Atmospheric new particle formation in India: Current understanding and knowledge gaps

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Atmospheric new particle formation (NPF) refers to the formation of secondary aerosols from gaseous vapours that undergo gas-to-particle (GTP) conversion. NPF is the largest source of aerosol numbers to the terrestrial atmosphere. It produces more than half of the present-day cloud condensation nuclei (CCN), thus influencing cloud properties and Earth's energy budget. But, very little is known on the physio-chemical processes leading to NPF and airborne production of aerosol mass in India. The first-ever evidence of atmospheric NPF in India was reported in 2005. To date, there are only 22 published papers based on independent field campaigns and long-term field observations in India. These studies mainly reported the key NPF characteristics such as NPF frequency, particle formation rate, growth rate and atmospheric conditions influencing NPF. The chemical mechanisms responsible for NPF are yet to be explored in India because field observations using state-of-the-art instruments (e.g., Cluster-CIMS, APi-ToF, etc.) are not available for real-time identification and quantification of gas-phase and particle-phase compounds in the air. In this talk, I will present a synthesis of the observed characteristics of NPF in different environments of India and present critical knowledge gaps for future NPF studies in India.

Bioactive trace metal composition and their fractional solubility in aerosols from the Arabian Sea during the Southwest Monsoon

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Atmospheric dust deposition supplies significant amount of macro and micro (trace metals) nutrients to surface ocean water, thus, plays vital role in modulating phytoplankton growth. Here we report, soluble and total bioactive trace metals (Fe, Mn and Cu) along with aeoilan dust concentration measured in aerosol samples collected over wide area of the Arabian Sea during southwest monsoon month in two consecutive years (2017 and 2018). Relatively higher mineral dust concentrations were observed during the campaign period compared to those reported in the Arabian Sea, highlighting emission and transport of dust from surrounding active sources. A large spatial variability (similar to mineral dust) in total (30.6-2830.4 ng m^{-3}) and soluble Fe (3.6 - 32.8 ng m^{-3}) concentration were observed in contrast to Mn and Cu. However, the operational fractional solubility (defined as fraction of soluble metal leached using Milli-Q water out of total metal) is relatively low (less than 3.5 %) for Fe as compared to Mn (range: 3.6 - 94.6 %) and Cu (3.6 - 97.9 %). Insignificant contribution of the anthropogenic Fe and Mn is seen during the study period which is evident form their enrichment factor (EF less than 10 w.r.t. continental crustal ratio). However, relatively higher EF for Cu is found in majority of samples, indicating partial contribution from anthropogenic emissions. An inverse hyperbolic relationship between fractional solubility and total metal is observed for Fe (similar to previous observations) however, no such association found in case of Mn and Cu. The dry deposition fluxes of Fe, Mn and Cu to the surface water of the Arabian Sea are estimated as 720.6, 38.1 and 1.4 μg m^{-2} day^{-1}, respectively. These fluxes are relatively on higher side compared to those reported from other oceanic region over the Globe.

Keywords: Aerosols; Trace metals; Mineral dust; Deposition Flux; Arabian Sea

Air chemistry in a tropical urban environment of India: A modeling perspective

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Air chemistry over tropical India has pronounced impacts on the air quality and climate; nevertheless, studies dealing with detailed composition remain few in this region. In this regard, we combined a suite of in situ and remote sensing measurements with a photochemical box model (NCAR Master Mechanism) to simulate the chemistry and quantify effects of meteorological changes over Ahmedabad. Several trace gases of natural and anthropogenic origin have been included in the model under prescribed environmental conditions of this region. Model results show strong ozone (O_3) build-up with levels exceeding 100 ppbv before a gradual decrease in the downwind of Ahmedabad. The ozone-rich air masses are seem to circulate across the rural areas and thereafter enter the marine boundary layer of the Arabian sea. Besides O_3, significant amounts of secondary chemical species e.g. ketones (∼11 ppbv) are produced in the outflow. Model successfully reproduced a dramatic impact of the variation in aerosol optical depth (AOD) on O_3, i.e. when AOD is enhanced from 0.1 to 1.5 in the model, the noontime O_3 is reduced by about 40 ppbv. Additionally, the model unravelled a remarkable impact of meteorological transition (by ∼16%) in enhancing O_3 besides due to the unprecedented reduction in anthropogenic emissions (by ∼25%) during the COVID-19 lockdown. Our simulation results would be valuable to design adequate strategies towards cleaner air and climate mitigation in the region.

Green Technology to Mitigate Air Pollution – Real Time Data Based Analysis

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Aerosols are tiny particles that have a significant impact on the atmosphere. Its effects are both direct and indirect. The most serious consequence of aerosols that has a direct impact on human health is air pollution caused by particulate matter emissions from various industries. Every year, poor air quality kills 7 million people prematurely and causes serious lung and heart disease in more than half of the population. Pure Skies technology is a novel technology that uses pulsed radio frequency waves to reduce particulate pollution. The radio frequency waves are transmitted using a custom-made omnidirectional antenna. The technology is used to reduce particle pollution levels, particularly PM10 and PM2.5. The complete unit consists of antenna, signal source, power source, internet of things (IoT) hardware for communication from the laboratory to the unit, an uninterrupted power supply (UPS), and miscellaneous hardware for electrical safety and security.

Pure Skies technology suggest that the posited mechanism of action of the pulsed radio wave technology is to accelerate the process of dry deposition of particles less than 20-30 microns in diameter. The working hypothesis is that the pulsed radio wave technology takes advantage of the dielectric effect created under the influence of a spatially non-uniform electric field. The radio wave energy which is broadcasted in a pulsed manner is likely to generate a non-uniform electric field with the strength of the field varying with distance from the antenna which accelerates dry deposition by inducing charge on particulate pollutants.

The presentation provides an overview of various case studies involving pulsed radio waves to mitigate particulate pollution in various sectors, as well as a few experimental and modelling results obtained from the studies carried out IIT Kanpur.

The first case studies were conducted at the thermal power plant's outdoor and indoor locations, where the 24-hour average PM2.5 and PM10 levels were reduced by 54% and 41%, respectively.

The second case study was conducted in the cement industry, where PM2.5 levels were reduced by 48% and PM10 levels were reduced by 50%.

The entire set of results along with the working principle will be presented at the conference.

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Are fireworks a significant episodic source of brown carbon?

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Abstract

We hypothesize that firework events involving combustion of charcoal fuel, organic binders, metal salts and cellulose-based wrapping material could be significant transient sources of aerosol brown carbon (BrC). To test this, we couple high time-resolution (1 min) measurements of black carbon (BC) and BrC absorption from a 7-wavelength Aethalometer with time-integrated (12-24 h) measurements of filter extracts, i.e., UV-Visible, fluorescence and Fourier-transformed infrared (FT-IR) signatures of BrC, total and water-soluble organic carbon (OC and WSOC), ionic species, and firework tracer metals during a sampling campaign covering the Diwali fireworks episode in India. In sharp contrast to BC, BrC absorption shows a distinct and considerable rise of 2-4 times during the Diwali period (Figure 1), especially during the hours of peak firework activity, as compared to the background. Fluorescence profiles (Figure 2a) suggest enrichment of humic-like substances (HULIS) in the firework plume while the enhancement of BrC absorption showed (Figure 2b) the 400-500 nm range suggests presence of nitroaromatic compounds (NACs). Considerable contributions of WSOC and secondary organics to OC (44.1% and 31.2%, respectively) and of the water-soluble fraction of BrC to total BrC absorption (71.0%) during the Diwali period point toward an atmospherically-processed, polar signature of firework-related BrC (Figure 3), which is further confirmed by FT-IR profiles. This aqueous BrC exerts a short-lived but strong effect on atmospheric forcing (12.0% vis-à-vis BC in the UV spectrum), could affect tropospheric chemistry via UV attenuation, and lead to a stabilization of the post-Diwali atmosphere resulting in enhanced pollutant build-up and exposure.

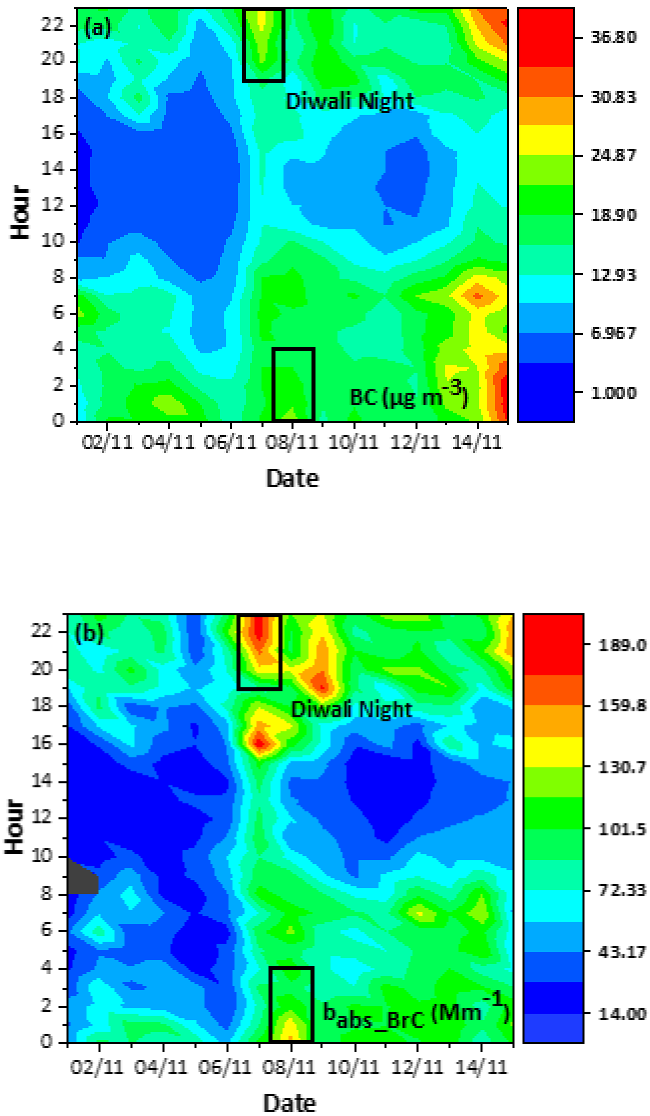

Fig. 1. Contour maps showing the hourly variation of (a) BC (µg m^{-3}), and (b) b_{abs_BrC} (Mm^{-1}) derived from the Aethalometer for the study period. The Diwali night is marked with a black rectangle.

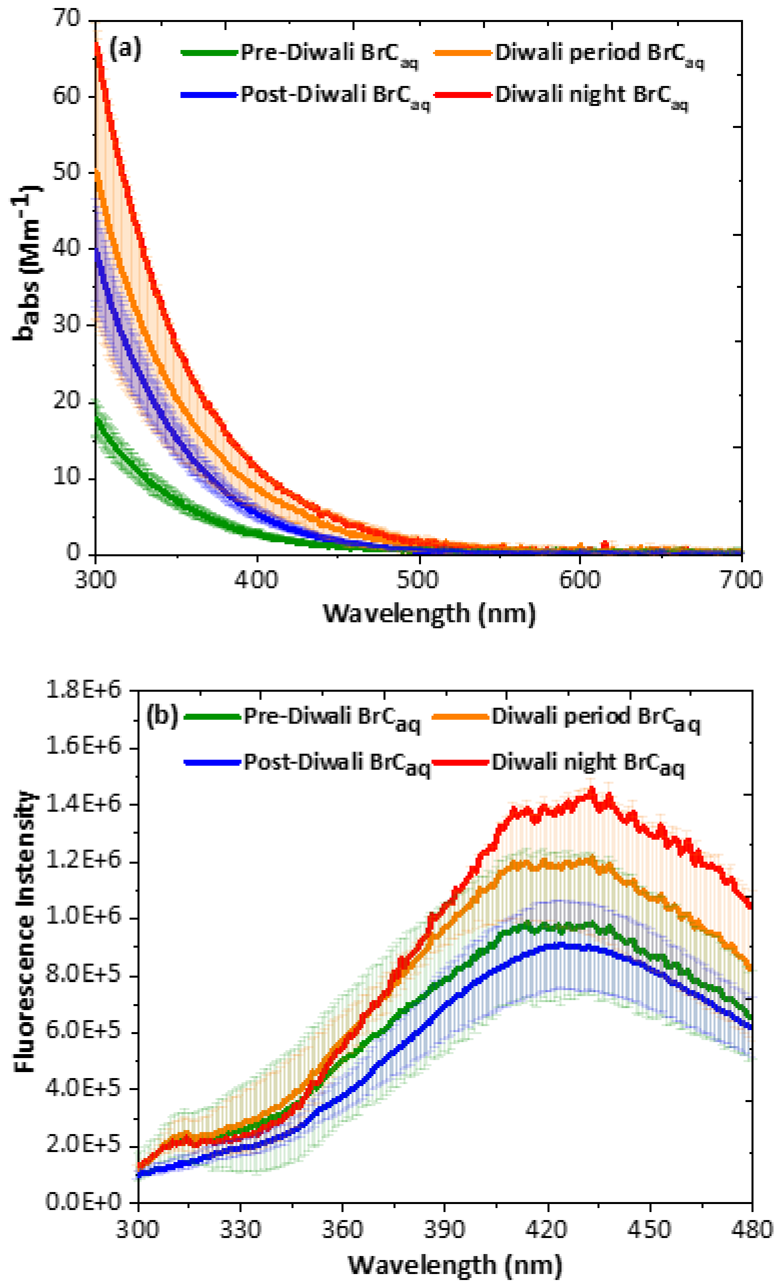

Fig. 2. Characteristics of BrC_{aq} for the pre-Diwali, Diwali and post-Diwali periods, and on Diwali night in terms of UV-Vis absorption coefficients (a), and fluorescence emission ($\lambda_{excitation}$ = 280 nm) (b).

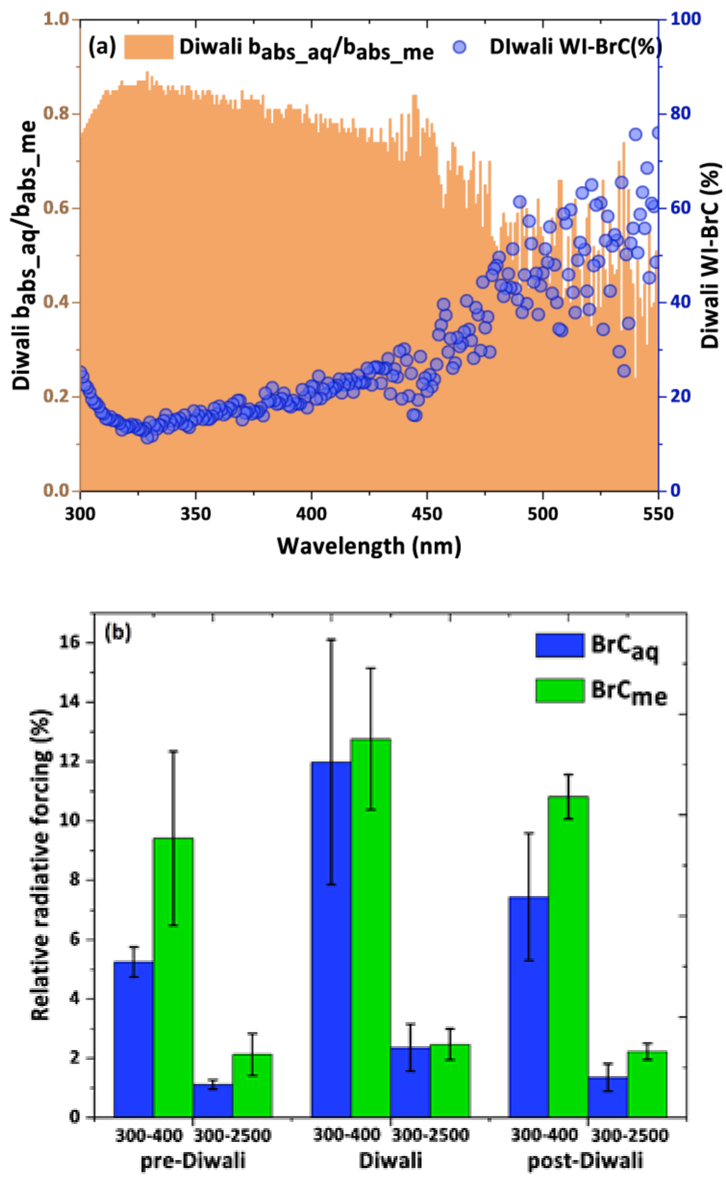

Fig. 3. Wavelength-dependent variation of b_{abs_aq}/b_{abs_me} and water insoluble chromophores for the Diwali period (a) and relative radiative forcing of BrC_{aq} and BrC_{me} for the Diwali period (b). The x-axis in (b) shows wavelength ranges in nm (300-400, and 300-2500).

AEROSOL PHYSICAL-CHEMICAL PROPERTIES AND ITS ASSOCIATION WITH CLOUD CONDENSATION NUCLEI ACTIVATION OVER A TROPICAL COASTAL LOCATION

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Abstract

One of the largest uncertainties in the present understanding of climate change is the inability to accurately represent aerosol-cloud interactions and associated feedback processes. Cloud condensation nuclei (CCN) are the subset of atmospheric aerosols which activate in to cloud droplets under sufficient atmospheric conditions, and accurate estimation of CCN number concentration is essential to incorporate aerosol-cloud interaction in the climate models. Dry particle size, chemical composition (hygroscopicity) and the way in which each chemical species are mixed in the population (mixing state) are the major parameters deciding the CCN activation ability of aerosols. Among these parameters, relative importance of chemical composition and mixing state on CCN activation are still under debate and is one of the widely investigated topics. Recent studies show, organics, which are the dominant component in the sub-micron aerosols, have significant influence on the CCN activation. Due to thousands of internal molecular components and various atmospheric processes acting on them, exact knowledge about hygroscopicity and quantified impact of organics on CCN activation is not yet achieved. The lack of availability of high resolution chemical composition data from organics dominated sites worsens this situation. In this regard, high resolution measurements of aerosol physical-chemical properties were carried out from a tropical coastal location Thumba during winter (2017-20). Being a coastal location, the site experiences contrasting air masses owing to mesoscale land-sea breeze circulation which provides a unique opportunity to study the CCN properties under contrasting conditions. The results revealed larger variability in the aerosol number concentration, chemical composition and CCN activation (0.3-0.6) within a day. Interestingly aerosol number size distributions were nearly similar (change in mode diameter

~9nm). Additionally, Positive matrix factorization (PMF) analysis was applied on the organics data collected with mass spectrometer and found secondary organics as the major component in the bulk organics.The dominance of sulfate and secondary organics during daytime resulted in highly hygroscopic CCN active system; whereas hydrophobic organics severely reduced its activation efficiency during night time. Köhler theory with various mixing state assumptions was used to estimate CCN number concentrations and the results were compared with the measured values (CCN closure studies). It is found that mixing state assumptions have least role in CCN activation compared to the organics hygroscopicity. More results will be presented.

Understanding the variation of particulate matter over Ahmedabad city

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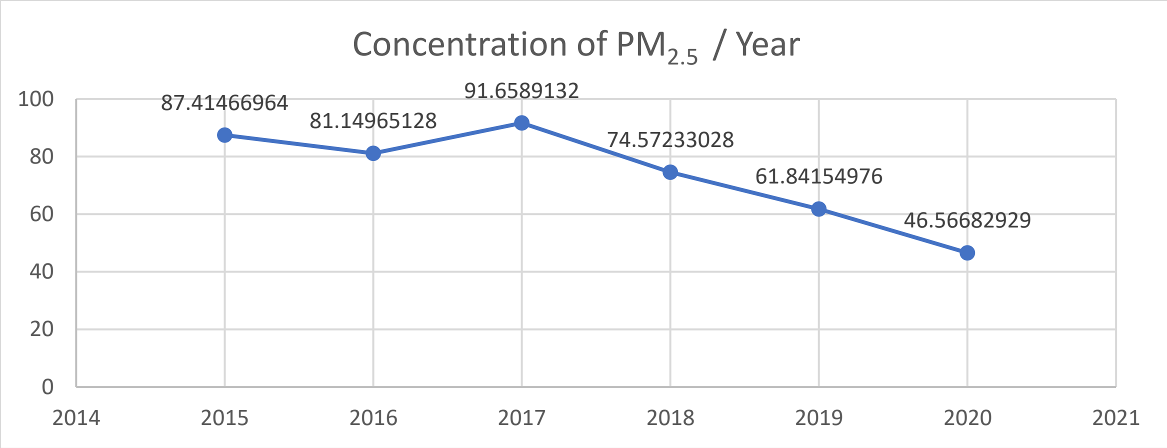
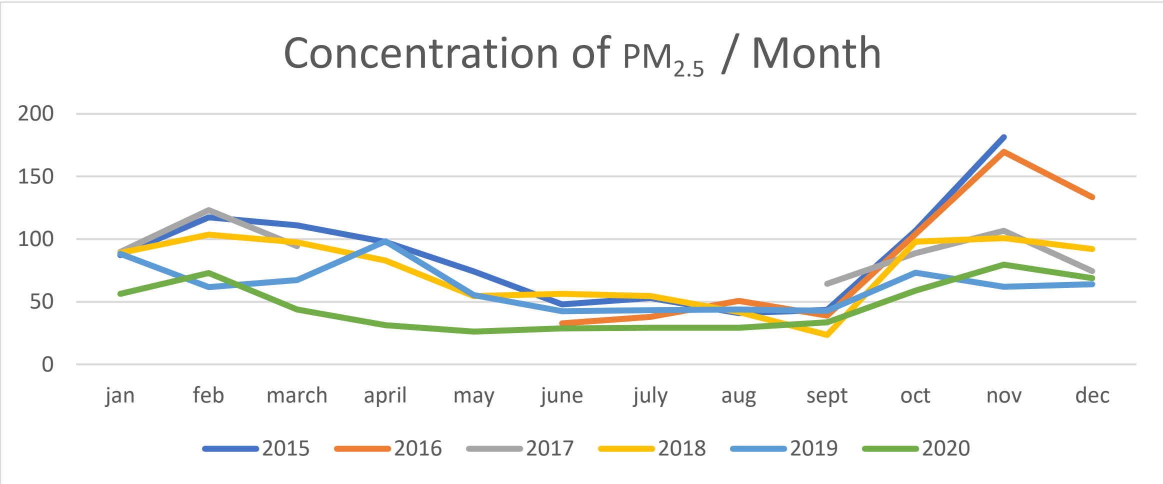
ABSTRACT

Experimental studies around the world have shown the significant of concentration of particulate matter for human health. Fine particulate matter ($PM_{2.5}$, PM_{10} & $PM_{0.1}$) causes a risk to human health due to the efficiency of penetrating deep in to lungs and other cardiovascular effect. The purpose of present study is to observe the concentration of $PM_{2.5}$ in Ahmedabad (urban Industrial region) from 2015 to 2020. Observation indicates variation of $PM_{2.5}$ concentration from 87.41466964 µg/m³ to 46.56682929 µg/m³ for the period of 2015 to 2020. The highest $PM_{2.5}$ concentration was in 2017 which was 91.6589132 µg/m³ and the lowest was in year-2020 due to global pandemic imposed lockdown. Yearly variation was like in the year of 2016 the concentration of $PM_{2.5}$ was decreased as compared to 2015, whereas it increased in the year of 2017, in 2017 the concentration of $PM_{2.5}$ was on its peak, and then it is constantly decreasing from the year 2017 to 2020.

In most of the years the concentration of $PM_{2.5}$ between June to September was at its lowest point due to monsoon. While during post monsoon the concentration of $PM_{2.5}$ was at its peak in November due to Festivals time.





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Impact of PM_{10} and $PM_{2.5}$ on air quality during Diwali festival at Agra

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Diwali is one of the largest festival celebrated, it's a festival of lights and one of the major festivals celebrated by Hindus, Jains, Sikhs and some Buddhists in the month of October - November. During the Diwali festival days pervasive use of fireworks leads to aerosol contribution, composing a significance source of particulate matter in the ambient air. Firing crackers on Diwali increase the concentration of dust and pollutants in the air. After firing, the fine dust particles get settled on the surrounding surfaces which are packed with chemicals like copper, zinc, sodium, lead, magnesium, cadmium and pollutants like oxides of sulphur and nitrogen. These invisible yet harmful particles affect the environment, reduce visibility and in turn, put our health at stake. The present study focuses on the influence of Diwali fireworks emission on particulate matter PM_{10} $PM_{2.5}$. Data was collected from CPCB (https://app.cpcbccr.com/ccr/#/caaqm-dashboard-all/caaqm-landing/datadays). The pollutants were analysed for pre-Diwali, Diwali and post -Diwali in order to reveal the festivals contribution to the ambient air quality over the city and exceeds in their concentration in Agra. The concentration of PM_{10} during Pre-Diwali, Diwali and Post Diwali 238.32, 380.24 and 170.28 $\mu g/m^3$ respectively. The concentration of $PM_{2.5}$ during Pre-Diwali, Diwali and Post Diwali 150.33,180.62 and 110.28 $\mu g/m^{3.}$ More Concentration was observed during Diwali days. The Percentage (%) Change in the concentration of PM_{10} on Pre Diwali and Post Diwali 59.55% and 28.5% respectively. The percentage % Change in the concentration of $PM_{2.5}$ on Pre Diwali and Post Diwali 16.77% and 38.94% respectively. Air Quality Index (AQI) index was very unhealthy on Diwali days comparative to pre-Diwali days due to increase in concentration of particulate matter as outcome of fireworks.

COMPARATIVE STUDY OF $PM_{2.5}$ DIMINUTION AND HAZE EVENTS OVER DELHI AND AGRA DURING THE COVID-19 LOCKDOWN PERIOD

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Agra, a UNESCO World Heritage site and Delhi-NCR, a tropical Indian megacity, experience severe air pollution in the world, linked with diverse anthropogenic and biomass burning emissions. First phase of COVID-19 lockdown in India, implemented during 25 March to 14 April 2020 resulted in a dramatic near-zeroing of various activities (e.g. traffic, industries, constructions), except the "essential services". In this study, variations in the fine particulate matter ($PM_{2.5}$) over the Agra-Delhi-NCR region were studied. Results concludes that 27% increase in $PM_{2.5}$ and a 65% increase in PM_{10} compared to the first two weeks of the lockdown (25 March to 6 April) was observed in the second week of April (7 April to 15 April). However, $PM_{2.5}$ levels were still lower by 39% than pre-lockdown concentrations in Dehli-NCR region. This may primarily be attributed to change in meteorological conditions. Measurements revealed large reductions in $PM_{2.5}$ during the first week of lockdown (25–31 March 2020) as compared to the pre-lockdown conditions in Agra. However, O_3 pollution remained high during the lockdown due to non-linear chemistry and dynamics under low aerosol loading. Due to the onset of summers, temperature has started to increase with a minimum and maximum temperature of 12.6 ºC and 27 ºC on 16th March 2020 to 24 ºC and 40ºC on 15th April 2020, leading to dry and dusty conditions. Notably, it was reported that a mild dust storm from western part of the country and the gulf regions hit Delhi on 14- 15th April, thus rapidly increasing the PM levels in Agra-Delhi-NCR region. The study highlights a highly complex chemistry between the baseline pollution and meteorology leading to enhancements in pollution, besides an overall improvement in air quality during the COVID-19 lockdown in this part of the world.

Keywords: Covid-19, meteorology, $PM_{2.5}$, Agra-Delhi-NCR region

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FINDING AND ANALYZING THE SOURCE FOR THE PRODUCTION OF CARBON MONOXIDE OVER INDIA USING SATELLITE DATA.

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ABSTRACT

Nowadays, dealing with global warming and climate variability is one of the utmost challenges. This paper investigates one of the trace gases, i.e., carbon monoxide and presents a source contribution for the concentration of carbon monoxide and identify the hotspot area on India over the year 2019 and 2020. The work has undergone using the TROPOMI instrument, on-board Sentinel-5 Precursor. It is observed that Orrisa, West Bengal, and Jharkhand are considered to be the hotspot area with concentrations (≥50000) µmol/m^2. The key contribution to carbon monoxide concentration is anthropogenic activities and biomass burning in India. Besides, CO over the Bay of Bengal was much higher compared to the Arabian Sea. The above situation explains the fact that proximity of land directly affects CO levels. All in all, other factors like Industrial activities, Vehicles emission also contribute to the concentration (≥40000) µmol/m^2 of carbon monoxide in the zone like Bihar, Delhi, Indo-Gangetic Plain, etc., are deliberated in this paper.

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Impact of Covid-19 pandemic on the variation of Black carbon over an urban city Delhi

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ABSTRACT

This work is aimed to the study the impact of Covid-19 lockdown on Black carbon concentrations in the atmosphere of an urban city Delhi. For this purpose, we have acquired the data from three continuous monitoring stations in Delhi operated by The Centre of Pollution Control Board for the years 2019, 2020, 2021. The concentration of black carbon levels is plotted against the respective months of the three years and against the period of phases of lockdown. For the year 2020, it is observed that the pre lockdown black carbon levels were in the range 2.9 to 5.5 µg/m^3, after which with the onset of lockdown the values fell sharply by 70% to 80% and were in the range 0.2 to 1.0 µg/m^3 for the first four lockdown phases. The values started increasing gradually from June or Phase Unlock 1. Black carbon levels rose to at least 50% of its pre lockdown value and the range was 0.3 to 2.2 µg/m^3 by August or Phase Unlock 3. Overall it

was observed that the black carbon aerosol levels decreased substantially with lockdown restrictions, and this decrease can be attributed to the decrease in anthropogenic activities which are major contributors to the black carbon concentration such as industrial and vehicular emissions. The gradual increase after June is in correlation with the increase in anthropogenic activities as the restrictions were gradually lifted.

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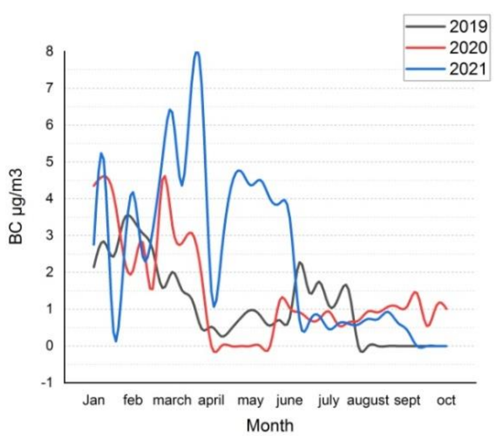

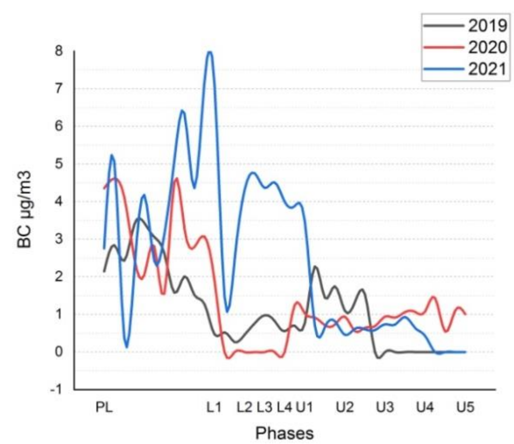

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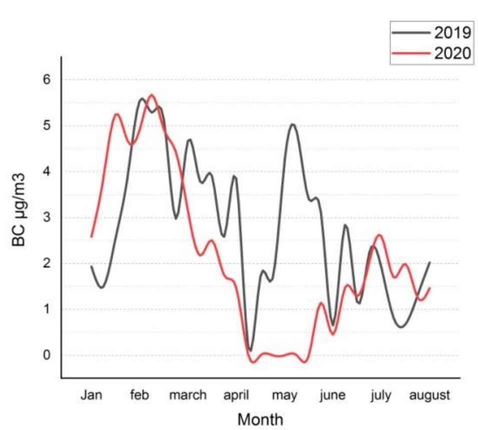

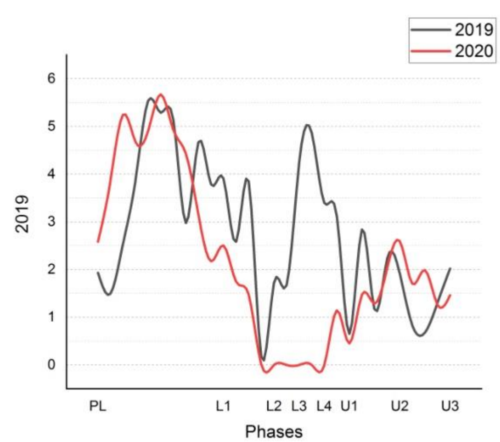

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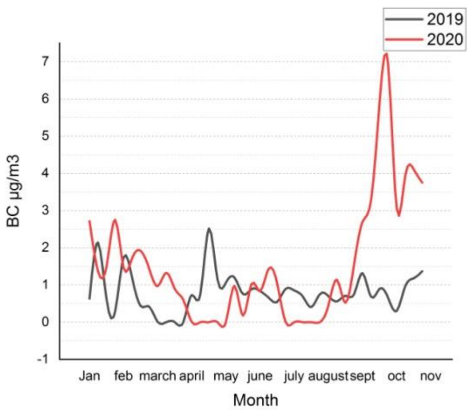

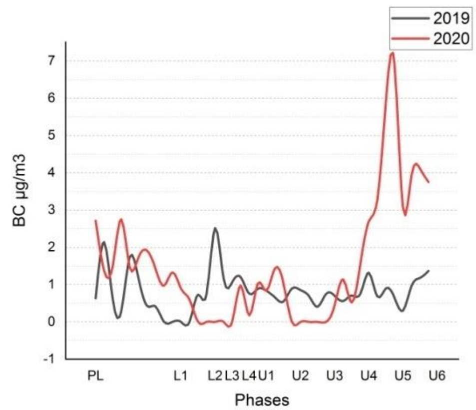

Keywords: Black Carbon (BC), Covid-19 lockdown

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A three-year record of chemical composition and $^{87}Sr/^{86}Sr$ in rainwater over Bhopal, the second cleanest city of India

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Rainwater chemistry is a useful indicator for determining the regional air quality [1, 2]. In the present study, chemical and Sr isotope compositions of monsoonal rainwater (133 individual showers) collected outskirts of Bhopal, Central India in three successive years (2016–2018) have been measured to quantify various solute contributions. The pH of rainwater covers a range of ~3.8–8.01 with an average value of 6.11, indicating the alkaline nature. The Ca and NH_4 are major species neutralizing the rainwater acidity. Considering Cl as a marine index, non-marine proportions of K, Ca, Mg, SO_4, and Sr are found significant in the rainwater. The scatter plots of (a) Ca/Na versus Mg/Na and (b) Ca/Sr versus $^{87}Sr/^{86}Sr$ reveal that atmospheric dust from the Deccan Basalt lithology is the major contributor of base cations to the regional rainwater. This inference is also supported by the 5-days air parcel back trajectories showing the predominance of westerly monsoonal winds from the Arabian Sea.

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THE IMPACT OF LOCKDOWN ON AIR POLLUTION LEVELS AND CHANGE IN AIR QUALITY AT SUB-URBAN SITE DAYALBAGH, AGRA

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The nationwide lockdown in India announced from March 25-May 31, 2020 in different phases to prevent the rapid spread of pandemic COVID-19 has resulted in the reduction of anthropogenic emission sources (vehicular and industries mainly) to a great extent. Present study reports change in air quality during the lockdown period at Dayalbagh, Agra, a semi-urban site in Northern India. Present study reports change in air quality during the lockdown period at Dayalbagh, Agra, a semi-urban site in Northern India. The data showed a remarkable reduction in the mean pollutant levels influenced by traffic emissions like Nitric oxide (NO) reduced by 54.1%, Nitrogen Dioxide ($NO_{2)}$ by 86.7% - (64.6% (NO_x) and $PM_{2.5}$ by 28.7% during lockdown over same period in the previous year. Comparatively, a lower reduction of Carbon monoxide (CO) 8.6% may be attributed to the dominance of natural atmospheric chemical regulation, biogenic sources in addition to anthropogenic contributions and long-life span. An enhancement of secondary pollutant - Ozone (O_3) 5.1% was observed during lockdown over same period in the previous year (2019). O_3 showed same diurnal pattern during lockdown phase as in other phases, while the bi-modal peaks of NO, NO_2 (NOx), $PM_{2.5}$ were supressed due to less vehicular emission and other anthropogenic activities, however CO showed prominent bi-modal peaks during lockdown. The concentration of NO, NO_2, NOx, $PM_{2.5}$ and CO reduced by 38.0%, 71.9%, 48.6%, 40.2% and 34.83% respectively during lockdown period in comparison to pre-lockdown period (2020), in contrast O_3 concentration increased by 24.5%; while, concentrations of NO, NO_2, NOx, $PM_{2.5}$ and CO increased by 44.4%, 79.7%, 72.02%, 34.6% and 3.5% respectively as the country unlocked in comparison to lockdown period, while O_3 concentration decreased by 16.2%. Air Quality Index (AQI) was very unhealthy during the pre-lockdown periods but during the lockdown periods almost all anthropogenic sources were reduced so AQI so may be said to be better than pre-lockdown periods but still unhealthy for sensitive groups during the lockdown period.

Variation of Nitrogen Dioxide (NO_2) over metropolitan areas of India

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ABSTRACT

The continuous monitoring of pollutants like Nitrogen Dioxide (NO_2) is a mandatory step towards the understanding of the air quality of the region and public health. In this study, we analyzed the variation of Nitrogen Dioxide (NO_2) over all the metropolitan areas of India which are given in table-1. We have done our analysis over the years 2019 and 2020. For this study, we used data derived from ESA's Sentinel-5P satellite. To understand the seasonal variation of NO_2 concentrations over the years 2019 and 2020, The mean of daily data is carried out for monthly mean NO_2 concentration to understand the seasonal variation. This COVID-19 pandemic in the year 2020 led us to a lockdown period. To quantify the effect of lockdown the same process is done over the lockdown period (LP) and compared with the Before and After lockdown period. In Table-2, the average seasonal value of NO_2 concentrations is given for the years 2019 and 2020. We can see the effect of lockdown brought by the COVID-19 pandemic in results. On an average overall region, NO_2 concentration reduced about -20.14% due to lockdown. After the lockdown, with resuming of daily life the concentrations were raised to 17.25% overall regions as assumed. The average fall in seasonal trend over all areas was about -7.57% in 2020 as compared to 2019 over all areas. This fall in seasonal trend can be explained by the lockdown effect of the COVID-19 pandemic.

Ahmedabad	Kolkata	Hyderabad	Kochi	Madurai	Bangalore	Chennai
Coimbatore	Delhi	Jaipur	Jodhpur	Kanpur	Kozhikode	Mumbai
Nagpur	Patna	Pune	Salem	Surat	Thiruvananthapuram	Vishakhapatnam

Table-1: List of metropolitan areas of India

Seasonal value of NO_2 concentration (mol/m^2)								
Metropolitan area	**2019**				**2020**			
	Seasons							
	Win	Sum	Pre mon	Post mon	Win	Sum	Pre mon	Post mon
Ahmedabad	138.38	134.79	102.42	106.33	137.35	98.45	88.44	111.01
Kolkata	130.23	114.50	100.31	94.36	125.97	99.70	90.52	88.56
Hyderabad	86.35	111.20	82.75	66.71	81.39	84.63	69.81	74.16
Kochi	71.80	67.79	53.28	52.90	68.16	58.85	51.69	51.60
Madurai	53.99	74.14	65.33	54.53	52.33	61.44	60.30	60.25
Bangalore	89.65	117.54	65.68	63.49	83.76	77.82	58.77	62.57
Chennai	82.29	85.08	88.03	76.48	77.35	65.72	70.24	81.79
Coimbatore	61.62	80.96	59.46	53.57	60.22	63.76	55.50	54.82
Delhi	178.87	137.77	126.33	117.69	148.86	105.30	105.95	114.39
Jaipur	100.38	101.11	88.78	84.24	96.87	83.80	82.28	85.44
Jodhpur	81.70	87.56	79.36	77.72	87.55	71.94	76.65	77.09
Kanpur	101.56	100.85	93.21	83.08	93.27	86.38	84.43	86.58
Kozhikode	55.89	60.342	50.62	45.91	54.77	51.74	47.31	47.34
Mumbai	175.76	129.77	82.39	93.16	158.51	93.22	71.43	100.11
Nagpur	138.09	148.9	92.89	92.43	127.27	96.82	76.93	121.98
Patna	95.42	105.19	99.96	86.89	93.52	87.68	85.32	87.47
Pune	104.71	120.51	71.80	67.11	98.17	84.89	60.43	72.32
Salem	56.90	81.34	66.72	52.18	55.54	67.20	62.77	58.47
Surat	117.85	116.96	79.73	80.10	118.07	94.56	70.47	92.64
Thiruvananthapuram	51.04	56.22	47.29	44.85	50.09	48.76	45.46	45.53
Vishakhapatnam	79.92	96.84	89.56	73.51	81.14	84.83	74.12	74.36

Table-2: Metropolitan area wise seasonal value of NO_2 concentration for year 2019 and 2020

Keywords: Nitrogen Dioxide (NO_2), Seasonal trend, Sentinel-5P, COVID-19 lockdown

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Mixing ratios and stable isotopes in CO_2 and N_2O in a coastal station of a western pacific island: quantification of influences from regional and long range transported sources

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Abstract

Stable isotope ratios are widely used to understand the sources of greenhouse gases such as CO_2 , CH_4 and N_2O. Here we analysed stable isotope ratios of CO_2 and N_2O ($\delta^{15}N$ and $\delta^{18}O$ of N_2O and $\delta^{13}C$ of CO_2) collected at Fugue Cape, a coastal station located at the northern tip of Taiwan during 2018 -2020 to understand the sources of greenhouse gases in the region. Using Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model, we identified the sources of high and low CO_2 and N_2O in the study region. It is observed that the higher CO_2 concentration and relatively lower $\delta^{13}C$ values are associated with the wind coming from the eastern industrial belt of China while the air mass originated from the oceanic region has lower CO_2 concentration and higher $\delta^{13}C$ values. The wind reaching to the study region from the South Pacific Ocean the variation in the concentration and $\delta^{15}N$ value of N_2O is caused by oceanic upwelling. Again as the wind from the Trajectory is seen coming from the Eastern Chinese industrial belt, it can be inferred that the variation in $\delta^{15}N$ of N_2O or $\delta^{13}C$ of CO_2 was caused by the anthropogenic emissions from the belts. The data is taken for a time span of two year (2018 to 2020) and the inference was drawn denoting the variation in the stable isotopes

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Impact of the COVID-19 Lockdown on Air Pollution Levels in Jalandhar, Punjab

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Abstract

This disease, which was determined to be a new type of corona virus, began to break out in Wuhan, China in December 2019, and was later called COVID-19. The virus has been spreading all over the world. Subsequently, the World Health Organization (WHO) declared it an epidemic. In order to reduce the impact of this virus, almost all countries in the world have closed their countries and implemented blockades. The closure of the city has had a significant impact on the degree of environmental pollution, and since there was no human activity in a short period of time, the quality of air and water has also been improved. The current research scientifically analyses the available data of Jalandhar major air pollutants, such as $PM_{2.5}$, N_O, NO_2, O_3 and SO_2. The analysis is based on air quality data before lock-in (February 25th to March 24th, 2020) and the lock-in month (March 25th to April 24th, 2020). Through this study, it was found that the air pollution in Jalandhar during the month of closure has been greatly improved.