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 / 99 / 12

This report is based on preliminary data:

Institut für Ostseeforschung Warnemünde
an der Universität Rostock
Seestraße 15
D-18119 Rostock- Warnemünde
GERMANY
+49-381-5197-0
+49-381-5197 440

1. **Cruise No.:** 44 / 99 / 12

2. **Dates of the cruise:** from 17.08.1999 to 03.09.1999

3. **Particulars of the research vessel:**
   Name: A. v. Humboldt
   Nationality: Germany
   Operating Authority: Baltic Sea Research Institute Warnemünde (IOW)

4. **Geographical area in which ship has operated:**
   Eastern Gotland Basin (56.9°- 57.6°)N; (19.5°- 20.5 °)E

5. **Dates and names of ports of call**
   nil

6. **Purpose of the cruise**
   Study of 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
   J. Reissmann

   Engineers: P. Wlost
   H. Will
   Technicians: W. Hub
   G. Plüschke

9. **Co-operating institutions:**
   nil

10. **Scientific equipment:** Sea-Bird CTD – probe SBE911+, Towed CTD (SeaBird System), Thermosalinograph, Automatic Weather Station

11. **General remarks and preliminary results** (ca. 5 pages)

Warnemünde, 09 September, 1999

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 via the Stolpe Furrow.
Our hydrographic activities support 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. The programme ‘**Meso-Scale Dynamics/ MESODYN**’ runs for four years (1996- 1999) above deep Baltic basins. Eddy-resolving CTD-profiles have a station spacing of about 2.5 n.m. to study exchange processes of water properties between different layers in the water column, between coastal zones and central parts of the Baltic as well as between different basins during different seasons. Previous field campaigns have been carried out in the Eastern Gotland Basin during June, 1996; September, 1997; April and November 1998. Such activities will be continued by one hydrographic survey planned for the early spring, 2000. So, repeated CTDO measurements will be performed at the same positions to describe the seasonal cycle in meso-scale patterns of the mass-field and associated fluxes of energy and matter. Resulting data sets will be analysed to estimate statistics of baroclinic eddy-like features and associated changes in the net volume transport, especially in layers within and beneath the permanent halocline (60-140 dbar). The area under investigations is shown in Fig.1 while the related hydrographic station grid is plotted in Fig. 2.

The weather situation was dominated by southerly winds with velocities between 5 m/s and about 15 m/s. The regular field campaign started on 19 August at station no. 1 in the north-west corner and ended on 25 August at station no. 221 in the south-east corner of the area under investigation. So, 17 zonal sections have been performed, each with 13 CTD stations. The eddy resolving station spacing was 2.5 n.m. because the first mode internal radius of deformation varies between 10 km (summer) and 7 km (winter) in that region. Using our CTDO- SeaBird System, the mass-field was vertically profiled from the sea surface down to the near bottom layer. The profiling velocity was about 1.5 m/s.

Furthermore, a diagonal transect was carried trough the investigation area using a towed CTD (SeaBird system). This section started with the CTD station no. 222 in the south-west and ended with the CTD station 223 in the north-east. The ‘CTD-fish’ undulated between 60 dbar and 140 dbar within the layer of the main halocline. This device was trawled by a mean speed of about 6 knots and the constant up-downward velocity of 0.3 m/s. So, we got a horizontal resolution of CTD data in the range of about 1 km along the section plotted by a thin broken line in Fig.2.

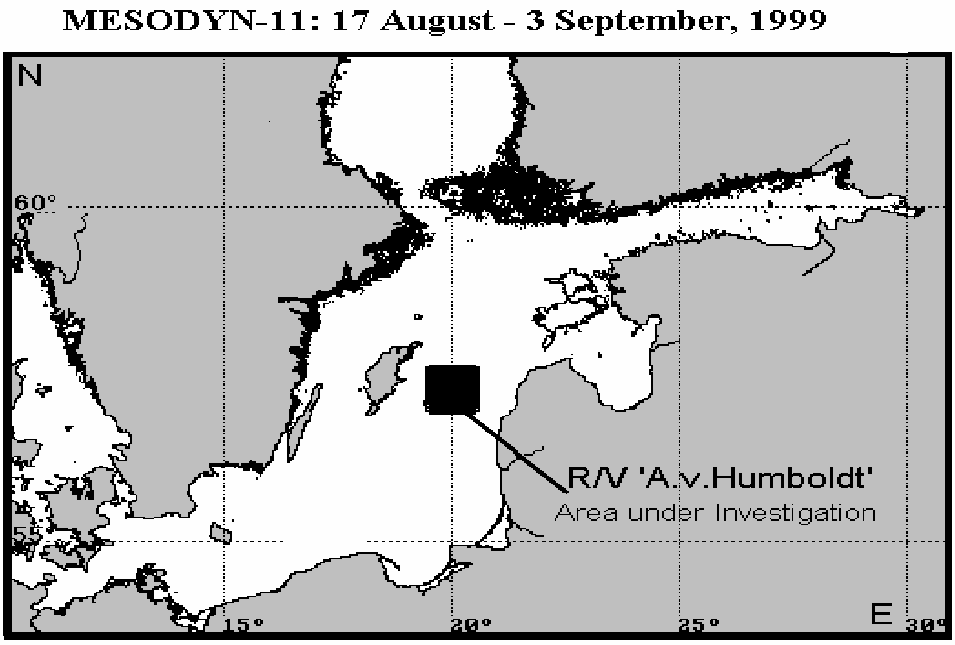
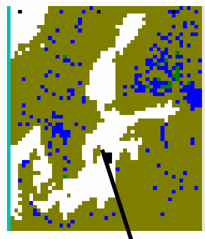


Fig.1 Area under investigation in the Eastern Gotland Basin (EGB) during the campaign MESODYN-11.

Thereafter, serious problems occurred with hardware of our ‘fish’ and no further tracks could be carried out. That was the reason to repeat usual CTD measurements at 36 positions (stations no. 224-259), which enclosed an identified eddy-like feature. This area is marked by a rectangle of bold broken lines in Fig.2. In order to study the space-time behaviour of radial pressure gradients through the flank of such phenomena, we additionally profiled three selected stations ten times. The station- triangle (stations no. 260-289) is shown in Fig.2. Finally, we repeated again 36 CTD profiles at selected stations (stations no. 291- 326) to estimate the associated displacement. The result is shown in Fig.3.

Spatial anomalies of related mass-field patterns, which can be expressed by the Relative Dynamical Topography 90/50 dbar, reveal similar phenomena. Positive (negative) values correspond to

Station Map



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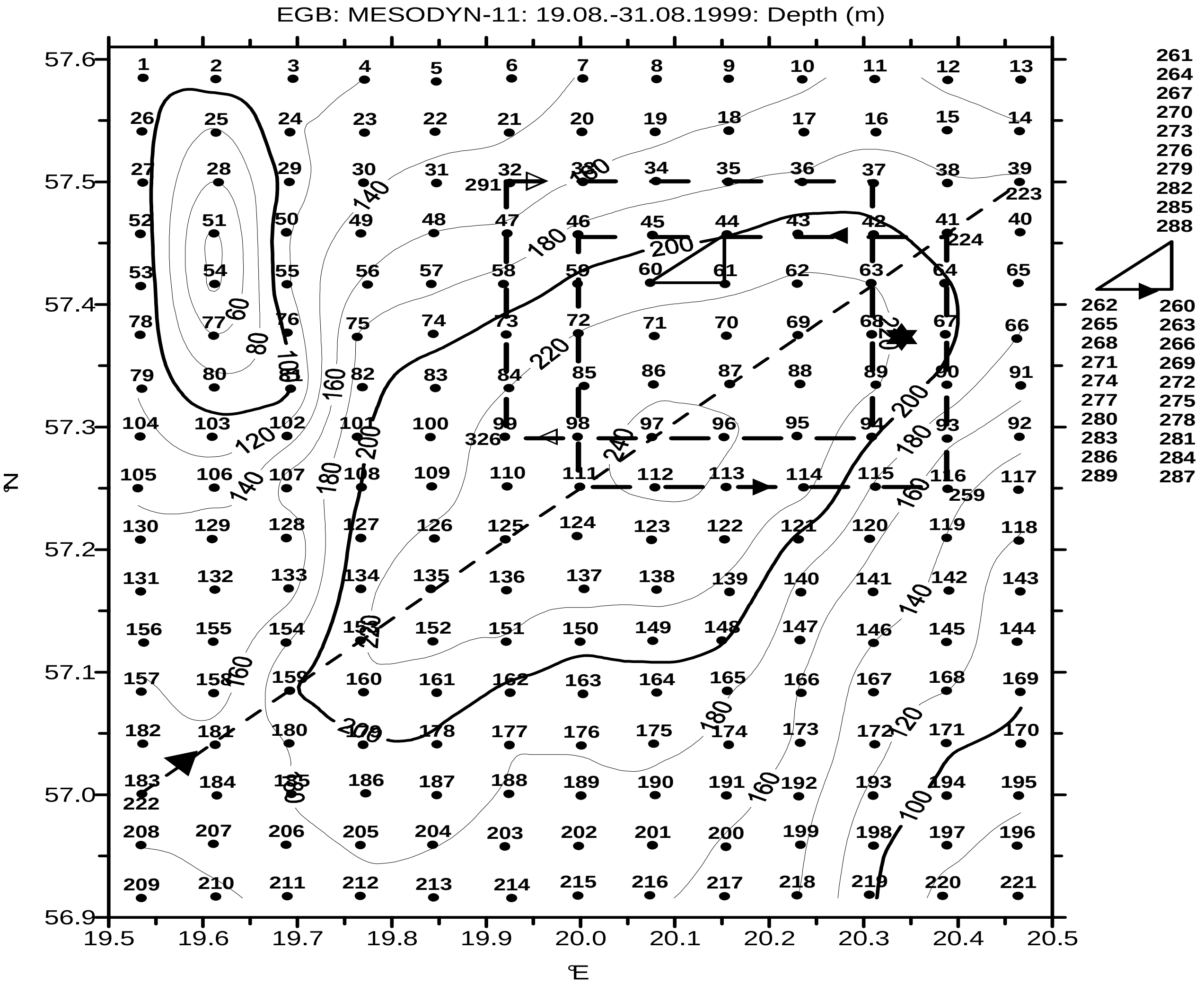

Fig.2: Dot: CDTO- Station, Thin Broken Line: Towed CTD (60-140 dbar), Triangle and Bold Broken Lines: Repeated CTDO Stations, Star: Current Meter Mooring (RCM‘s at 215m, 200m, 170m depth)

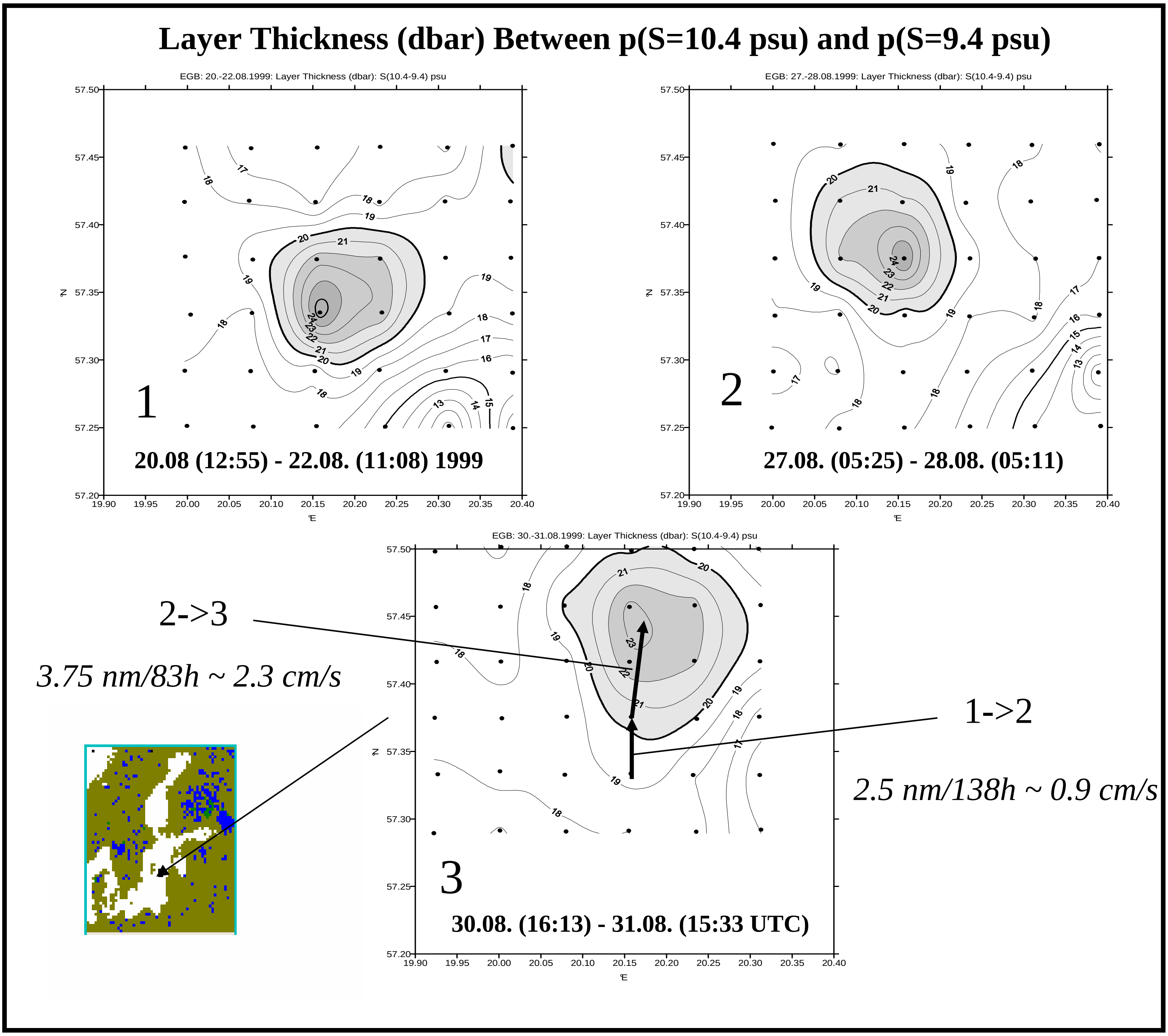

Fig.3 Three subsequent snapshots (1,2,3) of the layer thickness between two selected isohaline surfaces; values larger than 20m are shadowed and indicate the shape of a clockwise rotating eddy-like feature, which is embedded within the main halocline; arrows indicate its displacement direction.

a clockwise (anticlockwise) rotation sense in Fig.4. Associated tangential velocities indicated the geostrophic speed in the range of 4-9 cm/s. Alternating cyclonic and anticyclonic eddy-like features follow the topographic rim of the Eastern Gotland Basin with a ‘wave length’ of about 30-40 km. Their layer thickness reaches several decametres.

Temperature records of the CTD probe were controlled by three reversing thermometers at different depths at 12 stations, which were irregularly distributed in the area shown in Fig.2. The resulting mean difference between thermometer and CTD-sensor was - 0.002 K. An analogous procedure was performed for salinity with the aid of salinometer measurements. We got a mean deviation of +0.002 psu. Comparing measurements by the Winkler- Method with those of the oxygen-sensor, it turned out that the CTDO-probe underestimated dissolved oxygen by about 1.5 ml/l. All necessary corrections will be made by the procedure of data validity in due time.

We deployed a subsurface current meter mooring on 30 August at the position which is marked by a star in Fig.2. The related string was equipped with two recording current meters (RCM) of the type Aanderaa RCM-7 (170m and 215m water depth) and one RCM-9 (200m depth). Each instrument also measures temperature and conductivity while the RCM-9 additionally records pressure. The top of this mooring is placed near 130m water depth. All RCM's will be recovered in August 2000.

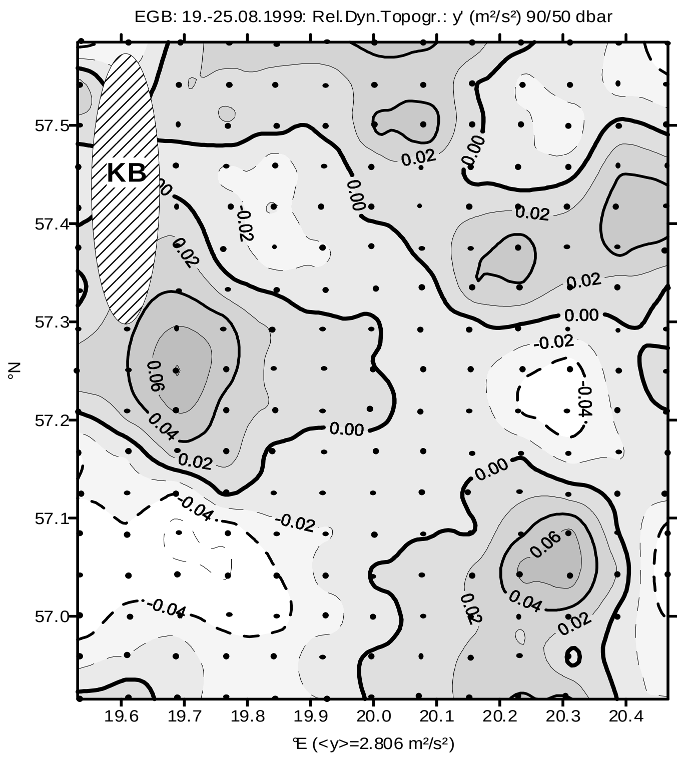

Fig.4 Spatial anomalies of the ‚Relative Dynamical Topography 90/50 dbar' with respect to the mean value of <y>=2.806 m²/s²; positive (negative) centres of anomalies correspond to their clockwise (anticlockwise) rotation, the Klints Bank (KB) is schematically drawn, station positions are given by dots.

E. Hagen

Chief scientist