**Urban atmospheric dispersion modeling with artificial neural networks: using the Indianapolis data set.**

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**Highlights**

* Artificial neural networks are used to forecast dispersion concentrations
* Two dimensional model is used
* Results show improvement compared to Gaussian models while keeping low computing time

**1. Introduction**

Atmospheric dispersion modelling in complex environment is a tricky task because of the number of parameters involved. Indeed, dispersion in the free field is highly influenced by stability of the atmosphere. Moreover, when complex terrain is considered, the process of dispersion may be considered as non-linear due to the directivity of the flow with buildings. In order to evaluate the performance of atmospheric model, different data set are used. One of them is helpful to deal with dispersion around urban area. The Indianapolis dataset correspond to a 170 hours recording of SF6 concentration with 160 ground level monitors. The SF6 source was released from the top of an elevated stack inside the urban area. While Gaussian models are usually applied very fast, they present low level of performance. On the other hand, models from Computation Fluids Dynamics (CFD) are accurate but requires high expertise and important computer resources. In this paper, we investigate the potential of a neural network to predict concentrations in the urban field, using the Indianapolis experiments as a database for the training process.

**2. Methods**

The EPRI Indianapolis field study involved SF​6​ tracer releases from the 83.8 m stack at the Perry K power plant in Indianapolis, Indiana, USA in a typical urban area with many buildings within two kilometers of the stack. 170 hours of tracer data are available from September and October, 1985, and represent all stability classes and most wind speed ranges. Meteorological observations were taken from a 94 m height at the top of a building in the middle of the urban area. Concentrations were measured on a network of about 160 ground-level monitors on arcs at distances ranging from 0.25 to 12.0 km from the stack.

Before training the neural network, the example database has to be built from the initial one. Several recordings exist for the meteorological data. A correlation matrix including measured concentrations is made in order to established the weather station to use. The inputs selection is made through this use. Inputs used are related to the weather, the release and the location where the concentration has to be predicted. In order to compare ANN method to Gaussian models, we use same inputs as Gaussian models to train a Multi Layer Perceptron (MLP). The training phase is optimized through the variation of three parameters: initialization, number of neurons in hidden layer and variable selection. Evaluation of the model performance is done through the use of Hanna and Chang criteria.

**3. Results and discussion**

To select the best model, several initializations are made. The influence of this parameter on the result is emphasized through the value of the coefficient of determination. Moreover, increasing the number of neurons in hidden layer shows an improvement in the results. For each best initialization, the best model is obtained with less than 10 neurons in hidden layer. Finally, the selection of the variables shows that the best variables to be selected as inputs are those traditionally used in Gaussian model. This model shows an improvement compared to Gaussian model.

**4. Conclusions**

The model presented here uses neural networks to forecast concentration on the two dimensional dispersion field. It improves the results of Gaussian models giving the maximum concentration by searching in the entire database of the Indianapolis data set. Finally, the model gives the opportunity of building a two dimensional map of the concentration through time.

**References [Calibri 10]**

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