

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2021-805

Anonymous Referee #1

Referee comment on "Arctic spring and summertime aerosol optical depth baseline from long-term observations and model reanalyses – Part 1: Climatology and trend" by Peng Xian et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-805-RC2>, 2021

The paper entitled "Arctic spring and summertime aerosol optical depth baseline from long-term observations and model reanalyses, with implications for the impact of regional biomass burning processes" by Peng Xian and coauthors presents a comprehensive view on long-term measurements and modelling of aerosol optical depth (AOD) in the Arctic. They consider ground-based AERONET sun photometer measurements, observations by three spaceborne instruments, and results from three aerosol reanalyses as well as their composite to investigate (i) the consistency of the different data sets, (ii) the annual and seasonal variation as well as the long-term trend in AOD together with the importance of biomass-burning smoke, and (iii) statistics on the occurrence of extreme AOD events.

While the work is of interest to the readers of ACP, it is far too much material for one publication. This review is late, also because it is impossible to read the manuscript in one sitting. In fact, the content could be split in as much as three papers according to the list of topics provided above. Such an approach would lead to very good papers that could be much more reader-friendly than the current submission. This reviewer therefore recommends to reject the paper in its current form and to re-submit after a thorough revision of content and readability. Alternatively, the work requires major revisions, shortening, and a decision on which of the three topics to focus in this particular submission.

Please find some more specific comments below:

- The paper is rather lengthy and would benefit from trimming the text and content to what's really needed. A start would be a shorter title such as, e.g. to Arctic spring and summertime aerosol optical depth baseline from long-term observations and model reanalyses.

- Entire paragraphs could be omitted as they are repeating points made earlier or are just redundant, e.g. lines 24-31 (not needed in the Abstract), 141-148, 176-182, 299-303 (why mention if the statement end with "is not used here"),...

- The entire part about FLAMBE (description and results) could be omitted. In fact, the point made here could be condensed down to something along the lines of "findings are also supported by burning emissions from FLAMBE" later in the discussion.

- There are way too many figures for one publication. In addition, some information in these figures could be moved to the supplement to improve the discussion of the findings. For instance, the main figures could stick to the Multi-Reanalysis Consensus and their discussion could link to more detailed figures including the specific findings of the three models in the supplement. The authors should re-evaluate if a figure that isn't thoroughly discussed in the text is needed in the manuscript.

- The study makes use of height-resolved measurements from CALIOP and considers detailed aerosol re-analyses fields. The work would be even stronger if this information was to be used to also investigate the vertical distribution of Arctic aerosols. Such an attempt would partly compensate for the disadvantage of AOD to refer to column aerosol load.