Overview of Blockage research

Åre, Sweden, Feb 3rd 2020

About the speaker

Name: Martin de Maré

Feb 2018 – present: Senior Research Scientist at **RISE**

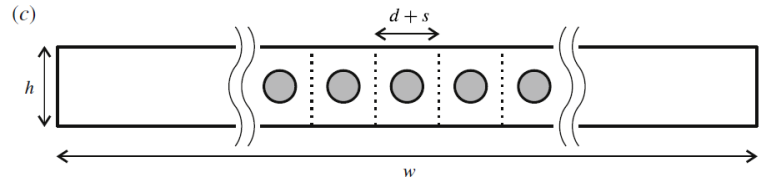
Feb 2013 – Jan 2018: As Wind Energy Analyst at **Ørsted** (formerly known as DONG Energy) I performed yield calculations and layout optimizations of planned wind farms.

Sep 2010 – Sep 2015: Industrial PhD at Risø **DTU**, while being an employee of first Vestas Wind Systems A/S and, as of February 2013, DONG Energy A/S.

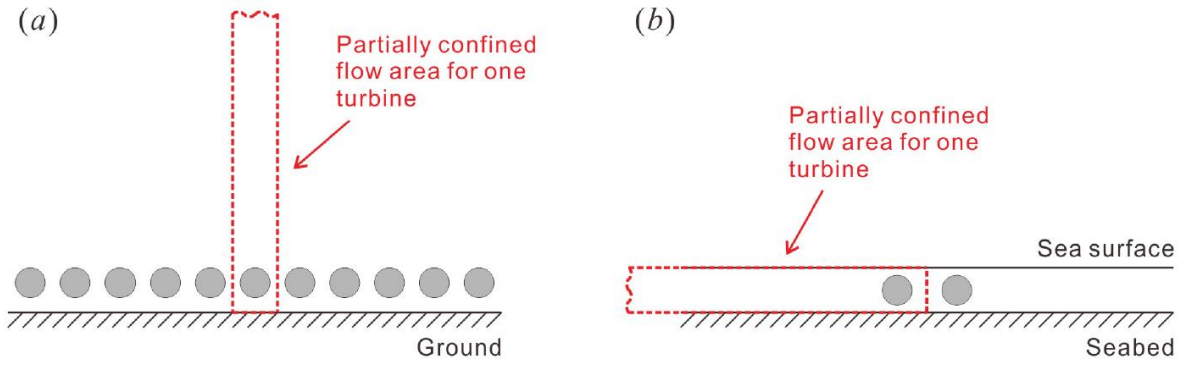
Aug 2007 – Sep 2010: As Power Performance and Loads Engineer at **Vestas** Wind Systems A/S I organized measurement campaigns on prototype turbines, mainly for the purpose of verification and turbine certification.

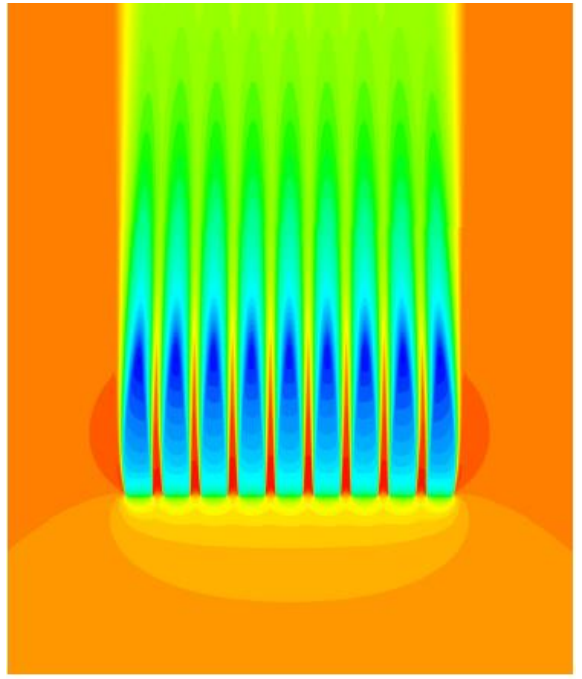
Blockage definitions: Local vs global blockage factor

- Nishino and Willden (2012) defines a global blockage factor and a local blockage factor for tidal turbines and investigates how the maximum CP depends on these two factors.



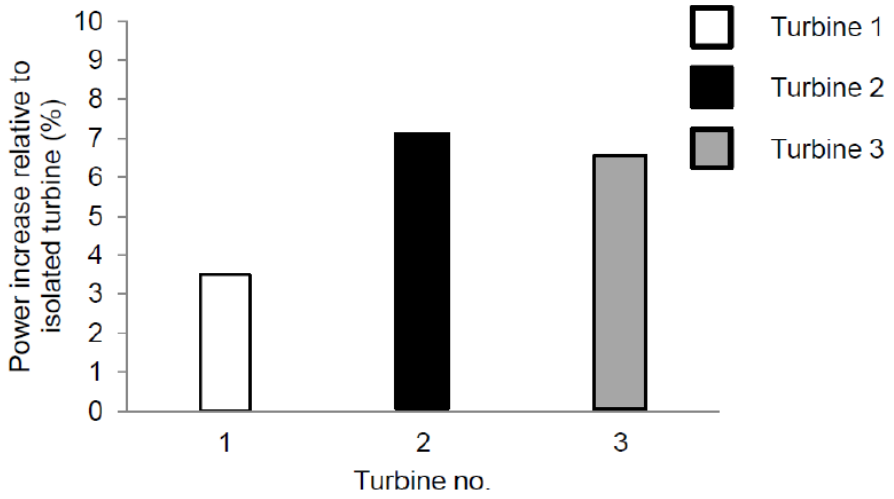
- Nishino and Draper (2015) found that the concepts of local and global blockage were useful however applying the associated modelling framework to wind turbines wasn't straight forward.

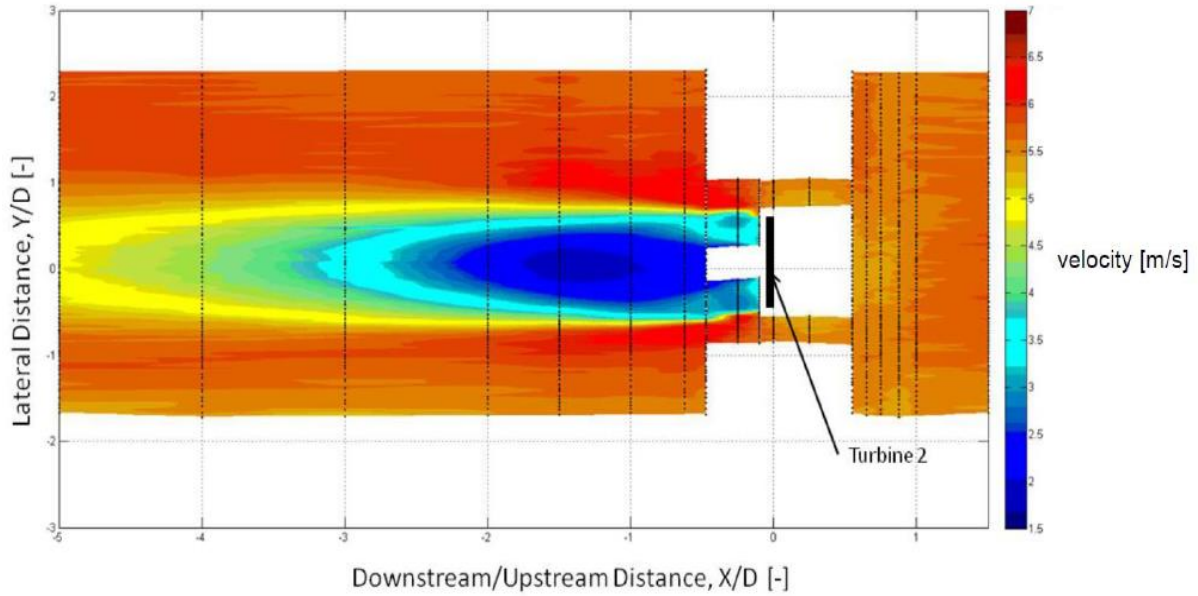


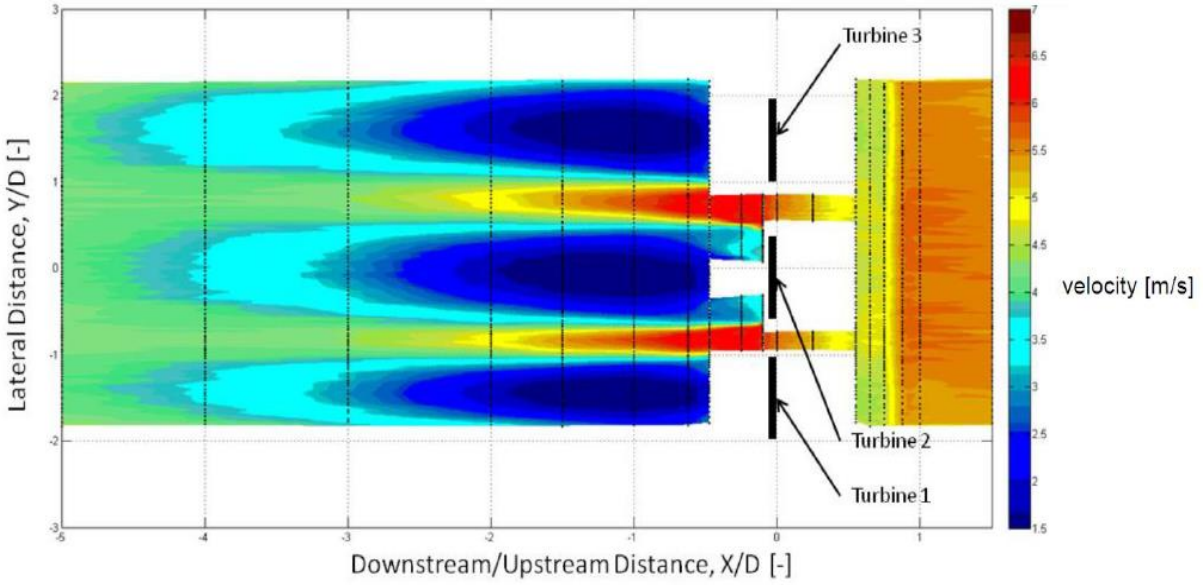


Blockage definitions: Wind speed vs Power

Feszty et al (2016) compared wind tunnel measurements to LES calculations.



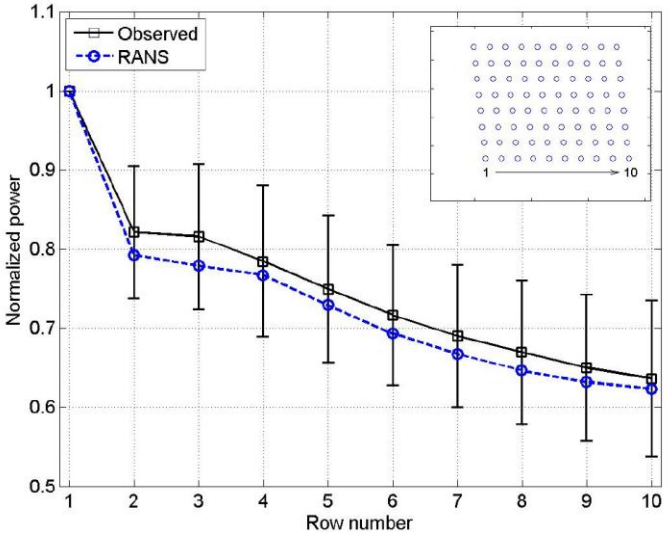




It is clear that a lower incoming wind speed doesn't necessarily result in lower power production.

Blockage definitions: ”Wakes-only prediciton bias”

Bleeg et al (2018) describes how wake models are developed to predict downstream power production based on unwaked references turbines, which are typically assumed to be operating undisturbed. The paper argues that a production bias due to blockage for the reference turbine therefore propages to the the whole downstream row.



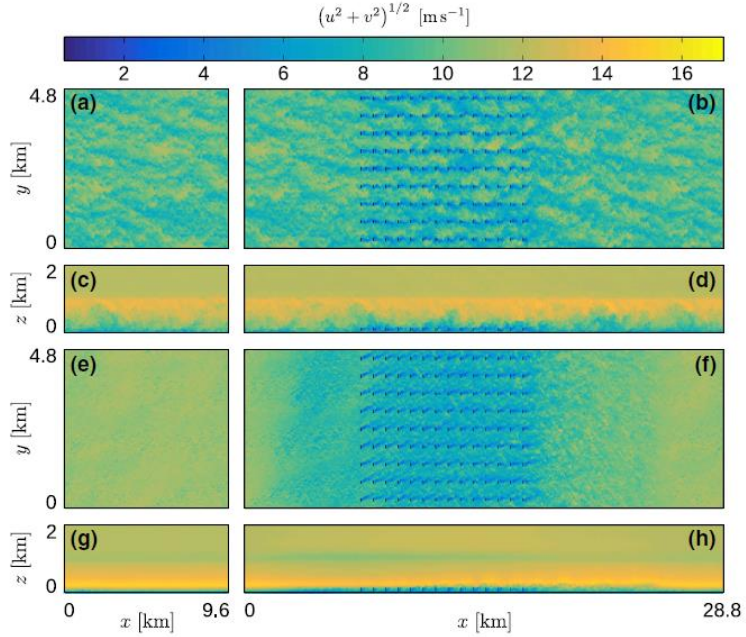
Bias in Wakes-only predicton:

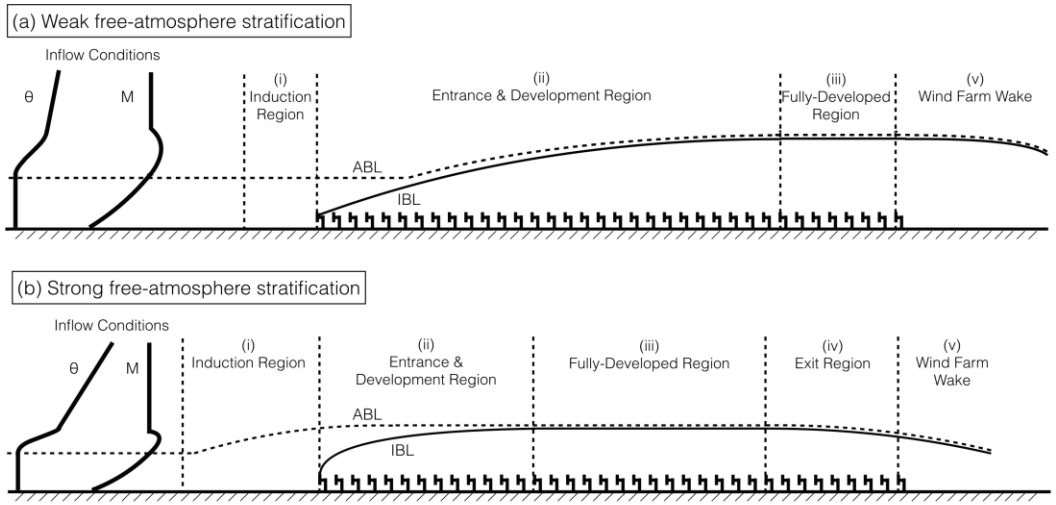
1. *For each unwaked turbine, replace the turbine power from the wind farm simulation with the turbine power corresponding to its simulation in isolation.*
2. *Calculate a scaling factor equal to the factor by which Step 1 increases the power of the unwaked, waking turbines.*
3. *For each waked turbine, apply the scaling factor to the simulated power in order to preserve the original power relationship between the waked turbines and the unwaked turbines waking them*

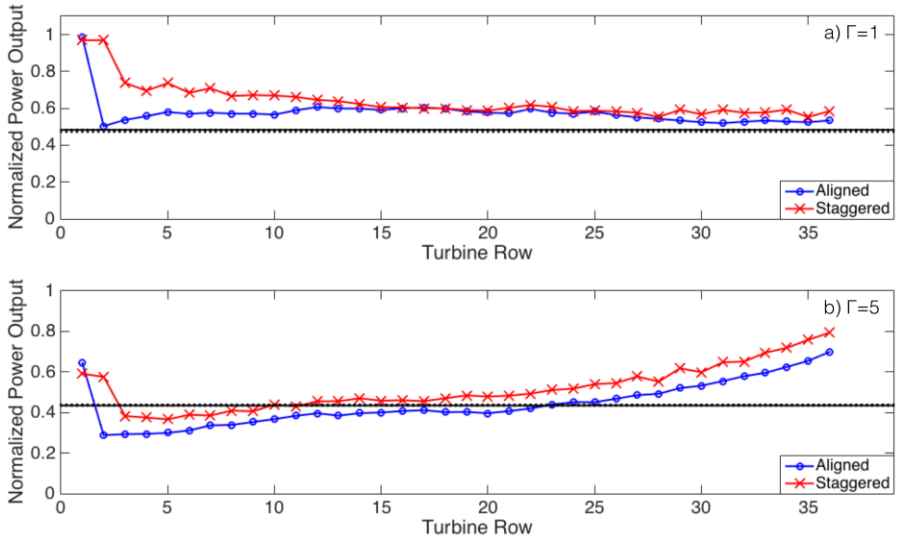
Factors influencing blockage: Stability

Allaerts and Meyers (2017) found using LES that the blockage effect during stable conditions could match wake effects in magnitude.

Wu and Porté-Agel (2017) found that the blockage effect is sensitive to the stratification of the free atmosphere above the boundary layer.

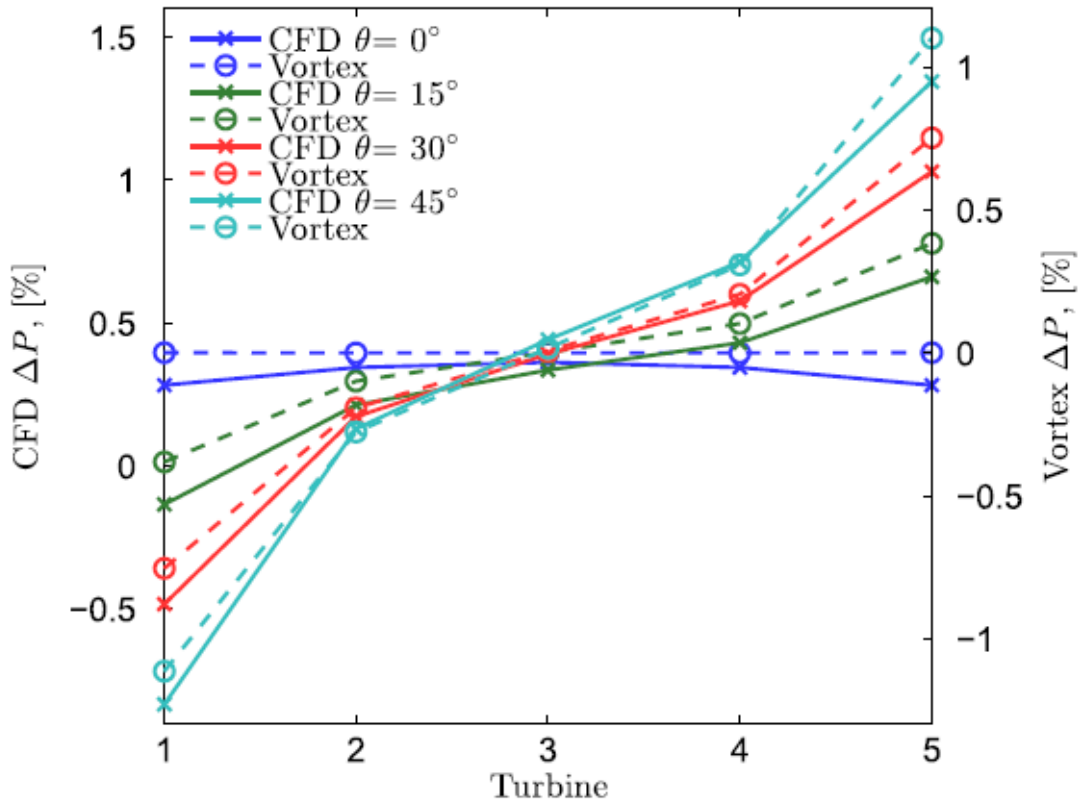


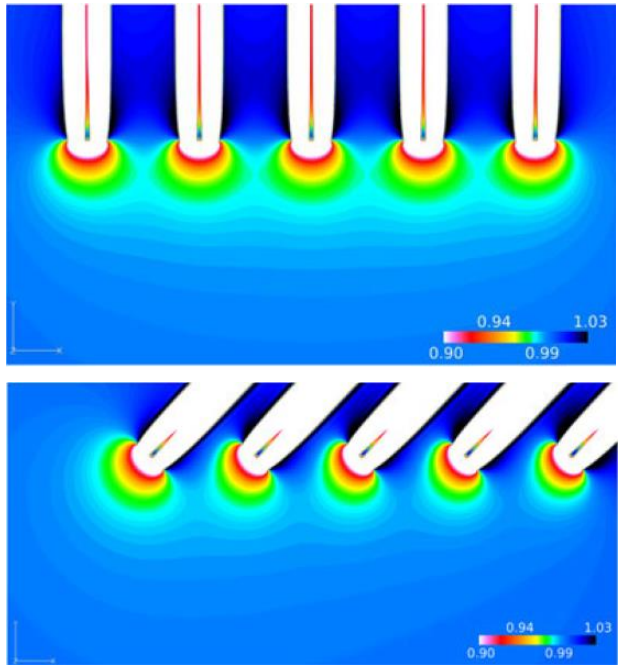




Factors influencing blockage: Wind direction

Forsting et al (2016) compared LES calculations to a vortex model. The wind direction was varied from 0 to 45 degrees.

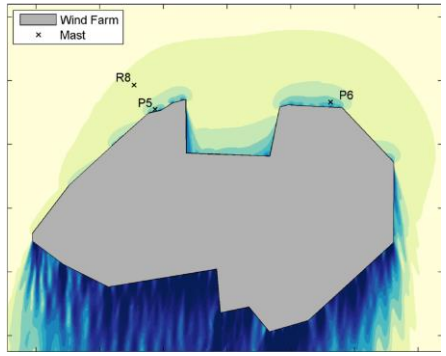


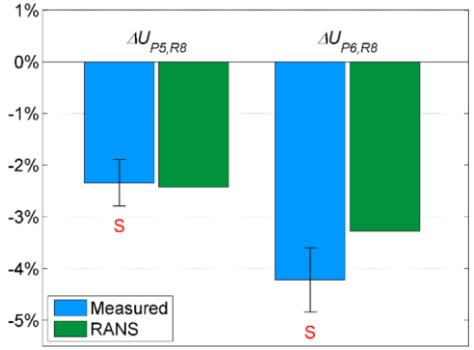


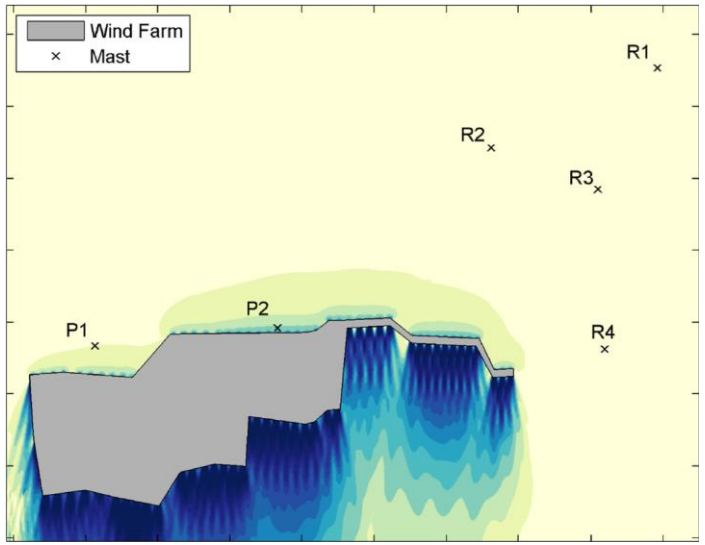
θ [°]	⟨ΔP⟩ [%]
0	0.576
15	0.556
30	0.572
45	0.582

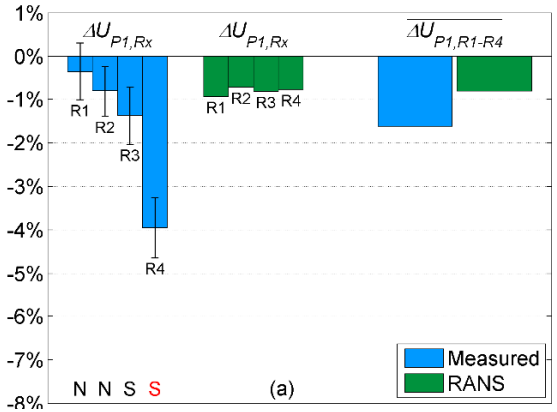
Validation vs field data

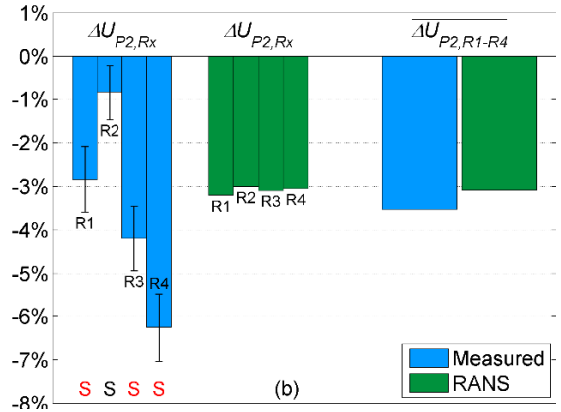
- Bleeg et al (2018) compared simulated wind speeds vs long standing metmasts.

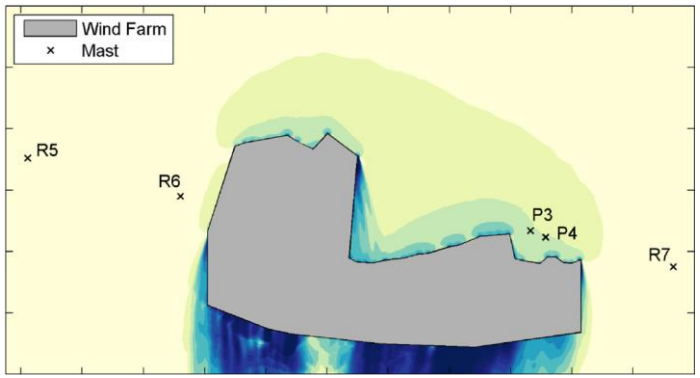


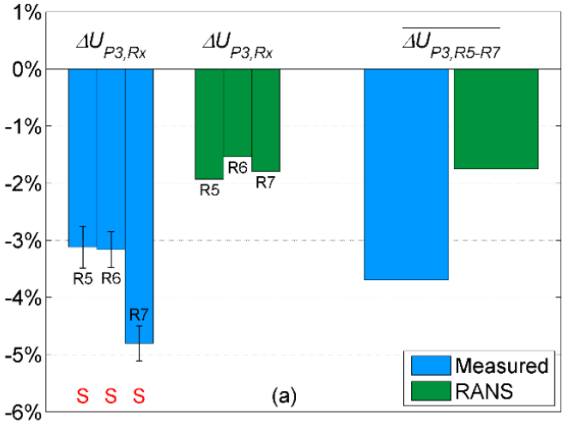


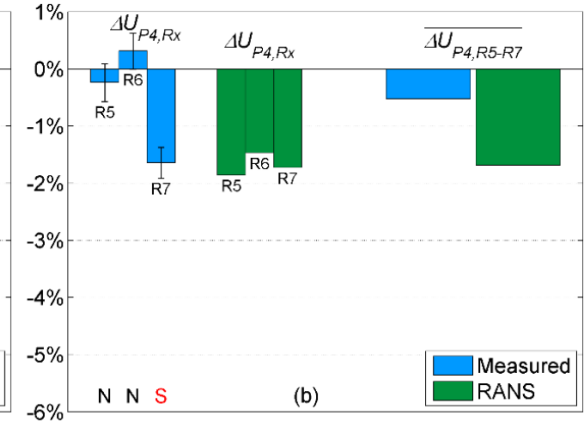












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