DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2015/68

Past climate and sea ice variability in the Danmarksfjord - Wandel Sea region, Northeast Greenland

Report of the ASP/ARC/GEUS Geoscience campaign at the Villum Research Station, Station Nord (11th April-2nd May 2015)

Sofia Ribeiro, Niels Nørgaard-Pedersen & Marit-Solveig Seidenkrantz

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Fieldwork participants
Sofia Ribeiro & Niels Nørgaard-Pedersen, GEUS

Campaign overview and objectives

This campaign was an initiative of the Arctic Science Partnership (ASP) and the Arctic Research Centre (ARC) at Aarhus University, and part of the inaugural field season based at the new Villum Research Station at Station Nord, Northeast Greenland.

Fieldwork for retrieval of marine sediment cores took place during Leg 1, from 11^{th} April to 2^{nd} May 2015, in the ice covered fjord area off Station Nord. The Geological Survey of Denmark and Greenland (GEUS) was a partner in the planning and execution of the geoscience fieldwork.

Research Scientist Sofia Ribeiro and Senior Research Scientist Niels Nørgaard-Pedersen from GEUS conducted the fieldwork while based at the Villum Research Station. Professor Marit-Solveig Seidenkrantz (MSS) from AU was the campaign PI.

Figure 1 – Villum Research Station (main building)

The main objective of the geoscience fieldwork was to collect sediment core records in order to reconstruct past sea ice variability (hundreds to thousands of years) in Northeast Greenland, and its impact on primary productivity, with implications for the biogeochemical cycle and ecosystem functioning.
The sediment cores are also expected to provide new information on water mass variability, local ice sheet dynamics, and glacier melting rates through time. Surface sediment samples will be used to study the modern sea ice and phytoplankton communities both through assemblage composition and DNA analyses, whenever possible.
Additionally, water-depth measurements were performed during leg 1 by both the Geosciences team (at each coring site) and the Oceanography team (CTD casts). A compilation of these valuable new data will contribute to a more accurate knowledge of the bathymetry of the area, which is poorly known at present.

Planning

Sampling sites were selected based on high-resolution radar satellite images (Sentinel-1 SAR) revealing areas of 1st and multiyear ice, as well as the scattered existing knowledge on sea bottom bathymetry for the area. Results based on the first marine sediment cores collected from this area (Nørgaard-Pedersen *et al*. 2008) were also taken into consideration during the planning. Additional depth measurements from CTD casts performed by the Oceanography team during leg 1 (CEOS, Manitoba, Canada) were also useful for the ongoing planning of the campaign.

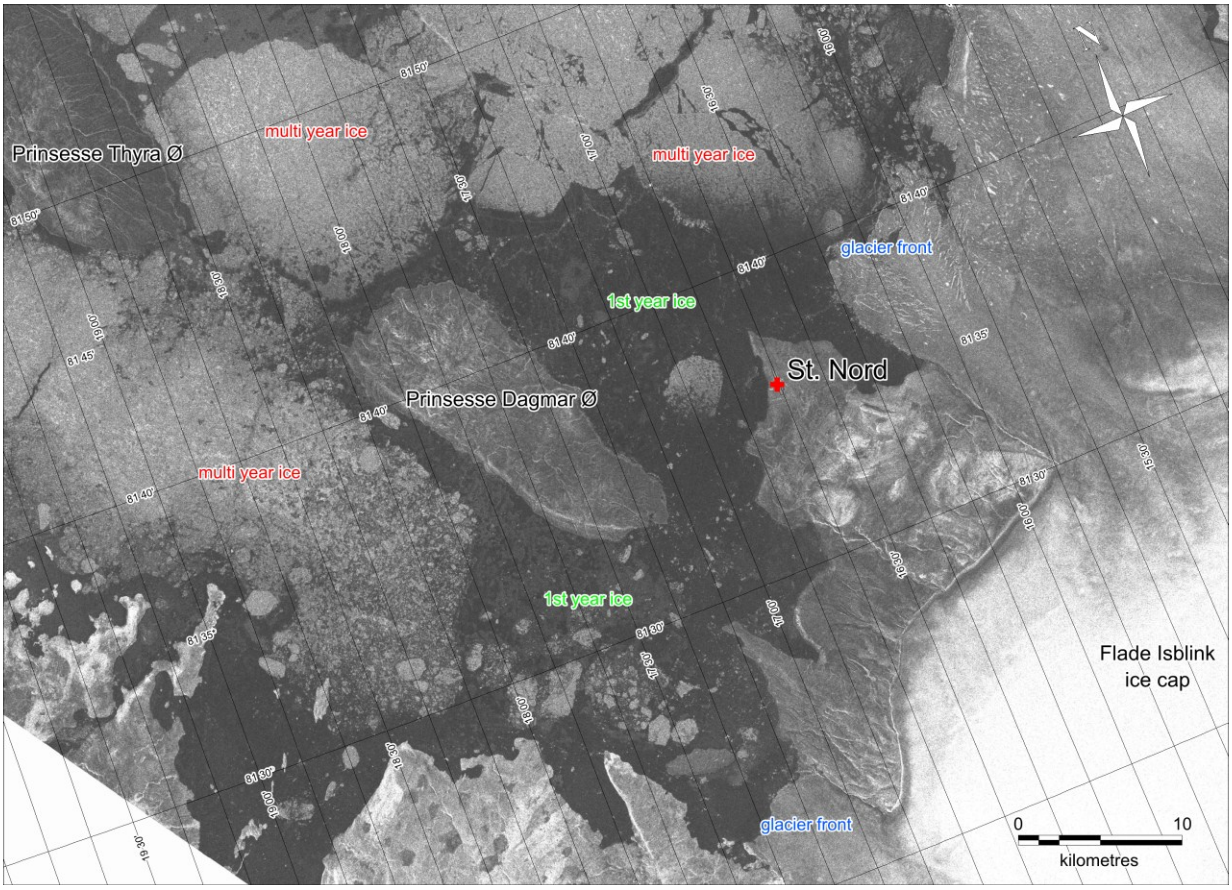

Figure 2 – Radar satellite image of the study area, revealing areas of seasonal and multi-year ice (background image courtesy of Leif Toudal, DMI).

Methods

Sediment sampling

Surface sediment samples were retrieved using a Van Veen Grab sampler. The sediment surface was subsampled after retrieval of the Grab, and subsamples were placed in small plastic containers and finally stored at 2-4 °C upon arrival to the Villum Research Station (VRS).

Sediment cores were retrieved using both a Rumohr lot and Kayak corer, through holes drilled in the ice (1-3 m thickness) with a 9-inch ice auger.
Two set-ups were used depending on whether Rumohr lot or Kayak coring was intended. For Rumohr lot coring, 6-9 holes were drilled contiguously in the ice with the ice auger in order to achieve a hole with >65cm of diameter (approximate diameter of the Rumohr lot metal ring), and a tripod was mounted with a pothauler winch driven by a hydraulic power unit. For Kayak coring, 1-2 overlapping holes were drilled in the ice and a hand-winch was mounted on the tripod.

In order to optimize our time in the field (as drilling through 1-3m of sea ice was challenging and time-consuming), Kayak coring was deemed the most efficient approach.

Figure 3 – Drilling through the ice (a) and deployment of the Kayak corer (B)

Sea ice sampling – Algal communities and biomarkers

Sea ice cores were collected using a Kovacs ice driller for biochemical and taxonomic studies of the sea ice algal communities. Extensive sampling showed, however, that during leg 1 the sea ice was still barren of algae. This was attributed to light attenuation by the snow (average snow thickness of 1m). *In situ* light measurements, and fluorescence measurements on 25 sea ice core samples (bottom 5cm) using a phytoPAM showed no detectable photosynthetic activity (Leg 1; Phytobiology team, Aarhus University).

Figure 4 – Sea ice corer (a) and bottom section of a sea ice core, with no visible algal growth band (b).

Depth measurements
At every station, depth measurements were performed using a portable echo sounder. Additional depth measurements from CTD casts performed by the Oceanography team were also considered, as mentioned above.

Core inventory
A total of 37 sediment cores were retrieved from 17 sites along transects up to ca. 30 km of distance from Station Nord.

Duplicates or triplicates of Kayak cores were taken at most stations and one Kayak core from each site was subsampled at 1 cm intervals (slices) in the wet lab at St. Nord. These samples as well as the remaining intact cores were kept cooled during transport to Denmark and finally stored at 4 °C.

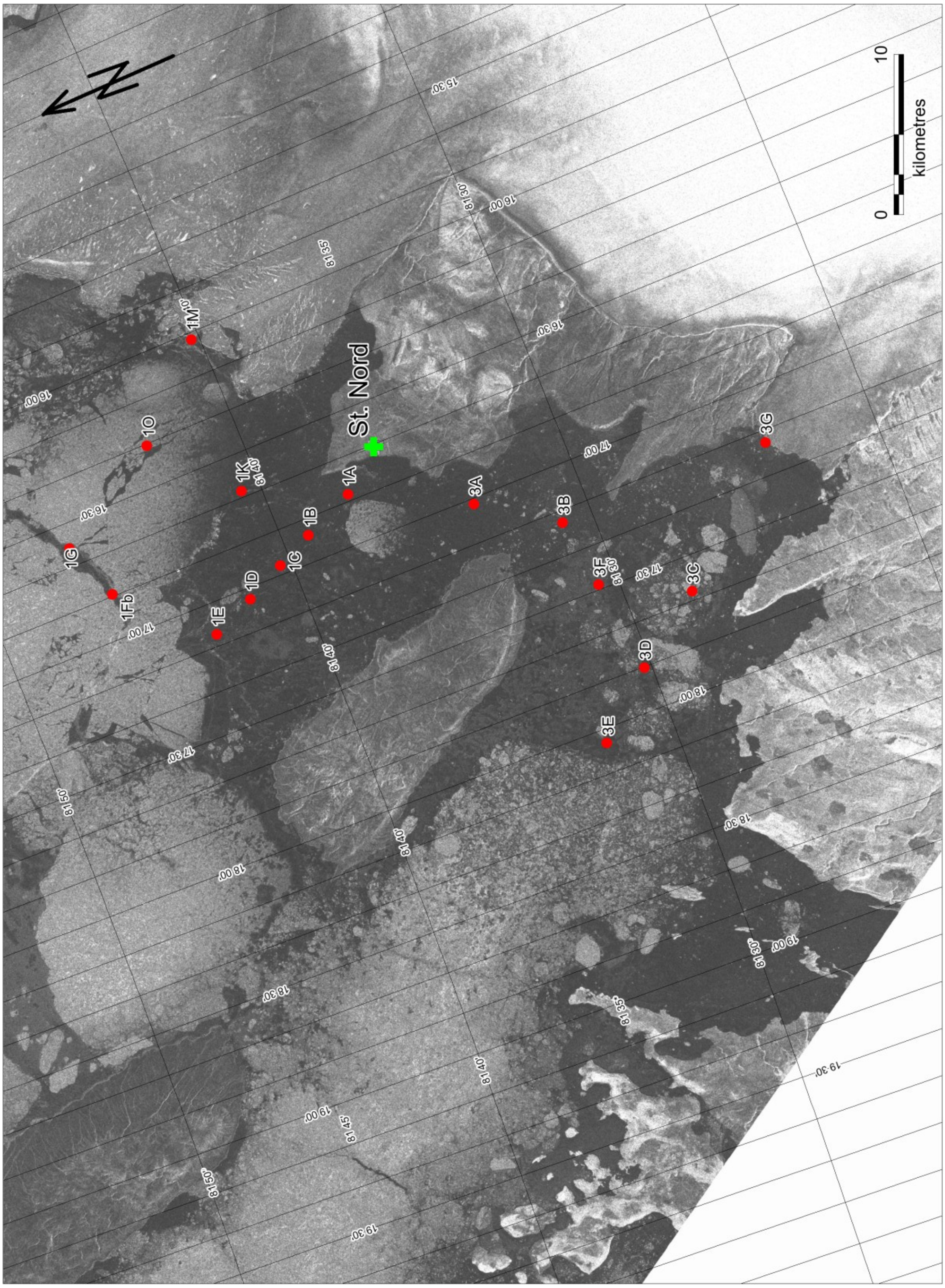

Figure 5 – Sampling stations

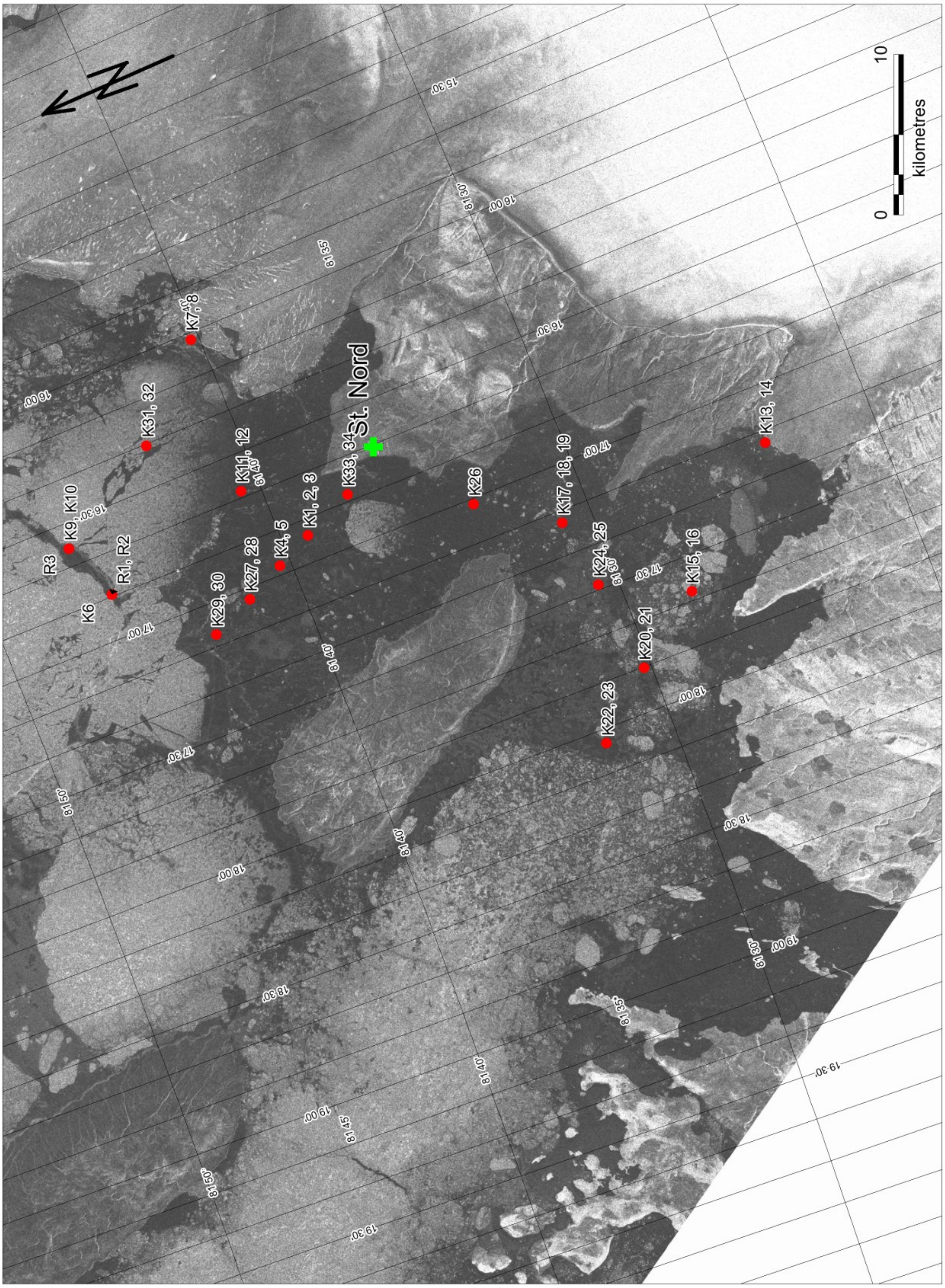

Figure 6 – Core locations

Table 1 – Sample inventory

Collection date	Site	Sample code	Sample type	Core lenght	Latitude	Longitude	Water depth	Sea ice thickness (cm)	Snow cover (cm)
15-04-15	1B	S1_1	Grab	n/a	81,65198	-16,8964	57	99	115
	1B	S1_2	Grab		81,65198	-16,8964	57	99	115
	1C	S2_1	Grab		81,67298	-16,96524	73	101	110
	1C	S2_2	Grab		81,67298	-16,96524	73	101	110
17-04-15	1B	K1	Kayak	8	81,65198	-16,8964	57	99	115
	1B	K2	Kayak	17	81,65198	-16,8964	57	99	115
	1B	K3	Kayak	19	81,65198	-16,8964	57	99	115
	1C	K4	Kayak	16,5	81,67298	-16,96524	73	101	110
	1C	K5	Kayak	17,5	81,67298	-16,96524	73	101	110
18-04-15	1Fb	K6	Kayak	17,5	81,76615	-16,825016	128	125	115
	1Fb	R1	Rumohr	57,5	81,76615	-16,825016	128	125	115
	1Fb	R2	Rumohr	62	81,76615	-16,825016	128	125	115
20-04-15	1M	K7	Kayak	30	81,671116	-16,026366	111	250	130
	1M	K8	Kayak	17	81,671116	-16,026366	111	250	130
21-04-15	1G	K10	Kayak	6,5	81,77878	-16,596316	154,5	115	105
	1K	K11	Kayak	13,5	81,677533	-16,641133	20,8	<100	156
	1K	K12	Kayak	14	81,677533	-16,641133	20,8	<100	156
	1G	K9	Kayak	11	81,77878	-16,596316	154,5	115	105
	1G	R3	Rumohr	45	81,77878	-16,596316	154,5	115	105
24-04-15	3G	K13	Kayak	30	81,39508	-17,2115	55	120	~170
	3G	K14	Kayak	67	81,39508	-17,2115	55	120	~170
	3C	K15	Kayak	21	81,4638	-17,6313	113	100	100
	3C	K16	Kayak	14	81,4638	-17,6313	113	100	100
25-04-15	3B	K17	Kayak	13	81,51717	-17,21174	54,5	122	90
	3B	K18	Kayak	13	81,51717	-17,21174	54,5	122	90
	3B	K19	Kayak	15	81,51717	-17,21174	54,5	122	90
	3D	K20	Kayak	11	81,504	-17,837	135	99	82
	3D	K21	Kayak	14	81,504	-17,837	135	99	82
	3E	K22	Kayak	18	81,5387	-18,0531	115	127	90
	3E	K23	Kayak	17	81,5387	-18,0531	115	127	90
	3F	K24	Kayak	16	81,5111	-17,48025	61	122	40
	3F	K25	Kayak	15	81,5111	-17,48025	61	122	40
	3A	K26	Kayak	20	81,5596	-17,0216	5,5	98	92
27-04-15	1D	K27	Kayak	12	81,6956	-17,0425	75	133	95
	1D	K28	Kayak	14	81,6956	-17,0425	75	133	95
	1E	K29	Kayak	13	81,7203	-17,1209	87	130	98
	1E	K30	Kayak	15	81,7203	-17,1209	87	130	98
	1O	K31	Kayak	30	81,716935	-16,33982	154	310	156
	1O	K32	Kayak	28	81,716935	-16,33982	154	310	156
	1A	K33	Kayak	21	81,62295	-16,80726	19,6	95	105
	1A	K34	Kayak	20	81,62295	-16,80726	19,6	95	105

Acknowledgments
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