

**MVP Data Processing Notes – 2016 Leg2**

Last updated on 21 June 2017

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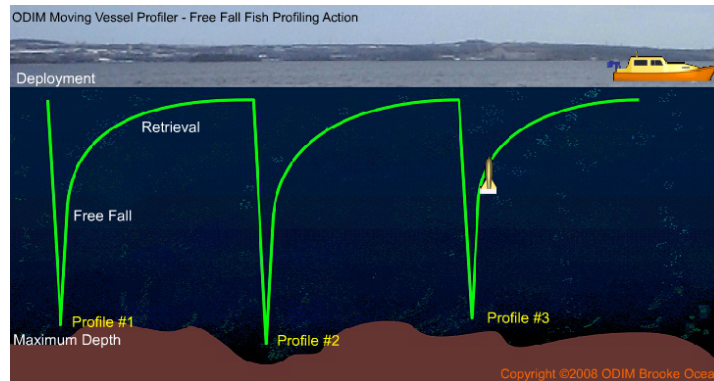
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## 1. Introduction

The Canadian research icebreaker CCGS *Amundsen* is equipped with a Moving Vessel Profiler™ (MVP). It is a multi-purpose instrument for aiding in the collection of both shallow and deep-water datasets. The MVP's primary function is to allow accurate data collection without the need to stop the vessel.

The system includes a computer-controlled smart winch and deployment system that allows the free fall fish to be deployed while the vessel is underway.

The fish is equipped with several sensors to record data on temperature, salinity, Fluorescence, sound velocity, dissolved oxygen and transmittance.



**Down cast (free fall) and up cast (low recovery)**



**Winch operation**



**Fish (Sensors platform)**

**Table 1: Instruments and probes**

<b>Instrument</b>	<b>Company</b>	<b>Unit</b>	<b>Serial number</b>	<b>Calibration date</b>
<b>Temperature</b>	AML	°C	7437	2015-12-04
<b>Conductivity</b>	AML	mS/cm	7437	2015-12-04
<b>Pressure</b>	AML	Db	7437	2015-12-04
<b>Sound velocity</b>	AML	m/s	7438	2015-12-04
<b>Pressure</b>	AML	db	7438	2015-12-04
<b>Dissolved Oxygen</b>	Rinko	%	149	2016-09-23
<b>Fluorescence</b>	WetLabs	ug/L	FLRTD-678	2015-12-16
<b>Transmittance</b>	WetLabs	%	1049DR	2016-01-12

**Table 2: Recorded variables**

<b>Instrument</b>	<b>Company</b>	<b>Measurement</b>	<b>Specification</b>	
<b>Micro CTD</b>	AML	Temperature	Range (°C)	-2 to +32
			Initial Accuracy (°C)	0.005
			Resolution (°C)	0.001
		Conductivity	Range (mS/cm)	2 to 70
			Initial Accuracy (mS/cm)	0.01
			Resolution (mS/cm)	0.0015
		Pressure	Range (m)	0 to 6000
			Initial Accuracy (%FS)	0.05
			Resolution (%FS)	0.005
<b>Micro SV</b>	AML	Sound velocity	Range (m/s)	1375 to 1600
			Initial Accuracy (m/s)	0.05
			Resolution (m/s)	0.01
		Pressure	Range (m)	0 to 6000
			Initial Accuracy (%FS)	0.05
			Resolution (%FS)	0.005
<b>Rinko III</b>	JFE Alec	Dissolved Oxygen	Range (%)	0-100
			Response time (s)	0.9 (90%)
			Drift (%/month)	5
<b>ECOFLO</b>	WetLabs	Fluorescence	Range (ug/L)	0 to 125
			Sensitivity (ug/L)	0.062
			Wave length (nm)	470/695
<b>C-Stars</b>	WetLabs	Transmittance	Range (%)	0 to 100
			Path length (cm)	25

## **2. Processing protocol**

The following treatment steps were performed using the script: Processing\_Amundsen\_MVP.m developed in Matlab in Amundsen Science offices.

### **A: Data reading**

#### **A1: Read TSG data**

From processed TSG data (files \*.int, see TSG processing report – Amundsen technical team)

#### **A2: Read CTD rosette data**

From processed Rosette data (files \*.int, see Rosette processing report – Amundsen technical team)

#### **A3: Read MVP data**

From MVP raw data (files \*.raw)

### **B: Flag and processing**

The processing steps in section B are sequentially applied on each cast of a given MVP transect.

#### **B.1: Calibration of the analogic inputs**

MVP data from the transmissometer, fluorimeter and dissolved oxygen sensors are recorded in volts 0-5V. Calibration coefficients are applied in post processing to transform the volt values into the recognised units for these recorded variables. Calibration dates are given in table 1.

#### **B.2: Averaging pressure**

The SVP and CTD sensors both record pressure. Data from the two datasets are averaged to improve the accuracy of the variable.

#### **B.3: Low pass filter (SBE data processing toolbox)**

A Low pass filter is applied on the temperature, conductivity, sound velocity, transmittance, fluorescence and dissolved oxygen time series data. The time constant is fixed at 0.2s to keep the accuracy of the measure and allow for further filtering on averaged bin performed in B8. For instance, with a free fall at  $\sim 3\text{m/s}$ , the filter does not affect a depth gap of one meter ( $3 \times 0.2 = 0.6\text{m}$ ).

#### **B.4: Align sensor filter (SBE data processing toolbox)**

The temperature and conductivity sensors do not have the same response time. This filter aligns data parameters by time, relative to pressure. This ensures that calculations of salinity and other derived parameters are made using measurements from the same parcel of water. The time offset corrections are the following:

- Temperature: + 0.200s
- Conductivity: + 0.025s

The comparison with and without the Low pass filter and Align sensor filter is presented in annex 5.

#### **B.5: Loop edit filter (SBE data processing toolbox)**

The Loop Edit processing tests the data for pressure slowdowns and reversals (typically caused by ship heave). It flags scans that fail these tests. Loop edit filter marks also scans associated with an initial surface soak.

The thresholds for the tests are:

- Minimum velocity: 0.25m/s
- Surface soak depth: 8m
- Minimum soak depth: 5m
- Maximum soak depth: 20m

#### **B.6: Flag out-of-range values**

For pressure, latitude and longitude, temperature, conductivity, sound velocity, transmittance, fluorescence and dissolved oxygen values, the flag checks if the values are not out of range (see thresholds in section 3 “Processing characteristics”).

#### **B.7: Flag of spiking values**

For each measurement (temperature, conductivity, sound velocity, transmittance, fluorescence and dissolved oxygen), the flag checks spiking values (see thresholds in section 3 “Processing characteristics”) as follows:

$|V2 - (V3 + V1) / 2| - |V1 - V3| / 2 > \text{threshold}$ , where V1, V2 and V3 are 3 consecutive values.

#### **B.8: Bin average filter (SBE data processing toolbox)**

The bin average filter averages data, using averaging intervals based on the pressure ranges. The bin sizes are fixed at one meter.

### **B.9: Calculation of the derived parameters**

These calculations use pressure, temperature, and conductivity data to compute the following oceanographic parameters: salinity, sound velocity, density, freezing point, depth and DO<sub>2</sub> saturation (sea water toolbox V3.2 from CSIRO).

### **B.10: Manual data check**

A graphic toolbox allows the analyst to check, compare and flag the measurements for the following variables:

- Temperature profile: down cast, up cast and freezing point
- Salinity profile: both down and up casts
- Sound velocity profile: both down and up casts from measurements and down cast from derived value (calculated from pressure, salinity and temperature)
- Transmittance: both down and up casts
- Fluorescence: both down and up casts
- Dissolved oxygen: both down and up casts
- Density: both down and up casts
- $d(\text{density})/d(\text{pressure})$ : both down cast and up casts

See example in annex 6.

## **C: Correction and inter-comparison**

The processing steps described in section C are applied on each MVP transect.

### **C.1: Transmittance maximum adjustment**

Transmittance values of each MVP cast are adjusted with the transect maximum transmittance as follows:

$$V_{\text{corrected}} = V_{\text{measured}} + (100 - \text{maximum}).$$

### **C.2: Fluorescence minimum adjustment**

This step determines the minimum fluorescence recorded value for each MVP cast. The calculated median of these minimum values is then subtracted from all fluorescence values of all casts:

$$V_{\text{corrected}} = V_{\text{measured}} - \text{minimum}.$$

### **C.3: Dissolved oxygen adjustment**

The oxygen sensor output also has a non-negligible drift with time. The calibration coefficients (measured before the cruise) are not sufficient to calibrate the sensor. A comparison with the oxygen sensor on the rosette is therefore required: the percentage of dissolved oxygen measured with the co-localised rosette is averaged between 150 and 250-meter depth. This value is then compared to the MVP up cast at the same depths and a constant error is calculated. This error adjustment is then applied on all MVP casts for all depths of each transect.

### **C.4: Rosette inter-comparison**

- All rosettes done between 24 hours before the first cast and 24 hours after the last cast of the transect are detected.
- Each of these rosettes is associated to the nearest MVP cast for variables inter-comparison (rejected if the distance is greater than 10.8NM – Nautical Mile).
- The variable of each MVP profile are then plotted (down casts) with the profiles of the bordering rosette. In addition, mean and standard deviation of all MVP down cast profiles of each transect are plotted (for geographic variability visualisation). See plot for this leg in annex 1.

### **C.5: TSG inter-comparison**

- The first 10 meters of MVP salinity and fluorescence records are averaged for each down cast and each up cast.
- TSG data are co-localised and averaged on 5 minutes



- Differences (MVP-TSG) are flagged if:
  - 1- MVP vertical standard deviation (on first 10 meter) > threshold
  - 2- TSG time series standard deviation (on 5 minutes) > threshold
  - 3- Difference > median (differences) +/- standard deviation (differences).
- Remaining differences (not flagged) are plotted and then a constant is selected and applied on all casts (for salinity and fluorescence).

See annex 2 for graph and section 3 Processing characteristics for thresholds.

#### **D: Final data format**

Data profiles (down cast profiles only, excepted dissolved oxygen data) are saved in text format with the extension \*.int. One folder per MVP transect and one file per cast are created.

**Table 3: Final data file format**

<b>Col</b>	<b>Content</b>	<b>Format</b>	<b>Units</b>
1	Pressure	F12.2	dB
2	Temperature (ITS-90)	F12.2	deg C
3	Practical Salinity	F12.2	psu
4	Sound velocity	F12.2	m/s
5	Transmittance	F12.2	%
6	Fluorescence	F12.2	ug/L
7	Dissolved Oxygen	F12.2	mL/L
8	Absolute Salinity (TEOS-10)	F12.2	g/kg
9	Conservative Temperature (TEOS-10)	F12.2	deg C
10	In situ density (TEOS-10)	F12.2	kg/m <sup>3</sup>
11	Potential density (TEOS-10)	F12.2	kg/m <sup>3</sup>

NaN stands for: Not a Number. It indicates that no data was recorded or that the data was flagged and mistrusted.

### 3. Processing characteristics

This information is automatically generated from the processing program.

#### 3.1 Transect 1

Amundsen MVP data processing

Amundsen\_2016002

Year: 2016

Leg: 2

Transect: 1

Processing date: 20-Jun-2017

////////// Limits and Thresholds Settings //////////

B6: -2.00 db - Minimum pressure

B6: 7000.00 db - Maximum pressure

B6: -3.00 °C - Minimum temperature

B6: 30.00 °C - Maximum temperature

B6: 0.00 mS/cm - Minimum conductivity

B6: 70.00 mS/cm - Maximum conductivity

B6: -0.10 ug/L - Minimum fluorescence

B6: 20.00 ug/L - Maximum fluorescence

B6: 1400.00 m/s - Minimum sound velocity

B6: 1500.00 m/s - Maximum sound velocity

B6: 0.00 % - Minimum dissolved oxygen

B6: 100.00 % - Maximum dissolved oxygen

B6: 0.00 % - Minimum transmittance

B6: 120.00 % - Maximum transmittance

B7: 0.40 °C/m - Temperature limit spike

B7: 0.20 mS/cm - Conductivity limit spike

B7: 4.00 m/s/m - Sound velocity limit spike

B7: 4.00 %/m - Transmittance limit spike

B7: 10.00 ml/L/m - Dissolved oxygen limit spike

B7: 10.00 ml/L/m - Fluorescence limit spike

C5: 10.00 m - Lower depth for comparison MVP-TSG

C5: 0.05 psu - Standard deviation flags on MVP salinity at several depths for comparison MVP-TSG

C5: 0.20 ug/L - Standard deviation flags on MVP fluorescence at several depths for comparison MVP-TSG

C5: 0.04 psu - Standard deviation flags on TSG salinity during 5 minutes for comparison MVP-TSG

C5: 0.05 ug/L - Standard deviation flags on TSG fluorescence during 5 minutes for comparison MVP-TSG

//////// Processing //////////

----- Inter-comparison-----

C1: Bias applied on Transmittance

Constant bias correction: -0.600 %

C2: Bias applied on Fluorescence

Constant bias correction: -0.100 ug/l

C3: Bias applied on Dissolved oxygen

Constant bias correction: -0.511%

C5: Salinity bias statistics

Number of samples used (TSG) = 22

Median (bias)= -0.040

Mean (bias)= -0.040

Standard deviation (bias)= 0.013

Accuracy (bias)= 0.003

C5: Fluorescence bias statistic calculate

Number of samples used (TSG) = 26

Median (bias)= -0.056

Mean (bias)= -0.036

Standard deviation (bias)= 0.053

Accuracy (bias)= 0.010

C5: Bias applied on Salinity

Constant bias correction: -0.040 psu

C5: Bias applied on Fluorescence

Constant bias correction: 0.000 ug/L

///// List of Casts /////

Cast	File_name	Date	Hour
1	1602001_0001.raw	07-Aug-2016	19:40:10
2	1602001_0002.raw	07-Aug-2016	19:42:38
3	1602001_0003.raw	07-Aug-2016	19:45:20
4	1602001_0004.raw	07-Aug-2016	19:48:10
5	1602001_0005.raw	07-Aug-2016	19:50:50

6	1602001_0006.raw	07-Aug-2016	19:53:20
7	1602001_0007.raw	07-Aug-2016	19:55:51
8	1602001_0008.raw	07-Aug-2016	19:58:22
9	1602001_0009.raw	07-Aug-2016	20:01:13
10	1602001_0010.raw	07-Aug-2016	20:04:39
11	1602001_0011.raw	07-Aug-2016	20:08:38
12	1602001_0012.raw	07-Aug-2016	20:13:26
13	1602001_0013.raw	07-Aug-2016	20:18:17
14	1602001_0014.raw	07-Aug-2016	20:23:54
15	1602001_0015.raw	07-Aug-2016	20:30:07
16	1602001_0016.raw	07-Aug-2016	20:36:53
17	1602001_0017.raw	07-Aug-2016	20:44:03
18	1602001_0018.raw	07-Aug-2016	20:51:47
19	1602001_0019.raw	07-Aug-2016	21:00:05
20	1602001_0020.raw	07-Aug-2016	21:08:51
21	1602001_0021.raw	07-Aug-2016	21:19:13
22	1602001_0022.raw	07-Aug-2016	21:29:45
23	1602001_0023.raw	07-Aug-2016	21:40:29
24	1602001_0024.raw	07-Aug-2016	21:51:49
25	1602001_0025.raw	07-Aug-2016	22:02:56
26	1602001_0026.raw	07-Aug-2016	22:14:22
27	1602001_0027.raw	07-Aug-2016	22:25:13
28	1602001_0028.raw	07-Aug-2016	22:35:58
29	1602001_0029.raw	07-Aug-2016	22:45:30
30	1602001_0030.raw	07-Aug-2016	22:50:27
31	1602001_0031.raw	07-Aug-2016	22:54:09
32	1602001_0032.raw	07-Aug-2016	22:57:16
33	1602001_0033.raw	07-Aug-2016	23:00:01
34	1602001_0034.raw	07-Aug-2016	23:02:35
35	1602001_0035.raw	07-Aug-2016	23:04:53
36	1602001_0036.raw	07-Aug-2016	23:07:12
37	1602001_0037.raw	07-Aug-2016	23:09:37
38	1602001_0038.raw	07-Aug-2016	23:12:02
39	1602001_0039.raw	07-Aug-2016	23:14:24
40	1602001_0040.raw	07-Aug-2016	23:16:41

### 3.2 Transect 2

Amundsen MVP data processing

Amundsen\_2016002

Year: 2016

Leg: 2

Transect: 2

Processing date: 20-Jun-2017

////////// Limits and Thresholds Settings //////////

B6: -2.00 db - Minimum pressure

B6: 7000.00 db - Maximum pressure

B6: -3.00 °C - Minimum temperature

B6: 30.00 °C - Maximum temperature

B6: 0.00 mS/cm - Minimum conductivity

B6: 70.00 mS/cm - Maximum conductivity

B6: -0.10 ug/L - Minimum fluorescence

B6: 20.00 ug/L - Maximum fluorescence

B6: 1400.00 m/s - Minimum sound velocity

B6: 1500.00 m/s - Maximum sound velocity

B6: 0.00 % - Minimum dissolved oxygen

B6: 100.00 % - Maximum dissolved oxygen

B6: 0.00 % - Minimum transmittance

B6: 120.00 % - Maximum transmittance

B7: 0.40 °C/m - Temperature limit spike

B7: 0.20 mS/cm - Conductivity limit spike

B7: 4.00 m/s/m - Sound velocity limit spike

B7: 4.00 %/m - Transmittance limit spike

B7: 10.00 ml/L/m - Dissolved oxygen limit spike

B7: 10.00 ml/L/m - Fluorescence limit spike

C5: 10.00 m - Lower depth for comparison MVP-TSG

C5: 0.05 psu - Standard deviation flags on MVP salinity at several depths for comparison MVP-TSG

C5: 0.20 ug/L - Standard deviation flags on MVP fluorescence at several depths for comparison MVP-TSG

C5: 0.04 psu - Standard deviation flags on TSG salinity during 5 minutes for comparison MVP-TSG

C5: 0.05 ug/L - Standard deviation flags on TSG fluorescence during 5 minutes for comparison MVP-TSG

//////// Processing //////////

----- Inter-comparison-----

C1: Bias applied on Transmittance

Constant bias correction: -1.000 %

C2: Bias applied on Fluorescence

Constant bias correction: -0.100 ug/l

C3: Bias applied on Dissolved oxygen

Constant bias correction: 1.501%

C5: Salinity bias statistics

Number of samples used (TSG) = 3

Median (bias)= 0.510

Mean (bias)= 0.516

Standard deviation (bias)= 0.072

Accuracy (bias)= 0.042

C5: Fluorescence bias statistic calculate

Number of samples used (TSG) = 74

Median (bias)= 0.190

Mean (bias)= 0.182

Standard deviation (bias)= 0.091

Accuracy (bias)= 0.011

C5: Bias applied on Salinity

Constant bias correction: -0.040 psu

C5: Bias applied on Fluorescence

Constant bias correction: 0.000 ug/L

///// List of Casts /////

Cast	File_name	Date	Hour
1	1602002_0001.raw	15-Aug-2016	03:06:45
2	1602002_0002.raw	15-Aug-2016	03:09:36
3	1602002_0003.raw	15-Aug-2016	03:12:29
4	1602002_0004.raw	15-Aug-2016	03:15:21
5	1602002_0005.raw	15-Aug-2016	03:18:17
6	1602002_0006.raw	15-Aug-2016	03:21:09
7	1602002_0007.raw	15-Aug-2016	03:24:02

8	1602002_0008.raw	15-Aug-2016	03:26:56
9	1602002_0009.raw	15-Aug-2016	03:29:43
10	1602002_0010.raw	15-Aug-2016	03:32:24
11	1602002_0011.raw	15-Aug-2016	03:35:18
12	1602002_0012.raw	15-Aug-2016	03:38:11
13	1602002_0013.raw	15-Aug-2016	03:41:01
14	1602002_0014.raw	15-Aug-2016	03:44:01
15	1602002_0015.raw	15-Aug-2016	03:47:01
16	1602002_0016.raw	15-Aug-2016	03:50:02
17	1602002_0017.raw	15-Aug-2016	03:53:09
18	1602002_0018.raw	15-Aug-2016	03:56:27
19	1602002_0019.raw	15-Aug-2016	03:59:52
20	1602002_0020.raw	15-Aug-2016	04:03:08
21	1602002_0021.raw	15-Aug-2016	04:06:13
22	1602002_0022.raw	15-Aug-2016	04:09:21
23	1602002_0023.raw	15-Aug-2016	04:12:42
24	1602002_0024.raw	15-Aug-2016	04:15:59
25	1602002_0025.raw	15-Aug-2016	04:19:13
26	1602002_0026.raw	15-Aug-2016	04:22:26
27	1602002_0027.raw	15-Aug-2016	04:25:41
28	1602002_0028.raw	15-Aug-2016	04:28:58
29	1602002_0029.raw	15-Aug-2016	04:32:19
30	1602002_0030.raw	15-Aug-2016	04:35:37
31	1602002_0031.raw	15-Aug-2016	04:38:52
32	1602002_0032.raw	15-Aug-2016	04:42:03
33	1602002_0033.raw	15-Aug-2016	04:45:17
34	1602002_0034.raw	15-Aug-2016	04:48:28
35	1602002_0035.raw	15-Aug-2016	05:26:16
36	1602002_0036.raw	15-Aug-2016	05:29:30
37	1602002_0037.raw	15-Aug-2016	05:33:06
38	1602002_0038.raw	15-Aug-2016	05:36:29
39	1602002_0039.raw	15-Aug-2016	05:39:57
40	1602002_0040.raw	15-Aug-2016	05:43:29
41	1602002_0041.raw	15-Aug-2016	05:47:03
42	1602002_0042.raw	15-Aug-2016	05:50:40
43	1602002_0043.raw	15-Aug-2016	05:54:14
44	1602002_0044.raw	15-Aug-2016	05:57:42
45	1602002_0045.raw	15-Aug-2016	06:01:06
46	1602002_0046.raw	15-Aug-2016	06:04:35

47	1602002_0047.raw	15-Aug-2016	06:08:11
48	1602002_0048.raw	15-Aug-2016	06:11:56
49	1602002_0049.raw	15-Aug-2016	06:15:43
50	1602002_0050.raw	15-Aug-2016	06:19:36
51	1602002_0051.raw	15-Aug-2016	06:23:33
52	1602002_0052.raw	15-Aug-2016	06:27:29
53	1602002_0053.raw	15-Aug-2016	06:31:27
54	1602002_0054.raw	15-Aug-2016	06:35:20
55	1602002_0055.raw	15-Aug-2016	06:39:15
56	1602002_0056.raw	15-Aug-2016	06:43:11
57	1602002_0057.raw	15-Aug-2016	06:47:13
58	1602002_0058.raw	15-Aug-2016	06:51:18
59	1602002_0059.raw	15-Aug-2016	06:55:25
60	1602002_0060.raw	15-Aug-2016	06:59:39

### 3.2 Transect 3

Amundsen MVP data processing

Amundsen\_2016002

Year: 2016

Leg: 2

Transect: 3

Processing date: 20-Jun-2017

////////// Limits and Thresholds Settings //////////

- B6: -2.00 db - Minimum pressure
- B6: 7000.00 db - Maximum pressure
- B6: -3.00 °C - Minimum temperature
- B6: 30.00 °C - Maximum temperature
- B6: 0.00 mS/cm - Minimum conductivity
- B6: 70.00 mS/cm - Maximum conductivity
- B6: -0.10 ug/L - Minimum fluorescence
- B6: 20.00 ug/L - Maximum fluorescence
- B6: 1400.00 m/s - Minimum sound velocity
- B6: 1500.00 m/s - Maximum sound velocity
- B6: 0.00 % - Minimum dissolved oxygen
- B6: 100.00 % - Maximum dissolved oxygen
- B6: 0.00 % - Minimum transmittance



B6: 120.00 % - Maximum transmittance  
B7: 0.40 °C/m - Temperature limit spike  
B7: 0.20 mS/cm - Conductivity limit spike  
B7: 4.00 m/s/m - Sound velocity limit spike  
B7: 4.00 %/m - Transmittance limit spike  
B7: 10.00 ml/L/m - Dissolved oxygen limit spike  
B7: 10.00 ml/L/m - Fluorescence limit spike  
C5: 10.00 m - Lower depth for comparison MVP-TSG  
C5: 0.05 psu - Standard deviation flags on MVP salinity at several depths for comparison MVP-TSG  
C5: 0.20 ug/L - Standard deviation flags on MVP fluorescence at several depths for comparison MVP-TSG  
C5: 0.04 psu - Standard deviation flags on TSG salinity during 5 minutes for comparison MVP-TSG  
C5: 0.05 ug/L - Standard deviation flags on TSG fluorescence during 5 minutes for comparison MVP-TSG

////////// Processing //////////

----- Inter-comparison-----

C1: Bias applied on Transmittance

Constant bias correction: -0.800 %

C2: Bias applied on Fluorescence

Constant bias correction: -0.100 ug/l

C3: Bias applied on Dissolved oxygen

Constant bias correction: 0.163%

C5: Salinity bias statistics

Number of samples used (TSG) = 1

Median (bias)= 2.113

Mean (bias)= 2.113

Standard deviation (bias)= 0.000

Accuracy (bias)= 0.000

C5: Fluorescence bias statistic calculate

Number of samples used (TSG) = 38

Median (bias)= 0.073

Mean (bias)= 0.076

Standard deviation (bias)= 0.048

Accuracy (bias)= 0.008

C5: Bias applied on Fluorescence

Constant bias correction: 0.000 ug/L

C5: Bias applied on Salinity

Constant bias correction: -0.040 psu

///// List of Casts /////

Cast	File_name	Date	Hour
1	1602003_0001.raw	15-Aug-2016	22:29:07
2	1602003_0002.raw	15-Aug-2016	22:38:09
3	1602003_0003.raw	15-Aug-2016	22:47:13
4	1602003_0004.raw	15-Aug-2016	22:56:31
5	1602003_0005.raw	15-Aug-2016	23:05:55
6	1602003_0006.raw	15-Aug-2016	23:15:32
7	1602003_0007.raw	15-Aug-2016	23:25:20
8	1602003_0008.raw	15-Aug-2016	23:35:17
9	1602003_0009.raw	15-Aug-2016	23:45:21
10	1602003_0010.raw	15-Aug-2016	23:55:31
11	1602003_0011.raw	16-Aug-2016	00:05:49
12	1602003_0012.raw	16-Aug-2016	00:16:13
13	1602003_0013.raw	16-Aug-2016	00:26:40
14	1602003_0014.raw	16-Aug-2016	00:37:09
15	1602003_0015.raw	16-Aug-2016	00:47:41
16	1602003_0016.raw	16-Aug-2016	00:58:15
17	1602003_0017.raw	16-Aug-2016	01:08:48
18	1602003_0018.raw	16-Aug-2016	01:19:21
19	1602003_0019.raw	16-Aug-2016	01:29:57
20	1602003_0020.raw	16-Aug-2016	01:40:31
21	1602003_0021.raw	16-Aug-2016	01:51:05
22	1602003_0022.raw	16-Aug-2016	02:01:38
23	1602003_0023.raw	16-Aug-2016	02:12:13

### 3.4 Transect 4

Amundsen MVP data processing

Amundsen\_2016002

Year: 2016

Leg: 2

Transect: 4

Processing date: 20-Jun-2017

////////// Limits and Thresholds Settings //////////

B6: -2.00 db - Minimum pressure

B6: 7000.00 db - Maximum pressure

B6: -3.00 °C - Minimum temperature

B6: 30.00 °C - Maximum temperature

B6: 0.00 mS/cm - Minimum conductivity

B6: 70.00 mS/cm - Maximum conductivity

B6: -0.10 ug/L - Minimum fluorescence

B6: 20.00 ug/L - Maximum fluorescence

B6: 1400.00 m/s - Minimum sound velocity

B6: 1500.00 m/s - Maximum sound velocity

B6: 0.00 % - Minimum dissolved oxygen

B6: 100.00 % - Maximum dissolved oxygen

B6: 0.00 % - Minimum transmittance

B6: 120.00 % - Maximum transmittance

B7: 0.40 °C/m - Temperature limit spike

B7: 0.20 mS/cm - Conductivity limit spike

B7: 4.00 m/s/m - Sound velocity limit spike

B7: 4.00 %/m - Transmittance limit spike

B7: 10.00 ml/L/m - Dissolved oxygen limit spike

B7: 10.00 ml/L/m - Fluorescence limit spike

C5: 10.00 m - Lower depth for comparison MVP-TSG

C5: 0.05 psu - Standard deviation flags on MVP salinity at several depths for comparison MVP-TSG

C5: 0.20 ug/L - Standard deviation flags on MVP fluorescence at several depths for comparison MVP-TSG

C5: 0.04 psu - Standard deviation flags on TSG salinity during 5 minutes for comparison MVP-TSG

C5: 0.05 ug/L - Standard deviation flags on TSG fluorescence during 5 minutes for comparison MVP-TSG

//////// Processing //////////

----- Inter-comparison-----

C1: Bias applied on Transmittance

Constant bias correction: -1.000 %

C2: Bias applied on Fluorescence

Constant bias correction: -0.100 ug/l

C3: Bias applied on Dissolved oxygen

Constant bias correction: 1.098%

C5: Salinity bias statistics

Number of samples used (TSG) = 28

Median (bias)= 0.141

Mean (bias)= 0.167

Standard deviation (bias)= 0.095

Accuracy (bias)= 0.018

C5: Fluorescence bias statistic calculate

Number of samples used (TSG) = 84

Median (bias)= 0.020

Mean (bias)= 0.057

Standard deviation (bias)= 0.073

Accuracy (bias)= 0.008

C5: Bias applied on Salinity

Constant bias correction: -0.040 psu

C5: Bias applied on Fluorescence

Constant bias correction: 0.000 ug/L

///// List of Casts /////

Cast	File_name	Date	Hour
1	1602004_0001.raw	16-Aug-2016	13:55:51
2	1602004_0002.raw	16-Aug-2016	14:00:13
3	1602004_0003.raw	16-Aug-2016	14:05:09
4	1602004_0004.raw	16-Aug-2016	14:09:50
5	1602004_0005.raw	16-Aug-2016	14:14:26
6	1602004_0006.raw	16-Aug-2016	14:19:08
7	1602004_0007.raw	16-Aug-2016	14:24:08

8	1602004_0008.raw	16-Aug-2016	14:29:23
9	1602004_0009.raw	16-Aug-2016	14:34:13
10	1602004_0010.raw	16-Aug-2016	14:38:51
11	1602004_0011.raw	16-Aug-2016	14:43:57
12	1602004_0012.raw	16-Aug-2016	14:48:20
13	1602004_0013.raw	16-Aug-2016	14:52:08
14	1602004_0014.raw	16-Aug-2016	14:55:56
15	1602004_0015.raw	16-Aug-2016	15:00:25
16	1602004_0016.raw	16-Aug-2016	15:05:17
17	1602004_0017.raw	16-Aug-2016	15:09:03
18	1602004_0018.raw	16-Aug-2016	15:12:49
19	1602004_0019.raw	16-Aug-2016	15:16:26
20	1602004_0020.raw	16-Aug-2016	15:20:03
21	1602004_0021.raw	16-Aug-2016	15:23:53
22	1602004_0022.raw	16-Aug-2016	15:27:26
23	1602004_0023.raw	16-Aug-2016	15:30:01
24	1602004_0024.raw	16-Aug-2016	15:32:25
25	1602004_0025.raw	16-Aug-2016	15:34:50
26	1602004_0026.raw	16-Aug-2016	15:37:18
27	1602004_0027.raw	16-Aug-2016	15:40:01
28	1602004_0028.raw	16-Aug-2016	15:42:55
29	1602004_0029.raw	16-Aug-2016	15:45:40
30	1602004_0030.raw	16-Aug-2016	15:48:04
31	1602004_0031.raw	16-Aug-2016	15:50:10
32	1602004_0032.raw	16-Aug-2016	15:52:21
33	1602004_0033.raw	16-Aug-2016	15:55:11
34	1602004_0034.raw	16-Aug-2016	15:59:02
35	1602004_0035.raw	16-Aug-2016	16:01:32
36	1602004_0036.raw	16-Aug-2016	16:03:50
37	1602004_0037.raw	16-Aug-2016	16:06:05
38	1602004_0038.raw	16-Aug-2016	16:08:50
39	1602004_0039.raw	16-Aug-2016	16:12:41
40	1602004_0040.raw	16-Aug-2016	16:16:08
41	1602004_0041.raw	16-Aug-2016	16:19:57
42	1602004_0042.raw	16-Aug-2016	16:22:49
43	1602004_0043.raw	16-Aug-2016	16:25:38
44	1602004_0044.raw	16-Aug-2016	16:28:07
45	1602004_0045.raw	16-Aug-2016	16:30:35
46	1602004_0046.raw	16-Aug-2016	16:32:40

47	1602004_0047.raw	16-Aug-2016	16:34:38
48	1602004_0048.raw	16-Aug-2016	16:36:49
49	1602004_0049.raw	16-Aug-2016	16:38:46
50	1602004_0050.raw	16-Aug-2016	16:40:33
51	1602004_0051.raw	16-Aug-2016	16:42:17
52	1602004_0052.raw	16-Aug-2016	16:44:10
53	1602004_0053.raw	16-Aug-2016	16:46:19
54	1602004_0054.raw	16-Aug-2016	16:48:35
55	1602004_0055.raw	16-Aug-2016	16:51:52

### 3.5 Transect 5

Amundsen MVP data processing

Amundsen\_2016002

Year: 2016

Leg: 2

Transect: 5

Processing date: 20-Jun-2017

////////// Limits and Thresholds Settings //////////

- B6: -2.00 db - Minimum pressure
- B6: 7000.00 db - Maximum pressure
- B6: -3.00 °C - Minimum temperature
- B6: 30.00 °C - Maximum temperature
- B6: 0.00 mS/cm - Minimum conductivity
- B6: 70.00 mS/cm - Maximum conductivity
- B6: -0.10 ug/L - Minimum fluorescence
- B6: 20.00 ug/L - Maximum fluorescence
- B6: 1400.00 m/s - Minimum sound velocity
- B6: 1500.00 m/s - Maximum sound velocity
- B6: 0.00 % - Minimum dissolved oxygen
- B6: 100.00 % - Maximum dissolved oxygen
- B6: 0.00 % - Minimum transmittance
- B6: 120.00 % - Maximum transmittance
- B7: 0.40 °C/m - Temperature limit spike
- B7: 0.20 mS/cm - Conductivity limit spike
- B7: 4.00 m/s/m - Sound velocity limit spike
- B7: 4.00 %/m - Transmittance limit spike

B7: 10.00 ml/L/m - Dissolved oxygen limit spike  
B7: 10.00 ml/L/m - Fluorescence limit spike  
C5: 10.00 m - Lower depth for comparison MVP-TSG  
C5: 0.05 psu - Standard deviation flags on MVP salinity at several depths for comparison MVP-TSG  
C5: 0.20 ug/L - Standard deviation flags on MVP fluorescence at several depths for comparison MVP-TSG  
C5: 0.04 psu - Standard deviation flags on TSG salinity during 5 minutes for comparison MVP-TSG  
C5: 0.05 ug/L - Standard deviation flags on TSG fluorescence during 5 minutes for comparison MVP-TSG

////////// Processing //////////

----- Inter-comparison-----

C1: Bias applied on Transmittance

Constant bias correction: -1.000 %

C2: Bias applied on Fluorescence

Constant bias correction: -0.100 ug/l

C3: Bias applied on Dissolved oxygen

Constant bias correction: 1.000%

C5: Salinity bias statistics

Number of samples used (TSG) = 8

Median (bias)= 0.231

Mean (bias)= 0.218

Standard deviation (bias)= 0.103

Accuracy (bias)= 0.036

C5: Fluorescence bias statistic calculate

Number of samples used (TSG) = 46

Median (bias)= 0.015

Mean (bias)= 0.011

Standard deviation (bias)= 0.016

Accuracy (bias)= 0.002

C5: Bias applied on Salinity

Constant bias correction: -0.040 psu

C5: Bias applied on Fluorescence

Constant bias correction: 0.000 ug/L

///// List of Casts /////

Cast	File_name	Date	Hour
1	1602004_0056.raw	16-Aug-2016	16:54:19
2	1602004_0057.raw	16-Aug-2016	16:56:58
3	1602004_0058.raw	16-Aug-2016	16:59:12
4	1602004_0059.raw	16-Aug-2016	17:01:37
5	1602004_0060.raw	16-Aug-2016	17:03:49
6	1602004_0061.raw	16-Aug-2016	17:06:10
7	1602004_0062.raw	16-Aug-2016	17:08:24
8	1602004_0063.raw	16-Aug-2016	17:10:30
9	1602004_0064.raw	16-Aug-2016	17:12:31
10	1602004_0065.raw	16-Aug-2016	17:14:51
11	1602004_0066.raw	16-Aug-2016	17:17:13
12	1602004_0067.raw	16-Aug-2016	17:20:15
13	1602004_0068.raw	16-Aug-2016	17:23:09
14	1602004_0069.raw	16-Aug-2016	17:25:05
15	1602004_0070.raw	16-Aug-2016	17:26:50
16	1602004_0071.raw	16-Aug-2016	17:29:05
17	1602004_0072.raw	16-Aug-2016	17:31:25
18	1602004_0073.raw	16-Aug-2016	17:33:54
19	1602004_0074.raw	16-Aug-2016	17:36:39
20	1602004_0075.raw	16-Aug-2016	17:39:14
21	1602004_0076.raw	16-Aug-2016	17:41:17
22	1602004_0077.raw	16-Aug-2016	17:43:16
23	1602004_0078.raw	16-Aug-2016	17:45:29
24	1602004_0079.raw	16-Aug-2016	17:48:29
25	1602004_0080.raw	16-Aug-2016	17:51:47
26	1602004_0081.raw	16-Aug-2016	17:54:58
27	1602004_0082.raw	16-Aug-2016	17:58:18
28	1602004_0083.raw	16-Aug-2016	18:01:42
29	1602004_0084.raw	16-Aug-2016	18:05:05



### 3.6 Transect 6

Amundsen MVP data processing

Amundsen\_2016002

Year: 2016

Leg: 2

Transect: 6

Processing date: 20-Jun-2017

////////// Limits and Thresholds Settings //////////

B6: -2.00 db - Minimum pressure

B6: 7000.00 db - Maximum pressure

B6: -3.00 °C - Minimum temperature

B6: 30.00 °C - Maximum temperature

B6: 0.00 mS/cm - Minimum conductivity

B6: 70.00 mS/cm - Maximum conductivity

B6: -0.10 ug/L - Minimum fluorescence

B6: 20.00 ug/L - Maximum fluorescence

B6: 1400.00 m/s - Minimum sound velocity

B6: 1500.00 m/s - Maximum sound velocity

B6: 0.00 % - Minimum dissolved oxygen

B6: 100.00 % - Maximum dissolved oxygen

B6: 0.00 % - Minimum transmittance

B6: 120.00 % - Maximum transmittance

B7: 0.40 °C/m - Temperature limit spike

B7: 0.20 mS/cm - Conductivity limit spike

B7: 4.00 m/s/m - Sound velocity limit spike

B7: 4.00 %/m - Transmittance limit spike

B7: 10.00 ml/L/m - Dissolved oxygen limit spike

B7: 10.00 ml/L/m - Fluorescence limit spike

C5: 10.00 m - Lower depth for comparison MVP-TSG

C5: 0.05 psu - Standard deviation flags on MVP salinity at several depths for comparison MVP-TSG

C5: 0.20 ug/L - Standard deviation flags on MVP fluorescence at several depths for comparison MVP-TSG

C5: 0.04 psu - Standard deviation flags on TSG salinity during 5 minutes for comparison MVP-TSG

C5: 0.05 ug/L - Standard deviation flags on TSG fluorescence during 5 minutes for comparison MVP-TSG

//////// Processing //////////

----- Inter-comparison-----

C1: Bias applied on Transmittance

Constant bias correction: -1.000 %

C2: Bias applied on Fluorescence

Constant bias correction: -0.100 ug/l

C3: Bias applied on Dissolved oxygen

Constant bias correction: -0.961%

C5: Salinity bias statistics

Number of samples used (TSG) = 4

Median (bias)= 0.455

Mean (bias)= 0.439

Standard deviation (bias)= 0.046

Accuracy (bias)= 0.023

C5: Fluorescence bias statistic calculate

Number of samples used (TSG) = 24

Median (bias)= 0.001

Mean (bias)= 0.009

Standard deviation (bias)= 0.034

Accuracy (bias)= 0.007

C5: Bias applied on Salinity

Constant bias correction: -0.040 psu

C5: Bias applied on Fluorescence

Constant bias correction: 0.000 ug/L

///// List of Casts /////

Cast	File_name	Date	Hour
1	1602004_0001.raw	16-Aug-2016	13:55:51
2	1602004_0002.raw	16-Aug-2016	14:00:13
3	1602004_0003.raw	16-Aug-2016	14:05:09
4	1602004_0004.raw	16-Aug-2016	14:09:50
5	1602004_0005.raw	16-Aug-2016	14:14:26
6	1602004_0006.raw	16-Aug-2016	14:19:08
7	1602004_0007.raw	16-Aug-2016	14:24:08

8	1602004_0008.raw	16-Aug-2016	14:29:23
9	1602004_0009.raw	16-Aug-2016	14:34:13
10	1602004_0010.raw	16-Aug-2016	14:38:51
11	1602004_0011.raw	16-Aug-2016	14:43:57
12	1602004_0012.raw	16-Aug-2016	14:48:20
13	1602004_0013.raw	16-Aug-2016	14:52:08
14	1602004_0014.raw	16-Aug-2016	14:55:56
15	1602004_0015.raw	16-Aug-2016	15:00:25
16	1602004_0016.raw	16-Aug-2016	15:05:17
17	1602004_0017.raw	16-Aug-2016	15:09:03

### 3.7 Transect 7

Amundsen MVP data processing

Amundsen\_2016002

Year: 2016

Leg: 2

Transect: 7

Processing date: 20-Jun-2017

////////// Limits and Thresholds Settings //////////

- B6: -2.00 db - Minimum pressure
- B6: 7000.00 db - Maximum pressure
- B6: -3.00 °C - Minimum temperature
- B6: 30.00 °C - Maximum temperature
- B6: 0.00 mS/cm - Minimum conductivity
- B6: 70.00 mS/cm - Maximum conductivity
- B6: -0.10 ug/L - Minimum fluorescence
- B6: 20.00 ug/L - Maximum fluorescence
- B6: 1400.00 m/s - Minimum sound velocity
- B6: 1500.00 m/s - Maximum sound velocity
- B6: 0.00 % - Minimum dissolved oxygen
- B6: 100.00 % - Maximum dissolved oxygen
- B6: 0.00 % - Minimum transmittance
- B6: 120.00 % - Maximum transmittance
- B7: 0.40 °C/m - Temperature limit spike
- B7: 0.20 mS/cm - Conductivity limit spike
- B7: 4.00 m/s/m - Sound velocity limit spike

B7: 4.00 %/m - Transmittance limit spike  
 B7: 10.00 ml/L/m - Dissolved oxygen limit spike  
 B7: 10.00 ml/L/m - Fluorescence limit spike  
 C5: 10.00 m - Lower depth for comparison MVP-TSG  
 C5: 0.05 psu - Standard deviation flags on MVP salinity at several depths for comparison MVP-TSG  
 C5: 0.20 ug/L - Standard deviation flags on MVP fluorescence at several depths for comparison MVP-TSG  
 C5: 0.04 psu - Standard deviation flags on TSG salinity during 5 minutes for comparison MVP-TSG  
 C5: 0.05 ug/L - Standard deviation flags on TSG fluorescence during 5 minutes for comparison MVP-TSG

////////// Processing //////////

----- Inter-comparison-----

C1: Bias applied on Transmittance

Constant bias correction: -1.000 %

C2: Bias applied on Fluorescence

Constant bias correction: -0.100 ug/l

C3: Bias applied on Dissolved oxygen

Constant bias correction: 9.940%

C5: Bias applied on Salinity

Constant bias correction: 0.000 psu

C5: Bias applied on Fluorescence

Constant bias correction: 0.000 ug/L

C5: Bias applied on Salinity

Constant bias correction: -0.040 psu

C5: Bias applied on Fluorescence

Constant bias correction: 0.000 ug/L

///// List of Casts /////

Cast	File_name	Date	Hour
1	1602005_0003.raw	24-Aug-2016	15:13:57
2	1602005_0004.raw	24-Aug-2016	15:16:21
3	1602005_0005.raw	24-Aug-2016	15:18:47
4	1602005_0006.raw	24-Aug-2016	15:21:13
5	1602005_0007.raw	24-Aug-2016	15:23:35

6	1602005_0008.raw	24-Aug-2016	15:25:57
7	1602005_0009.raw	24-Aug-2016	15:28:22
8	1602005_0010.raw	24-Aug-2016	15:30:48
9	1602005_0011.raw	24-Aug-2016	15:33:11
10	1602005_0012.raw	24-Aug-2016	15:35:38
11	1602005_0013.raw	24-Aug-2016	15:38:10

#### 4. Data quality discussion

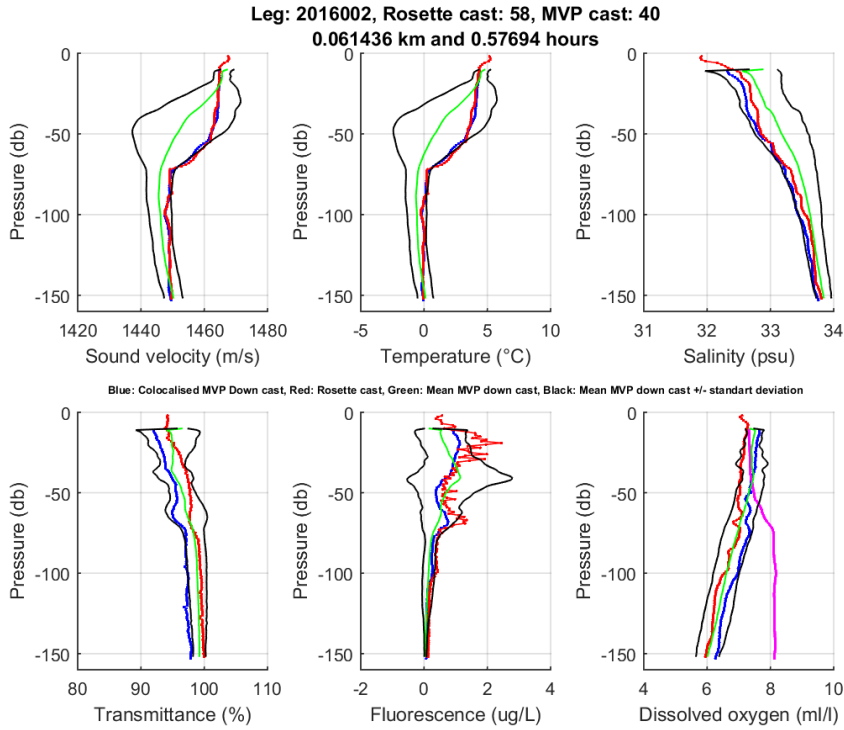
- Temperature uncertainty is in the order of  $0.01^{\circ}\text{C}$  or better. Inter-comparisons with the co-localised Rosette provide validation for the MVP temperature data.
- Salinity uncertainty is in the order of  $0.01\text{psu}$  (good Rosette inter-comparison) or better during periods of low vertical variability. However, the uncertainty can exceed  $0.015\text{psu}$  during high vertical gradient.
- The sound velocity sensor worked well. Its measurements can be interpreted with an uncertainty in the order of  $0.02\text{m/s}$ . The MVP sound velocity variation exactly corresponds to those calculated using the pressure, the salinity and the temperature. However, a constant difference persists between the MVP sound velocity values and values estimated from pressure, salinity and temperature ( $\sim 0.3\text{-}0.4\text{m/s}$ ). These differences persist for every legs and years. This might suggest that the method of estimating sound velocity from salinity and temperature is not suitable.
- The transmissometer provides very good results for this kind of use. The measurement noise is smaller than  $0.1\%$ .
- The dissolved oxygen sensor on the MVP provides satisfying results. However, adjustments from CTD-Rosette data is needed due to an important drift in time. Adjustments are performed on data from transects associated with CTD-Rosette casts performed before and after. Dissolved oxygen shows then an accuracy of  $\sim 1\%$ . When comparison with CTD-Rosette data is not possible, the accuracy is higher ( $\sim 5\%$ ). Furthermore, the uncertainty may exceed the above values in presence of high vertical temperature and salinity gradients. The equation to convert % to  $\mu\text{g/L}$  uses the temperature and the salinity. A very small misalignment between the two sensors can lead to high dissolved oxygen bias ( $>3\%$ ).

Note: The cable of the sensor failed during transect 7. All dissolved oxygen data were removed for this transect.

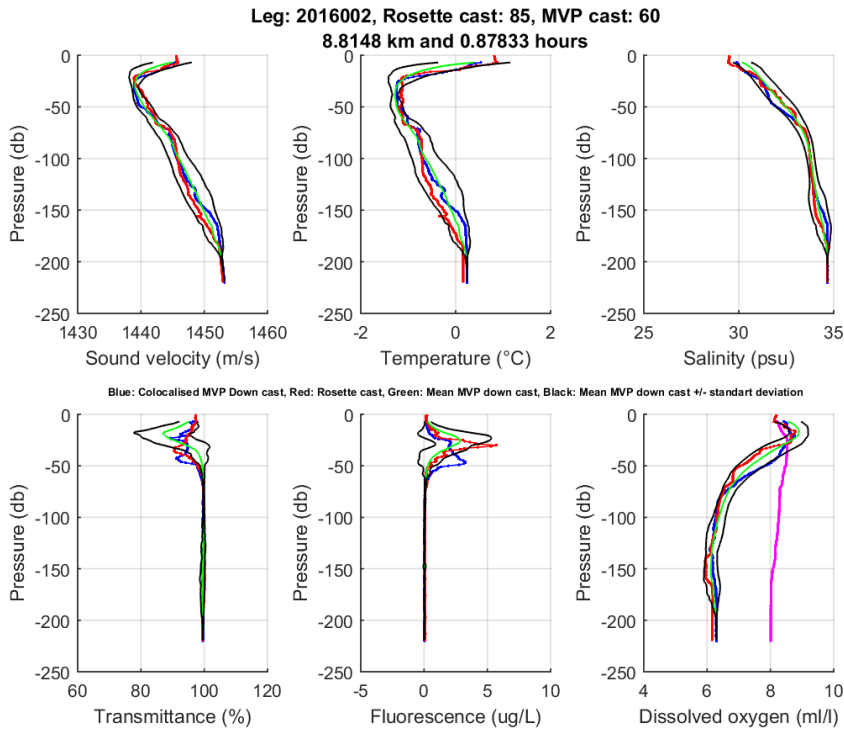
- The fluorimeter provides good data. Its accuracy is estimated at  $0.1\mu\text{g/L}$ . Comparisons with the CTD-Rosette are good.

# Annex 1: Rosette Inter-comparison plot

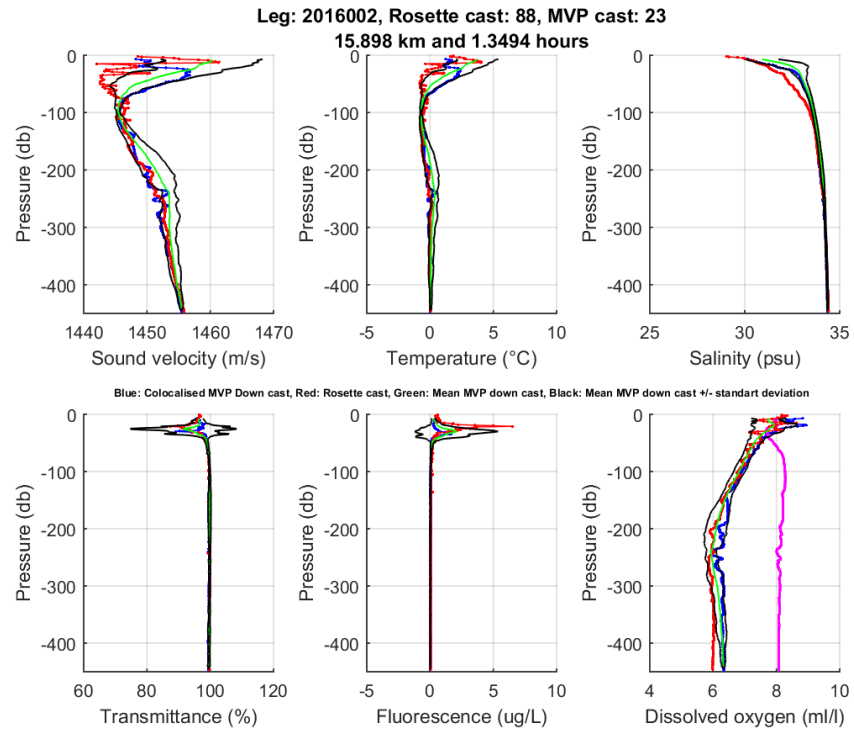
## ○ Transect 1



## ○ Transect 2



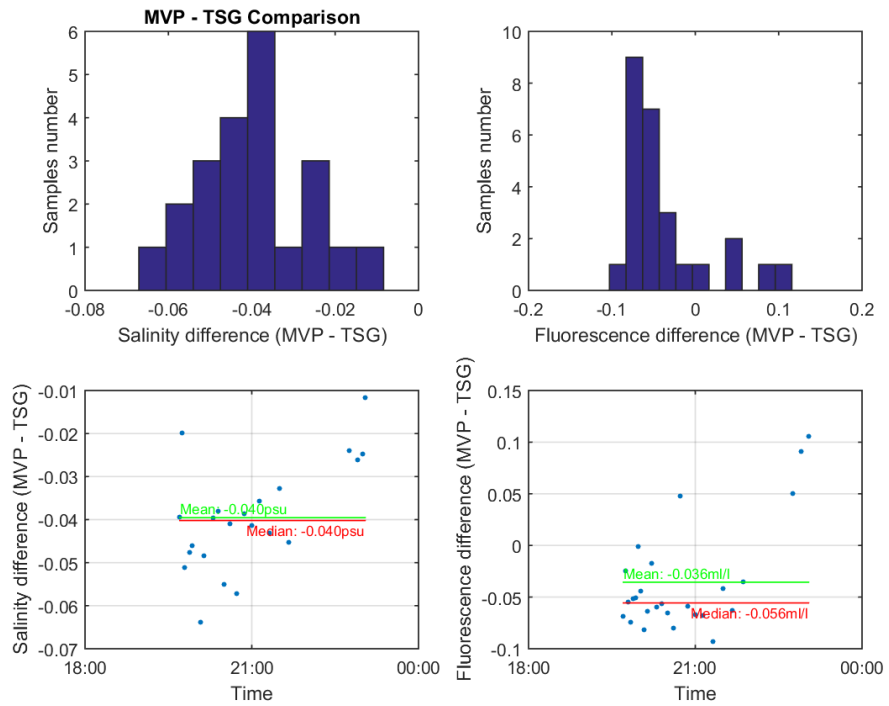
○ Transect 3





## Annex 2: TSG Inter-comparison plot

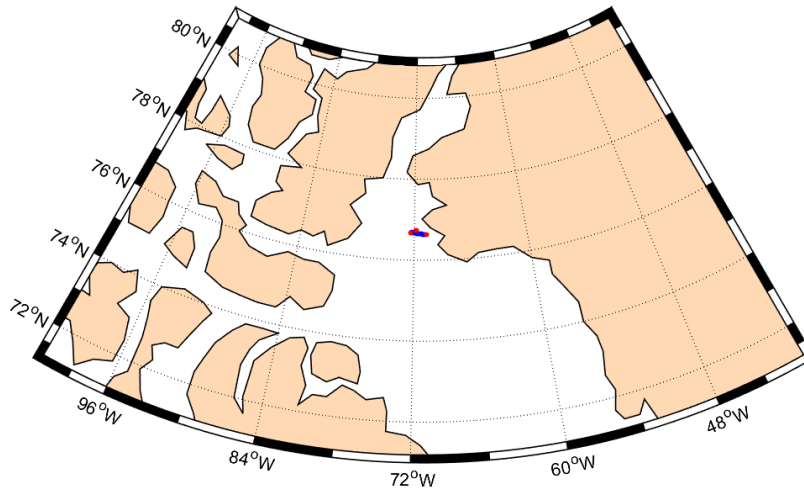
- Transect 1



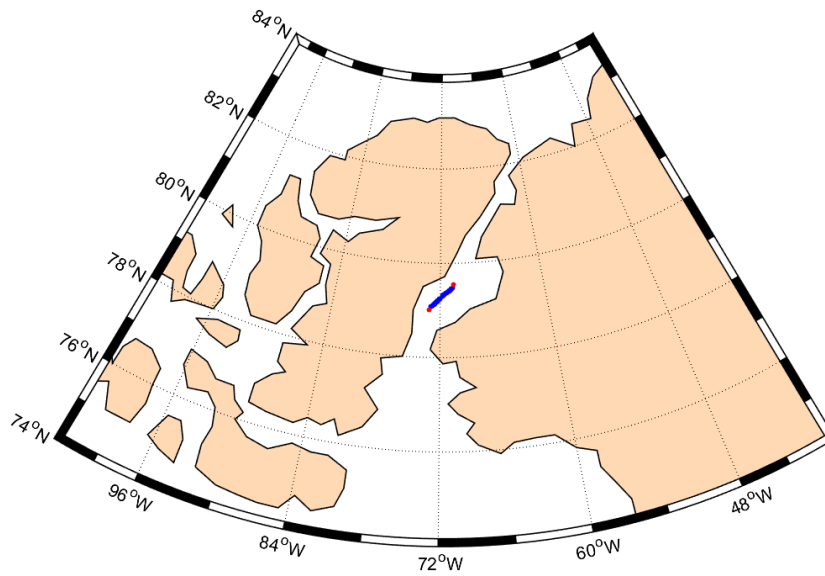
### Annex 3: Mapping

Blue points represent the MVP cast positions and red points the co-localized rosette positions.

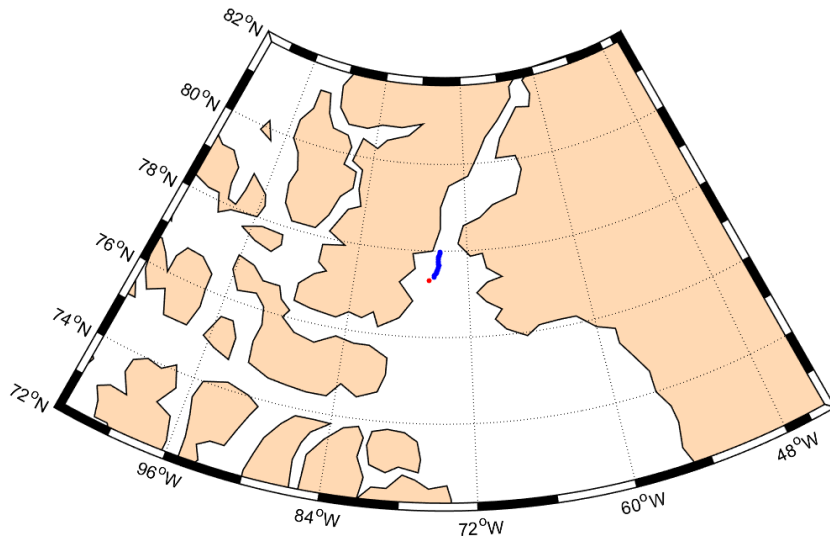
- Transect 1



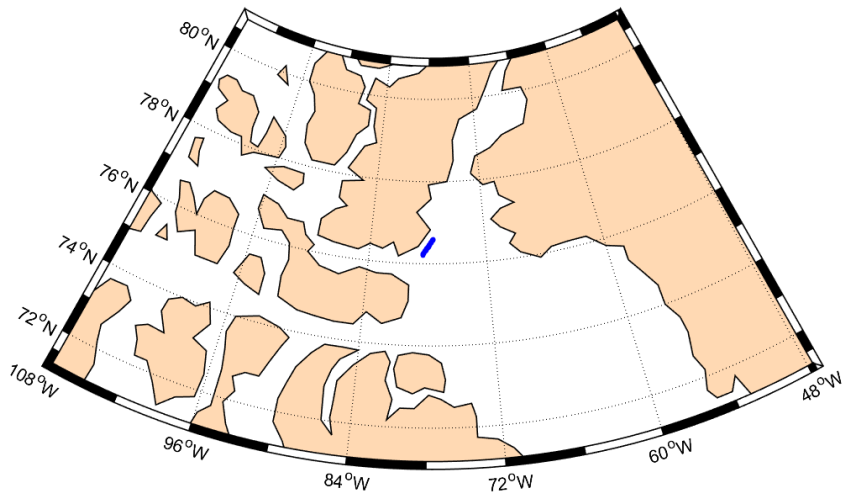
- Transect 2



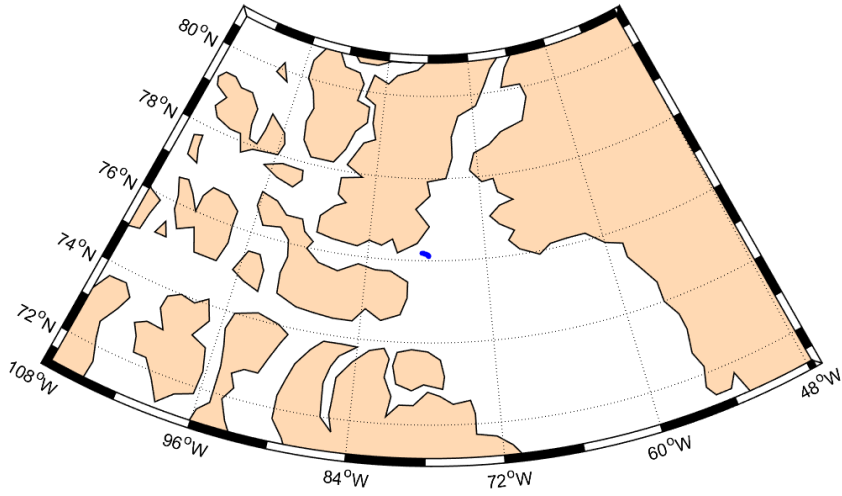
○ Transect 3



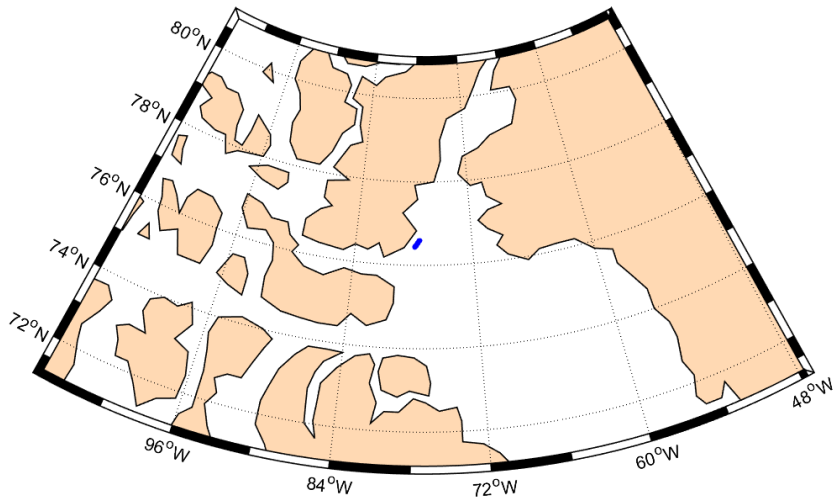
○ Transect 4



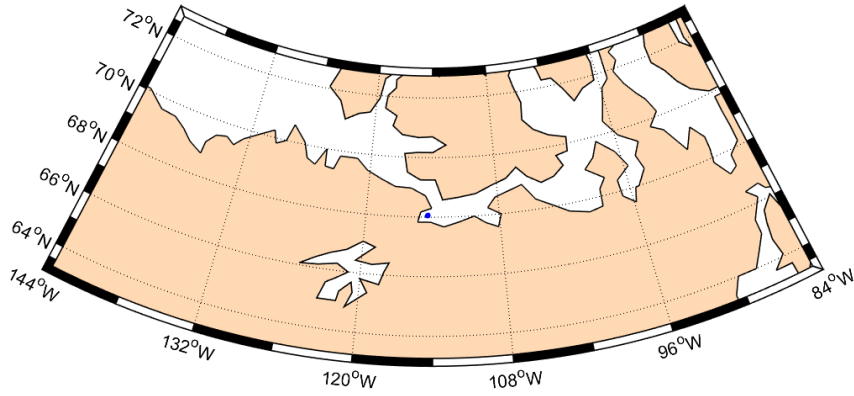
- Transect 5



- Transect 6



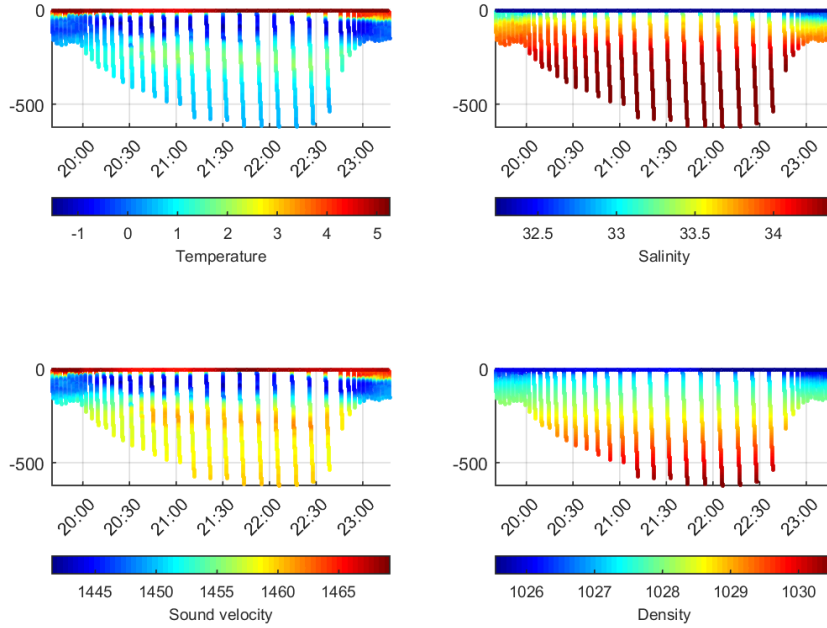
- Transect 7



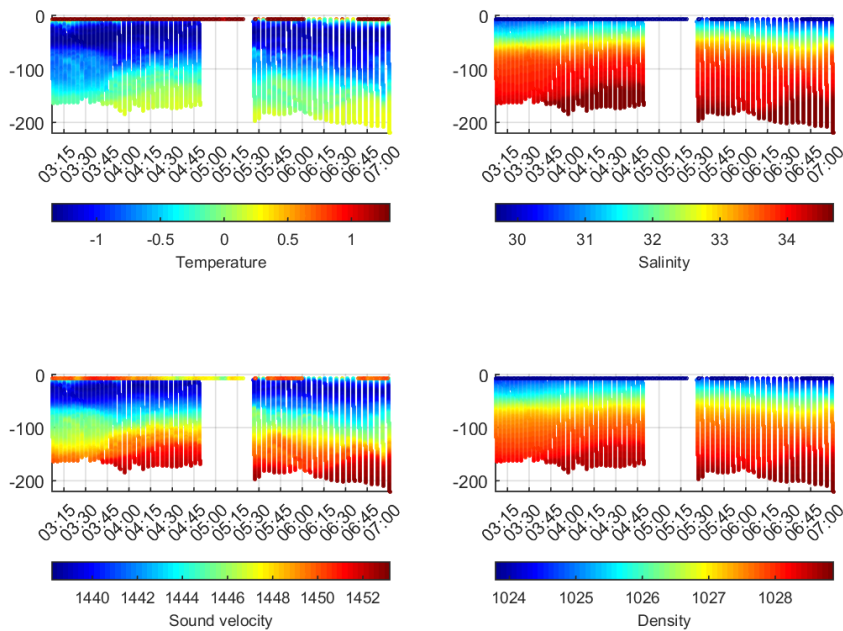
## Annex 4: Scatter plots (MVP+ TSG)

TSG data are the points represented near the surface.

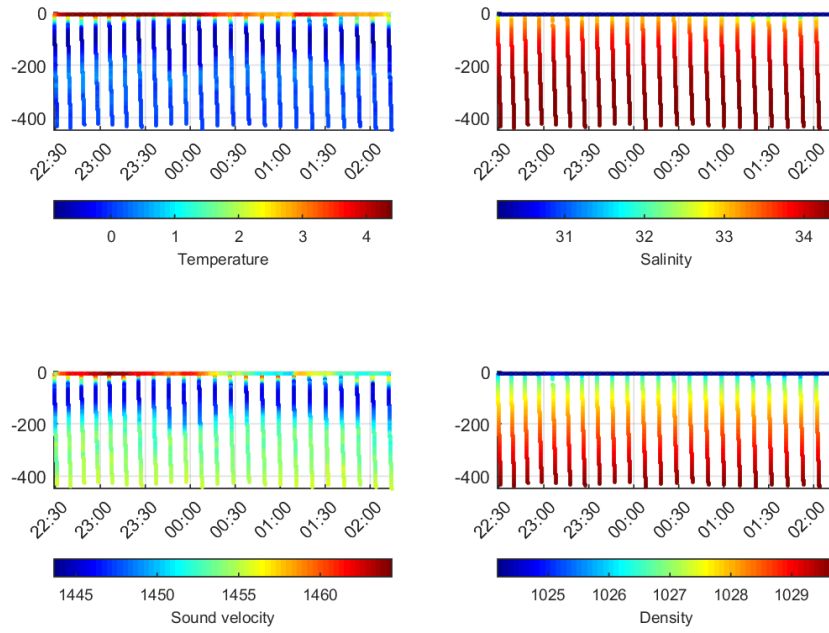
### ○ Transect 1



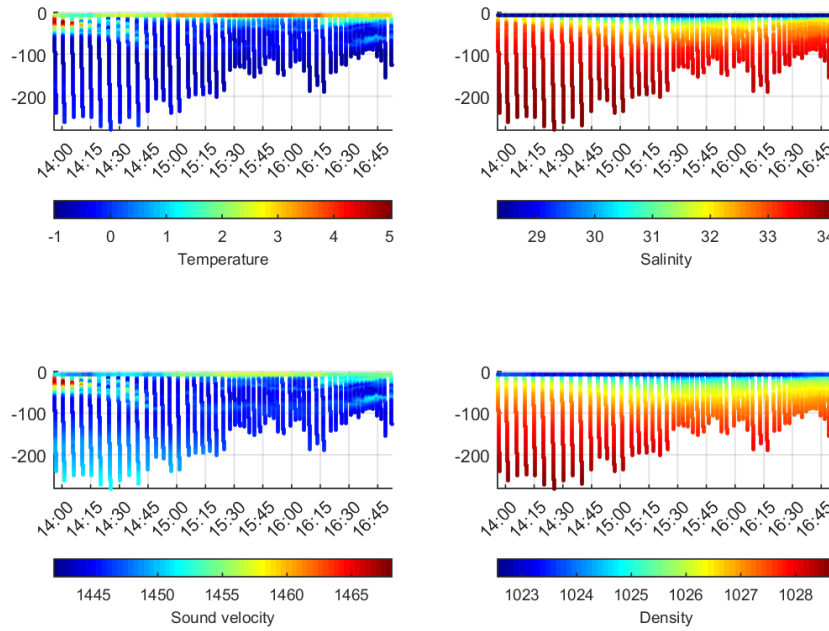
### ○ Transect 2



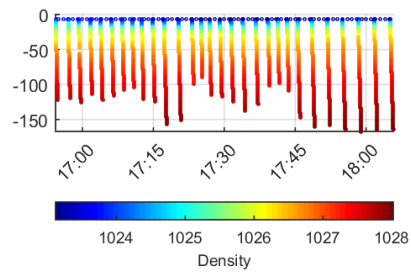
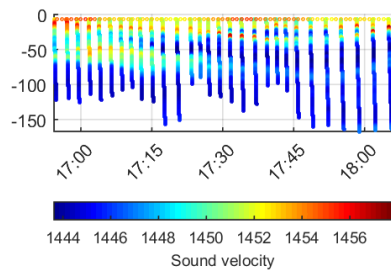
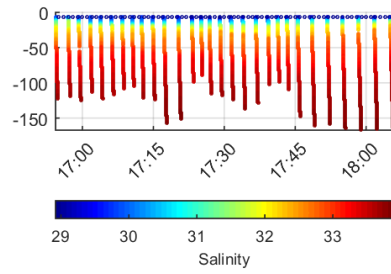
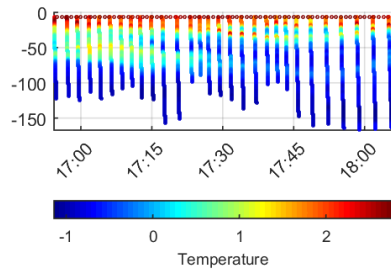
○ Transect 3



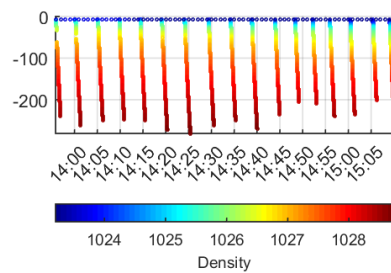
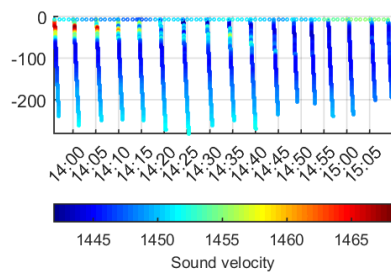
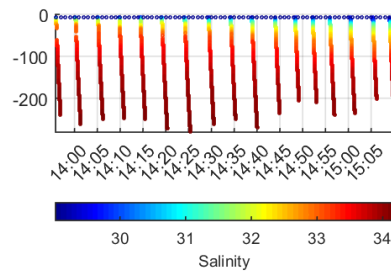
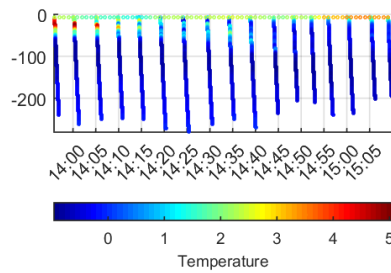
○ Transect 4



○ Transect 5

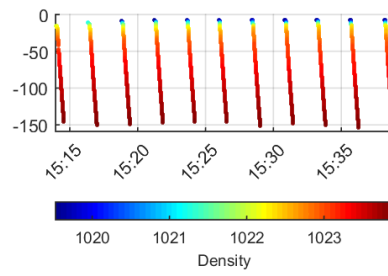
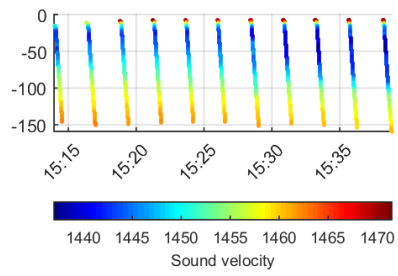
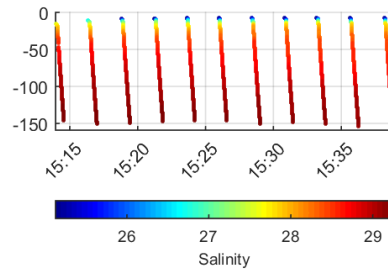
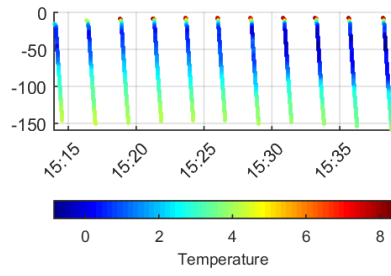


○ Transect 6

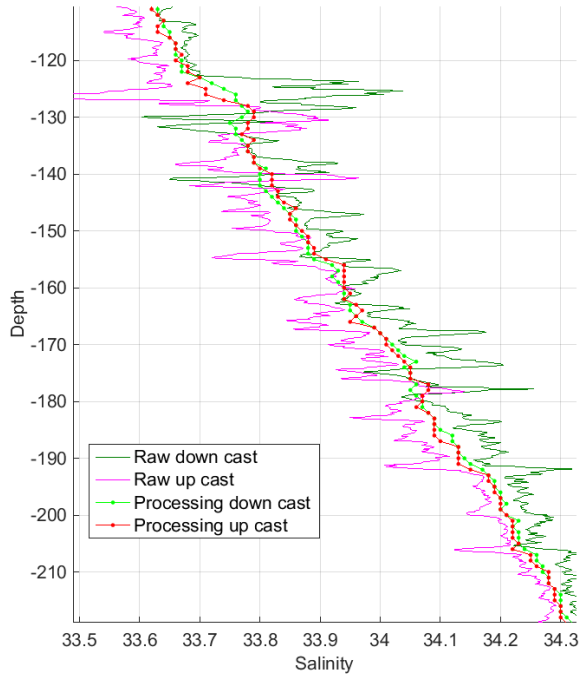




○ Transect 7

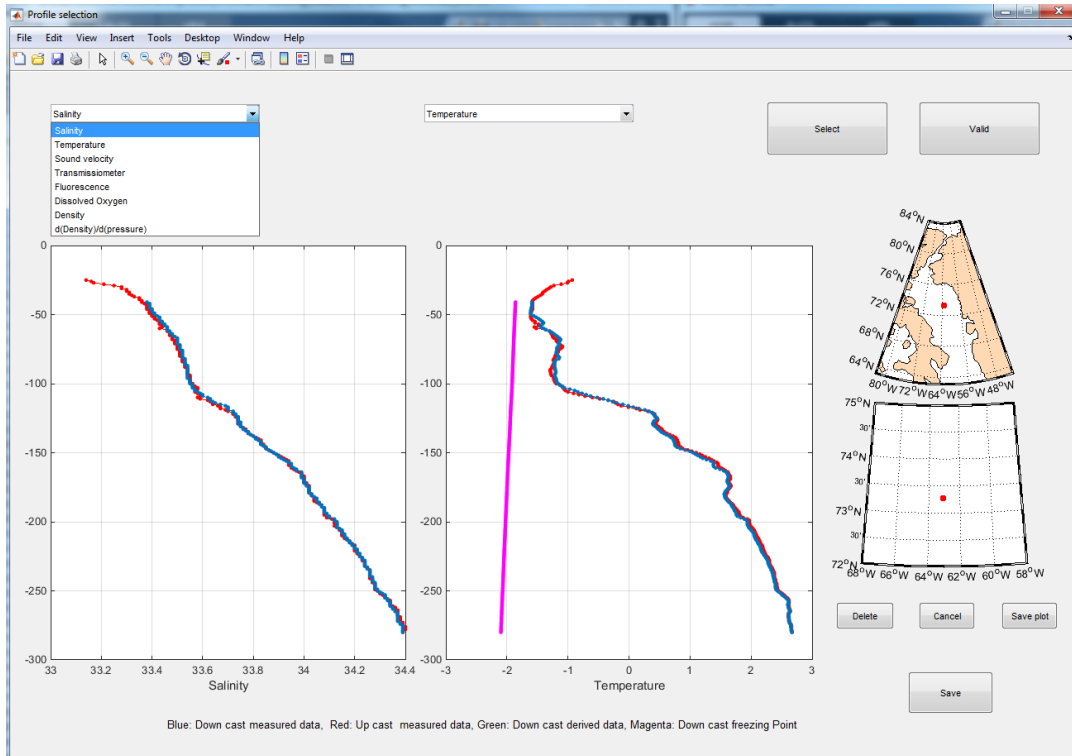


## Annex 5: Filter comparison

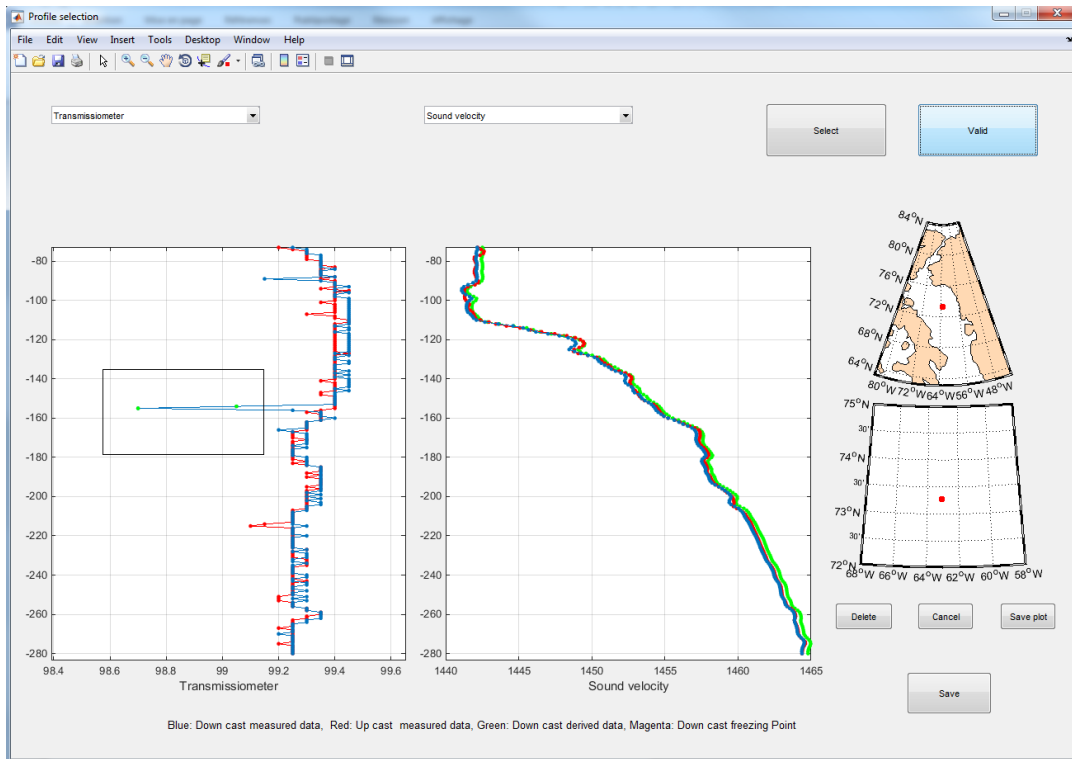


Processed cast is the result of a Low pass filter and Align sensor filter.

## Annex 6: Data visualizer



Selection of the variable to observe



Selection and flag of bad points