



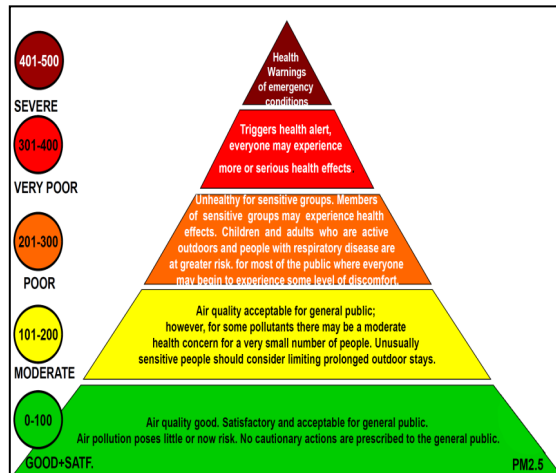
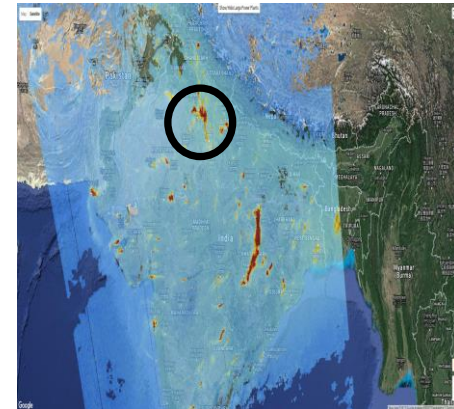
Ministry of Earth Sciences
Government of India

Integrated Air Quality Forecasting and Decision Support System for Delhi

Indian Institute of Tropical Meteorology,
Ministry of Earth Sciences, India

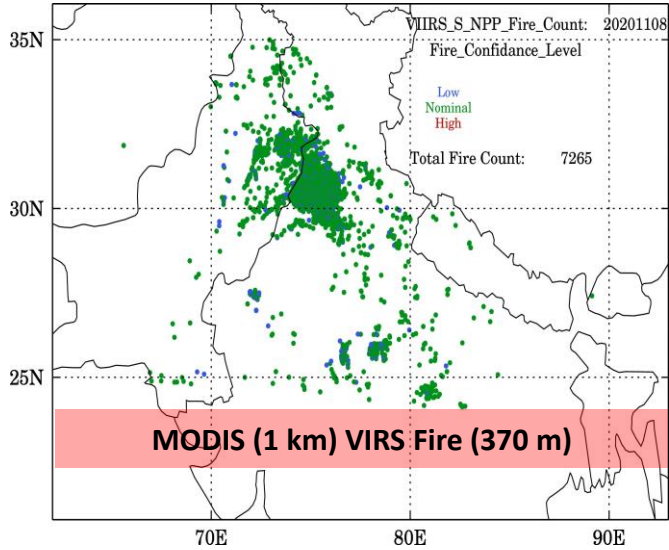
Sachin D Ghude (IITM Pune, India) and Rajesh
Kumar (NCAR, USA)

Gaurav Govardhan (IITM), Chinmay Jena (IMD),
and Dr. V.K.Soni (IMD)

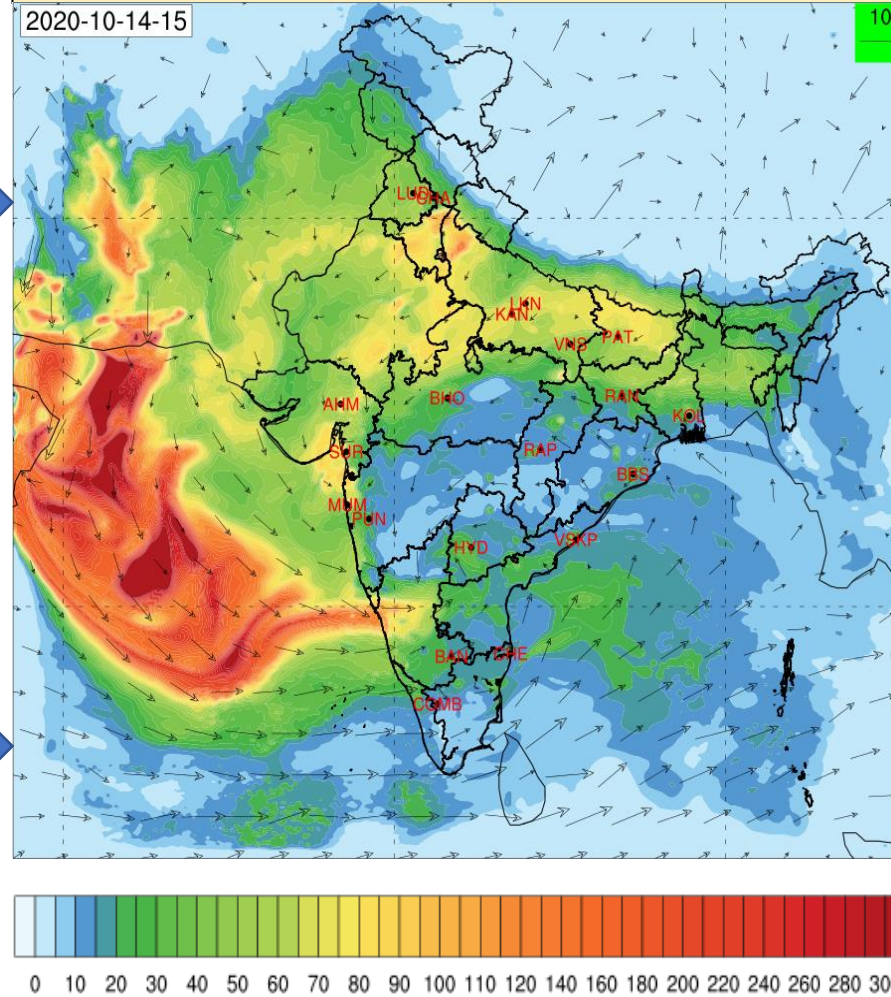


Operational Air Quality Early Warning System (AQEWS) – V2.0

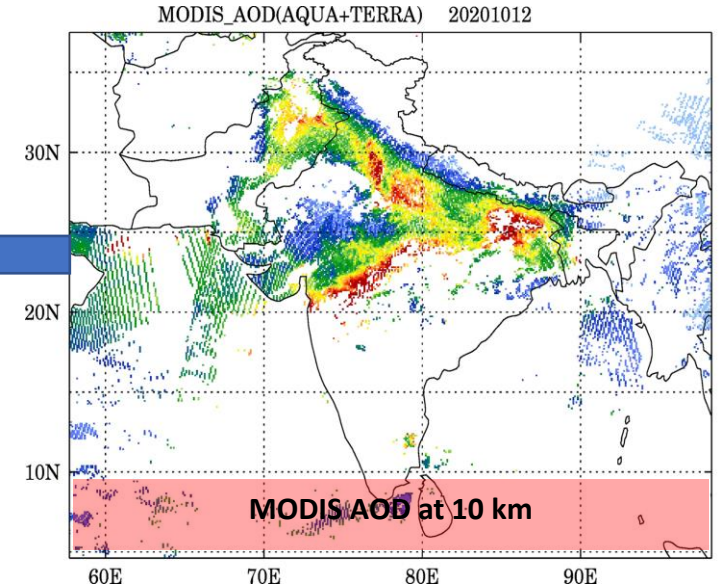
NRT Fire Assimilation



Regional PM_{2.5} forecast at 10 km (WRF-Chem, EDGAR+Delhi_EI)

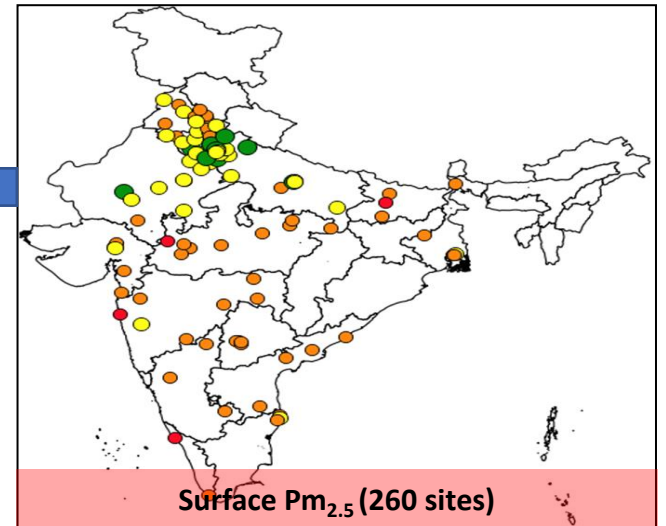


3D-var GSI Data Assimilation



Driving Meteorology:
Ensemble-Kalman filtering
at 12.5 km grid resolution

IITM-IMD GFS, T1534



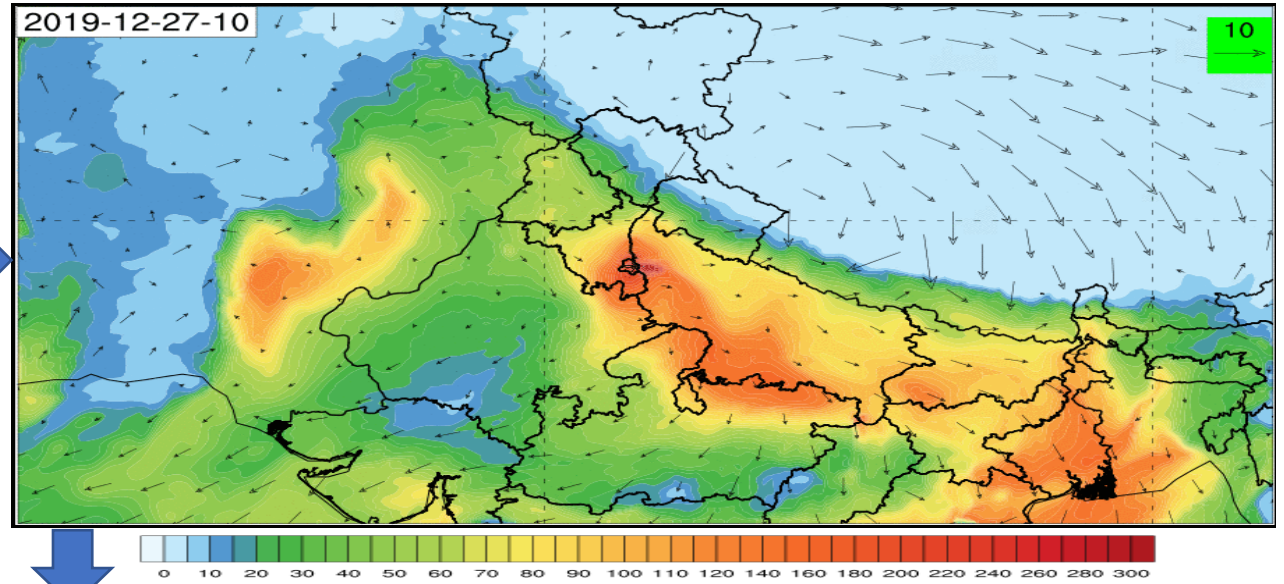
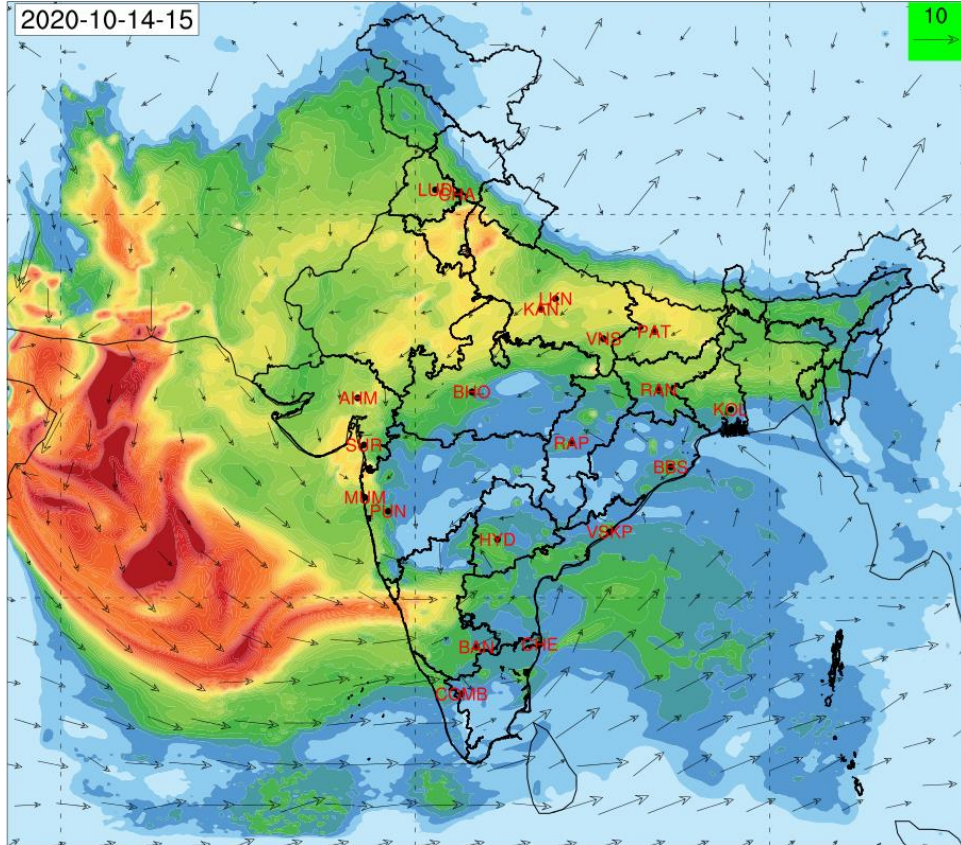
MOZART-GOCART



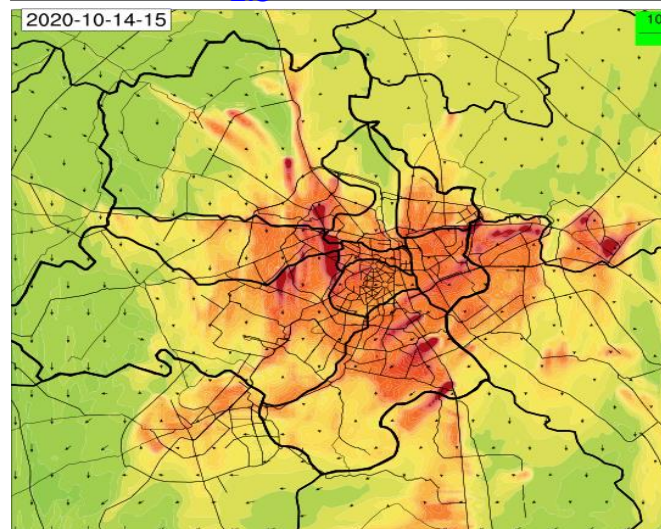
Operational Air Quality Early Warning System (AQEWS) – V2.0

Dynamical Downscaling

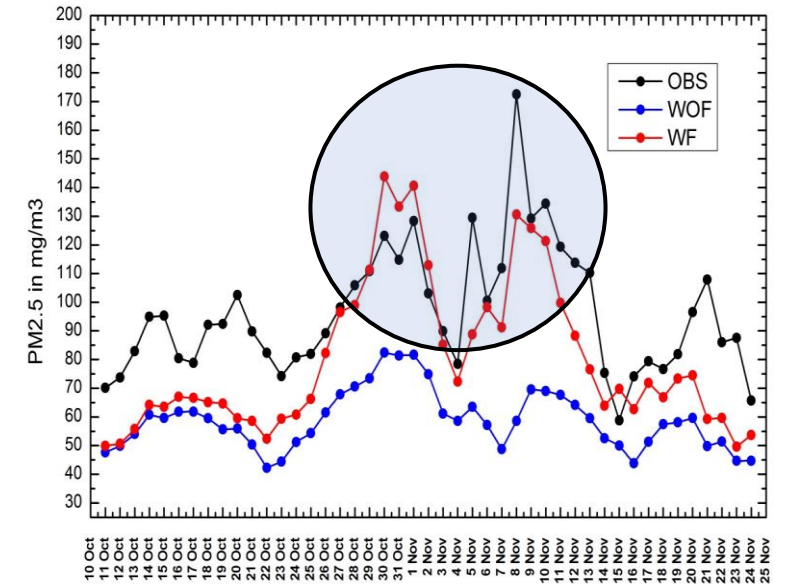
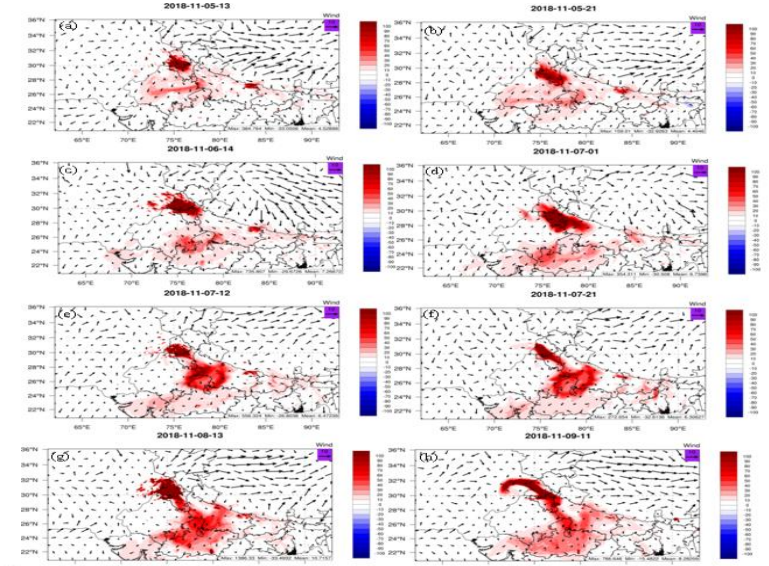
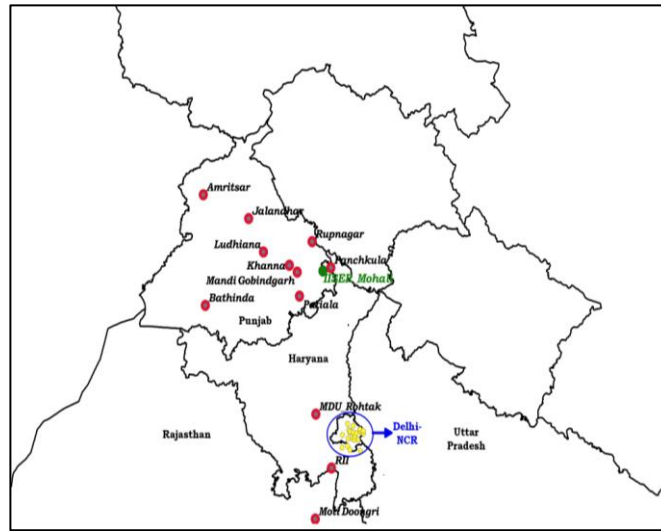
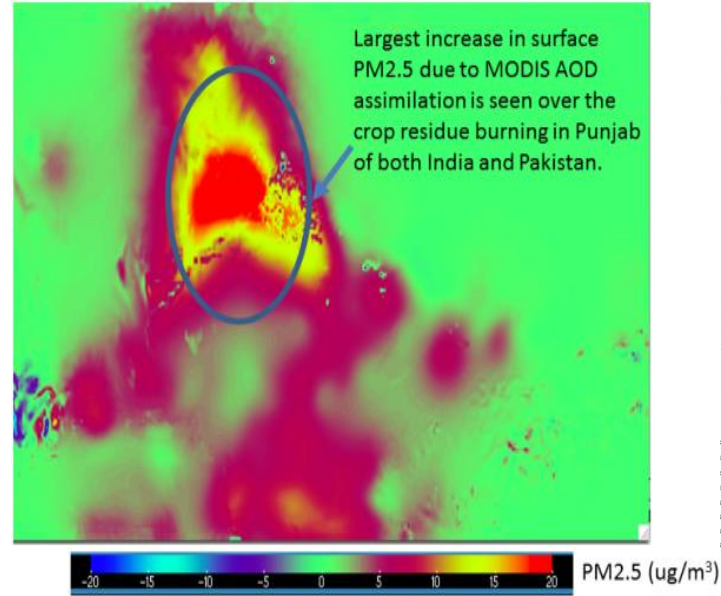
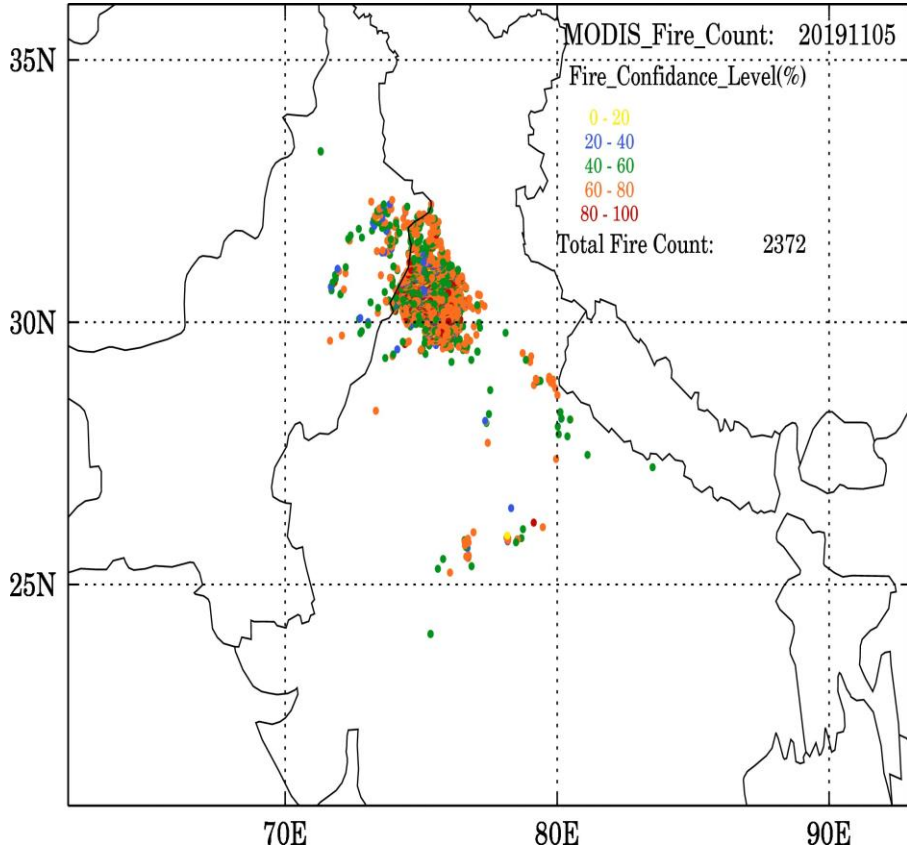
Regional PM_{2.5} forecast at 10 km



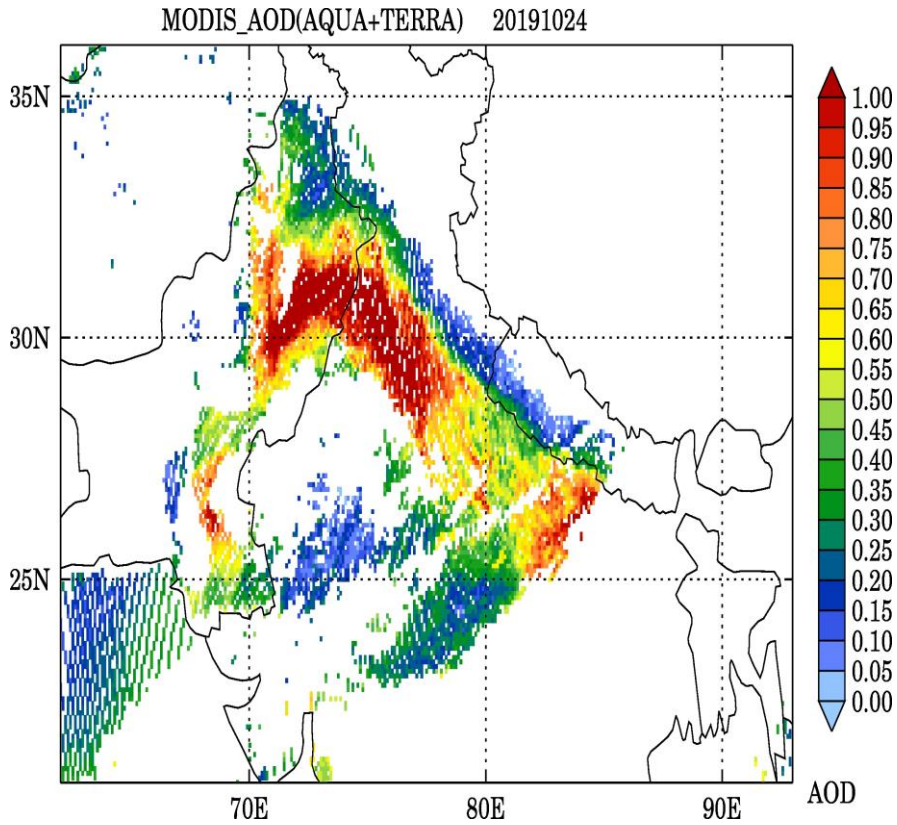
Delhi PM_{2.5} forecast at 400 m



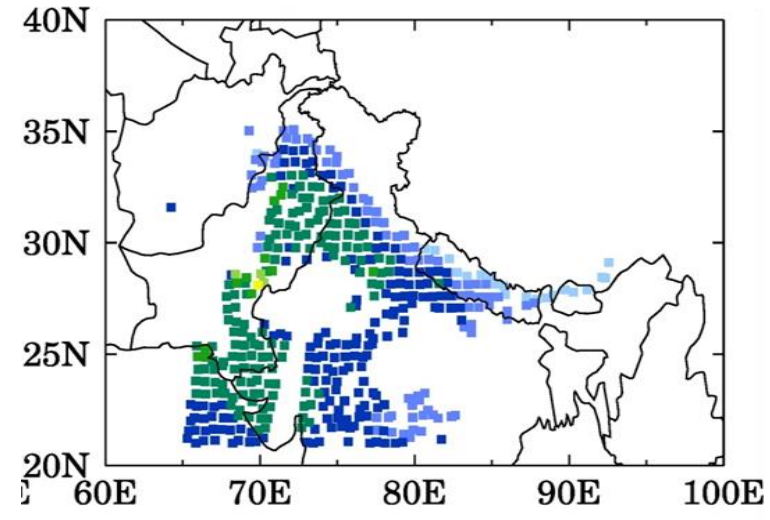
Improvement in PM_{2.5} Predication after inclusion of satellite data on crop-fire



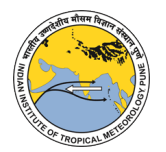
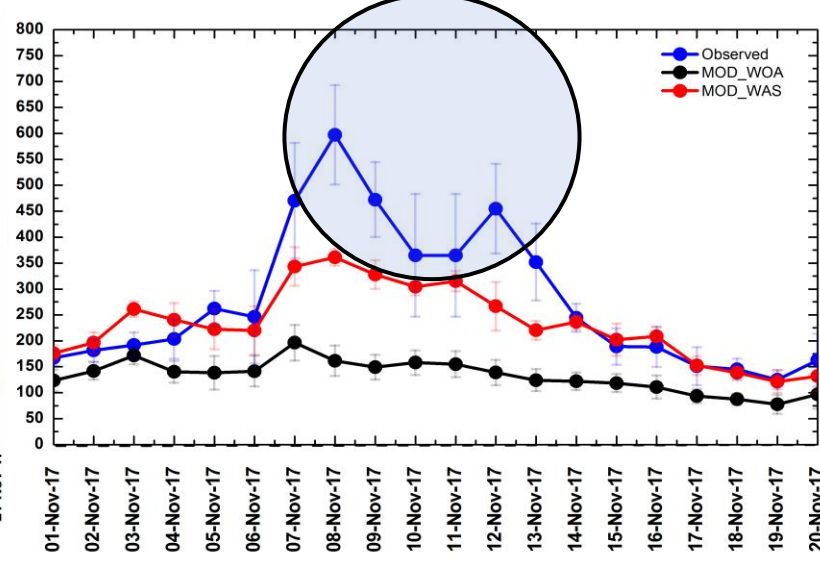
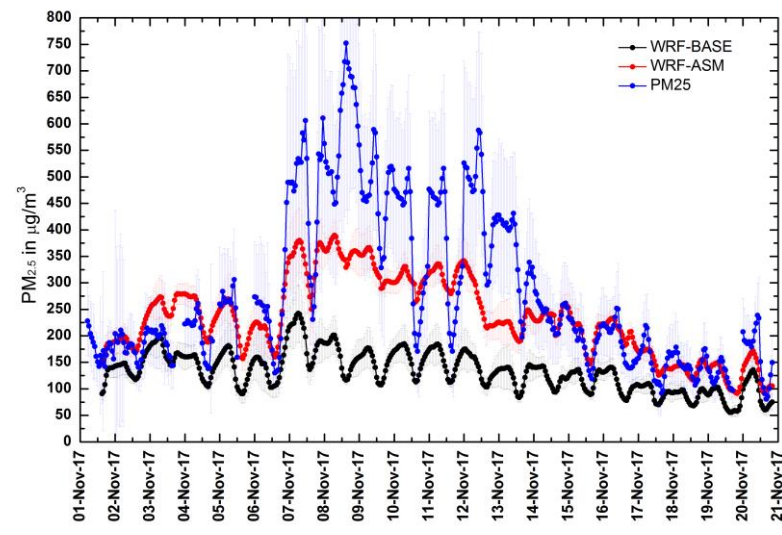
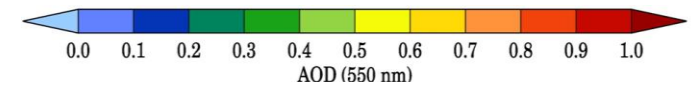
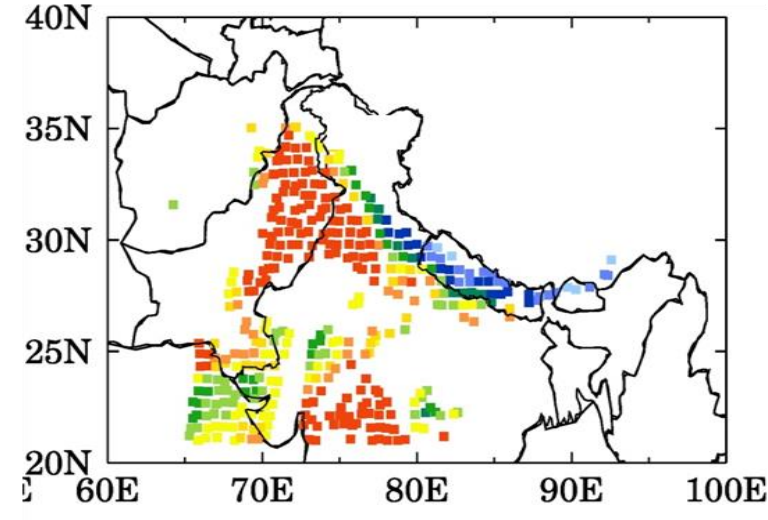
Improvement in PM_{2.5} Predication after inclusion of MODIS AOD



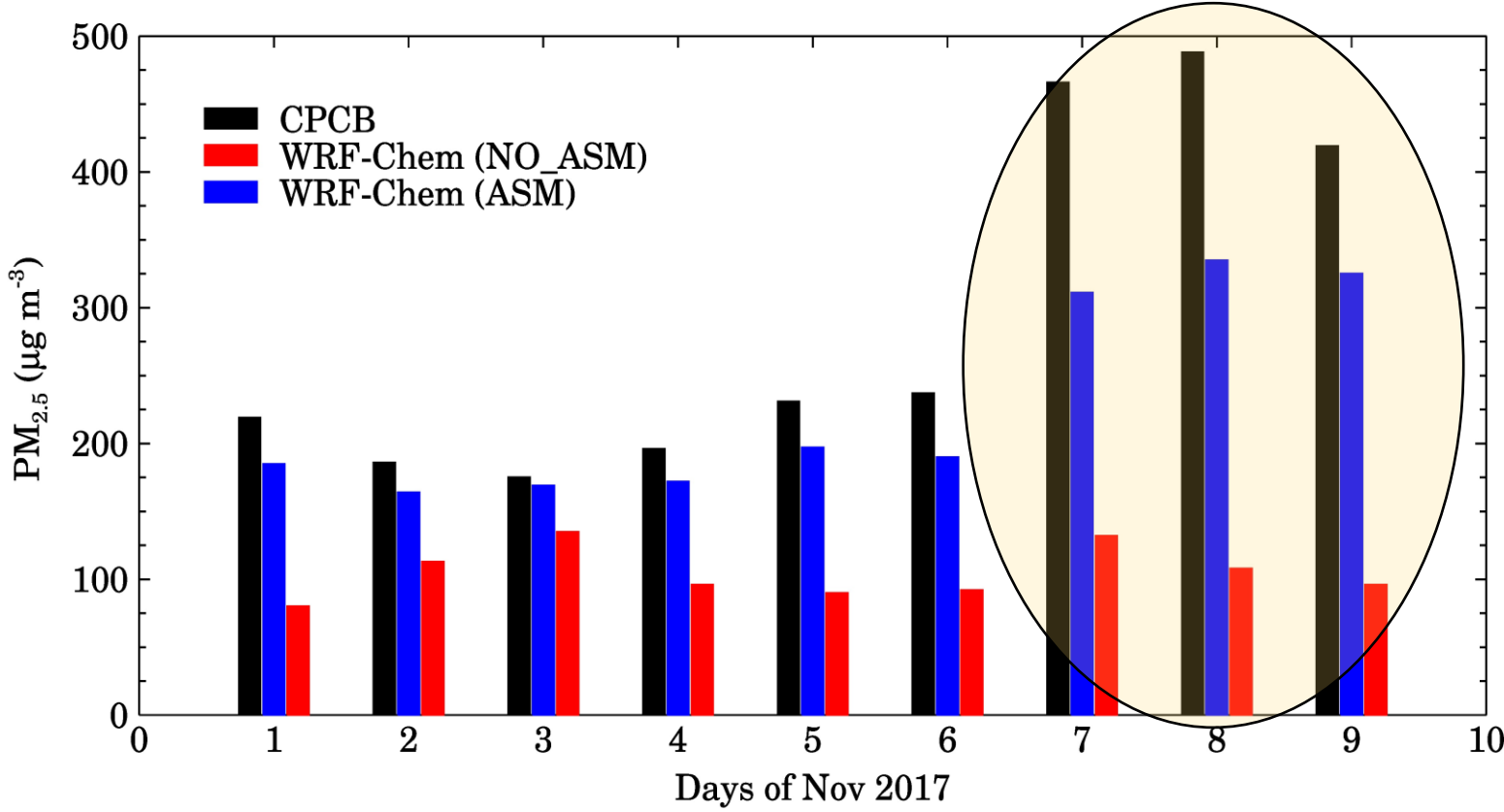
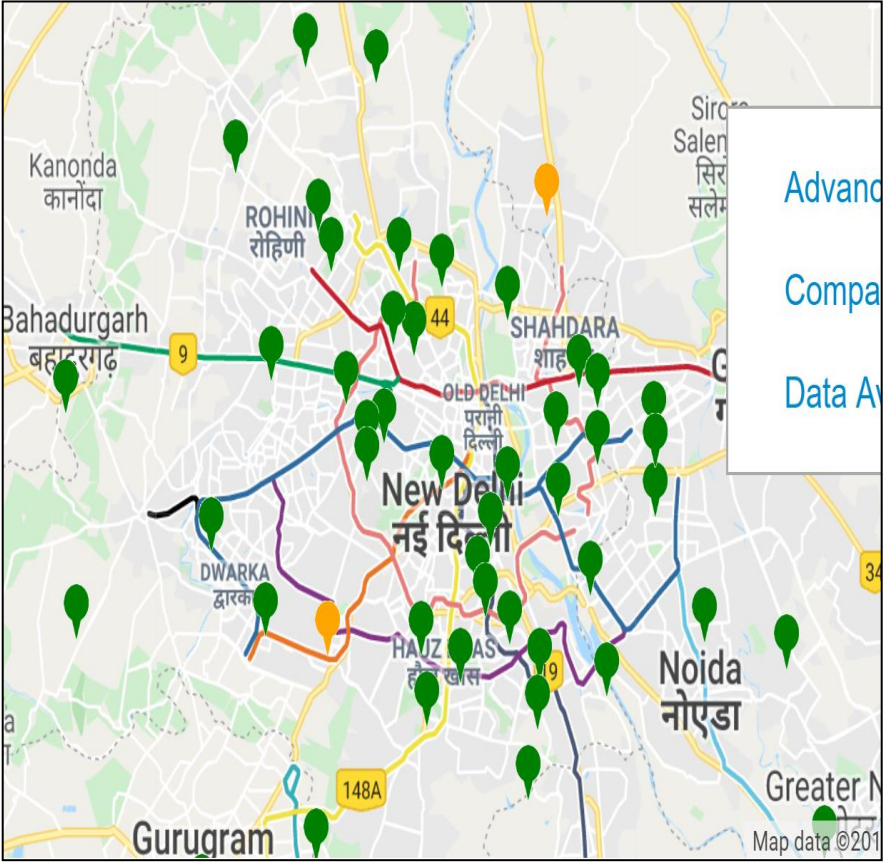
WRF-Chem (No Assimilation)



WRF-Chem (Assimilation)



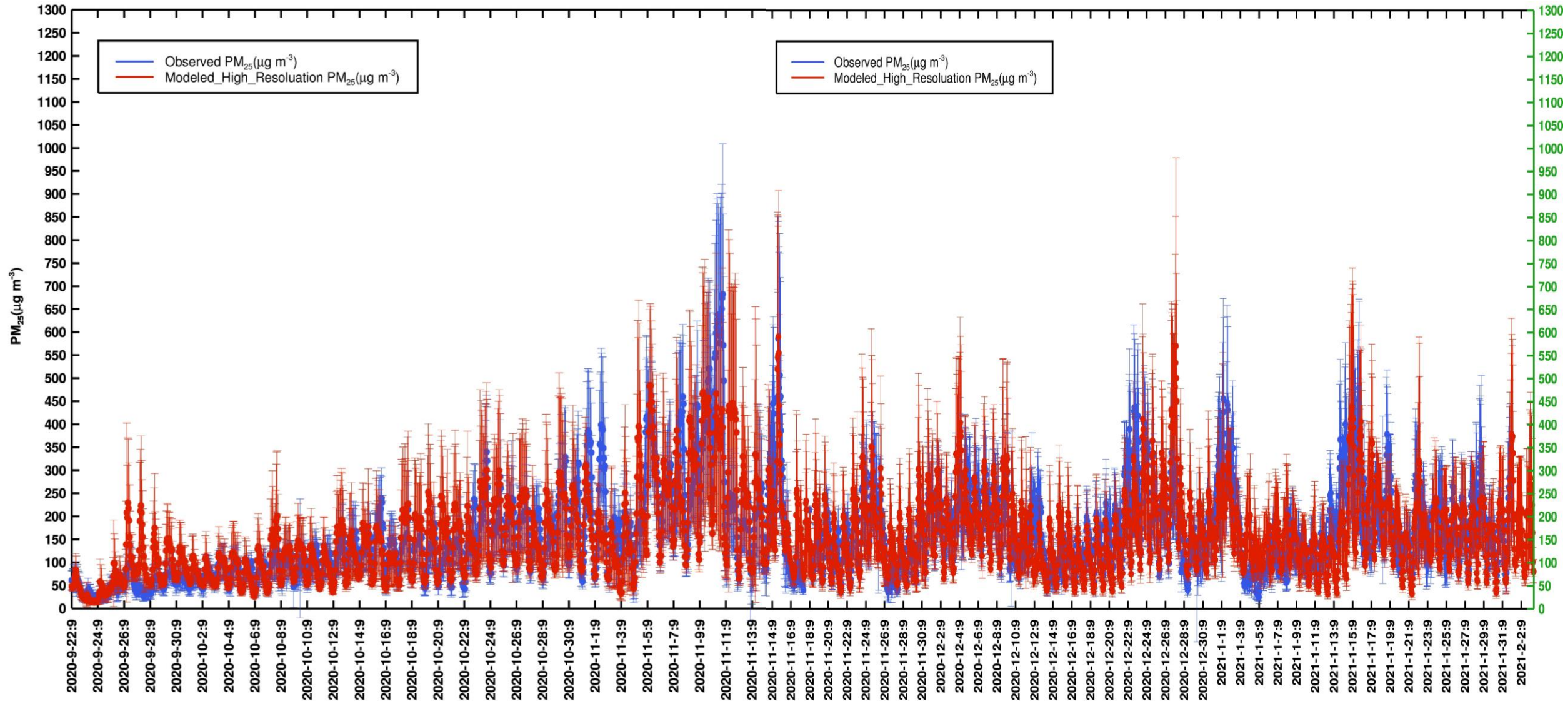
Surface PM_{2.5} assimilation



43 AQMS (CPCB, DPCC, IITM)

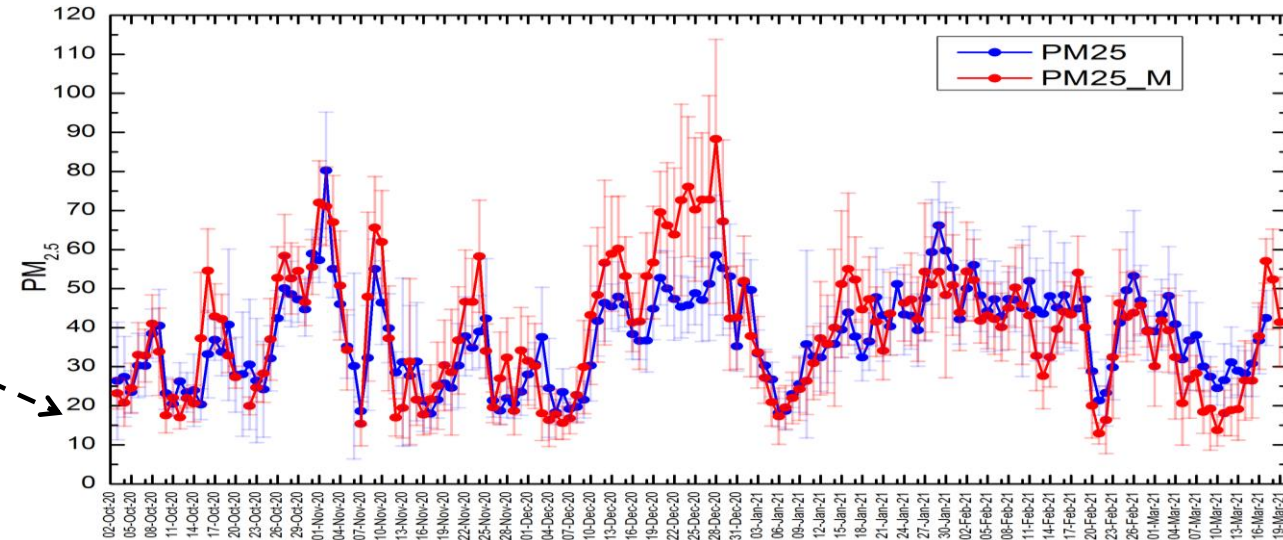
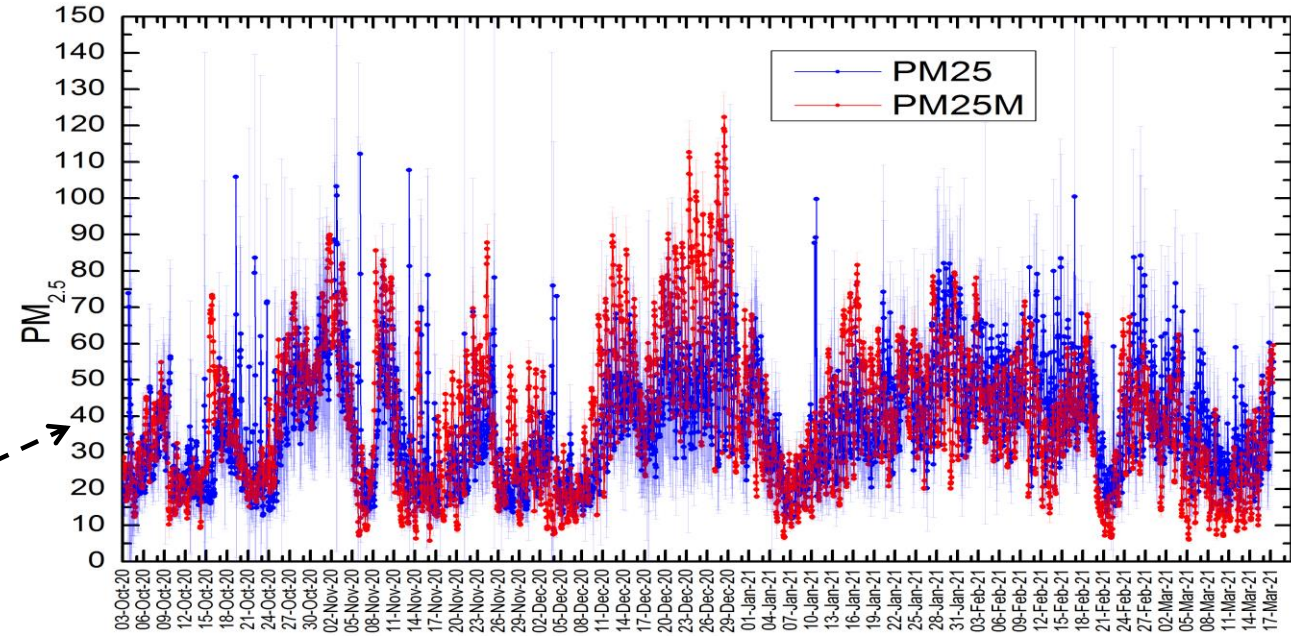
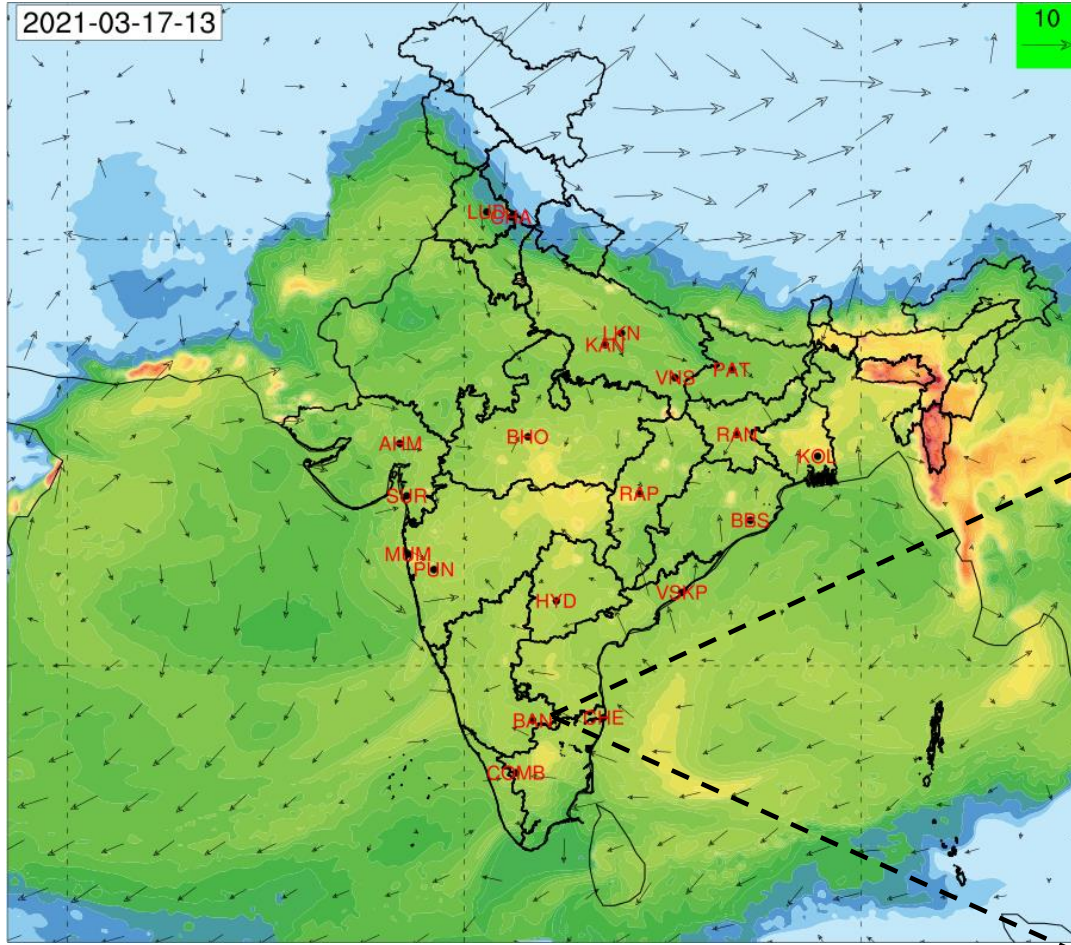


Forecast Evaluation @ 400 meter resolution (Winter 2020-2021)



Operational Air Quality Early Warning System (AQEWS) – V2.0

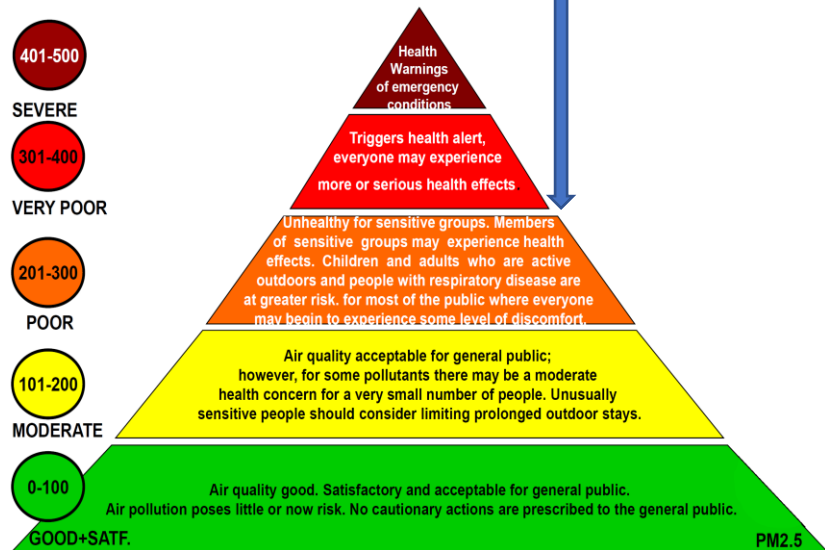
Forecast Evaluation for Bangalore city (Winter 2020-2021)





How good is forecast for absolute AQI index?

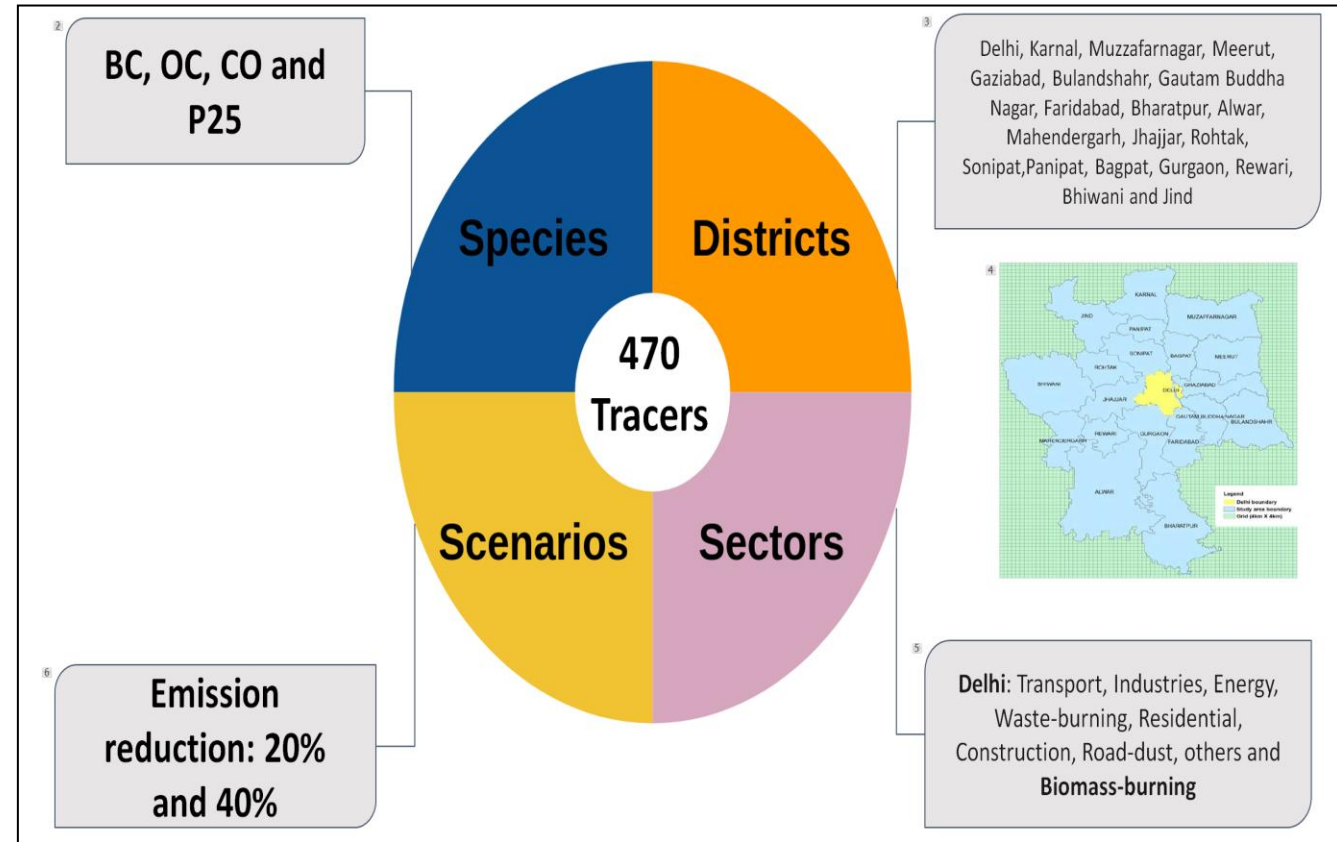
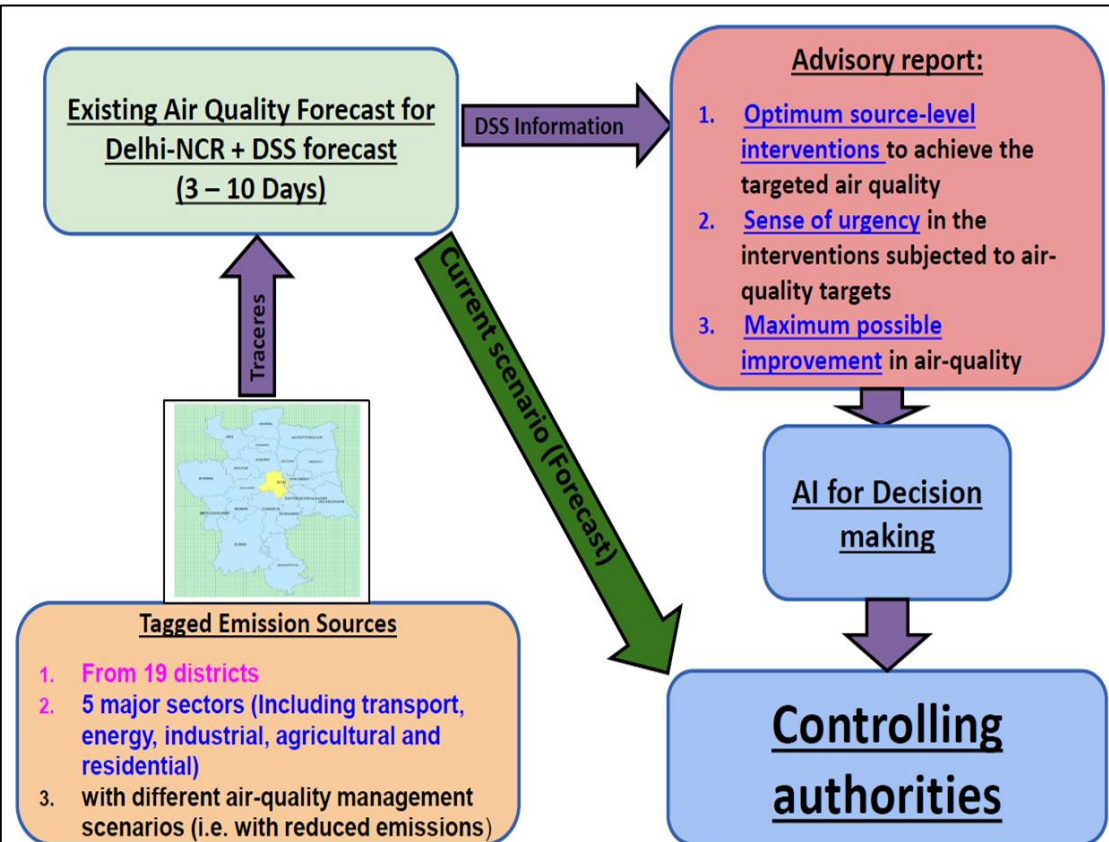
AIR QUALITY INDEX (AQI)		10km		400 meter	
		NMFB (%)	NMFE (%)	NMFB (%)	NMFE (%)
Very Poor (301-400)	1 st day	1.2	6.4	2.3	6.8
	2 nd day	- 5.3	9.1	- 0.8	6.9
	3 rd day	- 8.3	11.4	- 3.9	8.7
Severe (401-Above)	1 st day	- 11.1	15.6	- 13.9	16.3
	2 nd day	- 22.1	22.2	- 17.2	17.8
	3 rd day	- 26.7	26.7	- 20.7	20.9



Forecast Evaluation

PM ₂₅ AQI Category	Variables	10km		400 meter	
		FAR	Accuracy	FAR	Accuracy
Unhealthy (200-above)	1 st day	0.10	0.88	0.11	0.88
	2 nd day	0.08	0.89	0.09	0.90
	3 rd day	0.08	0.85	0.09	0.88
Very-Unh (300-above)	1 st day	0.24	0.76	0.28	0.72
	2 nd day	0.18	0.78	0.25	0.75
	3 rd day	0.17	0.77	0.23	0.74
Severe (400-above)	1 st day	0.10	0.88	0.35	0.82
	2 nd day	0.17	0.82	0.15	0.85
	3 rd day	0.02	0.81	0.25	0.82

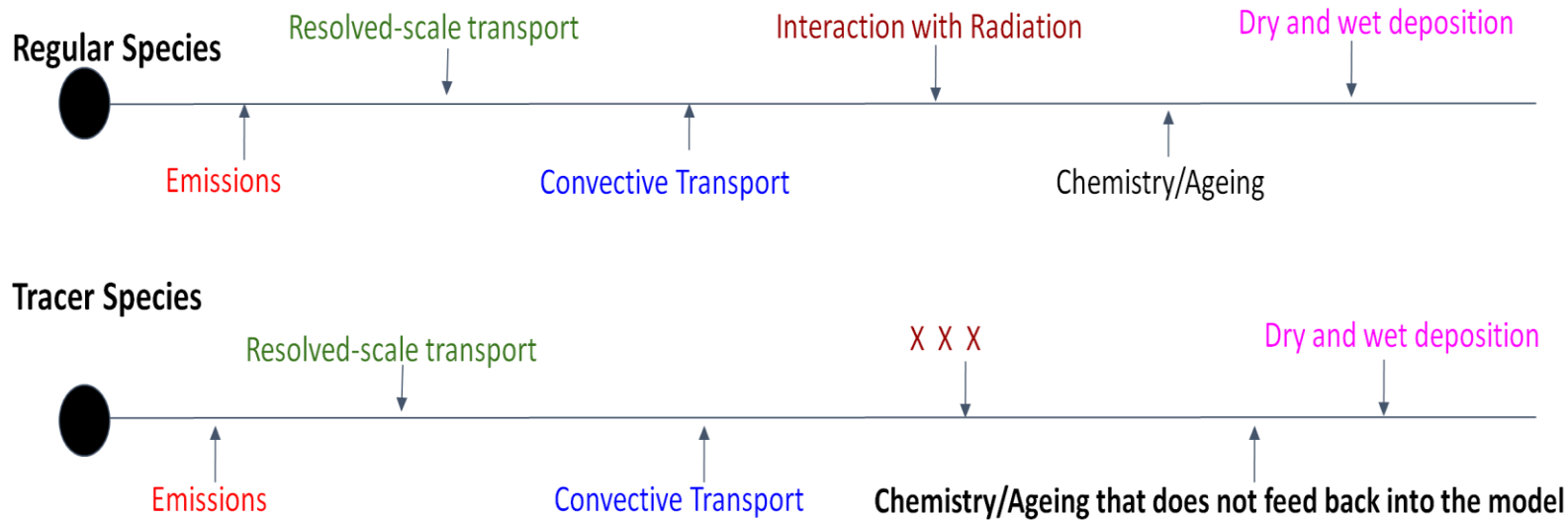
Decision Support System (DSS) for air-quality management in Delhi



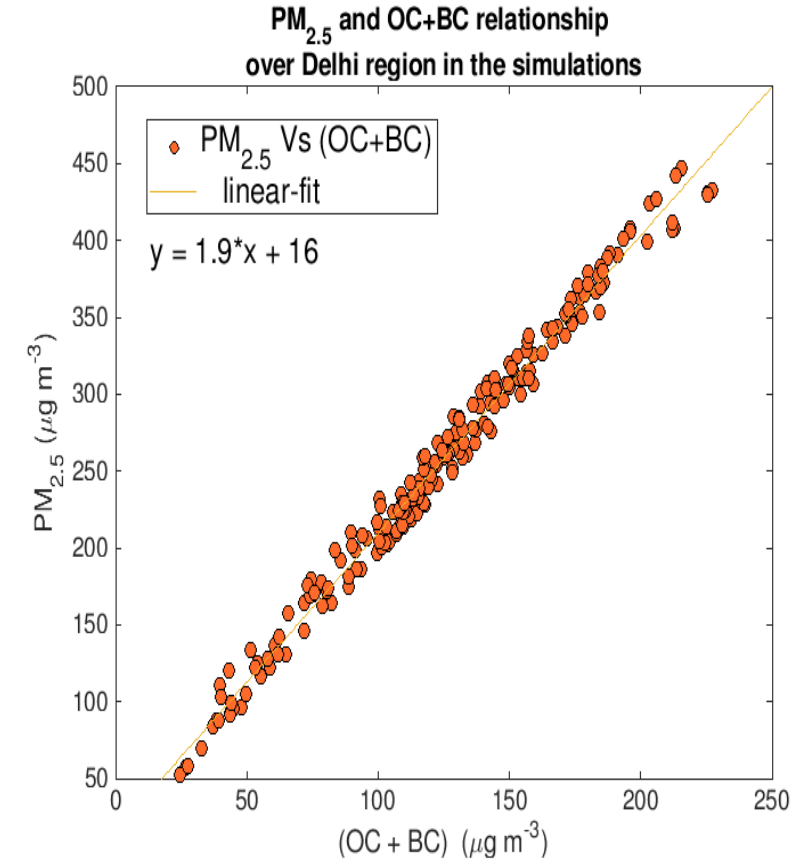
- Early warnings and possible ways to prevent the occurrence of the event
- Effectiveness of the possible solution **before the actual implementation**
- Effective decision in a timely manner

Methodology: Implementation of tracers

- CO, BC and OC, P₂₅ (BC1_tracer -> BC2_tracer in 2.5 days OC1_tracer -> OC2_tracer in 2.5 days) variables are tagged to identify and quantify the emission sources and regional contributions.
- In the model, each of the tracers is considered as an individual transported species. E.g.

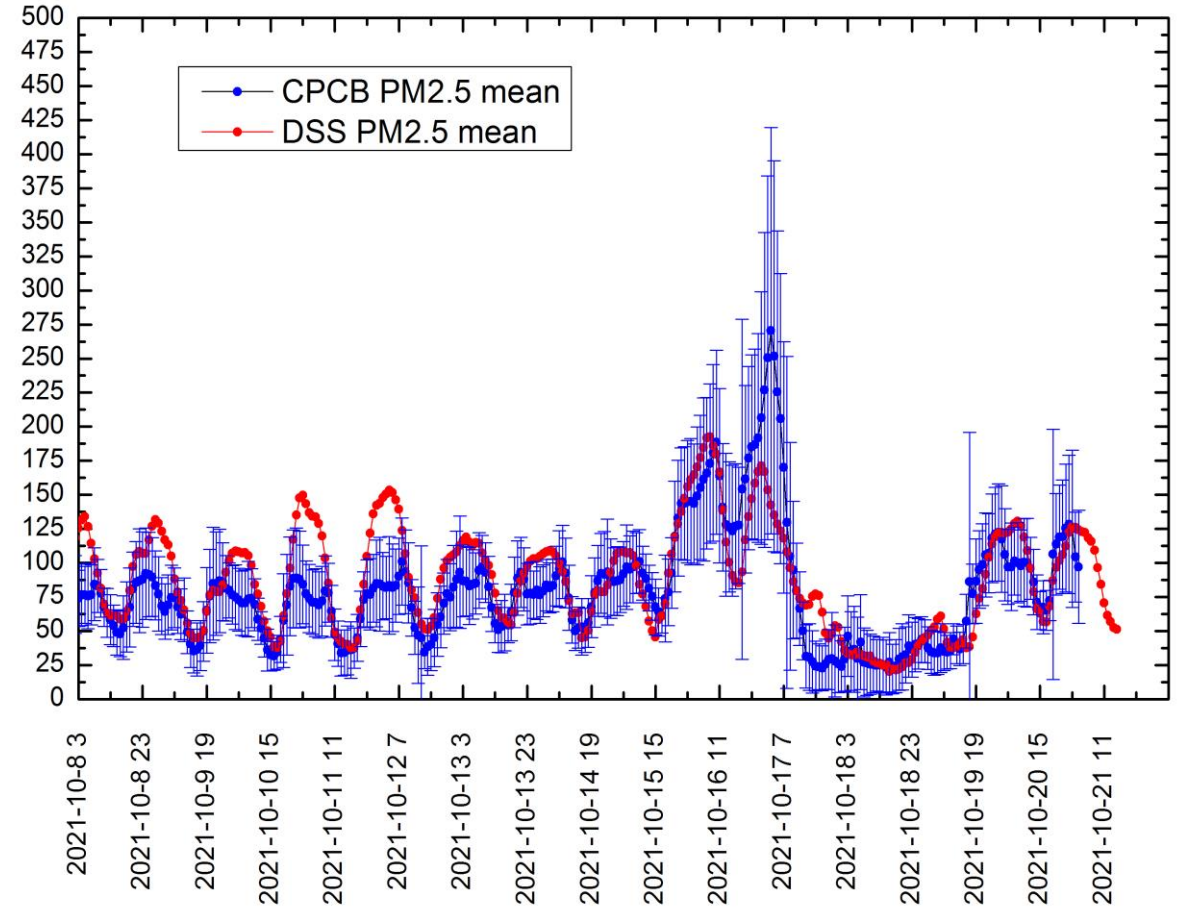
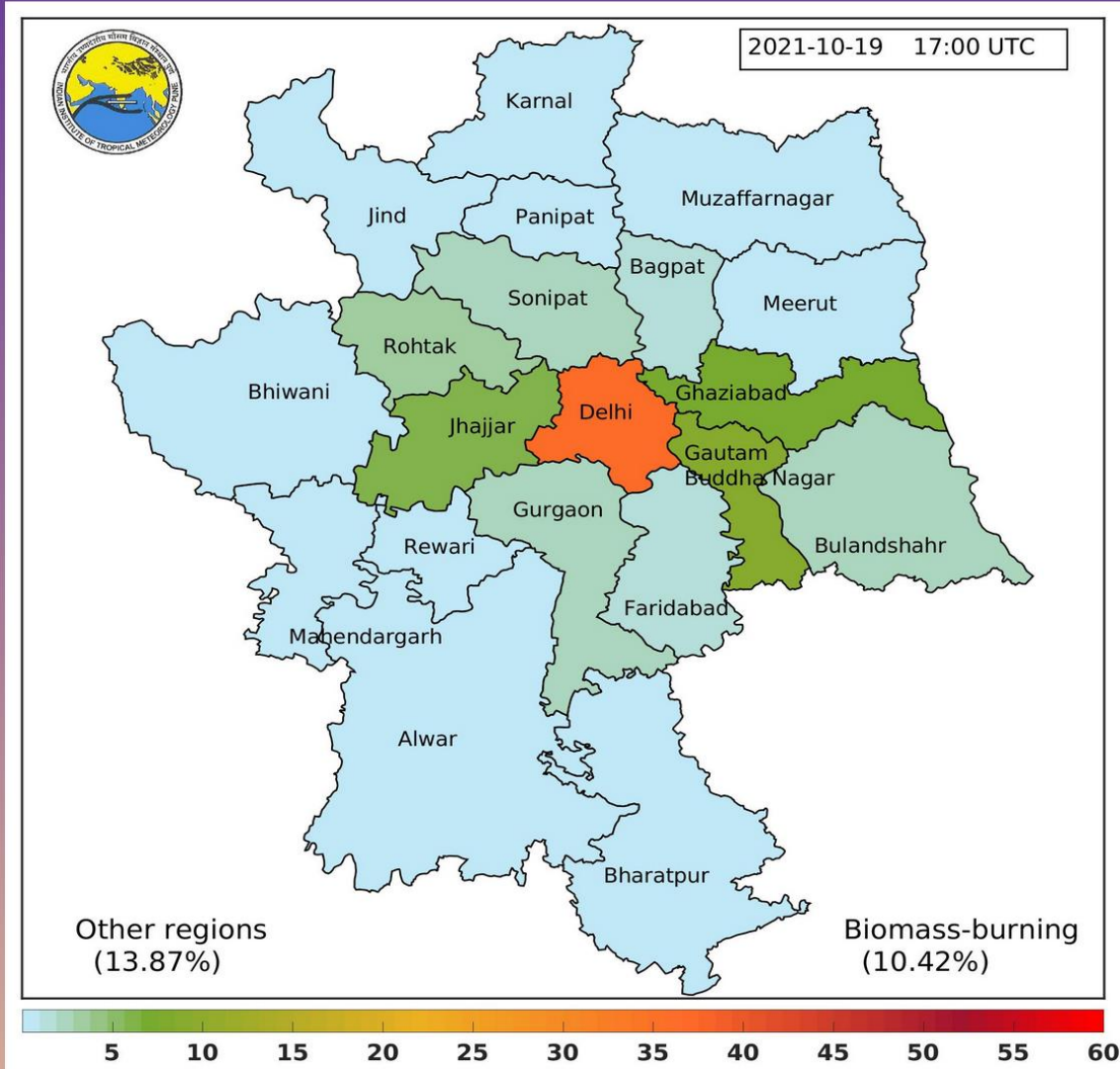


- Non-interactive chemistry/ageing:



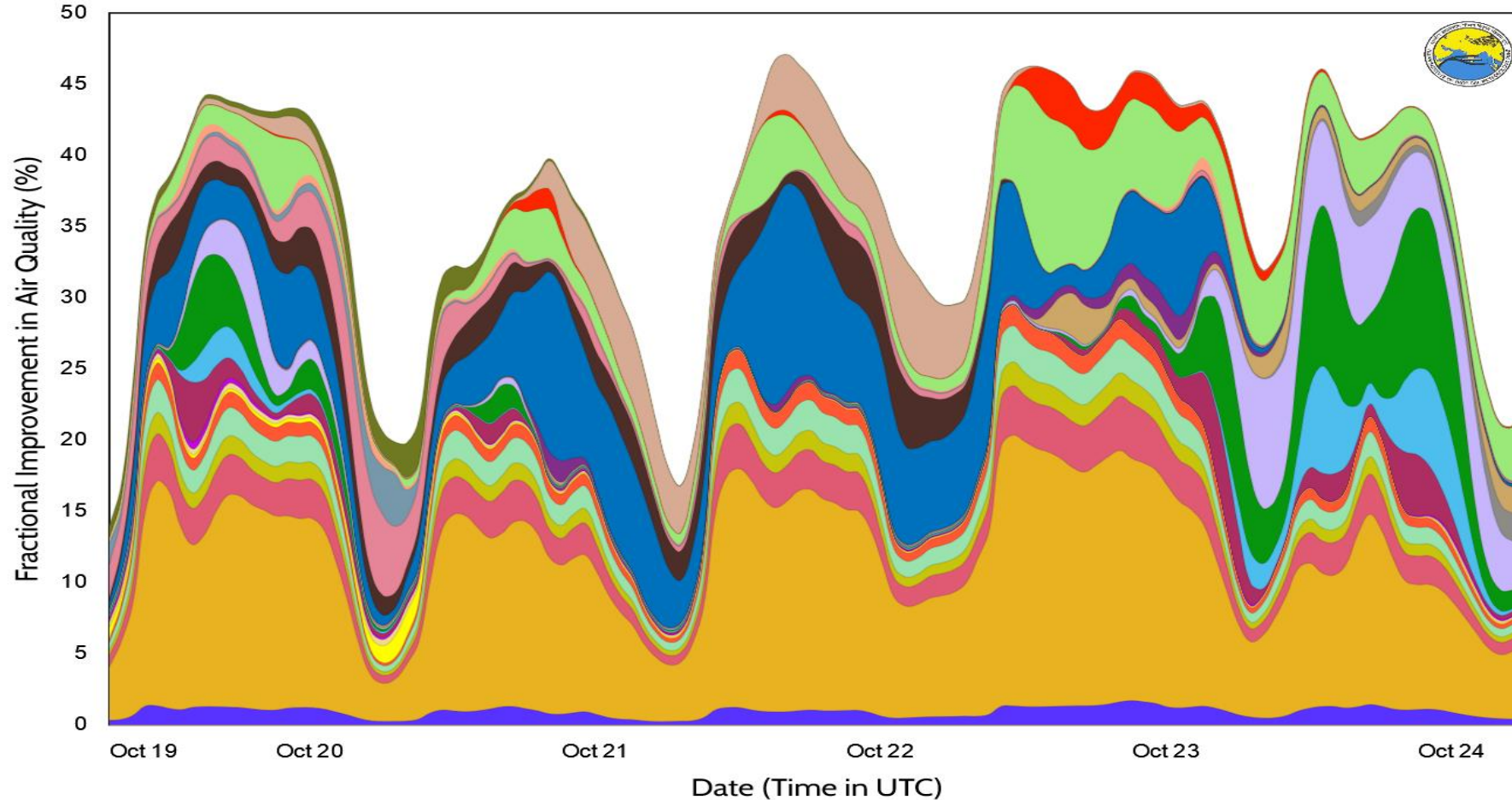
Decision Support System (DSS) for air-quality management in Delhi

District-specific Fractional Contribution to Particulate Matter (PM_{2.5}) in Delhi



Create an emission-reduction scenario to manage air quality in Delhi

Select the desired checkboxes to create an emission reduction scenario. Users can specify a reduction of 20% or 40% or 20+40 i.e. 60% in the PM_{2.5} emissions from the individual districts or the individual emission sectors in Delhi. The graphic shows the fractional improvement in air quality in Delhi upon employing the user-specified emission reduction scenario for the next five days.



- Select All
- 20% | 40% | District & Emission Sector
- Delhi Energy
- Delhi Transport
- Delhi & peripheral Industries
- Delhi Waste burning
- Delhi Construction
- Delhi Road dust
- Karnal
- Muzaffarnagar
- Meerut
- Ghaziabad
- Bulandshahr
- Gautam Buddha Nagar
- Faridabad
- Bharatpur
- Alwar
- Mahendergarh
- Jhajjar
- Rohtak
- Sonipat
- Panipat
- Bagpat
- Gurgaon
- Rewari
- Bhiwani
- Jind

Public dissemination system (ews.tropmet.res.in)

AQWES

DSS

AIR QUALITY EARLY WARNING SYSTEM FOR DELHI
 MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA
 पृथ्वी विज्ञान मंत्रालय, भारत सरकार
(Project By : Indian Institute of Tropical Meteorology, Pune)

AIR QUALITY FORECAST
FOG FORECAST (WIFEX)
ANALYSIS
HOME
ABOUT US
PEOPLE
EVENT
CONTACT US

Air Quality Forecast (UTC)

2021-06-17-17 Twitter

Bulletin & Message

Air Quality and Weather Bulletin for Delhi NCR (18.06.2021)

1. The air quality over Delhi-NCT is likely to remain in Moderate to Satisfactory category on 18.06.2021 and 19.06.2021. The air quality is likely to improve marginally but remain in Satisfactory category on 20.06.2021. The predominant pollutant will be PM10 as strong winds raise dust locally and transport of dust from nearby regions. The Outlook for subsequent 5 Days: The air quality is likely to remain in Moderate to satisfactory category.
2. The predominant surface wind is likely to be coming from Southeast/East directions of Delhi with wind speed of 10-18 kmph and partly cloudy sky with very light rain/thundershowers on 18.06.2021. The predominant surface wind is likely to be coming from East-Southeast directions of Delhi with wind speed upto 10 kmph and generally cloudy sky with very light rain/thundershowers on 19.06.2021. The predominant surface wind is likely to be coming from Southeast directions of Delhi with wind

Air Quality Forecast Over India

2021-06-17-14

Tweets by iitmpune

Current AQI @Delhi 2021-06-18 07

79

Forecast AQI @Delhi 2021-06-19 03

89

Visibility in Meter @IGIA 2021-06-18 09:00:00

3000

Total Visitors : 66991

- 52090	- 348	- 8089	- 329
- 582	- 788	- 501	- 339
- 269	- 778	- 37	- 134

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DECISION SUPPORT SYSTEM FOR AIR QUALITY MANAGEMENT IN DELHI
 MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA (पृथ्वी विज्ञान मंत्रालय, भारत सरकार)
 INDIAN INSTITUTE OF TROPICAL METEOROLOGY, PUNE

Effects of emission reductions
Scenarios
About DSS
People
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AOEWS
Contact

Delhi. The system can quantify the possible reduction in particulate matter pollution upon carrying out specifier

District-specific Fractional Contribution to Particulate Matter (PM_{2.5}) in Delhi

2021-10-21 14:00 UTC

Other regions (19.79%) Biomass-burning (1.63%)

Air Quality Index at Delhi

Current AQI - 182
2021-10-21 10

Forecast AQI - 291
2021-10-22 04

Current Weather at Delhi

2021-10-21 14:30 IST

Temp 32 °C Humidity 31% Wind 8.3 km/h

Bulletin

On 22.10.2021, the prevailing surface wind is likely to be coming from South directions of Delhi with wind speed of 04-08 kmph and partly cloudy sky with possibility of very light

Local and Non-Local Fractional Contribution to PM_{2.5} in Delhi for the next five days

Note: Please use the checkboxes to select/deselect any particular source

<input checked="" type="checkbox"/> Select All	<input checked="" type="checkbox"/> Delhi Energy	<input checked="" type="checkbox"/> Delhi Transport	<input checked="" type="checkbox"/> Delhi & peripheral Industries	<input checked="" type="checkbox"/> Delhi Waste burning
<input checked="" type="checkbox"/> Delhi Construction	<input checked="" type="checkbox"/> Delhi Road dust	<input checked="" type="checkbox"/> Delhi Residential	<input checked="" type="checkbox"/> Delhi Other sectors	<input checked="" type="checkbox"/> Karnal
<input checked="" type="checkbox"/> Muzaffarnagar	<input checked="" type="checkbox"/> Meerut	<input checked="" type="checkbox"/> Ghaziabad	<input checked="" type="checkbox"/> Bulandshahr	<input checked="" type="checkbox"/> Gautam Buddha Nagar
<input checked="" type="checkbox"/> Faridabad	<input checked="" type="checkbox"/> Bharatpur	<input checked="" type="checkbox"/> Alwar	<input checked="" type="checkbox"/> Mahendergarh	<input checked="" type="checkbox"/> Jhajjar
<input checked="" type="checkbox"/> Rohtak	<input checked="" type="checkbox"/> Sonapat	<input checked="" type="checkbox"/> Bagpat	<input checked="" type="checkbox"/> Gurgaon	<input checked="" type="checkbox"/> Gurgaon
<input checked="" type="checkbox"/> Rewari	<input checked="" type="checkbox"/> Bhiwani	<input checked="" type="checkbox"/> Jind	<input checked="" type="checkbox"/> Biomass Burning	<input checked="" type="checkbox"/> Others

Team Members IITM

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Sreyashi Dabnath
Prakash Pithani

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Dr. Siddhartha Singh

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Dr. Rajesh Kumar (NCAR)

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Dr. E.N. Rajagopal, Director NCMRWF
Dr. Mrutyunjay Mohapatra, DG IMD
Dr. K.J. Ramesh (former DG IMD)

Patron

Dr. M. Rajeevan, Chairman ESSO and Secretary, MoES, Govt. of India

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Patron

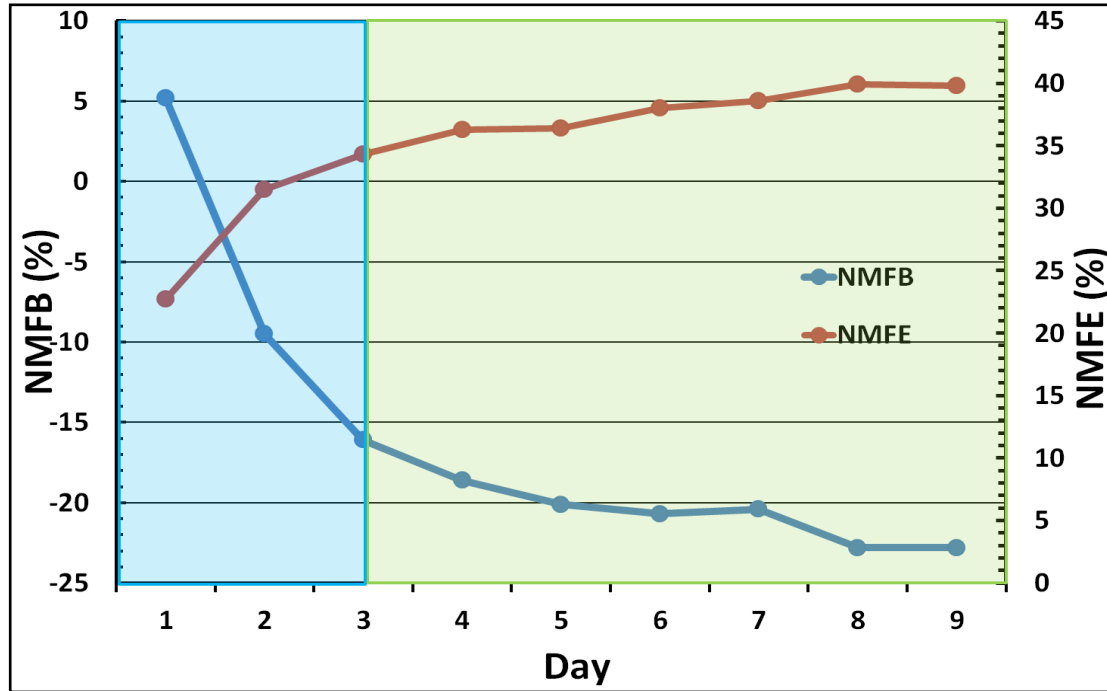
Dr. M. Ravichandran, Secretary, MoES, Govt. of India
Dr. M. Rajeevan, Former Secretary, MoES, Govt. of India
Total visitors since 12th Oct 2021: 827

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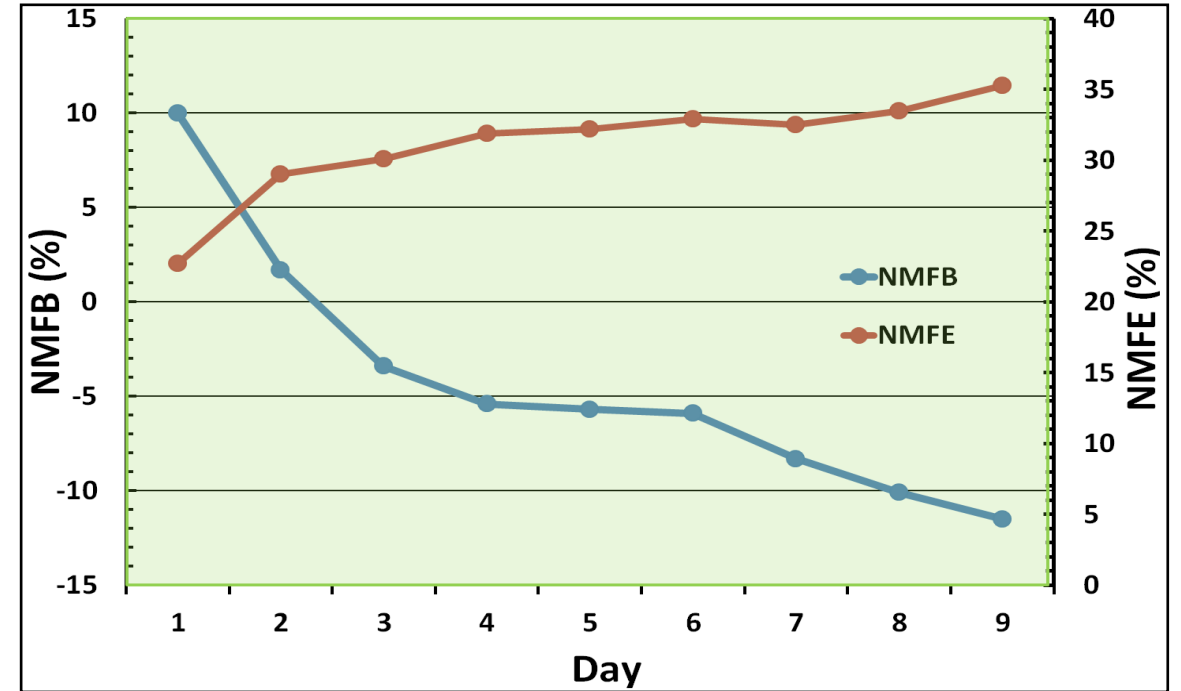
Thank You

Forecast Evaluation for 10 days

10 days skill @ 10 km



10 days skill @ 2km



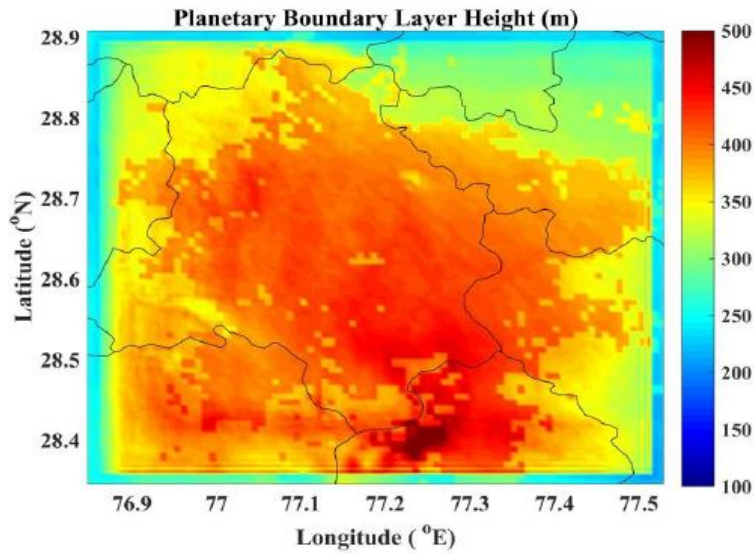
➤ The overall Performance of forecast is excellent for 3 days lead time and good for next 7 days at 10 km resolution

➤ The overall Performance of forecast is excellent for 9 days lead time at 2 km resolution

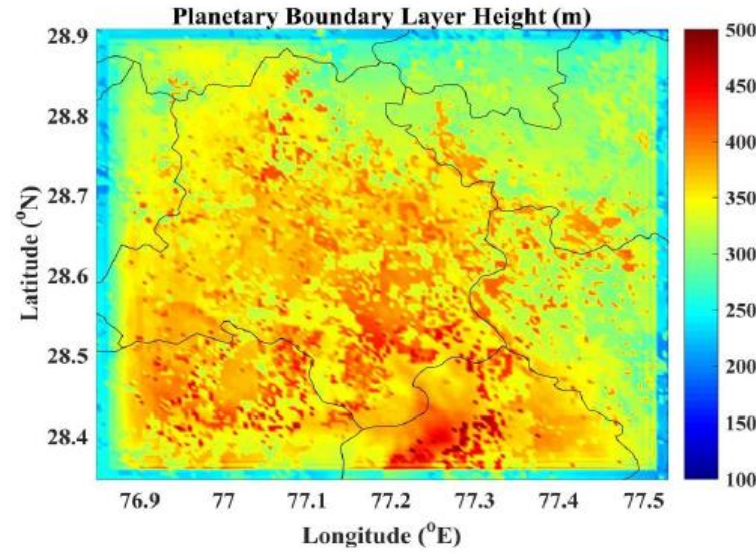


Updated Land-Use Classifications over Delhi

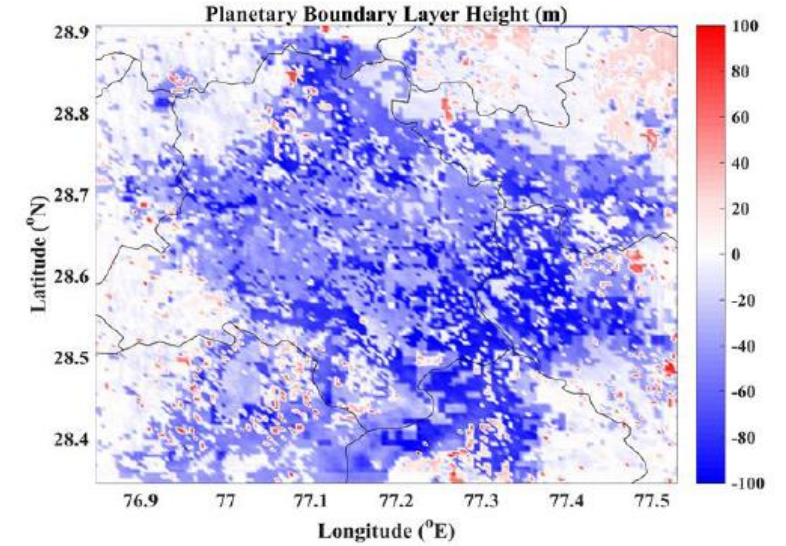
MODIS



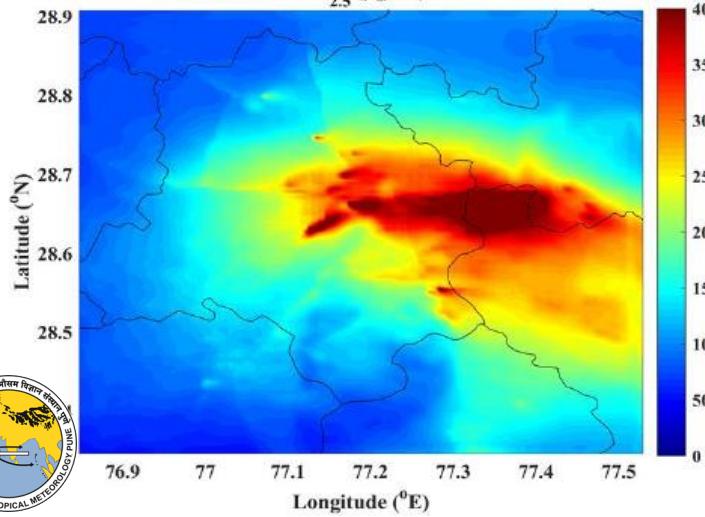
Sentinel



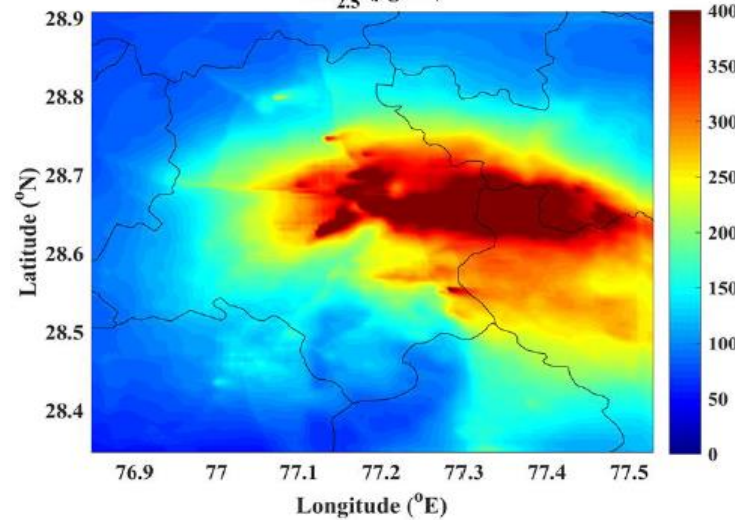
Difference (S-M)



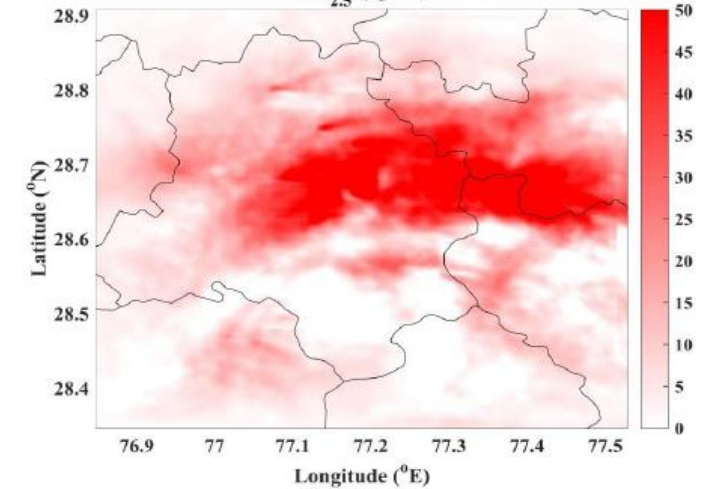
PM_{2.5} (µg/m³)



PM_{2.5} (µg/m³)



PM_{2.5} (µg/m³)



Improvement in PM_{2.5} initial conditions due to satellite (MODIS) and Surface PM_{2.5} In India at assimilation Cycle (T=0)

