Assessment of ECMWF's 100m EPS Winds in probabilistic Wind Power Forecasting

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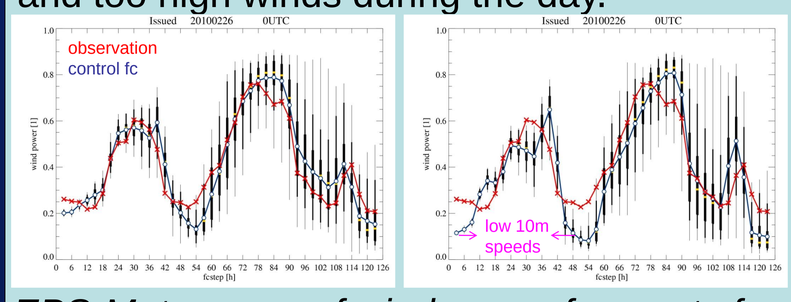
New 100m EPS Winds

At 26 Jan 2010 u and v winds in 100m height became operational output at ECMWF for the EPS. Until that date wind speeds in 10m heights had to be used for probabilistic wind power forecasting. But,10m winds without atmospheric stability information lead to strong diurnal biases in wind power due to too low forecasted wind speeds during night and too high winds during the day.



EPS-Meteogram of wind power forecasts for Germany. 100&10m wind power (left) and 10m (right) is normalized to installed capacity.

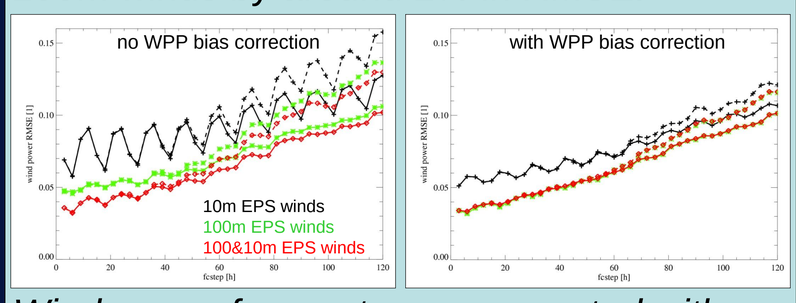
This study shows the benefits of 100m EPS winds for deterministic and probabilistic forecasts up to lead times of 120h.

Ensemble Wind Power Forecasts for Germany

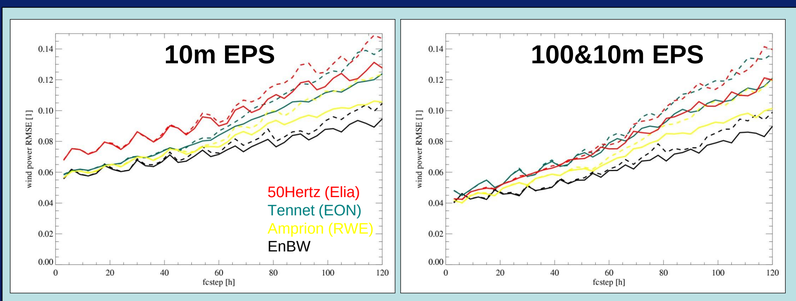
Ensemble wind power predictions (WPP) have been computed from Feb 2010 to April 2011 with 00&12 UTC forecasts for four Transmission System Operators (TSOs) in Germany utilizing three methods to derive wind speeds at hub height which varies between 50 and 120m:

a) 10m winds are extrapolated using the neutral logarithmic wind profile and the surface roughness
b) 100m winds are extrapolated using the neural logarithmic wind profile and the surface roughness
c) 100&10m winds are used for linear interpolation to hub height

The systematic diurnal wind power forecast error is removed with a time of the day dependent WPP-MOS. The Control and Ensemble mean forecasts are superior using 100m winds by around 2% in RMSE.



Wind power forecast error computed with Control run (dashed) and ensemble mean (solid) for different input EPS winds.

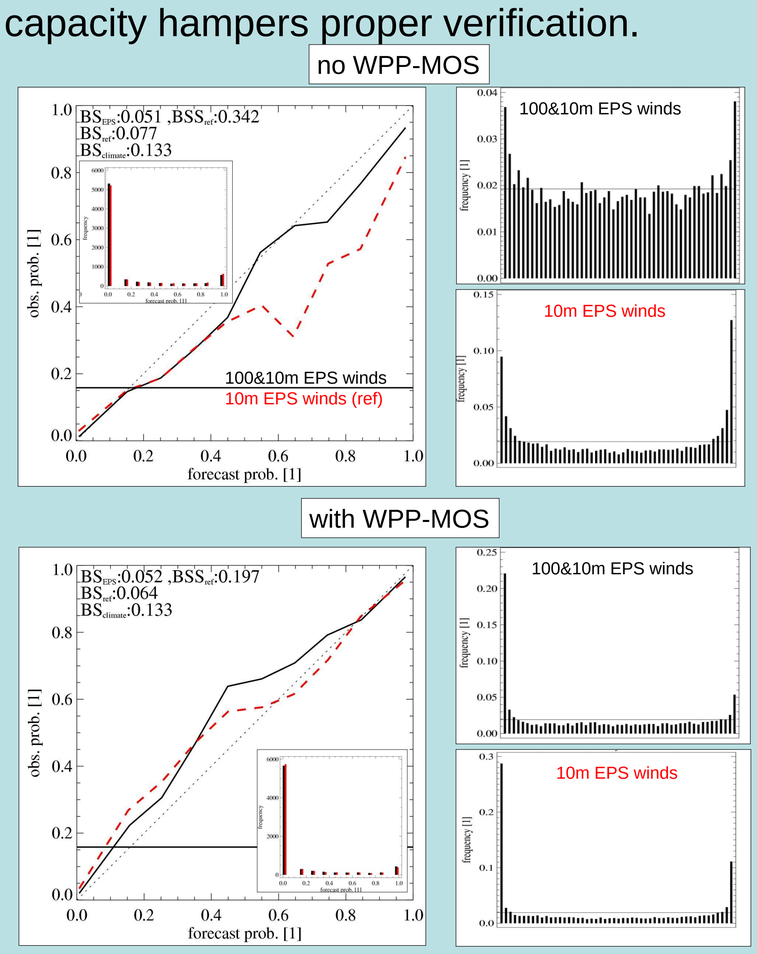


Wind power forecast error (with WPP-MOS) for all four German TSOs with Control (dotted) and ensemble mean (solid)

RMSE errors are normalized to installed wind power (~27GW). The Ensemble mean is substantially better than the Control from Day 4 onwards for each TSO. A slight diurnal cycle remains after WPP-MOS for 10m winds.

Probabilistic Forecasts

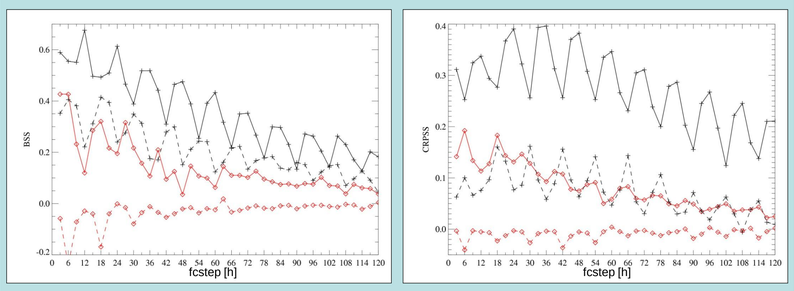
It is questionable if the WPP-MOS applied to all Ensemble members will preserve the characteristics of the EPS. At Day 3 the ensemble wind power forecast with 100m winds has a good reliability which degrades slightly after the WPP-MOS. Furthermore the WPP-MOS makes the ensemble members underdispersive (see Talagrand Histogram). 10m ensemble members are extremely underdispersive and WPP-MOS is doing worse. However, the reliability is improved for 10m winds. In general, the low frequency of wind power exceeding 30% of rated capacity hampers proper verification.



Reliability Diagram (left) for >30% wind power production in Germany and Talagrand Rank Histograms (right, all cases) at Day 3 for different input EPS winds and no WPP-MOS (top) and with WPP-MOS (bottom)

Brier Score (left) and ROC Area (right) for wind power exceeding 30% of rated wind power capacity. Dashed line for WPP-MOS

The 10m Ensemble forecast profits a lot from the WPP-MOS in terms of Brier score improvement. Nevertheless the Brier Score and ROC area of 100&10m EPS winds is much better for all lead times. The benefit of the WPP-MOS is marginal for 100&10m.



Brier Skill Score (left) for wind power >30% and CRPSS (right) with (dashed) and without WPP-MOS (solid) for 100&10m winds compared to 10m (black) and 100&10m winds compared to 100m winds alone (red).

Probabilistic wind power forecasts utilizing 100m winds clearly outperform 10m winds in terms of BSS and CRPSS. The improved skill decreases with lead time.

The skill of 10m winds can be considerably increased by MOS to overcome the deficiency of missing information to interpolate the wind profile to hub height.

Conclusions

The skill of probabilistic wind power forecasts that use 100m EPS winds is considerably higher than only 10m winds. No WPP-MOS is required and the forecasts have good reliability. The 100m Ensemble is only slightly underdispersive. The usage of 10 and 100m winds give best results. Further studies should reveal if even more vertical wind speed levels will be beneficial to model more accurately the wind speed at hub height.

Acknowledgement

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