CTD Data RV Heincke HE570
Data Processing Report

Contents

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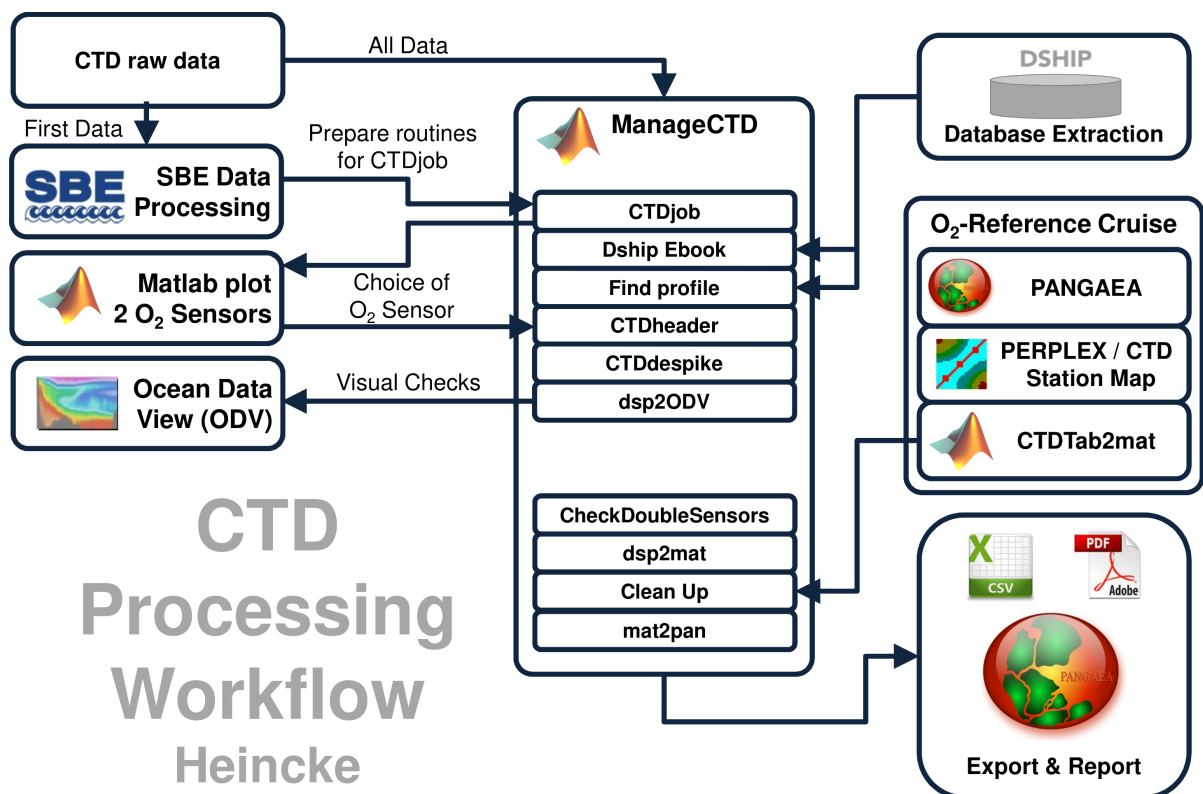Schleusenstr. 14, D-27568 Bremerhaven, GERMANY

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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 HE570.

2 Workflow

The different steps of processing and validation are visualized in Figure 1. The CTD raw data and station books are delivered from Gerd Rohardt or Sandra Tippenhauer (AWI). 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	HE570
Cruise start	01.03.2021 Bremerhaven
Cruise end	18.03.2021 Bremerhaven
Cruise duration	18 days
No. of CTD casts	42

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	1373	11-Oct-19
3	ConductivitySensor	1198	17-Sep-19
45	PressureSensor	1015	26-Jan-17
55	TemperatureSensor	2929	13-Sep-19
3	ConductivitySensor	1199	17-Sep-19
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	26-Aug-20
38	OxygenSensor	3654	13-Feb-20

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).
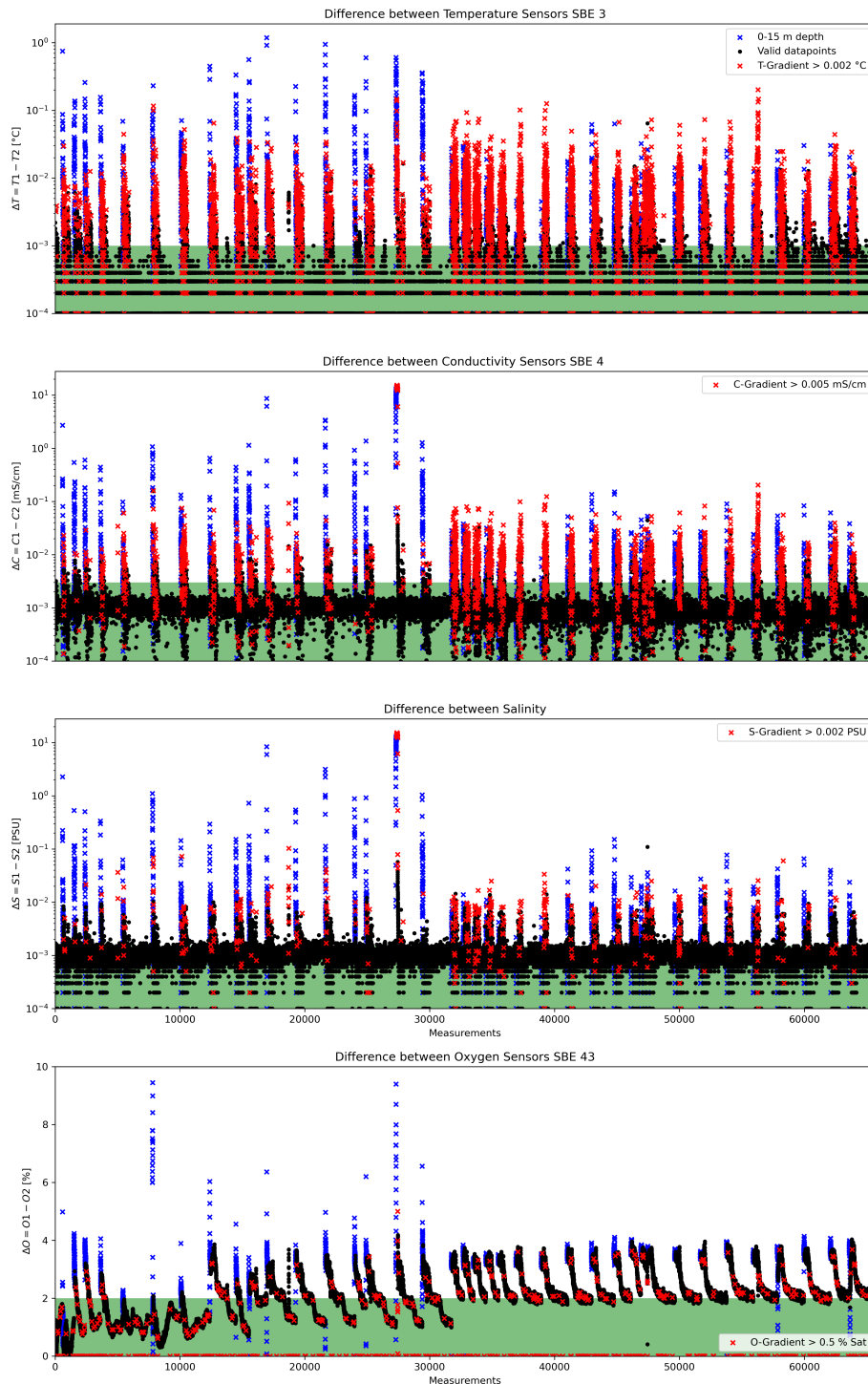
Sensor Differences

Figure 2: Data accuracy of sensor pairs HE570

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	$\pm 0.001\,^{\circ}C$	11.74%	93.16%
Conductivity	$\pm 0.003\,mS/cm$	7.30%	96.70%
Salinity	$\pm 0.0015\,PSU$	4.74%	91.83%
Oxygen	$\pm 2.0\,\%\,of\,saturation$	4.93%	41.08%

Comments

- 37 CTD "max depth/on ground" entries in DShip station book

- 4 CTD "in the water" entries in DShip station book without comment "max depth/ on ground" (HE570_043-1, HE570_107-1, HE570_142-1, HE570_187-1)

- 41 CTD raw data sets delivered

- 1 CTD cast was invalid or test (HE570_004, HE570_004b)

- 1 CTD station book entry (HE570_118-1) has no corresponding CTD cast

- 39 CTD casts processed and uploaded

- of these 39 processed CTD casts:
    - 0 oxygen profiles deleted (spiky and not matching to reference casts)
    - 1747 data points interpolated
    - 63 data points erased

Result files

Text File (HE570_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-HE570-report.pdf):

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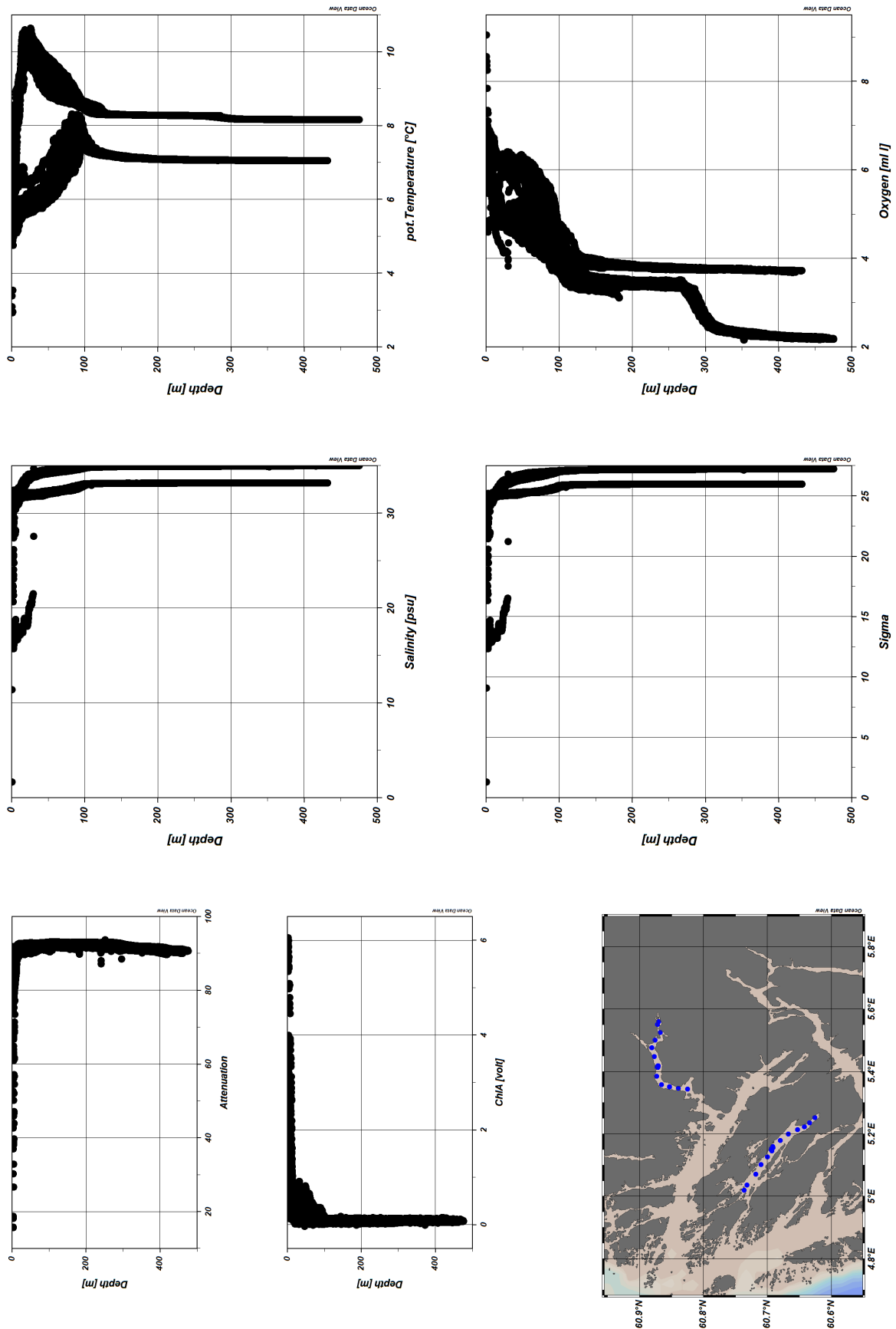| Station HE570_	Gear Abbr.	Date	Time	Position Latitude	Position Longitude	Depth [m]	File Name HE570_	Sensor pair	Temp interp	Temp erased	Sal interp	Sal erased	Trans interp	Trans erased	Fluor interp	Fluor erased	Oxy interp	Oxy erased	complete interp	complete erased	2 Oxy Sensors Sensor	2 Oxy Sensors Offset	Oxygen reference cruise/sss-cc	dist. (km)	Offset	Comments
14-1	CTD	04.03.2021	14:36	60° 52,231'N	005° 33,538'E	174.3	002	1	6		6		6		6		6		30		2292	-0.056	HE462/02-2	34.69	2.50	
20-1	CTD	04.03.2021	17:43	60° 52,064'N	005° 31,480'E	186.2	003		7		7		7		7		7		35		2292	-0.009	HE462/02-2	33.65	2.50	
23-1	CTD	04.03.2021	19:30	60° 51,932'N	005° 30,214'E	167.3	004b																			no valid cast, probably aborted
26-1	CTD	05.03.2021	7:02	60° 52,575'N	005° 30,017'E	179.4	005		9		9		9		9		9		45		2292	-0.099	HE462/02-2	30.80	2.50	
29-1	CTD	05.03.2021	8:37	60° 52,866'N	005° 28,551'E	256.1	006		11		11		11		11		11		55		2292	-0.108	HE462/02-2	30.13	2.50	
32-1	CTD	05.03.2021	10:41	60° 52,644'N	005° 26,804'E	354.7	007		11		11		11		11		11		55		2292	-0.087	HE462/02-2	29.74	2.50	
36-1	CTD	05.03.2021	14:12	60° 52,288'N	005° 25,034'E	476.9	008		10		10		10		10		10		50		2292	-0.077	HE462/02-2	29.74	2.50	
40-1	CTD	05.03.2021	17:52	60° 52,430'N	005° 23,051'E	459.8	009		8		8		8		8		8		40		2292	-0.079	HE462/02-2	28.57	2.50	
43-1	CTD	05.03.2021	20:30	60° 51,953'N	005° 21,437'E	437.9	010		15		15		15		15		15		75		2292	-0.077	HE462/02-2	28.61	2.50	
46-1	CTD	06.03.2021	7:18	60° 51,215'N	005° 20,974'E	422.5	011		12		12		12		12		12		60		2292	-0.146	HE462/05-1	29.3	4.00	
49-1	CTD	06.03.2021	9:54	60° 50,364'N	005° 20,736'E	208.4	012		5		5		5		5		5		25		2292	-0.098	HE462/05-1	30.22	4.00	
52-1	CTD	06.03.2021	11:53	60° 49,494'N	005° 20,600'E	293.5	013		7		7		7		7		7		35		2292	-0.141	HE462/05-1	31.28	4.00	
59-1	CTD	06.03.2021	18:54	60° 52,256'N	005° 25,046'E	475.5	014		8		8		8		8		8		40		2292	-0.133	HE462/02-2	29.8	2.50	
68-1	CTD	07.03.2021	1:51	60° 52,289'N	005° 24,705'E	479.5	015		10		10		10		10		10		50		2292	-0.129	HE462/02-2	29.58	2.50	
75-1	CTD	07.03.2021	10:10	60° 52,378'N	005° 24,831'E	475.9	016		8		8		8		8		8		40		2292	-0.129	HE462/02-2	29.5	2.50	
78-1	CTD	07.03.2021	16:54	60° 52,326'N	005° 32,996'E	185.0	017		7		7		7		7		7		35		2292	-0.151	HE462/02-2	34.22	2.50	
82-1	CTD	08.03.2021	12:38	60° 52,278'N	005° 24,933'E	476.3	018		13		13		13		13		13		65		2292	-0.125	HE462/02-2	29.71	2.50	
92-1	CTD	09.03.2021	10:04	60° 51,222'N	005° 20,997'E	422.7	019		9		9		9		9	2	9		45	2	2292	-0.263	HE462/05-1	29.3	3.00	
98-1	CTD	09.03.2021	15:37	60° 52,308'N	005° 24,943'E	476.4	020		9		9		9		9		9		45		2292	-0.127	HE462/02-2	29.67	2.50	
101-1	CTD	11.03.2021	7:43	60° 37,574'N	005° 15,078'E	189.9	021		5		5		5		5		5		25		2292	-0.180	HE462/05-1	47.75	4.00	
107-1	CTD	11.03.2021	9:56	60° 38,071'N	005° 14,121'E	179.8	022		9		9		9		9		9		45		2292	-0.186	HE462/05-1	46.58	4.00	
110-1	CTD	11.03.2021	11:44	60° 38,546'N	005° 13,325'E	193.6	023		3		3		3		3		3		15		2292	-0.183	HE462/05-1	45.52	4.00	
113-1	CTD	11.03.2021	13:20	60° 39,206'N	005° 12,774'E	207.6	024		5		5		5		5		5		25		2292	-0.189	HE462/05-1	44.2	4.00	
116-1	CTD	11.03.2021	14:58	60° 40,058'N	005° 11,889'E	285.5	025		6		6		6		6		6		30		2292	-0.172	HE462/05-1	42.44	4.00	
118-1	CTD	11.03.2021	15:42	60° 40,052'N	005° 11,956'E	291.8	025																			no valid cast for this station
120-1	CTD	11.03.2021	17:03	60° 40,802'N	005° 10,692'E	413.4	026		14		14		14		14		14		70		2292	-0.163	HE462/05-1	40.79	4.00	
123-1	CTD	11.03.2021	19:38	60° 41,496'N	005° 09,324'E	402.3	027		8		8		8		8		8		40		2292	-0.160	HE462/05-1	39.19	4.00	
134-1	CTD	12.03.2021	13:17	60° 41,998'N	005° 07,555'E	397.1	028		13		13		13		13		13		65		2292	-0.163	HE462/05-1	37.85	4.00	
137-1	CTD	12.03.2021	15:48	60° 42,629'N	005° 06,033'E	366.3	029		11		11		17		11		11		61		2292	-0.164	HE462/05-1	36.38	4.00	
142-1	CTD	12.03.2021	18:36	60° 43,130'N	005° 04,180'E	276.9	030		8		8		8		8		8		40		2292	-0.178	HE462/05-1	35.12	4.00	
146-1	CTD	12.03.2021	21:17	60° 43,944'N	005° 02,096'E	159.9	031		7		7		7		7		7		35		2292	-0.215	HE462/05-1	33.31	4.00	
150-1	CTD	12.03.2021	22:46	60° 44,202'N	005° 01,112'E	116.6	032		4		4		4		4		4		20		2292	-0.234	HE462/05-1	32.72	4.00	
155-1	CTD	13.03.2021	7:21	60° 41,536'N	005° 09,494'E	432.5	033		10		10		10		10		10		50		2292	-0.163	HE462/05-1	39.16	4.50	
163-1	CTD	13.03.2021	13:28	60° 41,679'N	005° 08,928'E	414.0	034		6		6		6		6		6		30		2292	-0.165	HE462/05-1	38.75	4.50	
168-1	CTD	13.03.2021	16:52	60° 41,646'N	005° 09,081'E	430.0	035		7		7		7		7		7		35		2292	-0.163	HE462/05-1	38.86	4.50	
187-1	CTD	14.03.2021	6:58	60° 41,621'N	005° 09,077'E	431.1	036		12		12		15		12		12		63		2292	-0.171	HE462/05-1	38.9	4.50	
192-1	CTD	14.03.2021	13:20	60° 41,619'N	005° 08,710'E	396.1	037		7		7		7		7		7		35		2292	-0.169	HE462/05-1	38.81	4.50	
210-1	CTD	15.03.2021	10:07	60° 41,606'N	005° 09,210'E	428.2	038		13		13		20	61	13		13		65		2292	-0.167	HE462/05-1	38.97	4.50	
212-1	CTD	15.03.2021	14:42	60° 41,570'N	005° 09,160'E	431.0	039		12		12		12		12		12		68		2292	-0.166	HE462/05-1	39.02	4.50	
214-1	CTD	15.03.2021	15:33	60° 41,601'N	005° 09,206'E	427.6	040		7		7		7		7		7		35		2292	-0.178	HE462/05-1	38.98	4.50	
216-1	CTD	15.03.2021	18:44	60° 41,636'N	005° 09,111'E	430.0	041		14		14		14		14		14		70		2292	-0.170	HE462/05-1	38.89	4.50	
									346	0	346	0	363	61	346	2	346	0	1747	2						

Figure 3: CTD data Processing Summary HE570

Figure 4: ODV Screenshot of HE570 CTD data