BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Scientific Cruise Reports

Reise 19016
August 26 - September 17, 2019
Hamburg (Germany) - Bergen (Norway)

Holger Klein

RV Celtic Explorer

BSH Hamburg and Rostock, 2019

R/V *Celtic Explorer* 19016
August 26th – September 17th, 2019

Report of the Chief Scientist

ICES Cruise Id: 45CE19016

CSRREF: 20193201

Holger Klein

Hamburg, September 2019

Contents:

Participants

Science Crew BSH	Working Group	Ship Crew	Rank
Holger Klein	Marine Physics, Chief Scientist	Antony Hobin	Master
Peter Löwe	Marine Physics	Damien McCallig	Chief Engineer
Katrin Latarius	Marine Physics	Basil Murphy	Chief Officer
Sören Joswig	Marine Physics	Paddy Kenny	2nd Officer
Stefanie Schmied	Marine Chemistry, Radioactivity	Caoimhin Costello	2nd Engineer
Andrea Meyer	Marine Chemistry, Radioactivity	Paul Taylor	ETO
Roswitha Velten	Marine Chemistry, Nutrients	Ken O'Neill	Bosun
Wiebke Brandt	Marine Chemistry, Nutrients	Gavin Cunningham	Cook
Andreas Jacobsen	Marine Chemistry, Metals	Michelin Faherty	Bosun's Mate
Ina Raschke	Marine Chemistry, Metals	Jimmy Burke	AB Deckhand
		Declan Horan	AB Deckhand
		Jacek Ronowicz	Assistant Cook
		Marc O'Connor	Technician
		Philip Gunnip	AB Deckhand
		Jason Reynolds	AB Deckhand
		Conor Kiely	Cadet
		Máirtin ÓMéalóid	Cadet

Fig. 1: *The crew (ltr): Jimmy Burke, Basil Murphy, Paddy Kenny, Wiebke Brandt, Sören Joswig, Ina Raschke, Andreas Jacobsen, Jacek Ronowicz, Peter Löwe, Antony Hobin, Ken O'Neill, Holger Klein, Gavin Cunningham, Roswitha Velten, Katrin Latarius, Damien McCallig, Paul Taylor, Stefanie Schmied, Conor Kiely, Michelin Faherty, Máirtin ÓMéalóid,Caoimhin Costello, Jason Reynolds, and Philip Gunnip.*

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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 the 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 or 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.

The BSH North Sea Summer Surveys (NSSS) started in 1998 and 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. They were realised at a time when thermal stratification was 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 station without an A, B, or C in Fig. 3). Between the CTD-stations ship-mounted temperature-, salinity- and optical sensors provided data at about 4 m depth.

For the monitoring of artificial radio nuclides additional stations in the English Channel respectively in the Skagerrak are served alternately every second year.

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), selected surface data (5 m) are also fed into the MEris MAtchup In-situ Database (MERMAID).[1]

[1] http://www.bsh.de/en/Marine_data/Observations/DOD_Data_Centre/index.jsp
http://hermes.acri.fr/mermaid/home/home.php

survey period	research vessel and cruise id	nominal distance [nm]	marine physics, oxygen, pH-value	nutrients, chlorophyll	organic contaminants	trace metals	artificial radio nuclides	air chemistry
24.06.1998 – 16.07.1998	R/V Gauss 317	~ 2600	●	●				
02.07.1999 – 22.07.1999	R/V Gauss 335	~ 2600	●	●				
09.08.2000 – 23.08.2000	R/V Gauss 353	~ 2600	●	●				
11.07.2001 – 02.08.2001	R/V Gauss 370	~ 2600	●	●				
16.07.2002 – 31.07.2002	R/V Gauss 385	~ 2600	●	●	●			
28.07.2003 – 13.08.2003	R/V Gauss 405	~ 2600	●	●	●			
05.08.2004 – 20.08.2004	R/V Gauss 425	~ 2600	●	●		●		
10.08.2005 – 29.08.2005	R/V Gauss 446	~ 2600	●	●	●		●	
02.08.2006 – 20.08.2006	R/V Gauss 463	~ 2600	●	●		●		
03.08.2007 – 17.08.2007	R/V Pelagia 273	~ 2600	●	●	●			
21.07.2008 – 05.08.2008	R/V Pelagia 293	2715	●	●		●		
20.08.2009 – 09.09.2009	R/V Pelagia 311	3610	●	●	●		●	
04.08.2010 – 22.08.2010	R/V Pelagia 323	3310	●	●		●	●	
08.08.2011 – 28.08.2011	R/V Celtic Explorer 11010	3220	●	●	●		●	
07.08.2012 – 30.08.2012	R/V Celtic Explorer 12011	3500	●	●		●	●	
10.08.2013 – 04.09.2013	R/V Celtic Explorer 13012	4090	●	●	●		●	
01.08.2014 – 25.08.2014	R/V Celtic Explorer 14012	3470	●	●		●	●	●
07.08.2015 – 30.08.2015	R/V Celtic Explorer 15013	3580	●	●			●	●
03.08.2016 – 26.08.2016	R/V Celtic Explorer 16011	4000	●	●	●		●	●
11.08.2017 – 03.09.2017	R/V Celtic Explorer 17013	3600	●	●	(●)	●	●	●
28.08.2018 – 13.09.2018	R/V Celtic Explorer 18019	3150	●	●	●		●	
26.08.2019 – 17.09.2019	R/V Celtic Explorer 19016	3800	●	●		●	●	

Table 1: *BSH North Sea Summer Surveys 1998-2019.*

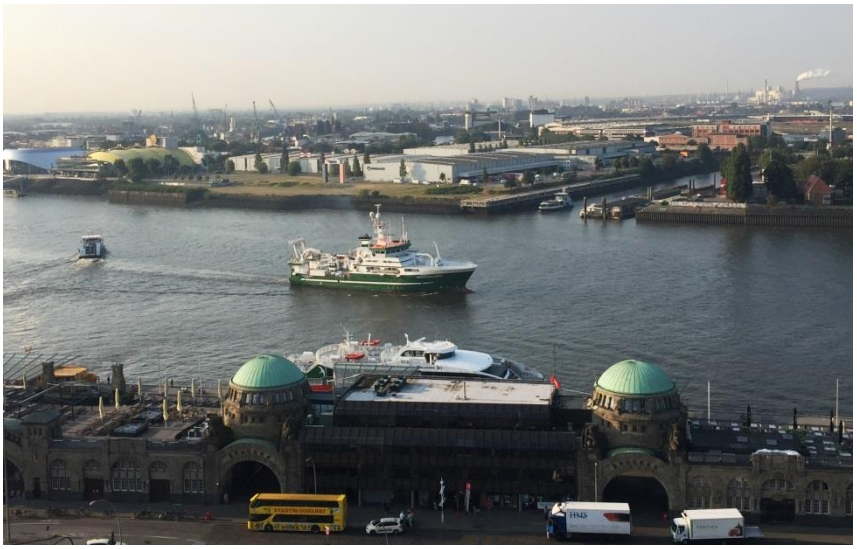


Fig. 2: *Celtic Explorer leaving Hamburg*
(© D. Hauck)

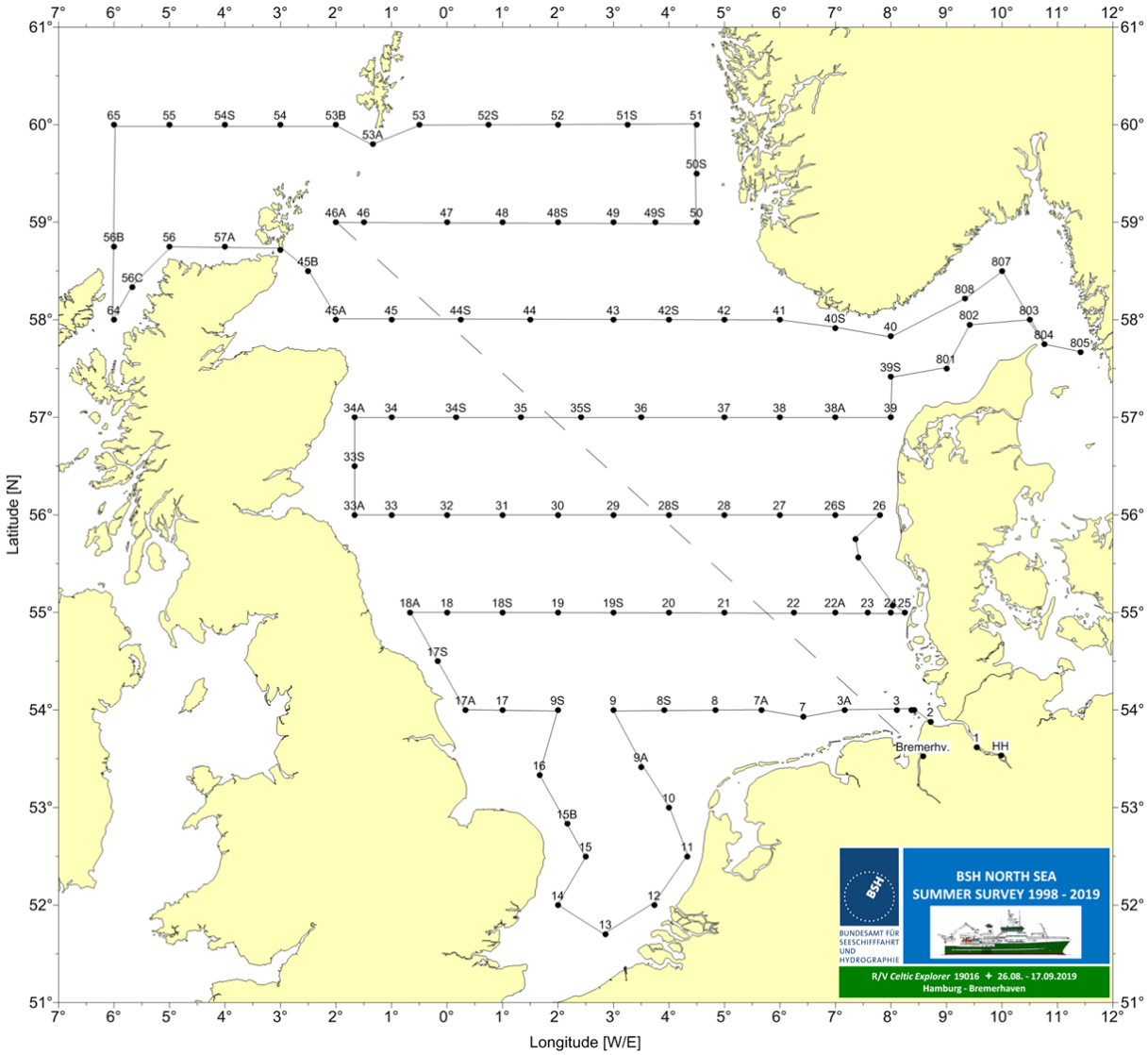


Fig. 3: *Ship track and sampling stations (26S = 26A).*

Equipment and Methods

Marine Physics:

- Vertical CTD profiles (temperature, salinity, pressure, chlorophyll, turbidity, oxygen, pH) and 10 l water samples at selected depths at all stations.

CTD Station 1-55: S6, bei Station 55 werden keine brauchbaren Daten aufgenommen - Kabel/Übergang Einleiter-Sonde defekt						
Sonde S6 SBE911+	09P56228	Druck	Sea-Bird	SBE9P	1005	20.03.19
		Temperatur	Sea-Bird	SBE3T	5254	27.05.19
		Leitfähigkeit	Sea-Bird	SBE4C	3694	15.04.19
Deck Unit CTD			Sea-Bird	SBE11+	11P-0529	
Rosette 7		24 x 10L (Goflos+Niskin)				
Fluorometer			Wetlabs	WetlabECO	4964	15.01.18
Turbidimeter			Wetlabs	WetlabECO	4964	"
Oximeter			SBE43	SBE43	3152	04.01.19
Altimeter			Teledyne	Benthos		
pH			Sea-Bird	SBE18	1441	*kurz vor der Reise*

CTD Station 56-60: S1						
Sonde S1 SBE911+	09P21787	Druck	Sea-Bird	SBE9P	577	06.02.19
		Temperatur	Sea-Bird	SBE3T	2584	07.06.19
		Leitfähigkeit	Sea-Bird	SBE4C	2886	07.06.19
Deck Unit CTD			Sea-Bird	SBE11+	11P-0529	
Rosette 1		12 x 10L				
Fluorometer			Wetlabs	WetlabECO	3427	30.06.15
Turbidimeter			Wetlabs	WetlabECO	3427	"
Oximeter S2			SBE43	SBE43	3266	29.12.18
Altimeter			Teledyne	Benthos		-
pH			-	-	-	

CTD Station 61-101: S1 mit Fluorometer von S6, mit pH-Sensor, Station 63/GN806 wurde nicht genommen						
Sonde S1 SBE911+		Druck	Sea-Bird	SBE9P	577	06.02.19
	09P21787	Temperatur	Sea-Bird	SBE3T	2584	07.06.19
		Leitfähigkeit	Sea-Bird	SBE4C	2886	07.06.19
Deck Unit CTD			Sea-Bird	SBE11+	11P-0529	
Rosette 1		12 x 10L				
Fluorometer			Wetlabs	WetlabECO	4964	15.01.18
Turbidimeter			Wetlabs	WetlabECO	4964	"
Oximeter			SBE43	SBE43	3152	04.01.19
Altimeter			Teledyne	Benthos		
pH			Sea-Bird	SBE18	1441	*kurz vor der Reise*

Date:	**26.08.19**	**30.08.19**	**01.09.19**	**04.09.19**	**06.09.19**	**11.09.19**
CTD:	**S6**	**S6**	**S6**	**S1**	**S1**	**S1**
Position Release Module	Bottle ID	Bottle ID	Bottle ID	Bottle ID	Bottle ID	Bottle ID
1	181004	181004	181004	181001	181001	181001
2	Goflo	Goflo	Goflo	9	9	9
3	Goflo	Goflo	Goflo	181003	181003	181006
4	Goflo	Goflo	Goflo	11	11	181014
5	181011	181006	181006	181005	181005	181005
6	181013	181013	181013	—	181006	
7	181014	181014	181014	—	181013	181013
8	181015	181015	181015	—	181014	181003
9	181009	181009	181010	—	—	—
10	181002	181002	181002	—	—	—
11	181006	181011	181011	—	191010	191010
12	191010	191010	191010	—	191009	191009

Nutrients:

- Oxygen determination according to Winkler-Carpenter by means of a SIS Dissolved Oxygen Analyser (DOA) with photometric end point determination at selected depths.
- Determination of the pH value (CTD samples and continuously via the sea water pipe).
- Determination of depth of visibility by means of a Secchi disk at daylight stations.
- Filtration of surface water samples and freezing of the glass fiber filters for the determination of chlorophyll according to Jeffrey and Humphrey after the cruise.
- Determination of sea water alkalinity.
- Sampling and freezing aboard for determination of Total-N and Total-P ashore (German-Bight-stations).

Radiochemistry:

- 2 x 35 l surface water for the determination of strontium-90 after the cruise.
- One liter surface samples for the analysis of tritium after the cruise.
- 150 l surface water samples for the on-board analysis of caesium-137 by means of an ion exchanger (KNiFC-PAN).
- 100 l surface water samples for the on-board analysis of transuranic elements.
- 270 l samples taken at station GN808 for the determination of strontium and tritium after the cruise and of caesium and transuranic elements on board.

Trace Metals:

- Determination of metal concentrations in sea water and suspended matter. Sampling via Clean CTD with GoFlo sampler or - if Clean CTD is not possible - MERCOS sampler with plastic covered wire.

Container Plan

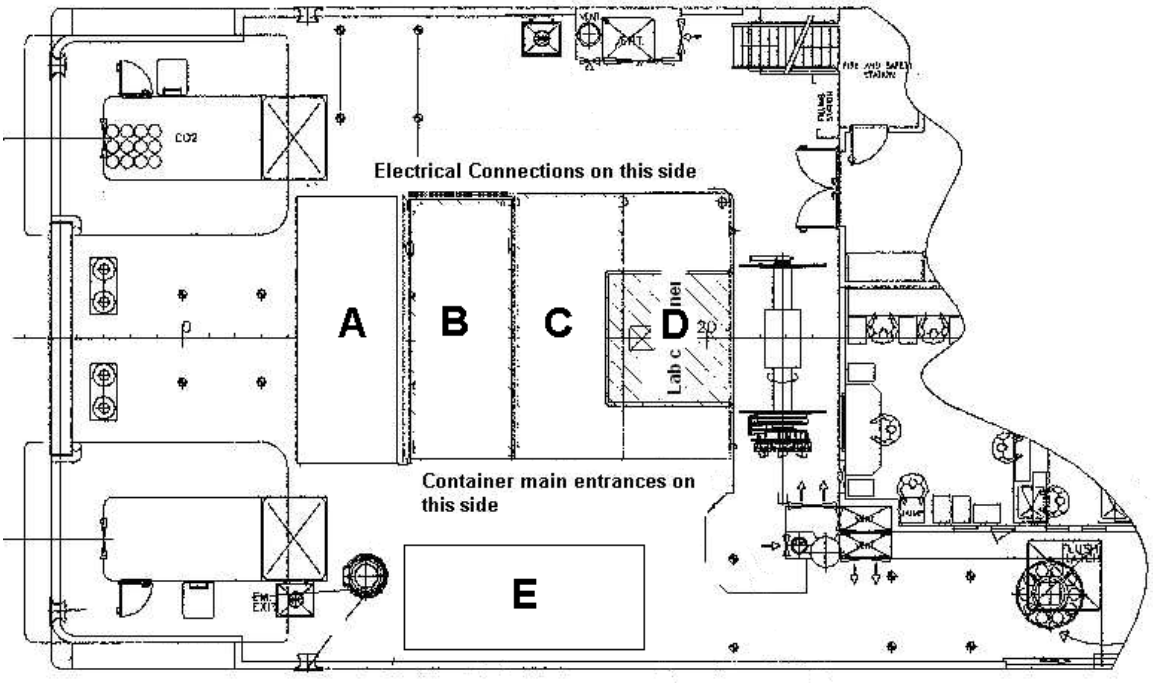


Fig. 4: *Container plan Celtic Explorer*

slot	container type	weight	power supply
A	Four 600 l drums for nutrients and calibration lab		
B	Bottom: 20" M34 lab container, height 3.1 m (HM) Top: —	9 t	2 x 32 A
C	Bottom: 20" Transport container radioactivity Top: —	9 t —	— —
D	Bottom: 20“ M32 lab container for radioactivity, fresh- and sea water Top: —	5 t	32 A
E	20" Transport and store container	9 t	—
F	—	—	—

F: Bow position

Diary

Time: UTC

🡻 Specifications regarding fixed stations, ship stops for vertical CTD profiles and water sampling.

W&S Weather & Sea:
T_A = air temperature,
Water temperature (T_W) and salinity data are raw data from the CTD bottle file for 5 m depth.

Definition Cloud Cover	Category
0/8 Sky clear	fine
1/8 of sky covered or less, but not zero	fine
2/8 of sky covered	fine
3/8 of sky covered	partly cloudy
4/8 of sky covered	partly cloudy
5/8 of sky covered	partly cloudy
6/8 of sky covered	cloudy
7/8 of sky covered or more, but not 8/8	cloudy
8/8 of sky completely covered, no breaks	overcast

Radioactivity (artificial nuclides), sea water samples are taken for the following artificial nuclides: Cs-137 = cesium-137; Cs-134 = cesium-134; Sr-90 = strontium-90; H-3 = tritium, Pu = plutonium, Am = americium, Cm = curium, TU = transuranic elements (Pu, Am, Cm). If no samplers are used, samples are taken from the seawater pipe.

Trace Metals: Samples taken by Clean-CTD with GoFlo sampler or separately with MERCOS sampler.

Watch table marine physics:

00-04/12-16: Katrin
04-08/16-20: Peter
08-12/20-00: Sören

Watch table radioactivity:

00-12: Steffi
12-00: Andrea

Watch table nutrients:

06-18: Rosa
18-06: Wiebke

Watch table metals:

04-16 Ina
16-04 Andreas

For sample details see Appendix 5!

Monday, August 26th, 2019

07:30 Arrival of science crew at Celtic Explorer. Berth: Schuppen 62, Süd-West-Terminal, Am Kamerunkai 5, 20457 Hamburg.

09:20 Arrival of containers and equipment. Start of mobilisation by use of the local crane.

12:35 Container loading and crane assistance is finished.
Preparation of dry lab and wet labs and installation of sensor systems.

15:00 Security instructions by the chief officer Basil Murphy.

Tuesday, August 27th, 2019

05:50 Sailing.

🡻 **07:55 – 08:09 Station STADE:**
Water samples for artificial nuclides and GoFlo sampler for metals.
W&S: No wind data, 1018 hPa, T_A = 26.6 °C, fine. T_w = 21.7 °C.

🡻 **11:49 – 12:03 Station MEDEM:**
Water samples for artificial nuclides and GoFlo sampler for metals.
W&S: Bft. 2-3, 70°, 1017 hPa, T_A = 27.8 °C, fine. T_w = 20.9 °C.

🡻 **13:53 - 14:10 Station GN003/ELBE1:**
Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
W&S: Bft. 2, 50°, 1016 hPa, T_A = 25.2 °C, fine, T_w = 19.3 °C,S = 32.90 psu.

15:50: Muster Station exercise

🡻 **17:39 – 17:51 Station GN003A:**
Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
W&S: Bft. 3-4, 80°, 1015 hPa, T_A = 22.2 °C, fine, T_w = 20.0 °C, S = 32.90 psu.

🡻 **20:54 – 21:10 Station GN007 (Borkumriffgrund):**
Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
W&S: Bft. 4, 80°, 1014 hPa, T_A = 22.4 °C, obscured sky, T_w = 19.8 °C, S = 33.29 psu.

🡻 **23:43 – 23:59 Station GN007A:**
Clean-CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
W&S: Bft. 4, 120°, 1013 hPa, T_A = 21.9 °C, obscured sky, T_w = 20.1 °C, S = 34.58 psu.

Wednesday, August 28th, 2019

🡻 **02:50 – 03:08 Station GN008:**
Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
W&S: Bft. 4, 160°, 1011 hPa, T_A = 21.0 °C, obscured sky, T_w = 19.8 °C, S = 34.49 psu.

- **06:53 – 07:02 <u>Station GN008S</u>:**
  Clean-CTD profile with rosette sampler for salinity.
  W&S: Bft. 2, 250°, 1011 hPa, T_A = 22.7 °C, fine, T_w = 19.2 °C, S = 34.67 psu.

- **10:17 – 10:45 <u>Station GN009</u> (Outer Well Bank):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 3, 270°, 1012 hPa, T_A = 19.9 °C, cloudy, T_w = 17.5 °C, S = 34.66 psu.

- **14:55 – 15:15 <u>Station GN009A</u>:**
  Secchi depth and Clean-CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 2, 230°, 1013 hPa, T_A = 21.1 °C, cloudy, T_w = 18.8 °C, S = 34.42 psu.

- **18:09 – 18:19 <u>Station GN010</u> (west of Den Helder):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 3, 200°, 1013 hPa, T_A = 20.2 °C, cloudy, T_w = 19.1 °C, S = 35.14 psu.

- **21:38 – 21:46 <u>Station GN011</u> (west of Ijmuiden):**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: No wind data, 1015 hPa, T_A = 19.9 °C, obscured sky, T_w = 19.6 °C, S = 32.54 psu.

Thursday, August 29th, 2019

- **02:40 – 02:54 <u>Station GN012</u> (west of Hoek van Holland):**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: No wind data, 1015 hPa, T_A = 19.1 °C, obscured sky, T_w = 19.9 °C, S = 34.50 psu.

- **06:50 – 07:02 <u>Station GN013</u> (Rabsbank):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 4, 260°, 1017 hPa, T_A = 19.1 °C, partly cloudy, T_w = 19.1 °C, S = 35.03 psu.

- **09:45 - 11:1 <u>Station GN014</u> (Outer Gabbard):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 2, 270°, 1020 hPa, T_A = 19.2 °C, fine, T_w = 18.6 °C, S = 35.12 psu.

- **14:04 – 14:17 <u>Station GN015</u> (east of Lowestoft):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 2-3, 210°, 1020 hPa, T_A = 21.8 °C, fine, T_w = 19.1 °C, S = 34.70 psu
  Due to strong tidal currents no near-bottom sampling.

- **16:31 – 16:43 <u>Station GN015B</u>:**
  Secchi depth and Clean-CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 5, 190°, 1019 hPa, T_A = 18.6 °C, fine, T_w = 18.6 °C, S = 34.23 psu

- **20:43 – 20:54 <u>Station GN016</u> (Haddock Bank):**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides. 10-fold determination of oxygen.
  W&S: Bft. 3, 210°, 1019 hPa, T_A = 17.8 °C, obscured sky, T_w = 17.0.0 °C, S = 34.46 psu.

Friday, August 30th, 2019

- **02:26 – 02:42 <u>Station GN009S</u> (Outer Silver Pit):**
  Clean-CTD profile with rosette sampler salinity.
  W&S: Bft. 4, 220°, 1018 hPa, T_A = 17.2 °C, obscured sky, T_w = 17.2.0 °C, S = 34.64 psu.

- **06:39 – 06:48 <u>Station GN017</u> (east of Flamborough Head):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 6, 220°, 1017 hPa, T_A = 16.4 °C, cloudy, T_w = 15.9 °C, S = 34.34 psu.

  The position of bottle S-ID181011 and S-ID181006 in the rosette sampler frame was exchanged.

- **09:26 – 09:37 <u>Station GN017A</u>:**
  Secchi depth and Clean-CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 4-5, 200°, 1017 hPa, T_A = 17.1 °C, cloudy, T_w = 14.8 °C, S = 34.25 psu

- **12:42 – 12:54 <u>Station GN017S</u>:**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients and salinity. 10-fold determination of chlorophyll.
  W&S: Bft. 4-5, 210°, 1015 hPa, T_A = 18.6 °C, cloudy, T_w = 15.7 °C, S = 34.00 psu.

- **16:45 – 16:56 <u>Station GN018A</u>:**
  Secchi depth and Clean-CTD profile with rosette sampler salinity. Water samples for artificial nuclides.
  W&S: no wind data, 1013 hPa, T_A = 18.1 °C, cloudy, T_w = 14.6 °C, S = 34.26 psu.

- **19:12 – 19:29 <u>Station GN018</u> (Baymans Hole):**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 4, 220°, 1013 hPa, T_A = 17.9 °C, cloudy, T_w = 16.9 °C, S = 34.54 psu.

- **22:59 – 23:13 <u>Station GN018S</u> (Bruceys Garden):**
  Clean-CTD profile with rosette sampler for salinity.
  W&S: Bft. 5, 210°, 1013 hPa, T_A = 18.6 °C, obscured sky, T_w = 17.2 °C, S = 34.62 psu.

Saturday, August 31st, 2019

- **02:43 – 02:56 <u>Station GN019</u> (Doggerbank):**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: no wind data, 1026 hPa, T_A = 17.7 °C, obscured sky, T_w = 17.0 °C, S = 34.61 psu.

- **06:18 – 06:28 <u>Station GN019S</u>:**
  Secchi depth and Clean-CTD profile with rosette sampler for salinity.
  W&S: Bft. 5-6, 190°, 1011 hPa, T_A = 17.7 °C, partly cloudy, T_w = 17.3 °C, S = 34.67 psu.

- **09:44 – 10:05 <u>Station GN020</u> (east of Doggerbank):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 6-7, 210°, 1011 hPa, T_A = 18.6 °C, partly cloudy, T_w = 17.4 °C, S = 34.69 psu.

- **13:40 – 13:53 <u>Station GN021/AWZW2</u> (Nordschillgrund):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 4-5, 170°, 1009 hPa, T_A = 20.2 °C, partly cloudy, T_w = 17.9 °C, S = 34.65 psu.

- **18:19 – 20:14 <u>Station GN022</u> (Weiße Bank):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  4 × 500-l-sampler for flushing and filling of two 600 liter containers with sea water low in nutrients.
  W&S: Bft. 3, 180°, 1008 hPa, T_A = 20.1 °C, obscured sky, T_w = 18.9 °C, S = 34.55 psu.

- **22:50 – 23:05 <u>Station GN022A</u>:**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: No wind data, 1008 hPa, T_A = 18.4 °C, obscured sky, T_w = 19.5 °C, S = 33.64 psu.
  Bottle S-ID181009 had contact to the ship´s side, thus drain cock was damaged. It was replaced by bottle S-ID181010.

Sunday, September 1st, 2019

- **01:01 – 01:09 <u>Station GN023</u>:**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: No wind data, 1007 hPa, T_A = 18.1 °C, obscured sky, T_w = 18.9 °C, S = 33.31 psu.

- **03:09 – 03:20 <u>Station GN024</u>:**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity.
  W&S: Bft. 3, 250°, 1007 hPa, T_A = 18.3 °C, obscured sky, T_w = 19.6 °C, S = 32.08 psu.

- **04:49 – 05:02 <u>Station GN025</u> (west of Sylt):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 6, 3100°, 1007 hPa, T_A = 18.6 °C, partly cloudy, T_w = 19.9 °C, S = 31.37 psu.

- **13:05 – 13:16 <u>Station GN026</u> (west of Lyngvik):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 3, 260°, 1011 hPa, T_A = 17.7 °C, cloudy, T_w = 18.7 °C, S = 32.96 psu.

- **16:33 – 16:42 <u>Station GN026A</u>:**
  Secchi depth and Clean-CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 4, 270°, 1012 hPa, partly cloudy, T_A = 17.1 °C, T_w = 18.1 °C, S = 34.18 psu.

- **20:47 – 20:57 <u>Station GN027</u>:**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: No wind date, 1013 hPa, T_A = 15.9 °C, obscured sky, T_w = 17.5 °C, S = 34.76 psu.

Monday, September 2nd, 2019

- **01:01 – 01:13 <u>Station GN028</u>:**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: No wind data, 1015 hPa, T_A = 15.5 °C, obscured sky, T_w = 17.1 °C, S = 34.88 psu.

- **04:56 – 05:08 <u>Station GN028S</u>:**
  Clean-CTD profile with rosette sampler for salinity.
  W&S: Bft. 3-4, 300°, 1017 hPa, T_A = 14.6 °C, partly cloudy, T_w = 16.9 °C, S = 34.89 psu.

- **08:40 – 08:54 <u>Station GN029</u>:**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 4, 240°, 1018 hPa, T_A = 17.0 °C, partly cloudy, T_w = 16.6 °C, S = 34.90 psu.

- **03:02 – 03:19 <u>Station GN030</u>:**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 4-5, 230°, 1017 hPa, T_A = 15.7 °C, partly cloudy, T_w = 16.4 °C, S = 34.80 psu.

- **16:33 – 16:46 <u>Station GN031</u>:**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 6-7, 230°, 1013 hPa, T_A = 15.0 °C, overcast, rain, T_w = 16.5 °C, S = 34.70 psu.

- **21:57 – 22:14 <u>Station GN032</u>:**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: No wind data, 1012 hPa, T_A = 12.2 °C, obscured sky, T_w = 15.2 °C, S = 34.69 psu.

Tuesday, September 3rd, 2019

- **02:18 – 02:36 Station GN033 (east of Firth of Forth):**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: No wind data, 1014 hPa, T_A = 14.8 °C, obscured sky, T_w = 14.0 °C, S = 34.63 psu.

- **05:03 – 05:17 Station GN033A:**
  Secchi depth and Clean-CTD salinity. Water samples for artificial nuclides.
  W&S: Bft. 4, 250°, 1014 hPa, T_A = 14.6 °C, partly cloudy, T_w = 13.4 °C, S = 34.88 psu.

- **08:24 – 08:36 Station GN033S (Marr Bank):**
  Secchi depth and Clean-CTD profile with rosette sampler for salinity.
  W&S: Bft. 3, 130°, 1016 hPa, T_A = 13.2 °C cloudy, T_w = 12.4 °C, S = 34.64 psu.

  The bottom sampler could not be closed because it was connected to the wrong release hook.

- **11:10 – 11:23 Station GN034A:**
  Secchi depth and Clean-CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 4, 160°, 1015 hPa, T_A = 13.4 °C, cloudy, T_w = 12.6 °C, S = 34.70 psu.

- **13:33 – 13:47 Station GN034 (Aberdeen Bank):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides. 10-fold determination of alkalinity.
  W&S: Bft. 4, 140°, 1014 hPa, T_A = 14.0 °C, cloudy, T_w = 13.3 °C, S = 34.69 psu.

- **17:34 – 17:47 Station GN034S:**
  Secchi depth and Clean-CTD profile with rosette sampler for salinity.
  W&S: Bft. 4, 200°, 1012 hPa, T_A = 14.5 °C, cloudy, T_w = 13.6 °C, S = 34.91 psu.

- **21:36 – 21:56 Station GN035 (Coal Pitt):**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 4, 220°, 1010 hPa, T_A = 15.0 °C, obscured sky, T_w = 14.2 °C, S = 34.87 psu.

Wednesday, September 4th, 2019

- **01:18 – 01:33 Station GN035S:**
  Clean-CTD profile with rosette sampler for salinity.
  W&S: No wind data, 1008 hPa, T_A = 15.1 °C, obscured sky, T_w = 15.9 °C, S = 34.78 psu.

- **05:02 – 05:16 Station GN036:**
  Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 4-5, 220°, 1005 hPa, T_A = 15.8 °C, cloudy, T_w = 16.1 °C, S = 34.77 psu.

- **10:26 – 10:39 <u>Station GN037</u> (Große Fischerbank):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: Bft. 5, 250°, 1003 hPa, T_A = 16.2 °C, cloudy, T_w = 16.1 °C, S = 34.77 psu.

- **13:48 – 13:58 <u>Station GN038</u> (Kleine Fischerbank):**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: No wind data, 1004 hPa, T_A = 16.0 °C, partly cloudy, T_w = 16.7 °C, S = 34.73 psu.

  16:00: Bft 5, 300°, strong swell.

- **17:05 – 17:21 <u>Station GN038A:</u>**
  Secchi depth and Clean-CTD profile with rosette sampler for nutrients, metals, and salinity. Water samples for artificial nuclides.
  W&S: No wind data, 1004 hPa, T_A = 16.0 °C, partly cloudy, T_w = 16.7 °C, S = 34.76 psu.

  Problems occurred with data transmission between CTD and deck unit. Checked all plug connectors. Test on deck OK, will make a final check on next station.

- **20:34 – 21:07 <u>Station GN039</u> (east of Jyske Rev):**
  CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 4, 280°, 1004 hPa, T_A = 15.3 °C, obscured sky, T_w = 17.2 °C, S = 34.34 psu.

  One cable of the Clean-CTD was defect, changed to CTD S1.

- **23:34 – 23:47 <u>Station GN039S</u>:**
  CTD profile with rosette sampler salinity.
  W&S: No wind data, 1004 hPa, T_A = 14.9 °C, obscured sky, T_w = 16.5 °C, S = 31.69 psu.

Thursday, September 5th, 2019

- **02:56 – 03:23 <u>Station GN801</u>:**
  CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 36, 280°, 1003 hPa, T_A = 13.8 °C, obscured sky, T_w = 17.0 °C, S = 34.36 psu.

- **06:16 – 06:52 <u>Station GN802</u>:**
  Secchi depth and CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 4, 240°, 1002 hPa, T_A = 13.8 °C, partly cloudy, T_w = 16.5 °C, S = 30.54 psu.

- **10:31 – 11:15 <u>Station GN803</u>:**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 5, 310°, 1002 hPa, T_A = 13.1 °C, partly cloudy, T_w = 16.6 °C, S = 30.29 psu.

Test of Clean-CTD failed, changed to CTD S1 for the remaining stations. We exchanged pH-senor and fluorometer from CTD S6 to CTD S1.

- **13:00 – 13:23 Station GN804:**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 6, 270°, 1003 hPa, T_A = 14.8 °C, partly cloudy, T_w = 17.1 °C, S = 31.39 psu.

  Waypoint for entry in Swedish waters: 57° 40'N; 11° 10'E.

- **15:23 – 15:51 Station GN805:**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 5, 280°, 1005 hPa, T_A = 16.6 °C, partly cloudy, T_w = 17.1 °C, S = 30.56 psu.

Friday, September 6th, 2019

- **23:59 – 00:47 Station GN807:**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 4, 270°, 1010 hPa, T_A = 14.1 °C, obscured sky, T_w = 16.6 °C, S = 30.78 psu.

- **04:59 – 09:59 Station GN808:**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 4, 260°, 1012 hPa, T_A = 13.1 °C, cloudy, T_w = 16.2 °C, S = 29.81 psu.

  Taking three 270 liter samples for the determination of artificial nuclides at 39, 97, and 262 m depth.

- **15:36 – 16:22 Station GN040 (Skagerrak):**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: No wind data, 1008 hPa, T_A = 15.0 °C, partly cloudy, T_w = 16.8°C, S = 28.64 psu.

- **20:46 – 21:12 Station GN040S:**
  CTD profile with rosette sampler for salinity.
  W&S: No wind data, 1008 hPa, T_A = 14.9 °C, obscured sky, T_w = 16.3°C, S = 33.00 psu.

Saturday, September 7th, 2019

- **00:39 – 01:16 Station GN041 (west of Lindesnes):**
  CTD profile with rosette sampler for salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 2, 310°, 1009 hPa, T_A = 14.7 °C, obscured sky, T_w = 16.3 °C, S = 31.66 psu.

- **04:49 – 05:21 <u>Station GN042</u> (Eigersundbank):**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: No wind data, 1011 hPa, T_A = 13.9 °C, partly cloudy, T_w = 15.9 °C, S = 31.66 psu.

  07:30: Bft 6-7, 340°, strong swell.

- **09:53 – 10:30 <u>Station GN042S</u>:**
  CTD profile with rosette sampler for salinity.
  W&S: No wind data, 1016 hPa, T_A = 14.3 °C, partly cloudy, T_w = 14.3 °C, S = 34.92 psu.

- **14:30 – 15:00 <u>Station GN043</u> (Lingbank East):**
  CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 5-6, 350°, 1020 hPa, T_A = 13.8 °C, partly cloudy, T_w = 14.3 °C, S = 34.88 psu.

- **20:32 – 21:02 <u>Station GN044</u> (Lingbank West):**
  CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: No wind data, 1024 hPa, T_A = 12.3 °C, obscured sky, T_w = 13.7 °C, S = 35.05 psu.

Sunday, September 8th, 2019

- **01:14 – 01:28 <u>Station GN044S (Witch Ground):</u>**
  CTD profile with rosette sampler for salinity.
  W&S: Bft. 2, 340°, 1025 hPa, T_A = 11.6 °C, obscured sky, T_w = 13.4 °C, S = 35.12 psu.

- **05:25 – 05:55 <u>Station GN045</u> (east of South Bank):**
  Secchi depth and CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 1, 210°, 1025 hPa, T_A = 10.2 °C, fine, T_w = 12.4 °C, S = 35.19 psu.

  W&S 07:40; Bft 4, 170°, fine.

  Between GN045 and GN045 we filled two 600 liter containers with surface seawater for the calibration lab.

- **08:54 – 09:07 <u>Station GN045A</u> (West Bank):**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: No wind dat, 1023 hPa, T_A = 11.8 °C, fine, T_w = 12.1 °C, S = 34.97 psu.

- **12:00 – 12:11 <u>Station GN045B</u> (east of Pentland Firth):**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 4, 180°, 1021 hPa, T_A = 14.3 °C, fine, T_w = 12.8 °C, S = 34.79 psu.

- **17:08 – 17:19 <u>Station GN057A</u> (east of Pentland Firth):**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 4, 160°, 1015 hPa, T_A = 14.3 °C, cloudy, T_w = 13.3 °C, S = 34.49 psu.

- **20:39 – 21:10 <u>Station GN056</u> (Cape Wrath):**
  CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 3, 160°, 1013 hPa, T_A = 14.5 °C, obscured sky, T_w = 13.3 °C, S = 34.58 psu.

Monday, September 9th, 2019

- **00:27 – 00:42 <u>Station GN056C</u> (North Minch):**
  CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 5, 200°, 1010 hPa, T_A = 13.9 °C, obscured sky, T_w = 13.0 °C, S = 34.49 psu.

- **03:06 – 03:32 <u>Station GN064</u> (Shiant East Bank):**
  CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: No wind data, 1008 hPa, T_A = 13.5 °C, overcast, T_w = 13.1 °C, S = 34.48 psu.

- **05:34 – 05:47 <u>Station GN056B</u> (Sulisker Bank South):**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 5-6, 350°, 1008 hPa, T_A = 12.8 °C, overcast, rain, T_w = 13.6 °C, S = 34.76 psu.

13:00 **W&S:** Bft. 4, 0°, 1010 hPa, overcast, T_A = 12.6 °C.

15:00 **W&S:** Bft. 2-3, 0°, 1011 hPa, overcast, T_A = 12.7 °C.

- **16:28 – 17:47 <u>Station GN065</u> (Færoe Bank Channel):**
  Secchi depth and CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 2, 330°, 1011 hPa, T_A = 12.2 °C, partly cloudy, T_w = 12.1 °C, S = 35.22 psu.

- **20:44 – 21:33 <u>Station GN055</u>:**
  CTD profile with rosette sampler for nutrients, and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 2, 320°, 1014 hPa, T_A = 11.8 °C, overcast, T_w = 12.5 °C, S = 35.18 psu.

Tuesday, September 10th, 2019

- **00:36 – 00:49 <u>Station GN054S</u>:**
  CTD profile with rosette sampler for salinity.
  W&S: Bft. 4, 310°, 1014 hPa, T_A = 12.0 °C, obscured sky, T_w = 12.8 °C, S = 35.14 psu.

- **04:12 – 04:43 <u>Station GN054</u> (Otter Bank):**
  CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 3, 300°, 1014 hPa, T_A = 11.7 °C, partly cloudy, T_w = 12.7 °C, S = 34.91 psu.

- **07:30 – 07:42 <u>Station GN053B</u> (Foula Bank):**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 3, 300°, 1014 hPa, T_A = 11.8 °C, partly cloudy, T_w = 11.8 °C, S = 35.12 psu.

- **09:59 – 10:10 <u>Station GN053A</u> (Sumburgh Head):**
  Secchi depth and CTD profile with rosette sampler for salinity. Water samples for artificial nuclides.
  W&S: Bft. 4, 290°, 1014 hPa, T_A = 12.2 °C, cloudy, T_w = 11.9 °C, S = 35.16 psu.

  We are seeking shelter from ex-hurricane Dorian in the Voe of Cullingsbergh at the east coast of Bressay, Shetland (60° 10.1927'N; 001°03.7017' W).

17:30 **W&S:** Bft 5-6 from the south in the sheltered bay.

Wednesday, September 11th, 2019

05:15 **W&S:** Bft. 5-6, gusts up to 7, 240°, 994 hPa, cloudy.

10:30 **W&S:** Bft. 5-6, gusts up to 7, 260°, 996 hPa, cloudy.

14:00 Leaving the Voe of Cullingsbergh and heading to GN0053.
W&S: Bft. 5-6, 250°, 1000 hPa, T_A = 13.5 °C, partly cloudy.

- **16:32 – 16:59 <u>Station GN053</u> (E-lich Shetlands):**
  Secchi depth and CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 7, 270°, 1002 hPa, T_A = 13.9 °C, partly cloudy, T_w = 12.7 °C, S = 35.17 psu.

- **20:45 – 21:03 <u>Station GN052S (Forty Mile Ground)</u>:**
  CTD profile with rosette sampler for salinity.
  W&S: Bft. 5-6, 270°, 1006 hPa, T_A = 12.5 °C, obscured sky, T_w = 12.9 °C, S = 35.12 psu.

Thursday, September 12th, 2019

- **00:55 – 01:23 <u>Station GN052</u> (Bergen Bank):**
  CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
  W&S: Bft. 5, 260°, 1008 hPa, T_A = 13.2 °C, obscured sky, T_w = 13.5 °C, S = 34.71 psu.

- **05:15 – 05:46 <u>Station GN051S</u>:**
  Secchi depth and CTD profile with rosette sampler for salinity.
  W&S: Bft. 5, 250°, 1010 hPa, T_A = 13.0 °C, cloudy, T_w = 13.1 °C, S = 34.90 psu.

↓ **09:23 – 10:05 <u>Station GN051</u> (west of Selbjörnsfjord):**
Secchi depth and CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
W&S: No wind data, 1013 hPa, T_A = 13.7 °C, overcast, T_w = 15.6 °C, S = 31.21 psu.

↓ **13:41 – 13:58 <u>Station GN050S</u>:**
Secchi depth and CTD profile with rosette sampler for salinity.
W&S: No wind data, 1015 hPa, T_A = 14.6 °C, overcast, T_w = 15.6 °C, S = 31.79 psu.

↓ **17:38 – 18:24 <u>Station GN050</u> (Utsira Loch):**
Secchi depth and CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
W&S: No wind data , 1015 hPa, T_A = 14.1 °C, partly cloudy, T_w = 15.3 °C, S = 31.87 psu.

↓ **21:33 – 21:58 <u>Station GN049S</u>:**
CTD profile with rosette sampler for salinity.
W&S: Bft. 5, 300°, 1017 hPa, T_A = 14.2 °C, obscured sky, T_w = 15.3 °C, S = 31.67 psu.

Friday, September 13th, 2019

↓ **01:46 – 02:22 <u>Station GN049</u> (Utsira Grund):**
CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
W&S: No wind data, 1020 hPa, T_A = 13.5 °C, obscured sky, T_w = 13.7 °C, S = 34.53 psu.

05:00 **W&S:** Bft. 5, 270°, 1022 hPa, T_A = 13.1 °C, partly cloudy.

↓ **07:10 – 07:21 <u>Station GN048S</u>:**
Secchi depth and CTD profile with rosette sampler salinity.
W&S: Bft. 6, 290°, 1024 hPa, T_A = 14.3 °C, partly cloudy, T_w = 13.2 °C, S = 35.03 psu.

10:45 **W&S:** Bft. 7, 270°, 1027 hPa, T_A = 13.3 °C, partly cloudy.

↓ **13:20 – 13:49 <u>Station GN048</u>:**
Secchi depth and CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
W&S: Bft. 7, 270°, 1027 hPa, T_A = 14.1 °C, fine, T_w = 13.1 °C, S = 35.04 psu.

17:00 **W&S:** Bft. 4-5, 270°, 1028 hPa, T_A = 13.9 °C, partly cloudy.

↓ **18:50 – 19:20 <u>Station GN047</u> (Fladengrund Rinne):**
Clean-CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides. MERCOS-sampler for metals.
W&S: Bft. 4, 270°, 1029 hPa, T_A = 13.4 °C, partly cloudy, T_w = 13.0 °C, S = 35.13 psu.

Saturday, September 14th, 2019

- **00:34 – 01:23 Station GN046:**
  CTD profile with rosette sampler for nutrients and salinity. Water samples for artificial nuclides, MERCOS-sampler for metals.
  W&S: Bft. 5, 250°, 1027 hPa, T_A = 12.6 °C, obscured sky, T_w = 12.2 °C, S = 35.06 psu.

- **03:04 – 03:19 Station GN046A:**
  CTD profile with rosette sampler for salinity and water samples for artificial nuclides.
  W&S: Bft. 6, 250°, 1025 hPa, T_A = 13.0 °C, overcast, T_w = 12.5 °C, S = 34.94 psu.

03:20 Heading for Bremerhaven.

05:15 **W&S:** Bft. 4-5, 220°, 1024 hPa, T_A = 12.7 °C, cloudy.

09:30 **W&S:** Bft. 5-6, 200°, 1021 hPa, T_A = 11.9 °C, overcast.

10:40 **W&S:** Bft. 6-7, gusts up to 8, 200°, 1019 hPa, T_A = 12.4 °C, overcast, rain.

16:45 **W&S:** Bft. 6, gusts up to 8, 200°, 1014 hPa, T_A = 14.2 °C, overcast, rain.

Final processing of the last water samples for RA and nutrients

Sunday, September 15th, 2019

04:45 **W&S:** Bft. 5-6, 300°, 1015 hPa, T_A = 14.8 °C, overcast, rain.

09:45 **W&S:** Bft. 5-6, 300°, 1018 hPa, T_A = 14.6 °C, overcast.

12:30 **W&S:** Bft. 5-6, 300°, 1019 hPa, T_A = 14.7 °C, overcast.

15:00 **W&S:** Bft. 6, 310°, 1020 hPa, T_A = 14.7 °C, overcast.

17:15 **W&S:** Bft. 4-6, 310°, 1019 hPa, T_A = 14.7 °C, cloudy.

Monday, September 16th, 2019

04:00 Pilot on board.

05:15 **W&S:** Bft. 4, 320°, 1019 hPa, T_A = 14.8 °C, partly cloudy.

08:30 Arrival at BREDO Dry Dock, Bremerhaven

15:00 Post Cruise Conference

Tuesday, September 17th, 2019

07:00 De-mobilization with local crane.

11:00 Departure for Hamburg by bus.

Preliminary findings

With the exception of statements concerning the area averaged North Sea sea surface temperature (SST), the following assessments are based on CTD raw data (bottle files) collected during the cruise. There will be a second check of the CTD data after the cruise and - if necessary - temperature and salinity data will be re-calibrated prior to their final processing and analysis.

SST

SST is a reliable representative for of the seasonal mixed layer temperature. Due to increasing solar radiation a seasonal stratification is established during spring over wide areas of the North Sea which lasts normally until end of August or beginning of September. Then the water column will be vertically mixed again by the first fall storms. At water depths greater than about 30 m the upper layer is separated from the colder bottom layer by a sharp thermocline with vertical gradients in the order of up to 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 greater 35 psu[2] via the northern open boundary to the Atlantic and to a lesser degree via the English Channel. Only the knowledge of the hydrographic conditions in both layers, determined by the spatial distribution of temperature and salinity, allows the calculation of heat and salt budgets.

The area-averaged North Sea SSTs started in 2019 with positive monthly anomalies between 1.0 and 1.3 K between January and April (see Table 2 and Fig. 5) and moderate anomalies between 0.5 and 0.7 K from May to July. During the first week of August the seasonal cycle reached its maximum of 17.0 °C, followed by a 1 K drop during the subsequent two weeks. During the first week of the survey SST increased slightly to 16.3 °C and decreased to 14.7 °C until the end of the survey.

SST averaged 16.7 °C in August and remained at 1.6 K above normal. During the survey the North Sea had an averaged SST of 15.5 °C.

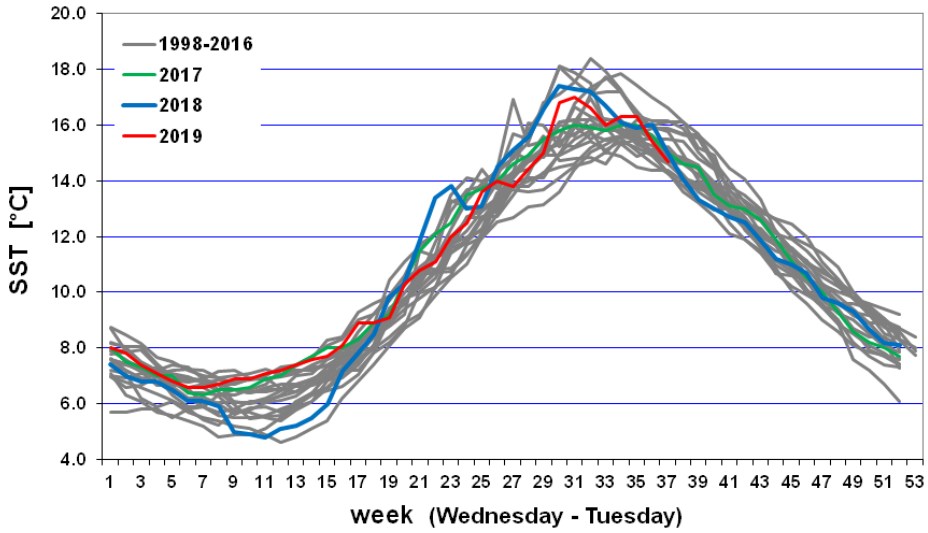


Fig. 5: *Weekly area averaged North Sea SST January 1998 – 17.09.2019*

[2] psu = practical salinity units

Table 2: Monthly North Sea area-averaged SSTs and SST anomalies in 2019 (Reference period 1971-1993)

2019	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep
°C	7.6	6.7	7.0	7.9	9.6	12.6	15.0	17.6	14.8
K	1.0	1.0	1.3	1.2	0.5	0.6	0.7	1.6	1.1

Temperature

Due to an unusual high intensity of solar radiation during the first days of the cruise, there was a moderate temperature stratification along the zonal (east-west) 54° N section. This section is normally completely vertically mixed due to tidal mixing and low water depths. The same was observed along the shallow eastern part of the 55° N section. The deeper western part of the 55° N section and all sections up to 60° N showed a massive, homogeneously mixed surface layer with a strong thermocline at about 30 m depth which grows weaker along the UK coast due to strong tidal currents. In the Norwegian Trench the thermocline had deepens to about 100 m. The temperature difference between surface and bottom temperature was greater 10 K at the deep stations in the Skagerrak and about 8 K in the central North Sea.

Salinity

As in the previous year, there was a relative narrow inflow of Atlantic Water (S >35 psu) over the East Shetland Shelf and the Fair Isle Channel in the surface layer which was also visible on the 59° N section but not on southern sections. In the bottom layer a broad inflow over the entire northern sections down to 58°N was observed reaching southward with a small tip to 56° N. At the southern connection between North Sea and Atlantic, the eastern approach to the Strait of Dover, a small tongue of Atlantic Water was detected in both layers extending north-eastward up to Station GN010 west off Den Helder. The total salt budget will not be calculated prior to the final processing of the data and the analysis of the in-situ salinity samples for CTD calibration.

Fig. 6: *Choppy waters (© H. Klein)*

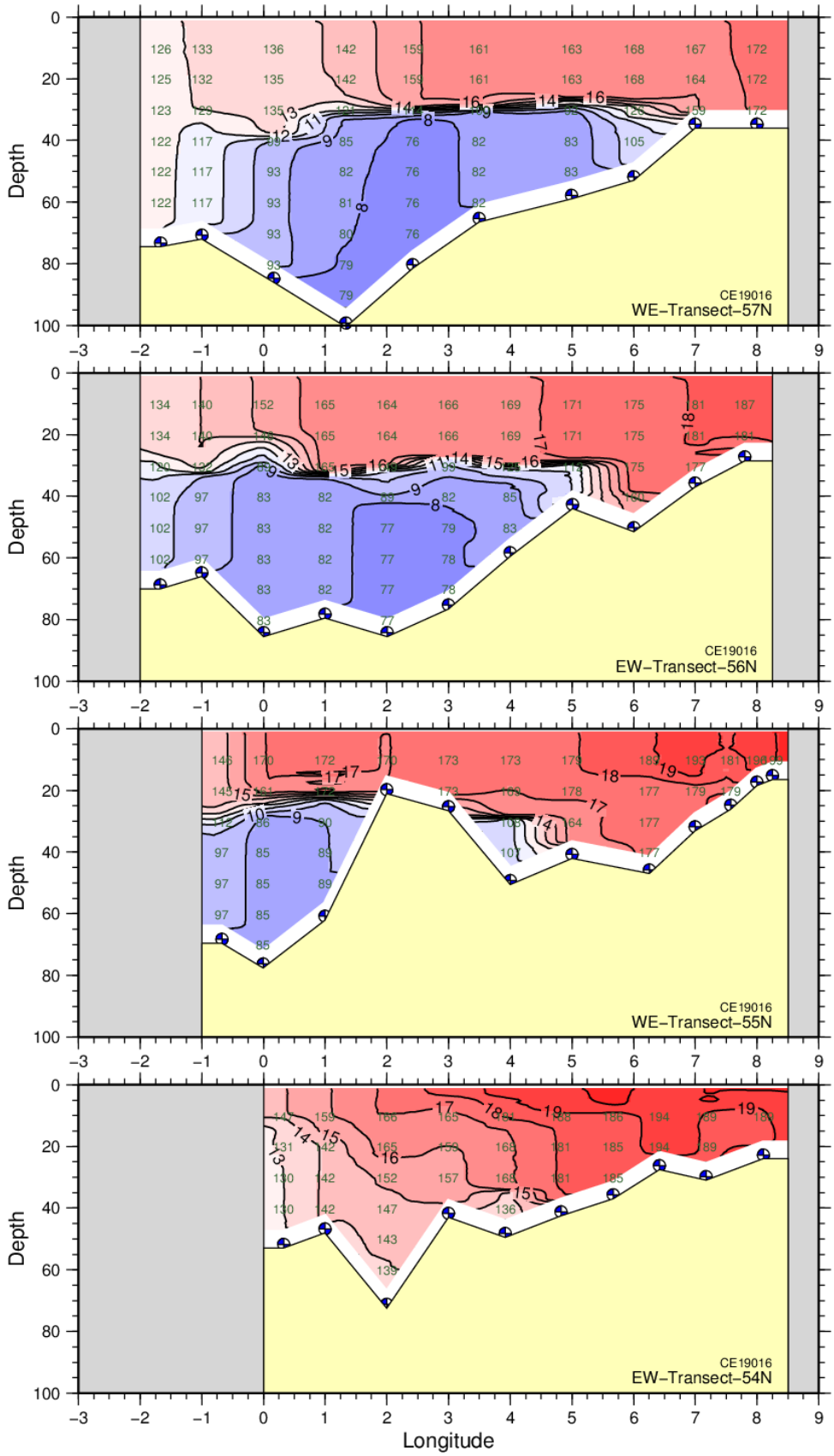


Fig. 7: *Vertical temperature distribution along the 54°, 55°, 56°, and 57°N sections basing on CTD raw data. The numbers in the section give temperatures × 10 for selected data points.*

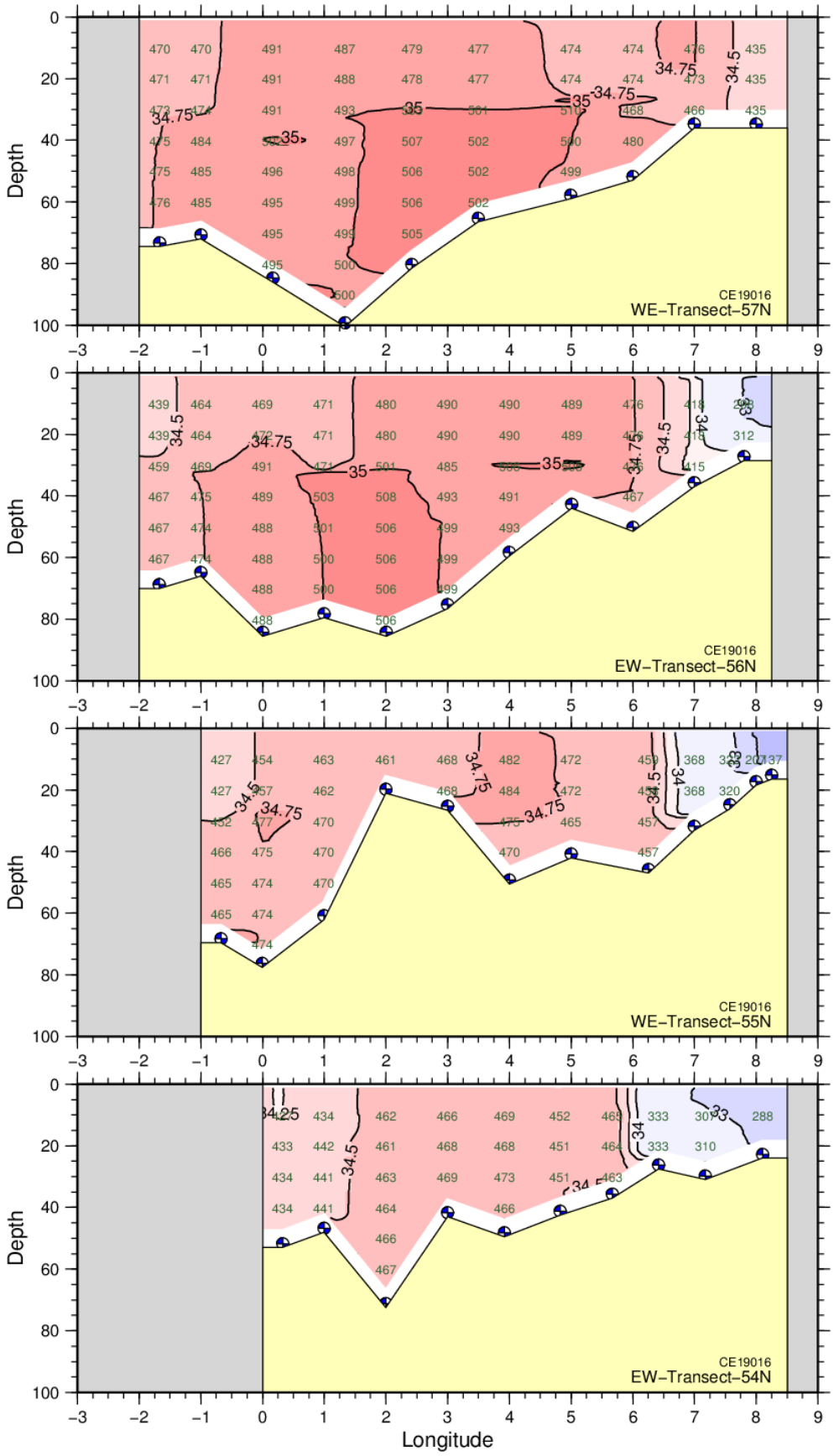


Fig. 8: *Vertical salinity distribution along the 54°, 55°, 56°, and 57°N sections basing on CTD raw data. The numbers in the section give (salinities × 100) - 3000 for selected data points.*

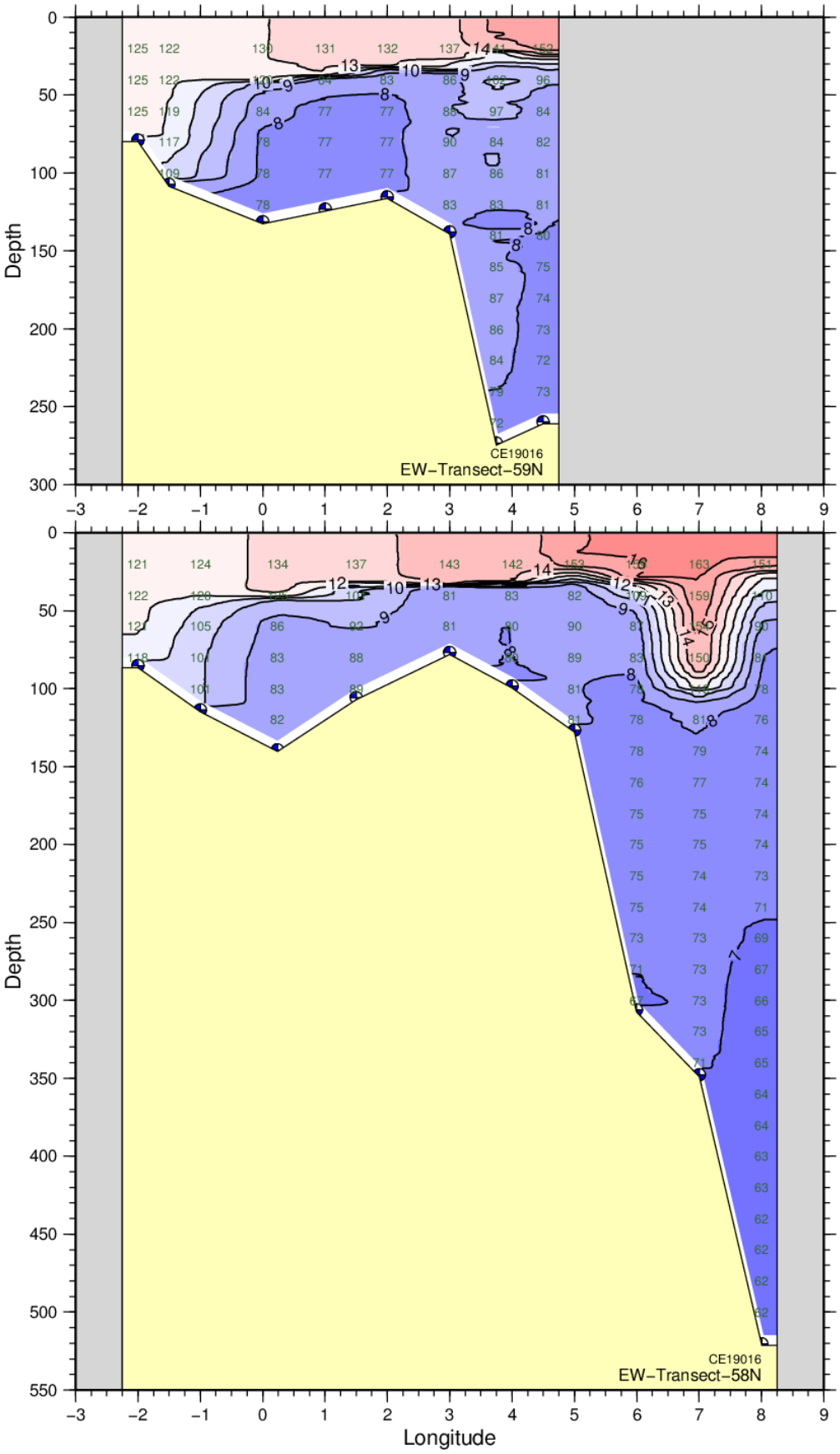


Fig. 9: *Vertical temperature distribution along the 58° and 59°N sections basing on CTD raw data. The numbers in the section give temperatures × 10 for selected data points.*

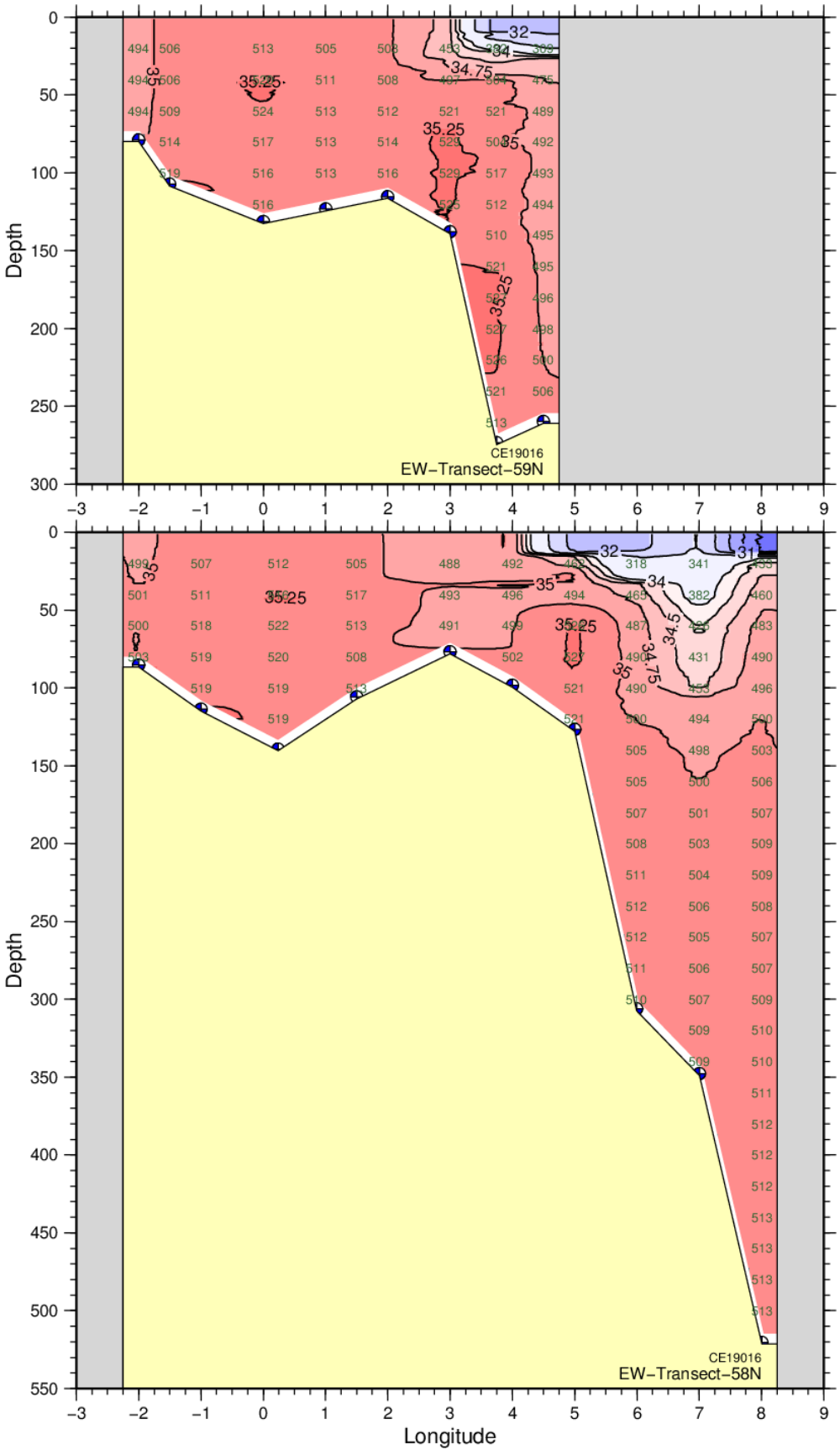


Fig. 10: *Vertical salinity distribution along the 58° and 59°N sections basing on CTD raw data. The numbers in the section give (salinities × 100) - 3000 for selected data points*.

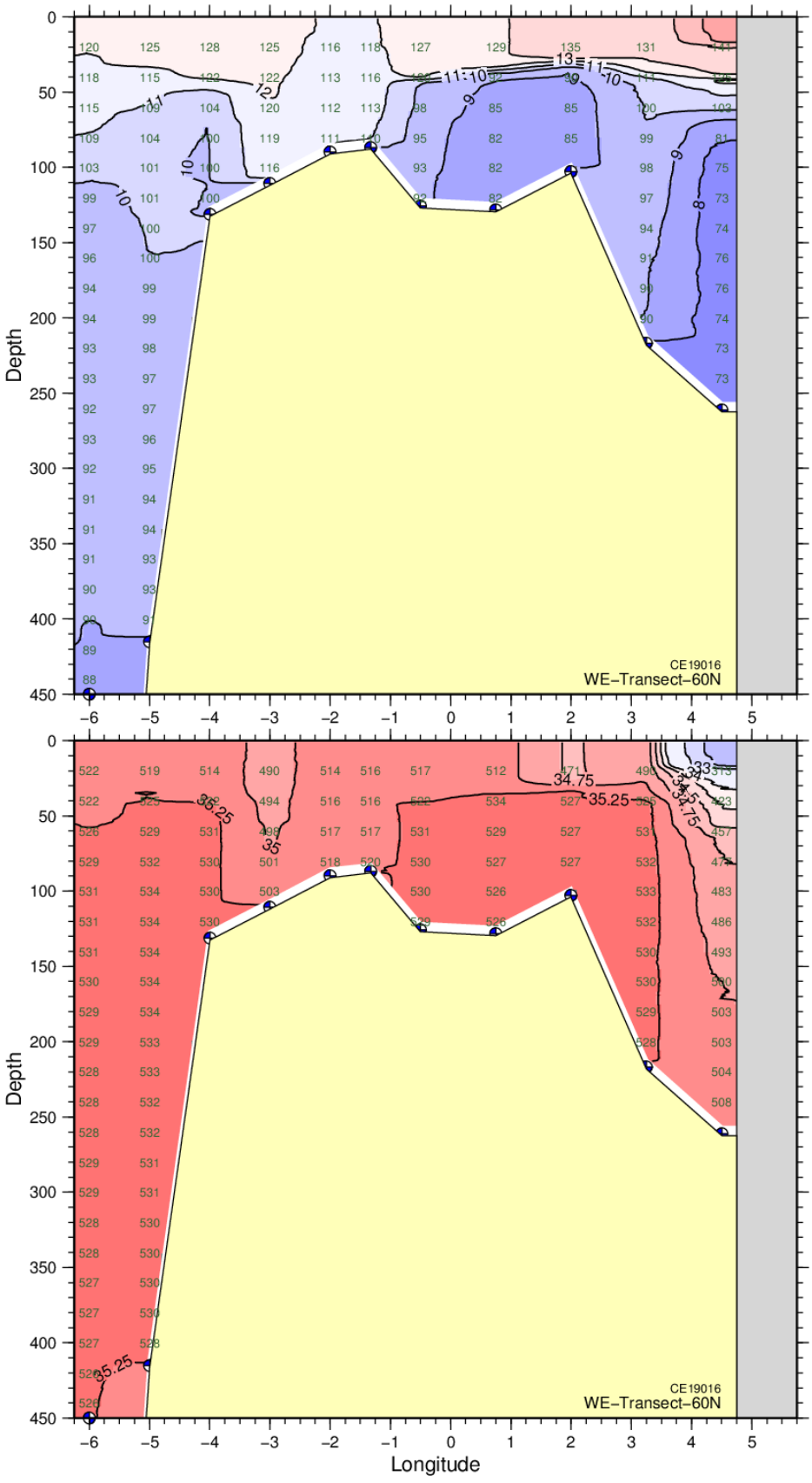


Fig. 11: *Vertical temperature (top) and salinity (bottom) distribution along the 60°N section basing on CTD raw data. The numbers in the section give the temperatures × 10 and (salinities × 100) - 3000 for selected data points.*

Acknowledgement

All participants accomplished a big amount of work in a good temper and made the North Sea Summer Survey 2019 again a big success! Thank you very much to all of you!

The help and professional good-humoured support provided by captain Antony Hobin and his crew is gratefully acknowledged. We all enjoyed the last nine summer cruises onboard Celtic Explorer and felt “home away from home”.

Holger Klein

Hamburg, September 2019

Appendix 1: List of samples

CTD-profiles with rosette:	100 stations
Secchi depth:	50 stations (daylight stations only)
Salinity:	281 samples
Total Alkalinity:	150 samples incl. 10fold determination
Oxygen:	242 samples incl. 10fold determination
pH-value:	150 samples incl. 10fold determination
Chlorophyll:	81 samples incl. 10fold determination
Total-N	36 samples
Total-P	36 samples
Radioactivity (artificial nuclides):	80 stations 39 samples à 2 35-l-drums strontium-90 (pure) 30 samples à 1-l-bottles tritium (pure) 52 samples à 100 l transuranic elements (concentrated) 83 samples à 150 l caesium-137 (concentrated)
Trace metals:	65 stations, 260 samples

Appendix 2: Surface and bottom temperatures and salinities

The following tables are based on CTD bottle file raw data.

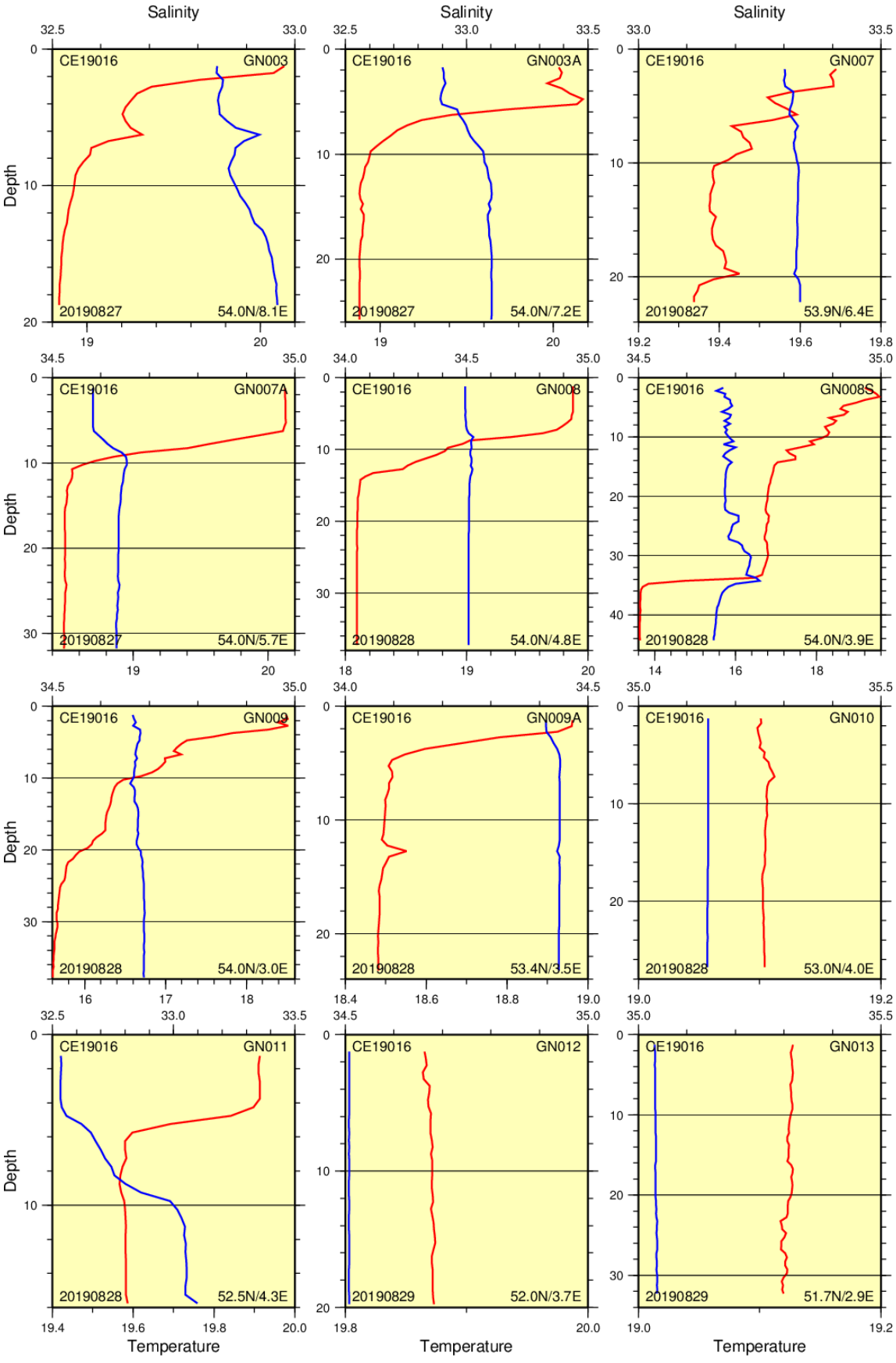
Station ID	Secchi depth [m]	water depth [m]	T_{sur} [°C]	T_{bot} [°C]	T_{sur} - T_{bot} [K]	thermo-cline depth [m]	S_{sur} [psu]	S_{bot} [psu]	S_{bot} - S_{sur} [psu]
GN003	4.0	23	19.3	18.9	0.4	—	32.90	32.97	0.07
GN003A	8.0	30	20.0	18.9	1.1	—	32.90	33.10	0.20
GN007	—	27	19.8	19.4	0.4	—	33.29	33.32	0.03
GN007A	—	36	20.1	18.5	1.6	7	34.58	34.63	0.05
GN008	—	42	19.8	18.1	1.7	8	34.49	34.51	0.02
GN008S	—	46	19.2	13.6	5.6	33	34.67	34.65	-0.02
GN009	18.5	41	17.5	15.6	1.9	18	34.66	34.69	0.03
GN009A	6.5	28	18.8	18.5	0.3	—	34.42	34.44	0.02
GN010	10.0	30	19.1	19.1	0.0	—	35.14	35.14	0.00
GN011	—	19	19.6	19.6	0.0	—	32.54	33.10	0.56
GN012	—	25	19.9	19.9	0.0	—	34.50	34.51	0.01
GN013	10.0	36	19.1	19.1	0.0	—	35.03	35.04	0.01
GN014	3.5	31	18.6	18.5	0.1	—	35.12	35.12	0.00
GN015	5.0	46	19.1	—	—	—	34.70	—	—
GN015B	2.5	40	18.6	18.6	0.0	—	34.23	34.22	-0.01
GN016	—	31	17.0	17.0	0.0	—	34.46	34.46	0.00
GN009S	—	71	17.2	13.8	3.4	30	34.64	34.67	0.03
GN017	7.5	47	15.9	14.2	1.7	15	34.34	34.41	0.07
GN017A	10.5	52	14.8	12.9	1.9	12	34.25	34.34	0.09
GN017S	9.5	61	15.7	10.5	5.2	18	34.00	34.58	0.58
GN018A	>8.0	68	14.6	9.7	4.9	22	34.26	34.65	0.39
GN018	—	75	16.9	8.5	8.4	23	34.54	34.74	0.20
GN018S	—	62	17.2	8.9	8.3	23	34.62	34.69	0.07
GN019	—	29	17.0	17.0	0.0	—	34.61	34.61	0.00
GN019S	10.5	25	17.3	17.3	0.0	—	34.67	34.67	0.00
GN020	14.0	48	17.4	10.7	6.7	28	34.69	34.81	0.12
GN021	14.5	41	17.9	16.4	1.5	22	34.72	34.65	-0.07
GN022	10.0	44	18.9	17.6	1.3	16	34.55	34.57	0.02
GN022A	—	32	19.5	17.9	1.6	17	33.64	33.68	0.04
GN023	—	26	18.9	17.9	1.0	7	33.31	33.20	-0.11
GN024	—	18	19.6	19.5	0.1	—	32.08	32.03	-0.05
GN025	3,5	14	19.9	19.9	0.0	—	31.37	31.37	0.00
GN026	7.5	29	18.7	17.7	1.0	18	32.96	33.24	0.28
GN026A	10.0	35	18.1	17.2	0.9	27	34.18	34.10	-0.08
GN027	—	49	17.5	15.6	1.9	35	34.76	34.63	-0.13
GN028	—	43	17.1	11.0	6.1	27	34.88	34.96	0.08
GN020S	—	58	16.9	8.2	8.7	32	34.89	34.93	0.04
GN029	25.5	74	16.6	7.8	8.8	30	34.90	34.99	0.09
GN030	13.5	86	16.4	7.7	8.7	35	34.80	35.06	0.26
GN031	9.0	78	16.5	8.2	8.3	32	34.70	35.00	0.30
GN032	—	84	15.2	8.3	6.9	25	34.69	34.80	0.11
GN033	—	66	14.0	9.7	4.3	30	34.63	34.74	0.11
GN033A	9.0	69	13.4	10.1	3.3	25	34.38	34.67	0.29
GN033S	13.0	50	12.4	12.4	0.0	—	34.64	34.64	0.00
GN034A	>9.5	23	12.6	12.2	0.4	—	34.70	34.75	0.05
GN034	10.5	70	13.3	11.6	1.7	33	34.69	34.85	0.16
GN34S	9.5	86	13.6	9.3	4.3	37	34.91	34.95	0.04
GN035	—	99	14.4	7.8	6.6	32	34.87	35.00	0.13
GN035S	—	81	15.9	7.6	8.3	30	34.78	35.05	0.27
GN036	—	65	16.1	8.2	7.9	30	34.77	35.02	0.25
GN037	13.0	58	16.3	8.3	8.0	27	34.74	34.99	0.25

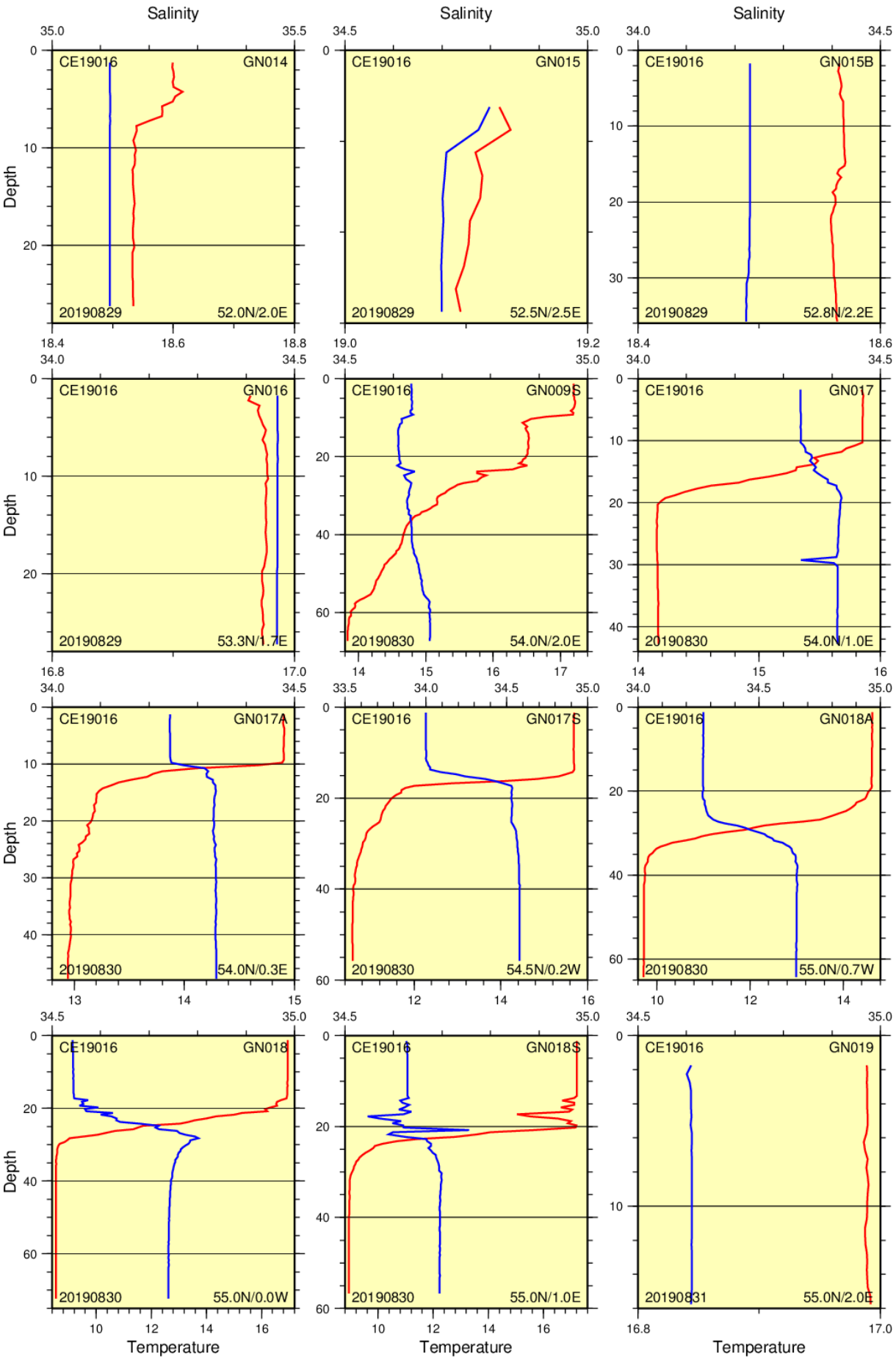
Station ID	Secchi depth [m]	water depth [m]	T_{sur} [°C]	T_{bot} [°C]	T_{sur} - T_{bot} [K]	thermo-cline depth [m]	S_{sur} [psu]	S_{bot} [psu]	S_{bot} - S_{sur} [psu]
GN038	11.0	53	16.7	10.4	6.3	30	34.73	34.80	0.07
GN038A	12.0	34	16.7	15.9	0.8	—	34.76	34.66	-0.10
GN039	—	34	17.2	17.2	0.0	—	34.34	34.35	0.01
GN039S	—	91	16.5	8.6	7.9	38	31.69	34.87	3.18
GN801	—	29	17.0	17.0	0.0	—	34.36	34.36	0.00
GN802	4.5	217	16.5	7.9	8.6	38	30.54	35.14	4.60
GN803	9.0	125	16.6	8.2	8.4	50	30.29	34.92	4.63
GN804	5.5	23	17.1	17.5	-0.4	—	31.39	32.81	1.42
GN805	6.0	88	17.1	13.3	3.8	65	30.56	33.85	3.29
GN807	—	536	16.6	6.2	10.4	10	30.78	35.13	4.35
GN808	9.5	680	16.2	6.1	10.1	10	29.81	35.13	5.32
GN040	7.0	523	16.8	6.2	10.6	25	28.64	35.13	6.49
GN040S	—	350	16.3	7.1	9.2	100	33.00	35.09	2.09
GN041	—	310	16.3	6.7	9.6	50	31.66	35.09	3.43
GN042	8.5	128	15.9	8.1	7.8	30	31.66	35.21	3.55
GN042S	—	99	14.3	7.8	6.5	33	34.92	35.09	0.17
GN043	—	77	14.3	8.1	6.2	33	34.88	34.91	0.03
GN044	—	105	13.7	8.9	4.8	30	35.05	35.13	0.08
GN44S	—	139	13.4	8.2	5.2	40	35.12	35.19	0.07
GN045	11.5	115	12.4	10.1	2.3	45	35.07	35.19	0.12
GN045A	13.0	85	12.1	11.8	0.3	—	34.97	35.03	0.06
GN045B	13.0	72	12.8	12.4	0.4	—	34.79	34.94	0.15
GN057A	14.0	79	13.3	13.0	0.3	—	34.49	34.64	0.15
GN056	—	86	13.3	13.0	0.3	—	34.58	34.63	0.05
GN056C	—	109	13.0	12.1	0.9	—	34.49	34.60	0.11
GN064	—	65	13.1	13.2	0.1	—	34.48	34.49	0.01
GN056B	15.5	119	13.6	10.6	3.0	75	34.76	34.98	0.22
GN065	12.0	1064	12.1	-0.6	12.7	580	35.22	34.91	-0.31
GN055	—	410	12.5	9.1	3.4	(33)	35.18	35.28	0.10
GN054S	—	129	12.8	10.0	2.8	45	35.14	35.30	0.16
GN054	—	111	12.7	11.5	1.2	—	34.91	35.04	0.13
GN053B	14.0	88	11.8	11.1	0.7	—	35.12	35.18	0.06
GN053A	13.0	86	11.9	10.0	1.9	—	35.16	35.20	0.04
GN053	11.0	127	12.7	9.2	3.5	33	35.17	35.29	0.12
GN052S	—	126	12.9	8.2	4.7	33	35.12	35.25	0.13
GN052	—	104	14.5	8.5	6.0	30	34.71	35.27	0.56
GN051S	7.5	217	13.1	8.9	4.2	30	34.90	35.28	0.38
GN051	8.0	261	15.6	7.3	8.3	~50	31.21	35.09	3.88
GN050S	10.5	266	15.6	7.3	8.3	~50	31.79	35.10	3.31
GN050	9.0	259	15.3	7.3	8.0	30	31.87	35.11	3.24
GN049S	—	273	15.3	7.2	8.1	20	31.67	35.13	3.46
GN049	—	138	13.7	8.0	5.7	33	34.53	35.25	0.72
GN048S	13.0	114	13.2	7.7	5.5	33	35.03	35.16	0.13
GN048	9.5	125	13.1	7.4	5.7	38	35.04	35.13	0.09
GN047	—	130	13.0	7.8	5.2	40	35.13	35.16	0.03
GN046	—	107	12.2	10.9	1.3	85	35.06	35.18	0.12
GN046A	—	78	12.5	12.5	0.0	—	34.94	34.94	0.00

T_{sur}, T_{bot}: surface (5 m) and bottom temperature.
S_{sur}, S_{bot}: surface and bottom salinity. Blue: Coastal Water ≤34 psu, red: Atlantic Water ≥35 psu.

Appendix 3: T and S profiles, all stations

The following temperature and salinity profiles are based on CTD raw data.

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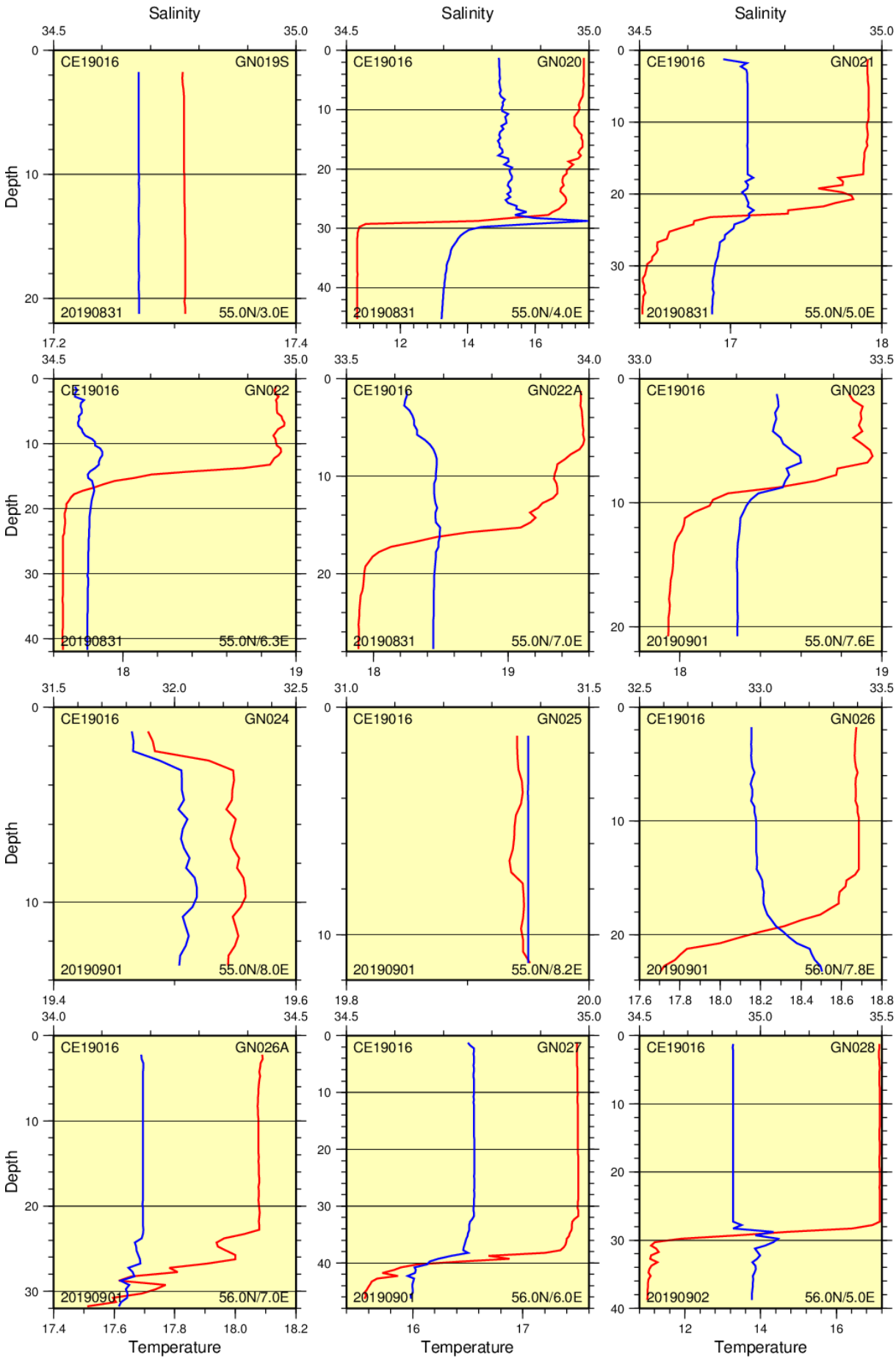
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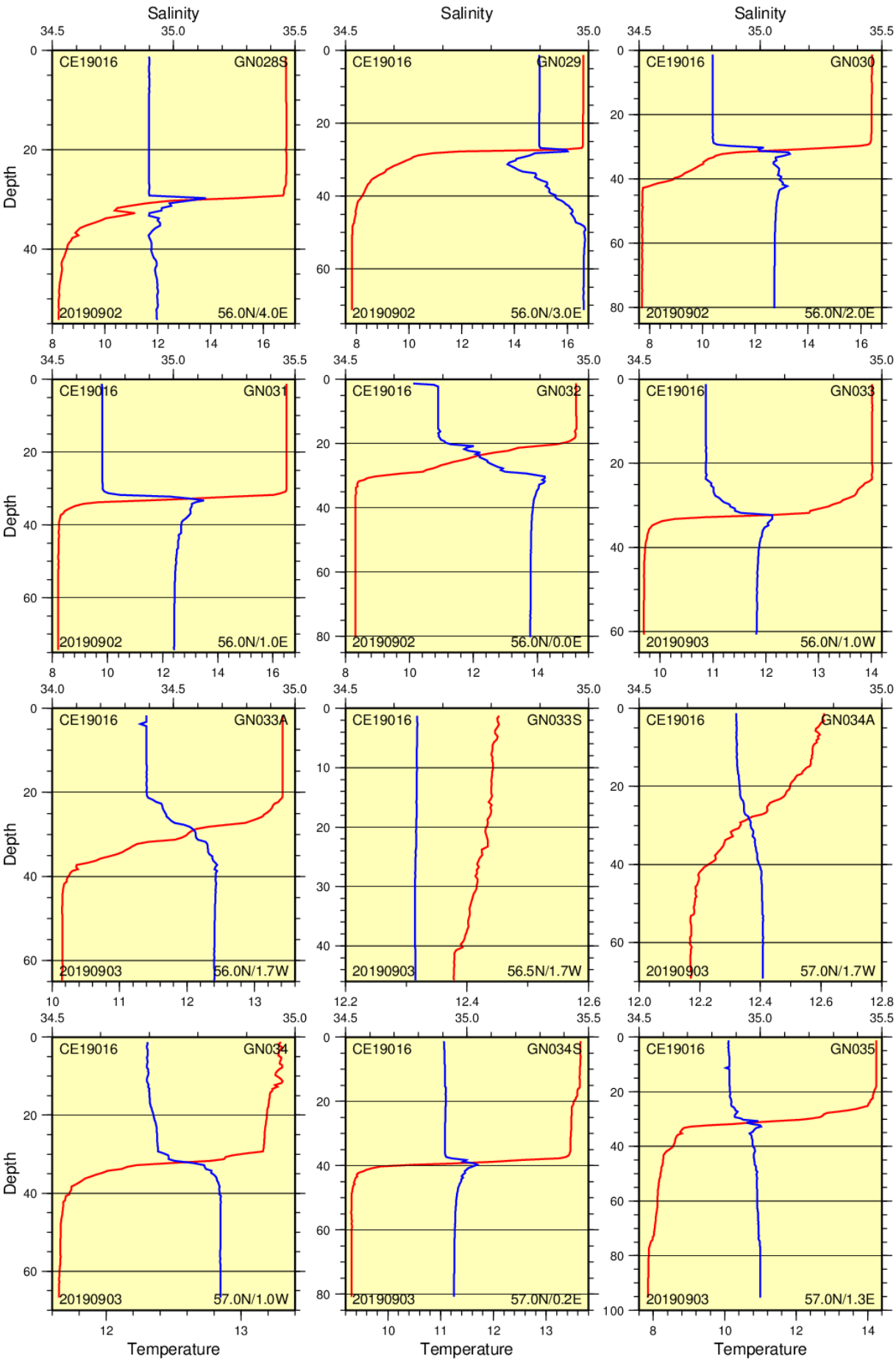
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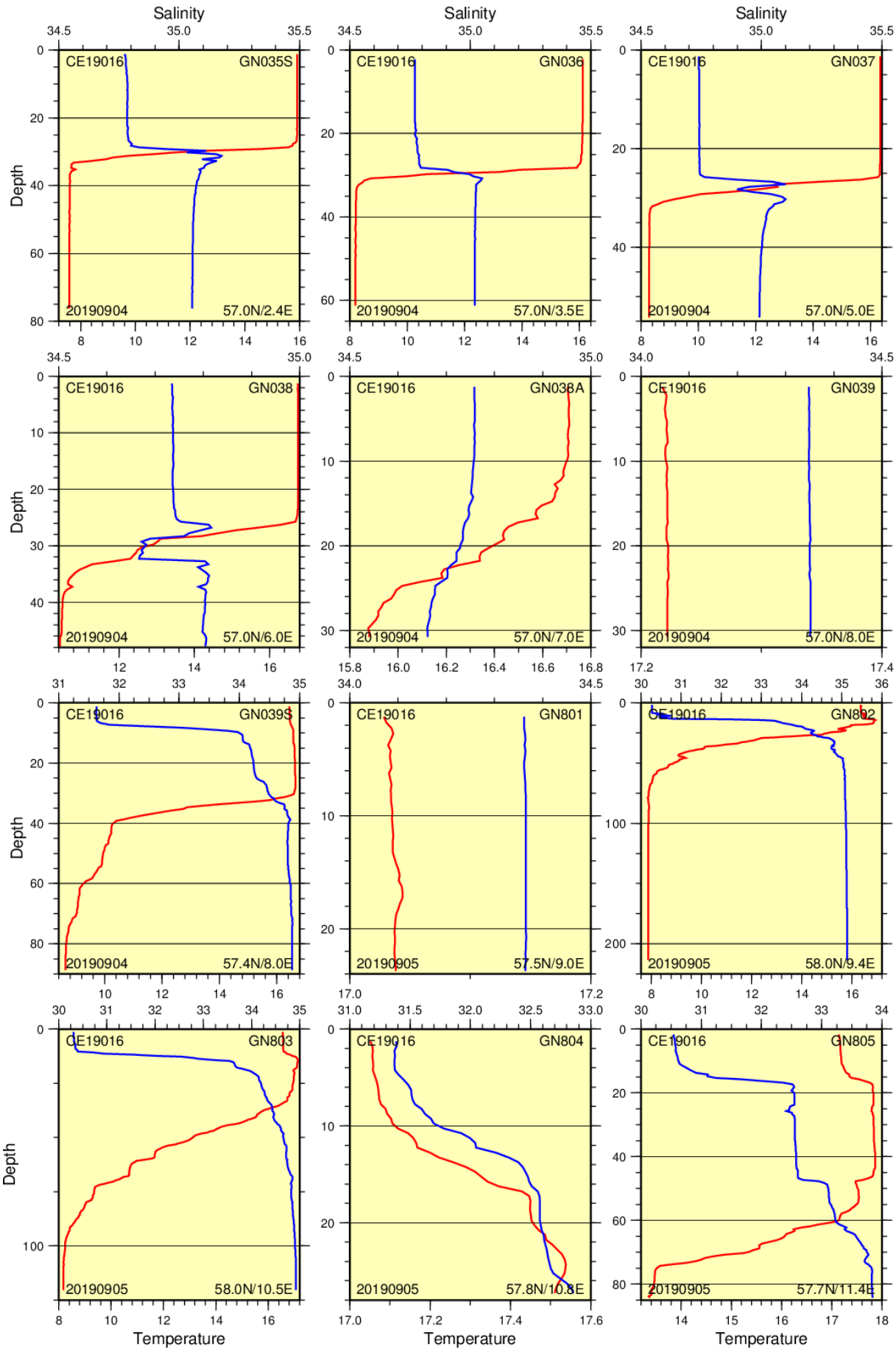
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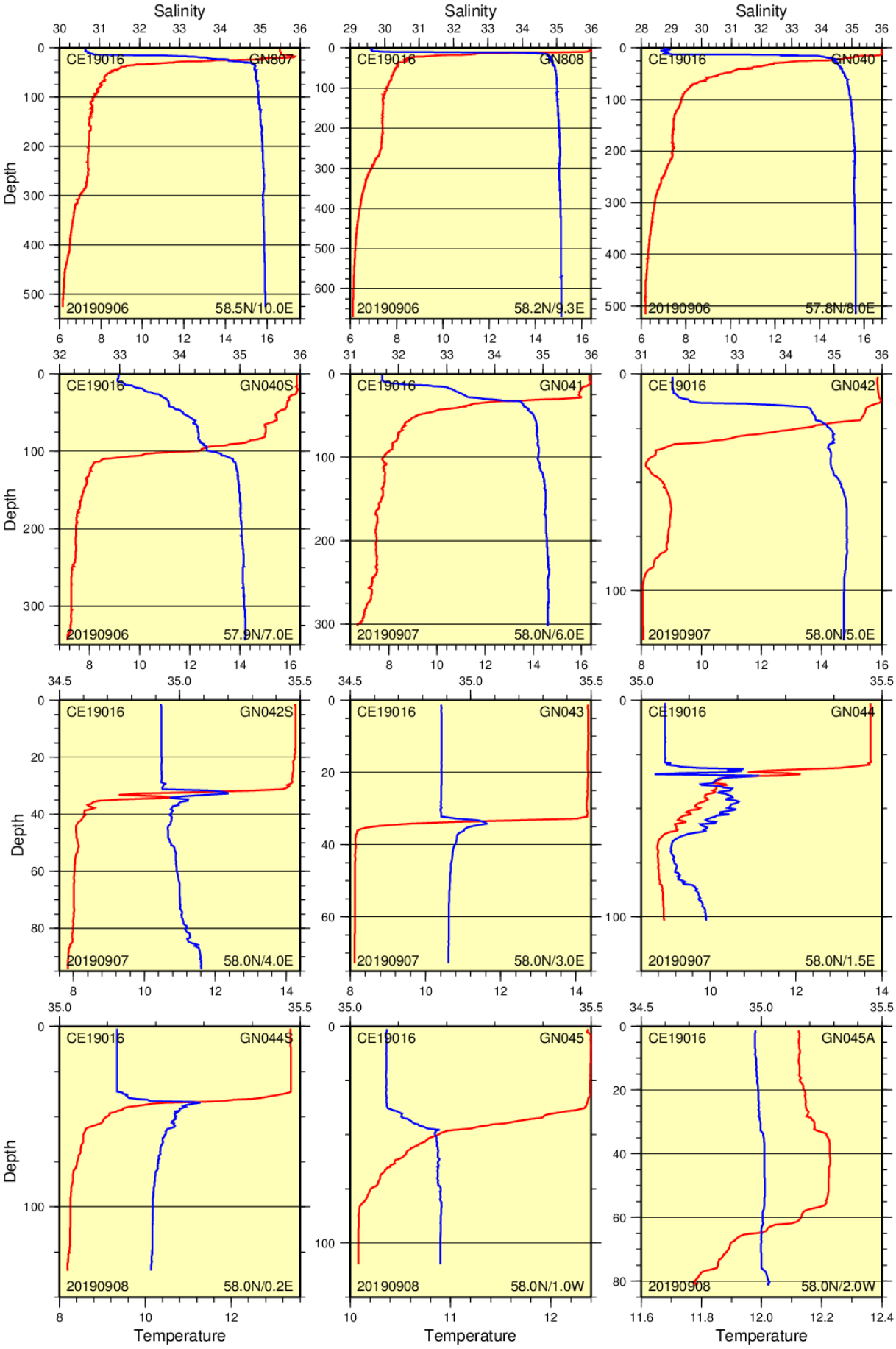
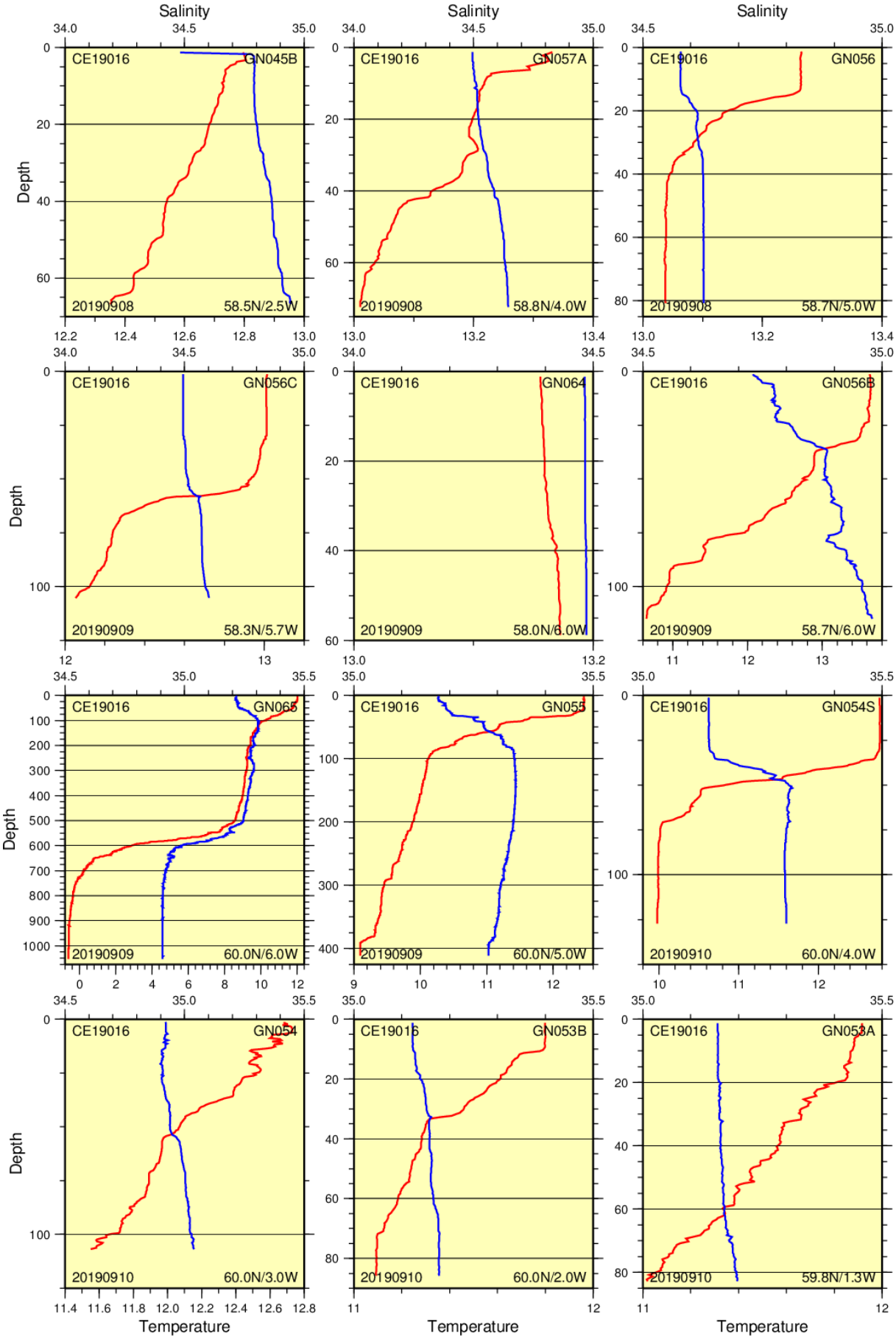
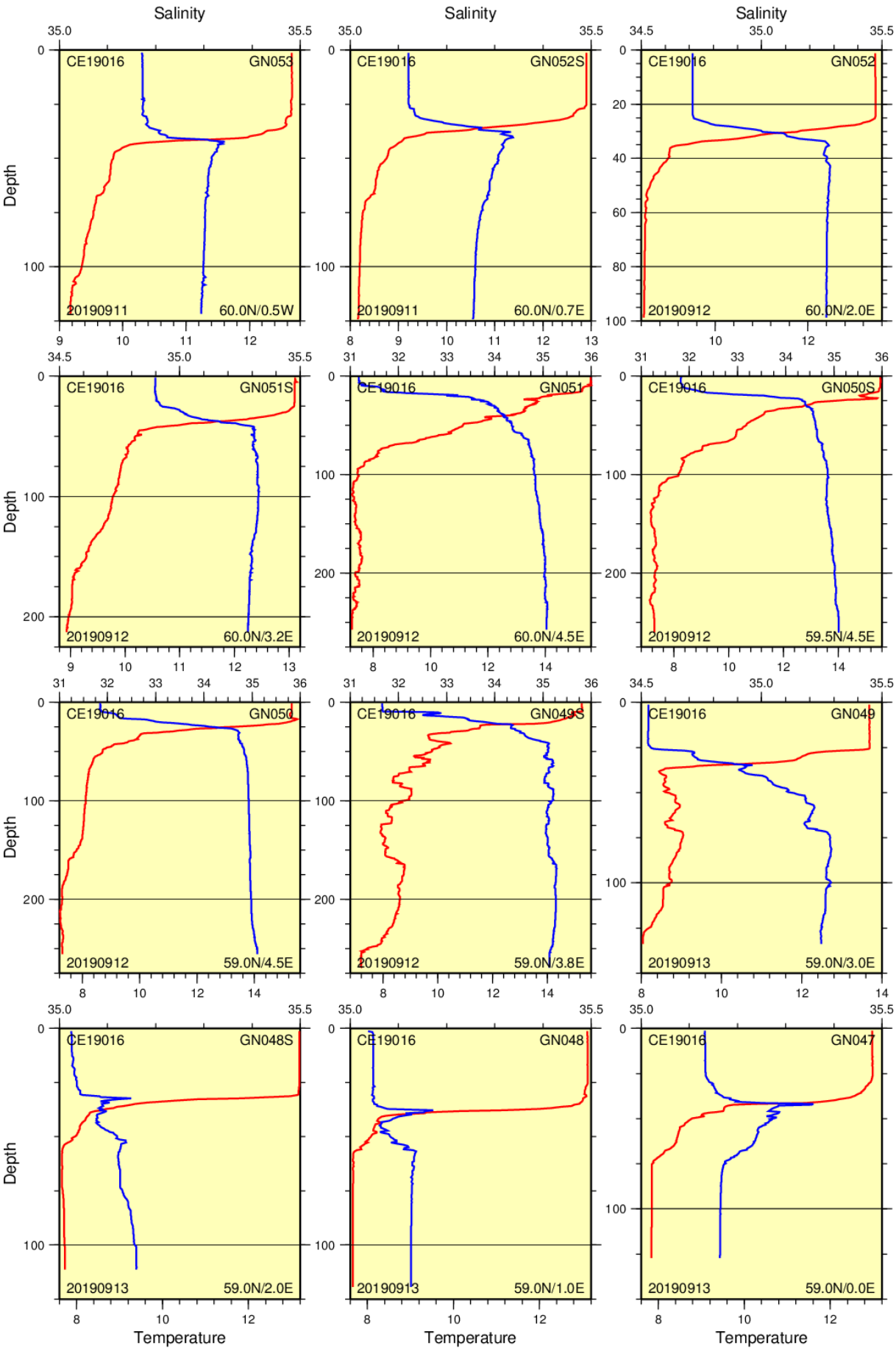
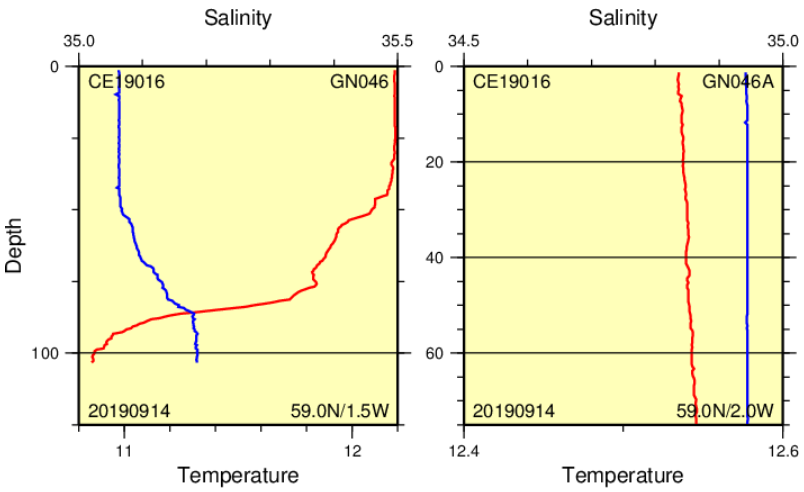
CE19016 GN805 20190905 57.7N/11.4E


Salinity
Salinity
Salinity
Depth
Depth
Depth
Depth
Temperature
Temperature
Temperature
CE19016 GN807
20190906 58.5N/10.0E
CE19016 GN808
20190906 58.2N/9.3E
CE19016 GN040
20190906 57.8N/8.0E
CE19016 GN040S
20190906 57.9N/7.0E
CE19016 GN041
20190907 58.0N/6.0E
CE19016 GN042
20190907 58.0N/5.0E
CE19016 GN042S
20190907 58.0N/4.0E
CE19016 GN043
20190907 58.0N/3.0E
CE19016 GN044
20190907 58.0N/1.5E
CE19016 GN044S
20190908 58.0N/0.2E
CE19016 GN045
20190908 58.0N/1.0W
CE19016 GN045A
20190908 58.0N/2.0W

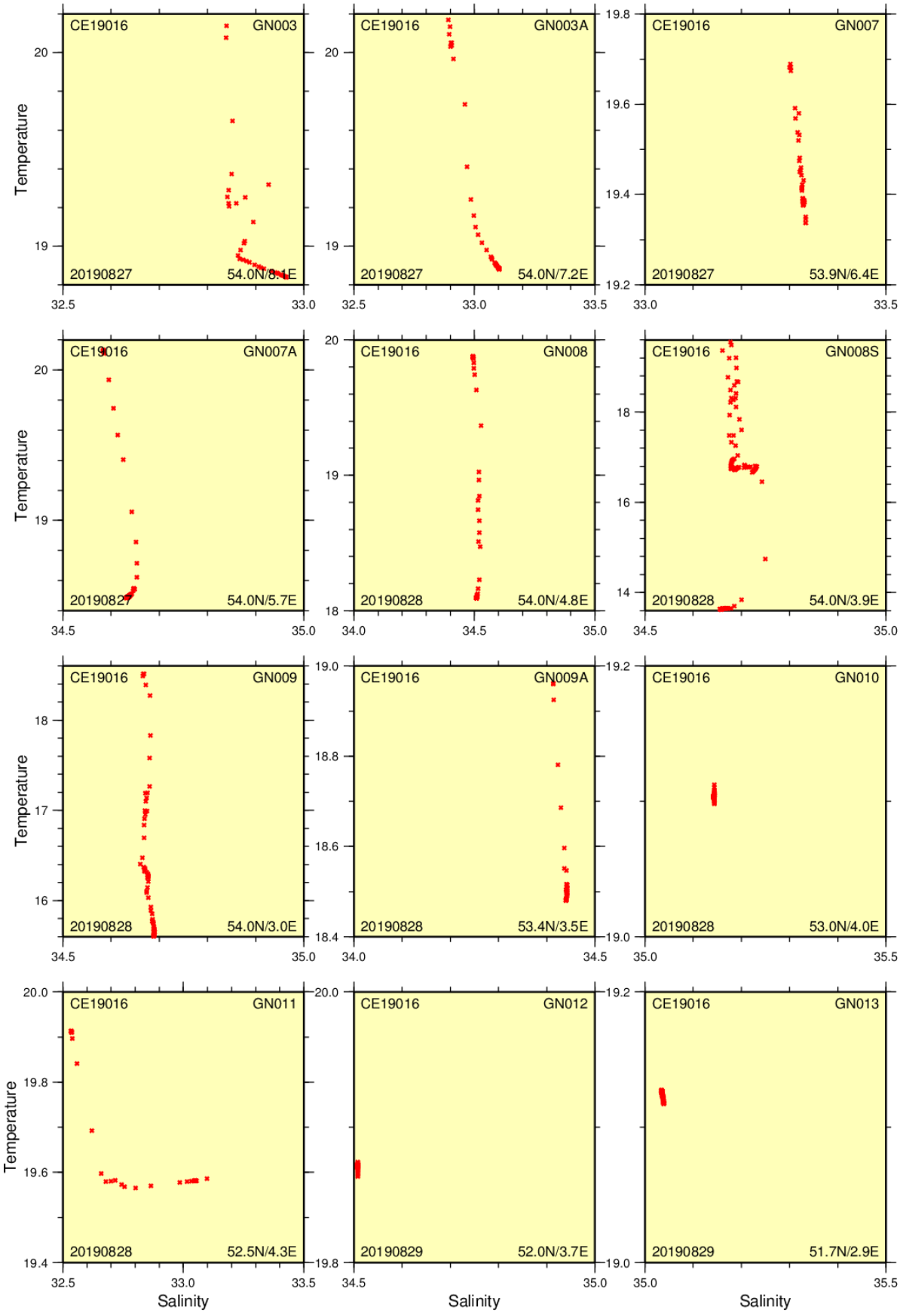

Salinity
Depth
Temperature
CE19016
GN045B
20190908
58.5N/2.5W
GN057A
58.8N/4.0W
GN056
58.7N/5.0W
GN056C
20190909
58.3N/5.7W
GN064
58.0N/6.0W
GN056B
58.7N/6.0W
GN055
60.0N/6.0W
GN054S
20190910
60.0N/4.0W
GN054
60.0N/3.0W
GN053B
60.0N/2.0W
GN053A
59.8N/1.3W

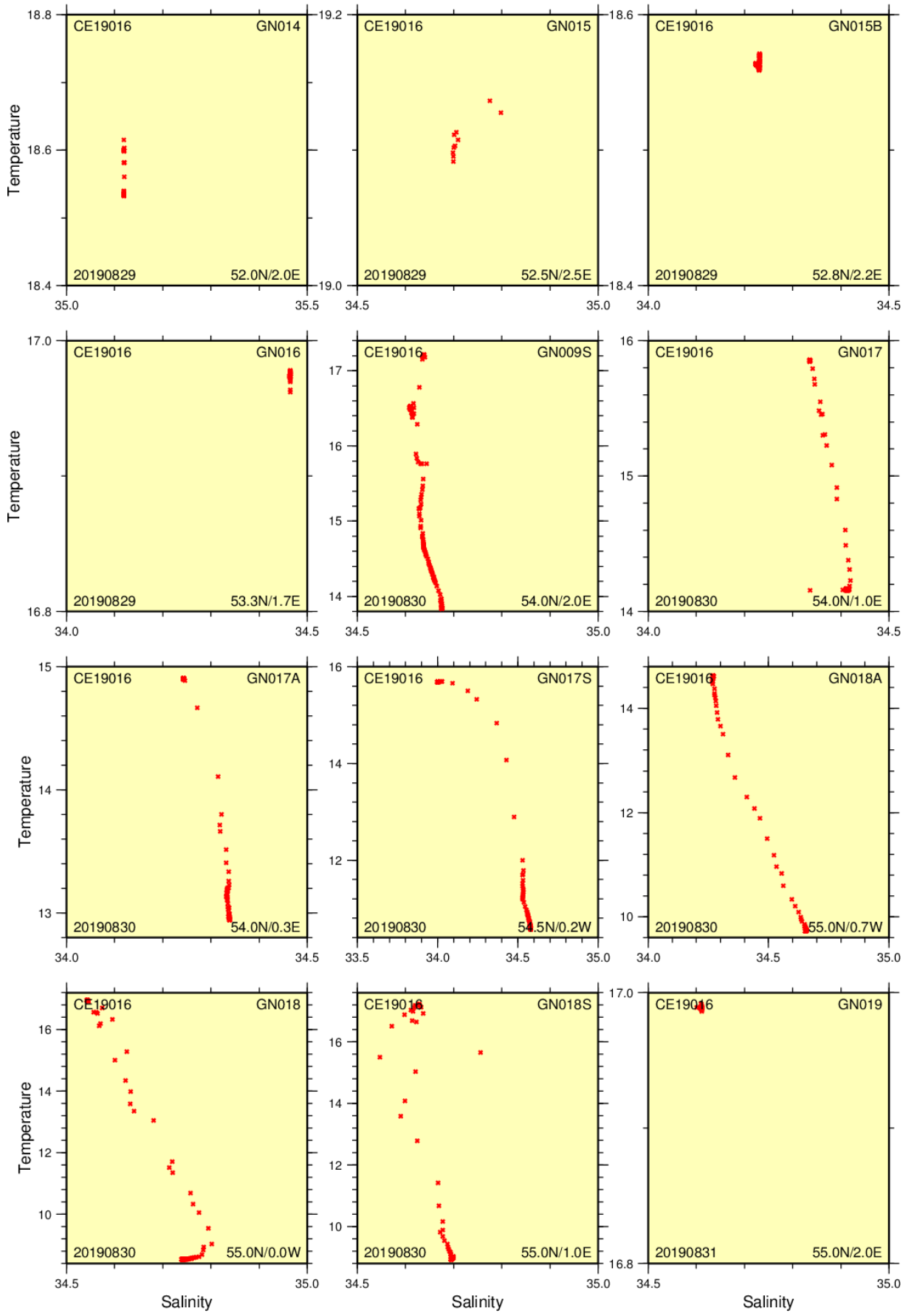

Salinity
Salinity
Salinity
Depth
Depth
Depth
Depth
Temperature
Temperature
Temperature
CE19016 GN053
20190911 60.0N/0.5W
CE19016 GN052S
20190911 60.0N/0.7E
CE19016 GN052
20190912 60.0N/2.0E
CE19016 GN051S
20190912 60.0N/3.2E
CE19016 GN051
20190912 60.0N/4.5E
CE19016 GN050S
20190912 59.5N/4.5E
CE19016 GN050
20190912 59.0N/4.5E
CE19016 GN049S
20190912 59.0N/3.8E
CE19016 GN049
20190913 59.0N/3.0E
CE19016 GN048S
20190913 59.0N/2.0E
CE19016 GN048
20190913 59.0N/1.0E
CE19016 GN047
20190913 59.0N/0.0E

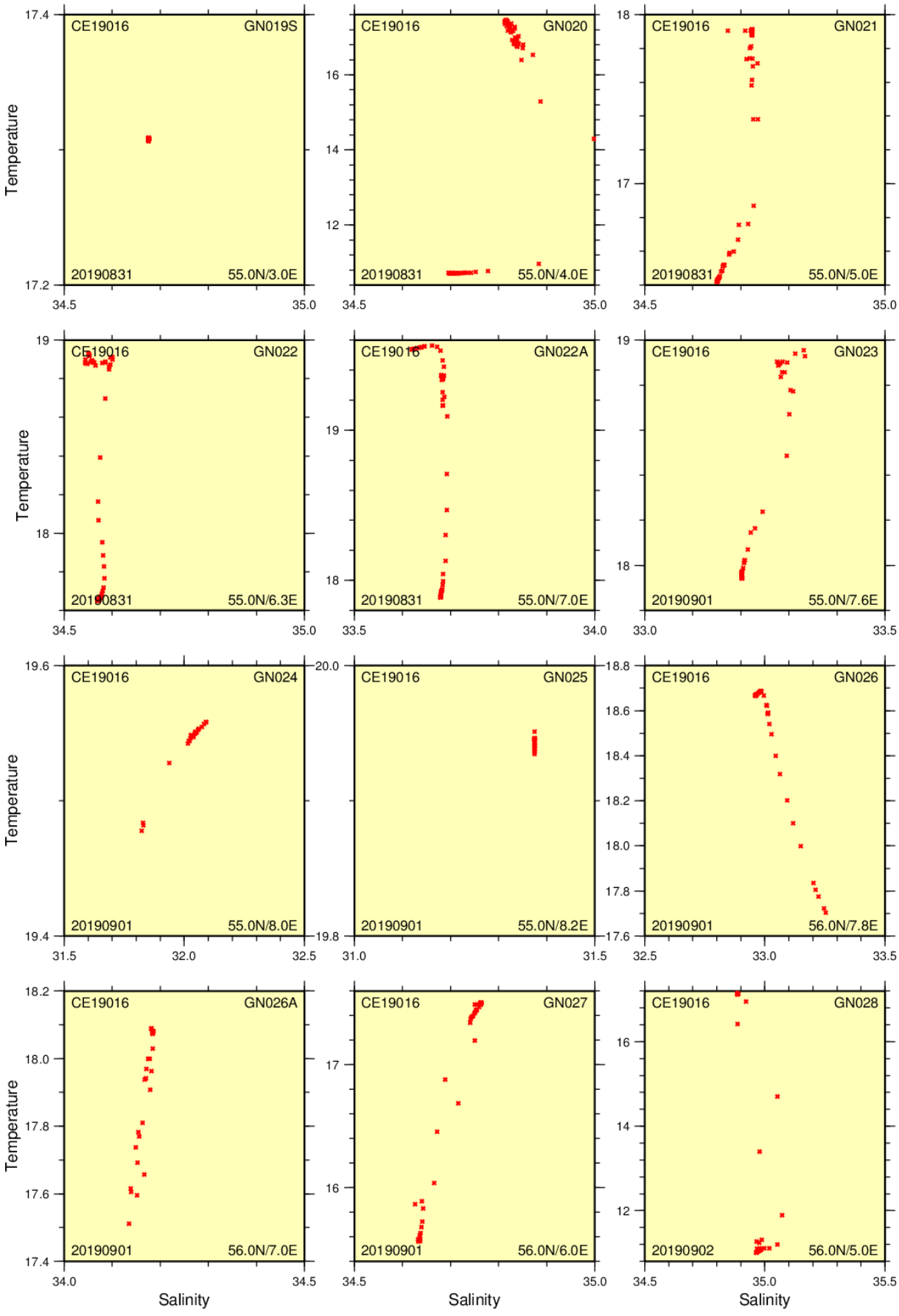

Salinity
35.0
35.5
0
CE19016
GN046
Depth
100
20190914
59.0N/1.5W
11
12
Temperature
Salinity
34.5
35.0
0
CE19016
GN046A
20
40
60
20190914
59.0N/2.0W
12.4
12.6
Temperature

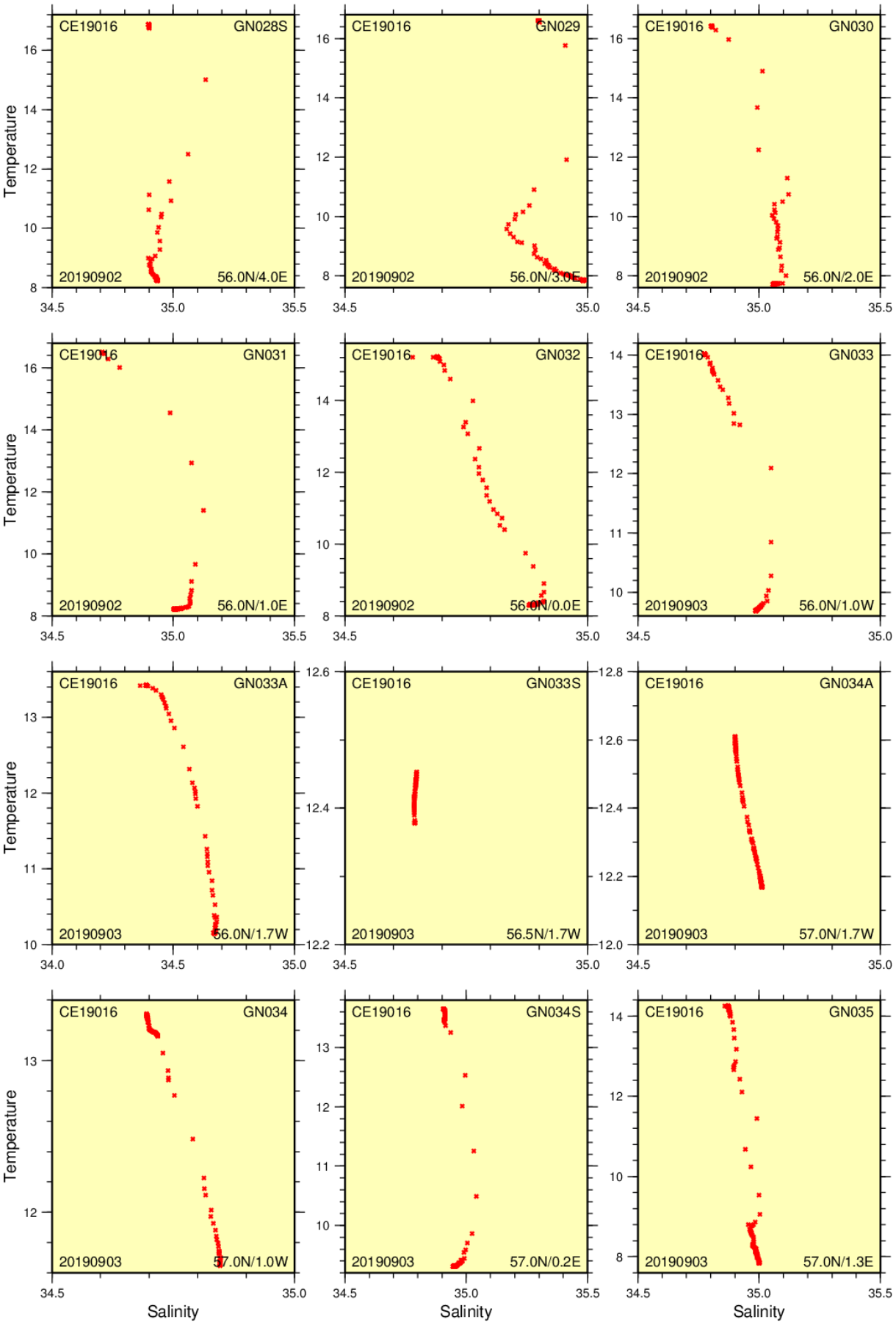
Appendix 4: T/S diagrams, all stations

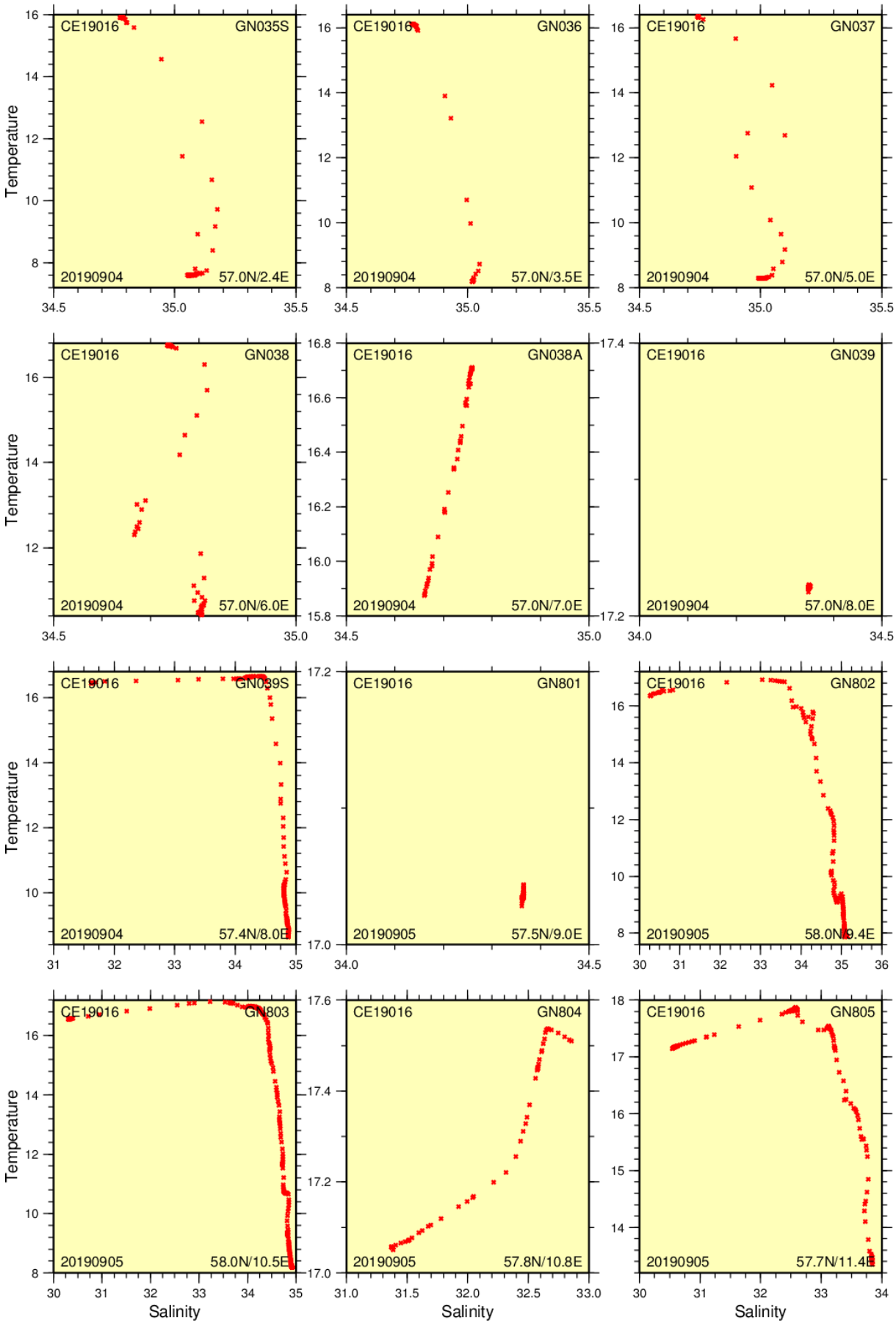
The following diagrams are based on CTD raw data.

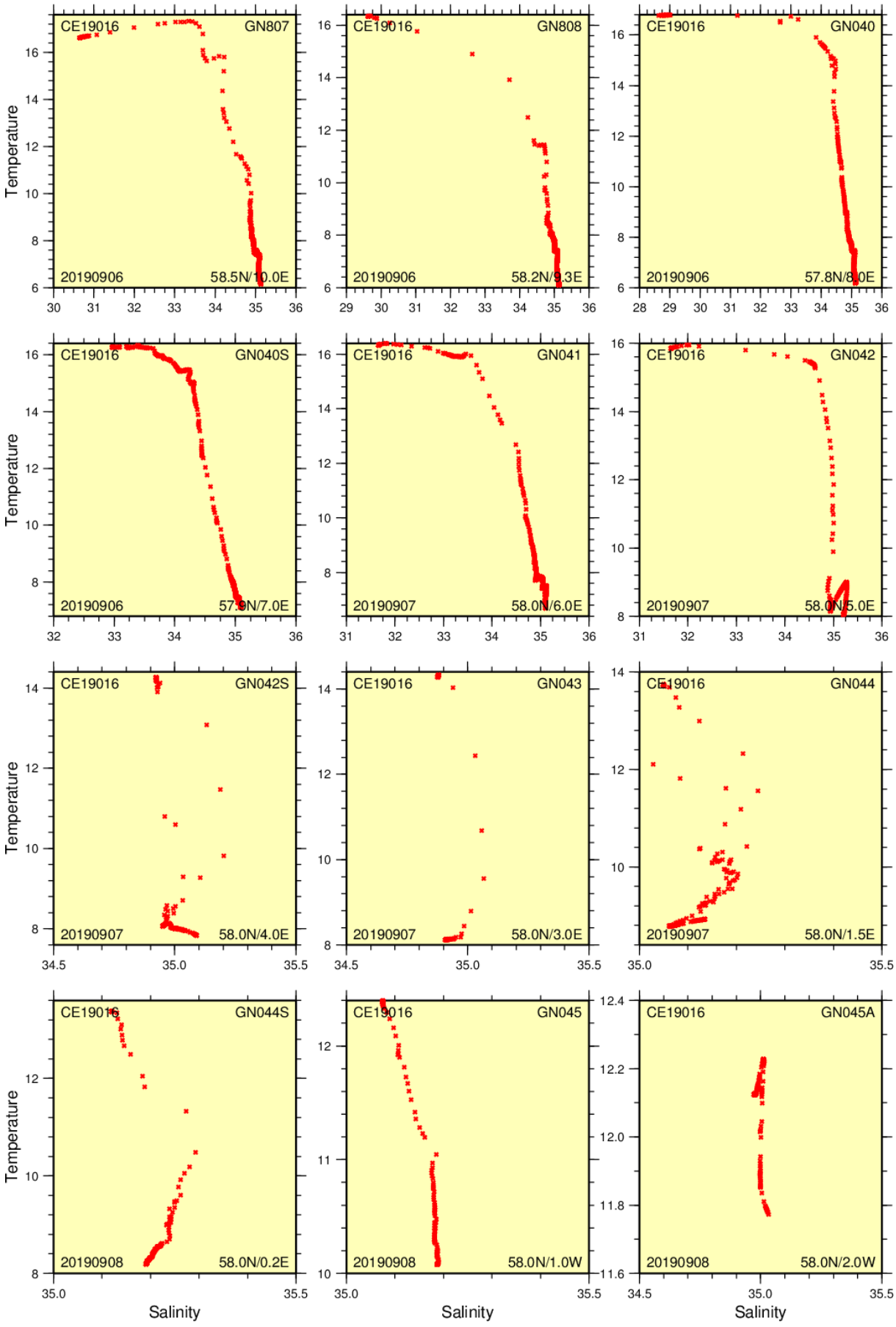


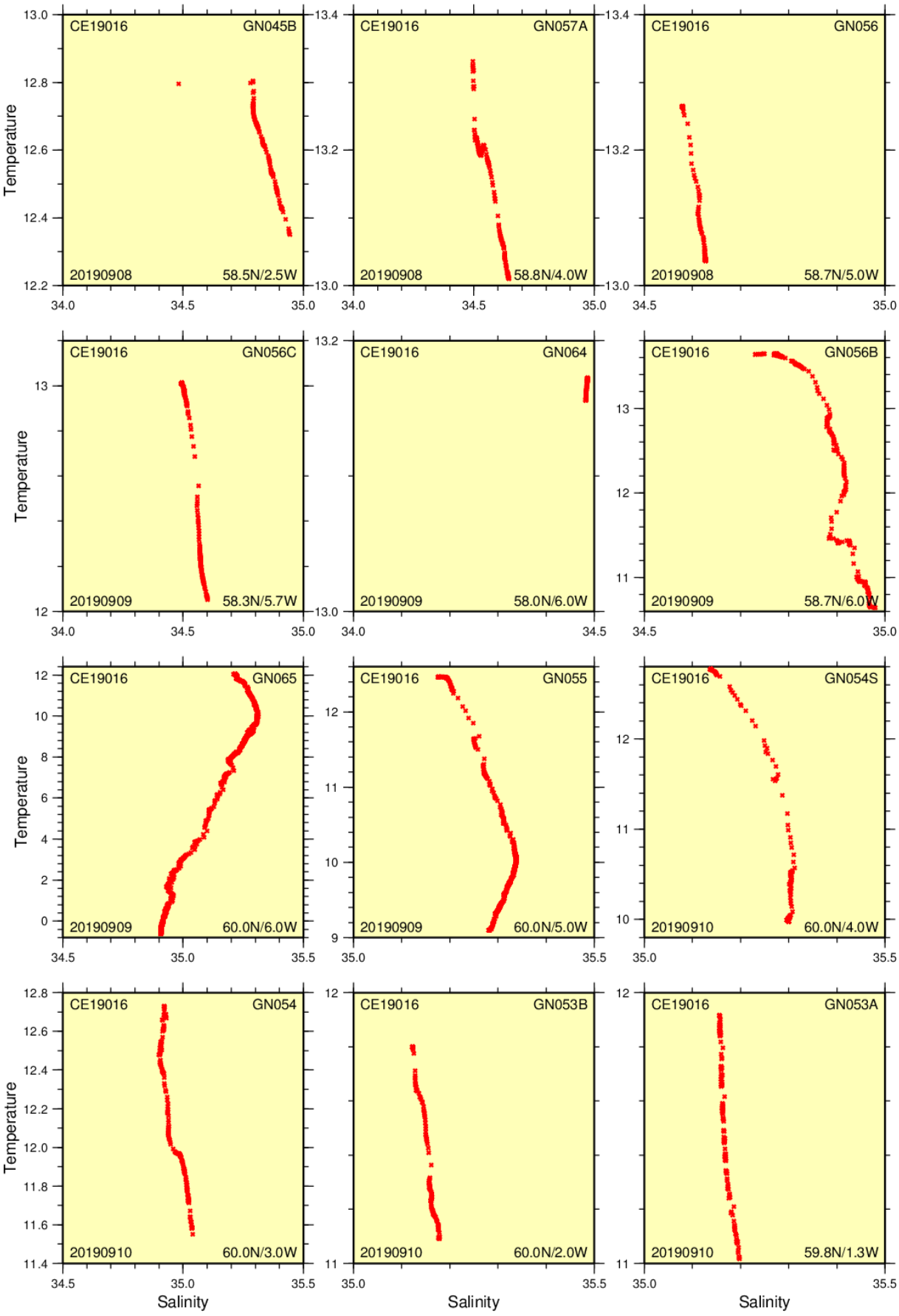

CE19016 GN014 20190829 52.0N/2.0E
CE19016 GN015 20190829 52.5N/2.5E
CE19016 GN015B 20190829 52.8N/2.2E
CE19016 GN016 20190829 53.3N/1.7E
CE19016 GN009S 20190830 54.0N/2.0E
CE19016 GN017 20190830 54.0N/1.0E
CE19016 GN017A 20190830 54.0N/0.3E
CE19016 GN017S 20190830 54.5N/0.2W
CE19016 GN018A 20190830 55.0N/0.7W
CE19016 GN018 20190830 55.0N/0.0W
CE19016 GN018S 20190830 55.0N/1.0E
CE19016 GN019 20190831 55.0N/2.0E
Temperature
Salinity

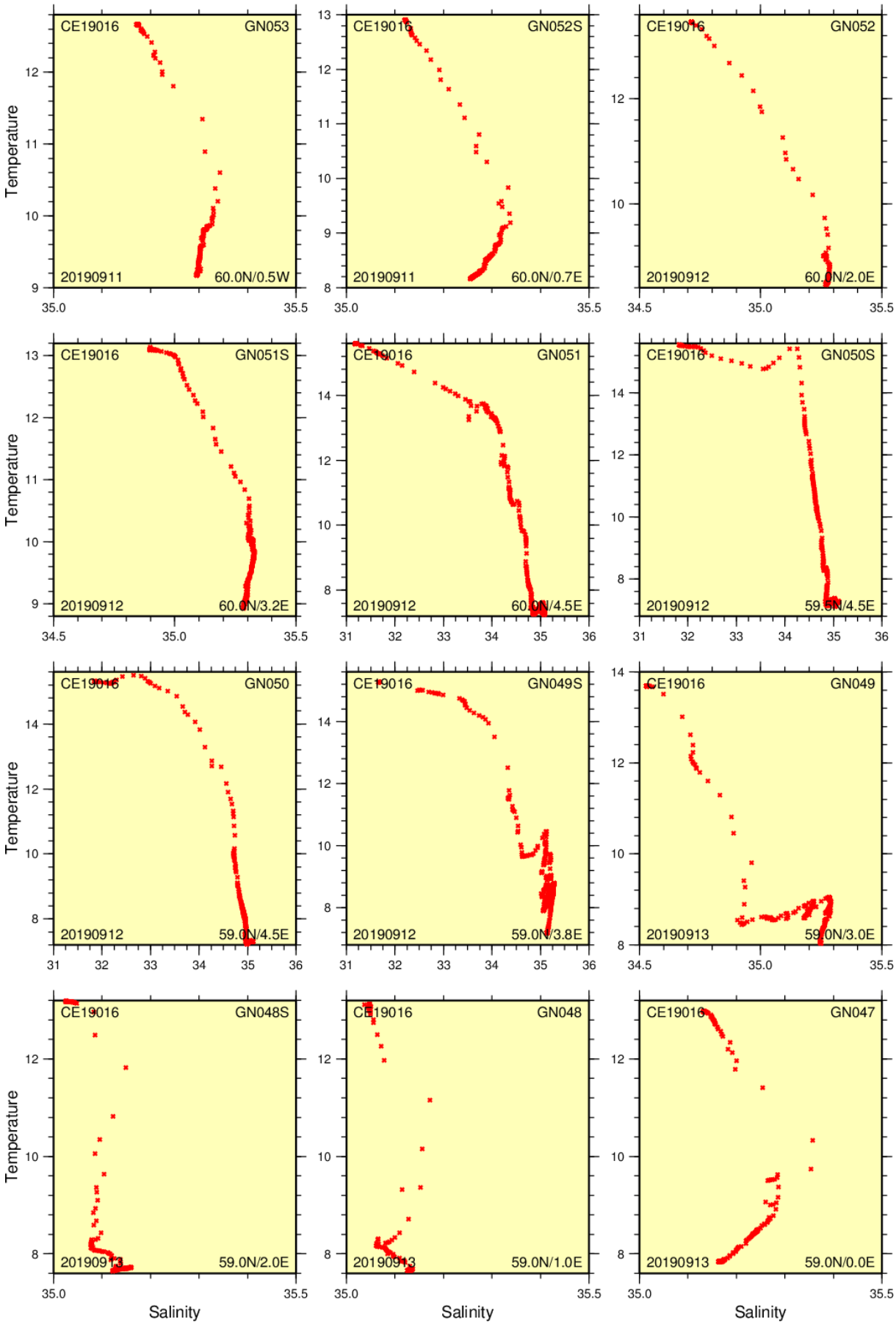

CE19016 GN019S
20190831 55.0N/3.0E
CE19016 GN020
20190831 55.0N/4.0E
CE19016 GN021
20190831 55.0N/5.0E
CE19016 GN022
20190831 55.0N/6.3E
CE19016 GN022A
20190831 55.0N/7.0E
CE19016 GN023
20190901 55.0N/7.6E
CE19016 GN024
20190901 55.0N/8.0E
CE19016 GN025
20190901 55.0N/8.2E
CE19016 GN026
20190901 56.0N/7.8E
CE19016 GN026A
20190901 56.0N/7.0E
CE19016 GN027
20190901 56.0N/6.0E
CE19016 GN028
20190902 56.0N/5.0E
Temperature
Salinity

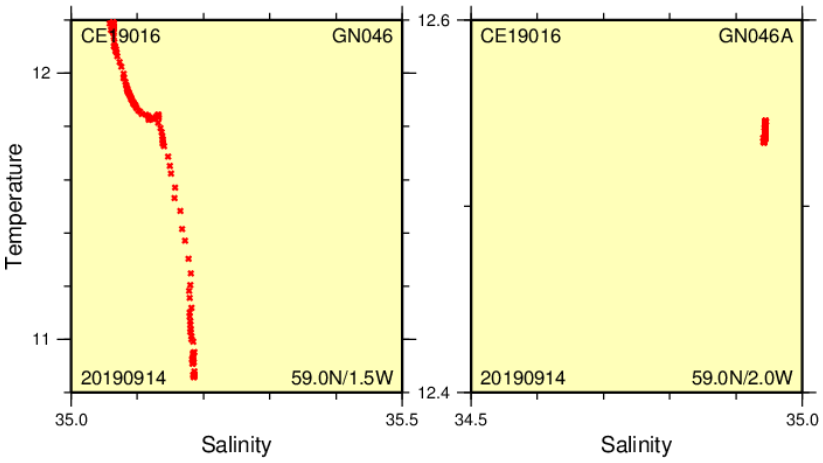

CE19016 GN028S
20190902 56.0N/4.0E
CE19016 GN029
20190902 56.0N/3.0E
CE19016 GN030
20190902 56.0N/2.0E
CE19016 GN031
20190902 56.0N/1.0E
CE19016 GN032
20190902 56.0N/0.0E
CE19016 GN033
20190903 56.0N/1.0W
CE19016 GN033A
20190903 56.0N/1.7W
CE19016 GN033S
20190903 56.5N/1.7W
CE19016 GN034A
20190903 57.0N/1.7W
CE19016 GN034
20190903 57.0N/1.0W
CE19016 GN034S
20190903 57.0N/0.2E
CE19016 GN035
20190903 57.0N/1.3E
Temperature
Salinity


CE19016 GN035S 20190904 57.0N/2.4E
CE19016 GN036 20190904 57.0N/3.5E
CE19016 GN037 20190904 57.0N/5.0E
CE19016 GN038 20190904 57.0N/6.0E
CE19016 GN038A 20190904 57.0N/7.0E
CE19016 GN039 20190904 57.0N/8.0E
CE19016 GN039S 20190904 57.4N/8.0E
CE19016 GN801 20190905 57.5N/9.0E
CE19016 GN802 20190905 58.0N/9.4E
CE19016 GN803 20190905 58.0N/10.5E
CE19016 GN804 20190905 57.8N/10.8E
CE19016 GN805 20190905 57.7N/11.4E
Temperature
Salinity


CE19016 GN807
20190906 58.5N/10.0E
CE19016 GN808
20190906 58.2N/9.3E
CE19016 GN040
20190906 57.8N/8.0E
CE19016 GN040S
20190906 57.9N/7.0E
CE19016 GN041
20190907 58.0N/6.0E
CE19016 GN042
20190907 58.0N/5.0E
CE19016 GN042S
20190907 58.0N/4.0E
CE19016 GN043
20190907 58.0N/3.0E
CE19016 GN044
20190907 58.0N/1.5E
CE19016 GN044S
20190908 58.0N/0.2E
CE19016 GN045
20190908 58.0N/1.0W
CE19016 GN045A
20190908 58.0N/2.0W
Temperature
Salinity


CE19016 GN045B
20190908 58.5N/2.5W
CE19016 GN057A
20190908 58.8N/4.0W
CE19016 GN056
20190908 58.7N/5.0W
CE19016 GN056C
20190909 58.3N/5.7W
CE19016 GN064
20190909 58.0N/6.0W
CE19016 GN056B
20190909 58.7N/6.0W
CE19016 GN065
20190909 60.0N/6.0W
CE19016 GN055
20190909 60.0N/5.0W
CE19016 GN054S
20190910 60.0N/4.0W
CE19016 GN054
20190910 60.0N/3.0W
CE19016 GN053B
20190910 60.0N/2.0W
CE19016 GN053A
20190910 59.8N/1.3W
Temperature
Salinity


CE19016 GN053
20190911 60.0N/0.5W
CE19016 GN052S
20190911 60.0N/0.7E
CE19016 GN052
20190912 60.0N/2.0E
CE19016 GN051S
20190912 60.0N/3.2E
CE19016 GN051
20190912 60.0N/4.5E
CE19016 GN050S
20190912 59.5N/4.5E
CE19016 GN050
20190912 59.0N/4.5E
CE19016 GN049S
20190912 59.0N/3.8E
CE19016 GN049
20190913 59.0N/3.0E
CE19016 GN048S
20190913 59.0N/2.0E
CE19016 GN048
20190913 59.0N/1.0E
CE19016 GN047
20190913 59.0N/0.0E
Temperature
Salinity


CE19016
GN046
20190914
59.0N/1.5W
Temperature
12
11
35.0
35.5
Salinity
CE19016
GN046A
20190914
59.0N/2.0W
12.6
12.4
34.5
35.0
Salinity

Appendix 5: Station List

Positions are taken at the beginning of station work!
Radioactivity: Cs = Caesium-137; Sr = Strontium-90; Tu = transuranic elements (Pu, Am, Cm); H3 = Tritium
Water depth corrected for draft (5 m)! bo = bottom

station name	latitude	longitude	water depth [m]	water sampling & CTD [m]	Secchi depth [m]	radio-activity	trace metals [m]	nutrients [m]	Bedford ID 195nnn	date [dd.mm.yy]	time [UTC]
STADE	53° 37.19‘ N	009° 32.70‘ E	17	—	—	Cs, Tu	10	—	001	27.08.19	07:55 – 08:09
MEDEM	53° 52.98‘ N	008° 43.04‘ E	14	—	—	Cs, Tu	10	—	002	27.08.19	11:49 – 12:03
GN003 ELBE1	54° 00.18‘ N	008° 06,42‘ E	23	bo, 10, 5	4.0	Cs, Tu	10	bo, 5	003-005	27.08.19	13:53 – 14:10
GN003A	54° 00.15‘ N	007° 10.35‘ E	30	bo, 10, 5	8.0	Cs, Tu	10	bo, 5	006-008	27.08.19	17:39 – 17:51
GN007	53° 55.70‘ N	006° 25.27‘ E	27	bo, 10, 2×5	—	Cs, Tu	10	bo, 5	009-011	27.08.19	20:54 – 21:10
GN007A	53° 59.98‘ N	005° 40.03‘ E	36	bo, 5	—	Cs, Sr, H3, Tu	—	—	012-013	27.08.19	23:43 – 23:59
GN008	54° 00.01‘ N	004° 49.62‘ E	43	bo, 10, 5	—	Cs	10	bo, 5	014-016	28.08.19	02:50 – 03:08
GN008S	53° 59.98‘ N	003° 55.14‘ E	46	bo, 5	—	—	—	bo, 5	017-018	28.08.19	06:53 – 07:02
GN009	54° 00.00‘ N	002° 59.93‘ E	41	bo, 10, 5	18.5	Cs, Sr, H3, Tu	10	bo, 5	019-021	28.08.19	10:17 – 10:45
GN009A	53° 25.20‘ N	003° 29.95‘ E	28	bo, 5	6.5	Cs	—	—	022-023	28.08.19	14:55 – 15:15
GN010	52° 59.87‘ N	003° 59.83‘ E	30	bo, 10, 5	10.0	Cs, Sr, H3, Tu	10	bo, 5	024-026	28.08.19	18:09 – 18:19
GN011	52° 30.99‘ N	004° 19.14‘ E	19	bo, 7x12	—	Cs	12	bo, 12	027-034	28.08.19	21:38 – 21:46
GN012	51° 59.93‘ N	003° 43.79‘ E	25	bo, 10, 5	—	Cs, Sr, H3, Tu	10	bo, 5	035-037	29.08.19	02:40 – 02:54
GN013	51° 41.91‘ N	002° 51.54‘ E	36	bo, 10, 5	10.0	Cs, Sr, H3, Tu	10	bo, 5	038-040	29.08.19	06:50 – 07:02
GN014	52° 00.14‘ N	001° 59.95‘ E	31	bo, 10, 5	3.5	Cs, Sr, H3, Tu		bo, 5	041-043	29.08.19	10:52 – 11:10
GN015	52° 29.96‘ N	002° 30.25‘ E	46	5	5.0	Cs	5	5	044-045	29.08.19	14:05 – 14:17
GN015B	52° 49.79‘ N	002° 10.07‘ E	40	bo, 5	2.5	Cs	—	—	046-047	29.08.19	16:31 – 16:43
GN016	53° 19.82’ N	001° 40.20‘ E	31	bo, 6×10, 5	—	Cs, Sr, H3, Tu	10	bo, 5	048-055	29.08.19	20:43 – 20:54
GN009S	53° 59.92‘ N	001° 59.96‘ E	71	bo, 5	—	—	—	—	056-057	30.08.19	02:26 – 02:42
GN017	53° 59.98‘ N	001° 00.06‘ E	47	bo, 10, 5	7.5	Cs		bo, 5	058-060	30.08.19	06:39 – 06:48
GN017A	54° 00.12‘ N	000° 19.63‘ E	52	bo, 5	10.5	Cs, Sr, H3, Tu	—	—	061-062	30.08.19	09:26 – 09:37
GN017S	54° 30.18‘ N	000° 10.09‘ W	61	bo, 5×10, 5	9.5	—		10	063-069	30.08.19	12:42 – 12:54
GN018A	54° 59.89‘ N	000° 40.31‘ W	68	bo, 5	>8.5	Cs	—	—	070-071	30.08.19	16:45 – 16:56
GN018	55° 00.01‘ N	000° 00.07‘ W	75	bo, 10, 5	—	Cs	10	bo, 5	072-074	30.08.19	19:12 – 19:29
GN018S	54° 59.95‘ N	000° 59.91‘ E	62	bo, 5	—	—	—	—	075-076	30.08.19	22:59 – 23:13
GN019	54° 59.91‘ N	002° 00.08‘ E	29	bo, 10, 5	—	Cs/Tu	10	bo, 5	077-079	31.08.19	02:43 – 02:56
GN019S	55° 00.00‘ N	003° 00.08‘ E	25	bo, 5	—	—	—	—	080-081	31.08.19	06:18 – 06:28
GN020	55° 00.07‘ N	004° 00.16‘ E	48	bo, 10, 5	14.0	Cs	10	bo, 5	082-084	31.08.19	09:44 – 10:05
GN021 AWZW2	54° 59.89‘ N	005° 00.16‘ E	41	bo, 10, 5	14.5	Cs		bo, 5	085-087	31.08.19	13:40 – 13:53

station name	latitude	longitude	water depth [m]	water sampling & CTD [m]	Secchi-depth [m]	radio-activity	trace metals [m]	nutrients [m]	Bedford ID 195nnn	date dd.mm.yy	time [UTC]
GN022	54° 59.96‘ N	006° 15.31‘ E	44	bo, 10, 5 2×500 l for nutrients	10.5	Cs	10	bo, 5	088-090	31.08.19	18:19 – 20:14
GN022A	55° 00.01‘ N	006° 59.85‘ E	32	bo, 10, 5	—	Cs	10	bo, 5	091-093	31.08.19	22:50 – 23:04
GN023	54° 59.90‘ N	007° 34.49‘ E	26	bo, 10, 5	—	Cs/Tu	5	bo, 5	094-096	01.09.19	01:01 – 01:09
GN024	55° 00.00‘ N	008° 00.02‘ E	18	bo, 10, 5	—	—	10	bo, 5	097-099	01.09.19	03:09 – 03:20
GN025	54° 59.95‘ N	008° 14.76‘ E	13	bo, 10, 5	3.5	Cs/Tu	10	bo, 5	100-102	01.09.19	04:49 – 05:01
GN026	56° 00.05‘ N	007° 48.01‘ E	29	bo, 10, 5	7.5	Cs, Sr, H3, Tu	10	bo, 5	103-105	01.09.19	13:05 – 13:16
GN026A	56° 00.00‘ N	006° 59.83‘ E	35	bo, 5	—	Cs, Sr, H3, Tu	—	—	106-107	01.09.19	16:33 – 16:42
GN027	56° 00.00‘ N	005° 59.99‘ E	49	bo, 10, 5	—	Cs	10	bo, 5	108-010	01.09.19	20:47 – 20:57
GN028	56° 00.01‘ N	005° 00.42‘ E	43	bo, 10, 5	—	Cs	10	bo, 5	111-113	02.09.19	01:01 – 01:13
GN028S	56° 00.01‘ N	003° 59.92‘ E	58	bo, 5	—	—	—	—	114-115	02.09.19	04:56 – 05:08
GN029	56° 00.00‘ N	002° 59.99‘ E	74	bo, 10, 5	25.5	Cs/Tu	10	bo, 5	116-118	02.09.19	08:40 – 08:54
GN030	56° 00.10‘ N	002° 00.16‘ E	86	bo, 10, 5	13.5	Cs	10	bo, 5	119-121	02.09.19	12:27 – 12:41
GN031	55° 59.95‘ N	001° 00.08‘ E	78	bo, 10, 5	9.0	Cs	10	bo, 5	122-124	02.09.19	16:33 – 16:46
GN032	56° 00.06‘ N	000° 00.05‘ E	84	bo, 10, 5	—	Cs	10	bo, 5	125-127	02.09.19	21:57 – 22:14
GN033	55° 59.95‘ N	001° 00.03‘ W	66	bo, 10, 5	—	Cs	10	bo, 5	128-130	03.09.19	02:18 – 02:36
GN033A	55° 59.99‘ N	001° 40.29‘ W	69	bo, 5	9.0	Cs, Sr, H3, Tu	—	—	131-132	03.09.19	05:03 – 05:17
GN033S	56° 30.02‘ N	001° 40.18‘ W	50	bo, 5	—	—	—	—	133	03.09.19	08:24 – 08:36
GN034A	57° 00.00‘ N	001° 40.08‘ W	23	bo, 5	—	Cs, Sr, H3, Tu	—	—	134-135	03.09.19	11:10 – 11:23
GN034	56° 59.91‘ N	000° 59.58‘ W	70	bo, 6×10, 5	10.5	Cs	10	bo, 10, 5	136-143	03.09.19	13:33 – 13:47
GN034S	56° 59.87‘ N	000° 10.15‘ E	86	bo, 5	—	—	—	bo, 5	144-145	03.09.19	17:34 – 17:47
GN035	56° 59.86‘ N	001° 20.20‘ E	99	bo, 10, 5	—	Cs	10	bo, 5	146-148	03.09.19	21:36 – 21:52
GN035S	57° 00.12‘ N	002° 25.05‘ E	81	bo, 5	—	—	—	bo, 5	149-150	04.09.19	01:18 – 01:33
GN036	56° 59.80‘ N	003° 29.95‘ E	65	bo, 10, 5	—	Cs, Sr, H3, Tu	10	bo, 5	151-153	04.09.19	05:02 – 05:16
GN037	57° 00.13‘ N	004° 59.83‘ E	58	bo, 10, 5	13.0	Cs		bo, 5	154-156	04.09.19	10:26 – 10:39
GN038	56° 59.89‘ N	006° 00.09‘ E	53	bo, 10, 5	11.0	Cs		bo, 5	157-159	04.09.19	13:48 – 13:58
GN038A	56° 59.92‘ N	006° 59.73‘ E	34	bo, 10, 5	12.0	Cs/Sr/H3/Tu	3×10	—	160-162	04.09.19	17:05 – 17:21
GN039	57° 00.02‘ N	008° 00.03‘ E	34	bo, 10, 5	—	Cs/Sr/H3/Tu	10	bo, 5	163-165	04.09.19	20:34 – 21:07
GN039S	57° 25.15‘ N	007° 59.92‘ E	91	bo, 5	—	—	—	—	166-167	04.09.19	23:34 – 23:47
GN801	57° 30.15‘ N	009° 00.04‘ E	29	bo, 10, 5	—	Cs, Sr, H3, Tu	10	—	168-170	05.09.19	02:56 – 03:23
GN802	57° 57.00‘ N	009° 25.24‘ E	217	bo, 10, 5	4.5	Cs, Sr, H3, Tu	10	—	171-173	05.09.19	06:16 – 06:52
GN803	57° 59.92‘ N	010° 29.83‘ E	125	bo, 10, 5	9.0	Cs, Sr, H3, Tu	10	—	174-176	05.09.19	10:31 – 11:15
GN804	57° 45.00‘ N	010° 46.11‘ E	23	bo, 10, 5	5.5	Cs, Sr, H3, Tu	10	—	177-179	05.09.19	13:00 – 13:23
GN805	57° 40.19‘ N	011° 25.14‘ E	88	bo, 10, 5	6.0	Cs, Sr, H3, Tu	10	—	180-182	05.09.19	15:23 – 15:51
GN807	58° 29.78‘ N	009° 59.81‘ E	536	bo, 10, 5	—	Cs, Sr, H3, Tu	10	—	183-185	05.09.19	23:59 – 00:47

station name	latitude	longitude	water depth [m]	water sampling & CTD [m]	Secchi-depth [m]	radio-activity	trace metals [m]	nutrients [m]	Bedford ID 195nnn	date dd.mm.yy	time [UTC]
GN808	58° 13.21‘ N	009° 19.84‘ E	680	bo, 8, 5. 270 l sampler: 39, 97, 262	—	Cs, Sr, H3, Tu	10	—	186-188	06.09.19	04:59 – 09:59
GN040	57° 49.86‘ N	008° 00.33‘ E	523	bo, 10, 5	7.0	Cs, Sr, H3, Tu	10	bo, 5	189-191	06.09.19	15:36 – 16:33
GN040S	57° 55.19‘ N	007° 00.09‘ E	350	bo, 5	—	—	—	bo, 5	192-193	06.09.19	20:46 – 21:11
GN041	57° 59.98‘ N	005° 59.67‘ E	310	bo, 10, 5	—	Cs, Sr, H3, Tu	10	bo, 5	194-196	06.09.19	00:39 – 01:16
GN042	58° 00.05‘ N	005° 00.05‘ E	128	bo, 10, 5	8.5	Cs	10	bo, 5	197-199	07.09.19	04:49 – 05:21
GN042S	58° 00.03‘ N	004° 00.20‘ E	99	bo, 5	—	—	—	bo, 5	200-201	07.09.19	09:53 – 10:30
GN043	57° 59.99‘ N	003° 00.09‘ E	77	bo, 10, 5	—	Cs	10	bo, 5	202-204	07.09.19	14:30 – 15:00
GN044	57° 59.98‘ N	001° 29.94‘ E	105	bo, 10, 5	—	Cs, Sr, H3, Tu	10	bo, 5	105-207	07.09.19	20:32 – 21:02
GN044S	58° 00.15‘ N	000° 14.42‘ E	138	bo, 5	—	—		bo, 5	208-209	08.09.19	01:14 – 01:28
GN045	57° 59.97‘ N	001° 00.02‘ W	115	bo, 10, 5	11.5	Cs, Sr, H3, Tu	10	bo, 5	210-212	08.09.19	05:25 – 05:55
GN045A	57° 59.96‘ N	001° 59.97‘ W	85	bo, 5	13.0	Cs, Sr, H3, Tu	—	—	213-214	08.09.19	08:54 – 09:07
GN045B	58° 29.98‘ N	002° 30.16‘ W	72	bo, 5	13.0	Cs, Sr, H3, Tu	—	—	215-216	08.09.19	12:00 – 12:11
GN057A	58° 45.05‘ N	003° 59.94‘ W	79	bo, 5	14.0	Cs	—	—	217-218	08.09.19	17:08 – 17:19
GN056	58° 44.97‘ N	004° 59.95‘ W	86	bo, 10, 5	—	Cs	10	bo, 5	219-221	08.09.19	20:39 – 21:21
GN056C	58° 19.94‘ N	005° 40.16‘ W	109	bo, 5	—	Cs/Tu	—	—	222-223	09.09.19	00:27 – 00:42
GN064	57° 59.96‘ N	006° 00.03‘ W	65	bo, 10, 5	—	Cs, Sr, H3, Tu	10	bo, 5	224-226	09.09.19	03:06 – 03:32
GN056B	58° 44.93‘ N	005° 59.99‘ W	119	bo, 5	—	Cs, Sr, H3, Tu	—	bo, 5	227-228	09.09.19	07:55 – 08:08
GN065	59° 59.96‘ N	005° 59.99‘ W	1064	bo, 1000, 900, 10, 5	12.0	Cs, Sr, H3, Tu	10	bo, 5	229-233	09.09.19	16:28 – 17:47
GN055	59° 59.99‘ N	004° 59.99‘ W	410	bo, 10, 5	—	Cs/Tu	10	bo, 5	234-236	09.09.19	20:44 – 21:33
GN054S	59° 59.99‘ N	003° 59.68‘ W	128	bo, 5	—	—	—	bo, 5	237-238	10.09.19	00:36 – 00:49
GN054	59° 59.89‘ N	003° 00.13‘ W	111	bo, 10, 5	—	Cs	10	bo, 5	239-241	10.09.19	04:12 – 04:43
GN053B	59° 59.91‘ N	002° 00.26‘ W	88	bo, 5	14.4	Cs	—	bo, 5	242-243	10.09.19	07:30 – 07:42
GN053A	59° 47.95‘ N	001° 19.71‘ W	86	bo, 5	13.0	Cs	—	bo, 5	244-245	10.09.19	09:59 – 10:10
GN053	60° 00.01‘ N	000° 30.17‘ W	127	bo, 10, 5	11.0	Cs, Sr, H3, Tu	10	bo, 5	246-248	11.09.19	16:32 – 16:59
GN052S	59° 59.93‘ N	000° 44.93‘ E	126	bo, 5	—	—	—	bo, 5	249-250	11.09.19	20:45 – 21:03
GN052	60° 00.15‘ N	001° 59.86‘ E	104	bo, 10, 5	—	Cs	10	bo, 5	251-253	12.09.19	00:55 – 01:23
GN051S	59° 59.93‘ N	003° 14.95‘ E	217	bo, 5	7.5	—	—	bo, 5	254-255	12.09.19	05:15 – 05:46
GN051	60° 00.04‘ N	004° 30.08‘ E	261	bo, 10, 5	8.0	Cs, Sr, H3, Tu	10	bo, 5	256-258	12.09.19	09:23 – 10:05
GN050S	59° 30.19‘ N	004° 29.88‘ E	266	bo, 5	10.5	—	—	bo, 5	259-260	12.09.19	13:41 – 13:58
GN050	59° 00.07‘ N	004° 30.05‘ E	259	bo, 10, 5	9.0	Cs, Sr, H3, Tu	10	bo, 5	261-263	12.09.19	17:38 – 18:24
GN049S	58° 59.99‘ N	003° 45.04‘ E	273	bo, 5	—	—	—	bo, 5	264-265	12.09.19	21:33 – 21:58
GN049	58° 59.98‘ N	003° 00.22‘ E	138	bo, 10, 5	—	Cs	10	bo, 5	266-268	13.09.19	01:46 – 02:22
GN048S	59° 00.00‘ N	002° 00.05‘ E	114	bo, 5	—	—	—	bo, 5	269-270	13.09.19	07:10 – 07:21
GN048	58° 59.93‘ N	001° 00.22‘ E	125	bo, 10, 5	9.5	Cs, Sr, H3, Tu	10	bo, 5	271-273	13.09.19	13:20 – 13:49
GN047	59° 00.01‘ N	000° 00.04‘ E	130	bo, 10, 5	—	Cs	10	bo, 5	274-276	13.09.19	18:50 – 19:20

station name	latitude	longitude	water depth [m]	water sampling & CTD [m]	Secchi-depth [m]	radio-activity	trace metals [m]	nutrients [m]	Bedford ID 195nnn	date dd.mm.yy	time [UTC]
GN046	58° 59.95‘ N	001° 30.11‘ W	107	bo, 10, 5	—	Cs	10	bo, 5	277-279	14.09.19	00:57 – 01:23
GN046A	59° 00.02‘ N	001° 59.89‘ W	78	bo, 5	—	Cs, Sr, H3, Tu	—	—	280-281	14.09.18	03:04 – 03:19