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Comment on acp-2021-562

Anonymous Referee #2

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-RC2, 2021

Review comment on "Aerosol optical properties calculated from size distributions, filter samples and absorption photometer data at Dome C, Antarctica and their relationships between seasonal cycles of sources" by A. Virkkula et al.

This manuscript presents aerosol optical properties measured at inland Antarctic station, Dome C. Continuous measurements of aerosol optical properties through the year are limited in the Antarctic stations, especially in the inland (plateau) area. Thus, these results are very important and interesting to understand aerosol cycles and their impact on climate in the Antarctic. As a whole, the topic of the manuscript is relevant and suitable for the scope of the "Atmos. Chem. Phys.". Basically, this manuscript was well-written and discussed. However, there are several points which require careful revision before publication.

Major point

In this study, aerosol mass and scattering coefficient were estimated from aerosol number size distributions measured by SMPS and OPC. This approach is common. However, it must be notice that larger aerosol particles, e.g., coarse particles measured by OPC, can be segregated in the inlet and can be lost efficiently by impaction onto surface/wall of the tubes. Although number concentrations of coarse particles are generally lower than those in sub-micron particles, intensity of scattering light of coarse particles is much greater than that in sub-micron particles. The under-estimation of aerosol number concentrations in coarse modes can lead to mis-estimation of the aerosol properties in this study. Therefore, passing efficiency of aerosol particles into each instrument, particularly OPC, should be taken into account. Actually, authors attempted to discuss difference of scattering coefficient estimated from different procedures in many parts in the manuscript. Furthermore, single scattering albedo estimated in the present study seems be lower than that in previous works. If aerosol number size distributions were corrected using the passing efficiency, aerosol properties such as aerosol mass, absorption/scattering coefficient, and single scattering albedo are close to true values. I recommend that aerosol number concentrations are corrected using the passing efficiency, and then that the other aerosol properties such as scattering coefficient, mass, absorption coefficient, and single scattering albedo are re-estimated. All descriptions about these points are required to be modified based on results of re-estimations.

Minor points

Page 6 Line 12-15: Scattering coefficient was estimated using Mie-theory and aerosol number distributions. What is range of scattering angle to integrate light scattering of aerosols? In general, nephelometer does not integrate light scattering aerosols in a whole angle (0-360°).

Page 15 Section 2.7.1: To be honest, I do not follow estimation procedures in the equations (18 and 19), because procedures to obtain the values of "S" were unclear. Additionally, Hirdman et al. (2010) was not listed in the references. Please add short explanation and reference.

Page 19 Line 16-20: Scattering coefficient measured using nephelometer can be varied by relative humidity in the nephelometer. Because difference between ambient air temperature (i.e., outside) and temperature in the instrument is larger in the wintertime, sea-salt aerosols can be solid by efflorescence under lower relative humidity conditions.

The phase change can modify scattering coefficient. In general, solid particles with irregular shape have larger scattering coefficient than that of droplets. Therefore, this likelihood for the large difference of scattering coefficient in the winter should be discussed.

Page 24 Line 1: Fig. 11c? (not Fig. 11b?) Please check.

Page 24 Line 14-27: It is true that NPF is important process to supply aerosols into the atmosphere during summer in the Antarctic. But feBC variation is associated with seasonal variations of eBC source strength and transport strength in the Antarctic. Discussion of these issues are needed.

Page 26 Line 31 – Page 27 Line 3: Cloud and precipitation are very important for wet deposition of BC. Moreover, diamond dust occurs frequently in the Antarctic plateau. Although this phenomenon is limited lower troposphere, this may contribute greatly to BC deposition onto snow surface. Add short discussion and explanation.

Section 3.4.4: In this study, biomass burning is considered as main BC sources in the Antarctic and Southern hemisphere. Basically, I agree with this assumption. Considering economic activity in the countries of the Southern hemisphere, anthropogenic BC emission may be important. Add short discussion and explanation.

Page 29 Line 2-5: Was emission of sea-salt aerosols from sea-ice estimated in this study? If sea-salt aerosol emission was assumed only from open sea-surface, the estimated values are under-estimated strongly in the winter. Previous works presented that sea-salt aerosols were supplied from sea-ice surface (e.g., Frey et al., Atmos. Chem. Phys., 2019;

Hara et al., Environ. Sci. Process Impact, 2020). More careful discussion and explanation are need to be added.

Page 29 Line 13: What is time zone? UT? or LT?

Page 30 Line 2: Is it possible that secondary aerosols were present for one month in the upper troposphere of the Antarctic? More careful discussion is required. If available, add references.

Page 30 Line 5-7: Solar radiation shows maximum in December (i.e., summer solstice) in the Antarctic. It should notice that sea-ice extent shows minimum in February – March. In sea ice margin, bioactivity in the ocean is often active, just like blooms. Therefore, approach of sea ice margin with bioactivity (i.e., origins of aerosol precursors) in February – March may relate closely to variations of secondary aerosols such as sulfates and organics. This should be discussed in addition to discussion on NPF and growth.