WAKEBENCH. A new IEA Task for the Benchmarking of Wind Farm Flow Models

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WAKEBENCH: Benchmarking of wind farm flow models

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Motivation

Classical wind farm models, typically based on linearized and algebraic approximations, are being complemented with a large variety of numerical models based on Computational Fluid Dynamics (CFD)

- More realistic description of the flow behavior around complex terrain/wind farm topologies
- More degrees of freedom in the modeling chain → more flexibility for the developer and end-user
- More training/experience requirements
- More user-dependency
- Lack of traceability

Need for quality-checked “best practice” procedures for...
- The evaluation of the numerical models
- The validation and verification strategy
- The selection and definition of test cases for validation

EU TPWind 3% Vision: Model uncertainties below 3% by 2030 regardless of site conditions → Realistically the vision is now around 30% → long way to go!
Main Objective

- To improve wind farm modeling techniques and provide a forum for industrial, governmental and academic partners to develop, evaluate and improve atmospheric boundary layer and wind turbine wake models for use in wind energy
  - from flat to complex terrain,
  - from single to multiple wakes,
  - both onshore and offshore,
  - using well defined test cases from the literature and test wind farms (“research” conditions) as well as from industrial sites (“real-life” conditions)

- Aligned with the activities of Working Group 2 of the EERA Wind Conditions sub-programme.
  - Investigation of the model chain
  - Evaluation of model performance and uncertainties using the data generated by WG1
What makes one modelling approach better than the other?

Initial deliverable will be a consensus on metrics used for comparing data to simulations.
Test Cases. Example 1: ABL models

- Single-column model intercomparison for stably stratified Atmospheric Boundary Layer (ABL) (Cuxart et al., 2005)
  - ABL parameterizations from the major climate research centres
  - First-order (RANS-type) and LES turbulence closures
  - Very large dispersion of results!
Test Cases. Example 2: Complex Terrain

Bolund experiment and blind comparison (Bechmann et al., 2009)
- Well defined boundary conditions
- 52 model runs: RANS, LES and wind tunnel models
- Very large dispersion of results! Errors in wind speed ~ 15%
Status and Outlook

- IEA Task 31 was approved by the IEA-Wind ExCo in October 2010
- The Task has two operating agents
  - Javier Sanz (CENER), to take the overall management of the Task and the “wind” programme
  - Patrick Moriarty (NREL), to manage the “wake” programme
- Now assembling participants from IEA-Wind countries
  - Australia, Austria, Canada, China, Denmark, European Commission, EWEA, Finland, Germany, Greece, Ireland, Italy, Japan, Korea, Mexico, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States
  - 28 expressions of interest received so far from 12 countries
- Negotiation with IEA members for budget allocation under way
- Task 31 to effectively start in the second half of 2011