Influence of Asian Monsoon on the

Trend, Chemical Composition, and Emission Sources of $PM_{2.5}$ in Bangladesh

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Overview of the Air Pollution Situation in Bangladesh

- **Bangladesh is one of the densely populated country in the World with about 170 million people within about 144 thousand Km^2 area. GDP growth is about 6% - Economy is transferring from agriculture to industry**
- **Capital Dhaka (with a population of about 17 million) and other cities (e.g., Narayangonj, Gazipur, etc.) in Bangladesh are in the top ranking cities for worst air quality by WHO.**
- **Sources of air pollution are mainly Traffics emission, Brick kilns, Industries, Constructions, Power plant, Biomass burning and Long range transport.**
- **Thousands of people were died each year in Bangladesh for both indoor and outdoor air pollution.**
- **Air pollution cost about 1% of our GDP growth.**

DEATH FROM POLLUTION, FORGONE LABOUR OUTPUT, TOP 10 COUNTRIES

Country	TOTAL DEATHS FROM AIR POLLUTION 2013	Men annual ambient pm2.5 (OG/M3) 2013	TOTAL FORGONE LABOUR OUTPUT 2013
China	16,25,164	54.36	44,567
India	14,03,136	46.68	55,390
Indonesia	1,62,410	14.77	11,899
Pakistan	1,56,191	46.18	6,582
Bangladesh	1,54,898	48.36	2,579
Russian Federation	1,04,379	14.23	8,604
Nigeria	97,248	29.51	7,338
United State	91,045	10.75	18,127
Ethiopia	71,018	17.6	793
Vietnam	66,314	25.47	1,557

Year of Bangladesh can be divided into four seasons:

Pre-monsoon (March-May)

Monsoon (June-September)

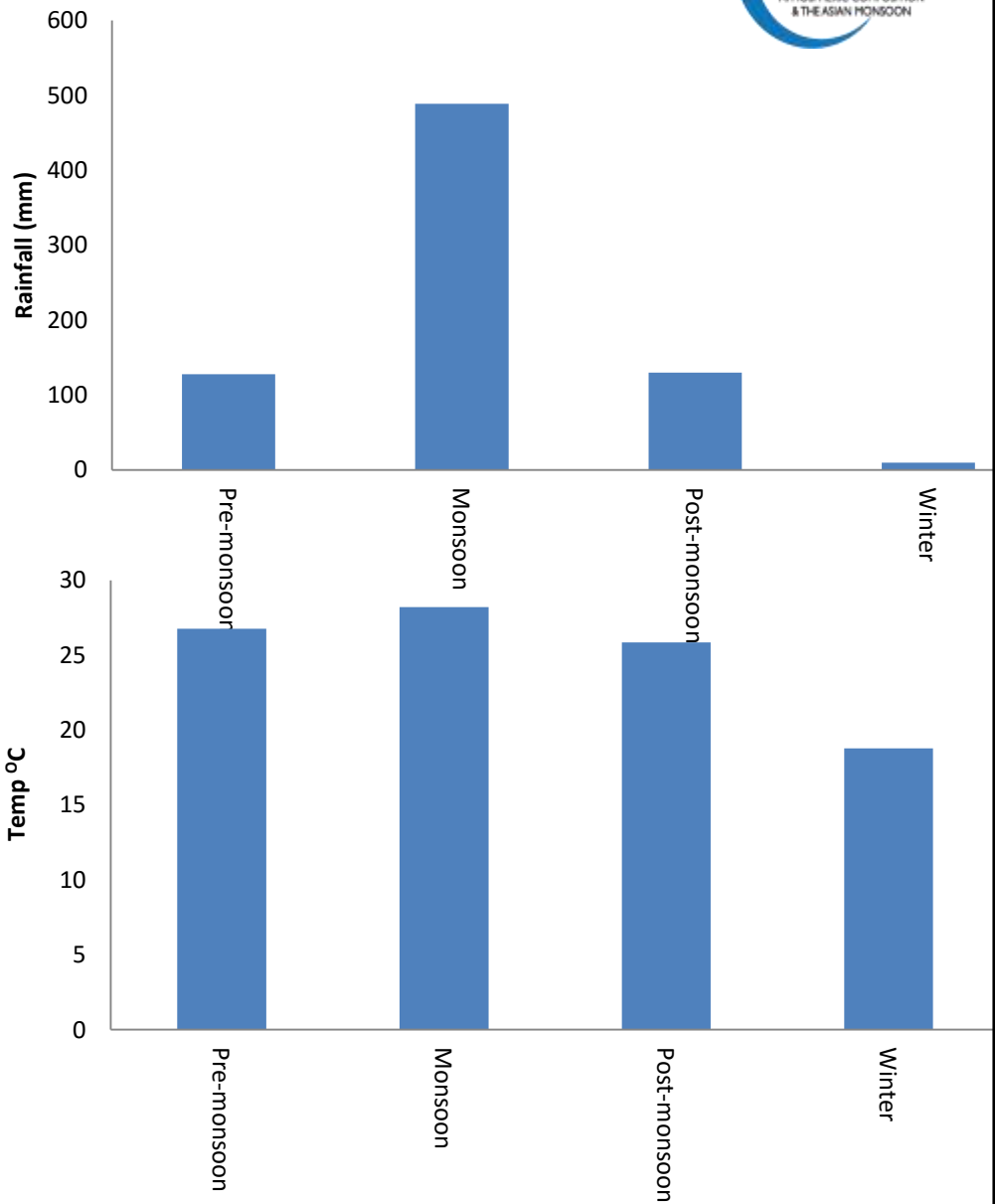
Post monsoon (October-November)

Winter (December-February)

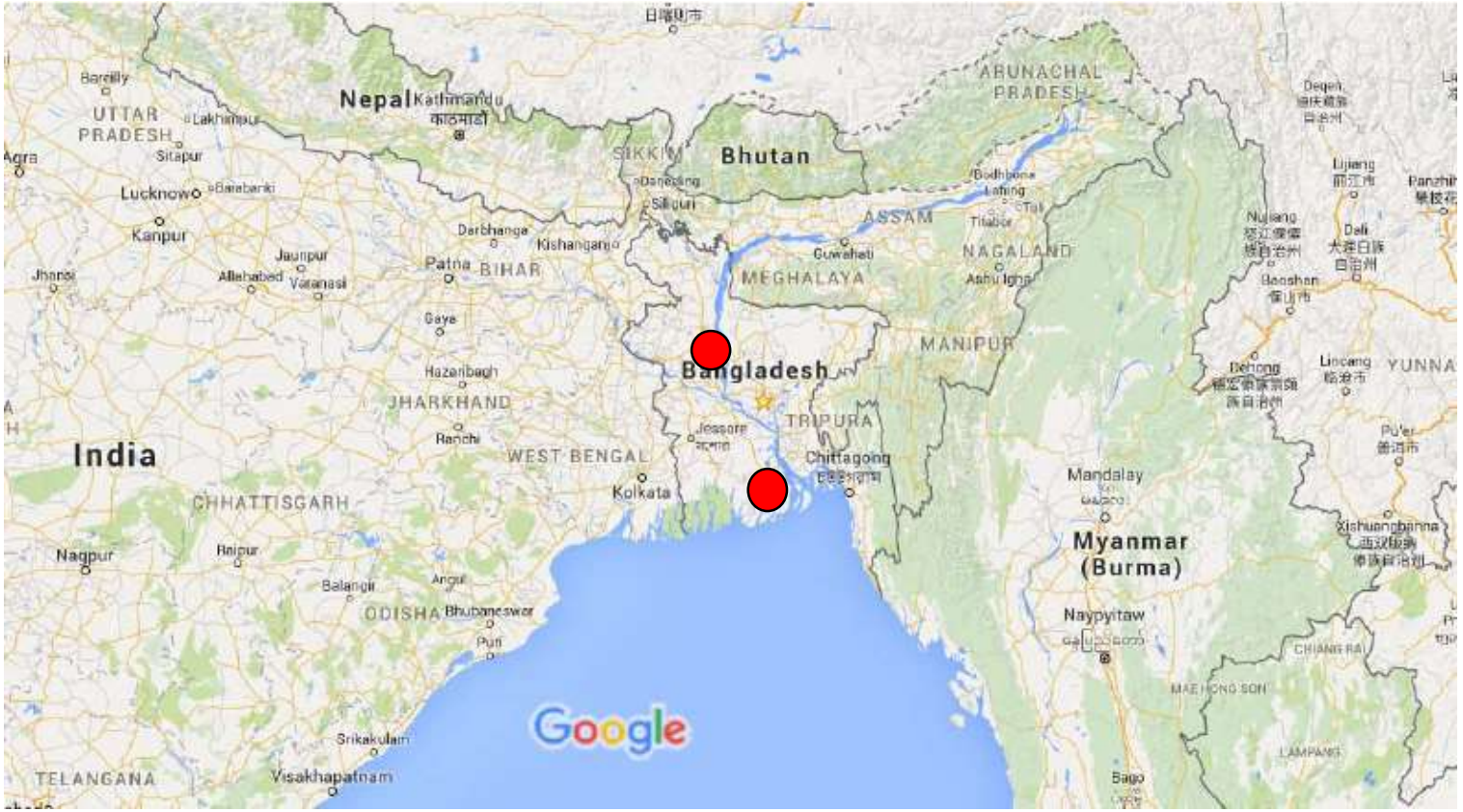
Average temperatures are varying:

Between 8°C and 25°C in winter

Between 25°C and 39°C in summer



Map of Bangladesh showing two red cycles for two observatories (Dhaka and Bhola) operated by the Department of Chemistry, University of University



Dhaka Station (N 23° 43'40"; E 90°23'52, 34.0 m asl)

NASA AERONET Sunphotometer,

PM_{10} and $PM_{2.5}$ Sampler,
Hi vol TSP Sampler,

Real time PM sampler (mass and number concentrations)

Gas analyzer

SPARTAN $PM_{2.5}$ and Nephlometer

Bhola Observatory

- About 1 km far from nearby roads
- No industrial emission
- Very low traffic emission
- Biomass burning for cooking and agricultural activities, fertilizers, etc
- Long range transports during winter

Bhola is an Island of the Bay of Bengal. It is most southern part of the country and also the biggest Island of Bangladesh. It is about 300 km far the capital city.

Latitude: N 22°10'01“, Longitude: E 90°45‘ 00", Elevation: 10.0 meters.

Instruments: NASA Aeronet Sunphotometer, TSP sampler, Digitel $PM_{2.5}$ Sampler, CO monitor

Sources of air pollution:
Traffic Emissions

- Severe traffic jams in the street of Dhaka

- 20 years old vehicle banned
- Ban of leaded gasoline
- Trying to use low sulfur content fuel
- Improvement of traffic signals
- Ban of track and heavy duty vehicle during day time
- Change of holidays for shopping malls
- Change of routes of different bus lines

Brick kilns emissions

Coal is the main fuel for the brick Kilns, power plant, rice mils.

About 1200 hundreds in and around Dhaka mega city; and about 6000 brick kilns are in all over Bangladesh.

Coal has also high sulfur and Hg.

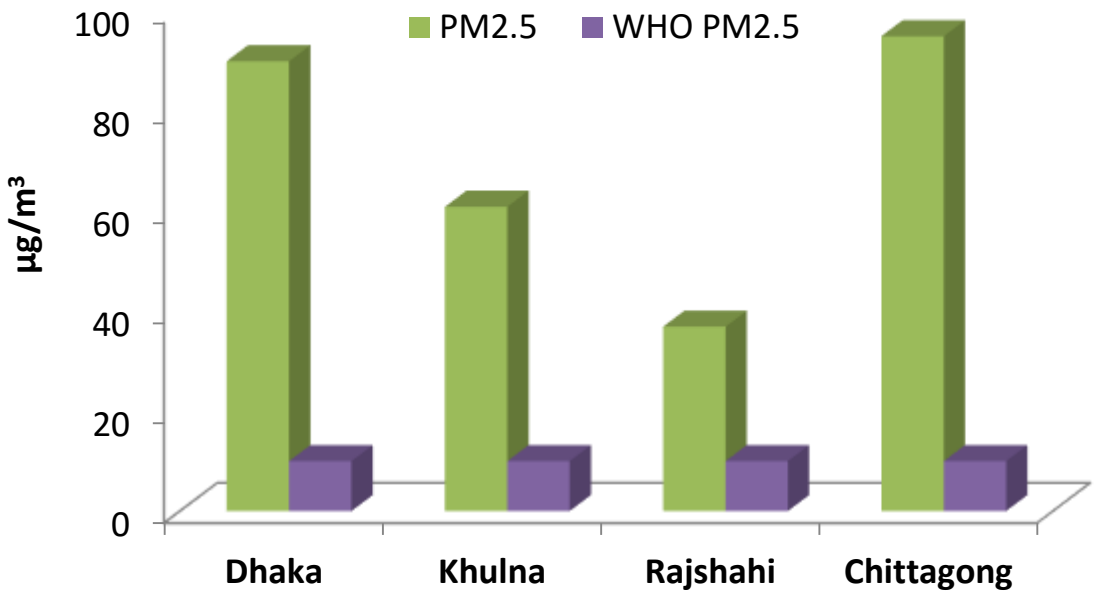
- **Ban of biomass burning in the brick kilns**
- **Stack height not less than 120 ft**
- **Phase out of traditional kilns to relatively modern kilns (Hoffman, Zig Zag, Tunnel kilns.)**
- **Rules for not cutting soil from agricultural land or from hills.**
- **Rules also for setting the kilns location**

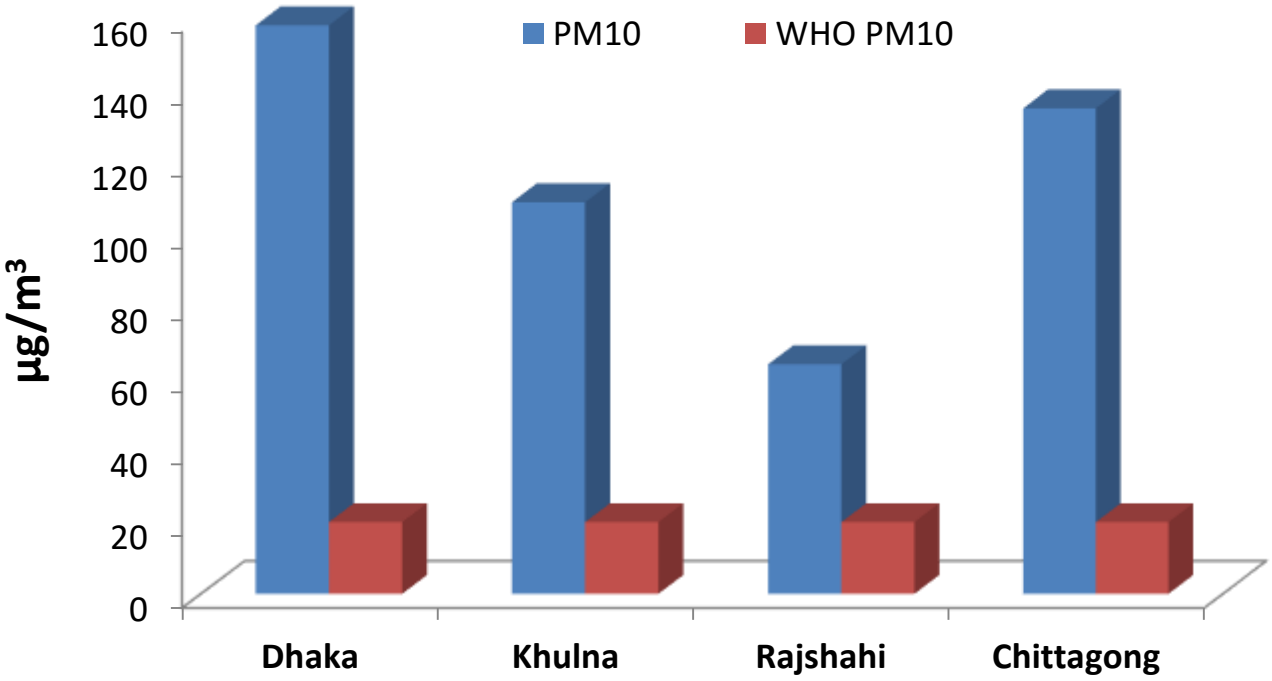
আজ বিশ্ব পরিবেশ দিবস। পরিবেশ রক্ষায় নানামুখী উদ্যোগ নিলেও ইটের ভাটার ধোঁয়া সবসময়ই দূষিত করছে নগরীর পরিবে –ইত্তেফাক

Other Sources of Air Pollution in Bangladesh

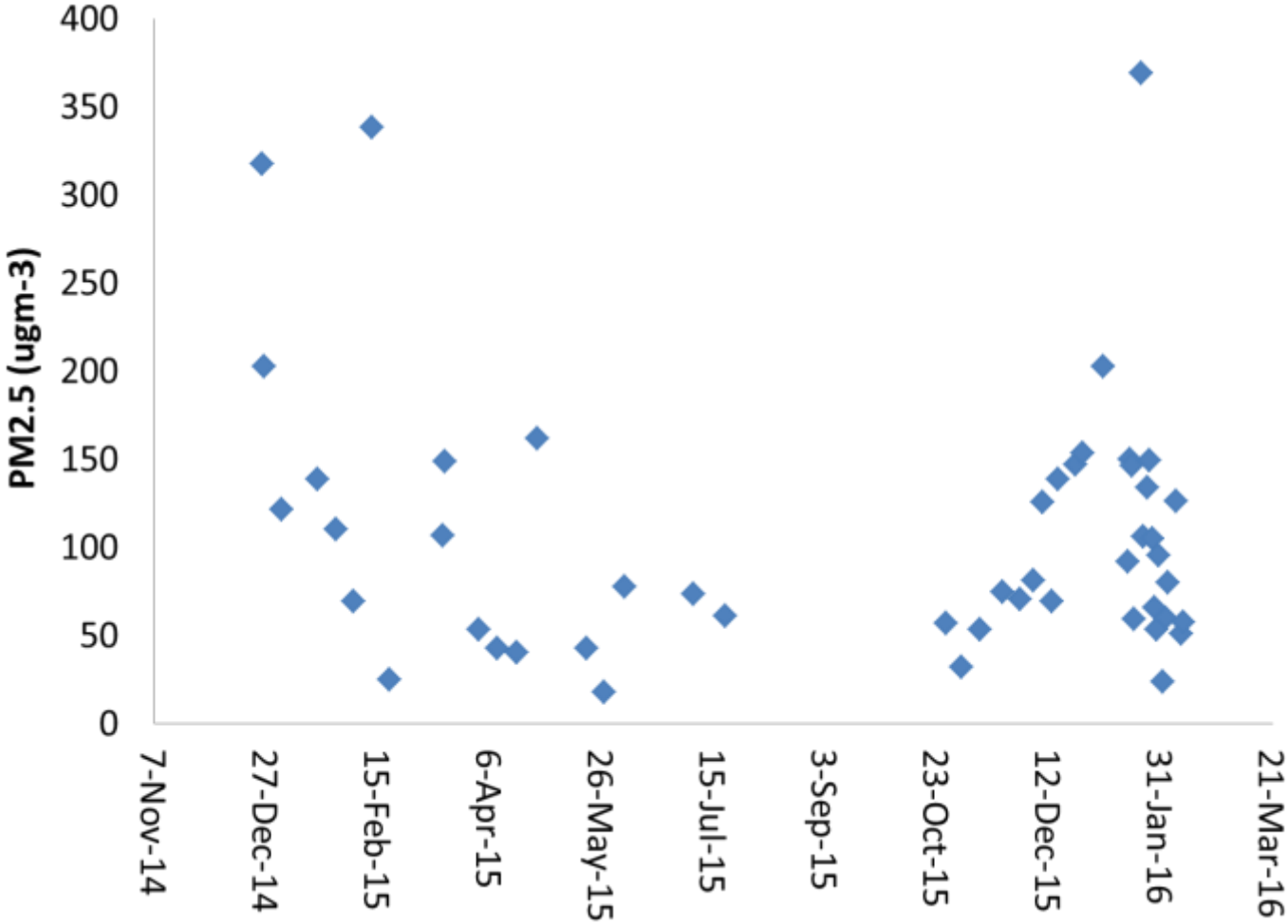
পুরান ঢাকার নবাবপুর রোডে ভূগর্ভস্থ পাইপ বসানোর জন্য রাস্তা খোঁড়াখুঁড়ি চলছে। এতে পথচারীদের চলাচল ব্যাহত হচ্ছে ● ছবি : প্রথম আলো

$PM_{2.5}$ and PM_{10} at Four Cities in Bangladesh

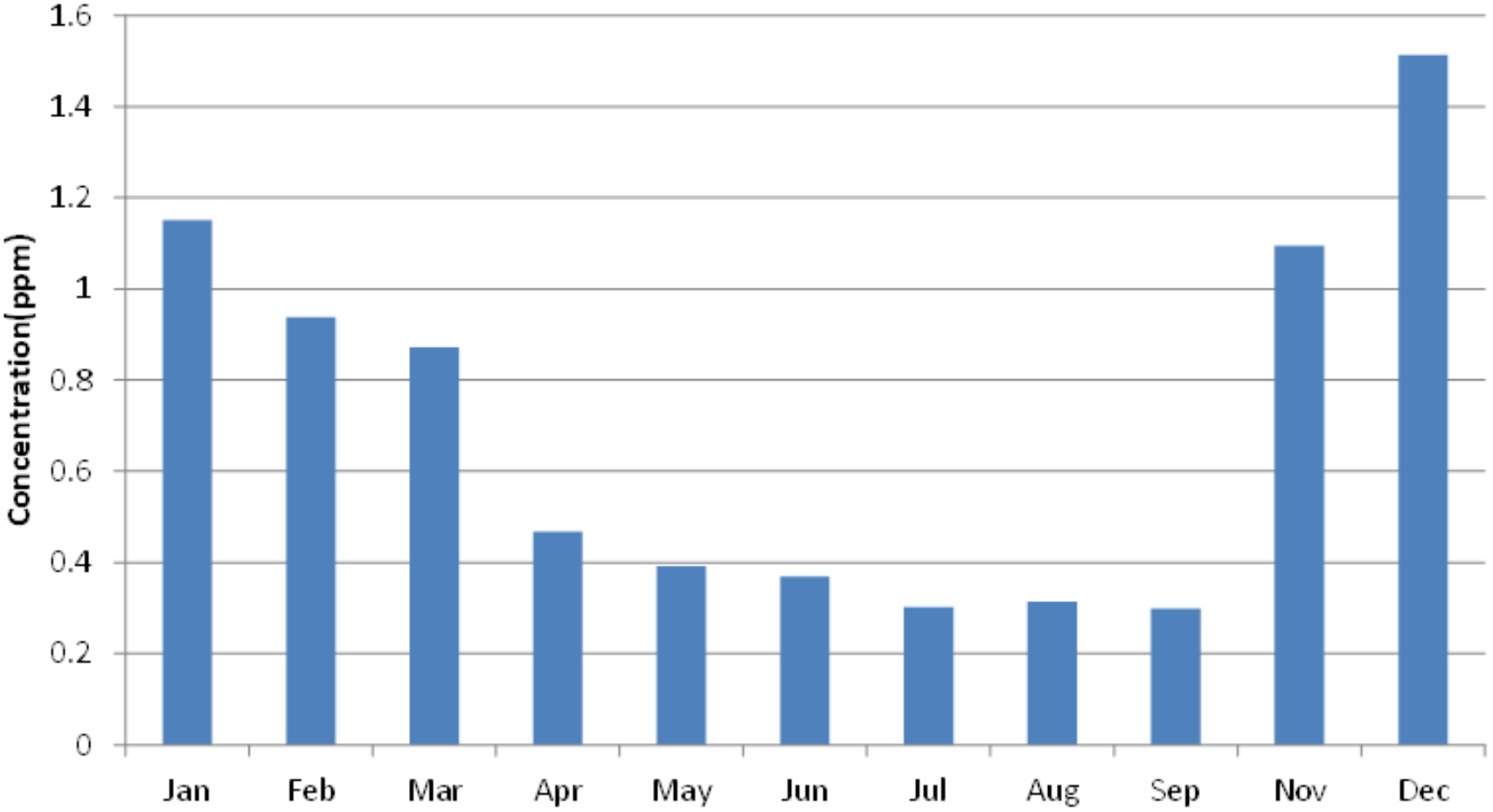




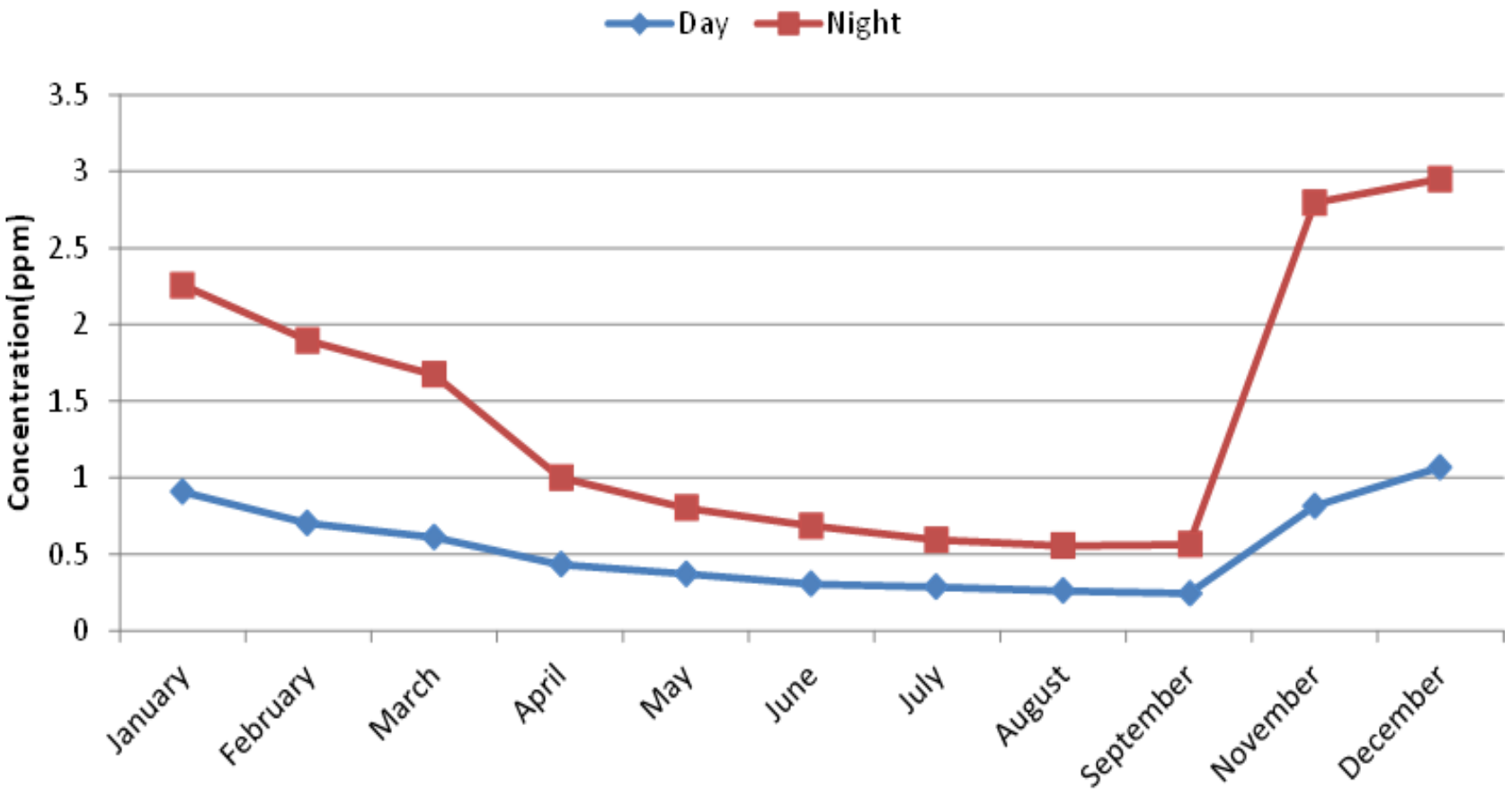
Variation of $PM_{2.5}$ between 2014 and 2016 in Bhola, Bangladesh



Average CO concentrations from 2013 to 2016 in Dhaka, Bangladesh



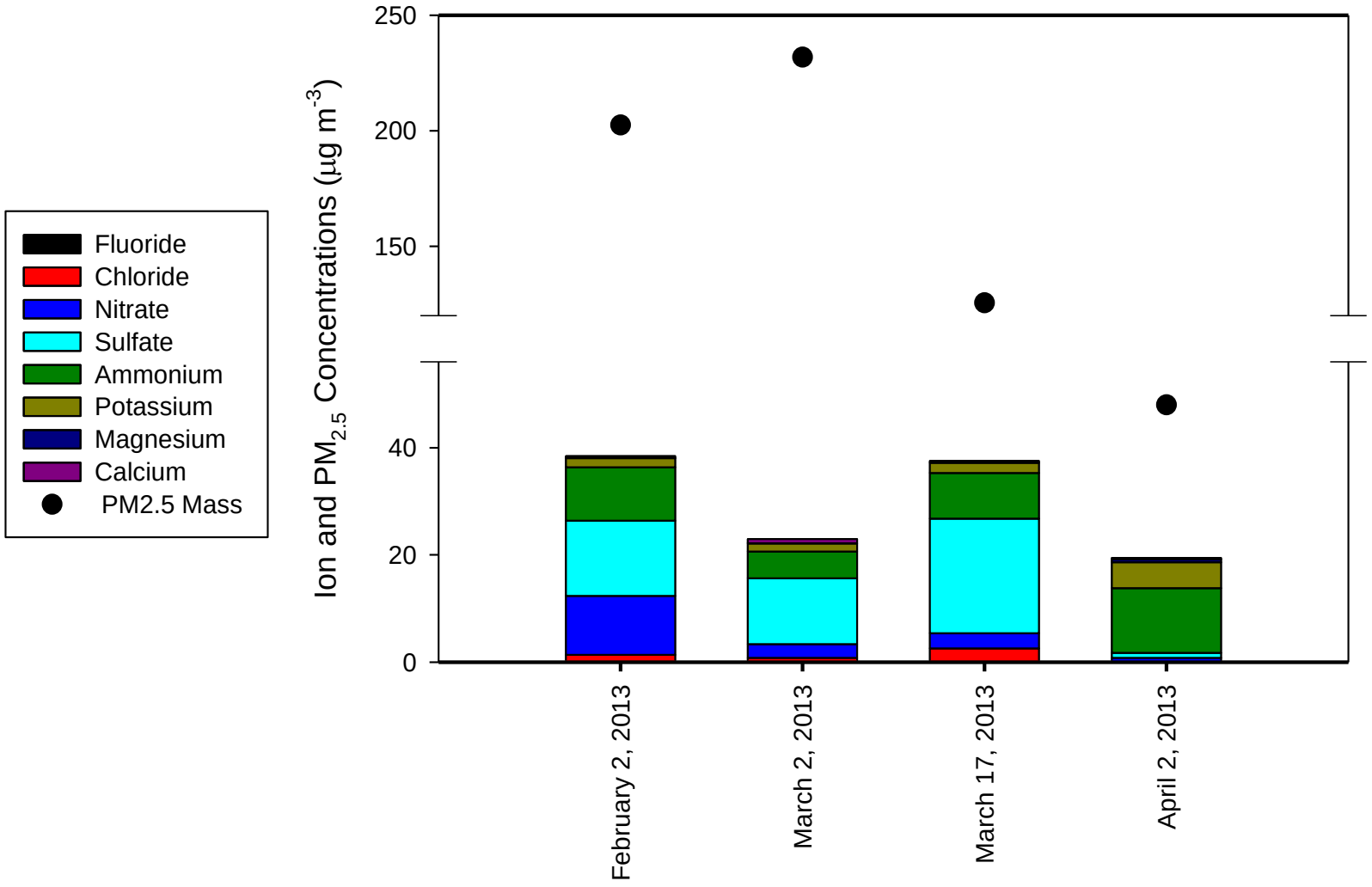
Day and Night variation of monthly average CO concentrations in Dhaka, Bangladesh



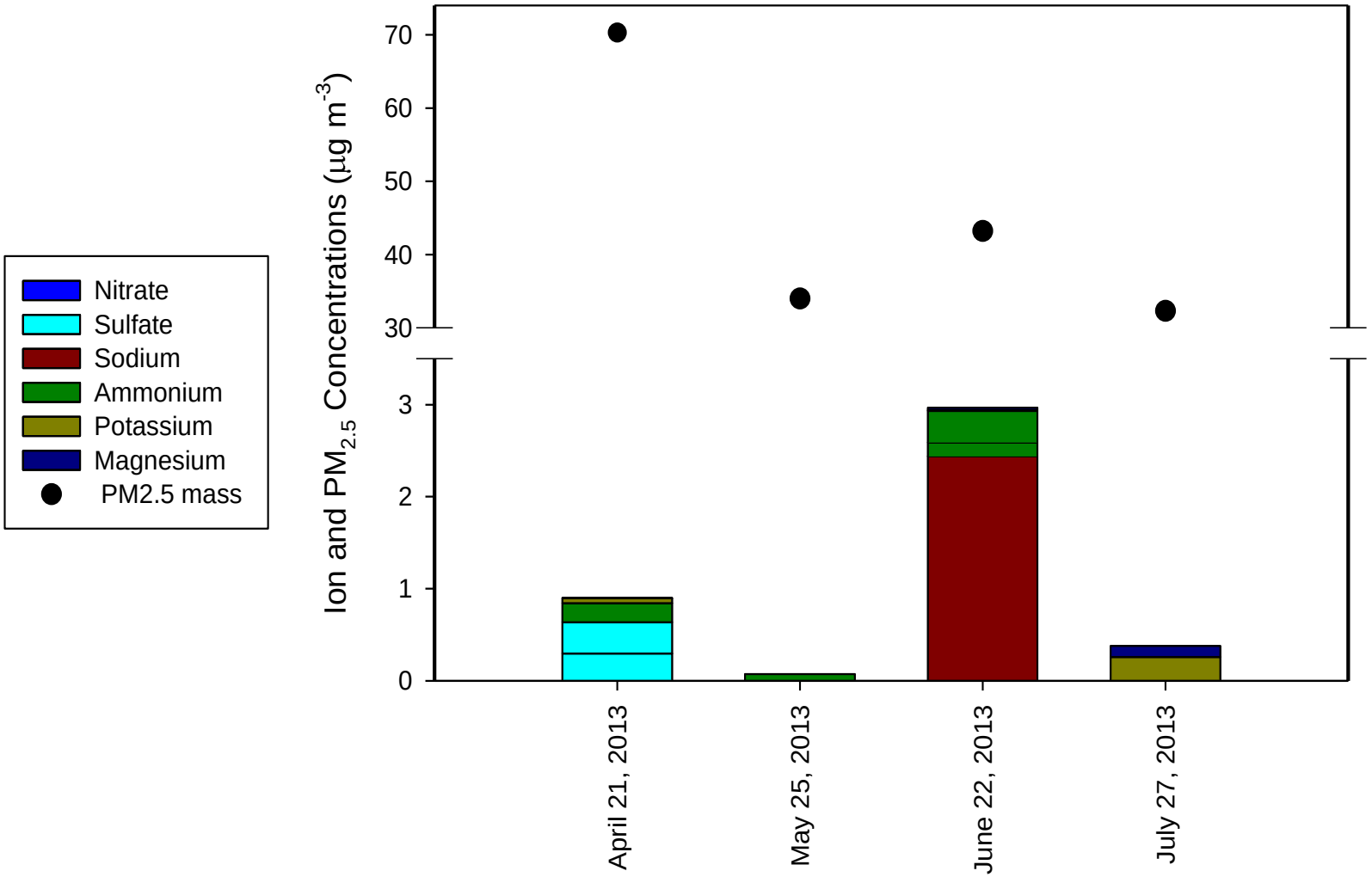
Carbonaceous species concentrations on 2003 and 2014 in Dhaka and Bhola

	Urban Dhaka (μgm^{-3})			Rural Island Bhola (μgm^{-3})	
	2003 (TSP)	2014 ($PM_{2.5}$)		2003 (TSP)	2014 ($PM_{2.5}$)
EC	22.0	13.0		2.80	0.60
OC	45.7	40.2		4.60	2.20

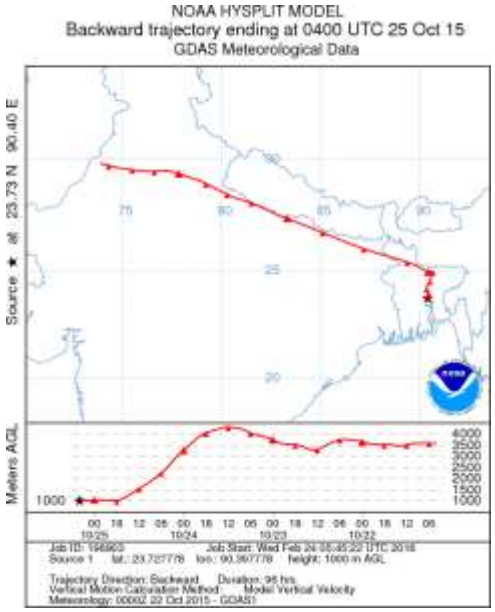
Water Soluble ions in $PM_{2.5}$ composition in Dhaka, Bangladesh

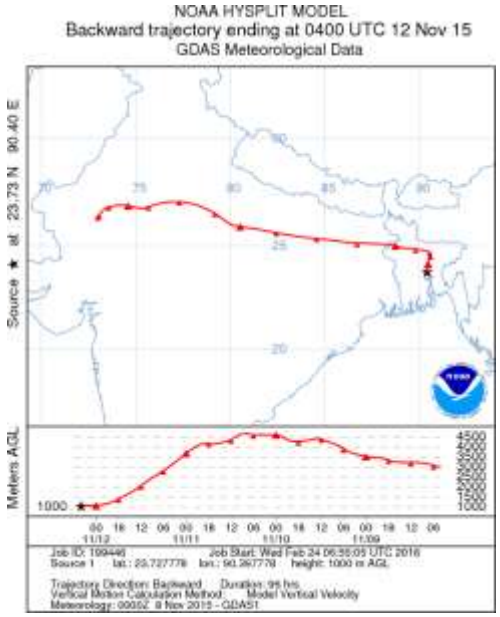


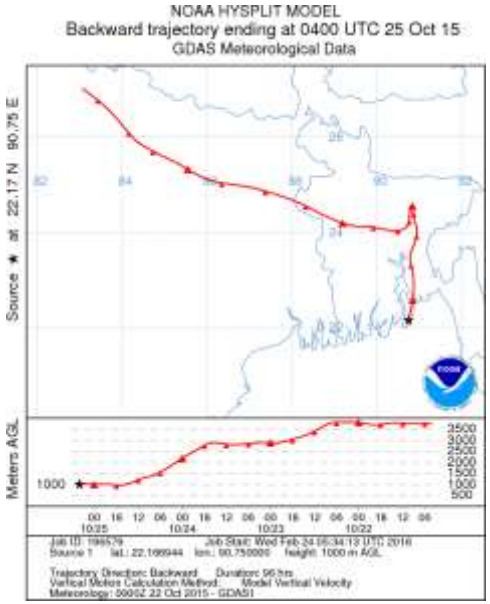
Water Soluble ions in $PM_{2.5}$ composition in Bhola, Bangladesh

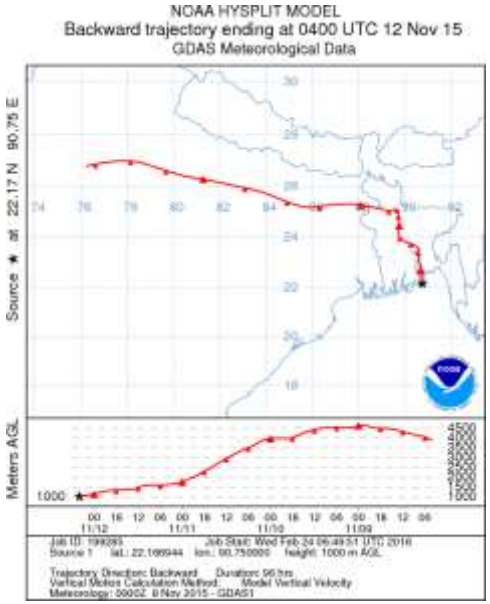


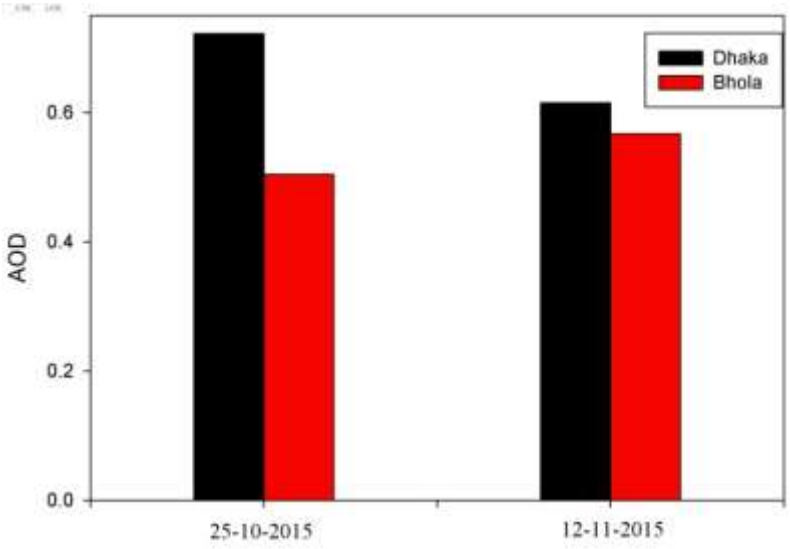
AOD in October and November



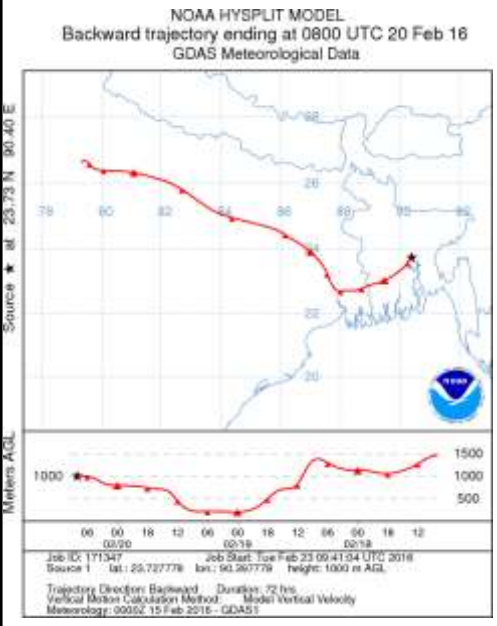


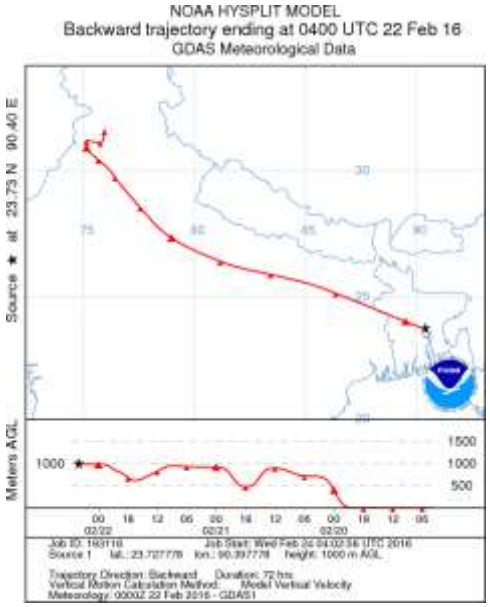


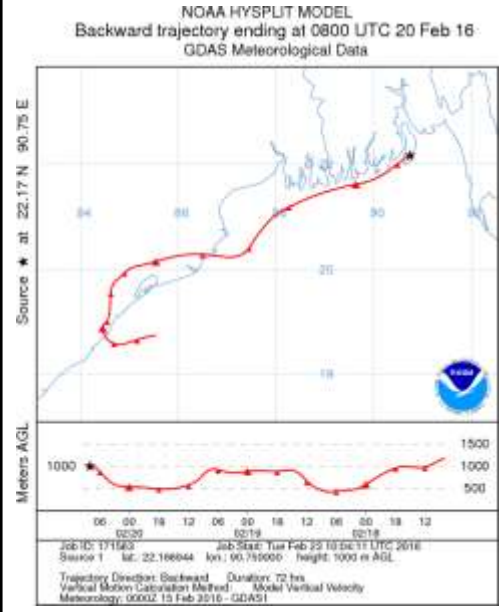


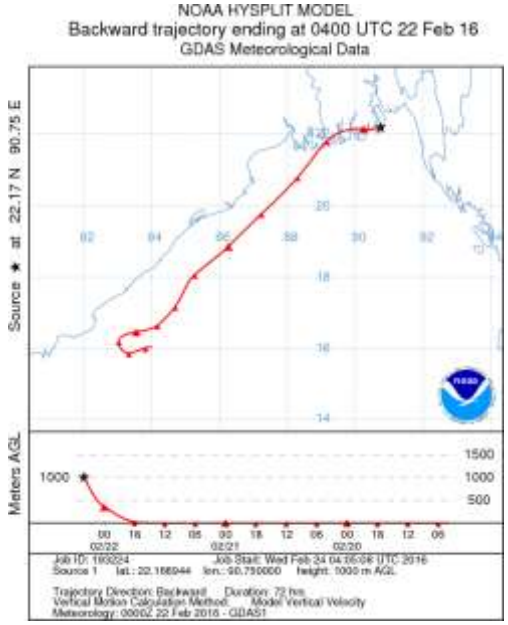


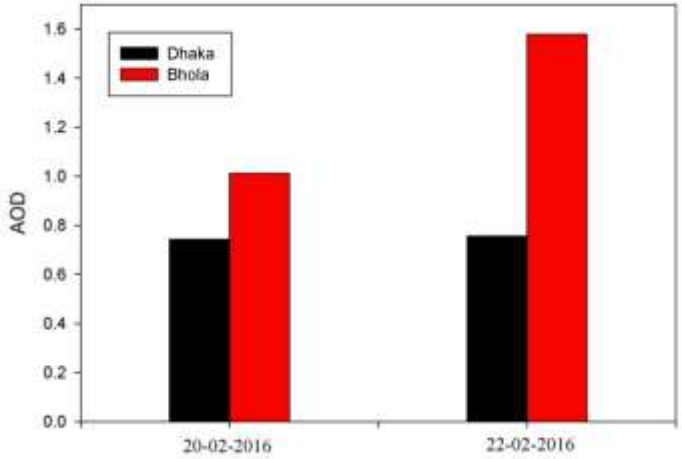
AOD in February



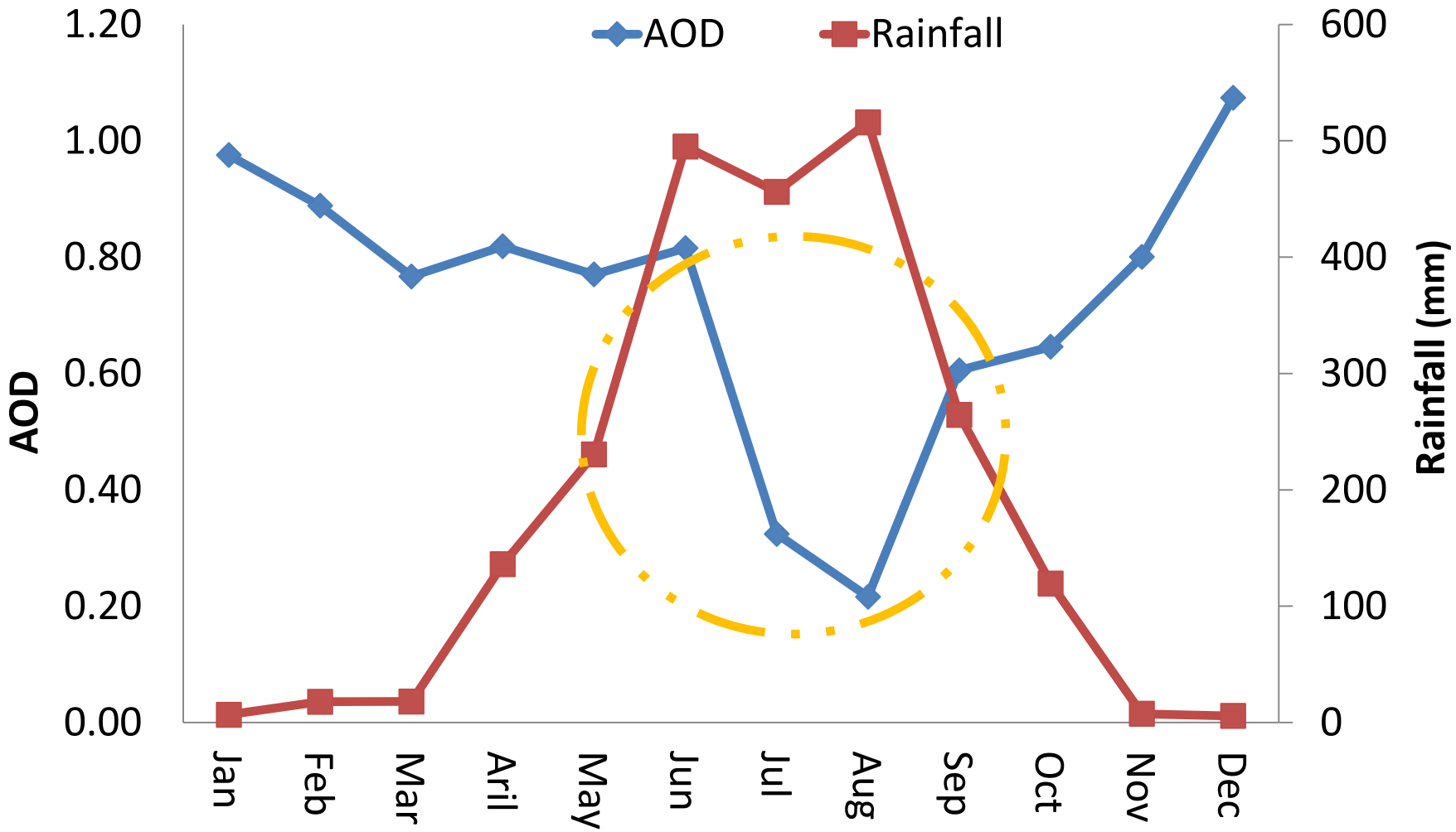




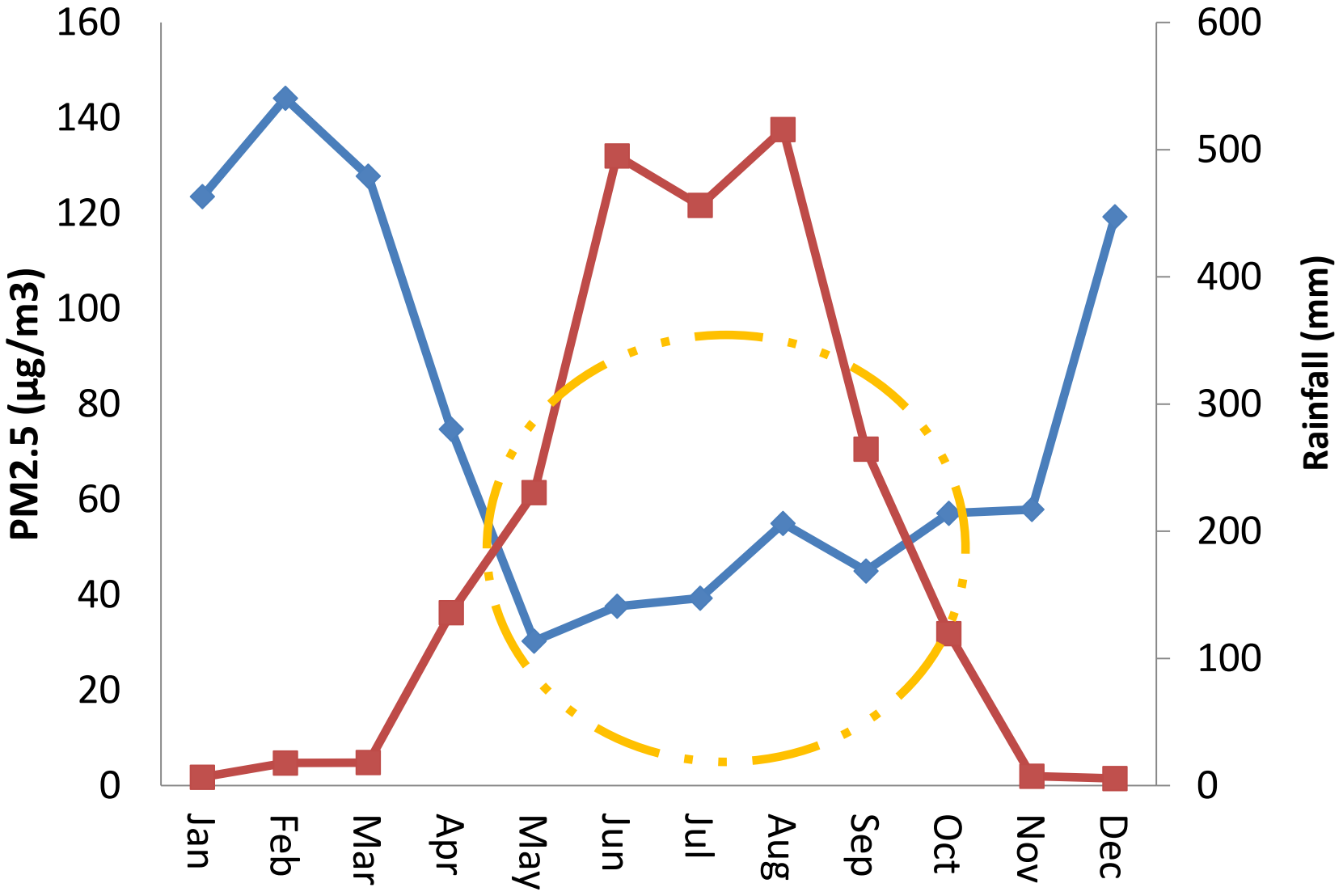




Influence of Monsoon on AOD values in Bangladesh



Influence of monsoon on $PM_{2.5}$ in Bangladesh



Conclusion

- Very high concentrations of particulate matters ($PM_{2.5}$ and PM_{10}) were observed both in Urban and Rural areas in Bangladesh.
- Long range transported air mass has significant impact on the air quality in Bangladesh.
- CO concentrations were lower than WHO limit value. The day time concentrations were lower than night times in Dhaka.
- AOD values at the coastal Bhola is one of the highest as a rural location during winter time, even higher at the end of winter (in February) due to change of wing direction.
- Monsoon has drastically reduce the pollution levels (CO, AOD and $PM_{2.5}$) in Bangladesh.

Our Collaborations

AERONET
AEROSOL ROBOTIC NETWORK

DEPARTMENT OF STATE
UNITED STATES OF AMERICA

StratoClim

Stockholm University

ARCADIS
Infrastructure · Water · Environment · Buildings

ICIMOD

Office of Naval Research
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Our Group Members

Thanks!