



Research Article

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The Creation of 120-day Hurricanes of Sistan in Iran

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ABSTRACT

120-day winds of Sistan blow in summer raging from middle of May to Middle of September, which affect large areas of Sistan and Baluchistan Province in southeast of Iran. They blow from northeast to southeast with high speed in summer and when the temperature reaches the highest value, the storm will be created. By changing the pressure pattern in winter, these winds will be vanished. Oman Sea and Strait of Hormuz (east of Persian Gulf) are directly influenced by 120-day winds of Sistan. The winds due to small scale are not in climatological and meteorological models, which results in lack of comprehensive studies in this field. The least-square method using data of NCEP-NCAR with 2.5° spatial resolution was used to determine the period of 120-day winds of Sistan. The genetic factors of 120-day winds of Sistan show that wind is affected by the arrangement of pressure centers in the region. Genetic factors affecting 120-day winds included the relationship between pressure and heat in tropical and sub-tropical regions, establishing the low pressure center up to 700 hPa, approaching isobaric lines on the region, making an inverse temperature gradient at the ground surface between Sistan region and south east of the Caspian Sea, getting active the low level vortex of troposphere, the effect of thermal factors, making pressure reverse slope and following the direction of the winds. 120-day winds blow from May to August so that significantly affect Oman Sea and Strait of Hormuz. Besides, the wind speed in east part of Oman Sea is more than that in west part of it. The highest value of 120-day wind speed is observed in July, and their 50% hazards influence the floating units with less than 500 tons in Oman Sea.

Keywords: Sistan wind, Oman coast, Monsoon, Hurricane.

INTRODUCTION

120-day winds of Sistan are considered as particular winds in Iran, which blow in summer raging from South Khorasan to Sistan. These winds blow from middle of May to Middle of September, which affect large areas of Sistan and Baluchistan Province in eastern part of Iran. By changing the pressure pattern in winter, the Sistan winds will be ceased. 120-day winds of Sistan are the sequence of monsoon in India, and get powerful in Afghanistan especially in the Thar desert and then pass through the flat areas of Afghanistan to enter Iran [1]. At the beginning of the warm season in northern hemisphere, the sun gradually transferred from the northern hemisphere. Following the displacement, the thermal equator gradually moves to latitudes of the northern hemisphere and establishes in geographical areas away from the equator. In this time, subtropical high-pressure dynamics are formed in subtropical zone that becomes smooth weather. Energy receiving to earth due to such factors is more than others during the year leading to increase the heat on the earth surface. The extreme heat generates the centers of low-pressure heat in South Asian. Monsoon circulation is created by the formation of thermal low-pressure system [5], which belongs to Indian Monsoon. In addition, low-pressure Monsoon has gradually spread throughout Southeast Asia. The low pressure in a large cyclone brings the moisture of Indian ocean to inland area and provides summer

moisture of the region. In the warm season, middle and upper tropospheric levels is dominated by the Azores high pressure and it influences all middle and upper levels of atmosphere of Iran in summer [7]. Monsoon rains of Indian ocean origins from tropical region, which reaches to Sistan in warm season as shower rainfalls [10].

The genetic factors of 120-day winds of Sistan show that wind is affected by the arrangement of pressure centers in the region. In this regard, distributing the pressure centers were identified at different atmospheric levels and to assess the surface pressure centers, ground surface, level 850, level 700, and level 500 hPa were studied. Genetic factors affecting 120-day winds include the relationship between pressure and heat in tropical and sub-tropical regions, establishing the low pressure center up to 700 hPa, approaching isobaric lines on the region, making an inverse temperature gradient at the ground surface between Sistan region and south east of the Caspian Sea, getting active the low level vortex of troposphere, the effect of thermal factors, making pressure reverse slope and following the direction of the winds [10]. 120-day winds of Sistan is one of the phenomena of the earth's surface and rarely spread to the upper level and they are not observed at the 850-millibar level maps. The main factor in creating the 12-day winds is a low pressure in south of Iran and two high pressure centers located in the Caspian sea and southeast places at outdoor of Iran. The role of the Caspian sea is more highlight in respect to others in creating and powering these winds [8]. Hosaini-Arani *et al* [3] indicated that the navy flotation units in east of Oman sea has an inappropriately atmospheric condition in respect to its west part. The wind caused by the Monsoon system in the Persian Gulf and Oman Sea is called Sohail, which its creation is due to passing the low-pressure systems on Persian Gulf and it blows in southwest part [9]. The main pressure centers, which generate 120-day winds are located in north of the Caspian Sea and south of Iran. These centers accelerate the power and development of winds by their western-eastern movements [2]. Figure 1 indicates the features of pressure centers in June, July, and August. At this time, two pressure centers including low pressure of Sistan (cyclone) and high pressure of Turkmenistan (anticyclone) were created in south of Asia.

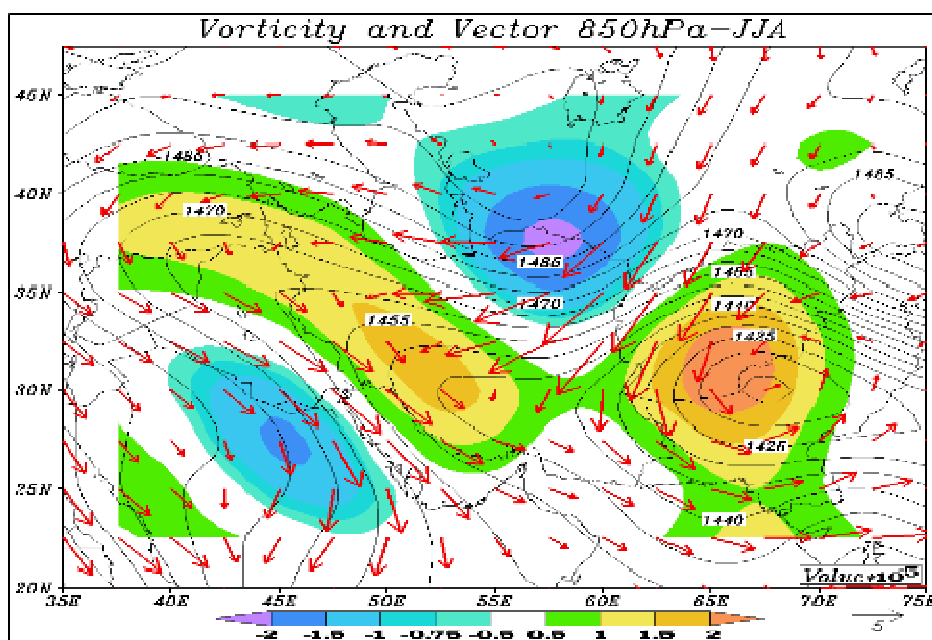


Figure 1: The pressure centers in June, July, and August. Low pressure of Sistan and high pressure of Turkmenistan [6]

Experimental section

Site description

The study area is Makran coast in north of the Oman Sea. Due to the large extent and a few changes of winds across the coast, two points have been taken on these shores. Point 1 was selected in margins of Chabahar, which is affected by the winds of the Indian Ocean. Point 2 is located on the sidelines of Hormozgan province closed to Jask. This points are as boundary points of Makran coast (input and output) (Figure 2).

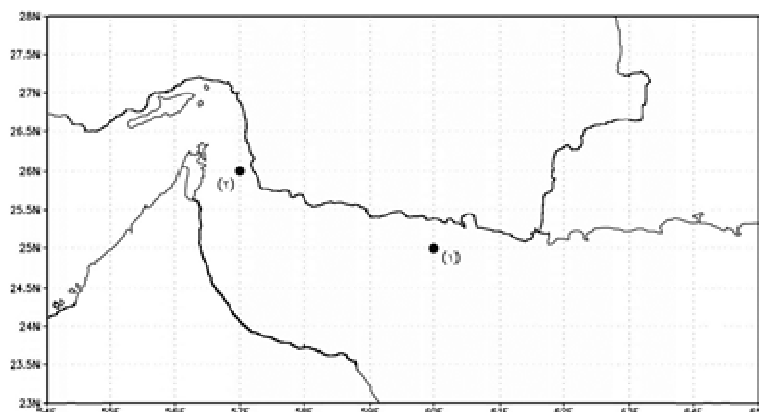


Figure 2: The selected points to investigate the wind properties in the Oman Sea and east of Persian Gulf

The studied data

The data of Ncep-Ncar analysis (International Centre of Oceanography and Meteorology - Channel 1996) were used to study wind characteristics. Wind speed was recorded from 2000 to 2010. This data has a spatial grid with 2.5° accuracy. The most appropriate data type to our subject was daily-average wind. It is a symbol of all winds blowing during the day. Wind speed was measured at weather stations every 6 hours and 4 times per day. The present study used data recorded four times per day to measure wind speed in different times of day.

Methods

Wind speed data have been arranged as a network on the site. This data is retrieved by Grads software (network data analysis) and used for subsequent analysis. To identify 120-day winds, least square method was applied. In this method, a curve is obtained each year, which assess the wind speed in different days of year. In this regard, y is the fitted wind and x is the different days of year. Polynomial curve fitting error on the wind speed is defined as follow:

$$y = a_0 + a_1x + a_2x^2 + \dots + a_nx^n \quad (1)$$

e = fitting error; y = wind speed. For reaching the optimum fitting, sum squares should be minimum, where S = sum of errors, $N=n+1$,

$$e_i = Y_i - y_i = Y_i - a_0 - a_1x - a_2x^2 - \dots - a_nx^n \quad (2)$$

to minimize the errors of equation 3, $\partial s / \partial a_0, \partial s / \partial a_1, \dots, \partial s / \partial a_n = 0$.

Gaussian elimination method is used to solve the matrix coefficients. $a = [a_0 \ a_1 \ a_2 \ \dots \ a_n]^T$, where T is transpose.

$$s = \sum_{i=1}^N e_i^2 = \sum_{i=1}^N (Y_i - a_0 - a_1x - a_2x^2 - \dots - a_nx^n)^2 \quad (3)$$

Reanalyzed data of wind speed for each year from 2000 to 2010 were solved using equation 7.

$$\frac{\partial s}{\partial a_0} = 0 = \sum_{i=1}^N 2(Y_i - a_0 - a_1x - a_2x^2 - \dots - a_nx^n)(-1) \quad (4)$$

$$\frac{\partial s}{\partial a_1} = 0 = \sum_{i=1}^N 2(Y_i - a_0 - a_1x - a_2x^2 - \dots - a_nx^n)(-x_i) \quad (5)$$

$$\frac{\partial s}{\partial a_n} = 0 = \sum_{i=1}^N 2(Y_i - a_0 - a_1x - a_2x^2 - \dots - a_nx^n)(-x_i^n) \quad (6)$$

Seventh grade polynomials had the best fit and shows start and end time of 120-day winds better than other polynomials (See Gerald, 1999).

$$\begin{bmatrix} N & \sum x_i & \sum x_i^2 & \sum x_i^3 & \dots & \sum x_i^n \\ \sum x_i & \sum x_i^2 & \sum x_i^3 & \sum x_i^4 & \dots & \sum x_i^{n+1} \\ \sum x_i^2 & \sum x_i^3 & \sum x_i^4 & \sum x_i^5 & \dots & \sum x_i^{n+2} \\ \sum x_i^n & \sum x_i^{n+1} & \sum x_i^{n+2} & \sum x_i^{n+3} & \dots & \sum x_i^{2n} \end{bmatrix} a = \begin{bmatrix} \sum Y_i \\ \sum x_i Y_i \\ \sum x_i^2 Y_i \\ \sum x_i^n Y_i \end{bmatrix} \quad (7)$$

RESULTS

The fitted curve of degree 7 on reanalyzed wind speeds is shown in Figure 3. According to the figure, reanalysis data are scattered and we can find no meaningful concept, while the fitted curve has fluctuations that can help to detect the start and end of 120-day winds of Sistan on the Makran coast. In 03/21/2006 (80th day of the year), the fitted curve has raised up to around 9 mph. The increase in wind speed in fitted curves continues until 08/13/2006 (225th day of year). This period is in the time of 120-day winds of Sistan. According to figure 4a, in the period of 120-day winds, the fitted curve of wind speed has greater values than other days of the year.

In 05/20/2007 (140th day) wind speed increased and this trend continues until 09/07/2007 (250th day). In 2008, 120-day winds starts from 20 of May (140th day). In this day, there is found an increase in the wind speed and the trend continues in wind speed until 09/14/2008 (257th day). In 2009, an increase has been observed from 30 of May (150th day) to 2 of September (245th day).

This value is observed in a period between 21 of March and 18 of August. There is observed an increase for 2001 and 2005 in the given period. In figure 5, there is a comparison of fitted curve for points 1 and 2. In all figures, wind speed curve at point 1 is higher than point 2. The curves indicate the wind speed on the first and last days of year in points 1 and 2 approximately similar and they meet each other in first and last days of year. The main difference of two curves is recorded in their meeting in 120-days winds of Sistan, and specifically the maximum difference is observed in 200th day of year. The remarkable thing is that in all curves, maximum wind speed occurred in around of 19 July (200th Day) of all years and also the highest difference is recorded between the fitted curve in points 1 and 2. The east part of Oman Sea has higher wind speed than its west part and also the east part of Oman Sea is covered by 120-day winds of Sistan more than other parts. According to figures 2 and 3, 120-day winds of Sistan on Oman Sea blow from May (140th day) to September (260th day). In this period, wind speed clearly has increased on fitted curves and based on figure 3, the speed 120-day winds in point 1 is more than point 2. To investigate blowing the 120-day winds of Sistan on Oman Sea in detail, wind data of four times per day were analyzed from 2006 to 2010. At first, the wind speed data at 00, 06, 12 and 18 o'clock were selected, and then wind data were recorded in these times (figures 6 and 7). In hourly analysis, the least-square method was used due to the importance of comparing the curves. Figure 6 indicated fitted curves of wind speed for point 1, which wind speed at 12 and 18 o'clock was more than that in 00 and 06 o'clock.

DISCUSSION

A difference between the wind speed at 12 /18 o'clock and 00 /06 o'clock in maximum point is about 10 knots (18 km/h). Therefore, if the daily average wind speed is 15 knots, we expect wind speed of about 20 knots per hour at 12 and 18 o'clock, and about 10 knots at 00 and 06 o'clock. Figure 7 indicates the fitted graph for 5-year wind speed of grade 3 in point 2, which the highest and lowest wind speed creates at 18 and 06 o'clock, respectively. The difference between maximum and minimum points is 5 knots (9 km/h), which is a half of that in point 1.

Information of wind conditions in different times of day in the 120-day period can help to investigate marine hazards in points 1 and 2. In the present study, daily average wind speed is 10 knots for threshold of floating units

less than 500 tons (threshold of wind speed is the wind speed value, which damages sea crafting more than 50 percent) and 15 knots is for threshold of floating units ranging 500 to 100 tons. Fishing and local passenger vessels are considered as less than 500 tons floating and ocean-going ships are considered as more than 500 tons floating.

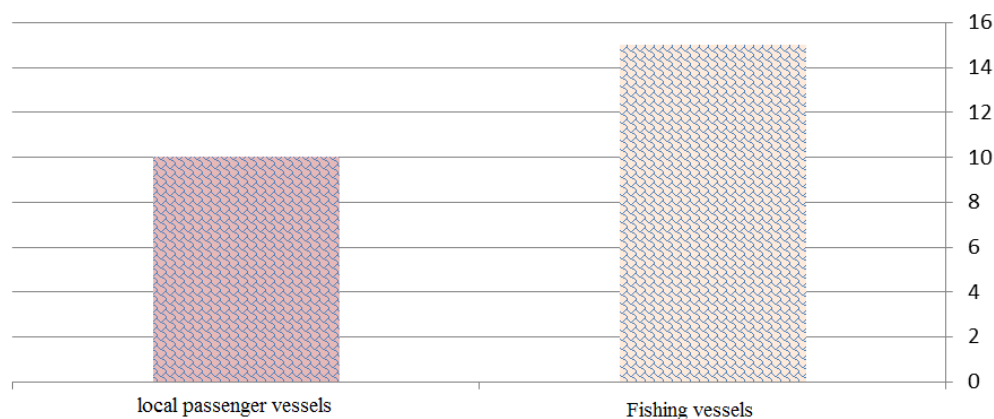


Figure 3: Threshold for floating of Oman Sea and Persian Gulf

The information of daily average wind speed from 2001 to 2010 of 120-day winds has shown that 1260 records have reached daily average wind speed, 635 records have more than 10 knot of daily average wind speed. It shows there is a 50 % hazard of sailing for less than 500 tons units in point 1. In point 2, 210 records (16.6 %) have more than 10 knots of the daily average wind speed, which shows a 16.6 % hazard for floating units with less than 500 tons in point 2. There is observed 50 records more than 15 knots (threshold for floating units ranging 500 to 1000 tones), which is 4 percent. Hence, it can be concluded that 120-day winds of Sistan do not have significant impacts on Oman Sea in point 1.

Daily average wind speed (mph)

Julian days of the year in order from the first day

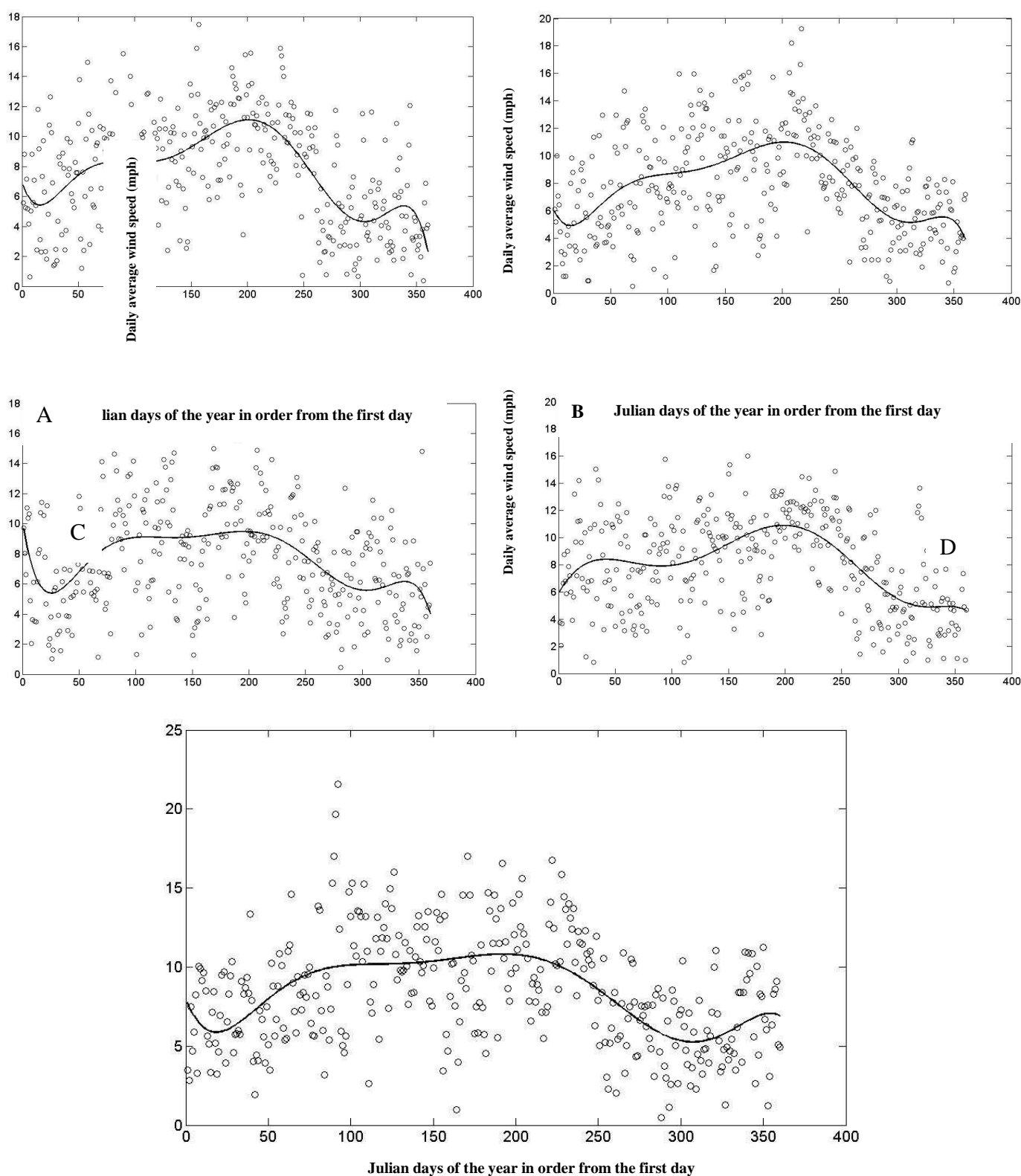


Figure 4: a. Reanalyzed data of wind speed (circles) and fitted curve of grade 7 to wind speed in different days of 2006 for point 1, b. like a for 2007, c. like a for 2008, d. like a for 2009, e. like a for 2010

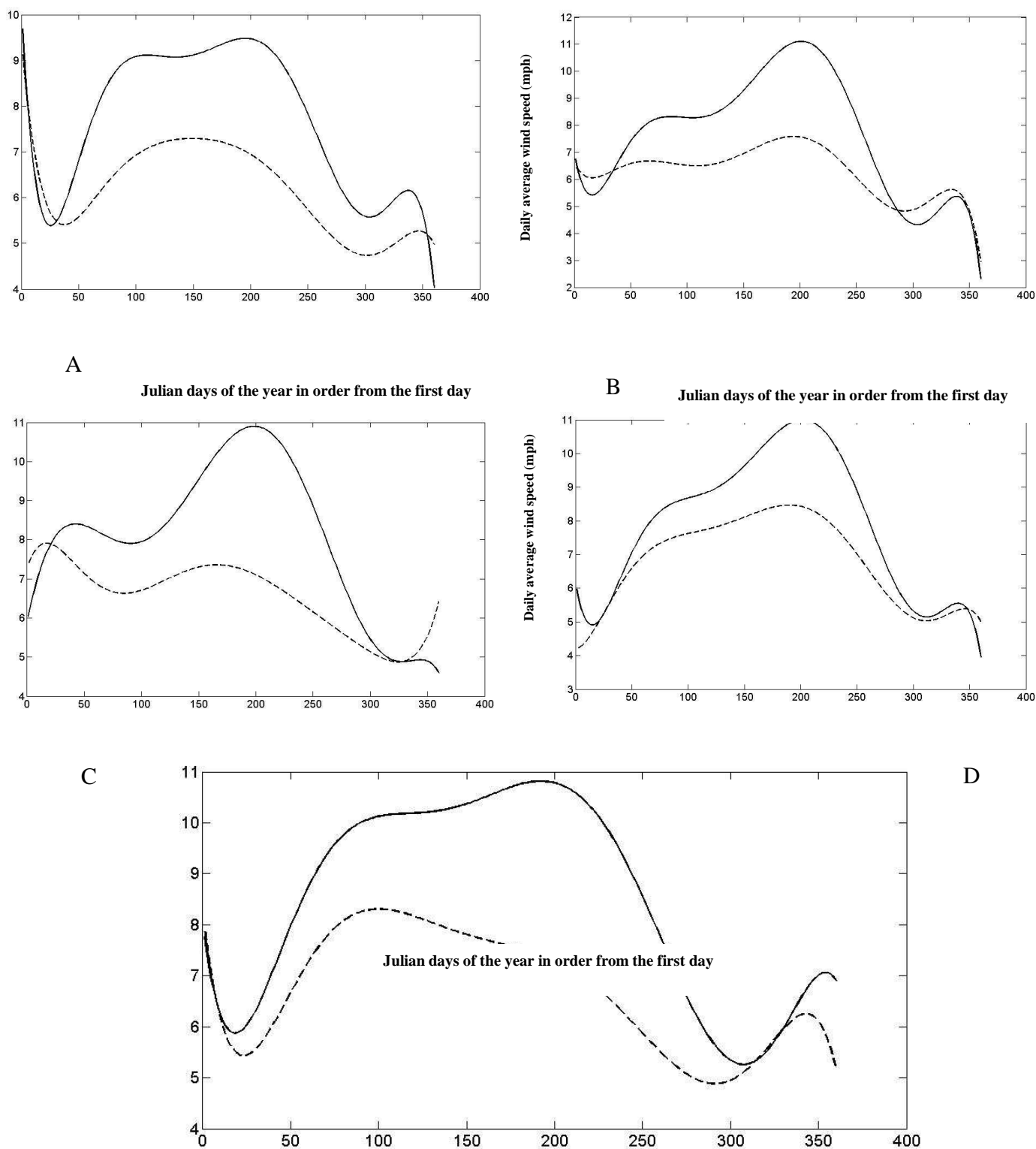


Figure 5: a. Fitted curve of grade 7 for wind speed in different days of 2006 for point 1 (lines) and point 2 (dashes), b. like a for 2007, c. like a for 2008, d. like a for 2009, e. like a for 2010

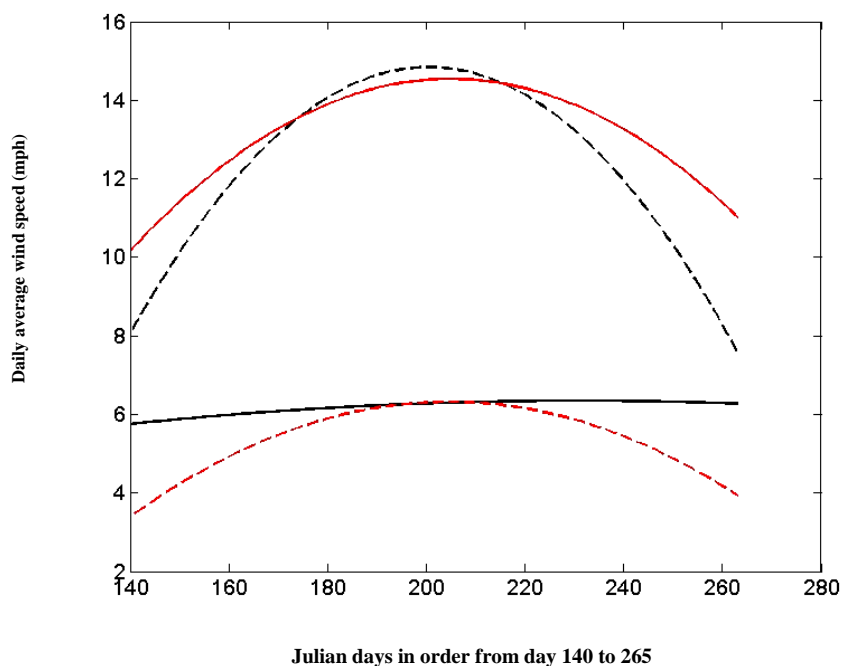


Figure 6: Least square of wind speed with grade 3 in 2005-2010 period, the daily average wind speed at 00 o'clock (block lines), at 06 o'clock (red dashes), at 12 o'clock (block dashes), and at 18 o'clock (red lines) for point 1

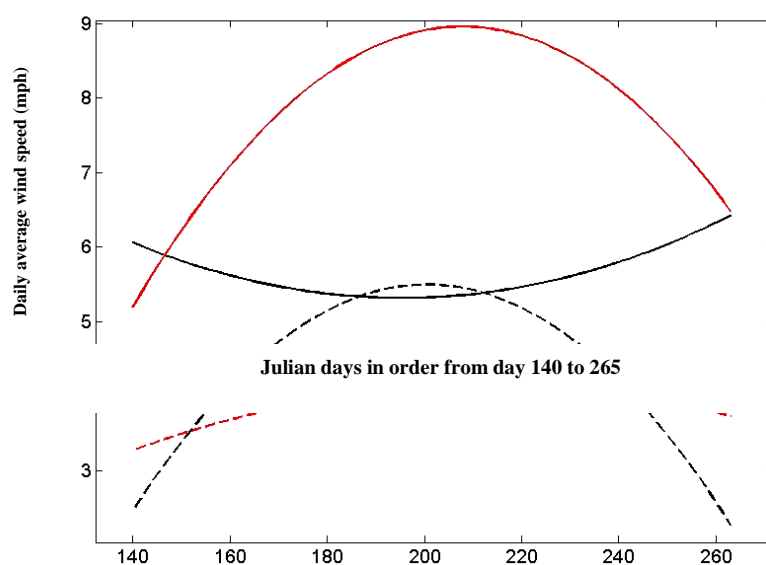


Figure 7: Least square of wind speed with grade 3 in 2005-2010 period, the daily average wind speed at 00 o'clock (block lines), at 06 o'clock (red dashes), at 12 o'clock (block dashes), and at 18 o'clock (red lines) for point 2

CONCLUSION

The present study was conducted to investigate the impacts of 120-day winds of Sistan on Oman Sea and east of Persian Gulf (Strait of Hormuz). The findings indicate that wind speed in the 120-day period (May to August) was more than other days in Oman Sea and Strait of Hormuz. Oman Sea and its northern coast (Makran coast) is influenced by 120-day winds. The wind speed in east parts of Oman Sea is significantly more than that in west parts. So vessels that move from east to west parts of Oman Sea will be faced with various hazards induced by high wind

speed. The maximum wind speed for all years is approximately in 19 of July. July has the worst condition for sailing and marine transportation. 120-day winds significantly affect the floating units with less than 500 tons, while there is no significant effect of these winds on floating units with more than 500 tons. In addition, the maximum wind speed is expected in the evening time.

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