EGU22-6026, updated on 11 Aug 2022
https://doi.org/10.5194/egusphere-egu22-6026
EGU General Assembly 2022


# Pan-Arctic trends of aerosol particle number concentrations in different size fractions

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## Introduction

The Arctic region is particularly sensitive to global climate change, experiencing warming at twice the rate of the global average. Changes within and outside of the Arctic (e.g., meteorology, atmospheric transport, and precipitation patterns) can have consequences for the sources and sinks of aerosols. Atmospheric aerosols can alter the planetary radiation balance directly through scattering and absorption and indirectly through modification of cloud properties. Understanding the direction and magnitude of recent changes in the Arctic aerosol population is key to elucidating the implications for the changing Arctic, although this remains a scientific challenge. Here we report a Pan-Arctic view of recent trends for aerosol particle number concentrations in different size fractions.

## Measurement Site & Methods

Measurements were obtained from different stations around the Arctic including Villum Research Station (Villum, 81°36′ N, 16°39′ W, 24 m a.s.l) in northeastern Greenland, Alert (81°28′ N, 62°30′ W, 210 m a.s.l.) in the Canadian Archipelago, Zeppelin Observatory (78°56′ N, 11°53′ E, 474 m a.s.l.) on Svalbard, Pallas (67°58′N, 24°07′ E, 560 m a.s.l.) in northern Finland, and Tiksi (71°36′ N, 128°53′E, 1 m a.s.l.) in the Siberian Arctic.

Particle number size distributions (PNSD) were measured using a Scanning Mobility Particle Sizer (SMPS) at Villum and Alert, and a Differential Mobility Particle Sizer (DMPS) at Zeppelin, Pallas, and Tiksi. Measurements were collected from 2010 to 2018 at all sites except for Zeppelin (2011 to 2019). Number concentrations were calculated by integrating the PNSD for three size fractions: Nucleation (10-35 nm), Aitken (35-80 nm), and Accumulation (80-300 nm). Nucleation number concentrations were unavailable for Zeppelin.

The trends in the number concentration for these size fractions were identified and quantified using the Mann-Kendal test and Theil Sen slope on the $90^{th}$ % confidence interval via the 3PW algorithm, using the daily median as temporal aggregation and meteorological seasons as temporal segmentation. Only statistically significant trends are discussed.

**Results**

Although the sites Villum, Alert, and Zeppelin are all located in the High Arctic (> 75° N) and relatively close to one another, there are differences between the direction and magnitude of trends for the size fractions. For example, at Villum, increasing trends are observed for the Nucleation fraction during spring and summer. Interestingly, at Alert, decreasing trends are observed for the Accumulation fraction during spring and autumn. At Zeppelin, no significant trends were observed for any fraction during any season.

Similar to the High Arctic sites, for the continental sites, Tiksi and Pallas, no uniform picture for the direction and magnitude of trends in the size fractions is observed. At Tiksi, decreasing trends for both the Aitken and Accumulation fractions are detected during summer and autumn. While at Pallas, no significant trends were observed during any season.

This work offers insight into the climatic implications (i.e., radiative balance and cloud properties) for a future Arctic climate by monitoring changes of aerosol concentrations in optically and cloud-relevant sizes. Future work will investigate the causes of these trends.