Chapter 18
Evolutionary Lagrangian Inverse Modeling for PM$_{10}$ Pollutant Dispersion

Alejandro Peña
Escuela de Ingeniería de Antioquia, Colombia

Jesús A. Hernández
Universidad Nacional de Colombia, Colombia

María Victoria Toro
Universidad Pontificia Bolivariana, Colombia

ABSTRACT

One of the main concerns when it comes to mitigating the effects of the concentration of the particulate matter PM$_x$ in an area of study is the fact to determine its behavior over time, overcoming both physical and mathematical limitations in terms of a phenomenon of dispersion. Therefore, this chapter develops and analyzes a model based on the principles of evolutionary computation (EC) in order to determine the space-time behavior of the concentration of the particulate matter PM$_x$ in a study area. The proposed model has three submodels within an integrated solution, which constitute the individual to evolve. The transformation of the possible solutions or generational population is made by using an asynchronous evolutionary model, due to genetic dependency between substructures. The proposed model was validated for configurations of $n$ sources of emissions and $m$ monitoring stations that measure the quality of the air in a study area.

INTRODUCTION

One of the main concerns when it comes to reducing the concentration values for particulate matter PM$_x$ in a study area, is the fact to determine their spatial behavior over time. In order to describe this behavior, it is necessary to overcome a series of physical and mathematical constraints. From the physical point of view, the restrictions are determined by the number of monitoring stations for air quality that are located in an area of study, or by the inability to carry out campaigns that enable the identification of the behavior of a pollutant over time, especially in areas where access is difficult. From a mathemati-
that is why this chapter analyzes and develops a model based on the principles of evolutionary computation (EC), which includes two submodels in one solution or an individual to evolve, which is based on a Kohonen Map Features Model (KFM) (Galvan & Isaz, 2004). The first substructure is used for estimating emissions in $n$ sources from a series of measurements of the concentration for $PM_x$ taken from $m$ monitoring stations that they measurement the air quality. This substructure is associated with the pattern of emissions or input to the KFM model. The dynamics of the dispersion model, which is used for estimation, is governed by a lagrangian gaussian puff tracking model LGPT (Martín et al., 2002), which is based on the principles of a backward gaussian puff tracking (BGPT) (Israelsson et al., 2006). The second substructure permits to determine the spatial distribution of the concentration for $PM_x$ starting from identifying the concentration of puffs in the study area, thus macropuffs are generating a special type of functions, called Non Uniform Puffs Functions (NUPFS) (Peña & Hernández, 2007(a); Peña & Hernández, 2007(b)). The model for the interpolation representation that determines the second structure is defined by the principles of a Takagi– Sugeno Model (TKS) (Sanchez et al., 2005) with NUPFS base functions. For the transformation of the possible solutions, or population of the present generation, the model uses an asynchronous evolutionary model (AEM), due to the genetic dependency between substructures. Finally, the proposed evolutionary model was validated in a real part of the study area, in which $n$ selected sources of an industrial type and $m$-monitoring stations are located spatially. In order to validate this model, a study area, comprising an area of about 25*25 km$^2$, was selected in the Aburrá Valley, located in Antioquia, Colombia, South America.

**BACKGROUND**

The pollutant dispersion models have been used over time to determine the concentrations and flow and trace of elements according to the spatial distribution of sources and drains, the effect of the transport by flows mean and turbulent in the atmosphere, which are obtained from meteorological models or by detailed observation of the environment (Gallardo, 1997). According to this dynamics, currently there are a number of questions that are directly related to how and in which form emissions of pollutants from different sources occur, or what is the contribution or...
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