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# Scientific Cruise Reports

# R/V „Celtic Explorer“

## Cruise 14012a, August 1<sup>st</sup> – 25<sup>th</sup>, 2014

Report of the Chief Scientist

ICES Cruise Id: 45CE14012a

CSRREF: 20143280

Holger Klein



Hamburg, September 26<sup>th</sup>, 2014

(CR-Celtic-Explorer-14012A.docx)

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## Participants

Science Crew	Working Group	Ship Crew	Rank
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Andreas Pfeiffer	Marine Physics	Damien McCalling	Chief Engineer
Sören Joswig	Marine Physics	Kenny Downing	Chief Officer
Dr. Jan Reißmann	Marine Physics	Barry Hooper	2 <sup>nd</sup> Officer
Peter Löwe	Marine Physics	David Stack	2 <sup>nd</sup> Engineer
Jens Gerull	Marine Physics	Dave Steward	ETO
Dr. Christian Senet	Marine Physics	Gerry Carty	Bosun
Wiebke Brandt	Marine Chemistry, Nutrients	Tony Reck	Cook
Roswitha Velten	Marine Chemistry, Nutrients	Ken O'Neill	Bosun's Mate
Christina Wehner	Marine Chemistry, Radioactivity	Martin Goggin	AB Deckhand GP1
Anke Gottschalk	Marine Chemistry, Radioactivity	Paddy Kenny	AB Deckhand GP1
Andreas Jacobsen	Marine Chemistry, Metals	Michael Doogan	Assistant Cook
		Brian Sharkey	Technician
		Declan Horan	AB Deckhand GP1
		Noel O'Driscoll	AB Deckhand GP1
		Daniel Rose	Eng. Cadet

## Objectives and scientific background

The North Sea is a shallow shelf sea with a deep trough along the Norwegian coast with depth exceeding 700 m locally. Its physical status, primarily characterised by temperature and salinity, is to a large extent determined by the exchange of water masses with the Atlantic at its open northern boundary. There is also a link to Atlantic via the English Channel which is important for the shallow southern North Sea. The Baltic Sea is linked to the North Sea via Skagerrak, Kattegat, Great and Little Belt, and The Sound. The Baltic outflow with its low saline water influences significantly the oceanographic conditions of the Skagerrak and Norwegian Coastal Current. Other drivers are inter alia continental river run-offs, the ocean-atmosphere heat exchange, and the rate of precipitation to evaporation.

All parameters exhibit a strong seasonal and/or inter-annual variability. Seasonal heating leads to the establishment of a seasonal thermocline between spring and end of August/midst of September with vertical gradients exceeding 3 K/m in most of the years. Strength and depth of the thermocline vary locally and from year to year. Near-bottom tidal mixing and wind induced mixing at the surface suppress stratification in areas shallower than 25 to 30 m. Stratified and vertically mixed areas are separated by so-called tidal mixing fronts.

In order to assess the summer state of the North Sea the BSH started its North Sea Summer Surveys (NSSS) in 1998. They cover the entire North Sea with seven coast to coast east-west sections between 54° and 60°N and additional stations between 54°N and the entrance of the English Channel. The surveys were realised at a time when thermal stratification is expected to be at its maximum and phytoplankton production has passed its maximum. With the exception of the first survey in 1998 all surveys served a fixed grid of vertical CTD casts (see red dots in Fig. 1). Between these fixed stations a towed CTD-system (1998-2008 the

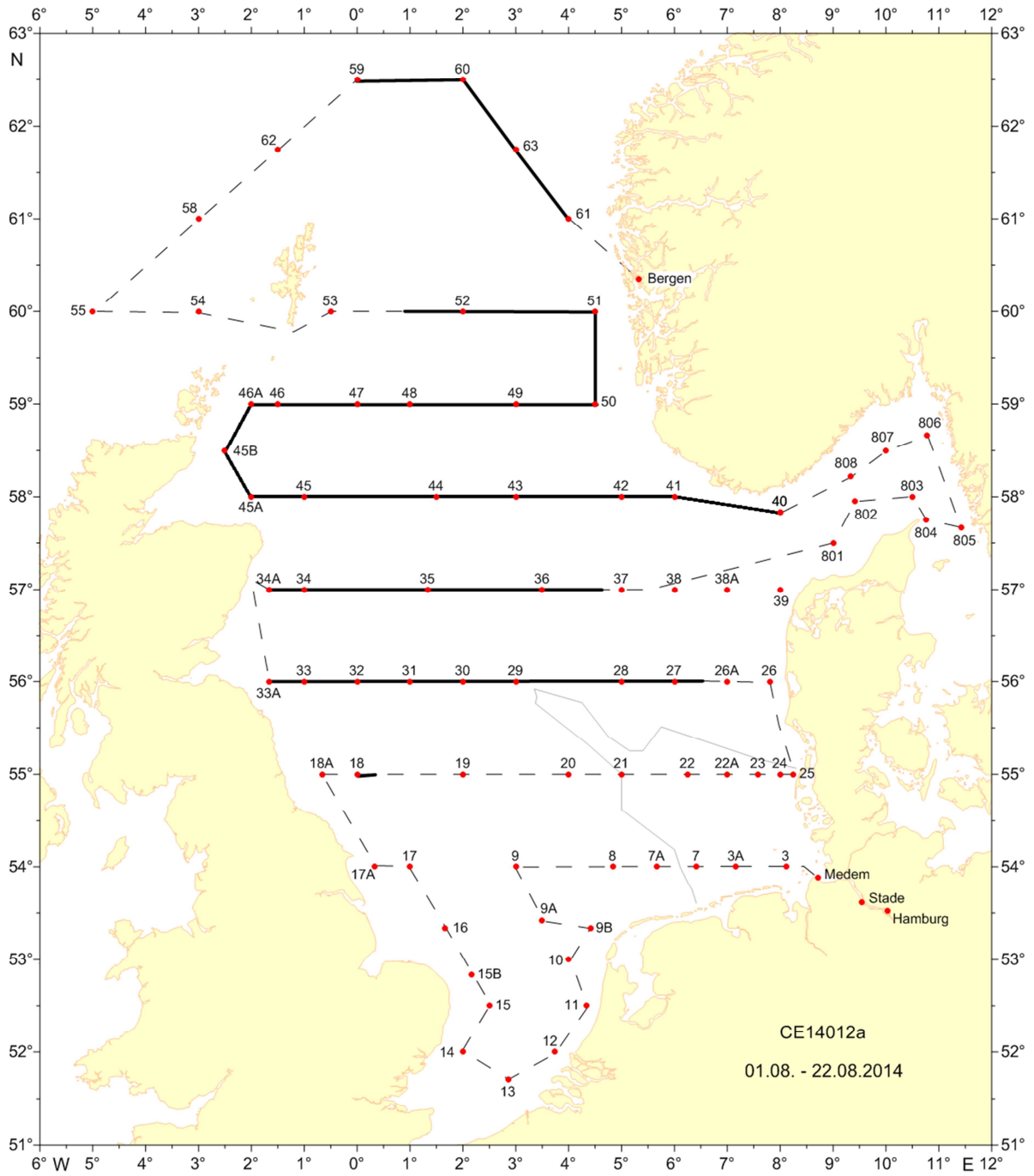
BSH *Delphin*, since 2009 an EIVA *MK2 ScanFish*) was deployed which oscillated between surface and bottom to record the distribution of relevant oceanographic parameters with high resolution in space and time (24 Hz). Both CTD-systems are recording temperature, salinity, fluorescence (chlorophyll-a, yellow substance), and oxygen concentration. Additionally, ship-mounted temperature-, salinity- and optical sensors provided data at about 4 m depth. In order to sample the transition area between North Sea and Atlantic the survey was expanded northwards to 62.5°N since 2010.

The objective of the NSSSs is the assessment of the oceanographic and chemical state of the North Sea, the calculation of heat and salt budgets, and the identification of changes due to climate change. The data are also used for the validation of operational and climate models and for the calibration of satellite-based ocean colour data and downstream products (Secchi depth, turbidity, CDOM, chlorophyll-a) which are used for assessments and MSFD reporting. All NSSSs are listed in Table 1. Most of the data are available via the German Oceanographic Data Centre (DOD) and the MERis MATCHup In-situ Database MERMAID.<sup>1</sup>

date of cruise	ship & cruise id
24.06.1998 – 16.07.1998	R/V Gauss 317
02.07.1999 – 22.07.1999	R/V Gauss 335
09.08.2000 – 23.08.2000	R/V Gauss 353
11.07.2001 – 02.08.2001	R/V Gauss 370
16.07.2002 – 31.07.2002	R/V Gauss 385
28.07.2003 – 13.08.2003	R/V Gauss 405
05.08.2004 – 20.08.2004	R/V Gauss 425
10.08.2005 – 29.08.2005	R/V Gauss 446
02.08.2006 – 20.08.2006	R/V Gauss 463
03.08.2007 – 17.08.2007	R/V Pelagia 273
21.07.2008 – 05.08.2008	R/V Pelagia 293
20.08.2009 – 09.09.2009	R/V Pelagia 311
04.08.2010 – 22.08.2010	R/V Pelagia 323
08.08.2011 – 28.08.2011	R/V Celtic Explorer 11010
07.08.2012 – 30.08.2012	R/V Celtic Explorer 12011
10.08.2013 – 04.09.2013	R/V Celtic Explorer 13012
01.08.2014 – 25.08.2014	R/V Celtic Explorer 14012

**Table 1:** BSH North Sea Summer Surveys 1998-2014.

<sup>1</sup> [http://www.bsh.de/en/Marine\\_data/Observations/DOD\\_Data\\_Centre/index.jsp](http://www.bsh.de/en/Marine_data/Observations/DOD_Data_Centre/index.jsp)  
<http://hermes.acri.fr/mermaid/home/home.php>



**Fig. 1:** Stations marked with an A or B are transit stations. The ScanFish was towed along the solid lines.

## Equipment and Methods

### Marine Physics:

- CTD Seabird SBE 911+ (SBE1, S/N 0577) with SBE 43 oxygen sensor, 3-Kanal Backscat II fluorimeter and rosette water sampler with twelve 10-liter bottles.
- ScanFish (SF1 = S/N 380, SF2 = S/N 390) with Seabird SBE 911+ CTD, AMT oxygen sensor, and TRIOS fluorimeter „TwinFlu“ (SF1, S/N 6811).
- Seabird thermosalinograph SBE 21 with turbidity and chlorophyll sensors.

### Nutrients:

- Oxygen determination according to Winkler-Carpenter by means of a SIS Dissolved Oxygen Analyser (DOA) with photometric end point determination at selected depths.
- Continuous pH determination via the sea water pipe.
- Continuous phosphate, silicate (MiniMon) and nitrate determination (nitrate spectrometer) via the sea water pipe and daily reference samples.
- Determination of the pH value (CTD samples).
- Determination of depth of visibility by means of a Secchi disk at every daylight station.
- Filtration of surface water samples and freezing of the glass fiber filters for the determination of chlorophyll via Lorenzen photometry after the cruise.
- Determination of alkalinity of sea water.
- Extra samples for the UK Shelf Sea Biochemistry Programme:
  - Daily filtration of nutrient samples (polycarbonate filters) and freezing.
  - Daily surface samples for DIC/TA (they were poisoned with Mercuric chloride).

### Radiochemistry:

- 2 x 35 l surface water for the extraction of strontium 90 after the cruise.
- One liter surface samples for the analysis of tritium after the cruise.
- 100 l surface samples for the determination of plutonium und americium on board.
- 270 l samples taken at selected stations at great depths for the determination of strontium and tritium after the cruise and of cesium, plutonium, and americium on board.
- At the above mentioned deep stations additionally 100 l surface water samples for the determination of plutonium and americium, which had been filtered before analysis in contrast to the other samples.
- 100-150 l surface water samples for the on-board analysis of cesium-137 by means of a ion exchanger.

### Atmospheric Chemistry

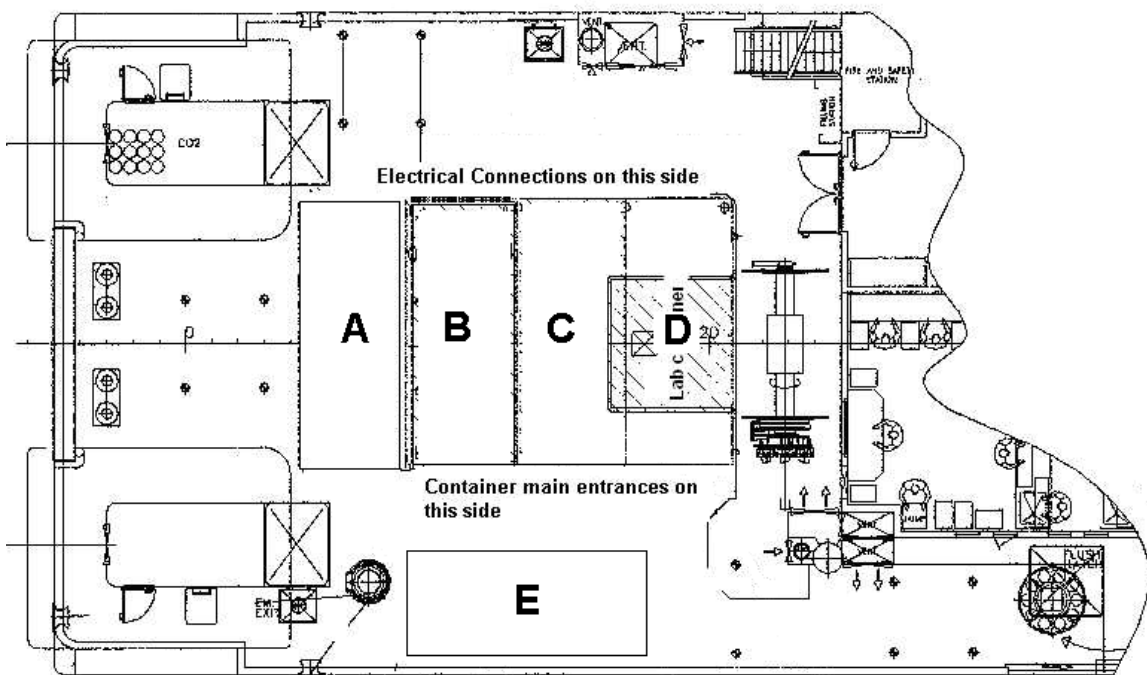
- Continuous trace gas analysis of nitric oxides (NO<sub>x</sub>, NO und NO<sub>2</sub>) by means of HORIBA APNA-370, of sulphur dioxide (SO<sub>2</sub>) by means of HORIBA APSA-370 and of ozone (O<sub>3</sub>) by means of HORIBA APOA-370.
- CO<sub>2</sub> and water vapor determination by means of LiCOR840a (Co. LiCOR).
- Recording of meteorological parameter like wind speed and direction, air temperature, air pressure and precipitation by means of the meteorological monitoring system WS-600-UMB (Co. Lufft) and data logger µIOx (Co. Gemi).

- Monitoring of current AIS signals in order to relate recorded emissions to ships passing windward.
- Collecting fine dust samples via a Riemer „High Volume Sampler“ Digital DHM-60 which will be analyzed for contaminants like sulfate and nitrate after the cruise.

**Trace Metals:**

- Sampling via MERCOS sampler and Clean CTD (plastic covered wire) with GoFlo sampler for the determination of the metal concentrations within sea water and suspended matter.

**Container Plan for leg a & b**



	container type	weight	power supply	used on leg
A	600 l drum for nutrients, no container!			1
B	Bottom: 20" M33 lab container, height 3.1 m (HM)	9	2 x 32 A	2
B	Top: 20"-flat with 2 winches: W5 (3.5 t) and W20 (1.8 t).	7 t	64 A	1
C	Bottom: 20" M34 lab container (organic)	9 t	1 x 32 A	2
C	Top: 10" Store container for marine chemistry	2 t	-	1&2
D	Bottom: 20" M32 lab container, fresh- und sea water (radioactivity)	5 t	32 A	1
D	Top: 2 x 600 l drum for sea water (calibration lab)			
E	20" Transport container radioactivity	9 t	-	1
F	20" Transport and store container	5 t	-	1&2

F: Bow position



## Diary

### All time specifications in Central European Summer Time (CEST = UTC + 2)

- ↓ Specifications regarding fixed stations, ship stops for vertical CTD profiles and water sampling
- SF** ScanFish
- T** Specifications regarding transit stations where water samples for radioactivity are taken from the sea water pipe during transit
- SF▶** Start of ScanFish profile
- SF◀** End of ScanFish profile
- W&S** Weather & Sea:  $T_A$  = air temperature,  $T_W$  = water temperature at 4 m depth
- RA** Radioactivity, sea water samples are taken for the following artificial nuclides: Cs-137 = cesium-137; Sr-90 = strontium-90; Pu = plutonium, H-3 = tritium

There are no data from the Seabird thermosalinograph SBE 21 available due to a blocked outlet and also no air temperatures due to sensor problems!

### Watch table Marine Physics:

- 00-04/12-16: Christian & Jan
- 04-08/16-20: Jens & Peter
- 08-12/20-00: Andreas & Sören

## Friday, August 1<sup>st</sup>, 2014

**08:00:** Arrival at Celtic Explorer, shed 72 (Kaiser-Wilhelm-Harbour).

**08:30:** Mobile crane arrives.

Three TV teams came on board (Hamburg 1, RTL Nord, Sat.1), interviews with chief scientist and crew. Telephone interviews with WDR.

**11:30:** Arrival of container and material, start of mobilization.

**W&S 12:30:** Bft. 2, 179°, 1012 hPa, clear sky.

**17:30:** Activities requiring the external mobile crane are finished.

The winch for Clean-CTD was installed in front of dry lab. Both ScanFish winches have been equipped with a new Rochester coax cable, 8.18 mm (Signal Transmission Cable, Code: SC0010132CO00, Part No. A320327) after the last cruise in 2013. We expect to reduce the electrostatic problems which occurred during the ScanFish launches during the last surveys. Further on we decided to reduce the tow velocity to 8 kn (through water, not over ground!).

**18:30:** Security instructions by the second mate Barry Hooper.

**19:19** Short meeting of the marine physics group for a review of the work to be done in the next days: The new wire on both winces must still be terminated which needs 36 hours, the Cruise Assistance System has to be adopted to the new data distribution

system of the Celtic Explorer, the complete SF-system has to be tested after the repair by EIVA and the replacement of the communication unit, the new cable of winch W5 needs to be connected and a plug must be replaced.

After the meeting the CTD-system was completed and successfully tested.

## Saturday, August 2<sup>nd</sup>, 2014

**W&S 06:30:** Bft. 3, 114°, 1010 hPa, clear sky.

**06:38** Sailing.

↓ **08:28 – 08:44 Station Stade:**

GoFlo for metals und salinity.

RA: Cs-137: 150 L, Sr-90: 2x90 L, Pu: 100 L, H-3: 1 L.

↓ **11:38 – 11:52 Station Medem:**

GoFlo for metals und salinity

RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**W&S 12:00:** Bft. 4, 120°, 1009 hPa, clear sky.

↓ **13:54 - 14:25 Station GN003 (Elbe 1):**

Secchi depth and CTD profile with rosette sampler.

RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

In the afternoon we took a first attempt to terminate the cable of the KC-winch. It took us about 4 hours, but the attempt fail because we were not able to place the cone in the center of the SF handle.

**W&S 18:15:** Bft. 4, 80°, 1006 hPa, clear sky.

**T 18:10 – 18:24 Transit station GN003A:**

RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

↓ **20:43 – 20:57 Station GN007 (Borkumriffgrund):**

Secchi depth and CTD profile with rosette sampler.

RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

The position of GN007 had to be changed to 53° 56' N, 006° 25' E due to a new wind park under construction!

**W&S 22:00:** Bft. 1, variable, 1006 hPa, cloudy.

**T 23:31 – 23:46 Transit station GN007A:**

RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

## Sunday, August, 3<sup>rd</sup>, 2014

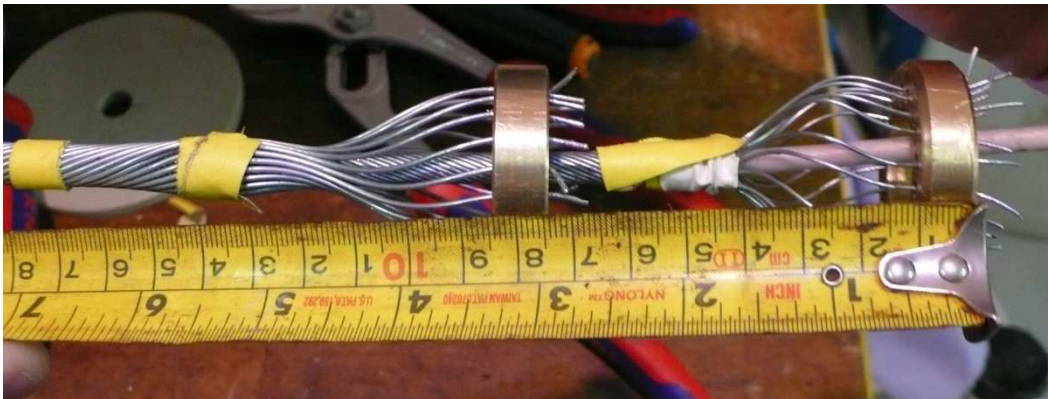
↓ **02:44 – 03:13 Station GN008:**

CTD profile with rosette sampler and GoFlo for metals.

RA: Cs-137: 150 L.

**W&S 06:30:** Bft. 5, 225°, 1006 hPa, cloudy,  $T_w = 20.6$  °C.

In the morning second attempt to terminate the KC-winch. Now we succeeded and tested the link by hanging a 330 kg railroad wheel on the wire. It took us again 4 hours for three people to handle the wire.



- ↓ **09:48 – 10:05 Station GN009 (Outer Well Bank):**  
 Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
 RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.
- W&S 12:15:** Bft. 4, 230°, 1009 hPa, clear sky,  $T_w = 19.1$  °C.
- T 13:54 – 14:04 Transit station GN009A:** RA: Cs-137: 150 L.
- T 17:07 – 17:28 Transt station GN009B:**  
 RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.
- W&S 18:30:** Bft. 2, 210°, 1011 hPa, clear sky,  $T_w = 19.1$  °C.
- ↓ **19:31 – 19:52 Station GN010 (west of Den Helder):**  
 Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
 RA: Cs-137: 150 L.
- ↓ ↓ **23:31 – 23:45 Station GN011 (west of Ijmuiden)**  
 CTD profile with rosette sampler and GoFlo for metals.  
 RA: Cs-137: 150 L.

### Monday, August 4<sup>th</sup>, 2014

- ↓ **03:59 – 04:22 Station GN012 (west of Hoek van Holland):**  
 CTD profile with rosette sampler and GoFlo for metals.  
 RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.
- W&S 07:00:** Bft. 2, 260°, 1014 hPa, cloudy,  $T_w = 19.8$  °C.
- ↓ **08:52 – 09:19 Station GN013 (Rabsbank):**  
 Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
 RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.
- ↓ **13:05 - 13:30 Station GN014 (Outer Gabbard):**  
 Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
 RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.
- W&S 13:30:** Bft. 2, 225°, 1016 hPa,  $T_w = 19.5$  °C.

The terminatin of the the KC-winch is nearly finished an we tried to activiate both SF systems with the new cable. One SF seems to be o.k., we got the CTD data and had contact to the SF controller. We also get the CTD data from the second SF, but no contact to the controller, i.e., we couldn't navigate the system. Because the CTD stations confirm a vertically mixed water body along the UK coast, the chief scientist decided to terminate the cable of the second winch (W5) tomorrow morning and to check the cabelling and mechanics of the working SF carefully in the afternoon in order to start the SF survey along the 55 °N section to the east with two working winches because we expect a strong stratification due to the high STT values during the last weeks along some parts of this section.

↓ **17:28 – 17:44 Station GN015 (east of Lowestoft):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.

**W&S 18:00:** Bft. 2, 200°, 1017 hPa,  $T_w = 18.8$  °C.

We detekted several cuts and damages at the plastik coated Kevlar cable of the Clean CTD. We covered the cuts with tape but have not been able to identify the reason for the cuts. Must have an eye on it during the next days.

**T 19:55 – 20:14 Transit station GN015B:** RA: Cs-137: 150 L.

↓ **23:44 – 00:09 Station GN016 (Haddock Bank):**  
CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

## Tuesday, August 5<sup>th</sup>, 2014

↓ **05:11 – 05:32 Station GN017 (east of Flamborough Head):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**W&S 07:00:** Bft. 2, 10°, 1018 hPa, clear sky,  $T_w = 17.2$  °C.

**T 07:51 – 08:16 Transit station GN017A:**  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**W&S 12:00:** Bft. 2, 100°, 1018 hPa, clear sky,  $T_w = 18.3$  °C.

There is a problem with the K5 winch. It worked properly at Co. Hatlapa where they coiled the new cable onto the drum, but now the clutch is not working, i.e. we can't move the drum with the cable. Jens is working on the winch and tries to fix the problem.

**T 15:04 – 15:19 Transit station GN018A:** RA: Cs-137: 150 L.

**SF▶ 17:41:** Start SF profile 2 to station GN018 with SF1. (Profile 1 has been a test only!)

**W&S 18:00:** Bft. 4, 130°, 1016 hPa,  $T_w = 18.5$  °C.

**SF◀ 18:25:** End of SF profile 2.

↓ **18:27 – 18:50 Station GN018 (Baymans Hole):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**SF▶ 19:03:** Start SF profile 3, GN018 →GN019.

Profile must be cancelled due to communication problems between SF and deck unit. After testing all cables and cable connections it showed up that sea water intruded into the termination of the cable at the SF handle.

**SF ◀ 19:54:** End of SF profile 3.

W5 is working again now and we can start to terminate this cable also.

**W&S 00:00:** Bft. 3, 180°, 1015 hPa,  $T_w = 18.3$  °C.

### Wednesday, August 6<sup>th</sup>, 2014

↓ **03:40 – 04:01 Station GN019 (Doggerbank):**  
CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**W&S 07:00:** Bft. 4-5, 170°, 1012 hPa, covered,  $T_w = 15.2$  °C.

Perpared the new termination of the KC winch and tested the link with a 330 kg weight.

↓ **11:09 – 11:27 Station GN020 (east of Doggerbank):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.

**W&S 12:00:** Bft. 3-4, 185°, 1012 hPa,  $T_w = 19.5$  °C.

↓ **15:08 – 15:28 Station GN021 (Nordschillgrund):**  
Secchi depth, CTD profile with rosette sampler.  
RA: Cs-137: 150 L.

**W&S 19:00:** Bft. 4, 160°, 1012 hPa,  $T_w = 20.4$  °C.

↓ **19:43 – 18:01 Station GN022 (Weiße Bank):**  
Secchi depth, CTD profile with rosette sampler.  
RA: Cs-137: 150 L.

**T 22:27 – 22:37 Transit station GN022A:** RA: Cs-137: 150 L.

**W&S 23:00:** Bft. 4, 180°, 1013 hPa,  $T_w = 21.2$  °C.

### Thursday, August 7<sup>th</sup>, 2014

↓ **00:37 – 00:54 Station GN023:**  
CTD profile with rosette sampler.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

↓ **02:55 – 03:04 Station GN024:**  
CTD profile with rosette sampler

↓ **04:06 – 04:21 Station GN025 (west of Sylt):**  
Secchi depth, CTD profile with rosette sampler.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**W&S 07:00:** Bft. 5-6, 185°, 1011 hPa, covered,  $T_w = 21.2$  °C.

↓ **12:00 – 12:18 Station GN026 (west of Lyngvik):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**W&S 12:45:** Bft. 5, 170°, 1011 hPa, covered,  $T_w = 20.6$  °C.

Termination of winch W5 finished and tested.

**T 15:40 – 15:53 Transit station GN026A:**

RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**W&S 16:00:** Bft. 3, 270°, 1012 hPa, cloudy,  $T_w = 20.9$  °C.

**SF▶ 17:41:** Start SF profile 5, GN026A →GN027. (Profile 4 has been a test only!)

**SF◀ 19:54:** End of SF profile 5.

**↓ 20:14 – 20:25 Station GN027:**

Secchi depth, CTD profile with rosette sampler and GoFlo for metals.

RA: Cs-137: 150 L.

**SF▶ 20:32:** Start SF profile 6, GN027 →GN028.

**W&S 21:00:** Bft. 2, 305°, 1013 hPa, cloudy,  $T_w = 20.5$  °C.

### **Friday, August 8<sup>th</sup>, 2014**

**SF◀ 00:44:** End of SF profile 6.

**↓ 00:58 – 01:12 Station GN028:**

CTD profile with rosette sampler and GoFlo for metals.

RA: Cs-137: 150 L.

**SF▶ 01:20:** Start SF profile 7, GN028 →GN029.

**W&S 07:00:** Bft. 3-4, 290°, 1014 hPa,  $T_w = 18.7$  °C.

**SF◀ 09:47:** End of SF profile 7.

**↓ 10:04 – 10:17 Station GN029:**

Secchi depth, CTD profile with rosette sampler.

RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**SF▶ 10:29:** Start SF profile 8, GN029 →GN030.

**W&S 12:00:** Bft. 1, variable, 1014 hPa, clear sky,  $T_w = 18.7$  °C.

**SF◀ 14:31:** End of SF profile 8.

**↓ 14:41 – 14:57 Station GN030:**

Secchi depth, CTD profile with rosette sampler and GoFlo for metals.

RA: Cs-137: 150 L.

**SF▶ 15:05:** Start SF profile 9, GN030 →GN031.

**W&S 17:00:** Bft. 4, 140°, 1011 hPa, clear sky,  $T_w = 18.2$  °C.

**SF◀ 19:22:** End of SF profile 9.

**↓ 19:26 – 19:45 Station GN031:**

Secchi depth, CTD profile with rosette sampler and GoFlo for metals.

RA: Cs-137: 150 L.

**SF▶ 19:55:** Start SF profile 10, GN031 →GN032.

**W&S 23:00:** Bft. 5, 120°, 1006 hPa, covered,  $T_w = 17.7$  °C.

**SF◀ 23:57:** End of SF profile 10.

## Saturday, August 9<sup>th</sup>, 2014

### ↓ 00:10 – 00:23 Station GN032:

CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.

SF▶ 00:34: Start SF profile 11, GN032 →GN033.

SF◀ 04:51: End of SF profile 11.

### ↓ 04:57 – 05:10 Station GN033 (east of Firth of Forth):

Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.

SF▶ 05:15: Start SF profile 12, GN033 →GN033A.

W&S 07:00: Bft. 2-3, 10°, 999 hPa, covered,  $T_w = 16.5$  °C.

SF◀ 08:03: End of SF profile 12.

### ↓ T 08:05 – 08:15 Transit station GN033A:

RA: Cs-137: 150 L, Sr-90: 2×35 L, Pu: 100 L, H-3: 1 L.

We are going directly to Aberdeen to disembark our cook who has a medical problem with his eyes and to get a new cook onboard. Are running with 12 kn to be in time for the flight times of the cook, therefore no SF to GN034A.

W&S 12:00: Bft. 4, 300°, 998 hPa,  $T_w = 13.9$  °C.

Position off Aberdeen: 57° 08.70' N, 002° 02.51' W, sailing 16:00.

### T 17:14 – 17:26 Transit station GN034A:

RA: Cs-137: 150 L, Sr-90: 2×35 L, Pu: 100 L, H-3: 1 L.

SF▶ 17:24: Start SF profile 13, GN034A →GN034.

SF◀ 18:27: End of SF profile 13.

Take the SF for a short inspection on board, because the fluorimeter and oxygen values are questionable.

SF▶ 18:53: Start SF profile 14, GN034A →GN034.

W&S 20:00: Bft. 4, 250°, 998 hPa, cloudy,  $T_w = 15.1$  °C.

SF◀ 20:33: End of SF profile 14.

### ↓ 20:46 – 21:04 Station GN034 (Aberdeen Bank):

Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2×35 L, Pu: 100 L, H-3: 1 L.  
Change of TRIOS fluorimeter from SF2 to SF1.

SF▶ 21:11: Start SF profile 15, GN034 →GN035.

W&S 23:40: Bft. 5-6, 250°, 1002 hPa, clear sky,  $T_w = 15.8$  °C.



## Sunday, August 10<sup>th</sup>, 2014

**SF ◀ 04:51:** End of SF profile 15

**↓ 06:55 – 07:20 Station GN035 (Coal Pitt):**

Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.

**W&S 07:00:** Bft. 3, 160°, 1004 hPa, covered,  $T_w = 16.5$  °C.

During the deployment of the SF it was heavily hit by a wave which caused damage at the termination. The change from the KC to W5 winch required the disassembly of the meter wheel and the cable counter because the termination (handle) can't be passed through the block.

**SF ▶ 10:51:** Start SF profile 16, GN035 →GN036.

Profile 16 has some short interruptions due to problems with the meter wheel.

**W&S 12:00:** Bft. 2-3, 90°, 1003 hPa, covered and rain,  $T_w = 16.8$  °C.

**W&S 18:00:** Bft. 7-8, 130°, 996 hPa, covered,  $T_w = 16.7$  °C.

**SF ◀ 19:23:** End of SF profile 16.

**↓ 19:27 – 19:47 Station GN036:**

Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**SF ▶ 20:06:** Start SF profile 17, GN036 →GN037.

**SF ◀ 22:18:** End of SF profile 17 due to strong wind and high waves.

**W&S 23:00:** Bft. 8-9, 140°, 998 hPa, rain and thunderstorm,  $T_w = 16.8$  °C.

## Monday, August 11<sup>th</sup>, 2014

**↓ 02:51 – 03:22 Station GN037 (Große Fischerbank):**

Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**W&S 07:00:** Bft. 7-8, 190°, 991 hPa, covered,  $T_w = 17.6$  °C.

**W&S 12:00:** Bft. 8, 210°, 994 hPa, covered,  $T_w = 17.7$  °C.

Stations 38, 38A and 39 are canceled due to bad weather condition, CTD and SF measurements are not possible. Ship turns bow into the sea and stands by.

16:10: En route directly to station GN801.

**W&S 18:00:** Bft. 7-8, 220°, 999 hPa, cloudy,  $T_w = 17.5$  °C.

## Tuesday, August 12<sup>th</sup>, 2014

**↓ 01:17 – 02:09 Station GN801:**

CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.



- ↓ **05:18 – 05:43 Station GN802:**  
CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.
- W&S 07:00:** Bft. 4-5, 200°, 999 hPa, cloudy,  $T_w = 18.0$  °C.
- ↓ **09:16 – 09:43 Station GN803:**  
Secchi, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.
- ↓ **11:35 – 11:48 Station GN804:**  
Secchi, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2×35 L, Pu: 100 L, H-3: 1 L.
- W&S 12:00:** Bft. 4, 200°, 1002 hPa, cloudy,  $T_w = 18.1$  °C.
- ↓ **14:18 – 14:30 Station GN805:**  
Secchi, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.
- W&S 21:00:** Bft. 6, 220°, 1001 hPa, cloudy and lightning,  $T_w = 18.0$  °C.
- ↓ **21:16 – 21:35 Station GN806:**  
Secchi, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.

### Wednesday, August 13<sup>th</sup>, 2014

- ↓ **01:31 – 02:07 Station GN807:**  
CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.
- ↓ **05:58 – 10:45 Station GN808:**  
Secchi, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2×35 L, Pu: 100 L, H-3: 1 L.  
270-l-samplers for radioactivity at 50, 100, 250, 500 and 668 m depth, however, only the first two samplers closed properly due to strong tidal currents.
- W&S 09:30:** Bft. 5, 190°, 1000 hPa, cloudy,  $T_w = 19.1$  °C.
- W&S 16:30:** Bft. 3-4, 180°, 998 hPa, covered,  $T_w = 18.0$  °C.
- ↓ **16:48 – 18:20 Station GN040 (Skagerrak):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2×35 L, Pu: 100 L, H-3: 1 L.
- SF▶ 19:02:** Start SF profile 18, GN040 →GN041.
- SF◀ 19:43:** End of SF profile 18 due to communication problems, possibly due to water in the termination.
- W&S 20:00:** Bft. 2, 210°, 998 hPa, cloudy, rain shower,  $T_w = 19.1$  °C.

## Thursday, August 14<sup>th</sup>, 2014

- ↓ **01:53 – 02:19 Station GN041 (west of Lindesnes):**  
CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.
- ↓ **06:10 – 06:41 Station GN042 (Eigersundbank):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.
- W&S 07:00:** Bft. 3, 10°, 996 hPa, cloudy,  $T_w = 15.4$  °C.
- W&S 12:00:** Bft. 3-4, 340°, 1002 hPa, cloudy,  $T_w = 14.7$  °C.
- ↓ **12:59 – 14:11 Station GN043 (Lingbank East):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.
- SF▶ 13:49:** Start SF profile 19, GN043 →GN044.
- W&S 18:00:** Bft. 4-5, 330°, 1006 hPa, clear sky,  $T_w = 14.4$  °C.
- SF◀ 19:24:** End of SF profile 19.
- ↓ **19:27 – 19:46 Station GN044 (Lingbank West):**  
Secchi depth, CTD profile with rosette sampler.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.
- SF▶ 19:54:** Start SF profile 20, GN044 →GN045.

## Friday, August 15<sup>th</sup>, 2014

- W&S 00:00:** Bft. 3-4, 320°, 1009 hPa,  $T_w = 14.2$  °C.
- SF◀ 06:03:** End of SF profile 20.
- ↓ **06:15 – 06:37 Station GN045 (east of South Bank):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.
- SF▶ 06:41:** Start SF profile 21, GN045 →GN045A.
- SF◀ 10:42:** End of SF profile 21.
- T 10:37 – 10:52 Transit station GN045A (east of Orkneys):**  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.
- SF▶ 10:43:** Start SF profile 22, GN045A →GN045B.
- W&S 12:00:** Bft. 2-3, 320°, 1016 hPa, covered,  $T_w = 13.4$  °C.
- SF◀ 14:55:** End of SF profile 22.
- T 14:57 – 15:12 Transit station GN045B (east of Pentland Firth):**  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L  
Exchange of oxygen sensor, SF check, and check of CTD channels (chlorophyll, CDOM, turbidity).
- SF▶ 15:28:** Start SF profile 23, GN045B →GN046A.
- SF◀ 17:04:** End of SF profile 23 due to a communication error, we change of from W5 to KC winch.

- SF▶ 19:00:** Start SF profile 24, GN045B →GN046A.
- SF◀ 19:13:** End of SF profile 24. SF capsized at depth due to strong cross currents, recovered SF.
- W&S 20:00:** Bft. 5-6, 290°, 1015 hPa, covered,  $T_w = 12.6$  °C.
- T 20:05 – 20:17 Station GN046A:**  
 RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.
- At GN046 we run 3 CTD casts with different wire velocities (up and down): 5, 15, and 25 m/min. First two cast with open bottles between 5 and 70 m, last cast with 25 m/min down to full depth and bottle sampling.
- SF▶ 20:30:** Start SF profile 25, GN046A →GN046.
- SF◀ 22:14:** End of SF profile 25.
- ↓ 22:23 – 23:26 Station GN046 (east of Orkney-Inseln):**  
 Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
 RA: Cs-137: 150 L.
- SF▶ 23:32:** Start SF profile 26, GN046 →GN047.
- W&S 23:45:** Bft. 5, 280°, 1015 hPa, covered,  $T_w = 14.7$  °C.

### **Saturday, August 16<sup>th</sup>, 2014**

- SF◀ 05:23:** End of SF profile 26.
- ↓ 05:29 – 05:48 Station GN047 (Fladengrund Rinne):**  
 Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
 RA: Cs-137: 150 L.
- SF▶ 05:54:** Start SF profile 27, GN047 →GN048.
- W&S 07:00:** Bft. 5, 230°, 1009 hPa, covered,  $T_w = 14.5$  °C.
- SF◀ 09:55:** End of SF profile 27.
- ↓ 10:06 – 10:26 Station GN048:**  
 Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
 RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.  
 2 x 600 l sea water for the BSH calibration lab.
- SF▶ 10:33:** Start SF profile 28, GN048 →GN049.
- All along the 59 °N section problems with strong cross currents, SF capsized occasionally at depth of about 40 – 50 m.
- W&S 18:00:** Bft. 5, 240°, 1004 hPa, rain,  $T_w = 14.7$  °C.
- SF◀ 18:19:** End of SF profile 28.
- ↓ 18:25 – 18:44 Station GN049 (Utsira Grund):**  
 Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
 RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L
- SF▶ 19:30:** Start SF profile 29, GN049 →GN050.
- W&S 23:30:** Bft. 3-4, 240°, 1000 hPa, covered,  $T_w = 14.5$  °C.

## Sunday, August 17<sup>th</sup>, 2014

**SF ◀ 00:59:** End of SF profile 29.

↓ **01:07 – 01:37 Station GN050 (Utsira Loch):**  
CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L

**SF ▶ 01:50:** Start SF profile 30, GN050 →GN051.

**W&S 07:00:** Bft. 3-4, 240°, 994 hPa, cloudy,  $T_w = 16.1$  °C.

**SF ◀ 09:21:** End of SF profile 30.

↓ **09:29 – 10:01 Station GN051 (west of Selbjørnsfjord):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L

**SF ▶ 10:09:** Start SF profile 31, GN051 →GN052.

**W&S 15:00:** Bft. 2, 150°, 994 hPa, cloudy,  $T_w = 14.6$  °C.

**SF ◀ 19:45:** End of SF profile 31.

↓ **19:50 – 20:11 Station GN052 (Bergen Bank):**  
Secchi depth, CTD profile with rosette sampler and GoFlo for metals.  
RA: Cs-137: 150 L.

**W&S 20:15:** Bft. 4, 50°, 994 hPa, cloudy,  $T_w = 14.9$  °C.

**SF ▶ 20:19:** Start SF profile 32, GN052 →GN053.

**SF ◀ 23:54:** End of SF profile 32. Profile must be canceled due to rough sea.

**W&S 00:00:** Bft. 5-6, 20°, 995 hPa, covered,  $T_w = 14.9$  °C.

## Monday, August 18<sup>th</sup>, 2014

**Station GN053** canceled due to rough sea.

**W&S 07:00:** Bft. 4-5, 0°, 1000 hPa, cloudy,  $T_w = 13.9$  °C.

Take shelter in the Bay of Quendale (Shetlands) to change from Clean CTD to BSH-CTD which allows profiling under rougher weather conditions by using the hydraulic TRIPLEX arm and which has sufficient cable length for the deep in the north.

**W&S 11:30:** Bft. 6, 330°, 1004 hPa, cloudy,  $T_w = 12.1$  °C.

**W&S 17:00:** Bft.5-6, 350°, 1002 hPa, cloudy,  $T_w = 11.9$  °C.

↓ **20:03 – 20:45 Station GN054 (Otter Bank):**  
Secchi depth, CTD profile with rosette sampler, and MERCOS sampler for metals.  
RA: Cs-137: 150 L.

**W&S 21:00:** Bft. 5-6, 340°, 1005 hPa, covered,  $T_w = 12.4$  °C.

## Tuesday, August 19<sup>th</sup>, 2014

↓ **04:14 – 05:10 Station GN055:**  
Secchi depth, CTD profile with rosette sampler, and MERCOS sampler for metals.  
RA: Cs-137: 150 L, Sr-90: 2x35 L, Pu: 100 L, H-3: 1 L.

**W&S 07:00:** Bft. 5-6, 0°, 1009 hPa, covered,  $T_w = 13.0$  °C.

**W&S 15:00:** Bft. 6-7, 0°, 1010 hPa, covered,  $T_w = 12.3$  °C.

↓ **19:34 – 20:33 Station GN058:**  
Secchi depth, CTD profile with rosette.  
RA: Cs-137: 150 L.

**W&S 20:00:** Bft. 7, 340°, 1011 hPa, covered,  $T_w = 13.1$  °C.

### **Wednesday, August 20<sup>th</sup>, 2014**

↓ **06:26 – 07:30 Station GN062:**  
Secchi depth, CTD profile with rosette sampler.  
RA: Cs-137: 150 L.

**W&S 07:00:** Bft. 5-6, 320°, 1008 hPa, covered,  $T_w = 12.4$  °C.

**W&S 11:30:** Bft. 4-5, 340°, 1007 hPa, covered,  $T_w = 13.0$  °C.

↓ **15:56 – 17:39 Station GN059:**  
Secchi depth and CTD profile with rosette sampler.  
RA: Cs-137: 150 L, Sr-90: 2×35 L, Pu: 100 L, H-3: 1 L, and 600 L for testing and calibration.

**SF▶ 17:47:** Start SF profile 33, GN059 →GN060.

**W&S 18:00:** Bft. 4-5, 350°, 1007 hPa, cloudy,  $T_w = 13.2$  °C.

### **Thursday, August 21<sup>st</sup>, 2014**

**SF◀ 00:35:** End of SF profile 33.

↓ **00:43 – 01:12 Station GN060:**  
Secchi depth, CTD profile with rosette sampler, and MERCOS sampler for metals.  
RA: Cs-137: 150 L.

**SF▶ 01:21:** Start SF profile 34, GN060 →GN063.

**W&S 07:00:** Bft. 3, 340°, 1005 hPa, covered,  $T_w = 14.1$  °C.

**SF◀ 08:02:** End of SF profile 34.

↓ **08:05 – 08:51 Station GN063:**  
Secchi depth, CTD profile with rosette sampler, and MERCOS sampler for metals.  
RA: Cs-137: 150 L.

**SF▶ 08:55:** Start SF profile 35, GN063 →GN061.

**W&S 12:00:** Bft. 2-3, 190°, 1006 hPa, covered,  $T_w = 14.8$  °C.

Releasing 800 m cable from the KC winch and flushing of the cable with fresh water during coiling the cable onto the winch.

**SF◀ 15:20:** End of SF profile 35.

↓ **15:58 – 16:32 Station GN061:**  
Secchi depth, CTD profile with rosette sampler, and MERCOS sampler for metals.  
RA: Cs-137: 150 L, Sr-90: 2×35 L, Pu: 100 L, H-3: 1 L.

**W&S 17:00:** Bft. 2, 290°, 1006 hPa, cloudy,  $T_w = 15.7$  °C.

**23:00:** Arrival in Bergen.

### **Friday, August 22<sup>nd</sup>, 2014**

Disassembly of the oceanographic equipment related to the SF measurements and dismounting of the SF, all parts are flushed with fresh water, dried, and finally mounted together again. Chemical analyses and reprocessing of the last water samples for RA and metals.

### **Saturday, August 23<sup>rd</sup>, 2014**

Continuations of the works from the previous day.

**16:00:** Exchange of the transport containers between forecastle and main deck by a land-based mobile crane.

### **Sunday, August 24<sup>th</sup>, 2014**

**16:00:** Arrival of a new science crew for the second leg. Handover of the chemistry labs and logistic arrangements for the second leg. Preparation of next days the crew change.

### **Monday, August 25<sup>th</sup>, 2014**

Crew change and return flight to Hamburg via Copenhagen.

## Preliminary findings

With the exception of statements concerning the sea surface temperature (SST), all assessments are basing on raw data collected during the cruise. All temperature and salinity data will be processed and – if necessary – re-calibrated after the cruise.

In the month before the cruise the monthly means of the area averaged North Sea SSTs exceeded the climatological means by about 2 K. July 2014 was the warmest July since 1969 with an anomaly of +2.1 K. The weekly mean July 23<sup>rd</sup> – 29<sup>th</sup> directly before the cruise amounted to 18.1 °C, this is only 0.3 K below the records of the extremely warm years 2003 and 2006. During the week August 13<sup>th</sup> to 19<sup>th</sup> the area averaged North Sea SST dropped by 1.6 K!

The SST is a good representative for the temperature of the seasonal upper warm layer. Due to increasing solar radiation the North Sea established a seasonal stratification during spring over wide areas of the North Sea which last normally until end of August or beginning of September. Then the water column will be vertically mixed again by the first fall storms. The upper layer is separated from the colder bottom layer by a sharp thermocline with vertical gradients of the order of 3 K/m. While the oceanographic conditions in the upper layer are mainly determined by local radiation, the conditions in the bottom layer are influenced by the inflow of Atlantic Water (AW) with salinities >35 psu via the northern open boundary to the Atlantic and to a lesser degree via the English Channel. Only the knowledge of the hydrographic condition in both layers, determined by the spatial distribution of temperature and salinity, allows the calculation of heat and salt budgets.

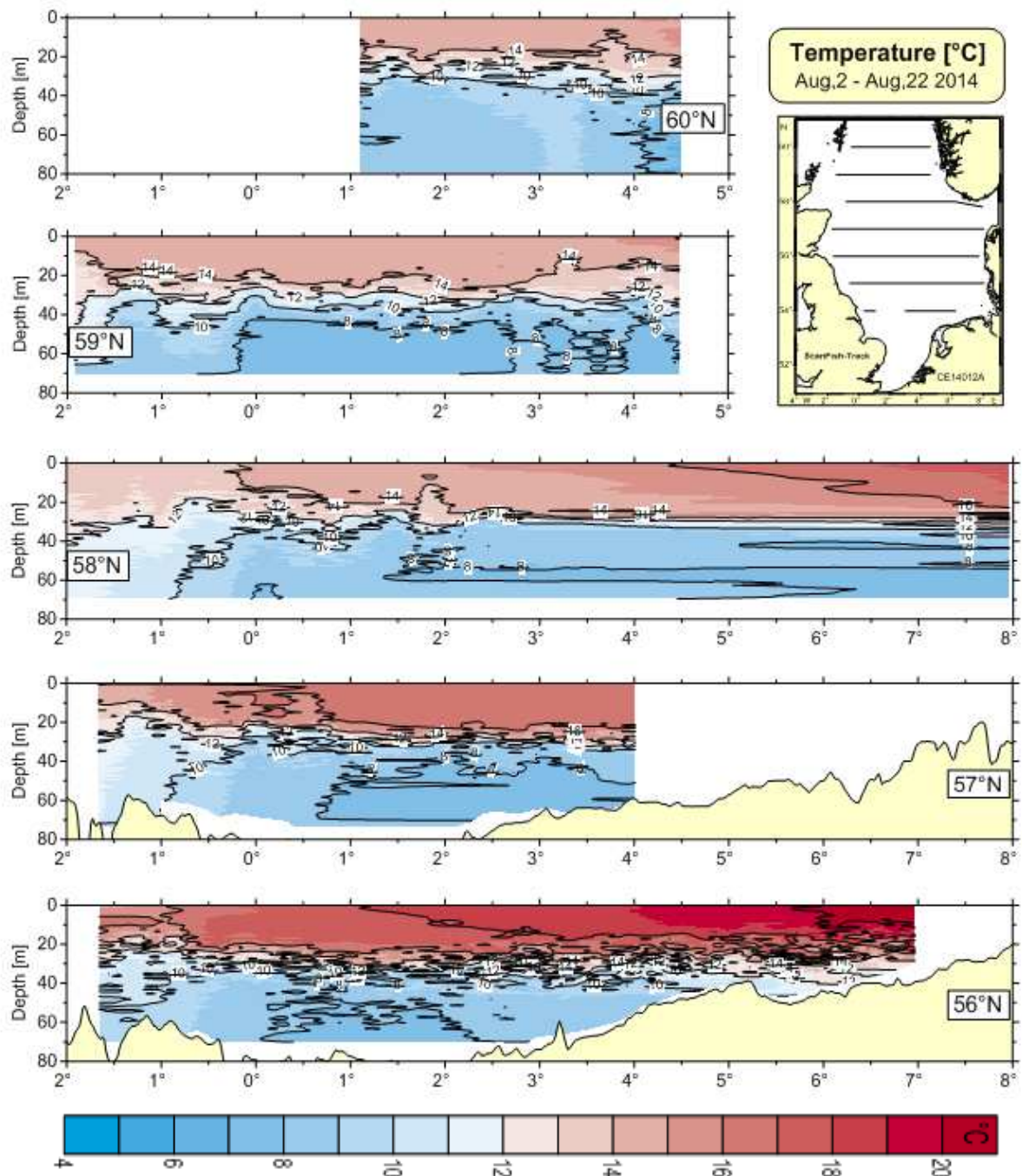
The spatial structure of temperature distribution corresponds largely to that of the reference period (RP) 2000-2010 with upper layer depths between 20 and 30 m and the shallow south-eastern part of the North Sea vertically mixed. However, in 2014 the temperatures in the south-eastern North Sea exceed the RP by about 2 K. Reliable data about the strength of the vertical gradient can be provided not before the re-processing of the raw data. Also the temperature distribution of the bottom layer corresponds largely to that of the RP with the exception of the eastern part of the 58 °N section. Here the passage of ex-hurricane “Bertha” probably caused a vertical mixing inside the upper and bottom layer in the central and eastern part of the section.

Atlantic Water intruding from the northern boundary is traceable as a massive structure down to 57 °N and shaped as small lenses at 56 °N. Generally, the volume of AW is smaller as that of the RP. It is concentrated to the bottom layer and shows a reduced vertical extension. The inflow paths via the Fair-Isle-Channel and the East Shetland Shelf can be distinguished clearly along the 58 °N section.

Concerning SST the summer 2014 was significantly warmer as the climatological mean, this holds also for the volume of the south-eastern North Sea. The total salt content is expected to be below the long-term mean. However, quantitative assessments concerning the North Sea summer state 2014 will be possible not before the re-processing of the data at BSH.



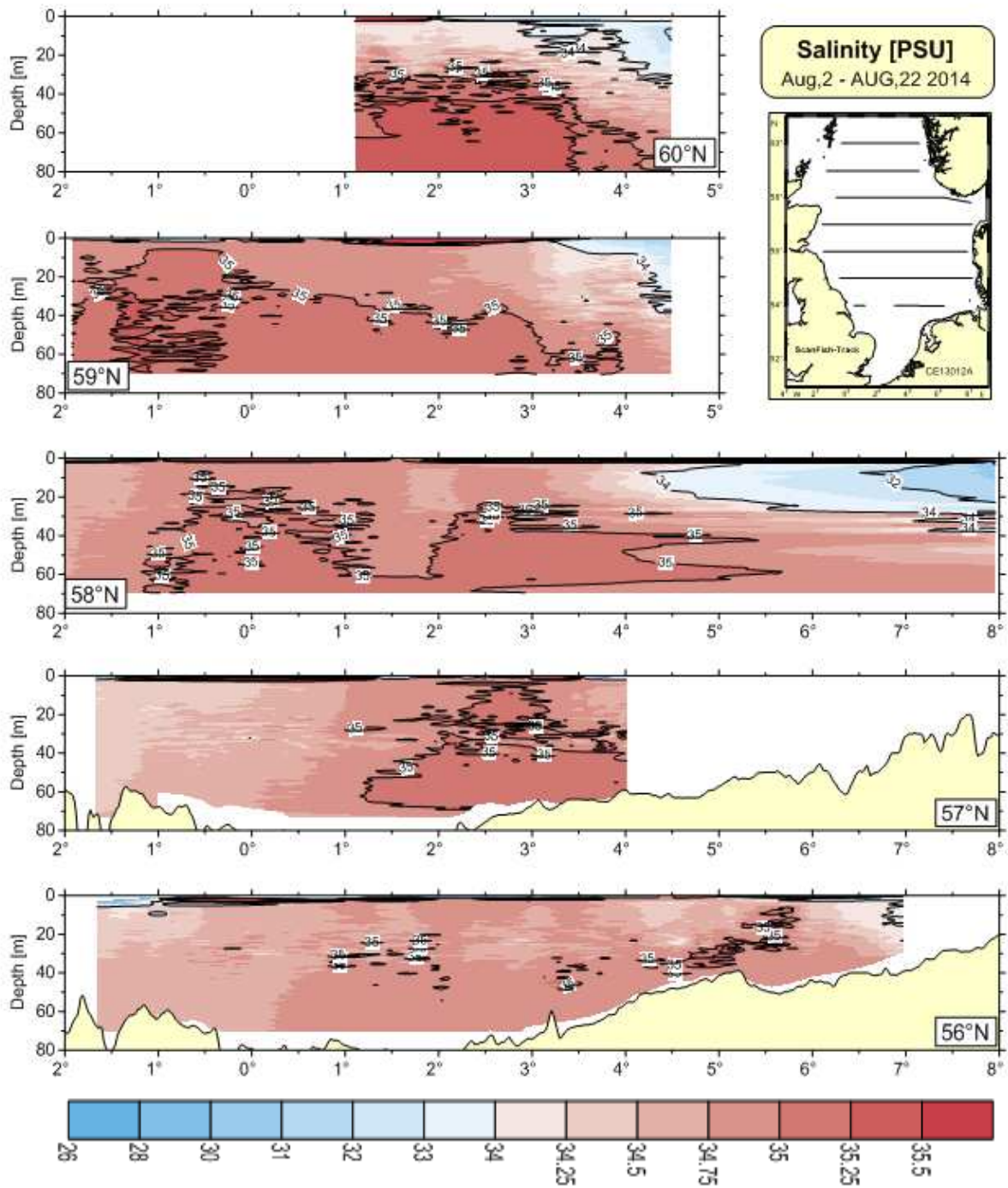
2014



**Fig. 2:** Vertical temperature distribution along the zonal sections, ScanFish data.



2014



**Fig. 3:** Vertical salinity distribution along the zonal sections, ScanFish data.

## Acknowledgement

Despite some technical problems the North Sea Summer Survey was a big success. All participants of the individual working groups accomplished a big amount of work.

The help and professional support of captain Antony Hobin and his crew is gratefully acknowledged.

Holger Klein

Bergen, August 25<sup>th</sup>, 2014

## Appendix 1: List of samples

CTD-profiles with rosette:	61 stations
Secchi depth:	38 stations (daylight stations only)
Salinity:	204 samples
Transit stations for radioactivity:	14 stations
Dissolved nutrients	21 samples for the calibration of the auto-analyser
Oxygen:	132 samples
pH-value:	158 samples
Chlorophyll:	106 samples
Alkalinity:	224 samples
Extra samples for the UK Shelf Sea Biogeochemistry Programme:	18 nutrient samples 17 DIC/TA samples
Metals (TRFA, ICPUC, CUAAS, AAS):	45 stations 180 water samples 90 suspended matter samples 45 salinity samples
Radioactivity (artificial nuclides):	44 samples à 2 30-l-drums Strontium-90 (pure) 44 samples 1-l-bottles Tritium (pure) 44 samples à 100 l Plutonium (concentrated) 82 samples à 150 l Caesium-137 (concentrated)

## Appendix 2: Station List

Positions are taken at the beginning of the stations! Radioactivity: Cs = Cesium-137; Strontium-90 = Sr; Plutonium = Pu; Tritium = H3

station name	latitude	longitude	water depth [m]	water sampling Clean CTD [m]	Secchi-depth [m]	radio-activity	Bedford-Nr. 144nnn	date dd.mm.yy	time [UTC]
Stade	53° 37.03' N	009° 32.79' E	15	10 (GoFlo)	-	Cs/Sr/Pu/H3	001	02.08.14	06:27 – 06:44
Medem	53° 52.97' N	008° 42.86' E	19	10 (GoFlo)	-	Cs/Sr/Pu/H3	002	02.08.14	09:38 – 09:52
GN003	53° 59.98' N	008° 06.75' E	26	bottom, 5	4.5	Cs/Sr/Pu/H3	003-004	02.08.14	11:54 – 12:25
GN003A	54° 00.01' N	007° 11.02' E	30	Transit station	-	Cs/Sr/Pu/H3	-	02.08.14	16:10 – 16:24
GN007	53° 56.01' N	006° 25.05' E	26	bottom, 5	6.0	Cs/Sr/Pu/H3	005-006	02.08.14	18:43 – 18:57
GN007A	53° 59.89' N	005° 41.30' E	37	Transit station	-	Cs/Sr/Pu/H3	-	02.08.14	21:31 – 21:46
GN008	53° 59.98' N	004° 49.75' E	43	bottom, 10, 5	-	Cs	007-009	03.08.14	00:44 – 01:13
GN009	53° 59.96' N	003° 00.11' E	42	bottom, 10, 5, 5	11.0	Cs/Sr/Pu/H3	010-013	03.08.14	07:48 – 08:05
GN009A	53° 26.01' N	003° 29.72' E	29	Transit station	-	Cs	-	03.08.14	11:54 – 12:04
GN009B	53° 20.27' N	004° 23.33' E	27	Transit station	-	Cs/Sr/Pu/H3	-	03.08.14	15:00 – 15:28
GN010	52° 59.96' N	003° 59.84' E	29	bottom, 10, 5, 5	11.0	Cs	014-017	03.08.14	17:31 – 17:52
GN011	52° 30.65' N	004° 19.55' E	20	bottom, 10, 5	-	Cs	018-020	03.08.14	21:31 – 21:45
GN012	51° 59.88' N	003° 43.65' E	25	bottom, 10, 5	-	Cs/Sr/Pu/H3	021-023	04.08.14	01:59 – 02:22
GN013	51° 42.08' N	002° 51.70' E	39	bottom, 10, 5	4.0	Cs/Sr/Pu/H3	024-026	04.08.14	06:52 – 07:19
GN014	51° 59.98' N	001° 59.93' E	30	bottom, 10, 5	4.5	Cs/Sr/Pu/H3	027-029	04.08.14	11:05 – 11:30
GN015	52° 29.83' N	002° 29.96' E	40	bottom, 10, 5	8.5	Cs	030-032	04.08.14	15:28 – 15:44
GN015B	52° 49.18' N	002° 10.68' E	41	Transit station	-	Cs	-	04.08.14	17:55 – 18:14
GN016	53° 19.84' N	001° 40.19' E	32	bottom, 10, 5	-	Cs/Sr/Pu/H3	033-035	04.08.14	21:44 – 22:09
GN017	53° 59.90' N	001° 00.09' E	45	bottom, 10, 10, 5	-	Cs	036-039	05.08.14	03:11 – 03:32
GN017A	53° 59.99' N	000° 21.09' E	53	Transit station	-	Cs/Sr/Pu/H3	-	05.08.14	05:51 – 06:16
GN018A	54° 59.11' N	000° 39.61' W	66	Transit station	-	Cs	-	05.08.14	13:04 – 13:19
GN018	55° 00.04' N	000° 00.01' W	74	bottom, 10, 5, 5	11.0	Cs	040-043	05.08.14	16:27 – 16:50
GN019	55° 00.01' N	002° 00.02' E	28	bottom, 10, 10, 5	-	Cs/Sr/Pu/H3	044-047	06.08.14	01:40 – 02:01
GN020	55° 00.01' N	004° 00.11' E	48	bottom, 10, 5, 5	15.0	Cs	048-051	06.08.14	09:09 – 09:27
GN021	55° 00.00' N	005° 00.03' E	41	bottom, 5, 5	13.0	Cs	051-054	06.08.14	13:08 – 13:28
GN022	55° 00.00' N	006° 14.63' E	45	bottom, 5, 5	13.0	Cs	055-057	06.08.14	17:43 – 18:01
GN022A	55° 00.14' N	006° 58.60' E	32	Transit station	-	Cs	-	06.08.14	20:27 – 20:37
GN023	55° 00.01' N	007° 34.79' E	26	bottom, 5, 5	-	Cs/Sr/Pu/H3	058-060	06.08.14	22:37 – 22:54
GN024	55° 00.00' N	007° 59.95' E	17	bottom, 5	-	-	061-062	07.08.14	00:55 – 01:04
GN025	54° 59.97' N	008° 14.82' E	14	bottom, 5	-	Cs/Sr/Pu/H3	063-064	07.08.14	02:06 – 02:21
GN026	55° 59.47' N	007° 47.95' E	27	bottom, 10, 5	5.0	Cs/Sr/Pu/H3	065-067	07.08.14	10:00 – 10:18
GN026A	55° 59.95' N	007° 01.19' E	34	Transit station	-	Cs/Sr/Pu/H3	-	07.08.14	13:40 – 13:53

station name	latitude	longitude	water depth [m]	water sampling Clean CTD [m]	Secchi-depth [m]	radio-activity	Bedford-Nr. 144nnn	date dd.mm.yy	time [UTC]
GN027	56° 00.00' N	006° 00.14' E	48	bottom, 10, 5, 5,	12.5	Cs	068-071	07.08.14	18:14 – 18:25
GN028	55° 59.99' N	005° 00.01' E	43	bottom, 10, 5, 5,	-	Cs	072-075	07.08.14	22:58 – 23:12
GN029	56° 00.03' N	002° 59.92' E	74	bottom, 5, 5	16.0	Cs/Sr/Pu/H3	076-078	08.08.14	08:04 – 08:17
GN030	56° 00.00' N	002° 00.01' E	87	bottom, 10, 5, 5	20.5	Cs	079-082	08.08.14	12:41 – 12:57
GN031	56° 00.01' N	001° 00.00' E	77	bottom, 5, 5	14.5	Cs	083-085	08.08.14	17:26 – 17:45
GN032	56° 00.08' N	000° 00.09' W	86	bottom, 10, 5, 5	-	Cs	086-089	08.08.14	22:10 – 22:23
GN033	56° 00.00' N	000° 59.86' W	64	bottom, 10, 5, 5	-	Cs	090-093	09.08.14	02:57 – 03:10
GN033A	56° 00.66' N	001° 40.25' W	67	Transit station	-	Cs/Sr/Pu/H3	-	09.08.14	06:05 – 06:15
GN034A	57° 00.53' N	001° 41.33' W	86	Transit station	-	Cs/Sr/Pu/H3	-	09.08.14	15:14 – 15:26
GN034	57° 00.06' N	000° 59.99' W	70	bottom, 10, 5	10.0	Cs	094-096	09.08.14	18:46 – 19:04
GN035	56° 59.82' N	001° 20.26' E	98	bottom, 10, 5, 5	16.0	Cs	097-100	10.08.14	04:55 – 05:20
GN036	56° 59.15' N	003° 32.38' E	64	bottom, 5, 5	11.0	Cs/Sr/Pu/H3	101-103	10.08.14	17:27 – 17:47
GN037	57° 00.02' N	005° 00.00' E	59	bottom, 5, 5	-	Cs	104-106	11.08.14	00:51 – 01:22
GN801	57° 30.19' N	008° 59.75' E	30	bottom, 10, 5	-	Cs	107-109	11.08.14	23:17 – 00:09
GN802	57° 57.02' N	009° 45.43' E	214	10	-	Cs	110	12.08.14	03:18 – 03:43
GN803	57° 59.97' N	010° 30.02' E	212	bottom, 10, 5	>10	Cs	111-113	12.08.14	07:16 – 07:43
GN804	57° 45.06' N	010° 46.28' E	33	bottom, 5	6.0	Cs/Sr/Pu/H3	114-115	12.08.14	09:35 – 09:48
GN805	57° 40.20' N	011° 25.21' E	88	bottom, 10, 5	8.0	Cs	116-118	12.08.14	12:18 – 12:30
GN806	58° 40.32' N	010° 46.81' E	94	bottom, 10, 5	7.5	Cs	119-121	12.08.14	19:16 – 19:35
GN807	58° 30.03' N	010° 00.01' E	534	bottom, 10, 5	-	Cs	122-124	12.08.14	23:31 – 00:07
GN808	58° 13.12' N	009° 19.80' E	679	bottom, 10, 5 270-l-sampler: 50, 100, 250, 500, 668		Cs/Sr/Pu/H3	125-127	13.08.14	03:58 – 08:45
GN040	57° 49.98' N	008° 00.38' E	523	bottom, 10, 5, 5;	9.0	Cs/Sr/Pu/H3	128-131	13.08.14	14:48 – 16:20
GN041	58° 00.02' N	006° 00.05' E	312	bottom, 10, 5, 5	-	Cs/Sr/Pu/H3	132-135	14.08.14	01:53 – 02:19
GN042	57° 59.91' N	005° 00.09' E	127	bottom, 10, 5, 5	12.0	Cs	136-139	14.08.14	06:10 – 06:41
GN043	58° 00.03' N	003° 00.06' E	77	bottom, 10, 5, 5	13.0	Cs	140-143	14.08.14	10:59 – 11:11
GN044	57° 59.90' N	001° 29.17' E	106	bottom, 5, 5	13.0	Cs/Sr/Pu/H3	144-146	14.08.14	17:27 – 17:46
GN045	57° 59.91' N	000° 59.91' W	114	bottom, 10, 5, 5	9.5	Cs/Sr/Pu/H3	147-150	15.08.14	04:15 – 04:37
GN045A	57° 59.99' N	001° 58.53' W	72	Transit station	-	Cs/Sr/Pu/H3	-	15.08.14	08:37 – 08:52
GN045B	58° 29.01' N	002° 29.00' W	73	Transit station	-	Cs/Sr/Pu/H3	-	15.08.14	12:57 – 13:12

station name	latitude	longitude	water depth [m]	water sampling Clean CTD [m]	Secchi-depth [m]	radio-activity	Bedford-Nr. 144nnn	date dd.mm.yy	time [UTC]
GN046A	58° 59.30' N	002° 00.95' W	80	Transit station	-	Cs/Sr/Pu/H3	-	15.08.14	18:05 – 18:17
GN046	59° 00.01' N	001° 30.00' W	106	bottom, 10, 5	-	Cs	151-153	15.08.14	20:23 – 21:26
GN047	59° 00.01' N	000° 00.22' E	133	bottom, 5, 5	-	Cs	154-156	16.08.14	03:29 – 03:48
GN048	59° 00.03' N	001° 00.22' E	123	bottom, 10, 5, 5	15.0	Cs/Sr/Pu/H3	157-160	16.08.14	08:06 – 08:26
GN049	59° 00.05' N	003° 00.53' E	138	bottom, 10, 5, 5	11.0	Cs	161-164	16.08.14	16:25 – 16:44
GN050	59° 00.02' N	004° 29.33' E	260	bottom, 5, 5	-	Cs/Sr/Pu/H3	165-167	16.08.14	23:09 – 23:37
GN051	60° 00.26' N	004° 30.12' E	260	bottom, 10, 5, 5	10.5	Cs/Sr/Pu/H3	168-171	17.08.14	07:29 – 08:01
GN052	59° 59.88' N	002° 00.48' E	103	bottom, 10, 5, 5	10.5	Cs	172-175	17.08.14	17:50 – 18:11
GN054	60° 00.01' N	002° 59.92' W	104	bottom, 10, 5, 5	7.0	Cs	176-179	18.08.14	18:03 – 18:45
GN055	59° 59.88' N	004° 59.61' W	405	bottom, 10, 5, 5	-	Cs/Sr/Pu/H3	180-183	19.08.14	02:14 – 03:10
GN058	60° 59.89' N	003° 00.03' W	712	bottom, 5, 5	10.0	Cs	184-186	19.08.14	17:34 – 18:33
GN062	61° 44.86' N	001° 30.04' W	837	bottom, 5, 5	8.5	Cs	187-189	20.08.14	04:26 – 05:30
GN059	62° 29.97' N	000° 00.04' E	1123	Bottom, 10, 5, 5	9.5	Cs/Sr/Pu/H3	190-193	20.08.14	13:56 – 15:39
GN060	62° 29.96' N	002° 00.02' E	539	bottom, 5, 5	-	Cs	194-196	20.08.14	22:43 – 23:12
GN063	61° 45.07' N	003° 00.06' E	411	bottom, 10, 5, 5	12.0	Cs	197-200	21.08.14	06:05 – 06:51
GN061	60° 59.99' N	004° 00.01' E	349	bottom, 10, 5, 5	11.0	Cs/Sr/Pu/H3	201-204	21.08.14	13:58 – 14:32

Water depth corrected for draft (5 m)!