

24 November 2017

Minutes of the IEA WIND Task 32 General Meeting 2017

Date: 09/11/2017

Venue: campus.guest, University of Stuttgart

Minutes by Tim Hagemann, Holger Fürst, Florian Haizmann, Andy Clifton, Ines Würth, David Schlipf

Minutes

Day 1

9:00	Start of workshop – Introductions to Task 32 and workshop, introduction round
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Welcome by Prof. Cheng and introduction by David Schlipf

- Overview IEA Task 32 & review of workshops
- Introduction Round

9:22	Peter Clive Workshop #5 - Use Cases and Uncertainty Calculations in Complex Flow and Wakes
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- Articulating data requirements is much harder than anticipated
- The capabilities of lidar are making us think harder about things we are not used to thinking about: “what do I want to measure” rather than “what can I measure”
- “Completeness” of uncertainty budget is simply the assumption that the likelihood a significant contribution has been neglected is itself negligible
- Impossible to prove completeness, as this is the same as saying the unforeseeable has been foreseen
- However, good experiment design is about limiting the chance of something unforeseen to the best of your current knowledge
- Uncertainty is a measure of what you learn when the unexpected does occur, not the likelihood of it occurring
- Using valid lidar use cases is the same as good experiment design
- *Question by Andy Clifton:* What do we need to change?
 - Integration of measurement and models

9:57

Ioannis Antoniou

Workshop #6 - Nacelle lidar for power curve

- Session 1: What are the challenges we must overcome to improve nacelle lidar calibration and uncertainty estimation? The new standard needs to:
 - address the gap between LOS speed and horizontal speed uncertainties in white-box calibration approach
 - Remain open to reference instruments alternative to cup anemometer (define measurement requirements and not required instruments)
 - Propose a clear recommendation on the calibration uncertainty assessment
 - Clarify what should be included in the nacelle lidar classification/operational uncertainties
 - Give a recommendation regarding the frequency of calibration
- Session 2: What are the challenges when using nacelle lidars for power curve measurements? The new standard needs to:
 - define what is included in the term “Nacelle mounted” lidars (is spinner lidar included as well?)
 - provide lidar performance requirements instead of design requirements in order to be technology agnostic.
 - Provide some mounting requirements/recommendations
 - provide recommendation regarding the measurements or temperature pressure and humidity (without mast)
- PT61400-50-3 Kick-off meeting; discussed questions:
 - Timeline: standard ready in 3 years
 - Reorganisation of -12-1 documents: where does new standard fit?
 - Application: main focus on power performance verification
 - Complex terrain: is it mature enough?
 - Nacelle lidar measurement uncertainties:
- *Question by Peter Clive:* Is there stuff we can use from site calibration for complex terrain?
 - Site calibration is not there yet.
- What’s the status of IEC 61400-12-4 (numerical site calibration)?
 - finished technical report: more work is needed

11:02

Andy Clifton

Workshop #7 - Lidar Campaigns in Complex Terrains

- Identified Barriers
 - Existential
 - Do we trust the tower, lidar, or met mast in complex terrain?
 - What is the uncertainty of a device deployed on its own?
 - How do we transfer learning from one site to another?
 - Practical
 - How do we show clients the added value from lidar?
 - How do we get enough experts trained up?
 - How can we embed experience in processes or software?
- Proposed Solutions
 - Administrative

- IEA as a forum for exchange between researchers, practitioners, and users
 - IEC develops standards using IEA and others' experience
 - Complex terrain R&D needs EU and national support
 - Technical / Research
 - Improved flow modeling
 - Scanning and multi-lidar
 - Nacelle-based lidar
 - Physics-based uncertainty models for stand-alone lidar
 - Model validation techniques
 - Campaign design tools
- Discussion on separate IEA Task "Complex Terrain"
 - *Peter Clive*: CT task is a good idea; no consistent prediction of power if site is changed, not even a consistent agreement on what complex terrain
 - *Detlef Stein*: separate task might be too much for this topic
 - Idea for topical expert meeting: Figure out the need for new task

11:31

Antoine Borraccino

UniTTe results - Power curve measurements in complex terrain with a nacelle lidar

- Method to include terrain data in WFR developed
- Site calibrations are hard to trust
- Power performance in complex terrain:
 - Demonstrated using the nacelle lidar short-range
 - measurement technique (0.5D to 1D)
 - Wind speed results as "good" as at 2.5D
 - Power curve shows much lower scatter
- *Question by Julia Gottschall*: How did you consider terrain data?
 - Extracted elevation line and add height difference to "height above terrain"
 - *Comment by David Schlipf*: possible to include into reconstruction model to identify slope

11:48

Doron Callies

The LIMES Project: Optimization of Lidar Based Measurement Strategies For Site Assessment of Wind Farms

- Thorough planning of measurement campaigns can save costs and reduce wind farm project risk
- LiMeS can make an important contribution to the better quantification and objectification of uncertainties
- LiMeS can make an important contribution to spatially and temporally flexible use of LiDARs for site assessment
- A LiDAR availability map for Germany is being developed to allow identifying locations with potentially low weather related availability before the start of the measurement
- The developed tool shall support the planning of wind measurement
- *Question by Liliana Del Angel Bulos*: Have you considered splitting measurements to cover seasonal changes? Yes
- *Question by Detlef Stein*: To what extent have they understood the risks of lidar to fog?
 - Not yet; but the idea and inputs are appreciated.

13:00	Julia Gottschall Recommended Practices 18 on Floating Lidar Systems
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- Presentation of RP including History, Content, and recommendation for future work.
- *Comments from Julia Gottschall and the members of the Advisory Board:* Many thanks to David for his great support throughout the whole process of writing the recommended practices 18. And for doing a great job as Operating Agent of the IEA Wind Task 32.

13:38	Andrew Scholbrock Using Lidars to Measure Wind Turbine Wakes for Wind Plant Control Research
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- Lidars can be used to reduce wind turbine loading using feed forward control, as well as improve turbine yaw alignment with the wind
- Atmospheric stability plays a large role in wake meandering and needs to be taken into account as an input for coordinated wind farm control
- Wakes are possibly scalable between different turbine sizes
 - Traditional Scaling parameters (D, V_∞) are insufficient
 - Need to take Tl, Ct into account as well
- *Question from Detlef Stein:* Why is this kidney-shaped velocity deficit off axis?
 - Turbine was not fully aligned because the nacelle wind vane operated not well.
- *Question from Ines Würth:* Were only LOS wind speeds shown in the graphs?
 - They were some sort of projection. For more details, see papers from Tommy Herges at Sandia National Lab.

14:06	Robert Menke, Norman Wildmann Full scale experiments of the NEWA project
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- overview of field campaigns within the NEWA (New European Wind Atlas) project
- project aim is the accurate mapping of wind conditions for the estimation of resources and loads
- a series of atmospheric field experiment will be used to validate flow models and the atlas
- field experiments took place and are planned in Denmark, Sweden, Germany, Portugal, Latvia and Spain
- all experiments use lidar technology
- 180+ sonics, 20 scanning lidars and various other instruments were installed in Perdigão
- More information see
 - <http://www.neweuropeanwindatlas.eu/>
 - <https://windsp.fe.up.pt/>
 - <https://www.eol.ucar.edu/events/perdig%C3%A3o>

14:50	Shumpei Kameyama Recent advances on Mitsubishi Electric's Wind lidar "DIABREZZA"
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- The development concepts of "more intelligent" and "measurement further" were shown.
- For "more intelligent", Mitsubishi Electric developed the adaptive parameter tuning function and showed the demonstration in the recent conferences.
- As the latest progresses, the verification and validation tests by DNV-GL and CMR, and the first demonstration of lidar-assisted turbine control with DIABREZZA were also shown.
- *Question from Rob K. Newsom: Is it possible to play with the range gate size when using your adaptive technique?*
 - Yes, it is.
- Tobias Klaas pointed out that the adaptive technique has an impact on the verification procedure?

15:03	Paul Mazoyer Recent advances on Leosphere's Lidars
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- FCR (Flow Complexity Recognition) finds the best guess which matches to the Windcube measurement while matching the mass conservation equation for the surrounding topography.
- Limitations are known and best practices exist in consequence.
- Documentation is necessary for an optimized uncertainty assessment.
- Leosphere will soon release a comprehensive document on FCR principles.
- *Questions from David Schlipf: FCR uses on the one hand an improved model with the mass conservation and on the other hand includes a term which penalizes the deviation from the homogeneous flow model, which we know it is not true. This seems to be inconsistent. Wouldn't it better to use the mass conservation together with a more sophisticated model based wind field reconstruction?*
 - The constraints have been included to avoid deviation too far from useful values.
- *Question from Sara Koller: Why are momentum and energy conservation equations are not included?*
 - Solving these equations takes a lot of computation time and furthermore parameterization is difficult to handle.

15:25	Carlo Alberto Ratti Scaling the numbers and maintaining the quality: a challenge for lidar manufacturers
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- Lidar market is expanding due to larger use of lidars in wind-power applications as well as new applications for lidars.
- To scale up production without affecting the quality, manufacturers have to reconsider their production procedures.
- ZephIR Lidar has heavily invested in a new lidar production centre last year.
- +90% in productivity and reduction of servicing times are the most immediate results.
- Increased production capacity add flexibility to the production chain, with opportunities for possible customization of products.
- *Question from Liliana Del Angel Bulos: Have you considered to build a met mast taller than 90 meters?*
 - Yes, but the cost of the structure and for planning is too high at the moment.

15:45	Dominique Held Recent advances of Windar Photonics' LiDARS
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- Presentation of a comparison between a wind turbine and a 2-beam and 4-beam nacelle lidar
 - Good 10Min average speed correlation after induction model is applied on lidar data
 - Improved coherence for 4-beam compared to 2-beam indicating that smaller structures can be resolved with 4-beam
 - Advection time analysis shows good agreement with expected values
- An example of wake detection in the inflow turbines and an example of yaw alignment correction were given.
- Smart beam switching example that shows how blade blockage can be reduced substantially was presented.
- *Question from David Schlipf: Are you consider the filtering time when you calculate your time delay?*
 - No, not yet.

16:07	Eloise Burnett Reducing LiDAR Uncertainty - Results and Ideas from Offshore Wind Accelerator Research
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- Introduced the offshore wind accelerator programme
- Described the outputs of the LiDAR Uncertainty Review Project; the 23 research projects suggested, 3 projects likely to go ahead under the OWA:
 - Critical review of IEC-61400-12-1
 - Calibrate using Lidics rather than cup anemometry
 - LiDAR to LiDAR calibration
- Informed the group of other active projects which involve LiDAR
 - Power Curve Validation Version 2
 - Thrust curve measurements
 - LiDAR for Site Assessment
 - Coastal effects
 - Boundary layer profiling
 - Update to Floating LiDAR roadmap
 - Wind Farm Control Trials Project

16:17	Steffen Raach Recent Field-Testing Results of Lidar-Assisted Control
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- The basic concept of lidar-assisted collective pitch control was recapped.
- Consistency in field testing results and simulation data was shown.
- Application to specific site and turbine type was done via
 - optimization of data processing.
 - optimization in controller retuning.
- A consistent process in realizing lidar-assisted control is very important.

Day 2

9:04	Start of day 2 - Mitigating barriers in 2018
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Welcome by Ines Würth and introduction to goals of day 2

- First an outlook on workshop #8 will be given.
- Afterwards, several people will present suggested workshop topics for 2018.
- Then these suggestions will be discussed, extended and refined in a World Café by the participants.
- Finally one voting per application area will be held to find out what topics are of most interest to the participants.

9:10	David Schlipf Outlook Workshop #8: Certification of Lidar-Assisted Control Applications
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- Facts: 4th workshop of 2017 round, will take place on 30.-31. January 2018 at DNV GL in Hamburg, led by Nikolai Hille
- Topic: Certification of Lidar-assisted control (LAC) applications
- Motivation:
 - LAC has been a promising area of research for the past decade and shown significant improvements in wind turbine performance and structural load reduction
 - But existing design standards used for Type Certification of wind turbines do not contain technical requirements for the evaluation and verification of wind turbines with LAC
- Objectives:
 - Bridge the gap between wind turbine and lidar manufacturers, researchers, and certification bodies to gain a common understanding of the challenges of certification with LAC
 - Use the expertise of these groups to identify modifications or additions that should be made to design standards to account for LAC
- Concept:
 - Day 1: Invited Presentations from DNV GL, wind turbine manufacturers, lidar suppliers, and researchers
 - Day 2: Working Group Discussions
- Outcome:
 - An IEA Wind Task 32 document containing suggestions for certification of LAC applications (will be incorporated into the DNV GL standards on wind turbine certification with LAC)
- Please register until December 15th (participation might be limited due to room capacities) by email under ieawindtask32@ifb.uni-stuttgart.de

- 1) Site Assessment (Julia Gottschall)
 - a) **Site suitability with lidar data** (from last year):
key issue: to what extent can lidars measure turbulence
 - b) **Floating lidar update** (Julia Gottschall):
follow-up of workshop #1, introduction/discussion/review of RP 18 document, OWA roadmap update

- 2) Power Performance (Andy Clifton)
 - a) **Ideal offshore power performance testing** (Julia Gottschall):
comparison of different lidar technologies: nacelle- vs. floating- vs. transition piece - lidar
- *Comment from Rebeca Lamata*: One work package of the OWA already addressed this
- *Reply from Julia Gottschall and Andy Clifton*: Yes, we are aware of this
 - b) **Wind field reconstruction using Lidars for PCV** (Rebeca Lamata):
bigger rotors (200m) lead to $2.5D=500m >$ current lidar ranges, -> stronger lasers? -> also decorrelation problem, discussion on wind field reconstruction with "simple" induction models, in Q3-4 at Ørsted, led by Rozenn Wagner or Antoine Borraccino
- *Comment from Ines Würth and Julia Gottschall*: Could be in accordance/merged with proposal a)
 - c) **Power Performance Testing** (Andy Clifton):
Lack of experience in using lidar for power performance testing, especially in complex terrain -> Concept: Case studies for different approaches to power performance testing with different levels of complexity

- 3) Loads and Control (David Schlipf)
 - a) **Estimating turbulence with lidar** (from last year):
Amea Sathe has not been able to hold this workshop so far but will maybe next year
 - b) **Load verification with lidar** (from last year):
Follow up workshop: how can we use TI measurement and possible other measurements to verify the load on a wind turbine.
 - c) **Lidars for use in wind plant applications** (Andrew Scholbrock):
Can lidars provide information on atmospheric stability? How to use lidars for closed loop wake steering? Optimal deployment of lidars in a wind plant?, expands workshop #3, in Q4 at NWTC or Sandia

- 4) Out of the box (Ines Würth)
 - a) **CNR data filtering** (from last year, Davide Trabucchi):
No clear indication about how to filter lidar data and optimize their availability, -> blind test based on publicly available data
 - b) **Open Lidar** (from last year, Andy Clifton):
Lack of open-source modular lidar that can be modified for R&D applications,
Concept: show examples of implementation and develop modular concept/data bus/
data language, some existing work from OpenLidar working group, no place yet,

1-1.5 days

- *Comment from Peter Clive:* Another interesting body for this could be data handling specialists

c) **Very short-term forecasting of wind power** (Ines Würth)

Collaboration of IEA Wind Task 32 & Task 36, Goal: How to close the gap of numerical weather prediction models to forecast power output in very short-term periods, led by Ines Würth & Laura Valdecabres & Elliot Simon & Mike Courtney, in Stuttgart or Oldenburg

5) Complex Flow (Peter Clive)

a) **Integration of wind models & measurements** (Peter Clive):

-> see Eolics proposal

b) **Verification of dynamic wake meandering with lidar** (Peter Clive):

Many datasets available, opportunity for a focussed and effective workshop with the right people, could be combined with other wake workshops

c) **Application of lidar measurement in accordance with standards** (Peter Clive):

Follow on from work started by OWA etc.

d) **Eolics** (Peter Clive):

Lidar measurements + CFD/Models = Eolics / Wind science, Integration of lidar measurements and models leads to an equivalent of WTG digital twin

-> is a cross-cutting theme in Task 32

Concept: Review state of the art, e.g. FCR, DTU nacelle mounted fast-solver, induction zone modelling, etc. and Identify routes to generalising to less constrained sets of circumstances

6) Any other suggestions?

a) Tobias Klaas: **Common data model for RWS and associated data.** Currently a european project is running on this, led by Nikola Vasiljevic, ending this year.

- *Comment from Ines Würth:* would probably fit into "Out of the box"

b) Carlo Ratti: **Requirements to the development of new lidars.**

Comment from Ines Würth: Maybe a subject for OpenLidar?

- *Comment from Andy Clifton:* It sounds like a different approach

- *Comment from Ines Würth:* Then it probably would fit also into "Out of the box"

10:101

Ines Würth

World Café: Group discussions for the new workshops

- World Café has five continents: the 5 application areas
- Participants are asked to travel around and extend/discuss and refine the workshop suggestions in more detail
- Outcome from each continent should be max. 4 workshop suggestions which will be used for a vote from the participants afterwards

11:50

Ines Würth

Presentation of results of World Café and voting for new workshop topics

Results from World Café (pictures of flip charts) are attached at the end of this document

1) Site Assessment		
a) Lidar for Site Assessment	9	
b) Lidar in complex terrain		17
c) Floating lidar update	5	
2) Power Performance		
a) Practical issues and gaps in standards	10	
b) Wind field reconstruction in induction zone		18
c) Power curve working group -12-1	1	
d) Something, something offshore	3	
3) Loads and Control		
a) Turbulence Intensity		14
b) Barriers of lidar for use in wind plant applications	7	
c) Systems engineering	5	
d) Data availability/ robustness	7	
4) Complex Flow		
a) How to characterize complexity in advance?		25
b) Three step strategy: tune, measure, correct	9	
5) Out of the box		
a) Very short-term forecasting of wind power		10
b) Lidar data filtering	8	
c) Data format	11	
d) Lidar 2.0	4	

12:19	David Schlipf Discussion on next phase of IEA Wind Task 32, Proposal for General Meeting 2018
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- David Schlipf shows results of feedback survey (see slides): a big majority thinks that there should be a third phase of Task 32
- Simon-Philippe Breton suggests to hold the next General Meeting in November 2018 in Montreal, Canada
 - *Comment from Rebeca Lamata:* It could be problematic for some companies to grant the travel budget for Canada
 - *Comment from Detlef Stein:* It would help to give some arguments for the travelling (like a workshop or other events in combination with the GM)

12:32	David Schlipf End of meeting
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- David Schlipf thanks all participants for their attendance, the members of the Advisory Board and all who helped in organizing the GM and closes the meeting.

Participants



Name	Country	Institution
Alexander Basse	Germany	University of Kassel
Andrew Clifton	Germany	WindForS
Andrew Scholbrock	USA	NREL
Antoine Borraccino	Denmark	DTU Wind Energy
Bastian Schmidt	Germany	DNV GL
Carlo Alberto Ratti	UK	ZephIR Lidar
Christoph Tiefgraber	Austria	Energiewerkstatt
Christophe Lepaysan	France	Epsiline
Christos Tsouknidas	Denmark	Siemens Gamesa
David Böckler	Germany	Enercon
David Schlipf	Germany	SWE University of Stuttgart
Davide Trabucchi	Germany	University of Oldenburg
Detlef Stein	Germany	Multiversum
Dominique Philipp Held	Denmark	Windar Photonics
Dong-Hun Ryu	South Korea	Korea Testing Laboratory
Doron Callies	Germany	Fraunhofer IWES
Eloise Burnett	UK	Carbon Trust
Florian Haizmann	Germany	SWE University Stuttgart
Guillaume Sabiron	France	IFP Energie Nouvelles
Holger Fürst	Germany	SWE University of Stuttgart
Ines Würth	Germany	SWE University of Stuttgart
Ioannis Antoniou	Denmark	SGRE
Jens Riechert	Germany	DNV GL
Julia Gottschall	Germany	Fraunhofer IWES
Julian Hieronimus	Germany	M.O.E. GmbH
Ko Jungmin	South Korea	Jeju Energy Corporation
Koh Seunghoon	South Korea	Jeju Energy Corporation

Kyungnam Ko	South Korea	Jeju National University
Lei Liu	China	Goldwind
Liliana Del Angel Bulos	Germany	Windtest Grevenbroich
Lorenz Hutzler	Germany	Enercon
Madalina Marilena Jogararu	Denmark	EMD International
Martin Hofsäß	Germany	SWE University of Stuttgart
Mingyuan Jiang	China	Goldwind
Mun-jong Kang	South Korea	Korean Register
Murray Dawson	France	Epsilone
Norman Wildmann	Germany	DLR
Oliver Bischoff	Germany	SWE University of Stuttgart
Paul Mazoyer	France	Leosphere
Peter Clive	UK	Wood Group
Rebeca Rivera Lamata	Denmark	Ørsted
Rob K. Newsom	USA	PNNL
Robert Menke	Denmark	DTU Wind Energy
Sara Koller	Switzerland	Meteotest
Shumpei Kameyama	Japan	Mitsubishi Electric Corp.
Simon-Philippe Breton	Canada	TechnoCentre Éolien
Stefan Goossens	Netherlands	Vattenfall
Steffen Raach	Germany	SWE University of Stuttgart
Tim Hagemann	Germany	SWE University of Stuttgart
Tobias Klaas	Germany	Fraunhofer IWES

Appendix - Results from World Café

Site Assessment

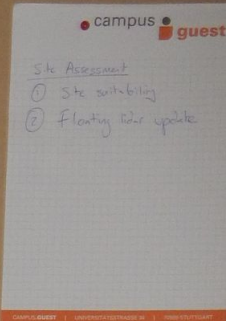
lidar (TI) is a key issue for site assessments (!) → solutions (?)
 ↳ altern. parameter (?) applicable (!)
 ↳ extremes? (shear?)
 (David, Bastian, Detlef)

+ further parameter (3)
 if (lidar stand-alone as use case)
 Or combine with mast (?)
 IEC power perf.

② → WRA → Site Assess-ment (!)
 ↳ lidar uncertainty in complex terrain
 ↳ considers complete lidar campaign → stand-alone use case
 ↳ follow-up WS # 7 *incl. TI as well
 [Doron, Kassel] 1 day? May/June 2018
 + Liliána/Windtest, Christoph (?)
 ↳ Sum-up conclusion, present to (e.g.) FGW

• new technologies (!?) ; what is already applicable? (e.g. PTB?)
 / other

③ Floating lidar update
 ↳ after OWA roadmap update | avoid overlap (!)
 ↳ find out if we need PP18 update



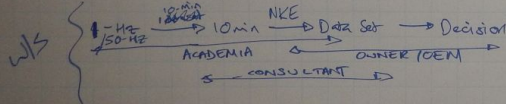
Power Performance

Topics - barriers - outcomes - hosts?

- ① Nacelle-based (on/offshore) NEAR TERM
- HOLDS cost, lower effort! ^{mounting} interaction w/ turbine
 - Barriers = knowledge, guidance
 - Outcomes = Sharing experience, best practices - minutes
 - Update to guidance → IEC input to SC-3
- 1/2 day experience, 1/2 day review, 1/2 day write
 ? GE@Barcelona? / IEC SC-3
 = 1

- ② -12-1 UNCERTAINTY
- FOLLOW UP TO W/SHOP ON UNCERTAINTY
 - PCWG - TASK 32

- ③ WIND FIELD RECONSTRUCTION IN THE INDUCTION ZONE ^(MID TERM)
- INFORM NEXT IEC (2019/2020) - IS 2SD RELEVANT?
 - OUTCOME = BEST PRACTICE / SUB GEO-F
 - ROUNDROBIN / INTERCAL IMPLEMENTATIONS OF UNTRD DATA
 - CASE SHARING?



④ PRACTICAL ISSUES!

- CONTRACTUAL AGREEMENTS!
- FREE SECTORS!
- ALTERNATIVE/CHEAPER
- ~~FSM~~ MAKE IT EVERY DAY
- STAKEHOLDER PERSPECTIVES

① PRACTICAL + STANDARDS GAPS

② WINDFIELD RECON. IN THE INDUCTION ZONE

③ REVISITING -12-1 UNCERT.

Loads & Control

1. TI

2. Load verification

Ameya?
DTU?
DIN GL?

- Software for TI
- New devices
- New definitions
- Guidelines
- Round Robin

3. Wind farm
↳ Guidelines

Andy/Paul!

- need to decide
- # of DOF???
- Round Robin
- Lidar Simulator, Controller
- Lidar Cost function / Performance

4. System Engineering
with T37

Holger

- ↳ Journal Paper / open source data base
- Doron?
- Open Lidar Files?

5. Robustness / Data Availability

6. Blade Lidars
Spinner

DTU (Mike, Torben)?

7. MPC Control challenge

Complex Flow

• def? flow where basic techniques fail
↳ specific measurements and models for WFR

• Parameters of wind models which can be measured with LiDAR

in advance

* How to detect complex flow characterize complexity

reanalysis data

• Failures (conditions)

• Simulation can give indications about how to measure

• Simulation tool

* Distribute complex flow cases and ask for a suitable strategy

• Search for alternative approaches

• Turbulence is complex

• Uncertainty given by complexity

campus guest
Complex Flow
① Integration of wind models & measurements
② Verification of wind measurements
③ Application of wind models to complex terrain

→ Complex Flows

• changes in roughness

• ridges

• forests

• low level jet

• wakes

• stability

Out of the box

- Data format

Barrier: Every lidar has a different format

Goal: Discuss a common data format and which ^{discuss} level of data (raw data, processed data) should be stored

Host: Nicola V. (DTU), Tobias K. (M&E)

- improve storage (~~communication protocol~~)
- easier exchange of data
- store meta data of measurements (also campaign specific)

→ get an overview of different existing data formats

- Verification Protocol

- Lidar 2.0

Barrier: Current lidars on the market do not meet all the users needs

Goal: Get feedback from the users to the manufacturers what the needs are and exchange an ideas about future lidar systems

Host: Holger F. (USTM); Zephire

- find out needs
- find out obstacles
- find out how a optimized lidar 2.0 could look like
- focus on commercial lidars
- include communication protocol
- include data format
- focus on practical issues

- Forecasting using long-range lidar
Barrier: Close the gap of NWP models by
measuring

- secure grid stability
- ^{comparing with} altitude storage

Goal: Discuss different approaches

- overlap with application airports?
- overlap with storage
- forecast quality

Related to: Beacon Project, Pierre Julien Trompe (Weather radars
the new eyes for offshore wind farms)

- Open Lidar | modular
Barrier: Adaptable lidar system

- sit together ~~with~~ with interested parties
- Protect IP, who to set the line
-

- Data filtering
Barrier: How to best filter the data for each application

- optimization of filtering methods

