



## **Determining the bounds of skilful forecast range for probabilistic prediction of system-wide wind power generation**

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State-of-the-art wind power forecasts beyond a few hours ahead rely on global numerical weather prediction models to forecast the future large-scale atmospheric state. Often they provide initial and boundary conditions for nested high resolution simulations. In this work, both upper and lower bounds on forecast range are identified within which global ensemble forecasts provide skilful information for system-wide wind power applications. An upper bound on forecast range is associated with the limit of predictability, beyond which forecasts have no more skill than predictions based on climatological statistics. A lower bound is defined at the lead time beyond which the resolved uncertainty associated with estimating the future large-scale atmospheric state is larger than the unresolved uncertainty associated with estimating the system-wide wind power response to a given large-scale state. The bounds of skillful ensemble forecast range are quantified for three leading global forecast systems. The power system of Great Britain (GB) is used as an example because independent verifying data is available from National Grid. The upper bound defined by forecasts of GB-total wind power generation at a specific point in time is found to be 6–8 days. The lower bound is found to be 1.4–2.4 days. Both bounds depend on the global forecast system and vary seasonally. In addition, forecasts of the probability of an extreme power ramp event were found to possess a shorter limit of predictability (4.5–5.5 days). The upper bound on this forecast range can only be extended by improving the global forecast system (outside the control of most users) or by changing the metric used in the probability forecast. Improved downscaling and microscale modelling of the wind farm response may act to decrease the lower bound. The potential gain from such improvements have diminishing returns beyond the short-range (out to around 2 days).