

***Interactive comment on* “Extreme dust storm over the eastern Mediterranean in September 2015: Lidar vertical profiling of desert dust at Limassol, Cyprus” by R.-E. Mamouri et al.**

Anonymous Referee #4

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This brief study presents lidar measurements acquired during an extreme dust storm which swept across the Middle East in September 2015. The lidar observations are high quality and are fascinating. I have no particular issues with the data processing etc... However, I think that the scientific content of the paper is weak. I do not recommend publication in ACP, for the reasons detailed below.

I believe the paper would be a better match for AMT.

General Comments

1. In particular, I am missing an analysis of the synoptic situation leading to the dust storm, and how this situation evolved and led to the demise of the dust storm as ob-

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served with MODIS and the lidar in Limassol. I am also missing a detailed analysis of the processes leading to the dust emission and transport, as well as the activated source regions. In several instances, the authors state that dust transport models failed to predict this record dust event, without giving precision on the models, their resolution, etc... An analysis of such processes would be extremely useful to understand why the transport models did fail, if they did.

2. I also find the interpretation of the HYSPLIT back trajectories to lack insightful analysis. The authors find them to be in contradiction with their dust observations, and ascribe the differences to erroneous meteorological fields provided by global scale models. This may well be the case but the main issue is that HYSPLIT cannot not deal with turbulence and transport in turbulent planetary boundary layers (PBLs). However, this is not verified in the present study and one wonders what is the worth of including these back trajectories in the analysis (?).

3. Emphasis is put in the abstract on the supposedly large AOD and mass concentration during the event. However, these values are not observed on 8 September (the day when the storm was most intense), and are only speculative, extrapolated from indirect measurements, or based on assumptions. They can be discussed in the text, but should not be emphasized that much in the Abstract and in the conclusion (where they are presented as results, see p5, l 28: “Dust AOT values of the order of 6-10 occurred over Cyprus [...]”). Furthermore, the very large AOD values (6-10) inferred on that day from pseudo-lidar measurements and yet MODIS retrievals on the same day are thought to be biased (p2, l30).

4. The 2-layer structure observed by lidar on 7 September suggests different emission source regions and transport regimes from Middle East, as is the case in other parts of the world, like the Sahara. This structure likely relates to differential advection and PBL dynamics over the emission regions. Knowledge of these processes would be extremely useful for a comprehensive analysis of the back trajectories.

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Minor comments

P1, l 14: where does the number 1000 $\mu\text{g m}^{-3}$ come from? P1, l 17: which models do you refer to? P1, l 24: imagery

P2, l20: [...] we in some parts so dense [...] P2, l 24-25: yet you show later on that dust plumes were observed by lidar above that height... Does this mean that the dust plume transported at higher altitude was less optically thick? P2, l 30: why are they biased?

P3, l 24-26: how do you know particles bigger than 10 μm are transported to Cyprus? Furthermore, what is the influence of marine aerosols on these measurements? Would not they influence the surface mass concentration measurements (Limasol is close to the sea)? P3, section 3.3: in this section, nothing is said about the high backscatter values observed in the lower layer (island or marine PBL?). Do not you expect dust to also be present in the lower layers as the result of entrainment at the top of the PBL? P3, l30: regarding the 2 layer structure: you do not have lidar data, but do you have met soundings to show the suggested layering?

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