

The Vertical Distribution of Particle Shape (VDPS): Introduction, Application and Evaluation

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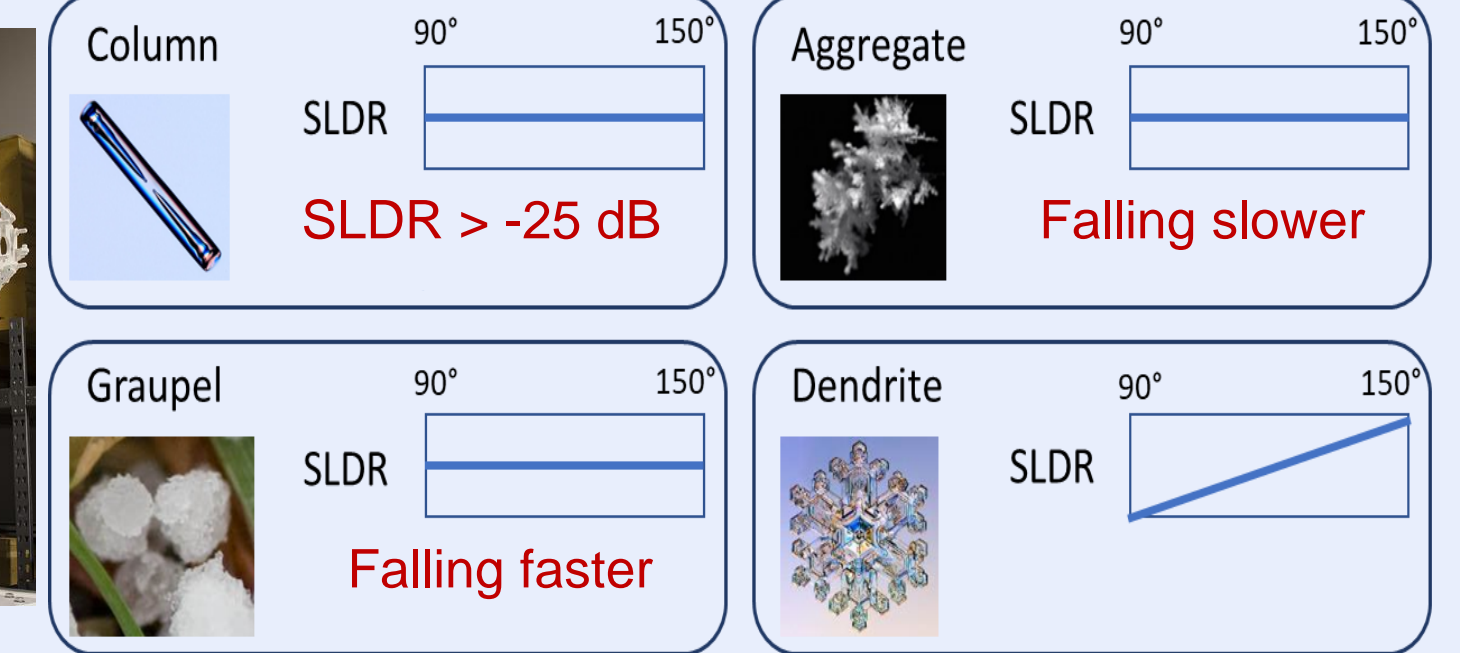
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How does identification of particle shape contribute to the interpretation of microphysical processes?

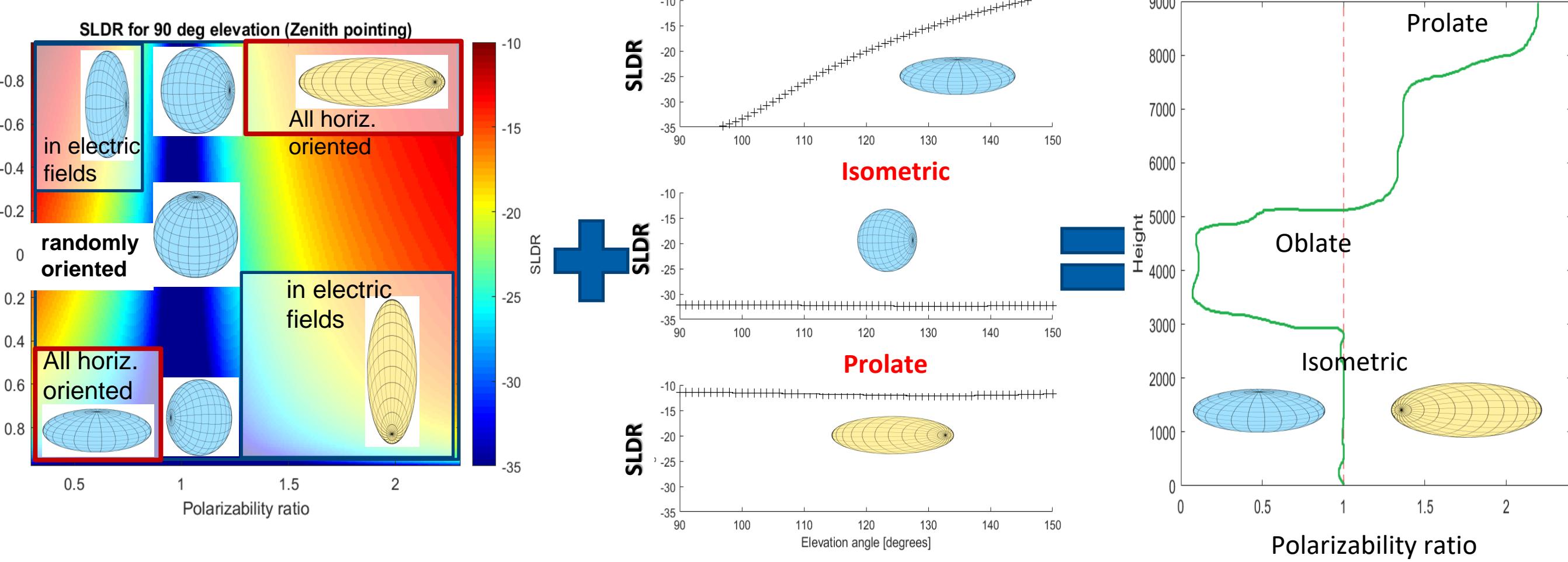
Observing the shape of ice particles is crucial for understanding cloud microphysical processes such as riming, aggregation, and depositional growth.

- Utilization of scanning (30°-90°) 35-GHz Slanted Linear Depolarization Ratio (SLDR)-mode cloud radar Mira-35
- Application of the elevation (RHI-) scans of polarimetric variable SLDR
- Derivation of the corresponding ellipsoidal shape of hydrometeors
- Multi-peak detection using the VDPS method with SLDR calculated from Signal-to-Noise Ratio (SNR) in the co- and cross-channel



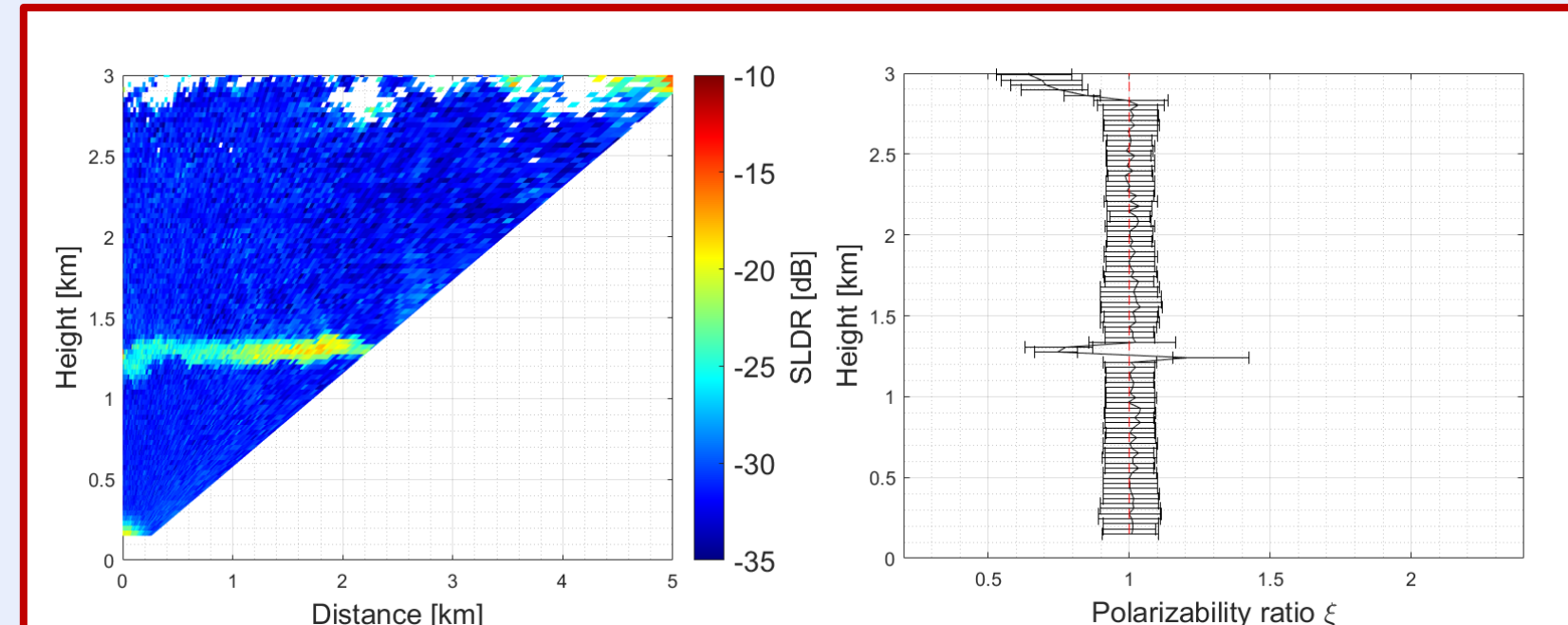
The VDPS method: Introduction

VDPS Method:



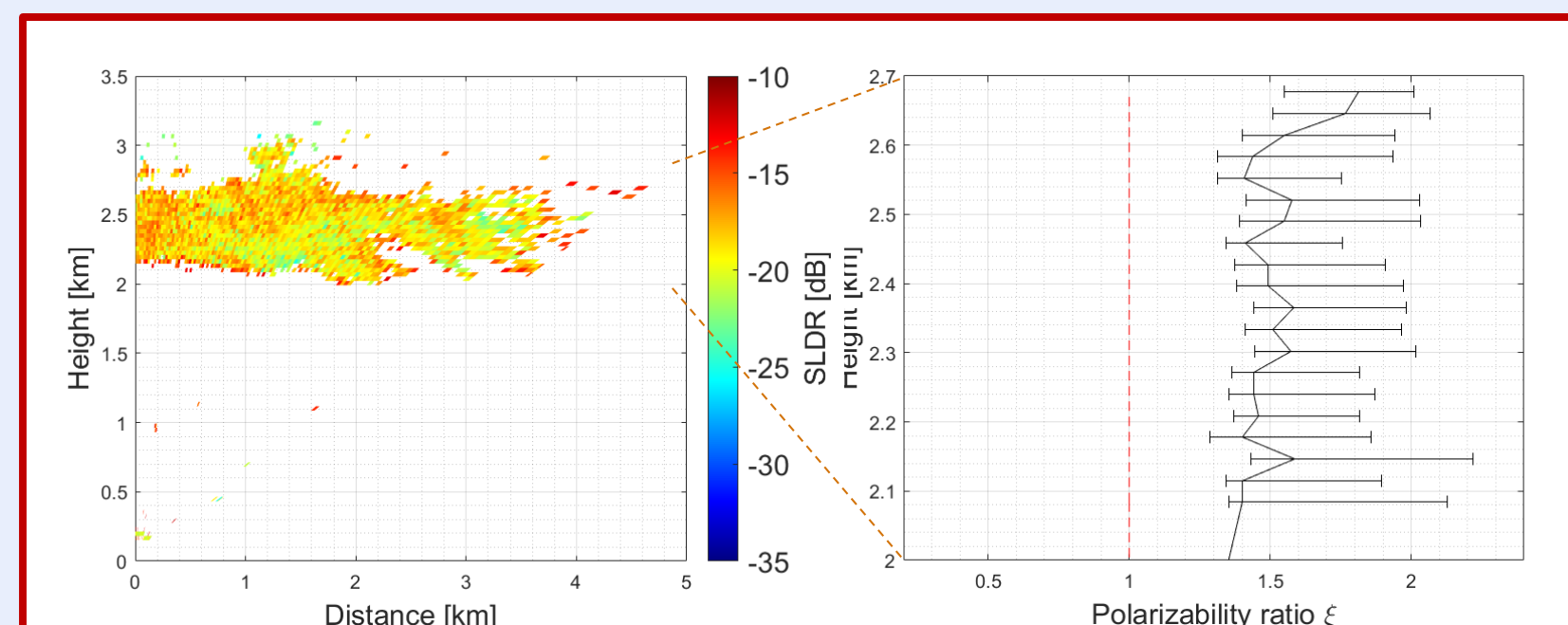
Isometric particles: Rain

- Low values of SLDR constant from 90° to 150° elevation angle.
- Polarizability ratio $\xi \approx 1$



Oblate particles: Plate-like

- Low SLDR values at 90° and high SLDR values at 150° elevation angle.
- Polarizability ratio $\xi < 1$



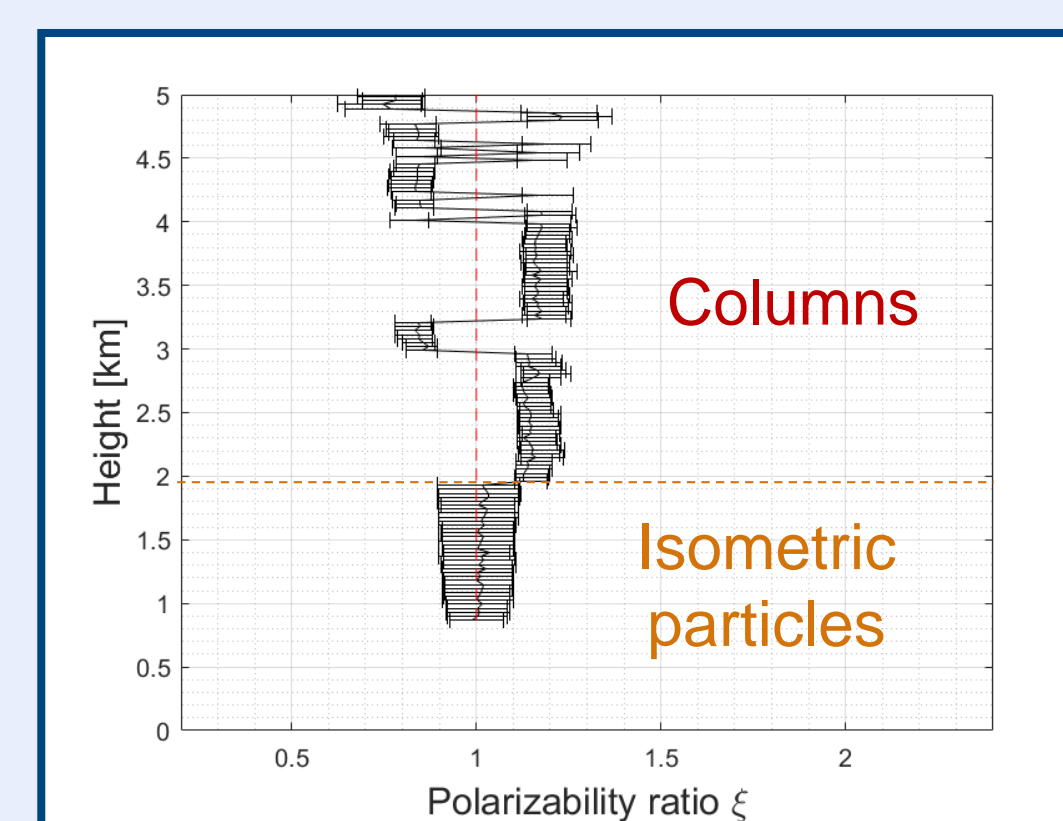
Prolate particles: Columns

- Low values of SLDR constant from 90° to 150° elevation angle.
- Polarizability ratio $\xi > 1$

Data set: CyCARE campaign, Limassol, Cyprus (2017)

Riming and aggregation processes identification

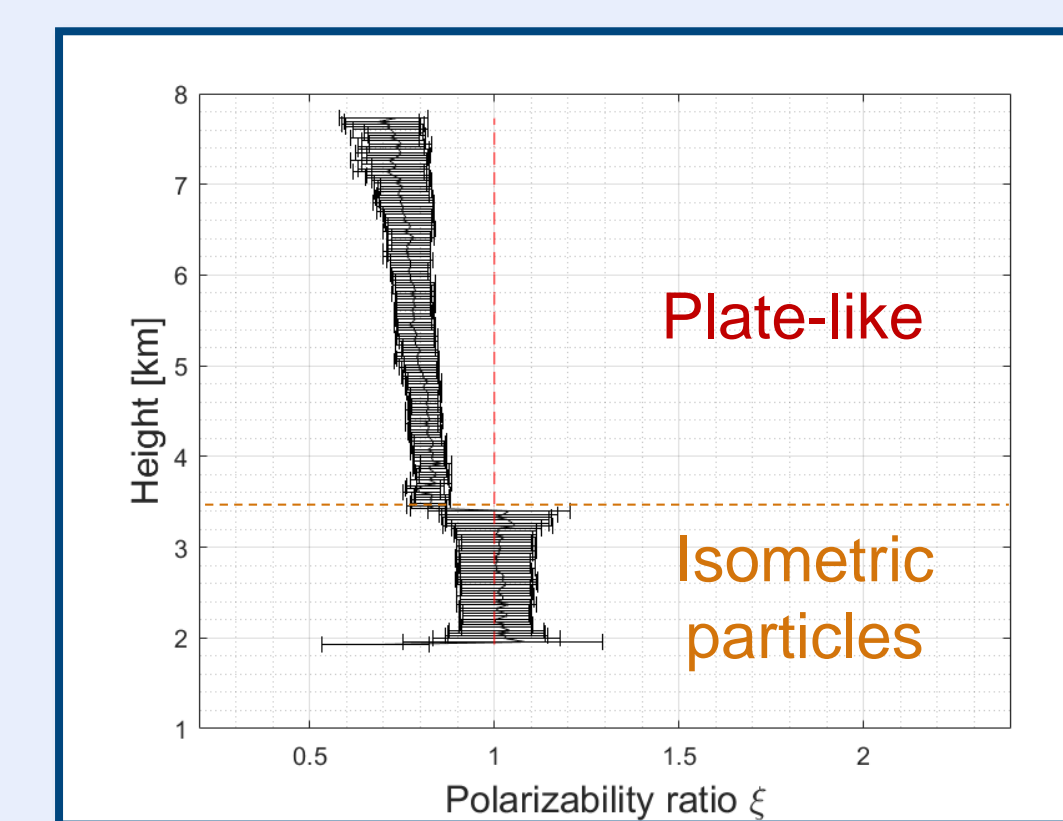
Riming detection:



→ 2.4 – 1.8 km: Detection of supercooled liquid droplets in the reflectivity (Z_e) height spectrum.

Riming process

Aggregation detection:

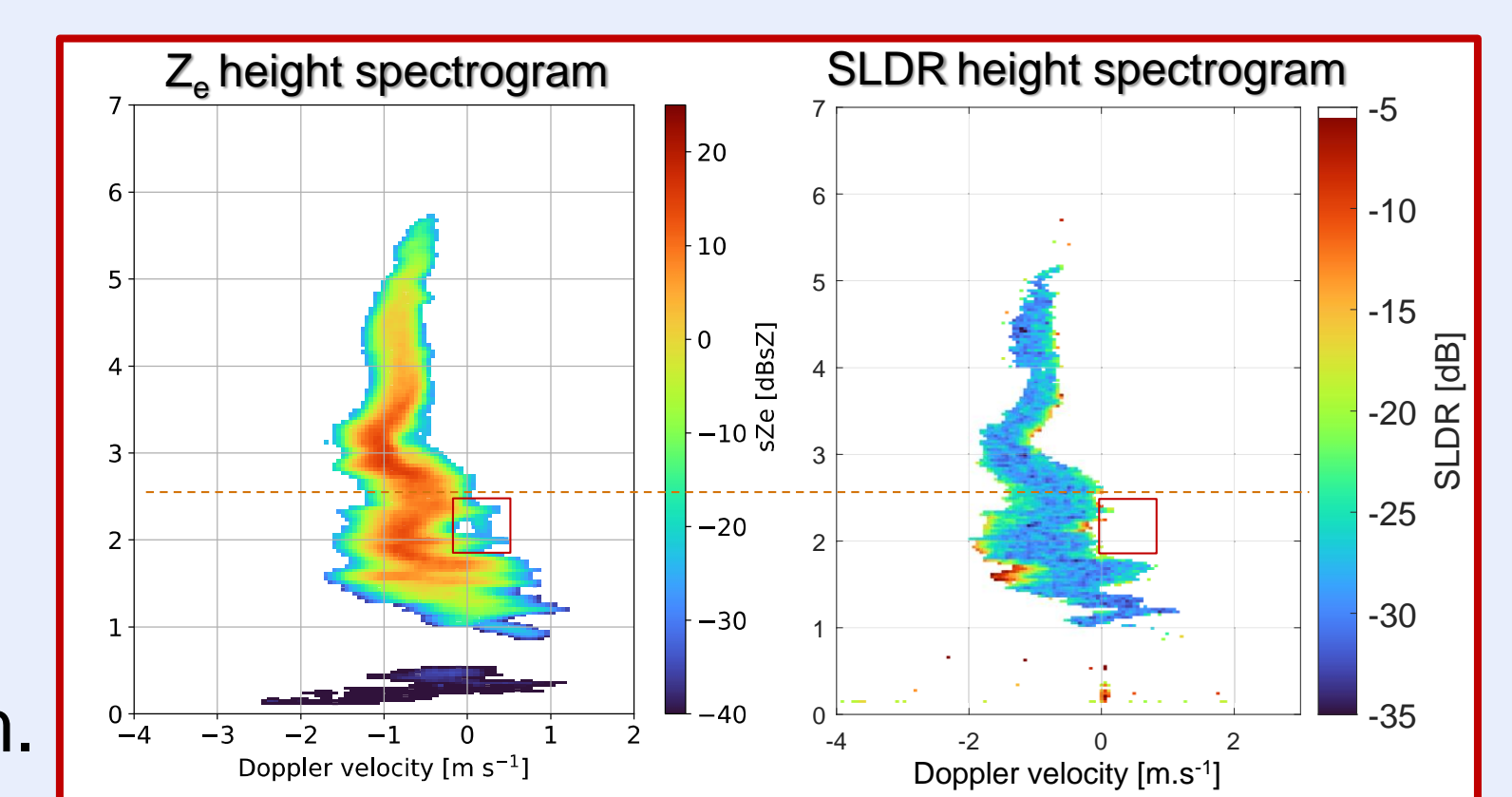


→ No detection of supercooled liquid droplets.
→ 4.2 – 3.4 km: Detection of a second plate-like crystal population

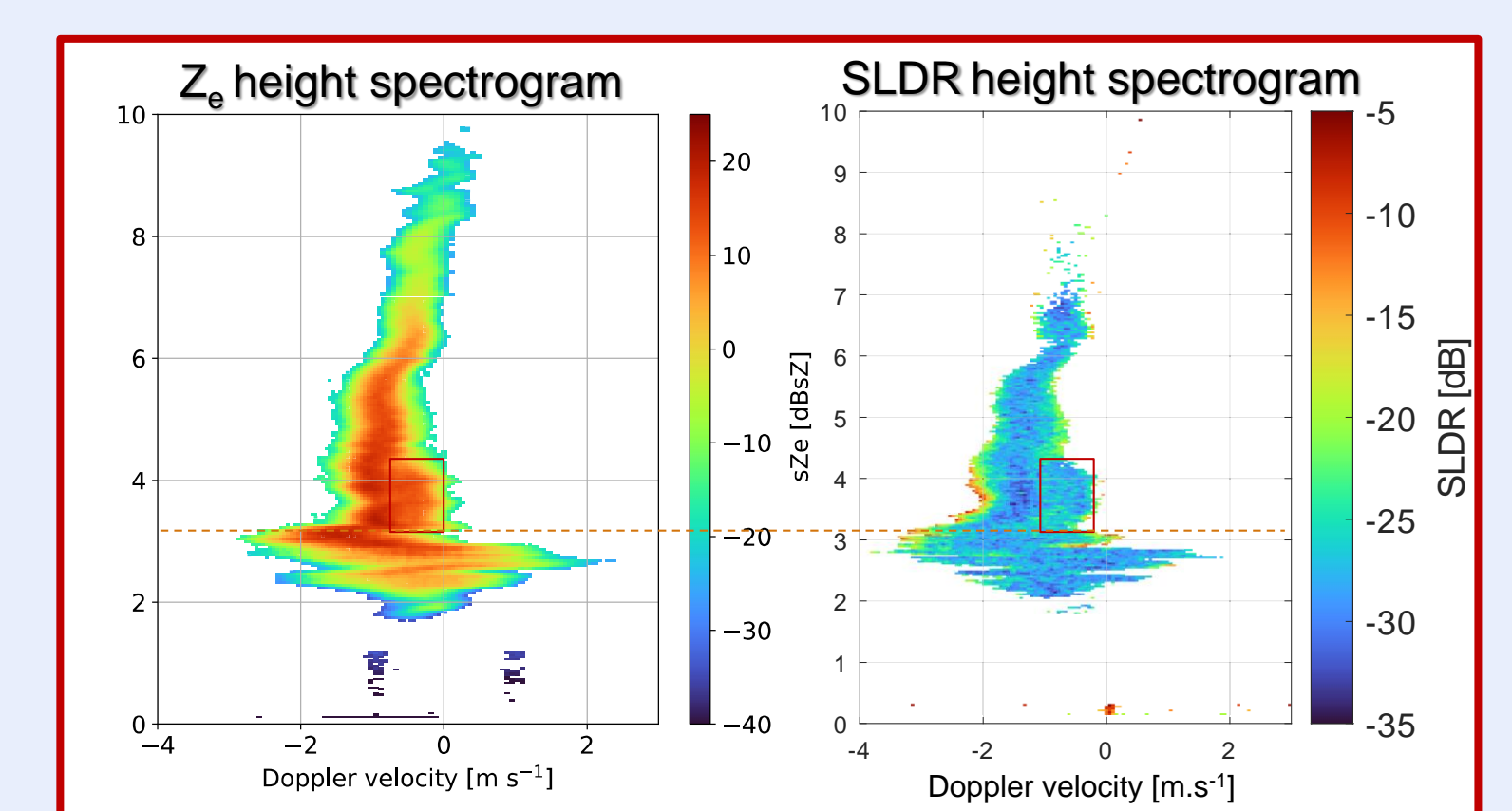
Aggregation process

~2km : Transition from prolate shape crystals into isometric shape crystals.

Graupel or aggregates?



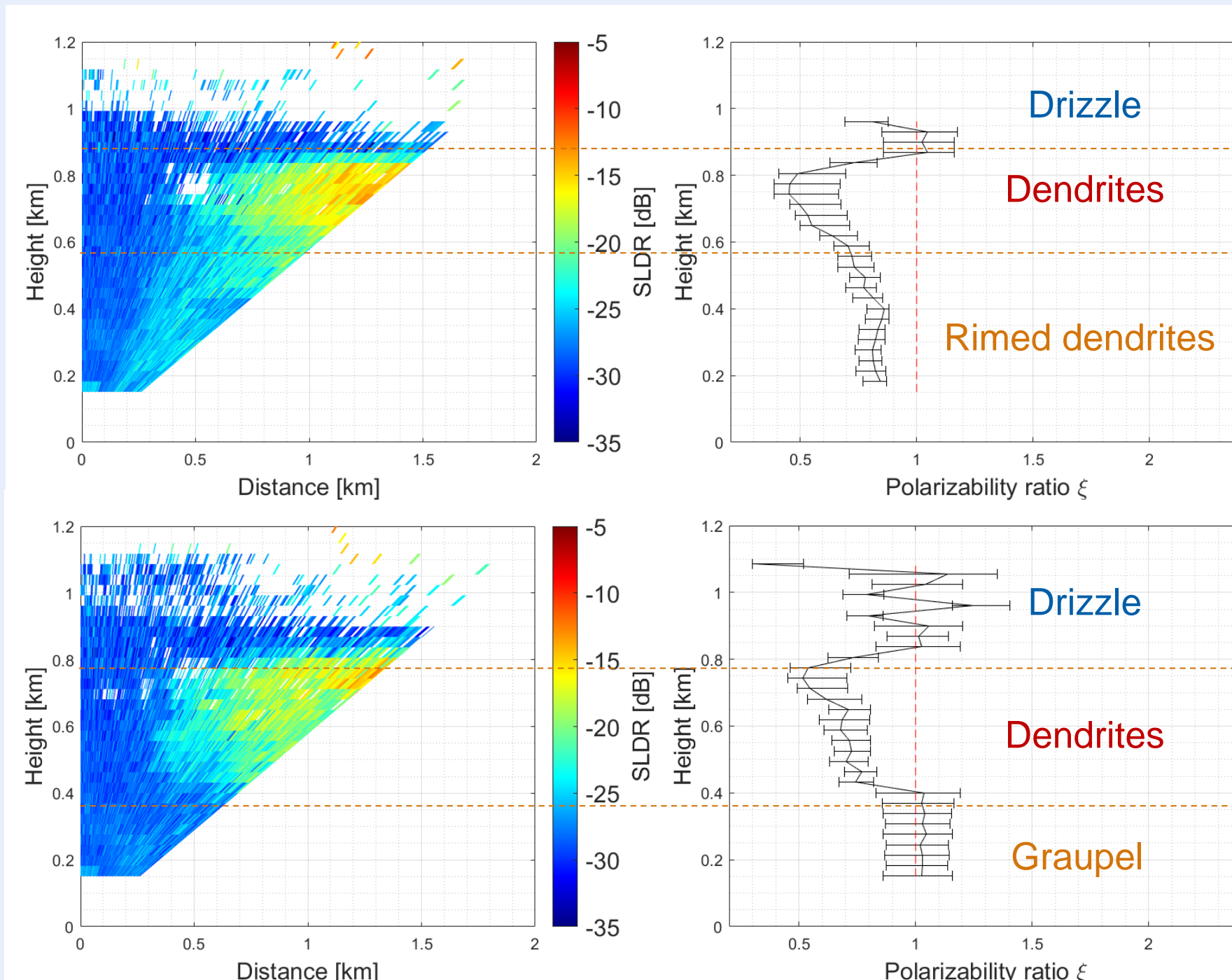
Graupel or aggregates?



Data set: DACAPO-PESO campaign, Punta Arenas, Chile (2019)

Evaluation of the VDPS method using Video In Situ Snowfall Sensor (VISS)

Observation of rimed dendrites and graupel:



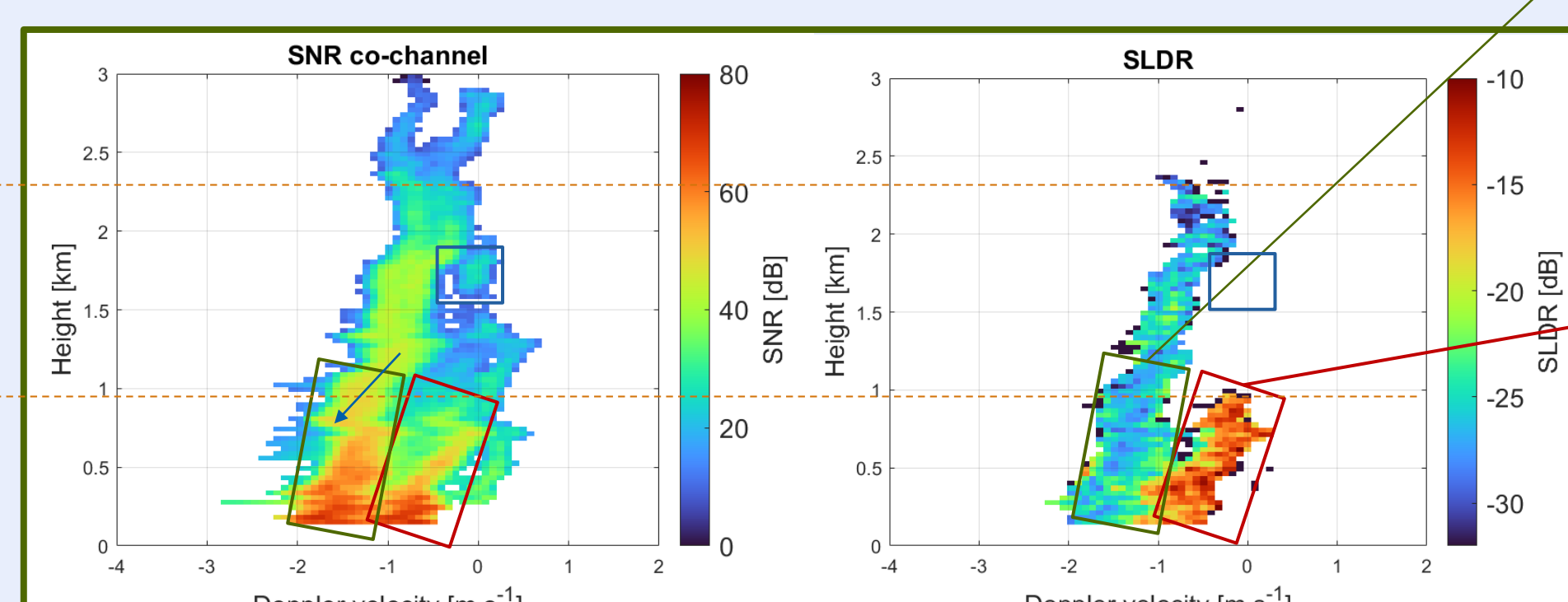
→ Observation of rimed dendrites at the ground with VISS
→ VDPS derives slightly oblate particles

→ Graupel are observed with VISS
→ Isometric particles are derived by the VDPS method

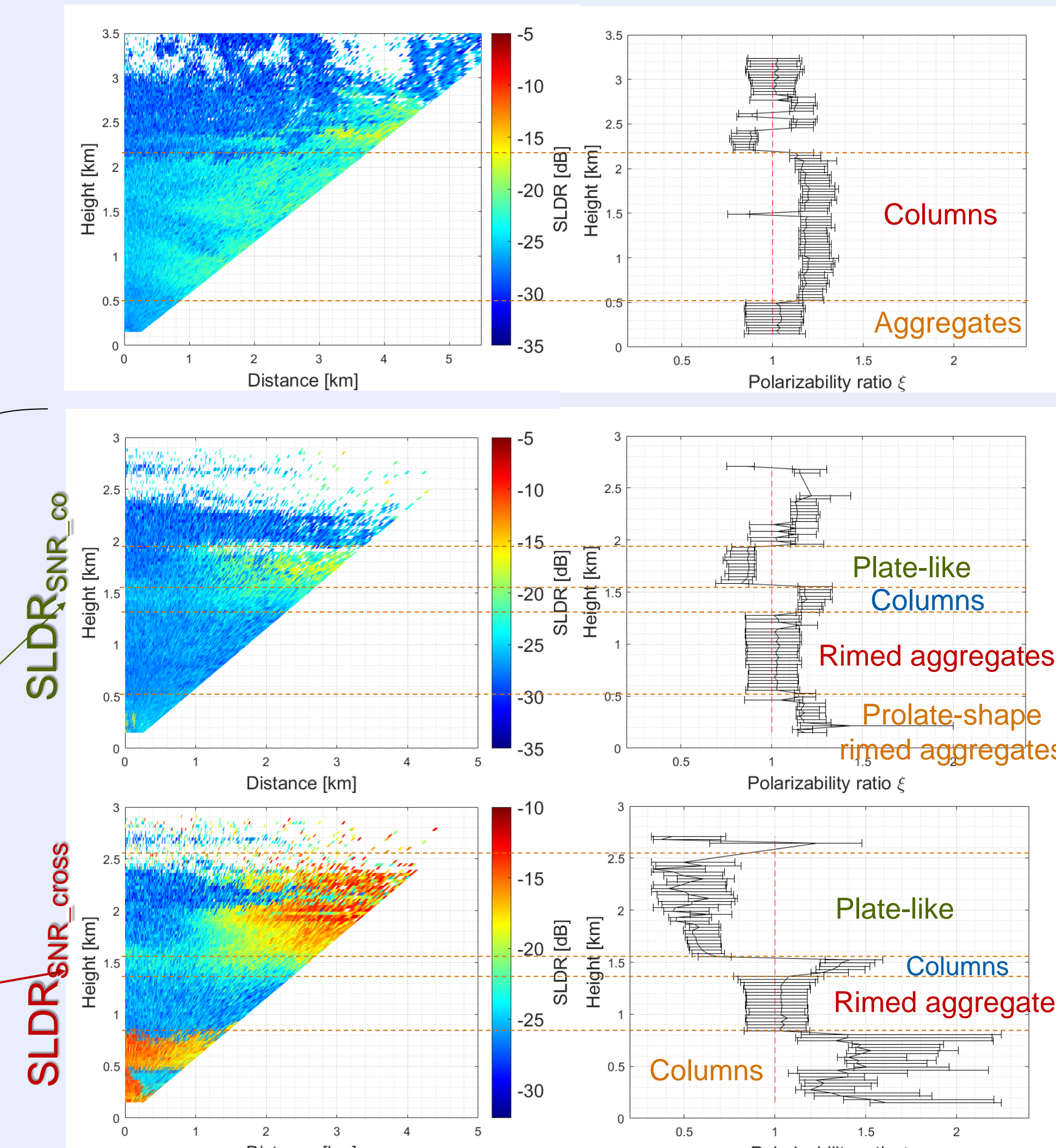
Coexistence of supercooled liquid droplets and other ice crystals

Presence of supercooled liquid droplets + increase in Doppler velocity and SNR → Riming

Multi-peak detection: two ice crystal populations



Observation of aggregates and secondary ice production:



Columnar crystals (depolarizing a lot) are derived by the VDPS method using SNR_{cross} and rimed aggregates using SNR_{co} → Secondary Ice Production

Data set: CLOUDLAB campaign, Erwisil, Switzerland (2023)

References:

- Teisseire, A., Seifert, P., Myagkov, A., Bühl, J., and Radenz, M.: Determination of the vertical distribution of in-cloud particle shape using SLDR-mode 35 GHz scanning cloud radar, Atmos. Meas. Tech., 17, 999–1016, <https://doi.org/10.5194/amt-17-999-2024>, 2024.
- Teisseire, A., Billault-Roux, A.-C., Vogl, T., and Seifert, P.: Attribution of riming and aggregation processes by application of the vertical distribution of particle shape (VDPS) and spectral retrieval techniques to cloud radar observations, EGUSphere [preprint], <https://doi.org/10.5194/egusphere-2024-2711>, 2024.