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HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Chapter 2.1: CACOON Ice spring campaign, part of:

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Berichte
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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

2.1 CACOON Ice: Spring campaign NERC-BMBF project 'Changing Arctic Carbon Cycle in the Coastal Ocean Near-Shore (CACOON)'

Jens Strauss [1], Olga Ogneva [2], Juri Palmtag [2], Alexey Aksenov [3], Matthias Fuchs [1]

[1] Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Potsdam, Germany

[2] Northumbria University, Newcastle, United Kingdom

[3] Arctic and Anarctic Research Institute, St. Petersburg, Russia

Fieldwork period and location
From March 26th to April 10th, 2019 (on Tiksi Bay nearshore and Lena river channel Sardakhskaya).
Expedition lead
J. Strauss (Section Permafrost Research, AWI Potsdam, jens.strauss@awi.de)
Scientific coordination
J. Strauss and P. Mann (Northumbria University, Newcastle, UK, Paul.Mann@northumbria.ac.uk)
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).

Contribution to public outreach
We contribute field stories, interviews and pictures to the newsletter 'sustainability' by the German Federal Goverment. Moreover, our research is highlighted on the website of the federal goverment.
(`https://www.bundesregierung.de/breg-de/aktuelles/tauender-permafrost-eine-unterschaetzte-gefahr-fuer-das-weltklima-1614664`)

General scientific rationale and objectives
With the CACOON project, we aim to quantify the effect of changing freshwater export and terrestrial permafrost thaw on the type and fate of river-borne organic matter (OM) delivered to Arctic coastal waters, and resultant changes on ecosystem functioning in the coastal Arctic Ocean. The CACO**ON ice** expedition was the first step to set the observational basis for the projects combined observational, experimental and modelling approach. With the gained sample material, we will conduct laboratory experiments to parameterise the susceptibility of terrigenous carbon to abiotic and biotic transformation and losses, and then use the results from these to deliver a marine ecosystem model capable of representing the major biogeochemical cycles of carbon, nutrients and OM cycling in these regions. We will apply this model to assess how future changes to freshwater runoff and terrigenous carbon fluxes alter the biogeochemical structure and function of shelf ecosystems. Our aims for the project are the following:

- generate novel seasonally-explicit datasets of OM source and transformation across the Lena River nearshore environments
- identify and parameterise key abiotic and biotic processes affecting terrestrial organic matter fluxes from land-to-ocean
- deliver projections of how future changes to freshwater runoff and terrestrial organic matter fluxes will alter the biogeochemical structure and function of shelf ecosystems.

Methods and fieldwork summary

The expediting participants are listed in Table 2.1-1 and on the group picture (Figure 2.1.1). The Expedition itinerary is listed in Table 2.1-2.

Expedition itinerary and general logistics

Starting from Tiksi, we (Figure 2.1.1) planned to go out as far as possible with our camp on sledges (Figure 2.1.2) on the sea ice for getting the biggest possible salinity gradient from the river into the shelf. In total, we planned to be in the field for 14 days. 2.5 days each were planned for transit, resulting in a 9-day sampling program. We planned to sample 12 sites on a 100 km long east to west transect starting offshore and ending in the mouth of the Sardakhskaya channel.

Figure 2.1.1: *Participants from left to right: Jens Strauss, Olga Ogneva, Alexey Aksenov, Juri Palmtag, Matthias Fuchs, Yuri Nasyrov, Victor Dobrobaba, Valeri Kulikov, Sergei Kamanin, Missing: Alexander Shiyan, picture: Jens Strauss*

Figure 2.1.2: *Vehicles during expedition. (From left to right) the camp consists of a freight sledge, a vezdekhod (caterpillar all-terrain vehicle) for reaching field sites further away from campsites, a cabin on sledges (balok) used for accommodation and laboratory work and a tractor for pulling the sledges.*

However, as there was a unbreachable crack (72.5255°N; 129.8648°E, see Figure 2.1.3) to the north and to the east of approximate 5 m width with very thin ice to open water, we were not able to do the transect on the shelf.

Figure 2.1.3: *Crack in the sea ice blocking the way east to sample the transect to the shelf*

Adapting to such an event, we shifted to our alternative sampling strategy and sampled a transect upstream to a heavily eroding permafrost cliff ca. 40 km upstream the Sardakhshaya channel with sampling locations every 5 km (see Figure 2.1.4). At each site, we collected 20 l water with a water sampler from up to 3 depth levels. In addition we took 3 ices cores (Kovacs Mark II ice corer) and up to two UWITEC (gravity corer) short cores from the surface sediments. Moreover, at each site we took gas (CO_2, N_2O or CH_4) and snow samples, snow depth measurements and environmental data using a Multiparameter Water Quality Sonde (water depth, salinity, pH, dissolved oxygen, conductivity, etc.). Impression from the sampling are shown in Figure 2.1.5).

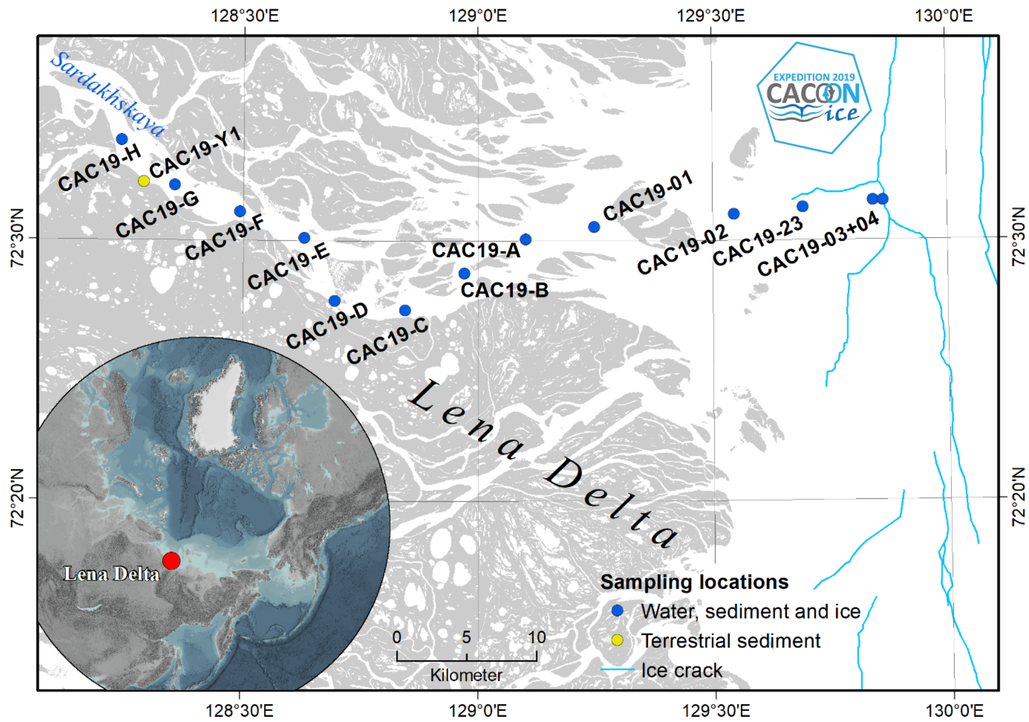

Figure 2.1.4: *Sampling locations of the adjusted field plan as well as cracks identified on remote sensing images after field work. Map compiled by M. Fuchs.*

Outreach

Our weekly reports (in German only) are available for our first and second week of fieldwork:

1. https://www.awi.de/fileadmin/user_upload/AWI/Forschung/Geowissenschaft/Periglazialforschung/Bilder_Peri/Stationen/Wochenberichte_Samoylov/2019_1_Wochenbericht_CACOON_ice.pdf
2. https://www.awi.de/fileadmin/user_upload/AWI/Forschung/Geowissenschaft/Periglazialforschung/Bilder_Peri/Stationen/Wochenberichte_Samoylov/2019_2_Wochenbericht_CACOON_ice.pdf)

Figure 2.1.5: *Field work in progress, a) ice core drilling, b) ice thickness measurement, c) measurement of ice core temperature, d) water sampling, e) CTD measurements, and f) sediment coring*

Table 2.1-1: Participants of the expedition CACOON Ice 2019, list of participants is sorted alphabetically.

Name	Institute	Responsibilities
Aksenov, Alexey	AARI St. Petersburg	Logistics: Deep drilling
		Science: sub sampling deep cores for diatoms and dating
Dobrobaba, Viktor	Hydrobase Tiksi	Field logistics, head of the Hydrobase crew
Fuchs, Matthias	AWI-P, Germany	CTD profiles, ice coring
Kamanin, Sergey	Hydrobase Tiksi	Cook helper
Kulikov, Valeri	Hydrobase Tiksi	Cook
Nasyrov, Yuri	Hydrobase Tiksi	Vezdekhod driver
Ogneva, Olga	AWI-B, Germany	Water sampling and processing
Palmtag, Juri	Northumbria University, UK	Water sampling and processing, CTD profiles
Shiyan, Alexander	Hydrobase Tiksi	Tractor driver
Strauss, Jens	AWI-P, Germany	Logistics: german expedition lead
		Science: ice coring, UWITEC short core sampling

Table 2.1-2: Timetable for the expedition CACOON Spring: Camp and deep drilling rig location

Date	Location
25.03.2019	Arrival in Tiksi
26.03.2019	Tiksi on-site logistics, packing
27.03.2019	Loading and reparation expedition vehicles, starting to first stop (Lake Golzovove) late afternoon
28.03.2019	Transfer
29.03.2019	Arrival at first sampling location on afternoon, start sampling
05.04.2019	End of sampling, start transfer to Tiksi late afternoon
06.04.2019	Transfer
07.04.2019	Transfer
08.04.2019	Arrival at Tiksi early morning and preparation of the sample freight and equipment
09.04.2019	Preparation of the sample freight and equipment
10.04.2019	Departure

Preliminary results

Material and data in a nutshell

Water samples

- 21 samples (1-3 depth per Station) with 455 subsamples

- 407 L of water were filtered

UWITEC gravity sampler cores

- 13 short cores

Ice cores

- 39 ice cores from 13 sites (ca. 78 m in total)

Gas samples

- 42 gas samples

Sampling strategy

To give a broad overview, following sampling procedures and analyses were in the focus of the campaign: Recovered water samples were frozen and unfrozen, filtered and unfiltered. Ice cores were taken close to water sampling locations.

The sample name code for the majority of the samples is composed of the abbreviation of the project CACOON (CAC), the year (19), the site (e.g. 01) and additional number like water sampling depth or number for ice core. All Sardakhskaya (upstream) sample locations are marked with a capital letter instead of a number (see Figure 2.1.4).

Work package 1: Water and gas sampling

Olga Ogneva [1], Juri Palmtag [2], and Matthias Fuchs [1]

[1] Alfred Wegener Institute Helmholtz Centre for Polar- and Marine Research, Potsdam, Germany

[2] Dept of Geography & Environmental Sciences, Northumbria University, Newcastle upon Tyne, UK

Background and objectives

Gas and water samples were obtained and preserved for further laboratory analysis in Bremerhaven and Potsdam Germany and Newcastle upon Tyne, UK.

Sampling and methods

Water samples were taken from ice core holes using a water sampler. Immediately after the water was sampled, the work continued in the provisional laboratory (Balok). Water samples were subsampled for Dissolved and Particulate OC (DOC/POC), ON (DON/PON), POC δ^{13}C, POC Δ^{14}C, PON δ^{15}N, cDOM, DOC δ^{13}C, DOC Δ^{14}C, DIC, DIC δ^{13}C, DIC Δ^{14}C, H_2O isotopes, anions & cations, gas samples (CO_2, N_2O or CH_4) and biomarkers. Samples were filtered, acidified or poisoned to preserve if needed and stored either frozen or at 4 °C for further analysis in Germany or United Kingdom. Water samples for dissolved methane concentration were collected into 100 ml headspace vials using Direct-Fill VOA method to minimize contact with air and then preserved with sulfuric acid and stored at 4 °C.

Preliminary results

Prior to any water sampling, CTD (conductivity, temperature, depth) were measured using a handheld CastAway-CTD from SonTek/YSI Inc. Each location was measured with at least two measurement runs. Preliminary results from each location are summarized in Table 2.1-3 and Figure 2.1.4. These results show that water depth is between 2 and 18 m and that the water temperature in general is below 0.25 °C (except CAC19-F) (Figure 2.1.6a). The conductivity (Figure 2.1.6b) is decreasing with depth for the top two meters of the water column and then becomes stable for deeper profiles (except CAC19-E and -F).

Table 2.1-3: Summary of the CTD measurements along the transect

	Latitude	Longitude	Date	Depth [m]	Mean Temp. [°C]	Mean Conductivity [μS cm^{-1}]	Mean Sound velocity [m s^{-1}]	Mean Specific conductance [μS cm^{-1}]	Mean Salinity [psu]	Mean Density [kg m^{-3}]
CAC19-01	72.5090	129.2480	30.03.2019	19.57	0.08	232.83	1403.14	464.23	0.21	1000.04
CAC19-02	72.5168	129.5455	29.03.2019	2.48	0.05	232.83	1402.94	464.74	0.21	1000.02
CAC19-03	72.5254	129.8420	30.03.2019	3.13	0.05	239.57	1402.95	478.20	0.21	1000.03
CAC19-04	72.5255	129.8639	31.03.2019	2.88	0.07	240.02	1403.06	478.67	0.21	1000.03
CAC19-23	72.5214	129.6930	31.03.2019	2.05	0.08	238.79	1403.12	475.96	0.21	1000.03
CAC19-A	72.5013	129.1017	01.04.2019	11.72	0.06	231.59	1403.08	462.00	0.21	1000.05
CAC19-B	72.4794	128.9711	01.04.2019	5.31	0.08	232.79	1403.12	464.08	0.21	1000.03
CAC19-C	72.4556	128.8445	02.04.2019	1.99	0.03	238.73	1402.86	476.85	0.21	1000.03
CAC19-D	72.4615	128.6944	02.04.2019	17.95	0.05	230.54	1403.05	460.22	0.21	1000.06
CAC19-E	72.5019	128.6298	03.04.2019	2.75	0.10	227.77	1403.20	453.70	0.20	1000.02
CAC19-F	72.5188	128.4922	03.04.2019	3.37	1.31	285.76	1409.22	542.93	0.25	1000.12
CAC19-G	72.5354	128.3533	04.04.2019	8.09	0.13	234.50	1403.39	466.59	0.21	1000.04
CAC19-H	72.5641	128.2385	04.04.2019	3.14	0.09	235.19	1403.17	468.63	0.21	1000.03

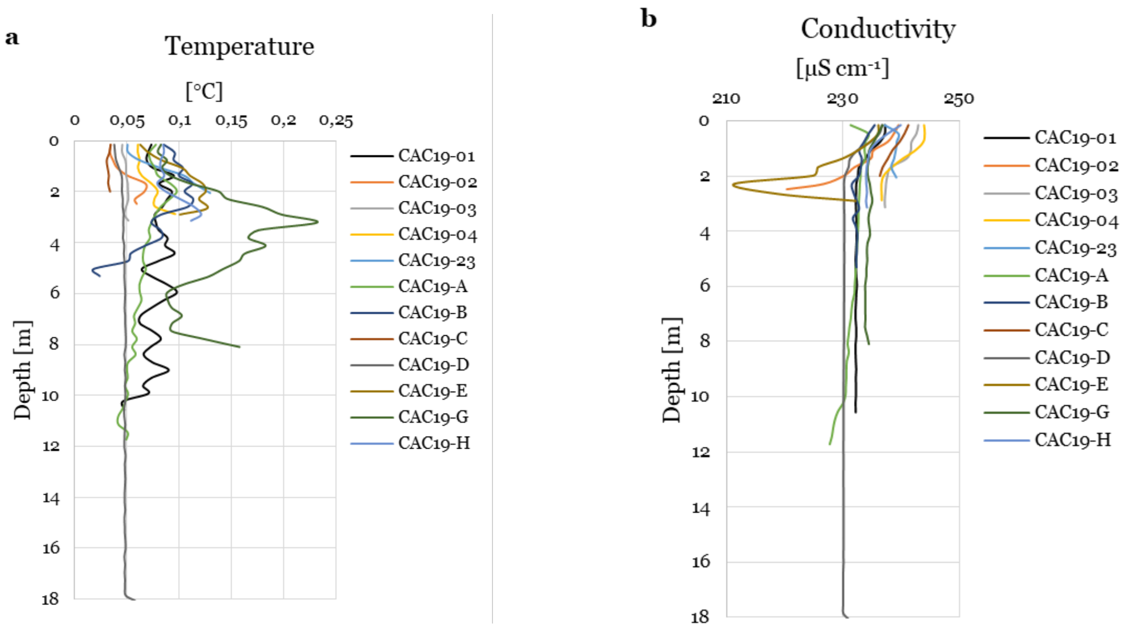

Figure 2.1.6: *Temperature (a) and conductivity (b) distribution with depth for profiles along the transect. CAC19-F is excluded from these graphs, because this location deviates strongly from the other points.*

Work package 2: ice sampling

Jens Strauss [1], Matthias Fuchs [1], Alexey Aksenov [2], (Ingeborg Bussmann [3], Ellen Damm [4], Paul Overduin [1], Melanie Bergmann [4]: not in field)

[1] Alfred Wegener Institute Helmholtz Centre for Polar- and Marine Research, Potsdam, Germany

[2] Arctic and Antarctic Research Institute, St. Petersburg, Russian Federation

[3] Alfred Wegener Institute Helmholtz Centre for Polar- and Marine Research, Helgoland, Germany

[4] Alfred Wegener Institute Helmholtz Centre for Polar- and Marine Research, Bremerhaven, Germany

Objectives

Ice cores were obtained for later analysis of the methane cycle and microplastic content.

Methods

For each station, three ice cores were drilled with a Kovacs Mark II ice coring system (9 cm diameter). The first core (labelled with “-1”) is collected to measure the *in-situ* temperature and will be handled as back-up core. The second core (“-2”) was collected for methane analysis and the third core (“-3”) for microplastic analysis.
The ice temperature was measured immediately after retrieval with a temperature probe (Testo 720) in predrilled holes every 10 cm. The ice cores for temperature and methane measurements were packed in PE tubings and stored continuously frozen in thermo boxes.

Preliminary results

Site and ice core descriptions

In total 39 cores were collected with a diameter of 9 cm (Figure 2.1.7, Kovacs Mark II coring system) leading to a total of 75.76 m of ice retrieved. A summary is given in Table A.2.1.

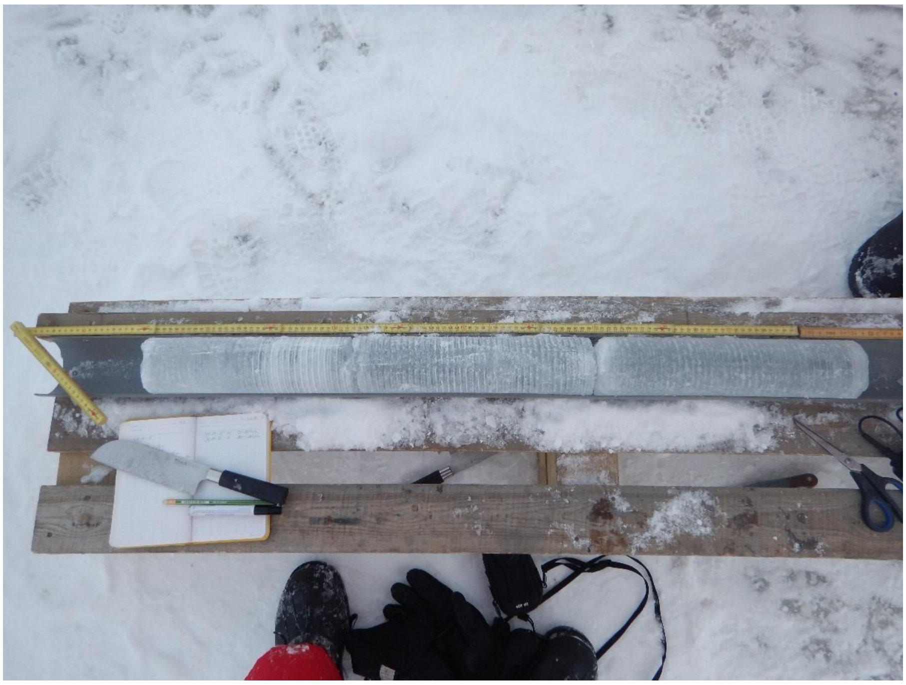

Figure 2.1.7: *Example of an ice core taken and described in the field. Ice core CAC19-E-1 segment II (101-207.5 cm)*

Work package 3: Sediment sampling

Jens Strauss [1], Alexey Aksenov [2], and Matthias Fuchs [1]

[1] Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Potsdam, Germany

[2] Arctic and Antarctic Research Institute, St. Petersburg, Russia

Objectives

Sea and riverbed sediment cores were collected to analyze the carbon and nitrogen contents.

Methods

Samples were collected with an UWITECH gravity corer. For most sample locations, however, only the top most sediment layers (ca. 0-20 cm) could be retrieved, due to the coarse fraction of the sediment.

Preliminary results

Often the small height of drop and the sandy, compact river bed led to only short sediment cores (Figure 2.1.8). Nevertheless, in total 13 sediment cores could be retrieved and are summarized in Table 2.1-4.

Table 2.1-4: List of sediment cores retrieved during the expedition

Location	Latitude	Longitude	Sediment core	Depth	Remarks
CAC19-03	72.5254	129.8420	CAC19-03-SED-1	5	with Uwitec, but not in a liner
CAC19-04	72.5259	129.8638	CAC19-04-SED-1	?	-
CAC19-23	72.5213	129.6930	CAC19-23-SED-1	29	21-22.5 cm: air bubble
			CAC19-23-SED-2	48.5	29-39.5 cm: air and water
CAC19-A	72.5013	129.1016	CAC19-A-SED-1	5	mixed sample in bag
			CAC19-A-SED-2	5	small core
CAC19-B	72.4794	128.9711	CAC19-B-SED-1	17.5	sand
CAC19-C	72.4557	128.8445	CAC19-C-SED-1	22.5	-
			CAC19-C-SED-2	56	
CAC19-E	72.5018	128.6297	CAC19-E-SED-1	35	-
CAC19-F	72.5187	128.4922	CAC19-F-SED-1	15.5	
			CAC19-F-SED-2	?	mixed sample in bag
CAC19-G	72.5354	128.3532	CAC19-G-SED-1	3	-

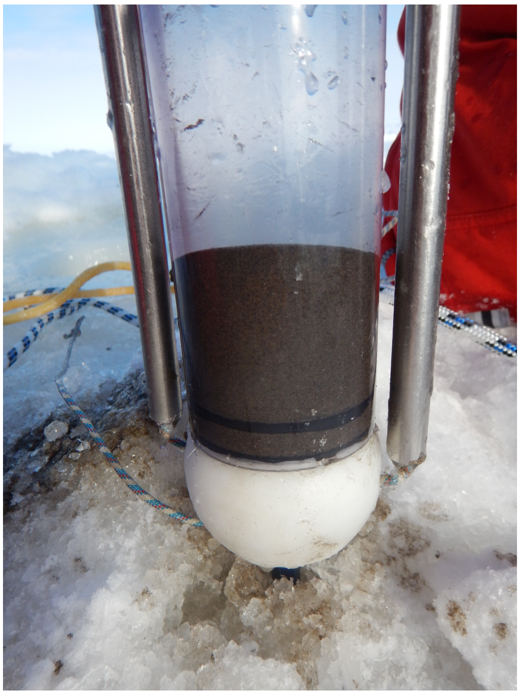

Figure 2.1.8: *A sandy sediment sample from CAC19-4-SED-1*

Acknowledgements
We thank **W. Schneider** and **D. Melnichenko** and all technical expedition members for making this fieldwork possible! Especially Victor Dobrobava and his team for onsite field logistics from Hydrobase Tiksi, and the Lena Delta Reverse.

Table A.1.3: List of participants in the CACOON spring expedition

No.	Name	Institution	Duration
1	Aksenov, Alexey	AARI	25.03.19-10.04.19
2	Dobrobaba, Viktor	HBT	25.03.19-10.04.19
3	Fuchs, Matthias	AWI P	25.03.19-10.04.19
4	Kamanin, Sergey	HBT	25.03.19-10.04.19
5	Kulikov, Valeri	HBT	25.03.19-10.04.19
6	Nasyrov, Yuri	HBT	25.03.19-10.04.19
7	Ogneva, Olga	AWI P	25.03.19-10.04.19
8	Palmtag, Juri	NU	25.03.19-10.04.19
9	Shiyan, Alexander	HBT	25.03.19-10.04.19
10	Strauss, Jens	AWI P	25.03.19-10.04.19

A.2 Supplementary material - Expedition Lena 2019

Table from 2.1.

Table A.2.1: Ice cores collected during the CACOON Ice expedition

Ice core location	Lat.	Long.	Snow height [cm]	Water table [cm]	Core names	Core length [cm]	Remarks
CAC19-01	72.5091	129.2479	11	-	CAC19-01-1 CAC19-01-2 CAC19-01-3	205 189 188	Small chips 10-29 dark ice
CAC19-02	72.5168	129.5457	0	-	CAC19-02-1 CAC19-02-2 CAC19-02-3	193 179 199	Chips, core segment lost?
CAC19-03	72.5254	129.8420	0	-	CAC19-03-1 CAC19-03-2 CAC19-03-3	196 192 194	30-35 bubbles in ice
CAC19-04	72.5259	129.8638	0-14	-16	CAC19-04-1 CAC19-04-2 CAC19-04-3	189 189 194	126-129 & 149-153 dark ice
CAC19-23	72.5213	129.6930	-	-11	CAC19-23-1 CAC19-23-2 CAC19-23-3	192 193 191	187-193 sediment with ice Big air bubbles/holes in core
CAC19-A	72.5013	129.1016	0-26	-6	CAC19-A-1 CAC19-A-2 CAC19-A-3	173 173 169	-
CAC19-B	72.4794	128.9711	24	-2	CAC19-B-1 CAC19-B-2 CAC19-B-3	170 168 166	-
CAC19-C	72.4557	128.8445	0	-19	CAC19-C-1 CAC19-C-3 CAC19-C-3	207 204 209	-
CAC19-D	72.4615	128.6946	0-15	-17	CAC19-D-1 CAC19-D-2 CAC19-D-3	208 209 207	-
CAC19-E	72.5018	128.6297	0-6	-45	CAC19-E-1 CAC19-E-2 CAC19-E-3	207.5 205 209	-
CAC19-F	72.5187	128.4922	0-2	-40	CAC19-F-1 CAC19-F-2 CAC19-F-3	206 202 204.5	-
CAC19-G	72.5354	128.3532	6	-12	CAC19-G-1 CAC19-G-2 CAC19-G-3	195 198 199	38-58.5 sediment within ice
CAC19-H	72.5641	128.2387	0-2	-17	CAC19-H-1 CAC19-H-2 CAC19-H-3	200 203 201	-

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BREMERHAVEN

Am Handelshafen 12
27570 Bremerhaven
Telefon 0471 4831-0
Telefax 0471 4831-1149
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