Dissertations

Modified variational method for for reconstruction of hydrophysical fields in the sea and its application in Fram Strait

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The thesis presents a method for reconstruction of hydrophysical fields from noisy, scattered measurements and the results of its application to the hydrographic data in a region with complex topography. The method generates three-dimensional (3-D), continuous, smooth fields and a crude estimate of their error variance. The mathematical formulation of the problem allows for physical constraints.

The method is called by the author "the variational-statystical method" because it incorporates elements of two interpolation techniques, one - variational, based on the general theory of splines, and the other - satistical, namely the objective analysis. The searched-for field is decomposed in vertical into a series of analytical functions while the amplitudes of these functions are approximated on a 2-D finite elements grid. To find the coefficients of the amplitudes, one minimizes a functional composed of a measure of roughness of the field and a measure of the distance between the solution and the data. Both, the original and the objectively analysed data at different depth levels are used. The free parameters of the method are chosen in a way which garantees a correspondence between the objectively analysed fields and the 3-D solution. An estimate of the error field is found by an independent 3-D approximation of the standard deviation of error obtained in the 2-D objective analysis.

The method was applied to reconstruct the large-scale fields of potential temperature, salinity and potential density in Fram Strait from the MIZEX'84 data. This particular set-up provided a good frame for testing the method. The MIZEX'84 data set, although the most abundant in the region, is highly irregular as far as the spatial coverage with measurements is concerned. In addition, the structure of hydrographic fields in Fram Strait is complex and the bottom topography complicated.

In the final 3-D solutons one finds all known large-scale structures of the hydrographic fields in the strait, e.g. the Eest Greenland Polar Front, the Boreas Basin Gyre, the recirculation branches of the West Spitsbergen Current and the extreems in the salinity distribution at the bottom. On the basis of these solutions a classification of water masses in Fram Strait for
the summer period was proposed. The estimated fields may be also used for various other purposes, e.g. for testing some dynamical hypothesis, calculating heat and salt fluxes or initialization of prognostic models.

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