INFLUENCE OF LATERAL SPACING ON THE INCREMENTS IN POWER GENERATED BY MULTI WIND TURBINE CONFIGURATIONS

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Introduction

- There is a vast amount of wind resource at sea locations with **large water depths**
- It is still necessary to **reduce the cost and uncertainties** of **floating** offshore **wind turbines (FOWT)** in order to take advantage of this resource

- **Increase the installed power per floating platform**

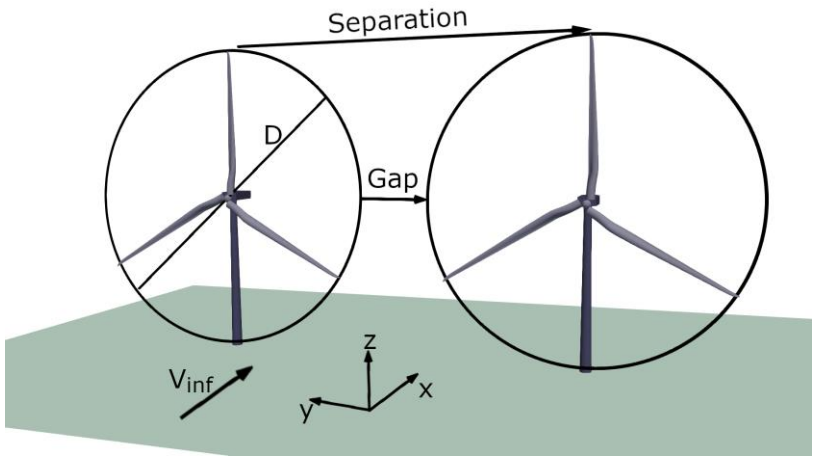
Larger Single-Rotor

Multi-Rotor Wind Turbines

How does the distance between laterally aligned rotors affect the increase in power and thrust due to the combined blockage effect [1], [2] **?**

Methodology

- Two multi wind turbine onshore laterally aligned configurations have been simulated with AeroVIEW [3]: **2WT** and **5WT**
- All wind turbines are NREL 5-MW wind turbines [4] modelled as a fully rigid structure
- Four separation distances: **1.1D, 1.5D, 2.25D and 3D**
- All these setups have been simulated operating at **8 m/s uniform** wind speed, **9.21 rpm** with a fixed blade **pitch** angle of **0 deg**
- Simulation tool: **AeroVIEW** [3] based on Free wake Vortex Method (FVM)



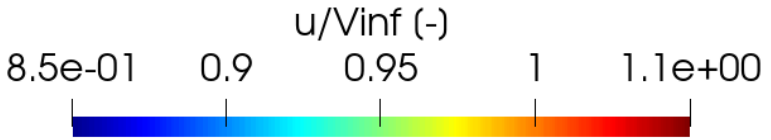
Following results are:

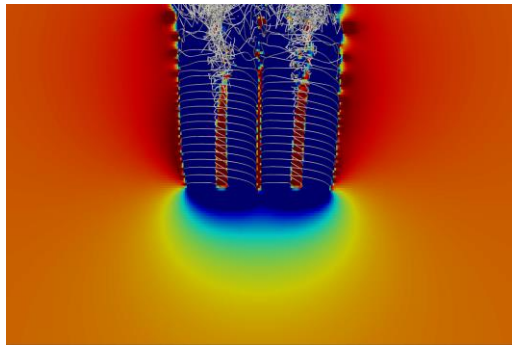
- Nondimensional velocity field in the wind direction → $\frac{u}{V_{inf}}$ [-]
- Percentage of difference with respect to the reference single WT

$$\Delta C_P^i[\%] = 100 \cdot \frac{C_P^i - C_P^{ref}}{C_P^{ref}}$$

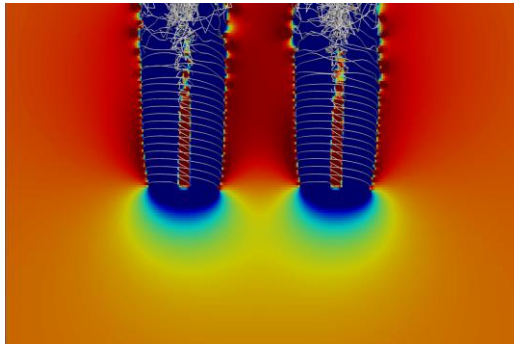
$$\Delta C_T^i[\%] = 100 \cdot \frac{C_T^i - C_T^{ref}}{C_T^{ref}}$$

Velocity Fields

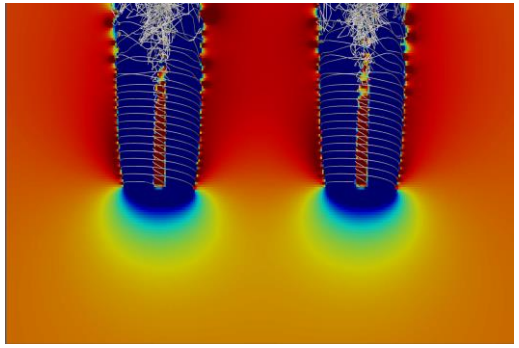




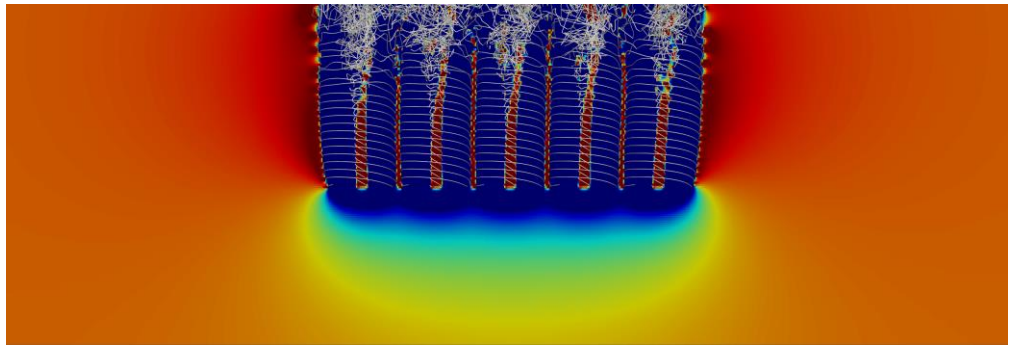
2WT 1.1D



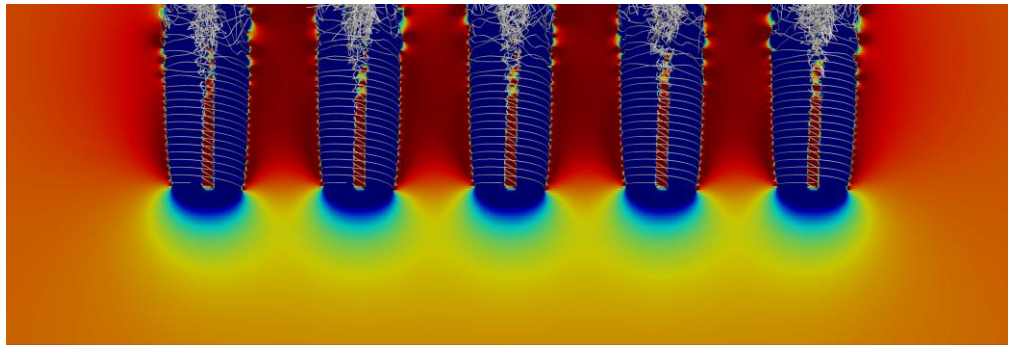
2WT 2.25D



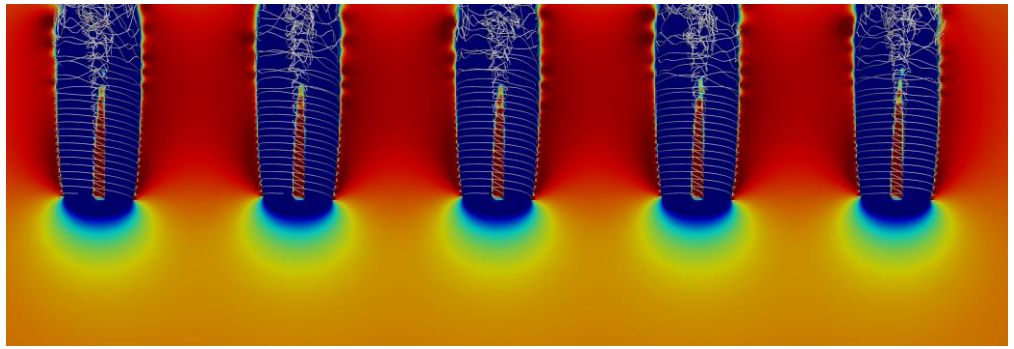
2WT 3D



5WT 1.1D



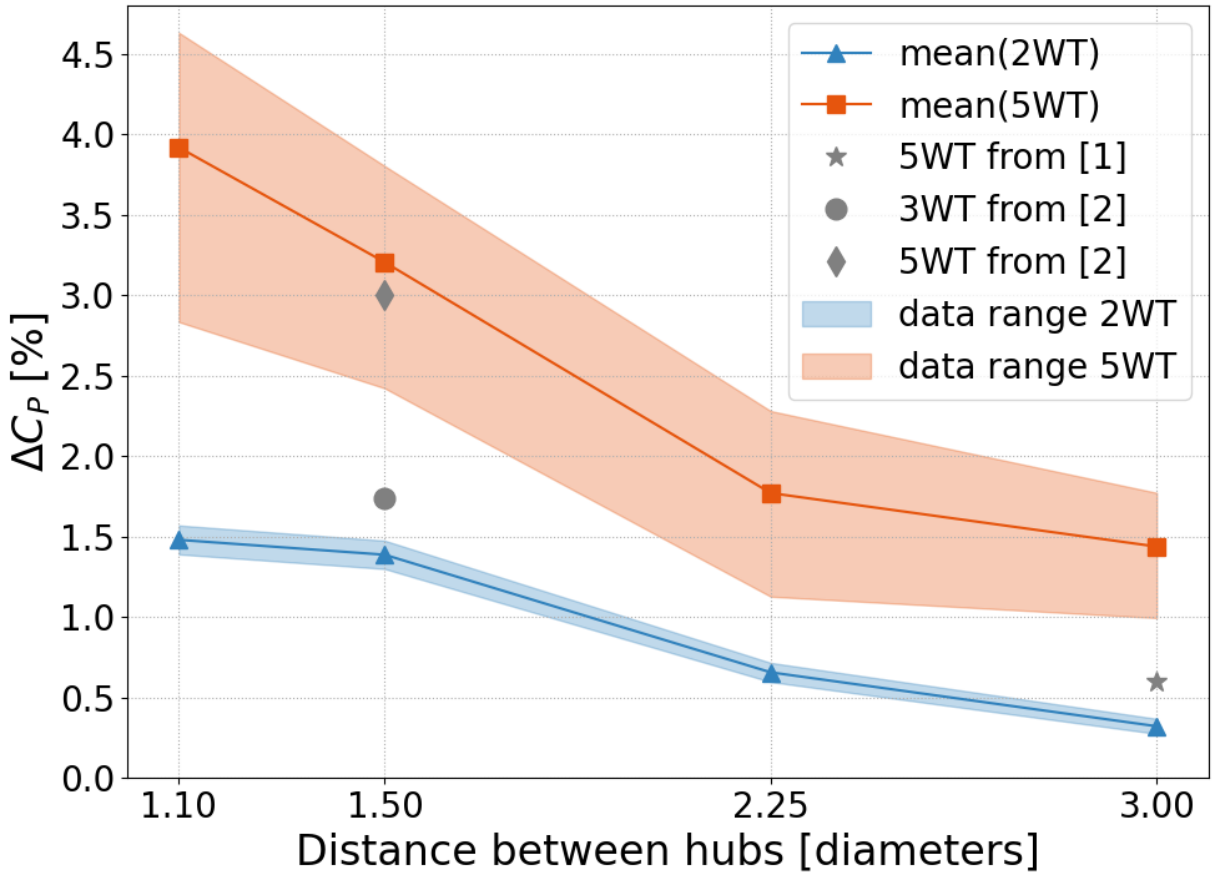
5WT 2.25D



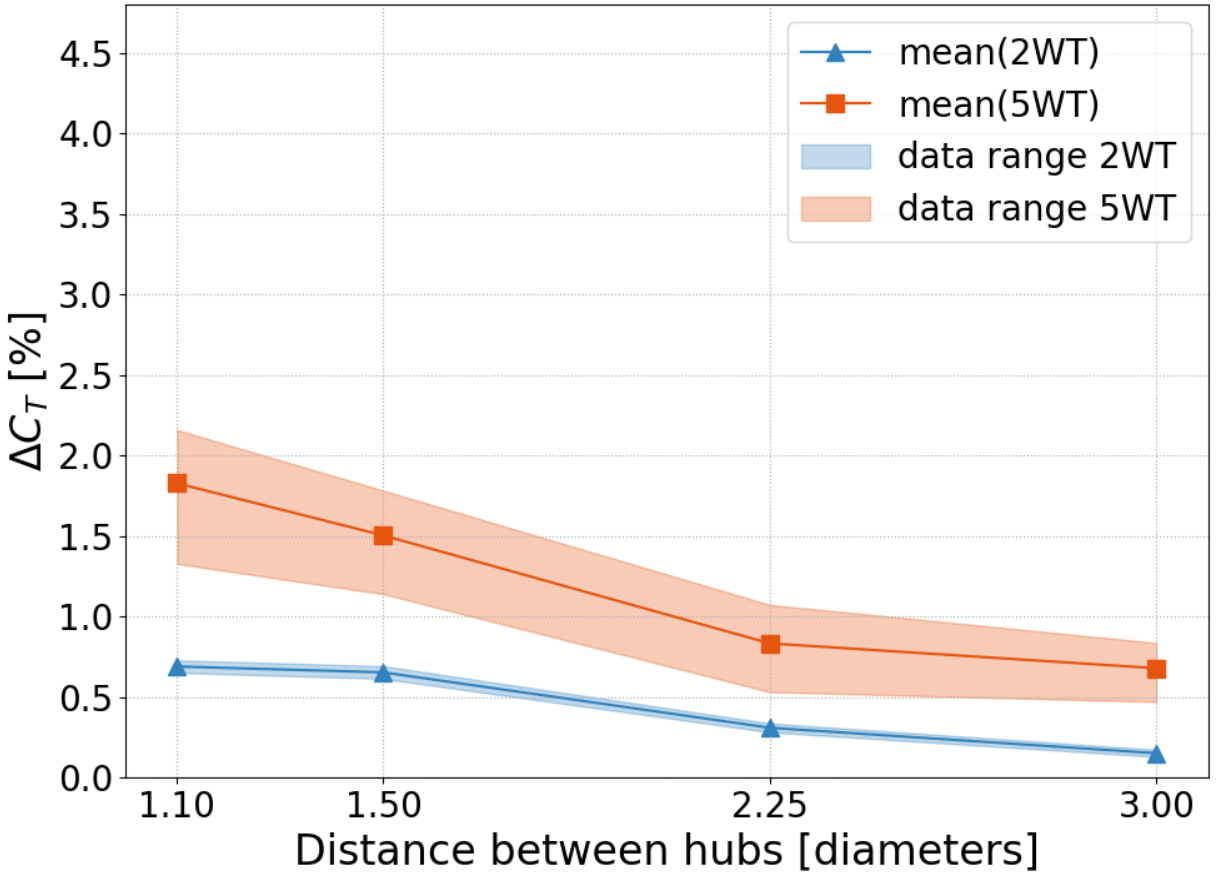
5WT 3D

Influence on ΔC_P and ΔC_T

$C_P^{ref} = 0.476$



$C_T^{ref} = 0.778$



Conclusions

- The increases of power obtained with AeroVIEW, for the two sets of wind turbines (5 and 2 WT), are very similar to published results obtained with high fidelity tools [2]
- The results show a higher increment of power for the lower separation distances
- The beneficial effect on the generated power has a counterpart in the increment of the average thrust
- The percentage of increase in thrust has been found to be only of half of that obtained in power

References

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[3] R. Martín-San-Román, P. Benito-Cia, J. Azcona-Armendáriz, and A. Cuerva-Tejero, “Validation of a free vortex filament wake module for the integrated simulation of multi-rotor wind turbines,” Renew. Energy, vol. 179, pp. 1706–1718, 2021.

[4] Jonkman, J.M., Butterfield, S., Musial, W. and Scott, G., “Definition of a 5-MW Reference Wind Turbine for Offshore System Development,” 2007.

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