Observation and modeling the vertical variability of the single scattering properties during Arctic Haze

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iAREA project

The iAREA project was created in order to contribute a new knowledge on the impact of absorbing aerosols on the climate system in the European Arctic. The main objectives are:

- modelling of direct aerosol forcing in the Arctic by estimating the new values of radiative forcing (RF) and reducing uncertainties,
- investigating factors that underlie the present uncertainty of RF and to quantify uncertainties in RF related to poorly recognized parameters,
- determining the impact of vertical profile of absorbing properties and relative humidity on RF and to determine the effect of simplification in parameterization of vertical variability of aerosol optical properties on RF results,
- developing methods to retrieve vertical profiles of single-scattering properties such as the single scattering albedo from synergy of in-situ and remote sensing observations, of the aerosol single-scattering properties,
- determining the vertical structure of the Arctic haze, especially vertical profiles of single-scattering properties as well as contribution of absorbing aerosol optical depth (AOD) in the Arctic haze layer to the entire column,
- improving knowledge about ship track impacts on AAs optical properties in the Arctic by estimation of contributions of ship emissions to the total aerosol optical properties,
- validating results from the GEM-AQ models in the Arctic region.

Structure of iAREA

- WP1: Development and adaptation of in-situ and remote sensing aerosol instruments for field campaigns.
- WP2: A new approach to obtain profiles of aerosol single-scattering properties.
- WP3: Impact of air-sea exchange on Arctic absorbing aerosols.
- WP4: Variability of vertical structure of aerosol properties during the Arctic haze events.
- WP5: Modelling of chemical and optical properties of the Arctic aerosols (at the regional scale) for campaign support and post analysis.
- WP6: Horizontal inhomogeneity of aerosol optical properties in the European polar regions including Svalbard fiords.
- WP7: Modelling of aerosol radiative effect (forcing) over Svalbard fjords.
- WP8: Modelling of aerosol direct radiative forcing in the European Arctic.

iAREA field campaign - Spitsbergen 2014

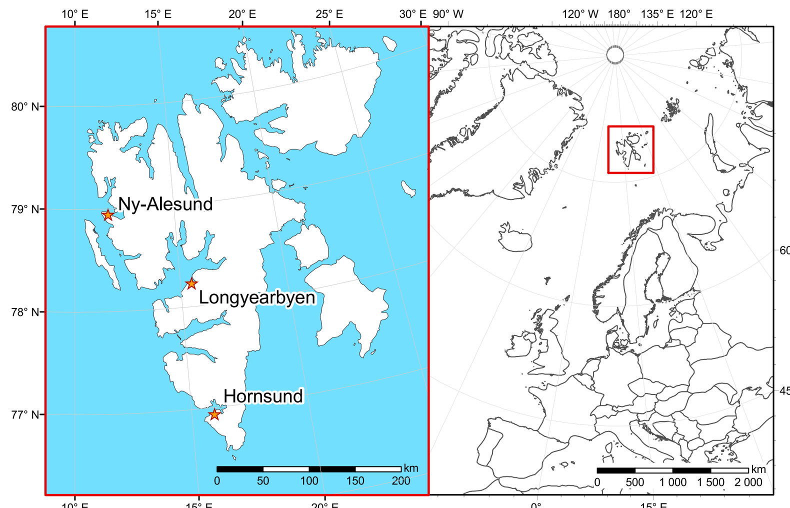

Fig. 4. Places, where iAREA field campaign was carried out during 15.03-14.04.2014.

Methodology

Models: NAAPS • GEM-AQ • MACC • HYSPLIT

Insitu measurements: Aethalometer (AE-31) • Nephelometer (Aurora 4000, TSI 3563) • Photoacoustic Extinctiometer (PAX) • Laser Aerosol Spectrometer (3340) • Particle Measurement Systems (CSASP-100HV) • Tethered baloon (micro-Aethalometer AE51, prototype mini-Nephelometer)

Remote sensing: Lidar (KARL) • Ceilometer (CHM15k, CL-51) • Sun Photometers Microtops II • AERONET

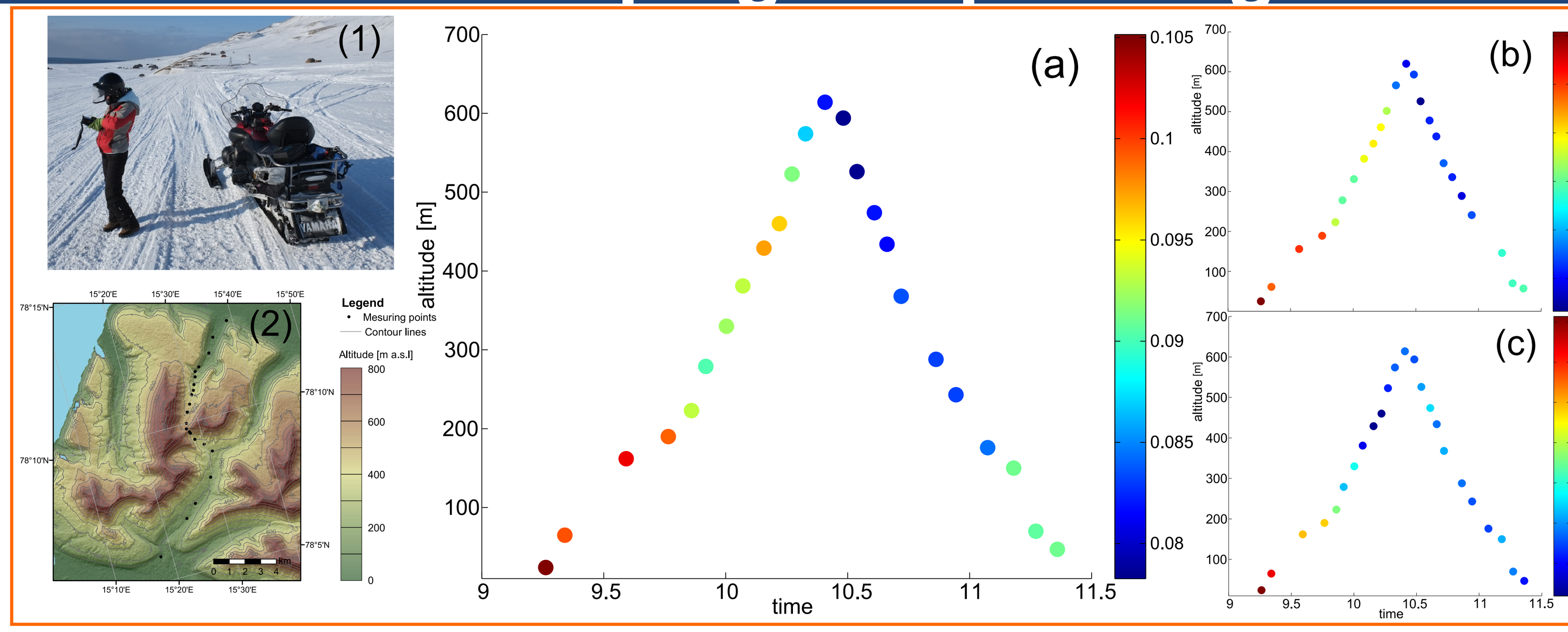

Fig. 6. Measurements of aerosol optical properies with sun photometer MICROTOPS II (1) along route through two valleys (2) in 6.04.2014 in Longyerabyen (Spitsbergen). Vertical profiles of aerosol optical depth (a),(b) [500nm] and Angstrom exponent(c).

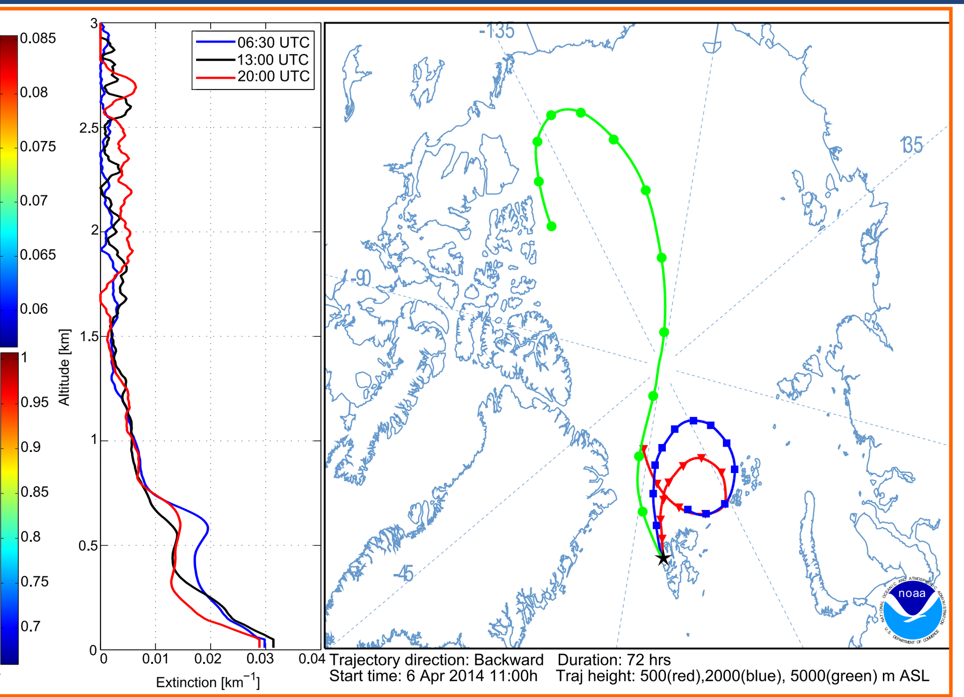

Fig. 10. Vertical profile of extinction coefficient [910nm] from Ceilometer(CL-51) and back trajectories from HYSPLIT model on 6.04.2014.

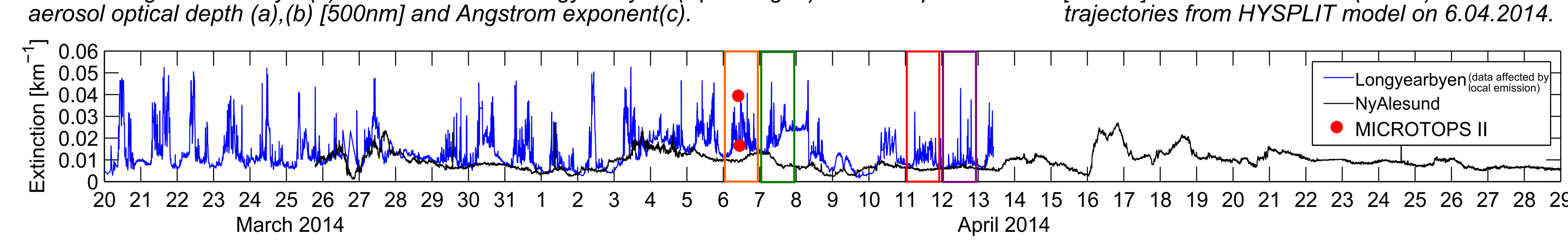

Fig. 7. Measurements of extinction coefficient [500nm] during the field campaign retrieved from Nephelometer and Aethalometer data.

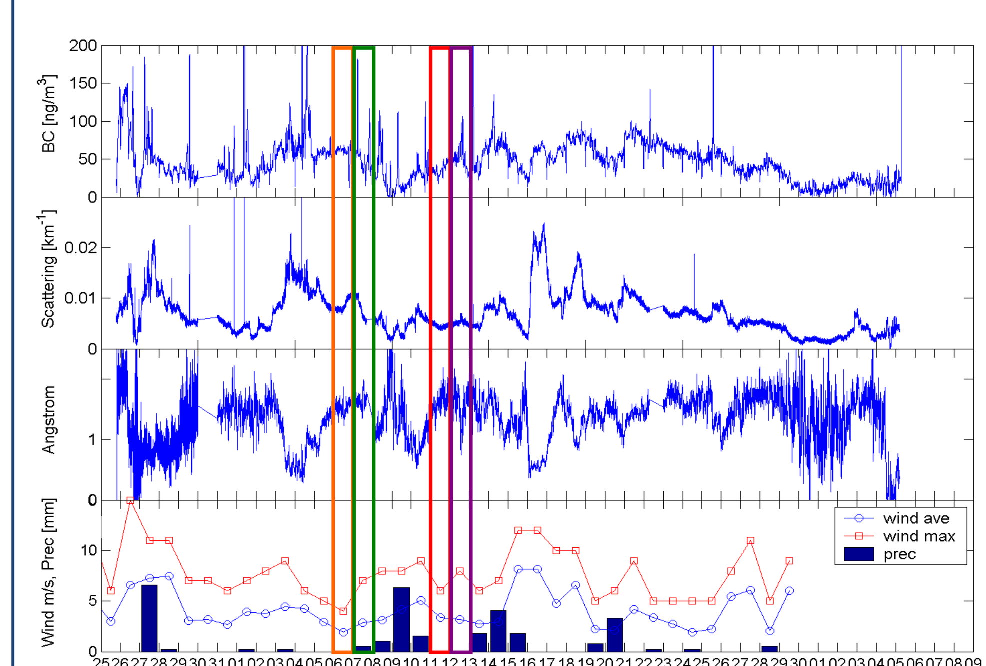

Fig. 5. Aerosol optical properties as well as meteorological data in Ny-Alesnud during the field campaign.

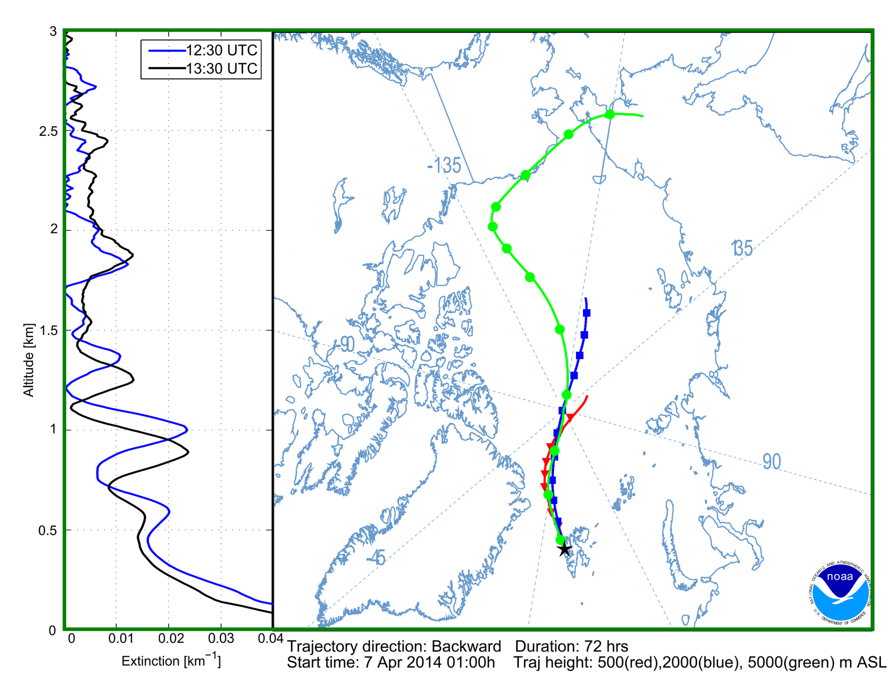

Fig. 8. Vertical profiles of extinction coefficient [910nm] from Ceilometer(CL-51) and back trajectories from HYSPLIT model on 7.04.2014.

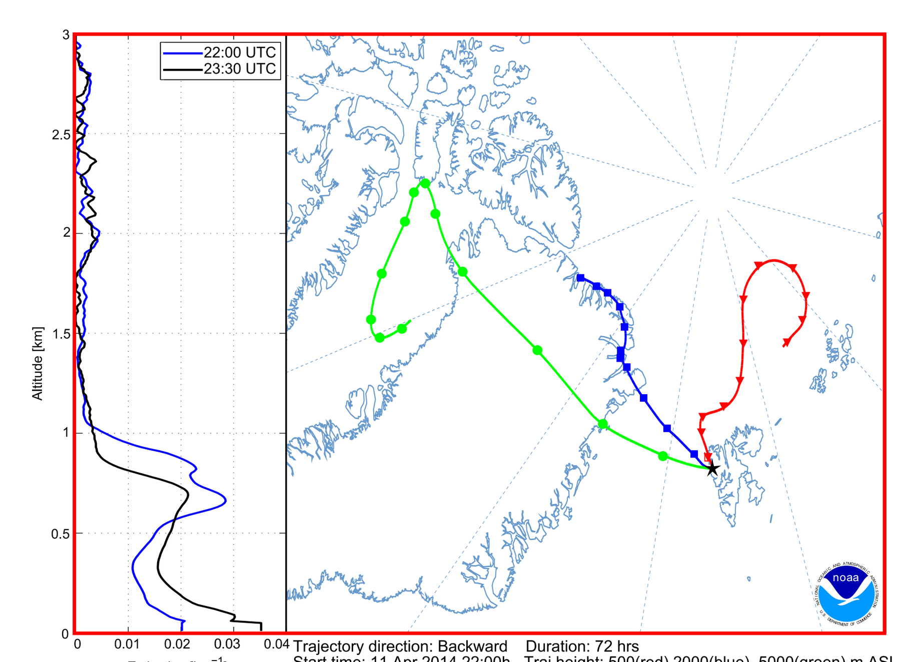

Fig. 9. Vertical profiles of extinction coefficient [910nm] from Ceilometer(CL-51) and back trajectories from HYSPLIT model on 11.04.2014.

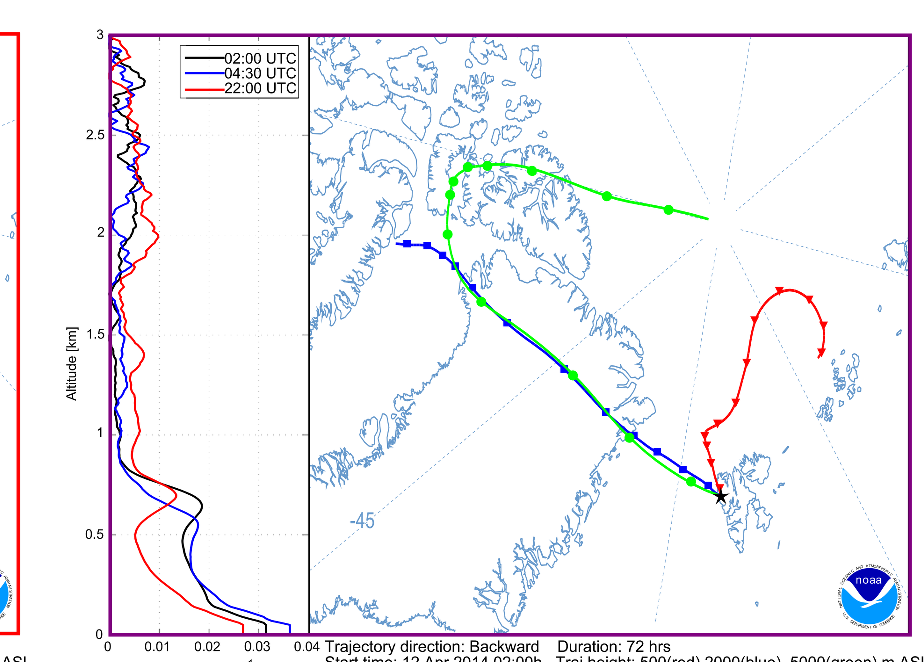

Fig. 11. Vertical profiles of extinction coefficient [910nm] from Ceilometer(CL-51) and back trajectories from HYSPLIT model on 12.04.2014.

Climatology of Aerosol Optical Properties

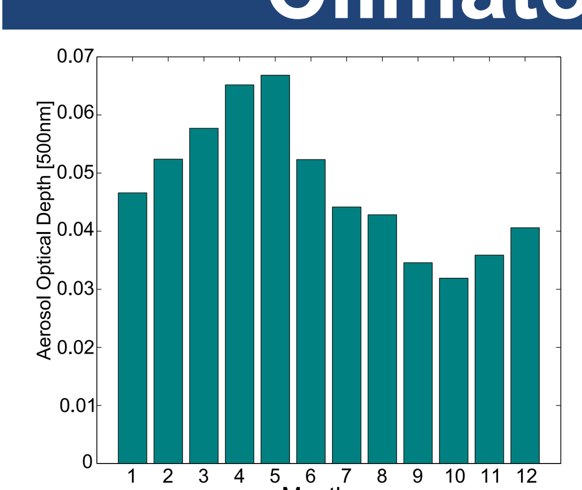

Fig. 1. Monthly mean of aerosol optical depth [500nm] in Ny-Alesund in 2002-2012 (NAAPS).

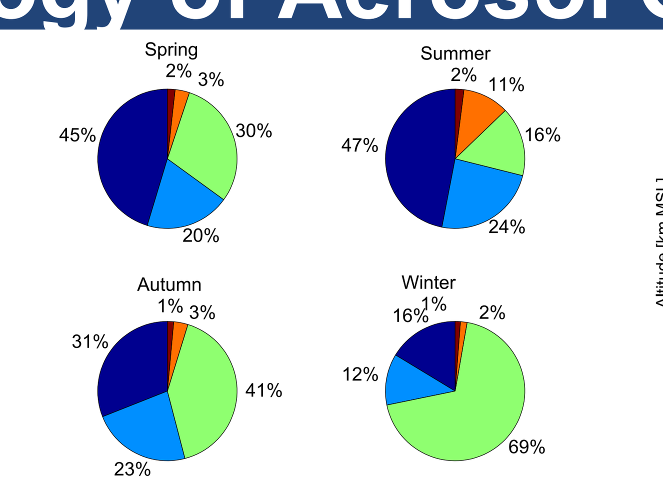

Fig. 2. Seasonal mean structure of aerosol components [550nm] in Ny-Alesund in 2002-2012 (MACC).

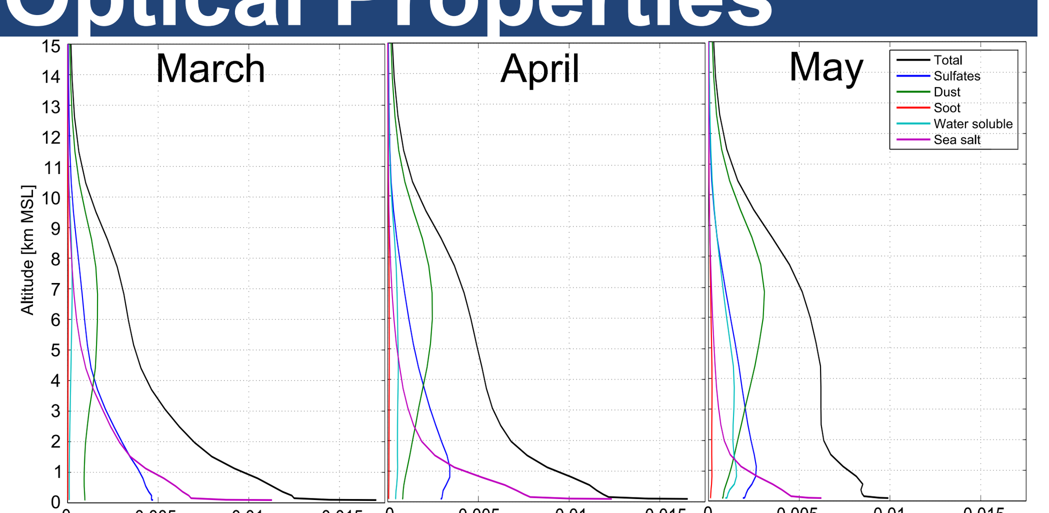

Fig. 3. Vertical profiles of monthly mean total aerosol extinction coefficient [500nm] and its components in Ny-Alesund in 1999-2006 and 2011-2012 (NAAPS).

Acknowledgements

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Conclusions

During iAREA field campaign, which was carried out between 15.03-14.04.2014 in Ny-Alesund and Longyearbyen (Spitsbergen), a typical strong spring advection of Arcitc Haze was not observed. However, some small events of enhanced values of aerosol optical depth and surface scattering coefficient were measured. They are believed to have been mostly consisted of sea salt local emission. Regarding ceilometer data, thin layers of mentioned aerosol occurred usually at 0.5km and 1km (extinction coefficient 0.02 - 0.04 km^{-1}). The reason for such small amount of Arctic Haze advection during 2013/2014 season might be strongly connected with weather anomalies: enhanced snow conditions during previous summer as well as higher mean temperature during winter. There is a strong need for further processing of collected data to create wide conclusions.