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Interactive comment on “Dust–air pollution dynamics over the Eastern Mediterranean” by M. Abdelkader et al.

Anonymous Referee #2

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The manuscript attempts to pin down the importance of the chemical aging process of dust over the Eastern Mediterranean. Aging occurs when polluted air laden with acids (for ex: H₂SO₄, HNO₃, HCl...) encounters parcels containing dust. This is a well chosen topic relevant to ACP, but the way the authors treat the results significance does not establish the proof that aging is the main cause for the observed decrease in dust lifetime and loading. To convince the reader with the results from model, the authors would have to show that it mimics the atmosphere behavior. That includes two points that I could not find in the paper: 1/ Show that a majority from the air mass that encounters air pollution are aged. A number of factors relevant to this aging being omitted from the discussion (see below) 2/ That the hygroscopicity of the dust exposed to acids is well represented.

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Both points require a careful comparison with observations from either or both laboratory and field studies. Even when dust is exposed for a long duration to H₂SO₄ in the laboratory, it hardly becomes hygroscopic. I did not see a review of the work that has been done on this topic. Studies such as the one of Tobo et al. (2009) indicate that in the presence of H₂SO₄, dust gets hardly hydrated except if chloride is present. Another important limiting factor in the uptake of acids and hence in the aging of dust is its calcite content. Fairlie et al. (2010) have treated this limitation but no discussion is made of how this is considered in the present work. Since these factors are paramount to the effect studied here, much more effort should be put to assess whether the model is considering them adequately and this is missing from this work.

This being said the region of study and the cases chosen are very good choices to address the ageing of dust. There is an inference in this work that I did not see well documented. The authors are convinced that in polluted air masses dust grows hygroscopically very rapidly compared to an air mass with dust in the absence of pollution. The simple observations of changes in altitude of the dust layer cannot suffice to prove it. Other factors such as dynamical or thermodynamical can bring the dust layers to a lower altitude, so why claim that this is caused by aerosol growth?

Other minor points : In the abstract, the sentence: “Our results show the importance of chemical aging and deposition of the dust during transport.” Needs to be completed by saying for what aspect of dust is this chemical aging important.”

The following sentence p 7496, lines 11 to 13 : “ Since Cyprus lows are often associated with precipitation, the residence time of dust particles in the atmosphere can be relatively short (approximately one day).”, is vague and the estimation of the residence time is not substantiated.

Page 7496 lines 24-28 : “ Especially the interaction between dust and anthropogenic pollution from eastern and western Europe (Levin et al., 2005) in addition to intercontinental air pollution transports from North America and Asia (Lelieveld et al., 2002)

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deserves attention, being the focus of this study.”, needs to be reworked

Page 7497, lines 19 to 20 : the fraction of water on dust is very much debated, some authors argue that dust can seldomly uptake dust. You need to review the experimental and field evidence to backup this claim : “ The latter includes in- and below cloud scavenging, and depends on the chemical composition of the dust surface, which can include a large 20 fraction of water.” Page 7500, lines 7 to 11 : “ We consider the calcium cation (Ca²⁺) as a chemically reactive tracer on the dust, being emitted in the insoluble accumulation and insoluble coarse modes as a fraction of the dust emission flux (25 and 5% for the accumulation and coarse mode, 10 respectively).” These are critical numbers for this paper, the 25% in the accumulation mode is a very large number compared to the composition of dust observed, how was it chosen ? What are the measurements to back it up ?

Page 7508 lines 13 to 16: “ For this case, both the model and the CALIPSO results show that dust was removed during transport from the atmosphere by wet and dry deposition, since the height of 15 the dust plume decreases from about 4000m over the central Mediterranean on 21 September to about 2000m over the EM on 22 September.”. How do you infer directly from a change in height of a dust plume that deposition has occurred ?

Figure 12 is a consequence of the properties you imposed to aged dust in the model. What evidence do you have that for an air parcel with the same characteristics the size distribution is profoundly changed between a parcel that encounters pollution and one that does not?

You state page 7512 line 26 that aged dust proxy increases from 1 to 13. What measurements or other evidence back up this number?

Page 7513, line 25: you mention that dust is rapidly aged, please give a the time it takes for the model in hours/days to age dust with respect to the concentration(s) of acid(s) present and indicate what observations it can be compared to.

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References: Tobo, Y., D. Zhang, N. Nakata, M. Yamada, H. Ogata, K. Hara, and Y. Iwasaka (2009), Hygroscopic mineral dust particles as influenced by chlorine chemistry in the marine atmosphere, *Geophys. Res. Lett.*, 36, L05817, doi:10.1029/2008GL036883.

Fairlie, T. D., Jacob, D. J., Dibb, J. E., Alexander, B., Avery, M. A., van Donkelaar, A., and Zhang, L.: Impact of mineral dust on nitrate, sulfate, and ozone in transpacific Asian pollution plumes, *Atmos. Chem. Phys.*, 10, 3999-4012, doi:10.5194/acp-10-3999-2010, 2010.

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