September 2016

Details
to the IEA Wind Task 31+32 Workshop on

Lidar measurements for wake assessment and comparison with wake models

Date: October 4th 2016
Venue: Technical University of Munich, Munich, Germany
Immediately preceding The Science of Making Torque from Wind conference 2016
Workshop leaders:
Task 31: Javier Sanz Rodrigo, CENER, Spain
Task 32: Davide Trabucchi, ForWind – University of Oldenburg, Germany

Introduction

Within IEA Wind Tasks, experts from the wind energy academy and the industry work together to translate scientific results into practical guidelines to be applied in commercial applications.
In this framework, Task 31 aims to verify, validate, and quantify the uncertainties of the most widely used models on the basis of experimental datasets and Task 32 deals with wind lidar measurements in order to identify and mitigate barriers to the use of lidar technology in wind energy applications. More details about these projects can be found on the Task 31 and Task 32 websites.

Workshop Concept

Some possibilities to measured complex flows such as wakes with lidars have been explored recently with positive results. These studies suggest that lidar measurement could be included in the verification and validation process of wake models.
These models are important for wind turbine and wind farm design as well as wind farm control. However, the use of the lidar technology in this field is hindered by different knowledge of lidar measurement limitations and wake models and limited access to data. The main objective of this workshop is to bring experts from Task 32 and Task 31 together to discuss following questions:

1. What has been done so far?
2. What are the objectives of lidar wake measurements?
3. How can we collaborate with existing measurement data?
4. How can we collaborate in future?

Expected Outcome

Based on the results of the workshop, a report will be compiled to guide the design of a lidar experimental campaign as part of the verification and validation process of wake models. Besides this, preliminary recommendations on how to deal with the corresponding datasets will be included.
All participants are invited to discuss during the last session about the form of the report and to contribute to the preparation of the report after the workshop, with a target completion date of December 2016.

Program

8:30 Welcome and introduction round

9:00 Introduction to the workshop
Javier Sanz Rodrigo (Task 31) and Davide Trabucchi (Task 32)

9:30 Invited presentations:
What has been done so far?

- David Maniaci (Sandia): Lidar measurements at SWIFT and NWTC
- Sandrine Aubrun (University of Oreleans): SMARTEOLE I
- Nicolai Gayle Nygaard (DONG Energy): Westermost Rough wind farm
- Paul Fleming and Matthew Churchfield (NREL), and Steffen Raach (SWE): The DOE 1.5 campaign at NWTC
- Juan-José Trujillo (ForWind – University of Oldenburg): Measuring the wake profile from lidar measurements: The effect of fixed and moving frame of reference
- Kurt Schaldemose Hansen (DTU): Perdigão wind turbine wake measurements

11:00 Coffee break

11:15 Group discussion:
What are the objectives of lidar wake measurements?

12:30 Lunch

13:30 Comparative exercise: wake study based on lidar measurements

14:30 Plenary discussion:
How can we collaborate with existing measurement data?

15:30 Coffee break

15:45 Group discussion:
How can we collaborate in future?

16:45 Workshop wrap-up and formulation of next steps

17:30 End of workshop
Attendees of the conference “The Science of Making Torque from Wind (TORQUE 2016)” will have the possibility to visit the Welcome Cocktail (17:00-20:00).
Additionally, we can organize a dinner, if desired.

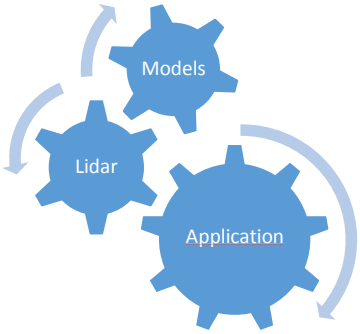
Program Details

Invited presentations: What has been done so far?

Each of the invited presentations will be 15 min including 5 min for questions. The presentations will review existing lidar measurements campaigns for wake assessment and focus on

1. What were the objectives for the campaign and the corresponding measurement scenarios?
   Quantities, trade-off with lidar measurement principle
2. How did you meet the objectives?
   Challenges, problems, uncertainties

Group discussions: What are the objectives of lidar wake measurements?



The objectives of lidar wake measurements are determined by the application, the wake models and the lidar system: The level of detail of the wake models does not only have to meet the requirements imposed by the chosen application, but also needs to be in accordance with the feasibility of the used lidar system. Since we will have experts for wake modelling, lidar systems and from the various applications, we invite you to discuss about why, what and how we measure. Groups will be randomly be selected. The objectives could be grouped either in

- Model type: steady, meandering, RANS, …
- Model subsystem: inflow, near wake, far wake, …
- Application area: wind park design, turbine design, wind farm control, …

Documentation will be on flipcharts. Last 15 min will be the presentations of the results to the plenum.

Comparative exercise: Wake study based on lidar measurements

In order to evaluate the possible methods that could be applied to evaluate the characteristics of a wind turbine wake from lidar measurements of a shallow conical sector, i.e. a PPI scan, we propose a comparative exercise. In this regard, simulations of lidar measurements in Large Eddy Simulation (LES) wind field are provided. Interested participants are invited to reconstruct the horizontal profile of the wind turbine wake included in the LES and intersected by the PPI scan.
This exercise and its documentation is available as gitlab project at
https://gitlab.uni-oldenburg.de/zana6011/Task32_WS03.
Everybody is invited to complete the exercise, possibly before the meeting. For questions please contact Davide Trabucchi.
The methodology applied and the corresponding results will be presented during the meeting (please, let Davide know if you intend to). Tentatively the results could be collected before the meeting and compared against the reference field.

Plenary discussion: How can we collaborate with existing measurement data?

This session will show how one can collaborate with Task 31 in the setting up of a validation benchmark for the intercomparison of wake models. After a short introduction about the rationale behind the validation process, Lukas Vollmer will present a case study around a lidar experiment in Alpha Ventus and some multi-scale simulations that followed. We will then discuss how we can set-up a benchmark for the intercomparison of wake models following the procedures established in Task 31: statement on validation objectives, assessment of input data, address the modelling scope and required simulation set-up for a meaningful model intercomparion, quantities of interest that will be analyzed, validation data and post-processing to get to the relevant quantities of interest, metrics to quantify model performance, etc. The benchmark will be part of the follow-up collaboration between Task 31

and 32 to discuss procedures for the use of lidar experiments in wake model validation. Additionally, the collaboration will be extended to Task 30 (offshore aero-elastic codes) to define the turbine specifications and evaluate turbine loading.

Group discussions: How can we collaborate in future?

The same groups formed in the morning will discuss about the near future collaboration (outcome of this specific meeting) and far future expectations (use cases, working groups, IEA Recommended Practices, …). Documentation will be on flipcharts. Last 15 min will be the presentations of the results.

Practical Arrangements

Venue Information

The workshop will be held prior the beginning of the Science of Making Torque from Wind Conference 2016 on October 4th, 2016 in Munich at the Technical University of Munich, Campus Garching:

Boltzmannstraße 15
85748 Garching bei München, Germany

Further information is provided in the venue section on the website of the Science of Making Torque from Wind Conference.
The meeting room will be MW 2250. More details see RoomFinder.

Contact Information

Please contact Davide Trabucchi and Javier Sanz Rodrigo (workshop leaders), or David Schlipf (IEA Wind Task 32 Operating Agent) with any questions you may have about the workshop.

Participant List

Name	Country	Institution
Arièle Défossez	France	EDF
Ashim Giyanani	Netherlands	TU Delft
Bart Doekemeijer	Netherlands	TU Delft
Beatriz Cañadillas	Germany	DEWI
Benny Svardal	Norway	Christian Michelsen Research AS
Breanne Gellatly	Italy	AXYS Technologies
Carlo Alberto Ratti	UK	ZephIR
Chen Fei	China	Goldwind
Christian Jonsson	UK	Natural Power
David Maniaci	USA	Sandia
David Schlipf	Germany	SWE University Stuttgart
Davide Trabucchi	Germany	ForWind - Univeristy of Oldenburg
Domenico di Domenico	France	IFP Energie Nouvelles
Dongheon Shin	South Korea	Jeju University
Donghun Ryu	South Korea	Korea Testing Laboratory
Ervin Bossanyi	UK	DNV GL
Fabrice Guillemin	France	IFP Energie Nouvelles
Frank Klintø	Denmark	Suzlon
Frederic Blondel	France	IFP Energie Nouvelles
Hu Wei	China	Goldwind
Hugo Herrmann	UK	EDF Energy
Jan Willem Wagenaar	Netherlands	ECN
Jason Jonkman	USA	NREL
Javier Sanz Rodrigo	Spain	CENER
Jinhyuk Son	South Korea	Jeju University
Jonathan W. Naughton	USA	University of Wyoming
Juan José Trujillo	Germany	ForWind - Univeristy of Oldenburg
Juan Pablo Murcia Leon	Denmark	DTU
Jun Li	China	Envision
Kurt Schaldemose Hansen	Denmark	DTU
Kyungnam Ko	South Korea	Jeju University
Laura Corrochano	Spain	Suzlon
Ludwig Wagner	Germany	GWU-Umwelttechnik
Lukas Vollmer	Germany	ForWind - Univeristy of Oldenburg
Matthew Churchfield	USA	NREL
Mikel Iribas Latour	Spain	CENER
Milekovic Malika	France	IFP Energie Nouvelles
Nick Johnson	USA	DOE
Nicolai Gayle Nygaard	Denmark	DONG Energy
Niels Troldborg	Denmark	DTU
Norman Wildmann	Germany	DLR
Patrick Moriarty	USA	NREL
Paul Fleming	USA	NREL

Peter Clive	UK	SgurrEnergy
Philipp Gasch	Germany	KIT
Pierre-Elouan Réthoré	Denmark	DTU
Pieter Gebraad	Denmark	Siemens
Rebecca J. Barthelmie	USA	Cornell University
Sandrine Aubrun	France	University of Orleans
Shi Shaoping	China	Huaneng Clean Energy Research Institute
Sjoerd Boersma	Netherlands	TU Delft
Søren Juhl Andersen	Denmark	DTU
Steffen Raach	Germany	SWE University Stuttgart
Suresh Pillai	India	Suzlon
Thomas Herges	USA	Sandia
Tom Berdowski	Netherlands	TU Delft
Wang Bin	China	Goldwind
Wang Haibin	China	Goldwind
Wiebke Langreder	Denmark	Wind Solutions
Yan Shu	China	Huaneng Clean Energy Research Institute
Yuko Ueda	Japan	Wind Energy Institute of Tokyo