ORIGINAL ARTICLE

Statistical analysis of high-resolution mesoscale meteorology derived from weather research and forecasting model

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Abstract

India experiences different types of seasons each year due to its position on the globe. Seasonal and spatial scale-based variation in weather conditions and topographical features of the region result in various climate of that specific region. Measured weather parameters are analyzed and variations can be seen with respect to the desired time resolution. However, measured parameters represents micro-meteorology and space-based extrapolation is difficult in the manners of topography, land use and its physics. Simulation-based mesoscale weather parameters can be analyzed and variation for short period can be seen. Ahmedabad city of Gujarat State in India has been taken as a study area for analysis of meteorological parameters. Weather parameters were obtained by simulating weather research and forecasting model using two way nested for three domains and evaluated with micrometeorological tower observations in the previous study. Various weather parameters such as temperature, rainfall, humidity, wind speed, wind direction and cloud cover were studied with respect to 3 hourly intervals for 3 months (January, February and March) for the year of 2015. A statistical analysis including average, correlation and standard deviation was carried out for the parameters to study the weather for the city. It was found that the all parameters have maximum deviation from 12 noon to 18 p.m. except wind in a day over the period. More variations were seen between February 27, 2015 and March 02, 2015 for all the parameters, which is majorly due to the season change from the retreating winter to the onset of summer. This study can help to understand the change in micro and mesoscale meteorology based on atmospheric earth system.

Introduction

India lies in Tropic of Cancer (sub-tropical high pressure belt) and the climate is mostly tropical (Kuriyan 1969). Average temperature of the country is above 25 °C (Solanki 2014). India is a monsoon-dependent country and most of the parameters are closely related to the monsoon season (Mohanty et al. 2013). Climate change and air pollution are observed when there are changes in statistical distribution of weather parameters over a period of time. Statistical modeling plays a vital role in explaining the relationships between different parameters.

There are numerous statistical studies undertaken to study the relationships amongst parameters to assess climate change and its impact on different aspects. Meteorological parameters are fully related to climate and atmospheric earth system. Micro- and mesoscale meteorology play significant impact to simulate the atmospheric earth system. Accurate micro-meteorology is obtained through monitoring of weather parameters and its variation and relationship is studied using these data. However, these data are site specific or mainly point location oriented and very sensitive in urban area as land use and topography are varied at micro scale. Also, these data are extrapolated spatially and temporally which may cause errors in consecutive results. The errors are mainly due to spatial extrapolation. Mesoscale meteorological model is used to simulate and obtain weather parameters at various temporal and spatial scales. Weather parameters are either monitored or obtained from a meteorological model. Monitoring requires many resources to install weather stations and take care of operation and maintenance, while modeling can help generate onsite metrological data which can save time and resources (Kumar et al. 2015a, b).

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Weather research and forecasting (WRF) model is one of the mesoscale meteorological models. It is the most preferred model for studying these parameters. A case study on monsoon rainfall over Gujarat state in relation to low-pressure systems explains rainfall pattern in Gujarat state depending on the type of wind (Mohanty et al. 2013). Future Directions of meteorology related to air quality research states the application of WRF in air quality study and its advantages in prediction of severe air quality episodes (Seaman 2003). The meteorological model systems are in the field of weather forecasting and simulation. Research and development in the field of air quality include methods for forecasting atmospheric dispersion, decay and deposition of pollutant and methods for smog, ozone forecasting, and pollen forecasting (Skamarock et al., 2008).Fully revised resource for researchers and practitioners in the growing field of meteorological modeling is known as the second edition of Mesoscale Meteorological modeling at the Mesoscale. The next-generation of mesoscale numerical meteorological model for weather prediction system is WRF model. This has been designed to serve both atmospheric research and operational forecasting needs and have multiple nesting capabilities with one way and two way coupling (Henmi et al. 2005). Weather is the state of atmosphere at a given time and a given space depending upon various variables viz; temperature, pressure, humidity, wind direction, wind speed, rainfall and cloud cover. These factors have a significant role to play in several phenomena in climate change as well as air pollution (Kumar et al. 2017). Weather of a particular region is mostly determined by the temperature and precipitation of that region (Kumar et al. 2016a). Also, there are various factors that affect both temperature and precipitation. The correlation between these factors may be positive or negative that affects the climate to a greater extent. Also, these parameters can be a step towards the understanding of change in air pollution and various other atmospheric phenomena. WRF model has been used in many case studies to provide meteorological data in air quality dispersion model (Kesarkar et al. 2007; Kumar et al. 2015a, b; ; Kumar et al. 2016a, b, c).

The government has placed number of air quality monitoring stations around the cities to keep track of pollution levels. Urbanization has affected the pollution intensity, but the meteorology of a particular area plays an important role in dispersion or dilution of the pollutants. The winter and pre-monsoon seasons are very important as the air pollutant concentration is high during these seasons. The increased levels of pollution can also alter the weather to some extent (Trenberth et al. 2000). It also changes the rate of agriculture production (Chaware et al. 2017; Kapoor and Bhardwaj 2016). These alterations can be studied further in the direction of awareness against pollution and its health impacts to see atmospheric earth system. There are many studies related to weather parameters for monsoon seasons and air pollution for winter seasons (Singh and Perwez 2015). However, weather parameters have not been analyzed from winter to pre-monsoon season to see the trend and change on weather parameters obtained by simulating mesoscale meteorological model at high resolution. Therefore, this study deals with analyzed weather parameters of the period from January to March to understand the change in micro and mesoscale meteorology using atmospheric earth system.

Gay-Lussac's Law (Pressure–Temperature Law) states that at a constant volume, pressure of a given amount of gas is directly proportional to the temperature (K):

$$\frac{P1}{T1} = \frac{P2}{T2}, \tag{1}$$

where $P1$ and $T1$ are the initial pressure and temperature of the gas, respectively, and $P2$ and $T2$ are the final pressure and temperature of the gas, respectively.

Unlike pressure, the relative humidity (RH) is inversely proportional to the temperature (Lawrence 2005). RH is the percentage of water vapor in a volume of air at a given temperature and the amount that it can hold at that given temperature. Increase in the temperature causes RH to decrease. RH will be more for the same percentage of water vapor in cool air than in warm air. Hence, RH is higher at the higher surfaces and lower at the ground. Temperature is not directly related to the wind speed and wind direction, but the pressure is. Pressure gradient determines the speed of the wind. If area which has high air pressure is very close to the area which has low air pressure, the pressure gradient is more and wind speed is high. Gradation in pressure also affects the wind direction. Wind blows form high pressure area to low-pressure area.

Pressure and temperature are both inversely proportional to cloud cover. Cloudy sky lowers the temperature below the clouds which in turn lets the air sink. Sinking of the air creates high-pressure area and inhibits the formation of clouds. Increase in the cloud cover increases the amount of moisture in air. Moisture in air also depends on the direction of the wind. For e.g., the wind blowing across the ocean carries moisture with it. This moist laden wind then brings rainfall in the particular area. Increase in the temperature increases pressure and decreases the RH. Lower the RH, higher is the pollution rate. Water molecules act as nuclei to the air pollution making them heavy for further dispersion. Moreover, direction and speed of the wind decides the sources and diffusion of pollutants.

Present study evaluated the parameters of the weather using WRF model for 3 h interval for 3 months (January, February and March) and their statistical analysis such as variation and correlation. The time period of study was

taken from winter to premonsoon which is critical to our environment. The study would further relate the variations in parameters and their impact on air pollution.

Study area

The objectives of this study were to understand and correlate the meteorological parameters on the 3 h interval basis for the study area "Ahmedabad city" as shown in Fig. 1. This city is located on the banks of river Sabarmati in the northern part of Gujarat state and the western part of India. It has a hot, semi-arid and dry climate. The weather in Ahmedabad is largely influenced by the Arabian Sea. The average temperature of the city ranges between 12° and 41° Celsius. South western monsoons sweep into Ahmedabad in mid-July. During this time, the weather in Ahmedabad is humid. Monsoon continues till the month of September. The average annual rainfall received by the city is 612 mm (Solanki 2014). The monsoons in Ahmedabad are often characterized by torrential infrequent rains. Ahmedabad is one of the fastest growing cities of the decade as listed in *Forbes*. It is also one of the 100 cities which are to be developed as the smart city (Aijaz and Hoelscher 2015).

Methodology

WRF model version 3.5 was used to generate weather parameters for the study area. The three domains were used to downscale the resolution from large scale to simulate atmospheric earth system for predicting weather parameters. The model set up in this study was selected using two way nesting grid with horizontal resolution of 45, 15 and 5 km over the study area with 676×721 grid points and Arakawa C-grid staggering for the horizontal grid and third-order Runge–Kutta scheme for time split integration (Wicker and Skamarock 2002) as shown in Fig. 2. The microphysics option was WSM 6-class graupel scheme (Lin et al. 1983), shortwave and longwave radiations were Dudhiya (Dudhia 1989) and rapid radiative transfer model (Mlakar and Boznar 1997), respectively, and Noah land-surface model (Chen and Dudhia 2001) was taken in this study. After prediction of weather parameters, model was evaluated with meteorological tower observations in the previous study. More details of this model set up evaluation are studied (Kumar et al. 2015a, b).

Seven weather parameters data (temperature, pressure, rainfall, humidity, cloud cover, wind direction and wind speed) were extracted after prediction of the model with 3 h interval. These seven parameters with three hours interval
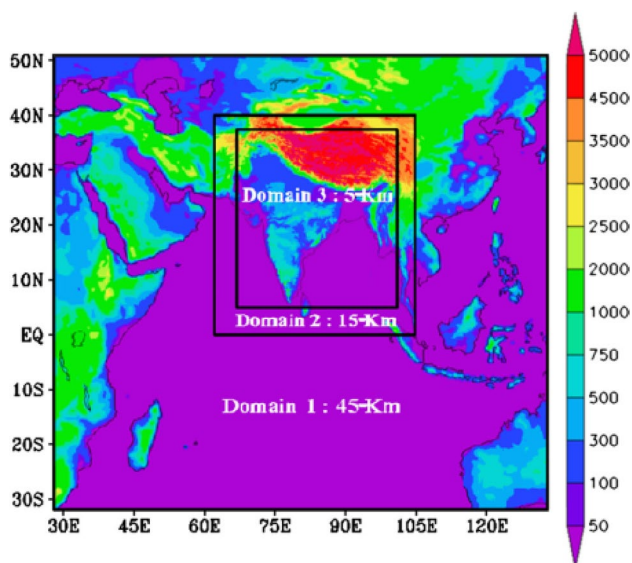

Fig. 1 Study area: Ahmedabad

Fig. 2 WRF domain for the study (Kumar et al. 2015a, b)

for 3 months (January, February and March) for the year 2015 were studied. Each parameter was prepared in a spreadsheet to compare separately in plotted graphs for 3 months with respect to time. Average and standard deviation for all the parameters have been estimated for the study period (Davis). The parameters are correlated to each other and the results are tabulated.

Correlation is the method to quantify the extent to which two quantitative variables can be related. Correlation coefficient is the measure of correlation and is generally calculated using Karl Pearson's method. The degree of relationship is expressed by coefficient which ranges from correlation $(-1 \leq r \geq +1)$. For e.g., if two quantitative variables are taken to be X and Y, then the high values of both X and Y denotes positive relations. On the contrary, high values of X with the low values of Y, gives a negative correlation. $r=0$ indicates that there is no relation between the variables. If the graph is plotted with X and Y axis and an imaginary line is made to pass between X and Y, then the positive correlation shows scattered points aligning to the imaginary line, whereas scattered points adhering marginally to the imaginary line shows negative correlation. Correlation coefficient is mostly calculated by Pearson's method:

The correlation coefficient (r) of two variables X and Y is:

$$r = \frac{E[XY] - E[X]E[Y]}{\sqrt{\left(E\left[X^2\right] - [E[X]]^2\right)}\sqrt{\left(E\left[Y^2\right] - [E[Y]]^2\right)}}, \quad (2)$$

E is the expectation, $E(X) = \mu_X$, where μ_X is the mean of X, $E(Y) = \mu_Y$, where μ_Y is the mean of Y, $E(XY) = \mu_{XY}$, where μ_{XY} is the mean of XY, $E(X^2) = \mu_X^2$, where μ_X^2 is the mean of X^2, $E(Y^2) = \mu_Y^2$, where μ_Y^2 is the mean of Y^2.

Result and discussion

The meteorological data obtained by simulating WRF model were studied statistically for understanding the variation temporally over the study period, initiated from January 01, 2015 till the end of March, 2015. The parameters such as temperature, pressure, rainfall, humidity, cloud cover, wind direction and wind speed were prepared in Excel spreadsheet after simulation process. The minimum and maximum temperatures were 284 K and 315 K on January 16, 2015 and March 28, 2015, respectively. The minimum and maximum relative humidity was 9% and 96% in March and January, respectively. There was no significant variation in the pressure throughout this period. Wind speed was low almost throughout the period. The highest windspeed was in March (8 m/s). January 22 had 2 mm rainfall, February had no rainfall and the cloud was clear throughout the month, while March had 6 mm rainfall for 3 days. Three hourly weather data were converted to six hourly (0–6, 6–12, 12–18 and 18–24 h) to see the overall variation in time split. Six-hourly and monthly average and its standard deviation were estimated for each parameter and are presented section wise in this paper. Correlation study was also carried out for each parameter with six hourly and daily average data. Basically, it represents the consideration of dependency and independency of one parameter with the other parameters. A relative difference for weather parameters was studied (De Almeida Bressiani et al. 2015).

Temperature

Temporal variation of temperature is shown in Fig. 3. A gradual increase is observed in the monthly temperature profile over the duration of study. This is due to the seasonal variation from January to March where summer approaches. Constant rise and fall is also observed in the hourly temperature profile where 6–12 and 12–18 h have shown the higher temperature than 0–6 and 18–24 h. This is due to daily day and night cycle. Table 1 shows the hourly and monthly average temperatures and its deviation from the mean. The hourly and seasonal minimum temperature was observed to be 287 K in the month of January during 18–24 h and the maximum observed temperature was 307 K in the month of March during 6–12 h. There was a constant variation observed from the mean (standard deviation) for both monthly and hourly basis, which means there were no drastic changes in the temperature throughout the study.

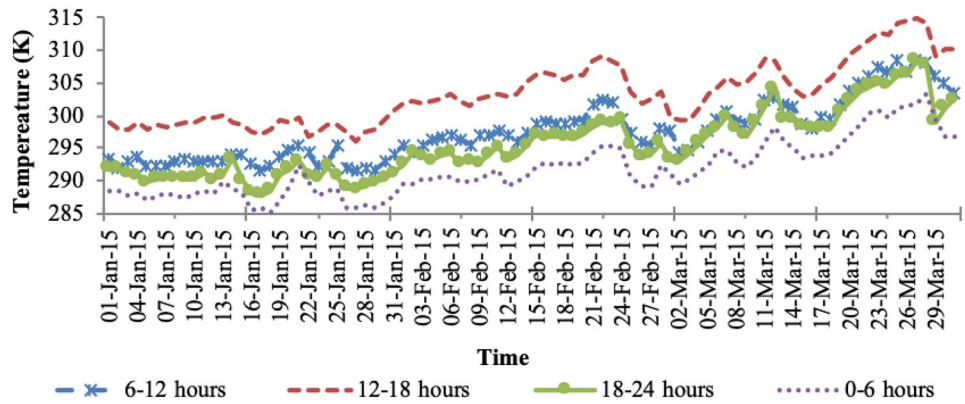**Fig. 3** Six hourly temporal variations in temperature (K) for 3 months

Table 1 Average and standard deviation of six hourly temperatures (K) variation for 3 months

Temperature	0–6 h	6–12 h	12–18 h	18–24 h	6- Hourly average	Hourly std. dev.
January	293	298	290	287	292	4.69
February	297	304	295	291	296.75	5.43
March	301	307	300	296	301	4.55
Monthly average	297	303	295	291		
Monthly std. dev.	4	4.58	5	4.50		

Fig. 4 Six hourly variation in pressure (m bar) for 3 months
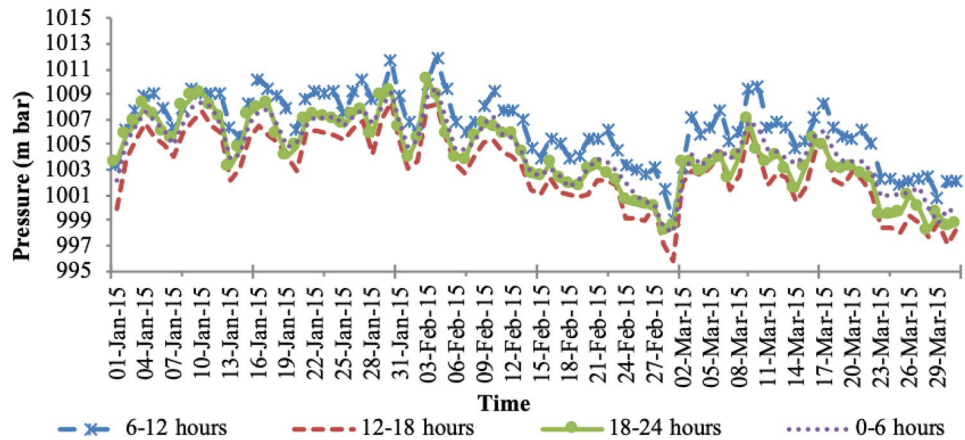
Table 2 Average and standard deviation of six hourly pressure variation (m bar) for 3 months

Pressure	0–6 h	6–12 h	12–18 h	18–24 h	6-Hourly average	Hourly std. dev.
January	1008	1005	1006	1006	1006	1.21
February	1005	1002	1003	1003	1004	1.40
March	1004	1001	1002	1003	1002	1.53
Monthly Average	1006	1003	1004	1004		
Monthly std. dev.	1.7	2.09	2.36	1.86		

Pressure

Figure 4 shows the pressure variation in terms of mbar. Atmospheric pressure is mainly the factor of the area topography and is inversely related to the elevation of the location from mean sea level. It is observed maximum at the sea level and with the increase in elevation, the atmospheric pressure decreases gradually. There was no significant variation seen in the study period as shown in Table 2. This is because the topography was almost constant throughout the study area. Only a slight pressure drop was observed from February 27, 2015 to March 02, 2015,

which might be the result of high temperature. Increase in the temperature expands the air allowing it to rise high, thus creating a low-pressure area. Low cloud cover may also be the main reason in increasing the temperature. Changes in the weather parameters together signal the retreating summer and the onset of monsoon.

Relative humidity (RH)

Relative humidity (RH) is the ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at a given temperature. Relative humidity depends on the temperature and pressure of the system of interest. It requires less water vapor to attain high relative humidity at low temperatures; more water vapors are required to attain high relative humidity in warm or hot air. Figure 5 shows the relative humidity profile for the time duration of study. As seen in Fig. 5, there is a gradual decrease in the RH profile as we approach the end of the study. Pressure was almost constant throughout the study period so the RH profile was mainly dependent on the temperature. The RH value is seen to decrease gradually with the approach of summer season. In addition to that, the rainfall intensity was low during this time, so there is no drastic change in the RH. Table 3 shows the average RH of the study.

Wind speed

Figure 6 and Table 4 show the wind speed profile. There is not much variation observed in the wind speed. It is almost constant throughout and this is because of very less pressure variation. Pressure gradient in the atmosphere results in wind turbulence and is the root cause of high wind speed. Highest wind speed is recorded from February 27 to March 2. This might be due to the pressure difference observed at the same time of the study, or due to the northern winds passing over the study area. These winds bring chills in the month of January and February. There was a constant variation observed from the mean (standard deviation) for both monthly and hourly basis, which means that there were no drastic changes in the wind speed throughout the study.

Wind direction

Figure 7 shows that the direction of the wind is highly varying. Also, the average and standard deviation in Table 5 showed variation. Ahmedabad especially lies in a low-pressure area which attracts the winds towards it. Attraction and distraction of the wind may have caused the variation in the direction of the wind.
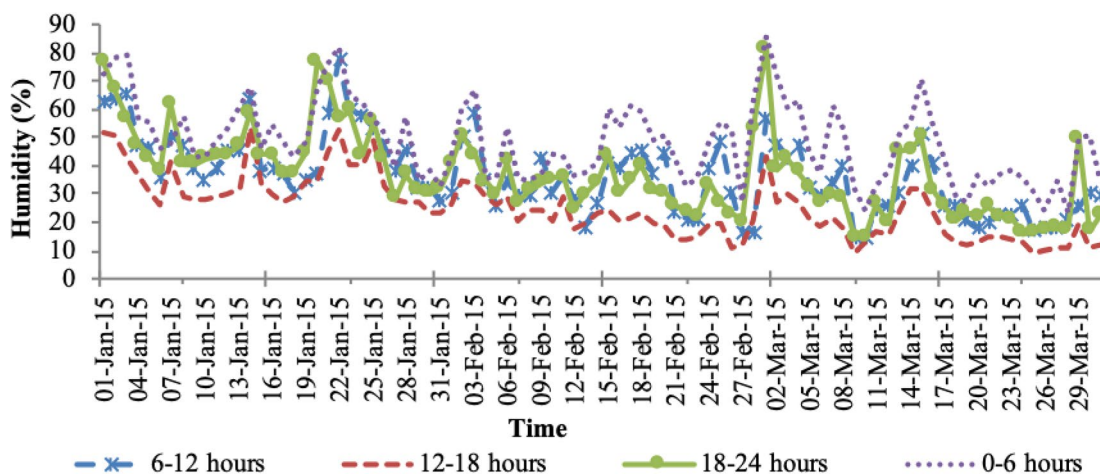

Fig. 5 Six hourly variations in relative humidity (%) for 3 months

Table 3 Average and standard deviation of six hourly relative humidity (%) variation for 3 months

RH (%)	0–6 h	6–12 h	12–18 h	18–24 h	6-Hourly average	Hourly std. dev.
January	46.35	35.07	47.64	55.34	46.1	8.36
February	33.80	21.82	33.30	46.46	33.84	10.07
March	29.55	18.38	29.12	44.10	30.29	10.55
Monthly average	36.57	25.09	36.69	48.63		
Monthly std. dev.	8.73	8.80	9.72	5.93		

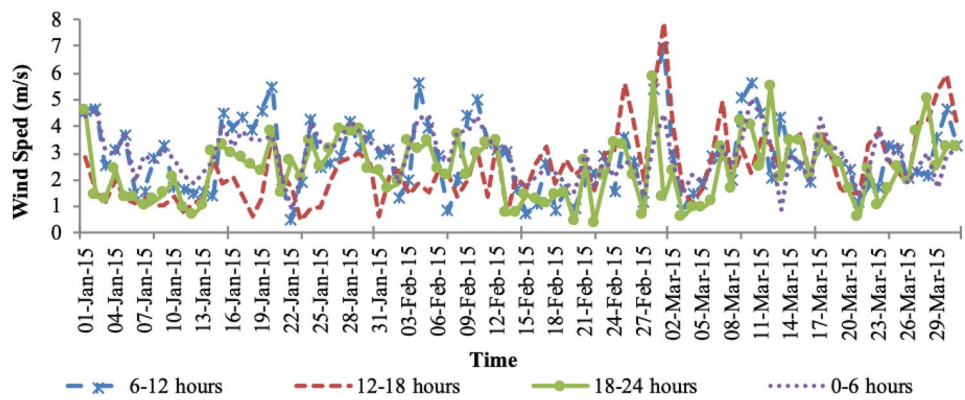**Fig. 6** Six hourly variations in wind speed (m/s) for 3 months

Table 4 Average and standard deviation six hourly wind speed (m/s) variations for 3 months

WS (m/s)	0–6 h	6–12 h	12–18 h	18–24 h	6-Hourly average	Hourly std. dev.
January	3.00	1.67	2.35	3.12	2.53	0.66
February	2.55	2.46	2.24	2.79	2.51	0.23
March	2.95	3.20	2.52	2.82	2.88	0.28
Monthly average	2.83	2.44	2.37	2.91		
Monthly std. dev.	0.24	0.76	0.14	0.18		

Fig. 7 Six hourly variations in wind direction (degree) for 3 months
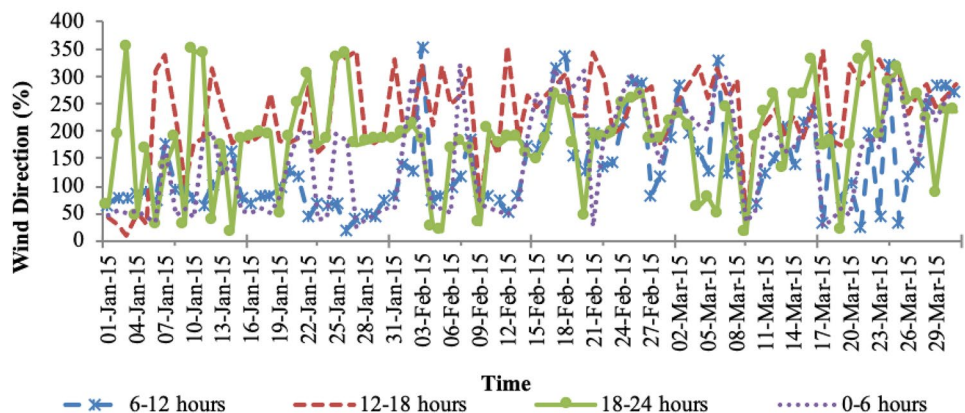

Table 5 Average and standard deviation of six hourly wind direction (degree) variation for 3 months

WD	0–6 h	6–12 h	12–18 h	24 h	6-Hourly average	Hourly std. dev.
January	83	198	181	89	138	60.4
February	161	247	175	181	192	38.6
March	167	254	202	186	203	37.5
Monthly average	137	233	186	152		
Monthly std. dev.	46.9	30.6	14.4	54.8		

Cloud cover

Table 6 showed stable average and standard deviation. Cloud cover was seen to be more in the between February 27 and March 02. 18–24 h data has frequent variations after February 22, 2015. Less variation in wind speed may have encouraged the accumulation of clouds over the study area (Fig. 8).

Table 6 Average and standard deviation of six hourly cloud cover (0–1) variation for 3 months

Cloud cover	0–6 h	6–12 h	12–18 h	18–24 h	6-Hourly average	Hourly std. dev.
January	0.04	0.05	0.02	0.04	0.04	0.01
February	0.01	0.00	0.01	0.01	0.01	0.00
March	0.05	0.06	0.07	0.04	0.05	0.01
Monthly average	0.03	0.04	0.04	0.03		
Monthly std. dev.	0.01	0.02	0.03	0.01		

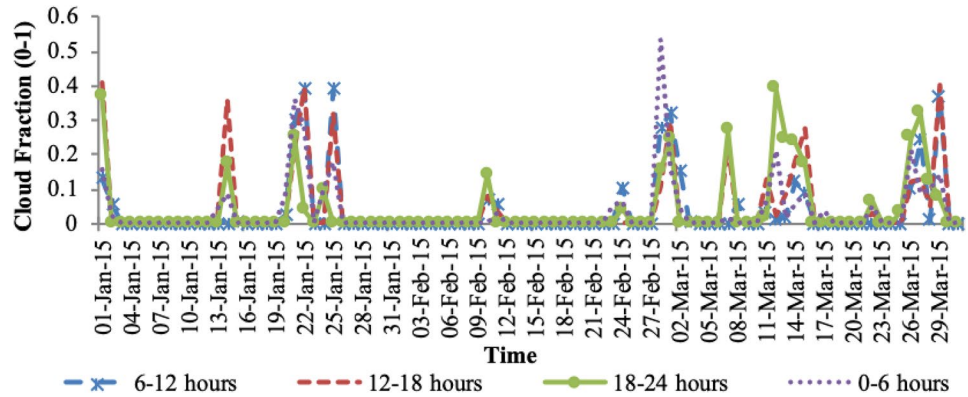**Fig. 8** Six hourly variations in cloud cover (0–1) for 3 months

Fig. 9 Six hourly variations in rainfall (mm) for 3 months
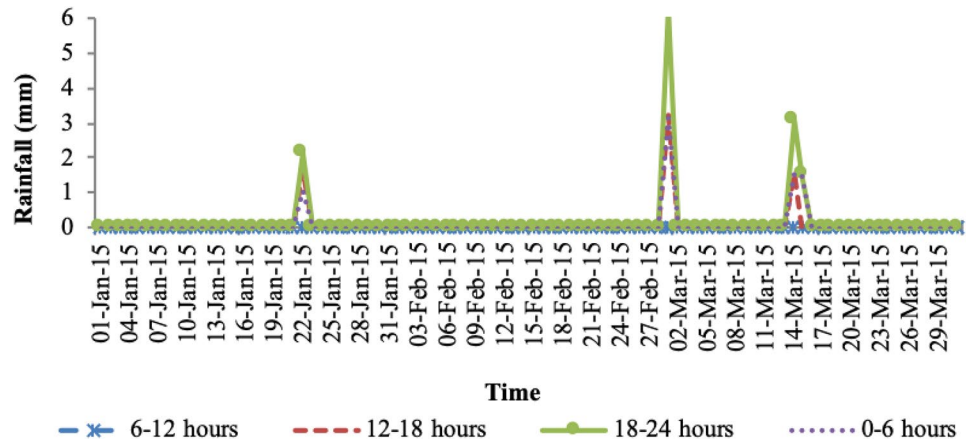

Table 7 Average and standard deviation for six hourly rainfall (mm) variation for 3 months

Rainfall	0–6 h	6–12 h	12–18 h	18–24 h	6-Hourly average	Hourly std. dev.
January	5	0.05	0.06	0.03	0.03	0.02
February	0	0	0	0	0	0
March	0	0.15	0.34	0.19	0.17	0.14
Monthly average	0	0.20	0.49	0.23		
Monthly std. dev.	0	0.07	0.18	0.10		

Rainfall

Month of January showed no signs of rainfall (Fig. 9). Most parts of India experiences south-west monsoon starting in the month of June. The small amount of rainfall experienced by the city can be due to the moist laden winds from the Arabian Sea. Because of that, there is small amount of rainfall observed during this period of time (Table 7).

Correlation

All the 6-hourly data of a day are correlated separately for 3 months and is shown in the following tables. Table 8 shows correlation of the parameters in 0–6 h. Wind direction showed a negative correlation with most of the parameters. Rainfall and cloud cover showed positive relation with most of the parameters. But the extent of correlation is very less. It can be said that the parameters are sparsely related to each other in 0–6 h of the day.

Table 9 shows correlation of the parameters in 6–12 h. Relative humidity and pressure have perfect positive linear relationship. As the pressure of the system increases isothermally, the relative humidity of the system increases, because the partial pressure of water in the system increases with the volume reduction. It can be said that the parameters are sparsely related to each other in 6–12 h of the day.

Table 10 shows the correlation of the parameters in 12–18 h. Relative humidity and pressure have perfect positive linear relationship. Wind Direction, cloud cover and rainfall also have a perfect positive linear relationship. Also, it can be said that the parameters are sparsely related to each other in 12–18 h of the day.

Table 11 shows the correlation of the parameters in 18–24 h. Wind speed and pressure has perfect positive linear relationship. More wind will flow from the region of higher atmospheric pressure as the other regions are at low atmospheric pressure. Speed of the wind depends on the pressure difference between the two regions. Cloud cover is almost correlated with all other parameters positively.

An estimation of average of the day was calculated for each weather parameters to correlate that represents dependency or independency of one parameter to another parameter. Table 12 shows the correlation for the average values of

Table 8 0–6 h correlation of parameters for 3 months

	Temperature	Relative humidity	Pressure	Wind speed	Wind direction	Rainfall	Cloud cover
Temperature	1.00						
Relative humidity	− 0.96	1.00					
Pressure	− 0.96	1	1.00				
Wind speed	− 0.1	0.37	0.37	1.00			
Wind direction	0.90	− 0.98	− 0.98	− 0.53	1.00		
Rainfall	− 0.87	0.97	0.97	0.59	− 1.00	1.00	
Cloud cover	0.24	0.04	0.04	0.94	− 0.22	0.28	1.00

Table 9 6–12 h correlation of parameters for 3 months

	Temperature	Relative humidity	Pressure	Wind speed	Wind direction	Rainfall	Cloud cover
Temperature	1.00						
Relative Humidity	− 0.99	1.00					
Pressure	− 1.00	1.00	1.00				
Wind Speed	0.99	− 0.95	− 0.97	1.00			
Wind Direction	0.98	− 1.00	− 0.99	0.92	1.00		
Rainfall	0.50	− 0.38	− 0.42	0.64	0.30	1.00	
Cloud Cover	− 0.03	0.17	0.12	0.14	− 0.25	0.85	1.00

Table 10 12–18 h correlation of parameters for 3 months

	Temperature	Relative humidity	Pressure	Wind speed	Wind direction	Rainfall	Cloud cover
Temperature	1.00						
Relative humidity	− 0.95	1.00					
Pressure	− 0.96	1.00	1.00				
Wind speed	0.60	− 0.33	− 0.36	1.00			
Wind direction	0.74	− 0.50	− 0.53	0.98	1.00		
Rainfall	0.77	− 0.54	− 0.56	0.97	1.00	1.00	
Cloud cover	0.78	− 0.55	− 0.57	0.97	1.00	1.00	1.00

Table 11 18–24 h correlation of parameters for 3 months

	Temperature	Relative humidity	Pressure	Wind speed	Wind direction	Rainfall	Cloud cover
Temperature	1.00						
Relative humidity	− 0.93	1.00					
Pressure	− 0.83	0.98	1.00				
Wind speed	− 0.78	0.96	1.00	1.00			
Wind direction	0.86	− 0.99	− 1.00	− 0.99	1.00		
Rainfall	0.82	− 0.55	− 0.37	− 0.29	0.41	1.00	
Cloud cover	0.06	0.32	0.50	0.57	− 0.46	0.62	1.00

Table 12 Correlation of parameters for 3 months

	Temperature	Relative humidity	Pressure	Wind speed	Wind direction	Rainfall	Cloud cover
Temperature	1.00						
Relative humidity	− 0.96	1.00					
Pressure	− 0.98	1.00	1.00				
Wind speed	− 0.82	− 0.63	− 0.69	1.00			
Wind direction	0.95	− 1.00	− 0.99	0.59	1.00		
Rainfall	− 0.32	− 0.05	− 0.12	0.81	0.00	1.00	
Cloud cover	0.72	− 0.50	− 0.56	0.99	0.46	0.89	1.00

parameters for the entire day for 3 months. Relative humidity and pressure have perfect positive linear relationship. Also, the wind speed and cloud cover are positively correlated, as the speed of the wind depends on the difference in pressure or temperature, which in turn depends on the difference in the cloud cover between the two regions. There is no linear relationship between wind direction and rainfall. Also, it can be said that the parameters are sparsely related to each other for average values of parameters in a 3-month period.

Conclusions

Seven weather parameters were simulated using WRF Model with 3 h interval for 3 months (January, February and March) of the year 2015. These data were statistically analyzed temporally and for their correlation with each other. Many parameters were found to be directly or inversely proportional to each other. However, correlations among these parameters in both direct and inverse way constitute the weather patterns of the specific area. Since Ahmedabad city is near the coastal area towards the south of Gujrat, Bhavnagar, the air pressure over and around Ahmedabad is low. Hence, high variations were seen in the direction of the wind for the entire duration of study. More variations were seen between February 27, 2015 and March 02, 2015 for all the parameters, which is majorly due to the transition of season from winter to summers as well as the prevailing winds which blows across the country during that particular time of the year. Also, Pearson correlation is only useful for finding relationship between linear variables. As the wind direction is a nonlinear variable, its relationship with other variables cannot be accurately correlated using Pearson correlation. Winter season increases the air pollution levels due to the cold weather and the stagnant air. Result shows increase in temperature and wind speed which would disperse the air pollutants. Study helps in determining the worst possible scenarios of air pollution and would aid in prior precautionary measures.

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