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# Load calculation in wind farm clusters

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## Outline

- a) CFD and aeroelastic turbine models (WP3)
- b) Calculation of loads and power for wind farms (WP3)
- c) Data base structure for simulation results (WP3)
- d) Offshore load measurement campaign (WP7)
- e) Summary

## a) CFD and aeroelastic turbine models (WP3)

### 1. Combination of CFD and turbine models to improve wake modelling

- Large Eddy Simulation code PALM at University of Oldenburg
- Flex5 Turbine model at REpower
- Direct coupling of PALM and Flex5: Actuator Line simulations with exchange of flow field at each time step
- Consecutive use of PALM and Flex5 (Indirect coupling): Actuator Disc simulations with PALM as input for aeroelastic simulations with Flex5

## b) Calculation of loads and power for wind farms (WP3)

### **2. Improve fast calculations of loads and power for a complete wind farm**

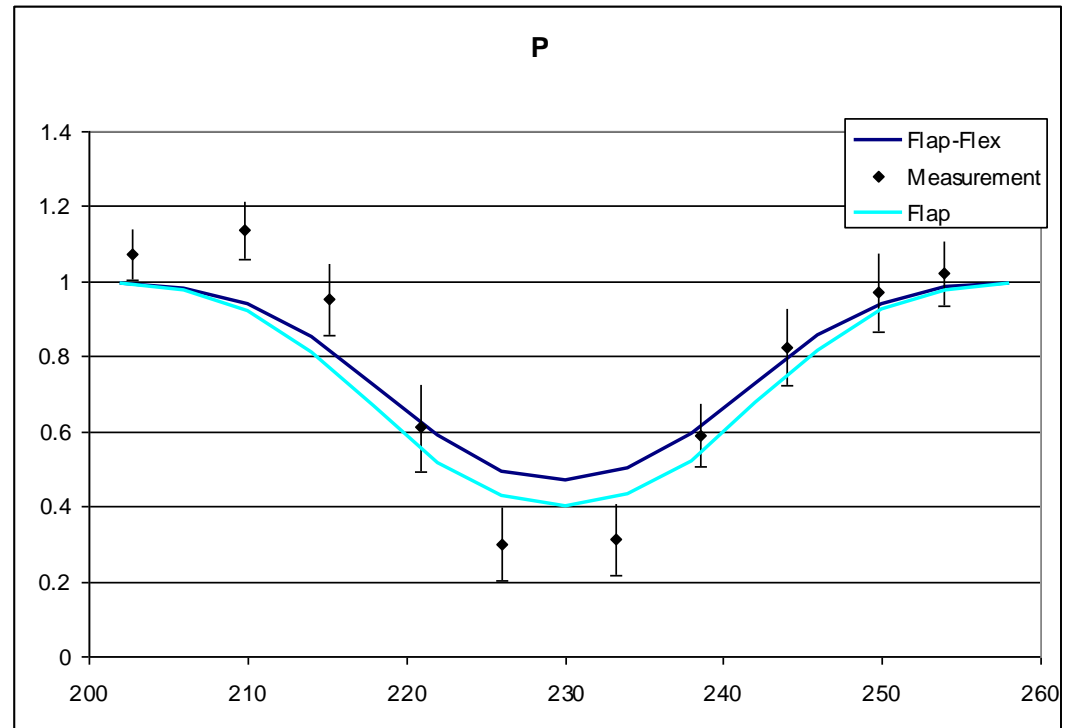
- Combination of different fast wind farm flow models with aeroelastic turbine models needed
- Approach of characteristic local flow parameters (Turbulence, wind speed, shear)
- Wind farm flow model FLaP at University of Oldenburg
- Wind farm flow model FarmFlow at ECN
- Turbine model Flex5 at Repower

## b) Calculation of loads and power for wind farms (WP3)

### Example 1: FLaP and Flex 5, reactive power in single wake

Check for plausibility by  
comparison of power  
deficits

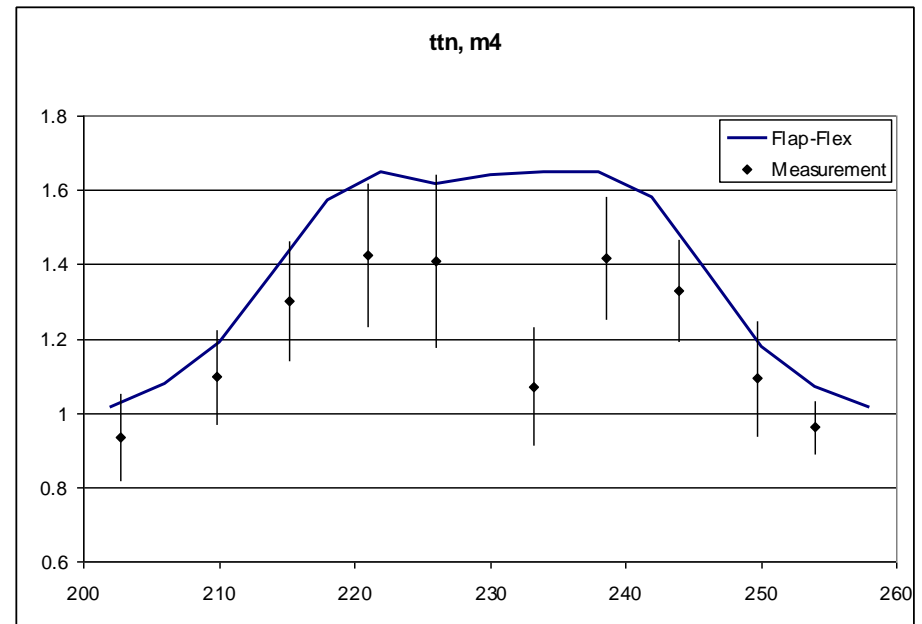
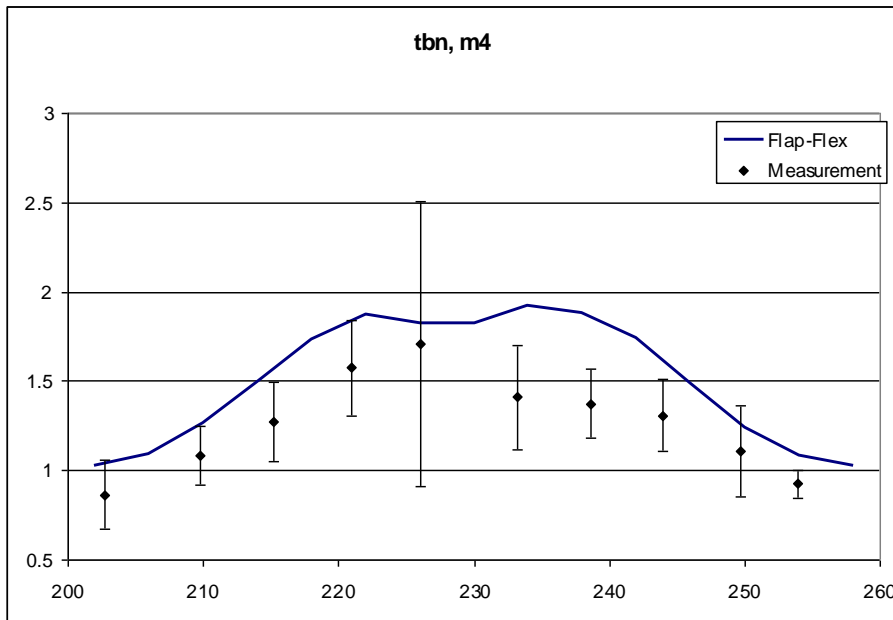
Gap between deficits  
probably due to  
inaccurate loss  
modelling



=> Wind farm model is more appropriate for performance calculations

## b) Calculation of loads and power for wind farms (WP3)

### Example 2: FLaP and Flex 5, relative tower fatigue loads in single wake

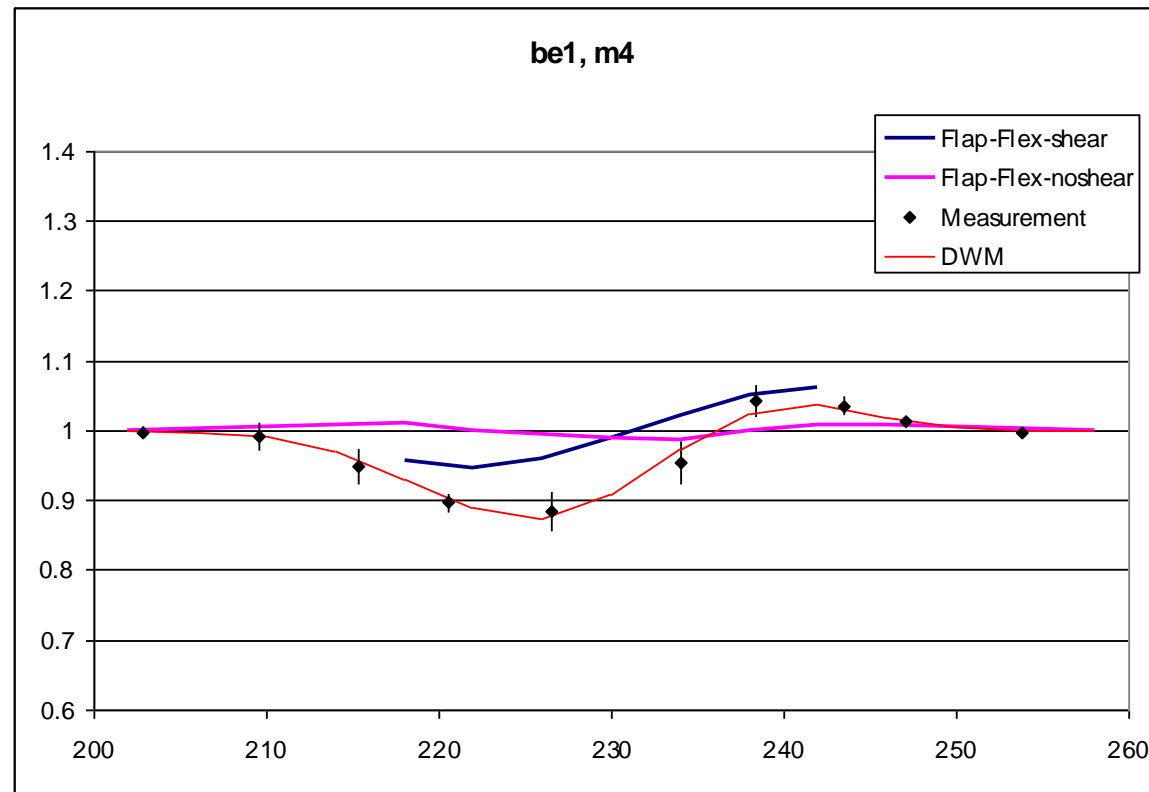


=> Fits measurements quite good, but is still conservative

## b) Calculation of loads and power for wind farms

### Example 3: FLaP and Flex 5, introduction of horizontal shear

- Simple modelling of asymmetric mean flow field
- Improves interaction of aerodynamics and gravity
- Big impact on blade loads
- Nearly no impact on power and most of the other loads



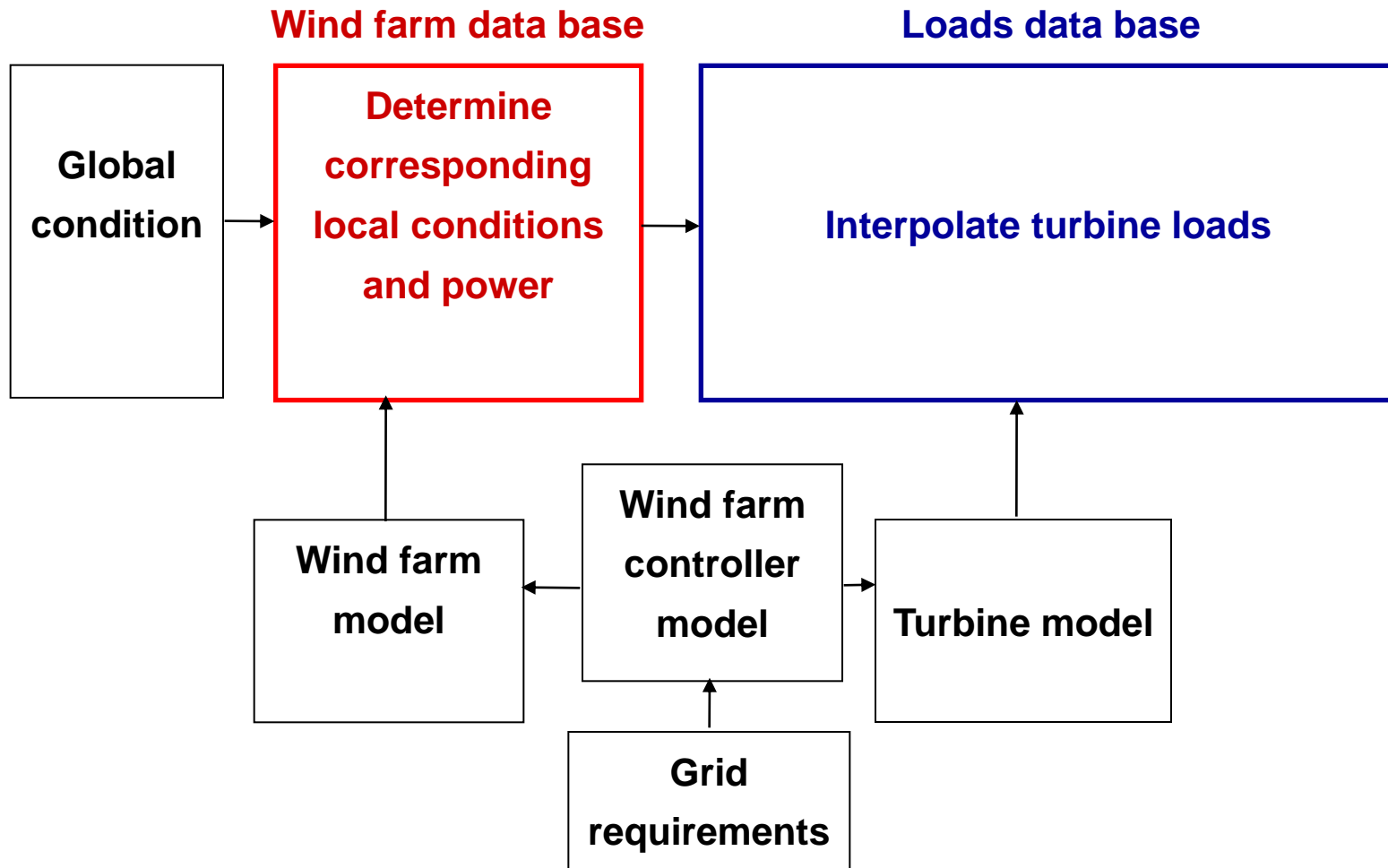
## c) Data base structure for simulation results (WP3)

### **3. Determination of impact on loads and power for specific wind farm control concepts**

- Development of a data base structure for simulation results to minimize calculation time
- Number of necessary simulations reduced by interpolation
- Fast and detailed results for arbitrary input conditions



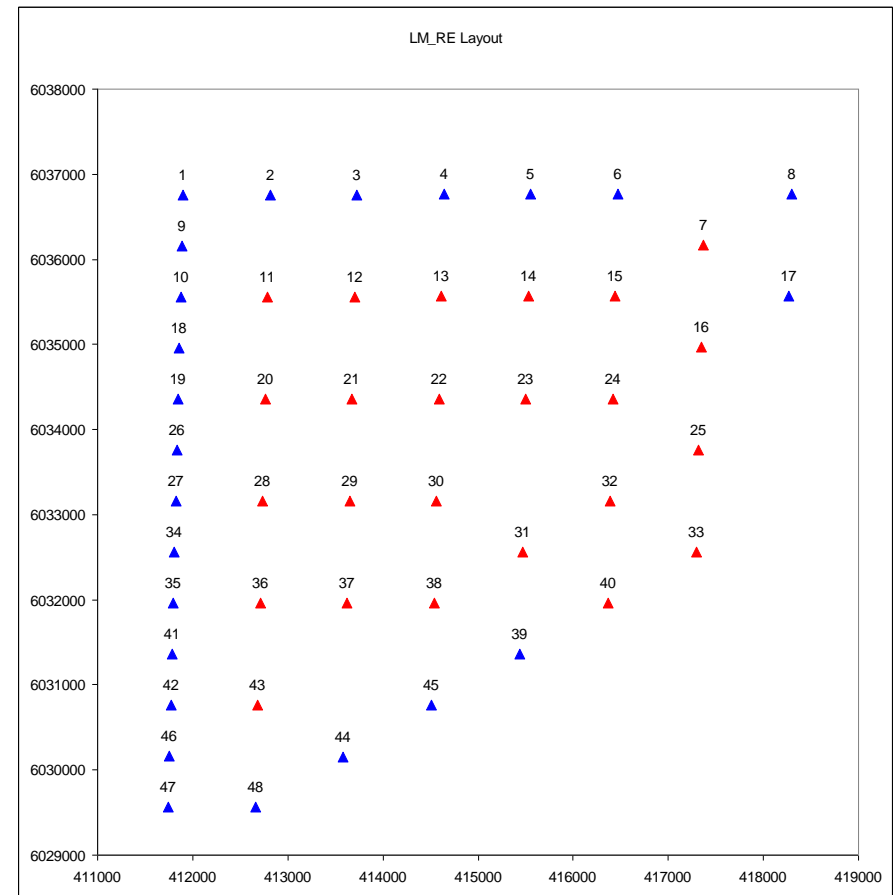
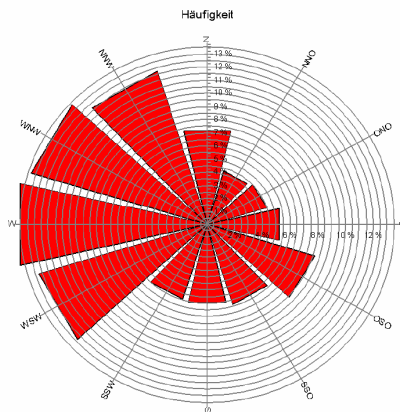
### c) Data base structure for simulation results (WP3)



## d) Offshore load measurement campaign (WP7)

Measured turbines have

- Identical aerodynamics
- Wake and free flow for main wind directions
- Short distance to the met mast



## e) Summary

- Wake modelling accuracy with respect to loads and power will be improved
- A fast estimation method for loads and power for a whole wind farm is developed and will be implemented
- The impact of specific wind farm control concepts on loads and power will be determined
- The findings will be validated through a full scale loads and power measurement in an offshore wind farm

**Thank you!**