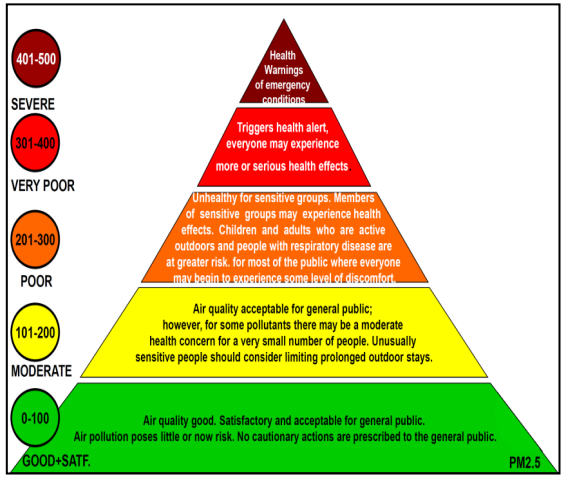
Ministry of Earth Sciences
Government of India

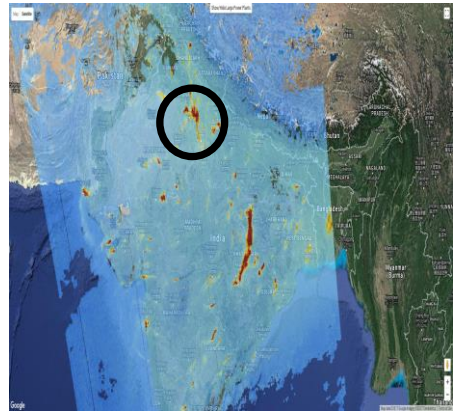
Integrated Air Quality Forecasting and Decision Support System for Delhi

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

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

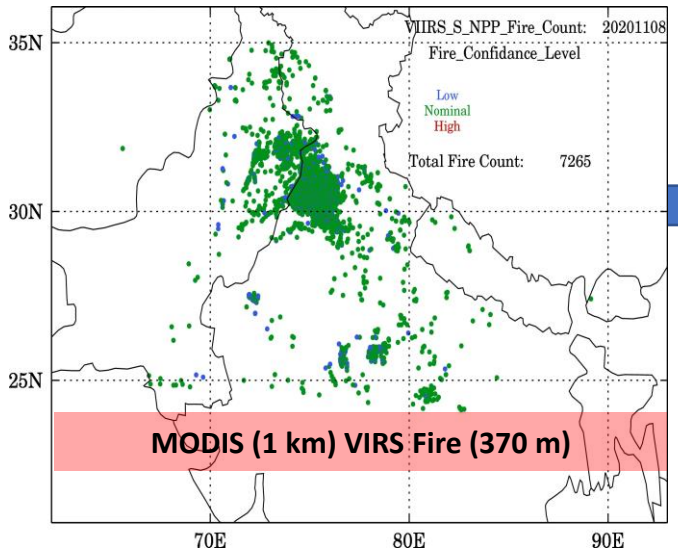
Gaurav Govardhan (IITM), Chinmay Jena (IMD), and Dr. V.K.Soni (IMD)





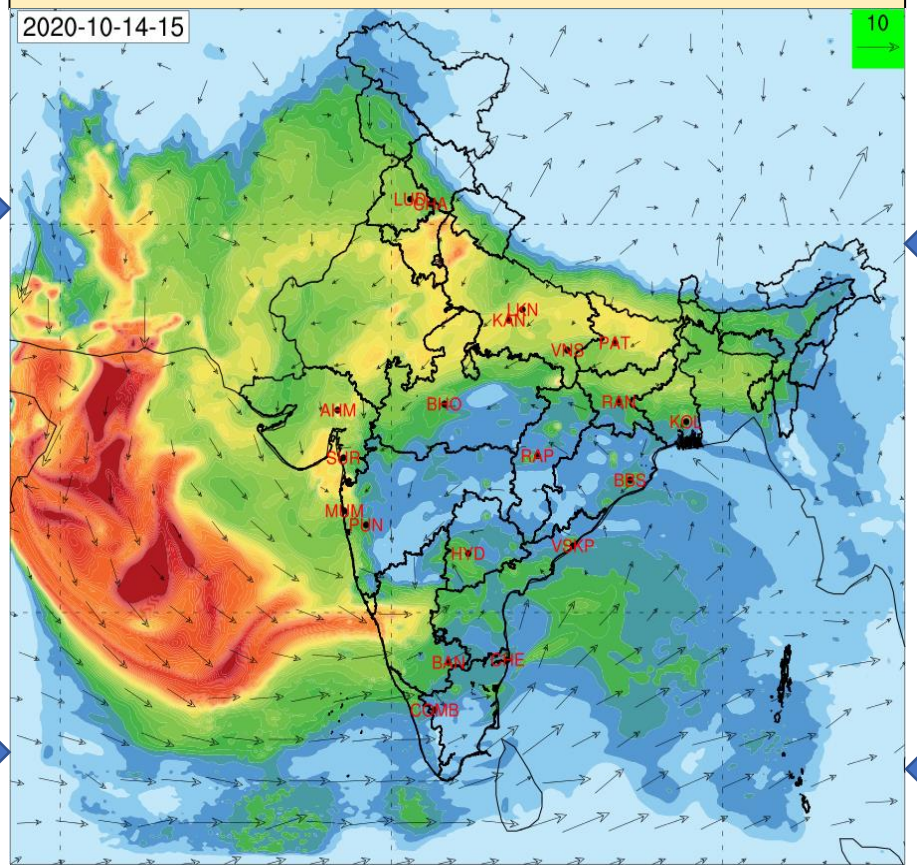
Operational Air Quality Early Warning System (AQEWS) – V2.0

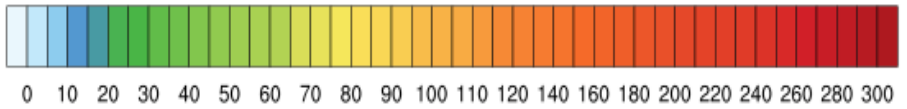
NRT Fire Assimilation



MODIS (1 km) VIRS Fire (370 m)

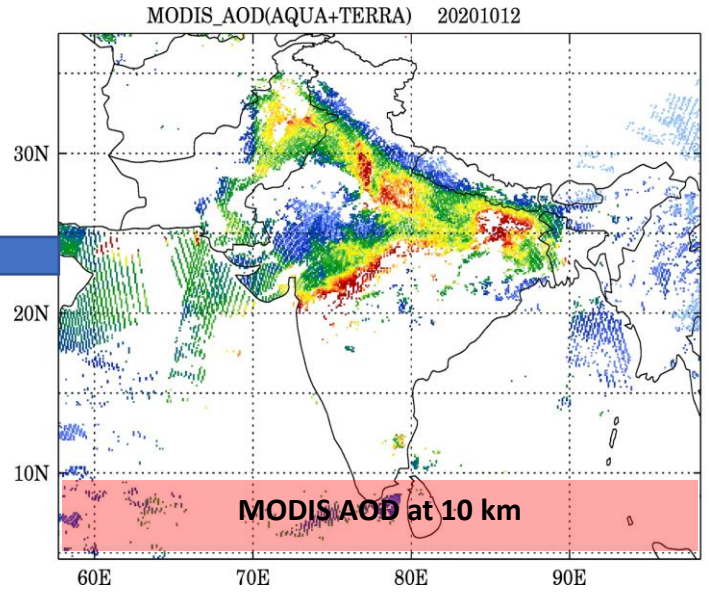
Regional $PM_{2.5}$ forecast at 10 km (WRF-Chem, EDGAR+Delhi_EI)



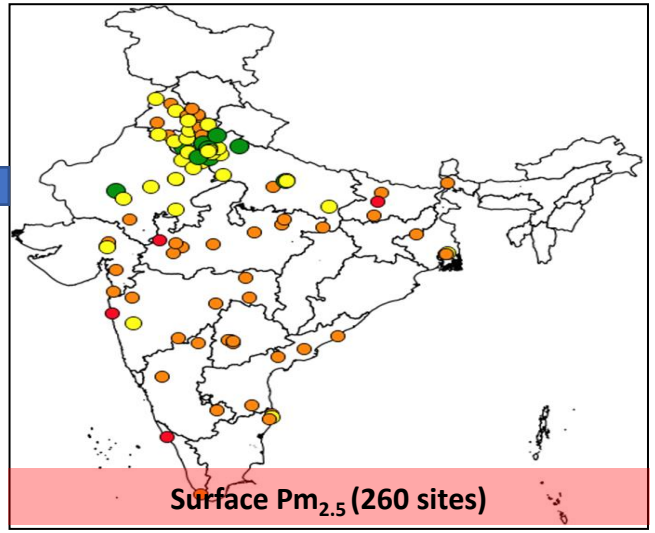


MOZART-GOCART

3D-var GSI Data Assimilation



MODIS AOD at 10 km



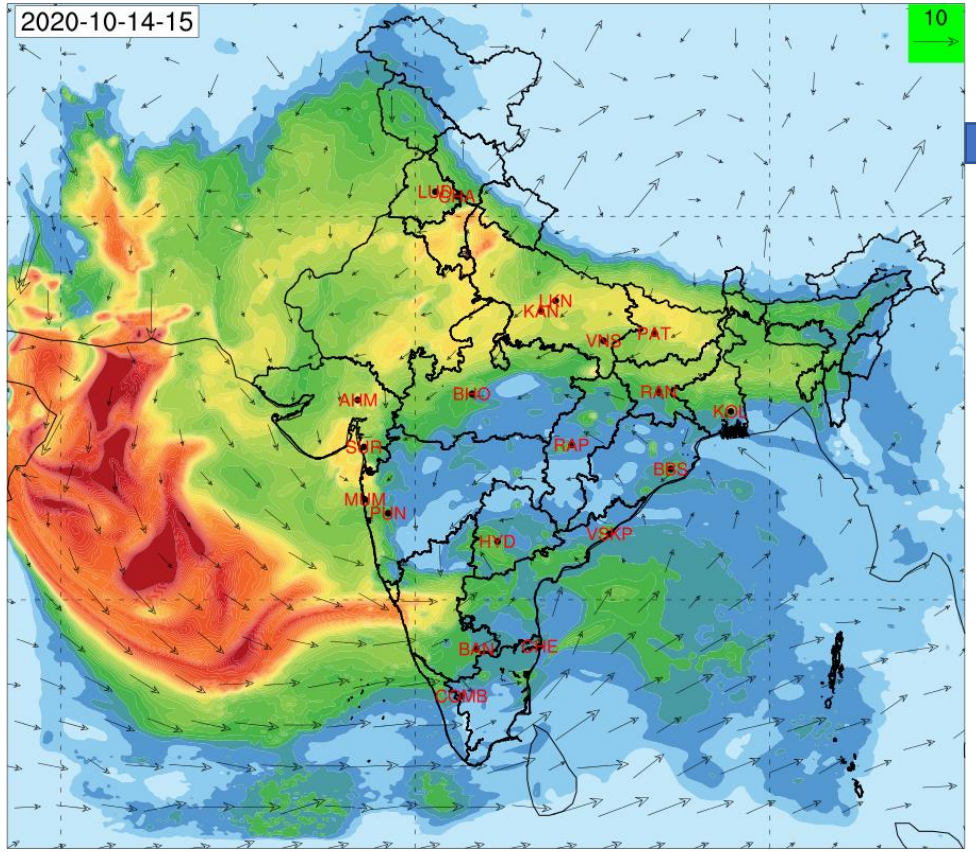
Surface $Pm_{2.5}$ (260 sites)

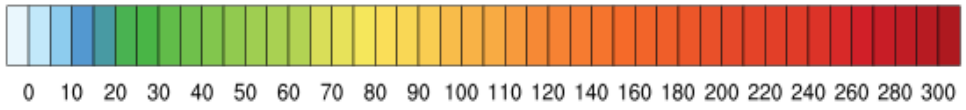
Driving Meteorology: Ensemble-Kalman filtering at 12.5 km grid resolution

IITM-IMD GFS, T1534

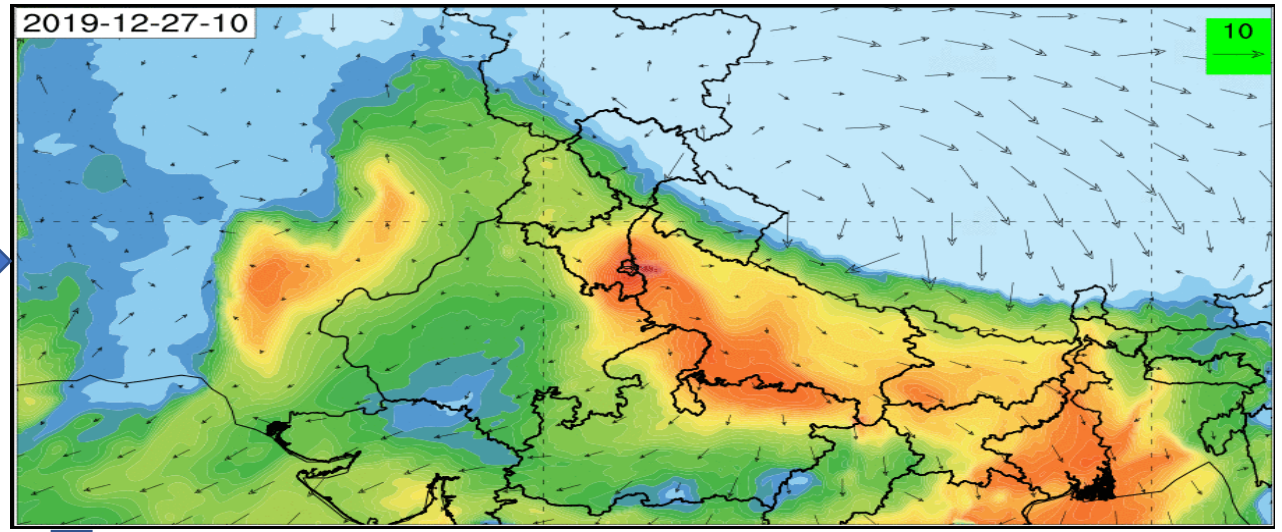
Operational Air Quality Early Warning System (AQEWS) – V2.0

Regional $PM_{2.5}$ forecast at 10 km

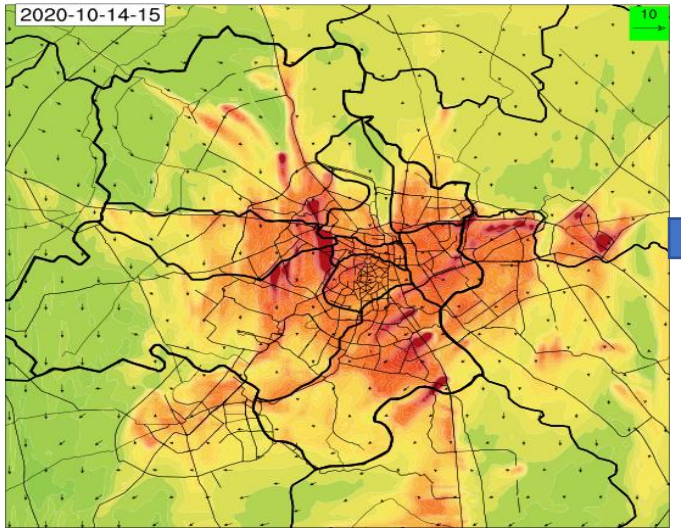




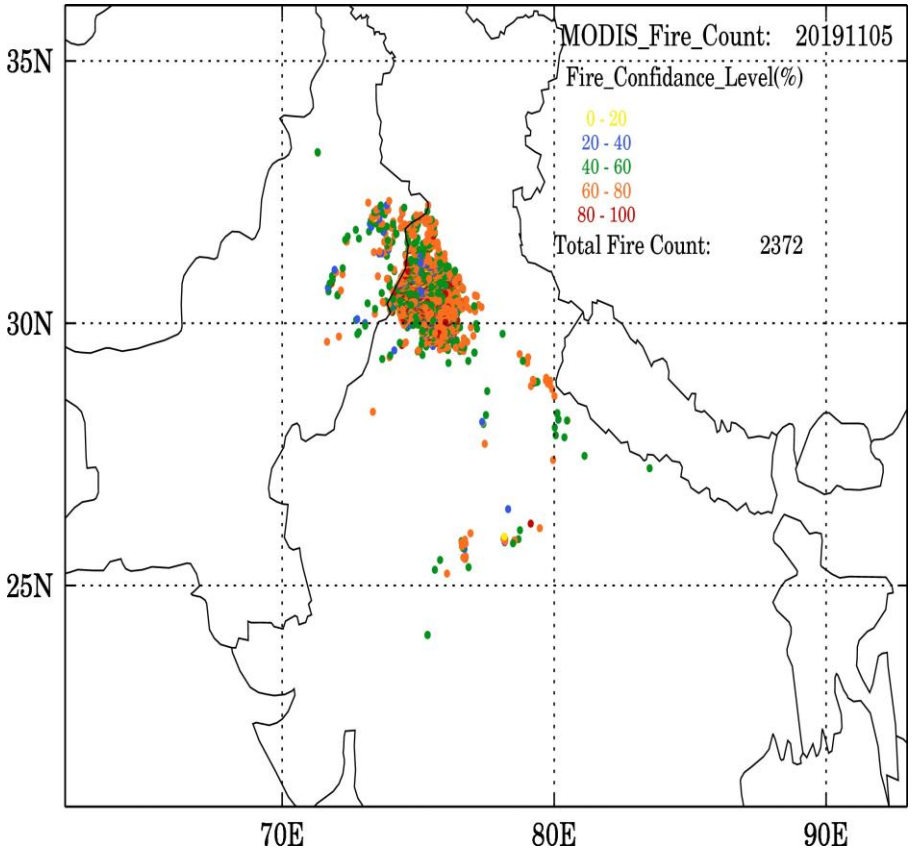
Dynamical Downscaling

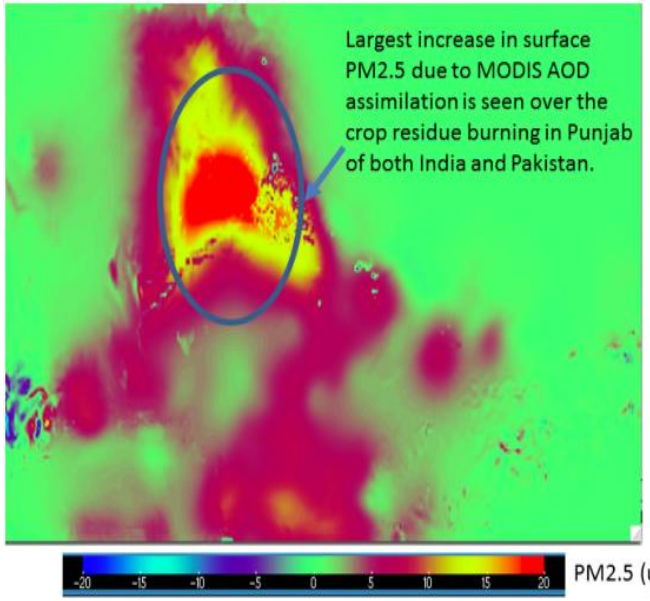


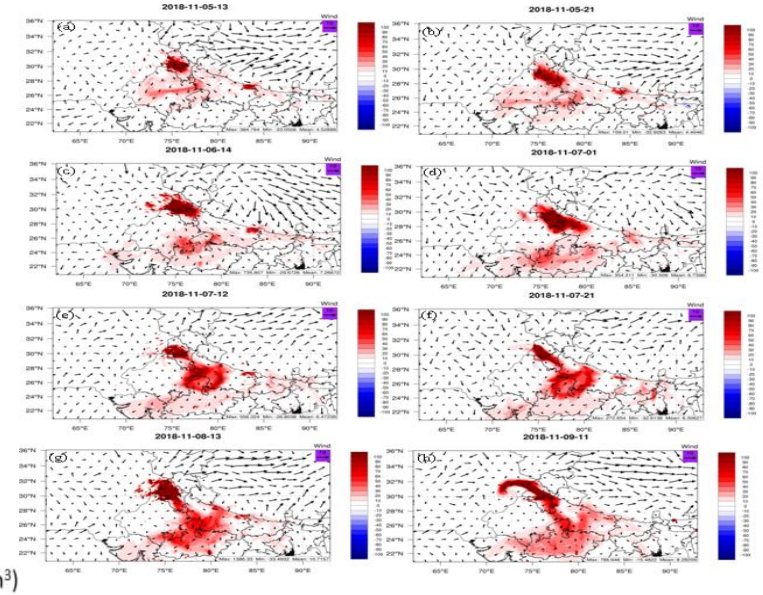
Delhi $PM_{2.5}$ forecast at 400 m

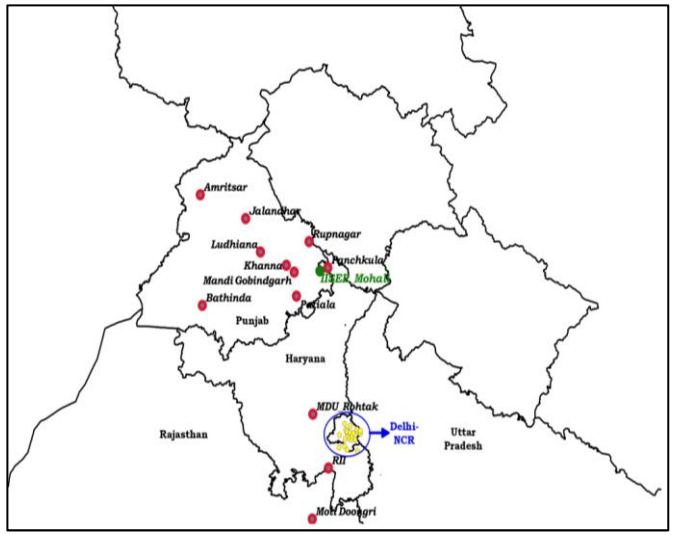


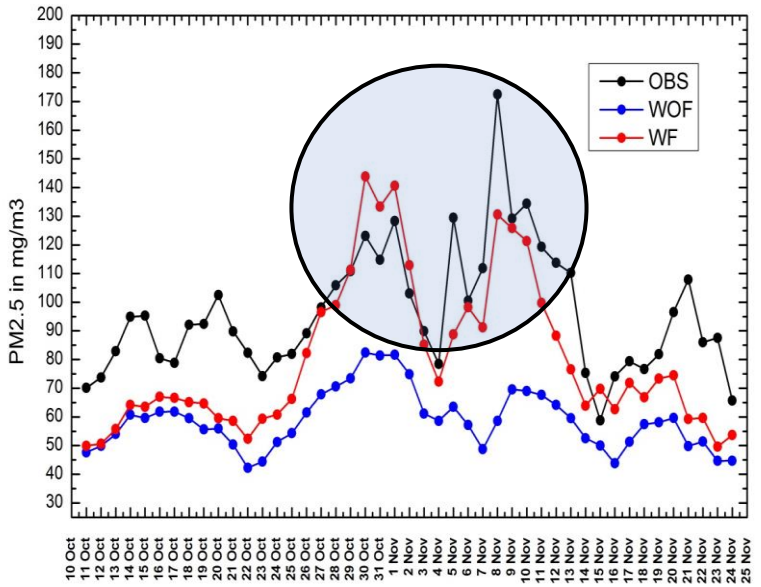
Improvement in $PM_{2.5}$ Predication after inclusion of satellite data on crop-fire



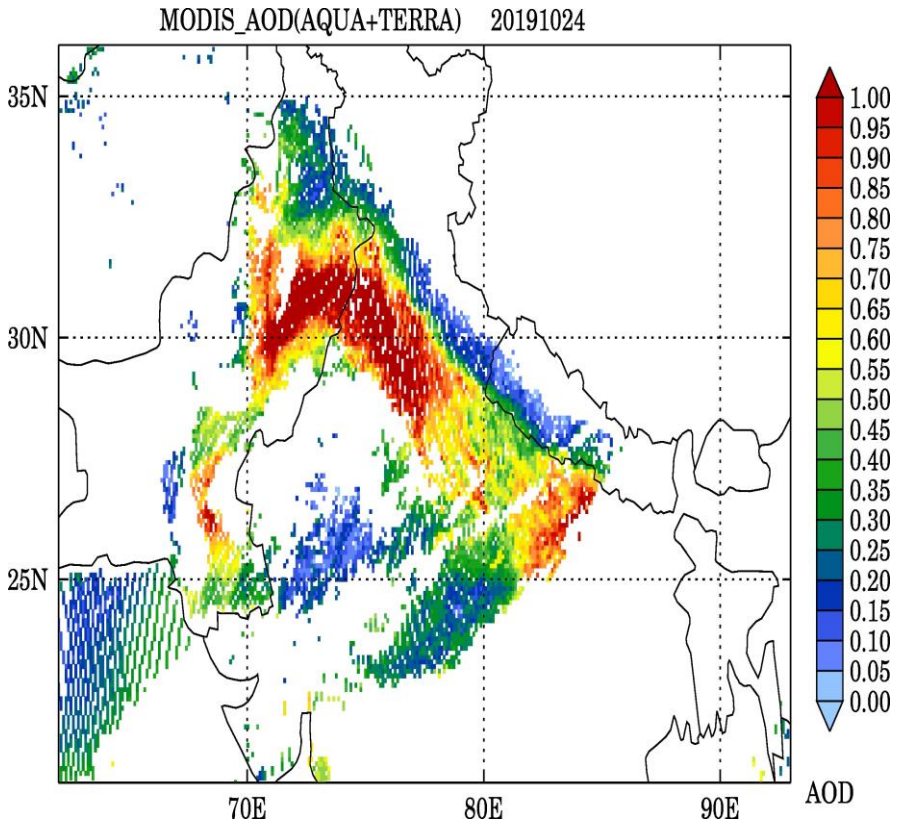


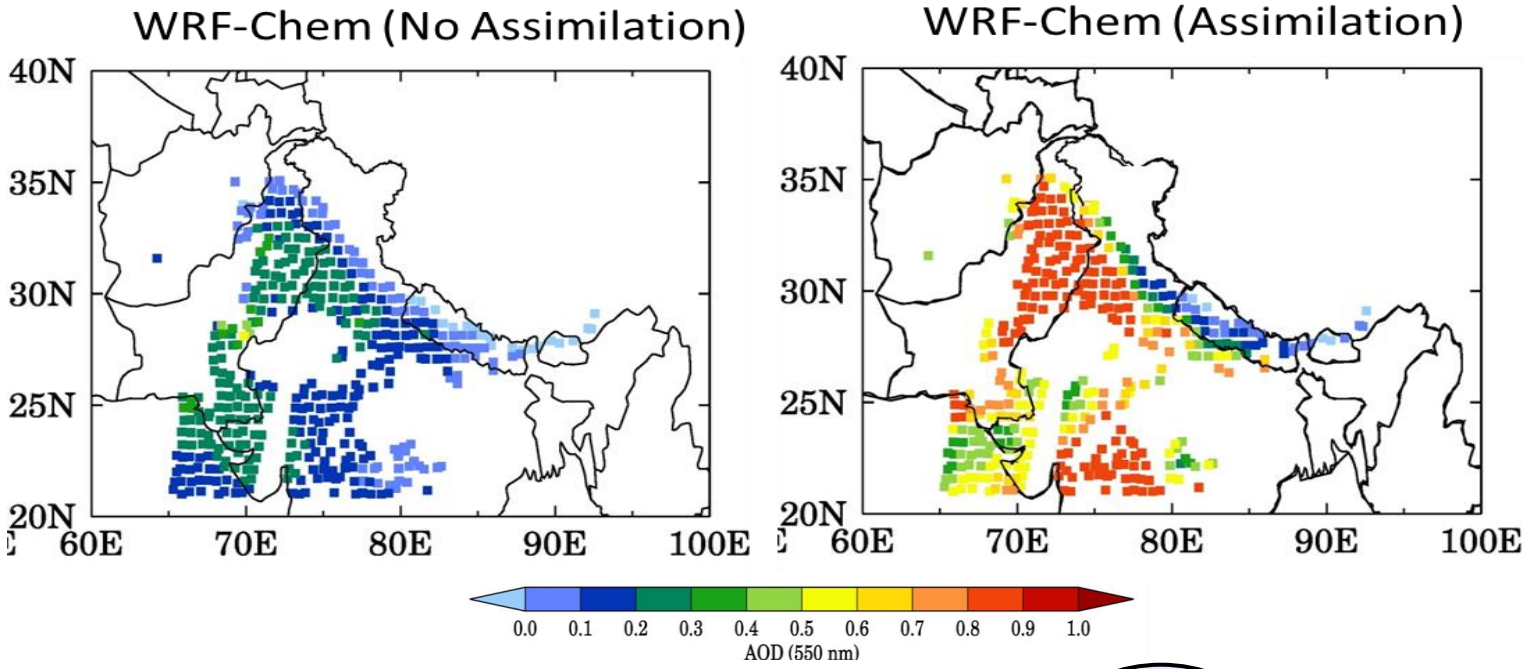


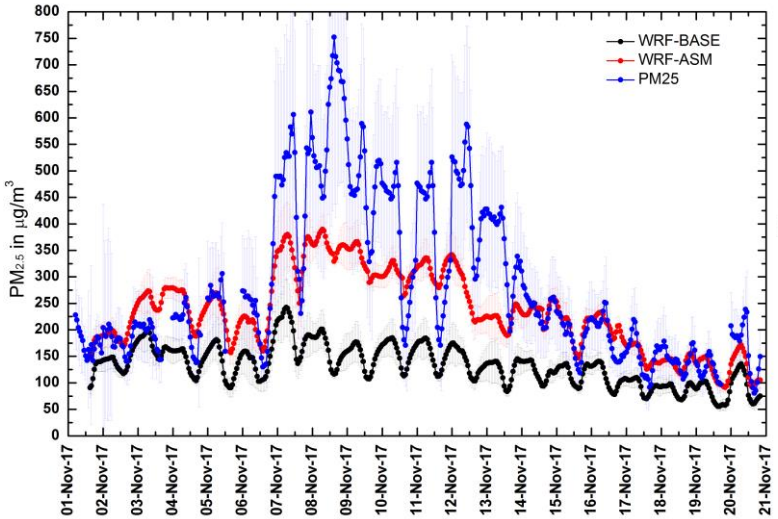


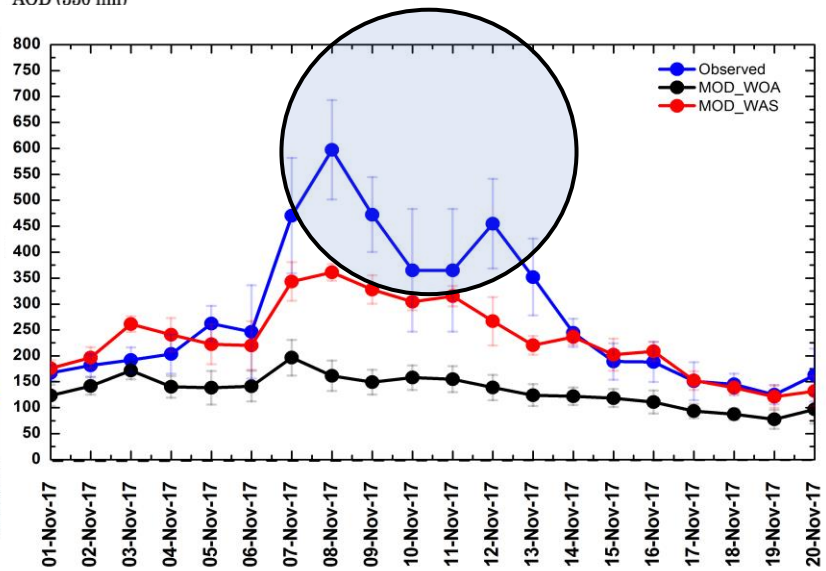


Improvement in $PM_{2.5}$ Predication after inclusion of MODIS AOD

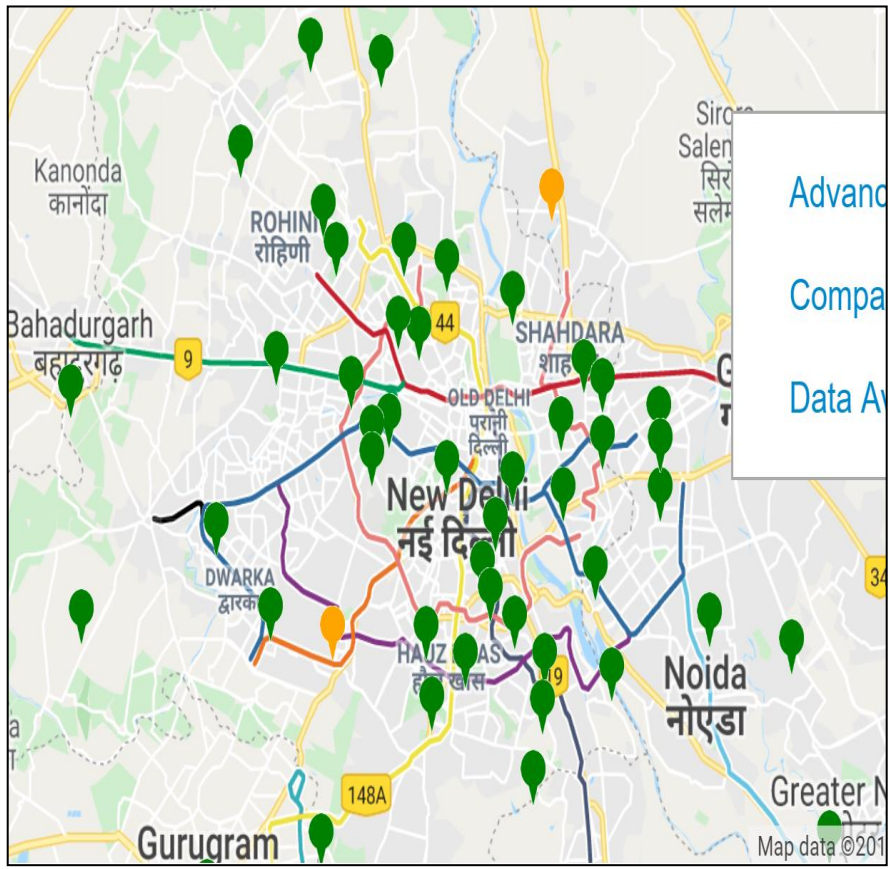


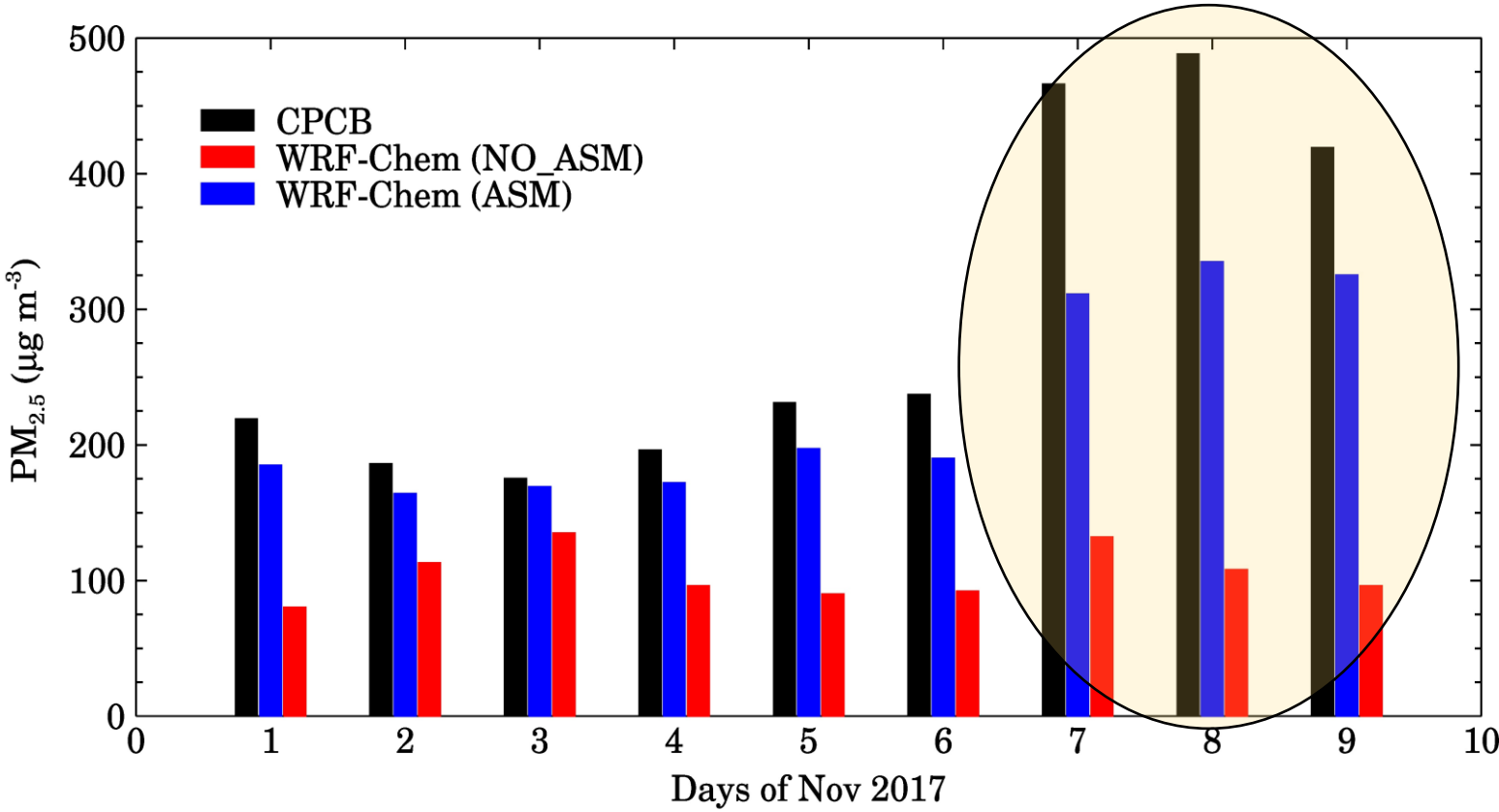






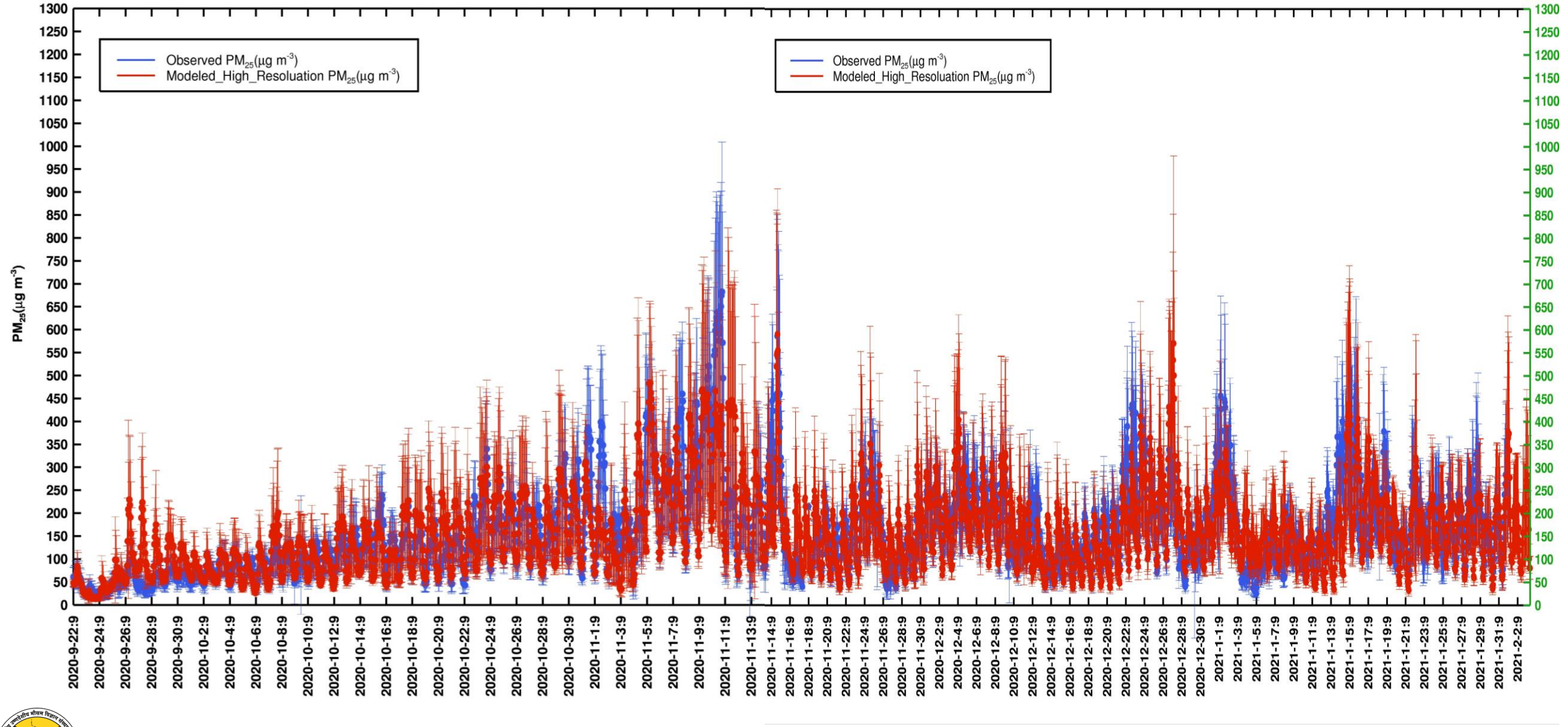
Surface $PM_{2.5}$ assimilation



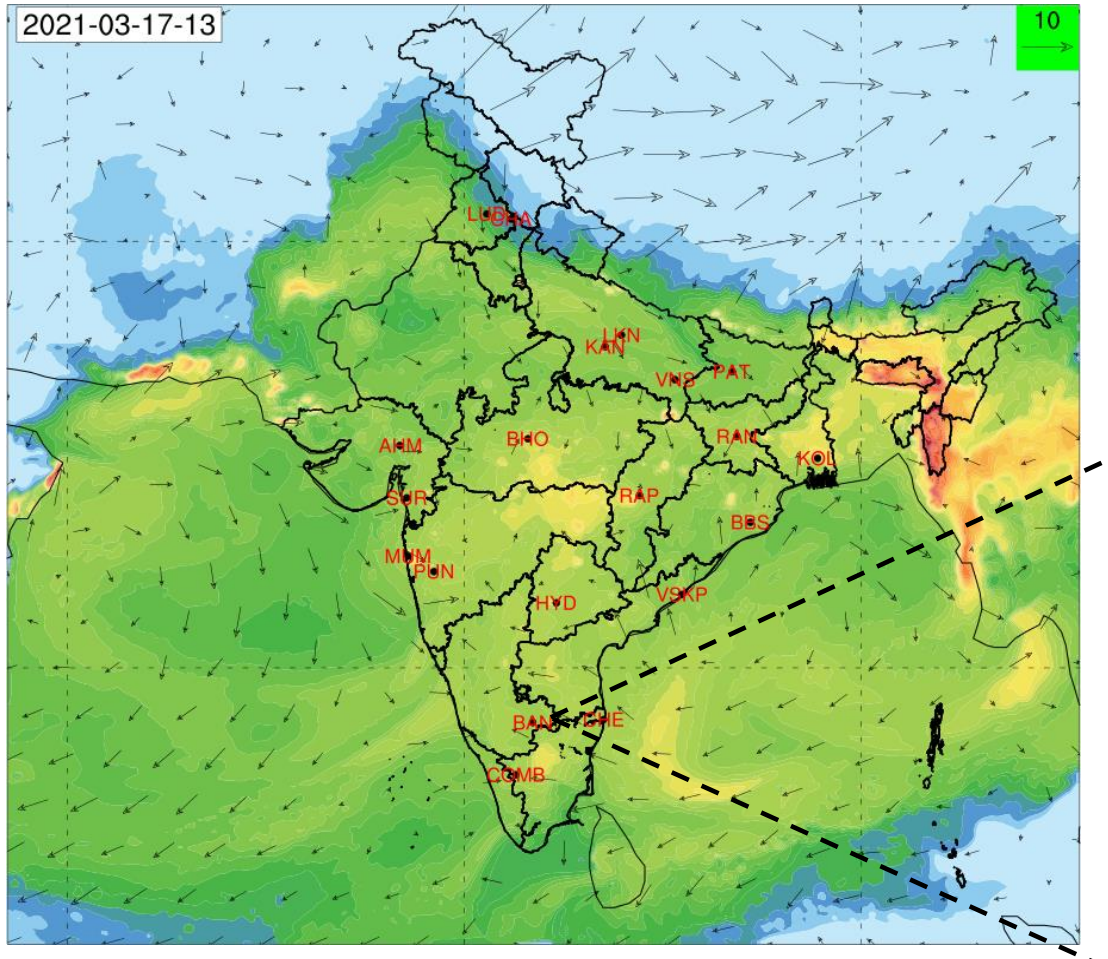


43 AQMS (CPCB,DPCC, IITM)

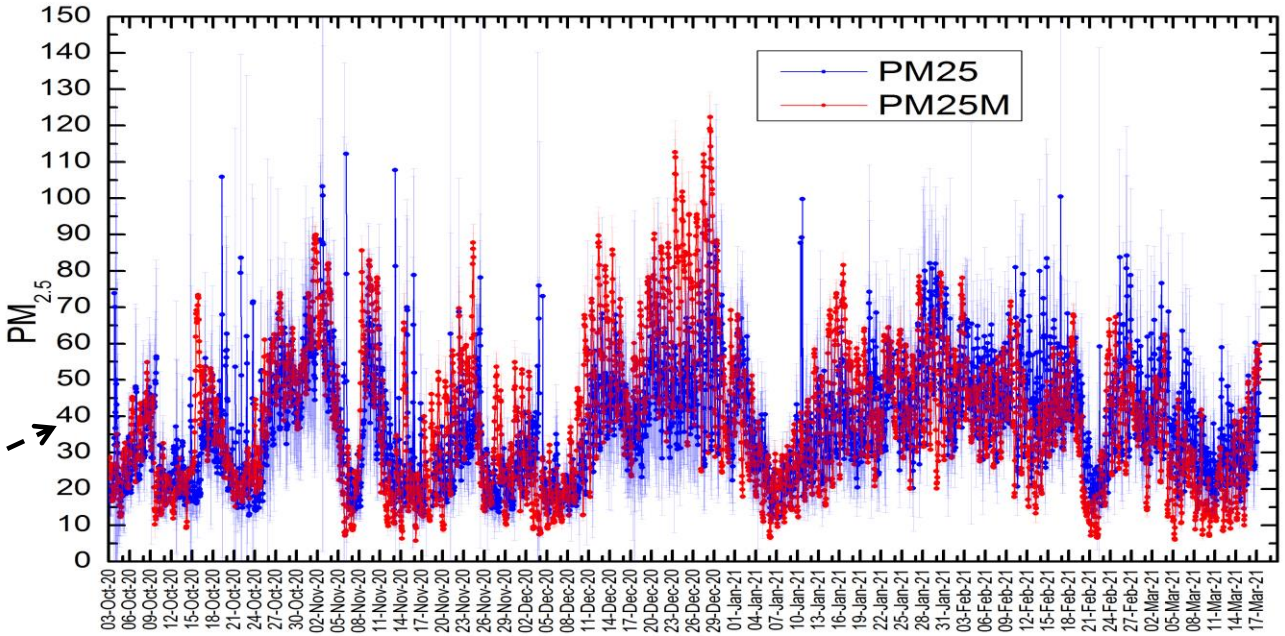
Forecast Evaluation @ 400 meter resolution (Winter 2019-2020)

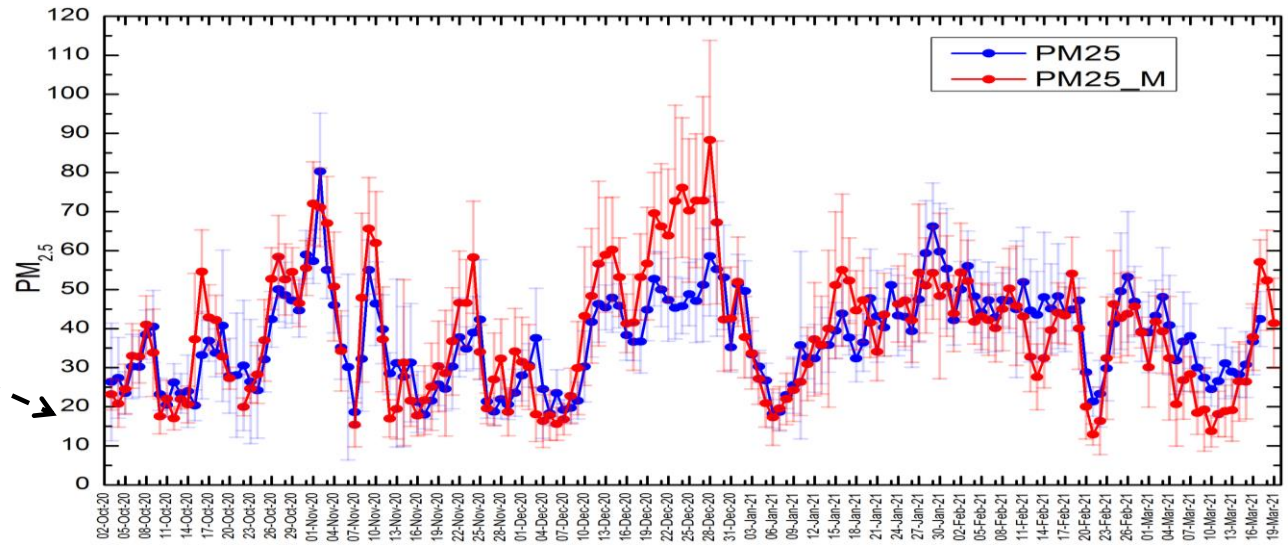


Operational Air Quality Early Warning System (AQEWS) – V2.0



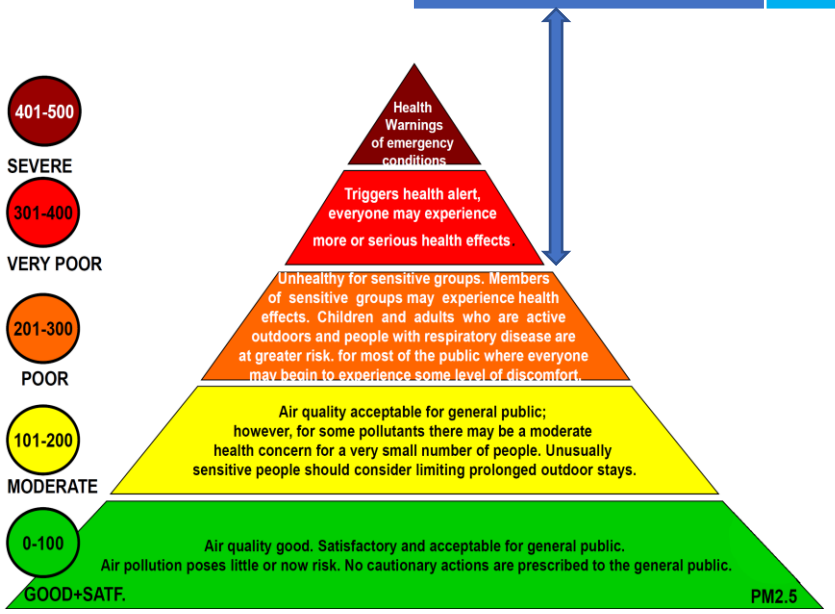
Forecast Evaluation for Bangalore city (Winter 2020-2021)





How good is forecast for absolute AQI index?

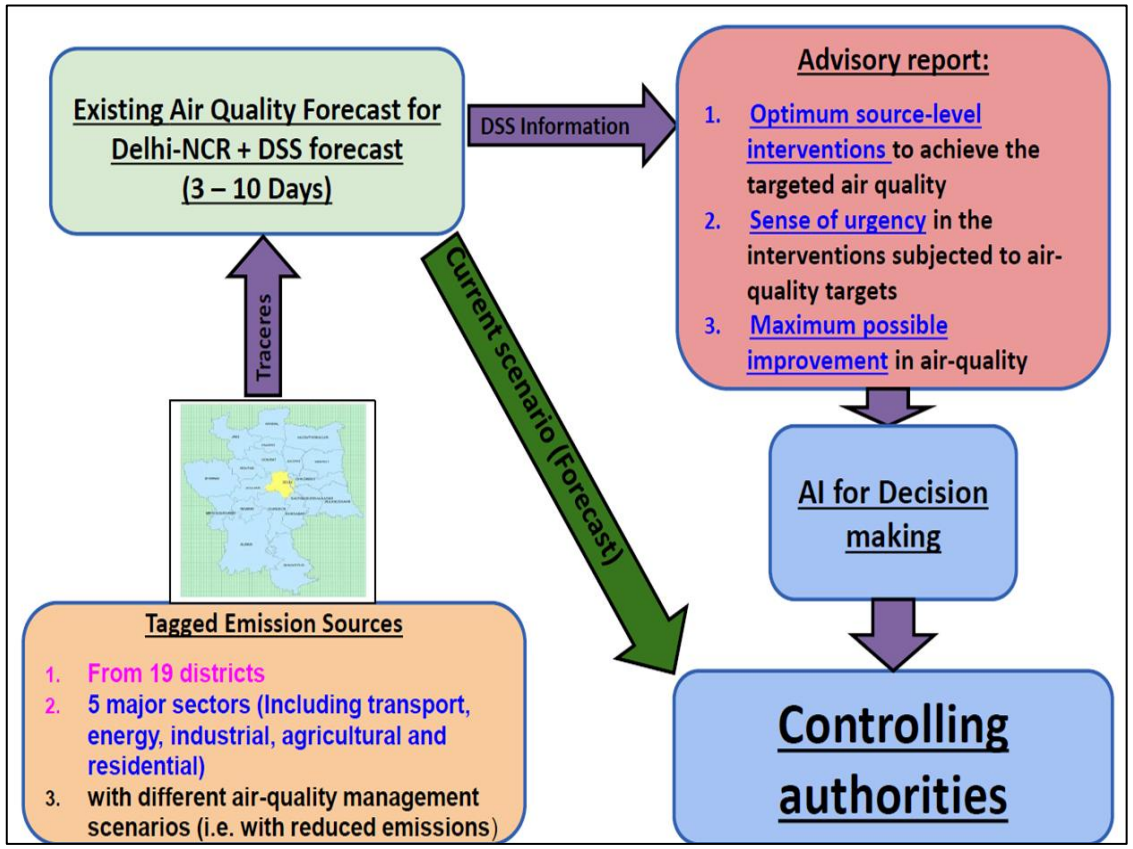
AIR QUALITY INDEX (AQI)		10km		400 meter	
		NMFB (%)	NMFE (%)	NMFB (%)	NMFE (%)
Very Poor (301-400)	1st day	1.2	6.4	2.3	6.8
	2nd day	- 5.3	9.1	- 0.8	6.9
	3rd day	- 8.3	11.4	- 3.9	8.7
Severe (401-Above)	1st day	- 11.1	15.6	- 13.9	16.3
	2nd day	- 22.1	22.2	- 17.2	17.8
	3rd day	- 26.7	26.7	- 20.7	20.9

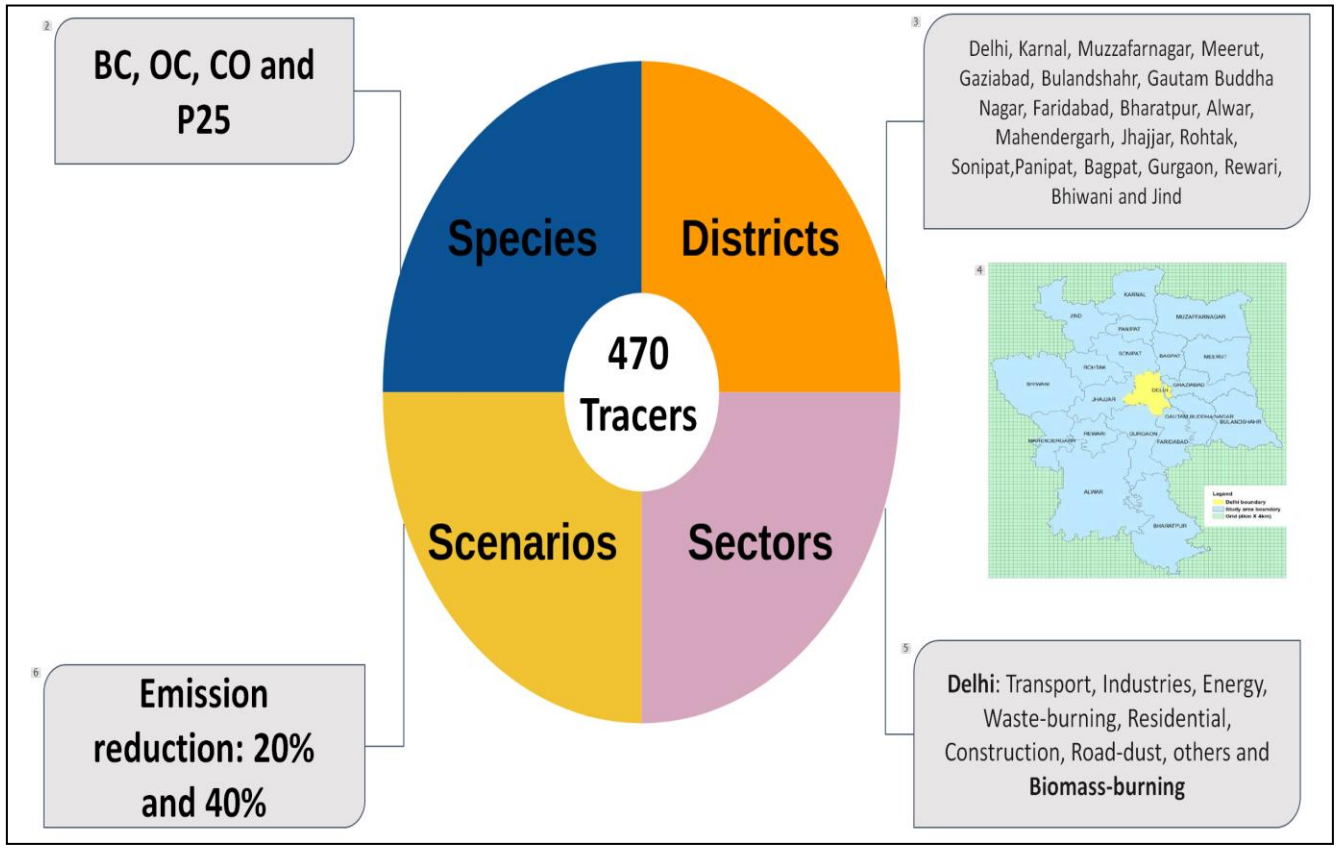


Forecast Evaluation

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

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

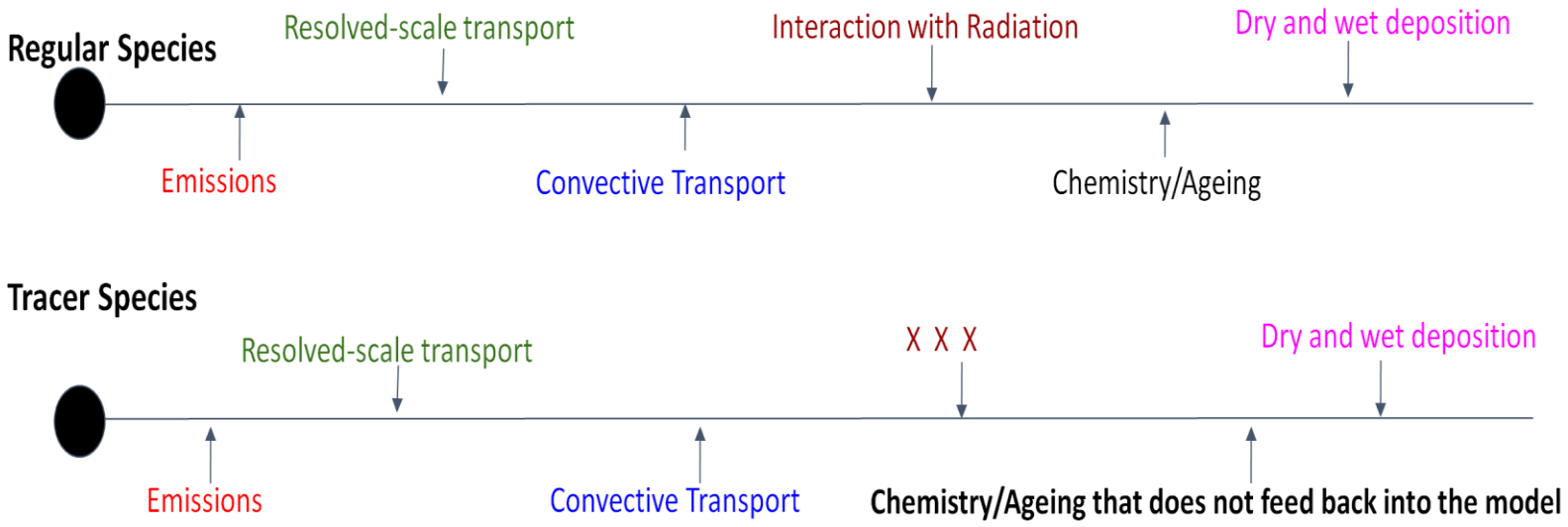


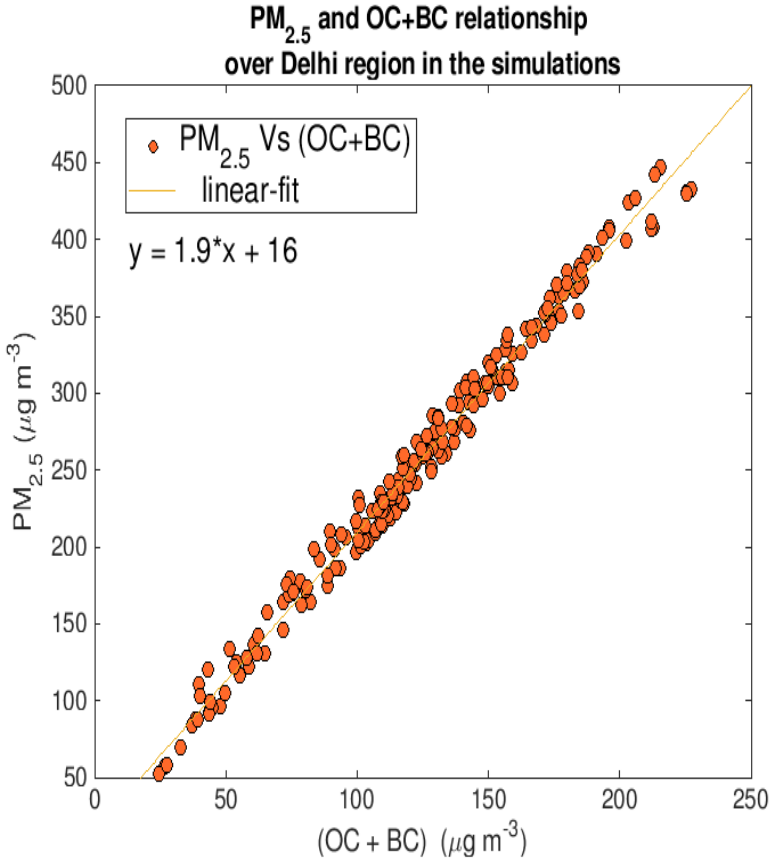


- Early warnings and possible ways to prevent the occurence of the event
- Effectiveness of the possible solution before the actual implementation
- Effective decision in a timely manner

Methodology: Implementation of tracers

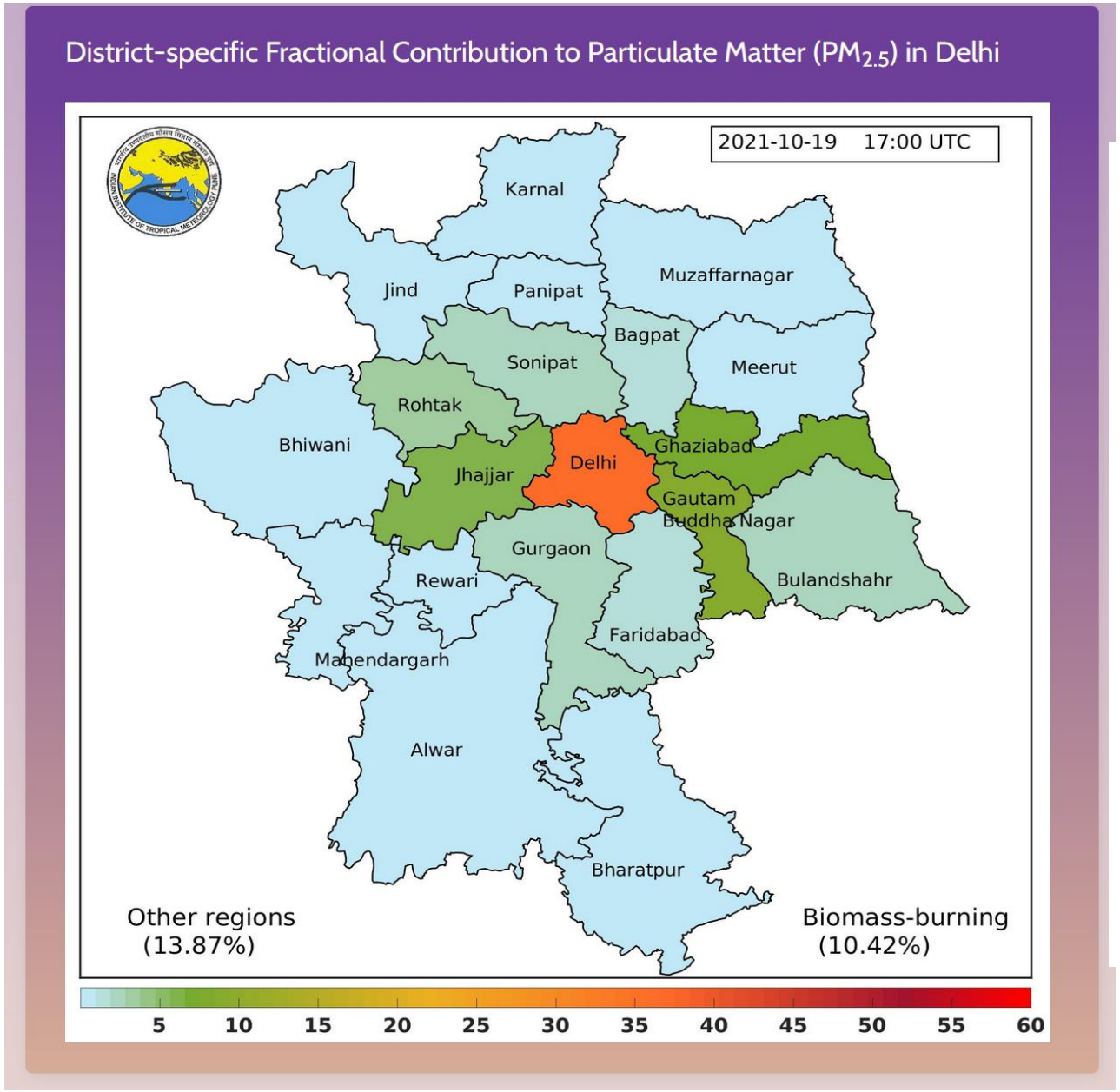
- **CO, BC and OC, P_{25} (BC1_tracer -> BC2_tracer in 2.5 days OC1_tracer -> OC2_tracer in 2.5 days) variables are tagged to identify and quantify the emission sources and regional contributions.**
- In the model, each of the tracers is considered as an individual transported species. E.g.

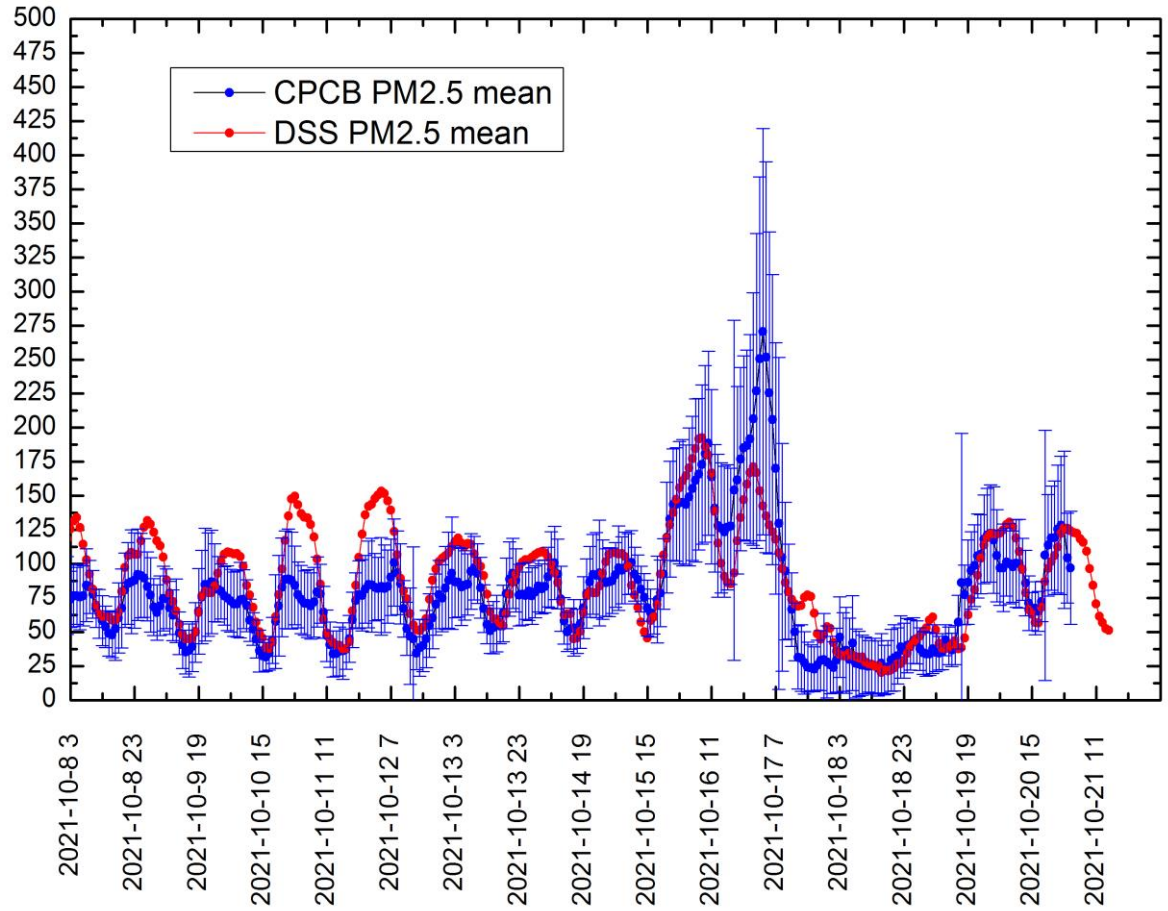




- **Non-interactive chemistry/ageing:**

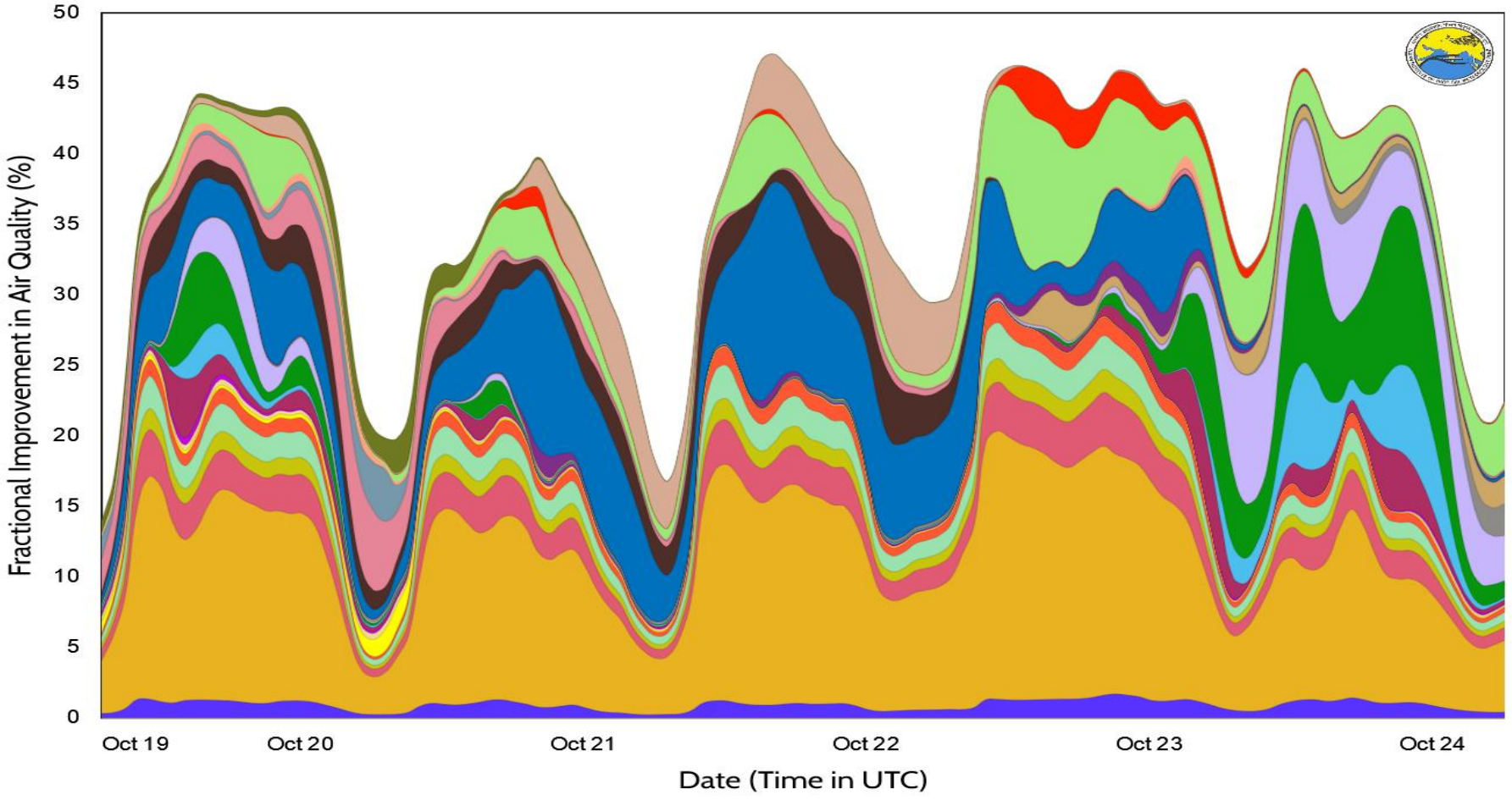
Decision Support System (DSS) for air-quality management in Delhi





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.



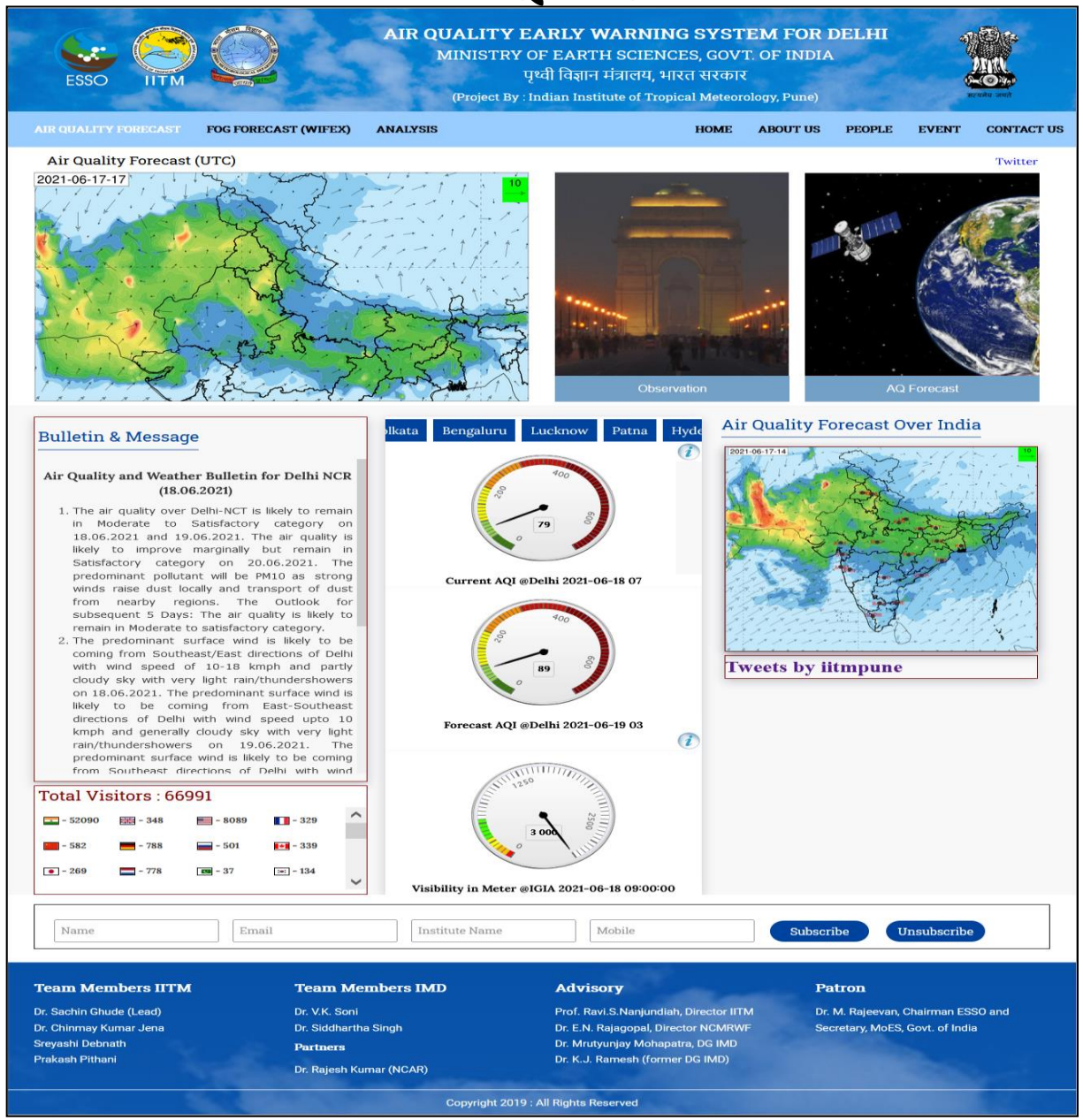
Select All

20% | 40% | District & Emission Sector

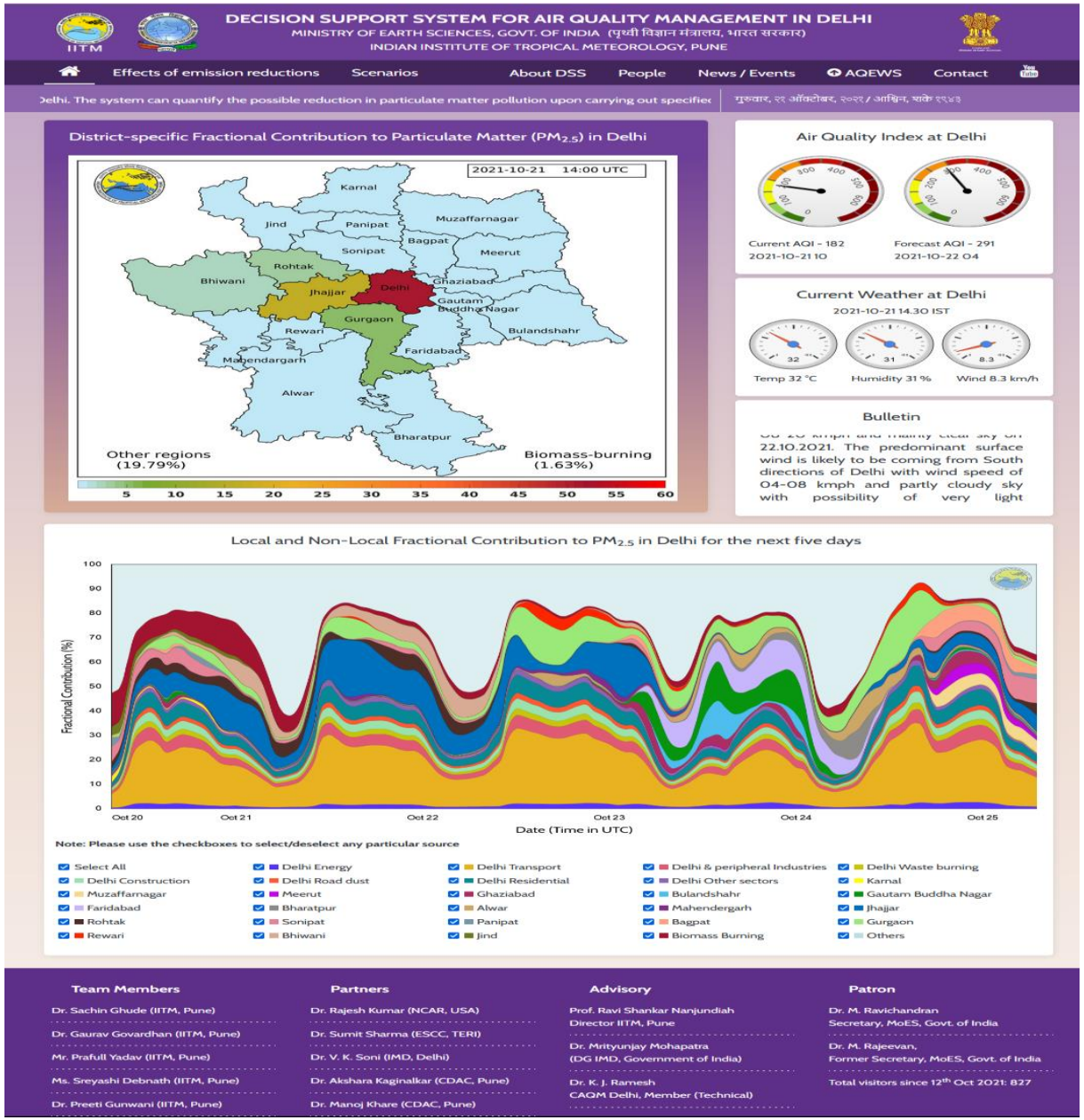
- Delhi Energy
- Delhi Transport
- Delhi & peripheral Industries
- Delhi Waste burning
- Delhi Construction
- Delhi Road dust
- Karnal
- Muzaffarnagar
- Meerut
- Ghaziabad
- Bulandshahr
- Gautam Buddha Nagar
- Faridabad
- Bharatpur
- Alwar
- Mahendergarh
- Jhajjar
- Rohtak
- Sonipat
- Panipat
- Bagpat
- Gurgaon
- Rewari
- Bhiwani
- Jind

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

AQWES



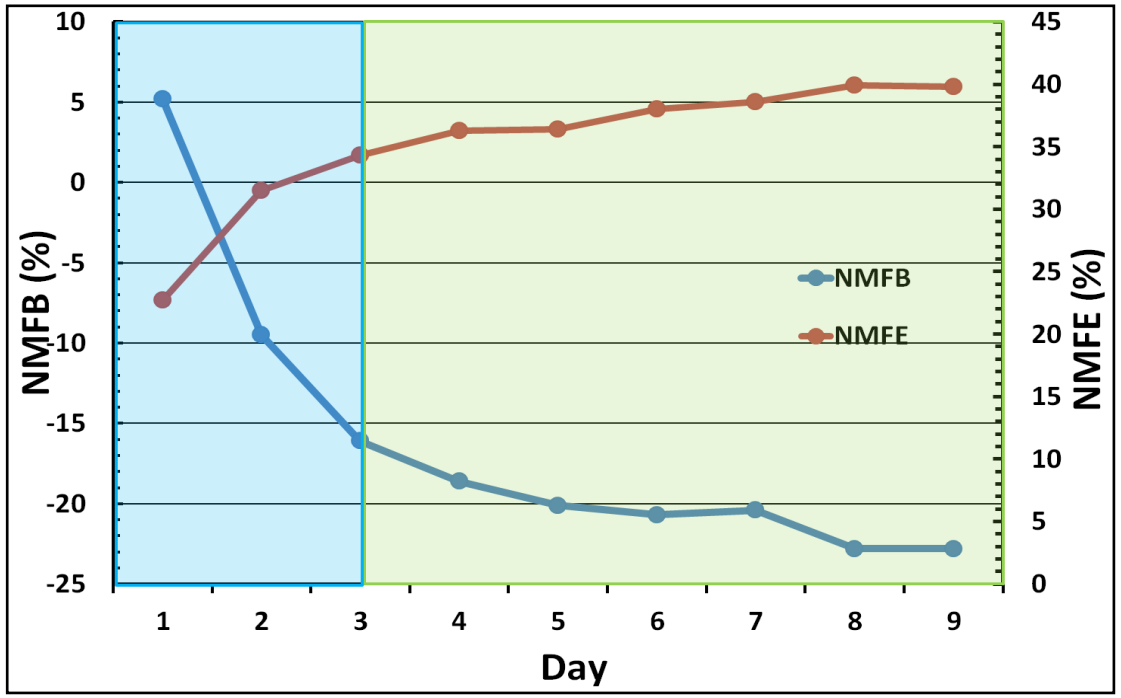
DSS



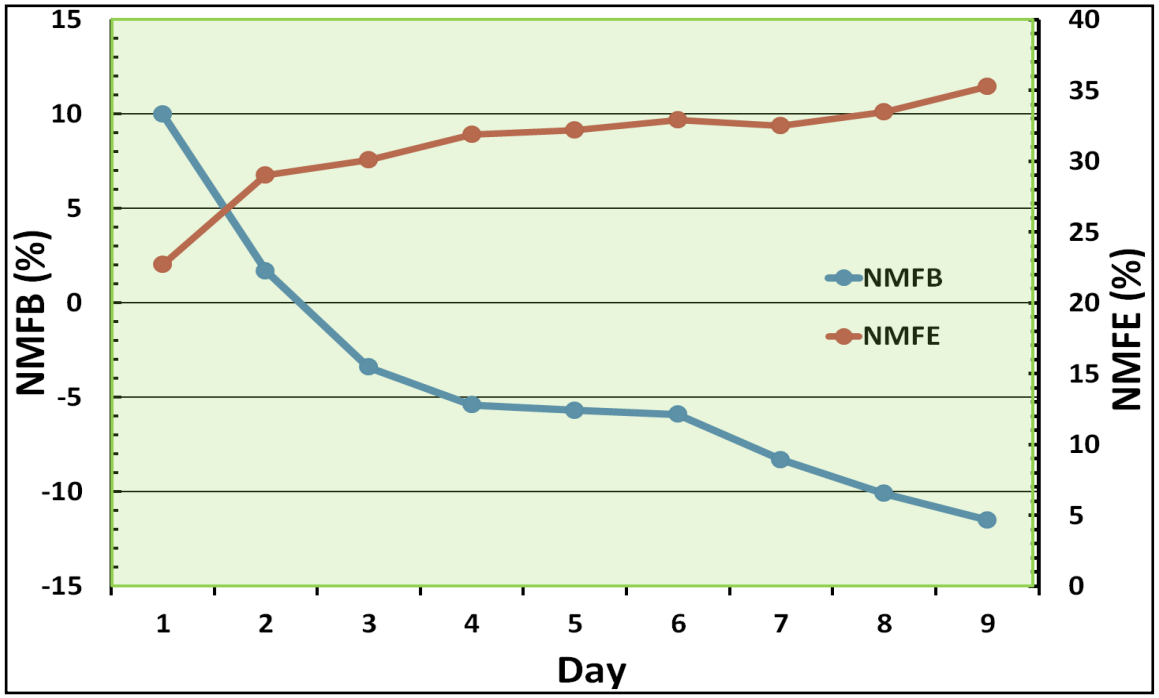
Thank You

Forecast Evaluation for 10 days

10 days skill @ 10 km



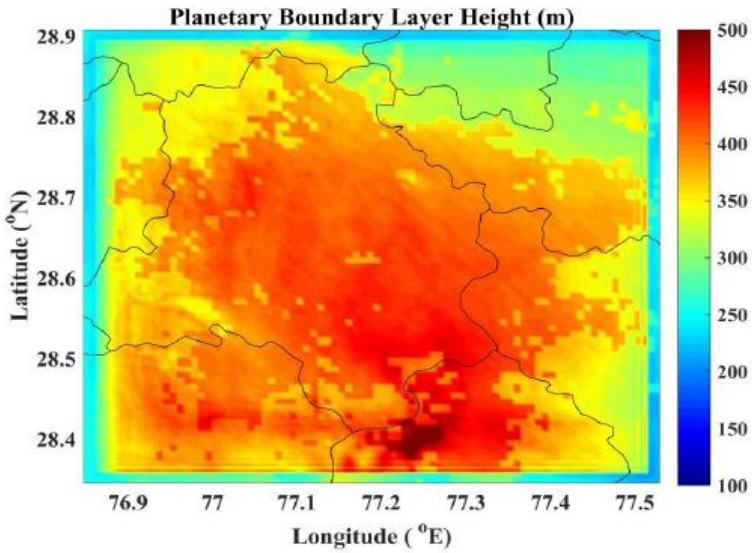
10 days skill @ 2km

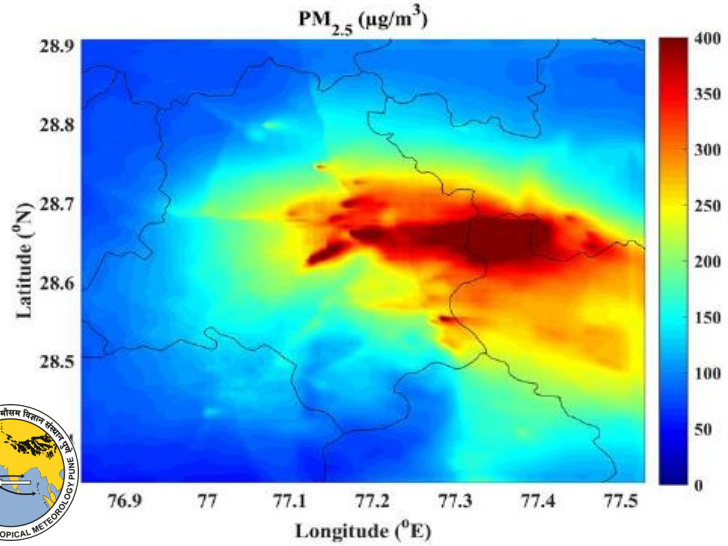


- The overall Performance of forecast is excellent for 3 days lead time and good for next 7 days at 10 km resolution
- The overall Performance of forecast is excellent for 9 days lead time at 2 km resolution

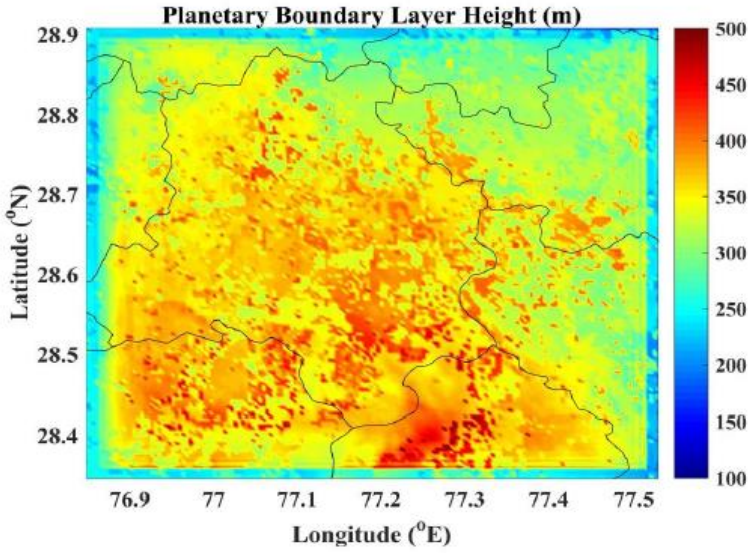
Updated Land-Use Classifications over Delhi

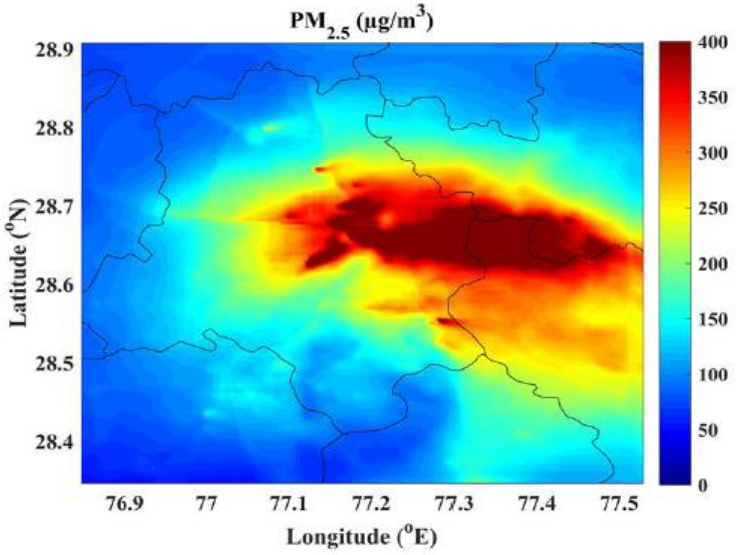
MODIS



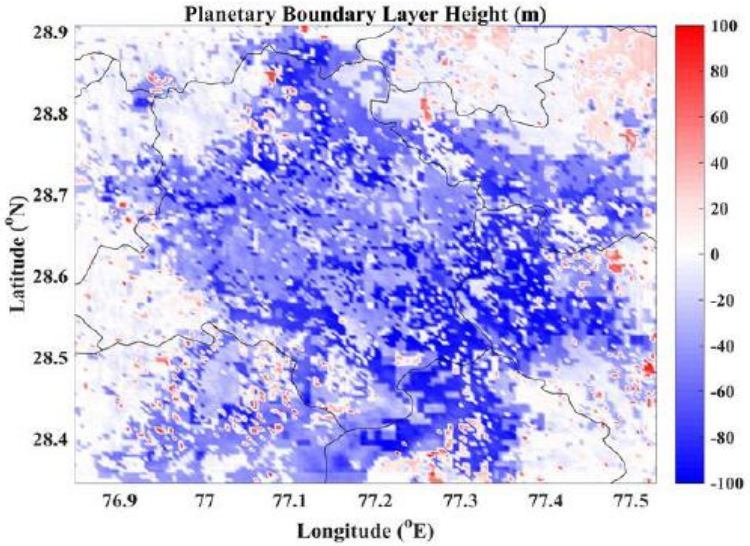


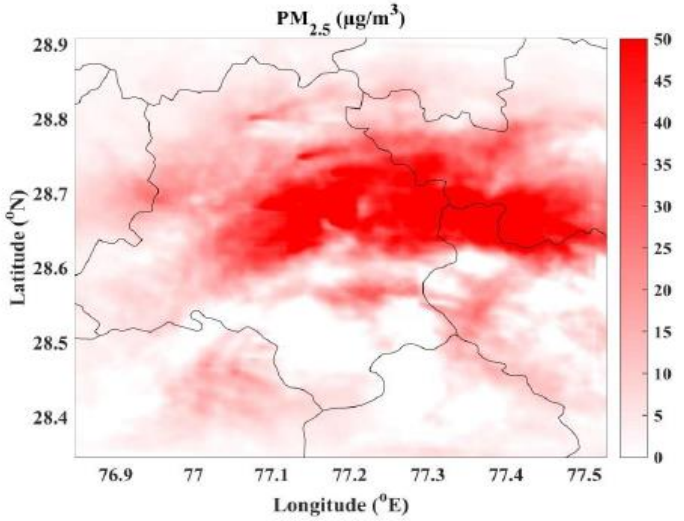
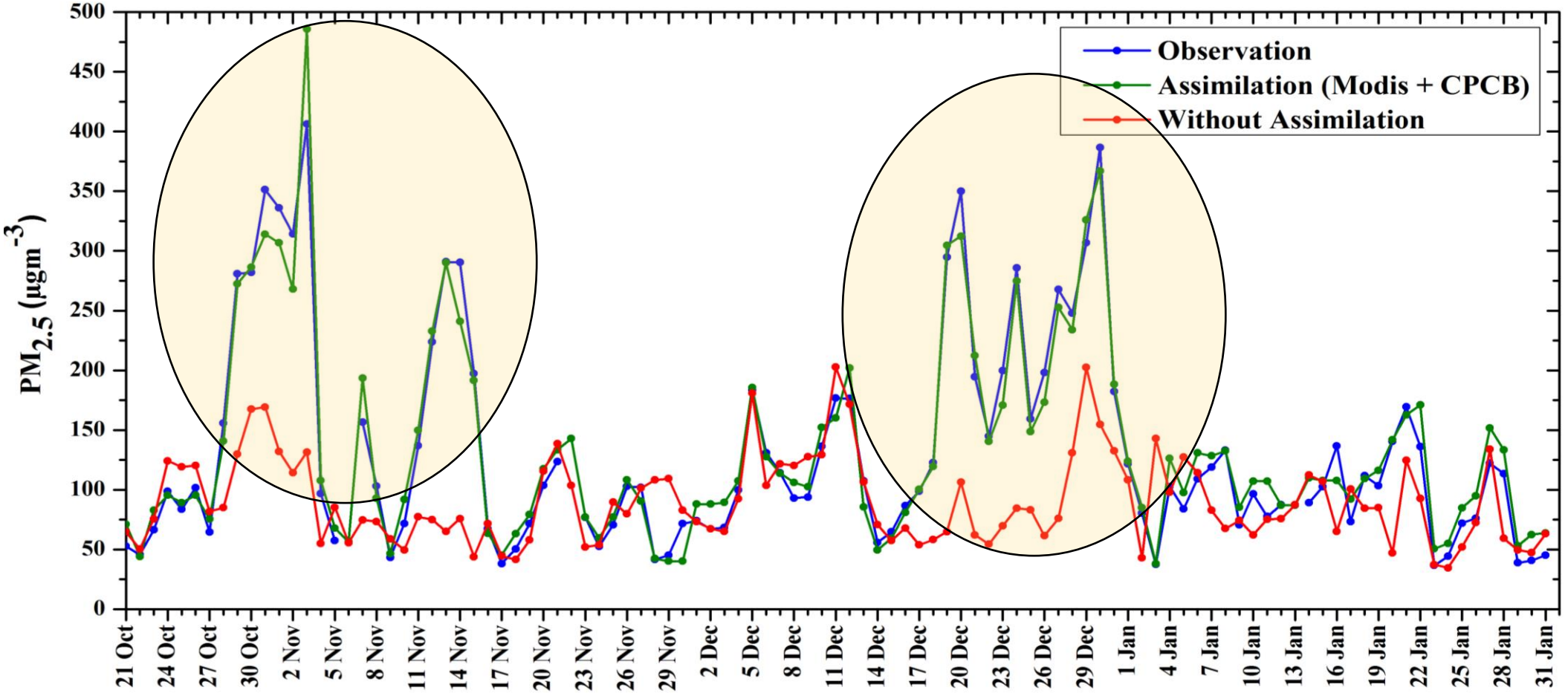
Sentinel





Difference (S-M)





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