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Highlight results

- **Proposition of a methodology to analyse 50 years return with regards to extrem winds**

Background:

As demand for wind power grows, there is an increasing need to establish appropriate quality controls and adequate risk management. Selecting sites for wind farms presents a challenge to finding a balance between having sufficient wind to operate efficiently but not too much that turbines are exposed to a high risk of being damaged. Recent research focuses on the specific challenge of assessing the risk that turbines in a wind farm could be damaged during a severe windstorm. A measure of this risk is an important factor when a wind farm operator considers a potential site and when financial support is being sought. The biggest challenge to performing this risk assessment is data availability. Unfortunately, potential sites for wind farms are typically in locations where there has been little reason to measure and record wind speeds. For this reason, there is a substantial technical challenge in undertaking the risk assessment using only a short record of historical wind speed data.

Reanalysis data:

Our approach focuses on the use of information generated by numerical weather prediction (NWP) models to provide adequate risk analysis for the wind power industry. More specifically, we employ reanalysis data (produced using fixed, modern versions of the data assimilation systems developed for NWP) to facilitate the risk assessment exercise. The challenge of using reanalysis data for risk analyses is that it is sampled less frequently and has a courser spatial

resolution in comparison to the wind speed data available at wind farm sites; this results in underestimation of the extreme wind speed. The actual wind speed observations used in our work were collected at Schiphol airport in the Netherlands. This extensive time series is approximately 45 years long and ranges from 01-Sep-1957 to 31-Aug-2002. The corresponding ECMWF ERA-40 reanalysis times series used is sampled at six-hourly intervals, implying that it has a courser temporal resolution than the hourly values in the actual wind speed time series.

Motivation:

We are using classical extreme value theory in order to estimate a 50-year return value using the block maxima technique. We define this 50-year return level as the extreme wind speed value that is exceeded, on average, once a year with a probability of 2%. Our work was motivated by the practical need for an innovative way of producing accurate 50-year return wind speeds, when we have only a limited length of actual wind speed data. Our objectives were to answer the following questions:

- What is the most appropriate method if we have a small time series (k-years long) of actual wind speed data?
- Can we use a long series of reanalysis data to produce reliable 50-year return speeds comparable to estimates from long series of actual data?
- How can we overcome the problem of different temporal resolutions of the actual and reanalysis series?

Methodology – Extreme Value Theory

In order to answer these questions we applied the block maxima method to 2000 surrogates of the actual and reanalysis series, by assuming we only had access to k years of actual data (for k=1,...,45) but 45 years of reanalysis data. We introduced the quantile calibration method in order to overcome the challenge of different sampling frequencies of the two series and systematic underestimation of the reanalysis time series.

Results

The results show that for $1 \leq k \leq 20$, using all 45 years of reanalysis data and the quantile calibration method applied to the k years of actual data, yields 50-year return estimates that are less biased than the estimates produced by just applying the block maxima method directly to the k years of actual data (Figure 1). Moreover, the 50-year return levels produced by the quantile calibration method are less variable and hence more reliable (especially for $2<k<35$ years) than the estimates produced by the block maxima method applied directly to k years of actual data (Figure 2).

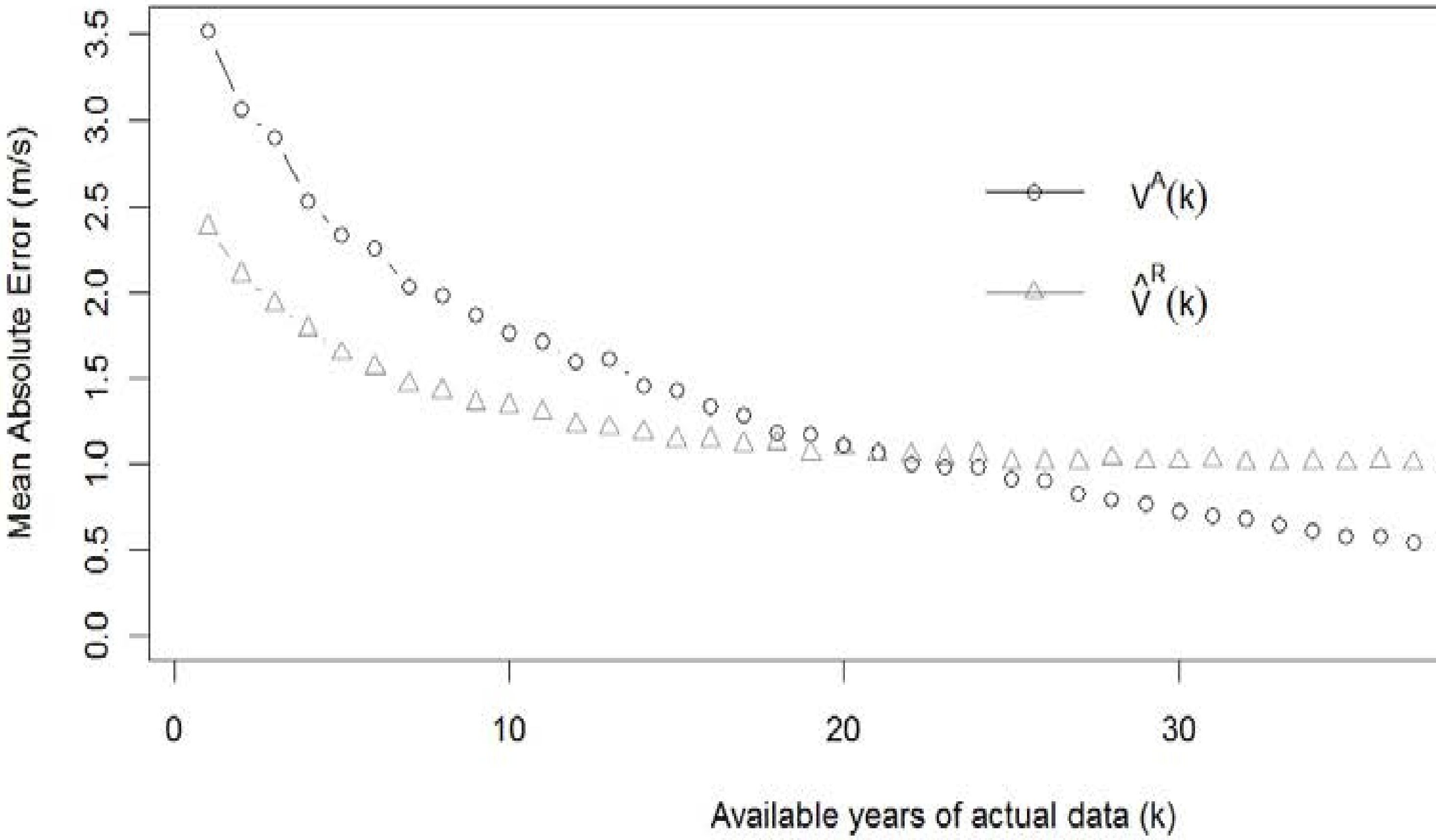

Figure 1: Mean Absolute Error of the calibrated reanalysis 50-year return, V^R (k), estimates and the 50-year return V
A
(k) estimates produced by applying the block maxima method to k years surrogates of actual data.

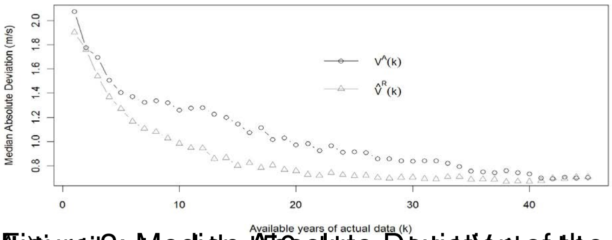

Figure 2: Median Absolute Deviation of the calibrated reanalysis 50-year return $V^R(k)$ actual data estimates produced by applying the block maxima method to k years surrogates of

Further work:

Further work will include testing the novel quantile calibration method for more potential wind farm sites where both a long record of actual wind speed and reanalysis data are available. Moreover, this method could be combined with other techniques for producing 50-year return estimates given less than 20 years of actual available data, such as the peaks over threshold (POT) method and the method of independent storms (MIS).

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