Fram Strait Cruise Report

11th August – 12th September 2013

Norsk Polarinstitutt
Framsentret
9296 Tromsø

Tel: +47 77 75 05 00
Fax: +47 77 75 05 01

Scientific Participants

Physical and chemical oceanography

1. Paul Dodd, NPI, Cruise Leader, CTD/tracers and ADCP responsible
2. Mats Granskog, NPI, Deputy Cruise Leader, CTD/tracers responsible
3. Cecilia Perralta Ferriz, APL/UW, CTD team
4. Laura Niederdrenk, MPI, CTD team
5. Celine Heuze, UEA, CTD team **(first leg only)**
6. Marta Konik, IOPAS, CTD team **(first leg only)**
7. Colin Stedmon DTU Aqua, CTD team/chemical oceanography **(first leg only)**
8. Agneta Fransson, NPI, chemical oceanography **(first leg only)**
9. Melissa Chierici, IMR, chemical oceanography **(first leg only)**
10. Kristen Fossan, NPI, engineer, mooring work responsible
11. Marius Bratrein, NPI, engineer, mooring work & EM bird

Sea ice

12. Gunnar Spreen, NPI, Sea ice work leader **(first leg only)**
13. Justin Beckers, University of Alberta **(first leg only)**
14. Are Bjørdal, NPI
15. Jakob Grahn, University of Tromsø
16. Malin Johansson, Chalmers University
17. Sergey Kulyakhtin, NTNU **(first leg only)**
18. Cathrine Pedersen, NTNU/UNIS **(first leg only)**
19. Dmitry Divine, NPI, Stereocamera responsible

Helicopter team

20. Pilot, Airlift **(first leg only)**
21. Technician, Airlift **(first leg only)**

Figure 1: *Scientific participants of the complete cruise: 1: Are Bjørdal, 2: Marius Bratrein, 3: Dmitry Divine, 4: Paul Dodd, 5: Cecilia Perralta Ferriz, 6: Kristen Fossan, 7: Jakob Grahn, 8: Mats Granskog, 9: Malin Johansson, 10: Laura Niederdrenk.*

Cruise Outline

Since 1997 NPI has maintained an array of oceanographic moorings in the East Greenland Current at Fram Strait. This array has provided a long time series of observations with which to monitor the outflow from the Arctic Ocean. The main purpose of the 2013 Fram Strait cruise was to recover and redeploy the mooring array. All six moorings were recovered and redeployed as planned.

NPI has completed annual sections of CTD and conservative tracer measurements along 78°50'N since 1997. The zonal extent of sections varies from year to year, but the region between the 0 and W 010° (which includes the main outflow from the Arctic Ocean) has been sampled in every year. During the 2013 Fram Strait cruise a CTD section was completed between W 013° to E 008°. Samples were collected for analysis of $\delta^{18}O$, nutrient, coloured dissolved organic matter (CDOM), dissolved organic carbon-13 ($DO^{13}C$), dissolved inorganic carbon (DIC), total alkalinity (A_T), Iodide, Iodate and ^{129}I samples at most stations along the section.

A second CTD and tracer section was completed across the Norske Trough between N 77° 48', W 017° 30' and N78° 24', W 014 on the East Greenland Shelf. The primary purpose of this section was to study the circulationulation of warm Altantic water within the Belgica - Norske - Westwind trough system. Atlantic water in the trough system is thought to cross the shelf before reaching the Greenland coast, where it interacts with the floating glacier tongues through basal melting.

Ice conditions were favourable along the 78°50'N section and the Norske trough section; wide leads, generally open drift ice and a predominance of small ice floes allowed the moored array to be recovered in good time and mostly during daylight hours. However this predominance of small ice floes (few exceeding 25 m in diameter) impeded the sea ice work requiring large ice floes.

Three days into the cruise on 13 August 2013, R/V Lance experienced a serious problem with the clutch between the engine and propeller shaft, which necessitated an immediate return to port in order to undertake repairs. All scientific personal were put ashore in Longyearbyen on 14 August and R/V Lance returned to Tromsø for repair. Ten of the original scientific personnel were able to rejoin R/V Lance in Longyearbyen on 29 August 2013 and participated in the complete cruise. Nine of the original 19 participants were unable to rejoin the cruise (which was extended at short notice following the clutch failure) and did not have the opportunity to complete any scientific work. No helicopter was available to join the second leg of the cruise.

The locations of moorings deployed during FS2013 as well as the CTD and sea ice stations are shown in figure 1 and listed in tables 1 to 3.

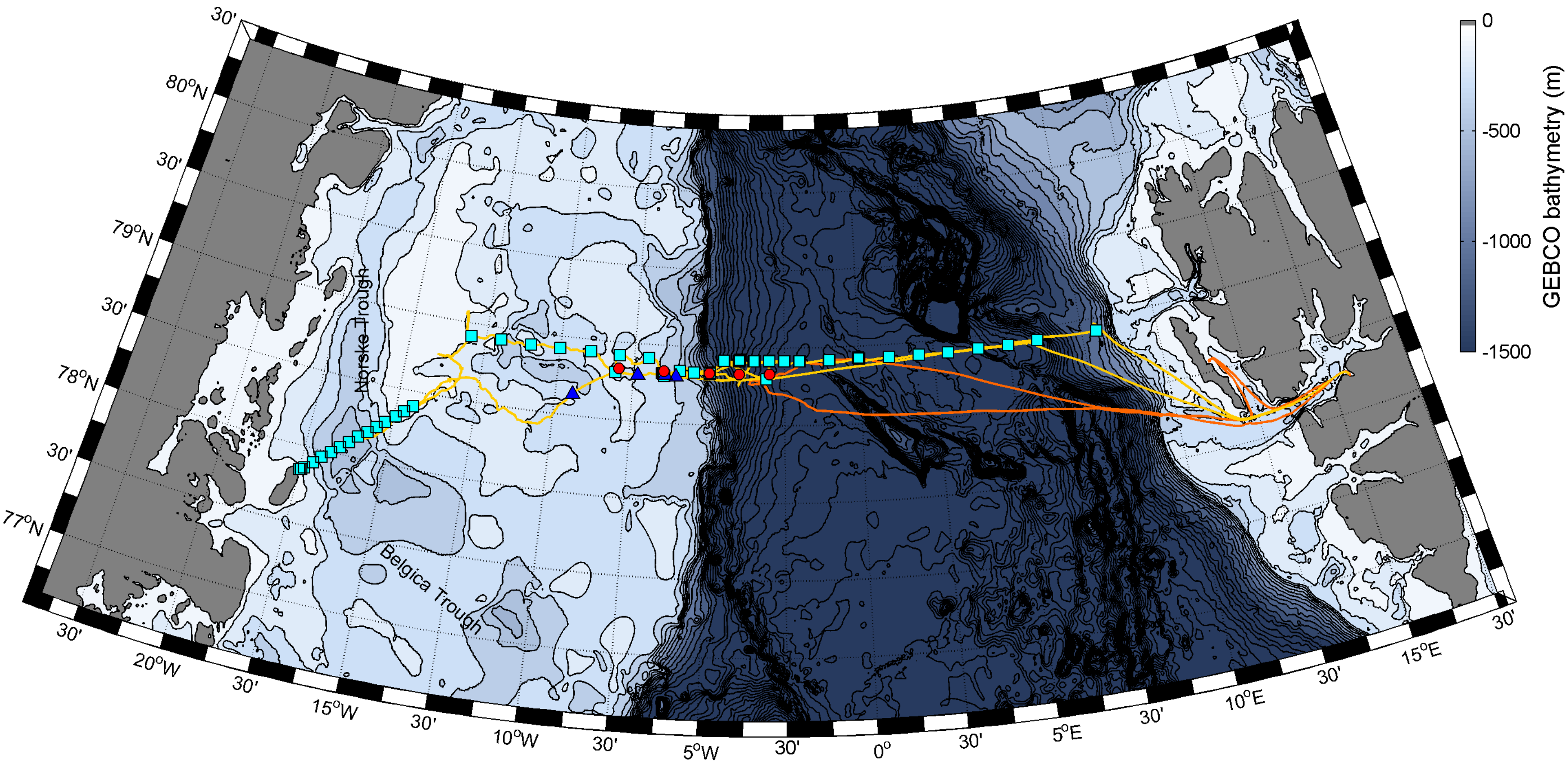


Figure 2. *Chart showing the locations of major activities during the FS2013. Red circles indicate mooring positions; cyan squares indicate CTD, LADCP and tracer stations; blue triangles indicate sea ice stations. Bathymetric contours are drawn at 100m intervals. The ship track for the first leg of the cruise (up until the clutch failure) is shown in light orange. The ship track for the second part of the cruise is shown in dark orange.*

Sailing Log

Date	**Activity** (all times UTC)
Saturday 10 August 2013	**15:00** First meeting on board Lance CTD installed and made ready
Sunday 11 August 2013	**15:15** Departed Longyearbyen (Bykaia) *Sailing towards geology camp on Prins Karls Foreland* **22:00** In place ready for helicopter operation. Bad weather. **23:30** Helicopter operation started after waiting 1.5 hours for visibility, but helicopter could not drop gear because of poor visibility
Monday 12 August 2013	**03:00** Re-attempted helicopter operation. Success this time **05:00** Steaming at normal speed towards mooring array **19:25** CTD station 001 (W 00°02', N 78°56') **22:24** CTD station 002 (W 00°02', N 78°55')
Tuesday 13 August 2013	**00:14** CTD station 003 (W 01°01', N 78°55') **03:18** CTD station 004 (W 01°59', N 78°55') **09:28** Begin searching for F11 on echo sounder **11:36** F11 released **12:30** Clutch failure. A temporary repair is made but Lance is forced to return to Tromsø via Longyearbyen. **14:00** (ca.) Helicopter pilot is airlifted to Longyearbyen with suspected appendicitis. *Sailing to Longyearbyen*
Wednesday 14 August 2013	**17:00** (ca.) Arrived Longyeabyen (Bykaia) Scientific personnel put ashore **19:00** (ca.) Departed Longyeabyen (Bykaia). *Sailing to Tromsø*
Thursday 15 August 2013	*Sailing to Tromsø*
Friday 16 August 2013	*Sailing to Tromsø*
Saturday 17 August 2013 to Sunday 25 August 2013	*Repair work in Tromsø*
Monday 26 August 2013	Depart Tromsø (Eidkjosen) *Sailing to Longyearbyen*

Tuesday 27 August 2013	*Sailing to Longyearbyen*
Wednesday 28 August 2013	*Sailing to Longyearbyen*
Thursday 29 August 2013	**10:25** Arrived Longyearbyen *Loading personnel and equipment* **15:00** Departed Longyearbyen *Sailing towards BPR at E 001° 12 ', N 78° 55'*
Friday 30 August 2013	**03:40** Receiving data from BPR at E 001° 12 ', N 78° 55' **16:36** CTD station 005 (W 03°05', N 78°48') **22:22** CTD station 006 (W 03°00', N 78°55')
Saturday 31 August 2013	**01:05** CTD station 007 (W 02°30', N 78°55') **03:51** CTD station 008 (W 03°30', N 78°55') **06:17** CTD station 009 (W 03°60', N 78°55') **09:09** CTD station 010 (W 04°01', N 78°55') **11:16** CTD station 011 (W 04°30', N 78°55') **14:20** Began F11 deployment. Kevlar snapped during deployment. Lower portion of F11 recovered immediately.
Sunday 01 September 2013	**01:15** F11 Deployed (correctly) **17:06** CTD station 012 (W 04°59', N 78°50') **19:18** CTD station 013 (W 04°59', N 78°50')
Monday 02 September 2013	**00:06** CTD station 014 (W 05°30', N 78°50') **01:56** CTD station 015 (W 05°58', N 78°50') **08:25** CTD station 016 (W 06°33', N 78°49') **09:47** F14 Released **16:49** CTD station 017 (W 07°01', N 78°55') **23:26** CTD station 018 (W 08°01', N 78°55')
Tuesday 03 September 2013	**06:21** F17 Released **09:15** F18 Released **09:46** CTD station 019 (W 08°06', N 78°48') **13:01** CTD station 020 (W 08°58', N 78°55') **15:31** CTD station 021 (W 10°00', N 78°55') **18:33** CTD station 022 (W 10°60', N 78°55') **21:02** CTD station 023 (W 11°60', N 78°55') **23:18** CTD station 024 (W 12°60', N 78°55') *Sailing to Norske Trough section*
Wednesday 04 September 2013	*Sailing to Norske Trough section*
Thursday 05 September 2013	*Sailing to Norske Trough section* **00:13** CTD station 025 (W 17°30', N 77°51') **00:55** CTD station 026 (W 17°30', N 77°51') **01:16** CTD station 027 (W 17°29', N 77°51')

	01:38 CTD station 028 (W 17°27’, N 77°51’) **02:09** CTD station 029 (W 17°22’, N 77°52’) **03:09** CTD station 030 (W 17°08’, N 77°55’) **04:27** CTD station 031 (W 16°56’, N 77°57’) **05:58** CTD station 032 (W 16°40’, N 78°00’) **07:01** CTD station 033 (W 16°26’, N 78°03’) **07:58** CTD station 034 (W 16°12’, N 78°05’) **09:09** CTD station 035 (W 15°58’, N 78°08’) **10:32** CTD station 036 (W 15°42’, N 78°11’) **11:59** CTD station 037 (W 15°27’, N 78°14’) **12:56** CTD station 038 (W 15°13’, N 78°16’) **14:16** CTD station 039 (W 14°56’, N 78°19’) **15:17** CTD station 040 (W 14°43’, N 78°22’) **16:38** CTD station 041 (W 14°28’, N 78°24’) **21:30** Moored to large piece of glacial ice shelf to attempt ADCP calibration. **22:45** Calibration exercise terminated
Friday 06 September 2013	**12:06** Ice station 1 (4 pax) **12:25** GPS buoy deployed **12:50** Ice station 1 completed **15:26** F14 Deployed **21:28** F17 Deployed
Saturday 07 September 2013	**00:31** F18 Deployed **07:36** Ice station 2 (4 pax) **08:50** Ice station 2 completed **13:16** CTD station 042 (W 06°31’, N 78°49’) **15:26** F14 Deployed **17:15** ice station 3 (9 pax) **19:10** Ice station 3 completed **19:37** CTD station 043 (W 06°29’, N 78°48’)
Sunday 08 September 2013	**07:35** CTD station 044 (W 04°59’, N 78°50’) **09:22** CTD station 045 (W 04°31’, N 78°55’) **11:18** CTD station 046 (W 03°59’, N 78°56’) **15:21** F13 Deployed
Monday 09 September 2013	**06:35** Ice station 4 (7 pax) **10:40** Ice station 4 completed **12:40** Began deployment of F12 **14:35** Deployed F12 at incorrect depth
Tuesday 10 September 2013	**13:20** Recovered F12 **21:36** F12 deployed correctly **16:58** CTD station 047 (W 03°31’, N 78°55’) **20:50** CTD station 048 (W 03°00’, N 78°55’)
Wednesday 11 September 2013	**00:07** CTD station 049 (W 02°30’, N 78°55’) **02:44** CTD station 050 (W 02°00’, N 78°55’) **06:08** CTD station 051 (W 00°60’, N 78°55’)

	09:22 CTD station 052 (E 00°00’, N 78°55’) **12:12** CTD station 053 (E 01°00’, N 78°55’) **14:59** CTD station 054 (E 01°60’, N 78°55’) **17:56** CTD station 055 (E 02°59’, N 78°55’) **20:48** CTD station 056 (E 04°01’, N 78°55’) **23:44** CTD station 057 (E 05°00’, N 78°55’)
Thursday 12 September 2013	**02:31** CTD station 058 (E 06°00’, N 78°55’) **06:56** CTD station 059 (E 08°00’, N 78°55’) Sailing to Longyearbyen **18:00** (ca.) Arrived Longyearbyen

CTD Measurements

The CTD used as an SBE911+ unit. Niskin bottles were closed using the bottle fire command within the Sea-Bird acquisition software so that a .bl file was created for each deployment when bottles were fired.

NMEA time and position information was fed to the acquisition computer and added to each scan line of the data files. Cast starting times were automatically added to the header of all data files.

A paper log sheet was completed at each CTD station. Log sheets list the depths at which bottles were fired and the samples taken from each bottle. Times and positions manually recorded on log sheets are indented as a backup in the case of a problem with the data acquisition, not a replacement for logged time and position data.

CTD Package Configuration

- Primary temperature sensor serial number 5258 was used for the entire cruise
- Secondary temperature sensor serial number 5299 was used for the entire cruise
- Primary conductivity sensor serial number 3525 was used for the entire cruise
- Secondary conductivity sensor serial number 3742 was used for the entire cruise
- Digiquartz pressure sensor serial number 0972 was used for the entire cruise

Station Locations

CTD stations were organized along two sections.

1. **Main Section:** An east-west section along the Fram Strait mooring array line at 78º 50 N, which is repeated annually. Figure 4 shows the data collected along the Main repeated section.

2. **Norske Trough Section:** A high-resolution (7 km spacing) southwest-northeast section across the NorskeTrough on the East Greenland continental shelf. This section begins at the tip of Isle de France and crosses crossing the complete trough. Figure 5 shows the data collected along the Norske Trough section.

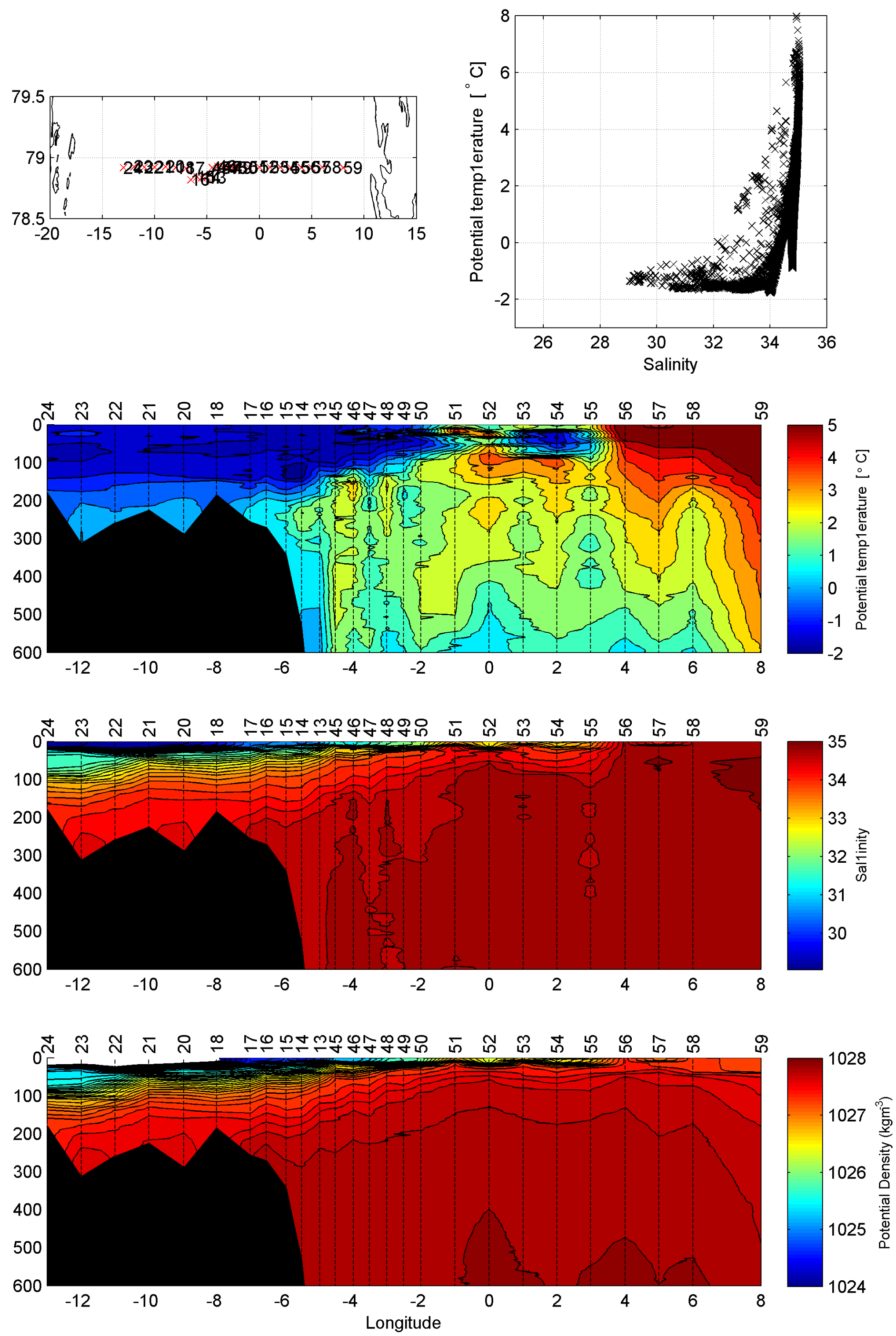


Figure 4: *Map showing the location of CTD stations along the main section (top left panel); Measurements from the primary temperature and salinity sensors in θ-S space (tope left panel); and sections of potential temperature, salinity and density (lower 3 panels respectively). Station locations are indicated by dotted lines in sections. Station numbers are plotted above sections.*

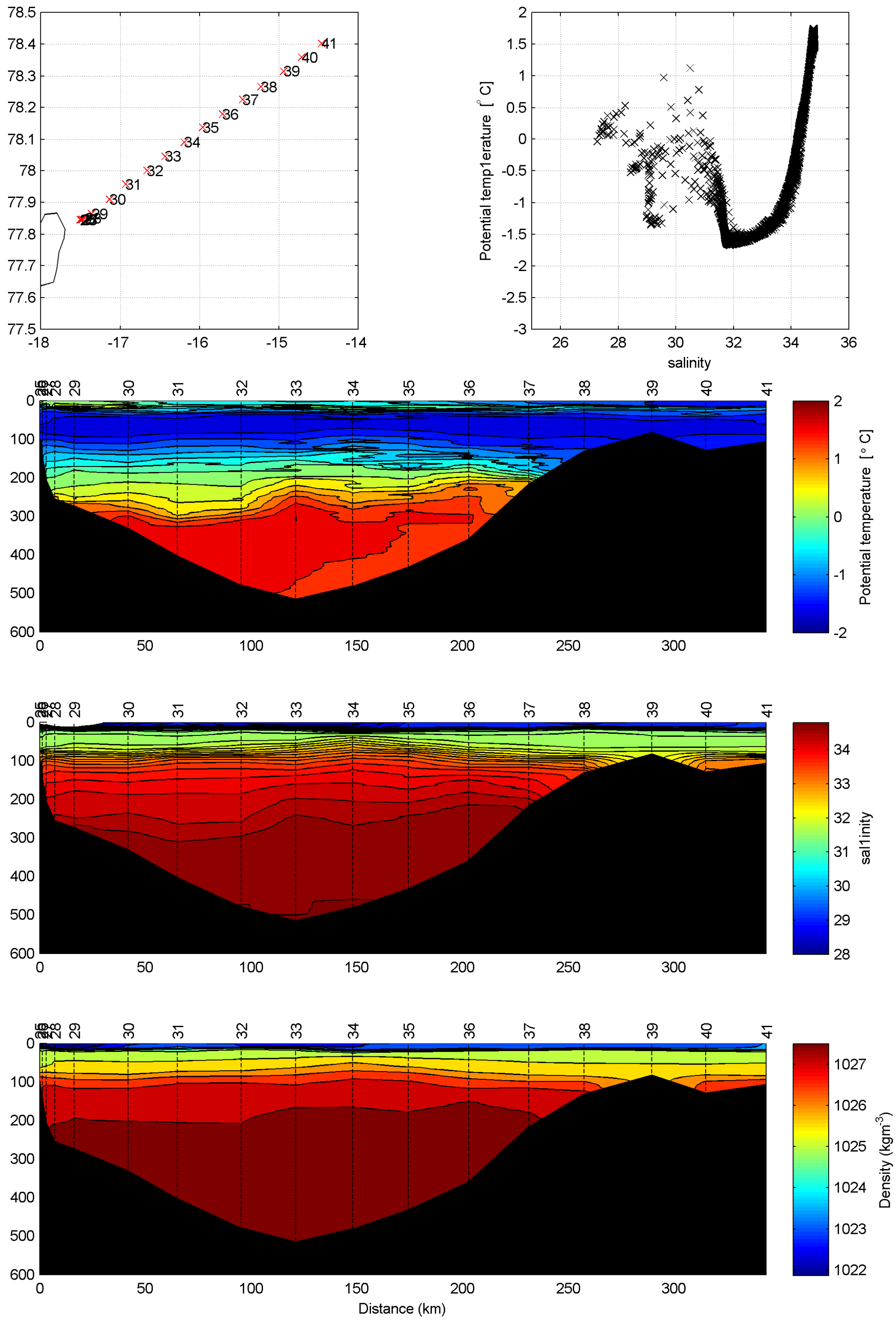


Figure 5: *Map showing the location of CTD stations along the Norske Trough section (top left panel); Measurements from the primary temperature and salinity sensors in θ-S space (tope left panel); and sections of potential temperature, salinity and density (lower 3 panels respectively). Station locations are indicated by dotted lines in sections. Station numbers are plotted above sections.*

Sensor Calibration

Water samples for laboratory salinity measurement were collected at most CTD stations. At stations where tracer samples were collected, salinity samples were collected at standard depths of 5, 15, 25, 50, 75, 100, 150, 200 and 300 dbar, plus two samples from the bottom of the water column. At stations where tracer samples were not collected, samples for salinity measurement were collected from deep parts of the water column where the salinity gradient was shallow. Deep regions provide the best data for conductivity sensor calibration as the water trapped in the Niskin bottles is most similar to that sampled by the CTD.

Salinity samples were analysed on broad Lance using a Guildline Portasal portable salinometer which was standardised after every 24 measurements using IAPSO P-series standard seawater.

Comparison of laboratory salinity measurements and CTD-salinity measurements revealed an offset of around 0.129 psu for the primary sensor group (Figure 6). The offset between the primary sensor group and the laboratory measurements very large, however, the offset is constant with changing pressure (Figure 7) and in time (Figure 8). Similarly large offsets have been encounters on previous Fram Strait cruises. The standard deviation of measurements is with an acceptable range for a pumped CTD system at 0.005 psu.

Comparison of laboratory salinity measurements and CTD-salinity measurements revealed an offset of around -0.002 practical salinity units for the secondary sensor group (Figure 6). An offset of this magnitude is typical for the type of sensors used during the cruise and it remained constant with changing pressure (Figure 7) and in time (Figure 8). The standard deviation of measurements is with an acceptable range for a pumped CTD system at 0.004 psu.

Both sensor groups remained stable during the cruise and had similar standard deviations, when compared to laboratory salinity measurements. However, the second sensor group seems to have the most accurate measurements. Notice the peak of the histogram showing measurements from the second sensor package is much sharper than from the primary sensor package (Figure 6).

No provisional calibration offset will be applied to the CTD data. A final calibration will be performed when post-deployment calibration data are available for the sensors used during the cruise.

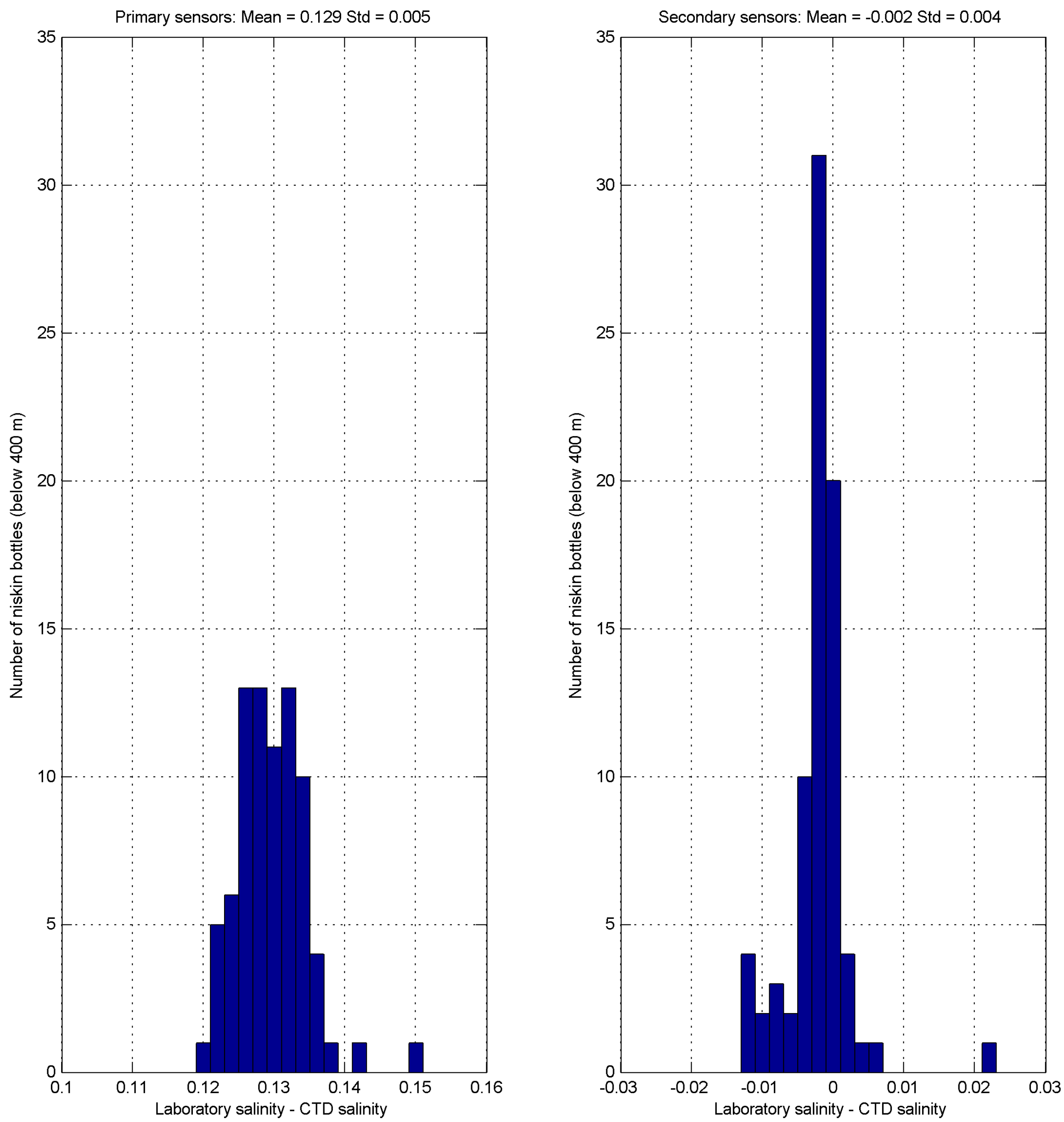


Figure 6: *Histograms showing the difference between laboratory salinity measurements and the primary (left hand panel) and secondary (right hand panel) sensor groups on the CTD. Only points deeper than 400 m are considered.*

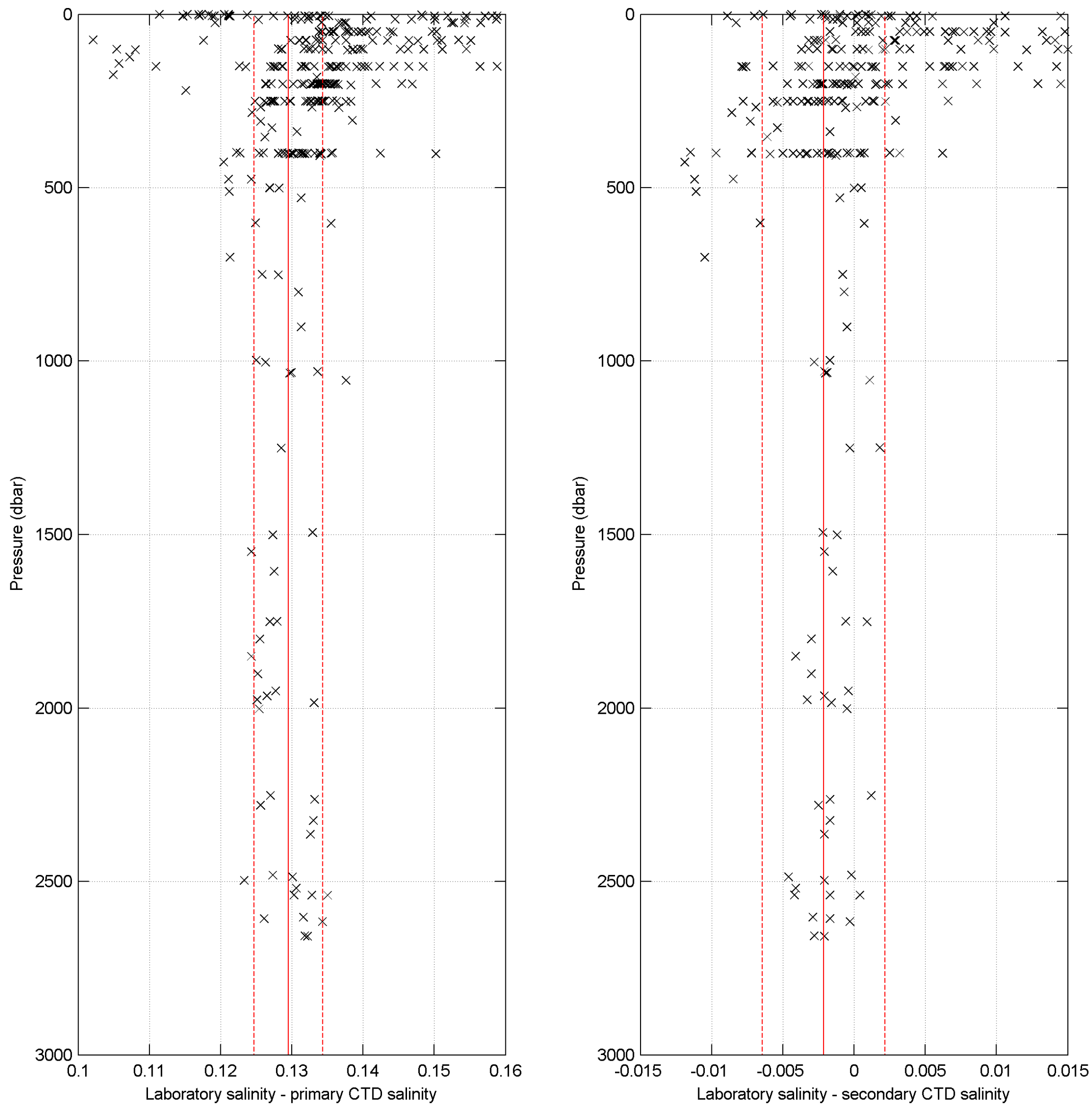


Figure 7: *Difference between laboratory salinity measurements and the primary (left hand panel) and secondary (right hand panel) sensor groups on the CTD plotted against pressure. Solid red lines indicate the mean offset calculated using points below 400 m. Doted red lines indicate one standard deviation.*

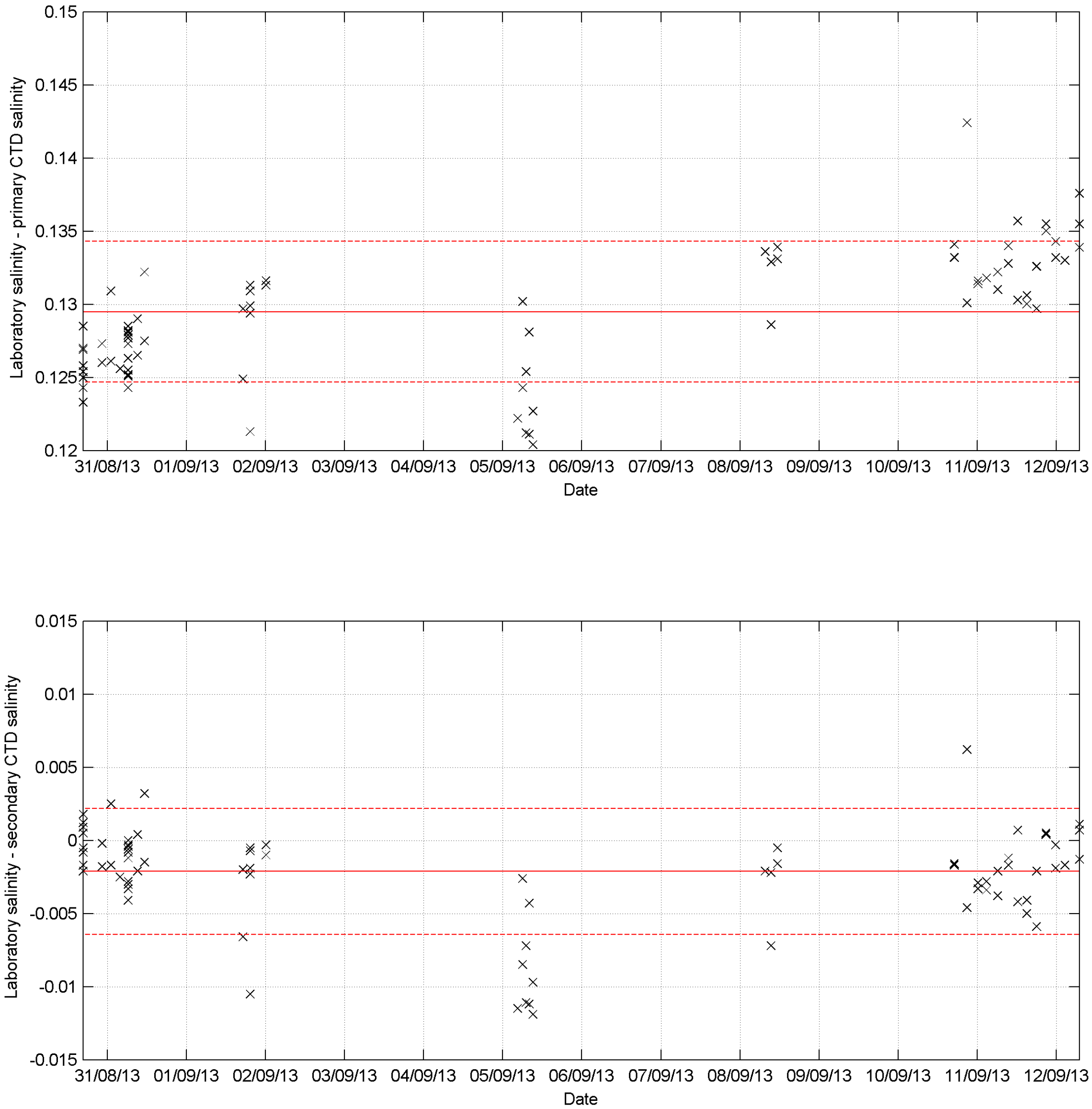


Figure 8: *Difference between laboratory salinity measurements and the primary (left hand panel) and secondary (right hand panel) sensor groups on the CTD plotted against time. Solid red lines indicate the mean offset calculated using points below 400 m. Doted red lines indicate one standard deviation.*

Tracer Sampling

Overview: Water samples were collected at standard pressures of 5, 15, 25, 50, 75, 100, 150, 200, 250, 400 dbar and at the bottom of each cast.
Samples were collected in the following order:

1. pH & Total alkalinity
2. CDOM (Filtered)
3. DOC (Filtered)
4. Nutrients
5. $\delta^{18}O$
6. Iodide / Iodate
7. Salinity
8. ^{129}I

Laboratory salinity analysis: Samples for laboratory salinity analysis were collected from all Niskin bottles. When the surface of the water column is strongly stratified, the salinity of water trapped in Niskin bottles can be significantly different from that measured by the conductivity sensor at the bottom of the CTD package, which is approximately 1 meter deeper then the top of the Niskin bottles. Independent laboratory salinity measurements give salinity measurements which correspond exactly to the other tracer measurements made from Niskin bottles. Laboratory measurements were made with a Guildline Portasal 8400b salinometer, which was standardized every 24 samples using P-series seawater supplied by OSIL.

Oxygen isotope ratio analysis and dissolved nutrient analysis: Samples for $\delta^{18}O$ isotope ratio analysis and dissolved nutrient analysis were collected at the locations listed in appendices 1 and 2. Note that samples for $\delta^{18}O$ and dissolved nutrients were always collected concurrently.

Coloured dissolved organic matter (CDOM): Samples for CDOM analysis were collected at the locations listed in appendix 3. Samples for $\delta^{18}O$ isotope ratio analysis and dissolved nutrient analysis were always collected when CDOM samples were collected.

Total alkalinity and dissolved inorganic carbon (A_T & DIC): Samples total alkalinity and dissolved inorganic carbon analysis were collected at the locations listed in appendix 4. Samples for $\delta^{18}O$ isotope ratio analysis and dissolved nutrient analysis were always collected when Total Alkalinity and Dissolved Inorganic Carbon samples were collected.

Iodide / Iodate: Samples total alkalinity and dissolved inorganic carbon analysis were collected at the locations listed in appendix 5. Samples for Iodide / Iodate were collected at a limited number of stations chosen so as to sample inflowing Atlantic water entering the Arctic Ocean as well as recirculating and return Atlantic water passing out of the Arctic Ocean.

^{129}I: Samples ^{129}I analysis were collected at the locations listed in appendix 6. Samples for ^{129}I were collected at a limited number of stations chosen so as to sample inflowing Atlantic water entering the Arctic Ocean aswell as reciruclating and return Atlantic water passing out of the Arctic Ocean. Due to the high cost of ^{129}I analyses, samples for ^{129}I were only collected at selected depths.

Niskin bottle operations: The rubber bands which hold the Niskin bottles closed were in good condition at the beginning on the cruise and did not require any attention during the cruise. All taps, values and rubber seals on Niskin bottles remained in good working order throughout the cruise.

Lowered ADCP Measurements

An RDI Workhorse Sentinel lowered ADCP (LADCP) was deployed from the CTD rosette in a downward looking orientation at all CTD stations. The same configuration parameters have been used for this LADCP unit on all Fram Strait cruises since 2008.

The ADCP was deployed with the following script. However, the script was edited to change the name of the date file before each deployment. LADCP data file names match raw CTD data filenames from the same cast.

```
P **********************************************************************
P *******  LADCP Deployment with one ADCP.  Usually looking down **********
P **********************************************************************
; Set to factory defaults:
CR1
; Record data internally:
CF11111
; Name data file (changed on each station):
RN L001_
; Heading alignment set to 0 degrees:
EA0
; Heading bias:
EB-0360
; Set transducer depth to zero:
ED0
; Set salinity to 35ppt:
ES35
; Set system coordinate:
EX11111
; Set to use a fixed speed of the sound:
EZ1111111
; Set LADCP to output Velocity, Correlations, Amplitude, and Percent Good:
LD111100000
; Set blank to 176 cm (default value) (Use WF if LADCP option is not enabled):
LF0176
; Set to record 20 bins (Use WN if LADCP option is not enabled):
LN020
; Set one ping per ensemble (Use WP if LADCP option is not enabled):
LP1
; Set bin size to 400 cm. (Use WS if LADCP option is not enabled).
LS400
; Set max radial (along the axis of the beam) water velocity to 176 cm/sec
; (Use WV if LADCP option is not enabled):
LV175
; Set ADCP to narrow bandwidth and extend range by 10%:
LW1
; Set one ensemble/sec
TE00:00:01.00
; Set one second between pings
TP00:01.00
; Save set up:
CK
; Start pinging
CS
;
;Instrument         = Workhorse Sentinel
;Frequency          = 307200
;Water Profile      = YES
;Bottom Track       = NO
;High Res. Modes    = NO
;High Rate Pinging  = NO
;Shallow Bottom Mode= NO
;Wave Gauge         = NO
```

```
;Lowered ADCP       = YES
;Beam angle         = 20
;Temperature        = 5.00
;Deployment hours   = 6.00
;Battery packs      = 1
;Automatic TP       = YES
;Memory size [MB]   = 16
;Saved Screen       = 1
;
;Consequences generated by PlanADCP version 2.02:
;First cell range   = 6.13 m
;Last cell range    = 82.13 m
;Max range          = 113.20 m
;Standard deviation = 2.96 cm/s
;Ensemble size      = 548 bytes
;Storage required   = 15.05 MB (15782400 bytes)
;Power usage        = 12.63 Wh
;Battery usage      < 0.1
;
; WARNINGS AND CAUTIONS:
; Lowered ADCP feature has to be installed in Workhorse to use selected option.
; Advanced settings has been changed.
```

Clock Synchronisation

Repeatedly adjusting the LADCP clock leads to sudden jumps in the LADCP clock drift. During fs2013 we tracked the clock drift relative to GPS time so that it may be corrected later by applying a correction. Table 1 lists LADCP clock checks were made during fs 2012:

GPS time (UTC)	Lowered ADCP (UTC)
13/08/12 16:54:22	13/08/12 16:54:22 (Synchronised)
13/08/31 05:35:45	13/08/31,05:35:45 (ADCP 0 seconds slow
13/09/05 06:34:30	13/09/05,06:34:29 (ADCP 1 seconds slow
13/09/10 09:02:20	13/09/10,09:02:18 (ADCP 2 seconds slow
13/09/12 17:37:15	13/09/12,17:37:12 (ADCP 3 seconds slow

Table 1: *LADCP clock synchronisation and drift information.*

LADCP Operations

The LADCP unit reports an error about the active flux gate compass calibration matrix on start-up. This error occurred last year and has not been corrected. The LADCP may be collecting bad data due to the error and should be repaired.

The LADCP was sometimes unable to transmit data files to the host PC after deployment. When this problem occurred, files could usually be recovered by requesting the data from the previous deployment – the LADCP would then actually transmit the file from the desired deployment. Problems connecting to the LADCP and in transferring files seem to occur if the battery voltage drops too low. Replacing the ADCP battery seemed to solve connection problems.

Vessel-Mounted ADCP Measurements

The vessel mounted ADCP was deployed using the S_300B4 configuration script designed by Pierre Jarracrd (4 metre bin size, standard range parameters, bottom tracking mode on). The same configuration was used for the duration of the cruise. The precise configuration can be determined from examination of the deployment script (below). Bottom tracking pings were sent during complete cruise. Sending bottom tracking pings in deep water is ineffective and slightly reduces the amount of good data water column data collected, but this approach avoids the situation where nobody remembers to turn on bottom tracking when the ship enters shallow water. During Fram Strait cruises we are principally interested in vessel mounted ADCP data collected in shallow water.

```
BEGIN RDI CONFIGURATION FILE (L300B4.CFG)

COMMUNICATIONS
{
ADCP         ( ON   COM2 38400 N 8 1 ) [ Port Baud Parity Databits Stopbits ]
ENSOUT       ( OFF  COM4 9600 N 8 1 ) [ Port Baud Parity Databits Stopbits ]
NAV          ( ON   COM1 9600 N 8 1 ) [ Port Baud Parity Databits Stopbits ]
REFOUT       ( OFF  COM4 4800 N 8 2 ) [ Port Baud Parity Databits Stopbits ]
EXTERNAL     ( ON   COM3 9600 N 8 1 ) [ Port Baud Parity Databits Stopbits ]
}

ENSEMBLE OUT
{
ENS CHOICE   ( N N N N N N N N )  [ Vel Corr Int %Gd Status Leader BTrack Nav ]
ENS OPTIONS  (BOTTOM   1   8   1   8 )  [ Ref First Last Start End ]
}

ADCP HARDWARE
{
Firmware       ( 5.46 )
Angle          (      30 )
Frequency      (     150 )
System         (    BEAM )
Mode           (       4 )
Orientation    (    DOWN )
Pattern        ( CONCAVE )
}

DIRECT COMMANDS
{
WS400
WF200
BX4000
WN064
WD111100000
WP00001
BP001
WM4
TP000010
BM4
TE00000050
EZ0000001
EP0
ER0
EH0
WB2
}

RECORDING
{
Deployment ( OAER )
Drive 1    (   C  )
```

```
Drive 2    (   C  )
ADCP       ( YES )
Average    ( YES )
Navigation ( YES )
}

CALIBRATION
{
ADCP depth                  (    6.00 m      )
Heading / Magnetic offset  (   0.00      0.00 deg )
Transducer misalignment    (    0.00 deg    )
Intensity scale            (    0.43 dB/cts )
Absorption                 (   0.039 dB/m   )
Salinity                   (    35.0 ppt    )
Speed of sound correction  (   NO   1500.0  )
Pitch & roll compensation  (     YES        )
Tilt Misalignment          (    0.00 deg    )
Pitch_Offset               (    0.000 deg    )
Roll_Offset                (    0.000 deg    )
Top discharge estimate     (    CONSTANT    )
Bottom discharge estimate  (    CONSTANT    )
Power curve exponent       (      0.1667   )
}

PROCESSING
{
Average every ( 300.00 s )
Depth sounder (  NO )
Refout_info (   1   8  30.00  1.000 0      1) [bins:1st last, limit, weight, format,
delaysec]
External_formats  ( N N Y N )  [ HDT HDG RDID RDIE ]
External_decode   ( Y Y Y  N ) [ heading pitch roll temp ]
}

GRAPHICS
{
Units        ( SI )
Velocity Reference (    NONE    )
East_Velocity      ( -100.0  100.0  cm/s )
North_Velocity     ( -100.0  100.0  cm/s )
Vert_Velocity      ( -100.0  100.0  cm/s )
Error_Velocity     ( -100.0  100.0  cm/s )
Depth              (      1     61   bin )
Intensity          (      0    200     dB)
Discharge          (  -1000   1000  m3/s )
East_Track         ( -107681 1191414     m )
North_Track        ( -300000 1357285     m )
Ship track         (  5 bin  100.0  cm/s )
Proj_Velocity      ( -100.0  100.0  cm/s )
Proj_Angle         (    0.0  deg from N )
Bad_Below_Bottom   (   NO  )
Line1              (                                                  )
Line2              (                                                  )
}

HISTORY
{
SOFTWARE       ( BB-TRANSECT )
Version        ( 2.72 )
}

END RDI CONFIGURATION FILE
```

Mooring Operations

Six moorings were recovered, and six new moorings were redeployed. The configuration of the recovered moorings is listed in Table 2 and the configuration of the deployed moorings is listed in Table 3. The recovered moorings are illustrated in Figures 8 to 13 and deployed moorings are illustrated in Figures 14 to 19**.**

Mooring	Position	Depth	Date and time (UTC)	Instrument	Serial no	Instrument Depth (m)
F11-14	N 78° 48.068’, W 003° 04.767’	2472	Deployed: 07 September 2011 13:50 Released: 11 August 2013 11:36	IPS SBE37 ADCP SBE37 RCM9 SBE37 RCM11 SBE37 RCM8 AR861	51062 3490 17461 4702 1324 3552 494 8821 10071 287	54 55 60 299 303 1553 1556 2456 2459 2463
F12-14	N 78° 47.927’, W 004° 00.887’	1830	Deployed: 03 September 2012 14:20 Released: 01 September 2013 08:29	IPS SBE37 ADCP SBE37 SGUARD SBE37 RCM11 SBE37 RCM11 AR861	51063 3489 17462 4837 884 3554 235 8822 228 182	54 56 60 313 316 1516 1519 1819 1822 1826
F13-14	N 78° 49.972’, W 004° 59.256’	1020	Deployed: 02 September 2012 12:10 Released: 01 September 2013 12:40	IPS SBE37 ADCP SBE16 RAS AURAL SBE16 RAS SBE37 RCM9 SBE37 RCM11 AR861	1047 7056 16831 6693 6694 3993 1327 3551 561 053	47 49 53 67 67 75 146 146 247 250 1000 1003 1007
F14-14	N 78° 48.956’, W 006° 30.446’	270	Deployed: 01 September 2012 10:55 Released: 02 September	IPS SBE37 ADCP SBE37 RCM9 AR861	51064 3492 16876 3992 1046 409	48 52 56 256 259 263

			2014 07:47			
F17-9	N 78° 50.536', W 008° 08.408'	229	Deployed: 31.08.2012 11:25 Released: 03 September 2013 06:21	ADCP SBE37 RAS AR661	7636 7062 110	109 113 113 222
F18-9	N 78° 48.250', W 008° **0**4.694'	211	Deployed: 31.08.2012 Released: 03 September 2013 09:15	DL7 AR861	1649 291	57-107 208

Table 2: *Moorings recovered during FS2013*

Mooring	Position	Depth (m)	Date and time (UTC)	Instrument	Serial #	Instrument depth (m)
F11-15	N 78° 48.4100', W 002° 58.0500'	2470	Deployed: 01 September 2013 01:15	IPS SBE37 ADCP SBE37 RCM9 SBE37 RCM11 SBE37 RCM8 AR861	51062 7054 17461 3996 1049 7061 538 8226 10069 499	54 56 60 299 303 1553 1556 2456 2459 2463
F12-15	N 78° 47.6720' W 003° 57.8600'	1873	Deployed: 10 September 2013 21:36	IPS SBE37 ADCP SBE37 RCM9 SBE37 RCM11 SBE37 RCM11 AR861	51063 7055 17462 3994 836 10295 556 8227 117 500	124 126 130 353 1517 1556 1559 1859 1862 1866
F13-15	N 78° 50.0378', W 004° 59.5912'	1012	Deployed: 08 September 2013 15:21	IPS SBE37 ADCP SBE16 RAS AURAL SBE16 SBE37 RCM9 SBE37 RCM11 AR861	1047 7059 16831 7212 TBC TBC 7339 7060 1326 10294 345 743	47 49 53 68 68 76 147 247 250 1000 1003 1008

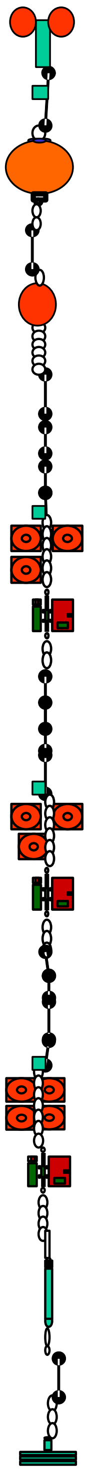
F14-15	N 78° 49.0115', W 006° 31.0877'	266	Deployed: 07 September 2013 15:26	IPS SBE37 ADCP SBE37 RCM9 AR861	51064 7058 16876 7057 1325 568	58 62 66 257 260 264
F17-10	N 78° 50.6103', W 008° 08.4930'	225	Deployed: 06 September 2013 21:28	SBE37-IM SBE16 ICEBOX RAS ADCP SBE37 AR661	TBC 7253 TBC TBC 7636 3993 501	29 57 57 58 109 113 222
F18-9	N 78° 48.3092', 008° 04.6912'	217	Deployed: 07 September 2013 00:31	DL7 AR861	1632 553	57-107 217

Table 3*: Moorings Deployed during FS2013*

Rigg F11-14 78 48,06N Dyp: Fra bunn: Ut:

Satt ut 7 SEP 2012 kl 13:54 003 04,76W

Tatt opp AUG 20 kl



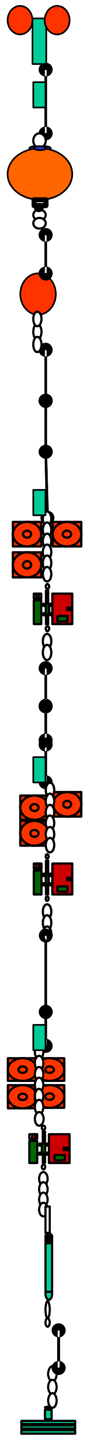
IPS	SNR. 51062		54	2416	13:30
SBE37	SNR. 3490		55	2415	13:30
5 m Kevlar					
ADCP300	SNR: 17461		60	2410	13:30
0,5 m Kjetting galvanisert					
10 m Kevlar					
Stålkule 37 (snr 596) McLane 7			74	2396	
0,5 m Kjetting galvanisert					
20 + 5 m Kevlar					
40 m Kevlar					
100 m Kevlar					
10 m Kevlar					
50 m Kevlar					
SBE37	SNR. 4702		299	2171	13:13
3 Glasskuler					
2 m Kjetting galvanisert					
RCM9	SNR.1324		303	2167	13:13
0,5 m Kjetting galv					
200 m Kevlar					
500 m Kevlar					
500 m Kevlar					
40 m Kevlar					
10 m Kevlar					
SBE37	SNR. 3552		1553	917	12:50
3 Glasskuler					
2 m Kjetting galvanisert					
RCM11	SNR.494		1556	914	12:50
0,5 m Kjetting galv					
500 m Kevlar					
100 m Kevlar					
100 + 100m Kevlar					
40 + 50 +10 m Kevlar					
SBE37	SNR. 8821		2456	14	12:32
4 Glasskuler					
2 m Kjetting galvanisert					
RCM8	SNR.10071		2459	11	12:32
0,5 m Kjetting rustfri					
Svivel					
AR861	SNR. 287	Pinger på: Pinger av: Release: Release m/ping:			
5 m Kevlar					
2 m Kjetting galvanisert					
ANKER 1200/(960) kg			2470	0	

Figure 8: Recovered mooring F11 14

Rigg F12-14 78 47,93N

Settes ut 3 SEP 2012 kl 14:22 004 00,888W

Tatt opp AUG 20 kl



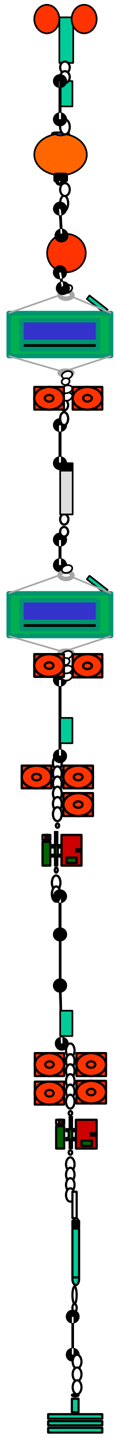
			Dyp:	Fra bunn:	Ut:
IPS	SNR. 51063		54	1779	14:18
SBE37	SNR.3489		56	1777	14:18
5 m Kevlar					
ADCP300	SNR: 17462		60	1773	14:18
0,5m Kjetting galvanisert					
10 m Kevlar					
Stålkule 37			72	1761	
0,5m Kjetting galvanisert					
20 m Kevlar					
20 m Kevlar					
200 m Kevlar					
SBE37	SNR.4837		313	1520	13:58
3 Glasskuler					
2 m Kjetting galvanisert					
SEAGUARD	SNR. 884		316	1517	13:58
0,5 m Kjetting galv					
500 m Kevlar					
500 m Kevlar					
200 m Kevlar					
SBE37	SNR.3554		1516	317	12:43
3 Glasskuler					
2 m Kjetting galvanisert					
RCM11	SNR.235		1519	314	12:43
0,5 m Kjetting galv					
200 m Kevlar					
100 m Kevlar					
SBE37	SNR. 8822		1819	14	12:30
4 Glasskuler					
2 m Kjetting galvanisert					
RCM11	SNR.228		1822	11	12:30
0,5 m Kjetting rustfri					
Svivel					
AR861	SNR. 182	Pinger på: Pinger av: Release Release m/ping:			
5 m Kevlar					
2 m Kjetting galvanisert					
ANKER 1200/(960) kg			1833	0	

Figure 9. Recovered mooring F12-14.

Rigg F13-14 78 47.972N

Settes ut 2 SEP 2012, kl 12:10 004 59.2W

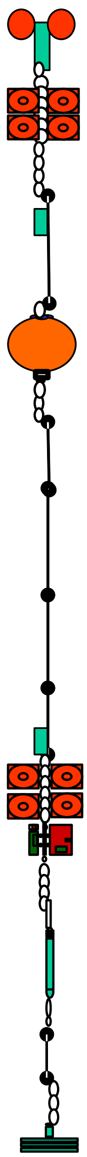
Tatt opp AUG 201 kl :00



			Dyp:	Fra bunn:	Ned i vann:
IPS4	SNR. 1047		47	967	11:47
SBE37	SNR: 7056		49	965	11:47
5 m Kevlar					
ADCP300	SNR: 16831		53	961	11:47
0,5 m Kjetting galv					
10 m Kevlar					
Stålkule 37			64	950	
2 m Kevlar					
SBE16	SNR. 6693		67	947	11:38
Vannhenter					
1,5 m Kjetting galv.					
2 Glasskuler					
5 m Kevlar					
Hvallydopptaker			75	939	11:30
0,5 m Kjetting galv.					
50 + 20 m Kevlar					
SBE16	SNR. 6694		146	868	11:23
Vannhenter					
1 m Kjetting galv.					
2 Glasskuler					
100 m Kevlar					
SBE37	SNR.3993		247	767	11:18
3 Glasskuler					
2 m Kjetting galv.					
RCM9	SNR.1327		250	764	11:18
0,5 m Kjetting galv					
500 m Kevlar					
200 m Kevlar					
50 m Kevlar					
SBE37	SNR.3551		1000	14	10:59
4 Glasskuler					
2 m Kjetting galv.					
RCM11	SNR. 561		1003	11	10:59
0,5 m Kjetting rustfri					
Svivel					
AR861	SNR. 053	Ping på: Ping av: Release: Release m/ping:			
5 m Kevlar					
2 m Kjetting galvanisert					
ANKER	1100/(880) kg		1014	0	

Figure 10: Recovered mooring F13-14

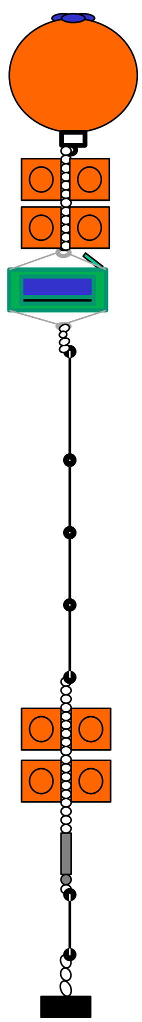
Rigg F14-14 78 48.0N
Satt ut 1 SEP 2012 , kl 11:00 006 30,4W



			Dyp:	Fra bunn:	Ned i vann:
IPS	SNR. 51064		48	222	10:57
4 Glasskuler 2 m Kjetting galv.					
SBE37	SNR: 3492		52	218	10:57
5 m Kevlar					
ADCP 300	SNR: 16876		56	214	10:49
1 m Kjetting Galv.					
40 m Kevlar					
100 m Kevlar					
50 m Kevlar					
10 m Kevlar					
SBE37	SNR.3992		256	14	10:40
4 Glasskuler 2 m Kjetting Galv.					
RCM9	SNR. 1046		259	11	10:40
Svivel					
AR861	SNR. 409	Arm: Range: Ping on:			
5 m Kevlar					
2 m Kjetting					
ANKER 900/(720) kg			270	0	

Figure 11. Recovered mooring F14-4.

Rigg F17-9	78 50.54 N		Dyp:	Fra bunn:	Ut:
Satt ut 31 AUG 2012 , kl 11:35	008 08.49W				



ADCP	SNR.7636		109	120	11:31
2 m Kjetting galv.					
4 Glasskuler					
SBE37	SNR.7062		113	116	11:31
Vannhenter			113	116	11:31
50 m Kevlar					
40 m Kevlar					
10 m Kevlar					
5 m Kevlar					
2 m Kjetting galv.					
4 GLASSKULER			219	10	
AR661	SNR. 110	Ping on: Release:			
5 m Kevlar.					
2 m Kjetting galv.					
ANKER	780/(620)kg		229	0	

Figure 12:. Recovered mooring F17-9.

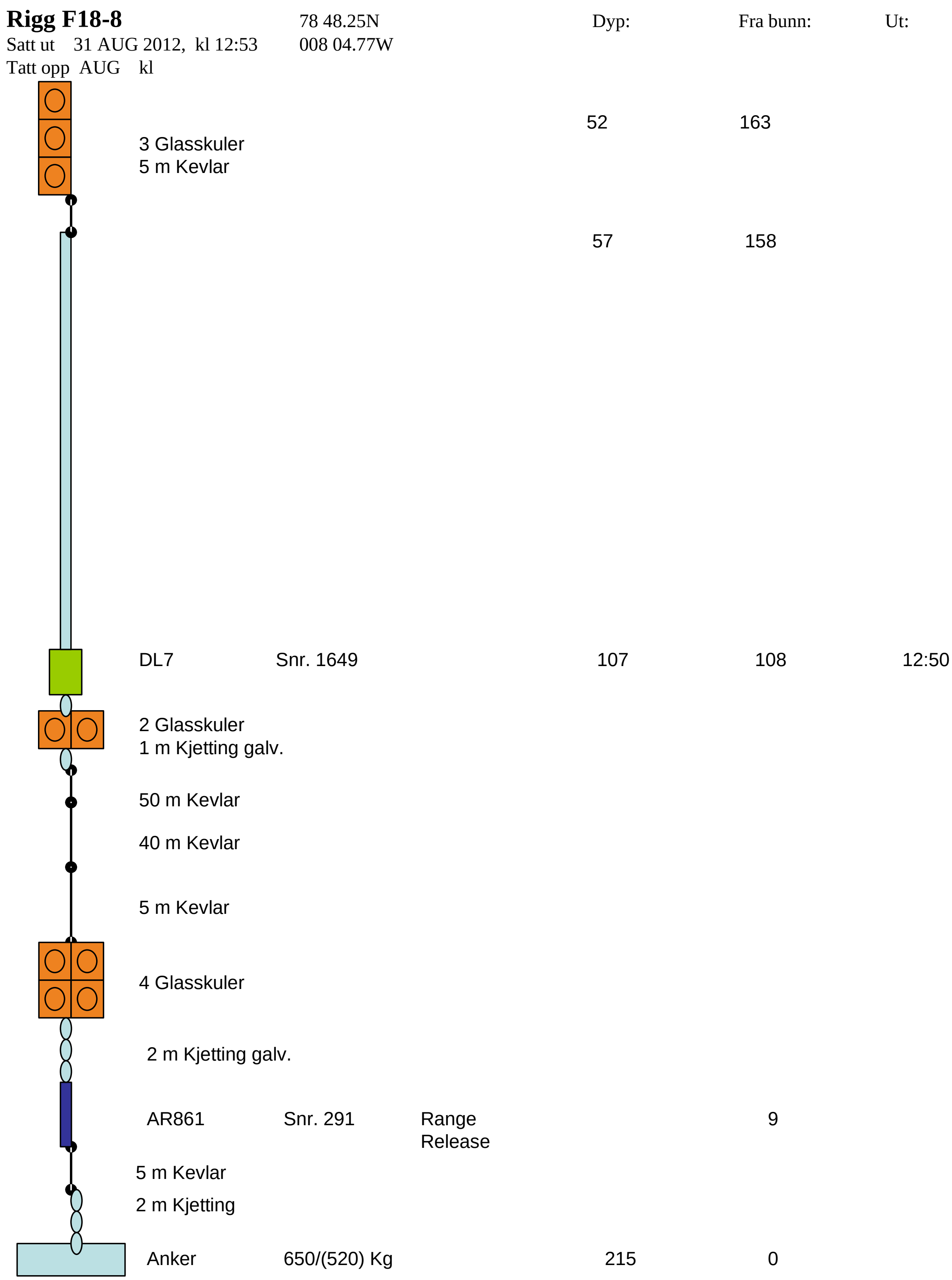
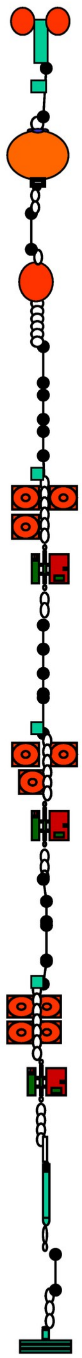


Figure 13:. Recovered mooring F18-8.

Rigg F11-15

Satt ut 1 SEP 2013 kl 01:13 | 78 48,41N
Tatt opp AUG kl | 002 58,05W



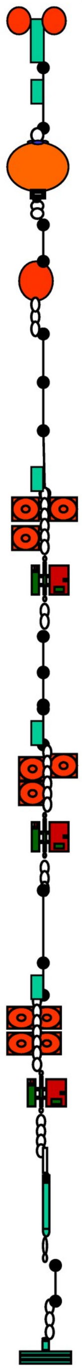
			Dyp:	Fra bunn:	Ut:
IPS	SNR. 51062		54	2416	23:43
SBE37	SNR. 7054		56	2414	23:43
5 m Kevlar					
ADCP300	SNR: 17461		60	2410	23:43
1 m Kjetting galvanisert					
10 m Kevlar					
Stålkule 37 McLane			72	2398	
1 m Kjetting galvanisert					
100 m Kevlar					
50 m Kevlar					
20 m Kevlar					
50 m Kevlar					
5 m Kevlar					
SBE37	SNR. 3996		299	2171	22:54
3 Glasskuler					
2 m Kjetting galvanisert					
RCM9	SNR.1049		303	2167	22:54
0,5 m Kjetting galv					
200 m Kevlar K					
500 m Kevlar K					
500 m Kevlar					
40 + 10 m Kevlar					
SBE37	SNR. 7061		1553	917	22:18
3 Glasskuler					
2 m Kjetting galvanisert					
RCM11	SNR.538		1556	914	22:18
0,5 m Kjetting galv					
500 m Kevlar K					
200 m Kevlar					
200 m Kevlar					
SBE37	SNR. 8226		2456	14	21:48
4 Glasskuler					
2 m Kjetting galvanisert					
RCM8	SNR.10069		2459	11	21:48
0,5 m Kjetting rustfri					
Svivel					
AR861	SNR. 499	Pinger på: Pinger av: Release: Release m/ping:			
5 m Kevlar					
2 m Kjetting galvanisert					
ANKER 1190/(960) kg			2470	0	

Figure 14: Deployed mooring F11-15

Rigg F12-15   78 47,672N

Settes ut   10 SEP 2013   kl   13:20   003 57,860W

Tatt opp   AUG 20   kl



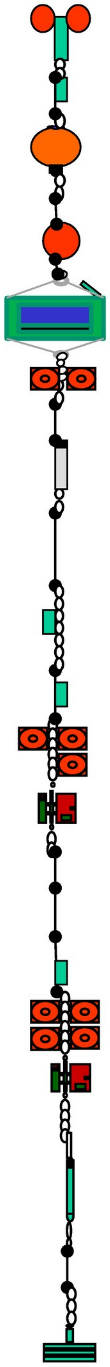
			Dyp:	Fra bunn:	Ut:
IPS	SNR. 51063		124	1749	11:26
SBE37	SNR.7055		126	1747	11:26
5 m Kevlar					
ADCP300	SNR: 17462		130	1743	11:26
0,5m Kjetting galvanisert					
10 m Kevlar					
Stålkule 37			142	1731	
1 m Kjetting galvanisert					
10 m Kevlar					
200 m Kevlar					
SBE37	SNR.3994		353	1520	11:22
3 Glasskuler					
2 m Kjetting galvanisert					
RCM9	SNR. 836???		356	1517	11:22
0,5 m Kjetting galv					
500 m Kevlar					
500 m Kevlar					
200 m Kevlar					
SBE37	SNR.10295		1556	317	11:03
3 Glasskuler					
2 m Kjetting galvanisert					
RCM11	SNR.556		1559	314	11:03
0,5 m Kjetting galv					
200 m Kevlar					
100 m Kevlar					
SBE37	SNR. 8227		1859	14	10:54
4 Glasskuler					
2 m Kjetting galvanisert					
RCM11	SNR.117		1862	11	10:54
0,5 m Kjetting rustfri					
Svivel					
AR861	SNR. 500	Pinger på: Pinger av: Release Release m/ping:			
5 m Kevlar					
2 m Kjetting galvanisert					
ANKER	1170/(940) kg		1873 (1833)	0	

Figure 15: Deployed mooring F12-15

Rigg F13-15 78 50.038N

Settes ut 8 SEP 2013, kl 17:20 004 59.591W

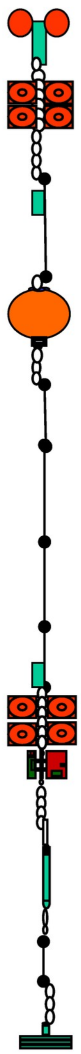
Tatt opp AUG 201 kl :00



		Dyp:	Fra bunn:	Ned i vann:
IPS4	SNR. 1047	47	968	15:14
SBE37	SNR: 7059	49	966	15:14
5 m Kevlar				
ADCP300	SNR: 16831	53	962	15:14
0,5 m Kjetting galv				
10 m Kevlar				
Stålkule 37		65	950	
2 m Kevlar				
SBE16	SNR. 7212	68	947	15:00
Vannhenter				
1,5 m Kjetting galv.				
2 Glasskuler				
5 m Kevlar				
Hvallydopptaker		76	939	15:00
0,5 m Kjetting galv.				
50 + 20 m Kevlar				
SBE16	SNR. 7339	147	868	14:40
1 m Kjetting galv.				
100 m Kevlar				
SBE37	SNR.7060	247	768	14:33
3 Glasskuler				
2 m Kjetting galv.				
RCM9	SNR.1326	250	765	14:33
0,5 m Kjetting galv				
500 m Kevlar K				
100 + 50 m Kevlar				
50 +10 + 40 m Kevlar				
SBE37	SNR.10294	1000	15	14:13
4 Glasskuler				
2 m Kjetting galv.				
RCM11	SNR. 345	1003	12	14:13
0,5 m Kjetting rustfri				
Svivel				
AR861	SNR. 743 Ping på: Ping av: Release: Release m/ping:			
5 m Kevlar				
2 m Kjetting galvanisert				
ANKER 1130/(900) kg		1015	0	

Figure 16: Deployed mooring F13-15

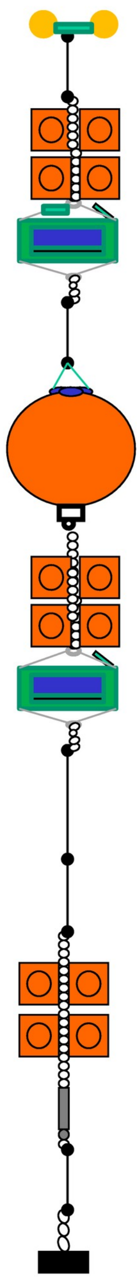
Rigg F14-15 78 49.012N
Satt ut 7 SEP 2013 , kl 15:27 006 31,087W



			Dyp:	Fra bunn:	Ned i vann:
IPS	SNR. 51064		58	213	15:22
4 Glasskuler 2 m Kjetting galv.					
SBE37	SNR: 7058		62	209	15:22
5 m Kevlar					
ADCP 300	SNR: 16876		66	205	15:20
1 m Kjetting Galv. 0,5 m Kjetting Galv.					
40 m Kevlar					
100 m Kevlar					
50 m Kevlar					
SBE37	SNR.7057		257	14	15:14
4 Glasskuler 2 m Kjetting Galv.					
RCM9	SNR. 1325		260	11	15:14
Svivel					
AR861	SNR. 568	Arm: Range: Ping on:			
5 m Kevlar					
2 m Kjetting					
ANKER	900/(720) kg		271	0	

Figure 17: Deployed mooring F14-15

Rigg F17-10 | 78 50.610 N | Dyp: | Fra bunn: | Ut:
Satt ut 6 SEP 2013 , kl 21:28 | 008 08.493W



			Dyp	Fra bunn	Ut
ICECat	SNR.		29	200	21:26
25 m Wire Weak link					
2 m Kjetting galv. 4 Glasskuler					
SBE16	SNR.7253		57	172	21:26
ICECAT Modem					
Vannhenter			58	171	21:26
50 m Kevlar					
ADCP	SNR.7636		109	120	21:19
2 m Kjetting galv. 4 Glasskuler					
SBE37	SNR.3993		113	116	21:19
Vannhenter			113	116	21:19
100 m Kevlar					
5 m Kevlar					
2 m Kjetting galv.					
4 GLASSKULER			219	10	21:10
AR661	SNR. 501	Ping on: Release: Arm:			
5 m Kevlar.					
2 m Kjetting galv.					
ANKER	780/(620)kg		229	0	

Figure 18: Deployed mooring F17-10

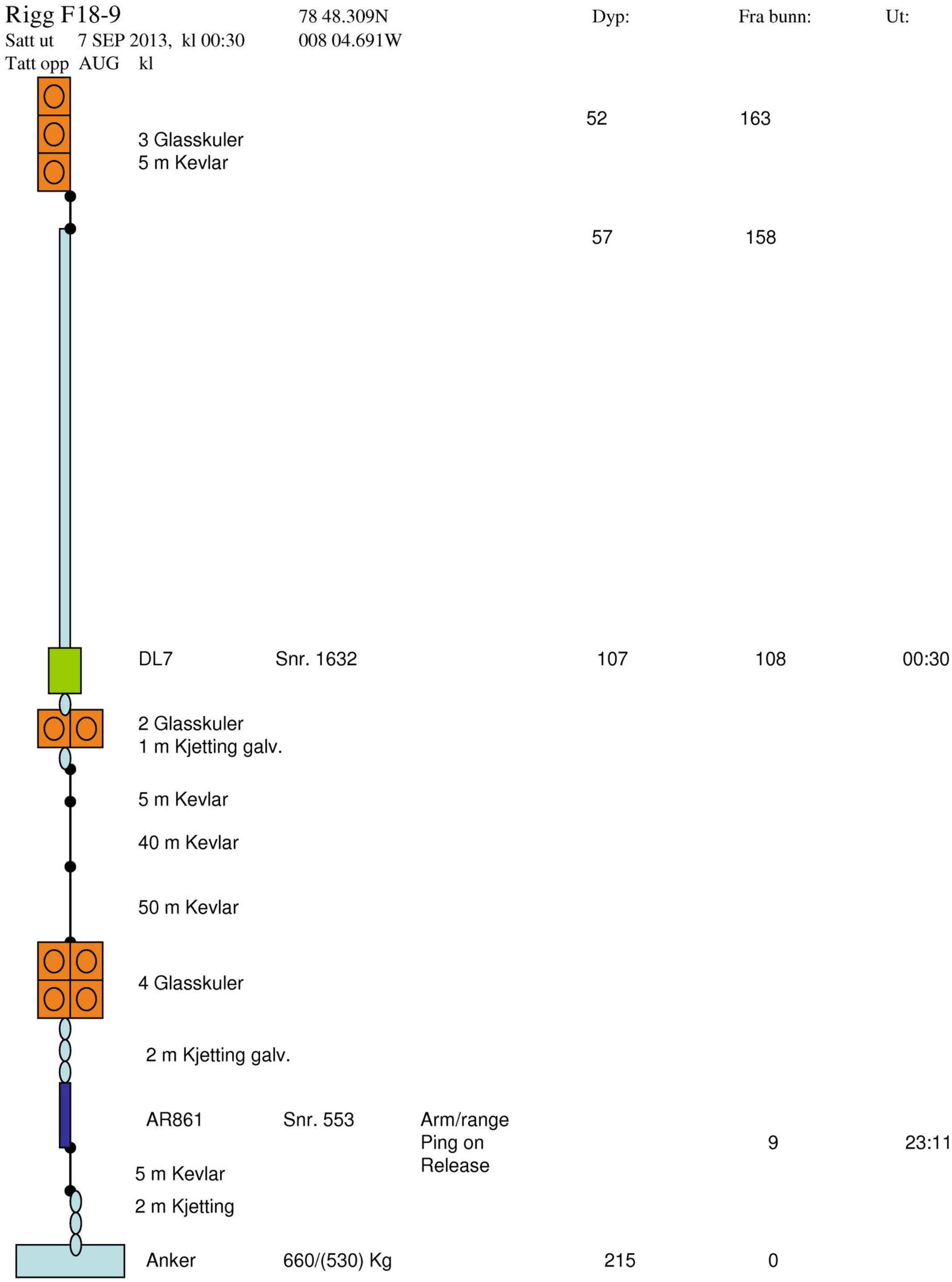


Figure 19: Deployed mooring F18-9

Remote Access Water Samplers

Recovery & Sampling

Three remote access water samplers were recovered from during the FS2013, one from F17 and two from F13. Serial number MLl12239-02 was not deployed from 2012-2013 so was not recovered. MLl12239-02 was held in storage at NPI in Tromsø.

- Serial number MLl12239-01 was deployed at 113 m depth on Mooring F17. Microcat serial number 37sm54280-7062 was attached to MLl12239-01. MLl12239-01's clock was 38 minutes and 5 seconds ***slow*** relative to GPS time upon recovery.

- Serial number ML12852-01 was deployed at 67 m depth on mooring F13. Seacat serial number 16p61772-6693 was attached to ML12852-01. ML12852-01's clock was 8 mins 55 seconds ***slow*** relative to GPS time upon recovery.

- Serial number ML12852-02 was deployed at 146 m depth on mooring F13. Seacat serial number 16p61772-6694 was attached to ML12852-02. ML12852-02's clock was 5 mins 45 seconds ***fast*** relative to GPS time upon recovery.

Samples for $\delta^{18}O$, dissolved nutrients and total alkalinity were collected from all three samplers. Sample bags contained a significant volume of water after samples were collected. Bags were retained and labelled so that the remaining water might in future be analysed for additional parameters. All bags contained 0.07 g of $HgCl2$ dissolved in 1 ml of filtered low nutrient seawater (salinity ~35) provided by OSIL.

Bags were removed from samplers in the Heated CTD tent. Bag taps were closed before bags were removed from the samplers. Immediately after removal, bags were dried, labelled, divided into sets of 10 and placed in a refrigerator, where they remained for the duration of the cruise.

Sub-samples were drawn from bags in a fume cupboard ashore in Longyearbyen. When bags were removed from the refrigerator onboard Lance in Longyearbyen it was noted that sample water had leaked out of the sample bags and accumulated the polythene bags containing sets of 10 sample bags. This was likely due to the weight of fluid lying on sample bags at the bottom of each set. We assume that fluid leaked out of bags, but not in.

Paper log sheets listing the sample numbers of $\delta^{18}O$, dissolved nutrients and total alkalinity samples collected from each bag are included in appendix 6.

All samplers were programmed to perform a 10 ml acid flush before each sample collection, but all samplers contained a full bag of acid after deployment. The reason for this is not known, but the same problem was observed during the 2011-2012 deployment.

Preparation and Deployment

Three remote access water samplers were deployed during FS2013.

1. Serial number ML112239-01 was deployed at 113 m depth at F17 microcat serial number 3993 was attached to ML112239-01. The Microcat was programmed to measure at 15 minute intervals beginning at 00:00

2. Serial number ML112239-02 was deployed at 57 m depth at F17 Seacat serial number 7253 was attached to ML112239-02. The Seacat was programmed to measure at 15 minute intervals beginning at 00:00

3. Serial number ML12852-01 was deployed at 068 m depth at F13. Seacat serial number Seacat 16p61772-7212 was attached to ML12852-01. The Seacat was programmed to measure at 15 minute intervals beginning at 00:00

0.07 g of $HgCl_2$ dissolved in 1 ml of filtered low nutrient seawater (salinity ~35) provided by OSIL was added to all samples bags in all samplers deployed during FS2013. Salinity (sample 925), δ18O (sample 464), nutrients (sample 9999) , At (2280 umol/l) and Ct (2027 umol/l) samples were taken from this water.

Sample tubes (between the value and the bag) of all samplers were filled with the same low nutrient sea water provided by OSIL. Salinity (#319), $\delta^{18}O$ (#305), nutrient (#294), CDOM (#100) and A_T (#188) samples were collected from this water.

Acid bag were not added to samplers deployed during FS2013. The acid-flush procedure did not work during the 2011-2012 or 2012-2013 deployments. It seemed better to omit the acid-flush procedure than to program the RAS-samplers to perform a procedure that hd not worked during the two previous deployments. If acid is somehow pumped into undesired locations it could cause other problems.

None of the gears or seals in the micro pumps of the samplers were replaced before deployment. Spare pump parts were not available due to the loss of a pallet of equipment following FS2012, which was only detected shortly before FS2013 departed. We note that gear-replacement (replacing the gears in the gear-pump) before deployment during FS2012 did not seem to increase the volume of sample collected in bags by sampler ML112239-01.

Many of the sample bags provided by McLane for use during FS2013 were found to leak. The leaks were not apparent until the bags were installed in sample tubes, when air trapped in the bag could clearly be seen escaping from around the tap in the bag nozzles in small bubbles. When leaks were noticed, the leaking sample bags was removed and a different sample bag was installed instead. It was only possible to deploy 3 of the 4 samplers due to a lack of properly manufactured bags.

The samplers, Microcat and Seacat clocks were set to GPS (UTC) time before deployment.

Sea Ice Stations

Ice station 1
W 009° 26', N 78° 38'
Friday 06 September 2013 12:06 - 12:50 (4 pax)

Ice station 2
W 007° 21', N 78° 48'
Saturday 07 September 2013 07:36 - 08:50 (4 pax)
Short station on a floe with diameter of about 50 m. Collected ice core for archive and salinity profile. Some thickness drilling. No temperature core or EM31.

Figure 20: *Ice station 2 floe.*

Ice station 3
W 007° 21', N 78° 48'
Saturday 07 September 2013 09:00
Short station on small floe, diameter about 30 m, very level floe. Thickness drillings. No temperature core. Archive and salinity core collected. No EM31.

Ice station 4
W 006° 27', N 78° 49'
Saturday 07 September 2013 17:15 - 19:10 (9 pax)
Short EM31 run. Archive, salinity and temperature cores collected.Thickness drillings.

Figure 21: *Station 4 ice floe.*

Ice station 5
W 006° 06', N 78° 48'
Monday 09 September 2013 06:35 - 10:40 (7 Pax) (time interval is for stations 5-7)
Short EM31 run. Archive, salinity and temperature cores collected. Thickness drillings.

Figure 22: *Ice station 5*

Ice station 6
W 006° 16.2', N 78° 48.74'
Monday 09 September 2013 06:35 - 10:40 (7 Pax) (time interval is for stations 5-7)
Adjacent to station 5. EM31 and thickness drillings. Snow depths. No coring.

Ice station 7
W 006° 16.2', N 78° 48.74'
Monday 09 September 2013 06:35 - 10:40 (7 Pax) (time interval is for stations 5-7)
Adjacent to station 5 & 6 floe. EM31 and thickness drillings. Snow depths. No coring.

Sea-ice chemistry
Ice cores for chemical analysis at were collected at ice stations 2, 3 and 4. The ice cores were cut into 10 cm pieces, which were later melted. In-situ temperatures were measured from a separate core adjacent to the sampled core. Melted samples were transferred into bottles for total inorganic carbon (DIC), total alkalinity (AT), $\delta^{18}O$ and nutrients.