An Old School Approach to Taking Care of Wind Turbine Echoes

Alamelu KILAMBI[1] and Frédéric FABRY[1,2]

[1] J.S. Marshall Radar Observatory, McGill University, Montreal, Canada
[2] Department of Atmospheric and Oceanic Science, McGill University, Montreal, Canada

A. Why are wind farms a problem for radars?

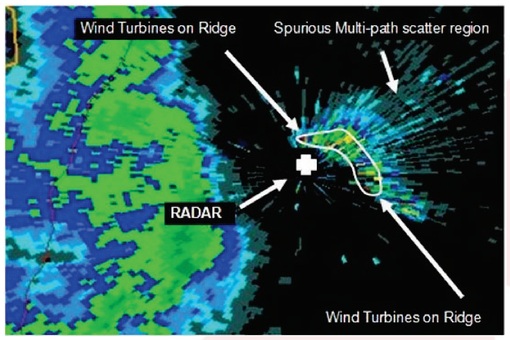

Fig. A.1. : Example of radar echoes caused by wind turbines (Courtesy of NOAA ROC)

1. Echoes from the wind turbines themselves
2. Multi-path echoes from the wind farm

Unlike traditional ground targets, **wind farms don't have zero Doppler velocity** making them more **difficult to remove with automatic ground target filters**.

B. Context:

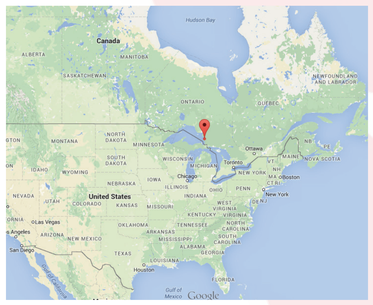

Fig. B.1. : Map of North America with location of the wind farm noted in red. (Courtesy of Google Maps)

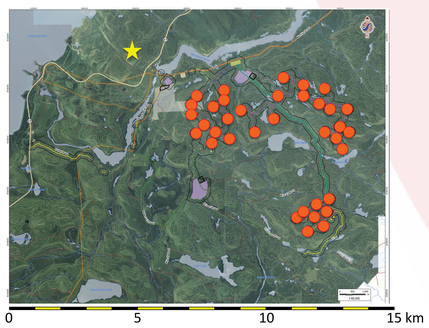

Fig. B.2. : Topographic map showing the location of the Montreal River radar (yellow star) and the locations of the wind turbines (orange dots). (courtesy of Stantec)

In Canada, wind farm promoters must consult with Environment Canada (EC) before installing wind farms in order to reduce the potential interference with the Canadian weather radars (mostly single-pol radars).

In this particular case, EC, given the proximity of the wind farm to the Montreal River radar, demanded that the promoters pay to get the wind farm out of the radar display. This is the reason for which we were contacted.

Our mission: **Make the wind turbines disappear from EC's radar displays.**

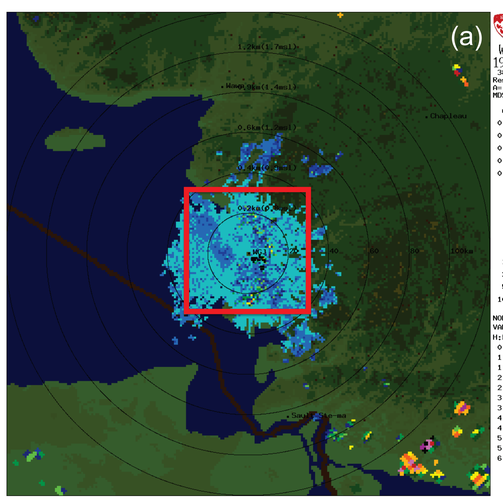

Fig.B.3. : Montreal River radar PPI map. Area marked is region of zoomed image shown in Fig. B. 4.

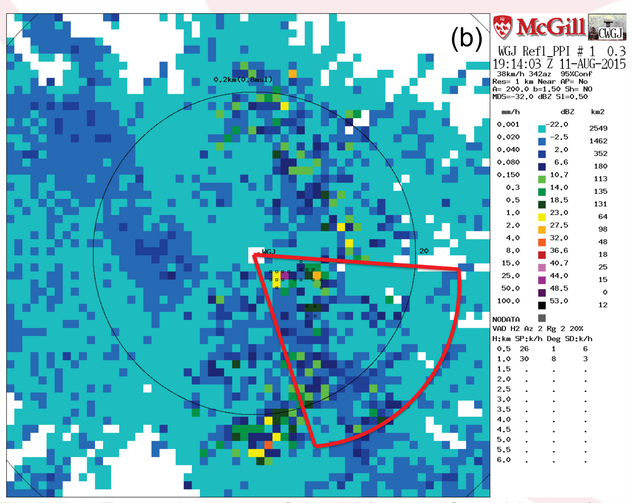

Fig.B.4. : Zoomed portion of the PPI map of the Montreal River radar map over the wind farm. Sector indicates region used in the range-azimuth plots.

C. Approach :

We elected to try an old-school approach: **identify and replace the pixels by interpolation using "clean" neighbors**.

Identifying contaminated pixels:
- Wind turbines characteristics that are generally well documented and remain fixed.
- Given radar characteristics, we can determine location of wind turbines on radar maps.
- Multi-path echoes are only located on azimuths where wind turbines are found.

Hence, the **location of all potentially contaminated cells are known and their data can be corrected**.

Replacing contaminated pixels:
- Echoes at locations over wind turbines are always declared contaminated
- Multi-path echoes are weak and are only important in the absence of significant weather.

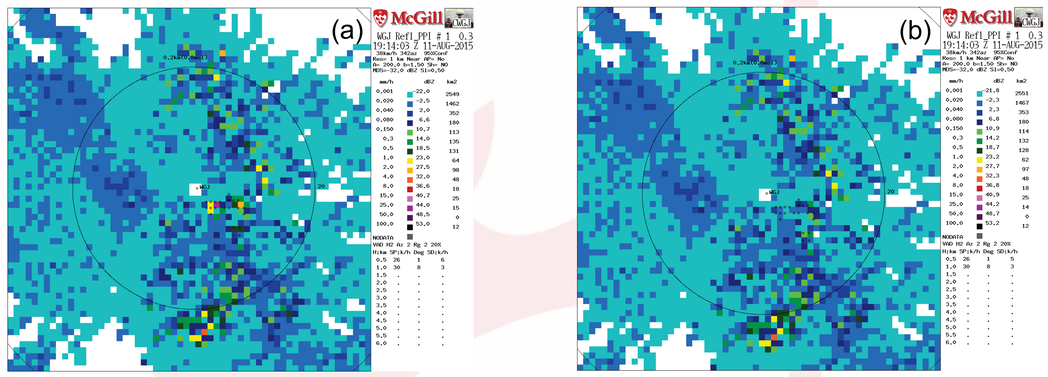

Fig. C.1. : Zoomed PPI Map of the Montreal River radar without correction (a) and with correction (b).

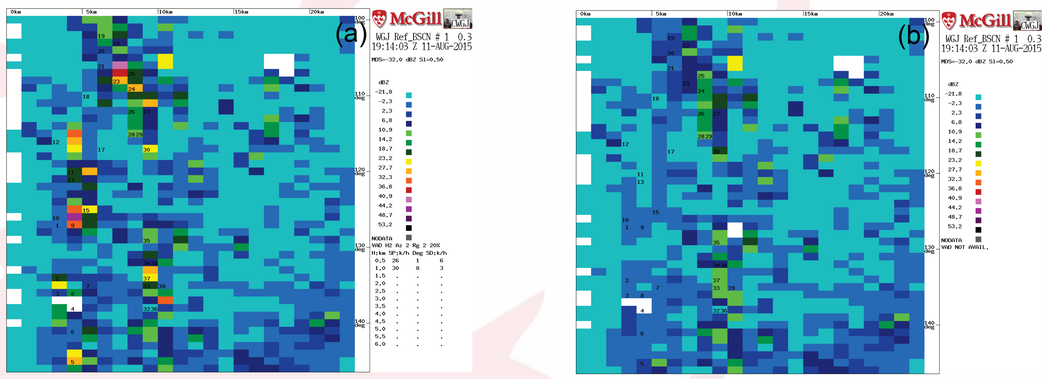

Fig. C.2. : Range-Azimuth plots generated from the sector shown in Fig. B.4. without correction (a) and with correction (b).

D. Future work :

The algorithm has not been tested on the removal of the multi-path echoes caused by the wind farm as the wind farm is not yet fully operational.

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Contact: alamelu.kilambi@mcgill.ca