भारत मौसम विज्ञान विभाग

INDIA METEOROLOGICAL DEPARTMENT

CLIMATE OF NAGPUR

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Zero Mile Point


Diksha Bhoomi


Oranges in Nagpur

FOREWORDS

Climate of Nagpur represents a core part of the economy of the city and provides developing and livelihood activities to much of the population. However, in order to keep pace with the increasing population, the growth in production should be sustainable in the long run. Uncertainty of weather and climate pose a major threat to economy security of the city. Meteorologists have tough challenges ahead in understanding the impact of weather and climate on growth and yield of industrial products. Exciting opportunities exist today to help the corporate community through meteorological services. I feel that more concerted efforts are essential to realize the present day needs of the industrialists by the corporate community of the city and also meet the demands of the poor section of the country.

It gives me a great pleasure to present the "Climate of Nagpur" based on the data for the period 1969 to 2010. This booklet provides a summary of highlights on various information provided to the users under long term average basis. I appreciate the initiative taken by the officers and staff members of India Meteorological Department, Nagpur in bringing out the climate of Nagpur for the people of India.

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PREFACE

Climate of a place plays a vital role in all aspect of life. The importance of climatology for economic and social benefits of the society is being realized increasingly all over the World. Innovations in the field of agriculture, aviation, energy, Industry, ecology and urban designs require climatological information for planning and successful execution of the projects with a view to derive maximum advantage out of the climatological information.

Apart from general weather information required by common man, hundreds of enquiries received by Regional Meteorological Centre, Nagpur from general public and print media are about current weather as well as extreme weather conditions for central parts of the country comprising the state of Madhya Pradesh, Chhattisgarh and Vidarbha region of Maharashtra.

Daily and weekly weather reports for the region are prepared as a routine by this centre. These summaries, however, do not readily provide answers to many of the general queries; such as –"Was yesterdays' rainfall a record"? Or "When was April so hot or August so wet in the past?" Climatic features of Nagpur have been described in details in this publication to answer these queries and for making considered decisions.

This book contains monthly summaries, divided into four seasons, describing the average and extreme temperature, rainfall, wind and humidity. Occurrences of different weather phenomena such as heavy rains, thunderstorms, hailstorm, squalls and fog are described in detail to provide information as to how many of these phenomena occur on an average and what have been their highest value in the past.

We are thank full to Shri D, S. Gaikwad , Shri S. S. Ashtikar and Shri M. M. Phadke for their help in compilation of data. We also thank the National data Centre, Pune and Regional Meteorological Centre, Nagpur for providing the required data.

Nagpur
Dated 16/12/2011

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CONTENTS

1. History and Geography

Vidarbha is the eastern region of Maharashtra state made up of Nagpur and Amravati divisions. It occupies 31.6 % of total area and gives 21.3% of total production of Maharashtra state. It borders the state of Madhya Pradesh to north, Chhattisgarh to east, Andhra Pradesh to south and Marathawada and Khandesh regions of Maharashtra to west. It is situated in the central part of India.

Nagpur was the capital of Bhonsale dynasty of Marathas who in the mid eighteenth century created an independent Hindu princely state that covered much East Central India. After their defeat in the third Anglo Maratha war in 1818, the Bhonsale dominions were reduced to Nagpur division. In 1853, the last Maharaja of Nagpur died without a male heir and subsequently Nagpur division was incorporated into mainstream British India. Nagpur division became a part of British Raj's Central Province in 1861.

Figure 1.1 :- Map of Nagpur District

The amazing fact of the geography of Nagpur is that it lies in the centre of India and zero mile stone of India is situated within the city. The geographical location of the Nagpur district varies from latitude 21° 41' N to 20° 35' N and Longitude 78° 15' E to 79° 45' E and situated at height of 312.4 meters above mean sea level. The main structure of Nagpur is the British fort built in 1818 which stands tall on twin hills of Sitabuldi in the middle of the city. The Nagpur lies on the Deccan plateau of the Indian peninsula and surrounded by plateaus of Satpura range. The total land area of Nagpur city is 228 sq. km. and of district is 9892 sq. km.

As per 2011 census report, the total population of the Nagpur is 46,53,171. Nagpur is the winter capital of the state of Maharashtra. The map of Nagpur is shown in Figure 1.1above.

2. General climate of Nagpur

The city of Nagpur enjoys a very dry and semi humid climate throughout the year excepting monsoon season (June to September). Nagpur climate witness a very hot weather during the month of summer. It reaches the pinnacle in the month of May. Mean and extreme monthly data of Nagpur during the period from 1969 to 2010 is given in Table 1(A) & 1(B) below.

Table 1(A). : Mean and Extreme monthly data of Nagpur

	Temperature in °C						Rainfall					
Month	Max Temp	Highest MaxTemp	Date/ Year	Mean Min Temp	Lowest Min Temp	Date/ Year	Rainfall mm	Heaviest monthly R/F mm	Year	Heaviest 24 hrs R/F	Date/ Year	No. of Rainy Day
Jan	28.9	36.6	25/1996	13.1	6.4	03/1991	15.3	129.3	2005	77.8	31/2005	1.1
Feb	31.8	39.2	24/2006	15.6	7.4	2/2008	20.8	151.5	1975	130.1	20/1975	1.3
Mar	36.5	42.5	23 , 24/ 2010	19.7	10.1	10/1979	18.1	99.6	1995	38.2	15/2006	1.5
Apr	40.7	47.1	30/2009	24.2	16.2	02/1996	8.6	60.8	1996	37.4	22/1982	1.0
May	42.7	47.6	23/2005	27.8	20.4	06/1997	18.2	76.5	1990	31.6	30/1970	1.9
Jun	37.8	47.7	05/2003	26.4	21.0	18/1971	163.4	398.8	1970	170.7	14/2001	8.7
Jul	31.7	40.6	11/1992	24.2	19.5	31/1980	304.0	677.5	1994	304.0	12/1994	13.7
Aug	30.6	37.6	15/2000	23.7	19.8	21/1992	275.0	557.7	1979	215.4	04/1979	13.2
Sep	32.2	38.5	02/2007	23.1	16.6	23/1972	170.1	406.8	1981	143.8	03/1976	8.3
Oct	33.0	39.5	29/2001	20.0	12.6	29/1974	61.2	363.1	1985	172.8	12/1985	3.1
Nov	30.9	35.6	07/1977	15.8	7.0	30/1974	16.8	100.2	1998	66.2	30/1997	1.0
Dec	28.8	34.0	27/2007	12.6	5.7	28/1983	11.7	126.5	1978	50.9	03/1978	0.8

Table1(B) : Mean and Extreme monthly data of Nagpur

Miscellaneous								
Month	Wind Speed	Mean Evaporation mm.	Mean Sun Shine 0.1 hr	Number of days with				
				Hailstorm	Thunder	Fog	Dust storm	Squall
Jan	5.5	3.5	84.5	0.5	1.0	0.6	0.0	0.1
Feb	6.6	4.4	94.1	0.0	1.6	0.1	0.0	0.3
Mar	6.8	5.9	92.4	0.1	3.0	0.0	0.1	0.5
Apr	7.5	7.4	95.3	0.0	4.1	0.1	0.1	0.6
May	9.9	8.7	95.3	0.0	6.1	0.0	0.2	1.9
Jun	10.0	6.3	64.1	0.0	10.7	0.0	0.0	2.3
Jul	8.3	3.8	38.4	0.1	8.8	0.1	0.0	0.7
Aug	7.8	3.4	37.1	0.1	7.2	0.1	0.0	0.4
Sep	6.5	4.1	61.0	0.0	8.5	0.0	0.0	0.5
Oct	5.6	4.3	82.6	0.0	2.8	0.1	0.0	0.1
Nov	5.6	3.7	86.4	0.0	0.8	0.2	0.0	0.0
Dec	5.0	3.3	86.1	0.0	0.3	0.5	0.0	0.0

Blowing dry wind makes the climate scorching almost throughout the summer. The maximum temperature remains more than 42° C. At times, it may reach to 48° C. Monsoon advances in the month of June (Normal date of onset of monsoon over Nagpur is 10th June).

Maximum rainfall occurs during July and August months. Winter season of Nagpur is spine chilling. Minimum temperatures hovers around 12° C. and at times even dip below that level.

3. Data used

A meteorological observatory is situated at Nagpur airport, which represent the climate of Nagpur. Daily Meteorological data of this observatory have been used to prepare the climatology of Nagpur. The climatological study of rainfall, Temperature, wind & humidity are carried out by using 42 years data for the period 1969-2010. The extremes of rainfall described are from the year 1875-2010 & those of temperature from 1901 to 2010. The data on weather phenomenon are for a 42 year period from 1969-2010.

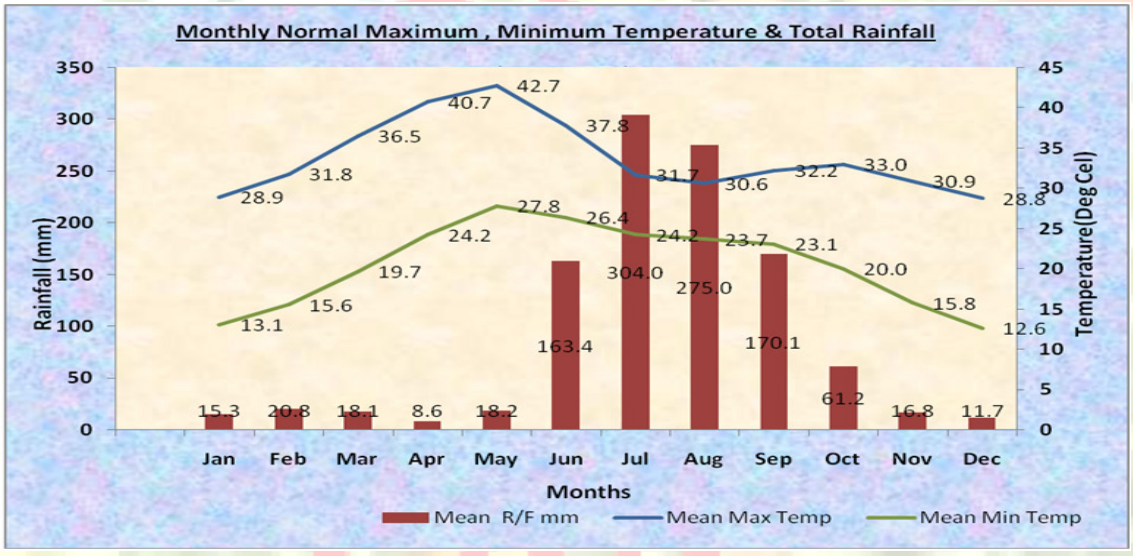

Fig. 2.1 :- Annual variation of maximum and minimum temperature and rainfall

The annual variation of maximum and minimum temperature and rainfall is shown in Figure 2.1. It shows that the maximum temperatures are at their peak in the month of May. It starts falling sharply in the month of June & July. The maximum temperature remains stationary in the month of July & August. It starts increasing slowly in the month of September and October. The maximum temperature again starts falling gradually in the month of November & reaches lowest temperature in the month of January. It again starts increasing gradually in the month of February and reaches at peak in the month of May. Thus two Maxima & two minima have been observed. Similar trend also have been observed in minimum temperature. However only one maxima & one minima has been observed in annual variation of minimum temperature. Maximum temperature decreases slowly from the month of November, whereas minimum temperature decreases sharply from the month of October, with January the coldest month. The normal rainfall increases from the month of June , with the onset of pre monsoon rainfall activity towards first week of June and

monsoon towards middle of the month. July is the rainiest month followed by August. Monsoon withdraws toward first week of October. The rainfall decreases drastically from the month of October, with April being the driest month of the year.

Monthly mean and extreme of temperature, monthly total and extreme rainfall & average number of days with different weather phenomenon are given in Table 1(A) & 1(B) and number of days with heat / cold wave given in Fig.4.4. Also extreme temperatures during 1969-2010 are shown in Table. 2

4. Summer Season

The month of March, April & May constitute the summer season. This season is characterized by dry & hot weather in Nagpur. Increasing solar radiation and rise in temperature with high incidence of convective weather phenomenon like thunderstorm, hailstorm & squall are the main weather features of the season. Incursion of moisture either from the Bay of Bengal or Arabian Sea and/or operation of any trigger mechanism create condition conducive for explosive convective phenomenon.

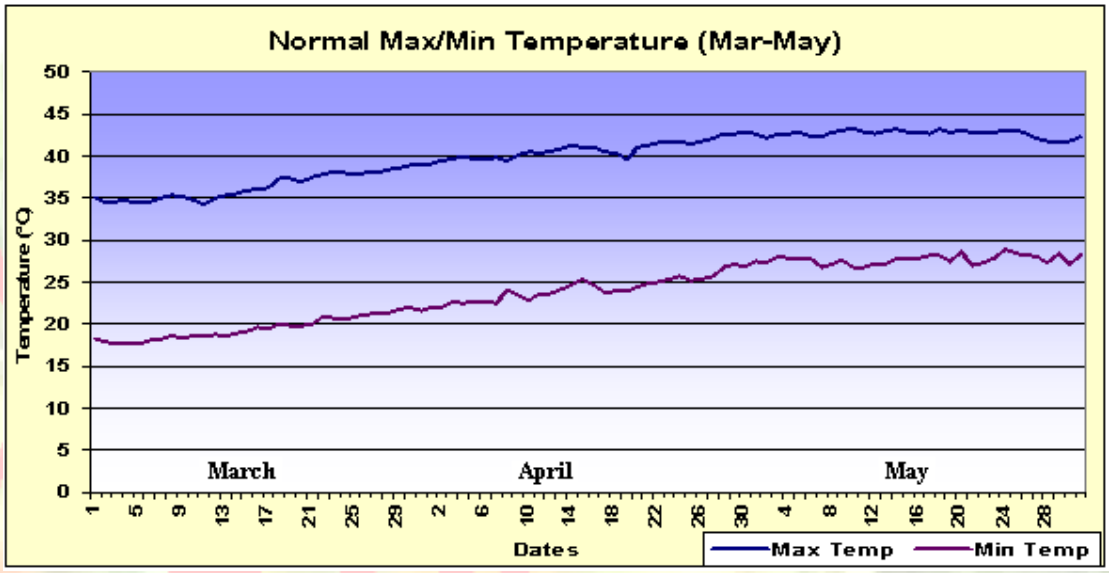

Figure 4.0:- Normal Maximum & Minimum Temperature for Summer season

Daily Temperature continues to increase is the main feature of the season. Figure 4.0 shows the daily normal temperature for the season. Both the temperatures register continuous and sharp increase from the beginning of March to May. The maximum temperature shows sharp increase from 35° C in the first week of March to about 44° C till the end of May, occasionally reaching to around 47° C .The minimum temperature also have a similar rising tendency from about 19° C in the beginning of March to about 29° C by the end of May.

4.1 Diurnal variation of Temperature

Diurnal variation of the temperature during summer season (March to May) is depicted in Figure 4.1. The minimum temperature of the day is recorded around 0700 hrs I.S.T. in March and around 0600 hrs I.S.T. in April & May. As the Sun start rising earlier,

the temperature increase sharply from 0700 hrs I.S.T. to 1300 hrs I.S.T. and reach their peak value around 1500 hrs. I.S.T. The decrease in temperature from afternoon to night is gradual as compared to sharp rising trend during forenoon hours and winter season.

The difference in temperature of March & April is about 4° C at each hour of the day and about 2° C for those of May indicating gradual increase in temperature through the month of May. The days in the month of May have about 6 hours of temperatures in excess of 40° C.

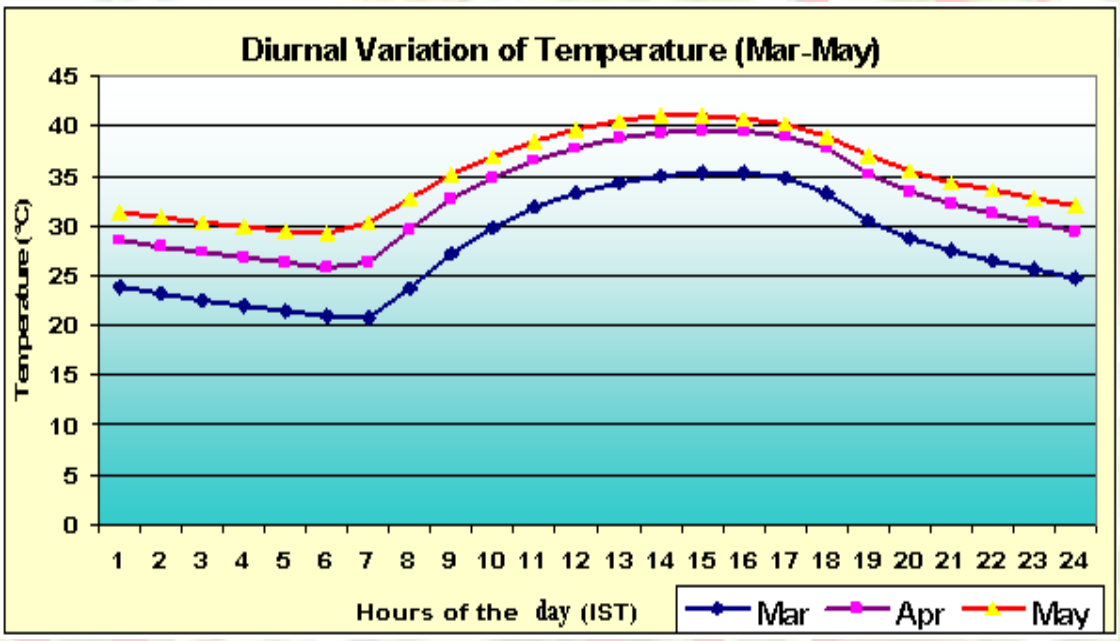

Figure 4.1:- Diurnal variation of temperature during summer season

4.2 Relative Humidity in Summer

Daily mean maximum and minimum relative humidity (Figure 4.2) shows that the maximum relative humidity falls from 60% at the beginning of March to about 45% towards the end of the March. The relative humidity again rises by about 10% in the first half of April. This rise may be due to occurrence of more convective activity during first half of April. Relative humidity again starts falling gradually in the second half of April reaching lowest (35%) in the first half of May. Significantly increasing trend also noticed during second half of May.

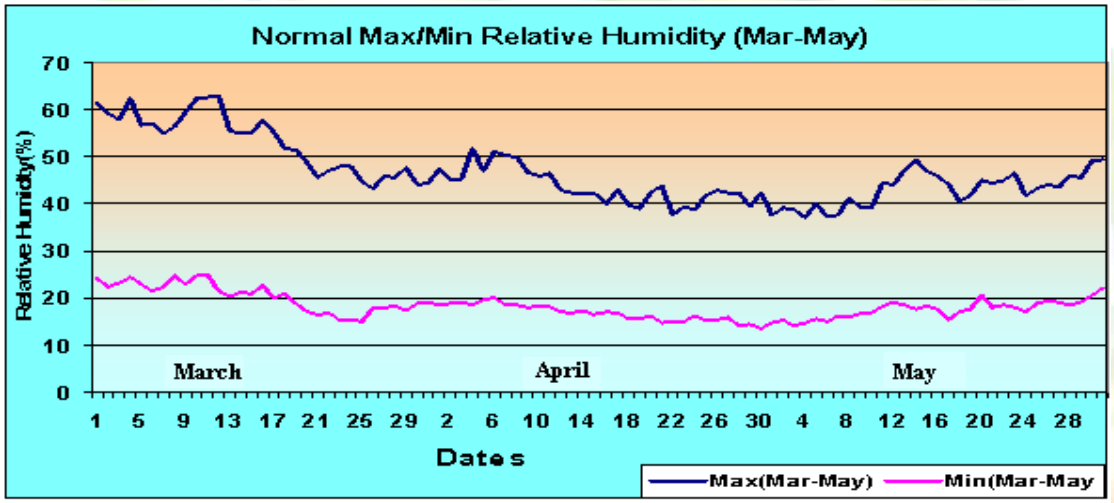

Figure 4.2:- Normal maximum and minimum humidity during summer season

Similar trend has been observed in minimum relative humidity. The minimum relative humidity remains within the range of 15% to 25% throughout the summer season. However, lowest minimum relative humidity has been observed during end of April to first week of May and increases slowly in the second half of May.

4.3 Diurnal variation of Relative Humidity during summer (March to May)

The diurnal variation of relative humidity is shown in Figure 4.3. The maximum and minimum relative humidity has been noticed at 0700 hours and between 1600 to 1800 hours I.S.T. respectively. The relative humidity is about 10% more in March as compared to April & May. However, no significant difference has been noticed in minimum amount of relative humidity in all the months of summer season. No large variation in relative humidity distribution has been noticed in the Month of April and May.

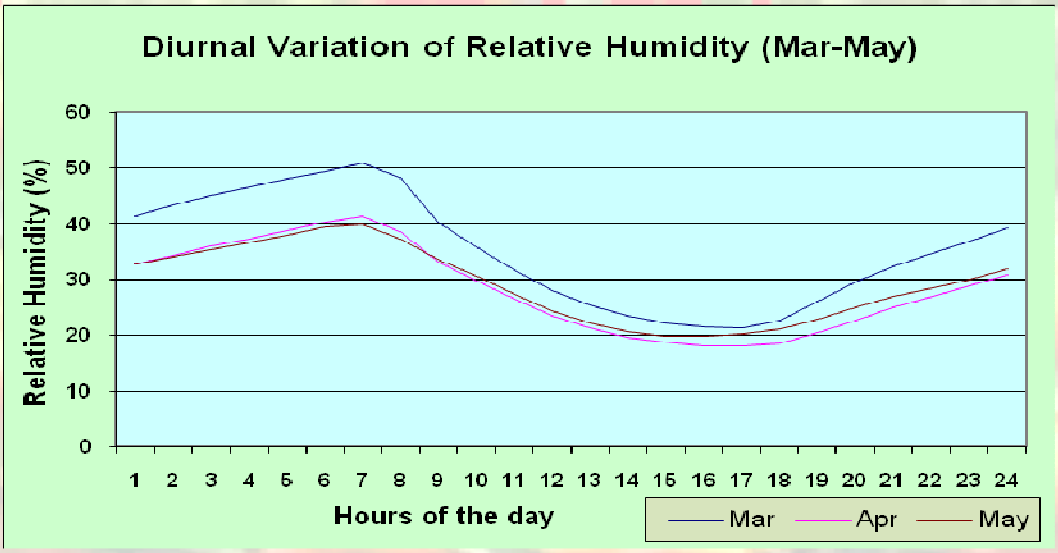

Figure 4.3:- Diurnal variation of humidity during summer (March to May)

The maximum relative humidity is 50%, 41 % & 40% at 0700 hours I.S.T. in March, April and May respectively. Similarly, minimum relative humidity is 22%, 19% & 20% between 1600 to 1800 hours I.S.T in March, April & May respectively. The relative humidity decreases gradually from 0800 to 1800 hours I.S.T. and attains minimum at 1600 hours I.S.T. throughout the summer season. It continues to remain minimum relative humidity till 1800 hours I.S.T. It again starts increasing gradually from 1900 hours I.S.T. and attains maximum at 0700 hours I.S.T.

4.4 Extreme temperature

The highest maximum temperature during the summer season for the period from 1969 to 2010 are shown in Table 2 and number of days of heat wave during period from 1969 to 2010 is shown in Figure 4.4. The highest maximum temperature of 45° C or more was most frequent during most of the years. The extreme temperature of Nagpur during summer season is given in Table 2. The highest maximum and minimum temperature in March is 42.2° C (30/03/1996) and 28.0° C (29/03/1996) respectively.

The highest maximum and minimum temperature in April is 46.0° C (27/04/1973) and 31.9° C (23/04/1973) respectively and in May is 47.6° C (23/05/2005) and 34.3° C (15/05/1970) respectively. However, extreme recorded maximum temperature is 47.7° C on 26/05/1954.

The lowest maximum and minimum temperature in March is 20.6° C (11/03/2006) and 10.1° C (10/03/1979) respectively. The lowest maximum and minimum temperature in April is 30.8° C (19/04/2000) and 16.2° C (02/04/1996) respectively and in May is 24.8° C (13/05/1990) and 20.4° C (06/05/1997) respectively.

Table 2. Extreme Temperatures at Nagpur (1969-2010)

Season	Months	Maximum temperature				Minimum Temperature			
		Highest	Date	Lowest	Date	Highest	Date	Lowest	Date
Summer	Mar	42.5	23 , 24/ 2010	20.6	11.03.2006	28.0	29.03.1996	10.1	10.03.1979
	Apr	47.1	30/2009	30.8	19.04.2000	31.9	23.04.1973	16.2	02.04.1996
	May	47.6	23.05.2005	24.8	13.05.1990	34.3	15.5.1970	20.4	06.05.1997

The average number of heat wave in March, April & May is 0.5, 2.4 & 7.2 days respectively. May is the most discomfort and hot month during summer season. Maximum 18 days of heat waves experienced during 1973, 1988 & 2010 in May.

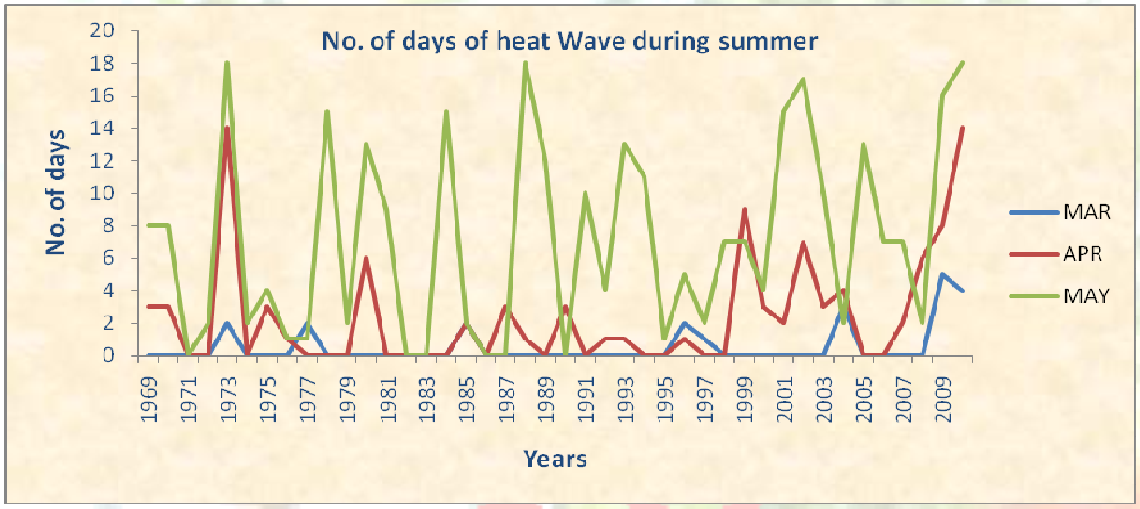

Figure 4.4.1:- Number of days of Heat Wave during summer

4.5 Thunderstorm and other weather phenomena

The summer season is characterized by severe weather activity like thunderstorm, dust storm, hails and squall. These activities are associated with tall cumulonimbus clouds which form in the field of upper air divergence ahead of eastward moving trough in middle and upper tropospheric westerlies.

Thermal convection also causes the development of thunderstorm in the afternoon/evening hours when sufficient moisture in the lower tropospheric level arrived over Nagpur due to prevailing of strong southwesterlies along the Konkan coast or strong southeasterlies along the Andhra coast. The severe downdraft from the cumulonimbus cloud results in squall / hail. The analysis of data shows that the average number of thunderstorm during March, April and May is 3.0, 4.1 and 6.1 days respectively (Table 1(B)).

Diurnal variation of thunderstorm (Figure 4.5.1) shows that afternoon hours (1500-1800 & 0000-0300 hours I.S.T) are the most preferred time for occurrence of thunderstorm. Frequent thunderstorm can also be experienced during 1200-1500 hours I.S.T. and 1800-2400 hours I.S.T. The thunderstorms are less frequent during 0300-1200 hours I.S.T. The thunderstorms accompanying with squall/hail and dust storm are also very much predominant during summer season. Even though the thunderstorm accompanying with squall, hail/dust storm are known for causing loss of life and property and other inconvenience to the public but also provide temporary relief from the scorching heat of the summer season. Maximum temperature generally falls by 4 to 5° C in 24 hours due to thundery activity.

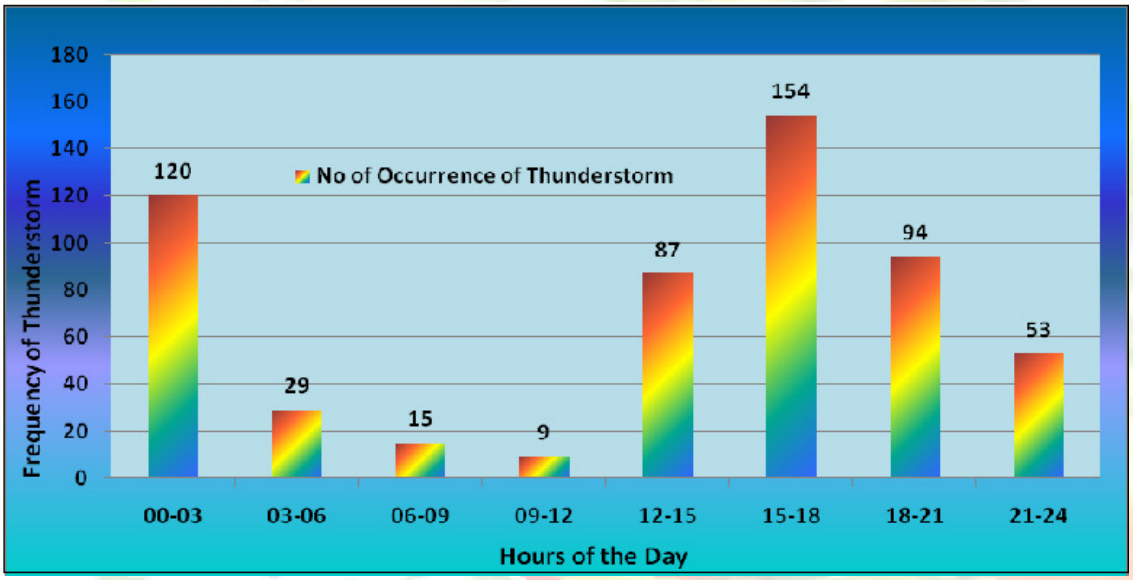

Figure 4.5.1:- Diurnal variation of Thunderstorm during March-May.

Generally hail storm occurs during March only whereas dust storm occurs during March and April. The frequency of occurrence of these phenomena is very less (0.1 day). The squalls have occurred more frequently (0.8 day) in May and less frequently 0.3 days in March and April. The frequency of squall and maximum force (wind) are depicted in radar diagram in Figure 4.5.2. The squalls are more frequent from northwest direction and stronger force from north direction. Strong winds are also expected from west, northwest and southeast direction.

Though, the squall from southeast direction is less frequent but it can be of destructive in nature with maximum wind speed of 100 KMPH. Thus, Nagpur may experience frequent and destructive squalls approaching from west, northwest & north direction.

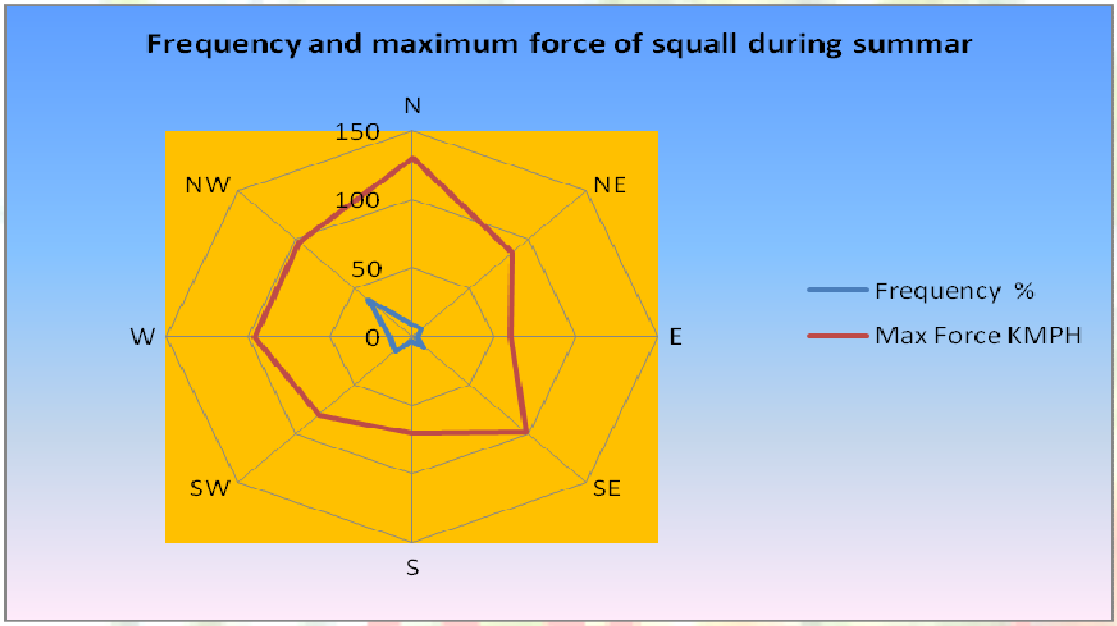

Figure 4.5.2:- Frequency and maximum force (KMPH) of squall during summer

4.6 Rainfall in summer

Summer is dry weather season for Nagpur. Most of the rainfall in association with the thunderstorm on most of the days is caused due to incursion of moisture through the prevailing southeasterly winds over Andhra coast (Bay of Bengal) or southwesterly winds along the Maharashtra – Goa coast (the Arabian Sea) in the lower troposphere. Daily normal rainfall for the season (Figure 4.6) shows the maximum rainfall (more than 1 mm) in the mid of May followed by last week of May and first week of March. Rainfall amount during remaining period is very less (less than 1mm). April did not show any significant variation in daily rainfall. Thus, the period from second week of March to Mid of May is the driest period of the summer season.

The number of rainy days in March, April & May are 1.5, 1.1 & 1.9 days respectively (Table I(A)). The highest monthly and heaviest rainfall in 24 hours is also depicted in Table I(A). The highest monthly rainfall in March, April and May are 99.6, 60.8 and 76.5 mm respectively. Similarly, heaviest rainfall in 24 hours in March, April and May are 38.2, 37.4 and 31.6 mm.

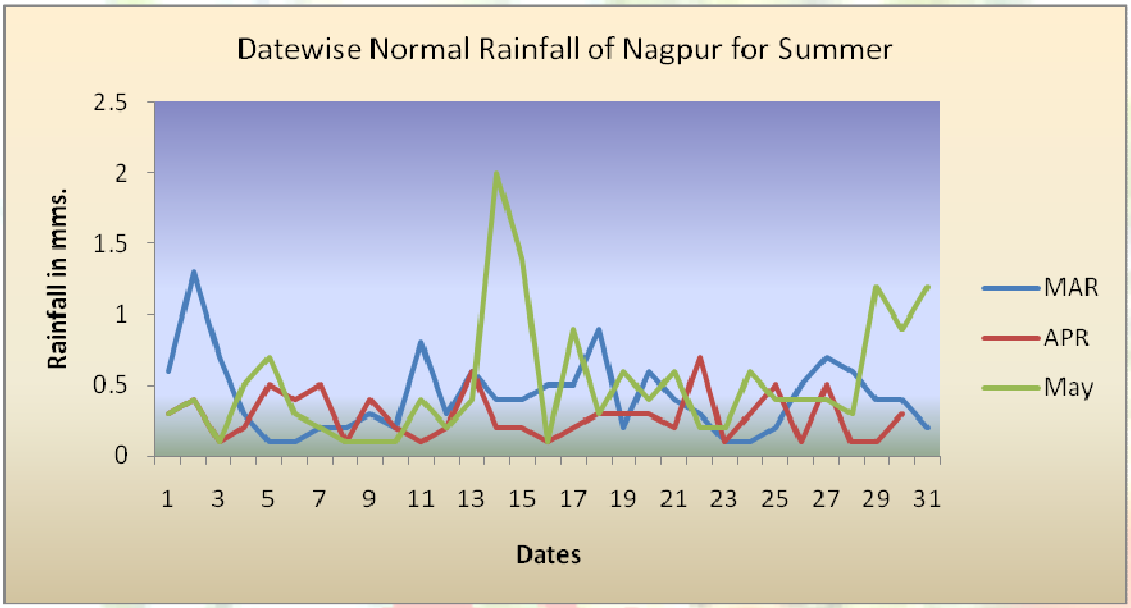

Figure 4.6:- Date wise normal rainfall during summer

4.7 **Winds in summer**

Wind roses during March, April and May are depicted in Figure 4.7(A), 4.7(B) & 4.7(C) respectively. Light northerly wind (up to 4.5 mps) has been predominant followed by northeasterly during morning hours and blowing from all direction during evening hours in the month of March. However, south westerly are more predominant during the evening of March. Occasionally, stronger winds (up to 14 mps) have also been prevailed in the evening of March. Calm winds during morning hours are high (17%) compared to that in the evening (10%).

North westerly winds are more frequent during morning and from western side of the Nagpur during evening of April. However, winds are more prominent from west to northwest direction during evening hours. Occasionally, stronger winds up to 9 mps and 7 mps are also significantly observed from west to northwest direction during morning and evening hours respectively. Calm winds are high (12%) during morning hours as compared to that in the evening (10%)

Calm winds are less frequent in May. Generally, stronger winds are observed in May. North westerly winds with speed reaching up to 11 mps are more predominant during morning and North westerly winds with speed reaching up to 11 mps are more predominant followed by westerly during evening hours in May. Stronger winds with speed reaching up to 14 mps have been also significant during morning and evening hours. Occasionally, wind speed exceeding 25 mps during evening of May.

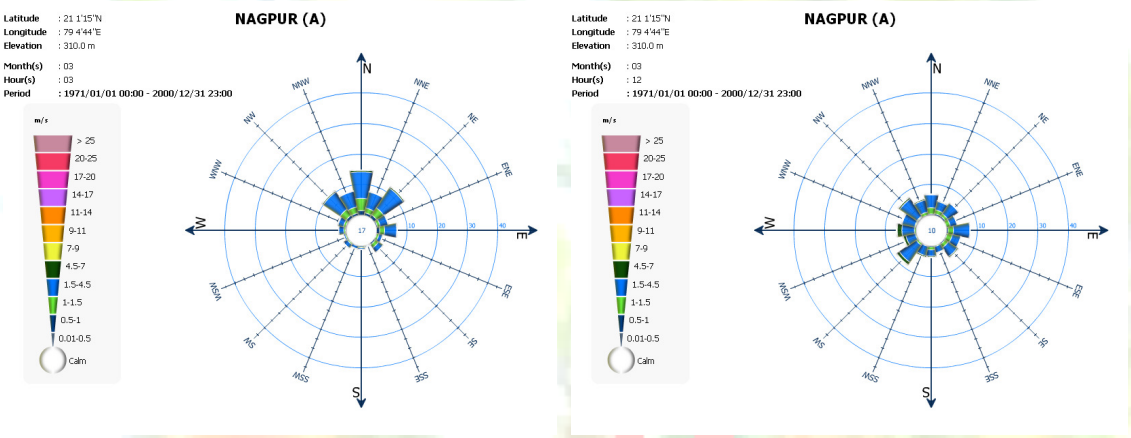

Figure 4.7(A) Wind rose at 0830 & 1730 hours I.S.T. during March

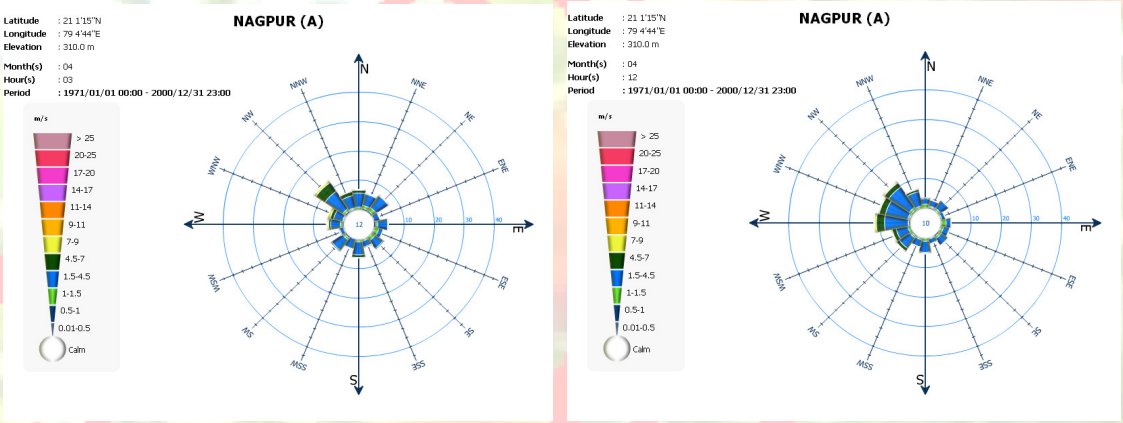

Figure 4.7(B) Wind rose at 0830 &1730 hours I.S.T. during April

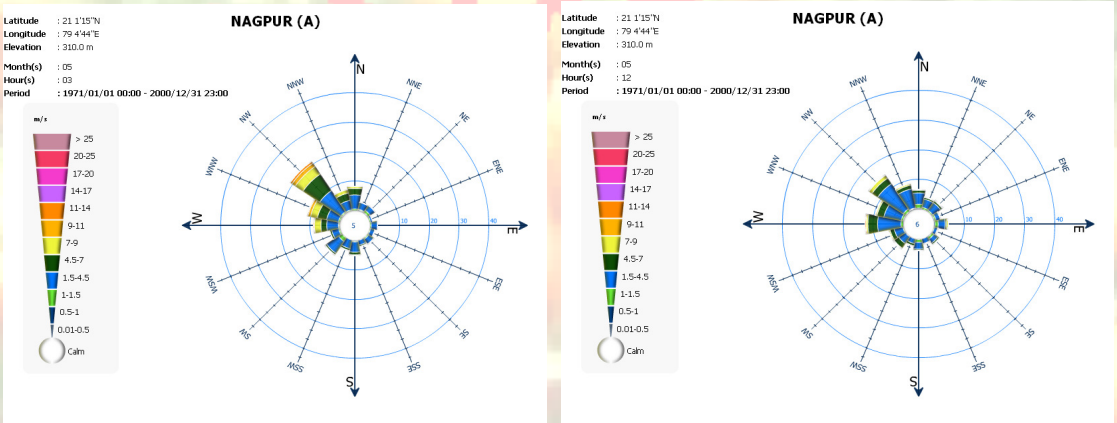

Figure 4.7(C) Wind rose at 0830 &1730 hours I.S.T. during May

4.8 Diurnal variation of wind speed

The diurnal variation of wind speed is depicted in figure 4.8. Weaker winds experience in March compared to April and May. Strengthening of wind speed observed after 0700 hours I.S.T. Weaker winds continued to prevail during late night hours to early morning hours i.e. from 1900 hours I.S.T. to 0700 hours of next day.

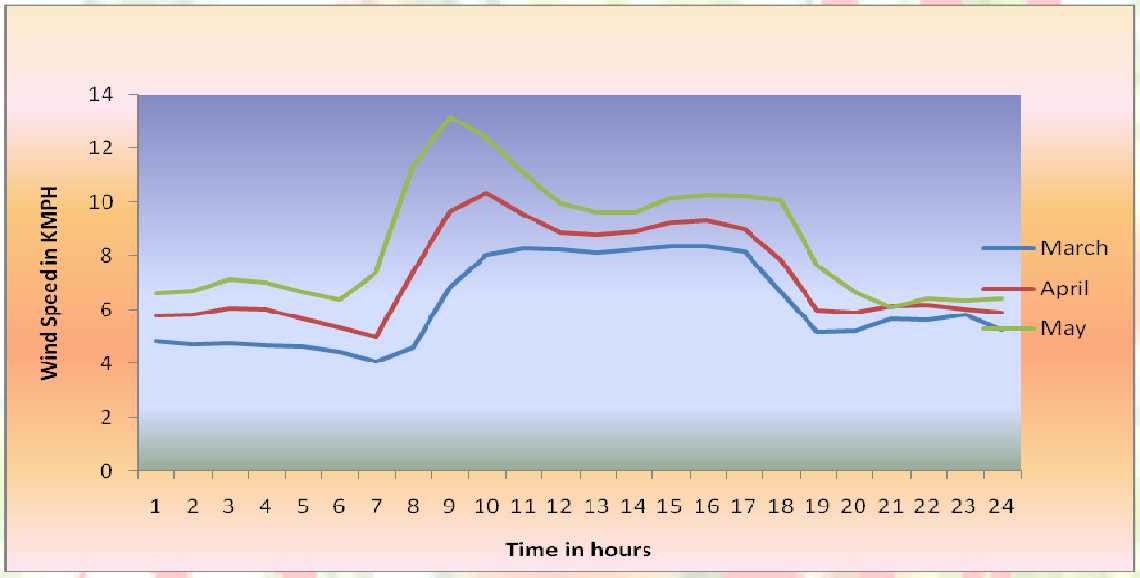

Figure 4.8.1 :- Diurnal variation of wind speed during summer

As the season progresses, winds strengthen gradually. May is characterized with stronger winds. In March, weaker wind (4.1 KMPH) has been observed at 0700 hours I.S.T. and stronger wind (8.4 KMPH) at 1500 & 1600 hours I.S.T. In April, weaker wind (5.0 KMPH) has been also observed at 0700 hours I.S.T. and stronger wind (10.3 KMPH) at 1000 hours I.S.T. Similarly In May, weaker wind (6.4 KMPH) has been observed at 0600 hours I.S.T. and stronger wind (13.2 KMPH) at 0900 hours I.S.T.

5. Monsoon Season

Monsoon is the life line of the population of Nagpur. Monsoon rains, not only influence the life harmony in many ways but also seriously affect other activities like public transportation, power generation, industrial production, marketing of food and other domestic items etc. The monsoon season spans a four months period from June to September, known as the 'Summer Monsoon' or 'South West Monsoon' season. This season is characterized by rain with thunderstorm with some times flooded over and little cold weather. The kharif crop depends on the summer monsoon rains and more than 60% of the annual production of India is produces during this season.

5.1 Onset and Withdrawal of Monsoon

The setting in of monsoon in India is a gradual process. It initially approaches to Andaman and Nicobar islands on 25th of May and gradually widens northwest wards to Indian continent and covers entire country till the mid of July. The onset of monsoon not only blesses relief from hot summer but also provides new energy to population for next financial, agricultural and economic planning.

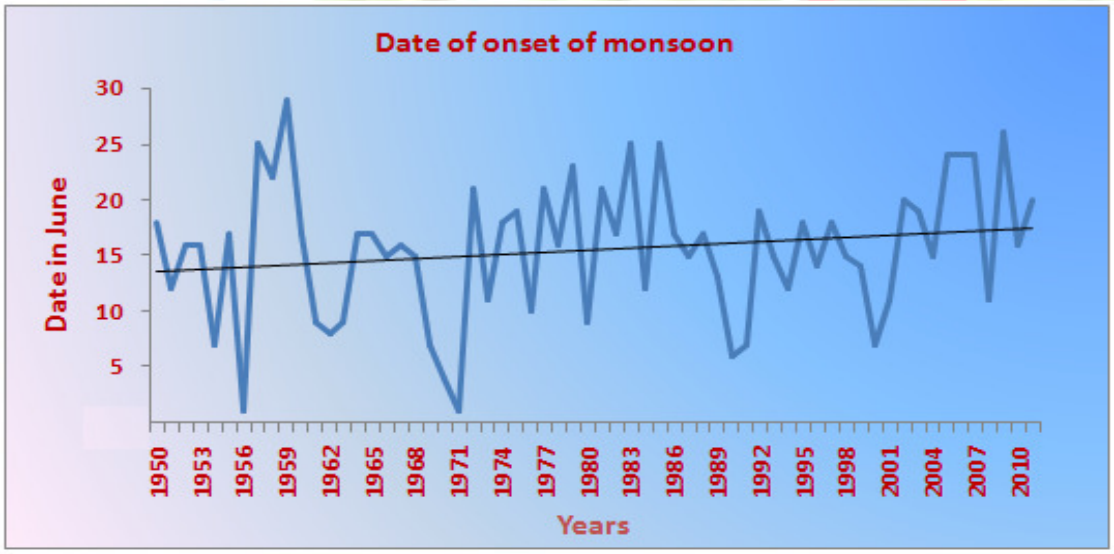

Figure 5.1.1:- Dates (in June) of onset of Monsoon over Vidarbha

The increasing isolation and rise in temperature over the city in Pre Monsoon season prior to the monsoon season gives early advance of South-West monsoon into Nagpur by third week of June. The date of advance of monsoon varies from year to year. The monsoon usually advances over Vidarbha during end of second week or in third week of June. The year wise date of onset of monsoon over Vidarbha has been shown in Figure 5.1.1

In recent years after 2000, the onset of monsoon has occurred in the third week of June except in the years 2001 and 2008 in which monsoon set in on 11th June. The linear trend line in the graph indicates that the onset of Monsoon over Nagpur has been delayed during recent years.

There are cases of onset of monsoon very early in June like on 1st of June in the years 1956 and 1971 whereas, it was in the year 1959 when monsoon delayed significantly to set in over Vidarbha on 29th of June. The normal date of onset of monsoon over Nagpur is 10-12 June, yet in recent years it has reached to some where in third week of June as shown by the trend line. The number of occasion of onset of monsoon event in percentage has been calculated in every five day interval period and depicted in figure 5.1.2

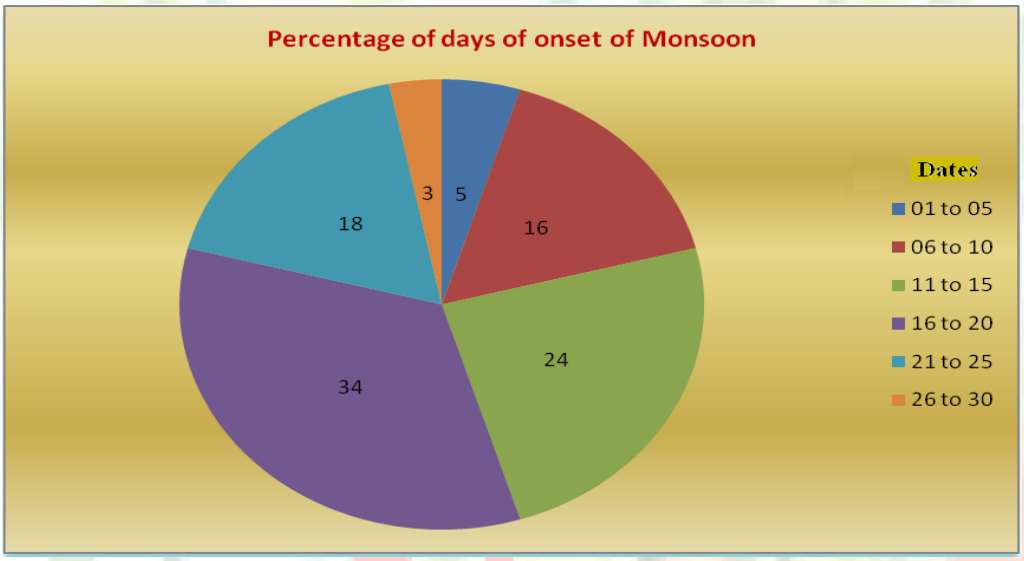

Figure 5.1.2 :- Percentage of days of onset of monsoon

As shown in the Figure 5.1.2, the percentage of days of onset of monsoon is the highest (34%) for dates between 16 to 20 of June and it is the least (3%) for dates between 26 to 30 June and little more (5%) for dates between 1 to 5 June. Hence in very near future we would be able to assume that the SW monsoon sets in over Nagpur in third week of June.

The active monsoon condition is characterized by week long rainy days. In monsoon, the rainy weather is not seen in the city due to monsoon breaks for one week to one month long. During the break monsoon period the rainfall activity is mostly stopped in the city. Generally clear sky with increase in maximum temperature has been experienced. This situation causes humid and temperate weather in the city which remains sufficiently inconvenient to the population.

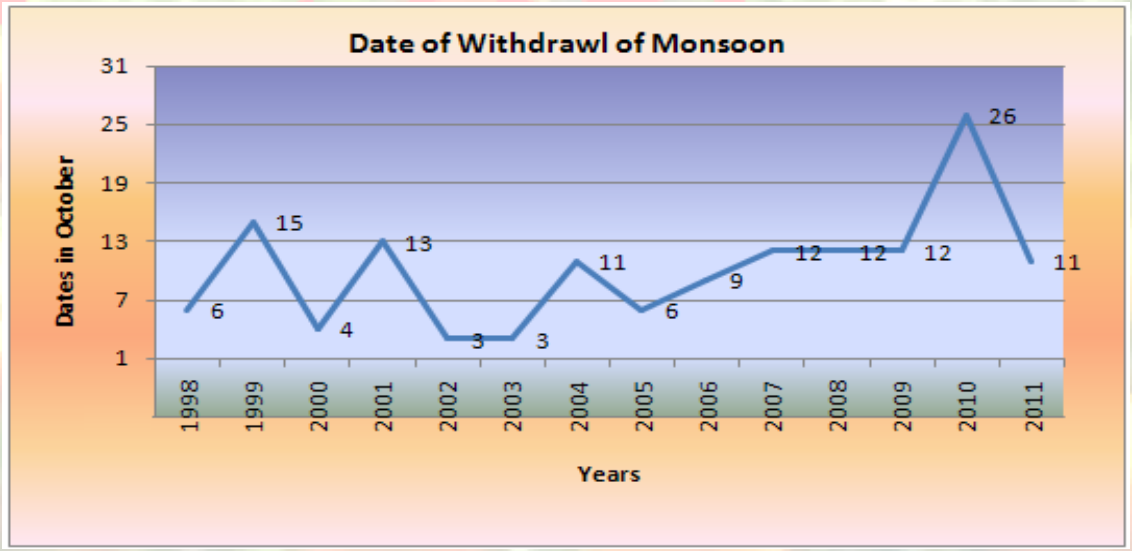

Figure 5.1.3:- Dates (in October) of withdrawal of monsoon

Withdrawal of SW Monsoon starts from north-west India by the beginning of September and roughly proceeds in a direction opposite to that of advance. Withdrawal of south west monsoon from Nagpur as well as Vidarbha takes place during first fortnight of October as shown in figure 5.1.3. The withdrawal of monsoon is characterized by the reversal of winds from South West to North East. It also associates the end of extensive rainfall activity in the city.

5.2 Temperature in Monsoon

The variation in daily normal maximum and minimum temperatures in the monsoon season in Nagpur has been shown in the Figure 5.2.1. The daily maximum temperature decreases sharply from around 42º C to 33º C in the month of June and gradually decreases up to 30-31º C in July. It then remains nearly constant between mid July to end of August and starts increasing slightly in September, in which it reaches to 33º C.

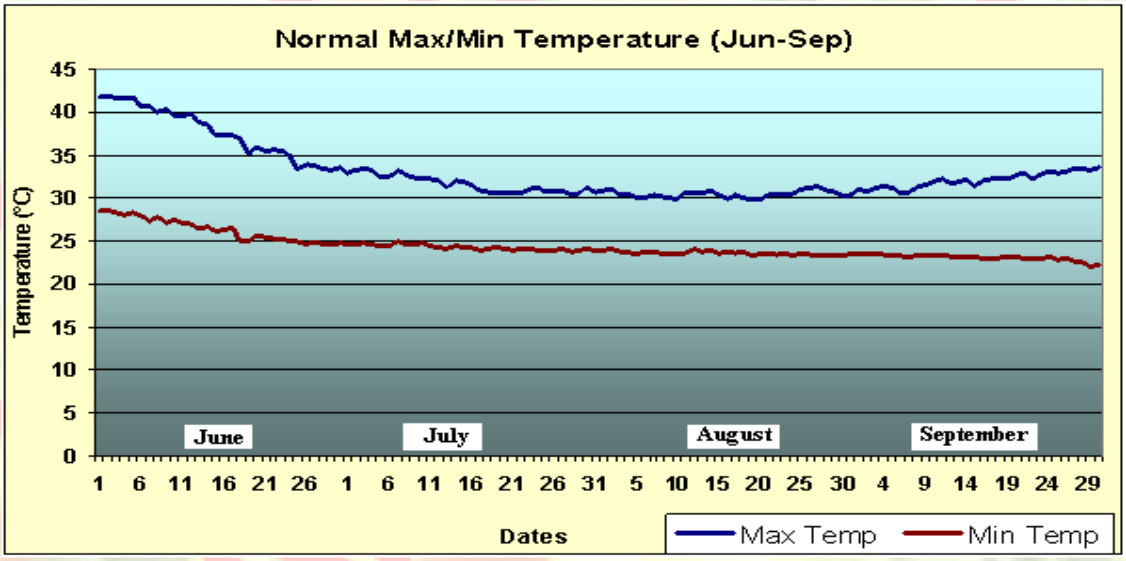

Figure 5.2.1:- Normal maximum and minimum temperature in monsoon season

The minimum temperature decreases sharply in mid of June and remaines practically stable throughout the season. It may be due to sudden changing over of the summer season to rainy season and onset of SW Monsoon over the city.

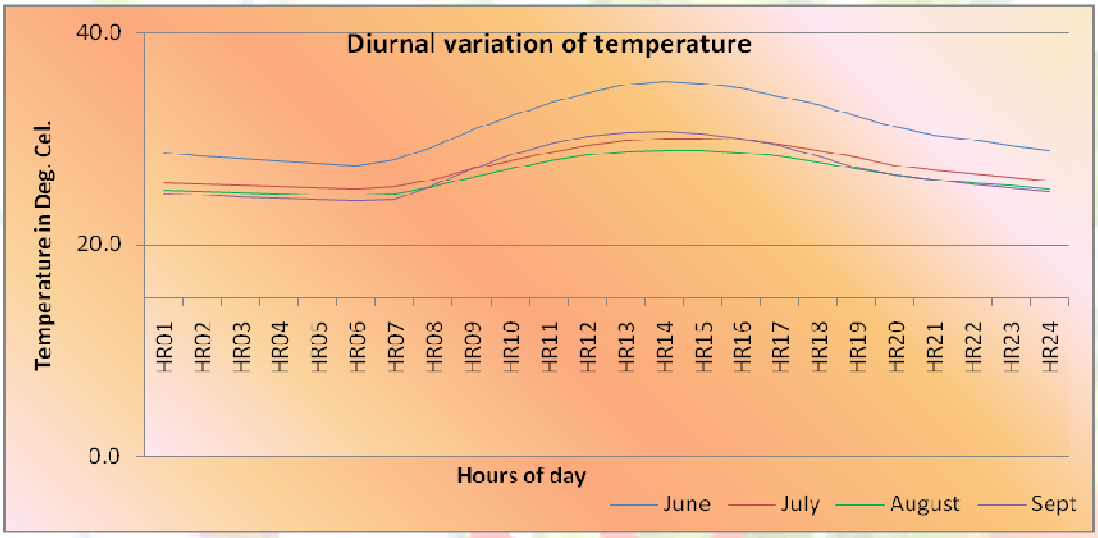

Figure 5.2.2 :- Diurnal variation of temperature during SW Monsoon season

The diurnal variation of the temperature during monsoon season (June to September) is depicted in Figure 5.2.2. The minimum temperature of the day is recorded around 0600 hrs IST in the month of June and the time for attaining minimum temperature shifted to 0700 hours IST with advance of the season in the city. As the Sun starts rising earlier the day temperature increases sharply from 0700 hours IST to 1300 hours IST and reach their peak value around 1500 hours IST. The decrease in temperature from afternoon to night is gradual as compared to the winter season & also as compared to increase in temperature during forenoon hours.

5.3 Extreme temperature

The highest and lowest maximum and minimum temperatures during Monsoon season for the period from 1969 to 2010 have been shown in Table 3. The highest maximum temperature of 45° C or more was most frequent in the month of June during most of the years.

Table 3 :- Extreme Temperature at Nagpur during monsoon

Months	Catagory	Maximum Temp	Date	Minimum Temp	Date
June	Highest	47.7	05, 2003	34.3	13, 2005
	Lowest	24.9	24, 1971	21	18, 1971
July	Highest	40.6	11, 1992	29	08, 1992
	Lowest	24	19, 2000	19.5	31, 1980
August	Highest	37.6	15, 2000	28.1	02, 1970
	Lowest	23.3	18, 1984	19.8	21, 1992
September	Highest	38.5	02, 2007	27.6	08, 1996
	Lowest	23.7	06,1994	16.6	23, 1972

The highest maximum temperature of the season for Nagpur falls in June at which Monsoon advanced in second or third week. It has reached to a peak value of 47.7° C on 05 June 2003 which is also the highest temperature of the station for the entire period of study. The lowest minimum temperature has been recorded as 16.6° C on September 23, 1972. The highest Maximum temperature decreases till the month of August in which it reaches to 38º C and there after it slightly increases to nearly 39 ºC. Apart from this and similar to minimum temperature, the lowest minimum temperature also continues to decrease during monsoon season.

The average highest maximum temperature and average lowest minimum temperature for the monsoon months has been depicted in Figure 5.3.1. These temperatures also show the same trend as for that of highest maximum temperature which decreases from 44º C to 34º C and then increases to 35º C whereas the average lowest minimum temperature shows continues decrease from 23º C to 21º C.

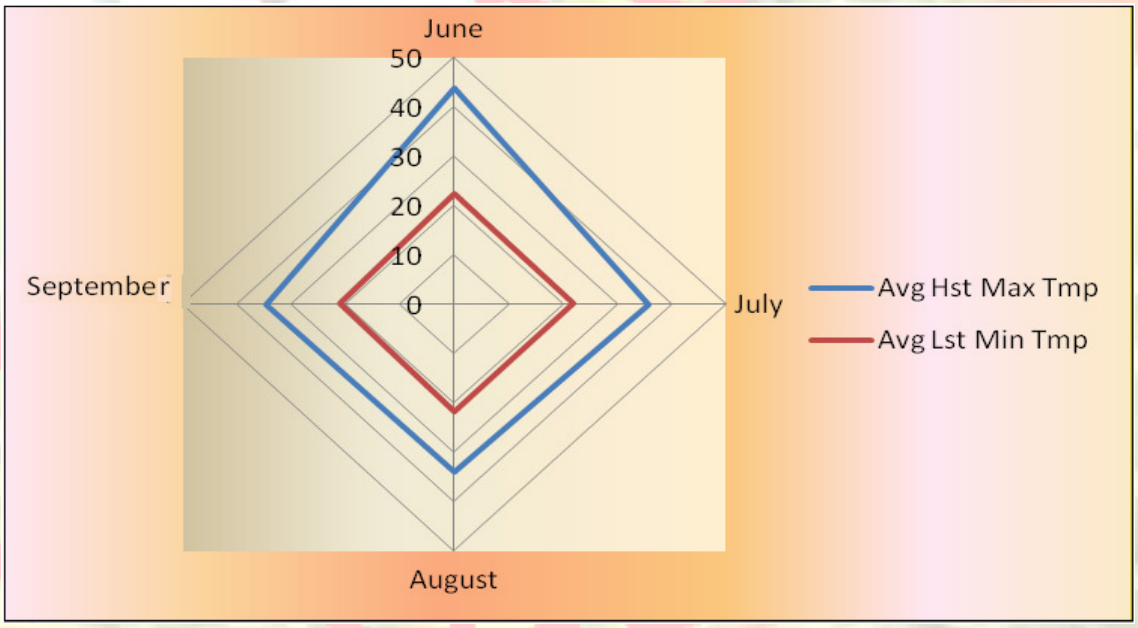

Figure 5.3.1 :- Average highest maximum and lowest minimum temperature (in °C)

5.4 Relative Humidity

Daily mean maximum and minimum relative humidity (Figure 5.4.1) shows that the maximum relative humidity rises from 50% through the month of June in the beginning to more than 90% towards the end of the month. The maximum relative humidity then remains nearly constant till the end of the monsoon season. This rise may be due to advance of monsoon and rainfall activity during first half of June.

Similar trend has been observed in mean minimum relative humidity in the first half of the season. Apart from the maximum relative humidity, the minimum relative humidity decreases from 70% to around 50% during the second half of the season. The minimum relative humidity remains within the range of 20% to 70% throughout the monsoon season.

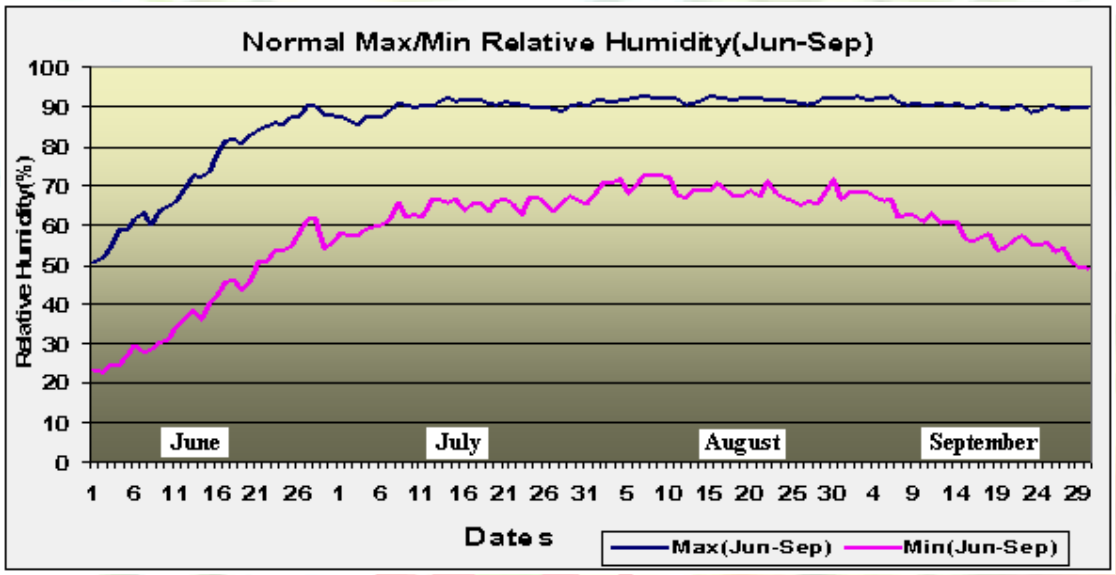

Figure 5.4.1 :- Maximum and minimum Relative Humidity during summer season

5.5 Diurnal variation of relative humidity during monsoon season

The diurnal variation of relative humidity is shown in Figure 5.5.1. The highest maximum relative humidity around 70% in June and July and around 90% in other two monsoon months have been noticed to be at 0700 hours. The relative humidity starts decreasing gradually and attains minimum value of around 45% in June and July and around 72% in August and 62% in September between 1600 to 1700 hours IST. It again increases gradually to maximum value in all the months of the season.

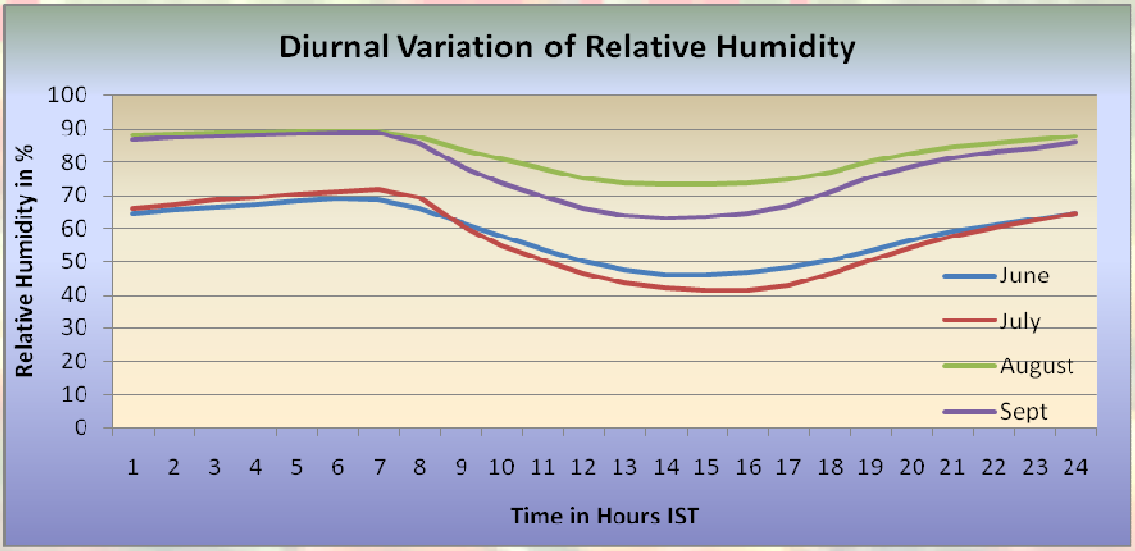

Figure 5.5.1 :- Diurnal variation of Relative Humidity during Monsoon

5.6 Thunderstorm, Fog, Squall and other weather phenomena

The monsoon season is characterized by severe weather activity like heavy rain, thundershowers, squally wind etc. These activities are associated with tall cumulonimbus clouds which form in the field of upper air divergence ahead of eastward moving trough in middle and upper tropospheric westerly. The thermal convection also causes the development of thunderstorm in the afternoon or evening hours when sufficient moisture in the lower tropospheric level arrived over Nagpur due to prevailing of strong south-westerly along the Konkan coast or strong south-easterlies along the Andhra coast. The severe downdraft from the cumulonimbus cloud results in squall, hailstorm and dust storm (in first week of June).

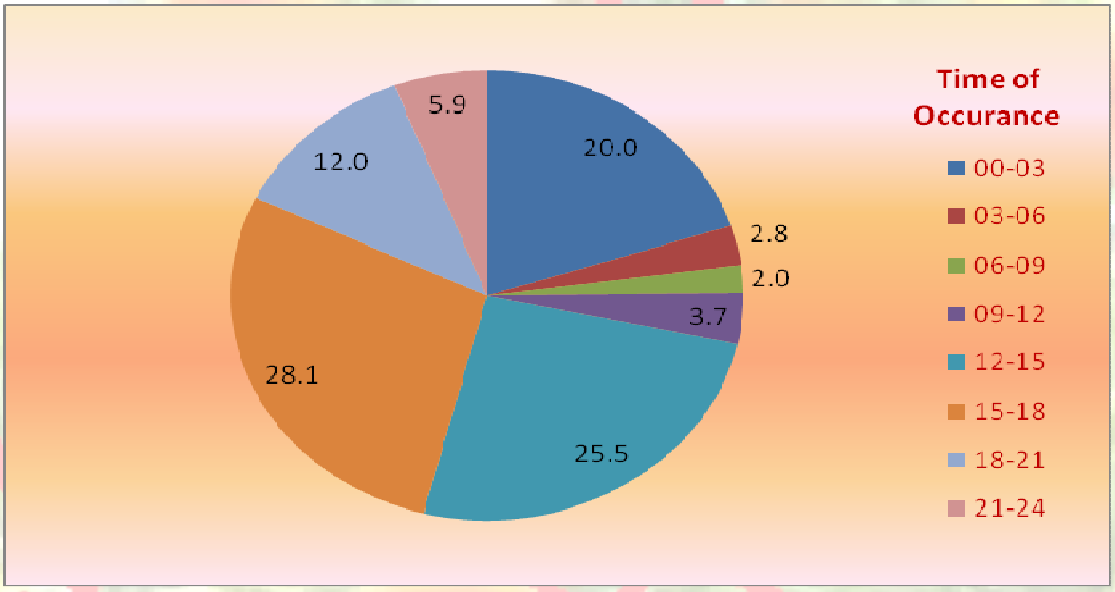

Figure 5.6.1:- Diurnal variation (in %) of Thunderstorm during monsoon

Diurnal variation of thunderstorm (Fig. 5.6.1) shows that afternoon hours (1200-1800 hours) and late night (0000-0300 hours) are the most preferred time for occurrence of thunderstorm. Most of the thunderstorms occur during this period. Even though the thunderstorm accompanying with squall, hail / dust storm are known for causing loss of life and property and other inconvenience to the public but also provide temporary relief from the scorching heat of the summer season. Maximum temperature generally falls by 4 to 5° C in 24 hours due to thundery activity.

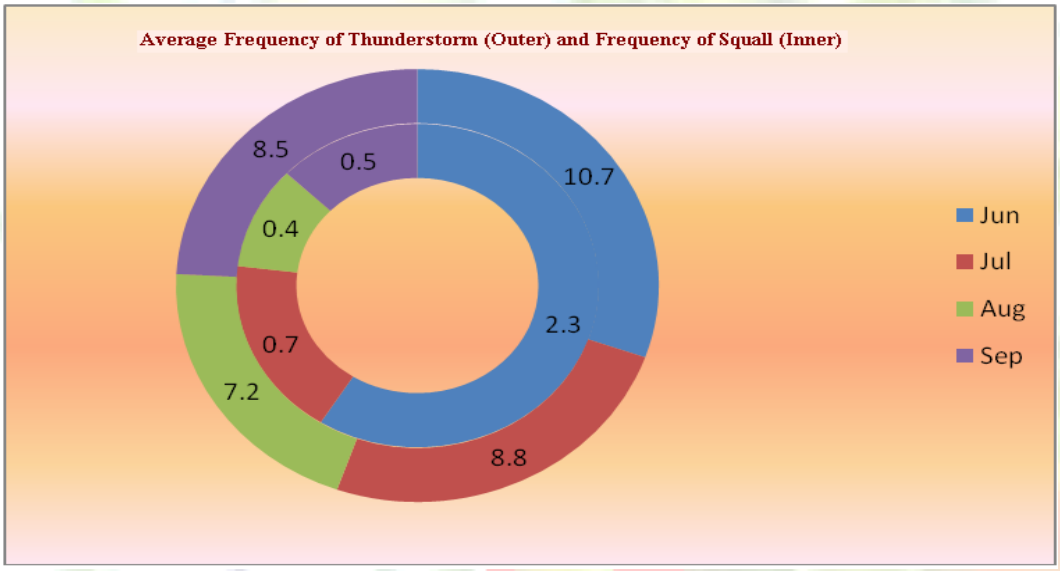

Figure 5.6.2:- Average Frequency of Thunderstorm (Outer) and Squall (Inner)

The analysis of data (outer circle in Figure 5.6.2)) shows that the average number of days of thunderstorm is the highest during June (10.7 days). It is slightly less in other months of monsoon, numerically 8.8 days in July, 7.2 days in August and 8.5 days in September. The number of days of thunderstorm is in decreasing order from June to August and in September it is slightly more as shown above figure 5.6.2.

Squall is the most hazardous phenomena occurring during the monsoon season in Nagpur city, Like thunderstorm, the occurrence of squall is also in decreasing number from June to August and it is little more in September. The average frequency of squall has been shown in Figure 5.6.2 (inner circle). The squalls have occurred more frequently (2.3 day) in June, 0.7 days in July, 0.4 days in August and 0.5 day in September.

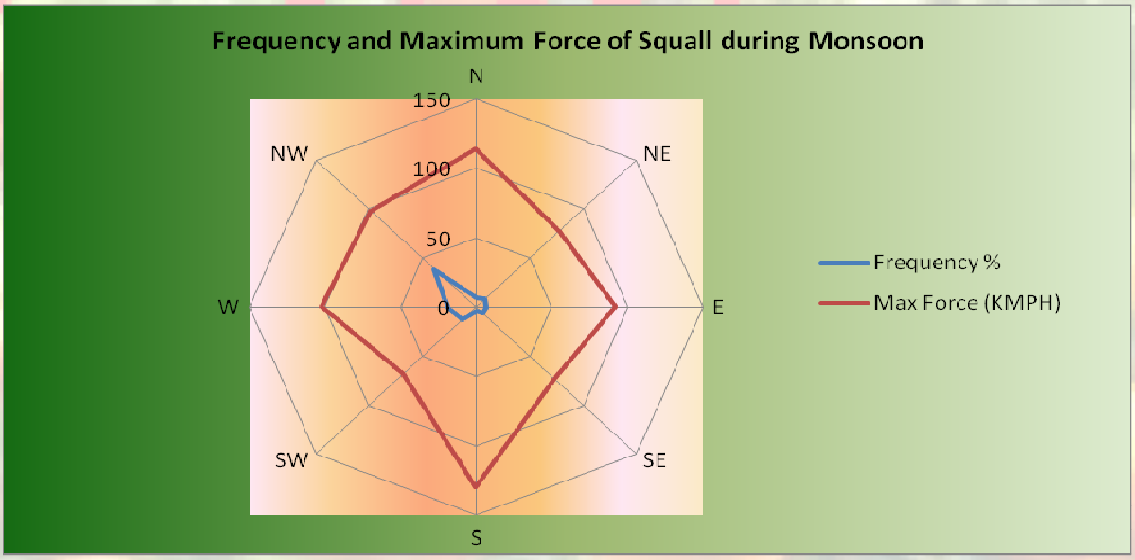

Figure 5.6.3:- Frequency (%) and maximum Force (kmph) of Squall during monsoon

The frequency of squall and maximum force (wind) are depicted in radar diagram in Figure 5.6.3. The squalls are more frequent from northwest direction and stronger force from south direction. Strong winds are also expected from west, northwest and north direction. Though the squall from Southerly direction is less frequent but it can be of destructive in nature with maximum wind speed of 130 KMPH. Thus, Nagpur may experience frequent and destructive squalls approaching from Northwest direction.

Fog is an important weather in monsoon. After continuous rain for 4-5 days or even for more days, the air gets saturated and temperature is also decreased. This results in the formation of fog in the second half of the season. The frequency of occurrence of these phenomena is very less (0.1 day) over Nagpur (Table 1(B)).

5.7 Rainfall in monsoon

South West Monsoon, being the major part of rain giving season, it contributes a good amount of rainfall in the city. Monsoon rain lasts for about three and half months.

The average number of rainy days in this season in Nagpur is 43 days. During monsoon, it provides the city on the whole with about 90 cm of rainfall which is almost 86% of the annual rainfall as shown in figure 5.7.1 below.

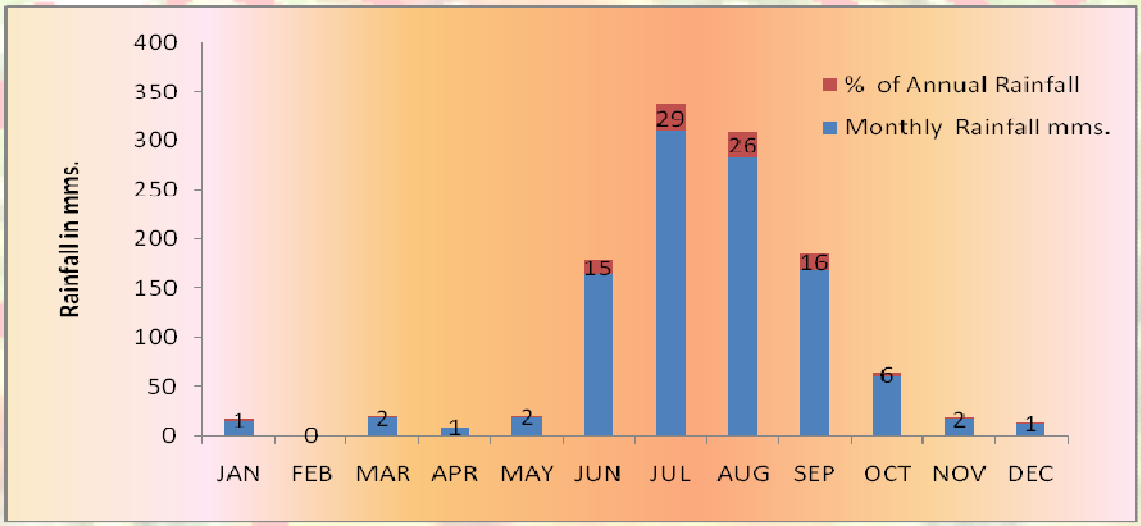

Figure 5.7.1 : - Monthly rainfall with percentage of annual rainfall

Nagpur receives about 163 mms. of rainfall in June. The amount of rainfall is increased in July to 294 mms. Gradual decrease of rainfall has been observed from July to August (278 mms) and September (160 mms). The year wise monsoon and yearly rainfall over Nagpur has been depicted in Figure 5.7.2. The analysis shows that the year 1994 was the wettest year with yearly rainfall 1656 mms (+51%) and monsoon rainfall of 1427 mms (+54%). The year 1972 remained the year of least yearly rainfall of 603 mms (-45%) and monsoon rainfall of 533 mms (-43%).

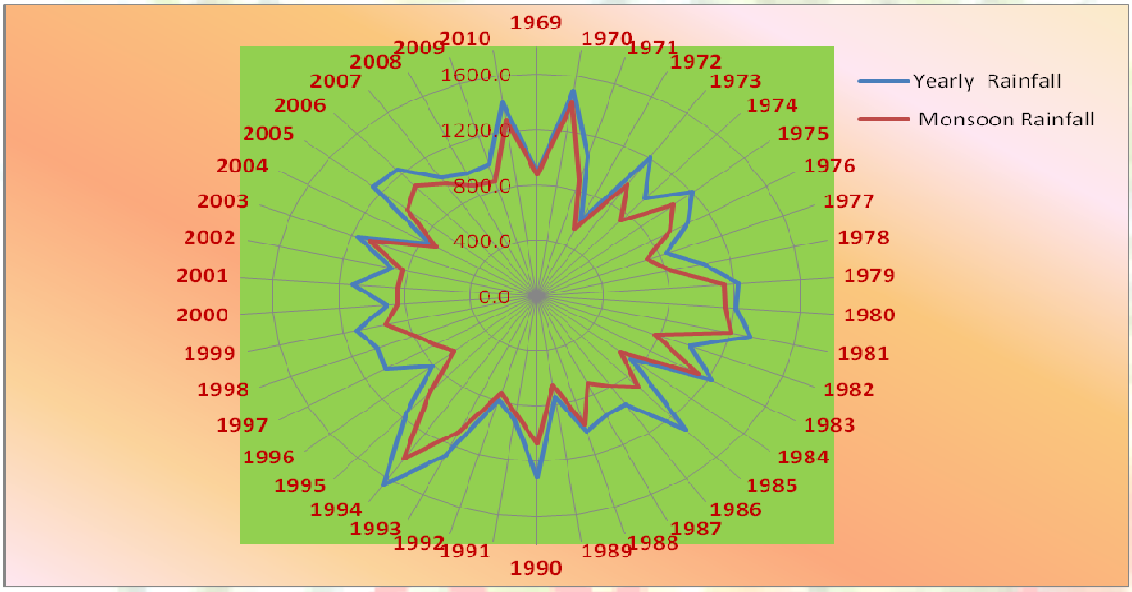

Figure 5.7.2:- Year wise monsoonal and yearly rainfall (mms) in Nagpur

With high incidence of convective weather phenomenon like thunderstorm, hailstorm & squall are the main weather features of the season. Incursion of moisture either from the Bay of Bengal or Arabian Sea and/or operation of any trigger mechanism create condition conducive for explosive convective phenomenon. The average frequency for various intensity of rainfall over Nagpur has been represented in Table 4. It is clear from the table that extremely heavy rainfall (more than 245 mms in a day) occurs rarely during June and July in the city.

Table 4 : - Number of days (in %) for various intensity of rainfall

Month	No Rain	Very Light Rain (0.1 -- 2.4 mm)	Light Rain (2.5 -- 7.5 mm)	Moderate Rain (8 – 35 mm)	Rather Heavy Rain (36 – 64 mm)	Heavy Rain (65 – 124 mm)	Very Heavy Rain (125 – 244 mm)	Extremely heavy Rain (>= 245 mm)
June	57.2	14.1	11.6	13.0	2.7	1.2	0.1	0.1
July	32.4	23.3	14.7	21.8	5.8	1.6	0.3	0.1
August	33.3	23.5	14.3	21.4	5.0	2.0	0.4	0.0
September	54.2	18.3	10.1	13.3	2.5	1.3	0.2	0.0

Daily normal rainfall for the monsoon season (Figure 5.7.3) shows the maximum rainfall (nearly 16 mm) in the mid of July followed by first week of August and last week of June. Rainfall amount during remaining period is very less (less than 1mm). It has also been seen that the daily normal rainfall increases in the month of June and decreases in September. On the other hand it fluctuates in the months of July and August.

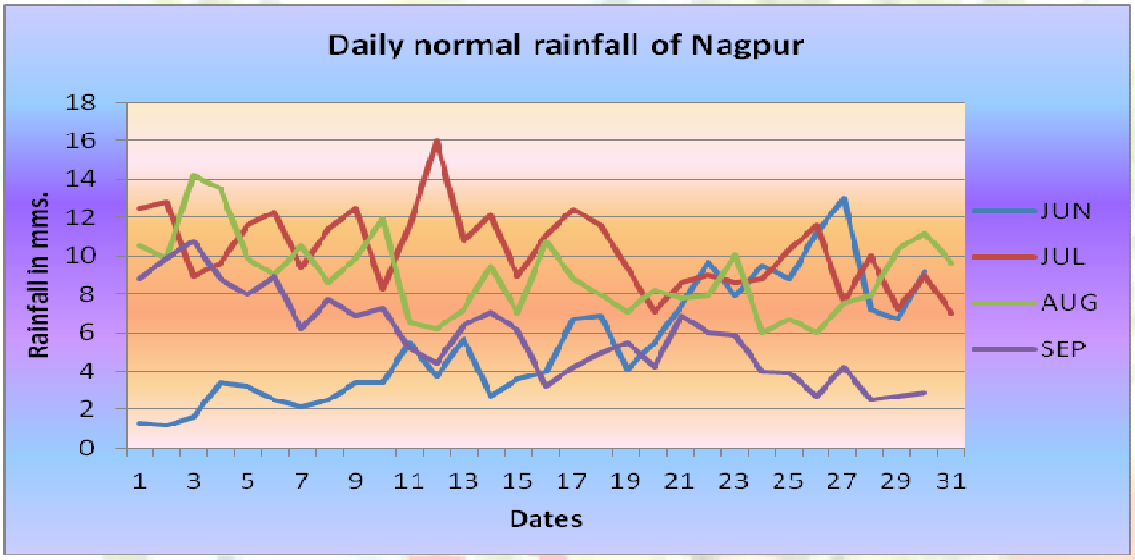

Figure 5.7.3 :- Daily normal rainfall in monsoon months

5.8 Surface Winds

Wind roses at 0830 and 1730 hours I.S.T. for the month of June, July, August and September has been depicted in Figure 5.8.1(a), 5.7.1(b), 5.8.1(c) & 5.8.1(d) respectively. Light Westerly wind (up to 4.5 mps) has been predominant followed by South westerly during both morning and evening hours in the month of June, July and August. However, south westerly are more predominant during the evening of the above months. Whereas during September, North westerly wind of speed up to 4.5 mps is more predominant in the morning and evening hours.

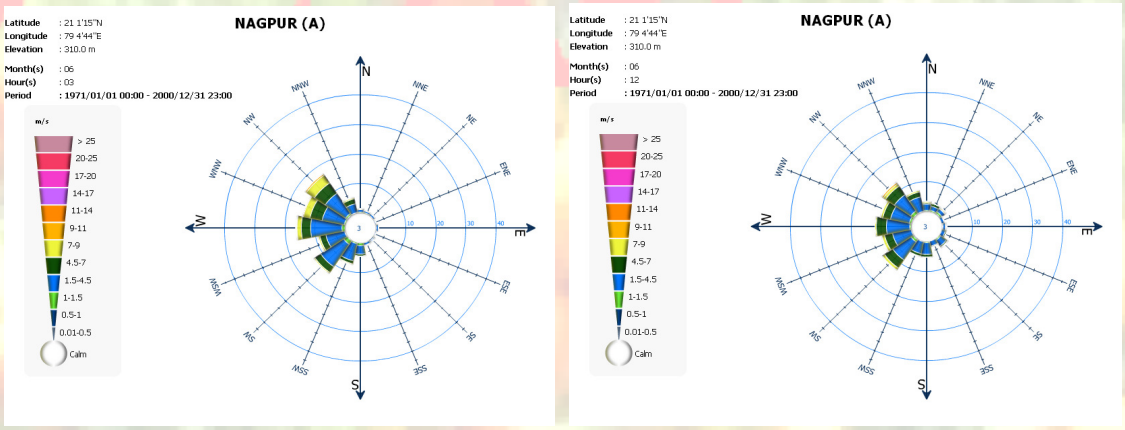

Figure 5.8.1(A) :- Wind rose at 0830 hours and 1730 hours I.S.T. for June

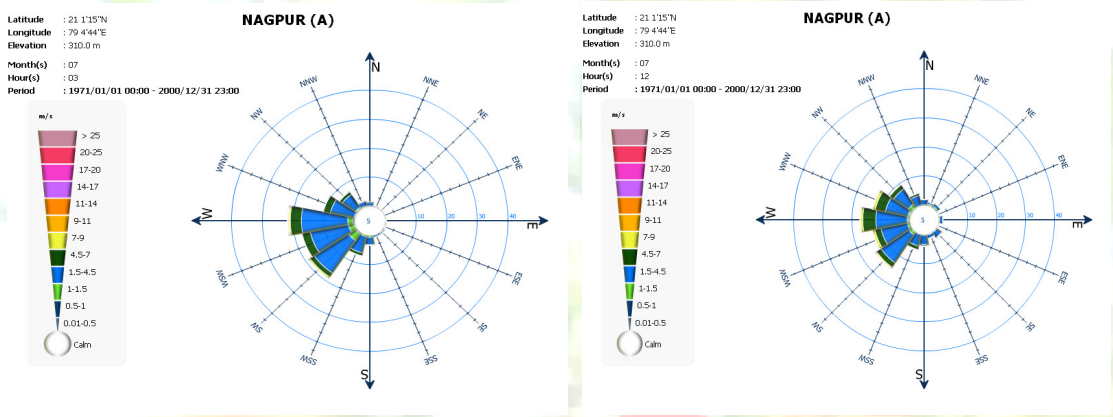

Figure 5.8.1(B) :- Wind rose at 0830 hours and 1730 hours I.S.T. for July

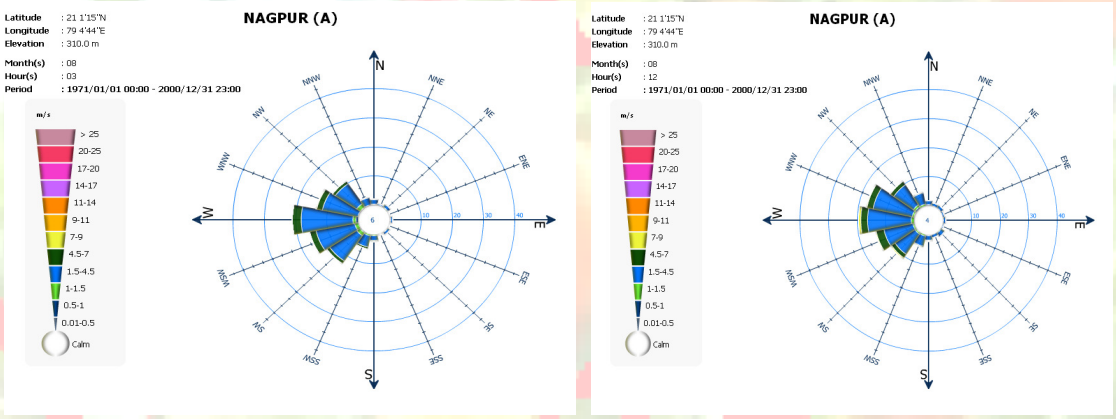

Figure 5.8.1 (C):- Wind rose at 0830 hours and 1730 hours I.S.T. for August

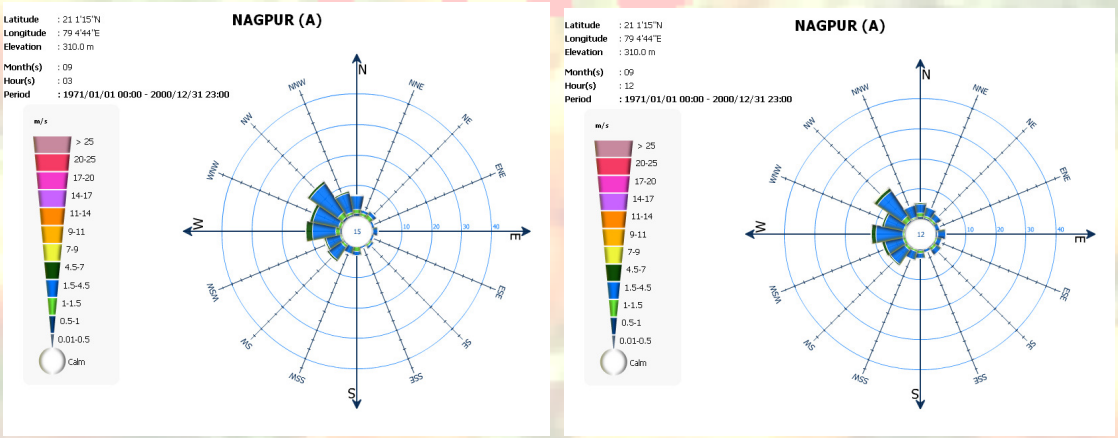

Figure 5.8.1(D):- Wind rose at 0830 hours and 1730 hours I.S.T. for September

North westerly winds are more frequent during morning and evening of September. However, winds are more prominent from west to northwest direction during evening hours. Occasionally, stronger winds up to 9 mps and 7 mps are also significantly observed from west to northwest direction during morning and evening hours respectively. Calm winds are high (12%) during morning hours as compared to evening (10%).

Calm winds are less frequent in the monsoon months except in September. Generally, stronger winds are observed in the morning hours of June. North westerly winds with speed reaching up to 11 mps are more predominant during morning followed by westerly during evening hours in June. Stronger winds with speed reaching up to 14 mps have been also significant during morning and evening hours. Occasionally, wind speed exceeding 25 mps during evening of June.

5.9 Diurnal variation of wind speed

Stronger winds in June and weaker winds in September experienced compared to other monsoon months, whereas in July and August, the wind speeds are nearly the same. Strengthening of wind speed observed after 0700 hours I.S.T. (Figure 5.9.1). Weaker winds continued to prevail during late night hours to early morning hours of next day. (i.e. from 1900 hours I.S.T. to 0700 hours of next day.

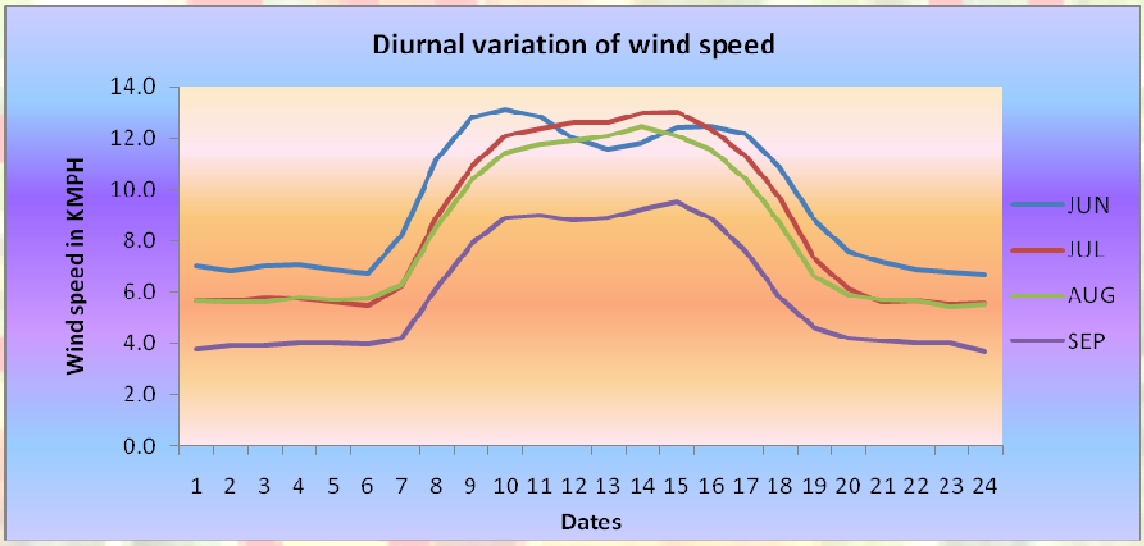

Figure 5.9.1:- Diurnal variation of wind speed during monsoon

As the season progresses, winds are weakening gradually. September month is characterized with light winds. In June, wind speed of around 7 KMPH has been observed at 0700 hours I.S.T. and stronger wind (13 KMPH) at 09000 & 1600 hours I.S.T. In July and August, weaker wind (6.0 KMPH) has been also observed at 0700 hours I.S.T. and stronger wind (around 12 KMPH) from 1000 hours to 1600 hours I.S.T. Similarly In September, weaker wind (4 KMPH) has been observed up to 0700 hours I.S.T. and stronger wind (around 0900 KMPH) at 1400 hours to 1600 hours I.S.T.

6 Post Monsoon season (October – November)

The months October-November are termed as post monsoon Season. There is an increasing chill as the minimum temperature decreases. The fall in maximum temperature is also gradual but not as steep as minimum temperature. The fall in normal daily minimum temperatures over the month is about 5 to 6° C. The days are comfortable and nights are cooler. The Figure 6.1 shows the maximum and minimum temperatures are steady during 1st and mid of 2nd week of October. Later on, maximum temperature falls slowly but the Minimum temperature fall is steep till the end of November.

6.1 Normal Maximum and Minimum Temperature

The Normal Maximum temperature is about 33° C in the beginning of October which decreases to about 29° C in the last week of November. The normal minimum temperature is about 22.5° C in the beginning of October and falls to about 14° C towards the end of the November.

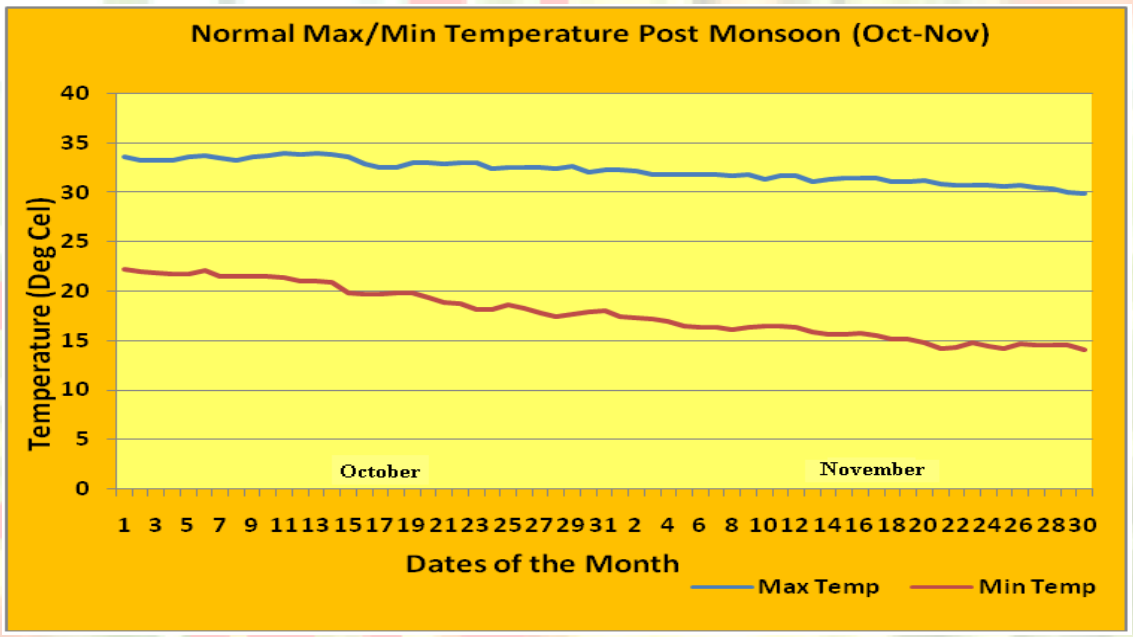

Fig 6.1:- Normal Maximum & Minimum Temperature for Post Monsoon season

6.2 Diurnal variation of Temperature

The Diurnal variation of temperature for the months October & November is more or less the same (Figure 6.2). As the solar energy from the SUN heats up lower layer of air just above the ground, the temperatures start rising around 0700 hours I.S.T. and continue to rise steadily up to 1200 hours I.S.T. It remained stable up to 1700 hours I.S.T. As the afternoon approaches, the temperature falls by about six degrees from its peak values. After the sunset the fall in temperature is gradual throughout the night and continues to lose around 0.5 to 0.8° C per hour till sunrise. October month is warmer by about 3-4° C as compared to November month. The lowest temperature reaches around 0700 hours I.S.T and highest temperature around 1400 hours I.S.T.

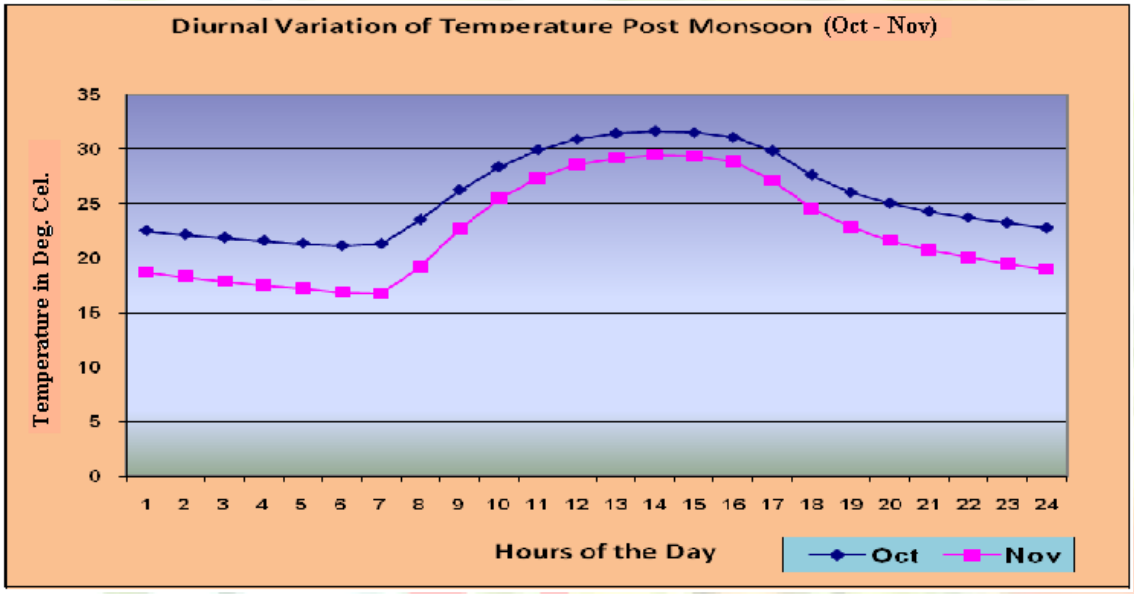

Fig 6.2:- Diurnal variation of temperature during Post Monsoon season

6.3 Relative Humidity

In the post monsoon months, the relative humidity plays a crucial and important role in comfort factor. Since October is the transit month where the monsoon ends, but the winter not set in.

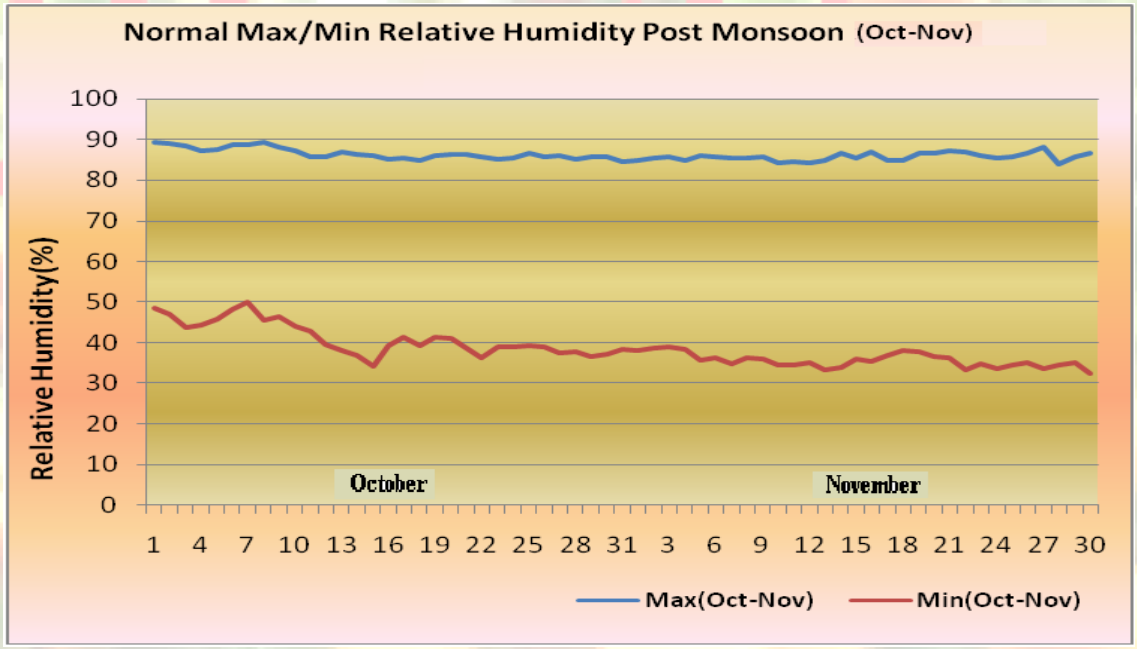

Figure 6.3 :- Normal maximum and minimum humidity during Post Monsoon season

Daily normal maximum and minimum relative humidity during post monsoon season is depicted in Figure 6.3. The Maximum relative humidity softens around 05 to 07% only for the whole month; the minimum relative humidity shows a wide variation, falling to about 15% in the first half of the month, then shows a rising trend in the third week of October and again falling in the fourth week. Thus it is very hot in the day time due to high humidity (the sweat will not evaporate giving a feeling of much higher temperatures) and the nights are relatively cooler. The minimum relative humidity and maximum relative humidity for the months of November shows a similar trend of steady fall, but the total fall is in the range of 10% only in case of minimum relative humidity.

6.4 Diurnal variation of Relative humidity during Post Monsoon season

The figure 6.4 shows the diurnal variation of relative humidity. The maximum and minimum relative humidity has been noticed at 0700 hours and between 1400 to 1600 hours I.S.T. respectively. No significant difference in relative humidity has been noticed in the maximum amount of relative humidity in the post monsoon months. However, the relative humidity is about 08% more in October as compared to November.

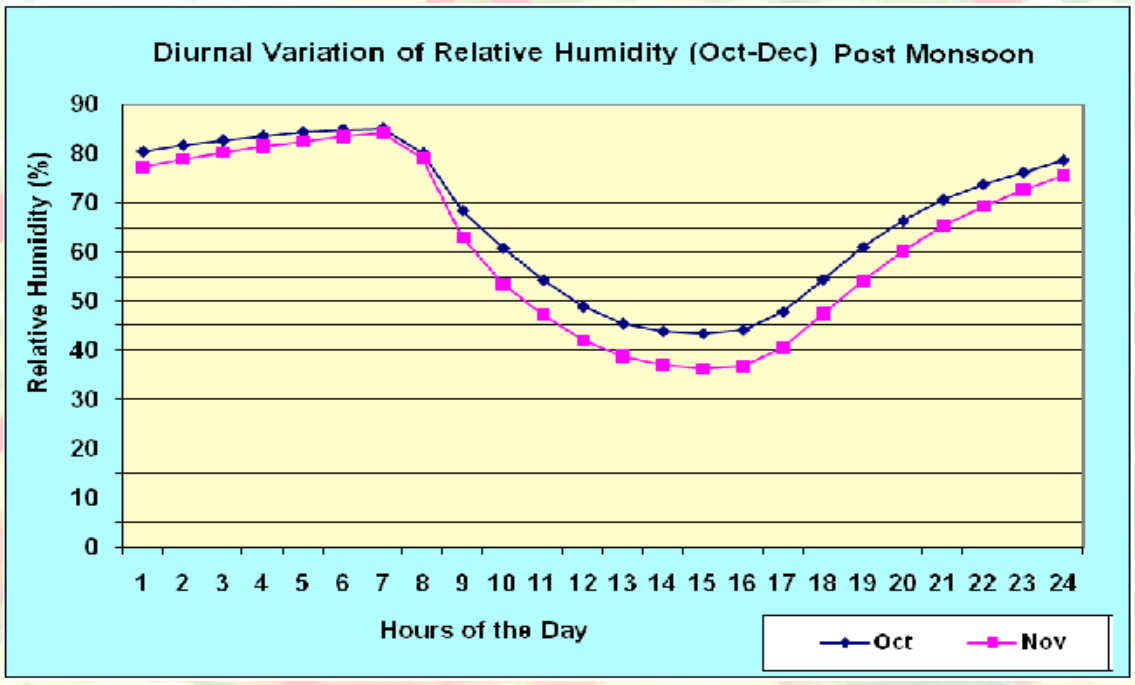

Figure 6. 4 :- Diurnal variation of Relative humidity during Post Monsoon season

The maximum amount of relative humidity is 85% & 84 % at 0700 hours I.S.T. in October & November respectively. Similarly, minimum amount of relative humidity is 44% & 36% between 1400 to 1600 hours I.S.T in October & November respectively. The relative humidity decreases gradually from 0700 hours I.S.T. and attains minimum value of relative humidity around 1500 hours I.S.T. in all the month of Post Monsoon season. It continues to remain lowest till 1600 hours I.S.T. and again starts increasing gradually from 1700 hours I.S.T. and attains maximum value at 0700 hours I.S.T.

6.5 Extreme temperature

The Extreme temperature during the Post monsoon season for the period from 1969 to 2010 is shown in Table 5. The highest maximum and minimum temperature in October is 39.5° C (29/10/2001) and 28.0° C (11/10/1996) respectively. The highest maximum and minimum temperature in November is 35.6° C (07/11/1977) and 24.2° C (01/11/2007) respectively. Similarly, lowest maximum and minimum temperature in October is 22.5° C (24/10/1973) and 12.6° C (29/10/1974) respectively. The lowest maximum and minimum temperature in November is 22.6° C (18/11/2009) and 07° C (29/11/1970, 30/11/1974) respectively.

Table 5 :- Extreme Temperatures at Nagpur during Post Monsoon (Oct-Nov) (1969-2010)

Season	Months	Maximum temperature				Minimum Temperature			
		Highest	Date & year	Lowest	Date & year	Highest	Date & year	Lowest	Date & year
Post Monsoon	Oct	39.5	29,2001	22.5	24, 1973	28	11, 1996	12.6	29, 1974
	Nov	35.6	07, 1977	22.6	18, 2009	24.2	01, 2007	7	29, 1970, 30, 1974

6.6 Thunderstorm, Squall and other weather phenomena

The thunderstorm activities are more frequent in October and less frequent in November. Thunderstorms are associated with tall cumulonimbus clouds which form in the field of upper air divergence ahead of eastward moving trough in middle and upper tropospheric westerlies. The thermal convection also causes the development of thunderstorm in the afternoon/evening hours when sufficient moisture in the lower tropospheric level reaches up to Nagpur due to prevailing of strong southeasterlies along Andhra coast or strong southwesterlies along west coast. The analysis of data shows that the average number of thunderstorm during October & November month is 2.8 and 0.3 days resp. (Table 1(B)).

Diurnal variation of thunderstorm (Figure 6.5) shows that the afternoon hours (12-18 hours I.S.T.) are the most preferred time for occurrence of the thunderstorm. About 86 thunderstorm occures during 12-18 hours I.S.T. and 74 thunderstorm during 18-03 hours I.S.T. Thunderstorms are less frequent during 03-12 hours I.S.T. Post monsoon season is free from dust / hail storm and squall. However, fogs are expected during morning hours in November month. Fog is hazardous to many activities like aviation,transportation etc.

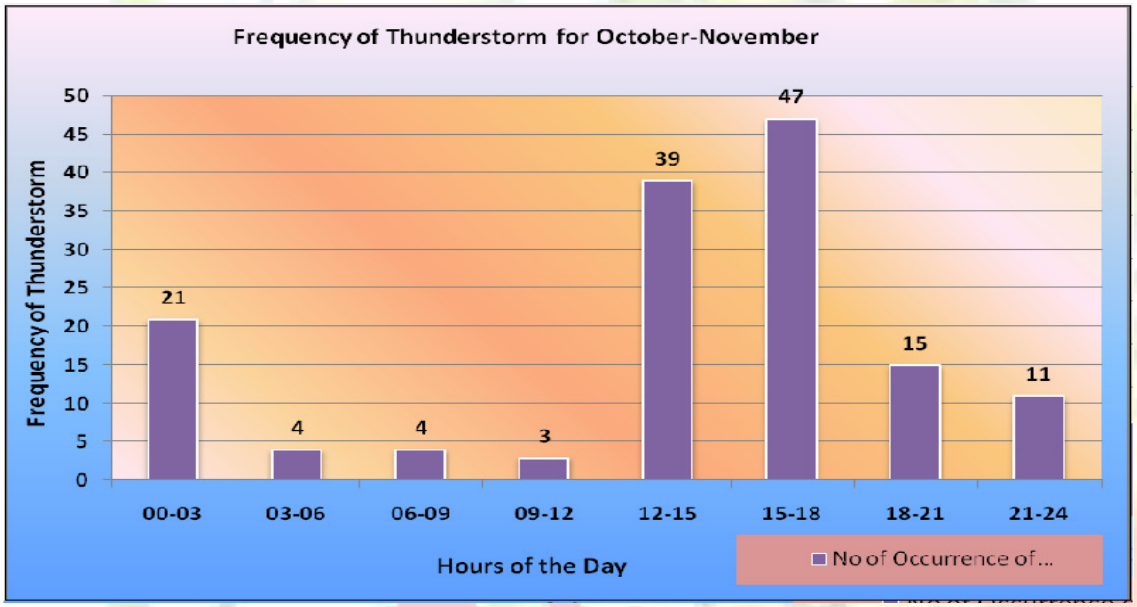

Figure 6.5 Diurnal variation of thunderstorm during post monsoon season.

The frequency and maximum force of wind of squall during post monsoon season is shown in Figure 6.6. The squalls are rarely experienced during the October month. However, November month is free from squall. Maximum wind speed of 85 KMPH has been observed from south and 80 KMPH from northwest direction. Occasionally experiencing strong wind associated with a low pressure system moved towards Vidarbha region from the Bay of Bengal.

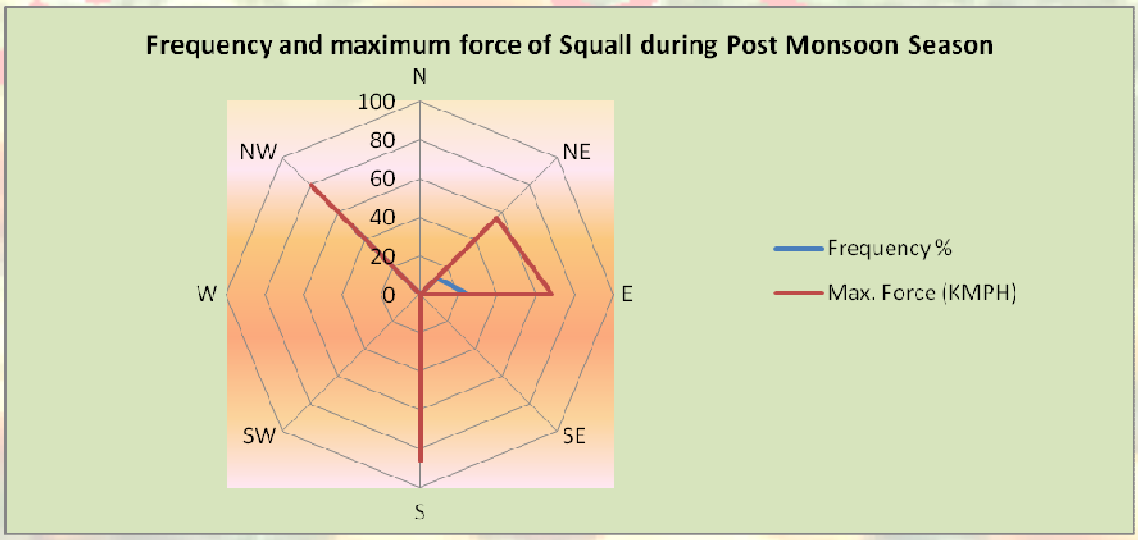

Figure 6.6:- Frequency & Maximum force of wind of squall during post monsoon

6.7 Rainfall in Post Monsoon

Daily normal rainfall during post monsoon season is shown in figure 6.7. Daily normal rainfall during the October month is higher compared to November month. Rainfall of 6.7 mm. in a day can be expected in first week of October in the in influence of Western Disturbance; whereas normal rainfall in November never crossed 3 mm. in a day.

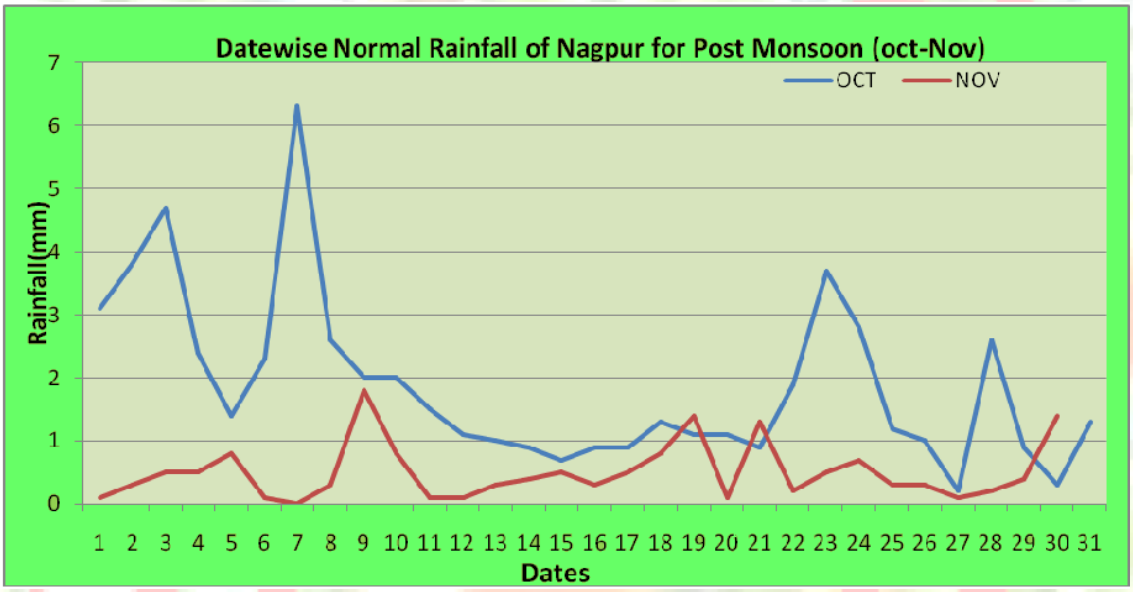

Figure 6.7:- Daily normal rainfall during post Monsoon season.

Monthly rainfall during post monsoon season is shown if Figure 6.8. The highest amount of rainfall of 172 mm. observed during October 1985 and 100 mm. during October 1974 whereas the highest rainfall of 68 mm. observed during November 1971 and 1987. The October month has received more rainfall compared to November rainfall.

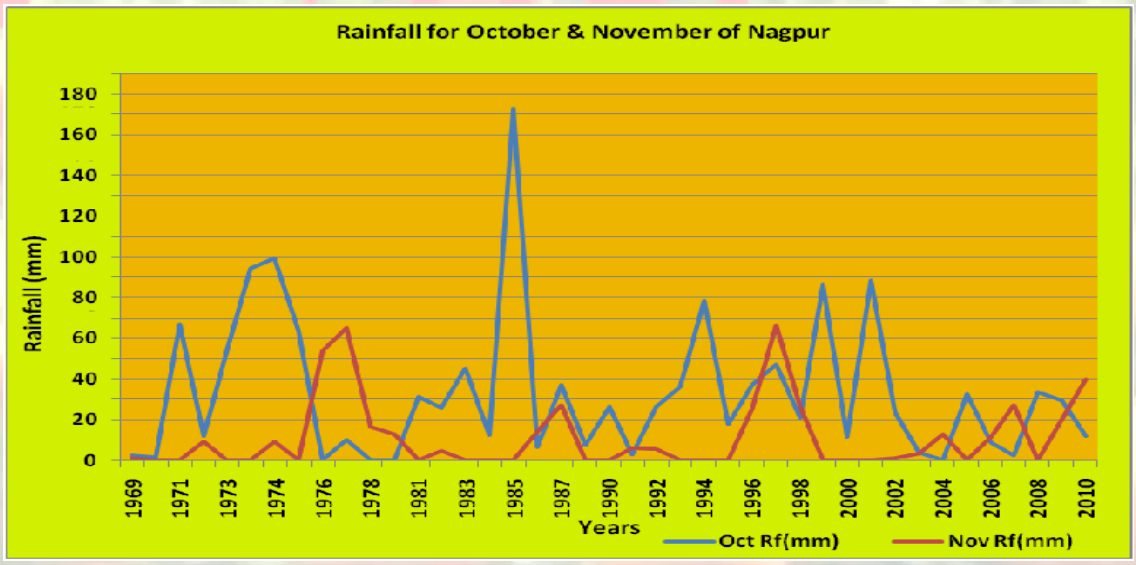

Figure 6.8:- Monthly rainfall during post monsoon season.

6.8 Winds in Post Monsoon

Mainly northwesterly to north easterly wind blow (up to 4.5 mps) during morning hours with northwesterly and northerly wind more predominant and blowing from all direction during evening hours in the month of October. However, north easterly and easterly are more predominant during evening hours of October. Calm winds during morning hours are high (26%) compared to evening (22%).

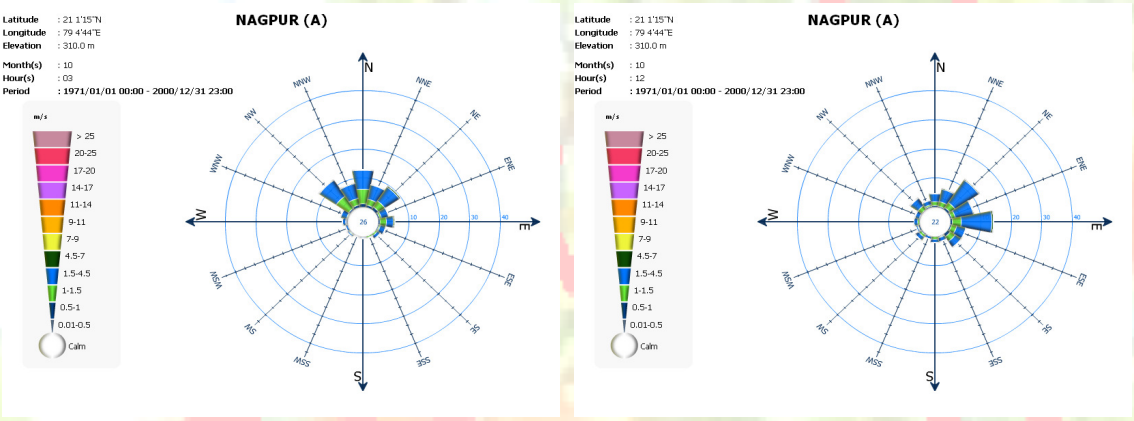

Figure 6.8(A). Wind rose at 0830 & 1730 hours I.S.T. during October

Mainly northerly wind blow (up to 4.5 mps) during morning hours along with north north easterly to easterly wind and mainly north easterly to easterly wind blow (up to 4.5 mps) in the evening hours in the month of November . Calm winds during evening hours are high (27%) compared to morning (23%).

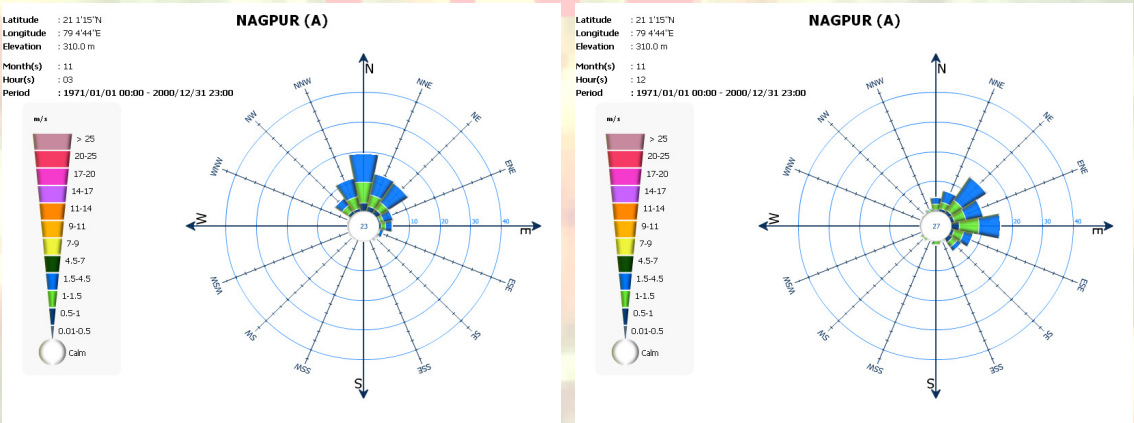

Figure 6. 8(B):- Wind rose at 0830 & 1730 hours I.S.T. during November

6.9 Diurnal variation of wind speed

Diurnal variation of wind speed in post monsoon season is shown in Figure 6.9. Weaker winds experience in November compared to October. Strengthening of wind speed observed after 0700 hours I.S.T. Weaker winds continued to prevail during late night hours to early morning hours of next day. (i.e. from 2000 hours I.S.T. to 0700 hours of next day).

As the season progresses, wind speed are weak. October is characterized with stronger winds. In October, Weaker wind (3.0 KMPH) has been observed at 2100 hours I.S.T. and stronger wind (7.5 KMPH) has been observed at 1500 hours I.S.T. In November, weaker wind (2.6 KMPH) has been observed at 2100 hours I.S.T. and stronger wind (6.9 KMPH) at 1200 hours I.S.T.

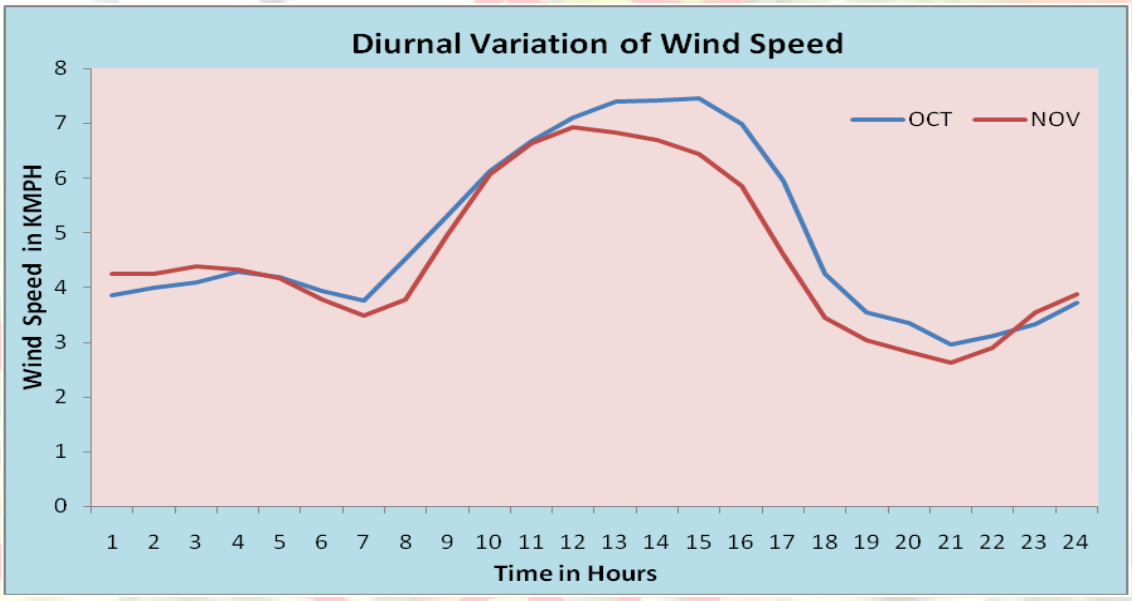

Figure 6.9:- Diurnal variation of wind speed during post monsoon season

7. Winter Season (December- February)

The winter season comprises the month of December, January & February. The winter season is characterized by dry and cold weather. Daily normal maximum and minimum temperature during December, January & February is shown in Figure 7.1.1. Normal maximum temperature decreases gradually in December month and reached lowest in the first week of January. It starts increasing gradually from the second week of January and continued to increase in February month. Normal minimum temperature decreases gradually in December month and reached lowest in the first week of January. It starts increasing gradually from the second week of January and continued to increase in February month.

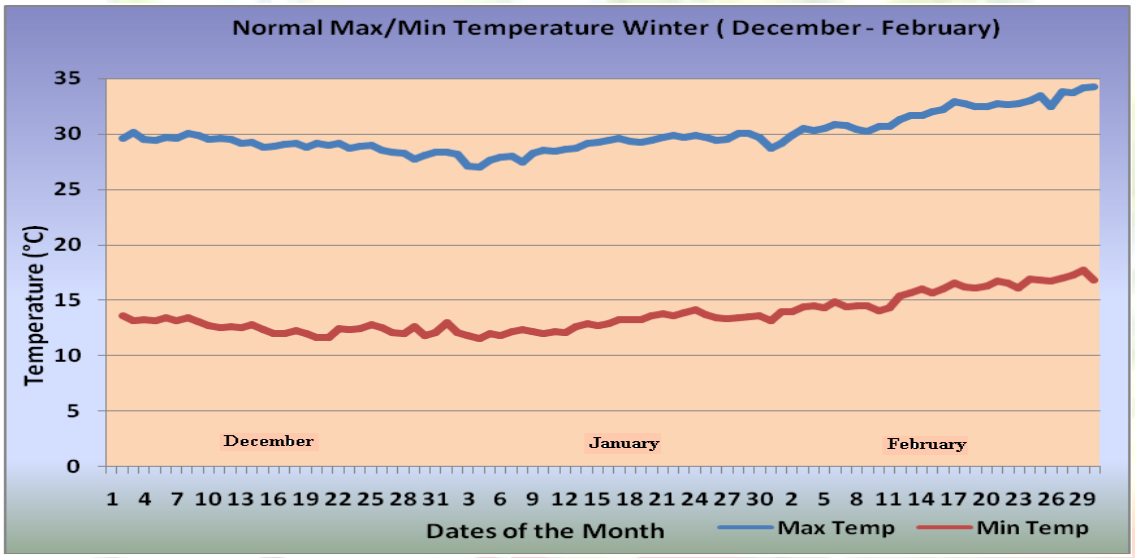

Figure:- 7. 1.1:- Normal Maximum & Minimum Temperature for winter season

7.1 Diurnal variation of Temperature

Diurnal variation of temperature during winter season is depicted in Figure 7.1.2. Temperature during 1700 to 0700 hours I.S.T is colder in December compared to January. However, no significant difference in temperature has been observed during 0800 to 1600 hours I.S.T. in December & January. February is warmer by about 3° C compared to December & January. The lowest temperature attains around 0700 hours I.S.T. and increases steadily up to 1500 hours I.S.T. in all the months of winter season. It attains highest temperature around 1500 hours I.S.T. and remained stable up to 1700 hours I.S.T. It decreases steadily from 1700 to 0700 hours I.S.T.(next day) reaching lowest around 0700 hours I.S.T.

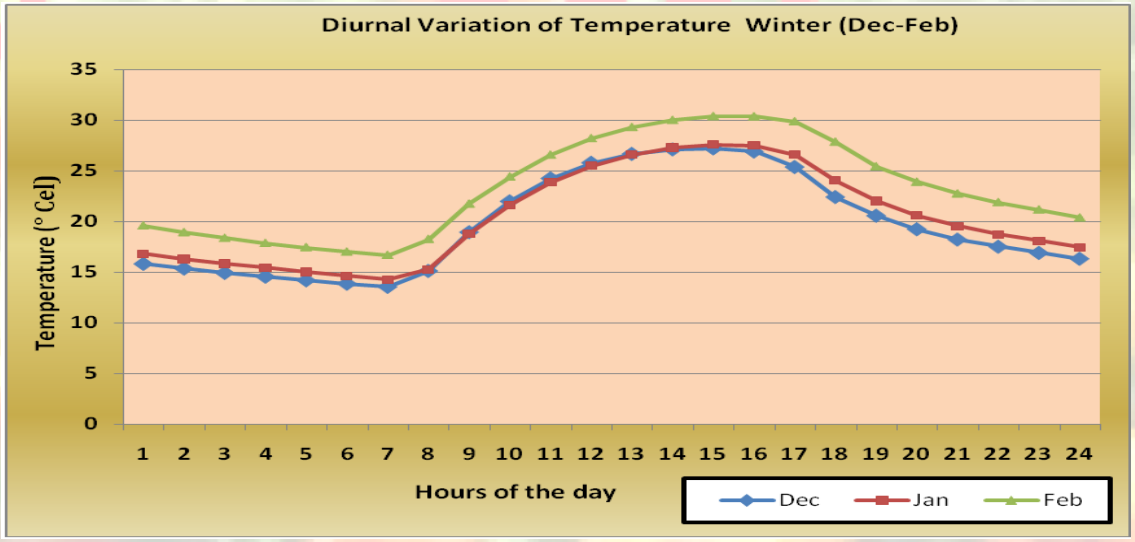

Figure 7.1.2:- Diurnal variation of temperature during winter season.

7.2 Relative Humidity

Daily normal maximum & minimum relative humidity during winter season is shown in Figure 7.2. Normal maximum relative humidity lies in the range of 80% to 90% during the period from first week of December to third week of January. It decreases gradually from the third week of January and remained within the range of 70% to 80% up to second week of February. It decreases sharply (52%) during the period from second week to end of February.

Normal minimum relative humidity hovers in the range of 20% to 40% during winter season. It lies in the range of 30% to 40% during the period from January to second week of February and then decreases gradually to lowest relative humidity during end of February.

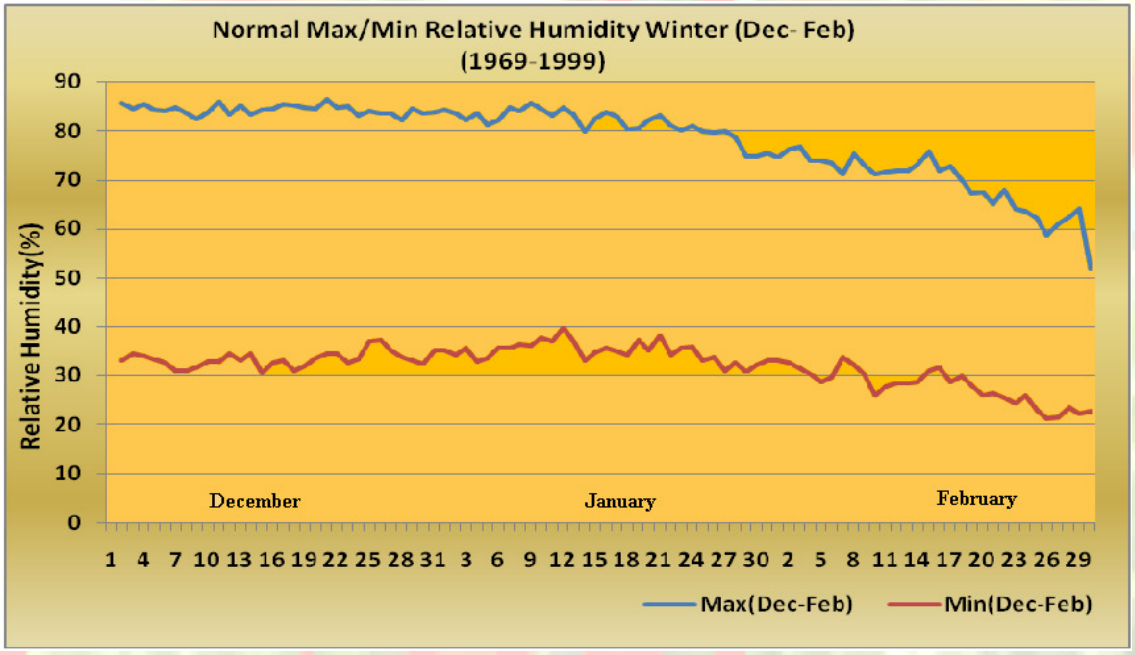

Figure 7.2:- Normal maximum and minimum Relative Humidity

7.3 Diurnal variation of Relative humidity during winter season

Diurnal variation of relative humidity during winter season is shown in Figure 7.3. The relative humidity attain maximum value around 0700 hours I.S.T. and decreases sharply thereafter attaining lowest relative humidity around 1600 hours I.S.T. in all the month during winter season. The relative humidity is more between 1800 to 0700 hours I.S.T (next day) and less between 0900 to 1600 hours I.S.T. in December compared to January. No large variation during December & January has been observed. The maximum relative humidity is 83%, 79% & 66% (around 0700 hours I.S.T.) in December, January & February respectively. Similarly, the minimum relative humidity is 34%, 35% & 29% (around 1600 hours I.S.T.) in December, January and February respectively. February month is much drier compared to December and January in winter season.

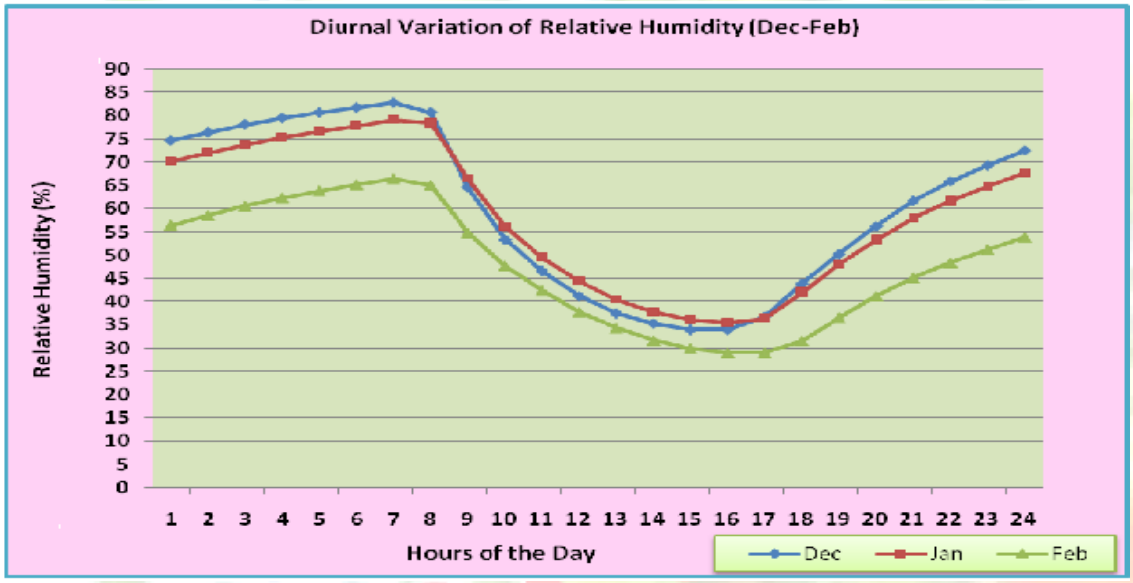

Figure 7.3:- Diurnal variation of Relative humidity during winter season

7.4 Extreme temperature during winter season

The highest maximum temperature during winter season for the period from 1969-2010 is shown in Table 6. The highest maximum temperature of 34.0° C (27/12/2007), 36.6° C (25/1/1996) & 39.2° C (16/2/2000 & 24/2/2006) respectively has been observed in December, January & February. Similarly, the lowest maximum temperature of 19.1° C (31/12/1989), 16.2° C (7/1/2004) & 17.5° C 25/2/2004) respectively have been observed in December, January & February.

Table 6:- Extreme Temperatures during winter season (December- February)

Season	Months	Maximum temperature				Minimum Temperature			
		Highest	Date & year	Lowest	Date & year	Highest	Date & year	Lowest	Date & year
Winter	Dec	34.0	27, 2007	19.1	31, 1989	20.2	01, 1997	5.7	28,1983
	Jan	36.6	25, 1996	16.2	7, 2004	20.0	25, 1996	6.4	03,1991
	Feb	39.2	16, 2000 24, 2006	17.5	25, 2000	22.4	20, 1977	8.1	10,1972

The highest minimum temperature of 20.2° C (1/12/1997), 20.0° C (25/1/1996) & 22.4° C (20/2/1977) respectively have been observed in December, January & February. Similarly, the lowest minimum temperature of 5.7° C (28/12/1983), 6.4° C (3/1/1991) & 8.1°C (10/2/1972) respectively have been observed in December, January & February.

7.5 Thunderstorm, Fog and other weather phenomena

The analysis of data shows that the average number of thunderstorms in December, January and February are 03, 1.0 & 16 days respectively (Table 1(B)). The diurnal variation of thunderstorm during winter season is shown in Figure 7.5. Thunderstorms are more frequent during 0000-0300 hours I.S.T and 1500-2100 hours I.S.T. They are less frequent during 0600-1200 hours. I.S.T.

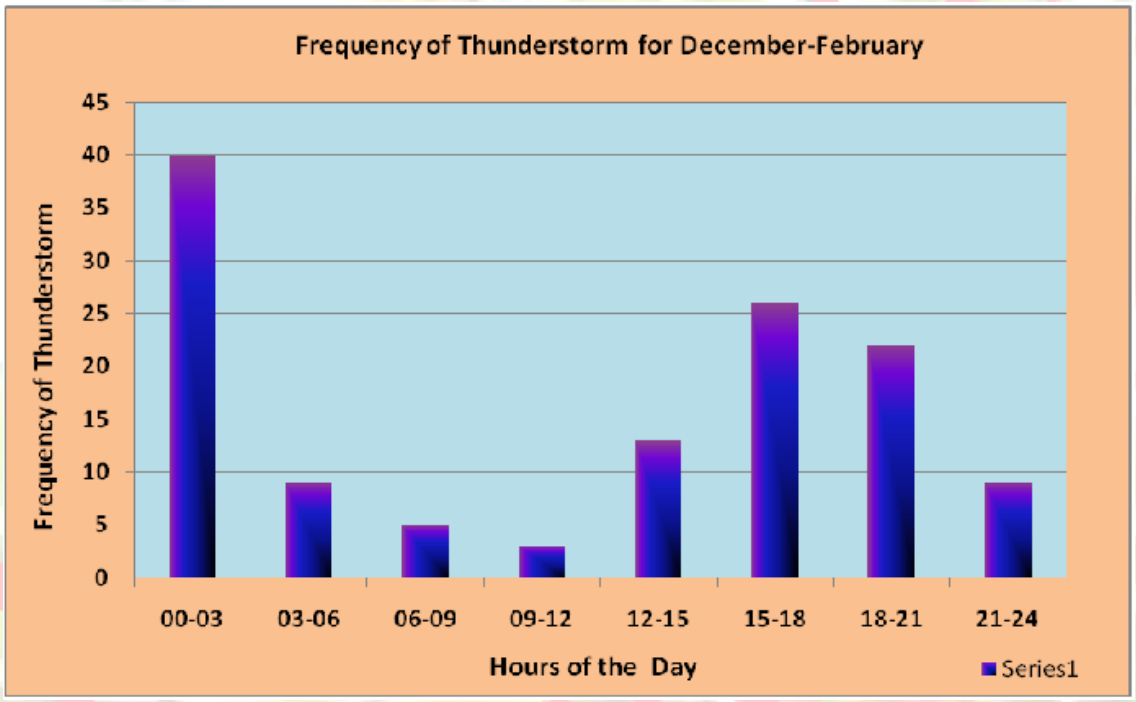

Figure 7.5:- Diurnal variation of thunderstorm during winter season.

The fog is hazardous to many activities like aviation, transportation etc. The fogs are more frequent in December (0.5 days) & January (0.6 days) compared to February & all other month (Table 1(B)).

7.6 Rainfall during winter season

Mean & heaviest monthly rainfall during winter season is shown in Table 1(A). Mean rainfall in December, January & February is 11.7 mm, 15.3 mm & 20.8 mm respectively. The heaviest monthly rainfall in December, January & February is 126.5 mm (1978), 129.3 mm (2005) & 151.5 mm (1975) respectively. Similarly, heaviest 24 hours rainfall in December, January & February is 50.9 mm (3/ 12/1978), 77.8 mm (31/1/2005) 7 130.1 mm (20/2/1975) respectively. The number of rainy days in December, January & February is 0.8, 1.1 & 1.3 days respectively.

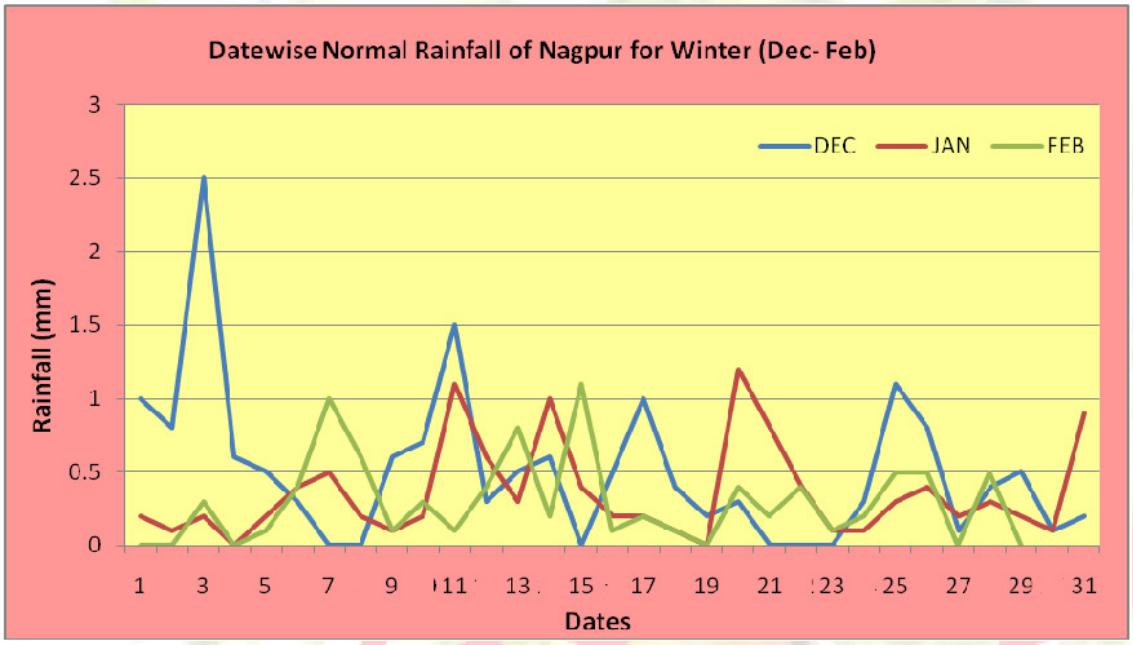

Figure 7.6:- Daily normal rainfall during winter season.

Daily normal rainfall during winter season is shown jn Figure 7.6. rainfall up to 2.5 mm in a day is expected in the first week of December. However, a light rainfall up to 1.0 mm is also expected during second week in all the months of winter season. Very light rain (less than 0.5 mm) can occurred at any time during winter season.

7.7 Winds in winter

Monthly wind speed in December, January & February is 5.0, 5.5, 6.6 mps respectively (Table 1(B)). Wind roses at 0830 & 1730 hours for December, January & February are shown in Figure 7.7 (A), Figure 7.7 (B), & Figure 7.7 (C) respectively. Mainly northerly wind with speed up to 4.5 mps prevailed in December & January and north to northeasterly during morning. Calm winds are also more frequent during morning compared to evening. Calm winds during morning of December, January 7 February are 31%, 32% & 21% respectively.

Wind veers during evening in winter season. Easterlies are more predominant during the evening of December. Easterly to south easterlies are also more predominant during the evening of January. However, wind blows from all the direction during the evening of February and north easterlies to easterlies are more frequent. Calm winds during the evening of December, January & February are 29%, 22% and 11% respectively.

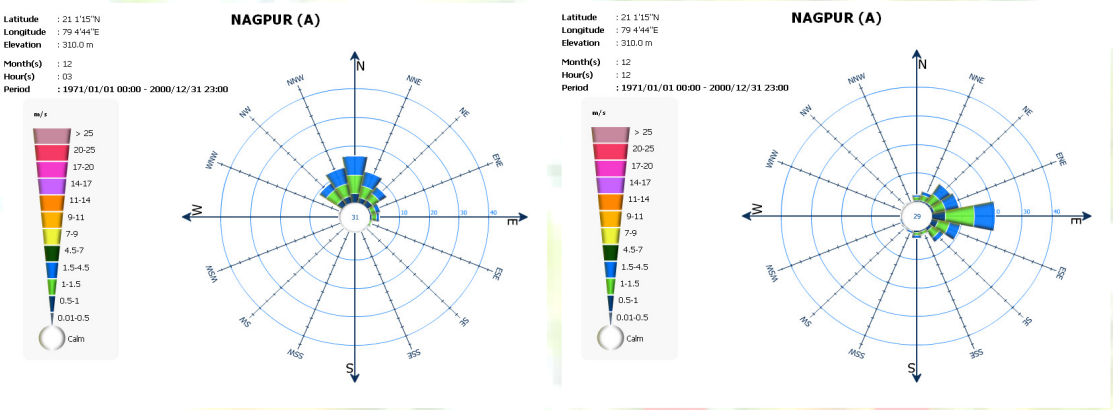

Figure 7.7 (A):- Wind rose at 0830 & 1730 hours I.S.T. during December

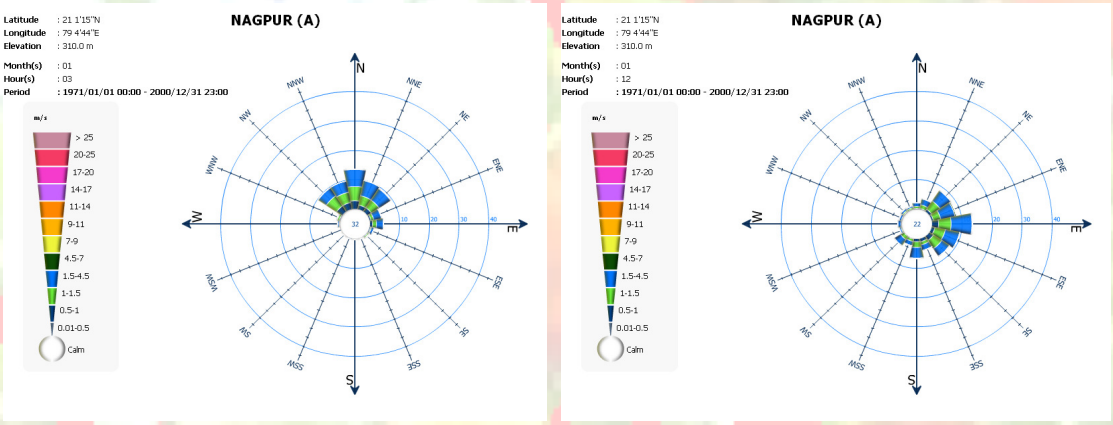

Figure 7.7 (B):- Wind rose at 0830 & 1730 hours I.S.T. during January

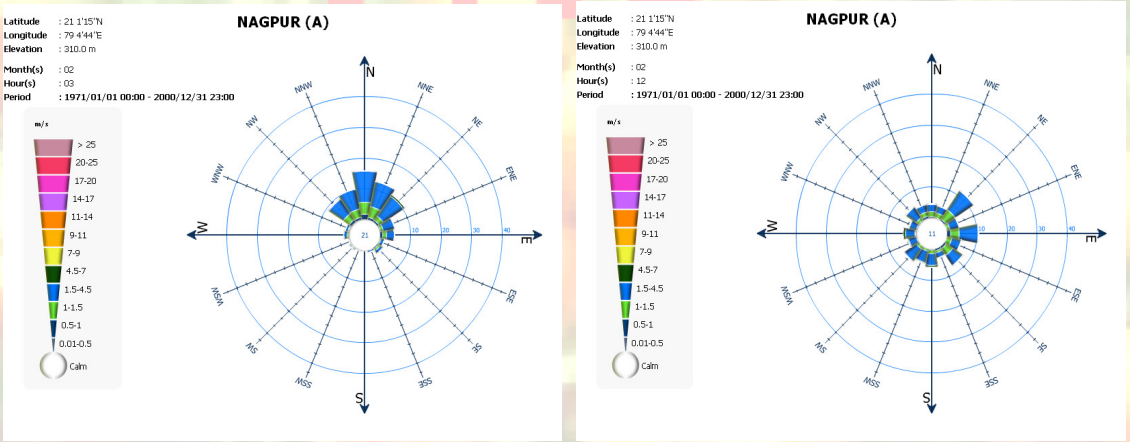

Figure 7.7 (C):- Wind rose at 0830 & 1730 hours I.S.T. during February

7.8 Diurnal variation of wind speed

Diurnal variation of wind speed during winter season is shown in Figure 7.8. Stronger wind in February and weaker wind in December has been observed. Afternoon winds are stronger in January compared to December. Steep rise in wind speed from 2.9 to 5.3 KMPH has been observed from 0800 to 1000 hours I.S.T. and reaches maximum to 5.9 KMPH at 1100 hours I.S.T. in December. It decreases gradually reaching to 2.5 KMPH at 2100 hours I.S.T. & increases further between 2100 to 2400 hours I.S.T. and remains stable between 2400 to 0800 hours I.S.T. in December.

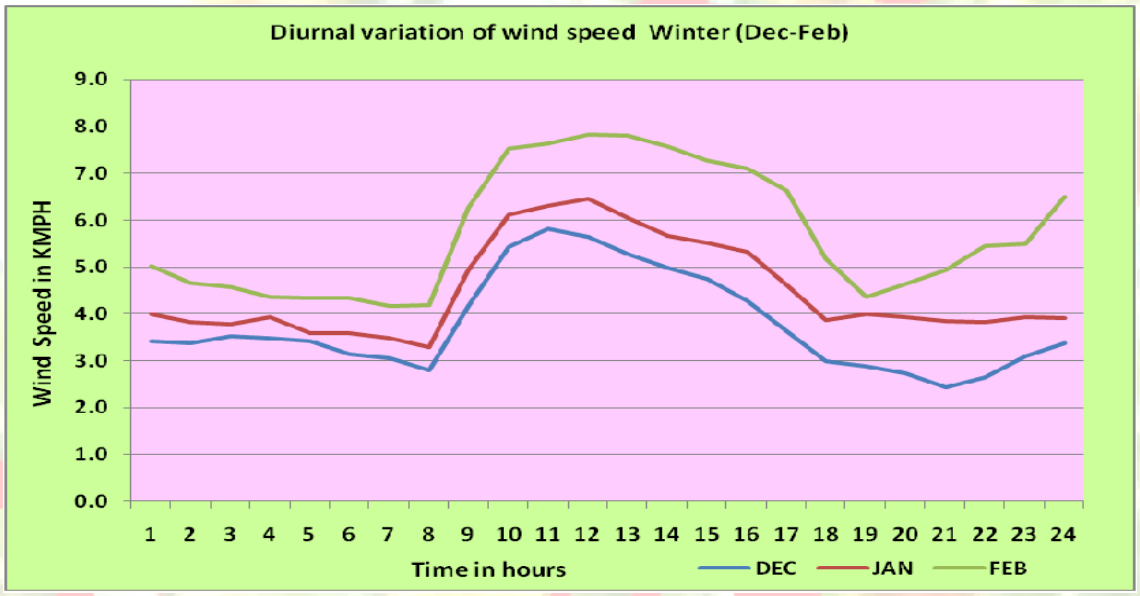

Figure 7.8:- Diurnal variation of wind speed during winter season

Steep rise in wind speed from 3.3 to 6.1 KMPH has been observed from 0800 to 1000 hours I.S.T. and reaches maximum to 6.2 KMPH at 12100 hours I.S.T. in January. It decreases gradually reaching to 3.9 KMPH at 1800 hours I.S.T. and remains stable between 1800 to 0300 hours I.S.T. and slightly decreases thereafter reaching lowest to 3.2 KMPH in January. Steep rise in wind speed from 4.1 to 7.7 KMPH has been observed from 0800 to 1000 hours I.S.T. and reaches maximum to 7.9 KMPH at 12100 hours I.S.T. in February. It decreases gradually reaching to 4.4 KMPH at 1900 hours I.S.T. and increases gradually reaching to 6.6 KMPH at 2400 hours I.S.T. and slightly decreases thereafter reaching lowest to 4.1 KMPH at 0800 hours I.S.T. in February.

7.9 Squall during winter

The frequency and maximum force of wind of squall during winter season is shown in Figure 7.9. The squalls are rarely experienced during the winter season. The frequency of squalls in December, January & February is 0.0, 0.1 & 0.3 days respectively (Table 1(B)).

Squalls are occurring from west to northwest direction. Maximum wind speed of 100 KMPH has been observed from southwest and 90 KMPH from northwest to north direction. The strong winds are also predominant from east to southeast direction.

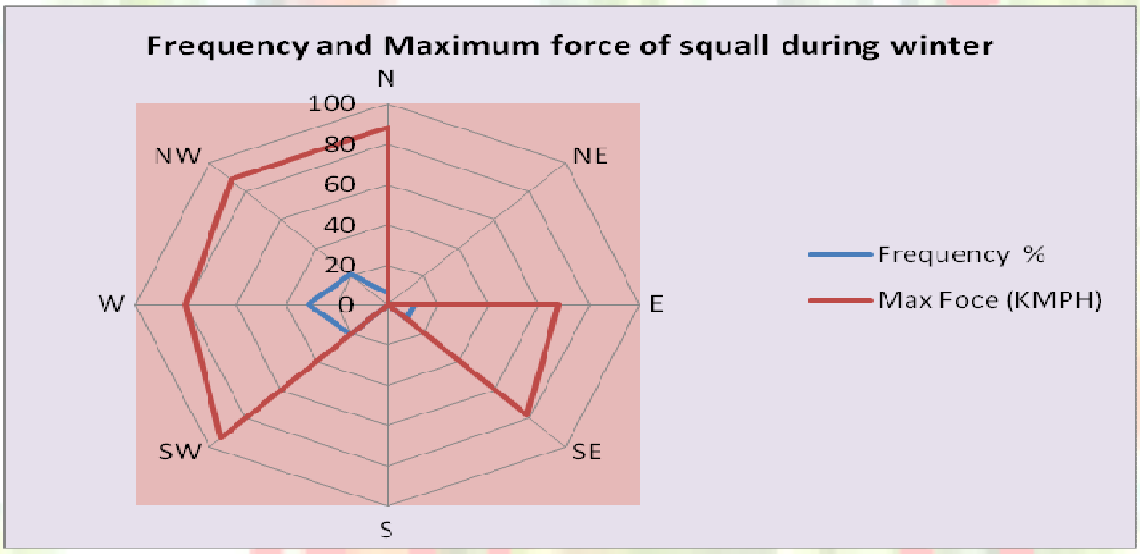

Figure 7.9:- Frequency & Maximum force of wind of squall during winter Season

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