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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A 3-D evaluation of the MACC reanalysis dust product over Europe, Northern Africa and Middle East using CALIOP/CALIPSO dust satellite observations" *by* Aristeidis K. Georgoulias et al.

Anonymous Referee #3

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General comments

This paper presents an evaluation of the MACC reanalysis dust product by using the pure dust LIVAS database constructed from the space-borne Lidar CALIOP/CALIPSO. Focusing on 3 regions, namely Europe, Northern Africa and Middle East, the evaluation covers both the columnar properties of dust (dust optical depth) and the vertical distribution of the natural aerosols (dust and sea salts) in 4 layers from 1200 m to 8400 m a.s.l. In the Introduction, the authors summarize the different effects of dust and highlight the needs in the dust production and transport forecasts. The second

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Discussion paper

section is dedicated to the presentation of the datasets (MACC reanalysis and LIVAS CALIOP/CALIPSO) and the methodology. The comparisons are performed with time and space colocated datasets on a monthly granularity. In order to limit the contribution of the sea salts in the natural profiles delivered by the model, the authors focus in 4 separated layers located above the altitude of 1.2 km. The results are presented in the section 3, starting with the columnar dust load. The spatial distribution of dust is well reproduced by the model that captures the major hot spots. Underestimated DODs are found in areas close to the dust sources associated with high dust loads (DOD>0.3), while DODs are overestimated elsewhere, which represent the majority of the cases. The correlation is much higher for cases where DOD<0.3. The seasonality is quite well reproduced by the model which reveals similar annual cycles with the observations in the different regions despite the important bias previously described. The resulting bias over the whole domain presents maximum values in late autumn around 0.03, and a minimum in summer, but still greater than zero. The evaluation of the profiles shows that the model overestimates systematically the extinction in the highest layer over the whole domain. This layer is also associated with a poor correlation. In respect with the columnar loads observations, overestimations are found far from the sources while extinction underestimation are found close to the dust sources. A large overestimation of the extinction in the lowest layer is found in the Atlantic region, due to the presence of sea salts above 1.2 km in the model. The absolute bias tends to decrease with the altitude. The monthly analysis of the profiles reveals similar patterns than for the columnar loads, with greater absolute biases located in the lowest layers.

The paper brings novelty in using original datasets for an extended period and over different regions. The vertical distribution is a key parameter for the aerosols modelling. Such a study, highlighting the differences with observations, is of help for improving the aerosols modelling. The scope, therefore innovative, is well-addressed. The paper is well written, the Figures of high quality, and the English is precise.

I recommend it for publication after the authors respond to the few points listed here-

after.

Specific comments/questions

Following, some specific comments: 3.1.1, p8: different hypothesis are given in order to explain the respective overestimation and underestimation of the dust load in the datasets in the different regions. First, the fraction of fine and coarse particles that could permit to the dust to be transported further from the sources if the dust are considered as too fine in the model. It might be interesting to compare these fractions of fine/coarse mode with some climatological value given by the AERONET retrievals at some key stations (even though this won't say how, in the column, varies this fraction). 3.1.1, p8: another hypothesis given by the authors is the limited sensitivity of CALIOP, as mentioned especially daytime, for detecting small amount of dust. Do you think that the statistics would be significantly different using only night-time Lidar data? 3.2.1: regarding the annual profiles, there is no mention about the associated uncertainty. Is it available from LIVAS product, and what is the confidence in the layer 4 observations (overestimation of the model) when one knows that CALIOP sensitivity is limited when the extinction is small?

Technical corrections

No major technical correction have been found: Figure 3: the three last letters of the subfigures j), k) and l) are missing Figure 6: Hide, similarly to Figure 8 (gray area), below 1.2 km of altitude as well? Or show in both, but this should be consistent Figure 6: The averaging time period should be mentioned in the legend

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