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Comment on acp-2021-562

Anonymous Referee #1

Referee comment on "Aerosol optical properties calculated from size distributions, filter samples and absorption photometer data at Dome C, Antarctica, and their relationships with seasonal cycles of sources" by Aki Virkkula et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-562-RC1, 2021

General comments:

Aerosol optical properties are one of the pivotal determinant to assess aerosol – climate interaction. Accordingly, a wealth of corresponding data from numerous worldwide observations are available. Notwithstanding, there persists a serious lack of such data from south polar latitudes, in particular from continental Antarctica. To remedy this deficiency, the authors provide the presently most comprehensive data set on aerosol optical properties, based on largely continuous measurements conducted at Dome C between 2006 and 2013. The results are discussed along with available measurements from South Pole Station and coastal Antarctic sites. Finally, a source assignment using FLEXPART back trajectory analyses completes the data evaluation. The presented results and conclusions are derived from an in-depth and sound data evaluation. All employed assumptions are identified clearly and conscientiously. I especially appreciate the rigorous and reproducible data evaluation methodology described in chapter 2!

In summary, the authors have accomplished a clear, well-organized and concise paper. From my point of view all parts, including figures and tables, are essential. The manuscript certainly addresses the scientific scope of ACP and I recommend a final publication after few minor revisions I specified below.

Specific comments:

- Chapter 2.3.1: I assume that your measurements refer to dry aerosol (rh < 40% inside the instruments), correct?
- Page 11, lines 7 – 13: To be honest, I do not understand the motivation of this approach. As you mention below, the difference between two consecutive time steps is not purely noise but also includes "true" variability. Maybe you unduly over-estimate the random noise by this procedure?
- Page 18, line 9: Please (generally) specify what type of regression is employed (ordinary least square, reduced major axis regression, York regression, …).
- Page 25, line 11: Is it realistic, assuming that all particles had a BC core? Is there a convincing reason?
- Chapter 3.4.2: High RD values over large areas above the southern East Pacific (west of South America) appears somewhat suspicious. From the meteorological point of view, I would have expected such enhanced RD east of South America, i.e. the western part of the South Atlantic.
- Chapter 3.4.4 and Figure 14a: I am particularly amazed about the long residence time of BC emissions in the troposphere before entering continental Antarctica (about 2 months!). Actually this would mean, that BC emissions from any continent of the southern hemisphere would be well stirred before arriving Antarctica. I agree that on average South America is the dominant source region. Nevertheless, this would mean that particular BC concentrations measured in continental Antarctica (derived from atmospheric or ice core data either) would not allow a meaningful source apportionment but merely represent southern hemispheric BC emissions as a whole.
- Figure 15: It is remarkable that concordant for all regions, meridional air mass transport (i.e. transport towards Antarctica) is by far most pronounced between June and October. Is there a link to the polar vortex?

Technical corrections:

- Page 2, line 30: Karpetchko et al. 2005 is absent in the "References".
- Page 14, line 25: Stohl et al., 2005 and Pisso et al., 2020 are absent in the "References".
- Page 31, line 18: s_{sp} (sigma(sp) is meant, not s_{sp} (sigma(ap).