Short-Term Forecasting of Wind Speed and Direction
Exploiting Data Non-Stationarity
Alice Malvaldi, Jethro Dowell, Stephan Weiss, and David Infield
University of Strathclyde

Abstract
As worldwide more and more wind power sources are integrated into the national transmission systems, the accuracy of wind farms’ power output is of fundamental importance for power system operators. The high uncertainty of wind decreases the reliability and stability of power systems and therefore the operational costs are increased. Accurate forecasts are valuable also for wind farm operators trading on the energy market, as these will result in more precise bids avoiding penalties for not producing the power they declared in advance.

Wind speed and direction are forecasted using hourly measurements from M geographically separate sites. The proposed predictor is a complex-valued multichannel linear filter and its general structure is outlined in Fig. 1. The British Atmospheric Data Centre provided the Met Office Integrated Data Archive System (MIDAS) set of hourly onshore weather data from 22 stations across the UK.

Results
Benchmark model:
- Persistence: \( x_{\text{meas}}[n] = x_{\text{meas}}[n-1] \)

Cyclo-stationary models:
- 6h/day
- ... 12h/day
- ... 24h/day

Results for site 12, Coningsby (East England)

Cyclo-stationary Model
The cyclo-stationary model is based on the complex-valued multichannel Wiener filter where the hypothesis on the non-stationarity of data are made. It is assumed that the data are stationary within a time window of length \( L = 15 \) weeks and for \( h \) hours per day. Figure 2 shows the selection of data to calculate the filter coefficients.

Conclusions
Performance of the models is site specific, however it is possible to identify two main common features:
- When the wind speed changes slowly, the error tends to increase as fewer hours per day are selected to calculate the statistics.
- When there are abrupt changes in the wind, the 6h/day model has a better performance than persistence.

References