"Artic 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 Xian et al. takes a multi-sensor/dataset approach to characterizing Arctic aerosols climatologically and their trends over the past almost two decades. These results are interpreted geographically, seasonally, as well as by aerosol species and instrument sensors.

In general, my recommendation to the editor is minor revisions for this publication. While I am not familiar with all the literature out there on Arctic aerosols, this study seems to be quite comprehensive, which provides value in characterizing Arctic aerosols from many different angles across the entire region. However, there were a few scientific and presentation matters that should be addressed prior to publication.

For the AERONET data, I wonder about how the availability of AERONET data plays out when using a 6-hour averaging interval. AERONET data is primarily a daytime measurement, therefore it is affected by the changing of daylight. For example, if there are more measurements closer to summer solstice because of daylight hours, does that impact the results? I am not sure how that would play out on the results here but see Appendix B of "The Diurnal Variation of the Aerosol Optical Depth at the ARM SGP Site" by Balmes et al. (2021, Earth and Space Science; doi.org/10.1029/2021EA001852) which showed that the changing of the season affected the diurnal cycle of AOD when considering AERONET measurements. Since AERONET is the basis for much of the comparison in this study, the averaging interval should be carefully considered to ensure the conclusions are not artifacts of data availability.

An additional scientific issue I wonder about is that the CALIOP data only considers AODs greater than zero. Do other studies do this with CALIOP data? While there are instrument sensitivity limitations that preclude detecting all aerosols, leaving out when AOD=0 will artificially increase the mean AOD to a value not actually observed by the instrument. It is well documented that CALIOP cannot detect all aerosols and clouds and several of studies are cited in this reference, however, perhaps it would be more representative of the data to also include figures and data if AOD=0 is considered for CALIOP. Another option is the Level 3 AOD product which attempts to overcome the sensitivity issue. This data product is mentioned in the discussion but perhaps more discussion or a supplementary figure showing the various CALIOP AOD results from different data products and thresholds would be more representative of the instrument and data products.

Below are minor comments I had and typos I found while reviewing:

Minor Comments:

The title is really long. Perhaps it should be shortened for brevity.

Lines 138-139: "We define the Arctic/high-Arctic as regions north of 60°N/70°N, and sub-Arctic as regions between 60°N-70°N." It took me a second read through to understand this correctly. Since it is a definition sentence, it seems worth it to make it two sentences or edit it for clarity.

Data section: there is quite a lot of data used in this section so it leaves the reader a little overwhelmed to read through as well as to reference later on in the paper. Perhaps a table listing all the data described would be a useful summary to reference?

Figure 1: "Warm colors represent fine mode and cool colors represent coarse mode." I think this should be more explicit to avoid confusion, e.g., "warm colors (red, orange, and pink) … cool colors (green and blue)"

Line 765: "(i.e. the square …" should have a comma after the i.e

Line 989-997 and throughout: I think "95% percentile mark" should be "95th percentile mark"? 95% percentile sounds redundant

Figure 16: I think there may be a typo in the caption as it says 12 September 2012 after August 5, 2021?

Line 1078: "black colors, respectively"

Line 1124: figures should be capitalized

Line 1134: Does the parenthesis starting "(e.g. …" go all the way to line 1139? I think this should be rewritten, very challenging to make sense of a 5 line parentheses

Line 1134 and 1143: should have a comma after e.g. I think this might be an issue throughout for i.e. and e.g. so check throughout the text