CENER | CENTRO NACIONAL DE ENERGÍAS RENOVABLES

IEA Wind Task 31 Wakebench

Benchmarking of Wind Farm Models

VII Asamblea General REOLTEC

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GOBIERNO DE ESPAÑA | MINISTERIO DE INDUSTRIA, ENERGÍA Y TURISMO | MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

Gobierno de Navarra

Task 31 in Figures

Period: Oct. 2011 – Sep. 2014 (3 years)

Budget: 100 k€/year

IEA Countries

- Signed in (13): Canada, Denmark, China, Germany, Greece, Italy, Japan, Norway, Spain, Sweden, Switzerland, U.K., U.S.
- To sign (1): Netherlands
- Under negotiation (3): Ireland, Finland, Rep. Korea

Task Organization

- 2 Operating Agents: CENER (2/3) and NREL (1/3)
- 10 Working Groups
- Advisory and Scientific Committees

People

- 80+ organizations have expressed interest
- 200+ people in the mail list
- 130+ members in the Wakebench LinkedIn group

Participación Española

- CENER coordina la Tarea 31 y esponsoriza la participación de los participantes españoles
- Participantes (muestras de interés):
  - ❑ ACCIONA
  - ❑ AWS Truepower
  - ❑ Barlovento Recursos Naturales
  - ❑ CENER
  - ❑ EREDA
  - ❑ EDP Renovaveis
  - ❑ ENEL Green Power
  - ❑ GAMESA
  - ❑ Iberdrola Renovables
  - ❑ Suzlon
  - ❑ Universidad Politécnica de Madrid
  - ❑ Vortex

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)

Objectives

- To make an inventory of state-of-the-art models for the simulation of wind and wakes for site assessment applications: inputs, model equations, outputs, etc
- To define procedures for the definition of test cases for validation purposes of wind and wake models: requirements on measurement data, filtering processes, metrics, etc
- To identify the most critical aspects of the modeling chain by quantifying the associated uncertainties: boundary conditions, turbulence model, atmospheric stability, etc
- To define the range of applicability of the models under investigation: site conditions, wind regimes, wind farm size, etc
- To reach consensus on best practice guidelines for the verification and validation of wind and wake models
- To reach consensus on best practice guidelines for industry use of wind farm modeling tools and associated errors

Task Structure and Deliverables

WP0: Management and Coordination

Administrative
O.A.-CENER (Spain)

Sci & Tech: Wind
O.A.-CENER (Spain)

Sci & Tech: Wakes
O.A.-NREL (US)

Scientific Committee

Advisory Committee

WP1: Setting-up of the benchmark platform and schedule

- Task 1.1: Setting-up of the benchmark platform
- Task 1.2: Definition of validation procedures for wind and wake modeling
- Task 1.3: Definition of test cases and schedule

→ **Model Evaluation Protocol**

WP2: Benchmark of research and industrial test cases

- Task 2.1: Verification of models and evaluation protocol
- Task 2.2: Benchmark of research test cases
- Task 2.3: Benchmark of industrial test cases

→ **Inventory of models and test cases**

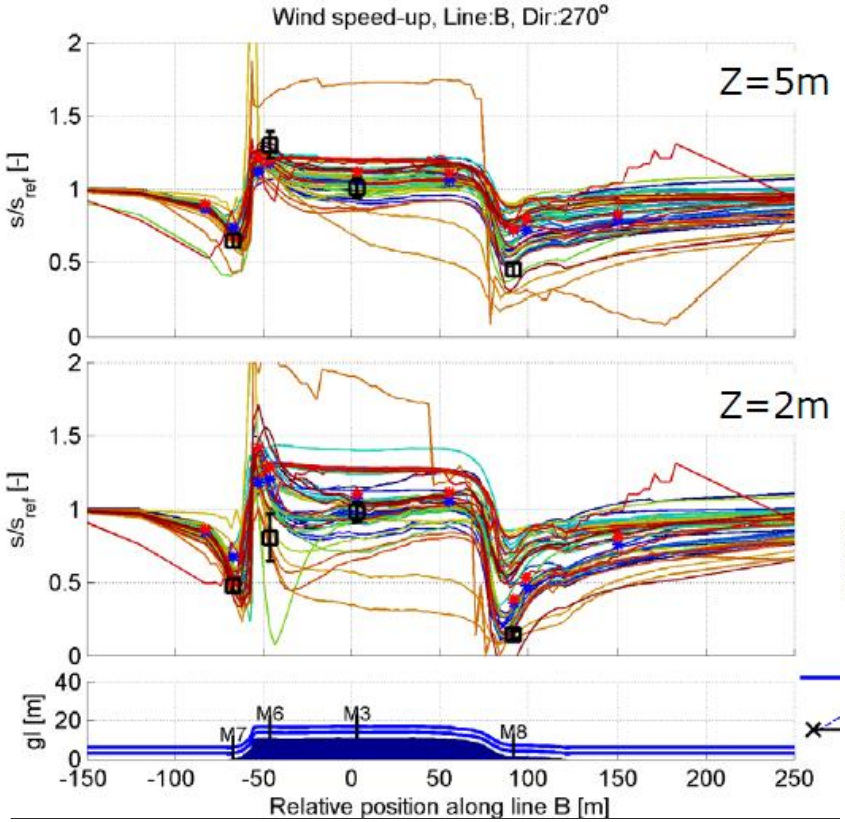
WP3: Best practice procedures

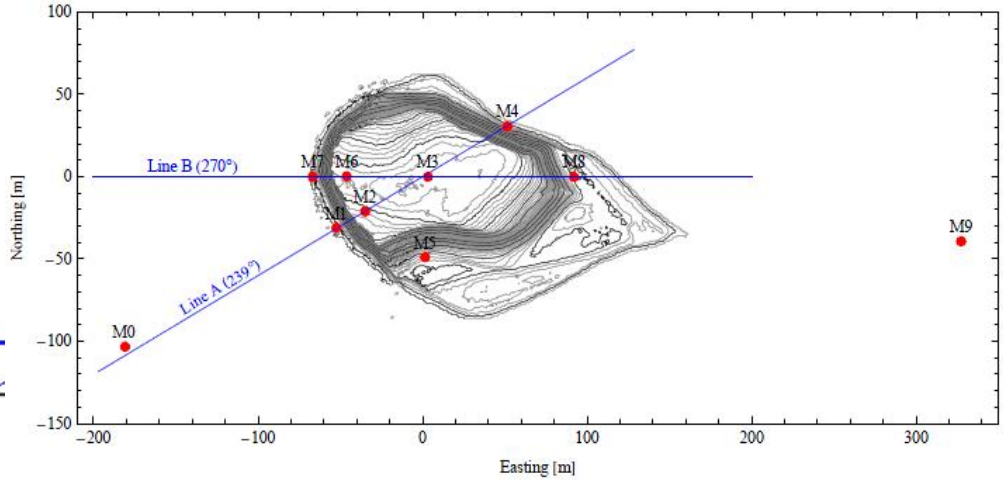
- Task 3.1: Compilation of validation results
- Task 3.2: Uncertainty analysis
- Task 3.2: Best practice procedures

→ **Best practice procedures**

Example 1: Bolund Blind Test (2009)

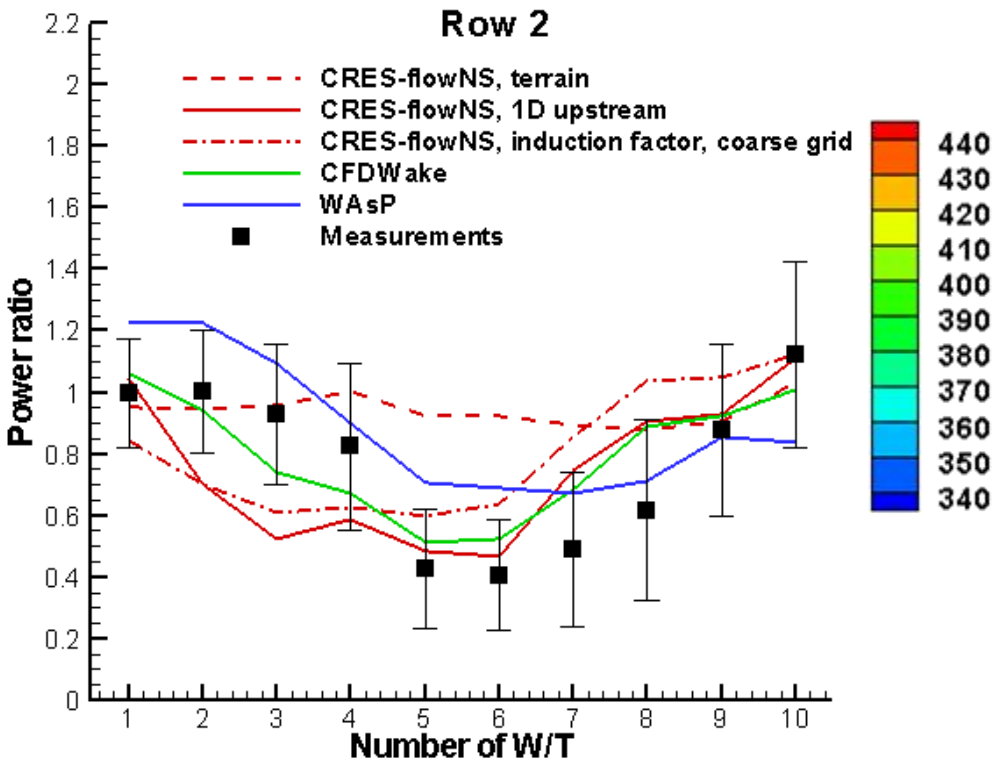
- Bolund experiment and blind comparison (Bechmann et al., 2009)
  - ❑ Well defined boundary conditions
  - ❑ 52 model runs: RANS, LES and wind tunnel models
  - ❑ Very large dispersion of results! Errors in wind speed ~ 15%

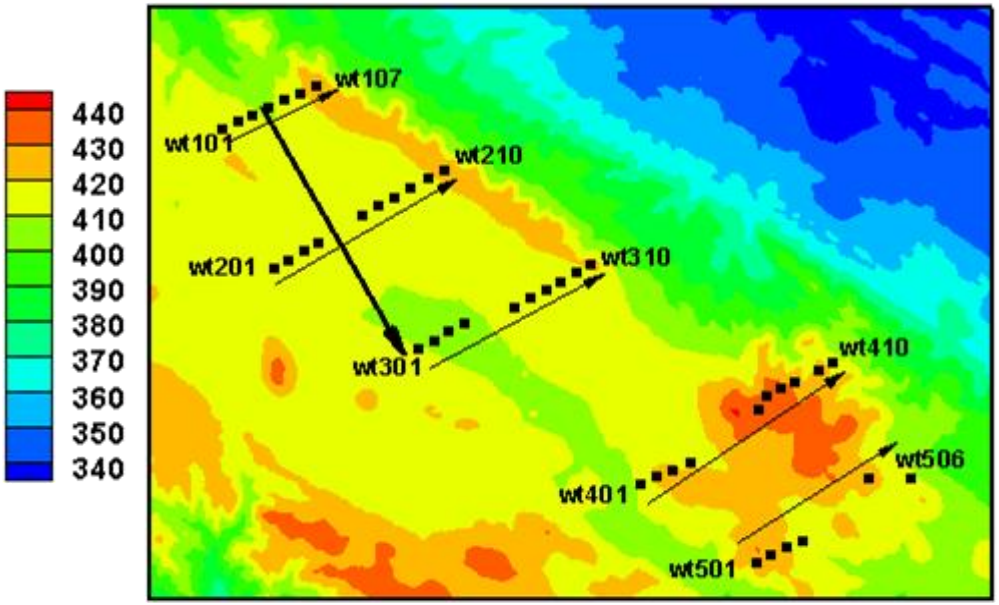




Example 2: UPWIND Complex Terrain Wakes (2011)

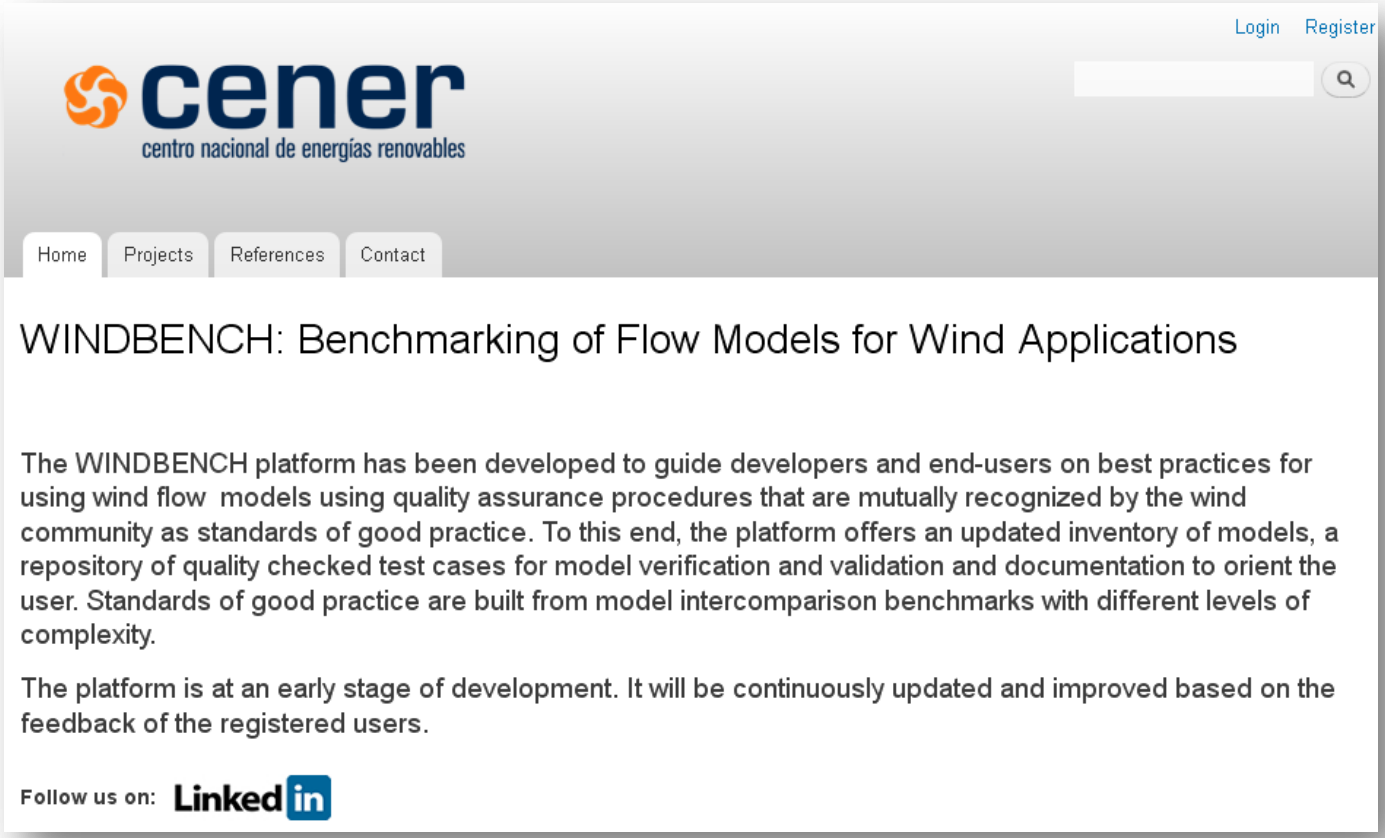
- FP7-UPWIND project, complex terrain wind farm (Politis et al., 2010)
  - ❑ Algerbraic and RANS models
  - ❑ Underestimation of wake losses by 10-20%





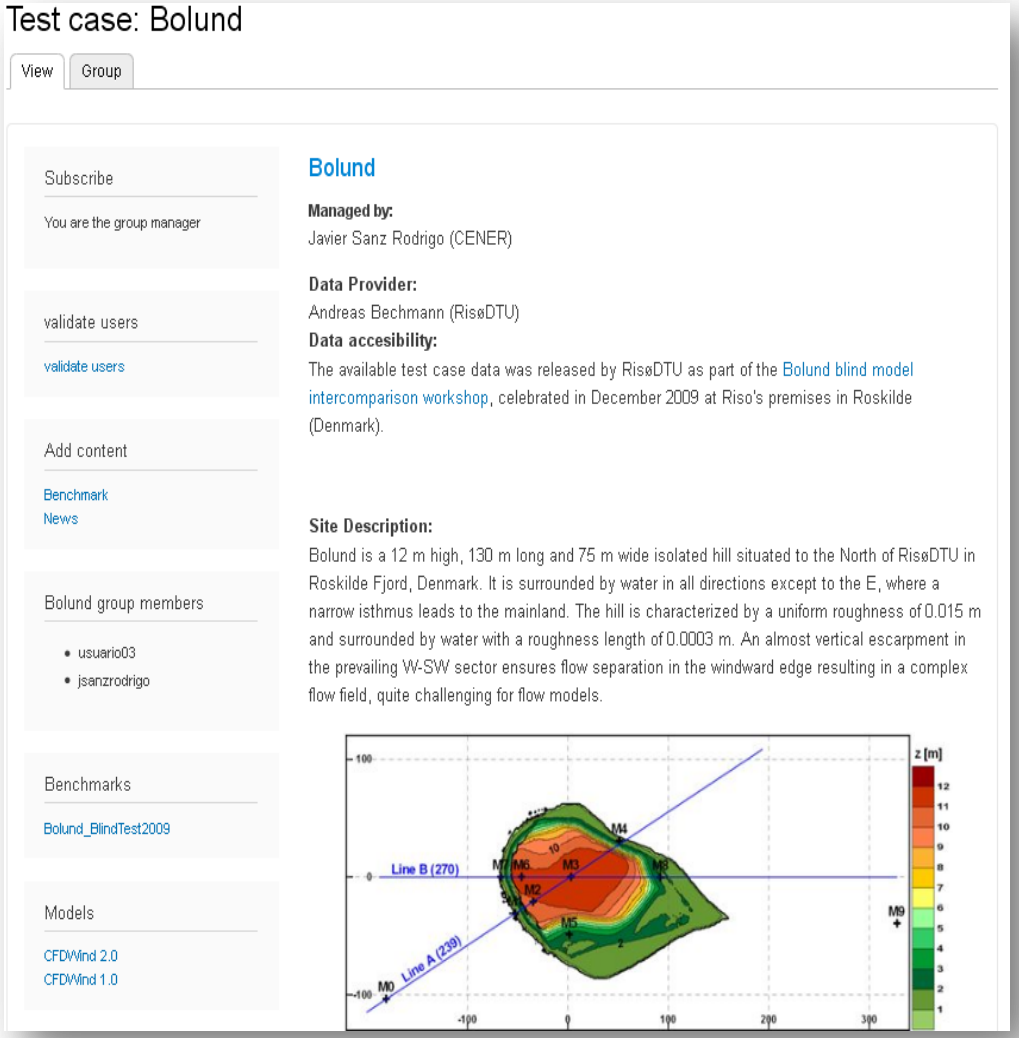
Management of Databases: the WINDBENCH platform

- Developed and administrated by CENER
- Soon online



Management of Databases: the WINDBENCH platform

- Administration of…
  - User accounts
  - Catalogue of Models
  - Test Cases / Benchmarks
  - Documentation
- IPR protection ensured by allowing the Test Case/ Benchmark Manager to control the users accessibility to data
- Quality ensured by peer-review from SC members
- Aim for a long-standing and mutually recognized reference in the wind community



Meetings

- Progress meetings every 6 months in spring and autumn before ExCo meetings

- Spring meetings will be organized around webinars to report on the progress and results of the different benchmarks

- Autumn meetings, in person, will be used to discuss key aspects of the Task in a workshop format
  - ❑ Kick-off: state-of-the-art and work plan definition (M0, CENER)
  - ❑ Workshop on model evaluation protocol (M13, NREL)
  - ❑ Workshop on model uncertainties (M24, TBD)
  - ❑ Workshop on best practice procedures (M33, TBD)

- Working Group (benchmark) meetings whenever necessary by webinar

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