Arctic aerosol, cloud, and radiation characteristics from ground–based observations and modelling

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1 Summary

Main Goal:

Quantify cloud & aerosol surface radiative forcing under sea-ice conditions via

- Detailed profiling of aerosols and clouds from ground (ship, ice station)
- High-resolution (spectral, spatial, temporal) radiative flux measurements
- Large Eddy Simulations (LES) along ship trajectories
- Model-Observation combination for identification of dominate in surface forcing

Hypothesis

The cloud and aerosol direct and indirect radiative effects dominate over the surface-albedo feedback in the Arctic.

2 Research rationale

State-of-the-art

Do aerosol particles and clouds amplify or dampen surface warming?

- Need for detailed characterisation of aerosol properties (type, size & mass) from the ground to the troposphere as well as cloud properties, e.g. mixed phase
- Relation of aerosol and clouds to the radiation field concentration especially challenging in the marginal sea ice zone

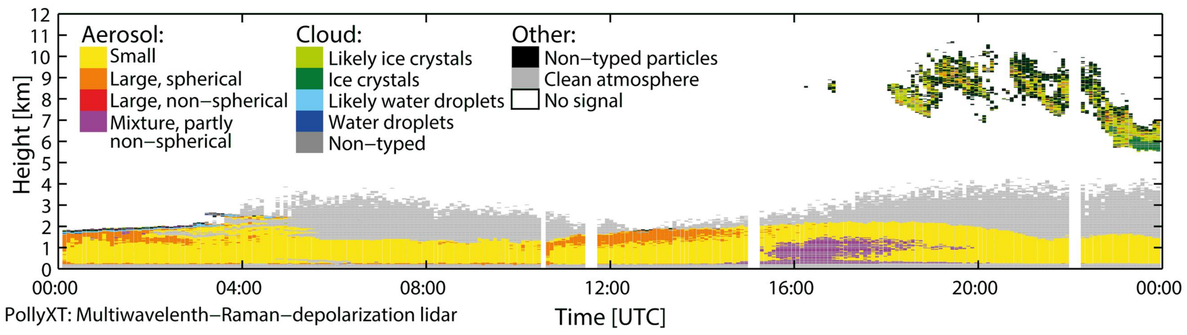


Fig. 1: Aerosol & cloud typing based on 24/7 lidar observations for an example day in Germany.

Preliminary work

- Detailed aerosol & cloud characterization from multi-wavelength polarization Raman lidar & cloud radar worldwide (TROPOS)
- Development of parameterization testbed LES setup (UNI-K)

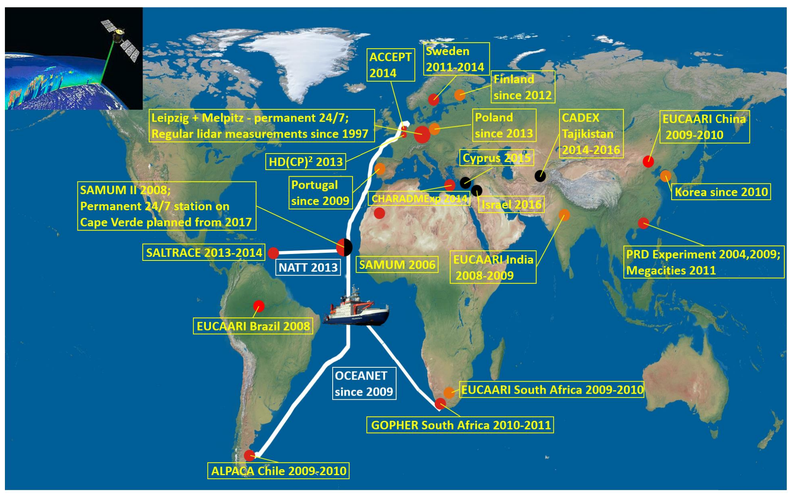


Fig. 2: Global map of TROPOS field campaigns with atmospheric profiling.

- 10 years of Polarstern expeditions with detailed radiation closure studies over the Atlantic ocean
- Operation of high density pyranometer networks & LES for field campaigns
- Approved Arctic Polar-stern expedition PASCAL: *Physical feedbacks of Arctic PBL, Sea ice, Cloud And Aerosol*

3 Research plan

Central research topics

- Radiation closure studies to investigate link between changes in ice albedo and changes in aerosol & cloud radiative fluxes
  - Exploit continuous active and passive remote sensing of the atmosphere
  - Use network of 50 pyranometers on sea ice for spatio–temporal variability
  - Extend local observed aerosol and cloud fields with 3d LES runs
- Confront the LES with state–of–the–art observations

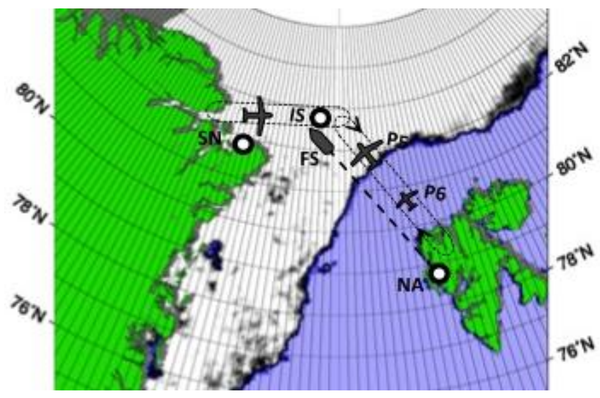
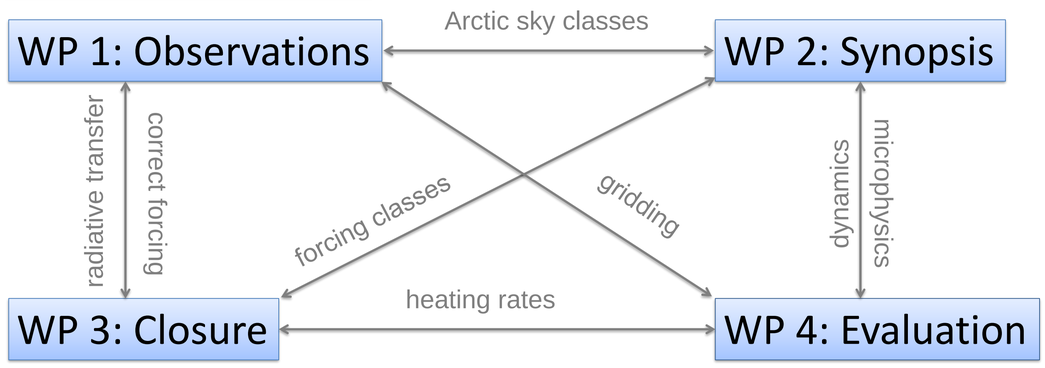


Fig. 3: Operation area for Polarstern expedition PASCAL in June 2017.

Fig. 4: Synergy between ground based and airborne observations.

- Synchronise with with aircraft in-situ & remote sensing measurements (B03) and combine with boundary layer in-situ flux & microphysics (A02)
- Investigate representativeness of sites across the Arctic using ground-based supersites incl. MOSAiC and satellite data (link E02)

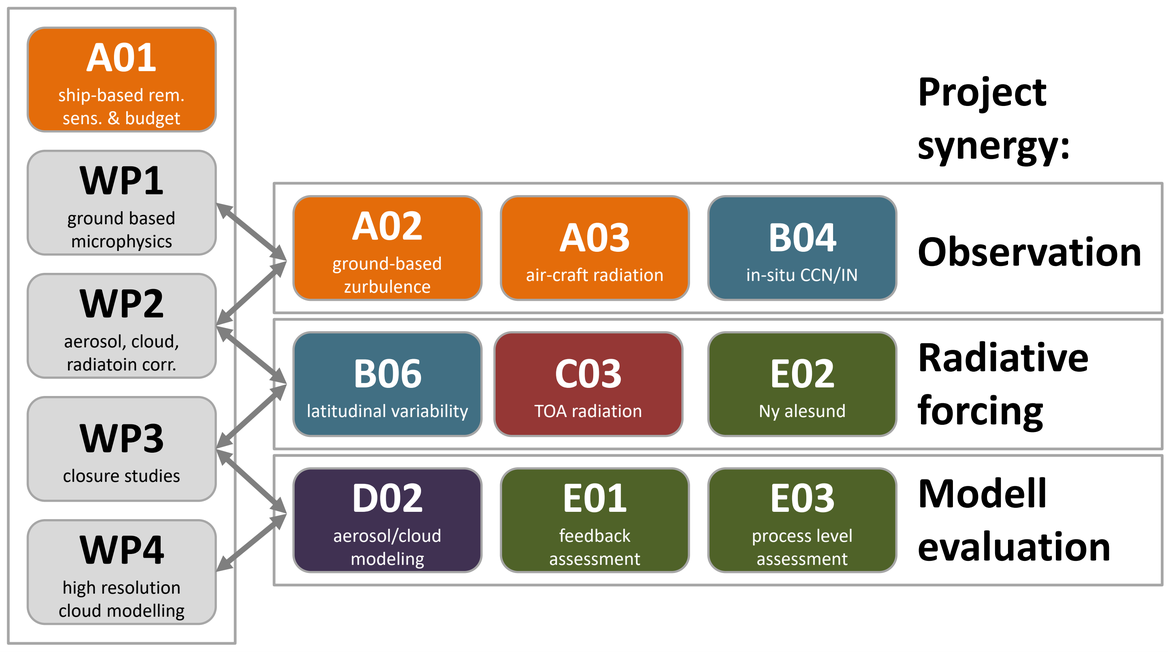
Work Packages (WP)



4 Role within (AC)³ & perspectives

Collaborations within (AC)³

- Ground site in Cluster **A**, microphysics closure in Clusters **B and D**
- Radiation budget in Cluster **C**, process understanding in **E** and **A**-**D**



Perspectives

- Model evaluation based on observed relation between aerosol, clouds & surface radiative forcing during onset of ice meld from observations
- Full annual cycle of central Arctic aerosol-cloud-radiation relation during Polarstern drift campaign MOSAiC
- Testbed for LES studies on cloud structure & microphysics
  ➔ initiate int. LES intercomparison
- Combination of active ground- and satellite-based remote sensing using EarthCARE

Fig. 5: EarthCARE satellite mission starting 2017/2018

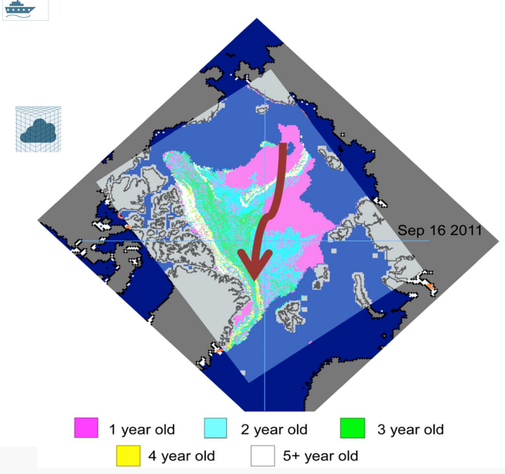


Fig. 6: Possible MOSAiC trajectory within the transpolar drift

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