marine aerosol improve the AOD retrievals.

Overall, the paper is of good quality, structured and well-written and should be published after only a few minor revisions (listed below).

Response: We thank the reviewer for the feedback and constructive comments, which we believe have helped improve the quality of this paper.

Line 84: It would be worth mentioning a few of the campaigns used, in addition to a number of studies that revealed a bias induced by the marine aerosol type in the CALIPSO data.

Response: We named some of the campaigns used, and these are also included in Table 2. We interpret "bias induced by the marine aerosol type" as a low bias in CALIPSO AOD for marine aerosols compared to other instruments/retrievals (e.g., MODIS, SODA, and HSRL). The following text was added in the revised manuscript:

"These include the Second Aerosol Characterization Experiment (ACE 2; e.g., Ansmann, 2001), Indian Ocean Experiment (INDOEX; e.g., Welton et al., 2002), and airborne High Spectral Resolution Lidar (HSRL) underflights of CALIPSO (e.g., Rogers et al., 2014). Relevant details of these campaigns are found in Table 2. Note that several studies reported lower marine aerosol optical depths (AODs) for CALIPSO compared to Moderate Resolution Imaging Spectroradiometer (MODIS; e.g., Oo and Holz, 2011), Synergized Optical Depth of Aerosols (SODA; e.g., Dawson et al., 2015), and HSRL (e.g., Rogers et al., 2014). These discrepancies were at least partly attributed to the assignment of incorrect S_a, including through possible aerosol misclassification."

Line 86-89: Similarly, as above, one should acknowledge previous studies that highlighted the necessity for the introduction of the dusty marine type.

Response: As noted in Kim et al. (2018), we have added three previous studies that demonstrate the mixing of dust and marine aerosol in the Atlantic Ocean. We have also included a sentence concerning the Burton et al. (2013) study that reports HSRL lidar ratio measurements more indicative of dust and marine aerosol than dust and smoke aerosol for CALIPSO V3 "polluted dust" aerosol layers.

The modified sentences are included in the revised manuscript as follows:

"This type was added to account for mixtures of marine and dust aerosol occurring over the oceans, especially Saharan dust during transport across the Atlantic Ocean (e.g., Liu et al., 2008; Groß et al., 2016; Kuciauskas et al., 2018). In V3, these features would typically be classified (incorrectly) as polluted dust, as airborne HSRL measurements of S_a for CALIPSO "polluted dust" aerosol layers (~35 sr) suggest a mixture of dust and marine as opposed to that of dust and smoke (Burton et al., 2013)."

Section 2.1: While I really appreciate the fact that the authors provide the filenames of the products that they've used, I find it slightly interruptive for reading. The data availability section contains the filename already. Same applies for sect. 4.3 and the names of the variables used.

Response: Thank you for this comment. We prefer to keep the product filenames in these sentences as currently written, as they clearly provide the reader the details of which datasets were used in our analyses.

Line 322: Please cite the available software properly.

Response: We have added a "Code Availability" section and cited collopak as follows:

"The Collopak toolkit for collocating satellite observations is distributed by the Space Science and Engineering Center at the University of Wisconsin – Madison and publicly available at https://www.ssec.wisc.edu/~gregq/collopak/."

Lines 328-330: Why is the lidar ratio allowed to vary to physically meaningless values, i.e., -50 sr? Aren't the retrievals stable for a range 0 to 150 sr? Could the authors also provide references for the sensitivity studies that they mention?

Response: Yes, the retrievals were stable for the 0 to 150 sr range, but we chose -50 to 150 sr instead as the range for the Fernald iterations because we wanted to capture a wide spectrum of lidar ratios and examine the impact it had on the constrained retrievals. Our approach is similar to using a bisection method which establishes an initial zero crossing interval by choosing initial values of $S_a = -50$ sr and $S_a = 150$ sr. To emphasize what is stated in the paper, note that a very small (~0.05%) number of resultant lidar ratio retrievals were negative (and we use median values for our maps), thus the negative lidar ratios have a negligible impact on our results. Also, there are no references for the sensitivity studies we mentioned, as these were internal analyses we conducted as part of the work for this paper. We have modified the sentence in question to the following:

"S_a are allowed to vary over a range from –50 sr to 150 sr to capture a wide spectrum of S_a and because the iterations for the Fernald retrieval were numerically stable for this range (determined through sensitivity studies)."

Line 340: Please explain the quality flags selected for the MODIS data. A reader might not know what a Land Ocean Quality Flag value greater or equal to 1 means.

Response: The Land Ocean Quality Flag is interpreted as follows: 0=bad retrieval, 1=marginal, 2=good, and 3=very good. We have rewritten that sentence in the manuscript as follows:

"To ensure high quality Ångström interpolations we required positive values for all four MODIS AODs and rejected those cases flagged as "bad retrievals" by MODIS's Land Ocean Quality Flag."

Lines 361-368: It is not clear why the additional filtering step was used. Please explain and also summarize in 1-2 sentences the main points of Li et al., 2022 regarding the SNR/classification confidence relationship.

Response: This filtering step was used to increase the confidence of the CALIOP aerosol classification, which is important for this study because of our focus on CALIOP-classified marine aerosols. Li et al. (2022) partitioned their CALIPSO-SODA lidar ratios as a function of horizontal averaging and pointed out challenges in CALIOP aerosol typing at longer averages (i.e., 80 km) based on their results. For example, they state "Classification issues for 80 km averaged samples are likely, as spatial averaging are performed to increase the SNR for tenuous aerosol layers, rendering more uncertain retrievals than its 5 and 20 km counterparts." This helped motivate our study to limit the analysis to only those profiles in which at least part of the aerosol layer was detected at 5 km. We have modified the text in the revised manuscript.

Section 4.1: Some details regarding the GEOS GOCART model could have been included earlier in the methods section.

Response: Thank you to the reviewer for this suggestion, however we believe the paper flows better if we include the GOCART model description and methods in the discussion provided in Section 4.1.

Lines 488-489: Please rephrase, is "replacing" indeed the right word?

Response: We have changed "replacing" to "becoming more dominant than".

Line 496: "Eq." is missing before the parenthesis.

Response: Based on the Copernicus style guide, "Eq." should not be placed before the parentheses when defining the equation, but rather when referencing it in the text (as we do in a previous line).

Lines 526 and 535: How was the minimum of 50 points selected?

Response: This threshold was selected after conducting sensitivity studies to ensure a statistically robust characterization of the lidar ratio, while also accounting for satellite data coverage seasonally within each grid box over the study period. We have added this statement to the revised manuscript.

Line 553: The authors could discuss the meteorological conditions leading to the seasonal aerosol transport.

Response: For the sentence in question, we were referring to the Indian monsoon pattern, and the associated prevailing seasonal wind patterns and aerosol transport. These topics are discussed more thoroughly in the Bay of Bengal and Arabian Sea case study of Section 4.4. We have modified the sentence to the following: "These patterns are indicative of seasonal aerosol transport based on the global atmospheric circulation simulated by the GOCART model, including the Indian monsoon (as discussed in more detail in Sect. 4.4)."

Lines 600-606: Could you please elaborate more on the additional procedures, especially on the second one? The minimum lidar ratio of 15 sr is justified from the field measurements. What drove you into implementing the outlier replacement procedure? Where there many outliers and could you please include a statement regarding that?

Response: The outlier replacement procedure was implemented to address some significant discontinuities observed in earlier test versions of the lidar ratio maps. However, there were not many of these cases. For DJF, MAM, and SON, outlier values consisted for ~1% for all grid boxes over water. For JJA, the frequency increased to ~2%. This is discussed further in the paper during the narrative concerning the lidar ratio method flag maps (Fig. 12). We have added the following statement to the revised manuscript:

"This was done to address some significant discontinuities observed in earlier test versions of the S_a maps. However, they only accounted for ~1-2% of all grid boxes over water (Fig. 12)."

Lines 618-619: The reported maximum lidar ratios are clearly influenced by non-marine aerosol and they should be discussed together with the SSVF.

Response: The maximum value for MAM was mistakenly provided as 57 sr but the correct value is 56 sr. It is a model-assisted value in the Bohai Sea (near China), corresponding to a SSVF of 3.5%. The maximum value for JJA is modeled as 57 sr, located in the Caspian Sea (Middle East) and corresponds to a SSVF of 2.5%. The maximum values for SON and DJF are retrievals near the coast in the northern Bay of Bengal and thus are not influenced by modeled SSVF. We have added this discussion to the revised manuscript.

Lines 626-629 and Fig. 11: A lot of pixels flagged as "Retrieval" in Fig. 12 are accompanied by the maximum assigned uncertainty of 22% (e.g., South Atlantic and Pacific during SON). Could you please provide a statement with the typical range of the uncertainty (before the assignment of 22%) for the pixels with the assigned 22% uncertainty?

Response: The reasoning for our use of a maximum assigned uncertainty of 22% is maintaining heritage with the CALIPSO Version 4 products (Kim et al., 2018) and operational expediency due to the ending of the CALIPSO satellite mission. We have added the following statement to the manuscript to address the typical range of uncertainty for the grid cells in question:

"Note that for those grid cells with retrievals and an assigned uncertainty of 22%, the uncertainty median ± uncertainty MAD prior to assignment is 25% ± 2% (DJF and MAM) and 26% ± 2% (JJA and SON)."

Lines 690-695: How and why were the study regions defined as such? It should be stated that by this selection regions with e.g., modelled-only lidar ratios, high SSVF-low lidar ratios etc. were covered.

Response: The study regions were chosen to capture different model scenarios (e.g., coastal versus open oceans) and different derived lidar ratio regimes (e.g., model-assisted vs. retrieval). The following sentence was added to the paper to reflect this:

"These regions were selected specifically to capture different aerosol model scenarios, including coastal (typically low SSVF, thus higher S_a) and open oceans (typically high SSVF, thus lower S_a), and various derived-S_a regimes in general (e.g., model versus retrieval)."

Lines 746-747: For clarity, please point out again that these results correspond to 2015.

Response: We have made this change as suggested.

References:

Ansmann, A., Wagner, F., Althausen, D., Müller, D., Herber, A., & Wandinger, U. (2001). European pollution outbreaks during ACE 2: Lofted aerosol plumes observed with Raman lidar at the Portuguese coast. *Journal of Geophysical Research: Atmospheres*, *106*(D18), 20725-20733, https://doi.org/10.1029/2000JD000091.

Burton, S. P., Ferrare, R. A., Vaughan, M. A., Omar, A. H., Rogers, R. R., Hostetler, C. A., and Hair, J. W.: Aerosol classification from airborne HSRL and comparisons with the CALIPSO vertical feature mask, Atmos. Meas. Tech., 6, 1397–1412, https://doi.org/10.5194/amt-6-1397-2013, 2013.

Dawson, K. W., Meskhidze, N., Josset, D., & Gassó, S. (2015). Spaceborne observations of the lidar ratio of marine aerosols. *Atmospheric Chemistry and Physics*, *15*(6), 3241-3255, https://doi.org/10.5194/acp-15-3241-2015.

Groß, S., Gasteiger, J., Freudenthaler, V., Müller, T., Sauer, D., Toledano, C., & Ansmann, A. (2016). Saharan dust contribution to the Caribbean summertime boundary layer–a lidar study during SALTRACE. *Atmospheric Chemistry and Physics*, *16*(18), 11535-11546, https://doi.org/10.5194/acp-16-11535-2016.

Kim, M. H., Omar, A. H., Tackett, J. L., Vaughan, M. A., Winker, D. M., Trepte, C. R., ... & Magill, B. E. (2018). The CALIPSO version 4 automated aerosol classification and lidar ratio selection algorithm. *Atmospheric measurement techniques*, *11*(11), 6107-6135, https://doi.org/10.5194/amt-11-6107-2018.

Kuciauskas, A. P., Xian, P., Hyer, E. J., Oyola, M. I., & Campbell, J. R. (2018). Supporting weather forecasters in predicting and monitoring Saharan air layer dust events as they impact the greater Caribbean. *Bulletin of the American Meteorological Society*, *99*(2), 259-268, https://doi.org/10.1175/BAMS-D-16-0212.1.

Li, Z., Painemal, D., Schuster, G., Clayton, M., Ferrare, R., Vaughan, M., ... & Trepte, C. (2022). Assessment of tropospheric CALIPSO Version 4.2 aerosol types over the ocean using independent CALIPSO–SODA lidar ratios. *Atmospheric Measurement Techniques*, *15*(9), 2745-2766, https://doi.org/10.5194/amt-15-2745-2022.

Liu, Z., Omar, A., Vaughan, M., Hair, J., Kittaka, C., Hu, Y., ... & Pierce, R. (2008). CALIPSO lidar observations of the optical properties of Saharan dust: A case study of long-range transport. *Journal of Geophysical Research: Atmospheres*, *113*(D7), https://doi.org/10.1029/2007JD008878.

Oo, M., & Holz, R. (2011). Improving the CALIOP aerosol optical depth using combined MODIS-CALIOP observations and CALIOP integrated attenuated total color ratio. *Journal of Geophysical Research: Atmospheres*, *116*(D14), https://doi.org/10.1029/2010JD014894.

Rogers, R. R., Vaughan, M. A., Hostetler, C. A., Burton, S. P., Ferrare, R. A., Young, S. A., ... & Winker, D. M. (2014). Looking through the haze: evaluating the CALIPSO level 2 aerosol optical depth using airborne high spectral resolution lidar data. *Atmospheric Measurement Techniques*, *7*(12), 4317-4340, https://doi.org/10.5194/amt-7-4317-2014.

Welton, E. J., Voss, K. J., Quinn, P. K., Flatau, P. J., Markowicz, K., Campbell, J. R., ... & Johnson, J. E. (2002). Measurements of aerosol vertical profiles and optical properties during INDOEX 1999 using micropulse lidars. *Journal of Geophysical Research: Atmospheres*, *107*(D19), INX2-18, https://doi.org/10.1029/2000JD000038.