UNIVERSITY OF BERGEN

Geophysical Institute

# The ISOBAR project (2016–2018) – Observations on the stable polar Atmospheric Boundary Layer from Remotely Piloted Aircraft Systems

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# Overview

- About the Project
- Background
- Methods
- 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

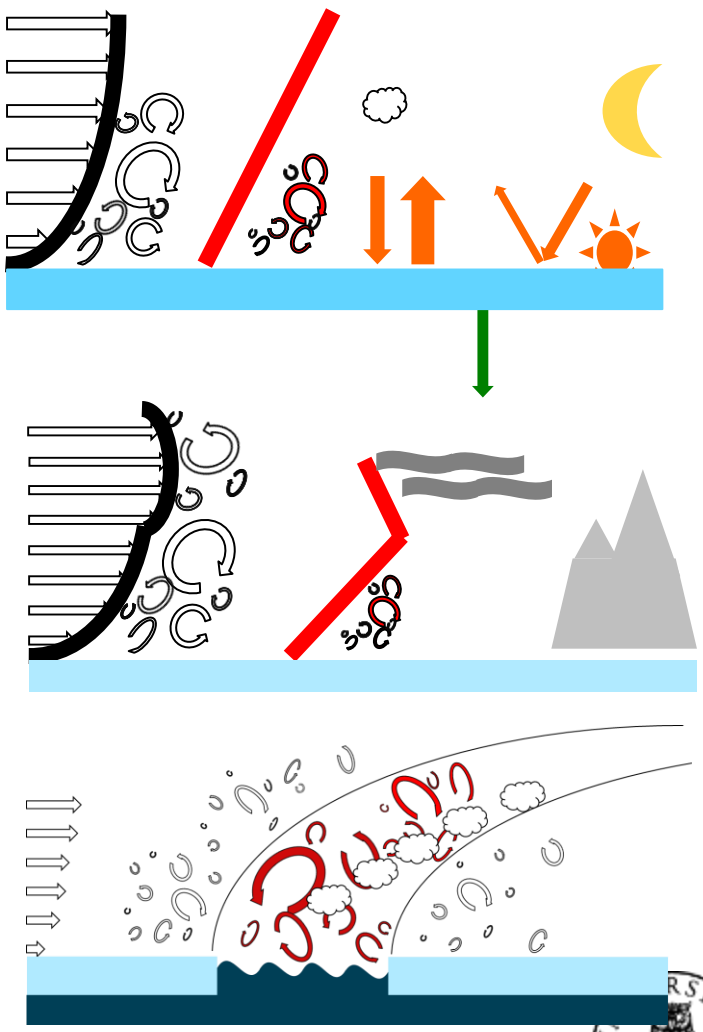
- ABL Parameterization Schemes

# 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)

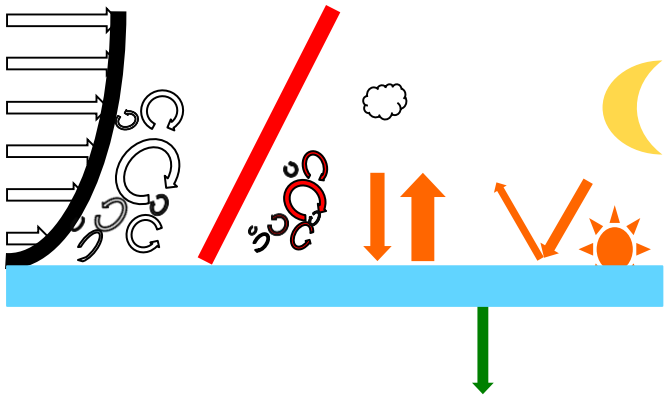
# Work packages

- 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 meausurement stragegies

# WP2: Observations on the Arctic SBL over homogeneous ice surface



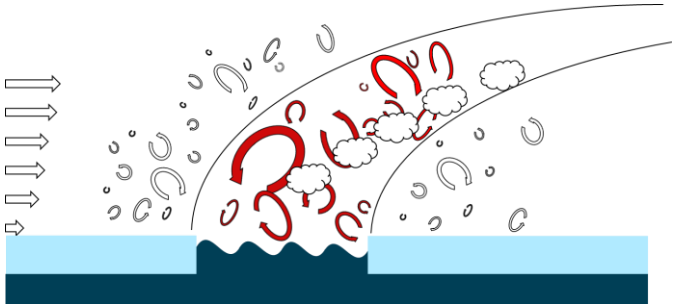
- Planned for winter/spring 2017
- Ship based measurement campaign
- Measurements:
  - 10m-mast with several EC systems
  - Profiling systems (tethersonde, remote sensing)
  - RPAS systems
    - High resolution ABL profiles: Bebop2
    - Tropospheric profiles: SUMO
    - Area averaged flux measurements: 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**