

# CRYOVEX 2008

## Data Acquisition Report



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## 1 Introduction

The European Space Agency (ESA) CryoSat Validation Experiment, CryoVEx 2008 was carried out in April and May 2008. The airborne operations were coordinated by the National Space Institute, Danish Technical University (DTU Space) and took place in the period April 15 to May 8. The work consisted of:

- Airborne data collection with ASIRAS and laser scanner system. The operations were coordinated with ground and helicopter activities over land and sea ice in Greenland and Canada.
- Logistical support for participants in the CryoVEx 2008 experiment especially concerning transport and access to military facilities in Canadian Forces Station Alert and Thule Air Base as well as aircraft support to the UK team on the north Greenland ice sheet.

Figure 1 shows the full flight tracks for the airborne Twin Otter operation in April and May 2008.

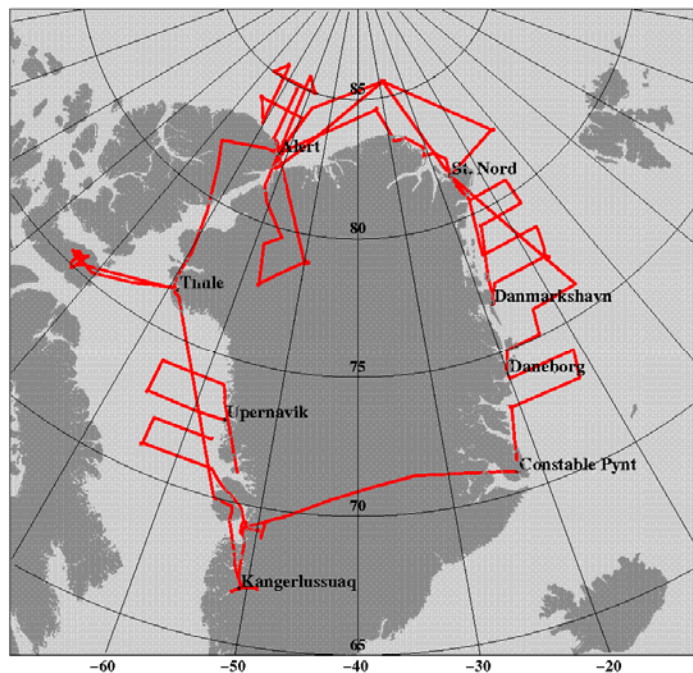


Figure 1. Flight tracks for airborne Twin Otter observations

## 2 Summary of operations

The DTU Space operations started out on April 15 in Kangerlussuaq, Greenland, with installation of the laser scanner and ASIRAS system in the Air Greenland Twin Otter reg. OY-POF following the same procedures as certified in 2006. Due to a minor technical problem with the Twin Otter the aircraft was not available until the 16<sup>th</sup>. This did not affect the installation since the first day was spent on retrieving the cargo with the equipment and unpacking the boxes. Assistance with the ASIRAS system was provided by Raumfahrt Systemtechnik's engineer.

After installing the equipment in the Air Greenland hanger and performing ground tests, a successful test flight was carried out on April 17<sup>th</sup>. Apart from minor problems with the backup system for the laser measurements – INS and laser altimeter – the full system of laser scanner and ASIRAS was working as expected. The problems with the backup system were sorted out on ground prior to the next flights.

The next two days were spent on a survey for the Bureau of Minerals and Petroleum, BMP, Greenland Home Rule Government, monitoring the sea ice off the Greenland west coast near Upernavik. After this the EGIG line was surveyed April 20<sup>th</sup> on transit from Ilulissat to Constable Pynt on the east coast. En route, observations on a line near Ilulissat, both High Altitude and Low Altitude ASIRAS data were gathered.

Next the Twin Otter continued to St. Nord, northeast Greenland, where again observation was carried out for the BMP. On April 26<sup>th</sup> a coordinated flight was carried out near KV Svalbard, the coast guard vessel from Svalbard, which was on a scientific cruise in the Fram Strait. The ship was anchored to an ice floe that was surveyed with the airborne system as well as on the surface from the ship in coordination with the Norwegian Polar Institute. From St. Nord a second survey was done on April 27<sup>th</sup> in order to re-measure lines north of Greenland. On April 28<sup>th</sup> the aircraft continued to CFS Alert to meet the ground teams there, who flew in from Canada and Qaanaaq, North Greenland, with dedicated Twin Otter flights (chartered from Ken Borek) on April 28<sup>th</sup> and 30<sup>th</sup>.

In the meantime the other Air Greenland Twin Otter reg. OY-ATY equipped with skies deployed the UK1 team, of Liz Morris and Martin Hignell, on the ice sheet in northern Greenland via Qaanaaq and Thule Air Base. These operations were delayed by poor weather and took place from April 23<sup>rd</sup> to 25<sup>th</sup> and consisted of transport from Kangerlussuaq to Qaanaaq on April 23<sup>rd</sup> and put in on the ice over the next two days including deployment of two depots with fuel and other supplies for the transect.

From Alert lines were surveyed in the Arctic Ocean on May 1<sup>st</sup> and 2<sup>nd</sup>. In addition the validation sites near the coast were observed on May 1<sup>st</sup> and on May 2<sup>nd</sup> a coordinated line was flown with the helicopter-borne EM bird system from Alfred Wegener Institute/University of Alberta, Edmonton.

A second coordinated helicopter and Twin Otter flight was cancelled in the last minute on May 5<sup>th</sup> due to poor visibility. The Twin Otter flew a few survey lines near the AUV (Autonomous Underwater Vehicle) camp just off the coast but this also had to be altered to a lower altitude due to low clouds. Afterwards, the aircraft-team continued to Thule Air Base via Grant Ice Cap and Mt. Oxford on Ellesmere Island to position the Twin Otter for operations over Devon Island. Initially it was planned to

use the small inuit settlement Grise Fiord as base for the Devon survey but the weather favoured operations out of the larger and better equipped airfield in Thule. The Devon ice cap was then surveyed on May 6<sup>th</sup> where the main lines N-S and E-W was flown repeatedly to ensure corner reflector hits and a few lines suggested by the Canadian team was also surveyed.

After the Devon flight the Twin Otter returned to Kangerlussuaq on May 7<sup>th</sup> to be used for a test campaign for the DTU Space P-Sounder instrument. The ASIRAS system was un-mounted and returned to RST.

Table 1 gives an overview of the specific flights in chronological order and below a short day-to-day description is found.

### Day2day

April 15-17	Installation and test of ASIRAS and laser scanner system on Twin Otter
April 18	Survey of icebergs near Ilulissat for DMI and local flight for Danish Television reporters
April 19	Sea ice observations coordinated with helicopter in-situ measurements off the west coast near Upernavik
April 20	Transit to the east coast with survey of CryoSat line near Ilulissat and the EGIG line across the ice sheet
April 21	Transit to St. Nord after cancellation of helicopter operations near the east coast due to ice fog in survey area. Some observations with laser and ASIRAS en route with refuelling in Daneborg
April 22-23	No flights due to bad weather in St. Nord
April 24	Over-flight of KV Svalbard in the Fram Strait and survey of E-W lines between St. Nord and Danmarkshavn. Refueling in Danmarkshavn
April 25-26	No flights due to bad weather in St. Nord
April 27	Observation on lines north of Greenland
April 28	Transit to Alert with survey of sea ice near the coast and parts of the coast of northern Greenland
April 29	Survey of the UK1 site on the northern ice sheet
April 30	Dense fog at Alert – no flights
May 1	Survey of long lines north-east and survey of validation sites near Alert in the afternoon
May 2	Survey of square north-west and coordinated flight of N-S line in the afternoon
May 3	Snow and dense fog – no flights
May 4	Planned afternoon flight with helicopter but had to cancel due to bad weather
May 5	Planned coordinated helicopter flight cancelled due to low clouds. Survey of AUV site altered to low altitude followed by survey of Grant Ice Cap, Ellesmere Island, en route to Thule
May 6	Devon ice cap survey
May 7	Return to Kangerlussuaq with sea ice observations en route and survey over Disko Island
May 8-	Un-mount ASIRAS and P-sounder test

The airborne field team consisted of:

DTU Space: Sine M. Hvidegaard (SMH), Lars Stenseng (LS), and Henriette Skourup (HSK).

RST: Harald Lentz (HL).

*Table 1. GRL08 flights*

Date/JD	Flight	Track	Off block UTC	Take off UTC	Landing UTC	On block UTC	Air-borne	Survey operators
108/Apr 17	Test/drop	SFJ-SFJ	1837	1842	1955	2000	1h18	SMH/LS/HL
109/Apr 18	ICB	JAV-SFJ	1448	1453	1616	1621	1h33	SMH/LS
109/Apr 18	Journalists	JAV-JAV	1756	1801	1835	1840	0h44	SMH/LS
110/Apr 19	K1-K4	JAV-JUV	1023	1028	1443	1448	4h25	SMH/LS
110/Apr 19	K5-HE-K8	JUV-JAV	1552	1557	2108	2113	5h21	SMH/LS
111/Apr 20	JAV-T-EG	JAV-CNP	1119	1124	1548	1553	4h34	SMH/LS
112/Apr 21	K9-K12	CNP-DNB	1009	1014	1410	1415	4h06	SMH/HSK
112/Apr 21	K13-K15	DNB-NRD	1505	1510	2000	2005	5h	SMH/HSK
115/Apr 24	K16-K19 KV Svalbard	NRD-DMH	1004	1009	1442	1447	4h43	SMH/HSK
115/Apr 24	K20-K23	DMH-NRD	1528	1533	1922	1927	3h59	SMH/HSK
118/Apr 27	F	NRD-NRD	1013	1018	1523	1528	5h15	SMH/HSK
119/Apr 28	E	NRD-YLT	1437	1442	1835	1840	4h03	SMH/HSK
120/Apr 29	ICE	YLT-YLT	1350	1355	1922	1927	5h37	SMH/HSK
122/May 1	F-S	YLT-YLT	1340	1345	1825	1830	4h50	SMH/HSK
122/May 1	MYI-FYI	YLT-YLT	1847	1852	2037	2042	1h55	SMH/HSK
123/May 2	H	YLT-YLT	1330	1335	1916	1921	5h51	SMH/HSK
123/May 2	A1-FUE-A2	YLT-YLT	2040	2045	2308	2313	2h33	SMH/HSK
126/May 5	M-cal-GM	YLT-THU	1322	1327	1803	1808	4h36	SMH/HSK
127/May 6	DEVON	THU-THU	1154	1159	1703	1708	5h14	SMH/HSK
128/May 7	DISKO	THU-SFJ	1211	1216	1653	1658	4h47	SMH/HSK
Total								72h00

### 3 Recorded data

The equipment was installed in the Twin Otter OY-POF in the Air Greenland hangar in Kangerlussuaq. The installation was similar to the setup certified in 2006. For this campaign a new laser scanner was used. In addition the backup system consisting of a profiling laser altimeter and inertial measurement unit has been updated.

#### 3.1 GPS

Kinematic differential GPS is the key positioning method of the aircraft. GPS dual-frequency phase data were logged at 1 Hz using 1-2 ground base receivers at one or more reference sites, and 4 aircraft receivers; one of these dedicated to the ASIRAS system.

The aircraft GPS receivers are named AIR1 (Trimble 4000-SSI), AIR2 (Ashtech Z-extreme), AIR3 (Javad, Lexion), and AIR4 (Trimble 4000-SSI, connected to ASIRAS). AIR1 and AIR2 share the front GPS antenna; AIR3 and AIR4 the rear antenna. Antenna offsets are given in Table 2. Data were logged in the receivers during flights and downloaded upon landing on laptop PCs. 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 AIR4 receiver had a problem with the serial port and was not downloaded after April 20.

*Table 2. The (dx, dy, dz)' offsets. The lever arm from the GPS antennas to the origin of the laser scanner, and to the back centre of ASIRAS antenna frame (See arrow):*

<b>to laser scanner</b>	<b>dx (m)</b>	<b>dy (m)</b>	<b>dz (m)</b>
from AIR1/AIR3 (front)	- 3.70	+ 0.52	+ 1.58
from AIR2/AIR4 (rear)	+ 0.00	- 0.35	+ 1.42
<b>to ASIRAS antenna</b>	<b>dx (m)</b>	<b>dy (m)</b>	<b>dz (m)</b>
from AIR1/AIR3 (front)	-3.37	+0.47	+2.005
from AIR2/AIR4 (rear)	+0.33	-0.40	+1.845

<sup>c</sup>Offset definition: x positive to the front, y positive to the right, and z positive down.

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

Table 3 Data holding from aircraft instruments and reference stations

JD/Date	AIR1	AIR2	AIR3	AIR4	ALT	EGI	IMU	SCAN- NER	GPS REF1	GPS REF2	GPS REF3	Ver cam	ASIRAS	REMARKS
108/Apr 17	X	X	X	X	n/a	!		X	KELY			(X)	HAM+L AMa	Test flight,
109/Apr 18	X	n/a	X	X	X	!	X	X	SFJ1			(X)		Iceberg obs
109/Apr 18	n/a	X	X	X	X	!	X	X	SFJ1			X		Fjord trip for journ
110/Apr 19	X	X	X	X	X	!	X	X	SFJ1	JAV		X''	LAMa	Scanner PC cold no start
110/Apr 19	X'	X	X	X	X	!	X	X	SFJ1	JAV	JUV	X''	LAMa	Pass over heli at 1620
111/Apr 20	n/a	X	X	X	X	!	X	X		CNP		X	HAM+L AMa	EGI difficult start up
112/Apr 21	X	X	X		X	!	X	X	SCO	NYA2		X'''	LAMa	EMAP probl with laptop
112/Apr 21	X	X	X		X	!		X	SCO	NYA2		X	LAMa	Changed survey lines
115/Apr 24	X	X	X		X	X	X	X	NRD1	NRD2		X	LAMa	
115/Apr 24	X	X	X		X	X	X	X		NRD2		X	LAMa	
118/Apr 27	X	X	X		X	X	X	X	NRD1	NRD2		X	LAMa	Perfect weather...
119/Apr 28		X	X		X	X	x	X	THU3	NYA		X	LAMa	IMU on late at 1707
120/Apr 29			X		X	X	X	X	YLT1	YLT2		X	LAMa	CR on ice sheet
122/May 1	X	X	X		X	X	X	X	YLT1	YLT2		X	LAMa	
122/May 1	X		X		X	X	X	X	X	YLT1	YLT2		X	LAMa
123/May 2	X	x	X		X	X	X	X	YLT1	YLT2		X	LAMa	
123/May 2	X	X	X		X	X	X	X	YLT1	YLT2		X	LAMa	CR on site FUE, + heli
126/May 5	X	X	X		X	X	X	X	YLT2	THU2	THU3	X	LAMa	Poor vis near YLT
127/May 6	X	X	X		X	X	X	X	THU2	THU3		X	LAMa	
128/May 7	X	X	X		X	X	X	X	THU2	THU3	KELY	X		Disko in diff. alt.

' stopped after end of survey line

' not adjusted – images not clear – adjusted just after heli pass

'' very cloudy

''' EGI data collected by P-Sounder system

### 3.2 INS

A Honeywell medium grade inertial navigation system H764-G, EGI, was used throughout the surveys to record inertially integrated position, velocity and attitude information. Data were logged on a rack mounted PC with solid state hard-disks in binary format through a 1558 mil-spec communication bus. Data from all flights have been secured. The data from April 17<sup>th</sup> to April 21<sup>st</sup> have not been initialised properly at the alignment but this will not affect the laser scanner processing as the files still contains the information needed about attitude changes.

Recordings and comments can be found in Table 3.

*Table 4. GPS Reference Stations*

Name	Location	Hardware (antenna type)
SFJ1	Kangerlussuaq, on met hut roof	Javad maxor, ext ant
JAV	On latter to roof, airport	Javad maxor, int ant
JUV	Upernavik near airport	Javad Legacy
CNP	On hotel roof	Javad Legacy
NRD1	Station Nord, on snow next to apron	Javad Maxor, int ant
NRD2	Station Nord, on snow next to apron	Javad Legacy
YLT1	On snow next to Spinnaker, small tripod	Javad Maxor, int ant
YLT2	Back side of Hurricane, on stick	Javad Legacy
THU2	Thule Air Base, permanent station	Javad Legacy
THU3	Thule Air Base, permanent station	Ashtech UZ-12
KELY	Kangerlussuaq, permanent station	Ashtech Z-XII3
NYA2	Ny Ålesund, Svalbard, permanent station	AOABenchmark ACT
SCOR	Scoresbysund, permanent station	Ashtech UZ-12

### 3.3 Laser Scanner

The laser scanner system has been upgraded to the new Riegl LMS Q240i laser altimeter. This will provide similar measurements with near-infrared laser of the distance between the aircraft and the snow or ice surface as the old laser scanner previously used. The main difference is an improvement of the range; ranging up to 650 m over snow/ice and the smaller footprint; approximately 0.7x0.7 m at the nominal flying altitude of 300m.

The laser scanner data were logged as hourly files on a dedicated PC. The files are time-tagged by 1 PPS signal from the AIR1 GPS receiver and synchronised once per flight by the operator and named with the start time. Table 5 shows the logged files with start /stop times. The data rate has been fixed to 250 observations per line and 40 lines per second throughout the campaign.

The synchronisation of the data has failed for part of the flights which means that the synchronisation has to be checked for each of these files during processing. This will not affect the data quality.

Laser scanner data were recovered for most flights except minor parts with low clouds or fog. Some problems occurred with the laser scanner PC at start up of the system caused by the cold weather. This was solved by heating the PC or running it during night on external power.



Table 5. Recorded laser scanner files

JD	File name	2dd format	Start (dechr)	Stop (dechr)	Comments
108 17/4-08	GroundTest.2dd 108_185200.2dd	X	18.83333	19.86874	Test flight
109 18/4-08	109_154800.2dd	X	15.53333	16.28035	Iceberg survey
110 19/4-08	110_105900.2dd 110_115430.2dd 110_130300.2dd 110_140000.2dd 110_155800.2dd 110_164700.2dd 110_174130.2dd 110_183300.2dd	X X X X X X X X	10.98333 11.90833 13.05000 14.00000 15.96667 16.78333 17.69167 18.55000	11.98568 13.03057 13.98347 14.73355 16.76490 17.67876 18.53849 19.41839	No sync
111 20/4-08	111_113715.2dd 111_121200.2dd 111_125700.2dd 111_140000.2dd	X X X X	11.62083 12.20000 12.95000 14.00000	12.18098 12.93720 13.98334 14.86993	No sync
112 21/4-08	112_101630.2dd 112_110900.2dd 112_115400.2dd 112_121300.2dd 112_134630.2dd 112_151530.2dd	X X X X X X	10.27500 11.15000 11.90000 12.21667 13.77500 15.25833	11.13432 11.74556 12.17062 12.68043 14.20751 15.98591	No sync
115 24/4-08	115_104200.2dd 115_113730.2dd 115_123500.2dd 115_122500.2dd 115_141630.2dd 115_153600.2dd 115_163330.2dd 115_174000.2dd	X X X X X X X X	10.70039 11.62539 12.58377 13.41702 14.27542 15.60043 16.55869 17.66705	11.61595 12.57430 13.40475 14.26649 14.48988 16.54883 17.65387 18.81385	
118 27/4-08	118_102000.2dd 118_112530.2dd 118_121530.2dd 118_131245.2dd 118_134830.2dd 118_142000.2dd 118_145900.2dd	X X X X X X X	10.33367 11.42543 12.25873 13.21292 13.80868 - 14.98377	11.41592 12.24841 13.18812 13.79712 14.31342 - 15.40674	Time gaps
119 28/4-08	119_144400.2dd 119_154000.2dd 119_163400.2dd 119_172430.2dd	X X X X	14.73374 15.66705 16.56705 17.40874	15.65350 16.55936 17.39945 18.61004	
120 29/4-08	120_135330.2dd 120_143930.2dd 120_161330.2dd 120_171400.2dd 120_175900.2dd 120_185615.2dd	X X X X X X	13.89212 14.65883 16.22645 17.23375 17.98373 18.93793	14.64593 16.21969 17.22395 17.97291 18.92643 19.10401	
122 1/5-08	122_134000.2dd 122_143500.2dd 122_153330.2dd 122_162730.2dd 122_173000.2dd 122_184630.2dd 122_193645.2dd	X X X X X X X	13.66705 14.58370 15.55870 16.45869 17.50040 18.77561 19.61290	14.57000 15.55050 16.45018 17.48911 18.22298 19.60370 20.62406	Few time gaps of 1 sec

123 2/5-08	123_133030.2dd	X	13.50888	14.50900	Few time gaps of 1 sec
	123_143100.2dd	X	14.51708	15.24099	
	123_151500.2dd	X	15.25039	16.23944	
	123_161500.2dd	X	16.25038	17.44694	
	123_172730.2dd	X	17.45870	18.62964	
	123_183830.2dd	X	18.64210	19.29238	
	123_204600.2dd	X	20.76706	21.99410	
	123_220030.2dd	X	22.00874	22.86155	
123_230100.2dd	X	23.02184	23.14300		
126 5/5-08	126_131800.2dd	X	13.30041	14.55898	Few time gaps of 1 sec
	126_143400.2dd	X	14.56704	14.98449	
	126_145930.2dd	X	14.99203	15.49834	
127 6/5-08	127_120015.2dd	X	12.00458	13.18491	Few time gaps
	127_131200.2dd	X	13.20036	13.49056	
	127_133000.2dd	X	13.50038	14.25457	
	127_141600.2dd	X	14.26708	14.99530	
	127_150030.2dd	X	15.00874	15.84995	
128 7/5-08	128_121800.2dd	X	12.30033	12.74411	
	128_124515.2dd	X	12.75456	13.68720	
	128_134200.2dd	X	13.70036	14.42977	
	128_142630.2dd	X	14.44210	15.17147	
	128_151100.2dd	X	15.18378	15.90188	

### 3.4 ASIRAS

The ASIRAS system was installed in the same manner as for the CryoVEx 2006 campaign. The new LAMa mode with reduced data rate was used for the surveys except for the CryoSat line near Ilulissat (April 20) where the HAM mode was used. The system was timed with PPS signal and ASCII datation string from the AIR4 Trimble GPS receiver.

Installation, ground test and test flight were performed with assistance from RST engineer H. Lentz in Kangerlussuaq. No problems occurred. The data were logged on the dedicated hard-disks in the ASIRAS PCs during flight and transferred to the PCs for backup after surveys. The data was backed up on hard-disk after the flights with a second copy on a spare set of disks.

Data were acquired continuously over the main sites and for parts of the other survey lines. The operator log files can be found in the Appendix together with a list of 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 carefully checked. Examples can be found in the specific site descriptions, Section 4. The final processing of the acquired ASIRAS data will be the responsibility of the Alfred Wegener Institute (AWI) with input of GPS and INS position and attitude data from DTU Space.

### 3.5 Auxiliary data

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

A downward looking web-camera was installed next to the laser scanner and operated during flights acquiring visual documentation of the surface. Images were captured every 2 seconds and time tagged using GPS. The image files were stored on a laptop PC during flight and backed up on hard-disk after each flight.

As backup for the laser scanner a profiling laser altimeter was installed next to the laser scanner and web camera. Also an extra inertial navigation unit was run as backup to the EGI instrument. These instruments were all timed by 1 PPS signals from GPS and data has been recorded on a dedicated PC and backed up post flight.

## 4 Site descriptions

### 4.1 Northern Greenland Ice Sheet - UK1

The UK1 team was positioned at the ice with the Air Greenland Twin Otter reg. OY-ATY from Thule Air Base. This “put-in” of the team was delay a few days caused by poor weather along the Greenland west coast but the UK team managed to be ready for the planned over-flight.

The UK1 site on the ice sheet was over-flown with the airborne laser and radar system on April 29. The reflector at the site (named ICE2) was passed from north and two times from east to west. The best hit of the reflector was the first pass from the north. Figure 2 shows a “Quicklook” image of the ASIRAS radar signal from the corner reflector at ICE2.

Thereafter the full transect was flown from ICE2 to ICE4 and the survey continued back to Alert over the Petermann glacier.

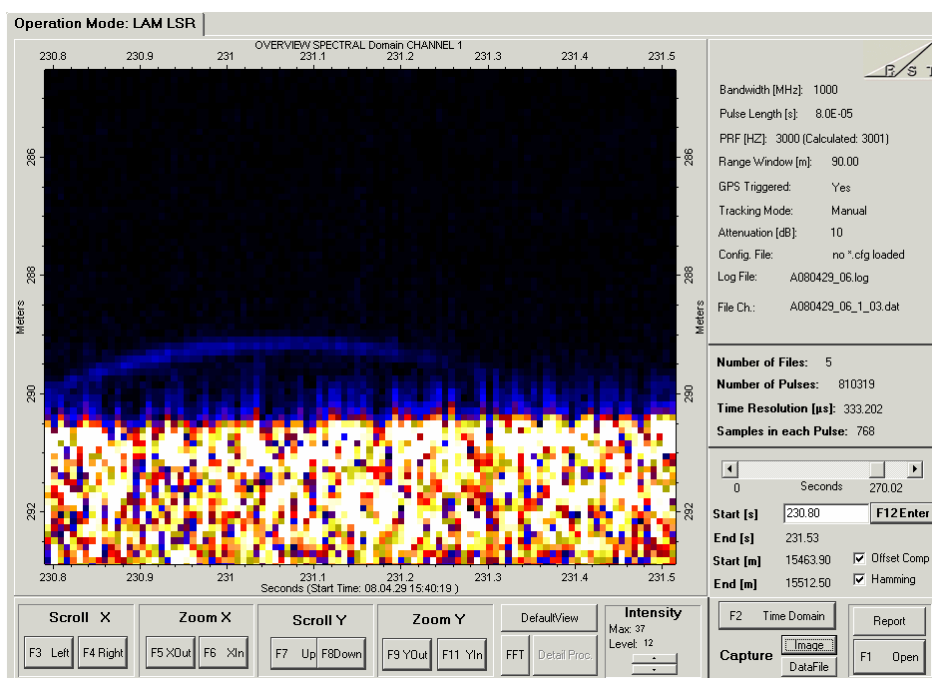


Figure 2. “Quicklook” image showing radar signal from the corner reflector at ICE2

### 4.2 Alert Sea Ice

The operations out of Alert focused on the validation sites near the coast on multiyear ice (MYI) and first year ice (FYI) and coordinated operations with the helicopter-borne EM bird system. In addition, longer surveys were carried out in the Arctic Ocean north-east and north-west of the station and a smaller survey near the AUV camp on the sea ice near Alert.

As describe in section 2 the flights were done on May 1<sup>st</sup>-2<sup>nd</sup> and May 5<sup>th</sup>. Figures 3 show the details of the flight lines over the validation sites flown on May 1<sup>st</sup>. Both sites were over-flown repeatedly and in two altitudes 1000 ft and 1500 ft. At both sites two corner reflectors had been put up and these were hit more than once at each altitude.

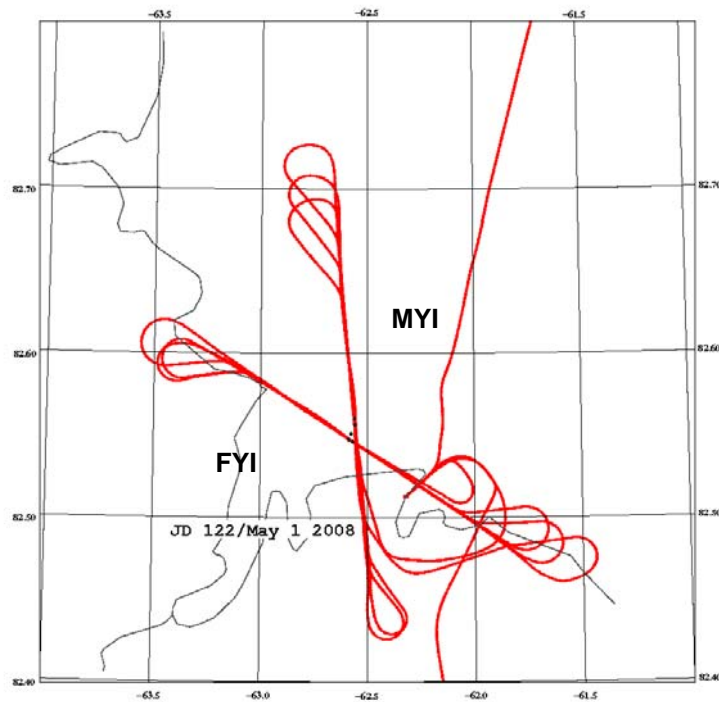


Figure 3. Tracks from over flight of the FYI and MYI validation sites on May 1<sup>st</sup>

A coordinated flight with laser/radar from Twin Otter and EM from a helicopter was done in the afternoon on May 2<sup>nd</sup>. The helicopter was over-flown near the fuel cache laid out to enable a longer operation. The helicopter was definitely hit within the footprint of ASIRAS as it is clearly seen on the radar return, see Figure 4.

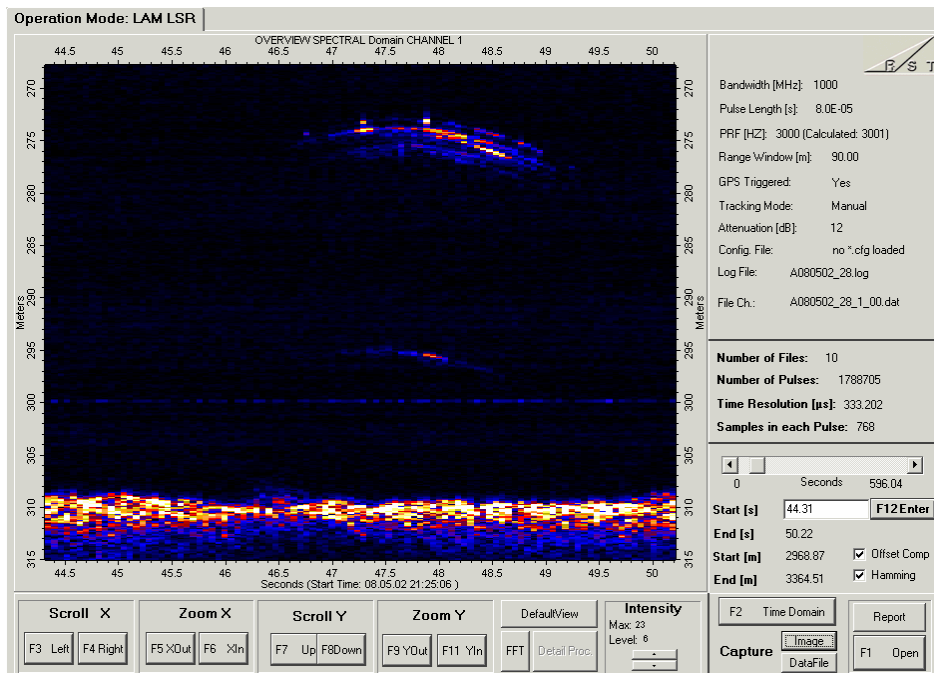


Figure 4. “Quicklook” image of helicopter over flight on May 2<sup>nd</sup>. Note the reflection from both the helicopter itself and the EM bird below it

### 4.3 Devon Ice Cap

The Devon site was surveyed on May 6<sup>th</sup>. It was planned to base the survey in the local settlement Grise Fiord but the weather did not favour this very small airfield and the base was moved to Thule Air Base. The main survey lines (E-W and N-S), see Figure 5, were observed twice to ensure good alignment over corner reflectors put up at the line crossing and at a handful other sites along the lines.

The reflectors were hit and also two additional lines were measured, as requested by the Canadian team on the Devon Ice Cap, before returning the aircraft to Thule.

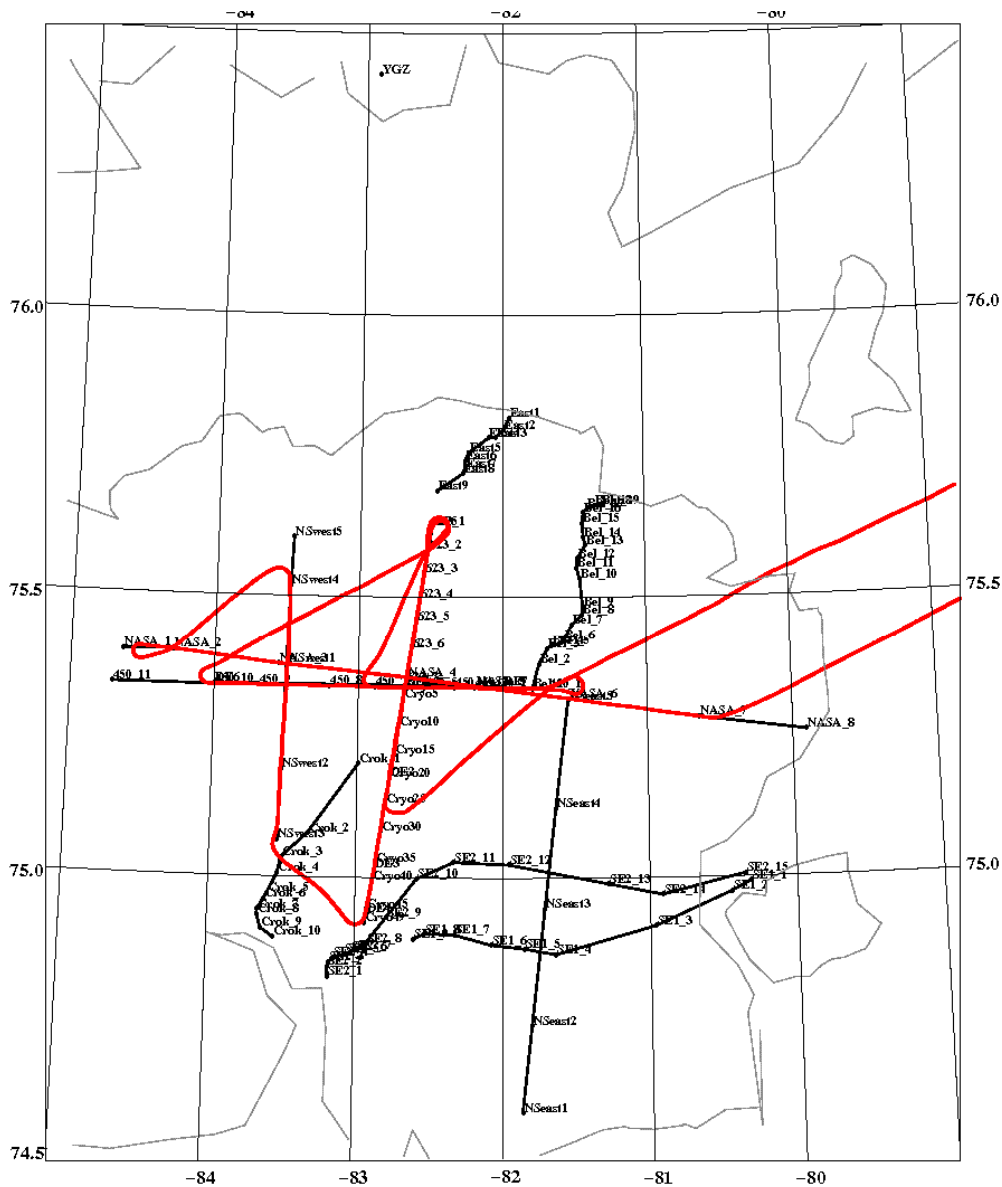


Figure 5 Flight tracks of the Devon Ice Cap survey on May 6<sup>th</sup> (red). (In black the planned lines – some on opportunity basis and not all observed)

#### 4.4 Others: Ilulissat and Fram Strait

On April 20<sup>th</sup> the EGIG line crossing the Greenland ice sheet between 70 and 72 N was surveyed. A line, similar to the future CryoSat tracks, was also flown on this flight over the inner part of Jakobshavn Isbræ near Ilulissat. This line almost heading N-S was measured both at high altitude (approx. 1100 m above the ice) in HAM mode and at 300 m in LAMa mode together with laser scanner observations.

The Norwegian coastguard vessel KV Svalbard (see photograph) has been on a scientific cruise for the Norwegian Polar Institute in April and May 2008. During the first part of the cruise the ship anchored to an ice floe in the Fram Strait between Greenland and Svalbard. Surface observations were done on this floe from the ship. A survey line on the floe was over flown with the airborne system on April 24<sup>th</sup> together with sea ice observations on east-west lines along the Greenland coast. The sea ice team on KV Svalbard also erected a corner reflector on the line but so far we can not confirm that this has been hit with the ASIRAS.



*KV Svalbard in the Fram Strait (77N25, 7W22) on April 24<sup>th</sup> 2008*

## 5 Conclusions

The airborne part of CryoVEx 2008 has successfully been carried out by DTU Space and the gathered data sets are now secured at DTU Space on central servers backed up on magnetic tapes. A total of 72 hr were flown with the Air Greenland Twin Otter plus additional 15 hrs for the transport of the UK1 team to the ice sheet. Laser scanner data has been gathered on most lines and ASIRAS data was recorded over test sites and on large parts of the other lines.

At the time of writing this report the post processing of the GPS, INS and laser scanner data has started at DTU Space. The GPS and INS information will be delivered to AWI for the ASIRAS data analysis.

## 6 Appendix

Operator logs for laser scanner system(left) and ASIRAS (right):

JD 108 17/4-08 SFJ-drop-test-SFJ

1842	Take off	
185200?	New scanner file	
	Tent dropped on the ice	<u>Asiras CryoVEx 2008</u>
	Climb to 6000ft	JD 108 - 17 04 08
	Decent to approx. 900m	SFJ -> SFJ testflight
	Decent slowly to 1000ft in fjord	
	Return at 1000ft	
1941	Over blue building 1	2038 take off
	Cross over building at 1000ft	2155 landed
1955	Landing	

JD 109 18/4-08 SFJ-ICB-JAV

1453	Take off	
	Image capture off for adjusting	<u>Asiras CryoVEx 2008</u>
153200	Scanner sync	JD 109 - 18 04 08
	No power on Air2 cable	JAV -> JAV flight for DR journalists
	remounted	
1541	Air2 restarted	1800 take off
154800	New scanner file, +1sec?	1802 system on
1556	ICB1; Alt 230m/800ft	1807 IRF calibration
	Deviate line to obs icebergs	1810 LAM mode
1616	Landing	1812 record on (sea ice)
	JAV-fjord-JAV for journalists	1818 record off (turn)
1758	Taxi	1820 record on
1801	Take off	1825 record off
180800	Scanner sync	1827 record on
180953	New scanner file, file name	1830 record off
181000		1830 IRF calibration
	Started 181057	1834 system off
1818	Turn over Isbræ edge	1835 landed
1828	IMU restart logging	
1835	Landing	

JD 110 19/4-08 JAV-K-JUV-HELI-K-JAV

	Scanner pc down – too cold	<u>Asiras CryoVEx 2008</u>
	Try to shift to laptop not ok	JD 110 - 19 04 08
1028	Take off	JAV -> UPERNAVIK
	Pass over runway for journalists	
103500	Scanner sync, scanner start no	1032 system on
signal		1035 IRF calibration
	problem with logging on Lars'	1058 record on (test)
pc		1103 record off
104600	Scanner sync	1145 record on (sea ice)
105700	Scanner sync, scanner pc up	1220 record off
105900	New scanner file	1220 record on
1104	Image capture started	1255 record off (turn)
1120	Xtra monitor tested ok	1300 record on
	Some clouds JAV-K1	1325 record off (turn)
1147	K1	1328 record on
115430	New scanner file	1407 record off
1300	K2, tear drop turn	1407 record on
130300	New scanner file	1419 record off (turn)
1326	K3, direct turn	1424 IRF calibration
140000	New scanner file	1425 system off
1419	K4, open water and thin ice	
1443	Landing JUV	



Coordinate with helicopter		UPERNAVIK -> JAV
1510	Take off helicopter	
	Download 1 <sup>st</sup> part	1601 system on
1557	Take off	1603 IRF calibration
155800	New scanner file	1605 record on (thin sea ice)
1604	HE2	1620 overhead helicopter
1616	HE5	1635 record off
1620	HE6, overflight of heli on ground	1635 record on
	Perfectly coordinated	1705 record off
1633	Light fog	1705 record on
164700	New scanner file	1721 record off (turn)
1721	K6, tear drop turn	1724 record on
174130	New scanner file	1745 record off (switch to PC2)
1800	K7	1746 record on
183200 (183300?)	New scanner file	1758 record off (turn)
1856	K8, end of line	1759 record on
	Obs of icebergs	1830 record off
1922	Start climb	1830 record on
1925	Stop logging scanner + alt	1855 record off (turn)
	Stop logging Air1 to download	1856 record on
2108	Landing	1923 record off
		1924 IRF calibration
		1927 system off

JD 111 20/4-08 JAV-EGIG-CNP

Hard to start up EGI  
Perhaps Air1 was started after

EGI

No lock on sat, fixed height

align

1113 NavRdy finally

1115 Engine start up

1125 Take off

11?? Scanner sync

113718 New scanner file called 113715  
JAV line 1-10, 1000ft south

1150 JAV5 1<sup>st</sup> time, some low clouds

1156 Return north, aprox 1100m  
above ice

121200 New scanner file

121230 JAV10, decent to 1000ft

1223 T1

1227 T3

123130 T5

125700 New scanner file

140000 New scanner file

1452 Scanner file closed

1548 Landing CNP

Asiras CryoVEx 2008

JD 111 - 20 04 08  
JAV -> CNP

1130 system on

1132 IRF calibration

1135 record on

1142 record off

1144 record on

???? record off

12?? record on (HAM)

1213 record off

1215 record on (LAM)

1246 record off

1246 record on

1313 record off

1313 record on

1330 record off

1330 record on

1400 record off

1400 record on

1430 record off

1430 record on

1451 record off

1455 IRF calibration

1458 system off

JD 112 21/4-08 CNP-K-DNB-Krev-NRD

Scanner sync on ground  
 Pobl with EMAP start up  
 Perhaps problems with serial  
 port on laptop  
 1000 Engine start  
 1010 Taxi  
 1014 Take off  
 101630 New scanner file  
 1030 EMAP up on smh laptop  
 1040 Decent to 1000ft  
 1045 End of fast ice  
 110900 New scanner file  
 1115 K9 tear drop turn  
 1123 Low clouds  
 1130 Climb to 460m  
 1144 Scanner file closed  
 115400 New scanner file (start 04)  
 Clouds partly broken  
 1201 Decent, try to get under clouds  
 1204 Icing, climb  
 1220 Broken clouds, 660m alti, some  
 scanner  
 1228 K10, 750m, only ASIRAS  
 1238 800m  
 1254 K11, clouds, only little sea ice  
 134630 New scanner file still in clouds  
 1358 K12  
 1407 Overflight runway DNB

ASIRAS log: 21/4-2008, JD 112:

Operator: HSK  
 Flight: CNP-DNB, DNB-NRD:  
 Take off Constable Pynt  
 start log file A080421\_00,  
 flight altitude 300m  
 1116 Ascend to 480m  
 1130 Ascend to 540m  
 1142 Descend to 300m  
 1200 new log file A080421\_01  
 1203 Climb to 660m  
 1222 climb to 720m  
 1227 turn – stop logging  
 1254 new log file A080421\_02  
 1301 climb to 900m  
 climb to 960m  
 1309 descend to 900m  
 1311 descend to 840m  
 1333 descend to 660m  
 1337 descend to 540m  
 1340 descend to 420m  
 1350 descend to 360m  
 1309 descend to 300m  
 1356 stop logging  
 1357 calibration  
 Landing Daneborg  
 Take off Daneborg  
 new log file A080421\_03,  
 300m  
 1507 Taxi climb to 600m  
 1510 Take off new log file A080421\_04  
 1540 After Shannon Island in fog new log file A080421\_05  
 again new log file A080421\_06  
 1610 Deviate line, direct north new log file A080421\_07,  
 163130 New scanner file 300m  
 1634 1000ft, turn towards K15  
 1642 Long leads and large patches new log file A080421\_08  
 without leads 1714 turn  
 1723 K15, turn direct towards NRD new log file A080421\_10  
 172500 New scanner file new log file A080421\_11  
 181400 New scanner file fog/low clouds new log file A080421\_12  
 – some broken frostflowers  
 1843 Scanner logging stopped 1812 PC1 full change to PC2  
 185900 New scanner file new log file A080421\_13  
 1935 Flade isblink start 1829 new log file A080421\_14  
 2000 Landing NRD 1843 new log file A080421\_15  
 1859 new log file A080421\_16  
 1914 new log file A080421\_17  
 1929 stop radar  
 Calibration  
 Shut down system  
 Landing St. Nord

JD 115 24/4-08 NRD-K-KV Svalbard-DMH-K-NRD

Problems with scanner start up  
PC restarted several times –  
without scanner on  
Connected but no data in  
1000 Taxi  
1009 Take off  
Scanner restarted 1000 times,  
check of net-connection  
Finally receives data + sync  
104200 New scanner file  
1047 Image capture started  
1130? EGI input stopped, program  
restarted  
1135 K20, turn  
113730 New scanner file  
1233 K21  
123500 New scanner file  
1248 KV Svalbard, 77 25N 7 22W,  
VHF 130.5  
200 m line east of ship  
1300 Overhead KV Svalbard  
1322 3 passes and overhead ship into  
line  
132500 New scanner file  
141630 New scanner file, end of line  
1442 Landing DMH  
6 drums of fuel  
  
EGI restarted and aligned  
153045 Taxi  
1533 Take off  
153600 New scanner file  
1553 Air1 start logging  
1612 Image capture restarted  
163330 New scanner file  
1652 K21, tear drop turn  
170620 End of fast ice  
1718 Some clouds  
1738 K22, direct turn  
174000 New scanner file  
1808 K23  
1848 End of line, K24  
Scanner file closed  
1922 Landing

ASIRAS log: 24/4-2008, JD 115:

Operator: HSK  
Flight: NRD-KV Svalbard-DMH, DMH-NRD:

0830 Take off NRD  
1015 ASIRAS startup, int.  
calibration  
1019 Ready  
1136 new log file A080424\_00,  
300m  
1150 new log file A080424\_01  
1205 new log file A080424\_02  
1220 new log file A080424\_03  
1233 log stopped, turn  
1235 new log file A080424\_04  
1250 new log file A080424\_05  
1259 new log file A080424\_06  
1300 KV Svalbard  
1303 stop file  
1304 new log file A080424\_07  
1307 KV Svalbard  
1309 stop log file  
1310 new log file A080424\_08  
1312 KV Svalbard  
1314 stop log file  
1315 new log file A080424\_09  
13 KV Svalbard  
1319 stop log file  
1323 new log file A080424\_11  
1333 new log file A080424\_12  
1344 new log file A080424\_13  
1355 new log file A080424\_14  
1405 new log file A080424\_15  
1415 new log file A080424\_16  
1417 stop file  
1418 stop radar, int. calibration  
Landing DMH  
  
Take off DMH  
1541 ASIRAS startup, int.  
calibration  
1556 test PC1 55% A080424\_18  
1655 new log file A080424\_19  
1705 new log file A080424\_20  
1716 new log file A080424\_21  
clouds  
1725 new log file A080424\_22  
1735 new log file A080424\_23  
1737 stop file  
1808 new log file A080424\_24  
1818 new log file A080424\_25  
1828 new log file A080424\_26  
1838 new log file A080424\_27  
1847 stop file  
1848 stop radar, int. calibration  
Landing NRD

JD 118 27/4-08 NRD-F-NRD

Problems with scanner start up  
PC lost all settings  
100230 Scanner sync  
1006 Engine start  
1013 Taxi  
1018 Take off  
1020 New scanner file  
103430 End of fast ice  
1040 Large lead  
1124 Start new line after F1 tear drop  
turn  
112530 New scanner file  
1159 Image capture restarted  
Scanner logging stopped?  
121530 New scanner file  
131245 New scanner file  
1312 F2 tear drop turn  
Scanner logging slow, stopped  
again  
134830 New scanner file  
142000 New scanner file – logging  
never started!  
143640 Large open lead, shear zone  
Very thick fast ice edge  
145900 New scanner file  
1505 Runway pass  
1509-> Building over flight  
1523 Landing

ASIRAS log: 27/4-2008, JD 118:

Operator: HSK  
Flight: NRD-trekant-NRD:  
  
Take off NRD  
1018 startup system  
1020 int. calibration  
1026 new log file A080427\_01  
1035 new log file A080427\_02  
1045 new log file A080427\_03  
1059 new log file A080427\_04  
1110 new log file A080427\_05  
1116 stop log file, teardrop  
1120 new log file A080427\_06  
1130 new log file A080427\_07  
1140 new log file A080427\_08  
1151 new log file A080427\_09  
1200 new log file A080427\_10  
1210 new log file A080427\_11  
1220 new log file A080427\_12  
1230 new log file A080427\_13  
1242 new log file A080427\_14  
1300 new log file A080427\_15  
1308 stop log file, teardrop  
1313 new log file A080427\_16  
1325 new log file A080427\_17  
1335 new log file A080427\_18  
1346 new log file A080427\_19  
1358 new log file A080427\_20  
1410 new log file A080427\_21  
1425 new log file A080427\_22  
1432 refrozen lead  
1435 new log file A080427\_23  
1445 new log file A080427\_24  
1455 new log file A080427\_25  
1458 new log file A080427\_26  
1502 overflight runway NRD  
1503 stop log files  
1505 new log file A080427\_27  
1505 turn  
1507 overflight building NRD  
1508 stop log file  
1508 new log file A080427\_28  
1510 stop log file  
1511 new log file A080427\_29  
1514 overflight building NRD  
1515 stop log file  
1516 new log file A080427\_30  
1517 overflight building NRD  
1518 stop log file, int. calibration  
Landing NRD

JD 119 28/4-08 NRD-E-YLT

Problems with IMU start up  
No network connection, no data  
in  
142300 Scanner sync  
1439 Taxi  
1442 Take off  
144400 New scanner file  
1458 E3  
150430 ALT restarted, IMU still off  
R4-R1 (off E3-E2 at 1512)  
153130 Back on E3-E2 shear zone, lead  
154000 New scanner file  
1554 T4-T1  
1558 T1-S4 over glacier  
1607 S4-S1  
161245 Fast ice edge  
161650 E2  
163400 New scanner file  
163740 E1, tear drop turn  
1704 ALT stop logging, try to restart  
IMU by power off  
1707 IMU+ALT restarted!  
172430 New scanner file  
1835 Landing

ASIRAS log: 28/4-2008, JD 119:

Operator: HSK  
Flight: NRD-YLT  
1442 Take off NRD  
1621 ASIRAS startup, int.  
calibration  
1625 new log file A080428\_00, test  
1638 new log file A080428\_01  
1651 new log file A080428\_02  
1700 new log file A080428\_03  
1710 new log file A080428\_04  
1720 new log file A080428\_05  
1731 new log file A080428\_06  
1737 open lead, event mark 1  
1740 new log file A080428\_07  
1751 new log file A080428\_08  
1756 FY ice  
1800 new log file A080428\_09  
1810 new log file A080428\_10  
1812 rubled ice, pix 215/216  
1813 FYI  
1820 new log file A080428\_11  
1826 stop file  
1827 int. calibration, shut down  
system  
Landing YLT

JD 120 29/4-08 YLT-ICE-A-YLT

Scanner PC too cold  
Problems with scanner PC connection  
PC restarted several times  
134000 Scanner sync  
1352 Taxi  
135330 New scanner file  
1355 Take off  
143930 New scanner file, start of ice sheet  
154400 CR from north ~0m  
155330 CR from east ~10m  
160210 CR from east ~15m  
161040 CR from east ~13m  
161330 New scanner file (started  
161334)  
1618 CR from east ~25m  
Continue on line to ICE3  
1641 ICE3  
1710 ICE4  
171400 New scanner file  
1744 A2  
175900 New scanner file  
1800 A3  
1844 End of glacier  
184730 A5  
185615 New scanner file  
1922 Landing

ASIRAS log: 29/4-2008, JD 120:

Operator: HSK  
Flight: YLT-ICESHEET-PETERMAN GL.-YLT  
Take off YLT  
1355 ASIRAS startup, int.  
calibration  
1439 new log file A080429\_00,  
240m  
1440 climb to 300m  
1449 new log file A080429\_01  
1459 new log file A080429\_02  
1509 new log file A080429\_03  
1520 new log file A080429\_04  
1530 new log file A080429\_05  
1540 new log file A080429\_06  
1544 stop log file, tear drop  
1551 new log file A080429\_07  
15535 reflector, event mark 1  
1554 stop log file  
1600 new log file A080429\_08  
1602 stop log file  
1608 new log file A080429\_09  
1611 stop log file  
1616 new log file A080429\_10  
1626 new log file A080429\_11  
1636 new log file A080429\_12  
1646 new log file A080429\_13  
1656 new log file A080429\_14  
1708 end of line, stop log file  
1714 new log file A080429\_15  
1725 new log file A080429\_16  
1735 new log file A080429\_17  
1744 end of line, stop log file  
1745 new log file A080429\_18  
1759 end of line, stop log file  
1800 new log file A080429\_19  
1810 new log file A080429\_20  
1820 new log file A080429\_21  
1832 new log file A080429\_22  
1841 new log file A080429\_23  
1844 event marker 1, end of glacier  
1852 new log file A080429\_24  
1900 new log file A080429\_25  
Climbing to 1020m  
1906 stop file, internal calibration  
Shut down system  
Landing YLT

JD 122 1/5-08 YLT-F-S-YLT-MYI-FYI-YLT

1331 Problems with POF HF radio  
 restarted) EGI logging restarted (program  
 133530 Scanner sync  
 134000 New scanner file, still on ground  
 1343 Taxi  
 1345 Take off  
 143500 New scanner file  
 1437 F3  
 153330 New scanner file  
 1547 F2, tear drop turn  
 162730 New scanner file  
 Loose connection in power in to  
 rack,  
 running on batteries for a while,  
 look out for the plug  
 173000 New scanner file  
 1807 End of line  
 1825 Landing

ASIRAS log: 1/5-2008, JD 122:

Operator: HSK  
 Flight: YLT-triangle-YLT, YLT-MYI-FYI-YLT

Take off YLT  
 1350 ASIRAS startup, int. calibration  
 1352 new log file A080501\_00, 300m  
 1402 new log file A080501\_01  
 1412 new log file A080501\_02  
 1422 new log file A080501\_03  
 1433 new log file A080501\_04  
 1437 stop log file, end of line  
 1445 new log file A080501\_05  
 1456 new log file A080501\_06  
 1505 new log file A080501\_07  
 1515 new log file A080501\_08  
 1526 new log file A080501\_09  
 1535 new log file A080501\_10  
 1547 stop file, teardrop  
 1551 new log file A080501\_11  
 1600 new log file A080501\_12  
 1610 new log file A080501\_13  
 1620 new log file A080501\_14  
 1630 system down, power failure  
 1642 start up, int. calibration  
 1643 new log file A080501\_15  
 1655 new log file A080501\_16  
 1705 new log file A080501\_17  
 1715 new log file A080501\_18  
 1725 new log file A080501\_19  
 1736 new log file A080501\_20  
 1746 new log file A080501\_21  
 1756 new log file A080501\_22  
 1807 stop file  
 1808 int. calibration, shut down  
 On ground YLT

	Pick up MD		Take off YLT
1000ft over CR	and then 2000ft	1854	turn on system, int. calibration
183630	New scanner file	1858	new log file A080501_23, PC2
1850	Taxi		MYI S → N 1,000ft
1852	Take off, heading towards MY	1901	stop file
185920	CR ~30-40m	190551	new log file A080501_24
190945	CR ~4m		MYI N → S 1,000ft
191730	CR ~-6m, from south	1911	stop file
192630	CR ~-1m	191523	new log file A080501_25
	Climb to 2000ft	191730	MYI S → N 1,000ft
1934	CR ~0m!	1919	stop file
193645	New scanner file	192302	new log file A080501_26
194210	CR ~-3m	192630	MYI N → S 1,000ft
195150	Crossing runway, heading for	1927	stop file
FYI			Climb to 2,000ft
195310	CR ~10m	193120	new log file A080501_27
200127	CR ~-2m	193400	MYI S → N 2,000ft
	Decent to 1000ft	193536	stop file
200240	Crossing runway	193915	new log file A080501_28
200828	Crossing runway	194206	MYI N → S 2,000ft
200950	CR ~-5m	194315	stop file
2017	CR ~6m	194945	new log file A080501_29
2025	CR ~3m	195248	FYI E → W 2,000ft
203225	CR ~6m	195456	stop file
2037	Landing	195832	new log file A080501_30
		200127	FYI W → E 2,000ft
		200145	stop file
			Descend to 1,000ft
		200636	new log file A080501_31
		200945	FYI E → W 1,000ft
		201134	stop file
		201426	new log file A080501_32
		201710	FYI W → E 1,000ft
		201812	stop file
		202205	new log file A080501_33
		202457	FYI E → W 1,000ft
		202619	stop file
		202925	new log file A080501_34
		203204	FYI W → E 1,000ft
		203234	stop file
		2033	int, calibration, shut down system
			Landing YLT



JD 123 2/5-08 YLT-H-YLT-A-FUE-A-YLT

Problems with scanner PC start  
up  
132800 Scanner sync  
133030 New scanner file  
1335 Take off  
Local patches of fog  
143100 New scanner file  
1500 H1  
151500 New scanner file, fog  
1608 H3  
161500 New scanner file  
1720 Air2 stopped logging, card full,  
restarted  
1720 H5  
172730 New scanner file  
1747 H6  
1837 H7  
183830 New scanner file  
1916 Landing  
Fuel  
New start up  
Coincident flight with helicopter  
2020 Heli take off  
202800 Scanner sync  
2045 Take off  
204600 New scanner file  
2105 A1 after turn to align on track  
2127 FUE ~0m  
2126 Heli over flight  
21?? Air1 stop logging, disc full  
215905 A2  
220030 New scanner file  
220310 A2  
223058 FUE ~6m, heli on ground  
2251 A1, end of survey line  
Low level in to YLT  
2308 Landing

ASIRAS log: 2/5-2008, JD 123:

Operator: HSK  
Flight: YLT-H-YLT, YLT-A1-A2-A1-YLT  
Take off YLT  
1336 ASIRAS startup  
1343 int. calibration  
1344 new log file A080502\_00, 300m  
1355 new log file A080502\_01  
1405 new log file A080502\_02  
1415 new log file A080502\_03  
1425 new log file A080502\_04  
1435 new log file A080502\_05  
1445 new log file A080502\_06  
1455 new log file A080502\_07  
1501 stop file, end of line  
1518 new log file A080502\_08  
1530 new log file A080502\_09  
1540 new log file A080502\_10  
1550 new log file A080502\_11  
1600 new log file A080502\_12  
1608 stop log file, end of line  
1626 new log file A080502\_13  
1636 new log file A080502\_14  
1645 new log file A080502\_15  
1655 new log file A080502\_16  
1705 new log file A080502\_17  
1715 new log file A080502\_18  
1722 stop file, end of line  
1751 new log file A080502\_19  
1800 new log file A080502\_20  
1810 new log file A080502\_21  
1820 new log file A080502\_22  
1830 new log file A080502\_23  
1837 stop line  
1840 int. calibration  
Landing YLT/Take off YLT  
2045 system startup  
2050 int. calibration  
2051 new log file A080502\_24, test  
2058 new log file A080502\_25 (NW)  
2100 stop log file  
210525 new log file A080502\_26, A1  
2115 new log file A080502\_27  
212500 new log file A080502\_28  
212643 reflector, helicopter  
213500 new log file A080502\_29  
214500 new log file A080502\_30  
215500 new log file A080502\_31  
215915 stop log file, A2  
220240 new log file A080502\_32  
221200 new log file A080502\_33  
222200 new log file A080502\_34  
222700 new log file A080502\_35  
223058 over airstrip, fuelcache  
223700 new log file A080502\_36  
224700 new log file A080502\_37  
225126 stop log file, end of survey  
2252 int. calibration, shut down  
On ground YLT

JD 126 5/5-08 YLT-M-cal-GM-THU

Scanner PC reconnected  
Power loss on ground cable  
Restart with engine on  
Scanner sync  
130700 New scanner file, on ground  
Start with Mow-the-lawn  
1327 Take off  
Poor visibility, change alt to  
200m  
Only chose central lines and add  
more close to camp  
+-150m of camp approx.  
1416 End of survey lines E-W  
1420 Start calib over Spinnaker  
1432 End of calib  
143400 New scanner file, up through  
clouds  
Heading for GM1-GM8  
145930 New scanner file  
152930 GM8, end of survey  
1803 Landing

ASIRAS log: 5/5-2008, JD 126:

Operator: HSK  
Flight: YLT-AUV-ice on Ellesmere Island-  
THU  
Take off YLT  
1327 ASIRAS startup  
1333 int. calibration  
133455 new log file A080505\_00, 300m  
AUV M1-M2  
1338 stop file, end of line  
134644 new log file A080505\_01, 240m  
135108 stop file, end of line  
AUV M5-M6  
135510 new log file A080505\_02, 240m  
135928 stop file, end of line  
AUV M7-M8  
140314 new log file A080505\_03, 240m  
AUV  
140745 stop file, end of line  
141241 new log file A080505\_04, 240m  
AUV  
141708 stop file, end of line  
142009 new log file A080505\_05  
Overflight Runway+Spinnaker  
building YLT  
142105 stop file  
142308 new log file A080505\_06  
Overflight Spinnaker  
142400 stop file  
1426 new log file A080505\_07  
Overflight Spinnaker  
142740 stop file  
143030 new log file A080505\_08  
Overflight Spinnaker  
143208 stop file  
144930 new log file A080505\_09\*  
145939 stop file  
151140 new log file A080505\_10\*  
152100 new log file A080505\_11\*  
1529 stop file  
1533 int. calibration, shut down system  
Landing Thule AB

\* Survey on Ellesmere Island, various heights  
due to changing surface heights.

JD 127 6/5-08 THU-DEVON-THU

Normal start up with engine on  
 114500 Scanner sync  
 1159 Take off  
 120015 New scanner file  
 1225 EMAP restarted Cy1, Cy5  
 deleted  
 Too close to CR  
 131200 New scanner file  
 133000 New scanner file  
 1336 45\_4 ~6m  
 CR ~18m  
 1345 End of 45\_1-45\_10  
 1401 62\_2 after tear drop turn into  
 line  
 CR ~17m  
 140830 Cy10 ~4m  
 Cy19 ~8m  
 141600 New scanner file  
 Repeat 45\_1-45\_9  
 142440 45\_1, start line  
 1428 45\_4 ~12m  
 CR ~20m  
 1440 N-S line repeated  
 1447 CR ~2m  
 1456 Cy45, turn towards NSw1  
 150030 New scanner file  
 150250 NSw1  
 1514 NSw4, turn towards NASA line  
 1524 NA2  
 1547 NA7, end of line  
 1550 End of survey, scanner logging  
 off  
 Direct THU  
 1703 Landing

ASIRAS log: 6/5-2008, JD 127:

Operator: HSK  
 Flight: THU-Devon icecap-THU  
 Take off THU  
 1202 ASIRAS startup  
 1204 int. calibration  
 1205 new log file A080506\_00, 300m  
 1222 new log file A080506\_01  
 1232 new log file A080506\_02  
 1242 new log file A080506\_03  
 1252 new log file A080506\_04  
 1302 new log file A080506\_05  
 1312 new log file A080506\_06  
 1318 stop file  
 Devon icecap  
 133228 new log file A080506\_07  
 133745 reflector/camp  
 134534 stop file, end of line  
 140047 new log file A080506\_08, 420m  
 140115 300m  
 140656 reflector  
 140820 360m  
 140838 300m  
 141109 stop file  
 142408 new log file A080506\_09  
 143009 camp/reflector  
 143102 stop file  
 144128 new log file A080506\_10, 480m  
 144258 360m  
 144346 300m  
 144747 reflector  
 145208 360m  
 145225 300m  
 145628 PC1 record stopped  
 1457 new log file A080506\_11, test  
 1458 new log file A080506\_12, test  
 Stopped again  
 1459 change to PC2  
 1500 new log file A080506\_13, test  
 1501 stop file - OK  
 150305 new log file A080506\_14  
 1506 try 360m back to 300m  
 151425 stop file  
 152330 new log file A080506\_15, 420m  
 152358 360m  
 152425 300m  
 153130 new log file A080506\_16  
 153500 camp on starboard  
 154100 new log file A080506\_17, 300m  
 154240 360m  
 154340 420m  
 154724 stop file, end of survey  
 1548 int. calibration  
 1550 shut down system  
 Landing Thule AB

JD 128 7/5-08 THU-DISKO-SFJ

	Normal start up with engine on
120000	Scanner sync
1204	IMU+ALT restarted, IMU input stopped
1207	Taxi
1216	Take off
121800	New scanner file
1228	EMAP restarted – new map on screen
124515	New scanner file
	Melville Bay open water in northern part
134200	New scanner file
142630	New scanner file
151100	New scanner file
1552	End of Disko survey
	Direct SFJ
1653	Landing

List of recorded ASIRAS files with start/stop times, range window and number of pulses:

*Table Recorded ASIRAS files*

File name [AYYMMDD]	Start time	Stop time	Range Window [m]	# Pulses
A080417_00.log	16:02:40	16:02:45	18.00	5783
A080417_01.log	16:04:14	16:04:19	90.00	9419
A080417_02.log	16:06:56		90.00	
A080417_03.log	16:09:30	16:09:36	18.00	7500
A080417_04.log	21:13:03	21:15:12	18.00	375148
A080417_05.log	21:24:23	21:26:44	90.00	347498
A080417_06.log	21:28:37	21:30:33	90.00	284998
A080417_07.log	21:33:09	21:36:15	90.00	459998
A080418_00.log	20:07:07	20:13:34	90.00	1152455
A080418_01.log	20:15:45	20:21:31	90.00	1032407
A080418_02.log	20:22:29	20:25:12	90.00	483191
A080419_00.log	12:52:16	12:58:17	90.00	1074424
A080419_01.log	13:40:34	14:15:01	90.00	6194438
A080419_02.log	14:15:02	14:49:44	90.00	6242456
A080419_03.log	14:54:35	15:21:34	90.00	4855910
A080419_04.log	15:23:28	16:03:00	90.00	7112798
A080419_05.log	16:03:02	16:14:22	90.00	2034802
A080419_06.log	16:05:44	16:35:25	90.00	5339104
A080419_07.log	16:35:37	17:05:39	90.00	5402127
A080419_08.log	17:05:40	17:21:16	90.00	2800102
A080419_09.log	17:24:41	17:45:19	90.00	3706460
A080419_10.log	17:46:17	17:58:36	90.00	2208870
A080419_11.log	17:59:36	18:30:59	90.00	5642220
A080419_12.log	18:31:01	18:55:50	90.00	4459755
A080419_13.log	18:56:50	19:23:32	90.00	4801889
A080420_00.log	11:35:44	11:42:10	90.00	1152454
A080420_01.log	11:44:09	11:56:25	90.00	2202868
A080420_02.log	12:00:37	12:12:31	18.00	2136858
A080420_03.log	12:15:03	12:46:23	90.00	5636219
A080420_04.log	12:46:24	13:13:43	90.00	4906931
A080420_05.log	13:13:45	13:29:32	90.00	2839118
A080420_06.log	13:29:33	14:00:05	90.00	5492161
A080420_07.log	14:00:07	14:30:14	90.00	5414130
A080420_08.log	14:30:26	14:51:40	90.00	3817502
A080421_00.log	11:16:29	12:02:24	90.00	8262252
A080421_01.log	12:02:29	12:27:01	90.00	4408735
A080421_02.log	12:54:30	13:56:27	90.00	11149385
A080421_03.log	15:33:41	16:01:27	90.00	4993966
A080421_04.log	16:01:28	16:15:40	90.00	2551004
A080421_05.log	16:15:42	16:33:22	90.00	3175249
A080421_06.log	16:33:25	16:52:52	90.00	3499377
A080421_07.log	16:52:54	17:14:23	90.00	3862520
A080421_08.log	17:14:25	17:21:40	90.00	1299511
A080421_09.log	17:22:15	17:22:44	90.00	81032
A080421_10.log	17:23:24	17:35:29	90.00	2169854
A080421_11.log	17:35:32	17:49:16	90.00	2469972
A080421_12.log	17:49:18	18:11:48	90.00	4042590
A080421_13.log	18:12:30	18:29:50	90.00	3115226
A080421_14.log	18:29:54	18:43:23	90.00	2421953
A080421_15.log	18:43:27	18:59:16	90.00	2839118

A080421_16.log	18:59:17	19:14:26	90.00	2722071
A080421_17.log	19:14:27	19:29:35	90.00	2719070
A080424_00.log	11:35:59	11:50:12	90.00	2554005
A080424_01.log	11:50:14	12:05:36	90.00	2761087
A080424_02.log	12:05:39	12:20:08	90.00	2602024
A080424_03.log	12:20:10	12:33:23	90.00	2373934
A080424_04.log	12:35:10	12:50:58	90.00	2839117
A080424_05.log	12:51:03	12:59:06	90.00	1443569
A080424_06.log	12:59:07	13:03:10	90.00	723285
A080424_07.log	13:04:14	13:09:31	90.00	945372
A080424_08.log	13:10:53	13:14:08	90.00	579228
A080424_09.log	13:15:48	13:19:38	90.00	684270
A080424_10.log	13:21:03	13:21:42	90.00	111044
A080424_11.log	13:23:18	13:33:19	90.00	1797716
A080424_12.log	13:33:20	13:44:42	90.00	2040803
A080424_13.log	13:44:43	13:55:07	90.00	1866735
A080424_14.log	13:55:09	14:05:21	90.00	1830721
A080424_15.log	14:05:23	14:15:32	90.00	1821717
A080424_16.log	14:15:39	14:16:57	90.00	225090
A080424_17.log	15:55:48	15:56:01	90.00	33014
A080424_18.log	16:53:28	16:53:39	90.00	27011
A080424_19.log	16:55:14	17:05:10	90.00	1779702
A080424_20.log	17:05:11	17:16:22	90.00	2004789
A080424_21.log	17:16:23	17:25:44	90.00	1674659
A080424_22.log	17:25:45	17:35:20	90.00	1716675
A080424_23.log	17:35:21	17:37:49	90.00	438173
A080424_24.log	18:08:09	18:18:31	90.00	1857731
A080424_25.log	18:18:32	18:28:31	90.00	1788704
A080424_26.log	18:28:33	18:38:56	90.00	1860732
A080424_27.log	18:38:57	18:47:17	90.00	1494589
A080427_00.log	10:21:42	10:21:54	90.00	27011
A080427_01.log	10:26:30	10:35:58	90.00	1698670
A080427_02.log	10:35:59	10:45:49	90.00	1761695
A080427_03.log	10:45:50	10:59:38	90.00	2475976
A080427_04.log	10:59:39	11:11:09	90.00	2064814
A080427_05.log	11:11:10	11:16:01	90.00	864341
A080427_06.log	11:20:47	11:30:22	90.00	1716676
A080427_07.log	11:30:24	11:40:19	90.00	1779701
A080427_08.log	11:40:19	11:51:23	90.00	1983782
A080427_09.log	11:51:25	12:00:56	90.00	1707673
A080427_10.log	12:00:57	12:10:21	90.00	1686664
A080427_11.log	12:10:21	12:20:51	90.00	1878740
A080427_12.log	12:20:51	12:31:10	90.00	1848728
A080427_13.log	12:31:10	12:42:12	90.00	1977779
A080427_14.log	12:42:13	13:00:09	90.00	3220268
A080427_15.log	13:00:09	13:08:44	90.00	1536605
A080427_16.log	13:13:30	13:25:36	90.00	2172855
A080427_17.log	13:25:37	13:35:09	90.00	1713675
A080427_18.log	13:35:11	13:46:27	90.00	2022796
A080427_19.log	13:46:29	13:58:33	90.00	2163852
A080427_20.log	13:58:33	14:10:24	90.00	2127837
A080427_21.log	14:10:26	14:25:20	90.00	2680055
A080427_22.log	14:25:21	14:34:53	90.00	1707672
A080427_23.log	14:34:54	14:45:03	90.00	1821717

A080427_24.log	14:45:05	14:55:53	90.00	1938763
A080427_25.log	14:55:58	14:58:29	90.00	447176
A080427_26.log	14:58:52	15:03:34	90.00	840331
A080427_27.log	15:05:27	15:07:57	90.00	444175
A080427_28.log	15:08:42	15:10:52	90.00	384152
A080427_29.log	15:11:34	15:15:01	90.00	615243
A080427_30.log	15:16:09	15:18:19	90.00	384151
A080428_00.log	16:25:27	16:27:02	90.00	276110
A080428_01.log	16:38:10	16:51:57	90.00	2472974
A080428_02.log	16:51:57	17:00:18	90.00	1491588
A080428_03.log	17:00:19	17:10:11	90.00	1767697
A080428_04.log	17:10:11	17:20:37	90.00	1872737
A080428_05.log	17:20:39	17:31:21	90.00	1914754
A080428_06.log	17:31:21	17:40:14	90.00	1593628
A080428_07.log	17:40:15	17:51:08	90.00	1953769
A080428_08.log	17:51:09	18:00:08	90.00	1605632
A080428_09.log	18:00:09	18:10:22	90.00	1833722
A080428_10.log	18:10:23	18:20:06	90.00	1743686
A080428_11.log	18:20:07	18:26:56	90.00	1218480
A080429_00.log	14:38:26	14:49:22	90.00	1962774
A080429_01.log	14:49:24	14:59:26	90.00	1800709
A080429_02.log	14:59:40	15:09:19	90.00	1731682
A080429_03.log	15:09:21	15:20:01	90.00	1914754
A080429_04.log	15:20:03	15:30:16	90.00	1833722
A080429_05.log	15:30:17	15:40:15	90.00	1788704
A080429_06.log	15:40:16	15:44:49	90.00	810319
A080429_07.log	15:51:42	15:54:11	90.00	441175
A080429_08.log	16:00:36	16:02:45	90.00	378149
A080429_09.log	16:08:06	16:11:07	90.00	537212
A080429_10.log	16:16:36	16:26:48	90.00	1827719
A080429_11.log	16:26:49	16:36:38	90.00	1761694
A080429_12.log	16:36:39	16:46:25	90.00	1752690
A080429_13.log	16:46:26	16:56:16	90.00	1761694
A080429_14.log	16:56:17	17:08:45	90.00	2238881
A080429_15.log	17:14:09	17:25:28	90.00	2028798
A080429_16.log	17:25:29	17:35:13	90.00	1746688
A080429_17.log	17:35:15	17:43:58	90.00	1563616
A080429_18.log	17:45:28	17:59:23	90.00	2499984
A080429_19.log	18:00:50	18:10:18	90.00	1698669
A080429_20.log	18:10:19	18:20:08	90.00	1761693
A080429_21.log	18:20:09	18:33:07	90.00	2328917
A080429_22.log	18:33:08	18:41:26	90.00	1488586
A080429_23.log	18:41:27	18:52:45	90.00	2028799
A080429_24.log	18:52:46	18:59:52	90.00	1272501
A080429_25.log	18:59:56	19:06:06	90.00	1104435
A080501_00.log	13:51:54	14:02:07	90.00	1773699
A080501_01.log	14:02:09	14:12:07	90.00	1791706
A080501_02.log	14:12:08	14:22:19	90.00	1827720
A080501_03.log	14:22:32	14:33:37	90.00	1989784
A080501_04.log	14:33:39	14:45:15	90.00	2085822
A080501_05.log	14:45:17	14:56:29	90.00	2010792
A080501_06.log	14:56:33	15:05:30	90.00	1605633
A080501_07.log	15:05:31	15:15:05	90.00	1716676
A080501_08.log	15:15:06	15:26:33	90.00	2055810

A080501_09.log	15:26:35	15:35:39	90.00	1626641
A080501_10.log	15:35:41	15:47:17	90.00	2082820
A080501_11.log	15:51:22	16:00:38	90.00	1662654
A080501_12.log	16:00:39	16:10:47	90.00	1818716
A080501_13.log	16:10:48	16:20:36	90.00	1758693
A080501_14.log	16:20:37		90.00	
A080501_15.log	16:43:32	16:55:54	90.00	2220874
A080501_16.log	16:55:54	17:05:09	90.00	1656652
A080501_17.log	17:05:10	17:15:41	90.00	1887743
A080501_18.log	17:15:41	17:25:10	90.00	1698669
A080501_19.log	17:25:11	17:36:54	90.00	2103828
A080501_20.log	17:36:55	17:46:42	90.00	1755691
A080501_21.log	17:46:42	17:56:05	90.00	1680662
A080501_22.log	17:56:05	18:07:28	90.00	2040803
A080501_23.log	18:58:44	19:00:54	90.00	381150
A080501_24.log	19:05:49	19:11:16	90.00	975384
A080501_25.log	19:15:19	19:19:09	90.00	684270
A080501_26.log	19:23:00	19:27:04	90.00	726287
A080501_27.log	19:31:18	19:35:30	90.00	750295
A080501_28.log	19:39:11	19:43:12	90.00	714281
A080501_29.log	19:49:45	19:54:58	90.00	933368
A080501_30.log	19:58:30	20:01:45	90.00	579228
A080501_31.log	20:06:40	20:11:34	90.00	876345
A080501_32.log	20:14:23	20:18:11	90.00	678267
A080501_33.log	20:22:03	20:26:20	90.00	765302
A080501_34.log	20:29:25	20:32:41	90.00	582230
A080502_00.log	13:44:29	13:55:04	90.00	1833723
A080502_01.log	13:55:06	14:05:07	90.00	1800710
A080502_02.log	14:05:09	14:15:26	90.00	1845728
A080502_03.log	14:15:27	14:25:12	90.00	1749690
A080502_04.log	14:25:14	14:35:42	90.00	1878741
A080502_05.log	14:35:43	14:45:13	90.00	1704671
A080502_06.log	14:45:15	14:55:11	90.00	1782702
A080502_07.log	14:55:12	15:01:02	90.00	1044411
A080502_08.log	15:18:20	15:30:03	90.00	2106830
A080502_09.log	15:30:05	15:40:43	90.00	1908752
A080502_10.log	15:40:44	15:50:02	90.00	1668657
A080502_11.log	15:50:04	16:00:02	90.00	1788704
A080502_12.log	16:00:03	16:08:39	90.00	1542608
A080502_13.log	16:26:52	16:36:05	90.00	1653651
A080502_14.log	16:36:06	16:45:02	90.00	1602631
A080502_15.log	16:45:03	16:55:02	90.00	1791706
A080502_16.log	16:55:03	17:05:03	90.00	1794706
A080502_17.log	17:05:04	17:15:06	90.00	1800709
A080502_18.log	17:15:07	17:22:47	90.00	1374542
A080502_19.log	17:51:42	18:00:03	90.00	1497590
A080502_20.log	18:00:04	18:10:02	90.00	1788704
A080502_21.log	18:10:03	18:20:21	90.00	1848728
A080502_22.log	18:20:22	18:30:19	90.00	1785703
A080502_23.log	18:30:20	18:37:23	90.00	1263497
A080502_24.log	20:51:41	20:51:58	90.00	42017
A080502_25.log	20:57:56	21:00:58	90.00	540213
A080502_26.log	21:05:21	21:15:19	90.00	1788705
A080502_27.log	21:15:20	21:25:03	90.00	1743688



A080502_28.log	21:25:04	21:35:02	90.00	1788705
A080502_29.log	21:35:03	21:45:05	90.00	1800709
A080502_30.log	21:45:06	21:55:04	90.00	1788705
A080502_31.log	21:55:05	21:59:17	90.00	750296
A080502_32.log	22:02:35	22:12:02	90.00	1695668
A080502_33.log	22:12:03	22:22:02	90.00	1788704
A080502_34.log	22:22:03	22:27:02	90.00	891352
A080502_35.log	22:27:03	22:37:02	90.00	1791705
A080502_36.log	22:37:04	22:47:02	90.00	1788704
A080502_37.log	22:47:03	22:51:18	90.00	759300
A080505_00.log	13:34:44	13:38:28	90.00	663262
A080505_01.log	13:46:44	13:51:10	90.00	789311
A080505_02.log	13:55:08	13:59:33	90.00	789312
A080505_03.log	14:03:17	14:07:48	90.00	804317
A080505_04.log	14:12:41	14:17:12	90.00	807319
A080505_05.log	14:20:07	14:21:06	90.00	171068
A080505_06.log	14:23:08	14:24:02	90.00	153061
A080505_07.log	14:26:55	14:27:39	90.00	123050
A080505_08.log	14:30:30	14:32:12	90.00	300119
A080505_09.log	14:49:31	14:59:42	90.00	1827720
A080505_10.log	15:11:40	15:21:10	90.00	1701670
A080505_11.log	15:21:10	15:29:49	90.00	1551611
A080506_00.log	12:05:40	12:22:44	90.00	2872132
A080506_01.log	12:22:46	12:32:07	90.00	1680663
A080506_02.log	12:32:08	12:42:08	90.00	1794707
A080506_03.log	12:42:09	12:52:04	90.00	1779701
A080506_04.log	12:52:05	13:02:17	90.00	1830721
A080506_05.log	13:02:18	13:12:03	90.00	1749689
A080506_06.log	13:12:04	13:18:16	90.00	1110437
A080506_07.log	13:32:26	13:45:36	90.00	2364931
A080506_08.log	14:00:47	14:11:11	90.00	1866736
A080506_09.log	14:24:08	14:31:23	90.00	1299512
A080506_10.log	14:41:29	14:56:19	90.00	2665049
A080506_11.log	14:56:42	14:56:57	90.00	39015
A080506_12.log	14:58:36	14:59:26	90.00	144057
A080506_13.log	15:00:22	15:02:04	90.00	300119
A080506_14.log	15:03:06	15:14:27	90.00	2037802
A080506_15.log	15:23:30	15:31:32	90.00	1437566
A080506_16.log	15:31:33	15:41:04	90.00	1707672
A080506_17.log	15:41:05	15:47:26	90.00	1137448