



Dutch Offshore Wind Atlas

R&D North Sea Offshore Wind Energy

Jan Willem Wagenaar, Ine Wijnant, Remco Verzijlbergh

9/2/2018



Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Waterstaat



Content

- The Problem

Why are we doing this project?

- The Impact

What is the main outcome?

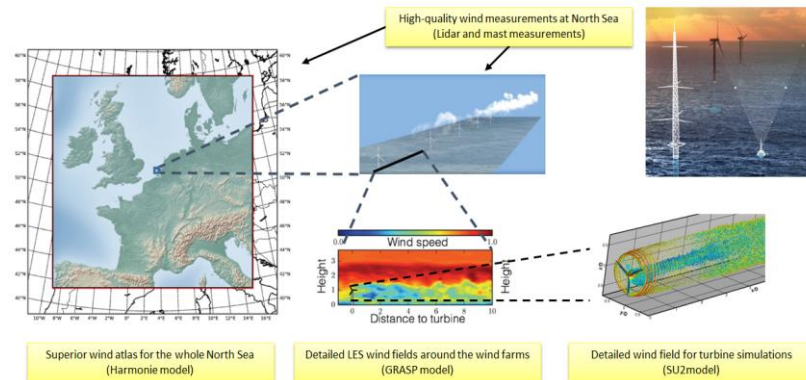
- The Approach

How are we going to achieve these results?

- Initial Results

What results have so far been obtained?

- Summary



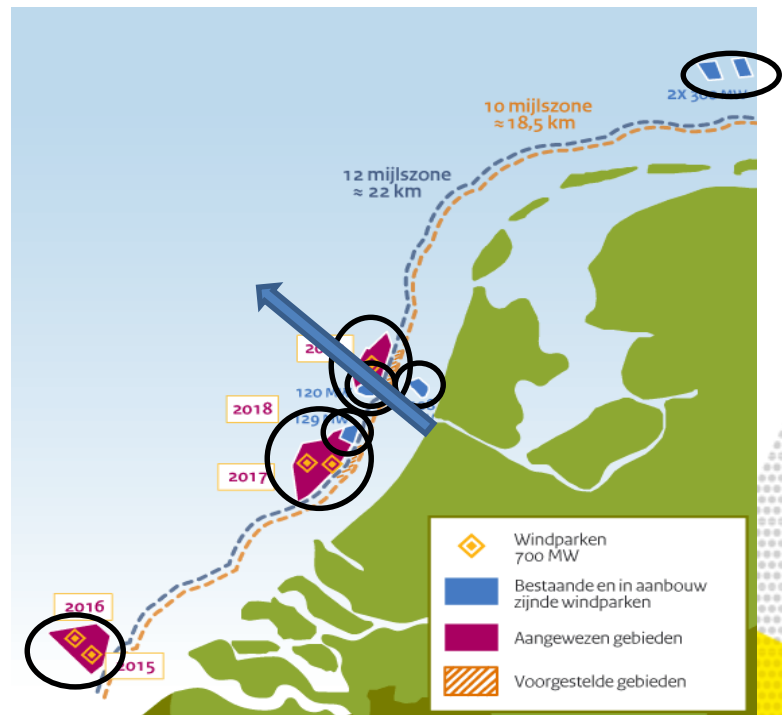
Why are we doing this project?

THE PROBLEM



Background

- Operational (957MW)
 - OWEZ 2006 108MW
 - Amalia 2008 120MW
 - Luchterduinen 2015 129MW
 - Gemini 2017 600MW
- Tender (3500MW)
 - Borssele I+II 2016 700MW
 - Borssele III+IV 2016 700MW
 - HKZ 2017 700MW
 - HKZ 2018 700MW
 - HKN 2019 700MW



Overview measurement platforms



All data publicly available at www.windopzee.net

The Problem

Current atlases are insufficient

- KNW incomplete, i.e. up to 2013
- Daily cycle not included
 - *Measure Correlate Predict*
- No information at higher altitude for
 - *Larger wind turbines, airborne wind power, large wind farm*
- Wake effects of existing wind farms not included



What is the main outcome?

THE IMPACT



Objectives



- Make available the Dutch Offshore Wind Atlas (DOWA)
 - *Including long term climatology and wind field information aiming specifically at the wind energy industry.*
- Understanding of offshore wind conditions up to large heights
 - *Wind profile up to 600m height*
 - *Extreme events (low-level jets) and understanding of occurrence*
- Development of detailed wind fields for more accurate wind resource and wind load assessments
 - *LES models are nested within weather models*
- Include offshore wind farms (and their wakes) in the wind field modelling
 - *Development and demonstration only*

The Impact

- Developer's perspective
 - *Higher accuracy, lower uncertainty*
 - *Better business case, better financing conditions*
- Manufacturer's perspective
 - *Information at higher altitudes*
 - *Lower risk, better turbine design*
 - *Airborne wind power*
- Lender's perspective
 - *Lower risk*

Good and strong consortium

Wind atlases available through KDC, incl user manuals

Helpdesk for data users



How are we going to achieve these results?

THE APPROACH



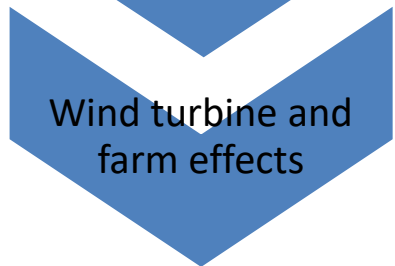
General approach



- Update for the recent years
- Total period of over 40 years



- Up to a height of 600m
- Better correlation e.g. daily cycle



- Accurate wind field modelling: 1h/2.5km -> 10s/100m
- Wake effects of wind farm clusters

Detailed approach

WP1 Update

- Update existing KNW atlas
- Scanning LiDAR campaign for high altitudes

WP4 LES

- LES turbine parameterization in GRASP
- Wind farm wake modelling in Harmonie
- Nudging methodologies for high res.
- Time series and simulations

WP2 Offshore

- Understanding of the offshore wr
- High altitude comparison KNW atlas with measurements

WP5 Validation

- Validation and comparisons
- Extreme events
- Fluid structure interaction

WP3 DOWA

- Creation of DOWA
- Updated versions ERA5 and Harmonie
- Validation with various sources

WP6 Unc

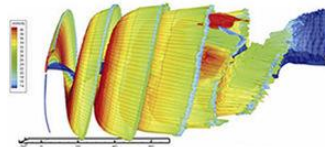
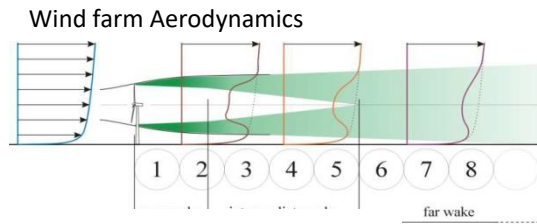
Recommendations and uncertainty quantifications for power production estimates

Validation sources

- Long range scanning LiDAR
- Measurement network North Sea
- Satellite (ASCAT) measurements
- Airplane (MODE-S EHS) measurements
- FarmFlow
- EMD-ConWX
- Aeromodule
- SU2



WINDCUBE
2005



SU²
The Open-Source CFD Code

What results have so far been obtained?

INITIAL RESULTS

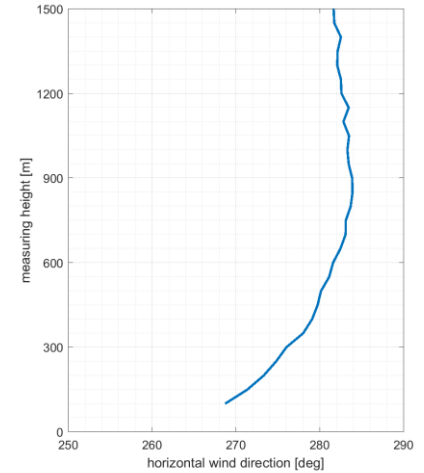
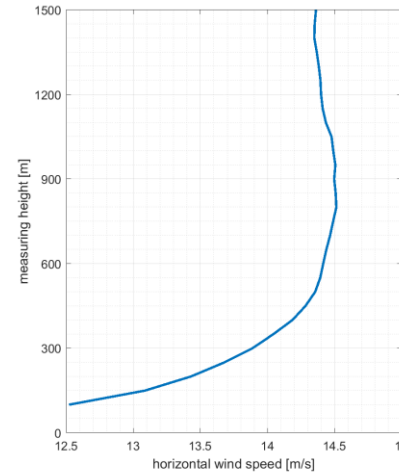
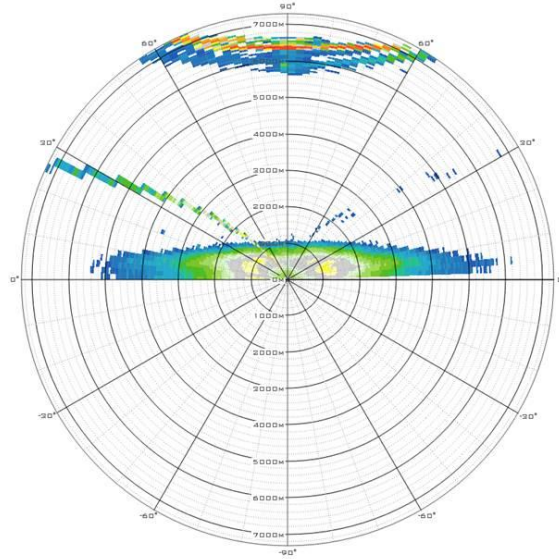
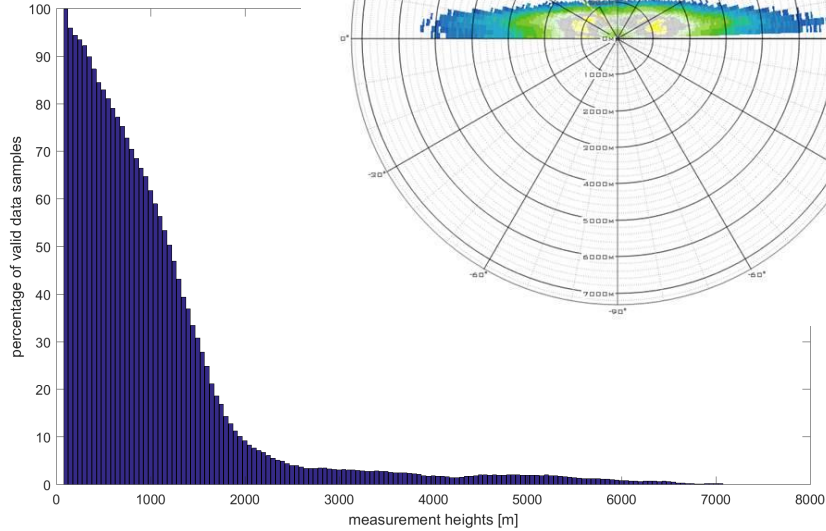
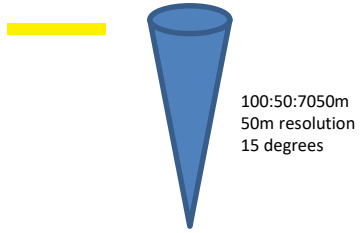


Results so far

- KNW atlas updated until august 2017
- Scanning LiDAR measurements completed
- First analyses offshore wind measurements
- DOWA runs started
- First LES turbine parametrization and LES runs



Scanning LiDAR measurements



SUMMARY



Summary

- Important project for WRA
- Support from leading companies
- Higher accuracy
 - Day-night
 - Higher altitude
 - Wind farm effects
- Strong consortium
- DOWA will become available end of 2019

DOWA specifications

- Wind speed (validated) and wind direction climatology
- 2008-2017
- 2.5km x 2.5km grid
- 10m to 600m height



(1.4470E, 54.7358N), (8.2222E, 54.4725N)
(1.3114E, 50.4210N), (7.4570E, 50.1823N)



Thank you for your attention
- Questions?
- Specific DOWA requests?