HYSPLIT Modelling Approach for the Assessment of PM$_{2.5}$ 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)
Sampling Station Locations

Source: Google Maps
PM$_{2.5}$ Sampler Setup & Training

YMCA, Faridabad

Amity University, Gurugram
Filter Papers

Unused PTFE

Sampled PTFE

Unused Tissuequartz

Sampled Tissuequartz
### Average Concentration of PM$_{2.5}$

<table>
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<th>Summer</th>
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<th>Post Monsoon</th>
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Exceedances from NAAQS

PDM Bahadurgarh

Amity University, Noida

IIT Delhi

MMU Mullana

24 Hr Average

PM 2.5 Standard

06-05-2020

APHH Review Meeting
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 Langrangian 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.

Ref: https://www.ready.noaa.gov/HYSPLIT.php
Install supporting programs

Inventory data

Plot data

Setup run

Simulation of the trajectory with HYSPLIT

Analyze Variance

Compute Possible no. of clusters

Plot clusters

Display clusters
Winter (15/01/2018-15/02/2018)

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<th>PM$_{2.5}$ (µg/m$^3$)</th>
<th>clus1</th>
<th>clus2</th>
<th>clus3</th>
<th>clus4</th>
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<td>351</td>
<td>400</td>
<td>478</td>
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</table>
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 μg/m³. The maximum value for PM$_{2.5}$ is observed in this cluster as 478 μg/m³.

• Cluster 3 indicated recirculation of air masses, which causes PM concentrations to be higher during that period. Highest average PM$_{2.5}$ concentration 237.20 μg/m³.

• 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

- An Overview Of The Hysplit Modeling System For Trajectory ..., https://www3.epa.gov/scram001/9thmodconf/draxler.pdf