

Contents

1	Internal Waves in Lakes: Generation, Transformation, Meromixis – An Attempt at a Historical Perspective	1
	K. Hutter	
1.1	Thermometry	1
1.2	Internal Oscillatory Responses	3
1.3	Observations of Nonlinear Internal Waves	10
	References	15
2	Field Studies of Non-Linear Internal Waves in Lakes on the Globe	23
	N. Filatov, A. Terzevik, R. Zdrovennov, V. Vlasenko, N. Stashchuk, and K. Hutter	
2.1	Overview of Internal Wave Investigations in Lakes on the Globe	24
2.1.1	Introduction	24
2.1.2	Examples of Nonlinear Internal Waves on Relatively Small Lakes	29
2.1.3	Examples of Nonlinear Internal Waves in Medium- and Large-Size Lakes	33
2.1.4	Examples of Nonlinear Internal Waves in Great Lakes: Lakes Michigan and Ontario, Baikal, Ladoga and Onego	41
2.1.5	Some Remarks on the Overview of Nonlinear Internal Wave Investigations in Lakes	49
2.2	Overview of Methods of Field Observations and Data Analysis of Internal Waves	50
2.2.1	Touch Probing Measuring Techniques	50
2.2.2	Remote-Sensing Techniques	54
2.2.3	Data Analysis of Time Series of Observations of Internal Waves	60
2.3	Lake Onego Field Campaigns 2004/2005: An Investigation of Nonlinear Internal Waves	67

2.3.1 Field Measurements	67
2.3.2 Data Analysis	71
2.3.3 Summary of the Lake Onego Experiments	88
2.4 Comparison of Field Observations and Modelling of Nonlinear Internal Waves in Lake Onego	90
2.4.1 Introduction	90
2.4.2 Data of Field Measurements in Lake Onego	91
2.4.3 Model	93
2.4.4 Results of Modelling	94
2.4.5 Discussion and Conclusions	98
References	99
 3 Laboratory Modeling on Transformation of Large-Amplitude Internal Waves by Topographic Obstructions	 105
N. Gorogedtska, V. Nikishov, and K. Hutter	
3.1 Generation and Propagation of Internal Solitary Waves in Laboratory Tanks	105
3.1.1 Introduction	105
3.1.2 Dissipation Not in Focus	107
3.1.3 Influence of Dissipation	115
3.1.4 Summary	119
3.2 Transmission, Reflection, and Fission of Internal Waves by Underwater Obstacles	120
3.2.1 Transformation and Breaking of Waves by Obstacles of Different Height	120
3.2.2 Influence of the Obstacle Length on Internal Solitary Waves	141
3.3 Internal Wave Transformation Caused by Lateral Constrictions	148
3.4 Laboratory Study of the Dynamics of Internal Waves on a Slope ...	163
3.4.1 Reflection and Breaking of Internal Solitary Waves from Uniform Slopes at Different Angles	163
3.4.2 Influence of Slope Nonuniformity on the Reflection and Breaking of Waves	179
3.5 Conclusions	186
References	189
 4 Numerical Simulations of the Nonhydrostatic Transformation of Basin-Scale Internal Gravity Waves and Wave-Enhanced Meromixis in Lakes	 193
V. Maderich, I. Brovchenko, K. Terletska, and K. Hutter	
4.1 Introduction	193
4.1.1 Physical Processes Controlling the Transfer of Energy Within an Internal Wave Field from Large to Small Scales	193
4.1.2 Nonhydrostatic Modeling	194
4.2 Description of the Nonhydrostatic Model	196
4.2.1 Model Equations	196

Contents	xi
4.2.2 Model Equations in Generalized Vertical Coordinates	199
4.2.3 Numerical Algorithm	203
4.3 Regimes of Degeneration of Basin-Scale Internal Gravity Waves ..	209
4.3.1 Linearized Ideal Fluid Problem	209
4.3.2 Nonlinear Models of Internal Waves	211
4.3.3 Energy Equations	213
4.3.4 Classification of the Degeneration Regimes of Basin-Scale Internal Gravity Waves in a Lake	215
4.4 Numerical Simulation of Degeneration of Basin-Scale Internal Gravity Waves	218
4.4.1 Degeneration of Basin-Scale Internal Waves in Rectangular Basins	218
4.4.2 Modeling of Breaking of Internal Solitary Waves on a Slope	225
4.4.3 Degeneration of Basin-Scale Internal Waves in Basins with Bottom Slopes	242
4.4.4 Modeling of Interaction of Internal Waves with Bottom Obstacles	247
4.4.5 Degeneration of Basin-Scale Internal Waves in Basin with Bottom Sill	257
4.4.6 Degeneration of Basin-Scale Internal Waves in Basins with a Narrow	261
4.4.7 Degeneration of Basin-Scale Internal Waves in a Small Elongated Lake	264
4.5 Conclusions	270
References	272
Lake Index	277