

Climate Change Impact on Offshore Wind Energy Resources in Japan

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This study investigated the impact of global warming on Japanese wind energy resources and their short-term variations using the large ensemble d4PDF dataset, which consists of dynamically downscaled historical and +4K future climate projections. The capacity factor under the future and present climate was estimated from an idealized power curve based on hourly near-surface wind speeds. The +4K warming future climate projections showed significant changes in wind energy resources that varied both regionally and seasonally. The wind energy potential was projected to slightly increase (decrease) from winter to spring over northern (southern) Japan and decrease from summer to autumn over most of Japan. The projected annual production decreased by about ~5% over Japan in response to climate change. The frequency of wind ramp events also decreased in the latter seasons. The relationship to synoptic weather was investigated using self-organizing maps, whereby weather patterns (WPs) over the region in the present and future +4K climate were classified for a two-dimensional lattice. Future probabilistic projections of WPs under the global warming scenario showed both increases and decreases in the frequency of different WPs, with corresponding advantages and disadvantages for wind power generation with regard to future changes in capacity factors in Japan. The importance of these frequency changes on the total change was further assessed by separating the dynamical and thermodynamic contributions.

Keywords: Wind energy, Wind ramp events, Climate change, Global warming, d4PDF, Weather pattern