Dear reviewer,

We would like to thank you for carefully reading the manuscript and providing useful feedback to improve the paper. In the following, we address the major comments (shown in grey) point by point, with our response formatted in black. Text additions or alterations to the manuscript are shown in blue.

▷ Although such information might be available in the publications referenced, the authors should provide a comment, how they define from the measurement conditions an aerosol type as pure. Do they consider only the location of the site or they use also other tools such as trajectories or models?

Thank you for pointing out the need for further clarification. When we refer to pure aerosol types, we refer to the observation of single aerosol types such as marine, smoke, pollution, or dust. Therefore, an aerosol mixture can never be considered as a pure aerosol type.

Even though primarily the optical properties are the major criterion for typing, several parameters are taken into account when it comes to aerosol characterization, including the meteorology (backward trajectories), location and altitude of the aerosol plume, advection, connection with e.g., a big event such as a volcanic eruption or wildfires, etc.

We have included a new statement in the revised version of the manuscript (now lines 226-232): "Along with the determination of the intensive optical properties, which play a crucial role in the categorization of the observed particles, other tools such as e.g., backtrajectories are also widely considered. Trajectory and particle dispersion models (e.g., HYSPLIT, FLEXPART; Stein et al., 2015; Pisso et al., 2019) provide valuable information about the source, the distance traveled and the destination of an air-mass for a specific transport time (simulation performed either backward or forward in time). Recently, an automated air-mass source attribution tool, which combines backward trajectories (or particle positions from a dispersion model) with geographical information (land cover classification), TRACE (Radenz et al., 2021b), was developed at TROPOS."

▷ Do the authors consider the ageing of the observed aerosols as a parameter for the typing (this was found in previous studies to be crucial especially for smoke)? A relevant comment should be added in the discussion.

This is a very good point. In the current version of DeLiAn we do not consider further classification based on the aging of the aerosol. For instance, the broader smoke category includes both measurements from fresh and aged smoke. However, we have revised the "Smoke" paragraph carefully and now it provides more information with respect to the age of the smoke particles (see now lines 395-417).

▷ It is confusing, as written, how the authors distinguish "pollution" type and "central European background". More or less for both categories they use measurements from the same stations. They should provide a comment, why in certain cases they consider an observation as representative for pollution and why as background.

Thank you for your comment. Indeed, the "Pollution" and "Central European background" aerosol categories are optically similar and the measurements "share" stations. For instance, in Leipzig, we observed both aerosol types. However, a measurement is considered as representative for Central European background when the following criteria are met: station located in the indicated geographical location, no advection takes place and the aerosol layers must be confined to the

planetary boundary layer and exhibit an aerosol optical thickness of less than 0.2. For clarity, we have updated the text "Central European background" category (now in lines 476-480): "An aerosol layer must follow certain criteria to be categorized as Central European background aerosol, which include the absence of advection of aerosol, the confinement of the particles within the planetary boundary layer and an optical thickness of less than 0.2. In this way, both Central European background and Pollution categories can be separated, even though they both contain mainly aerosol of anthropogenic origin."

▷ The authors group separately mixtures of different aerosol types, especially dust with smoke, dust with pollution and dust with marine. They should provide more details how they define an aerosol scene as a mixture. To my understanding they average all relevant scenes in order to provide a representative value for a certain mixture. Does the mixing ratio of the pure types involved play a role in the typing and do the authors claim that this ratio is not significantly different from location to location?

Thank you for bringing this up. Indeed, lofted layers carrying desert dust are subject to long-range transport and, therefore, mixtures of dust with other aerosol types are dominating.

An aerosol layer is considered a mixture first and foremost based on the intensive optical properties and the information known from the literature. However, this is not the only source of information that helps the correct assignment of an observation to an aerosol type. Tools such as trajectory and aerosol dispersion models are very effective in the correct characterization of the observed particles as they provide information of the source, altitude and distance that an air mass travelled prior to the observation. For clarity, we have updated the manuscript (now in lines 485-488): "Apart from pure aerosol types, aerosol mixtures of dust particles with smoke, pollution and marine particles have been considered in DeLiAn. The determination of the main aerosol types present in an aerosol mixture (performed by the authors of the respective studies) was based on combined information on the intensive optical properties of the aerosol layers and air-mass analysis with the help of trajectory or particle dispersion modelling." With respect to DeLiAn, indeed, we average all the available known mixtures to provide representative values for the intensive properties (Table 1). The individual observations are visualized in Figures 2 and 3 and the data collection is publicly available via Zenodo (https://doi.org/10.5281/zenodo.7751752). The mixing ratio of the pure types, especially the dust contribution, plays a role in the observed aerosol properties. For instance, dust and marine mixtures with higher contributions of dust exhibit significantly higher values of particle linear depolarization ratio compared to those with lower dust contributions (note the wide spread of the dust and marine category in Figures 2 and 3), regardless of the observation location. This effect is also nicely visualized in Figure 7 of Wandinger et al., 2022, in EGUsphere (https://doi.org/10.5194/egusphere-2022-1241), where an aerosol microphysical model is being described based on the DeLiAn observations.

In addition to the comments addressed, we would like to inform you about the following changes in the manuscript:

- New section 2.1 now describes the intensive optical properties
- Section 2.2.3: parts of the description have been updated and others omitted for clarity
- Figure 1: updated background Earth map
- The name of Cabo Verde has been corrected (was Cape Verde)
- Figures A1 and A2 have been reworked to increase readability
- Data availability statement