Investigation of WRF configuration for offshore wind resource maps in Japan

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Introduction
Since July 2015, the national project for making offshore wind resource maps in Japan has been undertaken by the New Energy and Industrial Technology Development Organization (NEDO). In this project, 500m-gridded offshore wind resource maps are planned to be created for the coastal waters within 30 km from the coasts, using the mesoscale model WRF (the Weather Research and Forecasting model). The development target on the map accuracy is a bias of within ±5% in annual mean wind speed at the height of 80 m. This paper describes simulation experiments to define the model configuration for a large amount of simulation to make offshore wind resource maps.

Methods
In this study, the simulation experiments are conducted using in-situ measurements from the mast at Kitakyushu, Fukuoka Prefecture, shown in Figure 1. Simulations with the Advanced Research WRF version 3.6.1 are performed using two domains with 2.5 km and 0.5 km grids, as shown in Figure 2. Table 1 summarizes the model configuration tested in this study. In total, seven WRF simulations are carried out with slightly different model configurations. They are named Case 1 through Case 7 and are compared each other to find the best model configuration.

Results
Table 2 summarizes statistics (bias, root-mean-square-error (RMSE), their relative values to mean wind speed, correlation coefficient (CC), and ratio of observed and simulated standard deviations) on the accuracy of WRF-simulated wind speeds at the height of 80 m. Figure 3 shows monthly and annual biases in the WRF-simulated 80m-height wind speeds. Figure 4 depicts annual biases at each measurement height, meaning vertical profiles of the bias from 30 m to 80 m.

Conclusions
By setting up simulation conditions properly and selecting higher quality input data, the WRF simulation can achieve a target bias of ±5 % in annual mean wind speed at a hub height (80m) even in Japanese coastal waters, where it is known that the accuracy of mesoscale modelling cannot be higher compared to European seas due to their complex topography and wind climate [1]. The best model configuration found in this study will be used in the ongoing national project for making offshore wind resource maps under NEDO.

References

Table 1 Model configuration (Red: choices tested in this study)

Table 2 Accuracy comparison of WRF-simulated 80m-height wind speeds among Cases 1 to 7

Figure 1 NEDO offshore meteorological mast off Kitakyushu (NEDO HP)

Figure 2 Domains used in WRF simulations (left: 2.5 km-gridded domain. right: 0.5 km-gridded domain)

Figure 3 (Upper) Monthly and annual biases in WRF-simulated 80m-height wind speeds for all cases

Figure 4 (right) Biases in annual mean wind speed at measurement heights from 30 m to 80 m for all cases.

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