

# Contents

<b>1</b>	<b>Formulation of the Problem, Transformation of Equations and Elaboration of Ocean Circulation Models</b>	1
1.1	Initial Equations, Their Simplification and Transformations	1
1.1.1	Initial Equations and Boundary Conditions	1
1.1.2	Simplification of Equations and Boundary Conditions for Large-Scale Flows	3
1.1.3	Velocity in the Quasi-Geostrophic Model: Calculation Formulas	9
1.1.4	Equations for Integral Functions in Off-Equatorial Current Models	11
1.1.5	Evaluation of the Order of Magnitude of the Quantities in the Equations for Integral Functions	15
1.1.6	Equations for the Calculation of Sea-Surface Topography at the Basin Boundary in an Off-Equatorial Currents Model	18
1.2	Diagnostic Sea Current Models	19
1.2.1	Quasi-Geostrophic Model for the Calculation of Sea-Surface Topography and Flow Velocity	19
1.2.2	Quasi-Geostrophic Model for the Calculation of the Total Mass Transport Stream Function and Flow Velocity	24
1.2.3	A Non-Linear Model for the Calculation of Sea-Surface Topography and Flow Velocity	30
1.2.4	The List of the Main Correlations in the Spherical System of Coordinates and for the Southern Hemisphere	36
1.3	Some Numerical Methods of Solving Simplified Equations of Hydrodynamics	40

<b>2</b>	<b>The Simplest Methods of Difference Approximation and Constructed Equations Solution</b>	53
2.1	The Construction of Difference Grids	53
2.2	The Methods of Approximation and Equation Solutions	55
2.2.1	The Methods of Calculating the Sea-Surface Topography (SST) at the Basin Boundary	55
2.2.2	Methods of Difference Approximation and Solutions of the Equations of Quasi-Geostrophic Models	58
2.2.3	The Methods of Difference Approximation and Solutions of the Equations of a Non-Linear Model	67
<b>3</b>	<b>Numerical Methods of Solving Ocean Dynamics Problems</b>	75
3.1	The Construction and Methods of Solving Simplified Problems of Ocean Dynamics	75
3.2	The Operator Representation of the Problem and the Principal Algorithm of the Splitting	82
3.3	The Evolutional Statement of the Problem	93
3.4	The Difference Schemes for the Equations of Motion	98
3.5	The Approximation of Adaptation Equations by Spacial Variables	101
3.6	The Approximation of the Adaptation Equations by Time	109
3.7	The Choice of the Parameters for Approximation in the Simplest Model	116
3.8	The Organization of the Numerical Algorithm	121
<b>4</b>	<b>The Stationary Problems of Ocean Dynamics</b>	123
4.1	The Statement of the Linearized Problem of the Ocean Climatic Condition	123
4.2	The Simplest Model of the Stationary Ocean Currents	124
4.3	The Ocean Dynamics Model, Taking into Account the Wind-Driven Currents	130
4.4	The Difference Operators of the Ocean Dynamics Problem and the Methods of Approximation	134
4.5	The Iterative Processes for Solving the Ocean Dynamics Difference Equations for the Barotropic Component	139
4.6	The Solution of the Difference Equations of the Ocean Dynamics Baroclinic Component	143

4.7	The Modified Iterative Process . . . . .	144
4.8	The Simplest Model of Ocean Dynamics, Taking into Account the Non-Linear Turbulent Exchange . . . . .	151
4.9	The Statement of Several Non-Linear Problems . . . . .	152
4.10	The Problem of Non-Stationary Adjustment of Flow Fields to Atmospheric Disturbances . . . . .	154
4.11	The Formation of the Thermocline in the Ocean . . . . .	156
<b>5</b>	<b>The Analysis of the Results of Calculations . . . . .</b>	<b>162</b>
5.1	On the Results of Diagnostic Calculations of the Currents in Different Oceanic Basins . . . . .	162
5.2	The World Ocean Surface Topography and the Surface Gradient Currents . . . . .	167
5.2.1	Density and Wind Fields for Diagnostic Calculations. Filtration of the Fields . . . . .	167
5.2.2	Specified Data and Peculiarities of Calculating World Ocean Currents . . . . .	169
5.2.3	The Peculiarities of the World Ocean Surface Topography and the Surface Gradient Currents for the Summer Season . . . . .	184
5.3	The Large-Scale Circulation and Seasonal Variation of the World Ocean Waters . . . . .	189
5.3.1	The Circulation in the World Ocean Surface and Intermediate Layers in the Summer Season . . . . .	189
5.3.2	The World Ocean Deep and Bottom Layer Water Circulation . . . . .	205
5.3.3	The Vertical Structure of the World Ocean Currents . . . . .	214
5.3.4	Seasonal Variations of the World Ocean Surface Topography and the Surface Gradient Currents . . . . .	216
5.3.5	Seasonal Variations of the Upper Layer Water Circulation of the World Ocean . . . . .	220
5.3.6	The Structure and Seasonal Variations of the Vertical Circulation of the World Ocean Waters . . . . .	233
5.4	The Hydrodynamic Adjustment of the Ocean Temperature, Salinity, Density and Flow Fields . . . . .	236
5.5	The Diagnostic Calculations of Flows and the Adjustment of the Hydrological Elements of the North Atlantic . . . . .	241
5.5.1	The Diagnostic Calculations of Flows by the Quasi-Geostrophic Model . . . . .	241
5.5.2	The Diagnostic Calculations of Flows by the Non-Linear Model . . . . .	244
5.5.3	The Adjustment of the Temperature, Salinity, Density and Flow Fields by the Quasi-Geostrophic Model . . . . .	245

5.5.4	The Adjustment of the Temperature and Flow Fields by the Non-Linear Model . . . . .	248
5.6	The Diagnostic Calculations of Flow in the Equatorial Belt of the Ocean . . . . .	252
5.6.1	The Equatorial Atlantic Flow Calculations by the Quasi-Geostrophic Model: the Assessment of the Validity Limits of the Models . . . . .	253
5.6.2	The Calculations of Flows of the Equatorial Belts in the Atlantic and Indian Oceans by the Non-Linear Model . . . . .	257
5.7	The Calculation of Flows in the Black Sea Offshore Zone . . . . .	266
5.7.1	The Diagnostic Calculations of Flows for the Summer and Fall Seasons . . . . .	267
5.7.2	Numerical Experiments on the Calculation of the Vertical Velocity Component . . . . .	274
5.7.3	The Adjustment of the Density and Flow Fields . . . . .	279
<b>References</b>	. . . . .	285
<b>Subject Index</b>	. . . . .	291