VALIDATION OF HUB-HEIGHT WIND SPEED ESTIMATED FROM ASCAT WIND SPEED WITH THREE DIFFERENT PROFILE MODELS IN THE NORTH SEA

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Introduction

Offshore wind energy is expected to be one of promising renewable energies in Japan. Though Japan has the sixth largest Exclusive Economic Zone (EEZ) in the world, evaluation of offshore wind energy potential is still in the preliminary stage especially at the hub height of wind turbine. Since FINO meteorological masts in the North Sea provides hub-height wind speeds open to the public, this creates the unique opportunity to validate hub-height wind speeds with different wind speed profile models. The purpose of the study is to investigate the performance of wind speed profile models by using the scatterometer ASCAT and the mesoscale model WRF in the North Sea.

Data and methods

Scatterometer used in the study is ASCAT launched by ESA in 2006. Level 2 product with 12.5km spatial resolution is used. Wind speeds from ASCAT are defined as ENW(Equivalent Neutral Wind) speeds assuming neutral stability. WRF(Weather Research and Forecasting model) is a mesoscale numerical weather prediction system developed by seven institutes in the United States including National Centers for Environmental Prediction and National Center for Atmospheric Research. Table 1 shows the configuration of WRF. In this study ECMWF Operational Analysis data and OSTIA-SST are used as input to WRF. Wind speeds observed at FINO1 shown in Fig.1 are used for validation. study period is from May, 2009 to April, 2010. Three kinds of vertical wind speed profile (a difference between 80m-height to 10m-height wind speeds), obtained from the LKB code, COARE 3.0, and WRF are used for validation. Fig.2 shows a schematic of the height conversion of wind speed from 10 m to 80 m. Wind speed at the height of 80m (U80) is calculated as follows based on ASCAT-derived wind speed at the height of 10m(U10(ASCAT)).

$$U80 = U10(ASCAT) + (U80(WRF) - U10(WRF)) \quad (1)$$

Table 1. Configuration of WRF

Model	Advanced Research WRF (ARW) ver 3.3.1
Period	1 May 2009 through 30 April 2010 (1 year)
Grids	Domain1: 8km x 8km, 300 x 300 grids
	Domain2: 2km x 2km, 420 x 260 grids
Levels	40 levels (Surface to 50 hPa)
	Lowest levels: 12m, 40m, 76m, 116m, 161m, 214m
Input data	6-houlry, 0.25ºx0.25º ECMWF Operational Analysis
	Daily, 0.05ºx 0.05º UK Met Office OSTIA SST
4DDA	Domain1: Enabled
	Domain2: Enabled, but excluding below 2,000 m
Physics	Dudhia shortwave scheme
options	RRTM longwave scheme
	Eta microphysics scheme
	Betts-Miller-Janjic cumulus parameterization scheme
	Mellor-Yamada-Janjic (Eta) TKE PBL scheme
	Monin-Obukhov (Janjic Eta) surface-layer scheme
	Noah land surface scheme

Fig.1 Location of FINO1 (54.0N, 6.6E, http://www.fino-offshore.de/de)

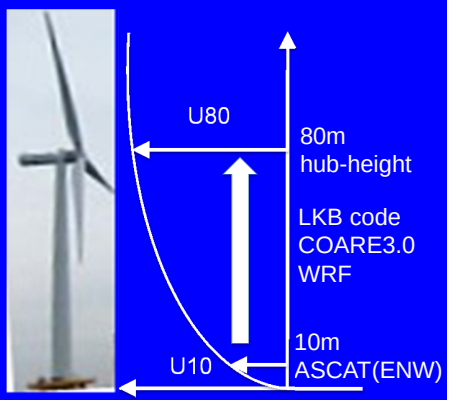

Fig.2 Wind speed profile models between 10 and 80m

Results

Fig.3 shows the results of validation based on 3 wind speed profile models. It is found that COARE3.0 plus WRF and LKB plus WRF show the lower RMSEs and biases against FINO1 than those of LKB and COARE3.0 wind speed profile models. Among the wind speed profile models the COARE3.0 plus WRF-simulated wind speed indicates the lowest bias of -0.75% against FINO1. Since RMSEs of wind speed profile models are not much different and lower than 20%, COARE3.0 plus WRF-simulated wind speed is suitable for estimating offshore wind energy resource at the hub height with high accuracy.

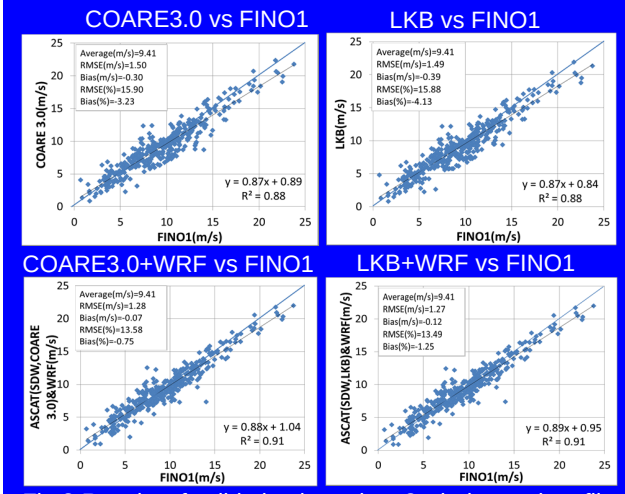

Fig.3 Results of validation based on 3 wind speed profile models

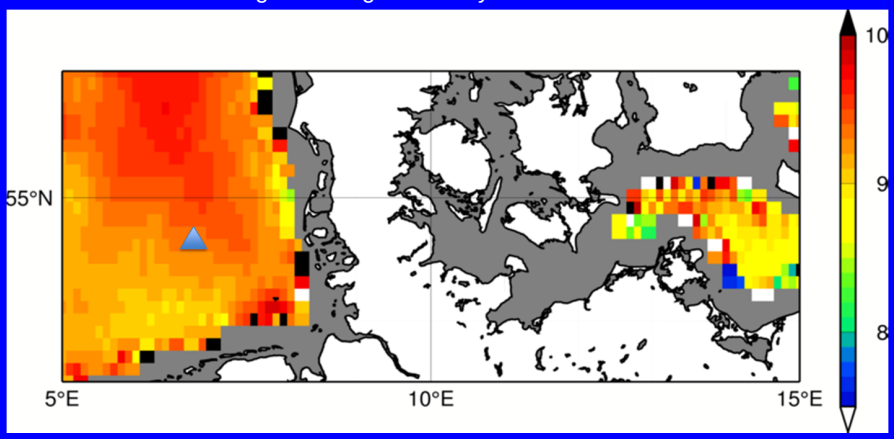

Fig.4 Annual mean wind speed at the height of 80m based on COARE3.0 (Triangle indicates the location of FINO1.)

Conclusions

Comparison of wind speed profile models, COARE3.0, LKB code and WRF-simulated wind speed difference indicates that COARE3.0 and WRF-simulated wind speed difference shows the lowest bias against FINO1. The bias is less than ±5% and the RMSE is less than 20%. Therefore These errors are considered to be low enough to estimate offshore wind energy potential at the hub height with high accuracy.

Acknowledgements

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