Evaluation of cloud microphysical parameterization schemes by polarimetric radar

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Polarimetric Radar Observations

Polarization Diversity Radar POLDIRAD

- **Frequency**: 5.503 GHz
- **Wavelength**: 5.45 cm
- **Band**: C-Band

**Types of precipitation observed**:
- Rain
- Graupel
- Hail
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Differential Reflectivity

Range (km)

Height (km)

60            65            70           75           80

2

4

6

8

10

12 14

ZDR (dB)

-3   -0.5  +0.5  4.5

Reflectivity

Height (km)

2

4

6

8

10

12 14

Reflectivity (dBZ)

0 40 55 60

Differential Reflectivity

Range (km)

Height (km)

60            65            70           75           80

LDR (dB)

-35    -28   -19    -13

Depolarization Ratio

Height (km)

2

4

6

8

10

12 14

LDR (dB)

-35 -28 -19 -13

Hydrometeor Type

Range (km)

Height (km)

60            65            70           75           80

Tumbling, not spherical hydrometeors

(Graupel, Hail)
Advantages of polarimetry

- Polarimetric variables depend on phase, shape, density, falling behaviour

**Goal:** Identification of critical model parameters and deficiencies in the microphysical parameterization schemes

- Classification of hydrometeors
- Insights in Microphysics of convective System
Synthetic Polarimetric Radar: SynPoIRad

Reflectivity, LDR, ZDR
Polar Coordinates

Specific water content of hydrometeors
Model Grid
Synthetic Polarimetric Radar: SynPolRad

Reflectivity, LDR, ZDR
Polar Coordinates

Specific water content of hydrometeors
Model Grid

Polarimetric Radar Forward Operator: SynPolRad

Reflectivity, LDR, ZDR,
Model Grid

Synthetic Reflectivity, LDR, ZDR,
Model Grid
Synthetic Polarimetric Radar (SynPolRad)

- Radar Beam
- Horizontal
- Vertical
- Attenuation by atmospheric gases
- Scattering and attenuation by hydrometeors
- Beam bending because of refraction and earth curvature

Model Domain
Case Study: 12th August 2004, 15 to 20 UTC

LMK 3.18:
- 2 component
- 3 component
- Thompson
LMK 3.18: 17 UTC

Poldirad

2 comp

3 comp

Thompson
LMK 3.18: 18:00 UTC

Poldirad

2 comp

3 comp

Thompson
LMK 3.18: 19:00 UTC

Poldirad

2 comp

3 comp.

Thompson
LMK 3.18: 20 UTC

Poldirad

2 comp

3 comp

Thompson
Temporal evolution of the storm

Time series of histograms of classes of reflectivity

25 dBZ ≤ Reflectivity < 35 dBZ

35 dBZ ≤ Reflectivity < 45 dBZ

25 dBZ < Zhh < 35 dBZ

35 dBZ < Zhh < 45 dBZ
Total precipitation at the ground (hourly accumulated)
RHI Reflectivity

Poldirad
LMK,
2 comp.
Rain, Snow

LMK,
3 comp.
Rain, Snow, Graupel

LMK,
Thompson,
Rain, Snow, Graupel
Hydrometeor Classification

Poldirad

LMK, 2 comp.
Rain, Snow

LMK, 3 comp.
Rain, Snow, Graupel

LMK, Thompson, Rain, Snow, Graupel
Conclusions and Outlook

The representation of microphysical processes in NWP models has a major effect on QPF.

How to improve the description of microphysical processes?

- Systematic evaluation of current microphysical parameterization schemes
  - Identification of major and systematic problems.
- Development of new microphysical parameterization schemes closely linked to observations
- Assimilation of observations of precipitation and especially polarimetric radar data
Systematic Long-Term Model Evaluation

1. Mesoscale Models have major problems in the vertical distribution of intensities and hydrometeor types.

2. Regarding precipitation, polarimetric radar is a key instrument for providing information about microphysical processes.

3. The polarimetric radar forward operator SynPolRad provides the means for a systematic model evaluation.

4. The precipitation at the ground is the final product of a number of processes taking place in the atmosphere. For a complete evaluation of model physics, it has to be combined with other remote sensors.

5. Life Cycle, Feed back onto dynamics and redistribution of latent heat???

6. LAF ensemble???
AQUARadar: Special Observation Period

Advances in Quantitative Areal Precipitation Estimation

- Weather Radars
- MRRs
- Disdrometers
- Rain Gauges