Geophysical Research Abstracts
Vol. 13, EGU2011-930, 2011
EGU General Assembly 2011

Multiscale analysis of wind energy fluctuations

George Fitton (1), Ioulia Tchiguirinskaia (1), Daniel Schertzer (1), and Shaun Lovejoy (2)

(1) Université Paris Est, Ecole des Ponts ParisTech, LEESU, 6-8 avenue B. Pascal, Cité Descartes, 77455 Marne-la-Vallée cedex 02 France ; tel. : 33 1 6415 3607, fax: 33 1 6415 3764 ; (fittong@cereve.enpc.fr), (2) McGill University, Physics department, 3600 University street, Montreal, Quebec, Canada

Multiscale analysis of wind energy fluctuations

George Fitton (1), Ioulia Tchiguirinskaia (1), Daniel Schertzer (1), Shaun Lovejoy (2)

(1) Université Paris Est, Ecole des Ponts ParisTech, LEESU, 6-8 avenue B. Pascal, Cité Descartes, 77455 Marne-la-Vallée cedex 02 France ; tel. : 33 1 6415 3607, fax: 33 1 6415 3764 ; fittong@cereve.enpc.fr

(2) McGill University, Physics department, 3600 University street, Montreal, Quebec, Canada

As the world's fastest growing energy source with an estimated potential to supply up to 20% of the worlds electricity, wind power production has become the focus of a great deal of time and investment. However, although the potential for a competitive share in the market is there, poor power prediction and early warning system models are resulting in under estimated power production and damage to turbine gears. This in turn has made wind energy unreliable thus hindering the market's ability to become a mainstream competitor. The issue of unreliability is related to a common underlying problem; that current models are incorrectly describing intermittent turbulent effects and anisotropic velocity fields.

In order to analyse both intermittency and anisotropy it is first necessary to find a suitable dataset. We used a six-month sample of wind velocity data at 10Hz taken from a mast in a test wind farm (subject to wake turbulence effects) at three heights 22m, 23m and 43m. One problem encountered with the data was that a large number of corrupt and missing files made it difficult to have long runs of continuous error free data. The days with corrupt data were removed leaving a sample of 161 days from the total 181 days. Out of the 181 days the longest run of days without any errors having to be removed was 9 days. The first spectral analysis was done on this data over the range scale 0.1 sec - 1hr with the ensemble average then taken for all 9 days. The result from the spectral analysis of this data was rather unexpected: isotropic scaling of the three velocity components was observed up to and just over 1 minute. Next the full set of data with all of the corrupted files removed (where data was above 99.99% in quality for each day where quality = 1 - removed files/total files x 100) was then used to investigate the scaling behaviour over the larger range of 15hr per day, where again an ensemble average of the data was taken. The results from the analysis reconfirmed the isotropic features occurring again up to and just over 1 minute for all three wind velocity components.

Based on the scaling behaviour over larger scales, the spectral analyses were split into two distinct sets. The first set, which consisted of 116/161 of the days, followed a power scaling law up to 10 minutes after which both of the horizontal velocity components departed from the scaling with the same gradient. The vertical component departed at a much steeper gradient thus flattening much faster and thus emphasizing anisotropy within the system. The second set, which consisted of 45/161 of the days, followed a rather similar path for the vertical velocity component however both horizontal components maintained scaling up to an hour before both departing. The flattening of power spectra over scales larger than 10 minutes implied some interesting results would appear after further comparisons to the standard Van De Hoeven diagram. In fact the comparison showed large discrepancies between the Van De Hoeven model and our data. The first being the positioning of the turbulence peak at 5 to 10 seconds instead of Van De Hoeven's at 1 minute also the size of the peak is much smaller than that of the Diurnal turbulence peak which should be larger in comparison.

In respect of current developments the paper will discuss a possibility to explain the observed changes in scaling behaviour among different wind velocity components with the help of an anisotropic miltifractal model. The results from this analysis allow better understanding of the effects of wind turbine wakes and put forward the question of whether or not the amount of information being lost by the standard models, that use only information at 10 minutes (EU standard database), is suitable.