# A general hybrid data assimilation scheme in conjunction with HYCOM

Konstantin Belyaev (1,3), Andrew Kuleshov (2), Clemente Tanajura (3), and Natalia Tuchkova (4)

(1) Shirshov Institute of Oceanology, RAS, Moscow, Russia (kosbel55@gmail.com), (3) Federal University of Bahia, Salvador, 40170-280, Brazil (clemente.tanajura@gmail.com), (2) Keldysh Institute of Applied Mathematics, RAS, Moscow, Russia (andrew_kuleshov@mail.ru), (4) Dorodnicyn Computing Centre, FRC CSC RAS, Moscow, Russia (tuchkova@ccas.ru)

A new data assimilation method is derived. The method combines variational and statistical approaches commonly used in data assimilation theory. The proposed scheme based on the path-of-least-resistance principle and minimizes the variance of the trajectory of the process in conjunction with the numerical model. This scheme differs from the Kalman-filter but also reduces the assimilation problem to a system of linear equations in model phase-space. The data assimilation scheme is constrained from two relations

$$X_a = X_b + K(Y - HX_b), \tag{1}$$

$$K = \frac{(C - \Lambda)(H\Lambda)'Q^{-1}}{(H\Lambda)'Q^{-1}H\Lambda} \tag{2}$$

In (1-2) $X_a$, $X_b$ are two model state vectors, after and before assimilation, analysis and background, respectively; $Y$ is an observational vector, $K$, $H$ are two matrices, Kalman gain matrix and projection matrix, respectively. Unlike the standard Kalman filter scheme, the Kalman gain matrix is found out with respect to formula (2), where $Q$ is the covariance matrix of the model error, $Q = E(Y - HX_b)(Y - HX_b)' + R$ symbol $E$ stands for mathematical expectation (ensemble mean value), $R$ denotes the covariance matrix of error measurements, and apostrophe above stands for transpose of vector or matrix. Two vectors $C$, $\Lambda$ mean the observed and model trend on one time-step, respectively. This formula (2) has been derived from the theory of stochastic diffusion processes and path-of-least-resistance principle.

This method is applied into the HYbrid Coordinate Ocean Model (HYCOM) and assimilates satellite sea level anomaly data from the Archiving, Validating and Interpolating Satellite Ocean Data (AVISO) over the Atlantic Ocean. Several numerical experiments have been performed.