UNIVERSITY OF HELSINKI
FACULTY OF SCIENCE

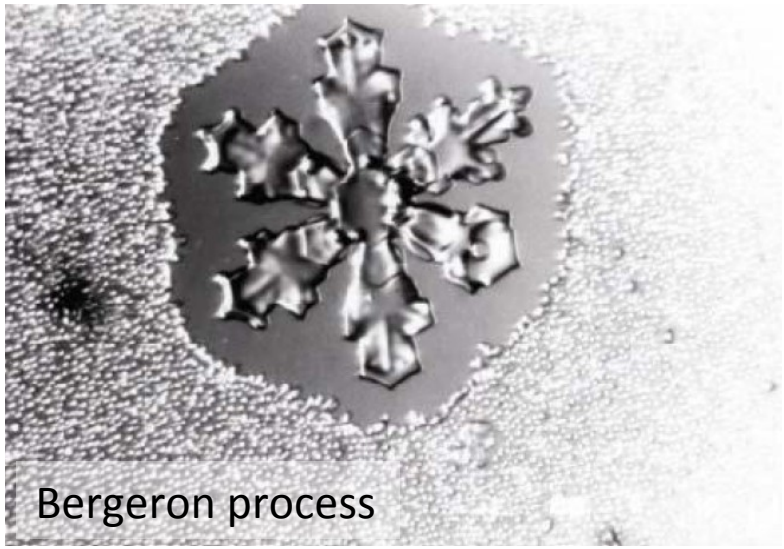
Colorado State University

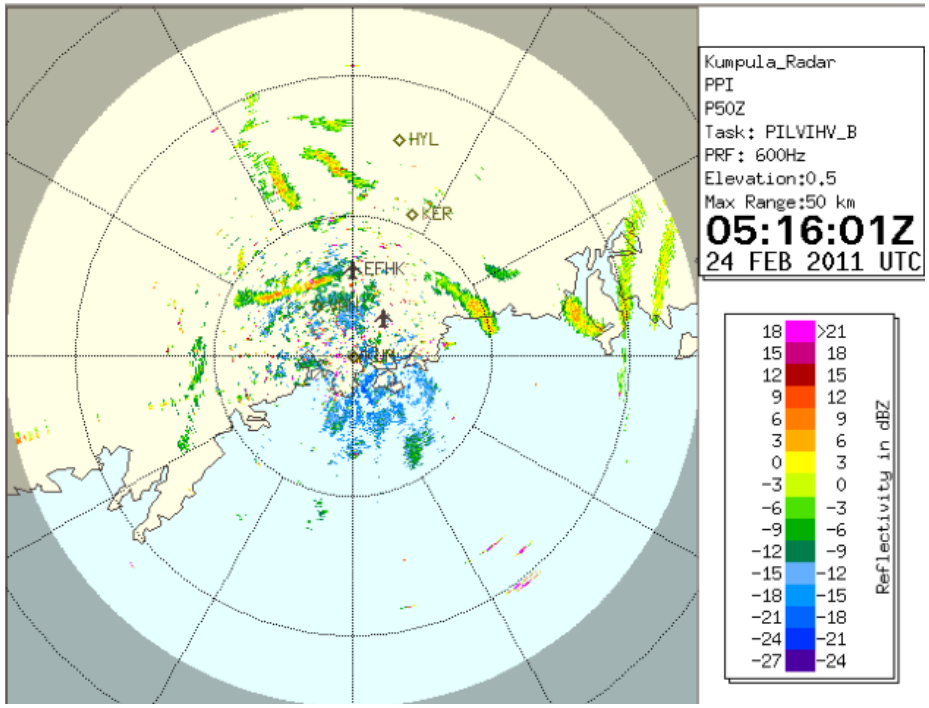
Quizzes for the one day course on applications of dual-polarization weather radars

August 31, 2014

Quiz 1 - Understanding of radar fundamentals fundamentals

Hole punch and canal clouds are formed by homogeneous freezing of supercooled water droplets induced by air expansion over wings (or propellers) of an aircraft. Newly formed ice crystals grow rapidly at the expense of the surrounding water droplets (Bergeron process) and precipitate out of the cloud.



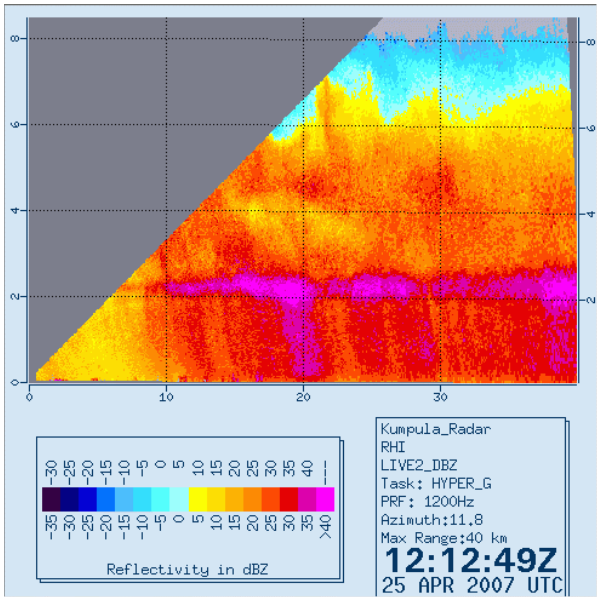


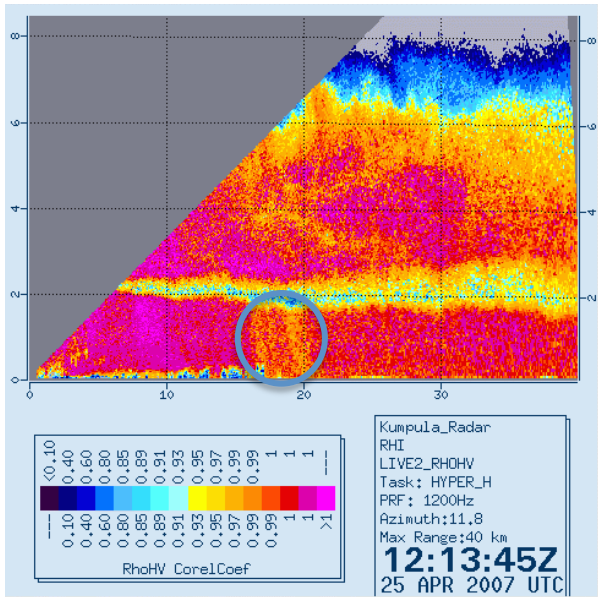
$$\sigma_b = \frac{\pi^5 |K_w|^2}{\lambda^4} D^6$$

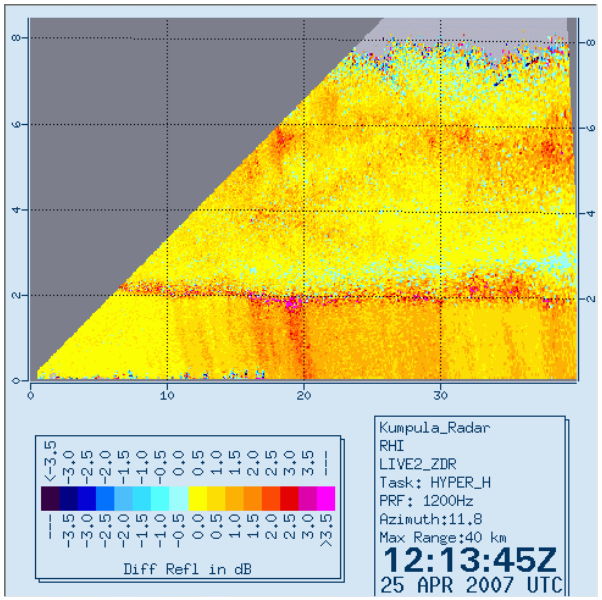
For ice - $|K|^2 = 0.17$
For water - $|K|^2 = 0.93$

Ice particle diameter is 150 μm
Water droplet diameter is 10 μm

On Feb 24, 2011 we have observed canal clouds (elongated hole punch clouds), or so we think, using Kumpula radar (see figure on the next page). As you can see in the radar picture there are a number of elongated features observable on the radar display. The geometry of those features are somewhat related to the geometry of Helsinki-Vantaa runways. Our interpretation is that the radar signal is caused by ice particles falling from canal clouds. **Please verify whether our interpretation is right or at least not obviously wrong**.







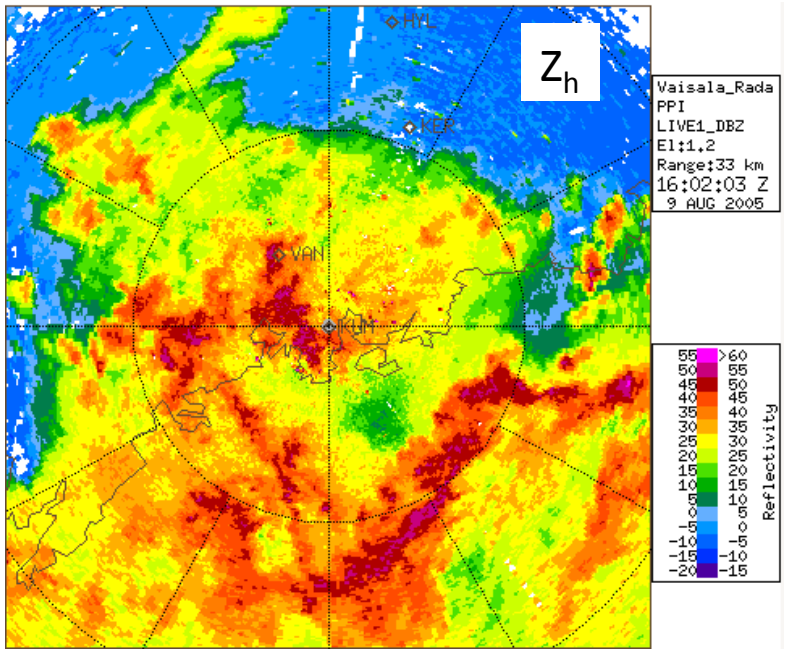
- Can you explain decrease in the co-polar correlation coefficient in rain?
- What does it tell us about DSD?

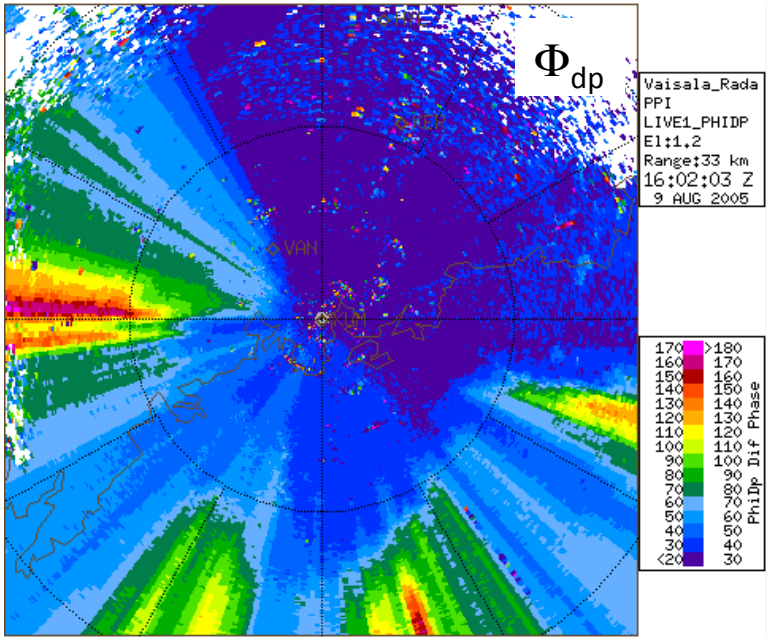
Quiz 2 - Understanding of dual-polarization fundamentals

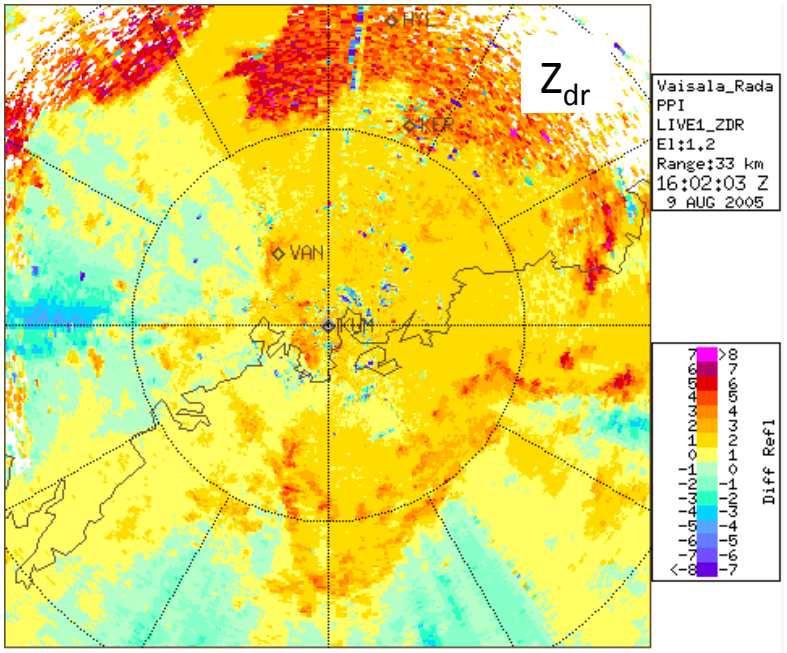
Analyze radar measurements presented in the images on the next page

- Can you identify areas that are affected by attenuation? Please mark them on the reflectivity plot. What are the telling signs of the attenuation? How do you identify those areas and what radar variables do you use for the analysis?
- What is the cause for the differential reflectivity observations to become negative in the figure below?

Figures for quiz 2







Answers:

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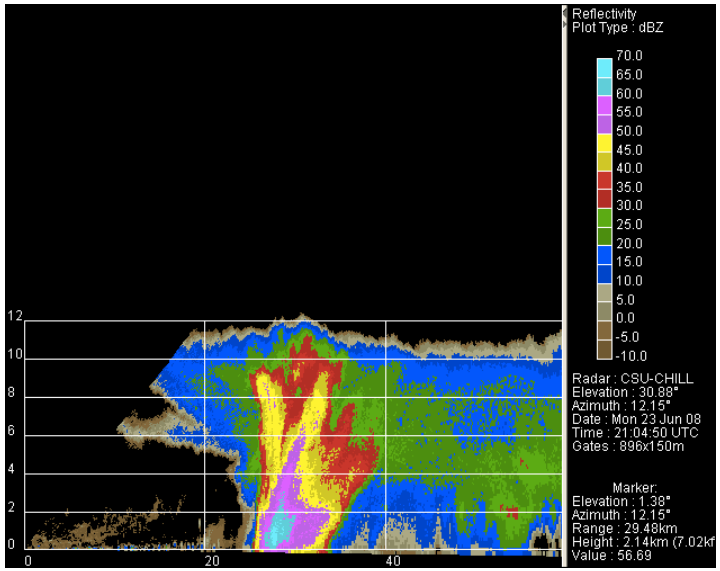
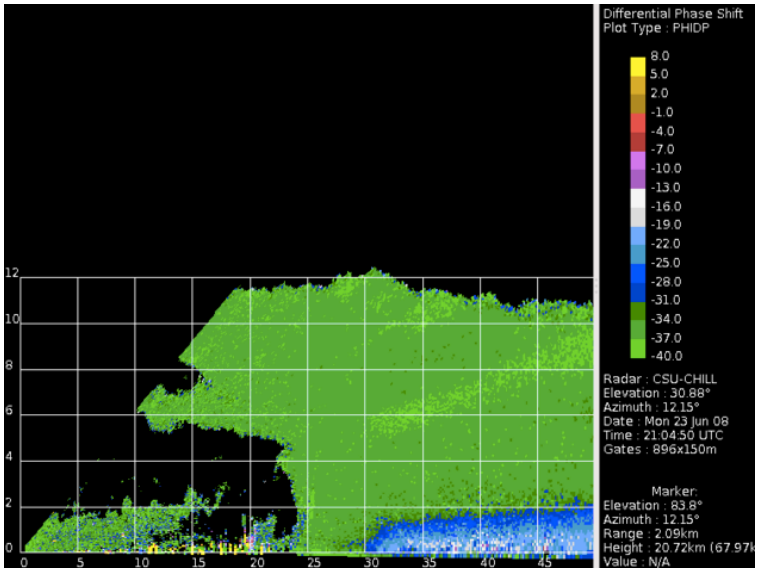
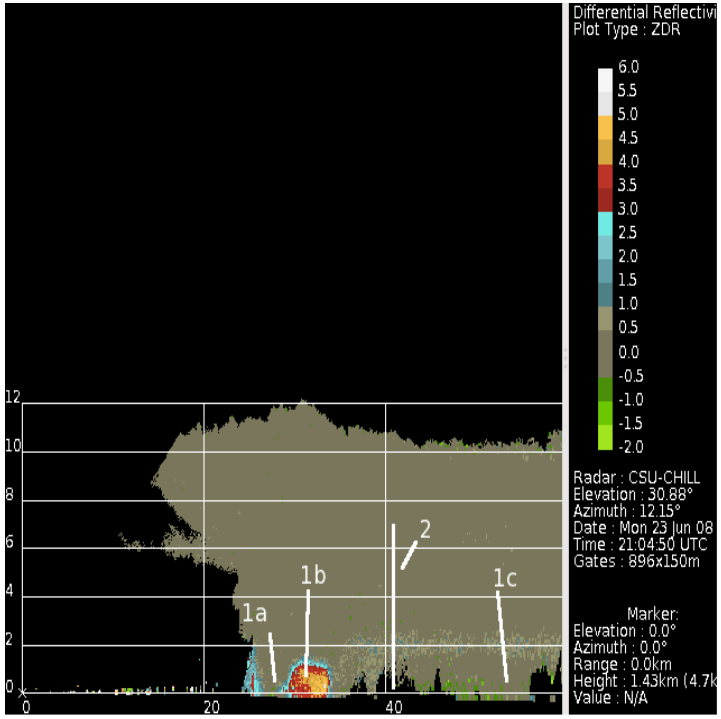






Several data fields from a CSU-CHILL RHI scan through a thunderstorm.

- What is the dominant form of precipitation at the points marked in the Zdr plot?

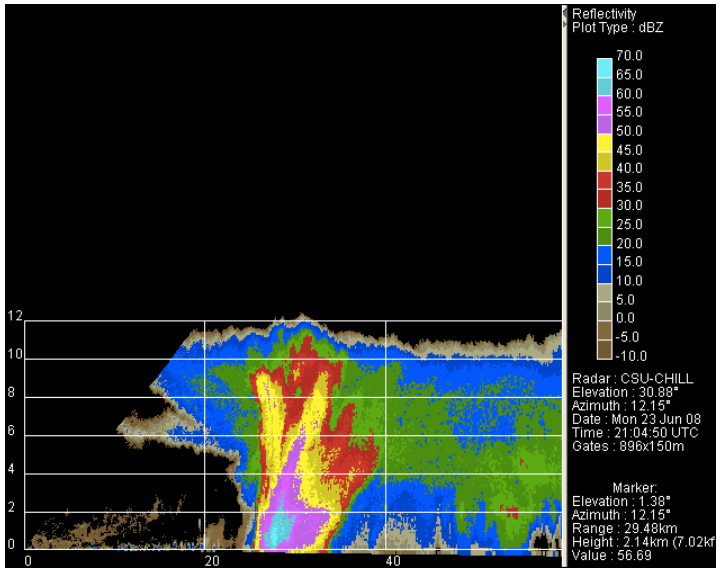
1a:

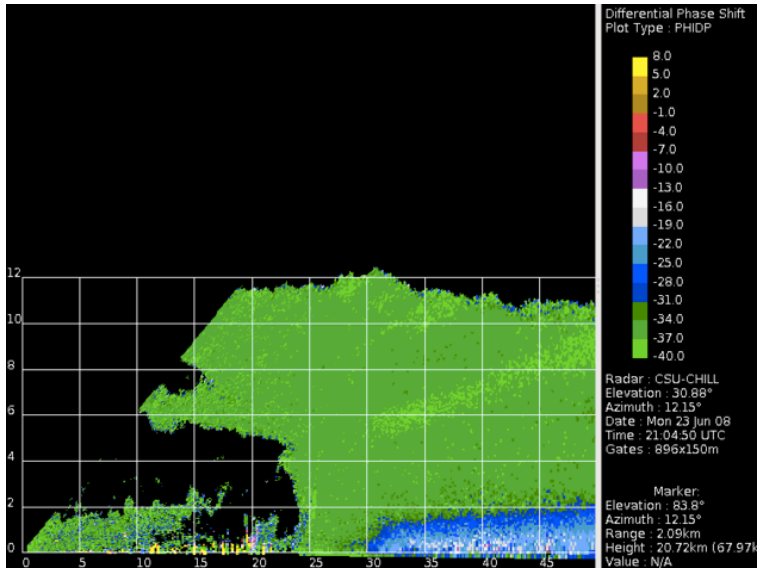
1b:

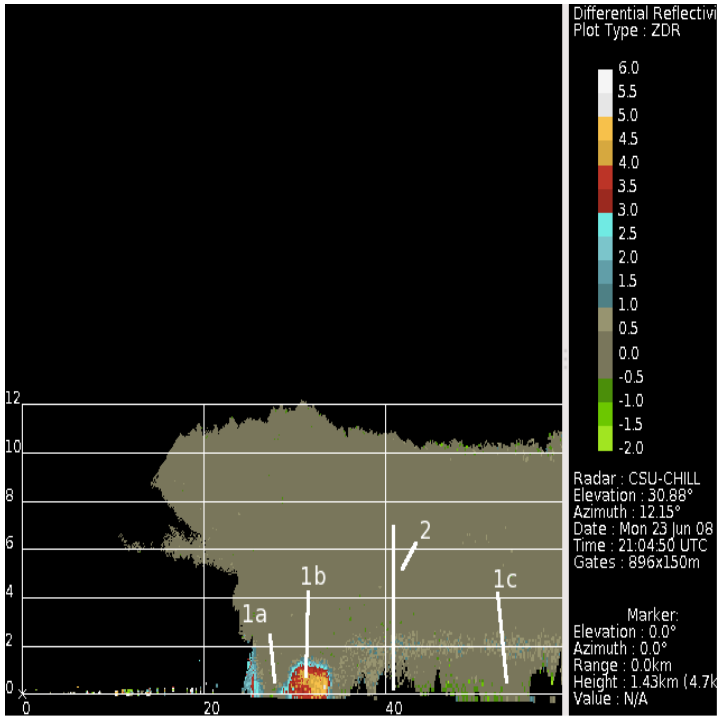
1c:

- Consider the vertical profile of Zdr along the vertical line marked as point 2 in the Zdr image. What is the probable cause of the locally positive Zdr layer located near the 2 km AGL height line?

2:







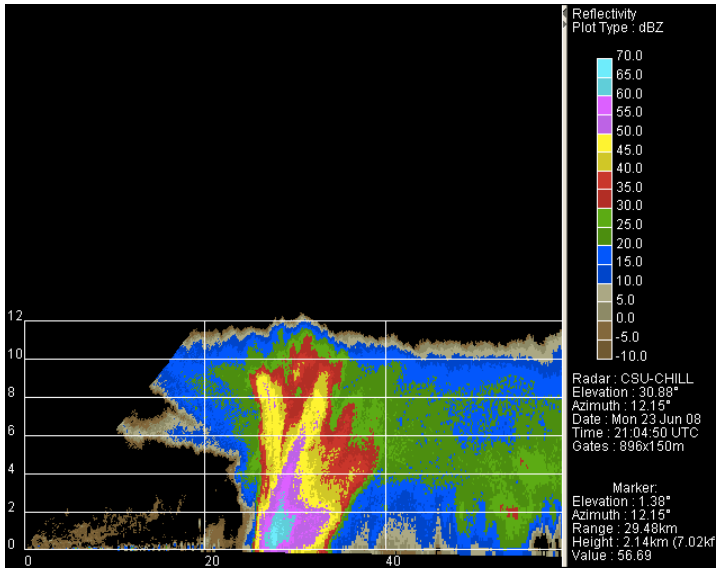
Several data fields from a CSU-CHILL RHI scan through a thunderstorm.

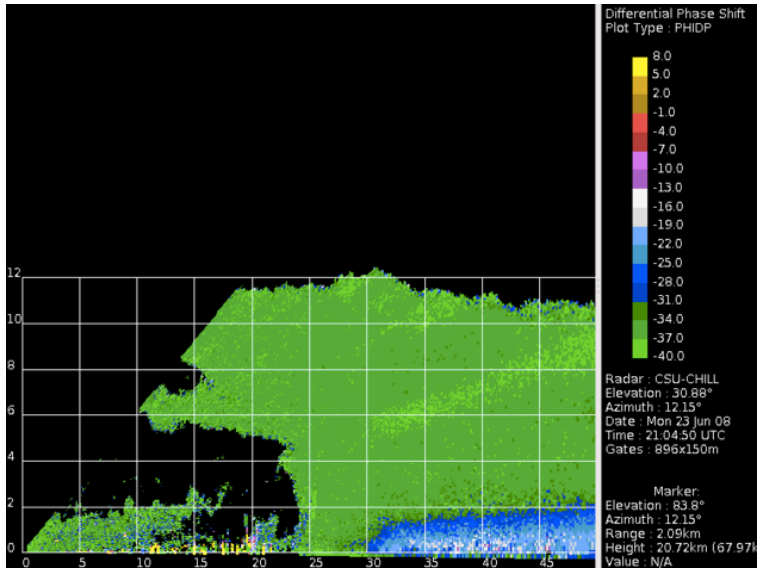
- Over what range interval does the greatest phidp change take place?

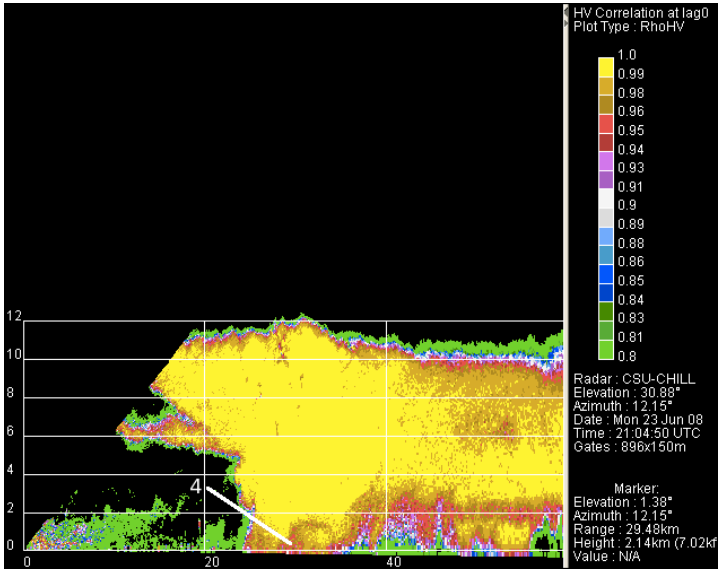
3a:

- The presence of what hydrometeor type is causing this increasing lag between the H and V return signals?

3b:







The correlation field has a local relative minimum of ~ 0.95 at the point marked.

4. What precipitation composition is probably responsible for this?

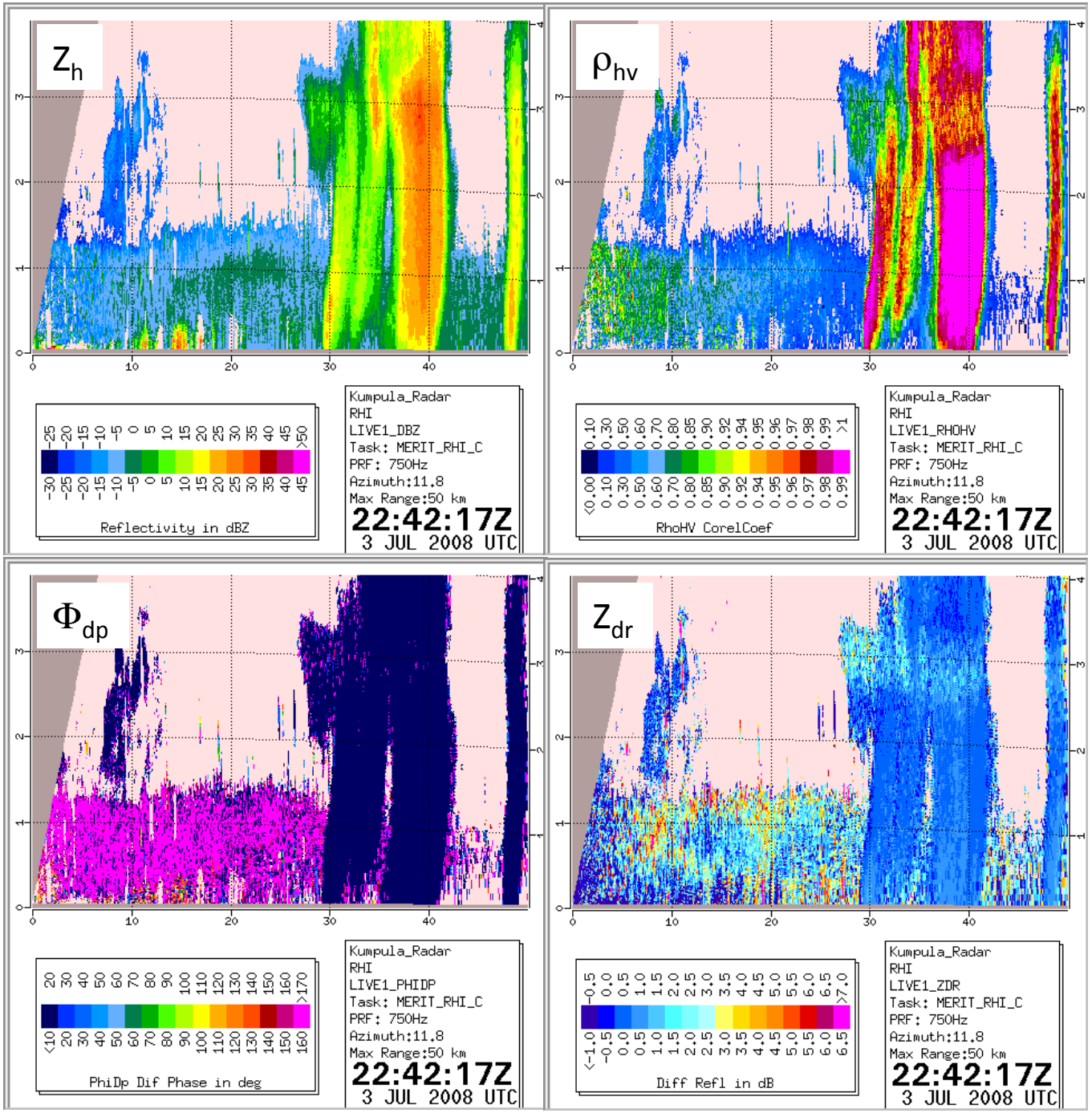
4:

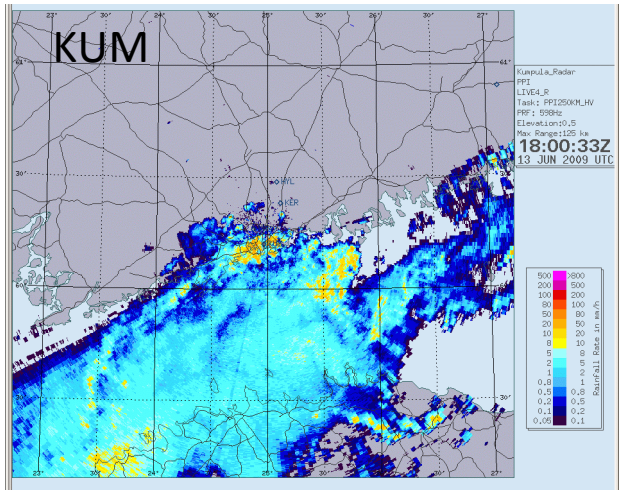
Quiz 3 - Interpretation of dual-pol observations

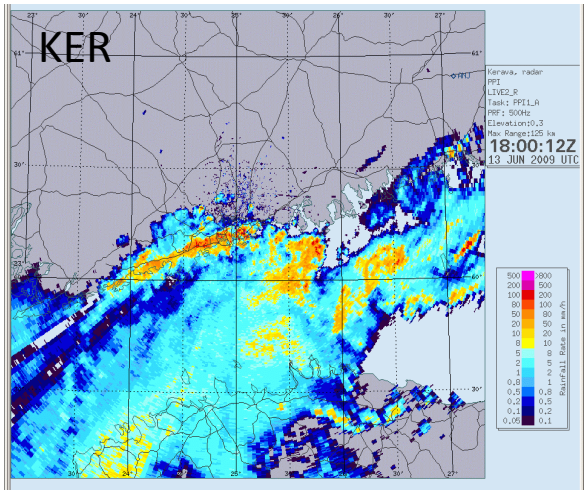
Analyze attached RHI plots.

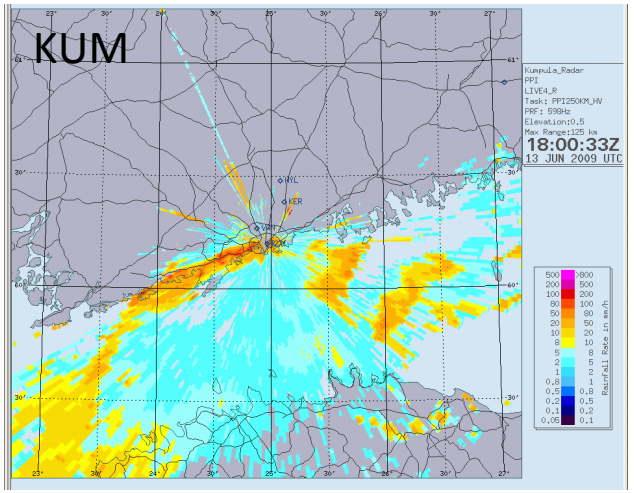
- Can you identify meteorological and non meteorological echoes? Please mark them on the plots. Please explain your decision criteria.
- Can you identify melting layer of precipitation? Please mark it on the plot and explain how you made this decision.

Figures for quiz 3









On August 8, 2010 a MCS passed over Helsinki. Above calculated rain rates from two radars, Kumpula and Kerava, using a Z-R relation are shown. Kerava radar is located 22 km north of Kumpula. At 1800 UTC it was raining in Kumpula.

- Can you explain differences in the recorded rain rates?
- The right figure shows R estimated from K_{dp} observations. If you compare it to the other two figures, what can you tell about using Z-R and Kdp-R relations?