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Analysis and Forecasting of Winds and Waves at Floating Type Wind Turbine Demonstration Site

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1. Introduction
The floating type wind turbine demonstration project is being performed in Japan, and a 1:2 scale model was installed off the Kabashima Island in Nagasaki Prefecture on June 11th, 2012.
As for the design, external forces such as wind and wave on the floating type wind turbine demonstration site were evaluated using various kinds of re-analysis and prediction data including NCEP wind data, JMA meteorological GPV data and NEDO data. Considerations for the design were given for wave characteristics of maximum and mean wave height, crest height, 2D height-period distribution, and wave energy spectrum. Tides, currents and winds were also evaluated. In addition the extreme wind speed was estimated including typhoon effects considering grid resolution dependence gust factor.
A wind and wave prediction system was developed and its validity was examined by statistically comparing predicted values with measured data at the demonstration site. The present information system gives information for various user selected areas and lead times with both visual animations and time series graphs.
2. Design wave and wind
The site is located off the Kabashima Island in Nagasaki Prefecture, Japan. Design forces were determined from extreme wind and wave statistics and an empirical method. The results are:
50 years return period wave and wind: Hs = 7.73 m, Ts = 14.0 s, U = 53.1 m/s
100 years return period wave and wind: Hs = 8.20 m, Ts = 14.3 m, U = 57.0 m/s
Other characteristics were also determined, such as the maximum wave height, crest height, 2D height-period distribution and wave energy spectrum, tide, current and maximum wind.
3. Wind and wave prediction system
The system composed of NCEP GFS (Global Forecasting System) meteorological data, down-scaling wind field by WRF (Weather Research Forecasting), JMA HAGPV (Hourly Analyzed Grid Point Value) 10m wind data, and wind-wave forecast data by SWAN (Simulating Waves Nearshore). The flowchart shown in Fig. 1 displays the information and process flow of wind and wave data, where a new web information site has been developed.
4. Verification of predictions
Satisfactorily good agreement between prediction and observation has been found when evaluating the indices of correlation coefficient, root mean square error, and Brier score. The prediction system is shown to be useful for obtaining vital offshore wind and wave information.