Objective estimation of velocity streamfunction field with discretely sampled oceanic data

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Two objective methods for the generation of velocity streamfunction are presented for dealing with discretely sampled oceanic data. First method (M1) treats a Poisson equation (forced by vorticity) derived from Helmholtz theorem in which streamfunction is obtained by isolating the non-divergent part of the two-dimensional flow field. The method is implemented with a mixed boundary condition and vorticity field estimated from interpolated field. Second method (M2) is an application of least-square regression analysis. The coefficients of a streamfunction that is expanded in terms of trigonometric basis function are obtained by enforcing the horizontal non-divergence of two-dimensional flow field. This method avoids interpolation which is inherent in M1 and gives a root-mean-square (rms) residual of fit which includes the divergent part and noisiness of oceanic data. The implementation of the method is done by employing a boundary-fitted, curvilinear orthogonal coordinate which facilitates the specification of boundary conditions. An application is successfully made to the Texas-Louisiana shelf using the 32 months (Arpil 1992 - November 1994) LATEX (Texas-Louisiana Shelf Circulation and Transport Processes Study) current meter data (31 moorings). Both methods result in consistent pattern with observation and with each other. This fact increases the confidence of the methodologies adopted in our study. In addition, the rms residual of the fitting by M2 is relatively small for the shelf, which indicates the field is well represented by the streamfunction. Thus generated streamfunction field presents an opportunity to initialize and to verify computer models for local forecasts of environmental flow conditions for oil spill, nutrient and plankton transports as well as opportunity to understand shelf-wide low-frequency currents.