

The Near-surface Layer of the Ocean

Editors:

K.N.Fedorov and A.I.Ginsburg

///VSP///

UTRECHT, THE NETHERLANDS
TOKYO, JAPAN

The Near-surface Layer of the Ocean

K. N. FEDOROV and A. I. GINSBURG

Translated by M. Rosenberg

283/3513 INSTITUT
FÜR METEOROLOGIE U. KLIMATOLOGIE
UNIVERSITÄT HANNOVER
HERRENHAUSER STR. 2 3000 HANNOVER 21

///VSP///

Utrecht, The Netherlands

Contents

<i>Foreword</i>	ix
<i>Preface</i>	xi
Chapter 1. Object and methods of the investigation	1
1.1. Object of the investigation and its basic characteristics	1
1.2. Basic types of vertical thermal structure of the near-surface layer of the ocean and several characteristics of the temperature variability in it	3
1.3. Variability of salinity in the near-surface layer of the ocean	10
1.3.1. Freshening of coastal ocean regions by the discharge from large rivers	11
1.3.2. Coastal upwellings	11
1.3.3. Thermohaline and salinity fronts	12
1.3.4. Non-uniform wind-driven mixing	14
1.3.5. Precipitation, ice melting, and evaporation	14
1.3.6. Certain general consistencies	17
1.4. Methods of studying the near-surface layer of the ocean	19
Chapter 2. The surface of the ocean and its anomalous conditions	23
2.1. The role of the free surface of the ocean in the formation of the structure and regimes of the near-surface layer	23
2.2. Anomalous conditions of the ocean surface	24
2.2.1. Slicks and smooth patches	31
2.2.2. Choppy water	34
2.2.3. Ordered alternation of bands (or patches) of slicks and ripples (or choppy water)	36
2.2.4. Bands of foam and debris	40
2.2.5. Eddies, whirlpools, small vortices	40
2.2.6. Current rips	42
2.2.7. Fronts and their visible manifestation on the ocean surface	47
2.3. Anomalous phenomena on the ocean surface through observations of seamen	49
Chapter 3. The thermal boundary layer of the ocean and the primary scales of convection	63
3.1. On 'warm' and 'cold' boundary layers	64
3.2. The structure of the warm boundary layer	65

3.3.	The cold boundary layer	66
3.3.1.	The nature of convective motion and the primary scales of convection developing near the free surface of fresh- and salt water	68
3.3.2.	Fine structure of the cold boundary layer	75
3.3.3.	On the critical boundary Rayleigh number for cooling water from the free surface	79
3.3.4.	On the role of salinization of evaporation in the thermal boundary layer structure and dynamics. Salt boundary layer	80
3.3.5.	On the quantitative relationship $\overline{\Delta T_0} = f(q_0)$ during free and forced convection. Results of laboratory and field measurements	86
3.3.6.	Estimation of the thermal boundary layer thickness	94
3.3.7.	Effects of various factors on the value of $\overline{\Delta T_0}$ under field conditions	94
3.3.8.	On the space-time variability of $\overline{\Delta T_0}$ and the temperature of the ocean surface T_0	98
3.4.	Methodological questions on measuring the temperature difference in the thermal boundary layer of the ocean	98
3.5.	Practical problems arising in connection with the contribution of the thermal boundary layer to the overall variability of temperature of the near-surface layer of the ocean	100
3.6.	On the satellite measurement of the ocean surface temperature	102
Chapter 4.	The cyclical nature and space structure of the near-surface layer in connection with solar heating and convection	105
4.1.	Volume absorption of solar energy in the near-surface layer of the ocean. Irradiance models	105
4.2.	Propagation of cyclical heating through the near-surface layer thickness	112
4.3.	The diurnal (daily) thermocline and variability of the thermal structure of the near-surface layer of the ocean in a diurnal cycle	114
4.4.	The blocking role of the diurnal thermocline with regard to turbulence in the near-surface layer of the ocean	124
4.5.	Typical scales and characteristics of space structure inhomogeneities of the near-surface layer of the ocean	127
4.5.1.	Thermal effect of strong atmospheric formations and processes	128
4.5.2.	Thermal effect of atmospheric convective cells	132
4.5.3.	Effects of precipitation in the near-surface layer of the ocean	133

4.5.4.	Modulation of the thermal structure of the near-surface layer of the ocean by internal waves and Langmuir circulations	140
4.5.5.	Manifestation of convection in the thermal structure of the near-surface layer of the ocean. Hierarchy of convection scales	144
4.5.6.	Thermal regime in the vicinity of fronts, shoals, banks, and coasts	151
Chapter 5.	Characteristic features of water motion in the near-surface layer of the ocean	155
5.1.	What are the components of the currents that are recorded in the near-surface layer of the ocean?	155
5.2.	Marginal ice zones	175
5.3.	Coherent (ordered) forms of non-stationary motion in the near-surface layer of the ocean	184
5.3.1.	'Mushroom-like' currents in the near-surface layer of the ocean	184
5.3.2.	Systems of transversal filaments in coastal upwellings	196
5.3.3.	On the near-surface circulation of waters in the sub-arctic frontal zone (by satellite data)	203
Chapter 6.	The near-surface layer and the effectiveness of remote sensing of the ocean	209
6.1.	On the oceanological information content of the temperature fields of the surface and near-surface layer of the ocean	211
6.2.	An estimate of the velocity field characteristics by a passive tracer observation in the near-surface layer of the ocean	222
6.3.	On the information content of the characteristics of surface waves	226
6.3.1.	The spectral approach and its information content	228
6.3.2.	Other statistics and different approaches to the analysis of the characteristics of surface waves	239
6.4.	Conclusion	242
	<i>References</i>	245
	<i>Subject index</i>	257