CTD Data RV Heincke HE527

Data Processing Report

Contents

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1 Introduction

This report describes the processing of CTD raw data acquired by Seabird SBE 911plus CTD on board RV Heincke during expedition HE527.

2 Workflow

The different steps of processing and validation are visualized in Figure 1. The CTD raw data are delivered from Andreas Wisotzki (AWI). The station book of the RV Heincke cruise is extracted from the DAVIS SHIP data base (https://dship.awi.de). The first CTD station and cast is processed manually in SBE Data Processing to configure the *.psa Seabird routines *Data Conversion*, *Wild Edit*, *Bottle Summary*, *Split*, *Translate*, *Cell Thermal Mass*, *Loop Edit* and *Bin Average*. The Seabird routines are then run in a batch job *CTDjob* in ManageCTD to process the complete CTD data set. The downcast of each CTD station/cast is used for further processing. In *CTDjob* the start record and the lowest altimeter point of the downcast is selected. From the downcast data figures to compare both oxygen sensors are generated. The oxygen sensor choice and the offset between the two oxygen sensors is documented in the processing summary table. With the *Utilities* → *Dship Ebook* function of ManageCTD the DAVIS SHIP station book extraction is used for getting the header information of all CTD stations/casts of the cruise. ManageCTD *Utilities* → *Find Profile* function compares station times of the header with the entries in the station book to find out the correct naming of the stations and casts. In *CTDheader* in ManageCTD the header information of each CTD station/cast is displayed, controlled and corrected if necessary. *CTDdespike* in ManageCTD is used for a visual check of the data and to erase/interpolate spikes in the data if necessary. Additionally, a sensor pair (Temp1/Sal1 or Temp2/Sal2) is chosen for each station/cast of the RV Heincke cruise in *CTDdespike*.

ManageCTD *Utilities* → *CheckDoubleSensors* controls the quality of temperature and conductivity sensors. For this purpose outliers of too high sensor pair differences could be removed. The data is then converted to spreadsheet format with *dsp2odv* for visualization of the data in Ocean Data View (ODV). The second visual inspection of the CTD data allows a comparison with data from other CTD casts from close-by stations to verify the oxygen sensor data. Therefore, potential reference cruise data is downloaded from PANGAEA (http://www.PANGAEA.de). The reference data is converted to *.mat format. In the ManageCTD Final Processing the CTD data is displayed together with the reference data. Bad data points, sensors or casts are interpolated or erased from the data set and filters are applied if necessary. The processed CTD data are written to text files and imported to PANGAEA (http://www.PANGAEA.de) for publication.

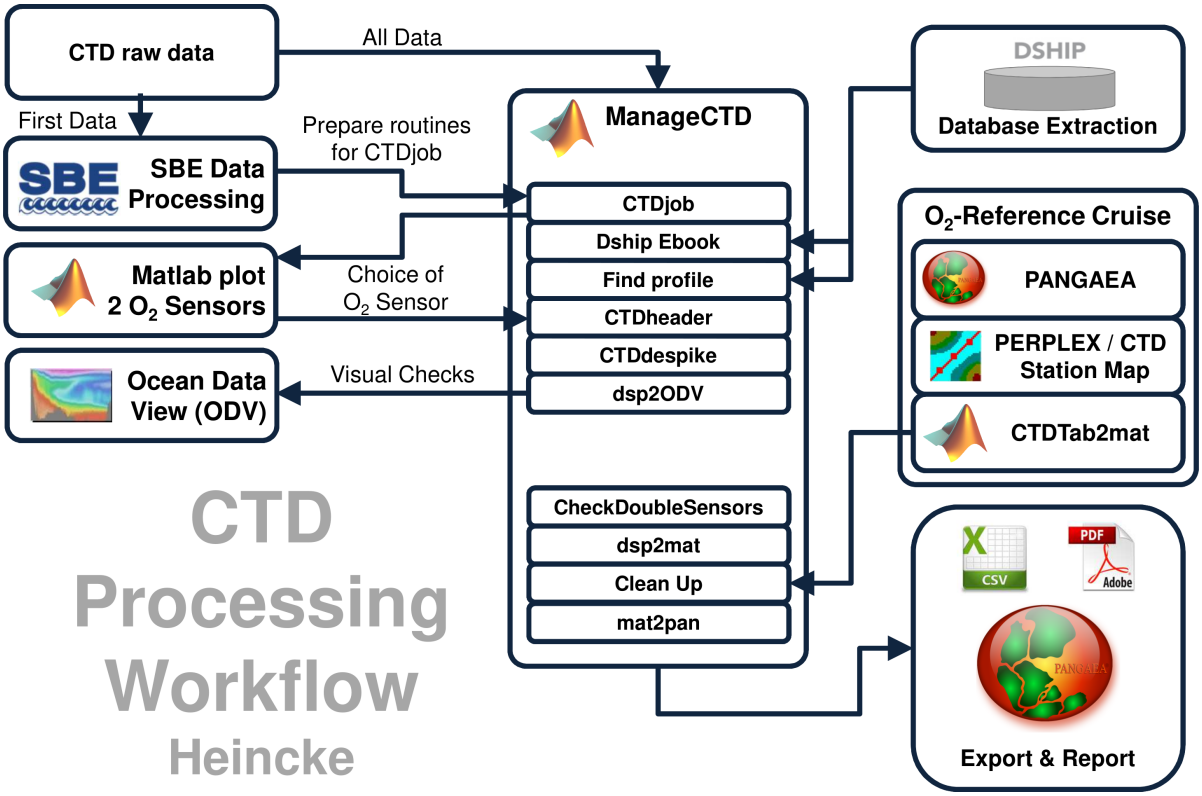

Figure 1: CTD data Processing Workflow

3 Cruise details

Vessel name	RV Heincke
Cruise name	HE527
Cruise start	19.03.2019 Bremerhaven
Cruise end	31.03.2019 Bremerhaven
Cruise duration	13 days
No. of CTD casts	82 and 2 additional casts without separate station book entry (p003a02 and p049a02)

4 Sensor Layout

This chapter describes the CTD sensors mounted during this cruise:
SBE 911plus CTD (SN: 1015), SBE Instrument Configuration Version 7.23.0.1.

ID	Sensor Name	Serial No.	Calibration Date
55	TemperatureSensor	5354	30-Nov-18
3	ConductivitySensor	2470	04-Dec-18
45	PressureSensor	1015	26-Jan-17
55	TemperatureSensor	5375	30-Nov-18
3	ConductivitySensor	3573	04-Dec-18
0	AltimeterSensor	46466	23-Mar-09
71	WET_LabsCStar	1348DR	28-Jan-2016
20	FluoroWetlabECO_AFL_FL_Sensor	1365	15-Jan-2016
38	OxygenSensor	2292	28-Dec-18
38	OxygenSensor	3654	28-Dec-18

5 Processing

Details of processing procedures and processing parameters are described in *CTD Processing Logbook of RV Heincke* (hdl: 10013/epic.47427).

Density Inversions and Manual Validation

Obvious outliers were removed manually. For the visual check density inversions > 0.005 kg/m^3 and > 0.01 kg/m^3 were flagged differently for display but not removed automatically. Decisions whether the flagged values were manually removed or not are based on the description in *CTD Processing Logbook of RV Heincke* (hdl: 10013/epic.47427).

Sensor Differences

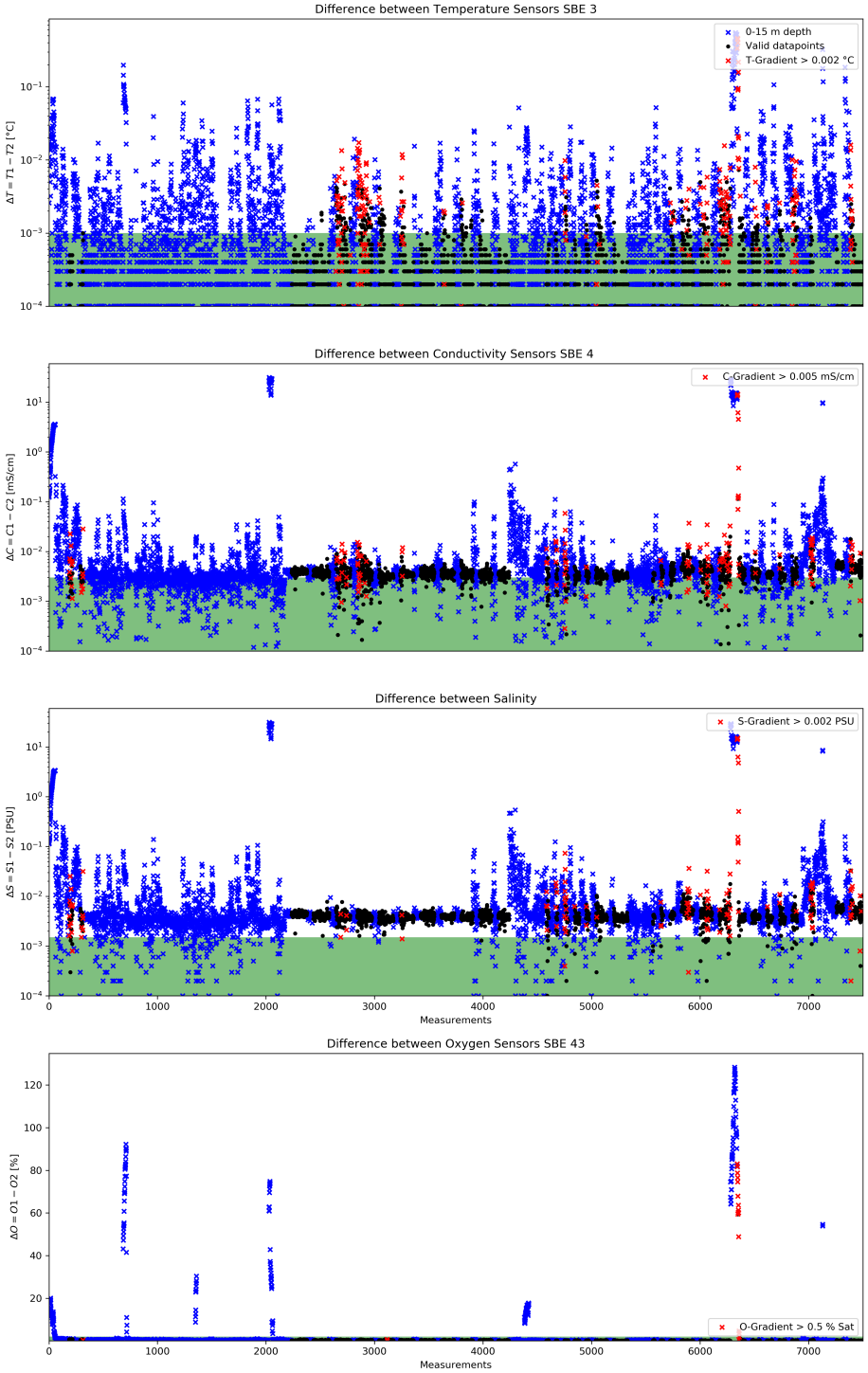

Figure 2: Data accuracy of sensor pairs HE527

6 Results

A complete processing overview for each sensor at each station is summarized in the table in the Appendix (Figure 3).

Double Sensor Check

In Figure 2, the absolute residuals between the sensorpairs are shown for the measured parameters *Temperature* and *Conductivity*, the derived parameter *Salinity* and the measured parameter *Oxygen*. Measurements in shallow water depths < 15 m (blue crosses) and gradients between two datapoints exceeding a defined threshold (red crosses) were omitted for accuracy calculation.

Parameter	**Accuracy** given by manufacturer	**Measurements removed** Surface 0-15m + gradient filter	**Remaining measurements** within accuracy specifications
Temperature	$\pm 0.001\ °C$	66.80%	90.61%
Conductivity	$\pm 0.003\ mS/cm$	65.85%	13.90%
Salinity	$\pm 0.0015\ PSU$	65.37%	1.96%
Oxygen	$\pm 2.0\ \%\ of saturation$	63.90%	99.89%

Comments

- 81 "CTD max depth/on ground"' entries in DShip station book
- 86 CTD raw data sets delivered
- 2 CTD casts were invalid or test
- 2 CTD casts were made twice on a station
- 3 CTD casts had a wrong filename
- 84 CTD casts processed and uploaded
- of these 84 processed CTD casts:
  - 0 oxygen profiles deleted (spiky and not matching to reference casts)
  - 150 data points interpolated
  - 469 data points erased

Result files

Text File (HE527_phys_oce.tab):

The format is a plain text (tab-delimited values) file.

Column separator	Tabulator "\t"
Column 1	Event label
Column 2	Date/Time of event
Column 3	Latitude of event
Column 4	Longitude of event
Column 5	Elevation of event
Column 6	DEPTH, water
Column 7	Pressure, water
Column 8	Temperature, water
Column 9	Conductivity
Column 10	Salinity
Column 11	Temperature, water, potential
Column 12	Density, sigma-theta (0)
Column 13	Oxygen
Column 14	Oxygen, saturation
Column 15	Attenuation, optical beam transmission
Column 16	Fluorometer
Column 17	Number of observations

Processing Report (CTD-HE527-report.pdf):
This PDF document.

Station	Gear Abbr.	Date	Time	Position Latitude	Position Longitude	Depth [m]	File HE527_	Sensor pair	Temp		Sal		Trans		Fluor		Oxy		complete		2 Oxy Sensors		Oxygen reference			Comments
									interp	erased	interp	erased	interp	erased	interp	erased	interp	erased	interp	erased	Sensor	Offset	cruise/sss-cc	dist. (km)	Offset	
1-1	CTD	19.03.2019	09:22:00	53° 31.134' N	008° 33.227' E	9.5	p001a01	1		5		5		5		5		5		25	2292	0.9	HE399/24-1	59.42	0.8	lowest part of profile deleted
2-1	CTD	19.03.2019	11:54:00	53° 43.104' N	008° 16.243' E	10.3	p002a01	1													2292	0.05	HE399/24-1	34.2	0.8	
3-1	CTD	19.03.2019	13:21:00	53° 46.913' N	008° 08.617' E	19.7	p003a01	1	1		1		1		1		1		5		2292	0.04	HE399/24-1	28.35	0.9	
3-1	CTD	19.03.2019	13:21:00	53° 46.913' N	008° 08.617' E	19.7	p003a02	1													2292	0.01	HE399/24-1	28.35	0.9	no separate station book entry for p003a02
5-1	CTD	20.03.2019	10:06:00	53° 48.451' N	007° 37.040' E	10.5	p005a01	1													2292	0.02	HE399/26-16	4.1	0.6	
6-1	CTD	20.03.2019	11:17:00	53° 48.951' N	007° 44.356' E	10.2	p006a01	1													2292	0.03	HE399/26-61	4.49	0.6	
7-1	CTD	20.03.2019	13:15:00	53° 48.446' N	007° 37.010' E	9	p007a01	1													2292	0.03	HE399/26-16	4.13	0.7	
8-1	CTD	20.03.2019	14:55:00	53° 47.290' N	007° 29.966' E	8.5	p008a01	1													2292	0.03	HE399/27-2	3.18	0.7	
10-1	CTD	20.03.2019	16:45:00	53° 48.440' N	007° 37.045' E	7.6	p010a01	1	1		1		1		1		1		5		2292	0.03	HE399/26-16	4.11	0.7	
11-1	CTD	20.03.2019	18:02:00	53° 48.999' N	007° 44.416' E	9.1	p011a01	1													2292	0.03	HE399/26-61	4.49	0.6	
12-1	CTD	20.03.2019	19:36:00	53° 48.441' N	007° 37.004' E	9.5	p012a01	1													2292	0.05	HE399/26-16	4.15	0.7	
13-1	CTD	20.03.2019	20:51:00	53° 47.259' N	007° 30.064' E	11	p013a01	2										35	35	2292	0.1	HE399/27-2	3.25	0.3	upper part of oxygen profile deleted because of high and contrasting O2 values compared to second Oxygen sensor
14-1	CTD	20.03.2019	22:21:00	53° 48.450' N	007° 37.017' E	10.6	p014a01	1													2292	0.04	HE399/26-16	4.12	0.7	
15-1	CTD	21.03.2019	00:10:00	53° 48.958' N	007° 44.210' E	9.7	p015a01	1													2292	0.03	HE399/26-61	4.34	0.6	
16-1	CTD	21.03.2019	01:51:00	53° 48.418' N	007° 36.855' E	8.8	p016a01	1													2292	0.03	HE399/26-16	4.29	0.7	
17-1	CTD	21.03.2019	03:29:00	53° 47.279' N	007° 29.985' E	8.1	p017a01	1													2292	0.03	HE399/27-2	3.2	0.3	
18-1	CTD	21.03.2019	04:58:00	53° 48.443' N	007° 37.027' E	7.3	p018a01	1	1		1		1		1		1		5		2292	0.02	HE399/26-16	4.12	0.7	
19-1	CTD	21.03.2019	06:27:00	53° 49.005' N	007° 44.458' E	8.6	p019a01	1													2292	0.02	HE399/26-61	4.53	0.5	
20-1	CTD	21.03.2019	08:15:00	53° 48.465' N	007° 37.065' E	10	p020a01	1													2292	0.02	HE399/26-16	4.07	0.7	
21-1	CTD	21.03.2019	09:37:00	53° 47.264' N	007° 30.122' E	10.8	p021a01	1	1		1		1		1		1		5		2292	0.02	HE399/27-2	3.24	0.2	
22-1	CTD	21.03.2019	11:05:00	53° 48.455' N	007° 37.051' E	11	p022a01	1													2292	0.02	HE399/26-16	4.09	0.7	
23-1	CTD	21.03.2019	12:40:00	53° 49.025' N	007° 44.240' E	11.3	p023a01	1													2292	0.02	HE399/26-61	4.3	0.6	
24-2	CTD	21.03.2019	14:12:00	53° 48.424' N	007° 36.777' E	9.7	p024a01	1													2292	0.03	HE399/26-16	4.34	0.7	
25-1	CTD	21.03.2019	15:29:00	53° 47.307' N	007° 30.019' E	9.4	p025a01	1													3654	0.1	HE399/27-2	3.15	0.4	no btl-file
25-2	CTD	21.03.2019	15:37:00	53° 47.297' N	007° 29.984' E	8.5	p025a02	1													2292	0.01	HE399/27-2	3.17	0.4	
26-1	CTD	21.03.2019	17:08:00	53° 48.440' N	007° 36.968' E	7.3	p026a01	1	1		1		1		1		1		5		2292	0.01	HE399/26-16	4.18	0.7	
27-1	CTD	21.03.2019	18:42:00	53° 48.981' N	007° 44.397' E	8.9	p027a01	1													2292	0.03	HE399/26-61	4.49	0.6	
28-1	CTD	21.03.2019	20:20:00	53° 48.431' N	007° 37.090' E	9.9	p028a01	1													2292	0.01	HE399/26-16	4.09	0.7	
29-1	CTD	21.03.2019	21:50:00	53° 47.235' N	007° 30.009' E	10.2	p029a01	1													2292	0.02	HE399/27-2	3.28	0.3	
30-1	CTD	21.03.2019	23:06:00	53° 48.477' N	007° 37.064' E	11	p030a01	1													2292	0.01	HE399/26-16	4.05	0.7	
31-1	CTD	22.03.2019	00:43:00	53° 48.974' N	007° 44.203' E	10.5	p031a01	1													2292	0.02	HE399/26-61	4.32	0.7	
32-1	CTD	22.03.2019	02:14:00	53° 48.532' N	007° 36.814' E	9.9	p032a01	1													2292	0.02	HE399/26-58	4.16	0.7	
33-1	CTD	22.03.2019	03:40:00	53° 47.282' N	007° 29.932' E	8.5	p033a01	1													2292	0.03	HE399/27-2	3.2	0.3	
34-1	CTD	22.03.2019	05:40:00	53° 48.461' N	007° 36.997' E	7.5	p034a01	1													2292	0.01	HE399/26-16	4.12	0.6	
35-1	CTD	22.03.2019	07:15:00	53° 48.992' N	007° 44.475' E	8.7	p035a01	1	1		1		1		1		1		5		2292	0.03	HE399/26-61	4.56	0.6	
36-1	CTD	22.03.2019	08:44:00	53° 48.442' N	007° 37.098' E	9.5	p036a01	1													2292	0.02	HE399/26-16	4.06	0.6	
37-1	CTD	22.03.2019	10:04:00	53° 47.290' N	007° 29.982' E	10.9	p037a01	1	1		1		1		1		1		5		2292	0.02	HE399/27-2	3.18	0.3	
38-1	CTD	22.03.2019	11:58:00	53° 48.537' N	007° 37.180' E	11.7	p038a02	1	1		1		1		1		1		5		2292	0.07	HE399/26-16	3.87	0.7	wrong station name
39-1	CTD	22.03.2019	13:08:00	53° 49.003' N	007° 44.155' E	10.7	p039a01	1													2292	0.03	HE399/26-61	4.25	0.7	
42-1	CTD	23.03.2019	07:32:00	55° 23.897' N	004° 28.949' E	40.9	p042a01	1													2292	0.01	HE399/39-1	143.27	1.0	
42-4	CTD	23.03.2019	08:06:00	55° 23.763' N	004° 28.958' E	41.5	p042a04	1	1		1		1		1		1		5		2292	0.02	HE399/39-1	143.27	1.0	
43-1	CTD	23.03.2019	11:04:00	55° 11.457' N	004° 57.119' E	38.9	p043a01	1	1		1		1		1		1		5		2292	0.02	HE399/39-1	105.76	1.0	
43-4	CTD	23.03.2019	11:35:00	55° 11.490' N	004° 56.907' E	39.3	p043a04	1													2292	0.02	HE399/39-1	105.99	1.0	
44-1	CTD	23.03.2019	15:05:00	54° 59.488' N	005° 24.920' E	38.2	p044a01	1	1		1		1	1	1	1	1		5	2	2292	0.01	HE399/39-1	69.0	0.9	
44-4	CTD	23.03.2019	15:37:00	54° 59.535' N	005° 24.631' E	38.5	p044a04	1	4		4		4		4		4		20		2292	0.02	HE399/39-1	69.3	0.9	
45-1	CTD	24.03.2019	07:01:00	54° 46.900' N	005° 54.086' E	38.8	p045a01	1	2		2		2		2		2		10		2292	0.02	HE399/39-1	30.53	0.9	

Figure 3: CTD data Processing Summary HE527

Station	Gear Abbr.	Date	Time	Position Latitude	Position Longitude	Depth [m]	File HE527_	Sensor pair	Temp		Sal		Trans		Fluor		Oxy		complete		2 Oxy Sensors		Oxygen reference			Comments
									interp	erased	interp	erased	interp	erased	interp	erased	interp	erased	interp	erased	Sensor	Offset	cruise/sss-cc	dist. (km)	Offset	
46-1	CTD	24.03.2019	10:03:00	54° 34.491' N	006° 23.216' E	36.2	p046a01	1													2292	0.01	HE399/39-1	10.77	0.7	
46-6	CTD	24.03.2019	10:26:31	54° 34.096' N	006° 23.531' E	36.8	p046a04	1													2292	0.02	HE399/39-1	11.57	0.7	wrong station name
47-1	CTD	24.03.2019	13:06:00	54° 21.370' N	006° 54.017' E	35.3	p047a01	1													2292	0.02	HE399/36-1	6.88	0.8	
47-4	CTD	24.03.2019	13:34:00	54° 21.200' N	006° 53.765' E	36.6	p047a04	1	1		1		1		1		1		5		2292	0.01	HE399/36-1	7.02	0.8	
48-1	CTD	26.03.2019	09:11:00	53° 58.107' N	008° 29.804' E	11.9	p048a01	1	1		1		1		1		1		5		2292	0.02	HE399/24-1	16.22	1.0	
49-1	CTD	26.03.2019	11:20:00	53° 52.776' N	008° 43.403' E	9	p049a01	1										1		1	2292	0.04	HE399/24-1	33.91	1.4	
49-1	CTD	26.03.2019	11:20:00	53° 52.776' N	008° 43.403' E	9	p049a02	1													2292	0.01	HE399/24-1	33.91	1.3	no btl file, no separate station book entry for p049a02
50-1	CTD	26.03.2019	13:12:00	53° 51.568' N	009° 00.038' E	7.9	p050a01	1	1		1		1		1		1		5		2292	1.13	HE399/24-1	51.35	0.5	
51-1	CTD	27.03.2019	07:01:00	54° 17.044' N	008° 23.377' E	8.3	p051a01	1													2292	0.03	HE399/20-1	5.72	1.0	
52-1	CTD	27.03.2019	08:29:00	54° 16.967' N	008° 15.042' E	10.6	p052a01	1	1		1		1		1		1		5		2292	0.02	HE399/20-1	6.32	1.0	
53-1	CTD	27.03.2019	10:07:00	54° 16.947' N	008° 06.043' E	17	p053a01	1	1		1		1		1	1	1		5	1	2292	0.01	HE399/20-1	15.22	0.9	
53-4	CTD	27.03.2019	10:27:00	54° 16.687' N	008° 06.177' E	16.1	p053a04	1													2292	0.01	HE399/20-1	14.95	0.9	
54-1	CTD	27.03.2019	11:56:00	54° 16.942' N	007° 57.182' E	20	p054a01	1													2292	0.01	HE399/06-1	19.35	0.6	
55-1	CTD	27.03.2019	13:52:00	54° 16.962' N	007° 47.882' E	21.5	p055a01	1	1		1		1		1		1		5		2292	0.01	HE399/06-1	10.31	0.6	
55-4	CTD	27.03.2019	14:16:00	54° 16.857' N	007° 47.966' E	21.8	p055a04	1													2292	0.01	HE399/06-1	10.32	0.6	
56-1	CTD	27.03.2019	15:35:00	54° 16.995' N	007° 38.122' E	32.9	p056a01	1													2292	0.01	HE399/06-1	5.87	0.6	
57-1	CTD	27.03.2019	17:04:00	54° 17.016' N	007° 29.286' E	37.3	p057a01	1	1		1		1		1		1		5		2292	0.01	HE399/06-1	12.86	0.6	
58-1	CTD	28.03.2019	06:58:00	54° 45.988' N	008° 08.767' E	8.4	p058a01	1													2292	0.02	HE399/18-1	30.46	0.0	
59-1	CTD	28.03.2019	08:23:00	54° 45.953' N	008° 00.325' E	11.6	p059a01	1	1		1		1		1		1		5		2292	0.01	HE399/18-1	29.41	0.0	
60-1	CTD	28.03.2019	09:46:00	54° 45.946' N	007° 51.377' E	12.8	p060a01	1	1		1		1		1		1		5		2292	0.02	HE399/18-1	31.31	0.04	
61-1	CTD	28.03.2019	11:17:00	54° 45.867' N	007° 42.822' E	15.9	p061a01	1													2292	0.02	HE399/16-1	29.31	0.3	
62-1	CTD	28.03.2019	12:55:00	54° 45.917' N	007° 34.222' E	17.3	p062a01	1													2292	0.02	HE399/16-1	29.93	0.3	
63-1	CTD	28.03.2019	14:39:00	54° 46.027' N	007° 25.146' E	20.2	p063a01	1	1		1		1		1		1		5		2292	0.01	HE399/43-1	30.12	1.0	
64-1	CTD	29.03.2019	07:01:00	54° 14.274' N	007° 14.764' E	34.5	p064a01	1													2292	0.01	HE399/36-1	19.23	0.9	
64-4	CTD	29.03.2019	07:30:00	54° 14.328' N	007° 15.168' E	34.3	p064a04	1													2292	0.01	HE399/36-1	19.54	0.9	
65-1	CTD	29.03.2019	09:10:00	54° 06.960' N	007° 18.634' E	33.5	p065a01	1	2		2		2		2		2		10		2292	0.01	HE399/45-5	23.75	0.8	
66-1	CTD	29.03.2019	11:09:00	54° 00.357' N	007° 22.020' E	26.9	p066a01	1		81		81		81		81		81		405	2292	0.1	HE399/12-1	19.32	0.02	upper part of profile faulty and deleted
66-3	CTD	29.03.2019	11:36:00	54° 00.430' N	007° 21.638' E	26.9	p066a04	1	1		1		1		1		1		5		2292	0.01	HE399/12-1	19.42	0.15	no btl file
67-1	CTD	29.03.2019	13:04:00	53° 56.241' N	007° 24.863' E	23	p067a01	1													2292	0.01	HE399/12-1	12.7	0.15	
68-1	CTD	29.03.2019	14:50:00	53° 51.555' N	007° 27.779' E	23.4	p068a01	1													2292	0.01	HE399/27-1	5.32	0.15	
68-4	CTD	29.03.2019	15:14:00	53° 51.584' N	007° 27.955' E	22.7	p068a04	1													2292	0.01	HE399/27-1	5.29	0.15	
69-2	CTD	29.03.2019	17:42:00	53° 47.316' N	007° 29.805' E	9.1	p069a01	1													2292	0.01	HE399/27-1	3.15	0.15	
70-1	CTD	30.03.2019	07:04:00	53° 32.971' N	006° 40.895' E	19	p070a01	1													2292	0.02	HE399/32-1	30.81	0.5	
71-1	CTD	30.03.2019	08:58:00	53° 29.387' N	006° 47.949' E	6.8	p071a01	1													3654	0.01	HE399/32-1	31.96	0.3	
72-1	CTD	30.03.2019	10:43:00	53° 24.674' N	006° 56.764' E	6	p072a01	1													2292	0.01	HE399/32-1	37.92	0.3	
73-1	CTD	30.03.2019	12:16:00	53° 20.418' N	006° 59.598' E	13.1	p073a02	1													2292	0.02	HE399/32-1	45.62	0.2	wrong station name
75-1	CTD	30.03.2019	17:18:00	53° 51.791' N	006° 21.510' E	24.8	p075a01	1													2292	0.01	HE399/32-1	44.15	0.7	
76-1	CTD	31.03.2019	04:06:00	54° 03.843' N	007° 50.781' E	36.6	p076a01	1													2292	0.01	HE399/02-1	10.06	0.7	
									30	86	30	86	30	87	30	88	30	122	150	469						

Figure 4: CTD data Processing Summary HE527

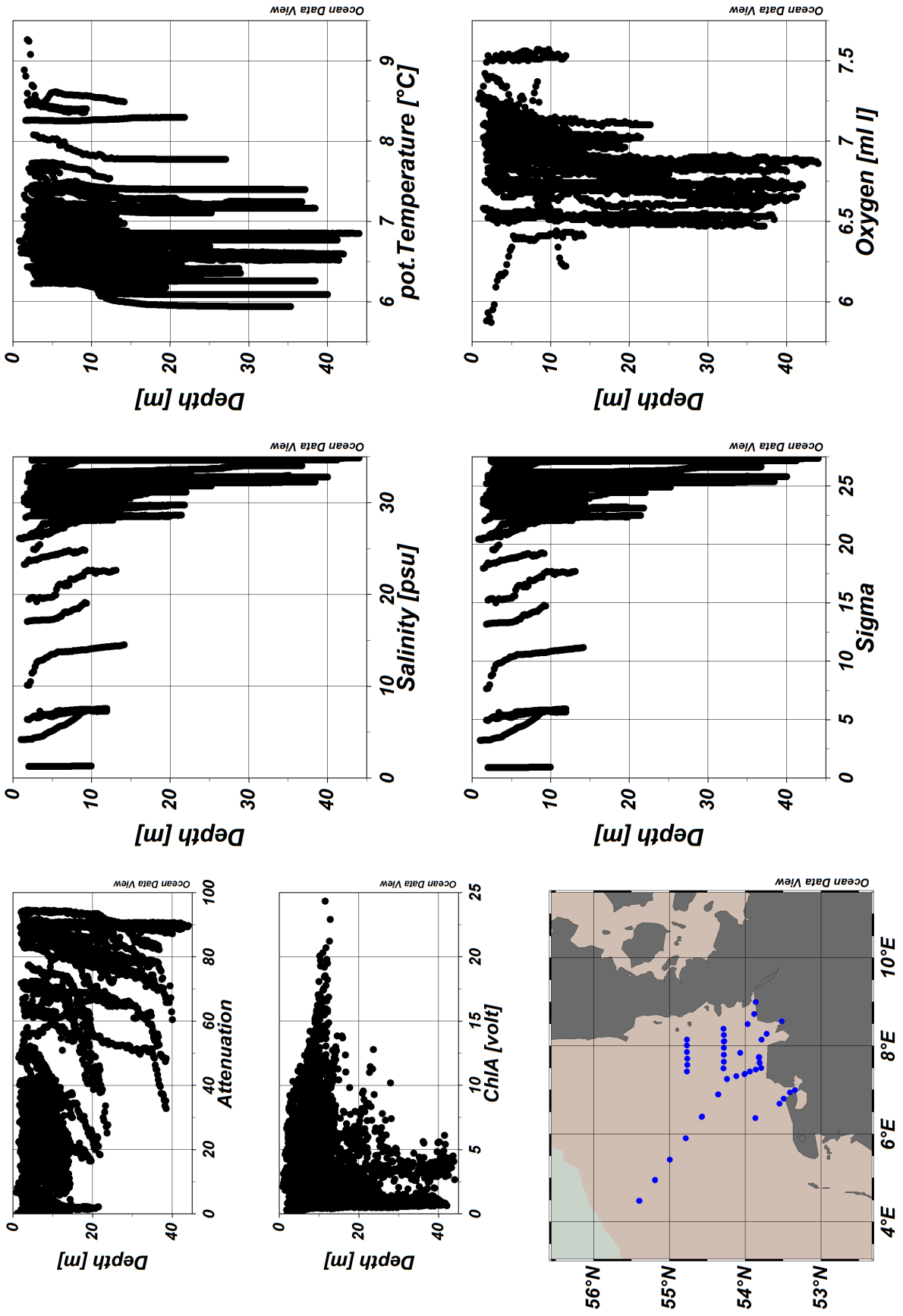

Figure 5: ODV Screenshot of HE527 CTD data