ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR-
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Campaign report July/August 2025

IceBird Summer 2025 Campaign

Sea ice surveys with Polar 6 from Station Nord

HELMHOLTZ ASSOCIATION

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IceBird Summer 2025 campaign

Campaign overview	
Base/Route	Longyearbyen / Station Nord / Longyearbyen
Duration	July 20 – August 25, 2025
Survey hours	58 (without ferry and transfer flights)
Aircraft	Polar 6
Crew	Robert McIntyre (captain, July 20-31), Kyle McLenaghan (captain, August 01-25), Dario Giorgio (first officer), Mireille Paquette (AME)
Science	Eduard Gebhard (engineer, July 20-31), Maximilian Stöhr (engineer, August 01-19), Mara Neudert (scientist), Gerit Birnbaum (PI)

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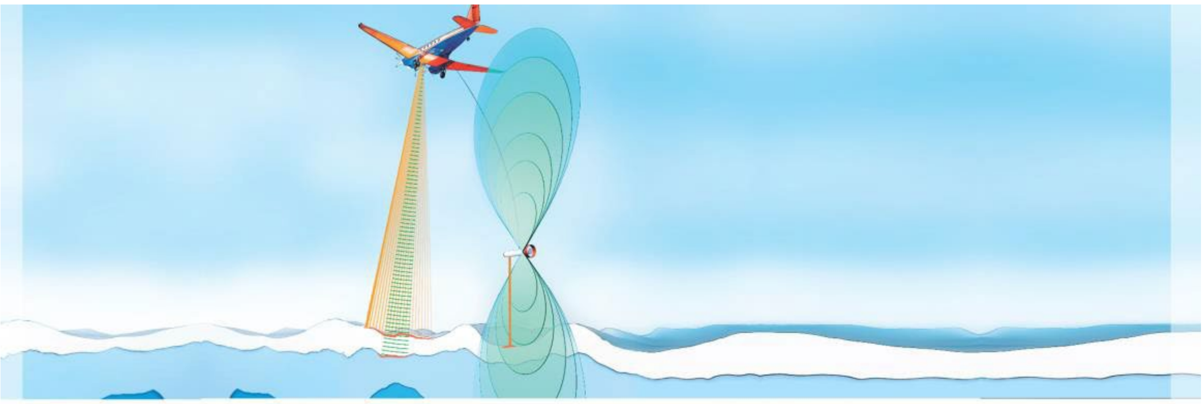


AWI IceBird

Leading Airborne Program for Direct Sea Ice Observations

1.0 Objectives

The AWI IceBird program, conducted by the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), is a series of airborne surveys to collect measurements of sea ice thickness in the Arctic. Airborne surveys enable the characterization of sea ice thickness distribution, distinguishing between thermodynamic growth and dynamic processes, and offer valuable information on the composition, structure, and seasonal evolution of the ice cover. Additional foci are melt pond characteristics in summer and snow cover characteristics in winter. The AWI IceBird campaigns take place twice a year: In summer (July/August) and winter (March/April), when sea ice extent and thickness are at their minimum and maximum, respectively.

The survey program comprises and continues all airborne ice thickness measurements obtained since 2002 in the central Arctic, the Fram Strait and the Last Ice Area with the objective to ensure the long-term availability of a unique data record of direct sea ice thickness and surface state observations. IceBird's ice thickness measurements use a tethered electromagnetic sensor, the EM-Bird, towed by research aircraft 50 feet (15 m) above the ice surface. Parallel to the ice thickness measurements, laser scanners and optical systems are operated to derive sea ice surface topography as well as melt pond fraction and characteristics.

Long-term objectives and special scientific focus in 2025

With the survey flights in 2025 we intended to repeat flight tracks of previous years and as such to expand insights into long-term variability and trends in ice thickness and ice surface properties over the past two decades.

In addition, a certain amount of flight hours was used for joint surveying activities with RV Polarstern cruise PS149/CONTRASTS. CONTRASTS focused on in-situ observations in three different sea ice regimes: First-year ice that formed during last winter and is expected to dominate the Arctic in the future; second-year ice, which has drifted over the pole along with the Transpolar Drift before melting in the Fram Strait, characteristic of the present status quo; and multi-year ice, which has resided north of the Canadian Arctic Archipelago and Greenland for years, in the so-called "Last Ice Area", which has declined in extent over the past decades. By the time our aircraft campaign started, the team on RV Polarstern had already set up observation networks / ice stations on three ice floes representing these regimes. Each floe was visited by RV Polarstern several times. Our airborne surveys in the CONTRASTS expedition region will help to better understand the differences, transitions and gradients between the three sea ice regimes. Our grid surveys over the ice stations in second- and multi-year ice will enable comparisons of sea ice property measurements obtained from ground-based, helicopter and drone-based surveys with those acquired from the aircraft Polar 6.

2.0 Methods and Sensors

Survey flight organization and pattern

To maximize the flight range of polar aircraft, IceBird Summer is designed as a lightweight campaign. Therefore, instrumentation is limited to the EM-Bird, laser scanners, optical and infrared cameras, and radiation sensors to document sea ice properties.

Standard IceBird survey flights were made from the operation base (Station Nord) towards one or more pre-defined points of return. The point of return and profile length were chosen according to fuel capacity, weather conditions, and ice conditions.

Each survey typically consisted of two parts. In the first, sea ice thickness and morphology were measured with the EM-Bird, laser scanners and camera systems at low flight altitude (50 feet bird altitude). In the second, morphology and melt ponds were observed with only the laser scanners and camera systems at higher altitude (1000 feet aircraft altitude), usually along the same flight line(s) as in the first part.

Weather and Sea Ice Information

In general, assessing the weather situation at Station Nord, at our alternate Longyearbyen, and over the survey areas is based on different sources of information. Main components are aviation weather forecasts, the use of the weather app windy.com (premium) and the use of forecast products provided by the German Weather Service (DWD) (see Fig. 1 and 2). The latter include real-time satellite images, which allow for a detailed assessment of the cloud situation and the detection of fog and clear sky regions. The satellite images are most helpful especially in the morning or during stand-by for a potential flight to develop suitable flight plans for the coming hours.

Weather information from the German Weather Service were obtained via SFTP. The DWD provided satellite images, a selection of meteograms for different key locations as well as forecast maps for spread (dew point difference), cloud cover (total, low, medium, high), surface pressure, wind, temperature, and humidity. All of these parameters were provided from the ECMWF forecast system, and some in addition from the GFS forecast system. Both model systems are initialized at 00UTC and 12UTC, and data are available with a 4-9 h delay.

Near-real time sea ice information (sea ice concentration (see Fig. 3), drift forecasts and Sentinel-1 imagery) were obtained via the https://icysea.app/ developed by [Drift+Noise Polar Services](#).

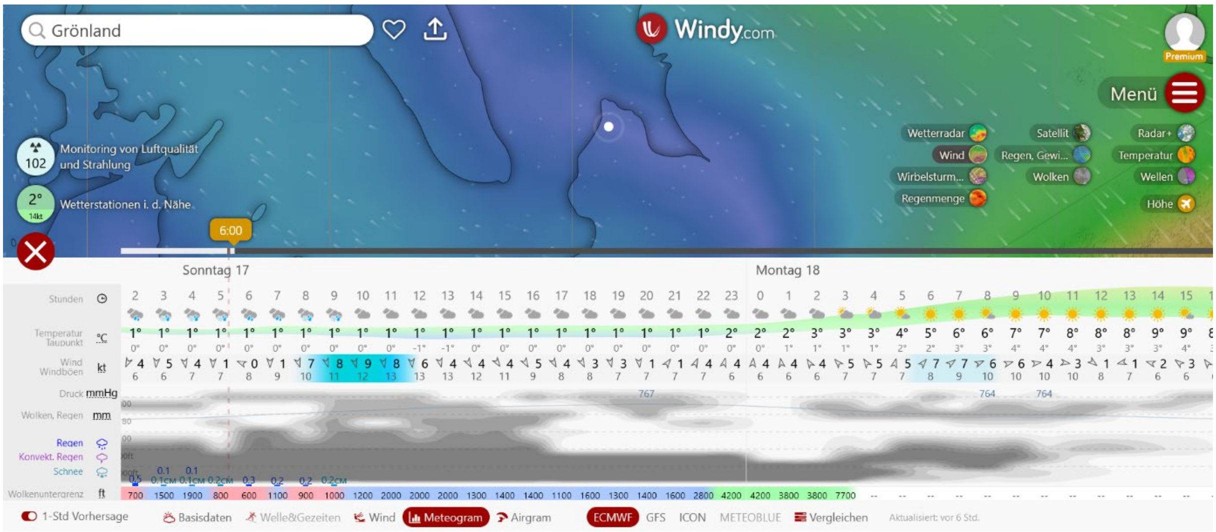


Figure 1: Example for an ECMWF meteogram provided by the Windy.com App for Station Nord on August 17th, 2025.

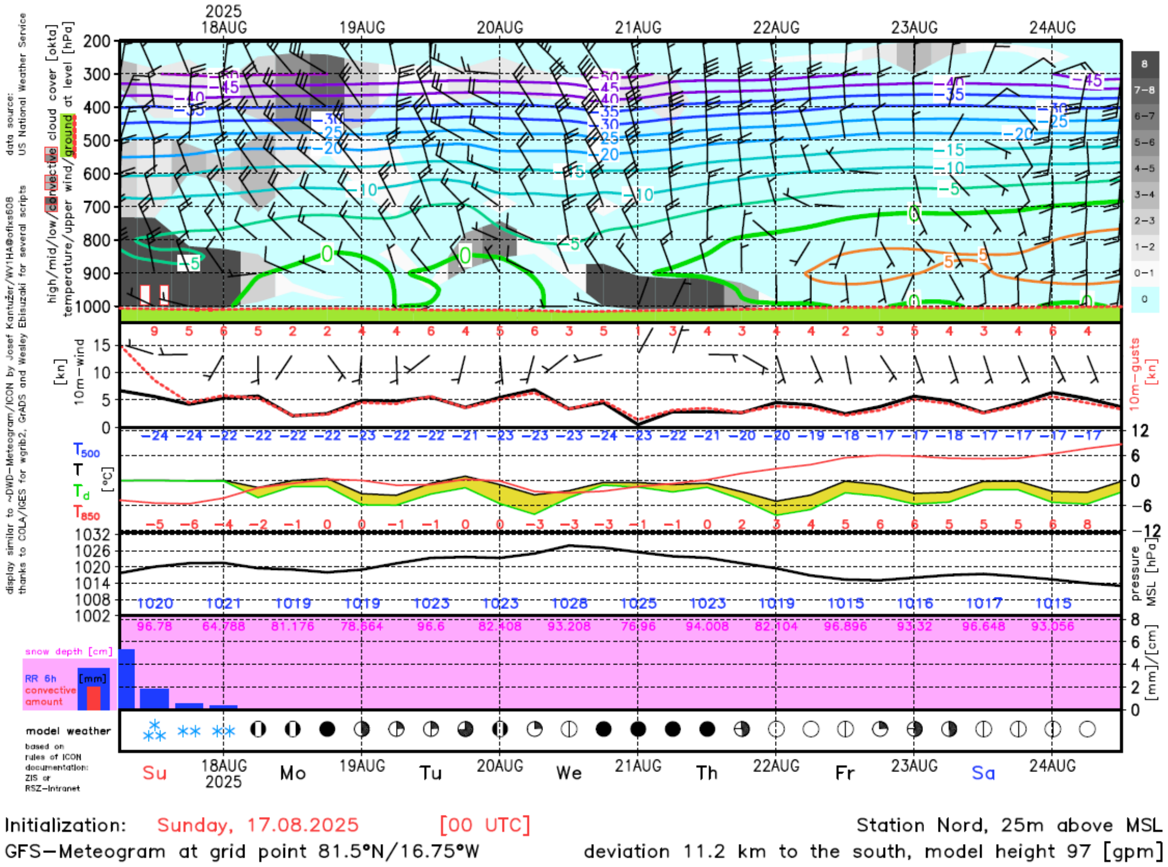


Figure 2: Example for a GFS meteogram provided by the DWD for Station Nord on August 17th, 2025.

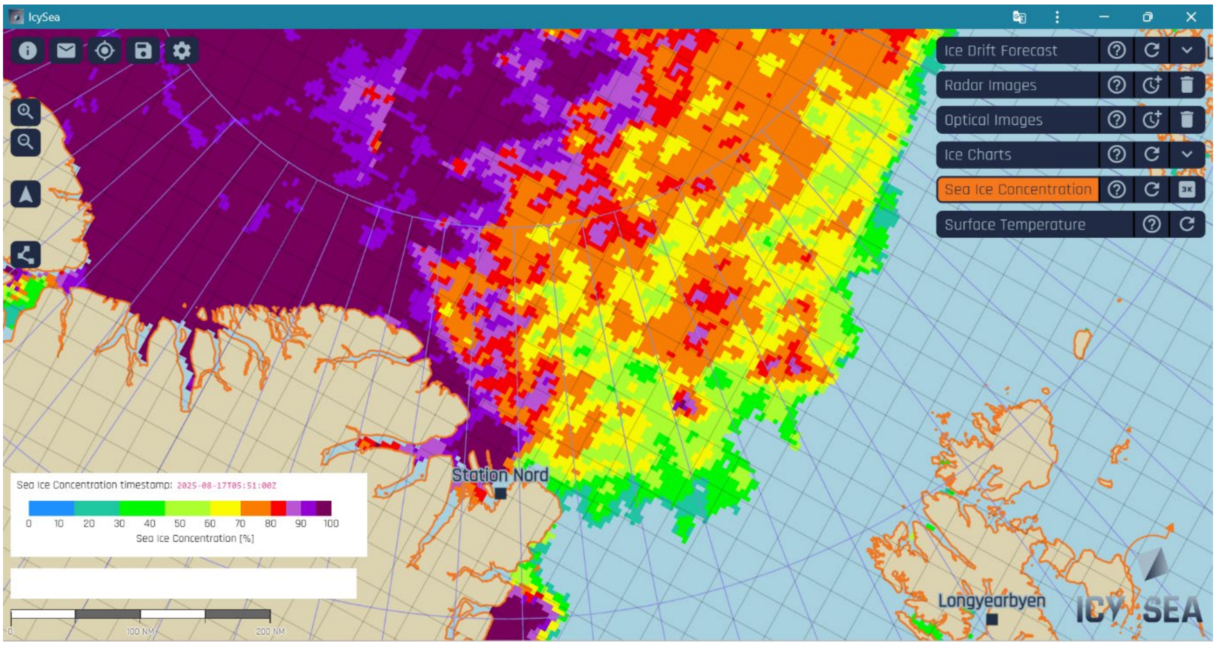


Figure 3: Screenshot of the IcySea App providing sea ice concentration (example for August 17th, 2025).

Instrumentation

The electromagnetic induction sounding sensor, short **EM-Bird,** is a sensor system that is towed by a research aircraft nominally at 50 feet above the ice surface. The EM sensor utilizes the contrast of electrical conductivity between sea water and sea ice to determine the distance of the instrument to the ice-water interface (EM distance). An additional laser altimeter in the EM-Bird provides the distance to the snow/ice surface. The difference between EM and laser distance measurements is the ice plus snow thickness with an accuracy in the order of ±0.1 m over level sea ice. The so-retrieved thickness data enables us to determine the general thermodynamic and dynamic boundary conditions of ice formation. The most frequently occurring ice thickness, the mode of the distribution, represents level ice thickness and is the result of winter accretion and summer ablation.

The **MACS** (Modular Aerial Camera System) is a photogrammetric camera developed by DLR's Institute of Optical Sensor Systems. It consists of a computing unit and a sensor head. The sensor head is equipped with matrix array CCD/CMOS/thermal-infrared cameras and is mounted in the lower fuselage providing free downwards view. To meet the specific requirements of each application, the sensors, their geometry, and spectral settings are adjusted accordingly.

For IceBird Summer 2025, two airborne laser scanners **(ALS)** were installed in Polar 6. From data of the near-infrared Riegl VQ-580 scanner, sea ice surface roughness and freeboard of floes are derived. From data of the green Riegl VQ-860-G scanner, melt pond bathymetry is determined. Both scanners were operated during EM-Bird flights as well as at higher survey altitudes (without EM-Bird).

3.0 Campaign overview

Sea ice age, drift trajectories and origins in summer 2025

Different sea ice regimes in terms of age and origin were derived from two different satellite-based estimates of age and motion (pers. comm. Thomas Krumpen). The first method for determining ice age and origin is based on a Lagrangian drift model called *IceTrack*, which tracks points on a 25×25 km grid back in time. Drift trajectories are computed using the OSI-405-c motion product (Ocean and Sea Ice (OSI) Satellite Application Facility (SAF), Lavergne et al., 2016). The tracking approach works as follows: sea ice is tracked backward from a grid point on a daily basis, halting when the ice reaches the coastline or fast ice edge, or when the satellite-based ice concentration (provided by OSI-430-a and OSI-450-a, OSI SAF) at a given location falls below 20%. The ice age is then inferred from the temporal length of the trajectories (Krumpen et al., 2020). A detailed description of *IceTrack* is provided in Krumpen et al. (2025). Figure 4 provides an overview of the sea ice age north of Fram Strait derived from *IceTrack* for July 1st and 15th 2025, as well as for August 1st, and 15th 2025.

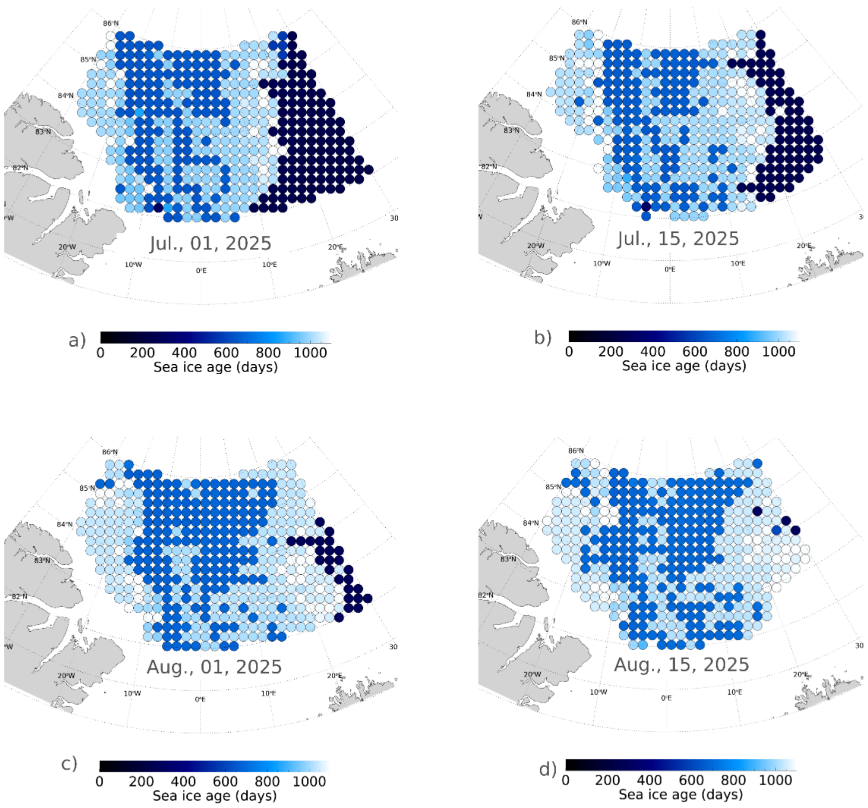


Figure 4: Sea ice age at four different times during the expedition, derived from IceTrack, a Lagrangian trajectory model. Values are given in days.

In addition, the NSIDC ice age product was used for the identification of different ice regimes. The NSIDC product is based on a similar Lagrangian tracking approach, using weekly gridded ice motion vectors (v.4.1, Tschudi et al., 2020). The weekly product is provided on a 12.5 × 12.5 km grid. Figure 5 presents the weekly sea ice age in Fram Strait, displayed at two-week intervals. Its physical approach differs slightly from *IceTrack* and follows the principle of "oldest ice age assignment": if two parcels of different ages are advected into the same grid cell, the oldest age is assigned to that cell, under the assumption that younger ice is more easily deformed than older ice (Regan et al., 2023). The NSIDC sea ice age product is a widely used reference for monitoring changes in the Arctic sea ice cover because of its high consistency and extensive temporal and spatial coverage (e.g., Ye et al., 2023). We gratefully acknowledge Scott Stewart, Mark Tschudi, and Walt Meier for providing accelerated access to the NSIDC sea ice age data.

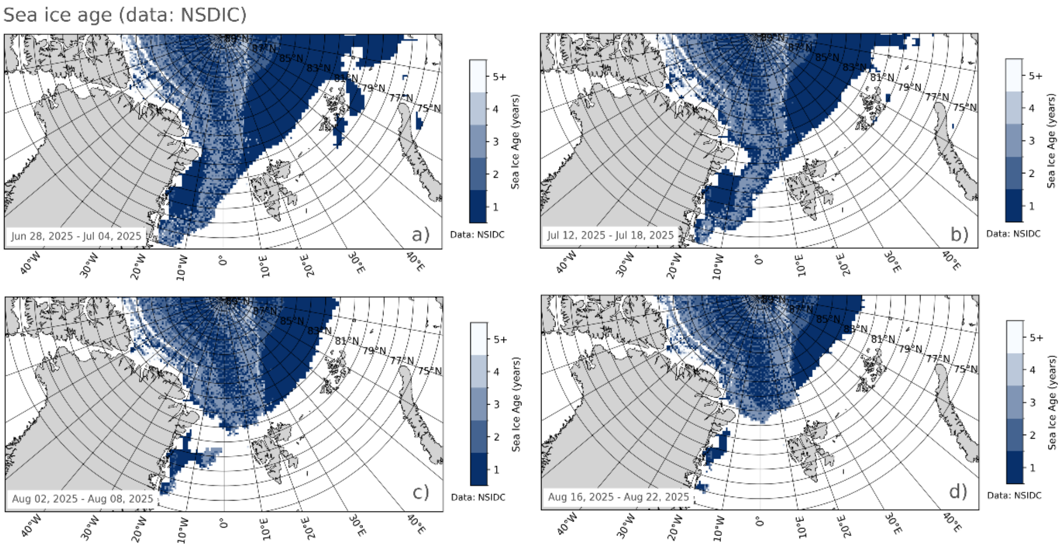


Figure 5: Sea ice age estimates derived from the NSIDC product, expressed in years (source: Scott Stewart, NSIDC).

To identify ice regimes beyond those defined solely by ice age, we additionally used sea ice surface roughness information derived from the ICESat-2 satellite. These data were provided by Kyle Duncan and Sinead Farrell for February 2025, which we gratefully acknowledge. In addition to surface roughness, the dataset includes information on sail frequency (n/km) and the height of pressure ridges at the basin scale (for details see Duncan and Farrell, 2022). To make the February data applicable to the summer months, we used *IceTrack* to advect the ICESat-2 observations forward by 120 days, thereby obtaining an impression of the morphological regimes at the beginning of the expedition (pers. comm. Thomas Krumpen). The results of the forward-advected ICESat-2 data from February are presented in Fig. 6.

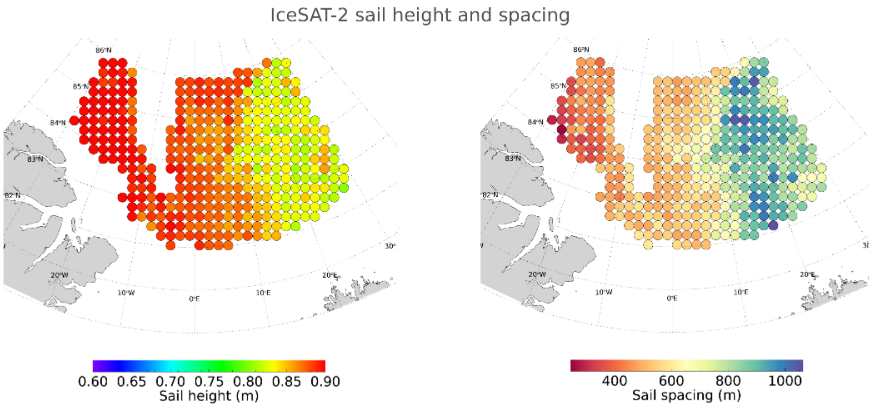


Figure 6: Sail spacing and sail height derived from ICESat-2 observations in February 2025. To enable their use for expedition planning, the data were advected 120 days forward with IceTrack to July 1st 2025.

Satellite data to support flight planning

Near-real-time synthetic aperture radar (SAR) data supported planning of flight tracks. The widest spatial coverage of the campaign region was provided by ESA Sentinel-1 imagery, with acquisition frequency temporarily increased for the duration of the simultaneous CONTRASTS cruise (see Fig. 7). Sentinel-1 and RCM are C-band radar satellites with an image resolution of approximately 30 m.

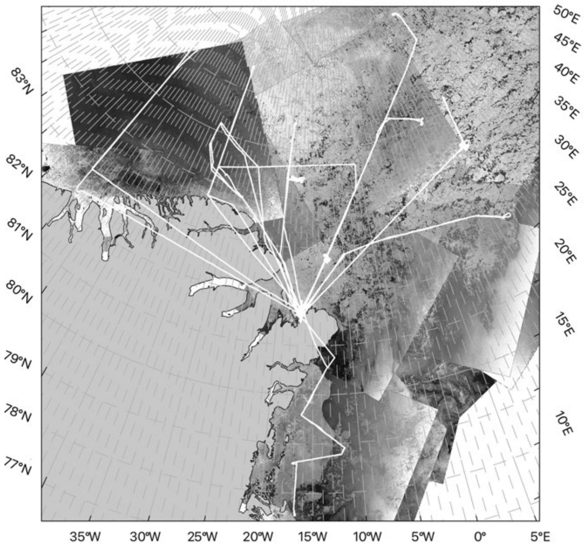


Figure 7: Composite of some SAR data (Sentinel-1 and Radarsat) acquired over the campaign area.

Sea ice age distribution in the working area of the CONTRASTS expedition (early July)

At the beginning of July, both age products reveal a pronounced west–east gradient in sea-ice age across northern Fram Strait (see Fig. 5, panel a, and Fig. 4, panel b). The drift paths and source regions associated with the main age zones at expedition start are summarized in Fig. 8.

- **Regime 1: First-year ice / marginal ice zone (FYI/MIZ)**

  The easternmost part (east of 20°E) of the area reachable with Polar 6 was dominated by first-year ice originating primarily from the Kara Sea, where the first ice station of PS149/CONTRASTS was established. The approximate drift route of this FYI, reconstructed with *IceTrack*, is shown as a black arrow in Fig. 8. Owing to its younger age, this ice exhibits markedly lower pressure ridge frequencies and reduced sail heights (see Fig. 6). During the expedition, this FYI band drifted strongly eastward, particularly in July, in response to passing cyclones. Farther west the eastward deflection was weaker, creating a divergent drift pattern across the study region and contributing to locally reduced ice concentration (pers. comm. Thomas Krumpen).

- **Regime 2: Second- and multi-year ice of Siberian origin (SYI/MYI)**

  Central parts of the expedition area were characterized mainly by second- and multi-year ice that formed largely offshore to the north of the Laptev Sea and the New Siberian Islands (Fig. 8, blue and red arrows). SYI constitutes the bulk of the pack within the study domain. It transited from its formation areas across the central Arctic into Fram Strait; western SYI zones are sourced predominantly from the New Siberian Islands sector, whereas the eastern SYI zones trace back toward the Laptev Sea sector. Occasional patches of older, three- to four-year ice of Siberian origin are also present and are unusual compared with the last two decades. During 2022–2023, an extended Beaufort Gyre and suppressed Transpolar Drift limited the sea ice export from the Laptev Sea, allowing ice to persist and recirculate there for two years. In October 2024, **the influence of the Beaufort Gyre diminished and strong offshore winds finally exported portions of this older ice toward the pole.** Part of it is currently being incorporated into the *Last Ice Area*, while a smaller fraction turned towards Fram Strait. The second ice station of PS149/CONTRASTS (R2) was set on this latter branch. Icebergs embedded in the pack near that station contained substantial sediment, likely entrained when the ice was near Severnaya Zemlya; sediment found on floe R2 and in its vicinity further supports a shallow-shelf origin or repeated shelf contact (pers. comm. Thomas Krumpen).

- **Regime 3: Old ice linked to the Last Ice Area (MYI)**

The third regime consists of old multi-year ice (MYI), concentrated mainly in the near-coastal sectors north of Greenland and Canada (the Last Ice Area, LIA). An offshoot of this area had formed a long, narrow band that connected directly to the second-year ice (SYI) zone to the east. This band of ice provided the basis for Regime 3 (R3). The ice had previously transited through the Beaufort Gyre and was continuing its drift toward Fram Strait, with its approximate trajectory shown by the orange arrow in Fig. 8. In contrast to the first-year ice (FYI) zones, the western sectors exhibit substantially higher sail frequency and greater sail heights (Fig. 6). During the final phase of the expedition and upon the floe's entry into Fram Strait, the narrow band of older ice dispersed, leaving the surroundings of floe R3 dominated by younger and significantly less deformed ice (pers. comm. Thomas Krumpen).

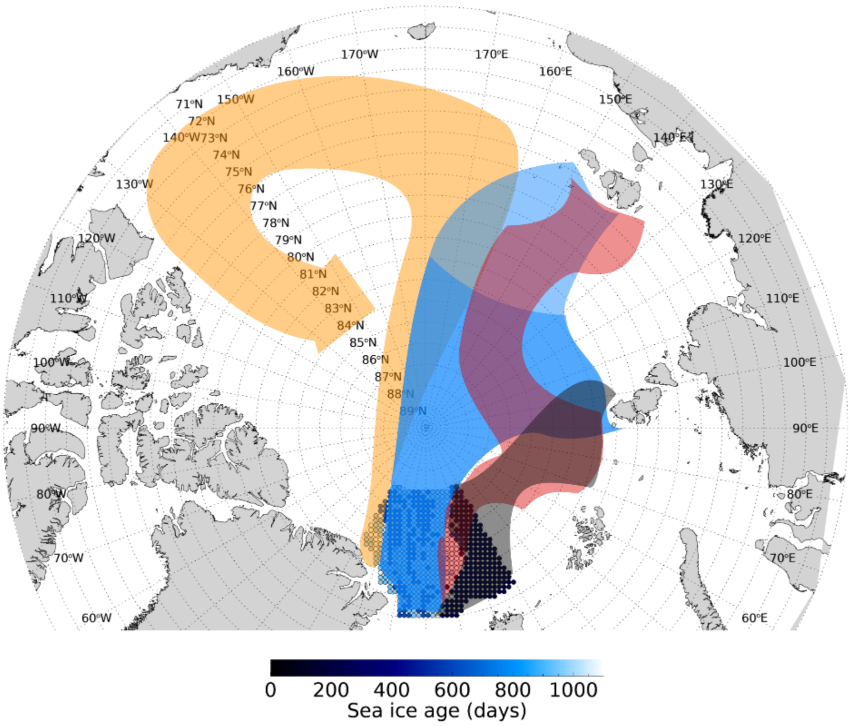


Figure 8: Approximate drift pattern and source region of the individual sea ice regimes present in the survey area at the beginning of the expedition.

Origins and drift patterns of R1–R3

Below, the likely origins of the individual floes, as derived from backtracking with *IceTrack*, are summarized:

- **R1**: As shown in Fig. 9, R1 originated in the Kara Sea and is ~1 year old.
- **R2:** The second station (Fig. 9, R2) originated in the Siberian marginal seas, likely in the vicinity of the New Siberian Islands. Because export toward the central Arctic was intermittently suppressed in 2022–2023, the ice recirculated north of Severnaya Zemlya for an extended period before progressing toward the central Arctic and, eventually, Fram Strait.
- **R3:** The R3 floe traces back to the Beaufort Gyre and possibly to sectors of the LIA north of Canada (Fig. 9, R3). Sediments incorporated within the ice are extremely fine; we infer they were entrained from the Mackenzie River plume/delta during freeze-up and subsequently transported within the pack (pers. comm. Thomas Krumpen).

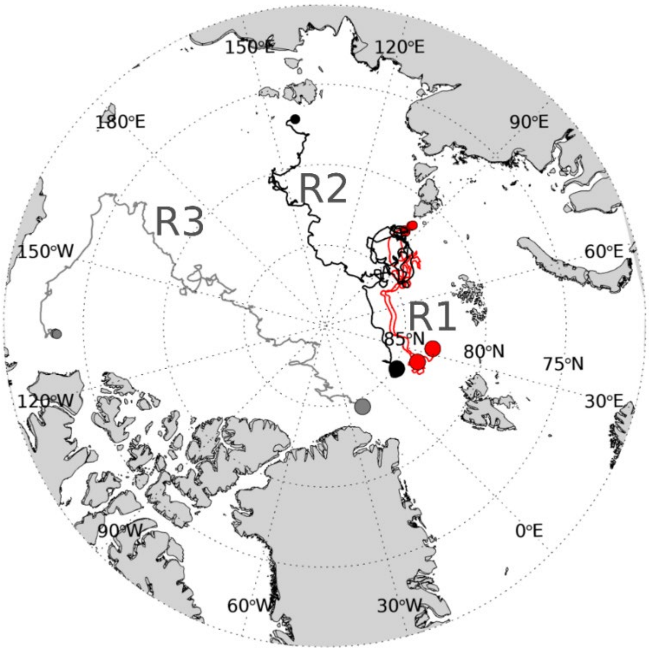


Figure 9: Back-trajectories of the three floes R1, R2, and R3 using IceTrack.

In the following a summary of the weekly IceBird Summer activities is given.

Summary of IceBird Summer activities between July 20 and 26

The IceBird team transferred from Longyearbyen to Station Nord on July 20th for the start of the campaign. July 21st was dedicated to instrument preparation, ground testing, and flight planning.

A weather window opened up north of Station Nord on July 22nd, so we took the opportunity to make a first survey flight. Cloud conditions were most suitable at 20°W. On that day, RV Polarstern was still operating at Ice Station 3 during the first round. The floe was situated at about (84.4°N, 17.9°W). Hence, we were able to include the floe into our flight plan.

A large polynya had opened up in recent weeks between the fast and pack ice north of Station Nord. We transferred to the southern edge of the pack ice, and started an EM-Bird section at 20°W to the north. At the latitude, where RV Polarstern was operating, we turned to the east and performed an EM-Bird flight over the floe with Ice Station 3. This was followed by a grid survey with the two laser scanners and the MACS camera in operation at 2000 ft, 1000 ft, and 500 ft. We flew back to 20°W and continued scanner and camera measurements at 1000 ft up to 85.5°N. On the inbound flight leg, laser scanners and MACS camera were operated as well; see Fig. 10 and Fig. 11.

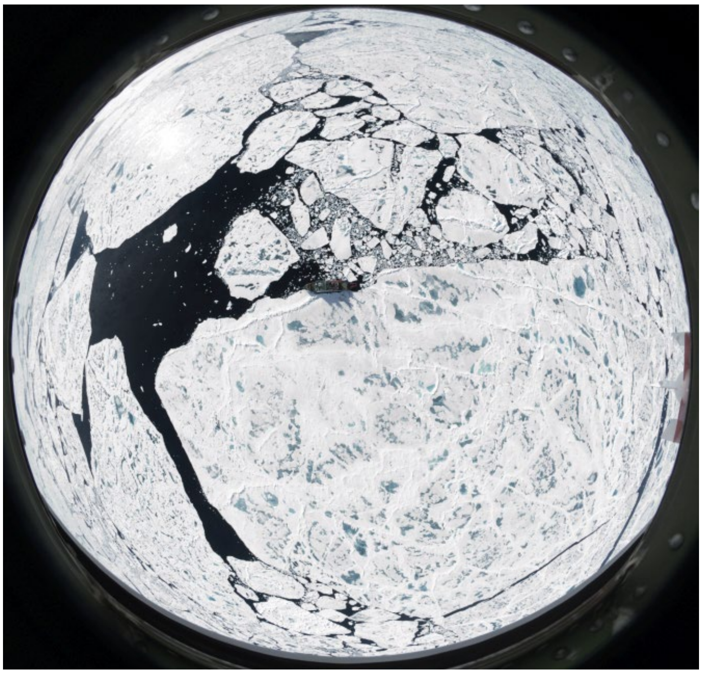


Figure 10 (left): Flight track on July 22nd, 2025.
Figure 11 (right): Image taken with a fish-eye lens, when Polar 6 overflew Ice Station 3 at 2000 ft.

On July 23rd bad conditions at our alternate, Longyearbyen airport, only allowed for an operation close to Station Nord. We flew calibration patterns for the two laser scanners over the runway followed by two radiation squares for the pyranometers.

From July 24th to July 26th poor weather (low clouds and fog) in the survey blocks prevented us from flying.

Summary of IceBird Summer activities between July 27 and August 02

The second week started as the first had ended. Poor weather (low clouds and fog) in the pack ice and fast ice survey areas still prevented us from flying until July 28th. In the morning of July 29th, it got very foggy in the station area. We could not even see the aircraft from our accommodation in Villum Station. The fog persisted the whole day. This situation not only prevented a science flight, it made it also impossible to do a transfer flight to Svalbard for a crew exchange earlier than planned.

The exchange of our captain and AWI engineer in Longyearbyen was originally planned for July 30th or 31st. However, weather predictions for our survey block over pack ice on both days were very promising. Hence, we started to figure out how to combine two science flights with the crew exchange.

The southern edge of the pack ice with sea ice concentrations larger than 80% was situated at about 82.5°N in Fram Strait and north of Svalbard. In the morning of July 30th, a clear sky area opened up in this region and we took this chance to perform a science flight. We transferred to the northeastern edge of the polynya close to Station Nord, where the EM-Bird was winched out, and we started an EM-Bird section towards the waypoint (83.0°N, 5.0°W). At this waypoint, we turned to the east and continued operating the EM-Bird at approx. 83°N up to 17°E (see Fig. 12). The return leg mirrored the outbound route. At 1000 ft we operated the two laser scanners as well as the camera systems and the optical sensors. Fig. 13 shows typical ice conditions encountered along 83°N latitude.

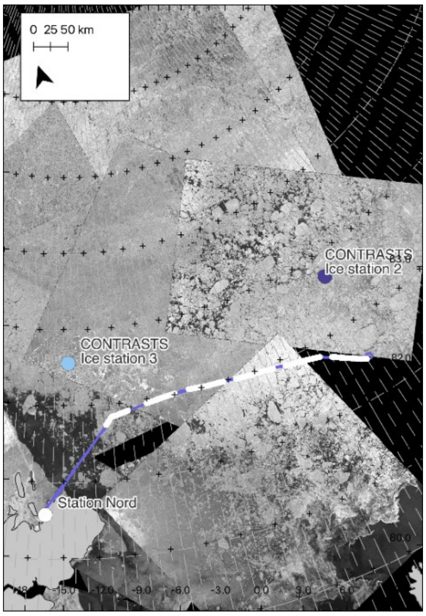
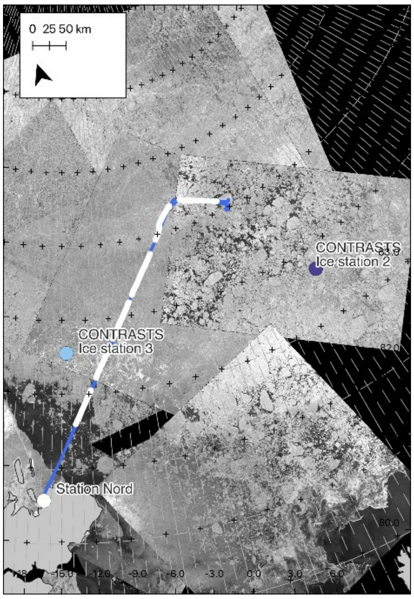


Figure 12 (left): Flight track on July 30th, 2025. White colored sections of the track indicate low level parts of EM-Bird profiles during the outbound flight.
Figure 13 (right): Image taken on July 30th, 2025 at 1000 ft during the inbound flight.

On the following day, July 31st, a clear sky region northeast of Station Nord allowed for a further science flight. The flight track shown in Fig. 14 was selected based on satellite image information in the morning. We transferred again to the northeastern edge of the polynya close to Station Nord, where the EM-Bird was winched out, and we started an EM-Bird section towards the waypoint (85°N, 0°E). Close to 85°N we had to adjust the track to a low-level cloud layer. At (85.3°N, 5.0°E) we encountered fog and turbulence. We turned to the East, and we were able to do a final EM-Bird profile over a region with large floes but also large open water stretches. Another profile was not started due to proximity to fog. Fig. 15 shows the cloud situation during the flight. The inbound flight at 1000 ft with the two laser scanners, the camera systems and the optical sensors followed the same route as the outbound. After landing at Station Nord, the EM-Bird and nest were uninstalled and the crew prepared Polar 6 for the transfer flight to Longyearbyen.

Polar 6 took off at 16:53 UTC and landed at 21:42 LT in Svalbard. The crew exchange took place, and on August 1st, Polar 6 returned to Station Nord, landing at 09:19 UTC. Unfavorable weather conditions in the survey blocks prevented a further science flight at the same day, and also on August 2nd.



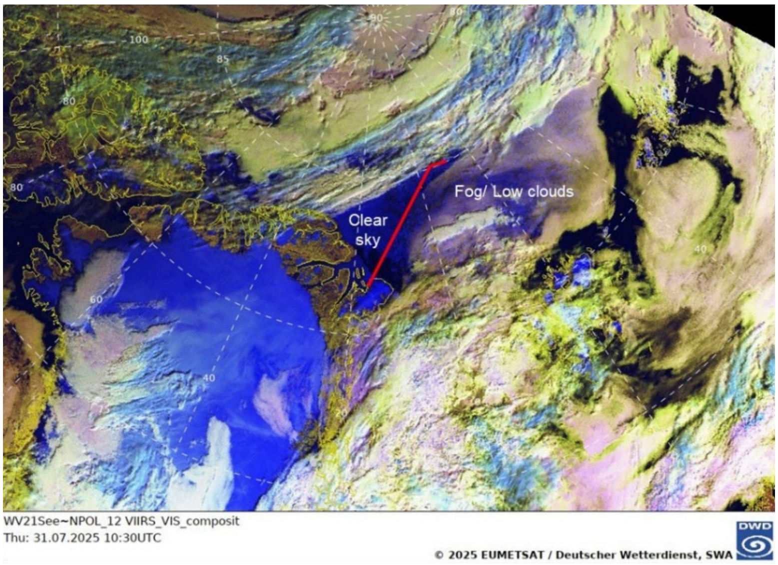
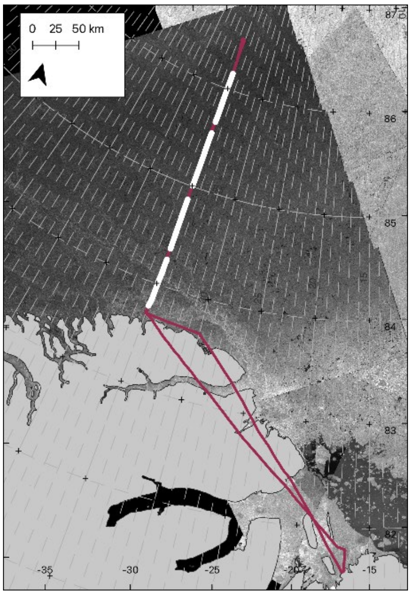


Figure 14 (left): Flight track on July 31st, 2025. White colored sections of the track indicate low level parts of EM-Bird profiles during the outbound flight.
Figure 15 (right): Satellite image showing the cloud situation in our survey block at 10:30 UTC on July 31st. The red line indicates the flight track.

Summary of IceBird Summer activities between August 03 and 09

In the morning of Sunday, August 3rd, satellite images and cloud forecasts for the coming hours suggested a cloud-free corridor around noon time between 30°W and 40°W from the coast up to 87°N. We decided to take this chance and transferred over Peary Land to a point very close to Cape Morris Jesup, the northernmost point of mainland Greenland. The EM-Bird was winched out, and we started an EM survey at 35°W to the north (see Fig. 16 and Fig. 17). The ice concentration was very high, up to 99%. No open leads were present. The ice was much more deformed than the floes we had surveyed so far during this campaign. The return leg mirrored the outbound route. At 1000 ft we operated the two laser scanners as well as the camera systems and the optical sensors. After reaching the north coast of Greenland we transferred back to Station Nord.

On August 4th, conditions at Station Nord would have allowed for take-off and landing. However, we could not identify a suitable survey area without low clouds or fog. Due to very unfavorable forecasts for the next day, August, 5th, we announced a day off in the evening before.



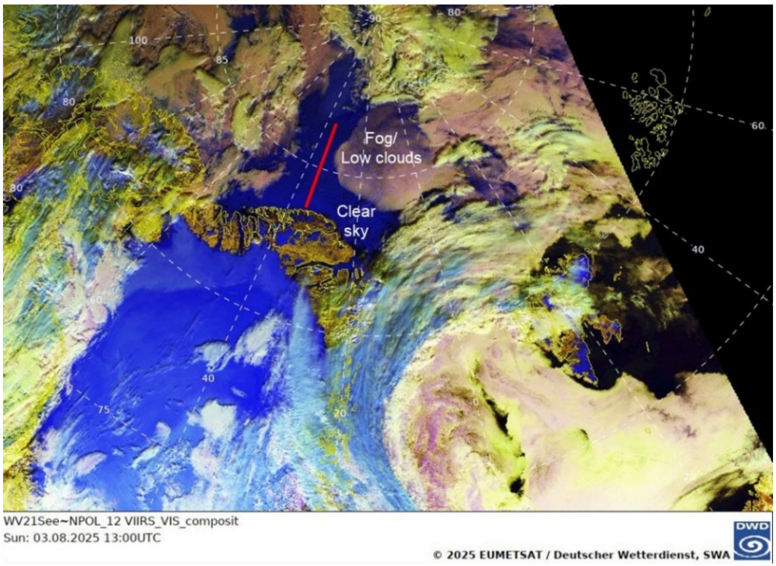
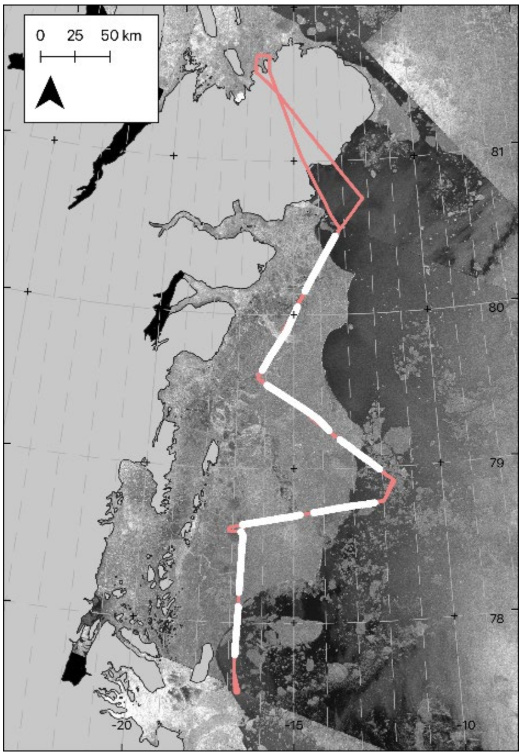


Figure 16 (left): Flight track on August 03rd, 2025. White colored sections of the track indicate low level parts of EM-Bird profiles during the outbound flight.
Figure 17 (right): Satellite image showing the cloud situation in our survey block at 13:00 UTC on August 03rd, 2025. The red line indicates the flight track over sea ice.

On the following day, August 6th, poor weather conditions over the pack ice survey block prevented a flight to this region. However, a comparison of the sequence of satellite images taken during the early morning with cloud forecasts suggested a weather window for a survey flight over fast ice along the east coast of Greenland between 80.5°N and 77.5°N (called Norske Øer Ice Barrier). Surveying this fast ice region is frequently a part of the Ice Bird campaigns. Southerly winds determined the movement of clouds and fog along the east coast. Fog, present in the northern part of the survey area in the morning, moved away and a high- and mid-level cloud layer approached from the south. During our survey time, the clear sky conditions in the northern part and the absence of low-level clouds in the southern part of the Norske Øer Ice Barrier allowed for 4 EM-Bird profiles on the outbound flight and a continuous survey at 1000 ft on the inbound flight (see Fig. 18). The state of surface melt and the characteristics of melt ponds, e.g., size, in this fast ice region varied quite a lot (see Fig. 19).

On August 7th, we were facing a situation with very contradictory weather forecasts for Station Nord. Two very different scenarios seemed to be possible due to slight differences in the location of pressure systems in various models. Scenario 1 predicted a wind shift leading to northerly winds in the afternoon with fog and rain at the station. Scenario 2 predicted persistent southerly winds with good landing conditions in the afternoon. Based on these uncertainties, we decided not to perform a flight.

The last two days of week 3 were characterized by very poor conditions at Station Nord. In the morning of August 8th, dense fog moved into the station area. Around noon it started to rain. This mixture of fog and rain persisted the whole day and also on August 9th.



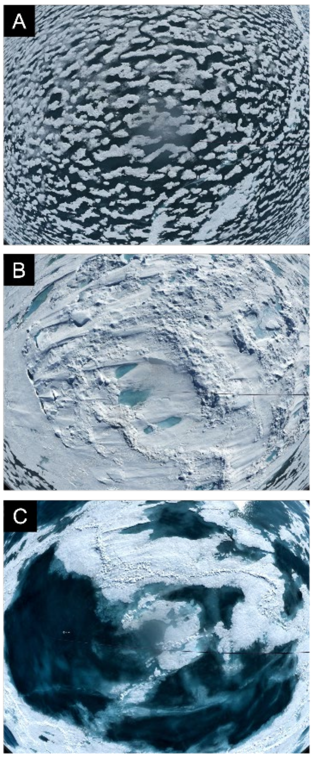
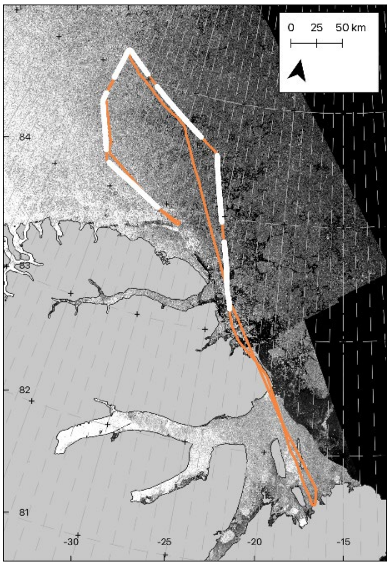


Figure 18 (left): Flight track on August 06th, 2025. White colored sections of the track indicate low level parts of EM-Bird profiles during the outbound flight.
Figure 19 (right): Different patterns, areal fraction and size of melt ponds on fast ice overflown during EM surveys. Images taken with a fish-eye lens.

Summary of IceBird Summer activities between August 10 and 16

At Station Nord, week 4 of Ice Bird Summer was primarily characterized by a mixture of fog/ very low clouds and high precipitation rates (rain and snow). Over pack ice, no survey area opened up at 6 of 7 days. The whole survey block was covered by fog and clouds, except on August 11th.

The satellite images in the morning of August 11th showed a clear sky area extending from the northern coast of Greenland up to approx. 85°N between 20°W and 40°W. The cloud-free area and the surrounding fog moved to the west. Hence, the actual flight track had to be adjusted to the location of the fog edges (see Fig. 21). Nevertheless, we were able to perform 3 EM-Bird profiles and an inbound flight at 1000 ft close to the track of the outbound flight (see Fig. 20). We encountered a gradient in ice concentration. At approx. 37°W only few open water patches were observed. Towards the east, ice concentration was decreasing up to less than 70%.



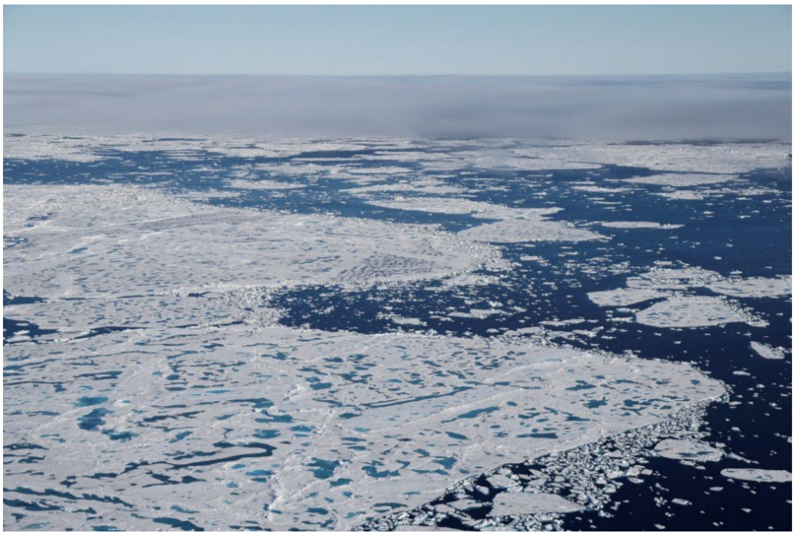


Figure 20 (left): Flight track on August 11th, 2025. White colored sections of the track indicate low level parts of EM-Bird profiles during the outbound flight.
Figure 21 (right): Fog edge limiting the survey area.

Summary of IceBird Summer activities between August 17 and 25

The last week of IceBird Summer offered the best weather conditions for surveying during the whole campaign. This applies to both, the weather at Station Nord and the weather in the survey block. We were able to perform four survey flights in a row.

On Sunday, August 17th, it was still raining at Station Nord in the morning. However, the cloud base rose continuously during the afternoon.

The weather predictions for Monday, August 18th, were very promising in a way that a second visit of Ice Station 3 of the CONTRASTS expedition seemed to be possible. At this day, RV Polarstern was alongside floe 3. Hence, conditions for comparing ground based and airborne measurements were ideal again. Ice Station 3 was situated right on a line from Station Nord to (85°N, 0°E), a section we had surveyed on July, 31st. In the course of the campaign, it became a goal to resample this section to determine the decrease in ice thickness on that line. This time we did not operate the EM-Bird over floe 3. We focused on the grid survey with the two laser scanners and the MACS camera, which were in operation at 500 ft, 1000 ft and 2000 ft. After leaving Ice Station 3 the EM-Bird was winched out, and we started a first Bird profile on the line to (85°N, 0°E). A fog edge prevented us from reaching the desired coordinate. We turned to the north and finally to the west to stay clear from low clouds; see Fig. 22 and Fig. 23.

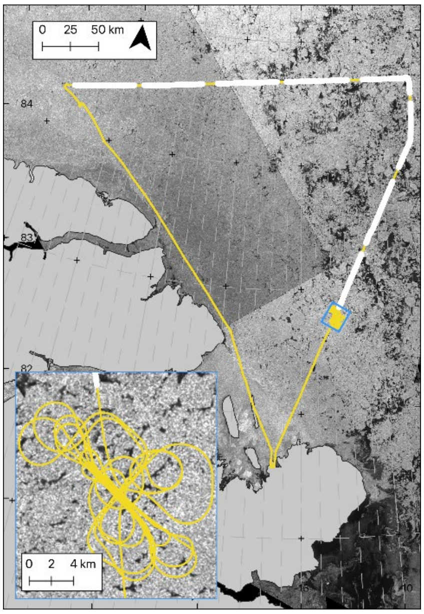
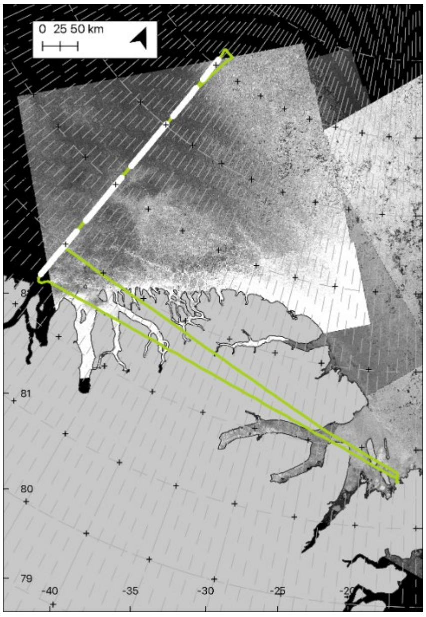


Figure 22 (left): Flight track on August 18th, 2025. White colored sections of the track indicate low level parts of EM-Bird profiles during the flight. The flight pattern over CONTRASTS Ice Station 3 is shown in the box in the lower left corner.
Figure 23 (right): Polar 6 surveying over Ice Station 3 (Photo: Marcel Nicolaus).

On Tuesday, August 19th, a clear sky area opened up in the Lincoln Sea close to the border between Greenland and Canada. Forecasts indicated a widening of the area without fog and low clouds to the north during the day. Hence, we decided for a later take off time than usual. After a transfer at high altitude of almost two hours, we reached the longitude 55°W just off the coast of Greenland. On the outbound flight at this longitude, the EM-Bird was operated up to 86°N. The ice concentration was very high. No open leads were present, only few open water patches. Sea ice surface roughness decreased towards the north. Most probably, we surveyed the transition from multi-year ice in the southern to second-year ice in the northern part of the flight track; see Fig. 24 and Fig. 25.



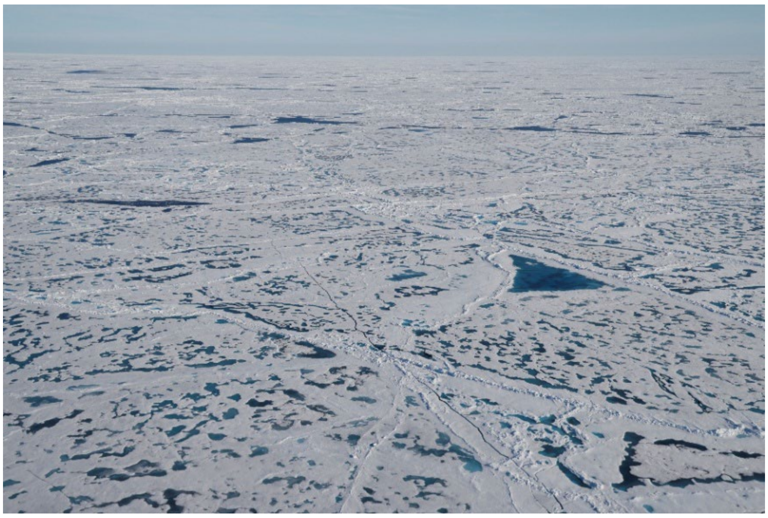
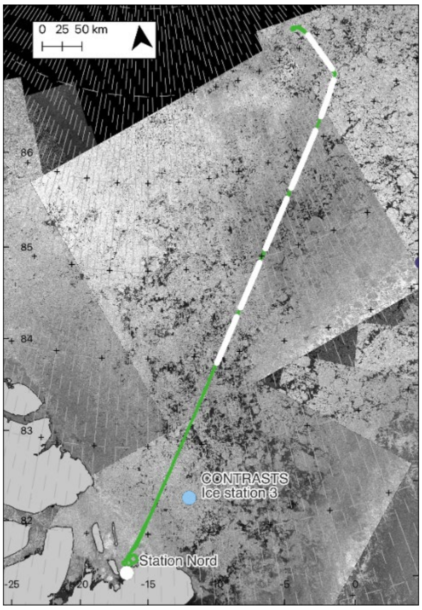


Figure 24 (left): Flight track on August 19th, 2025. White colored sections of the track indicate low level parts of EM-Bird profiles during the outbound flight.
Figure 25 (right): Image taken on August 19th, 2025 during the outbound flight (Photo: Gerit Birnbaum).

On Wednesday, August 20th, we got a new chance to survey on the line from Station Nord to (85°N, 0°E) and beyond. The EM-Bird was winched out at a latitude, where we had to turn away from this line earlier this week. This time it was possible to continue the EM-Bird profiles, and we even reached the easternmost longitude and northernmost latitude of the campaign, 23.3°E and 87.1°N, respectively; see Fig. 26 and Fig. 27. During the flight it became obvious that refreezing of melt ponds and formation of new ice on open water areas had started.



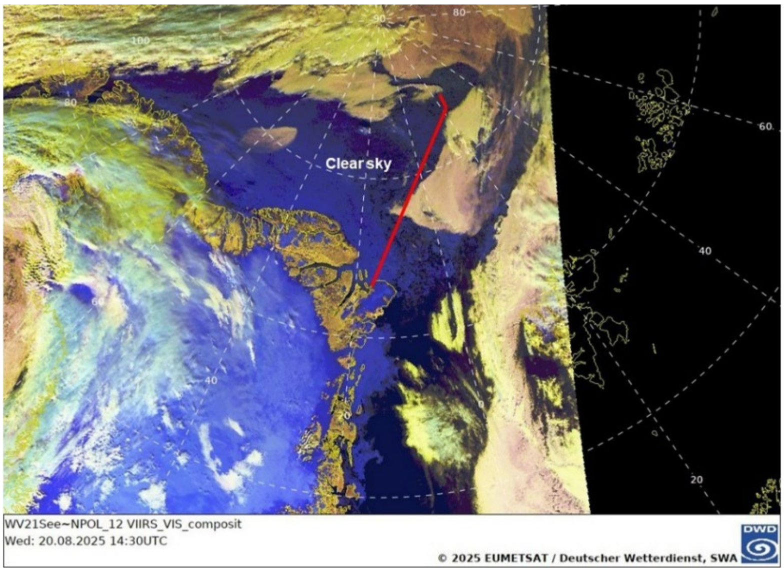


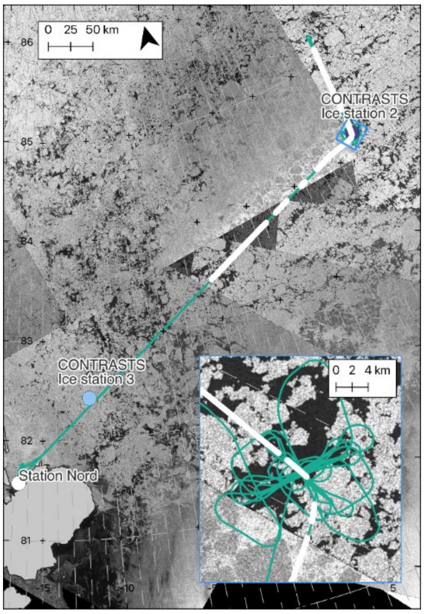
Figure 26 (left): Flight track on August 20th, 2025. White colored sections of the track indicate low level parts of EM-Bird profiles during the outbound flight.
Figure 27 (right): Satellite image showing the cloud situation in our survey block at 14:30 UTC on August 20th, 2025. The red line indicates the flight track over sea ice.

On Thursday, August 21st, satellite images showed clear sky conditions over Ice Station 2 of the CONTRASTS expedition – for the first time during the entire IceBird Summer campaign. Although RV Polarstern was not present in this area, we decided together with the sea ice physics team onboard the ship to perform a grid survey with the two laser scanners and the MACS camera over floe 2. Without the ship being alongside the floe, it took us quite a bit of time to find the right floe and the equipment installed on the ice, which should serve as orientation for the survey grid. As previously over Ice Station 3, we finally operated the laser scanners and the MACS camera at 500 ft, 1000 ft, and 2000 ft. After finishing the survey pattern over Ice Station 2, we continued the outbound flight to the north up to (85.0°N, 18.6°E). On the inbound flight on the same track the EM-Bird was operated; see Fig. 28 and Fig. 29. During the flight, we observed quite a lot of new ice again.

The hope for a further flight on Friday, August 22nd, was destroyed in the morning of this day by the weather predictions for Station Nord.

Very poor weather conditions during the weekend at Station Nord (fog, rain, snow) and in Longyearbyen prevented flight operations on Saturday and Sunday, August 23rd and 24th, respectively.

On Monday, August 25th, the IceBird Summer team transferred from Station Nord to Longyearbyen, where the campaign ended.



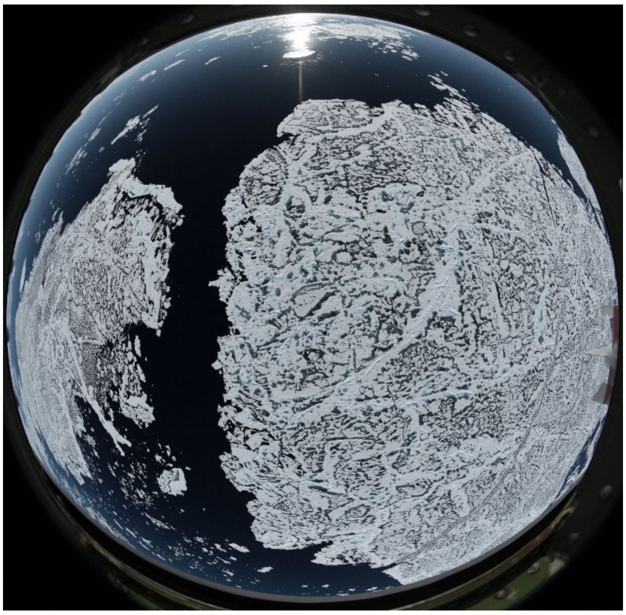


Figure 28 (left): Flight track on August 21st, 2025. White colored sections of the track indicate low level parts of EM-Bird profiles during the inbound flight. The flight pattern over CONTRASTS Ice station 2 is shown in the box in the lower right corner.
Figure 29 (right): Image taken with a fish-eye lens, when Polar 6 overflew Ice Station 2 at 2000 ft.

Summary of flight operations

The campaign was successfully completed without any equipment problems. A particular feature this year was that both pilots flew the EM-Bird for the first time. In total, approximately 2700 km of survey lines were flown. The flight patterns were largely determined by prevailing weather conditions, as explained above.

Overview of flights carried out during IceBird Summer 2025

(see also Fig. 30)

Date	Activity	Duration hh:mm (Air time)	Flight hours
2025-07-20	Ferry flight Longyearbyen – Station Nord		
2025-07-22	Sea ice survey to (85.5°N, 20.0°W), Survey pattern over ice station 3 of the CONTRASTS expedition (RV Polarstern)	04:54	4.90
2025-07-23	Flight for sensor calibrations in the area of Station Nord	01:26	1.43
2025-07-30	Sea ice survey at approx. 83°N between 10°W and 17°E	04:36	4.60
2025-07-31	Sea ice survey to approx. (85.3°N, 5.0°E) and further to (85.1°N, 12.1°E)	04:39	4.65
2025-07-31	Ferry flight Station Nord - Longyearbyen		
2025-08-01	Ferry flight Longyearbyen – Station Nord		
2025-08-03	Sea ice survey at 35°W up to 86.5°N	05:04	5.07
2025-08-06	Fast ice survey along the east coast of Greenland between 80.5°N and 77.5°N	05:13	5.22
2025-08-11	Sea ice survey in an area from 83°N to 85°N between 23°W and 37°W	05:24	5.40
2025-08-18	Survey pattern over Ice Station 3 of the CONTRASTS expedition (RV Polarstern) followed by an EM-Bird survey to (84.6°N, 5.8°W) and further to (84.4°N, 34.0°W)	06:05	6.08
2025-08-19	Sea ice survey at 55°W from the coast to 86.1°N	06:50	6.83
2025-08-20	Sea ice survey on the line of the flight on July 31st, Extension to (87.1°N, 23.3°E)	06:20	6.33
2025-08-21	Survey pattern over Ice Station 2 of the CONTRASTS expedition followed by an EM-Bird survey starting at (85.0°N, 18.6°E); Laser Scanner calibration over the runway at Station Nord	07:24	7.40
2025-08-25	Ferry flight Station Nord – Longyearbyen		

Total flight hours for survey during the entire campaign: 57.9

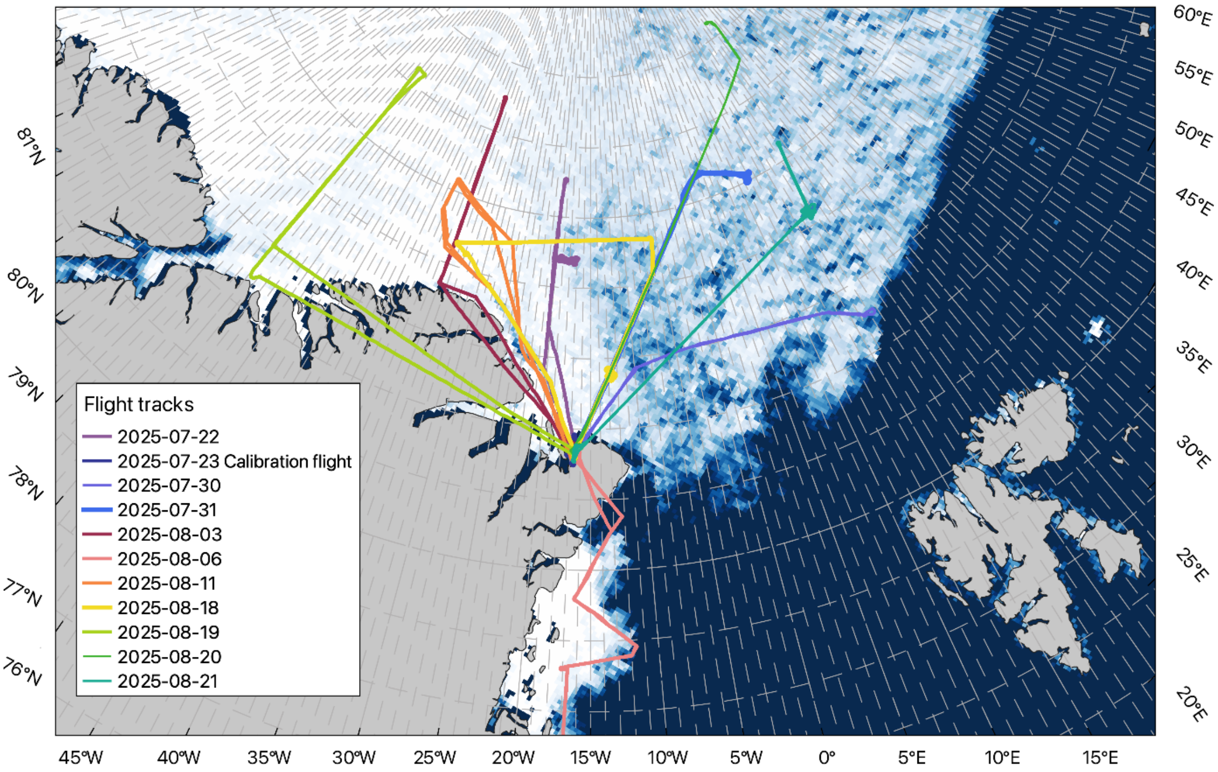


Figure 30: Flight tracks of all survey flights of the campaign. Ice concentration displayed is based on AMSR2 data from August 21st, 2025.

Campaign Participants

	Name	Role
1	Robert McIntyre (KBA)	Captain (until July 31)
2	Kyle McLenaghan (KBA)	Captain (from August 1)
3	Dario Giorgio (KBA)	First Officer
4	Mireille Paquette (KBA)	AME
5	Eduard Gebhard (AWI)	Engineer (until July 31)
6	Maximilian Stöhr (AWI)	Engineer (from August 1)
7	Mara Neudert (AWI)	Operator EM-Bird
8	Gerit Birnbaum (AWI)	PI, Operator Laser Scanners and Optical Systems

4.0 Preliminary results

Ice thickness

As an example, Fig. 31 shows the EM total thickness after processing the raw data from the flight on August 20th, alongside the altimeter range, which represents the EM-Bird's height above the snow or ice surface. The flight consisted of three profiles, each including two low-altitude sections, resulting in six segments of uninterrupted data and a total distance of about 460 km. All data has been processed for ice thickness. Overall, the data quality is satisfactory.

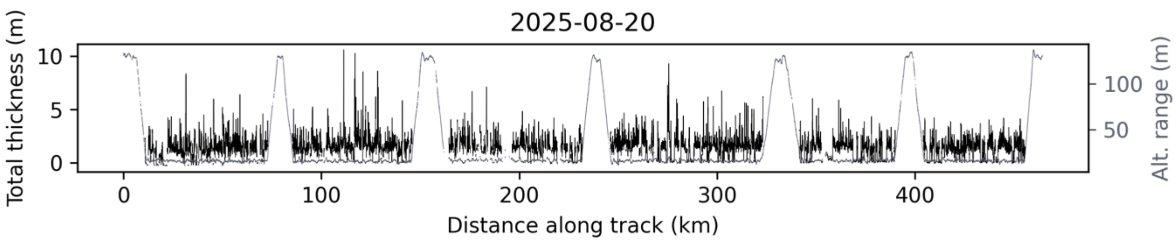


Figure 31: Profile of EM total thickness (black) and altimeter height (grey) for the entire bird flight on August 20th.

Repeated sections sampled early and late in the campaign reveal changes in level ice thickness over time. In the area dominated by second-year ice (SYI), modal ice thickness decreased from about 1.8 m to 1.3 m within three weeks (Fig. 32, pink area, subfigures G–I), which coincides with the CONTRASTS R3 regime. In a region of younger ice further northeast, thickness was reduced by approximately 0.4 m during the same period (Fig. 32, yellow area, subfigures E and F). These data will be used to complement the ground-based and helicopter EM measurements collected during the RV Polarstern expedition.

Along the 55°W transect, old ice with a modal thickness of 2.7 m (Fig. 32, blue area, subfigure A) transitions northward into thinner ice, where modal thicknesses reach about 1.7 m (Fig. 32, dark blue area, subfigures B and C).

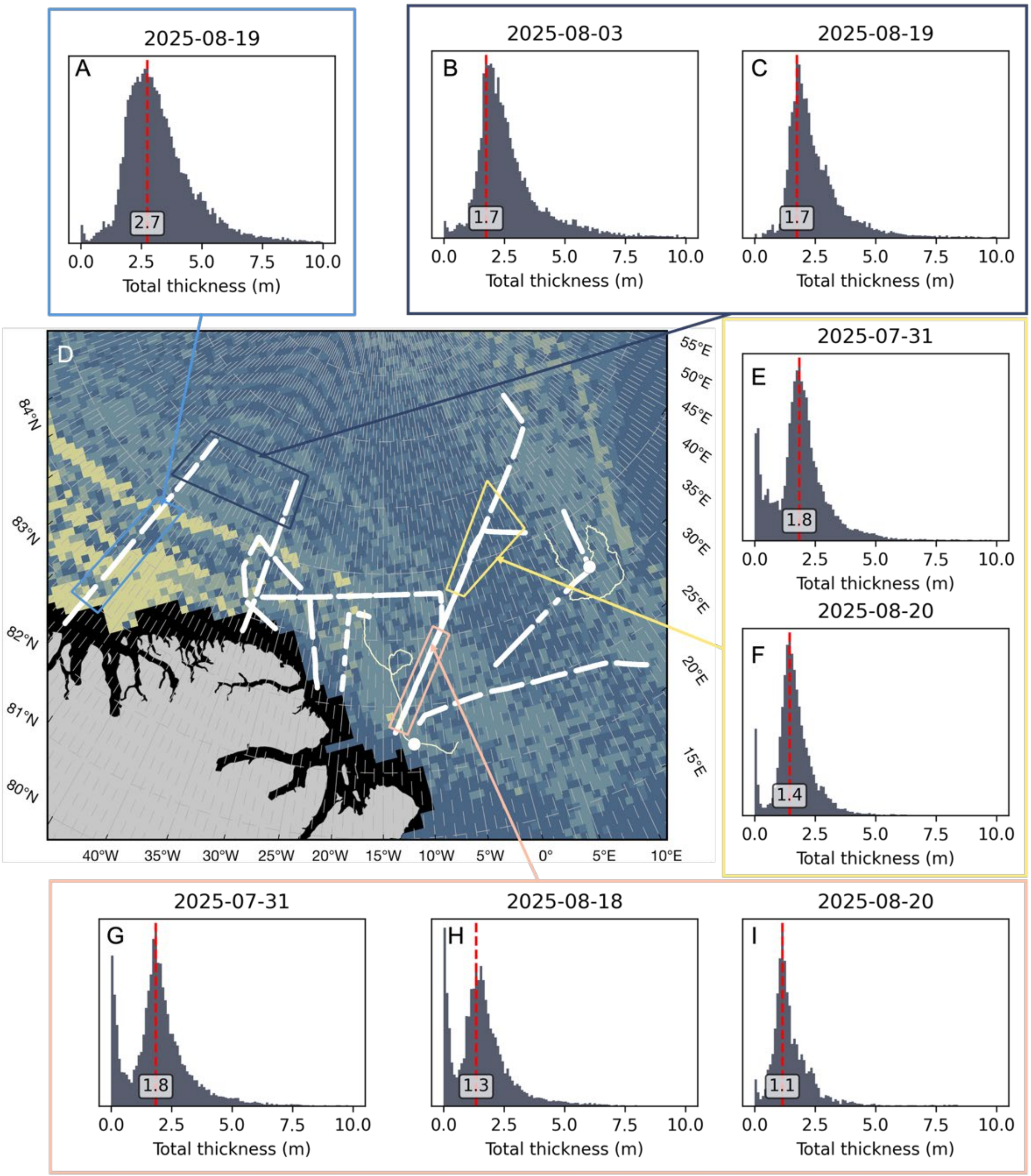


Figure 32: Histograms of EM total thickness for different regions and dates.

The flight over Norske Øer Ice Barrier (NØIB) on August 6th also reveals contrasts between younger and older ice regimes. The NØIB is a remarkably extensive region of landfast sea ice off northeast Greenland. It lies adjacent to major floating outlet glacier (Nioghalvfjerdsfjorden (79N) and Zachariae Isstrøm) and plays a critical role in buttressing glacier termini and modulating iceberg calving and subsurface melting. Complete breakups were rare in historical context, but their frequency increased notably since 2000 (Sneed and Hamilton, 2016). Satellite imagery shows that in August 2025 the ice barrier extended approximately 140 km east from 79°N and up to 320 km from south to north (Fig. 33), similar to the extent reported for June 2012 by Sneed and Hamilton, 2016. In the southern and central sections, thicknesses were generally between 0.6–1.6 m, characteristic of younger seasonal ice. Further north, thickness increased to 2.5–4 m, with isolated pockets exceeding 5 m, indicating the presence of older multi-year ice. The different ice regimes are reflected by different melt pond patterns, size distributions and fractions (see Fig. 33, Nikon images).

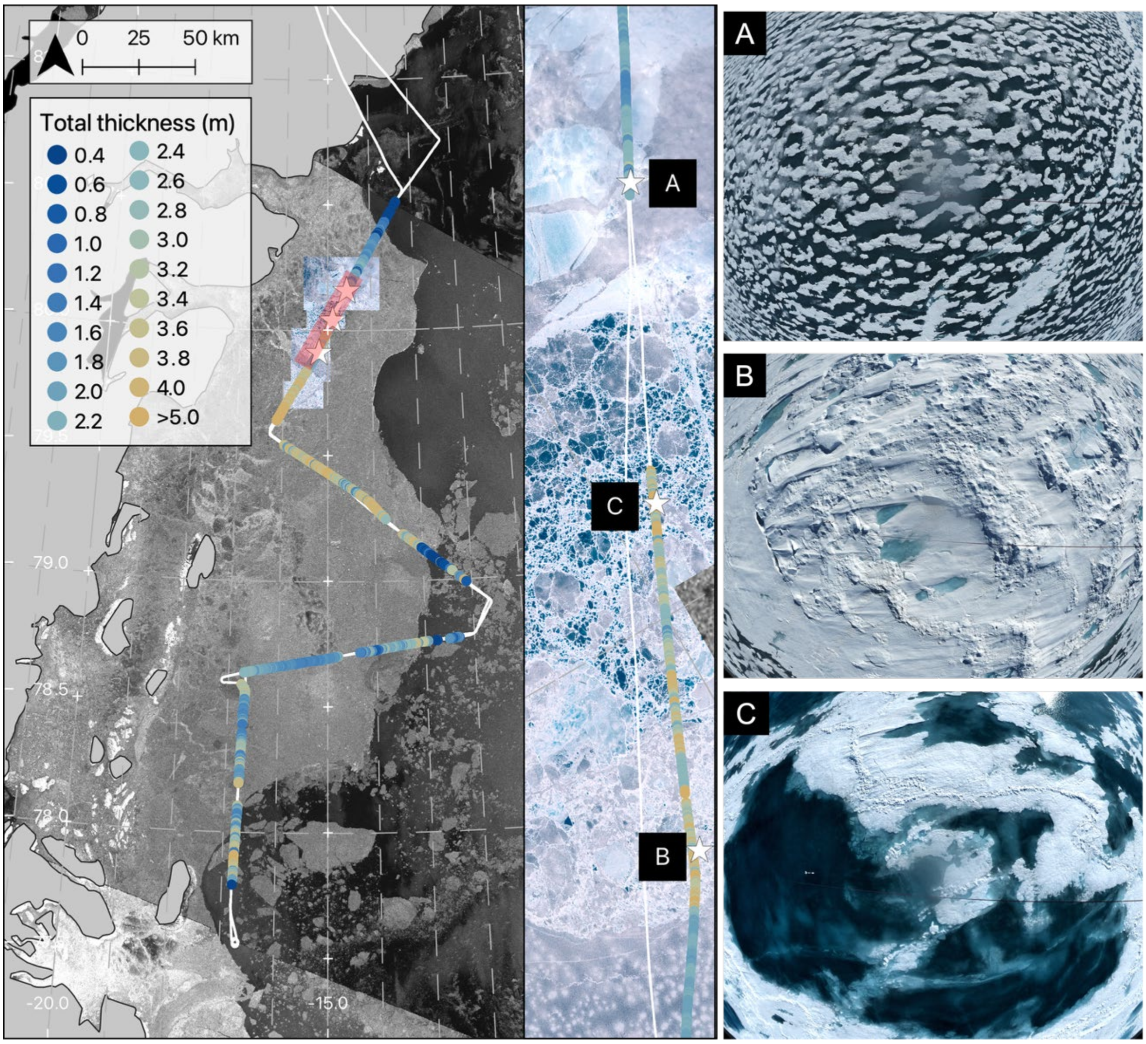


Figure 13: EM total thickness of Norske Oer Ice Barrier (August 6th). Greyscale image is a RADARSAT image from August 4th. The true color images are Sentinel-2 images from August 2nd. The inset shows the location of the Nikon fish-eye images.

5.0 References

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