

[Editor comments are in italics]

Dear Editor,

Thank you for your comments on the revised version of the manuscript. We have addressed these comments and the changes made are outlined below.

General issues

Throughout the manuscript, there are issues with implicitly or explicitly interpreting correlation as causation, without considering or discussing confounding factors, for example (line numbers refer to the tracked manuscript version):

Response: Thank you for this comment. We understand that there are several places throughout the manuscript where the implications of the text were unclear. To rectify this, we have made several edits to the manuscript that are outlined below.

- *Line 12: “A case study of two developing AEWs highlights a difference in heating rate on the order of 1 to 2 K/day between an AEW developing into a Category 4 Hurricane (Fiona) and a short-lived tropical storm (TS Hermine).”*

Response: To avoid any allusion to a correlation, this sentence in the abstract was changed to “Differences in heating rates were analyzed in a case study of two developing AEWs, one leading to a Category 4 Hurricane (Fiona) and another leading to a short-lived tropical storm (TS Hermine).”

- *Line 50: “Given that they share similarities in seasonality and geographical extent, the AEWs and Saharan dust are consequently coupled to influence each other.”*

Response: This statement was meant to reference results from previous research which was cited later in the paragraph. The text in this paragraph was rearranged to make the connection to the relevant literature more evident, with the citations immediately following the statements.

- *Line 479: “Over the ocean, dust tends to reduce specific humidity in the lower troposphere, particularly in regions with high aerosol loading, while simultaneously augmenting midlevel moisture levels.” No physical mechanisms to explain this are discussed.*

Response: A publication (Sun and Zhao, 2020) was cited further down. The text was rewritten to make this citation more evident, and some of the wording in this paragraph was changed to make the conclusions from this statement less ambiguous. We state that while the analysis done here does not allow us to make a conclusion on the impacts of dust on AEW development, “the large differences in heating at the lower levels of the atmosphere between the two cases raise the question of the impact of dust-induced radiative heating on AEW development.”

The manuscript makes strong statements about “truth” without explicitly and quantitatively considering uncertainties:

- *Although the analysis of heating rates heavily relies on the conversion of backscatter to extinction (depending on size, refractive indices and morphology) and the conversion of these extinction profiles through assumed radiative properties and size (using OPAC) to aerosol radiative properties provided to the radiative transfer model, the resulting uncertainties are not quantitatively discussed. With lidar ratios being under-constrained and OPAC being well-outdated (there exist much better databases on refractive indices these days), this leaves the question how these uncertainties propagate into the calculated heating rate profiles.*

Response:

Thank you for this very relevant comment. We acknowledge that there are more advanced aerosol climatologies available today compared to OPAC. However, OPAC remains widely used in most NWP models which is why it was chosen for this study. The choice was made to ensure consistency with the models that are most commonly used in the community and also both of the reanalysis used in this study also use it. We recognize and share the concerns you bring in here, for example the potential overestimation of single scattering albedo in transported dust in OPAC, and this has been a topic of multiple discussions throughout the course of this experiment. While these issues are important, they are beyond the scope of what we are trying to accomplish in this study.

Regarding the uncertainties associated with the conversion of backscatter to extinction and the use of assumed radiative properties and sizes from OPAC, it is important to note that these conversions are performed by the science team responsible for the data and are included in the dataset as they are. As users, we have assumed that these conversions are correct and have been done to the best possible knowledge of the science team. However, we recognize that these assumptions may introduce uncertainties, particularly in how they might propagate into the calculated heating rate profiles. Previous studies have highlighted similar uncertainties. For example, Dubovik

et al. (2002) examine the influence of particle nonsphericity on the retrieval of aerosol optical properties, while Kahn et al. (2005) discuss the uncertainties in aerosol models derived from satellite data. Additionally, Levy et al. (2010) address the challenges in retrieving accurate aerosol optical properties and their implications for climate models. These studies suggest that the propagation of such uncertainties can significantly affect the accuracy of radiative transfer models.

- *It is therefore not clear how to interpret the presented differences between observationally derived heating rates (referred to as “truth”) and reanalyses – do they lie within or without the error bars for derived heating rates?*

Response: In response to your concerns, we have made some edits to the wording in Section 3 and have added lines in Section 2.6.1 OPAC to address these issues. The word “truth” was replaced with “observation” or “observational data” in Section 3.2 Impact of aerosol on heating rates and in Section 3.3 Dataset comparison, and a paragraph on the limitations of OPAC was added to the conclusions. While a detailed quantitative analysis of these uncertainties was beyond the scope of this paper, we acknowledge their significance and suggest this as an important area for future research. In future studies, incorporating more recent databases on refractive indices and considering the implications of under-constrained lidar ratios could provide a more refined analysis.

Specific issues:

- *Title: consider adding “the” ahead of AEW Development Region”*

Response: The title was changed accordingly.

- *Fig. 1: “Image” is not reproducible for an imager with many channels.*

Response: The word “image” was removed from the figure caption.

- *Line 165: AEW and storms are related but seem to be used here interchangeably. This requires an appropriate definition of terminology and consistent use throughout.*

Response: We appreciate this comment and agree that the distinction needs to be made clearer. In Section 2.4 AEW Tracking, the word storm was changed to AEW. In Section 3.1 Description of AEW events during CPEX-CV, the word storm was qualified to clarify whether it was referring to an AEW or a tropical storm. In Section 3.5 Case study: Hurricane Fiona and TS Hermine, the word “storm” is replaced in several

locations depending on what it is referring to with: “AEW (and the TC it develops into)”, “AEW/TC”, “development of the AEW” and “TS”, and removed completely in one case. In *Section 4 Conclusion*, the word storm was changed to “TS” in one case and to “development of the AEW” in another.

- *Line 296: This statement is confusing. HALO is flown on CPEX-CV and shows the variability. Presumably you mean something different here?*

Response: This typo was changed from “CPEX-CV” to “CAMS”.

Other changes made:

Typos were corrected throughout the text. Some repetitions in the methods section were removed. Minor edits were also made for clarity.