Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2022-60

Anonymous Referee #3

Referee comment on "Employing relaxed smoothness constraints on imaginary part of refractive index in AERONET aerosol retrieval algorithm" by Alexander Sinyuk et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-60-RC2, 2022

General comments:
- This manuscript shows how much the quality of AERONET retrieval algorithm is enhanced with the usage of new relaxed smoothness constraints (REL). Anaysis looks reasonable in general. The history of treated topic and moviation of this study is well suggested in the introduction part. Theory chapter includes the explanations in detail, which looks helpful to the readers and researchers for the aerosol optical properties. So I think the publication of this manuscript will be very useful to the research community of aerosol optical properties. For the final publication, however, it seems that some revisions are needed related to the questions and comments provided as below.

Questions:
- What is the dominant aerosol component in Rexburg, Mongu, Mezaira, and GSFC, and how is it justified? Any supporting information to describe the air condition (particularly the aerosol composition) for selected cases. For example, readers do not know if BrC is really dominant for the cases treated in Fig. 1.
- Can we generalize the finding and lessons in this study based on this four sites only?
- Why this new REL only make some change for the BrC-dominated biomass burning (BB) aerosols, not the mineral dust and BC-dominated BB aerosols, which are other radiative absorbing aerosols?
- This new REL can help the retrieval of qualified SSA data in 340 nm channel?
- This new REL enable us to have SSA data more under the low AOD case; Usually the SSA analysis relates to the polluted case, at least AOD > 0.4 due to the uncertainty issue. It is curious to see if this REL can lower the uncertainty of SSA retrieval in less-polluted case. In other words, application of new REL is only helpful for the retrieval in the polluted condition (often related to the high AE because of the general contribution of find mode particle to the large air pollution), or it is also useful to improve the retrieval in the lower AOD case of polluted (urban) area where the brown carbon is dominant.

Minor and specific comments:
- Nowadays, there are so many AERONET stations and really long-term measurement data

have been accumulated. In this situation, it is curious if we really can apply the analysis result only based on a several cases to the general situation (only some days were selected for the analysis even in only 'four' sites). The analysis in this study looks qualified with reliable cases showing clear dominance of a target aerosol composition, which can be a representative example for the meaningful discussion for new REL impact under the certain situation. But still, it seem the limited discussion because now we have so abundant information of AERONET measurement for several hundreds of local stations. Thus, the statistical analysis using the large number of dataset will be more expected for the generalization of findings in this work. In my opinion, this manuscript can be a good paper as a case study to show the 'possibility' for the usage of new REL for better expression of BrC optical properties. But it may be better to prepare another manuscript for the 'generalization of finding in this study'. In the second manuscript, the statistical analysis looks much required.
- Abstract seems too long, so the key point of this study is not well transferred to readers. The word number in this abstract is > 800, which looks too much compared to the general criteria (~ 200 to 300 words. I do not know the limitation of word number in ACP/AMT).
- Some sentences are too long so it is not easy to read. It will be better to have shorter length of sentence, or to use punctuation marks properly (e.g., commas for splitting the phrases).
- Line 46-50: Two sentences are not connected well (First one mentioned DRAGON campaign, but second on mentioned the DISCOVER-AQ campaign. How to connect the story here?)
- Line 56-57: How to understand this sentence? (what is the relationship between the insigficant impact for the mineral dust and relatively small impact for the BC-dominated biomass burning aerosol?)
- Line 104-106: The reference or clues are required to raise this issue about the BrC. Now there is no surporting information associated with this statement, which looks very essential for the motivation of this study.
- Line 214: => For example,
- Line 242: BrC carbon => BrC
- Line 252-255: I am not sure if this kind of discussion is possible without any fire or humidity information in this case.
- Line 270-307: I am not sure the existence of BrC in GSFC, but It may be also possible to see high amount of BrC in the urban region in the urban region, and the BrC pattern (e.g., hygroscopic growth related to the extent of aging) can be regionally different: (e.g., Zhang et al., GRL, 2011, https://doi.org/10.1029/2011GL049385). It will be useful to see if there is difference of the BrC optical pattern between the biomass burning and urban area in the further study.
- Line 360-363: This manuscript does not have the chapter of 'data description' or 'methodology'. So there is no information of SSA from in-situ measurement in DRAGON-MD campaign. A short phrase to mention Schafer et al. (2014) may not be enough because the SSA estimation using in-situ measurement itself can make the large difference from the optically measured SSA (e.g, surface representative vs. column information). so at least several statements about the data/methodology of in-situ SSA calculation looks needed.