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Numerical solution of a 4D-variational initialization problem for the Indian Ocean

E. Parmuzin (1), A. Rusakov (1) and V. Zalesny (1)
(1) Institute of Numerical mathematics RAS (parm@inm.ras.ru)

We present numerical technique and results of the solution of the 4D-variational ocean initialization problem. The numerical procedure is intended for a sigma coordinate free surface primitive equation model which is written in a semi-divergent symmetrized form (Zalesny, Rusakov, 2007). The process of solving the forward model is split into a number of stages. Multi-component splitting is realized with respect to the physical processes, space coordinates, etc. We construct an adjoint subsystem for each separate splitting stage, and the set of subsystems yields a full adjoint model. The method is the constructive basis for the modular computing system of simulation and initialization of the Indian Ocean fields, which consist of three main components. The main component of the computing system is the forward sigma-coordinate model of the free surface thermohaline dynamics of the Indian Ocean. The modular principle is inherent in the code implementation of the model. Each separate splitting stage corresponds to a separate program module. The second component of the computing system is an adjoint model. The third component is a procedure or an algorithm for functional minimization describing a measure of the misfit between data and model fields. Numerical experiments on identifying the initial condition for temperature, salinity, velocity, and sea surface height in the Indian Ocean primitive equation model were carried out. The spatial resolution of the model with respect to the horizontal variables amounted to 1*0.5 grad. The grid domain size was 124*135*33. The results show that the developed algorithm reconstructs with good accuracy the initial fields. In the conclusion analysis of numerical experiments is presented.

Reference: 1. Zalesny V.B., Rusakov A.S. Numerical algorithm of data assimilation based on splitting and adjoint equation methods. Russ. J. Numer. Anal. Math. Mod-

elling, 2007, Vol. 22, No. 2, pp. 199-219.