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Overview

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• Work packages
  – Development and Validation
  – Observations over homogeneous surface
  – Observations over heterogeneous surface
  – Numerical modelling experiments
• Summary
ISOBAR (Innovative Strategies for Observations in the arctic atmospheric Boundary lAyeR)

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Project Partners:
Geophysical Institute, University of Bergen
Uni Research AS, Bergen
The University Centre in Svalbard, Longyearbyen
Finnish Meteorological Institute, Helsinki
University of Tübingen
University of Applied Sciences Ostwestfalen-Lippe
Leibniz University Hannover
Marquette University, Milwaukee
Purpose

• ABL processes in the Arctic
• Turbulence within the Stable ABL

Goal

• ABL Parameterization Schemes

Approach

• Observations targeting all relevant processes
  – AWS
  – Profiling systems (RPAS, balloon, remote sensing)
  – Turbulence systems (RPAS, ground based)
• Numerical Modelling
Characteristics of the Stable ABL

- Weak SW fluxes
- Weak turbulent fluxes
- Strong gradients
- Inversions
- Intermittent turbulence
- Very shallow ABL height
- Gravity waves
- Low Level Jets (LLJ)
- Internal boundary layers (surface heterogeneities)
Problems with Stable ABL in numerical Models

- Poor vertical resolution for shallow ABL
- Warm temperature bias in NWP and climate models
- Overestimation turbulent mixing rates
- Overestimation of the ABL height
- Insufficient surface layer scaling
- Room for improvements in ABL parameterization schemes
Methods

• Measurement strategy
  – ground based flux and met stations
  – ABL remote sensing and profiling systems
  – RPAS

• Numerical modeling experiments
  – Single Column Model (SCM)
  – Large-Eddy Simulation (LES)
  – Weather Research and Forecasting Model (WRF)
Work packages

• WP1: Development and proof of concept
• WP2: Observations over homogeneous ice surface
• WP3: Observations over strong surface heterogeneities
• WP4: Numerical modelling experiments
WP1: Development and proof of concept

• Characterization of the fixed wing turbulence systems
• Characterization of the Quadcopter turbulence system
• Validation Campaign:
  – Andøya Rocket Range, Norway
  – (Lindenberg Observatory (DWD), Germany)
  – (Lannemezan)
  – Winter 2016/17
  – EC tower
  – Remote sensing and profiling systems
• Optimize measurement strategies
WP2: Observations on the Arctic SBL over homogeneous ice surface

- Planned for winter/spring 2017
- Ship based measurement campaign
- Measurements:
  - 10m-mast with several EC systems
  - Profiling systems (tethersonde, remote sensing)
  - RPAS systems
    - High resolution ABL profiles: Bebop2
    - Tropospheric profiles: SUMO
    - Area averaged flux measurements: SUMO, MASC, MiniTalon
    - Fixed position flux measurements: large Quadcopter
WP2: Observations on the Arctic SBL over homogeneous ice surface

• Unsolved challenges:
  – Campaigns to join:
    • Svalbard fjord
    • UNIS cruise
    • Northern Scandinavia, e.g. Sodankylä (FMI), Bothnian Bay
    • Antarctic austral winter cruise
    • MOSAiC Project (anticipated for 2019-20)
  – Permissions
  – Logistics
WP3: Observations on the Arctic SBL over strong surface heterogeneities

- Planned for winter/spring 2018
- Around Svalbard
- Measurements:
  - 10m-mast
  - Profiling systems
  - RPAS systems
    - Profiles and turbulence measurements on both sides of the internal boundary
    - Flights across the internal boundary
WP4: High-resolution numerical model experiments

- Single Column Model
  - Develop improved stability functions based on WP2
  - Compare model results to experiments
- LES (PALM)
  - Idealized simulations of Arctic ABL, initialized with observations
  - Virtual RPAS measurements compare to observations
- WRF
  - Idealized simulations
  - Implementation of improved stability functions in parametrization schemes
  - Comparison of measurements to simulations based on different parameterization schemes
Summary

- Study the Polar Boundary Layers
  - Implement RPAS based turbulence systems
  - Measurement strategies combining RPAS with ground based and ABL remote sensing systems
  - Validation campaign
  - Campaign over homogeneous surface
  - Campaign over heterogeneous surface
  - Numerical Modeling experiments

Improved parametrization schemes for the stably stratified ABL