Predictability assessment of climate predictions within the context of the New European Wind Atlas project (NEWA)

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Introduction

A wind atlas is useful for the planning phase of wind energy development, which can last several years. Until now, the uncertainty of how winds could vary over future time-scales has not been addressed.

While the energy sector has routinely been using weather forecasts out up to 15 days, beyond this time horizon, climatological data (e.g. last 30-years average) are used. This approach assumes that future conditions will be similar to past conditions, however advances in climate prediction science can provide additional value for wind energy applications.

Within the NEWA project, this work aims to identify main skill sources in the climate prediction systems at different scales: sub-seasonal, seasonal and decadal.

![Prediction of temperature produced by ECMWF](image)

Fig 1. Observations (dotted) and forecasts (solid) made by ECMWF at the beginning of June of European 3-lead temperatures (°C). Source: Rodwell and Doblas-Reyes, 2006

Climate predictions, sources of predictability

Climate predictions do not have skill in forecasting wind extremes at hourly or daily timescales. However, climate predictions have nonetheless some skill in predicting anomalies of the climate (monthly, seasonal averages, etc.). This skill is present regardless of the daily timing of the major weather events within the period.

![Main sources of predictability of wind speed](image)

Fig 2. Main sources of predictability of wind speed. Each color corresponds to a different timescale: sub-seasonal (blue), seasonal (red) or decadal (green). The areas outlined are: NAO (North Atlantic Oscillation), ENSO (El Niño Southern Oscillation), MJO ( Madden-Julian Oscillation), PIOP (Interdecadal Pacific Oscillation), AMO (Atlantic Multidecadal Oscillation), AO (Atlantic Oscillation), PDO ( Pacific Decadal Oscillation), NAO (North Atlantic Oscillation), SCI (Slow Climate Extremes), SCI (Slow Climate Extremes).

Methods

Steps for each timescale: 1) comparison of the forecasts with the observations by means of different skill scores; 2) detection of the strength of the relationship between wind speed and its various sources of predictability (see Figure 2).

Sub-seasonal predictions (predictions initialized the 15th, 22nd and 29th of January 2015):

- ECMWF sub-seasonal prediction system
- CMA prediction system
- NCEP real-time forecasts

Seasonal predictions (predictions initialized the 1st of November from 1981 to 2013):

- ECMWF System 4

For each case, the maximum number of prediction systems has been used to reduce the wind speed inaccuracy, since averaging across a number of predictions, model errors partially compensate each other. The use of multimodel ensembles also allows to quantify the uncertainty associated to the forecasted values of wind speed, by measuring the spread between the different outcomes.

Results

Sub-seasonal (preliminary results):

- The CMA prediction system displays lower correlations than those from ECMWF and NCEP.
- The considered prediction systems show statistically significant levels of correlation for the three lead times.

![Correlation coefficient of 10-m wind speed for the forecasts of January 1985-2014](image)

Fig. 3. Correlation coefficient of 10-m wind speed for the forecasts of January 1985-2014. The forecast time of 19-25 (left) 22-28 (middle) and 25-31 (right) days are considered.

Seasonal (preliminary results):

To assess the variation of the potential predictability in Europe at different lead times, Fig. 4 illustrates the seasonal variation of the correlation coefficient for lead 0, 1, 2 and 3.

![Correlation coefficient between 10-m WS of the ECMWF54 hindcasts and ERA-Interim (1981 to 2013). Forecasts of the boreal winter (DF)](image)

Fig. 4. Correlation coefficient between 10-m WS of the ECMWF 54 hindcasts and ERA-Interim (1981 to 2013). Forecasts of the boreal winter (DF).

To illustrate the evolution of skill with the lead time, Fig. 5 illustrates the variation of the correlation coefficient for two locations which correspond to different wind farms.

![Evolution of the anomaly correlation coefficient between 10-m WS of ECMWF54 hindcasts and ERA-Interim with different initialization in months in the period from 1981 to 2013 for the prediction of the boreal winter](image)

Fig. 5. Evolution of the anomaly correlation coefficient between 10-m WS of ECMWF 54 hindcasts and ERA-Interim with different initialization in months in the period from 1981 to 2013 for the prediction of the boreal winter.

A positive phase of the NAO has a marked effect upon wind speed in the north of Europe, the Mediterranean and Northern Africa. A positive phase of the El Niño increases causes increases in wind speed in northern South America.

![Difference in WS (m/s) between years with a positive NAO index and years with a neutral NAO index (Diff. (right panel) NMI index)](image)

Fig. 6. (left panel) Difference in WS (m/s) between years with a positive NAO index and years with a neutral NAO index (Diff. (right panel) NMI index).

Conclusions

Preliminary results from the hindcasts analysis detected at least two windows of opportunity (positive forecast skill) over Europe, one at sub-seasonal time scale, for a lead time of 12-18 days, and another at seasonal scale, for a lead time of one month. This skill is found to exist mainly over Central and Northern Europe during winter months, and to a lesser degree in the Iberian Peninsula.

Future work:

- Verification against other datasets
- Assessment of different systems
- Apply bias-correction techniques
- Categorization of regions

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