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Deutscher Wetterdienst
Wetter und Klima aus einer Hand

On the verification of DWD's polarimetric hydrometeor classification and improved QPE

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Since dual polarimetric weather radar measurements join the game in meteorological observations, the determination of a hydrometeor classification (Hymec) and the refinement of the quantitative precipitation estimation (QPE) are achievable. In this study, the focus is laid on the verification of the (high spatially distributed) results from the German weather radar network with ground truth (point) measurements from an optical disdrometer network.

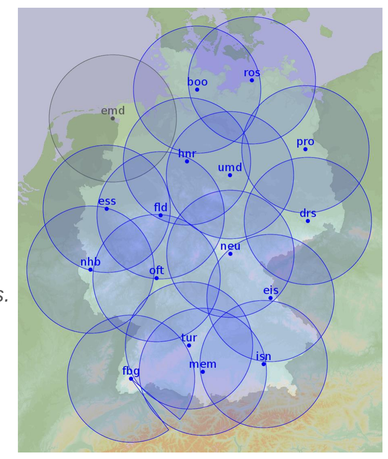

Fig. 1: *Current state of operational DWD radar network shown with a 150 km coverage radius. blue: dual polarisation system; grey: single polarisation system. Geo data: © GeoBasis-DE / BKG 2014.*

Hydrometeor Classification and QPE with corresponding Measurement Height

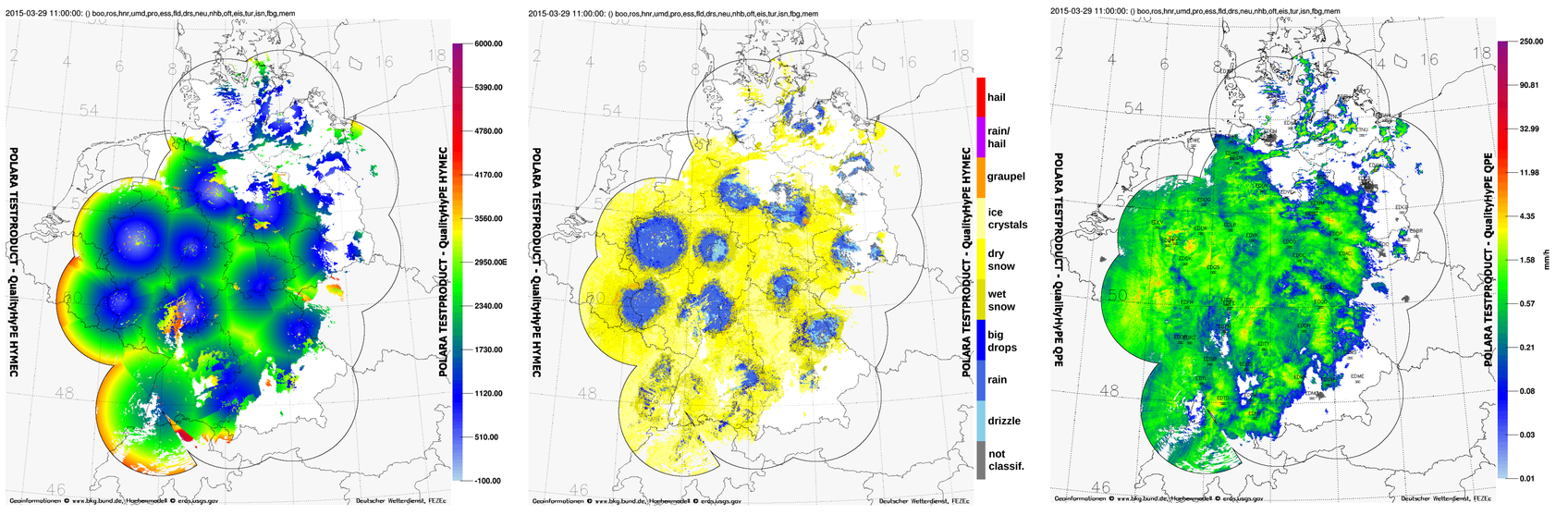

Fig. 2: *Case study of a stratiform weather event recorded on 29.03.2015 11:00 UTC with German weather radar network. Used is the terrain following 'precipitation' scan. Left: height above MSL in m of the radar measurements, center: hydrometeor classification, right: quantitative precipitation estimation. Represents one timestamp from verification timespan described below.*

Disdrometer Network

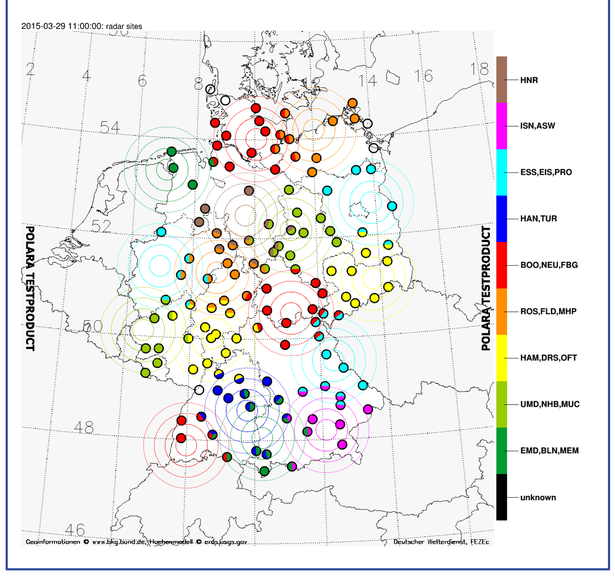

Fig. 3: *Disdrometer positions: black circles. Filling color is related to the coverage of a radar site (max. distance 120 km). Thin range circles around the radar sites for every 25 km.*

Radar Systems

- operating at C-band
- five minute scan cycle
  (one terrain following sweep, 10 fixed-elevation sweeps and two 90° (bird-bath) sweeps)
- range resolution of 250 m for near ground information

Hydrometeor Classification

- processed on single sweeps
- input: quality assured radar data and 0°C isotherm (from NWP model COSMO-DE)
- stand-alone bright band detection
- fuzzy-logic core

Quantitative Precipitation Estimation

- processed on single sweeps
- input: quality assured radar data and the results of the hydrometeor classification
- individual, specialised algorithm (or algorithm sets) for each single hydrometeor class

Optical Disdrometers

- count particle spectra
- deliver precipitation rate
- estimate hydrometeor phase
- one minute resolution
- 4 to 15 disdrometers per radar site

Verification of the Hydrometeor Classification

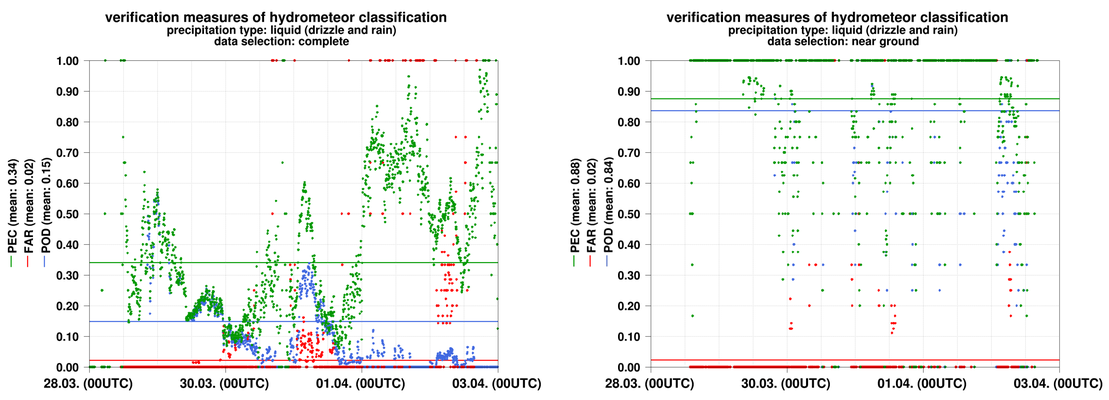

Fig. 4: *Verification measures for hydrometeor classification of liquid hydrometeors for German radar sites for timespan from 28.03.2015, 0:00 UTC to 03.04.2015, 0:00 UTC. Plotted is the complete dataset on the left and the reduced dataset with limited range and height difference (near ground) on the right. The dots represent 15 minute averages and the horizontal lines are the mean values for the whole timespan. Plotted are POD (blue), FAR (red) and PEC (green).*

- weather situation along the six days was stratiform with mainly rain and a little wet snow precipitation at surface
- for this setting in sum 70075 samples are available for the verification (Fig. 4 left); the number reduces to 2447 samples by looking at a limited range distance of 50 km and height difference of max. 250 m (Fig. 4 right)
- verification of liquid precipitation (drizzle and rain) delivers for the complete dataset a probability of detection **POD = 15%**, a very good false alarm ratio **FAR = 2%** and a percent correct value of **PEC = 35%**
- reduced dataset gives a stable **FAR = 2%** and better results for **POD = 84%** and **PEC = 88%** due to a less overestimation of the wet snow hydrometeor type

Outlook

→ development of algorithm for determination of *Hymec* near ground needed
→ expanding of existing classification with additional input (ground measurements) for better rain / snow discrimination

Verification of the Quantitative Precipitation Estimation

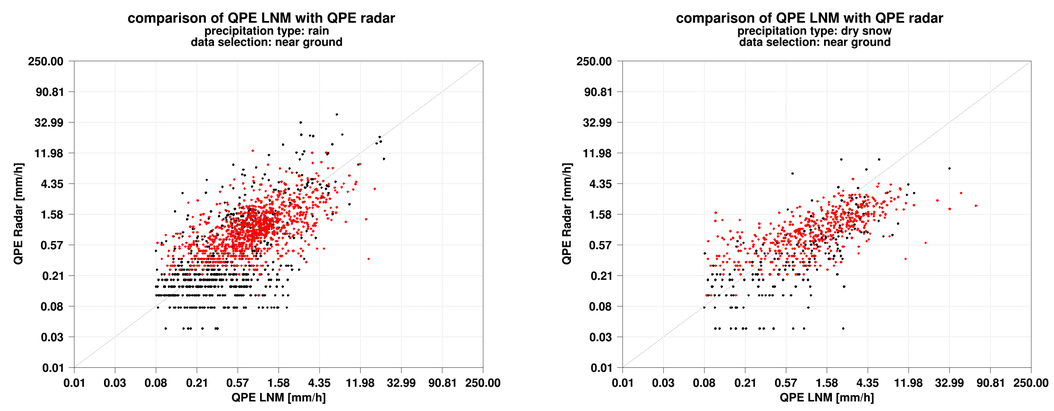

Fig. 5: *Scatter plots showing the precipitation rate estimated using the optical disdrometer measurements (QPE LNM) versus the precipitation rate estimated using the radar measurements (QPE Radar, German radar sites). The timespan is identical to the one used for Fig. 4 and the plots show subsets of the reduced (range, height) dataset. Shown on the left is the subset for the hydrometeor class rain and on the right for the hydrometeor class dry snow.*

- verification of QPE for the individual radar hydrometeor classes (*Hymec*)
  - Fig. 5 highlights in red the points where the radar hydrometeor classification and the optical disdrometer classification indicate identical hydrometeor classes (left: rain, right: dry snow), black points correspond to the disdrometer hydrometeor classification
- verification for different environmental scenarios like "distance of the disdrometer to the radar site" or "distance disdrometer and radar volume"
  - Fig. 5 shows the result for a maximum height distance of 250 m
- verification results for the analysed dataset (identical classification, red points)
  - rain: 1033 samples, correlation 0.5, RMSE 1.5, bias 0.0
  - dry snow: 502 samples, correlation 0.4, RMSE 4.1, bias -1.2

Outlook

→ extrapolation from radar sweep height (radar volume) to the ground is needed
→ expanding verification with ombrometer ground measurements

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