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Which Lidar System Should be Used for Offshore Wind Resource Assessments in the Turkey Market?

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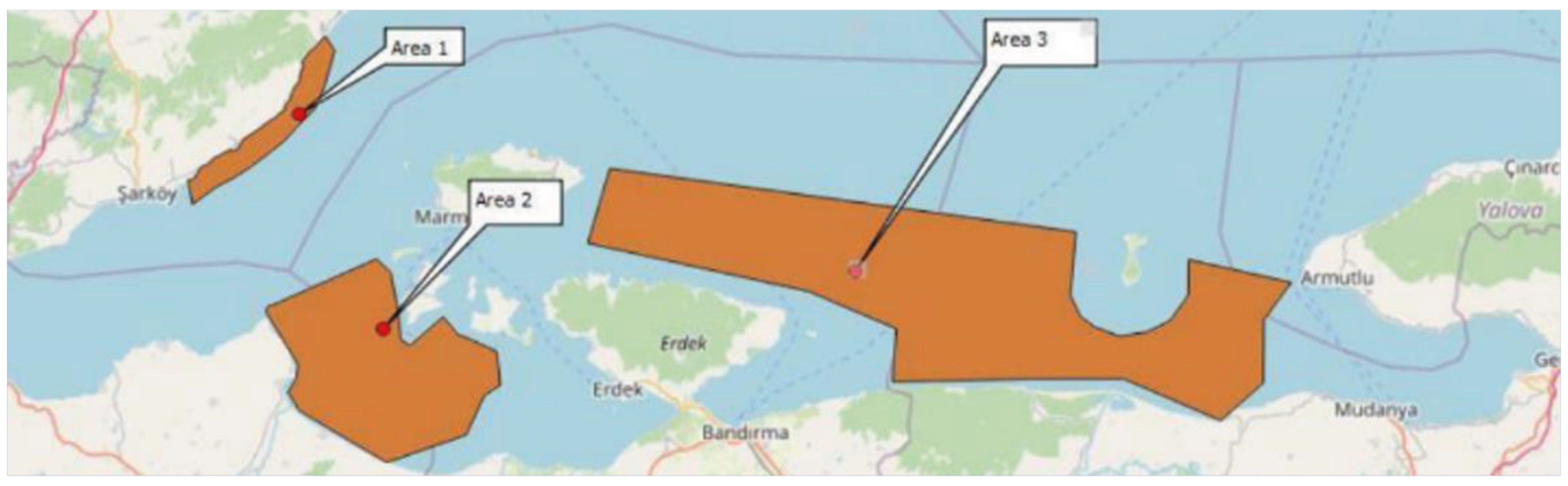
ABSTRACT

The Turkish Ministry of Energy and Natural Resources (MENR) has identified three offshore wind development zones, as shown in figure 1, to encompass metocean and wind resource measurement [1].

The expected proximity of prospective wind farm development to the Turkey coastline presents an opportunity for dual scanning lidars (DSLs) to be used in the wind resource assessments (WRAs) of those developments, in addition to the now commonly used floating lidar.

A theoretical model of the uncertainty of dual scanning lidar measurements, combined with a high-resolution coastline dataset, is used to create a map of dual scanning lidar uncertainty across the Turkey offshore region. This is compared to the uncertainty of a floating lidar to provide information on where each type of instrument is preferable to be used for an offshore wind resource assessments.



METHODS

Vaisala has developed a theoretical model of DSL measurement uncertainty as a function of beam geometry, among other inputs. This error model has been presented and validated in [2]. It considers the three main sources of DSL measurement error:

- The base uncertainty of the individual scanning lidars
- Assumptions made when reconstructing the horizontal wind speed
- Measuring the wrong part of the shear profile due to pointing inaccuracy

All maps in this poster were made using the Cartopy Python library [3], coastline data from [5], and wind data from [6]. A fine grid of potential measurement points was created, and a quad tree algorithm linked each to nearby lidar-accessible sites. The site pair with the most orthogonal azimuth angle was used in the error model to calculate and map measurement uncertainty.

To do a geographical comparison of where DSL can achieve lower uncertainty than floating lidar systems (FLS) in the Turkey offshore region, a typical FLS measurement uncertainty was assumed. As a conservative estimate for a FLS, 3.5% is taken [4].

RESULTS

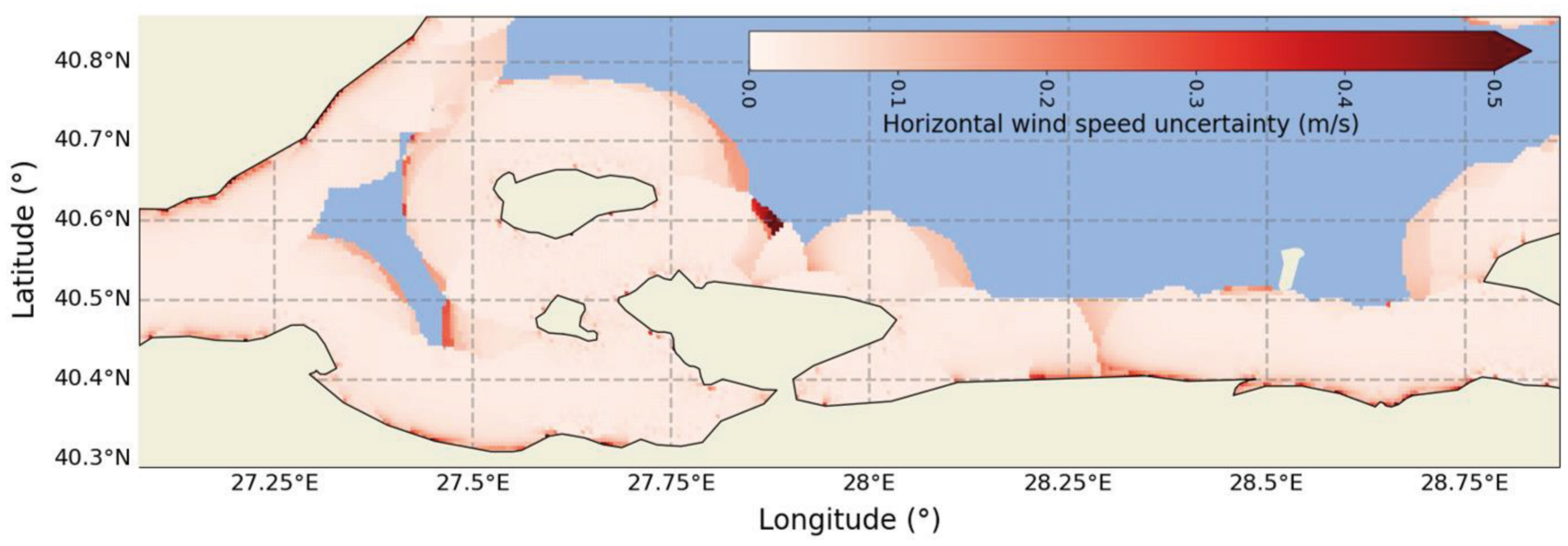


Figure 2: All possible DSL measurement locations plotted over a map of the selected Turkey offshore region.

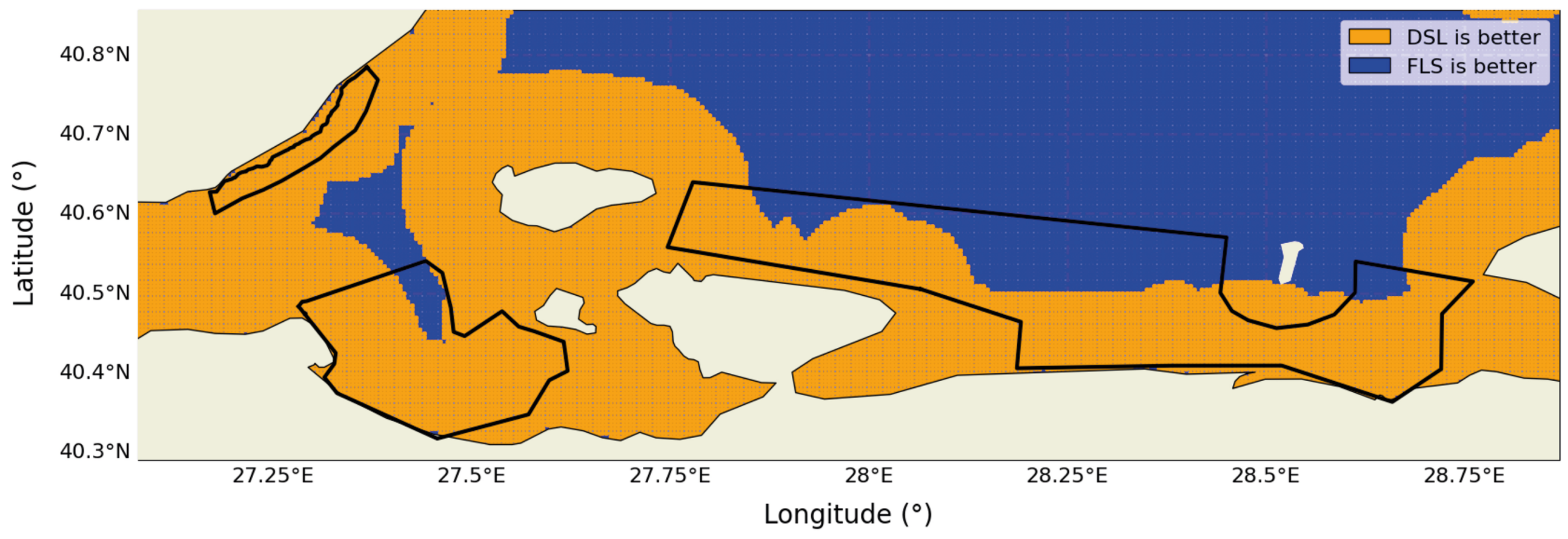


Figure 3: Comparison of where, in terms of measurement uncertainty, it is better to use DSLs or a FLS for an offshore WRA.

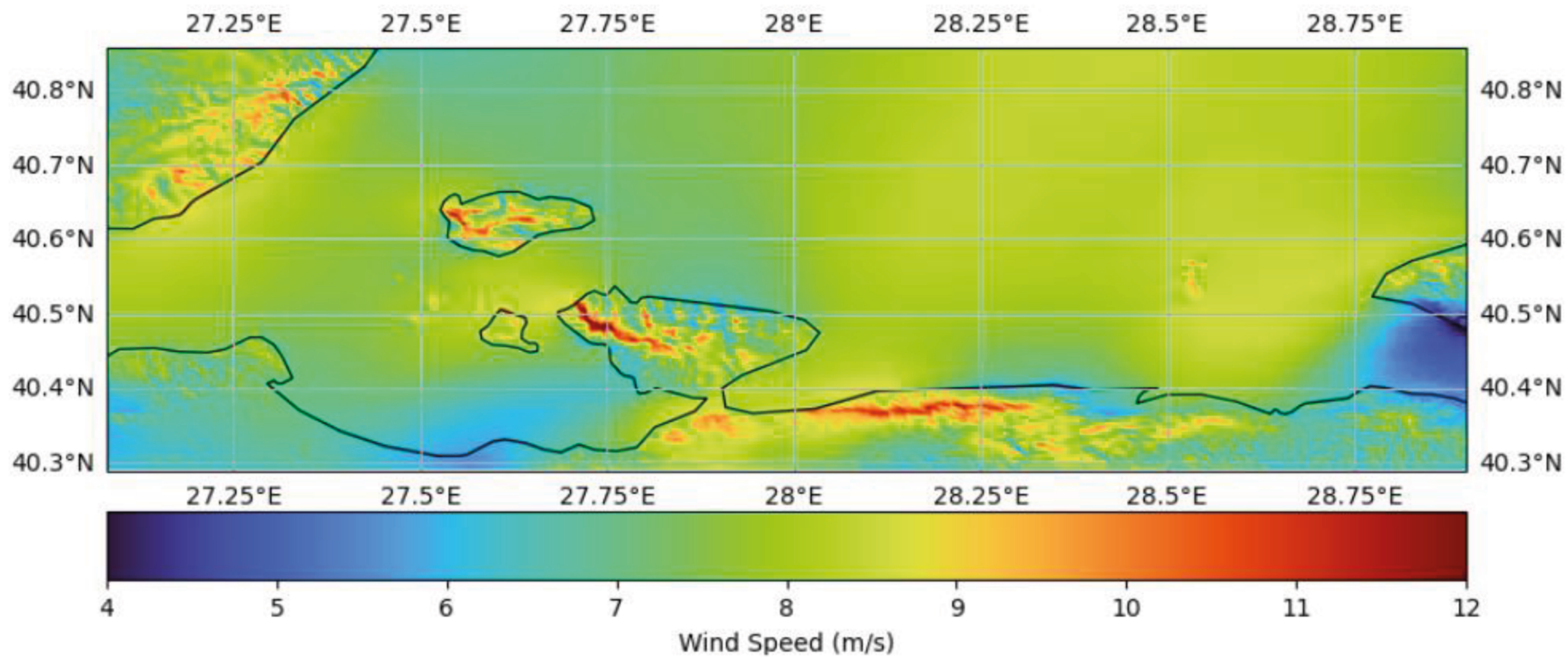


Figure 4: Wind speed variation at 150 m shows strong spatial variation, which can be captured by DSL systems but not FLS [6].

CONCLUSION

When suitable sites are within range of a particular measurement point and allow for good beam geometry, DSL typically outperforms FLS in terms of measurement uncertainty, often achieving values below 0.1 m/s. DSL also has the advantage of capturing spatial variations in wind speed, as it can measure multiple points, which is not the case for FLS. FLS, on the other hand, has the advantage of being applicable almost anywhere, even above the deep ocean far from any landmass, while still achieving a suitable level of uncertainty for wind resource assessment.

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