AWI Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft

SIZONet 2010
Helicopter EM
Data Aquisition Report

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1. Overview

The SIZONet project (An integrated Seasonal Ice Zone Observing NETwork) investigates the environmental, geo-political and socio-economic impact of the changing sea ice cover near the coast of the arctic ocean in Alaska. As a basic parameter, the knowledge of the thickness of the drifting sea ice as well as the landfast ice is crucial for the overall ice physics, the role of sea ice as a habitat for marine mammals and commercial operations.

As an international partner, the Alfred Wegener Institute for Polar and Marine Research provides measurements of sea ice thickness obtained by a helicopter based electromagnetic induction sensor, the so-called EM-Bird. A description of the system is given in *Haas et al.* (2009). Data from the SIZONet field campaign from 2007-2008 was used in the publication of *Haas et al.* (2010).

As in previous years, the field activities in 2010 were based in Barrow (North Slope Borough). All data presented here was collected during three survey flights over sea ice north of Point Barrow and east of Barrow between April 09 and April 12, 2009. The purpose of this document is to give an overview of data aquisition and a summary of processings steps and data delivery format.

1.1. Acknowledgements

SIZONet is a NSF funded project (Award Nr. 0632130). The helicopter was operated by ERA helicopters. We thank Hajo Eicken and Lewis Brower for their support in Barrow. Mette Kaufman provided outstanding logistical support.

2. Data Collection and Processing

Two types of datasets were collected during the helicopter operations over sea ice:

1. EM-Bird ice thickness
2. Aerial photography

2.1. Helicopter EM ice thickness

The EM-Bird (Figure 2.1) is usually towed at an altitude of 10-15 meters above the sea ice surface. A transmitter/receiver pair of coils operating at a frequency of 4.09 kHz is used to estimate the distance of the instrument to the ice-water interface. A laser altimeter records the height above the sea ice surface, hence ice thickness can be obtained by the difference of both distances. Since the laser altimeter is reflected at the top snow surface, the resulting thickness value always includes the thickness of the snow layer, if present.

Figure 2.1.: EM Bird with Eurocopter A-Star helicopter at Roger Wileys Airport (Barrow)

2.1.1. Processing

The remaining dataset was processed using the standard 1D processing approach with a sea water conductivity of 2400 mS/m. An drift correction of the instrument was conducted every 15 to 20 minutes, while open water sites were used for absolute thickness calibration.
After processing ice thickness data points influenced by instrument roll (inferred by GPS heading rate), static discharges during flight and altitudes larger than the threshold of 25 m (laser range) where removed from the final data product.

2.1.2. Ice Thickness Results

The surveys include ice thickness data from firstyear (FYI) and multiyear (MYI) sea ice in the Beaufort/Chukchi Sea as well as fast ice thickness around Point Barrow. Figures 2.2 - 2.4 illustrate the regional distribution of ice thickness of the three flights.

A rough classification of the profiles into subsections of FYI and MYI is shown in figure 2.5. The classification was based on ice thickness results and visual observations during flight instead of satellite images (e.g. SAR brightness). The identified MYI sections might also contain a FYI ice between the MYI floes. In addition some FYI rubble ice zones might be wrongly classified as MYI, since there appearance in the thickness profile is very similar to deformed MYI.

Based on the manual classification 13.6% of all ice thickness points where identified as MYI. The corresponding thickness distributions and statistics are shown in figure 2.6.

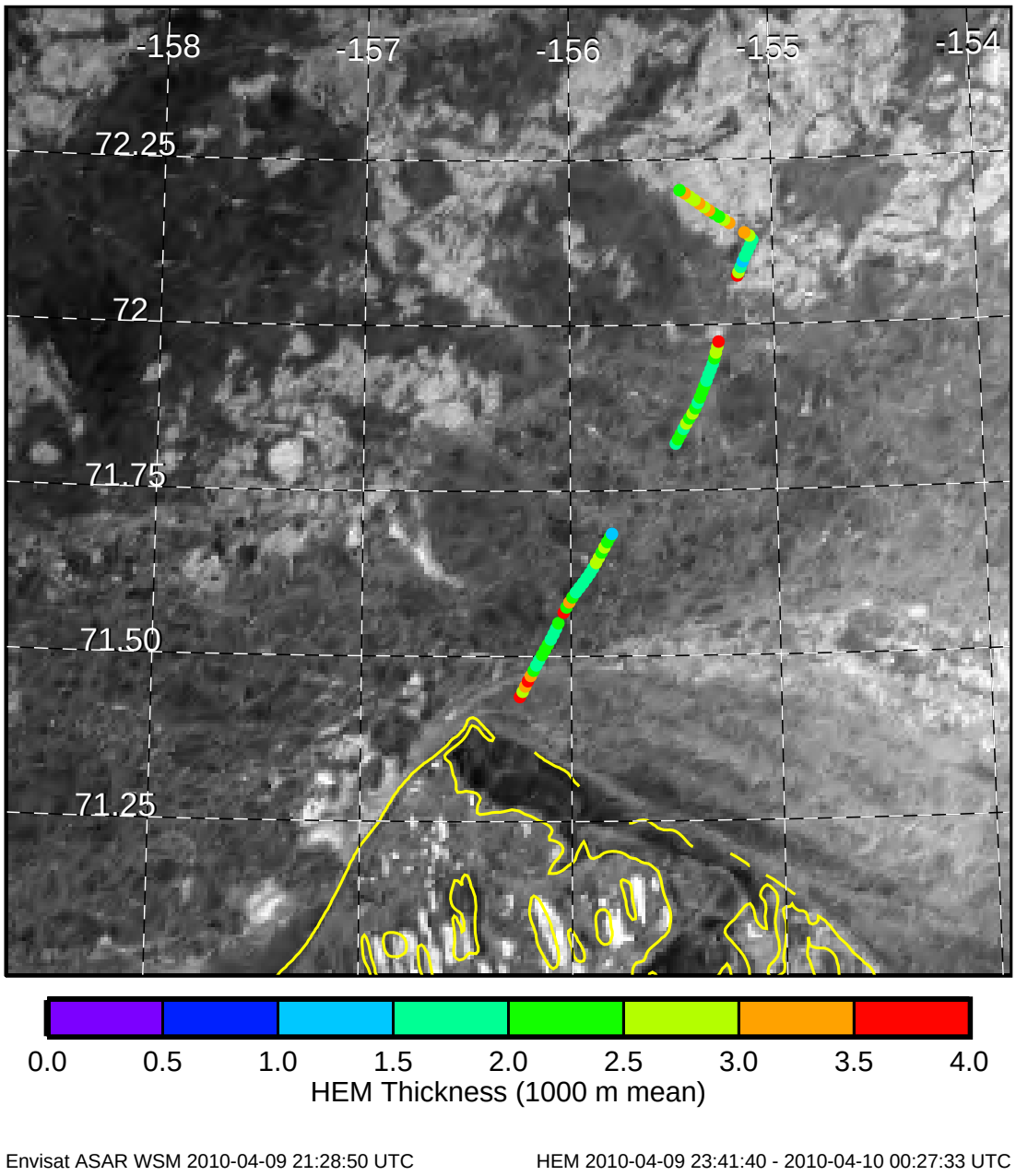


Figure 2.2.: HEM thickness results from survey flight on April 09, 2010

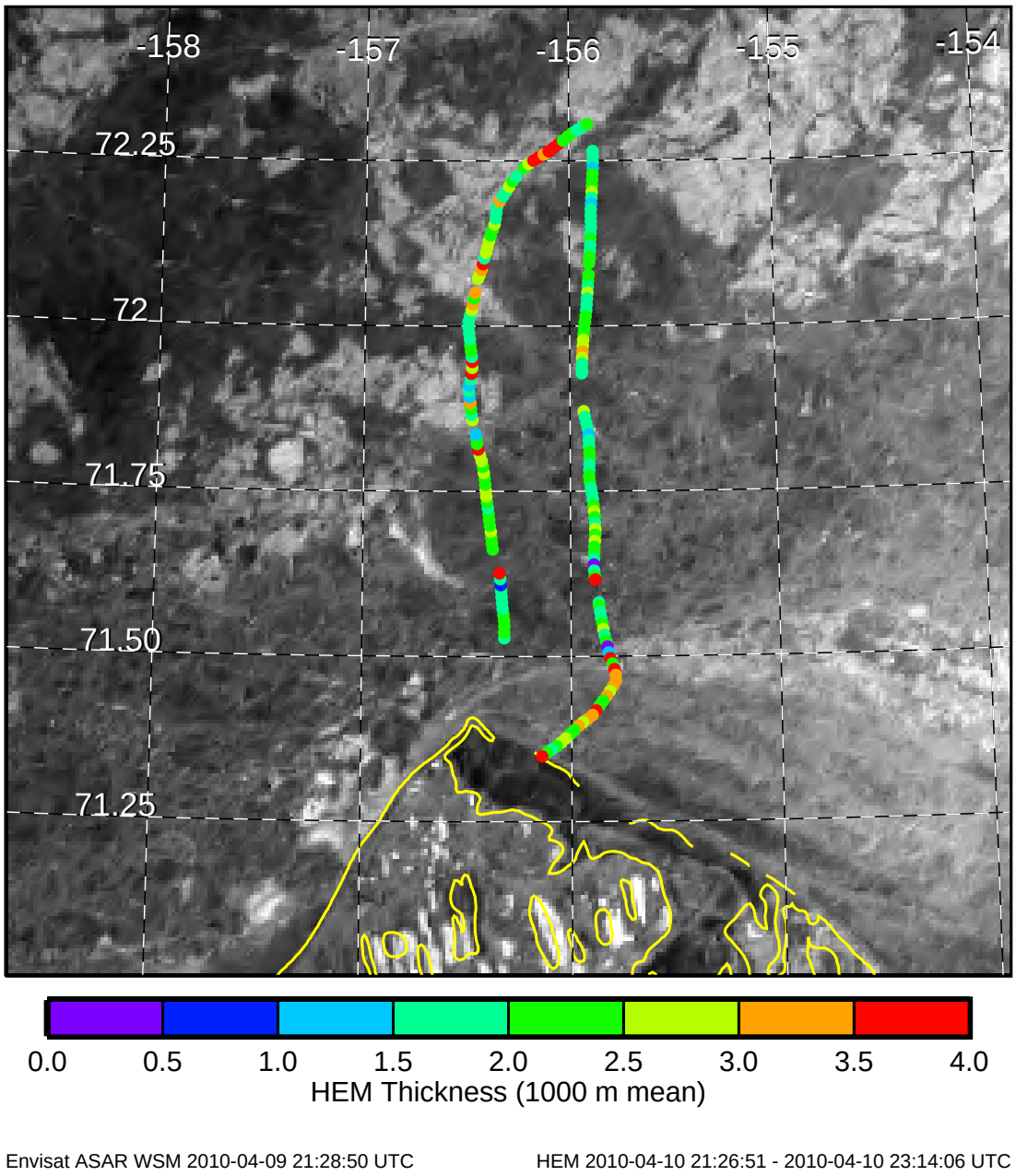


Figure 2.3.: HEM thickness results from survey flight on April 10, 2010

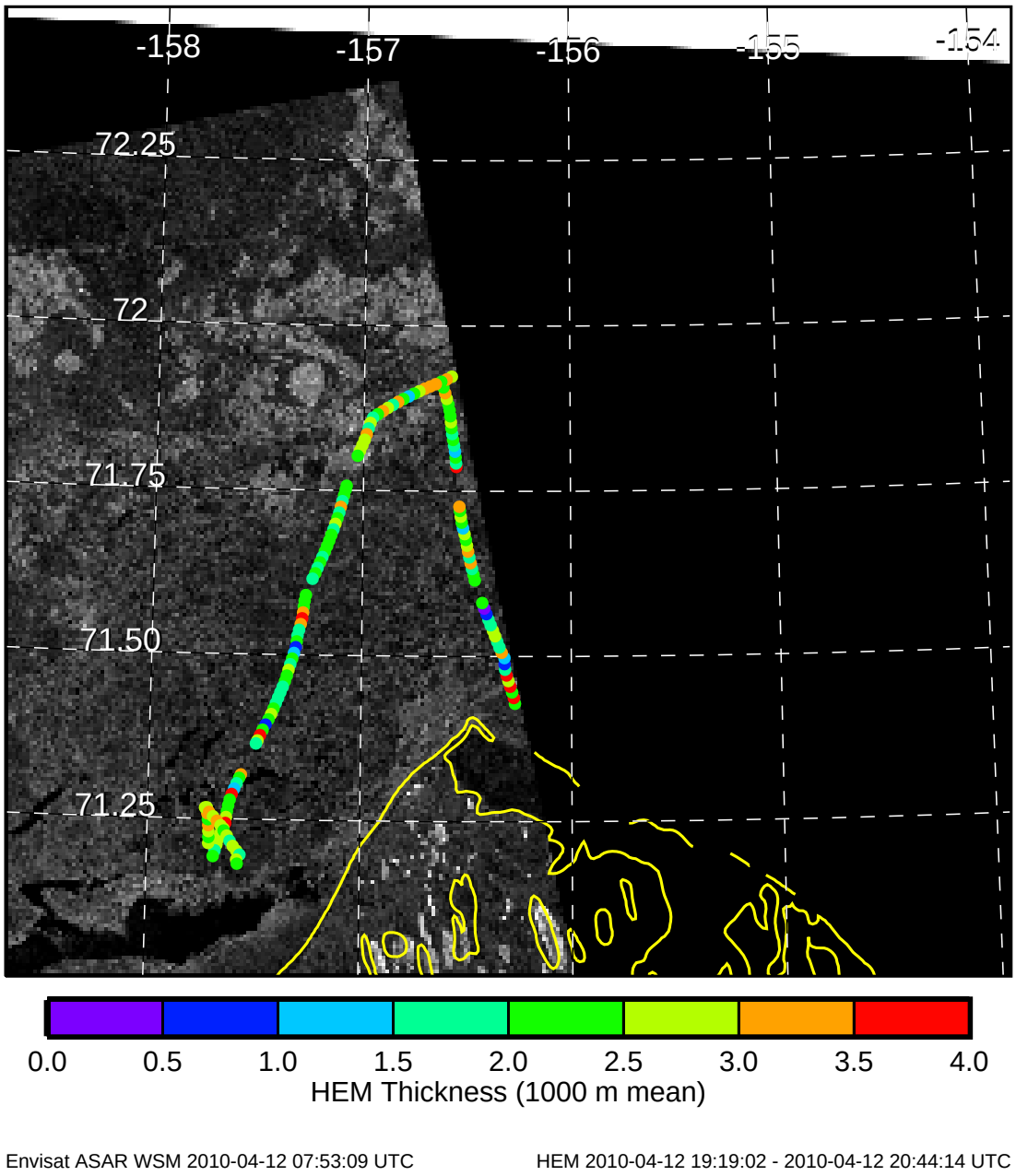


Figure 2.4.: HEM thickness results from survey flight on April 12, 2010

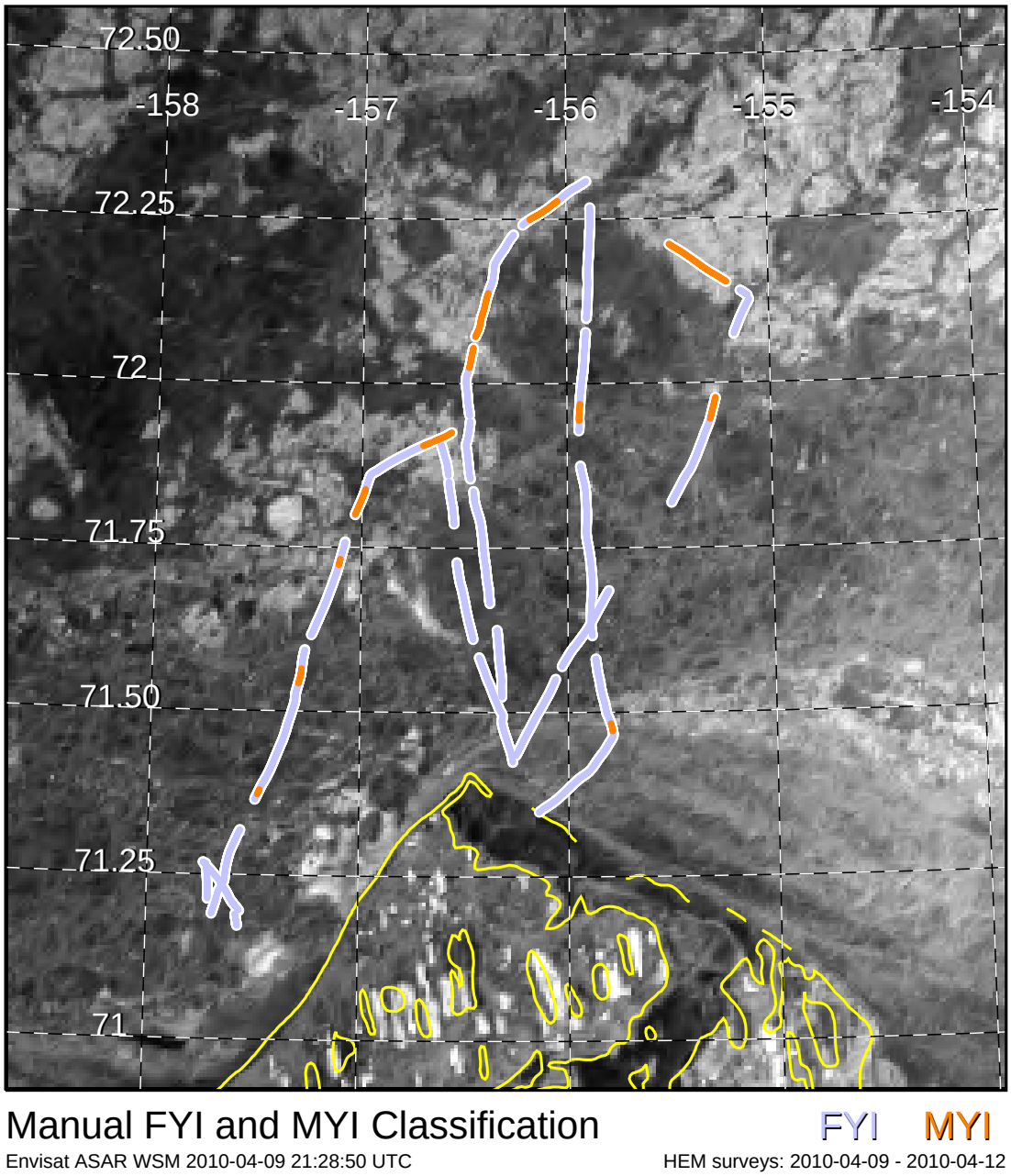


Figure 2.5.: Manual classification of profile data into firstyear (FYI) and multiyear (MYI) sea ice for all SIZONet 2010 profiles.

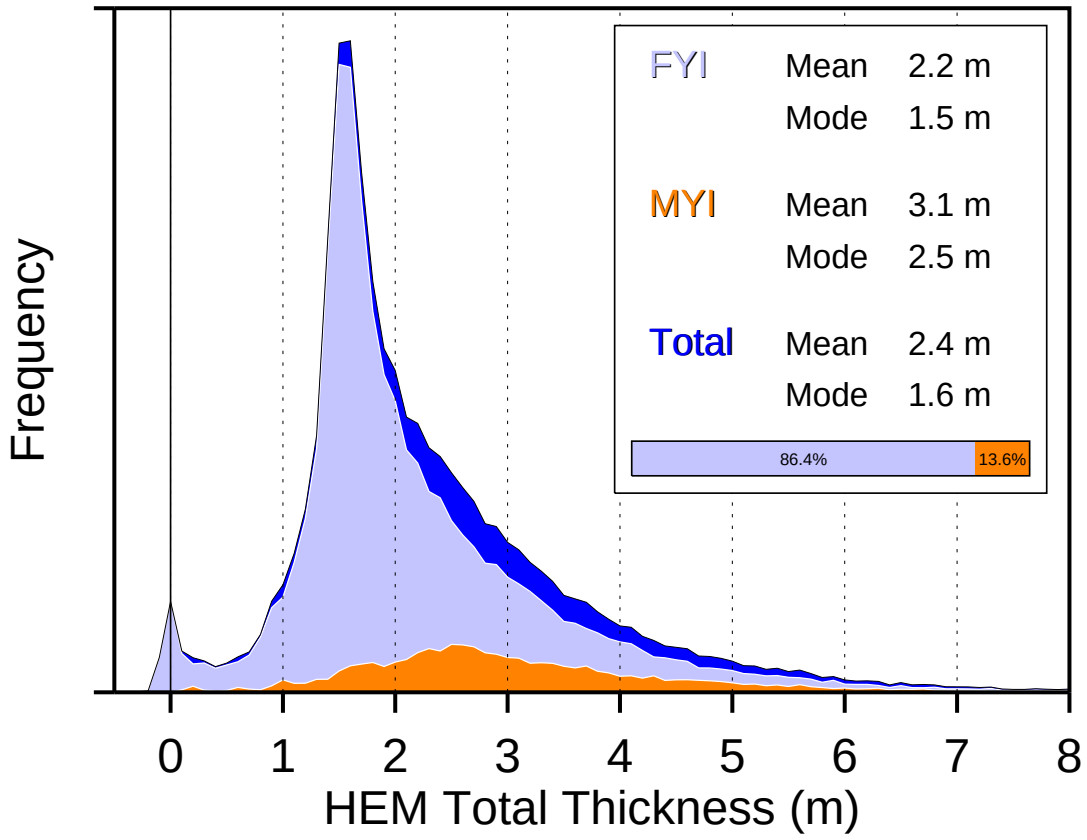


Figure 2.6.: Histogram of all SIZONet 2010 HEM ice thickness data, divided into firstyear (FYI) and multiyear (MYI) sea ice.

2.2. Aerial Photography

Visual sea ice observation were recorded with a digital camera (Ricoh 500Se) during all flights. The pictures were taken from inside the cabin at various inclinations and headings with regard to the flight track.

The camera features a mounted GPS module and a wireless connection to external GPS antennas, however technical difficulties with the external GPS module during two flights and poor signal reception during one flight prevented the recording of useful GPS positions for each image. Therefore, the camera time stamp was synchronized with the GPS time and position were calculated with the GPS position recorded by the EM-Bird. No coordinates were assigned to pictures taken before or after the EM measurements.

Figures 2.7 - 2.9 show the position of aerial photos during the surveys.

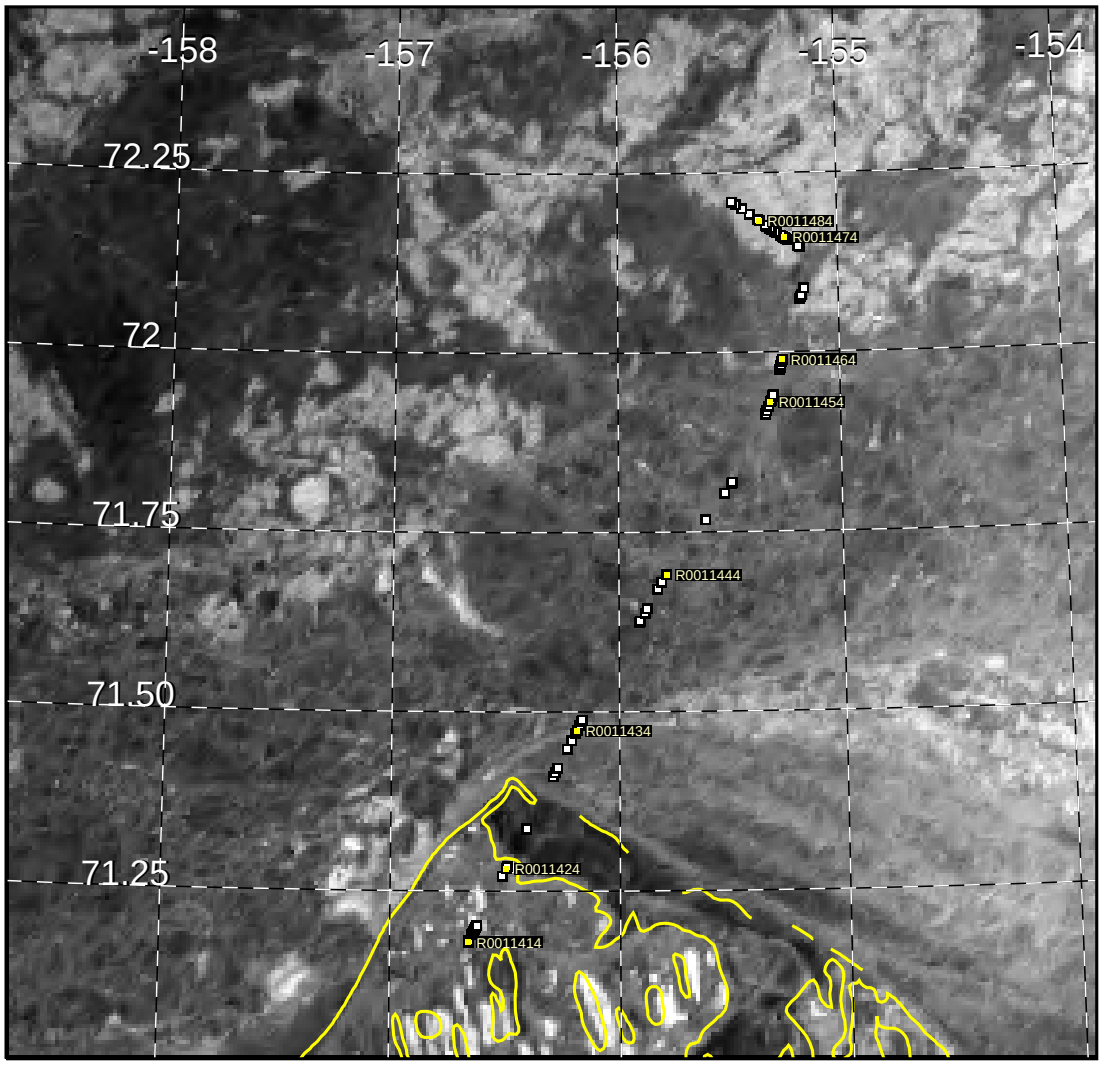


Figure 2.7.: Map of geocoded aerial photos taken from the helicopter during survey flight on April 09, 2010

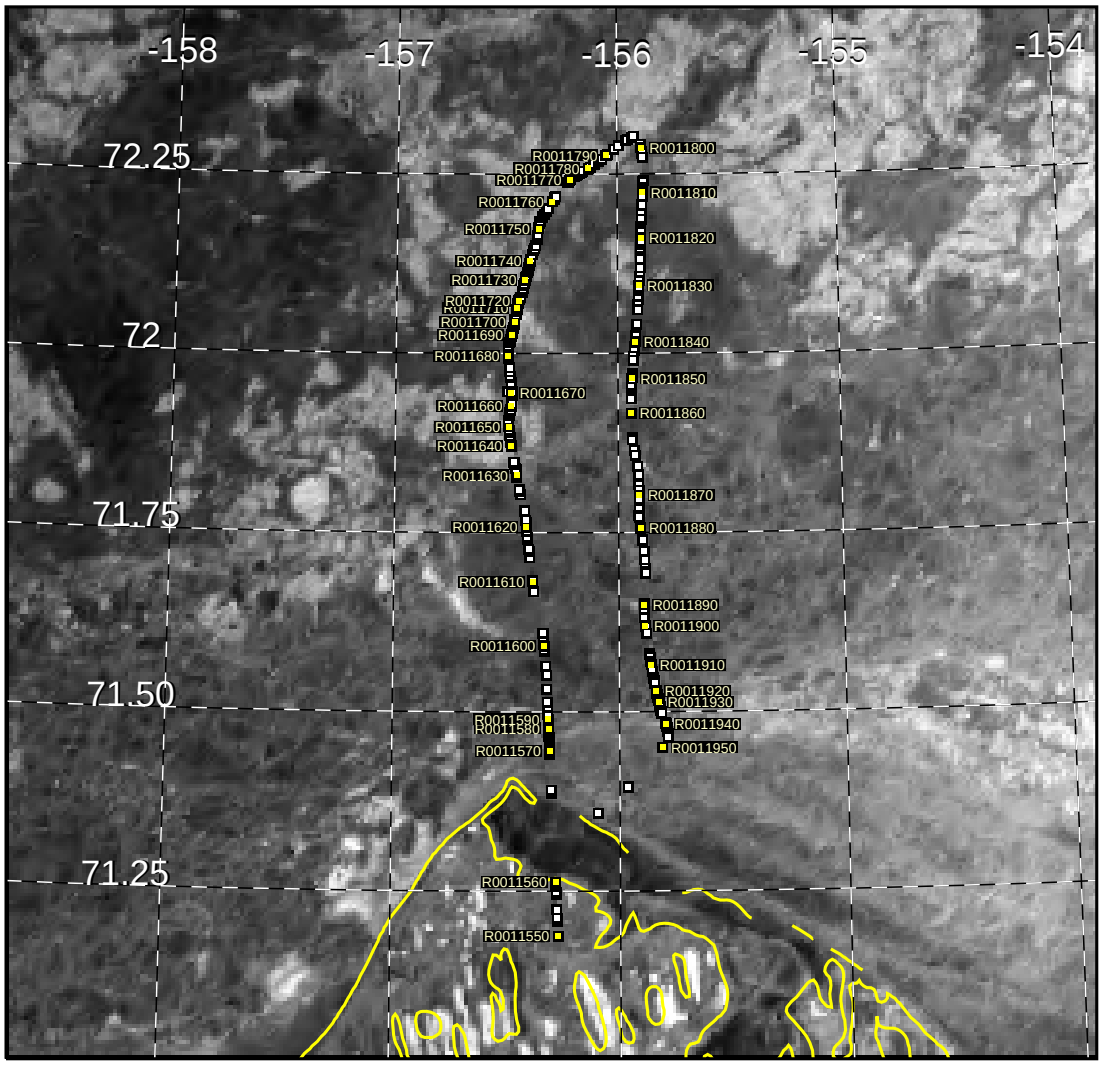


Figure 2.8.: Map of geocoded aerial photos taken from the helicopter during survey flight on April 10, 2010

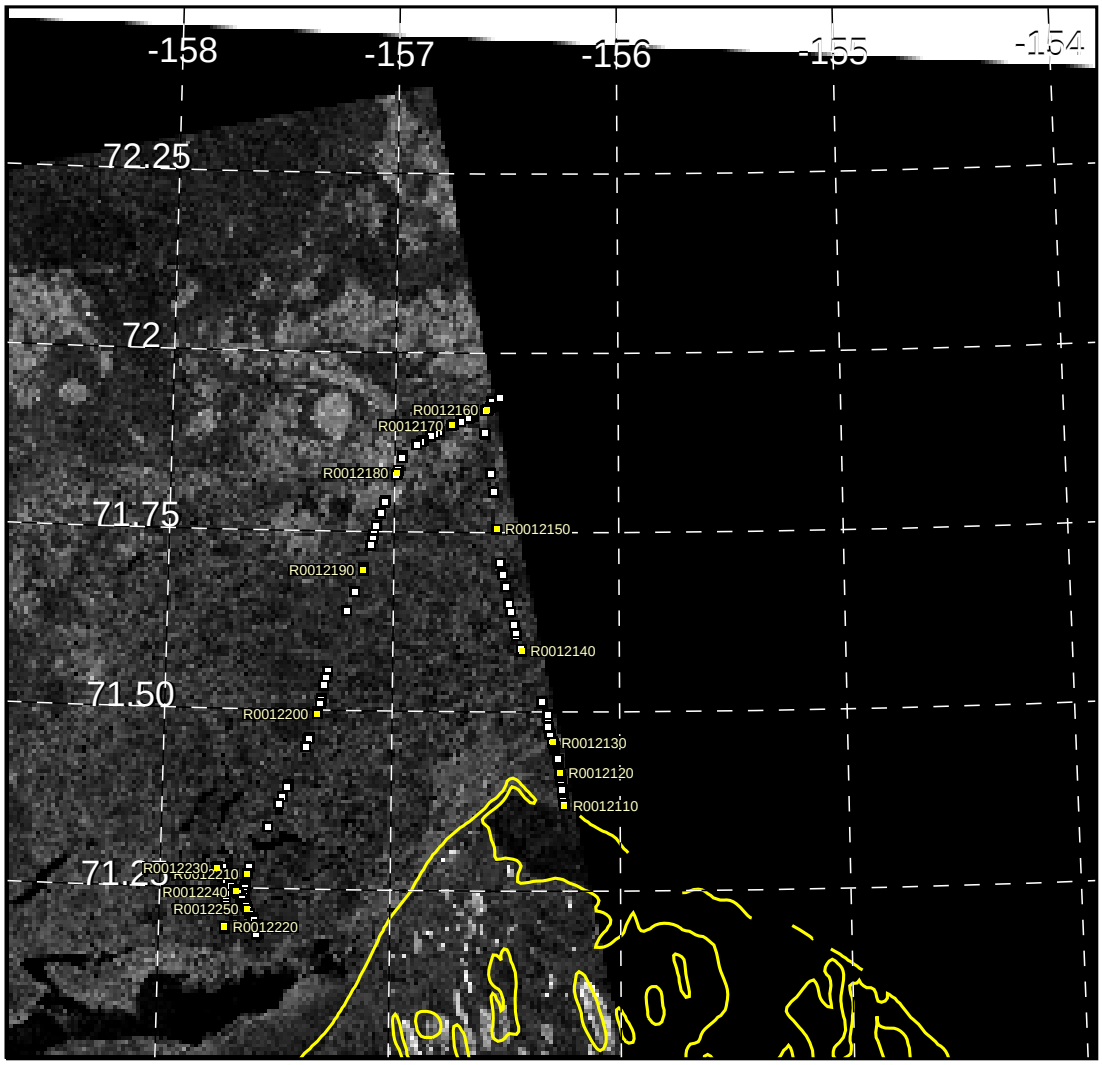


Figure 2.9.: Map of geocoded aerial photos taken from the helicopter during survey flight on April 12, 2010

3. Delivery

3.1. List of HEM Profiles

`HEM_SZN10_20100409T234140_20100410T002733`

Date : 2010/04/09

Survey north-east of Point Barrow. At the northern-most points technical difficulties with the connector of the power cable prevented further measurements. The problem was solved directly after landing and did not occur again.

`HEM_SZN10_20100410T212651_20100410T231406`

Date : 2010/04/10

Survey north of Point Barrow. The aim was to maximize coverage of multiyear ice thickness, however profile mainly consists of first-year ice with some multiyear floes. At the end of the surveys sporadic static discharges due to presence of low clouds caused significant EM noise. The corresponding sections were removed from the final ice thickness product. In addition, the remaining ice thickness data may be influenced by shallow bathymetry.

`HEM_SZN10_20100412T191902_20100412T204414`

Date : 2010/04/12

Survey north-west of Barrow. The first part targeted multiyear ice northwest of the Point, the second part two perpendicular crossings over a mooring in the Chukchi Sea.

Table 3.1.: List of Profiles

3.2. File Naming Conventions

The filename contains a shortcut for the campaign and the start and stop time of the data file. The id for the SIZONet 2010 field campaign is given by `SZN10`.

```
HEM_CMPID_SSSSSSSSSSSSSSS_PPPPPPPPPPPPPPP.dat
```

Token	*Description*
`CMPID`	Contains campaign name (3 letters + 2 digits of year)
`SSSSSSSSSSSSSSS`	`YYYYMMDDTHHMMSS` : Start and Stop time
`PPPPPPPPPPPPPPP`	

Table 3.2.: File naming convention of EM data files

3.3. Data Format

The EM data is delivered in blank separated ASCII data format described in table 3.3. All time tags are standard UTC time.

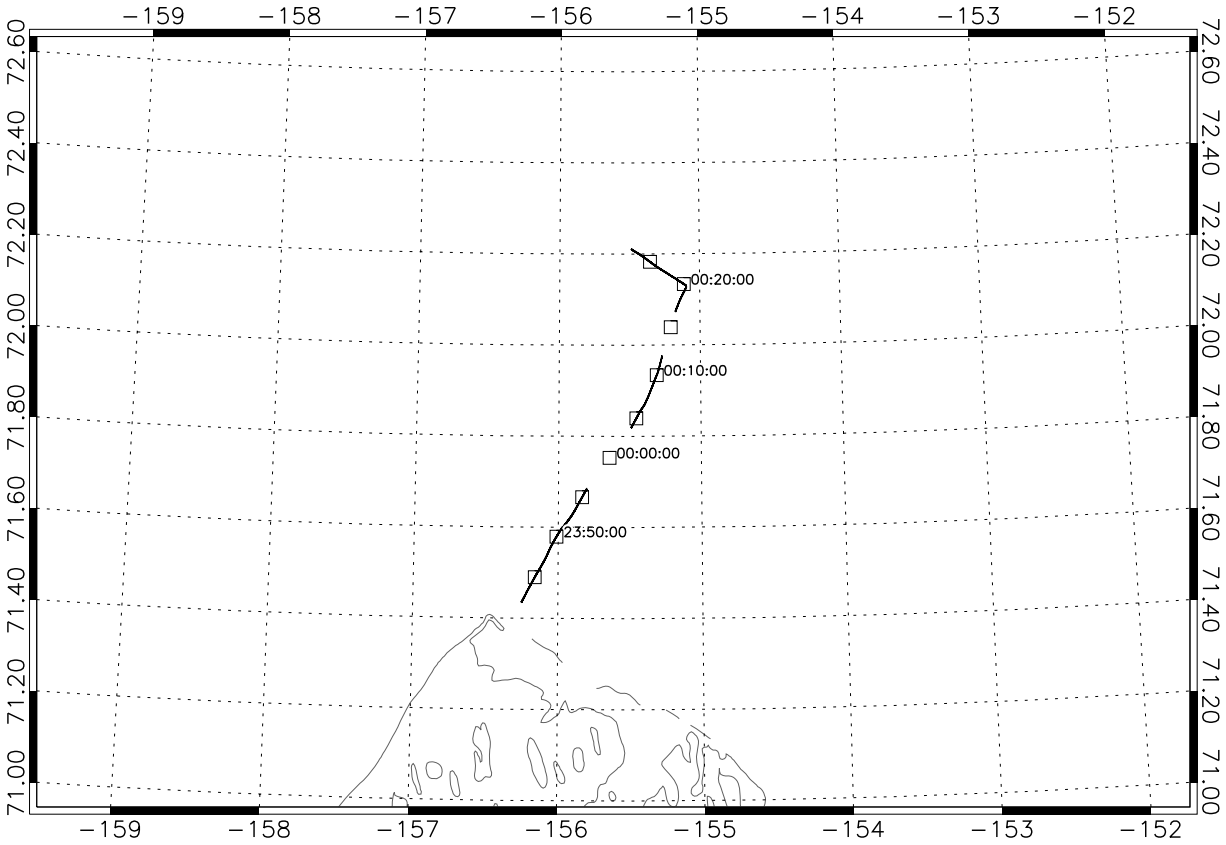
Column	*Description*	*Format*	*Unit*
1	Year	I4	–
2	Month	I2	–
3	Day	I2	–
4	Time	F8.2	Seconds of the day
5	Fiducial Number	I9	–
6	Latitude	F12.7	degree
7	Longitude	F12.7	degree
8	Distance	F12.3	m
9	Thickness	F8.3	m
10	Laser Range	F8.3	m

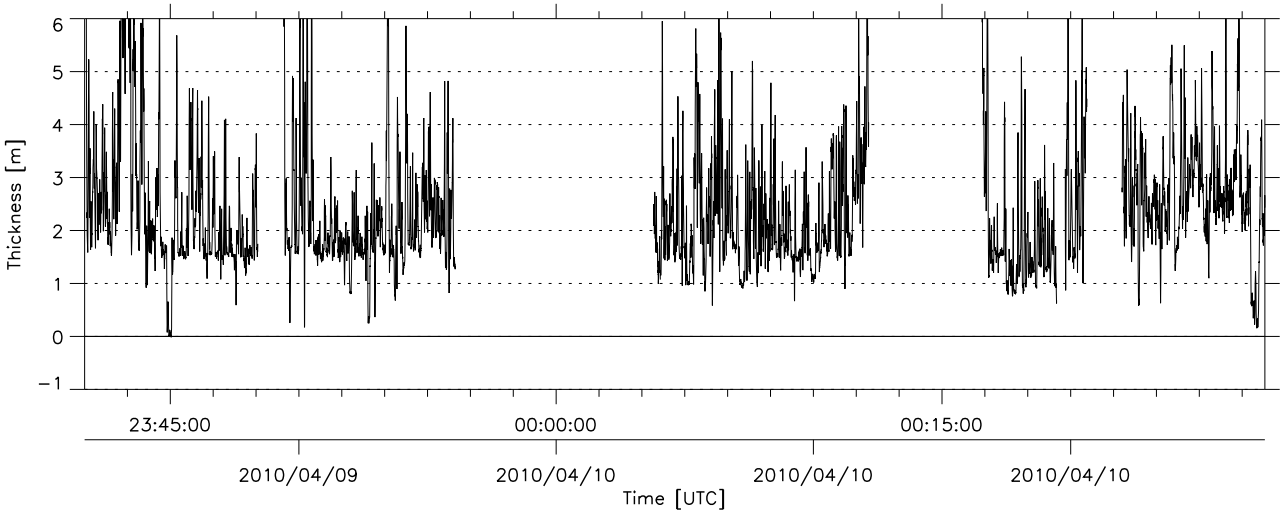
Table 3.3.: File format for EM data delivery

One flight is separated into several profiles with a calibration at the beginning and the end. The distance flown is calculated for this individual profiles and therefore not cummulative for the entire flight. The fiducial number can be discontinous if a reboot of the system was necessary during the flight.

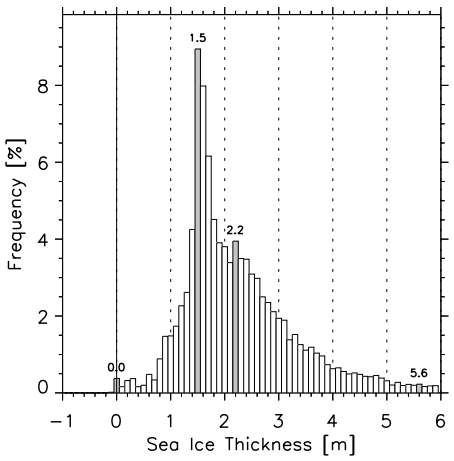
A. Flight Summary

HEM_SZN10_20100409T234140_20100410T002733.nc





Date	2010/09/04
Duration	00:45:52
Length	74.6 km
Mean Thick.	2.39 m
Median Thick.	2.06 m
Stand. Dev.	1.24 m



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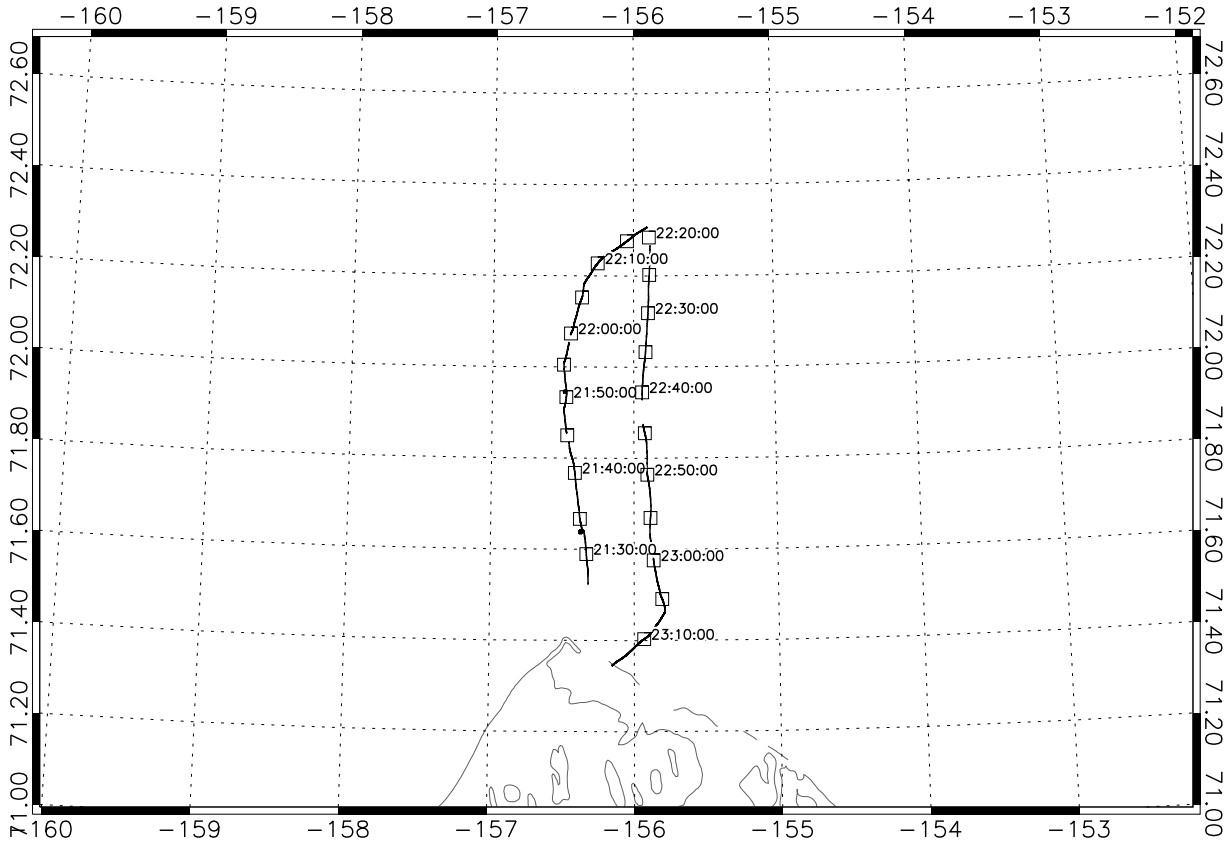
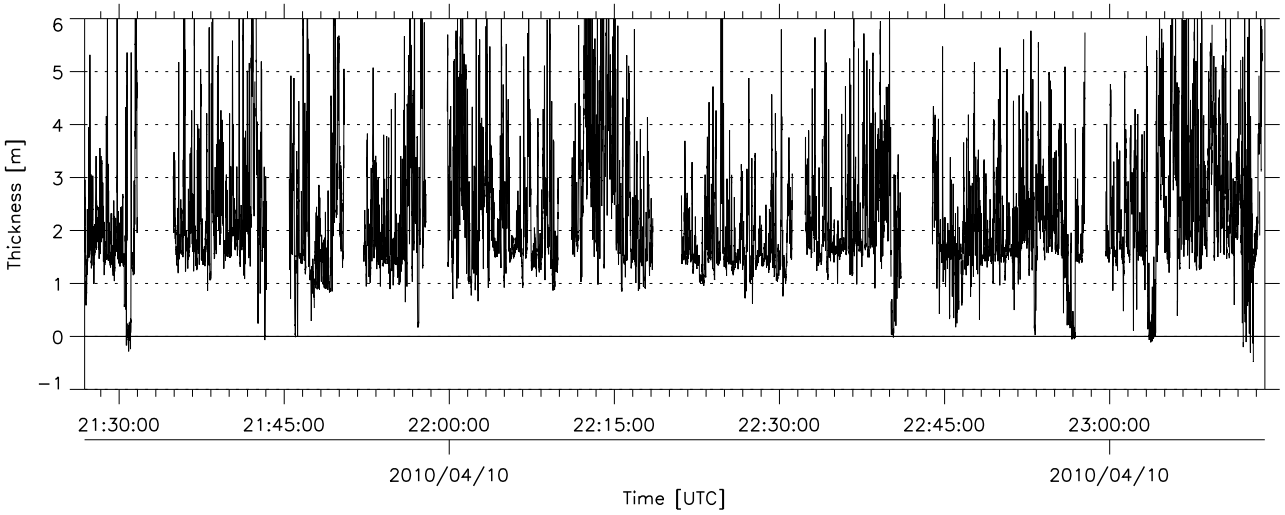
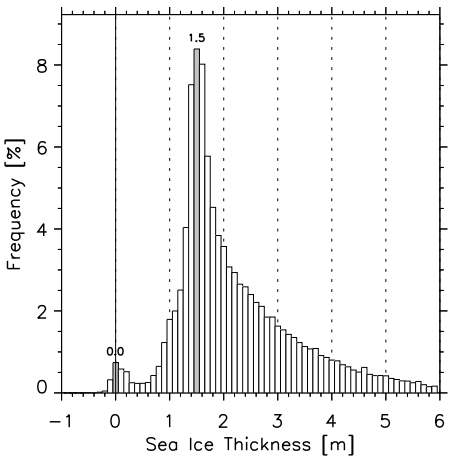




Date	2010/10/04
Duration	01:47:14
Length	196.1 km
Mean Thick.	2.30 m
Median Thick.	1.92 m
Stand. Dev.	1.23 m



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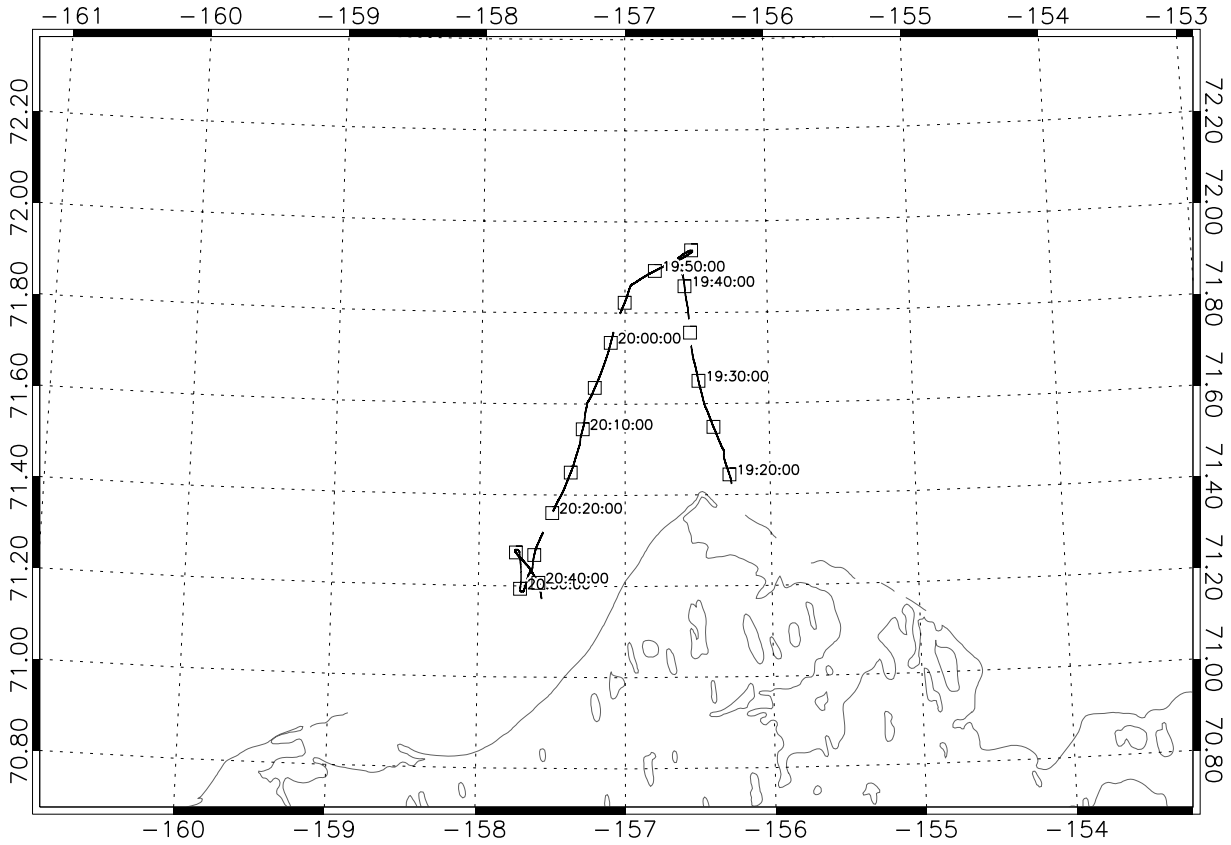
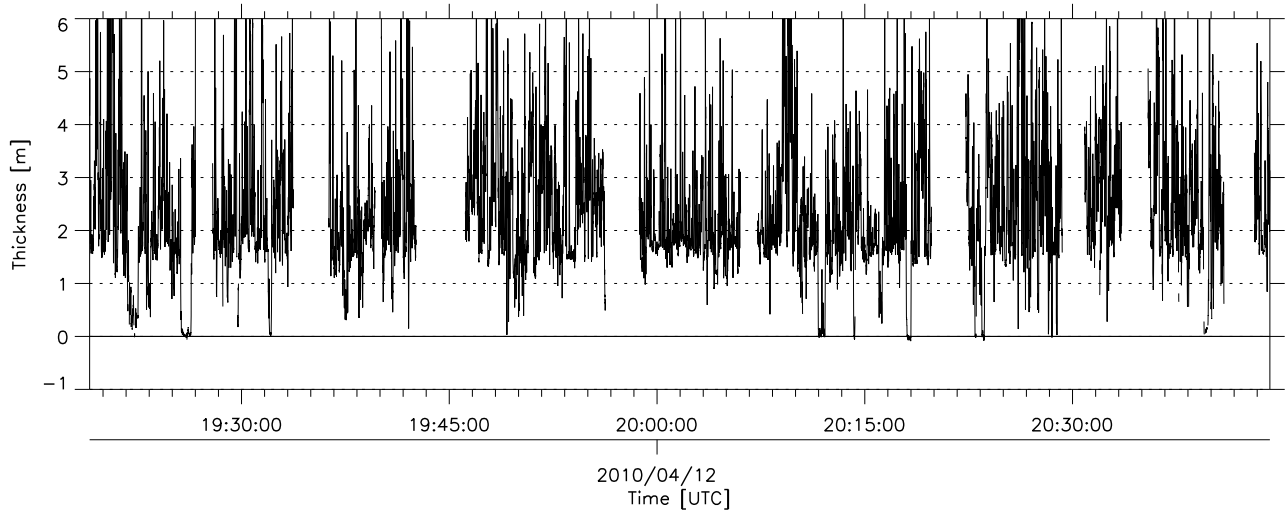
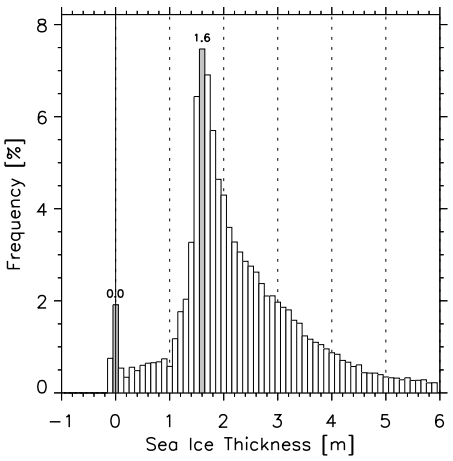




Date	2010/12/04
Duration	01:25:12
Length	166.8 km
Mean Thick.	2.42 m
Median Thick.	2.08 m
Stand. Dev.	1.36 m



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