2016 Hydrobios-CTD Data Processing Notes

Last updated on 06 December 2016

NGCC ✦ CCGS

AMUNDSEN

Table of Contents

1. Introduction 3
2. Processing protocol 4
A: Data reading 4
B: Flag and processing 5
C: Correction and inter-comparison 7
D: Output data 7
3. Processing characteristics 9
4. Data quality discussion 11
Annex 1: Inter-comparison plot 12
Annex 2: Mapping 13
Annex 3: Data visualizer 14

1. Introduction

The Canadian research icebreaker CCGS *Amundsen* is equipped with a multi-plankton sampler system called Hydrobios. It consists of a deck command unit and a stainless steel frame with canvas part to which 9 net bags are attached by means of zip fasteners.

The net bags are opened and closed by means of an arrangement of levers, which are triggered by a Motor Unit.

The MultiNet Type *Maxi* is used for vertical collections.

An integrated CTD unit is also integrated and allows for the record of the sampled water characteristics.

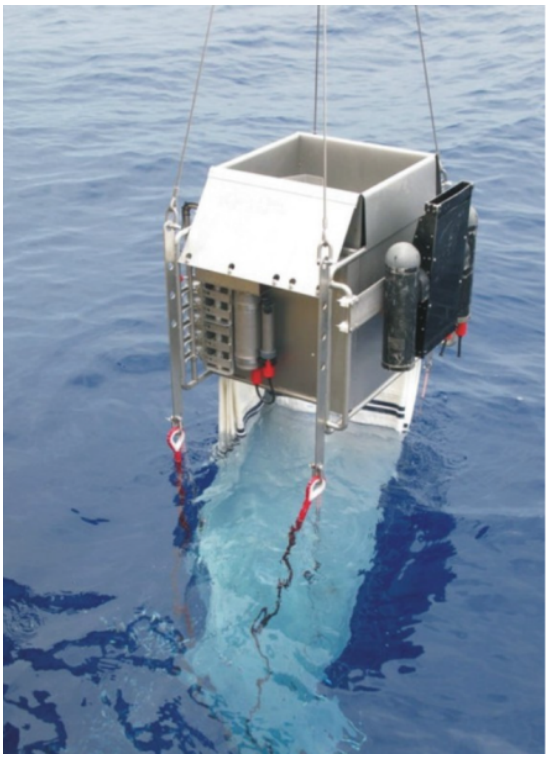
Table 1: Instruments and probes

Instrument	Company	Unit	Serial number	Calibration date
Temperature	Hydrobios	°C	Unit 1	2016-01-15
Conductivity	Hydrobios	mS/cm	Unit 1	2016-01-15
Pressure	Hydrobios	db	Unit 1	2016-01-15

Table 2: Recorded variables

Instrument	Company	Measurement	Specification	
Net Probe	Hydrobios	Temperature	Range (°C)	-2 to +32
			Initial Accuracy (°C)	0.005
			Resolution (°C)	0.001
		Conductivity	Range (mS/cm)	2 to 65
			Initial Accuracy (mS/cm)	0.01
			Resolution (mS/cm)	0.001
		Pressure	Range (dB)	0 to 3000
			Initial Accuracy (% f.s.)	0.1
			Resolution (dB)	0.1

Illustration of the Hydrobios-CTD (left) and of the Hydrobios frame (right):



2. Processing protocol

The following treatment steps were performed using the script:
Processing_Amundsen_Hydrobios.m developed in Matlab in Amundsen Science offices.

A: Data reading

A1: Read CTD rosette

From processed Rosette data (files *.int, see Rosette data processing report by the Amundsen Science technical team).

A2: Read NAV data

From processed Navigation data (files *.int, see NAV processing report by the Amundsen Science technical team).

A3: Read Hydrobios

From Hydrobios raw data (files *.txt)

B: Flag and processing

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

B.1: Interpolation of navigation data

The positions (latitude and longitude) from the NAV data are interpolated on the Hydrobios data time series.

B.2: Flag out-of-range values

For pressure, conductivity and temperature values, the flag checks out-of-range values (See limits in section 3 "Processing characteristics").

B.3: Flag of spiking values

For temperature and conductivity, the flag checks spiking values (see thresholds in section 3 "Processing characteristics"):

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

B.4: Net processing

For each net, the limit depth for opening the net, the total opening duration and the total volume of water collected are calculated. The volume is calculated from the net surface ($0.5m^2$), the vertical distance (from the pressure sensor) and a net input flow ratio of 81% (100*flow in/ flow ext).

Note: ArcticNet is not responsible for water volume calculation. These values are only provided as general information.

B.5: Low pass filter (SBE data processing toolbox)

A Low pass filter is applied on the temperature and conductivity. The time constant is fixed at 0.5s to keep the accuracy of the measures and allow for further filtering on averaged bin performed in B.8. The Hydrobios vertical speed is around ~0.5m/s, therefore the filter does not affect a depth gap of two meters (2x0.5=1m).

B.6: Align sensor filter (SBE data processing toolbox)

The temperature and conductivity sensors do not have the same time response. The Align sensor 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 best time offsets correction are the following:

Temperature: + 0.150s
Conductivity: + 0.100s

B.7: 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 the test. Loop edit filter marks also scans associated with an initial surface soak.

The thresholds are:

- Minimum velocity: 0.10m/s
- Surface soak depth: 8m
- Minimum soak depth: 5m
- Maximum soak depth: 20m

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

The Bin average filter averages data, using intervals based on pressure ranges. The bin sizes are fixed at two meters.

B.9: Calculation of the derived parameters

These calculations use the pressure, temperature, and conductivity to compute the following oceanographic parameters: salinity, density, freezing point and depth (sea water toolbox V3.2 from CSIRO).

B.10: CTD-Rosette co-localization

Most of the time, Hydrobios deployments are performed during a station and there are always one or several CTD-Rosette casts done at one station. Therefore comparisons can often be made inside small time and distance intervals. Hydrobios casts are co-localized with CTD-Rosette casts, which are within 5 hours and 5.4 NM (Nautical Mile) away.

B.11: Manual data check

A graphic toolbox allows the analyst to check, compare and flag measurements by selecting the values directly on screen for the following variables:

- Temperature profile: Hydrobios down cast, Hydrobios up cast, CTD-Rosette down cast and freezing point.
- Salinity profile: Hydrobios down cast, Hydrobios up cast and CTD-Rosette down
- Density: Hydrobios down cast and up cast
- d(density)/d(pressure): Hydrobios down cast and up cast
- Open net number: Hydrobios down cast and up cast

See annex 3.

C: Correction and inter-comparison

The processing steps in section C are applied on each leg.

C.1: Rosette inter-comparison

Using the co-localization performed in B10, the difference between data of the Hydrobios up-cast and of the CTD-Rosette is calculated for temperature and salinity data (below 150 meter depth). Then, bias on Hydrobios data can be determined and removed.
The differences are illustrated in the graphs of annex 1.

D: Output data

For each cast, two data files are created: one for the profile data (down cast + up cast) and one for the net data (only up cast).

D.1: Profile data

Data are saved in text format with the extension *.int. One folder per leg and one file per cast are created.

Table 3: Profile data file format

Col	Content	Format	Units
1	Pressure	F10.2	dB
2	Temperature	F10.2	deg C
3	Salinity	F10.2	psu
4	Open net number	F10.2	nb

NaN stands for: Not a Number. It indicates that no data was recorded or that the data was flagged and mistrusted.
For the column open net number, 0 stands for: No net open.

D.2: Net data

Data are saved in text format with the extension *_Net.int. One folder per leg and one file per cast are created.

Table 4: Net data file format

Col	Content	Format	Units
1	Net	F5.0	nb
2	Open pressure	F10.2	dB
3	Close pressure	F10.2	dB
4	Total opening duration	F10.2	s
5	Total volume sampled	F10.2	m^3
6	Temperature averaged	F10.2	deg C
7	Temperature standard deviation	F10.2	deg C
8	Salinity averaged	F10.2	psu
9	Salinity standard deviation	F10.2	psu

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

3. Processing characteristics

- Leg 1

Amundsen HYDROBIOS data processing
Amundsen_2016001
Year: 2016
Leg: 1
Processing date: 06-Dec-2016

////////// Limits and Thresholds Settings //////////
B2: -10.00 db - Minimum pressure
B2: 7000.00 db - Maximum pressure
B2: -3.00 °C - Minimum temperature
B2: 30.00 °C - Maximum temperature
B2: 5.00 mS/cm - Minimum conductivity
B2: 70.00 mS/cm - Maximum conductivity
B3: 0.10 °C/m - Temperature limit spike
B3: 0.25 mS/cm/m - Conductivity limit spike
B5: 81.00 % - Net input flow ratio

////////// Processing //////////
------ Inter-comparison------
C1: Bias applied on salinity
Constant bias correction: -0.035 psu
C1: Bias applied on temperature
Constant bias correction: 0.000 °C

////// Cast List //////

Cast	File_name	Date	Hour
1	MPS XL_1610_2016-06-11_22-44-31.txt	11-Jun-2016	22:44:32
2	MPS XL_1610_2016-06-15_15-45-00.txt	15-Jun-2016	15:45:01
3	MPS XL_1610_2016-06-19_20-16-03.txt	19-Jun-2016	20:16:04
4	MPS XL_1610_2016-06-20_16-15-03.txt	20-Jun-2016	16:15:04
5	MPS XL_1610_2016-06-21_23-41-49.txt	21-Jun-2016	23:41:50
6	MPS XL_1610_2016-06-25_19-42-35.txt	25-Jun-2016	19:42:36
7	MPS XL_1610_2016-06-26_21-09-11.txt	26-Jun-2016	21:09:12
8	MPS XL_1610_2016-06-27_23-03-59.txt	27-Jun-2016	23:04:00
9	MPS XL_1610_2016-07-02_23-29-38.txt	02-Jul-2016	23:29:39

10	MPS XL_1610_2016-07-03_20-44-06.txt	03-Jul-2016	20:44:07

4. Data quality discussion

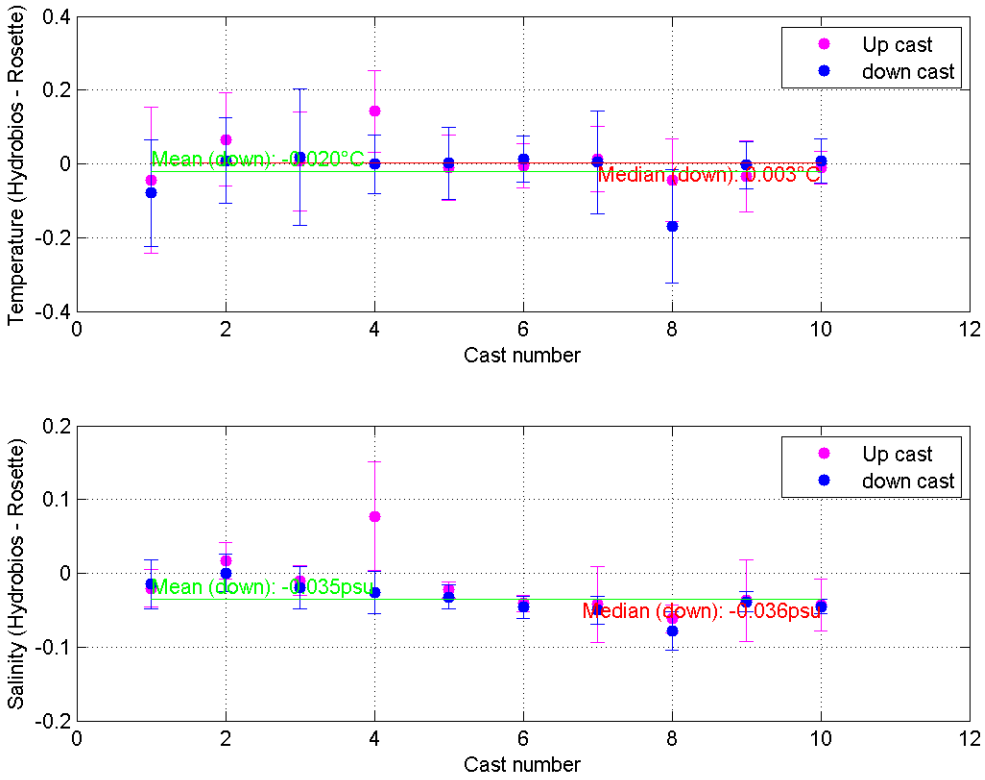
- Temperature uncertainty is in the order of 0.01°C or better. Inter-comparisons with the co-localised Rosette provide validation for the Hydrobios temperature data.

- Salinity uncertainty is in the order of 0.02psu (good Rosette inter-comparison) after bias correction.

- The calculation of the sampling volume of the nets is approximate. The ratio, the tilt and the distance traveled are not exactly known. For example, the traveled distance used in the calculation does not take into account cable winding. The volume is only given for general information. ArcticNet and Amundsen Science are not responsible for these calculations. Each user should verify the volume values.

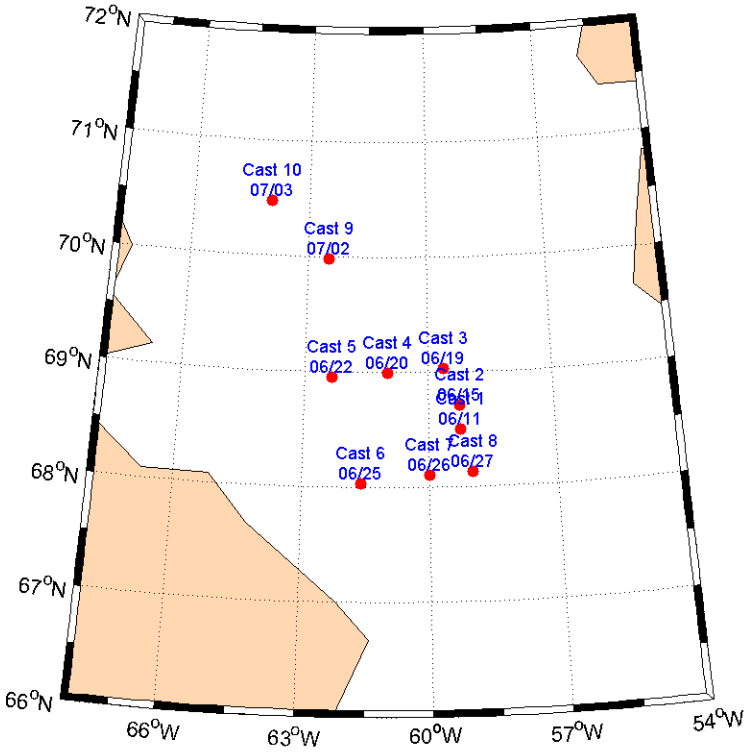
Annex 1: Inter-comparison plot

- Leg1



Annex 2: Mapping

- Leg 1



Annex 3: Data visualizer