

Campaign report

July/August 2011

TIFAX 2011 Summer Campaign

**Sea ice thickness
measurements with Polar 5
from Station Nord and
Svalbard**



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1.0 Aims/objectives of TIFAX 2011

During the last decade, an increased advection of thick multi-year ice that originates from an area north of Greenland, out of the Arctic through Fram Strait was observed. A replacement of this old and thick sea ice by much thinner ice might precondition for rapid sea ice retreat in summer. Aim of the TIFAX campaign is to monitor ice conditions during summer in the main export pathway of the Arctic Ocean. The campaign complements the large scale spring sea ice surveys in April 2009 and 2011 (PAMARCMIP) and is a continuation of the TIFAX campaign in 2010.

This document summarizes data and quality of the data taken on flight with the HEM-Bird, a laserscanner and a nadir looking camera system mounted on board the Polar 5.

2.0 Flight operations

All Laser scanner, HEM-Bird and camera measurements/observations across the Fram Strait and in the area north of Greenland were performed between July 31 and August 04. Tracks were taken towards a pre-defined point of return and back. Start and end node, the point of return and track length were chosen according to

1. the operating area of other ongoing campaigns,
2. available fuel capacity,
3. weather condition,
4. ice condition.

In total, 4 flights were made between July 31 and August 04, 2011. The flight time amounts to roughly 19 hours.

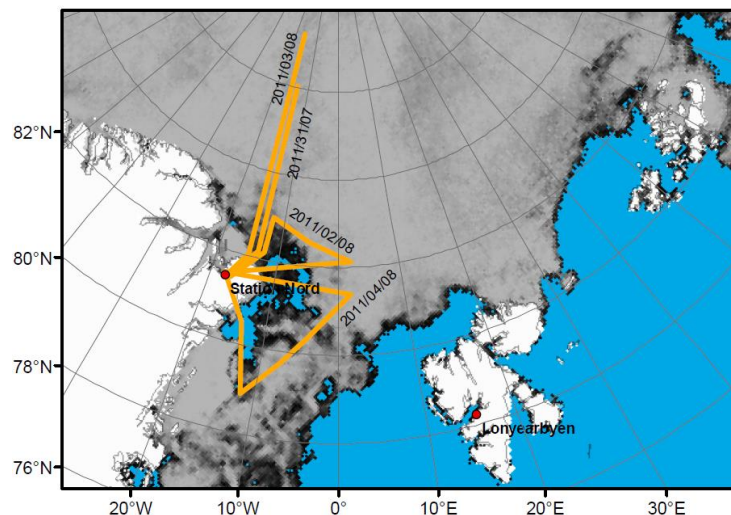


Figure 1 : All flights taken during TIFAX 2011 campaign

2.1 Flight tracks

The flight tracks contain 3 south-north transects and 1 west-east transects. Because the HEM-Bird requires in-flight instrument drift correction, flight tracks are divided into profiles with a length of 10 to 25 minutes. The camera was constantly taking pictures during the entire flight, while Laserscanner data take was interrupted during Bird calibration procedure.

The individual profiles are presented in section 3. Fig. 1 shows all flights made between July 31 and August 04, 2011. Note that during the first flight, the EM-Bird was not working correctly. Hence, for July 31, 2011 only camera and laserscanner data is available.

2.2 Name of EM-Bird, laserscanner and camera operators

Name	Address	Contact
Krumpen, Thomas	Busse Str. 24, 27570 Bremerhaven, Germany	+49 471 4831 1753 tkrumpen@awi.de
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3.0 EM-Bird principle

Below, the EM-Bird concept is introduced. For a detailed description on the laserscanner principles, we refer to earlier data reports (e.g. Pamarmip).

The EM system consists of a transmitter/receiver system for harmonic electro-magnetic signals. The transmitter coil emits electromagnetic waves (primary field) at a certain frequency, which leads to induction of eddy currents in any conductive layers beneath the instrument. These eddy currents induce again an electromagnetic field (secondary field), which is measured together with the primary field by a receiver coil. Because of induction processes, the secondary field has a phase shift to the primary field. This phase shift together with the strength of the secondary field is a function of the thickness and the conductivity of layers underneath the instrument.

Due to the large conductivity contrast to the saline sea water, the air-, snow- and ice-layer can be assumed to be electrical insulators. With known sea water conductivity the EM signal can be modelled as a function of height above the sea level (Figure 2).

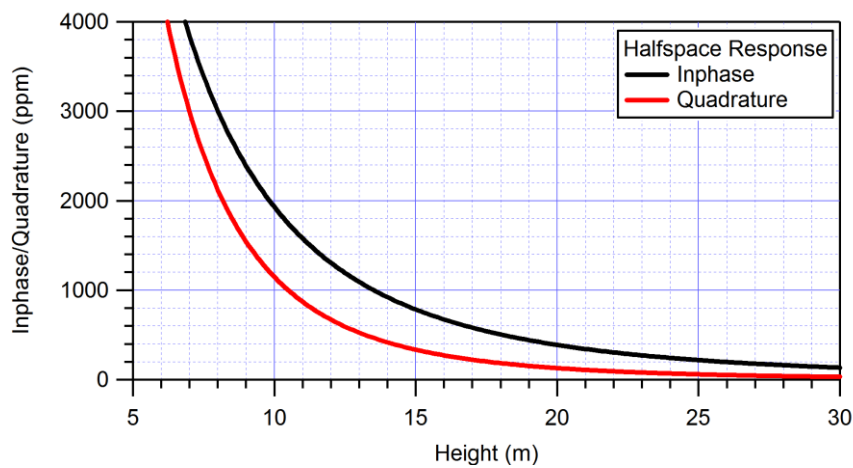


Figure 2: Forward model results for inphase and quadrature channels (conductivity 2500 mS/m)

While the EM system gives the distances from the instrument to the sea surface (under the sea ice) a laser altimeter records the distances to the top of the sea ice or snow layer. The snow plus ice thickness is equal to the laser range minus the EM derived distance.

3.1 Salt water conductivity

Note that a salt water conductivity of 2500 mS/m was used for data processing.

3.2 Camera system

The camera system consists of a nadir-looking mounted CANON (EOS-1D Mark III) camera. The GPS information is stored in the EXIF header of an image. Fig. 3 shows an image that was taken over ice (open water and ice with melt ponds) during HEM-Bird operation on July 31, 2011.

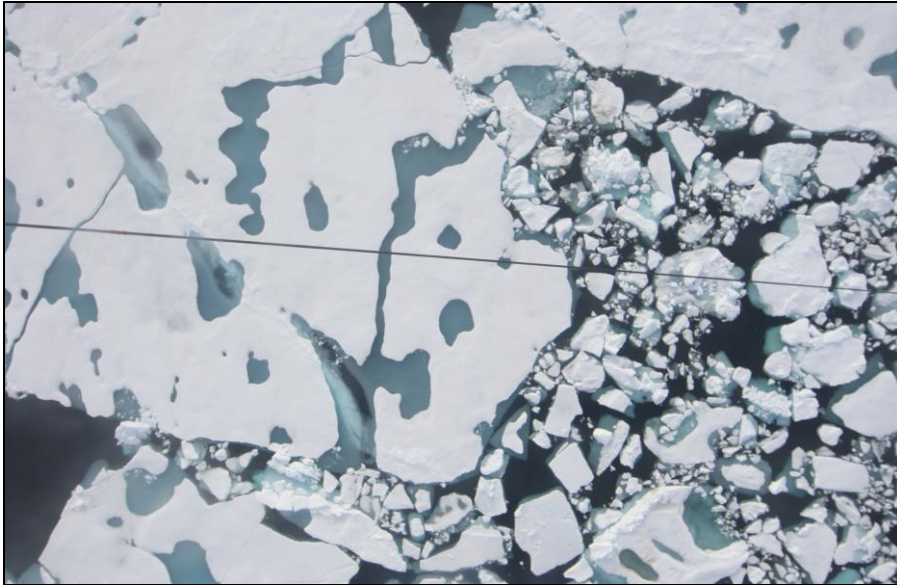


Figure 3: Image taken by the camera system mounted on board the Polar 5 (nadir view).

4.0 Data structure

4.1 HEM-Bird

The ice thickness information obtained with the EM-Bird on a specific date is stored in an ascii file. The file name consists of the date (e.g.20110804) and an “_allfinal.dat” extension.

A single data take (row) includes the year (1st column), the month (2nd column), the day (3rd column), the FID (4th column), Latitude (5th column), Longitude (6th column), Distance from FID 0 (7th column), Ice thickness (8th column) and instrument height above ice (9th column).

4.2 Laserscanner

For a detailed description on the laserscanner file structure we refer to earlier data reports (e.g. Pamarmip)

4.3 Camera system

GPS information for image registration are stored in the EXIF header. Below, a subset of available image information is given:

Filename - 110802_0377.CR2
ImageWidth - 1936
ImageLength - 1288
ApertureValue - F 8.00
FocalLength - 14 mm
GPS information: -
GPSVersionID - 2.2.0.0
GPSLatitudeRef - N
GPSLatitude - 82 56.48 0 (82.941333)
GPSLongitudeRef - W
GPSLongitude - 13 40.48 0 (13.674667)
GPSAltitudeRef - Sea level
GPSAltitude - 59.67 m
GPSTimeStamp - 13 8 13.00
GPSImgDirectionRef - True direction
GPSImgDirection - 0.00/0.00
GPSDateStamp - 2011:08:02

5.0 Results and quality of individual profiles

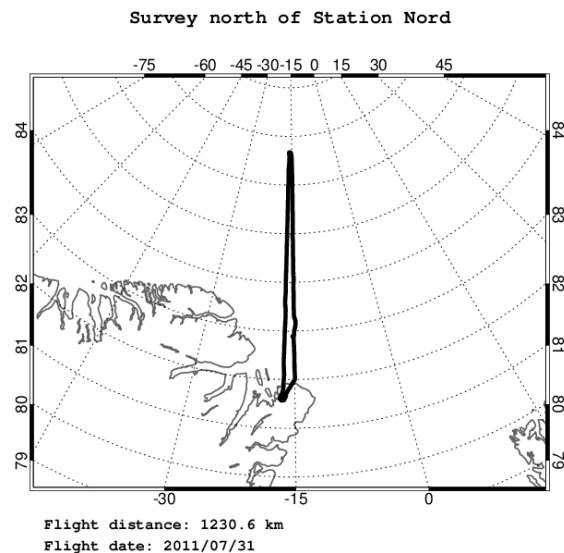
Below, information about

- flight conditions
- data coverage and
- quality of HEM-Bird, laserscanner and camera data

are given.

5.1 July 31, 2011

First flight was performed north of Station North. Weather conditions were good with high visibility, low cloud coverage and temperatures above zero. Sea ice showed high melt pond coverage (~ 30 %) during the entire flight (see Fig. X).



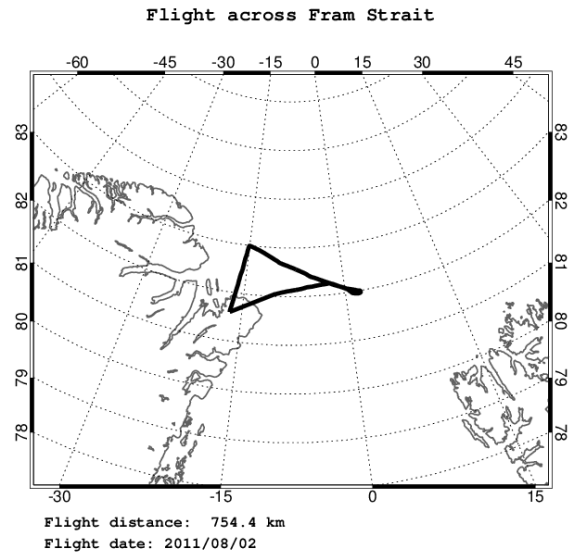
Operation	Date	Boarding	Take off	Landing
Flight north of Station Nord, along 15 W from 82N to 86 N	31.07.2011	10:00 UTC	10:35 UTC	16:07 UTC

Track	File	Description
EM-BIRD	201107311147.dat	<i>All data taken shows strong instrument drift that turned out to be associated to a broken DSP card or A4D4. Therefore, data is invalid and can not be used for processing. Problems turned out only after the flight.</i>
	20110731214.dat	
	201107311223.dat	
	201107311245.dat	
	201107311303.dat	
Laserscanner	110731_104832_Scanner1.rxp	<i>no comments</i>
	110731_113526_Scanner1.rxp	<i>Limited use due to cloud coverage</i>
	110731_154303_Scanner1.rxp	<i>Image interval reduced to 15 sec. Temporarily failure of the system near Station Nord</i>
Camera (way to)	110803_0 - 110803_0xxx	<i>Time interval 7 sec.</i>
Camera (way back)	110803_0xxx- 110803_0xxx	<i>Time interval 15sec.</i>

Table 1: Way out to 86N, 15W from Station Nord on July 31, 2011

5.2 August 02, 2011

Low sea ice concentration and cloud banks and high melt pond coverage dominated the first part of the flight. On the way out, EM-Bird measurements were made. When reaching 82N, 2E Station Nord reported poor visibility. Hence, the transect flight was interrupted and we returned home straight.



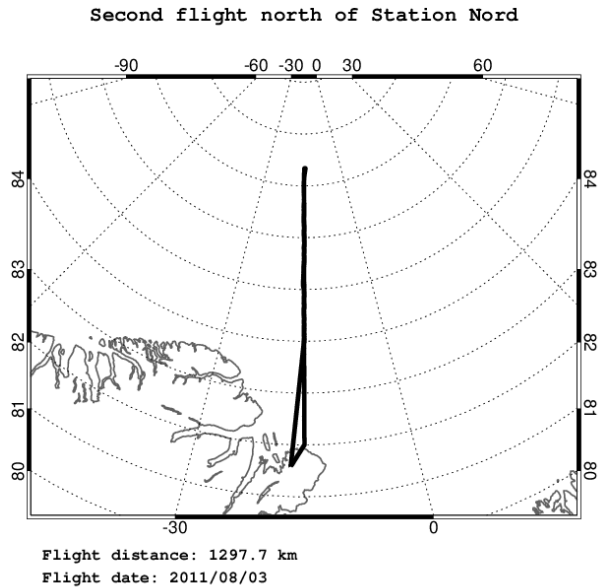
Operation	Date	Boarding	Take off	Landing
Flight north of Station Nord towards 82N 2 E, across Fram Strait	02.08.2011	11:50	12:18	15:36

Track	Files	Description
EM-BIRD	201108021254.dat	EM measurements over pack ice. A lot of open water and melt ponds
	201108021304.dat	EM measurements over pack ice. A lot of open water and melt ponds
	201108021330.dat	EM measurements over pack ice. A lot of open water and melt ponds. The null measurements at 400 ft were made too low and should not be used as a reference for drift corrections.
	201108021357.dat	EM measurements over pack ice. A lot of open water and melt ponds
Laserscanner	110802_123806_Scanner1.rxp	First two files cover several EM-flights. The last file covers the third EM-file. The last EM profile is not covered at all.
	110802_132843_Scanner1.rxp	
	110802_135647_Scanner1.rxp	
Camera (way to)	110803_0 - 110803_0xxx	Time interval 7 sec.
Camera (way back)	110803_0xxx- 110803_0xxx	Time interval 15sec.

Table 2: Instrumentation and data quality for flight on 2011/02/08

5.3 August 03, 2011

Clear sky during the entire flight and absence of low cloud level banks. Temperatures were above freezing and ice showed high melt pond coverage as observed during previous days. Due to good weather conditions, the flight was extended to 87° N.



Operation	Date	Boarding	Take off	Landing
Reputation of flight from July 31. Flight from Station Nord to 87N, 15W	03.08.2011	09:00	09:25	15:00

Track	Files	Description
EM-BIRD	201108030939.dat	<i>EM measurement covers mainly fast ice. Profile ended at fast ice edge</i>
	201108030946.dat	<i>Measurements made over pack ice. Profil shows some laser failures in the beginning.</i>
	201108031000.dat	<i>longer profile with null measurement made at 400 ft.</i>
	201108031024.dat	<i>longer profile with much less laser failures</i>
	201108031043.dat	<i>long profiles, no comments</i>
	201108031105.dat	<i>long profiles, no comments</i>
	201108031131.dat	<i>long profiles, no comments</i>
Laserscanner	201108031155.dat	<i>long profiles, no comments</i>
	110803_093025_Scanner1.rxp	<i>no comments</i>
	110803_094525_Scanner1.rxp	<i>no comments</i>
	110803_100033_Scanner1.rxp	<i>no comments</i>
	110803_102328_Scanner1.rxp	<i>no comments</i>
	110803_104130_Scanner1.rxp	<i>no comments</i>
	110803_110410_Scanner1.rxp	<i>no comments</i>
	110803_112944_Scanner1.rxp	<i>no comments</i>
110803_115344_Scanner1.rxp	<i>no comments</i>	

Camera (way to) 110803_0 - 110803_0834

Time interval 7 sec. Camera failure during second EM-Bird profile at image 110803_220. Back to normal at 10:53 UTC during second half of third Bird profile. A second camera failure appeared at image 0353 during 6th EM Bird profile. Camera was restarted during same profile and went back to normal for the rest of the way to point of return.

Camera (way back) 110803_0834 - 110803_X

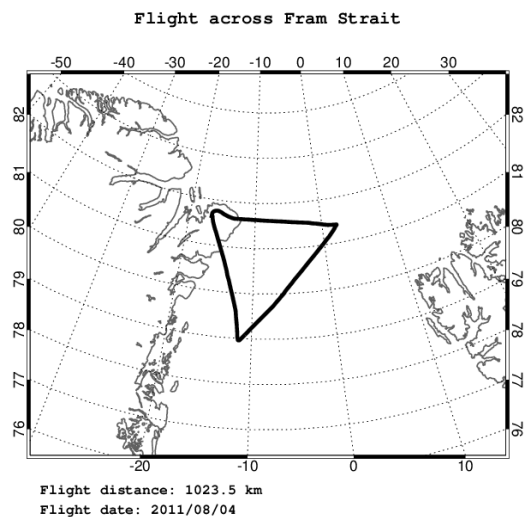
Time interval 715sec.

Table 3: Instrumentation and data quality for flight on 2011/03/08

5.4 August 04, 2011

Stabile high pressure cell over western Greenland provided good flight conditions in the morning. The presence of large open water areas near Station Nord prevented any EM-Bird measurements during the beginning of the flight. Only south of 79.5°N, ice concentration got high enough to start measuring at low level. However, at 79°N, low fog banks appeared, making a continuation of the flight in southern direction impossible (presence of icebergs and increased risk of icing). Therefore the flight route was changed towards a northern point, where weather situation seemed to be more stabile.

On the way to 81.5N, 2.5 E the EM-Bird had ground contact. After winching up the instrument, the flight was interrupted and we returned straight to Station Nord.



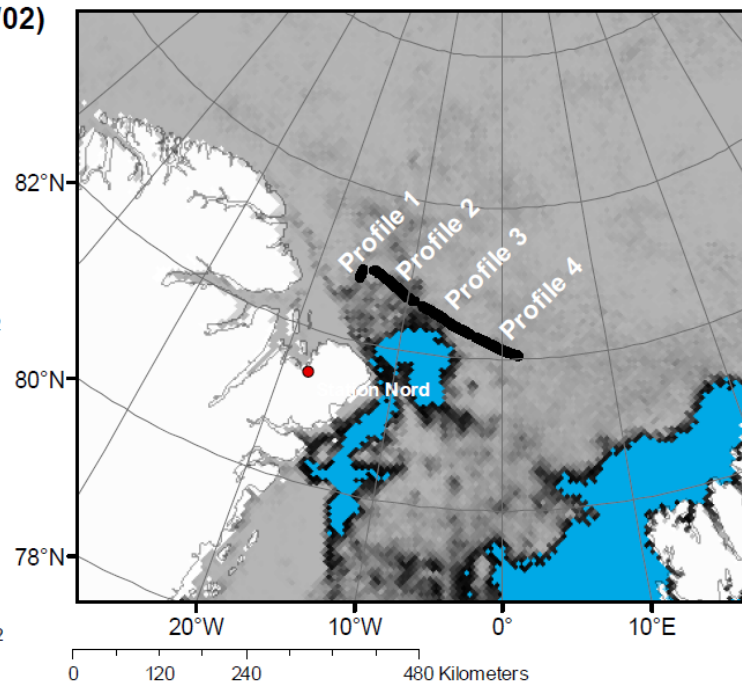
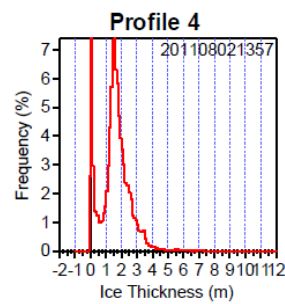
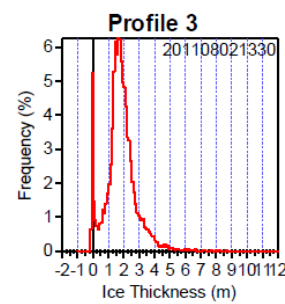
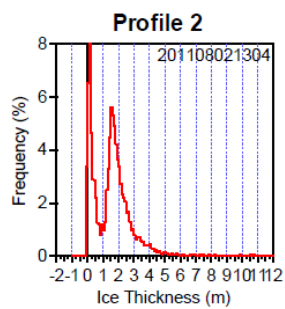
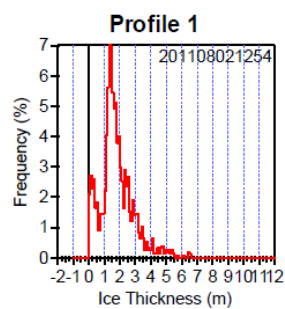
Operation	Date	Boarding	Take off	Landing
Flight from Station Nord toward 76N 10W and back to Station Nord	04.08.2011	08:55	09:25	13:39

Track	Files	Description
EM-BIRD	201108041026.dat	<i>Frequent open water patches. At 78.6N, 11W fog bank showed up ahead. Therefore profile was stopped. Since there was no significant improve further south, flight route was changed towards a northerly located waypoint (80.3N, 2.5W)</i>
	201108041041.dat	<i>Rough air makes keeping flight height difficult, good visibility</i>
	201108041110.dat	<i>Long profile with less open water spots.</i>
	201108041139.dat	<i>Long profile, stabil instrument drift, more open water areas</i>
	201108041202.dat	<i>Ground-contact iwth instrument.</i>
Laserscanner	110804_102142_Scanner1.rxp	<i>no comments</i>
	110804_104108_Scanner1.rxp	<i>no comments</i>
	110804_111022_Scanner1.rxp	<i>no comments</i>
	110804_113951_Scanner1.rxp	<i>no comments</i>
	110804_120244_Scanner1.rxp	<i>no comments</i>
Camera (way to)	110804_0 - 110803_XXX	<i>Time interval 7 sec. Camera was working ok, all flight</i>
Camera (way back)	110804_XXX - 110803_XXX	<i>Time interval 715sec.</i>

Table 4: Instrumentation and data quality for flight on 2011/04/08

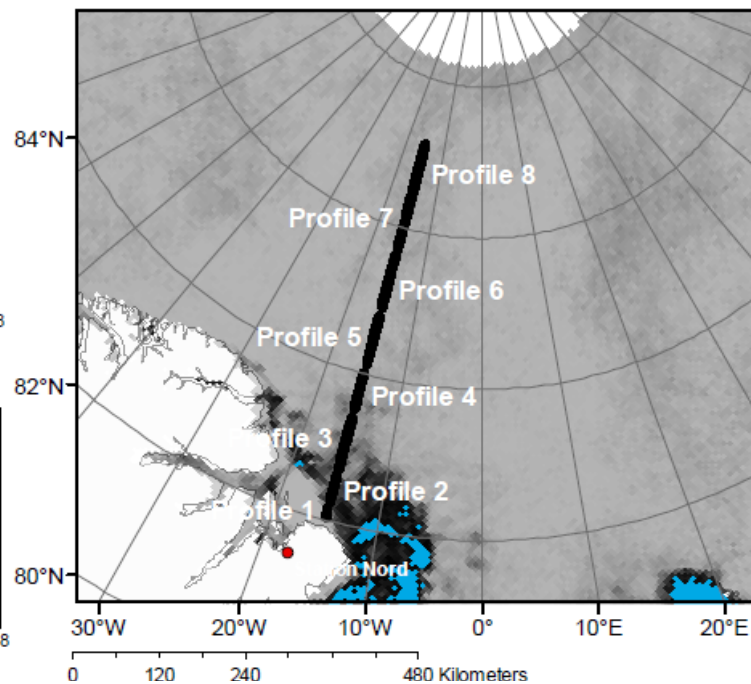
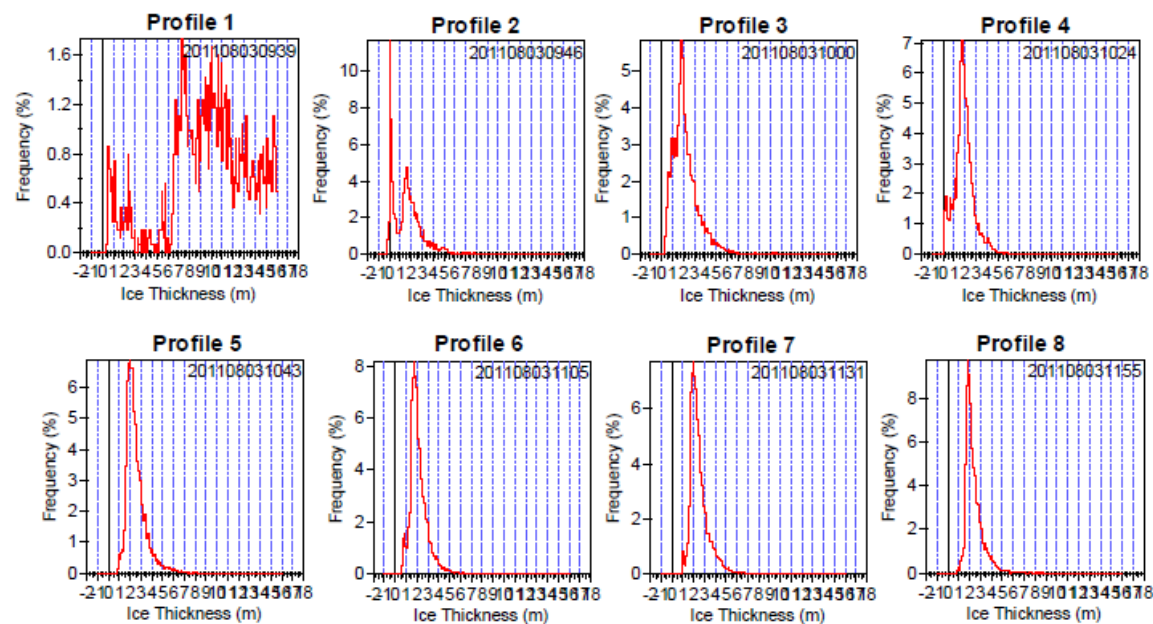
Attachment (I)

EM-Bird ice thickness survey (2011/08/02)



Attachment (II)

EM-Bird ice thickness survey (2011/08/03)



Attachment (III)

EM-Bird ice thickness survey (2011/08/04)

