Observational and Synoptic Behavior of Shamal Wind in the North West Coast of Persian Gulf: Bushehr, Iran

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Extended Abstract

Introduction

Shamal winds recognized as a climate regime with a common occurrence in the Persian Gulf makes periodically adverse weather conditions in this region. Among the phenomena occurring under the influence of Shamal wind, we can mention dust storms, low-level winds and turbulent marine conditions (Rao, 2003). Shamal winds are categorized into two types, winter Shamal and summer Shamal. Sea-land breezes are also classified as a frequent mesoscale and heat driven flow associated with coastal areas. Temperature gradient between sea and land is the main reason for the formation of a sea breeze circulation blowing from sea to land in low level coastal atmospheric boundary layer. The suitable condition for sea-land breezes is when the synoptic winds are weak (low synoptic forcing) and temperature level is high in the coastal city of Bushehr (Bidokhti and Moradi, 2004).

The purpose of this research is to investigate seasonal Shamal wind event and its associated synoptic conditions by observations analysis and numerical experiments on Persian Gulf. The impacts of these conditions on wind pattern are studied in the northwestern Persian Gulf coastal area and in optional case in the coastal area of Bushehr. It is intruded interaction between meteorological mesoscale (sea-land breeze) and large-scale (synoptic pattern Shamal wind) forcing effects in this area.

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Materials and Methods

Study Area

North part of middle east is dominated by the seasonal Shamal wind regime, that begin from the central deserts of Iraq and the mountains of northern Iraq, Turkey and Syria to Persian Gulf. In this study, the coastal city of Bushehr in the northwest Persian Gulf and southwest Iran have been selected as a case to investigate about interaction of Shamal wind pattern on local breeze on the coastal areas (Figure 1). Based on the location of Bushehr and sea-land breeze definition, it can be said that sea breeze will occur in the sector of 180-270 degree.

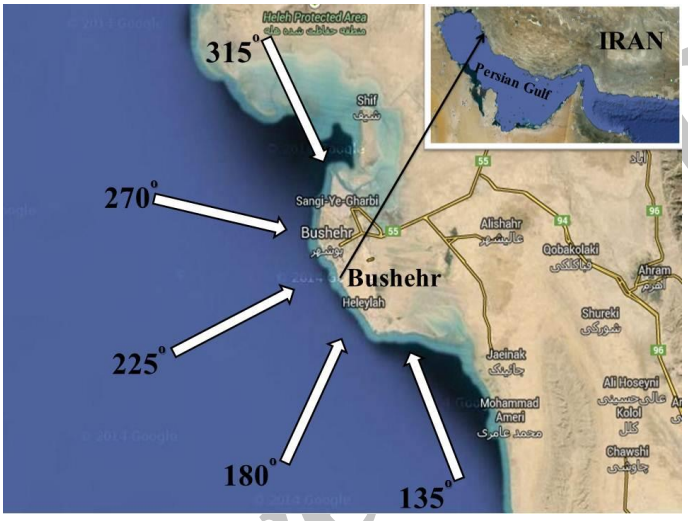

Fig. 1. Coastal case study area

Basic data

In order to analyze the time series of coastal wind, we used hourly wind speed and direction data from meteorological tower and meteorological station of Bushehr power plant and also wind data from Bushehr airport weather station. The meteorological station of Bushehr power plant is located at 28°59' N and 50°00' E and Bushehr Airport Station is located at 28°58' N and 50°49' E. Both the weather stations are located in a relatively small distance from each other.

In the next step, the NCEP FNL data are used to generate the initial and boundary conditions for regional simulations by WRF model. These data has 1° × 1° resolution and are available for every 6 hours. The data are produced by Global Data Assimilation System (GDAS) that continuously receive monitoring global data for analysis from Global Telemetry System (GTS) and other resources. Selected physical schemes for Model setup are represented in table 1:

Table 1. Selected physical schemes for WRF model setup

scheme	Selected physical scheme
Microphysics of cloud	WSM 6 (Hong et al., 2004)
Radiation of short wavelength	Dudhia (Dudhia, 1989)
Radiation of long wavelength	RRTM (Mlawer et al., 1997)

Physics of soil	NOAH [Chen and Dudhia, 2001; Ek et al., 2003] time interval of summer Shamal PX (Pleim and Xiu, 2003) time interval of winter Shamal
Physics of surface layer	MM5 SLS (Zhang and Anthes, 1982) time interval of summer Shamal
	PX (Pleim and Xiu, 2003) time interval of winter Shamal
Boundary layer	YSU [Hong et al., 2006; Hong, 2010] time interval of summer Shamal
	ACM2 (Pleim, 2007), time interval of winter Shamal
Convection of Cumulus	Kain-Fristch (Kain and Fristch, 1993; Kain, 2003)

Results and Discussion

The results of the observational time series analysis from the meteorological tower of Bushehr power plant are shown in table 2 for winter (January) and summer (May). These results show the mean detail information of typical wind regimes such as summer and winter Shamal and sea-breeze regimes during January and May, 2010. This table represented formation quality, duration, mean speed, mean direction of sea-breeze wind in the beginning and ending of sea-breeze regimes during these months. It also represented frequency of daily occurrences of typical wind regimes with their mean speed in Bushehr coastal area.

Table 2. Specifications of typical wind regimes in Bushehr coastal area during January and May 2010

Shamal wind regime Type	Mean wind speed of Shamal wind regime	Number of the days with Shamal wind activity during the days without sea-breeze occurrence	Mean wind speed of sea-breeze regime	Pure sea-breeze occurrence (225 °)	Daily duration of sea-breeze activity (hours)	Mean wind direction in the ending time of sea-breeze period	Mean wind direction in the beginning of sea-breeze period	**Month**
Winter	14 m/s	5 days	12.5 m/s	9 m/s	no	6	290	269	**January**
Summer	14 m/s	14 days	14 m/s	9 m/s	yes	9	230	210	**May**

Figure 1 represents synoptic condition at 10 pm, 24 June 2010, local time. As it can be seen, the northern Saudi Arabia is influenced by a high pressure system with central pressure around 1012 hPa in this region. As well, on the Persian Gulf a low pressure trough is dominant with 1000 hPa central pressure. In addition, a heat low pressure system is seen over east Iran (region of Afghanistan, Pakistan and etc.). This area is experienced the pressure less than 996 hPa. Turkey, Iraq and west Zagross mountain rang are affected with interaction of these dynamical systems that lead to the creation of Shamal wind in northwest of Persian Gulf.

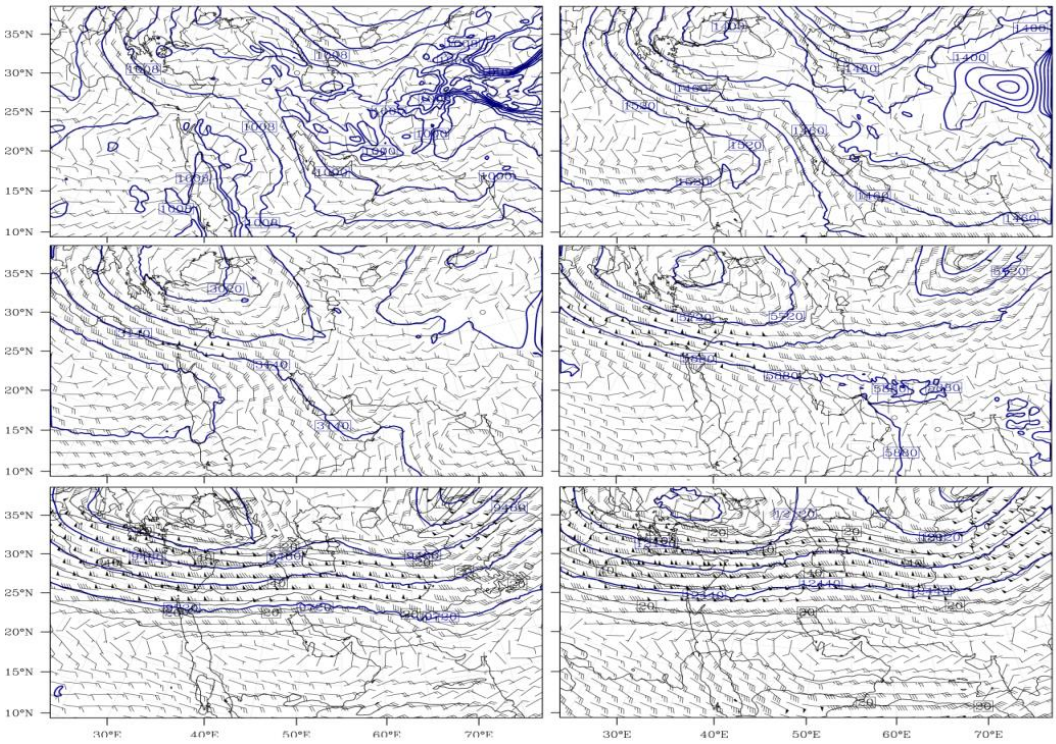

Fig. 1. Simulated synoptic maps for 24 June 2010 at 10 pm local time (top left: sea level pressure, top right: 850 hPa, middle left: 700 hPa, middle right: 500 hPa, down left: 300 hPa and downright: 200 hPa)

Conclusion

In general, Shamal wind affects Turkey, Iraq, Iran, Arabian Peninsula and adjacent areas. The maximum activity during 2010 was observed in the winter in late January and in the summer in June by maximum number of Shamal. This result is obtained by analysis of the data from the meteorological tower 100 meters high in Bushehr weather station. The summer Shamal caused disruption of coastal wind pattern in 14 days of May, 14 days in June, and about 10 days in July, and usually less than three to five days in other months. Winter Shamal occurs at intervals of 3 to 9 days from December to March. During the period that the sea-breeze is removed by synoptic Shamal winds, the average daily wind speed is more than period of sea-breeze activity.

Keywords: Bushehr, rose diagram, Shamal Wind, sea breeze, WRF.