2 Campaign log

IceBird is a long-term airborne observation campaign that monitors changes in sea ice in the Arctic using AWI's research aircraft (Figure 1). The 2025 winter campaign was carried out from 3 March to 22 April and covered the Beaufort Sea, the Canadian Arctic Archipelago, the Lincoln Sea, the Fram Strait, and Storfjorden east of Svalbard.

The campaign was led by Christian Haas, who served as principal investigator (PI) and operated the EM Bird system. Richard Kelly, acting as co-principal investigator (Co-PI) from the University of Waterloo, Ontario, Canada, joined the Canadian segment to conduct CryoSAR measurements. Luisa Wagner, a PhD student at AWI, operated the snow radar, while aircraft science engineer Maximilian Stöhr provided technical support for the airborne sensor suite.

Figure 1: AWI's research aircraft, Polar 6

The instruments deployed during the campaign enabled the collection of high-resolution measurements of sea ice thickness, snow depth, surface roughness, and the optical and thermal properties of sea ice. The overarching aim of the campaign was to continue long-term observations of these parameters and to investigate the backscattering characteristics of various ice types under differing environmental conditions. A key objective in the framework of St3TART-FO was the validation of ice thickness retrievals from Sentinel-3. To this end, survey flight planning was aligned with Sentinel-3 tracks wherever possible. The feasibility of these underflights depended on weather conditions, the geographical position of the satellite tracks, the high-latitude location of the study area, and logistical constraints.

A total of six S3 underflights (see Figure 2), with a length of approximately 1185 km, were completed. Due to the latitudinal limit of the satellite tracks, the main focus of data collection was on the Beaufort Sea and the Fram Strait, shorter surveys were carried out in the interior of the Canadian Archipelago and close to Svalbard.The following table summarises all achieved Sentinel-3 underflights:

Table 1: Achieved Sentinel-3 underflights during the campaign

Survey date	Station	Area	Satellite and orbit number	Satellite acquisition date	Approx. length (km)	Altitude
23.3.2025	Inuvik	Beaufort Sea north of Mackenzie delta	S3A 47376	23.3.2025	80	73 m
25.3.2025	Inuvik	Beaufort Sea north of Liverpool Bay	S3B 36025 S3A 47385	25.3.2025 23.3.2025	200 160	73 m
26.3.2025	Inuvik	Beaufort Sea north of Liverpool Bay	S3B 36034	26.3.2025	135	73 m
29.3.2025	Cambridge Bay	Victoria Strait	S3B 36104	31.3.2025	110	73 m
20.4.2025	Station Nord	Fram Strait	S3B 36389	20.4.2025	300	457m
21.4.2025	Longyearbyen	Storfjorden	S3B 36446	24.4.2025	200	73 m

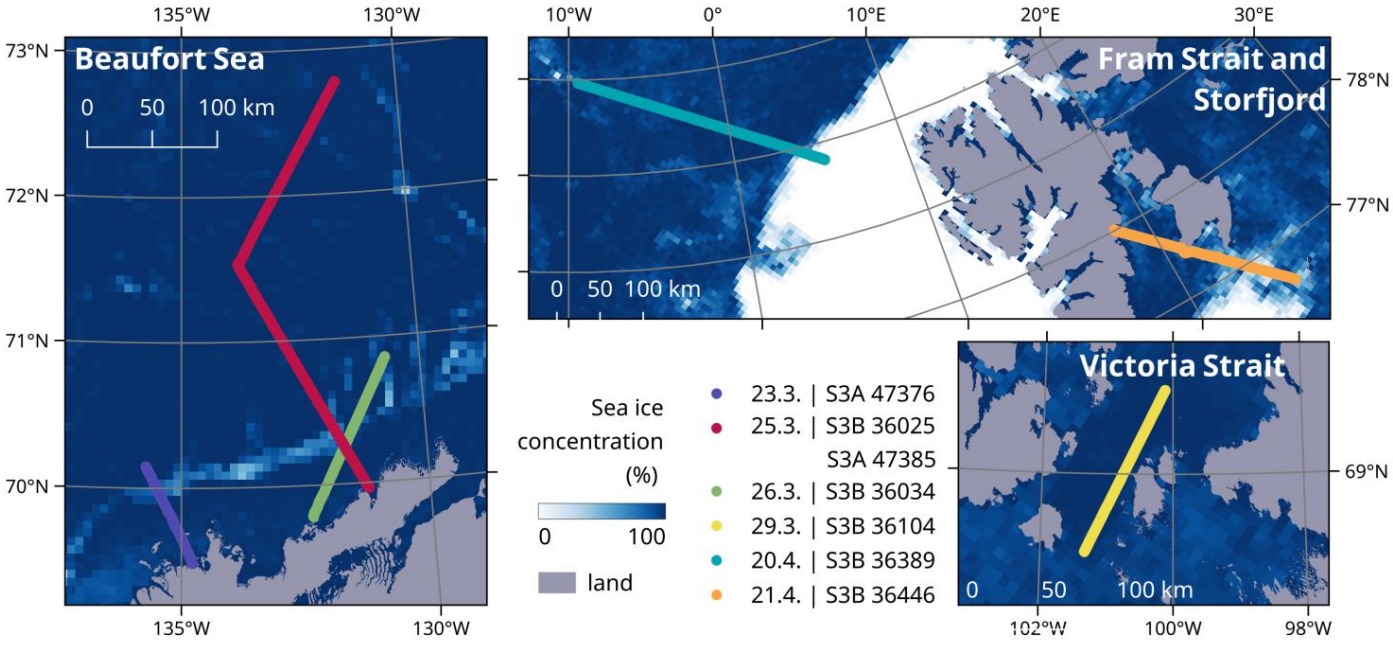

Figure 2: Overview map of accomplished Sentinel-3 underflights

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2.1 Inuvik

After two weeks of preparing the aircraft and testing the sensors, and after completing the first set of measurements in terrestrial study areas near Whitehorse, we began the sea ice-focused part of the campaign. From 21 to 26 March, we were based in Inuvik, a favourable point of departure for surveys of the southern Beaufort Sea. On 23 March, we initiated a sea ice survey and a Sentinel-3 underflight north of Tuktoyaktuk, however we were forced to abort the mission after approximately 80 km due to an unexpected bank of cloud of undetermined extent.

Due to our early morning departure and early solar time, no suitable satellite images were yet available that would have shown the clouds.

Based on this experience we decided to plan flights only later in the day, since good images were available from 11 am and later. These showed good conditions over the Beaufort on March 25 and 26 despite questionable ECMWF cloud forecasts. We successfully conducted two sea ice surveys north of Liverpool Bay on these dates, which include sections aligned with Sentinel 3 tracks (orbits 36020 and 36025 on March 25, and orbit 36034 on March 26).

The completed underflights spanned a range of ice conditions, among others the Mackenzie polynya, first year ice near the coastline, multiyear ice farther north and freshly formed ridges and leads exhibiting various types of new ice. Overall, snow cover was moderate.

Figure 3: Fresh ridges and leads in multiyear ice floes, Beaufort Sea, March 26, 2025

Figure 4: New lead covered with various types of new ice, Beaufort Sea March 26, 2025

2.2 Cambridge Bay

Our next station was Cambridge Bay, where we remained until 31 March. On 29 March, we conducted a sea ice survey over Victoria Strait, which included an underflight of Sentinel-3, orbit 36104, acquired on 31 March. The sea ice was mobile and heavily deformed with large open leads and sparse snow cover (Figure 5).

Further underflights were hampered by both unfavourable weather conditions and the absence of suitable Sentinel-3 tracks. Compared to the Beaufort Sea, flight planning for surveys over the narrow sea sounds within the Canadian Archipelago is less flexible, and the likelihood of encountering appropriate Sentinel-3 tracks within feasible range is significantly reduced. Consequently, the campaign's subsequent stations – Resolute Bay and Eureka – were also not conducive to underflights. The latter is located so far north that surveys were outside the coverage area of Sentinel-3.

Figure 5: Open lead and heavily deformed ice in Victoria Strait, March 29, 2025

2.3 Station Nord

From 15 to 20 April, we stayed at Station Nord, conducting surveys north of Greenland, partially outside the Sentinel-3 coverage area. On 19 April, we headed east to underfly a Sentinel-3 track; however, the survey had to be cancelled due to turbulence and extensive cloud cover.

To compensate for the unsuccessful attempt the previous day, we elected to follow a Sentinel-3 track during the ferry flight to Longyearbyen on the following day. This particular track was optimally aligned with the planned route.

Although weather conditions had only marginally improved compared to the previous day, they were sufficient to permit snow radar and laser scanner operations at an altitude of 457 m, with brief disruptions due to cloud density and icing.

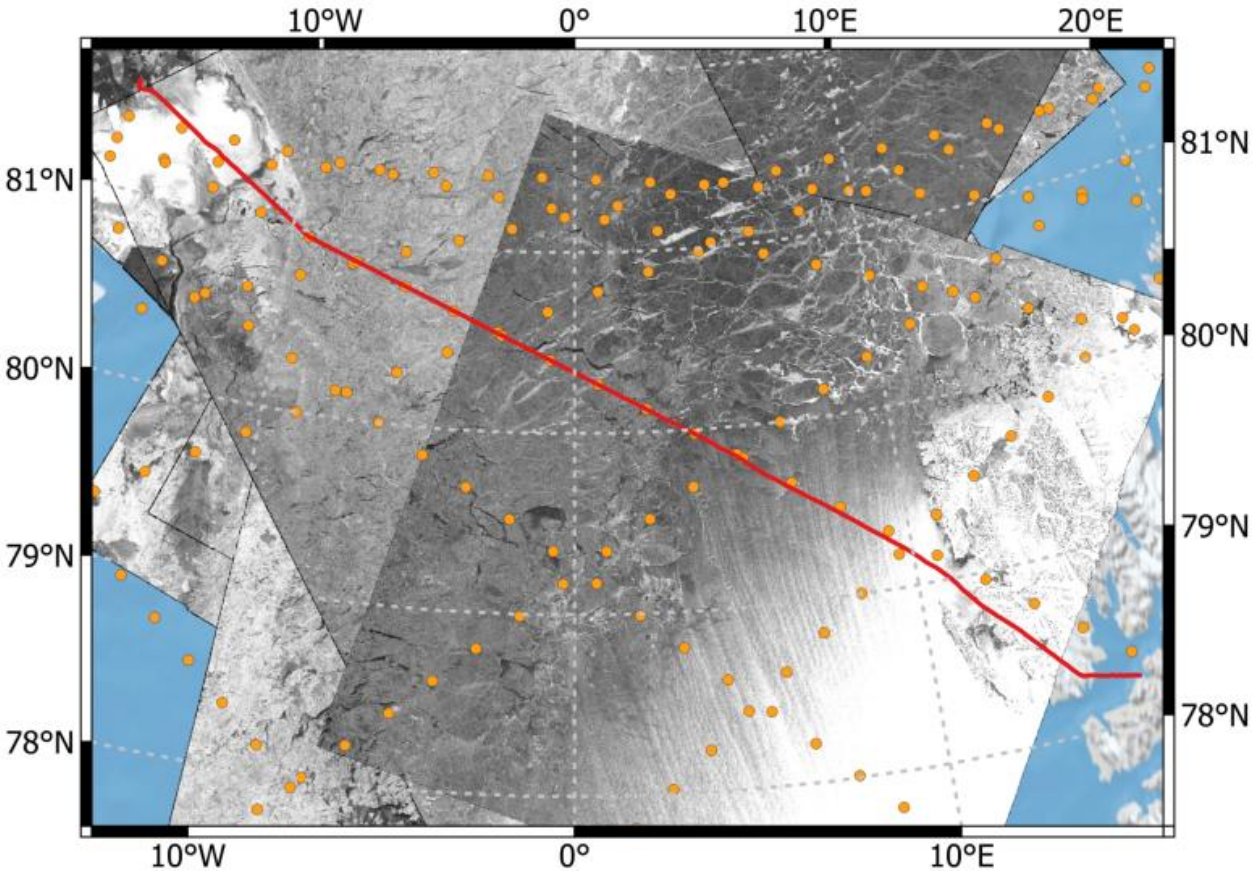

Figure 6: Map of the ferry flight from Station Nord to Longyearbyen across Fram Strait on April 20, where we were able to survey part of a Sentinel-3 ground track shown by orange circles. Note bright appearance of leads and streaks over the water south of the ice edge, indicative of strong northerly winds

2.4 Longyearbyen

The scheduled survey on 21 April in Svalbard commenced under uncertain weather conditions but ultimately proved favourable for the planned study areas. We traversed Spitsbergen to Storfjord, where we conducted a survey of the pack ice in the vicinity of Hopen, before returning to the mainland. This survey represented a rare repetition of earlier missions in Storfjorden (Hendricks et al., 2011; King et al., 2017), and concurrently supported St3TART-FO by underflying a long Sentinel-3 reference track. At the north-western end, in Agardhbukta, our survey also incorporated measurements along the same transects that were subsequently surveyed by the NORCE snow radar drone operated by Robert Ricker.

Ice conditions were characterised by extensive patches of newly formed ice, interspersed with fields of thick ice rubble and areas of open water. The snow cover was minimal to non-existent.

Figure 7: Typical ice conditions in Storfjord on April 21, with widespread new ice interspersed with field of thick rubble