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AWESCO
Airborne Wind Energy
System Modelling, Control & Optimisation

AWE Optimization on Big Wind Data

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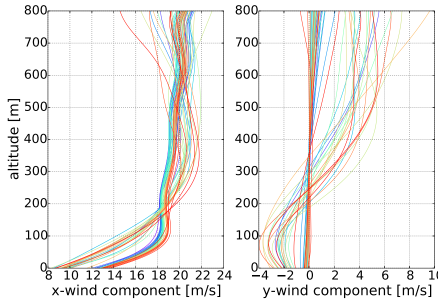
Airborne wind energy systems (AWE) are currently simulated and optimized using simple logarithmic wind profiles. This representation is known to be sufficient for wind power plants up to 100 m altitude, but AWE systems are likely to operate beyond that height, such that logarithmic profiles might not be adequate. Indeed, the optimization of AWE systems ought to take into account the overall wind profile at its location (wind speed and directions at different altitudes).

Wind data are abundantly available in electronic formats, either as direct measurements or as the output of state-of-the-art atmospheric models (or a combination of both), and could be used to investigate the optimal power output of AWE systems at different times and locations. Obtaining the optimal power output of AWE systems for a large number of wind data can be useful for e.g. estimating the performance of AWE systems, optimizing their design for realistic wind conditions, assessing installation sites, and for the integration of AWE systems in the power grid.

However, the optimization of AWE systems is known to be a computationally intensive and involved problem. Hence, computing the optimal trajectory and power output of AWE systems for a large number of wind profiles is a very challenging task. In this paper, we will present an early tool development which aims at tackling this problem. The MERRA [1] data on which the proposed tool is tapping consists of wind speeds and directions for a vertical resolution of 100m, available for every degree of latitudinal and longitudinal coordinates, and at a time resolution of 3 hours over the last 30 years. The solution approach we will propose is based on a combination of big data analysis using tools such as clustering, function approximators and data structuring, as well as techniques from parametric nonlinear programming (NLP) to handle the optimization problem on large data sets efficiently.



Example data of wind speed and direction projected into Cartesian coordinates

References:

[1] National Center for Atmospheric Research Staff (Eds): "The Climate Data Guide: NASA MERRA." Retrieved from https://climatedataguide.ucar.edu/climate-data/nasa-merra. Last modified 03-02-2017