1. SUMMARY AND ITINERARY

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SUMMARY

The leg 3 drift started on 3 March, 2020, with the leg 3 team having arrived at the floe aboard *Kapitan Dranitsyn* a few days earlier after leaving Tromsø on 27 January. Our drift ended on 15 May, 2020, when *Polarstern* left the MOSAiC floe, after removing large parts of the measurement infrastructure from the floe, in order to be able to carry out the exchange with the leg 4 team, arriving in Svalbard on 04 June. The drift was prominently southward, starting at 88° 08.5' N , 030° 33.2' E and ending at 83° 23.5' N, 009° 06.6' E. Our work concentrated on continuing the measurement program inherited from the leg 2 team of the coupled atmosphere-sea ice-ocean-ecosystem in terms of time series and dedicated sampling work, shared between the teams ATMOS, ICE, OCEAN, ECO and BGC and supported by the LOGISTICS, DATA and MEDIA teams. Leg 3 had special significance for MOSAiC as it covered the late-winter period of as well as the transition to the onset of surface melt. We witnessed temperatures as low as -40°C in early March to 0°C in Mid-May, as well as the rapid transition from polar night to polar day. Ice dynamics - lead and pressure ridge formation - from early-on during leg 3 made it challenging to both reach the measurement sites on the floe and maintain the energy supply required for the time series program in the different "cities". At the same time, these phenomena gave us amply opportunity to study atmosphere-sea ice-ocean-ecosystem interaction. Leg 3 was overshadowed by the global Corona pandemic, ultimately leading to the cancellation of the flight-based exchange with leg 4 which had been planned for early April. After a transit from Svalbard aboard *RV Sonne* and *RV Merian*, the leg 3 team arrived in Bremerhaven on 15 June.

ZUSAMMENFASSUNG

Der dritte Abschnitt (Leg 3) der Drift begann am 3. März 2020, einige Tage nachdem das Leg-3-Team an der MOSAiC Scholle an Bord der *Kapitan Dranitsyn* nach einem knapp 5-wöchigen Transit von Tromsö angekommen war. Unsere Drift endete nach dem Abbergen großer Teile der Messinfrastruktur auf dem Eis mit dem Verlassen der Scholle von Polarstern, um den Austausch mit dem Leg-4-Teams in Svalbard durchzuführen, wo wir am 4. Juni ankamen. Unsere Drift war vorwiegend südwärtig, von 88° 08.5' N , 030° 33.2' O bis 83° 23.5' N, 009° 06.6' O. Wir setzten das Messprogramm des gekoppelten Atmosphäre-Meereis-Ozean-Ökosystems von Leg 2 in Bezug auf Zeitserien und Probennahmen fort, aufgeteilt in den Teams ATMOS, ICE, OCEAN, ECO und BGC und unterstützt von den LOGISTICS, DATA und MEDIA Teams. Leg 3 hatte dahingehend Bedeutung, als dass wir die Periode des späten Winters sowie den Übergang zum Beginn der Oberflächenschmelze abdeckten. Wir waren Lufttemperaturen von -40°C im frühen März bis 0°C Mitte Mai ausgesetzt und wurden Zeugen

des schnellen Übergangs von Polarnacht zu Polartag. Von Beginn von Leg 3 an stellte Eisdynamik in der Form von Rinnen- und Presseisrückenbildung teilweise eine Herausforderung sowohl dahingehend dar, die Messorte auf dem Eis zu erreichen als auch die Energieversorgung für die Zeitserienprogramme an den verschiedenen „Cities“ aufrechtzuerhalten. Gleichzeitig gab uns das Auftreten dieser Phänomene vielfältige Möglichkeiten, die Wechselwirkungen innerhalb des Atmosphäre-Meereis-Ozean-Ökosystems zu erforschen. Leg 3 war hochgradig von der globalen Corona-Pandemie überschattet, was letztendlich in der Absage des für Anfang April geplanten, flug-basierten Austausches mit dem Leg 4 Team mündete. Nach einem Transit an Bord von *FS Sonne* und *FS Merian* kehrte das Leg 3 Team am 15 Juni nach Bremerhaven zurück.

1.1. General overview

1.1.1 Opening Remarks

The Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) is an international Arctic Research initiative that is motivated by the dramatic changes in the Arctic climate system over the last few decades, highlighted by significant losses of sea ice, and generally incomplete model representations of the important processes responsible for, and responding to, these changes. *The ultimate goal of the MOSAiC is to enhance understanding of central Arctic coupled processes in the atmosphere-ice-ocean-ecosystem* to improve numerical models for sea ice forecasting, extended-range weather forecasting, climate projections, and climate change assessment. This goal will be achieved by carrying out the most comprehensive, most accurate, most continuous, and most systematic interdisciplinary in-situ and airborne observations in the Arctic Ocean to date, and by obtaining these over a full seasonal cycle including the winter freezing and summer melting seasons.

At the core of MOSAiC the German research icebreaker *Polarstern* was frozen into the ice in the northern Laptev Sea in October 2019, and was subsequently drifting with the Transpolar Drift toward Fram Strait. *Polarstern* served as a research base from which the surrounding ice, water, and air could be explored.
Leg 3 had special significance as it covered the late-winter period of MOSAiC as well as the transition to the onset of surface melt. Leg 3 (Fig. 1.1) was remarkable in that we witnessed the transition from temperatures as low as -40°C in early March to 0°C in Mid-May (Fig. 1.2). In fact, the lowest temperature was recorded on March 10 of -39.5°C (Polarstern mast) and -42.3°C (ground temperature in Met City). The polar night ended with the first sunrise on 13 March, and only 8 days later the sun did not set any longer.

1.1.2 The drift of the Polarstern during MOSAiC's Leg 3 including supply logistic

Kapitan Dranistyn left the port of Tromsø on 27 January in order to bring the leg 3 members to *Polarstern. Kapitan Dranistyn* reached *Polarstern* on 28 February near 88° 21.2' N , 034° 14.5' E . The voyage of *Kapitan Dranitsyn* and their dedicated crew constituted a historical achievement, as during this time of the year, as no other vessel had ever managed to travel as for north using its own engines. After both the freight operations between the two vessels and the scientific handover were successfully accomplished, the leg 2 team left the floe on board *Kapitan Dranitsyn* on March 06 to return to Tromsø. This was a time of low temperatures (Fig 1.2), such that the crane and container operations were challenging. Without the dedicated and knowledgeable effort of the Russian and German crews, this operation couldn't have been accomplished in such a short time.

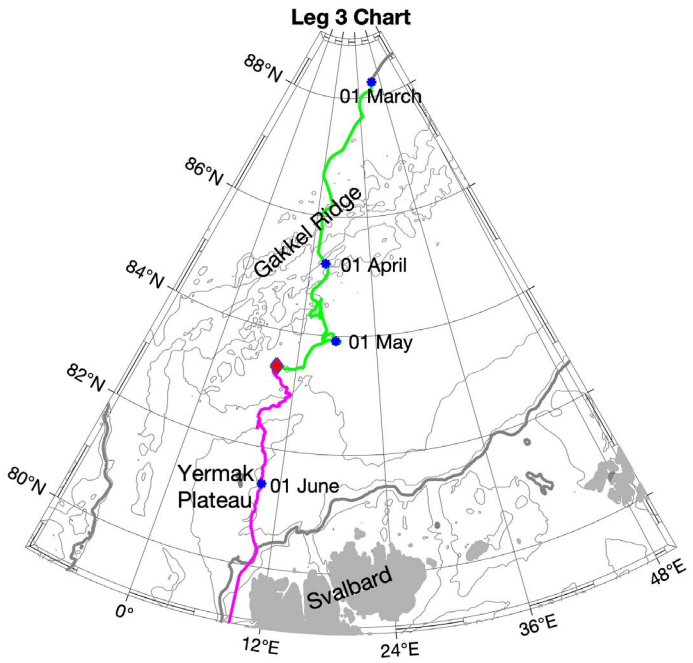


Fig. 1.1: *Drift trajectory of Polarstern anchored to the MOSAIC floe from 28 February to 16 May, 2020 (green line). The red diamond marks the end of the drift. The subsequent transit of Polarstern toward Svalbard from 16 May to 04 June, 2020, is shown as magenta line. The positions at the first day of each month are marked as blue dots. The thin grey contours denote the 200 m, 1000 m and 3500 m isobaths, while the thick grey contour highlights the 500 m one.*

Scientists and crew of Leg 3 left the MOSAiC floe on May 16, 2020, sailing back to Svalbard with *Polarstern* to carry out the handover to the leg 4 team (see transit route in Fig. 1.1). The initial plan had been a flight-based exchange between the leg 3 and leg 4 teams in early April, which both the dynamic ice conditions and the breakdown of the international flight traffic imposed as a consequence of the Corona pandemic had made impossible. The ensuing risk of losing valuable equipment also forced us to recover large parts of the infrastructure on installed on the central observatory before leaving for Svalbard on May 16.

We arrived in Svalbard on the morning of June 04, 2020. Thus, we were in charge of the scientific program on board *Polarstern* and on the floe from March 3 to June 04. The drift period covered by the leg 3 team therefore amounted to 74 days, and the transit took another 19 days. The leg 4 team had arrived in Svalbard on *RV Sonne* and *RV Maria S. Merian* on May 25, 2020. Upon completion of the handover, on 8 June *RV Sonne* and *RV Maria S Merian* departed from Adventfjord (Svalbard) and took the leg 3 team including *Polarstern* crew members to Bremerhaven, where we arrived on 15 June, while *Polarstern* headed back to the MOSAIC floe.

Between March 3 (12:00) and May 16 (22:00), *Polarstern* drifted from 88° 08.5' N , 030° 33.2' E to 83° 23.5' N, 009° 06.6' E (Figure 1.1). This was a direct distance of 380 nm (compared to 712 nm for Leg 1-3).
However, the total drifted distance amounted to 521 nm (compared to 1261 nm for Leg 1-3), due to the turns and loops assumed by the drift (Figure 1.1). The average hourly drift speed was 0.27 knots, or 6.4 nm (11.9 km) per day, with a net drift speed of 0.21 knots, or 5.1 nm (9.5 km) per day. The maximum drift speed of 0.97 knots was observed on May 13, coinciding with the passage of a storm with Bft 10 winds (maximum wind speed of 25.1 m/s, see Fig. 1.2). It was this event during by which the cold air masses were removed from the Arctic, marking the final transition to summer.

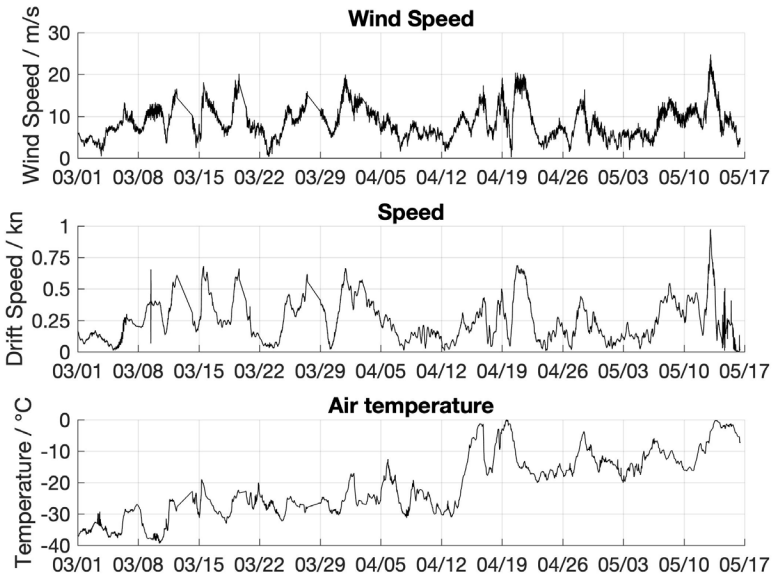


***Fig. 1.2**: Wind speed (m/s), drift speed (kn) and temperature (°C) observed aboard Polarstern during leg 3.*

1.1.3 Other notes

As during the previous legs, we organized our scientific work in five teams, namely ICE, ATMO,

OCEAN, BGC and ECO, which were supported by the LOGISTICS, DATA and MEDIA teams and by the *Polarstern* crew. We typically worked on the ice during 3 time slots, one morning block and two afternoon ones. Only on rare occasions did individual teams work on the floe in the evening or overnight. We held a science meeting each evening to prepare a work plan for the following day, and often gathered in the morning right after breakfast to discuss the safety requirements for the operations planned on that day. Our mission had been to observe the late-winter conditions of the coupled climate-ecosystem in the central Arctic Ocean. The relatively fast southward drift in March (see Fig. 1.1) meant that we crossed Gakkel Ridge earlier than anticipated, after which the influence of the saline Atlantic water masses became more apparent. The long extension of the expedition to Mid-May (compared to the initially planned flight-based exchange with leg 4 in early April) allowed us to study not only the later winter conditions but also the transition into the melt season. Scientifically, it was unfortunate that we had to leave the floe and recover major parts of the instrumentation at the time when the onset of melt pond formation became visible. By and large the teams we were able to accomplish the work goals owing to a great work spirit and the fact, that we inherited the floe and the infrastructures from the leg 2 team in a very good shape. It is the merit of the leg 3 team that we kept the sensor-based ocean, sea ice and atmosphere time series going and we carried out diverse multi-disciplinary sampling programs.

The harsh late-winter condition in the early part of the expedition, and the frequent events of ice dynamics posed at times major challenges for both the time series programs (relying on energy supply) and the sampling programs (relying on accessibility). A major setback for the water sampling program mainly of the ECO team was the loss of the CTD hole next to the ship.

The helicopter program was all in all a big success, consisting of ice remote sensing, maintenance and measurements including ice coring at the L and M sites, installations and recoveries of instruments and shuttle services to (temporarily) otherwise non-accessible areas as a result of ice dynamics. A total of 120 flight hours we accumulated. A part of the success of the flight operation was the competent forecasting service provided by the onboard DWD team.

The prevailing northerly and northwesterly wind direction meant, that the measurement program of atmospheric chemistry was strong impacted by the exhaust fume of *Polarstern*. In addition, there was a strong need for coordination between the helicopter flight program, atmospheric chemistry, and vessel loading operations. It was about managing the interests between the contamination of air chemistry measurements, safety aspects regarding pistenbullys and the availability of helicopters. During the very low temperature in March, the temperature limitation of skidoos, generators, the helicopter and the *Polarstern* cranes meant that we had to face restrictions in terms of operating these devices.

Subsequently additional logistical key dates and elements will be mentioned. On 17 March it was officially announced by AWI headquarters that the flight-based exchange between legs 3 and 4 had to be cancelled due to international mobility restrictions imposed in the context of the Corona pandemic. The scientific MOSAiC flight program had already been cancelled a few days earlier, which would have involved landings on and overflights over the MOSAiC floe. On 20 April a plan was finally approved by the members of leg 3, MOSAIC steering board and AWI headquarters regarding the handover between leg 3 and leg 4. On April 22 several members of the science crew were evacuated from *Polarstern* by two Twin-Otter planes (company Ken Borek) via Station Nord (North Greenland) to Resolute Bay, Canada (Fig. 1.3). This was a logistical masterpiece by AWI headquarters and the company Ken Borek – supported by the *Polarstern* crew and science party - in a time when the international flight

traffic had come to a complete halt. On 5 May we officially started to remove infrastructures from the ice, in order to prepare our departure on 16 May.

Fig. 1.3: *Two Twin Otter aircraft landed on the runway next to Polarstern on 22 April in order to evacuate members of the leg 3 team. Also shown is the Polarstern helicopter used to transfer the scientists and their luggage to the runway. Photo taken by T. Kanzow*

1.1.4 Selected scientific impressions

We experienced a high degree of ice dynamics involving the formation of both quickly refreezing leads and pressure ridges. The ridges and leads posed strong challenges in maintaining the observatories and conducting the field program during leg 3. At the same time, they offered ample opportunities for the study of the coupled atmosphere-ice-ocean-ecosystem. We therefore expect important scientific outcomes, for instance in studying the role of roughness induced by the ridges on the energy exchanges between the different compartments. The leads in turn prove to be centres of enhanced biological activity, accompanied by the production of dimethylsulfide (DMS), whose concentrations were clearly enhanced in the newly formed lead ice. DMS constitutes a possible precursor of cloud condensation nuclei, therefore representing an example of biological activity affecting the state of the Arctic climate system.

Snow on sea ice strongly regulates the ocean-to-atmosphere heat flux though the sea ice with implications for sea ice formation rates. However, very little was known regarding the snow accumulation on sea ice in the Arctic winter. During leg 3 we found the spatial snow thickness distribution to be quite inhomogeneous, with snow mostly accumulating near pressure ridge and at the edges of new leads whereas hardly any accumulation occurred on the level ice. In order to make robust statements on future sea ice retreat, climate models will have to exhibit realistic snow thickness distributions, with the MOSAiC data set representing a valuable calibration point.

The ocean mixed layer is in direct contact either with sea ice or with the atmosphere (during the occurrence of leads) and thus plays an important role in the energy exchange via turbulence. Our measurements revealed that the turbulent energy dissipation in the mixed layer was strongly tied to phases of fast drift of the floe driven by episodes of strong winds (see Fig. 1.2). The mixed layer depth roughly doubled between early March and Mid May, going along with a marked increase in salinity. This is in part a consequence of the seasonal salt rejection in winter time but also results from regional gradients across the Arctic given the distance of 380 nm which the MOSAiC floe covered during leg 3.

The end of the winter and the onset of the ice melt did not occur gradually but was linked to episodes of warm air intrusions in April (see Fig. 1.2). Finally, the passing of the strongest storm we experienced (10 Bft) resulted in the erosion of the Arctic air masses on 13 May which marked the end of winter and the onset of melt pond formation (occurring roughly 2 weeks earlier than normal).

1.2. Ice conditions

The thermodynamic ice growth during leg 3 amounted to roughly 35 cm in total. By the time of departure of *Polarstern* from the floe on May 16, sea ice growth had come to a halt, and onset of surface melt became apparent. Contrary to expectations, the sea ice turned out to be very dynamic already early on during our drift (compare lead formation between panels A and B in Fig. 1.4), resulting in a series of lead formation and ridging events, posing a strong challenge to our work. Already by mid-March, we had to abandon the idea of extending the existing (or building a new) runway for the flight-based exchange between Leg 3 and Leg 4 planned for early April, that would have relied on an Antonov plane.

The fact the *Polarstern* was located in a shear zone between two floes from Mid-March did not allow us to use the pistenbullys to access the existing, damaged runway for repair purposes. The conditions also led to frequent disruptions of the electrical power supply to the “cities”, because *Polarstern* was moved back and forth along the MOSAIC floe. This challenge stayed with us for the entire duration of leg 3. A particular concern early-on was the lead-pressure ridge system that had developed between the vessel and Met City / Remote Sensing. With easily accessible parts of the central observatory having shrunk to an area of roughly 400 by 500 m (i.e. the area not affected by ridging) by Mid-March, the need of the snow measurement program for space not affected by human activity posed a challenge for other science activities.

In certain phases of April the ice became less dynamic, such that the group were able to get into a regular work rhythm. We were able to collect time series of snow and ice properties and of the upper ocean, and the atmosphere. A plan to re-locate the vessel to a different position around the remaining part of the central observatory, beyond balloon town, in order to provide more stable conditions for *Polarstern* and possibly have the opportunity to create another CTD hole was ultimately decided against in order not to destroy ice and snow sampling fields. On 28 April for the first time a lead occurred that went right though the logistics area along-side the ship (see consequences below). The passing of the strongest storm during lead 3 on 13 May (Fig 1.2) resulted in a major breakup the ocean central observatory into numerous smaller floes. The situation on 16 May is depicted in Fig 1.8. Note that this image was taken by drone, after *Polarstern* had started to re-locate in order to get remaining parts of the measurement infrastructure on board as part of the departure from the floe.

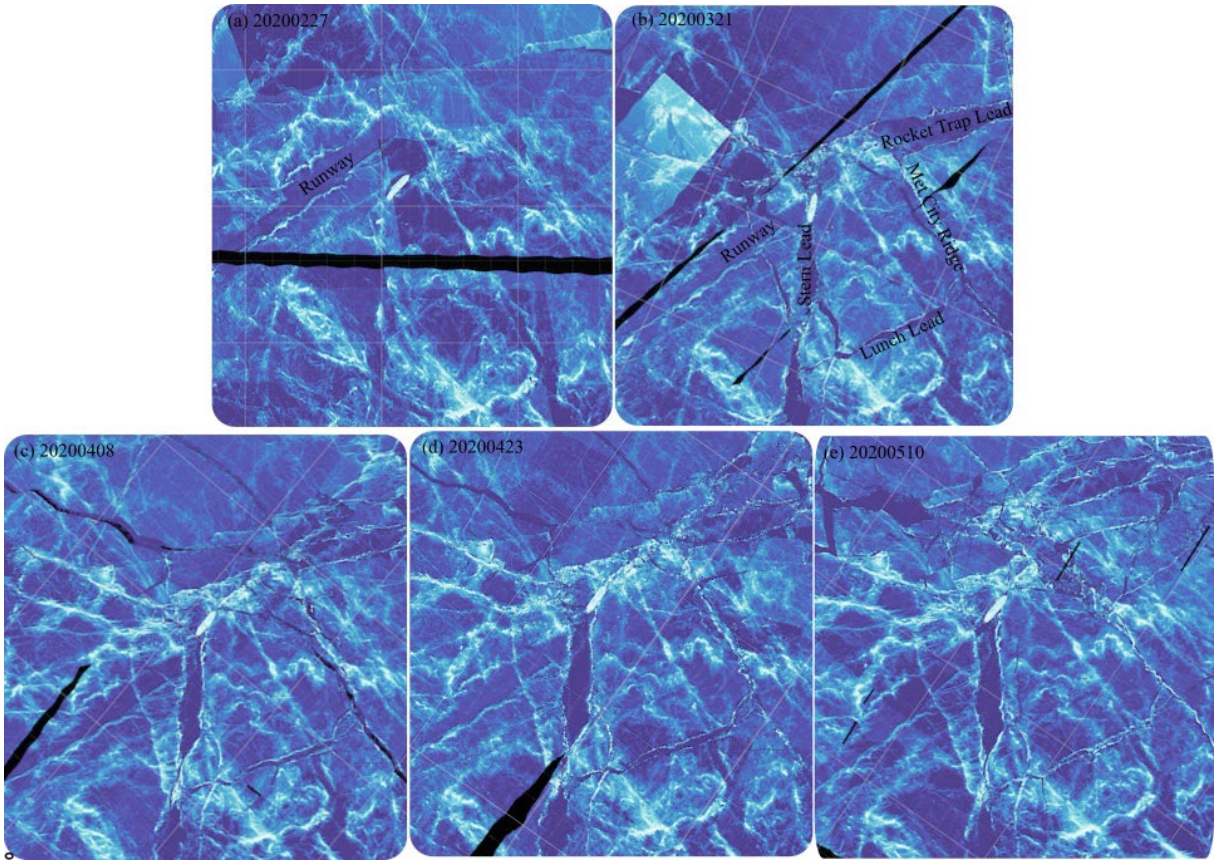


Fig. 1.4: *Five helicopter-based airborne laser scanner (ALS) maps on 27 Feb (a), 21 March (b), 8 April (c), 23 April (d) and 10 May (e), orientated such that the consolidated ridge in Snow 2 always points to the same direction. As everything was rotating, including the ship, the ridge in Snow 2 was chosen as reference point. The series of images does show nicely the difficulties we had in accessing Met City.*

Tab. 1.1: *Key dates of the expedition PS122/3*

Date	Action
27 January	Departure of Kapitan Dransitsyn from Tromsø
28 February	Kapitan Dransitsyn arrives at Polarstern
03 March	Leg 3 team takes over from Leg 2
06 March	Departure of Kapitan Dranitsyn with Leg 2 team on board
10 March	Lowest temperature recorded
11 March	First major lead event
13 March	MOSAIC flight campaign cancelled
13 March	End of Polar Night (1st sunrise)
15 March	Loss of CTD hole next to Polarstern
17 March	Announcement that flight-based exchange will be cancelled due to Corona
21 March	Begin of Polar Day (last sunset)
25 March	Re-Opening of Remote Sensing next to BGC1
20 April	Approval of plan for leg 3 - 4 exchange
22 April	Evacuation flights by Ken Borek
28 April	Lead occurring in central observatory
05 May	Start packing instruments
13 May	Passing of strongest storm even during leg 3
15-16 May	Departure from the floe
02 June	Arrival at ice edge north of Svalbard
04 June	Start of handover in Adventfjord (Svalbard)
08 June	Departure of Polarstern, Sonne and Merian from Svalbard
15 June	Arrival of Sonne and Merian in Bremerhaven

1.4. Floe Maps: State and evolution of ice camp

All installations and sites on the ice on the main floe around *Polarstern* are called the 'Ice Camp' or 'Central Observatory' (CO). By the end of Leg 1, the ice camp consisted of 5 Cities, 15 dedicated sampling and measurement sites (plots) and some 150 individual instruments and installations. By the end of leg 2, there were 16 plots (counting overlapping plots) and additional three remote sites outside the CO within 2 km of *Polarstern* (the two Dark Site plots and an area near the old heli pad). These elements were connected through a network of largely flagged walkways and roads, including several km of power and data cables on tripods (Fig. 1.5 shows the situation on 27 February, thus basically the setup leg 3 took over from leg 2 in early March).

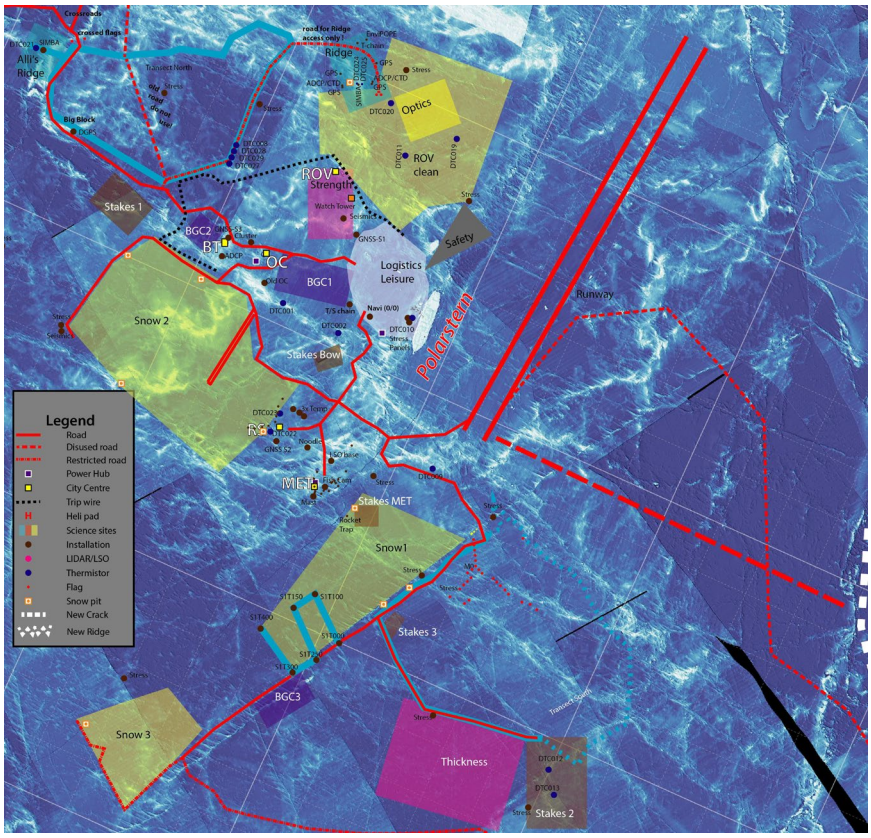


Fig. 1.5: *Central Observatory based on an Air-borne laser scanner (ALS) survey taken on 27 February by the leg 2 scientists. The orientation is such that the bow of Polarstern points to the south. The background image shows surface elevation derived from the airborne laser scanner The solid-line grid shows mesh sizes of 500 x 500 m², the dashed-line mesh size is 100 x 100 m².*

On 11 March – 8 days after the leg 3 team had taken over - the situation changed as a consequence of ice dynamics. In the morning a lead opened, which - coming from the southern end of the runway – extended across the hull of *Polarstern* and further along ROV City (such that ROV City was still part of the central floe). All ice anchors of *Polarstern* became loose. Another lead opened which ran from the runway behind Met City. In the afternoon a third one opened, which went from the bow of *Polarstern* in front of Met City and Remote Sensing from East to West. On 15 March, the CTD hole on the on the starboard side of the ship had to be given up, because of the motion of the ship along the floe segment on its starboard side. This constituted a major setback for the water sampling program mainly of Team ECO, that unfortunately remained could not be solved until the end of leg 3. Water sampling activities were subsequently shifted to Ocean City in order to partly compensate for the loss. In the following 2 – 3 weeks we experienced further massive ice dynamics.

As a consequence, only an area of 500 by 400 m on the starboard side of *Polarstern* was easily accessible (see Fig. 1.6), as it was surrounded by a system of quickly refreezing leads and ridges. On this floe segment, Ocean City, Balloon Town and ROV City were located. Instead Snow 2, Stakes 1 and the ROV clean area were heavily affected by the ice dynamics with leads running through them and shear motion occurring (see, for instance, see the shearing of Snow 2 and Stakes in Fig. 1.6). Met City had become disconnected from the intact floe segment.

In addition, lead formation, ridging and shearing made Met City and Remote Sensing become particularly affected in terms power cable disconnections. In fact, Remote Sensing was re-located re-located from its previous site (see Fig. 1.6) onto the intact part of the flow close to BGC1 in order to ensure a continuous power supply. It restarted operations on 25 March. We set up fuel-powered generators at several of the cities to ensure power supply during period of cable connection failures. Since the latter were not designed for continuous use, failures occurred a number of times. Subsequently, also the Droneville (DV; unmanned aerial vehicle facility) site also needed to be relocated (see change of site DV between *Polarstern* and Met City in Fig. 1.6 and to site DV2.0 located beyond Snow 2 in Fig. 1.7).

Also, it goes without saying that the dynamics created challenges in our mobility, with sites like Met City, Dark Site, Snow 3 and Fort Ridge being regularly inaccessible. Nonetheless, the ice coring activities coordinated between the teams ICE, BGC and ECO amounted a wealth of data at the Dark Side (both FYI and SYI sides) and on three BGC sites, and the ice transects and states measurements were repeatedly conducted.

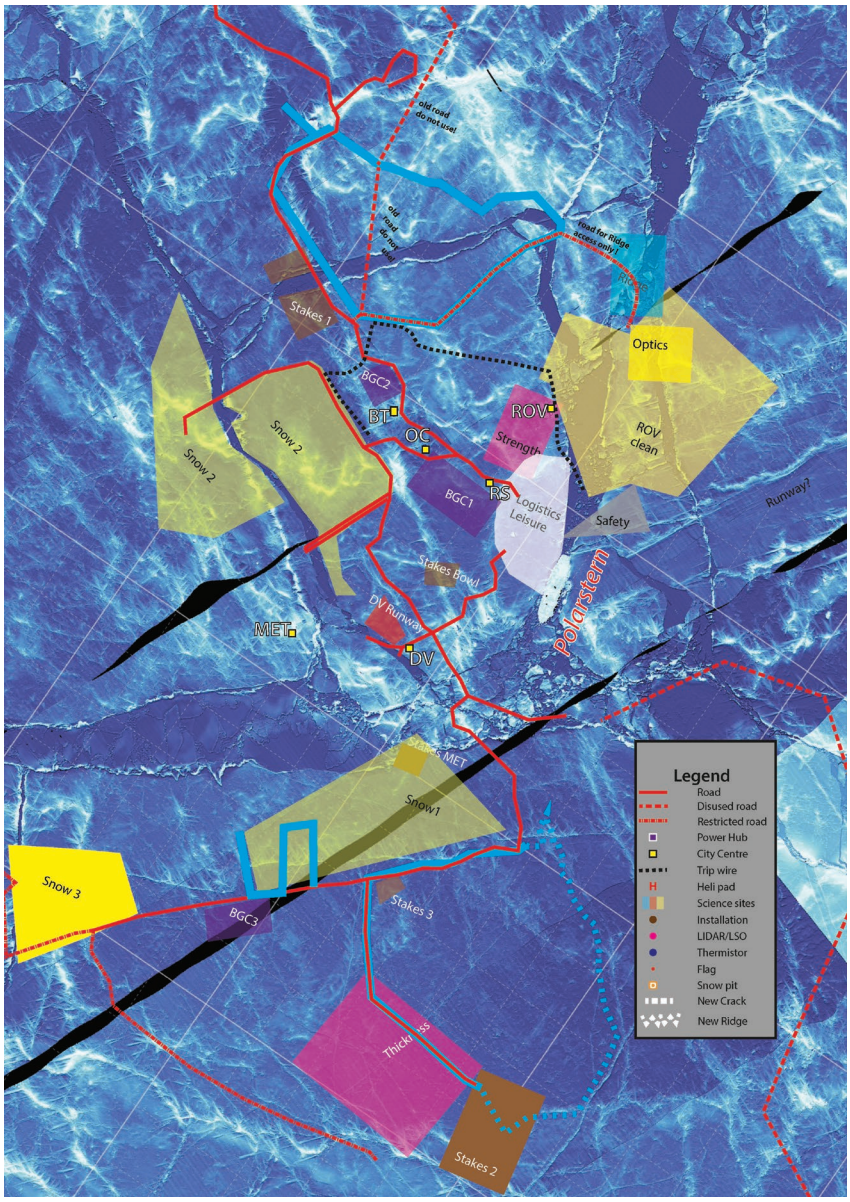


Fig. 1.6: *Map compiled on 24 March of the central Observatory and adjacent sites based on an Air-borne laser scanner survey taken on 21 March. The orientation is such that the bow of Polarstern points to the south.*

Near the end of April (day 28) a lead opened for the first time in the logistics area, extending all the way though ROV City and beyond. This meant the OCEAN City did not reside any longer on the same floe as the logistics area. From 5 May onward we started clearing the floe and bringing instrumentation and other pieces of equipment toward the logistics area. The floe map in Fig. 1.7 basically shows the arrangement of sites just before we started the clearing of the floe. The approaching of a major storm hitting us during the night from 12 May to 13 May, lead us to bring the measurement equipment from the different Cities on board until 12 May. The clearing involved Balloon Town, Remote Sensing, Ocean City, Met City, ROV City, Droneville 2.0, several distributed oceanographic and ice buoys, equipment in the logistics area, orientation marks, etc.

On the same evening a major disintegration of the floe started, which ultimately determined the end of the MOSAiC floe, the way we knew it (see Fig 1.9 comparing the situation on April 23 and May 16). Some pieces of equipment could not be rescued from the ice, such as the

Met City hut, several oceanographic buoys at Met City and the ROV tent, which were destroyed by pressure ridges before our eyes.

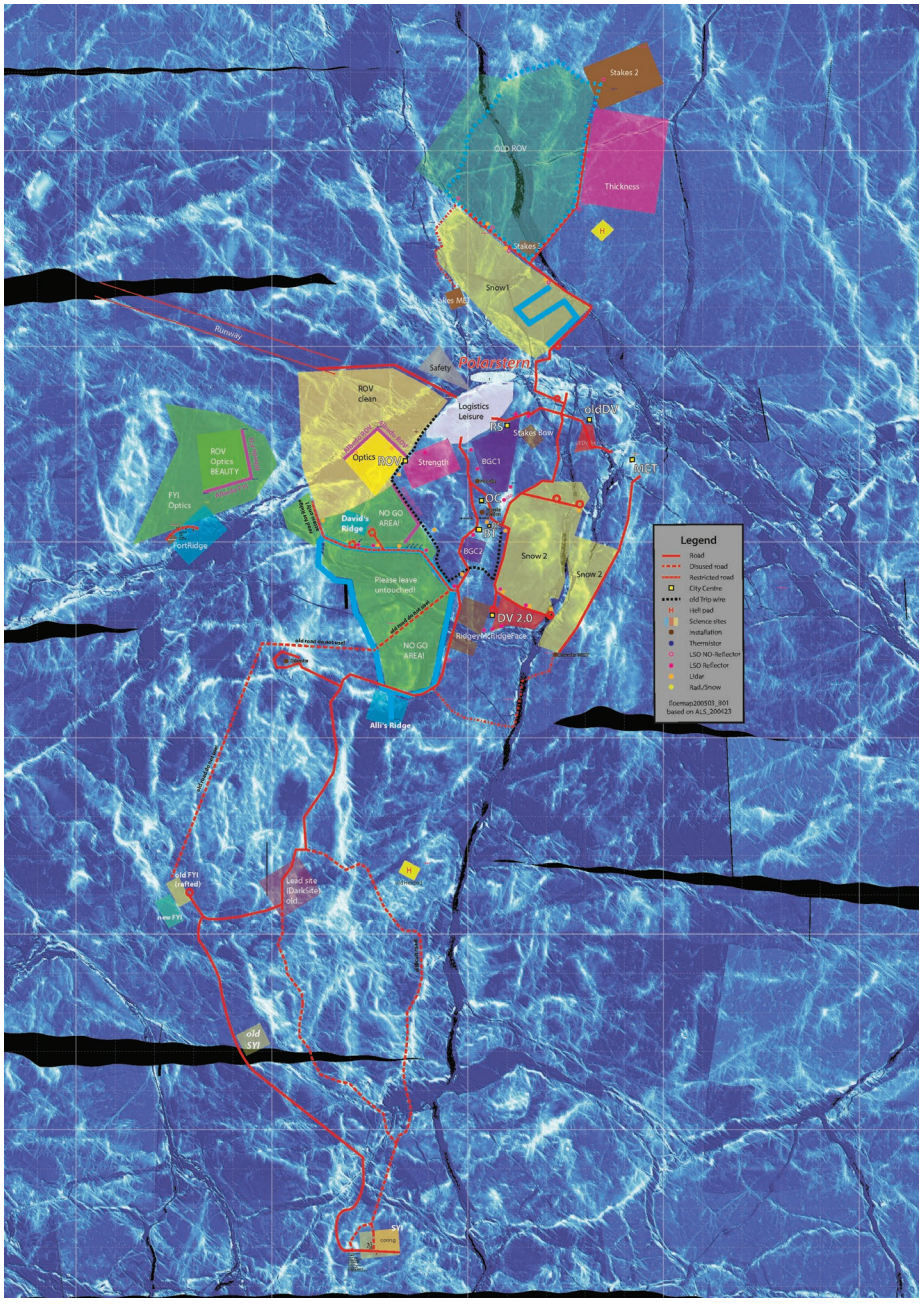
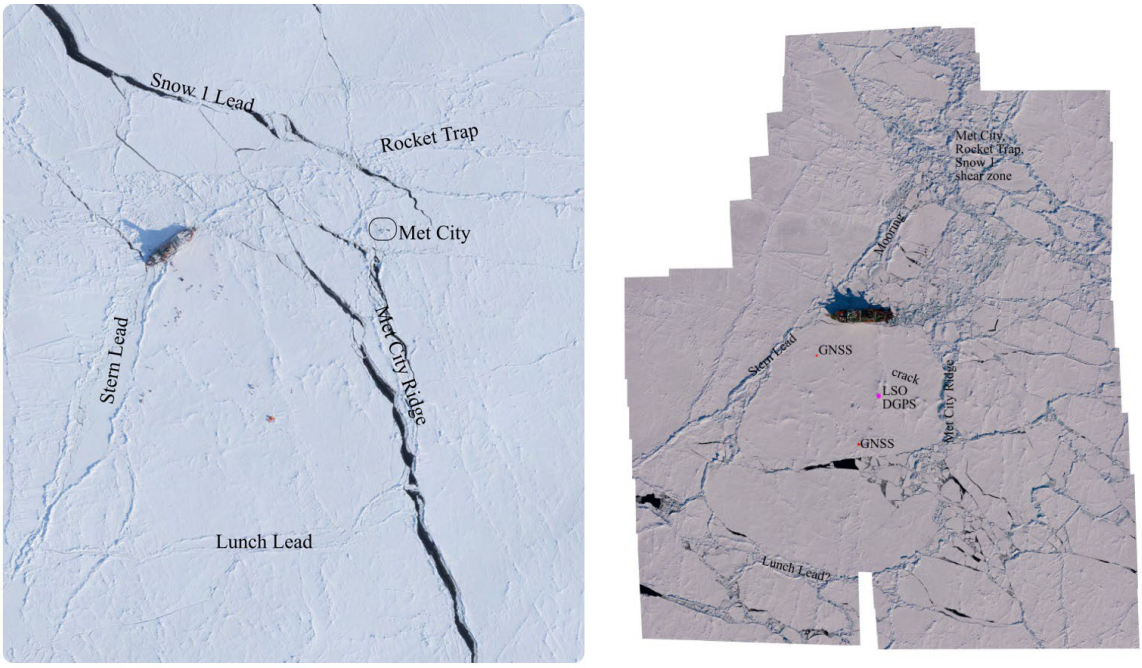


Fig. 1.7: *Map compiled on 3 May of the central Observatory and adjacent sites based on an Air-borne laser scanner survey taken on 23 April. The orientation is such that the bow of Polarstern points to the south.*



April 23: Aerial photo mosaic, Robert Ricker

May 16: Drone photo mosaic, Manuel Ernst

Fig. 1.8.: *Arial photography of the MOSAiC floe on 23 April (taken by helicopter) and 16 May after the relocation of Polarstern (taken by a drone).*

1.4. State and evolution of Distributed Network

The Distributed Network of medium (M) and large (L) buoy sites was deployed during leg 1a from *Ak Fedorov*. The location of the different sites in the DN relative to *Polarstern* changed significantly throughout the drift. The status and the start and toward the end of leg 3 is shown in Fig. 1.9.

The network of position tracking (GPS) buoys, such as “SVP”, consisted of 43 sites at the start of leg 3. With the sun returning on Leg 3 we aimed to deploy buoys to maintain a symmetrical shape of the array for deformation analysis, and to fill in gaps so deformation around M and L site could be estimated. On March 17, seven position tracking buoys were added. Six SVPs were deployed March 20th, and four SIMBA buoys placed in a 7km box around the CO on April 4th. At the end of Leg 3 49 position buoys and 6 SIMBAs were reporting from the P sites. In total during legs 1 to 3, 75 position buoys had been deployed and 6 SIMBAs at P-sites in the DN.

During leg 2 a deformation event at L3 had damaged some of the buoys there. Early in Leg 3 another ridging event at L1 sheared the site, destroying the Arctic Surface Flux System (ASFS) at L1, placed the WHOI Ice Tethered Profiler in the ridge and sheared the Arctic Ocean Flux Buoy to a location that was not found. At L2 all instruments continued to work, except the ASFS which had a power generator failure.

L-sites and M-sites were surveyed during visits for ASFS servicing, coring and CTDs. Photographs were taken of buoys, and the status of snow and ice reported. Depth of snow under snow buoys was recorded. The M and L site buoy status at the end of leg 3 is documented in table 1.2. Snow buoys were serviced at sites M1, M3, M6, L1, L2, L3, The ITP at L1 was serviced, replacing a data cable. This buoy started reporting data again some days after the service. The FIO fixed layer ocean buoy at L1 was recovered. One radiation buoy was deployed at L3 on April 24th.

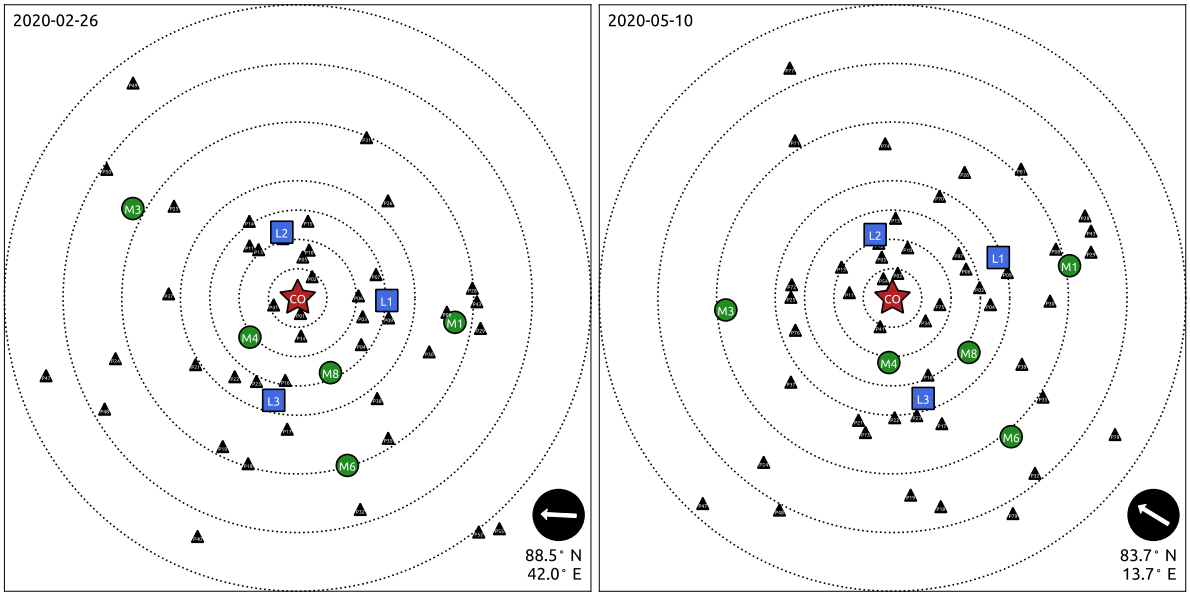


Fig. 1.9: *Maps of the DN is polarsteriographic projection. Position of the L-sites (blue squares) and M-sites (green circles) and P-sites (black triangles) in the Distributed Network, relative to Polarstern (red star), on 26 Feb (left) and 10 May (right) 2020. LM (Dark Site SYI) was omitted as it is very close to Polarstern. The dotted circles are range from the buoy marking the central observations (CO), at 5, 10, 15, 20, 30, 40 and 50km. The location of the CO and direction to north is given in the right bottom corner of each panel. Figure credit to Daniel Watkins.*

Tab. 1.2: *Status of buoys at the L and M sites.*

Site	Buoy	Date	Comment
L1	AOFB		Lost, not reporting
	ITP		Serviced
	SIMBA PRIC0906	2020-06-02	Reporting
	ASFS	2020-03-18	Destroyed, confirmed by visit
	FIO Fixed-layer		Recovered
	ITBOB (radiation/IMB/biooptics/CTD)		

	Snow	2020-06-02	Reporting
L2	Snow	2020-06-02	Reporting
	ITP		
	AOFB		
	ITBOB (radiation/IMB/biooptics/CTD)		
	ASFS	2020-04-06	Recovered
	SIMBA PRIC0902	2020-06-02	Reporting
	SIMBA PRIC0904	2020-06-02	Reporting
L3	Snow	2020-06-02	Reporting
	ASFS	2020-03-26	Recovered
	AOFB		Not Reporting
	ITP		Not Reporting
	SIMBA FMI0603	2020-06-02	Reporting
	PRIC Unmanned Ice Station		
	Radiation Buoy	2020-04-24	Deployed
M1	SIMBA fmi0602	2020-06-02	Reporting
	PG CTD	2020-06-02	Reporting
M2	SIMBA fmi0508	2020-01-18	Stopped Reporting
			No other buoys reporting to my knowledge since leg 1
M3	Snow	2020-06-02	Reporting
	SIMBA fmi0509	2020-06-02	Reporting
	PG CTD	2020-06-02	Reporting
M4	SVP5S	2020-06-02	Reporting
	SIMBA fmi0510	2020-06-02	Reporting
M5	PG CTD	2020-06-02	Reporting
	SIMBA fmi0605	2020-04-28	Stopped Reporting
M6	PG CTD	2020-06-02	Reporting
	Snow	2020-06-02	Reporting
	SIMBA pric0903	2020-06-02	Reporting
M7			All buoys lost Leg 1
M8	SIMBA fmi0602	2020-06-02	Reporting
	PG CTD		Not reporting since leg 1