Climatological attribution of wind power ramp events in East Japan and their probabilistic forecast based on multi-model ensembles

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This study presents an application of self-organizing maps (SOM) for the climatological/meteorological study of wind power ramp events. SOM constitutes an automatic data-mining clustering technique, which allows for summarizing of a high-dimensional data space in terms of a set of reference vectors. SOM is applied to analyze and establish the relationship between atmospheric synoptic patterns over Japan and an object e.g., wind power generation. In this study, synoptic patterns derived from the JRA-55 reanalysis over the Tohoku region in Japan are classified by using SOM into a two-dimensional lattice of patterns. Wind-power ramp events (defined as a 30% change in power in less than 6 h) mainly take place during the winter months in East Japan. Our SOM analysis for weather patterns in boreal winter extracts seven typical patterns that are linked to frequent occurrences of wind ramp events.
Medium-range probabilistic wind power prediction is derived by this SOM lattices based on the weather patterns of the multi-center grand ensemble forecasts for a particular day. Because this analog approach effectively handles the stochastic uncertainties indicated by the large number of ensemble members, a probabilistic wind power generation is easily and quickly obtained from the huge number of ensemble forecasts. The use of multi-center grand ensemble forecasts provides results better than those from one forecast model. 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. The advantage of this method is it can include the interpretative analysis of the impact of meteorological/climatological factors on the variation of the renewable energy.

Keywords: Wind power, Ramp events, Self-organizing maps, Weather patterns, Synoptic climatology, Renewable energy

