Sustainable Energy Systems 2050
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OffWind
(*Prediction tools for offshore wind energy generation*)

Kick-off event of Sustainable Energy System 2050

Helsinki

12 Oct 2011

Jafar Mahmoudi

Challenges

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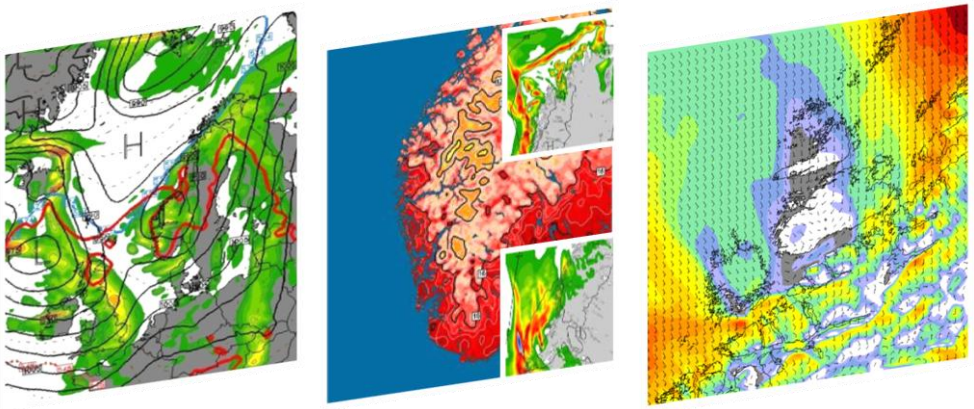
Atmospheric modelling

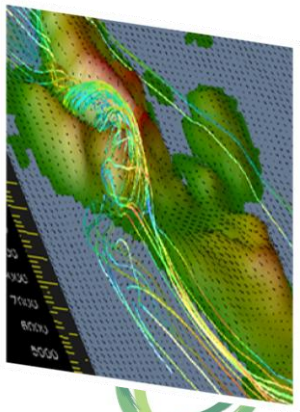
External Data

Global Obs. → Global Models → Regional Models → Local Models

WRF 9 km → WRF 3 km → WRF

ARPS 75m





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Projects

Challanges

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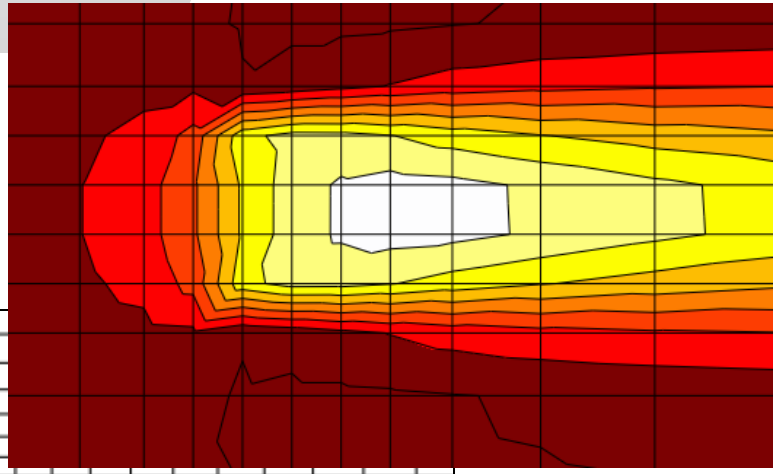
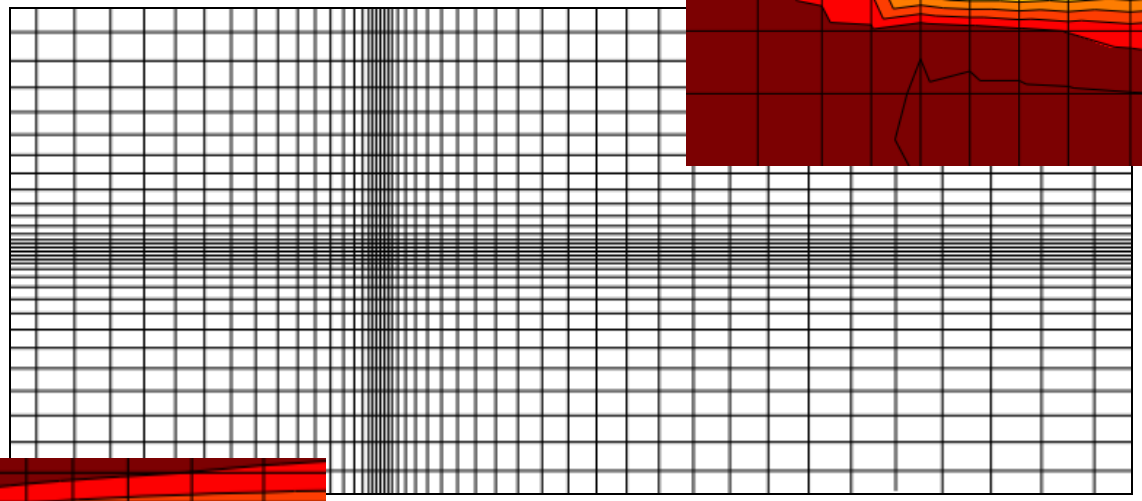
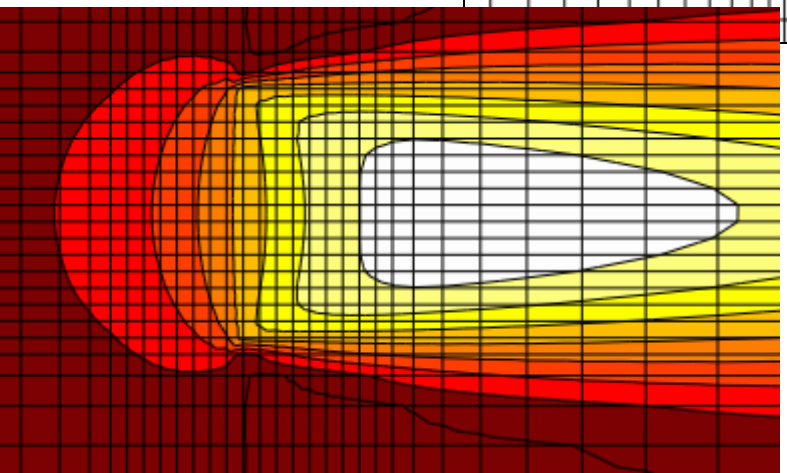
Grid independence study







Wind direction : 270 degrees

Wind speed: 10 m/s at hub height (75m asl)

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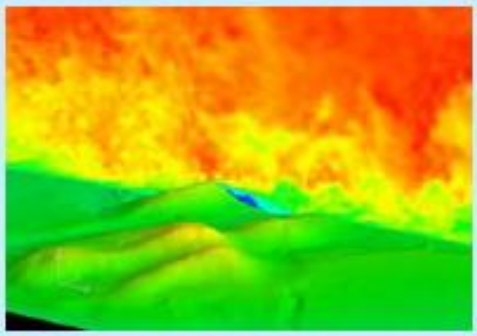
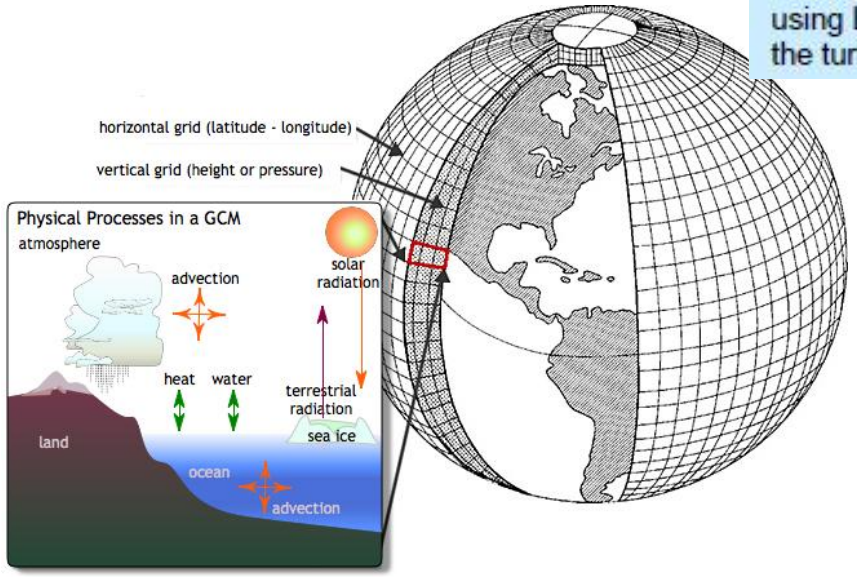
Challenges

multi-scale model simulations



Instantaneous velocity contours of the wind over the Askervein hill using LES (left) and RANS (Right). LES gives detailed information of the turbulent wind; However, the computational cost is high.



Will LES improve the flow statistics

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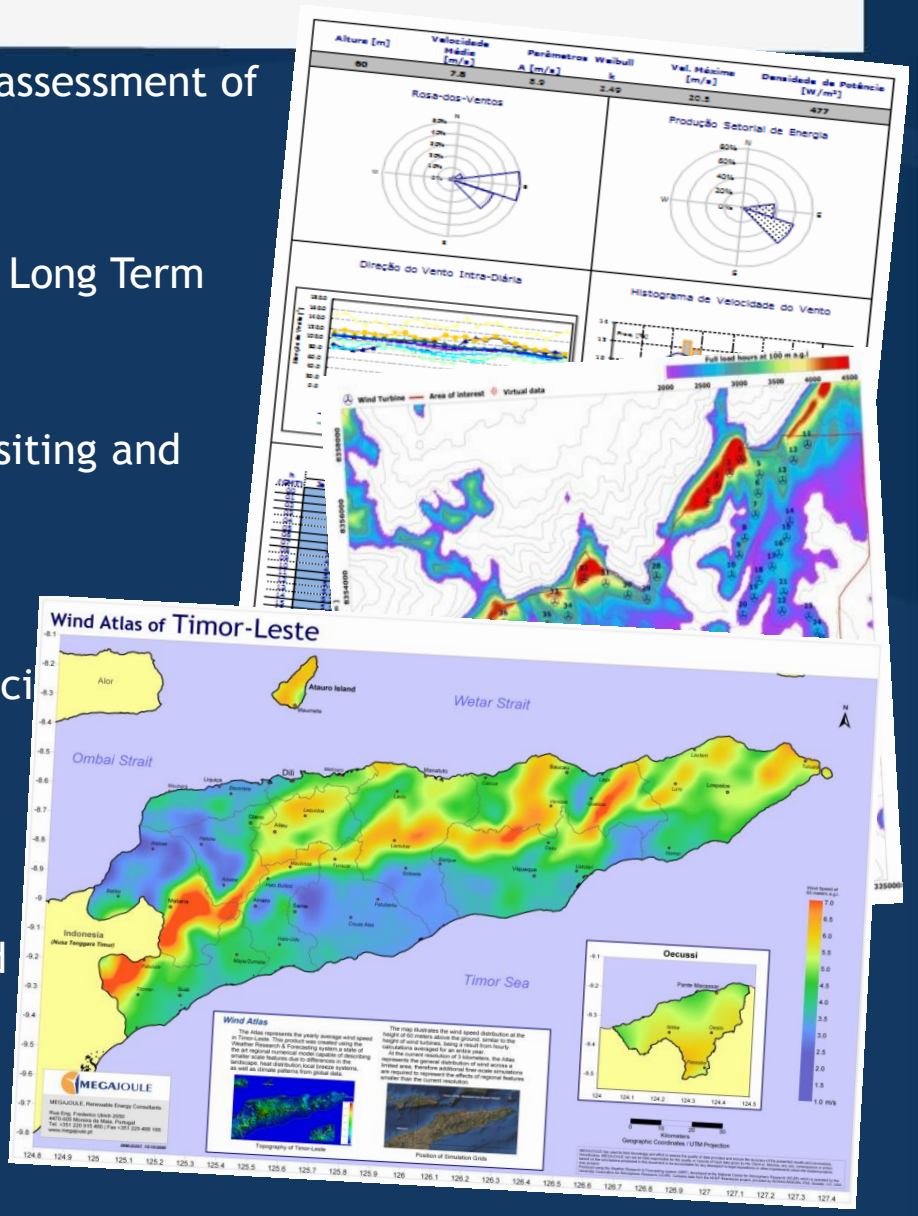
Challnges: Mesoscale/ Micro scale coupling

- **Wind Atlas and Wind Mapping** → Preliminary assessment of regional or site wind climate
- **Virtual Wind Data Series** → Annual Variability, Long Term correlation, coupling with Microscale
- **Meso/Micro Coupling** → Preliminary WF Micrositing and AEP Estimates
- **Meso/CFD Coupling** → First assessment of speci or hazardous wind conditions (Site Assessment)
- **Annual Variability** and **Wind Indexes**
- Quantification of **extreme events** → Icing and cold climates, Hot climates, Extreme winds



Challenges

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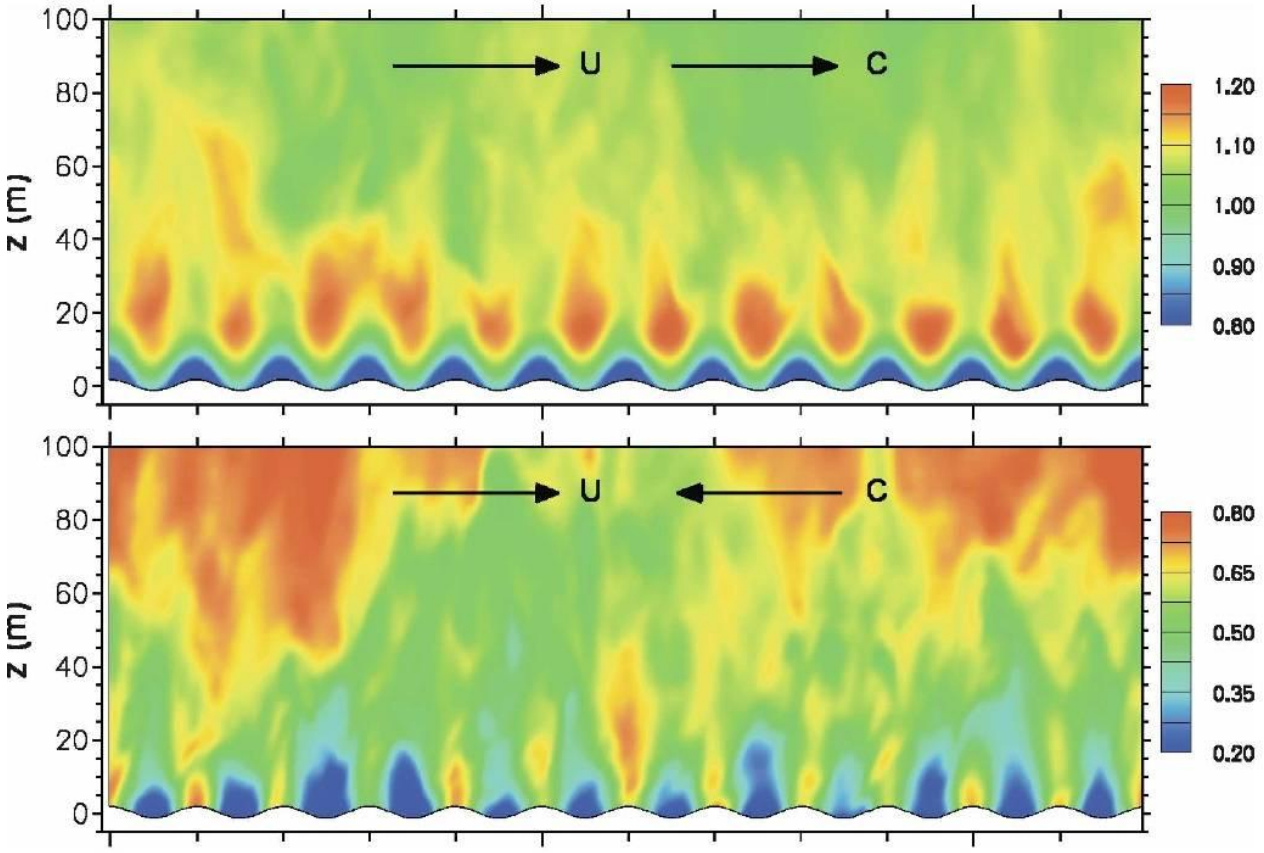
Wind-wave interactions - LES

Mean wind profile, turbulence variances and vertical momentum flux depends on the state of the wave field.



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Objectives

- The primary objective of the project is to develop tools for design and operation assessment and forecasting for offshore wind farms.

- The tools will lead to optimal localization of a wind farm and more importantly how to locate future wind farms with respect to each other within the same wind energy cluster.

- The tools will also lead to a more cost efficient and safer wind farm operation as the operation parameters can be more accurately predicted and thus optimize the total wind power generation from a wind energy cluster as well as reduce the probability of wind turbine failure under severe weather conditions.

Selected secondary objectives:

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- Assess existing tools with respect to wind flow, meteorology and grid interconnection (MetOcean-CFD codes, meso-/microscale codes, CFD/LES, WRF and PALM)
- Improve offshore meso-/microscale prediction methodologies
- Improve mesoscale CFD numerical models for offshore wind predictions using MetOcean Models/ data
- configuration wind- Wave interactions, wake evolutions
- Improve existing optimization tool for offshore wind turbine specification versus wind farm
- Develop methods for online nowcasting of available farm power (1-60 min)

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Offwind Wps

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- WP 1: Numerical modeling for wind turbine and wind farm performance predictions
- WP 2 Experiments and model validation and calibration
- WP3 Fully coupled wind-wave interaction model
- WP 4 Nowcasting of available farm power based on data driven modelling
- WP 5 Database

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Project Overview

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Organization	Country	Main partners	Participate
IRIS (Research center)	Norway	Wp1, Wp2,	Wp3, Wp5
SINTEF (Research center)	Norway	Wp1, Wp3	Wp4, Wp5
Statoil (Industry)	Norway	Wp5	Wp2
Aalborg (University)	Denmark	Wp4	Wp5
Vattenfall (Industry)	Denmark	Wp3, wp5	Wp1, Wp2
Megajoule	Portugal	Wp3	Wp3
Mälardalen university	Sweden	Wp1, Wp3	Wp5
FuE-Zentrum FH Kiel GmbH	Germany	Wp5	Wp2
Design Builder	UK	Wp1	Wp3

Summary /Goal

- This is a project proposal aiming at the development of computational tools for the prediction of the location and energy yield of offshore wind farms depending on the weather situation (condition of the ocean and atmosphere) and the presence of other wind farms (design and operation).
- Dynamically consistent coupling between meso- and microscale models
- MetOcean-CFD modelling approach
- Wind Farm and Wind Farm Cluster Characterization
- Fully functional prototype database