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Snow measurements in Sodankylä

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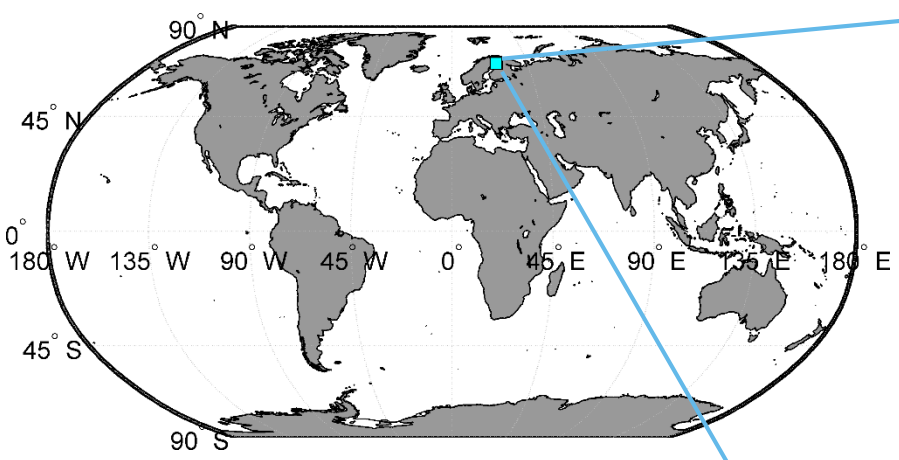
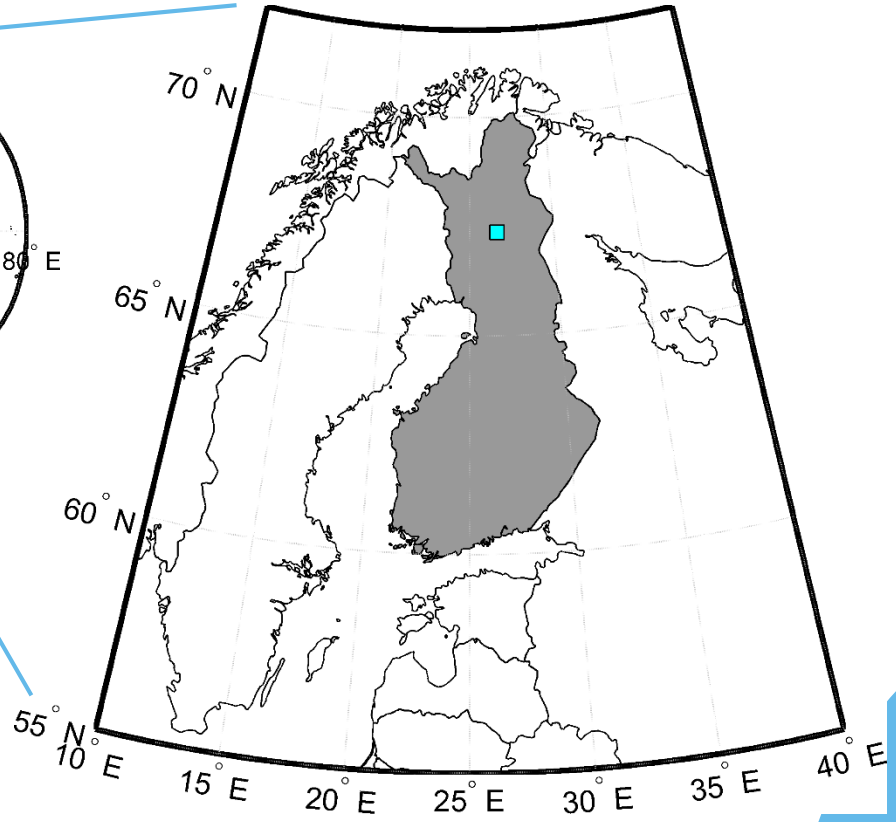
History

- Snow depth and SWE measurements since 1911
- SWE measured by melting before 1922, after that similar snow tube is used
- Snow course measurements (depth and SWE) since 1959
- Most of snow measurements started 2006
- Operational AWS measurements since 2008, manual daily measurements ended

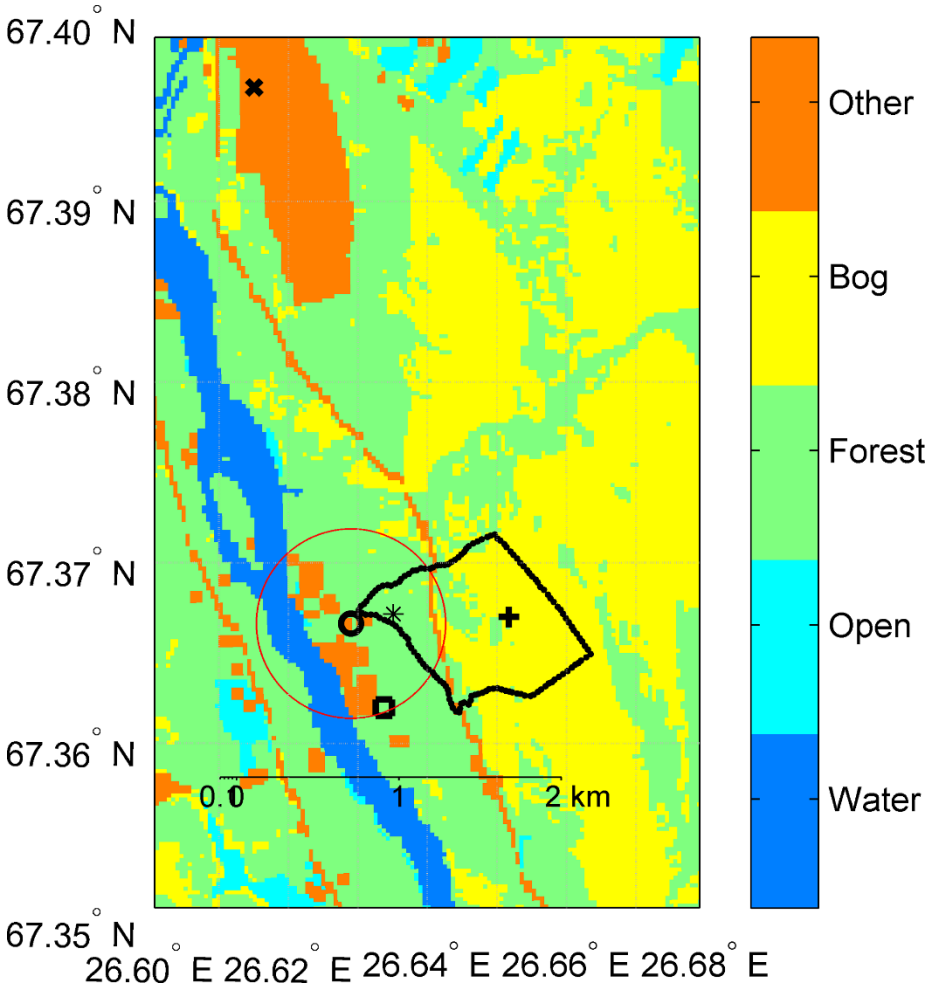
Location



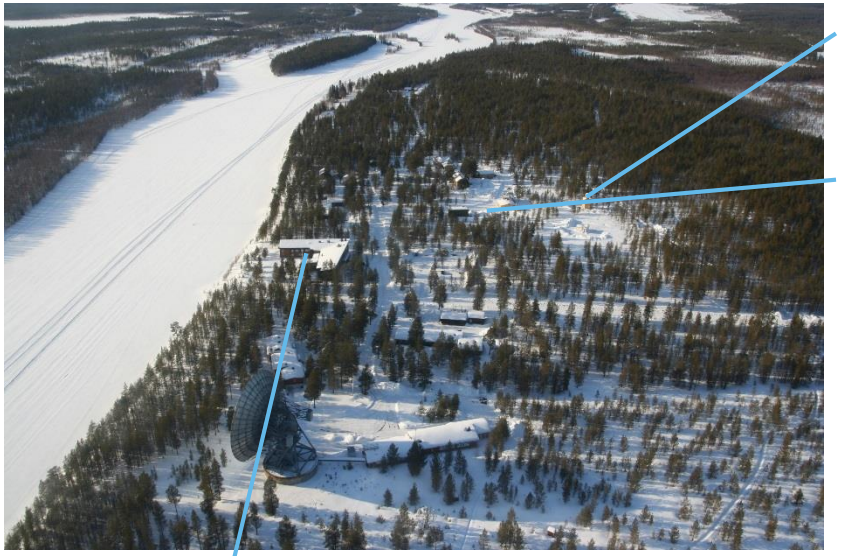


FMI Arctic Research Centre
Sodankylä, Finland
67.368 °N, 26.633 ° E,
179 m a.s.l.

Surroundings



- Institute area:
  - sparse pine forest
  - bog
  - river
- Other measurement sites:
  - Lake Orajärvi, dist. 10 km
  - Saariselkä tundra, dist. 130 km
- Sodankylä centre, dist. 9 km



Satellite reception

Sounding station: Weather station, radiation

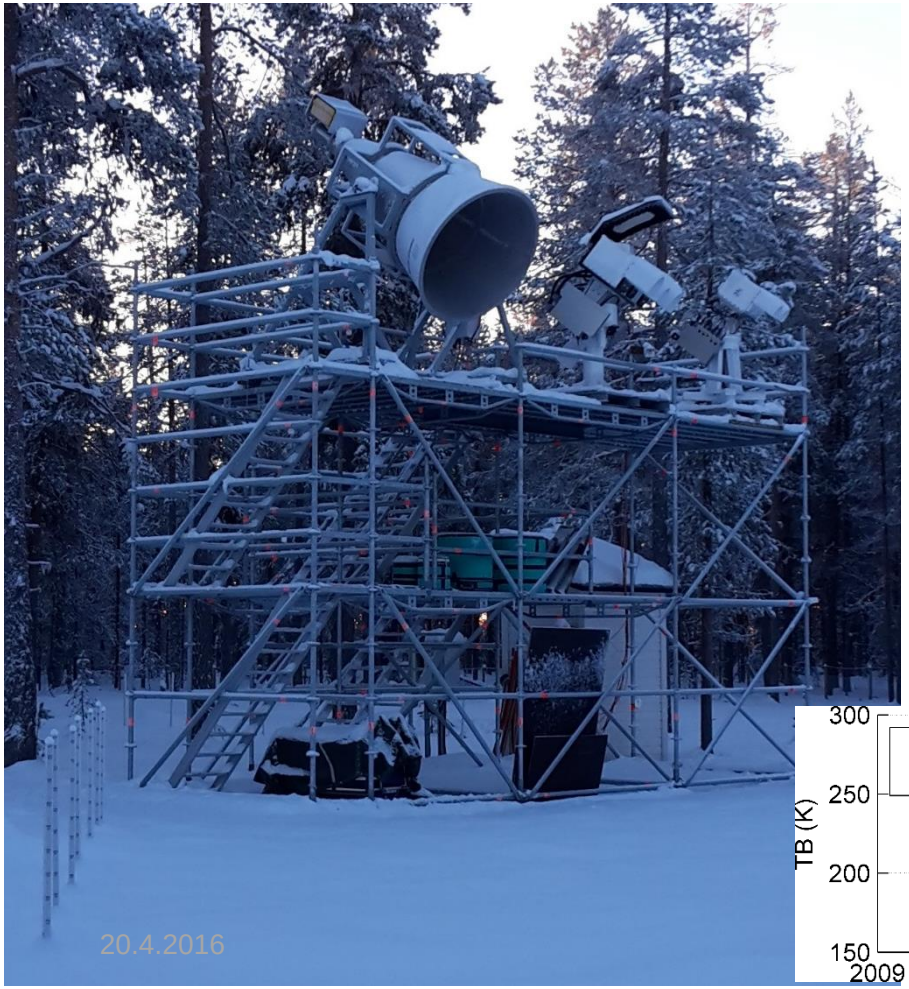
Main building

Intensive Observations Area (IOA):
Snow measurements, soil, radiation

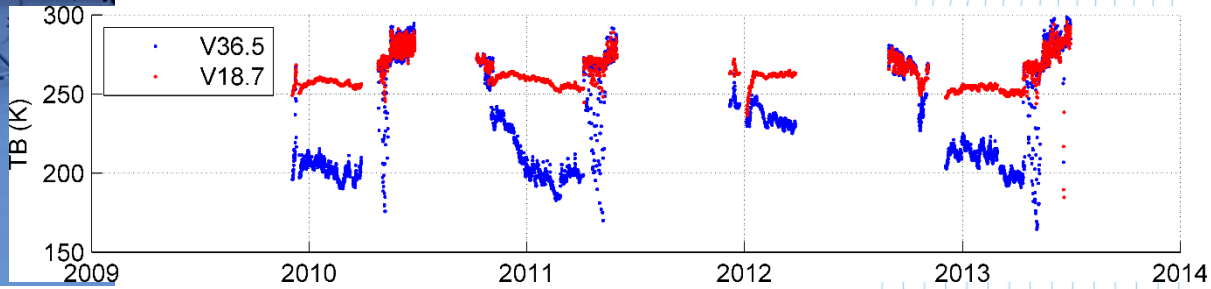
Bog site:
Weather station, radiation, soil, CO flux

Automatic snow measurements

Microwave radiometers



- ELBARA-II: ESA SMOS reference
  - 1.4 GHz
  - At forest site 2009-2012, 2015->
  - At bog site: 2012-2015
  - Elevation scan every hour
- SodRad1 & 2: RPG-DP-XCH
  - 10.7, 18.7, 21, 36.5, 89, 150 GHz
  - Since 2009/2012
  - 2D scan every hour



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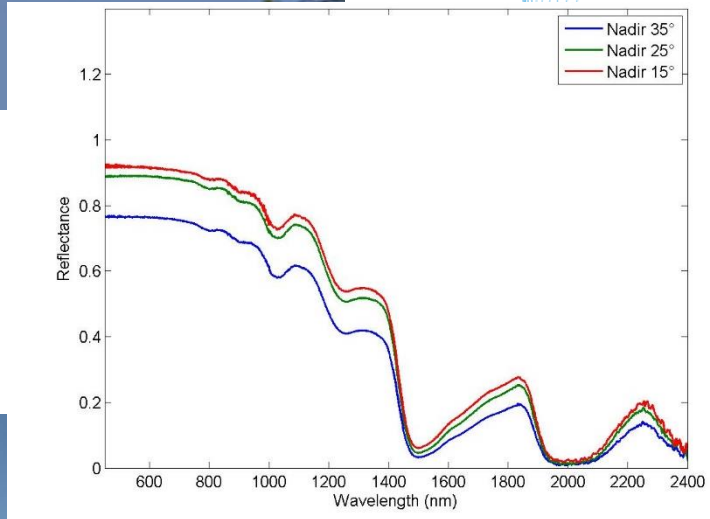
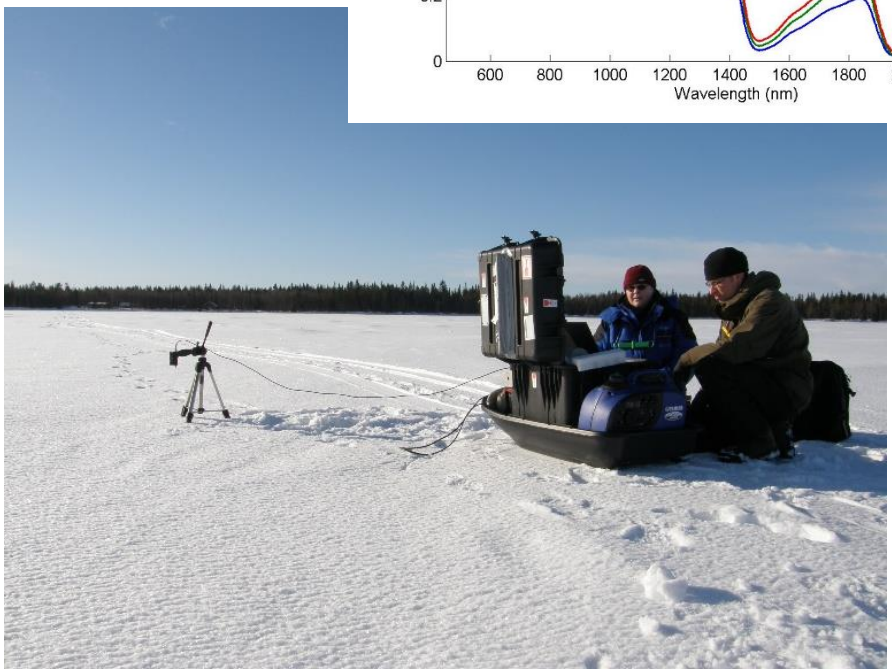
Optical spectrometer



- ASD FieldSpec Pro Jr
- VIS and NIR spectrum, 350-2500 nm (since 2015 only 350-1000 nm)
- Installed in a 30-m mast, measures forest and open area
- Similar instrument used in field and dark room laboratory measurements
- Since 2006



Long- and shortwave solar radiation

- IOA and bog site:
  - Global and reflected SW
- Met mast and forest:
  - Global and reflected SW+LW
- Sounding station:
  - Global and reflected SW at field and in tower
- Most since 2012

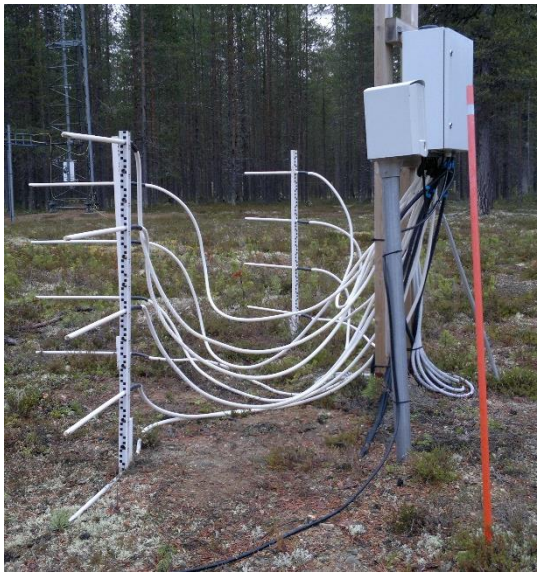
- Shortwave (285-)300-2800 nm
- Longwave 4500-42000 nm

Measurements at IOA

Snow depth, air temperature and humidity

Disdrometer (precipitation type and intensity)

Soil permittivity/temperature/moisture + Snow temperature



Snow scale (SWE)

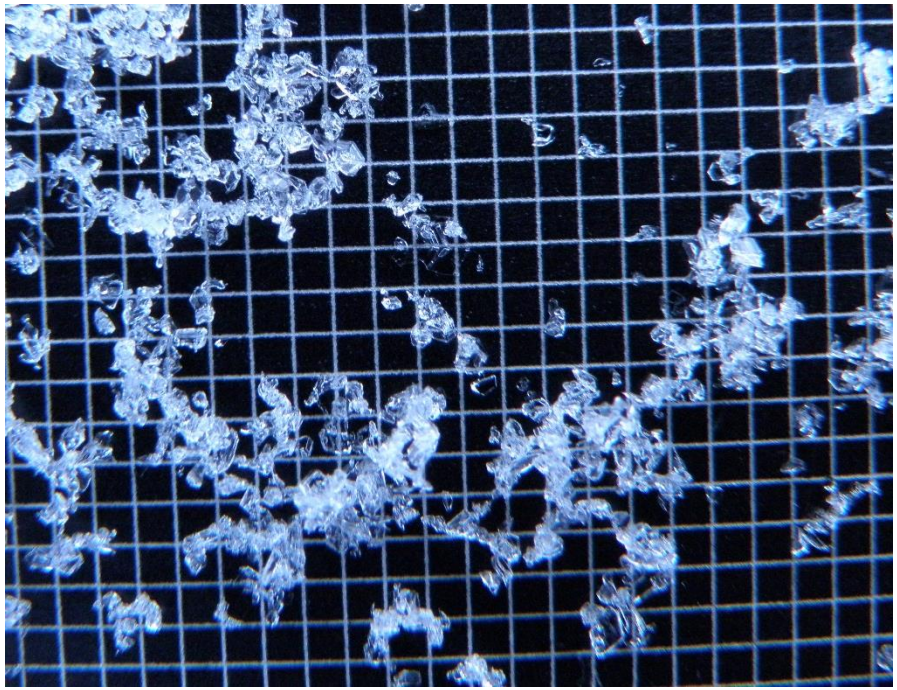
Manual observations

Snow pit

- Profiles of
  - Snow stratification (visual, SMP)
  - Grain size (visual, macrophotos)
  - SSA (IceCube)
  - Density and SWE (Snowfork, scale)
  - Temperature
  - Wetness (Snowfork)
- Operationally 1/week at IOA
  - Previously operationally also at bog and lake

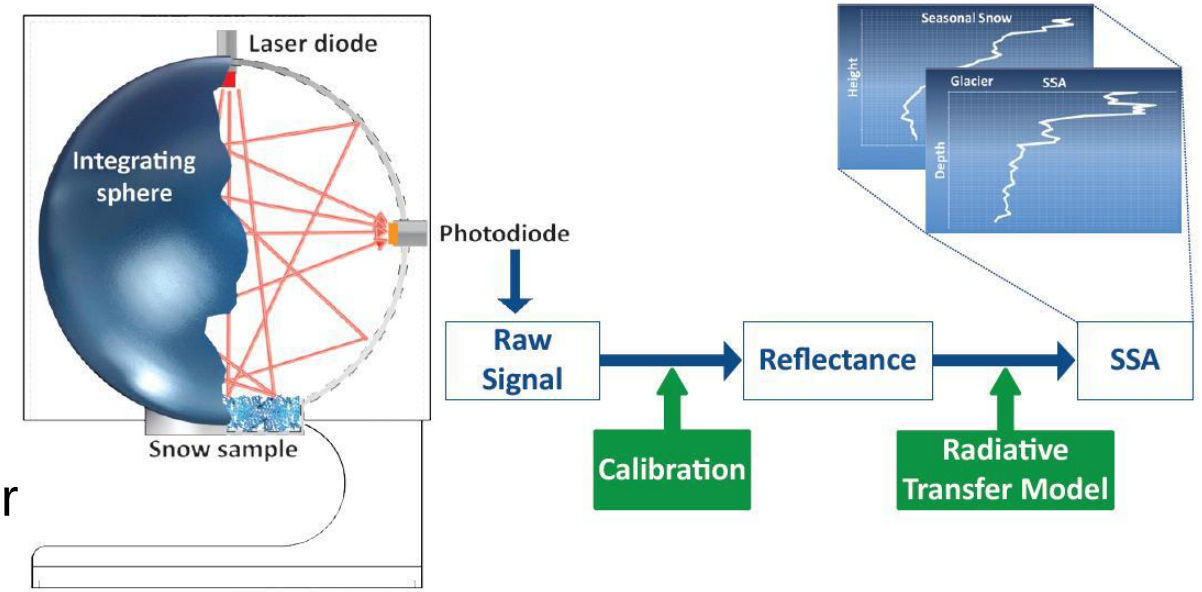
Stratigraphy

Grain size

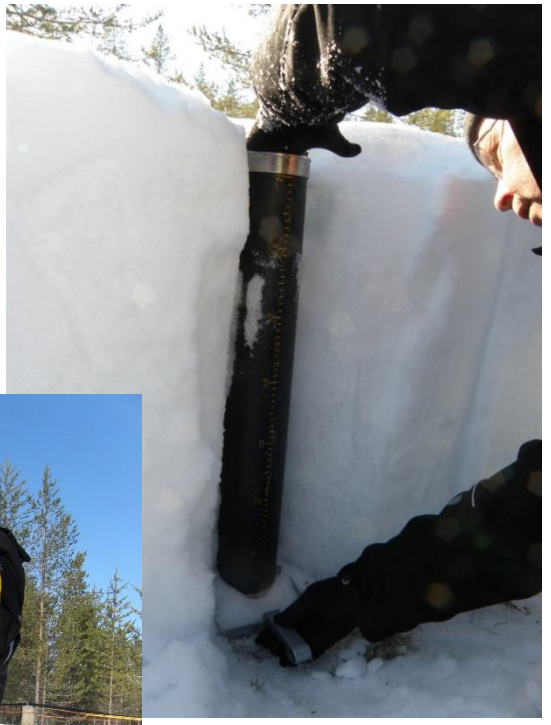


SSA

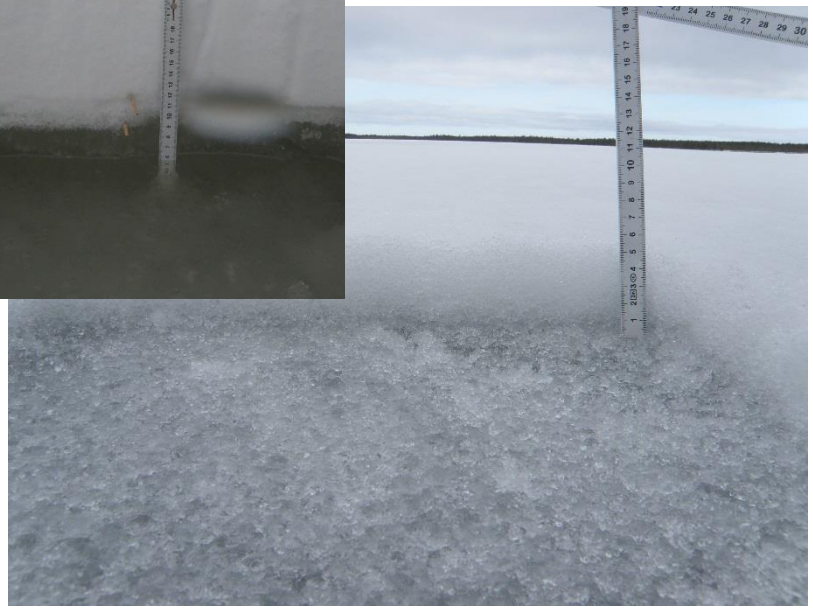
- SSA profile with 3 cm resolution
- Measures hemispherical reflectance of infrared laser (1310 nm) from snow sample surface
- Results are converted to reflectance and forward SSA with software



Density and SWE



Lake ice and snow



Snow courses

- Snow depth variability course
  - 8 stakes at IOA
- Snow depth and SWE variability course
  - 4 km long
  - 80 snow depth and 8 SWE

Examples of past campaigns

WMO SPICE

Solid Precipitation Intercomparison Experiment

- Intercomparison of precipitation detectors, precipitation gauges, snow depth sensors, SWE instruments
- 20 sites around the world
- Our interest: snow on ground
- Measurements 2012-2015, now data analysis

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ESA NoSREx
Nordic Snow Radar Experiment

- Goal: Provide data for proposed EE7 *CoReH$_2$O* Phase A studies:
  - Seasonal signatures of snow covered terrain (scatterometer + radiometer measurements at fixed site)
  - Spatial variability of backscatter signal (airborne measurements) → *CoReH$_2$O* retrieval algorithm development and mission concept demonstration
- Data from four full winter seasons
  - NosREx I: 2009-2010
  - NoSREx II: 2010-2011 (airborne test)
  - NoSREx III: 2011-2012 (airborne concept demo)
  - NoSREx IV: 2012-2013
- Continuous measurements with ESA SnowScat (X to Ku band scatterometer) and radiometers (L to W band)
- Weekly/daily observations of snow micro- and macrophysical properties
- Airborne campaigns with ESA SnowSAR system

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3rd Snow Science Winter School

- February 2017 in Sodankylä, Finland
- Lectures on snow structure, modeling, remote sensing, preparing a field campaign, measurement networks, …
- Focus on microwave measurements, in addition to field work, techniques, and instrumentation


Thank You for Your Attention!
Photo: Matias Takala