The Effect of Swell on Marine Atmospheric Boundary Layers

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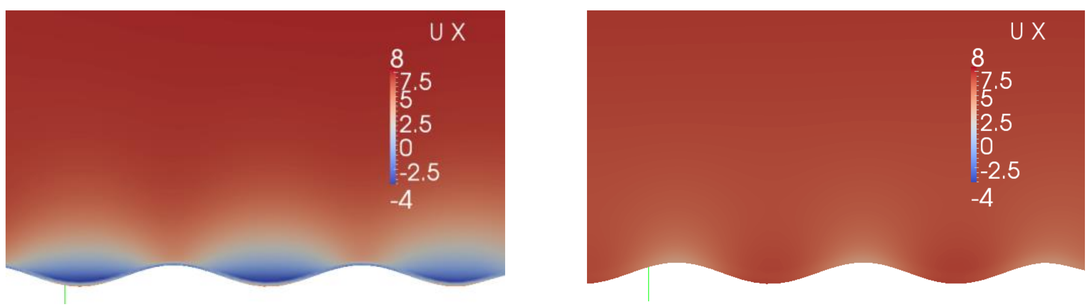
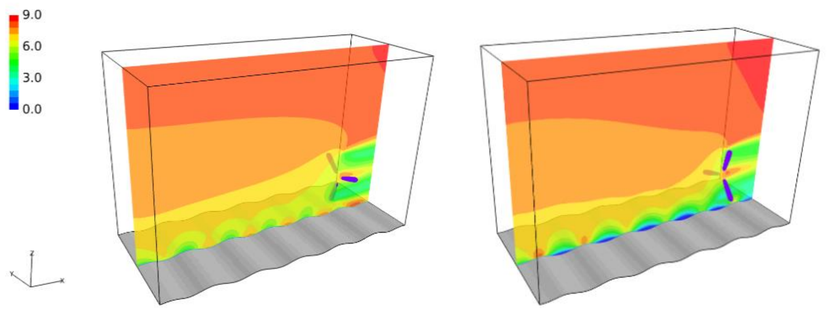
Background

- Several research groups have shown significant impact from waves on the MABL
- Kalvig showed that swell could affect offshore turbines
- Up to now not linked to stability classes
- Currently only aligned/opposed waves



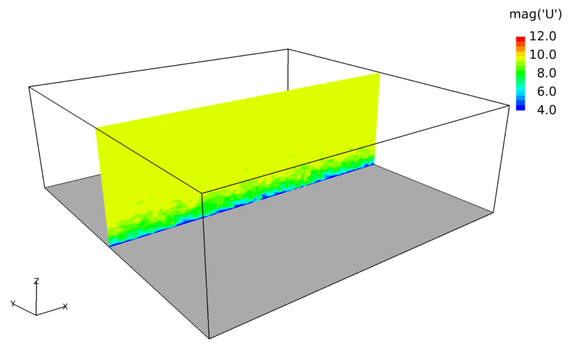
Wind response to opposing (left) and aligned (right) swell, Kalvig 2014

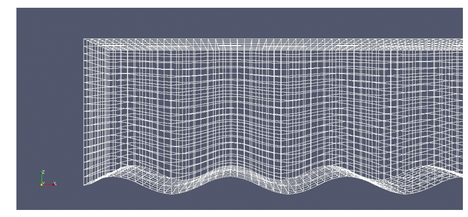


Effects of waves on wind turbines, Kalvig 2014

Method/Approach

- Utilize already developed tools
  - ABL solver provided as a part of SOWFA
  - Wave library developed by Kalvig/Manger
- Combine into a new Wave MABL solver
  - Adds stability/buoyancy effects to the wave solver





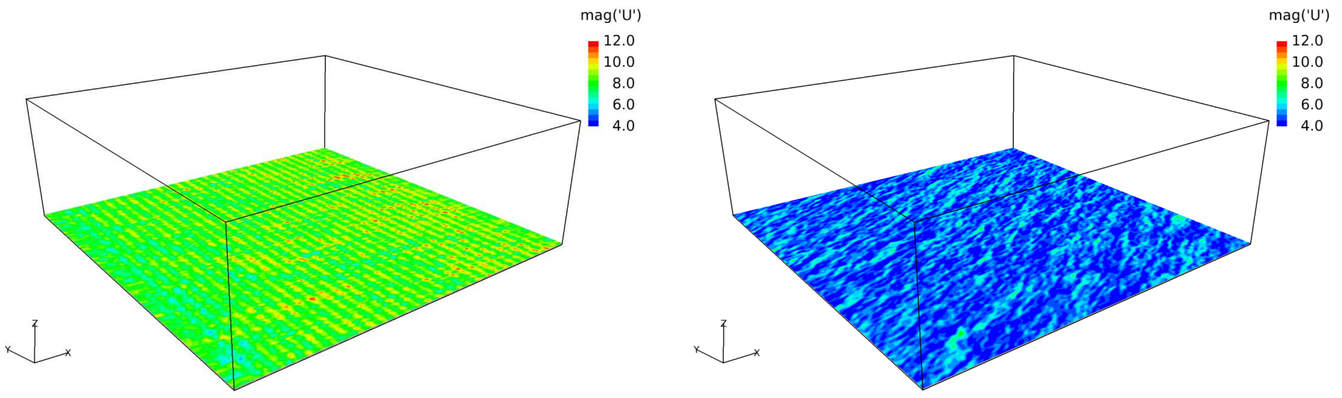
Wave MABL Solver

Results, Conclusions and Future Work

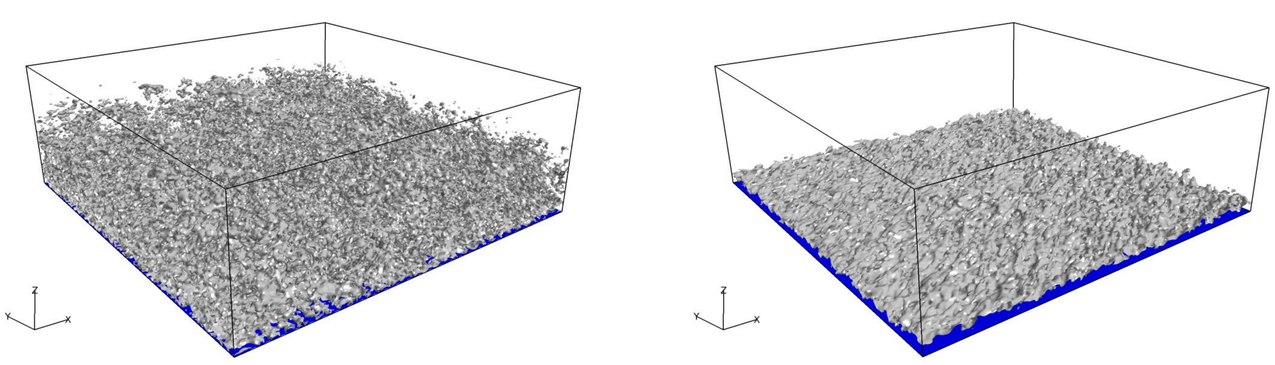
Wind: 8 m/s, 240 degrees, neutral

Waves: amplitude 3m, length 100m, 12 m/s, 270 degrees

Left: with waves. Right: without waves.



Velocity magnitude 10m above sea surface.



Iso-surfaces of 8m/s velocity magnitude.

Findings so far:

- Wind velocity and turbulence significantly influenced by the waves
- Boundary layer and disturbances extend further up when including waves

Future work:

- Statistical analysis
- Investigate the effect of waves in combination with other stability classes
- Link to FAST for studying wave MABL effects on turbines

For References:

"On wave-wind interactions and implications for offshore wind turbines" PhD Thesis, Siri Kalvig, November 2014.