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ESA CONTRACT REPORT

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ABSTRACT

This report describes the airborne part of the fieldwork performed as part of the CryoSat Validation Experiment (CryoVEx) 2006 and the processing of the collected dataset. The airborne part of the campaign was carried out by the Danish National Space Center (DNSC) using a Twin-Otter chartered from Air Greenland. The main purpose was to collect coincident ASIRAS and laser data at validation sites placed on land ice and sea ice in the Arctic area and offer logistic support to ground teams. The data collected will be important for the understanding of CryoSat-2 radar signals. A number of overflights of corner reflectors both on sea ice and inland ice will aid this understanding and serve the calibration of ASIRAS.

The airborne part of the CryoVEx 2006 campaign has successfully been carried out by DNSC during the period April 18 to May 18 and the gathered datasets are now stored and secured at DNSC and the Alfred Wegener Institute (AWI). Since then an intensive collaboration between ESA, AWI and DNSC have ensured a solid processing of data where many minor and major problems have been identified and solved. Different investigations of the ASIRAS datation have also been performed and are discussed in the report.

A description of the airborne system, the campaign, and the processing is given together with a short description of each validation site. This should aid the user in the understanding and correct use of the dataset.

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Contents

1 Introduction

The European Space Agency (ESA) CryoSat Validation Experiment (CryoVEx) 2006 took place during April and May 2006. During the period April 18 to May 18 the airborne part of this campaign was successfully carried out by the Danish National Space Center (DNSC) using a chartered Air Greenland Twin-Otter aircraft.

The DNSC fieldwork consisted of:

- Airborne data collection with the ASIRAS and laser scanner system following installation and certification of ASIRAS in the Air Greenland Twin Otter (Registration: OY-POF). The airborne operations were coordinated with ground and helicopter activities over land and sea ice in polar areas in Greenland, Svalbard, Canada, and the Arctic Ocean.
- Logistical support for participants in the CryoVEx 2006 experiment especially concerning access to military facilities in Thule Air Base and Canadian Forces Station Alert and aircraft support to the UK teams on the Greenland Ice Sheet.
- Support for the sea ice ground truth work by Finnish and UK teams off Alert.

In general the airborne activities were successful and the objectives were met. A few survey lines were canceled due to the weather conditions as well as the time plan had to be adjusted during the campaign, but overall the expected data collection was carried out. Following the campaign all hard disks with ASIRAS data were transfered to the Alfred Wegener Institute (AWI).

The GPS and INS data were processed at DNSC and delivered to AWI for the ASIRAS processing. Laser data from the validation sites were also processed at DNSC and delivered to AWI for comparison. Throughout the processing phase DNSC, ESA and AWI had several meetings and teleconferences to address issues in the datasets.

This report outlines the field operations and processing of the data collected by DNSC during the CryoVEx 2006 campaign. In addition examples from the processed datasets will be presented, some of which were presented in a preliminary form at the CryoSat Validation and Retrieval Team (CVRT) meeting, ESA-ESTEC, June 2006.

2 Summary of the DNSC Operations

After successful installation and certification in March 2006 of the joint ASIRAS and DNSC laser scanner system in the Air Greenland Twin Otter, the system was ready for operation for the April-May campaign. The installation of the system was this time carried out in the Air Greenland hangar in Kangerlussuaq after the first two days of the charter (April 18 and April 19) had been used to deploy the UK teams on their positions on the EGIG line on the ice sheet. This transport consisted of all together four flights from Kangerlussuaq to the T05 and T12 sites with cargo and personnel. A test flight was performed on April 20 after instrument installation and ground tests with assistance from Radar Systemtechnik's (RST) engineer. The next days were spent on a Danish project surveying the sea ice west of Greenland near the Disko Island until the UK teams were ready for overflights. These local flights were used for more extensive testing of the ASIRAS system and training of the DNSC scientists in operation and backup of the system.

The first main site overflight was carried out on April 25 with a repeated survey of one site (T05) on April 26. This was done since the overflight of T05 on April 25 was not optimal. The campaign flight tracks can be seen in Figure 1. Thereafter followed a few days of waiting caused by poor weather on the Greenland east coast and Svalbard. We succeeded in reaching Svalbard on April 30 in between low-pressure systems. Because of the delay, we decided to base our Svalbard operations out of Longyearbyen instead of Ny Ålesund as planned. Before the Austfonna overflight the Starlab Oceanpal GPS system was mounted on the aircraft to be tested during that flight. A planned sea ice flight on an Envisat track was canceled due to lack of sea ice near Svalbard. On April 2 and 3 the team transited to Thule Air Base via Station Nord, Northeast Greenland. The flight out of Svalbard was over the Kongsvegen glacier coordinated with the ground team there. Unfortunately the wind conditions made it difficult to follow the planned track. Over the Fram Strait an Envisat track was followed with some ASIRAS and laser scanner data acquired despite of some clouds in the area. Also a local flight out of Station Nord was carried out to resurvey previously surveyed lines in the Arctic Ocean.

From Thule Air Base the Devon site was overflown on April 5. The southern part of the track had to be aborted due to dangerous wind conditions. This was afterward discussed with the Devon ground team and it was agreed that they would focus their work near the summit of the ice cap where the best data was obtained. After transit to Canadian Forces Station Alert, Ellesmere Island, on May 8 sea ice flights were done in cooperation with the ground and helicopter work on the ice. Two sites on first year ice and multi year ice close to the station were selected where the work was focused. On May 10 corner reflector overflights were performed repeatedly for each site at different elevations together with runway and building calibration survey. Also longer flights of coordinated Twin Otter (laser scanning and ASIRAS radar altimetry) and helicopter electromagnetic (HEM) data acquisition were done. One of these flights involved placing of UK-SAMS GPS buoys along the line transmitting positions by satellite, as a test for aligning helicopter and Twin-Otter tracks during the future CryoSat calibration campaign.

The aim of the last part of the airborne work was to remeasure previously surveyed sea ice and inland ice margin lines and to assist a Danish glaciology team at Station Nord with transport of equipment and personnel to a local ice cap, Flade Isblink. On May 12 the Twin Otter transited from Alert to Station Nord with data acquisition over the sea ice in the Arctic Ocean and on May 14 the cargo flights to Flade Isblink was carried out. In order to protect the instruments, the ASIRAS system was unmounted before these local flights. The

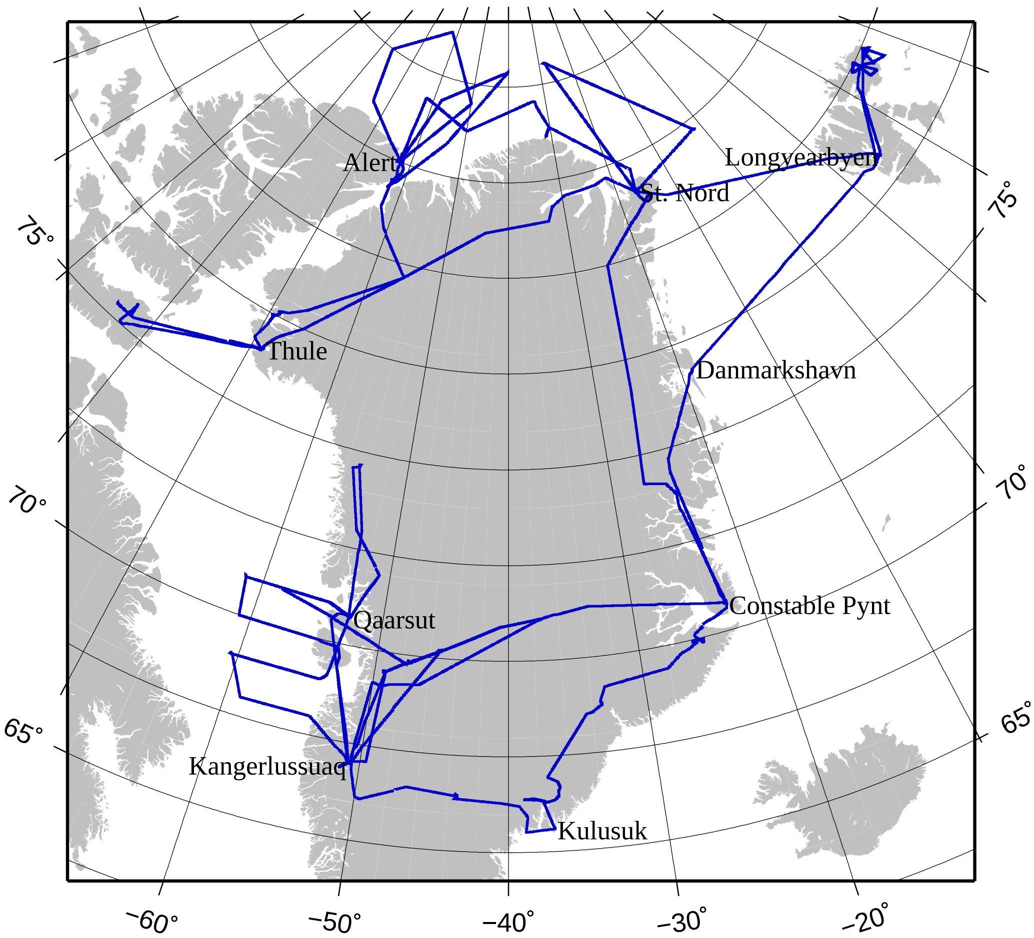


Figure 1: Tracks flown during CryoVEx 2006 by the Air Greenland Twin Otter equipped with the DNSC laser scanner system and the ASIRAS radar.

last flights back to Kangerlussuaq were over the East Greenland ice sheet margin including several outlet glaciers with landings at airfields in Constable Pynt and Kulusuk. After returning to Kangerlussuaq on May 17 the equipment was unmounted.

2.1 Overview of Day to Day activities

April 18-19: Deployment of UK teams to T05 and T12 on the ice sheet. Two flights per day. Installation of the instruments were started on April 19 after the last cargo flight.

April 20: Installation and local test flight.

April 21-24: West-coast sea ice project based in Qaarsut near Uummannaq. Extensive tests and training with RST on the ASIRAS system including the backup system.

April 25-26: EGIG line overflights including the T05 and T12 sites with corner reflectors. The April 26 flight also included a sea ice flight off the west coast coordinated with helicopter landings on the ice and a medical evacuation of the team on T12 due to illness.

April 27-28: No flights due to bad weather on the Greenland east coast.

April 29-30: Transit flights from Kangerlussuaq to Svalbard via the EGIG line, Constable Pynt, and Danmarkshavn. High level ASIRAS data acquisition over the ocean between East Greenland and Svalbard.

May 1: Over-flight of the Austfonna ice cap including 3 of the 4 corner reflectors. Small leg over sea ice east of Svalbard to test the Oceanpal GPS system.

May 2: Transit flight to Station Nord, Greenland via Kongsvegen glacier and Envisat track in the Fram Strait. Local sea ice survey from Station Nord.

May 3: Transit to Thule with survey of the northern part of the Greenland ice sheet.

May 4: No flight.

May 5: Devon ice cap survey. Southern part of the track was aborted due to dangerous wind conditions.Upon consultation with the pilot it was decided not to resurvey the southern part of Devon due to the continued dangerous conditions at the low flight elevations and a heavy aircraft.

May 6-7: No flight.

May 8: Transit to Alert via Politikens Bræ, Qaanaaq, Peterman Glacier, and the ice sheet margin. Change of personnel (R. Forsberg and H. Skourup replaces L. Stenseng and S. M. Hvidegaard, Susanne Hanson continues to Alert for in situ work).

May 9-11: Alert sea ice flights coordinated with sea ice ground observations and helicopter EM flights (HEM).

May 12: Transit flight to Station Nord with sea ice survey (with HEM). Unmount ASIRAS.

May 13: No flight.

May 14: Cargo flight to local ice cap for Danish glaciologists.

May 15: No flight.

May 16-17: Transit flight to Kangerlussuaq via Constable Pynt and Kulusuk, East Greenland. Unmount equipment.

May 18: Cargo flight to pick-up equipment for UK team.

May 19: Shipment of equipment.

Airborne field team:

DNSC: R. Forsberg (RF), S. M. Hvidegaard (SMH), H. Skourup (HSK), and L. Stenseng (LS).

RST: H. Lentz.

JD – Date	Flts	Track	Off B	T O	L	On B	Air	Operator
108 – April 18th	A	SFJ-T5	13:29			15:03	1h34	none
108 – April 18th	B	T5-T12	15:15			15:49	0h34	none
108 – April 18th	C	T12-SFJ	15:51			17:53	2h02	none
108 – April 18th	D	SFJ-T12	18:40			20:23	1h43	none
108 – April 18th	E	T12-SFJ	20:30			22:31	2h01	none
109 – April 19th	A	SFJ-T12	10:41			12:31	1h50	none
109 – April 19th	B	T12-SFJ	12:36			14:34	1h58	none
109 – April 19th	C	SFJ-T5	15:19			16:54	1h35	none
109 – April 19th	D	T5-SFJ	17:00			18:40	1h40	none
110 – April 20th		test	18:52	18:54	19:31	19:36	0h44	LS
111 – April 21st		V1-V4	11:10	11:15	15:49	15:54	4h44	LS/SMH
113 – April 23rd		A	21:49	21:54	01:54	01:59	4h10	SMH
114 – April 24th		V5-V8	17:21	17:26	22:11	22:16	4h55	SMH
115 – April 25th		X-EGIG	11:54	11:59	18:49	18:54	7h00	SMH
116 – April 26th	A	SFJ-JQA	12:53	12:58	14:57	15:02	2h09	SMH
116 – April 26th	B	JQA-V-T12	16:02	16:07	19:40	19:45	3h43	SMH
116 – April 26th	C	T12-SFJ	19:46	19:51	21:42	21:47	2h01	SMH
119 – April 29th	A	EGIG	11:07	11:11	16:54	16:59	5h52	SMH
119 – April 29th	B	B	17:43	17:48	20:53	20:58	3h15	SMH
120 – April 30th		DMH-LYR	08:22	08:27	11:57	12:02	3h40	SMH
121 – May 1st		AUSTFON	10:13	10:18	15:38	15:43	5h30	SMH
122 – May 2nd	A	KV-EN	08:33	08:38	11:50	11:55	3h22	SMH
122 – May 2nd	B	F	13:09	13:14	18:18	18:23	5h14	SMH
123 – May 3rd		H	10:42	10:47	16:06	16:11	5h29	SMH
125 – May 5th		DEVON	12:56	13:01	17:29	17:34	4h38	HSK
126 – May 6th	Weekend Thule Closed							
127 – May 7th								
128 – May 8th	A	TAB-NAQ	14:25	14:30	15:05	15:10	0h45	HSK
128 – May 8th	B	NAQ-YLT	15:33	15:38	18:50	18:55	3h22	HSK/RF
129 – May 9th		YLT-YLT	15:59	16:04	20:51	20:56	4h57	RF
130 – May 10th		YLT-YLT	17:47	17:52	19:45	19:50	2h03	RF
131 – May 11th		YLT-YLT	14:40	14:45	20:08	20:13	5h33	RF
132 – May 12th		YLT-NRD	14:43	14:48	19:29	19:34	4h51	RF
133 – May 13th	Station Nord							
134 – May 14th		Flade Isblink uplift, 8 flts					6h03	
135 – May 15th	no flights							
136 – May 16th		NRD-CNP	09:50	09:55	15:42	15:47	5h57	RF
137 – May 17th		CNP-KUS	08:40	08:45	13:39	13:44	5h04	RF
138 – May 18th		KUS-SFJ	14:30	14:35	18:01	18:06	3h36	RF
Total							127h00	

Table 1: GRL06 Flights. Off B: Off Bloc, T O: Take Off, L: Landing, On B: On Bloc, Air: Airborne.

3 Hardware Installation

In the Air Greenland hangar in Kangerlussuaq the equipment was installed in the Twin Otter according to the experience from the test campaign in Nuuk in March 2006. No major difficulties were encountered. Table 2 gives the offsets between the instruments and Figure 2 sketches the approximate position of the instruments in the aircraft.

For the Twin-Otter new antenna cables had to be made to accommodate the longer distance between the ASIRAS instrument and the ASIRAS antenna. After a discussion between DNSC, RST and Air Greenland engineers it was decided that the optimal installation in the aircraft would be with cables of 240 cm each. These 240 cm cables were then supplied by RST and used throughout the CryoVEx 2006 campaign.

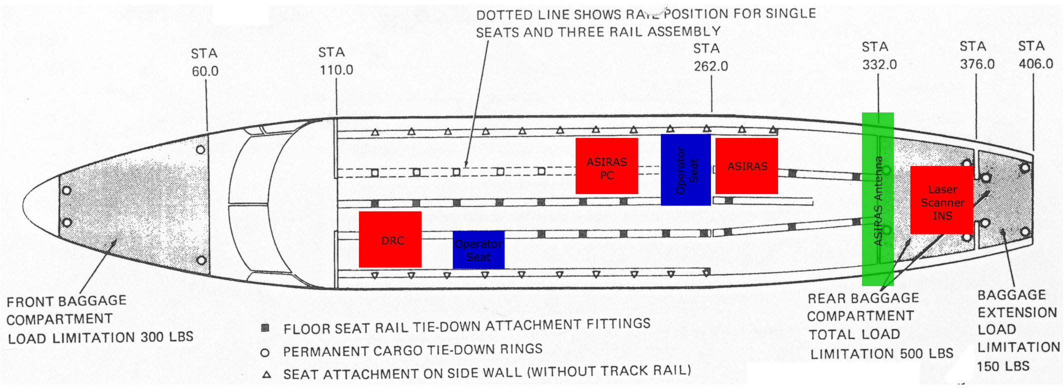


Figure 2: Sketch of approximate instrument positions.

to laser scanner	dX **(m)**	dY **(m)**	dZ **(m)**
from AIR1/AIR3 (front)	-3.70	+0.52	+1.58
from AIR2/AIR4 (rear)	+0.00	-0.35	+1.42
to ASIRAS antenna	dX **(m)**	dY **(m)**	dZ **(m)**
from AIR1/AIR3 (front)	-3.37	+0.47	+2.005
from AIR2/AIR4 (rear)	+0.33	-0.40	+1.845

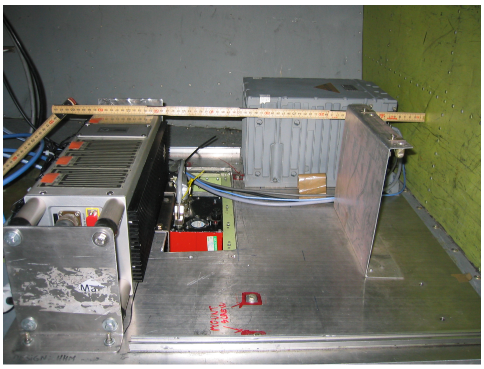
Table 2: The lever arm from the GPS antennas to the origin of the laser scanner, and to the back center of ASIRAS antenna frame (see arrow). Offset definition: X positive to the front, Y positive to the right and Z positive down.

(a) ASIRAS antenna mounted on OY–POF

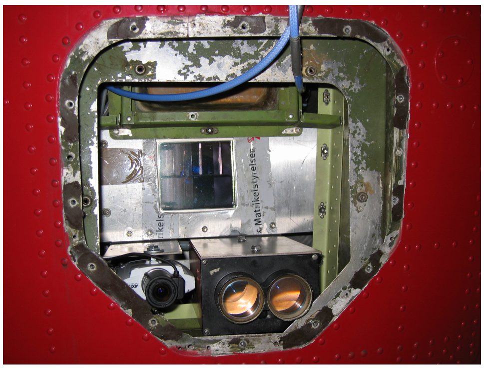
(b) ASIRAS instrument installed in the rack with AIR4 (Trimble 4000).

Figure 3: Photos of the ASIRAS installation.

(a) Setup inside the cabin during survey.



(b) From left: Laser scanner, altimeter, camera (behind altimeter) and INS installed in aft luggage compartment.



(c) Laser scanner (center), altimeter (botom right) and camera (bottom left) seen from outside.

Figure 4: Photos of the laser installation.

4 Overview of Acquired Data

During the CryoVEx 2006 Campaign the DNSC collected around 4.5 Tb of ASIRAS data and 30 Gb of GPS, INS, Laser and photos with the airborne system. ASIRAS data were stored on hard disks and backed up to AIT-3 tapes after each flight, using the ASIRAS PC3. The tapes are stored at DNSC and the hard disks were delivered to AWI for processing. All other data were stored on an external hard disk, written to CD-roms and copied to the operators laptops to minimize the risk of data loss due to media failure.

An overview of the collected data can be seen in Table 3 and a more detailed list of data can be found in the following sections and relevant appendices.

4.1 Auxiliary Data

During the survey flights operator logs were kept for both the DNSC laser scanner system and the ASIRAS radar system. These logs have been stored as separate files together with the data files and can also be found in the Appendix B and E.

A downward looking camera was installed next to the laser scanner and operated during most flights to acquire visual documentation of the observed surface. Images were obtained every 2 seconds with a resolution of 640 by 480 pixels, with one pixel roughly corresponding to 1 by 1 m. These were logged directly on a dedicated laptop PC after initial tests on a rack mounted PC was unsuccessful. In addition to the downward looking camera, the operators took digital photographs and digital video out of the Twin Otter windows on irregular basis during flights. These photos have been gathered and stored together with the survey data files.

As a backup for the laser scanner instrument a profiling laser altimeter (Optech) was mounted next to the scanner. The instrument was tested but data were only sporadically stored as most flights were out of range of this altimeter.

4.2 Summary

Nearly all data were recovered during the campaign except for the few cases discussed above. The full set of raw data is now stored on the DNSC server system (with tape backup) and copies are kept on CD-roms except for the ASIRAS data, which were stored on tapes and hard disks. The hard disks with ASIRAS data have been delivered to AWI and the backup tapes are at DNSC. An overview of collected data can be found in Table 3.

JD – Date	AIR1	AIR2	AIR3	AIR4	SCAN	EGI	ALT	CAM	CNP0	JQA1	KELY	LYR1	NRD1	NRD2	SCOR	SFJ1	TAB1	NYA2	UMD1	YLT1	YLT2	Remarks
110 – April 20th	X	X	X		X	X [a]		X								X						[b]
111 – April 21st	X	X	X	X	X	X										X						[c]
113 – April 23rd	X	X	X	X	X	X		X		X												
114 – April 24th	X	X	X	X	X	X		X											X			[d]
115 – April 25th	X	X	X	X	X	X		X								X						[e]
116 – April 26th	X	X	X	X	X	X		X			X											[f]
119 – April 29th	X	X	X	X	X	X	X	X							X	X						[g]
120 – April 30th	X	X		X	X	X	X	X				X										[h]
121 – May 1st	X	X	X	X	X	X	X	X				X										[i]
122 – May 2nd	X	X	X	X	X	X	X	X					X	X				X				[j]
123 – May 3rd	X	X [k]	X	X	X	X		X					X [l]									[m]
125 – May 5th	X	X	X	X	X	X	X	X									X					[n]
128 – May 8th	X	X	X	X	X	X	X	X									X					
129 – May 9th	X	X	X	X	X	X	X	X												X	X	
130 – May 10th	X	X	X	X	X	X	X	X												X	X	[o]
131 – May 11th	X	X	X	X	X	X	X	X												X	X	
132 – May 12th	X		X	X	X	X [p]	X	X					X									
136 – May 16th	X		X	X	X	X	X	X														
137 – May 17th	X		X	X	X	X	X	X	X													

Table 3: Data acquired from reference stations and aircraft instruments.

[a] EGI file errors when read by readegi, output to screen OK
[b] Test Flight, WEBCAM PC stopped halfway
[c] webcam PC error
[d] 1 hour side-looking radar
[e] EGI logging startet late
[f] no data in 2 scanner files
[g] no scanner data
[h] ASIRAS HAM
[i] 4 reflectors possible
[j] reflectors at KV. ASIRAS 2nd leg
[k] two files, mem card full
[l] ref. GPS too short 14:34 landing 16:06
[m] ASIRAS: Acad.+H6-7
[n] reflector at Devon
[o] reflectors at sea ice
[p] EGI disc full, last hour missing; scan file missing due to accidental closure of PC

5 Processing GPS and INS data

Kinematic GPS is the key positioning method of the aircraft. GPS dual-frequency phase data were logged at 1 Hz using one or several ground base receivers at one or more reference sites, and 4 aircraft receivers; one of these dedicated to datation for the ASIRAS system. The aircraft GPS receivers are named AIR1 (Trimble, 4000-SSI), AIR2 (Ashtech, Z-extreme), AIR3 (Javad, Legacy), and AIR4 (Trimble, 4000-SSI, connected to ASIRAS). AIR1 and AIR3 share the front GPS antenna; AIR2 and AIR4 the rear antenna. Antenna offsets are given in Table 2. Data were logged in the receivers internal memory during flights and downloaded to laptop PCs upon landing. Most data were recovered and only a few files missing, see Table 3, but the redundancy of receivers meant that GPS data are available for all flights. The AIR2 Ashtech receiver had a problem with the memory card and did not collect data on the last 3 flights.

The GPS base stations to be used as reference stations for differential post processing of the GPS data are listed in Table 4. These stations were mounted on roofs or tripods in the field near the landing sites during the flights; the reference points were generally not marked. In a few cases data from permanent GPS stations have been used.

Name	Location	Hardware (ant. type)
CNP0	Constable Pynt, near runway	Javad (Marant)
JQA	Western part of Nuussuaq, near Qaarsut, tripod on ground	Javad (Marant)
KELY	Kellyville permanent station	Ashtech Z-XII3
LYR1	Longyearbyen, tripod on ground near NPI Hotel	Javad (Regent)
NRD1	Station Nord, on building 7 roof (light pole)	Javad (Regent)
NRD2	Station Nord, on snow next to apron	Javad (Regent)
NYA2	Ny Ålesund, permanent station	AOA Benchmark ACT
SCOR	Scoresbysund, permanent station	Ashtech UZ-12
SFJ1	Kangerlussuaq, on KISS building roof (between tile 16 & 17 of the outermost row)	Trimble 4000 SSI
T12	On the ice sheet (8 m west of T12 corner reflector	Leica SR530
TAB1	Thule Air Base, on snow pile near Air Greenland hangar	Javad (Regent)
THU2	Thule Air Base, permanent station	Javad Legacy
THU3	Thule Air Base, permanent station	Ashtech UZ-12
UMD1	Uummannaq, at airfield point	Ashtech
YLT1	CFS Alert, tripod on ground near Spinnaker Building	Javad (Regent)
YLT2	CFS Alert, tripod on ground near garage	Javad (Marant)

Table 4: CryoVEx 2006 GPS Reference Stations

A Honeywell medium-grade inertial navigation system H764-G was used throughout the surveys to record inertially integrated position, velocity and attitude information. The unit has an on board GPS receiver for datation and position updates of the built in Kalman filter. Data packets were obtained through a 1553 mil-spec serial communications bus and logged on a rack mounted PC with a 2 Gb Compact Flash memory card in binary format. Data from all flights have been secured except for the following cases:

April 10 On the test flight the INS failed to initialize properly.
April 29 INS data logging stopped premature.
May 12 The last hour of data is missing due to an operator error.
May 16 INS data corrupted in the first part of the flight.

Recordings and comments can be found in Table 3.

JD – Date	Flight	Reference	Rover	File name	Start (dech)	End (dech)	Ratio	Ref. var.
110 – April 20th		SFJ1	2	110a2s1.p	18.6797	19.6058	1.2	1.279
111 – April 21th		SFJ1	2	111a2s1.p	11.1047	15.9364	1.4	4.288
113 – April 23th		JQA1	2	113a2jq1.p	21.7464	1.9142	10.7	0.971
114 – April 24th		UMD1	4	114a4umd.p	17.3475	22.1919	1.2	12.898
115 – April 25th		SFJ1	3	115a3s1.p	11.2297	18.8333	1.1	5.275
116 – April 26th		KELY	1	116ba1ke.p	14.5003	21.7183	1.1	10.777
119 – April 29th	a	SCOB	4	119aa4sc.p	11.0233	16.9733	1.1	11.276
119 – April 29th	b	SCOB	2	119ba1sc.p	17.6714	20.0458	1.4	6.854
120 – April 30th		LYR	2	120a2ly.p	8.4011	11.9989	1.4	4.443
121 – May 1st		LYR	2	121a2lyb.p	9.9719	15.7003	1.3	4.003
122 – May 2nd	a	NYA2	3	122aa3ny.p	8.3953	11.8858	15.2	1.103
122 – May 2nd	b	NRD2	2	122ba2n2.p	13.0464	18.3406	1.1	7.310
123 – May 3rd		NRD1	3	123a3n1.p	10.4317	14.5636	1.3	3.668
125 – May 5th		TAB1	3	125a3t1.p	12.7356	17.5294	5.4	0.846
128 – May 8th		TAB1	4	128a4t1.p	14.2514	18.9172	1.2	5.291
129 – May 9th		YLT1	3	129a3y1.p	15.6186	21.0125	1.1	1.091
130 – May 10th		YLT1	1	130a1y1.p	17.8161	19.9450	2.0	0.952
131 – May 11th		YLT1	2	131a2y1.p	14.3092	20.2544	1.2	0.837
132 – May 12th		NRD1	1	132a1n1.p	14.2928	19.6656	1.1	7.117
136 – May 16th		SCOR	1	136a1sc.p	9.4267	15.7950	1.2	5.678
137 – May 17th			3	137a3crr.p[1]	8.5319	18.1400		

Table 5: Processed GPS data selected for further use.

5.1 GPS Data Processing

GPS solutions is based on static processing of the reference stations and kinematic differential processing of the airborne data. First the position of the reference stations is determined using the SCOUT (Scripps Coordinate Update Tool) service operated by

SOPAC (Scripps Orbit and Permanent Array Center) (http://sopac.ucsd.edu). SCOUT calculates the reference station's position in ITRF2000 using data from three permanent GPS stations nearby. Even though there in the Arctic are several hundreds of kilometers to “nearby” permanent stations, the standard deviation of the resulting position is often within 2 cm.

Reference stations used during the CryoVEx 2006 campaign can be found in Table 4, note that data from permanent GPS stations in the Arctic also were used when available in 1 Hz.

The kinematic differential GPS processing were performed with GPSurvey (version 2.35) using precise IGS orbits and the Goad-Goodman tropospheric model. On each flight several solutions are made using different combinations of GPS reference stations and aircraft GPS receivers. The best solutions for each flight is shown in Table 5 and for a complete list of all GPS solutions see Appendix 23. On the last flight it was not possible to get an acceptable solution when using the GPSurvey software, instead a solution was calculated using CSRS-PPP (Canadian Spatial Reference System Precise Point Positioning) (http://http://www.geod.nrcan.gc.ca). Finally the GPS solutions were converted into binary format as specified in the ESA document by Cullen (2006) for the ASIRAS processing.

5.2 Merging GPS and INS Data

The position and attitude information is extracted from the INS data packets and averaged to 10 Hz. The averaging to 10 Hz has proven to be a good balance between file size and resolution in time. To obtain a higher resolution in the time domain and preserve precision the post processed GPS and the INS data is merged by draping the INS derived positions onto the GPS positions. This draping is done by modeling the function, found in equation (1), by a low pass filtered smooth correction curve, which is added to the INS.

$$\epsilon(t) = P_{GPS}(t) - P_{INS}(t) \quad (1)$$

This way a smooth GPS-INS solution is obtained, which can be used for geolocation of laser and camera observation. The full resolution INS data were also converted into binary format as specified in the ESA document for the ASIRAS processing by Cullen (2006).

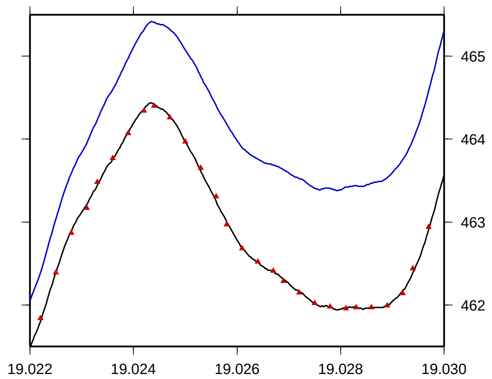


Figure 5: Draping high rate INS derived heights (blue) onto precise GPS heights (red) to get high rate, precise heights (black).

Date - JD	**Flight**	**Filename**	**Gps Solution**	**Start [dechr]**	**Stop [dechr]**	**Receiver**
111 – April 21th		111a2.pos	111a2s1.p	11.200	15.890	2
113 – April 23th		113a2.pos	113a2jq1.p	21.800	25.910	2
114 – April 24th		114a4.pos	114a4umd.p	17.370	22.190	4
115 – April 25th		115a3.pos	115a3s1.p	12.400	18.820	3
116 – April 26th	a	116aa1.pos	116ba1ke.p	14.510	9.800	1
116 – April 26th	b	116ba1.pos	116ba1ke.p	16.050	9.800	1
119 – April 29th	a	119aa4.pos	119aa4sc.p	11.030	9.800	4
119 – April 29th	b	119ba2.pos	119ba2sc.p	17.821	9.600	2
120 – April 30th		120a2.pos	120a2ly.p	8.410	11.980	2
121 – May 1st		121a2.pos	121a2lyb.p	10.200	15.680	2
122 – May 2nd	a	122aa3.pos	122aa3ny.p	8.550	9.800	3
122 – May 2nd	b	122ba2.pos	122ba2n2.p	13.100	9.800	2
123 – May 3^{ed}		123a3.pos	123a3n1.p	10.500	14.560	3
125 – May 5th		125a3.pos	125a3t1.p	12.850	17.500	3
128 – May 8th	a	128aa4.pos	128a4t1.p	14.260	9.800	4
128 – May 8th	b	128ba4.pos	128a4t1.p	15.230	9.400	4
129 – May 9th		129a3.pos	129a3y1.p	16.050	21.000	3
130 – May 10th		130a1.pos	130a1y1.p	17.820	19.810	1
131 – May 11th		131a2.pos	131a2y1.p	15.000	20.180	2
132 – May 12th		132a1.pos	132a1n1.p	14.300	18.940	1
136 – May 16th		136a1.pos	136a1sc.p	14.400	15.770	1
137 – May 17th		137a3.pos	137a3crr.p	8.761	18.110	3

Table 6: INS data processing.

6 Processing Laser Scanner Data

A Riegl laser scanner (LMS-Q140i-60) was used to measure the distance between the aircraft and the surface, with a range resolution of 5 cm. The nominal data logging rate is 40 scans/second; each scan consists of 208 single laser shots in a 60° cross track swath. The laser scanner data were logged as hourly files on a PC laptop. The files are time tagged by a 1 PPS signal from the AIR1 GPS receiver with start time of the scans given by the operator as the file name. It should be noted that this procedure gives a slight risk of timing errors of 1 second (approximately 60 m on ground) however after processing it is easy to identify and correct these time errors by visual inspection. Table 7 shows the laser scanner files logged during the campaign. The typical files size is about 200 Mb for one hour in the standard binary file format. Backup of the data was made on hard disk and CD-roms after flights.

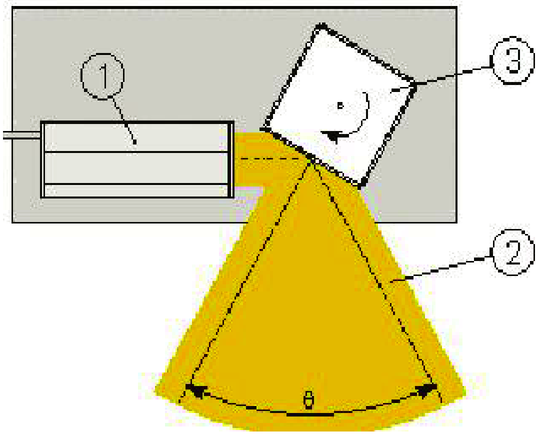


Figure 6: Sketch of the Riegl laser scanner principle. (1)Laser and photo diode assembly. (2)Swath pattern. (3)Rotating mirror.

The principle in the laser scanner can shortly be described as following:

1. The laser (1) emits a laser pulse and starts a timer, see Figure 6.
2. The pulse is reflected in a direction dictated by the mirror (3).
3. If the pulse hits a target with a suitable reflectance it is returned to the mirror (3) that reflects it into the photo diode (1) and hereby stops the timer.
4. The mirror (3) is now rotated by a small angle before the process is repeated.

After initial quality control of the laser scanner data, it was seen that scans were missing on a regular basis. The reason for this was believed to be increased vibrations of the laptop PC in the new aircraft installation. This lead to a shift in storage method in the PC from the standard hard disk to a 2 Gb Compact Flash memory card. This reduced the data loss from approximately 1 out of 4 to 1 out of 40 scans.

Laser scanner data were recovered for most flight lines except a few cases where fog or low clouds were encountered or system/operator errors occur. Also a loss of INS data will hinder the laser scanner data in being processed.

JD – Date	Filename	2dd	Start	Stop	Comments
110 – April 20th	184530.2dd	T	18.760840	19.483950	scans missing
111 – April 21st	111530.2dd	T	11.258335	11.384583	scans missing
	120600.2dd	T	12.100001	13.007563	each 40 line
	130130.2dd	T	13.025007	13.551934	approximately
	133400.2dd	T	13.566669	14.932408	
113 – April 23rd	231800.2dd	T	22.583340	23.282623	
	223500.2dd	T	23.300004	0.175676	
	001130.2dd	T	0.191668	1.124059	
114 – April 24th	173030.2dd	T	17.508333	18.498814	
	183030.2dd	T	18.508333	19.430473	
	192630.2dd	T	19.441673	20.402421	
	202500.2dd	T	20.416670	21.071510	
115 – April 25th	121000.2dd	T	12.166669	13.178247	
	131130.2dd	T	13.191670	13.915370	
	135530.2dd	T	13.925001	14.755536	
	144600.2dd	T	14.766673	15.742513	
	154530.2dd	T	15.758338	16.893572	
	165430.2dd	T	16.908335	17.790917	
116b – April 26th	161130.2dd	T	16.191669	17.063527	
	170430.2dd	T	17.075005	17.075660	no data recorded
	184900.2dd	T	18.816671	18.817555	no data recorded
	195130.2dd	T	19.858335	20.763953	
	204630.2dd	T	20.775000	21.047358	
	210900.2dd	T	21.150003	21.421910	
119a – April 29th	121800.2dd	T	12.300005	13.007190	
	130100.2dd	T	13.016668	14.001007	
	140100.2dd	T	14.016673	14.870217	
	145300.2dd	T	14.883334	15.755477	
119b – April 29th	193630.2dd	T	19.608338	19.645226	
120 – April 30th	083300.2dd	T	8.550001	9.533487	
	093230.2dd	T	9.541673	9.759714	every 4-5 scan missing
121 – May 1st	111700.2dd	T	11.283337	12.244791	
	121500.2dd	T	12.250004	13.175074	
	131230.2dd	T	13.208338	13.932468	
	135700.2dd	T	13.950001	14.762312	
122a – May 2nd	084030.2dd	T	8.675005	9.262118	
	102815.2dd	T	10.470840	10.471224	
	103930.2dd	T	10.658340	11.436391	
	112700.2dd	T	11.450001	11.839090	
122b – May 2nd	131300.2dd	T	13.216667	14.186186	
	141200.2dd	T	14.200004	15.093821	
	150600.2dd	T	15.100007	15.614641	
	161100.2dd	T	16.183338	17.165768	
	171030.2dd	T	17.175002	18.303756	
123 – May 3rd	104930.2dd	T	10.825005	11.961294	
	115830.2dd	T	11.975001	12.964702	
	125830.2dd	T	12.975006	13.902230	
	135500.2dd	T	13.916673	14.936772	
	145700.2dd	T	14.950000	15.482581	
125 – May 5th	130900.2dd	T	13.150001	14.128076	
	140900.2dd	T	14.150006	14.626117	

Continued on next page

JD – Date	Filename	2dd	Start	Stop	Comments
	143900.2dd	T	14.650005	15.629081	
	153900.2dd	T	15.650004	15.749702	
	162000.2dd	T	16.333337	17.439360	
128 – May 8th	143500.2dd	T	14.583336	15.050474	
	162800.2dd	T	16.466767	17.022718	
	171400.2dd	T	17.233503	18.375890	
	182400.2dd	T	18.400105	18.847553	
129 – May 9th	160300.2dd	T	16.050005	17.071888	
	170530.2dd	T	17.091673	18.119551	
	180800.2dd	T	18.133334	19.118778	
	190800.2dd	T	19.133339	20.128485	
	200900.2dd	T	20.150005	20.887151	
130 – May 10th	175500.2dd	T	17.916670	19.283643	
	193200.2dd	T	19.533335	19.759668	
131 – May 11th	154300.2dd	T	15.716668	16.903191	
	165500.2dd	T	16.916669	17.982145	
	180000.2dd	T	18.000006	19.189834	
	191200.2dd	T	19.200006	19.205010	
132 – May 12th	143500.2dd	T	14.583334	15.857933	
	155300.2dd	T	15.883336	16.951398	
	165800.2dd	T	16.966667	18.206486	
	181330.2dd	T	–	–	
	190200.2dd	T	19.033336	19.501453	
136 – May 16th	095300.2dd	T	9.883336	11.013569	
	110730.2dd	T	11.125007	11.219440	
	112130.2dd	T	11.358338	12.585829	
	123600.2dd	T	12.600002	13.699031	
	134300.2dd	T	13.716669	14.550885	
137 – May 17th	083900.2dd	T	8.650003	8.865336	
	091400.2dd	T	9.233336	9.611292	
	095700.2dd	T	9.950005	11.244140	
	111600.2dd	T	11.266668	12.223921	
	121400.2dd	T	12.233336	13.284667	
	143100.2dd	T	14.516668	15.641005	
	153900.2dd	T	15.650003	16.808849	
	165000.2dd	T	16.833335	17.499100	
	174900.2dd	T	17.816671	18.088543	

Table 7: Recorded Laser Scanner Files.

6.1 Processing of Laser Scanner Data

Geolocation of each point in the laser scanner data is performed with standard trigonometry in two steps. First all points are described as vectors ($dX_{NWU}, dY_{NWU}, dZ_{NWU}$) in a local cartesian North-East-Up system using the lever arm between the laser scanner and the gps (dX, dY, dZ), the range measured by the laser (r), the angle of the laser mirror (a) and the orientation of the laser in an earth fixed system ($\omega_r, \omega_p, \omega_h$). Next these vectors are added with the position derived from GPS

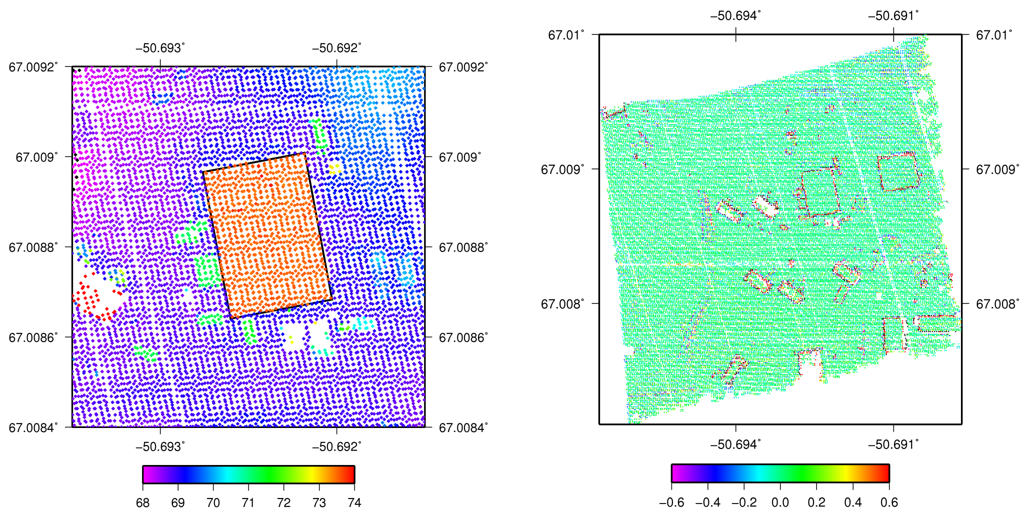
$(\varphi_{gps}, \lambda_{gps}, h_{gps})$ to get the position of the reflector in an earth fixed system (φ, λ, h).

$$\begin{aligned}
dX_{NWU} &= \cos(\omega_h)\cos(\omega_p)dX \\
&+(\cos(\omega_h)\sin(\omega_p)\sin(\omega_r) - \sin(\omega_h)\cos(\omega_r))(-\sin(a)r + dY) \\
&+(\cos(\omega_h)\sin(\omega_p)\cos(\omega_r) + \sin(\omega_h)\sin(\omega_r))(\cos(a)r + dZ) \\
dY_{NWU} &= -\sin(\omega_h)\cos(\omega_p)dX \\
&-(\sin(\omega_h)\sin(\omega_p)\sin(\omega_r) + \cos(\omega_h)\cos(\omega_r))(-\sin(a)r + dY) \\
&+(-\sin(\omega_h)\sin(\omega_p)\cos(\omega_r) + \cos(\omega_h)\sin(\omega_r))(\cos(a)r + dZ) \\
dZ_{NWU} &= \sin(\omega_p)dX \\
&-\cos(\omega_p)\sin(\omega_r)(-\sin(a)r + dY) \\
&-\cos(\omega_p)\cos(\omega_r)(\cos(a)r + dZ)
\end{aligned} \tag{2}$$

$$\begin{aligned}
\varphi &= \varphi_{gps} + \frac{dX_{NWU}}{degm} \\
\lambda &= \lambda_{gps} - \frac{dY_{NWU}}{degm\cos(\varphi)} \\
h &= h_{gps} + dZ_{NWU}
\end{aligned} \tag{3}$$

6.2 Calibration of Laser Scanner Data

The geolocation process just described assumes perfect alignment between the laser scanner and the INS system, this is however not practical possible in this type of installation. To compensate for the imperfect installation several calibration maneuvers are performed during the campaign. The purpose of these maneuvers is to determine and monitor the offset angles between the laser scanner and the INS.



(a) Zoomed in view of two flights over a building in Kangerlussuaq used for calibration.

(b) Difference between two flight over the building in Kangerlussuaq.

Figure 7: Laser data acquired over a building in Kangerlussuaq.

The main calibration site for the laser is a building where the corners of the roof is known from a GPS survey. Using this building and two swaths of laser scanner data, one east-west and one north-south, one can estimate the offset angles through an iterative process. In Figure 7a points from the two swaths (in height coded colors) are plotted on top of the black outline of the building. The difference between first and second swath can be seen in Figure 7b. Statics show a mean difference of 0.00 meters and a 0.43 meters standard deviation of the mean. The relatively high standard deviation is caused by the non-continuous surface, where the interpolation between the two data sets fails to describe the edges of buildings correctly, this is clearly seen in Figure 7b.

JD – Date	**Scanner file**	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Surface**
111 – April 21th	111530.2dd	0.00	0.43	-9.93	9.12	Building
113 – April 23th	001130.2dd	0.00	0.08	-0.44	0.39	Land ice
113 – April 23th	231800.2dd	0.00	0.08	-0.44	0.40	Land ice
114 – April 24th	183030.2dd	0.00	0.26	-2.38	2.58	Sea ice
115 – April 25th	131130.2dd	0.01	1.91	-152.68	185.54	Land ice
115 – April 25th	135530.2dd	0.00	1.12	-149.99	222.53	Land ice
121 – May 1st	111700.2dd	-0.01	0.09	-0.38	0.40	Land ice
121 – May 1st	121500.2dd	-0.02	0.15	-0.49	0.49	Land ice
122 – May 2nd	141200.2dd	0.01	0.39	-2.62	3.82	Sea ice
122 – May 2nd	171030.2dd	0.00	0.19	-5.88	5.66	Building
125 – May 5th	143900.2dd	-0.02	0.19	-0.70	0.66	Land ice
125 – May 5th	143900.2dd	0.00	0.20	-0.89	0.81	Land ice
125 – May 5th	143900.2dd	0.00	0.12	-0.67	0.73	Land ice
128 – May 8th	182400.2dd	-0.01	0.38	-3.03	3.33	Sea ice
130 – May 10th	175500.2dd	0.01	0.22	-2.41	2.70	Sea ice
130 – May 10th	193200.2dd	0.00	0.10	-0.95	0.76	Land ice
131 – May 11th	154300.2dd	0.00	0.20	-4.08	3.92	Sea ice
132 – May 12th	165800.2dd	0.00	0.15	-3.83	2.61	Sea ice
137 – May 17th	121400.2dd	-0.01	0.23	-4.94	5.21	Land ice
137 – May 17th	153900.2dd	0.00	0.11	-0.41	0.41	Land ice
137 – May 17th	153900.2dd	0.02	1.33	-13.00	183.25	Land ice

Table 8: Statics for crossing swaths. All units are meters.

Table 8 gives an overview of the the statics of all crossing swaths during the campaign. Each of these crossings is used to verify and, if necessary, correct the offset angles. Apart from crossing swaths where all three offset angles can be determined, it is also possible to determine the roll offset angle when flying over level sea ice and calm water. This is based on the assumption that the level sea ice and calm water is parallel with the geoid. The change in geometry will also have an influence when comparing crossing swaths over land ice areas with many crevasses and steep topography.

The table in Appendix 24 gives the offset angles and other parameters used in the processing of each laser scanner file. One should use the figures in Table 8 carefully. For example one would expect that sea ice has moved in the period from the first to the second flight and this gives a false impression of low accuracy. The change in geometry will also have an influence when comparing crossing swaths over land ice areas with many crevasses and steep topography.

6.3 Estimation of Ice Thickness from Freeboard Height

The sea ice freeboard (F) can be determined as a function of height above the ellipsoide from GPS (h), slant corrected laser range (r) and geoide height (N), see equation 4. e is a sum of local deviations of the sea surface and errors, that by means of a lowest level filter technique can be reduced or removed. This technique determines e by a selection of the lowest values in the dataset, assuming that these corresponds to the sea surface or very thin ice. The lowest values are then interpolated to form the filter.

$$F = h - r - N + e \tag{4}$$

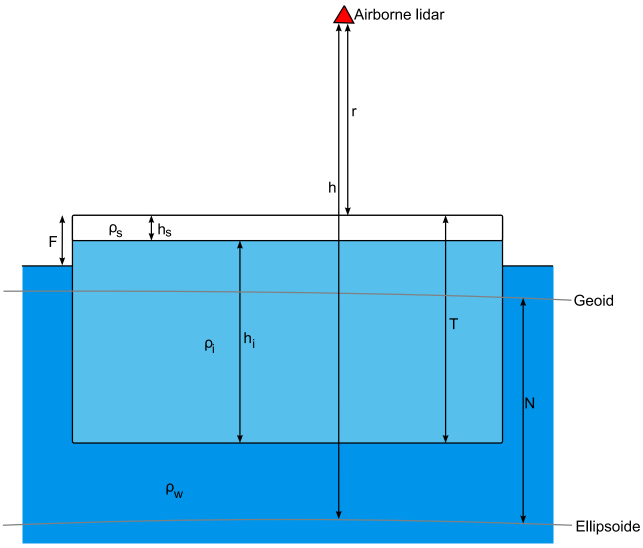


Figure 8: Sea ice thickness estimation.

From the freeboard data the total sea ice thickness (including snow cover), see T in equation 5 and Figure 8, can be estimated using the assumption of an isostatic balance between ice, including snow, and the seawater. This is commonly described by the single factor K. This factor is dependent of densities of ice, snow and seawater.

$$T = KF \tag{5}$$

$$K = 1 + \frac{\rho_i h_i + \rho_s h_s}{h_i(\rho_w - \rho_i) + h_s(\rho_w - \rho_s)} \tag{6}$$

It is now possible to calculate the freeboard heights from the laser scanner data and through this estimate the sea ice thickness. Figure 9 shows an example of sea ice freeboard heights north of Greenland.

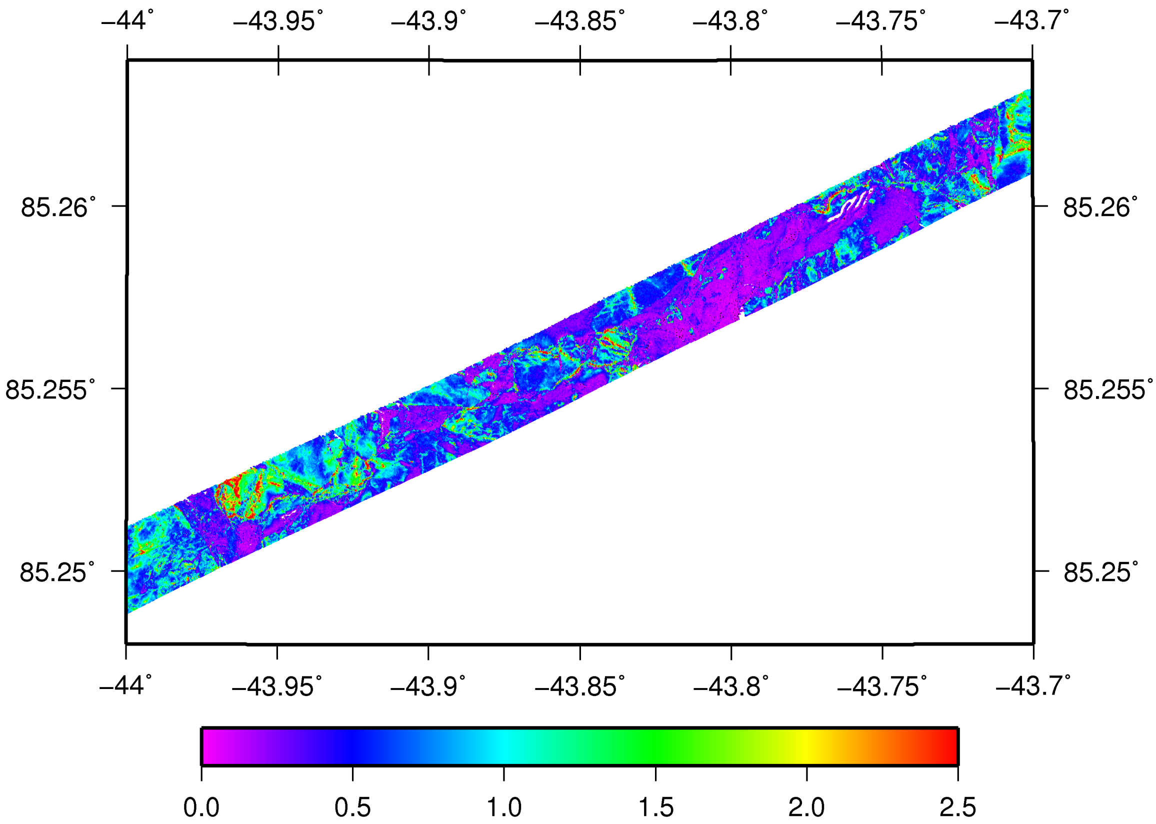


Figure 9: Example of sea ice freeboard.

7 ASIRAS Data Processing

The ASIRAS system was installed and run as tested during the test campaign in March 2006. The system was timed using a 1 PPS signal and an ASCII datation string from the AIR4 GPS receiver.

Extensive tests of the ASIRAS instrument and backup system were performed on the first flights: The tests flight near Kangerlussuaq and the lines off the Greenland west coast. The logged data were stored on the dedicated hard disks in the ASIRAS PCs during flight and transferred to the PCs for backup after flights. The data were then stored on AIT-3 magnetic tapes and on hard disks. No data compression was done as this method was tested to be more time consuming than regular data backup. All together 1 hr of ASIRAS data acquisition demanded approximately 7 hours of backup time.

ASIRAS data were obtained primarily in the LAM mode at 20 MHz. Data were acquired continuously over the main sites and limited to parts of the other survey lines. Tests of the HAM mode over open ocean were carried out on April 30 between Greenland and Svalbard. Operator log files regarding the ASIRAS data can be found in Appendix E and Appendix F lists the recorded data files.

The data quality has been checked after each survey flight with the "Quicklook viewer" software from RST. Especially for the corner reflector sites the data were checked, see Table 12 for corner reflector positions from hand held GPS receivers. Examples from the "Quicklook-Viewer" can be found in Section 9.

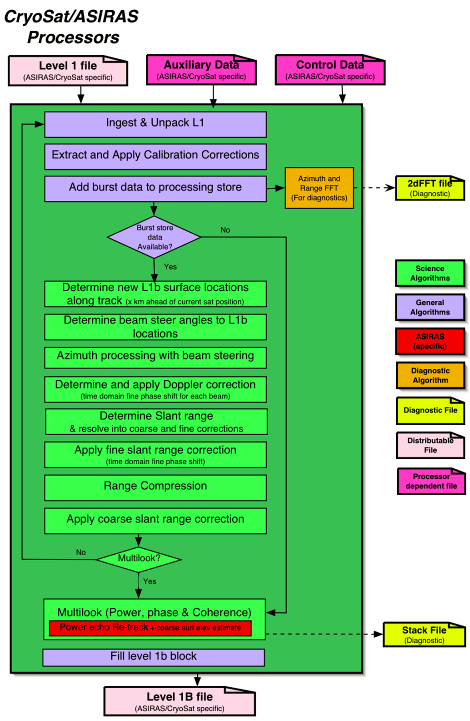


Figure 10: Outline of the ASIRAS processor (from Cullen (2006)).

7.1 Processing of ASIRAS Data

The processing of the acquired ASIRAS data were done by AWI with input of GPS position and INS attitude data from DNSC. Figure 10 briefly outlines the processing of ASIRAS L1b data. Plots, showing ground track and height estimates from the OCOG retracker, of all processed ASIRAS profiles can be found in Appendix G.

7.1.1 Low Altitude Mode Pulse to Pulse Phase Correction for 2.5 kHz PRF

It was noticed during routine level 1b processing of LAM acquisitions from Bay of Bothnia (Test campaign March 2005) that waveforms were highly degraded. Subsequent analysis of range and phase histories retrieved from passes over corner reflectors showed a linear pulse to pulse phase term and it was further shown that this phase term was different for each FMCW frequency offset (20, 40, 60 and 80 MHz) which are programmed as a function of aircraft altitude (shown in Figure 11)

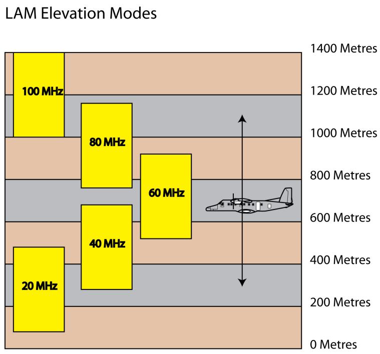


Figure 11: Frequency offset and corresponding elevations for ASIRAS LAM mode

The effect results in azimuth formed beams pointing in the wrong along-track direction. Empirical phase corrections were determined which solved the problem. An analysis of instrument operation resulted in speculation of the cause and the empirical phase corrections as a function of frequency offset were verified. March 2005 data were acquired at a pulse repetition frequency (PRF) of $\sim$ 3 kHz. CryoVEx 2006 acquisitions were recorded at a PRF of $\sim$ 2.5 kHz. Since it was known the phase term (error) was also a function of PRF phase corrections were computed following a test campaign in Greenland (March 2006) when no corner reflector deployment was possible. Corrections for 2006 are provided in Table 9.

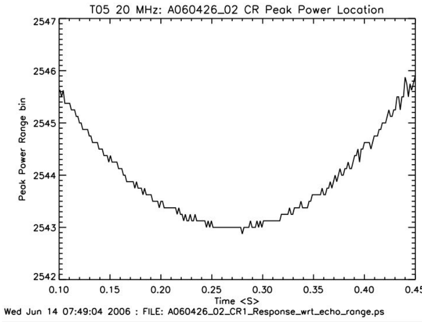
Frequency offset, F (MHz)	**ASIRAS to surface elevation range (meters)**	**Phase correction, $\phi(F)$ (radians)**
20	40-440	3.35103216
40	280-680	0.41887902
60	520-920	3.76991118
80	760-1160	0.83775804

Table 9: LAM phase corrections.

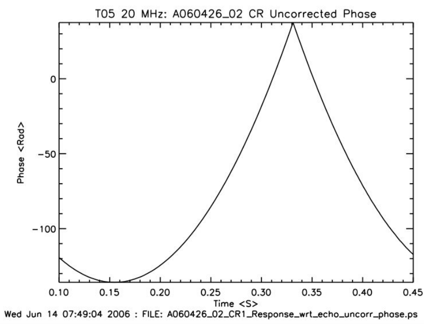
7.1.2 Echo phase correction

A complex raw time domain echo recorded by the ASIRAS can be described as $\psi_n[0, l-1]$ where, n, is the echo number (in the range 0 to $N-1$) and l is the number of samples (3072 sample for LAM). The phase corrected counterpart is given by

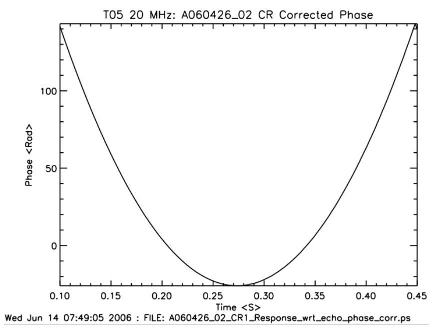
$$\forall k \in [0, l-1] \qquad \psi_n^c[k] = \psi_n[k]e^{i\phi(F)n}$$



(a) Range history computed by isolating corner reflector response from surface response and plotting the range bin at which the peak power is found. Waveforms have been interpolated by a factor 8. The jitter is due to the low interpolation factor and also SNR.



(b) Uncorrected phase history computed by computing the phase of the echo at the location determined by the plot (a)



(c) Phase history after correction. The curve appears smooth in comparison with (a) this shows the phase across the impulse response is stable. Phase noise is, however, evident if the smaller scale is examined.

Figure 12: An example of a corrected corner reflector phase history.

Note: Since the nature of the phase behavior is now understood efforts are being made to solve the pulse to pulse phase problem within the hardware. It is expected that, though not confirmed until mid April 2007, future campaign ASIRAS data will be free from this phenomena.

7.2 CryoVEx 2006 ASIRAS processing results

The ASIRAS processing of the CryoVex2006 data is analogous to the concepts already presented in Helm et al. (2006). The full data set was processed with ESA's processor version ASIRAS_03_06. In agreement with ESA, AWI processed the full rate data instead of the desampled data set. A summary of the processing is given in Appendix F and G gives plots of every single profile.

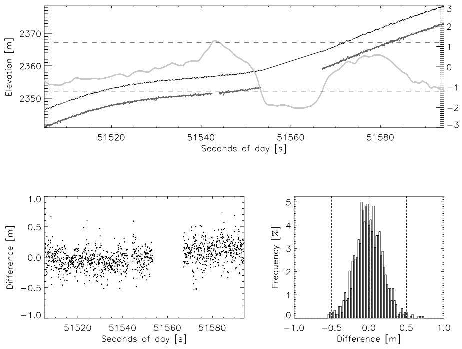
A couple of tests were applied to address datation issues and show the quality of the level_1b product (see Section 7.2.1). In general the data shows good quality, however in some specific areas the retracked elevation shows a lack of quality (Section 7.2.3). We suggest to apply a different retracker algorithm here, since the implemented OCOG retracker fails.

7.2.1 Datation tests

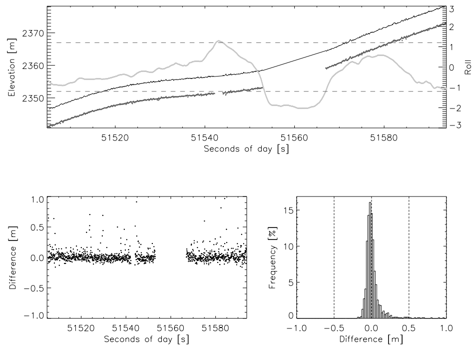
Two different types of tests were applied to investigate the datation issue. The first test uses ground positions of the corner reflector and compares them to the position derived from the analysis of ASIRAS echoes. Here we found no time shift, see Section 9.6. The second test is a comparison of the ASIRAS surface elevation with the laser scanner elevation model in small sections of some profiles. Details of the procedure are described in Helm et al. (2006). In table 10 a summary of the results are listed. In some of the tested profiles (retracked with a threshold spline retracker) we clearly identify that a time lag is present. The reason for the apparent time shift has not yet been identified and therefore the processing of the full data set were performed with a zero time shift.

Profile	STDDEV without tshift correction [m]	STDDEV witht shift correction [m]	Tshift [s]	Median difference between ALS and ASIRAS [m]	Remarks
A060510_12	0.08	0.04	-0.13	5.34	runway
A060425_00	0.06	0.06	0.01	5.30	EGIG
A060425_01	0.27	0.27	0.00	5.34	EGIG
A060425_02	0.11	0.10	-0.01	5.31	EGIG
A060425_03	0.17	0.13	-0.20	5.30	EGIG
A060425_04	0.07	0.07	0.00	5.29	EGIG
A060425_05	0.06	0.06	0.01	5.32	EGIG
A060425_06	0.22	0.08	-0.25	5.30	EGIG
A060425_07	0.18	0.07	-0.24	5.30	EGIG
A060425_08	0.11	0.11	-0.03	5.34	EGIG
A060425_09	0.14	0.11	0.06	5.32	EGIG
A060425_10	0.06	0.05	-0.01	5.34	EGIG
A060425_11	0.06	0.04	0.02	5.32	EGIG
A060425_12	0.05	0.05	0.00	5.33	EGIG

Table 10: Datation tests



(a) Median difference is determined to 5.30 ±0.18 m. The ASIRAS profile was shifted by 0.0 s.



(b) Median difference is determined to 5.30 ±0.07 m. The ASIRAS profile was shifted by -0.24 s.

Figure 13: Comparison between ASIRAS elevation of profile A060425_07 and ALS elevation model.

7.2.2 Runway overflights and comparison with ALS-DEM

Runway overflights where performed in Alert at 11^{th} may 2007. Figure 14 shows the laser scanner elevation model. ASIRAS profile A060510_12 was used to calibrate the system with the ALS-DEM. In figure 15b the comparison is shown. The black line in the upper panel shows the ALS elevation, whereas the dark gray line shows the ASIRAS elevation. The light gray line shows the roll, which is close to zero for this section. A difference of approx. 5.34 m between both elevations is determined. The lower left panel shows the variation of the difference around the median value. Statistics of this variation is shown in the histogram. The above calibration was done with a -0.14 s time shifted ASIRAS profile (figure 15b) and the original non time shifted ASIRAS profile (15a). Table 11 shows the result of the above calibration.

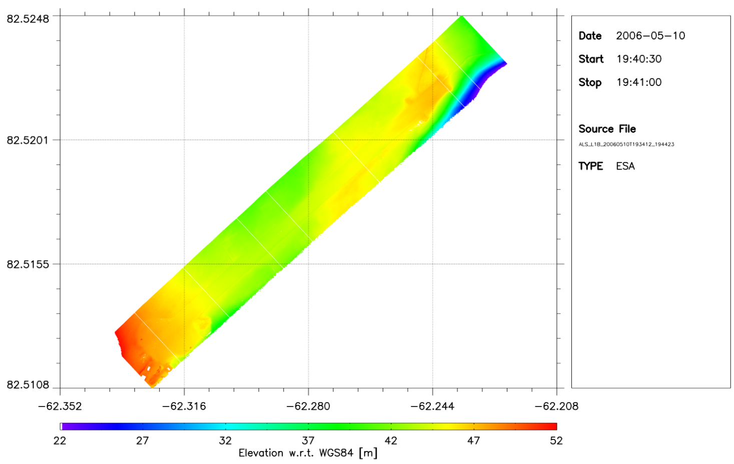
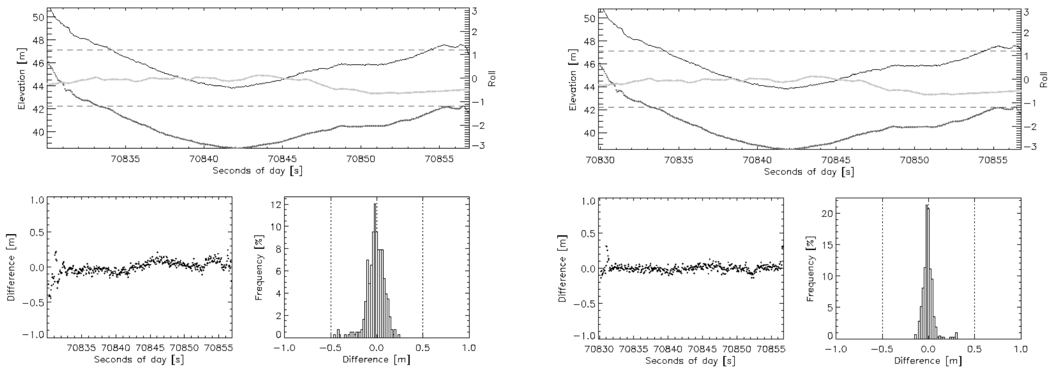


Figure 14: Laser scanner elevation model of runway in Alert



(a) Median difference is determined to 5.33 ±0.08 m. The ASIRAS profile was shifted by 0.0 s.

(b) Median difference is determined to 5.34 ±0.04 m. The ASIRAS profile was shifted by -0.13 s.

Figure 15: Comparison between ASIRAS elevation and ALS elevation model of runway in Alert.

Profile	**STDDEV without tshift correction [m]**	**STDDEV witht shift correction [m]**	**Tshift [s]**	**Median difference between ALS and ASIRAS [m]**	**Remarks**
A060510_12	0.08	0.04	-0.14	5.34	runway

Table 11: Runway calibration

7.2.3 Retracker performance

ASIRAS elevations are retracked by a simple but very fast and robust OCOG retracker. This value is a rough approximation and should be taken with care. It was shown in Helm et al. (2006) that the OCOG retracker gives very good results for the dry snow zone, however for the percolation zone the retracker fails in tracking the surface response. We found that this is also the fact for the 2006 LAM data. Figure 16 is showing two typical LAM-ASIRAS echoes in the percolation zone of Greenland. The vertical line shows the position of the re-tracked OCOG elevation. As it can be seen, the OCOG retracker jumps between the peaks and does not re-track the surface response in every case. Figure 18 shows the ASIRAS elevation for a 100 s long section in the percolation zone of Greenland. From this figure we can clearly identify the jumping of the OCOG retracker. We also determined such jumps over sea ice and in the dry snow zone (shown in figures 17 and 19). As a consequence, care must be taken when using the elevation data for further analysis.

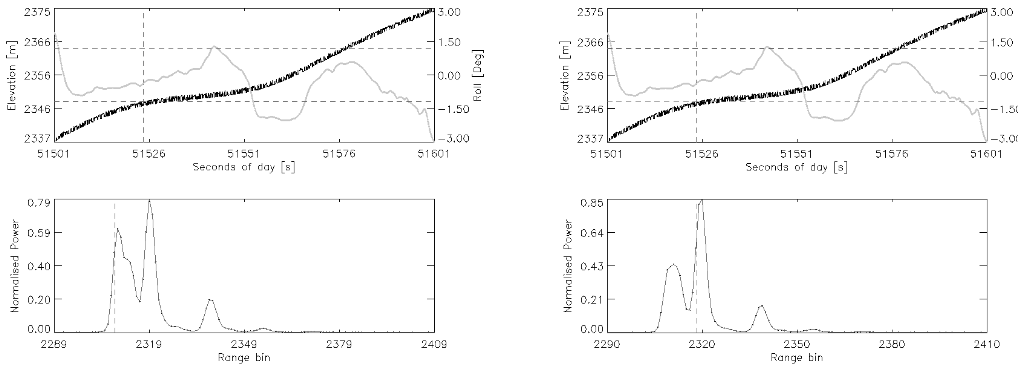


Figure 16: Two typical LAM-ASIRAS echo in the percolation zone of Greenland re-tracked with the standard OCOG retracker.

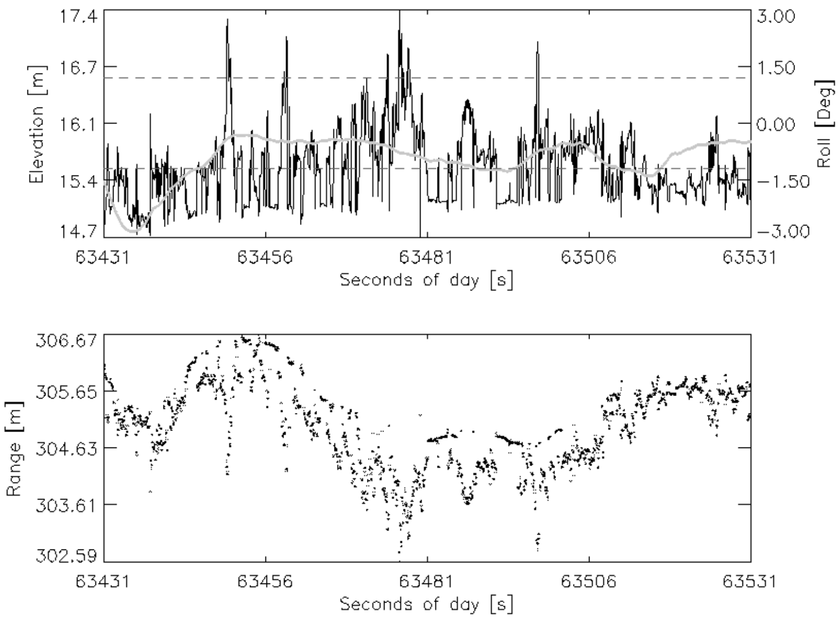


Figure 17: LAM-ASIRAS elevation for a 100 s long section over the sea ice. The elevation was determined by using the standard OCOG retracker.

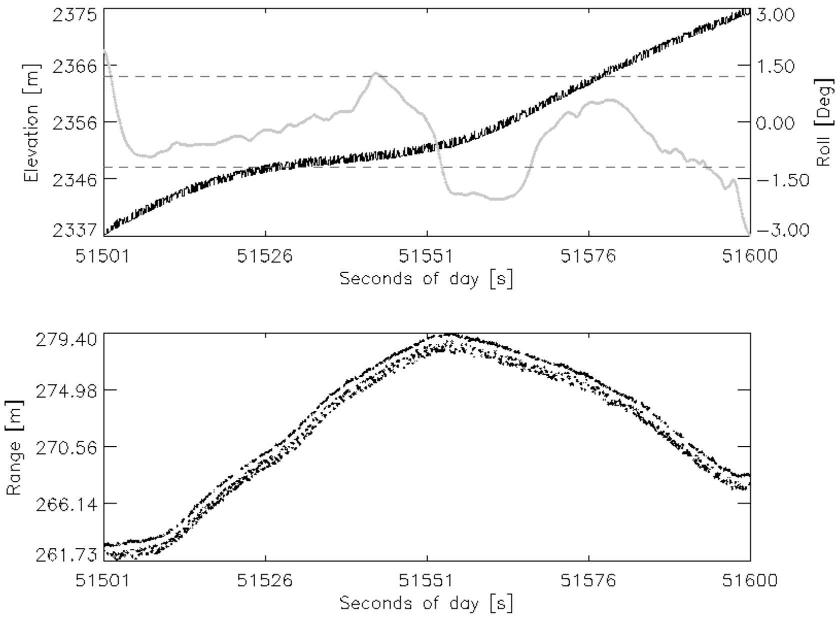


Figure 18: LAM-ASIRAS elevation for a 100 s long section in the percolation zone of Greenland. The elevation was determined by using the standard OCOG retracker.

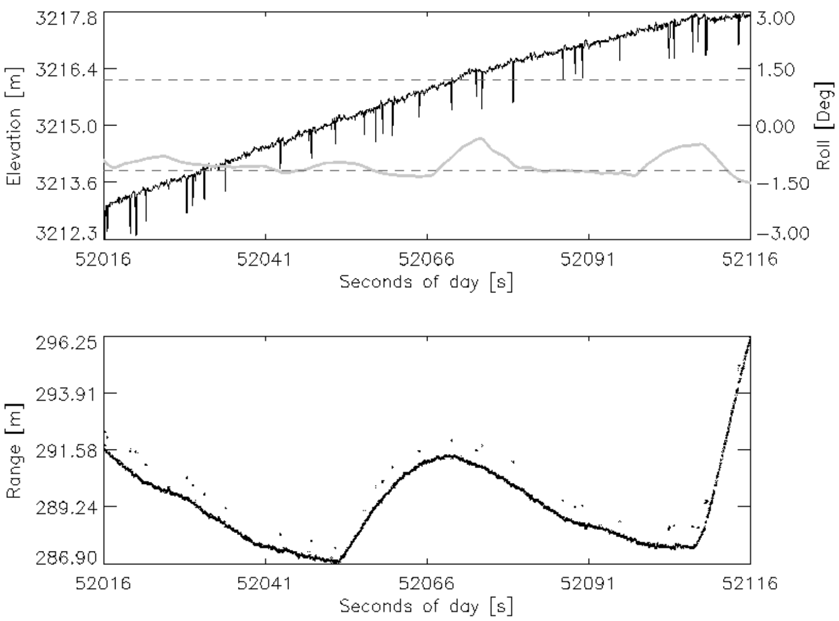


Figure 19: LAM-ASIRAS elevation for a 100 s long section in the dry snow zone of Greenland. The elevation was determined by using the standard OCOG retracker.

7.2.4 Corner reflector overflights

Throughout the campaign there have been overflights of the corner reflectors raised at the test sites. The positions of all the corner reflectors can be found in Table 12. Figure 20 and 21 shows details of one pass over the YLT3 corner reflector. Figure 21 shows the stack before the averaging that leads to the profile shown in Figure 20.

Site	Latitude	Longitude	Latitude	Longitude
T05	69°51′ 1.71154"N	47°15′30.50837"W	69.8504754	-47.2584745
T12	70°10′31.13635"N	45°20′51.38740"W	70.1753157	-45.3476076
AUST1	79°47′56.52000"N	24°25′ 3.66000" E	79.7990333	24.4176833
AUST2	79°49′55.26000"N	24° 0′13.92000" E	79.8320167	24.0038667
AUST3	79°44′ 1.50000"N	22°24′59.70000" E	79.7337500	22.4165833
AUST4	79°56′34.20000"N	24°14′36.72000" E	79.9428333	24.2435333
KONG1	78°45′20.00000"N	13°20′ 7.00000" E	78.7555810	13.3355170
KONG2	78°48′ 9.00000"N	12°57′35.00000" E	78.8025970	12.9599470
DEVON	75°20′17.28000"N	82°40′38.58000"W	75.3381333	-82.6773833
YLT1	82°33′48.00000"N	62°15′40.00000"W	82.5635300	-62.2611600
YLT2	82°33′45.00000"N	62°16′ 4.00000"W	82.5627100	-62.2679300
YLT3	82°38′21.00000"N	62°17′30.00000"W	82.6394300	-62.2918000
YLT4	82°38′17.00000"N	62°17′31.00000"W	82.6382300	-62.2920100

Table 12: Corner reflector positions.

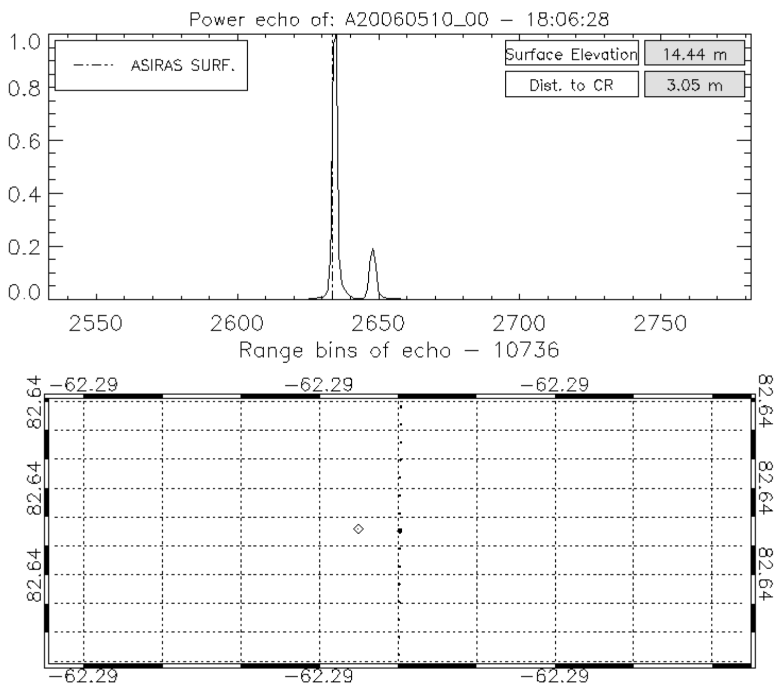


Figure 20: Echo (no. 10736) from a corner reflector overflight (profile A060510_00).

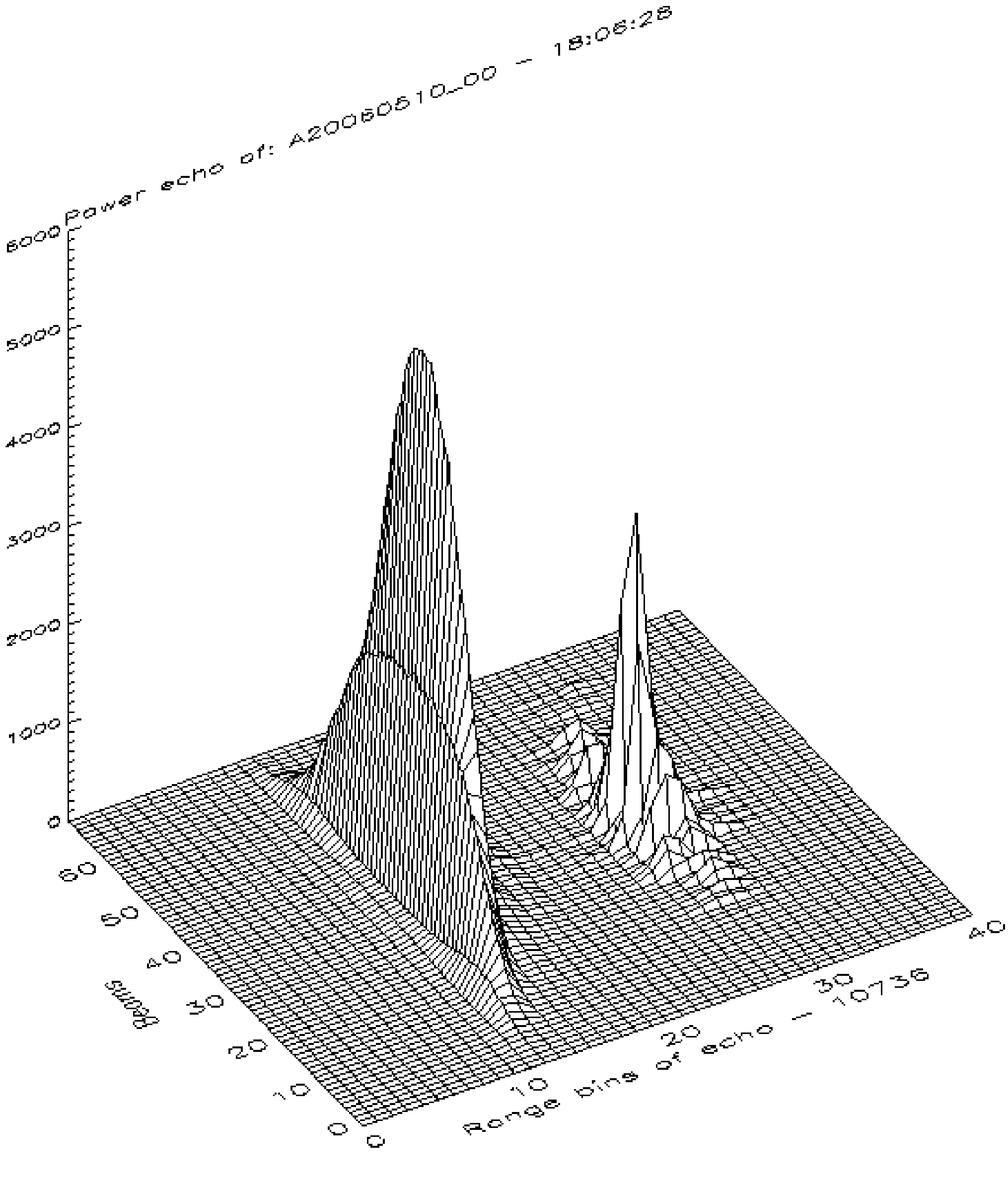


Figure 21: Stack (no. 10736) from a corner reflector overflight (profile A060510_00).

8 Geolocating Downward Looking Camera

The images, from the downward looking camera, were timestamped by an internal clock (adjusted to GPS time) in the camera and can, after data processing, roughly be geolocated using the laser scanner data. For an example see Figure 23. Table 13 shows the offset caused by drift in the cameras clock. Flights with downward looking images are listed in Table 3. Since the pictures are geolocated using the laser scanner data there are some days where existing pictures are not gelocated due to the lack of laser scanner data. Pictures from the downward looking camera is primarily used as an aid when differentiating between ice types. However the pictures are also helpful when investigating strange or unexpected features on the ice.

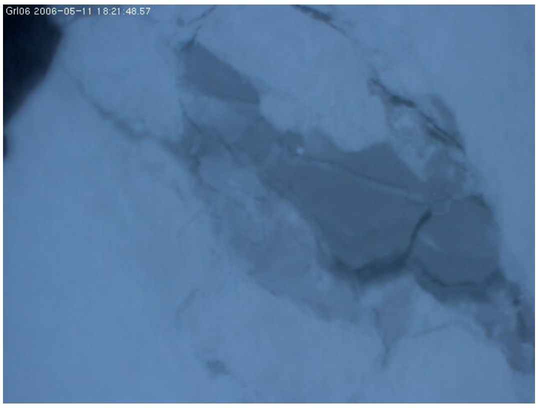


Figure 22: Uncorrected photo from the downward looking camera, with timestamp in the upper left corner.

Date - JD	Time Offset [sec]
115 – April 25th	10
116 – April 26th	0
119 – April 29th	-10
120 – April 30th	6
121 – May 1st	8
122 – May 2nd	1
123 – May 3^{ed}	2
125 – May 5th	10
128 – May 8th	10
129 – May 9th	13
130 – May 10th	14
131 – May 11th	18
132 – May 12th	20
136 – May 16th	? (no proc. laser)
137 – May 17th	28

Table 13: Time correction for the downward looking camera.

Figure 23 shows photos from the downward looking camera together with a laser scanner profile of some sea ice north of Greenland. The photos in the figure have been more precisely geolocated, stitched and color corrected manually.

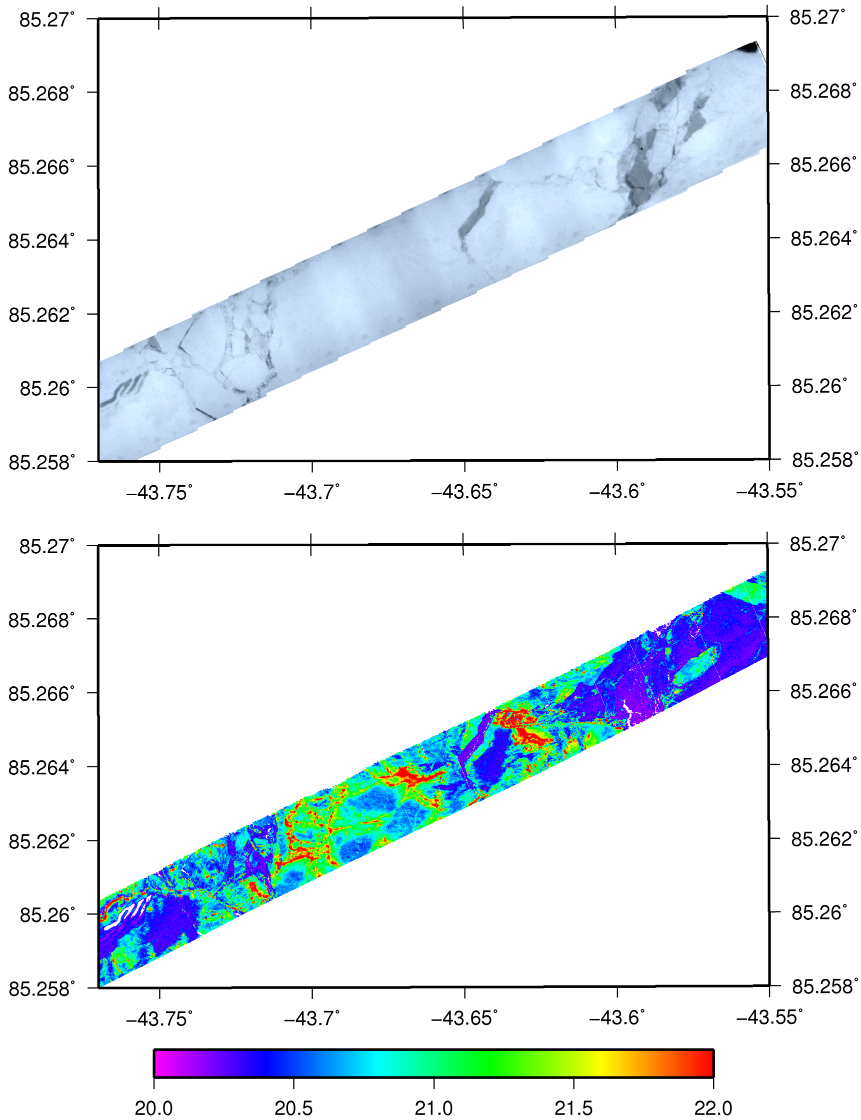


Figure 23: Laser scanner profile below; geolocated photos from the downward looking camera above.

9 Validation Sites

A main purpose of the CryoVEx 2006 campaign were to collect radar and laser data over several validation sites, see Figure 24. The sites represents the different snow and ice types one can expect to find in the Arctic. At least one radar corner reflector were installed at each sites, and in-situ measurements relevant for that particular site were performed.

In the following subsections are brief descriptions and some examples of ASIRAS and laser scanner data from each site. No corrections have been applied to the L1b ASIRAS data. These sections are meant as a quick overview of the sites and will not go into the in-situ measurements or a deeper description of the site.

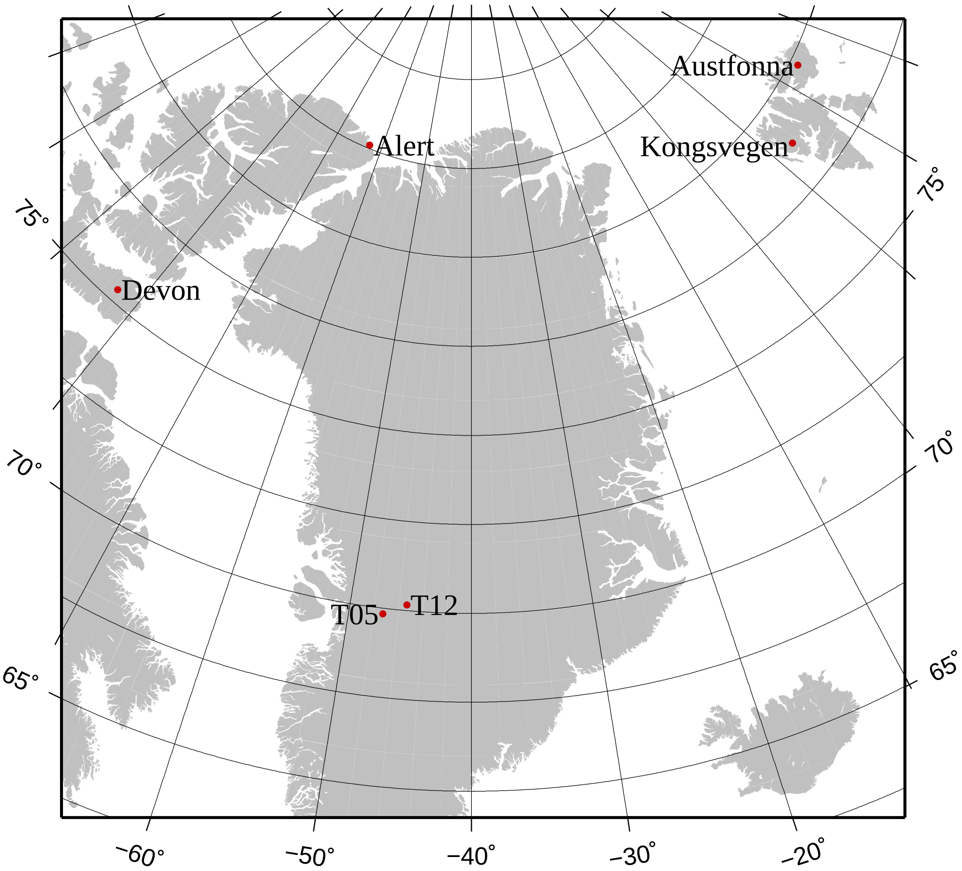


Figure 24: Validation sites overflown during CryoVEx 2006.

Since the Alert sea ice sites include several overflights of the same four corner reflectors, this site is described in greater details than the other sites. With the many overflights of each corner reflector it is possible to make an independent test of the datation issue of ASIRAS, see section 7.2.1.

In some of the figures of the L1b data the OCOG retracker have been included as an illustration of the product. It should be obvious, when seeing these figures, that the OCOG retracker is unsuitable as a description of the surface elevation.

The following marks have been used in the figures:

Gray dot Position of processed L1b echoes.

Red triangle Marks the position where the corner reflector is observed in the L1b product.

Black star Marks the position of the corner reflector obtained by the ground teams using a hand held GPS.

Red star Marks the estimated position of the corner reflector using multiple observations of the same corner reflector.

9.1 EGIG Line, T05

The T05 site is placed around 1940 meters ellipsoidal height on the EGIG line that crosses the icecap of Greenland from East to West. Figure 26a shows several radar echoes in columns next to each other, each row corresponds to a range bin that is color coded according to the normalized power of that particular echo. The Figure is overlayed with the OCOG retracker (white line). It is clear that this retracker does not track the surface, but a strong reflector at some depth. In Figure 26b the first echoes without corner reflector traces before and after the corner reflector are showed together with the echo closest to the corner reflector.

Figure 25 shows a elevation model based on laser scanner data. The model has been overlayed with positions of radar echoes (gray dots), the corner reflector (black star) and the echo closest to the reflector (red triangle).

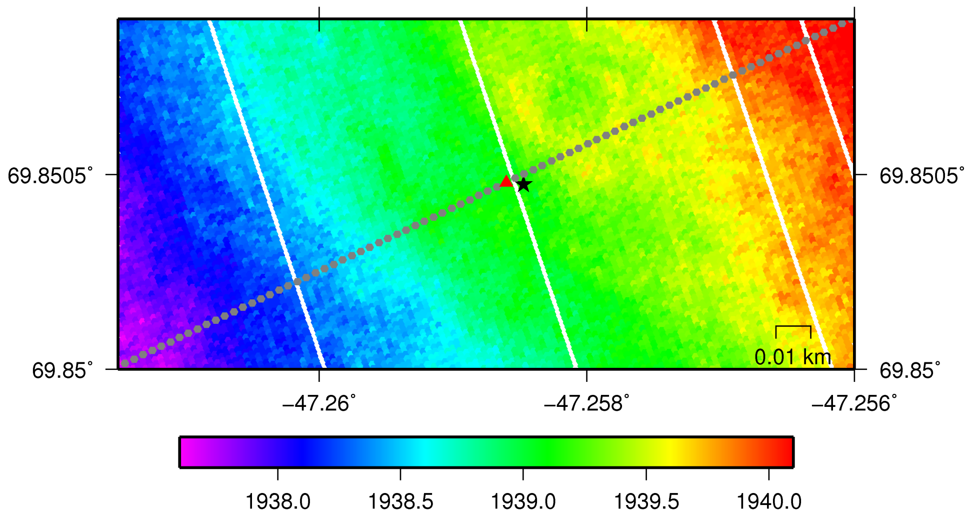
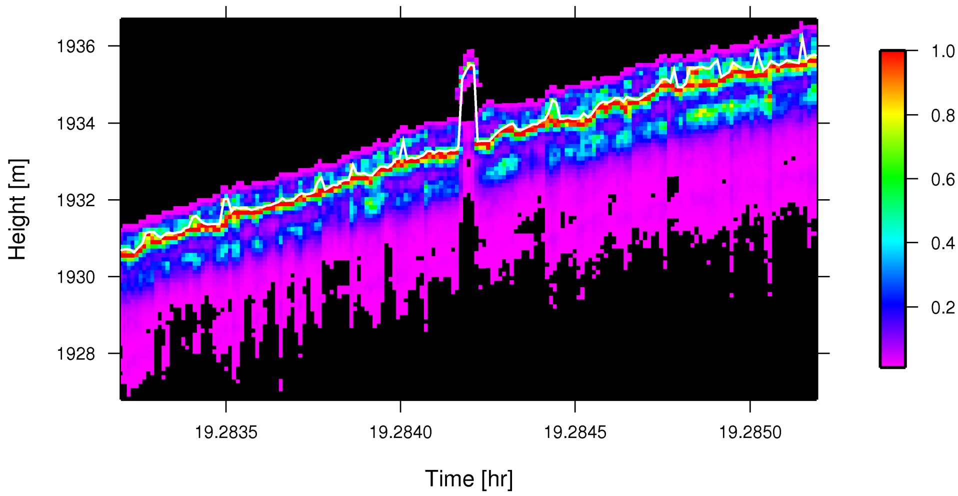
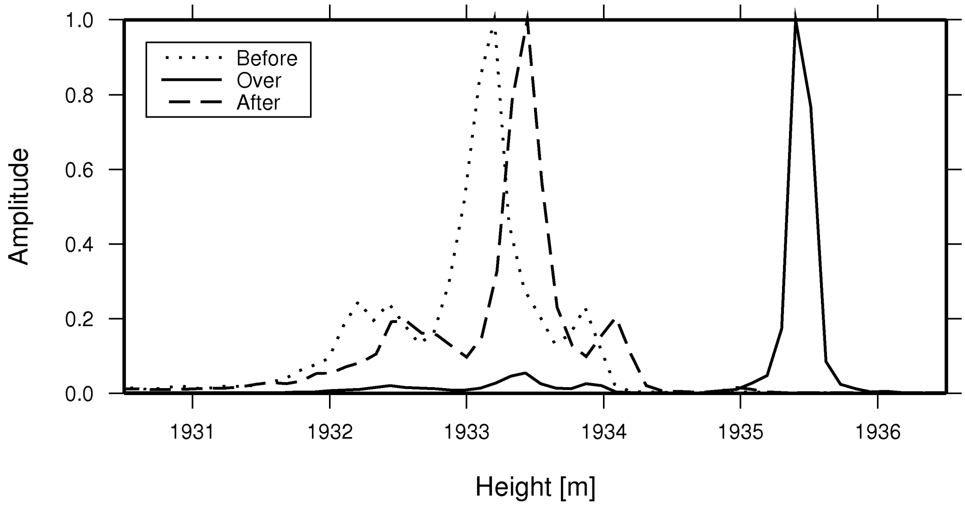


Figure 25: Laser scanner data from the 25th of April plotted with positions of ASIRAS echoes (gray dot and red triangle) and position of the corner reflector (black star).



(a) Normalized return power plotted in color as function of time and ellipsoidal height.

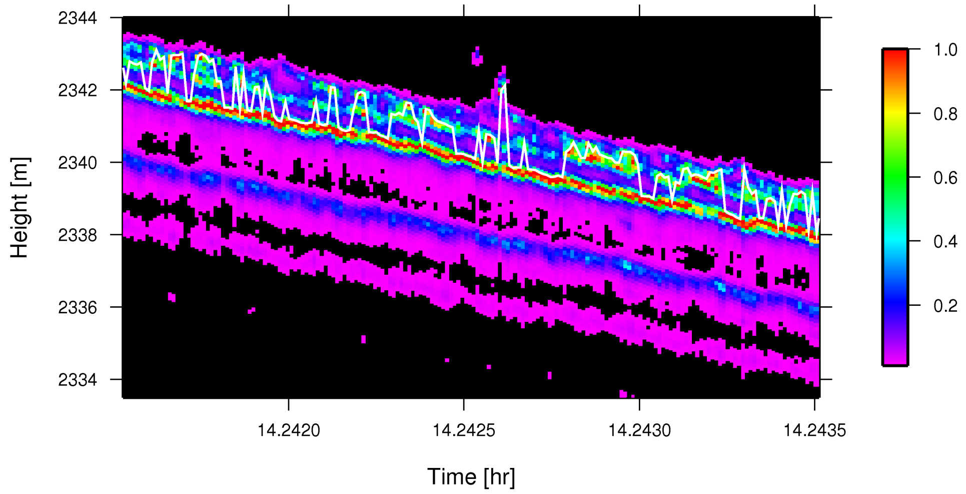


(b) Normalized return power plotted as function of ellipsoidal height for waveforms before, over, and after the corner reflector pass.

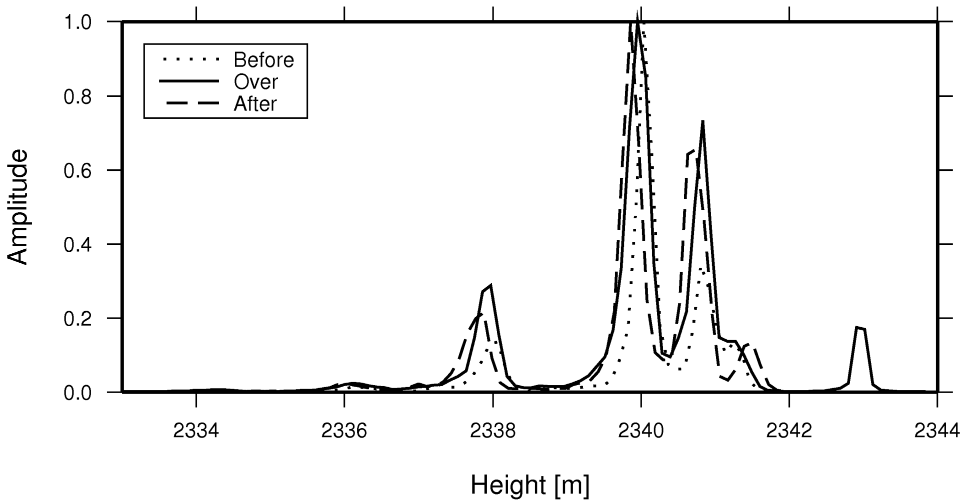
Figure 26: ASIRAS data from the T05 site on the 26th of April.

9.2 EGIG Line, T12

Further up on the greenlandic icecap at approximate 2350 meters ellipsoidal height is the T12 site. When inspecting the radar echoes plotted in Figure 27a two features, near the center of the plot, show up as possible corner reflector responses. After inspection of the ASIRAS profile before focusing it is clear that the left floating area is the true corner reflector response. A correspondence with the ground team revealed that the reflecting object after the corner reflector were an aluminum Zarges box. At the T12 site it is possible to detect deepere layers compared to the T05 site and the layers are more easy to follow through the profile.



(a) Normalized return power plotted in color as function of time and ellipsoidal height.



(b) Normalized return power plotted as function of ellipsoidal height for waveforms before, over, and after the corner reflector pass.

Figure 27: ASIRAS data from the T12 site on the 25^{th} of April.

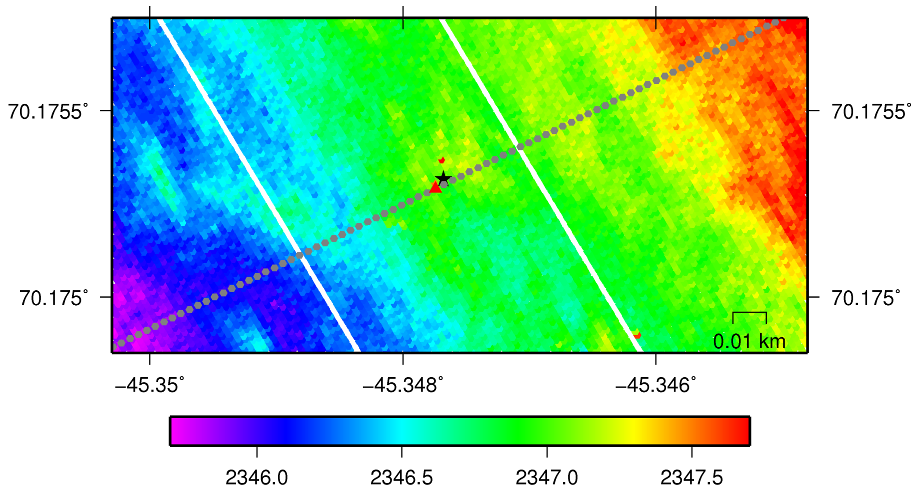


Figure 28: Laser scanner data plotted with positions of ASIRAS echoes (gray dot and red triangle) and position of the corner reflector (black star) from the 25^{th} of April

In Figure 28 two high objects (red/orange dots, one above the black star and one to the left partly covered by the red triangle) are seen near the assumed corner reflector position (black star). Since the point partly covered by the red triangle is very close to the corner reflector position found in Figure 27, it is possible that this point is the true corner reflector position that has been captured by the laser scanner. However since the laser captures two high objects near the observed corner reflector position (red triangle) it is not possible to make a final conclusion about the true corner reflector position. Another possibility is that the high objects seen by the laser scanner are part of the T12 sites equipment or camp items.

9.3 Austfonna Icecap

During the CryoVEx 2006 campaign four corner reflectors were placed on the Austfonna icecap, see Figure 30. The flight lines cover a series of ground validation tracks along which various snow and ice properties have been measured over a longer period of time.

In the L1b dataset a clear surface return is seen, together with another clear reflector approximate three meters down (See Figure 31a). Between the two strongly reflecting layers it is possible to detect three layers with a weaker reflection.

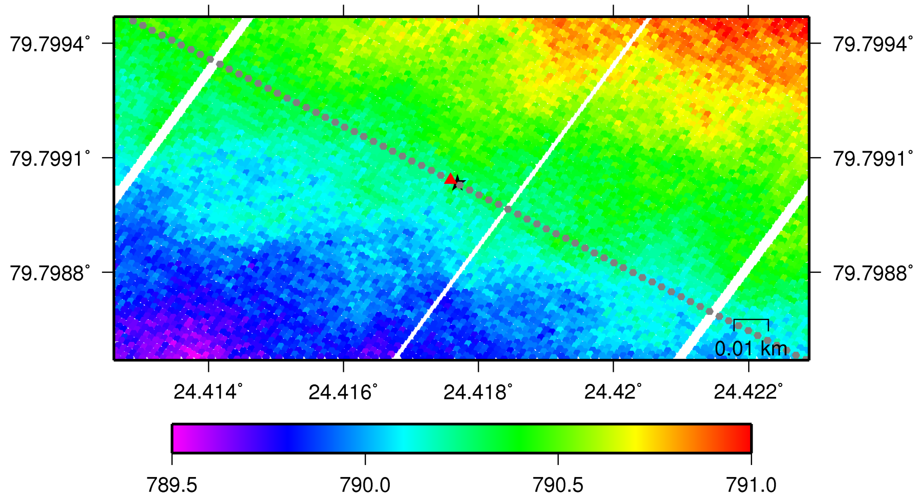


Figure 29: The AUST1 corner reflector position (black star) and ellipsoidal heights as measured with the laser scanner.

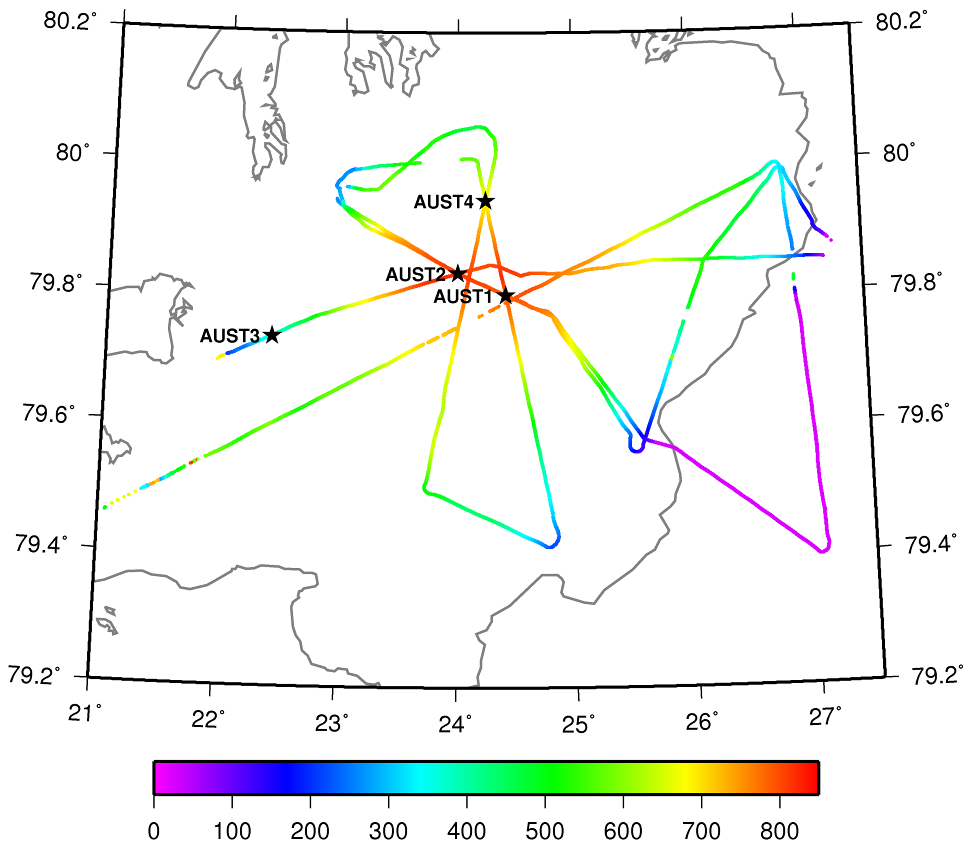
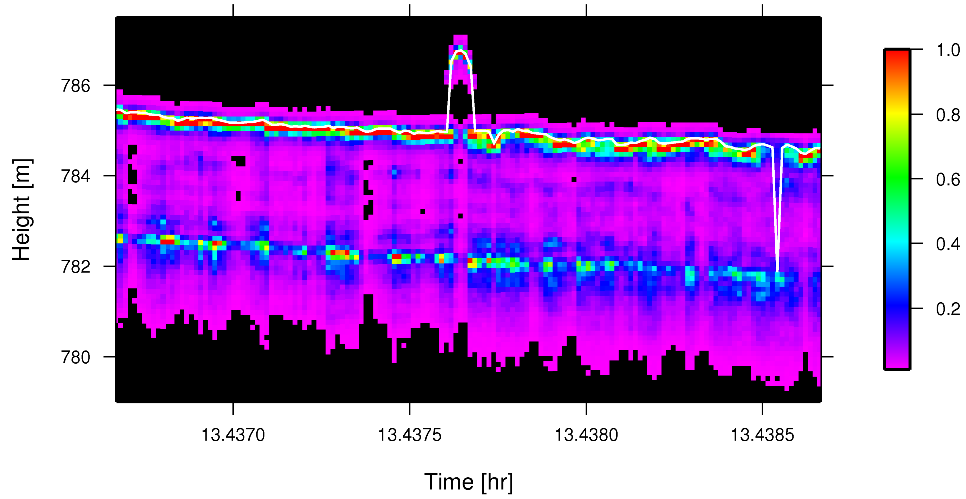
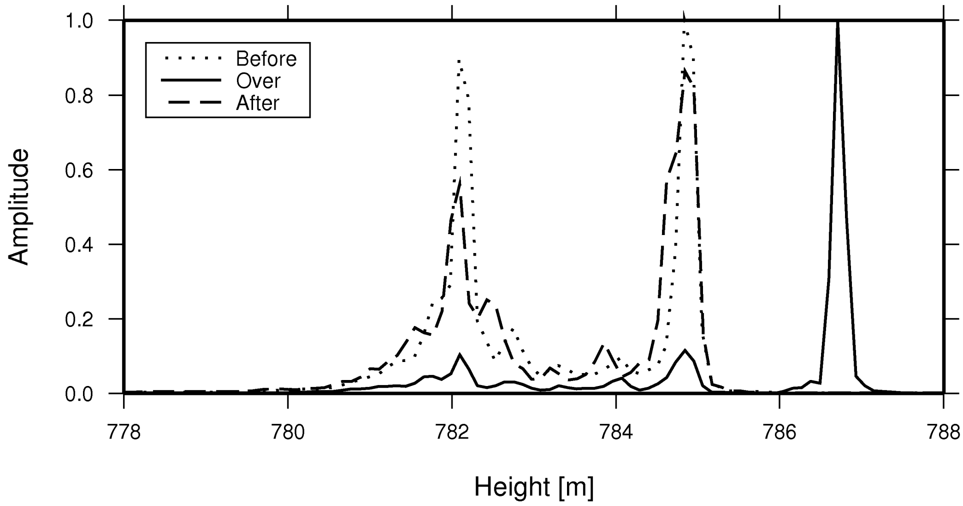


Figure 30: The four corner reflectors (black stars) on Austfonna and ellipsoidal heights as measured with the laser scanner.



(a) Normalized return power plotted in color as function of time and ellipsoidal height, at the AUST1 corner reflector.

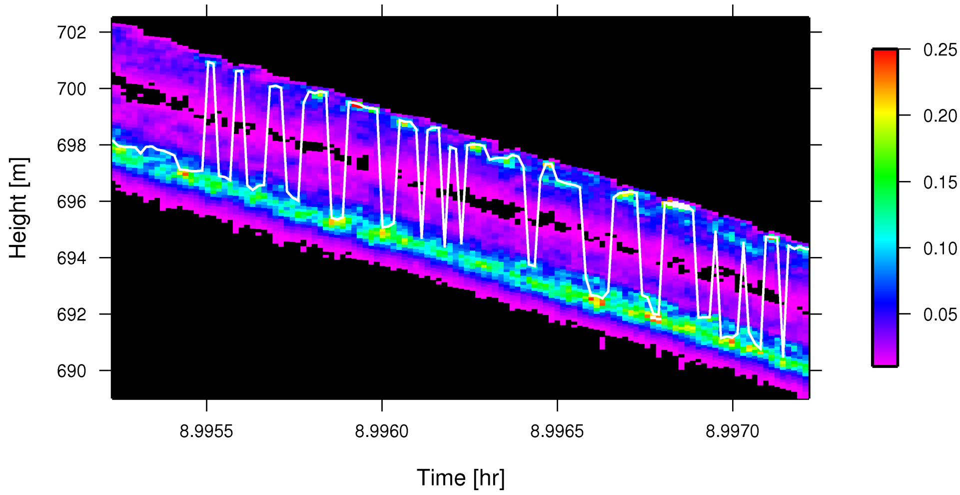


(b) Normalized return power plotted as function of ellipsoidal height for waveforms before, over, and after the corner reflector pass.

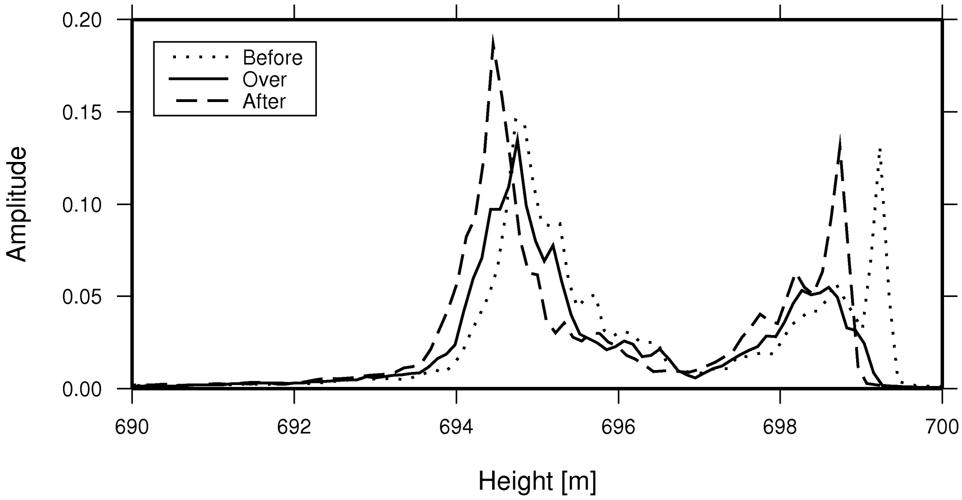
Figure 31: ASIRAS data recorded at Austfonna on the 1st of May.

9.4 Kongsvegen

Unfortunately the weather conditions were very bad at the Kongsvegen site with strong winds and low scattered clouds. These conditions made it difficult to perform a steady and near passage of the corner reflector site and clouds did block the view of the laser scanner, see the white areas in Figure 33. Despite the turbulens it is possible to detect two clear reflecting layers (see Figure 32a) in the first profile from the upper part of Kongsvegen, but the profile from the lower part is very noisy. Note also the scale on the normalized return power which indicates that other returns is stronger than the surface return.



(a) Normalized return power plotted in color as function of time and ellipsoidal height, near the KONG1 corner reflector position.



(b) Normalized return power plotted as function of ellipsoidal height for three waveforms around the corner reflector position.

Figure 32: ASIRAS data collected at Kongsvegen on the 2^{nd} of May.

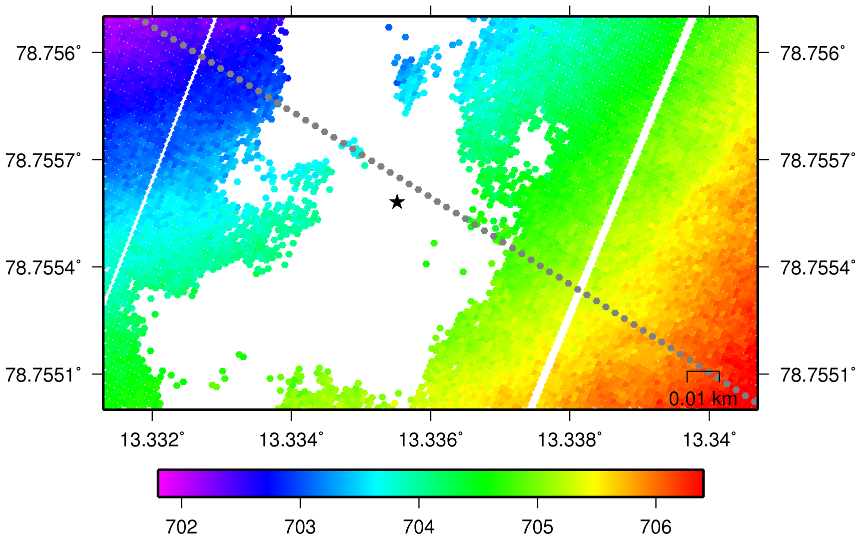


Figure 33: The corner reflector position (black star) on Kongsvegen and ellipsoidal heights as measured with the laser scanner.

9.5 Devon Icecap

The Devon Icecap corner reflector site were overflown three times, unfortunately it was not possible to detect the reflector in any of the passes. The north-south line had to be terminated after a while due to heavy downdraft on glacier and the full validation line is therefore not in the airborne dataset.

Both the ASIRAS and the laser figures shows similar features as the T05 site, with a strong reflector roughly one meter below the surface and weaker reflector above and below (see Figure 35a and 35b).

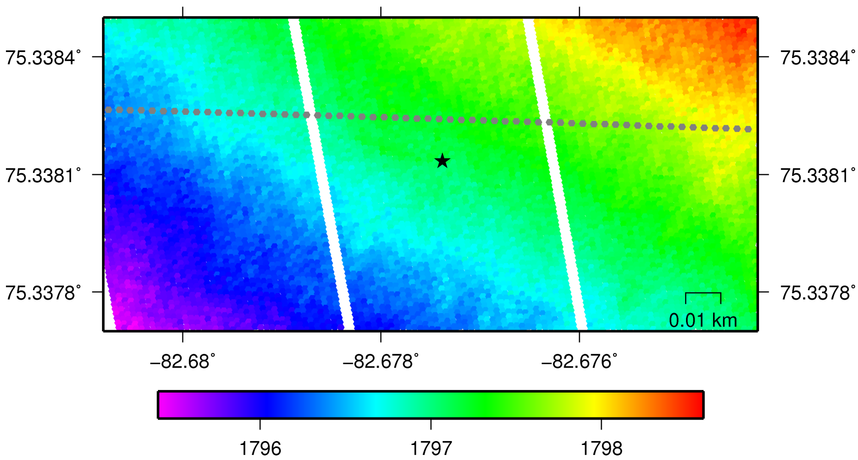
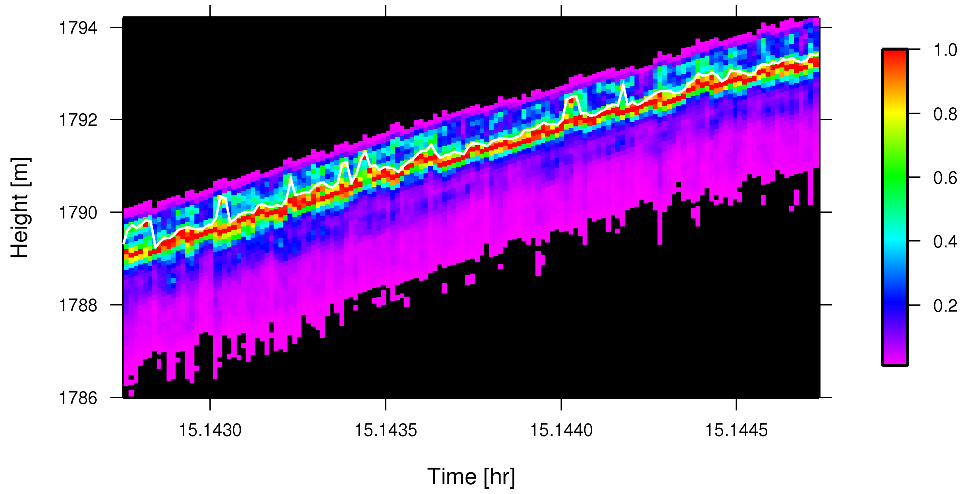
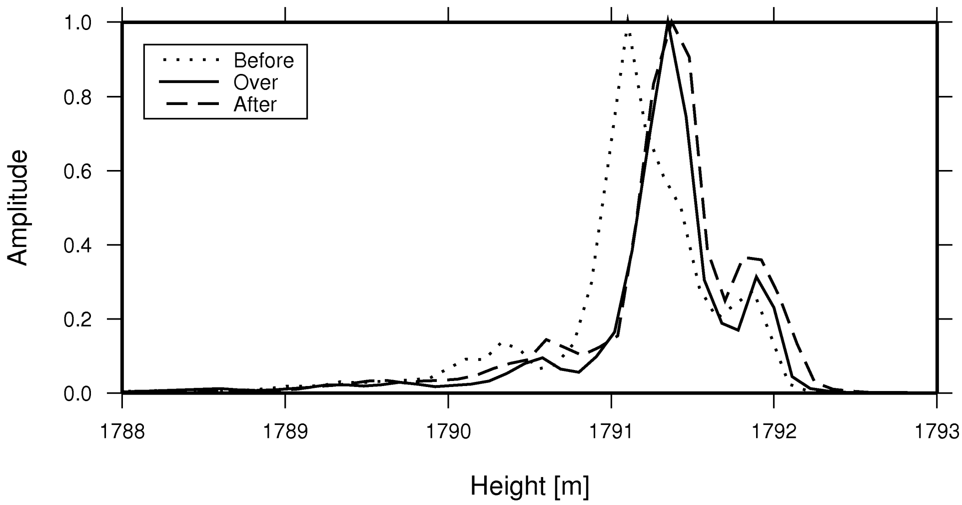


Figure 34: The corner reflector position (black star) on Devon and ellipsoidal heights as measured with the laser scanner.



(a) Normalized return power plotted in color as function of time and ellipsoidal height, on the north-south flight near the DEVON corner reflector position.



(b) Normalized return power plotted as function of ellipsoidal height for three waveforms around the corner reflector position.

Figure 35: ASIRAS data collected at Devon Icecap on the 5^{th} of May.

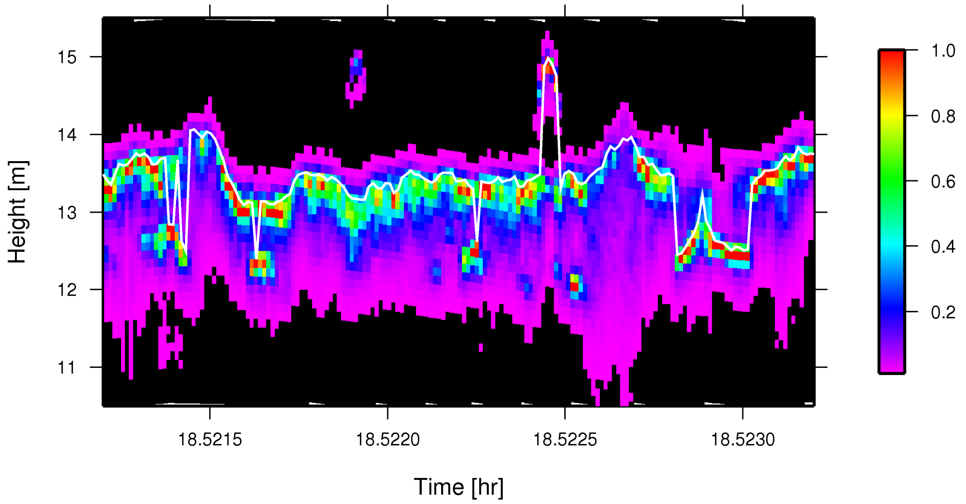
9.6 Sea Ice North of Alert

The sea ice sites north of Alert was located on the fast ice along the coast and consisted of one validation line on first year ice and one on multi year ice, with two corner reflectors each. At both sites the corner reflectors were placed approximate 120 meters apart. Several measurements of snow depth, ice thickness and density have been performed along the two validation lines.

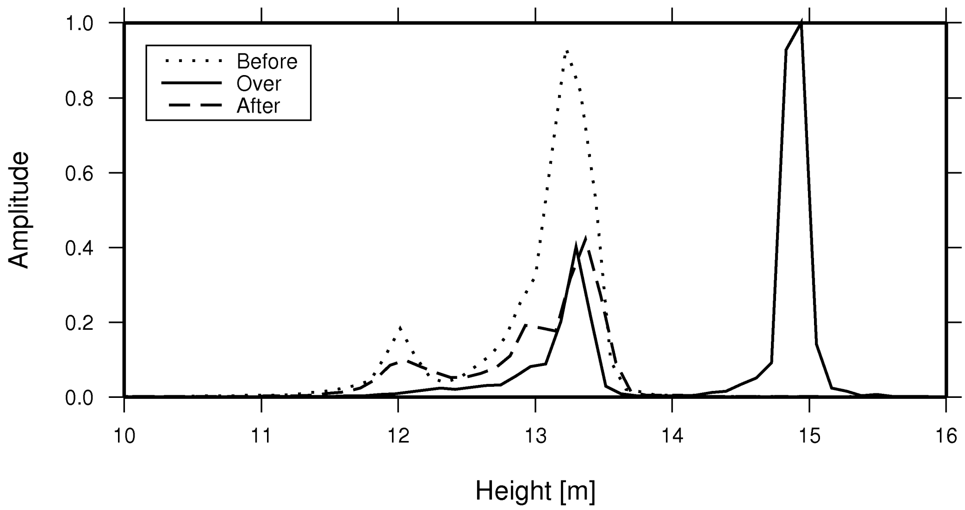
9.6.1 Multi year sea ice

The multi year ice site was placed approximately 5 km from Alert on a 200 m by 200 m patch with level ice surrounded by large ridges and heavy rubble. The snow surface at and between the two corner reflectors were relatively smooth. Figure 37 shows that the variation of the surface is below 50 cm between the two reflectors, but reaches more than 1 m outside the patch.

Figure 36a show the ASIRAS echoes from the site and it is clear that the area between two corner reflectors is much smoother than outside. The echoes in Figure 36b show a range of reflections from the complex structure of the multi year ice.



(a) Normalized return power plotted in color as function of time and ellipsoidal height at the YLT1 and YLT2 positions.



(b) Normalized return power plotted as function of ellipsoidal height for waveforms before, over, and after the YLT1 corner reflector pass.

Figure 36: Multi year ice north of Alert.

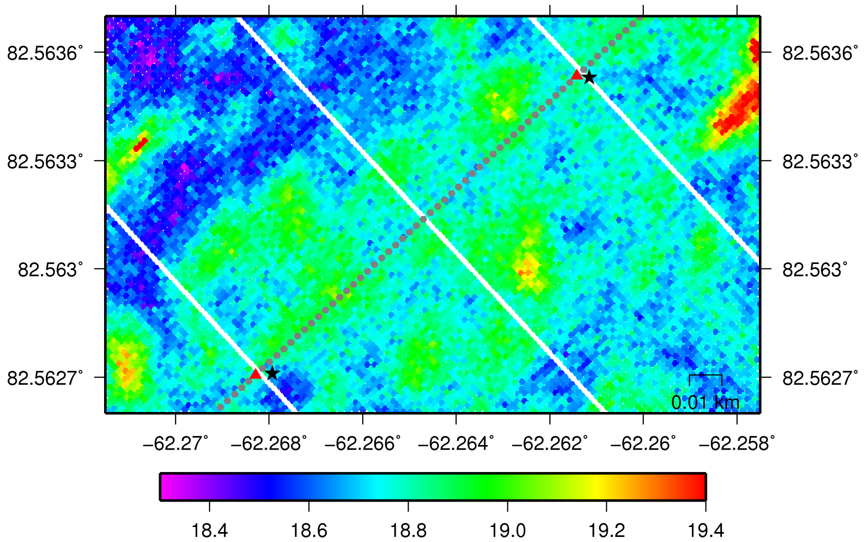


Figure 37: The YLT1 and YLT2 corner reflector positions (black stars) and ellipsoidal heights as measured with the laser scanner.

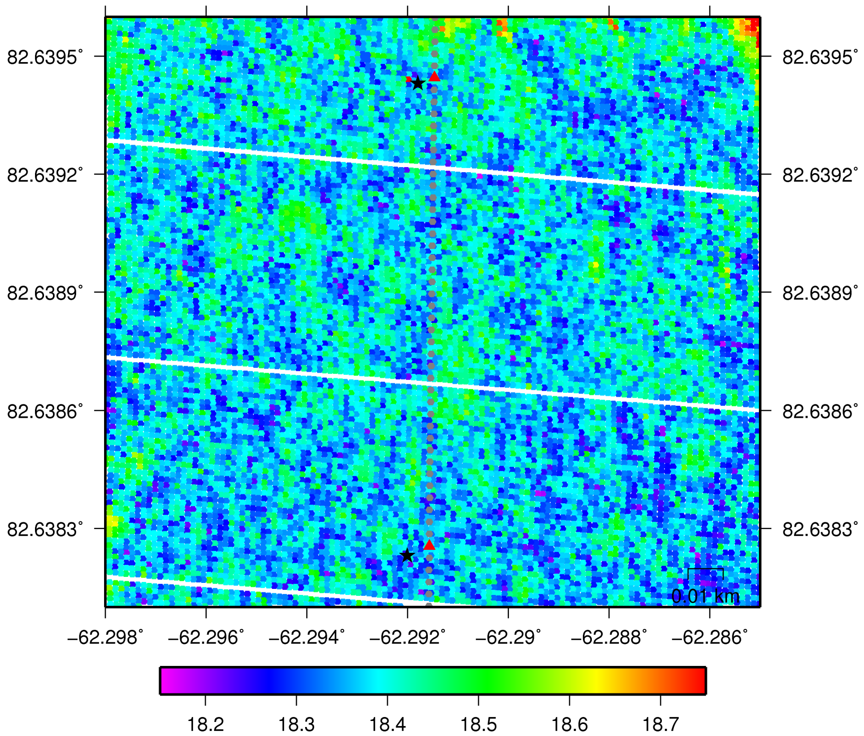
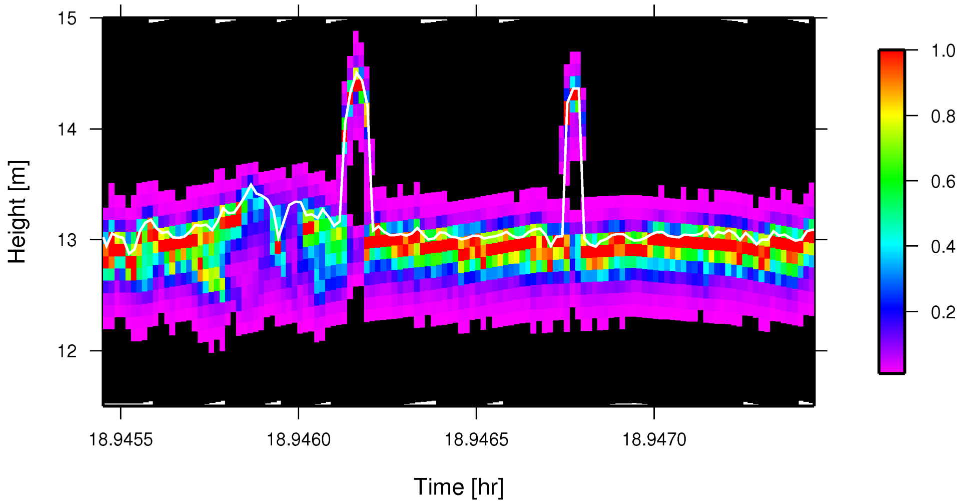


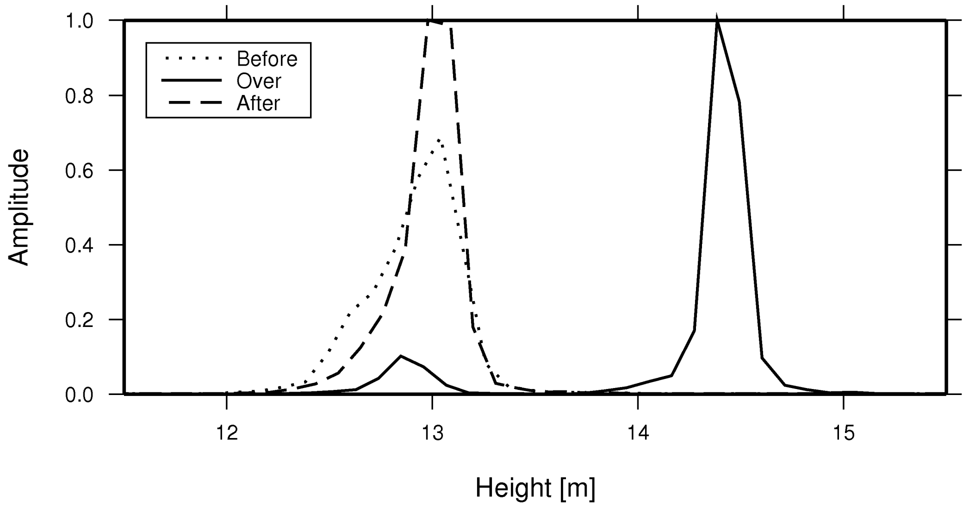
Figure 38: YLT3 and YLT4. The red dot (left of the upper black star) is believed to be the corner reflector captured by the laser scanner.

9.6.2 First year sea ice

The first year ice site was 200 m by 200 m and formed in a shear zone between multi year ice floes and therefore surrounded with large ridges and heavy rubble. The snow surface was very smooth with height variations around 20 cm, see Figure 39b. Figure 39a and 39b show simple echoes from one large and well defined reflection, corresponding to the snow/ice interface.



(a) Normalized return power plotted in color as function of time and ellipsoidal height at the YLT3 and YLT4 positions.



(b) Normalized return power plotted as function of ellipsoidal height for waveforms before, over, and after the YLT3 corner reflector pass.

Figure 39: First year ice north of Alert.

9.6.3 Comparing multiple corner reflector overflights

The repeated passes over the corner reflectors on the sea ice site makes it is possible to investigate the datation issue using only ASIRAS data. Figure 40, 41, 42, and 43 illustrates the several passes over the four corner reflectors YLT1, YLT2, YLT3, and YLT4. In the figures the flightpath is indicated by a colored line and each ASIRAS L1b echo is marked with a bullet. The echo in which the point of closed approach has been identified is marked with a triangle and the footprint of this echo is indicated with a colored rectangle.

If there exists a datation error in one of the corner reflector passes it would be impossible to find a position where all footprints overlap and thus the true position of the corner reflector. In Figure 40, 41, and 43 there exists a small and well defined area where all footprints overlap (marked with a red star). Figure 42 consists only of parallel flights and the overlap is therefor not a well defined area but instead a wide and short strip, the true position of the YLT3 corner reflector is therefor estimated from the laser scanner data which has captured the corner reflector, see Figure 38. The corner reflector position obtained from the laser scanner data lies within all footprints and is thus accepted as the true position.

All four figures also shows the positions of the corner reflectors as obtained by the ground team using hand held GPS receivers (black star). The distance between the positions reported by the ground team and the positions estimated from the airborne dataset is all within 7 m which is within the 10 m accuracy of real time GPS.

This analysis shows that there is very little or no datation error in the ASIRAS data collected at the four corner reflectors north of Alert. It can however only be concluded that the datation error is absent in these cases, and further tests must be conducted before a final conclusion can be drawn.

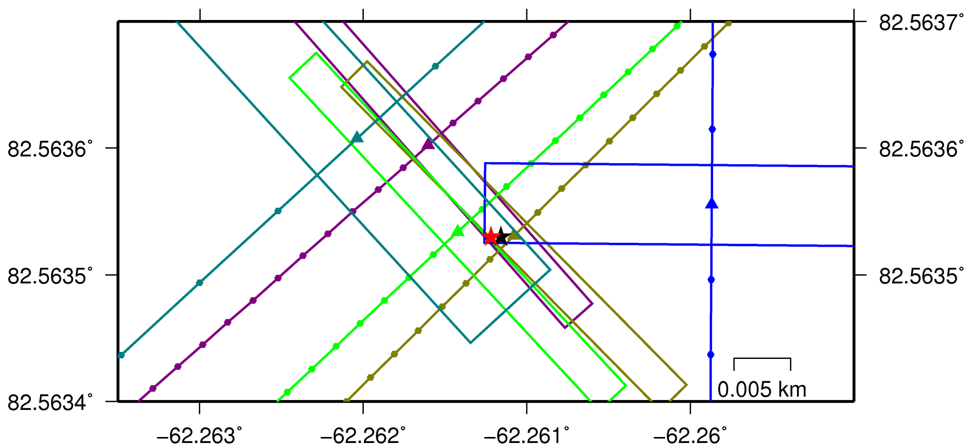


Figure 40: Five overflights of YLT1. Corner reflector position from hand held GPS (black star). Estimated true corner reflector position (red star).

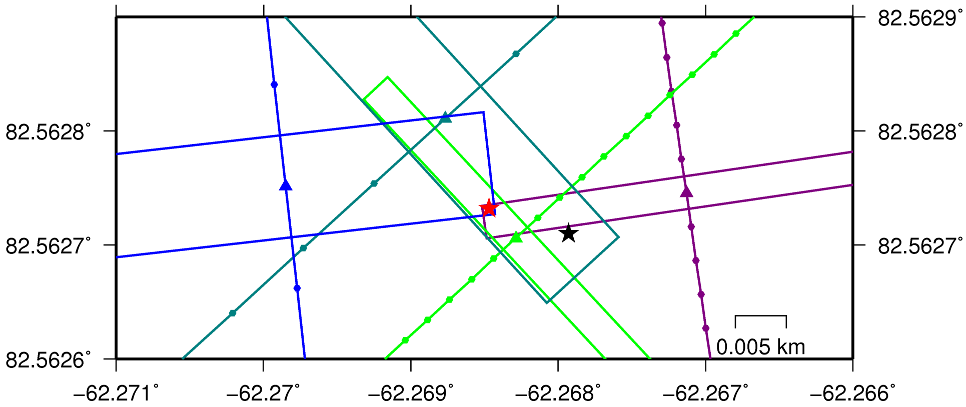


Figure 41: Four overflights of YLT2. Corner reflector position from hand held GPS (black star). Estimated true corner reflector position (red star).

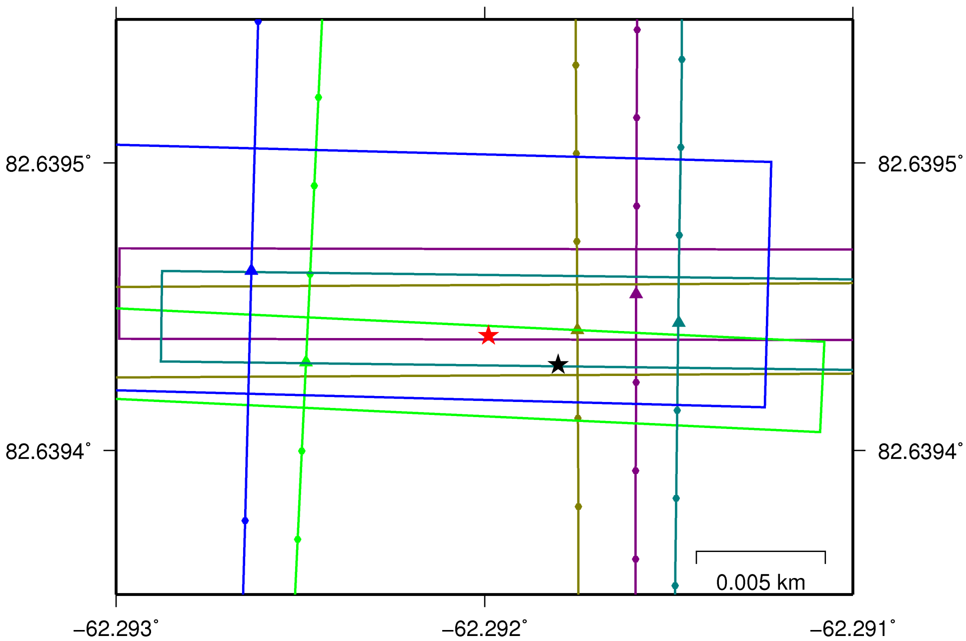


Figure 42: Five overflights of YLT3. Corner reflector position from hand held GPS (black star). Estimated true corner reflector position (red star).

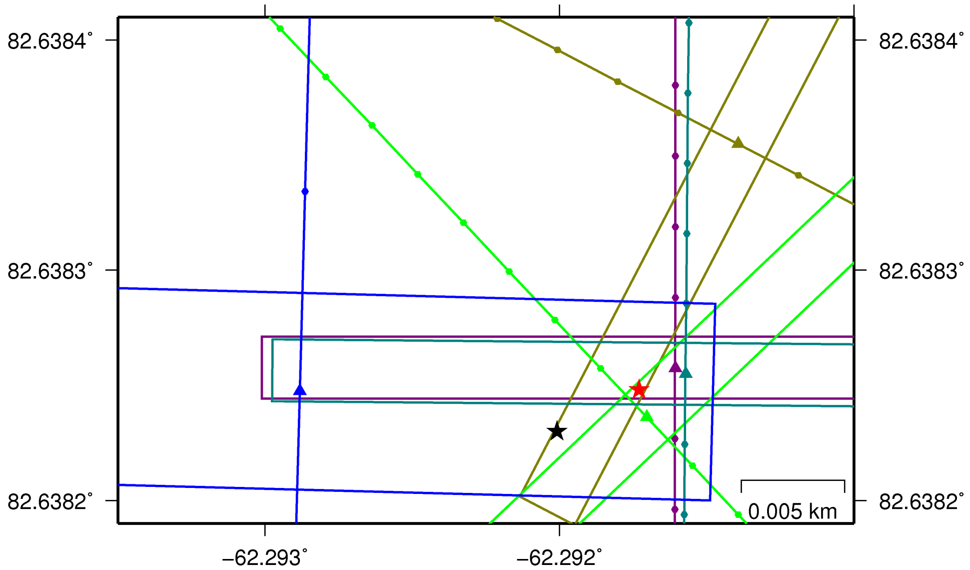


Figure 43: Five overflights of YLT4. Corner reflector position from hand held GPS (black star). Estimated true corner reflector position (red star).

10 Conclusions

The airborne part of the CryoVEx 2006 campaign has successfully been carried out by DNSC and the gathered data sets are now stored and secured at DNSC and AWI. A total of 127 hr were flown with the Air Greenland Twin-Otter where laser scanner data were acquired most of the time. ASIRAS radar data were gathered on the main campaign sites and on parts of the survey lines. About 25 hr were spend on flights over the main sites, 20 hr on positioning of the British ground teams on the ice sheet, 25 hr on different other project, and the rest on transit flights and repeated coverage of sea ice and land ice lines previously flown by DNSC.

Preliminary analysis of the data sets showed good results, which were presented to the involved parties at the June 15th-16th, 2006 CryoSat CVRT meeting at ESA-ESTEC. Since then an intensive collaboration between ESA, AWI and DNSC have ensured a solid processing of data where many minor and major problems have been identified and solved.

The data collected during CryoVEx 2006 will be important for understanding CryoSat-2 radar signals, and the processed data presents many opportunities for additional scientific investigations, such as e.g. the direct mapping of snow thickness by combination of laser and radar, detailed understanding on snow and firn penetration of CryoSat-2 signals etc. A number of overflights of corner reflectors both on sea ice and inland ice will aid this research, as well as serving the calibration of ASIRAS.

A number of independent in-situ data on ice thickness and snow depth were collected during CryoVEx 2006 on two large ice floes north of Alert; additional scientific activities included flights with the AWI EM-system, which provides an independent estimate of sea ice thickness. The comparison to the in-situ or EM data is outside the scope of this report, and will be presented in other scientific papers.

Please note: An investigation of the of the platform motion impact on ASIRAS have given new knownledge about the datation issue. Refer to the ESTEC Working Paper 2320: "ASIRAS Calibration and Validation, Simulation of Platform Motion Impact on DGPS Position and SARIn Phase Difference" by Marco Fornari.

References

Cullen, R. (2006). *ASIRAS, Product Description, Issue: 2.4.* European Space Agency.

Helm, V., Hendricks, S., Goebell, S., Rack, W., Haas, C., Nixdorf, U., and Boebel, T. (2006). Cryovex 2004 and 2005 (bob) data aquisition and final report. Technical Report 1.0, Alfred Wegener Institute.

A File Formats

The format description for the core products is taken from the "ASIRAS, Product Description, Issue: 2.4" by Cullen (2006) and the users should refer to this document for in depth information. The definition of the types used in the binary files can be found in Table 14.

Type	Description	Size (bytes)
uc	Unsigned character	1
sc	Signed character	1
us	Unsigned short integer	2
ss	Signed short integer	2
ul	Unsigned long integer	4
sl	Signed long integer	4
ull	Unsigned long long integer	8
sll	Signed long long integer	8
d	Double precision floating	8
f	Single precision floating	4
[n]	Array length n	

Table 14: Definition of binary types used in the describtion of the file formats.

A.1 ASIRAS L1b

Processed L1b ASIRAS data is delivered in binary, big endian format as described by Cullen (2006) and Tables 15, 17, and 18.

The L1b product consists of two elements.

1. An ASCII header consisting of a main product header (MPH), a specific product header (SPH), and the data set descriptors (DSDs).

2. A binary, big endian measurement data set (MDS).

Field #	Description	Units	Bytes	Format
Product Identification Information				
#01	PRODUCT=	keyword	8	8*uc
	quotation mark (")		1	uc
	Product File Name Left justified with trailer blanks		62	uc
	quotation mark (")		1	uc
	newline character	terminator	1	uc

Continued on next page

Field #	Description	Units	Bytes	Format
#02	PROC_STAGE=	keyword	11	11*uc
	Processing stage code: N = Near-Real Time T = Test O = OFF Line (Systematic) R = Reprocessing L = Long Term Archive		1	uc
	newline character	terminator	1	uc
#03	REF_DOC=	keyword	8	8*uc
	quotation mark (")		1	uc
	Reference DFCB Document describing the product		23	23*uc
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#04	Spare		40	40*uc
	newline character	terminator	1	uc
Data Processing Information				
#05	ACQUISITION_STATION=	keyword	20	20*uc
	quotation mark (")		1	uc
	Acquisition Station ID Filled by blanks		20	Kiruna
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#06	PROC_CENTER=	keyword	12	12*uc
	quotation mark (")		1	uc
	Processing Center ID code		6	PDS
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#07	PROC_TIME=	keyword	10	10*uc
	quotation mark (")		1	uc
	Processing Time (Product Generation Time)	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#08	SOFTWARE_VER=	keyword	13	13*uc
	quotation mark (")		1	uc
	Processor name, up to 8 characters, and software version number followed by trailer blanks if any. If not used set to blanks		14	14*uc ProcessorName/VV.rr
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#09	Spare (blank characters)		40	40*uc
	newline character	terminator	1	uc

Continued on next page

Field #	Description	Units	Bytes	Format
Information on Time of Data				
#10	SENSING_START=	keyword	14	14*uc
	quotation mark (")		1	uc
	UTC start time of data sensing. This is the UTC start time of the Input Level 0 Product. If not used set to 27 blanks	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#11	SENSING_STOP=	keyword	13	13*uc
	quotation mark (")		1	uc
	UTC stop time of data sensing. This is the UTC stop time of the Input Level 0 Product. If not used set to 27 blanks	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#12	Spare (blank characters)		40	40*uc
	newline character	terminator	1	uc
Orbit Information				
#13	PHASE=	keyword	6	6*uc
	Phase Code: phase letter (A, B, :.) If not used set to X		1	uc
	newline character	terminator	1	uc
#14	CYCLE=	keyword	6	6*uc
	Cycle number. If not used set to +000		4	%+04d
	newline character	terminator	1	uc
#15	REL_ORBIT=	keyword	10	10*uc
	Relative Orbit Number at sensing start time. If not used set to +00000		6	%+06d
	newline character	terminator	1	uc
#16	ABS_ORBIT=	keyword	10	10*uc
	Absolute Orbit Number at sensing start time. If not used set to +00000		6	%+06d
	newline character	terminator	1	uc
#17	STATE_VECTOR_TIME=	keyword	18	18*uc
	quotation mark (")		1	uc
	UTC state vector time It is filled properly in case of usage of FOS Predicted Orbit information otherwise it shall be set to 27 blanks	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc

Continued on next page

Field #	Description	Units	Bytes	Format
#18	DELTA_UT1=	keyword	10	10*uc
	Universal Time Correction: DUT1 = UT1 - UTC Not used for ASIRAS. It shall be set to +.000000	s	8	%+08.6f
	<s>	units	3	3*uc
	newline character	terminator	1	uc
#19	X_POSITION=	keyword	11	11*uc
	X position in Earth Fixed Reference. If not used set to +0000000.000	m	12	%+012.3f
	<m>	units	3	3*uc
	newline character	terminator	1	uc
#20	Y_POSITION=	keyword	11	11*uc
	Y position in Earth Fixed Reference. If not used set to +0000000.000	m	12	%+012.3f
	<m>	units	3	3*uc
	newline character	terminator	1	uc
#21	Z_POSITION=	keyword	11	11*uc
	Z position in Earth Fixed Reference. If not used set to +0000000.000	m	12	%+012.3f
	<m>	units	3	3*uc
	newline character	terminator	1	uc
#22	X_VELOCITY=	keyword	11	11*uc
	X velocity in Earth Fixed Reference. If not used set to +0000.000000	m/s	12	%+012.6f
	<m/s>	units	5	5*uc
	newline character	terminator	1	uc
#23	Y_VELOCITY=	keyword	11	11*uc
	Y velocity in Earth Fixed Reference. If not used set to +0000.000000	m/s	12	%+012.6f
	<m/s>	units	5	5*uc
	newline character	terminator	1	uc
#24	Z_VELOCITY=	keyword	11	11*uc
	Z velocity in Earth Fixed Reference. If not used set to +0000.000000	m/s	12	%+012.6f
	<m/s>	units	5	5*uc
	newline character	terminator	1	uc
#25	VECTOR_SOURCE=	keyword	14	14*uc
	quotation mark (")		1	uc
	Source of Orbit State Vector Record FP = FOS predicted DN = DORIS Level 0 navigator DP = DORIS precise orbit FR = FOS Restituted DI = DORIS Preliminary		2	2*uc
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#26	Spare (blank characters)		40	40*uc
	newline character	terminator	1	uc

Continued on next page

Field #	Description	Units	Bytes	Format
SBT to UTC conversion Information				
#27	UTC_SBT_TIME=	keyword	13	13*uc
	quotation mark (")		1	uc
	Not used and set to 27 blanks		27	27*uc
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#28	SAT_BINARY_TIME=	keyword	16	16*uc
	Satellite Binary Time Not used for Cryosat and it shall be set to zeros		11	+0000000000
	newline character	terminator	1	uc
#29	CLOCK_STEP =	keyword	11	11*uc
	Clock Step Not used for Cryosat and it shall be set to zeros		11	+0000000000
	<ps>	units	4	4*uc
	newline character	terminator	1	uc
#30	Spare (blank characters)		32	32*uc
	newline character	terminator	1	uc
Leap Second Information				
#31	LEAP_UTC=	keyword	9	9*uc
	quotation mark (")		1	uc
	UTC Time of the occurrence of the leap second. If a leap second occurred in the product window the field is set by a devoted function in the CFI EXPLORER_ORBIT library (see [EXPL_ORB-SUM] for details), otherwise it is set to 27 blanks. It corresponds to the time after the Leap Second occurrence (i.e. midnight of the day after the leap second)	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#32	LEAP_SIGN=	keyword	10	10*uc
	Leap second sign If a leap second occurred in the product window the field is set to the expected value by a devoted function in the CFI EXPLORER_ORBIT library (see [EXPL_ORB-SUM] for details), otherwise it is set to +000.	S	4	%+04d
	newline character	terminator	1	uc
#33	LEAP_ERR=	keyword	9	9*uc
	Leap second error flag. This field is always set to 0 considering that CRYOSAT products have true UTC times.		1	uc
	newline character	terminator	1	uc

Continued on next page

Field #	Description	Units	Bytes	Format
#34	Spare (blank characters)		40	40*uc
	newline character	terminator	1	uc
Product Confidence Data Information				
#35	PRODUCT_ERR=	keyword	12	12*uc
	Product Error Flag set to 1 if errors have been reported in the product		1	uc
	newline character	terminator	1	uc
Product Size Information				
#36	TOT_SIZE=	keyword	9	9*uc
	Total size of the product	bytes	21	%+021d
	<bytes>	units	7	7*uc
	newline character	terminator	1	uc
#37	SPH_SIZE=	keyword	9	9*uc
	Length of the SPH	bytes	11	%+011d
	<bytes>	units	7	7*uc
	newline character	terminator	1	uc
#38	NUM_DSD=	keyword	8	8*uc
	Number of Data Set Descriptors, including spares and all other types of DSDs		11	%+011d
	newline character	terminator	1	uc
#39	DSD_SIZE=	keyword	9	9*uc
	Length of each DSD	bytes	11	%+011d
	<bytes>	units	7	7*uc
	newline character	terminator	1	uc
#40	NUM_DATA_SETS=	keyword	14	14*uc
	Number of attached Data Sets (note that not all the DSDs have a DS attached)		11	%+011d
	newline character	terminator	1	uc
#41	CRC=	keyword	4	4*uc
	Cyclic Redundancy Code computed as overall value of all records of the Measurement Data Set. If not computed it shall be set to -00001		6	%+06d
	newline character	terminator	1	uc
#42	Spare (blank characters)		29	29*uc
	newline character	terminator	1	uc
TOTAL				**1247**

Table 15: ASIRAS main product header (MPH) format.

Field #	Description	Units	Bytes	Format
Product description and identification				
#1	SPH_DESCRIPTOR=	keyword	15	15*uc
	quotation mark (")		1	uc
	ASCII string describing the product Set to ASI_SAR_1B SPECIFIC HEADER		28	28*uc
	quotation mark (")		1	uc
	newline character	terminator	1	uc

Continued on next page

Field #	Description	Units	Bytes	Format
Product Time information				
#2	START_RECORD_TAI_TIME=	keyword	22	22*uc
	quotation mark (")		1	uc
	TAI of the first record in the Main MDS of this product	TAI	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#3	STOP_RECORD_TAI_TIME=	keyword	21	21*uc
	quotation mark (")		1	uc
	TAI of the last record in in the Main MDS of this product	TAI	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc
Product Orbit Information				
#4	ABS_ORBIT_START=	keyword	16	16*uc
	Absolute Orbit Number at Product Start Time		6	%06d
	newline character	terminator	1	uc
#5	REL_TIME_ASC_NODE_START=	Keyword	24	24*uc
	Relative time since crossing ascending node time relative to start time of data sensing	s	11	%011.6f
	<s>	units	3	3*uc
	newline character	terminator	1	uc
#6	ABS_ORBIT_STOP=	keyword	15	15*uc
	Absolute Orbit Number at Product Stop Time		6	%06d
	newline character	terminator	1	uc
#7	REL_TIME_ASC_NODE_STOP=	Keyword	23	23*uc
	Relative time since crossing ascending node time relative to stop time of data sensing	s	11	%011.6f
	<s>	units	3	3*uc
	newline character	terminator	1	uc
#8	EQUATOR_CROSS_TIME_UTC=	Keyword	23	23*uc
	quotation mark (")		1	uc
	Time of Equator crossing at the ascending node of the sensing start time	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#9	EQUATOR_CROSS_LONG=	Keyword	19	19*uc
	Longitude of Equator Crossing at the ascending node of the sensing start time (positive East, 0 = Greenwich) referred to WGS84	s	11	%+011d
	<10-6degE>	units	10	10*uc
	newline character	terminator	1	uc

Continued on next page

Field #	Description	Units	Bytes	Format
#10	ASCENDING_FLAG=	keyword	15	15*uc
	Orbit Orientation at the sensing start time A= Ascending D= Descending		1	uc
	newline character	terminator	1	uc
Product Location Information				
#11	START_LAT=	keyword	10	10*uc
	WGS84 latitude of the first record in the Main MDS (positive north)	[10-6 deg]	11	%+011d
	<10-6degN>	units	10	10*uc
	newline character	terminator	1	uc
#12	START_LONG=	keyword	11	11*uc
	WGS84 longitude of the first record in the Main MDS (positive East, 0 = Greenwich)	[10-6 deg]	11	%+011d
	<10-6degE>	units	10	10*uc
	newline character	terminator	1	uc
#13	STOP_LAT=	keyword	9	9*uc
	WGS84 latitude of the last record in the Main MDS (positive north)	[10-6 deg]	11	%+011d
	<10-6degN>	units	10	10*uc
	newline character	terminator	1	uc
#14	STOP_LONG= keyword 10 10*uc			
	WGS84 longitude of the last record in the Main MDS (positive East, 0 = Greenwich)	[10-6 deg]	11	%+011d
	<10-6degE>	units	10	10*uc
	newline character	terminator	1	uc
#15	Spare (blank characters)		50	50*uc
	newline character	terminator	1	uc
Level 0 Quality information				
#16	L0_PROC_FLAG=	keyword	13	13*uc
	Processing errors significance flag (1 or 0). 1 if the percentage of SIRAL packets free of processing errors is less than the acceptable threshold		1	uc
	newline character	terminator	1	uc
#17	L0_PROCESSING_QUALITY=	keyword	22	22*uc
	Percentage of quality checks successfully passed during the SP processing (max allowed +10000)	[10-2%]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc
#18	L0_PROC_THRESH=	keyword	15	15*uc
	Minimum acceptable percentage of quality threshold that must be passed during SP processing (max allowed +10000)	[10-2%]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc

Continued on next page

Field #	Description	Units	Bytes	Format
#19	L0_GAPS_FLAG=	keyword	13	13*uc
	Gaps significance flag (1 or 0). 1 if gaps (either caused by extraction or alignment failures) were detected during the SP processing		1	uc
	newline character	terminator	1	uc
#20	L0_GAPS_NUM=	keyword	12	12*uc
	Number of gaps detected during the SP processing (no gaps indicated as +0000000)		8	%+08d
	newline character	terminator	1	uc
#21	Spare (blank characters)	ascii	50	50*uc
	newline character	terminator	1	uc
ASIRAS Instrument Configuration				
#22	ASI_OP_MODE=	keyword	12	12*uc
	quotation mark (")		1	uc
	ASIRAS Operative Mode: HAM LAM (strings shorter than 10 are filled in with blanks)		10	10*uc
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#23	ASI_CONFIGURATION=	keyword	18	17*uc
	quotation mark (")		1	uc
	SIRAL Configuration: RX_1 RX_2 BOTH UNKNOWN (strings shorter than 7 are filled in with blanks)		7	7*uc
	quotation mark (")		1	uc
	newline character	terminator	1	uc
Surface Statistics				
#24	OPEN_OCEAN_PERCENT=	keyword	19	19*uc
	Percentage of records detected on open ocean or semi-enclosed seas	[10-2%]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc
#25	CLOSE_SEA_PERCENT=	keyword	18	18*uc
	Percentage of records detected on closed seas or inland lakes	[10-2%]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc
#26	CONTINENT_ICE_PERCENT=	keyword	22	22*uc
	Percentage of records detected on continental ice	[10-2%]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc

Continued on next page

Field #	Description	Units	Bytes	Format
#27	LAND_PERCENT Keyword 13 13*uc			
	Percentage of records detected on land	[10-2%]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc
#28	Spare (blank characters)	ascii	50	50*uc
	newline character	terminator	1	uc
	Level 1 Processing information			
#29	L1B_PROD_STATUS=	keyword	16	16*uc
	Complete/Incomplete Product Completion Flag (0 or 1). 1 if the Product as a duration shorter than the input Level 0		1	uc
	newline character	terminator	1	uc
#30	L1B_PROC_FLAG=	keyword	14	14*uc
	Processing errors significance flag (1 or 0). 1 if the percentage of DSR free of processing errors is less than the acceptable threshold		1	uc
	newline character	terminator	1	uc
#31	L1B_PROCESSING_QUALITY=	keyword	23	23*uc
	Percentage of quality checks successfully passed during Level 1B processing (max allowed +10000)	[10-2%]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc
#32	L1B_PROC_THRESH=	keyword	16	16*uc
	Minimum acceptable percentage of quality threshold that must be passed during Level 1B processing (max allowed +10000)	[10-2%]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc
#33	Spare (blank characters)	ascii	50	50*uc
	newline character	terminator	1	uc
TOTAL				**1112**
	DSD Section			

Table 16: ASIRAS specific product header (SPH) format.

Field #N	Description	Units	Bytes	Format
	DSD			
#N.1	DS_NAME=	keyword	8	8*uc
	quotation mark (")		1	uc
	Name describing the Data Set		28	28*uc
	quotation mark (")		1	uc
	newline character	terminator	1	uc

Continued on next page

Field #N	Description	Units	Bytes	Format
#N.2	DS_TYPE=	keyword	8	8*uc
	Type of Data Set. It can be: M = Measurement R = Reference		1	uc
	newline character	terminator	1	uc
External product reference				
#N.3	FILENAME=	keyword	9	9*uc
	quotation mark (")		1	uc
	Name of the Reference File. Used if DS_TYPE is set to R. It is left justified with trailer blanks. The file name includes the extension. If not used it is set to 62 blanks.		62	62*uc
	quotation mark (")		1	uc
	newline character	terminator	1	uc
Position and size of DS				
#N.4	DS_OFFSET=	keyword	10	10*uc
	Length in bytes of MPH + SPH (including DSDs) + DS size of previous Data Set (if any).	bytes	21	%+021d
	<bytes>	units	7	7*uc
	newline character	terminator	1	uc
#N.5	DS_SIZE=	keyword	8	8*uc
	Length in bytes of the attached Data Set Used if DS_TYPE is set to M If not used set to 0	bytes	21	%+021d
	<bytes>	units	7	7*uc
	newline character	terminator	1	uc
Number and length of DSRs				
#N.6	NUM_DSR=	keyword	8	8*uc
	Number of Data Set Records		11	%+011d
	newline character	terminator	1	uc
#N.7	DSR_SIZE=	keyword	9	9*uc
	Length in bytes of the Data Set Record If not used set to +0 If variable set to -1	bytes	11	%+011d
	<bytes>	units	7	7*uc
	newline character	terminator	1	uc
#N.8	Spare	ascii	32	32*uc
	newline character	terminator	1	uc
Total				**280**

Table 17: ASIRAS data set descriptors (DSD) format.

The MDS can be further divided into five parts as described below.

1. Time and Orbit Group (20 blocks per record).
2. Measurements Group (20 blocks per record).
3. Corrections Group (one block per record) (Zeroed for ASIRAS).
4. Average Waveforms Group (one block per record) (Zeroed for ASIRAS).
5. Waveform Group (20 blocks per record).

Identifier	Description	Units	Type	Size [Bytes]
Time & Orbit Group Repeated 20 times				**Sub Total=84*20**
1	Days	TAI	sl	4
2	Seconds		ul	4
3	Microseconds		ul	4
4	Spare		sl	4
5	Spare		us	2
6	Spare		us	2
7	Instrument Config		ul	4
8	Burst Counter		ul	4
9	Geodetic latitude of ASIRAS centre of baseline	10^{-7} Deg	sl	4
10	Longitude of ASIRAS centre of baseline	10^{-7} Deg	sl	4
11	WGS-84 ellipsoidal altitude of ASIRAS baseline centre	10^{-3} m	sl	4
12	Altitude rate determined from DGPS	10^{-6} m/s	sl	4
13	Velocity [x,y,z], described in ITRF	10^{-3} m/s	sl	3*4
14	Real antenna beam direction vector [x,y,z]	10^{-6} m	sl	3*4
15	Interferometer baseline [x,y,z]	10^{-6} m	sl	3*4
16	Measurement Confident data		ul	4
Measurements Group Repeated 20 times				**Sub Total=94*20**
17	Window delay	10^{-12} s	sll	8
18	Spare		sl	4
19	OCOG width	Range bins*100	sl	4
20	OCOG or threshold retracker range	10^{-3} m	sl	4
21	Surface elevation derived from field 20	10^{-3} m	sl	4
22	AGC Channel 1	dB/100	sl	4
23	AGC Channel 2	dB/100	sl	4
24	Total fixed gain Ch1	dB/100	sl	4
25	Total fixed gain Ch2	dB/100	sl	4
26	Transmit Power	10^{-6} Watts	sl	4
27	Doppler range correction	10^{-3} m	sl	4
28	Instrument range correction Ch 1	10^{-3} m	sl	4
29	Instrument range correction Ch 2	10^{-3} m	sl	4
30	Spare		sl	4
31	Spare		sl	4
32	Internal phase correction	10^{-6} rad	sl	4
33	External phase correction	10^{-6} rad	sl	4
34	Noise power	dB/100	sl	4
35	Roll	10^{-3} Deg	ss	2
36	Pitch	10^{-3} Deg	ss	2

Continued on next page

Identifier	Description	Units	Type	Size [Bytes]
37	Yaw	10^{-3} Deg	ss	2
38	Spare		ss	2
39	Heading	10^{-3} Deg	sl	4
40	Standard deviation of roll during stack integration	10^{-4} Deg	us	2
41	Standard deviation of pitch during stack integration	10^{-4} Deg	us	2
42	Standard deviation of yaw during stack integration	10^{-4} Deg	us	2
Corrections Group Once per record				**Sub Total=64**
Empty for ASIRAS				
43	Spare		uc	64*1
Average pulse-width limited Waveform group Once per record				**Sub Total=8236**
Empty for ASIRAS				
44	Spare		uc	8236*1
Multilooked Waveform Group Repeated 20 times				**Sub Total=8304*20**
45	Multi-looked Power Echo.	Counts (0-65535)	us	4096*2
46	Linear scale factor, A		sl	4
47	Power of 2 scale factor,B		sl	4
48	Number of multilooked echoes		us	2
49	Flags		us	2
50	Beam behaviour parameters[50]		us	50*2
Total				**177940**

Table 18: ASIRAS measurement data set (MDS) format.

A.2 GPS

Processed DGPS data is delivered in binary, big endian format with each record formated as described by Cullen (2006) and Table 19.

Identifier	Description	Unit	Type	Size [Bytes]
1	Days (MJD)	UTC	sl	4
2	Seconds		ul	4
3	Microseconds		ul	4
4	Latitude (WGS-84)	10^{-7} deg	sl	4
5	Longitude	10^{-7} deg	sl	4
6	Geodetic ellipsoidal height	m	d	8
7	Spare_7	N/A	d	8
8	Spare_8	N/A	d	8
9	Spare_9	N/A	d	8
10	Spare_10	N/A	d	8
Total				**72**

Table 19: GPS file format.

A.3 INS

Processed INS data is delivered in binary, big endian format with each record formated as described by Cullen (2006) and Table 20.

Identifier	Description	Unit	Type	Size [Bytes]
1	Days (MJD)	UTC	sl	4
2	Seconds		sl	4
3	Microseconds		sl	4
4	Latitude (WGS-84)	deg	d	8
5	Longitude	deg	d	8
6	Ground speed	kts	d	8
7	True Track	deg	d	8
8	True Heading	deg	d	8
9	Wind Speed	kts	d	8
10	Wind Direction	deg	d	8
11	Magnetic Heading	deg	d	8
12	Pitch	deg	d	8
13	Roll	deg	d	8
14	Pitch Rate	deg/s	d	8
15	Roll Rate	deg/s	d	8
16	Yaw Rate	deg/s	d	8
17	Body longitudinal Acceleration	g	d	8
18	Body lateral Acceleration	g	d	8
19	Body normal acceleration	g	d	8
20	Vertical Acceleration in G	g	d	8
21	Velocity Inertial Vertical	ft/min	d	8
22	Velocity North-South	kts	d	8
23	Velocity East-west	kts	d	8
Total				**172**

Table 20: INS file format.

A.4 Laser Scanner

Processed lidar data is delivered in binary, little endian format with each record formated as described in Table 21. Note that the time is decimal hours since the beginning of the day with respect to UTC time.

A.5 Vertical Camera

Approximate time and position of the vertical camera when a picture is taken is delivered in windows ASCII format as described in Table 22 and all individual pictures are in JPEG format. Each ASCII line gives the filename, time, and position for the named picture. If no DGPS data is available the time and position is replaced with the string "No position available".

Identifier	Description	Unit	Type	Size [Bytes]
	Header			
1	Header Size	bytes	uc	1
2	Number of scan lines, N_{als_scan}	lines	ul	4
3	Number of data points per line, N_{als_dppl}	points	uc	1
4	Bytes per line, N_{als_bbl}	bytes	us	2
5	Bytes sec line	bytes	ull	8
6	Year of acquisition	UTC	us	2
7	Month of acquisition	UTC	uc	1
8	Day of acquisition	UTC	uc	1
9	Acquisition Start time (Seconds of day)	UTC	ul	4
10	Acquisition Stop time (Seconds of day)	UTC	ul	4
11	Device name		uc	8
Total				**36**
	Time stamp array			
1	Array of time stamps for each scan line (Seconds of day)	UTC	ul	4*N_{als_scan}
Total				**4***N_{als_scan}
	DEM Record Repeated N_{als_scan} times			
1	Array of time stamps for each point (Seconds of day)	UTC	d	8*N_{als_dppl}
2	Array of latitudes for each point	degrees	d	8*N_{als_dppl}
3	Array of longitudes for each point	degrees	d	8*N_{als_dppl}
2	Array of ellipsoidal heights for each point	meter	d	8*N_{als_dppl}
Total				N_{als_bbl}

Table 21: Laser scanner file format.

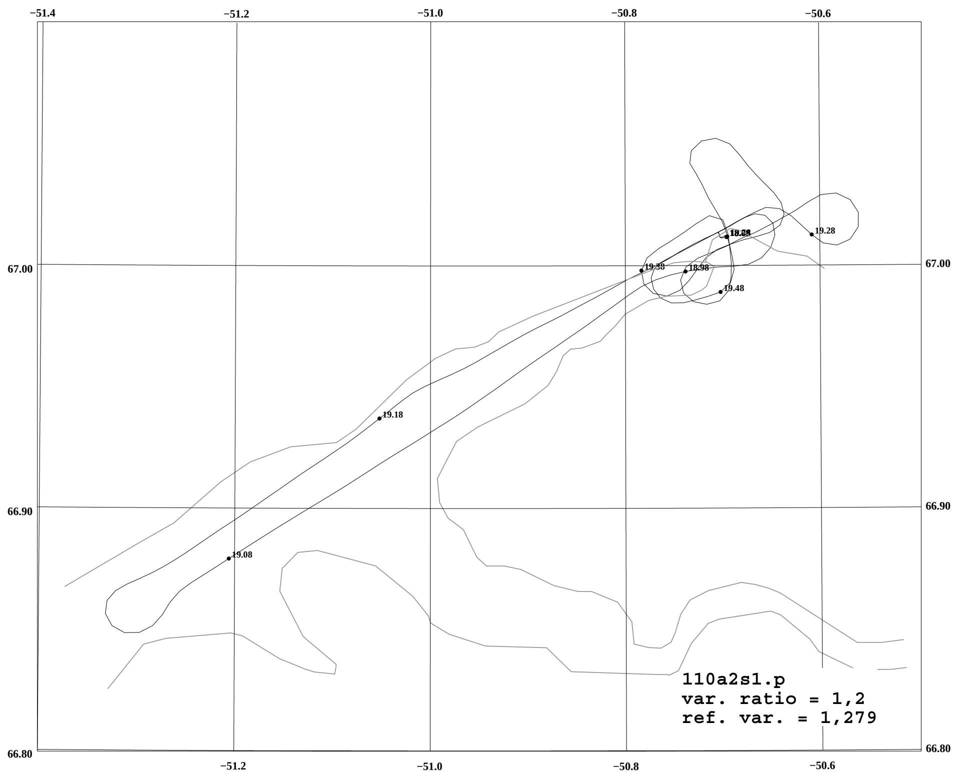
Identifier	Description	Unit
1	JPEG filename	
2	Decimal hours	hour
3	Latitude (WGS-84)	deg
4	Longitude	deg
5	Geodetic ellipsoidal height	m
6	Newline characters "\r \n"	

Table 22: Vertical camera file format.

B Airborne Log with GPS Track Plot

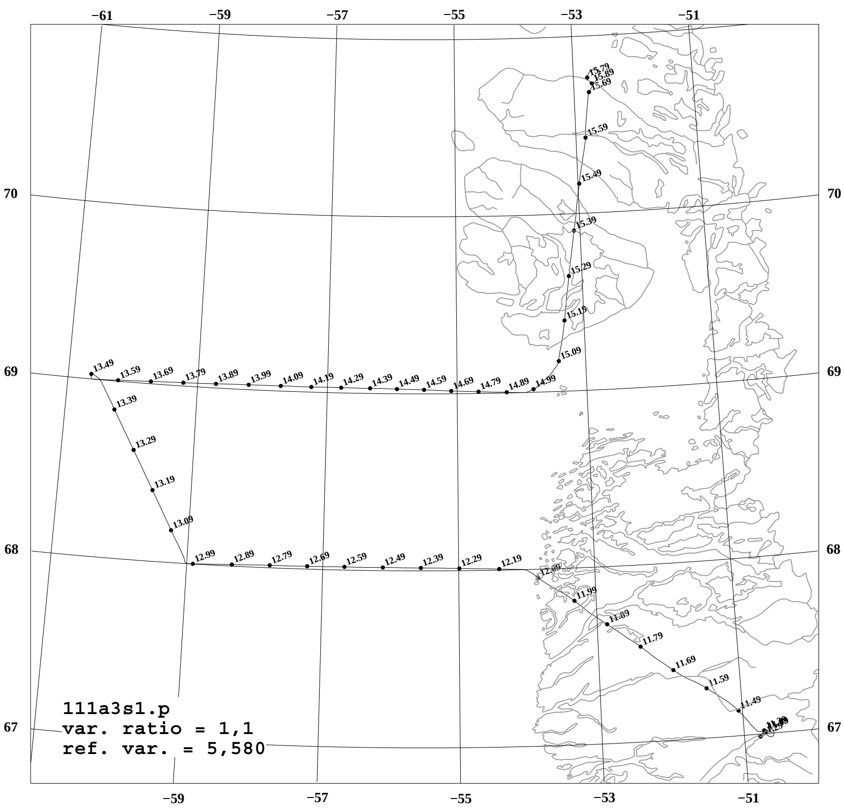
JD 110 – 2006 April 20th
GPS week 1371 (day 4)

18:45:30	new scanner file	19:00	out through the fjord
18:48	engines on	19:15:30	over the runway
18:53	taxi	19:18	webcam PC rebooted
18:56	start Trimble logging	19:31	landing



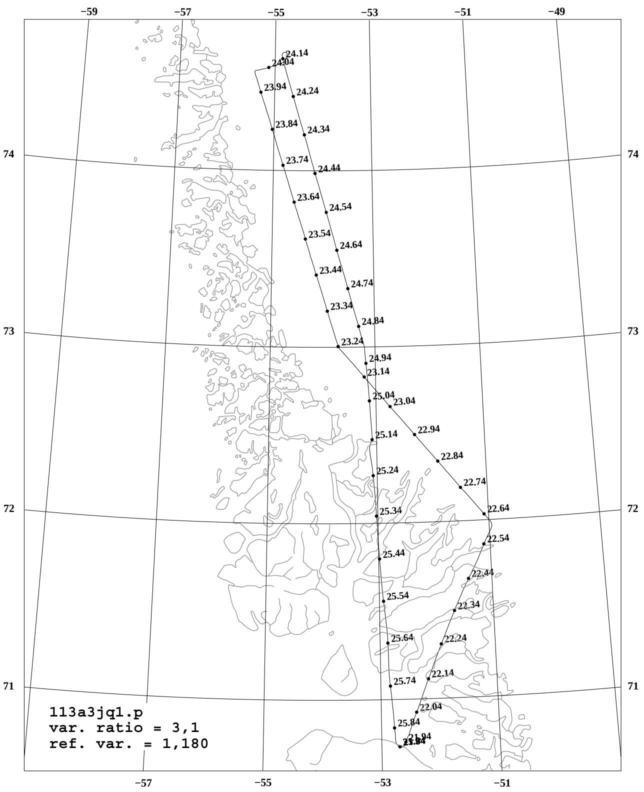
JD 111 – 2006 April 21st
GPS week 1371 (day 5)

11:06	engines on
11:15:30	new scanner file
	cross over building
	close scanner file, transit to V1
11:43	webcam rebooted
12:06:00	new scanner file
	over water near coast
12:07:20	V1
12:09	thin ice and water
12:14	broken floes in bands
13:01:30	new scanner file
13:34:00	new scanner file just after V3
	few min of video
13:57	few min of video
14:23	91 knots and fog
	67N 55 57W lead
14:56	scanner file closed at V4
15:49	landing



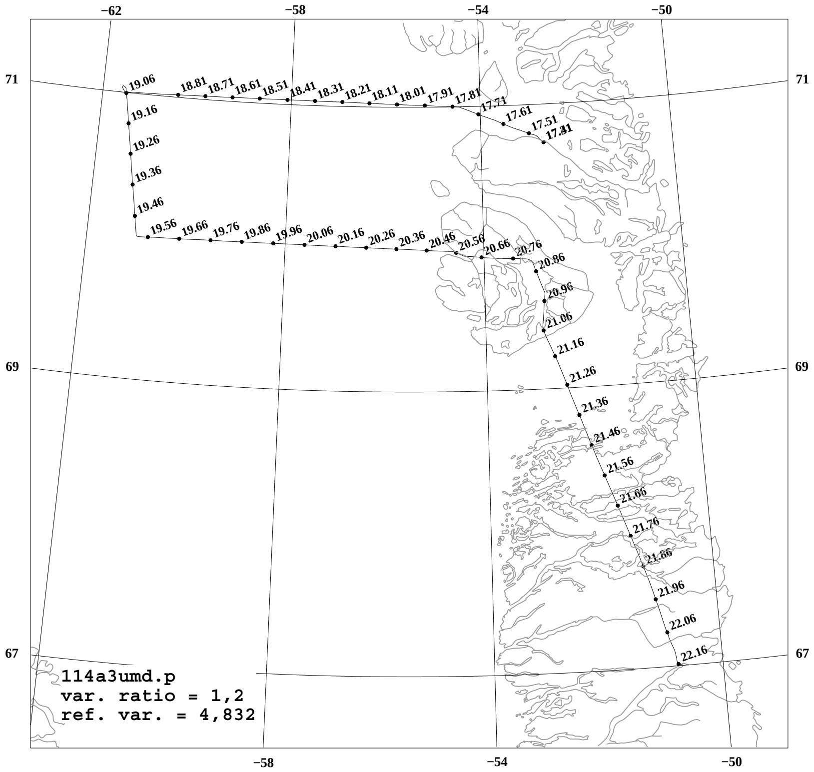
JD 113 – 2006, April 23rd
GPS week 1372 (day 0)

21:50	taxi	23:34	ASIRAS on 73° 25′N - 73° 40′N
21:54	take off	23:59	A3
22:35:00	new scanner file	23:59	tear drop turn at A4
22:31:30	A1	00:08:40	at A4, start line A4-A5
23:05 - 23:10	ASIRAS on	00:11:30	new scanner file
	where lines cross	00:53	A5
23:14	A2	01:10	scanner file closed at ice edge
23:18:00	new scanner file	01:54	landing



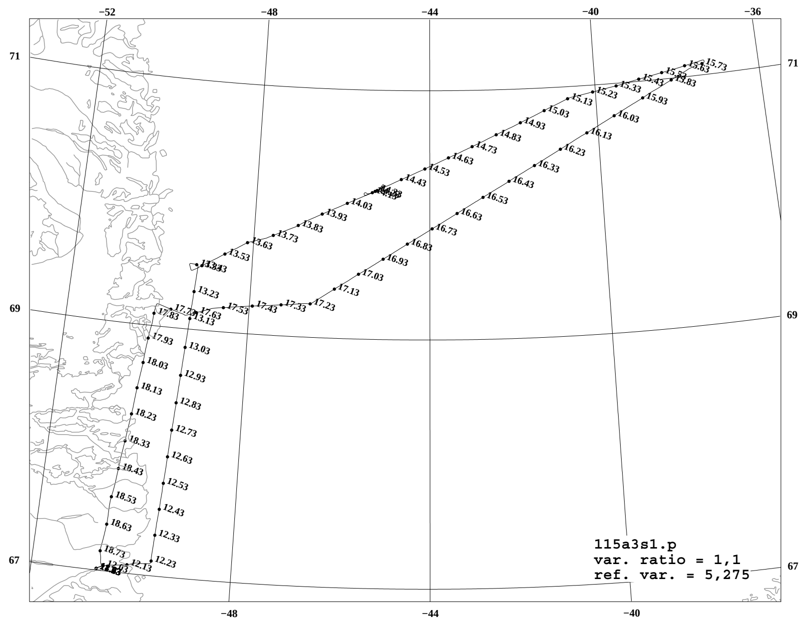
JD 114 – 2006, April 24th
GPS week 1372 (day 1)

17:23	taxi
17:26	take off
17:47	V5
18:05	video on, right window
18:30:30	new scanner file
18:46	video off
18:59	tear drop turn at V6
19:26:30	new scanner file
19:31	V7
20:23	V8, climb towards Disko
20:25:00	new scanner file
20:51	DI1
21:03	DI3
	scanner file closed
22:11	landing



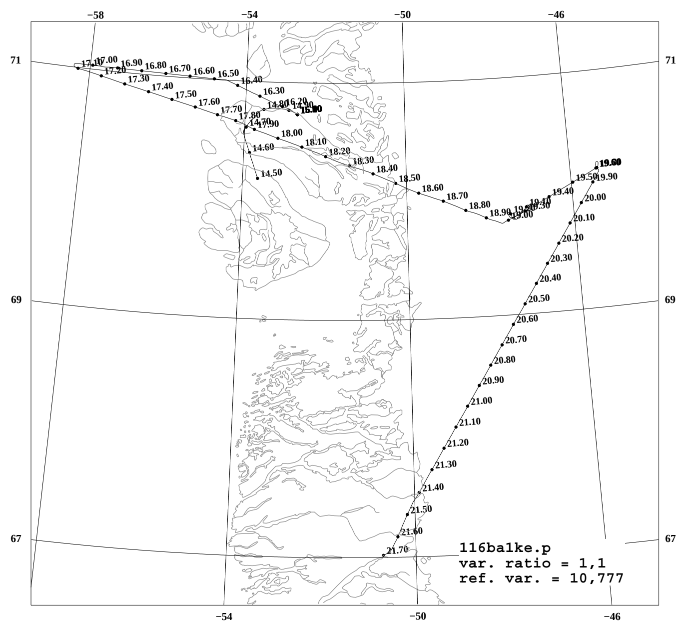
JD 115 – 2006, April 25th
GPS week 1372 (day 2)

11:57	taxi
11:59	take off
12:10:00	new scanner file
12:23	EGI logging started
13:11:30	new scanner file
13:19	X2, tear drop turn
13:38	T1
13:42	T3
13:46	T5, over corner reflector
13:54	T8
13:55:30	new scanner file
14:09	T12, over corner reflector, off by 20 m better 2nd time
14:18:30	T17
14:43	T21
14:46:00	new scanner file
14:54	T25
15:08	T31
15:18	T35
15:36	T41
15:43	T43
15:45:30	new scanner file
16:54:30	new scanner file (1 sec late?)
17:13	I5
17:28	I6
17:34	I7
17:40	I8
17:47	I9, end of line, scanner file closed
18:49	landing



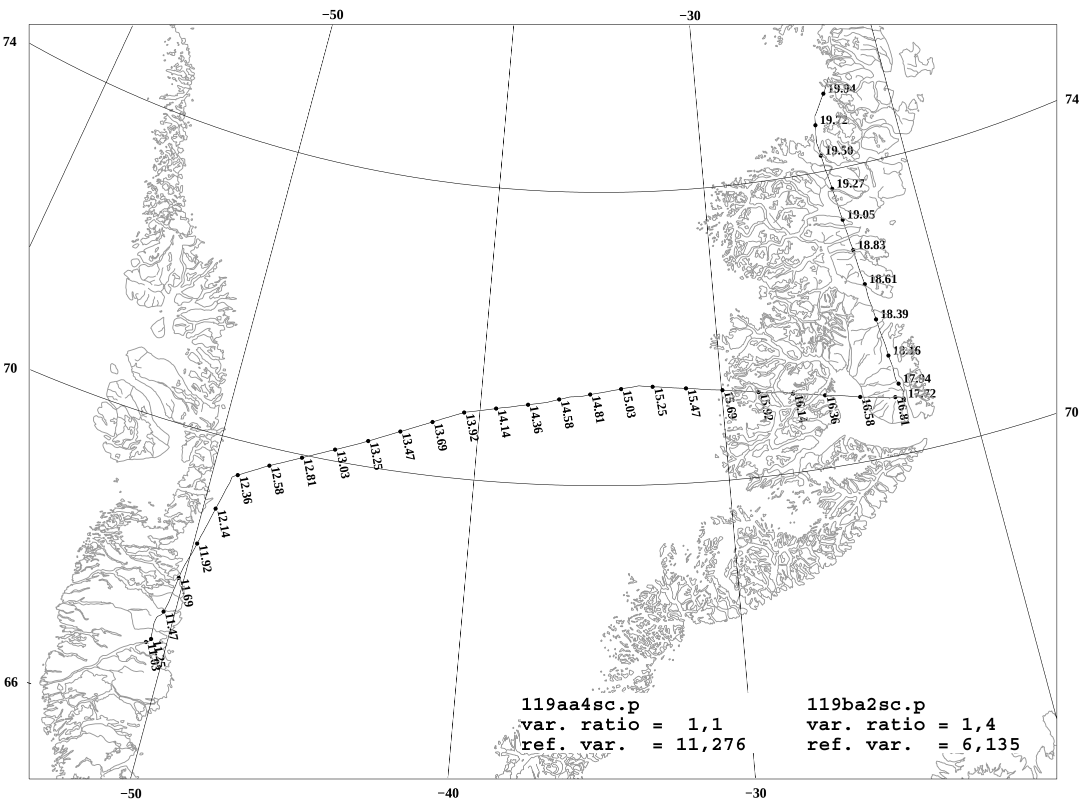
JD 116 – 2006, April 26th
GPS week 1372 (day 3)

12:55	taxi	17:03	V17, towards T3
12:58	take off	17:04:30	new scanner file - no data
14:29	Trimble logging stopped, stopped to delete file	18:49:00	new scanner file - no data
14:30	Trimble logging started	19:05 - 15	3 times over T5, 1st and 3rd best hit
14:41	deviate line to land in JQA, helicopter not departed	19:15	direct to T12 to pick up UK1, one is ill
14:57	landing JQA, air2, air3 logging stopped	19:40	landing at T12 on ice sheet
16:02	EGI logging stopped	19:49	take off T12 towards SFJ
16:03	EGI, air2, air3 logging started	19:51:30	new scanner file
16:04	taxi	20:46:30	new scanner file, memory out on PC-card at 2100
16:07	take off JQA	21:09:00	new scanner file
16:11:30	new scanner file	21:26	scanner file closed
16:26	V5	21:42	landing
16:57	over helicopter (on ice floe)	21:46	engines off



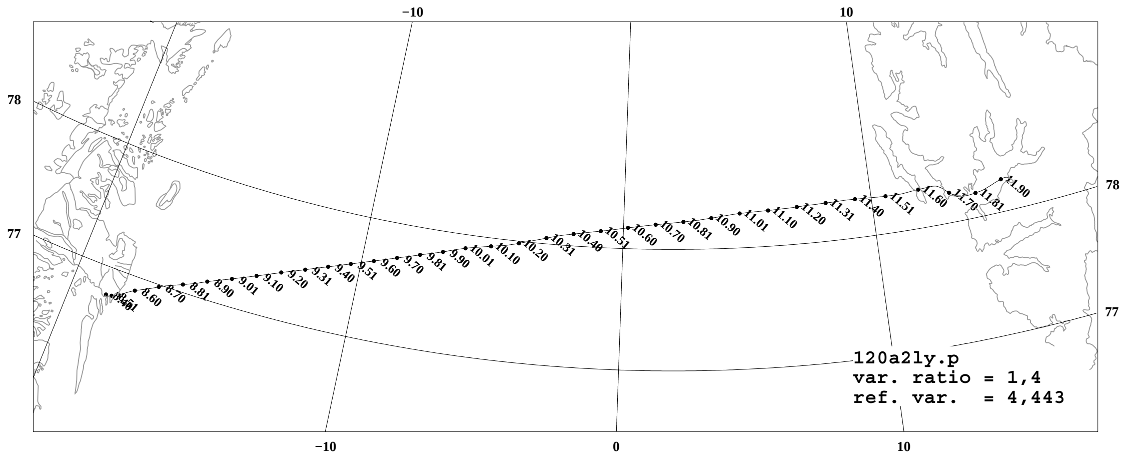
JD 119 – 2006, April 29th
GPS week 1372 (day 6)

11:01	engines on
11:09	taxi
11:11	take off
12:18:00	new scanner file
12:19	EG1
13:01:00	new scanner file, 1 sec late?
13:12	EG3
13:57	EG4
14:01:00	new scanner file
14:28	EG5
14:38	slightly off line - retype pos in GPS < 2 km off
14:53:00	new scanner file
15:45	scanner file closed, ice margin
16:54	landing CNP logging stopped all instruments
17:43	on
17:44	taxi
17:48	take off
17:49	EGI logging, Trimble started
19:36:30	B1, new scanner file
19:47	break off line, scanner cannot reach surface, strong winds, ice crystals in air? EGI stopped some time before B1?
20:53	landing



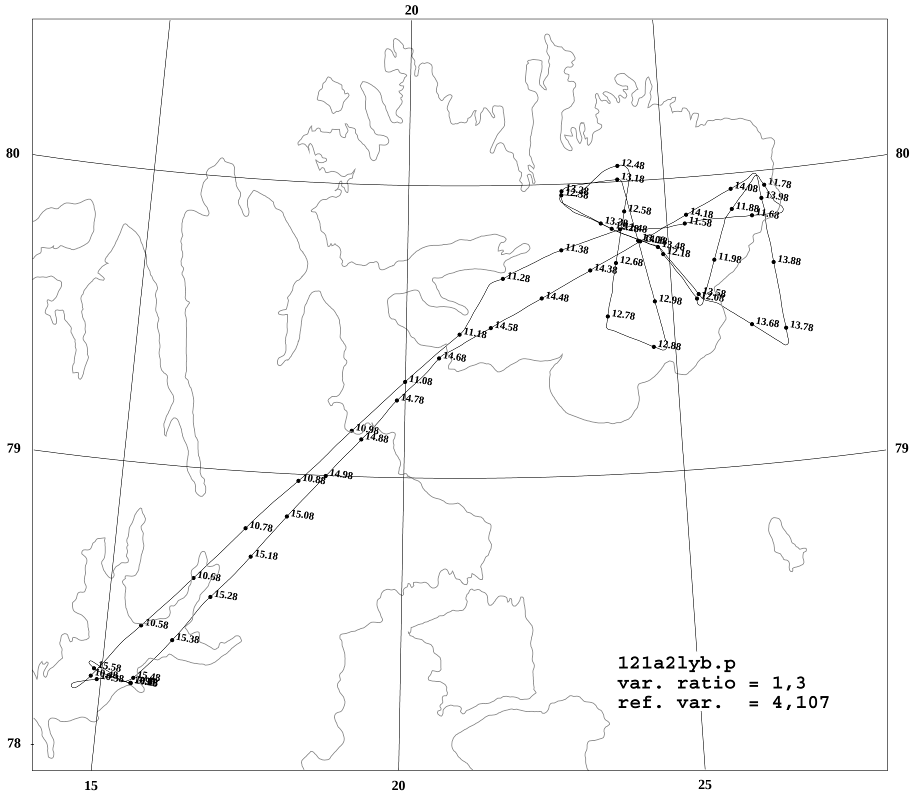
JD 120 – 2006, April 30th
GPS week 1373 (day 0)

08:27	take off
08:33:00	new scanner file
08:46	EMAP started, PC rebooted twice
09:32:30	new scanner file, follow ice edge
09:44:40	end of sea ice, scanner file closed
10:10	2 · 10 min HAM radar data at 2800 m some wind at surface, waves, see photo before climb
11:58	landing



JD 121 – 2006 May 1st
GPS week 1373 (day 1)

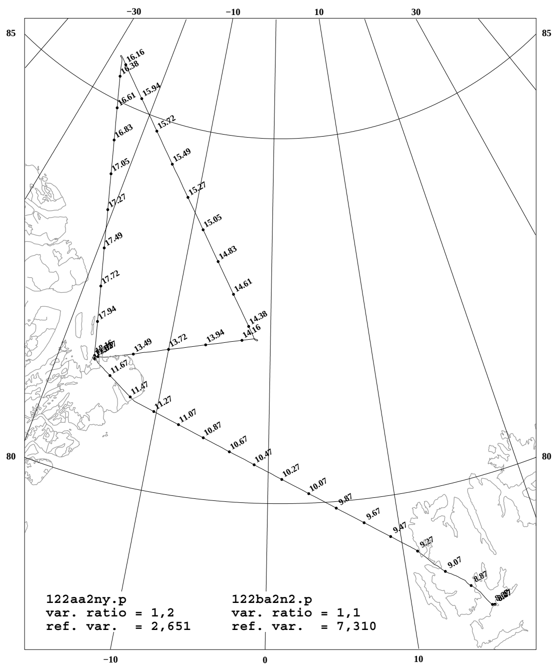
10:18	take off
11:17:00	new scanner file
	problems with EMAP on Trimble
	changed to Javad after several tries
12:15:00	new scanner file (121504/05)
12:32	4-1
12:32:30	R4
12:50	some fog is starting to reoccur
13:04	R1
13:08:40	R4
13:09:40	end of line
13:12:30	new scanner file (131235?)
13:35	NV11
	deviate line to fly over sea ice,
	SE of island
	back to K5 afterwards
13:57:00	new scanner file
14:00	K5
14:16	clouds on top of ice cap
14:47	end of survey,
	too much wind over mountains
15:38	landing



JD 122 – 2006, May 2nd
GPS week 1373 (day 2)

	engines on early, EGI restarted
08:35	taxi
08:38	take off
08:40:30	new scanner file
09:04	end of glacier
10	clouds to altitude 80 m
10:20	descend to observe cloud cover
10:28	clouds too low, some ASIRAS data gathered
10:39:30	new scanner file, only few higher clouds now
10:43	large ice floe
11:25	EN8
11:27:00	new scanner file, (1 sec early?)
11:50	landing

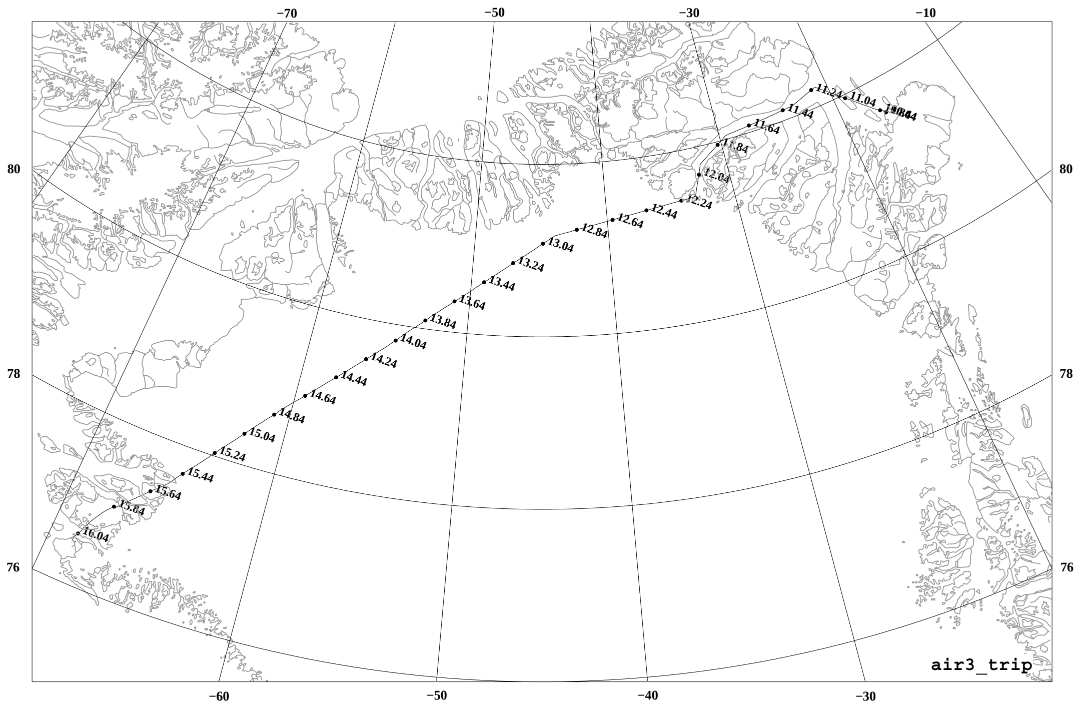
13:11	taxi
13:14	take off
13:13:00	new scanner file
13:29:30	lead, shear zone
14:12:00	new scanner file
14:13	F1
14:14	tear drop turn
15:06:00	new scanner file
15:33	fog, scanner file closed, ASIRAS still on
16:11:00	new scanner file
17:10:30	new scanner file
18:12	cross over building, (Ebbe Kold hal)
18:15	second pass
18:18	landing



JD 123 – 2006, May 3rd
GPS week 1373 (day 3)

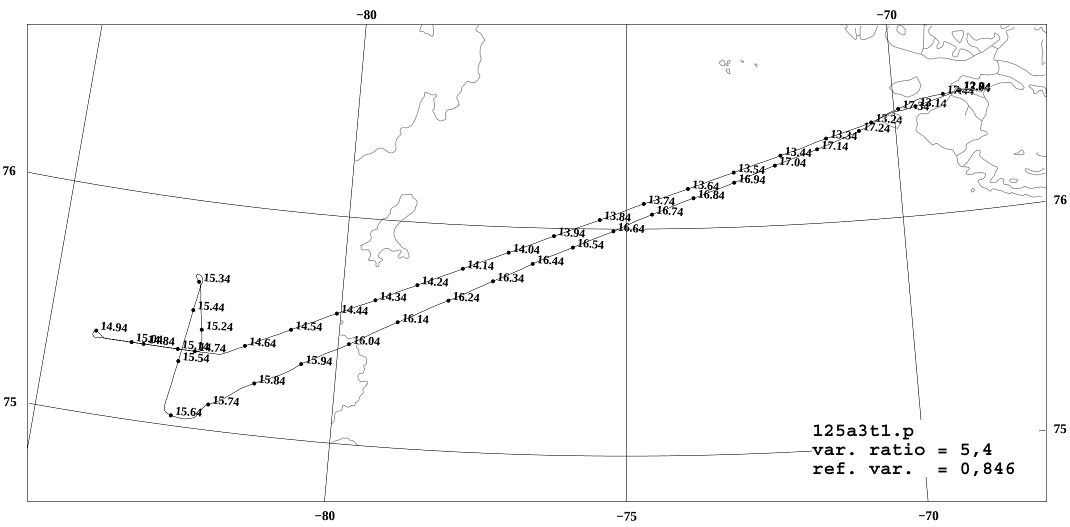
10:44	taxi
10:47	take off
10:49:30	new scanner file
11:12	H1
11:22	H2
11:34	H3
11:45	H4
11:58	H5
11:58:30	new scanner file
12:02	glacier start (margin in fjord)
12:09	H6
	AIR2 PC-card full,
	stopped and files deleted

12:55	AIR2 second file on
12:56	H7
12:58:30	new scanner file
13:55:00	new scanner file
14:06	H8
14:57:00	new scanner file
15:27	ice sheet margin
	scanner file closed
16:06	landing



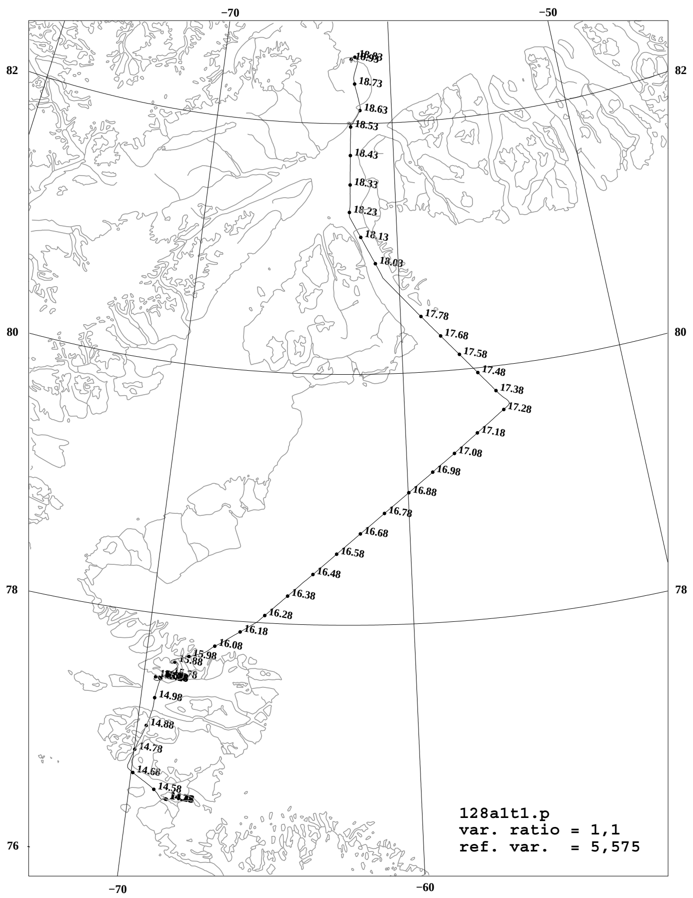
JD 125 – 2006, May 5th
GPS week 1373 (day 5)

12:50	EGI start	15:22	DE5
12:55	taxi	15:31	R1
13:01	take off	15:37	DE3
13:09:00	new scanner file	15:39:00	new scanner file
14:09:00	new scanner file	15:45	scanner file stopped
14:39:00	new scanner file	16:20:00	new scanner file
14:45	reflector R1	17:26	scanner file stopped
14:54	DE6	17:26	landing
14:08	R1		



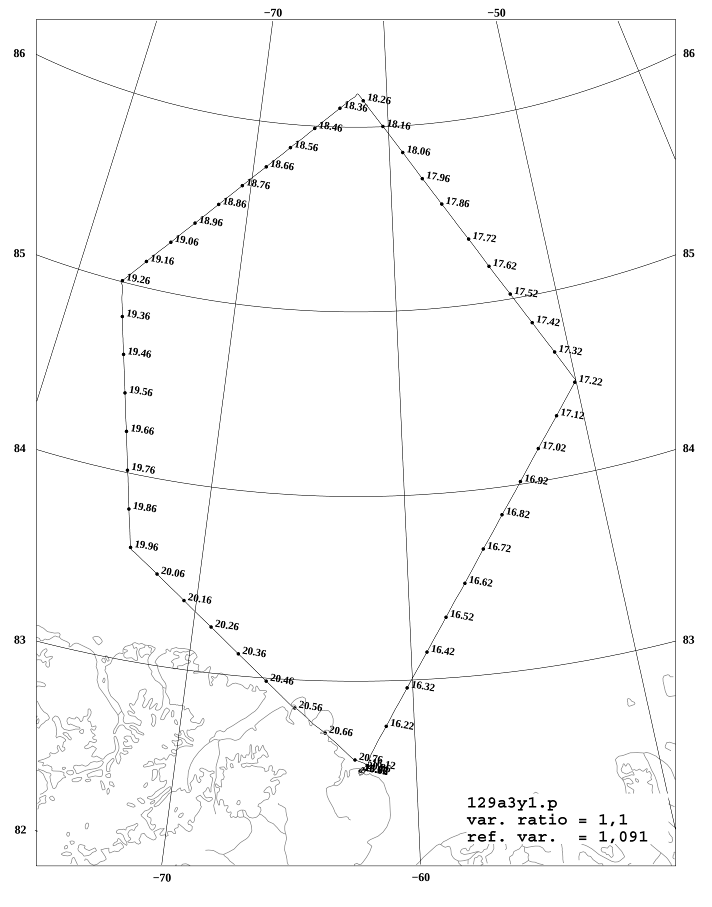
JD 128 – 2006, May 8th
GPS week 1374 (day 1)

14:20	system start up
14:24	taxi
14:30	take off
14:35:00	new scanner file
14:54	Politikens isbræ (POL)
15:05	on ground NAQ
15:34	engine on
15:37	taxi
15:38	take off
16:28:00	new scanner file
17:02	clouds
17:14:00	new scanner file
17:18	C2
18:00	C3
18:08	edge of Petermann, nearly no snow on sea ice
18:24:00	new scanner file
18:32	end of line
18:32	on ground



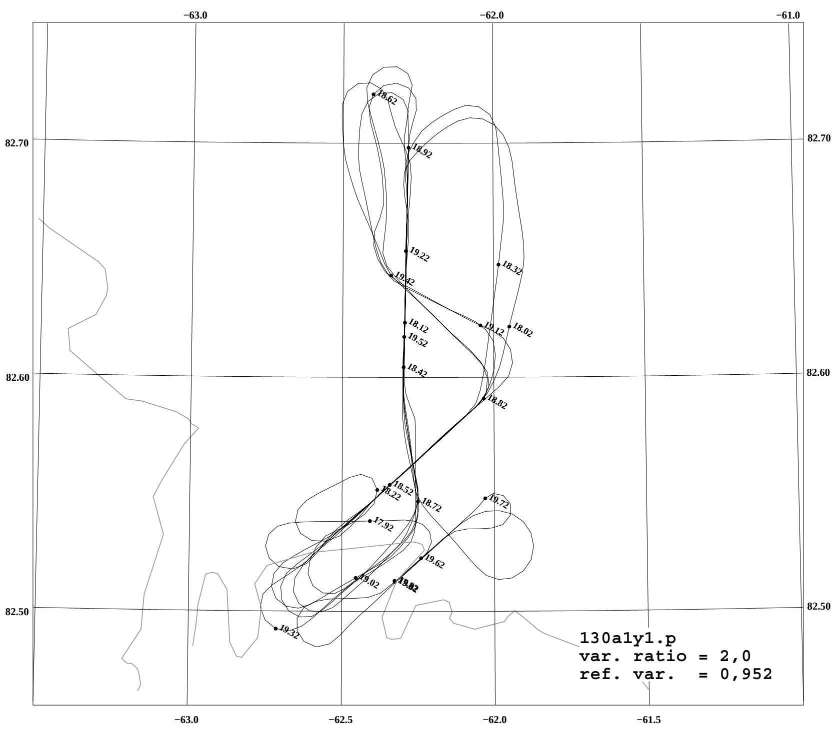
JD 129 – 2006, May 9th
GPS week 1374 (day 2)

16:00	INS aligned, start taxi (1200 local)
16:03:00	new scanner file
16:05	take off
16:33	video tape #2
17:05:30	new scanner file
17:13	Trn, wpt D4
18:08	new scanner file
18:17	wpt D3A, turn
19:08:00	new scanner file
19:15	wpt H3 turn
19:58	turn wpt H2
20:09:00	new scanner file
20:48	rwy overflight
20:52	landing



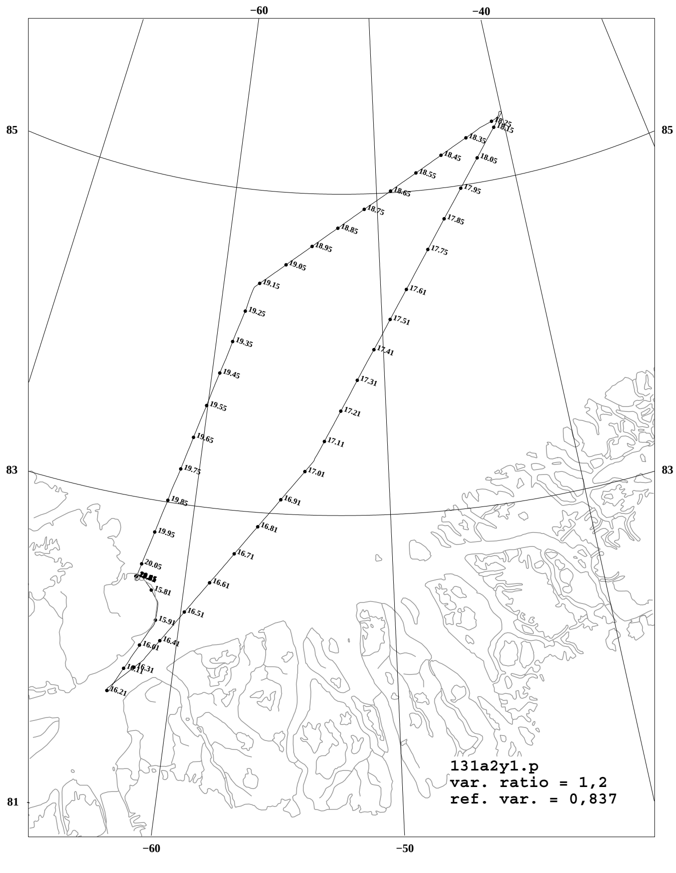
JD 130 – 2006, May 10th
GPS week 1374 (day 3)

17:52	take off
17:55:00	new scanner file
17:58:43	MY reflector, xte -31m
18:06:30	FY reflector
18:08:38	MY cross
18:16:09	MY refl #2 -2 m
18:24:00	MY refl #2 1.7 m
18:26:10	MY cross
18:31:25	MY #3 -2 m
18:34:20	FY cross refl
18:40:10	FY #3
18:42:25	MY cross
18:47:50	MY #4
18:50:42	FY cross
18:56:50	FY #4
18:59:14	MY cross
19:04:40	MY 1500 ft
19:08:00	FY cross
19:13:20	FY 1500 ft
19:15:40	MY cross
	climb to 2500 ft, scanner stopped giving data at 500 m
19:20:50	MY 2500 ft
19:24:40	FY cross
19:30:30	FY 2500 ft
19:32:00	new scanner file
19:32:30	MY cross
	descend 1500 ft to rwy overflt
19:37	rwy overflight 1500 ft
19:40	rwy overflt 1000 ft
19:45	landing



JD 131 – 2006, May 11th
GPS week 1374 (day 4)

15:20	Heli take off
15:30	start engines
	INS not aligned (after 45 min)
	set to NAV=NVRF
15:43:00	new scanner file
15:45	take off
16:15	G0
16:33	overhead helicopter
	82 26.0 N 59 19 W
16:51	fog patches
16:55:00	new scanner file
	(misnamed 165400.2dd)
17:54	descend, fog 250 m
18:00:00	new scanner file
18:11	end of line, turn
19:10	climb 1000 ft
19:12:00	new scanner file
20:04	over Spinaker bldg,
	not aligned to rwy
20:08	on ground

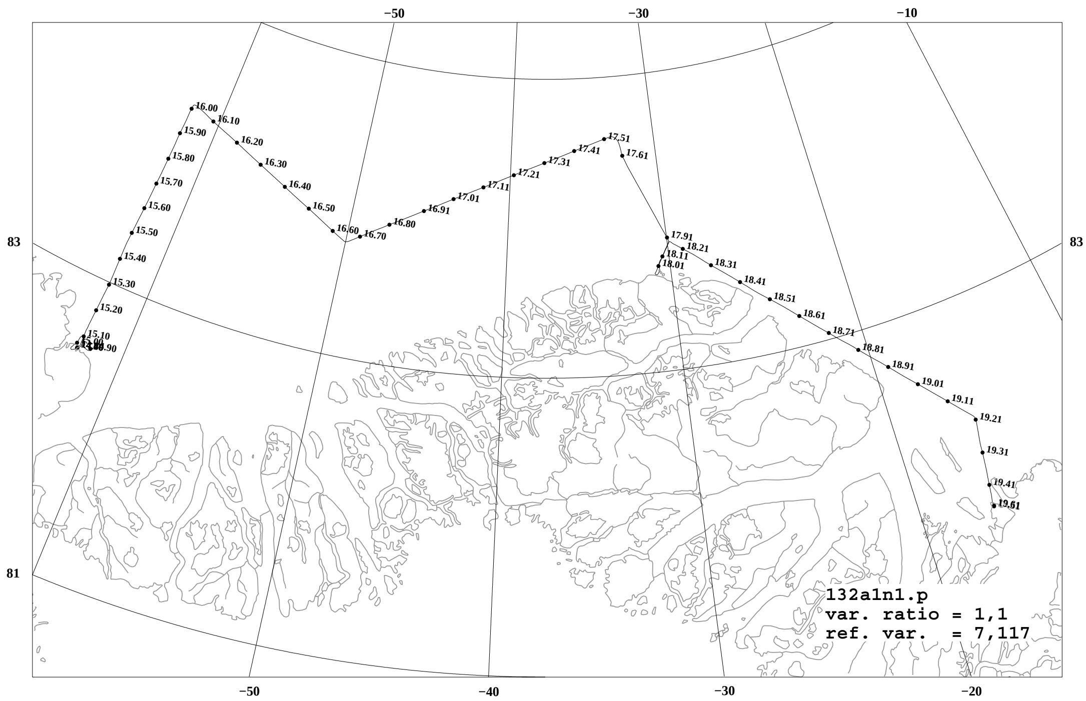


JD 132 – 2006, May 12th
GPS week 1374 (day 5)

14:35:00	new scanner file
14:48	airborne, departure shortly after heli EM helicopter returns 40 miles out from Alert
15:26	descend 700 ft.
15:53	new scanner file
16:00	abort line, to wpt. E0, thick fog
16:58	new scanner file
18:02	overhead Ultima Thule island
18:13:30	new scanner file
18:57	INS close output file? warning – disc full
18:58	PC on standby by accident
19:02	new scanner file on c:scanner
19:29	on ground, Station Nord

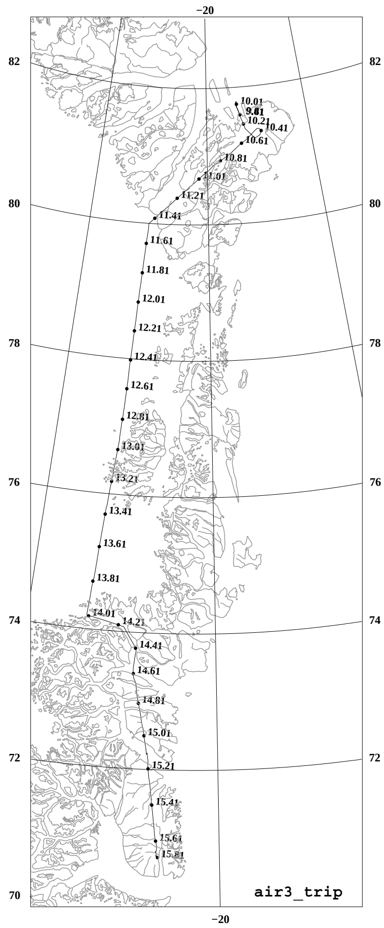
Buoy waypoints

B3	82° 33.832′ N	62° 15.511′ W
B4	82° 38.402′ N	62° 17.509′ W
B5	82° 59.921′ N	62° 12.142′ W
B7	83° 17.142′ N	62° 16.725′ W
B8	83° 35.500′ N	62° 10.932′ W
B9	83° 50.776′ N	62° 7.745′ W



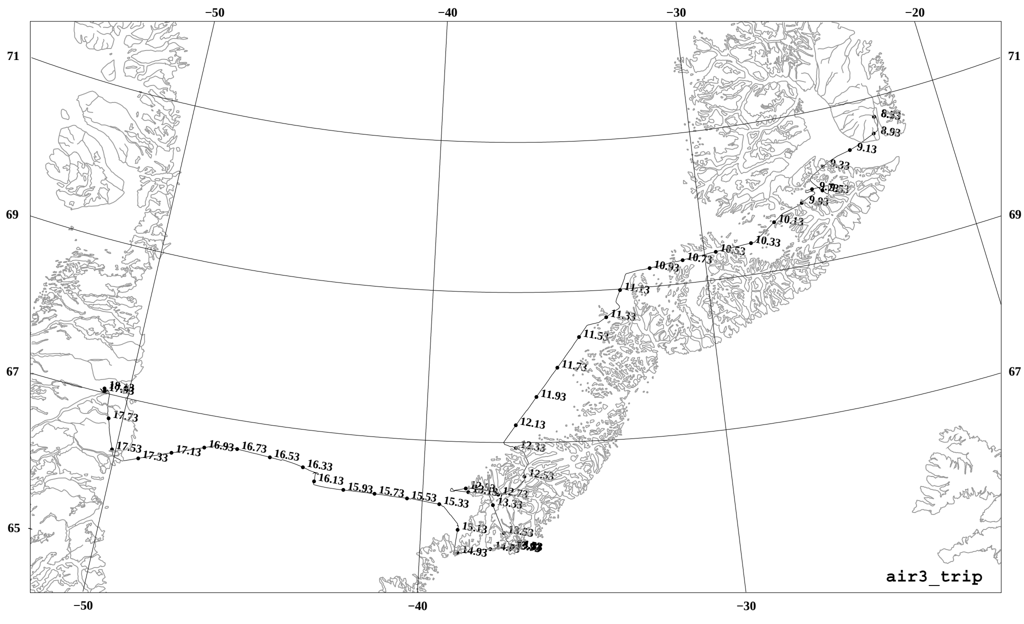
JD 136 – 2006, May 16th
GPS week 1375 (day 2)

09:53:00	new scanner file
09:55	take-off Nord
10:10	rwy overflight
10:30	over flade isblink drilling camp
11:07:30	new scanner file stopped short due to high topo
11:21:30	new scanner file inland ice edge
11:28	wpt. J1
12:36:00	new scanner file
13:05	Nunatak zone few laser returns
13:43:00	new scanner file
14:00	wpt. J2 flight down Waltershausen Glacier
14:33	fjord sea ice stop logging, climb
15:42	on ground CNP



JD 137 – 2006, May 17th
GPS week 1375 (day 3)

08:39	new scanner file
08:44	take-off CNP
08:52	stop scan
09:14	new scanner file
09:27	Geikie ice cap, clouds, ASIRAS only
09:36	stop scanner, too high
09:57	start logging
11:10	Kangarlussuaq, wind crevasses
11:16	new scanner file
12:14	new scanner file
13:17	stop scanner after Helheim
13:39	on ground KUS
14:31	start scanner
14:35	airborne KUS
15:03	fog on ice edge
15:39	new scanner file
16:50	new scanner file
17:28	ice edge, stop scanner
17:49	new scanner file runway overflight blue building
18:01	landing SFJ



C Processed GPS data

JD – Date	Flight	Reference	Rover	file name	ssk-file	start (GPSs)	end (GPSs)	start (dech)	end (dech)	var. ratio	ref. var.
110 – April 20th		SFJ1	1	110a1s1.p	98	413775	416204	18.9336	19.6083	1.2	1.419
			2	110a2s1.p	99	412861	416195	18.6797	19.6058	1.2	1.279
			3	110a3s1.p[2]	100	412783	416215	18.6581	19.6114	1.2	25.388
			3	trip110a3.pos[3]		412783	416215	18.6581	19.6114	0.0	0.012
111 – April 21th		SFJ1	1	111a1s1.p[4]	15	471930	489364	11.0878	15.9306	1.2	5.736
			2	111a2s1.p[5]	16	471991	489385	11.1047	15.9364	1.4	4.288
			3	111a3s1.p[6]	17	471937	489251	11.0897	15.8992	1.1	5.580
			4	111a4s1	18	472112	489364	11.1383	15.9306	1.1	14.551
			3	trip111a3.pos		471937	489251	11.0897	15.8992		
			3	111a3s1.p1[7]	4	471937	489251	11.0897	15.8992	1.3	7.030
113 – April 23th		JQA1	1	113a1jq1.p	119	78173	93409	21.7108	1.9431	16.2	1.188
			2	113a2jq1.p	120	78301	93305	21.7464	1.9142	10.7	0.971
			3	113a3jq1.p	121	78266	93582	21.7367	1.9911	3.1	1.180
			4	113a4jq1.p	122	78392	93306	21.7717	1.9144	8.3	1.117
114 – April 24th		UMD1	1	114a1umd.p	19	148801	166327	17.3297	22.1981	1.3	4.016
			2	114a2umd.p	20	148861	166305	17.3464	22.1919	1.3	3.704
			3	114a3umd.p	21	148725	166320	17.3086	22.1961	1.2	4.832
			4	114a4umd.p	22	148865	166305	17.3475	22.1919	1.2	12.898
115 – April 25th		SFJ1	1	115a1s1.p	23	213350	240628	11.2600	18.8372	1.1	8.171
			2	115a2s1.p	24	214831	238060	11.6714	18.1239	1.1	9.754
			3	115a3s1.p	25	213241	240614	11.2297	18.8333	1.1	5.275
			4	115a4s1.p	26	214922	240444	11.6967	18.7861	1.2	8.107
116 – April 26th		KELY	1	116ba1ke.p[8]	6	311415	337400	14.5003	21.7183	1.1	10.777
			2	116ba2ke.p[9]	7	316921	337390	16.0297	21.7156	1.1	11.855
			3	trip116ba3.pos		316862	337384	16.0133	21.7139	0.0	0.014
119 – April 29th	a	SCOB	1	119aa1sc.p	47	557062	579389	10.7356	16.9375	1.1	12.602
			2	119aa2sc.p	48	556861	581960	10.6797	17.6517	1.1	23.503
			3	119aa3sc.p	49	557065	579294	10.7364	16.9111	1.1	14.124
			4	119aa4sc.p	50	558098	579518	11.0233	16.9733	1.1	11.276
119 – April 29th	b	SCOB	2	119ba1sc.p	51	582031	590579	17.6714	20.0458	1.4	6.854
			3	119ba2sc.p	52	582189	590579	17.7153	20.0458	1.4	6.135
120 – April 30th		LYR	1	120a1ly.p	28	30397	43176	8.4397	11.9894	1.4	10.431
			2	120a2ly.p	29	30258	43210	8.4011	11.9989	1.4	4.443
			4	120a4ly.p	30	30302	43191	8.4133	11.9936	1.4	13.147
121 – May 1st		LYR	1	121a1ly.p	31	122650	142939	10.0656	15.7014	1.1	4.212
			2	121a2lya.p	32	117631	121900	8.6714	9.8572	11.1	0.860
			2	121a2lyb.p	33	122313	142935	9.9719	15.7003	1.3	4.003
			3	121a3LY.p	34	122640	142926	10.0628	15.6978	1.4	4.704
			3	121a3ly.p	34	122640	142926	10.0628	15.6978	1.4	4.704
			3	trip121a3.pos		122640	142926	10.0628	15.6978	0.0	0.012
			4	121a4ly.p	35	122506	142897	10.0256	15.6897	1.1	4.107
122 – May 2nd	a	NYA2	1	122aa1ny.p	53	203035	215633	8.3947	11.8942	15.5	1.174
			2	122aa2ny.p	54	201841	215625	8.0631	11.8919	1.2	2.651
			3	122aa3ny.p	55	203037	215603	8.3953	11.8858	15.2	1.103
			4	122aa4ny.p	56	203180	215625	8.4350	11.8919	12.2	1.064
122 – May 2nd	b	NRD1	1	122ba1n1.p	57	219912	238790	13.0828	18.3267	1.1	5.813
			2	122ba2n1.p	58	219781	238790	13.0464	18.3267	1.2	7.100
			3	122ba3n1.p	59	219749	238790	13.0375	18.3267	1.3	8.034
			4	122ba4n1.p	60	219785	238790	13.0475	18.3267	1.2	13.058
122 – May 2nd	b	NRD2	1	122ba1n2.p	61	219912	238833	13.0828	18.3386	1.1	10.455
			2	122ba2n2.p	62	219781	238840	13.0464	18.3406	1.1	7.310
			3	122ba3n2.p	63	219749	238825	13.0375	18.3364	1.8	5.959

Continued on next page

[2] JPL orbits, 10 degree cutoff angle
[3] Trip2 løsning (rms, weighted and unweighted)
[4] JPL orbits, 15 degrees, offset to air3/trip in start and end
[5] IGS orbits, 10 deg
[6] JPL orbits, 10 degree cutoff angle
[7] IGS orbits, 10 deg, correct via residuals
[8] IGS orbits, 15 deg
[9] IGS orbits, 15 deg, correct via residuals

JD – Date	Flight	Reference	Rover	file name	ssk-file	start (GPSs)	end (GPSs)	start (dech)	end (dech)	var. ratio	ref. var.
			4	122ba4n2.p	64	219785	238842	13.0475	18.3411	1.2	11.082
123 – May 3rd		NRD1	1	123a1n1.p	36	297612	311643	10.6661	14.5636	1.5	3.877
			2	123a2n1a.p	37	296491	304055	10.3547	12.4558	2.3	0.990
			2	123a2n1b.p	38	305736	311643	12.9228	14.5636	3.7	4.013
			3	123a3n1.p	39	296768	311643	10.4317	14.5636	1.3	3.668
			4	123a4n1a.p	40	297487	305632	10.6314	12.8939	1.6	1.106
			4	123a4n1b.p	41	305766	311643	12.9311	14.5636	2.4	22.042
125 – May 5th		TAB1	1	125a1TA.p	42	477935	495133	12.7558	17.5331	2.6	1.297
			2	125a2TAa.p	43	477841	487036	12.7297	15.2839	8.4	0.805
			2	125a2TAb.p	44	487045	495165	15.2864	17.5419	1.6	3.804
			3	125a3TA.p	45	477862	495120	12.7356	17.5294	5.4	0.846
			4	125a4TA.p	46	477932	495059	12.7550	17.5125	1.1	1.442
128 – May 8th		TAB1	1	128a1t1.p	65	137403	154632	14.1636	18.9494	1.1	5.575
			2	128a2t1.p	66	137461	154675	14.1797	18.9614	1.1	6.797
			3	128a3t1.p	67	136927	154603	14.0314	18.9414	1.5	6.436
			4	128a4t1.p	68	137719	154516	14.2514	18.9172	1.2	5.291
129 – May 9th		YLT1	1	129a1y1	69	229145	243681	15.6475	19.6853	2.4	1.163
			2	129a2y1	70	229452	248465	15.7328	21.0142	1.1	6.084
			3	129a3y1	71	229041	248459	15.6186	21.0125	1.1	1.091
			4	129a4y1	72	229412	248270	15.7217	20.9600	1.2	6.297
129 – May 9th		YLT2	1	129a1y2	73	229145	243681	15.6475	19.6853	1.3	1.592
			2	129a2y2	74	229452	248465	15.7328	21.0142	1.3	1.699
			3	129a3y2	75	229041	248459	15.6186	21.0125	1.3	1.613
			4	129a4y2	76	229412	248270	15.7217	20.9600	1.3	6.430
130 – May 10th		YLT1	1	130a1y1.p	77	323352	331016	17.8161	19.9450	2.0	0.952
			2	130a2y1.p	78	322291	331501	17.5214	20.0797	1.5	0.973
			3	130a3y1.p	79	322483	330936	17.5747	19.9228	9.4	1.019
			4	130a4y1.p	80	322353	330642	17.5386	19.8411	1.2	0.967
				trip130a3.pos		322484	330936	17.5750	19.9228		
130 – May 10th		YLT2	1	130a1y2.p	81	323897	331016	17.9675	19.9450	2.1	1.441
			2	130a2y2.p	82	322291	331210	17.5214	19.9989	2.4	1.244
			3	130a3y2.p	83	322483	330936	17.5747	19.9228	1.8	1.484
			4	130a4y2.p	84	322353	330642	17.5386	19.8411	1.5	1.227
131 – May 11th		YLT1	1	131a1y1a.p	85	397056	397670	14.2894	14.4600	14.7	1.916
			1	131a1y1b.p	86	397708	418644	14.4706	20.2861	2.9	1.138
			2	131a2y1.p	87	397127	418530	14.3092	20.2544	1.2	0.837
			3	131a3y1.p	88	396889	418354	14.2431	20.2056	3.1	1.285
			4	131a4y1.p	89	397171	418250	14.3214	20.1767	1.2	0.999
131 – May 11th		YLT2	1	131a1y2a.p	90	397056	397670	14.2894	14.4600	12.4	1.529
			1	131a1y2b.p	91	397708	418644	14.4706	20.2861	2.5	1.708
			2	131a2y2.p	92	397127	418530	14.3092	20.2544	1.1	1.602
			3	131a3y2.p	93	396889	418354	14.2431	20.2056	2.8	1.824
			4	131a4y2.p	94	397171	418250	14.3214	20.1767	1.2	1.789
132 – May 12th		NRD1	1	132a1n1.p	95	483468	502810	14.2928	19.6656	1.1	7.117
			3	132a3n1.p	96	483411	502709	14.2769	19.6375	1.3	10.908
			4	132a4n1.p	97	483983	502545	14.4358	19.5919	1.1	10.373
136 – May 16th		SCOR	1	136a1sc.p	200	206736	229662	9.4267	15.7950	1.2	5.678
			3	136a3sc.p	201	206689	229736	9.4136	15.8156	1.2	8.215
			4	136a4sc.p	202	206917	229651	9.4769	15.7919	1.1	8.045
137 – May 17th		CNP	1	137a1cp.p	185	289941	324516	8.5392	18.1433	1.8	2.481
			3	137a3cp.p	186	289941	324503	8.5392	18.1397	1.8	2.068
			4	137a4cp.p	187	290012	324339	8.5589	18.0942	1.1	1.888
			3	CRRSa3.137[10]		289915	324504	8.5319	18.1400		

Table 23: GPS data processing.

[10] Solution by CRRS

D Processed Laser Scanner Data

JD – Date	Filename	GPS/INS file	Time correction	GPS ant.	ω_p	ω_r	ω_h
111 – April 21th	111530.2dd	111a2.pos	1	Front	0.30	0.13	0.70
	120600.2dd	111a2.pos	0	Front	0.30	0.13	0.70
	130130.2dd	111a2.pos	1	Front	0.30	0.13	0.70
	133400.2dd	111a2.pos	0	Front	0.30	0.13	0.70
113 – April 23th	001130.2dd	113a2.pos	0	Front	0.30	0.15	0.70
	223500.2dd	113a2.pos	0	Front	0.30	0.15	0.70
	231800.2dd	113a2.pos	1	Front	0.30	0.15	0.70
114 – April 24th	173030.2dd	114a4.pos	0	Front	0.30	0.15	0.70
	183030.2dd	114a4.pos	0	Front	0.30	0.15	0.70
	192630.2dd	114a4.pos	0	Front	0.30	0.15	0.70
	202500.2dd	114a4.pos	0	Front	0.30	0.15	0.70
115 – April 25th	121000.2dd	115a3.pos	0	Rear	0.30	0.18	0.70
	131130.2dd	115a3.pos	0	Rear	0.30	0.18	0.70
	135530.2dd	115a3.pos	0	Rear	0.30	0.18	0.70
	144600.2dd	115a3.pos	0	Rear	0.30	0.18	0.70
	154530.2dd	115a3.pos	-1	Rear	0.30	0.18	0.70
	165430.2dd	115a3.pos	0	Rear	0.30	0.18	0.70
116 – April 26th	161130.2dd	116ba1.pos	0	Rear	0.30	0.13	0.70
	195130.2dd	116ba1.pos	0	Rear	0.30	0.13	0.70
	204630.2dd	116ba1.pos	0	Rear	0.30	0.13	0.70
	210900.2dd	116ba1.pos	0	Rear	0.30	0.13	0.70
119 – April 29th	121800.2dd	119aa4.pos	0	Front	0.39	0.05	0.70
	130100.2dd	119aa4.pos	-1	Front	0.39	0.05	0.70
	140100.2dd	119aa4.pos	0	Front	0.39	0.05	0.70
	145300.2dd	119aa4.pos	0	Front	0.39	0.05	0.70
	193630.2dd	119ba2.pos	0	Front	0.39	0.05	0.70
120 – April 30th	083300.2dd	120a2.pos	0	Front	0.30	0.16	0.70
	093230.2dd	120a2.pos	0	Front	0.30	0.16	0.70
121 – May 1st	111700.2dd	121a2.pos	0	Front	0.30	0.13	0.70
	121500.2dd	121a2.pos	4	Front	0.30	0.13	0.70
	131230.2dd	121a2.pos	5	Front	0.30	0.13	0.70
	135700.2dd	121a2.pos	0	Front	0.30	0.13	0.70
122 – May 2nd	084030.2dd	122aa3.pos	4	Rear	0.39	0.05	0.70
	103930.2dd	122aa3.pos	0	Rear	0.39	0.05	0.70
	112700.2dd	122aa3.pos	-1	Rear	0.39	0.05	0.70
	131300.2dd	122ba2.pos	0	Front	0.39	0.05	0.70
	141200.2dd	122ba2.pos	0	Front	0.39	0.05	0.70
	150600.2dd	122ba2.pos	0	Front	0.39	0.05	0.70
	161100.2dd	122ba2.pos	0	Front	0.39	0.05	0.70
	171030.2dd	122ba2.pos	0	Front	0.39	0.05	0.70
123 – May 3th	104930.2dd	123a3.pos	0	Rear	0.39	0.05	0.70
	115830.2dd	123a3.pos	0	Rear	0.39	0.05	0.70
	125830.2dd	123a3.pos	0	Rear	0.39	0.05	0.70
	135500.2dd	123a3.pos	0	Rear	0.39	0.05	0.70
	145700.2dd	123a3.pos	0	Rear	0.39	0.05	0.70
125 – May 5th	130900.2dd	125a3.pos	0	Rear	0.30	0.13	0.70
	140900.2dd	125a3.pos	0	Rear	0.30	0.13	0.70
	143900.2dd	125a3.pos	0	Rear	0.30	0.13	0.70

Continued on next page

JD – Date	Filename	GPS/INS file	Time correction	GPS ant.	ω_p	ω_r	ω_h
	162000.2dd	125a3.pos	0	Rear	0.30	0.13	0.70
128 – May 8th	143500.2dd	128aa4.pos	0	Front	0.39	0.15	0.70
	162800.2dd	128ba4.pos	0	Front	0.39	0.05	0.70
	171400.2dd	128ba4.pos	0	Front	0.39	0.05	0.70
	182400.2dd	128ba4.pos	0	Front	0.39	0.05	0.70
129 – May 9th	160300.2dd	129a3.pos	0	Rear	0.30	0.13	0.70
	170530.2dd	129a3.pos	0	Rear	0.30	0.13	0.70
	180800.2dd	129a3.pos	0	Rear	0.30	0.13	0.70
	190800.2dd	129a3.pos	0	Rear	0.30	0.13	0.70
	200900.2dd	129a3.pos	0	Rear	0.30	0.13	0.70
130 – May 10th	175500.2dd	130a1.pos	0	Rear	0.30	0.13	0.70
	193200.2dd	130a1.pos	0	Rear	0.30	0.13	0.70
131 – May 11th	154300.2dd	131a2.pos	0	Front	0.30	0.13	0.70
	165500.2dd	131a2.pos	0	Front	0.30	0.13	0.70
	180000.2dd	131a2.pos	0	Front	0.30	0.13	0.70
132 – May 12th	143500.2dd	132a1.pos	0	Rear	0.30	0.13	0.70
	155300.2dd	132a1.pos	0	Rear	0.30	0.13	0.70
137 – May 17th	083900.2dd	137a3.pos	0	Rear	0.30	0.13	0.70
	091400.2dd	137a3.pos	0	Rear	0.30	0.13	0.70
	095700.2dd	137a3.pos	0	Rear	0.30	0.13	0.70
	111600.2dd	137a3.pos	0	Rear	0.30	0.13	0.70
	121400.2dd	137a3.pos	0	Rear	0.30	0.13	0.70
	143100.2dd	137a3.pos	0	Rear	0.30	0.13	0.70
	153900.2dd	137a3.pos	0	Rear	0.30	0.13	0.70
	165000.2dd	137a3.pos	0	Rear	0.30	0.13	0.70
	174900.2dd	137a3.pos	0	Rear	0.30	0.13	0.70

Table 24: Processed Laser Scanner Files.

E Airborne Log of the ASIRAS Operations

JD 111 – 2006 April 21st
GPS week 1371 (day 5)

	PC1+PC2 on, ASIRAS on, CPC on
12:08	record on (0), open water
12:09	thin ice
12:10	open water
12:13	thin ice, floes
12:16	record off, descend due to snow
12:17	record on (1)
12:21	open water
12:23	record off
	Harald takes over ASIRAS
	Lars takes over DNSC system
13:40	Lars returns to ASIRAS
13:43	record on, sea ice with snow and some leads
13:51	record off
14:00	record on, some large leads
14:07	record off
14:15	record on, thick sea ice with snow
14:17	ice thickness decreases, bigger leads
14:22	record off
14:34	record on, open water scattered sea ice
12:40	record off
12:40	PC1+PC2 off, ASIRAS off, CPC off

JD 113 – 2006, April 23rd
GPS week 1372 (day 0)

21:54	take off
22:00	PC1+PC2 on, ASIRAS on, CPC on
22:37	record on (00)
22:43	record off
23:04	record on (01), 1. crossline
23:10	record off
23:26	record on (02), 73 25′
23:34	record off, 73 40′
23:50	record on (03), rugged ice
23:53	event (snow filled cracks)
23:54	event (bare ice)
23:55	record off
00:00	record on (04), up the ice
00:04	record off
00:18	record on (05), record off, operator error
00:34	record on (06), 73 40′
00:42	record off, 73 25′
00:53	record on (07), 2. crossline
01:04	record 0ff
01:10	PC1+PC2 off, ASIRAS off, CPC off
01:54	on ground

JD 114 – 2006, April 24th
GPS week 1372 (day 1)

17:26	take off
17:27	PC1+PC2 on, ASIRAS on, CPC on
17:56	record on (00), start of sea ice line
17:58	event (lead)
18:06	record off
18:06	record on (01)
18:16	record off
18:16	record on (02)
18:36	record off
18:36	record on (03)
18:59	record off, end of sea ice line
20:51	record on (04), Disko Island
20:55	record off
20:58	record on (05)
21:02	record off
21:10	PC1+PC2 off, ASIRAS off, CPC off
22:11	on ground

JD 115 – 2006, April 25th
GPS week 1372 (day 2)

11:59	take off
12:07	PC1+PC2 on, ASIRAS on, CPC on
13:04	record on (00), X-line Illulisat
13:11	record off
13:23	record on (01), EGIG X2 → T01
13:37	record off
13:38	record on (02), EGIG T01 → T03
13:41	record off
13:41	record on (03), EGIG T03 → T05
13:46	event, T05 camp
13:49	record off
13:49	record on (04), EGIG T05 → T08
13:54	record off
13:54	record on (05), EGIG T08 → T12
14:07	event, T12 camp
14:08	record off
14:12	record on (06), EGIG T12
14:14	event, T12 camp
14:15	record off
14:17	record on (07), EGIG T12
14:18	event, T12 camp
14:20	record off
14:20	record on (08), EGIG T12 → T17
14:33	record off
14:33	record on (09), EGIG T17 → T21
14:42	record off
14:44	switch to PC2
14:44	record on (10), EGIG T21 → T25
14:54	record off
14:54	record on (11), EGIG T25 → T31
15:07	record off
15:07	record on (12), EGIG T31 → T35
15:35	T41 → T43
15:42	record off
16:10	IRF calibration
17:14	record on (13), Illulisat
17:43	record off, PC2 disk full
17:43	switch to PC1
17:43	record on (14)
17:46	record off
17:55	PC1+PC2 off, ASIRAS off, CPC off
18:49	on ground

JD 116 – 2006, April 26th
GPS week 1372 (day 3)

12:58	take off
13:01	PC1+PC2 on, ASIRAS on, CPC on
14:48	PC1+PC2 off, ASIRAS off, CPC off
14:57	on ground
16:07	take off
16:10	PC1+PC2 on, ASIRAS on, CPC on
16:37	record on (00)
16:56	event, nothing
16:57	event, helicopter
17:03	record off, transit to T03
18:58	record on (01), T03->T05
19:02	event, nothing
19:03	event, T05 camp
19:04	record off
19:04	record on (02)
19:08	event, T05 camp
19:10	record off
19:10	record on (03)
19:17	event, T05 camp
19:22	record off
19:23	PC1+PC2 off, ASIRAS off, CPC off
19:25	on ground at T12 to pick up UK team
19:45	take off
19:50	PC1+PC2 on, ASIRAS on, CPC on
20:04	IRF calibration
20:16	record on (04), X-line Illulisat
20:29	record off
20:36	PC1+PC2 off, ASIRAS off, CPC off
21:42	on ground

JD 119 – 2006, April 29th
GPS week 1372 (day 6)

11:12	take off
11:16	PC1+PC2 on, ASIRAS on, CPC on
12:19	record on (00)
12:32	record off
12:32	record on (01)
12:45	record off
12:45	record on (02)
13:04	passed UK team
13:11	record off
13:11	record on (03)
13:25	record off
13:26	PC1+PC2 off, ASIRAS off, CPC off
	changed to pressure disks
13:30	PC1+PC2 on, ASIRAS on, CPC on
13:31	record on (04)
13:52	record off
13:52	record on (05)
14:14	record off
14:14	record on (06)
14:36	record off
14:36	record on (07)
14:53	record off
14:53	switch to PC2
14:54	record on (08)
14:59	record off, PC state bad
14:59	record on (09)
15:05	record off, PC state bad
15:13	record on (10)
15:45	record off
15:47	IRF calibration
15:50	PC1+PC2 off, ASIRAS off, CPC off
16:54	on ground, Constable Pynt
17:48	take off
18:40	PC1+PC2 on, ASIRAS on, CPC on
19:45	record on (11), 60MHz
19:46	record off, line aborted due to bad weather
19:48	PC1+PC2 off, ASIRAS off, CPC off
20:53	on ground

JD 120 – 2006, April 30th
GPS week 1373 (day 0)

08:27	take off
08:32	PC1+PC2 on, ASIRAS on, CPC on
08:47	record on (00)
09:11	record off
09:11	PC1+PC2 off, ASIRAS off, CPC off change disks on PC1
09:14	PC1+PC2 on, ASIRAS on, CPC on
09:15	record on (01)
09:38	record off
09:38	record on (02)
09:46	record off
10:08	record on (03), InSAR mode
10:24	record off
10:24	record on (04), EInSAR mode
10:35	record off
10:35	IRF calibration
11:17	PC1+PC2 off, ASIRAS off, CPC off
11:58	on ground

JD 121 – 2006 May 1st
GPS week 1373 (day 1)

10:18	take off
10:22	PC1+PC2 on, ASIRAS on, CPC on
11:18	record on (00)
11:28	event, camp
	record off
	record on (01)
12:11	record off
12:11	record on (02)
12:15	event, black thing on ice
12:16	event, camp
12:21	record off
12:30	record on (03)
12:33	event, reflector position
12:48	record off
12:54	record on (04)
13:04	event, reflector position
13:08	event, reflector position
13:09	record off
13:17	record on (05)
13:24	event, camp
13:26	event, reflector position
13:35	record off
13:35	record on (06)
13:51	record off
13:51	record on (07)
13:55	record off
14:01	record on (08)
14:35	record off
14:35	record on (09)
14:44	record off
14:44	record on (10), 40 MHz
14:45	record off
14:47	IRF calibration
14:51	PC1+PC2 off, ASIRAS off, CPC off
15:38	on ground

JD 122 – 2006, May 2nd
GPS week 1373 (day 2)

08:38	Take off (LYR)
08:48	ASIRAS turn on - OK
08:59	Record on
09:05	Record off
10:16	Record on 720 m 60 MHz
10:25	Record off
10:26	Record on 240 m 20 MHz
10:31	Record off
10:34	Record on 720 m 60 MHz
10:39	Record off
10:40	Record on 240 m 20 MHz
11:01	Record off
11:02	Record on
11:26	Record off
11:27	ASIRAS off
11:50	On ground (St. Nord)
13:14	Take off (St. Nord)
13:21	System on
14:19	Record on 240 m 20 MHz
14:40	Record off
14:41	Record on
15:03	Record off
15:04	Record on
15:24	Record off
15:25	Record on
15:40	Record off
15:41	Record on 480 m 40 MHz
15:46	Record off PC1 full
15:48	Record on PC2 480 m 40 MHz
15:57	Record off
15:58	Record on 720 m 60 MHz
16:08	Record off
16:10	Record on 240 m 20 MHz
16:14	Record off End of Line
17:46	ASIRAS shut down
18:18	On ground (St. Nord)

JD 123 – 2006, May 3rd
GPS week 1373 (day 3)

10:47	Take off (NRD)
	Minus altimeter
	PC1
12:01	Record on 240 m 20 MHz
12:06	Record off due to error on "DATA PC REC"
	Record on
12:07	Record off due to error on "DATA PC REC"
	Record on
12:08	Record off due to error on "DATA PC REC"
	Switch to PC2
12:09	Record on
12:30	Record off (25%)
	Record on
12:55	Record off - End of Line (55%)
16:06	On ground (TAB)

JD 125 – 2006, May 5th
GPS week 1373 (day 5)

13:00	take off
13:10	PC1+PC2 on, ASIRAS on, CPC on
13:26	record on (00)
13:44	record off
13:44	record on (01)
14:10	record off
14:40	record on (02)
14:45	event, reflector position
14:54	record off
14:57	record on (03)
15:08	event, reflector position
15:11	record off
15:22	record on (04)
15:30	event, reflector position
15:36	record off
15:46	IRF calibration
15:55	PC1+PC2 off, ASIRAS off, CPC off
17:28	on ground

JD 128 – 2006, May 8th
GPS week 1374 (day 1)

14:24	Taxi
14:30	Take off
16:32	System start up
17:09	Record on 720m 60MHz
17:12	Record off
17:14	Record on 240m 20MHz
17:25	Record off
17:45	Record on 240m 20MHz
17:57	C3
18:12	C4
18:14	Record off
18:30	System shut down
18:50	On ground YLT

JD 129 – 2006, May 9th
GPS week 1374 (day 2)

16:00	Taxi
16:04	Take off YLT
16:07	System on
16:12	Record on _00 (240m, 20MHz)
16:35	Record off (25%)
	Record on _01
16:58	Record off (52%)
17:13	WP D4
17:15	Record on _02
17:34	Record off (75%)
	Record on _03
17:55	Record off, PC1 full
18:16	WP D3
18:18	Record on _04, PC2
18:40	Record off (25%)
	Record on _05
19:03	Record off (52%)
19:15	WP H3
19:18	Record on _06
19:48	Record off (86%)
19:57	WP H2
19:58	Record on _07
20:09	Record off, PC2 full
20:10	IRF Calibration
20:12	System shut down
20:48	Overflight runway (1,000ft)
20:51	On Ground

JD 130 – 2006, May 10th
GPS week 1374 (day 3)

17:51	Taxi
17:52	Take off YLT
17:55	System on
17:57	Record on _00,
	1st loop (240m, 20MHz)
	RMY
18:06	RFY
18:10	Record off
	Record on _01, 2nd loop
	Record off _01, no reflector
18:15	Record on _02, Line MY
18:16	RMY
18:19	Record off
18:23	Record on _03, Line FY
18:24	RFY
18:27	Record off
18:29	Record on _04, 3rd loop
18:31	RMY, event 1
18:34	RFY (E/W), event 2
	Record off
18:55	Record on _05
18:40	RFY (N/S), event 1
18:42	RMY
18:43	Record off
18:45	Record on _06, 4th loop
	RMY (W/E)
18:50:39	RFY (E/W), event 1
18:51	Record off
18:54	Record on _07
18:57	RFY (N/S)
18:59	RMY (N/S)
19:00	Record off
	Climb to 15,000 ft
19:02	Record on _08 (480m, 40MHz)
	RMY
19:08	RFY (E/W), event 1
19:13	RFY (N/S)
19:15	RMY (N/S)
19:16	Record off
	Climb to 25,000 ft
19:20	Record on _09 (720m, 60MHz)
	RMY (W/E)
19:24:48	RFY (E/W)
19:25	Record off
19:28	Record on _10
19:30	RFY (N/S), event 1
19:32	Record off, decending 15,000 ft
19:35	Record on _11 (420m, 40MHz)
19:36	Overflight runway
19:37	Record off, decending 10,000 ft
19:39	Record on _12 (240m, 20MHz)
19:40	Overflight runway
	Record off
19:44	On ground

JD 131 – 2006, May 11th
GPS week 1374 (day 4)

15:30	Engine on
15:42	Taxi
15:44	Take off YLT
15:47	System on
16:13	G0
	Record on _00 (240m, 20MHz)
16:32	Record off (22%)
	Record on _01
16:33	Helicopter EM-bird
16:56	Record off (50%)
	Record on _02
17:21	Record off (77%)
	Record on _03
17:39	Record off PC1 full (100%)
17:41	Record on PC2 _04
17:55	Descending to 270m due to low clouds
18:08	Record off (30%)
	Record on _05
18:11	G3
18:24	Record off (50%)
	Record on _06
18:46	Record off (75%)
	Record on _07
19:08	Record off PC2 (100%)
	System shutdown
	climb to 320m (1,000 ft)
	change HDD PC1
19:18	Record on _08 PC1
19:41	Record off (25%)
	Record on _09
20:02	Record off
	IRF calibration
20:05	System shut down
20:08	On ground YLT

JD 132 – 2006, May 12th
GPS week 1374 (day 5)

14:29	Engine on
14:45	Taxi on
14:48	Take off YLT on
14:49	System on on
14:52	Record on _00 on
	(240m, 20MHz) on
14:57	Record off (6%) on
15:03	Record on _01 on
	B1 on
15:20	Record off (25%) on
	Record on _02 on
15:26	Decend to 200m, low clouds on
15:42	Record off (51%) on
	Record on _03 on
16:03	Record off (75%) on
	Record on _04 on
16:24	Record off (PC1 100%) on
	Change to PC2 on
16:26	Record on _05 on
16:49	Record off (27%) on
	Record on _06 on
17:09	Record off (50%) on
17:31	E1a on
17:34	Record on _07 on
17:54	E2 on
	Record off (73%) on
17:59	Record on _08 on
	"Odaq" ø ?? on
18:05	Record off (80%)
18:09	E2
18:20	Record on _09
18:28	Record off (PC2 100%)
18:29	IRF calibration
18:32	System shut down
	Change HDD PC1
18:47	Record on _10
19:09	Record off (25%)
	Record on _11
19:11	E3
19:18	Record off (36%)
19:21	IRF calibration
19:27	System shut down
19:29	On ground

JD 136 – 2006, May 16th
GPS week 1375 (day 2)

09:39	Engine on
09:51	Taxi
09:55	Take off NRD
09:59	System on
10:02	Record on _00 (240m, 20MHz)
	Measure line North of NRD
10:07	Overflight runway NRD
10:09	Record off (8%)
10:13	Fl. Isblink
	Record on _01 (480m, 40MHz)
10:14	Record off (9%)
10:15	Record on _02 (240m, 20MHz)
10:30:45	Icecamp
10:34	Record off (31%)
11:23	Record on _03
11:28	J1
11:39	Record off (50%)
	Record on _04
12:01	Record off (75%)
	Record on _05
12:24	Record off (PC1 100%)
13:49	Record on _06
13:59	WH1
14:14	WH2
	Record off (29%)
	Record on _07
14:15	Low clouds
14:26	Record off
14:28	IRF calibration
14:29	System shut down
15:42	On ground CNP

JD 137 – 2006, May 17th
GPS week 1375 (day 3)

08:36	Engine on
08:40	Taxi
08:45	Take off NRD
	System on
09:28	Record on _00 (1200m, 80MHz)
	Geikie, high altitude due to clouds
09:33	Record off (7%)
09:34	Record on _01
09:47	L4
	Record off (22%)
11:01	Record on _02 (240m, 20MHz)
11:02	L7, Kangerdlussuaq
11:13	Record off (34%), survey stopped
	due to strong winds
11:16	Record on _03 (720m, 60MHz)
11:18	Record off
	Record on _04 (480m, 40MHz)
11:25	Record off
12:12	Record on _05 (240m, 20MHz)
12:14	MG1
12:32	Record off (77%)
12:46	Record on _06
13:00	Record off (93%)
13:02	Record on PC2 _07
13:15	Record off (15%)
13:17	Record on _08, Fjord (720m, 60MHz)
	Record off
13:19	Record on _09
13:20	Record off (16%)
	IRF Calibration
13:21	System shut down
13:38	On ground KUS
14:29	Engine on
14:30	Taxi
14:34	Take off KUS
	System on
	log files 10-12, test
15:26	Record on _13
	(240m, 20MHz)
15:35	Record off (10%)
	Record on _14
15:45	Record off (20%)
15:58	Record on _15
16:06	SN4
16:24	Record off (50%)
16:49	Record on _16
17:09	Record off (72%)
17:54	Record on _17
17:55	Overflight runway
17:58	Overflight building
17:59	IRF calibration
18:01	On ground SFJ

F Processed ASIRAS files

Profile	Proc. ver. 03_06	L1	L1b	GPS	INS	Quality	Remarks
A060420_00				X			no INS data, see Chapter 4
A060420_01				X			no INS data, see Chapter 4
A060421_00	X	X	X	X	X		
A060421_01	X	X	X	X	X		
A060421_02	X	X	X	X	X		
A060421_03	X	X	X	X	X		
A060421_04	X	X	X	X	X		
A060421_05	X	X	X	X	X		
A060421_06	X	X	X	X	X		
A060421_07	X	X	X	X	X		
A060423_00	X	X	X	X	X		
A060423_01	X	X	X	X	X		
A060423_02	X	X	X	X	X		
A060423_03	X	X	X	X	X		
A060423_04				X	X		ASIRAS processor error
A060423_05				X	X		ASIRAS processor error
A060423_06				X	X		ASIRAS processor error
A060423_07				X	X		ASIRAS processor error
A060424_00	X	X	X	X	X		
A060424_01	X	X	X	X	X		
A060424_02	X	X	X	X	X		
A060424_03	X	X	X	X	X		
A060424_04	X	X	X	X	X		
A060424_05	X	X	X	X	X		
A060425_00	X	X	X	X	X		
A060425_01	X	X	X	X	X		
A060425_02	X	X	X	X	X		
A060425_03	X	X	X	X	X		
A060425_04	X	X	X	X	X		
A060425_05	X	X	X	X	X		
A060425_06	X	X	X	X	X		
A060425_07	X	X	X	X	X		
A060425_08	X	X	X	X	X		
A060425_09	X	X	X	X	X		
A060425_10	X	X	X	X	X		
A060425_11	X	X	X	X	X		
A060425_12	X	X	X	X	X		
A060425_13	X	X	X	X	X		
A060425_14	X	X	X	X	X		
A060426_00	X	X	X	X	X		
A060426_01	X	X	X	X	X		
A060426_02	X	X	X	X	X		

Continued on next page

Profile	Proc. ver. 03_06	L1	L1b	GPS	INS	Quality	Remarks
A060426_03	X	X	X	X	X		
A060426_04	X	X	X	X	X		
A060429_00	X	X	X	X	X		
A060429_01	X	X	X	X	X		
A060429_02	X	X	X	X	X		
A060429_03	X	X	X	X	X		
A060429_04	X	X	X	X	X		
A060429_05	X	X	X	X	X		
A060429_06	X	X	X	X	X		
A060429_07	X	X	X	X	X		
A060429_08	X	X	X	X	X		
A060429_09	X	X	X	X	X		
A060429_10	X	X	X	X	X		
A060429_11	X	X	X	X	X		
A060429_12	X	X	X	X	X		
A060430_00	X	X	X	X	X		
A060430_01	X	X	X	X	X		
A060430_02	X	X	X	X	X		
A060430_03	X	X	X	X	X		HAM (inSAR)
A060430_04				X	X		HAM (enhanced inSAR[11])
A060501_00	X	X	X	X	X		
A060501_01	X	X	X	X	X		
A060501_02	X	X	X	X	X		
A060501_03	X	X	X	X	X		
A060501_04	X	X	X	X	X		
A060501_05	X	X	X	X	X		
A060501_06	X	X	X	X	X		
A060501_07	X	X	X	X	X		
A060501_08	X	X	X	X	X		
A060501_09	X	X	X	X	X		
A060501_10	X	X	X	X	X		
A060502_00	X	X	X	X	X		
A060502_01	X	X	X	X	X		
A060502_02	X	X	X	X	X		
A060502_03	X	X	X	X	X		
A060502_04	X	X	X	X	X		
A060502_05	X	X	X	X	X		
A060502_06	X	X	X	X	X		
A060502_07	X	X	X	X	X		
A060502_08	X	X	X	X	X		
A060502_09	X	X	X	X	X		
A060502_10	X	X	X	X	X		
A060502_11	X	X	X	X	X		
A060502_12	X	X	X	X	X		

Continued on next page

[11] No processor available

Profile	Proc. ver. 03_06	L1	L1b	GPS	INS	Quality	Remarks
A060502_13	X	X	X	X	X		
A060503_00	X	X	X	X	X		
A060503_01	X	X	X	X	X		
A060503_02	X	X	X	X	X		
A060503_03	X	X	X	X	X		
A060503_04	X	X	X	X	X		
A060503_05	X	X	X	X	X		
A060505_00	X	X	X	X	X		
A060505_01	X	X	X	X	X		
A060505_02	X	X	X	X	X		
A060505_03	X	X	X	X	X		
A060505_04	X	X	X	X	X		
A060508_00	X	X	X	X	X		
A060508_01	X	X	X	X	X		
A060508_02	X	X	X	X	X		GPS gap, see Chapter 4
A060509_00	X	X	X	X	X		
A060509_01	X	X	X	X	X		
A060509_02	X	X	X	X	X		
A060509_03	X	X	X	X	X		GPS gap, see Chapter 4
A060509_04	X	X	X	X	X		
A060509_05	X	X	X	X	X		
A060509_06	X	X	X	X	X		
A060509_07	X	X	X	X	X		
A060510_00	X	X	X	X	X		
A060510_01	X	X	X	X	X		
A060510_02	X	X	X	X	X		
A060510_03	X	X	X	X	X		
A060510_04	X	X	X	X	X		
A060510_05	X	X	X	X	X		
A060510_06	X	X	X	X	X		
A060510_07	X	X	X	X	X		
A060510_08	X	X	X	X	X		
A060510_09	X	X	X	X	X		
A060510_10	X	X	X	X	X		
A060510_11	X	X	X	X	X		
A060510_12	X	X	X	X	X		
A060511_00	X	X	X	X	X		
A060511_01	X	X	X	X	X		
A060511_02	X	X	X	X	X		
A060511_03	X	X	X	X	X		
A060511_04	X	X	X	X	X		
A060511_05	X	X	X	X	X		
A060511_06	X	X	X	X	X		
A060511_07	X	X	X	X	X		
A060511_08	X	X	X	X	X		

Continued on next page

Profile	Proc. ver. 03_06	L1	L1b	GPS	INS	Quality	Remarks
A060511_09	X	X	X	X	X		
A060512_00	X	X	X	X	X		
A060512_01	X	X	X	X	X		
A060512_02	X	X	X	X	X		
A060512_03	X	X	X	X	X		
A060512_04	X	X	X	X	X		
A060512_05					X		GPS gap, see Chapter 4
A060512_06	X	X	X	X	X		
A060512_07					X		GPS gap, see Chapter 4
A060512_08	X	X	X	X	X		
A060512_09	X	X	X	X	X		
A060512_10				X			INS incomplete, see Chapter 4
A060512_11				X			INS incomplete, see Chapter 4
A060516_00				X			no INS data, see Chapter 4
A060516_01				X			no INS data, see Chapter 4
A060516_02				X			no INS data, see Chapter 4
A060516_03				X			no INS data, see Chapter 4
A060516_04				X			no INS data, see Chapter 4
A060516_05				X			no INS data, see Chapter 4
A060516_06				X			no INS data, see Chapter 4
A060516_07				X			no INS data, see Chapter 4
A060517_00	X	X	X	X	X		
A060517_01	X	X	X	X	X		
A060517_02	X	X	X	X	X		
A060517_03	X	X	X	X	X		
A060517_04		X	X	X	X		invalid ASIRAS data
A060517_05	X	X	X	X	X		
A060517_06	X	X	X	X	X		
A060517_07	X	X	X	X	X		
A060517_08	X	X	X	X	X		
A060517_09	X	X	X	X	X		
A060517_10				X	X		no ASIRAS data
A060517_11				X	X		no ASIRAS data
A060517_12	X	X	X	X	X		
A060517_13	X	X	X	X	X		
A060517_14	X	X	X	X	X		
A060517_15	X	X	X	X	X		
A060517_16	X	X	X	X	X		
A060517_17	X	X	X	X	X		

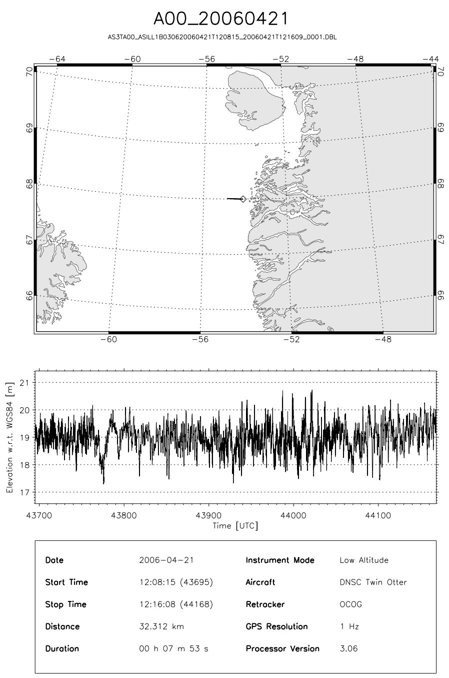
Table 25: ASIRAS processing.

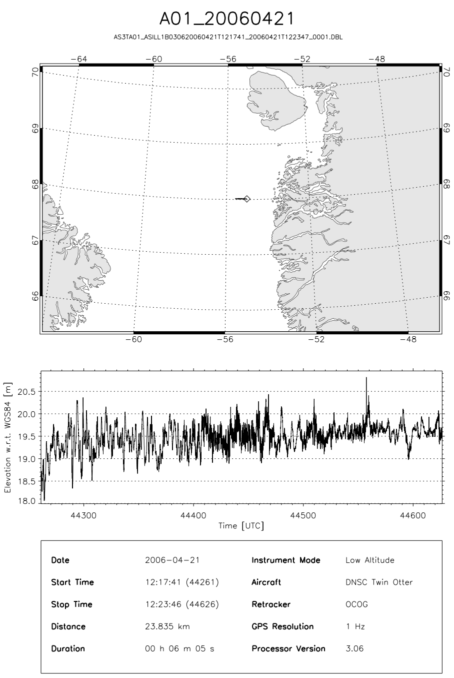
G Processed ASIRAS Profiles

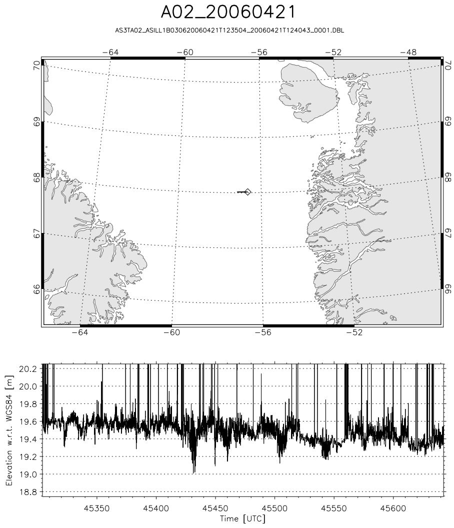
Following is plots showing all processed ASIRAS profiles. Each profile plot consists of four parts.

1. Header composed of daily profile number and the date and subheader with the filename.
2. Geographical plot showing the profile (diamond indicates start of profile).
3. Rough indication of height as determined by the OCOG retracker plotted versus time of day in seconds.
4. Info box with date, start and stop times in hour, minute, second and in square brackets second of day, acquisition mode, etc.

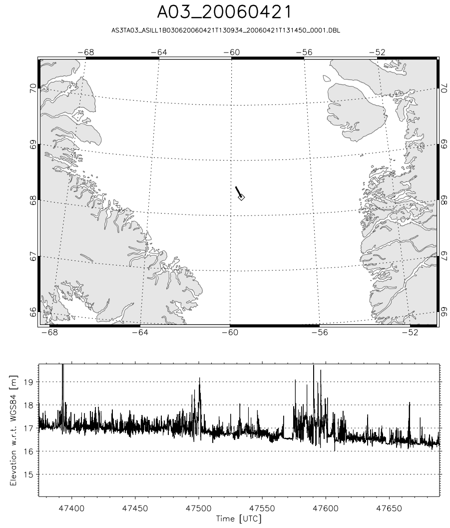
It should be emphasized that the surface height determined by the OCOG retracker is a rough estimation and not the true height.



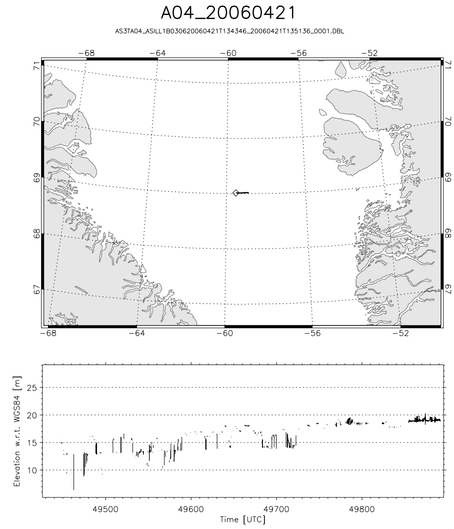




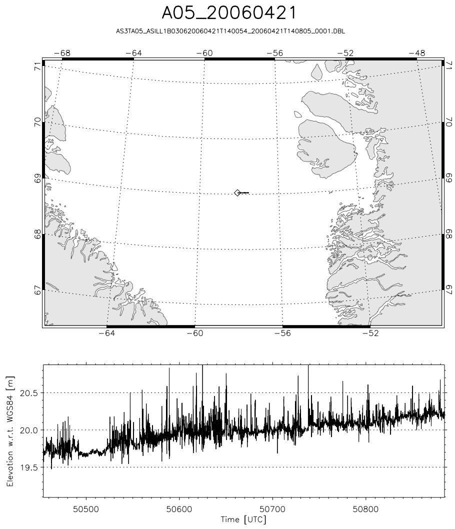
Date	2006-04-21	**Instrument Mode**	Low Altitude
Start Time	12:35:04 (45304)	**Aircraft**	DNSC Twin Otter
Stop Time	12:40:42 (45642)	**Retracker**	OCOG
Distance	21.521 km	**GPS Resolution**	1 Hz
Duration	00 h 05 m 38 s	**Processor Version**	3.06



Date	2006-04-21	**Instrument Mode**	Low Altitude
Start Time	13:09:34 (47374)	**Aircraft**	DNSC Twin Otter
Stop Time	13:14:49 (47689)	**Retracker**	OCOG
Distance	24.226 km	**GPS Resolution**	1 Hz
Duration	00 h 05 m 16 s	**Processor Version**	3.06



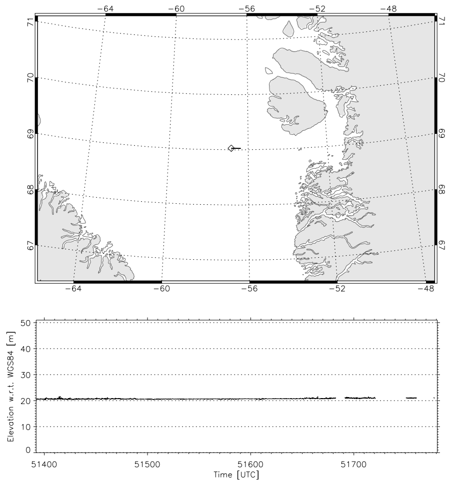
Date	2006-04-21	**Instrument Mode**	Low Altitude
Start Time	13:43:46 (49426)	**Aircraft**	DNSC Twin Otter
Stop Time	13:51:35 (49895)	**Retracker**	OCOG
Distance	25.970 km	**GPS Resolution**	1 Hz
Duration	00 h 07 m 49 s	**Processor Version**	3.06



Date	2006-04-21	**Instrument Mode**	Low Altitude
Start Time	14:00:54 (50454)	**Aircraft**	DNSC Twin Otter
Stop Time	14:08:04 (50884)	**Retracker**	OCOG
Distance	23.156 km	**GPS Resolution**	1 Hz
Duration	00 h 07 m 10 s	**Processor Version**	3.06

A06_20060421

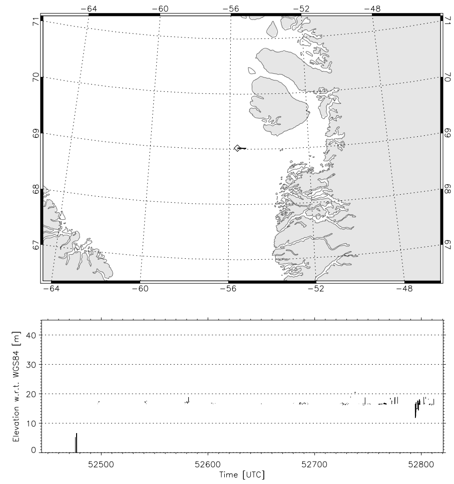
AS3TA06_ASILL1B030620060421T141632_20060421T142302_0001.DBL



Date	2006-04-21	**Instrument Mode**	Low Altitude
Start Time	14:16:32 (51392)	**Aircraft**	DNSC Twin Otter
Stop Time	14:23:00 (51780)	**Retracker**	OCOG
Distance	19.379 km	**GPS Resolution**	1 Hz
Duration	00 h 06 m 29 s	**Processor Version**	3.06

A07_20060421

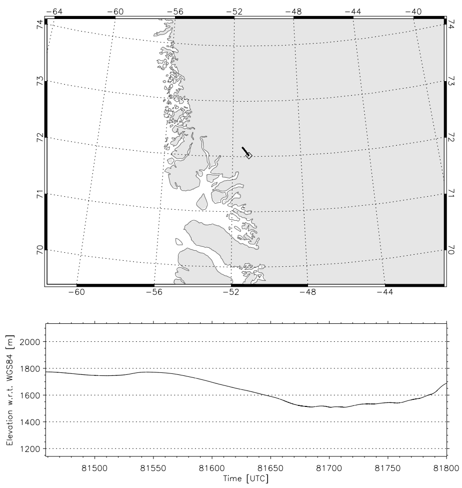
AS3TA07_ASILL1B030620060421T143404_20060421T144021_0001.DBL



Date	2006-04-21	**Instrument Mode**	Low Altitude
Start Time	14:34:04 (52444)	**Aircraft**	DNSC Twin Otter
Stop Time	14:40:20 (52820)	**Retracker**	OCOG
Distance	17.387 km	**GPS Resolution**	1 Hz
Duration	00 h 06 m 16 s	**Processor Version**	3.06

A00_20060423

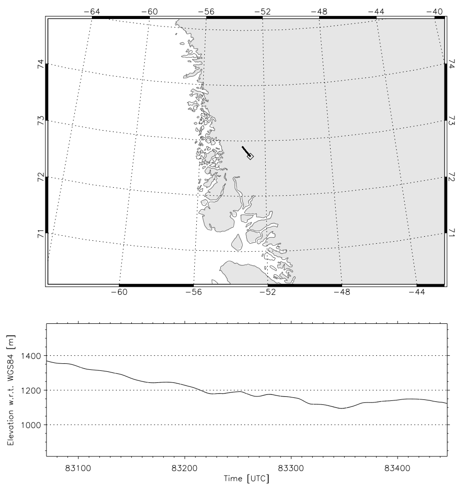
AS3TA00_ASILL1B030620060423T223738_20060423T224322_0001.DBL



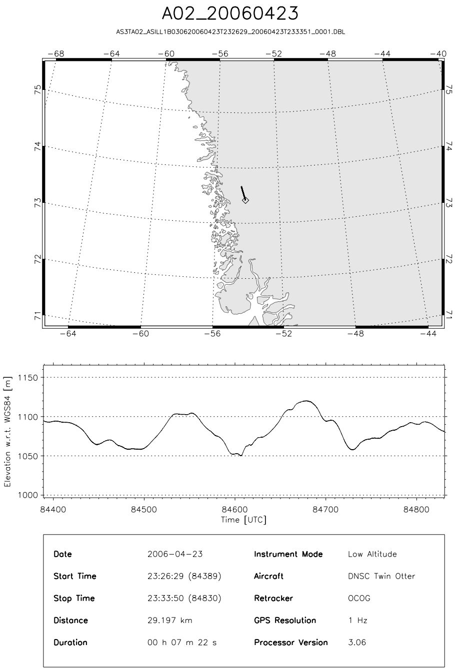
Date	2006-04-23	**Instrument Mode**	Low Altitude
Start Time	22:37:38 (81458)	**Aircraft**	DNSC Twin Otter
Stop Time	22:43:20 (81800)	**Retracker**	OCOG
Distance	21.526 km	**GPS Resolution**	1 Hz
Duration	00 h 05 m 42 s	**Processor Version**	3.06

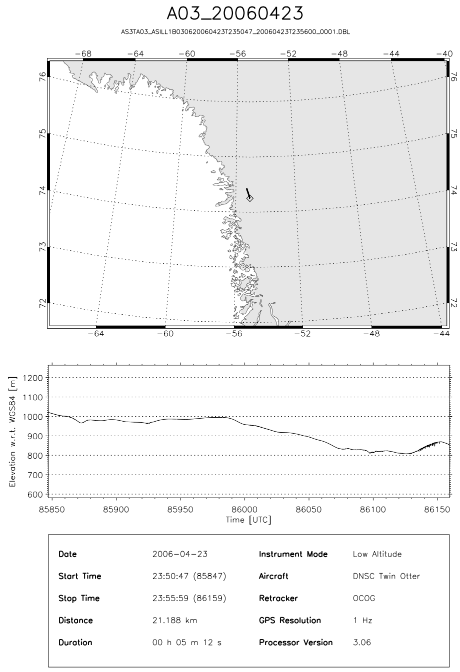
A01_20060423

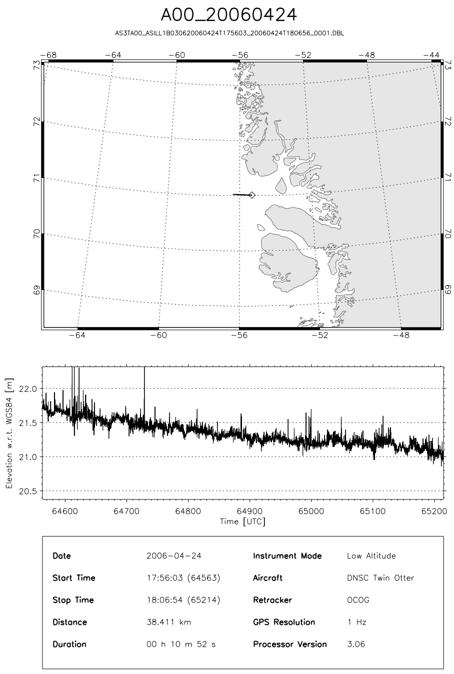
AS3TA01_ASILL1B030620060423T230430_20060423T231047_0001.DBL

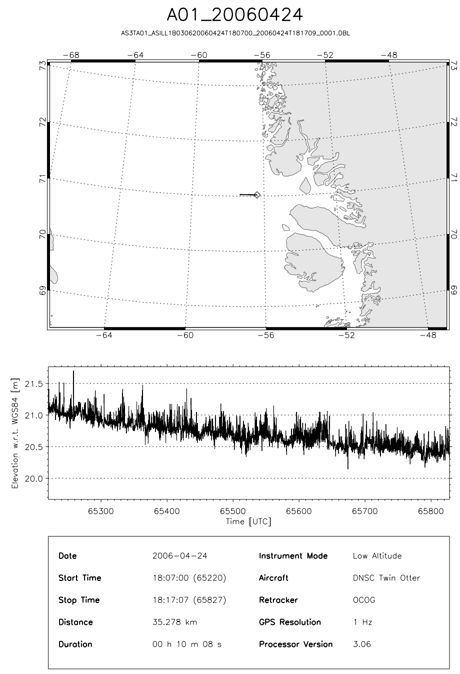


Date	2006-04-23	**Instrument Mode**	Low Altitude
Start Time	23:04:30 (83070)	**Aircraft**	DNSC Twin Otter
Stop Time	23:10:46 (83446)	**Retracker**	OCOG
Distance	26.015 km	**GPS Resolution**	1 Hz
Duration	00 h 06 m 17 s	**Processor Version**	3.06


A02_20060423
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-04-23
Start Time 23:26:29 (84389)
Stop Time 23:33:50 (84830)
Distance 29.197 km
Duration 00 h 07 m 22 s
Instrument Mode Low Altitude
Aircraft DNSC Twin Otter
Retracker OCOG
GPS Resolution 1 Hz
Processor Version 3.06

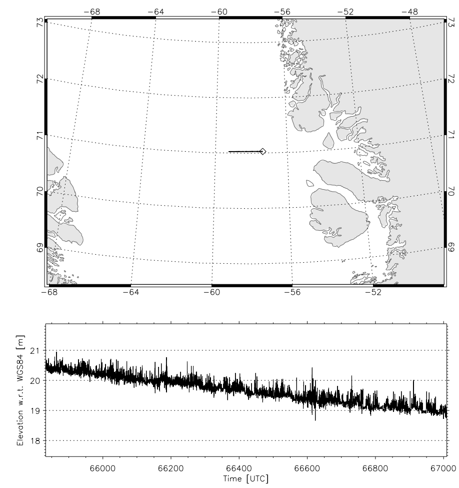

A03_20060423
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-04-23
Start Time 23:50:47 (85847)
Stop Time 23:55:59 (86159)
Distance 21.188 km
Duration 00 h 05 m 12 s
Instrument Mode Low Altitude
Aircraft DNSC Twin Otter
Retracker OCOG
GPS Resolution 1 Hz
Processor Version 3.06


A00_20060424
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-04-24
Start Time 17:56:03 (64563)
Stop Time 18:06:54 (65214)
Distance 38.411 km
Duration 00 h 10 m 52 s
Instrument Mode Low Altitude
Aircraft DNSC Twin Otter
Retracker OCOG
GPS Resolution 1 Hz
Processor Version 3.06


A01_20060424
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-04-24
Start Time 18:07:00 (65220)
Stop Time 18:17:07 (65827)
Distance 35.278 km
Duration 00 h 10 m 08 s
Instrument Mode Low Altitude
Aircraft DNSC Twin Otter
Retracker OCOG
GPS Resolution 1 Hz
Processor Version 3.06

A02_20060424

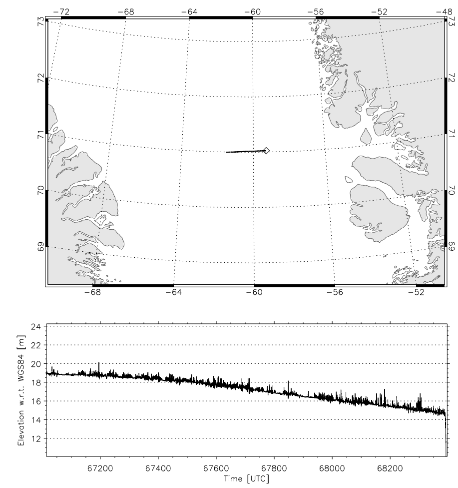
AS3TA02_ASILL1B030620060424T181712_20060424T183651_0001.DBL



Date	2006-04-24	**Instrument Mode**	Low Altitude
Start Time	18:17:12 (65832)	**Aircraft**	DNSC Twin Otter
Stop Time	18:36:49 (67009)	**Retracker**	OCOG
Distance	68.949 km	**GPS Resolution**	1 Hz
Duration	00 h 19 m 37 s	**Processor Version**	3.06

A03_20060424

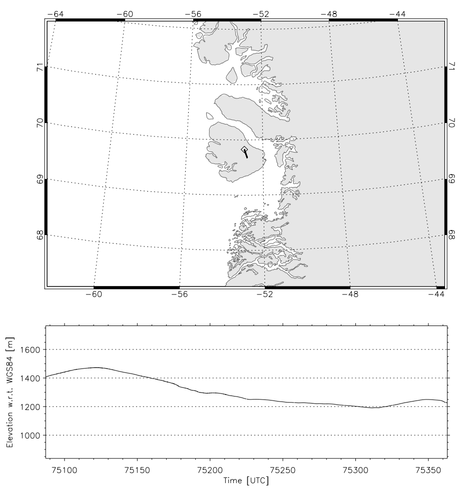
AS3TA03_ASILL1B030620060424T183654_20060424T185958_0001.DBL



Date	2006-04-24	**Instrument Mode**	Low Altitude
Start Time	18:36:54 (67014)	**Aircraft**	DNSC Twin Otter
Stop Time	18:59:56 (68396)	**Retracker**	OCOG
Distance	80.716 km	**GPS Resolution**	1 Hz
Duration	00 h 23 m 03 s	**Processor Version**	3.06

A04_20060424

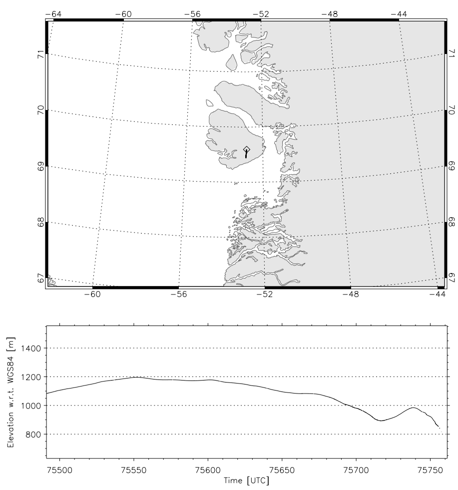
AS3TA04_ASILL1B030620060424T205127_20060424T205604_0001.DBL



Date	2006-04-24	**Instrument Mode**	Low Altitude
Start Time	20:51:27 (75087)	**Aircraft**	DNSC Twin Otter
Stop Time	20:56:02 (75362)	**Retracker**	OCOG
Distance	18.416 km	**GPS Resolution**	1 Hz
Duration	00 h 04 m 36 s	**Processor Version**	3.06

A05_20060424

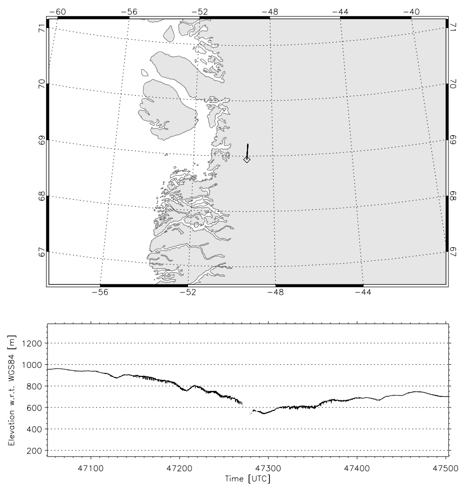
AS3TA05_ASILL1B030620060424T205811_20060424T210242_0001.DBL



Date	2006-04-24	**Instrument Mode**	Low Altitude
Start Time	20:58:11 (75491)	**Aircraft**	DNSC Twin Otter
Stop Time	21:02:41 (75761)	**Retracker**	OCOG
Distance	17.441 km	**GPS Resolution**	1 Hz
Duration	00 h 04 m 30 s	**Processor Version**	3.06

A00_20060425

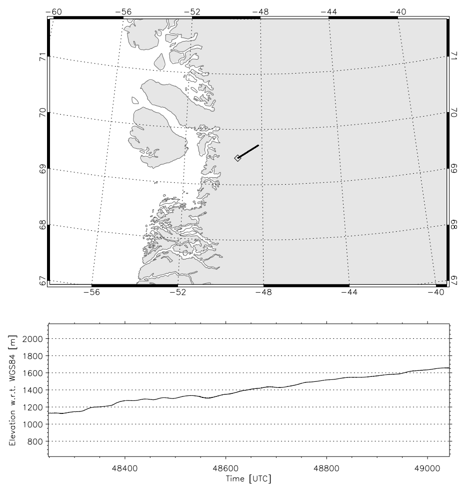
AS3TA00_ASILL1B030620060425T130411_20060425T131144_0001.DBL



Date	2006-04-25	**Instrument Mode**	Low Altitude
Start Time	13:04:11 (47051)	**Aircraft**	DNSC Twin Otter
Stop Time	13:11:43 (47503)	**Retracker**	OCOG
Distance	31.910 km	**GPS Resolution**	1 Hz
Duration	00 h 07 m 32 s	**Processor Version**	3.06

A01_20060425

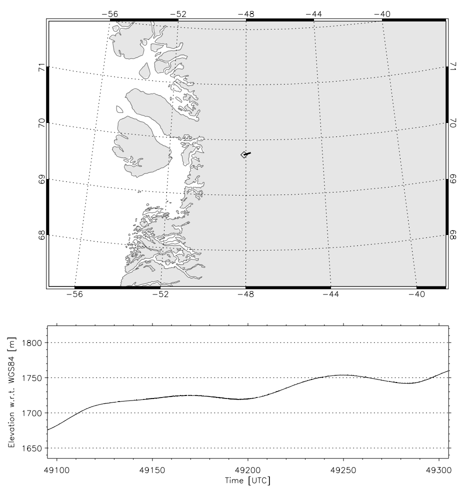
AS3TA01_ASILL1B030620060425T132408_20060425T133725_0001.DBL



Date	2006-04-25	**Instrument Mode**	Low Altitude
Start Time	13:24:08 (48248)	**Aircraft**	DNSC Twin Otter
Stop Time	13:37:23 (49043)	**Retracker**	OCOG
Distance	49.805 km	**GPS Resolution**	1 Hz
Duration	00 h 13 m 16 s	**Processor Version**	3.06

A02_20060425

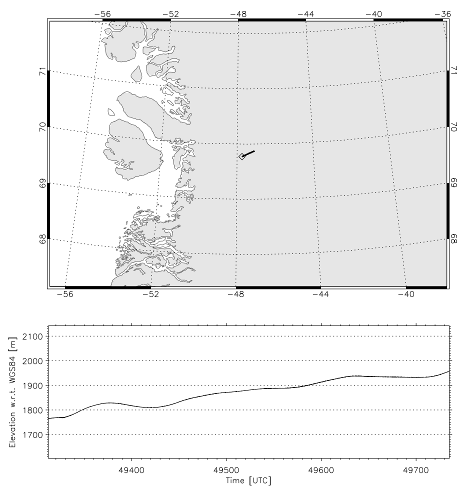
AS3TA02_ASILL1B030620060425T133815_20060425T134146_0001.DBL



Date	2006-04-25	**Instrument Mode**	Low Altitude
Start Time	13:38:15 (49095)	**Aircraft**	DNSC Twin Otter
Stop Time	13:41:45 (49305)	**Retracker**	OCOG
Distance	13.826 km	**GPS Resolution**	1 Hz
Duration	00 h 03 m 30 s	**Processor Version**	3.06

A03_20060425

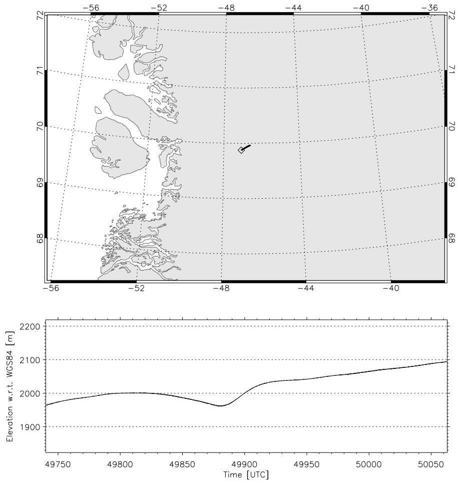
AS3TA03_ASILL1B030620060425T134152_20060425T134856_0001.DBL



Date	2006-04-25	**Instrument Mode**	Low Altitude
Start Time	13:41:52 (49312)	**Aircraft**	DNSC Twin Otter
Stop Time	13:48:55 (49735)	**Retracker**	OCOG
Distance	27.576 km	**GPS Resolution**	1 Hz
Duration	00 h 07 m 03 s	**Processor Version**	3.06

A04_20060425

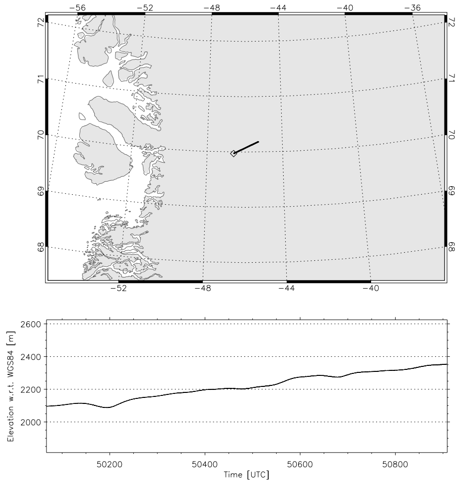
AS3TA04_ASILL1B030620060425T134900_20060425T135424_0001.DBL



Date	2006-04-25	Instrument Mode	Low Altitude
Start Time	13:49:00 (49740)	Aircraft	DNSC Twin Otter
Stop Time	13:54:22 (50062)	Retracker	OCOG
Distance	20.986 km	GPS Resolution	1 Hz
Duration	00 h 05 m 23 s	Processor Version	3.06

A05_20060425

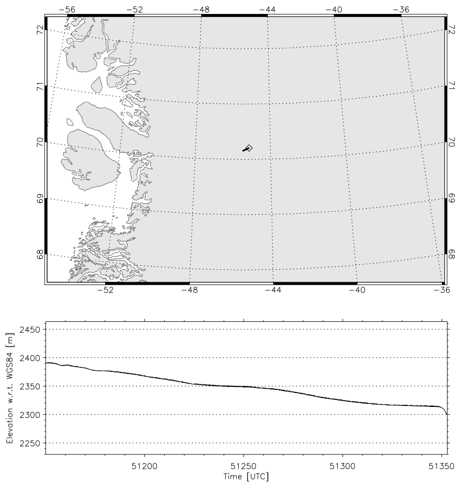
AS3TA05_ASILL1B030620060425T135427_20060425T140830_0001.DBL



Date	2006-04-25	Instrument Mode	Low Altitude
Start Time	13:54:27 (50067)	Aircraft	DNSC Twin Otter
Stop Time	14:08:28 (50908)	Retracker	OCOG
Distance	55.808 km	GPS Resolution	1 Hz
Duration	00 h 14 m 02 s	Processor Version	3.06

A06_20060425

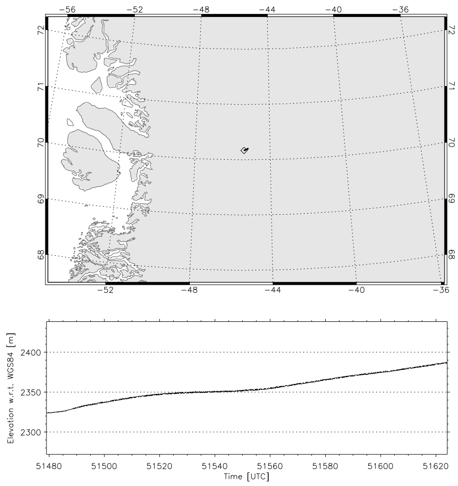
AS3TA06_ASILL1B030620060425T141230_20060425T141553_0001.DBL



Date	2006-04-25	Instrument Mode	Low Altitude
Start Time	14:12:30 (51150)	Aircraft	DNSC Twin Otter
Stop Time	14:15:52 (51352)	Retracker	OCOG
Distance	14.061 km	GPS Resolution	1 Hz
Duration	00 h 03 m 23 s	Processor Version	3.06

A07_20060425

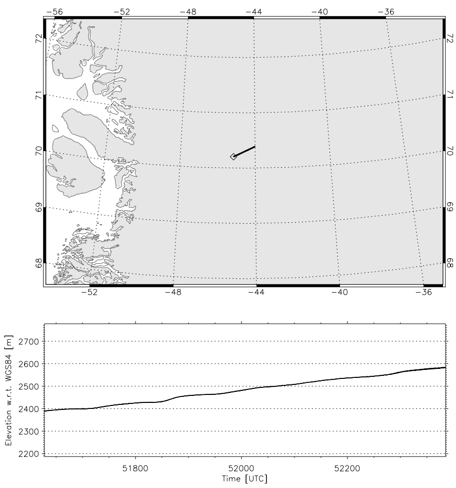
AS3TA07_ASILL1B030620060425T141759_20060425T142025_0001.DBL



Date	2006-04-25	Instrument Mode	Low Altitude
Start Time	14:17:59 (51479)	Aircraft	DNSC Twin Otter
Stop Time	14:20:24 (51624)	Retracker	OCOG
Distance	9.549 km	GPS Resolution	1 Hz
Duration	00 h 02 m 25 s	Processor Version	3.06

A08_20060425

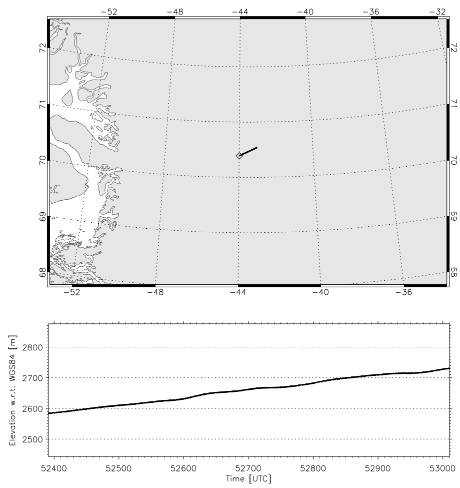
AS3TA08_ASILL1B030620060425T142028_20060425T143306_0001.DBL



Date	2006-04-25	**Instrument Mode**	Low Altitude
Start Time	14:20:28 (51628)	**Aircraft**	DNSC Twin Otter
Stop Time	14:33:05 (52385)	**Retracker**	OCOG
Distance	48.187 km	**GPS Resolution**	1 Hz
Duration	00 h 12 m 37 s	**Processor Version**	3.06

A09_20060425

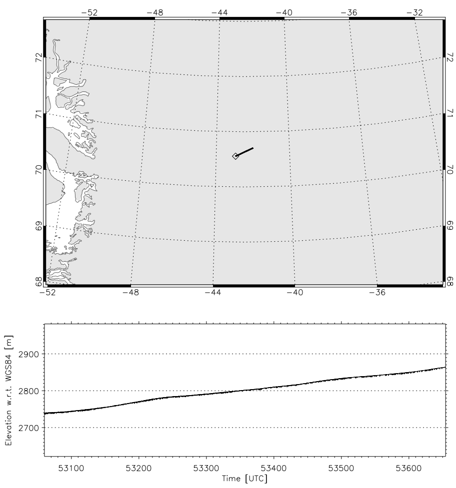
AS3TA09_ASILL1B030620060425T143311_20060425T144331_0001.DBL



Date	2006-04-25	**Instrument Mode**	Low Altitude
Start Time	14:33:11 (52391)	**Aircraft**	DNSC Twin Otter
Stop Time	14:43:30 (53010)	**Retracker**	OCOG
Distance	39.529 km	**GPS Resolution**	1 Hz
Duration	00 h 10 m 19 s	**Processor Version**	3.06

A10_20060425

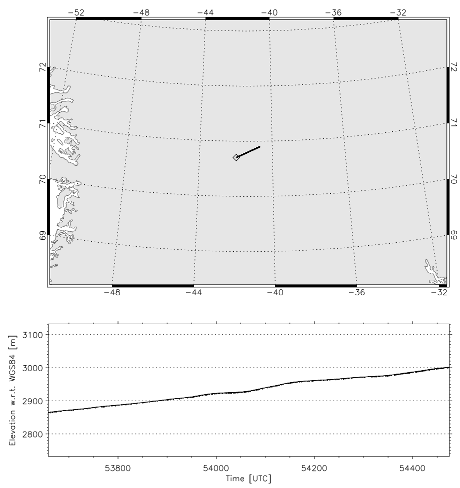
AS3TA10_ASILL1B030620060425T144420_20060425T145415_0001.DBL



Date	2006-04-25	**Instrument Mode**	Low Altitude
Start Time	14:44:20 (53060)	**Aircraft**	DNSC Twin Otter
Stop Time	14:54:14 (53654)	**Retracker**	OCOG
Distance	39.005 km	**GPS Resolution**	1 Hz
Duration	00 h 09 m 54 s	**Processor Version**	3.06

A11_20060425

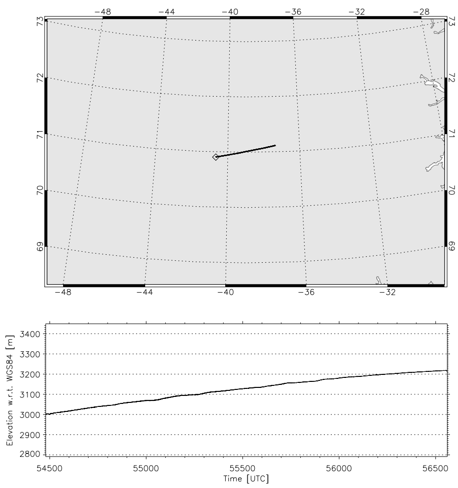
AS3TA11_ASILL1B030620060425T145418_20060425T150756_0001.DBL



Date	2006-04-25	**Instrument Mode**	Low Altitude
Start Time	14:54:18 (53658)	**Aircraft**	DNSC Twin Otter
Stop Time	15:07:55 (54475)	**Retracker**	OCOG
Distance	52.935 km	**GPS Resolution**	1 Hz
Duration	00 h 13 m 37 s	**Processor Version**	3.06

A12_20060425

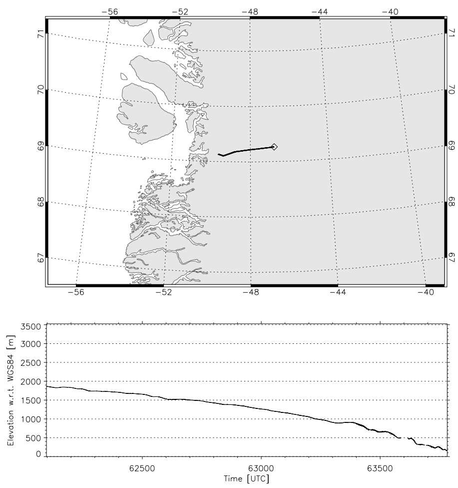
AS3TA12_ASILL1B030620060425T150759_20060425T154241_0001.DBL



Date	2006-04-25	Instrument Mode	Low Altitude
Start Time	15:07:59 (54479)	Aircraft	DNSC Twin Otter
Stop Time	15:42:40 (56560)	Retracker	OCOG
Distance	122.564 km	GPS Resolution	1 Hz
Duration	00 h 34 m 41 s	Processor Version	3.06

A13_20060425

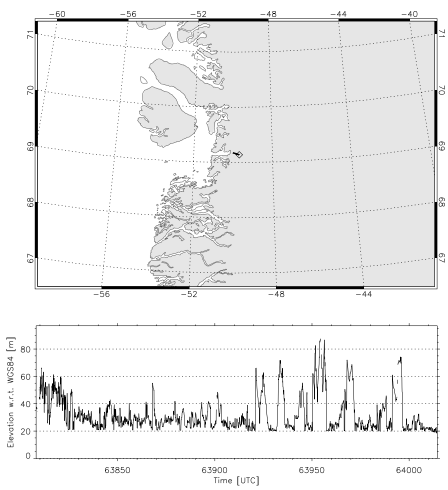
AS3TA13_ASILL1B030620060425T171457_20060425T174302_0001.DBL



Date	2006-04-25	Instrument Mode	Low Altitude
Start Time	17:14:57 (62097)	Aircraft	DNSC Twin Otter
Stop Time	17:43:01 (63781)	Retracker	OCOG
Distance	115.616 km	GPS Resolution	1 Hz
Duration	00 h 28 m 05 s	Processor Version	3.06

A14_20060425

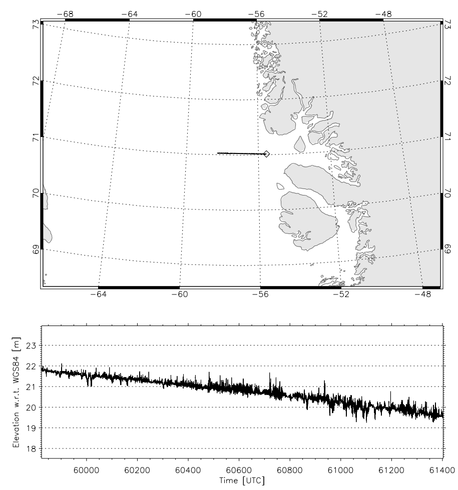
AS3TA14_ASILL1B030620060425T174328_20060425T174655_0001.DBL



Date	2006-04-25	Instrument Mode	Low Altitude
Start Time	17:43:28 (63808)	Aircraft	DNSC Twin Otter
Stop Time	17:46:54 (64014)	Retracker	OCOG
Distance	13.365 km	GPS Resolution	1 Hz
Duration	00 h 03 m 26 s	Processor Version	3.06

A00_20060426

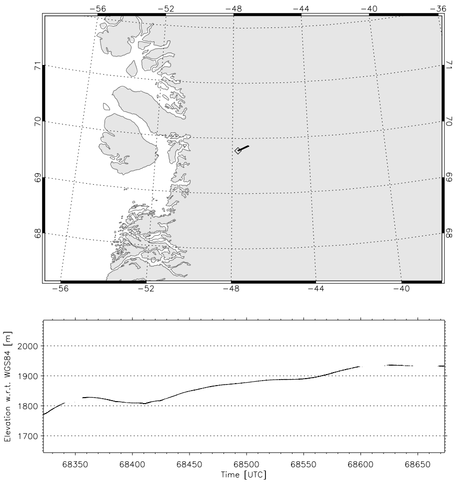
AS3TA00_ASILL1B030620060426T163703_20060426T170324_0001.DBL



Date	2006-04-26	Instrument Mode	Low Altitude
Start Time	16:37:03 (59823)	Aircraft	DNSC Twin Otter
Stop Time	17:03:22 (61402)	Retracker	OCOG
Distance	99.382 km	GPS Resolution	1 Hz
Duration	00 h 26 m 20 s	Processor Version	3.06

A01_20060426

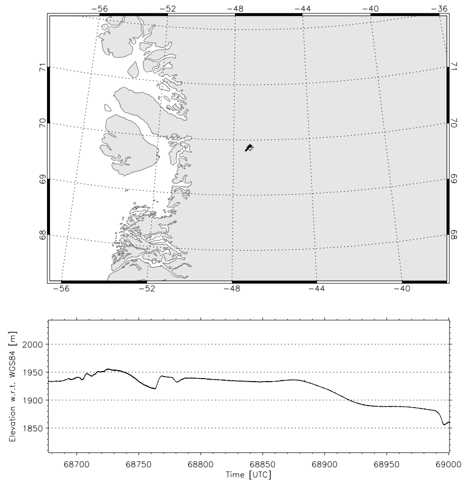
AS3TA01_ASILL1B030620060426T185842_20060426T190434_0001.DBL



Date	2006-04-26	**Instrument Mode**	Low Altitude
Start Time	18:58:42 (68322)	**Aircraft**	DNSC Twin Otter
Stop Time	19:04:33 (68673)	**Retracker**	OCOG
Distance	23.975 km	**GPS Resolution**	1 Hz
Duration	00 h 05 m 51 s	**Processor Version**	3.06

A02_20060426

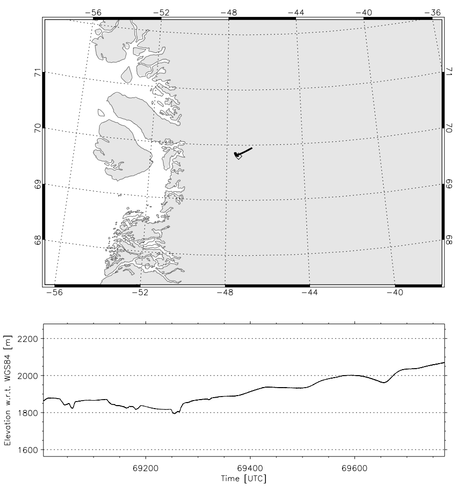
AS3TA02_ASILL1B030620060426T190437_20060426T191001_0001.DBL



Date	2006-04-26	**Instrument Mode**	Low Altitude
Start Time	19:04:37 (68677)	**Aircraft**	DNSC Twin Otter
Stop Time	19:10:00 (69000)	**Retracker**	OCOG
Distance	20.283 km	**GPS Resolution**	1 Hz
Duration	00 h 05 m 24 s	**Processor Version**	3.06

A03_20060426

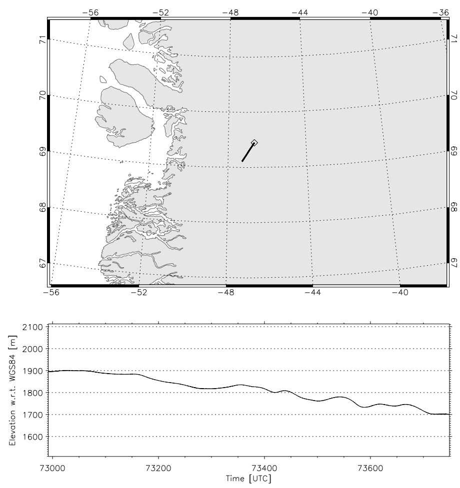
AS3TA03_ASILL1B030620060426T191004_20060426T192253_0001.DBL



Date	2006-04-26	**Instrument Mode**	Low Altitude
Start Time	19:10:04 (69004)	**Aircraft**	DNSC Twin Otter
Stop Time	19:22:52 (69772)	**Retracker**	OCOG
Distance	53.575 km	**GPS Resolution**	1 Hz
Duration	00 h 12 m 48 s	**Processor Version**	3.06

A04_20060426

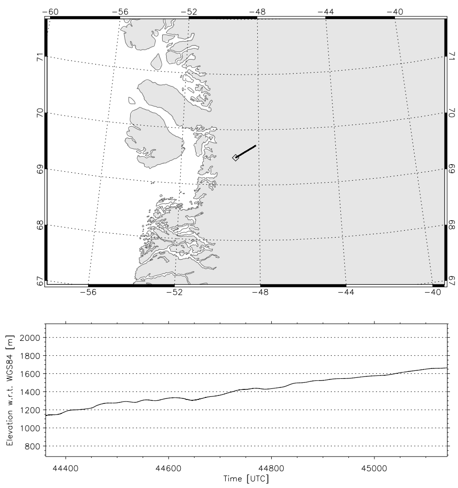
AS3TA04_ASILL1B030620060426T201632_20060426T202910_0001.DBL



Date	2006-04-26	**Instrument Mode**	Low Altitude
Start Time	20:16:32 (72992)	**Aircraft**	DNSC Twin Otter
Stop Time	20:29:09 (73749)	**Retracker**	OCOG
Distance	45.199 km	**GPS Resolution**	1 Hz
Duration	00 h 12 m 37 s	**Processor Version**	3.06

A00_20060429

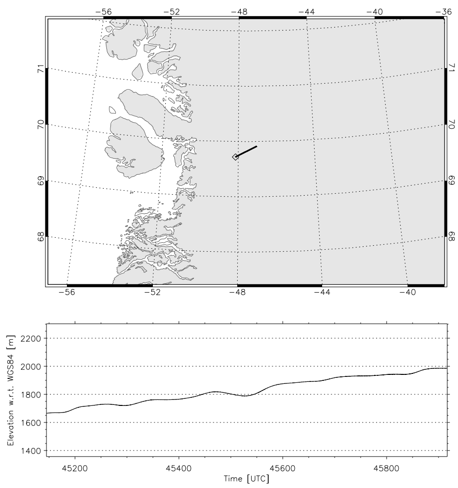
AS3TA00_ASILL1B030620060429T121921_20060429T123223_0001.DBL



Date	2006-04-29	Instrument Mode	Low Altitude
Start Time	12:19:21 (44361)	Aircraft	DNSC Twin Otter
Stop Time	12:32:21 (45141)	Retracker	OCOG
Distance	47.769 km	GPS Resolution	1 Hz
Duration	00 h 13 m 01 s	Processor Version	3.06

A01_20060429

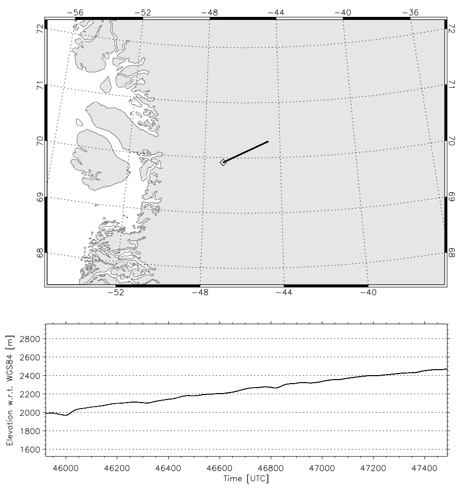
AS3TA01_ASILL1B030620060429T123225_20060429T124518_0001.DBL



Date	2006-04-29	Instrument Mode	Low Altitude
Start Time	12:32:25 (45145)	Aircraft	DNSC Twin Otter
Stop Time	12:45:16 (45916)	Retracker	OCOG
Distance	48.019 km	GPS Resolution	1 Hz
Duration	00 h 12 m 52 s	Processor Version	3.06

A02_20060429

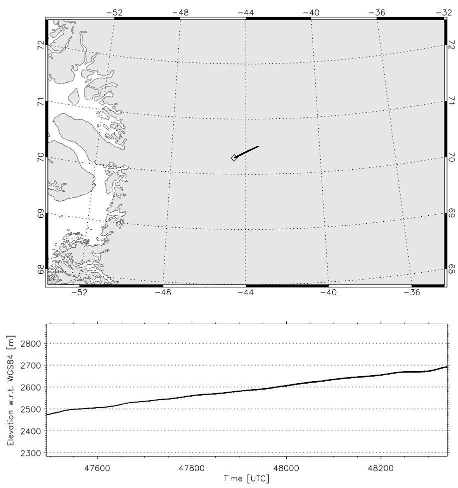
AS3TA02_ASILL1B030620060429T124521_20060429T131129_0001.DBL



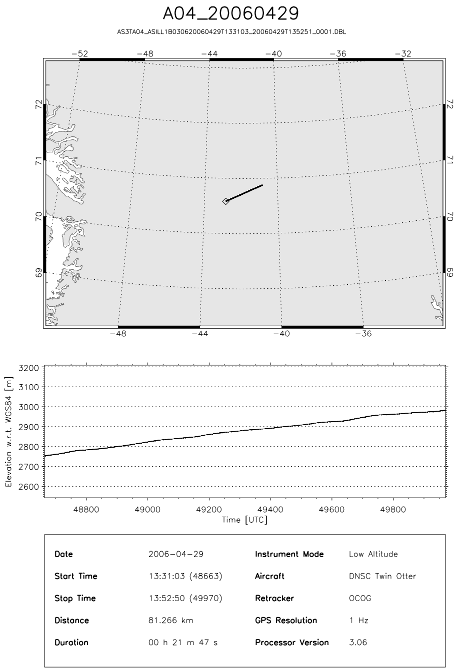
Date	2006-04-29	Instrument Mode	Low Altitude
Start Time	12:45:21 (45921)	Aircraft	DNSC Twin Otter
Stop Time	13:11:28 (47488)	Retracker	OCOG
Distance	100.010 km	GPS Resolution	1 Hz
Duration	00 h 26 m 07 s	Processor Version	3.06

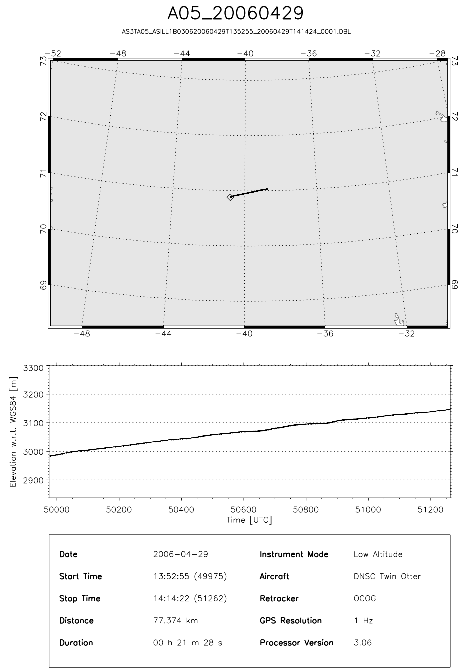
A03_20060429

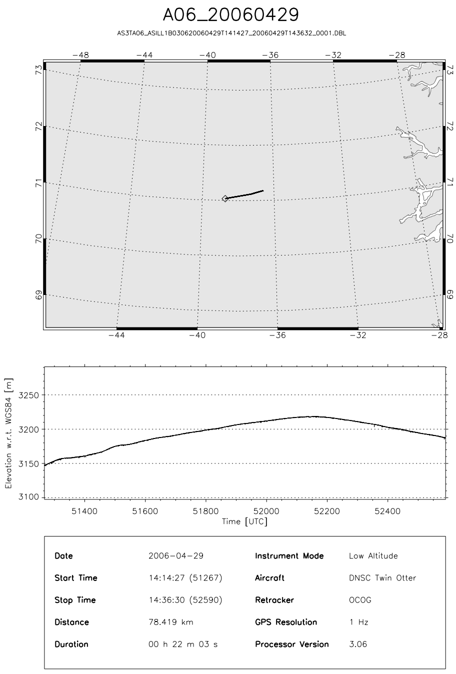
AS3TA03_ASILL1B030620060429T131132_20060429T132541_0001.DBL

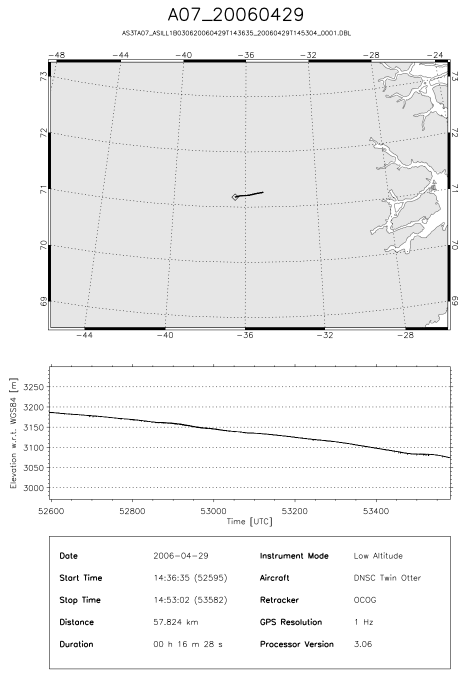


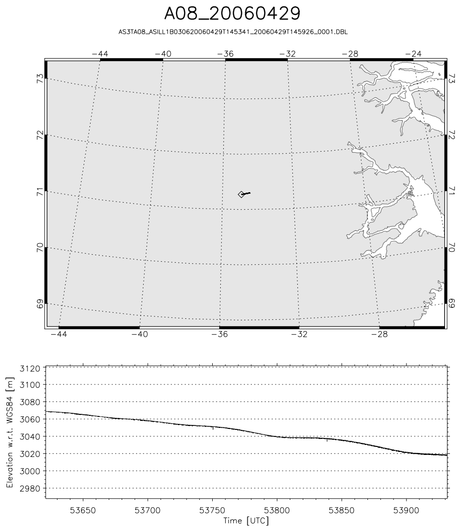
Date	2006-04-29	Instrument Mode	Low Altitude
Start Time	13:11:32 (47492)	Aircraft	DNSC Twin Otter
Stop Time	13:25:40 (48340)	Retracker	OCOG
Distance	53.364 km	GPS Resolution	1 Hz
Duration	00 h 14 m 08 s	Processor Version	3.06


A04_20060429
AS3TA04_ASILL1B030620060429T133103_20060429T135251_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-04-29
Instrument Mode Low Altitude
Start Time 13:31:03 (48663)
Aircraft DNSC Twin Otter
Stop Time 13:52:50 (49970)
Retracker OCOG
Distance 81.266 km
GPS Resolution 1 Hz
Duration 00 h 21 m 47 s
Processor Version 3.06

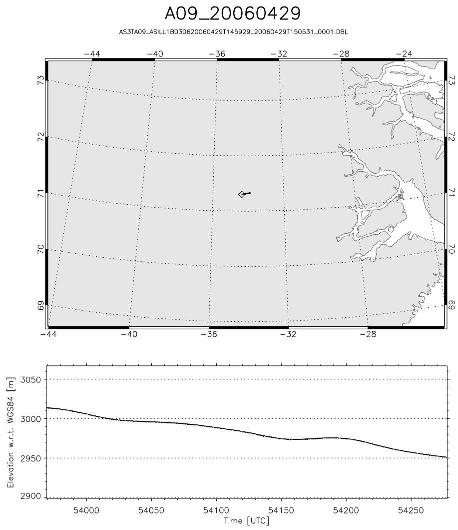

A05_20060429
AS3TA05_ASILL1B030620060429T135255_20060429T141424_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-04-29
Instrument Mode Low Altitude
Start Time 13:52:55 (49975)
Aircraft DNSC Twin Otter
Stop Time 14:14:22 (51262)
Retracker OCOG
Distance 77.374 km
GPS Resolution 1 Hz
Duration 00 h 21 m 28 s
Processor Version 3.06


A06_20060429
AS3TA06_ASILL1B030620060429T141427_20060429T143632_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-04-29
Instrument Mode Low Altitude
Start Time 14:14:27 (51267)
Aircraft DNSC Twin Otter
Stop Time 14:36:30 (52590)
Retracker OCOG
Distance 78.419 km
GPS Resolution 1 Hz
Duration 00 h 22 m 03 s
Processor Version 3.06

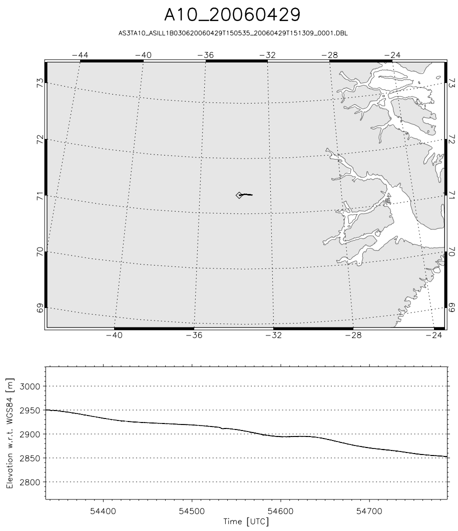

A07_20060429
AS3TA07_ASILL1B030620060429T143635_20060429T145304_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-04-29
Instrument Mode Low Altitude
Start Time 14:36:35 (52595)
Aircraft DNSC Twin Otter
Stop Time 14:53:02 (53582)
Retracker OCOG
Distance 57.824 km
GPS Resolution 1 Hz
Duration 00 h 16 m 28 s
Processor Version 3.06



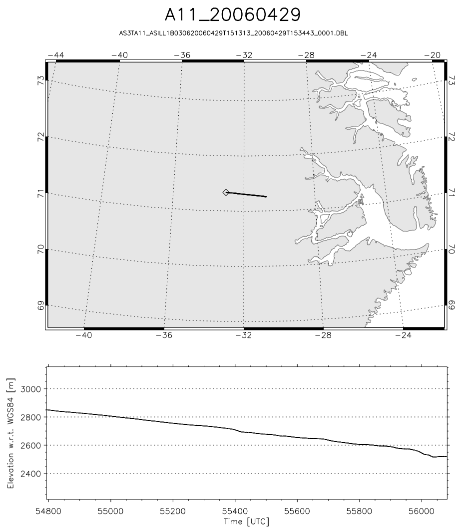
Date	2006–04–29	Instrument Mode	Low Altitude
Start Time	14:53:41 (53621)	Aircraft	DNSC Twin Otter
Stop Time	14:58:51 (53931)	Retracker	OCOG
Distance	18.222 km	GPS Resolution	1 Hz
Duration	00 h 05 m 11 s	Processor Version	3.06



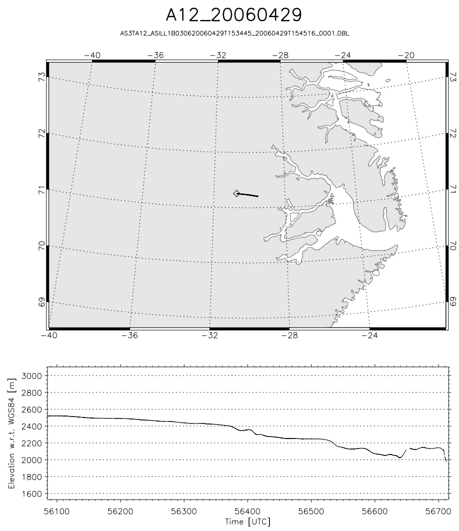
Date	2006–04–29	Instrument Mode	Low Altitude
Start Time	14:59:29 (53969)	Aircraft	DNSC Twin Otter
Stop Time	15:04:37 (54277)	Retracker	OCOG
Distance	18.135 km	GPS Resolution	1 Hz
Duration	00 h 05 m 09 s	Processor Version	3.06



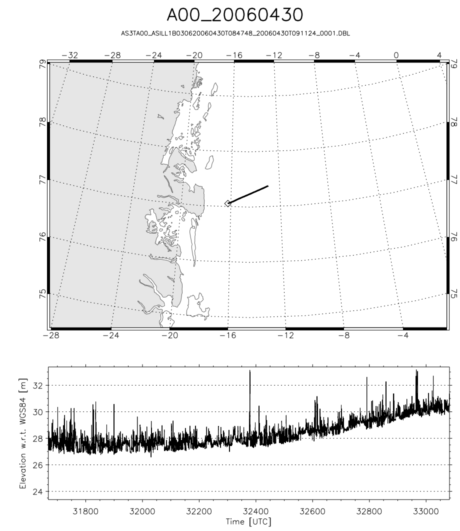
Date	2006–04–29	Instrument Mode	Low Altitude
Start Time	15:05:35 (54335)	Aircraft	DNSC Twin Otter
Stop Time	15:13:07 (54787)	Retracker	OCOG
Distance	26.910 km	GPS Resolution	1 Hz
Duration	00 h 07 m 33 s	Processor Version	3.06



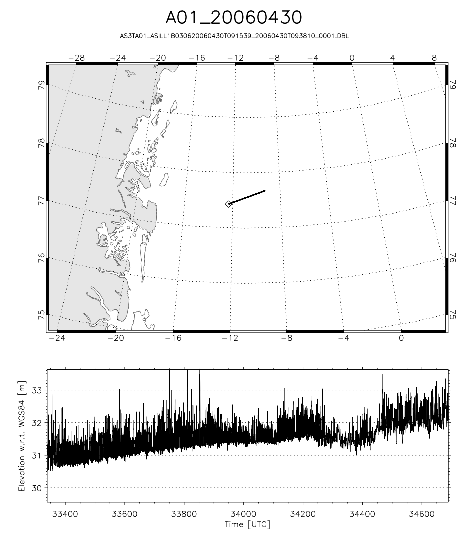
Date	2006–04–29	Instrument Mode	Low Altitude
Start Time	15:13:13 (54793)	Aircraft	DNSC Twin Otter
Stop Time	15:34:42 (56082)	Retracker	OCOG
Distance	82.160 km	GPS Resolution	1 Hz
Duration	00 h 21 m 29 s	Processor Version	3.06



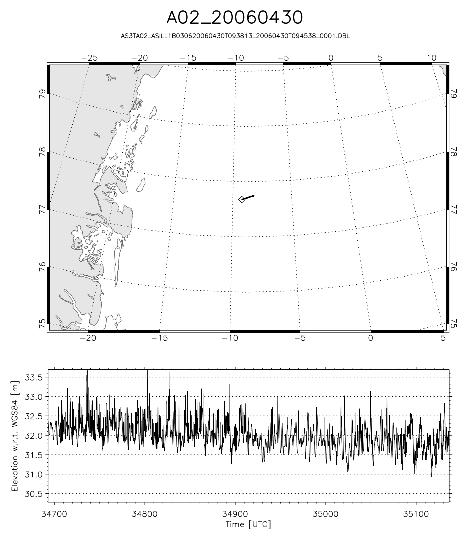
Date	2006-04-29	**Instrument Mode**	Low Altitude
Start Time	15:34:45 (56085)	**Aircraft**	DNSC Twin Otter
Stop Time	15:45:15 (56715)	**Retracker**	OCOG
Distance	43.540 km	**GPS Resolution**	1 Hz
Duration	00 h 10 m 31 s	**Processor Version**	3.06



Date	2006-04-30	**Instrument Mode**	Low Altitude
Start Time	08:47:48 (31668)	**Aircraft**	DNSC Twin Otter
Stop Time	09:11:22 (33082)	**Retracker**	OCOG
Distance	88.525 km	**GPS Resolution**	1 Hz
Duration	00 h 23 m 34 s	**Processor Version**	3.06



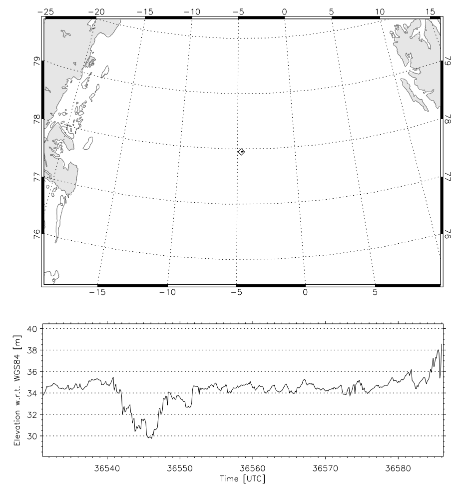
Date	2006-04-30	**Instrument Mode**	Low Altitude
Start Time	09:15:39 (33339)	**Aircraft**	DNSC Twin Otter
Stop Time	09:38:09 (34689)	**Retracker**	OCOG
Distance	79.087 km	**GPS Resolution**	1 Hz
Duration	00 h 22 m 30 s	**Processor Version**	3.06



Date	2006-04-30	**Instrument Mode**	Low Altitude
Start Time	09:38:13 (34693)	**Aircraft**	DNSC Twin Otter
Stop Time	09:45:36 (35136)	**Retracker**	OCOG
Distance	26.207 km	**GPS Resolution**	1 Hz
Duration	00 h 07 m 24 s	**Processor Version**	3.06

A03_20060430

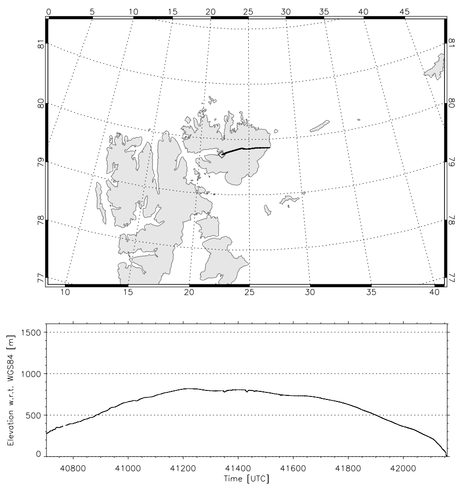
AS3TA03_ASIHL1B030620060430T100850_20060430T102307_0001.DBL



Date	2006-04-30	Instrument Mode	High Altitude
Start Time	10:08:51 (36531)	Aircraft	DNSC Twin Otter
Stop Time	10:09:46 (36586)	Retracker	OCOG
Distance	3.925 km	GPS Resolution	1 Hz
Duration	00 h 00 m 55 s	Processor Version	3.06

A00_20060501

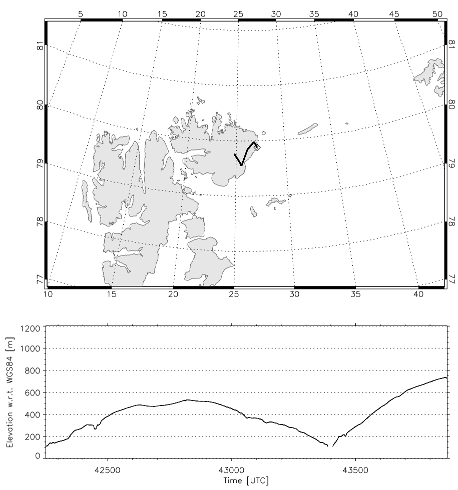
AS3TA00_ASILL1B030620060501T111823_20060501T114240_0001.DBL



Date	2006-05-01	Instrument Mode	Low Altitude
Start Time	11:18:23 (40703)	Aircraft	DNSC Twin Otter
Stop Time	11:42:39 (42159)	Retracker	OCOG
Distance	100.201 km	GPS Resolution	1 Hz
Duration	00 h 24 m 16 s	Processor Version	3.06

A01_20060501

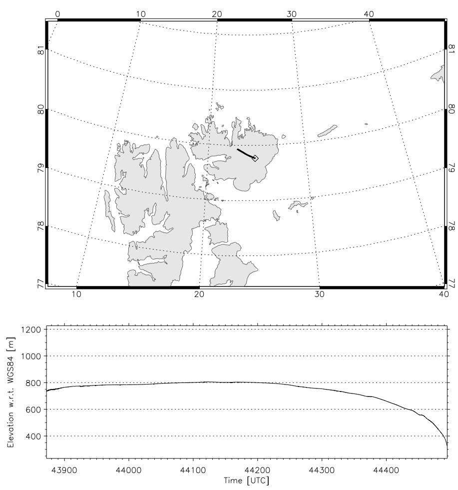
AS3TA01_ASILL1B030620060501T114410_20060501T121110_0001.DBL



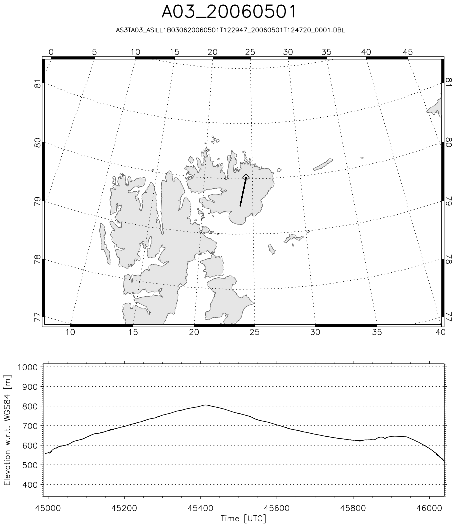
Date	2006-05-01	Instrument Mode	Low Altitude
Start Time	11:44:10 (42250)	Aircraft	DNSC Twin Otter
Stop Time	12:11:09 (43869)	Retracker	OCOG
Distance	95.396 km	GPS Resolution	1 Hz
Duration	00 h 26 m 59 s	Processor Version	3.06

A02_20060501

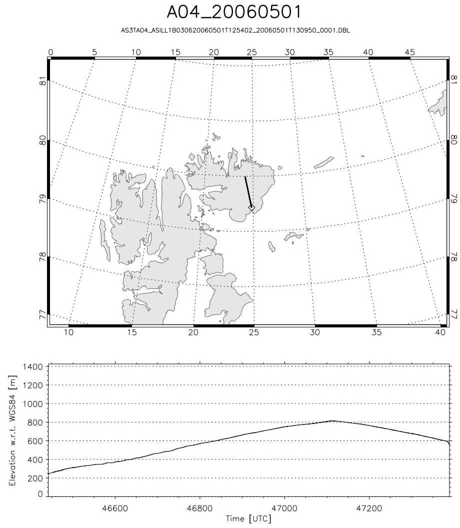
AS3TA02_ASILL1B030620060501T121112_20060501T122135_0001.DBL



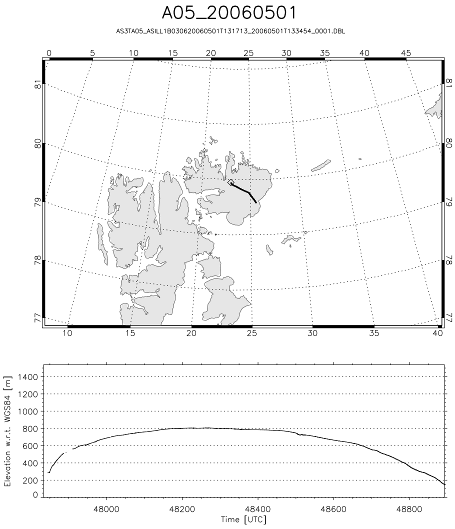
Date	2006-05-01	Instrument Mode	Low Altitude
Start Time	12:11:12 (43872)	Aircraft	DNSC Twin Otter
Stop Time	12:21:34 (44494)	Retracker	OCOG
Distance	40.361 km	GPS Resolution	1 Hz
Duration	00 h 10 m 22 s	Processor Version	3.06



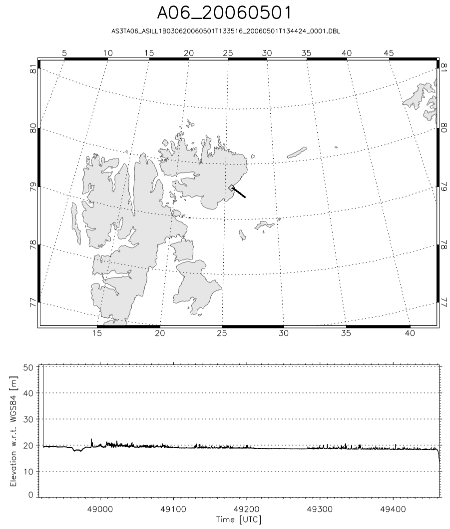
Date	2006-05-01	**Instrument Mode**	Low Altitude
Start Time	12:29:47 (44987)	**Aircraft**	DNSC Twin Otter
Stop Time	12:47:19 (46039)	**Retracker**	OCOG
Distance	59.348 km	**GPS Resolution**	1 Hz
Duration	00 h 17 m 32 s	**Processor Version**	3.06



Date	2006-05-01	**Instrument Mode**	Low Altitude
Start Time	12:54:02 (46442)	**Aircraft**	DNSC Twin Otter
Stop Time	13:09:49 (47389)	**Retracker**	OCOG
Distance	63.828 km	**GPS Resolution**	1 Hz
Duration	00 h 15 m 47 s	**Processor Version**	3.06



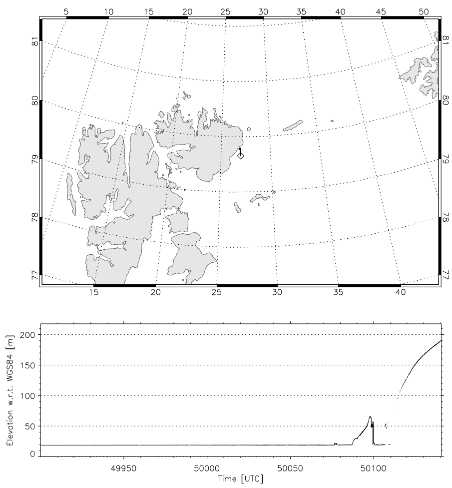
Date	2006-05-01	**Instrument Mode**	Low Altitude
Start Time	13:17:13 (47833)	**Aircraft**	DNSC Twin Otter
Stop Time	13:34:52 (48892)	**Retracker**	OCOG
Distance	67.745 km	**GPS Resolution**	1 Hz
Duration	00 h 17 m 40 s	**Processor Version**	3.06



Date	2006-05-01	**Instrument Mode**	Low Altitude
Start Time	13:35:16 (48916)	**Aircraft**	DNSC Twin Otter
Stop Time	13:44:23 (49463)	**Retracker**	OCOG
Distance	33.896 km	**GPS Resolution**	1 Hz
Duration	00 h 09 m 07 s	**Processor Version**	3.06

A07_20060501

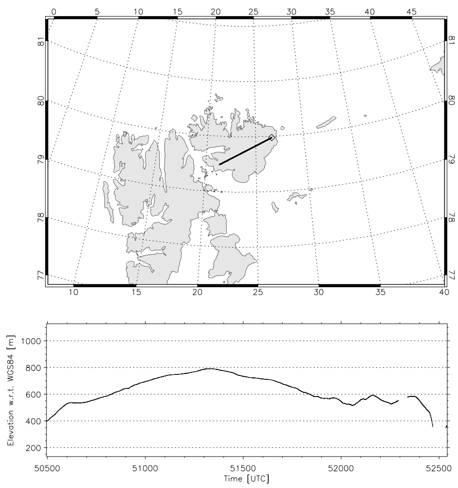
AS3TA07_ASILL1B030620060501T135140_20060501T135541_0001.DBL



Date	2006-05-01	Instrument Mode	Low Altitude
Start Time	13:51:40 (49900)	Aircraft	DNSC Twin Otter
Stop Time	13:55:40 (50140)	Retracker	OCOG
Distance	16.827 km	GPS Resolution	1 Hz
Duration	00 h 04 m 01 s	Processor Version	3.06

A08_20060501

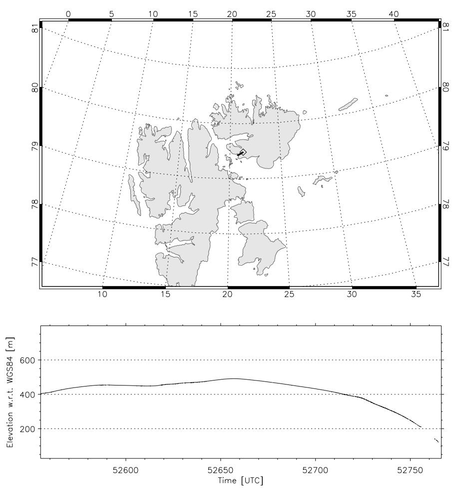
AS3TA08_ASILL1B030620060501T140135_20060501T143542_0001.DBL



Date	2006-05-01	Instrument Mode	Low Altitude
Start Time	14:01:35 (50495)	Aircraft	DNSC Twin Otter
Stop Time	14:35:41 (52541)	Retracker	OCOG
Distance	118.806 km	GPS Resolution	1 Hz
Duration	00 h 34 m 06 s	Processor Version	3.06

A09_20060501

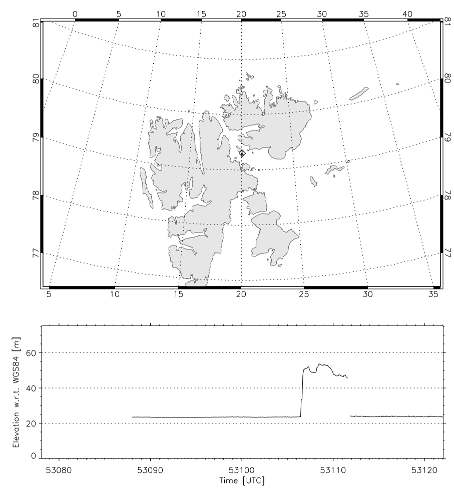
AS3TA09_ASILL1B030620060501T143555_20060501T143927_0001.DBL



Date	2006-05-01	Instrument Mode	Low Altitude
Start Time	14:35:55 (52555)	Aircraft	DNSC Twin Otter
Stop Time	14:39:26 (52766)	Retracker	OCOG
Distance	13.312 km	GPS Resolution	1 Hz
Duration	00 h 03 m 31 s	Processor Version	3.06

A10_20060501

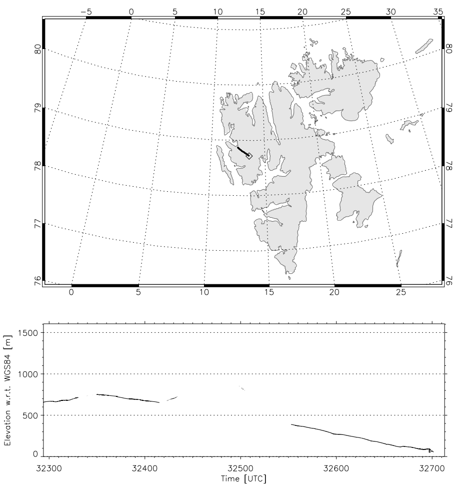
AS3TA10_ASILL1B030620060501T144438_20060501T144523_0001.DBL



Date	2006-05-01	Instrument Mode	Low Altitude
Start Time	14:44:38 (53078)	Aircraft	DNSC Twin Otter
Stop Time	14:45:22 (53122)	Retracker	OCOG
Distance	3.051 km	GPS Resolution	1 Hz
Duration	00 h 00 m 44 s	Processor Version	3.06

A00_20060502

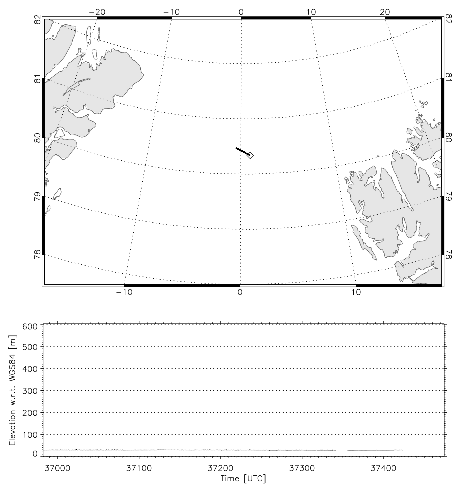
AS3TA00_ASILL1B030620060502T085814_20060502T090514_0001.DBL



Date	2006-05-02	Instrument Mode	Low Altitude
Start Time	08:58:14 (32294)	Aircraft	DNSC Twin Otter
Stop Time	09:05:13 (32713)	Retracker	OCOG
Distance	29.261 km	GPS Resolution	1 Hz
Duration	00 h 06 m 59 s	Processor Version	3.06

A01_20060502

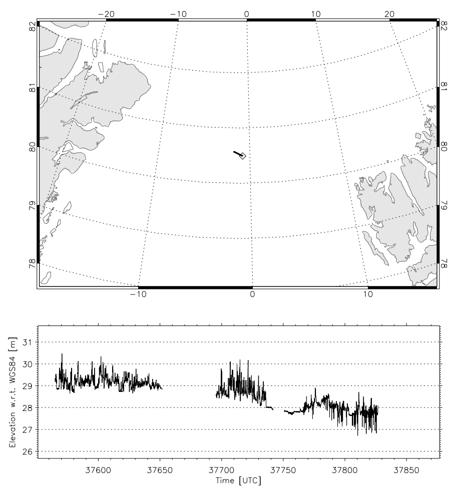
AS3TA01_ASILL1B030620060502T101622_20060502T102437_0001.DBL



Date	2006-05-02	Instrument Mode	Low Altitude
Start Time	10:16:22 (36982)	Aircraft	DNSC Twin Otter
Stop Time	10:24:34 (37474)	Retracker	OCOG
Distance	32.070 km	GPS Resolution	1 Hz
Duration	00 h 08 m 12 s	Processor Version	3.06

A02_20060502

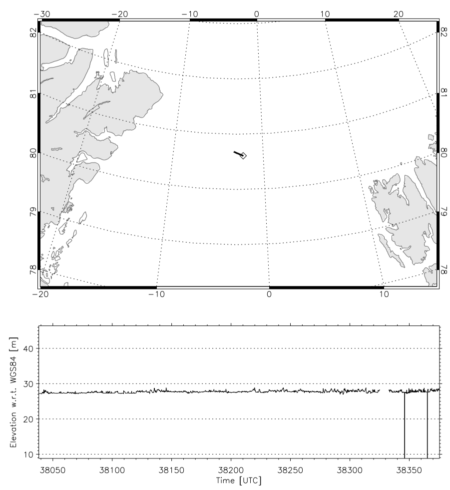
AS3TA02_ASILL1B030620060502T102551_20060502T103118_0001.DBL



Date	2006-05-02	Instrument Mode	Low Altitude
Start Time	10:25:51 (37551)	Aircraft	DNSC Twin Otter
Stop Time	10:31:16 (37876)	Retracker	OCOG
Distance	20.083 km	GPS Resolution	1 Hz
Duration	00 h 05 m 26 s	Processor Version	3.06

A03_20060502

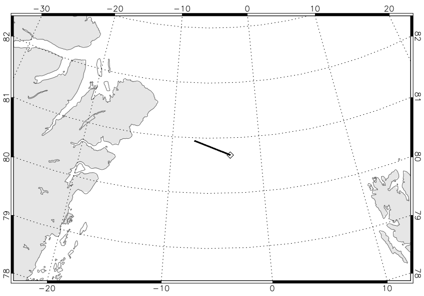
AS3TA03_ASILL1B030620060502T103358_20060502T103938_0001.DBL

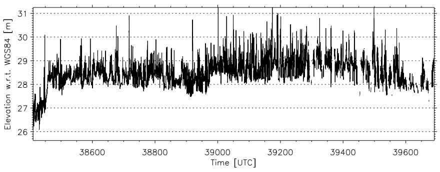


Date	2006-05-02	Instrument Mode	Low Altitude
Start Time	10:33:58 (38038)	Aircraft	DNSC Twin Otter
Stop Time	10:39:35 (38375)	Retracker	OCOG
Distance	20.282 km	GPS Resolution	1 Hz
Duration	00 h 05 m 37 s	Processor Version	3.06

A04_20060502

AS3TA04_ASILL1B030620060502T104011_20060502T110132_0001.DBL

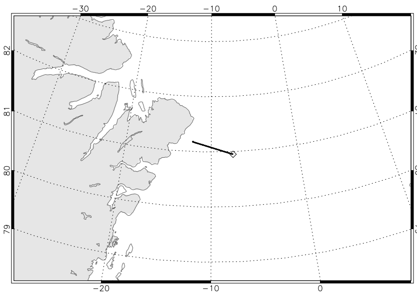


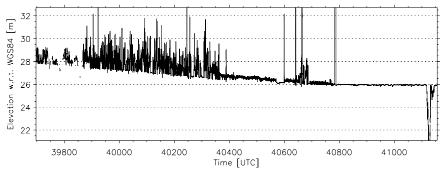


Date	2006–05–02	**Instrument Mode**	Low Altitude
Start Time	10:40:11 (38411)	**Aircraft**	DNSC Twin Otter
Stop Time	11:01:30 (39690)	**Retracker**	OCOG
Distance	77.741 km	**GPS Resolution**	1 Hz
Duration	00 h 21 m 20 s	**Processor Version**	3.06

A05_20060502

AS3TA05_ASILL1B030620060502T110137_20060502T112556_0001.DBL

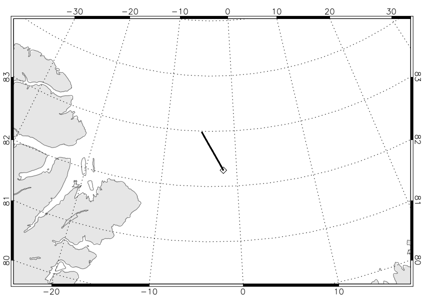


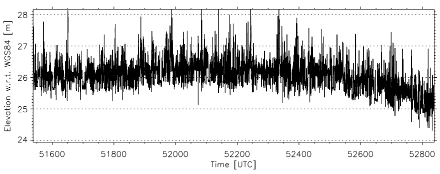


Date	2006–05–02	**Instrument Mode**	Low Altitude
Start Time	11:01:37 (39697)	**Aircraft**	DNSC Twin Otter
Stop Time	11:25:55 (41155)	**Retracker**	OCOG
Distance	86.054 km	**GPS Resolution**	1 Hz
Duration	00 h 24 m 19 s	**Processor Version**	3.06

A06_20060502

AS3TA06_ASILL1B030620060502T141858_20060502T144040_0001.DBL

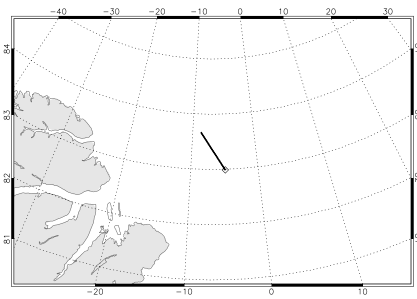


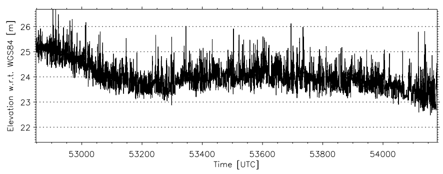


Date	2006–05–02	**Instrument Mode**	Low Altitude
Start Time	14:18:58 (51538)	**Aircraft**	DNSC Twin Otter
Stop Time	14:40:38 (52838)	**Retracker**	OCOG
Distance	88.230 km	**GPS Resolution**	1 Hz
Duration	00 h 21 m 41 s	**Processor Version**	3.06

A07_20060502

AS3TA07_ASILL1B030620060502T144048_20060502T150301_0001.DBL

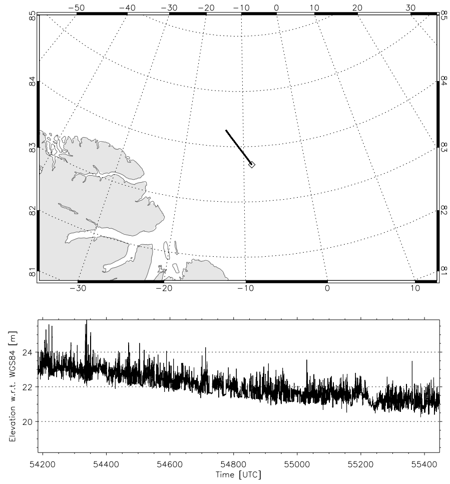




Date	2006–05–02	**Instrument Mode**	Low Altitude
Start Time	14:40:48 (52848)	**Aircraft**	DNSC Twin Otter
Stop Time	15:02:59 (54179)	**Retracker**	OCOG
Distance	90.180 km	**GPS Resolution**	1 Hz
Duration	00 h 22 m 12 s	**Processor Version**	3.06

A08_20060502

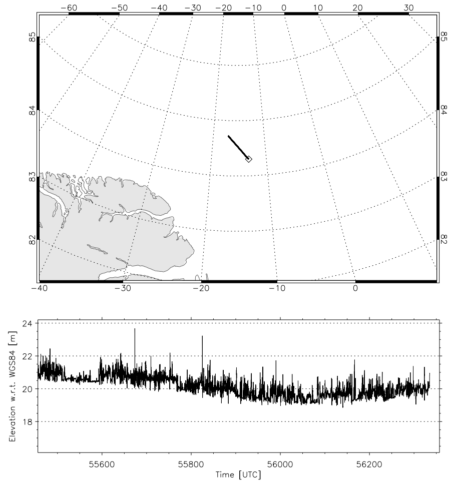
AS3TA08_ASILL1B030620060502T150305_20060502T152408_0001.DBL



Date	2006-05-02	**Instrument Mode**	Low Altitude
Start Time	15:03:05 (54185)	**Aircraft**	DNSC Twin Otter
Stop Time	15:24:07 (55447)	**Retracker**	OCOG
Distance	87.035 km	**GPS Resolution**	1 Hz
Duration	00 h 21 m 02 s	**Processor Version**	3.06

A09_20060502

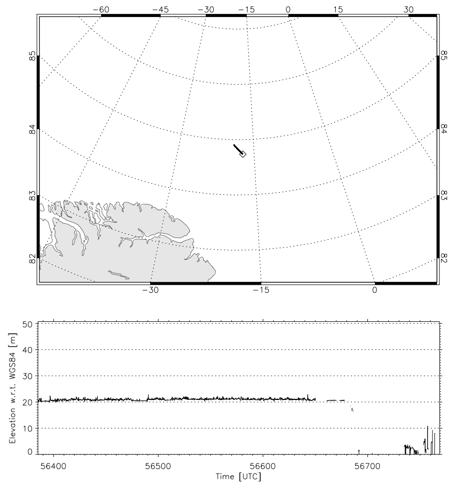
AS3TA09_ASILL1B030620060502T152416_20060502T153918_0001.DBL



Date	2006-05-02	**Instrument Mode**	Low Altitude
Start Time	15:24:16 (55456)	**Aircraft**	DNSC Twin Otter
Stop Time	15:39:17 (56357)	**Retracker**	OCOG
Distance	62.584 km	**GPS Resolution**	1 Hz
Duration	00 h 15 m 01 s	**Processor Version**	3.06

A10_20060502

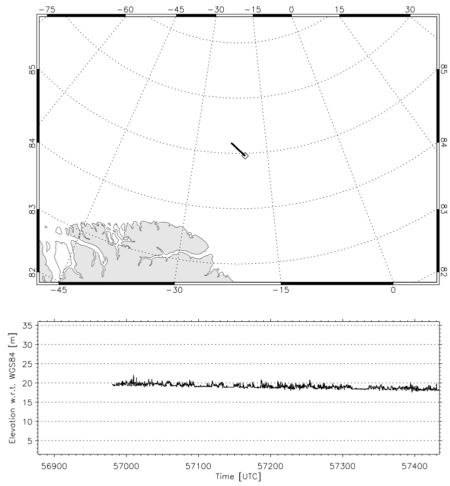
AS3TA10_ASILL1B030620060502T153945_20060502T154610_0001.DBL



Date	2006-05-02	**Instrument Mode**	Low Altitude
Start Time	15:39:45 (56385)	**Aircraft**	DNSC Twin Otter
Stop Time	15:46:08 (56768)	**Retracker**	OCOG
Distance	26.550 km	**GPS Resolution**	1 Hz
Duration	00 h 06 m 24 s	**Processor Version**	3.06

A11_20060502

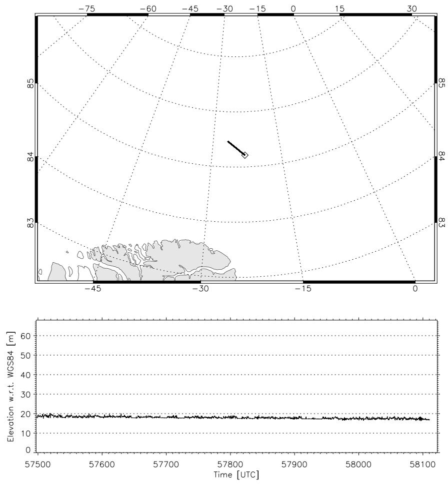
AS3TA11_ASILL1B030620060502T154757_20060502T155715_0001.DBL



Date	2006-05-02	**Instrument Mode**	Low Altitude
Start Time	15:47:57 (56877)	**Aircraft**	DNSC Twin Otter
Stop Time	15:57:14 (57434)	**Retracker**	OCOG
Distance	37.850 km	**GPS Resolution**	1 Hz
Duration	00 h 09 m 17 s	**Processor Version**	3.06

A12_20060502

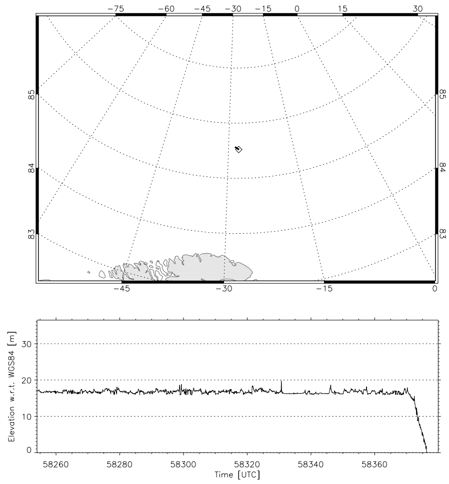
AS3TA12_ASILL1B030620060502T155817_20060502T160843_0001.DBL



Date	2006–05–02	**Instrument Mode**	Low Altitude
Start Time	15:58:17 (57497)	**Aircraft**	DNSC Twin Otter
Stop Time	16:08:42 (58122)	**Retracker**	OCOG
Distance	44.601 km	**GPS Resolution**	1 Hz
Duration	00 h 10 m 25 s	**Processor Version**	3.06

A13_20060502

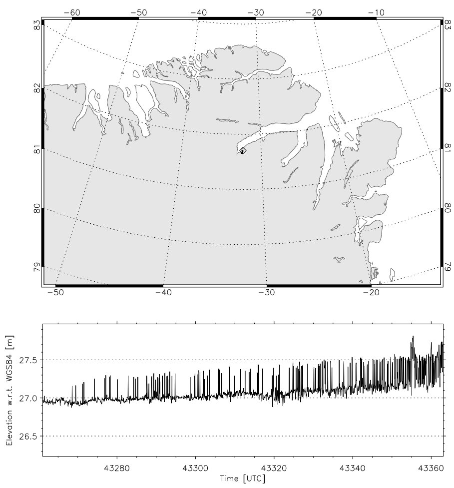
AS3TA13_ASILL1B030620060502T161054_20060502T161301_0001.DBL



Date	2006–05–02	**Instrument Mode**	Low Altitude
Start Time	16:10:54 (58254)	**Aircraft**	DNSC Twin Otter
Stop Time	16:12:59 (58379)	**Retracker**	OCOG
Distance	8.634 km	**GPS Resolution**	1 Hz
Duration	00 h 02 m 06 s	**Processor Version**	3.06

A00_20060503

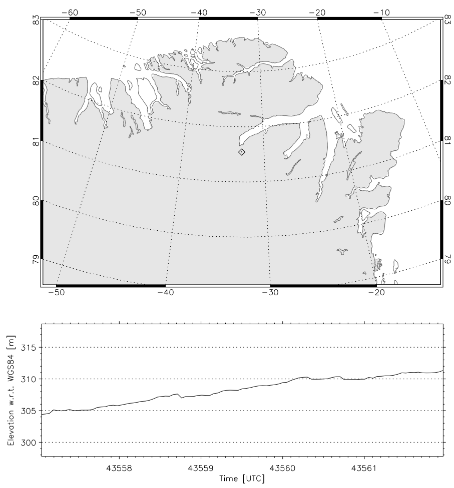
AS3TA00_ASILL1B030620060503T120101_20060503T120553_0001.DBL



Date	2006–05–03	**Instrument Mode**	Low Altitude
Start Time	12:01:01 (43261)	**Aircraft**	DNSC Twin Otter
Stop Time	12:02:43 (43363)	**Retracker**	OCOG
Distance	6.770 km	**GPS Resolution**	1 Hz
Duration	00 h 01 m 42 s	**Processor Version**	3.06

A01_20060503

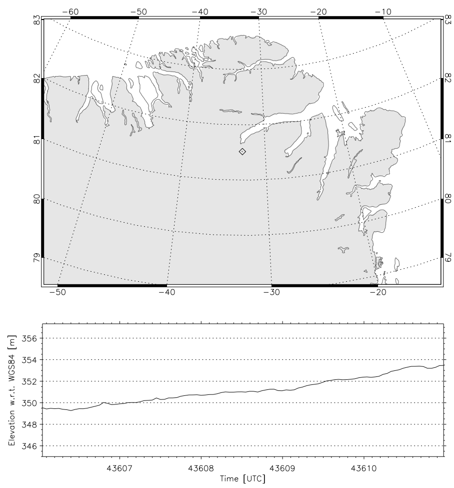
AS3TA01_ASILL1B030620060503T120557_20060503T120642_0001.DBL



Date	2006–05–03	**Instrument Mode**	Low Altitude
Start Time	12:05:57 (43557)	**Aircraft**	DNSC Twin Otter
Stop Time	12:06:01 (43561)	**Retracker**	OCOG
Distance	0.315 km	**GPS Resolution**	1 Hz
Duration	00 h 00 m 05 s	**Processor Version**	3.06

A02_20060503

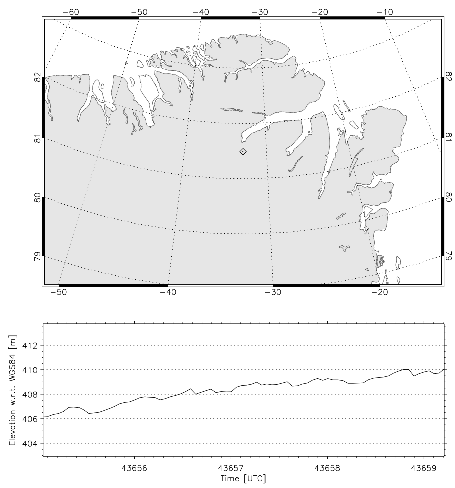
AS3TA02_ASILL1B030620060503T120646_20060503T120732_0001.DBL



Date	2006-05-03	**Instrument Mode**	Low Altitude
Start Time	12:06:46 (43606)	**Aircraft**	DNSC Twin Otter
Stop Time	12:06:50 (43610)	**Retracker**	OCOG
Distance	0.316 km	**GPS Resolution**	1 Hz
Duration	00 h 00 m 05 s	**Processor Version**	3.06

A03_20060503

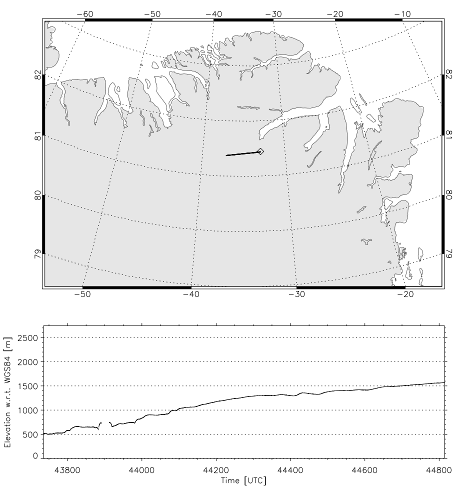
AS3TA03_ASILL1B030620060503T120735_20060503T120818_0001.DBL



Date	2006-05-03	**Instrument Mode**	Low Altitude
Start Time	12:07:35 (43655)	**Aircraft**	DNSC Twin Otter
Stop Time	12:07:39 (43659)	**Retracker**	OCOG
Distance	0.259 km	**GPS Resolution**	1 Hz
Duration	00 h 00 m 04 s	**Processor Version**	3.06

A04_20060503

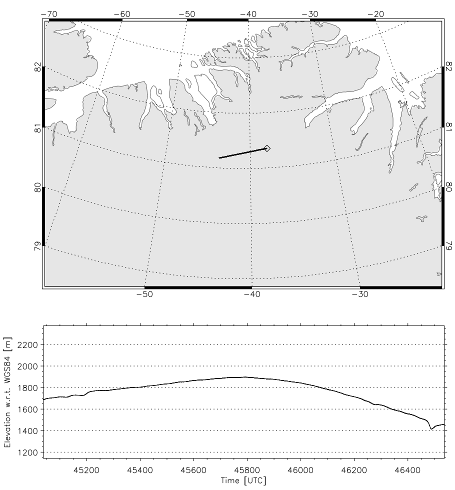
AS3TA04_ASILL1B030620060503T120855_20060503T123033_0001.DBL



Date	2006-05-03	**Instrument Mode**	Low Altitude
Start Time	12:08:55 (43735)	**Aircraft**	DNSC Twin Otter
Stop Time	12:26:54 (44814)	**Retracker**	OCOG
Distance	70.123 km	**GPS Resolution**	1 Hz
Duration	00 h 17 m 60 s	**Processor Version**	3.06

A05_20060503

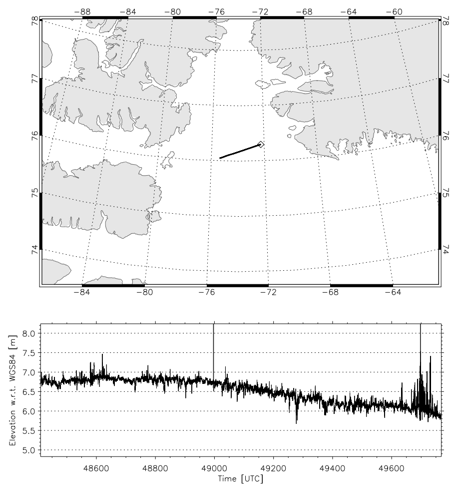
AS3TA05_ASILL1B030620060503T123038_20060503T125538_0001.DBL



Date	2006-05-03	**Instrument Mode**	Low Altitude
Start Time	12:30:38 (45038)	**Aircraft**	DNSC Twin Otter
Stop Time	12:55:36 (46536)	**Retracker**	OCOG
Distance	98.330 km	**GPS Resolution**	1 Hz
Duration	00 h 24 m 59 s	**Processor Version**	3.06

A00_20060505

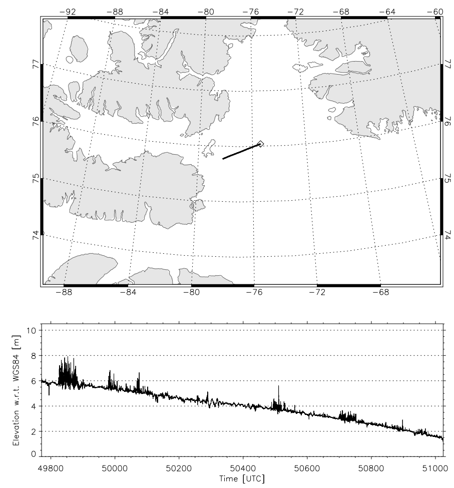
AS3TA00_ASILL1B030620060505T132651_20060505T134929_0001.DBL



Date	2006-05-05	**Instrument Mode**	Low Altitude
Start Time	13:26:51 (48411)	**Aircraft**	DNSC Twin Otter
Stop Time	13:49:28 (49768)	**Retracker**	OCOG
Distance	87.788 km	**GPS Resolution**	1 Hz
Duration	00 h 22 m 37 s	**Processor Version**	3.06

A01_20060505

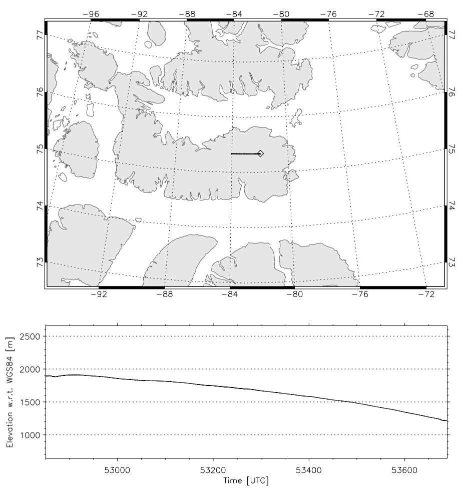
AS3TA01_ASILL1B030620060505T134931_20060505T141025_0001.DBL



Date	2006-05-05	**Instrument Mode**	Low Altitude
Start Time	13:49:31 (49771)	**Aircraft**	DNSC Twin Otter
Stop Time	14:10:24 (51024)	**Retracker**	OCOG
Distance	81.957 km	**GPS Resolution**	1 Hz
Duration	00 h 20 m 53 s	**Processor Version**	3.06

A02_20060505

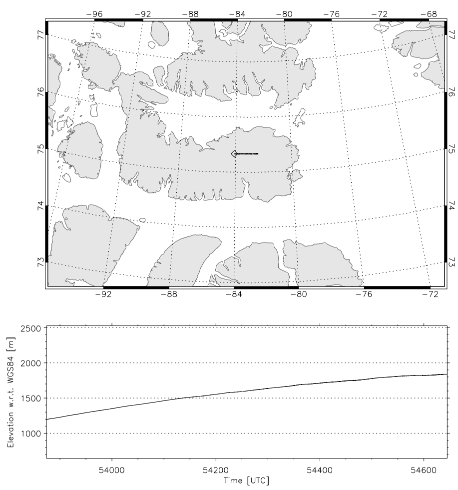
AS3TA02_ASILL1B030620060505T144050_20060505T145450_0001.DBL



Date	2006-05-05	**Instrument Mode**	Low Altitude
Start Time	14:40:50 (52850)	**Aircraft**	DNSC Twin Otter
Stop Time	14:54:48 (53688)	**Retracker**	OCOG
Distance	58.710 km	**GPS Resolution**	1 Hz
Duration	00 h 13 m 59 s	**Processor Version**	3.06

A03_20060505

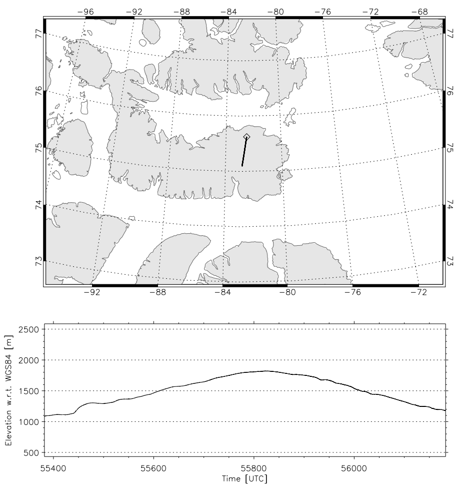
AS3TA03_ASILL1B030620060505T145754_20060505T151046_0001.DBL



Date	2006-05-05	**Instrument Mode**	Low Altitude
Start Time	14:57:54 (53874)	**Aircraft**	DNSC Twin Otter
Stop Time	15:10:44 (54644)	**Retracker**	OCOG
Distance	47.735 km	**GPS Resolution**	1 Hz
Duration	00 h 12 m 51 s	**Processor Version**	3.06

A04_20060505

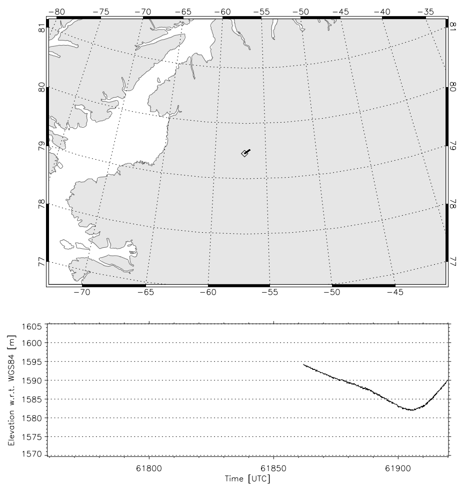
AS3TA04_ASILL1B030620060505T152302_20060505T153623_0001.DBL



Date	2006-05-05	**Instrument Mode**	Low Altitude
Start Time	15:23:02 (55382)	**Aircraft**	DNSC Twin Otter
Stop Time	15:36:22 (56182)	**Retracker**	OCOG
Distance	60.201 km	**GPS Resolution**	1 Hz
Duration	00 h 13 m 20 s	**Processor Version**	3.06

A00_20060508

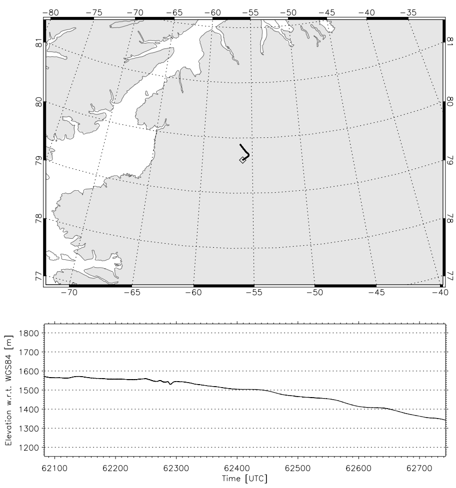
AS3TA00_ASILL1B030620060508T170919_20060508T171202_0001.DBL



Date	2006-05-08	**Instrument Mode**	Low Altitude
Start Time	17:09:19 (61759)	**Aircraft**	DNSC Twin Otter
Stop Time	17:12:00 (61920)	**Retracker**	OCOG
Distance	13.311 km	**GPS Resolution**	1 Hz
Duration	00 h 02 m 41 s	**Processor Version**	3.06

A01_20060508

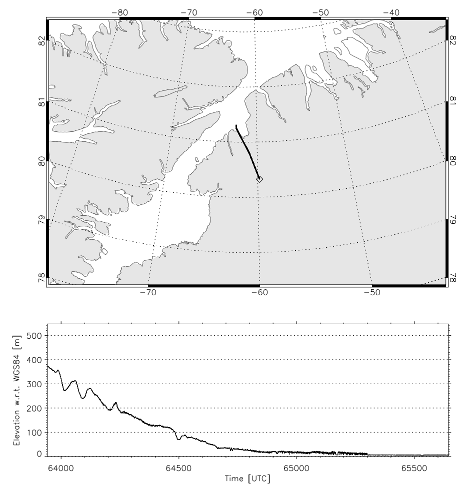
AS3TA01_ASILL1B030620060508T171443_20060508T172544_0001.DBL



Date	2006-05-08	**Instrument Mode**	Low Altitude
Start Time	17:14:43 (62083)	**Aircraft**	DNSC Twin Otter
Stop Time	17:25:42 (62742)	**Retracker**	OCOG
Distance	44.930 km	**GPS Resolution**	1 Hz
Duration	00 h 10 m 60 s	**Processor Version**	3.06

A02_20060508

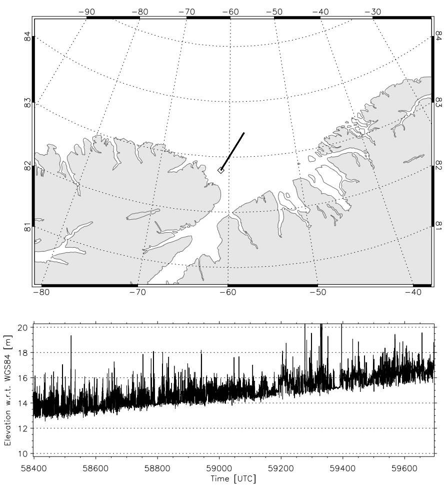
AS3TA02_ASILL1B030620060508T174541_20060508T181405_0001.DBL



Date	2006-05-08	**Instrument Mode**	Low Altitude
Start Time	17:45:41 (63941)	**Aircraft**	DNSC Twin Otter
Stop Time	18:14:04 (65644)	**Retracker**	OCOG
Distance	120.048 km	**GPS Resolution**	1 Hz
Duration	00 h 28 m 23 s	**Processor Version**	3.06

A00_20060509

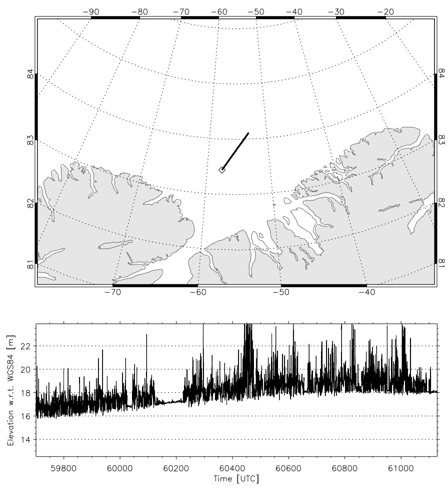
AS3TA00_ASILL1B030620060509T161317_20060509T163457_0001.DBL



Date	2006−05−09	**Instrument Mode**	Low Altitude
Start Time	16:13:17 (58397)	**Aircraft**	DNSC Twin Otter
Stop Time	16:34:55 (59695)	**Retracker**	OCOG
Distance	88.948 km	**GPS Resolution**	1 Hz
Duration	00 h 21 m 39 s	**Processor Version**	3.06

A01_20060509

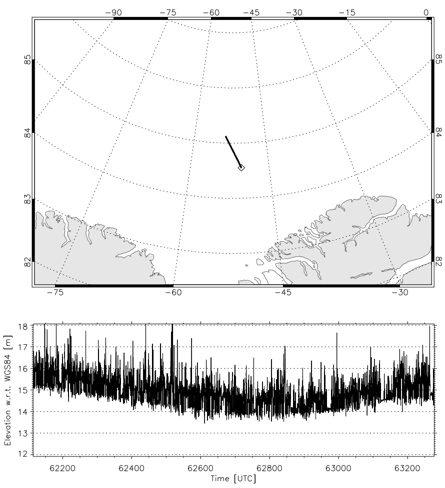
AS3TA01_ASILL1B030620060509T163501_20060509T165849_0001.DBL



Date	2006−05−09	**Instrument Mode**	Low Altitude
Start Time	16:35:01 (59701)	**Aircraft**	DNSC Twin Otter
Stop Time	16:58:48 (61128)	**Retracker**	OCOG
Distance	91.914 km	**GPS Resolution**	1 Hz
Duration	00 h 23 m 47 s	**Processor Version**	3.06

A02_20060509

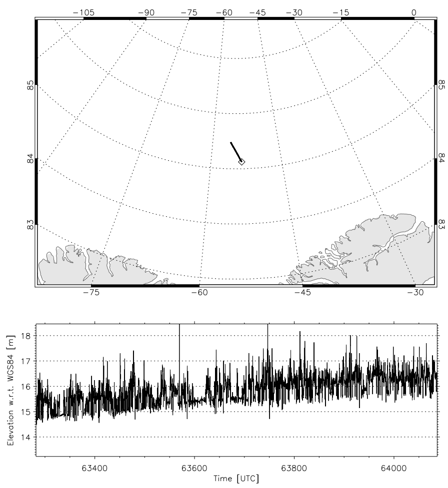
AS3TA02_ASILL1B030620060509T171514_20060509T173439_0001.DBL



Date	2006−05−09	**Instrument Mode**	Low Altitude
Start Time	17:15:14 (62114)	**Aircraft**	DNSC Twin Otter
Stop Time	17:34:37 (63277)	**Retracker**	OCOG
Distance	70.839 km	**GPS Resolution**	1 Hz
Duration	00 h 19 m 24 s	**Processor Version**	3.06

A03_20060509

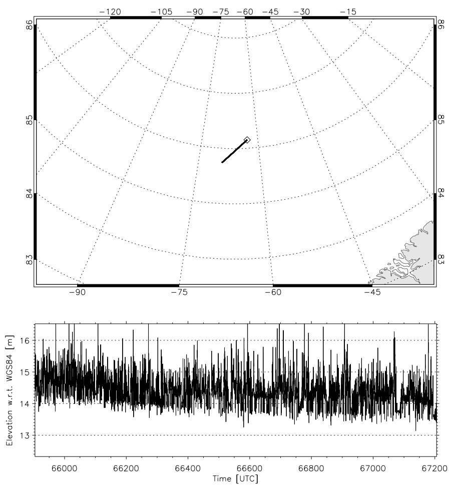
AS3TA03_ASILL1B030620060509T173442_20060509T175617_0001.DBL



Date	2006−05−09	**Instrument Mode**	Low Altitude
Start Time	17:34:42 (63282)	**Aircraft**	DNSC Twin Otter
Stop Time	17:48:06 (64086)	**Retracker**	OCOG
Distance	45.390 km	**GPS Resolution**	1 Hz
Duration	00 h 13 m 25 s	**Processor Version**	3.06

A04_20060509

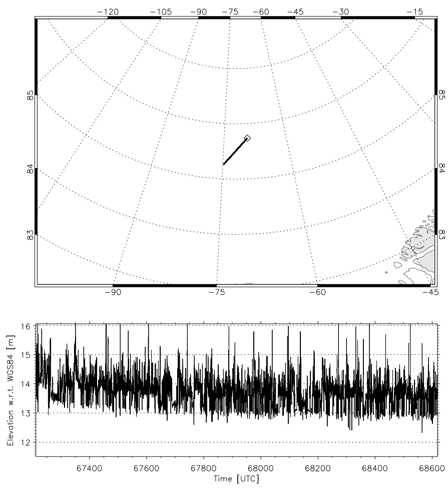
AS3TA04_ASILL1B030620060509T181824_20060509T184007_0001.DBL



Date	2006-05-09	Instrument Mode	Low Altitude
Start Time	18:18:24 (65904)	Aircraft	DNSC Twin Otter
Stop Time	18:40:05 (67205)	Retracker	OCOG
Distance	68.391 km	GPS Resolution	1 Hz
Duration	00 h 21 m 42 s	Processor Version	3.06

A05_20060509

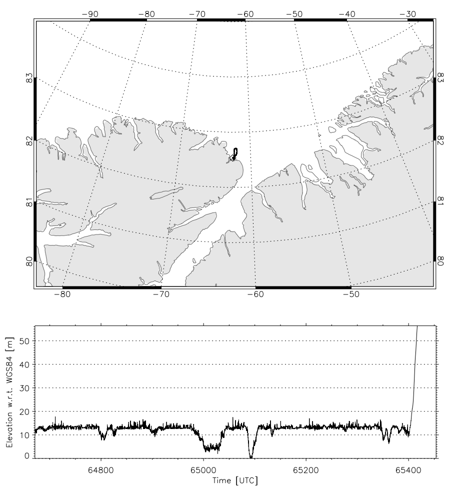
AS3TA05_ASILL1B030620060509T184012_20060509T190339_0001.DBL



Date	2006-05-09	Instrument Mode	Low Altitude
Start Time	18:40:12 (67212)	Aircraft	DNSC Twin Otter
Stop Time	19:03:38 (68618)	Retracker	OCOG
Distance	71.509 km	GPS Resolution	1 Hz
Duration	00 h 23 m 27 s	Processor Version	3.06

A00_20060510

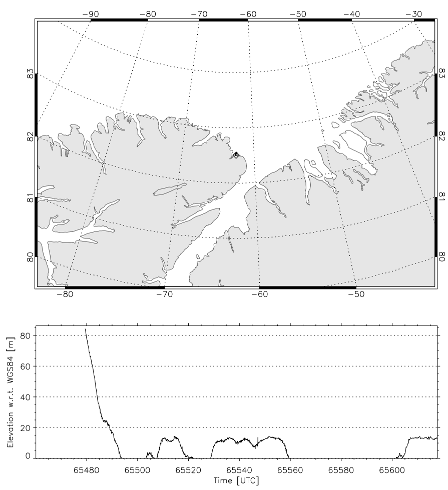
AS3TA00_ASILL1B030620060510T175751_20060510T181055_0001.DBL



Date	2006-05-10	Instrument Mode	Low Altitude
Start Time	17:57:51 (64671)	Aircraft	DNSC Twin Otter
Stop Time	18:10:53 (65453)	Retracker	OCOG
Distance	49.282 km	GPS Resolution	1 Hz
Duration	00 h 13 m 03 s	Processor Version	3.06

A01_20060510

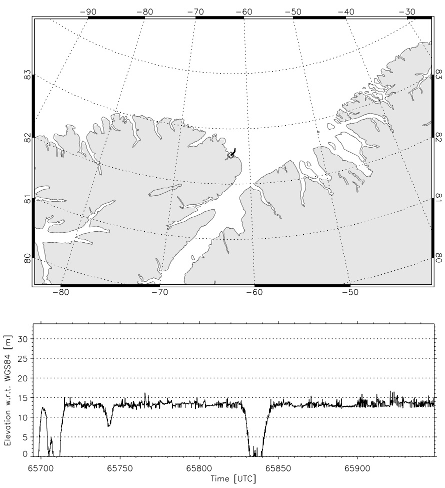
AS3TA01_ASILL1B030620060510T181100_20060510T181339_0001.DBL



Date	2006-05-10	Instrument Mode	Low Altitude
Start Time	18:11:00 (65460)	Aircraft	DNSC Twin Otter
Stop Time	18:13:37 (65617)	Retracker	OCOG
Distance	10.053 km	GPS Resolution	1 Hz
Duration	00 h 02 m 38 s	Processor Version	3.06

A02_20060510

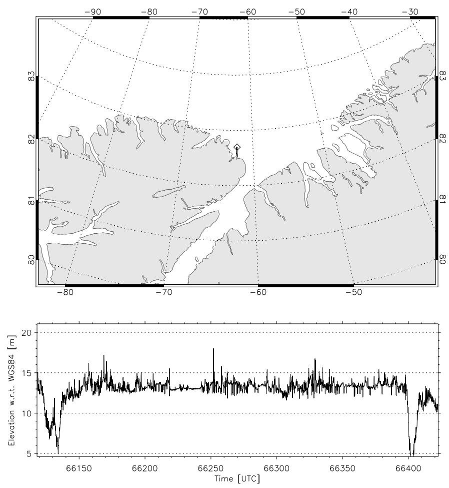
AS3TA02_ASILL1B030620060510T181455_20060510T181909_0001.DBL



Date	2006–05–10	**Instrument Mode**	Low Altitude
Start Time	18:14:55 (65695)	**Aircraft**	DNSC Twin Otter
Stop Time	18:19:08 (65948)	**Retracker**	OCOG
Distance	17.325 km	**GPS Resolution**	1 Hz
Duration	00 h 04 m 13 s	**Processor Version**	3.06

A03_20060510

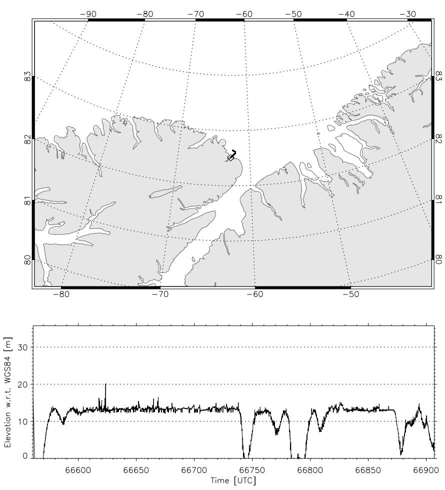
AS3TA03_ASILL1B030620060510T182158_20060510T182704_0001.DBL



Date	2006–05–10	**Instrument Mode**	Low Altitude
Start Time	18:21:58 (66118)	**Aircraft**	DNSC Twin Otter
Stop Time	18:27:02 (66422)	**Retracker**	OCOG
Distance	18.431 km	**GPS Resolution**	1 Hz
Duration	00 h 05 m 04 s	**Processor Version**	3.06

A04_20060510

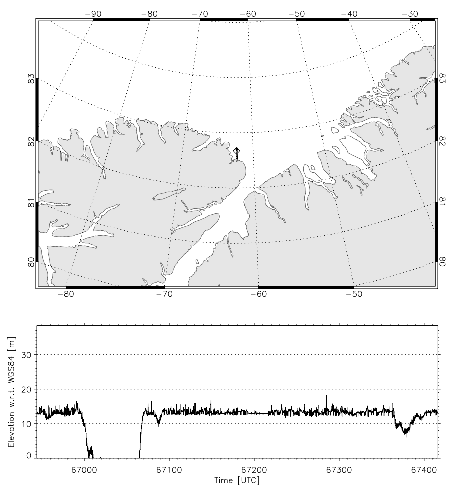
AS3TA04_ASILL1B030620060510T182921_20060510T183508_0001.DBL



Date	2006–05–10	**Instrument Mode**	Low Altitude
Start Time	18:29:21 (66561)	**Aircraft**	DNSC Twin Otter
Stop Time	18:35:06 (66906)	**Retracker**	OCOG
Distance	23.147 km	**GPS Resolution**	1 Hz
Duration	00 h 05 m 46 s	**Processor Version**	3.06

A05_20060510

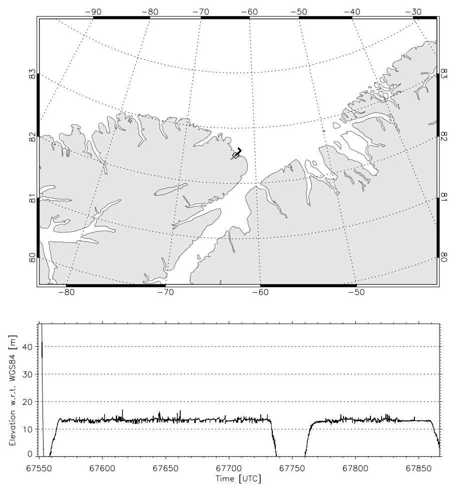
AS3TA05_ASILL1B030620060510T183544_20060510T184337_0001.DBL



Date	2006–05–10	**Instrument Mode**	Low Altitude
Start Time	18:35:44 (66944)	**Aircraft**	DNSC Twin Otter
Stop Time	18:43:36 (67416)	**Retracker**	OCOG
Distance	28.979 km	**GPS Resolution**	1 Hz
Duration	00 h 07 m 52 s	**Processor Version**	3.06

A06_20060510

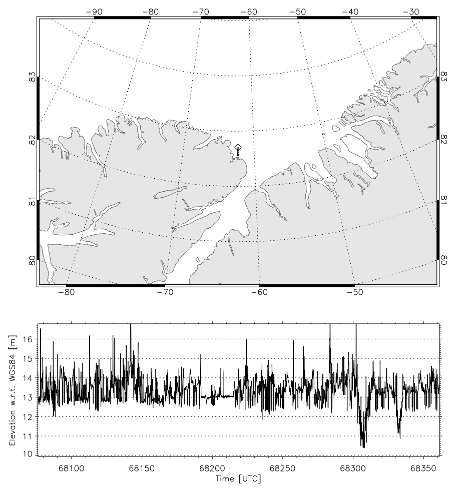
AS3TA06_ASILL1B030620060510T184549_20060510T185107_0001.DBL



Date	2006–05–10	Instrument Mode	Low Altitude
Start Time	18:45:49 (67549)	Aircraft	DNSC Twin Otter
Stop Time	18:51:06 (67866)	Retracker	OCOG
Distance	21.281 km	GPS Resolution	1 Hz
Duration	00 h 05 m 17 s	Processor Version	3.06

A07_20060510

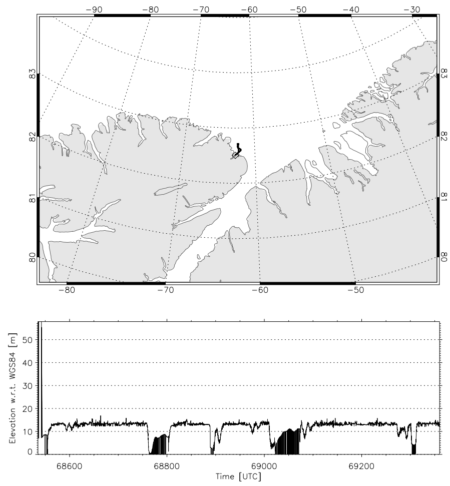
AS3TA07_ASILL1B030620060510T185436_20060510T185922_0001.DBL



Date	2006–05–10	Instrument Mode	Low Altitude
Start Time	18:54:36 (68076)	Aircraft	DNSC Twin Otter
Stop Time	18:59:21 (68361)	Retracker	OCOG
Distance	17.372 km	GPS Resolution	1 Hz
Duration	00 h 04 m 45 s	Processor Version	3.06

A08_20060510

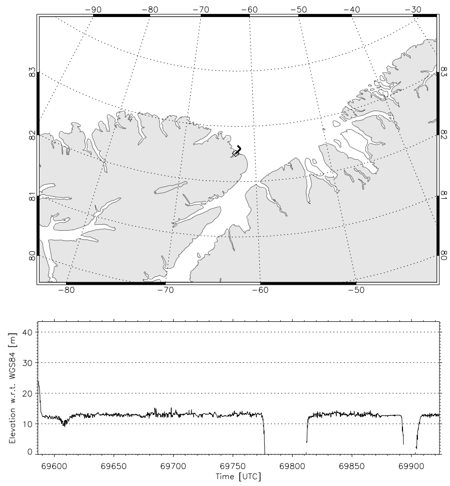
AS3TA08_ASILL1B030620060510T190215_20060510T191601_0001.DBL



Date	2006–05–10	Instrument Mode	Low Altitude
Start Time	19:02:15 (68535)	Aircraft	DNSC Twin Otter
Stop Time	19:16:00 (69360)	Retracker	OCOG
Distance	52.610 km	GPS Resolution	1 Hz
Duration	00 h 13 m 45 s	Processor Version	3.06

A09_20060510

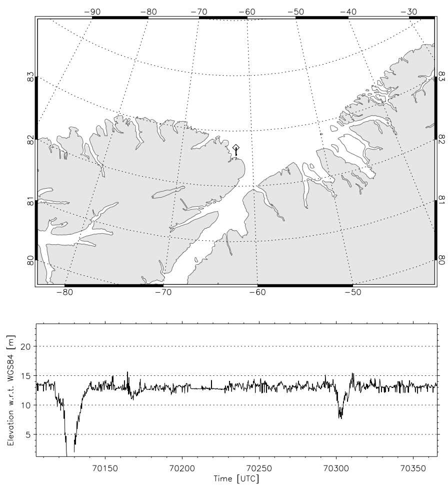
AS3TA09_ASILL1B030620060510T191946_20060510T192526_0001.DBL



Date	2006–05–10	Instrument Mode	Low Altitude
Start Time	19:19:46 (69586)	Aircraft	DNSC Twin Otter
Stop Time	19:25:23 (69923)	Retracker	OCOG
Distance	22.269 km	GPS Resolution	1 Hz
Duration	00 h 05 m 37 s	Processor Version	3.06

A10_20060510

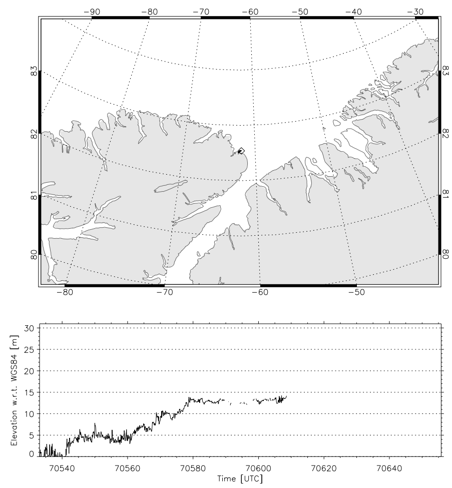
AS3TA10_ASILL1B030620060510T192825_20060510T193248_0001.DBL



Date	2006-05-10	**Instrument Mode**	Low Altitude
Start Time	19:28:25 (70105)	**Aircraft**	DNSC Twin Otter
Stop Time	19:32:45 (70365)	**Retracker**	OCOG
Distance	16.371 km	**GPS Resolution**	1 Hz
Duration	00 h 04 m 20 s	**Processor Version**	3.06

A11_20060510

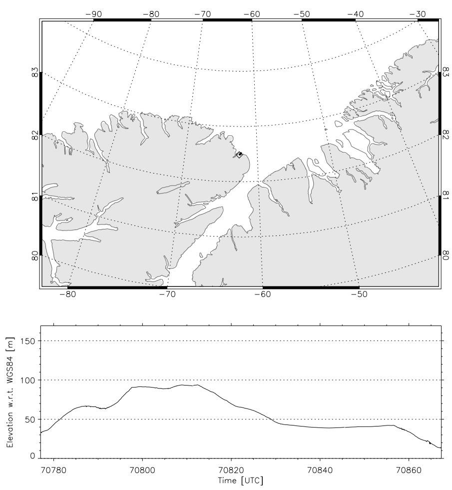
AS3TA11_ASILL1B030620060510T193533_20060510T193736_0001.DBL



Date	2006-05-10	**Instrument Mode**	Low Altitude
Start Time	19:35:33 (70533)	**Aircraft**	DNSC Twin Otter
Stop Time	19:37:35 (70655)	**Retracker**	OCOG
Distance	7.819 km	**GPS Resolution**	1 Hz
Duration	00 h 02 m 03 s	**Processor Version**	3.06

A12_20060510

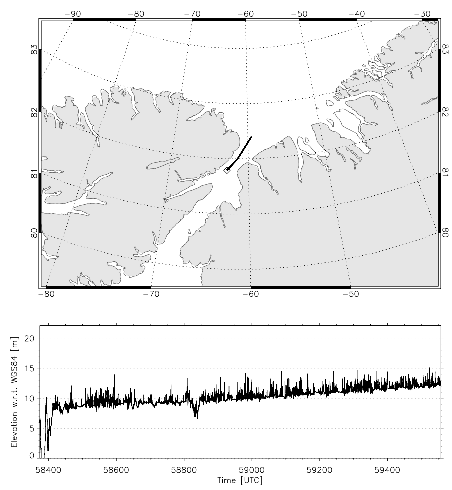
AS3TA12_ASILL1B030620060510T193937_20060510T194108_0001.DBL



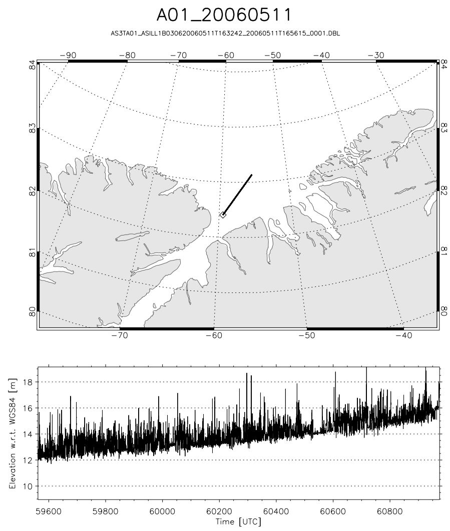
Date	2006-05-10	**Instrument Mode**	Low Altitude
Start Time	19:39:37 (70777)	**Aircraft**	DNSC Twin Otter
Stop Time	19:41:07 (70867)	**Retracker**	OCOG
Distance	6.041 km	**GPS Resolution**	1 Hz
Duration	00 h 01 m 30 s	**Processor Version**	3.06

A00_20060511

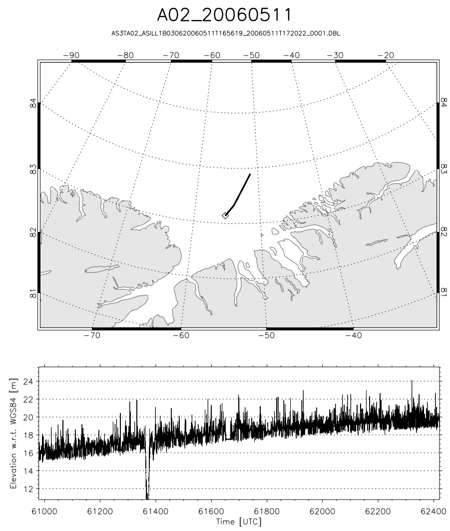
AS3TA00_ASILL1B030620060511T161254_20060511T163239_0001.DBL



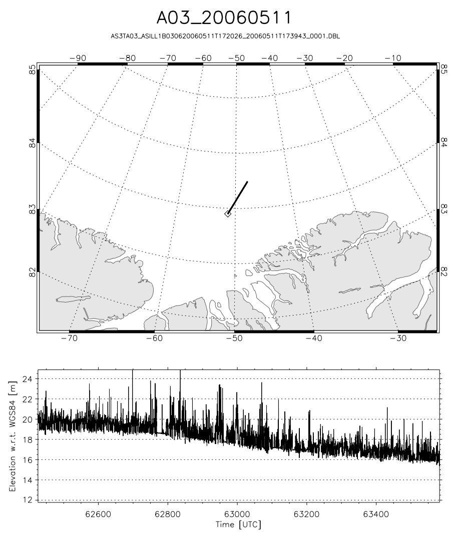
Date	2006-05-11	**Instrument Mode**	Low Altitude
Start Time	16:12:54 (58374)	**Aircraft**	DNSC Twin Otter
Stop Time	16:32:37 (59557)	**Retracker**	OCOG
Distance	84.764 km	**GPS Resolution**	1 Hz
Duration	00 h 19 m 44 s	**Processor Version**	3.06



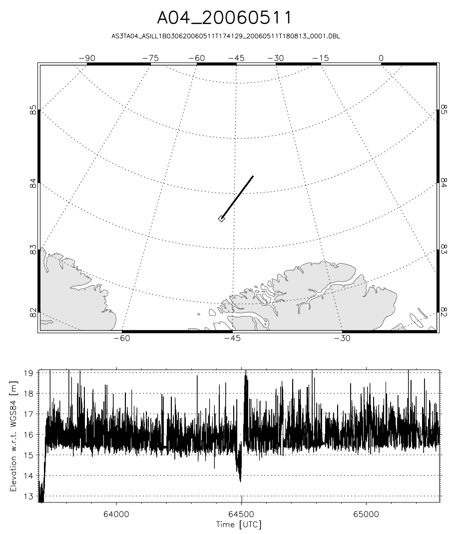
Date	2006–05–11	**Instrument Mode**	Low Altitude
Start Time	16:32:42 (59562)	**Aircraft**	DNSC Twin Otter
Stop Time	16:56:14 (60974)	**Retracker**	OCOG
Distance	100.040 km	**GPS Resolution**	1 Hz
Duration	00 h 23 m 32 s	**Processor Version**	3.06



Date	2006–05–11	**Instrument Mode**	Low Altitude
Start Time	16:56:19 (60979)	**Aircraft**	DNSC Twin Otter
Stop Time	17:20:20 (62420)	**Retracker**	OCOG
Distance	98.397 km	**GPS Resolution**	1 Hz
Duration	00 h 24 m 02 s	**Processor Version**	3.06



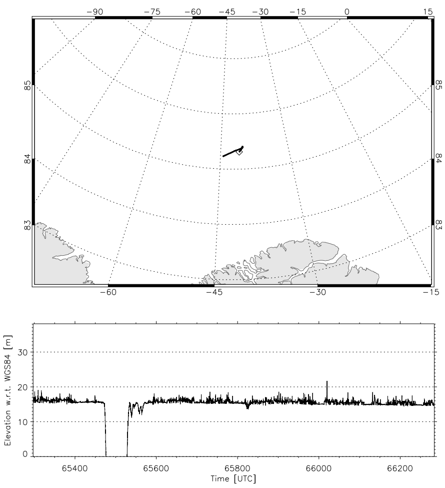
Date	2006–05–11	**Instrument Mode**	Low Altitude
Start Time	17:20:26 (62426)	**Aircraft**	DNSC Twin Otter
Stop Time	17:39:42 (63582)	**Retracker**	OCOG
Distance	76.104 km	**GPS Resolution**	1 Hz
Duration	00 h 19 m 16 s	**Processor Version**	3.06



Date	2006–05–11	**Instrument Mode**	Low Altitude
Start Time	17:41:29 (63689)	**Aircraft**	DNSC Twin Otter
Stop Time	18:08:12 (65292)	**Retracker**	OCOG
Distance	106.957 km	**GPS Resolution**	1 Hz
Duration	00 h 26 m 44 s	**Processor Version**	3.06

A05_20060511

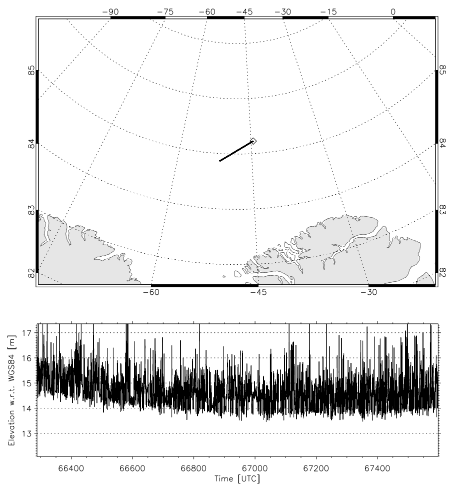
AS3TA05_ASILL1B0306200605511T180817_20060511T182444_0001.DBL



Date	2006-05-11	Instrument Mode	Low Altitude
Start Time	18:08:17 (65297)	Aircraft	DNSC Twin Otter
Stop Time	18:24:43 (66283)	Retracker	OCOG
Distance	59.410 km	GPS Resolution	1 Hz
Duration	00 h 16 m 27 s	Processor Version	3.06

A06_20060511

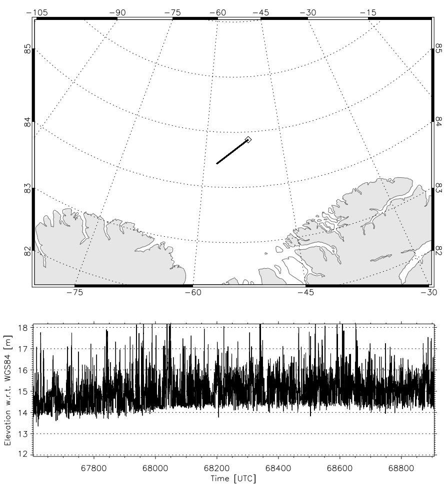
AS3TA06_ASILL1B0306200605511T182448_20060511T184639_0001.DBL



Date	2006-05-11	Instrument Mode	Low Altitude
Start Time	18:24:48 (66288)	Aircraft	DNSC Twin Otter
Stop Time	18:46:38 (67598)	Retracker	OCOG
Distance	79.009 km	GPS Resolution	1 Hz
Duration	00 h 21 m 50 s	Processor Version	3.06

A07_20060511

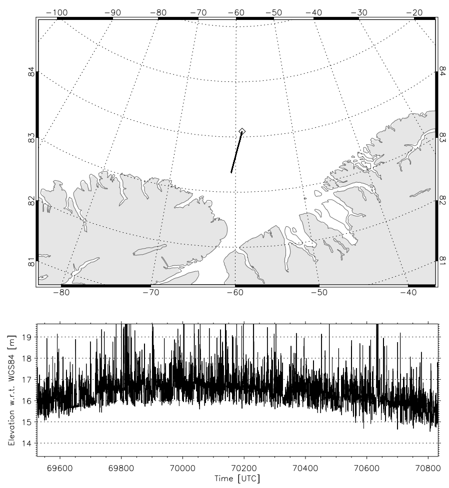
AS3TA07_ASILL1B0306200605511T184642_20060511T190831_0001.DBL



Date	2006-05-11	Instrument Mode	Low Altitude
Start Time	18:46:42 (67602)	Aircraft	DNSC Twin Otter
Stop Time	19:08:26 (68906)	Retracker	OCOG
Distance	80.016 km	GPS Resolution	1 Hz
Duration	00 h 21 m 45 s	Processor Version	3.06

A08_20060511

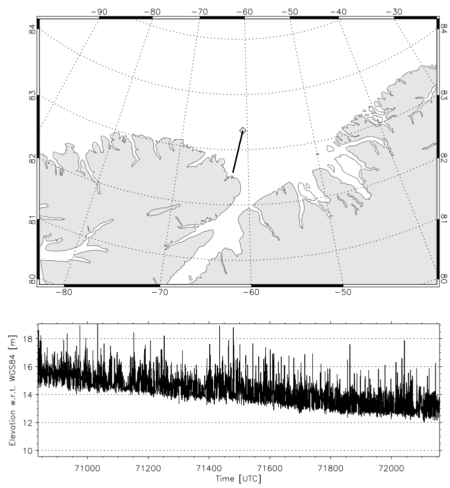
AS3TA08_ASILL1B0306200605511T191845_20060511T194034_0001.DBL



Date	2006-05-11	Instrument Mode	Low Altitude
Start Time	19:18:45 (69525)	Aircraft	DNSC Twin Otter
Stop Time	19:40:32 (70832)	Retracker	OCOG
Distance	86.316 km	GPS Resolution	1 Hz
Duration	00 h 21 m 48 s	Processor Version	3.06

A09_20060511

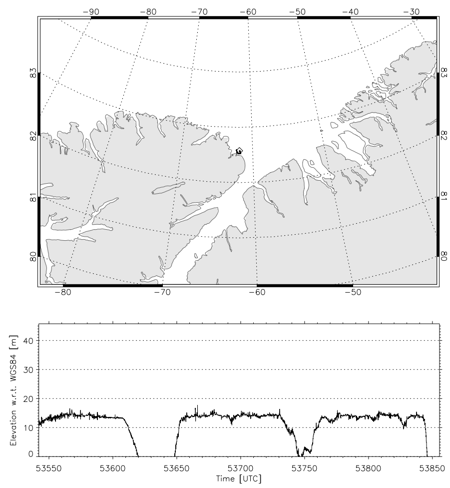
AS3TA09_ASILL1B030620060511T194037_20060511T200239_0001.DBL



Date	2006–05–11	**Instrument Mode**	Low Altitude
Start Time	19:40:37 (70837)	**Aircraft**	DNSC Twin Otter
Stop Time	20:02:38 (72158)	**Retracker**	OCOG
Distance	86.840 km	**GPS Resolution**	1 Hz
Duration	00 h 22 m 01 s	**Processor Version**	3.06

A00_20060512

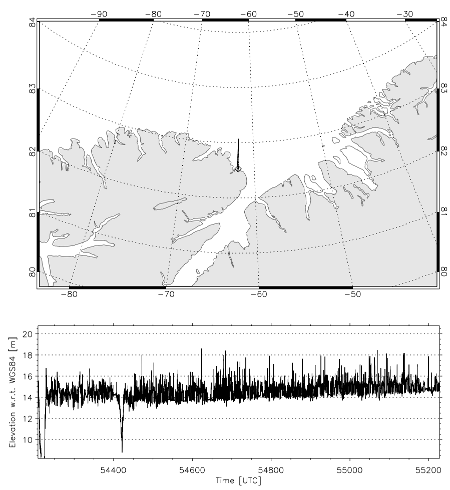
AS3TA00_ASILL1B030620060512T145222_20060512T145736_0001.DBL



Date	2006–05–12	**Instrument Mode**	Low Altitude
Start Time	14:52:22 (53542)	**Aircraft**	DNSC Twin Otter
Stop Time	14:57:35 (53855)	**Retracker**	OCOG
Distance	19.566 km	**GPS Resolution**	1 Hz
Duration	00 h 05 m 13 s	**Processor Version**	3.06

A01_20060512

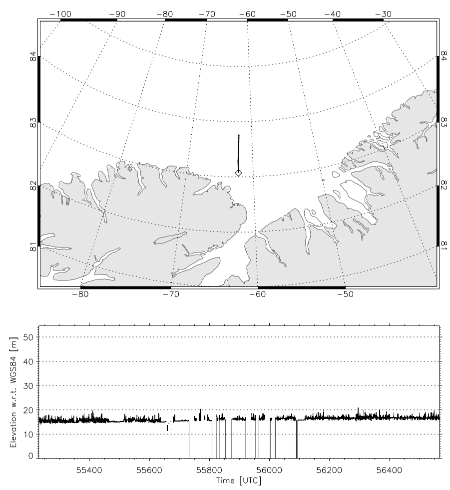
AS3TA01_ASILL1B030620060512T150328_20060512T152028_0001.DBL



Date	2006–05–12	**Instrument Mode**	Low Altitude
Start Time	15:03:28 (54208)	**Aircraft**	DNSC Twin Otter
Stop Time	15:20:27 (55227)	**Retracker**	OCOG
Distance	60.578 km	**GPS Resolution**	1 Hz
Duration	00 h 16 m 60 s	**Processor Version**	3.06

A02_20060512

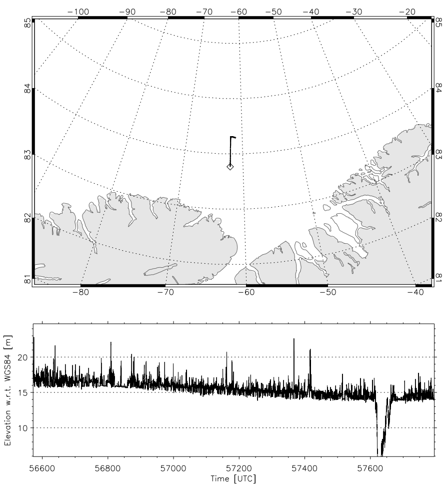
AS3TA02_ASILL1B030620060512T152031_20060512T154247_0001.DBL



Date	2006–05–12	**Instrument Mode**	Low Altitude
Start Time	15:20:31 (55231)	**Aircraft**	DNSC Twin Otter
Stop Time	15:42:46 (56566)	**Retracker**	OCOG
Distance	76.864 km	**GPS Resolution**	1 Hz
Duration	00 h 22 m 16 s	**Processor Version**	3.06

A03_20060512

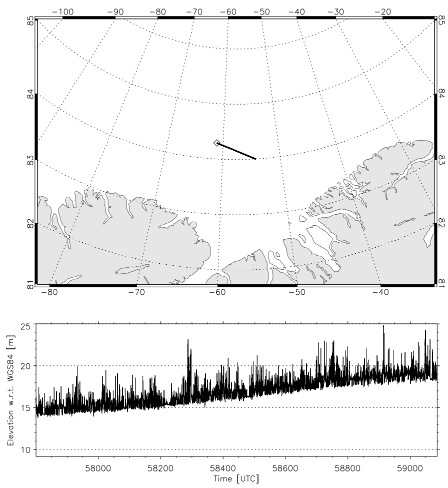
AS3TA03_ASILL1B030620060512T154252_20060512T160316_0001.DBL



Date	2006-05-12	Instrument Mode	Low Altitude
Start Time	15:42:52 (56572)	Aircraft	DNSC Twin Otter
Stop Time	16:03:14 (57794)	Retracker	OCOG
Distance	70.669 km	GPS Resolution	1 Hz
Duration	00 h 20 m 23 s	Processor Version	3.06

A04_20060512

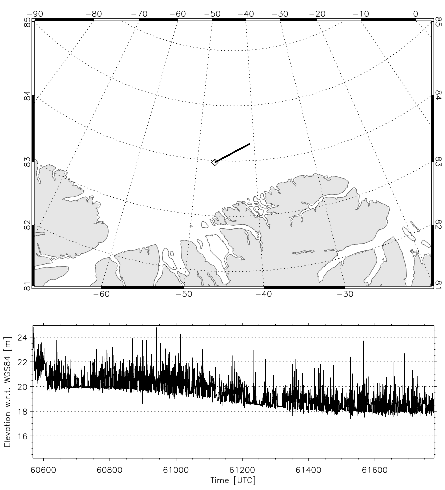
AS3TA04_ASILL1B030620060512T160320_20060512T162447_0001.DBL



Date	2006-05-12	Instrument Mode	Low Altitude
Start Time	16:03:20 (57800)	Aircraft	DNSC Twin Otter
Stop Time	16:24:46 (59086)	Retracker	OCOG
Distance	85.462 km	GPS Resolution	1 Hz
Duration	00 h 21 m 26 s	Processor Version	3.06

A06_20060512

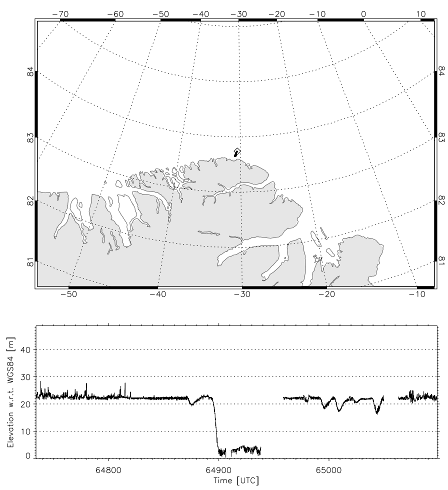
AS3TA06_ASILL1B030620060512T164928_20060512T170939_0001.DBL



Date	2006-05-12	Instrument Mode	Low Altitude
Start Time	16:49:28 (60568)	Aircraft	DNSC Twin Otter
Stop Time	17:09:38 (61778)	Retracker	OCOG
Distance	79.969 km	GPS Resolution	1 Hz
Duration	00 h 20 m 10 s	Processor Version	3.06

A08_20060512

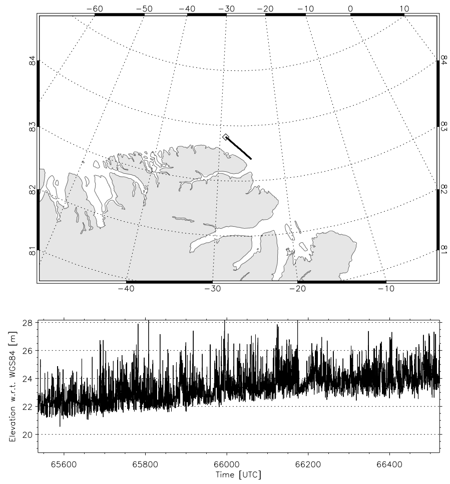
AS3TA08_ASILL1B030620060512T175854_20060512T180459_0001.DBL



Date	2006-05-12	Instrument Mode	Low Altitude
Start Time	17:58:54 (64734)	Aircraft	DNSC Twin Otter
Stop Time	18:04:58 (65098)	Retracker	OCOG
Distance	23.146 km	GPS Resolution	1 Hz
Duration	00 h 06 m 04 s	Processor Version	3.06

A09_20060512

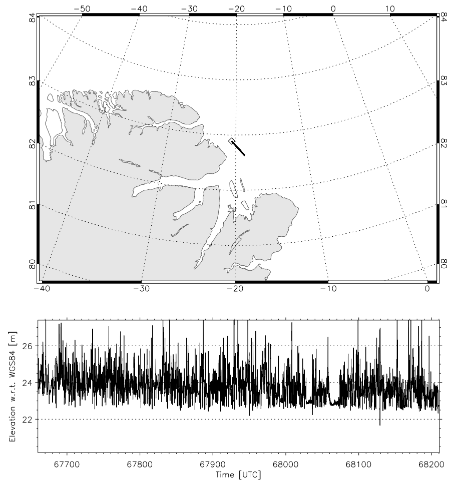
AS3TA09_ASILL1B030620060512T181216_20060512T182843_0001.DBL



Date	2006-05-12	**Instrument Mode**	Low Altitude
Start Time	18:12:16 (65536)	**Aircraft**	DNSC Twin Otter
Stop Time	18:28:42 (66522)	**Retracker**	OCOG
Distance	68.244 km	**GPS Resolution**	1 Hz
Duration	00 h 16 m 27 s	**Processor Version**	3.06

A10_20060512

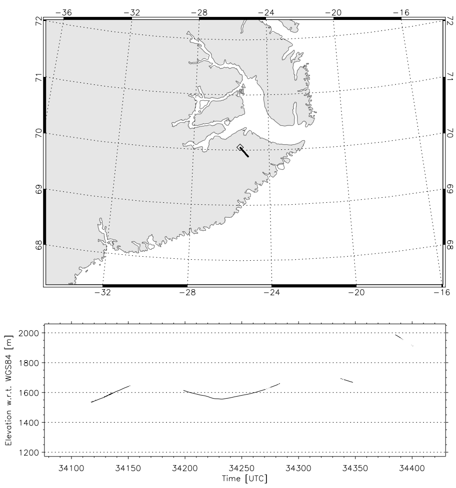
AS3TA10_ASILL1B030620060512T184740_20060512T190921_0001.DBL



Date	2006-05-12	**Instrument Mode**	Low Altitude
Start Time	18:47:40 (67660)	**Aircraft**	DNSC Twin Otter
Stop Time	18:56:50 (68210)	**Retracker**	OCOG
Distance	39.141 km	**GPS Resolution**	1 Hz
Duration	00 h 09 m 11 s	**Processor Version**	3.06

A00_20060517

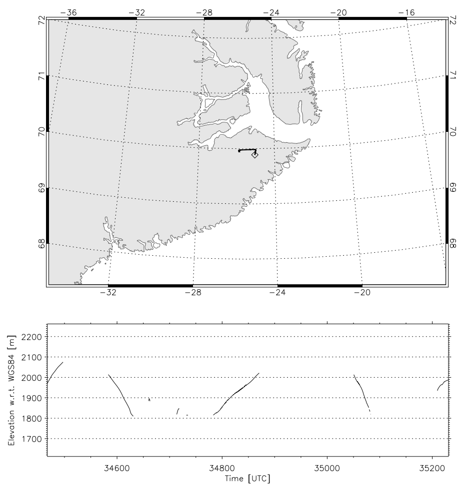
AS3TA00_ASILL1B030620060517T092756_20060517T093353_0001.DBL



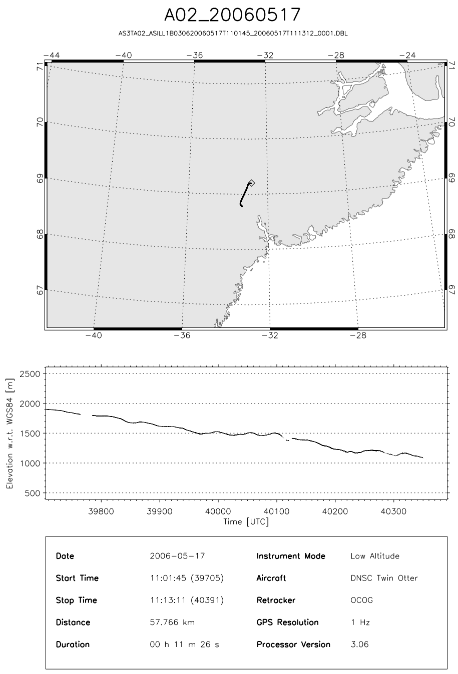
Date	2006-05-17	**Instrument Mode**	Low Altitude
Start Time	09:27:56 (34076)	**Aircraft**	DNSC Twin Otter
Stop Time	09:33:49 (34429)	**Retracker**	OCOG
Distance	26.162 km	**GPS Resolution**	1 Hz
Duration	00 h 05 m 53 s	**Processor Version**	3.06

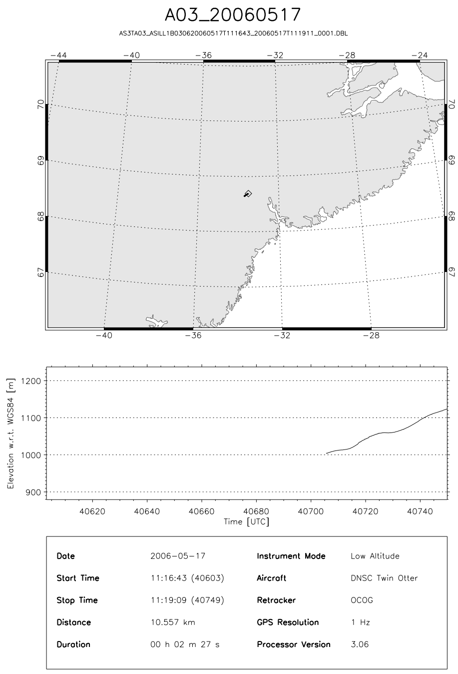
A01_20060517

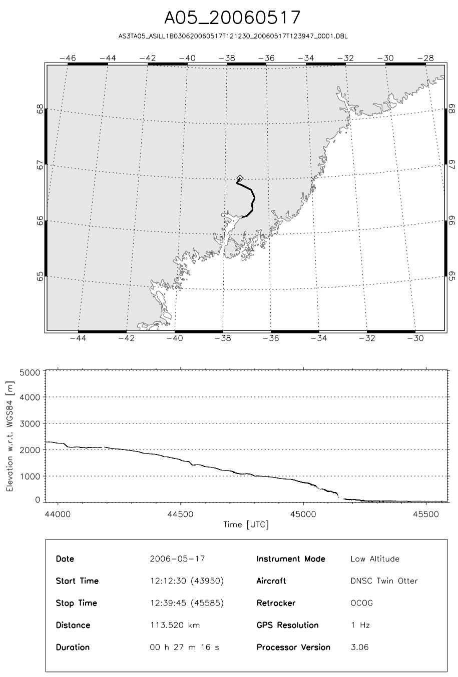
AS3TA01_ASILL1B030620060517T093427_20060517T094713_0001.DBL

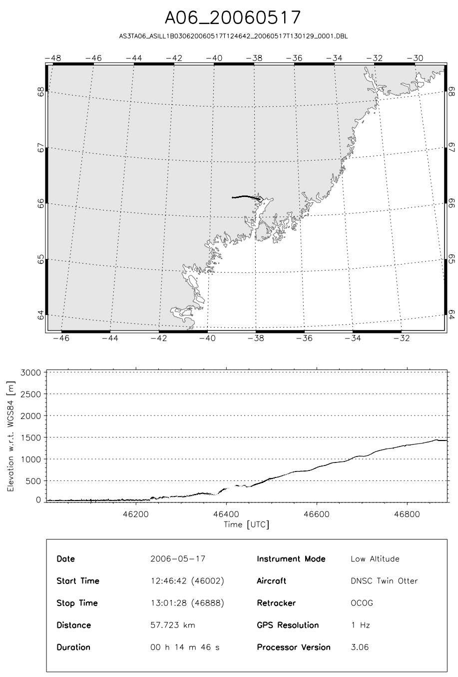


Date	2006-05-17	**Instrument Mode**	Low Altitude
Start Time	09:34:27 (34467)	**Aircraft**	DNSC Twin Otter
Stop Time	09:47:10 (35230)	**Retracker**	OCOG
Distance	48.815 km	**GPS Resolution**	1 Hz
Duration	00 h 12 m 43 s	**Processor Version**	3.06


A02_20060517
AS3TA02_ASILL1B030620060517T110145_20060517T111312_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-05-17
Instrument Mode Low Altitude
Start Time 11:01:45 (39705)
Aircraft DNSC Twin Otter
Stop Time 11:13:11 (40391)
Retracker OCOG
Distance 57.766 km
GPS Resolution 1 Hz
Duration 00 h 11 m 26 s
Processor Version 3.06


A03_20060517
AS3TA03_ASILL1B030620060517T111643_20060517T111911_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-05-17
Instrument Mode Low Altitude
Start Time 11:16:43 (40603)
Aircraft DNSC Twin Otter
Stop Time 11:19:09 (40749)
Retracker OCOG
Distance 10.557 km
GPS Resolution 1 Hz
Duration 00 h 02 m 27 s
Processor Version 3.06


A05_20060517
AS3TA05_ASILL1B030620060517T121230_20060517T123947_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-05-17
Instrument Mode Low Altitude
Start Time 12:12:30 (43950)
Aircraft DNSC Twin Otter
Stop Time 12:39:45 (45585)
Retracker OCOG
Distance 113.520 km
GPS Resolution 1 Hz
Duration 00 h 27 m 16 s
Processor Version 3.06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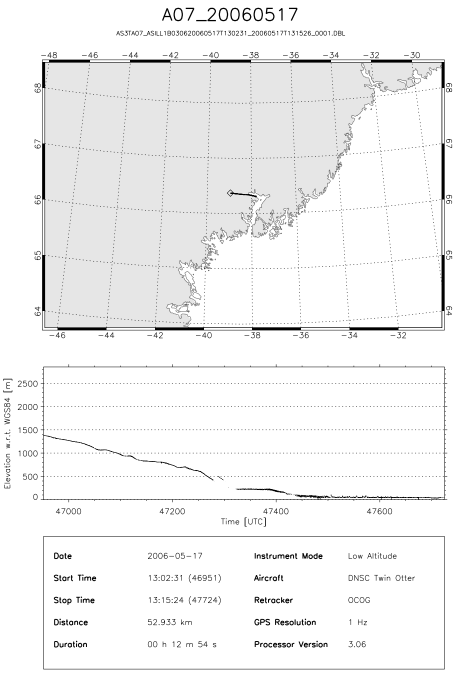
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-05-17
Instrument Mode Low Altitude
Start Time 12:46:42 (46002)
Aircraft DNSC Twin Otter
Stop Time 13:01:28 (46888)
Retracker OCOG
Distance 57.723 km
GPS Resolution 1 Hz
Duration 00 h 14 m 46 s
Processor Version 3.06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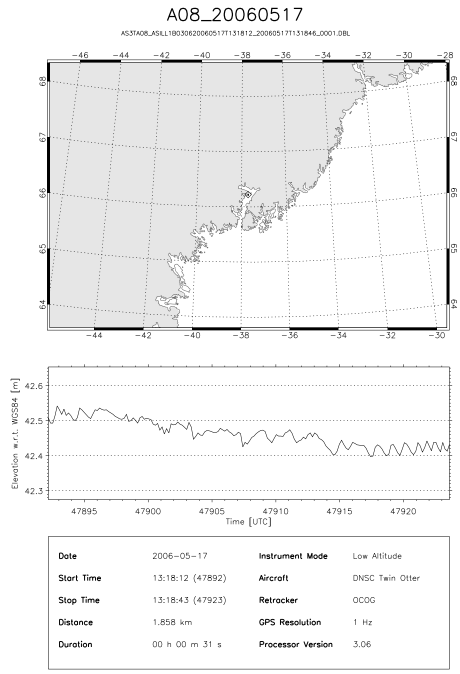
AS3TA07_ASILL1B030620060517T130231_20060517T131526_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-05-17
Start Time 13:02:31 (46951)
Stop Time 13:15:24 (47724)
Distance 52.933 km
Duration 00 h 12 m 54 s
Instrument Mode Low Altitude
Aircraft DNSC Twin Otter
Retracker OCOG
GPS Resolution 1 Hz
Processor Version 3.06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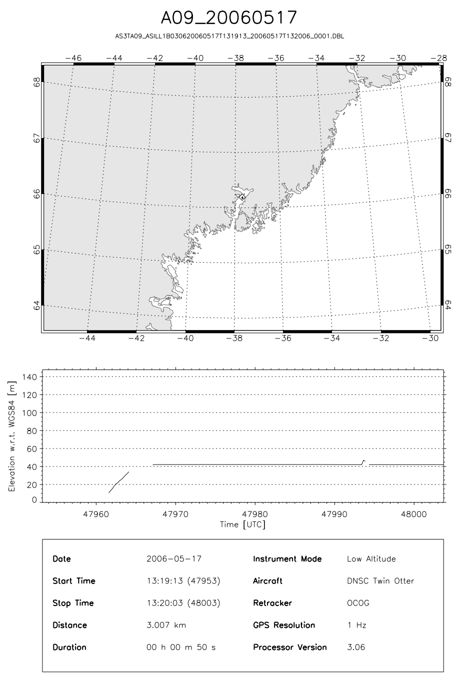
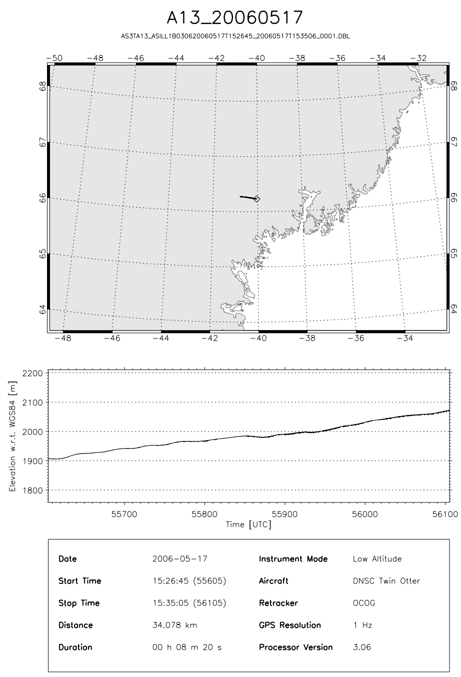
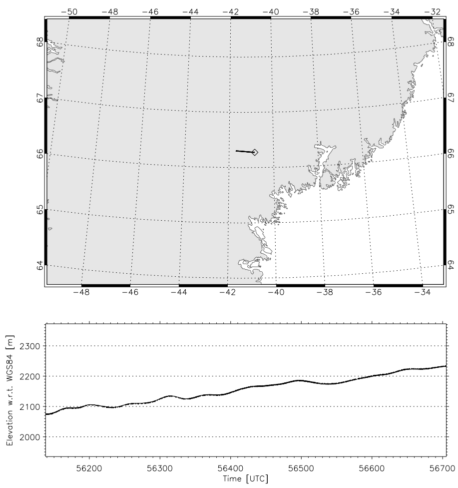
AS3TA08_ASILL1B030620060517T131812_20060517T131846_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-05-17
Start Time 13:18:12 (47892)
Stop Time 13:18:43 (47923)
Distance 1.858 km
Duration 00 h 00 m 31 s
Instrument Mode Low Altitude
Aircraft DNSC Twin Otter
Retracker OCOG
GPS Resolution 1 Hz
Processor Version 3.06


A09_20060517
AS3TA09_ASILL1B030620060517T131913_20060517T132006_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-05-17
Start Time 13:19:13 (47953)
Stop Time 13:20:03 (48003)
Distance 3.007 km
Duration 00 h 00 m 50 s
Instrument Mode Low Altitude
Aircraft DNSC Twin Otter
Retracker OCOG
GPS Resolution 1 Hz
Processor Version 3.06


A13_20060517
AS3TA13_ASILL1B030620060517T152645_20060517T153506_0001.DBL
Elevation w.r.t. WGS84 [m]
Time [UTC]
Date 2006-05-17
Start Time 15:26:45 (55605)
Stop Time 15:35:05 (56105)
Distance 34.078 km
Duration 00 h 08 m 20 s
Instrument Mode Low Altitude
Aircraft DNSC Twin Otter
Retracker OCOG
GPS Resolution 1 Hz
Processor Version 3.06

A14_20060517

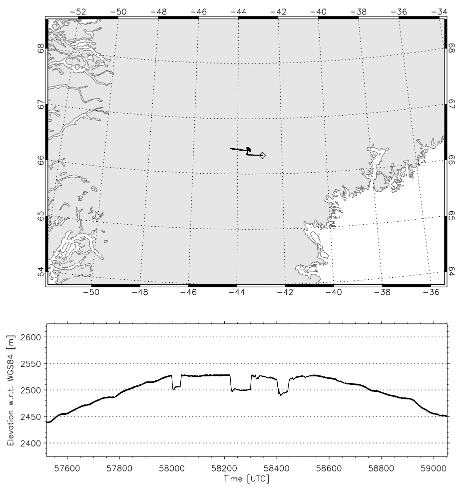
AS3TA14_ASILL1B030620060517T153538_20060517T154506_0001.DBL



Date	2006-05-17	Instrument Mode	Low Altitude
Start Time	15:35:38 (56138)	Aircraft	DNSC Twin Otter
Stop Time	15:45:05 (56705)	Retracker	OCOG
Distance	37.989 km	GPS Resolution	1 Hz
Duration	00 h 09 m 27 s	Processor Version	3.06

A15_20060517

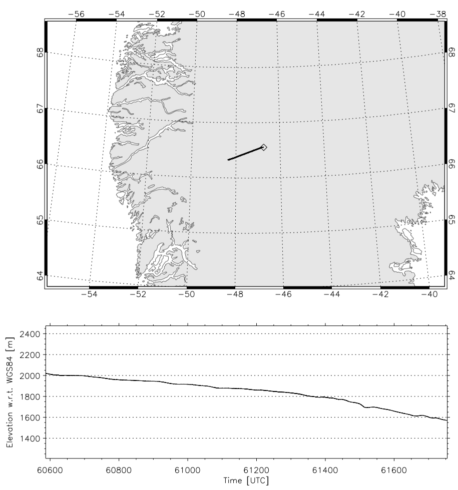
AS3TA15_ASILL1B030620060517T155840_20060517T162412_0001.DBL



Date	2006-05-17	Instrument Mode	Low Altitude
Start Time	15:58:40 (57520)	Aircraft	DNSC Twin Otter
Stop Time	16:24:11 (59051)	Retracker	OCOG
Distance	100.732 km	GPS Resolution	1 Hz
Duration	00 h 25 m 31 s	Processor Version	3.06

A16_20060517

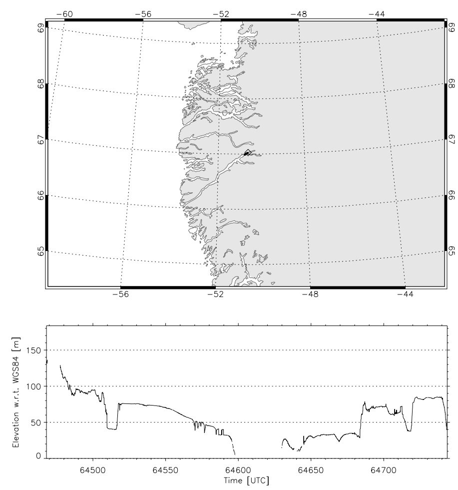
AS3TA16_ASILL1B030620060517T164947_20060517T170916_0001.DBL



Date	2006-05-17	Instrument Mode	Low Altitude
Start Time	16:49:47 (60587)	Aircraft	DNSC Twin Otter
Stop Time	17:09:14 (61754)	Retracker	OCOG
Distance	76.659 km	GPS Resolution	1 Hz
Duration	00 h 19 m 27 s	Processor Version	3.06

A17_20060517

AS3TA17_ASILL1B030620060517T175428_20060517T175904_0001.DBL



Date	2006-05-17	Instrument Mode	Low Altitude
Start Time	17:54:28 (64468)	Aircraft	DNSC Twin Otter
Stop Time	17:59:03 (64743)	Retracker	OCOG
Distance	16.847 km	GPS Resolution	1 Hz
Duration	00 h 04 m 36 s	Processor Version	3.06

Technical Report Series

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7. René Forsberg, H. Skourup, O. B. Andersen, P. Knudsen, S. W. Laxon, A. Ridout, J. Johannesen, F. Siegismund, H. Drange, C. C. Tscherning, D. Arabelos, A. Braun, and V. Renganathan: *Combination of Spaceborne, Airborne and In-Situ Gravity Measurements in Support of Artic Sea Ice Thickness Mapping*, 136 pp., 2007.
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