University of Macau

Abstract

The Multi-puff Approach and the Data Assimilation Technique to Improve a Classical Gaussian Plume Model

by Leong Ka U

Thesis Supervisors: Prof. K. M. Mok & Prof. Ana Isabel Miranda
Civil Engineering Program

The Gaussian plume model is the most common air pollution model which can be applied to relatively small areas with stationary and homogeneous conditions. However, these ideal conditions may not be present often. In order to model the dispersion of air pollutants under a more realistic non-homogeneous wind condition, the puff-approach was applied in this study. This approach is to use a series of discrete puffs with their concentrations following the Gaussian normal distribution while being advected to simulate a continuous meandering plume. The developed Gaussian-puff model was then applied to simulate the concentration of SO_2, a non-reactive pollutant, sourcing from sixty-five road traffic line segments over the city of Lisbon in Portugal. The results show that the model is capable of simulating the transport and dispersion of non-reactive pollutants from various sources under complex wind field and different atmospheric conditions. The model results are in good agreements with the field-monitored data qualitatively but could be better quantitatively.

To improve the simulation results, a data assimilation technique is introduced so that better results can be obtained through optimal interpolation in the sense of a

statistical approach between the model values and the observed data. The optimal interpolation is done by minimizing the error covariance of the analyzed data based on certain correlation functions. For the present Lisbon case study, the correlation functions were determined to be spherical from historical measurements obtained from the Lisbon air quality-monitoring network. The simulation results corrected by the optimal interpolation show that they can be improved by 36% over the non-assimilated results.