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

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IEA Wind - Task 31

WAKEBENCH: Benchmarking of wind farm flow models

wind power



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Porto, 26-01-2011



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🌀 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!





🌀 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.

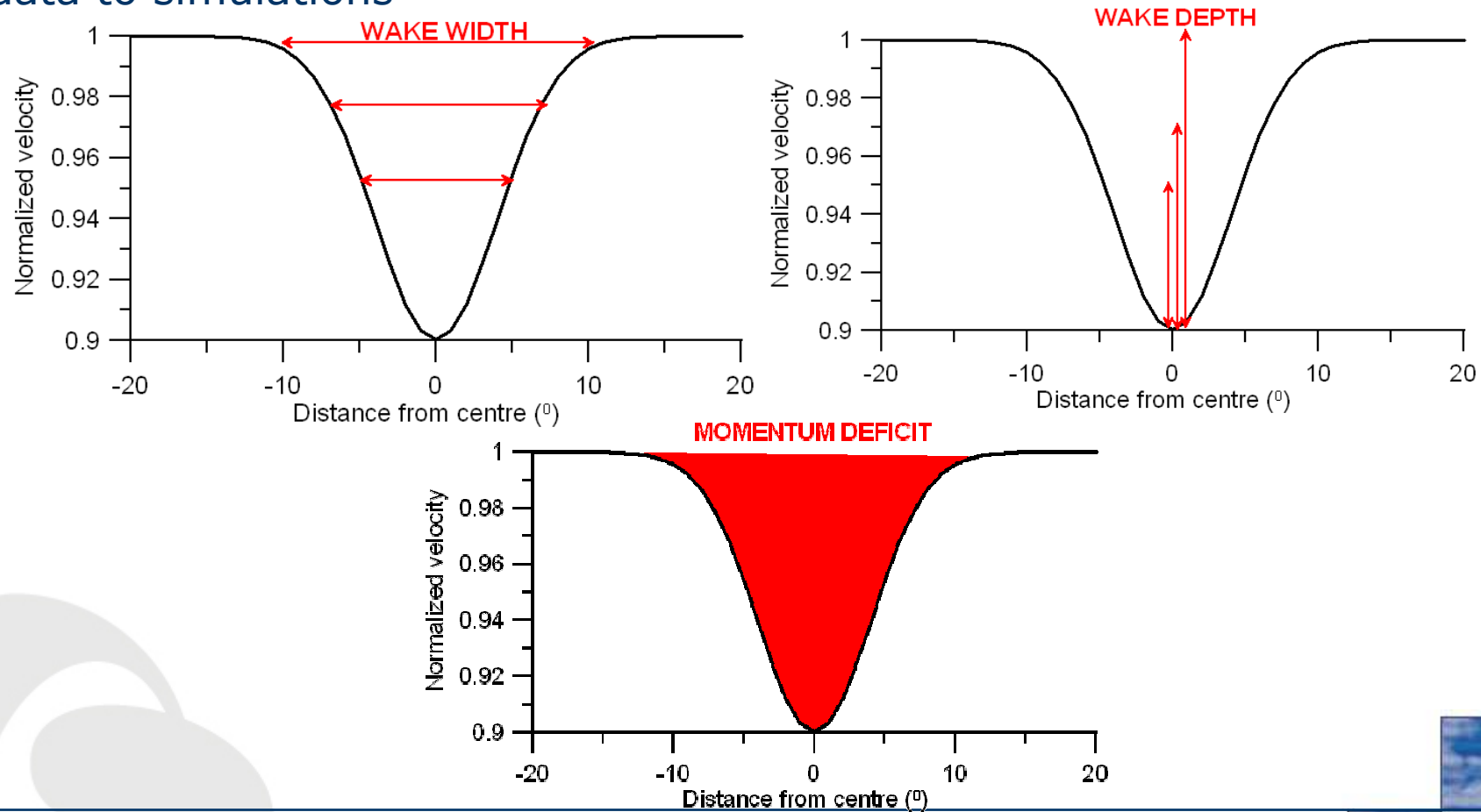
- Investigation of the model chain
- Evaluation of model performance and uncertainties using the data generated by WG1



Model Evaluation Procedures: Metrics



- What makes one modelling approach better than the other?
- Initial deliverable will be a consensus on metrics used for comparing data to simulations

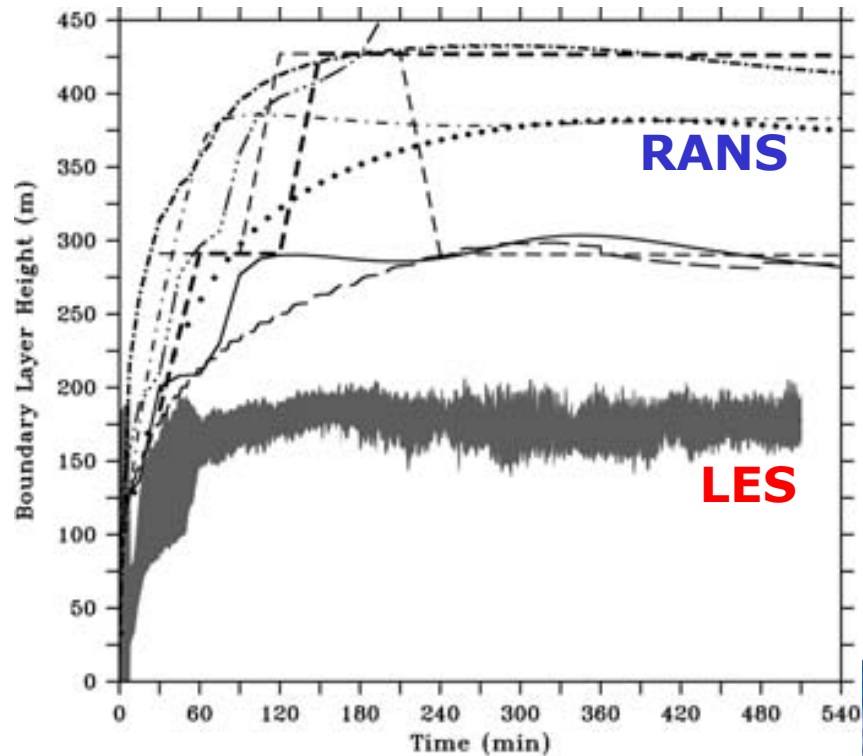
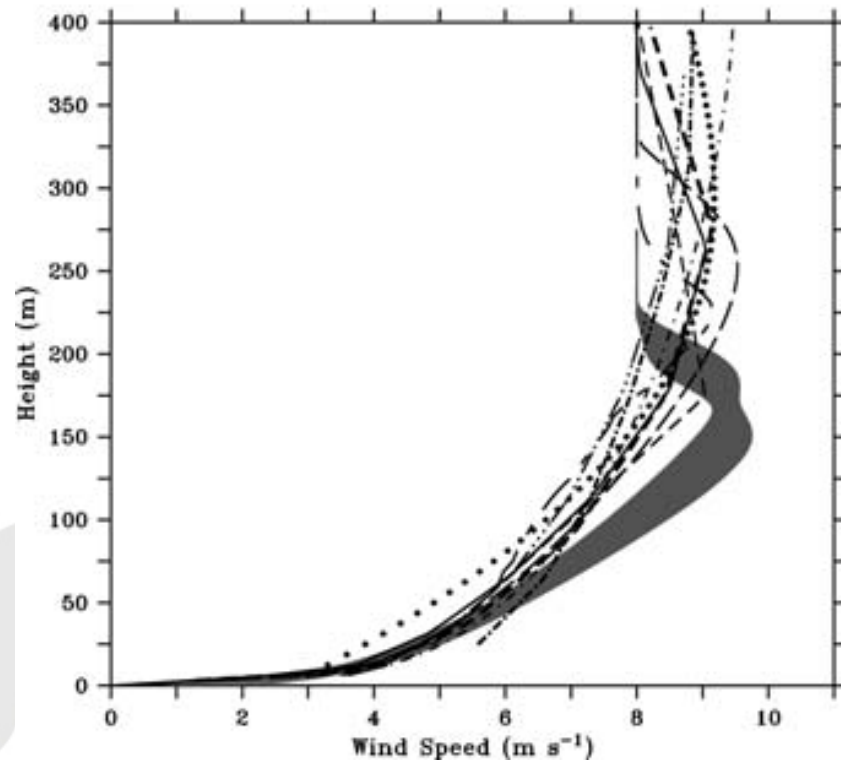


Test Cases. Example 1: ABL models



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!**

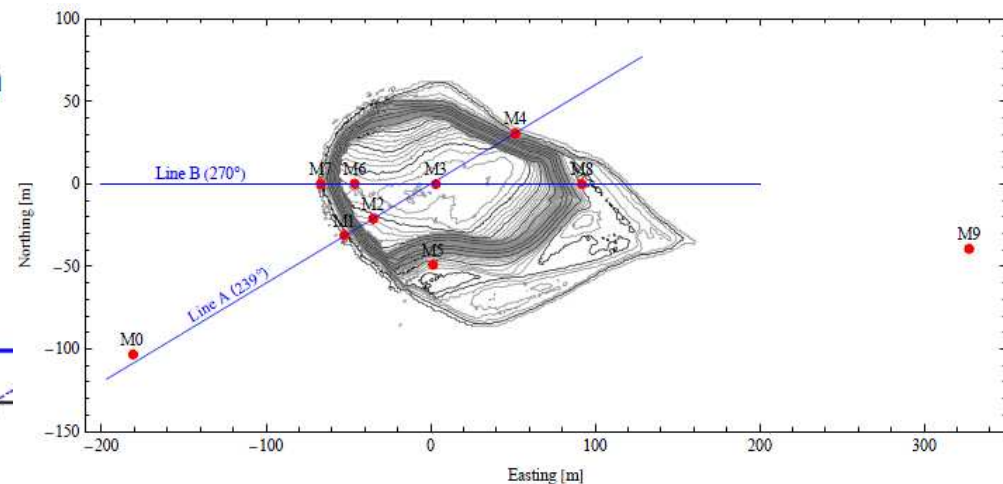
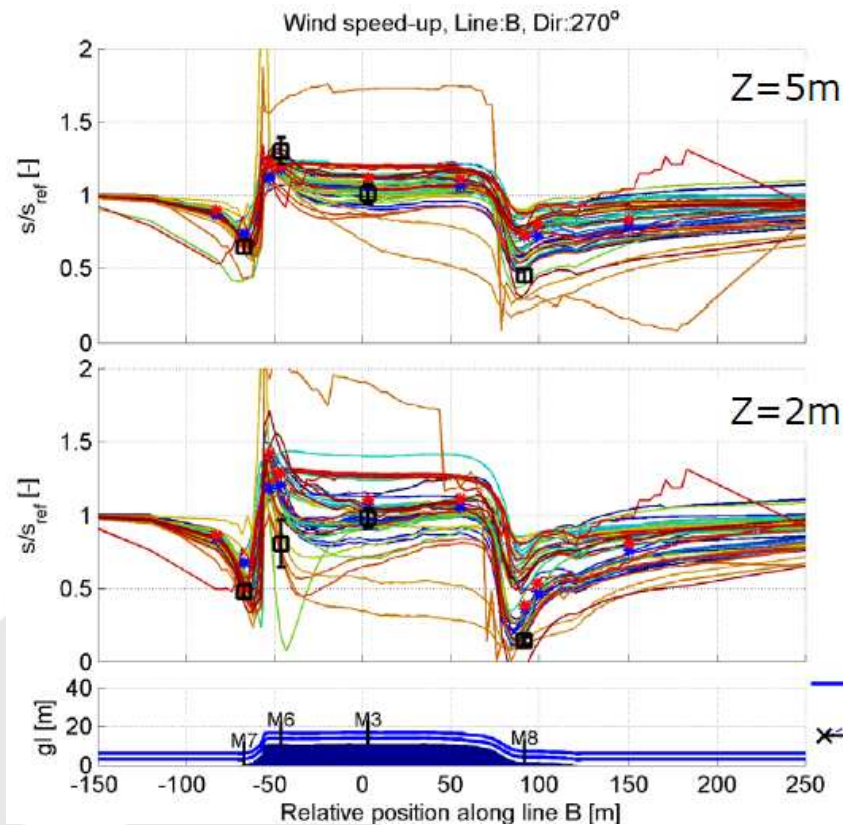


Test Cases. Example 2: Complex Terrain

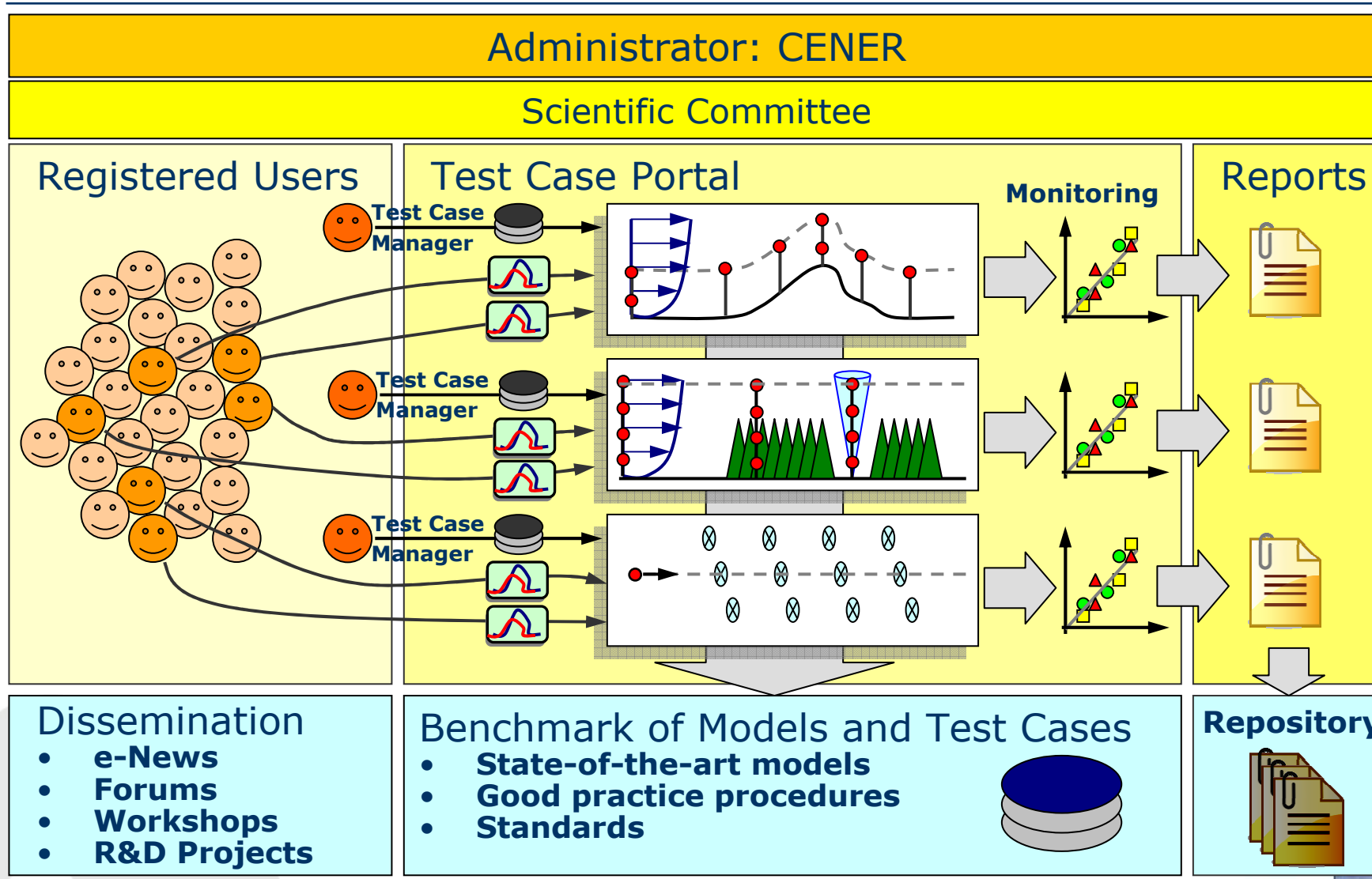


🌀 Bolund experiment and blind comparison (Bechmann et al., 2009)

- ❑ Well defined boundary conditions
- ❑ 52 model runs: RANS, LES and wind tunnel models
- ❑ **Very large dispersion of results! Errors in wind speed $\sim 15\%$**

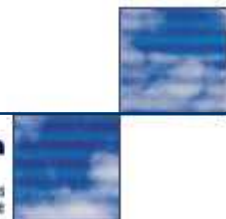


"WINDBENCH" Web Portal





- 🌀 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





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