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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Vertical profiles of optical and microphysical particle properties above the northern Indian Ocean during CARDEX 2012" *by* F. Höpner et al.

Anonymous Referee #3

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GENERAL REMARKS

The manuscript presents new and important results from an analysis of aerosol optical and microphysical properties over the Indian Ocean. The study combines ground-based in situ data, micro-pulse lidar observations and data from unmanned aerial vehicles (UAV) to construct vertical profiles of particle number concentration, aerosol light extinction, aerosol light absorption and equivalent black carbon (EBC). Back-trajectories are used to classify air mass origins. The key effort of the manuscript is to construct vertical profiles of the aerosol light absorption coefficient and then of EBC mass concentration. Both pieces of information provide valuable information to

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the scientific community which makes the manuscript highly relevant.

The topic is well suited for publication in ACP and the study is well conducted and scientifically sound. However, the presentation of the material may benefit from restructuring, and the key assumptions used for converting lidar backscatter profiles into light absorption profiles and finally into EBC mass concentration profiles require more careful elaboration and discussion of assumptions and resulting uncertainties; see specific comments below for details. In summary the manuscript is acceptable for publication in ACP after minor revisions have been considered.

SPECIFIC COMMENTS

1| Single-scattering albedo (SSA) profiles: Profiles of the SSA have been constructed from few UAV-borne measurement of aerosol light absorption, and profiles of aerosol scattering coefficients calculated form measured size distributions and Mie theory. Measured relative humidity was then used to convert the calculated dry values to values at ambient conditions. This approach contains a number of assumptions and potential sources of uncertainties which require further explanation or examination. This concern in particular:

(1) uncertainties of the measured light absorption by the Aethalometer (how was it corrected for scattering, filter loading etc.?),

(2) uncertainties in the calculated scattering coefficient (What is the error when using PSL refractive index for size distribution inversion? How variable is the humidity growth factor and the resulting hygroscopic enhancement of the scattering coefficient when probing air masses of different origins and this aerosol chemical composition?), and

(3) uncertainties in the vertical profiles of considered properties when inferring them from the lidar measurements and few collocated measurements by the UAV (Which lidar ratios have been applied for the different aerosol types?). In general, the entire method is reasonable, but the single steps require detailed discussion of assumptions

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and uncertainties.

2| Evaluation of absorption profiles: The construction and evaluation of absorption profiles inferred from lidar measurements is based on collocated UAV measurements (see comment above) combined with calculating light absorption coefficients from particle number concentrations. The correlation used here is derived from surface measurements. However, it is well known that aerosol in the free troposphere is decoupled from the surface. Thus this step requires an in-depth discussion of the approach and of related uncertainties. In particular, statement is expected whether or not the proposed methodology for constructing vertical profiles of absorption coefficients have worked. Looking at Fig. 8 a discussion of statistical significance of the regression analyses is required.

3| The determination of mass absorption efficiency requires a detailed analysis of systematic errors. In the presented approach the MAE values have been determined against NIOSH as the thermal-optical reference method for EC determination. Hover, IMPROVE and EUSAAR2 protocols are widely agreed for determining EC from filter samples, which differ significantly from NIOSH. The presented MAE values have to be discussed in this context. What MAE values could be expected when applying other thermal protocols than NIOSH?

4| Presentation of results In its abstract, the manuscript promises vertical profiles of aerosol optical properties over the Indian Ocean for different air masses or aerosol types, respectively. Although the material is all available the presentation of the results makes it difficult for the reader to extract the key pieces of information and to assess respective assumptions and uncertainties. The following structure for the results section starts with the methodological part and finishes with air mass-specific results. This structure may improve the presentation of the material:

Section 3.1 Evaluation of vertical profiles, including in-depth discussion of uncertainties

Section 3.2 Absorption values and MAE

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Section 3.3 Air mass classification

Section 3.4 Aerosol optical properties for probed air mass types, including comparison to earlier observations

MINOR ISSUES

1| Please add instrument models to Table 1.

2| In Table 3, units of properties should be given.

3| In Fig. 3 harmonized color-coding should be used for all displayed data.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 3907, 2015.