Locating and Quantifying Sources of Air Pollution
by Nonparametric Trajectory Analysis

Abstract

In order to improve air quality, it is necessary to identify the sources of airborne pollution. Local emissions are more controllable compared to regional emissions which may not even be in the same city or state as the impacted area. By knowing and reducing local emissions, even without completely eliminating them, air quality may be greatly improved.

There are generally two types of air quality models used to evaluate the impact of emissions on air quality on a local, regional, and global scale: traditional source-oriented models and receptor models. Source-oriented models require detailed information on emission composition and rates and also meteorological data. On the other hand, receptor models use chemical fingerprints to quantify sources affecting the monitoring site. This type of model does not consider the meteorological conditions such as wind speed and direction, which reduces the accuracy of locating the sources of air pollution. Receptor models cannot be used for some simple pollutants such as SO\(_2\) due to the lack of chemical fingerprints. Therefore, these models have some shortcomings in quantifying the emission sources on smaller scales. This is especially true when there are changes in emission rate and composition of sources and also for some hard to identify sources such as windblown dust and construction activities due to lack of chemical analysis.

This study proposes a new hybrid receptor model. Unlike source-oriented models, this model uses short time average observations of pollutant concentrations. And unlike conventional receptor models, this model uses meteorological data such as wind speed and wind direction. The goal is identification and quantification of local sources of emissions.

In order to identify the location of emission sources, back trajectories are calculated by using wind speed and wind direction from one or more monitoring sites. The points on each back trajectory are associated with the pollutant concentration when the trajectory arrives at the monitor. The average value of the pollutant at the monitor, given that air has passed near a geographical point on a grid, is calculated by nonparametric regression of the pollutant concentrations over all the back trajectories passing near the point for the period of interest. Using multiple monitors increases the reliability of back trajectories by combining metrological data. This will help expanding the range of back trajectories and reduced the error if one set of data is not available or unreliable.

The method is illustrated by application to 1-minute SO\(_2\) data from Long Beach, CA and 1-minute PM\(_{10}\) data from Rubidoux, CA along with meteorological data from 29 sites. The results identify the location of a refinery around the Port of Long Beach and the Port of Los Angeles with high emission of SO\(_2\). Using the Rubidoux data, emission sources are located at aggregate, ready mix, and asphalt factory and also at excavation and construction sites.