

Pollution level assessment and control of emission rates

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The main objective of the mathematical modeling in environment protection is the prediction of concentrations of pollutants and development of the methods protecting the people from dangerous pollution levels. In this work, we suggest methods for solving important problems related to point sources (industrial pollution, oil spill problem, aquatic system cleaning, etc.) and linearly distributed (automobile) sources. The adjoint approach utilizing direct and adjoint pollution concentration estimates in selected zones is used. The direct estimates require solving the pollution transport model and enabling a comprehensive analysis of ecological situation in the whole area. By contrast, the adjoint estimates use solutions to an adjoint model and depend explicitly on the number, positions and emission rates of the sources and on the initial distribution of pollutants. Besides, the adjoint model solution serves in such estimates as influence (weight) function providing valuable information on the role of each source and initial data in polluting a selected zone. These estimates are effective in studying the model response to variations in the emission rates and initial conditions, and in developing control strategies. The control over emission rates of industrial plants develops quantitative criteria which permit to avoid violations of existing sanitary norm by means of margin reductions of the original industrial emission rates. Such criteria are designed taking into account the complexity inherent to the processes of dispersion and transformation of pollutants in the atmosphere, the number of point sources to control, their locations in a region and the corresponding ecological laws. With adjoint estimates we have developed both non-optimal and optimal control strategies. The method is illustrated by a simple example with only two plants in operation. Another example shows that the same adjoint approach can be used to build an efficient control strategy for aquatic system cleaning. A method for detecting the enterprises, which violate the emission rates prescribed by a control, is given. It serves to detect the infractions and apply sanctions. A method of determining an optimal position of a new factory in the region is also described. The method is illustrated by a simple example when only two types of climatic wind, eleven enterprises and three ecologically most important zones are taken into account.