OFFSHORE WIND RESOURCE ASSESSMENT ON THE WEST COAST OF AWAJI ISLAND (COMPARISON BETWEEN GALION DOPPLER LIDAR AND METEOROLOGICAL MAST)

Ryuzo Araki[1], Hiromi Ueda[1], Teruo Ohsawa.[2], Keita Azechi[3] and Nemanja Komatinovic[3]
[1]Japan Meteorological Corporation, 556-0021 Japan
[2]Graduate School of Maritime Sciences, Kobe University, 658-0022 Japan
[3]Shizen Energy Inc., 810-0062 Japan

SUMMARY: As part of the Ministry of Environment's 2016 model project for developing a method to identify suitable sites for locally led wind energy projects, Sumoto City (Hyogo Prefecture, Japan) and Awaji Wind Power Generation Inc. used an onshore Galion Lidar to measure horizontal wind speed and direction at 1 km and 2 km off the coast of Sumoto City. Before assessing the offshore wind, the team first verified the Galion's accuracy by comparing its measurements with those taken by a traditional wind measurement device installed on a meteorological mast. We report herein the results of this comparison. The results indicated a strong correlation between the two sets of measurements, denoting that the Galion Lidar has robust accuracy.

Key words: Remote sensing, Doppler Lidar (Galion Lidar), offshore wind

INTRODUCTION

Doppler Lidar systems have attracted attention recently for their potential as wind-measurement tools in wind energy development projects. Compared to traditional meteorological masts, they are cheaper and easier to install, more portable, and can measure wind at more elevation points [1]. Horizontal scanning Doppler Lidars are particularly advantageous in that they can measure offshore wind from an onshore location. As such, many have noted their potential in offshore wind projects, which are attracting increasing attention. The principles underlying Doppler Lidar measurements differ from those of traditional mast devices. Therefore, when introducing a Doppler Lidar in a measurement campaign, it is essential to first compare and verify the accuracy of the Doppler Lidar to such traditional technologies [2]. Herein, we report on a comparison test that the team conducted ahead of a measurement campaign in which the Doppler Lidar captured data on wind conditions off Awaji Island, Sumoto City (Hyogo Prefecture, Japan). This campaign was a part of the Ministry of Environment's 2016 model project for developing a method to identify suitable sites for locally led wind energy projects.

GALION LIDAR, OBSERVATION SITE, AND DATA

Galion Lidar

The Doppler Lidar whose performance we compared to the met mast was a UK-made Galion Lidar G4000 (hereunder, 'Galion Lidar'). The Galion Lidar has an all-sky scanning capability. Rather than only measuring directly above, the Galion Lidar can measure wind in horizontally remote locations. Table 1 presents the Galion Lidar's specifications.

Table 1. Galion Lidar specifications

Device type	Galion Lidar (G4000)
Manufacturer	Wood Group (UK)
Range	80m up to 4000m
Measurement points	130 at 30m spacing
Spatial resolution	30m
Accuracy	±≤0.1 m/s*
Wind speed range	0m/s – 70m/s*

* Dependent on configuration

Observation Site

The observation site was on the west coast of Awaji Island. Figure 1 shows the relative locations of the met mast and the Galion Lidar (upper) and a schematic picture of the Galion Lidar measurement point (Lower). The area around the observation site was generally flat, and no large structures were apparent. For the comparison test, the Galion Lidar and the mast-mounted anemometer captured data on wind at 60 m height. The observation site was a coastal location with an expanse of sea to the west. The two measuring devices were separated by a distance of approximately 160 metres. Wind speed and wind direction at 60m height near the met mast were measured by the Galion Lidar. After the measurement was completed, the Galion Lidar's measurements were compared with those of the met mast.

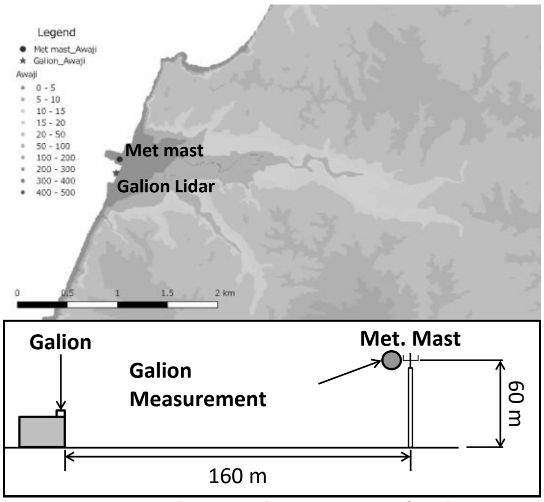

Figure 1. Relative locations of devices in observation site (upper) and schematic picture of the Galion Lidar measurement point (lower)

Data

The measurement period ran from 12 November to 13 December 2016. The data was averaged in 10-minute increments. For the comparative analysis, we extracted wind speed data at range of 4–16 m/s. For the comparison of wind direction, we excluded data from times when the wind direction was in the range of 352.5–7.5 degrees.

RESULTS OF COMPARISON ANALYSIS

Table 2 shows the period average bias, correlation coefficient, and RMSE for wind speed, and the correlation coefficient for wind direction. Figures 2 presents the comparisons of the Galion Lidar and met mast's data. Upper shows the results for wind direction, while lower shows the results for wind speed. Wind speed was standardised at maximum wind speed measured. Regarding wind direction, the intercept was large, about -7 degrees, but the coefficient of determination was favourable, at 1,000 (Fig.2 upper). Moreover, the coefficient of determination for wind speed was 0.981 (Fig.2 lower). When standardised at average wind speed, the wind speed bias was 1.84%, and the RMSE was 5.09% (Table 2).

Table 2. Bias and correlation coefficient for wind speed and wind direction

Wind Speed	
Bias	1.84 %
RMSE (%)	5.09 %
Correlation Coefficient	0.991
Wind Direction	
Correlation Coefficient	1.000

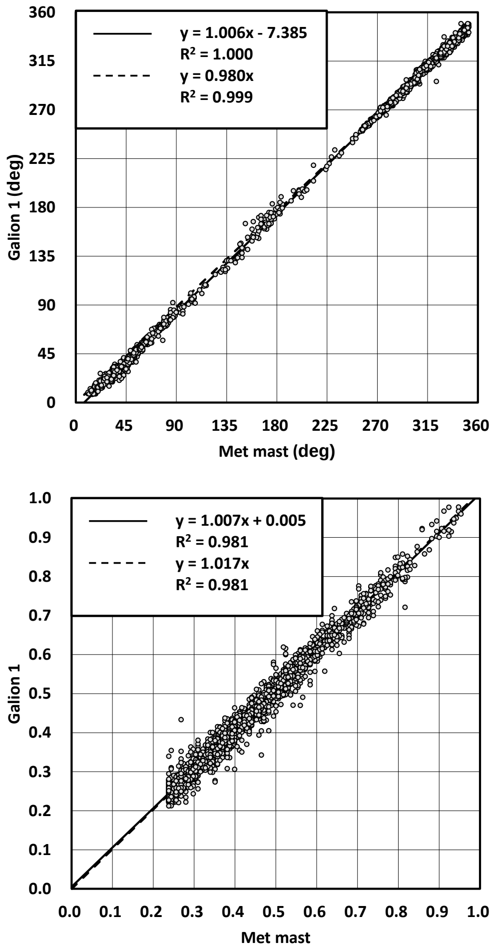

Figure 2. Scatterplot showing wind directions (upper) and wind speed (lower) measured by Galion Lidar and that measured by the met mast (Wind speed was standardised at maximum wind speed)

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References

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