Effects of wind turbines on radar data and products

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Wind turbines (WT) may bias weather radar data and increase their uncertainty. This in turn has a direct impact on radar based automated algorithms. Classic Doppler clutter filters are not effective to correct for moving targets such as wind turbines, and no method is known to correct for wind turbines due to their time-dependent clutter characteristics. Here we summarize observations on the influence of wind turbines on radar data and radar products such as hydrometeor classification (HMC) and quantitative precipitation estimate (QPE). We analyse range bin data of two dedicated clutter target scans of the Berlin (Prötzel) radar: one dwelling on a static clutter target (CT), and the second towards a small wind farm. In addition, we also extract the corresponding range bin of the scanning radar, where not all pulses are equally affected by the respective clutter target. Furthermore, we analyse the corresponding HMC and QPE results which are based on quality controlled data of the DWD radar data processing suite POLARA.

Radar data Prötzel CT and WT target scans:
WT PRO: range 13.87 km, az = 69.2º, el = -0.3º, Δr = 15 m
CT PRO: range 16.83 km, az = 266.3º, el ~ 0.4º, Δr = 15 m

Sampling: PW 0.8 s, PRF 1000 Hz, time sampling 128 pulses acquisition time 2 s (amounts to 13 identical rays).

Volume data
Range bin resolution: Δr = 500 m (precip) and Δr = 1000 m
WT: Hub height typically near 125 m, rotor radius 45 m.
Beam width 1º: Based on geometric considerations, only scans at el ≤ 0.5º should be affected.

HMC product in a wind farm area
There was no valid HMC classification possible over the wind farm. This was persistent for several scans during this event. Interpolation would have not been trivial: for example how to deal with graupel spots (often hail precursor) in the vicinity?

Summary
The influence of WT on HMC and QPE products has been illustrated. There is increased uncertainty of HMC in the presence of WT. Obviously, WT contaminated pixels passed the DWD operational QC prior HMC and do not fit HMC membership functions. In consequence, we find biased QPE estimates. Mitigation of WT influence: Not available yet. E.g. simple interpolation may lose important meteorological information, in particular for convective situations. See also DWD’s efforts with the WT problem on Poster 269 by Böhme and Seltmann.

Characteristics of the time series data of selected radar moments

Z_C: Doppler filter most effective for the clutter target scan CT and corresponding precip data.
UZDR: CT: smaller scatter than WT values, predominantly negative values. This is also true for the precip data.
ZDR: CT: ZDR effectively Doppler filtered, no weather signal. Precip: weather signal visible (ZDR slightly positive), clutter micro suppression works in this example. WT: predominantly negative ZDR values; precip data: large scatter, same pattern as for UZDR.
Φ_M: constant (~20º): precip: observed increase related to precipitation. WT: on average ~ 0º, large scatter; precip: large scatter, predominantly negative values.
ρ_v: CT: values close to one; precip: same is true; both about 1 even if there is no precipitation. WT: large scatter, small values, which are not indicative for precipitation.

In general: weather signal partially can be retrieved for isolated clutter targets. This appears not to be the case in the presence of wind turbines.

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