Baltic Sea Research Institute Warnemünde

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

R/V " Professor Albrecht Penck "

Cruise- No. 40 / 99 / 20

This report is based on preliminary data:

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1. **Cruise No.:** 40 / 99 / 20

2. **Dates of the cruise:** from 05.10.1999 to 21.10.1999

3. **Particulars of the research vessel:**
Name: Professor Albrecht Penck
Nationality: Germany
Operating Authority: Baltic Sea Research Institute
Warnemünde (IOW)

4. **Geographical area in which ship has operated:**
Arkona Basin (54°47.5'- 55°10')N; (13°- 14°27')E

5. **Dates and names of ports of call**
Sassnitz/ Germany

6. **Purpose of the cruise**
Study of exchange processes in deep meso-scale mass-field patterns

7. **Crew:**
Name of master: U. Scholz
Number of crew: 8

8. **Research staff:**
Chief scientist: R. Feistel and E. Hagen
Scientists: J. Reissmann
I. Schuffenhauer
A.Stips

Engineers: H. Ruickhold
D. Rüß

Technicians: W. Hub
G. Plüschke

9. **Co-operating institutions:**

Space Applications Institute (SAI), Joint Research Centre, I-21020 Ispra, Italy

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

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

MESODYN-12/ MITEC

Warnemünde, 29 October, 1999

This cruise contributed 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. Its part ‘**Meso-Scale Dynamics/ MESODYN**’ was scheduled for four years (1996- 1999) above deep Baltic basins. This cruise was not only the last field campaign under the umbrella of MESODYN but also the last measuring campaign of the EU-funded project **‘Microstructure Technology/ MITEC’** (1998- 1999).

Eddy-resolving hydrographic data sets, which were gathered above deep Baltic basins, will be used 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 Arkona Basin in December 1996 at the same station positions mapped in Fig.1.

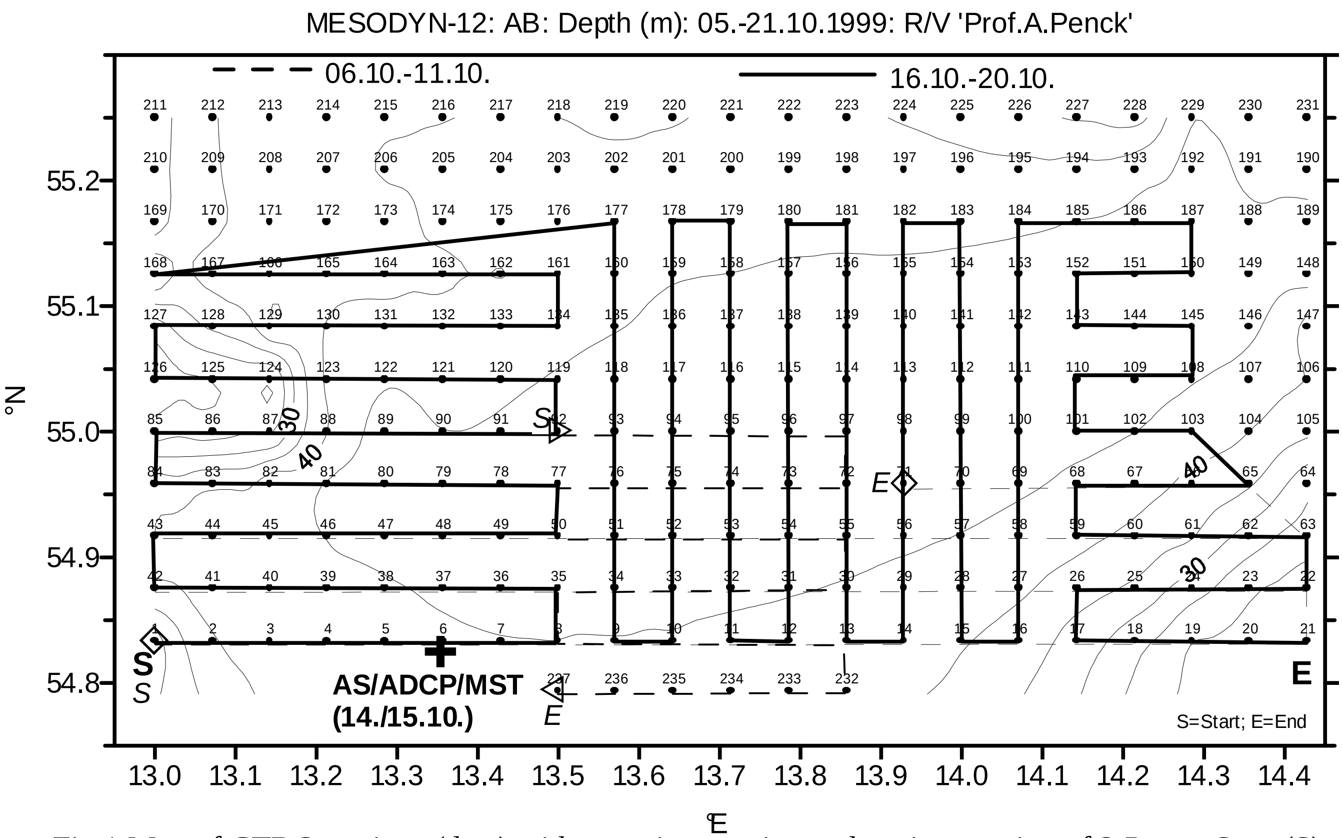

Fig.1 Map of CTDO-stations (dots) with a section spacing and station spacing of 2.5 n.m; Start (S) and end (E) positions are separately marked; broken lines indicate transects of leg 1 while full lines show those of leg 2; microstructure measurements have been carried out at the anchor station (AS) in vicinity of a moored ADCP by means of the MST-probe; depth contours are given in metres.

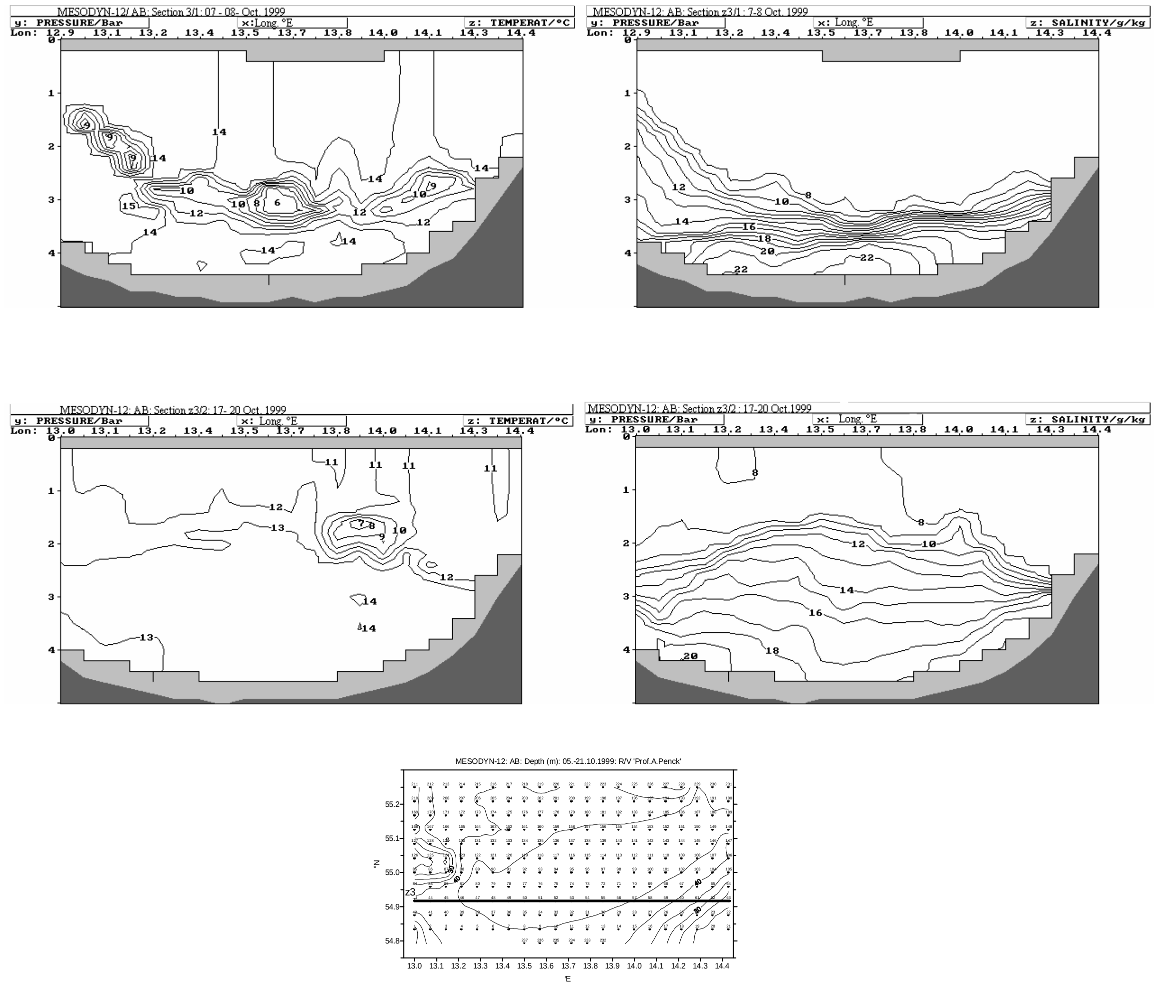

Fig.2. Vertical distribution of temperature (°C- left panel) and Salinity (psu-right panel) along the third zonal section measured under westerly winds during 7-8 Oct. (upper panel) but during relatively strong north-easterly winds during 17-20 Oct. (lower panel).

The whole cruise was divided by three legs. The weather situation was dominated by weak westerly winds during the first three days of the first one. Three moored strings could be successfully deployed during that time. Each mooring was equipped with one ADCP’s and several SeaCat’s for the SALPRO-project at the positions 54°49.22’N.,13°21,22’E; 55°01.15’N, 14°17.18’E, and 55°08.13’N, 12°36.51’E. Thereafter vertical CTDO-profiles started at station no.1 in the south-west corner of the MESODYN-station grid to follow zonal transects. The section spacing as well as the station spacing was about 2.5 n.m. as it is shown in Fig.1. Due to strong increasing westerly winds exceeding 15 m/s, these measurements were stopped after three completed sections above the southern rim of the Arkona Basin on 8 October. Nevertheless, this data set reveals several cold but poorly oxygenated water lenses within layers, which are placed above the perennial halocline, Fig.2. One of them was rediscovered by a grid of 6x6 stations during 10-11 October. Associated station positions are given in Fig.1.

Furthermore, it turned out that relatively strong north-easterly winds, which dominated the second cruise leg, significantly mixed saline deep water into intermediate layers, Fig.2.

The scientific crew was partially changed in the German port 'Sassnitz' on 11 October to start vertical profiling of microstructures within near surface mixed layers during the second cruise leg. Easterly winds with velocities up to 15-18 m/s shortened this field campaign drastically. Finally, about 600 casts could be sampled by the free rising microstructure probe (MST) during 45 hours at the position 54°50'N, 13°21.7'E in vicinity of the previously moored ADCP. Additionally, the velocity field was locally monitored by ship based ADCP measurements. Among other things, the MST probe of the SAI was equipped with sensors for pressure, acceleration, temperature, conductivity, and current shear. A typical vertical profile of two different shear sensors is plotted in Fig.3. Hourly CTDO profiles completed these activities. Related pressure-time plots of temperature, salinity, and oxygen are depicted in Fig.4.

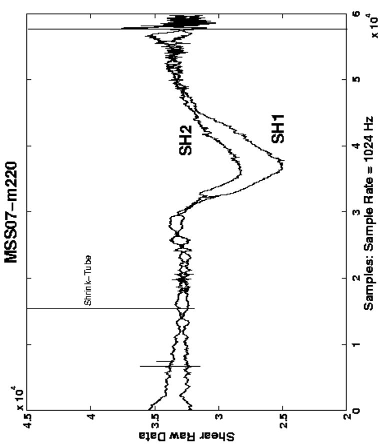

Fig.3 Records of two shear sensors (SH1, SH2) of the free rising MST probe MSS07 with a sampling rate of 1024 Hz; the water depth was 47 m at the anchor station (AS) shown in Fig.1.

Easterly winds with speeds larger than 12 m/s provided a well mixed top layer down to pressure levels of about 12 dbar during the first 24 hours. Thereafter, the wind relaxed significantly. Its velocities decreased by a factor of about two. Consequently, the location of the local thermocline and halocline indicate a trend into shallower pressure levels. No strong vertical gradients could be observed in the whole water column for dissolved oxygen at this position during the observational time.

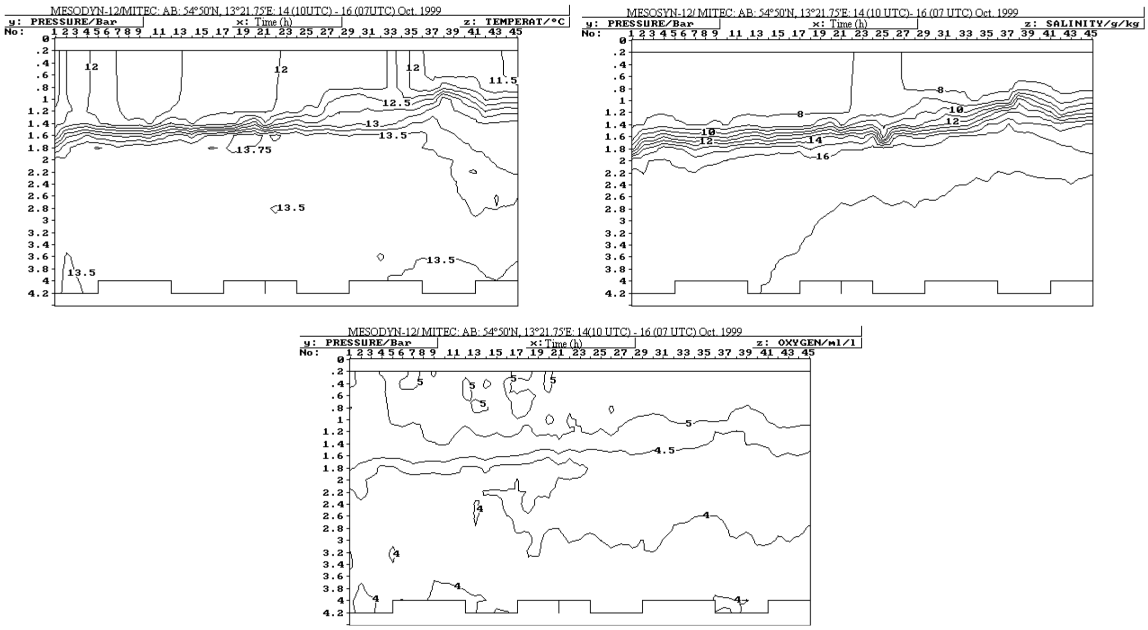

Fig.4 Hourly time series (14 Oct. 10 UTC- 16 Oct. 07 UTC) of temperature (°C), salinity (psu), and dissolved oxygen (ml/l) at the anchor station (depth =47m) shown in Fig.1; note the pressure scale is given in bar.

The second cruise leg ended on 16 October to change again the crew in the port 'Sassnitz'. The third leg repeated CTDO-profiles at station positions, which are connected by full lines in Fig.1. The profiling velocity was everywhere about 1.5 m/s. The resulting station grid well covered regions of the western, southern, and eastern rim currents, which commonly involve a significant geostrophic component. This leg started on 16 Oct. and ended on 21 Oct. without any breaks caused by bad weather conditions. For instance, spatial patterns of the isohaline surface of S=15 psu, which result from leg 1 and leg 3, are compared in Fig.5. In a first step of approximation, contours of salinity represent those of density. Consequently, patterns in the pressure level of a surface of constant salinity reflect structures in the geostrophic part of motion. Looking into the downstream direction, the distance between neighbouring isobars reveals the strength of geostrophic currents. Independently from different forcing conditions with moderate westerly winds during cruise leg 1 but relatively strong easterly winds during leg 3, there was an enhanced geostrophic eastward flow above the southern topographic rim of the basin. This follows Fig.5 and Fig.6. Wave-like meanders and several eddy-like features were superimposed, Fig.5.

We compared sensors of the SeaBird-system by a total of 10 *in situ* measurements for temperature, salinity, pressure, and dissolved oxygen. Three reversing thermometers were used in two different homogeneous layers.

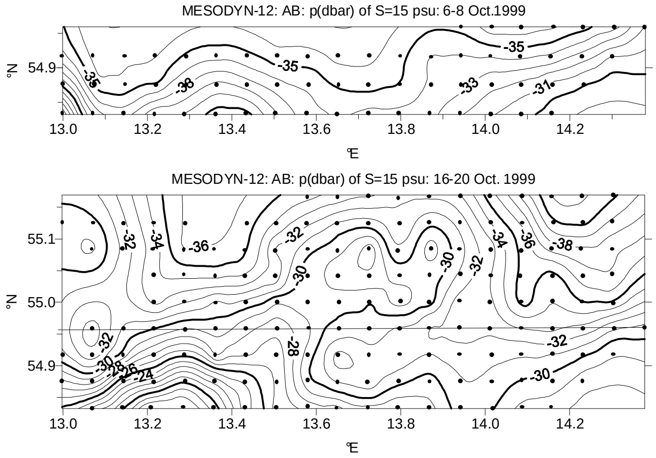

Fig.5. Pressure surface (dbar) of the isohaline surface S=15 psu above the southern rim of the Arkona Basin measured during cruise leg 1 (upper panel) and above central parts of the basin during leg 3; for comparison, the thin line in the lower panel line indicates the northern border of cruise leg 1.

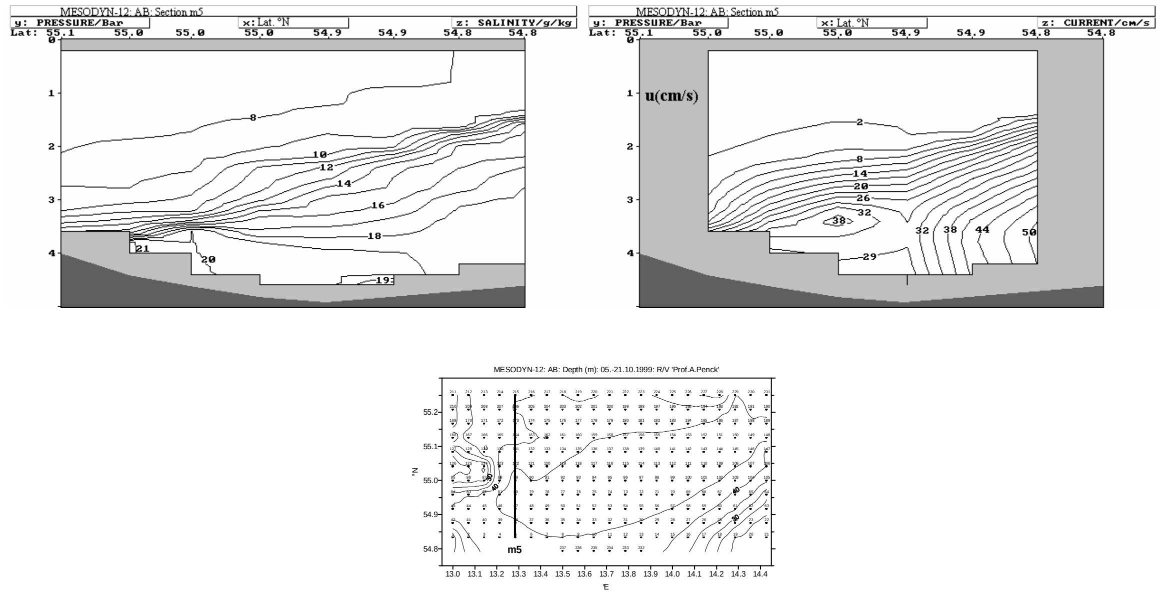

Fig.6. Vertical plots of the salinity (psu) and the geostrophic component of zonal currents (cm/s; u>0 to the east) along a meridional section in the west of the Arkona Basin; the reference level was placed at the sea surface

Bottle casts provided corresponding comparisons via salinometer measurements and the Winkler method. Averaged differences indicate that the temperature was overestimated by 0.0078 K, salinity was underestimated by 0.0012 psu, and dissolved oxygen involves a mean error of about 39 %. The pressure needs a correction of about + 0.1 dbar. All necessary corrections will be made by the procedure of data validation in due time.

R. Feistel & E. Hagen

Chief scientists