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

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The thesis presents a method for the 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 author calls his method 'the variational-statistical method' because it incorporates elements of two interpolation techniques, one – variational, based on the general theory of splines, and the other – statistical, *i.e.* the objective analysis. The searched-for field is decomposed in the 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 minimises 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 guarantees 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 the Fram Strait from the

MIZEX'84 data. This particular set-up provided a good framework for testing the method. Although the MIZEX'84 data set is the most abundant in the region, it is highly irregular as far as the spatial coverage with measurements is concerned. In addition, the structure of the hydrographic fields in the Fram Strait is complex and the bottom topography complicated.

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

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