Leibniz-Institut für Meereswissenschaften
IFM-GEOMAR

Date: 10.09.2009

Cruise Report

Compiled by: T.J. Müller

F.S.Poseidon **Cruise No.: P301, P302**

Dates of Cruise: 09.08-08.09.2003

Areas of Research: Physical oceanography

Port Calls:	Glasgow:	06.08.-09.08.2003
	Reykjavik:	21.08.-24.08.2003
	Reykjavik:	08.09.-11.09.2003

Institute: Institut für Meereskunde, Kiel

Chief Scientist: T.J. Müller

Number of Scientists: P301: 6
P302: 8

Projects:

- SFB460 of the University of Kiel, Germany
  - Subproject A1: Denmark Strait Overflow
  - Subproject A3: Water Mass Transformation in the Iceland Basin
- ANIMATE: Atlantic Network of European Time Series Stations, CIS

Cruise Report

This cruise report consists of XX pages including cover:

1. Scientific crew

P301, 09.08.-21.08., Glasgow-Reykjavik
P302, 24.08.-08.09., Reykjavik-Reykjavik

Name	Institute		P301	P302
Müller, Thomas J.	IFMK	Chief scientist	---------	----------
Homuth, Johannes	IFMK	Stud.		----------
Macrander, Andreas	IFMK	Phys. oc.	---------	---------
Smarz, Christopher	IFMK	Student	---------	----------
Linke, Petra	Guest	High school student	---------	----------
Lübbecke, Joke	IFMK	Stud.	---------	----------
Müsch, Kerstin	IFMK	Stud.	---------	----------
Solveig	MRI	Stud		----------
Total			**6**	**8**

IFMK Institut für Meereskunde, Kiel, *now: IFM-GEOMAR, Kiel*
MRI: Marine Research Institute, Reykjavik

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2. Research programme

Cruises P301 and P302 were aimed to study the variability of the overflow through Denmark Strait and to serve a time series station southeast of Greenland. Also, two sound source moorings in the Iceland Basin were to be recovered.

The overflow through the Faroe Channel and through Denmark Strait is one of two major sources to form North Atlantic Deep Water (NADW), and thus plays an essential role in the world-wide thermohaline circulation. Within the „Sonderforschungsbereich 460“ of the German Research Foundation (DFG), the dynamics of its variability and interaction with overlying water masses is investigated. In the Iceland Basin, a bunch of acoustically located floats (RAFOS type, Zenk et al., 2000) were used for direct Lagrangian flow measurements to identify pathways within both, the core of the Labrador Seawater and within the overflow. Two moored sound sources used to track the floats were to be recovered.

In Denmark Strait, direct measurements of currents and heights of sea surface and overflow layer at the sill depth, and the height of the reservoir in terms of temperature north of the sill were performed. During cruise P301, two ADCPs and two inverted echo sounder with pressure sensors (PIES) at the sill's bottom, and a mooring with temperature/depth recorders moored north of the sill were to be recovered (Area A1 in Fig.1). Also, one mooring that could not be recovered during an earlier cruise in 2003 was to be searched for.

Within the EU-funded project ANIMATE, three open ocean time series stations have been set up north of the Canary Islands (ESTOC), west of Ireland in the Porcupine Abyssal Plain (PAP) and southeast of Greenland in the Central Irminger Sea (CIS, Fig.1) since early 2002. All these stations are equipped with recently developed sensors to measure CO_2-flux, the contents of nutrients, and fluorescence as parameter for chlorophyll *a* in the upper 10 m to 90 m. Also, an inductive-modem based under-water data transfer and a small surface buoy is used to transmit near-real-time data of temperature and salinity from the upper 1000 m through satellite for open use. Technical problems had caused breaks in the upper parts of both CIS moorings earlier in 2003. One drifting part was recovered by HDMS HVIDBJOERNEN late April 2003, and both sub-surface parts by the Icelandic research vessel A. FRIDRIKSSON in July 2003. Cruise P302 was aimed to re-implement station CIS with two moorings.

3. Narrative of cruise with technical details

3.1 Cruise P301, 09.08.- 21.08.2003, Glasgow – Reykjavik

07th – 9th August, Glasgow
embark 6 scientists, provision, bunker
set up systems

9th August
09:00 sail, begin of cruise P301
set course to mooring V432/IM4 (Fig. 3.1) .

10th August– 12th August, transfer to Iceland Basin, mooring location IM4
08:00 start 150 kHz vmADCP
11th August
07:45 CTD test station, 300 m
08:45 start PC-log
10:00 start TS-graph

12th – 13th August, Iceland Basin
12th August
07:20 release and recover mooring V432/IM4,
RAFOS SoundSource S/N 48 safely recovered
13:33 start CTD section across the overflow, casts #1 to #4, partly with SF6 & Th samples
13th August
08:15 release mooring V384-2/IM1,
RAFOS SoundSource S/N 24 safely recovered
transfer to work area A1, Denmark Strait

14th – 19th August, area A1, Denmark Strait
14th August, A1, Denmark Strait sill region
18:35 start CTD and vADCP section across Denmark Strait sill region,
casts #5 to #14,partly SF6 samples.
15th August, sill region
08:07 mooring V422-03/PIES05 released, PIES05 safely recovered
11:28 mooring V425-03 released,
near bottom long ranging ADCP S/N 1181 safely recovered
15th August, A1, Denmark Strait sill region
14:00 mooring 423-03/SK, near bottom moored shielded ADCP,
acoustic contact successful,
no success to release, dredged with no succesess
several acoustic controls during the following days
16th August, A1, Denmark Strait sill region
09:35 mooring V421-02/PIES073, try to release, no success
21:33 tryto release mooring V421-02/PIES05, no success
22:34 acoustic check of mooring423-03/SK
finish CTD and vADCP section across sill
transit to northern entrance to Denmark Strait
17th August, area A1, northern entrance of Denmark Strait
07:07 start CTD northern entrance Denmark Strait section,
casts #15 to #18, partly SF6 samples

09:50 mooring 424-02/TP released,
all TP recorders and other instruments safely recovered,
17:10 mooring 424-01/TK with thermistor cable tried to dredge, no success
transit for sill region

18th August, Denmark Strait sill region
08:00 try to release mooring V423-03/SK, no success
09:43 try to release mooring V421-02/PIES073, no success
transit to northern entrance of Denmark Strait
20:45 final CTD, northern entrance, cast #18
transfer to Isafjördur to pick up the near surface buoyancy of mooring 424-01/TK which has been found drifting by Icelandic colleagues.
All science systems switched off

19th August
14:00 berth Isafjördur
visit the local maritime rescue station; retrieve buoyancy and ARGOS transmitter of mooring V424-1/TK picked up by rescue boat while drifting on the surface xxxx.

20th August
09:00 sail for Reykjavik

21st August
06:00 all science systems switched off
09:45 berth Reykjavik, end of cruise P301

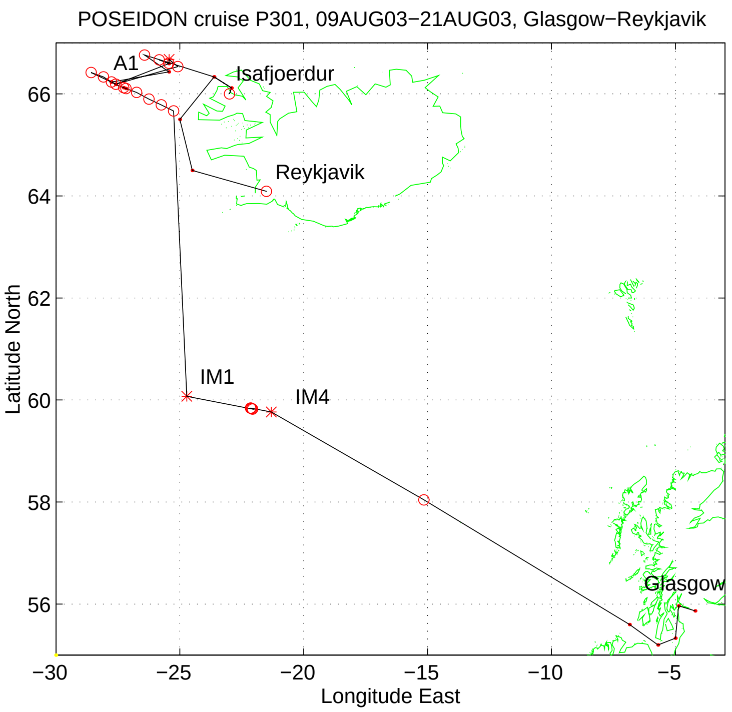


***Fig. 3.1:** POSEIDON cruise P301: cruise track with moorings (*) and CTD/rosette casts (o); sound source moorings IM4 and IM1.*
A1 denotes the work area in Denmark Strait. 150 kHz vADCP underway.

3.2 Cruise P302, 24.08. – 07.09.2003, Reykjavik – Reykjavik

21st - 24th August, Reykjavik
embark 2 scientists, provision bunker

24th August
09:00 sail from Reykjavik, satrt cruise P301
course set to mooring location CIS
16:00 start vADCP
19:35 re-start PC-log

25th – 27th August, on the way to CIS
25th August
15:30 2 CTD cast in deep water for to calibrate MicroCats
26th August
10:27 test acoustic relese

27th – 29th August, CIS location
27th August
14:04 mooring V434-02 deployed
14:25 2 CTD cast to calibrate fluorometer and moored sensors
28th August
12:40 mooring V433-02 deployed
17:50 1st of 6 CTD casts around CIS partly with SF6 samples
29th August
18:03 last of 6 CTD casts around CIS
proceed to area A1, Denmark Strait

29th – 30th August, on the way to work area A1

31st August – 02nd September, area A1, Denmark Strait sill area
31st August
21:31 start CTD and vADCP section across sill
02nd September
18:03 last cast on section
course to Isafjördur due to bad weather
All science systems switched off

03rd September
19:00 berth Isafjördur

06th September
09:00 sail for Reykjavik

07th September
17:00 berth in Reykjavik, demob, disembark, end of cruise P302

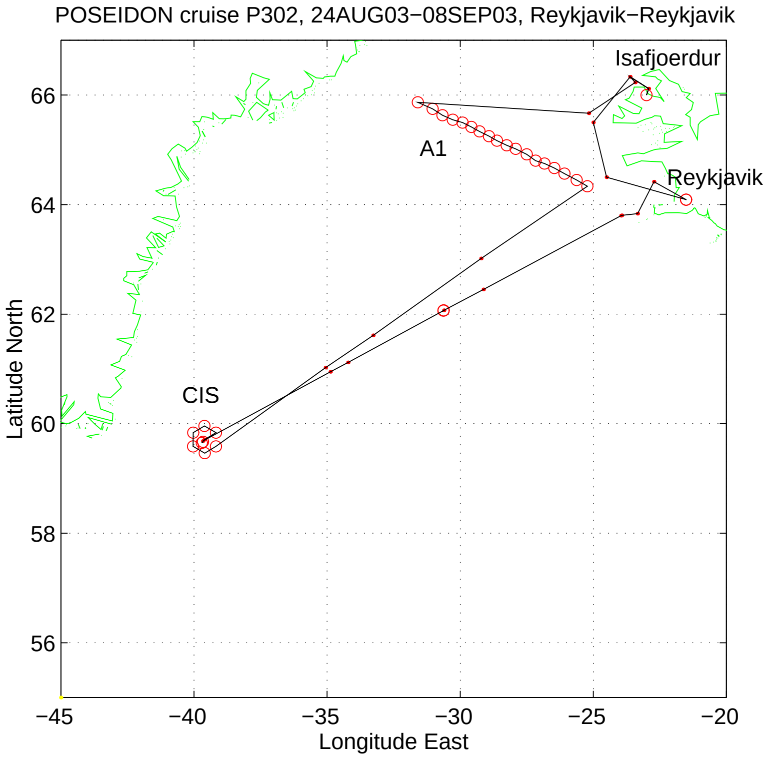


Fig. 3.2: *POSEIDON cruise P302: cruise track with moorings (*) and CTD/rosette casts (o); 150 kHz vADCP underway.*

4. Hydrographic conditions in Denmark Strait during the cruise

On average, hydrographic conditions and currents at Denmark Strait are characterized by near-surface and mid-depth inflow of warm and saline Atlantic waters at the esatern side as part of the subpolar gyre, while polar waters compensate this inflow as low-saline and near-surface East Greenland Current, and at the bottom as cold and dense overflow. Direct flow measurements were obtained during the cruise with an 150 kHz vessel mounted ADCP; long term direct measurements were made at certain locations with moored instruments (sse section 5). These direct current measurements are discussed elsewhere (Macrander, 2004). In this report, only hydrographic feautures will be presented.

The relation of potential temperature and salinity from the northern and southern part of Denmark Strait reveals the overall water mass structure (Fig. 4.1). In the South (cast 22, red dots in Fig. 4.1), the North East Atlantic Central water (NEACW) occupies the range 7 °C to 8 °C and about 35 in salinity. Towards the surface, less saline but summer heated nearsurface water is observed. Below, the NEACW mixes with less saline and colder intermediate and polar waters before the mixing curve turns again towards the higher saline values of the Denmark Strait Overflow (DSOW, S ~ 34.91). Well north of the strait's sill (cast 017, blue dots in Fig. 4.1) the summer heated near surface values with increasing depth quickly increase in salinity before the mixing cruve at at about 34.7 salinity sharply decreases in temperature and slightly in salinity to reach the the minimum in temperature in the polar water core. Below, the mixing between polar waters and NEACW and waters leads to two cores with higher salinity and temperature before the characteristics of DSOW are met as bottom water.

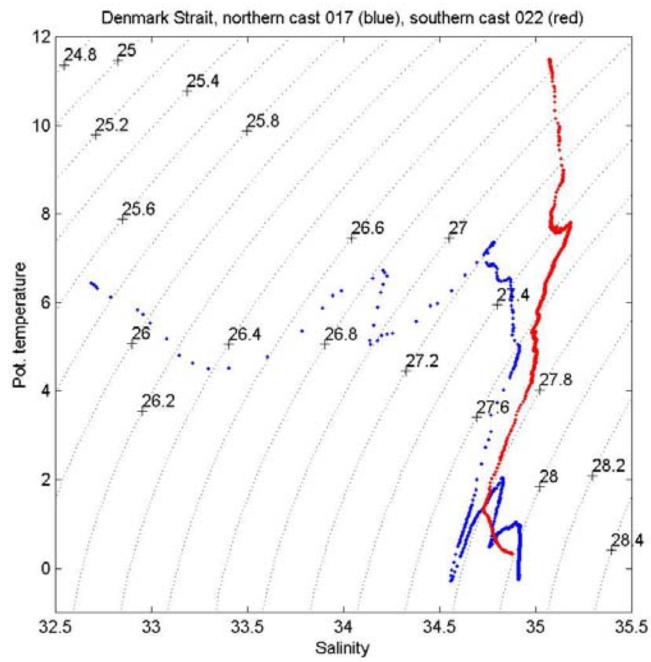
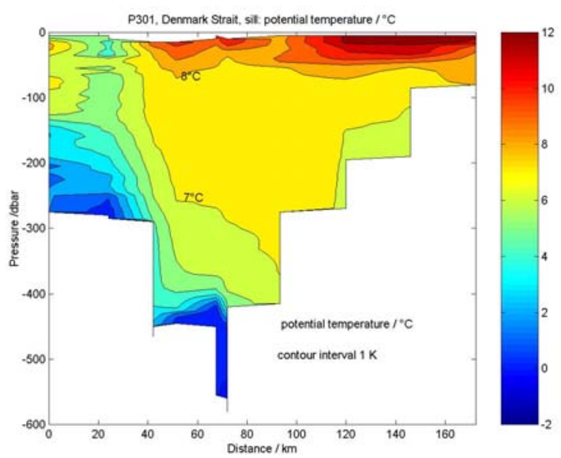
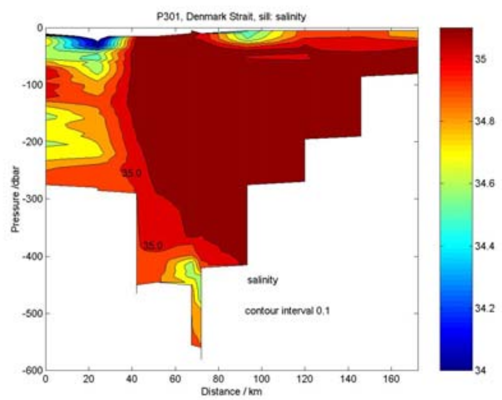


Fig. 4.1: *Potential temperature and salinity relation in southern Denmark Strait (cast 022, red, bottom pressure 1435 dbar) and northern Denmark Strait (cast 017, bottom pressure 740 dbar)*

This general situation is also well depicted in the section taken across the strait's sill (Fig. 4.2). A large pool of warm (> 7°C) and saline (>35.1) Atlantic water occupies the strait's eastern side. Low saline and rather cold water is found on the western side over the shelf while extremely cold (<1°C) and medium saline (34.9) is found as densest overflow water at the sill's bottom pressure (580 dbar).





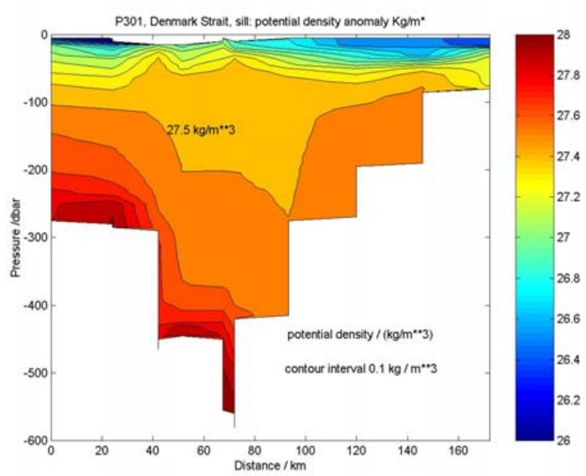
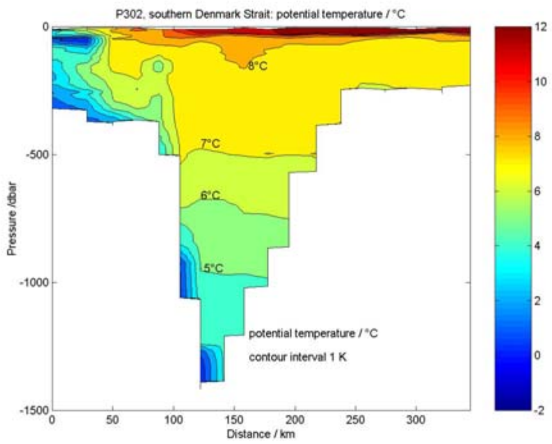
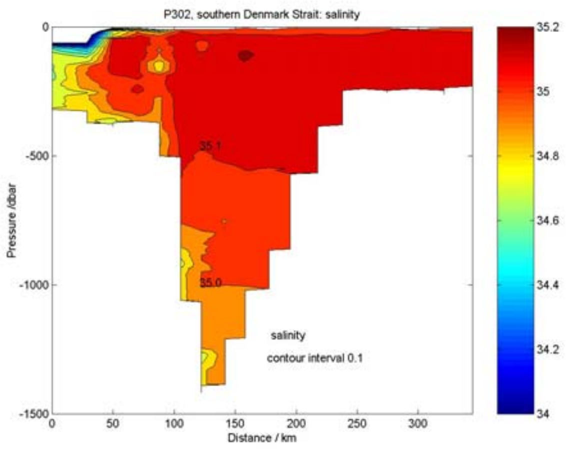


Fig. 4.2*: Denmark Strait sill hydrographic conditions: potential temperature (upper left), salinity (upper right, potential density anomaly (left); west ist left; contour intervals are given*

Further south (Fig. 4.3), the strait becomes deeper (bottom pressure ca 1400 dbar). The cold and low saline sothward flow still leans over western shelf, and the dense overflow has already mixed somewhat with the overlying Atlantic waters which forms the large wram and saline northward flowing pool..





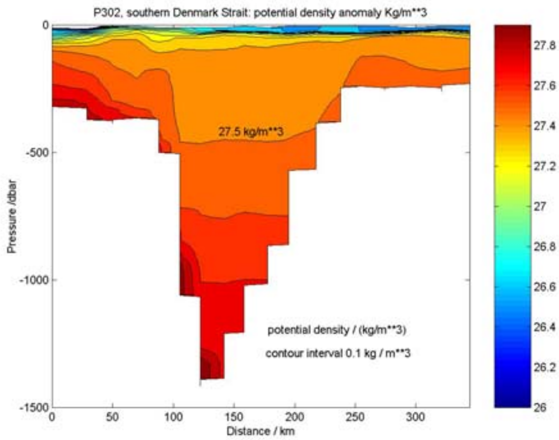


Fig. 4.3:*Southern Denmark Strait hydrographic conditions: potential temperature (upper left), salinity (upper right, potential density anomaly (left); west ist left; contour intervals are given*

5. Scientific equipment: moorings and instruments

5.1 Moorings

5.1.1 Summary

Table 5.1.1: *Summary of moorings recovered and deployed*

Mooring ID	**Latitude Longitude Water depth (sounding at 1500 m/s)**	**Date and cruise of launching**	**Date and cruise of recovery**	**Instruments**	**Remarks**
V432-1 / IM4	59° 46.0'N 021°18.4'W 2842 m	11.08.2002 Poseidon 293/1	12.08.2003 Poseidon 301	SoSo S/N68, 1404 m	
V384-2 / IM1	60°04.4'N 024°43.10'W 2285 m	29.06.1999 Meteor 45/2	13.08.2003 Poseidon 301	SoSo S/N 24, 1381 m	
V422-3 / PIES-05	66°06.45'N 027°10.55'W 623 m	30.08.2002 Poseidon 293/2	15.08.2003 Poseidon 301	PIES S/N 05, 1 m above bottom	
V425-3 / LR	66°07.25'N 027°16.20'W 578 m	30.08.2002 Poseidon 293/2	15.08.2003 Poseidon 301	ADCP S/N 1181, long ranger, 15 m above bottom	
V423-3 / SK	66°11.4'N 027°35.3'W 497 m	30.08.2002 Poseidon 293/2	16.-18.08.2003 Poseidon 301 2 attempts failed	ADCP 925, 1 m above bottom, shielded	given up 2005
V421-2 / PIES-73	66°13.95'N 027°46.29'W 474 m	10.11.2002 A. Frideriksson	16.-18.08.2003 Poseidon 301 2 attempts failed	PIES 73, 1 m above bottom, shielded	given up
V424-2 / TP	66°40.5'N 025°26.5'W 800 m	31.08.2002 Poseidon 292/2	17.08.2003 Poseidon 301	11 MTD, depth range 106 m to 654 m	
V424-1 / TK	66°35.59'N 025°26.45'W 664 m	26.07.2000 Poseidon 262	17.08.2003 Poseidon 301 try to drege	11 thermistors in cable, depth range 54 m to 454 m	given up
V434-02 / CIS2-02/Tele	45°41.05'N 039°40.05'W 2807 m	27.08.2003 Poseidon 302	2004 C. Darwin scheduled	11 MicroCats in upper 1000 m; telemetry	
V433-02 / CIS1-02	59°42.57'N 039°36.25'W 2805 m	28.08.2003 Poseidon 302	2004 C. Darwin scheduled	Mixed layer: CO2, nutrients, HS2 fluorimeter, CTD, 300 kHz ADCP, Deep ocean: sediment trap 2 RCM8 Aanderaa current meters	

Abbreviations:
SoSo: **So**und **So**urce (to track floats)
PIES: **P**resseure sensor and **I**nverted **E**cho **S**ounder

5.1.2 SFB 460, project part A3: RAFOS sound sources

V432/IM4, SoSo S/N 68 recovered
12th August
07:20 release and recover mooring V432/IM4 with sound source (SoSo) no. 68
ARGOS watch dog WD 615 well received during recovery
11:00, all parts safely on board.
11:30, ARGOS watch dog switched off
11:36, clock of SoSo No. 68 measured 1 s ahead to GPS time
11:39, SoSo 68 set to control mode

V384-2/IMI, SoSo S/N 24, recovered
13th August
08:15, # 597, release mooring V384-2/IM1 with SoSo 24
09:00, all mooring parts safely onboard
ARGOS watch dog switched off,
09:29, clock of SoSo 24 measured 9 s ahead of GPS time;
09:34, SoSo 24 set to control mode

5.1.3 SFB 460, project part A1: Denmark Strait overflow array

V422-03/PIES05 recovered
The PIES05 was moored in the overflow's cold core at the western flank 1 m above the bottom in a tri-pod since 2002. It was recovered 15th August 2003 during P301.

V425-03/LR recovered
A long ranging ADCP made by RDI, S/N 1181 was moored 11 m avove the bottom on the western flank of the sillwithin the cold core of the overflow water since 2002. This instrument was safely recoverd on 15th August 2003.

V423-03 / SK recovery failed
This 150 kHz ADCP was moored in 2002 during POSEIDON cruise P293/2 at the bottom at 497 m depth (uncorrected for stratification). The upward looking instrument was shielded to become trawl resistant. For release and control of inclination, two BENTHOS releasers with inclination meters were implemented. If triggered, the acoustic inclination signal should give response *yes / no* if the releaser's inclination is *more / less* 15 ° against vertical.

Immediately after deployment in 2002, both releasers gave less than 15° inclination; this was confirmed during the recovery trial on 16th August during this cruise in 2003. After the release command to both releasers, the distance from the ship to the releasers stayed almost constant. Despite numerous release commands i.e. the instruments did not rise. An acoustic survey to precisely estimate the mooring's location resulted actually in less than 25 m difference to the launch location in 2002. For 8 h POSEIDON tried to dredge the instrument, but without success; note the mooring is constructed '*trawl resistant*'. Also, during the following days until 18th August, both releasers' signals indicated bottom contact. As this type of releasers could not be switched off acoustically, batteries were expected down after 3 days transmitting. The ARGOS watch dog could never been spotted at the surface in the weeks, months and years to follow.

Two years later in 2005, a video of the shielded ADCP could be taken on it's position (Fig. 5.1.1) using a CHEROKEE ROV from POSEIDON. At that time, it showed the shield up-side down contradicting the inclination measurements after deployment in 2002 and during the recovery trial during this cruise in 2003.

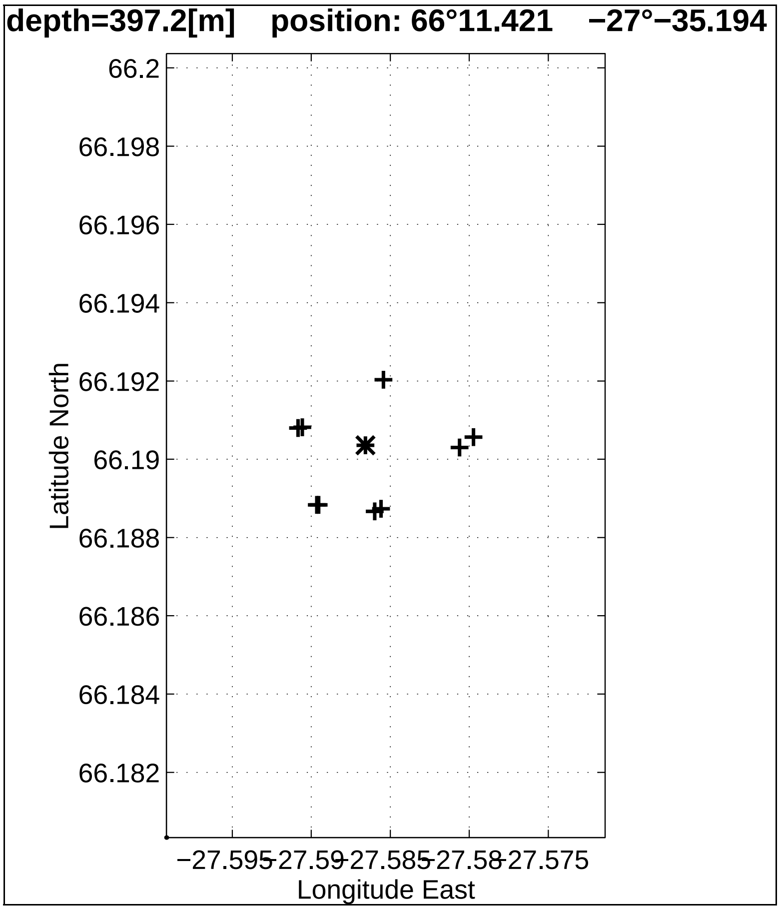


Fig. 5.1.1: *location (centre star) of V423-03/SK from 7 acoustic location positions (crosses) during P301*

V421-2/PIES73 recovery failed:
Moored PIES073 was deployed in a steel shield in November 2002 from the Icelandic fishery research vessel A. FRIDRIKSSON using a newly designed deployment frame. After deployment this frame did not return onboard; obviously, at least some parts stayed down and may have covered the shielded PIES073.

On 26th August the release function of the PIES was activated. The instrument responded correctly at 4 s interval, but did not rise towards the surface. As the release function of this instrument could not be switched off, it continued pinging until the batteries seized. Several controls during the following two days showed the instrument pinging on the bottom. It was given up.

V424-01/TK, dredging failed

Mooring V424-01/TK was to monitor the height of the ‘reservoir’ of the overflow water at the northern entrance of the strait which may control the strength of the overfolow in the strait itself (Käse, 2006). Mooring V424-01/TK was equipped with a tradiditional 400 m thermistor cable made by *Aanderaa Instruments, Norway*, and deployed in 2000 during POSEIDON cruise P262/2. An attempt to recover and replace it in 2001 during METEOR cruise M50/4 failed due to a huge ice-barrier blocking the way to the mooring’s site. Then, in 2002 during POSEIDON cruise 293/2, the releaser did not respond; also, after the release command no mooring parts were sighted on the surface. It maybe speculated that the mooring was damaged by the huge ice-barrier observed 2001. Now, on 17th August 2003, a final trial to dredge (Fig. 5.1.2) the mooring with the ship’s 1500 m long trawl wire at less 800 m depth was performed, unfortunately with no successs. This mooring was given up then.

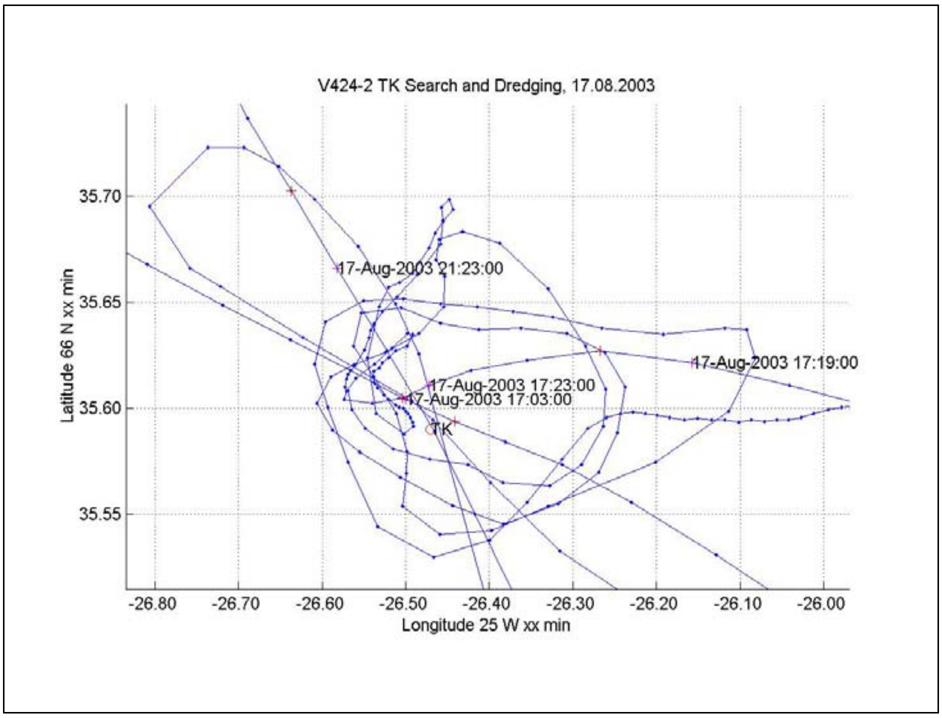


Fig. 5.1.2: mooring V424-01/TK location (red star) with course of dredge trial 17th August 2003

V424-02/TP recovered

Mooring V424-02/TP, had replaced mooring V421-02/TK during POSEIDON cruise P292/2 in 2002, carrying now 11 temperature-pressure recordes (TP) in the depth range 106 m to 654 m. On 25th May 2003, the main buoyancy was spotted at the surface through the ARGOS watch dog. The Icelandic rescue boat from Isafjördur, a small port next to the mooring site, was able to pick up the buoyancy. Now, during this cruise, all instruments were safely recovered; data read-out possible only later in the institute’s laboratory.

5.1.3 CIS: ANIMATE time series station re-implemented

In the Irminger Sea, the ANIMATE muti-sensor time series station CIS was re-implemented (Tab 5.1.1). One mooring (CIS2) carries 11 MicroCats in the upper 1000 m which data are telemetered on-line through a surface buoy and the ARGOS system. The other mooring (CIS1) is sub-surface with a bio-chemical sensor package at nominal 40 m depth (SAMI CO2, NASE-nutrients, HS2 fluorimeter, MicoCat CTD), a 300 kHz up-ward ADCP at 150 m, a MacLean type sediment trap at 2500 m, and 2 RCM8 Aanderaa current meters at 1000 m and 2540 m depth. While launching the mooring, sounding depths based on 1500 m/s average sound speed were corrected using a CTD cast from an earlier cruise (Fig. 5.1.3) to adjust wire lengths in order to meet nominal instrument depths.

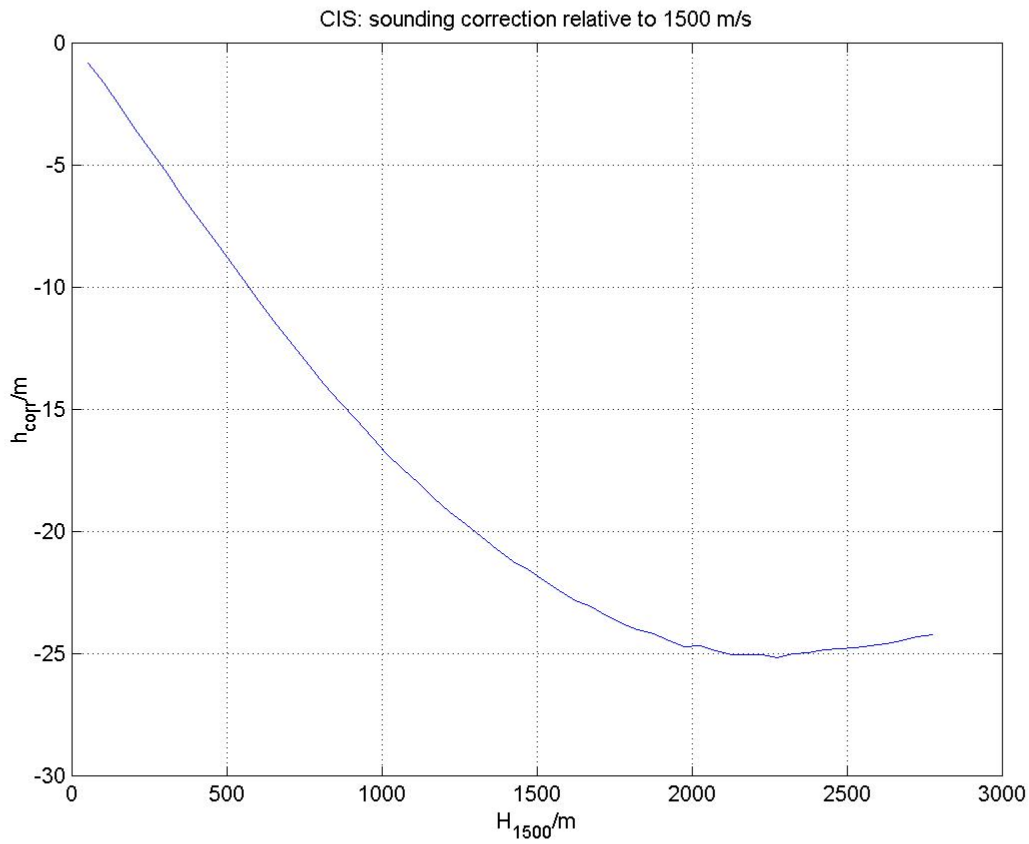


Fig. 5.1.3*: CIS location; corrections to 1500 m/s average sound speed using CTS cast from a previous cruise (P293-2, station 207).*

5.2 CTD and rosette bottle sampling

5.2.1 CTD and bottle salinity

For the CTD-measurements, a SeaBird SBE 911 (IFMK internal code SBE3) was used. Sensor calibration and data processing follow the procedure described by Müller (1998). A pre-cruise calibration for pressure and temperature sensors was performed at IFM Kiel in April 2003. As the cruise was only 6 months later, no post-cruise calibration was applied. Water samples for CTD salinity calibration routinely were taken from near the bottom and near the surface. The samples were analysed on a Guildline AUTOSAL model 8400A using IAPSO standard seawater batch P141 (K15=0.99993, S=34.9973) for instrumental calibration (Fig. 5.2.1.1 and 5.2.1.2) . As the laboratories onboard are not stable in temperature, the estimated accuracy of individual bottle salinities after removing outliers is not better than 0.003 on the ISS78 scale, slightly worse than usual.

No post-cruise laboratory calibration of the pressure and temperature sensors were performrd as the cruise happened just 6 months after the pre-cruise calibration and the sensors' high stability over such a short period of time are well known. Nevertheless, the expected accuracies of these sensors (as known from observed possible drifts in the calibration history) maybe less than usual, 0.003 K in temperature and 3 dbar at full pressure scale, respectively. Salinity calibration as compared to bottle salinities will be not affected by these small scale uncertainties in pressure and temperature accuracies; also, errors due to non-stable laboratory temperature are expected to be removed by averaging the calibration over all stations. Thus, final accuracy in final CTD salinity it is expected to be better 0.003 on the IPSS78-scale.

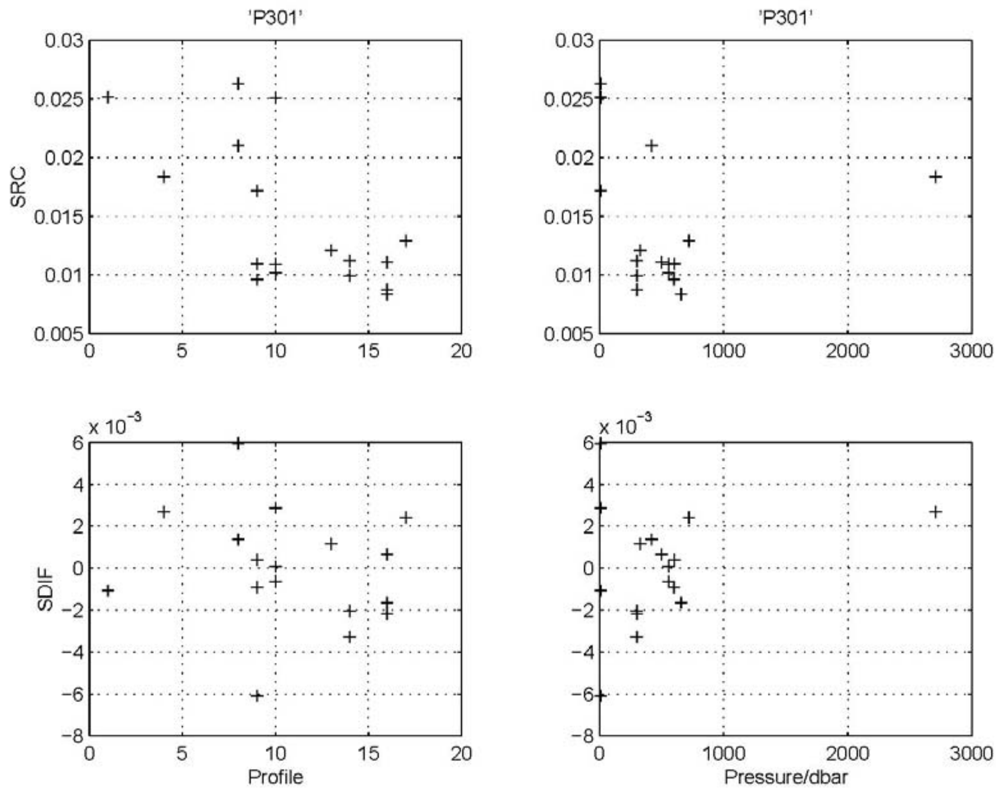


Fig. 5.2.1.1: *P301, in-situ salinity calibration. SRC (upper panel) is pre-calibration correction; SDIF (lower panel) is the final error SDIF between bottle (reference) and calibrated CTD salinity after applying a linear correction to conductivity (Müller, 1998); the overall standard deviation of SDIF is less 0.002 on the ISS78 scale.*

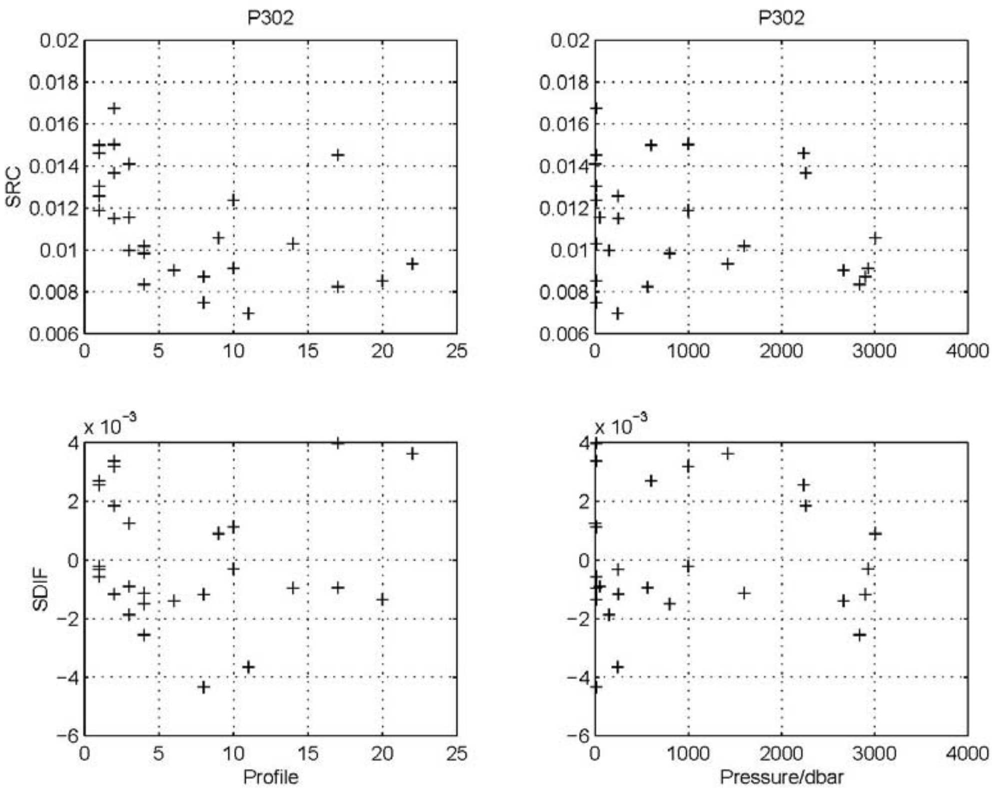


Fig. 5.2.1.2: *P302, as for P301, Fig. 5.1.1*

5.2.2 Sampling for nutrients, CO_2 and chlorophyll *a* at CIS

All samples were taken according to WOCE and JGOFS standards. Those for nutrients and chlorophyll were deep frozen, those for CO_2 stored cool and dark. Samples were transferred either via the Marine Research Institute, Reykjavik, or via the up-coming Poseidon cruises to the responsible groups for sample analysis at ICCM (nutrients, double samples at IFMK), chlorophyll (SOC) and CO_2 (IFMK) during the ANIMATE project.

5.3 Underway measurements

5.3.1 PC-Log

A PC-based programme package, PC-Log, is used to log consecutively the data streams from navigational units, the ship's meteorological sensors, the deep sea 12 kHz echo-sounder and from the thermosalinograph. Standard output format is binary, but ASCII transformation is an option .

While processing the data, spikes were removed in all data by a median criterion or a graphical editor. Bad data were replaced by dummies.

From the date and time columns, new columns were created with year, month, day, hour, minute, second and decimal yearday (with a resolution of 10 s) of 2003. Yearday=0 corresponds to 01-Jan-2003, 00:00:00 UTC. These new columns were right hand added to the original data matrix.

Data from the thermosalinograph needed calibration; see section below for details.

After editing and calibration, the Excel readable file *p3301_p302_underwaydata.csv* (ASCII with decimal points in data, and commas as seperators, -999 as dummies for non-existing or bad data) is the final output for underway maesurements.

Details of sensor check, processing and calibration as follows:

5.3.2 Navigational data

The PC-Log file provides the following navigational information:

- combined GPS-GLONASS date (UTC), time (UTC), and position (WGS84) from the GG24 system (Ashtech) at 10 s sampling rate
- heading of the gyro’s daughter digital output in the dry laboratory; 10 s sampling rate; this output needs offset adjustment to main compass which usually is performed at the beginning of a cruise while still in port without changes in compass readings.

The combined GPS-GLONASS signal showed good data quality which needed no ‘cleaning’ (Fig. 5.3.1).

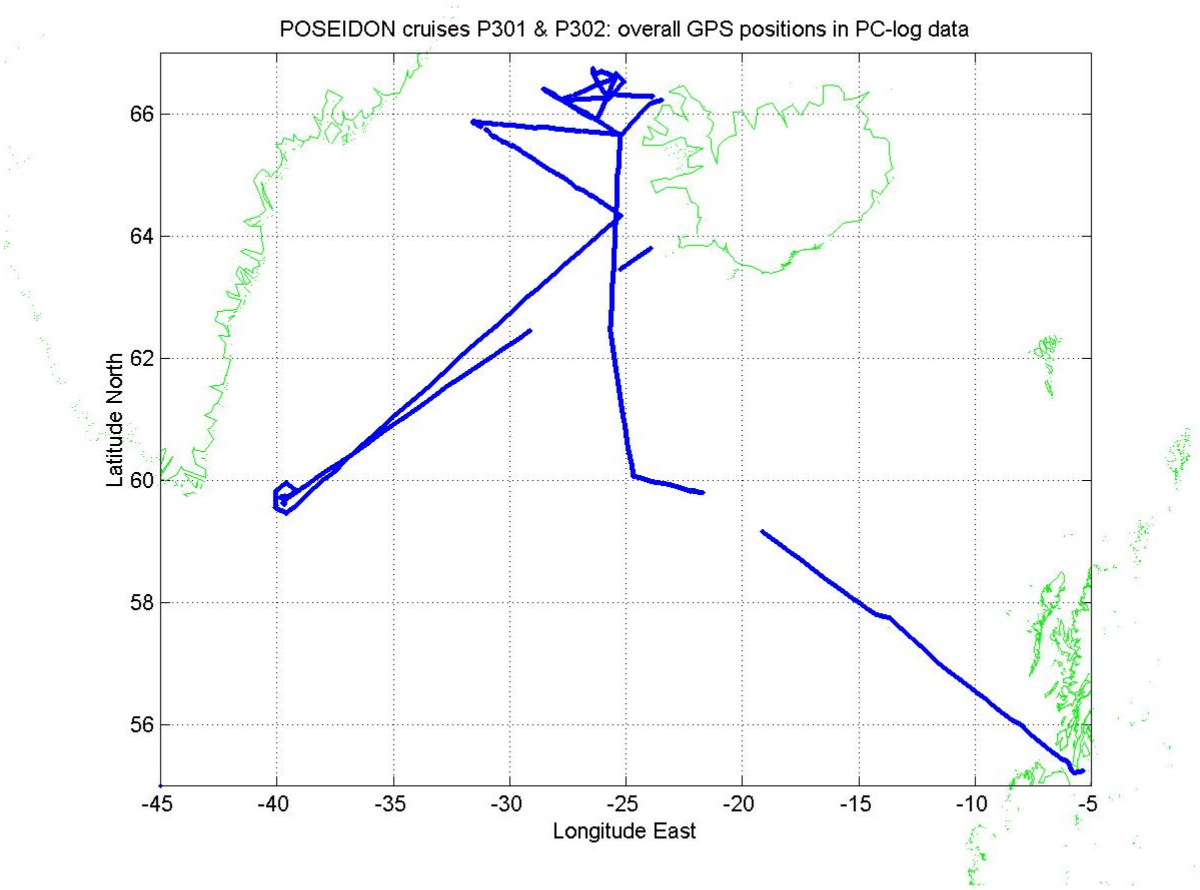


Fig. 5.3.1: *position data from the GG24 ASTECH navigational system as stored in the PC-log data set, 10 s rate.*

To process e.g. ADPC data, it is essential to know with high resolution in time not only accurately the ship's position, but also the ship's course over ground (COG) and the ship's keel's course (heading or STN) relative to true North. STN is measured by the ship's gyro compass, at least over quite long distances at constant course at no currents and wind effects. In case of POSEIDON, the compass' daughter in the dry laboratory provides the STN relative to an electronic *switch-on offset*.

Usually, this *switch-on offset* is corrected for by comparison with the compass' mother reading on the bridge at the very beginning of a cruise, and is less than a degree. To check the offset correction of the gyro's daughter, one can compare COG as calculated at rather large speeds from 'long' distances end point and time differences with the gyro's readings. Over a whole cruise with different courses, winds and currents, the differences should be constant, ideally should read zero. At speeds larger 8 kn, over time intervals of 5 minutes and over almost the whole range of courses, the median correction of the gyro's daughter reading referenced to overall COG estimates is -2.44° with standard deviation 1.77° (*Fig. 5.3.2*). The seven available ensemble medians differ less than a degree from the oveall median correction. Therefore the gyro's daughter digital output was corrected using the overall median correction of –2.44 °.

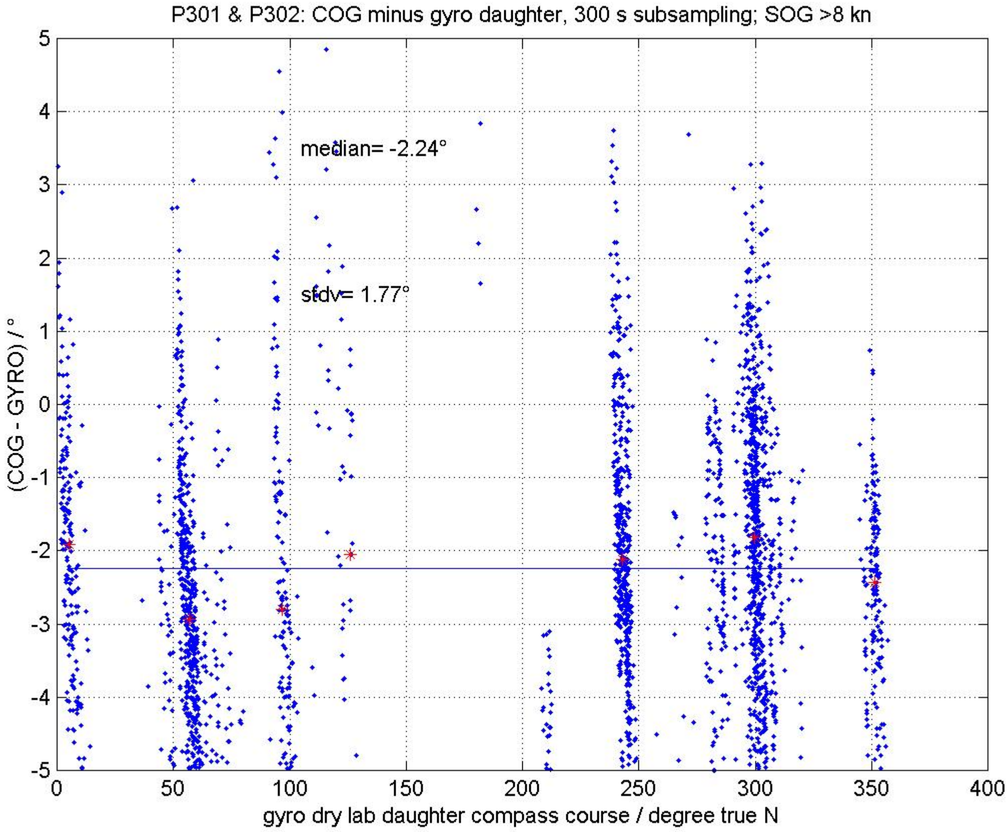


***Fig. 5.3.2**: Comparison of the ship's course over ground (COG) at speeds larger 8 kn with the gyro's daughter digital output. Overall median corrections (straight black line is –2.44°, standard deviations is 1.77°; red stars indicate median correction within 7 ensembles; they all differ less than 1° from the overall median thus indicating stable differences. The gyro's daughter signal therefore was corrected by –2.44°.*

5.3.3 Meteorological data

The meteorological sensors (wind speed and direction, temperature, humidity, surface air pressure, near surface water temperature) are set up and maintained by the German Weather Service (DWD), Germany. Operated as an automated station (ABWSt), data are transferred on a regular scale into the Global Telecommunication System (GTS) for analysis by WMO partners. The digital output is also transferred to the PC-Log system. The sensors were maintained early 2003 before Poseidon sailed from Kiel. All senors sampled at a 15 s rate. Output to PC-log data set was a 600 s subsample. After applying a median spike criterion, no obvious errors remain besides very few in wind direction (Fig. 5.3.3 – 5.3.6).

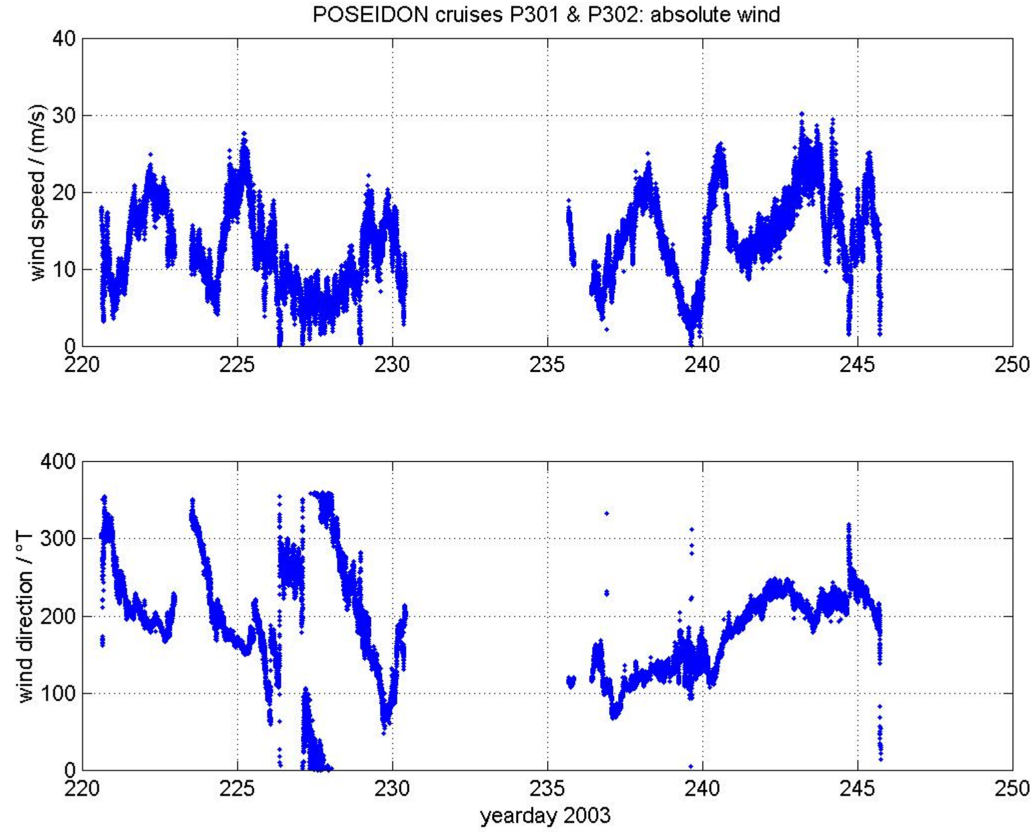


Fig. 5.3.3: *ABWSt absolute wind during the cruise*

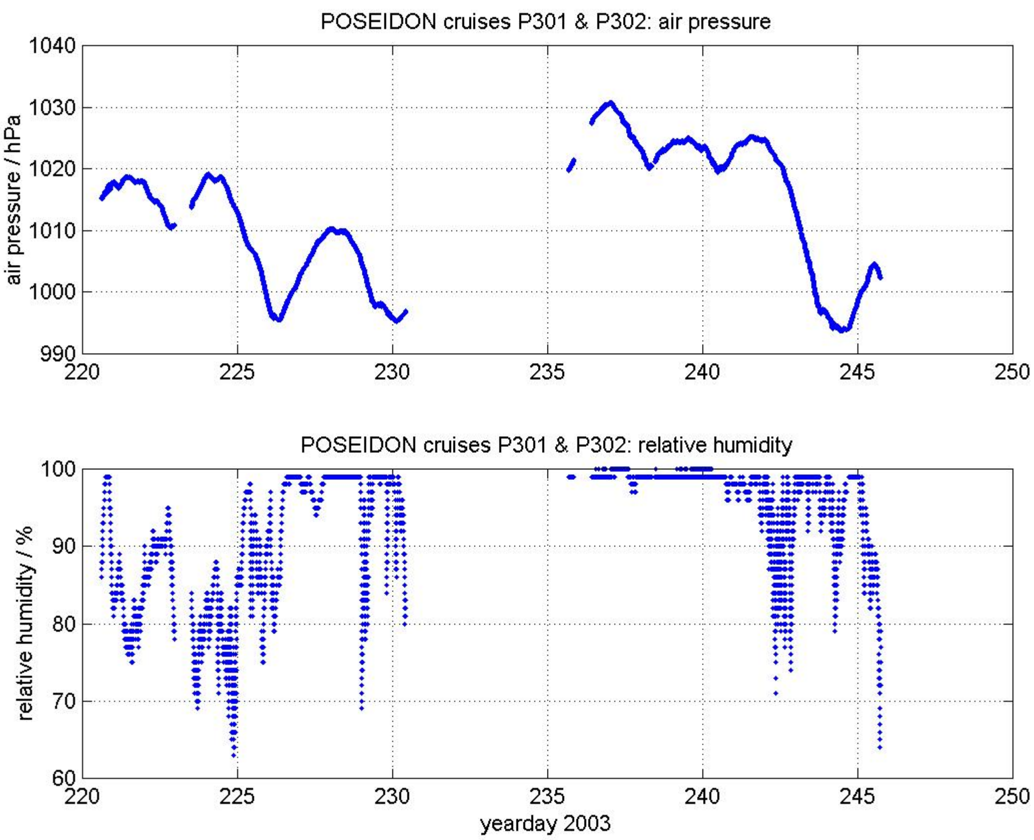


Fig. 5.3.4: *air püressure (upper panel) and relative humidity (lower) during the cruise*

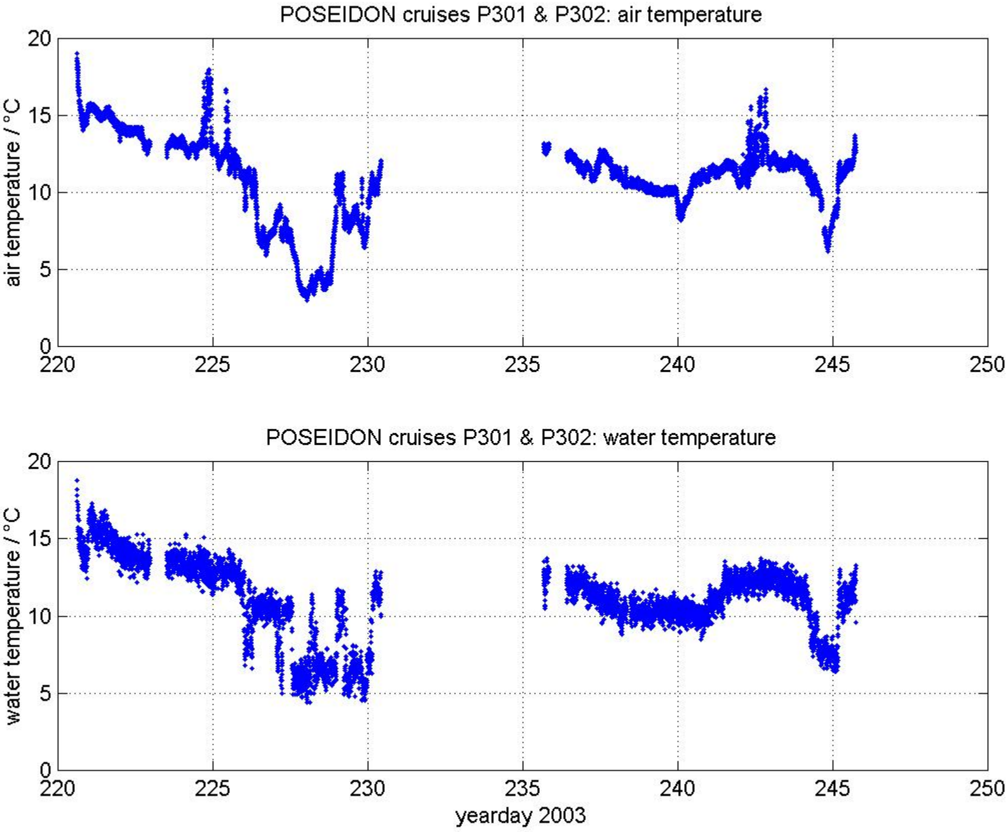


Fig. 5.3.5: *ABWSt air temperature (upper panel) and near-surface water temperature (lower) during the cruise*

5.3.4 Deep sea echo-sounder

A 12 kHz echo-sounder by ELAC provides depth information, both as standard graph on paper and as digital output. The sound velocity converting travel times to sounding depths was 1500 m/s. The signal is corrected for the transducer‘s depth (4.5 m). The digital output was input to the PC-Log system. Erroneous data were removed using a median spike criterion.The final data set shows no obvious errors (Fig. 5.3.6).

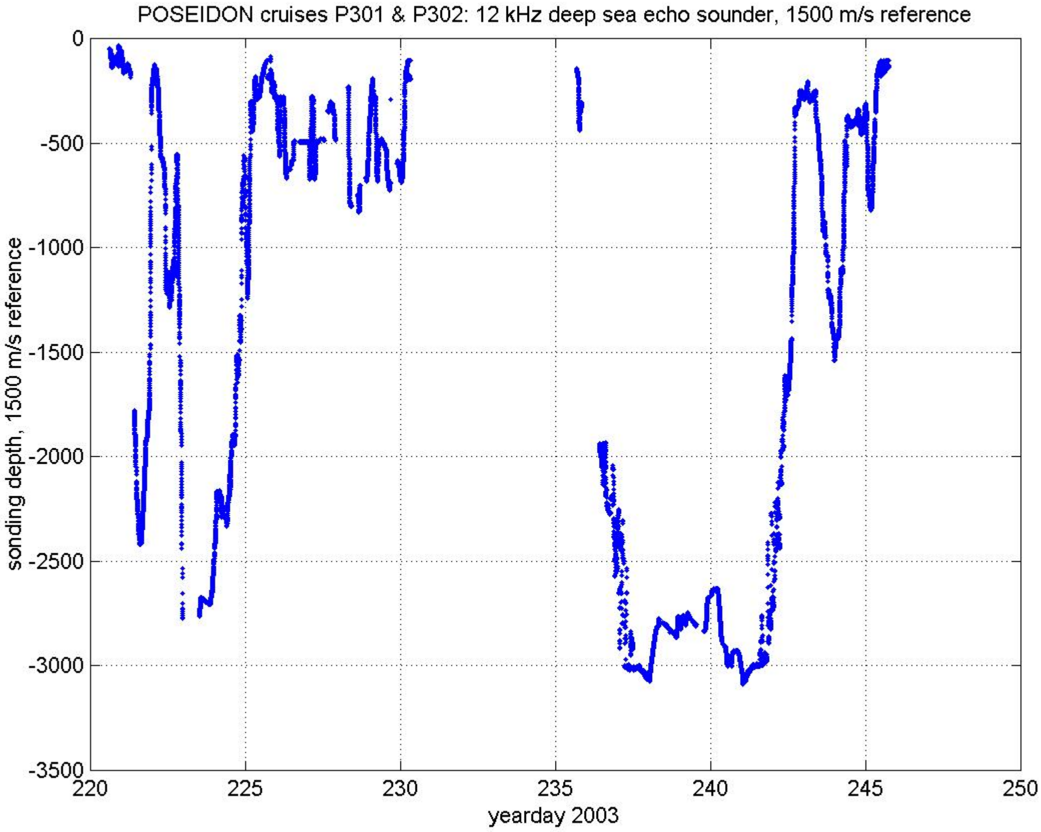


Fig. 5.3.6*: 12 kHz sounding depth reference sound velocity was 1500 m/s; offset of transducer depth below the keel is 4.5 m and is corrected for.*

5.3.5 Thermosalinograph

The digital output of the thermosalinograph raw data is transferred to the PC-Log system where it is converted to physical units for temperature and conductivity; salinity calculated according to 1978 practical salinity scale. Corrections with near surface CTD data (Tab. 5.3.1) while on station, improve the accuracy estimates to 0.02 K and 0.15 mS/cm for temperature and concuctivity, respectively. Corrected salinity was derived from corrected temperaure and corrected conductivity and is estimated to 0.015 psu.

Tab. 5.3.1: *Corrections applied to the thermosalinographs readings from comparisons with near-surface CTD values at less 10 dbar pressure.*

Median correction to meet CTD near-surface data	Overall offset median correction	Standard deviation of correction
Temperature	-0.018 K	0.06
Conductivity	0.011	0.05

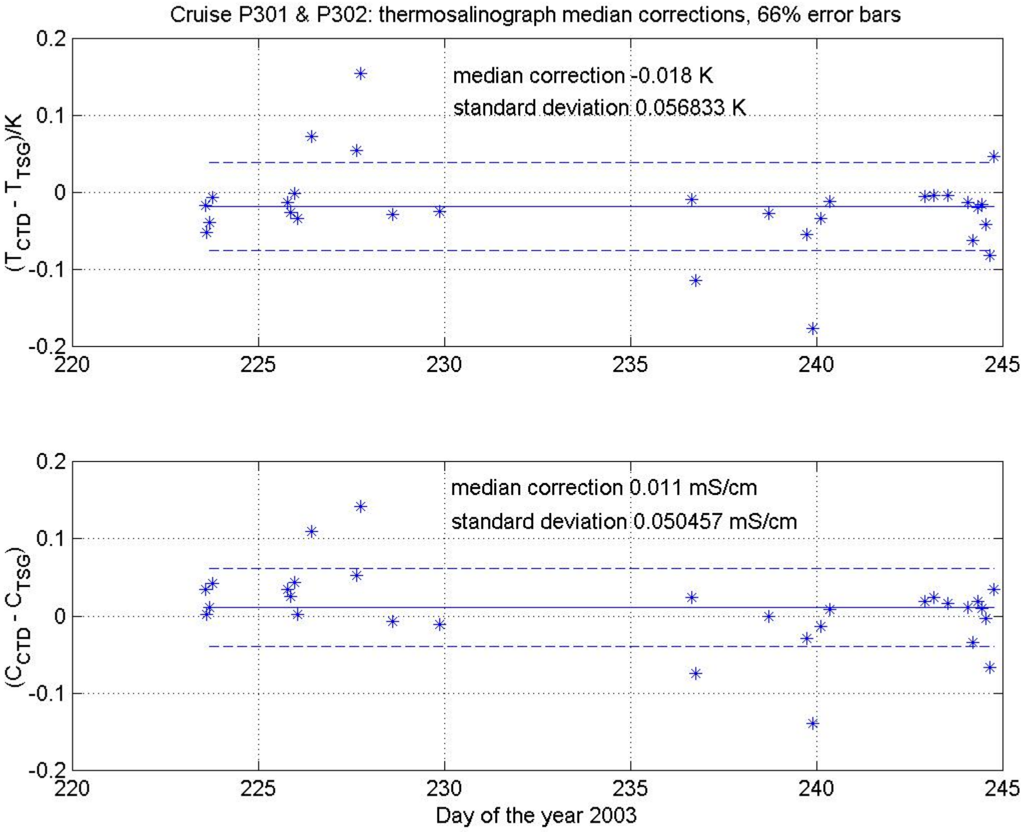


Fig. 5.3.7: *Corrections for thermosalinograph data using near surface data from 8 CTD casts.Offset correction values from median differences and standard deviations (66% confidence) are indicated (see Table 5.4.2).*

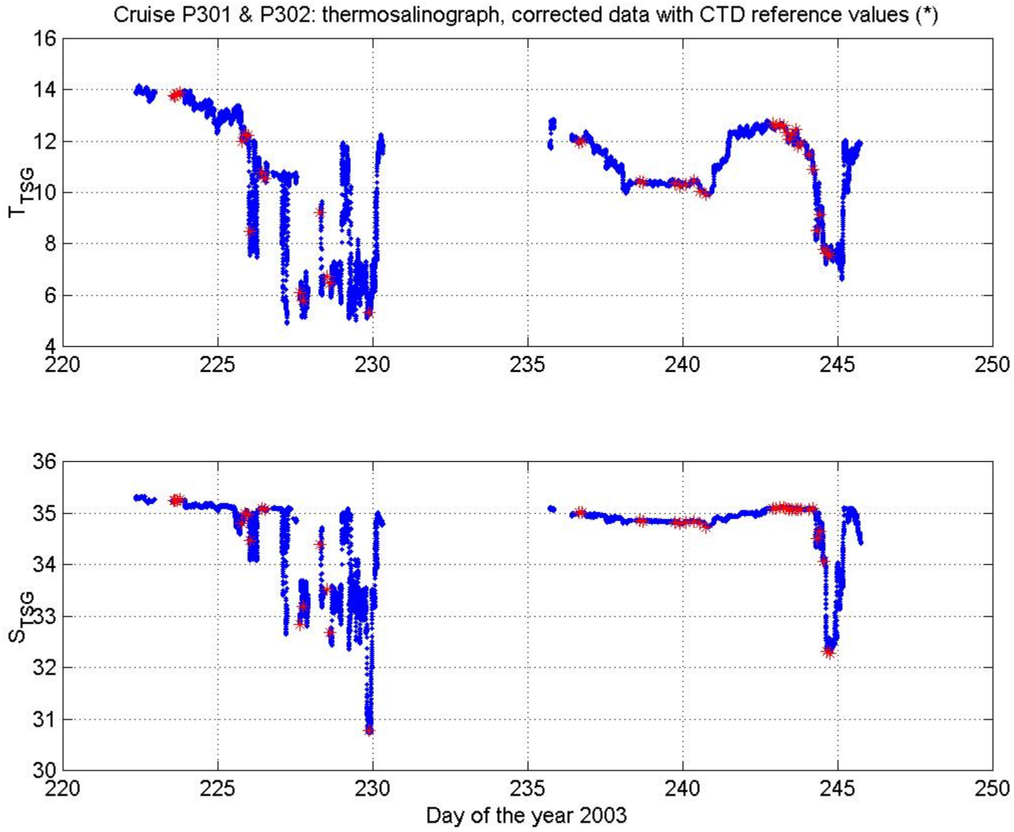


Fig. 5.3.8: *Corrected temperature and salinity from the thermosalinograph; red stars indicate near surface calibration values from CTD casts.*

5.3.6 vmADCP

The vessel mounted ADCP used *en route*, was a standard 150 kHz instrument made by RDI. Data from the ADCP were merged with the navigational data from the GG24 and the 3-dimensional ADU2, using RDI's data acquisition software DAS (RDI, 1990). As the 150 kHz ADCP's range of 300 m is much less than the major depth of currents of major interest during the cruise, these data were not analysed during and after this cruise.

5. Acknowledgements

Captain Michael Schneider and his crew advised and helped during this cruise. All members of the scientific party would like to acknowledge this.

6. References

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Zenk, W., Pinck, A., Becker, S., Tillier, P., (2000). The float park: A new tool for a cost-effective collection of Lagrangian time-series with dual release RAFOS floats. Journal of Atmospheric and Oceanic Technology 17, 1439–1443.

7. P301 and P302 science event log

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POSEIDON cruise 301, 09 AUG 2003 - 21 AUG 2003
Glasgow - Reykjavik
POSEIDON cruise 302, 24 AUG 2003 - 07 SEP 2003
Reykjavik - Reykjavik

Station and sample log

Status: 07-SEP-2003

XXX in remarks: check times and positions !!!!

List of abbreviations:
St    : Station no.
C     : CTD cast no., monotonically increasing during the cruise;
        all casts to near bottom if not indicated else
Wd    : Water Depth
Wl    : length of wire, instrumental depth
It    : Type of instrumentation or mooring or equipment with symbol
          It
VXXX  : 1  mooring
SBE3  : 2  SeaBird 911 CTD; IFMK code SBE3 with a 12x5 l bottle rosette from IFMH
TSG   : 4  Ship's thermasalinograph, 4 m, made by Meerestechnik Elektronik, Kiel,
          Germany
vADCP : 4  vessel mounted RDI ADCP, 150 KHz, 4 m
PC-LOG: 4 on-line log of GPS date, time, position, pitch & roll
          (ASHTEC GPS/GLONASS & ADU2);
           near-surface T, S by TSG;
           meteorological data of the ship's meteorological sensors;

Additional sensors on, and samples taken from CTD/rosette:
N  :   5 nutrient samples
Cl :   6 chlorophyll samples
S  :   7 salinity samples
CO2:   8 Alkalinity profile for CO2 system
Th :   9 Thorium samples
SF6 : 10 SF6 samples
CFC : 11 CFC samples

Year 2003
Date  Time  St    C  Latitude  Longitude     Wd   Wl It   Instrument / Remarks
UTC    UTC
MM DD hh mm          GG MM.MM  GGG MM.MM     m    m
x----------------------------------------------------------------------
08 09 09 00  -9  -9  55 52    -004 -12      -9   -9  4   sail from Glasgow;
                                                         begin of P301
08 09 -9 -9  -9  -9  55 58    -004 -52      -9   -9  4   WP Glasgow
08 09 -9 -9  -9  -9  55 20    -005 -00      -9   -9  4   WP Glasgow
08 09 -9 -9  -9  -9  55 12    -005 -42      -9   -9  4   WP Glasgow
08 09 -9 -9  -9  -9  55 36    -006 -51      -9   -9  4   WP Glasgow
08 10 08 -9  -9  -9 -99 -99   -099 -99      -9   -9  4   start vADCP, 150 Khz
08 11 07 54  -9   0  58 02.52 -015 -08.90   586  303 2   SBE3, test station, 300 m
08 11 08 45  -9  -9 -99 -99   -099 -99      -9   -9  4   start TS-graph
08 11 10 00  -9  -9 -99 -99   -099 -99      -9   -9  4   start PC-LOG
08 12 07 20 595  -9  59 46.0  -021 -18.40  2842   -9 1   mooring V432/IM4 recovered
08 12 13 33 596   1  59 50.51 -022 -08.94  2667  503 2   SBE3, Th, SF6 CFC
08 12 14 35 596   2  59 50.30 -022 -07.83  2673 1499 2   SBE3, Th, SF6 CFC
08 12 16 17 596   3  59 49.83 -022 -06.07  2686 2251 2   SBE3, Th, SF6 CFC
08 12 18 17 596   4  59 49.31 -022 -04.08  2693 2712 2   SBE3, Th, SF6 CFC
08 13 08 15 597  -9  60 04.40 -024 -43.15  2285   -9 1   mooring V384-2/IM1
                                                         recovered
08 14 18 35 598   5  65 39.89 -025 -15.17    80   80 2   SBE3, start cross section
08 14 20 50 599   6  65 46.97 -025 -45.24   210  208 2   SBE3
08 14 23 02 600   7  65 53.92 -026 -15.03   287  274 2   SBE3
08 15 01 08 601   8  66 01.73 -026 -44.92   430  420 2   SBE3, SF6 CFC
08 15 08 07 602  -9  66 06.24 -027 -10.60   618   -9 1   mooring V422-03/PIES05
                                                         recovered
08 15 10 21 602   9  66 06.29 -027 -10.69   620  601 2   SBE3, SF6 CFC
08 15 11 28 603  -9  66 07.32 -027 -16.17   580   -9 1   mooring V425-03/LR
                                                         recovered
08 15 12 19 603  10  66 07.40 -027 -16.10   577  558 2   SBE3, SF6 CFC
08 15 14 00 604  -9  66 11.04 -027 -35.30   497   -9 4   Dredging V423-03/SK
08 16 07 29 605  11  66 11.37 -027 -35.17   490  473 2   SBE3, SF6 CFC
08 16 08 24 605  -9  66 11.39 -027 -35.26   489   -9 4   V423-03/SK
                                                         Control of mooring
```

Year 2003

Date UTC MM DD	Time UTC hh mm	St	C	Latitude GG MM.MM	Longitude GGG MM.MM	Wd m	Wl m	It	Instrument / Remarks
08 16	09 35	606	-9	66 14.05	-027 -46.24	478	-9	4	attempt to recover V421-02/PIES073
08 16	12 19	606	12	66 13.98	-027 -45.84	473	466	2	SBE3
08 16	15 09	607	13	66 19.91	-028 -05.02	342	325	2	SBE3, SF6 CFC
08 16	17 54	608	14	66 25.00	-028 -34.96	317	301	2	SBE3, SF6 CFC
08 16	21 33	609	-9	66 13.95	-027 -46.29	474	-9	4	V421-02/PIES073 Control of mooring
08 16	22 34	610	-9	66 11.40	-027 -35.30	497	-9	4	V423-03/SK Control of mooring
08 17	07 07	611	15	66 32.02	-025 -04.96	234	218	2	SBE3
08 17	09 50	612	-9	66 40.50	-025 -26.05	800	793	1	mooring V424-02/TP recovered
08 17	12 20	613	16	66 36.03	-025 -26.68	681	659	2	SBE3, SF6 CFC
08 17	14 30	614	17	66 40.04	-025 -50.13	747	721	2	SBE3, SF6 CFC
08 17	17 10	615	-9	66 35.60	-025 -26.57	671	-9	4	Dredging V424-01/TK
08 18	08 00	616	-9	66 11.42	-027 -35.35	492	-9	4	V423-03/SK Control of mooring
08 18	09 43	617	-9	66 13.87	-027 -46.40	482	-9	4	V421-02/PIES073 Control of mooring
08 18	16 25	618	-9	66 25.89	-025 -26.42	-9	-9	4	Echosounding profile
08 18	20 45	619	18	66 45.65	-026 -25.46	594	568	2	SBE3, SF6 CFC, stop cross section
08 19	-9 -9	-9	-9	66 20.00	-023 -37.00	-9	-9	4	WP Isafjördur W
08 19	-9 -9	-9	-9	66 11.00	-023 -08.00	-9	-9	4	WP Isafjördur NW
08 19	-9 -9	-9	-9	66 06.00	-023 -04.80	-9	-9	4	WP Isafjördur N
08 19	14 00	-9	-9	66 04.26	-023 -06.90	-9	-9	4	arrival at Isafjördur
08 20	09 00	-9	-9	66 04.26	-023 -06.90	-9	-9	4	sail from Isafjördur
08 20	-9 -9	-9	-9	66 06.00	-023 -04.80	-9	-9	4	WP Isafjördur N
08 20	-9 -9	-9	-9	66 11.00	-023 -08.00	-9	-9	4	WP Isafjördur NW
08 20	-9 -9	-9	-9	66 13.74	-023 -25.17	124	-9	4	WP Sugandafjördur NW
08 20	-9 -9	-9	-9	66 12.00	-023 -37.00	-9	-9	4	WP Sugandafjördur W
08 20	-9 -9	-9	-9	65 30	-024 -48.00	-9	-9	4	WP Latrabjarg
08 20	-9 -9	-9	-9	64 51.00	-024 -12.00	-9	-9	4	WP NW Snaefellsnes
08 20	-9 -9	-9	-9	64 42.00	-024 -00.00	-9	-9	4	WP SW Snaefellsnes
08 21	-9 -9	-9	-9	-99 -99	-099 -99	-9	-9	4	TS-graph off
08 21	-9 -9	-9	-9	-99 -99	-099 -99	-9	-9	4	PC-LOG off
08 21	-9 -9	-9	-9	64 11.40	-022 -00.00	-9	-9	4	Reykjavik NW
08 21	-9 -9	-9	-9	64 09.78	-021 -55.20	-9	-9	4	Reykjavik N
08 21	09 45	-9	-9	64 09.18	-021 -56.16	-9	-9	4	arrival at Reykjavik end of P301
08 24	09 00	-9	-9	64 09.18	-021 -56.16	-9	-9	4	sail from Reykjavik begin of P302
08 24	-9 -9	-9	-9	64 09.78	-021 -55.20	-9	-9	4	Reykjavik N
08 24	-9 -9	-9	-9	64 11.40	-022 -00.00	-9	-9	4	Reykjavik NW
08 24	-9 -9	-9	-9	64 07	-022 -54	-9	-9	4	WP NW Reykjanes
08 24	15 53	-9	-9	63 48.26	-023 -55.35	-9	-9	4	start PC-LOG
08 24	16 00	-9	-9	63 47.82	-023 -57.10	-9	-9	4	start vADCP
08 24	19 35	-9	-9	-99 -99	-099 -99	-9	-9	4	restart PC-LOG
08 25	09 50	-9	-9	62 27.10	-029 -07.30	-9	-9	4	restart vADCP, PC-LOG
08 25	15 30	620	1	62 03.85	-030 -37.80	2241	2238	2	SBE3, calibration MC
08 25	17 50	620	2	62 04.17	-030 -37.20	2261	2262	2	SBE3, calibration MC
08 25	19 37	-9	-9	62 04.17	-030 -36.41	2184	-9	4	restart vADCP
08 26	08 14	-9	-9	61 07.01	-034 -12.69	3003	-9	4	restart vADCP
08 26	10 27	621	-9	60 56.78	-034 -52.28	2859	1000	4	release test
08 27	14 04	622	-9	59 41.05	-039 -40.05	2807	2807	1	mooring V434-02 deployed
08 27	14 25	622	3	59 40.06	-039 -39.70	2800	400	2	SBE3, calibration fluorometer, nutrients, CO2 CFC, MC
08 27	16 47	623	4	59 38.97	-039 -42.57	2826	2755	2	SBE3, nutrients CO2
08 28	12 40	624	-9	59 42.58	-039 -36.45	2805	2805	1	mooring V433-02 deployed
08 28	17 50	625	5	59 50.11	-039 -10.49	2830	2827	2	SBE3, SF6 CFC
08 28	21 42	626	6	59 57.54	-039 -36.54	2670	2667	2	SBE3
08 29	02 38	627	7	59 50.20	-040 -02.03	2632	2620	2	SBE3, SF6 CFC
08 29	08 07	628	8	59 35.23	-040 -02.10	2854	2890	2	SBE3
08 29	13 12	629	9	59 27.76	-039 -36.05	2996	2990	2	SBE3
08 29	18 03	630	10	59 35.12	-039 -10.44	2927	2920	2	SBE3
08 30	12 05	-9	-9	61 01.52	-035 -03.45	2996	-9	4	restart vADCP
08 30	18 14	-9	-9	61 36.73	-033 -16.07	-9	-9	4	restart vADCP
08 31	08 20	-9	-9	63 01.03	-029 -12.54	1840	4	4	restart vADCP
08 31	21 31	631	11	64 20.02	-025 -13.22	254	257	2	SBE3
09 01	00 13	632	12	64 26.93	-025 -37.60	327	282	2	SBE3
09 01	03 20	633	13	64 33.96	-026 -04.91	258	240	2	SBE3
09 01	06 10	634	14	64 40.02	-026 -27.91	275	296	2	SBE3
09 01	08 07	635	15	64 45.00	-026 -49.92	257	255	2	SBE3

Year 2003

Date UTC	Time UTC	St	C	Latitude	Longitude	Wd	Wl	It	Instrument / Remarks
MM DD	hh mm			GG MM.MM	GGG MM.MM	m	m		
09 01	09 52	636	16	64 47.99	-027 -09.86	421	398	2	SBE3
09 01	12 22	637	17	64 54.95	-027 -30.02	580	578	2	SBE3
09 01	15 11	638	18	65 00.91	-027 -55.16	899	871	2	SBE3
09 01	17 11	639	19	65 04.97	-028 -15.15	1026	1029	2	SBE3
09 01	19 30	640	20	65 10.04	-028 -37.02	1216	1200	2	SBE3
09 01	22 05	641	21	65 14.94	-028 -54.98	1378	1402	2	SBE3
09 02	01 15	642	22	65 20.03	-029 -16.46	1433	1433	2	SBE3, SF6 CFC
09 02	04 34	643	23	65 24.99	-029 -34.90	1120	1095	2	SBE3, SF6 CFC
09 02	07 59	644	24	65 29.85	-029 -54.62	490	520	2	SBE3
09 02	10 18	645	25	65 32.90	-030 -16.86	382	382	2	SBE3
09 02	12 57	646	26	65 37.84	-030 -40.08	400	400	2	SBE3, CFC
09 02	15 27	647	27	65 44.89	-031 -02.22	390	389	2	SBE3
09 02	18 03	648	28	65 52.05	-031 -35.40	339	339	2	SBE3
09 03	-9 -9	-9	-9	65 39.89	-025 -15.17	80	80	4	WP Central Section St. 598
09 03	17 32	-9	-9	66 13.74	-023 -25.17	124	-9	4	PC-Log, vADCP off
09 03	-9 -9	-9	-9	66 12.00	-023 -37.00	-9	-9	4	WP Sugandafjördur W
09 03	-9 -9	-9	-9	66 13.74	-023 -25.17	124	-9	4	WP Sugandafjördur NW
09 03	-9 -9	-9	-9	66 11.00	-023 -08.00	-9	-9	4	WP Isafjördur NW
09 03	-9 -9	-9	-9	66 06.00	-023 -04.80	-9	-9	4	WP Isafjördur N
09 03	19 00	-9	-9	66 04.26	-023 -06.90	-9	-9	4	arrival at Isafjördur
09 06	09 00	-9	-9	66 04.26	-023 -06.90	-9	-9	4	sail from Isafjördur
09 06	-9 -9	-9	-9	66 06.00	-023 -04.80	-9	-9	4	WP Isafjördur N
09 06	-9 -9	-9	-9	66 11.00	-023 -08.00	-9	-9	4	WP Isafjördur NW
09 06	-9 -9	-9	-9	66 13.74	-023 -25.17	124	-9	4	WP Sugandafjördur NW
09 06	-9 -9	-9	-9	66 12.00	-023 -37.00	-9	-9	4	WP Sugandafjördur W
09 07	-9 -9	-9	-9	65 30	-024 -48.00	-9	-9	4	WP Latrabjarg
09 07	-9 -9	-9	-9	64 51.00	-024 -12.00	-9	-9	4	WP NW Snaefellsnes
09 07	-9 -9	-9	-9	64 42.00	-024 -00.00	-9	-9	4	WP SW Snaefellsnes
09 07	-9 -9	-9	-9	64 11.40	-022 -00.00	-9	-9	4	Reykjavik NW
09 07	-9 -9	-9	-9	64 09.78	-021 -55.20	-9	-9	4	Reykjavik N
09 07	–9 –9	-9	-9	64 09.18	–021 –56.16	-9	-9	4	Reykjavik, end of P302