Third Generation Lidar Measurements

Prof. Dr. Peter J. M. Clive
Wood

Introduction

Turbines provide us with rich datasets
- CMS and SCADA
- Big data
- Sophisticated analytics

Wind measurements typically provide much more sparse data
- Met masts and profilers
- 1st generation methods
- Incomplete information
- Crude approximations, e.g.
- Wind shear exponent
- Turbulence intensity

There is a mismatch between information about the resource and information about the response to it

However, remote sensing techniques such as lidar mean we can
- Acquire project critical wind data earlier in the project lifecycle
- Acquire data that would not otherwise have been available

This is changing the way we do wind power. For example, we can
- Obtain evidence of adverse wind conditions pre-construction, before they are manifested as adverse consequences post-construction.
- De-risk assets post-construction by adopting radically new approaches to testing.

“Scanning lidar” is a very powerful instrument

It provides
- Information we would not otherwise have
- Earlier access to information we can get other ways

Scanning lidar allows multiple measurement methods which have been described as 2nd generation techniques.

The roadmap for sensor development must however consider the capabilities of 3rd generation instruments ...

Current status ... generation 2.5 😊

1st generation: extrapolation
- Mast mounted sensors and remote sensing vertical profilers
- Direct, intuitively understandable data, e.g. wind speeds and directions, are acquired at a point in space, or representing conditions at a specific location
- These are then extrapolated using various modelling techniques to represent a larger area, incurring significant uncertainties

2nd generation: inference
- Scanning lidars implementing use cases that entail PPI, RHI and compound scan geometry measurement methods to conduct wake studies, complex flow studies, etc.
- Inference of wind conditions from data acquired in multiple locations throughout the area of interest using scanning devices
- Data not intuitively understandable, e.g. measurements radial velocity vector components relative to the location of the scanning device, but requires expert knowledge and interpretation
- Trade-off required between time- and space-resolution: a scan geometry providing greater details in space takes a longer period of time to iterate

3rd generation: direct observation
- Wind parameters of interest are all directly observed within the entire domain of interest
- Measurement is intuitive: all that is required to interpret the measurement is knowledge of its purpose rather than instrument-specific expertise.
- Direct observation of measurements in all locations of interest analogous to measurements obtained at a single location by 1st generation devices
- Example: multiple synchronised lidars fulfil at least some of the requirements of a 3rd generation system
- No trade-off between time- and space-resolution: direct measurements obtained instantaneously in all locations.

The Big Picture

Historically projects have been developed on the basis of
- Incomplete information obtained using
- Limited data acquisition tools and techniques

This has resulted in
- Approximations that were only ever supposed to be temporary (wind shear exponents, TI, etc.)
- Different and competing priorities in relation to data requirements, depending on who you are, e.g.
  - A developer who wants to flip the project after FID but before construction
  - A wind turbine manufacturer who wants his turbines to survive the warranty period
  - An owner/operator seeking low OpEx and high productivity

These competing demands are artefacts of the incompleteness of our knowledge. The availability of new information
- Gives us the whole picture,
- Eliminates competing priorities, and
- Forces us to work together to achieve the same outcomes based on a single, well represented, and well understood, reality
- We adopt an outcome driven rather than constraint driven approach

The Big Picture

When we consider the possible uses of remote sensing it is intriguing to consider that our standards and procedures themselves have to change to take full advantage of the new information they make available.
- Standards will be rewritten or discarded
- No models or approximations will be required (TI, wind shear, etc.)
- No more scan geometries, no more trade-offs for data acquisition with 3rd generation methods
- Identical pre-construction and post-construction wind measurements

Meet us at Exhibition Booth 1E80

windeurope.org/confex2017
#windeurope2017