ARCTICNET 2007-2008 MCLANE MOORED PROFILER DATA - QUALITY CONTROL REPORT

By

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ABSTRACT

This report is a summary of the quality control process applied to the McLane Moored Profiler (MMP) data recorded between October 2007 and July 2008 during the Circumpolar Flaw Lead program. During this period, two MMP moorings funded by ArcticNet were deployed in the southern Beaufort Sea from the CCGS Amundsen. This report summarizes the problems encountered during data analysis and the corrections applied or suggested. The following text should be consulted prior to using the MMP data.

RÉSUMÉ

Ce rapport résume le processus de contrôle de qualité effectué sur les données recueillies par les profileurs de type McLane Moored Profiler (MMP) déployés entre octobre 2007 et juillet 2008 lors du programme « Circumpolar Flaw Lead ». Au cours de cette période, deux mouillages MMP financés par ArcticNet furent déployés au sud de la mer de Beaufort par le NGCC Amundsen. Ce rapport résume les problèmes rencontrés au cours de l’analyse des données et les corrections appliquées ou suggérées. Ce texte doit être consulté avant toute utilisation des données de ces appareils MMP.
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INTRODUCTION

The ArcticNet network was created in 2004 to assess the effects of ongoing warming and modernization on Canadian Arctic ecosystems, economies and societies. An important part of the ArcticNet program includes the monitoring and study of biological, chemical and physical components of the coastal Canadian Arctic seas. Between 2007 and 2008, six ArcticNet moorings were deployed in the Beaufort Sea (Figure 1). In this report, we will look at two of these moorings, which were equipped with McLane Moored Profilers (MMP) (McLane Research Laboratories, 2008): CA05MMP-07 and CA16MMP-07. For more information on the other moorings, please consult Boisvert et al. (2011) and Rail and Gratton (2010).

![FIGURE 1. Moorings deployed in Southern Beaufort Sea in fall 2007.](image)

Moorings CA05MMP-07 and CA16MMP-07 were deployed in Beaufort Sea from the CCGS Amundsen in October 2007. Both moorings were recovered in July 2008. Each mooring was equipped with a MMP, which is an instrument capable of completing autonomously time-series profiles of the water column by traveling vertically along the mooring line (Figure 2). Each MMP was equipped with a SBE 52-MP and a Seapoint Chlorophyll Fluorometer (SCF), which are used respectively to measure Conductivity, Temperature and Depth (pressure), and fluorescence. The characteristics of each instrument are provided in Table 1.

Quality control was only performed on conductivity-temperature data by following the ArcticNet Mooring’s Data Quality Control protocol (Guillot, 2003). Fluorescence data quality control was not performed.

<table>
<thead>
<tr>
<th>Mooring</th>
<th>Water depth</th>
<th>Position</th>
<th>Instrument</th>
<th>Serial No</th>
<th>Instr. Depth (m)</th>
<th>Date of first reliable data</th>
<th>Date of last reliable data</th>
<th>T (°C)</th>
<th>Cond (mS/cm)</th>
<th>Press (dbar)</th>
<th>Spd (m/s)</th>
<th>Dir (true)</th>
<th>Turb (FTU)</th>
<th>Oxy (uM)</th>
<th>Chl</th>
<th>pH</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA05MMP-07</td>
<td>233</td>
<td>71°24.1966' N 127°38.1112' W</td>
<td>MMP</td>
<td>12138-05</td>
<td>40 - 120</td>
<td>2007-10-23 04:00</td>
<td>2008-07-24 11:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3670 profiles</td>
</tr>
<tr>
<td>CA16MMP-07</td>
<td>355</td>
<td>70°45.699' N 136°0.503' W</td>
<td>MMP</td>
<td>12138-03</td>
<td>30 - 190</td>
<td>2007-10-22 01:12</td>
<td>2008-07-23 00:01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3301 profiles</td>
</tr>
</tbody>
</table>

**FIGURE 2.** A typical MMP mooring line.
METHODS

The quality control process included a validation of the metadata, the calibration coefficients, the instrument depth and clock, and the comparison of the mooring data with Rosette CTD data recorded around the same time. Missing and questionable data mentioned in this report were replaced with NaNs (i.e., not-a-number). A summary of the moorings’ characteristics is found in Table 1.

Calibration coefficients validation

All the instruments deployed were calibrated by their respective companies prior to the expeditions. The probes’ specifications: range, resolution and accuracy can be found in Appendix 1. The temperature calibration was done for a temperature range from +1 to +32°C. As the water temperature in the Arctic Ocean is generally below 0°C, the calibration range should be modified in the future. For this reason, the data recorded by the SBE 52-MP must be handled with care.

Data processing

All MMP binary data were first converted to physical units with the help of the software « UnPacker.exe » provided by McLane Research Laboratories. Subsequently, using Matlab®, all the data from the same profile were combined and the time of the first measurement of a profile was assigned to the rest of the profile. Next, each profile was averaged every 1 dbar. Finally, salinity was computed from the CTD data with the routine « SW_SALT.M » of the Sea Water Matlab library (CSIRO, 1994).

Date and time validation

The dates and times validation process was carried out by comparing the time of the first and last profiles of the MMPs with the GPS time recorded in the mooring logbook when the moorings were deployed and recovered. In addition, an inspection of the time interval between each profiles has been completed to confirm the profiling frequency.

Data validation: visual inspection (plots) and data comparison

Each variable was plotted on many separate figures for a visual inspection. Mooring salinity and temperature data were compared with data from a Seabird 911+ CTD lowered from the ship after every mooring deployment and before every mooring recovery. The CTD cast used were obtained within a 15 km radius from the mooring location. The CTD probes were calibrated frequently and are, therefore, considered reliable. The list of the CTD casts used for the data comparison can be found in Appendix 3.
RESULTS

1. **Mooring CA05MMP-07 (MMP #12138-05)**

   A total of 3670 profiles were recorded by this MMP between October 23, 2007, and July 24, 2008. The time of the first and the last profiles completed by the MMP are in agreement with the deployment and recovery time of the mooring line. This gives us no reason to suspect that there has been a major drift in the instrument’s clock. No correction is recommended.

   The pressure probe appears to have worked properly since the recorded values are consistent with the mooring design as well as with the other physical parameters recorded by the instrument. In addition, the probe recorded a pressure inferior to 1 dbar when the instrument was on the ship’s deck after the recovery. No correction is recommended. As presented on figure 3, the vast majority of the profiles were completed between 40 and 130 dbar. However, there were a few times when the profiler went below 130 dbar and, in some occasions, had some difficulties reaching depths above 60 dbar.

   Most of the profiles were two hour apart except for a few occasions (~400) when the interval was 15 minutes (figure 3). This might be related to the initial settings of the instrument.

   The temperature and the salinity recorded by the profiler were similar to the data recorded by CTD. No correction is recommended. A list of the CTD casts used for validation and the actual comparisons are presented in Appendices 2 and 3, respectively.

   Figure 4 presents contours of the CA05MMP-07 salinity and temperature profiles for the complete sampling season.
FIGURE 3. CA05MMP-07 MMP data statistics. (Top) The height of the black bars represent the proportion of the profiles that sampled the corresponding depth along the x-axis. (Bottom) Histogram of the period between two successive profiles.

FIGURE 4. CA05MMP-07 MMP complete data set.
2. Mooring CA16MMP-07 (MMP #12138-03)

A total of 3301 profiles were recorded by the second MMP between October 22, 2007, and July 23, 2008. The time of the first and the last profiles completed by the MMP are in agreement with the deployment and recovery time of the mooring line. This gives no reason to suspect that there has been a major drift in the instrument’s clock. No correction is recommended.

The pressure probe appears to have worked properly since the recorded values are consistent with the mooring design as well as with the other physical parameters recorded by the instrument. In addition, the probe recorded a pressure inferior to 1 dbar when the instrument was on the ship’s deck after the recovery. As presented on figure 5, the vast majority of the profiles were completed between 40 and 190 dbar. However, there were a few times when the profilers had some difficulties reaching depths above 50 dbar (figure 6).

Most profiles were two hours apart except a few occasions when the interval was of four hours (figure 5). This suggests that some profiles are missing.

The temperature and the salinity recorded by the profiler were similar to the data recorded by CTD. No correction is recommended. A list of the CTD casts used for validation and the actual comparisons are presented in Appendices 2 and 3, respectively.

Figure 6 presents contours of the CA16MMP-07 salinity and temperature profiles for the complete sampling season.
FIGURE 5. CA16MMP-07 MMP data statistics. (Top) The height of the black bars represents the proportion of the profiles that sampled the corresponding depth. (Bottom) Histogram of the period between two successive profiles.

FIGURE 6. CA16MMP-07 MMP complete data set
SUMMARY

The ArcticNet 2007-2008 mooring deployment in the Canadian Arctic included six mooring lines for a total of 52 instruments, which were all recovered. This report addressed the quality control of the data from the two McLane Moored Profilers. The quality control of the other instruments is described in another quality control report (Boivert et al., 2011).

The data quality control process of the MMP data included metadata, calibration coefficients, depth and time validation, and the comparison of mooring data with Rosette-CTD data recorded around the same time.

All of the MMP data appear reliable and no correction is recommended. Most calibrations seemed adequate after comparison with the SBE-911 CTD mounted on the NGCC Amundsen rosette. However, it is important to mention that the temperature calibration for all the SBE 52-MP sensors was performed within an inappropriate range (+1 to +32°C) and the temperature data should be used with caution.

BIBLIOGRAPHY


**APPENDIX 1:** Instrument specifications.

<table>
<thead>
<tr>
<th>SBE 52-MP</th>
<th>Range</th>
<th>Resolution</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>-5 to +35 °C</td>
<td>0.001°C</td>
<td>0.002°C</td>
</tr>
<tr>
<td>Conductivity</td>
<td>0 to 9 S m⁻¹</td>
<td>0.00005 S m⁻¹</td>
<td>0.0003 S m⁻¹</td>
</tr>
<tr>
<td>Pressure</td>
<td>0 to 600 m</td>
<td>0.001% of Range</td>
<td>0.1% of Range</td>
</tr>
</tbody>
</table>
APPENDIX 2: CTD casts used to validate the MMP salinity and temperature data.

<table>
<thead>
<tr>
<th>Mooring instruments</th>
<th>CTD cast numbers</th>
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<tbody>
<tr>
<td>Instrument MMP # 12138-03</td>
<td>0706070 0706071 0804133 0804134 0804142 0804143 0804144</td>
</tr>
<tr>
<td>Day of 2007</td>
<td>296; 571</td>
</tr>
<tr>
<td>Latitude [°N]</td>
<td>71.7534</td>
</tr>
<tr>
<td>Longitude [°E]</td>
<td>-126.5055</td>
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<tr>
<td>Instrument MMP # 12138-05</td>
<td>0706062 0706134 0707017 0707018 0708072 0708073 0804126</td>
</tr>
<tr>
<td>Day of 2007</td>
<td>296; 570</td>
</tr>
<tr>
<td>Latitude [°N]</td>
<td>71.7534</td>
</tr>
<tr>
<td>Longitude [°E]</td>
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CTD cast numbers (continued)

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<td>71.7019</td>
<td>71.6947</td>
<td>71.7057</td>
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<td>71.7932</td>
<td>71.7459</td>
<td>71.7067</td>
<td>71.7006</td>
<td>71.6939</td>
</tr>
</tbody>
</table>
APPENDIX 3: CTD profile comparisons.

1. CA05MMP-07

CA05MMP-07
Position: 71.402°N, 127.633°E
Profile time: 23-Oct-2007, 04:00

ARCTICNET & CFL 0706 Station 408
CTD cast number: 0706071
Position: 71.310°N, 127.629°E
Profile time: 23-Oct-2007, 14:00
Depth: 191 m

Distance between the two profiles: 14 km
Time interval between the two profiles: 9.58 hours

---

CA05MMP-07
Position: 71.402°N, 127.633°E
Profile time: 23-Oct-2007, 04:00

ARCTICNET & CFL 0706 Station 408
CTD cast number: 0706071
Position: 71.310°N, 127.629°E
Profile time: 23-Oct-2007, 14:00
Depth: 191 m

Distance between the two profiles: 10 km
Time interval between the two profiles: 5.42 hours

---
CA05MMP-07
Position : 71.4022°N, 127.6312°E
Profile time: 10-Jul-2018, 05:00
CTD cast number: 6904143
Position : 71.2907°N, 127.7575°E
Profile time: 16-Jul-2018, 05:48
Depth: 163 m
Distance between the two profiles: 13 km
Time interval between the two profiles: 0.49 hours

---

CA05MMP-07
Position : 71.4022°N, 127.6312°E
Profile time: 10-Jul-2018, 05:00
CTD cast number: 6904144
Position : 71.2884°N, 127.7568°E
Profile time: 16-Jul-2018, 05:50
Depth: 160 m
Distance between the two profiles: 13 km
Time interval between the two profiles: 0.49 hours

---

CA05MMP-07
Position : 71.4022°N, 127.6312°E
Profile time: 10-Jul-2018, 13:00
CTD cast number: 6904145
Position : 71.29°N, 127.7655°E
Profile time: 16-Jul-2018, 08:04
Depth: 156 m
Distance between the two profiles: 13 km
Time interval between the two profiles: 2.56 hours
CA05MMP-07
Position: 71.402°N, 127.642°E
Profile time: 24-Jul-2008, 11:00

CFL 0805 Station 414
CTD cast number: 6805503
Position: 71.4255°N, 127.366°E
Profile time: 24-Jul-2008, 11:27
Depth: 305 m

Distance between the two profiles: 104 km
Time interval between the two profiles: 10.27 hours
2. CA16MMP-07

CA16MMP-07
Position: 71.7937°N, 126.5088°E
Profile time: 22-Nov-2007, 00:00

ARCTICNET & CFL 07/08 Station MW-2
CTD cast number: 07/06082
Position: 71.7557°N, 126.5088°E
Profile time: 24-Oct-2007, 19:01
Depth: 354 m

Distance between the two profiles: 0 km
Time interval between the two profiles: 6.59 hours

- CTD cast
- MMP

CA16MMP-07
Position: 71.7937°N, 126.5088°E
Profile time: 23-Nov-2007, 12:00

ARCTICNET & CFL 07/08 Station I9009
CTD cast number: 07/06134
Position: 71.7661°N, 126.1369°E
Profile time: 03-Nov-2007, 11:09
Depth: 230 m

Distance between the two profiles: 14 km
Time interval between the two profiles: 0.50 hours

- CTD cast
- MMP

CA16MMP-07
Position: 71.7937°N, 126.5088°E
Profile time: 22-Nov-2007, 22:00

CFL 07/07 Station 437
CTD cast number: 07/08017
Position: 71.7335°N, 126.6474°E
Profile time: 22-Nov-2007, 21:33
Depth: 420 m

Distance between the two profiles: 5 km
Time interval between the two profiles: 0.26 hours

- CTD cast
- MMP
CA16MMP-07
Position: 71.7934°N, 126.4999°E
Profile time: 10-Aug-2003, 10:00

CFL 0104 Station 410
CTD cast number: 68044126
Position: 71.698°N, 126.482°E
Profile time: 08-Jul-2003, 09:11
Depth: 400 m

Distance between the two profiles: 6 km
Time interval between the two profiles: 0.46 hours

---

CA16MMP-07
Position: 71.7934°N, 126.4999°E
Profile time: 10-Aug-2003, 12:00

CFL 0104 Station 410
CTD cast number: 68044127
Position: 71.704°N, 126.493°E
Profile time: 10-Jul-2003, 12:48
Depth: 410 m

Distance between the two profiles: 6 km
Time interval between the two profiles: 0.48 hours

---

CA16MMP-07
Position: 71.7934°N, 126.4999°E
Profile time: 10-Aug-2003, 16:00

CFL 0104 Station 410
CTD cast number: 68044128
Position: 71.6947°N, 126.4948°E
Profile time: 10-Jul-2003, 15:25
Depth: 412 m

Distance between the two profiles: 7 km
Time interval between the two profiles: 0.55 hours

---
CA16MMP-01
Position: 71°39.3'N, 126°48.6'E
Profile time: 10-Jul-2008, 22:00

CFL 0604 Station 410
CTD cast number: 6004129
Position: 71°30.7'N, 126°48.7'E
Profile time: 10-Jul-2008, 19:01
Depth: 395 m

Distance between the two profiles: 5 km
Time interval between the two profiles: 0.57 hours

CTD cast
MMP

---

CA16MMP-01
Position: 71°39.3'N, 126°48.6'E
Profile time: 10-Jul-2008, 22:00

CFL 0604 Station 1900
CTD cast number: 6004147
Position: 71°30.7'N, 126°48.7'E
Profile time: 10-Jul-2008, 21:59
Depth: 236 m

Distance between the two profiles: 14 km
Time interval between the two profiles: 0.21 hours

CTD cast
MMP

---

CA16MMP-01
Position: 71°39.3'N, 126°48.6'E
Profile time: 22-Jul-2008, 20:00

CFL 0605 Station CA16-62
CTD cast number: 6005014
Position: 71°39.3'N, 126°48.6'E
Profile time: 23-Jul-2008, 20:17
Depth: 297 m

Distance between the two profiles: 4 km
Time interval between the two profiles: 0.17 hours

CTD cast
MMP
CA16MMP047
Position: 71.7931°N, 126.5855°E
Profile time: 23-Jul-2008, 00:00

CFL 0805 Station 437
CTD cast number: 68059017
Position: 71.7006°N, 126.6166°E
Profile time: 23-Jul-2008, 08:37
Depth: 440 m

Distance between the two profiles: 7 km
Time interval between the two profiles: 8:32 hours

---

CA16MMP047
Position: 71.7931°N, 126.5855°E
Profile time: 23-Jul-2008, 00:00

CFL 0805 Station 437
CTD cast number: 68059018
Position: 71.6939°N, 126.6002°E
Profile time: 23-Jul-2008, 10:23
Depth: 441 m

Distance between the two profiles: 7 km
Time interval between the two profiles: 10:23 hours

---

CTD cast
MMP