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Mathematical Methods and Models for Problems in Physics of Atmosphere and Ocean

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The evolution of scientific research and achievements in the field of mathematical modeling of large-scale circulation of the atmosphere and ocean as well as global climate changes is considered. The achievements in this field have been largely conditioned by the progress in meteorology, computing technologies, advanced methods of computational mathematics and atmospheric and oceanic physics. The contribution of prominent scientists is marked and some key points in the history of science in this field starting from W. Bjerknes to present days are highlighted.

The results of some investigations performed in the Institute of Numerical Mathematics of RAS are described, including the numerical experiments with a climate model and a model of the World Ocean. Particular emphasis is placed on the theory and solution methods of complex systems of differential equations for atmospheric and oceanic dynamics and on the method of adjoint equations developed by the author and his disciples. The use of these methods is illustrated for a number of applications.

An approach based on the theory of adjoint equations is described which made it possible to initiate a systematic investigation of the energy-active zones of the World Ocean responsible for the interaction between the atmosphere and ocean. Some environmental pollution problems of regional and global scales are considered on the basis of the methods developed.