APPLYING LAND SURFACE – ATMOSPHERE INTERACTIONS TO IMPROVING WIND ENERGY FORECASTING SYSTEMS

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Wind energy has emerged as an important source of renewable energy. Accurate forecasts of wind speeds are critical for harnessing energy from wind effectively. We present an approach for improving wind speed forecasts by evaluating uncertainty in observable quantities, and analyzing how these uncertainties propagate between coupled fields. This three-part approach employs the fully-coupled hydrologic and atmospheric modeling system ParFlow-WRF to dynamically simulate feedbacks between the subsurface, surface and atmosphere to generate physically-based wind speed forecast ensembles. We use a semi-idealized ensemble simulation to demonstrate that by reducing uncertainty in subsurface hydraulic conductivity – a controlling factor for soil moisture distribution – we reduce uncertainty in soil moisture, latent heat flux and wind speed. We further examine a non-idealized simulation ensemble using forcing data from the North American Regional Reanalysis at a location near the west coast of the United States comparing model simulation results with observed data and generating probabilistic wind speed forecasts based on the deterministic ensemble forecast outputs to improve forecast utility. We also perform a spatial analysis on these results using cross-variograms showing spatial cross-correlation between simulated results for hydraulic conductivity and soil moisture distribution; soil moisture and latent heat flux; and latent heat flux and wind speed. Finally, we analyze propagation of uncertainty and sensitivity of subsurface, surface and atmospheric variables including soil moisture sensible and latent heat fluxes, temperature and wind speed using an ensemble Kalman filter data assimilation technique to develop methods for optimizing data collection plans, both spatially and temporally.