General comments:

This is an important technical paper to accurately measure size-resolved BC mass and number concentrations in water samples including more non-BC particles (e.g., sea salt component). The authors investigated the impact of the sea salt on nebulization and rBC detection with SP2, by using an electrical conductivity (κ), to demonstrate that BC mass concentrations in water samples with more salinity are strongly affected by a SP2 mass detection efficiency. The paper is well organized and well written.

However, I have the following specific comments, minor comments, and technical corrections. Therefore, I recommend the major revision.

Specific comments:

1) Figure 2 and Table 1 are very interesting results. I am also interested in the bias of BC mass concentration in realistic surface snow samples (i.e., PASCAL snow samples). I suggest the investigation of the mass concentration of BC in the snow samples (μg/L) as a function of κ and NaCl concentration, like Figure 2. This evaluation is very useful to accurately estimate the snow surface albedo, especially on the sea ice. In addition, how about the BC mass size distributions aerosolized from PASCAL snow samples for salinity classes ?

2) Authors investigated that the sea salt affects the operation of the SP2, by using a FS suspension of 10 μg/L which values are representative of BC mass concentration in central Arctic Ocean snow (3-15μg/g), measured by an ISSW method (Doherty et al., 2010). However, the concentration values might be overestimated due to an interference from coexisting non-BC solid particles (Schwarz et al., 2012; Mori et al., 2019). Some studies have shown the lower BC mass concentrations in surface snow and rainwater in the Arctic and Antarctic regions (< 5.0 μg/L) by using a nebulizer-SP2 technique (Kinase et al., 2020; Marquetto et al., 2020; Mori et al., 2019, 2020; Sinha et al., 2018). Therefore, it is also better to evaluate the salt impact on the rBC mass quantification for the lower FS mass concentrations (e.g., 1μg/L and 5μg/L), although the high κ may cause the clogging of the SP2 aerosol jet.

3) Values of transport loss and efficiency are described in section 2.2 and 2.5.1, respectively. Although these values depend on microphysical properties (e.g., size, density, and shape) of aerosol particles, their transport pathway (e.g., length and thickness of the sampling line), and flow rate in the sampling lines, these detailed

calculations and assumptions are not shown in this manuscript. Please clarify how to estimate the transport loss or efficiency of the particles in the sampling line.

Minor comments and Technical corrections:

1) Abstract: This paper has evaluated the impact of sea salt, based on a measurement of an electrical conductivity (κ) in water samples, together with a nebulizer-SP2 technique. This point needs to be referred in the abstract.

2) Abstract L26: "We found strong correlations between both rBC mass concentration and rBC diameter with snow salinity".

rBC mass concentration → rBC number concentration ?

3) L77-79: Schwarz et al. (2012) and Mori et al. (2019) have also made a comparability with more traditional techniques (e.g. ISSW and TOT).

4) Table 1: I did not find the mass mixing ratio and geometric mean of the mass size distribution in this Table. In addition, some abbreviation parameters (e.g., M_{rBC}, GD_{rBC}, and GD_{p}) are not used in Table. Please add these parameters in this table. "number and mass sized distribution (GD_{rBC})" → "number and mass size distribution"

5) L118: Please add the measurement accuracy of the κ values. The accuracy depends on the temperature in sample water ? Please clarify.

6) L121: Did you measure κ in milliQ water? It is important to check that the κ value is much lower than that for snow samples.

7) L127-129: Please add a nebulizer extraction efficiency used in this study.

8) L140-141: Do you make multiple charge correction and diffusion correction for the measurement of total aerosol number concentration? These corrections strongly control the concentration. Please clarify.

9) L143: Please specify "Different chemical species".

10) L145-152: Repeating some of what was stated on section 2.5. I suggest that this

sentence is moved to section 2.5.

11) L147-149: “In general, the transport losses for both lines were negligible (<3%) for particles in the 30-1000 nm diameter range, while slightly higher losses (below 7%) were calculated for particles smaller than 30 nm.” Please add a reference.

12) Figure S1b and L203-204: Some studies suggested that sizes of BC particles in water sample increase by melt-refreezing cycles (Kinase et al., 2020). I think the different size distributions include this effect. Please clarify.

13) Figure S1 caption: “with the SMPS in the 14-680 nm diameter range nm” → “with the SMPS in the 14-680 nm diameter range”

14) L234: Figure number is different (Figure 4 → Figure 5)

15) L238: Figure number is different (Figure 5 → Figure 4)

16) Figure 4 caption: The figure caption does not explain the figure 4.

17) Figure 5 caption: The sentence related to a diameter is not needed.

18) L262-263: Please clarify the cause of the removal of solid salt obstruction.

19) L297-298: “varied 0.58 and 0.66” → “varied between 0.58 and 0.66” ?

20) Equation (1) and L313:

I think that the equation (1) is considered as the overall mass quantification efficiency of BC, if three efficiencies ($\varepsilon_{\mathrm{Neb}}$, $\varepsilon_{\mathrm{SP2}}$, and $\varepsilon_{\mathrm{Tm}}$) are independent of the size and the $\varepsilon_{\mathrm{SP2}}$ and $\varepsilon_{\mathrm{Tm}}$ are 100% within 70–1000 nm range. Please clarify.

21) L340, L413: NaCl density is different in L340 and L413. In addition, please add a reference.

22) L381-382: Is the relationship between changes in BC sizes and κ in FS samples similar to that for realistic PASCAL snow samples? Please add the mass concentration of BC and MMD in table 1.

23) L413-415: Mori et al. (2016) has estimated that the peak of the droplet size distribution, generated by the Marin-5 nebulizer, is 2-3 um, under condition of a gas flow rate of 1L/min and a liquid flow rate of 180 μL/min.

24) L417: from 59 nm at 50 μS cm^{-1} to 197 nm at 800 μS cm^{-1}
→ “from 47 nm at 50 μS cm^{-1} to 182 nm at 800 μS cm^{-1}”?

25) L421: Table S2 → Table S1

26) L427-430: Please add a new table showing the coating-rBC mass ratio, corresponding to table S1. This table is very useful to interpret the effect on the incandescence quenching.

27) Table 2: This table is not needed because the data have been already shown in Figure 6. In addition, this table is not referred in this manuscript.

References

1. Kinase, T., Adachi, K., Oshima, N., Goto-Azuma, K., Ogawa-Tsukagawa, Y., Kondo, Y., et al (2020). Concentrations and size distributions of black carbon in the surface snow of eastern Antarctica in 2011. Journal of Geophysical Research: Atmospheres, 125, e2019JD030737. https://doi.org/10.1029/2019JD030737

2. Marquetto, L., Kaspari, S., & Simões, J. C. (2020). Mass and number size distributions of rBC in snow and firn samples from Pine Island Glacier, West Antarctica. Earth and Space Science, 7, e2020EA001198. https://doi.org/10.1029/2020EA001198

3. Mori, T., Moteki, N., Ohata, S., Koike, M., Goto-Azuma, K., Miyazaki, Y., & Kondo, Y. (2016). Improved technique for measuring the size distribution of black carbon particles in liquid water. Aerosol Science and Technology, 50(3), 242–254. https://doi.org/10.1080/02786826.2016.1147644

4. Mori, T., Goto-Azuma, K., Kondo, Y., Ogawa-Tsukagawa, Y., Miura, K., Hirabayashi, M., et al. (2019). Black carbon and inorganic aerosols in Arctic snowpack. Journal of

Geophysical Research: Atmospheres, 124, 13,325–13,356. https://doi.org/10.1029/2019JD030623

5. Schwarz, J. P., Doherty, S. J., Li, F., Ruggiero, S. T., Tanner, C. E., Perring, A. E., et al. (2012). Assessing single particle soot photometer and integrating sphere/integrating sandwich spectrophotometer measurement techniques for quantifying black carbon concentration in snow. Atmospheric Measurement Techniques, 5(11), 2581–2592. https://doi.org/10.5194/amt-5-2581-2012

6. Sinha, P. R., Kondo, Y., Goto-Azuma, K., Tsukagawa, Y., Fukuda, K., Koike, M., et al. (2018). Seasonal progression of the deposition of black carbon by snowfall at Ny-Ålesund, Spitsbergen. Journal of Geophysical Research: Atmospheres, 123, 997–1016. https://doi.org/10.1002/2017JD028027