

Abstract

Due to the restrictions of the structure design of the met mast on the floater, the effect of met mast on the wind speed measurement is not negligible. In this study, flow simulation around the met mast of Fukushima FORWarD is carried out to correct the effect of the met mast. Simulated wind speed ratio between two anemometers shows good agreement with measurement. Estimated free flow field shows good agreement with lidar measurement.

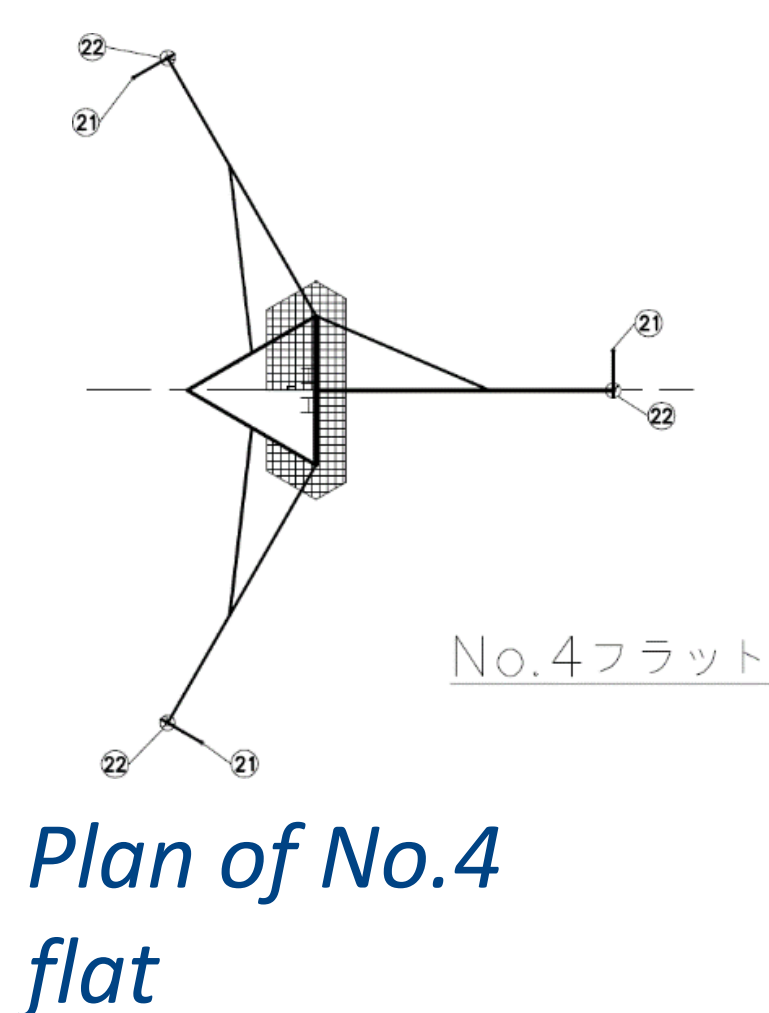
Objectives

In Fukushima Floating Offshore Wind Farm Demonstration Project (Fukushima FOWarD), wind speed measurement is carried out at a met mast located on the floating substation. The structure member of this met mast tends to be thicker compared to the usual onshore or bottom mounted offshore met masts, results in the violation of the condition specified in the standards such as IEC61400-12-1. This implies even if the met mast is equipped with multiple anemometers, simple choice of anemometer depending on the wind direction¹⁾ cannot be used. Some studies have been done on the flow simulation around met mast²⁾ but there was no validation of flow simulation.

In this study, first, flow simulation around the mast is carried out and validated by using the three anemometers located at the same height of the met mast. Then, the wind speed which is not affected by the met mast is estimated and results are compared with the measured wind speed by doppler lidar.

Floating met mast at Fukushima

- Three cup anemometers are installed at each height, at No.12 flat, No.8 flat and No. 4 flat.



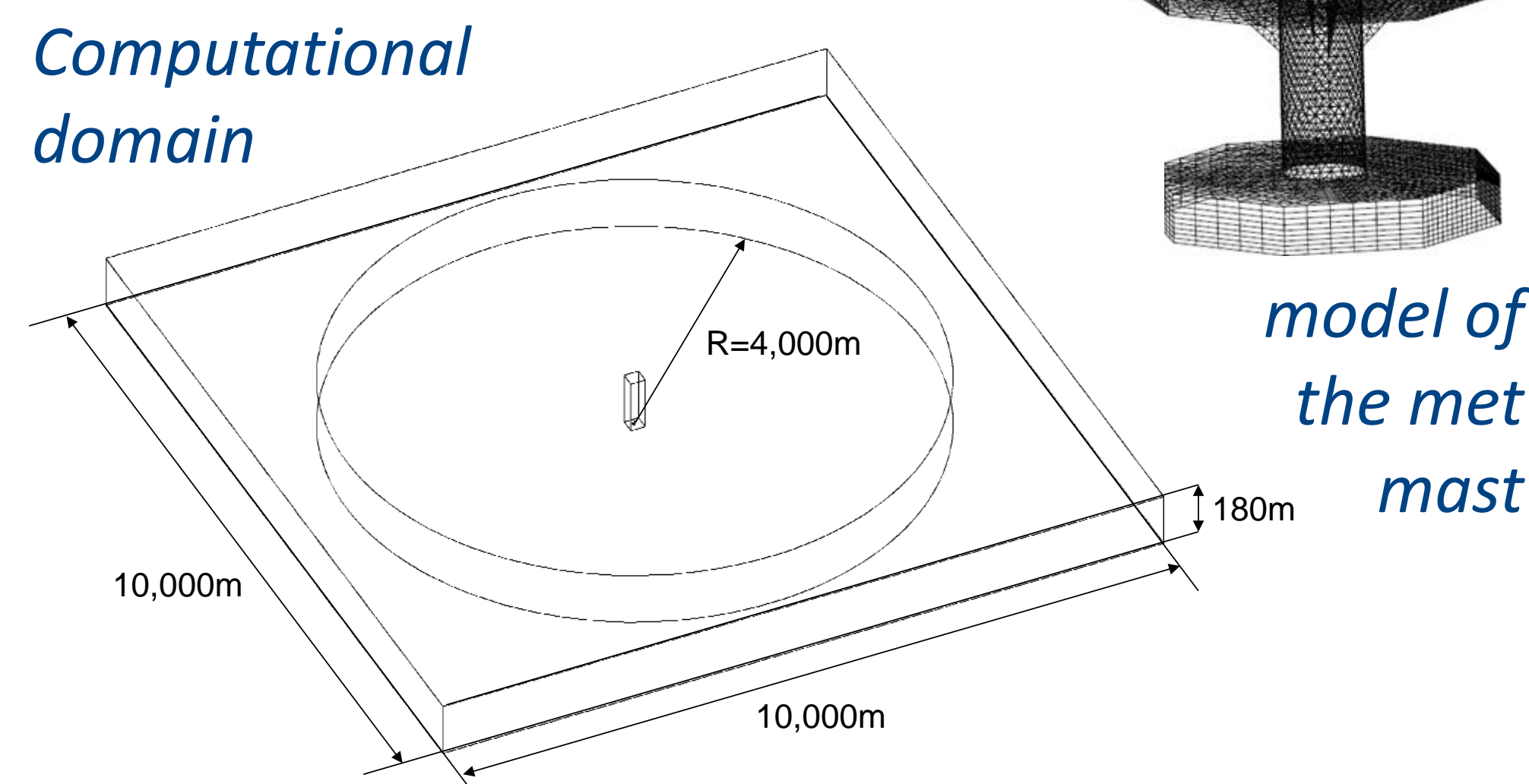
Flow simulation around met mast

Standard $k-\epsilon$ model was used for flow simulation around the met mast. 16 wind direction with 22.5 direction intervals were simulated.

Computation domain and grid

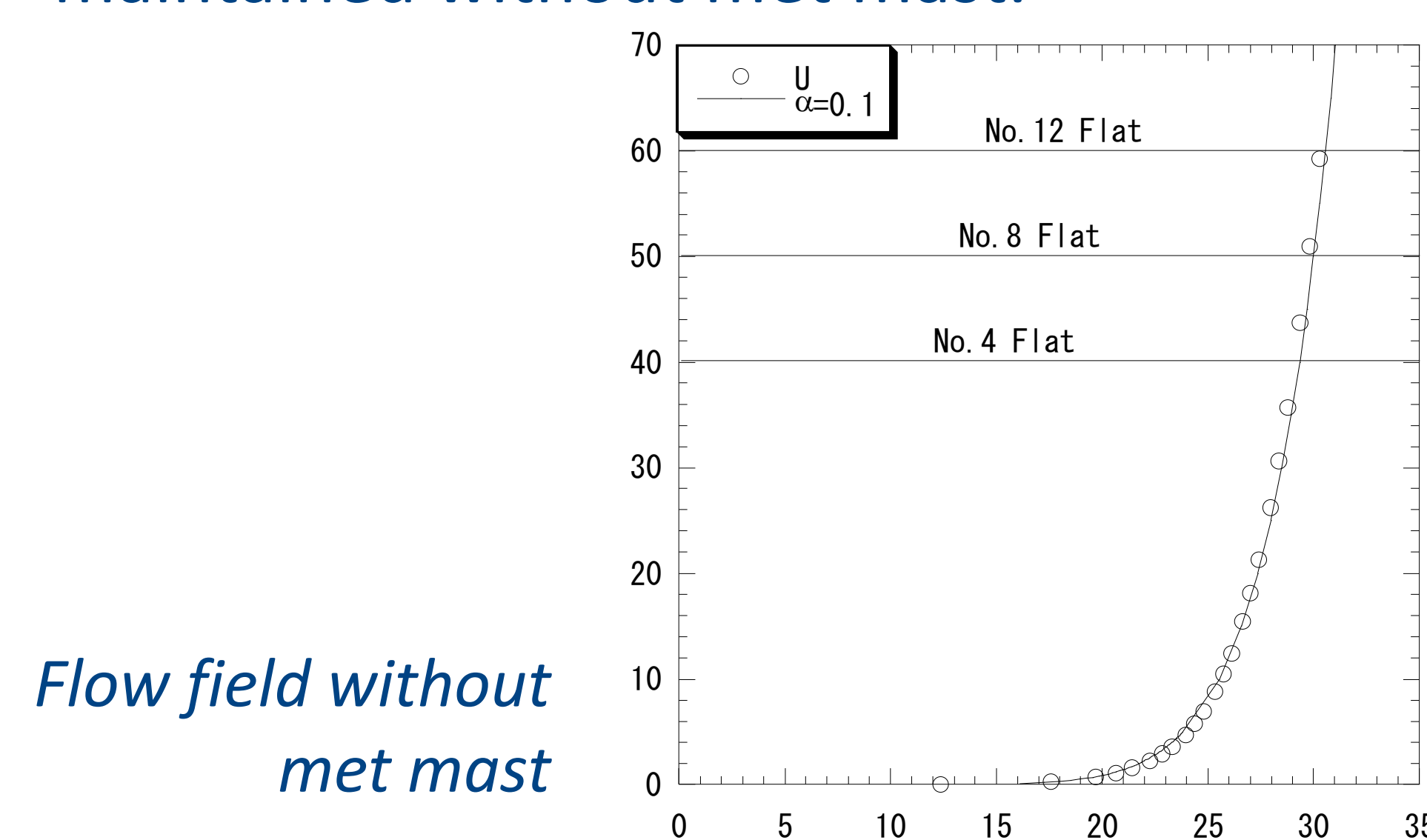
- Computational domain size: 10km x 10km x 185m
- Unstructure grid around the mast
- Total number of grid: 10,000,000

Computational domain

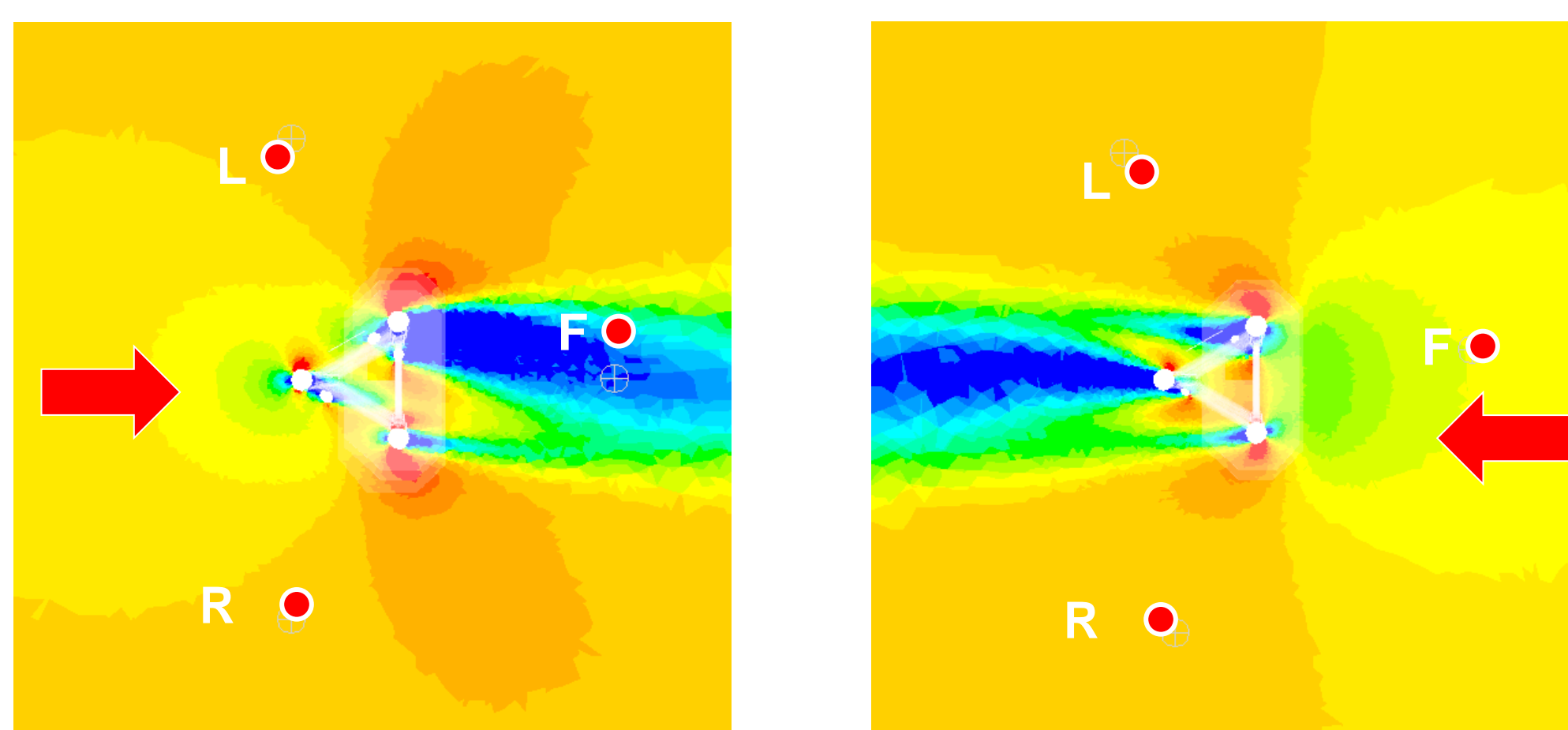


Inflow profile

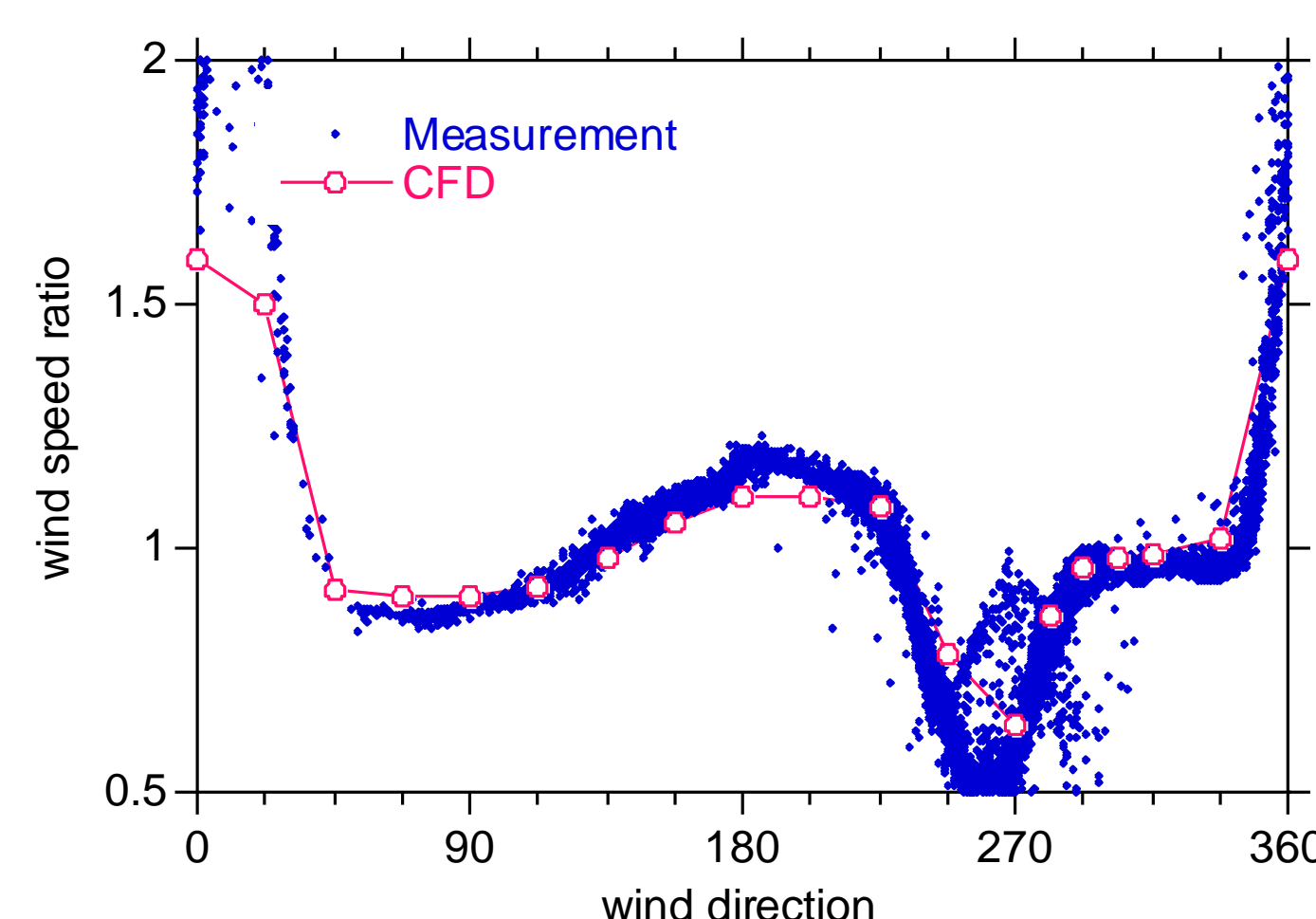
- Mean wind speed profile with $a=0.1$ was used as inflow.
- It was confirmed that the boundary layer is maintained without met mast.



Flow simulation results and validation



Wind speed ratio between two anemometers (F/R) at No. 4 flat

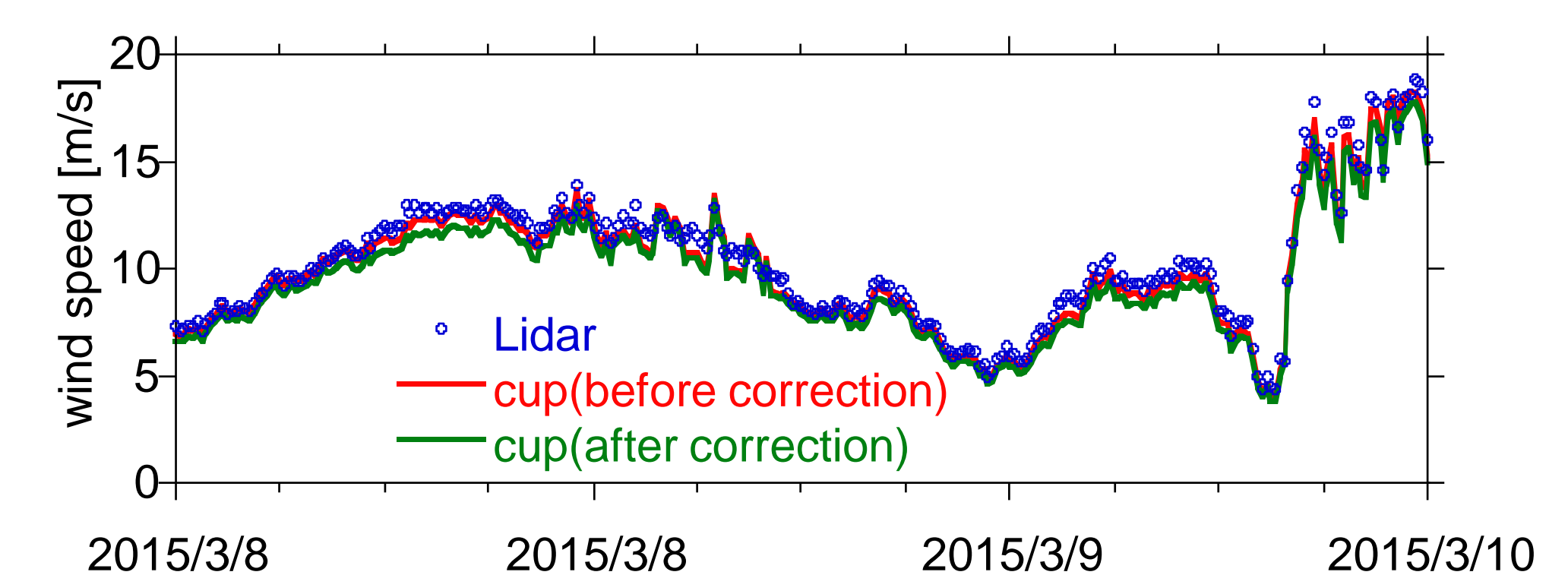
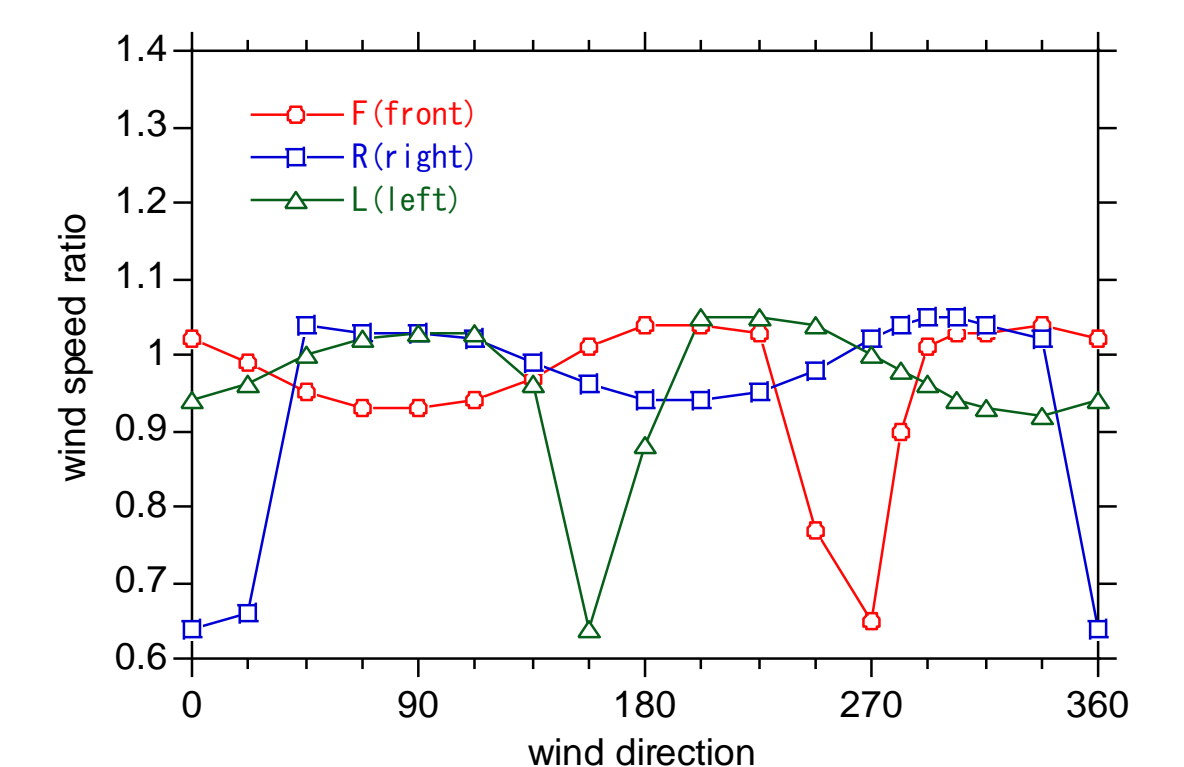


- Simulated wind speed ratio between two anemometers shows good agreement with measurement.

Wind speed correction

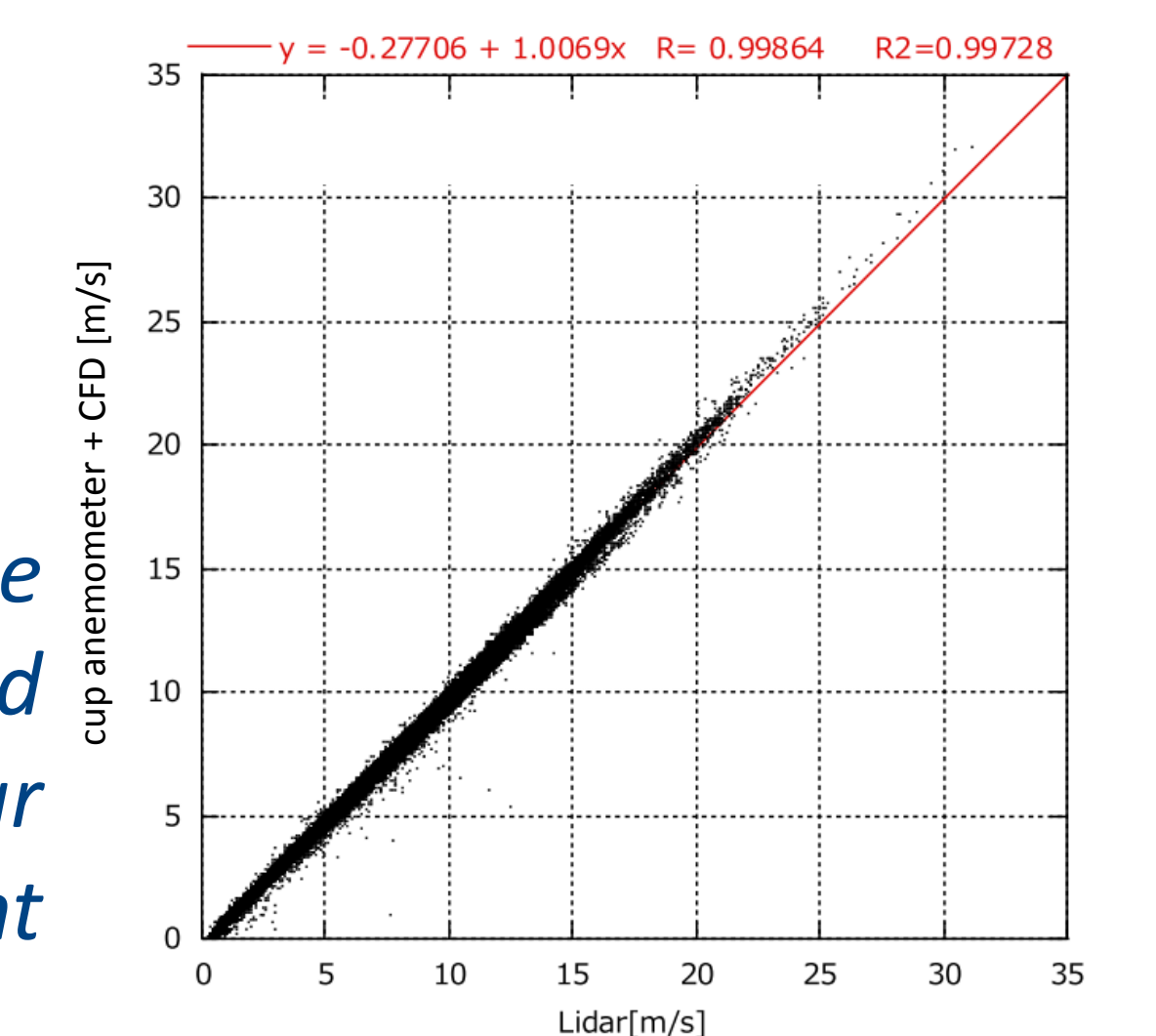
From CFD simulation, the free wind speed without met mast was estimated by dividing the measured wind speed by using cup anemometer by the wind speed ratio.

Wind speed ratio of each anemometers location to free wind speed.



Time series of the corrected wind speed

Comparison of the corrected wind speed and lidar measurement



- Estimated free wind speed shows good agreement with lidar.

Conclusions

In his study, flow simulation around floating met mast was carried out to estimate the free flow field. Following results were obtained.

- Simulated wind speed ratio between two anemometers shows good agreement with measurement.
- Estimated free flow field shows good agreement with lidar measurement.

Acknowledgement

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References

- J.W. Wagenaar and P.J. Eecen, Measurements of Wind, Wave and Currents at the Offshore Wind Farm Egmond aan Zee, ECN-E--09-015, 2009.
- M. Stickland, T. Scanlon, S. Fabre, A. Oldroyd and D. Kindler, Measurement and Simulation of the Flow Field around a Triangular Lattice Meteorological Mast, *Journal of Energy and Power Engineering* (7) 1934-1939, 2013

