Probabilistic Fine-Scale Weather Prediction
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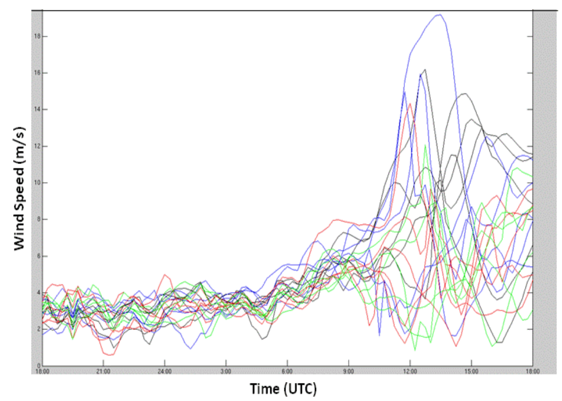
Weather forecasts are crucial for a variety of applications. Predicting the degree of wind energy in the coming days at existing wind farms, knowing if significant weather such as severe thunderstorms or icing will affect certain regions, and estimating how much rain will play a role in agricultural operations are all examples of the important role of weather forecasts. But these forecasts to be useful, they must be created in smart ways.



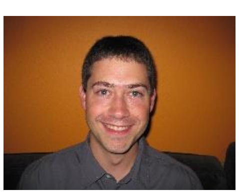
The uncertainty in predicted wind speed at a specific wind farm shown through a plot of 20 equally likely forecast ensemble members over a 24-hour period

There are two key characteristics of weather forecasts that make them most valuable: 1) that they are probabilistic, and 2) that they are created at high resolution. Weather forecasts suffer from the presence of chaos, which causes small errors in forecasts (which are impossible to remove) to grow rapidly as forecasts are run to longer times. Further, our weather prediction models are not perfect, and they themselves use estimates of different atmospheric processes such as clouds and turbulence near the surface. As a result, a single weather forecast is almost guaranteed to be wrong. To mitigate this issue, many forecasts can be run simultaneously (known as ensemble forecasting) to characterize the range of possible states the atmosphere will produce. Ensemble forecasting allows the straightforward production of high-quality forecast probabilities (e.g. the chance of wind ramp, or the probability produced power exceeds a chosen threshold) and uncertainty (how likely the forecast is to be correct), two aspects critical for end users to make smart decisions.

High resolution is another critical feature of modern weather forecasts. The ability to resolve high-impact features such as severe thunderstorms and localized heavy rainfall is required to accurately predict important weather and how it will affect end user applications. While computational cost used to prohibit real-time production of high-resolution ensemble forecasts, modern-day computing now allows this to be done at the National Wind Institute. In turn, we run a real-time, high-resolution, 52-member ensemble system over much of the U.S. that provides useful day-to-day forecast probabilities to numerous users and applications.

At the National Wind Institute, we're also studying ways to advance high-resolution, probabilistic forecasting to the degree it can provide even more benefits to industry, society, and the economy. We are leveraging big data capabilities to analyze statistical relationships within the vast amount of information contained with ensemble forecasts. As a result, we have begun to uncover ways to greatly improve forecasts of specific localized events to a degree that has yet to be realized.

About the Author



Brian Ancell is an Associate Professor of Atmospheric Science at Texas Tech University. Dr. Ancell has developed a nationally recognized research program focused on high-resolution probabilistic weather prediction and statistical big data tools to optimize forecasts. He runs a real-time ensemble system at Texas Tech that serves a large number of public and private users across several application domains.