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

Cruise Report

F.S. ALKOR Cruise No. AL340-2

12.06. – 15.06.2009

Project:
Student course, physical oceanography

Leg 1
12.06. – 13.06.2009
Kiel - Warnemünde

Leg 2
13.06. – 14.06.2009
Warnemünde – Warnemünde

Leg 3
14.06.-15.06.2009
Warnemünde - Kiel

Port calls
Warnemünde, 13.07.-14.06.2009
Warnemünde, 14.07.-15.06.2009

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

Principal Scientist
Dr. Thomas J. Müller

Number of Scientists:
Leg 1: 8
Leg 2: 10
Leg 3: 11

Ship's master
Jan-Peter Lass

1. Scientific crew

Leg1	12.06.-13.06.	Kiel - Warnemünde
Leg 2	13.06.-14.06.	Warnemünde - Warnemünde
Leg 3	14.06.-15.06.	Warnemünde - Kiel

Name	Given name	Function onboard	Leg 1	Leg 2	Leg 3
Müller	Thomas	Principal scientist	1	2	3
Neumann	Uta	Phd student	1	2	3
Link	Rudolf	Technician	1	2	3
Abel	Rafael	Bsc. stud. PHER			3
Bauer	Madeleine	Bsc. stud. PHER		2	
Busecke	Julius	Bsc stud. PHER			3
Dippe	Tina	Bsc. stud. PHER		2	
Hagenow	Alexander	Bsc. stud. Chemie		2	
Kleinelanghorst	Christin	Bsc. stud. PHER			3
Kopte	Robert	Bsc. stud. PHER			3
Laumer	Franziska	Bsc. stud. PHER		2	
Mengis	Nadine	Bsc. stud. PHER			3
Müller	Katharina	Bsc. stud. PHER			3
Olbert	Kai	Bsc. stud. PHER		2	
Ossenbürger	Holger	Stud. Mar. biol.	1		
Richter	David	Bsc. stud. PHER		2	
Scheef	Helga	Bsc. stud. PHER		2	
Schütte	Florian	Bsc. stud. PHER			3
Sendelbeck	Anja	Bsc. stud. PHER		2	
Thomsen	Soeren	Bsc. stud. PHER			3
Vardeh	David	Stud. Mar. biol.	1		
Vogel	Torsten	Stud. Mar. biol.	1		
Vogel	Sandra	Stud. Mar. biol.	1		
Zvolenszky	Gea	Stud. Mar. biol.	1		
		Total	**8**	**10**	**11**

PHER: Physics of the Earth's System.

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2. Scientific Background

On the long average, the Baltic Sea as a humid sea gains more fresh water through rain and river run-off than it looses to the atmosphere by evaporation. This excess of fresh water must be exported through the western exits of the Sound and the Belts towards the North Sea and open ocean. As the fresh water is less dense than the more salty water below, the water stays at the surface while mixing with the more salty water below and leaving the Baltic through the western exits as surface currents. Due to the earth's rotation, this surface outflow generally leans on the northern and eastern flanks of the narrow exits, the Sound and the Belts.

For a long term balance, the average loss of salt to fresher surface waters requires an inflow of salty waters fom the North Sea. Because of their higher density, such waters flow in as near bottom currents following the narrow and deep gaps connecting the Kattegat with the western and central Baltic's basins. Again, the earth's rotation forces these deep flows to the right viewing to the flow's direction, i.e. to the western and southern flanks. Upward mixing in the Baltic completes this general view of the Baltic's thermohaline circulation which of course is much disturbed by direct wind forcing on short time scales. Strong westerly winds enforce the inflow of salty waters which then may reach even the surface and contrarily, strong easterlies may stop the inflow completely for a period of time.

One of the choke points to study in- and outflow and their long-term variability, certainly is the Fehmarn Belt. IFM-GEOMAR therefore has decided to use student courses in physical oceanography for station work in that area. Three courses of 4 days length each are held annually in February, in June/July and in September/October. Shipborne Instruments used are: (i) CTD attached to a rosette water sampler; (ii) a 600 kHz ADCP; (iii) an on-line data logging system for navigational, meteorological and near-surface temperature and salinity data (DAVIS-SHIP). For continuous long-term measurements, , a mooring with near-bottom sensors for currents, temperature and salinity is maintained since 1997 at the southeastern exit of the belt at 27 m water depth. Since 2002, it consists of a trawl resisitent shield at the bottom, bearing a 300 kHz upward looking ADCP and a MicroCat CTD Iin 2008 this moored ADCP was replaced by a 600 kHz ADCP.

During AL340-2, the major objectives were to obtain hydrographic and current data (see map in Fig. 3.1)

- along section L that follows the deep channels connecting Vejsnaes Gap, Fehmarn Belt, Kadett Gap and the entrance to the Arkona Basin
- along section C across Fehmarn Belt
- along sectiuon D across Kadett gap
- long-term measurements from mooring site V431 at the southeastern exit of Fehmarn Belt

3. Narrative of the cruise with technical details

Overnight, the ship can carry 12 scientists at the most; therefore, with 3 advisors and 21 students the cruise was splitted in three legs with breaks scheduled for Warnemünde and Sassnitz for for the night 12^{th} to 13^{th} and the morning of the 14^{th} June to disembark and embark students. Due to gale wind from west-northwest on 12^{th} June, ALKOR had to change course during the southtwestward Fehmanrn Belt ADCP section to seek shelter southeast of the island. Also, it was not possible to berth in Warnemünde under these conditions, and therefore the first port call in Warnemünde had to be delayed until the afternoon of 13^{th} June, and the second to be shifted to Warnemünde for late afternoon of 14^{th} June.

Stations, sections and mooring work as follows; for more details see the complete log in the appendix.

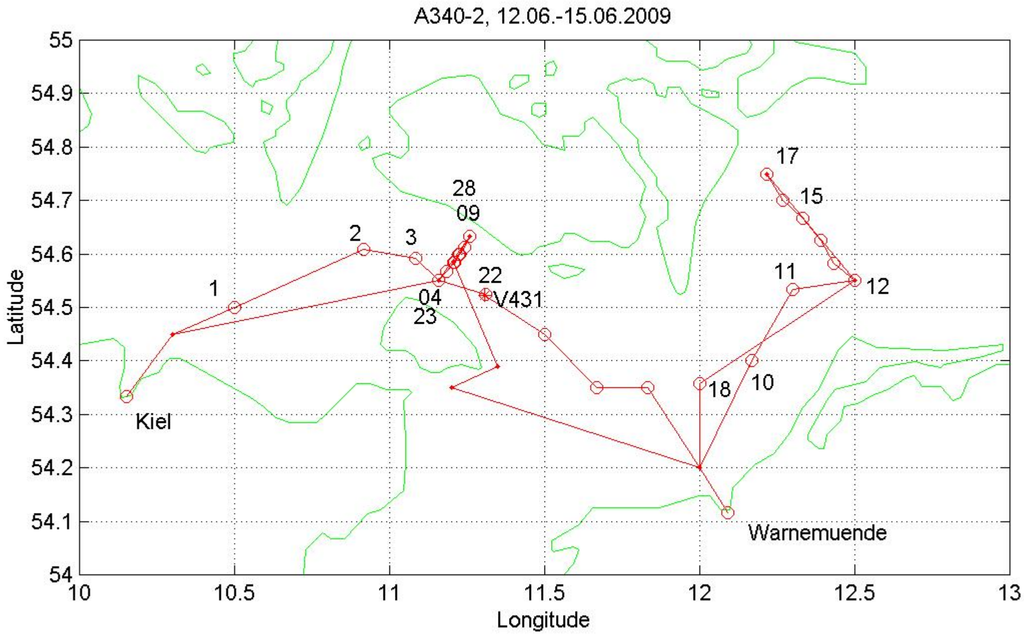

Fig. 3.1: ALKOR cruise AL340-2, 12.06.-15.06.2009 from Kiel Bight and Fehmarn Belt to Darss Ridge: CTD casts and mooring site V431; CTD sections across Fehmarn Belt (casts 2 – 9, 23 – 28), across Darss Ridge (12 – 17) and non-synoptic from Vejsnaes Gap to Darss Ridge (2, 3, 5, 22 – 18, 10, 11, 14). Port calls in Warnemünde

AL340-2, 12.06.-15.06.2009: Cruise narrative summary

Leg 1, 12th to 13th June, Kiel – Warnemünde, for locations of positions see map in Fig. 3.1

Date 2007	Time UTC	CTD cast no.	Action
12.06..	05:30		**Kiel, embark all participants for leg1, 1 *no-show-up* student**
	06:05		Sail, start DAVIS-SHIP
	08:15	01	Test CTD;
	09:01		start ADCP
	10:00	02	CTD, start section L along deep gaps in the west
	10:46	03	CTD, interrupt section L
	11:25	04	CTD, start section C in the south
	11:50	05	CTD, section C and L
	13:37	09	CTD, finish section C in the north
	13:47	09	ADCP, start section C in the north
	14:59	06	Change course towards southeast due to gale wind from WNW
	15:21		Stop ADCP; shelter southeast of Fehmarn
13.06.	14:00		**Berth in Warnemünde, disembark student's course 1, end of leg 1**

AL340-2, 12.06.-15.06.2009: Cruise narrative summary (continued)

Leg 2, 13th to 14th June, Warnemünde - Warnemünde

Date 2007	**Time UTC+2**	**Position no.**	**Action**
13.06.			**Warnemünde, embark student's course 2, 1 *no show-up* student, begin leg 2**
14.06.	04:00		Sail from Warnemünde;
	05:10		restart ADCP
	05:37	10	CTD, continue section L
	06:37	11	CTD, break section L; steam to positon 23
	07:27	12	CTD, start section D across Darss Ridge in the south
	08:22	14	CTD, also section L
	09:43	17	CTD, finish section D in the north;
	09:49	17	start ADCP section towards position 23
	12:09	12	Finish ADCP section in the south, steam to position 14
	14:15	18	CTD, section L, steam to Warnemünde
	15:08		Stop ADCP
14.06	15:30		**Berth in Warnemünde, disembark student's course 2, end of leg 2**

Leg 3, 14th to 15th June, Warnemünde - Kiel

Date 2007	**Time UTC+2**	**Position no.**	**Action**
14.06.	15:45		**Warnemünde, embark student's course 3, begin leg 3**
15.06.	04:00		Sail from Warnemünde
	05:30		start ADCP
	05:34	19 - 21	CTD, complete section L; steam to mooring V431, positon 10
	08:19	V431 22	recover TRB mooring V431-18; CTD close to mooring, Steam to position 04
	09:24	04 / 23	CTD, start section C in the south
	11:06	09 / 28	CTD, finish section C in the north;
	11:12	09 / 28	start ADCP sectioin C
	12:04	04 /23	Finish ADCP section C; finish station work; steam to Kiel
	16:00		**Berth in Kiel, disembark all; end of leg 3; end of cruise**

L: section along deep gaps from Fehmarnbelt – Darss Ridge, casts 2, 3, 5, 22 – 18, 10, 11, 14
C: Fehmarnbelt cross section, CTD casts 4 – 9, 23 - 28
D: Darss Ridge cross section, CTD casts 12 - 17

4. Scientific report and first results

4.1 General meteorological conditions (NCEP) and surface current predictions (BSH)

The area of the cruise west and east of the Fehmarn Belt, was dominated by a low pressure cell (Fig. 4.1.1) with core over South Scandinavia on 12th June, which moved slowly eastwards on 13th and 14th and then northwards on 15th June. The expected wind was strong to gale from WNW on the first two days, weakening and veering SW during the last two days.

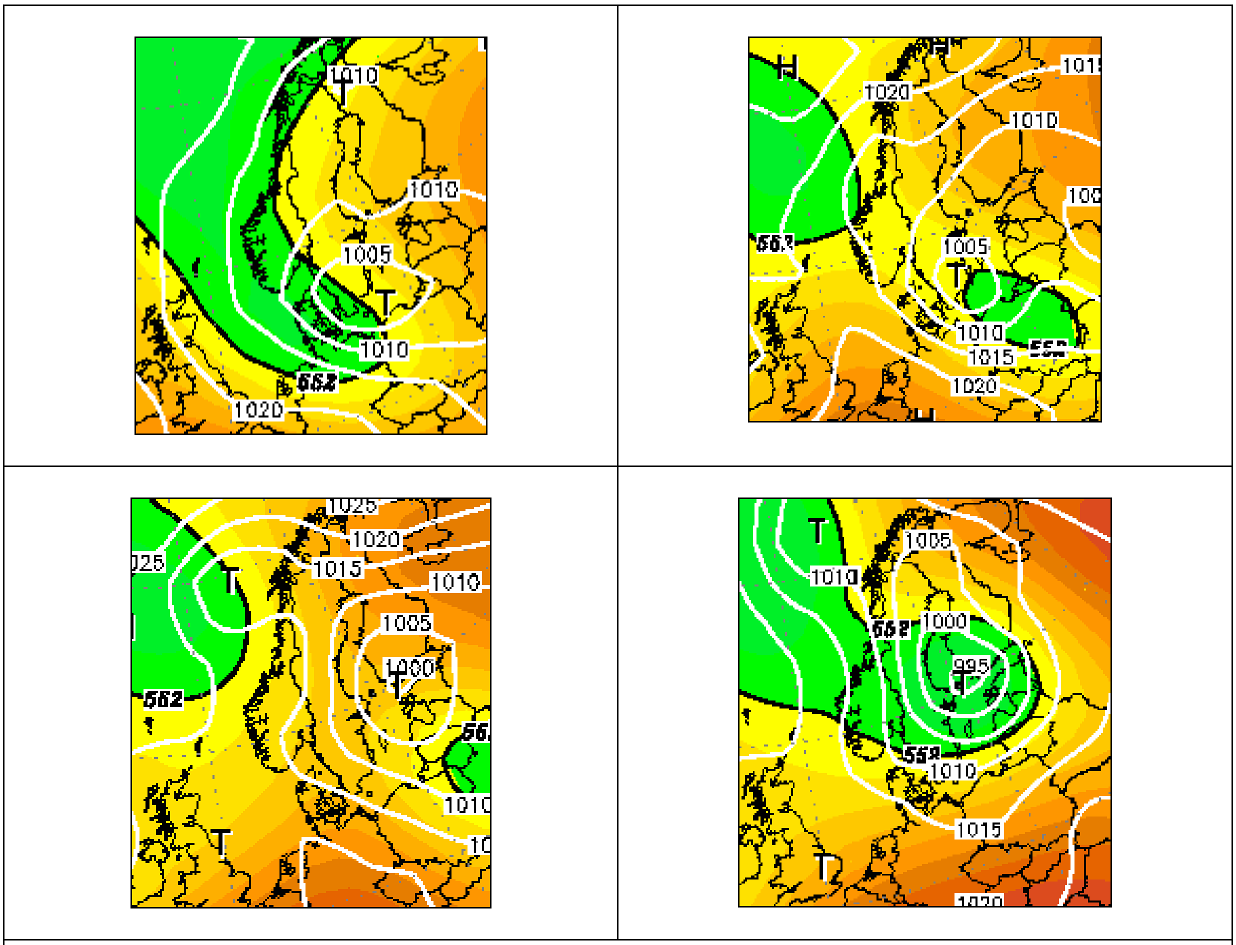

Fig. 4.1.1: *development of bottom air pressure over the North and Baltic seas: 12.06. (upper left), 13.06. (upper right), 14.06. (lower left), 15.06.2009 (lower right). Reanalysis of NCEP; source Wetterwelten*

The records of air-pressure and wind onboard the ship confirms this (Fig.4.1.2).

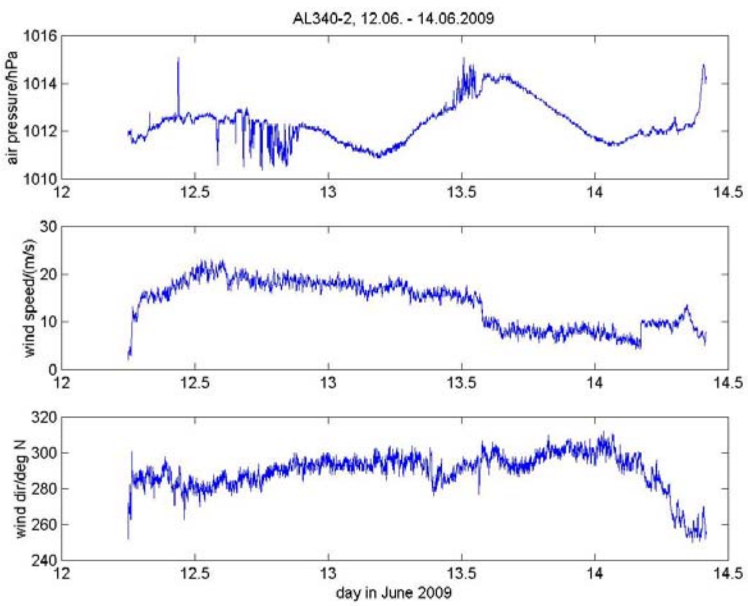

Fig. 4.1.2*: air pressure and wind as measured onboard ALKOR from 12.06. to 14.06.2010.*

The *'Bundesamt für Seeschiffahrt und Hydrographie, BSH'* in Hamburg produces and publishes daily predictions of mean currents for the near surface 0-8 m level in the German Bight and the western Baltic Sea. Figure 4.1.3 shows the prediction for the time period of the cruise, 12th to 15th June 2009. According to the low pressure cell over Southern Scandinavia (see Fig. 4.1.1) with resulting strong to gale winds from WNW on the 12th and 13th June and less strong to weak winds on the 14th and 15th June, the near surface currents in the Fehmarn Belt is eastward into the Baltic across the belt, thus masking the overall long term mean westward surface current on the Danish side of the belt. The wind presses the surface waters towards the East into the Baltic also during the next two days resulting in a sea level rise in the East, and surface inflow into the Baltic persisting until the 14th June. It is only on the 15th June that the inflow across the whole belt stops after a short adjustment.

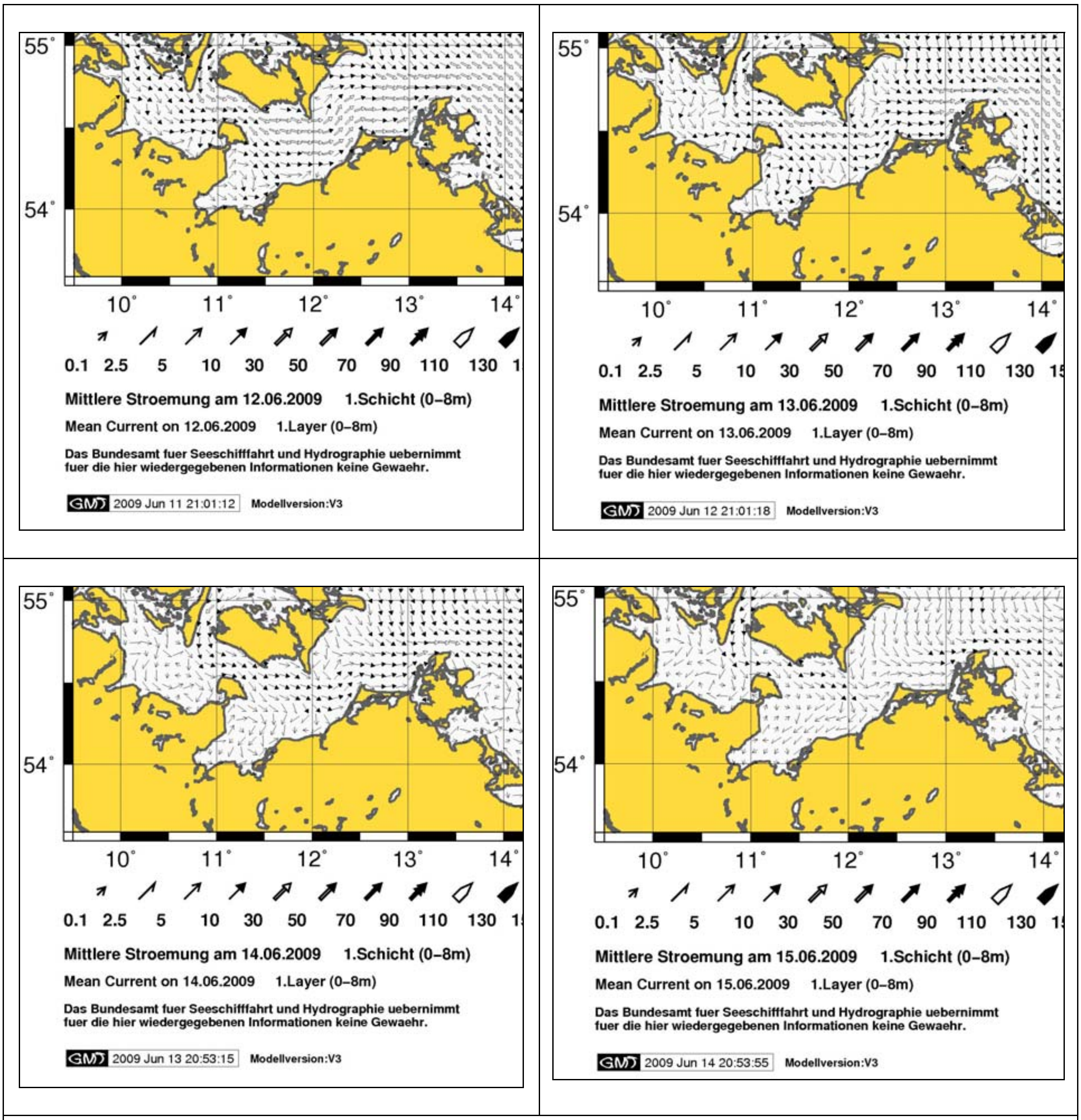

Fig. 4.1.3: *Model predictions of surface 24 h mean currents in the western Baltic for 12.06. (upper left), 13.06. (upper right), 14.06. (lower left) and 15.06.2009 (lower right); source BSH, Hamburg*

4.2 Hydrographic conditions during the cruise

Vertical variability

The typical early summer vertical distribution of temperature and salinity, the T/S relation along with density anomaly, dissolved oxygen and chlorophyll *a* in the west of the Fehmarn Belt is displayed in Figure 4.2.1, cast 03 in the map (Fig. 3.1). The temperature (upper left panel, red dots) down to 21 dbar is about 13.5 °C, when it sharply decreases over a 5 dbar thick interface to the temperature of the bottom layer with 11.5 °C. Salinity (same panel, blue dots) down to 20 dbar slowly increases from 13.7 psu to 15 psu where over the same interface it starts to increase sharply to its bottom value of 20.75 psu. The homogenous bottom layer indicates the saline wedge originating from the North Sea. According to its near bottom temperature, the bottom water has been already at the surface during early spring warming; the location of this contact with the atmosphere must be searched in the Skagerak.

Chlorophyll *a* (Fig. 4.2.1, lower right panel) has its maximum at about 4 m; this is the depth where due to increasing salinity also density increases and where still is sufficient light available for photosynthesis, a good spot for algae to keep depth with sufficient light to survive and bloom. This bloom results in a weak oxygen minimum (lower left panel) which is due to oxygen consumption. The sharp increase of dissolved oxygen in the bottom layer also indicates its recent contact with the surface, and together with the high salinity its origen in North Sea waters.

This vertical distribution is characteristic for all locations from West to East, with bottom salinity and oxygen decreasing to the East and towards northern flanks of gaps.

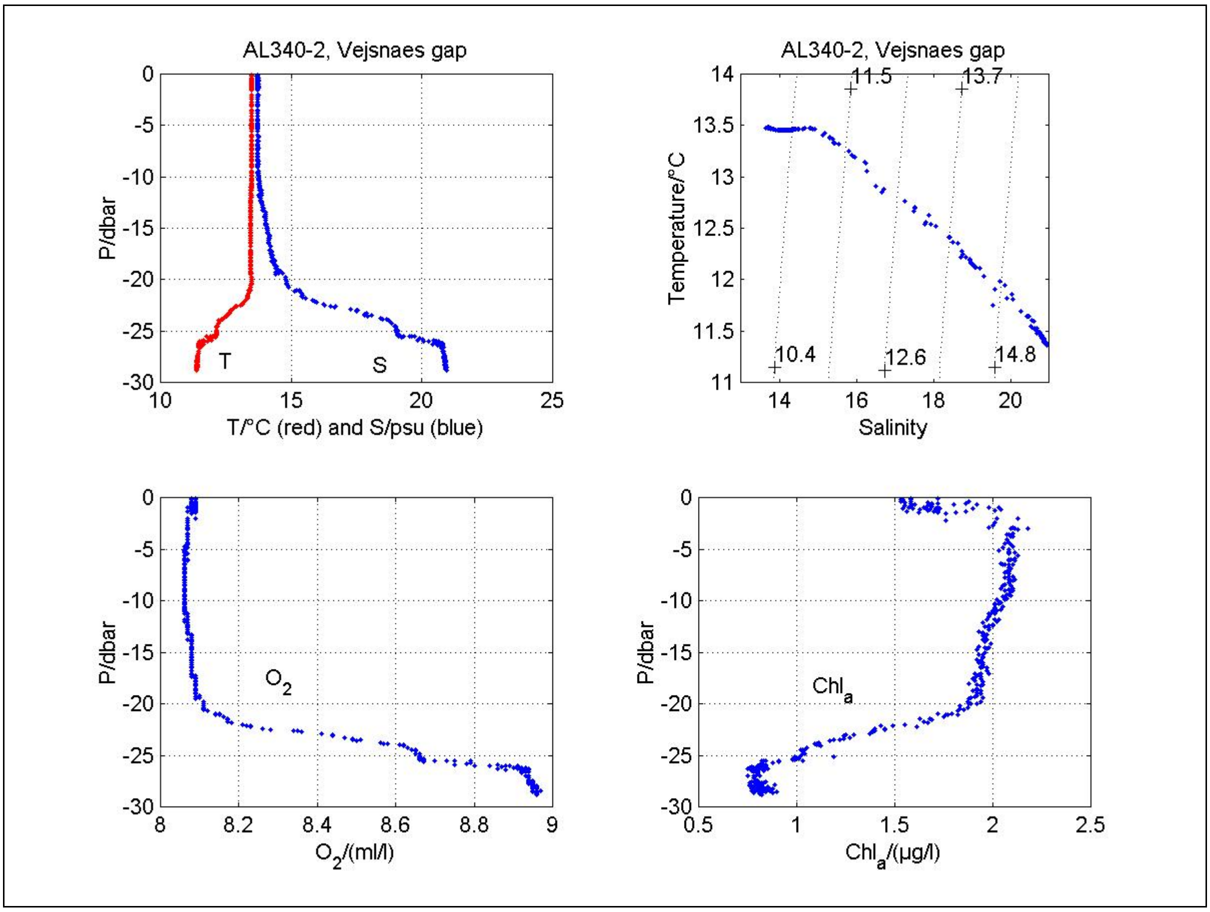

***Fig. 4.2.1**: Typical hydrographic cast for early summer, western Fehmarn Belt, 12-JUN-2009,cast 03: temperature and (upper left),temperature and salinity relation with density anomaly contours (upper right), oxygen cast (lower left), chlorophyll a cast (lower right).*

West to East variability

The section along the mean in- and outflow axis from Fehmarn Belt to the Cadet Gap (Darss Ridge, casts 02, 03, 05, 22 to 18, 10, 11, 14, Fig. 4.2.2) was taken over 4 days and therefore clearly is non-synoptic. Despite this, the section shows the typical early summer situation with temperature and salinity decreasing from West to East, reflecting the warming from higher winter temperatures in the west, and with lower salinities in the inner Baltic in the East. This general view is disturbed by an eddy structure in the Fehmarn Belt. The coldest water 8°C was measured near the bottom at the mooring position (cast 22, 40 km) where also highest salinity and oxygen content and lowest chlorophyll *a* is found. This patch is the clearest bottom inflow signal.

As noted earlier, the maximum of chlorophyll *a* is found at depths between 5 m and 10 m where still sufficient light is available and due to the summer density interface phytoplankton will not sink down.

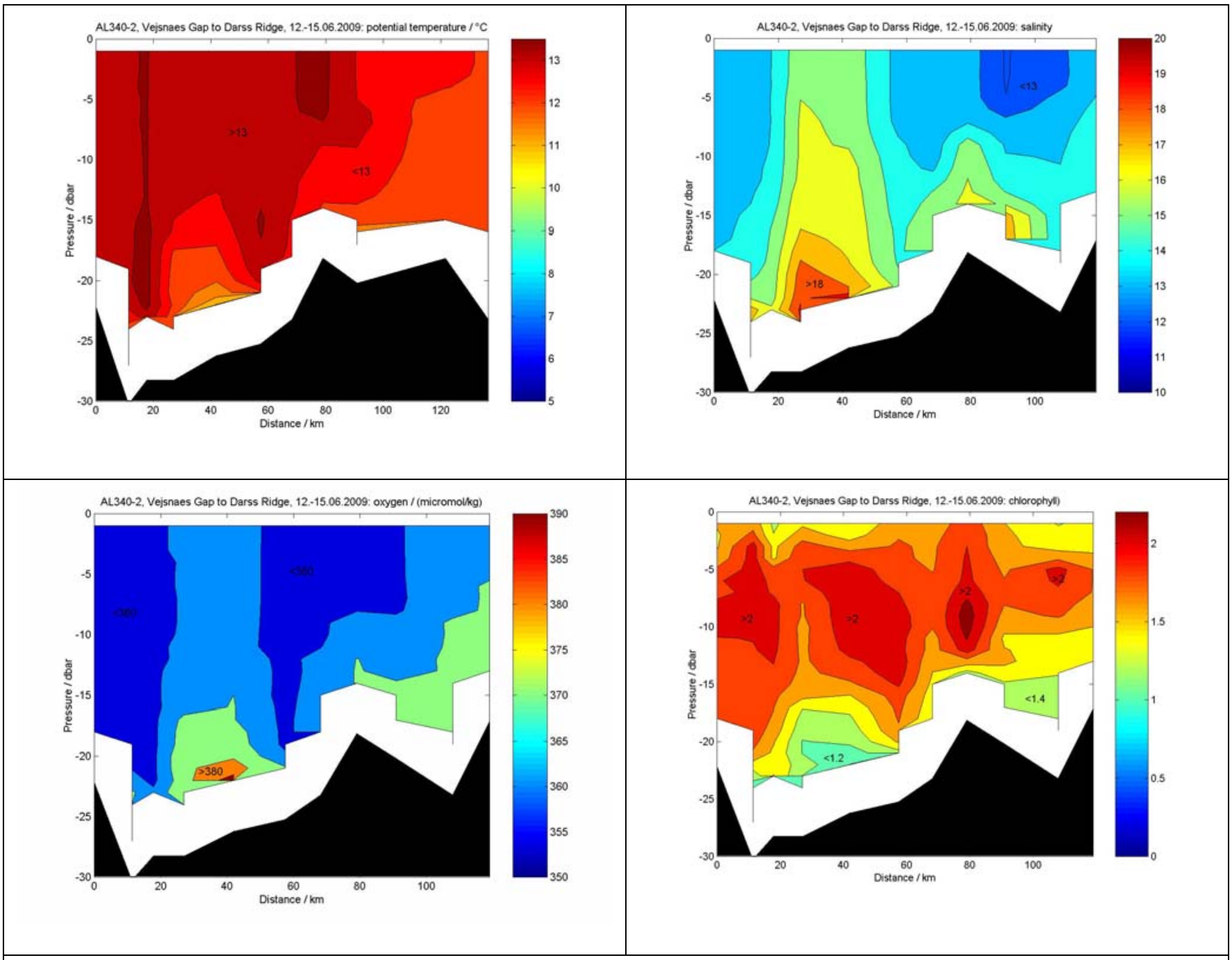

***Fig. 4.2.2**: Section from Fehmarn Belt (left) to Cadet Gap (right), casts 02, 03, 05, 22 to 18, 10, 11, 14; potential temperature (upper left, contour interval 1 K), salinity (upper right, 1 psu), dissolved oxygen (lower left, 10 µmol/kg), chlorophyll a (lower right, 0.2)*

Cross gap variability at Fehmarn Belt and Cadet Gap

In gaps, for near-bottom inflows and surface outflows, geostophic balance on the long-term average for the Northern hemispere requires that the flows adjusts their cores on the right-hand side of the channel, looking in flow direction. For the Fehmarn Belt and Cadet Gap dense bottom and less dense surface flows as indicated by high (low) salinity cores are therefore expected on the southern and northern border, respectively.

The cross Fehmarn Belt section of 12th June 2009 (Fig. 4.2.3, left panel) differs completely. The saline bottom water is found on the northern flank, and also the surface is colder and saltier in the North. Probably the extreme wind has totally changed the stratification by pressing the salty bottom water towards the northern flank and low salinity water from the Kiel bight into the southern belt. Note that applying an objective analysis extrapolates the sections to non-sampled areas in a plausible way (Fig. 4.2.3, right panel).

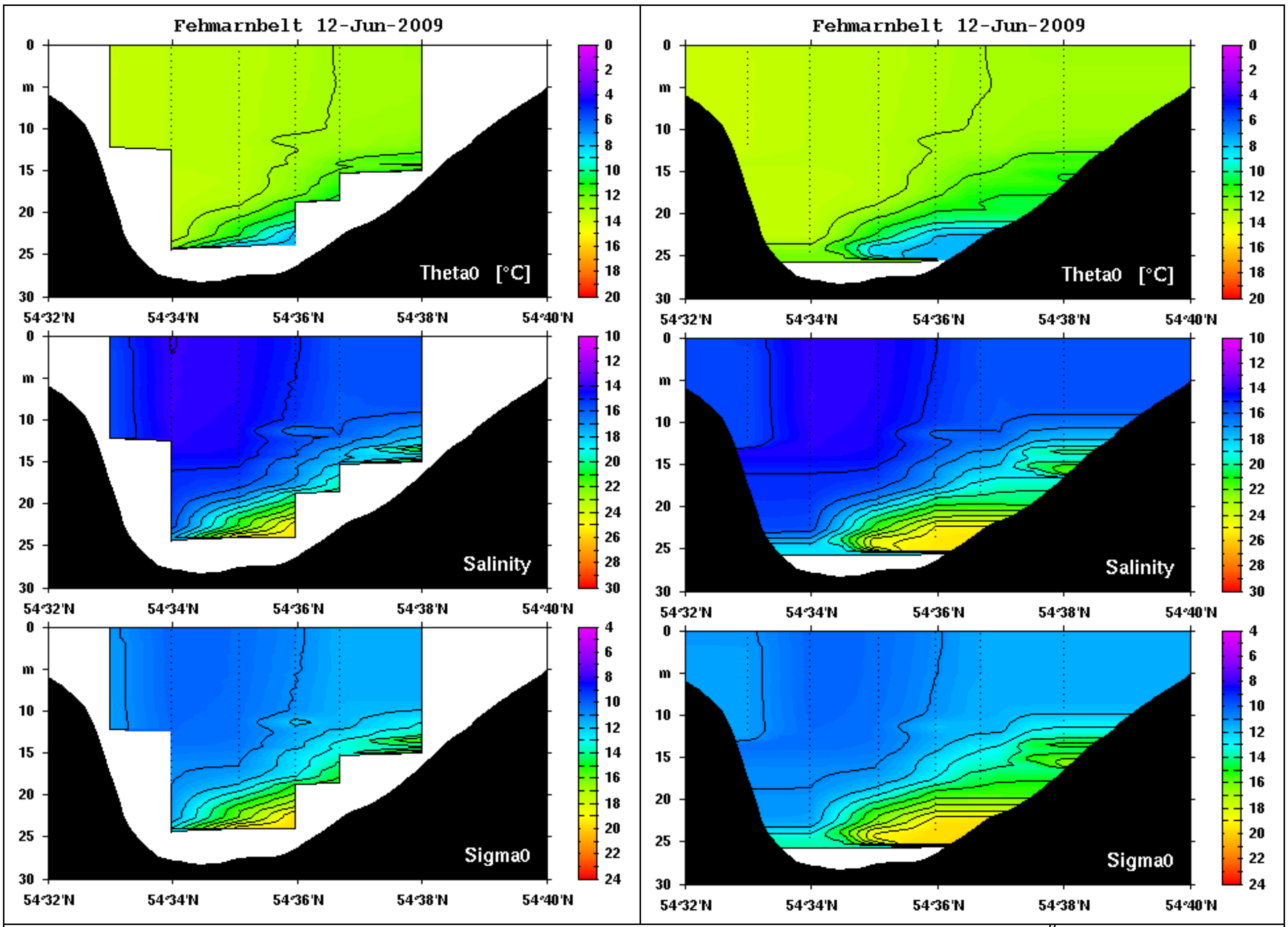

***Fig. 4.2.3:** Section across the western Fehmarn Belt from South (left) to North (right), 12th June, 2009; from top to bottom potential temperature, salinity and density anomaly; section form data sources only (left panel) and extended by objective analysis (right).*

The section across the western Fehmarn Belt was repeated 3 days later, 15th June 2009 (Fig. 4.2.4, left panel). As discussed earlier, the wind had seized and also has veered to SW which allowed the water masses to start to re-adjust again to the normal pattern, although the flow field from ADCP measurements still shows the unusual situation with eastward flow at all depths and across the whole section and near surface core in the South (Fig. 4.2.5).

Further east, in the Cadet Gap (14th June 2009, Fig. 2.4.4, right panel), the situation is similar to the one in Fehmarn Belt on the 12th June with high density water on the northern margin while the less dense bottom water is found on the southern margin.

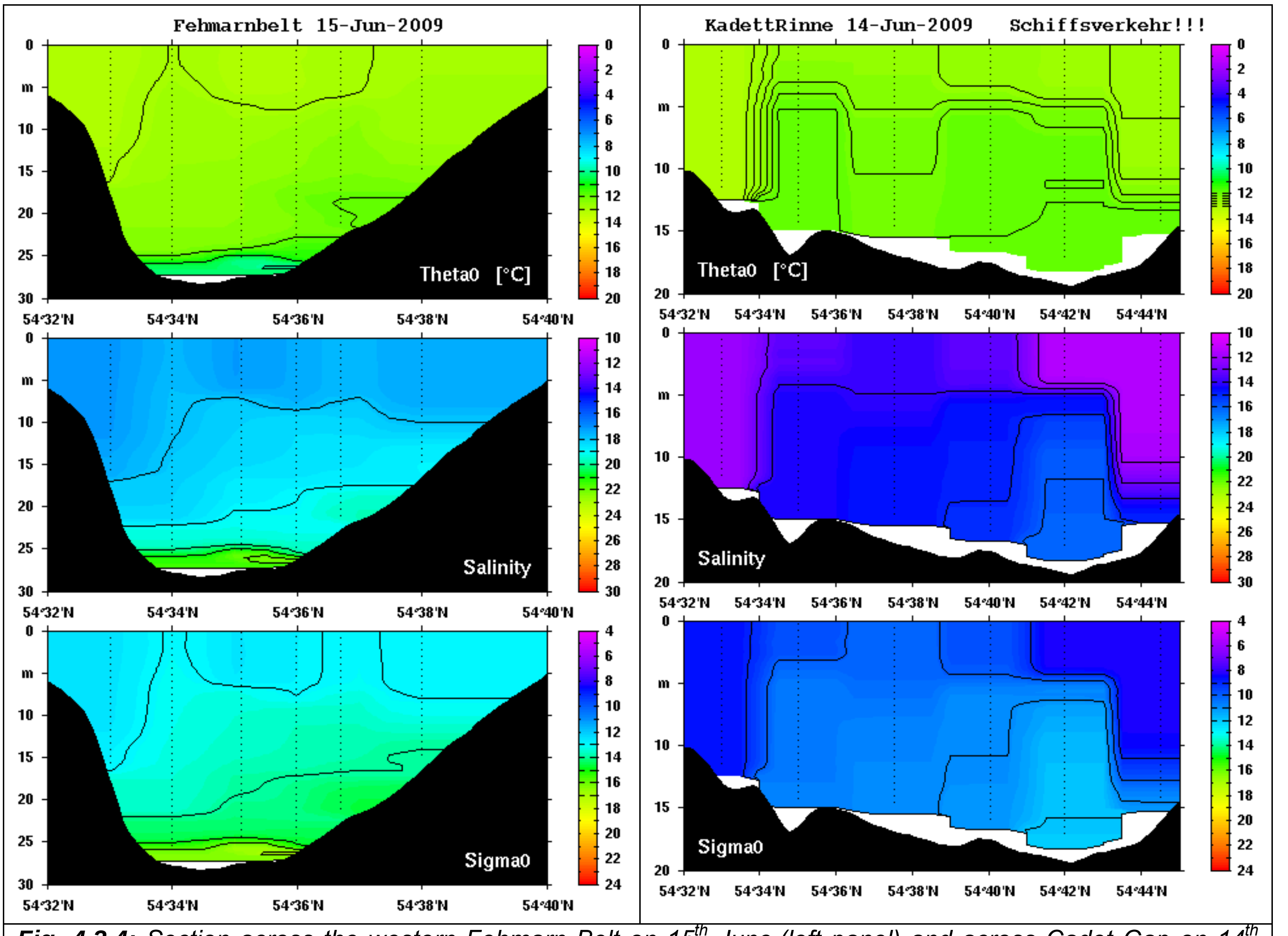

***Fig. 4.2.4:** Section across the western Fehmarn Belt on 15th June,(left panel) and across Cadet Gap on 14th June 2009 (right panel) from South (left) to North (right); potential temperature, salinity and density anomaly (top to bottom); extended by objective analysis*

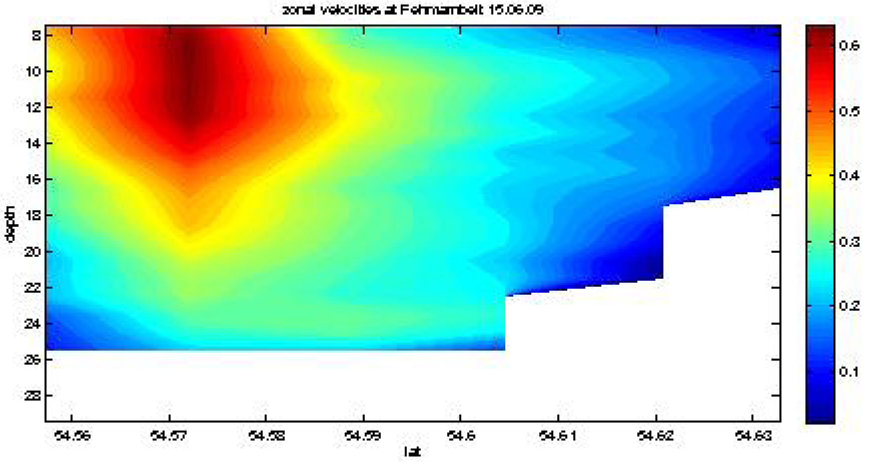

***Fig. 4.2.5:** western Fehmarn Belt; cross section from South (left) to North (right), vADCP, zonal velocity;*

4.3 Long-term observations in the Fehmanrn Belt

Due to a battery problem, the moored RDCP had only 1.5 months of record length; Also, it was not possible to make the records from the moored bottom CTD available; no analysis of the long-term records therefore here.

5. Scientific equipment: moorings and instruments

5.1 Mooring V431

V431 is a trawl resitent bottom (TRB) mooring AL200 made by Flotation Inc., CA, USA, for shallow waters (Fig. 5.1). It consists of a combined rack and flotation part that in the present version houses a 600 kHz AADI *Recording Doppler Current Profiler* (RDCP) with sensors for temperature, conductivity and dissolved oxygen measurements as well, and a Benthos shallow water acoustic releaser. The releaser fixes through a lever these floating parts to the bottom weight. Attached to the weight is a MicroCat. After the release command is received, the releaser frees the lever between rack and weight, and the flotation with ADCP and releaser surfaces. A nylon rope still connects the flotation part with the weight such that the weight also can be recovered. For mooring V431-18 at 28 m water depth, an 8 mm METEOR nylon rope of 40 m length was chosen.

***Fig. 5.1**: the trawl resistent bottom mooring's flotation part after 9 months deployment in mooring V431-18. On top the RDCP's tranducers. The MicroCat is attached to the weight (not shown here). The total weight is abot 1.500 kg.*

Because of the bad weather at the beginning of the cruise, recovery of mooring V431-18 was delayed until the cruise's last day on 15th June. After 9 months deployment it was not re-deployed because of lack of time for a carefull re-fit.

The RDCP had only 1.5 months of good records; from then on, recording had seized completely, probably due to a problem with the battery package.

The usual processing is the following: Raw data are decoded, converted to physical units, processed for spikes and low pass filtered to daily averages. For the current measurements, the coordinate system is rotated by 132° to align one current component to the Belt's main axis (main flow positive to the Southeast). A 7 d low pass filter is applied to both, MC and rotated RDCP data, to investigate long-term changes in the Belt's fow pattern and near botom hydrography.

Tab. 5.1 *Mooring details*

	launched	**recovered**	**ADCP**	**MicoCat**	**Releaser**
V431-18	30.09.2008	15.06.2009	RDCP600 600 kHz, S/N 227 T-sensor: yes C-sensor: yes O2: yes	SBE 37 SM S/N 2936	Benthos 875-A S/N: Hamburg unit 12 kHz, code C
V431-19	29.06.2009 (after this cruise; transit of R/V POSEIDON from Kiel to Warnemünde)		RDCP600 600 kHz, S/N 227 T-sensor: yes C-sensor: yes O2: yes	SBE 37 SM S/N 2936	Benthos 875 A S/N 45634 RX 12 kHz, Code C

5.2 CTD/rosette and salinometer

The CTD/rosette system is made by *HYDROBIOS, Kiel, Germany*. It is for shallow water (less 3000 m). The CTD package is battery powered, but provides data on-line via a one-conductor cable from the underwater unit to the deck unit where they are recorded by the software package *OCEAN LAB* on a PC. CTD data and bottle closure events are viewable on the PC's screen during a cast, and stored on hard disk.

Because of lack of time, no bottle salinities were measured for comparison and calibration of the CTD salinity.

5.3 Underway measurements

5.3.1 Navigational data

Two GPS (*LEICA MX* and *Shipmate*), EM log and gyro compass data are fed into the underway sampling and distribution system DAVIS-SHIP (see Sec. 5.3.6). Screens in the dry and wet labs display the *TRANSAS* electronic sea chart from the bridge. These include information on

- ship's location, speed and heading
- distance and ETA for next waypoint
- distance and ETA for total programmed way

5.3.2 Meteorological data

Sensors are installed in the mast; an additional sensor for water temperature sensor in ship's hull. All data are sampled by the *COMBILOG 1020* system of *Friedrichs & Co, Schenefeld, Germany*. Sensors are:

- barometric pressure, *Friedrichs type 5002*
- temperature and humidity sensor, *Friedrichs type 3030*, port and starboard side
- wind speed and direction (*Thiess 4.3324.21.000*), port and starboardside
- global radiation, *Kipp & Zonen pyranometer*
- IR radiation, *Eppley Lab., Inc., CM11*, S/N 3407F3
- water temperature *S-WM4*, last test 02-JAN-2004

COMBILOG samples all meteorological data and provides them as combined ASCII string each sampling interval to a RS232 interface. This string is fed into the *DAVIS-SHIP* system (see. Sec. 5.3.6.)

5.3.3 Thermosalinograph

A SBE37 thermosalinograph with additional external temperature sensor provides near-surface temperature and electric conductivity data form an inlet at about 3 m depth close the ship's bow. Data are converted and together with calculated salinity (PSS78) fed into the underway sampling and distribution system *DAVIS-SHIP* (see Sec. 5.3.6). Temperature and salinity data maybe calibrated *in-situ* by comparison with near-surface CTD data while on station taking the CTD as correct (Fig. 5.3.3.1).

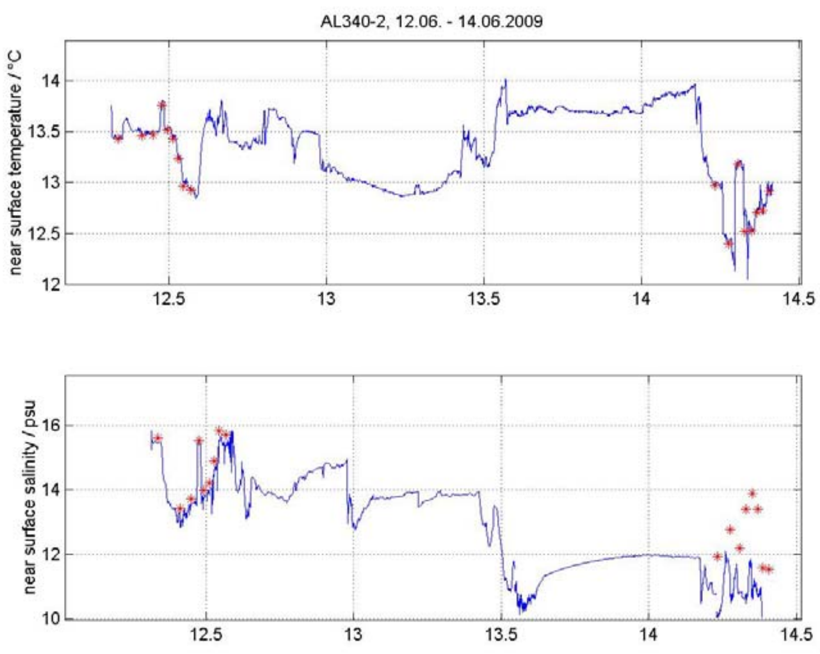

Fig. 5.3.3.1*: Thermosalinograph (blue) and near-surface CTD data (red dots), 12.06.-14.06.; temperature median correction (upper panel) is less 0.05 K and salinity median correction (lower panel)on 12th June is + 0.1 psu; on 14th June, the TS-g's pump obviously was not switched on.*

5.3.4 Single beam echosounder

A *SIMRAD EK60*, 38 kHz, at reference sound velocity 1.459.7 m/s was used. Data are fed into the *DAVIS-SHIP* system (see Sec 5.3.6). It has been shown during earlier cruises using CTD casts from Vings Grav in the west and the entrance to the Arcona Basin in the east (Position 30) that depth corrections are low (ca. 0.3 m) indicating that the reference sound velocity of 1459.7 m/s is well chosen. A comparison with new data from cast 22 close to the mooring locations confirms this.

5.3.5 Vessel mounted ADCP

A 300 kHz *work horse* ADCP made by *RDI* is mounted in the ship's moonpool. Because of shallow water, it could be used in bottom track mode. GPS navigational data come directly from the *DAVIS-SHIP* system; gyro compass data are converted first from *DAVIS-SHIP* to the special required format and then fed into the ADCP computer where standard software created in the department of *Physical Oceanography* is used for processing.

5.3.6 Underway sampling and distribution system (DAVIS-SHIP)

Underway data sampling, distribution and storage is performed by the hard- and software system *DAVIS-SHIP* from WEREUM, Lüneburg, *Germany*. Data sources are:

- Navigational data from main and secondary GPS including date and time
- Gyro compass
- Depths from navigational, sediment and *SIMRAD ER40* single beam sounders
- Meteorological data from the *COMBILOG* and automated weather station the *Deutsche Wetterdienst (DWD)* operates onboard (see Sec. 5.3.2)
- Thermosalinograph made by SeaBird, U.S.A.

Displays and network connections are available in the dry and wet laboratories.

6. Acknowledgements

We would like to thank master and crew of RV ALKOR for the helpful advise and support throughout the cruise.

7. Appendices

7.1 Cruise log AL340-2

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Oz. Praktikum
AL 340-2, 12.06.-15.06.2009
Bezeichnungen:
Datum: YYYY MM DD
Zeit: hh mm
P : Postions Nr. im Praktikum
C: CTD Nr.
Breite: dd mm.mm
Länge: ddd mm.mm
H     : Lottiefe / m
S     : Symbol Nr.
WP    : Wegpunkt

Leg 1, 12.06. - 13.06., Kiel - Warnemünde
YYYY MM DD hh mm P  C   Breite      Länge    H  S Bemerkung
2009 06 12 07 00 -9 -9  54 20.00   010  09.0 -9 2 Kiel
2009 06 12 18 05 -9 -9  54.45 0    010.3 0   -9 4 WP Kiel
Kieler Bucht
2009 06 12 08 06 01 01  54  30.0   010  30.0 14 2 Test CTD
Vejsnaes Rinne
2009 06 12 09 53 02 02  54  36.5   010  55.0 22 2 CTD, L West
2009 06 12 10 46 03 03  54  35.5   011  05.0 30 2 CTD, L
Fehmarnbelt quer
2009 06 12 11 25 04 04  54  33.0   011  09.5 17 2 CTD, C Süd
2009 06 12 12 50 05 05  54  34.0   011  11.0 28 2 CTD, C, L
2009 06 12 12 15 06 06  54  35.1   011  12.4 26 2 CTD, C
2009 06 12 12 41 07 07  54  36.0   011  13.4 26 2 CTD, C
2009 06 12 13 04 08 08  54  36.7   011  14.5 21 2 CTD, C
2009 06 12 13 38 09 09  54  38.0   011  15.5 17 2 CTD, C Nord,
2009 06 12 13 47 09 -9  54  38.0   011  15.5 -9 4 Beginn ADCP
2009 06 12 14 59 -9 -9  54  35.1   011  12.4 -9 4 Kursänderung, Sturm, Ende Schnitt
2009 06 -9 -9 -9 -9 -9  54.39 0.0   11.35 0.0 -9 4 WP östl. Fehmarn
2009 06 13 15 21 -9 -9  54.35 0.0  11.2  0.0 -9 4 SW Fehmarn, Schutz
2009 06 13 -9 -9 -9 -9  54.2 0.0   012  00.0 -9 4 WP Anlaufen Warnemünde
2009 06 13 14 00 -9 -9  54  07.00  012  05.50 -9 2 Warnemünde

Leg 2, 14.06., Warnemünde - Warnemünde
YYYY MM DD hh mm P  C   Breite      Länge    H  S Bemerkung
Warnemünde - Darss
2009 06 14 04 00 -9 -9 54 07.0    012  05.5 -9 2 Warnemünde
2009 06 14 -9 -9 -9 -9 54.2 0.0   012  00.0 -9 4 WP Warnemünde
2009 06 15 05 36 15 10  54  24.0   012  10.0 20 2 CTD, L
2009 06 14 06 37 16 11  54  32.0   012  18.0 23 2 CTD, L
Kadettrinne quer
2009 06 14 07 24 23 12  54  33.0   012  30.0 14 2 CTD, D, Süd
2009 06 14 07 53 24 13  54  35.0   012  26.0 17 2 CTD, D
2009 06 14 08 22 25 14  54  37.5   012  23.5 17 2 CTD, D
2009 06 14 08 50 26 15  54  40.0   012  20.0 18 2 CTD, D
2009 06 14 09 15 27 16  54  42.0   012  16.0 20 2 CTD, D
2009 06 14 28 09 43 17  54  45.0   012  13.0 16 2 CTD, D Nord
2009 06 14 09 49 28 -9  54  45.0   012  13.0 16 4 D Nord, Beginn ADCP Schnitt, 7 kn
2009 06 14 12 09 23 -9  54  33.0   012  30.0 14 4 D Süd, Ende ADCP Schnitt
2009 06 14 14 15 14 18  54  21.5   012  00.0 18 2 CTD, L
2009 06 14 -9 -9 -9 -9 54.2 0.0    012  00.0 -9 4 WP Warnemünde
2009 06 14 15 30 -9 -9  54 07.00   012  05.5 -9 2 Warnemünde
```

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Leg 3, 15.06., Warnemünde - Kiel
YYYY MM DD hh mm P  C   Breite      Länge    H  S Bemerkung
Warnemünde - Fehmarnbelt
2009 06 15 04 00 -9 -9  54 07.00   012  05.5 -9 2 Warnemünde
2009 06 15 -9 -9 -9 -9 54.2 0.0    012  00.0 -9 4 WP Warnemuende
2009 06 15 05 34 13 19  54  21.0   011  50.0 23 2 CTD, L
2009 06 15 06 22 12 20  54  21.0   011  40.0 25 2 CTD, L
2009 06 15 07 19 11 21  54  27.0   011  30.0 26 2 CTD, L
Fehmarnbelt Verankerung
2009 06 15 08 19 10 -9  54  31.32  011  18.31 28 1 Verankerung V431/18 aufnehmen
2009 06 15 08 40 10 22  54  31.5   011  18.5 28 2 CTD bei Verankerung
Fehmarnbelt quer
2009 06 15 09 24 04 23  54  33.0   011  09.5 18 2 CTD, C Süd
2009 06 15 09 42 05 24  54  34.0   011  11.0 28 2 CTD, C, L
2009 06 15 10 04 06 25  54  35.1   011  12.5 27 2 CTD, C
2009 06 15 10 25 07 26  54  36.0   011  13.5 27 2 CTD, C
2009 06 15 10 45 08 27  54  36.7   011  14.5 24 2 CTD, C
2009 06 15 11 07 09 28  54  38.0   011  15.5 17 2 CTD, C Nord, Beginn ADCP
2009 06 15 11 12 09 -9  54  38.0   011  15.5 -9 4 C, Nord, Beginn ADCP
2009 06 15 12 04 -9 -9  54  33.0   011  09.5 -9 4 C Süd, Ende ADCP
Fahrt nach Kiel
2009 06 15 12 05 -9 -9  54.45 0    010.3 0   -9 4 WP Kiel
2009 06 15 16 00 -9 -9  54 20.00   010  09.0 -9 2 Kiel
```