Summary of Research Project

Comparing Between Radar and Passive Satellite Measurements for Detecting Wind Turbines

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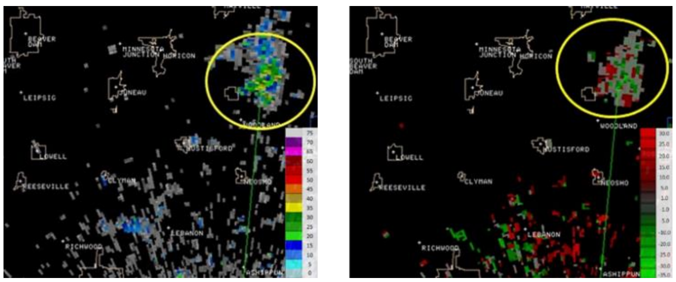
What is the problem?

Wind power continues to grow and expand in new areas. Accordingly, there is a greater likelihood that some wind park areas may be located within the line of sight of radar systems. Unfortunately, a rotating wind turbine blade is perceived by weather radar as a moving and reflective target. Therefore, it seems like the precipitation; showers, thunderstorm etc. As a result, the system may miss a high-risk weather warning or warn unnecessarily.

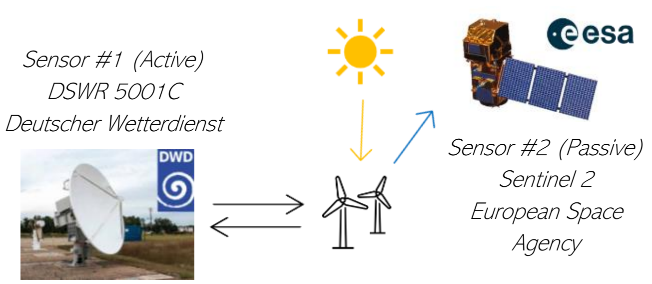


Reflectivity (Left) and doppler velocity (Right) measurement of wind park area

On the left side of the figure shown above, weather radar processes signal which returned from wind turbines as an area of precipitation (rainfall, storm). On the right side of the figure, rotating turbines also affect velocity data and are interpreted as tornado and storm motion.

What is the solution that is offered?

To filter wind turbines and their effects, the locations of the wind farms should be sensed. Multispectral satellite can be used for second sensor for determining locations in addition the weather radar. According to the two datasets, a comparison can be done, and researchers can obtain the location of wind turbines precisely. In this case, wind turbines that create interference can be filtered from weather radar measurements. **Therefore, solution is that sensing region of interest by multi sensor; sensor #1 (radar) and sensor #2 (satellite).**



Implementation on MATLAB

Sensor #1 - Radar

Raw data as IQ signals

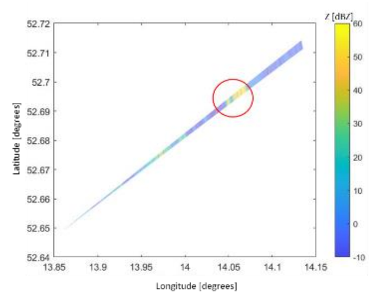
↓

Derivation of radar moments such as reflectivity via radar equation.

$$P_r = \frac{P_t G^2 \pi^3 c \tau \theta_h \theta_v}{1024 \ln 2 \lambda^2} \cdot |K^2| \cdot \Sigma D_i^6 \cdot \frac{1}{R^2}$$

↓

Mapping of radar data in the geographic coordinate system



Sensor #2 - Satellite

Raw data as reflectance

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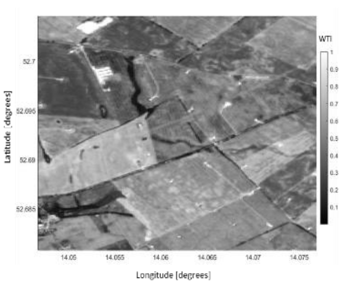
Derivation of data products such as radiance via conversion algorithm.

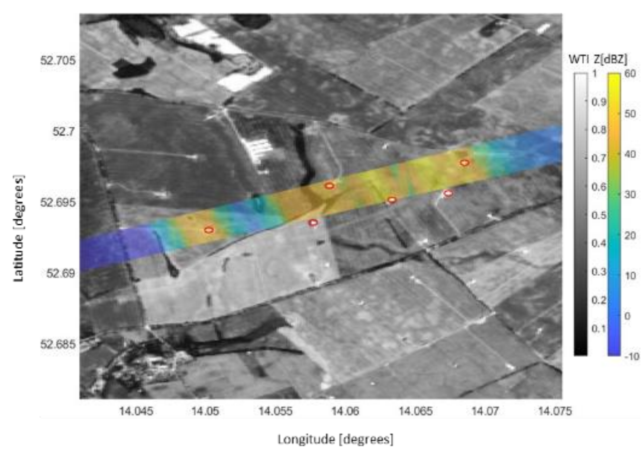
$$L_\lambda [W/(m2\ sr\ \mu m)] = \frac{\rho_\lambda\ \theta_s\ ESUN_\lambda}{d\ \pi}$$

↓

Developing of new spectral algorithm for wind turbine detection; WTI



Fusion of data



Compare and analyse points which have high WTI on region that have high reflectivity. On the figure shown above, wind turbines are marked with red circles.