Overview of wake measurement

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Purpose

TOPFARM report (D11) presents measurements available for the model verifications developed as part of TOPFARM WP1 & WP2

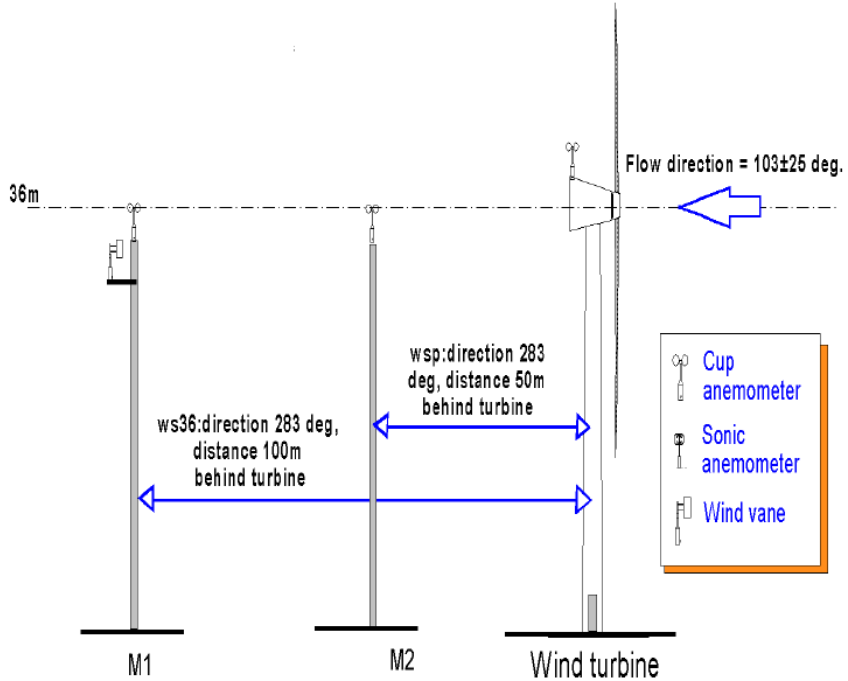
Based on a data catalog prepared during TOPFARM

Document:
Wake measurements for code validations
Deliverable D11: EU – TOPFARM
by Kurt S. Hansen
MEK-FM 2009-01; June 2009

Data catagories:

1. Wind turbine – mast interaction
2. Wind turbine – wind turbine interaction
3. Wind turbine wake charcteristics

1. Wind turbine – mast interaction



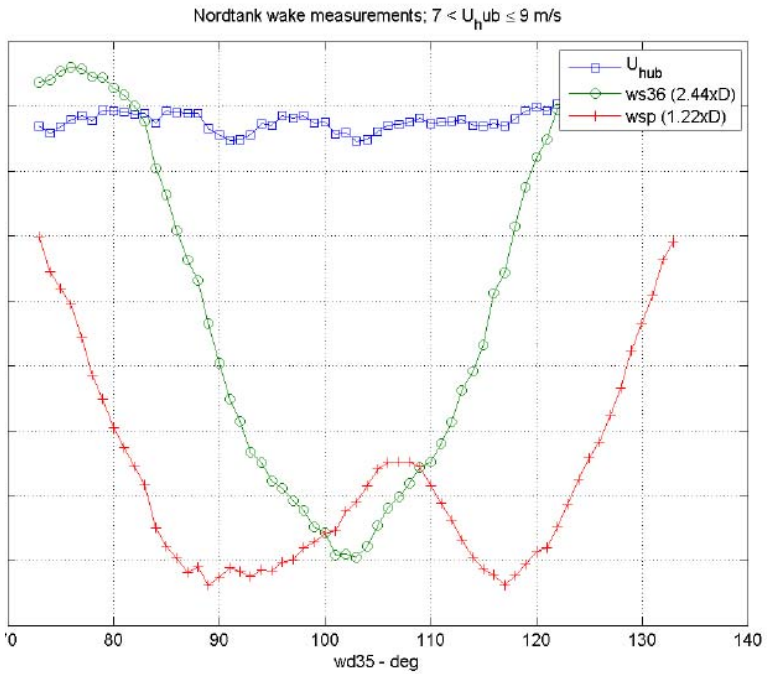


Figure 5: Mean wake deficit behind the Nordtank wind turbine at 8 m/s - as function of inflow direction where wd=103 deg is the reference direction.

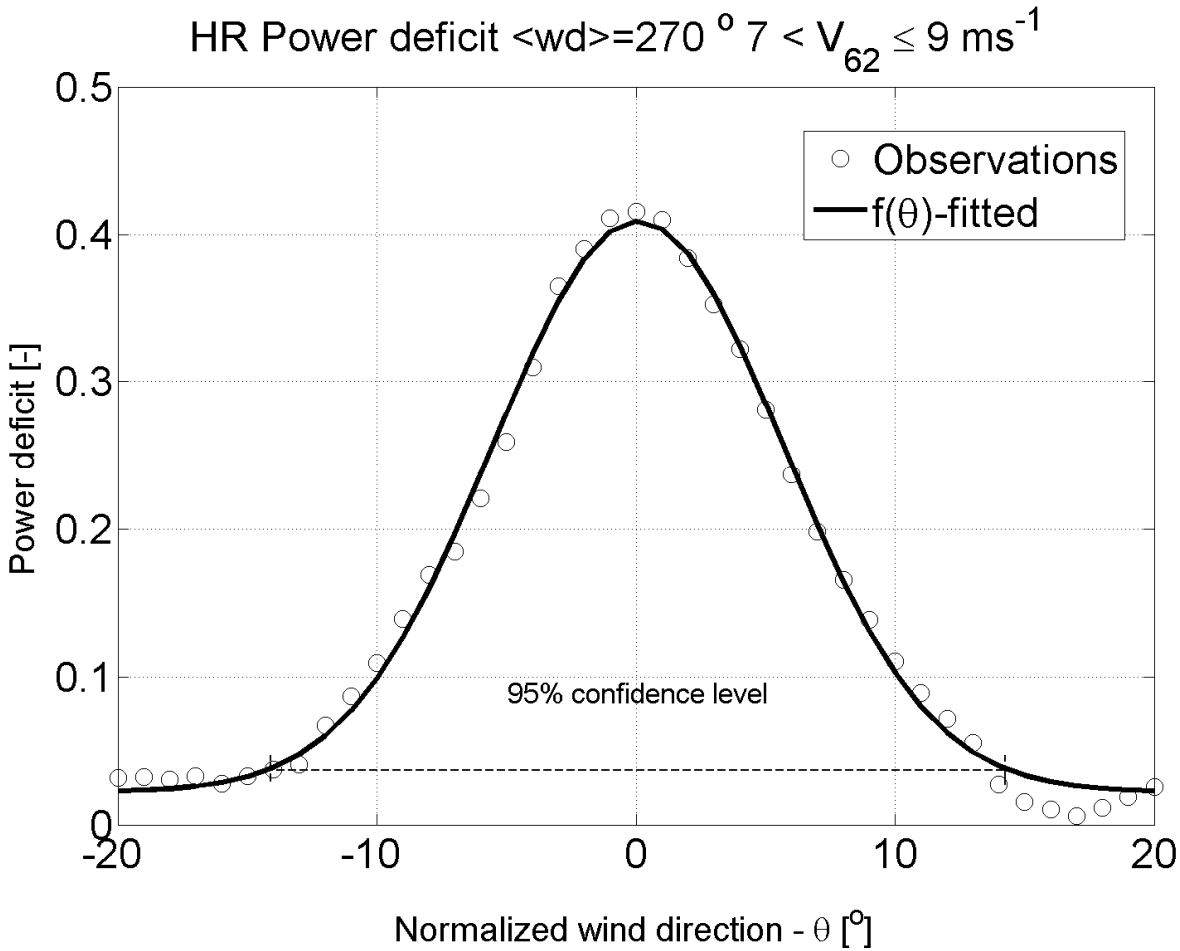
1. Wind turbine – mast interaction

1. **Nordtank** 41m/550kW stall regulated combined with 3D-sonic measurement 1D spacing & cups at 2.5D (time series)
2. **Nibe** 40m/2x630kW pitch&stall regulated with cup measurements at h=15, 25, 31, 38, 45, 56m; -2.5D, -1D, +1D & 2.5D spacing (Report is available but no data)
3. **Tjæreborg** 60m/2MW pitch regulated combined with mast measurements h=30,45,60,75 & 90m, 2D spacing.
4. **Alsvik** 23m/180kW 1-7D spacing (time series)
5. **Sexbierum**, onshore windfarm 18 x 180 kW (Report is available but no data).

1. Wind turbine – mast interaction

6. **Vindeby**; offshore 25m/11x450kW cups and sonics, 5,7,9 & 10D spacing (time series of climate and structural loads)
7. **Bockstigen**, offshore 37m/6 x 500kW, 5 – 14D spacing, cups h=9,22, 37, 40 m. (time series of climate and structural loads)
8. **Nysted,** offshore wind farm 76x2.3 MW, ≥2 D spacing, 10.minute statistics
9. **NoordZee**, offshore wind farm 36x 3 MW, ≥2 D spacing, 10.minute statistics

2. Wind turbine – wind turbine interaction



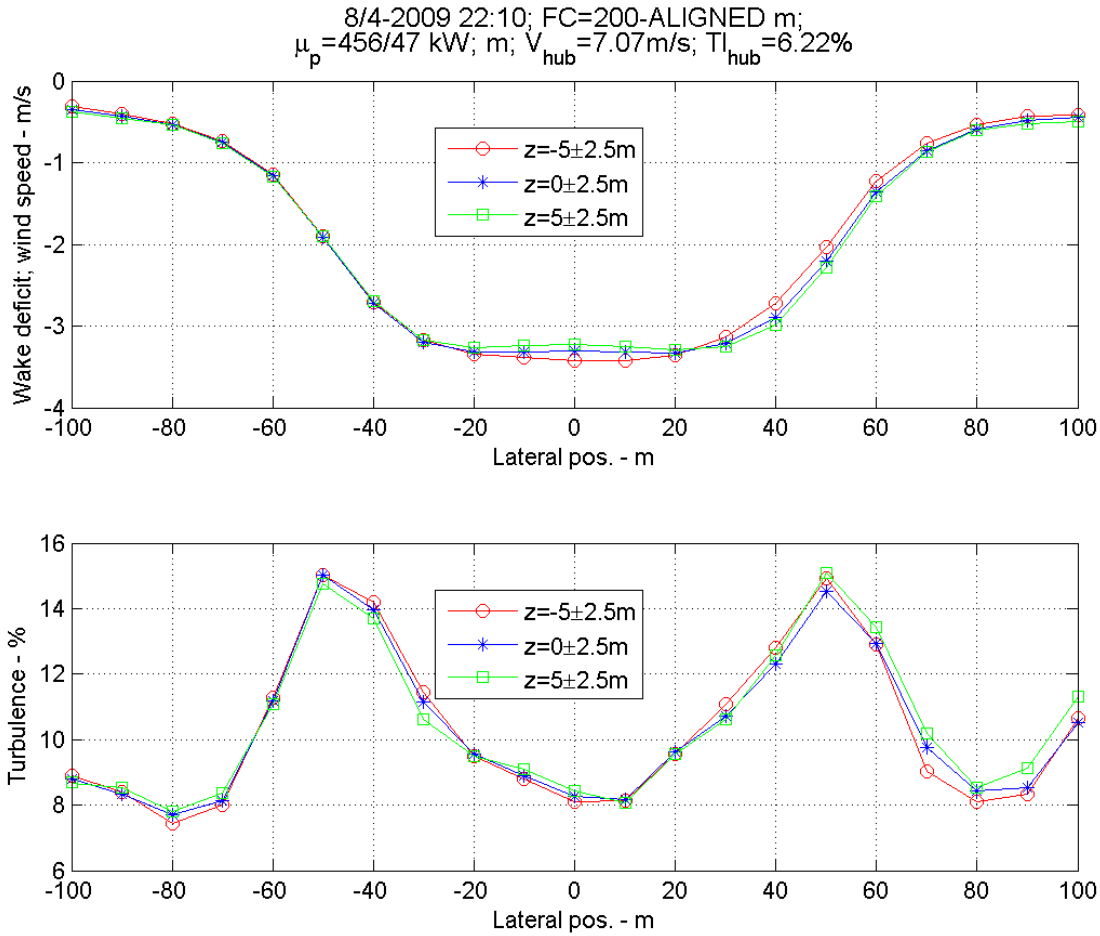
2. Wind turbine – wind turbine interaction

1. **Middelgrunden** offshore wind farm 76m/20x2MW; 2D spacing (10 minutes statistics);
2. **Nysted** offshore wind farm, 80m/72x2.3MW; 6, 10,11 & 13D spacing (1Hz park data and 10 minute SCADA data);
3. **Delabole**, onshore wind farm 38.8m/10x400kW; cups h=3,10,23,31,44 & 55 m 6,7 & 10D spacing (10 minute statistics of power and wind speed);
4. **Nørrekær Enge**, onshore wind farm 28m/42x300kW, cups, h=20,23,31,44 &51 m (1&20Hz of wind speeds and loads and 10 minute statistics of power and wind speeds);
5. **Spanish** wind farm in complex terrain, 43 x 750 kW (SCADA data + wind measurements)
6. **Spanish** wind farm in complex terrain, 13 x 2 MW (SCADA data + wind measurements)

2. Wind turbine – wind turbine interaction

7. **Tjæreborg** onshore park, 8 x 2-2.5 MW; 10 minute SCADA data & wind measurements;
8. **ECN** onshore research wind farm, 5 x 2.5 MW; 10 minute SCADA data;
9. **NoordZee** offshore wind farm, 90, 36x3MW, >13D spacing, (high sampled structural loads and 10 minute SCADA data);
10. **Horns Rev** offshore wind farm, 80m/80x2MW, 7, 9 & 10D spacing (high sampled structural loads, 1 Hz park data & 10 minute SCADA data);
11. **Lillgrund** offshore wind farm, 48 x 2.3 MW (SCADA data)

3. Wind turbine wake measurements



3. wind turbine wake measurements

1) **Tellus** experiment; 95kW wt located at Risø-DTU

- Wake measurements, which have already been analysed and reported at several conferences and papers.
- Wind field data measured in the nearby 500kW Nordtank rotor plane need a further analysis.

2) **Wake** measurements on a 80m/2.5MW wt in Tjæreborg, sampled with 349 Hz and representing different flow cases ranging from 1D-2.5D behind the rotor .

3) **Double wake** measurements on Tellus => Nordtank 500 kW