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Quantifying risks from spatially and temporally correlated hydrological and meteorological processes in wholesale electricity markets

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Hydrological extremes can cause periods of extreme (high or low) electricity prices in wholesale markets and financially impact both suppliers of electricity (utilities, renewable energy producers) and consumers. However, little previous research addresses this issue using a risk-based (probabilistic) framework, due in part to the modeling scale and resolutions required. Interconnected electric power systems can span areal extents much larger than those of hydrological drought, and their operations must be modeled at higher temporal resolutions than typical water balance simulations. At the same time, exploring important water resource dynamics (seasonality and interannual variability) requires simulations to be run for entire calendar years, on the order of 1000s of times. Capturing uncertainty in other environmental drivers is now essential as well, including air temperatures, wind speeds and cloud effects, which influence a range of grid processes (electricity demand, availability of wind and solar power, etc). This presentation will introduce and demonstrate an open source Python based stochastic modeling framework for evaluating risks from spatially and temporally correlated environmental processes in electricity markets at decision relevant scales. The framework is comprehensive in its treatment of stochastic inputs, simulation of relevant infrastructure (reservoir networks, power systems), and evaluation of outcomes (prices, emissions, etc.). In order to demonstrate the modeling framework's ability to accurately represent system behavior, it is first validated and then used to explore extreme conditions in a high profile test-bed– the western coast of the United States.