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Variational approach to direct and inverse problems of atmospheric pollution studies

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We present the development of a variational approach for solving interrelated problems of atmospheric hydrodynamics and chemistry concerning air pollution transport and transformations. The proposed approach allows us to carry out complex studies of different-scale physical and chemical processes using the methods of direct and inverse modeling [1-3]. We formulate the problems of risk/vulnerability and uncertainty assessment, sensitivity studies, variational data assimilation procedures [4], etc.

A computational technology of constructing consistent mathematical models and methods of their numerical implementation is based on the variational principle in the weak constraint formulation specifically designed to account for uncertainties in models and observations. Algorithms for direct and inverse modeling are designed with the use of global and local adjoint problems. Implementing the idea of adjoint integrating factors provides unconditionally monotone and stable discrete-analytic approximations for convection-diffusion-reaction problems [5,6].

The general framework is applied to the direct and inverse problems for the models of transport and transformation of pollutants in Siberian and Arctic regions.

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