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Is aerosol optical depth a good metric to map dust properties? Lessons learned from AER-D

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The main observable quantity used on a global scale to map aerosols is aerosol optical depth (AOD), from ground-based and satellite remote sensing. It is at the same time an optical property and a vertically integrated quantity, and it is commonly used as the main metric towards which to pull aerosol models, through data assimilation, verification, and tuning. Here we introduce a few reflections on how to better constrain our knowledge of the Saharan Air Layer and its associated mineral dust, following results from the AER-D campaign.

AER-D was a small field experiment in the Eastern Atlantic during August 2015, based on the opportunity given by the simultaneous ICE-D experiment. The purpose of AER-D was to investigate the physical properties of the Saharan Air Layer, and to assess and validate remote sensing and modelling products. The FAAM atmospheric research aircraft was used as a flying laboratory, and it carried a full set of instruments aimed at both in-situ sampling and remote sensing.

A broad distribution of particle sizes was consistently observed, with a significant giant mode up to 80 µm, generally larger than what was observed in previous experiments: we ascribe this to the set of instruments used, able to capture the full spectrum. We will discuss the representation of the particle size in operational models, and we will show that despite predicting an extinction coefficient of the correct order of magnitude, the particle size is generally underestimated. We will also discuss the implication of the giant particles for the ground-based remote sensing of columnar size-distributions from the SKYNET and AERONET networks (Sunphotometer Airborne Validation Experiment, which was a component of AER-D).

We will present the vertical structure of the Saharan Air Layer, and in particular one episode when the structure was very different than the one generally accepted in the conceptual model. Moreover, the comparison with the operational models showed that they can predict a correct aerosol optical depth (AOD, a vertically integrated quantity) despite missing the vertical distribution.

These findings lead to a series of reflections on how to better constrain our knowledge of the Saharan Air Layer and its representation in operational models. Size-resolved properties and the vertical distribution are essential companions of the global AOD observations commonly used

operationally. We will also discuss objectives and ideas for future field experiments.