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Analysis and probabilistic forecast of wind power generation and ramp in Japan based on multi-model ensembles

Masamichi Ohba, Daisuke Nohara, and Shinji Kadokura

Central research institute of electric power industry, Environmental Science Research Laboratory, Abiko, Japan (oba-m@criepi.denken.or.jp)

Weather events can interrupt the spin of wind turbines in large scale that cause unexpected “wind ramp events”. In this study, we present an application of self-organizing maps (SOMs) for climatological attribution of the wind ramp events and their probabilistic prediction. The SOM is an automatic data-mining clustering technique, which allows us to summarize a high-dimensional data space in terms of a set of reference vectors. The SOM is applied to analyze and connect the relationship between atmospheric patterns over Japan and wind power generation. SOM is employed on sea level pressure derived from the JRA55 reanalysis over the target area (Tohoku region in Japan), whereby a two-dimensional lattice of weather patterns (WPs) classified during the 1977–2013 period is obtained. To compare with the atmospheric data, the long-term wind power generation is reconstructed by using a high-resolution surface observation network AMeDAS (Automated Meteorological Data Acquisition System) in Japan. Our analysis extracts seven typical WPs, which are linked to frequent occurrences of wind ramp events.
Probabilistic forecasts to wind power generation and ramps are conducted by using the obtained SOM. The probability are derived from the multiple SOM lattices based on the matching of output from TIGGE multi-model global forecast to the WPs on the lattices. Since this method effectively takes care of the empirical uncertainties from the historical data, wind power generation and ramp is probabilistically forecasted from the forecasts of global models. The predictability skill of the forecasts for the wind power generation and ramp events show the relatively good skill score under the downscaling technique. It is expected that the results of this study provides better guidance to the user community and contribute to future development of system operation model for the transmission grid operator.