Retrieval of shape and orientation of multiple hydrometeor types from observations of scanning hybrid-mode Ka-band cloud radar

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PROM all hands meeting
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Leibniz Association

ACCEPT

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Outline

1 Motivation & Introduction

2 Methodology

3 Result

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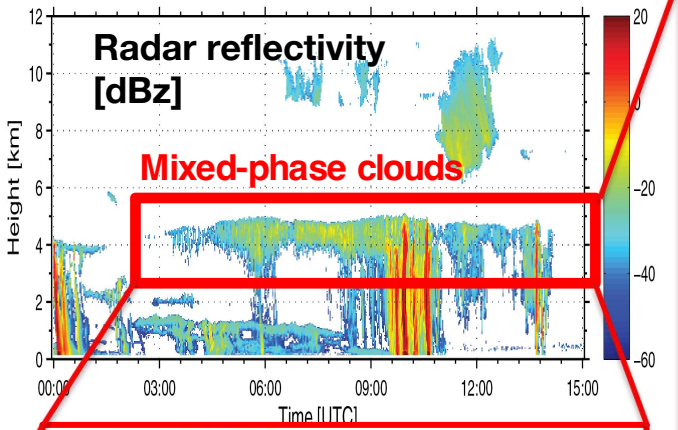
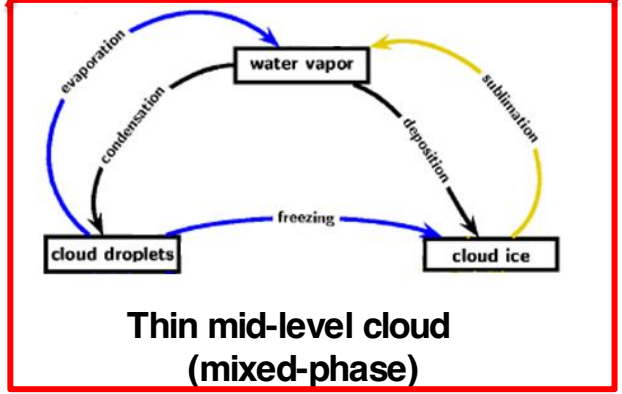
Motivation: shape retrieval idea in mixed-phase clouds

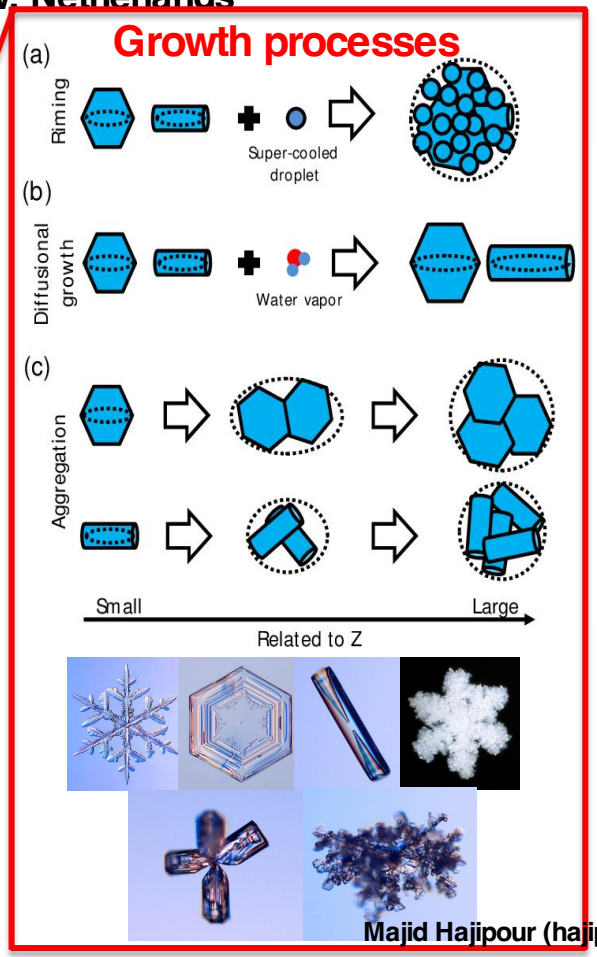
Layered clouds, 30 Oct 2014, Cabauw, Netherlands



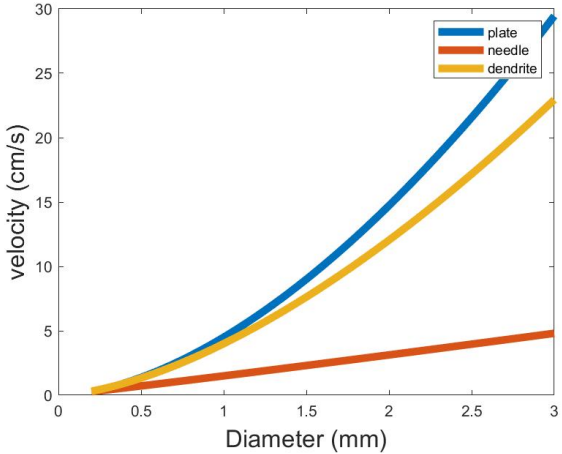


Thin mid-level cloud (mixed-phase)

Guichard et al. (2017)



Size-fall velocity relationships



Pfitzenmaier et al. (2018)

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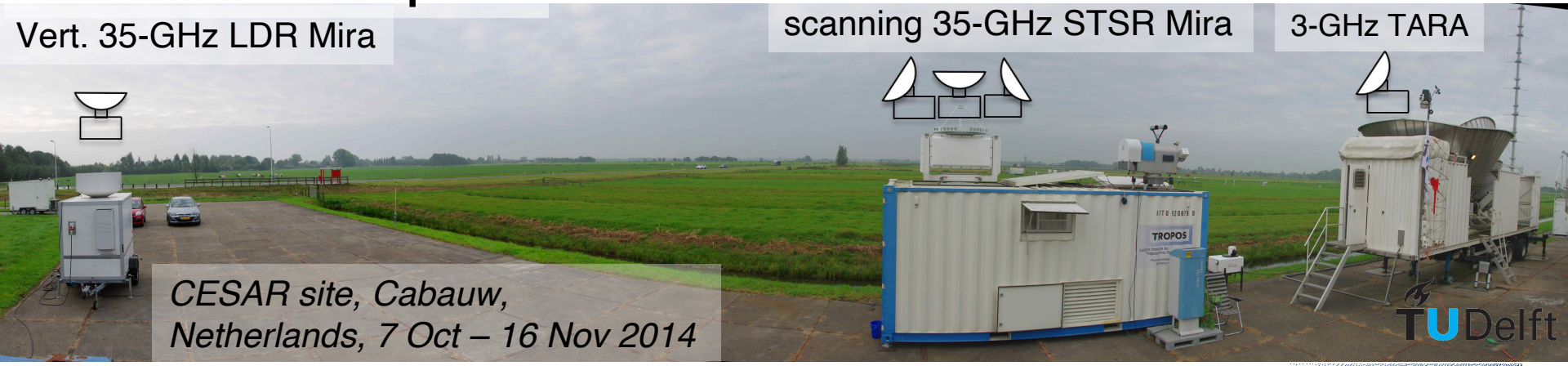
ACCEPT campaign

Analysis of the Composition of Clouds with Extended Polarization Techniques

- 6-week measurement campaign at CESAR obs., Cabauw
- **Vert. pointing LDR-mode Mira-35 (TROPOS)**
- **Scanning STSR-mode Mira-35 (TROPOS/Metek)**
- Tilted full polarimetric S-band TARA (TU Delft)

+ Lidars, MWR, Doppler lidar, wind profiler, radiosondes



CESAR site, Cabauw, Netherlands, 7 Oct – 16 Nov 2014

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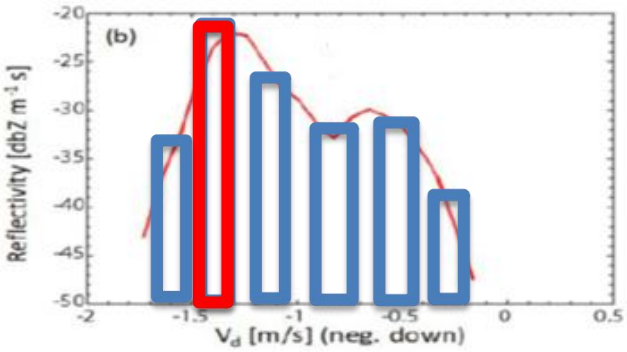
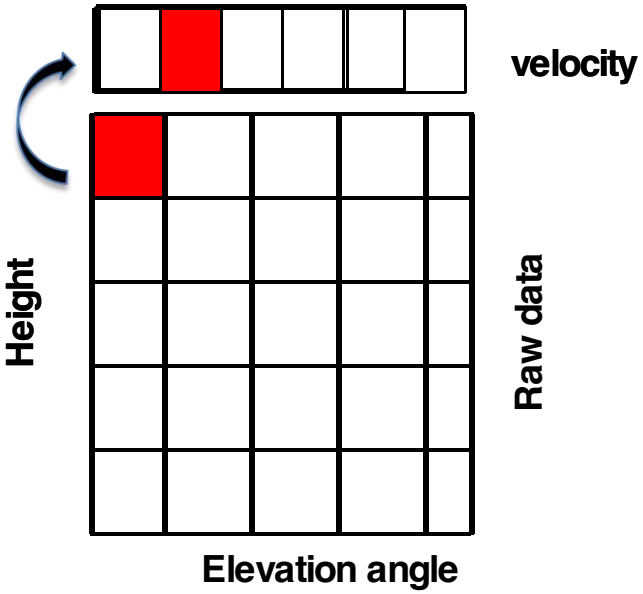
Original shape retrieval approach: Main peak of Doppler spectrum





Modeling

Simulation of polarimetric variables ZDR and ρ_{hv} for different values of shape and orientation as a function of antenna elevation

Observation

Selecting main peak of Doppler spectrum for each pair of height and elevation angle

Comparing observed and modeled ZDR and ρ_{hv} to find best agreement. (using minimum mean square error)

Shape & orientation

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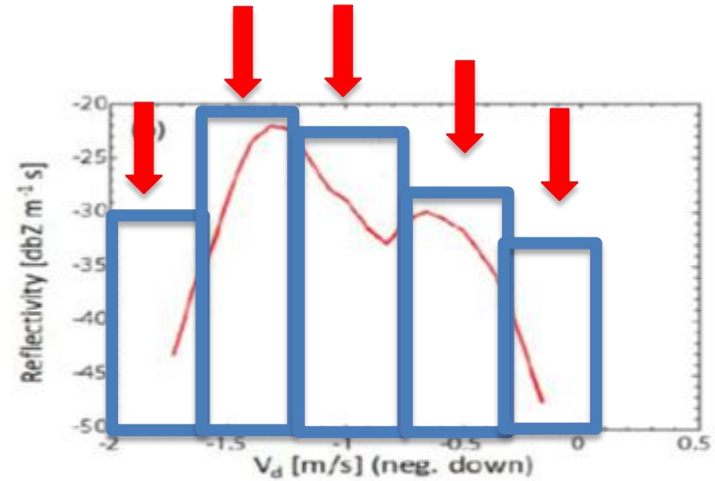
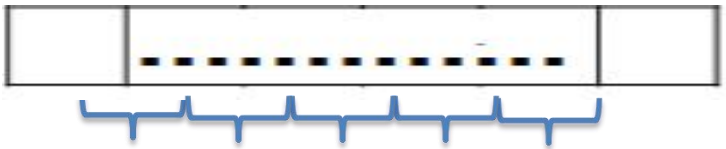
Extension of Myagkov et al. 2016 (AMT) shape retrieval approach

Retrieval method





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Modeling

Simulation of polarimetric variables ZDR and ρ_{hv} for different values of shape and orientation as a function of antenna elevation

Observation

Splitting Doppler spectrum into 5 bins for each pair of height and elevation angle

Comparing observed and modeled ZDR and ρ_{hv} to find best agreement. (using minimum mean square error)

Shape & orientation

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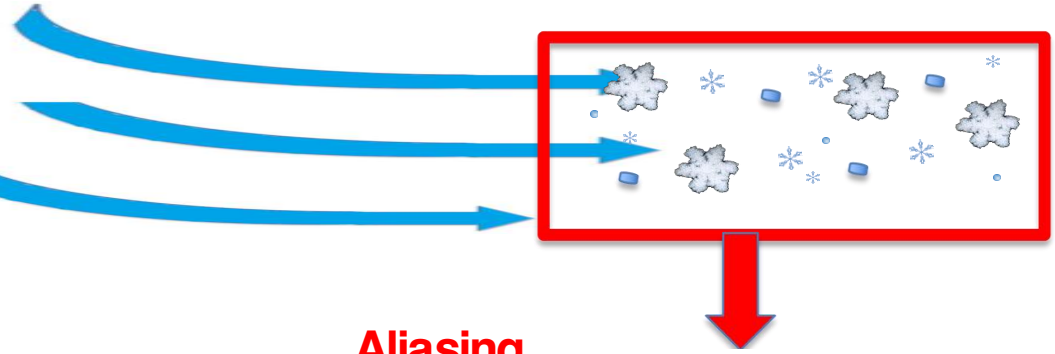
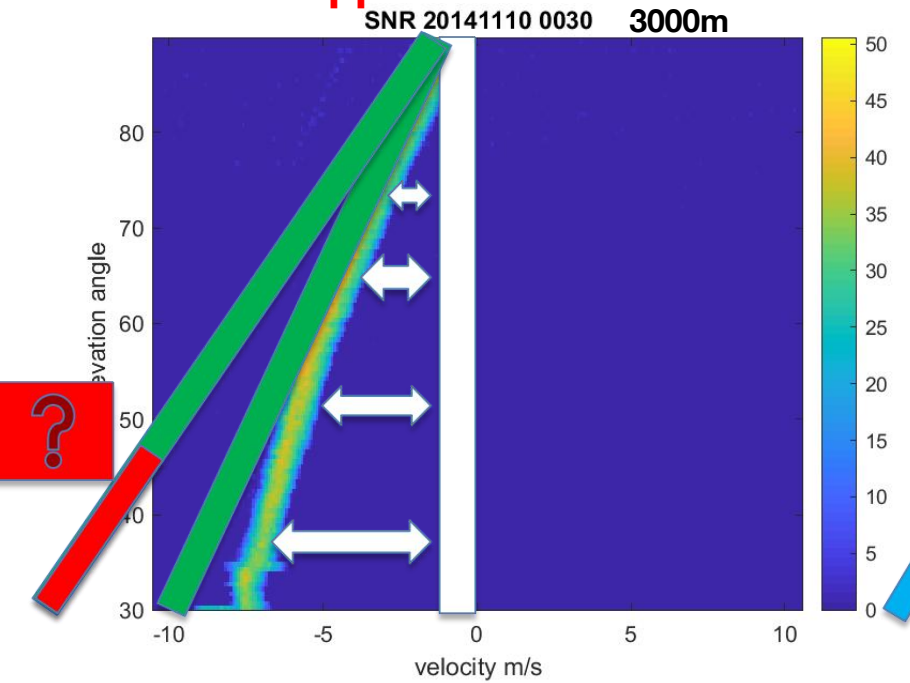
Wind effects

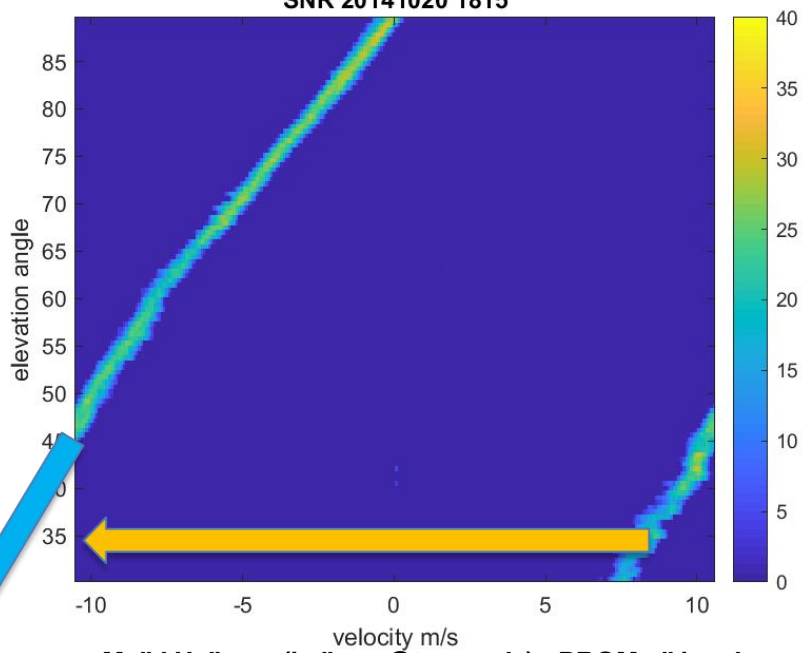
- ✓ horizontal wind effects shift the Doppler spectrum. This shift increases with decreasing elevation angle.



Doppler shift

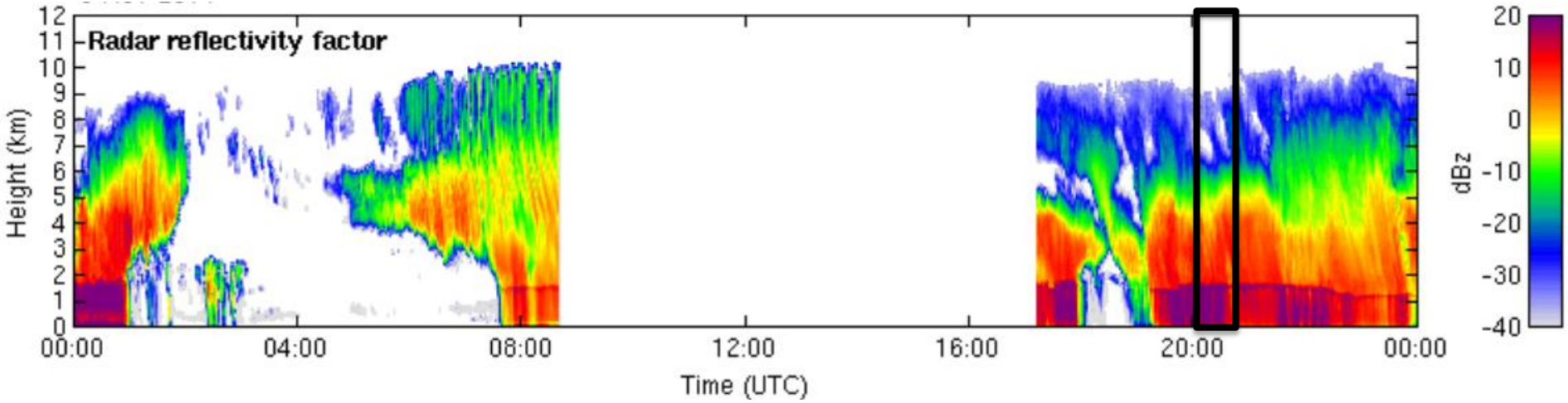


Aliasing

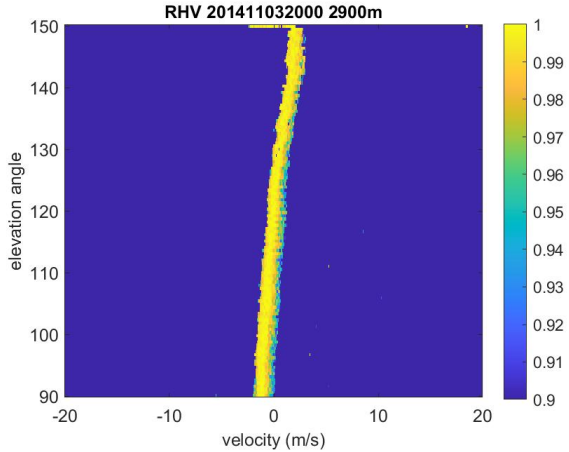


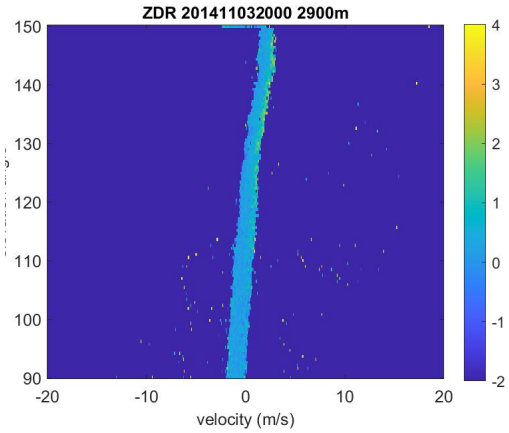
Result:

Case study: Date: 2014.11.03 Time: 20:00-20:15 Height: 3000 m



RHI 1





Split of RHI-scans of Doppler spectra of ZDR and RHV into 5 parts

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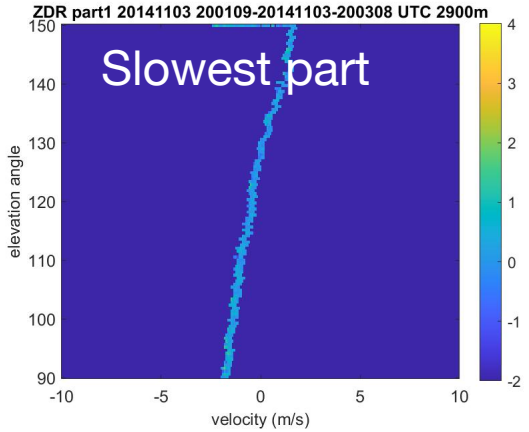
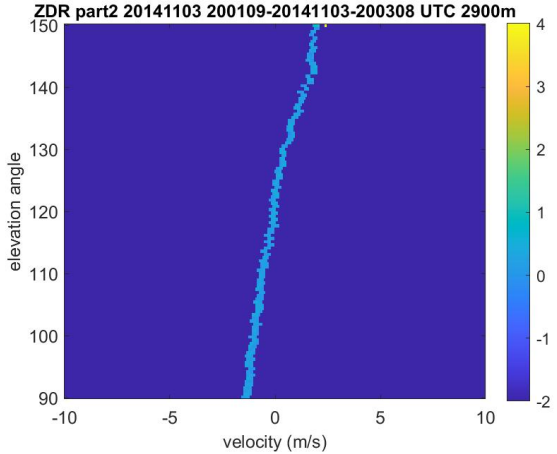
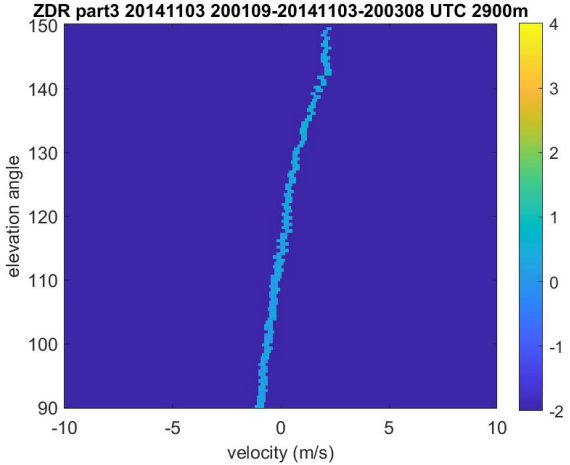
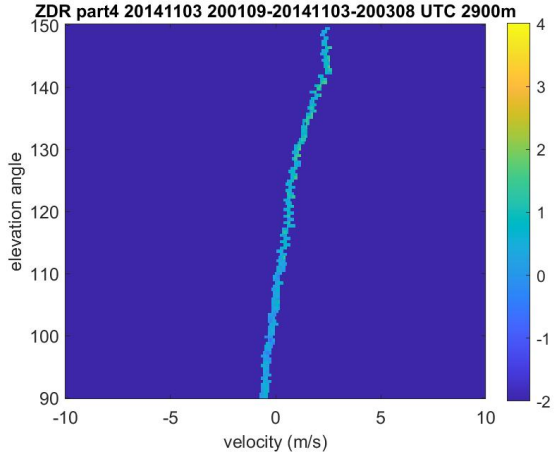
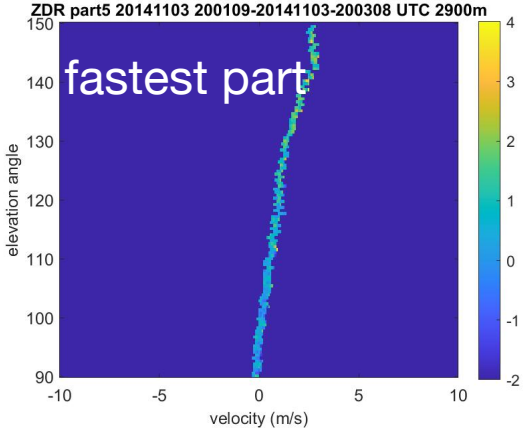
Differential Reflectivity (ZDR) for each Doppler part











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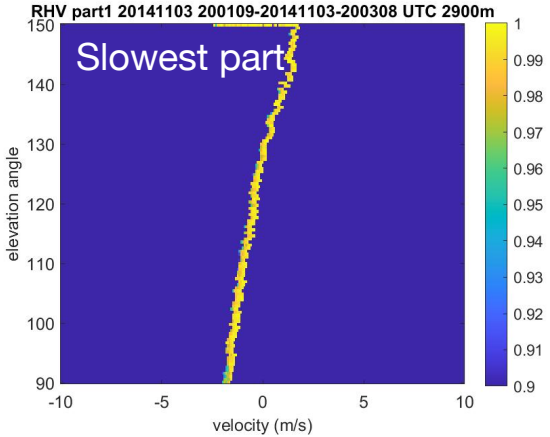
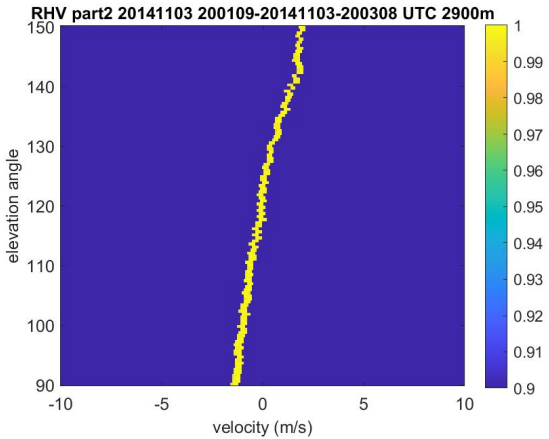
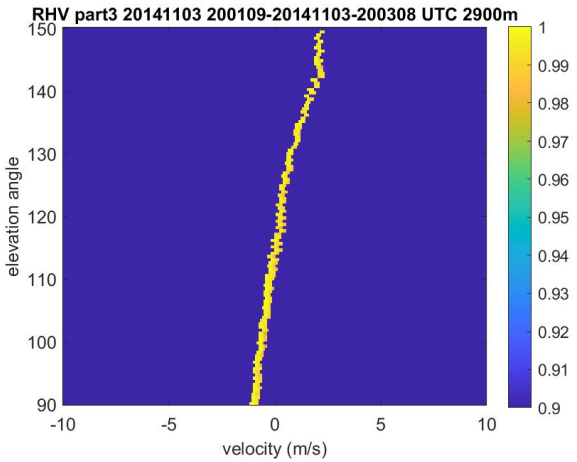
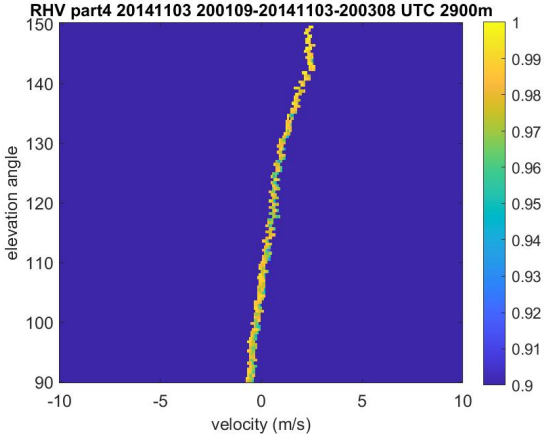
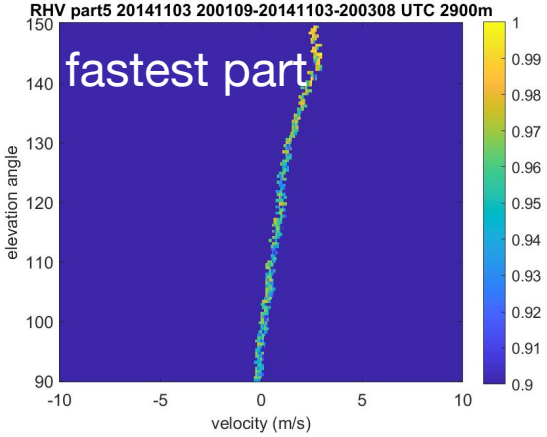
Correlation Coefficient (RHO_HV) for each Doppler part











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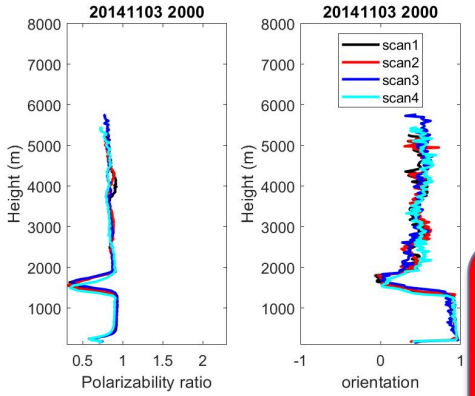
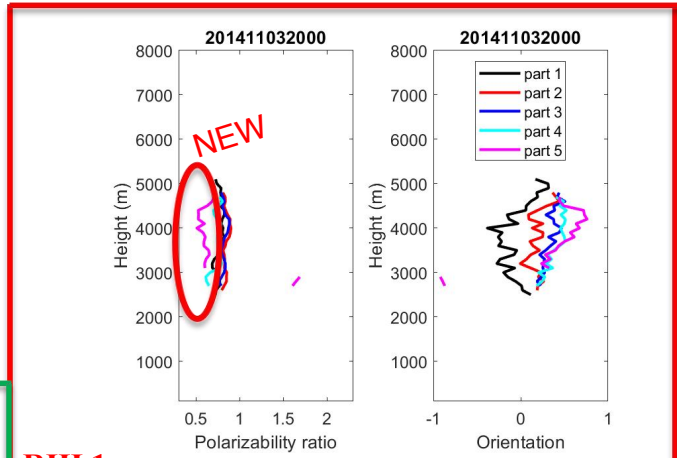
Retrieval results

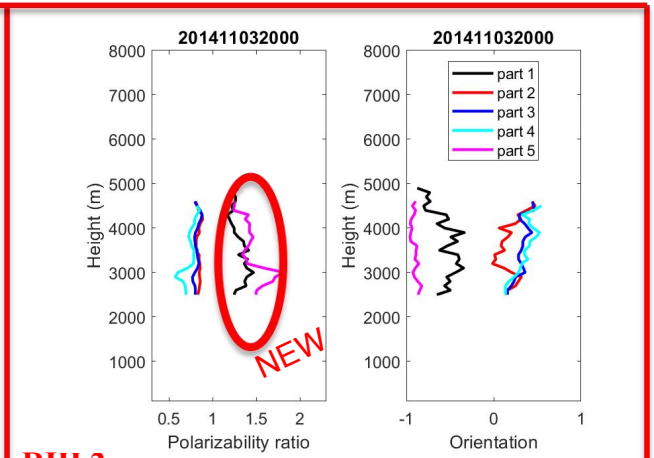
Date: 2014.11.03
Time: 20:00-20:15
Height: 3000 m

Main Peak

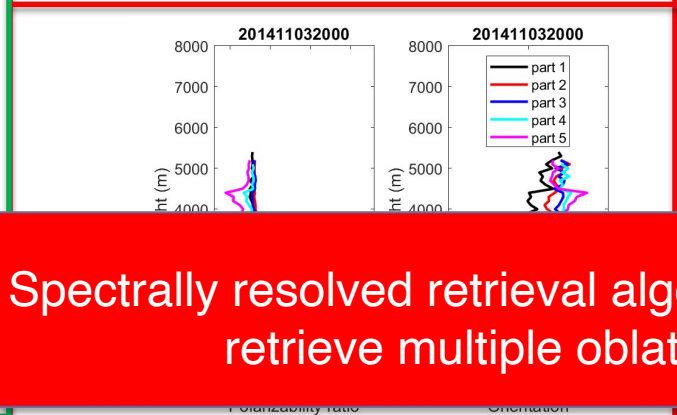




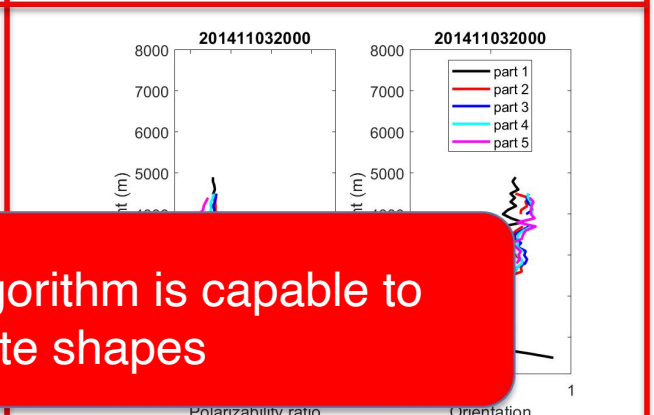
RHI 1



RHI 2



RHI 3



RHI 4

Spectrally resolved retrieval algorithm is capable to retrieve multiple oblate shapes

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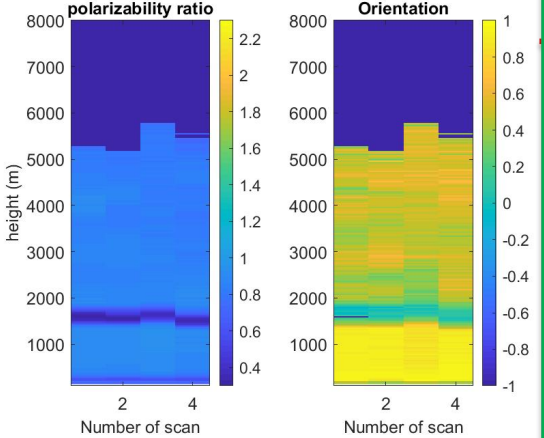
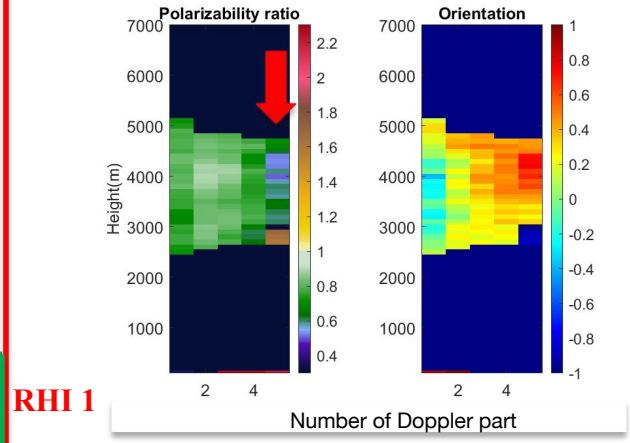
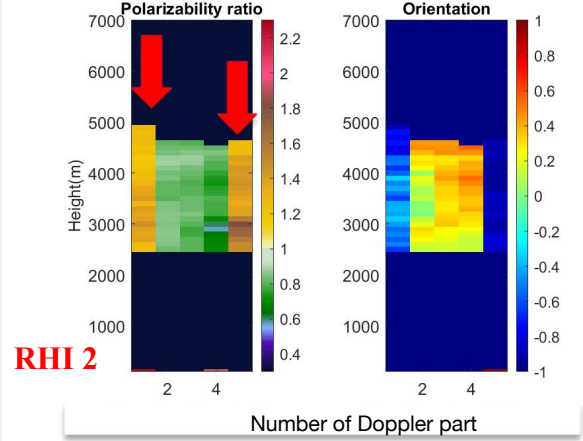
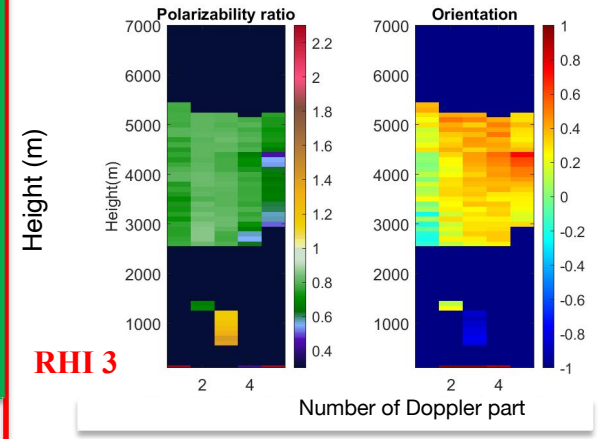
Retrieval results

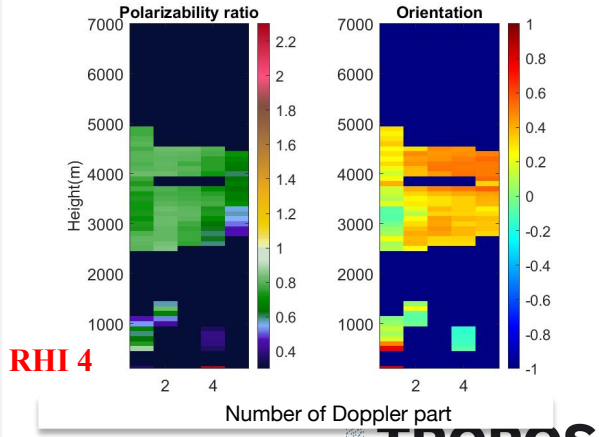
Date: 2014.11.03
Time: 20:00-20:15
Height: 3000 m











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Summary

Achievemnt so far:

1. Automatic retrieval exists Based on one 5–minute RHI scan of ZDR and RHV, information about shape distribution can be obtained regularly
2. Quantitative approach which can be applied to STSR(hybrid–mode) polarimetric (cloud) radars.
3. Scanning polarimetric cloud radar enables us to retrieve shape and orientation of ice particles.
4. Using spectrally resolved approach, multiple hydrometeor types can be retrieved.

Current task:

1. Statistics: Evaluate all RHI scans from ACCEPT for presence of multiple hydrometeor shape
2. Write and finish thesis
3. Evaluaton of the retrieval against auxiliary observations (e.g. spectral methods (PeakTree) or Cloudnet)”

Future task:

1. Publish article about shape retrieval technique
2. Publish article about specular reflecting ice crystals observed with co-located lidar and scanning hybrid-mode radar during ACCEPT

Thanks for your attention!

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