Cruise Report
F.S. ALKOR Cruise No. 305

Dates of Cruise: 04. Sept. to 06. Sept. 2007

Projects:
Student course in phys. oceanogr.

Areas of Research: Physical oceanography

Port Call: None

Institute: IFM-GEOMAR Leibniz-Institut für Meereswissenschaften an der Universität Kiel

Chief Scientist: Dr. Johannes Karstensen

Number of Scientists: 11

Master: N. Hechler

Chapter 1

Scientific personal

Cruise code: AL 305
Cruise dates: 04.09. – 06.09.2007
Port calls: Kiel - Kiel

Table 1.1: Scientific personal AL 305: IFM-GEOMAR: Leibniz-Institut für Meereswissenschaften an der Universität Kiel, Kiel, Germany (PO: Physical Oceanography lab); CAU: Christian Albrechts Universität Kiel, Kiel, Germany

Name	Institute	Function
Johannes Karstensen	IFM-GEOMAR	Chief scientist
Uwe Koy	IFM-GEOMAR	PO
Uta Neumann	IFM-GEOMAR	PO
Fritz Karbe	IFM-GEOMAR	PO
Pericles Neves Silva	TENATSO	technician
Tina Wunderlich	CAU	student
Venke Girzas	CAU	student
Kathrin Lieser	CAU	student
Jochen Kollofrath	CAU	student
Johannes Zocher	CAU	student
Dirk Schörner	CAU	student

Responsible for Report:
Johannes Karstensen phone: ++49 (0)431 600-4156
Leibniz-Institut für Meereswissenschaften fax: ++49 (0)431 600-4152
DÃ¼sternbrooker Weg 20 e-mail: jkarstensen@ifm-geomar.de
24105 Kiel, Germany

Chapter 2

Scientific Background

ALKOR cruise AL305 was three day cruise and the last student cruise in 2007. The scientific motivation of the cruise was to obtain a rather synoptic picture of the hydrography and water movement in the western Baltic and to maintain a mooring site at the southeastern opening of the Fehmarn Belt.

In general two section have been occupied: one section crossing the Fehmarn Belt (section 'C') and one section following the deepest topography from about 10°40 E to 14°21 E (section 'L'). Along both sections CTD/rosette sampling was performed as well as continuously recording of current velocities using a vessel mounted ADCP.

A mooring site (V431) is maintained (battery change, data read-out), located at the southeastern opening of the Fehmarn Belt. The mooring consists of a Workhorse-ADCP (300 kHz), and a self containing CTD (Type MicoCat) mounted in a commercial shield (Flotation Technology).

Besides the scientific motivation, the cruises are utilized for educational purposes. Undergraduate students are introduced into modern observational techniques of physical oceanography, basics in instrument calibration and interpretation of the observations. In addition the observations should give the students the opportunity to experience work and life at sea and to explore/investigate the Baltic Sea, the 'ocean' at their backyard.

Chapter 3

Cruise Narrative

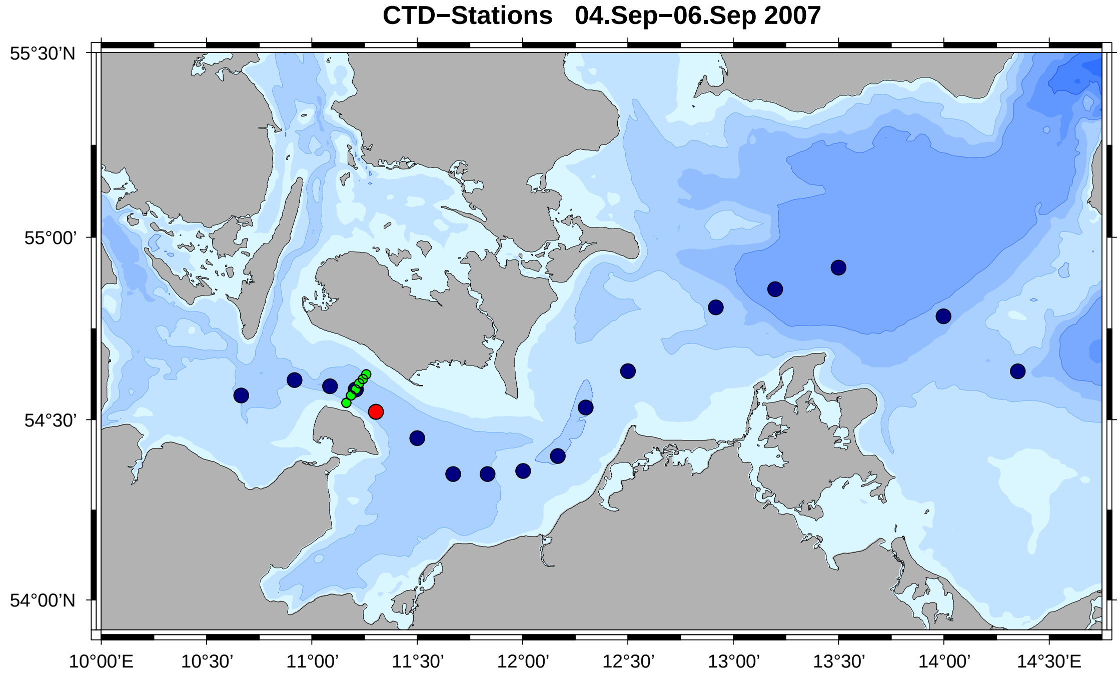

Figure 3.1: ALKOR 305 cruise track (black line, based on DATADIS recordings). Black (LG section)/ Green (FB section) and Red dot are the CTD stations, red dot is also location of the V431 mooring.

DAY 1 (Tuesday, 04.09.2007):
We left IFM-GEOMAR pier (Westufer) at 08:00 (all times given in the narrative are ALKOR local time; MESZ) with 11 'scientists' on board, 6 of them were undergraduate students, 1 person (P. Neves Silva) is a technician from the TENATSO project from the Cape Verde Islands.

Shortly after leaving Kiel the first officer introduced the students into the safety-on-board procedures and familiarized them with the ship. Next a brief introduction into the program for the following days was given.

As during a number of other cruise the DATADIS PC failed to work initially. Only after the ships electrician worked on the PC boards and after re-booting the DATADIS PC at the bridge the distribution worked. Other technical problems, namely the proper functioning of the heading converter for the ADCP have been solved as well as they were based on the DATADIS error.

At around 10:30 we started sampling the first two CTD stations of the zonal section ('L'). A rather large volume of water was collected at the station 1 and used as 'Substandard' for salinity calibration (see details below). Next the Fehmarnbelt section ('C') was sampled with a northward CTD section and a repeat section using the ADCP with 7 kn. After finishing the section, we headed for the V431 mooring at the southeastern opening of the Fehmarnbelt. In parallel to the CTD work the meteorological observations were made.

The mooring was spotted at 17:15 (MESZ) on starboard side about a minute after the release command had been send. However, the 6 to 7 Bft wind and sea made the recovery difficult and it took another hour until the whole mooring (including the ground weight) was safely on board.

Further stations of the 'L' section have been occupied (up to station #12) until 21:00. The night was used to stem to the eastern most position northeast of the island of Rügen, at the edge of the Arcona Basin.

DAY 2 (Friday, 05.09.2007):
At 07:30 we started CTD work again heading from east to west with meteorological observations in parallel. The weather was fine, sunny and with low winds and a very good sight. In the morning last repaired/refurbishment for the Beckman Salinometer have been done. In summary the vacuum pump was oiled, the PC-cards cleaned from corrosion, and a transistor was replaced. The salinometer work begun with an introduction of the measurement procedures (samples, substandard) to the whole group of students and a calibration of the instrument against IAPSO standard seawater. A very large adjustment from about 360 to more than 600 units was needed to 'zero' the salinometer with the standard seawater.

No problems occurred during the day and we made all remaining CTD of the 'L' section were occupied while slowly heading back to the Fehmarnbelt. CTD work was stopped at about 21:00 north of Warnemünde and we slowly moved northwestward to redeploy the mooring and do a second 'C' section occupation on the following day.

DAY 3 (Saturday, 06.09.2007):
The 15th deployment of the V431 mooring was scheduled for 06:00 and at 06:15 the instrument was launched 'free fall'. A CTD calibration cast at the V431 mooring site followed. Next we headed north-westward with less than 8 kn to the northernmost position of the Fehmarnbelt 'C' section doing an ADCP section. The slow speed over ground improves the quality of the ADCP measurements.

A re-occupation of the CTD 6 stations followed and allow a comparison with the first occupation order two days ago.

After the CTD section was occupied the scientific program was completed at 10:00 with stopping the ADCP and the TSG. ALKOR reached Kiel (IFM-GEOMAR pier Westufer) at 13:00.

Chapter 4

Preliminary results

4.1 Mooring V431: 16th deployment period

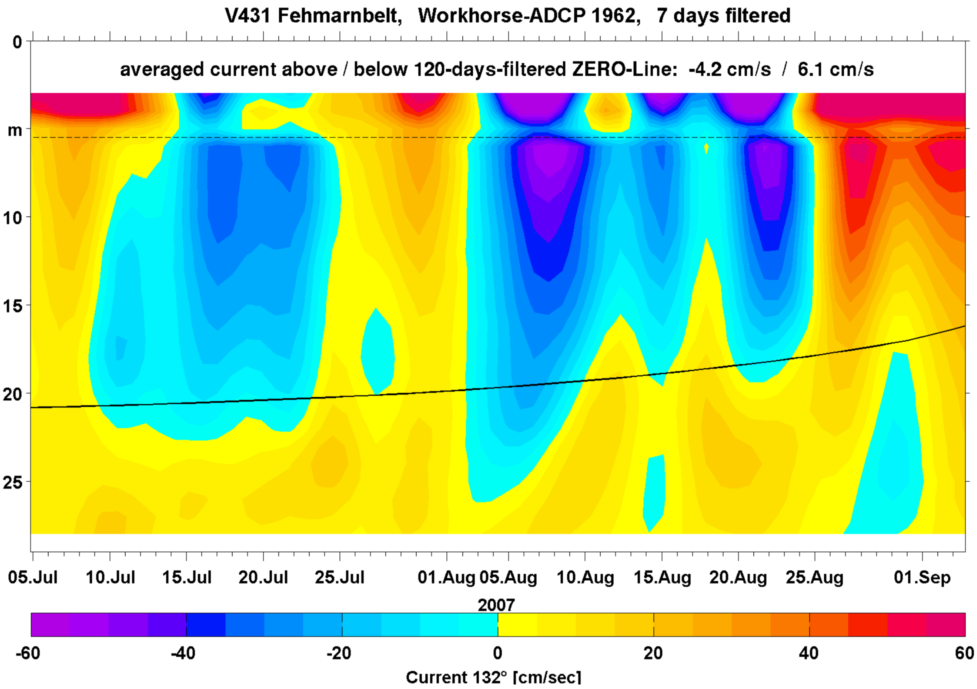

Figure 4.1: Mooring V431, upward looking Workhorse 300kHz ADCP - along bathymetry velocity (rotated to 132°). Values are linear averaged over 7 days.

The ADCP is placed in a shield frame at the bottom (about 28m water depth) of the Fehmarn Belt and measures current speed and direction upward looking. Data points are obtained in 1 m depth cells averaged over 0.5 hours, pinging every 0.5 minutes (30 seconds). A rotation of the velocities by 132°makes one component parallel and one perpendicular to the topography. The current component parallel to the topography is shown in the upper figure. Alternating currents of southeast/northwest directions can be seen. The minimum in fluctuations is at about 13 to 14m depth. Note, currents above about 6m depth are influence through the surface reflections (and side lopes) and the data is corrupt. The current fluctuations are mainly related to the wind forcing.

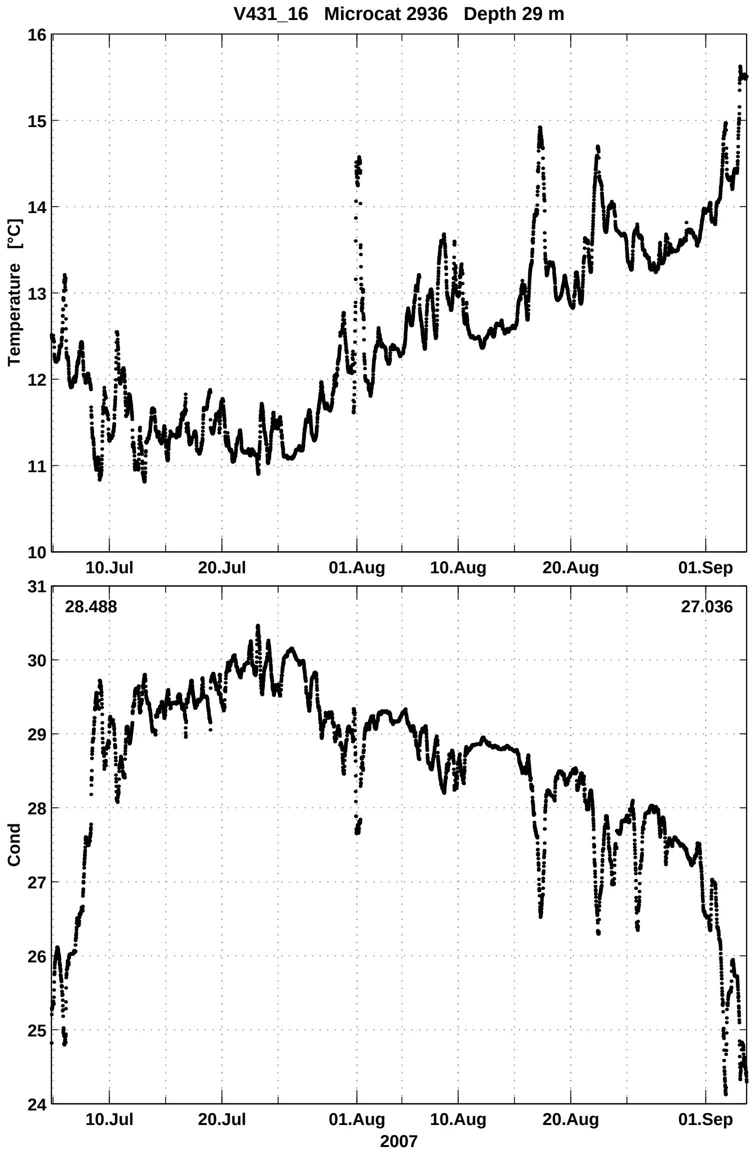

Figure 4.2: Time series temperature (lower) and conductivity (lower) from the 16th deployment period of V431 (07.07.2007 - 04.09.2007).

4.2 Meteorological observations

The large scale weather situation (fig. 4.3) was determined by a high-pressure region above Ireland with a warm front at its rim that influenced the Baltic Sea during the cruise.

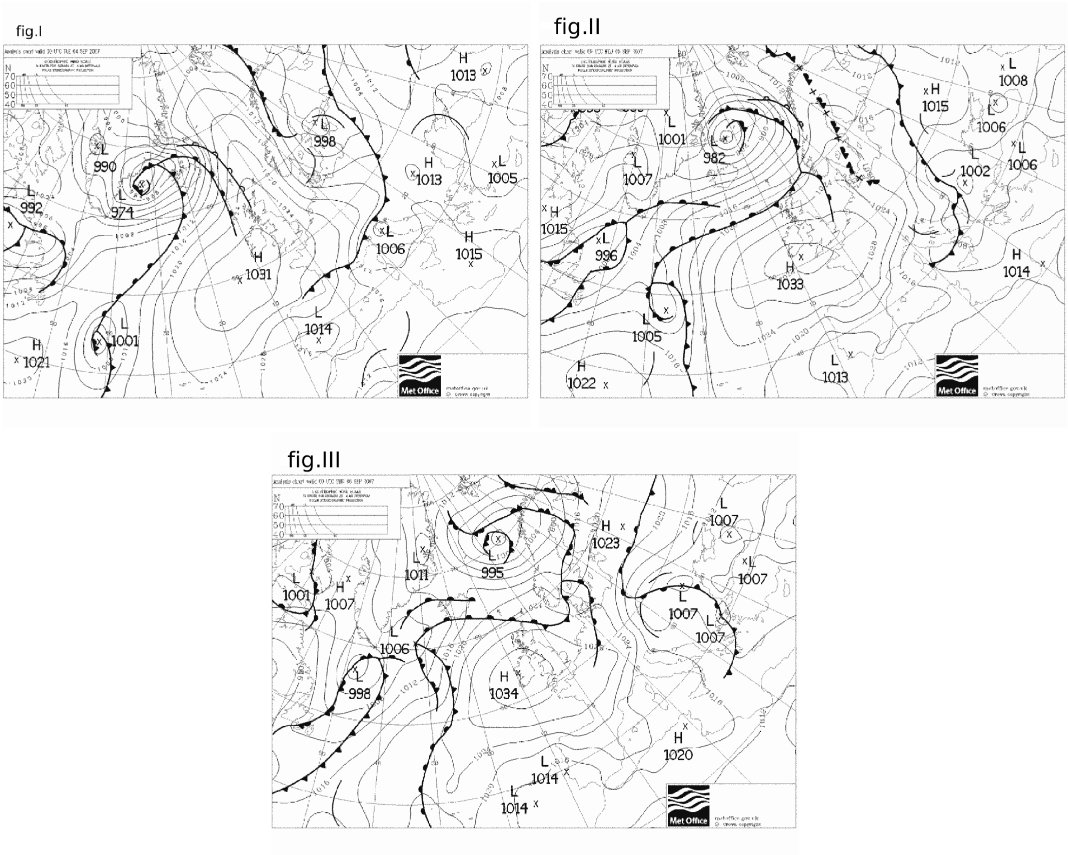

Figure 4.3: Surface pressure distribution 04. Sept. to 06. Sept. 2007 (UKMO-Bracknell, UK). Lower left: pressure readings during AL268.

The air temperature (Figure 4.4; fig.1) showed an overall trend of warming. Moving one degree around a mean value of about 13°C on the first one and a half days it increased over night on a significant higher level at about 15°C. Apart from the first day water temperature (Figure 4.4; fig.2) resembled this course but with higher temperatures of maximum 16.5°C. The qualitatively match between the data in the time period of 4 am to 3 pm on the second day of the cruise is remarkable. There is some evidence to be believe that temperature of both air and water are influenced by wind speed (Figure 4.4; fig.2) which changed permanently in a range from 5 to 20 m/s until the first night and remained stable at about 5 m/s afterwards. This weakening of strength of wind may have led to a corresponding warming. The increase in temperature may have also been an effect of the change of wind direction which occurred just in the concerned time at noon of second day. The formerly northern winds turned in a four hour period in an arc passing the south to west and northwest.

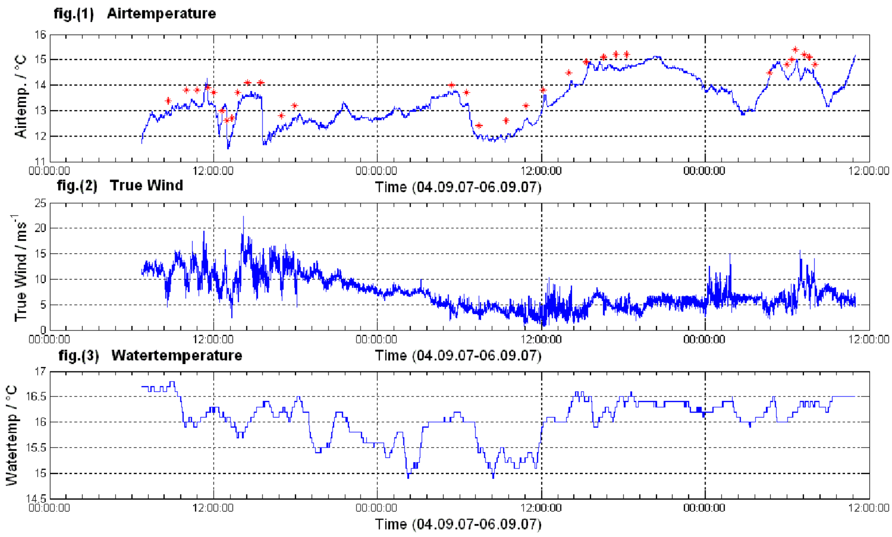

Figure 4.4: Air-temperature, true wind, and water temperature (upper to lower).

In accordance to the trend of air temperature the air pressure (Figure 4.5; fig.8) was increasing throughout the first 30 hours.

The relative humidity (Figure 4.5; fig.6) varied during the cruise between 50% and 100%. The relative humidity depends on the air temperature. With rising air temperature the relative humidity decreases as one may see at the beginning of the cruise. Fast changes in the temperature as can be seen at the morning of the 5th September have a direct effect on the relative humidity.

Shortwave radiation (Figure 4.5; fig.4) shows a typical diurnal curve depending on the sun height as well as on cloud cover. On our cruise the maximum SW radiation was about 900 $\mathrm{W\,m^{-2}}$on midday 4. Sept. . As one can see on the second day the curve is very continuous as there were only few clouds (Figure 4.5;fig.7). Downward longwave radiation (Figure 4.5; fig.5) was between 0 $\mathrm{W\,m^{-2}}$and 100 $\mathrm{W\,m^{-2}}$.

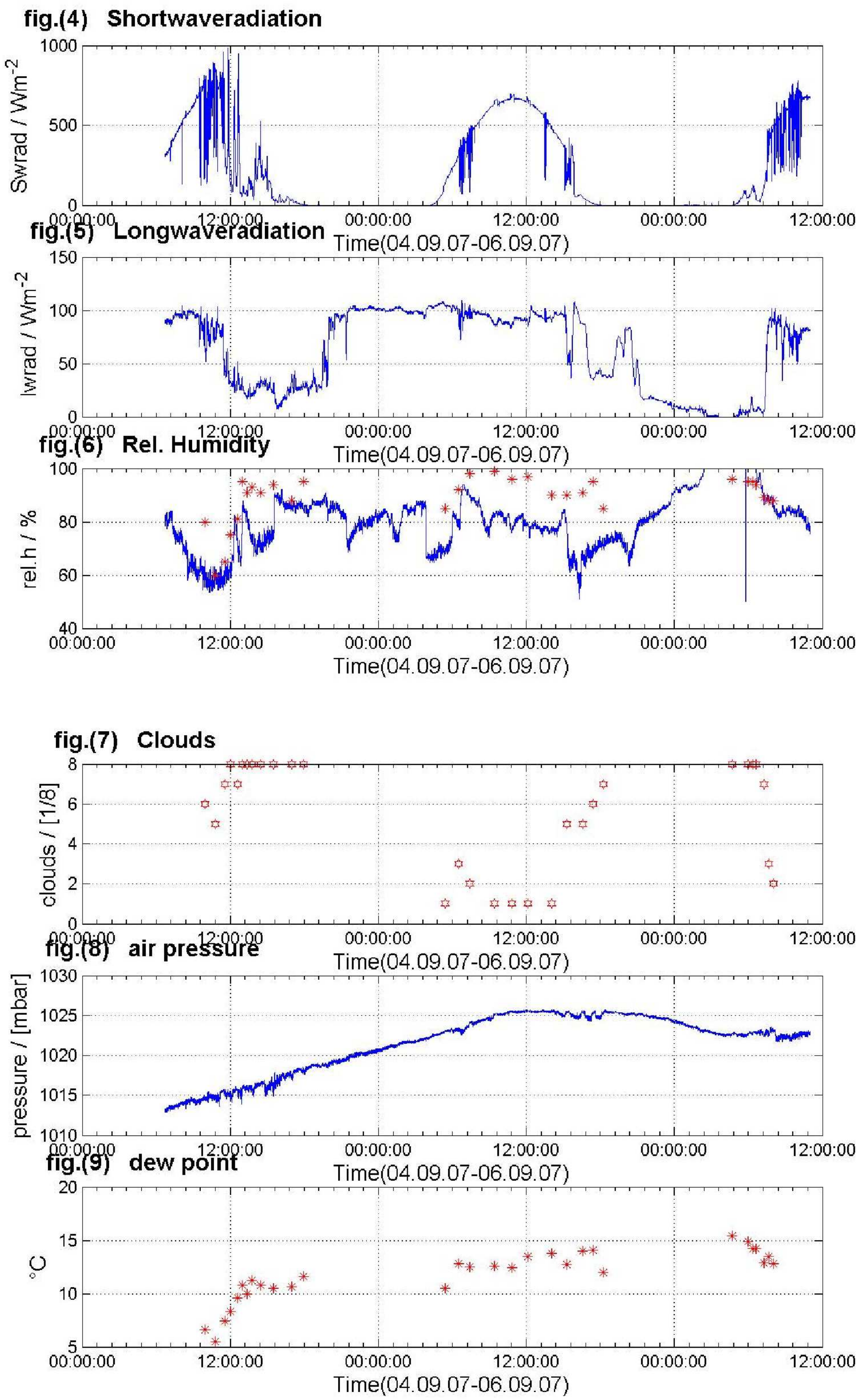

Figure 4.5: Shortwave, downward long wave and rel. humidity (upper to lower). Clouds (x/8), air-pressure and drew-point (upper to lower).

4.3 Hydrographic and currents along C and L section

4.3.1 Fehmarnbelt (C section)

The temperature distribution (figure 4.6, upper) is relatively homogeneously. It reaches from 15.9°C in the south to 15.2°C in North and in depth. We cannot identify any layers because the range of temperature is only 0.7°C.

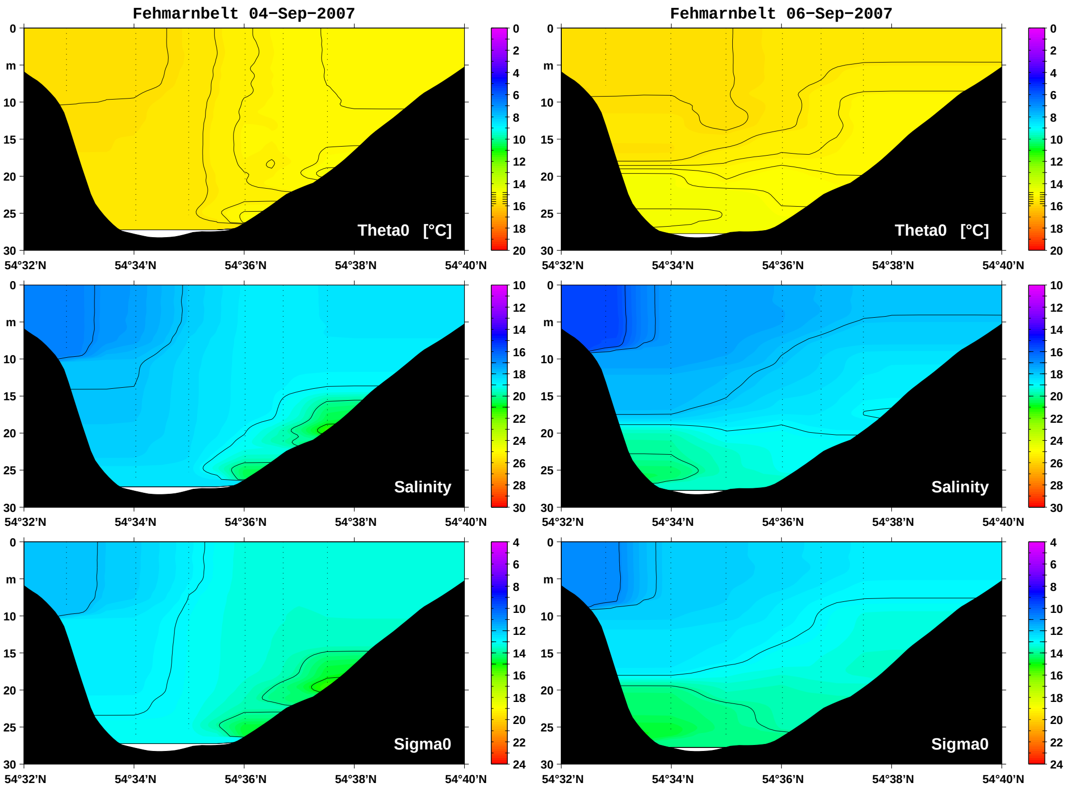

Figure 4.6: Temperature, salinity, and density as measured along the Fehmarn Belt. Left: 04. Sept. 2007; right: 06. Sept. 2007

The salinity distribution (figure 4.6, middle) is also homogeneously and similar to the temperature distribution. Lower salinity (16.5) is related to higher temperature and higher salinity (19.5 ppt) to lower temperature.

The oxygen distribution (figure 4.6, middle) appears to be related to the T/S distributions. In the south there is the lowest dissolved oxygen content (6.75 ml/l) while the content is the highest in the north and in the depth with about 7.05 ml/l. This is because we had the lowest temperatures at depth.

The distribution of the chlorophyll-a concentration (figure 4.6, lower) looks quite different. There are two maxima in the upper part of the water column. One is located at 54.58°N and the other one at 54.63°N (both: 3.2μg/l). The concentration decreases nearly linear with depth.

The repeat section in Figure 4.6, two days after what is shown in Figure 4.6, is rather similar in its general structure, However, it clearly shows that the system is very variable and even the inflow core of what is left form the North Sea Water has moved from the northern to the southern flank of the ridge.

4.3.2 Zonalsection (L section)

Noticeable are two irregularities in the temperature distribution (figure 4.7) at about 13.2°E to 14.2°E and about 17m to 35m depth in the basin. These are temperature minima with ca. 10°C to 14°C while the upper part above 15 m is relatively homogeneously with 14°C to 16°C. There might be a current in the basin causing the anomaly.

The salinity concentration (figure 4.7) is the highest in the western part (about 19) and decreases eastwards to 8 ppt. In the lowest part of the basin (35m-40m depth) the salinity increases again to 14. Between 11.5°E to 13°E there are some vertical inhomogeneities.

Like in the temperature distribution there are two anomalies at the same location in the oxygen concentration (figure 4.8). As in the Fehmarnbelt these oxygen maxima (7.5 ml/l) are related to temperature minima. The rest of the oxygen concentration is quite homogeneously with some weak vertical structures we also saw in the salinity distribution.

The chlorophyll-a concentration (figure 4.8) is not homogeneously distributed. There is one strong maximum (3-4 μg/l) between 11.5°E to 12.5°E and 0m to 10m depth. In the basin the concentration is the lowest and homogeneous (0.5-1 μg/l) while in the upper part the concentration spreads from 1.5-3μg/l.

The distributions in the Fehmarnbelt are more homogeneous than the ones in the zonal section. There are differences between the upper part and the lower part in the basin which may be caused by currents.

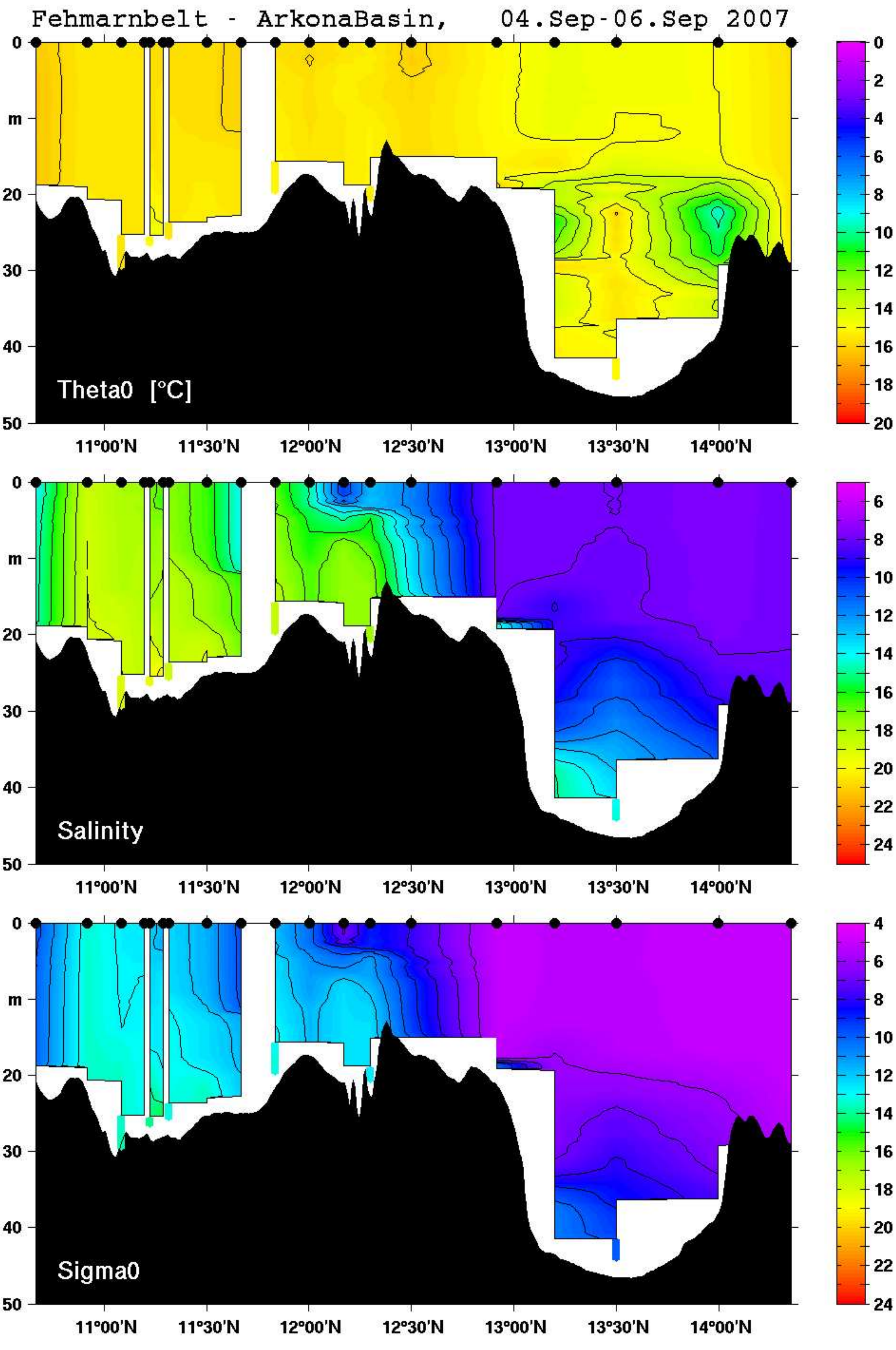

Figure 4.7: Temperature, salinity, and density as measured during AL305 (Sept. 2007).

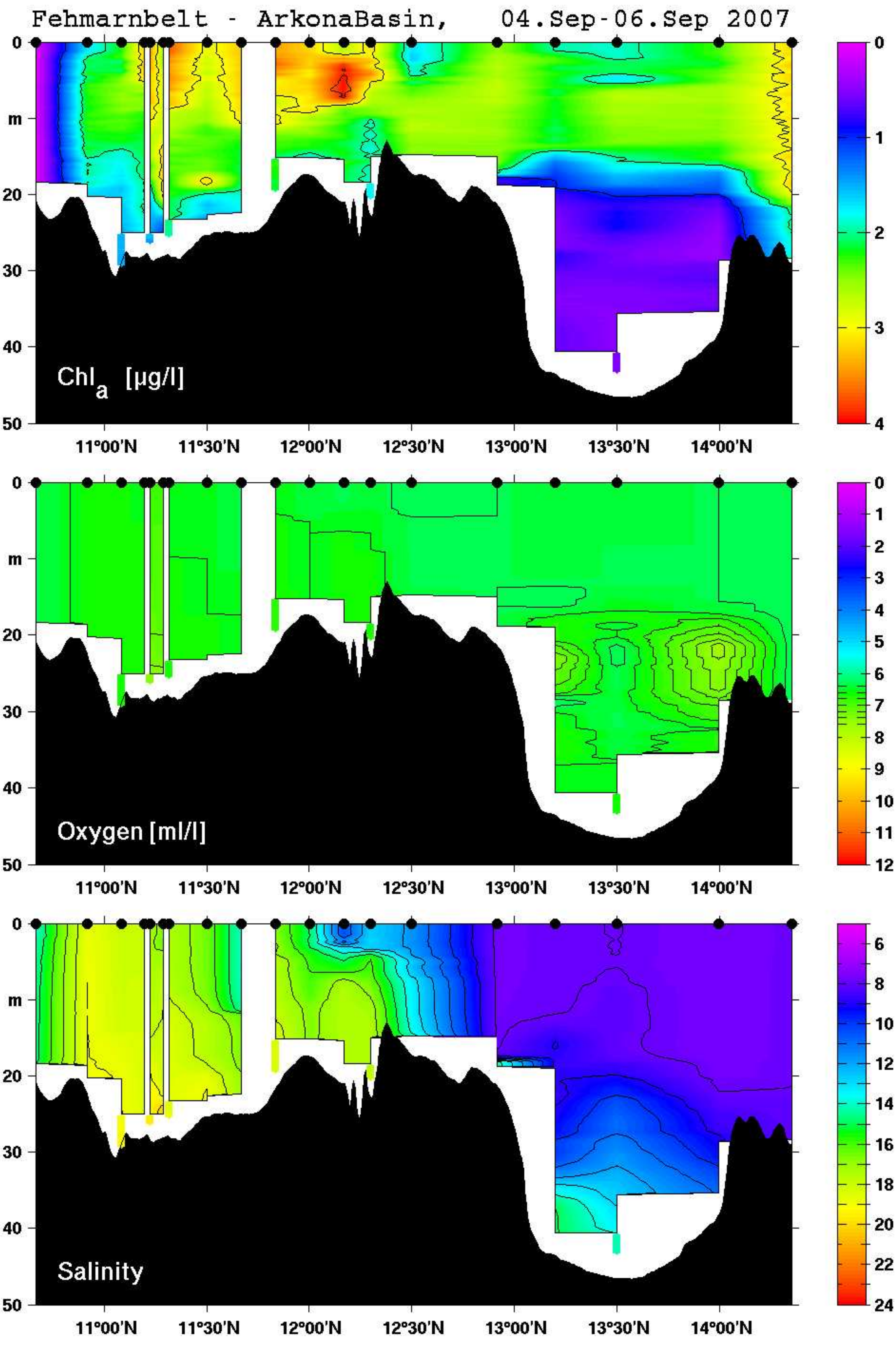

Figure 4.8: Chlorophyll-a, oxygen, and salinity as measured during AL305 (Sept. 2007).

Chapter 5

Equipment/instruments

5.1 Mooring V431

Mooring deployment site V431 is located in the military zone of Marienleuchte at the south-eastern opening of the Fehmarnbelt. Water depth is about 29m. V431 consists of a Workhorse ADCP (300kHz; Serial number 1962) and a self containing T/S recorder of type SBE-MicroCat (serial number 2936). Batteries for the MicroCat, the ADCP and the Benthos releaser have been exchanged. The ADCP was programmed to record every 1800s, the MicroCat every 900s.

Table 5.1: V431: Summary on 16th recovery and 17th deployment of trawl resistant bottom mooring V431.

date; time (UTC)	latitude	longitude	depth	comment
04.09.2007; 15:13				Recovery.
06.09.2007; 04:41	54°31.329’N	11°18.222’E	27.8 m	17th Redeployment.

5.2 CTD/Rosette and Salinometer

5.2.1 CTD

A Hydro-Bios CTD was used during the cruise.

5.2.2 Beckmann Salinometer

Reference measurements have been analyzed with the Beckman Salinometer. This instrument works with an inductive method and compares the conductivity of standard water to that of a probe. Because the salinity depends on temperature, the Beckman Salinometer also measures the temperature of the probe. To avoid large temperature fluctuations the probes have to stay in the laboratory for a day after collection to adjust to the room temperature. The accuracy of the salinometer is given as 0.003 from the manufacturer as long as the difference in temperature between probe and environment is less than 1 K. During AL305 a repeat accuracy of 0.01 was asked for. Before the measurements started, the salinometer had to be calibrated though. This was done with standard water that had a salinity of approximately 35. After that the first measurement was done with a substandard, taken at the first CTD station. This substandard was measured after every second probe to determine if there is a drift of the instrument. Also one is able to see if the instrument is still working properly if there is a reference value. With every new probe the instrument needed to be flushed before a valid measurement could take place. This was because of probable rests of the probe that was examined before.

Most samples have been taken at the bottom and top of each CTD profile. The HydroBios CTD salinity is measured with an accuracy of 0.002. The sensing element is a cylindrical, flow-through, borosilicate glass cell with three internal platinum electrodes. The sensor can permanently measure with 24Hz. However we are just considering the salinity at the time the probes of seawater were taken.

Every third measurement block (one block is a repeat samples with less than 0.01 repeatability) was measured the substandard which has an unknow but constant salinity (figure 5.1). Plotting these values with their standard derivation however shows that there are quite a few outlier. The red bar is the mean value for substandard salinity and the blue stars the values of salinity for number of measurement, provided with errorbars. The first outlier can be explained with the usage of standard water just before. Salinity values between standard water and substandard were quite different and thus the salinometer was probably not flushed often enough to delete all residues of standard water. Measurements after that do not differ a lot, but starting at approximately the 110th measurement, the derivation gets bigger for some of them. This can probably be explained with the failure of the vakuumpump of the salinometer. It worked well for some time interval until there were difficulties with it and it finally had to get fixed about every 40th measurement. However one can say that there is no trend in salinometer data. It always stays around the mean value.

Comparing data of the CTD profiler and the salinometer (figure 5.3) it becomes clear that there is good correlation between some of the measurements as well as quite a big difference (up to 0.6) between others. Also there is one outlier where the difference is more than 1 (sample 33). Standard deviation was included for CTD data. There doesn't seem to be a pattern or trend for differences in data. As well there is no offset. Differences can be caused by the extend of the CTD-sampling device. This contents several big bottles (10l each with a height of 85cm) which can be closed manually from board of the ship. The measuring unit of the CTD is quite small however and thus results can be very different if the gradient of salinity is steep. Since our measurements took place in the rather shallow Baltic Sea and there is exchange of North Sea and Baltic Sea water especially in the Fehmarnbelt, the gradients are quite steep in this area. Thus there is most likely a mixture of different salinities in the sampling device. If there are two blue crosses for one sample, there were two probes of seawater extracted from the rosette bottles.

Figures 5.3 shows the differences in salinity for the three different methods. For CTD-datadis and datadis-salinometer, an offset is visible in the data. Therefore one could argue that the datadis should be calibrated again, because CTD and salinometer data support each other. In these figures

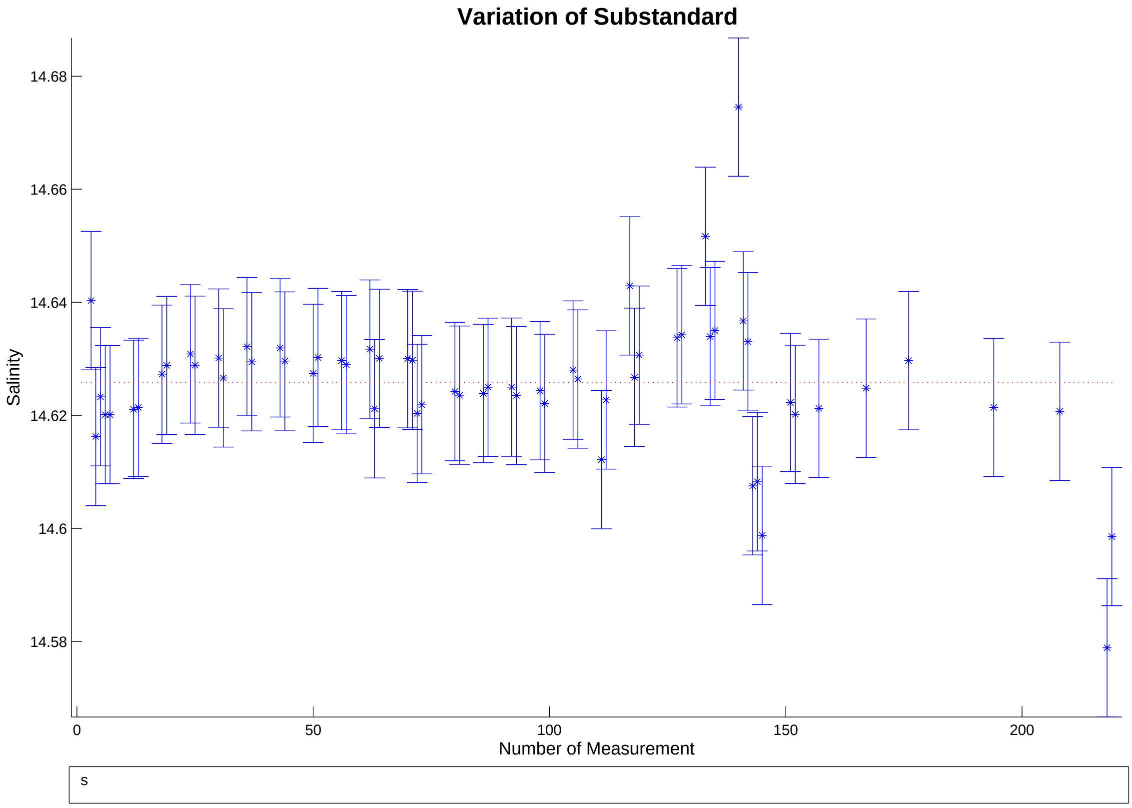

Figure 5.1: *Difference in substandard measurements during cruise*

the outliers described above are visible as well. Also figures 5-7 allow to estimate the quality of our measurements, which is satisfactory on most of the stations but really bad on others.

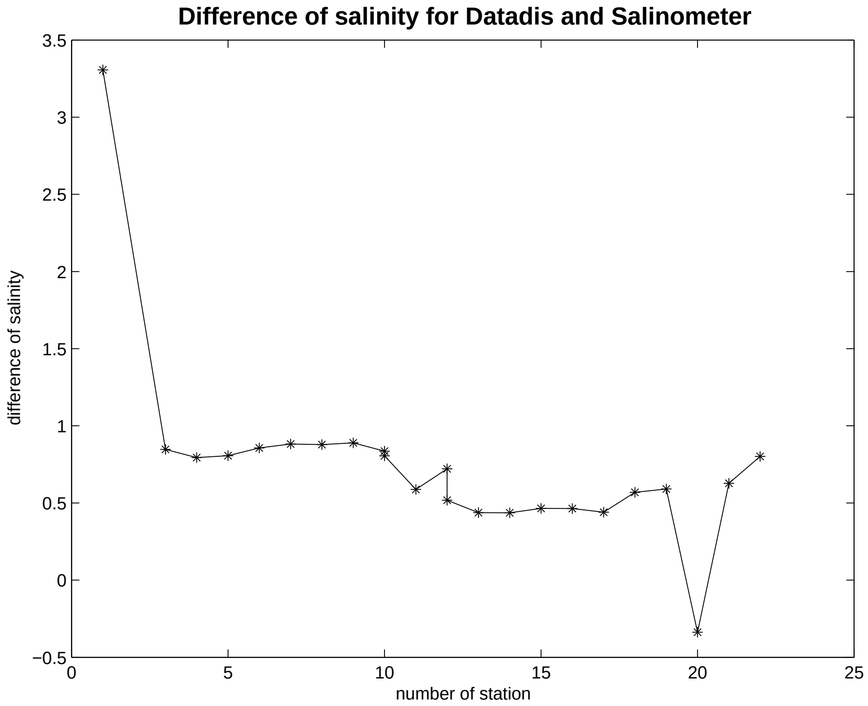

Figure 5.2: *Difference in substandard measurements during cruise*

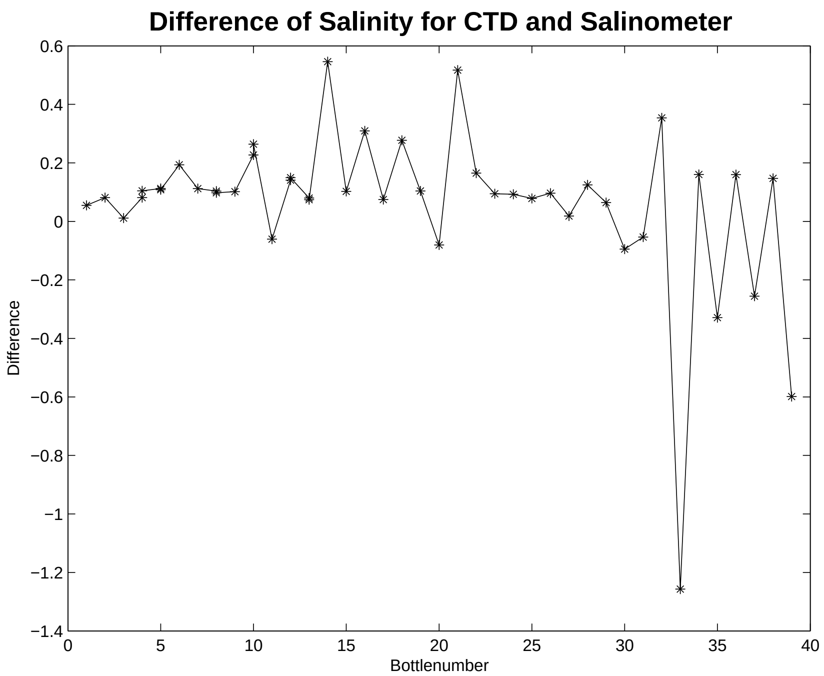

Figure 5.3: *Difference in substandard measurements during cruise*

5.3 Underway Measurements

5.3.1 DATADIS

ALKOR has a central data collection system, called DATADIS. Here data from a number of sources (sensors) is merged into a single file which can be used from other devices or/and stored for later processing. The Maritec Engineering DATADIS includes now UTC GPS based time stamps. However, SIMRAD depth soundings are still not available.

In addition one has to remember to take care on saving the data using the DATALOG program on the main PC at the bridge. We had a few stops of the PC system and rebooting the main PC was necessary.

5.3.2 Navigation

ALKOR has a GPS navigational system as well as a gyro compass available. Data is fed into DATADIS and from their available for other devices. For the use with the ADCP system a converter is needed that 'translates' the DATADIS string into a ADCP readable string (for heading only).

Two new monitor in the wet lab and in the dry lab allow to follow the navigation (way point, current position, distance and time to way point, ...) and to see the information embedded into a navigational map. This is a great new feature and very much appreciated.

5.3.3 Meteorological Data

Since March 2006 ALKOR is equipped with a so called automatic weather station which should acquires the basic meteorological parameters (air temperature, wind (speed and direction), wet-temperature, humidity, air-pressure). Shortwave radiation is also recorded. For long wave radiation an EPLAB (Eppley Laboratory, Inc.) Precision Infrared Radiometer (Model PIR) was installed last year - however, this is apparently not available in the D.

There where problems with the wet-temperature measurements or maybe only with the display in the DATADIS system. However, relative humidity may be corrupt...

5.3.4 Echo sounder

The ER 60 SIMRAD echo sounder was activated during the cruise but the data was not stored.

5.3.5 Thermosalinograph

The thermosalinograph (TSG) on ALKOR is permanently installed at about 4m depth, takes up about one litre per second and is a S/MT 148 type of Salzgitter Elektronik GmbH. TSG data is directly fed into the DATADIS. Calibration was done after the cruise after analysis of bottle samples.

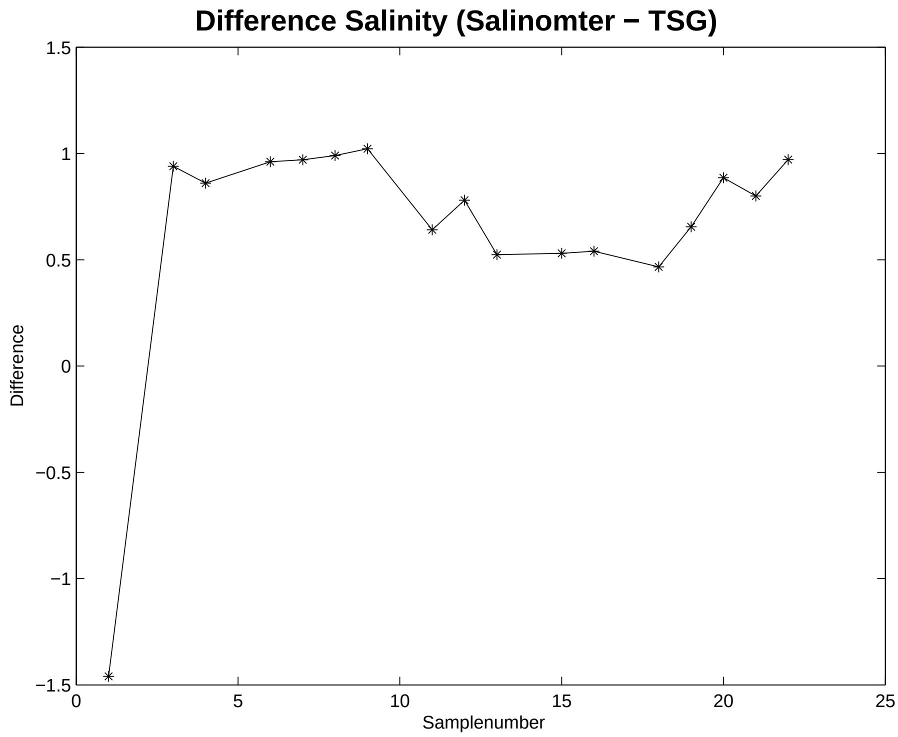

Figure 5.4: *Salinity difference between Salinometer minus TSG.*

Comparison between TSG and salinometer values (Figure **??**) reveals an offset of approximately 1 at most of the stations. One station has a negative offset however (station #20). This is most likely the result of a measurement error. The offset can have different reasons: First of all the water depth in which the measurement took place could be different from that where the probe was taken. As well the time at which salinity was recorded from the datadis was different than the time the probe was taken. The time interval in between was a few minutes. Offset can also be caused by differences in measuring techniques as well as a insufficient adjustment to temperature. Another reason can be that the bottle was not rinsed good enough before the probe was taken. Since the probe was taken at the surface and bottles have been filled with water from greater depth before (this is more salty than surface water) this would explain the positive offset. Also salt crystals from earlier less salty probes would result in a positive offset. The seven last points are only constrained by datadis data. This is because no more probes were taken at that time, because temperature adjustment would have taken too long. (See description of salinometer above)

5.3.6 Vessel mounted ADCP

A 300 kHz workhorse ADCP from RD Instruments was mounted in the ships hull. The vmADCP is used with bottom tracking mode. Navigational data comes from the DATADIS system.

Chapter 6

Acknowledgement

Herzlichen Dank an Kapitän Norbert Hechler und die gesamten Besatzung der ALKOR für ihre professionelle Unterstützung und die nette Atmosphäre an Bord.

Chapter 7

Appendix

Station table Station #, Year, Month, Day, Hour, Minute, lat, latmin, long, longmin, depth, Praktikum station #

01	2007	09	04	08	39	54	34.00	10	39.89	21.0	01
02	2007	09	04	09	59	54	36.55	10	55.07	23.0	02
03	2007	09	04	10	54	54	35.53	11	05.16	32.0	03
04	2007	09	04	11	39	54	32.77	11	09.84	10.0	04
05	2007	09	04	12	03	54	34.03	11	11.22	29.0	05
06	2007	09	04	12	29	54	34.99	11	12.44	28.0	06
07	2007	09	04	12	57	54	36.02	11	13.48	27.8	07
08	2007	09	04	13	23	54	36.71	11	14.50	24.0	08
09	2007	09	04	13	46	54	37.51	11	15.49	21.0	09
10	2007	09	04	14	53	54	31.34	11	18.26	27.6	10
11	2007	09	04	16	56	54	26.96	11	30.02	25.5	11
12	2007	09	04	17	56	54	21.00	11	40.23	26.0	12
13	2007	09	05	05	28	54	38.00	14	21.07	31.5	21
14	2007	09	05	07	25	54	47.05	13	59.91	38.8	20
15	2007	09	05	09	25	54	55.03	13	29.99	46.9	19
16	2007	09	05	10	45	54	51.50	13	11.94	44.0	19.5
17	2007	09	05	12	07	54	48.53	12	55.06	22.0	18
18	2007	09	05	14	04	54	38.02	12	30.02	18.0	17
19	2007	09	05	15	16	54	32.03	12	18.00	23.0	16
20	2007	09	05	16	34	54	23.99	12	10.04	20.8	15
21	2007	09	05	17	26	54	21.51	12	00.19	18.0	14
22	2007	09	05	18	16	54	20.99	11	50.04	22.0	13