Baltic Sea Research Institute

Warnemuende (IOW)

Cruise Report

No. 44/ 96/ 12
R/V "A.v.Humboldt"

MESODYN Cruise

03 to 14 September, 1996

Bornholm Basin / Baltic Sea

This report is based on preliminary data and is subject to changes.
Institut für Ostseeforschung Warnemünde
an der Universität Rostock
Seestr. 15
D-18119 Rostock
Germany

MESODYN-3

Cruise No 44/96/12

R/V "A.v.Humboldt"

Warnemünde, 19 September, 1996

The third scientific cruise of the Meso-Scale Dynamics (MESODYN) project was carried out with R/V „A.v.Humboldt“ in the Bornholm Basin during 3 - 14 September, 1996. These activities are part of 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.

This hydrographic programme runs for three years (1996- 1998) above deep Baltic basins to provide eddy-resolving data sets with a station spacing smaller than 2.5 n.m. 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.

Scientific staff participating:

Chief scientist:	E. Hagen
Participants:	R. Feistel
	S. Weinreben
	W. Hub
	H. Duncker (stud.rer.nat.)
Master:	O. Fuchs

Scientific program:

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 Bornholm Basin through the Stolpe Furrow into the eastern Gotland Basin.

The investigation of exchange processes between different basins of the Baltic Sea have been started by CDT-measurements above the Stolpe Furrow connecting the Bornholm - with the Gotland Basin during March, 1996. Similar campaigns were carried out in the Gotland Basin (June, 1996) and Bornholm Basin (September, 1996). Activities will be continued in the Arkona Basin (December, 1996). These hydrographic surveys contribute to the data base of the international, multidisciplinary project ***Baltic Sea System Study*** **(BASYS).** In the following three years, repeated measurements will be carried out at the same positions in order to describe the seasonal cycle in the mass-field and associated (iso- diapycnal) property-fluxes in each basin. Resulting data will be, among other things, used for the estimation of geostrophic motions in deep layers and associated volume transports as well as for the setup of numerical circulation models. The area of investigations is shown in Fig.1.

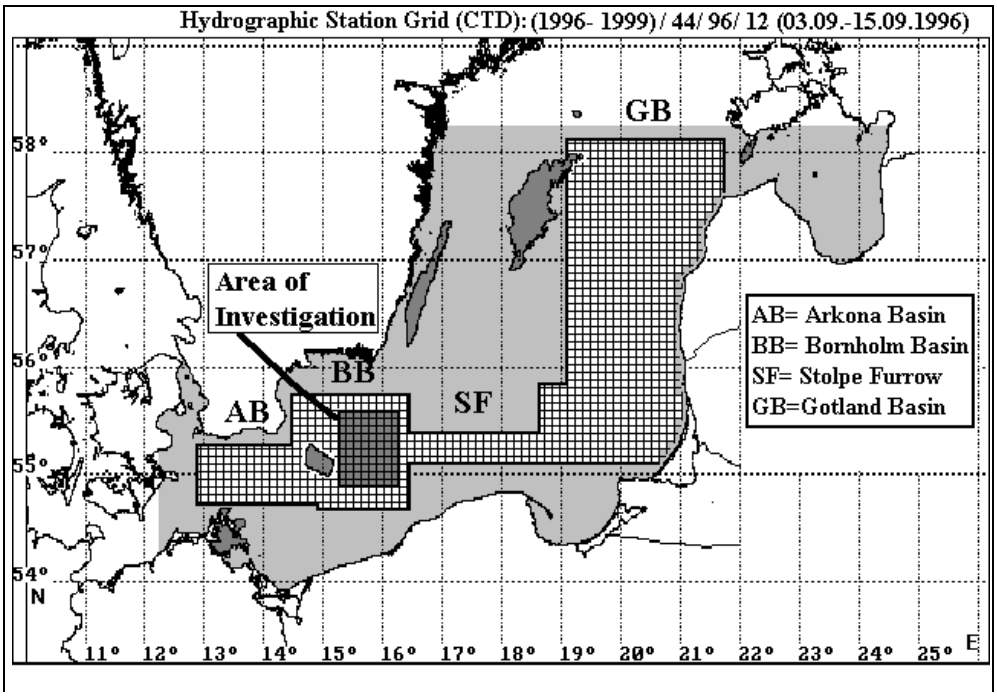

Fig.1 Investigation area of the RBS/ MESODYN-3 programme carried out during September 1996.

In completion of historical data sets (*Baltic Year*, *HELCOM*-monitoring, *Gotland Basin Experiment* (GOBEX),...), this time CTD measurements have been performed with the SeaBird System from the sea surface to the near bottom layer. The station spacing was 2.5 n.m. on a regular station grid, which covers the area between (55°- 55°35') N, (15°20.7'- 16°26.2') E as mapped in Fig.2. This map also involves selected depth contours, which result from actual echosoundings (DESO).

Measurements started in the northeast corner of the grid (station no. 1) and followed zonal transects with a separation distance of 2.5 n.m.. The bottom topography shows a closed ellipse-like shape for water depths deeper than about 85 m. Its large axis orientates from northwest to south-east. The last station (no.227) took place in the south-east corner of the station grid. A total of (16 stations x 14 transects) 224 vertical CTD-profiles was gathered. Conductivity (C), temperature (T), and pressure/ depth (D) were vertically profiled. After the

first three transects, strong north-easterlies (8-9 Bft) caused a break of about 60 hours. Thereafter the measurements started again with station no. 52 at the zonal transect no.4. We repeated the profiles at the first three stations (no 49, 50, 51) by stations 52(49), 53(50), and 54(51).

The temperature was controlled by three reversing thermometers at different depths twice a day. The resulting rms error is +/-0.001 K without any statistical correlation with the pressure. An analogous procedure was performed for salinity with the aid of salinometer measurements and dissolved oxygen resulting from bottle casts of the same horizons. Its largest rms values are found to be +/-0.2 ml/l of dissolved oxygen. Due to electronic uncertainties, we changed the C-sensor at station no 159. Between stations 129-158, temporally increasing deviations up to about 0.2 PSU could be observed between the salinometer values and those of the C-sensor.

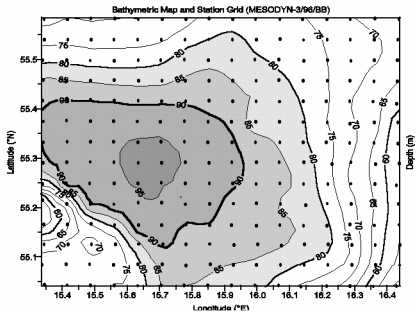

Fig.2 Bathymetric map (m) resulting from echosoundings at 224 hydrographic stations (dots) with the spacing of 2.5 n.m. above the Bornholm Basin during 03 -13 June, 1996.

Preliminary Results

Along the first three transects, relatively high sea surface temperatures (SST) of about 18□C could be observed under moderate winds with fluctuating directions. Thereafter strong winds (15-19 m/s) from northeast stirred the upper 20-30 m-layer and the SST decreased to values of about 15°C. At about 60m depth, for instance, the temperature ranged between 4°C and 9°C. Closed thermal contours reveal meso-scale eddy-like patterns with a diameter of about

5- 20 km as plotted in Fig.3. Such values well confirm the scale of the baroclinic radius of deformation as given in the literature. The meso-scale features are embedded in a rim zone of larger temperatures bounded by the 6°C- isotherms. This resulting ring of relative warm water (6<T<9)°C suggests the existence of an eddy-like circulation pattern. Its diameter confirms the deep basin scale (90m water depth). Lowest temperatures (T<6°C) occur above the deepest parts of the basin. Unfortunately, we are not able to show the corresponding map of the density due to our problems with the C-sensor. However, we selected three transects crossing the central

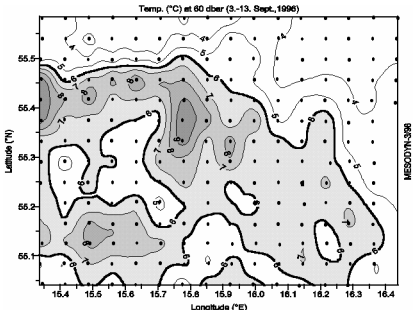

Fig.3 Temperature map (°C) of rough data at the pressure level of 60 dbar (values T>6°C are hatched)

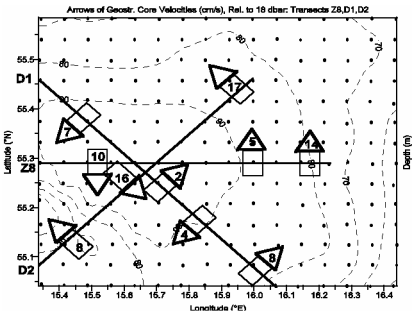

Fig.4 Rough bathymetric map with station positions (dots) and three transects (Z8, D1, D2) crossing the central Bornholm Basin; arrows of geostrophic core velocities (cm/s)

suggest (relatively to the reference level at 18 dbar) a basin-scale cyclonic circulation pattern with upward directed vertical velocities, which could explain the relative cold water pool (T<6°C) centred at about 55.3°N, 15.6°E in Fig.3

basin. Their location is shown in Fig.4 together with resulting arrows of geostrophic core velocities, which are computed relative to the reference level of 18 dbar. That depth nearly coincides with the value of the local wind penetration depth. Along relative steep topographic flanks, geostrophic currents occur with core speeds in the range of 10 -17 cm/s. On the basin scale, that cyclonic motion pattern clearly follows topographic contours. Its sense of rotation supports upward directed vertical velocities, which could be responsible for the generation/ maintenance of the cold water pool (T<6°C) shown above the basin's centre (55.3°N, 15.65°E) in Fig.3. This deep circulation could be actually forced by strong north-easterly winds due to the response of baroclinic motions on modulating barotropic flows. Only slight gradients in O_2 could be measured horizontally. The content of dissolved oxygen decreased to values smaller than 1 ml/l. Clear indications for H_2S could be subjectively observed at seven stations only, which were placed in the central part of the basin.

E. Hagen

(Chief scientist)