Seasonal Variation Characteristics Of Winds At The West Coast Of Ireland

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Abstract. Coastal areas have a large content of renewable energies such as wind energy, tidal energy and wave energy. With continuous development of wind power generation, wind energy research at home and abroad is increasing. In this research, wind data over one year were obtained from ECMWF. In order to study wind variation characteristics, wind dataset was divided into four seasonal categories. Analysis of seasonal variation characteristics of winds at the west coast of Ireland provides useful information for wind energy development and wind energy assessment.

1 Introduction

The wind energy resources on the earth are very rich. According to the World Meteorological Organization (WMO), the global wind energies are about 2.79×10^9MW, and the total amount of wind energy that can be exploited is approximately 2×10^7MW, which is 10 times larger than the total amount of hydropower that can be exploited and used in the world. In the twenty-first century, wind energy has been attached more importance to various governments, and the development of wind power technology is accelerating, especially in recent years [1,2].

With continuous development of wind power generation, wind energy research at home and abroad is increasing. The research of wind power is mainly focused on wind change, wind energy assessment, wind power generation technologies, wind speed, wind power and wind power generation forecasting [1].

Ireland is located in the North Atlantic. Its west coast extending from the Galway Bay is a hot place to explore renewable energies including wave energy, tidal energy and wind energy [3-5]. Since wind variation characteristic play a key role on efficiency of wind energy generation and wind energy resource assessment and so on [6]. This paper focus on studying wind variation characteristics at seasonal scale for the west coast of Ireland. In this research, wind data from a numerical forecasting model were used to explore characteristics of wind at the west coast of Ireland.

Structure of this paper is as follows: Section 2 introduces the research domain; wind data are presented in Section 3, followed by results in Section 4. Discussion and conclusions are finally presented in Section 5.

2 Research domain

Winds at the west coast of Ireland extending from the Galway Bay are influenced by the Atlantic climate. ECMWF (European Centre for Medium-range Weather Forecasts) can provide wind data including Galway Bay area. This area contains abundant renewable resource. In this research, we are interested in exploring wind variation characteristics in the domain as shown in Figure 1. Moreover, a 1/4-scale wave energy test site was selected in this area [7].

Fig. 1. West coast of Ireland

3 Wind data

ECMWF provides global forecasts, climate reanalyses and specific datasets. Wind data used in this research were downloaded from website (https://www.ecmwf.int/). Time interval of those downloaded ERA-Interim is 6 hours. Analysis period is from December, 2013 to November, 2014. In order to explore wind variation characteristics of wind in

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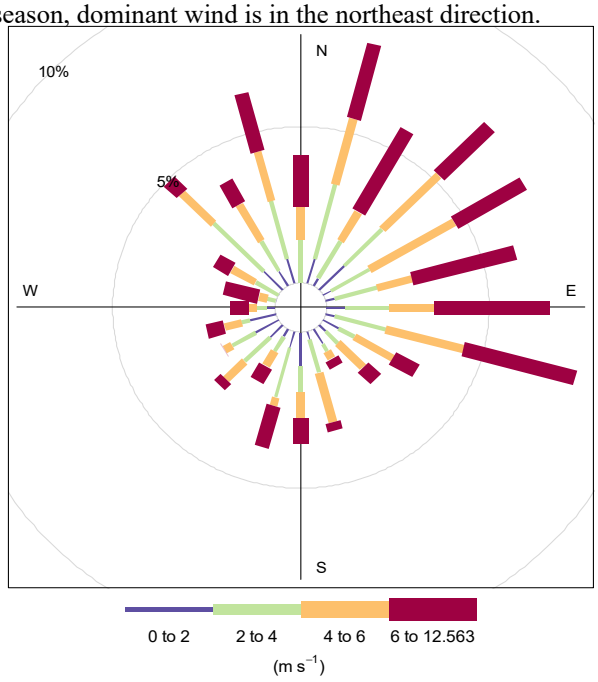
different periods, the full dataset was divided into four categories: winter (December, 2013-February, 2014), spring (March-May, 2014), Summer (June-August, 2014) and Autumn (September-November, 2014).

4 Results

Wind energy is generated by air flows, which is influenced by the climate background, weather conditions, condition of the underlying surface, topography and geomorphology and so on. Abvoe factors lead to the randomness, intermittency and non-controllability of wind power [1,8].

In order to explore wind energy variation characteristics, wind characteristics in four seasons over the year was studied separately in details. Wind rose during the spring season as shown in Fig. 2 shows that both wind speeds and wind directions varied in spring season, dominant wind is in the northeast direction.



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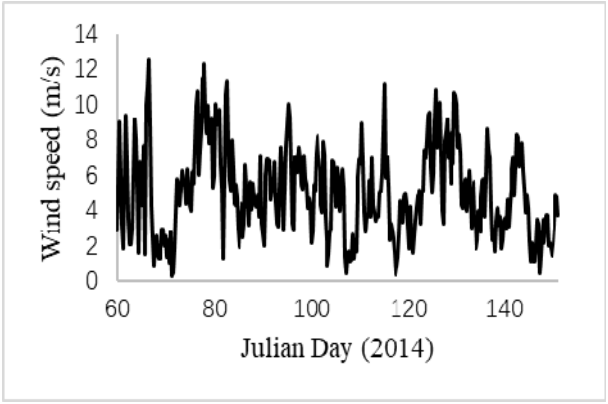
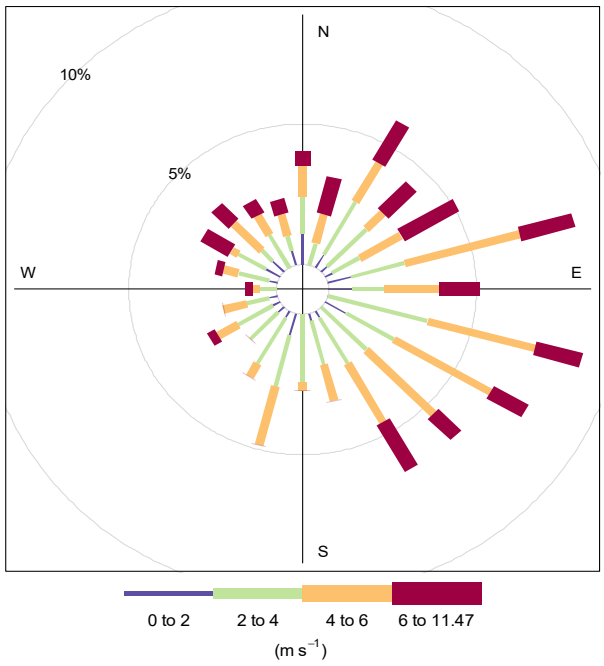


(b)

Fig. 2. Wind data during spring season

((a) wind rose, (b) time series of wind speed)



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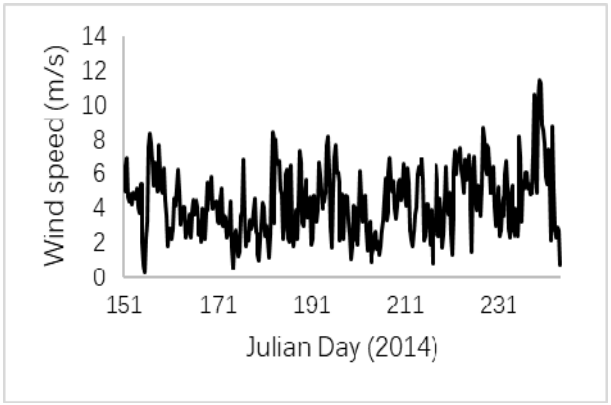
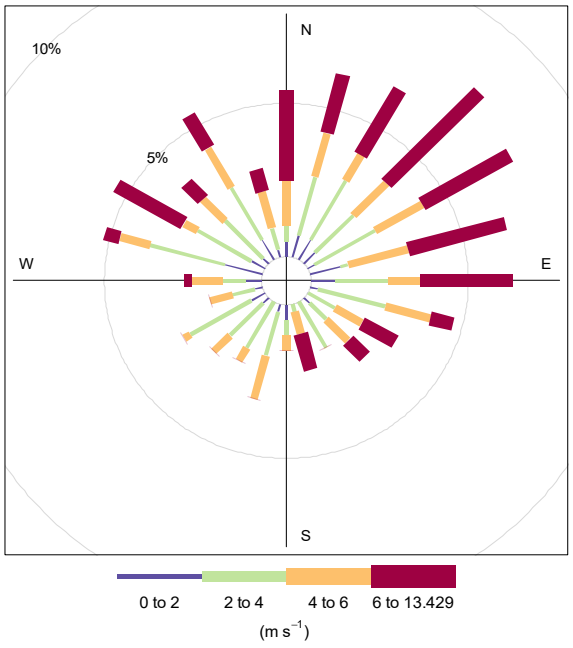


(b)

Fig. 3. Wind data during summer season

((a) wind rose, (b) time series of wind speed)

Wind rose as shown in Fig. 3 indicates that dominant wind in summer season is in the southeast direction. Wind speed varied over a large range.



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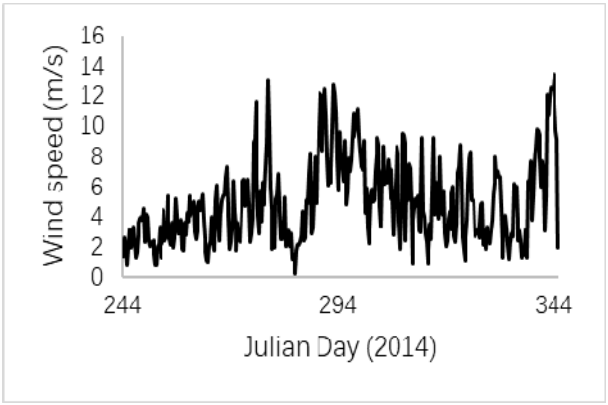
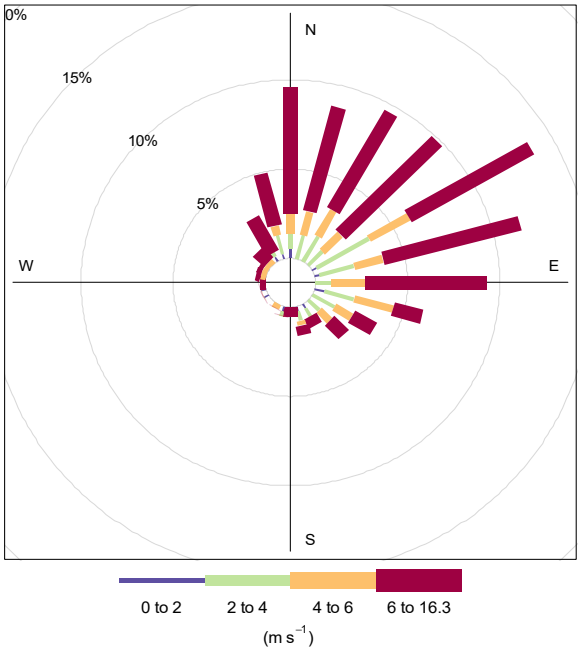


(b)

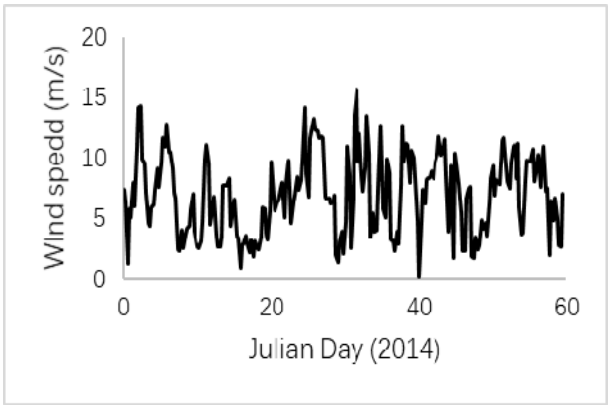
Fig. 4. Wind data during autumn season

((a) wind rose, (b) time series of wind speed)

Wind rose as shown in Fig.4 indicates that dominant wind in summer season is in the northeast and northwest directions. Wind speeds in the northern direction were larger than those in the southern direction.



(a)



(b)

Fig. 5. Wind data during winter season

((a) wind rose, (b) time series of wind speed)

Wind rose in winter as shown in Fig. 5 indicates that wind direction is mostly in the northeast direction. Moreover, wind speed was generally very large in this season than other seasons.

In order to quantitatively compare variation of wind speeds and wind directions in different seasons, statistics including means, minimum value and maximum of wind speeds and directions in four seasons are presented in Table 1. Averaged value of wind speeds in winter was significantly larger than that in other three seasons. The maximum wind speed was 16.3m/s in winter, which was larger than that value in summer by 30%. The minimum wind speed was quite similar among the four seasons. Wind direction was quite similar in spring, summer and autumn, but wind direction mean in wind was much smaller than that value in other three seasons.

Table 1 Statistics of wind data in four seasons

season	wind speed (m/s)			wind direction (˚)		
	mean	min	max	mean	min	max
spring	5.02	0.25	12.56	148.59	2.33	358.48
summer	4.36	0.26	11.47	151.59	0.08	359.97
autumn	4.96	0.23	13.43	158.24	1.36	359.88
winter	7.21	0.18	16.3	112.53	1.33	359.54

5 Conclusions

In this research, wind variation characteristics in four seasons: spring, summer, autumn and winter was studied based on data from a numerical reanalysis model. Results indicate that wind speed was significantly larger than that in spring, summer and winter. Wind directions on average in spring, summer and autumn were quite similar, but wind direction on average in winter was different from other seasons. Additionally, averaged wind speed in winter was larger than that value in summer by 30%. Wind in winter was mostly in the northeast direction, while percentage of wind in other directions in spring, summer and autumn were larger than in winter.

In short, wind at the west coast of Ireland varied at the seasonal scale, wind characteristics in winter was significant different from other seasons. Maximum wind existed in winter. Wind variation characteristics in spring, summer and autumn was quite similar.

Acknowledgment

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