Extracting power from the wind

NORCOWE 2nd SUMMER SCHOOL 14-19 August 2011

Location: Fjordslottet at Osterøy close to Bergen

This year summer school will focus on four main areas:

1. Large scale wind and wave conditions for wind resource mapping, dimensioning and short- term forecasting
2. Dynamic response of floating wind turbines to wind, waves and current loads
3. Physical processes in the atmospheric boundary layer inside offshore wind parks
4. Wind turbine design, small scale flow phenomena and blade response

NORCOWE 2nd SUMMER SCHOOL 2011.
Current time schedule

Every day all meals and breaks will be as follows:
0800-0845 Breakfast
1200-1300 Lunch
1500-1530 Break
1930: Dinner

Sunday 14 August:
1745 Bus from Flesland airport via city of Bergen (1800) to Fjordslottet
1930 Dinner at Fjordslottet

Monday 15 August
0900-1200 **Topic 1. Techniques for modeling and observing large scale wind and wave conditions for wind resource mapping, dimensioning and short-term forecasting (3hrs, JB):**
- Atmospheric reanalysis and downscaling techniques
- Wave modeling and wave hindcast techniques

1300 -1600 **Topic 2. Power extraction by wind turbines (3 hrs, JBJ)**
- Mean wind profile and turbulence characteristics.
- Power production, Betz and Glauert limits.
- Principles for modelling aerodynamic loads. BEM- theory and aerofoils.
- Extreme loads during idling
- Wake effect in wind farms – importance to aerodynamic loads.

1700-1900 Student poster session

Tuesday 16 August
0900-1100 **Topic 3 Wave loads (2hours, FGN)**
- Wave kinematics, linear theory
- Waves from deep to shallow water – refraction
- Slender body formulation of wave loads (Morison equation).
- Comments upon the effect of steep waves.

1100-1600 **Topic 1 Met-Oc (cont´d) 4 hrs**
- Wave and wind climatology and extremes for the North Sea and the Norwegian Sea (ØB)
- Wave growth, wave age and the roughness of the ocean (ØS)
- Boundary layer wind profiles and the influence of the sea state

1700-1900 Excursion to Herlandsfossen

Wednesday 17 August
0900-1500 **Topic 4 Aero-servo-elasticity of wind turbines (5 hours, MHH)**
- Repetition of linear vibration analysis,
  -Modal frequencies, damping ratio and mode shapes
- Wind turbine modes and terminology
  -Names of wind turbine modes and their order
- Structural wind turbine modes during operation
  -Coleman diagram and multi-blade coordinates
  -Modal components and frequencies in measurements
- Possible aeroelastic instabilities of wind turbines
  -Stall-induced vibrations and classical flutter
- Wind turbine controllers
  -Controller objectives and strategies - simple PI controller explained
  -Possible controller induced instabilities

1500-1700 **Topic 1 Met-Ocean revisit**
- Boundary layer wind profiles and the influence of the sea state (ØS)
- Modelled and observed wind profiles from 10-150 m height (BRF)

1700-1900 Student poster session

Thursday 18 August
0900-1500 **Topic 5 Support structures (5 hours)**
- Fixed offshore wind turbines, (2 h, JvT)
  Foundation principles. Dynamic properties, modal loads and response, interaction with soil, design principles and loads
- Floating wind turbines (2 h, FGN)
  Mooring principles, principles of response analyses, effect of negative aerodynamic damping
- Design principles and rules (1 h, JvT)
  Key principles, extreme (ULS) loads versus Fatigue (FLS), conditions to be checked

1600-1900 Hiking trip to Tyssebotn
(Remember to bring good hiking boots/shoes, windproof outdoor wear and swimsuits/shorts!)

Friday 19 August
0900-1200 **Exercises/feedback/Revisit Topic 1, 2 , 3 interaction**

1315 Departure bus to Bergen and Flesland airport

Lecturers

Jean Bidlot (JB)

He has a PhD in Geophysical fluid dynamics and works as a Senior Research Scientist at European Centre for Medium-Range Weather Forecasts (ECMWF), where he work on the ocean wave part of the ECMWF forecasting system.

Morten Hartvig Hansen (MHH),

Morten Hartvig Hansen is a Senior Scientist at Risø DTU where he since 1999 works with and teaches dynamics and aeroservoelastic stability of wind turbines. He holds a Ph.D. in mech. eng. from DTU with expertise in nonlinear dynamics and aeroelasticity.

Øyvind Sætre (ØS)

Jan van der Tempel (JvT)

PhD in offshore Wind energy with focus on Design of Support Structures for Offshore Wind Turbines, scientist at TU Delft.

Birgitte R. Furevik (BRF)

Scientist at the Norwegian Meteorological Institute (NMI), and works with Offshore forecasting and wind resource mapping.

Øyvind Breivik (ØB)

PhD (Dr Scient) in physical oceanography. Senior scientist at the Norwegian Meteorological Institute in Bergen and holds a part-time position as associate professor II at the Geophysical Institute, UoB. He has worked extensively in the field of wave modelling and high-resolution wave hindcasting. His scientific work is motivated by the potential of observing systems and numerical models of the atmosphere, the ocean, and the oceanic wave field to improve safety and to reduce the environmental impact of human activites at sea.

Jasna Bogunovic Jacobsen (JBJ), UiS

Professor in Structural Engineering and the Department of Mechanical and Structural Engineering and Material Technology, University of Stavanger.

Her research focuses on wind-induced response of slender structures, with emphasis on bridge aeroelasticity. She has been involved in the wind tunnel studies, the wind response analyses and the full-scale data interpretation for a number of long-span bridges in Scandinavia and elsewhere.

Finn Gunnar Nielsen (FGN), Statoil, UiB

Senior advisor, platform technology in Statoil R&D and adjunct professor at Institute of Geophysics, UiB.

His background is in marine hydrodynamics from NTNU. He has been working with methods and analysis of dynamics of offshore platforms for more than 30 years. In recent years he has been responsible for the R&D project developing the Hywind concept.