

# DWD Radar Products for Model Evaluation in SPP 1167

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## Radar Utilization

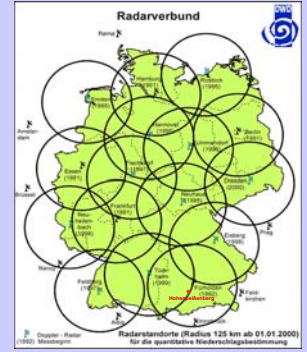
RADAR (Radio Detecting And Ranging) is the only remote sensing method to observe volumetric precipitation with a large areal coverage. It has the possibility of monitoring local and regional precipitation distribution with high temporal and spatial resolution.

Reflectivity is the primary measured radar quantity which is the sixth moment of the drop size distribution  $N(D)$ :  $Z = \int D^6 N(D) dD$  with  $D$  the diameter. Assumptions on  $N(D)$  and droplet falling speed  $V(D)$  enable the translation from radar reflectivity  $Z$  to precipitation rate  $R$  based on two parameters:  $Z = a \cdot R^b$ . Many DWD radar products are derived from the 2-dimensional DX product, which contains 5-min reflectivity values with high accuracy. Fine-tuned Z-R relations, statistical clutter filter and offline calibrations are employed in most of the products by DWD.

Compared to conventional in-situ observations, radar can provide detailed information on the time and location of precipitation events. However, quantitative determination of precipitation is prone to several errors (see below).

## DWD Radar Network

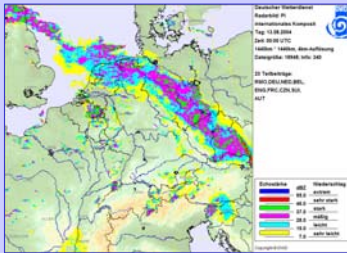
- 16 C-Band, 5.6GHz doppler radar (Feb 2004)
- 1 research radar at Hohenpeißenberg
- Retrieval of reflectivity (intensity) and mean radial wind velocity (doppler shift)
- Radar beam span approx. 1°
- Volume scan
  - 18 elevation angles ( $\Phi$ ) in 15 min
  - Altitude up to 12 km
  - Doppler mode:  $r = 120 \text{ km}, \Phi = 37.0^\circ - 4.5^\circ$
  - Intensity mode:  $r = 230 \text{ km}, \Phi = 4.5^\circ - 0.5^\circ$
- Precipitation scan
  - Orography dependent,  $\Phi = 0.5^\circ - 1.8^\circ$
  - $r = 128 \text{ km}$ , every 5 min
- Local real time image at radar sites
- 20+ derivable data products



## Major DWD Radar Products

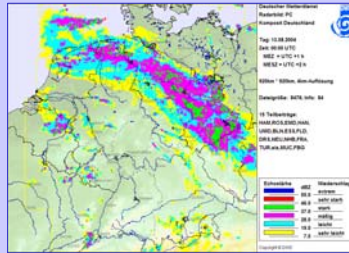
### PI

- International reflectivity composite
- Near-ground reflectivity in 6 classes
- Image domain 360x360 pixels
- Spatial: 4 km/pixel
- Temporal: every 15 min



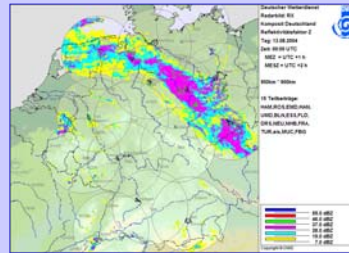
### PC

- National reflectivity composite
- Near-ground reflectivity in 6 classes
- Image domain 230x230 pixels
- Spatial: 4 km/pixel
- Temporal: every 15 min



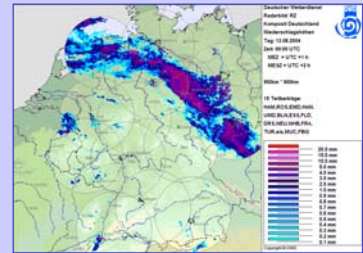
### RX

- National reflectivity composite
- Near-ground reflectivity from -32.5 to 95 dBZ with resolution of 0.5 dBZ
- Image domain 900x900 pixels
- Spatial: 1 km/pixel
- Temporal: every 5 min



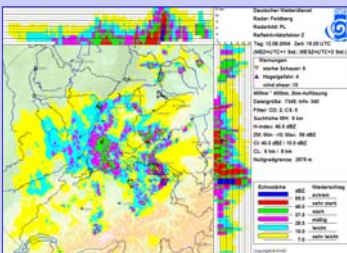
### RZ

- National precipitation composite
- Two variants: 5 min or hourly accumulated precipitation, both have resolution of 0.01 mm
- Image domain 900x900 pixels
- Spatial: 1 km/pixel
- Temporal: every 5 min/hour



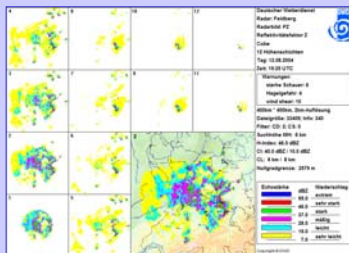
### PL

- Local radar reflectivity product
- Near-ground radar echo strength
- 6 reflectivity / precipitation classes
- Vertical sections of max. reflectivity
- Image domain: 200x200 pixels
- Spatial: 2 km/pixel
- Temporal: every 15 min



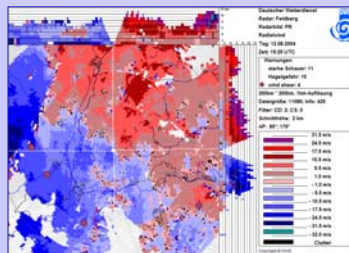
### PZ

- Local radar reflectivity product
- 3 dimensional radar reflectivity
- 12 layers that correspond to 1-12 km in altitude respectively
- 6 reflectivity classes
- Image domain: 200x200 pixels
- Spatial: 2 km/pixel
- Temporal: every 15 min



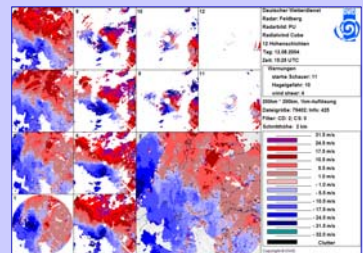
### PR

- Local wind speed product
- Near-station radial wind speed at a chosen height (standard 2 km)
- +32 km/s to -32 km/s in 12 classes
- Image domain: 200x200 pixels
- Spatial: 1 km/pixel
- Temporal: every 15 min



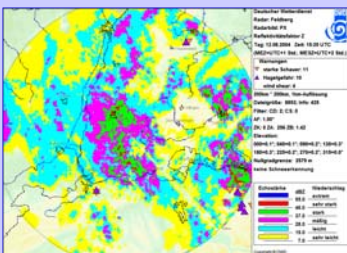
### PU

- Local wind speed product
- 3 dimensional radial wind speed
- 12 layers that correspond to 1-12 km in altitude respectively
- +32 km/s to -32 km/s in 12 classes
- Image domain: 200x200 pixels
- Spatial: 1 km/pixel
- Temporal: every 15 min



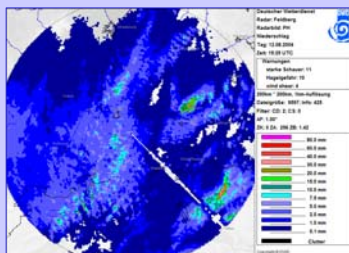
### PX/PF

- Local radar reflectivity image
- Near-station reflectivity in 6 (PX) or 15 (PF) classes
- Image domain 200x200 pixels
- Spatial: 1 km/pixel
- Temporal: every 5 min



### PH/PY

- Local precipitation image
- 12-class hourly (PH) or daily (PY) summed precipitation amount
- Image domain 200x200 pixels
- Spatial: 1 km/pixel
- Temporal: every 1 h or 24 h



## Error Sources

- By measuring reflectivity  $Z$ 
  - Radar calibration
  - Radar beam attenuation
  - Clear-air echo
  - Orographic shadowing
  - Assumption of Rayleigh-scattering
  - Inhomogeneity within the back-scattering volume
- By converting  $Z$  to precipitation rate  $R$ 
  - Assumptions on drop size distribution  $N(D)$  and droplet fall speed  $V(D)$
- By extrapolating measured precipitation quantities down to ground
  - Anomalous radar beam propagation
  - Radar volume above precipitating region
  - Evaporation taking place below the radar volume
  - Measurements made in the melting layer (bright-band)
  - Excess precipitation due to orography

