CENER | CENTRO NACIONAL DE ENERGÍAS RENOVABLES

Task 29: Analysis of Wind Tunnel Measurements and Improvement of Aerodynamic Models

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REOLTEC - VII Asamblea General

Salón de actos de CIEMAT

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

Ciemat

Gobierno de Navarra

1. Objetivo

MexNext

- Investigación de detalle de los experimentos del proyecto MEXICO
  - Túnel de viento de DNW 9.5m x 9.5m
  - 3 palas, diámetro de 4.5m, Vtip = 100m/s & 76m/s
  - Cp, PIV,...
- Atención especial a:
  - Flujos no estacionarios, efectos 3D, efectos de punta, a la no uniformidad del flujo entre palas, aerodinámica de la estela cercana, estela turbulenta, condición de standstill, efectos de túnel,...
- Herramientas empleadas:
  - CFD, métodos de estela, métodos ingenieriles,...

MexNext II

- Estudio de fenómemos no resueltos en MexNext
  - Geometría, relación cargas y velocidades,...
  - Selección de “antiguos” experimentos
- Nuevos datos experimentales
  - Modelos de MEXICO en los túneles de viento de INTA & KARI
  - Ensayos en DNW del aerogenerador de MEXICO (ruido, PIV raíz de pala,...)
- Herramientas empleadas:
  - Ensayos en túnel, CFD, métodos de estela, métodos ingenieriles,...

2. Organizaciones participantes

2. Organizaciones participantes

MexNext

- 20 Organizaciones
- 11 Países
  - 4 Asia, 3 América del Norte y 13 Europa

iea wind

ECN

cener centro nacional de energías renovables national renewable energy centre

DTU

ÉTS

ForWind Center for Wind Energy Research

Gotland University Passion & Science

IFE Institute for Energy Technology

INTA

KARI Korea Aerospace Research Institute

Fachhochschule Kiel University of Applied Sciences

KIER Korea Institute of Energy Research

MIE University

NREL National Renewable Energy Laboratory

Risø DTU National Laboratory for Sustainable Energy

Suzlon Blade Technology

Technion Israel Institute of Technology

TU Delft

University of Twente.

IAG Universität Stuttgart

University of Victoria

CENER Centro Nacional de Energías Renovables

Gobierno de Navarra

MexNext II

- 19-23 Organizaciones
- 11-12 Países
  - 5 Asia, 2-3 América del Norte y 13-15 Europa

MexNext + 中国可再生能源学会风能专业委员会 (中国风能协会) CHINESE WIND ENERGY ASSOCIATION + ENERCON ENERGY FOR THE WORLD ? Vestas – ÉTS ? University of Victoria

3. Planificación

MexNext

- WP1: Processing/presentation of data, uncertainties.
  - 1/**06/2008** - 1/06/2010
- WP2: Analysis of tunnel effects
  - 1/06/2008 - 1/01/2010
- WP3: Comparison of computations with Mexico measurement data.
  - 1/01/2009 - 1/09/2010
- WP4: Deeper investigation into phenomena
  - 1/01/2009 - 1/05/2011
- WP5: Comparison with results from other (mainly NASA-Ames) measurements.
  - 1/06/2009 - 1/**05/2011**

Finalizado el 1/10/2011

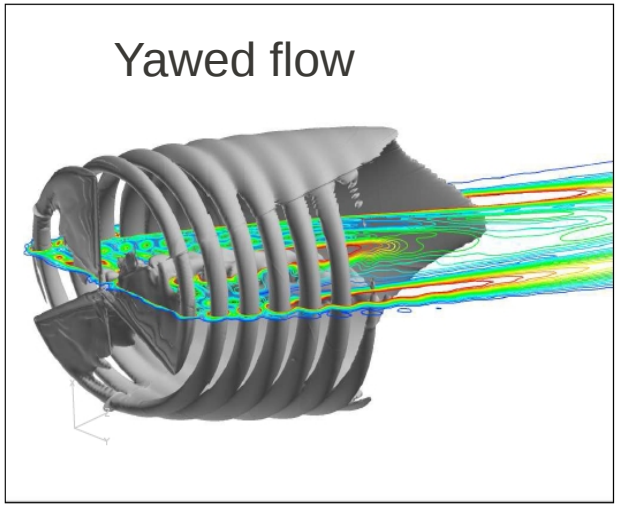
MexNext II

- WP1: Inventory of other experiments/historical research
  - 1/**11/2011** – 1/03/2014
- WP2: Processing/presentation of data, uncertainties, tunnel effects
  - 1/08/2012 – 1/06/2014
- WP3: Comparison of computations with measured data.
  - 1/06/2012 – 31/10/2014
- WP4: Deeper investigation into phenomena
  - 1/10/2012 – 31/**10/2014**

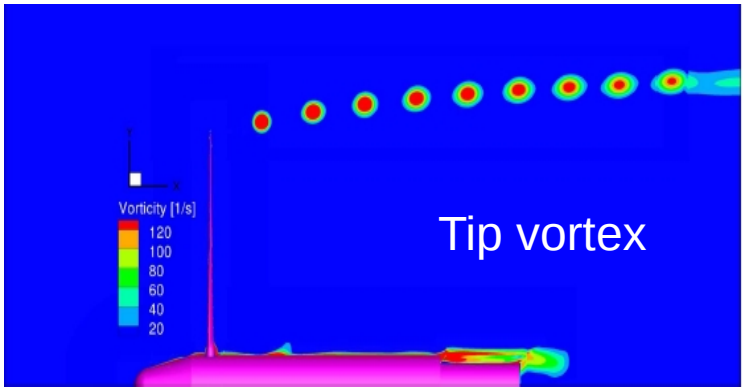
Finalización esperada: 31/12/2014

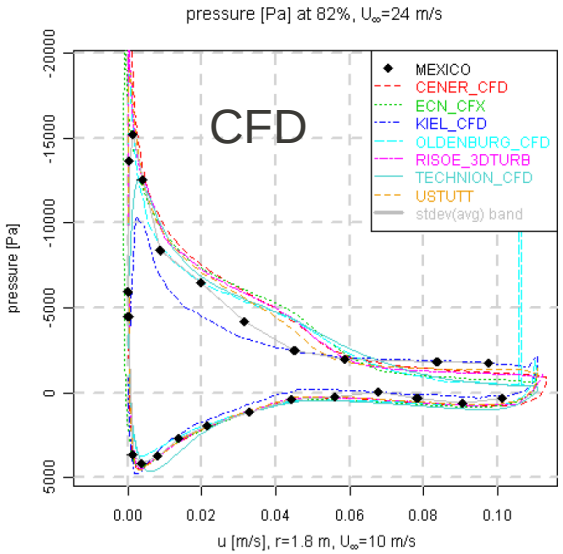
4. Resultados y conclusiones

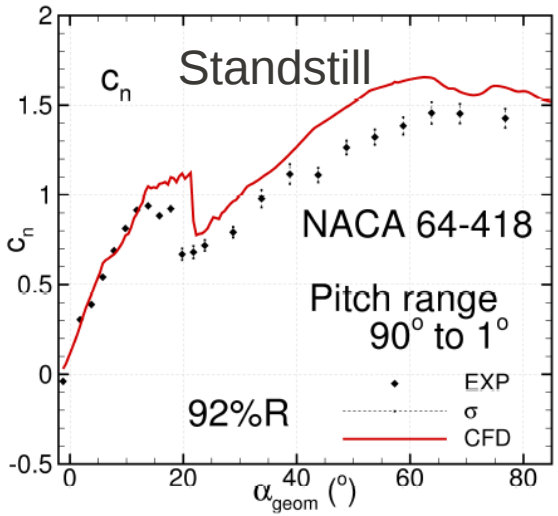
4. Resultados y conclusiones

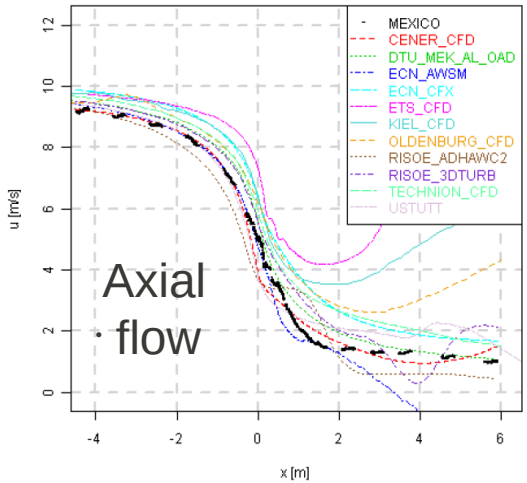


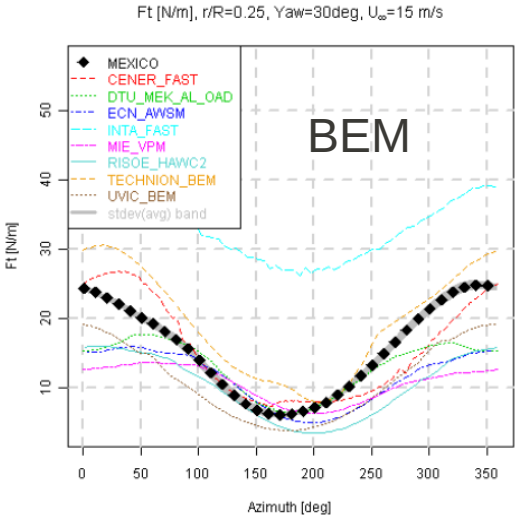
The vortex system behind the rotor for the 30 degrees yaw case











4. Resultados y conclusiones

- Experimentos (MEXICO) necesarios por incluir cargas detalladas y velocidades del campo fluido
- Los ensayos en el INTA y KARI ayudarán también a estudiar el efecto del escalado
- MexNext ha aumentado la comprensión de los investigadores sobre el flujo no planar
- Predicciones realizadas más parejas entre ellas que en comparativas anteriores.
- Las diferencias han mostrado la importancia de los investigadores que los emplean así como la necesidad de correcciones o ajustes más finos para captar mejor los fenómenos a estudiar.
- Indicado direcciones de mejora para modelos ingenieriles: el retraso de la pérdida, la dependencia del la relación de velocidad de punta en el factor de pérdida en punta de Prandtl, la inducción debida a la geometría 3D en condiciones de parked,...

4. Resultados y conclusiones

- Todos los modelos ingenieriles subestiman las cargas en condiciones de pérdida igual que ocurría en los anexos de la IEA Task 14/18 y 20.
- El CFD predice las cargas con y sin yaw mejor que la mayoría de modelos ingenieriles cuando la pala ha entrado en pérdida.
- Predicciones de las velocidades, incluso para condiciones con yaw, han sido buenas.
- Relación de cargas y velocidades desconocida, que puede ser debido entre otras cosas al vórtice que se forma cerca del 60%R por las variación geomética de la pala
- Los datos del experimento de MEXICO son accesibles para los que firmen un NDA con DTU/Riso
- Diseminación de resultados en artículos, documentos técnicos y conferencias.

5. Documentación disponible

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- H. Snel, J.G. Schepers, B. Montgomerie: ‘The MEXICO project (Model Experiments in Controlled Conditions): The database and first results of data processing and interpretation’, The Science of Making Torque from the Wind, 28–31 August 2007, Technical University of Denmark
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- Wen Zhong Shen et al Validation of the Actuator Line / Navier Stokes technique using Mexico measurements, 'The Science of Making Torque from the Wind', June 2010

5. Documentación disponible

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- S.K. Guntur, C. Bak and N.N. Sorensen, Analysis of 3D stall models for wind turbine blades using data from the Mexico experiment, 13th International conference on Wind Engineering, ICWE, Amsterdam Holland, July 2011
- D. Micallef et al, The relevance of spanwise flows for yawed horizontal-axis wind turbines, 13th International conference on Wind Engineering, ICWE, Amsterdam Holland, July 2011

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GRACIAS POR VUESTRO TIEMPO!!!

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