Indian POLar AERosol NETwork (POLAERNET)

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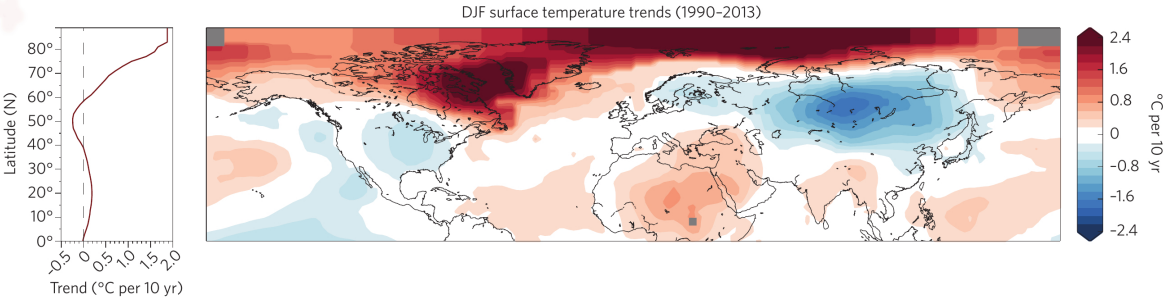
Outline

1. Aerosol-climate interactions
2. Scientific Challenges
3. POLar AERosol NETwork
4. Expected Outcomes and Future directions

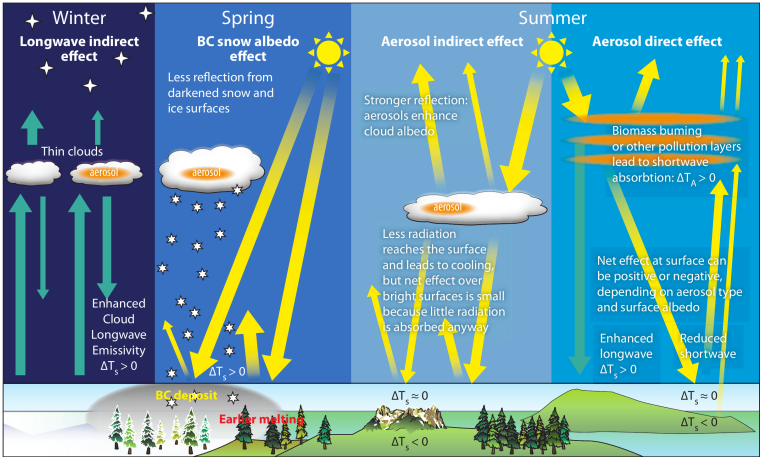
Arctic Amplification



Cohen et al., 2014, Nature Geoscience

- Increased air temperature (surface and aloft).
- Dramatic reduction in summertime sea ice extent.
- Loss of multi-year sea ice (reduction in mean thickness).
- Decrease in surface albedo

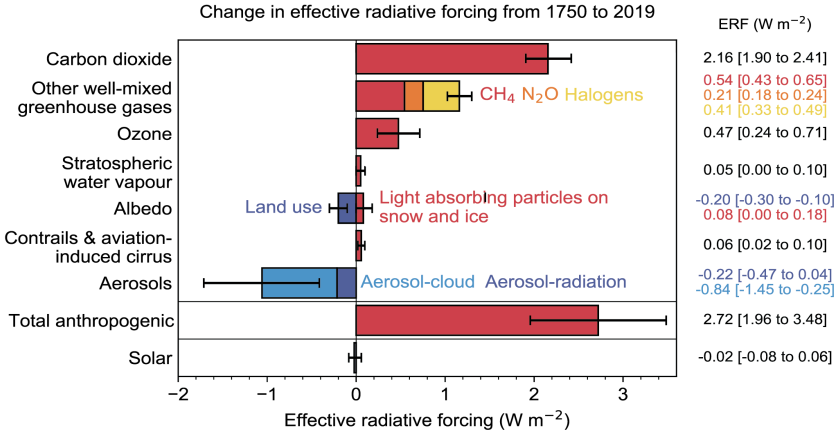
Aerosol radiation interaction over Arctic



AMAP, 2011

- Clouds exhibit global cooling effect
- In contrast, the low-level clouds in the Arctic warm the surface by re-emitting long-wave radiation in winter.
- Black Carbon deposited over snow, change the albedo.

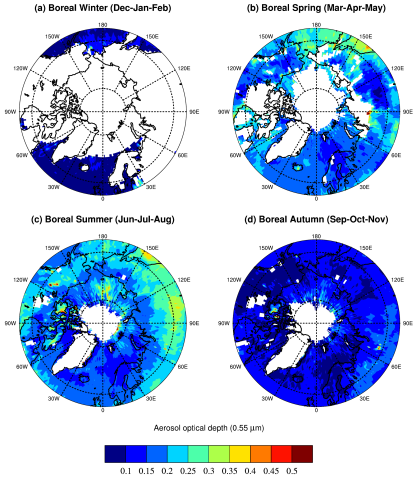
Scientific Challenges



- Absorbing aerosols over snow shows positive radiative forcing.

IPCC, 2021

Aerosol variations over Arctic



- MODIS (or Moderate Resolution Imaging Spectroradiometer) derived seasonal mean mid-visible (0.55 μm) aerosol optical depth.
- Satellite observations are challenging over the Polar region due to high reflecting surface
- Due to absence of solar radiations, aerosols cannot be retrieved by satellite observations.
- Seasonal variations can be observed over different part of Arctic region.

Srivastava R., The Three Poles, 2022

Recent efforts for aerosol and climate observations and modeling

- Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environments (NETCARE)
- Arctic CLoud Observations Using airborne measurements during polar Day (ACLOUD)
- Physical feedbacks of Arctic PBL, Sea ice, Cloud and AerosoL (PASCAL) campaign
- Cryosphere-Atmosphere Interactions in a Changing Arctic Climate (CRAICC)
- Microbiology-Ocean-Cloud-Coupling in the High Arctic (MOCCHA)
- Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC)
- Air Pollution in the Arctic: Climate, Environment and Society (PACES)
- Cryosphere and Atmospheric Chemistry (CATCH) Initiative
- Biogeochemical Exchanges at the Sea-Ice Interfaces (BEPSII)

POLar AERosol NETwork

Aethalometer
(measures Black Carbon mass)

Nephelometer
(measures aerosol scattering)

Aerodynamic Particle Sizer (APS) spectrometer (measures aerosol size distribution)

Radiation Sensor
(measures shortwave and longwave radiations)

Objectives of POLAERNET

- To understand the spatial and temporal variations of aerosol optical, physical, chemical and radiative properties over the polar region.
- To investigate the sources of aerosols over Polar region.
- To investigate the teleconnection between tropical and polar aerosols
- To understand role of aerosols on polar climate and their influence to Global climate
- Collaborate with other national and International organisations to improve scientific understanding on Polar aerosols and their climatic impact.

Measurements

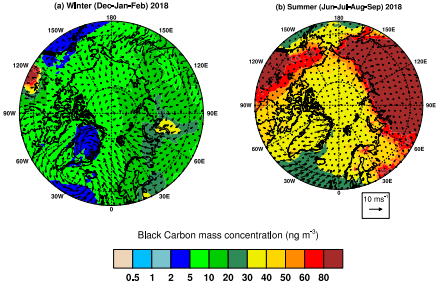
Long-term and continuous measurements of

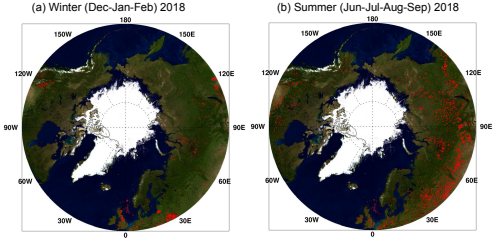
- Black Carbon (BC) mass concentrations using seven channel Aethalometer.
- Aerosol scattering coefficients using Nephelometer
- Aerosol size distribution in the size range of 0.5 to 20 μm using Aerodynamic Particle Sizer (APS) spectrometer;
  and in range of 1 nm to 1 μm using Scanning mobility particle sizer (SMPS) spectrometer.
- Shortwave and Longwave incoming and reflecting radiations using radiation sensors.
- Spectral aerosol optical properties (*viz.*, aerosol optical depth (AOD), single scattering albedo (SSA) and Asymmetry parameter (AP)) using sky radiometer.
- Aerosol sampling using High Volume Sampler and Aerosol chemical characterization such as trace metals, water soluble ions and organic carbon etc.

Modeling

- Regional climate Modeling simulations using chemistry module
- Validation of different climate models with the in-situ observations of meteorological parameters and aerosol properties
- Weather Research and Forecasting (WRF) with chemistry module are being used to simulate meteorological condition and aerosol properties.
- In collaboration with national and international organizations, Global coupled models will be utilize to understand the polar - tropics teleconnection.

Black carbon mass concentration





- BC masses are ranging from 5 - 20 ng m^{-3} over the most parts of the Arctic in boreal winter,
- BC values are double in summer.
- Siberian and Canadian regions show higher BC mass (> 30 ng m^{-3}), which could be due to the fire activities in these regions.

- The fire events in the western part of Arctic could not influence the major area,
- While fires in the Siberian region have affected much larger part of the Arctic as the winds are mostly from east to west in winter.

Srivastava and Ravichandran, 2021, Polar Science

Expected Outcomes and Future directions

- Long-term and continuous measurements of aerosol physical, chemical, optical and radiative properties will be useful in understanding the role of aerosols on polar climate.
- The information of sources and transport pathways of aerosols will be helpful in improving different emission dynamical processes.
- The observations of aerosols over different polar, Himalayan and southern ocean regions will provide an opportunity to investigate the connections between the polar, tropical and mid-latitude regions.
- The observations under **POLAERNET** program will be very helpful in validating the climate models which will enlighten to improve the model predictions of climate.
- National Centre for Polar and Ocean Research (NCPOR), India will be happy to collaborate with the members of Ny-Ålesund Atmosphere Flagship to improve our understanding on Arctic Aerosols and their climatic impacts.

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Thank you for your Attention

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