

Identification of Snow and Rain at the Surface using Polarimetric Radar

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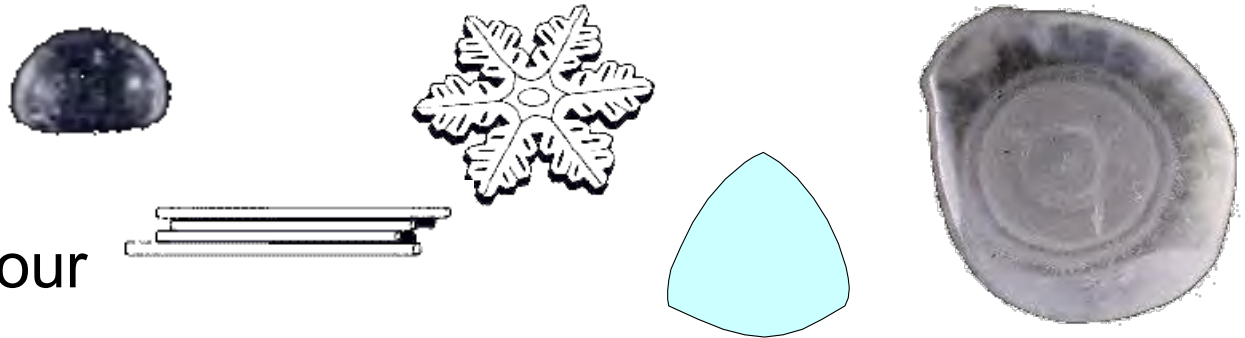
Knowledge for Tomorrow



Polarimetric Weather Radar

Cloud and precipitation particles have different:

- Size
- Phase
- Shape
- Falling behaviour

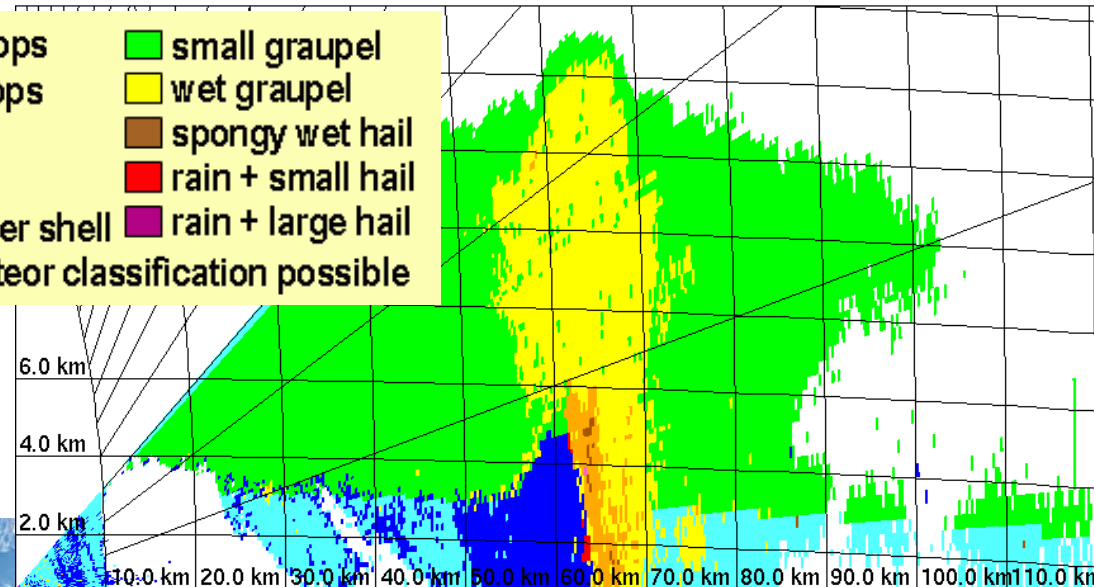
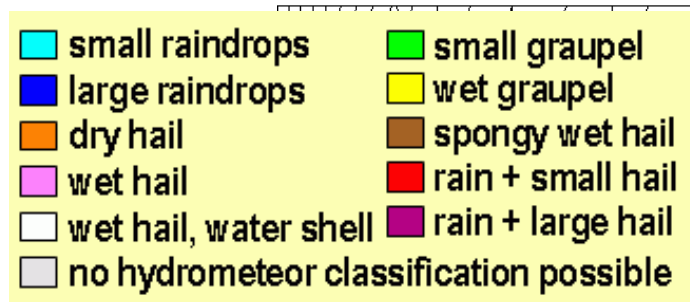
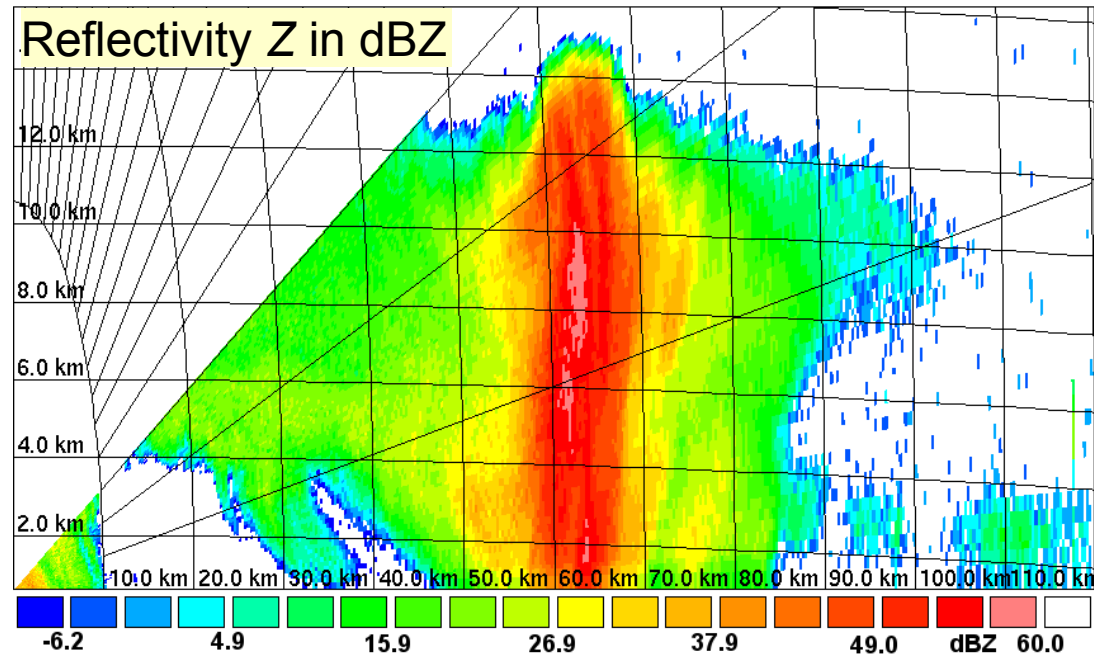


This results in different electromagnetic scattering properties and thus different ranges of polarimetric radar products like:

- Reflectivity Z
- Differential reflectivity Z_{DR}
- Co-polar correlation coefficient ρ_{HV}
- Linear depolarization ratio LDR
- Specific differential phase KDP

Hydrometeor Classification

- Automatic empirical hydrometeor classification using thresholds or fuzzy-logic techniques



Hydrometeor Classification

Why is not a unique classifier used?

- Radars use different wavelengths
 - Radar operators have different preferences
 - Radars can provide different sets of radar products
 - Radars provide radar products with different quality
 - Hydrometeor classifiers can be combined with additional products (like temperature profiles, ...)
 - ...
- Different membership functions and relative weights are used for fuzzy-logic hydrometeor classifiers



Identification of Rain and Snow at the Surface

Aviation and road authorities want to know:

- when does it start to snow?
(when does rain turn in snow?)
- how long does it snow?
- how much snow will fall?

How can we contribute with
polarimetric weather radar?

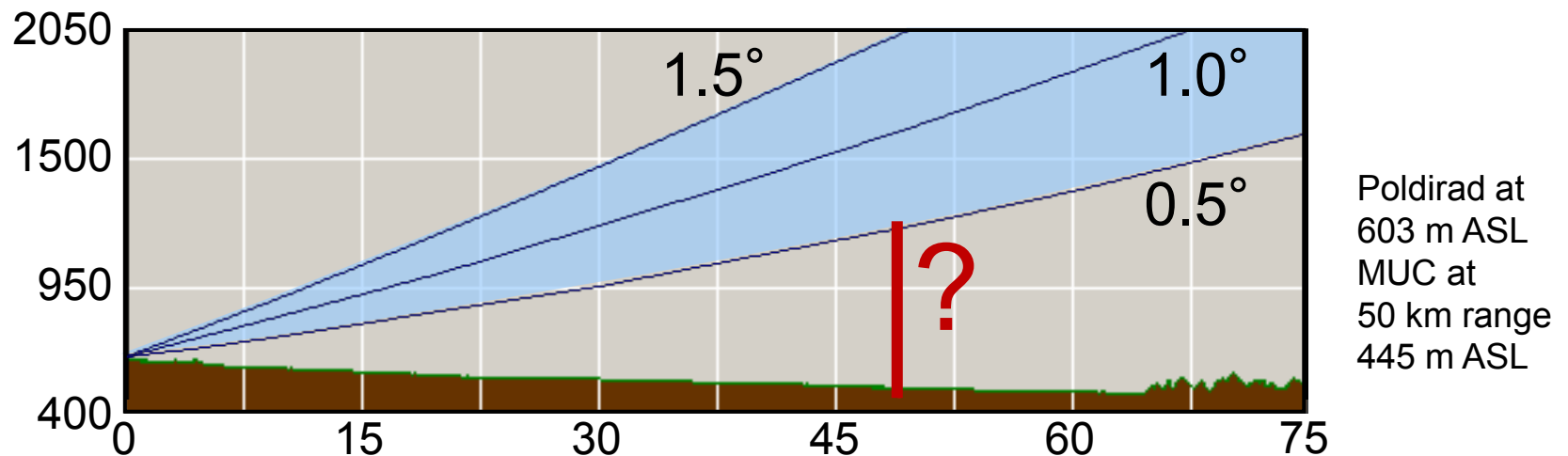
What additional tools or
measurements would be
required?



Identification of Rain and Snow at the Surface

Challenges

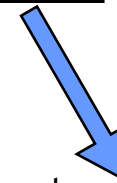
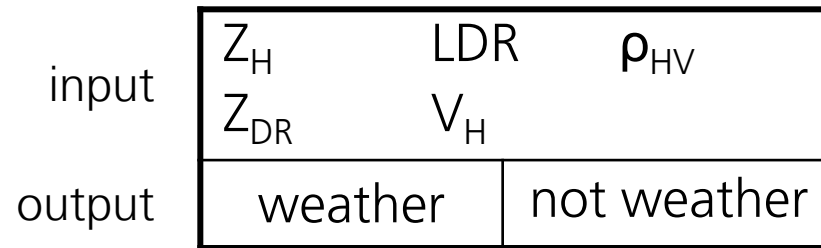
- What happens between the radar beam and the surface?



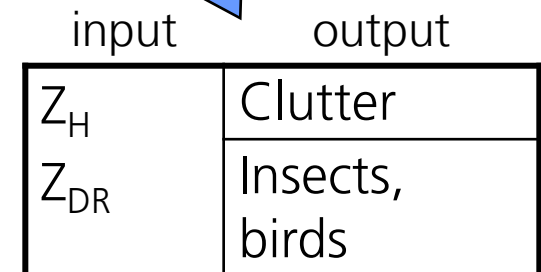
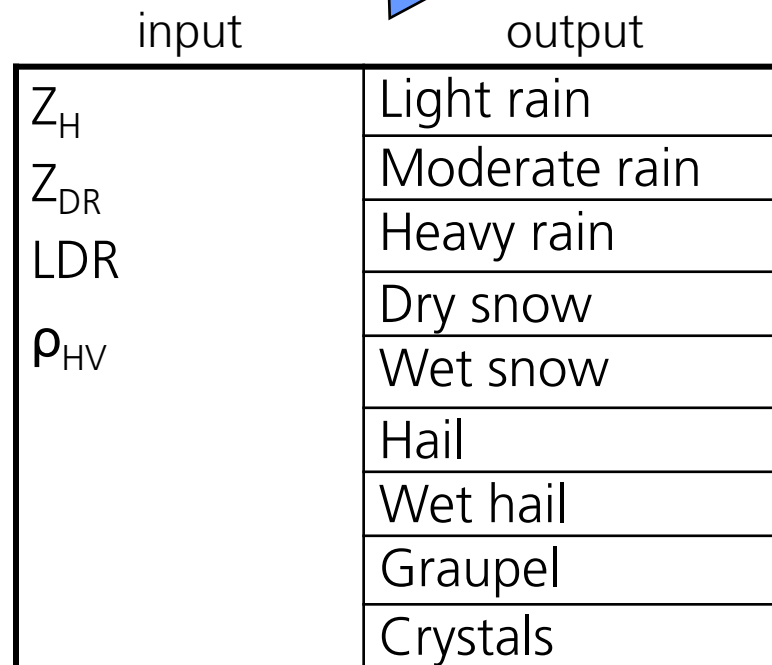
- How to identify freezing rain or drizzle?

Hydrometeor Classification Process

1st Step
fuzzy logic

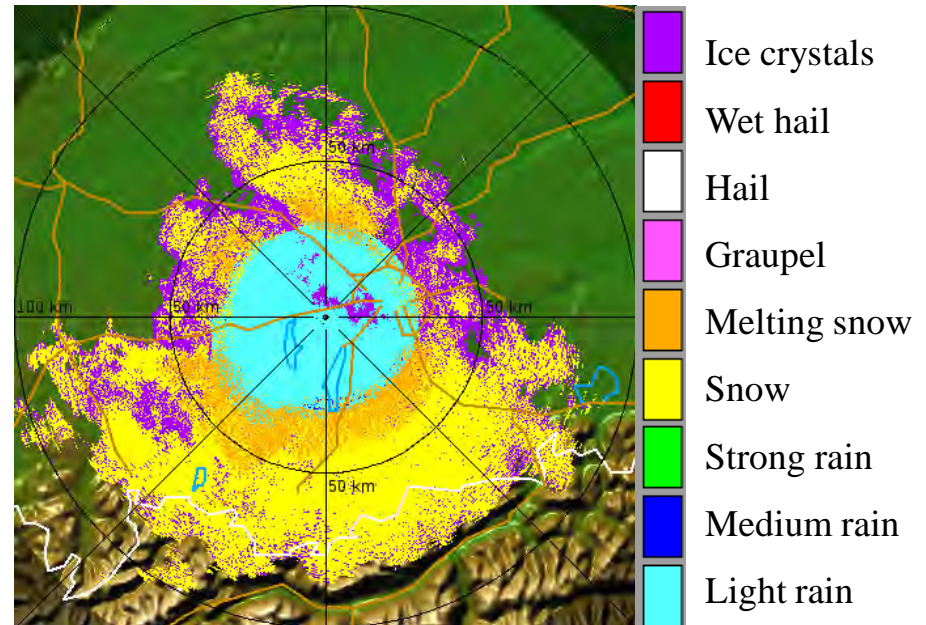
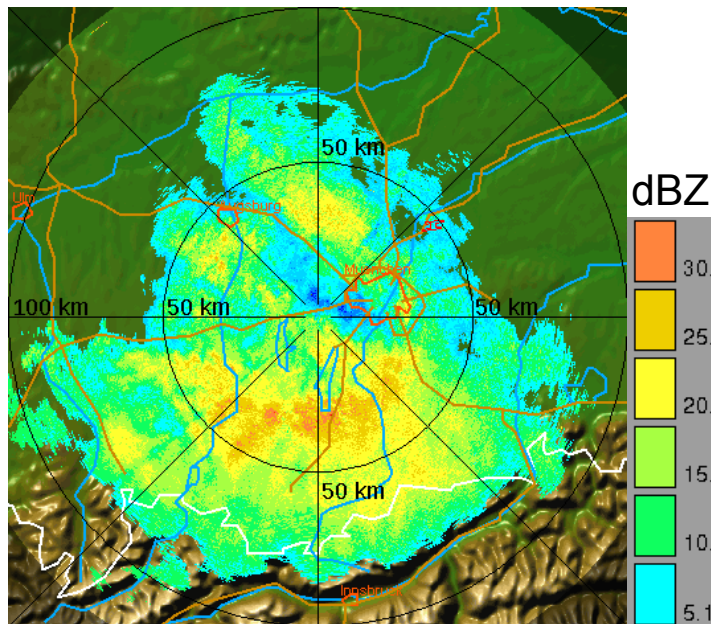


2nd Step
fuzzy logic

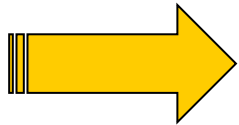


Hydrometeor Classification

- 1st Classification with some ambiguities:
light rain and snow have similar characteristics



From Classification to Precipitation at Ground



1st Hydrometeor classification



Bright band identification



2nd Hydrometeor classification



Weather situation classification

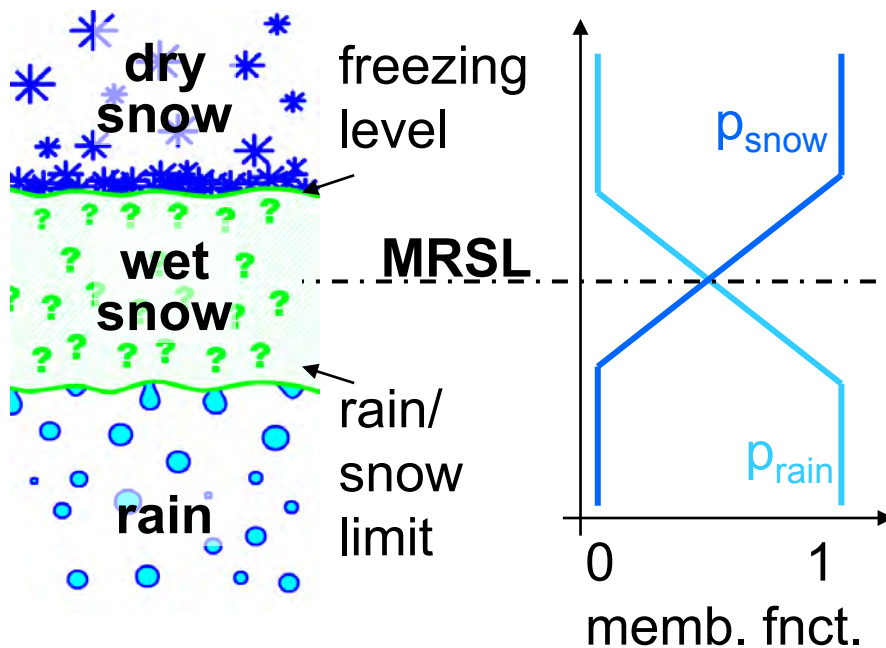


Precipitation at ground

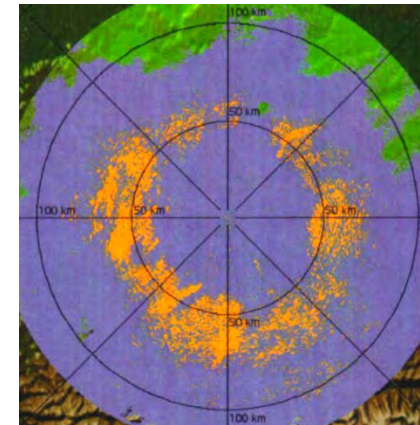


Bright Band Identification

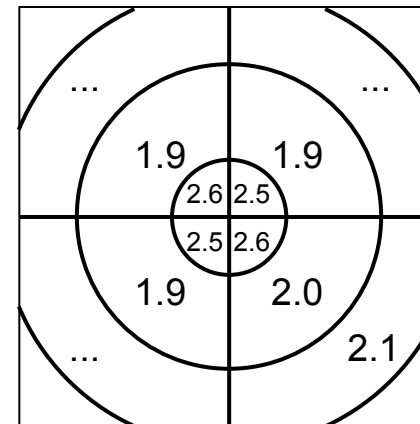
Modelized rain / dry snow limit (MRSL)



Estimation of MRSL for volume scan sectors



Classes:

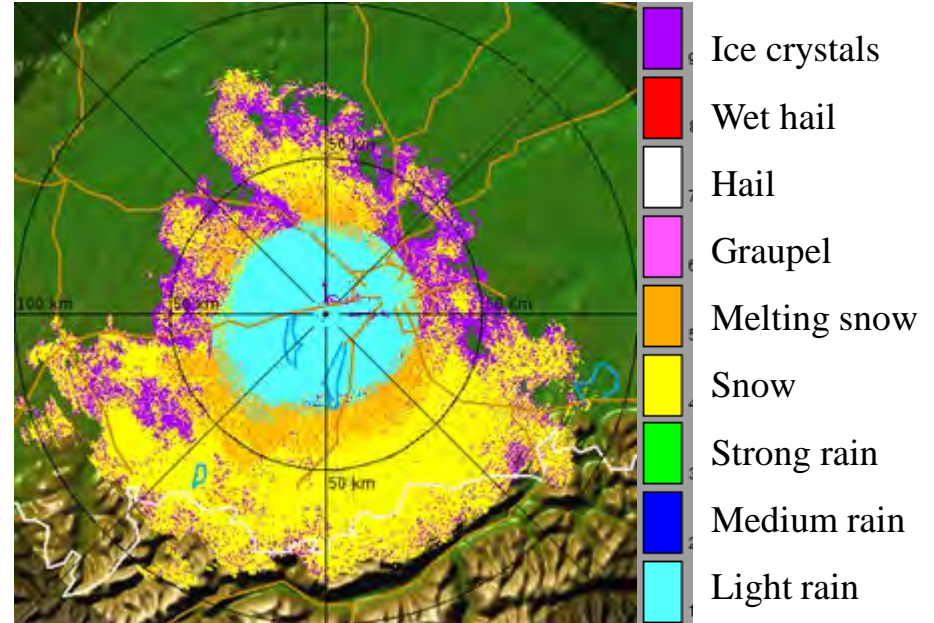
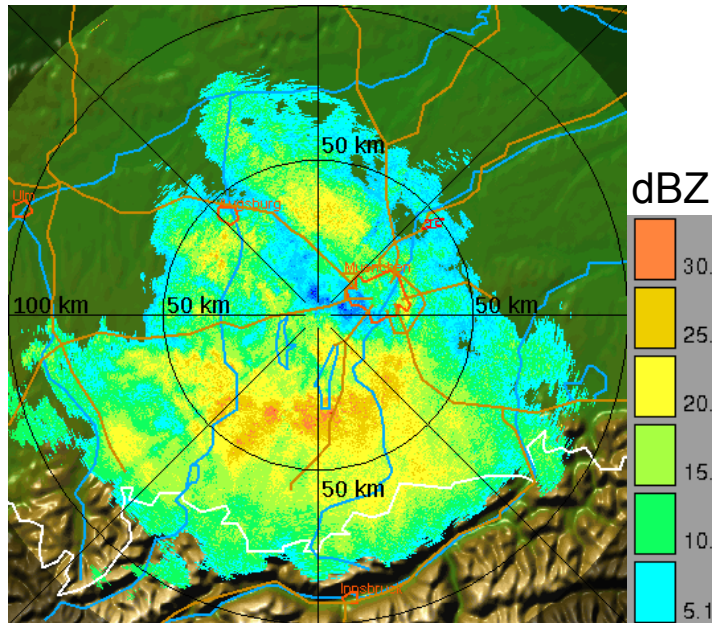


MRSL heights



Hydrometeor Classification

- 2nd Classification with ambiguities removed



From Classification to Precipitation at Ground

1st Hydrometeor classification



Bright band identification



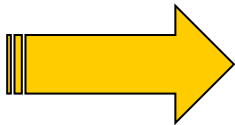
2nd Hydrometeor classification



Weather situation classification



Precipitation at ground

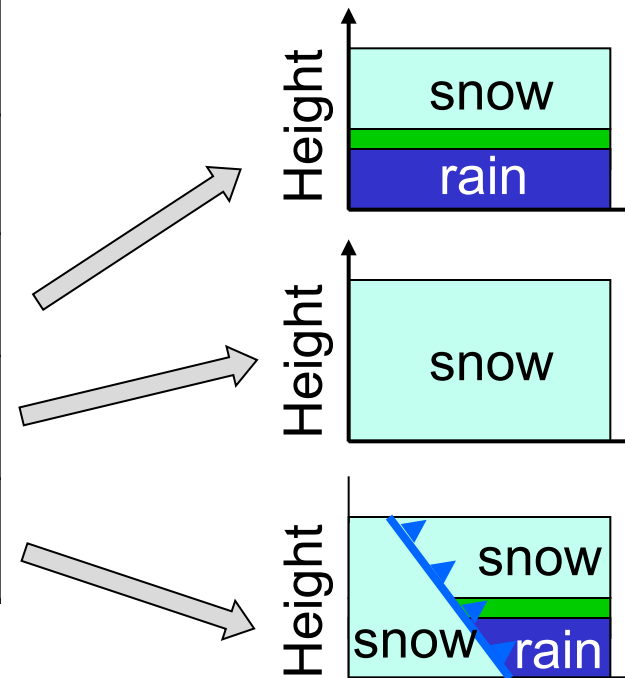


Weather Situation Classifier

Is it stratiform or convective?

- Indicator for convective: $Z_H > 40$ dBZ; $Z_H > 55$ dBZ; season
- Use of hydrometeor classification

	favouring hydrometeors	adverse hydrometeors
convective	hail, graupel	snow
stratiform rain	snow rain	hail, graupel
stratiform snow	snow	hail, graupel rain
stratiform front	snow	hail, graupel



Precipitation at Surface

- For stratiform precipitation events:
 - $Z_H < 20$ dBZ
 - Season
 - Is the melting layer visible; is it at ground?

situation	con- vect.	stratiform		
		ML	front	no ML
hydro- met.	rain, hail, graupel		rain, snow	snow

- Without further observations an extrapolation of radar hydrometeor classification towards the ground is limited to weather situations with standard linear temperature profile

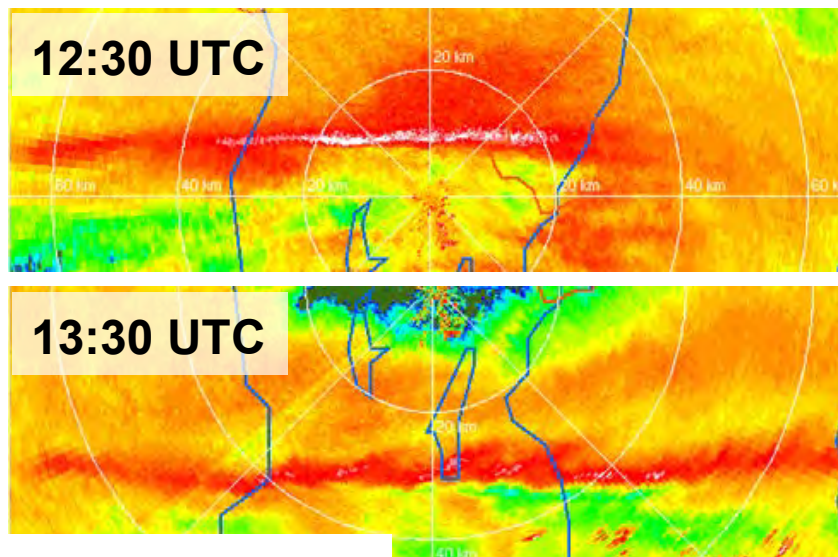
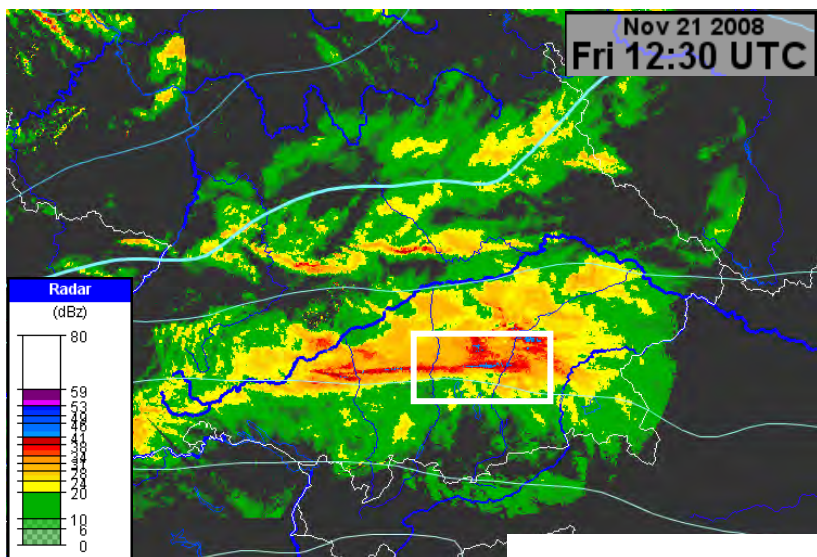


Precipitation at Surface

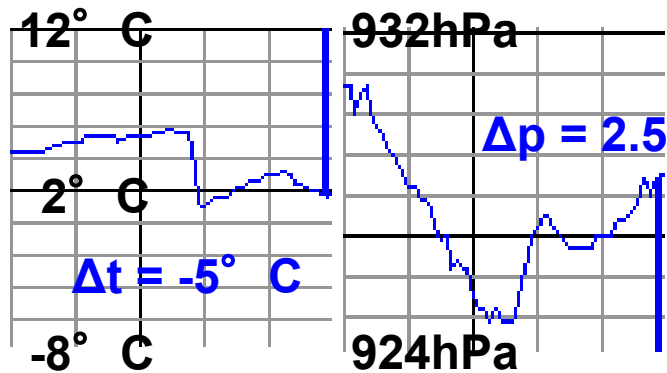
Example of a cold front approaching from the north

DWD radar composite

Poldirad reflectivity



Observations at radar site



Conclusions – Perspectives

- Importance of radar measurements for observation and nowcasting on the mesoscale for winterly weather conditions
- Detection of the bright band and snowfall
- Currently only standard linear temperature profiles are considered as no temperature information is used

Perspectives / Future work

- Improvement of the membership functions and weights
- Include surface temperature and temperature profiles from aircraft observations (AMDAR) or NWP temperature fields
- Identification of freezing rain or drizzle

