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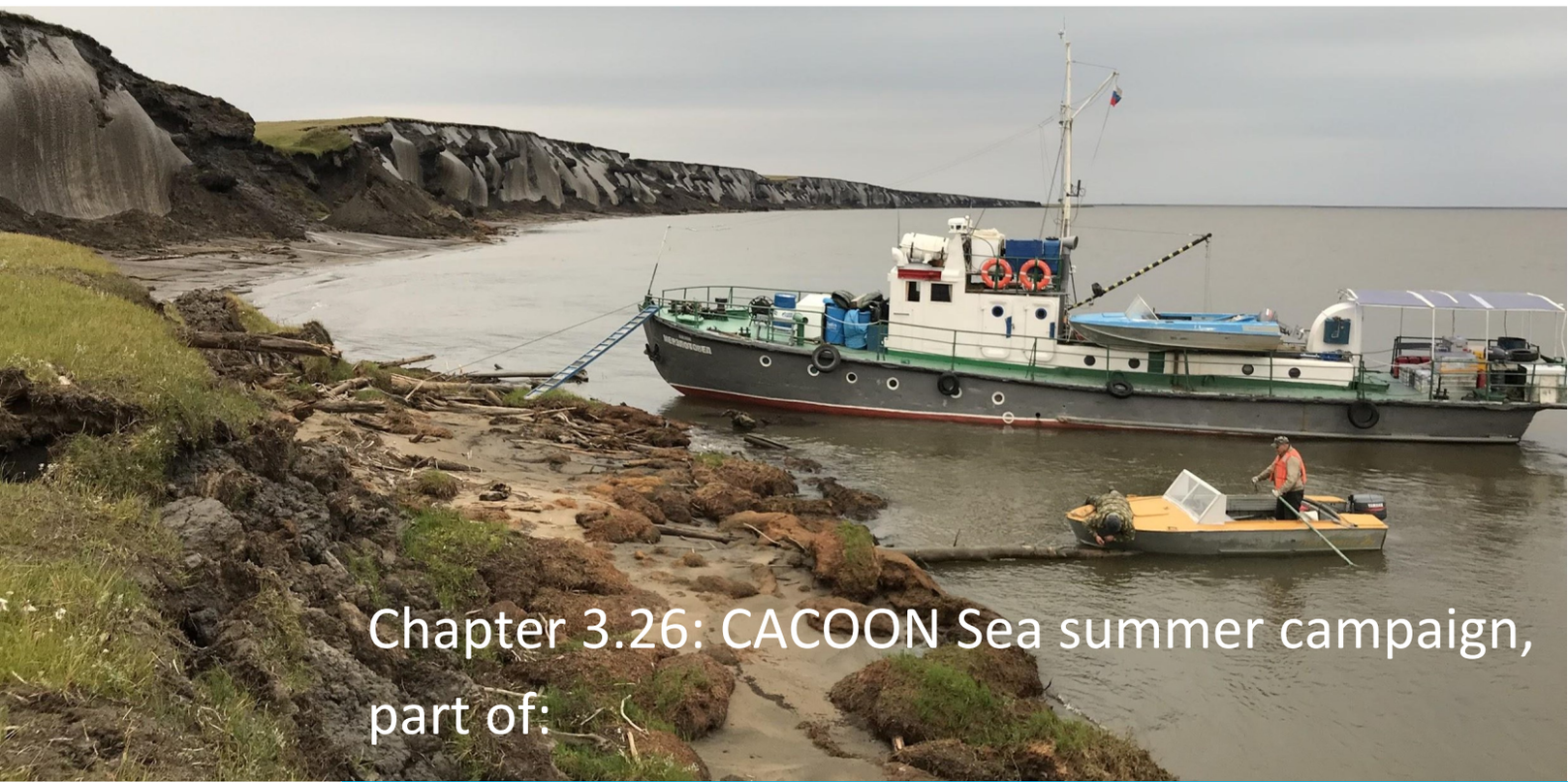

Chapter 3.26: CACOON Sea summer campaign, part of:

749
2021

Berichte
zur Polar- und Meeresforschung

Reports on Polar and Marine Research

Russian-German Cooperation: Expeditions to Siberia in 2019

Edited by
Matthias Fuchs, Dmitry Bolshiyanov, Mikhail Grigoriev, Anne Morgenstern, Luidmila Pestryakova, Leonid Tsibizov, and Antonia Dill

with contributions of the participants

HELMHOLTZ GEMEINSCHAFT

3.26 CACOON Sea - water sampling along the Sardakhskaya channel and near shore of the Laptev Sea

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[5] Free-lance artist and photographer, Munich, Germany

Fieldwork period and location
From July 28th to August 23th, 2019 (on Samoylov Island, Sardakhskaya channel and near-shore Laptev Sea).

Funding
This project was kindly funded by a joint BMBF-NERC's program "Changing Arctic Ocean" (CACOON-project, NERC grant no. NE/R012806/1, BMBF grant no. 03F0806A, EISPAC-project BMBF grant no. 03F0809A).

Contribution to public outreach
The artist and photographer Olaf Otto Becker will publish a photobook on this expedition. The publishing date is expected to be end of 2020. Moreover, he will contribute pictures and write articles for non-scientific journals with stories from this expedition. Expedition participant Dr. Tina Sanders wrote a blog (in German) on this expedition (https://blogs.helmholtz.de/kuestenforschung/2019/08/20/rueckkehr-ins-lena-delta-nach-mehr-als-10-jahren/).

Campaigns
This expedition contained three parts. The first part was a sea cruise (Figure 3.26.1) on the Laptev Sea with the vessel *Anatoliy Zhilinskiy*, the second part was a river cruise on the Sardakhskaya channel with the ship *Merzlotoved* and the third part included intensive laboratory work on Samoylov Research Station.
Our weekly reports (in German only) are available here:

1. https://www.awi.de/fileadmin/user_upload/AWI/Forschung/Geowissenschaft/Periglazialforschung/Bilder_Peri/Stationen/Wochenberichte_Samoylov/Wochenbericht-1_CACOONsea.pdf
2. https://www.awi.de/fileadmin/user_upload/AWI/Forschung/Geowissenschaft/Periglazialforschung/Bilder_Peri/Stationen/Wochenberichte_Samoylov/CACOON_weekly_report_2_de.pdf
3. https://www.awi.de/fileadmin/user_upload/AWI/Forschung/Geowissenschaft/Periglazialforschung/Bilder_Peri/Stationen/Wochenberichte_Samoylov/Wochenbericht_3_CACOON.pdf

4. https://www.awi.de/fileadmin/user_upload/AWI/Forschung/Geowissenschaft/Periglazialforschung/Bilder_Peri/Stationen/Wochenberichte_Samoylov/Wochenbericht_4_CACOON.pdf

CACOON SEA part 1: Laptev Sea transect
Time Period: 02.08.2019 - 04.08.2019
Region: Laptev Sea 20-80 km East of Lena delta (Sardakhskaya channel) (Figure 3.26.1)
Vessel: *Anatoliy Zhilinskiy* (Figure 3.26.2)

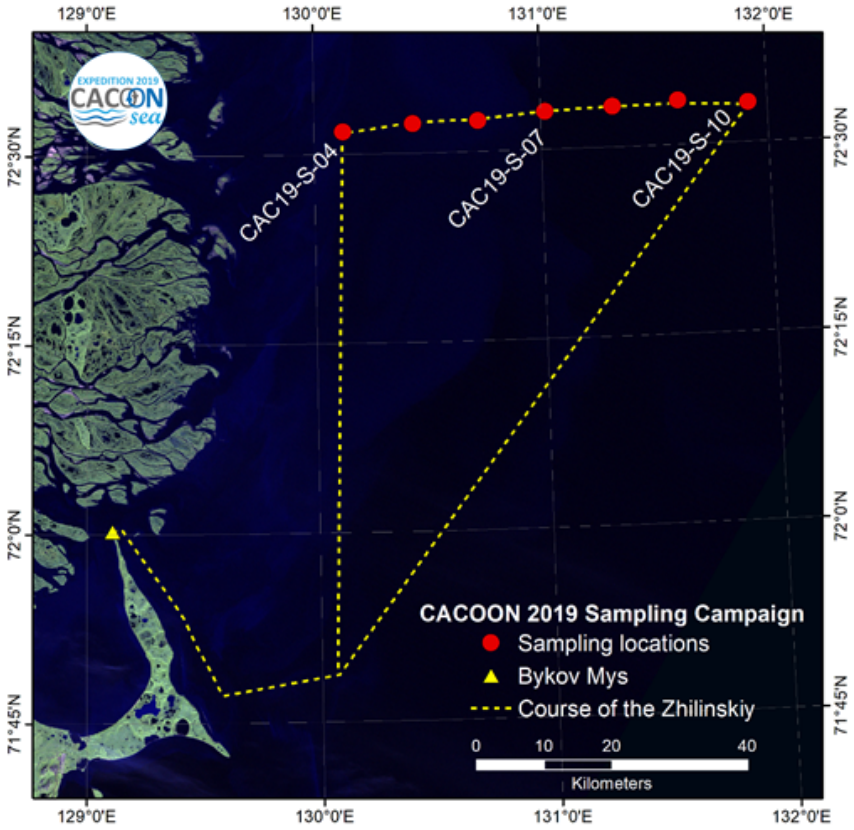

Figure 3.26.1: *Route of the CACOON Sea expedition on the ship Anatoliy Zhilinskiy*

Aim
The aim of the expedition was to investigate the transition from fresh water to salt water and its impact on fate and quality on dissolved and particulate organic and inorganic carbon and nitrogen. This is in accordance with the main Changing Arctic Carbon cycle in the cOastal Ocean Near-shore (CACOON, https://www.changing-arctic-ocean.ac.uk/project/cacoon/) project goal to investigate the changing freshwater export and impact of terrestrial permafrost thaw into the near-shore zone of the Laptev Sea.

Figure 3.26.2: *Left: The expedition team: Matthias Fuchs, Vyacheslav (Slava) Polyakov, Tina Sanders, Olga Ogneva, Waldemar Schneider. Right: The vessel "Anatoliy Zhilinskiy"*

Methods

Water samples were collected from three different depths (top, middle, bottom) with a UWITEC water sampler. Water was filled in 20 L canisters and kept cool for the return transport and processing on Samoylov Island. Water samples for nutrient analysis including dissolved organic and inorganic nitrogen were done immediately onboard with a syringe filter system (0.45 μm). In addition, sediment samples were retrieved with a gravity corer where possible; else a sediment grab was used to get the top 5 cm of the sea floor sediments. Prior to sampling, conductivity, temperature and depth of the water were measured.

Water samples will be filtered in the laboratory and later analyzed for dissolved inorganic carbon, dissolved organic carbon, particulate organic carbon, δ^{13}C, Δ^{14}C, biomarkers, cDOM, anions, cations, water isotopes, pH and conductivity/salinity, dissolved inorganic nitrogen, dissolved organic nitrogen, total nitrogen and δ^{15}N.

On two locations (CAC19-S-05 and CAC19-S-10) water samples for microplastic analysis were collected with a steal container and a hemp rope. In addition, sediment samples from the top 5 cm were collected with the sediment grab. These samples will be processes and analyzed by M. Bergmann (not in field) at AWI Bremerhaven.

Route

We left Bykov Mys (Figure 3.26.1) on August 2nd, 2019, 06:00 pm and shipped south along Bykovsky Peninsula following the shipping channel. At the southern tip of Bykovsky Peninsula we turned east until we reached the 12 mile zone border. From there we traveled northeast, heading directly to CAC19-S-10 (for coordinates see below in Table 3.26-1). We reached CAC19-S-10 on August 3rd, 2019, 06:30 am and started sampling immediately. We worked and sampled our way West along the planned transect with a 10 km distance between sample locations until we reached CAC19-S-04. CAC19-S-04 was the last sampling location since location CAC19-S-03 was too shallow to reach with the *Anatoliy Zhilinskiy*. The return travel was South, until we reached the 12 mile zone, then heading west to the southern tip of Bykovsky Peninsula from where we turned North until we reached Bykov Mys again, which was our final destination with the *Anatoliy Zhilinskiy* reached on August 4th, 2019, 11:30 am.

On the return travel from Bykovsky Mys to Samoylov Island, water samples were collected on nine different sites along the Bykovskaya channel (Figure 3.26.3, Table 3.26-2) from board of the vessel *Merzlotoved*.

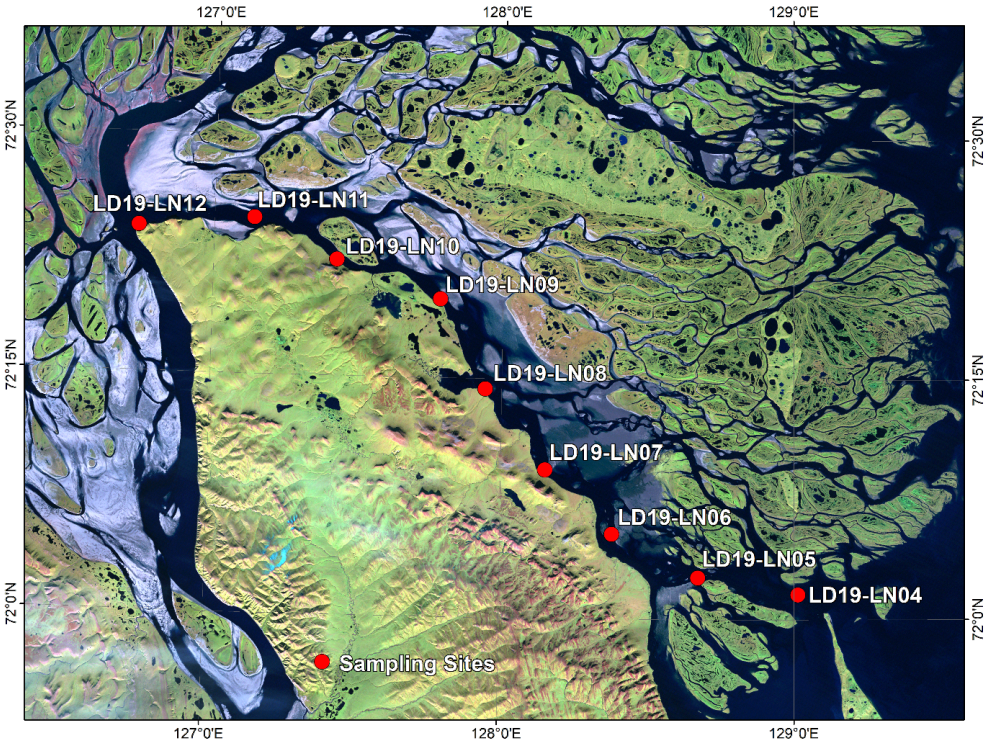

Figure 3.26.3: *Return route from Bykov Mys to Samoylov Island with sampling locations*

Sampling locations:

Table 3.26-1: Sampling locations on the Laptev Sea transect

Name	Latitude	Longitude	Date	Water depth	Samples collected
CAC19-S-04	N 72.53014°	E 130.12631°	03.08.2019	6.9	Water (from two depths only) and sediment with grab
CAC19-S-05	N 72.53928°	E 130.43433°	03.08.2019	13.0	Water and sediment core + samples for microplastic analysis
CAC19-S-06	N 72.54128°	E 130.72461°	03.08.2019	16.7	Water and sediment core
CAC19-S-07	N 72.55056°	E 131.01814°	03.08.2019	19.4	Water and sediment core
CAC19-S-08	N 72.55447°	E 131.31572°	03.08.2019	20.8	Water and sediment core
CAC19-S-09	N 72.55900°	E 131.91447°	03.08.2019	21.8	Water and sediment core
CAC19-S-10	N 72.55294°	E 131.91447°	03.08.2019	21.6	Water and sediment core + samples for microplastic analysis

Table 3.26-2: Sampling locations in the Bykovskaya Channel

Name	Latitude	Longitude	Date	Water Temp. [°C]	Samples collected
LD19-LN4	N 72.02644°	E 129.01319°	04.08.2019	14.6	Water samples by bucket
LD19-LN5	N 72.04394°	E 128.67339°	04.08.2019	14.5	Water samples by bucket
LD19-LN6	N 72.08897°	E 128.38069°	04.08.2019	14.5	Water samples by bucket
LD19-LN7	N 72.15556°	E 128.15086°	04.08.2019	14.6	Water samples by bucket
LD19-LN8	N 72.23922°	E 127.94347°	04.08.2019	14.4	Water samples by bucket
LD19-LN9	N 72.33236°	E 127.78397°	04.08.2019	14.6	Water samples by bucket
LD19-LN10	N 72.37144°	E 127.42497°	04.08.2019	14.6	Water samples by bucket
LD19-LN11	N 72.41331°	E 127.13744°	04.08.2019	14.7	Water samples by bucket
LD19-LN12	N 72.40217°	E 126.73853°	04.08.2019	14.6	Water samples by bucket

Preliminary results

During the *Zhilinskiy* cruise we collected 40-60 L of water for each sampling location (ca. 400 L in total). Sediment cores could be obtained for CAC19-S-05 to CAC19-S-10 with the gravity corer. However, all cores are shorter than 20 cm. For CAC19-S-04 sediments could only be obtained with the sediment grab. Microplastic samples (water + sediment from the top 5 cm) were collected from CAC19-S-05 and CAC19-S-10. First results of pH and conductivity measurements of the water samples show that there is a fresh water inflow from the Sardakhskaya channel into the Laptev Sea indicated by lower conductivity values for the top layer water samples for all seven sample locations (Figure 3.26.4 and Table A.2.15).

During the *Merzlozoved* passage to Samoylov Island (Figure 3.26.2), samples for measurement of dissolved organic nitrogen (DON) and dissolved inorganic nitrogen (DIN) e.g. ammonium (NH_4), nitrite (NO_2) and nitrate (NO_3), as well as for dual stable isotopes of nitrate (δ^{15}N and δ^{18}O) were collected. The samples were taken by a bucket, temperatures were measured and the samples were filtered and stored frozen (Table 3.26-2).

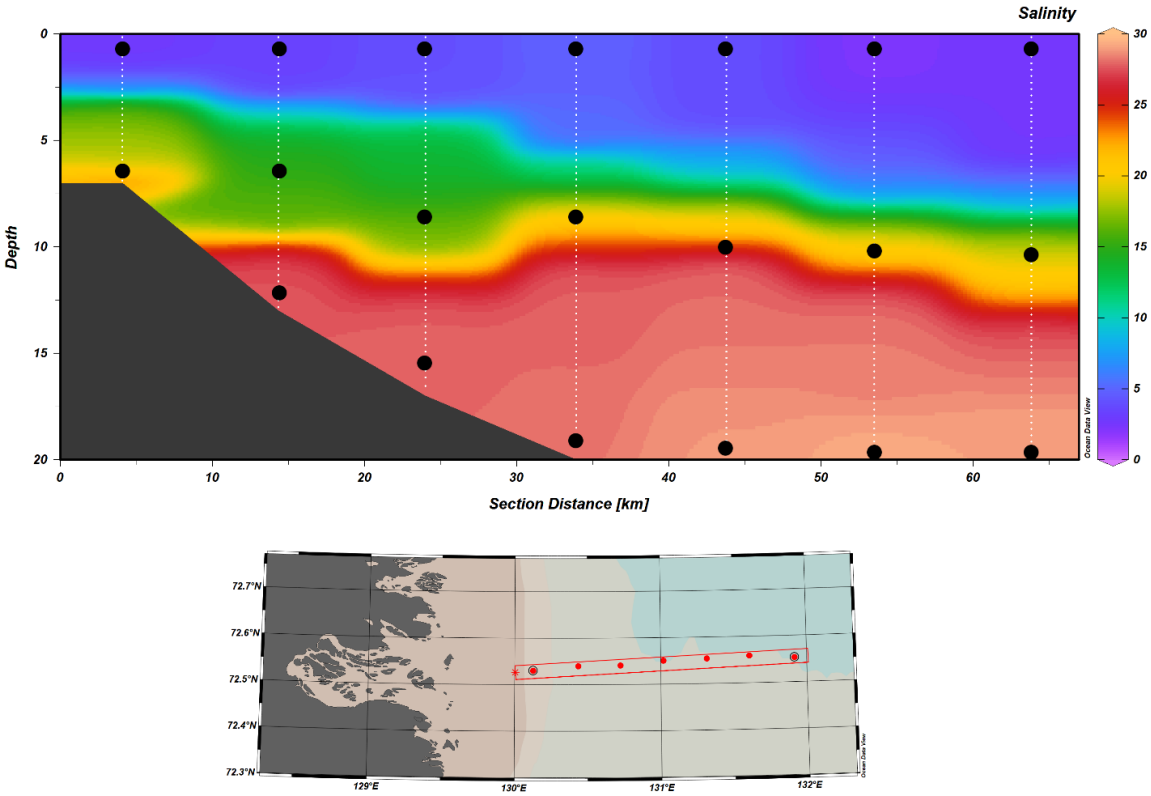

Figure 3.26.4: *Salinity profile along the transect from CAC19-S-04 (on the left side) to CAC19-S-10 (on the right side). Black dots indicate depths at which water samples have been collected.*

CACOON SEA part 2: Sardakhskaya channel transect
Time Period: 07.08.2019 - 09.08.2019
Region: Sardakhskaya channel from Stolb Island to the Lena River outlet (Figure 3.26.5)
Vessel: *Merzlotoved* (Figure 3.26.6)

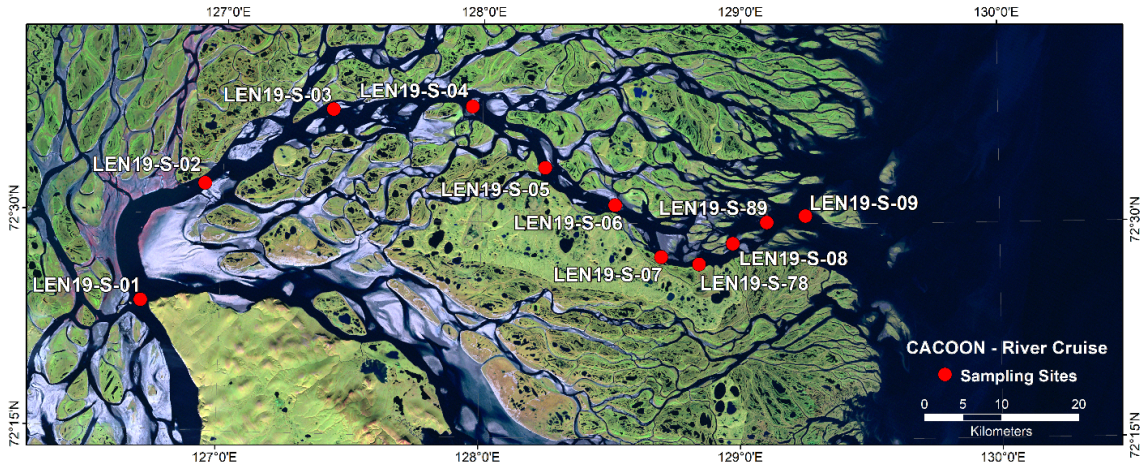

Figure 3.26.5: *CACOON sample locations on the Sardakhskaya channel in the Lena River Delta*

Aim

Degrading permafrost releases organic carbon and nitrogen to the Lena River and likely transports it to the Arctic Ocean. The CACOON project aim of the Sardakhskaya transect was to investigate the quality and quantity of particulate and dissolved organic carbon and nitrogen during this transport. Also, sample locations from the CACOON Ice expedition (see chapter 2.1) in spring 2019 were resampled to analyze the seasonality in particulate and dissolved organic carbon on its transport to the Laptev Sea.

Methods

The methods were the same like on the CACOON Sea Part 1 expedition. The only exception was that samples were taken from one to three different water depths depending on the depth of the water (Table 3.26-3). Sediment cores could not be retrieved in the Sardakhskaya channel, however sediment samples from each location were collected with the sediment grab. Again, samples were collected for hydrogeochemical, biogeochemical as well as microplastic analyses. Conductivity, depth and temperature (CTD) profiles were measured at each location with a handheld Sontek^{TM}CastAway conductivity, temperature, and depth sensor.

Route

The CACOON Crew started with the ship *Merzlotoved* (Figure 3.26.6) on August 7th, 2019 from Samoylov Island. During the first day, the cruise went all the way to Sobo-Sise Island and stopped for the night at Sobo-Sise Cliff (Figure 3.26.6). During the following day, the cruise continued and the CACOON team sampled sites on the way back from LEN19-S-09 to LEN19-S-06. For the night, the ship returned to Sobo-Sise Cliff. On the final day the ship traveled back to Samoylov Island sampling the sites LEN19-S-05 to LEN19-S-01. The distance between the sample locations varies. From LEN19-S-01 to LEN19-S-04 the distance is 20 km. Then a shorter distance was chosen (10 km) to sample multiple sample locations from the CACOON Ice expedition. This is also the reason that two additional sites (LEN19-S-78 and LEN19-S-89) were added in 5 km intervals.

Figure 3.26.6: *Left: The expedition team: Otto Olaf Becker, Vanja, Waldemar Schneider, Olga Ogneva, Tina Sanders and Matthias Fuchs, right: The vessel Merzlotoved in front of the Sobo-Sise-Cliff*

Sampling locations:

Table 3.26-3: Sampling locations on Sardakhskaya transect

Name	Latitude	Longitude	Date	Water depth	Samples collected
LEN19-S-01	N 72.39936°	E 126.69558°	09.08.2019	18.7	Water, sediments and microplastic samples
LEN19-S-02	N 72.53733°	E 126.92917°	09.08.2019	16.7	Water and sediment samples
LEN19-S-03	N 72.62711°	E 127.41936°	09.08.2019	5.6	Water, sediment and microplastic (only sediment) samples
LEN19-S-04	N 72.63353°	E 127.95914°	09.08.2019	2.7	Water and sediment samples
LEN19-S-05	N 72.56378°	E 128.24464°	09.08.2019	4.6	Water, sediment and microplastic (only sediment) samples
LEN19-S-06	N 72.52108°	E 128.51558°	08.08.2019	7.7	Water, sediment and microplastic (only sediment) samples
LEN19-S-07	N 72.46139°	E 128.69514°	08.08.2019	17.9	Water and sediment samples
LEN19-S-78	N 72.45311°	E 128.84103°	08.08.2019	9.3	Water and sediment samples
LEN19-S-08	N 72.47706°	E 128.97078°	08.08.2019	7.4	Water and sediment samples
LEN19-S-89	N 72.50167°	E 129.10172°	08.08.2019	12.9	Water samples
LEN19-S-09	N 72.50897°	E 129.25897°	08.08.2019	10.2	Water and sediment samples

Preliminary results

During the Sardakhskaya channel cruise, we sampled water and sediment at eleven different sites and collected ca. 460 liters of water. Sediment samples could be obtained with the sediment grab from all locations except LEN19-S-89. In general, the sediment was predominately sandy. First results of pH and conductivity measurements of the water samples show that there are only small variations in pH and conductivity throughout the entire Sardakhskaya channel (Table A.2.15).

CACOON SEA part 3: Samoylov Research Station - summary
Time Period: 10.08.2019 - 28.08.2019
Region: Samoylov Research Station

Aim
The aim of this third and last part of the CACOON Sea expedition was to subsample the collected water samples for the different planned analyzes and to prepare the samples for the transport.

Methods
The water samples were subsampled in different ways depending on the planned analyses (Table A.2.14). Water samples were filtered at Samoylov Research Station laboratory. The DOC and cDOM samples were filtered with a GF/F 0.71 μm filter, whereas the anions and cations samples were filtered with a 0.45 μm pore size filter. In addition, larger GF/F filters with a 25 mm diameter for POC analysis were stored frozen in pre-combusted glass petri dishes and GF/F filteres with a 114 mm diameter for biomarker analyzes were stored in pre-combusted aluminum envelope. The latter were frozen for safe transportation. For preservation, DOC samples were acidified with HCl and cations samples were acidified with HNO_3. In addition, 0.5 l of water was filtered through Sterivex filter units for aquatic microbial analysis.
For the DIN, DON and nitrate stable isotope analysis, water samples were filtered onboard and stored at -18°C. For element analysis of the suspended matter (SPM) water samples were filtered through pre-combusted GF/F filters (4 hrs, 450°C). Filter samples were dried at 50°C and stored frozen. The filters will be used for total nitrogen and organic carbon analysis as well as δ^{15}N of SPM. All sediments as well as all the microplastic samples were stored and transported frozen.

Preliminary results
In total, the CACOON Sea expedition collected nearly ca. 30 kg of sediment and 900 liters of water, which were later (on Samoylov Research Station) subsampled into ca. 1350 different sub-samples (Table A.2.14). In combination with the CACOON Ice expedition (see chapter 2.1) a transect of 200 km beginning from Stolb Island passing trough the entire Sardakhskaya channel and as far as 80 km into the Laptev Sea could be sampled. This allows us to analyze the transformation of organic carbon from degrading permafrost on its way to the Arctic Ocean.

Acknowledgements
We thank the captain and crew of the *Anatoliy Zhilinskiy* and the *Merzlotoved* for hosting us, as well as the staff and crew of Samoylov Research Station for logistic support during the laboratory analyses. We thank the AARI St. Petersburg (D. Bolshiyanov) for help with organization, Volkmar Aßmann for logistic support and the NERC and BMBF for funding our project.

Table A.1.4: List of participants in CACOON summer expedition

No.	Name	Institution	Duration
1	Becker, Olaf	photographer	07.08.19-09.08.19
2	Fuchs, Matthias	AWI P	01.08.19-04.08.19 and 07.08.19-09.08.19
3	Ogneva, Olga	AWI P	01.08.19-04.08.19 and 07.08.19-09.08.19
4	Polyakov, Vyacheslav	AARI	01.08.19-04.08.19
5	Sanders, Tina	HZG	01.08.19-04.08.19 and 07.08.19-09.08.19
6	Schneider, Waldemar	AWI P	01.08.19-04.08.19 and 07.08.19-09.08.19

Tables from 3.26.

Table A.2.14: Summary of the collected samples on the CACOON Sea Expedition 2019

Analysis	Sample type	Container	n Samples	Scientist
Anions	Water	plastic bottle (HDPE 8 ml)	43	Matthias Fuchs
Biomarker I	Sediment	Glass jar	9	Olga Ogneva
Biomarker II	Sediment	Petridishes glass 3x	6	Olga Ogneva
Biomarker III	Filter	142 mm GFF filter	43	Olga Ogneva
C/N; N-isotopes I	Filter	Filter box	42	Tina Sanders
C/N; N-isotopes II	Sediment	Plastic box / zip lock bag	15	Tina Sanders
Cations	Water	Plastic tube (15 ml)	43	Matthias Fuchs
cDOM	Water	Brown glass bottle (80 ml)	43	Matthias Fuchs
DIC I	Water	335 ml brown glassbottle	43	Olga Ogneva
DIC II	Water	4 ml brown glass vial	63	Olga Ogneva
DNA/RNA	Filter	Sterivex filter	23	Matthias Fuchs
DOC I	Water	500 ml HDPE bottles	20	Olga Ogneva
DOC II	Water	60 ml HDPE vials	262	Olga Ogneva
DOC III	Water	30 ml glass bottle	43	Matthias Fuchs
DON	Water	Falcon tube	51	Tina Sanders
Elemental analysis	Sediment	plastic tube / zip lock bag	26	Matthias Fuchs
Granulometry/ Microplastic	Sediment	zip loc bag	3	Matthias Fuchs
Isotopes	Water	30 ml glass bottle	43	Matthias Fuchs
Microplastic I	Sediment	Aluminium box	10	Matthias Fuchs
Microplastic II	Water	Milk canister	8	Matthias Fuchs
N-Isotopes	Water	Falcon tube	51	Tina Sanders
Nutrients	Water	Falcon tube	51	Tina Sanders
pH/conductivity	Water	30 ml PE plastic bottle	50	Matthias Fuchs
POC	Filter	filters in petri dishes, 25 mm	268	Olga Ogneva

Total N	Water	Falcon tube	51	Tina Sanders
Backup	Water	30 ml PE plastic bottle	43	Matthias Fuchs
AARI St. Petersburg	Sediment core	plastic tube	6	Slava Polyakov

Table A.2.15: pH, salinity and conductivity measurements on the CACOON Sea expedition

Site	Sample name	Sample type	pH	Salinity	conductivity [mS/cm]
CAC19-S-04	CAC19-S-04-1m	Water sample	7.68	2.9	5.62
CAC19-S-04	CAC19-S-04-6m	Water sample	7.51	19.6	31.8
CAC19-S-05	CAC19-S-05-12m	Water sample	7.42	25	39.9
CAC19-S-05	CAC19-S-05-1m	Water sample	7.7	3.4	6.4
CAC19-S-05	CAC19-S-05-6m	Water sample	7.68	15.2	25.2
CAC19-S-06	CAC19-S-06-15m	Water sample	7.41	24.3	38.6
CAC19-S-06	CAC19-S-06-1m	Water sample	7.72	4.2	7.6
CAC19-S-06	CAC19-S-06-8m	Water sample	7.62	10.9	18.38
CAC19-S-07	CAC19-S-07-18m	Water sample	7.34	29.2	45.4
CAC19-S-07	CAC19-S-07-1m	Water sample	7.74	4.9	8.85
CAC19-S-07	CAC19-S-07-8m	Water sample	7.63	9.2	15.67
CAC19-S-08	CAC19-S-08-0m	Water sample	7.7	4.2	7.51
CAC19-S-08	CAC19-S-08-10m	Water sample	7.48	14.4	23.9
CAC19-S-08	CAC19-S-08-19m	Water sample	7.4	29.7	44.8
CAC19-S-09	CAC19-S-09-0m	Water sample	7.77	2.3	4.5
CAC19-S-09	CAC19-S-09-10m	Water sample	7.55	8	13.76
CAC19-S-09	CAC19-S-09-20m	Water sample	7.43	30	46.5
CAC19-S-10	CAC19-S-10-10m	Water sample	7.52	11.2	18.82
CAC19-S-10	CAC19-S-10-1m	Water sample	7.6	2.7	5.1
CAC19-S-10	CAC19-S-10-20m	Water sample	7.4	29.7	45.9
LEN19-S-01	LEN19-S-01-18m	Water sample	7.88	0	0.172
LEN19-S-01	LEN19-S-01-1m	Water sample	7.96	0	0.183
LEN19-S-01	LEN19-S-01-9m	Water sample	7.87	0	0.172
LEN19-S-02	LEN19-S-02-16m	Water sample	7.78	0	0.168
LEN19-S-02	LEN19-S-02-1m	Water sample	7.79	0	0.174
LEN19-S-03	LEN19-S-03-1m	Water sample	7.77	0	0.164
LEN19-S-04	LEN19-S-04-1m	Water sample	7.75	0	0.158
LEN19-S-05	LEN19-S-05-1m	Water sample	7.79	0	0.158
LEN19-S-05	LEN19-S-05-4m	Water sample	7.74	0	0.158
LEN19-S-06	LEN19-S-06-1m	Water sample	7.78	0	0.156
LEN19-S-06	LEN19-S-06-6m	Water sample	7.78	0	0.157

LEN19-S-07	LEN19-S-07-15m	Water sample	7.92	0	0.155
LEN19-S-07	LEN19-S-07-1m	Water sample	7.8	0	0.159
LEN19-S-08	LEN19-S-08-1m	Water sample	7.71	0	0.156
LEN19-S-08	LEN19-S-08-6m	Water sample	7.77	0	0.156
LEN19-S-09	LEN19-S-09-10m	Water sample	7.78	0	0.157
LEN19-S-09	LEN19-S-09-1m	Water sample	7.8	0	0.158
LEN19-S-09	LEN19-S-09-5m	Water sample	7.81	0	0.157
LEN19-S-78	LEN19-S-78-1m	Water sample	7.84	0	0.156
LEN19-S-78	LEN19-S-78-8m	Water sample	7.8	0	0.155
LEN19-S-89	LEN19-S-89-12m	Water sample	7.8	0	0.157
LEN19-S-89	LEN19-S-89-1m	Water sample	7.73	0	0.159
LEN19-S-89	LEN19-S-89-6m	Water sample	7.77	0	0.157

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