

# HYSPLIT Modelling Approach for the Assessment of PM<sub>2.5</sub> over Indian Subcontinent

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# An Integrated Study of Air Pollutant Sources in the Delhi NCR :

## ASAP-Delhi

*IIT Delhi / NPL / Birmingham / Surrey*

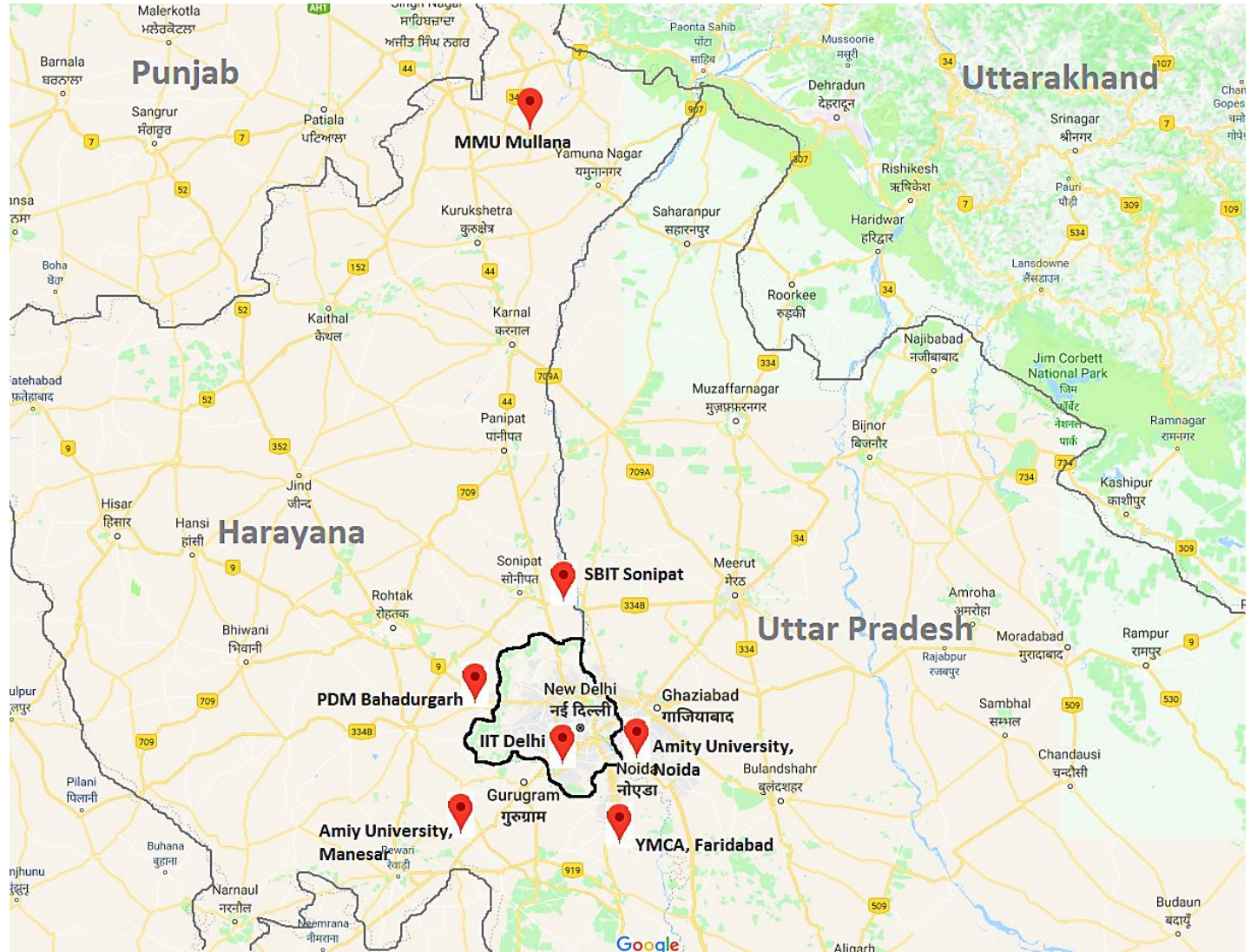
Prof Mukesh Khare (IIT Delhi) / Prof William Bloss (University of Birmingham)



UNIVERSITY OF BIRMINGHAM



# Sampling Station Locations



Source: Google Maps

# PM<sub>2.5</sub> Sampler Setup & Training



YMCA, Faridabad



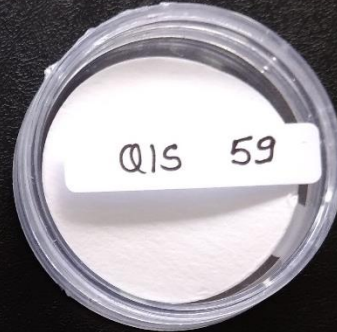
Amity University, Gurugram

# Filter Papers

Unused PTFE



QIS 59



Sampled PTFE

T SPARE 18



Q SPARE 18



Unused Tissuequartz

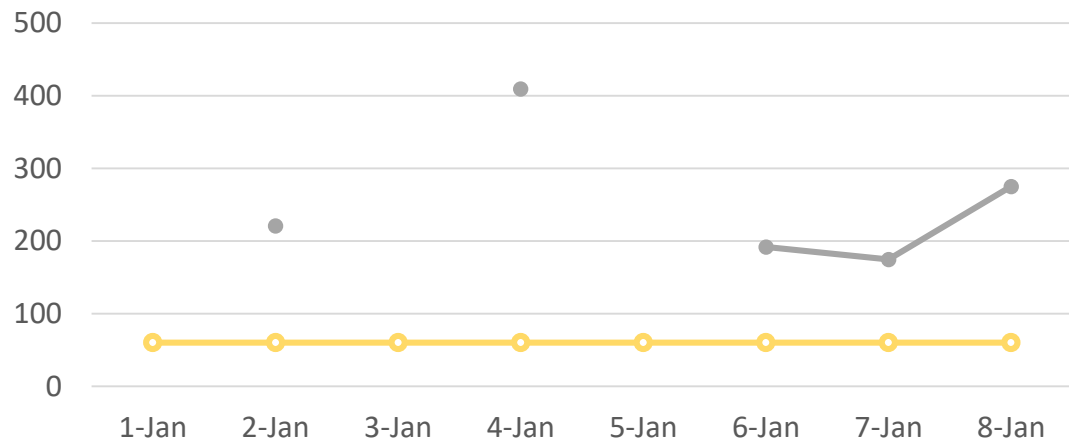
Sampled Tissuequartz

# Average Concentration of PM<sub>2.5</sub>

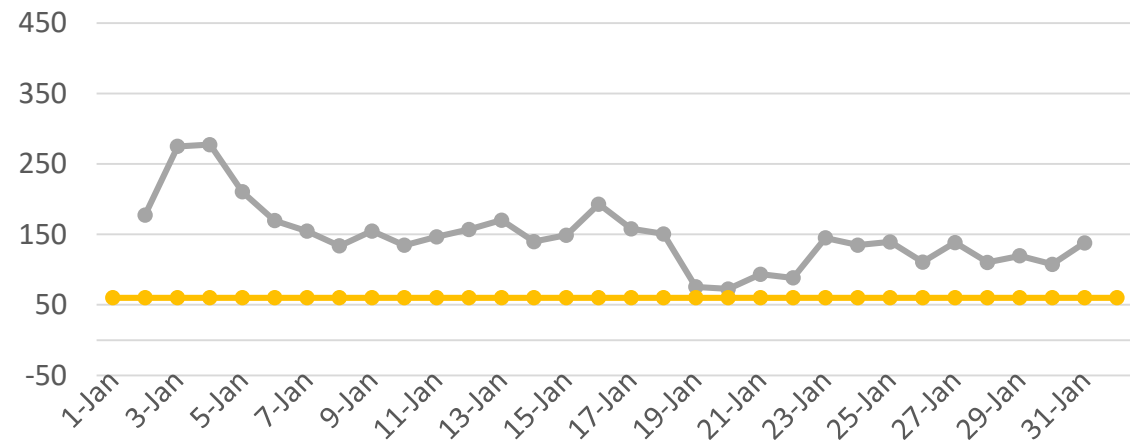
Stations	12-Hr Average Concentration of PM <sub>2.5</sub> (ug/m <sup>3</sup> )									
	Winter		Spring		Summer		Post Monsoon		Intensive	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
PDM Bahadurgarh	192	319	-	-	77	130	54	68	140	174
SBIT Sonipat	138	123	-	-	75	112	36	68	-	-
Amity Univ. Noida	104	164	61	114	72	132	42	78	-	-
YMCA Faridabad	91	183	59	129	46	58	78	126	-	-
Amity Univ. Gurugram	65	141	41	87	77	81	52	88	-	-
MMU Mullana	148	186	57	73	77	75	39	56	-	-
IITD Supersite	103	194	67	92	60	84	54	82	105	147

# Exceedances from NAAQS

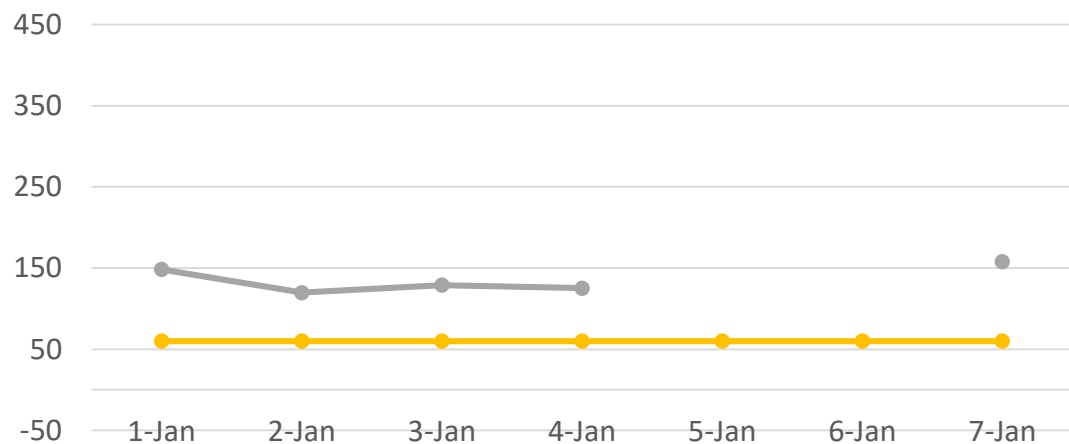
## PDM Bahadurgarh



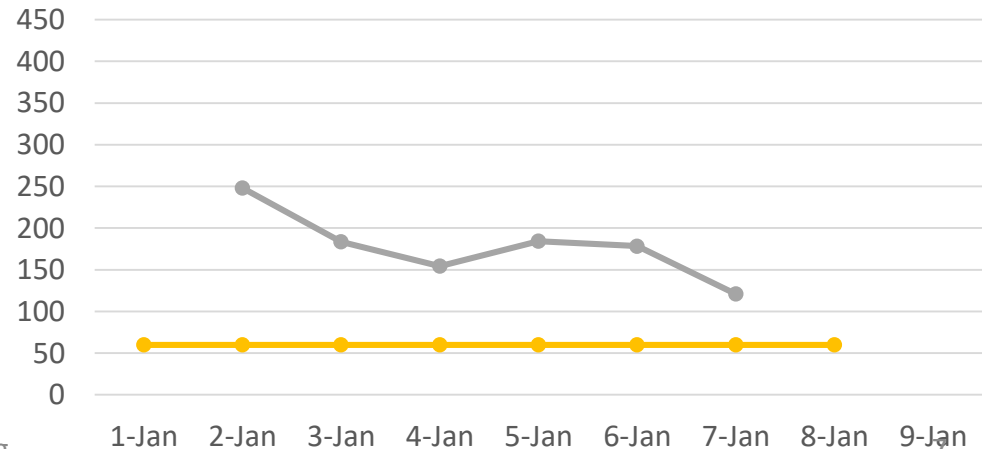
## IIT Delhi



## Amity University, Noida



## MMU Mullana



—●— 24 Hr Average    —●— PM 2.5 Standard

# Possible Sources in the Study Area

- **Delhi City**
  - Traffic
  - Industries (Thermal power plant, Industrial clusters)
  - Domestic (Kitchen)
  - *Open biomass burning*
  - *Construction dust*
  
- **NCR City Clusters**
  - Traffic from City clusters (only municipal areas)
  - Domestic (Kitchen)
  - Industries (Thermal power plant, any other Industrial clusters)
  - Brick kilns
  - Open biomass burning
  - *Agriculture residue burning*
  - Construction dust



# Transboundary Air Pollution

- Adverse impacts of emitted pollutants often cannot be confined to one location, one region, or even one continent.
- Agencies with environmental regulatory responsibilities need to *better understand*
- *How, when, and where long-range transport may lead to National Ambient Air Quality Standard (NAAQS) violations* or pollutant levels that exceed other regulatory guidelines.
- *Convention on Long-Range Transboundary Air Pollution* : only in developed countries

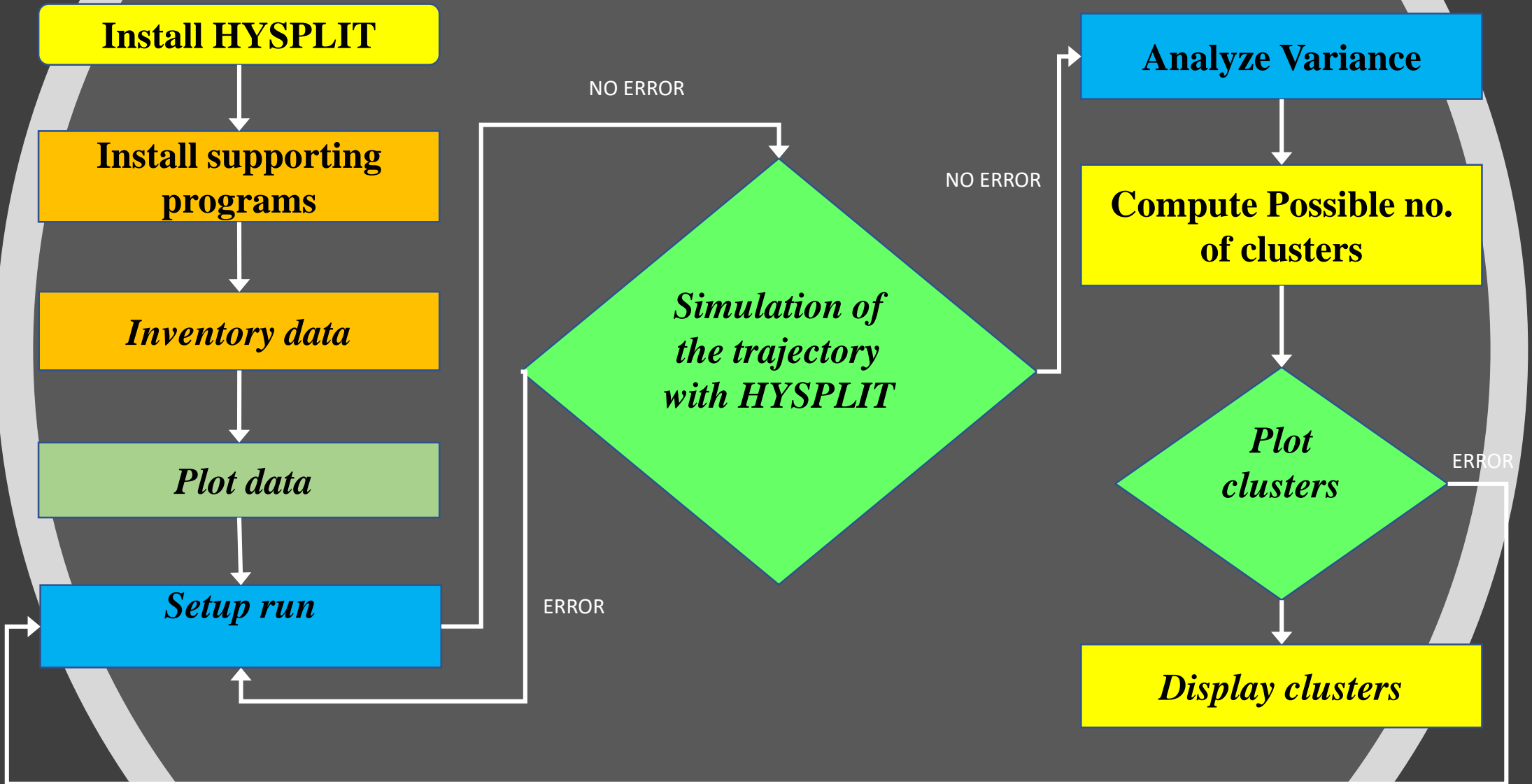
# Objectives

- Develop an approach using Hysplit backtrajectory analysis
- Identification of the possible source pathways at supersite IIT Delhi using cluster analysis
- To plot the hourly  $PM_{2.5}$  concentration and identify primary source areas by comparing it to air mass pathways.
- Understanding the effect of local and global meteorology on the movement of pollutants in Delhi NCR.

# HYSPLIT Model

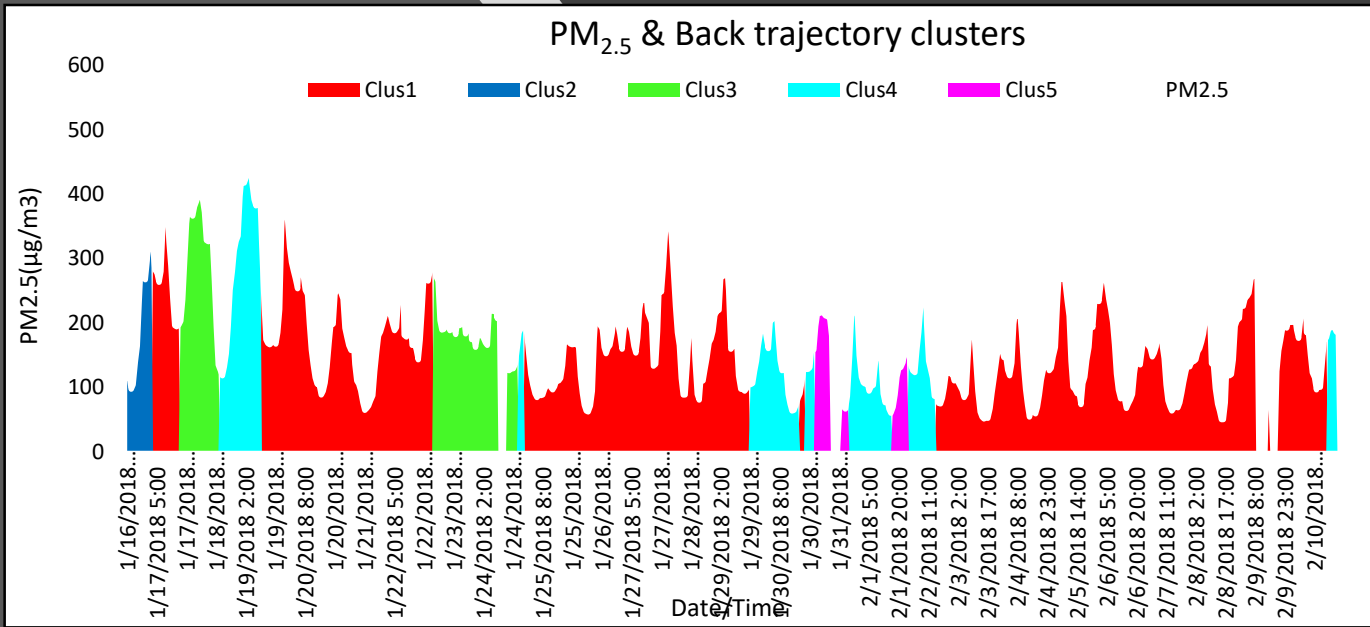
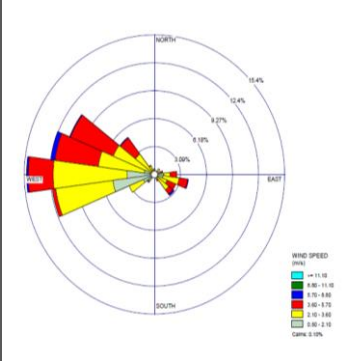
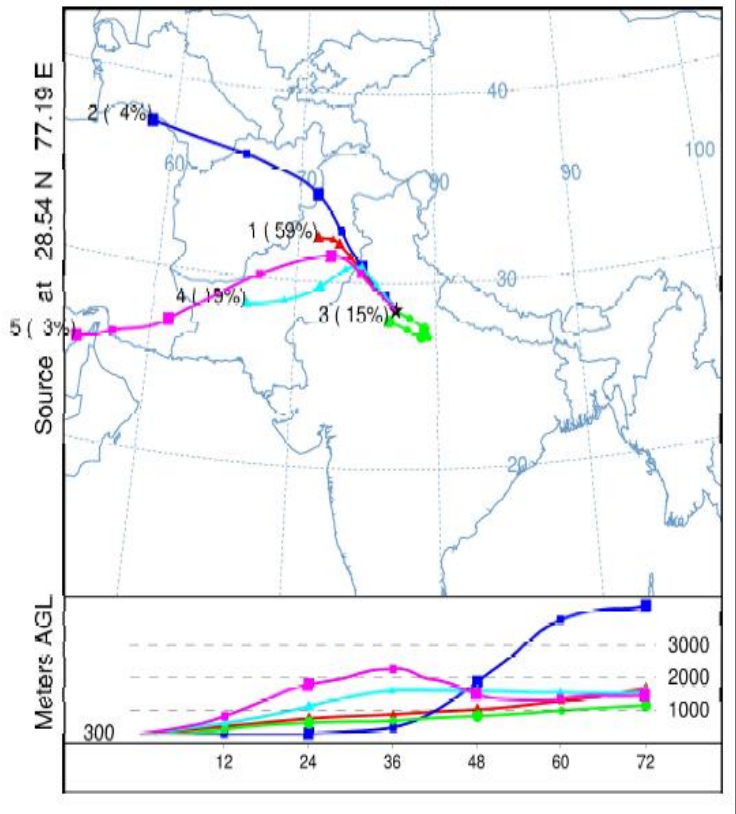
- The HYSPLIT model is a Lagrangian model that calculates the location of a single particle every hour backward from the starting point, which in this case is our sampling supersite IIT Delhi .
- HYSPLIT (Hybrid Single-Particle Lagrangian Trajectory) is useful to predict the trajectory, dispersion and concentration of pollutants from a point source, line and area.
- HYSPLIT uses meteorological data to track the movement and concentration either forward or backward in the period and at regular intervals.
- The output of the model consists of a text file in which each of these hourly locations is given (among other things) a time in negative hours and a position in latitude/longitude coordinates.

# Approach



# Winter (15/01/2018-15/02/2018)

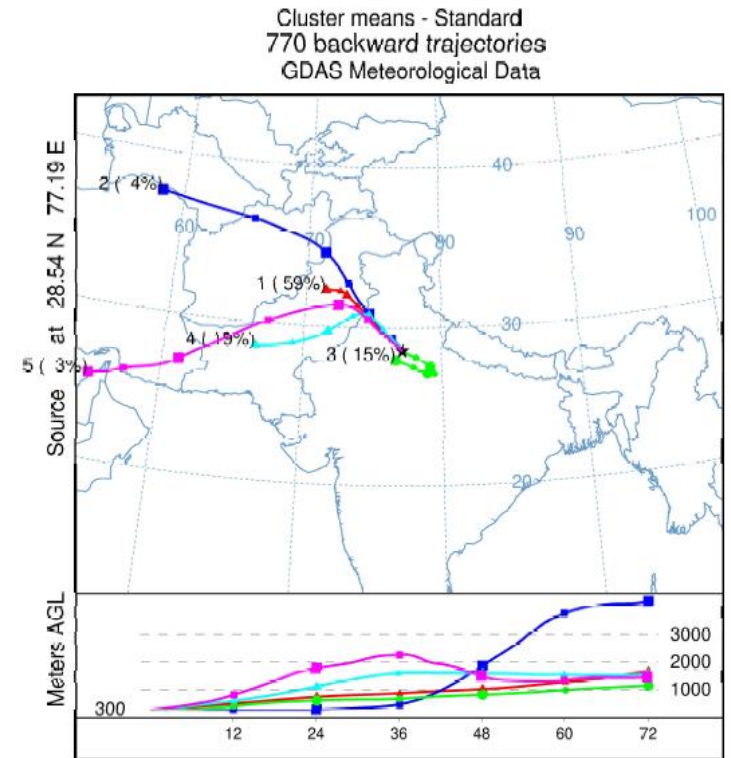
Cluster means - Standard  
770 backward trajectories  
GDAS Meteorological Data



PM <sub>2.5</sub> ( $\mu\text{g}/\text{m}^3$ )	clus1	clus2	clus3	clus4	clus5
avg	169	208	237	189	147
SD	73	95	81	103	59
min	50	97	126	60	66
max	419	351	400	478	229

# Observations

- Simulations indicate that 59 % of the air masses at IITD can be represented by cluster 1 (coming from Pakistan)
- Cluster 2 is coming from the North-North-West (from Iran), and the origin height is more than 3000m; it reduces to 300 m after it enters India.
- 9% of the clusters are represented by cluster 4 coming from Pakistan region with an average concentration of **189.02  $\mu\text{g}/\text{m}^3$** . The maximum value for  $\text{PM}_{2.5}$  is observed in this cluster as **478  $\mu\text{g}/\text{m}^3$**
- Cluster 3 indicated recirculation of air masses, which causes PM concentrations to be higher during that period. Highest average  $\text{PM}_{2.5}$  concentration **237.20  $\mu\text{g}/\text{m}^3$** .
- Windrose indicates that most of the times during the sampling period, wind was blowing from SW to NW direction, which is also the case in the air mass trajectories.



# References

- Xin, Y., Wang, G. and Chen, L., 2016. Identification of long-range transport pathways and potential sources of PM10 in Tibetan Plateau uplift area: Case study of Xining, China in 2014. *Aerosol Air Qual. Res*, 16(4), pp.1044-1054.
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- Tshela, Cheledi, and George Djolov. "Source profiling, source apportionment and cluster transport analysis to identify the sources of PM and the origin of air masses to an industrialised rural area in Limpopo." *Clean Air Journal* 28, no. 2 (2018): 54-66.



**THANK YOU**