# Master Project: Long-term trends of aerosol optical properties at Mt. Zeppelin station, Svalbard

This master thesis (30 or 45 hp) will be performed at the Air Research Unit at ACES.

## Introduction

Atmospheric aerosols, which are defined as solid or liquid particles suspended in the air, are tiny and mostly not visible to our eyes. Nevertheless, they may have an immense impact on our health but also affect our global climate. Atmospheric aerosols interact with the incoming solar radiation affecting the global radiative budget in several ways: directly, by scattering and absorbing the radiation and indirectly, by affecting cloud properties. High latitudes are of special interest since the consequences of any change in the global radiation balance will be amplified here. This effect is known as Arctic/Polar amplification and is mostly due to positive feedbacks from the retreat of ice and snow.

To study the effect of aerosols on climate, longterm in-situ measurements of their optical properties have been carried out across the globe in the last decades. At Mt. Zeppelin station on Svalbard in the Arctic (78° 54' 29" N 11° 52' 53" E, 475 m.a.s.l.), aerosol optical properties have been measured for more than a decade by Stockholm University, resulting in a unique dataset to understand the aerosol annual cycles and long-term trends in the Arctic during recent years. Moreover, this site has records for many other important aerosol parameters, like the aerosol size distribution, chemical composition, and meteorological data. This is a great opportunity to study the recent changes of Arctic climate using this unique dataset.

## Motivation of the study

The motivation of this study is to answer the following scientific questions:

- What are the recent trends in aerosols optical properties measured in the Arctic at Zeppelin station?
- How are the observed changes of aerosol optical properties linked to changes in microphysical and chemical compositions of these aerosol particles?
- Has the retreat of sea ice in the last decades led to changes in aerosol optical properties?
- How important are large (coarse mode) particles for the overall measured optical properties?

## Methods

We will mainly analyze existing longterm datasets from two ground-based instruments: nephelometer and particle soot absorption photometer, which measure the scattering and absorption coefficients, respectively. With this data we will be able to obtain other quantities of interest such as the Ångström Exponent, the single scattering albedo or the backscattering ratio. Other tools such as airmass trajectory analysis, Mie calculations or cluster analysis will also be available to corroborate the results obtained by our main optical dataset. In addition, the student is expected to perform a literature survey relevant to the project to become familiar with the topic.

Figure 1: View from Zeppelin station, Svalbard, showing the air inlets used to sample aerosol particles and cloud droplets. Data from this site will be mainly used in this study.

## Learning Outcomes

With the completion of the master thesis the student will:

- Improve their understanding of the various physical processes involving aerosols in the Arctic
- Be familiar with aerosol optical properties
- Improve their abilities in data processing and analysis
- Increase their skills to visualize data and her statistical analysis of field measurements

## Requirements

- Intermediate programming skills, experience in statistical computing and data visualization (possible recommended softwares: MatLab or Python).
- Basic knowledge and interest in atmospheric science
- Thesis should be preferable written in English

## Literature

Aaltonen et al., 2006. https://www.atmos-chem-phys.net/6/1155/2006/
Tunved et al., 2013. https://www.atmos-chem-phys.net/13/3643/2013/
Zieger et al., 2010. https://www.atmos-chem-phys.net/10/3875/2010/

## Contact

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