General Processing Report of Surface T/S Data

RV Polarstern Cruises: PS102, PS103, PS104, PS105

(12.11.2016 - 20.04.2017)

Contents

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1 Introduction

This report describes the processing of raw data acquired by the thermosalinographs on board RV Polarstern during the expeditions PS102, PS103, PS104, PS105 to receive cleaned up and corrected salinity data. Only one thermosalinograph was installed in Polarsterns keel compartment during these expeditions.

2 Workflow

The different steps of processing are visualized in Figure 1. The thermosalinograph (SBE21, Sea-Bird GmbH) is equipped with an internal and an external temperature sensor (SBE38, Sea-Bird GmbH). The external temperature sensor is installed close to the sea water inlet. After the cruise, the measured conductivity and temperature data are extracted in hexadecimal form as 1 sec values from the DAVIS SHIP database (https://dship.awi.de). Data of every cruise are processed separately. First, the hexadecimal sentences are converted to raw data according to the instruction given by the manufacturer. Afterwards the raw data are converted to temperature and conductivity values using the calibration coefficients from the calibration before deployment. However, data can only be finally processed after replacement and renewed calibration because correction values for the sensor drift can only be obtained by the post cruise calibration. The sensor drift is treated as a linear function during deployment and correction factors are calculated and applied for every day of deployment. See chapter 5 for further details on conductivity slope and temperature offset corrections. From the obtained internal temperature and conductivity data the salinity can be calculated according to the instructions from the Practical Salinity Scale PSS-78.
Afterwards 10-min-means are calculated with outliers outside a 2-times standard deviation range being removed from the calculations of the 10-min-means. The 10-min-means are visually inspected and - if necessary - manually despiked. Finally, the positions from the corrected mastertracks are assigned as spot-positions for the corresponding times. A speed filter of 0.5 knots minimum speed is applied to avoid redundant data.
Measurements of salinity with an OPTIMARE Precision Salinomter conducted during the cruises are represented for comparison in the Appendix of this report. Drift corrections using bottle samples were not attempted.
Also see the single detailled processing reports for each cruise.

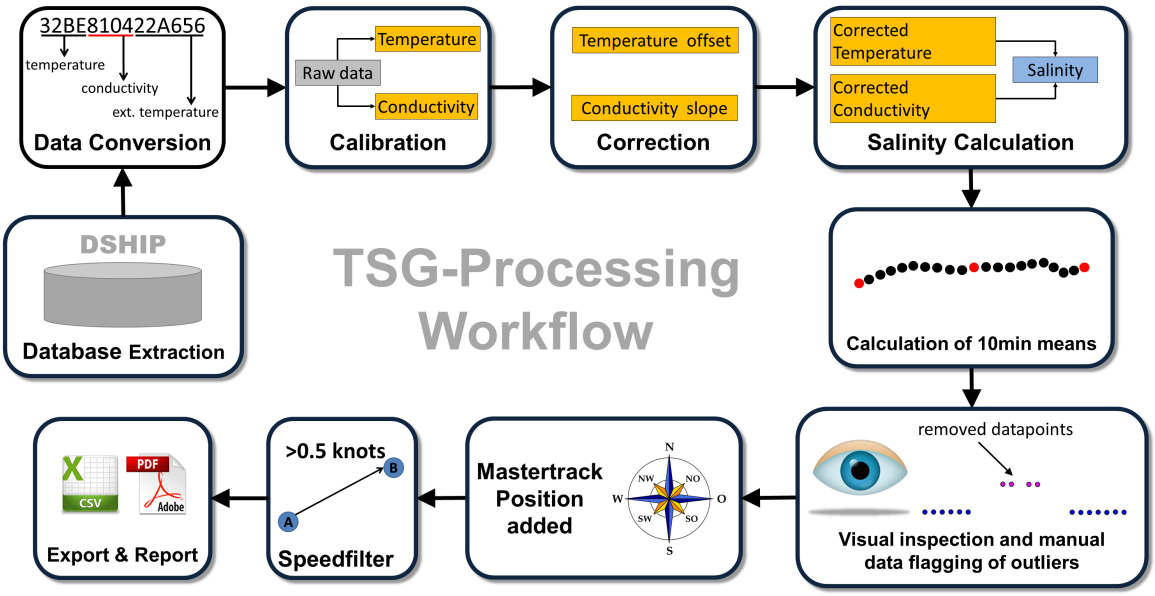

Figure 1: Workflow of Salinity data processing

3 Sensor Details

	TSG Keel
Serial number	SBE21-3191
Installation	2016-11-19
Deinstallation	2017-10-11
Days installed	326
External temperature sensor	SBE38-110
Calibration before installation	2015-04-15
Calibration after installation	2017-11-15
Temperature offset	-0.00073
Conductivity slope	0.9999939

4 Campaign Details

Data of following cruises were processed with the above mentioned sensors and calibration data. (Data extracted from **https://www.pangaea.de/expedition**)

Campaign	Start	Stop	From	To	Days
PS102	2016-11-12	2016-12-11	Bremerhaven	Cape Town	29
PS103	2016-12-16	2017-02-02	Cape Town	Punta Arenas	48
PS104	2017-02-05	2017-03-18	Punta Arenas	Punta Arenas	41
PS105	2017-03-21	2017-04-20	Punta Arenas	Bremerhaven	30

Following table shows the data details of the cruises considered in this report. The number of TSG messages is the number of data downloaded from DSHIP for the individual cruises. The number of result messages is the number of data remaining after calculation of 10min means, manual flagging and speed flagging.

Campaign	first message	last message	No. of messages	Result messages
PS102	2016-11-19T15:20:57	2016-12-11T06:11:56	449124	2831
PS103	2016-12-14T11:08:12	2017-01-30T18:11:33	994225	4475
PS104	2017-02-06T18:26:23	2017-03-16T12:05:30	709004	3081
PS105	2017-03-22T18:04:12	2017-04-17T15:52:55	537288	3581

5 Processing results

Correction for conductivity and temperature drift

Correction for conductivity and temperature drift of the sensor was accomplished following the instructions by SEA-BIRD Application Note 31 (Revision June 2016). Conductivity slope and temperature offset values were calculated for each day of deployment of the sensor using following equations.

Correction of conductivity data: islope = 1.0 + (b / n) [(1 / postslope) - 1.0]
b = number of days between begin of deployment and day of measurement
n = number of days between pre- and post-cruise calibrations
postslope = slope from post-cruise calibration sheet
corrected conductivity = islope * computed conductivity

Correction of temperature data: offset = b * (residual / n)
b = number of days between begin of deployment and day of measurement
n = number of days between pre- and post-cruise calibrations
residual = residual from post-cruise calibration sheet
corrected temperature = offset + computed temperature

Data for the correction values are given in the following table. The deployed days columns indicate the number of the first and the last day of each cruise within the deployment interval of the sensor (326 days). The start and stop values in the columns conductivity slope and temperature offset show the correction values for the first and last day of each cruise.

TSG Keel	deployed days		Conductivity slope		Temperature offset	
Cruise	first	last	start	stop	start	stop
PS102	4	26	1.00000007	1.00000045	-0.00000832	-0.00005407
PS103	29	76	1.00000050	1.00000132	-0.00006031	-0.00015806
PS104	83	121	1.00000144	1.00000210	-0.00017262	-0.00025165
PS105	127	153	1.00000221	1.00000266	-0.00026413	-0.00031821

Measured data

Data from the time range considered are show in Figure 2. Salinometer measurements of bottle samples are depicted in the plots of the salinity of TSG keel (also see Appendix: Measurements of salinity with the OPTIMARE salinometer). Also given are plots of the standard deviations of the 10min means for every parameter (Figure 3).

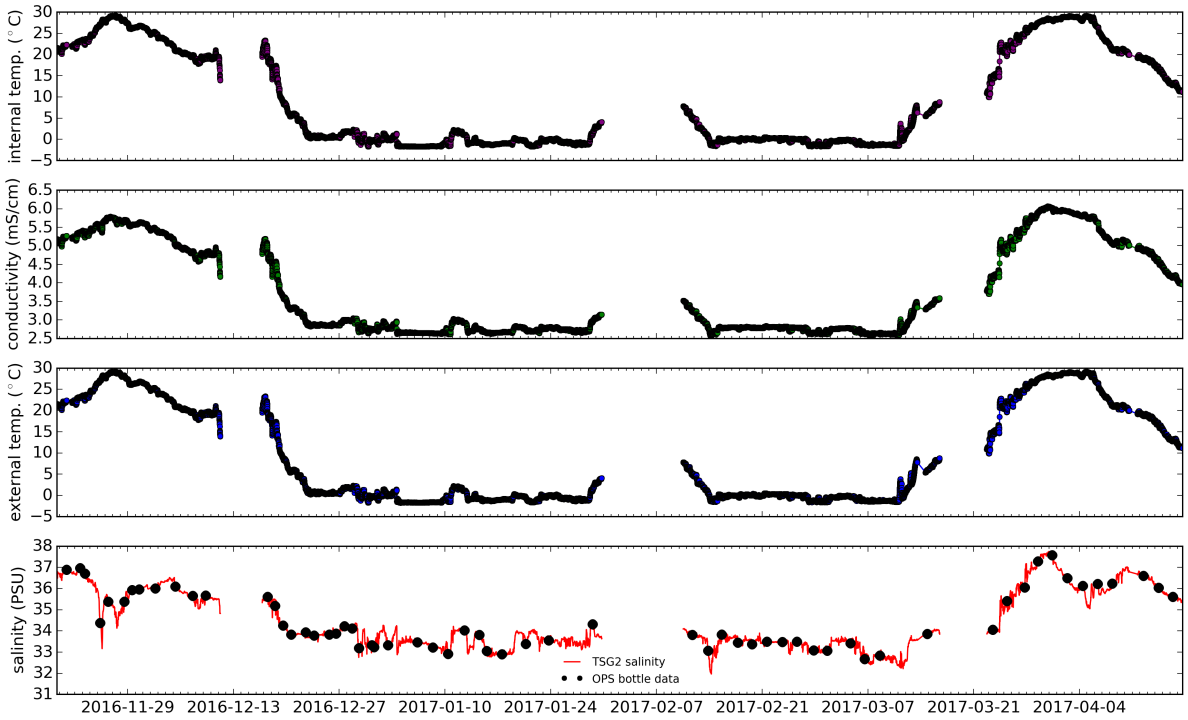

Figure 2: 10min means of data from TSG Keel

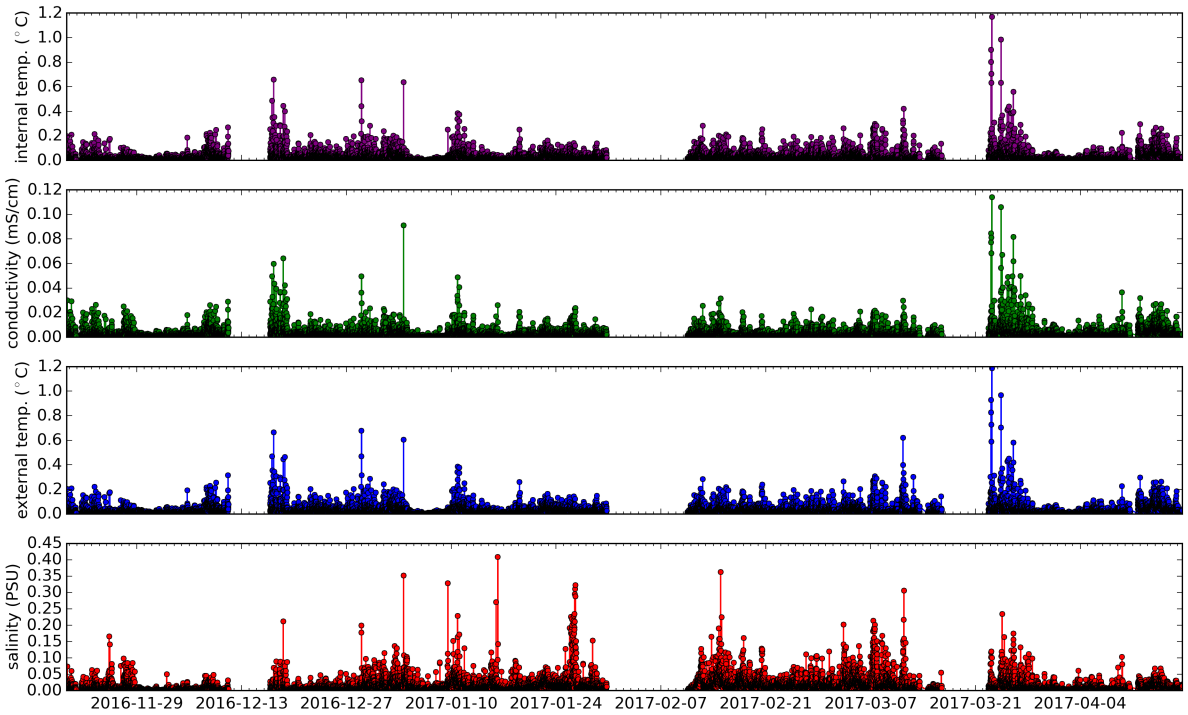

Figure 3: Standard deviations of 10min means of data from TSG Keel

Differences between internal and external temperature of the TSG keel sensors

Temperature differences between the internal and the external temperature sensor have to be small under normal circulation conditions. Means and standard deviations for the temperature differences are given in the following table and are shown in Figure 4.

	TSG keel temperature difference (mean ± std dev.)
Spot values	0.02676 ± 0.09824°C
10-min means	0.02271 ± 0.08521°C

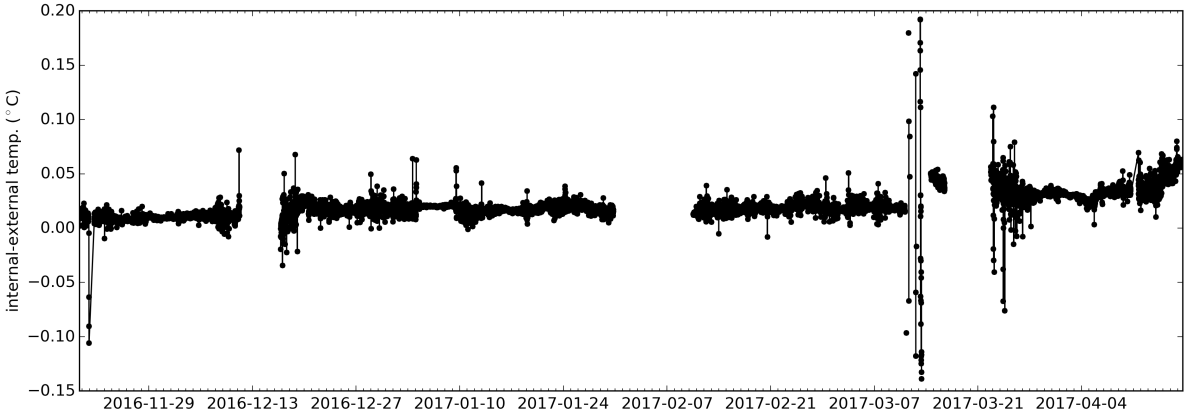

Figure 4: Temperature differences between internal and external temperature sensors of 10min means

Result file

Result files are given for each cruise individually. The result file is a plain text (tab-delimited values) file named *Cruise*_surf_oce.tab with one data row in 10-min interval. The water depth in the result file is the depth of the water inlet for the thermosalinographs. Further information about processing of the data of each cruise can be obtained from following cruise reports: PS102_TSG_nav.pdf, PS103_TSG_nav.pdf, PS104_TSG_nav.pdf, PS105_TSG_nav.pdf .

Column separator	Tabulator "\t"
Column 1	Date and time expressed according to ISO 8601
Column 2	Latitude in decimal format, unit degree
Column 3	Longitude in decimal format, unit degree
Column 4	Water depth, unit metre
Column 5	Temperature, unit degree Celsius
Column 6	Salinity PSU

6 Appendix

Measurements of salinity with the OPTIMARE salinometer

Bottle samples of sea water were continously taken during the cruises. Those samples were measured with the Optimare Salinometer onboard after temperature equalization. The bottle data are given here for reference. Drift correction using the bottle data was not applied.

Time of sampling	OPS Salinity [PSU]
2016-11-20T21:37:05	36.8813
2016-11-22T16:52:00	36.9518
2016-11-23T08:25:05	36.6916
2016-11-25T09:07:45	34.3694
2016-11-26T10:43:10	35.3675
2016-11-28T13:47:35	35.3728
2016-11-29T13:52:30	35.9260
2016-11-30T13:17:50	35.9543
2016-12-02T15:55:20	35.9970
2016-12-05T07:26:15	36.0860
2016-12-07T15:03:00	35.6477
2016-12-09T08:30:35	35.6598
2016-12-17T12:53:00	35.6063
2016-12-18T13:02:04	35.1822
2016-12-19T13:40:20	34.2499
2016-12-20T16:17:48	33.8290
2016-12-22T13:50:48	33.9293
2016-12-23T16:46:56	33.7730
2016-12-25T16:58:48	33.8222
2016-12-26T14:15:28	33.8746
2016-12-27T16:53:04	34.2177
2016-12-28T17:30:56	34.1149
2016-12-29T15:30:24	33.1760
2016-12-31T08:25:40	33.3137
2016-12-31T15:10:24	33.2295
2017-01-02T11:01:36	33.3146
2017-01-06T09:05:52	33.4524
2017-01-08T09:44:00	33.2159
2017-01-10T10:34:36	32.9060
2017-01-12T14:15:36	34.0158
2017-01-14T13:21:16	33.8033

Time of sampling	OPS Salinity [PSU]
2017-01-15T12:46:48	33.0516
2017-01-17T12:57:42	32.8996
2017-01-20T17:04:04	33.3794
2017-01-23T17:44:16	33.5499
2017-01-29T13:36:28	34.3095
2017-02-11T18:26:00	33.8108
2017-02-13T20:28:00	33.0533
2017-02-15T15:44:00	33.8267
2017-02-17T19:33:00	33.4455
2017-02-19T15:46:00	33.3628
2017-02-21T15:49:00	33.4901
2017-02-23T16:43:00	33.4727
2017-02-25T15:12:00	33.4874
2017-02-27T19:53:00	33.0698
2017-03-01T14:51:00	33.0589
2017-03-04T16:34:30	33.4079
2017-03-06T14:34:00	32.6667
2017-03-08T14:46:00	32.8347
2017-03-14T21:17:00	33.8580
2017-03-23T13:04:00	34.0512
2017-03-25T10:43:00	35.4028
2017-03-27T18:14:00	36.0392
2017-03-29T12:44:30	37.2843
2017-03-31T10:18:00	37.5669
2017-04-02T09:56:00	36.4901
2017-04-04T11:43:00	36.1247
2017-04-06T10:58:00	36.2094
2017-04-08T08:44:00	36.2250
2017-04-12T12:22:00	36.5995
2017-04-14T12:33:00	36.0280
2017-04-16T09:11:00	35.6019