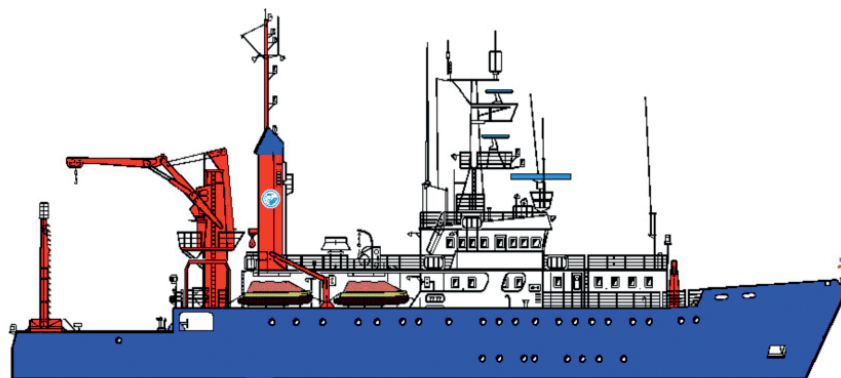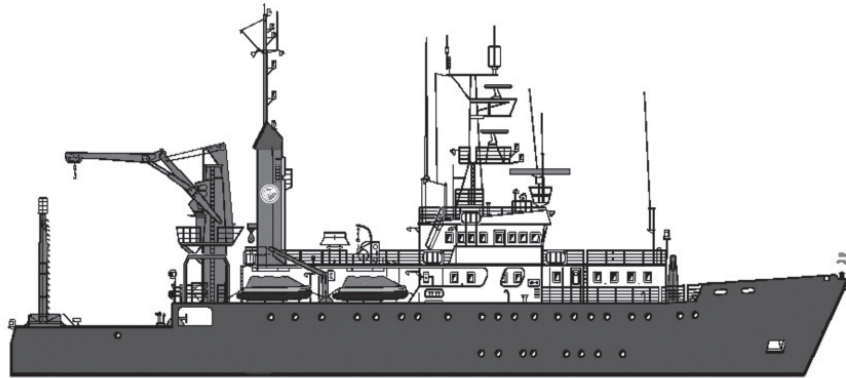GEOMAR REPORT

# GEOMAR
## Helmholtz-Zentrum für Ozeanforschung Kiel

# FS POSEIDON
# Fahrtbericht / Cruise Report
# POS421

08. – 18.11. 2011

Kiel - Las Palmas

Berichte aus dem Helmholtz-Zentrum
für Ozeanforschung Kiel (GEOMAR)

**Nr. 1 (N. Ser.)**

Januar 2012

# GEOMAR

Helmholtz-Zentrum für Ozeanforschung Kiel

## FS POSEIDON
## Fahrtbericht / Cruise Report
## POS421

08. – 18.11. 2011
Kiel - Las Palmas

GEOMAR

Helmholtz-Zentrum für Ozeanforschung Kiel

# <u>Cruise Report</u>

**Compiled by**: Thomas J. Müller

**R/V Poseidon**                                   **Cruise No.: POS421 (transit)**

**Dates of Cruise:** from 08.11.2011 to 18.11.2011

**Port of sailing**: Kiel, Germany

**Port of berthing**: Las Palmas de Gran Canaria, Spain

**Port Calls:**    No

**Areas of Research:** Technical tests underway

**Institute:**      Leibniz-Institut für Meereswissenschaften, IFM-GEOMAR
                   **Now**: GEOMAR | Helmholtz-Zentrum für Ozeanforschung Kiel
                   KIEL, Germany

**Chief Scientist:** Dr. Thomas J. Müller

**Number of Scientists:** 1

**Project:**       Technical tests on underway measurements of near surface salinity

**Contents**

# 1.     Scientific crew

| Name | Given name | Function | Institute |
|------|-----------|----------|-----------|
| Müller | Thomas | Principal scientist | IFM-GEOMAR |

IFM-GEOMAR          Leibniz-Institut für Meereswissenschaften, Kiel

*Principal Scientist and contact:*

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          Düsternbrooker Weg 20
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          tmueller@geomar.de
          www.geomar.de

# 2.     Technical test program

The three objectives of R/V POSEIDON's transit cruise POS421 from Kiel, Germany, to Las Palmas, GC, Spain, were:

- check underway temperature and salinity measurements of the ship's underway data acquisition system and, if data were reasonable, to provide these data as TRACKOB via the *German Hydrographic Office* (BSH) to the international GTS operated by the *World Meteorological Organization* and the *International Oceanographic Commission* (IOC) of the UNESCO through the *Joint Oceanographic Commission* (JCOMM).
- calibrate underway measured salinity in delayed mode by comparison with *in-situ* surface water sampling
- test if salinity as derived from directly measured near surface sound velocity and temperature is suitable as a back-up and long-term stability control for salinity as measured with the more precise standard thermosalinograph

## 3.    Narrative of cruise with technical details

All times are UTC

*08th November, 2011*
03:00, sail from Kiel, pass Kiel Canal towards the North Sea
03:40   switch on surface water pump in Kiel Fjord
03:45   surface sample cast no. 001 is sampled (ca. 1 l surface water), Kiel Fjord
03:50   switch off surface water pump in Kiel Fjord
04:08   on-line data acquisition WERUM DSHIP is on; surface data storage at 60 s rate;
15:45   switch on surface water pump close to light vessel ELBE 1
15:58   surface sample cast no. 002
21:13   surface sample cast no. 003

*09th November*
07:43   surface sample cast no. 004
15:56   surface sample cast no. 005
19:15   first TRACKOB to BSH, transmission mode is one TRACKOB per day
20:58   surface sample cast no.  006

*10th November*
07:35   surface sample cast no. 007
13:52   surface sample cast no. 008
20:11   surface sample cast no. 009

*11th November*
20:53   surface sample cast no. 010

*12th November*
12:59   surface sample cast no. 011

*13th November*
18:08   surface sample cast no. 012

*14th November*
18:20   surface sample cast no. 013

*15th November*
15:26   surface sample cast no. 014
19:25   surface sample cast no. 015

*16th November*
09:25   surface sample cast no. 016
13:52   surface sample cast no. 017
18:47   surface sample cast no. 018

*17th November*
11:25   surface sample cast no. 019
15:23   surface sample cast no. 020
17:19   surface sample cast no. 021

*18th November*
08:29   surface water pump and data recording switched off
10:05 , berth in Las Palmas, GC, Spain
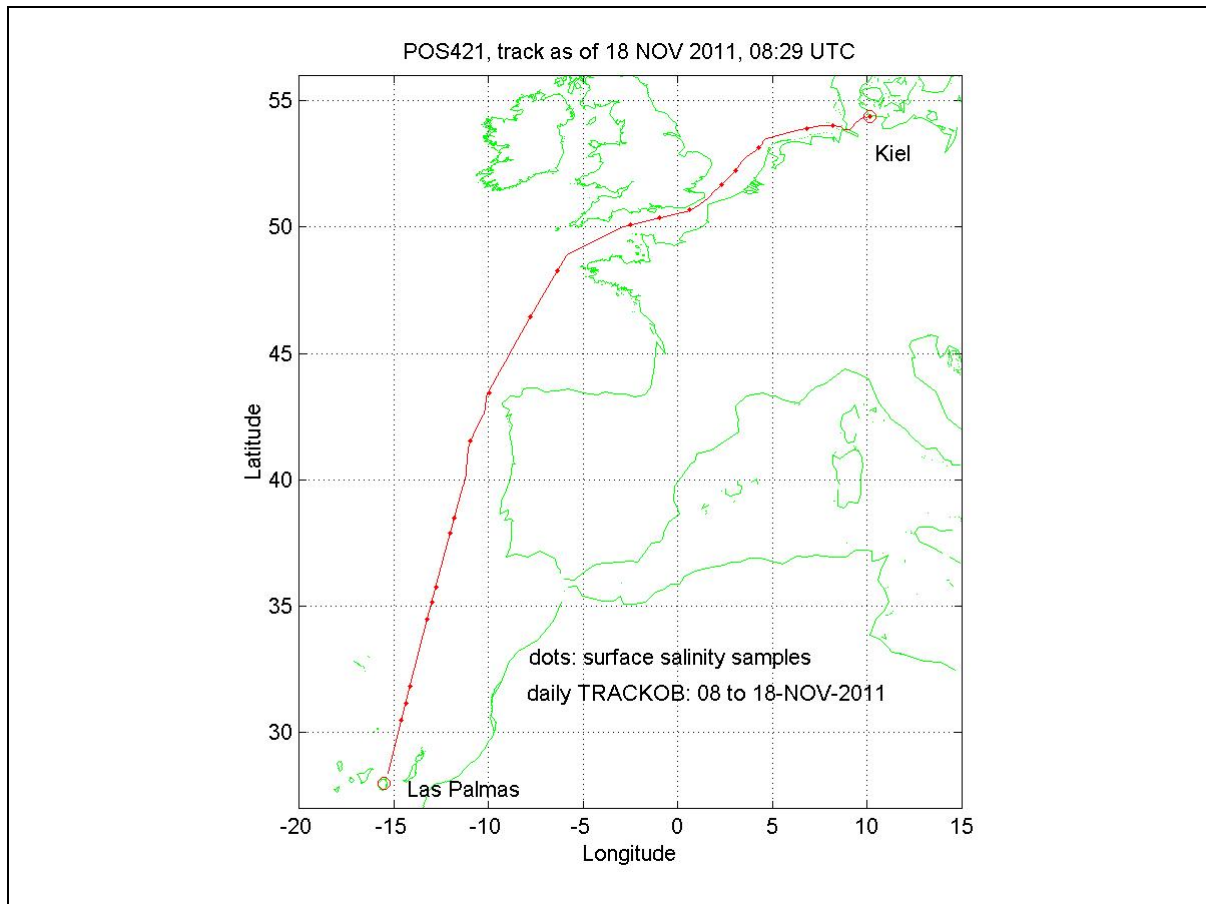
**Fig. 3.1: POSEIDON cruise POS421,** *08th November – 18th November, 2011, Kiel – Las Palmas, transit, cruise track; dots indicate positions of surface water sampling for in-situ calibration of salinity for calibration purposes*

# 4.    Scientific equipment used during the cruise

## 4.1    Moorings

No moorings

## 4.2    Underway measurements

### 4.2.1 DAVIS Ship

On R/V POSEIDON the data acquisition, distribution and storage system DAVIS Ship developed and serviced by WERUM, Lüneburg, Germany. Data distribution at 1 s rate to displays and client servers on the bridge and all laboratories, and to the local network. Data storage at 1 s rate to data bank. The major data sources are

- 2 x GPS, navigation, bridge
- GPS ASHTEC GG24, navigation, science
- GPS ASHTEC ADU5, navigation, science
- automated weather station, provided and serviced by the *German Weather Service* (DWD)
- echo sounder, L3-ELAC 30 kHz, navigation, bridge
- echo sounder, , L3-ELAC12 kHz, deep sea, science
- underway  through sea water flow system, pumped from 4 m depth at the bow
    - thermosalinograph SBE21, including external temperature from an SBE38
    - WETLAB fluorometer
    - Sound velocity and temperature from a Valeport Mini SVT
- Winch data from cable winches W2, W6  and deep sea winch W3,
- Global radiation sensor (if installed)

Complete sets or subsets of data will be made available on request by the institute's data management; contact:

Datenmanagement
GEOMAR | Helmholtz-Zentrum für Ozeanforschung Kiel
Wischhofstrasse 1-3
24148 Kiel, Germany
datamanagement@geomar.de
www.geomar.de

### 4.2.2 Automated Weather Station
The station is operated and serviced on an annual basis by the *German Weather Service* (DWD). Sensors for wind direction and speed, air temperature, humidity, air pressure and water temperature are implemented. Measurements of relative wind are converted to absolute wind using the ship's speed and heading from the station's own GPS. Output of 15 s averages to the log system DAVIS Ship every 60 s, and directly to the *Global Telecommunication System* (GTS) via METOSAT satellite every 2 hours.

### 4.2.3 Echo sounders

*Single beam echo sounders*
A 30 kHz navigational echo sounding system is operated when reasonable. A 12 kHz echo sounder (L3-ELAC HYDROSTAR 4900 with LAZ MP25x01) provides deep sea depth

information as digital output. The sound velocity to convert travel times to sounding depths was 1500 m/s. Sensor depth offset of 4.5 m is applied to correct transducer depth to surface. The digital output was input to the DAVIS Ship system.

*Multi-beam L3-ELAC SEABEAM echo sounding system*

Not used

## 4.2.4 Underway through flow system

The underway through flow system pumps near surface sea water at a nominal flow rate of 100 l/min from 4 m depth at the ship's bow. The flow passes in this order

- a filter to avoid large suspended material
- a SeaBird thermometer, SBE38, mounted close to the inlet to measure near surface temperature
- a SeaBird thermosalinograph, SBE21, with temperature and conductivity sensors to derive practical salinity and sound velocity assuming that salinity is not changed on the way from the inlet to the sensors; the SBE21 data is merged with the SBE38 data
- a fluorometer, Wetlabs EcoFLRT, no wiper
- a sound velocity sensor with additional temperature sensor, Valeport Mini SVT, 50 mm travel distance for the sound pulse.
- a PROMAG P50 digital through flow sensor

The fluorometer and the SVT are housed in a second steel compartment. The through flow data are all output to the DAVIS Ship data acquisition system.

**Note:** data are only good while the pump is switched on.

## 4.2.5 Vessel mounted current profiler (ADCP), RDI 75 kHz Ocean Surveyor

not installed

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# 5.     Preliminary results from tests on surface measurements

### 5.1 Near surface salinity samples

Near surface samples were taken directly from the through flow by opening a valve. After having adjusted to the laboratory temperature, their practical salinities were determined (Müller, 1999) using a Guildline AUTOSAL salinometer. As lab temperature is not sufficient stable, all measurements were made during darkness to avoid the usually higher temperature fluctuations during daylight. Specifications of standards and resulting overall statistics are:

**Salinometer**
Guildline Salinometer , IFM-GEOMAR internal ID:  AS05
Standard Sea Water, batch P151, K15=0.99997 => S=34.9988
Bath temperature: 27 °C
Lab temperature: ~23.5 °C
Drift: < 0.001
Constant drift correction: 0.0002

**Sample salinity statistics**
Number of casts: 21
Casts 1 to 10, and 16: 3 samples each cast
Casts 11 to 15, 17 to 21: 1 sample each cast
Total number of samples: 44
Sample bad from cast no. 12; value set to 'missing value' (-999)
Single sample precision: 0.001 (each sample measured three times after stabilization)
Single cast precision (from triple samples):  0.01 (river outflow influenced North Sea)
                                                      0.005 else
Sample salinity accuracy overall: 0.005

### 5.2 Data from the through flow system

The DAVIS Ship system offers real time ASCII data export of data subsets to any client of the system. According to the objectives of the tests to be made during this transit cruise, export ASCII files EXPORT_iii.TXT were created, where iii denotes the starting day in November, e.g. iii=011 for 11th of November 2011. Each file covers a ca. 24 h time period with a 60 s sampling rate  of
- date and time (UTC)
- position
- near surface (external) temperature, SBE38
- near surface (internal) temperature and conductivity, SBE21, and derived salinity and sound velocity
- near surface sound velocity and (internal) temperature, SVT

After completion, each ASCII file was converted to a corresponding MATLAB file, and all MATLAB files were combined to a single file for control and further processing. Data acquisition started on 08th November, 04:08 UTC in the Kiel Canal after sailing. Good data are available from 08th November, 16:05 UTC after having passed light vessel ELBE1 in the southern North Sea when the pump was switched on and the sensors had adjusted. Data acquisition was interrupted twice for some hours due to a break down of the DAVIS Ship system on 13th and on 14th November.

Due to problems with the conductivity cell, i.e. a sudden jump for unknown reasons in the cell's record, data of the SBE21 after 15th November, 22:55 UTC (YEARDAY 318.955) are

bad and eliminated (Fig. 5.1). The SBE21 together with the SBE38 was switched off on 17th November, 08:57 UTC. From then on, oceanographic data solely from the SVT are available. Data recording stopped shortly before berthing in Las Palmas, 18th November 2011, 08:22 UTC.
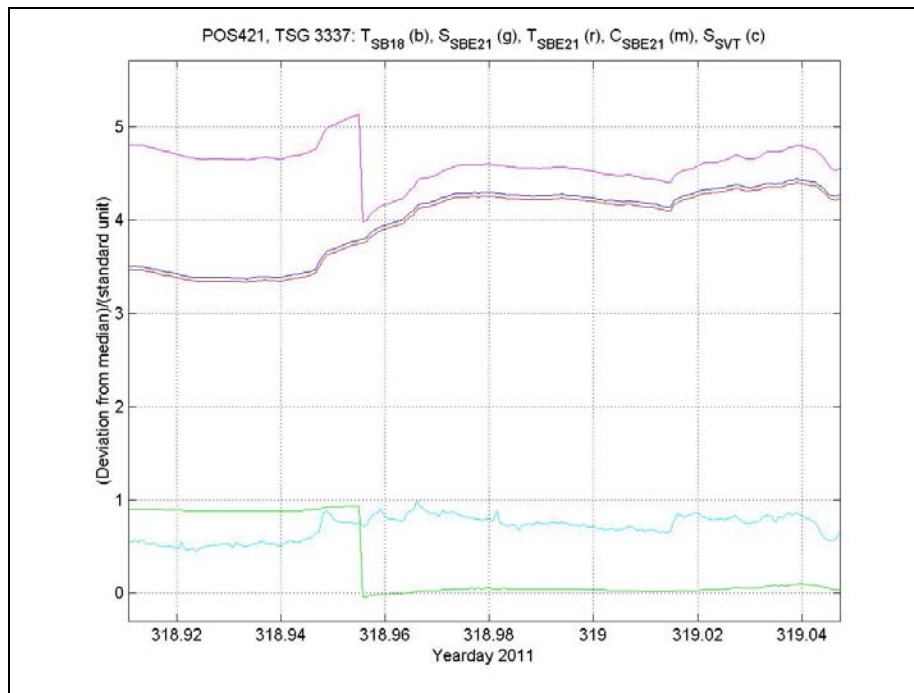


**Fig. 5.1:** *Records of the SBE38 temperature (blue), SBE21 salinity (green), SBE21 temperature (red), SBE21 conductivity (magenta) and SVT salinity (cyan) around the time of the failure of the SBE21 conductivity sensor at YEARDAY 318.955;*

**TRACKOBS**

From the evolving merged data set, daily TRACKOBS of underway temperature and salinity were created. Before the break down of the SBE21, external temperature of the SBE38 and practical salinity from the SBE21 were used. Thereafter, temperature and practical salinity from the SVT as derived from measured sound velocity and temperature for zero pressure by inverting the sound velocity formula recursively. Both, practical salinity and sound velocity formulas as requested by UNESCO (1983).

A low pass median filter and a preliminary offset correction from bottle salinities was applied before extracting hourly values for dissemination by e-mail to the national hydrographic office (BSH) in the TRACKOB format.

**Processed data**

Data recording started a few minutes after the first sampling and while the pump was already switched off again for the passage through the Kiel Canal. Therefore, the record with good data starts on 08th November a few minutes after the second switch on close to the light vessel ELBE1 in the North Sea. For the SBE21, the record stops on 15th November with the break down of the conductivity measurement mentioned above. For the SBE38 it stops on the 17th November with the removal of the SBE21 for repair as both data streams are coupled. For the SVT, recording stops just before entering port of Las Palmas on 18th November.

The SVT sound velocity sensor showed seven short intervals of obviously bad measurements caused probably by suspended material; these were eliminated. Then, three steps of smoothing were applied:

- de-spiking with a median filter over 9 cycles (9 minutes); in particular the SVT sound velocity measurements needed de-spiking
- a Hanning low pass filter over 9 cycles  (9 minutes)
- averaging over 5 cycles (5 minutes)

The smoothed – but not yet calibrated - data set is displayed in Figure 5.2. The three temperature measurements (Fig. 5.2, upper left panel) coincide quite well on this scale. Closer inspection of events, e.g. the minimum on the day 314, shows that there is no delay in the record although a water volume passed the sensors at slightly different times. Also, events have the same amplitude. In conclusion, the flow is sufficient strong to avoid phase shifts and amplitude changes on the chosen time interval (60 s) which could be caused by the different placements of sensors in the pipe system.

Derived and sample (star) salinities (Fig. 5.2, upper right panel) show unexpected large differences. The general increase in salinity from the North Sea to the subtropical Atlantic is obvious in all three curves. Also small events, e.g. the drop on day 317, are resolved with same amplitudes and no delay. However, the offsets of derived salinities from sample salinity are unexpectedly large and of opposite sign, and it looks like the salinity differences between the SBE21 and the SVT increase. Thus, the derived salinities need calibration. Also, the noise level of the SVT derived salinity even of the smoothed data is much higher than that of the standard thermosalinograph, SBE21.
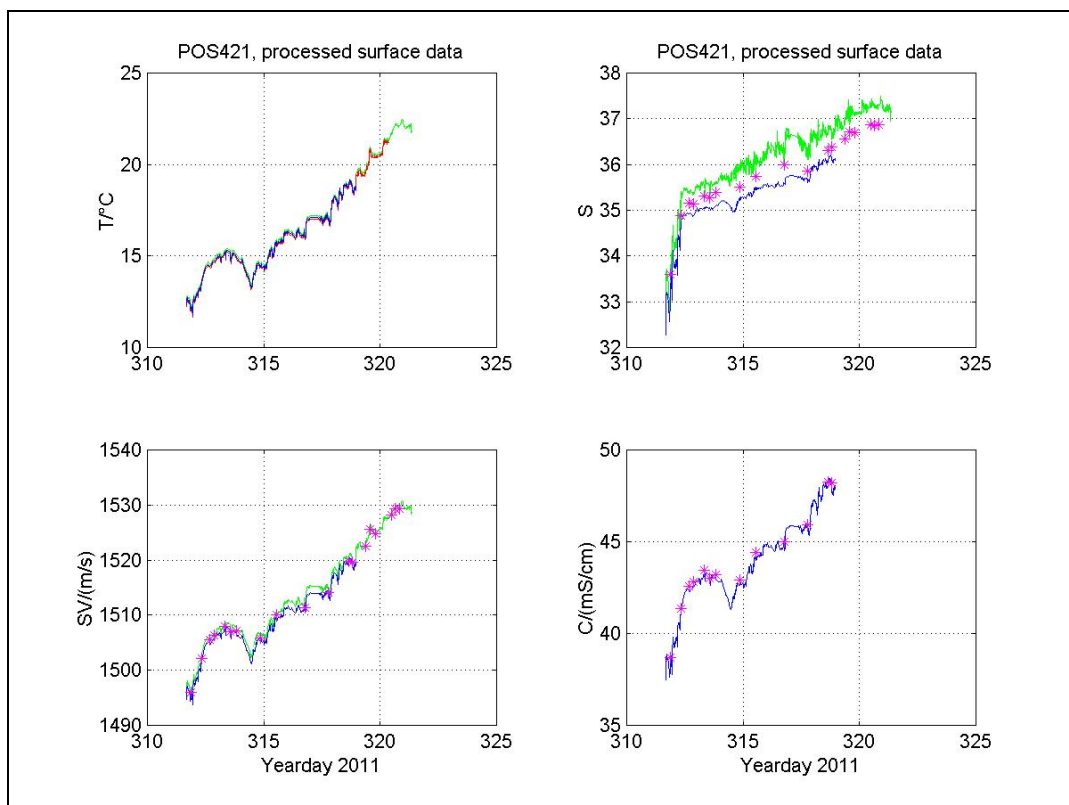


***Fig. 5.2****: Processed near surface data: temperature (upper left), salinity (upper right), sound velocity (lower left) and conductivity (lower right); straight lines for SBE38 (red) outer temperature, SBE21 (blue) temperature, conductivity, and calculated salinity and sound velocity, SVT(green) temperature, sound velocity and calculated salinity; stars for reference bottle salinity, derived reference conductivity (SBE21) and derived reference sound velocity (SVT); measurements from close to the light vessel ELBE1 (North Sea, day 311, 08th November 2011) to Las Palmas (day 321, 18th November 2011).*

Directly measured SVT sound velocity and derived SBE21 sound velocity  (Fig. 5.2, lower left panel) have same amplitudes and no delay in case of events, e.g. that on day 314. Reference sound velocity (stars) is calculated from measured SVT temperatures and sample salinities. In higher resolution, the differences again show the need of calibration of both, the SVT temperature and (eventually) the sound velocity sensor, and SBE21 salinity through SBE21 conductivity (Fig. 5.2, lower right panel).

### *In-situ* calibration

*Method*

To check and calibrate temperature, eventually sound velocity, and salinity measurements the following steps are performed:
- The first assumption usually made is that temperature measurements in underway systems are sufficient accurately (<0.1 K) calibrated, and that its calibration is stable over months up to years. It turned out, however, that the SVT temperature sensor needed linear (slope and offset) correction (see below)
- The second assumption is that salinity does not change while the water flows through the pipe system, and that either reference samples taken from the pipe system or CTD surface measurements represent the smoothed data at the sampling time. As mentioned above, observed variability on the sampling rate scale (60 s) of sea water showed neither delays nor changes of amplitudes at different sensors in the pipe system.
- The formulas for calculating practical salinity from temperature and conductivity, and sound velocity from temperature and salinity, are strongly nonlinear. Therefore by reference conductivity (reference sound velocity) at reference salinity (from bottle or CTD), from measured (calibrated) temperature and (assumed) zero pressure is calculated for direct comparison with measured conductivity and sound velocity, respectively.
- Eventual corrections for measured temperature, conductivity and sound velocity are then applied to smoothed data, and salinity and derived sound velocity are recalculated to create the final data set.

*SBE21*

The manufacturer's calibration used during the cruise was from February 2009, i.e. more than 2 1/2 years old during the cruise. To check the quality of temperature measurements, the temperature measurements from the SBE38 and the SBE21 are compared. Taking the SBE38 as reference, the SBE21 temperature is higher by 0.087 K on average with standard deviation of less 0.001 K. The higher average may be associated with warming of the water on its way through the pipe system and lies within expected values. As also the variance is low, and as correction of the SBE21 temperature sensor would result in higher salinity corrections, an offset correction would be uncertain, and therefore the SBE21 temperature measurements seem reasonable and no correction is applied for this sensor.

From temperature, and bottle (reference) salinity, reference conductivity is derived. Linear correction (Table 5.1) results to order 0.01 mS/cm residuals for conductivity (Fig. 5.3, upper right). Salinity corrections are of order 0.25 and with order 0.01 residuals (Fig. 5.3, lower left). Because of the relative old (1 1/2 years) basic calibration, the high corrections needed is not surprising.
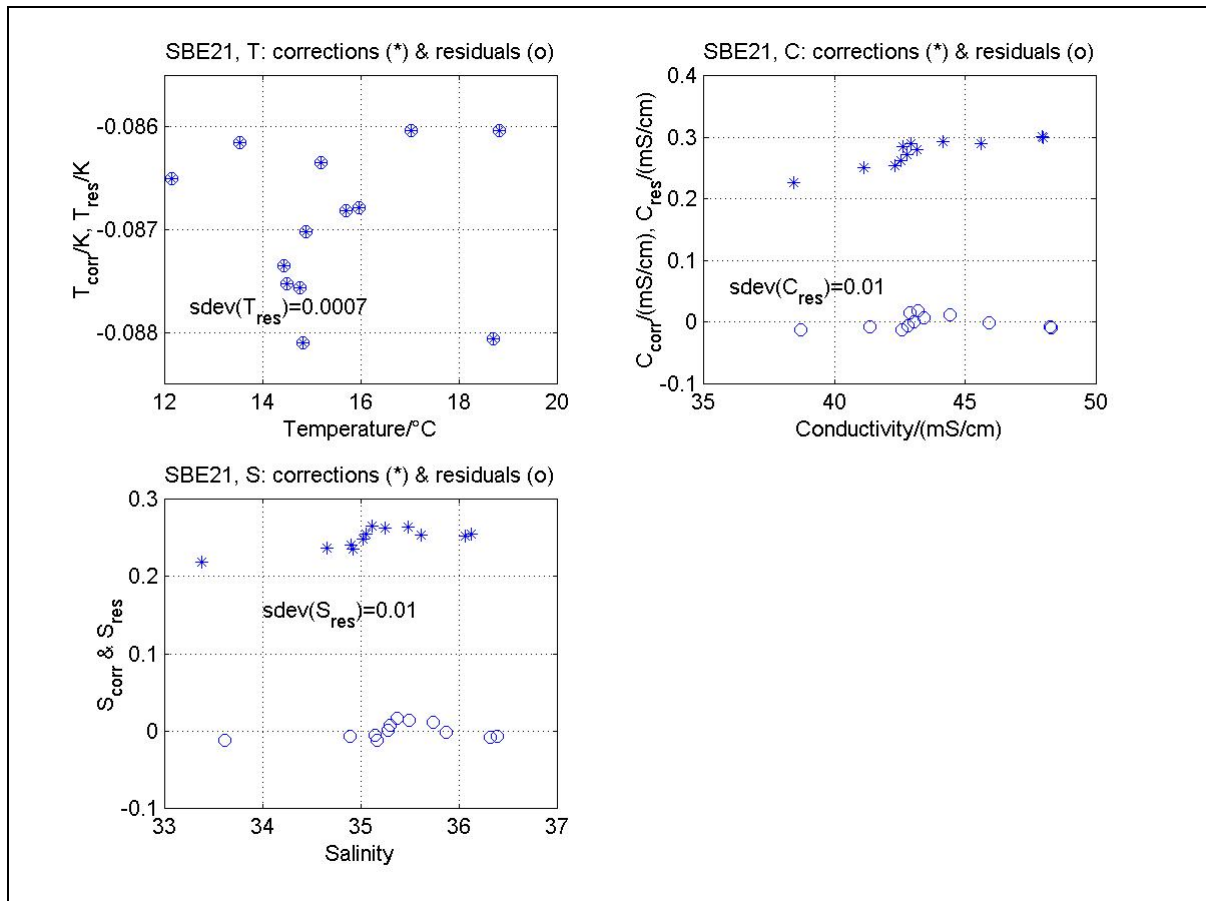
**Fig. 5.3:** *Calibration of the SBE21: temperature difference (upper left) of the SBE38-SBE21 is within expected range with low noise, and SBE21 temperature is not corrected (see text); conductivity corrections and residuals (upper right) and derived salinity corrections and residuals (lower left).*

*SVT*

The SVT temperature as compared with the SBE38 shows a clear slope (Fig. 5.4, upper left panel, stars). As the SBE21 is constantly off from the SBE38 (Fig. 5.3, upper left), any SVT linear temperature correction against either the SBE38 or the SBE21 will have the same slope but different offset. From this, it is concluded that the SVT temperature sensor is the one of the three which needs linear correction including a slope correction. As there are more joint data points with the SBE38, the calculation of the slope correction is done by comparison with the SBE38 (Fig. 5.4, upper left panel, circles). Assuming then that the SVT sound velocity measurement is sufficient accurate and needs no correction, the SVT temperature offset correction is determined as follows. Starting with the offset correction relative to the SBE38 temperature, the offset correction is iterated such that the mean difference between measured SVT sound velocity and reference sound velocity derived from reference salinity and corrected SVT temperature is dropped from initial ca. -0.3 m/s (Fig. 5.4, upper left, stars) to below 0.001 m/s (circles) on average. With that final offset correction for the SVT temperature being determined, derived SVT salinity differences from bottle (reference) salinity drop from non-constant order -0.3 to less than 0.0002 on average with acceptable standard deviation 0.09 (Fig. 5.4, lower left). Note, that the SVT salinity correction depends on SVT temperature correction only, and not on sound velocity correction.
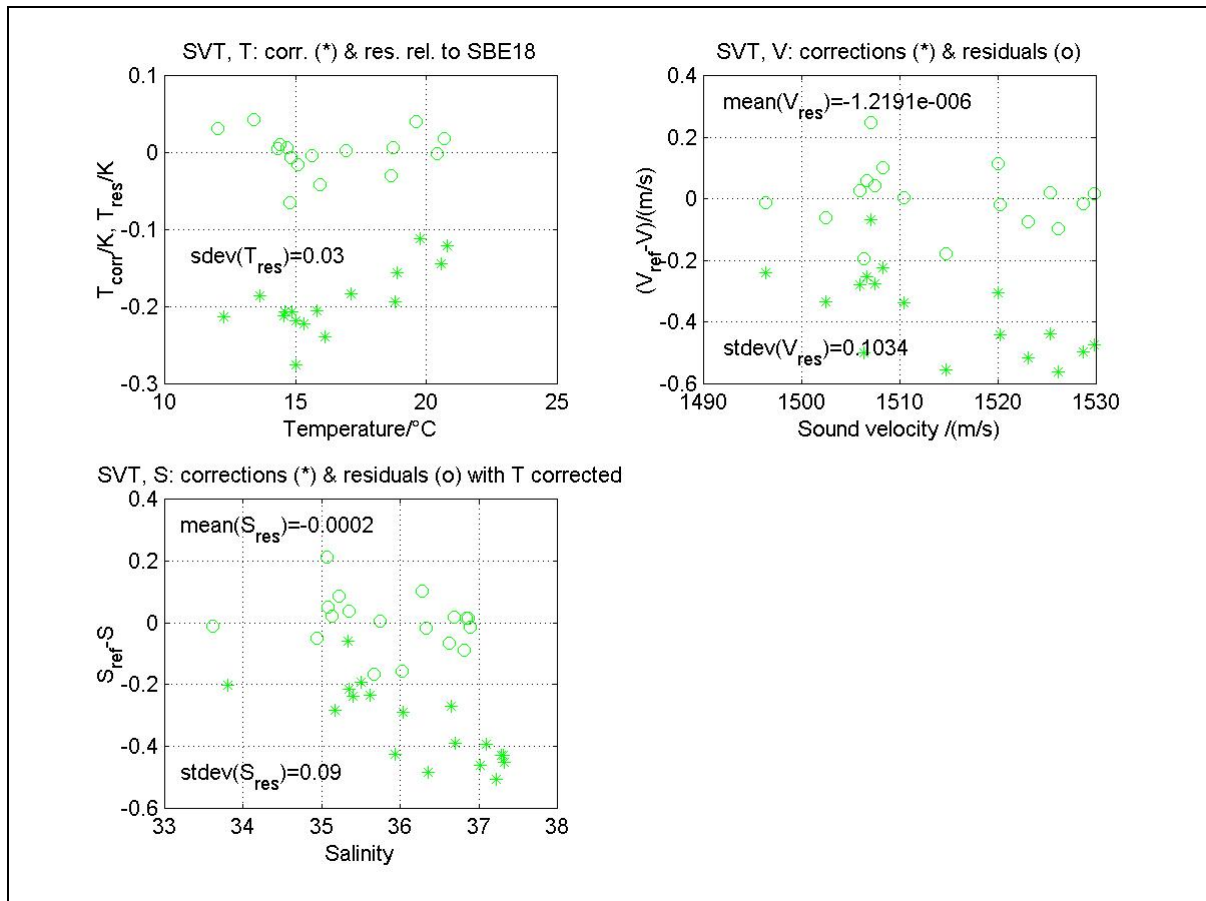
**Fig. 5.4:** Calibration of the SVT: temperature (upper left) corrections and residuals of the SVT against the SBE38 with residual standard deviation of 0.03 K. Sound velocity (upper right) and initial corrections and residuals after iteratively offset adjustment of measured temperature (and therefore VREF) such that the residual average residual becomes less $<10^{-5}$ m/s. Salinity initial corrections and residuals after temperature adjustment with residual mean $2*10^{-4}$ and standard deviation 0.09.

*Processed and calibrated data*

Corrections for SBE21 conductivity and SVT temperature are applied to the 5-minute filtered and averaged record (Table 5.1), and salinity and derived sound velocity recalculated (Fig. 5.5). Although the time series of salinity and sound velocities are closer together after calibration, there are still some obvious differences.

Therefore, in Figure 5.6 time series of differences between salinities and sound velocities are shown. First, the standard deviation of both, the SBE21 and the SVT salinity residuals at reference points is small on average. However, while standard deviation of the SBE21 salinity residuals is as expected (0.01), that of the SVT salinity is an order of one magnitude (0.09) higher (Tab. 5.1).

Second, the mean difference in both, salinity and sound velocity sensors (Fig. 5.6, upper right and lower left) is -0.07 and 0.7 m/s) with standard deviation 0.1 and 0.1 m/s. The means are much higher than expected from the mean differences of the residuals at reference points (Tab. 5.1), but results within the range of required salinity accuracies (0.1) for surface measurements. The variability, however, obviously is not normally distributed around the mean. One may speculate that small particles in the (filtered) flow may have influenced both, conductivity and sound velocity measurements for certain periods of time of the record and thus led to non-normal error distribution.
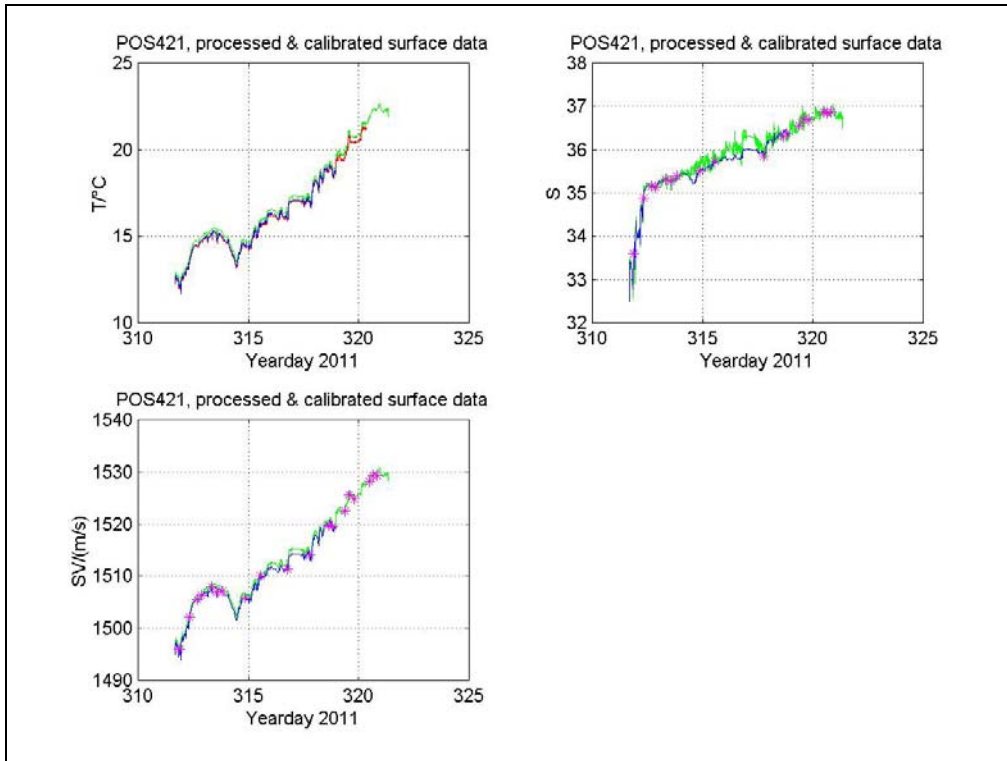
**Fig. 5.5**: *Processed and calibrated surface data; temperature (upper left), salinity (upper right), sound velocity (lower left); SBE38 temperature (red), SBE21 salinity and sound velocity (blue) and SVT temperature sound velocity and salinity (green); stars indicate calibration points*

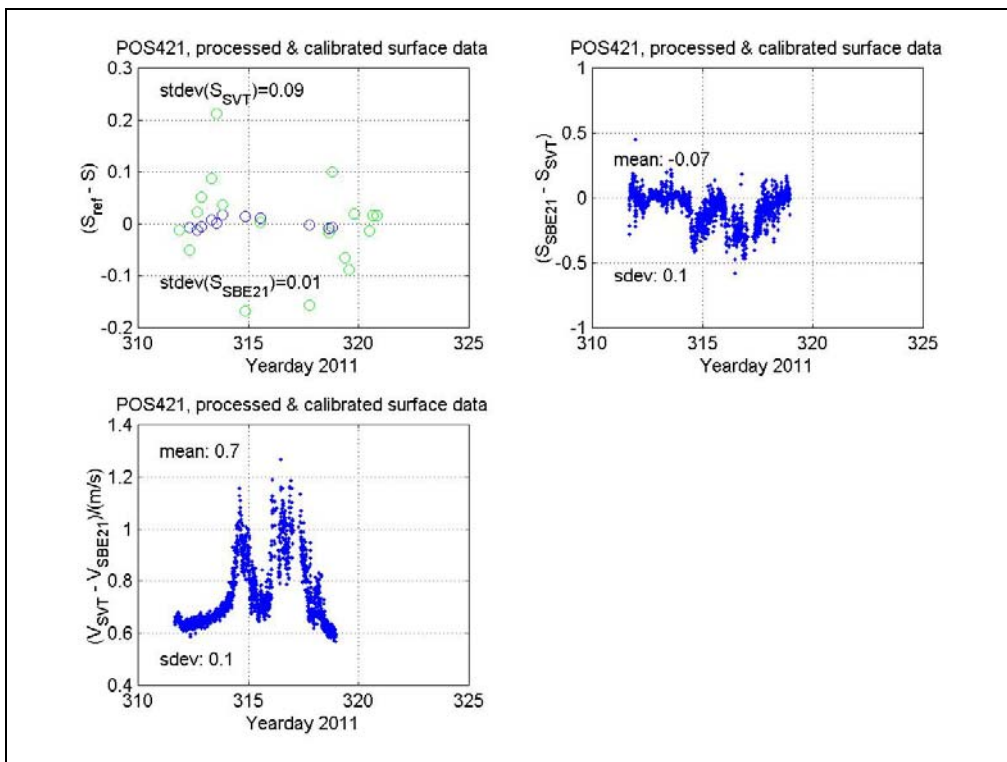

**Fig. 5.6:** *Residuals after calibration of the SBE21 salinity and SVT salinity relative to reference bottle salinity (upper left), salinities of SBE21 to SVT (upper right) and sound velocity measured by the SVT to SBE21 derived (lower left).*

**Table 5.1**: *linear correction coefficients: (corrected VALUE) = a + (1+b)\*VALUE; corrections applied for SBE21 conductivity and SVT temperature measurements; salinity recalculated; mean and standard deviation of the residuals at calibration points is given*

|  |  | Coefficients | | Residuals | | Comment |
|---|---|---|---|---|---|---|
|  |  | Offset a | Slope b | Mean | Standard deviation |  |
| **SBE21** | Temperature | -0.0869 | 0 |  | 0.0007 K | reference to SBE38; not corrected |
|  | Conductivity | -0.0438 | 0.0073 |  | 0.01 mS/cm | Corrected |
|  | Salinity |  |  | $2*10^{-5}$ | 0.01 | derived from temperature and corrected conductivity |
|  |  |  |  |  |  |  |
| **SVT** | Temperature | -0.0856 | 0.0124 | $-2*10^{-16}$ K | 0.03 K | slope from comparison with SBE38; offset iteratively determined from minimizing the difference between reference and measured sound velocity |
|  | Sound velocity |  |  |  |  | as measured; not corrected |
|  | Salinity |  |  | $-2*10^{-4}$ | 0.09 | derived from measured sound velocity and corrected temperature |

### 5.3 Conclusions

Near surface measurements of temperature, salinity and sound velocity with two different systems, a classic thermosalinograph (Seabird SBE21 combined with a SBE38) and a sound velocity and temperature sensor (Valeport Mini SVT), have been compared with respect to data quality, calibration and derived salinity using bottle salinity as reference.

- Measured SVT temperature and sound velocity data are much noisier than those from the SBE21
- Initial SVT temperature differences indicate that the manufacturer's lab calibration of the sensor of the SVT needs linear correction in both, slope and offset after a one-year installation in order to derive reliable salinity
- It has been shown that salinity as derived from directly measured temperature and sound velocity, can be used as a back-up for standard thermosalinograph (SBE21) data provided both sensors involved are calibrated with sufficient accuracy
- The cruise was too short to check long term stability of the SVT sound velocity sensor

It may be recommended, to routinely implement salinity calculation into the DAVIS Ship output of the SVT sensor. Whenever possible, CTD surface measurements should be made available for checking, calibrating and processing the underway measurements in delayed mode.

### 6.    Acknowledgements

## 7.    Appendices

### 7.1  References

Müller, T.J., 1999: Determination of Salinity. *In: Methods of Seawater Analysis, Grasshoff, K., K. Kremling, M. Ehrhardt (editors), Wiley, 600 pp.*

UNESCO, 1983: Algorithms for computation of fundamental properties of seawater, *UNESCO technical papers in marine science,* **44**

## 7.2  R/V POSEIDON, 08.11.2011-18.11.2011, Kiel - Las Palmas

### Cruise -Log

```
Principal Scientist        Dr. T.J. Müller


Acronyms
POSEIDON 421, 08.11.-18.11.2011
Kiel - Las Palmas
Dr. T.J. Mueler, IFM-GEOMAR


Cruise log


Status: 18-NOV-2011


Dates and times: UTC
LAT    : latitude N, DD mm.m
LON    : longitude E, DDD mm.m
CAST   : sampling no
TSGT   : SBE38 near surface water external temperature reading, TT.ttt
TSGS   : SBE21 near surface salinity reading, SS.sss
SVTT   : mini SVT near surface temperature reading, TT.ttt
SVTV   : mini SVT near surface sound velocity reading, VVVV.vv
BTL1-3 : sample bottles no 1 to 3
SREF1-3: salinities from bottles no 1 to 3
  -999 : missing data


YYYY MM DD HH mm Latitude   Longitude CAST   TSGT    TSGS    SVTT     SVTV BTL1 BTL2 BTL3 <SREF1>
2011 11 08 03 15 54 23.22  010  10.42 -999   -999    -999    -999     -999 -999 -999 -999 -999 sail Kiel, Lindenau Werft
2011 11 08 03 45 surface water pump on
2011 11 08 03 50 54 21.89  010  08.78  001 11.969   -999    -999     -999 0399 0913 1442 20.857 sample 2 minutes earlier
                                                                                                than on line data
2011 11 08 03 55 surface water pump off, passing Kiel Canal
2011 11 08 15 43 54 00.90  008  16.20 -999 14.214   -999    -999     -999 -999 -999 -999 -999  surface water pump on,
                                                                                              close to light ship ELBE 1
2011 11 08 15 58 54 01.33  008  12.23  002 11.706 30.572 12.032 1491.91 0365 0094 1059 30.581
2011 11 08 21 13 53 54.53  006  49.31  003 12.034 33.381 12.257 1496.16 0321 1143 1349 33.597
2011 11 09 07 43 53 07.87  004  16.40  004 13.481 34.636 13.628 1502.41 0994 1126 1393 34.886
2011 11 09 15 56 52 13.43  003  02.12  005 14.403 34.918 14.008 1505.89 0404 0433 1290 35.155
2011 11 09 20 58 51 41.70  002  17.50  006 14.665 34.892 14.872 1506.69 0391 1141 1184 35.135
2011 11 10 07 35 50 40.72  000  38.55  007 15.084 35.049 15.305 1508.21 0031 0366 1142 35.307
2011 11 10 13 52 50 22.04 -000 -58.81  008 14.722 35.019 14.964 1506.96 0375 1341 1119 35.274
2011 11 10 20 11 50 05.50 -002 -28.46  009 14.797 35.112 15.010 1507.40 0365 0399 1442 35.380
2011 11 11 20 53 48 16.37 -006 -21.01  010 14.323 35.243 14.542 1506.63 0321 0094 1059 35.504
```

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YYYY MM DD HH mm Latitude    Longitude CAST    TSGT    TSGS    SVTT     SVTV BTL1 BTL2 BTL3 <SREF1>
2011 11 12 12 59 46 26.72 -007 -46.92   011 15.505 35.457 15.770 1510.04 1143 -999 -999 35.747
2011 11 13 04 51 data recording to file export_012.txt broke
2011 11 13 08 30 data recording up again to export_013.txt
2011 11 13 18 18 43 27.36 -009 -57.16   012 18.894 35.739 17.056 1514.99 1349 -999 -999 36.001
2011 11 14 00 07 data recording to file export_013.txt broke
2011 11 08 20 data recording up again to export_014.txt
2011 11 14 18 20 41 31.59 -010 -56.68   013 16.943 35.609 17.117 1514.64 1393 -999 -999 35.864
2011 11 15 15 26 38 29.43 -011 -48.43   014 18.723 36.057 18.878 1520.26 0365 -999 -999 36.312
2011 11 15 19 25 37 52.98 -012 -01.18   015 18.583 36.116 18.788 1519.89 0399 -999 -999 36.377
2011 11 16 09 25 35 46.00 -012 -47.00   016 19.728 35.312 19.830 1523.15 0321 0094 1442 36.556
2011 11 16 13 00 sensor unit of SBE21 S/N 3344 removed, cleaned and mounted again,
                 sensor tries to adapt
2011 11 16 13 52 35 10.38 -012 -59.73   017 20.683 35.176 20.806 1526.14 1059 -999 -999 36.723
2011 11 16 15 15 salinity of SBE21 has not recovered to reasonable data; it rather stays stable
                 on too low level
2011 11 16 18 47 34 29.97 -013 -13.91   018 20.405 35.465 20.549 1525.30 0913 -999 -999 36.700 data jump in
                                                                                               conductivity cell
2011 11 17 09 00 TSG SBE21 S/N 3344 removed; spare S/N 3337 installed; no signal; needs to be set up
2011 11 17 11 25 31 49.00 -014 -09.30   019    -999    -999 21.715 1528.67 0365 -999 -999  36.876
2011 11 17 15 23 31 10.60 -014 -22.28   020    -999    -999 22.180 1529.80 0399 -999 -999  36.851
2011 11 17 19 45 30 28.85 -014 -36.29   021    -999    -999 22.175 1529.89 1442 -999 -999  36.878
2011 11 18 08 29 28 24.33 -015 -17.69 pump and on-line data recording switched off
2011 11 18 09 05 28 00.00 -015 -30.00 Las Palmas
```

# GEOMAR Reports

| **No.** | **Title** |
| --- | --- |
| 1 | FS POSEIDON Fahrtbericht / Cruise Report POS421, 08. – 18.11.2011, Kiel - Las Palmas, 26 pp, DOI: 10.3289/GEOMAR_REP_NS_1_2012 |

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