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Statistical model of interannual variability of the Arctic Ocean surface layer salinity in winter

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The surface layer of the Arctic Ocean occupies space from the ocean surface down to 10-40 m depth in summer and down to 25-100 m in winter. It is the boundary layer which constitutes the dynamical and thermodynamical link between the atmosphere and the underlying waters. The oceanographic database of AARI, composed of data at the standard horizons collected during both Russian and foreign expeditions in the winter period (March-May) between 1950-1993, was used to analyze the variability of salinity in the Arctic Ocean surface layer. Salinity data available as gridded fields with a spatial resolution of 200x200 km. Since most of the data starts from 5 m and the average thickness of the Arctic Ocean surface layer is 50 m, analysis of large-scale trends in the variability of salinity was made for the layer 5 -50 m.

Spatial variability of the mean salinity values at grid nodes has a complex temporal structure. Therefore, in order to describe interannual changes in the salinity fields, the method of mean salinity decomposition on Empirical Orthogonal Functions (EOF) was used and the time series of principal components (PC), which vary smoother and more regularly compared with the original values of salinity, for the winter period of 1950-1993 were obtained. Further analysis of the five initial EOF modes were used since they yield the largest contribution of the total dispersion of the original data (74.9%). This limitation allows to exclude small-scale processes and to focus on large-scale variability of the mean salinity field of the Arctic Ocean.

The impact of external factors on interannual variability of the mean surface layer salinity was estimated using correlation analysis of the first five principal components (PC) with indices of atmospheric circulation (Arctic Oscillation (AO), North-Atlantic Oscillation (NAO), North-Pacific Oscillation (NPO), and the Arctic Dipole Anomaly (DA)), the water exchange through the Bering Strait, Atlantic water salt fluxes through the Faeroe-Shetland Strait, river runoff and the area of open water of the Arctic seas in September. Significant correlation coefficients of each principal component with a different set of external factors were thus obtained.

The statistical model is represented by a system of equations for the five principal components PC1-PC5, which were obtained by the method of multiple linear correlations. The selection of predictors was carried out using the results of cross-correlation analysis and was based on the significance of the correlation coefficient between PC and predictor. In addition, we went over the different predictors, guided by physical interpretation of the mechanisms of influence these factors on the PC. As a result, the general correlation coefficients of principal components with the variables in the right part of equations are high and equal to: PC1 - 0,90; PC2 - 0,87; PC3 - 0,76; PC4 - 0,90; PC5 - 0,74. Thus, the calculated PC values can describe the main features of the temporal variability of the real principal components and also the surface salinity field of the Arctic Ocean fairly well.