30 October 2017

Details
to the IEA Wind Task 32 Workshop #7 on

Lidar Campaigns in Complex Terrain

Date: Wednesday 8th November 2017
Venue: Hotel campus.guest, University of Stuttgart, 70569 Stuttgart, Germany
Workshop leader: Andrew Clifton, WindForS

Introduction to IEA Wind Task 32

The main objective of the Task 32 is to identify and mitigate barriers to the use of lidar technology in wind energy applications such as site assessment, power performance, loads & control, and complex flow. One yearly workshop is organized for each of the four applications focusing on one specific problem, and with a well-defined program and tangible outcome.

More details can be found on the task website.

Background to the Workshop

At the 2016 IEA Wind Task 32 General Meeting in Glasgow, participants identified the practical aspects of lidar campaigns in complex terrain as a major barrier to the further deployment of wind lidar. Three general barriers to the use of lidar in complex terrain were identified:

1. **Operations**. Sites may be remote, which makes setting up and operating the lidar challenging.
2. **Data**. Data may be incomplete because of power or other issues, and may be difficult to interpret because of inhomogeneous flow conditions.
3. **Guidelines**. Existing recommended practices and standards do not explain what should be done to achieve satisfactory measurements in complex terrain.

The background to many of the challenges is described in a previous IEA Wind Task 32 report[1].
However, because of the lack of common experience, there is little agreement on what the most important barriers are, where there is most work required, or in what order the barriers should be addressed.

[1] See A. Clifton, M. Boquet, E. B. D. Roziers, A. Westerhellweg, M. Hofsäß, T. Klaas, K. Vogstad, P. Clive, M. Harris, S. Wylie, E. Osler, B. Banta, A. Choukulkar, J. Lundquist, and M. Aitken, "Remote sensing of complex flows by doppler wind lidar: issues and preliminary recommendations," NREL, NREL/TP-5000-64634, 2015.

Objective

This workshop will:

1. Provide practitioners with an overview of the state-of-the-industry and state-of-the-art in wind measurements in complex terrain.
2. Develop a set of worked examples for planning measurement campaigns in complex terrain
3. Identify critical barriers and develop a roadmap for mitigating them.

The scope of the workshop includes designing measurement campaigns, conducting field operations, and analyzing data. The workshop will identify best practices and barriers to the wider use of lidar in complex terrain.

Concept

The workshop will be a combination of

1. Presentations of past measurement campaigns, including positive and negative experience.
2. Case studies of planning for future measurements for resource assessment, power performance, or model validation.
3. Identifying gaps in existing products, services, or supporting recommended practices and standards, and potential solutions that already exist or need to be created.

Expected Outcome

Presentations and minutes of discussions that describe

1. Experience with the use of lidar in complex terrain for selected use cases
2. Examples of how to plan for a campaign in complex terrain
3. Identified issues with the current generation of products, services, recommended practices and standards, and suggested solutions

Expected Participants

This workshop is oriented towards wind plant developers and wind energy consultants currently using wind lidar to support wind plant developments or planning on starting to use lidar in the next year. Lidar manufacturers and suppliers and consultants who offer lidar-related services are also encouraged to take part.

The workshop will be limited to 30 places to enable active participation in the case studies.

Program

Start	
09:00	Arrival and registration
09:30	**Introduction** • Workshop goals • Introductions
10:00	**Challenges and Solutions** Experience from different groups with lidar measurements in complex terrain: • **CFD-based Lidar Correction Tools**. Sara Koller, Meteotest (15 mins) • **The Consultant's Perspective.** Detlef Stein, Multiversum (15 minutes)
10:30	Break
10:45	• **An OEM's experience with power performance testing**. Christos Tsouknidas, Siemens (15 minutes) • **Multi-lidar remote sensing measurements at Kassel**. Fraunhofer IWES (15 minutes).
11:30	**Introduction to Case Studies** • Explanation of goals and outcomes from each cast study (see Table 1). • Explanation of roles (see Table 2). • Introducing the Dungeon Masters
12:00	Lunch
13:00	**Case Study Working Session** In groups, develop solutions to each stage of planning and executing a measurement campaign • Identify gaps in products, services, recommended practices, guidelines, and standards • Suggest solutions for gaps / prioritize required research and development • Prepare short summary for the rest of the workshop
14:45	Break
15:15	**Results** • Presentation of results with prioritized barriers (20 minutes / group)
16:15	**Next Steps** • Summary of prioritized gaps and solutions • Draft roadmap
17:00	End
18:30	Dinner

Case studies

Case studies will be based on lidar-based measurement campaigns carried out near the IWES Rödeser Berg site near Kassel, Germany:

- For a schematic map of the local area, see Google maps.
- For a relief map, see Opentopomap.org. This map also includes the turbine locations on the Rödeser Berg.
- For examples of measurement campaigns at the site, see the NEWA website.

Group Tasks

Participants will be split into groups to create hypothetical plans for measurement campaigns in complex terrain. Each participant is encouraged to take on the role of a stakeholder during the planning session. This role may or may not correspond to their usual professional role!

Each group will be supported by a facilitator who will help the group progress.

Each group will provided with the following information:

- Measurement campaign goals (Table 1)
- Maps, photos, and other information to provide a feel for the site and challenges (Table 1)
- List of equipment (Table 1)
- List of suggested roles (Table 2)
- Campaign work sheet (Table 3).

Table 1: Case Studies

Group	Campaign Goal	Material provided	Equipment Pool
1	Data for planning a wind park	• Site maps • Wind rose • Work sheet	• Lidar wind profiler (200 m range, VAD or DBS measurement principle) • Scanner • 1x 100-m mast
2	Data for power performance tests through a wind park, with different turbine sizes: 2.1: 1.5-MW turbines 2.2: 6-MW turbines	As Group 1, and: • Turbine locations • Turbine dimensions	• Lidar wind profiler as in Group 1 • 1x hub-height met mast • 4xWind turbine
3	Data for validating a mesoscale to CFD/LES-turbine-scale model chain	As Group 1	• 200-m tower • 2x 100-m tower • 2x 60-m tower • 1x multi-lidar system (3x long-range scanning lidar) • Other equipment appropriate to a large-scale collaborative field campaign

The results from the case studies will be made public.

Group Roles

Roles for each of the group members are listed in Table 2

Table 2: Roles of each group member

Stakeholder roles	Responsible for
Project lead	Team management and coordination, focusing on ensuring each stakeholder's needs have been established and satisfied
Field team	Preparing, deploying, maintaining, and retrieving equipment
Data analysts	Converting data into usable results
Lidar supplier	Providing information about equipment, supporting deployments
Consultant	Ensuring actionable results
End users	Ensuring that the data delivered actually meet their needs

Case Study Work Sheet

This work sheet is based on Section 3 and 4 of https://www.atmos-meas-tech.net/10/3463/2017/amt-10-3463-2017.html. These steps may not be complete! Space is left for more steps if required. An electronic version will be provided for the meeting.

If there is not enough information available to progress to the next step, please consider if this is a barrier and/or if an assumption needs to be made to move on. The Dungeon Master will facilitate this.

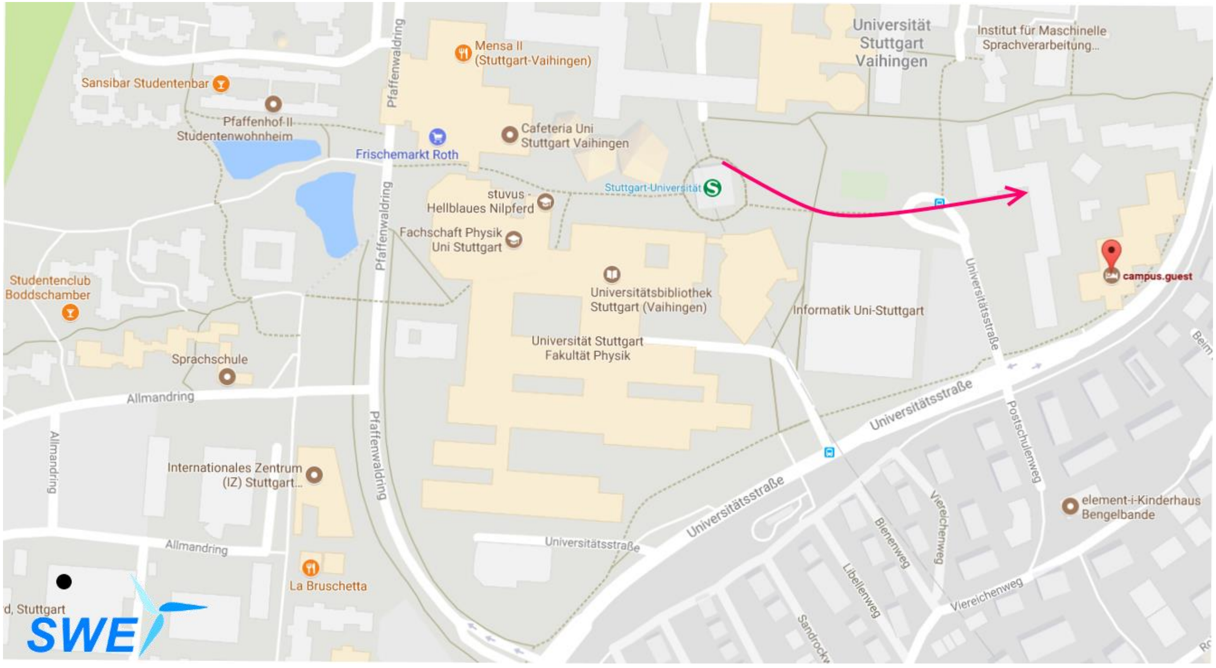
Table 3: Case Study Work Sheet.

ID	Step	Activities Who, what, where, when, why?	Barriers With ranking	Assumptions made to move on
1	Definition of objectives			
2	Site selection	N/A: location is defined		
3	Site characterization	N/A: location is characterized		
4	Campaign layout			
5	Scanning mode design			
6	Infrastructure planning			
7	Deployment and calibration			
8	Execution and data collection			
9	Decommissioning and post calibration			
10	Data archiving and dissemination			

Venue Information

The General Meeting will be held on November 9 and 10 at the Hotel campus.guest, which is conveniently placed in 3 min walking distance from the local train station “Stuttgart Universität”.

Hotel campus.guest
Universitätsstraße 34
70569 Stuttgart
Germany



Arrival by train

From Stuttgart main station, take the suburban railway lines S1 to Herrenberg, S2 to Vaihingen/Filderstadt or S3 to Vaihingen/Flughafen. Departure circa every 10 minutes, the journey time is about 10 minutes. Deboard at station „Universität“, and take the exit Universitätszentrum. Further steps: Please check map and photo above.

Arrival by airplane

From Stuttgart airport, take the suburban railway lines S2 to Schorndorf or S3 to Backnang. Departure circa every 10-20 minutes, the journey time is about 16 minutes. Get out at station „Universität“, and take the exit Universitätszentrum. Further steps: Please check map and photo above.

Arrival by car

Via motorways A8 from München or Karlsruhe, or A81 from Heilbronn or Singen drive until motorway junction Stuttgart. Then drive in direction „Stuttgart (Zentrum)“ and leave the motorway at exit „Universität“. At the traffic lights turn left. Pass the junction and stay on the Universitätsstraße and take the second turn right.

Participant List

Name	Country	Institution
Andreas Rettenmeier	Germany	ZSW
Andrew Clifton	Germany	Windfors
Andrew Scholbrock	USA	NREL
Antoine Larvol	Denmark	Windar photonics
Bastian Schmidt	Germany	DNV GL
Carlo Alberto Ratti	UK	ZephIR Lidar
Christos Tsouknidas	Denmark	Siemens
Cristoph Tiefgraber	Austria	energiewerkstatt
David Böckler	Germany	Enercon
David Schlipf	Germany	SWE University Stuttgart
Detlef Stein	Germany	Multiversum
Dimitri Foussekis	Greece	CRES
Dominique Deen	Netherlands	Solidwinds
Dominique Philipp Held	Denmark	Windar Photonics
Dong-Hun Ryu	South Korea	Korea Testing Laboratory
Doron Callies	Germany	Fraunhofer IWES
Guillaume Sabiron	France	IFP Energie Nouvelles
Holger Fürst	Germany	SWE University Stuttgart
Ines Würth	Germany	SWE University Stuttgart
Ioannis Antoniou	Denmark	Siemens
Jens Riechert	Germany	DNV GL
Julian Hieronimus	Germany	M.O.E. GmbH
Lei Liu	China	Goldwind
Liliana Del Angel Bulos	Germany	Windtest Grevenbroich
Madalina Marilena Jogararu	Denmark	EMD International
Martin Hofsäß	Germany	SWE University Stuttgart
Mingyuan Jiang	China	Goldwind
Mun-jong Kang	South Korea	Korean Register
Norman Wildmann	Germany	DLR
Oliver Bischoff	Germany	SWE University Stuttgart
Paul Mazoyer	France	Leosphere
Peter Clive	UK	SgurrEnergy
Robert Menke	Denmark	DTU Wind Energy
Sara Koller	Switzerland	Meteotest
Shumpei Kameyama	Japan	Mitsubishi Electric Corporation
Simon-Philippe Breton	Canada	TechnoCentre Éolien
Tobias Klaas	Germany	Fraunhofer IWES
Wang Bin	China	Goldwind