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Application of mesoscale models with wind farm parametrisations in EERA-DTOC

Volker, Patrick; Badger, Jake; Hahmann, Andrea N.; Hansen, S.; Badger, Merete; Husson, R.; Vincent, P.; Longepe, N.; Mouche, Alexis ; Hasager, Charlotte Bay

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Application of mesoscale models with wind farm parametrisations in EERA-DTOC

P. J. H. Volker(1), J. Badger(1), A. N. Hahmann(1),. S. Hansen(1), M. Badger(1), R. Husson(2),P. Vincent(2), N. Longepe(2), A. Mouche(3) and C. B. Hasager(1)
(1) DTU Windenergy (Denmark)
(2) CLS, Plouzane (France)
(3) IFREMER (France)

EERA DTOC

THE EUROPEAN ENERGY RESEARCH ALLIANCE
DESIGN TOOLS FOR OFFSHORE WIND FARM CLUSTER

Support by

Introduction

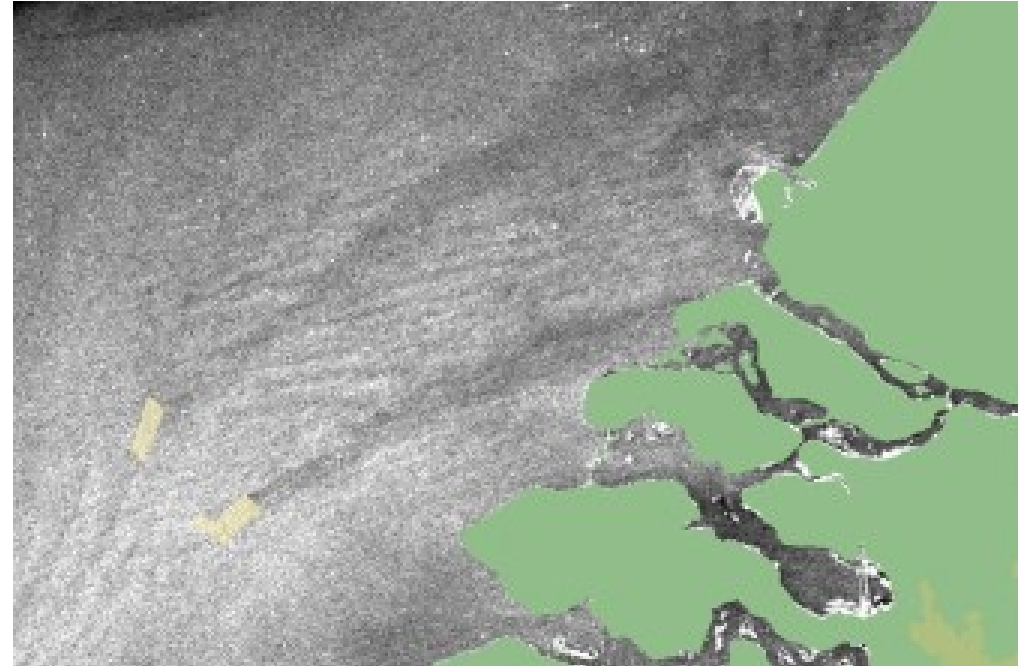Our aim is to understand better wakes of wind farms, especially their:

(1) Properties
  - Depth
  - Extension
  - Dynamics

(2) Long-term impact on
  - Wind resources
  - Environment (T, Q)

Wakes behind Belwind/Thornton

Content:
1) **Mesoscale models**
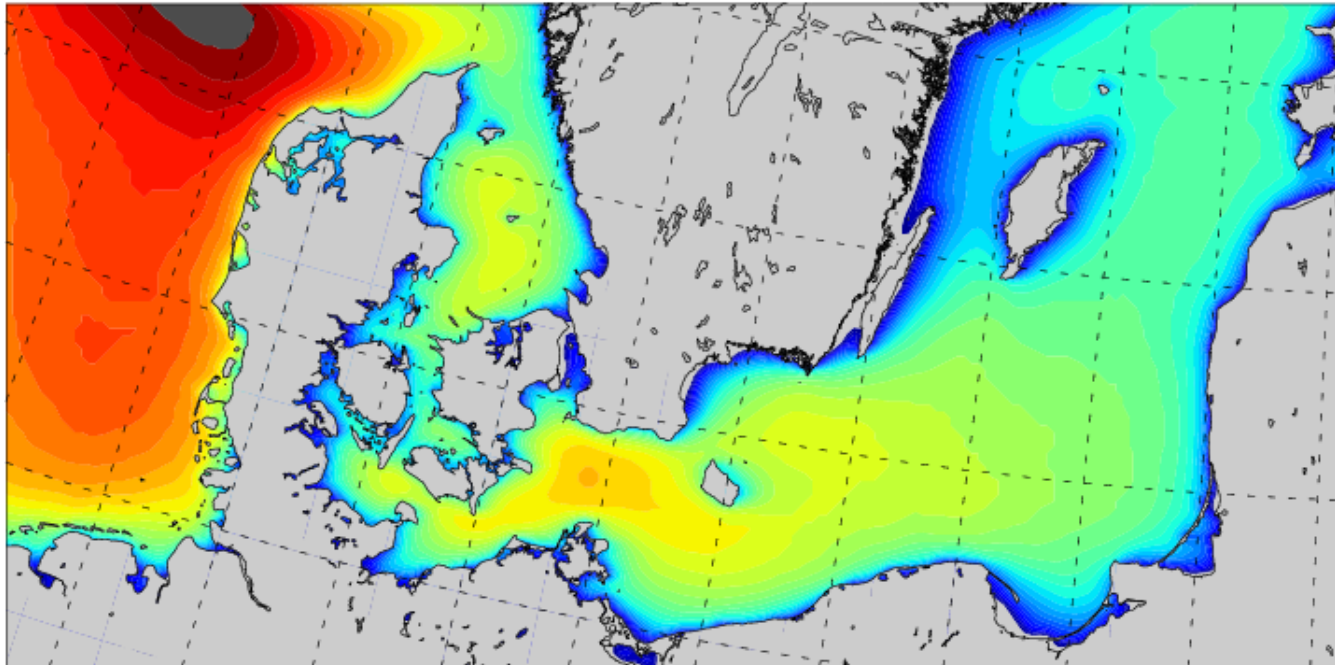2) **EERA**-**DTOC Project**
3) **Mesoscale models in EERA**-**DTOC**

Mesoscale Model (General)

Mesoscale models are used for: {
Forecasting the weather
Wind resource assessment
}

Mean Wind Speed, 2006/05-2007/04 ... Height: 100 meters

wind speed (m/s)

Weather Research and Forecast model (WRF)
2.750.000 Cells for an area $\approx$ 180.000 km^2
On our cluster: 2/3 Days per year on 70 X 20 processors
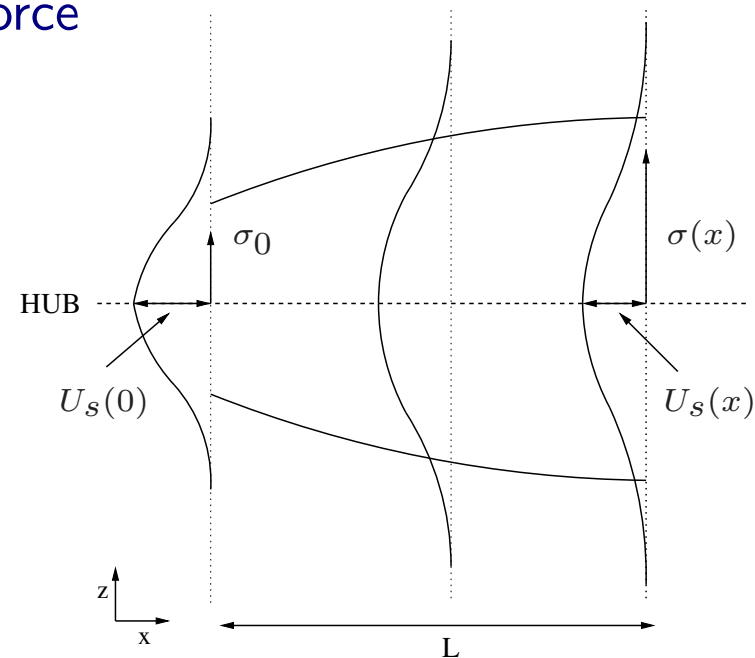
Wind Farm Parametrisations

WRF Wind Farm scheme (Fitch et al. 2012):

(1) Local drag force (Rotor swept area)

(2) Additional TKE source term

Explicit Wake Parametrisation (EWP) approach:

(1) Accounts for unresolved wake expansion

(2) Applies Grid-cell averaged drag force

Concept:

Sketch of the wake development within a grid-cell

For both schemes the full TKE budget is calculated by PBL-scheme

EERA-DTOC Project

EERA-DTOC (Seventh Framework Programme (FP7)):

European Energy Research Alliance - Design Tool for Offshore Wind Farm Cluster

"Integrated and validated design tool combining state-of-the-art wake, yield and electrical models"

Universities/Institutes:

- DTU Wind Energy (Denmark)
- ECN (Netherlands)
- Universität Oldenburg (Germany)
- Fraunhofer (Germany)
- CRES (Greece)
- CIEMAT (Spain)
- CENER (Spain)
- CLS (France)

Industry:

- Carbon Trust (United Kingdom)
- RES (United Kingdom)
- Overspeed (Germany)
- Statoil (Norway)
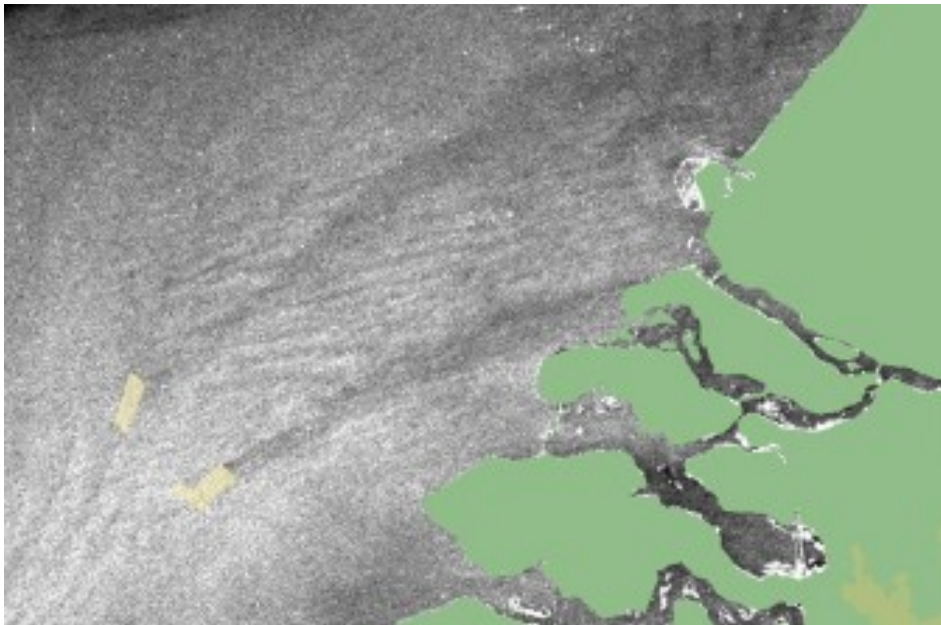- Statkraft (Norway)
- Iberdrola (Spain)
- EON (Sweden)

DTOC – Mesoscale Model Evaluation

Qualitative comparison with Synthetic Aperture Radar (SAR) images. They can retrieve wind speed from back-scatter (higher wind speeds are brighter):

RADARSAT-1/-2 from Data and Products ©MacDonald, Dettewiler and Associates Ltd are acknowledged.
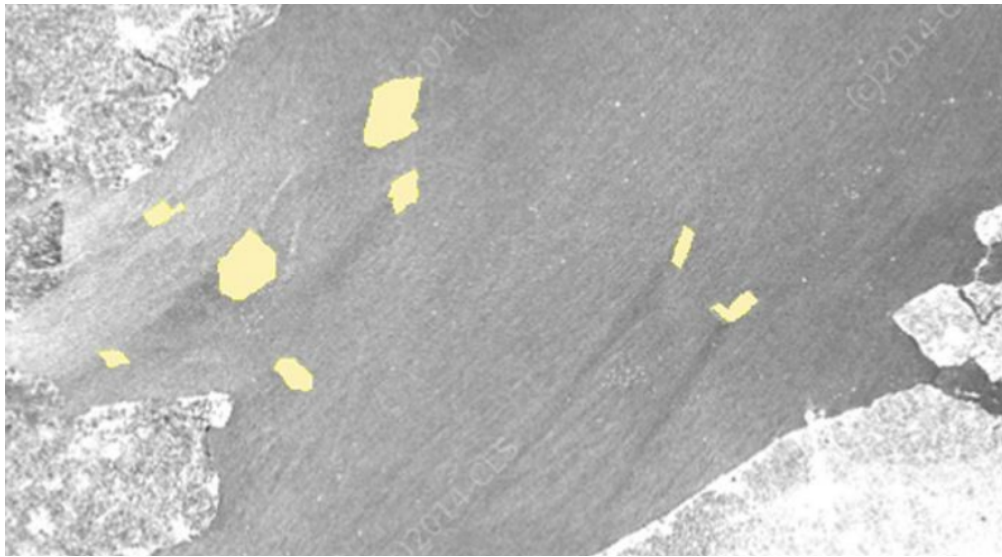
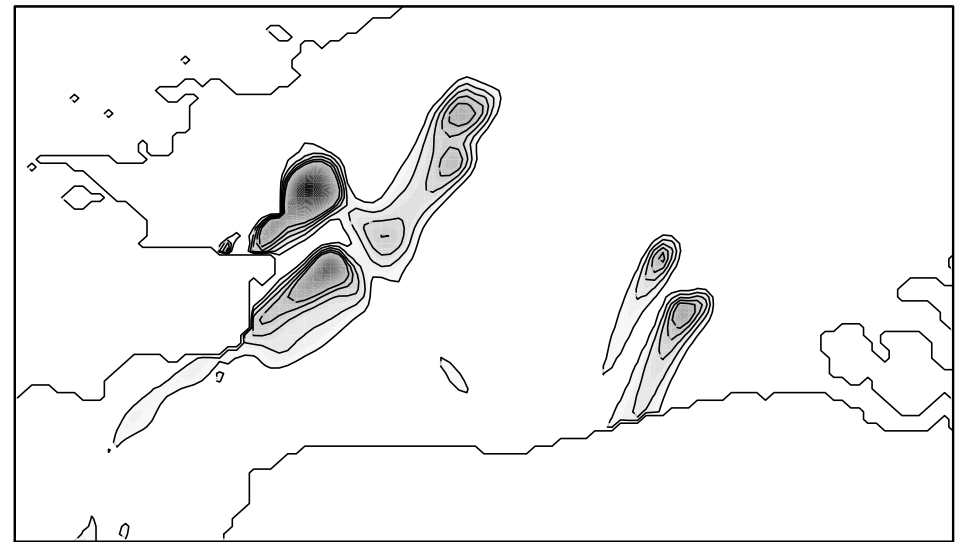| SAR Image (17:34 UTC)	WRF-EWP (17:30 UTC)

1st of July of 2013: Belwind & Thornton

⇒ Comparable extension and divergence

DTOC – Mesoscale Model Evaluation (cont'd)

SAR Image (17:41 UTC)

WRF-EWP (18:00 UTC)

30th of April 2013: UK wind farms and Belwind &Thornton

⇒ Challenge in timing snap-shots

DTOC - User Interface

Wind climate in the **target area** from WRF with/without **background** wind farms
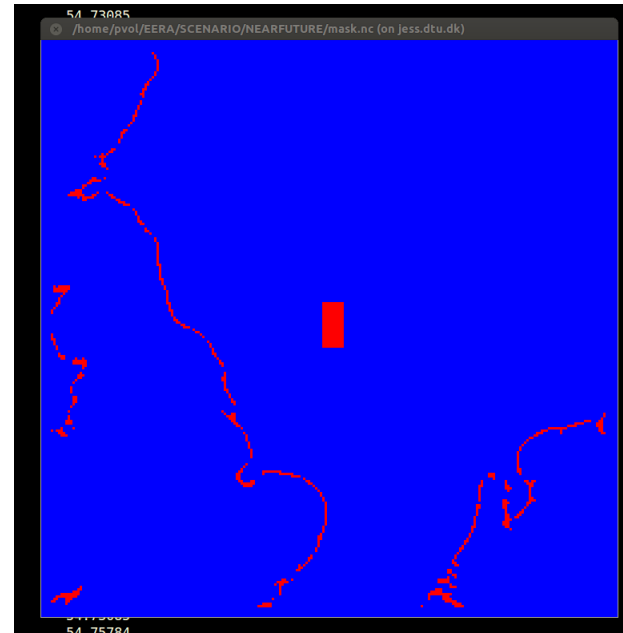

Outcome: Annual Energy Production of the target wind farm accounting for wake losses of neighbouring wind farms
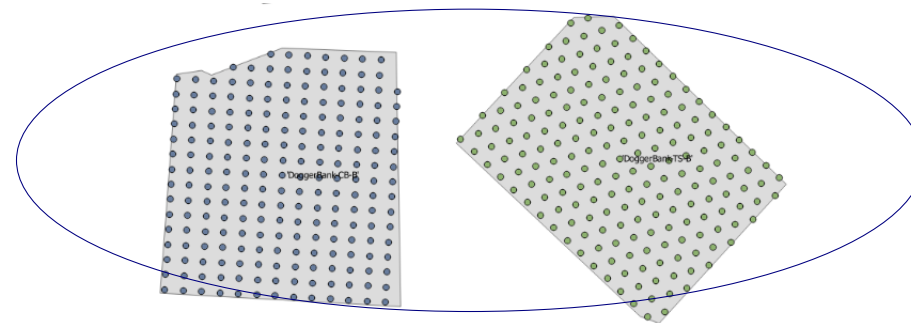
DTOC - Mesoscale Model Implementation

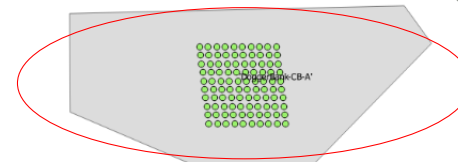Three institutes (CENER, CIEMAT and DTU) can calculate a Wind Climate for a **target area**

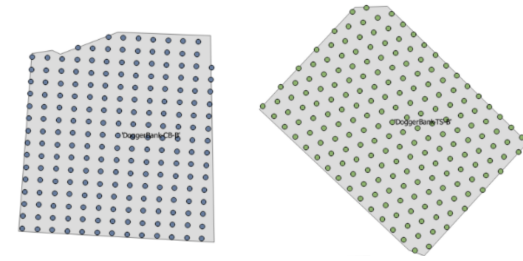Without and with **background** wind farms

Background

Target area

DTOC - Mesoscale Model Implementation

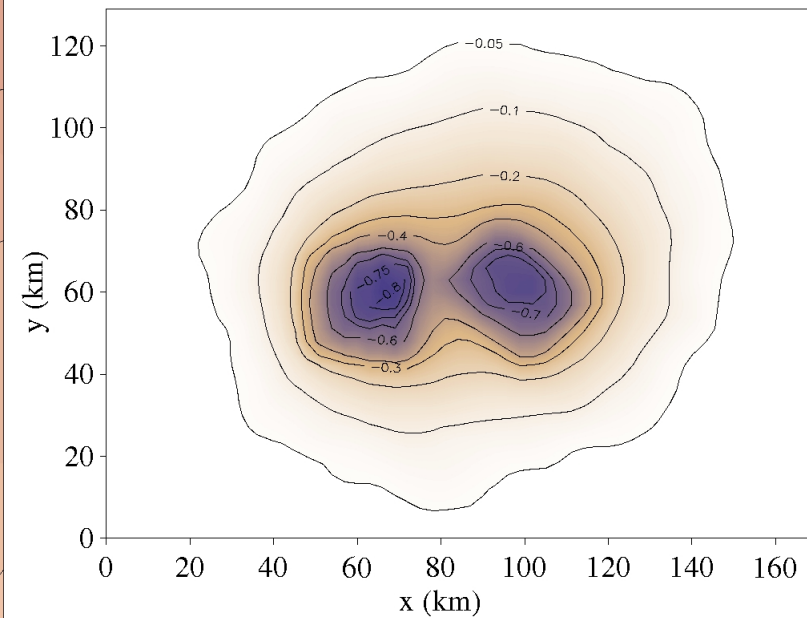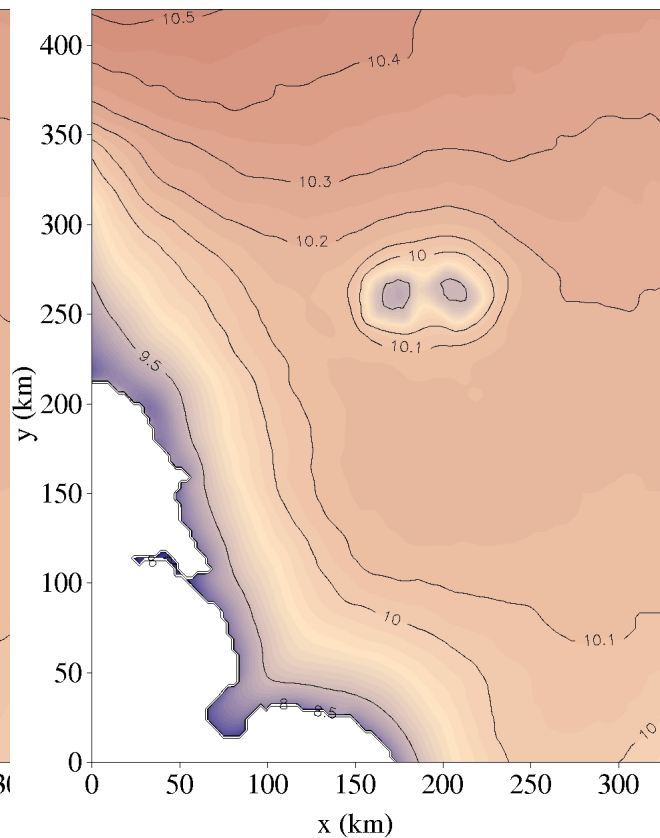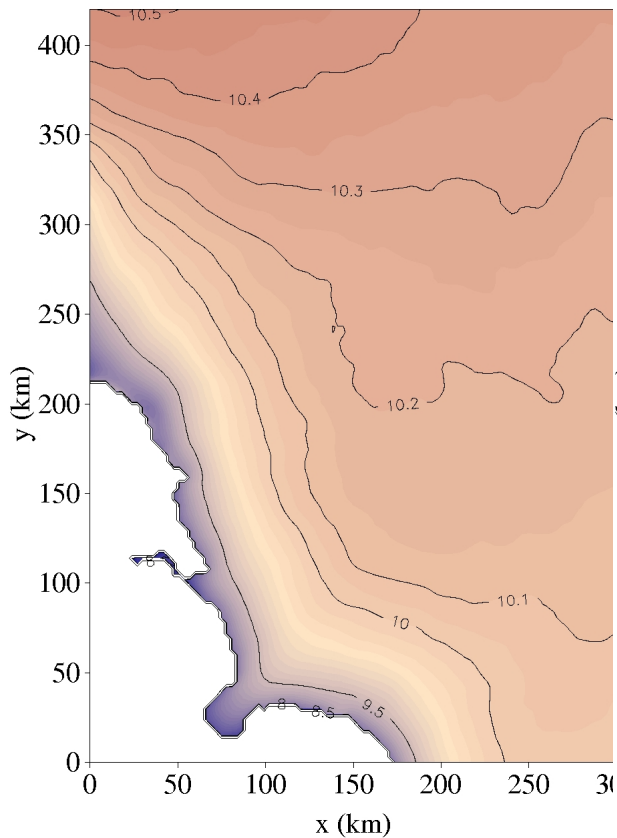2 years simulation with WRF-EWP in the North-Sea without/with **background** wind farms

Time averaged wind speed at hub-height (119 m)
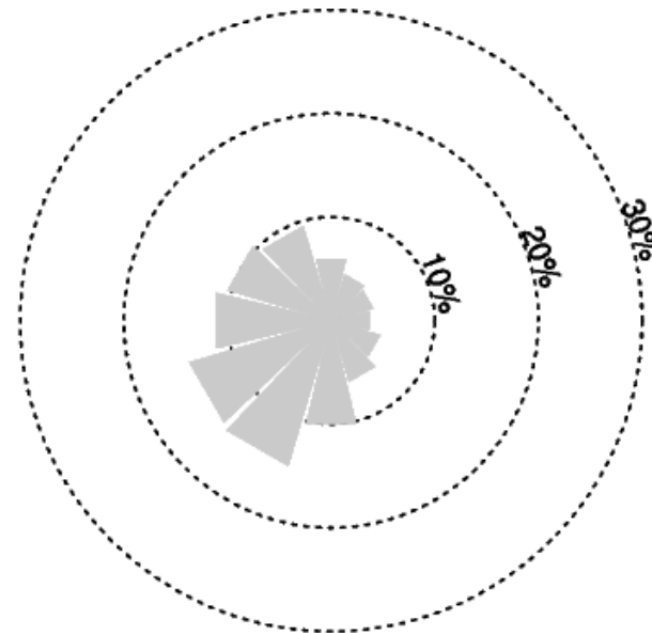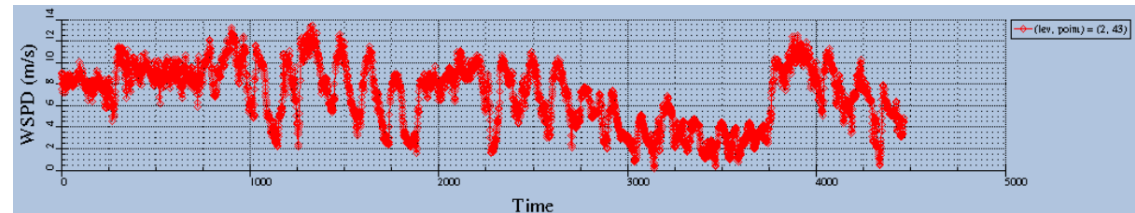
Reference **Wind Farm** **Difference** (0.05 − 0.8 m/s)

DTOC - Mesoscale Model Implementation

The Mesoscale model provides for all point within the **target area** in a given **period**:

- Time-Series

- Modelled Wind Climate

- Generalised Wind Climate (DTU)

Summary

Within the EERA-DTOC tool:

- Methodology has been implemented in the DTOC-TOOL

- Neighbouring wind farms can now be accounted for in time-series and the wind climate

$\Rightarrow$ Annual Energy production for a new wind farm for the Wind climate with/without neighbouring wind farms

Mesoscale models:

- Have the capability to accounts for the dynamics in the wind farm wake

- Further investigation of the long-term velocity reduction is needed

Support by