# Baltic Sea Research Institute Warnemünde

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

R/V "Prof. A. Penck"

Cruise No. 40 / 98 / 22

This report is based on preliminary data

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1. **Cruise No.:** 40 / 98 / 22

2. **Dates of the cruise:** from 1998-11-2 to 1998-11-12

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

4. **Geographical area in which ship has operated:**
   Baltic Sea / Stolpe Furrow

5. **Dates and names of ports of call**
   None

6. **Purpose of the cruise**
   CTD profiling for meso-scale mass field determination

7. **Crew:**
   Name of master: U.Scholz
   Number of crew: 10

8. **Research staff:**
   Chief scientist: R.Feistel
   Scientists: S.Feistel
   Engineers: I.Schuffenhauer
   Technicians: W.Hub

9. **Co-operating institutions:**
   none

10. **Scientific equipment**
    SeaBird CTD Probe SBE 911+

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

**MESODYN-9**

Warnemünde, 16 Nov., 1998

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 Arkona Basin through Bornholmsgat into Bornholm Basin in order to enter Stolpe Furrow.

Our hydrographic activities support running BASYS (Baltic Sea System Study) field campaigns and contribute to the German-Russian 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 CTDO-measurements in the Stolpe Furrow during March, 1996. Similar campaigns were carried out in the eastern Gotland Basin, the Bornholm Basin, and the Arkona Basin. In the following years, repeated measurements have been carried out at the same positions in order to describe the seasonal cycle in meso-scale patterns of the mass-field and associated property-fluxes. Resulting data will, among other things, be 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. Stations are labelled from SF0001 (NE corner) to SF0198 (NW corner), compare Fig.2.

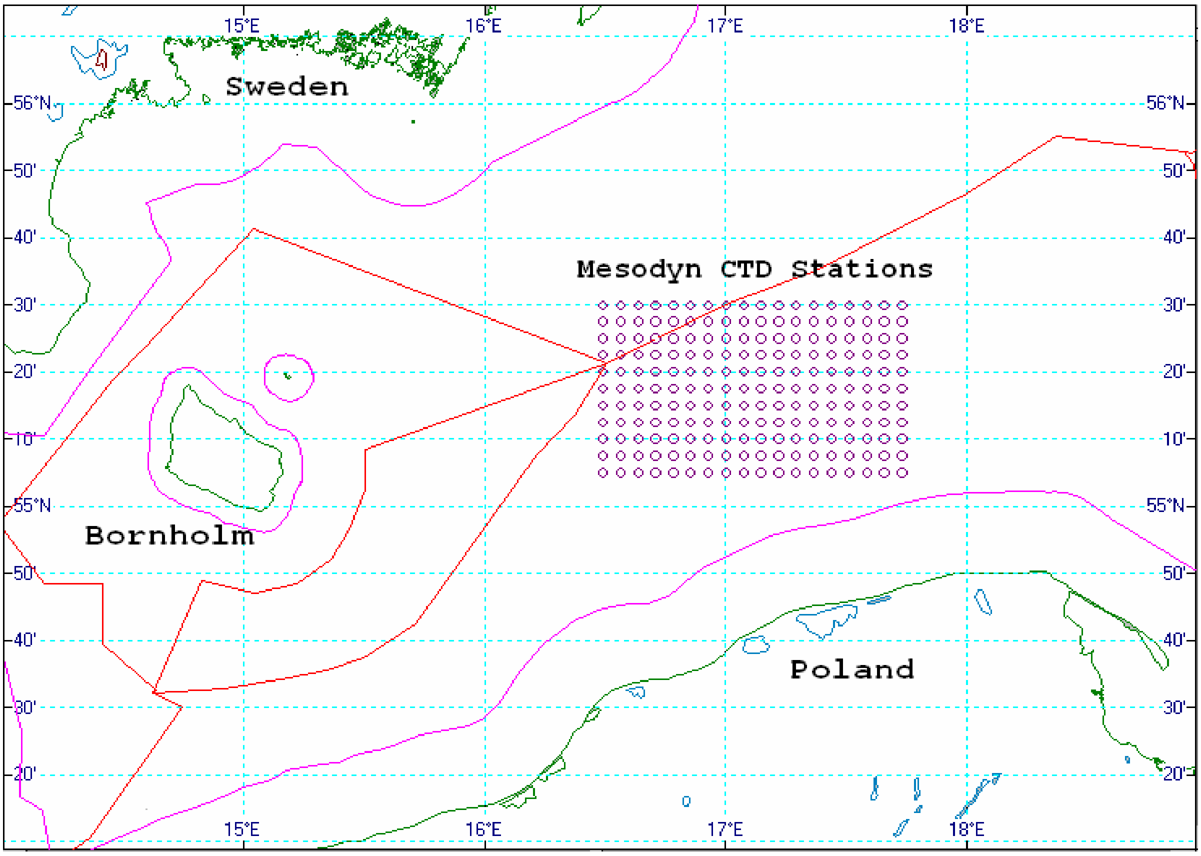


Fig. 1 MESODYN-9 CTD station locations at Stolpe Furrow (3.11.-12.11.1998)

Weather conditions in the Western Baltic during the last week of October (i.e. prior to the begin of the cruise) were coined by continued westerly winds up to gale strength (BF 10). Along with that, a significant salt water inflow from the North Sea had been recorded at the Darss Sill monitoring mast, and there the question arose whether or not traces of the inflow signal could already be detected 2 weeks later at Stolpe Furrow. However, the result turned out to be negative, salty deep water in the research area did not exceed dissolved oxygen concentrations of 3 ml/l, in contrast to saturation levels of about 8 ml/l that could have been expected for inflow waters. Fig. 3 shows $O_2$ concentrations at the western edge over a meridional section at 16°29.45’E between SF0198 and SF0188 (values are raw data, true concentrations in ml/l amount to about 2/3 of the figures displayed).

The corresponding data for the eastern edge between SF0001 and SF0011 are shown in Fig. 4. Again, only low oxygen concentrations have been observed in the deep water.

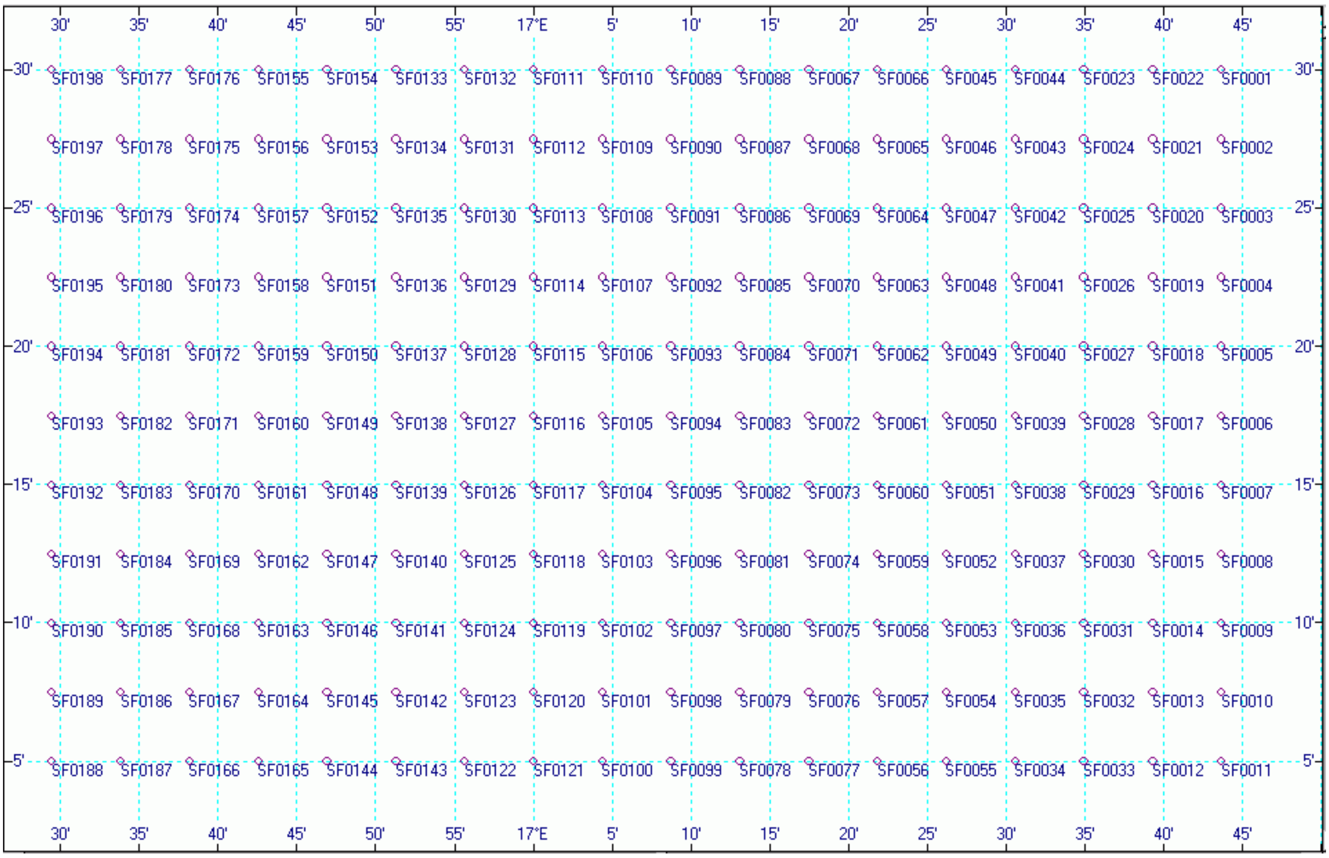


Fig. 2 MESODYN-9 CTD station labelling

The measurement period consisted of two different meteorological phases. In the first phase, a high pressure system extended along the Mediterranean, and along its northern boundary a series of troughs rapidly moved eastward, connected with prevailing westerly winds varying from moderate to storm strength. In the second phase this storm track became blocked by a high pressure bridge over Germany and Denmark, causing the gale cyclones over Britain and the North Sea tracking northward and leaving only their extensions felt at the southern Baltic. Winds blew from easterly directions with speeds between 5 and 13 m/s.

On Nov.4 the CTD profiling work began at station SF0001 with current number 2, running meridional transects one by one from east to west. Starting with almost calm weather the wind increased from SW until measurements had to be interrupted on Nov. 5 due to rough sea and wind speeds about 20 m/s. The final station of this phase was SF0060 with current number 61.

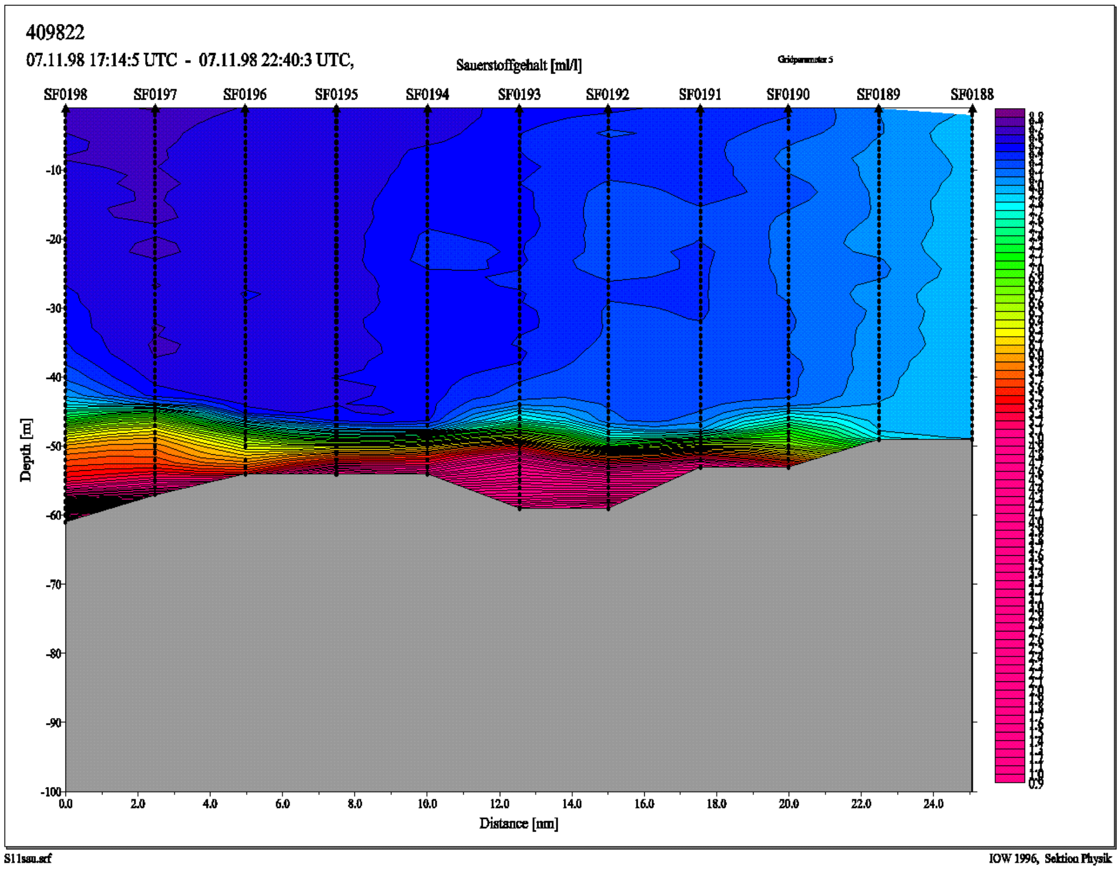


Fig.3 Oxygen distribution on a meridional section along 16°29.45'E

A second phase of measurements started on Nov.7 at position SF0188 with current number 62. Again, meridional transects have been scanned one by one, but this time from west to east. This phase was terminated at station SF0038 with current station number 237. All along the second phase moderate easterly wind conditions persisted, thus giving rise to almost stationary conditions all over the station grid. Three complete meridional sections have been measured twice, once under westerly wind conditions, once with easterly winds.

There was indication for relatively strong surface currents in the investigation area. Despite of a well-stirred surface layer of about 40 m thickness relatively strong horizontal gradients in salinity and temperature have been observed in the surface water. Figure 5 shows the horizontal distribution of salinity (and approximately of density as well) at a depth of 60m, which is below the halocline all over the considered area. Only station data of the second measurement phase (with easterly wind)

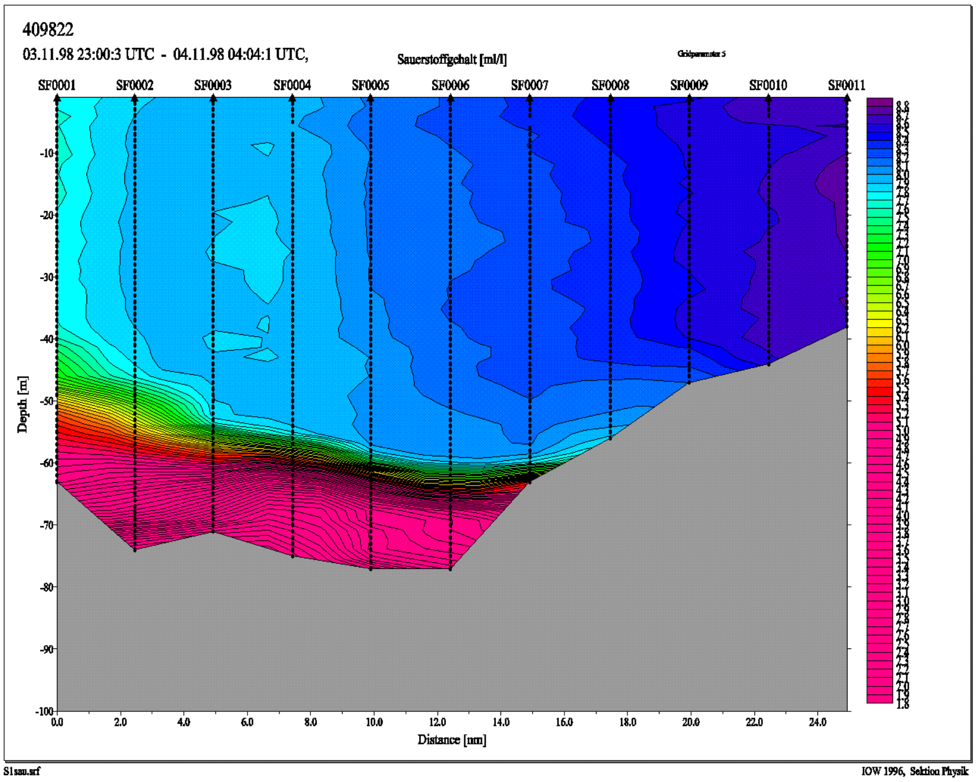


Fig.4 Oxygen Distribution on a Meridional Section along 17°43.7'E

have been used for this graph. In the interior of the furrow two opposite eddy-like features are visible. The pattern seem to suggest upwelling at the western flank and downwelling at the eastern flank of the valley.

The salinity profile along the trench in a zonal section at 55°15'N shown in Fig. 6 backs the assumption of existing eddy features. The corresponding distribution of temperatures as seen in Fig. 7 however leads to the conclusion that upwelling is stronger in the east than in the west.

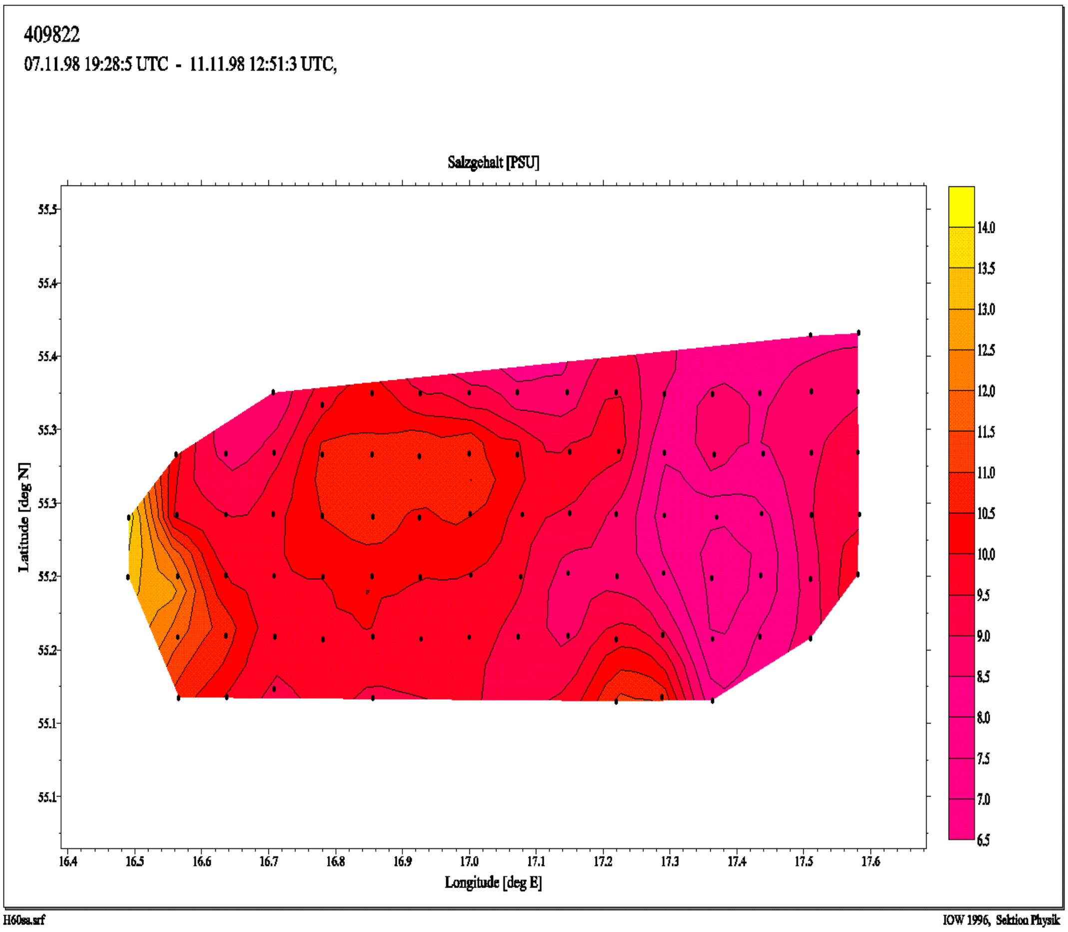


Fig.5 Horizontal Salinity Distribution at 60m Depth

The influence of the large scale wind field on the dynamics of the deeper water layers can clearly be demonstrated by a meridional section along 17°35'E, which has been investigated twice with a distance of about a week, in the 1.phase with westerly winds, in the second phase with easterly winds. Figures 8 and 9 show the temperature pattern in the first and in the second phase, with a significantly different shape and position of the thermocline. This is not caused by increased wind stirring depth because the thermocline has moved upward between the visits.

A similar behaviour is visible in the salinity distribution along the same meridional section along 17°35'E as shown in Fig. 10 for the first phase and Fig.11 for the second phase. The shape of the halocline looks rather different, especially at the southern flank (on the right in the picture). The decreased vertical salinity gradient of the halocline is not a result of direct wind stirring ("erosion"), as can be seen from the temperature profile in Fig.9.

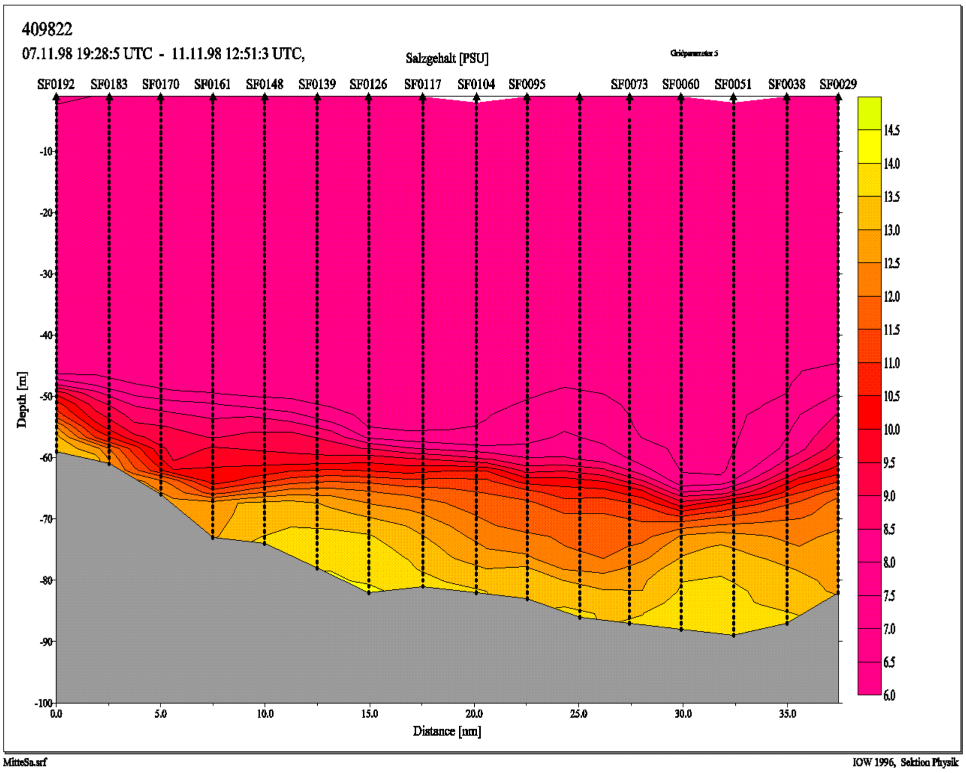


Fig.6 Salinity Distribution along a Zonal Section at 55°15’N

Thus, even if the water masses below thermocline and halocline are not subject to direct wind mixing processes, the deep water dynamics is strongly influenced by the large scale atmospheric wind field, and a substantial amount of kinetic energy seems to be transferred to even the deepest layers

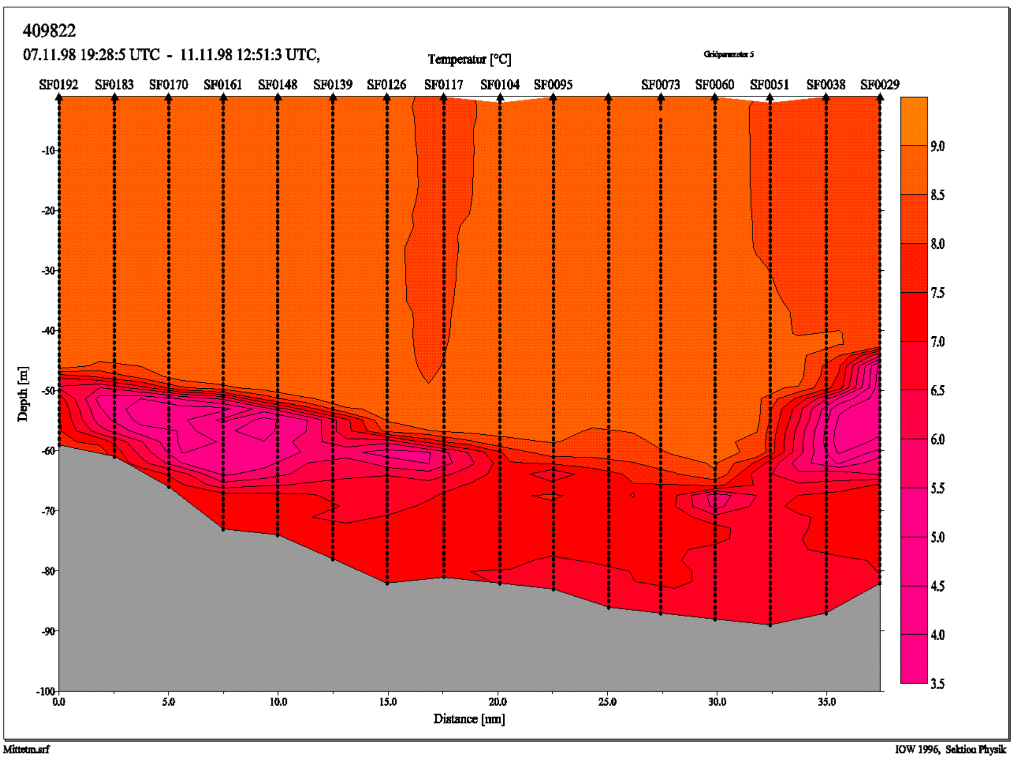


Fig. 7 Temperature Distribution on a Zonal Section along 55°15’N

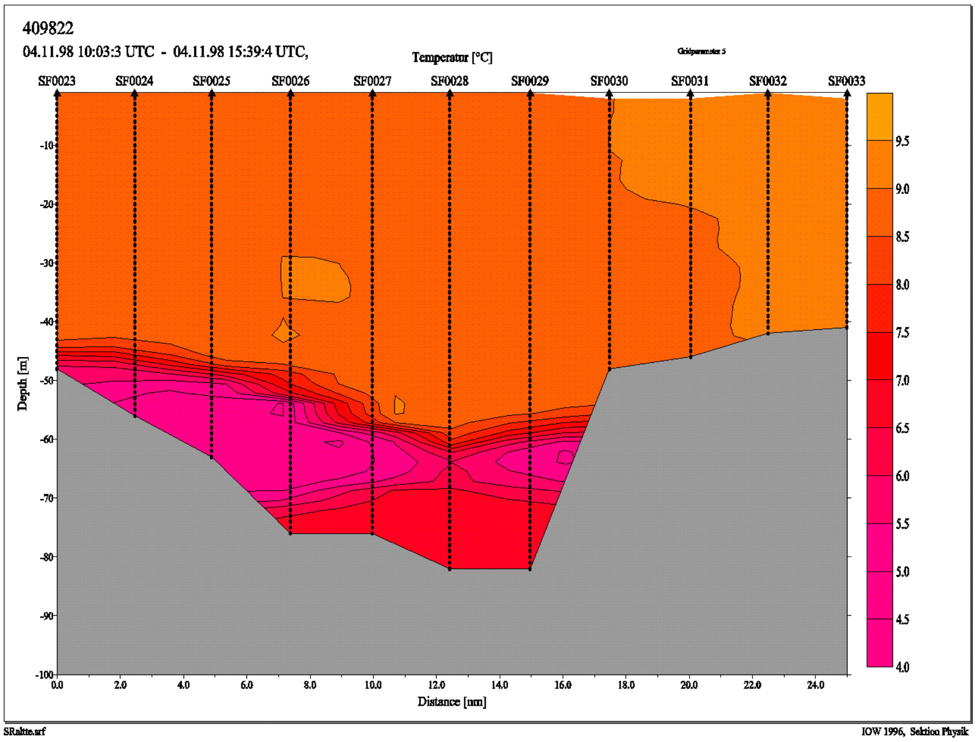


Fig. 8 Temperature Distribution on a Meridional Section along 17°35’E in the 1.Phase

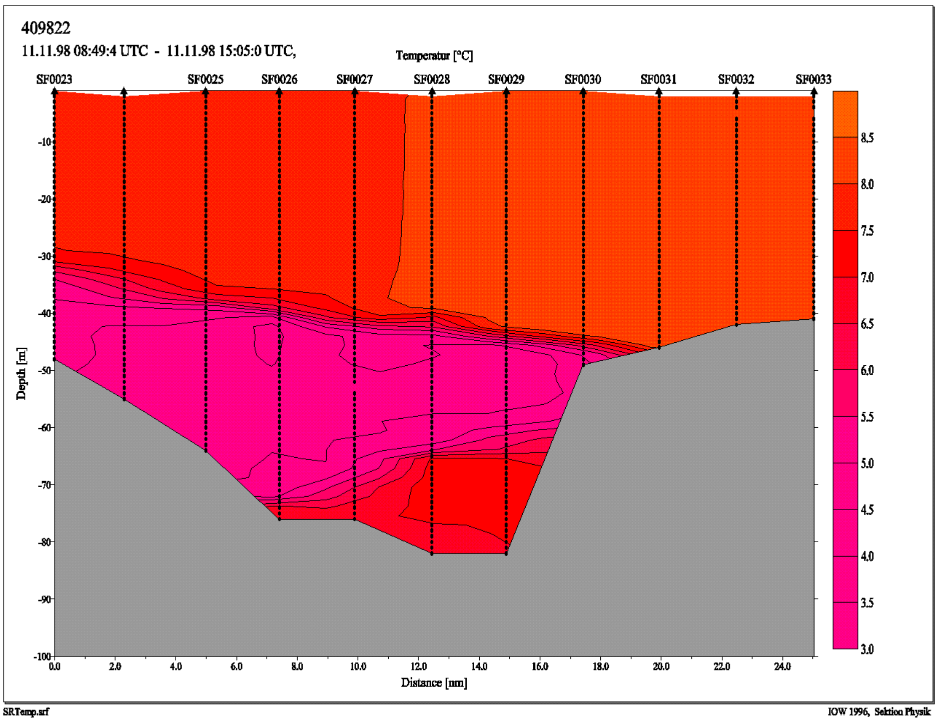


Fig. 9 Temperature Distribution on a Meridional Section along 17°35’E in the 2.Phase

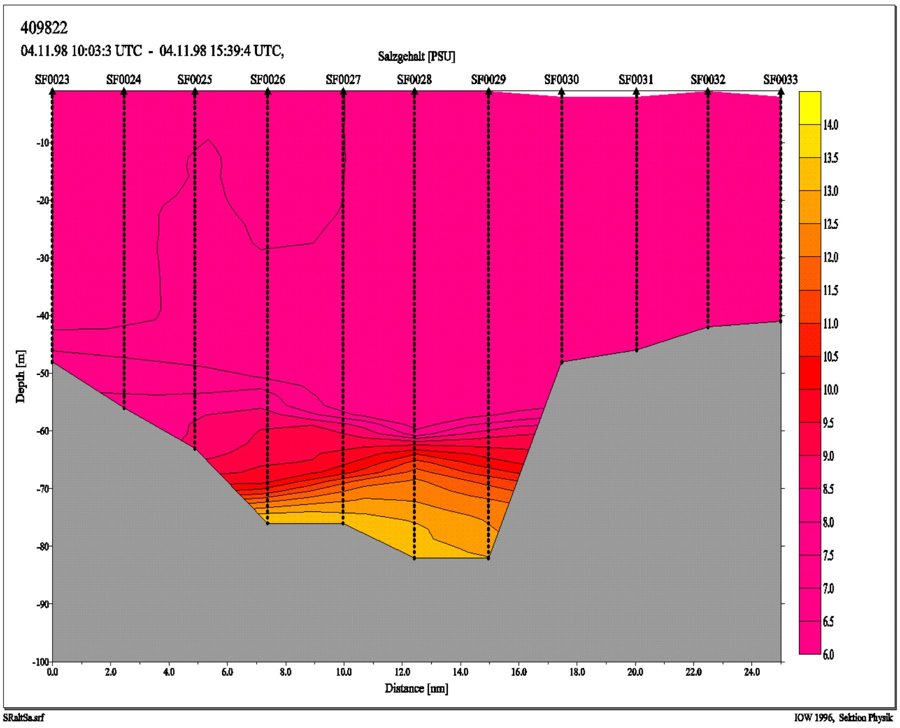


Fig. 10 Salinity Distribution on a Meridional Section along 17°35’E in the 1.Phase

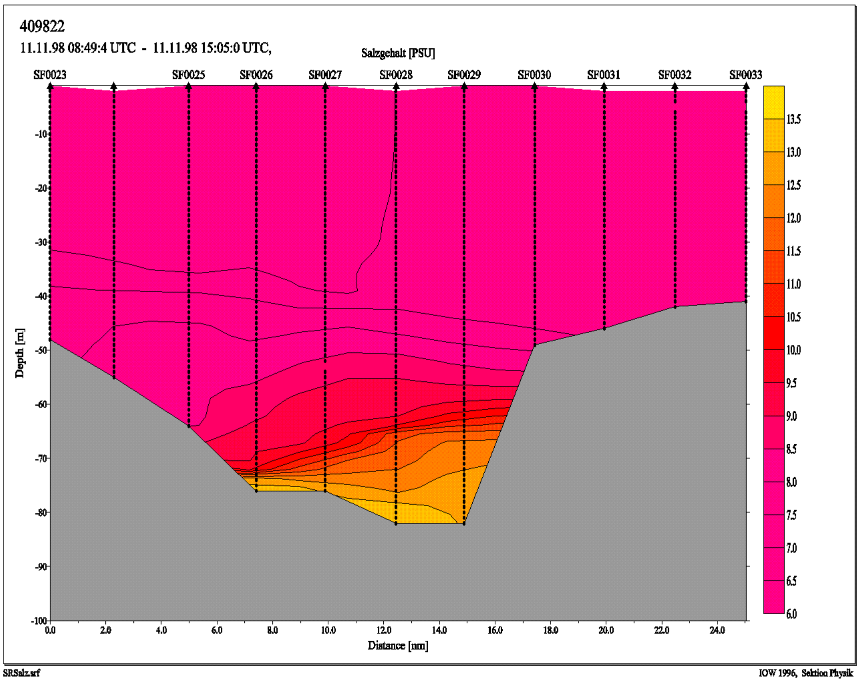


Fig. 11 Salinty Distribution on a Meridional Section along 17°35’E in the 2.Phase

R. Feistel

Chief scientist