Spatial and Temporal Rainfall Variation Observed by Vertically Pointing Radar Clusters and Disdrometers

Wenchieh Yen, Susanne Crewell

Institute for Geophysics and Meteorology, University of Cologne

Contact: yen@meteo.uni-koeln.de

Introduction

One of the major uncertainties in quantitative precipitation estimation using weather radar is the temporal and spatial ambiguity caused by the extrapolation to the ground. Information on **rain drop size distribution (RDSD)** is indispensable for identification and quantification of rainfall variations. The vertically pointing micro rain radar (MRR) can measure profiles of RDSD and integral rainfall parameters such as **rain rate (R)** and **radar reflectivity (Z)**. It thus can serve as a linkage between in-situ measurements at the ground and the radar pixel aloft.

Concurrent observations from a cluster of 9 micro rain radars and disdrometers at two sites are examined

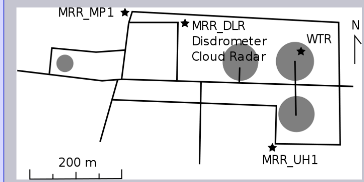
- to understand how well these instruments agree to each other.
- to investigate spatial and temporal variations can be revealed.

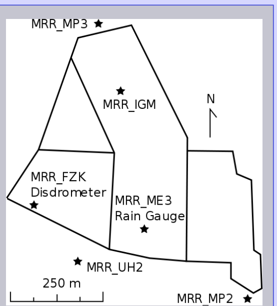
Data used were collected during the **AQUARadar** (Advances in Quantitative Areal Precipitation by Radar) field campaign in Bavaria.

Field Setup

- Continuous monitoring of precipitation for over 3 months in summer 2006 in Southern Bavaria, Germany
- Two sites aligned in a east-west fashion with a separation of 5.5 km over flat land.
- Over 200 hours of raining events; accumulated rainfall over 300 mm.

- 3 disdrometers
- 9 micro rain radars (MRR)
- 1 rain gauge





Lichtenau W ← **5.5 km** → E **Wielenbach**

Instruments

Joss-Waldvogel disdrometer

- Impact type
- Time resolution 60 s
- Sampling area 50 cm^2
- RDSD, R, Z

Parsivel disdrometer

- Optical type
- Time resolution: 60 s
- Sampling area: 54 cm^2
- RDSD, R, Z

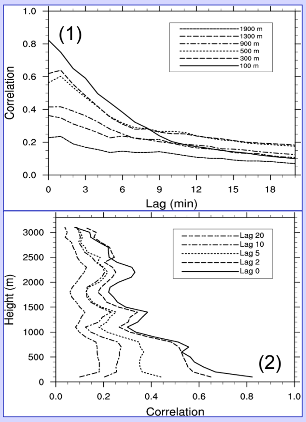
Micro rain radar

- Doppler radar at 24.1 GHz, Beam width 2°
- Vertical resolution: 100 m
- Time resolution: 10 s
- RDSD, R, Z

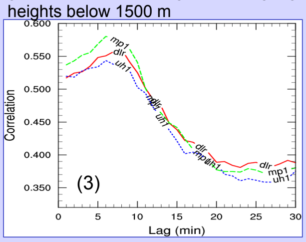
Temporal/Vertical Correlation

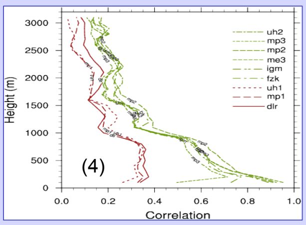
In order to examine to what extent MRR profiles can be linked to ground disdrometer measurements, rain rate time series analysis of collocated JWD and MRR (20.07-3.10. 2006) is performed:

- Highest correlation occurs at the lowest MRR gate 100 m above ground (603 msl) though the first reliable MRR gate should be at 300 m (1).
- Correlation rapidly decreases with time lag showing a correlation length of less than 5 min (1).
- Maximum correlation decreases strongly with height from 0.8 at the closest range gate to 0.25 at 1900 m. At 300 and 500 m maximum correlation occurs with 1 min time lag (1).
- Systematic local maxima of correlation are found at 1400 m and 2200 m indicating the dominant brightband heights due to two very long lasting stratiform events (2).



- The **cross-site rain rate correlation** between the MRRs at Lichtenau (west) and the rain gauge in Wielenbach (east) is maximum at +7 min lag time in accordance with the prevailing westerly winds with 30 out of 33 major rain days (3).
- The correlation in the heights at 0 lag of MRRs from the two sites (red: Lichtenau, green: Wielenbach) against the gauge in Wielenbach is strongly separated for heights below 1500 m

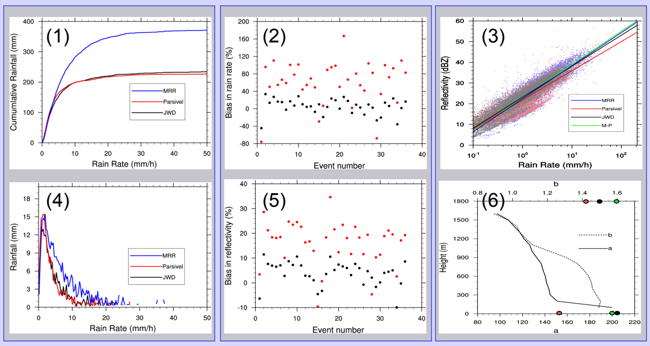




MRR Rainfall Estimation

JWD, Parsivel and MRR rain rate were compared for 36 rain events:

- The two disdrometers agree quite well, however MRR has an overestimation of the cumulative rain by ~70% (1) and for rain rate >1 mm/h (4).
- MRR overestimates rain rate (2) and reflectivity (3) during most – but not all events (black: JWD-Parsivel, red: MRR-Parsivel). Overall JWD has a bias of 5% and 4% in averaged rain rate and reflectivity while MRR has 61% and 16% against Parsivel.
- Z=a·R^b relations derived from all instrumets for the surface (3) show a large scatter and encompass the Marshall-Palmer (M-P) one. MRR shows a relatively constant b parameter from the surface up to 900 m (6) below brightband.



Summary/Outlook

- There is a good agreement between JWD and Parsivel.
- Rainfall observed by collocated MRR reveals reasonable correlation to that by ground disdrometers in time and space. However, R as well as Z are strongly overestimated.
- Individual rain event based analysis should help to identify variation of RDSD parameters and to understand how they are related to rainfall.

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