

Response to Referee 2

We thank Referee 2 for providing valuable suggestions that have improved the readability of our revised manuscript. Our responses to this Referee's comments are provided below.

Comments on abstract

[Comment 1] The abstract summary seems to concentrate on the MSA findings/impacts e.g. growth of new particles to CCN yet it is stated later that a more significant impact could be on the formation of Bio-SO₄²⁻ which potentially impacts more on new particle formation and therefore has a direct 10-fold impact on cooling. Is this less significant in this study because the absolute amounts of Bio-SO₄²⁻ aerosol are small compared to the MSA aerosol? It is unclear from the R_{Bio} ratio how significant this relative contribution is and whether it should be stated a bit more in the abstract?

[Response 1] The concentration of Bio-SO₄²⁻ was 3 to 10 times higher than that of MSA during the study period. The concentration of MSA is typically used as an indicator of DMS-derived particles. This is because MSA is exclusively formed by the oxidation of DMS, while sulfate is of multiple origins (including DMS, sea-salt, and anthropogenic emission) which are not possible to distinguish without knowing S-isotope information and ion concentration data. Thus, literature ratios of MSA to Bio-SO₄²⁻ are typically used to calculate the total amounts of DMS-derived aerosols (Udisti et al., 2012 and 2016; Norman et al., 1999).

We have added a short paragraph (lines 28–29) indicating the importance of this ratio in the abstract: The added statements read “*Another oxidation product of DMS is MSA, and the ratio of MSA to Bio-SO₄²⁻ is extensively used to estimate the total amount of DMS-derived aerosol particles in remote marine environments.*”. We also added “*MSA is not a conservative tracer for DMS-derived particles*” and deleted “*to a size at which they could act as condensation nuclei*” (lines 40–41).

Specific comments

[Comment 2] Line 23. How can 50% of the NSS-SO₄²⁻ be Anth-SO₄²⁻? Do you mean it was produced from it? Rephrase:

[Response 2] NSS-SO₄²⁻ is a sum of Anth-SO₄²⁻ and Bio-SO₄²⁻. This sentence appeared to be misleading. So we have changed “NSS-SO₄²⁻” to “NSS-SO₄²⁻ (sum of Anth-SO₄²⁻ and Bio-SO₄²⁻)” for clarity (line 23).

[Comment 3] Line 151. Reference needed for sources of black carbon from fossil fuel, burning?:

[Response 3] Relevant literatures have been cited (Chen et al., 2016; Massling et al., 2015) (line 161).

[Comment 4] Section 3.4. Could a table be included to summarise the R_{Bio} values in different conditions/air masses, maybe include the temperature/light intensity if dependence is interesting (with reference to lines 320–333)?

[Response 4] As this referee suggested, we have added a new table (Table S2) that summarizes multiple environmental variables that could affect R_{Bio}.

Table S2. Summarized seasonal temperature, solar radiation, and R_{Bio}

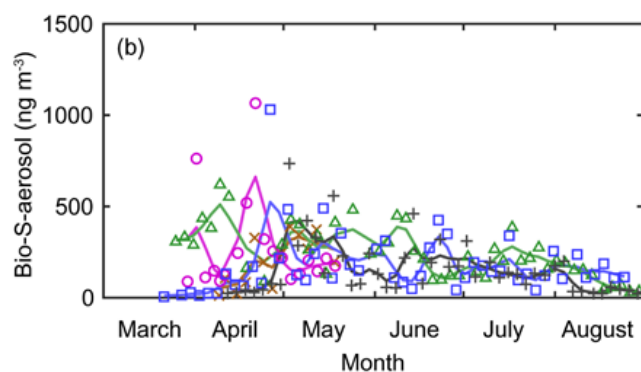
	Pre-bloom	Bloom	Post-bloom
Temperature (°C)	-1.8 ± 2.2	-3.4 ± 3.4	3.3 ± 1.5
Radiation (W m ⁻²)	51.3 ± 36.1	243.0 ± 63.4	222.5 ± 70.5
R _{Bio}	0.09 ± 0.07	0.32 ± 0.17	0.32 ± 0.13

[Comment 5] Line 288. Missing ‘hyphens’ in brackets:

[Response 5] We have hyphens in all relevant places in the brackets (line 308).

[Comment 6] Figure 5b. Set max y-axis scale to 1500?:

[Response 6] We have modified the y-axis scale of Figure 5b.



Revised Figure 5b: Aerosol concentration of Bio-S-aerosol (MSA + Bio-SO₄²⁻). The colored solid lines indicate 15-day moving mean values.

[Comment 7] Line 380. R_{Bio} , rather than just R:

[Response 7] We have changed “R” to “ R_{Bio} ”.

Comments on conclusions

[Comment 8] Since the concentration of OH plays such a big role in the DMS oxidation, is there anything that can be said about the climatic potential of the effect of increasing or decreasing OH concentrations over time on these findings (e.g. increasing global methane could lead to decreasing OH). Is there any potential trend over the years or just interannual variability?

[Response 8] We believe that interannual variation of OH radical may not seriously change the DMS oxidation pathway at this high Arctic site during our study period. Nevertheless, future studies on the climatic function of reactive oxidants are necessary to understand chemical oxidation process of biogenic DMS. Thus, we have added a short paragraph that emphasizes the potential impact of key oxidants including OH on DMS oxidation process as follows (lines 446–448): “Another important factor that may be involved in the formation of biogenic CCN is changes in the atmospheric concentrations of OH, NO_x and BrO; these are likely to be affected by future climate change and increasing anthropogenic perturbations (e.g., sea ice decline, increasing reduced carbon emissions) (Alexander and Mickley, 2015).” and we have replaced “including the gas-phase composition of sulfur species” to “including the concentration of key oxidant and gas-phase composition of sulfur species” (lines 450–451).

[Comment 9] I agree that more work should include integration with DMS, is this really beyond the scope of this paper?

[Response 9] Our measurements primarily focused on the seasonal and interannual variations in DMS-derived particles. Future studies are required to define the climatic roles of DMS-derived particles with comprehensive and simultaneous physiochemical properties of aerosol particles, and its precursor compounds.

References cited in our response to Referee #2’s comments (most references listed below were cited in our revised manuscript)

Alexander, B., and Mickley, L. J.: Paleo-perspectives on potential future changes in the oxidative capacity of the atmosphere due to climate change and anthropogenic emissions, Current Pollution Reports, 1(2), 57–69, <https://doi.org/10.1007/s40726-015-0006-0>, 2015.

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- Massling, A., Nielsen, I. E., Kristensen, D., Christensen, J. H., Sørensen, L. L., Jensen, B., Nguyen, Q. T., Nøjgaard, J. K., Glasius, M. and Skov, H.: Atmospheric black carbon and sulfate concentrations in Northeast Greenland, *Atmos. Chem. Phys.*, 15(16), 9681–9692, <https://doi.org/10.5194/acp-15-9681-2015>, 2015.
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