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Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD´s new operational scan strategy

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Over the past 25 years, DWD's radar scan strategy consisted of a sequence of dedicated scan modes to meet the diverging requirements of different users. Dense volumes were scanned at the cost of update rate, interrupted every 5 min by a priority low elevation sweep. Thus, only 2D mosaics could be used in QPE and cell recognition. Consequently, the legacy 5 min severe weather warning lacks height information, while a 15 min update rate turned out too slow for cell tracking. The current trend to automated applications in radar hydrology, NWP, nowcasting, ATC and warning calls for faster volume scanning.

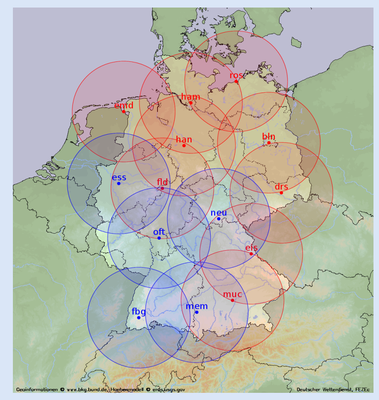

***Fig. 1**: Interim state of DWD operational weather radar network with single-pol (red) and dual-pol radars (blue). Circles indicate coverage of precipitation sweep.*

Former scan strategy

"Doppler mode": 18 elevation volume scanned downwardly every 15 minutes in staggered PRF (1200 Hz / 800 Hz, Nyquist interval +-32 m/s, 125 km), 3 rpm.
"Intensity mode": 5 low elevation sweeps upwardly at 600 Hz (250 km), reflectivity surveillance, 3 rpm, likewise at PW=0.8 µs and every 15 min..
Combined products could be created from both modes.
"Precipitation mode": one sweep at a roughly terrain-following lowest elevation, 600 Hz, 2 rpm, every 5 min.
"Idle mode": 4 min, no data ingest.

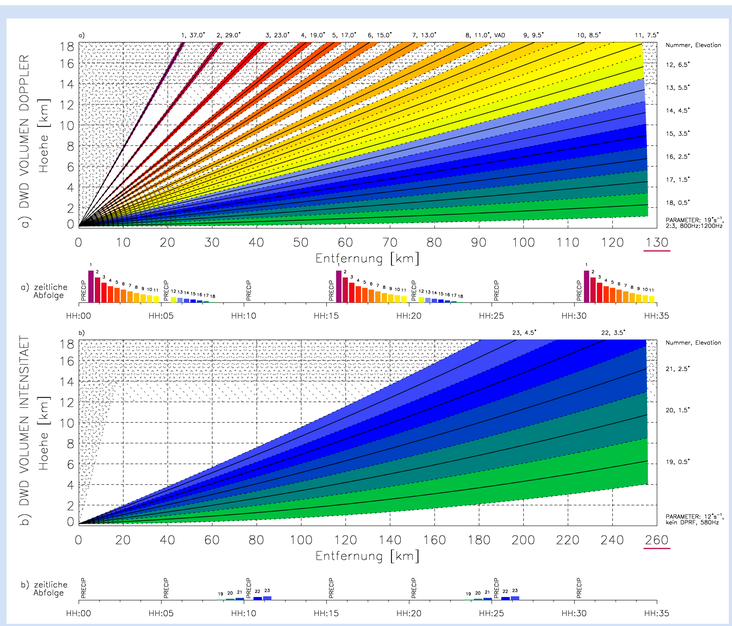

***Fig. 2:** DWD's former 15 min volume scan, consisting of 18 elevations in Doppler mode (125 km), 5 elevations in intensity mode (250 km)*

New specifications and trade-offs

Requirements:
- minimize time lag between and within volumes
- legacy products available with unchanged quality
- preserve full radar coverage of Germany
- maintain maximum unambiguous velocity and range
- homogeneity in space and time
- leave precipitation measurement unchanged
-Must be able to run with the legacy systems

Several scan patterns have been tested at the Hohenpeissenberg research radar. The impact of switching scan strategies on legacy radar products has been thoroughly checked, including theoretical and statistically based considerations.

Compromise found:
- 5min volumes (latch with satellite)
- homogeneous pattern, not interleaved nor adaptive
- abandon mode concept, no elevation scanned twice
- 10 elevations [formerly 18+5], lower vertical resolution
- decrease in range, 180 km [250 km]
- larger cone of silence 25 km at 1200 m height [15km]
- higher dual PRF unfolding (error prone) at low elev.
- unfolding is inhomogeneous over elevations

The trade-off regarding the sparser volume is deemed tolerable due to the high network coverage. A correction algorithm has been developed to minimize unfolding errors.

New scan strategy

The new elevation sequence is
5.5° 4.5° 3.5° 2.5° 1.5° 0.5° 8.0° 12.0° 17.0° 25.0°.

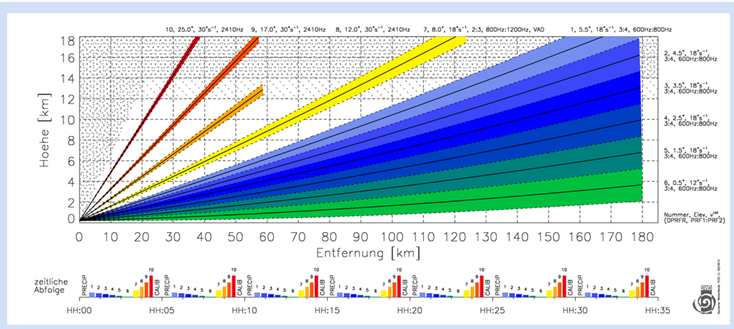

***Fig. 3:** The new 5 min elevation sequence consisting of 10 sweeps.*

The lowest 6 elevations between 0.5° and 5.5° have been preserved at 3 rpm, 0.8 µs as they contain ~80% of the weather data, yielding continuous height coverage up to 12 km (8 km) starting from a range of 100 km (70 km). An unambiguous velocity and range of +-32 m/s and 180 km are achieved by 3:4 staggered PRF (600/800 Hz). VAD is taken at el = 8° (1200:800 Hz, PW=0.8 µs, 125 km). The sweeps at 12°, 17° and 25° have been speeded up (30 °/s) and thinned out, as interpolation in space is considered more robust than in time. No staggering is performed (PRF 2400 Hz, PW 0.4 µs, slant range 60 km). For homogeneity, hybrid Mode has been chosen throughout in order to make copolar dualpol moments available instead of LDR.

Precipitation products

The 5-min precipitation scan has been maintained, but switching from H-only to hybrid mode, increasing range to 150 km (cf. fig. 1), and data resolution to 250m. In addition, the volume scan was timed such that one lowest sweep is available every 2.5 min.

Calibration scan

An additional vertical calibration scan (not available formerly) has been introduced (az rate 48°/sec, PRF 3000Hz, 25m range resolution, DAS 5°), which also yields boundary layer vertical profiles over the radar (cf. Frech, this conference).

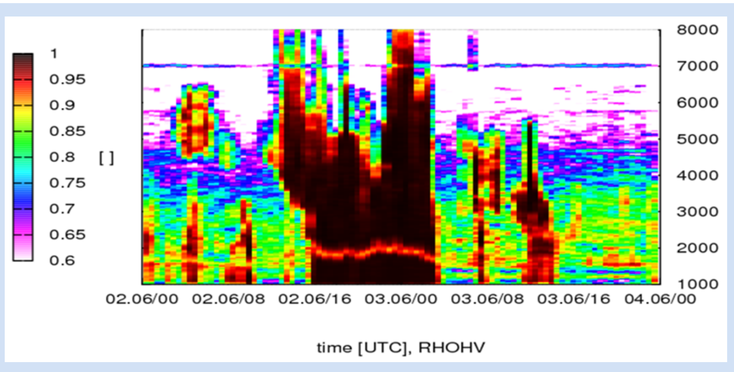

***Fig. 4:** Time series of vertical scan with the bright band clearly visible in RHOHV. Hohenpeissenberg radar, June 02 – 04, 2011.*

Evaluation

Qualitative products are only slightly affected by higher dealiasing ratio and elevation gaps (CAPPI rings), cf. fig.s 5 and 6.

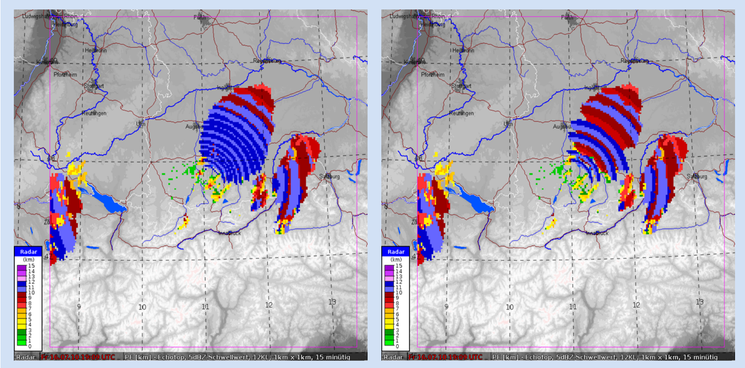

***Fig. 5:** Echotop derived from 15 min, 18 elevations (left) and from 5 min, 10 elevations (right) volume scans. Hohenpeissenberg, 16.7.2010*

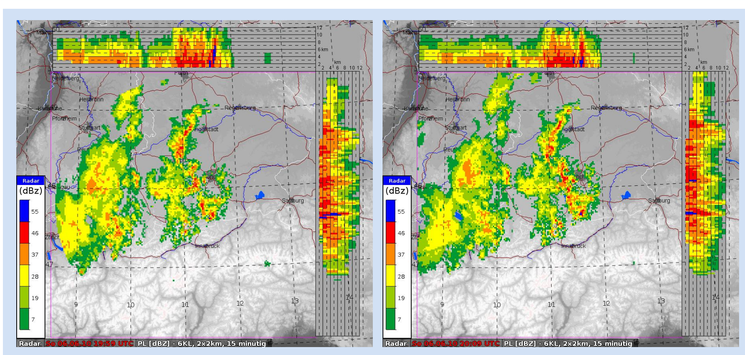

***Fig. 6:** 2.5-D product derived from 15 min, 18 elevations (left) and from 5 min, 10 elevations (right) volume scans. Hohenpeissenberg, 6.6.2010.*

A quantitative worst case estimation has been conducted for VIL calculation from both volume patterns.

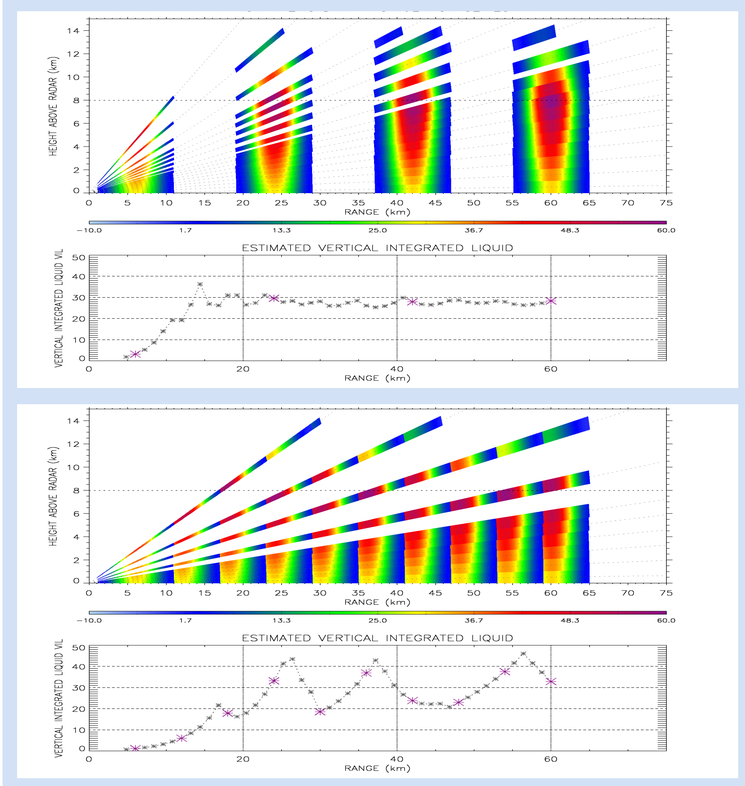

***Fig. 7:** Comparison of VIL derived from 15 min, 18 elevation volume (upper), and 5 min, 10 elevation volume (lower) for a model thunderstorm.*

Operationalization

The new scan strategy has been introduced into network operation throughout Germany in November 2012 even though the radar replacement project is still running. Thus, automated procedures may be adapted and developped in time (cf. Steinert, Tracksdorf, this conference). A design review and fine tuning of scan parameters will be conducted when all new network radars are in place.

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