ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Microphysics of snowflakes: What can we measure?

A. von Lerber *Finnish Meteorological Institute, Finland*
D. Moisseev, J. Tiira and M. Leskinen *University of Helsinki, Finland*
S. Kneifel, *University of Cologne, Germany*

Objectives

Painting picture of the microphysical properties of snow by observations from multi-instrumental measurements

Connecting quantitative estimation of snowfall with multi-frequency and dual-pol radar observations

Characterizing the performance of instruments for measuring hydrometeors

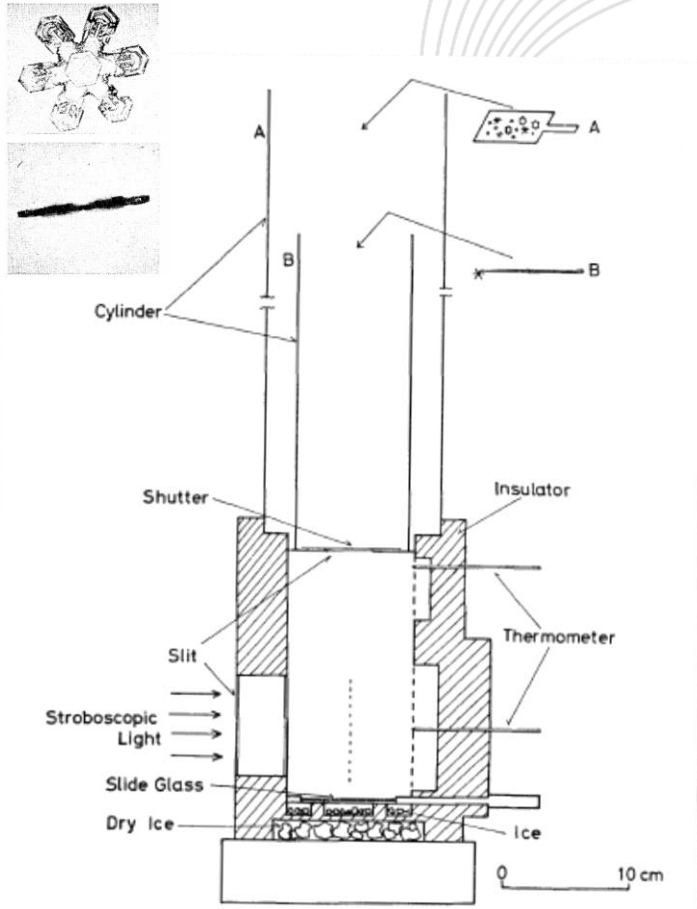


Fig. 1. Apparatus for measurement of falling velocity.

Kajikawa, 1972

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

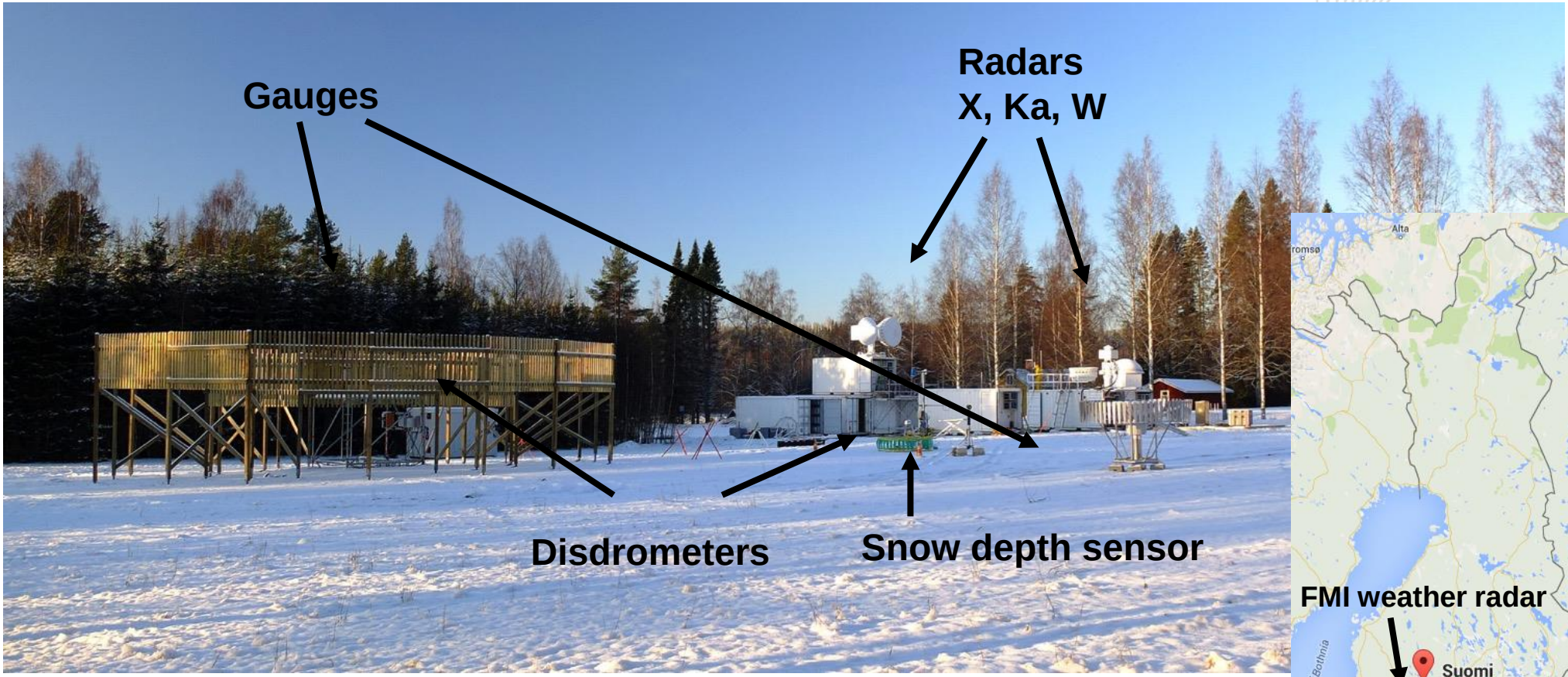
Measurement site

Field station in Hyytiälä, University of Helsinki

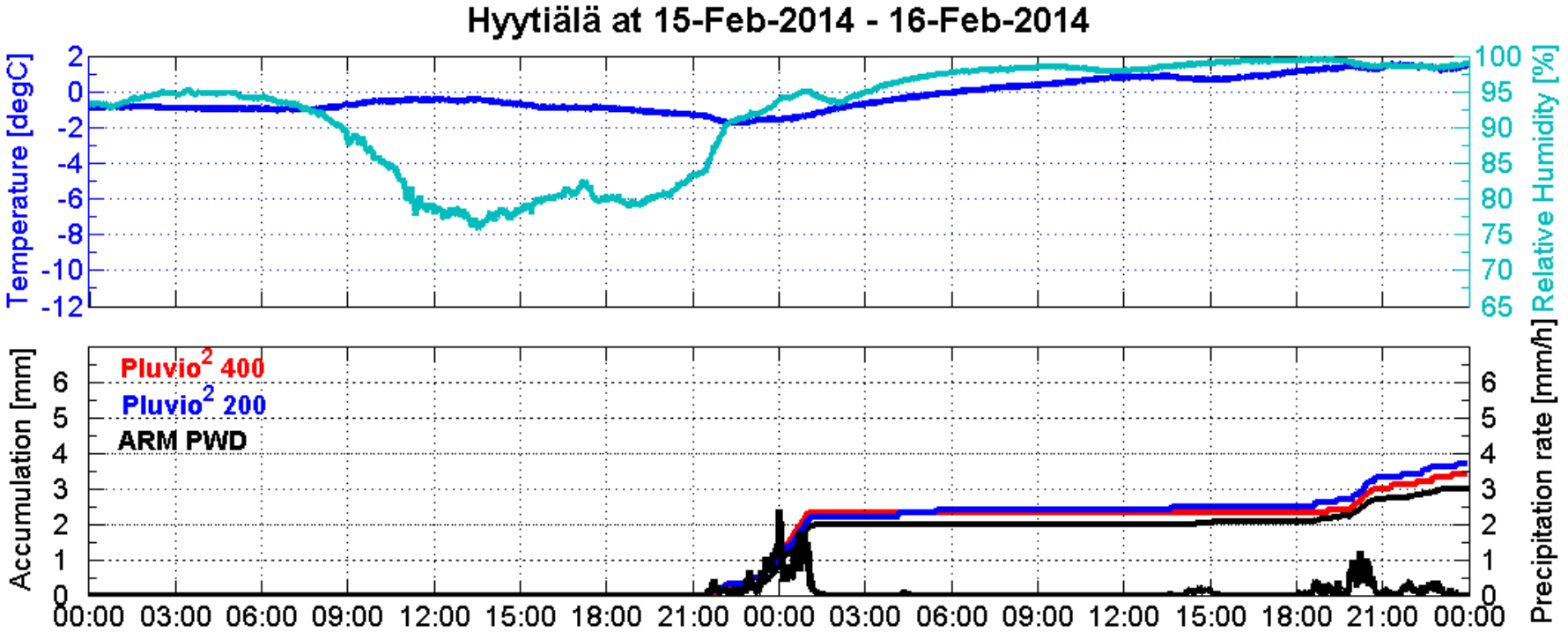
BAECC (Biogenic Aerosols - Effects on Clouds and Climate) Feb 1- Sep 12 2014

GPM Ground Validation program 2013-2018

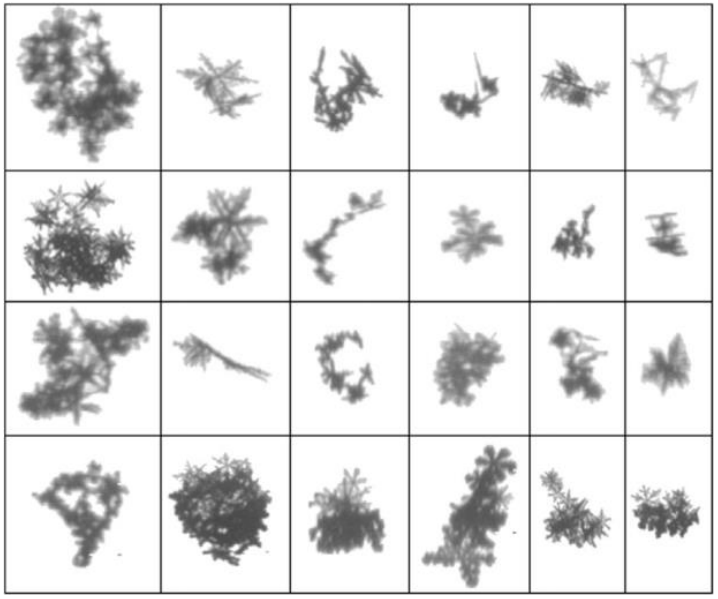
Measurement site



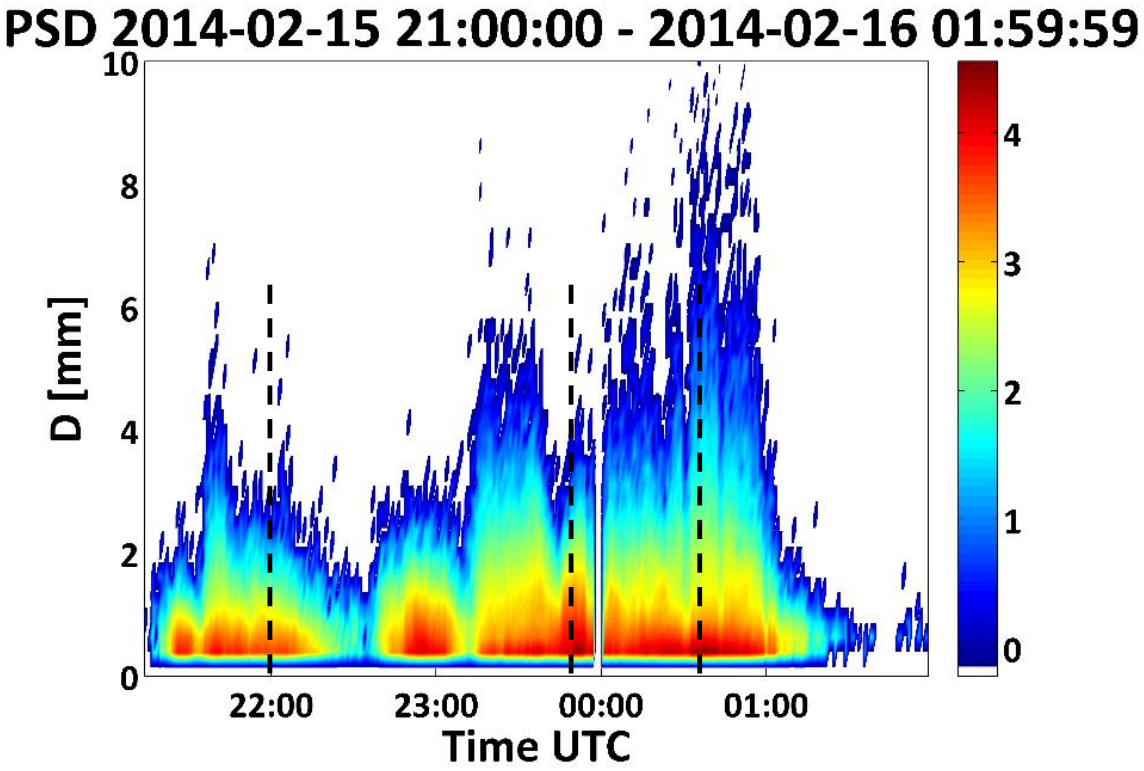
Snow Event on 15-16 Feb 2014

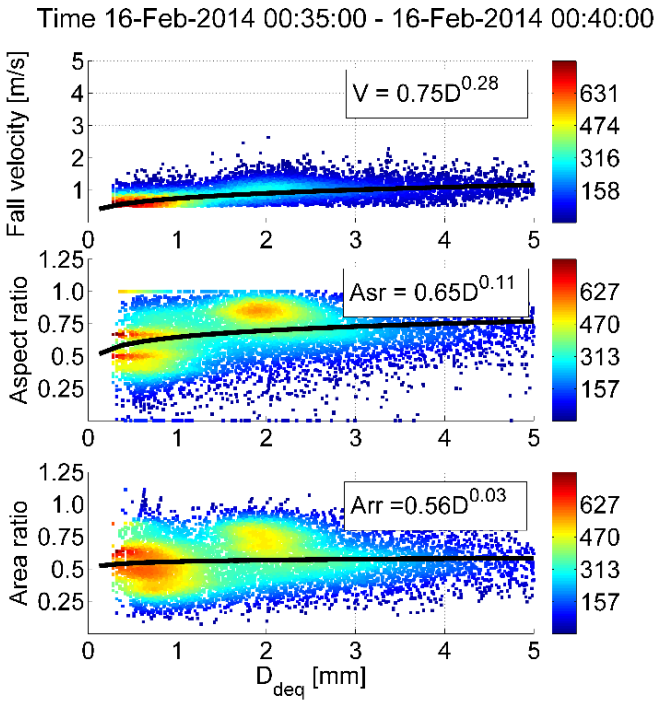


Disdrometer observations : PIP (Particle Imaging Package)

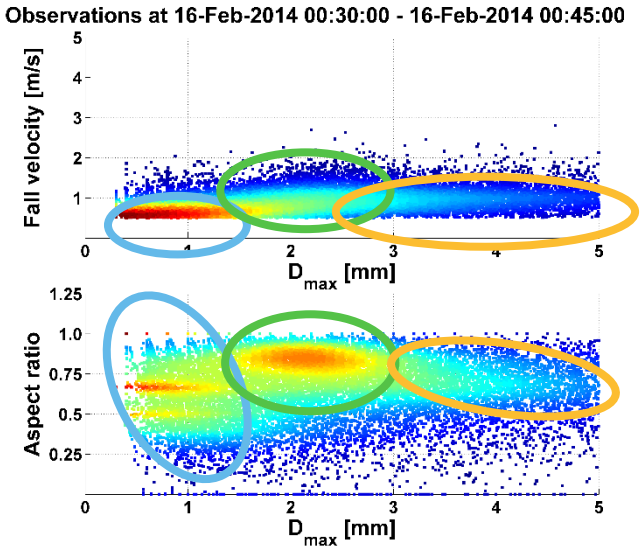


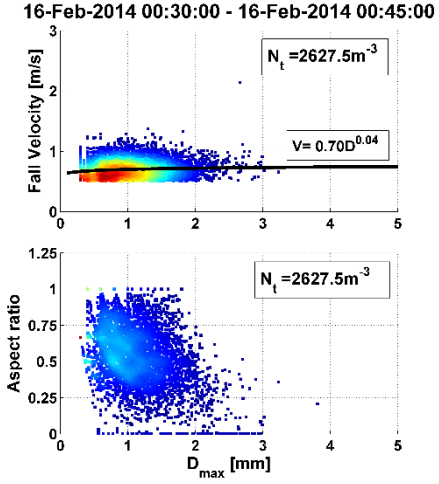
PIP: PSD, velocity, shape

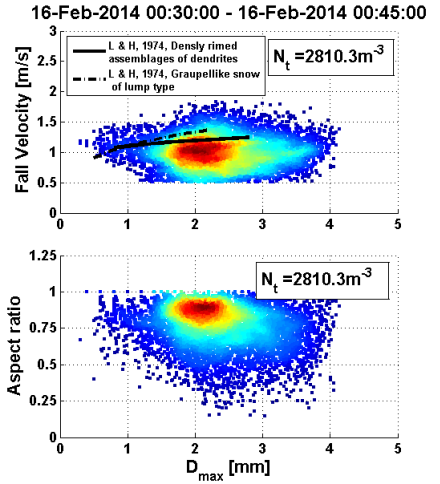


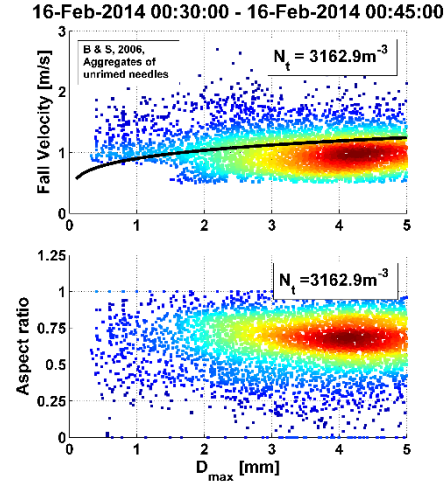


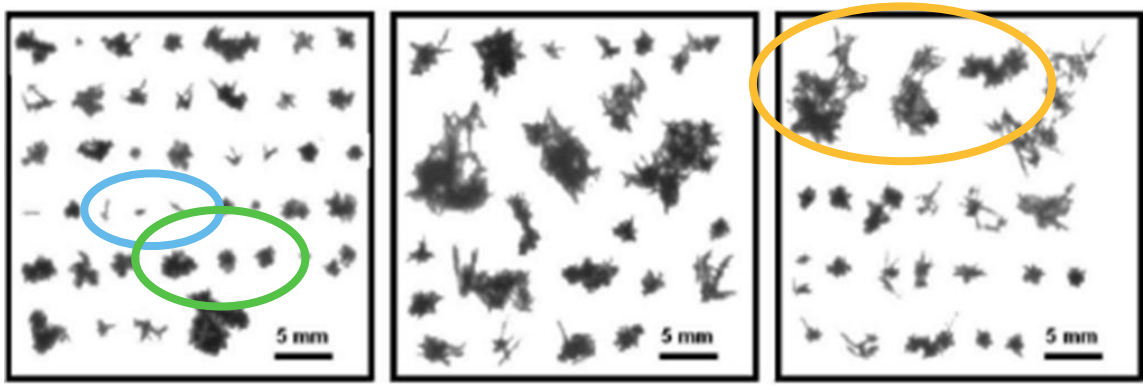
Clustering of snow particle types







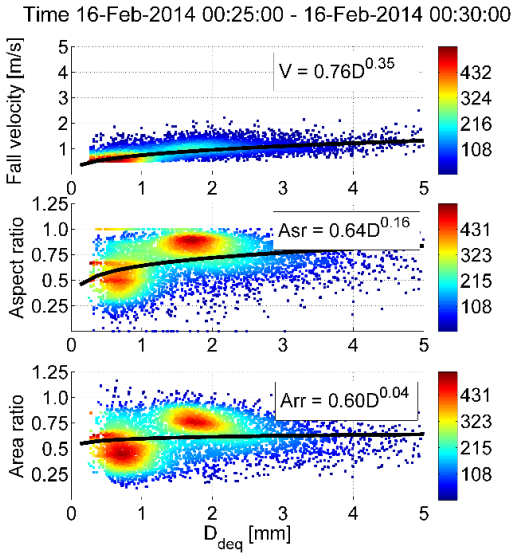


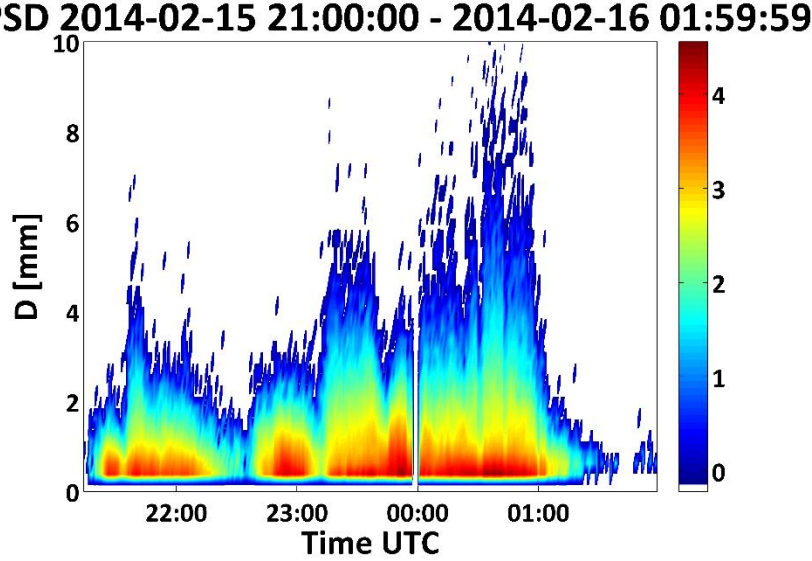


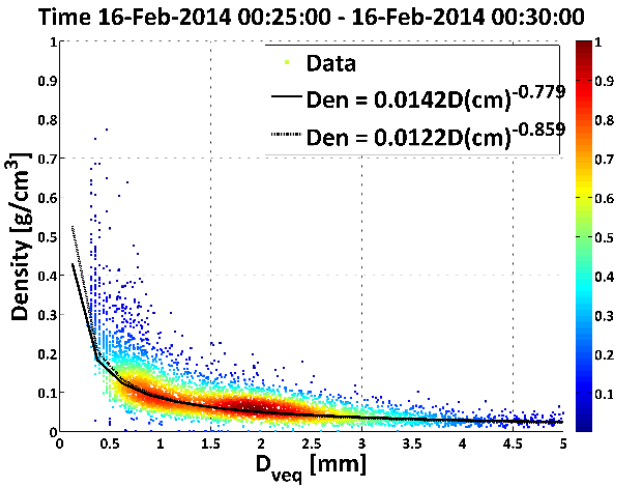
Retrieve density of snowflakes

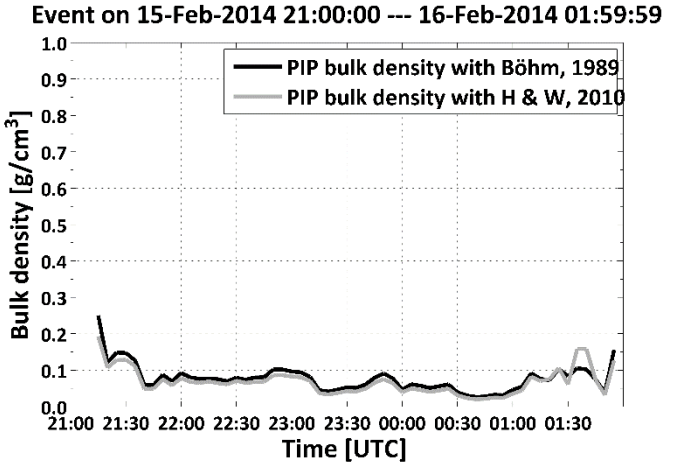
Utilizing the general hydrodynamic theory (Böhm, 1989)

- Drag force = gravity
- Depends on observations and assumptions of particle shapes

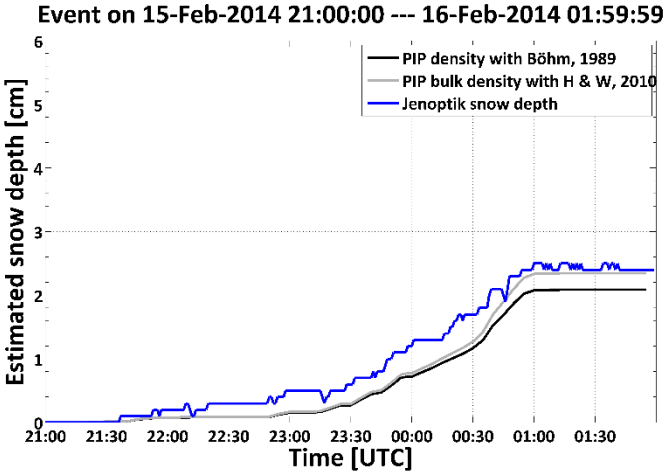


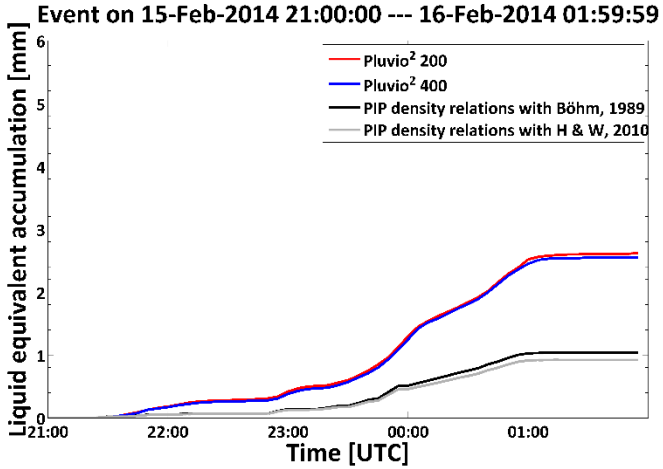






Comparison to gauges and snow depth sensor

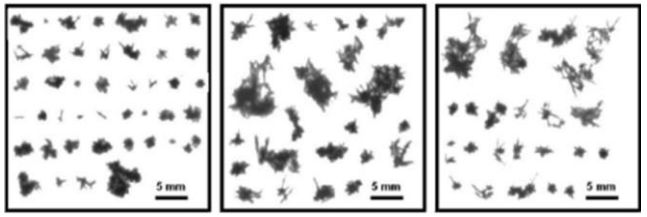


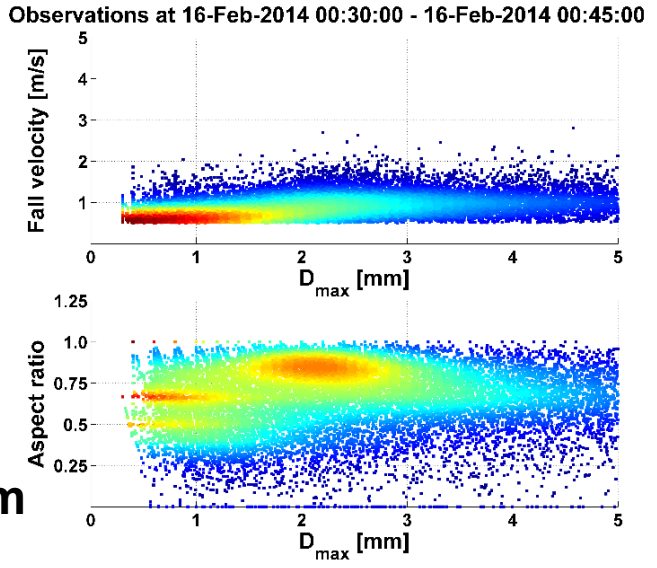


Microphysical processes

Ice multiplication process? (Hallet-Mossop)

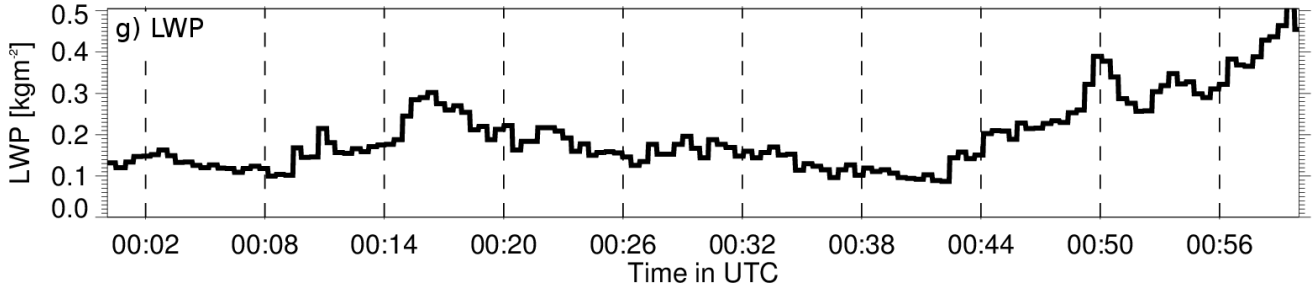
- Discrepancy between ice particle concentration and ice forming nuclei
- Production of ice splinters when a super cooled cloud droplets froze first on the surface
- Splinters grow with water vapor deposition
- Conditions:
  1. Temperature regime between -3 °C and -8 °C
  2. Cloud droplets D > 24 µm
  3. Coexistence of droplets D < 12 and D > 24 µm

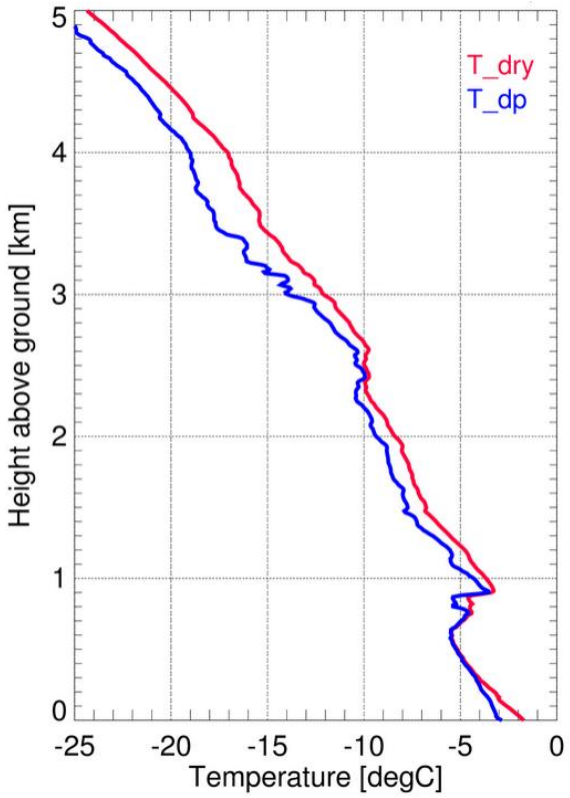




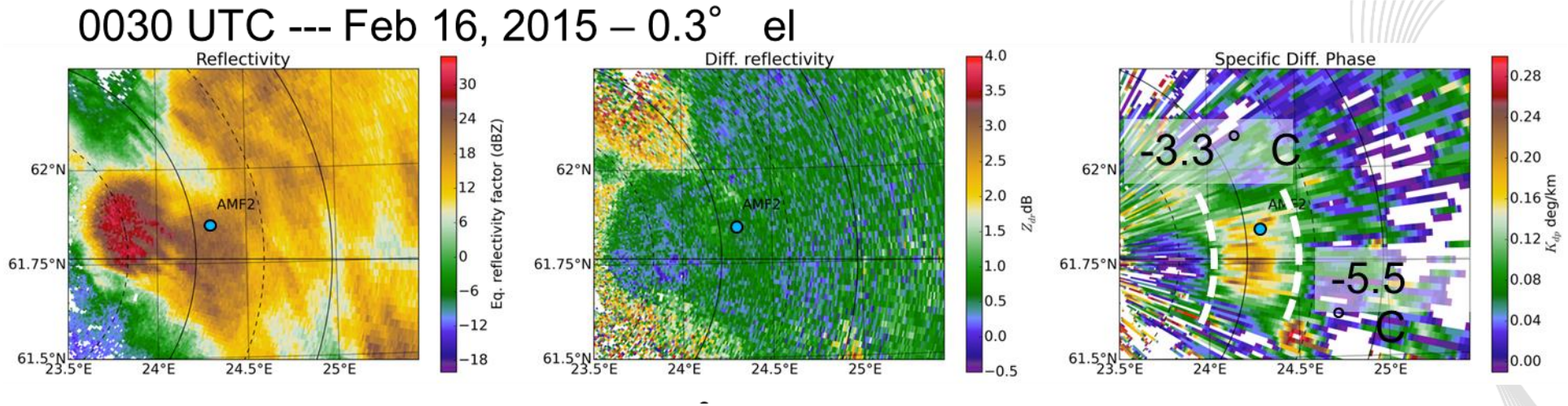
Microphysical processes

Ice multiplication process? (Hallet-Mossop)



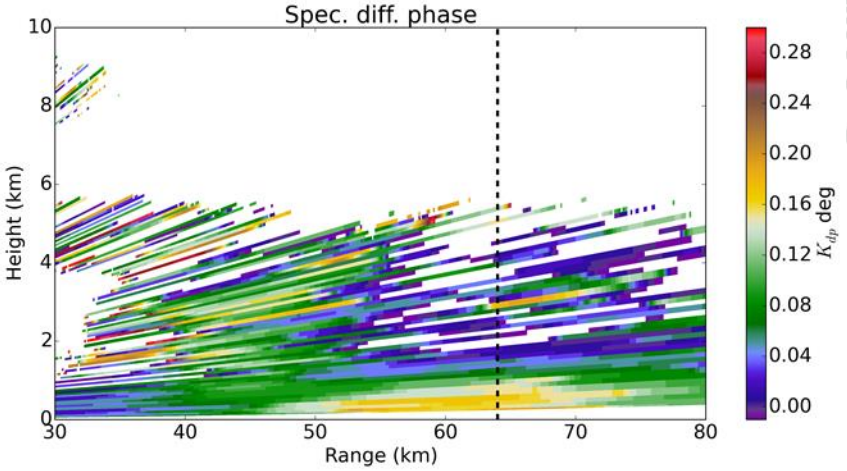


Comparison with weather radar

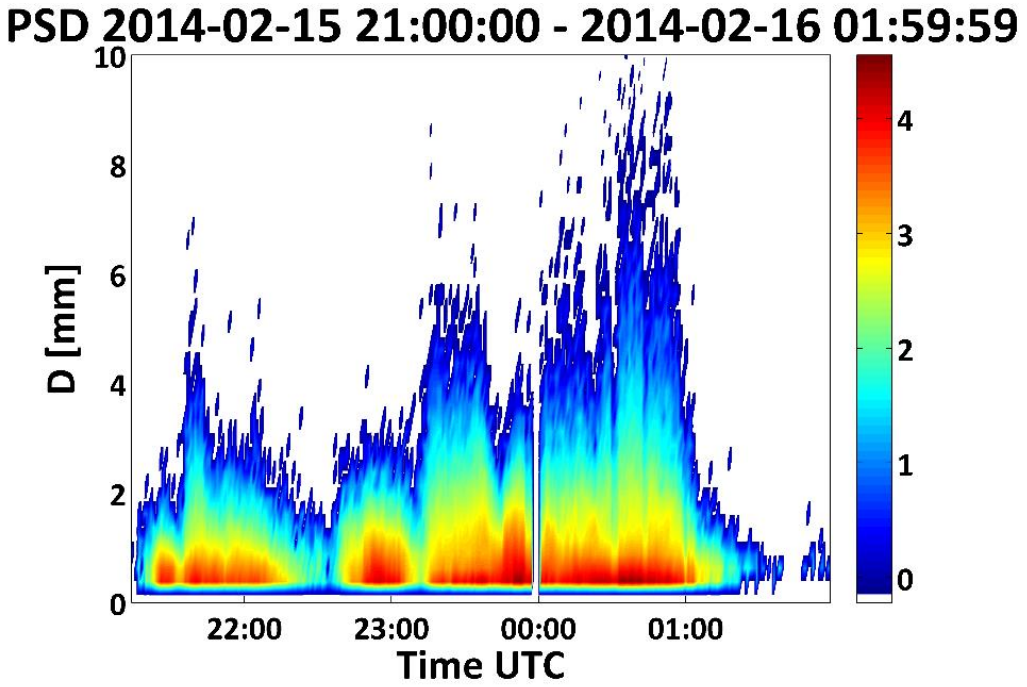


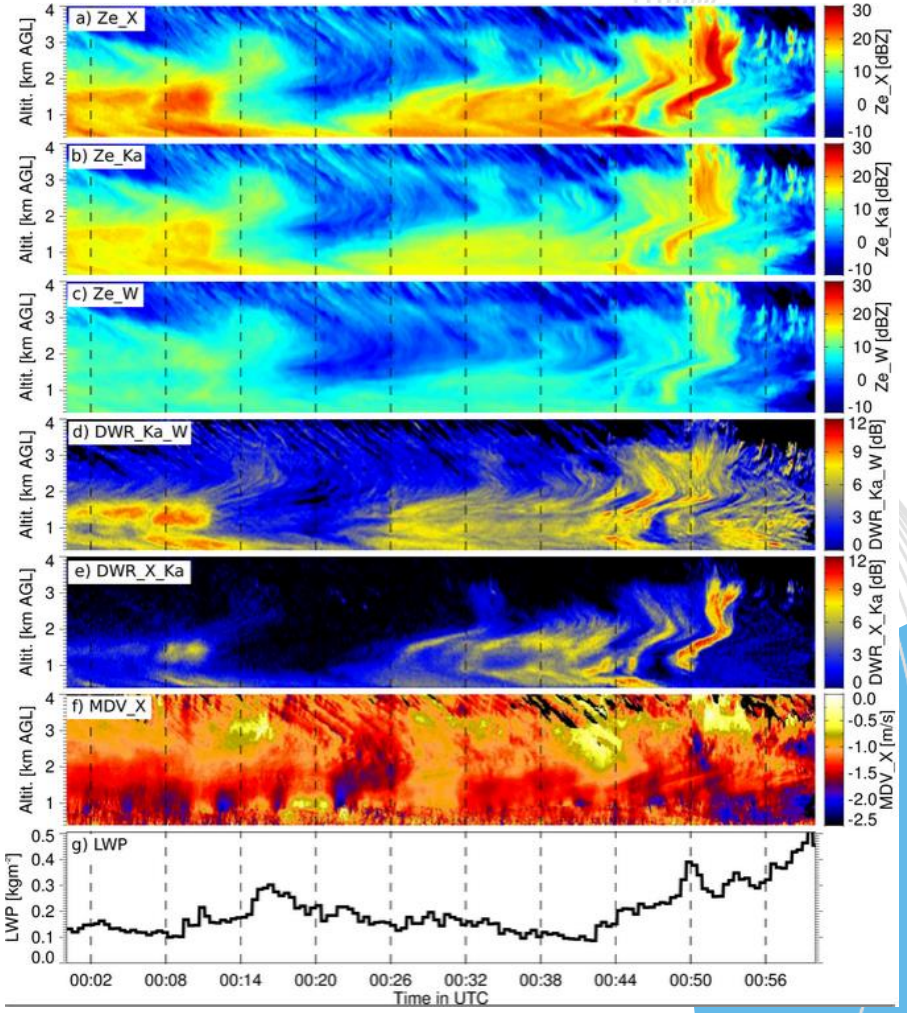
- **Zdr = differential reflectivity**
  - **Ratio of horizontal to vertical component**
  - **Indicates the shape of the scatterers**

- **Kdp = specific differential phase**
  - **derivative of the phase shift between the horizontal and vertical wave component**
  - **sensitive to number concentration and shape of oblate particles, can be used to distinguish anisotropic hydrometeors**



Triple-frequency observations





- **Applications in satellite observations, e.g. GPM**

Summery

- **Fall velocity and shape measurements can be utilized to classify snow particle types**
- **Density of falling snow can be retrieved from precipitation measurements**
- **Remote sensing observations can be used to describe snowfall microphysical processes**
  - **K_{dp} bands are a good tool for detection and characterization of secondary ice production zones**
  - **Indirectly indicates presence of super cooled water**
  - **Signifies onset of aggregation**
  - **Triple-frequency observations have distinguishable signatures for different particle sizes/types**

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE