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ADVANCED WIND RESOURCE RISK MANAGEMENT: Wind Speed Forecasting over Seasonal Time Scales

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Keywords: wind resource assessment, seasonal forecast, wind energy

Target Groups

- **Wind energy institutions** (EWEA, GWEC)
- **Wind energy stakeholders** (Project investors, insurance companies, project developers/ managers, grid operators/planners, wind resource assessment service providers)

Relevance to the Case-Study Requirements

The variability of wind resources is directly linked to the energy yield of a wind farm. Throughout a wind energy project's life, it is currently unknown how much the wind resources could vary from one season to the next. The assumption is therefore made that long-term wind resource availability is constant; that future wind resource will reflect the past and its variability is consistent across all timescales. The potential risk that future wind resources could be significantly different over space and time is currently not assessed, nor have tools been made available to deal with this risk. This creates an uncertainty that affects investment and operations for wind projects and the grid network.

The Approach

Long-term wind energy resource estimates are currently inferred from archives of global weather forecasts and in-situ observations of, e.g., the past 10 years, and reanalysis data of e.g. the past 30 years, when no direct observations are available. The statistical components (moving means etc.) of this data enables wind speeds to be forecast for weeks or months ahead, although with inherently large uncertainty. Seasonal climate forecasts can help to reduce this uncertainty i.e. to improve a longer-term forecast above the current observational estimate used. It achieves this by looking beyond the trend of the statistical components and assessing the variability of the climate means over past timescales.

Seasonal wind forecasts are divided into two stages: first, a climate forecast system produces seasonal wind predictions (3 months for each season) for as many cases in the past as possible (typically using a baseline period of 1981-2012). These predictions are based on the monthly means and include an estimate of their uncertainty, depending upon the spread of the forecast ensemble members and their ability to reproduce the observations. This measure of uncertainty is used to assess the forecast quality of the system (i.e. the skill). Second, probabilistic future wind information is produced as an operational tool that shows the distribution of the forecast ensemble members over three categories: above normal, below normal and normal wind speeds, and the probability of the event to happen, based upon the number of forecast members within each of the categories.

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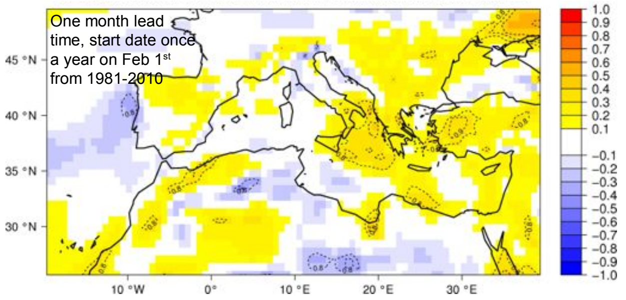
Product Example

Seasonal wind forecasts for Spring (March, April, May)

STAGE 1 : An estimate of the climate forecast system quality is made, by reproducing wind predictions for as many cases *in the past* as possible, and validating these forecasts against the ´observations´

Figure 1. 10m wind speed re-forecast anomaly correlation (AC) skill
(Climate forecast system : ECMWF S4, reanalysis ´observations´ : ERAInterim)

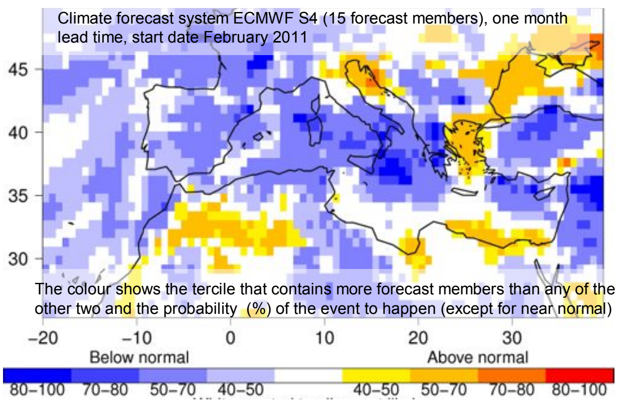


Result: Low, but predominantly positive skill is observed across the Mediterranean where the direct model output reaches approximately AC: 0.3 (Where 1 corresponds to a perfect forecast and 0 to a no information system).
A low climate forecast quality skill (figure 1) does not mean that there is no useful wind information in the forecast. The best way to extract this information is using probabilistic forecasts (figures 2, 3).

STAGE 2 : Operational predictions are issued that provide probabilistic *future wind information*

- Regional -

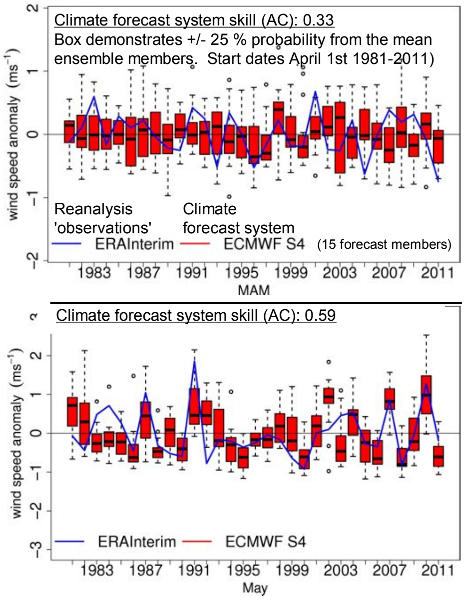
Figure 2. Spring 2011 forecast for 10m wind speed



Result : Below normal winds are generally predicted in western Europe in Spring 2011, with a probability of 70 % and higher. N.b. The credibility of these operational predictions is partially based upon the system forecast quality (stage 1), but a detailed analysis of the ability of the forecast system to reproduce the resource availability is needed for a full assessment of its value.

- Site Specific -

Figure 3. Three-month spring 2011 (top) and one-month May 2011 (bottom) forecast for 10m wind speed, Pamplona, Spain



Result: Some skill (AC: 0.33) is seen when predicting the wind variations for spring (3-month forecast).Considerably greater skill (AC: 0.59) is seen for a 1-month forecast during spring. N.b. In both cases, the fit varies from year to year.

Making the Product Usable

The skill of the climate forecast system to be able to predict spring winds (figure 1) suggests that an operational, probabilistic seasonal forecast (figure 2) contains some useful information for risk management when planning and operating wind energy projects over certain geographical regions. The 3-month probabilistic spring forecast for Pamplona, Spain (figure 3, top) shows certain years that demonstrate a reasonable forecast (e.g. 1997, 2000), although other years show little or no correspondence. The 1-month forecast (figure 3, bottom) over all years (1981-2011) in Spring shows promising skill of 0.59, and highlights the potential for using sub-seasonal wind forecast information in wind energy operational risk management for a given project site.

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