Joint Temporal Modeling of High-Frequency Wind Speeds and Directions via the Projected Normal

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Stochastic weather generators attempt to describe and capture the variability of climate systems for the purposes of simulating realistic replications of the underlying system. Such simulations can be leveraged to provide inferences on the entire system in less computations than an ensemble weather model might. In the case of wind climatology, both the ensemble models and the existing generative research emphasize average wind speeds over half-hour or longer period. However, short-scale variability is often important to broadcasting short-scale power futures and day-to-day wind farm optimization. This talk will present a method for simulating time series of wind data calibrated by real data from locations in the Colombia River Valley (Oregon, US). The method provides and fits a parametric model for local wind directions by embedding them into the angular projection of a bivariate normal. Incorporating a temporal autocorrelation structure in that normal induces a continuous angular correlation over time in the simulated wind directions. This is compared a prominent existing method for simulating angular time series of swapping between discrete regimes of wind direction, a method that often does not fully translate to high frequency data. We complete the talk by conditionally modeling wind speeds given the projected normal wind direction simulations, with discussion on the theory and challenges associated with hierarchically modeling cross-covariance structures. The final joint model for speed and direction can be decomposed into the simulation of a single multivariate normal and a series of transformations thereof, allowing for fast and easy repeated generations of long time series.