THE INFLUENCE OF INTERNAL WAVES UPON THE UPPER ACTIVE LAYER STRUCTURE IN THE BLACK SEA

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In the analysis hydrological and meteorological observations were used, performed by r/v "Vityaz" from February 9 till April 8, 1991 mainly in the central part of the Black sea. The calculation of heat currents through the sea surface and in the upper layer indicated that in February 1991 the conditions for thermal convection were absent both in the center of the Eastern Cyclonic Gyre (ECG) and along its periphery. This rules out the influence of horizontal advection upon the activization of convective processes. Nevertheless the hydrological analysis in the very center of ECG indicated the presence of rather important traits of convective mixing that may be connected with the existence of internal waves (IW) here.

That is why in the center of ECG at the station N 3311, made on February 18-22, 1991, special hysrophysical observations were performed with Neil-Brown probe every three hours to the depth of 150 m during 4.5 days.

The spectral analysis of the obtained data by the method of maximal entropy showed the presence of oscillations with the following periods: 4-6 days (synoptic); 33-34 hours (these oscillations appear to be an effect of the first baroclinic mode of Rossby waves or shelf waves); 16-17.3 hours (inertial waves); 11.7-12.2 hours (semi diurnal tide waves and a longitudinal single-noded seiche); 9.7 and 6 - hour oscillations (seiches peculiar to this region; BLATOV, 1984) and high-frequency oscillations with the periods of 160,20, 8.2, 5.5 min. in the upper part of the pycnocline, obtained according to the results of continuous three-hour registration of T, S and σ at the depth of 28 m. The latter had practically one-mode structure and agreed well with the spectrum GM-75. On the basis of dispersive relations (PHILLIPS, 1980) the wavelengths, local vertical scale and phase velocity were estimated for them which were changing over the range from 5 to 0.25 km, from 11 to 0.3 m and from 0.48 to 0.075 m/s respectively.

The studies of variation of IW spectral composition with depth (in the range from six-hour period to the synoptic) showed :

- in the homogeneous convective layer (HCL) the oscillations with the periods from 30 to 40 hours account for about 70% of IW total energy and the inertial and semi diurnal oscillations account for about 15%;
- in the upper part of the pycnocline (σ is from 15.1 to 15.6 kg/m^3 ; z is 25-35 m) synoptic oscillations (T is 100-150 hours) are notable. They account for 25-30% of total energy, thirty or forty-hour oscillations account for 20-25%, the inertial ones account for 10-15% and semi diurnal for 10%;
- in the rest part of the pycnocline (σ is from 15.7 to 17.6 kg/m^3 ; z is 400-200 m) the share of synoptic oscillations drops essentially (to 10%), but at the depths of 170-200 m it increases to 25-30% again; the share of energy of thirty or forty-hour oscillations increases to 25-30%, the share of energy of the inertial and semi diurnal oscillations makes up 10-15 or 5-10% respectively.

The analysis of currents in ECG demonstrated that about 90% of their variation falls on the inertial and semi diurnal oscillations, practically all the variation of currents falls on the rotating clockwise component that is the indicative of their inertial character. The estimation of spatial energetic spectral densities of current variation showed that these inertial waves were prevailing and, having the length of about 33 km, were moving to the South-East.

The obtained results indicate the important influence of IW on the formation of thermohalinic structure of the upper active layer in the Black sea. Under their influence the vertical gradients of density are considerably diminished both in HAL and in the upper part of the pycnocline that may cause the intensive mixing of waters over the pycnocline. Because of the considerable density gradients at the upper boundary of the pycnocline IW destructions are possible that results in the intensive transport of mass and properties through the upper boundary of the pycnocline.

The obtained data showed (Table) how important is to take into account the existence of IW in hydrophysical mesoscale surveys. It is quite necessary in the evaluations of thickness of HCL and the cold intermediate layer (CIL), in the studies of winter convection and other processes. The order of magnitudes of possible mistakes during measurements of hydrophysical parameters in the presence of IW for winter season in the open part of the Black Sea is given in the Table.

For the characteristic values of sigma-t σ (kg/m^3) the following symbols are used : $\Delta\sigma / \Delta z$ (kg/m^4) is a vertical gradient of density; z (m) is a mean depth; σ_z (m) is a mean-square deviation of z; $\Delta T/\Delta z$ (°C/m), $\Delta S/\Delta z$ (‰/m) - are mean for the given values of σ vertical gradients of temperature and salinity; ΔS(‰), T(°C) are deviations of salinity and temperature with the adequate σz ; R_Z, R_T, R_S (m) are maximal measured amplitudes of depth, temperature and salinity values respectively.

σ	$\Delta\sigma/\Delta z \cdot 10^{-2}$	Z	σ_Z	R_Z	$\Delta T/\Delta Z \cdot 10^{-2}$	ΔT	R_T	$\Delta S/\Delta Z \cdot 10^{-2}$	ΔS	R_S
14,95	0,56	15,3	8,55	27,8	0,3	0,25	0,28	0,05	0,004	0,26
15,00	1,40	21,9	5,53	18,8	0,3	0,165	0,32	0,5	0,0028	0,26
15,10	2,10	28,8	2,69	11,5	10,0	0,27	1,75	5,6	0,15	0,92
15,25	2,80	30,8	2,70	10,9	24,0	0,67	2,27	9,1	0,24	1,67
15,70	6,08	37,0	2,84	12,8	10,0	0,28	1,45	4,4	0,12	0,82
16,00	2,02	48,7	2,94	12,6	2,0	0,06	0,17	2,3	0,068	0,35
16,50	1,80	75,9	2,79	9,0	1,0	0,028	0,12	1,7	0,047	0,25
17,00	0,83	117,6	2,61	11,2	0,4	0,010	0,05	0,7	0,018	0,14
17,50	0,71	173,7	2,25	10,0	0,16	0,004	0,06	0,4	0,009	0,08

Table Statistical characteristics of the internal waves (IW)

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