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A new version of variational integrated technology for environmental modeling with assimilation of available data

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A modeling technology based on coupled models of atmospheric dynamics and chemistry are presented [1-3]. It is the result of application of variational methods in combination with the methods of decomposition and splitting. The idea of Euler's integrating factors combined with technique of adjoint problems is also used.

In online technologies, a significant part of algorithmic and computational work consist in solving the problems like convection-diffusion-reaction and in organizing data assimilation techniques based on them. For equations of convection-diffusion, the methodology gives us the unconditionally stable and monotone discrete-analytical schemes in the frames of methods of decomposition and splitting. These schemes are exact for locally one-dimensional problems respect to the spatial variables. For stiff systems of equations describing transformation of gas and aerosol substances, the monotone and stable schemes are also obtained. They are implemented by non- iterative algorithms. By construction, all schemes for different components of state functions are structurally uniform. They are coordinated among themselves in the sense of forward and inverse modeling.

Variational principles are constructed taking into account the fact that the behavior of the different dynamic and chemical components of the state function is characterized by high variability and uncertainty. Information on the parameters of models, sources and emission impacts is also not determined precisely. Therefore, to obtain the consistent solutions, we construct methods of the sensitivity theory taking into account the influence of uncertainty. For this purpose, new methods of data assimilation of hydrodynamic fields and gas-aerosol substances measured by different observing systems are proposed. Optimization criteria for data assimilation problems are defined so that they include a set of functionals evaluating the total measure of uncertainties. The latter are explicitly introduced into the equations of the model of processes as desired deterministic control functions. This method of data assimilation with control functions is implemented by direct algorithms.

The modeling technology presented here focuses on various scientific and applied problems of environmental prediction and design, including risk assessment in relation to existing and potential sources of natural and anthropogenic influences.

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