Editors: Claudia Pahl-Wostl, Sonja Schmidt,
Andrea E. Rizzoli, Anthony J. Jakeman

University of Osnabrück, Germany

iEMSs
INTERNATIONAL
Environmental
Modelling
and Software
SOCIETY

Complexity and Integrated Resources Management

Transactions of the 2nd Biennial Meeting of the International Environmental Modelling and Software Society

Vol. 3

14-17 June 2004

Source Parameter Estimation of Atmospheric Pollution from Accidental Gas Releases

P. Kathirgamanathan
Dept of Mathematics and Statistics, University of Jaffna, Jaffna, Sri Lanka
pkathirgamanathan@yahoo.co.uk

Abstract: This paper presents the development of an inverse model that may be used to estimate the source term parameters for a polluting gas released into the atmosphere from a point above the ground. The model uses measured pollution concentrations at observation sites on the ground as well as meteorological data such as wind speed and cloud cover. The inverse model is formulated as a least- squares minimisation problem coupled with the solution of an advection-dispersion equation. The minimisation problem where the pollutants are released instantaneously is well-posed and the source term is calculated with reasonable accuracy. However, the problem with a non-steady extended release source is ill-posed; consequently, its solution is extremely sensitive to errors in the measurement data. Tikhonov's regularisation, which stabilises the solution process, is used to overcome the ill-posedness of this problem and the regularisation parameter is estimated using the properties of the non-linear L-curve, and Wahhba's leaving-out-one lemma. Finally, the accuracy of the model is examined by imposing normally-distributed relative noise into concentration data generated by the forward model.

Keywords: *Non-linear ill posed problem; Inverse air pollution model; Parameter estimation*

1. INTRODUCTION

The analysis process for accidental gas releases are categorised into 4 cases as follows (Kathirgamanathan *et al.*, 2001, 2003a, 2003b): (1) instantaneous release from a known location, (2) instantaneous release from an unknown location, (3) extended release over a period of time from a known location, (4) extended release over a period of time from an unknown location. In this paper we propose a methodology for Case 4 where pollution originates from a point source with an extended release over a period of time from an unknown location. That is, we consider the problem where the transport properties of the medium are assumed to be known but the location and release history of the pollution are unknown.

The methodology for estimating the location and release rates of pollution sources is based on the solution of an advection-dispersion equation and a least squares technique. The least squares technique optimises the agreement between measured and model-predicted concentration by varying the model input parameters within reasonable ranges of uncertainties. In the solution process, the unknown release rate function is discretised into many components. The relationship between the concentration of pollution, C, and the discretised components is linear and that between C and the location parameters is non-linear. Therefore the problem involves estimating both non-linear and linear parameters. It has been shown already (Kathirgamanathan *et al.*, 2003) that estimating linear parameters (release rates) for given non-linear parameters (location) is a linear ill-posed problem. Therefore estimating release rates from a source of unknown location is a non-linear ill-posed problem. This problem is further complicated by inexact information. In reality, the data contains measurement errors, so the true solution will not fit the data. Also the meteorological parameters are not known exactly. In this model, these values are assumed to be uniform and constant; however in reality, they do vary in space and time and are difficult to model accurately.