Identifing Atmospheric Pollutant Sources Using Artificial Neural Networks

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The estimation of the area source pollutant strength is a relevant issue for atmospheric environment. This characterizes an inverse problem in the atmospheric pollution dispersion. In the inverse analysis, an area source domain is considered, where the strength of such area source term is assumed unknown. The inverse problem is solved by using a supervised artificial neural network: multi-layer perceptron. The conection weights of the neural network are computed from delta rule - learning process. The neural network inversion is compared with results from standard inverse analysis (regularized inverse solution). In the regularization method, the inverse problem is formulated as a non-linear optimization approach, whose the objective function is given by the square difference between the measured pollutant concentration and the mathematical models, associated with a regularization operator. In our numerical experiments, the forward problem is addressed by a source-receptor scheme, where a regressive Lagrangian model is applied to compute the transition matrix. The second order maximum entropy regularization is used, and the regularization parameter is calculated by the L-curve technique. The objective function is minimized employing a deterministic scheme (a quasi-Newton algorithm) [1] and a stochastic technique (PSO: particle swarm optimization) [2]. The inverse problem methodology is tested with synthetic observational data, from six measurement points in the physical domain. The best inverse solutions were obtained with neural networks. References: [1] D. R. Roberti, D. Anfossi, H. F. Campos Velho, G. A. Degrazia (2005): Estimating Emission Rate and Pollutant Source Location, Ciencia e Natura, p. 131-134. [2] E.F.P. da Luz, H.F. de Campos Velho, J.C. Becceneri, D.R. Roberti (2007): Estimating Atmospheric Area Source Strength Through Particle Swarm Optimization. Inverse Problems, Desing and Optimization Symposium IPDO-2007, April 16-18, Miami (FL), USA, vol 1, p. 354-359.

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