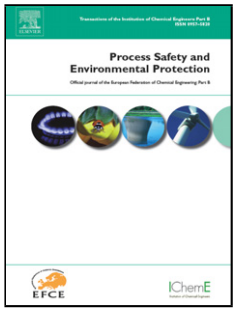

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Three Dimensional Gas Dispersion Modeling Using Cellular Automata and Artificial Neural Network in Urban Environment

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Abstract

The gas dispersion simulation in complex urban environment posts challenges on consequence analysis. Though computational fluid dynamics (CFD) are general approaches to provide building-resolving estimates, the time consuming calculation and complex process of modeling limit their application for emergency response. In this paper, a cellular automata dispersion model is prompted to simulate continuous point release of propane in 3-D domain with ground obstructions. An artificial neural network is employed to calculate the temporal state transition of cellular automata. To provide data for the neural network to train, fire dynamic simulator (FDS) code is adopted to simulate 100 scenarios of propane release from a fixed position in pre-specific domain with different combinations of meteorological conditions and source parameters. A proportion of the simulation results is selected to train the artificial neural network with different transition rules derived from the advection-diffusion equation. The dispersion processes are eventually replicated with the proposed approach on the remaining scenarios that the artificial neural network has never encountered. Provided with detailed meteorological field data, the cellular automata model could calculate the gas dispersion process about 1.5 times faster than FDS. As to the model performance, in the long term evolution, decreases in model accuracy are observed due to the nature of cellular automata in explicit evolution and the unavailability of error compensation methods. The transition rule that takes source terms into consideration outperforms in estimating the concentration distributions.

Keywords: Cellular automata, Artificial neural network, Consequence modeling, Fire dynamic simulators

1. Introduction

In recent years, the rapid urbanization extended the range of city to industrial regions that were originally located in rural areas. Release of flammable or toxic substances in urban environment put great threats on public safety and local environment. Generally, an accident related to hazardous chemical spill would go through three stages: source development, gas dispersion and the final consequence (toxicity, fire and explosion). The source development involves how chemical substance is released from a closed system; the gas dispersion determines how the released substance is distributed in time and space; the final consequences,

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