Geophysical Research Abstracts
Vol. 15, EGU2013-401-4, 2013
EGU General Assembly 2013

Taking potential probability function maps to the local scale and matching them with land use maps

Saryu Garg (1), Vinayak Sinha (1), Baerbel Sinha (2,3)

(1) Indian Institute of Science Education and Research (IISER) Mohali, S. A. S. Nagar, Manauli PO, Punjab, India (vsinha@iisermohali.ac.in), (2) Indian Institute of Science Education and Research (IISER) Mohali, Department of Earth Sciences, S. A. S. Nagar, Manauli PO, Punjab, India (bsinha@iisermohali.ac.in), (3) Max Planck Institute for Chemistry, Department of Particle Chemistry, Mainz, Germany

Source-Receptor models have been developed using different methods. Residence-time weighted concentration back trajectory analysis and Potential Source Contribution Function (PSCF) are the two most popular techniques for identification of potential sources of a substance in a defined geographical area. Both techniques use back trajectories calculated using global models and assign values of probability/concentration to various locations in an area. These values represent the probability of threshold exceedances / the average concentration measured at the receptor in air masses with a certain residence time over a source area. Both techniques, however, have only been applied to regional and long-range transport phenomena due to inherent limitation with respect to both spatial accuracy and temporal resolution of the of back trajectory calculations. Employing the above mentioned concepts of residence time weighted concentration back-trajectory analysis and PSCF, we developed a source-receptor model capable of identifying local and regional sources of air pollutants like Particulate Matter (PM), NO_x, SO_2 and VOCs. We use 1 to 30 minute averages of concentration values and wind direction and speed from a single receptor site or from multiple receptor sites to trace the air mass back in time. The model code assumes all the atmospheric transport to be Lagrangian and linearly extrapolates air masses reaching the receptor location, backwards in time for a fixed number of steps. We restrict the model run to the lifetime of the chemical species under consideration. For long lived species the model run is limited to $<$ 4 hrs as spatial uncertainty increases the longer an air mass is linearly extrapolated back in time. The final model output is a map, which can be compared with the local land use map to pinpoint sources of different chemical substances and estimate their source strength.

Our model has flexible space- time grid extrapolation steps of 1-5 minutes and 1-5 km grid resolution. By making use of high temporal resolution data, our model can produce maps for different times of the day, thus accounting for temporal changes and activity profiles of different sources.

The main advantage of our approach compared to geostationary numerical methods that interpolate measured concentration values of multiple measurement sites to produce maps (gridding) is that the maps produced are more accurate in terms of spatial identification of sources. The model was applied to isoprene and meteorological data recorded during clean post-monsoon season (1 October- 7 October, 2012) between 11 am and 4 pm at a receptor site in the North-West Indo-Gangetic Plains (IISER Mohali, 30.665° N, 76.729°E, 300 m asl), near the foothills of the Himalayan range. Considering the lifetime of isoprene, the model was run only 2 hours backward in time. The map shows highest residence time weighted concentration of isoprene (up to 3.5 ppbv) over agricultural land with high number of trees ($>$180 trees/gridsquare); moderate concentrations for agricultural lands with low tree density (1.5-2.5 ppbv for $<$180 trees/gridsquare) and lowest concentrations (< 1.5 ppbv) from urban and industrial areas.

We also applied the model to PM2.5 data recorded during winter season (10 December,2011 – 29 February, 2012). Keeping in consideration the limitation of linear extrapolation backwards in time, the model was run only for 4 hours. The full season average map highlights major highways and high traffic density roads with residence time weighted concentrations of more than 150-200 $\mu g/m^3$ for National Highway 1 (part of the Grand Trunk Road between Delhi and Punjab) and less than 100 $\mu g/m^3$ for other low traffic density areas. Restricting the analysis to evening peak traffic (5 pm -23 pm) residence time weighted concentrations > 250 $\mu g/m^3$ for traffic hotspots in Chandigarh City are observed. Based on the validation against the land use maps, the model appears to do an excellent job in source apportionment and identifying emission hotspots.

Acknowledgement: We thank the IISER Mohali Atmospheric Chemistry Facility for data and the Ministry of Human Resource Development (MHRD), India and IISER Mohali for funding the facility. Chinmoy Sarkar is acknowledged for technical support, Saryu Garg thanks the Max Planck-DST India Partner Group on Tropospheric OH reactivity and VOCs for funding the research.