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Atmospheric
Measurement
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Discussions

Interactive comment on "Enhancement of aerosol characterization using synergy of lidar and sun – photometer coincident observations: the GARRLiC algorithm" *by* A. Lopatin et al.

Anonymous Referee #1

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Review of paper:

Enhancement of aerosol characterization using synergy of lidar and sun-photometer coincident observations: the GARRLiC algorithm. by A.Lopatin et al.

Positives - photometer inversion ability to separate fine and coarse mode composition with added lidar data - well explained inversions method - very helpful demonstrations (sensitivity studies and test-cases) - honesty about the limitation

Concerns - efforts to analyze and comment on test cases including to inversions without lidar - more discussions to the use over std AeroCom inversions and outlook what we need to improve

General comments

The paper introduces a generalized algorithm to invert from simultaneous sun-/sky-photometer data and lidar data aerosol microphysical properties. With the addition of lidar data (which have been already deployed at many AERONET sites) not only the aerosol vertical distribution but also the compositional detail (e.g. refractive index and single scattering albedo) can be addressed separately for sub-micron and super-micron diameter aerosol particles. This extra aerosol detail is important for aerosol (satellite retrieval) validation and (global model) evaluation efforts. The capabilities of the new "GARRLiC" algorithm are demonstrated with synergetically prescribed scenarios and two observed aerosol events over Minsk, one smoke event and one dust event. The overall method and concept is nicely outlined. And since I am a potential data-user I prefer to focus on the presentation of the results, which also demonstrate differences to standard AERONET inversion products, when no extra lidar-data are available. I was very excited to hear that the coarse and fine mode compositional contributions can be distinguished with this new inversion only to learn later in the text that the sensitivity to the fine mode properties is rather limited, as "lidar measurements do not provide significant new info about refractive indices of the fine mode" (does this alternately mean that in case of the significant coarse mode the fine mode-mode can be alternately retrievals from [total] minus [coarse-mode]?). Aside from the sensitivity studies (where the figure(s) should be more clear, as to which investigated case(s) are displayed) also some real cases are investigated. There is a lot of material and comparison provided in almost 10 Figures and often inadequately "covered" in two sentences. Therefore I recommend to cut figures or add to explanations (I prefer the ladder). The paper (despite a few minor grammar /spelling issues – suggest careful re-reading) is well written (with a strong focus on describing the algorithm). The innovative new aspect is the (somewhat limited) capability to separate fine-mode composition from coarse mode composition via the lidar (-ratio) data, and in applications (sensitivity and cases) there should be a focus on that element. Otherwise this is a great contribution, especially as the number of co-located lidar and photometer sites are increasing and more detail on

aerosol below clouds are needed to understand aerosol-cloud interactions.

minor comments

2275 when introducing the 6 scenarios you may want to explicitly mention the associated fine and coarse AOD, since these are displayed in the plots

Fig 3/4 for uneven AOD contributions (by fine and coarse mode) underestimates for dust absorption are displayed and for lower fine-mode AOD overestimates for fine-mode absorption are displayed. These errors appear significant (as later also illustrated for associated SSA values) and I am not sure if the entire blame should go to the introduced noise.

2277 There are two major tendencies specifically mentioned, but based on what I see for the RFimag in Figures 3 and 4, this is not clear. I really would focus on RFimag, since mode absorption is the most interesting addition. It certainly is true that when AOD is low (as expected) error are larger, but for (larger) dust only when they are uneven.

2278 and Fig7 The retrieved vertical distribution is much better captured by the coarse mode than by the fine-mode. Is this related to available depolarization information by the lidar?

Fig 8 It is not quite clear that this figure relates to the orange case of the previous figures. Still I also wonder, what is the point of showing this graph? And why is the retrieved UV SSA profile so different?

2278 and Fig 9 the fine-mode lidar ratio shows relatively little RFimag dependence for the near-IR but there is some dependence for the VIS and especially the UV. Are there some other properties (e.g. involving the color ratio) considered that may help bring out more sensitivity?

2280 and Fig 10 what cases are these (brown and red with 0.8/0.2 and 0.2/0.8 for mode AODs) I assume the lidar ratios are derived from the retrieved size-distributions. . . so

I conclude that also the size-distribution data of the combined version will be more accurate (if so by how much?) . The results show that lidar ratios are much better for the minor mode . . . but is this also valid for small AOD cases?

Table 3 the three cases here are ‘olive’, ‘orange’ and ‘red’ (it is very confusing, what scenarios are displayed. This should be clear from locking at figure and not from detailed reading of the manuscript)

2282 and Fig 13 there are relatively more large aerosol sizes in the coarse mode. Is there any good explanation for the “size shift”? And from the explanation for the fine-mode difference in the dust case it is not quite clear, which of the two versions is considered more realistic since the GARRLiC sensitivities had problems for such case.

2282 and Fig 14 Why is the AERONET only absorption for the dust case smaller (and not in between)? And why is the coarse mode absorption for the smoke case basically zero – is this an artifact?

2283 and Fig 15/Fig16 Are there real profiles to compare with? And doesn’t a 3&2 RAMAN lidat provide lidar ratios at least at 355 and 532 nm, which could be displayed here? Is there any explanation for the high non-sphere contributions in the smoke event and the relatively low contributions in the dust case?

2283 and Fig 17 Why is the SSA now lower (absorption stronger) compared to AERONET?

2284 and Fig 21/Fig 22 In the end a comparison is given to results of the LiRIC algorithm, an already available sun-/sky photometer/lidar inversion method from the group in Belsk. Except for the different vertical resolution (or integration) the coarse and fine-mode profiles are quite similar. But is this plot needed? Similarly I wonder if Figure 22 is necessary?

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 2253, 2013.