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Overview paper: New insights into aerosol and climate in the Arctic

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Supplementary Information

Particle Measurements at Alert, Nunavut

The experimental methods for the particle microphysical and filter-based chemical measurements in Fig. 7 are discussed by Leaitch et al. (2013, 2018).

Monthly-averaged values of N>50 (number concentration > 50 nm diameter), N>100, N15–N30 (number concentration in the size interval 15 nm to 30 nm), N30–N50, and N50–N100 for the inclusive period of 2012–2014 are shown in Fig. 7a.

One estimate of the effect of growth of newly-formed particles on the concentrations of particles in the range of 15–100 nm is demonstrated using Fig. 2. Baseline concentrations are estimated by linearly interpolating each of the N15–N30, N30–N50 and N50–100 from May to October. These are shown as the dashed lines in Fig. 7a. The increases in N15–N30, N30–N50 and N50–N100 during the summer months, relative to the estimated baseline concentrations, are shown in Fig. 7b. The progressive decrease in N15–N30 to N30–N50 to N50–N100 is indicative of the average of growth from smaller to larger sizes. There is no obvious increase in particles larger than 100 nm during the summer, suggesting growth to such sizes is mostly undetectable by this approach. Despite the high frequency of NPF, the growth to 50 nm or larger during August is almost identical to that in July, suggesting that the levels of precursors for condensational growth are on average lower during August than July. The monthly-average OM/SO_4^{2-}, also shown in Figure 7b (from Leaitch et al. (2018)), increases substantially and coincidentally with the increases in 15–50 nm particle concentrations, suggesting that organic components are important for the growth of newly formed particles in the summer Arctic.

Two approaches were used to estimate the percentages of 30-50 nm particles resulting from naturally-formed new particles. The July and August total N30-N50 in Fig. 7a are 48 cm^{-3} and 66 cm^{-3}, respectively. Two approaches are used to estimate the reference or baseline for the non-natural contributions. One approach is to use the baseline interpolated from May to October (dashed lines in Fig. 7a). The second approach assesses the non-natural baseline based on black carbon (BC) measurements, as discussed by Leaitch et al. (2013). The first approach yields natural number concentrations for the July and August months discussed in Leaitch et al. (2018) of 33 cm^{-3} and 54 cm^{-3}, respectively. The BC approach gives natural number concentrations of 9 cm^{-3} and 13 cm^{-3} for July and August respectively. The BC approach most likely underestimates the natural influence because remnant BC can remain during summer even while natural processes re-generate particles. The result based on the interpolation in Fig. 7 is an upper estimate of the natural contribution to the 30-50 nm particles because it assumes no anthropogenic contributions above the interpolated baseline. Therefore, at Alert, the ranges of natural contributions to the average July and August N30-N50 are estimated to be 20-70% for July and 20-80% for August.

References

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