Vertical profiles of wind velocity and turbulence intensity during Low Level Jets at the selected European offshore sites

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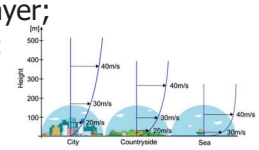
Introduction

- Main research effort regarding the atmospheric boundary layer is focused on the surface layer;
- Thickness of the boundary layer:
  Onshore: 200-800 m
  Offshore: down to 20 m;



- Oversimplified image: expected vertical profiles of velocity and turbulence intensity are disturbed by Internal Boundary Layer formation or Low Level Jets (LLJ);
- Low Level Jets are typical for areas dominated by strong spatial temperature contrasts (as the land-sea interface);
- Common characteristics of the Low Level Jets include wind-maxima that can exceed geostrophic, expected over the surface layer, wind speed values by 100% or more.

Problem

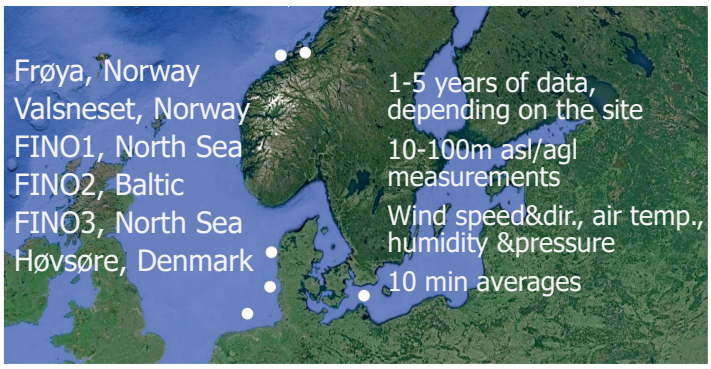
LLJ's in offshore and coastal locations are observable in direct proximity to the surface, down to tens of meters, influencing the wind turbines production and loads;

Detailed description of the wind characteristics during LLJ is missing.

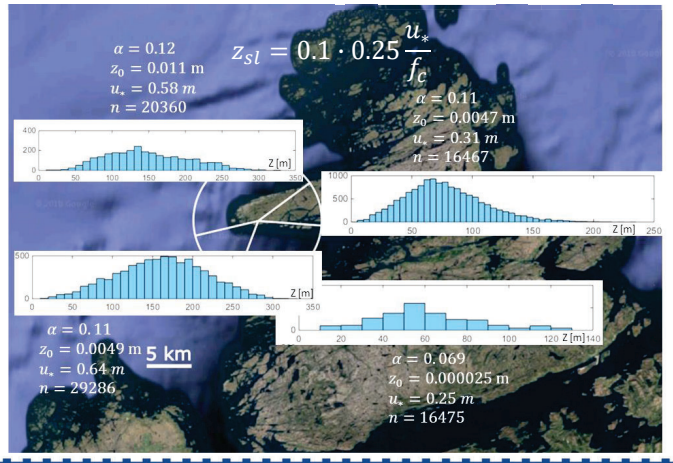
Objective

The objective of this study was identify the impact of LLJ presence on turbulence intensity (TI) characteristics.

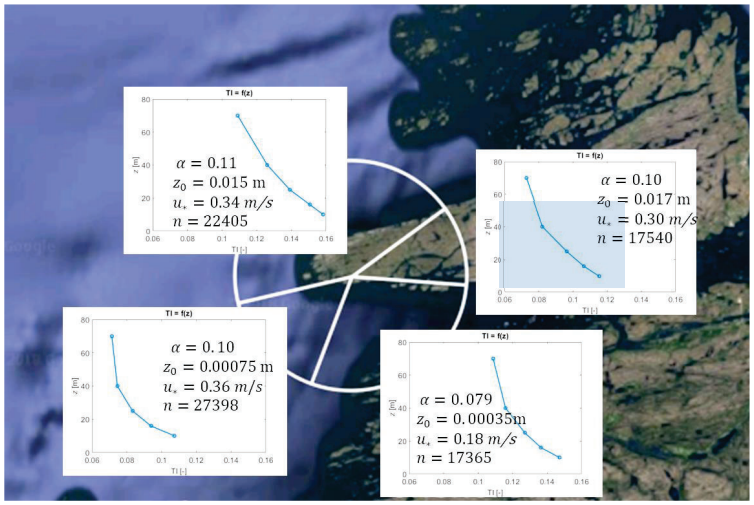
Database – site and data description



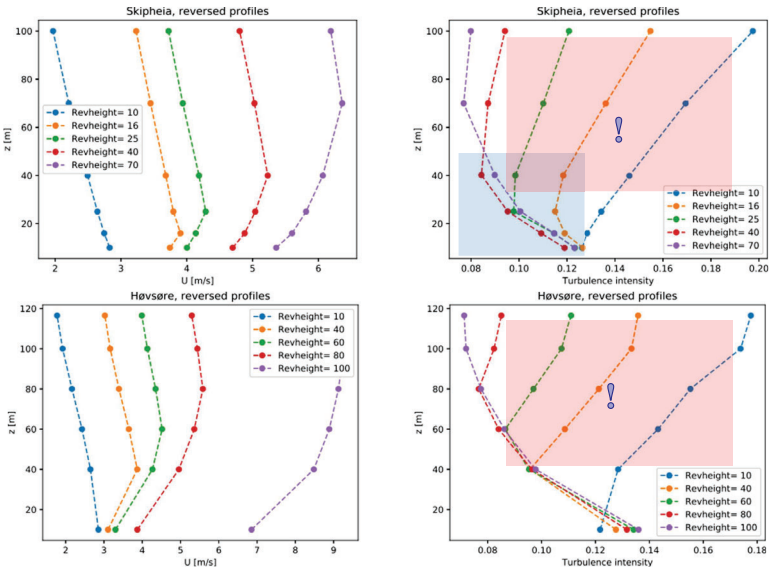
Surface layer thickness at the offshore site – Frøya, NO



Typical vertical TI profiles at offshore site (Frøya, NO)



Velocity and TI vertical profiles during LLJ event Frøya and Høvsøre*



Velocity profiles and corresponding TI profiles, binned by the height of the velocity maximum due to LLJ

*Other sites are showing similar pattern, however disturbed by Internal Boundary Layer formation.

Conclusions&open questions

- LLJ in offshore conditions cause significant velocity increase at hub height;
- Similar (up to 100%) increase of turbulence intensity can be observed;
- Reversed vertical profiles of velocity and turbulence intensity → unexpected turbine loading distribution;
- Work in progress, focusing on LLJ identification schemes, LLJ incidence and duration → implication on aviation safety, wildfires risk, modeling atmospheric dispersion and climatology.

References

Møller, M., Domagalski, P., and Sætran, L. R.: Comparing Abnormalities in Onshore and Offshore Vertical Wind Profiles, Wind Energ. Sci. in review.

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