Testing a new scan pattern for the German weather radar network to provide a better surveillance of rapid cell development at a one minute resolution

Jörg Seltmann[1], Thomas Hohmann[1], *Michael Frech[1]

1. Deutscher Wetterdienst

Scanning update rate has to be at a certain interval for a meaningful meteorological interpretation. At an early stage of radar meteorology, five minutes was shown to represent a sensible time interval for radar measurement in order to integrate rain accumulation. Equally, vertical extension of strong echoes, i.e. volume radar coverage, was recognized to be indicative of thunderstorms. Dense elevation coverage was considered essential, and slow volume update rates were common. At DWD, 23 volume sweeps at 18 different elevations sweeps were performed in 15 min, interrupted every five minutes by a priority low-elevation precipitation scan (pcp). This was the scanning sequence before 2012.
Over time, nowcasting requirements demanded faster update rates, and volumes were sped up to 10, 5 or even 2.5 min/volume at the expense of dense elevation coverage and number of samples available. DWD switched to 5 minute volumes (10 elevations plus one pcp) in 2012.
While customers particularly from hydrology and air traffic control are demanding higher update rates, mechanical scanning is considered to have reached its limits. In the future, electronic scanning by phased array weather radars may become an option. In the meantime, some improvement may still be obtained from intelligent scanning and data handling. One idea is to perform a prioritized sweep at low elevation every minute.
This is easily accomplished if the 1 min sweep is at a constant elevation. DWD’s specific precipitation scan (pcp), however, is a terrain following scan with varying elevations depending on radar site, so that pcp does not coincide with the lowest volume elevation at 0.5°. That is why the current tentative scan sequence is: pcp1, 8.0, 5.5, pcp2, 4.5, 3.5, pcp3, 2.5, 1.5, 0.5, 12, 17.0, 25.0, pcp5, mon, where “mon” is a sequence of monitoring scans including a birdbath scan for ZDR calibration . The missing pcp4 is numerically approximated from the 2.5°-1.5°-0.5° sequence. In the end, one minute update rate of the precipitation can be achieved
Using this approach, gaps due to rapid cell displacement may be closed in rain accumulation products, and independent current efforts to numerically extrapolate 2D mosaics on a 1 min base may be verified by measurement. A faster detection of thunderstorms is expected from this one-minute pattern as well. In nowcasting, a finer time resolution will help identify convective cells, assess cell dynamics and life cycle, detect displacements and developments such as right movers or splitting/merging, and increase warning lead time. With a sweep-wise data transmission, automated follow-up procedures may be updated at the same rate, if not after every incoming sweep.
The new scan sequences has been implemented at the DWD’s (German Meteorolgical Service) polarimetric C-band research radar located at the Hohenpeißenberg observatory. This research radar is technically identical to the 17 polarimetric C-Band radars of the German weather radar network and serves as a testbed for new developments for the radar network.
The benefits of this scan sequence is demonstrated with a very rapid cell development SW of Munich city, close to Hohenpeißenberg Observatory, on 1. August 2018. Two new very localized and stationary cells developed along a convergence zone within less than seven minutes. Hail observation were reported and at the Hohenpeißenberg Observatory 40.1 mm rain was measured within 49 minutes. Localized flooding was reported. The rapid intensification is nicely captured with the one minute scan sequence, while data

from an operational weather radar of the DWD weather radar network only shows the sudden presence of hail producing cell. Nowcasting algorithms will benefit significantly from this new scan sequence and further studies are underway assess the full potential and possible caveats of this new promising approach.

Keywords: scan pattern, cell development