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A sigma-coordinate, data assimilation ocean model based on splitting and adjoint equation techniques

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The variational method is successfully applied in oceanography to solve inverse problems. In 4D-var data assimilation a minimization algorithm is used to find a set of control variables, which minimize the norm of distance between observations and model predictions. Using the adjoint method the gradient of the cost function can be computed fast and optimal control methods can be implemented to solve problems arising in ocean modeling. Then the problem of construction of the adjoint model becomes important. Here we introduce adjoint model for sigma-coordinate ocean general circulation (OGC) model developed at the Institute of Numerical Mathematics (INM), Moscow, Russia [1]. The main peculiarity of the INM model, which distinguishes it from the other ocean models, is that the numerical technique is based on the splitting method by physical processes and space coordinates. Due to the splitting method the stable implicit scheme can be efficiently implemented and sufficiently large time step could be used for simulation. The system of partial derivatives adjoint equations is obtained for the INM OGC model. The splitting method allows building adjoint equations to every block/subsystem of the model and then combining them into the full adjoint model. This procedure allows construction of a set of non-negative split subsystems of adjoint operator of the problem which is also solved with implicit time scheme. Splitting method and special symmetrized form of governing equations allows using the same procedures for solving adjoint equations as for the forward model and saving an accuracy of gradient of functional to minimize. Assimilation technique is applied for the Indian Ocean initialization problem.

Reference: 1) Marchuk G.I., Rusakov A.S., Zalesny V.B., Diansky N.A. Splitting Numerical Technique with Application to the High Resolution Simulation of the Indian Ocean Circulation.//Pure appl. geophys. 162 (2005), pp. 1407-1429.