Identification of Snow and Rain at the Surface using Polarimetric Radar

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Hydrometeor Classification

Why again (and again)?

- 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, …)
- …

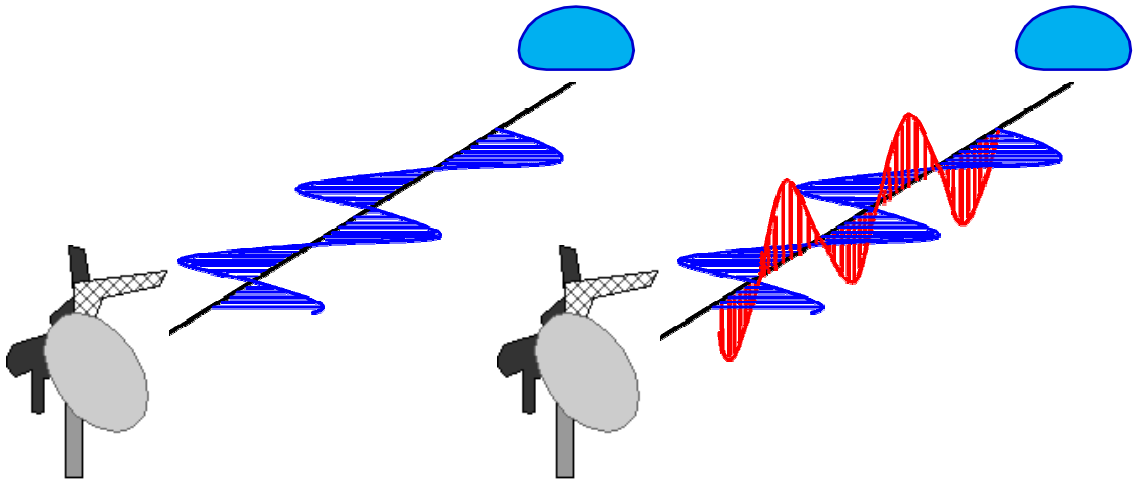
→ Different membership functions and relative weights are used for fuzzy-logic hydrometeor classifiers

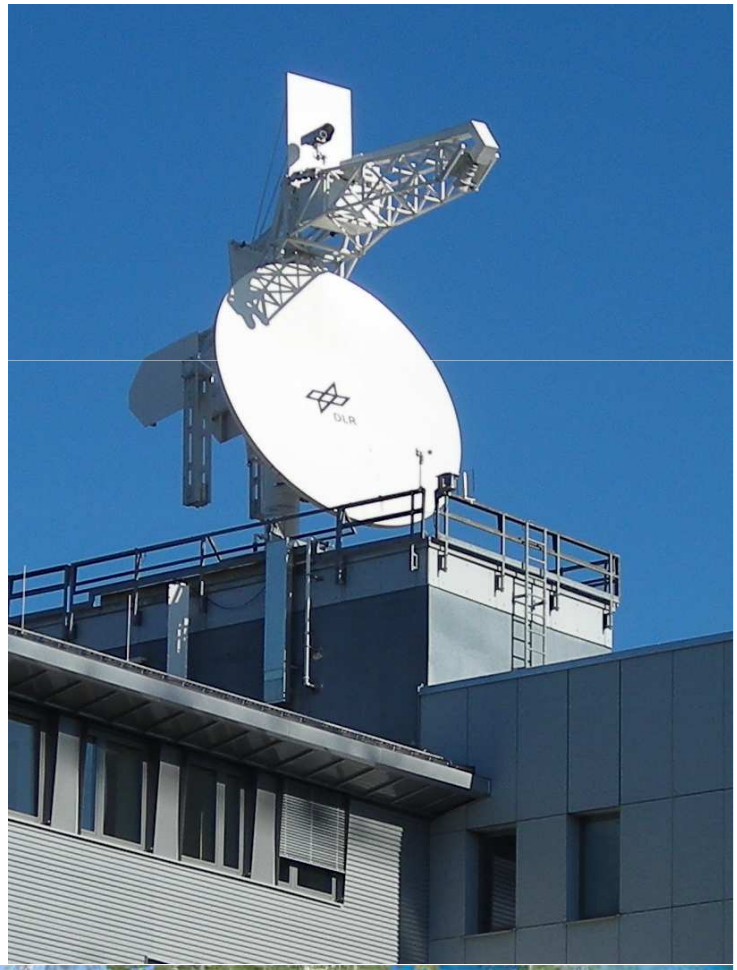
Hydrometeor Classification

DLR's POLDIRAD

uses most times alternate H V switching mode

and seldom hybrid (STAR) mode





→ rhoHV(1) is lower than rhoHV(0)

→ LDR is available

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?

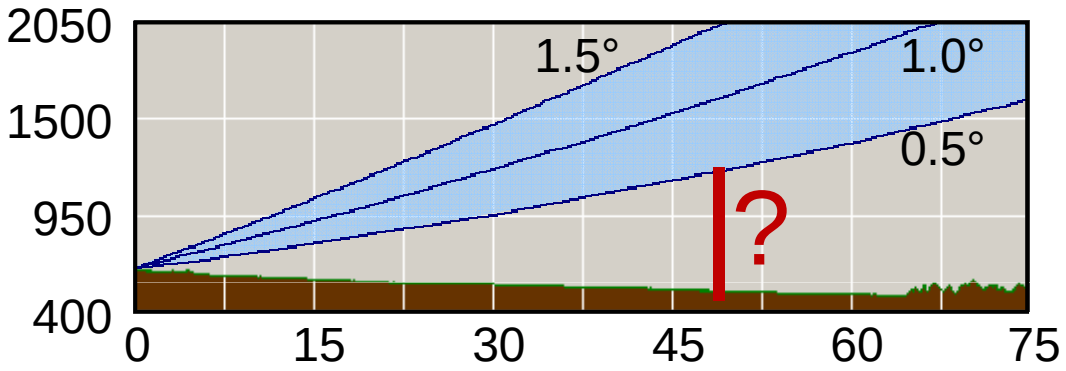
How can we contribute with polarimetric weather radar?

What additional tools or measurements would be required?

Identification of Rain and Snow at the Surface

Challenges

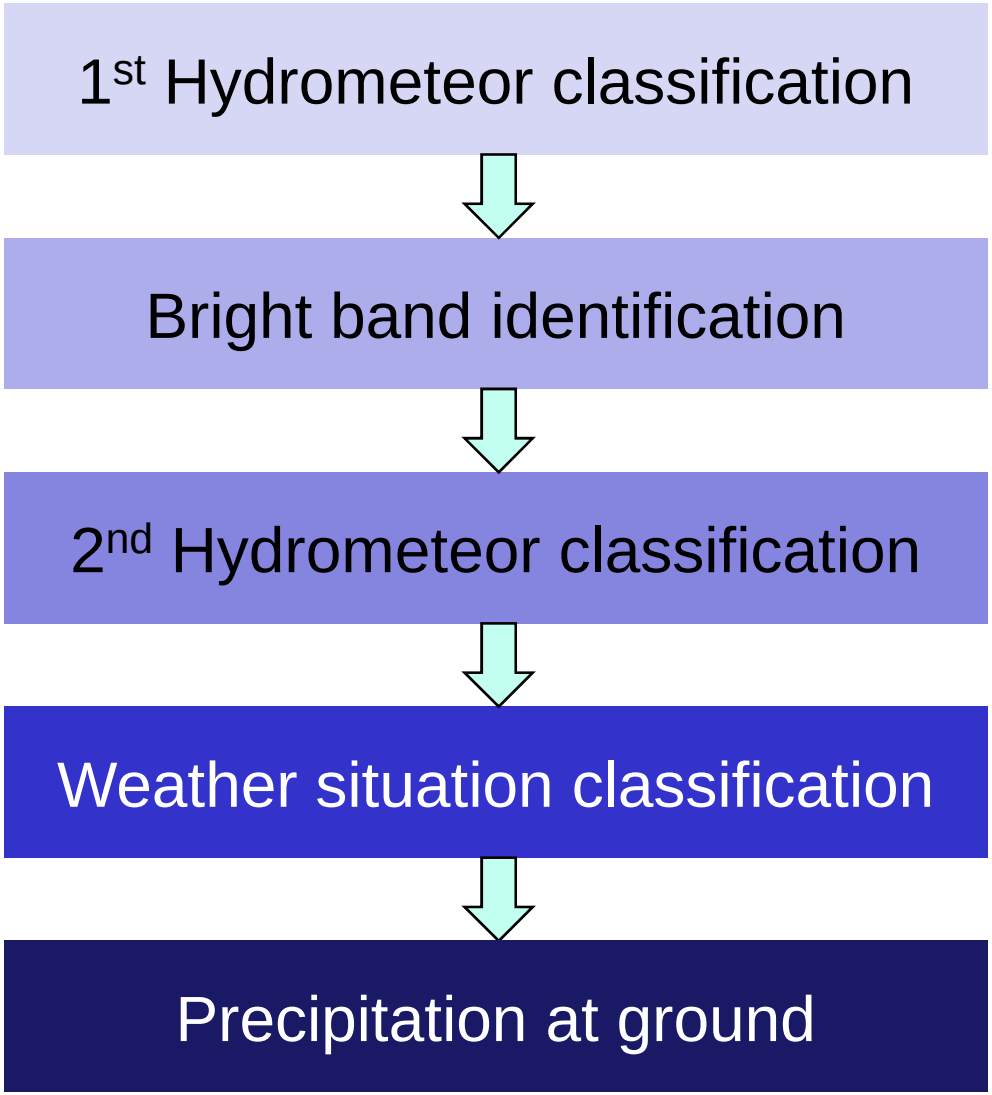
- What happens between the radar beam and the surface?



Poldirad at 603 m ASL
MUC at 50m range
445 m ASL

- Light rain and snow are hard to distinguish
- How to identify freezing rain or drizzle?

From Classification to Precipitation at Ground



Hydrometeor Classification Process

1st Step

fuzzy logic

input	Z_H	LDR	ρ_{HV}
	Z_{DR}	V_H	
output	weather	not weather	

2nd Step

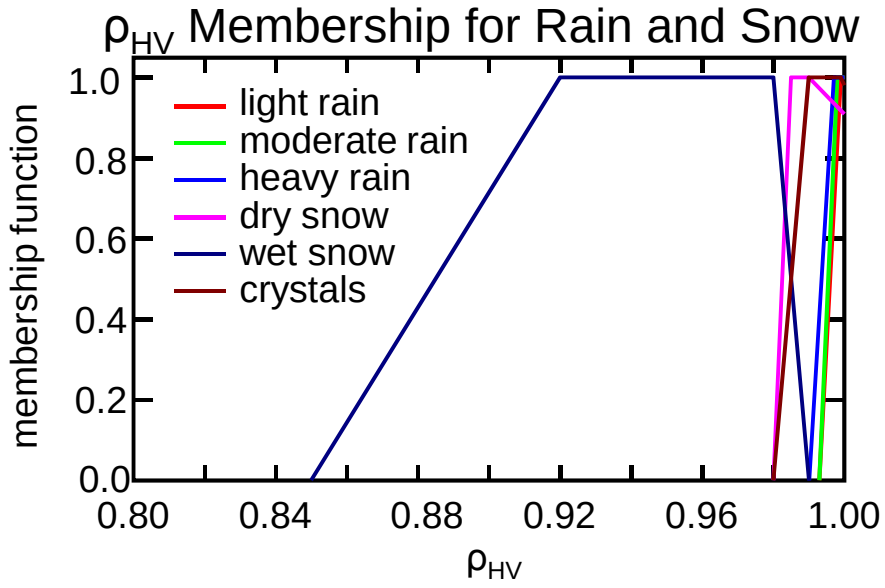
fuzzy logic

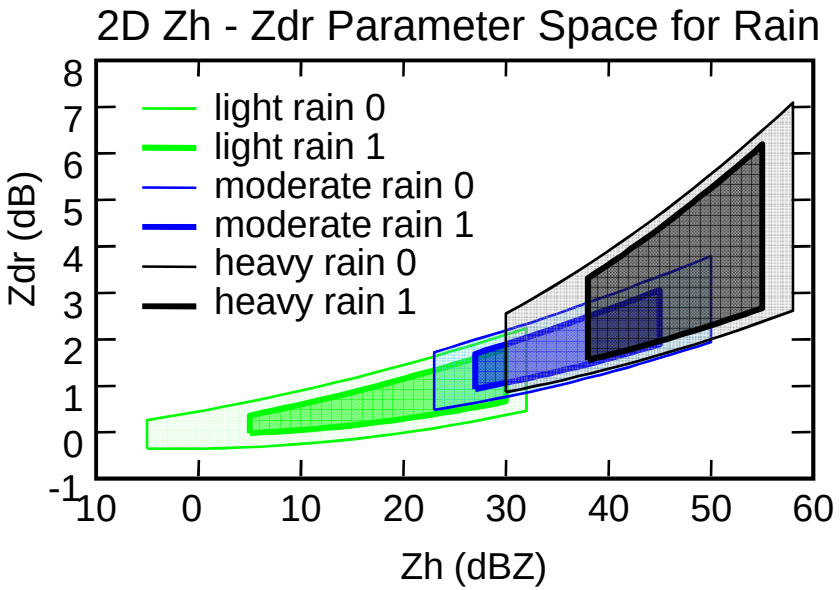
input	output
Z_H Z_{DR} LDR ρ_{HV} BB altitude Is-it-stratiform?	Light rain
	Moderate rain
	Heavy rain
	Dry snow
	Wet snow
	Hail
	Wet hail
	Graupel
	Crystals

input	output
Z_H Z_{DR}	Clutter
	Insects, birds

Fuzzy-logic Classification

- POLDIRAD can use LDR and ρHV for the identification of melting hydrometeors
- The current classification is optimized for winter conditions.
- 1-D and 2-D membership functions are used:

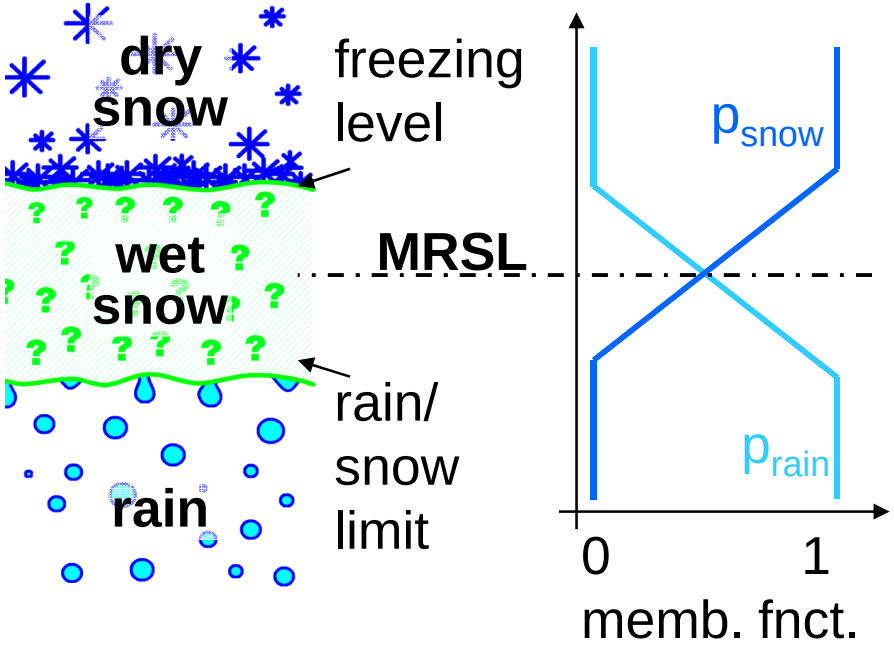




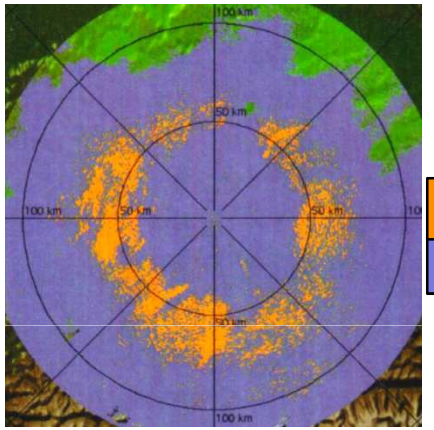
- Definition of membership functions and weights are empirical

Bright Band Identification

Modelized rain / dry snow limit (MRSL)



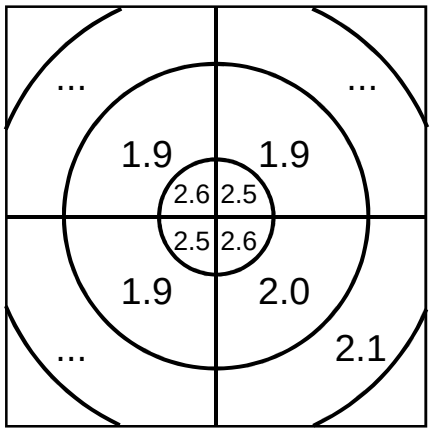
Estimation of MRSL for volume scan sectors



Classes:

wet snow

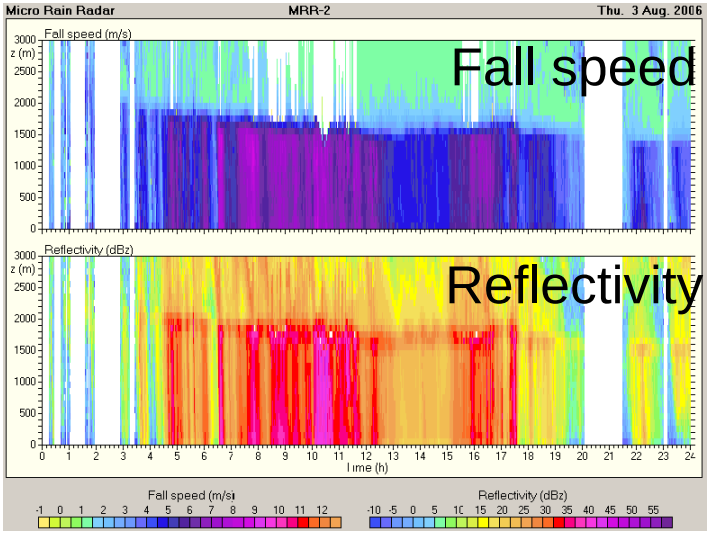
others

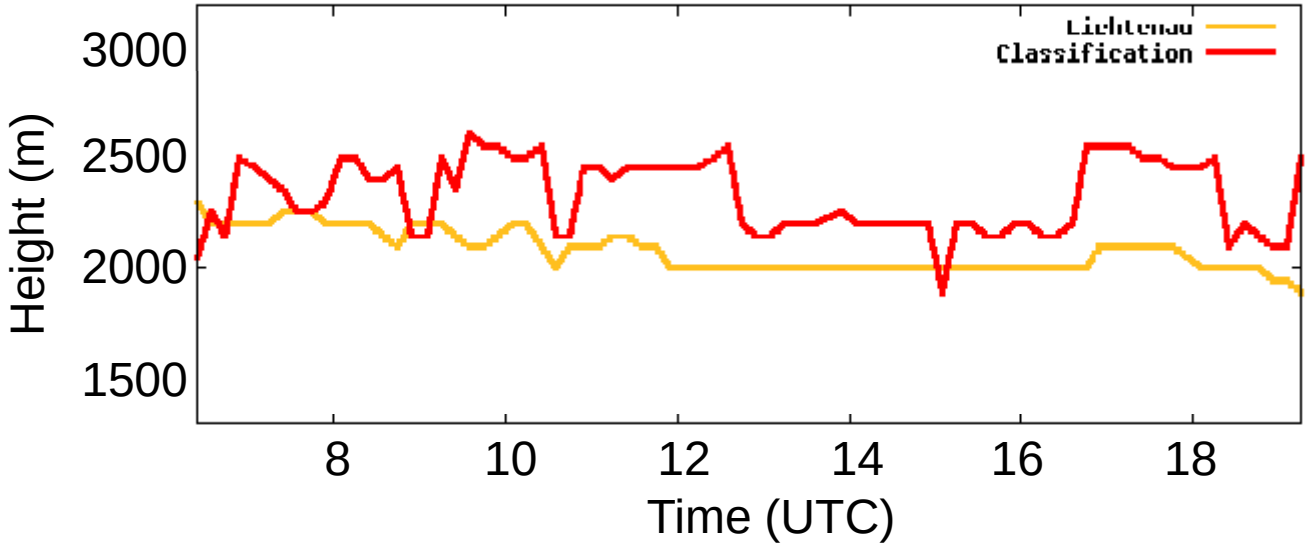


MRSL heights

Verification of Estimated Bright Band Height

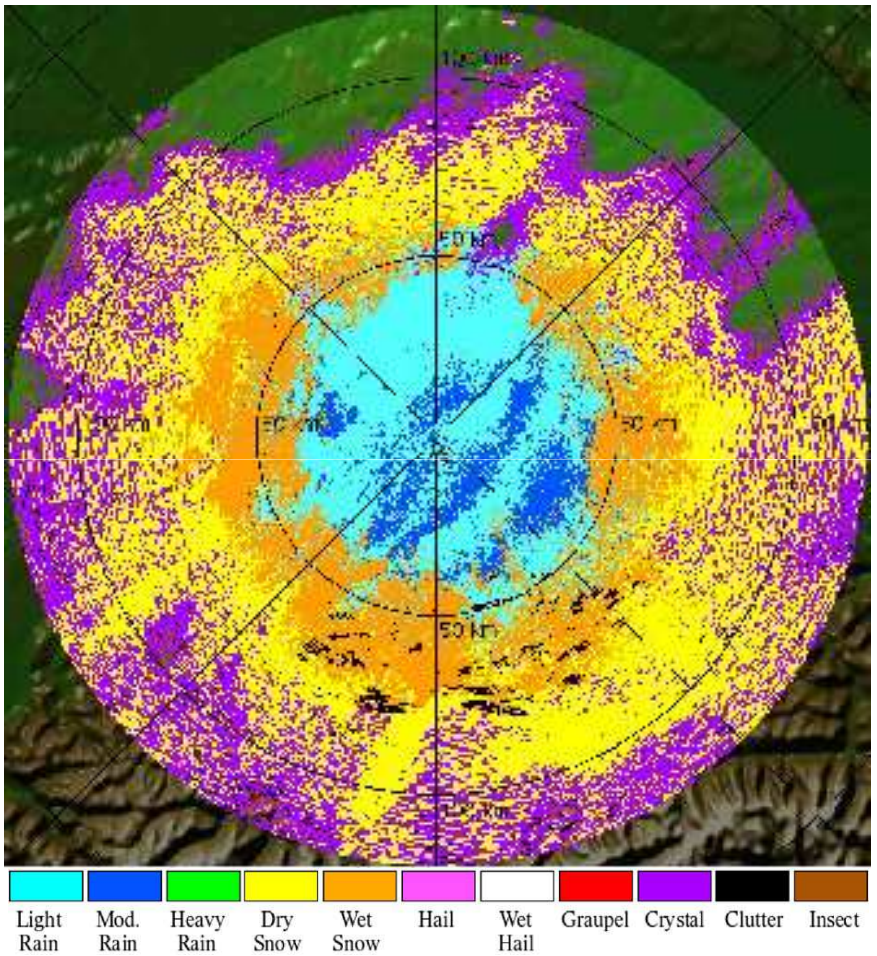
- Micro Rain Radar MRR (located at Lichtenau 27 km SW) provides good indication of bright band height (change of fallspeed)



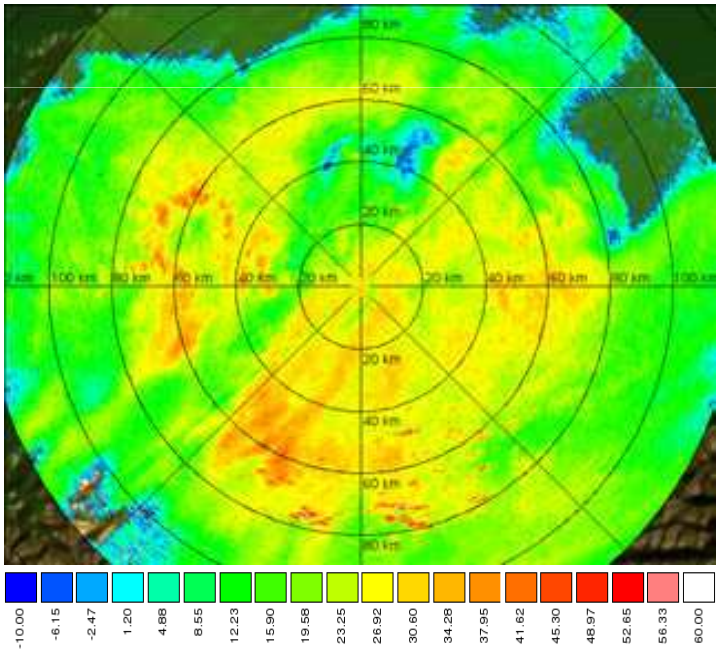


Hydrometeor Classification

- Final classification



- Reflectivity

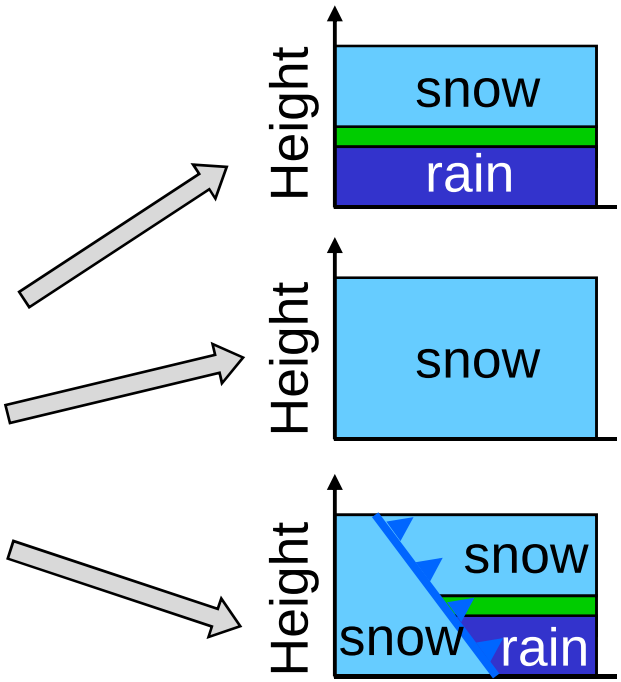


Weather Situation Classifier

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?

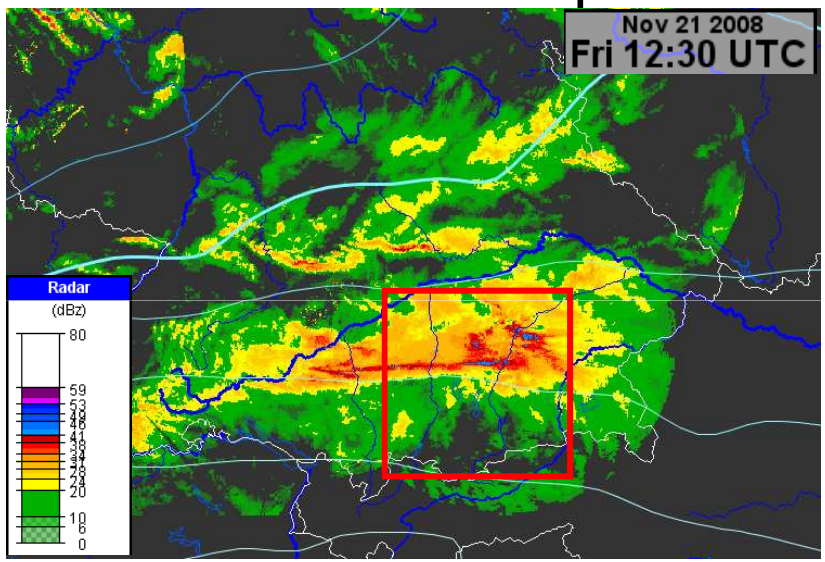
situation	con-vect.	stratiform		
		ML	front	no ML
hydro-met.	rain, hail, graupel		rain, snow	snow

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

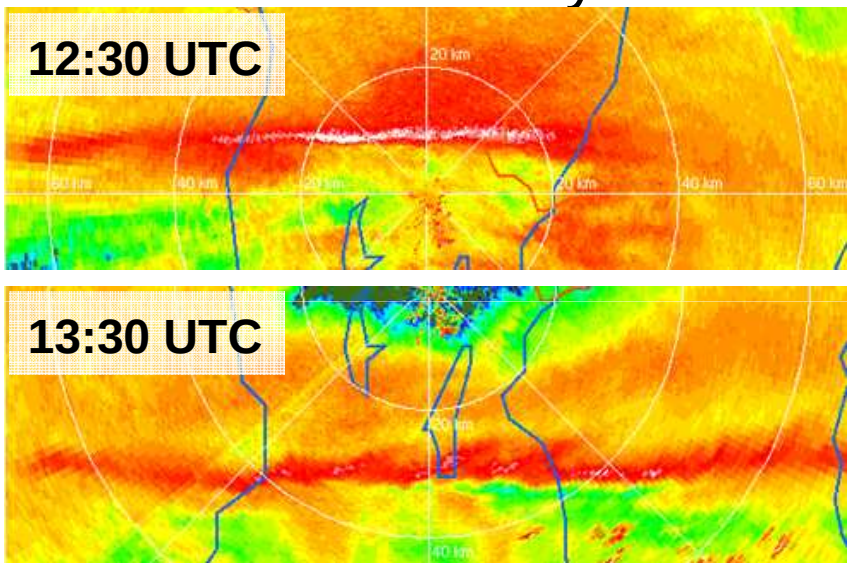
Precipitation at Surface

- Example of a cold front approaching from the north

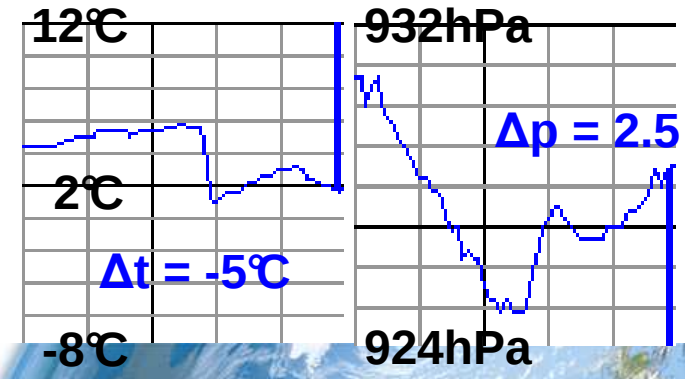
DWD radar composite



Poldirad reflectivity

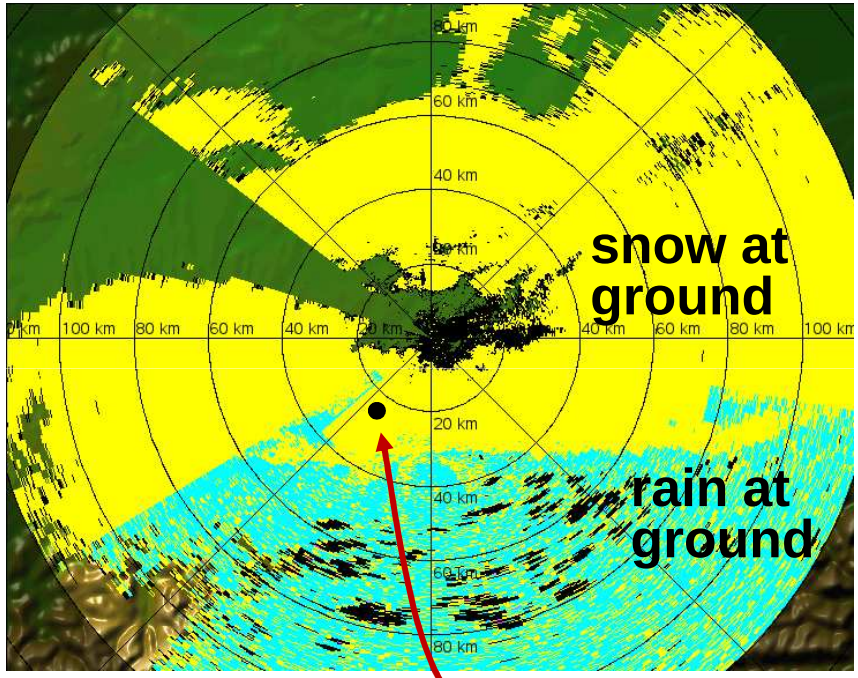


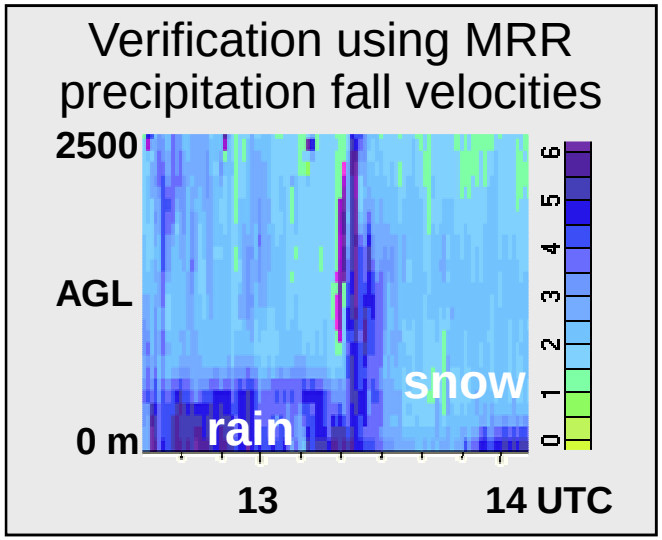
Observations at radar site



Precipitation at Surface

- Example of a cold front approaching from the north





Summary

Characteristics

- Globally robust method
- Correct detection of the non-meteorological echoes
- Acceptable restitution of the melting layer
- Quite good detection of the snowfalls

Limits

- Robust detection of snowfalls
- Detection of a front delineating an area of rain and of snow at the ground
- Limited precision in the hydrometeors classes
- Validity of the membership functions

DLR

Conclusions – Perspectives

- Importance and performance of radar measurements for observation and nowcasting on mesoscale
- The results of the detection of the bright band and snowfall are encouraging
- Up to now only standard linear temperature profiles are covered

Perspectives / Future work

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