OBSERVATIONS OF CURRENTS, TEMPERATURE AND SALINITY IN THE JAPAN SEA IN 1999-2000 BY PALACE FLOATS

Danchenkov M.A.[1], Riser S.C.[2]

[1]Far Eastern Regional Hydrometeorological Research Institute, Vladivostok, Russia
[2]School of Oceanography, University of Washington, Seattle, USA

Introduction

PALACE (Profiler Autonomous Lagrangian Circulation Explorer) floats are essentially new and effective instruments of research of water circulation and vertical water structure. They were constructed and developed by WEBB Corporation and Scripps Institution of Oceanography in 1991 (Davis *et al*., 1991). Their typical characteristics are presented in the Table 1.

Table 1

Basic characteristics of PALACE floats used in 1999

N	Parameter	
1	Maximum depth, m	2000
2	Endurance, years	5
3	Surface cycles	75
4	Mass, kg	23
5	Dimensions, cm	104×17
6	Sensors	SEA-BIRD
7	Period, days	7

Being equipped with temperature and conductivity sensors the PALACE float allows to get vertical profiles of water temperature and salinity in addition to information on deep currents (direction and speed). First experiments with such floats were implemented in the North Atlantic in 1997. The Japan Sea became a second large-scale area of such measurements (Taira, 1997). The Japan Sea is ideal place for such experiment among other seas of Northwestern Pacific ocean as it has no large ice cover like the Okhotsk Sea and Bering Sea or large shallow shelf as the East China Sea or the Bering Sea. A number of measurements of currents in the Japan Sea were very scarce before this experiment. Before 1999 PALACE floats in the Japan Sea never conducted measurements of temperature and salinity.

Before experiment all devices of floats were checked out (in WEBB Co floats already went through strong control) in University of Washington. Accuracy of temperature measurements was about 0.001 °C and salinity – 0.001 psu. The floats were balanced to dive down to 800 m and come up to the surface every 7 days providing measurements of temperature and conductivity. In total 32 floats with an interval of 7 days could produce more than 125 oceanographic stations in one month which is much more than in usual oceanographic expedition.

When the float appears at the surface it drifts there during about 6 hours to transmit the data via satellite communication system to coastal station. After preliminary processing the data are received by the University of Washington to make primary data control and calculation of salinity. Then the schemes of float trajectories and vertical water structure are put in special website (*www.runt.ocean.washington*).

Data

In the period of July 29 – August 11, 1999 32 PALACE floats were deployed in the Japan Sea on board of Russian research vessel “Professor Khromov”. Their initial positions are given in Fig. 1.

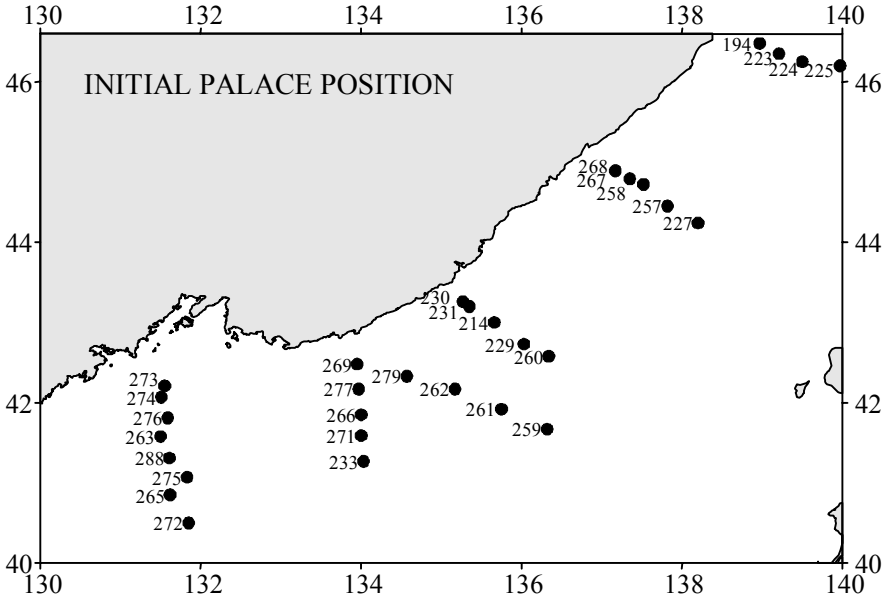

Fig. 1. Initial position of PALACE floats deployed in 1999 in the Japan Sea

In addition to them 2 PALACE floats were deployed in the Japan Sea by Seoul National University and 2 – by Japanese Atomic Energy Research Institute (JAERI).

Initial positions of floats were chosen to cover deep Japan Basin worst investigated in comparison with other part of the Sea. Very soon after deployment the position of floats changed and part of them have collected together along North-western thermal front located from Tumangan River toward the south-east (Fig. 2) and later – along basic Subarctic thermal front (along 40°N).

After one year of work the drifters covered an area between 39 and 47°N by dense net of stations – Fig. 3.

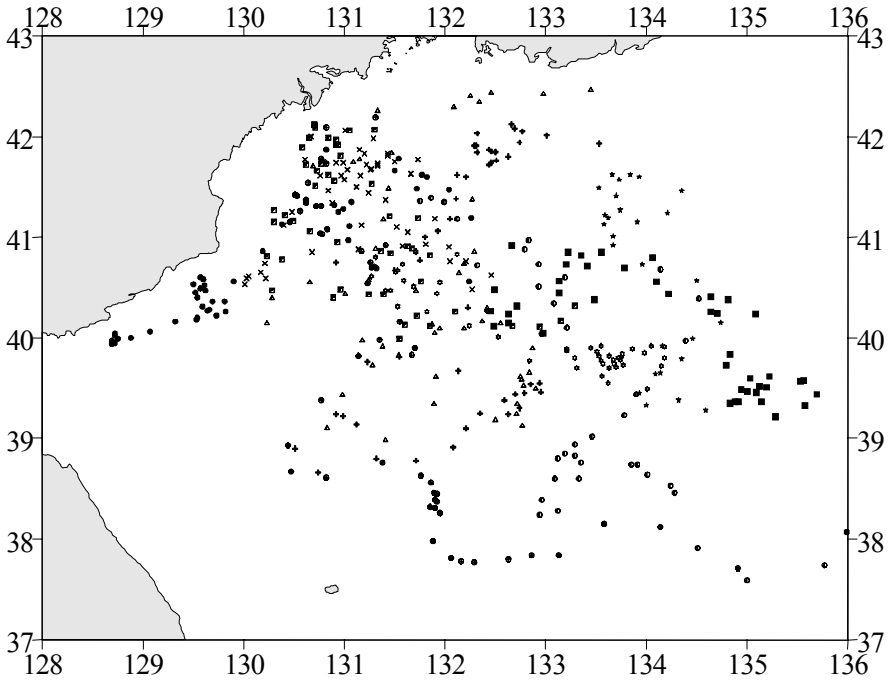

Fig. 2. Positions of PALACE stations in the north-west Japan Sea

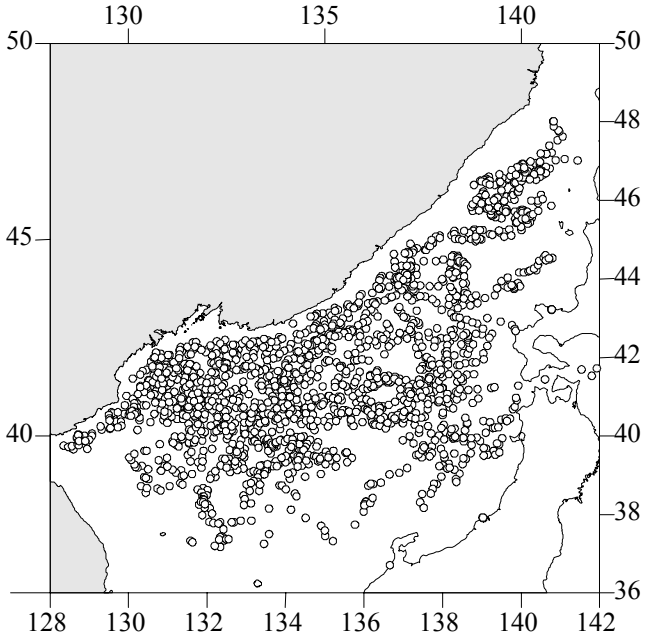

Fig. 3. Position of all PALACE stations in 1999-2000

Number of PALACE stations in the Japan Sea already became more than 1500. Therefore it is much more than number of all CTD of all expeditions of all countries in the last 5 years. It is interesting that most of floats have been drifted in deep Japan Basin. Only some of them visited northern parts of deep Tsushima and Yamato Basins. The floats deployed close to Tartar Strait were least active ones. Some of the floats (Fig. 4) were lost. Probably, fisheries recovered some of them. Some of them later were deployed again, but in the area east of the Japan Sea.

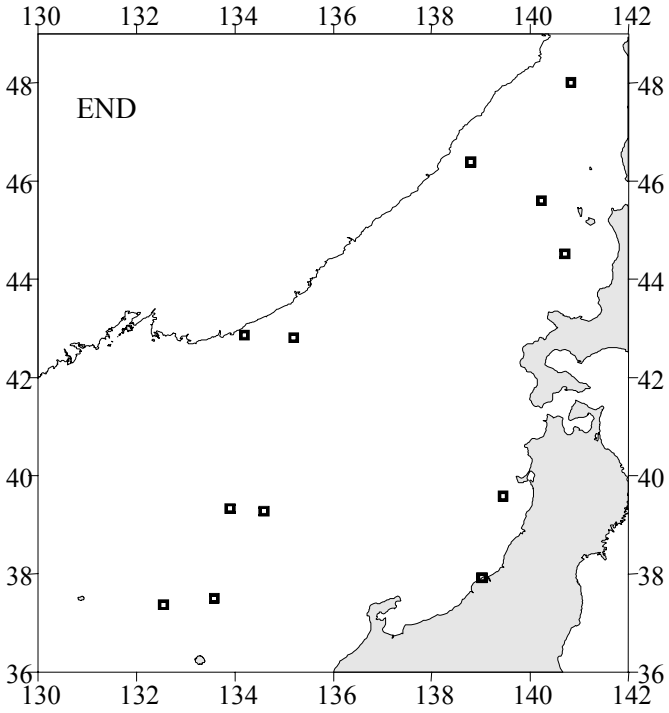

Fig. 4. Last positions of lost floats

Drift of Palace Floats at Deep Levels

Most typical water transport revealed by floats drift was traced from the west to the east along Subarctic front (40N-41°N) – Fig. 5.

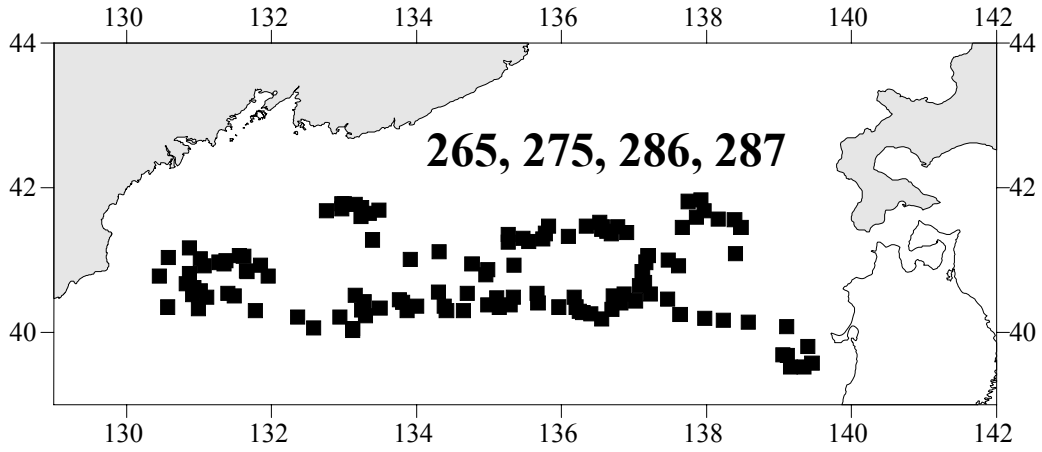

Fig. 5. Position of PALACE stations along 40°N and 41°N in 1999-2000

This deep flow is wider than current known here at the surface. The most interesting feature of deep-water circulation is large-scale gyre between 40°N and 43°N. At northern edge of gyre there is water transport to the west and at southern edge – to the east (Fig. 6).

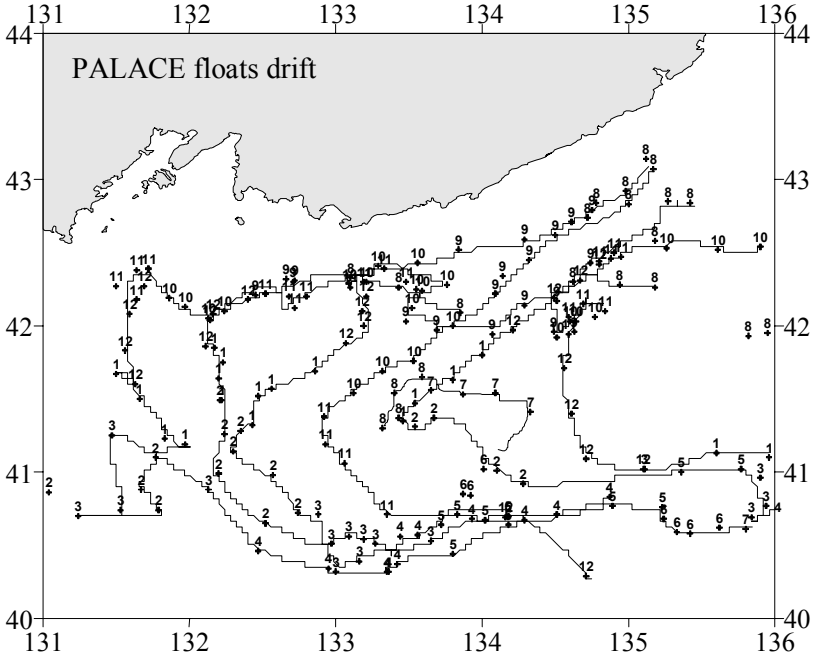

Fig. 6. Drift of PALACE floats between 40°N and 43°N in the central Japan Sea. Label near the place of stations is number of month

In east part of this area a cyclonic circulation is seen as well (Fig. 7). In general the floats followed to isobaths (Fig. 8).

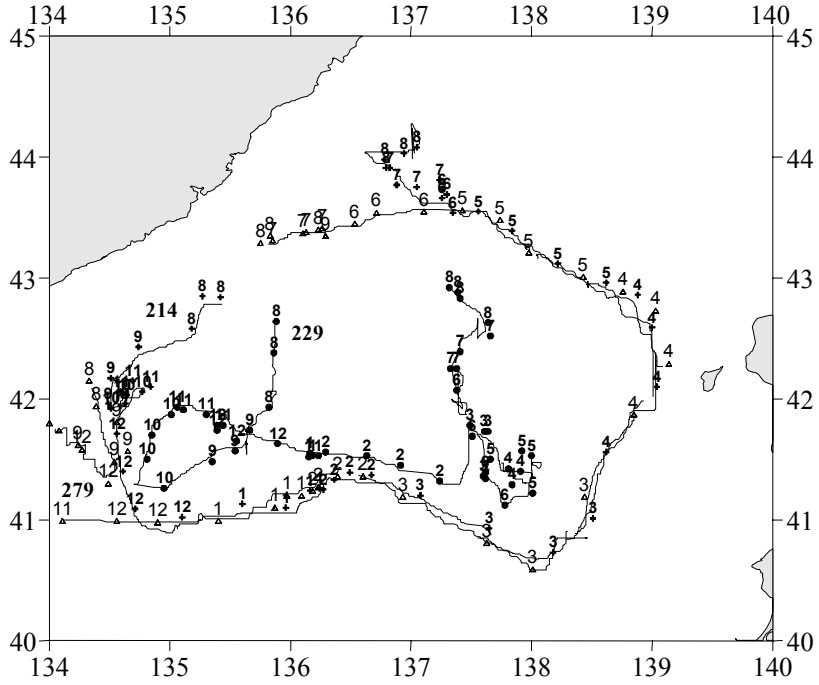

Fig. 7. Drift of three PALACE floats in the eastern Japan Sea. Label near places of stations is number of months

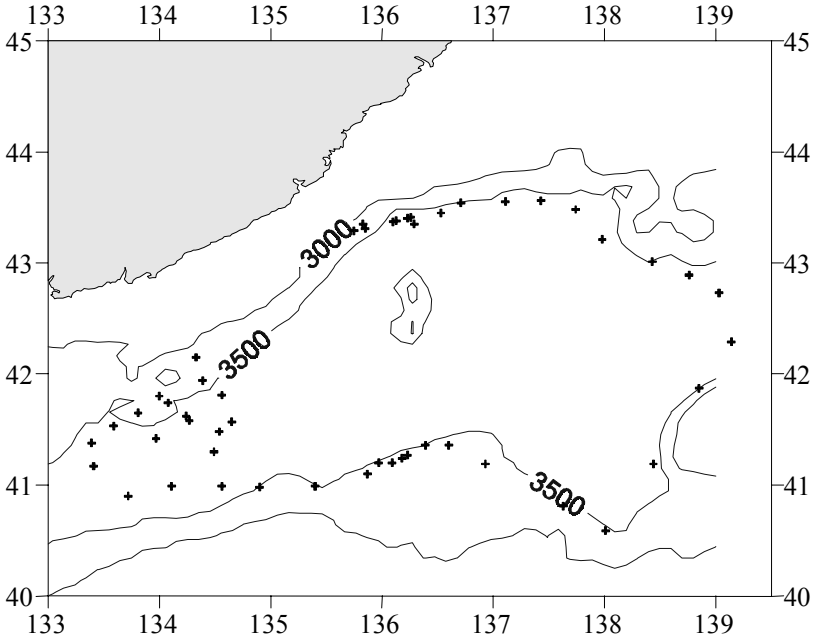

Fig. 8. Positions of PALACE float 279 in 1999-2000. Isobaths are in meters

To the north of this gyre floats have been drifting to the east or Northeast – Fig. 9.

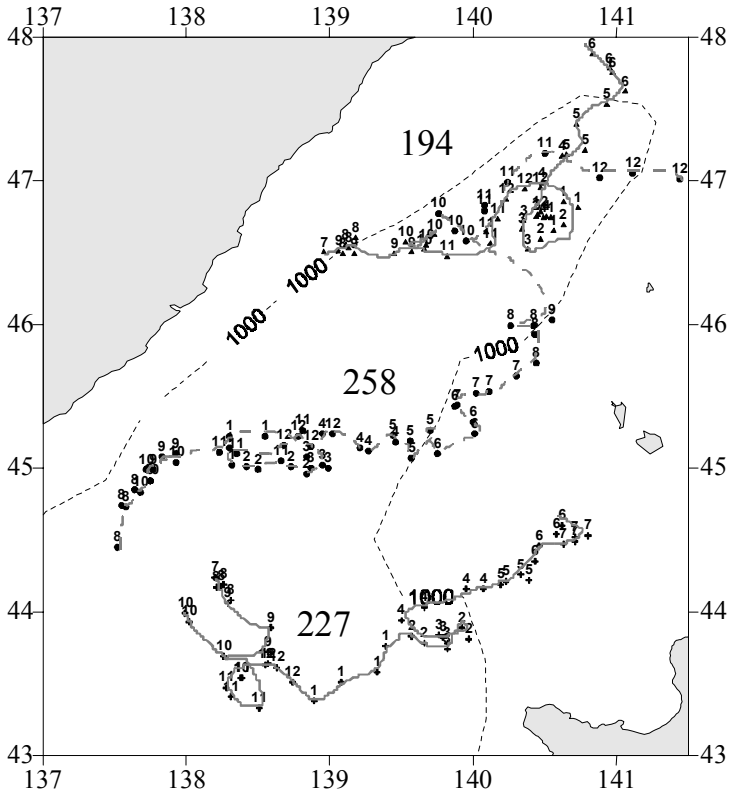

Fig. 9. Drift of PALACE floats north of Subarctic gyre

On Short-Term Drift of Palace Floats at the Surface

All floats drift at the surface during about 6 hours and at the 800 m level – about 170 hours. Due to different period of drift at the surface and at the work level it is difficult to compare them. But for area of gyre (with strong surface currents) a drift at both levels coincided on direction – Fig. 10.

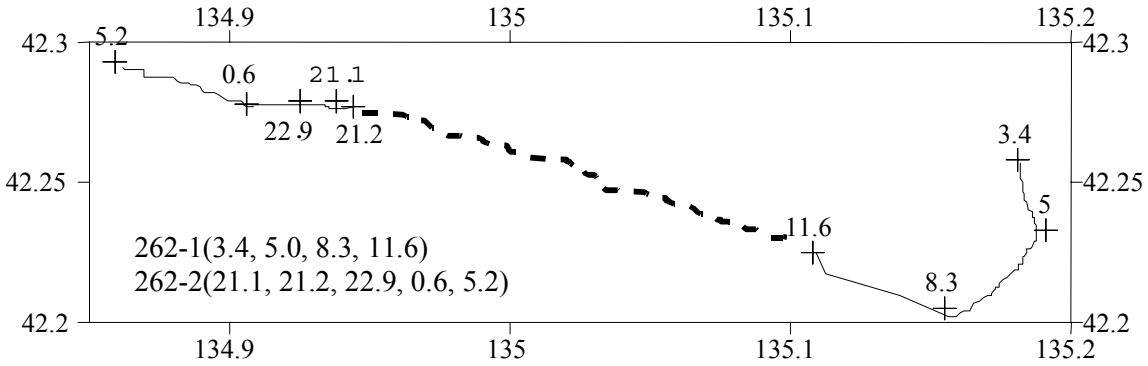

Fig. 10. Drift of PALACE float 262 at the surface (solid line) and at 800 m level (dotted line), August 11-18, 1999

Distribution of Salinity at Some Section Crossing the Gyre

Inside the cyclonic gyre over the central deep Japan Basin there is the belt of comparatively high salinity water (Fig. 11). This belt exists during whole year. In winter this belt is better seen at the surface and in summer (Fig. 12-13) – at subsurface levels. With the using of PALACE data this belt was traced along its location from northern part of Northwestern front (132°E) to Hokkaido (138°E). At 132°E the core of the belt is situated at 42°N while it is shifted slowly northward to 43°N at 138°E.

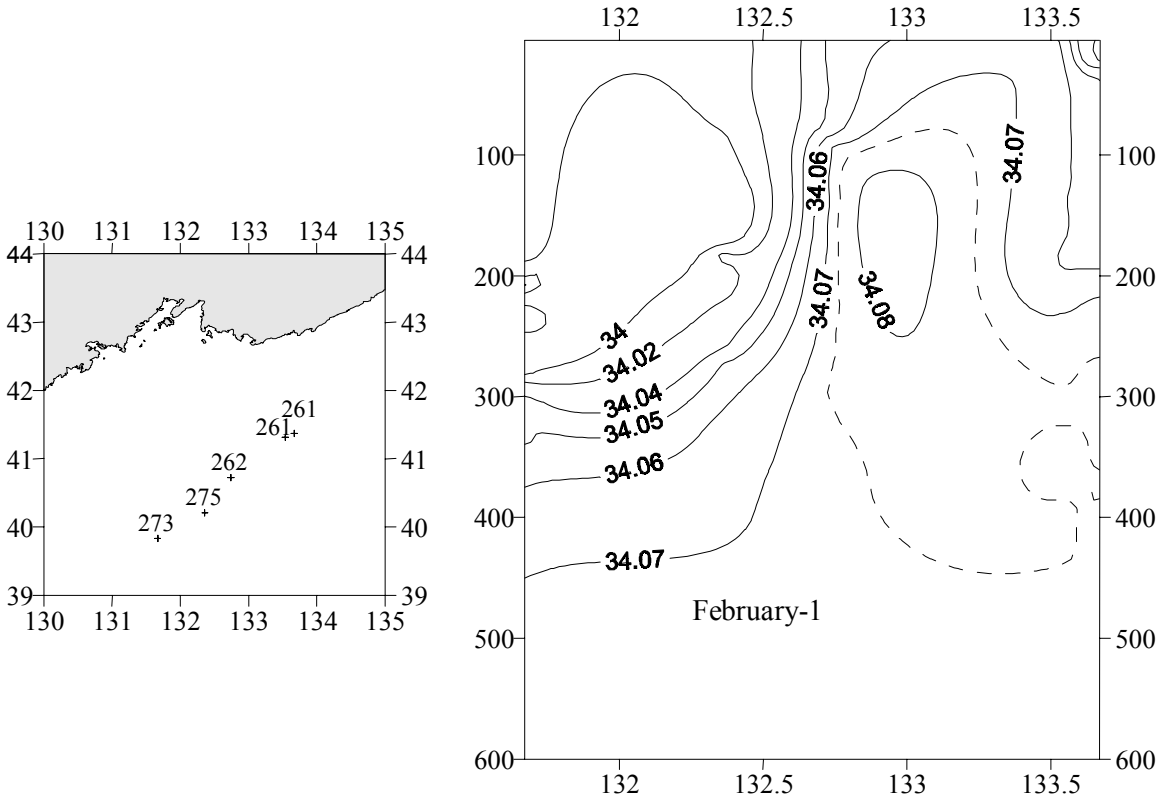

Fig. 11. Salinity section in the Northwestern Japan Sea in February of 2000.
At left figure there are positions of PALACE stations

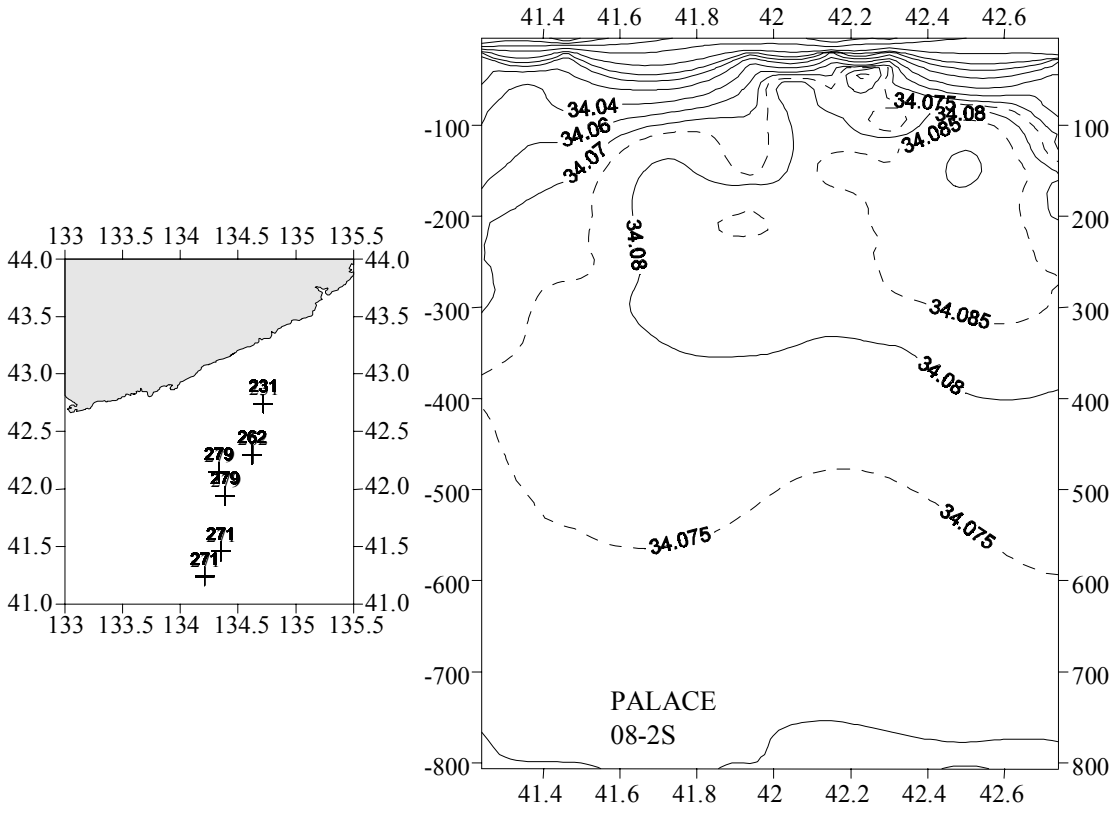

Fig. 12. Salinity section between 134°E-135°E in August of 1999.
At left figure there are positions of PALACE stations

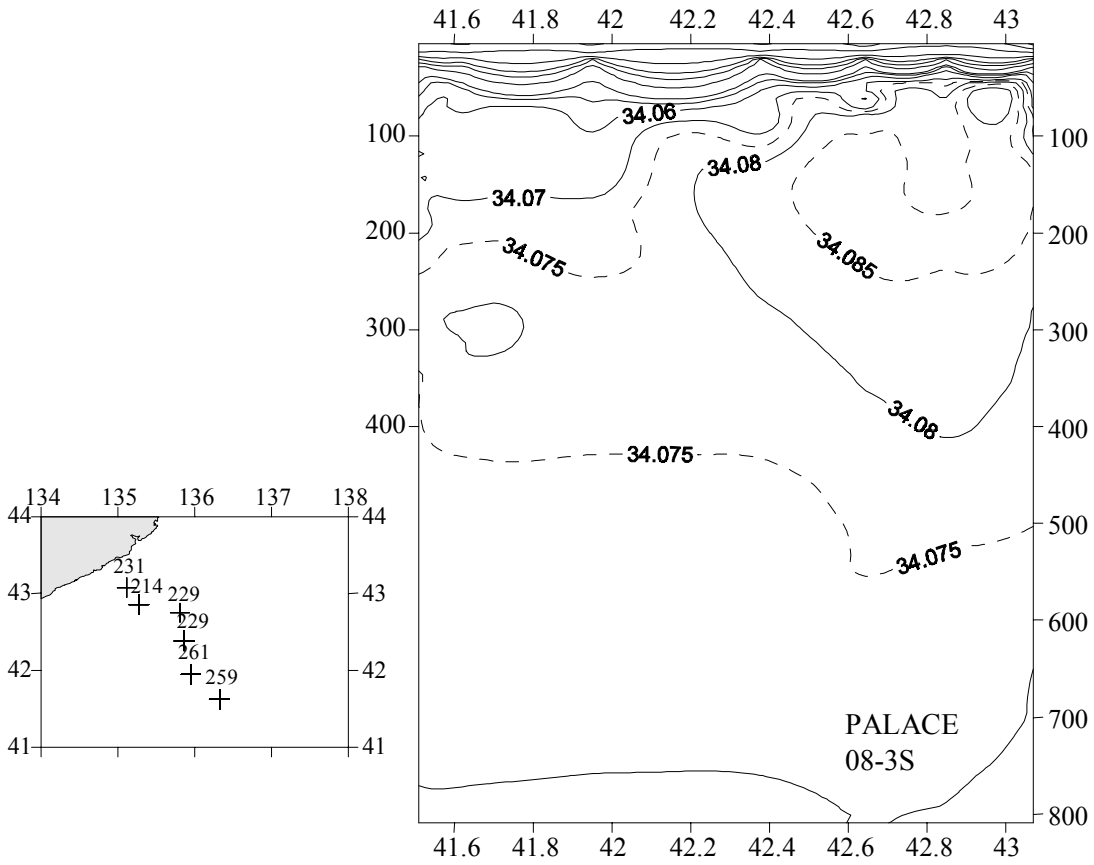

Fig. 13. Salinity section between 135°E-137°E in August of 1999

Conclusions

Using the PALACE floats measurements some new features of the Japan Sea deep-water circulation and water mass distribution were found. These are the gyre between 41°N and 43°N and the belt of salt water inside it.

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References

1. Davis R.E., Webb D.C., Regier L.A. & Dufour J. 1991. The Autonomous Lagrangian Circulation Explorer (ALACE) // J. Atmospheric and Oceanic Technology. Vol. 9. N 3. P. 264-285.
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