Deriving local wind speeds for a wind farm and a biocrop site using Grosswitterlagen weather types and the Weather Research and Forecasting model

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Microclimates

The Microclimates Consortium consists of four research groups from the universities of Leeds, Lancaster, Glasgow and Loughborough as well as Rothampstead Research. This consortium is developing new downscaling methodology to apply to three diverse demonstration applications (micro-climate prediction, wind farm (Black Law, Scotland) impacts on peatland carbon balance and the application of the micro-climate model to biorenewables). The project started in Summer 2010 and is due to complete in Spring 2013. Funded by NERC. http://ncasweb.leeds.ac.uk/microclimates/

Background

The UK wind farm industry requires high-frequency and high-resolution wind data to assess the energy outputs from wind turbines, and the likelihood of extreme weather. Part of the “Microclimates” project was therefore established to develop new downscaling modelling methodologies to link the synoptic-scale circulation (order ~1000 km) to local weather impacts (order ~200 m) for land-based renewable technologies. Furthermore, an additional aim to save costs, was to create representative high-resolution data without the need to downscale the whole of the ERA-40 time series.

Methodology

Local climatic conditions at a given UK location are strongly influenced by the prevailing synoptic scale weather patterns. In order to simplify the different synoptic weather conditions that affect the UK, an automated classification based on the German Grosswitterlagen (GWL) scheme was used.

West Circulation, cyclonic. (Hess and Brezowsky,1977). The composite has been calculated with an objective classification method following James (2007), using ERA-40 data (interpolated to 1° resolution). The composite is based on all days labelled as “WZ” during the extended winter season (ONDJFM) for the period 1957-1999. Shading represents the geopotential at 500 hPa, while contours represent the mean sea level pressure (hPa).

Mean Sea Level Pressure (MSLP) and Geopotential Height at 500 hPa over Northern and Western Europe were used to identify GWL types. A frequency analysis was then used to determine the most common type (WZ in this case). Further analysis identified periods of prolonged occurrence of that type (i.e. > 10 days). Four time periods were selected which conformed to these criteria. Two in summer (July) and two in winter (November). One of each season are shown here. The WRF model was run at high resolution (down to 200m) for a three day period within these selected periods. Wind speed and time speed were extracted for two Microclimates study sites: Black Law wind farm site in SW Scotland and a bio-crop site at Sicklinghall in Yorkshire. Both sites have automatic weather stations.

References

James, P. M., 2007: An objective classification method for Hess and Brezowsky Grosswitterlagen over Europe. Theoretical and Applied Climatology, 88, 17–42.


Summary

- WRF modelled data produce broadly similar trends to the wind speed data from meteorological sites
- The downscaling method produces greater accuracy in wind speeds than using reanalysis data alone in these test cases.
- Further WRF runs are planned at different locations e.g. valley, coastal and inland sites, and representative weather types.

Location

<table>
<thead>
<tr>
<th>Location</th>
<th>Wind Speed (m/s)</th>
<th>WRF Model runs</th>
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</thead>
<tbody>
<tr>
<td>Black Law</td>
<td>19th July 1999 to 21st July 1999 (low resolution, METAR and ERA-40)</td>
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<tr>
<td>Sicklinghall</td>
<td>19th July 1999 to 21st July 1999 (high resolution)</td>
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Two modelling approaches were used: i) Two week-long low resolution WRF simulations were performed for 4 different time periods. The inner domain covered the north of England and south of Scotland. ii) A smaller-scale 3-day (July 1974 and 6th to 9th Nov 1991) high-resolution WRF runs. Three nested domains were used with the inner domain covering a region of approximately 60 x 60 km. Data were extracted for Leeds Bradford airport and Salsburgh meteorological site.

Wind speed (m/s) for Leeds Bradford Airport 14th July 1999 to 23rd July 1999 (low resolution, METAR and ERA-40)

Salsburgh wind speed (m/s) for 6th November to 8th November 1991 (high resolution)

References
