# Application of a 35-GHz hybrid-mode cloud Doppler radar for the retrieval of hydrometeor ratios in mixed-phase clouds

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Member of the Leibniz Association

TROPOS
Leibniz Institute for Tropospheric Research

# PhD project SPOCC within DFG Priority program: PROM

*Polarimetric Radar Observations meet atmospheric Modelling*

- SPOCC: Spectrally resolved Polarimetric Observations and Computation of Clouds
  - → Toward the retrieval of hydrometeor ratios from polarimetric cloud radar observations
- Project started in March 2019
  - → This presentation will introduce the approach and previous work


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# Outline

1. Motivation
   - Why we need particle shape measurements

2. Application of cloud-radar polarimetry for detection of particle shape

3. The dataset: ACCEPT campaign 2014

4. SPOCC project: Outlook

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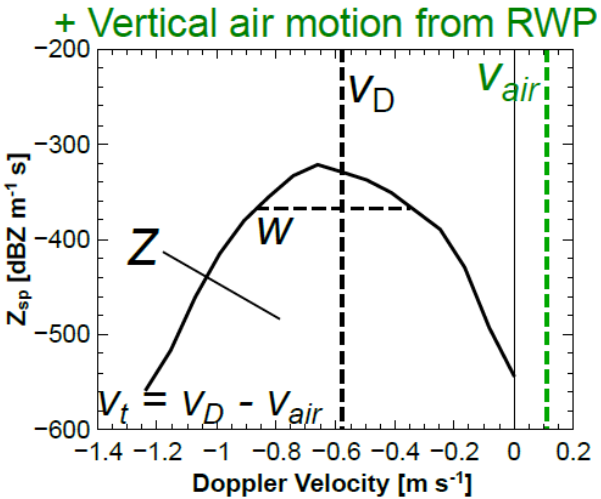
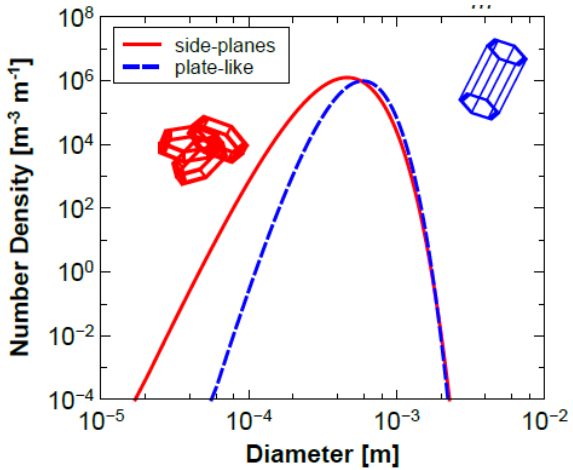
# Why we need particle shape measurements?

- Retrievals of ice microphysical properties, e.g., from cloud radars, require information about crystal shape
- Example: Bühl et al., AMTD, 2019

  → Observed Doppler spectra can be represented by ice particle size distributions for different crystal shapes




*Bühl et al., 2019, AMTD*



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# Application of cloud-radar polarimetry for detection of particle shape

- **Cloud radar required to detect small ice crystals**

Dendrite: Oblate ice crystal

Column: Prolate ice crystal

Crystals characterized by: shape and orientation

Kumjian et al., 2012, JAS:

- Shape and orientation defined by:
  - Differential reflectivity $Z_{DR}$ → oblateness
  - Cross-correlation coefficient $\rho_{hv}$ → diversity of scatterers

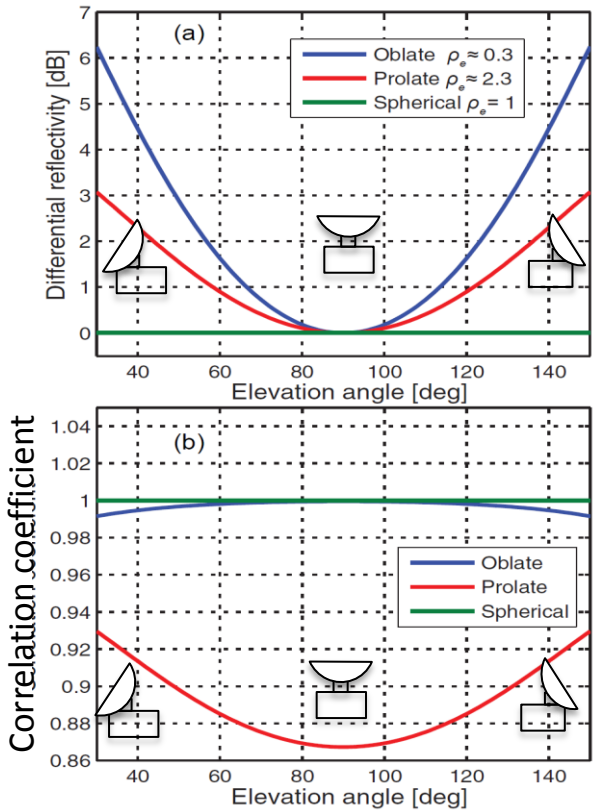
Range-height-indicator (RHI) scans to characterize particle shape and orientation from different elevation angles

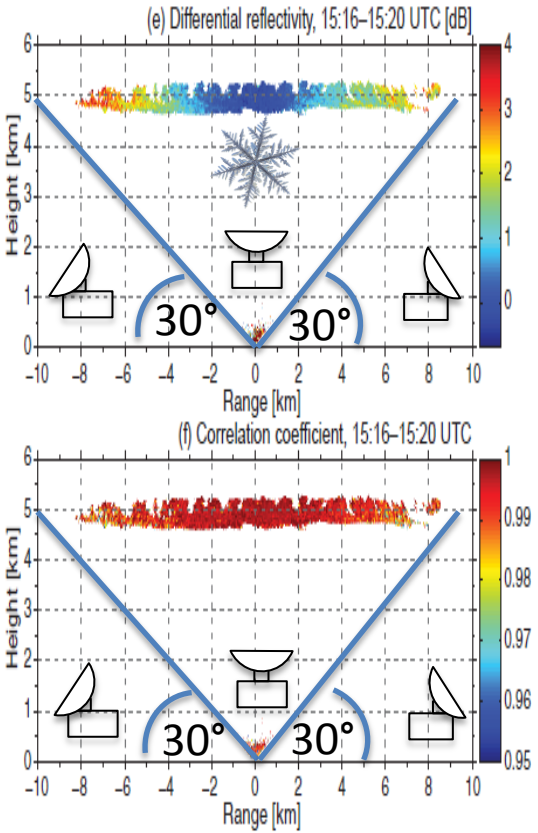
# Application of cloud-radar polarimetry for detection of particle shape

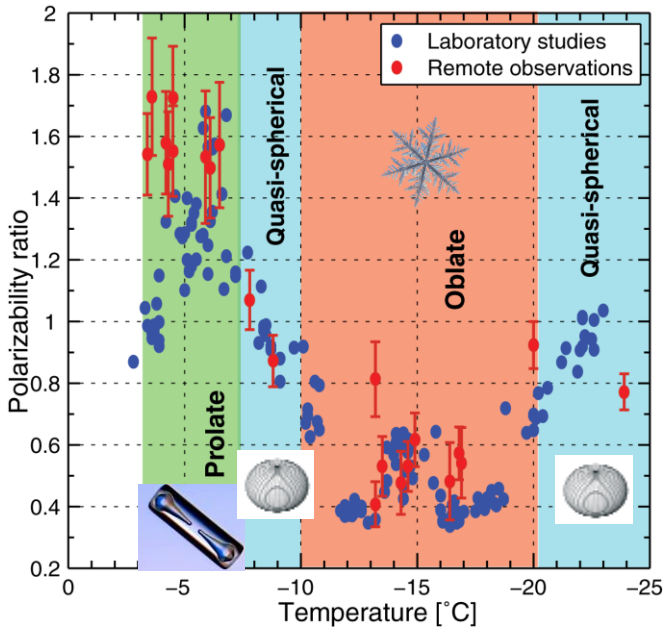
- Case Study: Usage of a polarimetric spheroidal model to obtain $Z_{DR}$ and $\rho_{hv}$

22 case studies of thin, liquid topped mixed-phase clouds

→ Only from the main peak in the Doppler spectrum




*Myagkov et al., AMT, 2015; Myagkov et al., AMT, 2016*

# Application of cloud-radar polarimetry for detection of particle shape

- Case Study: Usage of polarimetric spheroidal model

22 case studies of thin, liquid topped mixed-phase clouds

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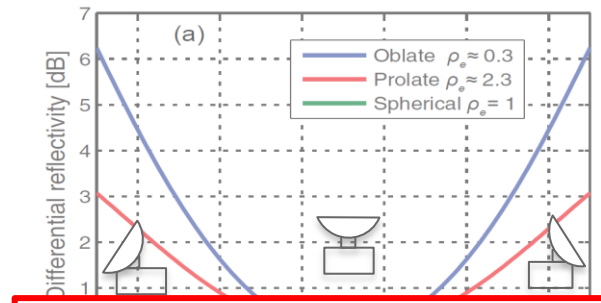
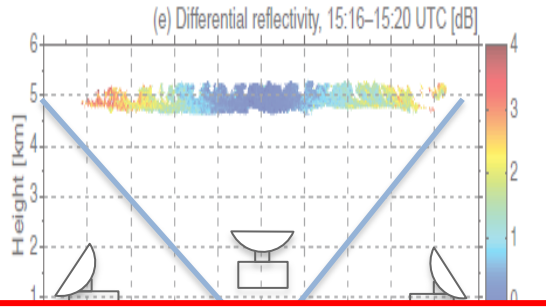
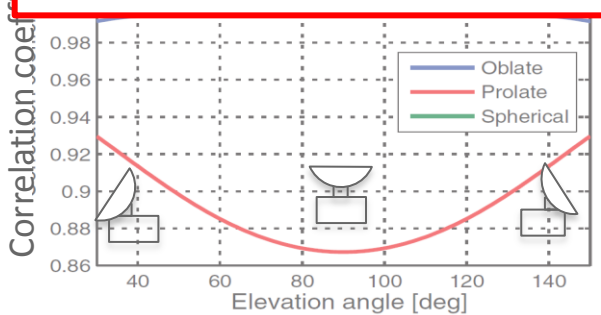
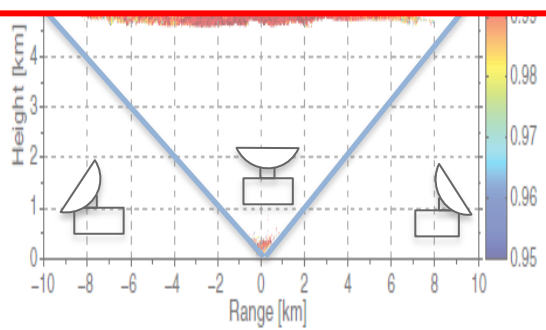
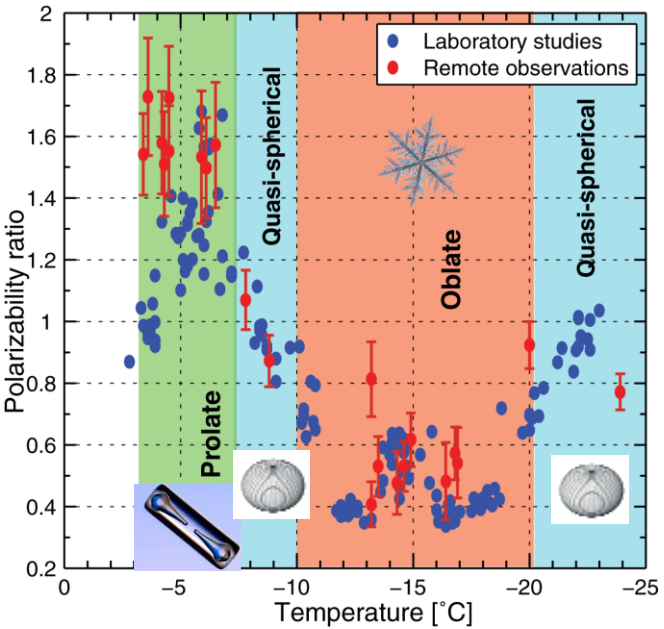



**Observations of stratiform mixed-phase clouds do well reproduce the ice crystal shapes of pristine ice crystals observed in the laboratory**

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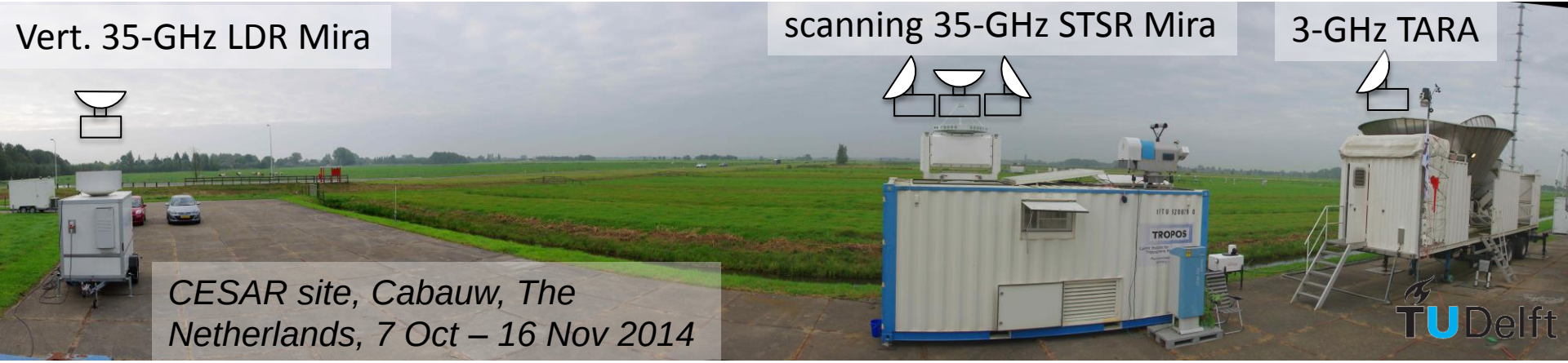
# Analysis of the Composition of Clouds with Extended Polarization Techniques

- 6-week measurement campaign at CESAR observatory, Cabauw, The Netherlands, 7 Oct – 16 Nov. 2014
- **Vertically pointing LDR-mode Mira-35 (TROPOS)**
- **Scanning STSR/hybrid-mode Mira-35 (TROPOS/Metek)**
- Tilted full polarimetric S-band TARA (TU Delft)

+ Lidars, microwave radiometer, Doppler lidar, wind profiler, disdrometer, radiosondes (LACROS)




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

Royal Netherlands Meteorological Institute
*Ministry of Infrastructure and the Environment*

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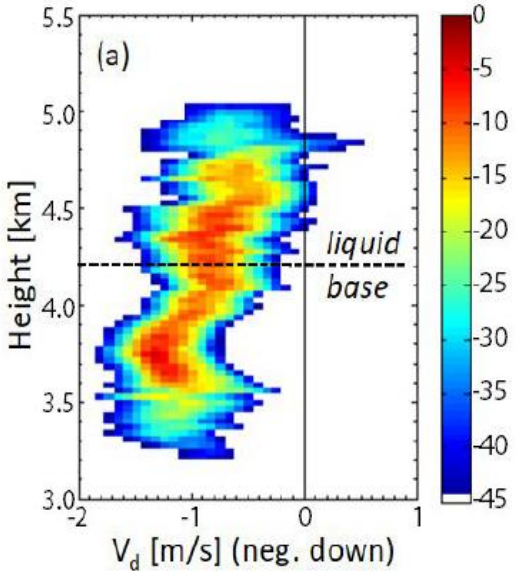
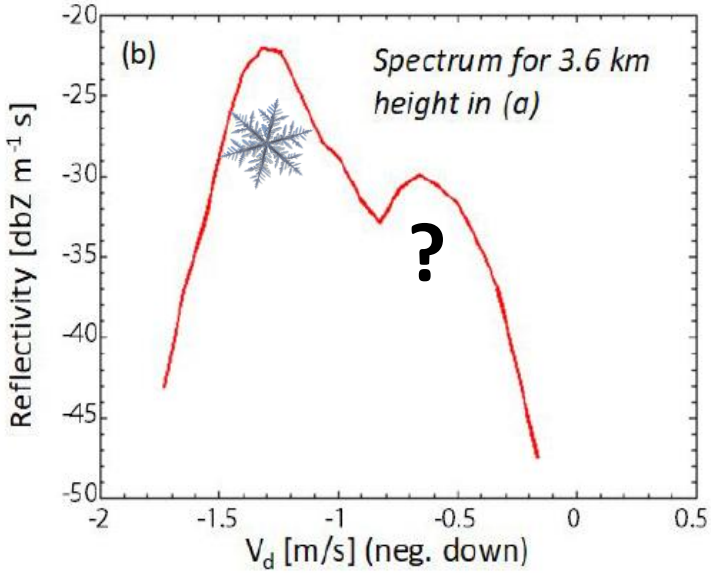
# ACCEPT campaign: Continuous retrieval of hydrometeor shape and orientation

**Next step** → Analyse the full Doppler spectrum

**Towards profiling the distribution of hydrometors in the radar volume**

**Retrieval of Alexander Myagkov is based only on the main peak of the Doppler spectrum**

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# Context of hydrometeor classification within SPOCC