Baltic Sea Research Institute Warnemünde

C r u i s e R e p o r t

R/V " A.v.Humboldt "

Cruise- No. 44 / 97 / 14

This report is based on preliminary data:

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1. **Cruise No.:** 44 / 97 / 14

2. **Dates of the cruise:** from 26.08.1997 to 09.09.1997

3. **Particulars of the research vessel:**

Name:	A.v.Humboldt
Nationality:	Germany
Operating Authority:	Baltic Sea Research Institute (BSRI) Warnemünde

4. **Geographical area in which ship has operated:**
Eastern Gotland Basin (56°55’-57°35’)N; (19°32.1-20°27.9’)E
Arkona/ Bornholm Basin (54°22’-55°25’)N; (11°09’- 16°10’)E

5. **Dates and names of ports of call**
no

6. **Purpose of the cruise**

Exchange processes in deep meso-scale mass-field patterns

7. **Crew:**

Name of master:	O. Fuchs
Number of crew:	10

8. **Research staff:**

Chief scientist:	E. Hagen
Scientists:	R. Feistel H. Giese J. Reissman
Engineers:	G. Plüschke S. Weinreben
Technicians:	W. Hub

9. **Co-operating institutions:**
-Institute of Marine Research, University Hamburg, Troplowitzstr.7, D-22529 Hamburg,
-BSH, Hamburg, Bernhard-Nocht-Strasse 78, D-20359 Hamburg,

10. **Scientific equipment:** Sea-Bird CTDO - probe
Deploy of two subsurface moorings with the top at 130 m depth; each with 3 RCM-7 current meters (215m, 200m, 170m) above the water depth of 220m; positions: (57°04.53’N, 19°45.12’E), (57°25.38’N, 20°20.83’E)

11. **General remarks and preliminary results** (ca. 8 pages)

MESODYN-7

Warnemünde, 17 September, 1997

Because of their depth and central location the deep basins are probably the most interesting regions for theoretical and experimental investigations in the context of thermodynamics and/ or kinetics of oceanic irreversible processes. There is some observational evidence that much of the diapycnal mixing is actually done before the dense deep water is incorporated into deep waters of the Baltic Proper. Associated processes of detrainment essentially modify dense bottom currents spreading from the Arkona Basin through the Bornholmgat into the Bornholm Basin in order to enter the Eastern Gotland Basin trough the Stolpe Furrow.

Our hydrographic activities support running BASYS (***Baltic Sea System Study***)-field campaigns and contribute to the Russian- German field study programme **„Research on the Baltic Sea (RBS)**“, which is partly funded by the Ministry of Science and Technical Politics of the Russian Federation and the Federal Ministry of Education, Scientific Research and Technology of the FRG. That programme runs for four years (1996- 1999) above deep Baltic basins to provide eddy-resolving data sets with a station spacing of about 2.5 n.m. in order to study exchange processes of water properties between different basins as well as between coastal zones and central parts of the Baltic during different seasons.

The investigation of exchange processes between different basins of the Baltic Sea has been started by CDTO-measurements in the Stolpe Furrow during March, 1996. Similar campaigns were carried out in the eastern Gotland Basin (June, 1996), the Bornholm Basin (September, 1996 and March, 1997), the Arkona Basin (December, 1996), the Bornholm Basin (May, 1997), and Eastern Gotland Basin (September, 1997). Our activities will be continued by three hydrographic surveys in 1998 in co-operation with the EU (MAST-III)-funded project ‘*Mi*crostructure *Tec*hnologies (MITEC)’ during 1998. Repeated measurements are planned at the same positions in order to describe the seasonal cycle in meso-scale patterns of the mass-field and associated property-fluxes, especially in superficial layers. Our field campaigns will be completed by records of moored current meters, ADCP-tracks, and enhanced dissipation profiling above steep topographic slopes.

Resulting data will be, among other things, used for the estimation of geostrophic motions in deep layers and related volume transports as well as for the initialisation/ validation of numerical circulation models.

The area of investigations is shown in Fig.1. CTDO - profiles have been performed with the SeaBird System from the sea surface down to the near bottom layer.

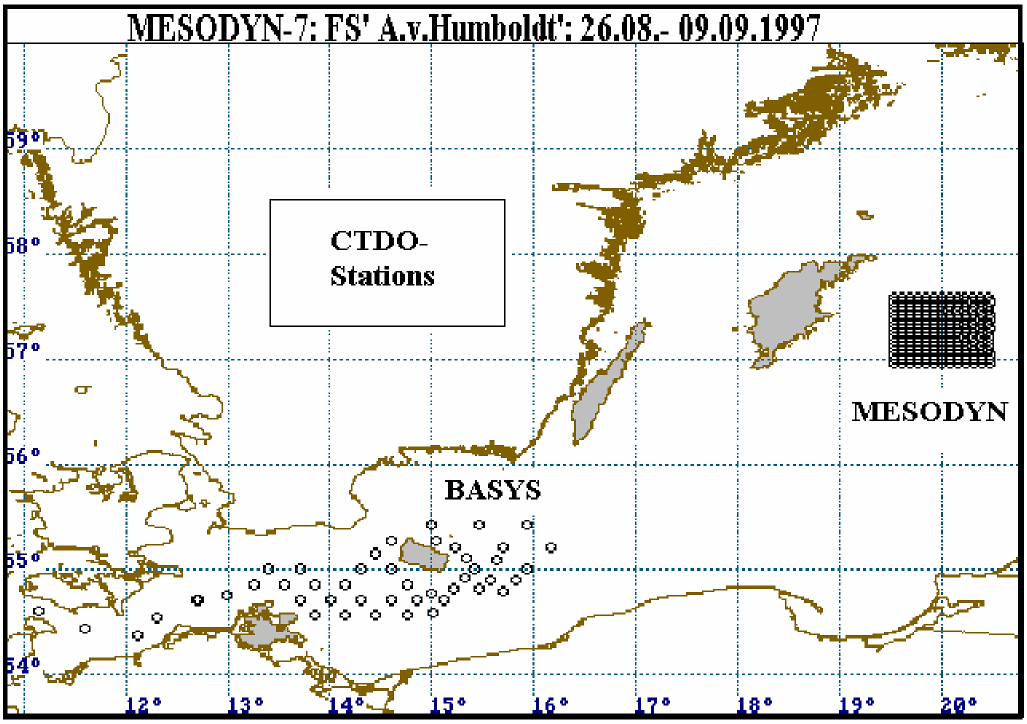

Fig.1 Hydrographic station map for the MEDODYN-7 field campaign carried out with R/V 'A.v.Humboldt'. The station spacing was 2.5 n.m. above the eastern Gotland Basin (EGB) but somewhat larger in the Bornhom & Arkona Basin. These irregularly arranged stations are part of a tracer-experiment performed for BASYS by the BSH-Hamburg (released by R/V 'Gauss', cruise -291, 1997) in co-operation with the Institute of Marine Research of the University of Hamburg.

The MESODYN-7 campaign was carried out on a regular station grid starting in the northwest corner along zonal transects. The area under investigation covers the region between (56°55'- 57°35') N and (19°32.1'- 20°27.9') E with 56 km x 69.3 km = 3881 km². Here, a total of 208 hydrographic stations (16 sections x 13 stations) was profiled under uniform environmental conditions during a week (29.08. -04.09.). Our bathymetric map results from local echosoundings (DESO-25), which are corrected for each station by vertically integrated sound-speed measurements, Fig.2.

The temperature was controlled by three reversing thermometers at different depths. The resulting rms error is (+/-) 0.003 K without any statistical correlation with the pressure. An analogous procedure was performed for salinity with the aid of salinometer measurements and for dissolved oxygen (Winkler method) resulting from bottle casts of the same horizons. Values of rms are found to be (+/-) 0.0007 (PSU) and (+/-0.49) ml/l, respectively.

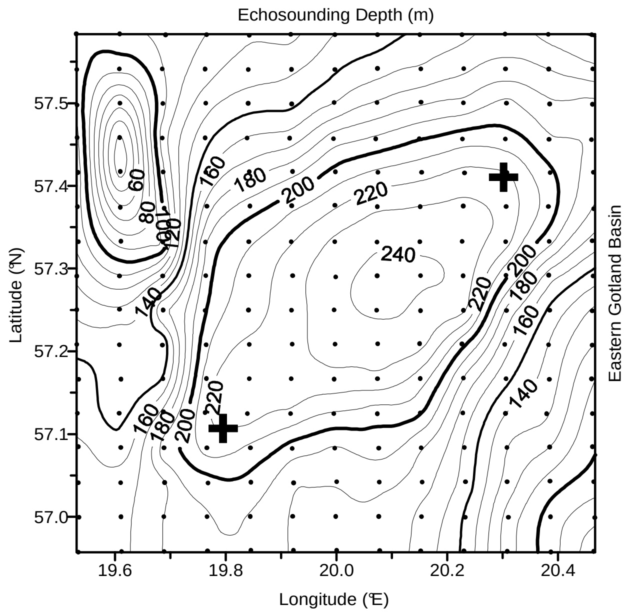

Fig.2 Bathymetric map of the MESODYN-7 area with positions (crosses) of two subsurface moorings each with three current meters (RCM-7) at 215m, 200m, and 170m above the sea bed at 220m; the top of the mooring locates at 130m depth; recovering is planned in May 1998; dots indicate hydrographic stations.

Moderate winds (< 5 m/s) only slightly stirred up the top layer. The wind direction changed between sectors S and SW. The temperature of the near surface layer was larger than 21.5°C in the south-west corner with S>7 (PSU), Fig.3. The spreading of more saline water suggests an anticyclonic curvature around the position of 57.15°N, 20.1°E, where the temperature is relatively low. For comparison, associated values of dissolved oxygen are plotted in the lower panel of Fig.4. while its upper panel shows the pressure level of the 20°C- isotherm. This isotherm roughly identifies the horizon of the seasonal thermocline. There is a significant pattern with a deepening of about 3 m. This must be the centre of an eddy-like feature. The 16 dbar isobar indicates its diameter to be between 20 and 25 km. Regional anomalies of the relative dynamic topography (10/40 dbar) confirm this conclusion, cf. Fig.5, but also indicate that this feature involves a relatively strong geostrophic component. Furthermore, the lower panel of Fig.4 suggests that intensified mixing processes provide a better ventilation of near-surface layers along the rim of that eddy-like feature, which takes place above the deepest part of the basin.

Concerning upper layers and comparing Fig.3,4,5, observed mass-field structures suggest that the central eddy vertically changes its sign from a cyclonic (shallow near surface layer) to an anticyclonic rotation above and within the seasonal thermocline. In deeper layers, which cover the permanent halocline, the sign changes again to a cyclonic sense of rotation with upward directed vertical velocities. This follows from the mapped pressure level of the 10 (PSU) salinity surface, Fig.6.

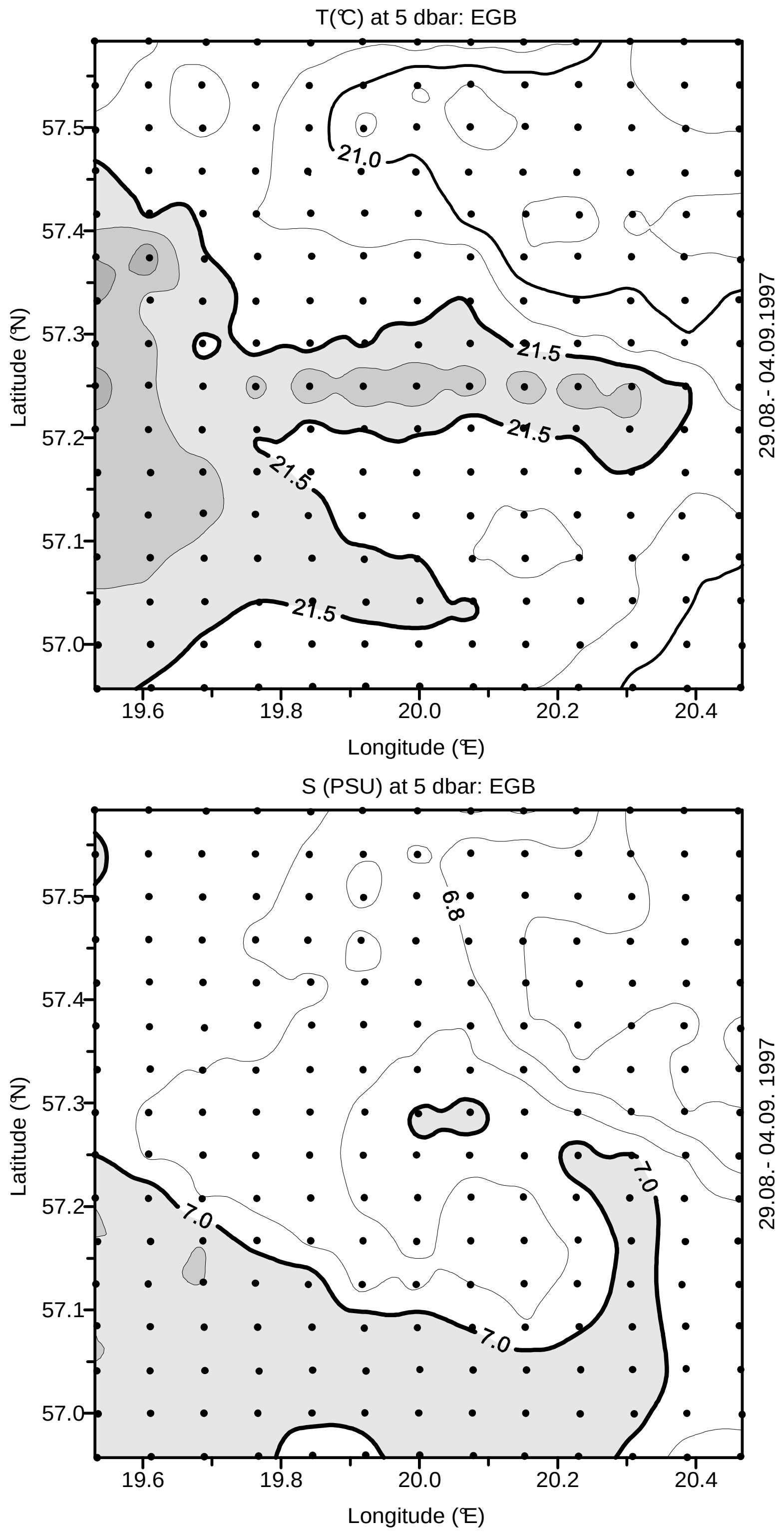

Fig.3 Patterns of temperature (T) and Salinity (S) at the pressure level of 5 dbar describing near-surface conditions.

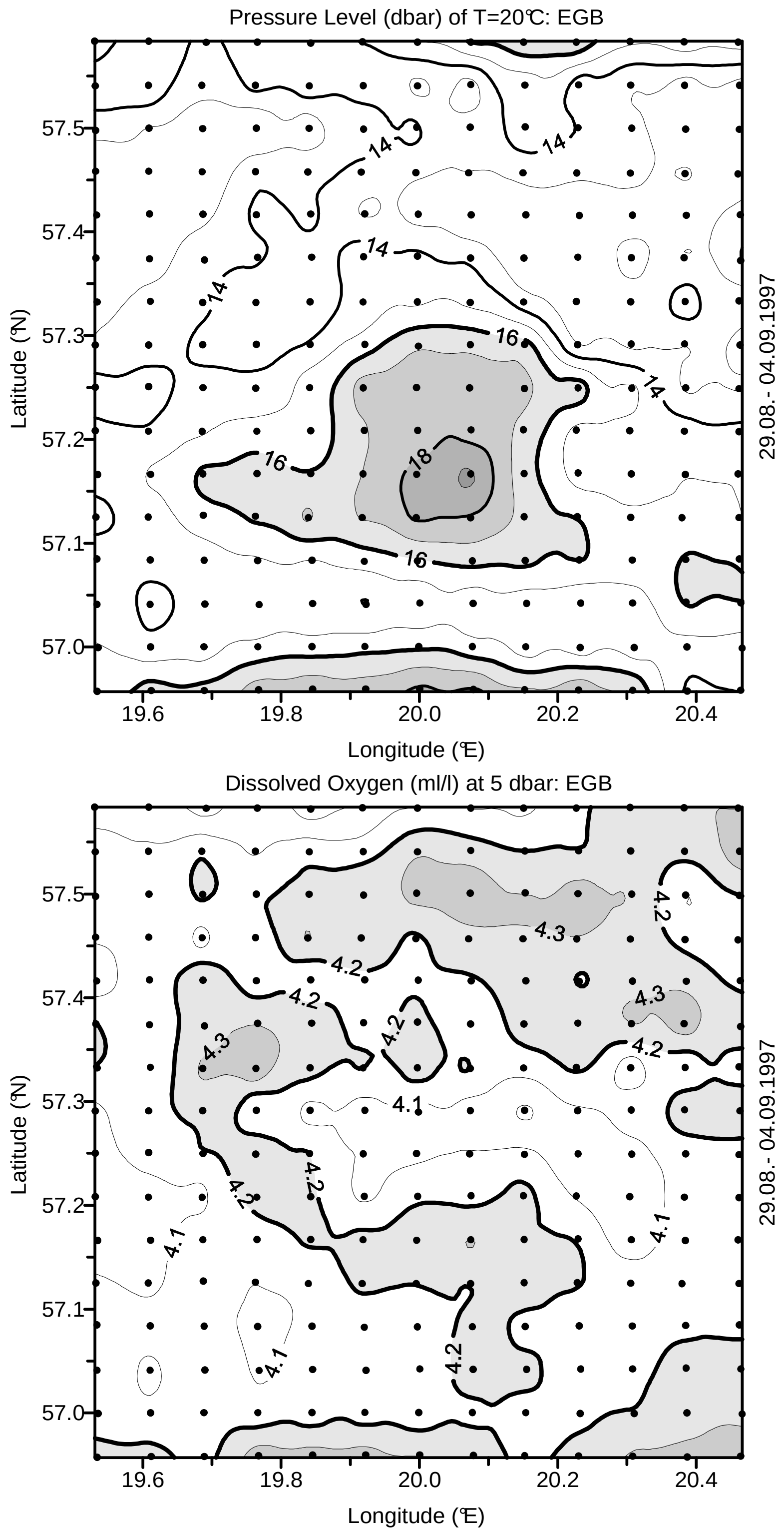

Fig.4 Pressure level (dbar) of the 20°C-isotherm, which roughly describes structures of the seasonal thermocline in comparison with the distribution of dissolved oxygen at 5 dbar within the near-surface layer.

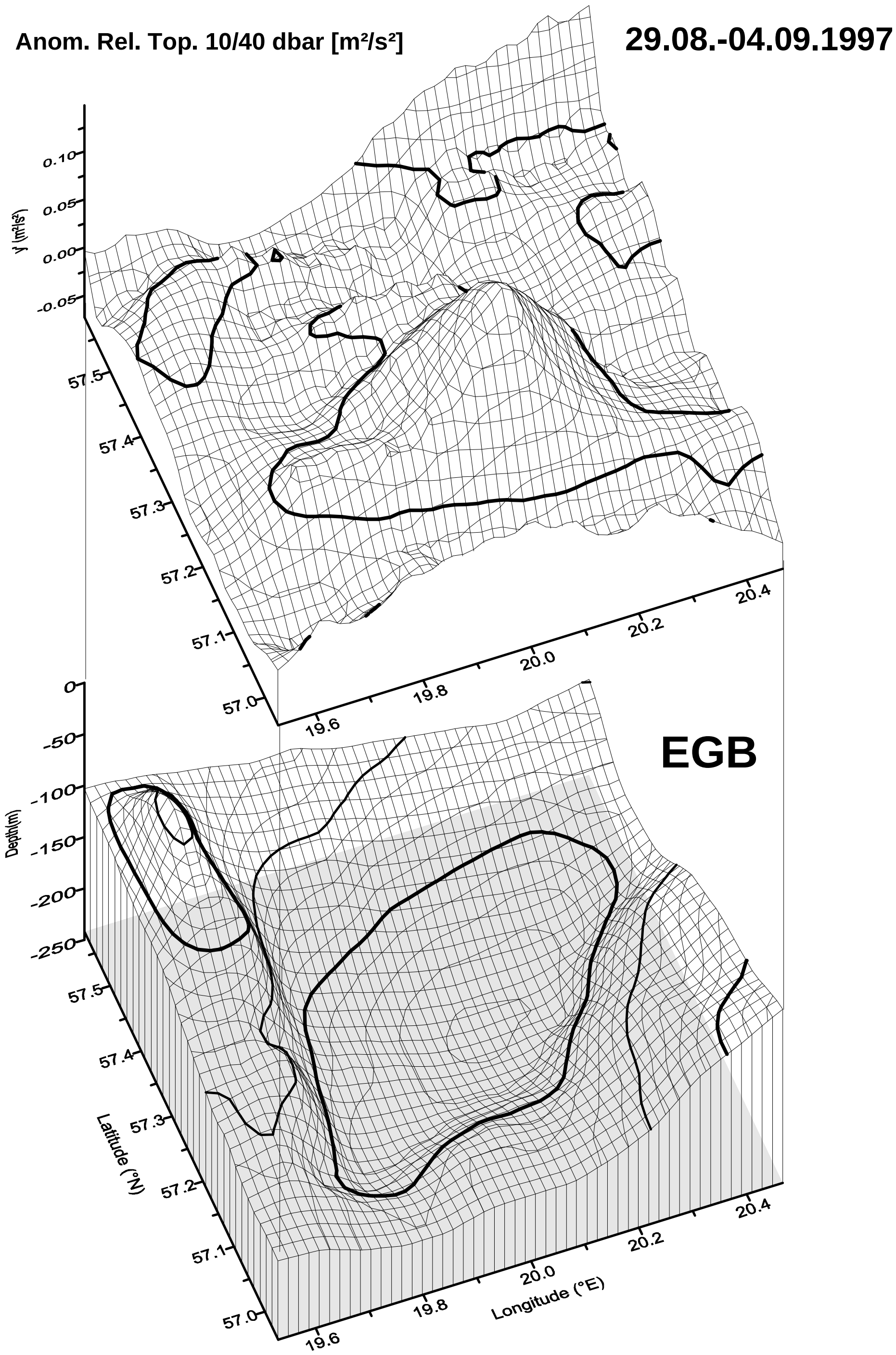

Fig.5 Anomalies of the relative dynamical topography (10/40 dbar) with respect to the regional mean value of -1.56 $m^2 s^{-2}$ (bold line) describing geostrophic motion patterns within superficial layers with positive anomalies (anticyclonic rotation) above the deep basin; bold lines of the bottom topography indicate 200m, 150m, and 100m water depth.

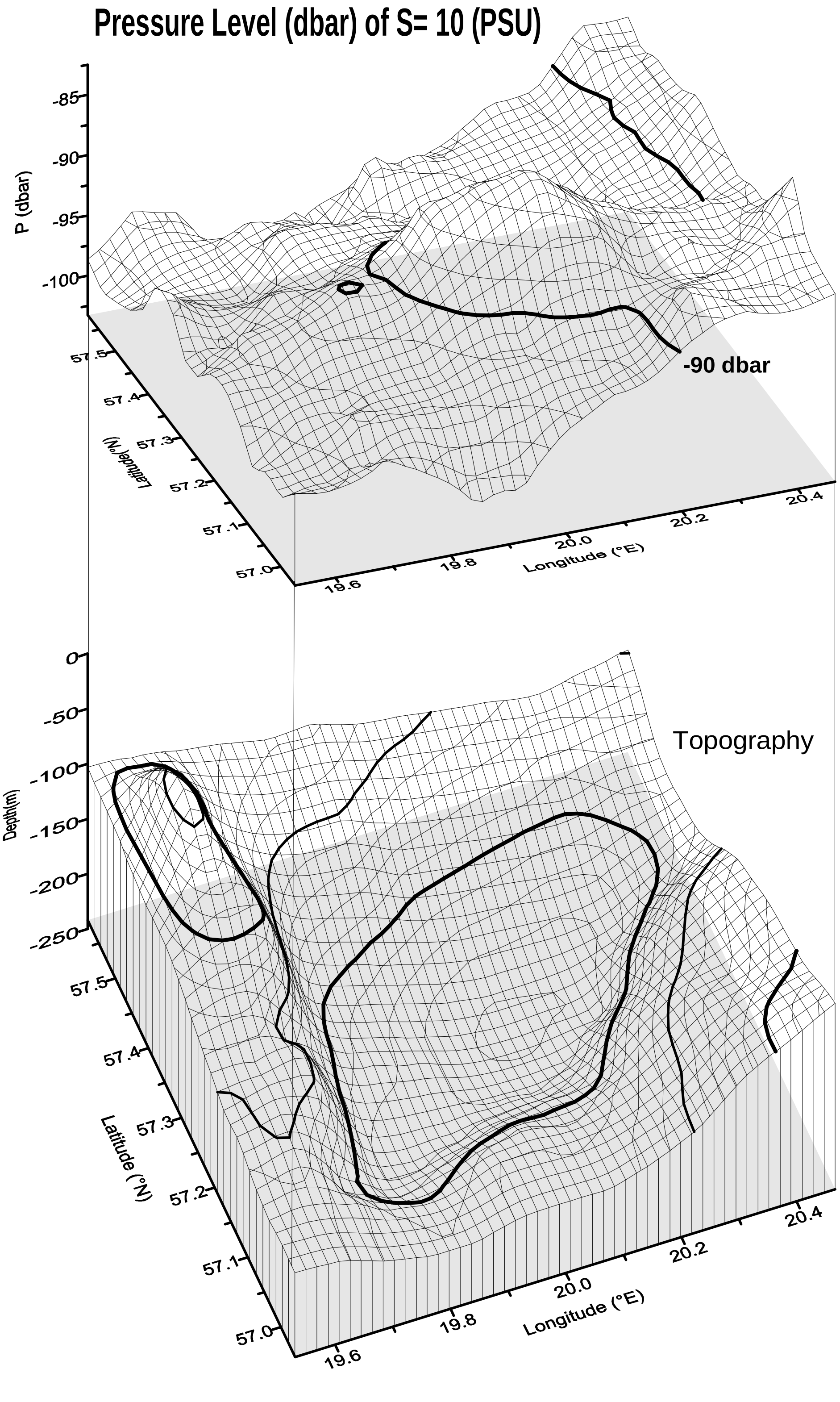

Fig.6 Mapped pressure level (dbar) of the 10 (PSU) salinity surface indicating spatial structures of the permanent halocline; the bold line shows the -90 dbar level; the upward displacement of the halocline indicates upward motions due to the cyclonic sense of rotation within the central eddy-like feature, which takes place above the deepest part of the basin; bottom topography as in Fig.5.

In layers beneath the halocline, series of smaller eddy-like features with a strong geostrophic motion component could be detected by means of the dynamical topography 130/ 190 dbar (not shown). It seems to be that such features ‘travel?’ along steep topographic slopes of the basin. Their diameter is about 5-15 km with a ‘wave-length’ of the same order between neighbouring events of the same sign. Their geostrophic ‘core speeds’ reach peak values of about 20 cm/s. Related propagation velocities will be studied by means of the expected current meter records of both deployed moorings.

E. Hagen
Chief scientist