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Climate change impact on the wind energy resources in Japan corresponding with weather pattern changes

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This study investigated about the impact of global warming on the resource of wind power generations by using the large ensemble simulation of the global warming experiments named d4PDF dataset. The d4PDF consists of outputs from general circulation models (d4PDF-GCM) and dynamically downscaled for the Japanese region using a regional climate model (d4PDF-RCM) for historical (1951–2010) and +4-K future climate (2051–2110) projections. The horizontal grid spacing of d4PDF-GCM and d4PDF-RCM were 60 km and 20 km, respectively. The capacity factor under the future and present climate is obtained from an idealized power curve. As for the result of the future projection of wind energy in Japan, we find the north-south contrast of the climate responses. Wind power generation slightly increased in Northeast Japan while significantly decreased Southwest Japan. To investigate about the detailed global warming impact on the capacity factor of wind energy in Japan, self-organizing maps (SOMs) is employed on atmospheric variables derived from the d4PDF over the region, whereby weather patterns (WPs) in present and future +4 climate were classified for a two-dimensional lattice. Future probabilistic projection of WPs under the global warming scenario show the increase in occurrence frequency of the WPs which has advantages for the wind power generations in East Japan. By using the probabilistic relationships between synoptic scale atmospheric variables over Japan and observed are integrated wind power generation in East Japan, we also find the increase (decrease) of ramp down (up) probability defined as a 30% change in power in less than six hours.