Statistical Study of Echoes from Wind Farms and Other Moving Clutter Targets

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The weather radars of Environment Canada regularly see a significant number of wind farms, with more farms continuously being proposed. Therefore there is a desire to quantify the impact of the turbines on the weather radar data and to understand the origins of spatial structure. This presentation shows the results of a few metrics that describe the variability of the echo intensity, with comparison to other moving targets such as traffic and sea clutter.

While forecasters and other users can readily identify wind turbines in the data, actually quantifying the turbine properties is difficult. The radar echoes around a wind farm due not follow Gaussian distributions, so some non-parameteric metrics have been developed along with standard metrics. Irrespective of the metrics chosen, wind turbines and traffic show considerably more temporal variation than weather targets, with variation of reflectivity similar to that from stationary ground targets. Looking at whether echoes in neighbouring bins are synchronized (by analogy to temporally correlated), bins with turbines stand out by their lack of synchronization relative to weather signals. That is, neighbouring bins change together relatively tightly in weather, but that is not the case for wind farms. Looking at signals from adjacent range bins at times without precipitation present, there seems to be little synchronization in the data, suggesting that multi-trip echoes are not a large component of the observed signals. There is weak synchronization of some echoes in neighbouring bins at the same range, indicating that at least strongly observed wind turbines are seen in radar side lobes.

These statistics have shown a similarity of wind farms to visible highways, but no strong signatures that make wind farms more obvious than do simple metrics, such as the higher persistence of turbine echoes relative to weather signals.