



# Air Quality Monthly Report

## November, 2013



Department of Environment  
Ministry of Environment, Forest and Climate Change  
Bangladesh

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## 1. Introduction

Air quality management plans based on knowledge of sources, appropriate air quality standards, accurate air quality data, and effective incentives; and enforcement policies is therefore needed to be adopted.

At this backdrop, real-time measurements of ambient level pollutants were made at 8 major cities (Namely, Dhaka, Narayanganj, Gazipur, Chittagong, Rajshahi, Khulna, Barisal and Sylhet) of Bangladesh. The data generated will be used to define the nature and severity of pollution in the cities; identify pollution trends in the country; and develop air models and emission inventories.

The program encompasses operation of the sampling and monitoring network, and quality assurance activities to ensure the quality of the data collected and disseminated by the CASE project.

CASE project monitors the criteria pollutants such as carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, PM10 and PM2.5. Monitoring is performed to demonstrate attainment or non-attainment of national ambient air quality standards to assess the trends of air pollution levels.

The main purpose of this report is to present, analyze and make available of these data to the general public, stakeholders, researchers and policy makers to develop effective air pollution abatement strategies. This report summarizes the air quality data collected at the different CAMS in operation under the Department of Environment (DoE) air quality monitoring network.

The basis for discussion of air quality has been the data collected from the Air Quality monitoring Network stations under DoE. The data have been quality controlled and the air pollution levels have been compared to the Bangladesh Ambient Air Quality Standard as adopted in 2005. Table 1 represents the current and approved air quality standards for Bangladesh.

Table 1: National Ambient Air Quality Standards for Bangladesh

Pollutant	Objective	Average
CO	10 mg/m <sup>3</sup> (9 ppm)	8 hours(a)
	40 mg/m <sup>3</sup> (35 ppm)	1 hour(a)
Pb	0.5 µg/m <sup>3</sup>	Annual
NO <sub>x</sub>	100 µg/m <sup>3</sup> (0.053 ppm)	Annual
PM10	50 µg/m <sup>3</sup>	Annual (b)
	150 µg/m <sup>3</sup>	24 hours (c)
PM2.5	15 µg/m <sup>3</sup>	Annual
	65 µg/m <sup>3</sup>	24 hours
O <sub>3</sub>	235 µg/m <sup>3</sup> (0.12 ppm)	1 hour (d)
	157 µg/m <sup>3</sup> (0.08 ppm)	8 hours
SO <sub>2</sub>	80 µg/m <sup>3</sup> (0.03 ppm)	Annual
	365 µg/m <sup>3</sup> (0.14 ppm)	24 hours (a)

Notes:

- (a) Not to be exceeded more than once per year
- (b) The objective is attained when the annual arithmetic mean is less than or equal to 50 µg/m<sup>3</sup>
- (c) The objective is attained when the expected number of days per calendar year with a 24-hour average of 150 µg/m<sup>3</sup> is equal to or less than 1
- (d) The objective is attained when the expected number of days per calendar year with the maximum hourly average of 0.12 ppm is equal to or less than 1 (Source: AQMP, DOE).

## 2. Monitoring Network

The main objective of the Bangladesh AQM network is to provide reliable information to the authorities and to the public about the air quality in most populous cities of Bangladesh.

As a part of the air quality monitoring strategy, several objectives can be achieved, including:

- Establish source/receptor relationships;
- Identify which are the pollutants of concern and their current status;
- Show how widespread air pollution problems are and indicate the general extent of the public exposure;
- Provide benchmarks against which trends in overall air quality can be compared and devise performance indicators for assessing the impact of an air quality management plan or strategy;
- Provide a data base for evaluation of effects; of urban, land use management, and transportation planning; of development and evaluation of abatement strategies; and of development and validation of atmospheric processes and models.

Another objective in the monitoring and management programme is to provide input data for modeling. These data will serve as a background for performing air quality planning and abatement studies. Model results may also serve as input to other studies such as health related investigations and exposure assessments.

The ambient air quality monitoring network Bangladesh consists of eleven (11) fixed Continuous Air Monitoring Stations (CAMS). The locations of the 11 CAMS are shown in Figure 1. Brief description of the monitoring stations and the list of measured parameters recorded at each station are provided in Table 2.

Table 2: Description of Monitoring Network:

City	ID	Location	Lat/Lon	Monitoring capacity
Dhaka	CAMS-1	Sangshad Bhaban, Sher-e-Bangla Nagar	23.76N 90.39E	PM10, PM2.5, CO, SO2, NOX, O3, and HC concentrations with meteorological parameters.
	CAMS-2	Firmgate	23.76N 90.39E	PM10, PM2.5, CO, SO2, NOX, O3, and HC with meteorological parameters.
	CAMS-3	Darus-Salam	23.78N 90.36E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.
Gazipur	CAMS-4	Gazipur	23.99N 90.42E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.
Narayangonj	CAMS-5	Narayangonj	23.63N 90.51E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.
Chittagong	CAMS-6	TV station, Khulshi	22.36N 91.80E	PM10, PM2.5, CO, SO2, NOX, O3, and HC with meteorological parameters.
	CAMS-7	Agrabad	22.32N 91.81E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.
Khulna	CAMS-8	Baira	22.48N 89.53E	PM10, PM2.5, CO, SO2, NOX, O3, and HC with meteorological parameters
Rajshahi	CAMS-9	Sopura	24.38N 88.61E	PM10, PM2.5, CO, SO2, NOX, O3, and HC with meteorological

City	ID	Location	Lat/Lon	Monitoring capacity
				parameters.
Sylhet	CAMS-10	Red Crecent Campus	24.89N 91.87E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.
Barisal	CAMS-11	DFO office campus	22.71N 90.36E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.



Figure 1: CAMS Location in Bangladesh

Monitoring data from network stations are transferred to a central data centre at the Department of Environment office in Dhaka and simultaneously transferred to Air Quality Management System based on NILU AIRQus system established under BAPMAN project. The data are stored in AIRQus database for quality check, control, evaluation, validation, statistical analysis. Quality controlled data are then stored in the final database for further analysis, reporting, presentations and future use.

### 3. Monthly Air Quality

The data presented in this report are based on measurements on air quality parameters during November 2013 at 11 CAMS operated under DoE monitoring network. Table-3 summarizes the basic statistics of the data along with the data capture rate and the number of days for which specific pollutant exceeded the Bangladesh National Ambient Air Quality Standard (BNAAQs). Since NO<sub>x</sub> have only annual standard, so for this pollutant daily 24-hours average concentration levels were compared with the annual average. During data quality control some data were flagged as invalid and those were not included in the analysis. Time series plots based on the data generated in the CAMS are also given in Annexes.

In general the data availability (valid data) found to be over 80% except few parameters in the CAMS in operation. In case of data capture rate below 75% for a particular averaging time are not reported with few exceptions. Sangsad Bhaban CAMS is now in operation from 17 November 2013 after months and the gaseous analyzer were found malfunctioning, so data capture rate is low. A few of the analyzers at different CAMS were under maintenance and eventually the data capture rate for those parameters found low and in some cases no data was available. Some of the old PM analyzers could not be operated due to non-availability of filter paper rolls.

Inspection of the data shows that there were some occurrences of non-compliance with respect to the BNAAQS for both PM<sub>10</sub> as well as PM<sub>2.5</sub> levels at some of the stations where data were available. It is observed that the monthly average concentration level of PM<sub>2.5</sub> and PM<sub>10</sub> measured at different CAMS were around 63-114µg/m<sup>3</sup> and 111-241µg/m<sup>3</sup> respectively during the month of November 2013. It is also seen that the concentration level of PM<sub>2.5</sub> exceeded the BNAAQS for 23 days at Darussalam & 07 days at Sylhet CAMS, 24 days at Gazipur CAMS and 12 days at Narayanganj, 10 days at Khulna & 29 days at Barishal CAMS and 19 days at CDA, Agrabad and 18 days at Rajshahi CAMS respectively. On the other hand PM<sub>10</sub> exceeded 08 days at Sangsad CAMS, 22 days at Darussalam CAMS, 08 days at TV Chittagong CAMS & 30 days at Narayanganj CAMS, 20 days at Barishal CAMS, 18 days at Gazipur CAMS, 02 days at Sylhet CAMS & 10 days at Agrabad, Chittagong & at khulna CAMS respectively. From the time series plot of both PM<sub>10</sub> and PM<sub>2.5</sub>, it is seen there are few episodes of low PM concentrations. Rainfall data shows that during those days rainfall occurred and PM levels became low due to washout. 24-hours average PM levels in all cities monitored are found little bit higher than previous month because the precipitation rate started reducing as rainy season tends to be over. It is also observed that all the gaseous pollutants except NO<sub>x</sub> in few CAMS did not exceed the BNAAQS. In case of NO<sub>x</sub> concentrations, there was non-attainment for 08 days at BARC CAMS, 07 days at Darussalam CAMS, 07 days at Gazipur (Dhaka) CAMS, 14 days at Rajshahi CAMS, 20 days at Narayanganj CAMS. On the other hand 8 hr average Ozone value exceeded 16 hours at this month in Gazipur CAMS.

In general PM pollution levels in the cities monitored during the reporting month started deteriorating compared to previous month in respect of public health. Usually in the wet seasons the pollution level reaches lowest and gradually starts increasing when dry season begin, which is reflected in the data monitored in all CAMS during month of November. It is observed that average wind speed and precipitation compared to previous month of October has decreased, which reduces the rate of dispersion of the pollutants and this might be a reason for observed increasing tendency of PM concentration.

Wind frequency distributions, also called Wind roses for all CAMS except TV-Station Chittagong (no wind data available for those stations) under the monitoring network are presented in ANNEX. From the wind rose patterns, it is observed that the predominant wind direction during the month November 2013 were mainly from north-east direction with few exceptions.

#### **4. Summary and conclusion**

Data obtained from CAMS operated under DoE air quality monitoring network during November 2013 have been analyzed and reported. Data availability was over 80% for all the criteria pollutant monitored at different CAMS with few exceptions. Air quality data for some pollutants were not reported because either the analyzer was not functional or the data capture rate was too low. From the analysis of the data following conclusion can be drawn:

- PM<sub>10</sub> and PM<sub>2.5</sub> are the most critical pollutants and 24-hour average for both PM<sub>10</sub> and PM<sub>2.5</sub> concentrations were found increasing tendency of non compliance with the BNAAQS during the month of November 2013. It is observed that the average concentration level of PM<sub>2.5</sub> and PM<sub>10</sub> were around 63-114µg/m<sup>3</sup> and 111-241µg/m<sup>3</sup> respectively during the month of November 2013.

- All gaseous pollutants except NO<sub>x</sub> measured at 11 CAMS did not exceed limit values except BARC, Darussalam, Narayonganj, Rajshahi, Gazipur stations. Maximum 24 hours NO<sub>x</sub> concentration at these stations found to be around annual average BNAQS limit values (53 ppb).
- Due to decreased average wind speed and precipitation during November-13, dispersion and wash out of pollutants has decreasing tendency and thus the pollution concentration levels showed increasing trend.

At present manual data quality checks and screening are performed for analyzing the air quality data, further strict quality assurance programme that will be developed for this programme which eventually will improve the data quality. During the reporting month a number of analyzers did not produce data and need maintenance. Data from Sangsad Bhaban CAMS were partially available for the whole month due to failure of air conditioning system. Some PM analyzer cannot be run due to lac of PM<sub>2.5</sub> and PM<sub>10</sub> filter paper at few CAMS. Necessary action for maintenance of the analyzers will be taken.

Table 3: Summary Air Quality and Meteorological data measured during November 2013 at different CAMS operated under DoE

Parameter	unit	NAAQS	Summary	CAMS-1 (S-Bhaban)	CAMS-2 (BARC) <sup>a</sup>	CAMS-3 (D-salam)	CAMS-4 (Gazipur)	CAMS-5 (Narayanganj)	CAMS-6 TV-St (Chittagong) <sup>a</sup>	CAMS-7 Agrabad-(Chittagong)	CAMS-8 (Sylhet)	CAMS-9 (Khulna) <sup>a</sup>	CAMS-10 (Rajshahi) <sup>a</sup>	CAMS-11 (Barisal)
SO <sub>2</sub> -24 hr	ppb	140	Average	DNA*	4.36	11.7	10.1	8.41	5.87	1.82	1.37	DNA*	0.41	2.86
			Max	DNA*	8.47	27.3	19.4	15.5	8.24	2.55	2.11	DNA*	0.63	3.41
			Min	DNA*	2.69	1.63	1.65	5.14	3.02	0.54	0.69	DNA*	0.19	2.41
			Excedance(Days)	DNA*	0	0	0	0	0	0	0	DNA*	0	0
			Data capture(%)	0	96	99	97	99	57	51	84	0	59	98
NO <sub>2</sub> -24 hr	ppb	53 (Annual)	Average	DNA*	88.5	64.0	34.5	58.7	DNA*	22.4	20.5	DNA*	54.8	8.04
			Max	DNA*	118	92.1	75.8	84.7	DNA*	36.9	36.1	DNA*	87.1	19.8
			Min	DNA*	69.5	41.1	8.44	26.7	DNA*	7.66	6.20	DNA*	33.7	1.86
			Excedance(Days)	DNA*	8	7	7	20	DNA*	0	0	DNA*	14	0
			Data capture(%)	0	52	40	95	96	0	88	93	0	92	98
CO- 1 hr	ppm	35	Average	DNA*	1.25	2.02	1.28	1.21	1.24	1.01	1.96	1.22	0.51	1.80
			Max	DNA*	4.23	4.54	6.09	3.45	5.62	4.31	7.64	4.13	0.83	5.55
			Min	DNA*	0.05	0.92	0.05	0.10	0.05	0.19	0.20	0.08	0.18	0.89
			Excedance(Hour)	DNA*	0	0	0	0	0	0	0	0	0	0
			Data capture(%)	0	95	99	60	99	63	97	93	65	98	98
CO-8hr	ppm	9	Average	DNA*	1.23	2.02	1.02	1.22	1.23	1.01	1.96	1.21	0.51	1.79
			Max	DNA*	3.93	3.91	3.16	2.89	3.50	2.60	4.59	3.28	0.63	4.07
			Min	DNA*	0.12	1.03	0.07	0.28	0.40	0.45	0.21	0.25	0.45	1.09
			Excedance(Hour)	DNA*	0	0	0	0	0	0	0	0	0	0
			Data capture(%)	0	98	100	82	100	67	100	97	67	100	100
O <sub>3</sub> -1hr	ppb	120	Average	DNA*	18.4	5.99	DNA*	8.22	15.8	10.2	8.52	3.60	12.5	13.8
			Max	DNA*	79.6	51.1	DNA*	47.1	52.3	65.5	32.9	26.3	53.0	36.4
			Min	DNA*	11.1	0.36	DNA*	1.83	5.29	0.05	1.30	0.05	0.05	0.05
			Excedance(Hour)	DNA*	0	0	DNA*	0	0	0	0	0	0	0
			Data capture(%)	0	99	68	0	99	64	93	94	63	98	63
O <sub>3</sub> -8hr	ppb	80	Average	DNA*	18.4	5.90	DNA*	8.19	15.7	9.91	8.49	3.51	12.8	13.8
			Max	DNA*	60.0	31.7	DNA*	33.5	36.7	53.3	23.1	17.1	41.9	34.8
			Min	DNA*	11.9	0.45	DNA*	2.26	8.44	0.07	1.73	0.15	0.26	0.07
			Excedance(Hour)	DNA*	0	0	DNA*	0	0	0	0	0	0	0
			Data capture(%)	0	98	72	0	100	67	99	97	69	100	66

CAMS= Continuous Air Monitoring Station, NAAQS=National Ambient Air Quality Standard, a=Refurbishment CAMS, PM= Particulate Matter

DNA= Data Not Available, \*=DNA due to malfunction of the analyzer/sensor, \*\*=DNA due to poor data capture rate

Table 3: Summary Air Quality and Meteorological data measured during November 2013 at different CAMS operated under DoE (Cont'd)

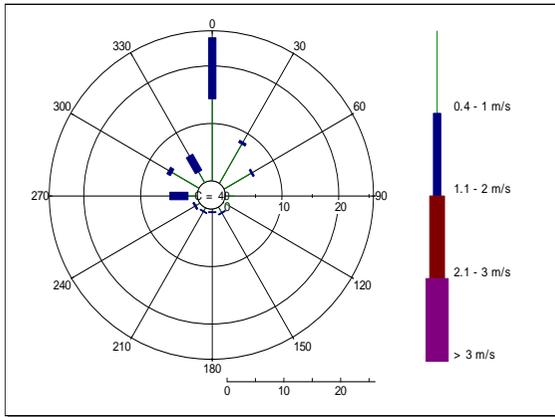
Parameter	unit	NAAQS	Summary	CAMS-1 (S-Bhaban)	CAMS-2 (BARC) <sup>a</sup>	CAMS-3 (D-salam)	CAMS-4 (Gazipur)	CAMS-5 (Narayonganj)	CAMS-6 TV-St (Chittagong) <sup>a</sup>	CAMS-7 Agrabad-(Chittagong)	CAMS-8 (Sylhet)	CAMS-9 (Khulna) <sup>a</sup>	CAMS-10 (Rajshahi) <sup>a</sup>	CAMS-11 (Barisal)
PM <sub>2.5</sub> -24hr	µg /m <sup>3</sup>	65	Average	DNA*	DNA*	107	103	112	DNA*	80.9	62.5	105	84.0	114
			Max	DNA*	DNA*	162	153	217	DNA*	119	97.7	141	132	157
			Min	DNA*	DNA*	56.1	45.3	77.2	DNA*	48.2	36.8	57.9	37.8	69.7
			Excedance(Days)	DNA*	DNA*	23	24	12	DNA*	19	7	10	18	29
			Data capture(%)	0	0	89	90	46	0	88	83	56	96	95
PM <sub>10</sub> -24hr	µg /m <sup>3</sup>	150	Average	156	DNA*	191	156	241	155	144	111	233	DNA*	169
			Max	224	DNA*	339	236	356	228	205	153	301	DNA*	247
			Min	127	DNA*	103	69.2	158	87.9	77.2	55.8	112.33	DNA*	103
			Excedance(Days)	8	DNA*	22	18	30	8	10	2	10	DNA*	20
			Data capture(%)	44	0	95	93	96	64	90	86	50	0	94
Solar rad. 1hr	watt/m <sup>2</sup>	NA	Average	135	260	201	190	153	DNA*	182	190	DNA*	3	179
			Max	606	552	878	809	734	DNA*	779	740	DNA*	19	764
			Min	6.62	161	7.47	7.44	4.33	DNA*	7.44	6.67	DNA*	0	8.16
			Data capture(%)	44	99	99	98	99	0	97	94	0	98	98
Relative Humidity 1hr	(%)	NA	Average	67.3	40	63.1	72.7	50	DNA*	66.5	68.3	66.7	79.6	73.4
			Max	95.5	64	89.4	95.7	57	DNA*	90.7	91.1	100.0	99.5	99.1
			Min	27.7	10	22.8	30.1	24	DNA*	35.2	31.7	14.7	36.7	26.8
			Data capture(%)	44	99	99	98	99	0	97	94	60	98	98
Ambient Temp. 1hr	(°c)	NA	Average	20.8	12	23	24.7	27.2	DNA*	24.7	24.5	23.9	22.5	26.7
			Max	29.7	33	33	34.5	33.1	DNA*	30.9	32.3	30.7	31.4	37.1
			Min	14.7	4	4	15.7	19.9	DNA*	17.6	17.3	17.0	15.6	18.9
			Data capture(%)	44	46	97	98	99	0	97	94	69	98	98
Rainfall 1hr	(mm)	NA	Average	0.03	1.06	0.06	0.04	0	DNA*	0.02	0.03	0.19	DNA*	0
			Max	0.40	4.53	0.24	2.00	0	DNA*	0.09	0.06	0.90	DNA*	0
			Min	0.02	0.03	0.02	0.02	0	DNA*	0.02	0.02	0.02	DNA*	0
			Data capture(%)	10	67	83	57	1	0	53	50	59	0	1

CAMS= Continuous Air Monitoring Station, NAAQS=National Ambient Air Quality Standard, a=Refurbishment CAMS, PM= Particulate Matter

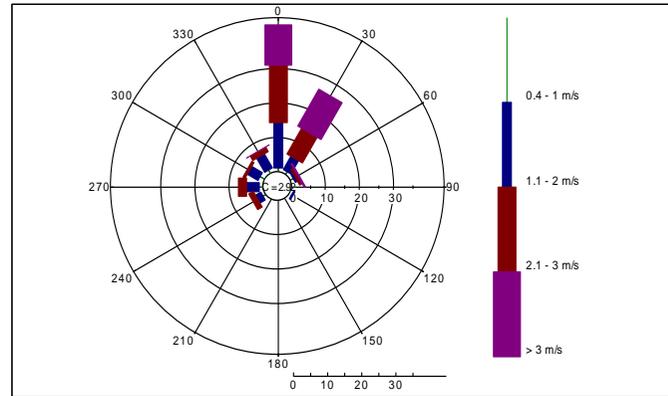
DNA= Data Not Available, \*=DNA due to malfunction of the analyzer/sensor, \*\*=DNA due to poor data capture rate

Figure 2: Wind frequency distributions (wind roses) from different CAMS monitored for November 2013 (cont'd).

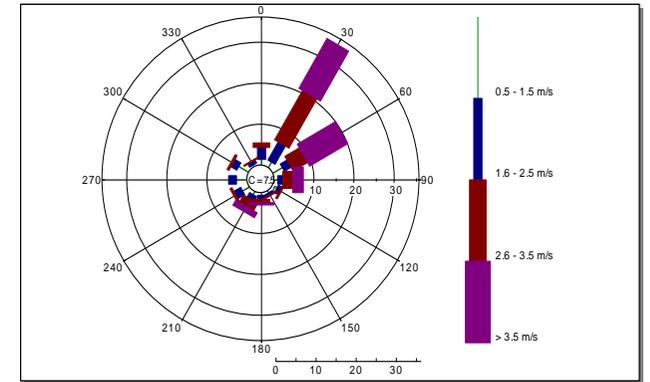
Wind Rose of Narayonganj CAMS



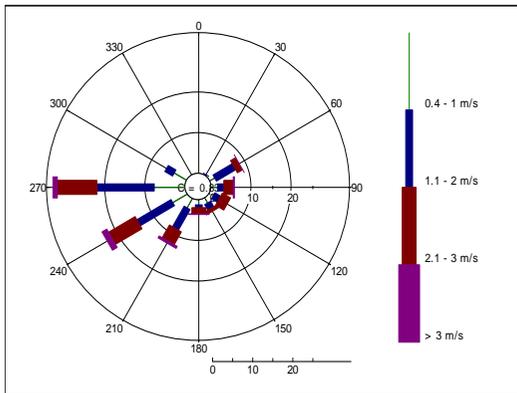
Wind Rose of Agrabad, Chittagong CAMS



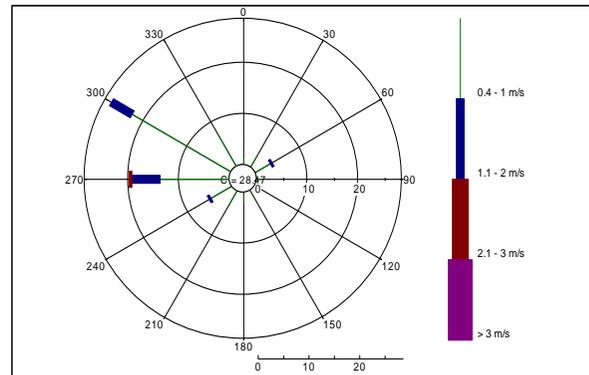
Wind Rose of Sylhet CAMS



Wind Rose of Darussalam CAMS



Wind Rose of Barisal CAMS



Wind Rose of Gazipur CAMS

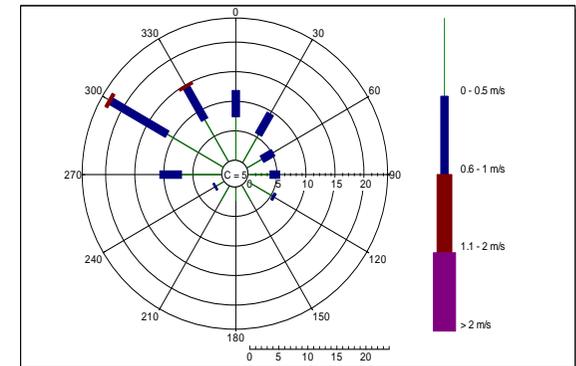
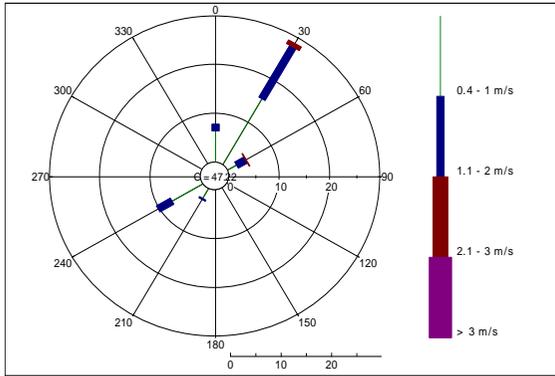
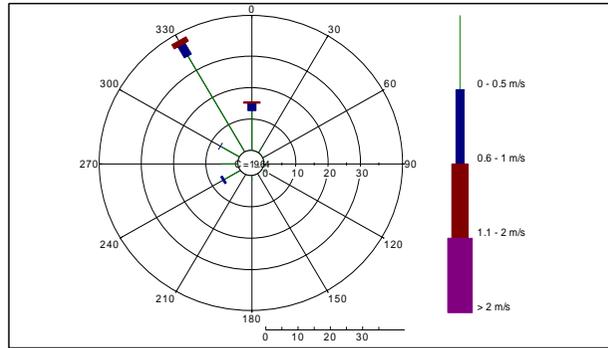


Figure 2: Wind frequency distributions (wind roses) from different CAMS monitored for November 2013 (cont'd).

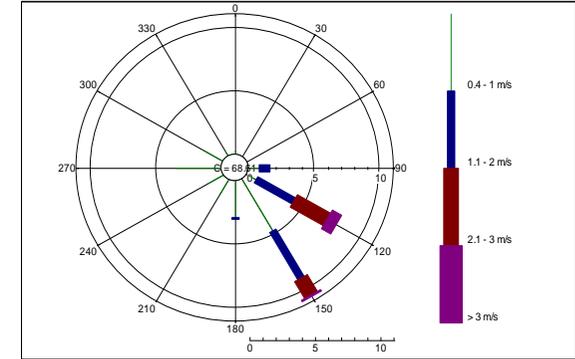
Wind Rose of BARC CAMS for this month



Wind Rose of Rajshahi CAMS for this month



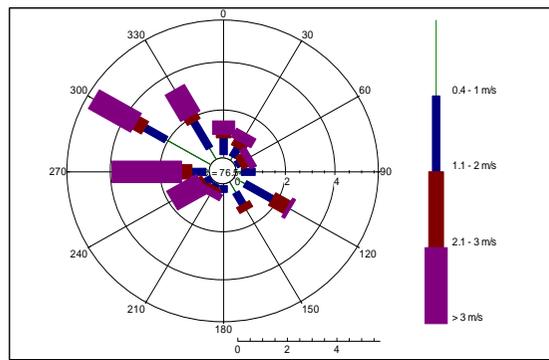
Wind Rose of Sangsad CAMS for this month



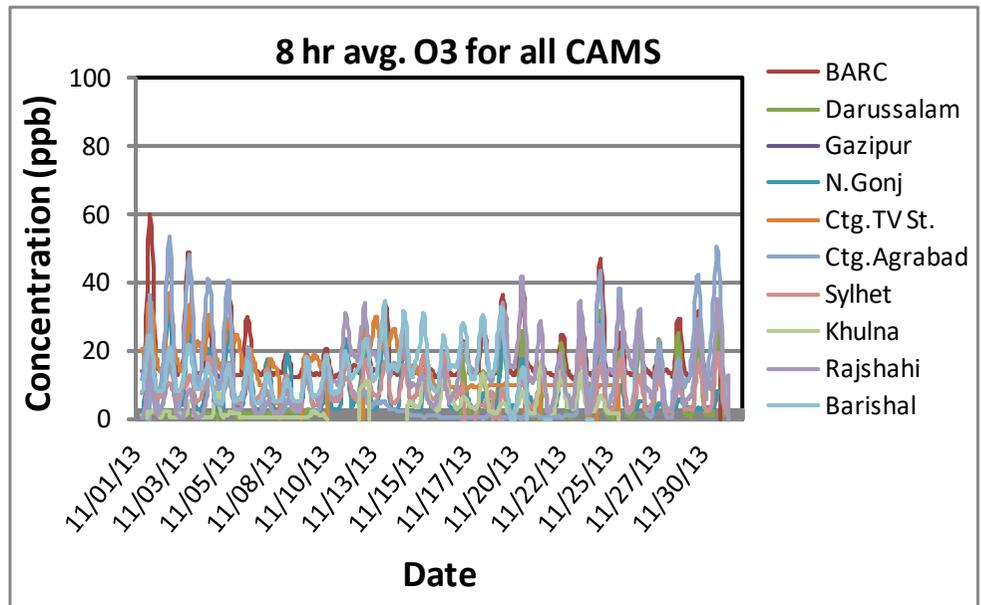
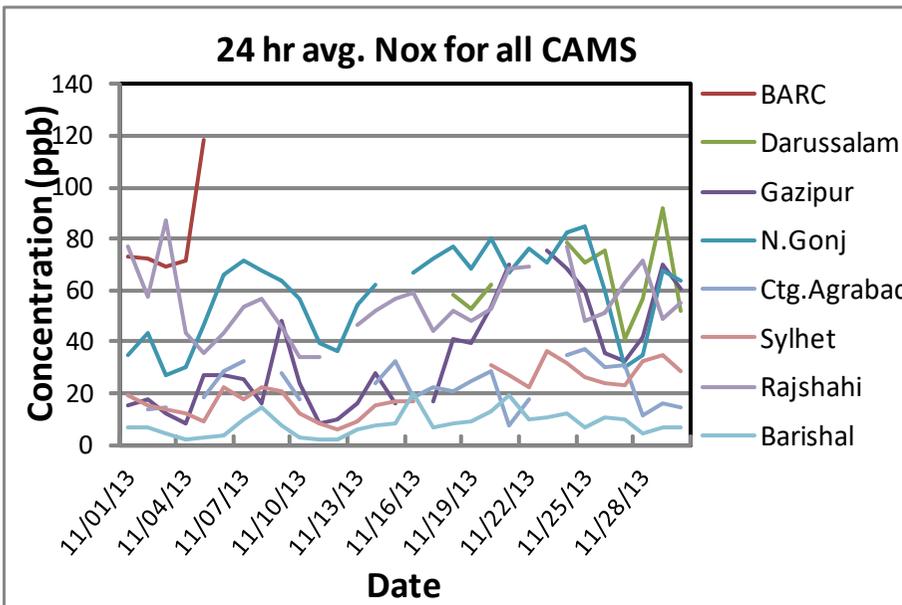
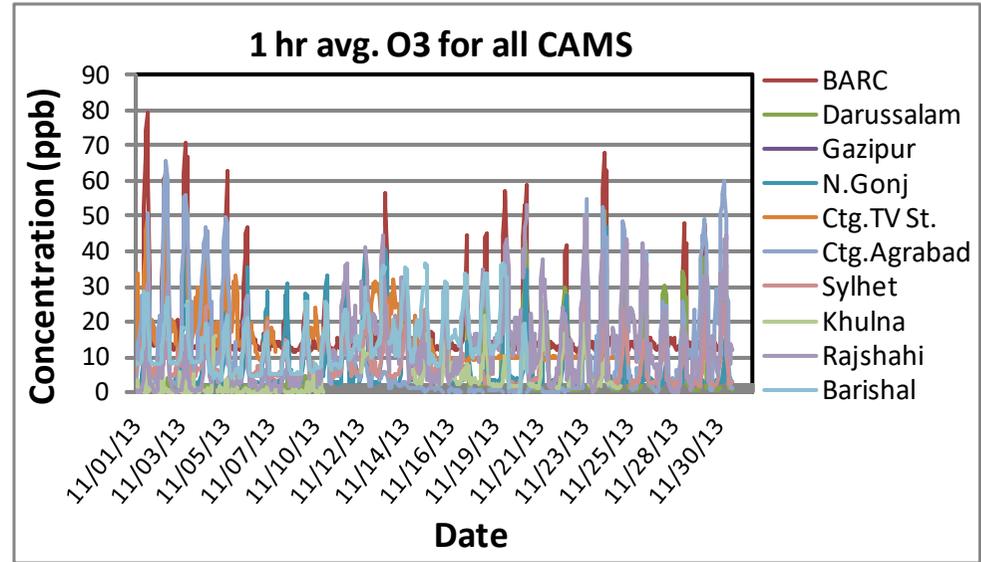
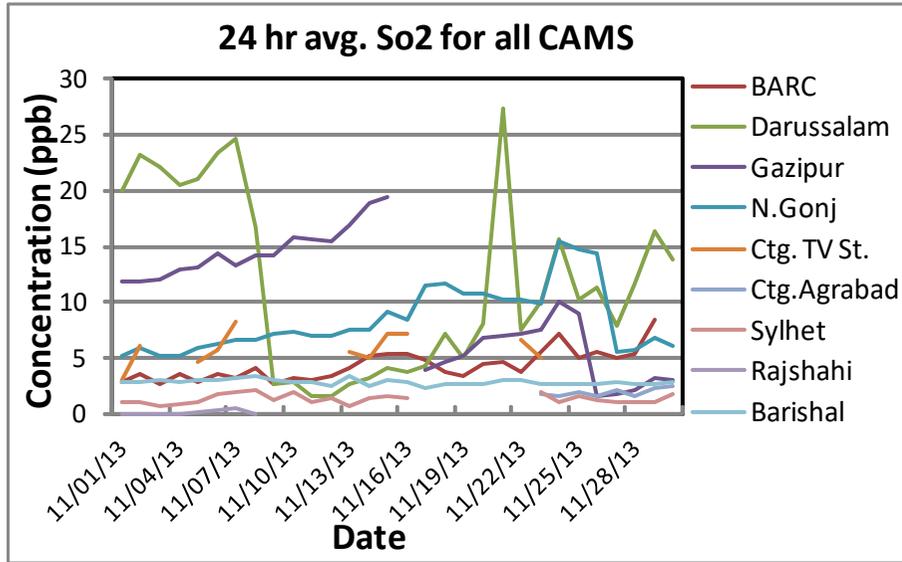
Wind Rose of TV-Chittagong CAMS for this month



Wind Rose of Khulna CAMS for this month



TIME SERIES OF ALL PARAMETERS (SO<sub>2</sub>, NO<sub>x</sub> AND O<sub>3</sub>) MEASURED IN ALL CAMS DURING November 2013



TIME SERIES OF ALL PARAMETERS (CO, PM10 AND PM2.5) MEASURED IN CAMS DURING November, 2013

