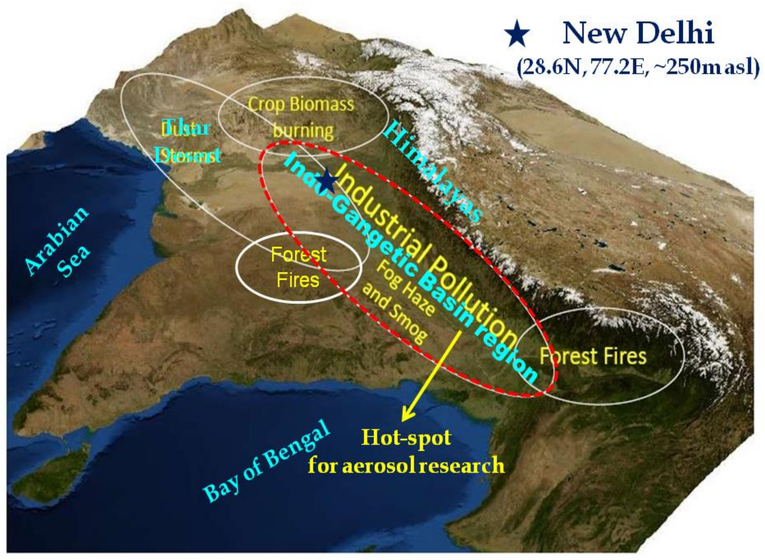
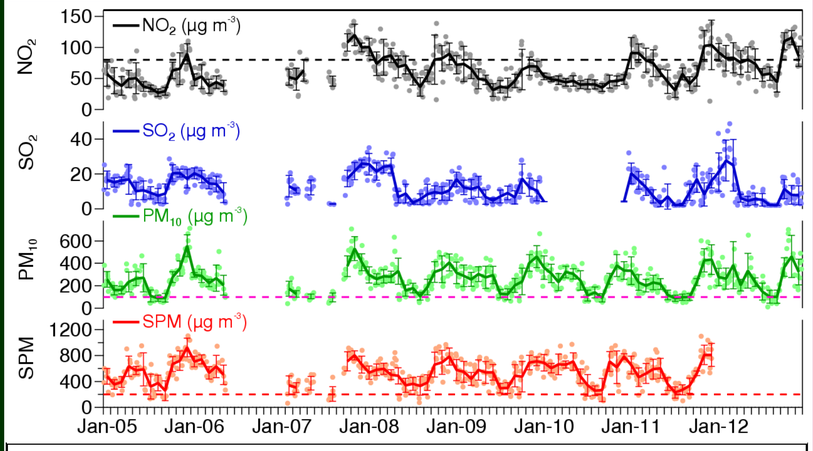
Physics and Dynamics of Tropical Clouds (PDTC) Program
Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX)
Characterization of Aerosols over Indo-Gangetic Basin: Key Findings and Future Plans

Background & Motivations



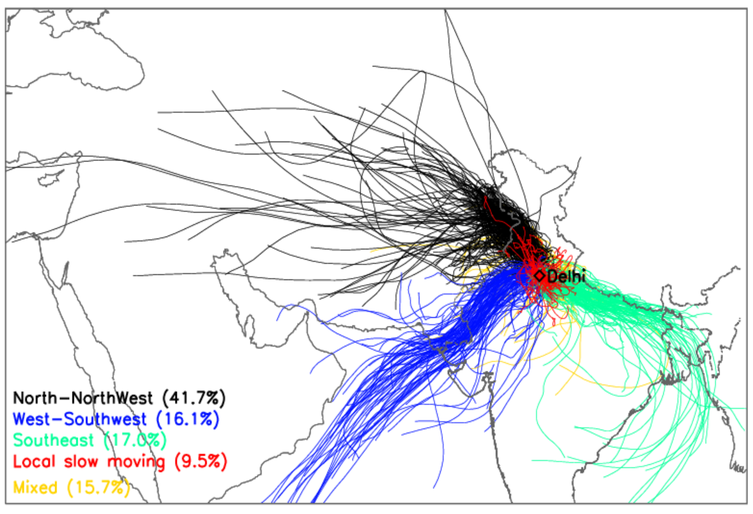
- The Indo-Gangetic Basin (IGB), located in the northern part of India, is one of the densely populated and industrialized regions where air pollutants not only affect the air quality but also on our environmental system and human health.
- Many Indian cities, especially those over the IGB, are amongst the most polluted cities in the world.
- New Delhi, an urban megacity situated at the north-west IGB in northern India, suffers from the intense pressure of urbanization and industrialization.
- These potential factors have caused sequential degradation of ambient air quality over the region, which may lead to urban and regional haze and pose potential health hazards.

Long-term measurements of near-surface air pollutants at an urban location in the IGB [Kishore et al., 2019]



Time series of mass concentrations of NO_2, SO_2, PM_{10} and SPM at Delhi during 2005-2012.

Despite the efforts of using clean fuels, and shutdown the hazardous industries, the annual levels of NO_2, PM_{10}, and SPM were persisted at their alarming levels (62±28, 254±134 and 530±213 μgm^{-3}, respectively) during the study period, with significant seasonal variability with higher concentrations (~62%) in post-monsoon season.

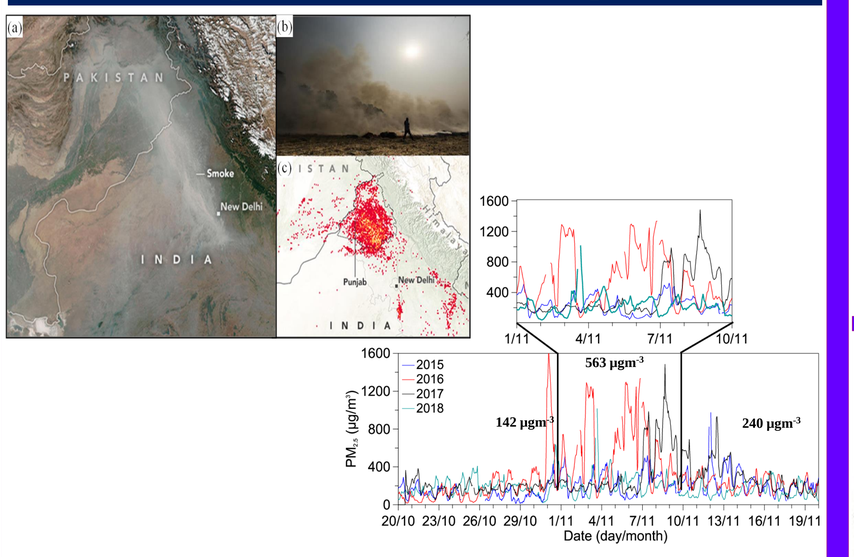


Air mass back-trajectory cluster analyses on the day of corresponding measurements of air pollution.

Association of identified trajectory cluster with air pollutants

	Trajectory occurrence (%)	NO_2 (μg m^{-3})	SO_2 (μg m^{-3})	PM_{10} (μg m^{-3})	SPM (μg m^{-3})
N-NW	41.7	71.9±29.6	15.4±8.6	314.2±122	608.8±190.2
W-SW	16.1	25.1±27.5	3.6±5.5	102.4±130.8	209.2±257.3
SE	17.0	23.3±26.6	2.9±5.1	69.1±92.6	141.4±200.1
LSM	9.5	56.9±40.8	9.8±8.1	241.8±188.8	438.2±336.1
M	15.7	50.5±31.2	10.7±8.8	198.2±128.5	408.0±268.2

What caused severe air pollution episode of November 2016 in New Delhi? [Kanawade et al., 2020]

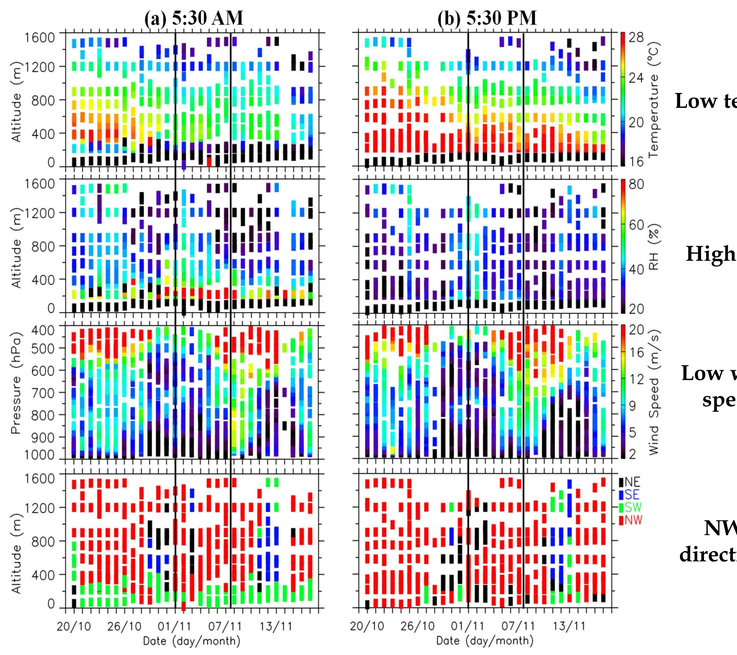


The abrupt and strong enhancement in aerosols indicates a significant contribution from the agricultural burning, which is more severe in 2016 as it prolonged for more than a week with favourable weather conditions, and termed as severe air pollution episode (SAPE) when the mean $PM_{2.5}$ concentration was ~4 times higher than the pre-SAPE.

Radiative implications

	Before SAPE	During SAPE	After SAPE
ARF_{SUR} (W/m^2)	-63.9±21.5	-130.2±28.5	-98.1±19.2
ARF_{ATM} (W/m^2)	47.2±18.3	107.5±24.5	79.1±16.9
HR (K/day)	1.3±0.5	3.1±0.7	2.2±0.5

Meteorology based on the model reanalysis and radiosonde observations



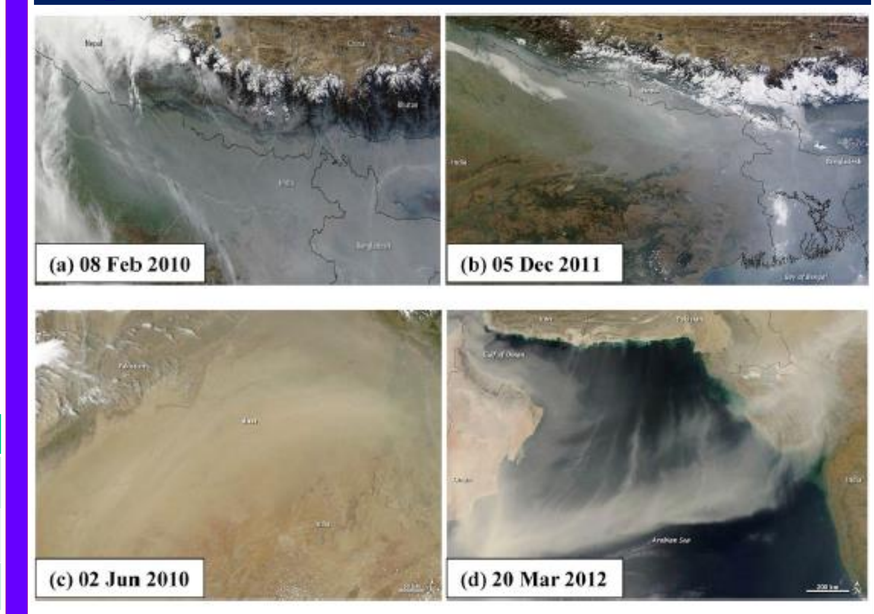
Stable atmosphere led to air stagnant, resulting into the accumulation of local as well as transported pollutants near to the surface during SAPE period and enhances atmospheric warming.

Air quality in megacity Delhi affected by countryside biomass burning [Bikkina et al., 2019]

Year-around and seasonal variability in the probable sources of BC aerosols at Delhi.

- ❖ High fraction biomass contribution to BC ($f_{bio\text{-}BC}$) was observed during autumn and winter (~30-57%) as compared to those in spring and summer (14-28%).
- ❖ The lower BC concentration in spring/summer are predominantly from fossil fuel sources (~83%); however, large-scale open biomass burning in nearby rural regions is contributing to sever haze pollution in Delhi during winter and autumn (~42%).
- ❖ The countryside biomass emission is found to have a key driver for seasonal variability in BC over Delhi.

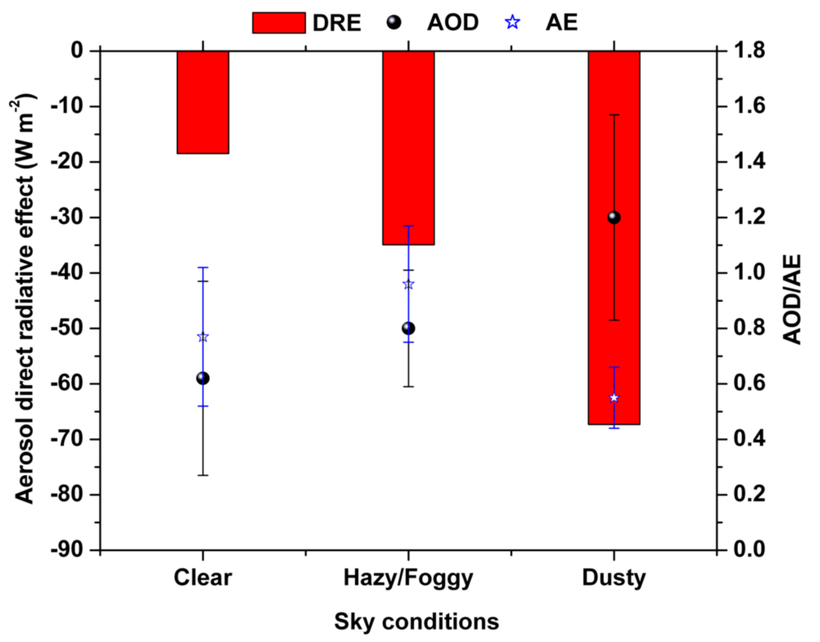
Solar radiation and its association with aerosol characteristics at an urban station over IGB: Implication to radiative effect [Kumar et al., 2019]



Solar radiation (SR) and aerosol optical parameters during clear, haze/foggy and dusty sky condition during 2010-12

	SR (W m^{-2})	AOD_{550}	AE
Clear	400±70	0.62±0.35	0.77±0.25
Haze/Foggy	227±44	0.80±0.21	0.96±0.21
Dusty	380±72	1.20±0.47	0.55±0.11

Implication to Direct Radiative Effect (DRE)



- ❖ The DRE at the surface was about -19 Wm^{-2} during clear sky day, which was ~16 and 48 Wm^{-2} higher than that of haze/foggy and dusty days, respectively.
- ❖ The observed higher surface cooling during dusty day is largely associated with the observed relative increase in AOD and decrease in AE values.

Future Plans

- ➢ Quantification of species wise optical and radiative characterization of aerosols over IGB.
- ➢ Climatological impact assessment of aerosols from dust and agricultural biomass burning over the IGB.
- ➢ Aerosol and rain drop characterizations and its possible association with each other over the northern part of India.

Publications

- ➢ Total publications : 15
- ➢ Total Impact Factor : 41.483
- ➢ Book Chapter : 01