Bulletin of the Maritime Institute

Gdańsk, 1999, 26, 1

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CURRENTS IN THE OPEN BALTIC SEA MEASURED DURING POLRODEX '97 EXPERIMENT PRELIMINARY INTERPRETATION

Abstract

The paper presents analysis of currents and other physical parameters of sea water: salinity, temperature, and water level. The measurements were made in the north – western part of the Gdańsk Bay during POLRODEX '97 experiment took place. Measured data are described, and their preliminary interpretation is given. Periodicity of currents and temperature oscillations is especially underlined.

1. Introduction

The main task of POLRODEX '97 experiment is validation of different mathematical models predicting hydrodynamic parameters of the sea and the movement of oil or chemical spill on the sea surface and in the water column. Measurements in situ can also be assimilated into the models. Baltic Sea is not an especially deep sea, but there is a pronounced vertical stratification. The differences of vertical temperature and salinity distribution are the main cause of the density differences.

Internal waves exist in a thermocline layer, with their large amplitudes and periods. The waves influence the currents in the water mass. Current velocities and directions that were recorded can be useful for validation of mathematical models, but there the question of the proper filtration arise. The vertical distribution of temperature, salinity and density are even more important for model validation.

In situ measurements can be also helpful in models with an open boundary crossing the measurements area - in such cases they can be used as boundary conditions.

2. Experimental set-up and instruments

Field measurements included currents, temperature, salinity and pressure of water on three levels, in one station. The station was placed at Baltic Beta oil platform, 55°29' N, 18°11' E, with the bottom depth of 80 m. The above mentioned parameters were measured by means of three electromagnetic current meters S4, of Inter Ocean Systems, USA. They record current with very good accuracy and resolution, and are equipped with additional

sensors of temperature, conductivity and hydrostatic pressure. The instruments were installed at three levels, 11 m, 35 m, and 67 m below average water level, on elastic verticals, with anchor and subsurface float. We used the equipment during three weeks, starting from September 11, up to September 30.

3. Results

Currents. Progressive vector plots of currents are shown in Fig. 1. The currents consist of two main components – drift current and inertial circulation. The currents differ at particular levels. The current in surface layer (11 m level) mostly has larger velocities, with maximum 0,39 m/s. In lower layers the maximum velocities are smaller, 0.26 and 0.31 m/s, at 35 and 67 m respectively. The differences are not so large. The currents are of similar range over all three levels and have significant inertial rotation component.

Temperature plots presented in Fig. 2 show that vertical stratification exists. Temperature of upper layer (11 m) falls from 16 to 14 °C during 20 days, while temperature of lower layer (67 m) oscillates about 4°C. The most impressive is the plot of temperature at 35 m level. It was the level of thermocline centre for a long time during our observations. The active upper layer deepens during all period of observations, and the deepening has oscillatory nature, with almost constant period, about 14 hours.

Salinity of water, calculated using temperature and conductivity of water, is shown in Fig. 3. Salinity at 11 m and 35 m levels changes in a range 7.1 – 7.5 psu, and only at 67 m has greater changes, from 7.5 to 9.0 psu.

Water level of the sea was calculated using hydrostatic pressure, and corrected with actual atmospheric pressure. Resulted data are shown in Fig. 4. The level (water layer thickness above instrument) has values from 10.05 to 10.78 m, and oscillates with period of 10 – 20 hours.

4. Oscillatory nature of water currents

A spectral analysis was performed to interpret the nature of recorded oscillations. Results of the analysis show that oscillations of velocities coincidence with temperature oscillation recorded at 35 m level. Maximum values of spectrum show the same period of main oscillation in both cases, that is equal to 14.5 hours.

5. Conclusions

The experiment was performed during late summer.

1. Temperature of upper layer decreases from 16 to 14°C, during 20 days, and thermocline was recorded at 35 m, with fast deepening during that time.
2. Salinity values change in a range 7 – 9 psu, with maximum value at 67 m level.
3. Currents were of similar nature on all three levels, with maximum value 0.39 m/s (15 min. average) at 11 m level.
4. Currents and temperature oscillations have the same main period, 14.5 hours. That coincidence suggests that the internal inertial wave of rotational nature influences the current in the central part of the sea.

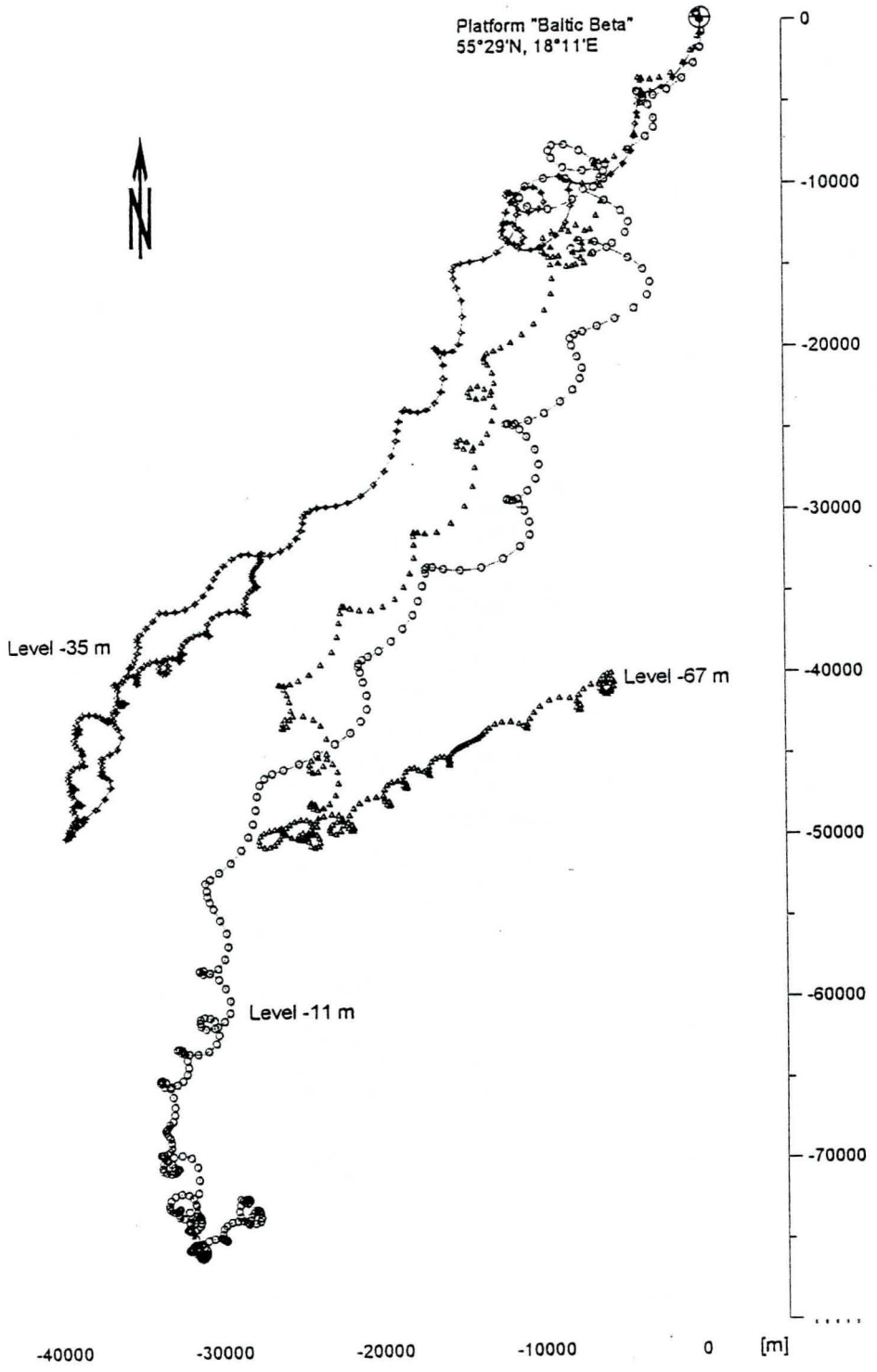

Fig. 1. Progressieve vector plots at "Baltic Beta" oil platform, at three levels, during 20 days, 11-30 September 1997

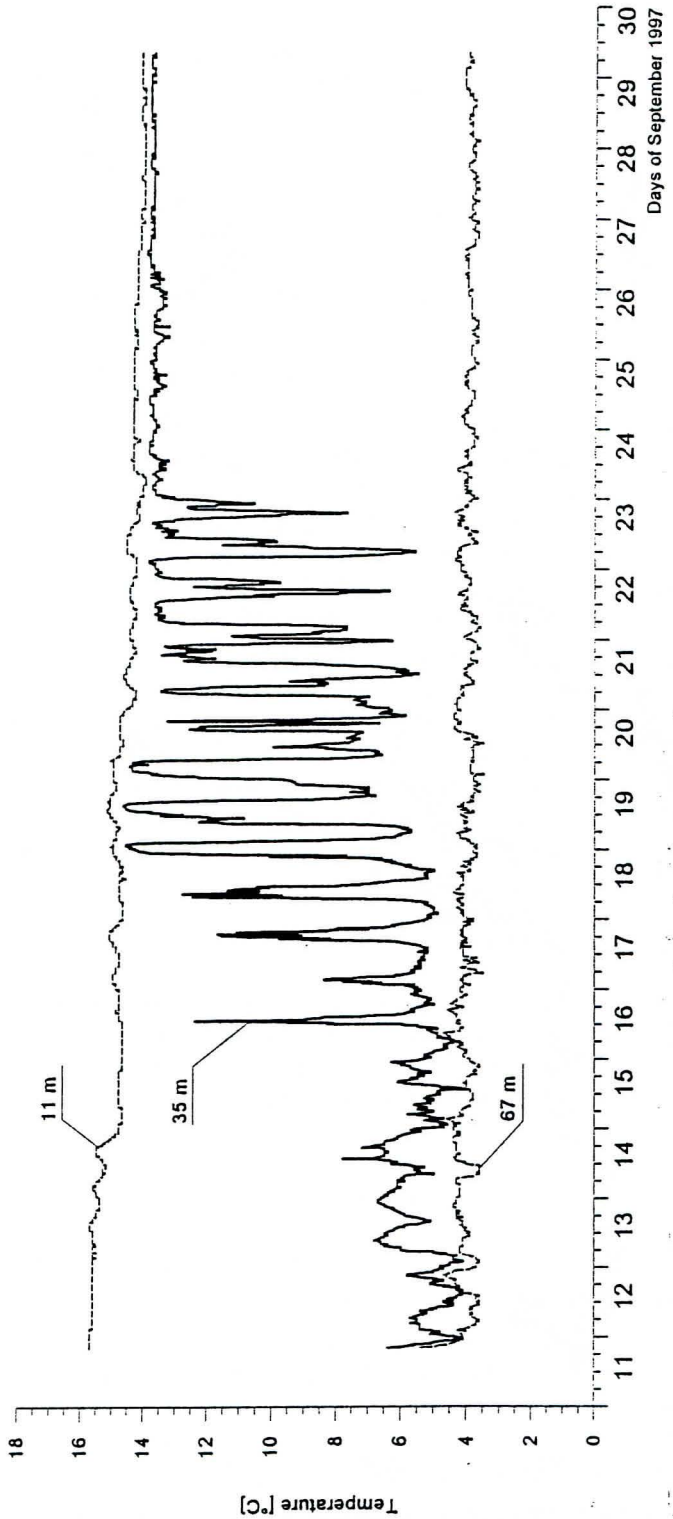

Fig. 2. Water temperature plots at "Baltic Beta" oil platform, at three levels

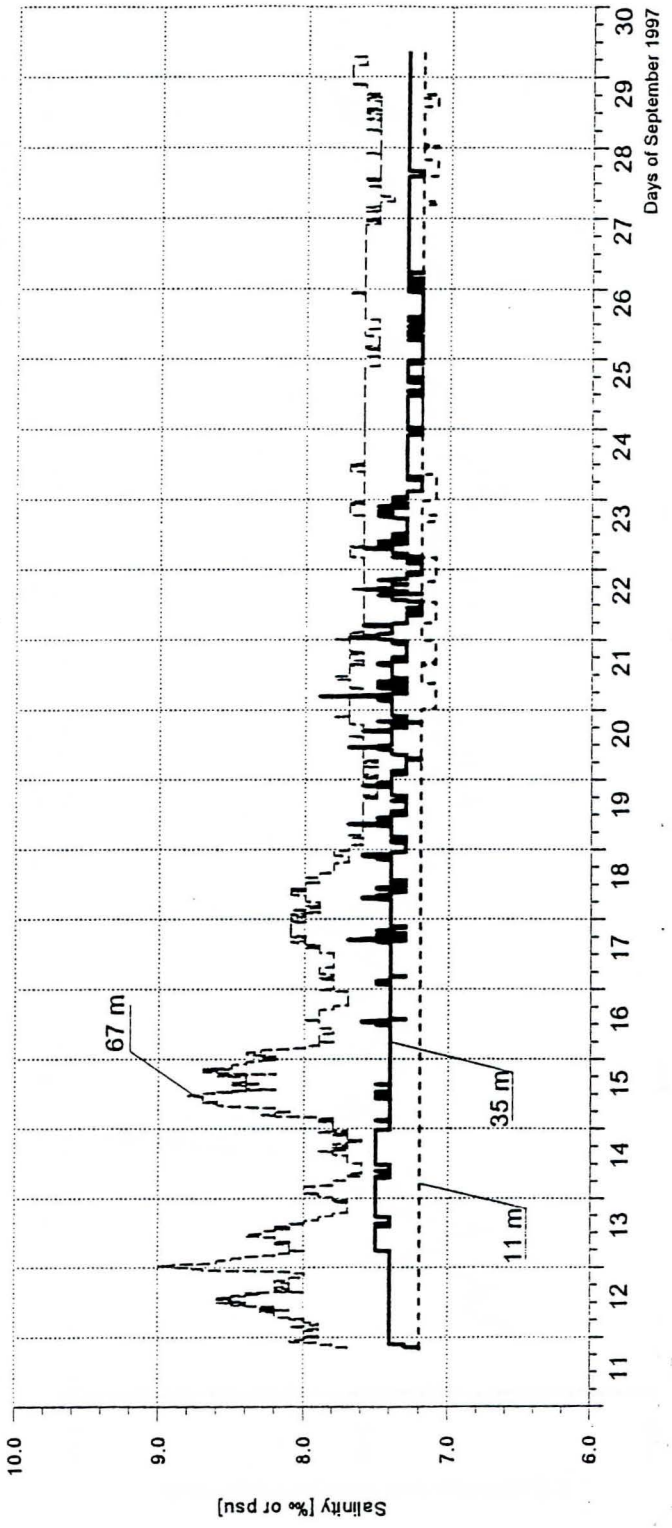

Fig. 3. Salinity at "Baltic Beta" oil platform, at three levels

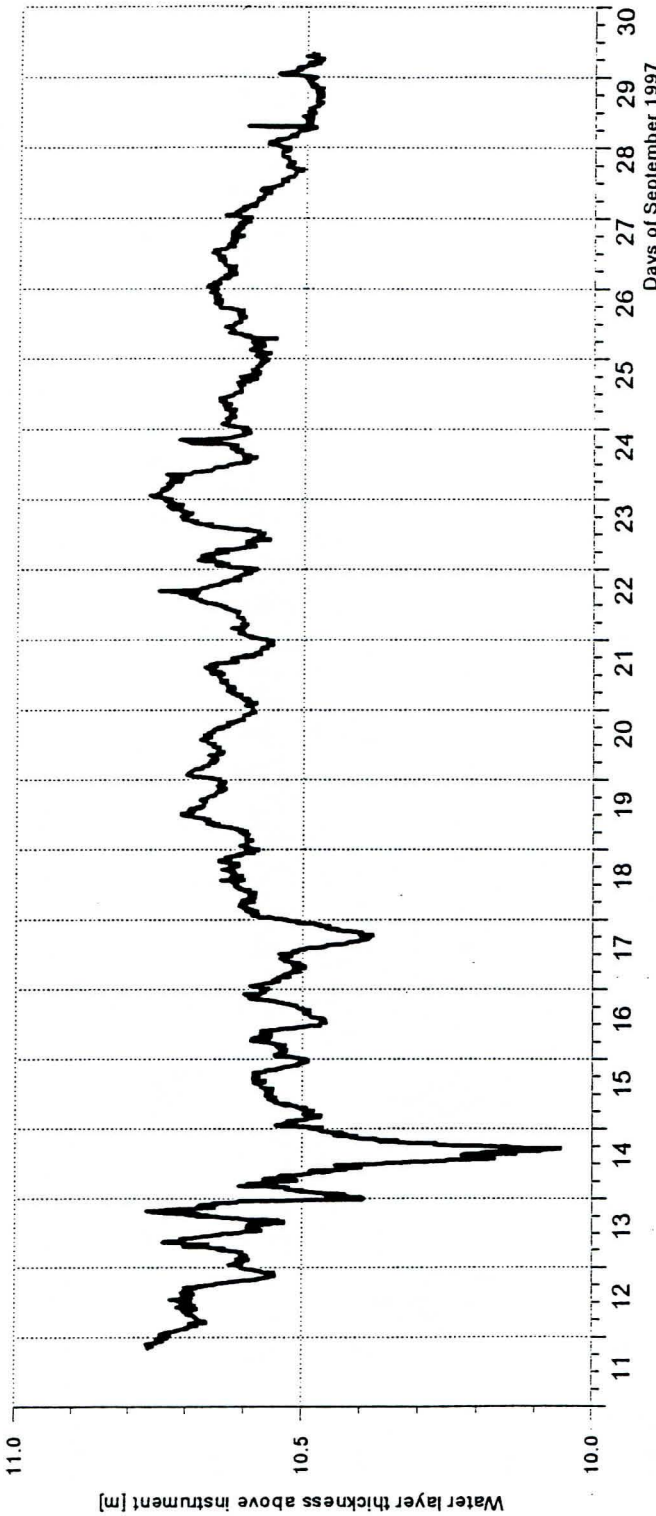

Fig. 4. Water level above instrument position, corrected using actual atmospheric pressure

Reference

Kaźmierski, J.: *Measurements of current on Gdańsk Bay during POLRODEX '97 experiment.* IBW PAN Gdańsk, 1997. (In Polish).