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Comparison of Remotely Sensed Wind Data over Sulawesi and Maluku Islands Sea Areas

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Abstract

In order to obtain accurate prediction of ocean wind energy, long term data are needed. However, one data sources might not able to provide long duration data. Therefore, the data need to be combined with other sources of data. However, before combining the data, it is important to compare and validate them to confirm their accuracy. In the present study, wind speed data collected by QuikScat and SSM/I (SSMIS) missions are compared and analyzed. QuikScat data were collected by a satellite with the same name, while Special Sensor Microwave Imager (SSM/I) and Special Sensor Microwave Imager Sounder (SSMIS) data are processed and offered by Remote Sensing System (RSS). SSM/I (SSMIS) are passive microwave radiometers carried onboard Defense Meteorological Satellite Program (DMSP). For the comparison, 5 (five) arbitrary positions over Sulawesi and Maluku islands sea areas are chosen for the analyses. For the evaluation purposes, beside time series of daily data from several chosen positions in research location, several statistical parameters are also computed and compared such as mean, standard deviation, root mean square (RMS), correlation coefficient.

Keywords: Energy Density, Satellite Data Comparison, Remote Sense Data, Sulawesi and Maluku islands

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1. Introduction

It is known that wind characteristics such as speed and direction, have seasonal variation. They are varied depending on time and location. Therefore, in order to maximize the harvested power, wind turbine system needs to be relocated from time to time. For this purpose, the National Institute for Environmental Studies (NIES) of Japan has studied and proposed a sailing-type floating turbine structure [1]. The structure is pontoon shaped and has no mooring system. It is supposed to be able to navigate with its own sails and azimuth thrusters. More detail studies about the structure can also be found in references 2 and 3.

Similar concept has also been introduced by Mahmuddin et al. [4, 5] to harvest ocean wind energy around Sulawesi and Maluku islands sea areas. The structure is known to be mobile floating structure (MFS). The MFS is designed not to sail but it can be relocated to other locations with higher energy density every certain time. In order to determine the location of the MFS, in the same studies, the energy density of the sea areas around Sulawesi and Maluku islands has also been assessed and simulated in order to predict the power production of the MFS in the areas. In the previous analysis, data collected by satellite QuikScat had been used. The satellite QuikScat used a scatterometer to measure the wind speed 10m above sea surface. However, QuikScat satellite operated only for around 10 years which are from year 1999 to 2009. Therefore, other sources of satellite data are needed to obtain longer data period to be used in analysis. Longer data period would improve the accuracy of long term assessment results.

There are numerous other satellite data sources that can be used for analysis. The summary of satellite data and their duration can be found in reference 6. Because of the convenience way to obtain the data, the present study uses data processed and offered by Remote Sensing System (RSS). RSS processed and analyzed data from several satellites. The data can be downloaded freely from their website. The data source processed by RSS which has the longest period is the data obtained from the Special Sensor Microwave Imager (SSM/I) and the Special Sensor Microwave Imager Sounder (SSMIS) missions. SSM/I (SSMIS) are passive microwave radiometers carried onboard Defense Meteorological Satellite Program (DMSP). The measurement device is different with the one used by QuikScat because QuikScat utilized scatterometer for its observations. However, before combining the QuikScat and the SSM/I (SSMIS) data in the analysis, it is important to compare and validate the data to confirm their accuracy. In the present study, wind speed data collected from QuikScat and SSM/I (SSMIS) missions are compared and analyzed. For this purpose, 5 (five) arbitrary positions over Sulawesi and Maluku islands sea areas are chosen for the analyses.

For the evaluation purposes, beside time series of daily data from several chosen positions in research location, several statistical parameters are also computed and compared such as mean, standard deviation, root mean square (RMS) and correlation coefficient.

2. Wind Data Models

There are numerous wind data models that could be used in a long term prediction of wind speed. The present study uses 2 (two) products of RSS which are SSM/I (SSMIS) and QuikScat.

3. SSM/I and SSMIS

The Special Sensor Microwave Imager (SSM/I) and the Special Sensor Microwave Imager Sounder (SSMIS) are satellite passive microwave radiometers. This series of instruments has been carried onboard Defense Meteorological Satellite Program (DMSP) satellites since 1987. The instruments are referred to by satellite number starting from F08 to F18. Ocean measurements derived from the radiometer observations include Surface Wind Speed, Atmospheric Water Vapor, Cloud Liquid Water, and Rain Rate [7]. The spatial resolution of the data is 25 x 25 km.

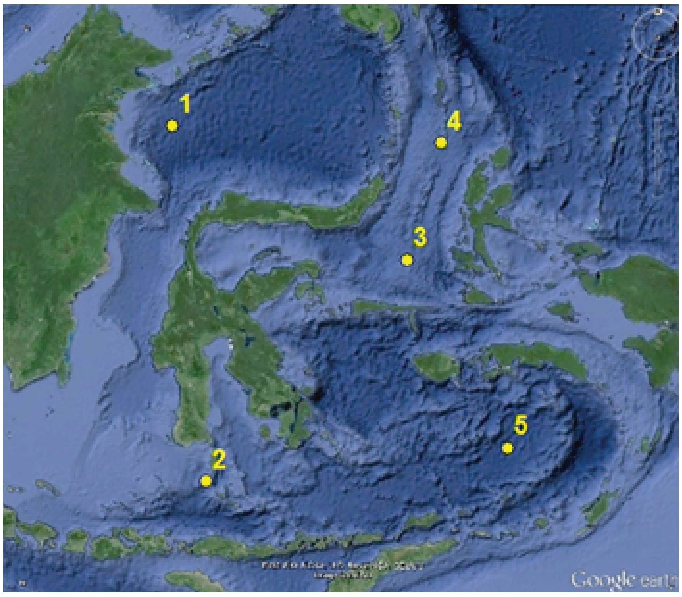

Figure 1: Location of the research and chosen positions.

3.1. QuikScat

The US launched SeaWinds scatterometer in June 1999. It continued to operate until November 2009. The SeaWinds scatterometer is active microwave radar with dual-beam, conical scan 1 m diameter reflector antenna, operating in Ku-band at 13.402 GHz [8]. The primary mission of these SeaWinds scatterometers was to measure winds near the ocean surface. They are also useful for some land and sea ice applications. The SeaWinds instruments are the third in a series of NASA scatterometers that operate at Ku-band (i.e., a frequency near 14 GHz). The first instrument was flown in 1978 on SeaSat mission, which was followed by the second Ku-Band scatterometer flown 18 (eighteen) years later on Japan's Midori-I (ADEOS-I) spacecraft in August 1996 named NSCAT.

4. Research Area

The location of the present study is the sea areas around Sulawesi and Maluku islands of Indonesia. Over the sea areas, 5 positions are chosen arbitrarily for data analysis. The map of research area and chosen positions are shown in the following Fig. 1. The basic image of the figure was produced using Google Earth version 7.1.2.2041.

The chosen positions are shown as yellow dots with their numbers in the map above. The exact coordinates of the chosen locations are shown in the following table.

In the present study, 1 (one) year data which is in year 2000 are extracted from each data sources to be compared. From all type of data available from RSS website, 3-day averaged data were chosen.

No	Longitude	Latitude
1	119	3.50
2	120	-7.00
3	126	-0.50
4	127	3.00
5	129	-6.00

Table 1: Coordinates of computed positions.

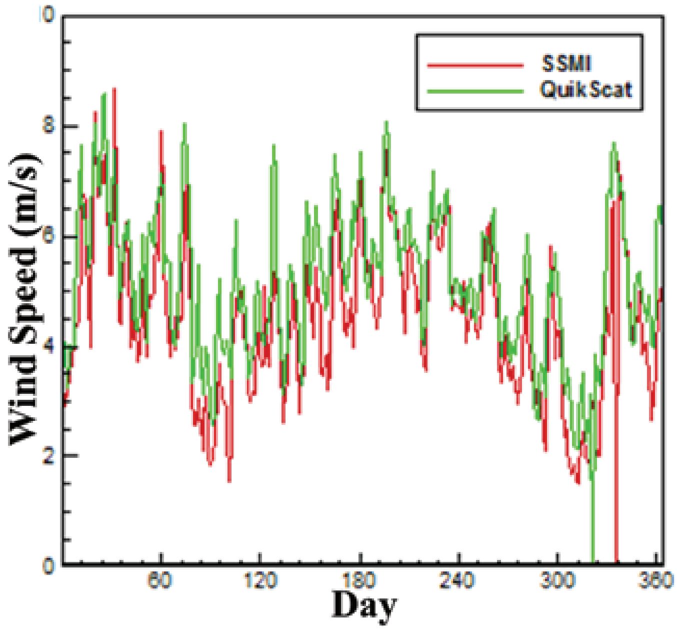

Figure 2: Daily wind speed comparison.

5. Results and Analysis

After extracting the wind speed information of the chosen positions from the data sources, the average of daily wind speed from chosen locations are computed and shown in the following figure. It can be seen from the Figure 2 that the general tendency are similar. However, magnitudes are found to be slightly different. It can also be noted that a line from each data sources reaches zero wind speed which indicates that no data available for the day. In order to observe more detail about the difference, the data above are averaged to obtain monthly averaged data. The computation results are shown in the following figure.

From Fig. 3, it can be seen that general tendencies of the wind speed are in a good agreement. However, significantly different magnitude of the wind speed can be observed. Moreover, in order to evaluate more closely the data, the statistical parameters of the data are computed and compared. The computation results are shown in the following table.

From the table above, it can be seen that difference can be found in all parameters. The two first compared parameters are mean speed and root mean square (RMS)

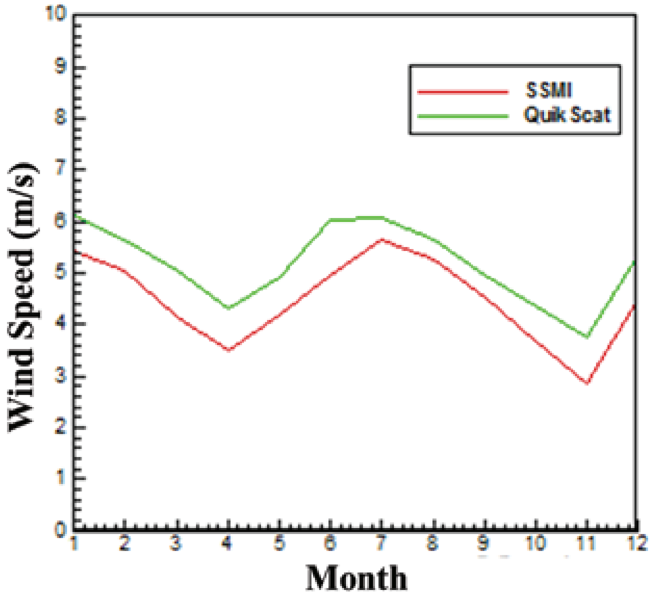

Figure 3: Monthly averaged wind speed comparison.

Parameters	SSMI	QuikScat
Mean	4.480	5.188
RMS	4.553	5.240
Standard deviation	0.810	1.020
Correlation coefficient	-0.358	-0.404

Table 2: Statistical parameters comparison.

which represent average of compared data. Both variables show difference of approximately 14%. Moreover, the table also shows that the standard deviation of QuikScat data is higher 0.21 point as compared to the one computed from SSMI data which means that Quikscat data has larger data range as compared to SSMI data.

The last row of the table shows that both correlation coefficients are in negative which means that both data have same tendencies. Higher negative value of Quikscat can be expected from higher standard variation as shown in third row. The differences and tendencies of the parameters could confirm the tendency found in Fig. 3. The finding found above should be considered when using satellite data to determine the wind energy density in certain areas.

6. Summary

The present study compared the QuikScat and SSM/I (SSMIS) data. It is found from the computation results that the tendencies of the computed Quikscat and SSM/I (SSMIS) data are in a good agreement but the magnitudes are significantly different. The difference between the data is approximately 14%. The finding should be considered in using the data for long term assessment analysis including for wind energy prediction.

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