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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Is there a bias in AERONET retrievals of aerosol light absorption at low AOD conditions?" *by* Elisabeth Andrews et al.

Anonymous Referee #2

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This paper deals with an important and challenging issue, certainly acceptable for ACPD. The authors argue that the aerosol absorption data most widely used in climate modeling is likely biased high at low AOD, based on coincident and climatological in situ data at two rural sites. I've included some notes below; in summary, there is a lot of good data presented here, but I think the estimates of uncertainty need to be tightened up in order to reach a strong conclusion. Also, evaluating AERONET SSA at AOD below the value they state as the lower limit of quality results is a key caveat, though I agree that the AERONET results are widely applied beyond their stated validity range. Note that this is actually my full review, so it can be considered as part of the formal review process rather than just as a "quick" review for ACPD posting.

Lines 73-79. This essentially makes the case for selection bias in the AERONET SSA and AAOD values by itself, though I don't think it negates the value of going further and

comparing with in situ observations. If the in situ data can show that in general, SSA is lower when AOD is higher, that could make a useful contribution to the argument.

Line 112. This is supported by the AERONET data themselves. AERONET does not offer global spatial coverage, but it does provide overwhelming evidence AOD_440 is generally <0.4 via direct-sun AOD measurements, which don't suffer from the uncertainties entailed in the model estimates.

Lines 242 to 258. As you know, in addition to collocation, the big challenges for this study are probably getting the total column data from the aircraft sampling right, and accounting for the difference between the properties of the ambient particle observed by AERONET and the dessicated ones measured in situ. Assuming that absorbing aerosol is hygrophobic seems a bit risky, especially for an SSA calculation, though this would be less of an issue for cases where the ambient RH is also low. (Do Lines 332-334 raise another question about getting SSA right?)

Ok. I see that you deal with these issues in Section 2.4.1. I'm thinking that the hygroscopicity issue might need a bit more consideration; there does not seem to be a conclusion about the uncertainty in SSA from the in situ observations, and it is not clear whether the general discussion derived from the literature is applicable to the aerosols observed over the AERONET sites in the current study. For the column AOD question, again the discussion does not seem to come to a real conclusion about the uncertainties. Having coincident lidar would help, and this might be available for at least some cases at one or both sites.

Section 2.4.2. There are other possible factors to consider here. For example, the AERONET retrievals report only one pair of (real, imaginary) refractive index values. If there are two or more modes in the column, this assumption will skew the result. You mention the possible surface reflectance contribution to the AERONET AOD uncertainty; there is a paper assessing this which might be worth considering (Sinyuk et al., Remote Sensing Environment 2007, doi:10.1016/j.rse.2006.07.022). Then there is

a question about whether the direct sun AOD measurements are used to obtain the extinction in the determination of aerosol absorption properties, or whether the scattering and extinction are both determined from the almucantar scan. In the latter case, the measurement uncertainty will be larger than 0.01 or 0.02, whereas in the former case, heterogeneity could affect the result, as the extinction and scattering data would be taken in different parts of the sky. Either way, the SSA result in most cases would be the small difference between two larger numbers, so accuracy could be an issue.

Lines 503-505. Perhaps the AOD comparisons address the total-column sampling question for the aircraft measurements, in addition to the uncertainty related to the hygroscopicity adjustment and possible large-particle under-sampling. Note that in general, a high correlation does not assure good quantitative values, as might be required for SSA assessment. So, quantitatively, how does this affect the uncertainty in subsequent SSA estimation?

Line 561. Again, it is not clear how much the measurement uncertainty contributes to the discrepancies between in situ and AERONET AAOD.

Line 567-568. Does this mean the in situ measurements are missing the extremes, either due to sampling, or to perhaps to conservative estimates of the hygroscopicity effect?

Lines 594-596. Right. But this does not address whether the underlying assumption that absorbing particles are non-hygroscopic is valid. If the absorbing species are OC rather than entirely BC, one might expect at least some hygroscipic growth is possible. And I think you concluded earlier that there must be something like OC, at least at one site.

Lines 614 to 617. Does this call into question whether the in situ measurements adequately sample the entire column observed by AERONET? I'm thinking Section 3.1.2 does not put to rest the question in the title of this section. So I'm uncertain whether you have established the conclusion stated in Lines 625-627, though I think AERONET

might overestimate absorption in many cases, due to the way they relate the measured extinction and scattering in order to derive absorption.

Lines 689-690. This might be stated differently, as it assumes no systematic underestimation of absorption for the in situ measurements.

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