

Identification of Snow and Rain at the Surface using Polarimetric Radar

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Knowledge for Tomorrow



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

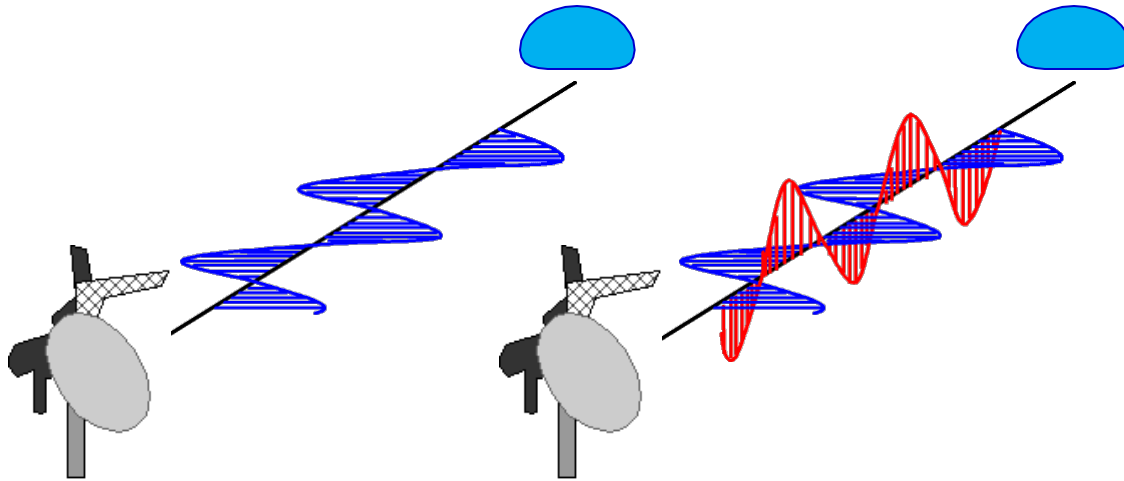


Hydrometeor Classification

DLR's POLDIRAD

uses most times
alternate H V
switching mode

and seldom
hybrid (STAR)
mode



→ $\rho_{HV}(1)$ is lower than $\rho_{HV}(0)$

→ 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?

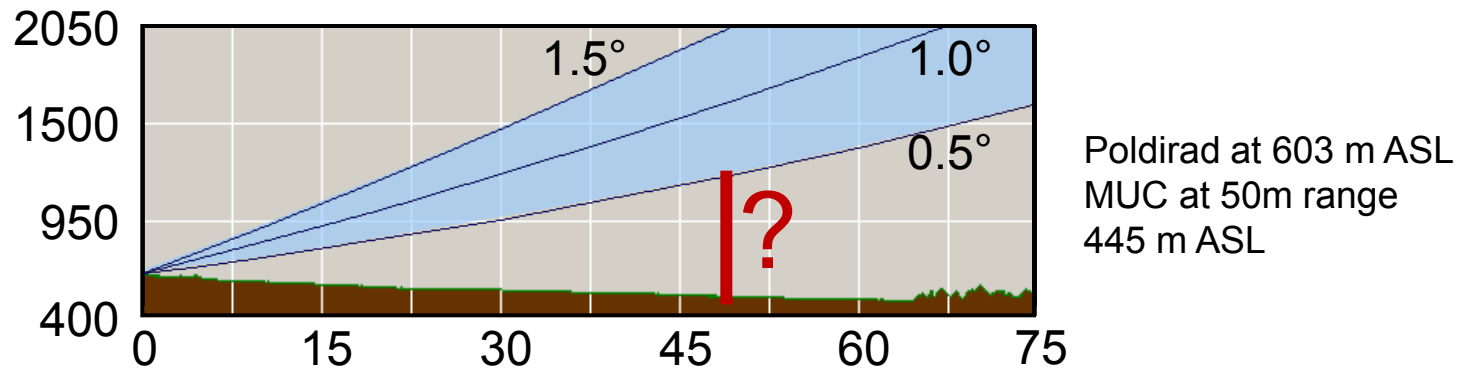
What additional tools or
measurements would be
required?



Identification of Rain and Snow at the Surface

Challenges

- What happens between the radar beam and the surface?



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

From Classification to Precipitation at Ground

1st Hydrometeor classification



Bright band identification



2nd Hydrometeor classification



Weather situation classification



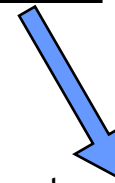
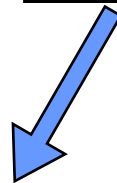
Precipitation at ground



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

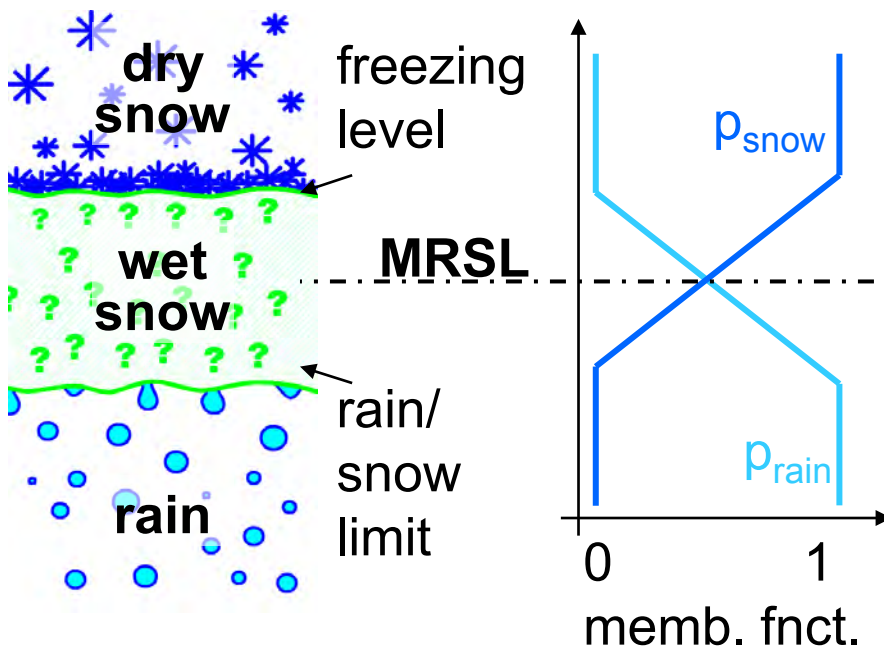
| input | output |
|-------------------|---------------|
| Z_H | Light rain |
| Z_{DR} | Moderate rain |
| LDR | Heavy rain |
| ρ_{HV} | Dry snow |
| BB altitude | Wet snow |
| Is-it-stratiform? | Hail |
| | Wet hail |
| | Graupel |
| | Crystals |

| input | output |
|----------|----------------|
| Z_H | Clutter |
| Z_{DR} | Insects, birds |

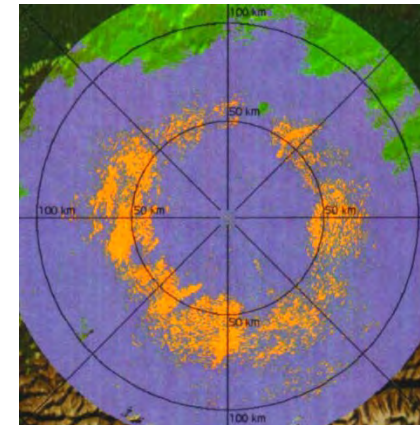


Bright Band Identification

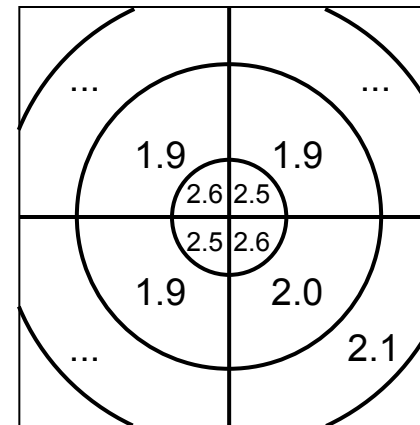
Modelized rain / dry snow limit (MRSL)



Estimation of MRSL for volume scan sectors



Classes:
wet snow
others

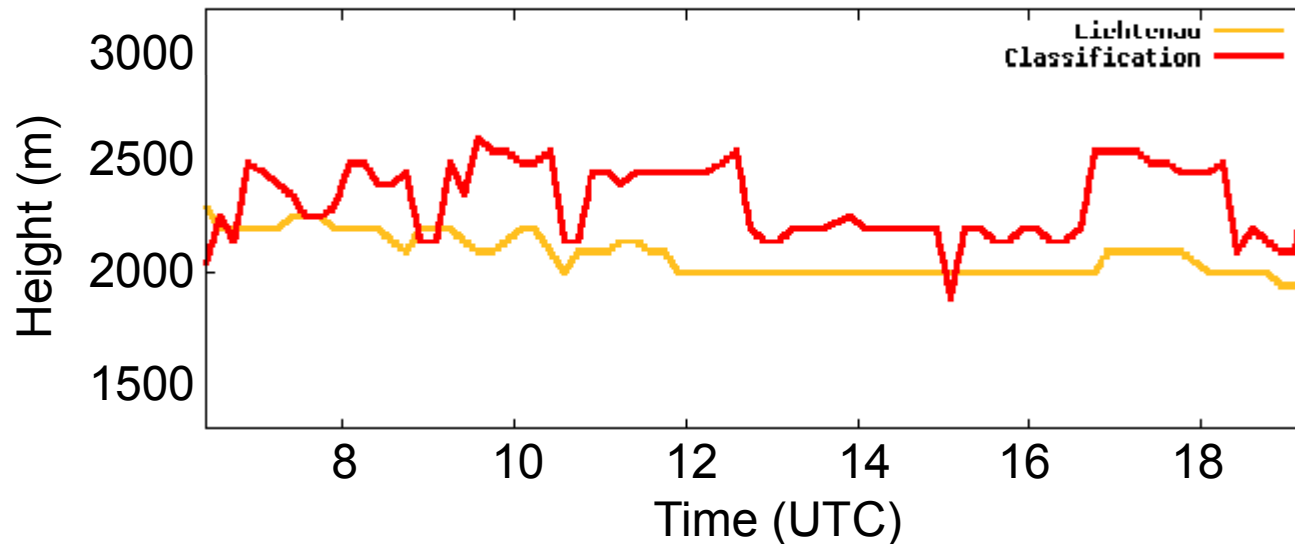
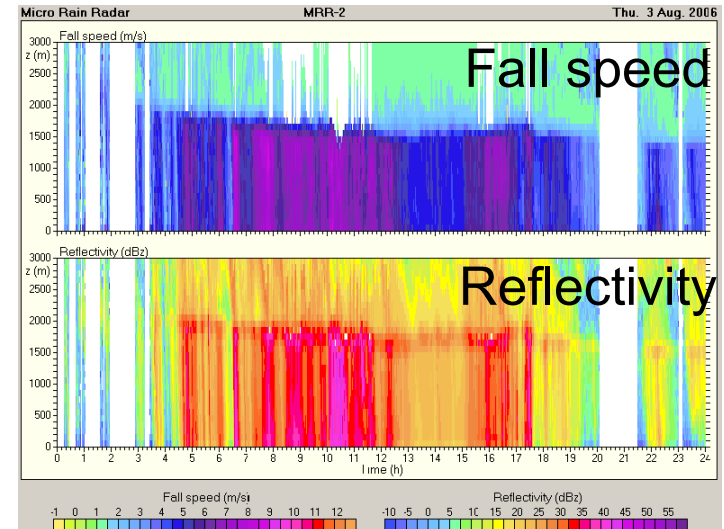


MRSL heights



Verification of Estimated Bright Band Height

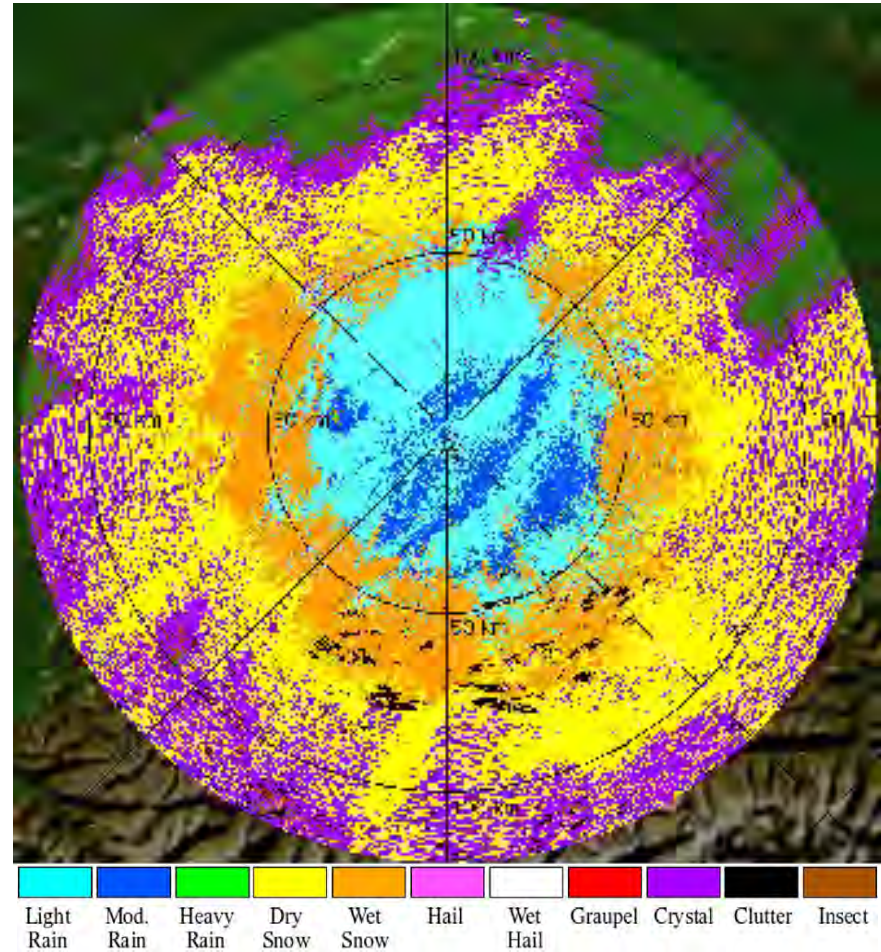
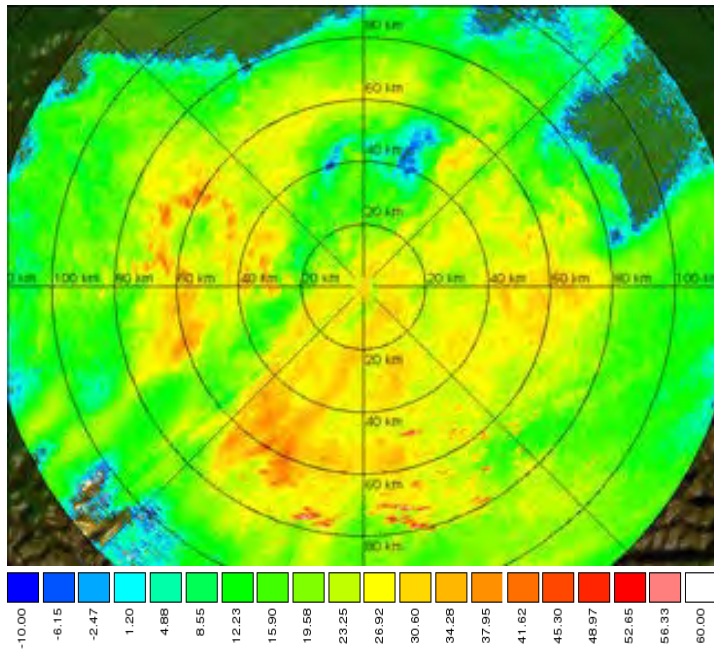
- Micro Rain Radar MRR (located at Lichtenau 27 km SW) provides good indication of bright band height (change of fallspeed)



Hydrometeor Classification

- Final classification

- Reflectivity

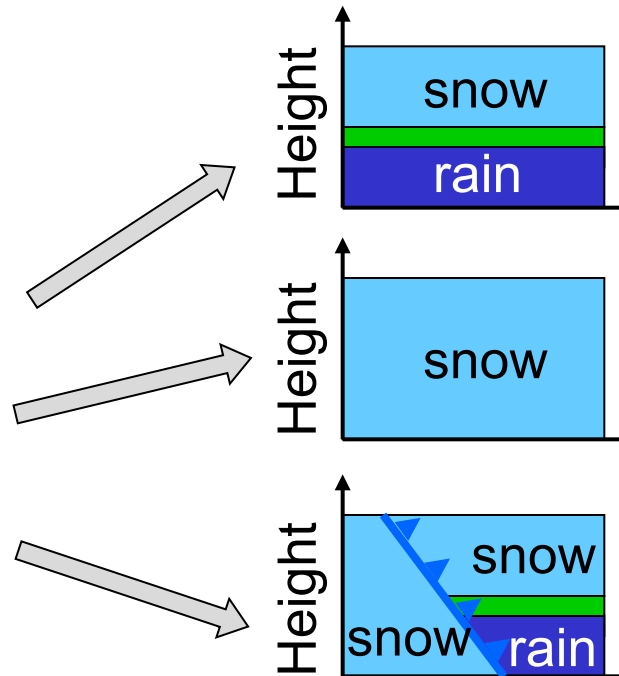


Weather Situation Classifier

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 |

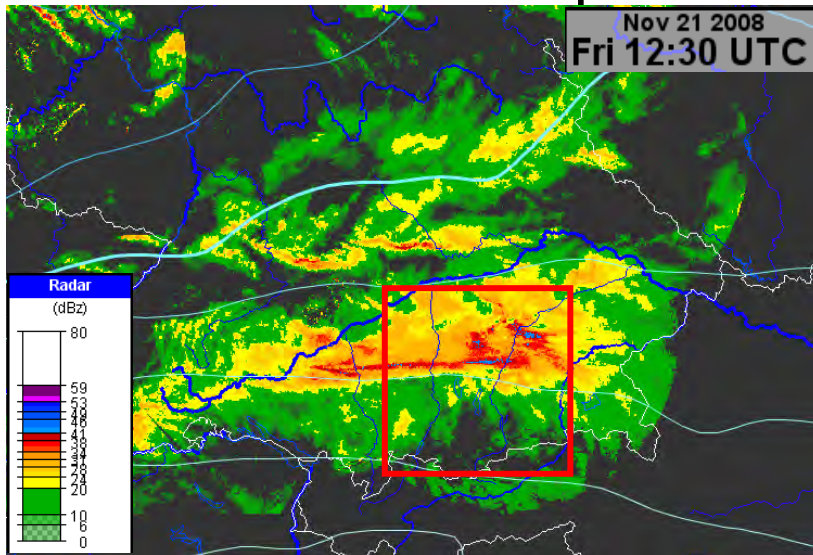
- Without further observations an extrapolation of radar hydrometeor classification towards the ground is limited to weather situations with standard linear temperature profile



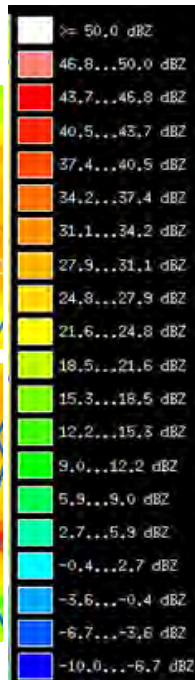
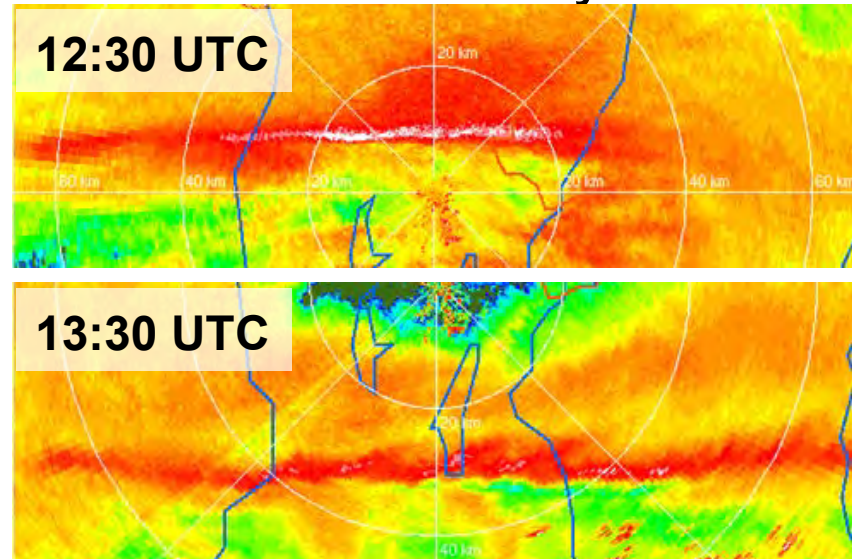
Precipitation at Surface

- Example of a cold front approaching from the north

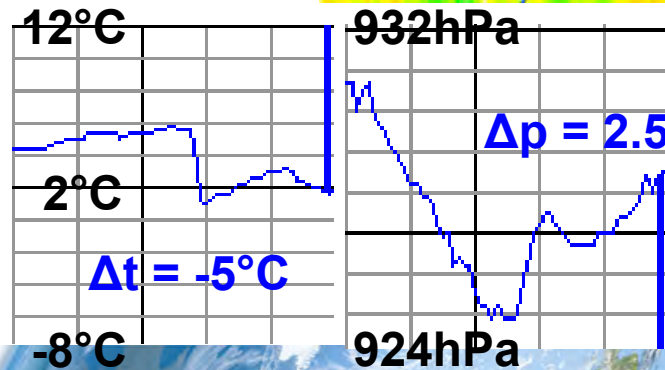
DWD radar composite



Poldirad reflectivity

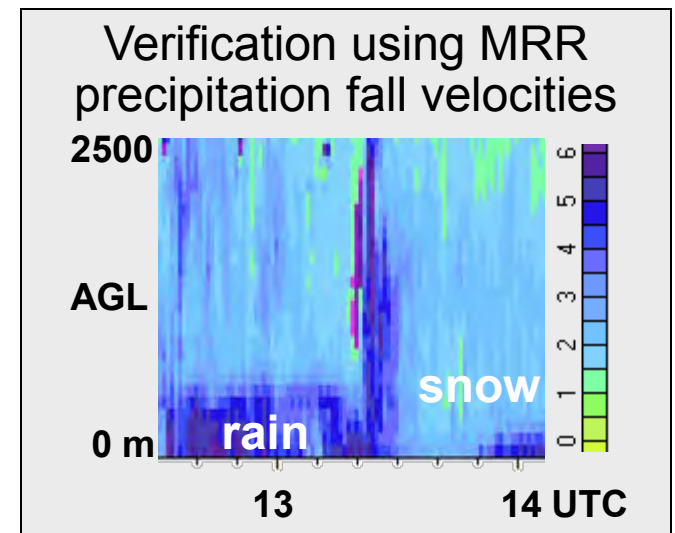
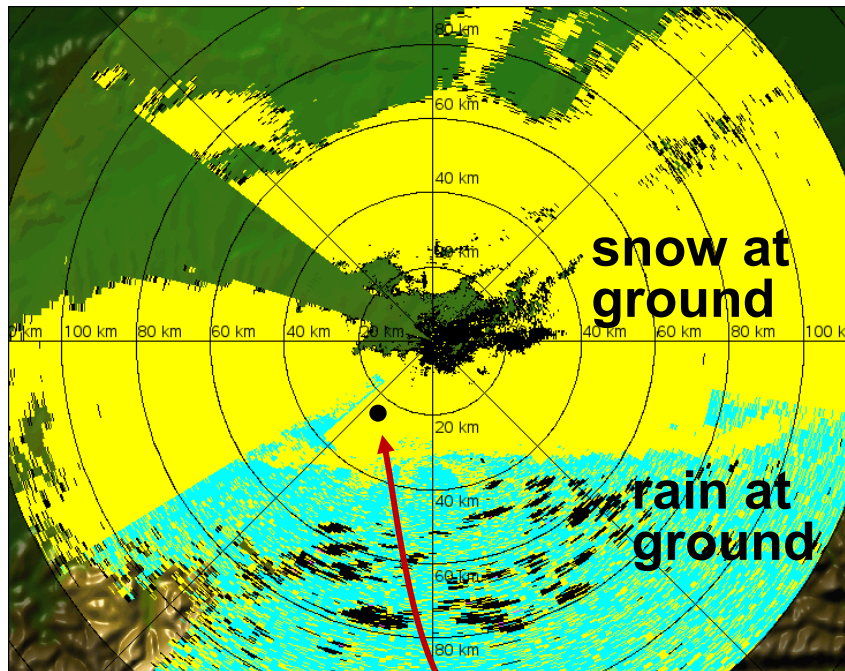


Observations at radar site



Precipitation at Surface

- Example of a cold front approaching from the north



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

