AWESCO Wind Field Datasets

Thomas Haas - thomas.haas@kuleuven.be
Johan Meyers - johan.meyers@kuleuven.be
KU Leuven

Introduction

The present datasets contain time-resolved three-dimensional wind field data computed by means of large-eddy simulations. The atmospheric boundary layer is modelled as pressure-driven boundary layer (PDBL) and the computations are performed using the software SPWind developed at KU Leuven. More information on SPWind can be found in [1]

Dataset information

Wind field data is provided for three different roughness classes corresponding to offshore conditions (class 0) and onshore conditions, in particular open land (class 1) and agricultural land (class 2). The characteristics of the different classes are specified in table 1 according to the European Wind Atlas[2] and the NREL wind power resource map[3].

The datasets cover a region of $L_x \times L_y \times L_z = 1000m \times 600m \times 802.5m$ in streamwise, spanwise and vertical direction, respectively. The spatial resolution is $\Delta x_i = 10m$ in each direction and the velocity fields are sampled at a frequency of $1Hz$. The original data is non-dimensional and needs to be scaled before use. The non-dimensional velocity components, domain dimensions and time samples are respectively scaled by the friction velocity u_τ (computed from the logarithmic velocity profile (1)), the boundary layer height $H = 1000.0m$ and the factor H/u_τ. Scaling examples are given in the provided scripts.

$$u(z) = \frac{u_\tau}{\kappa} \ln\left(\frac{z}{z_0}\right), \tag{1}$$

For each roughness class, 45 minutes of wind data is available in multiple files. The datasets are stored in HDF5 format for time series of 15 minutes. The file size of each time serie is approximately 10 GB. Each file contains metadata, ie. detailed information on the spatial and temporal discretization of the wind data, and the different velocity components u, v and w organised in distinct groups. The data can be accessed using processing scripts provided for both Python and MATLAB (tested for Python 2.7 and MATLAB R2015a).

Table 1: PDBL scaling for different roughness classes

Description	Quantity	Unit	Class 0	Class 1	Class 2
Roughness length	z_0	$[m]$	0.0002	0.03	0.1
Reference height	z	$[m]$	100.0	100.0	100.0
Reference speed	u	$[m/s]$	10.0	9.0	8.0
Friction velocity	u_τ	$[m/s]$	0.30482	0.44380	0.46325
von Kàrmàn constant	κ	$[-]$	0.4	0.4	0.4

Examples

To access the data, use the Python and MATLAB scripts *example.py* and *example.m*. The Python script provides in addition examples on how to use the datasets for several applications, including:

1. the extraction of vertical planes at a specific discrete time (fig. 1),
2. the extraction of horizontal planes at different discrete times (fig. 2),
3. the extraction of time series at a specific discrete location (fig. 3),
4. the interpolation of wind data in space and time along a circular orbit (fig. 4).

Citation and contact

Please cite this dataset according to the instructions provided on the Zenodo repository website and specify the following DOI http://doi.org/10.5281/zenodo.1418676.
For questions and comments please contact Thomas Haas (thomas.haas@kuleuven.be).

References

[1] W. Munters, C. Meneveau, and J. Meyers, "Turbulent Inflow Precursor Method with Time-Varying Direction for Large-Eddy Simulations and Applications to Wind Farms," *Boundary-Layer Meteorology*, 2016.

[2] I. Troen and E. Lundtang Petersen, *European Wind Atlas*. Risø National Laboratory, 1989.

[3] `https://www.nrel.gov`.

Application 1

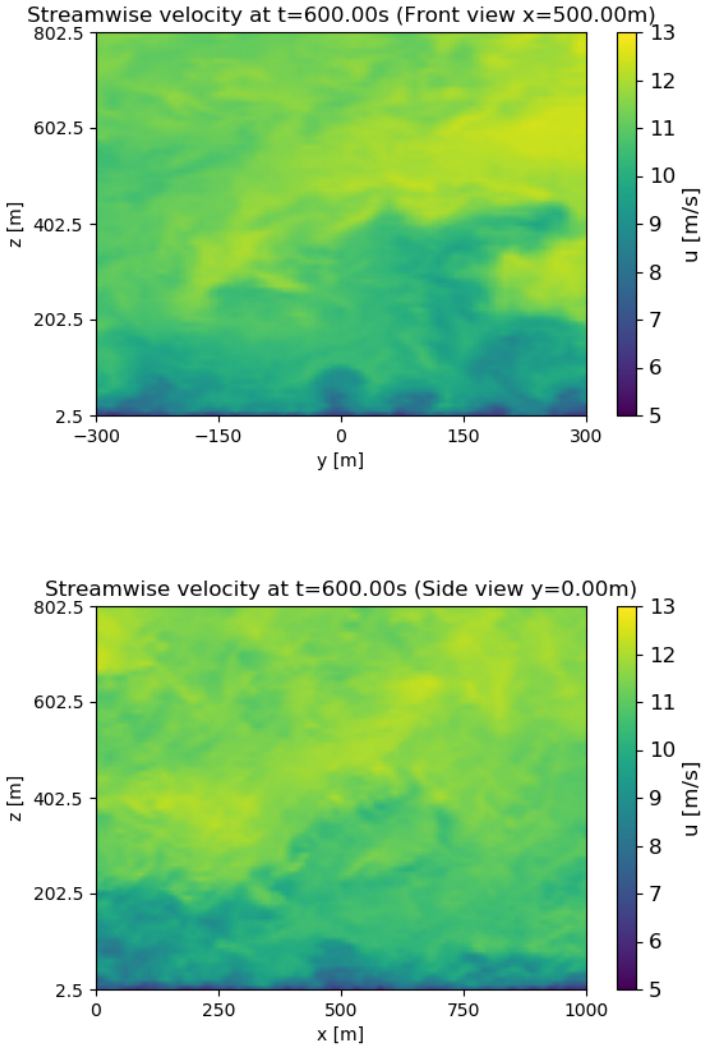

Figure 1: Front view at $x = 500.0m$ and side view at $y = 0m$

Application 2

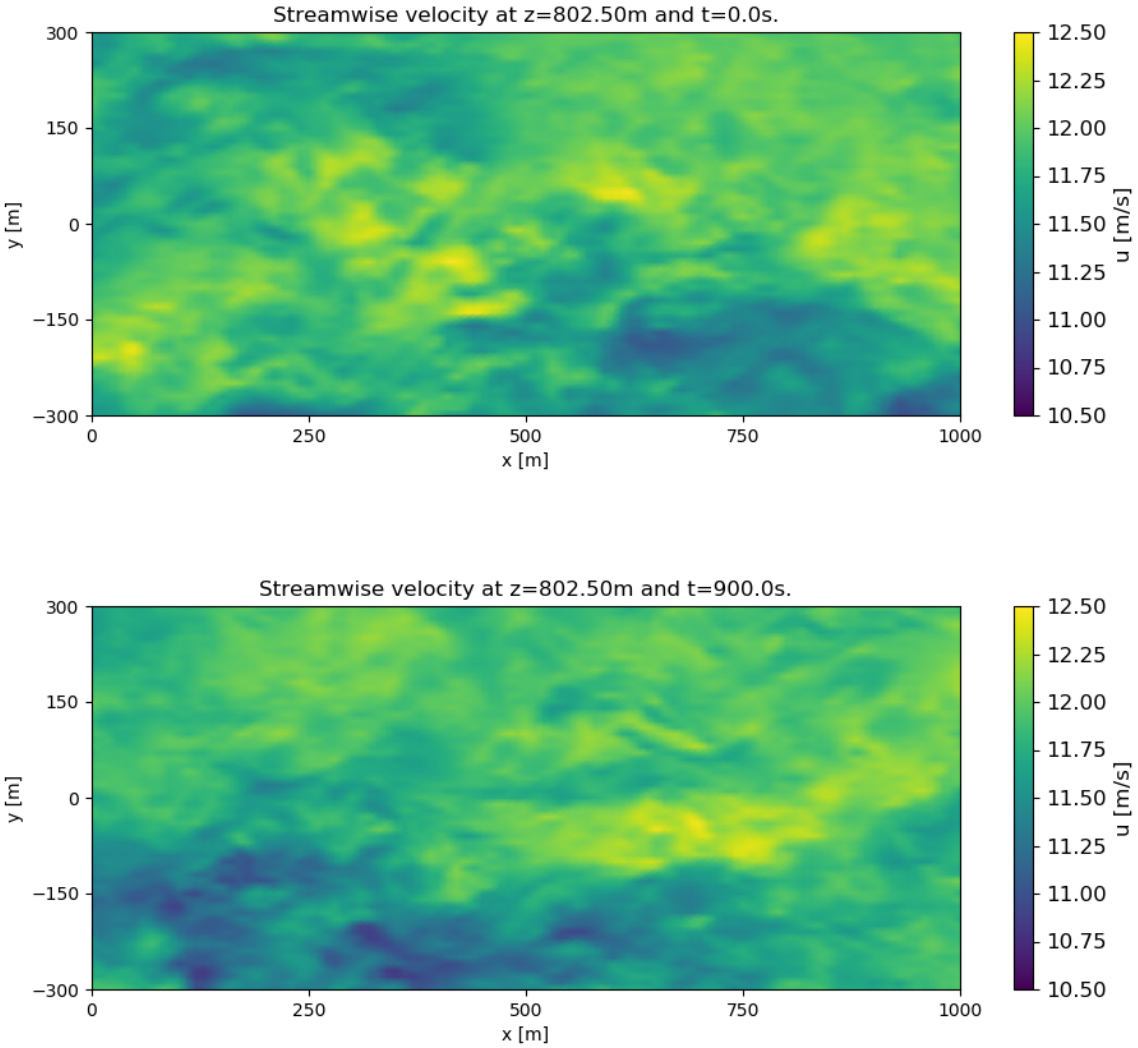

Figure 2: Top view at height $z = 802.5m$ and $t = 0.0s$ and $t = 900.0s$

Application 3

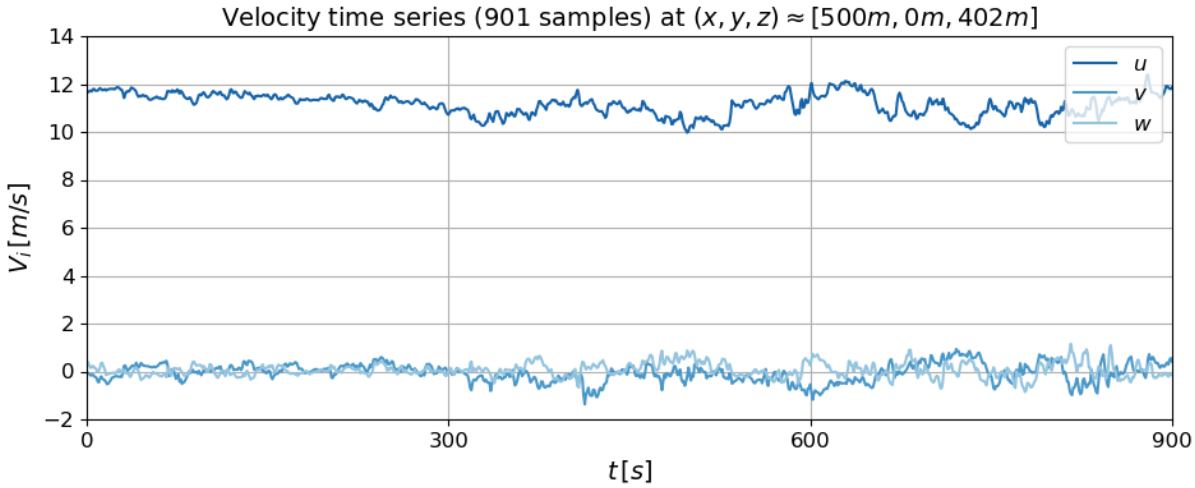

Figure 3: App.3: Time serie of velocity components at specific location

Application 4

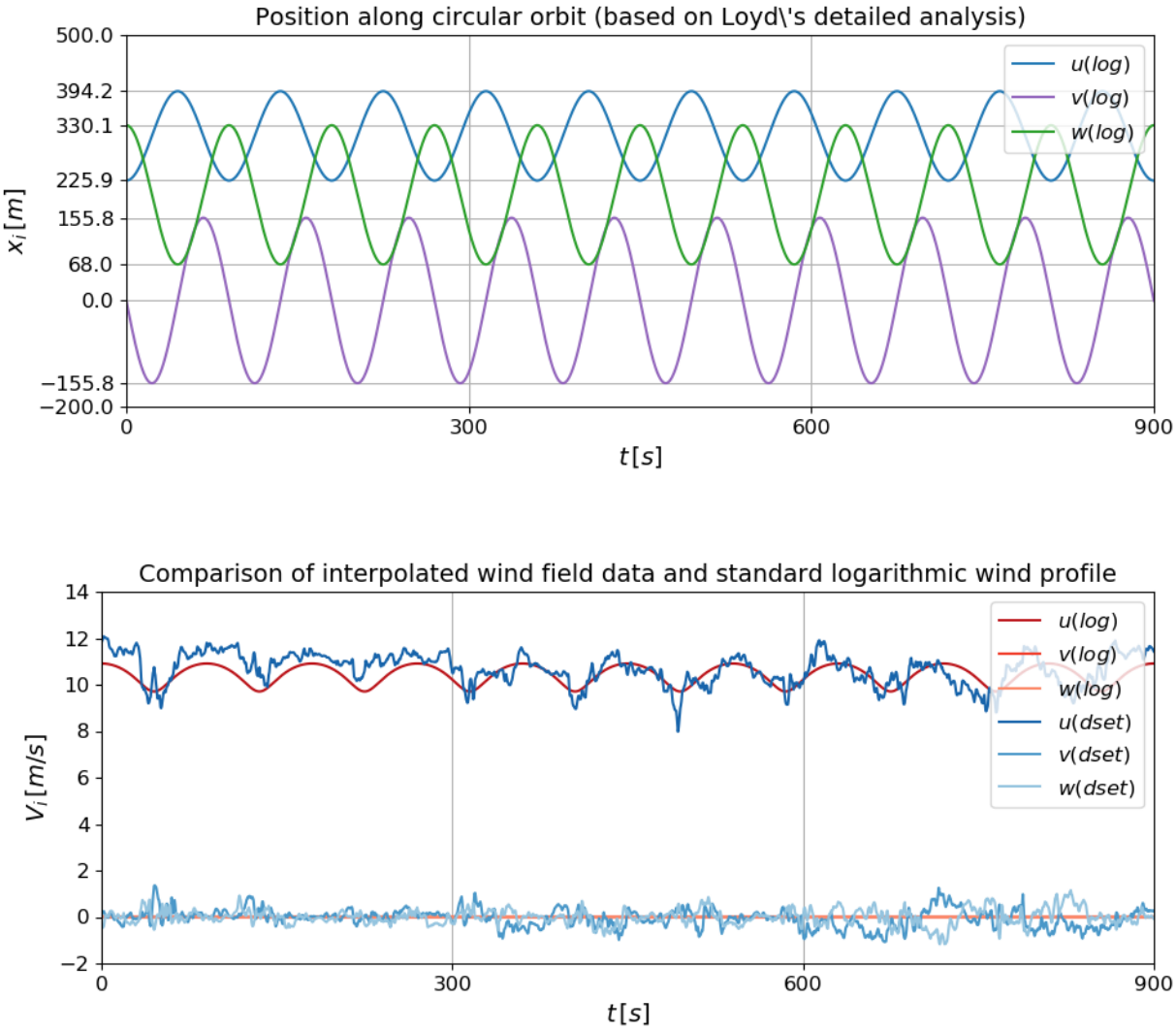

Figure 4: Interpolated velocity components along circular orbit