

2005 Bioness Data Processing Notes

Last updated on 28 July 2015

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1. Introduction

The Canadian research icebreaker CCGS *Amundsen* is equipped with BIONESS (Bedford Institute of Oceanography Net and Environmental Sampling System). It is a multiple-net sampler for zooplankton and micronekton (pelagic animals 1-10 cm in length). It uses a new design concept, with nets arranged horizontally rather than vertically, as in earlier multiple-net samplers. The 9 one metre-square nets open sequentially and are towed from a ship at a speed of ~3 knots on a conductor cable that transmits and receives information. The sampler supports sensors for temperature, conductivity, depth, illumination, pitch, roll and net closure. During the down cast, no net is open. During the up cast, launchings of the nets are done consecutively.

Table 1: Instruments and probes

Instrument	Company	Unit	Serial number	Calibration date
Temperature	SeaBird	°C	19P32436-4433	2005-03-08
Conductivity	SeaBird	mS/cm	19P32436-4433	2005-03-08
Pressure	SeaBird	db	19P32436-4433	2005-03-08

Table 2: Recorded variables

Instrument	Company	Measurement	Specification	
SBE 19 Plus SEACAT Profiler	SeaBird	Temperature	Range (°C)	-5 to +32
			Initial Accuracy (°C)	0.005
			Resolution (°C)	0.0001
		Conductivity	Range (mS/cm)	0 to 90
			Initial Accuracy (mS/cm)	0.005
			Resolution (mS/cm)	0.001
		Pressure	Range (db)	0 to 7000
			Initial Accuracy (% f.s.)	0.1
			Resolution (db)	0.002

2. Processing protocol

The following treatment steps were performed using the script:

Processing_Amundsen_Bioness.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 TSG data

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

A3: Read CTD Bioness Profile

From Bioness raw data (files *.DAT and *.RAW)

A4: Read Bioness net launch

From Bioness raw data (*.ECH files). This file gives the nets launching time.

B: Flag and processing

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

B.1: Flag out-of-range values

For Pressure, Conductivity and Temperature values, this flag checks out of range values (See limits in section 3 “Processing characteristics”).

B.2: Flag of spiking values

For each measurement (Temperature, Conductivity), this flag checks spike values (See thresholds in section 3 “Processing characteristics”):

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

B.3: Remove surface data

All data above 2db depth pressure are removed.

B.4: Processing of nets data

For each net, the maximum depth for opening the net, the total opening duration and the total volume collected are calculated. The volume is calculated from the net surface (1m^2), the horizontal distance (from the NAV vessel speed – see Readme file) and a net input flow ratio of 90% ($100 \times \text{flow in} / \text{flow ext}$).

Note: ArcticNet and Amundsen Science are 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 to the temperature and conductivity data. The time constant is fixed at 0.5s to keep the accuracy of the measures while allowing for further filtering on averaged bin performed in B.7.

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

The temperature and conductivity sensors don't have the same time response. The Align sensor filter aligns the data 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 is the following:

Temperature: + 0.20s

B.7: Bin averaged filter (SBE data processing toolbox)

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

B.8: Calculation of the derived parameters

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

B.9: CTD-Rosette co-localisation

Most of the time, Bioness 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. Bioness casts are co-localized with CTD-Rosette casts, which are within 5 hours and 5.4 NM (Nautical Mile) away.

B.10: TSG co-localisation

Each cast beginning and ending are co-localised with TSG data.

B.11: Manual data check

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

- Temperature profile: Bioness down cast, Bioness up cast, co-localized CTD-Rosette down cast, co-localized TSG and freezing point.
- Salinity profile: Bioness down cast, Bioness up cast, co-localized CTD-Rosette down cast and co-localized TSG.
- Density: Down and up cast
- $d(\text{density})/d(\text{pressure})$: Down and up cast
- Open net number: Down 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-localisation performed in B9, the differences between Bioness up cast and CTD-Rosette are calculated for temperature data and salinity data (below 40-meter depth) for each cast. Then, the median of the differences and the standard deviation are determined on all the legs. Final bias is determined by judgement of the analyst according to the number of comparisons and casts, and if the standard deviation is reasonable. Final bias is finally removed from the data (for temperature and/or salinity).

See plot annex 1

D: Output data

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

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 open net: number column 0 stands for: No net open.

D.2: Data net

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

Table 4: Data net 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 Bioness data processing

Amundsen_2005001

Year: 2005

Leg: 1

Processing date: 28-Apr-2015

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

B1: -10.00 db - Minimum pressure

B1: 7000.00 db - Maximum pressure

B1: -3.00 °C - Minimum temperature

B1: 30.00 °C - Maximum temperature

B1: 2.00 mS/cm - Minimum conductivity

B1: 75.00 mS/cm - Maximum conductivity

B2: 0.00 °C/m - Temperature limit spike (4Hz)

B2: 0.01 mS/cm - Conductivity limit spike (4Hz)

B6: 81.00 % - Net input flow ratio

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

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

C1: Bias applied on Salinity

Constant bias correction: 0.000 psu

C1: Bias applied on Temperature

Constant bias correction: 0.000 °C

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

Cast	File_name	Date	Hour
1	082405_St4.DAT	24-Aug-2005	09:55:34
2	083005_St7.DAT	30-Aug-2005	06:21:28
3	090205_StCA05(05).DAT	03-sept-05	02:40:38
4	090805_StCa08_05.DAT	09-sept-05	10:40:38

○ Leg 2

Amundsen Bioness data processing

Amundsen_2005002

Year: 2005

Leg: 2

Processing date: 28-Apr-2015

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

B1: -10.00 db - Minimum pressure
 B1: 7000.00 db - Maximum pressure
 B1: -3.00 °C - Minimum temperature
 B1: 30.00 °C - Maximum temperature
 B1: 2.00 mS/cm - Minimum conductivity
 B1: 75.00 mS/cm - Maximum conductivity
 B2: 0.00 °C/m - Temperature limit spike (4Hz)
 B2: 0.01 mS/cm - Conductivity limit spike (4Hz)
 B6: 81.00 % - Net input flow ratio

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

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

C1: Bias applied on Salinity

Constant bias correction: 0.000 psu

C1: Bias applied on Temperature

Constant bias correction: 0.000 °C

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

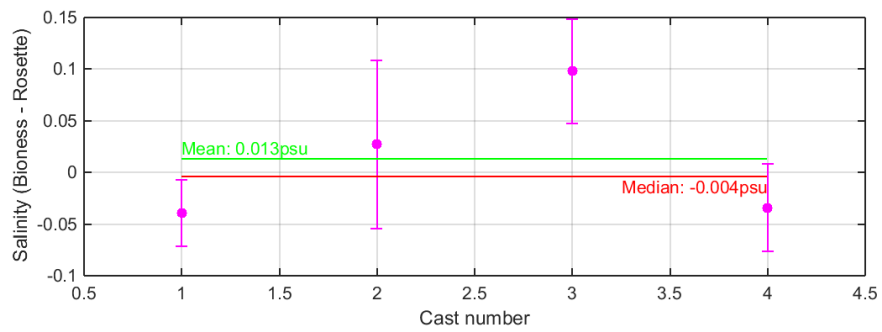
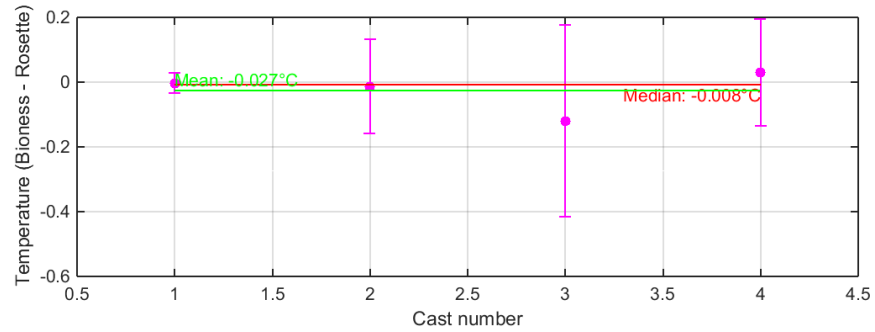
Cast	File_name	Date	Hour
1	092805_st18.DAT	28-sept-05	08:37:33
2	0930051_StAN03-05.DAT	01-oct-05	02:48:19
3	100205_St21E.DAT	02-oct-05	23:13:15
4	100605_st22.DAT	07-oct-05	21:43:22
5	121009_StAn02-05.DAT	13-oct-05	18:50:22
6	101305_StAN01-05.DAT	14-oct-05	06:00:28
7	101605_St27.2.DAT	17-oct-05	15:59:01

4. Data quality discussion

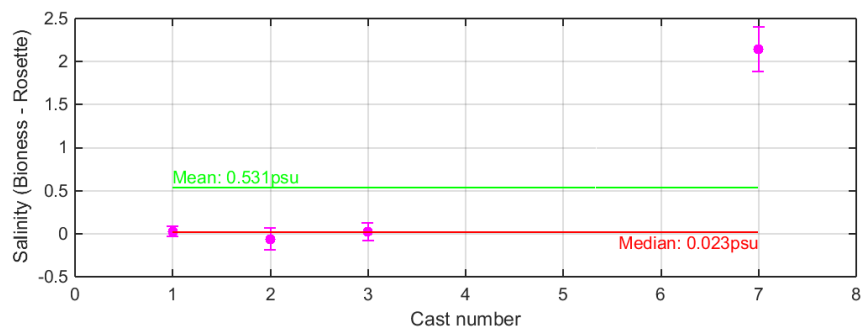
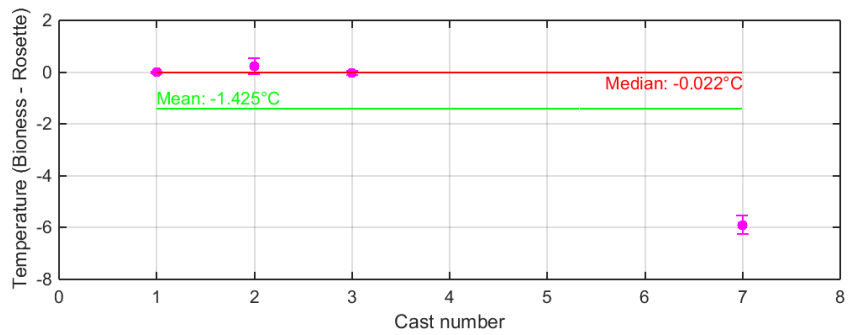
- Temperature uncertainty is in the order of 0.01°C or better. Inter-comparisons with the co-localised Rosette will provide validation for the Bioness temperature data.
- Salinity uncertainty is in the order of 0.01psu (good Rosette inter-comparison) but can increase up to 0.03psu during high vertical gradient.
- The calculation of the sampling volume of the nets is approximated. The ratio, the tilt and the distance traveled are not exactly known. For example, the used traveled distance does not take into account cable winding. ArcticNet and Amundsen Science is not responsible for these calculations. Each user should verify the volume values.

Annex 1: Inter-comparison plot

○ Leg 1

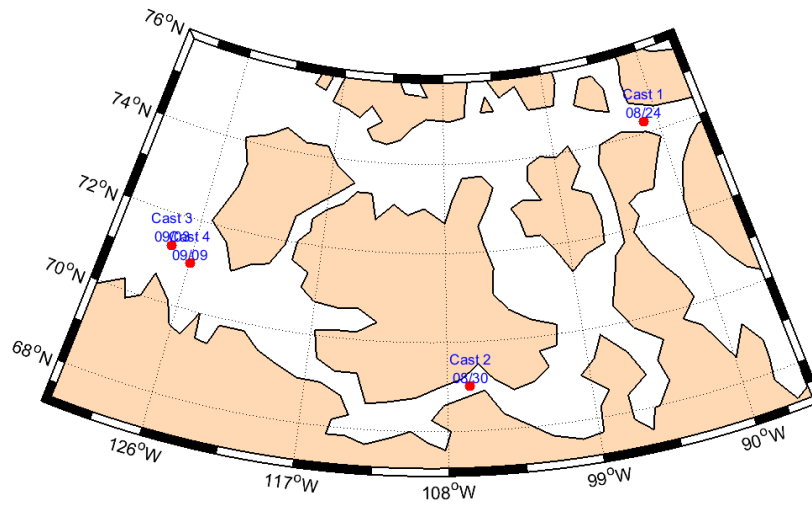


○ Leg 2

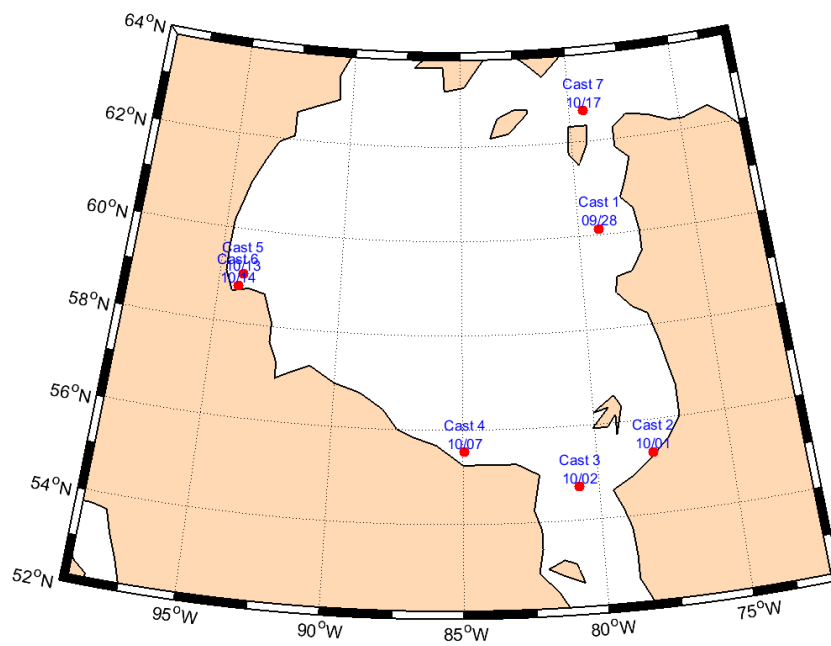


Annex 2: Mapping

○ Leg 1



○ Leg 2



Annex 3: Data visualizer

