AIRBORNE GRAVITY SURVEY OF SEA AREAS AROUND GREENLAND AND SVALBARD 1999-2001

by

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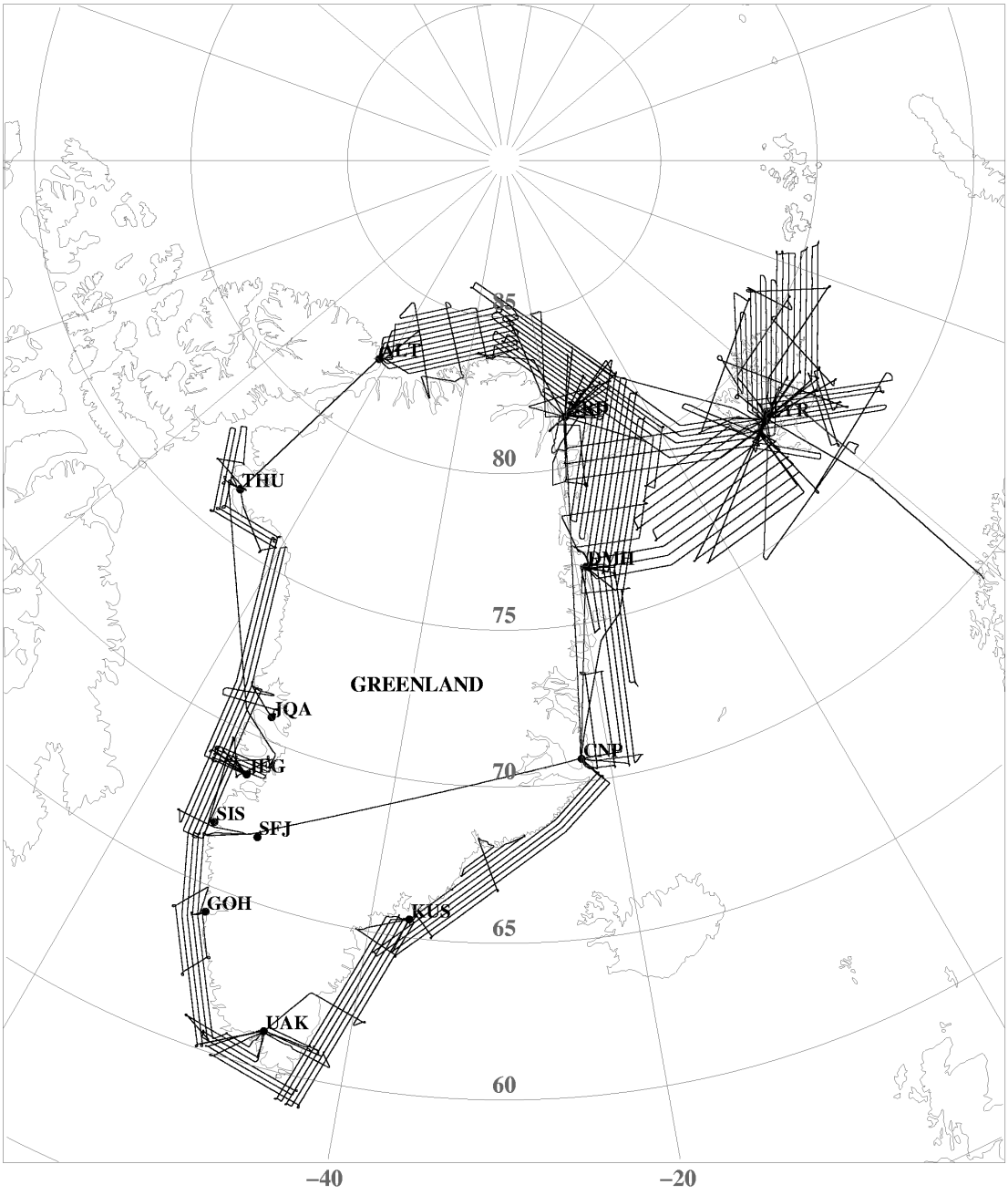

Fig. 1. All tracks of the 1998-2001 airborne gravity surveys of Greenland and Svalbard, including norwegian flights over Svalbard (processed separately and not treated in this report). The primary survey areas were: 1998 north Greenland shelf areas, 1999 north-east Greenland, 2000 south-eastern and western Greenland and 2001 the Fram Strait between Greenland and Svalbard and densification lines north of Greenland. Except the 2000 survey and the lines around Svalbard, most lines are covering areas more or less permanently covered with sea-ice.
GPS reference stations and airports: UAK = Narsarsuaq; GOH = Nuuk; SIS = Sisimiut; SFJ = Kangerlussuaq; JEG = Aasiat; JQA = Qaarsut; THU = Thule Air Base; NRD = Station Nord; DMH = Danmarkshavn; CNP = Constaple Pynt; KUS = Kulusuk; LYR = Longyearbyen, Svalbard.

1. INTRODUCTION

This report describes the field operations, hardware setup, processing and results of the 1999-2001 KMS airborne gravity survey of Greenland continental shelf areas, as well as surveys in the marine areas between Svalbard and Franz Josef Land and the Fram Strait between Greenland and Svalbard. The airborne gravity data have been acquired by low-level Twin-Otter flights using a Lacoste and Romberg gravimeter supported by GPS kinematic positioning, and are estimated to have accuracies around 2 mGal r.m.s.

The Greenland operations are the continuation of the 1998 marine airborne gravity measurements in the Arctic Ocean north of Greenland (Forsberg et al., 1999). With the new crossings and improvements in aerogravity software a reprocessing of the 1998 data have been done as well, and comparison results included in this report.

The survey of 1999 covered most of the wide, ice-covered North-East Greenland continental shelf between Scoresbysund and Station Nord. The 2000 survey covered a narrower region along the coast, from Scoresbysund to the south tip of Greenland, and along the Greenland west coast north to Thule. The 2001 surveys covered the Fram Strait region and densifications of lines north of Greenland to match the spacing of US Naval Research Laboratory lines further north in the Polar Sea. The flight tracks of all Danish-Norwegian operations 1998-2001 are shown in Fig. 1.

The Greenland surveys were primarily carried out to provide a seam-less gravity field model from the open ocean – where gravity derived from satellite altimetry is quite accurate – to the coastal region, where helicopter-based point measurements are available. In the ice-covered regions north-east and north of Greenland wider areas have been covered with airborne gravity surveys, as satellite altimetry are either unavailable due to the high latitude, or of poorer quality due to the presence of sea-ice.

KMS airplane in Svalbard. P3 aircraft of NRL aerogravity project in background.

The new data provides a more accurate, higher resolution supplement to the 1991-92 NRL high-altitude airborne gravity survey of the entire Greenland continental region (Brozena, 1991). The new airborne data will, together with the NRL data and the surface gravimetry of the ice-free coastal regions, ensure an improved and homogenous gravity field data coverage across the region, to take part in the ongoing ”Arctic Gravity Project” (Kenyon and Forsberg,

2000; http://www.nima.mil/gandg/arctic.htm), a project to compile all available data of the Arctic into a public-domain gravity data grid by 2002. The new data will also provide improved geoid models, especially along the coasts, where all Greenland settlements are located.

The Greenland flight operations were supported economically by National Imagery and Mapping Agency (NIMA).

The Svalbard measurements of 1999 were done prior to the measurements in Greenland by the same aircraft and system setup. The Svalbard and Fram Strait project was executed by Statens Kartverk (SK), Norway, in cooperation with University of Bergen and KMS. Additional economic support was provided from the Norwegian Petroleum Directorate (OD) and NIMA (through KMS).

In this report only the 1999 NIMA-KMS supported gravity lines east of Svalbard, covering the sea between Svalbard and Frans Josef Land (Russia), as well as the 2001 NIMA-KMS-OD supported Fram Strait flights are included.

Results of the complete 1998-99 Svalbard aerogravity data set will be published by Statens Kartverk (Dag Solheim). The 1998-99 Svalbard data were reprocessed in connection with the preparations of this report. The measurements between Svalbard and Frans Josef Land were done primarily to complement the high-arctic long-range airborne gravity surveys of NRL (Brozena, 1999), as well as to provide a link between Russian and western data for the Arctic Gravity Project.

2. THE KMS/UiB AEROGRAVITY HARDWARE SETUP

The hardware system for the aerogravity surveys is more or less identical to the 1998 setup (described in Forsberg et al., 1998). The set-up consists of a Lacoste and Romberg gravimeter; an electronics rack holding GPS receivers, computers, data logging and power/controller units; a floor-mounted Inertial Measurement Unit (IMU) and a Inertial Navigation System (INS); a laser altimeter and lidar scanner mounted in the tail luggage compartment; and two GPS antennas mounted front and aft of the wings. The system has evolved over the years; the Honeywell medium-grade INS system was added in year 2000 and the scanning lidar in 2001.

The hardware rack and power system was designed in 1998 with the assistance of Greenwood Engineering, Brøndby, Denmark, and described in the 1998 report (Forsberg et al., 1999). The system design is in part based on experience gained in the AGMASCO (Airborne Geoid Mapping System for Coastal Oceanography project, an EU-supported project under the MAST-III program, carried out in a Norwegian-Danish-German-Portuguese cooperation, involving airborne gravity surveys for geoid determination in Skagerrak (September 1996), the Fram Strait (August 1997), and the Azores (October 1997), cf. Forsberg et al (1996) or Bastos et al (1997).
The hardware system used in 1999 was a minor upgrade compared to 1998, with an improved power conditioning system, and an upgrade of the custom-made Greenwood strapdown IMU with improved fiber-optic gyros.

In year 2000 the system was updated by the addition of a Honeywell H764G integrated strapdown INS/GPS unit. The H764G was implemented to provide superior roll and pitch, GPS positioning augmentation, as well as eventually to provide an alternative gravity measurement system, augmenting the Lacoste and Romberg gravimeter. Software limitations in the H764G have, however, up to now prevented the recovery of gravity accelerations with sufficient accuracy.

In 2001 the laser altimeter was supplemented with a scanning laser (lidar), manufactured by Riegl Gmbh, Austria. The lidar allows the recovery of surface heights in a swath across the flight direction, with a total scan angle of 60°, yielding a swath width equal to the flight elevation. The Riegl lidar has especially been added to do auxiliary sea-ice studies, and as a backup to the single-beam Optech altimeter. The instruments are limited to a maximal height of 500 m, and are not routinely used for the aerogravity processing.

All surveys were done with the same aircraft, a Greenlandair Twin-Otter (OY-POF), normally used as a freight/passenger charter airplane. The Twin-Otter is a well-suited airplane for aerogravity in Greenland, due to the slow cruising speed (135 knots), and the ability to land on short, unprepared runways. The OY-POF airplane is especially well suited for aerogravity due to the availability of an autopilot, and an optional extra ferry tank, giving a maximal flight endurance of 6.5 hours. The 1999 and 2000 surveys were flown with wheels, whereas the 2001 springtime flights were done with skis (giving a lower airspeed).

Twin-Otter landing at Danmarkshavn weather station, North East Greenland

The gravimeter used is a Lacoste and Romberg marine gravimeter (S-99), modified for airborne use by ZLS Cooperation. S-99 is owned by the Institute of Geophysics, University of Bergen, Norway. The gravimeter sensor is mounted on pressurized vibration dampers, and placed inside a floor-mounted aluminum box.

The positioning of the aircraft was provided by different GPS receivers: Trimble 4000 SSI, Ashtech Z-Surveyor and, in 2000-2001 also a Javad Legacy GPS receiver. In 1999 a Trimble was connected to antenna #1 and a Trimble and an Ashtech was connected to antenna #2. In year 2000 and 2001 a Trimble and an Ashtech was connected to antenna #1 using a beam splitter, and a Javad was connected to antenna #3. For relative coordinates of the antennas see Table 1. In the 2000-2001 campaigns antenna #2 was used for the Honeywell H764G INS.

The position files was named AIR1 (Trimble), AIR2 (Ashtech) and AIR3 (Trimble/Javad). 1 Hz data were recorded during flights, and downloaded onto laptop PC's after landing.

Airplane heights above the sea-surface (mostly ice covered 1999 and 2001, and mostly open water 2000) were measured with an Optech Rangefinder unit, replacing an Optech 501 SX laser altimeter, which failed during the 1999 flights. The laser altimeters were mounted below the aft luggage compartment. Because of the more limited range of the Rangefinder compared to the 501 SX, flights in 1999-2001 were flown at lower elevations than in 1998, typically at 500-800 ft. The Riegl scanning lidar was mounted right next to the laser altimeter, sharing the same 15 cm x 15 cm hole below the luggage compartment of the aircraft.

The prototype strapdown IMU used in 1999 and 2000 was manufactured by Greenwood Engineering, Brøndby, and consists of 3 low-drift (1°/hr) µFORS fiber-optics gyros and 3 Schaewitz accelerometers, mounted in an aluminum housing. The custom-made INS electronics digitize data internally at up to 2kHz, and records averaged measurements at 18 Hz. Data from the INS and laser altimeter were logged together with GPS time tags and gravimeter data on a data logger unit, which together with aircraft power converters, gravimeter control electronics and the GPS receivers were mounted in a single 19" rack.

In year 2000 a new integrated H764G medium-grade inertial/GPS navigation unit was purchased from Honeywell Military Division, and used for the surveys. The H764G consists of "cherry-picked" QA-2000 accelerometers and a triad of laser gyros, tightly coupled with a C/A-code GPS receiver. Both post-Kalman filter blended GPS/INS and "free inertial" INS navigation solutions are available. The H764G data was logged from the military 1558 data bus on a stand-alone laptop, with GPS time providing the synchronization with other measurements. The H764G performed very reliably during the entire field campaign, and with free-inertial drifts generally well below specifications.

A sketch of the aircraft installation is shown in Fig. 2. The offsets of the various sensors relative to a zero-point below the wings are given in Table 1.

Cabin interior view (1999). Ferry tank on left, gravimeter on right, rack in background

Table 1. The offset of the various sensors relative to a zeropoint below the wings.

Units: cm	X (pos. forward)	Y (pos. left wing)	Z (positive up)
Gravimeter sensor	77	-31	40
IMU sensor	181	-34	10
INS sensor *	181	-13	10
GPS antenna #1	22	52	163
GPS antenna #2 **	-254	-20	157
GPS antenna #3 *	-348	-35	147
Laser altimeter	-348	0	-15

** Only used in the Greenland 2000/2001 campaign*
*** In the Greenland 2000/2001 campaign this antenna was used for the INS.*

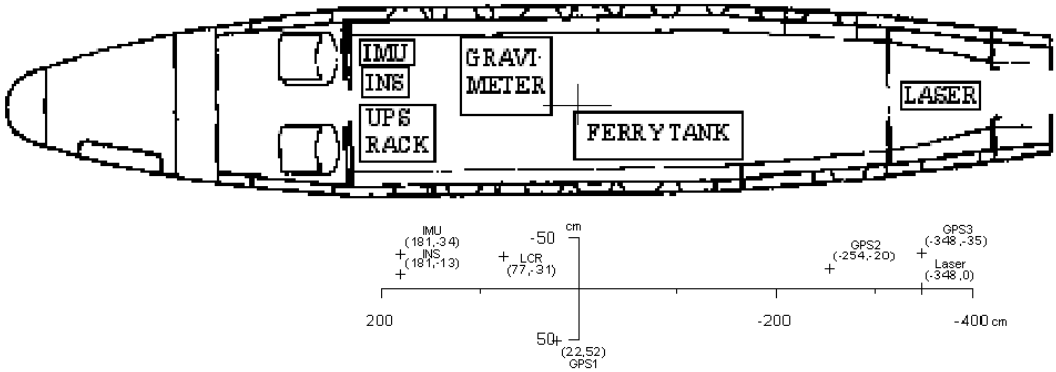

Fig. 2. Sketch of the gravity system installation in the Twin-Otter

The total weight of the equipment was approx. 180 kg, and designed for 1-man operation. The remaining payload of the "POF" Twin-Otter gave large operational flexibility, as the aircraft could move between operations bases transporting both project scientists and equipment, as well as doing routine measurements. This gave the opportunity to fly additional equipment. In Svalbard 1999 Ohio State University scientists (Chris Jekeli and Jay Kwon) participated in the flights with other inertial equipment (Litton LN93 and LN100 strapdown systems), with test results reported in Jekeli and Kwon (2001). Also in the same period two Russian scientists participated in a flight between Svalbard and Frans Josef Land, in connection with a follow-up workshop to the Greenland 1998 "Aerogravity and the Polar Gravity Field" workshop.

Visiting scientists on survey flight (S. Maschenkov, VNIIO and M. Sorokin, PMGE, St. Petersburg)

3. AIRBORNE GRAVITY SURVEY OPERATIONS 1999-2001

3.1. Svalbard and North East Greenland, August 1999

The installation of the equipment in the Twin-Otter was initialized in Longyearbyen Airport, Svalbard on July 28, with the first operational flight day July 31, following a test flight over Isfjorden. The operations were subsequently carried out jointly with Statens Kartverk, Norway, under the ”SAG99” (Svalbard Airborne Gravity campaign 1999). Table 2 shows the Svalbard flight days. The location of the NIMA-KMS tracks between Svalbard and Frans Josef Land are shown in Fig. 1. The last NIMA-KMS Svalbard survey flight was done on August 5. From August 6 to August 10 six survey flights around Svalbard were done for Statens Kartverk.

Table 2: SAG99 flights (NIMA-KMS only), total flight time 29 h 30.

Date/JD	Flight	Track	Track number	Take off UTC	Landing UTC	Airborne	Operator
July 31 / 212	LYR-LYR	D-C	1, 2	0910	1455	5 h 45	KRK/ AVO
Aug 2 / 214	LYR-LYR	B-A	3, 4	0651	1307	6 h 11	AVO
Aug 3 / 215	LYR-LYR	I-J-K	5, 6, 7	0715	1252	5 h 37	AG / KRK
Aug 4 / 216	LYR-LYR	U-T-O-N-M	8, 9, 10, 11	0711	1330	6 h 19	DS / AVO
Aug 5 / 217	LYR-LYR	V-W-P-S-X	12, 13	0700	1238	5 h 38	AG / AVO

The SAG99 flights were GPS positioned relative to two GPS receivers at the Norsk Polarinstitut lodging in Longyearbyen airport (LYR1 and LYR2) and an antenna located at a un-monumented point on top of a mountain close to the airport (LYR3).

The aircraft continued to Station Nord, North Greenland, on August 12, with a KMS crew of 3. One KMS geodesist remained at Station Nord to operate a GPS reference station, and the aircraft continued to the operation bases at the weather station Danmarkshavn and at Constaple Pynt airport with the remaining two scientists (RF and AVO). The aircraft returned to Longyearbyen August 19, after an intense survey week with excellent weather conditions. From Longyearbyen the aircraft continued to Mariehamn, Åland Islands, to initiate a 3-week joint Nordic airborne gravity survey of the Baltic Sea and interior waters of Denmark and Sweden. Table 3 shows the primary flight data of the Greenland campaign - GRL99.

Table 3: GRL99 flights, total flight time 79 h 43 (including the 3 flights from 1998)

Date/JD	Flight	Track	Track number	Take off UTC	Landing UTC	Airborne	Operator
June26 / 177 1998	NRD-NRD	AA, BB	91, 92	0915	1427	5 h 12	RF
June27 / 178 1998	NRD-NRD	CC, DD	93, 94	0911	1525	6 h 14	DS
June29 / 180 1998	NRD-LYR	EE	95	1004	1405	4 h 01	DS

Aug 12 / 224 1999	LYR-NRD	A	1	0958	1358	4 h 00	AVO
Aug 12 / 224	NRD-DMH	AA, C	2, 3	1655	2102	4 h 05	RF
Aug 13 / 225	DMH-DMH	D, E	4, 5	0847	1442	5 h 55	AVO
Aug 13 / 225	DMH-DMH	BB, F, G, CC	6, 7, 8, 9	1545	2146	6 h 01	RF
Aug 14 / 226	DMH-DMH			0915	0955	0 h 40	AVO
Aug 14 / 226	DMH-DMH	H, I, DD	10, 11, 12	1048	1646	5 h 58	AVO
Aug 14 / 226	DMH-DMH	N, EE, M	13, 14, 15	1745	2149	4 h 04	RF
Aug 15 / 227	DMH-DMH	P, Q	16, 17	1011	1232	2 h 21	AVO
Aug 15 / 227	DMH-DMH	FF, U, V, Z, GG	18, 19, 20, 21, 22	1342	1837	4 h 55	RF
Aug 16 / 228	DMH-CNP	II, T, HH	23, 24, 25	0850	1332	4 h 42	RF
Aug 16 / 228	CNP-DMH	S	27	1422	1814	3 h 52	AVO
Aug 16 / 228	DMH-CNP	R	28	1851	2245	3 h 54	AVO
Aug 17 / 229	CNP-CNP	X, W	29, 30	1035	1436	4 h 01	RF
Aug 19 / 231	CNP-NRD	J, K, L, LL	31, 32, 33, 34	1029	1608	5 h 390	AVO / RF
Aug 19 / 231	NRD-LYR	MM, B, NN	35, 36, 37	1911	2320	4 h 09	RF

Reference GPS stations for the North-East Greenland flights were located at Station Nord (NORD), Danmarkshavn (2 sites DMH1 and DMH2) and at Constaple Pynt (CNP1). In addition 1 sec data from the KMS permanent GPS stations at Scoresbysund and the SK station in Ny Ålesund, Svalbard, were utilized.

The flights of 1999 was somewhat hampered by low fog in Svalbard, whereas conditions were more favorable in Greenland. Only little turbulence was experienced, with flights over the sea generally being very smooth.

3.2. Greenland coastal regions, August 2000

The year 2000 aerogravity survey of the southeast and west Greenland coasts was initiated with a test flight on July 28 from Søndre Strømfjord, where the equipment was mounted. The aircraft continued on July 31 to Narsarsuaq, serving as a operations base until August 16, with aircraft utilizing Nuuk, Kulusuk, and Constaple Pynt airports for single overnight stays during the period, as required by weather and track logistics. During the period operations were significantly hampered by bad weather, but in the end all planned tracks were flown, albeit at major delays compared to the original plans.

Twin Otter at Station Nord, April 2001

The aircraft continued to Aasiat in central West Greenland on Aug 16, and then surveyed the northwestern tracks from Thule Air Base, Aasiat and Qaarsut until Aug 23, when the aircraft

returned to Søndre Strømfjord. The last part of the 2000 survey was again to some degree hampered by weather conditions.

Subsequently on August 25 and 26 an airborne laser scanning and ice-penetrating radar survey was done at inland ice margin south of Søndre Strømfjord in the ”Imersuaq” project in a cooperation with the Geological Survey of Denmark and Greenland, and the Technical University of Denmark. No gravimeter was carried on these low-level flights with large variability in altitude.

Table 4 shows the year 2000 gravity flights along the Greenland coasts, with track numbers.

Table 4: GRL00 flights, total flight time 121 h 54 min

Date/JD		Track	Track number	Take off UTC	Landing UTC	Airborne	Operator
July 31 / 213	SFJ-UAK	V, A	1, 2	1139	1716	5 h 37	AG
Aug 01 / 214	UAK-UAK	M, J, I, H, G	3, 4, 5, 6, 7	0959	1548	5 h 47	AG
Aug 01 / 214	UAK-UAK	E, D, C	8, 9, 10, 11	1631	2135	5 h 04	AG
Aug 03 / 216	UAK-KUS	I	125	1100	1409	5 h 09	AG
Aug 03 / 216	KUS-KUS	G, H	14, 15	1545	2035	4 h 50	AG
Aug 05 / 218	KUS-CNP	P	16	1101	1545	4 h 44	AG
Aug 07 / 220	CNP-KUS	O, N	17, 18	0952	1526	5 h 34	AG
Aug 07 / 220	KUS-CNP	Q	19, 20	1613	2147	5 h 34	KRK
Aug 09 / 222	CNP-KUS	N	21	0922	1240	3 h 18	KRK
Aug 10 / 223	KUS-UAK	J	225	1128	1421	2 h 53	KRK
Aug 10 / 223	UAK-GOH	Y, W	24, 25	1600	2135	5 h 35	AVO
Aug 11 / 224	GOH-GOH	C	26, 27, 28	1106	1439	3 h 33	AVO
Aug 11 / 224	GOH-UAK	W, B	29, 30	1535	1915	3 h 40	AVO
Aug 14 / 227	UAK-KUS	F, K	31, 32, 33	1135	1737	6 h 02	RF
Aug 15 / 228	KUS-KUS	R, U, T, S	34 – 40	1012	1642	6 h 30	AVO
Aug 15 / 228	KUS-L-UAK	L	41, 42, 43	1754	2126	3 h 34	RF
Aug 16 / 229	UAK-JEG	Z	44	1100	1558	4 h 58	RF
Aug 17 / 230	JEG-THU	B, I	46, 47, 48	1130	1634	5 h 04	RF
Aug 18 / 231	THU-THU	K, J, I	49, 50, 51, 52	1119	1408	2 h 49	AVO
Aug 18 / 231	THU-THU	I, H, G, F, L	53, 54, 55, 56	1501	1947	4 h 46	AVO
Aug 21 / 234	THU-JEG	H, E	57, 58, 59, 60	1112	1659	5 h 47	RF
Aug 22 / 235	JEG-JQA	A, Z	61, 62, 63, 64	1008	1602	6 h 18	RF
Aug 22 / 235	JQA-JEG	N, M, Z	65, 66, 67, 68	1723	2108	3 h 45	RF
Aug 23 / 236	JEG-JEG	W, Y, W	69, 70, 71	1114	1643	5 h 29	RF
Aug 23 / 236	JEG-SFJ	V, A, B, D	72 – 77	1716	2250	5 h 34	RF

Because of an expected high ionospheric variability in 2000, and flights passing through the auroral zone of southern Greenland, special care was taken in year 2000 to operate many GPS reference receivers. Sites were operational at Constaple Pynt, Kulusuk, Narsarsuaq, Nuuk, Søndre Strømfjord, Aasiat, Qaarsut and Thule as required during the survey, with typically 2-3 sites active in tracking a particular flight. Additional GPS data were provided by TU Dresden from a site in Sisimiut, and data from the permanent GPS station in Scoresbysund was also utilized.

3.3. Fram Strait and north Greenland shelf, April/May 2001

The flights of 2001 were done during spring (winter) conditions, where seasonal temperatures averaged around –20° to -10°C in Station Nord and around 0°C in Svalbard. The measurements were done in this relatively cold period to gain experience with "cold" operations, due to some gravimeter availability constraints, and due to coordination with a pilot project to do bathymetric measurements on the sea-ice north of Greenland, and a Twin-Otter landing on the recently discovered Tobias Island, located some 70 km from the north-east Greenland coast off 79-fjorden.

The operations started April 21 when hangar installation was complete, and the aircraft transited from Kangerlussuaq (SFJ) to Station Nord via Constable Pynt. KMS crew was exchanged, and participants in the bathymetry/Tobias Ø project were subsequently flown in during two survey flights between Station Nord and Svalbard. A Twin-Otter ski landing was done on Tobias Ø on April 28, but due to the expected rough conditions no gravimeter was carried on this flight. The flight lines north of Greenland and the northern Fram Strait lines were completed on April 30 when the aircraft shifted base to Longyearbyen, Svalbard. A major snowstorm at Station Nord gave the two project participants (RF/KMS and Jon Biggar, CHS/Canada) an extra week in Station Nord, awaiting the return of the Twin Otter. The Svalbard operations were ended on May 10 when the aircraft returned to Kangerlussuaq via Danmarkshavn and Constaple Pynt.

Table 5. GRL01 flights, total airborne time 104 h 0 m (April 28 Tobias Island flight not included)

Date/JD		Track	Track number	Take off UTC	Landing UTC	Airborne	Operator
April 21 / 111	SFJ-SFJ	test flight		1749	1834	0 h 45	KRK
April 23 / 113	SFJ-CNP	ferry flight		1115	1600	4 h 45	KRK
April 23 / 113	CNP-NRD	CN	1	1643	2134	4 h 51	KRK
April 24 / 114	NRD-LYR	D	2, 3, 4, 5	0706	1254	5 h 48	KRK
April 24 / 114	LYR-NRD	E	6, 7, 8	1411	1804	3 h 53	KRK
April 25 / 115	NRD-LYR	C	9, 10, 11	0706	1141	4 h 35	RF
April 25 / 115	LYR-NRD	G	12, 13	1309	1710	4 h 01	RF
April 26 / 116	NRD-NRD	A, C	14, 15, 16, 17	0908	1508	6 h 00	RF
April 26 / 116	NRD-NRD	F, G	18, 19, 20	1559	2018	4 h 19	RF
April 27 / 117	NRD-NRD	E	21, 22, 23, 24	1423	1842	4 h 19	RF
April 30 / 120	NRD-LYR	no measurem.		0829	1258	4 h 29	KRK
May 01 / 121	LYR-LYR	H, I	25, 26	0738	1318	5 h 40	AVO
May 03 / 123	LYR-LYR	J, K	27, 28	0729	1337	6 h 08	AVO
May 04 / 124	LYR-DMH	L	29, 30, 31	0950	1423	4 h 33	AVO
May 04 / 124	DMH-LYR	M	32, 33, 34	1523	2002	4 h 39	AVO
May 05 / 125	LYR-NRD	F	35, 36, 37, 38	0514	1059	5 h 45	AVO
May 05 / 125	NRD-LYR	A	39, 40, 41	1244	1706	4 h 22	AVO
May 07 / 127	LYR-LYR	O	42, 43, 44	0702	1254	5 h 52	AVO
May 09 / 129	LYR-LYR	P	45, 46, 47	0648	1224	5 h 36	AVO
May 10 / 130	LYR-DMH	N	49, 50, 51	0823	1330	5 h 07	AVO
May 10 / 130	DMH-CNP	DC	52	1440	1738	2 h 58	AVO
May 10 / 130	CNP-SFJ	CS	53	1844	0019+	5 h 35	AVO

Generally the cold-weather experience with the instruments went well, but some problems were encountered with laptops and the Riegl lidar, especially if the aircraft was left unheated during the night at Station Nord (a small warm-air blower was used to prevent too cold instruments and icing/condensation during the night). However, it was also clear that -20°C represents a lower practical limit for this type of operations, where the laser measure directly through a ca.15 x 15 cm hole without glass in the aft of the aircraft (the Riegl lidar is, e.g., only specified to be able to operate down to -10°C).

4. DATA PROCESSING

4.1 GPS reference sites

A precise GPS reference network was computed, to serve as base coordinates for the airplane kinematic GPS solutions. The GPS reference network datum was ITRF-97, and the network was tied to the International GPS Service (IGS) permanent stations in Thule, Kangerlussuaq (Kellyville) and Ny Ålesund, Svalbard, as well as to the fundamental Greenland reference gravity network (REFGR). For the 1999 campaign computations were done using the Trimble GPSurvey software and precise orbits and the 2000 campaign reference stations were computed with "autoGipsy" of NASA/JPL. The computed coordinates are shown in Table 6. Details of selected reference stations are given in Appendix 2.

Table 6. Used ITRF-97 coordinates of GPS reference sites

Site		Lat (N)	Lon (E)	Ellips. h (m)	Comment
SAG99:					
Longyearbyen	LYR1	78 14 51.0512	15 29 47.5481	53.876	NPI building roof
Longyearbyen	LYR2	78 14 50.6485	15 29 50.1992	55.050	NPI building roof
Longyearbyen	LYR3	78 13 51.6503	15 22 51.2544	486.436	Mountain pt
Longyearbyen	NOPO	78 14 51.8960	15 29 42.8984	49.262	NPI pillar
GRL99:					
Danmarkshavn	DMH1	76 46 9.7815	-18 40 5.5447	47.360	Roof point
Danmarkshavn	DMH2	76 46 13.4201	-18 39 29.2062	53.385	KMS point
Station Nord	NORD	81 35 49.7624	-16 39 24.8695	66.853	Temp roof point
Station Nord	1001	81 36 1.4627	-16 39 19.5929	68.383	Astro pillar
Constable Pynt	CNP1	70 44 40.2387	-22 38 53.4770	70.709	Roof
Constable Pynt	CNP2	70 44 23.9361	-22 38 27.5040	57.304	KMS
Scoresbysund	SCOB	70 29 6.8391	-21 57 3.0223	128.641	Permanent GPS
GRL00:					
Nuuk	ASIA	64 10 11.5293	-51 43 59.6988	66.74	Asiaq point
Constable Pynt	CNP1	70 44 40.2406	-22 38 53.4811	70.77	Roof point
Nuuk	GOH1	64 10 45.3330	-51 43 15.0763	48.88	Temp point
Aasiat	JEG1	68 43 10.3765	-52 47 32.5876	57.62	Temp tripod
Qaarsut	JQA1	70 44 03.7276	-52 41 36.6401	112.26	Temp tripod
Kulusuk	KUS1	65 34 36.9215	-37 09 01.3379	74.42	Temp tripod
Scoresbysund	SCOB	70 29 06.8415	-21 57 03.0262	128.71	Permanent GPS
Kangerlussuaq	SFJ1	67 00 21.6516	-50 42 09.6756	72.04	Met hut
Sisimiut	SIS1	66 56 13.0272	-53 40 11.1225	85.44	German data
Thule Air Base	THU0	76 32 16.5087	-68 47 47.9490	43.01	Temp point
Narsarsuaq	UAKJ	61 09 25.8950	-45 26 23.6382	44.83	Temp tripod

Narsarsuaq	UAKT	61 09 26.5109	-45 26 26.2120	44.84	KMS ref point
GRL01:					
Kangerlussuaq	SFJ1	67 00 21.6516	-50 42 09.6756	72.04	Met hut
Scoresbysund	SCOB	70 29 06.8415	-21 57 03.0262	128.71	Permanent GPS
Station Nord	NOR1	81 36 3.5569	16 39 39.1285	70.46	Roof (Javad)
Station Nord	NOR2	81 35 49.7651	16 39 24.8746	67.55	Roof (Ashtech)
Longyearbyen	LYR1	78 14 51.1348	15 29 46.1904	53.93	Roof (Ashtech)
Longyearbyen	LYR2	78 14 51.0705	15 29 47.3572	53.74	Roof (Javad)
Longyearbyen	LYR3	78 14 51.0701	15 29 47.3601	53.85	Roof (Ashtech)
Longyearbyen	LYR4	78 14 51.7853	15 29 38.4795	49.47	Ground (Javad)

4.2 Gravity reference values

The reference gravity values used for the flights were based on gravimeter ties from nearby KMS reference points, measuring to the aircraft parking spot on the airfield level. Table 7 gives the apron gravity values used for reference. These values have been based on absolute gravity measurements (Ilulissat, Thule, Alert and Ny Ålesund), which have been used to tie the numerous Lacoste and Romberg reading in the KMS Greenland gravity reference network, covering all cities and airports of Greenland. The apron ties were done using gravimeter G-867 of KMS. The adjusted standard deviation of the readings was 0.03-0.06 mGal for each year.

Table 7. Reference gravity values of gravity base stations and 1999-2001 apron values (mGal)

no.	g	location
990	982962.905	Longyearbyen SAS office
1351	983068.750	Station Nord apron
3395	982913.640	Thule hangar 7
33682	982944.710	Danmarkshavn elværk
59302	982614.763	Constaple Pynt
64227	982369.640	Sondrestrom Glace hangar (apron)
68210	982478.850	Aasiat KGH
71502	982337.577	Kulusuk astro exc
88106	981926.830	Hotel Narsarsuaq
88107	981921.100	Narsarsuaq Hangar
A6	982962.940	Longyearbyen apron (1999)
A7	981922.487	Narsarsuaq Apron (DMI hangar)
A8	981921.378	Narsarsuaq Apron II
A9	982333.558	Kulusuk Apron
A10	982475.712	Aasiat airport
A11	982916.855	Thule Air Base apron (2000)

The apron gravity values were corrected by –0.4 mgal to account for the height of the gravimeter above the apron (1.3 m) in the airborne gravity processing.

4.3 Kinematic GPS solutions

Aircraft GPS positions were computed using commercial kinematic GPS software (mainly “GPSurvey”, with additional flights processed by “Flykin” or “Geotracer”). All packages use

OTF ambiguity resolution techniques. Generally GPSurvey appears to give the best results, with fewer jumps due to changes in satellite constellations.

The kinematic GPS solutions were produced as 1 Hz files with latitude, longitude and ellipsoidal heights. The accuracy of the GPS positioning was checked by computing solutions for two aircraft antennas, or computing solutions from different reference stations to the same aircraft antenna. The typical agreement between the different solutions was at the 0.5 m level in height, with GPS reference baselines up to 500 km.

The major problem in the GPS processing was to isolate spurious effects in the GPS solutions due to changes in the visible satellite constellation and to ionospheric disturbance during the flight. Such spurious effects can yield filtered GPS accelerations up to the 10's of mGal level. They may be detected by comparing different baseline solutions, by comparisons of GPS derived vertical accelerations to unfiltered vertical accelerations from the INS and by inspection of unfiltered gravity residuals. The latter has been used routinely on all GPS solutions and has served as the main criterion in the evaluation.

The laser altimeter was used when tracking over ice and ocean to provide independent checks of GPS accelerations, but otherwise not used for the routine processing of gravity.

4.4 Airborne gravity processing

A proper synchronization of the involved data streams is obviously important. Both the gravimeter and GPS has a high frequency signal in common, the vertical acceleration of the aircraft. This signal is used to synchronize the data by cross correlation, see Olesen et al (1997).

The gravity sensor is mounted on a 2-axis gimbaled platform. The platform is kept horizontal by torque motors. A feedback loop with two horizontal accelerometers and two gyros gives the input signal to the torque motors. The gyros control the short-term behavior of the platform, while the horizontal accelerometers control the long-term level. In the absence of horizontal accelerations the platform is driven so that the accelerometer outputs are zero. That is the condition for the platform to be orthogonal to the gravity vector and gyro drift is automatically compensated. Details of the operation principle of the LCR gravimeter can be found in Valiant (1991).

The LaCoste & Romberg meter uses a combination of two internal measurements - spring tension and beam velocity - to obtain the relative gravity variations. The basic gravimeter observation equation for relative gravity y is of the form

$$y = sT + kB' + C$$

where T is spring tension, s the scale factor, B´ the velocity of the heavily damped beam and the factor k the beam velocity/acceleration scale. A beam-type gravimeter like the S-meter is sensitive to horizontal accelerations even when the platform is leveled, and a cross-coupling correction C is computed in real time by the gravimeter control computer.

Free-air gravity anomalies at aircraft level are (omitting second order terms) obtained by

$$\Delta g = y - y_0 - h'' + \delta g_{eotvos} + \delta g_{tilt} + g_0 - \gamma_0 - (h - N)\frac{\partial \gamma}{\partial h}$$

where h´´ is the GPS vertical acceleration, δg_{eotvos} the Eotvos correction (computed by the formulas of Harlan, 1968), y_0 the base reading, g_0 the apron gravity value, γ_0 normal gravity, h the GPS ellipsoidal height and N the geoid undulation (EGM96 used throughout). The platform off-level correction δg_{tilt} is expressed as

$$\delta g_{tilt} = \sqrt{y^2 + A_x^2 + A_y^2 - a_x^2 - a_y^2} - y$$

where a and A denotes horizontal kinematic aircraft accelerations and horizontal specific forces measured by the platform accelerometers, respectively. For formulae's relating the position in a local level system and accelerations in an inertial frame see e.g. Czompo (1994).

4.5 Filtering

Low pass filtering plays a fundamental role in airborne gravity processing. The objective of the filtering is both to account for the difference in inherent filtering from the data acquisition, and to remove the high frequency part of the gravity signal.

The gravimeter data acquisition system uses a 1 sec. boxcar filter on 200 Hz data, whereas the inherent filtering of the accelerations derived from GPS positions depends on the GPS processing software, and the operator algorithm applied for differentiation. This difference in filtering has no impact on the linear terms in the processing (the vertical GPS accelerations and the output from the vertical gravimeter sensor), but may have a big influence on the nonlinear terms (mainly squared horizontal accelerations derived from GPS and the platform horizontal accelerometers). Air turbulence causes accelerations that often reach hundred thousand mGal, while we are looking for gravity anomalies of magnitude a few mGal. The low signal to noise ratio mainly affects the short wavelengths, therefore low pass filtering allows recovery of a useful signal. The filter design ultimately boils down to a trade-off between resolution and measurement accuracy.

For most of the 1999-2001 data were filtered with a symmetric 2nd order Butterworth filter with a half power point at 200 seconds, corresponding to a resolution of 6 km (half-wavelength). Five of the tracks (track number 1, 7, 70, 125 and 225) in the Greenland 2000 campaign were filtered with a half power point at 260 seconds due to ionosphere disturbance in the GPS solution, corresponding to a resolution of 8 km.

5. Final results and evaluation

The final data are given in a number of files (sag99a.faa, grl99.faa, grl00.faa, grl01.faa) in the form

id, lat, lon, H, g, Δg, time (JD)

where id = lineno*1000 + running no, H the orthometric height, g absolute gravity and Δg the GRS-80 free-air anomaly in GRS80. The numeric line numbers are indicated in Table 2-4. Plots of the free-air anomalies for the different regions covered are shown in Fig. 3-7.

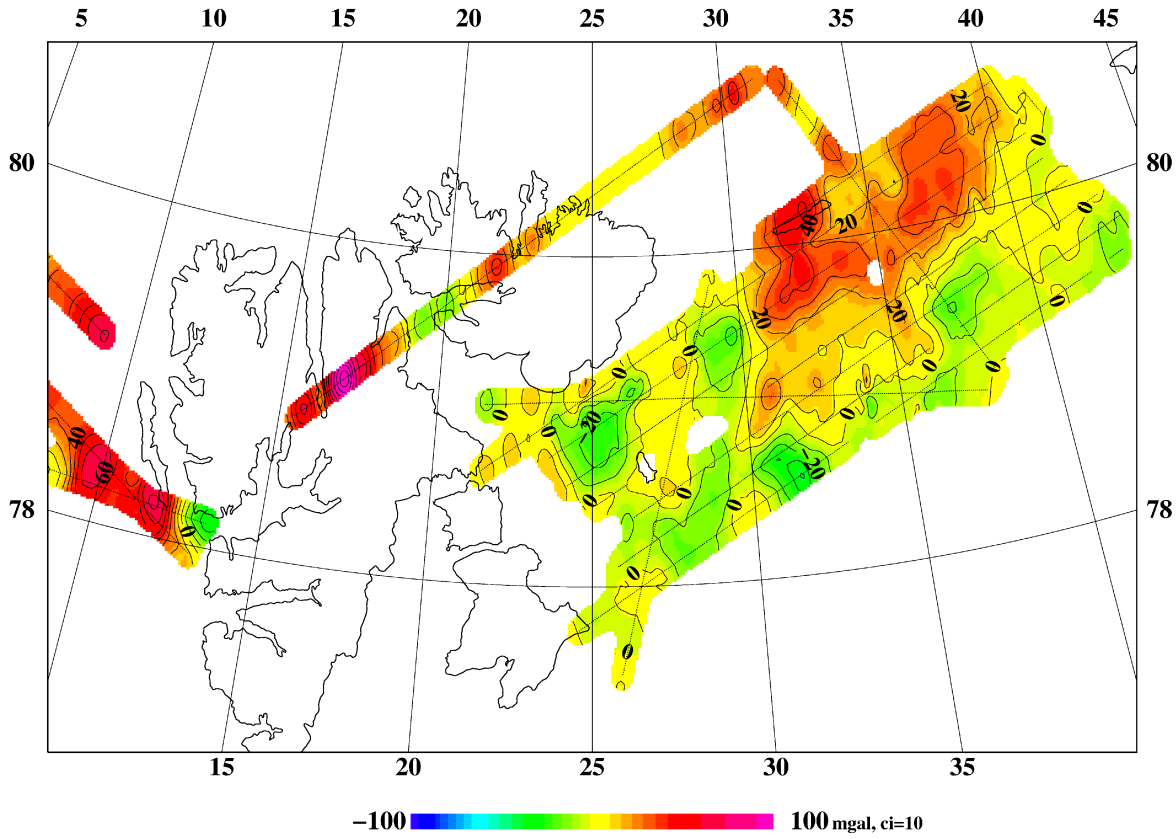

Fig. 3. Gravity anomalies between Svalbard and Frans Josef Land (Sag99). Contour interval 10 mGal.

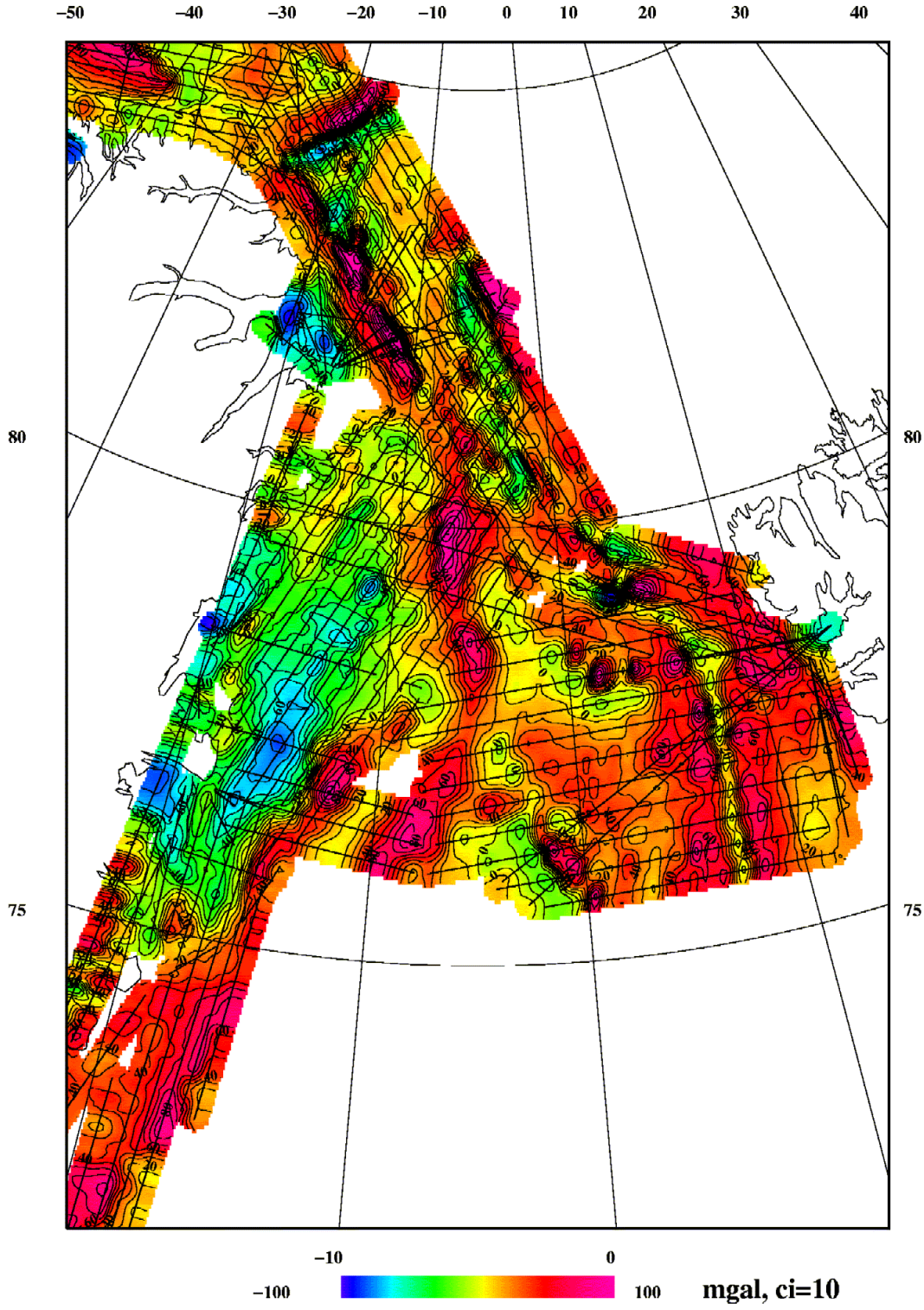

Fig 4. North East Greenland gravity anomalies (Grl98+Grl99+Grl01 flights).

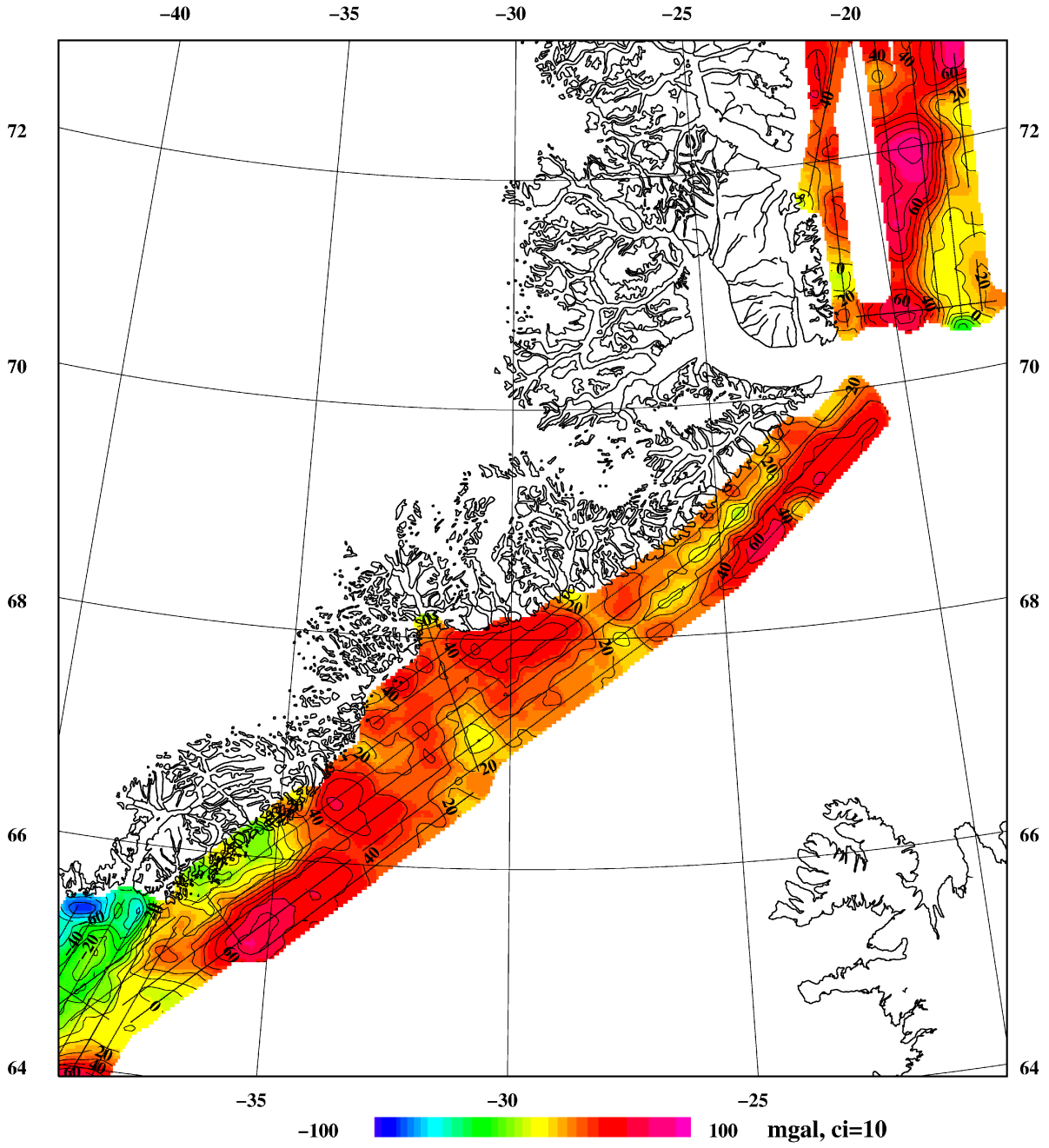

Fig. 5. Southeast Greenland gravity anomalies (Grl00).

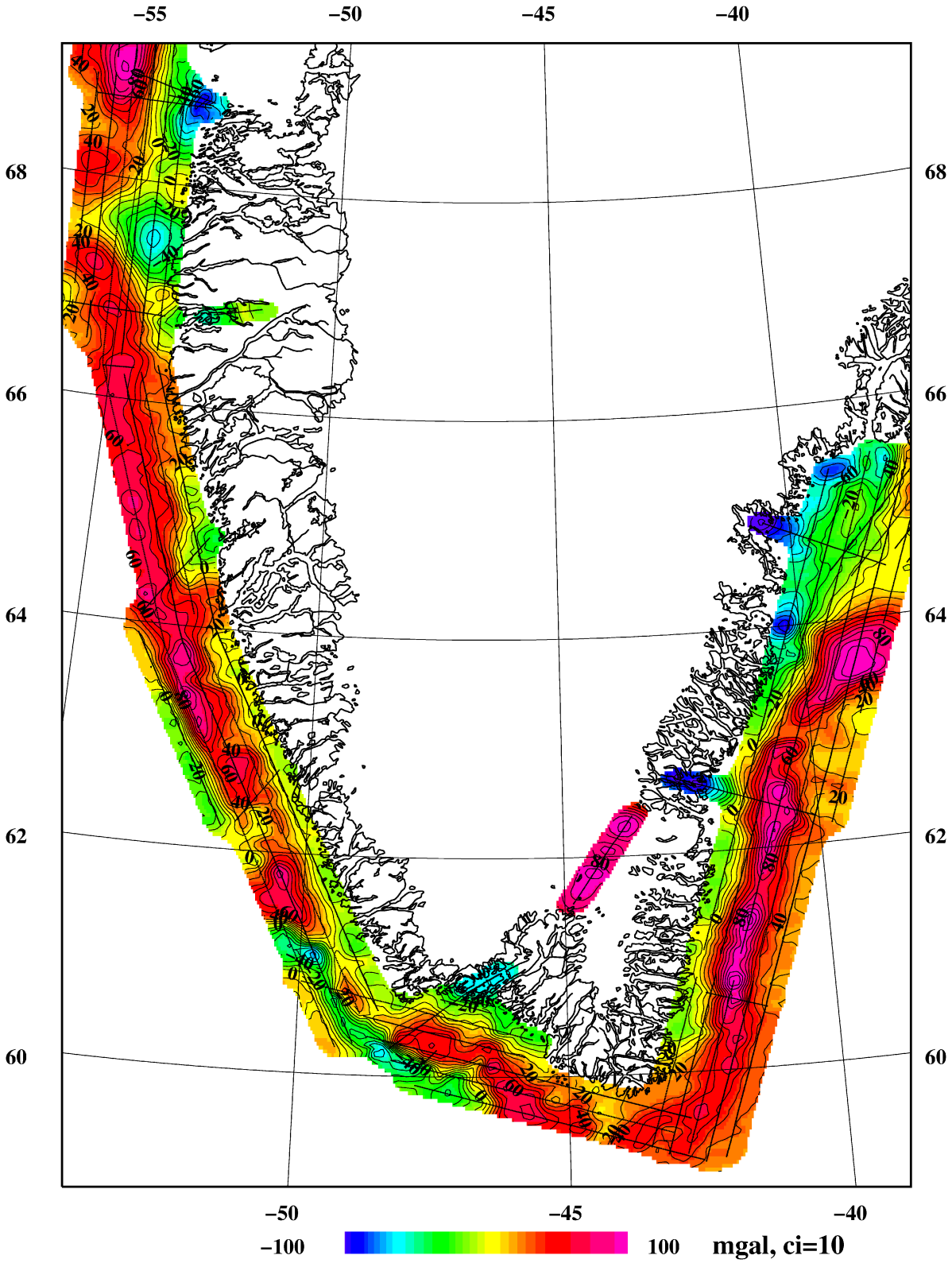

Fig. 6. Southwest Greenland gravity anomalies (Grl00).

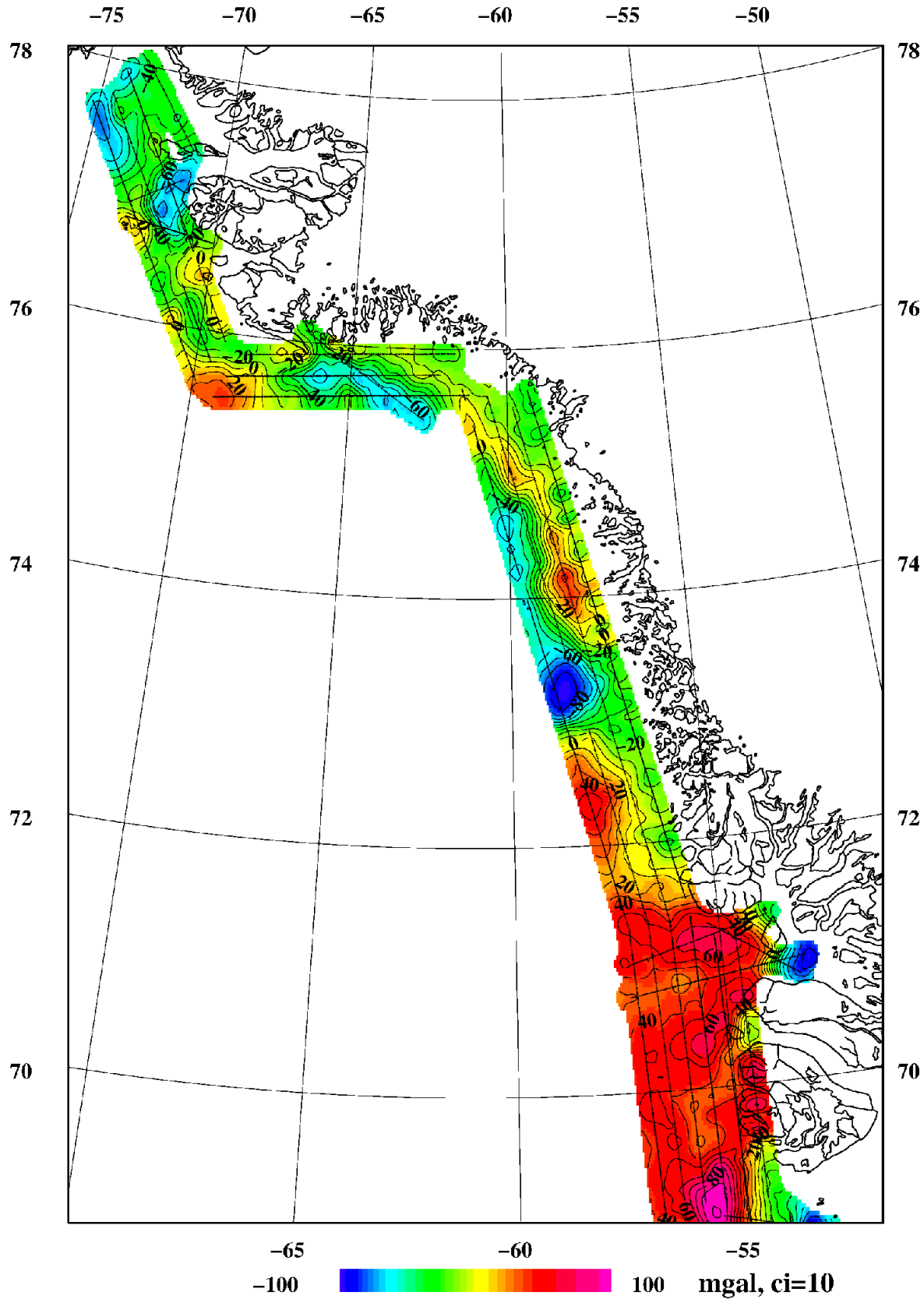

Fig. 7. Northwest Greenland gravity anomalies (Grl00).

5.1. Validation of the airborne gravity data

To judge the quality of the surveyed airborne gravity data, the data are compared internally through cross-overs, and externally to high-quality marine gravity data.

Table 8 shows the internal cross-over errors for each survey, and Table 9 the cross-over comparison between individual surveys. It is seen that r.m.s. cross-over errors in the range 1.8-2.8 mGal are obtained in Greenland. Assuming the track noise to be white, the estimated accuracy of the survey will be the r.m.s. error divided by √2, thus well below 2 mGal. In Svalbard the flights were flown at different elevations (up to 1800 m), and the cross-over errors contain errors due to upward continuation, which have not been taken into account.

Table 8. Internal cross-over errors (mGal) for each individual survey

	No of x-overs	Std. Dev.	Abs max
GRL98	86	1.8	4.5
GRL99	74	2.4	8.6
GRL00	96	2.8	9.3
GRL01	66	2.5	8.2
SAG98	22	2.5	7.4
SAG99	46	3.5	9.8

Table 9. Inter cross-over errors between different surveys

	# x-over	Mean	Std.dev.	Abs max
GRL98 x GRL00	30	-1.1	2.7	6.0
GRL98 x GRL01	62	-0.3	2.6	6.2
GRL99 x GRL01	72	-0.3	2.4	9.1
GRL01 x SAG98	37	0.5	3.4	10.0
SAG98 x SAG99	48	0.2	4.0	8.4

Table 10 shows the comparisons to Nunaoil KANUMAS marine gravity data. These data, surveyed in the 90's in connection with oil exploration were processed by KMS, and have an estimated accuracy better than 1 mGal. The survey covers a major part of the East Greenland continental shelf, as well as areas of West Greenland (Fylla Banke region and Melville Bugt). The comparisons are done by interpolating the airborne data to the locations of the Kanumas data, and comparing only points which are sufficiently close (within 1 or 2 km). Given that the marine data have noise, and the (small) effect of the upward continuation, these external comparisons show that the estimated 2 mGal accuracy of the airborne data is realistic.

Table 10. Comparisons to KANUMAS marine gravity data off East and West Greenland

	Within 1 km				Within 2 km			
	# Points	Mean	Std.dev.	Abs max	# Points	Mean	Std.dev.	Abs max
GRL98	344	0.2	2.6	8.1	540	0.1	2.9	11.4
GRL99	431	-0.6	2.3	8.2	976	-0.7	2.5	11.6
GRL00	351	-0.5	2.4	8.2	801	-0.6	2.8	14.0
GRL01	101	-0.7	3.0	13.1	207	-0.9	3.0	14.7
All	1212	-0.4	2.5	13.1	2455	-0.5	2.7	14.7

6. Conclusions

A high-quality airborne gravity survey of Greenland and Svalbard coastal regions has been performed, and the processing and reference data have been outlined. The surveys are based solely on gravity base readings; no cross-over adjustment of final data have been performed. External and internal accuracy estimates indicate an accuracy of 2 mGal r.m.s., with long-wavelength biases at a fraction of a mGal. The data are therefore highly useful for geoid determination. The new gravity anomalies of the North Greenland shelf will be a contribution to the Arctic Gravity Project, an ongoing international cooperation to compile and release an Arctic-wide gravity grid by year 2002.

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APPENDIX 1. Operator log files.

Airborne Gravimetry Log Svalbard 1999

JD 212 July 31

0910 take off
st slew 13938.1
st sync ok
0920 BU line XA, 5000 ft
0923 st on
0934 st sync ok
1011 BC, st off
slew+set 14339.0
1019 D1, BU
1022 st on, st sync ok
1033 climb/descent
1040 st sync ok
1041 climb/descent
1058 st sync ok
1110 turbulence to 1120 (approx)
1131 st g:14393.3 pc:14390.8
1154 st g:14372.8 pc:14370.3
1205 st g:14387.8 pc:14385.2
1206 d2, bc, st off
1207 st slew +300
1209 st set 14682.3 sync ok
1217 c2, torque off/on, bu
1220 st on
1243 st g14663.9 pc14664.0
1300 turbulence
1308 g14688.5 pc14686.9
1331 g 32.4 pc 31.0
1345 appr. climbing
1403 st off, bc, end line C
1405 st slew -350
1407 st set 14238.5
1407 torque off/on, bu, line XB
1412 st on
1417 st 14477.5 sync ok
1442 st sync ok
1449 bc, end line XB

Day 214 aug 2 LYR-B1-B2-A2-A1-LYR

take off
pushed 'roving' to late (after take off)
0702 st slew 13940.4, sync ok
0705 BU, LYR-B1 5000 ft
0711 ST on
0717 climb !!
0720 st sync ok
0748 g 13793.8 pc 13755.9 !!
0755 793.9 756.1
0758 BC, st off
st slew +340
st set 14113.0 sync
0808 BU, line B 330 ft
0810 ST on
0828 ST sync ok
0846 sync ok
0905 g 53.4 pc 53.2
laser ny vinkel
0922 g 58.2 pc 56.7
0923 g 49.0 pc 45.9
0924 g 40.2 pc 37.2
0939 g 47.6 pc 44.7
1006 g 46.5 pc 38.1 !!
1008 g 47.0 pc 38.4 !!
1010 BC, st off, end line B
1014 slew+set 14754.6 sync
1021 BU, line A, 250 ft
1024 st on
1025 g 47.8 pc 47.7
1040 g 43.2 pc 42.7
1046 turbulances
1052 g 73.0 pc 72.5
1104 g 51.0 pc 47.5
1105 g 39.0 pc 35.6
1110 turbulances
1118 g 41.2 pc 37.3
1119 g 38.5 pc 34.6
1126 g 33.5 pc 29.6
1136 g 06.2 pc 02.4
1150 g 12.6 pc 08.8
1201 g 10.5 pc 06.8
1207 g 14.0 pc 10.1
1217 BC, end line A
st slew -340
st set 14456.6
1225 BU, line A1-LYR 7000 ft
1228 st on
1229 g 329.9 pc 329.8
1238 g 10.5 pc 09.8
1253 g 65.0 pc 64.3
1257 BC, end line
1307 touch down

Aug 3 JD 215

beam zero 5
beam gain 9002
press 26.8
gravclock 20 sec. too fast
0710 14614.0 14614.0 8. 0.2
0711 st slewed to 13824, sync ok
0715 TAKE OFF
0730 7000 ft 145 kts 350 deg
0733 torque off/on
0734 bu, online 7 min before wp line i1i2
pga af is blev speed reguleret nogle gange
0735 ?? 13825.1 13838.7 0.5 -107 97.0
0736 pc:13852.6 g:13860.9
0743 sync ok
0800 sync ok
0810 sync ok
0900 sync ok
0913 i2
0915 bc, st off
0919 st slew + 650 to 1457.38 (500 ft)
0920 sync 14573.8 14573.9 ok, st slew +20,
0923 st 14593.8 (300 ft)
0924 bu line j1j2 (ingen is)
0925 st on
0926 sync ok
1019 sync ok
1026 bc, st off
1033 st slew 112 to 14600
1035 bu, st on, sync ok, line k1k2 (igen is og
regulering af speed)
1040 14600.3 14628.1 .3 -126 22.5, sync ok
1100 sync ok
1120 sync ok
1140 sync ok

1200 sync ok
1207 k2, fors'tter
1210 bc, st off, end of line
1212 st pc 14628.7 g:14628.8 sync ok.
1415 base reading @ green container 14614.1

JD 216 Aug. 4 U-T-O-N-M

0651 slew 14721.5
sync ok
0706 off block
0711 take off
0725 bu, U2, 300 ft
0728 st on
0729 st sync ok
0743 st sync ok
0802 bc, end U st off
0804 st slew -280
g 481.9 pc 481.8
0811 bu line T, 300 ft
0825 st sync ok
0853 st sync ok
0907 bc, st off, end T
0908 st slew +280
0910 g 631.9 pc 631.9
0914 bu, O2 300 ft
0916 st on
0936 st sync ok
0956 st sync ok
1012 bc, st off, end O
1013 st slew -25
1014 g 721.7 pc 721.7
1019 bu N2, 300 ft
1021 st on
1045 sync ok
1108 sync ok
1132 bc end N, st off
1134 st slew -150
1136 g 629.8 pc 629.7
1138 BU, M2 300 ft
1140 st on
1200 sync ok
1255 bc, end M, st off
1258 ultrasys stopped
1330 touch down
1332 on block
1358 g 497.0 pc 496.8
1400 basereading at gate
1500 basereading 14614.4 tc=0.0

JD 217 Aug. 5

V-W-P-S-X
0654 off block
0659 sync ok
0700 take off
0711 bu, V1, 5000 ft
0712 st on
0715 sync ok
0745 sync ok
0800 sync ok
0805 bc,end V, st off
0808 slew +316
0810 sync ok
0819 bu, W1, 5000 ft
0821 st on
0825 sync ok
0900 sync ok
0915 sync ok
0917 bc,st off, end W
0919 slew -261
g 905.7 pc 905.8
0928 bu, P1 5000 ft
0930 st on
1001 sync ok
1030 sync ok
1037 bc, end P, st off
1039 slew +228
1040 g 233.7 pc 233.8
1047 bu, S1 5000 ft
1049 st on
1050 sync ok
1115 sync ok
1120 bc, st off
1121 slew +32
1123 g 267.9 pc 268.0
1133 bu, X1 5000 ft
1135 st on
1138 sync ok
1200 sync ok
1222 sync ok
1231 bc, end X, st off
1234 sync ok
1238 touch down
1240 on block

Airborne Gravimetry Log Greenland 1999

11/8 JD 223

1300 basereading at P3 14612.8

12/8 JD 224

0930 baserading at P3 14612.8
air1 quickstart
0955 off block
0958 take off
1012 slew 14730.1
1012 sync ok
1022 bu, A1 300 ft
1025 st on
1030 sync ok
1315 bc, A2
1358 touch down
1359 on block

11 08 99 - JD 223

Waiting for weather to improve at Nord
1300 Basereading LYR 14612.8 (tc=0.1)

12 08 99 - JD 224
To Station Nord - line A, then DMH line C

0930 Basereading 14612.8
AIR1 quickstart
0955 off block
0958 take off
1012 slew 14730.1, sync OK
1022 B0, A1, 300 ft
1025 st on

1030-1258 sync OK
1315 beam clamp, A2
1358 touch down
1359 stop taxi

1600 basereading at Nord,
fuelpump 14720.4 14720.6 0 -8 -.4
1650 taxi, slew st 14530
1655 airborne
1658 unclamp, 1000 ft, sync ok
1705 comm. error - ultrasys restarted.
sync: g 14476.2 pc 14476.4
1740 st ok
1753 end of line, clamp beam, to C1
1758 on line, sync ok
1815 some turbulence
1830-1950 sync ok
2015 sync ok: g 562.0 pc 562.2, dig g 14570
2037 st ok
2045 end of line, close
2102 touch down

2130 basereading 14595.1 - acft in front of old power plant

GPS stations at DMH:
DMH1 = temporary, trimble on roof of building across from main entrance.
DMH2 = Ashtech, tripod on KMS 1997 reference, slant a.h. = 142.2 cm (ant. diam. = 17.4 cm).
GPS station at Nord:
Located at west end (apron) on top of northern lodging building at apron. Trimble.

13/8 JD225

0700 basereading
0847 take off
slew 14300
sync ok
0856 bu, D2 300 ft
0933 sync ok, sensor +0.2
1145 bc, D1
1148 slew 120, sync ok, sensor +0.1
1151 bu, E1 300 ft
1335 sync ok, sensor +0.2
1430 BC, E2
1442 touch down

second flight

1544 taxi
1549 BU, sync ok
1601 BC
1601 BU, g 290.0 pc 289.8
1645 g +.2
1822 g +.3
AIR3 on power
1846 BC
1856 BU, G1
g 52.4 pc 51.9
2014 g +.4
2018 AIR2 out of memory
host receiver error
2112 g 24.5 pc 24.1
2125 BC
2128 BU
2143 BC
2146 landing
2154 start basereading
2300 basereading 14595.0

14 Aug JD 226

0915 take off
0920 slew 14400
stepping motor not working
0933 return to DMH
0958 landed
stepping motor replaced
1048 take off
1052 slew 14400, sync ok
1118 BU, H2 300 ft
1225 sensor +0.1
1333 sensor +0.1
1337 BC, H1, slew +130, sync ok, sensor +0.1
1346 BU, I1 300 ft
1348 st on
1442 sensor +0.1
1605 sensor +0.1
1611 BC, I2
slew 250
1613 BU, I2-DMH 300 ft
sensor 0.0
1642 bc
1646 landed

2nd flight, 14-8-99, JD 226

1743 taxi
1745 takeoff
1748 ultrasys startet, ST off, clamp
slew to 1430
1759 AIR2 restartet (startet med 10 s)
1802 host receive error, restart ultrasys
1812 on line, level, ST on
1814 g 14292.5 pc 14292.6 sync ok
1905 end of line, sync ok
time sync: GPS 19:09:00, grav pc 19:09:53
1935 end of line, slew, clamp
1940 on line M, level, sync ok (14521.1 14521.3)
2030 sync OK
Jokelbugten: mange flade isbjerge (1-3 m hoeje)
2054 end of line, turn, clamp
2102 bred aaben revne, edge of floe
2105 clamp, stigning
2107 unclamp, level 2000 ft
2129 clamp beam, torque motors off
2136 ultrasys stoppet
2149 on ground

August 15. JD 227

1000 Basereading 14594.8 (not completed)
1011 take off
air1 not locked on SV
slew 14450, sync sensor -0.1 (0.0)
1020 BU, P1 300 ft
1023 st on
1101 sensor -0.1
1120 air3 started (sorry)
1121 BC, P2
1121 air locked on SV, loggin started
1132 BU, Q2 500 ft, sync ok, sensor 0.0
1224 BC Q1
1232 landed

15-8-99, JD227, 2nd flight

1339 start taxi
1342 take off

1344 ultrasys startet
1347 unclamp
1355 g 186.1 pc 186.2 sync ok
1414 clamp, level, slew, line U, st ok
1520 st ok, turbulence
time sync GPS 15:54:00, g-pc 15:54:53
1556 end of line, clamp
1605 on line, unclamp, sync ok
1721 sync ok
1725 end of line, clamp, st +250
1735 on line, unclamp, sync ok
1812 beam clamp, turn
1815 unclamp, st -250
1818 iceberg
1832 stop ultrasys
1837 landing
2015 basereading 14595.1

16-8-99, JD228, 1st flight DMH-CNP

0847 start taxi
0850 take off
0853 ultrasys startet
0854 g 534.0 pc 533.5
0858 g 157.1 pc 156.9 sync ok
0908 host receive error - 30 sec
0912 beam clamp, turn
0916 unclamp, on line
0919 g 588.0 pc 587.8 sync ok
1130 st ok
1223 end of line, turn, slew, sync ok
1236 on line, unclamp
1255 sync ok
1318 end of line, clamp
1328 low pass of runway
1332 landing

August 16, JD 228 CNP-DMH-CNP (S+R)

1422 take off, slew -300
1435 BU, CNP-S2, sync ok
1502 BC, S2, slew 14150
sync ok, sensor 14150.0 pc 14150.0
1505 air3 started
1507 BU, S2 350 ft
1541 sync ok
1657 sensor +0.1
1755 BC, S1
1814 landed
1851 take off, slew 14520, sync ok, sensor 0.0
1906 BU, R1 400 ft
1955 sync ok
2025 error 25344
2121 sync ok
2208 BC, R2, slew 400, sync ok
2213 BU, R2-CNP 3000 ft
2235 BC
2245 landed

August 16, JD 228
CNP-DMH-CNP (S+R)

1422 take off slew -300
1435 BU, CNP-S2, sync ok
1502 BC, S2 slew 14150
sync ok, sensor 14150.0 pc 14150.0
1505 air3 started
1507 BU, S2 350 ft
1541 sync ok
1657 sensor +0.1
1755 BC, S1
1814 landed
1851 take off, slew 14520, sync ok, sensor 0.0
1906 BU, R1 400 ft
1955 sync ok
2025 error 25344
2121 sync ok
2208 BC, R2, slew 400, sync ok
2213 BU, R2-CNP 3000 ft
2235 BC
2245 landed
2400 basereading 14262.9

17-8-99, JD229

AIR1 not available (not able to start)
1030 ultrasys restartet (power fail)
1035 take off, beam clamped to X1
sync g 14263.2 pc 14263.0
1111 unclamp, level. turbulence. sync ok.
1210 sync g 305.0 pc 304.6
1229 clamp, slew, end of line
1234 on line to W2, unclamp
1249 clamp Myggbukta
1258 unclamp, level
1303 sync g 377.5 pc 377.0
1306 host receiver error - 40 sec
1324 host receiver error (pc card cable?)
1400 st sync +0.5 off again
1416 end of line, stop ultrasys
1436 landing

19 08 99 - JD 231
Flight CNP-Nord (J-line) + Nord-LYR

1029 take off, slew 14150, sync ok
1052 unclamp, J4, 300 ft
1120 st sync +0.1
1155 st sync +0.2
1216 slew st -100, clamp beam
1218 J3, beam unclamp, sync sensor +0.1
1243 turn (clamp, unclamp), sync +0.2
1244 time sync: gps 12:56:00, grav pc 12:56:58
1330 st ok
1450 st g 534.0 pc 533.8
1459 end of line, clamp
1501 unclamp, enroute to St. Nord, sync ok
1520 (ca.) host receive error
1543 clamp beam, climb over Kilen
1608 landing (ultrasys on)

1700 base rdg 14719.4 (14719.4, 14719.4, 0, -2, .2)

1909 start taxi
1911 takeoff, start ultrasys
1919 AIR1 started (stuck)
1922 unclamp, transit to line, sync ok (g = pc+0.2)
2000 clamp, descend to 79-fjord
2008 unclamp, on line, st ok. Turbulence.
2105 host receive error 30 sec
2130 st ok
2221 st ok, host receiver error 2:30
2225 clamp, turn
2226 unclamp, line to LYR, st ok
2309 end of line in Isfjord, clamp beam
2316 laser test, 400 ft runway pass
2320 landing

22 08 99 - JD232

0940 basereading 14612.6, st sync?
1050 2nd basereading at P3 location, 0.3 m below old parking spot
dg 14612.2 st 14612.2 tc 0.0 - final 14612.3

19 08 99 - JD 231
Flight CNP-Nord (J-line) + Nord-LYR

1029 take off, slew 14150, sync ok
1052 unclamp, J4, 300 ft
1120 st sync +0.1
1155 st sync +0.2
1216 slew st -100, clamp beam
1218 J3, beam unclamp, sync sensor +0.1
1243 turn (clamp, unclamp), sync +0.2
1244 time sync: gps 12:56:00, grav pc 12:56:58
1330 st ok
1450 st g 534.0 pc 533.8
1459 end of line, clamp
1501 unclamp, enroute to St. Nord, sync ok
1520 (ca.) host receive error
1543 clamp beam, climb over Kilen
1608 landing (ultrasys on)

1700 base rdg 14719.4 (14719.4, 14719.4, 0, -2, .2)

1909 start taxi
1911 takeoff, start ultrasys
1919 AIR1 started (stuck)
1922 unclamp, transit to line, sync ok (g = pc+0.2)
2000 clamp, descend to 79-fjord
2008 unclamp, on line, st ok. Turbulence.
2105 host receive error 30 sec
2130 st ok
2221 st ok, host receiver error 2:30
2225 clamp, turn
2226 unclamp, line to LYR, st ok
2309 end of line in Isfjord, clamp beam
2316 laser test, 400 ft runway pass
2320 landing

22 08 99 - JD232

0940 basereading 14612.6, st sync?
1050 2nd basereading at P3 location, 0.3 m below old parking spot
dg 14612.2 st 14612.2 tc 0.0 - final 14612.3

21 08 99 - JD233
LYR-Tromso, high level flight (3300 m)
(laser turned off slightly after start)

0815 start taxi
0819 airborne
0839 on fl 110, unclamp, st ok
<910 host rcv error, ultrasys locked
0914 ultrasys restartet
1030 sync g = pc + 0.4
1143 clamp, descend, stop ultrasys
1158 touch down

22 08 99 - JD234

IFR ferry flight Tromso-Mariehamn. No measurements.

0832 take off
1213 landed

Airborne Gravimetry Log Greenland 2000

27/7-2000 JD209 Thursday

Kangerlussuaq
Installation of equipment onboard OY-POF
including L&R air-sea gravity meter S-99

28/7-2000 JD210 Friday
Kangerlussuaq

Base reading in Greenlandair Hangar
16:19:00 G=14014.7 ST=14014.6
Base reading on apron at Greenlandair Hangar
21:50:00 G=14014.7 ST=14014.7

29/7-2000 JD 211 Saturday
Kangerlussuaq

No flight to Narsarsuaq due to bad weather.
Base reading on apron
13:51:00 G=14014.8 ST=14014.7

30/7-2000 JD 212 Sunday
Kangerlussuaq
No flight due to bad weather.

31/7-2000 JD 213 Monday
Kangerlussuaq
Fast base reading on apron before take off.
11:32:30 G=14014.5 ST=14014.6

11:34: ST off clamp beam
11:35: Leave apron
11:39:40 In air
11:43: ST sync. ok
11:45 Slew ST to 13700.
12:13 Slew ST +33 to 13733.

Start line V4V3
==========
12:24 Torque m. off/on Unclamp beam
12:25 ST on
12:31 Turbulence, foggy: Altimeter don't func.
12:29 ST sync. ok (monitor +0.1)
13:58 Turns slowly towards new line

13:59 Start line V3V2
==========
14:00 ST sync. ok (mon. +0.1)
14:04 Some turbulence
14:33 ST sync. (mon. +0.2)
Cross coupling 17.
15:00 Less turbulence
16:20 ST sync. (mon. +0.2)
16:21 ST off, clamp beam.
End of line
16:22 Slew ST -229 to 13023.6

Start line A1A2
==========
16:37 Torque m. off/on, unclamp beam
16:37:40 At waypoint A1
16:38 ST on
16:39 ST sync. (mon. +0.2)
16:56:30 ST off, clamp beam.
End of line

End of measurements for the day.
Flies towards Narsarsuaq
17:14 Brattalid down at left
17:15:40 Landed at Narsarsuaq Airport
17:17:40 On apron
17:18 External power
17:19 ST on, unclamp beam

Base reading on apron at Narsarsuaq
19:40:00 G=13566.1 ST=13566.0

1/8-2000 JD 214 Tuesday
Narsarsuaq
Fast base reading on apron before take off
09:53 G=13566.1 ST=13565.2

09:54 Leave apron
09:55 ST off, clamp beam
09:58 Slew ST to 12934.
09:59 In air
10:13 Set ST to 12934.4

Start line M1M2
==========
10:31:30 Unclamp beam
10:32:50 ST on. Alt.m.=200m, speed=149 knots.
10:36 ST sync. ok
10:53:50 ST off, clamp beam
End of line.
10:57 Slew ST +669 to 13570.
ST sync. ok

Start line J3J1
==========
11:10:30 Torque m. off/on, unclamp beam
11:12:00 ST on. Alt.m.=197m, speed=130 knots
11:35 Foggy, no reading from altimeter.
12:06:40 ST off, beam clamped.
End of line
12:10 ST slewed -324 to 13206.3
ST sync. ok

Start line I1I3
==========
12:16:00 Toreque m. off/on, unclamp beam
12:17:00 ST on
12:38 ST sync. ok
13:00:40 ST off, clamp beam
End of line
13:04 Slew ST +308 to 13743.
ST sync. ok

Start line H3H1
==========
13:09:40 Torque m. off/on, unclamp beam
13:11:00 ST on
13:15 Some turbulence
13:31 ST sync: ST +0.2.
13:58 Foggy, no reading from alt.m.
14:04 ST off, clamp beam.
ST mon.=13544.8, ST sensor=13544.5
End of line
14:07 ST slewed -313 to 13231.9, ST mon. +0.3

Start line G1G3
==========
14:13:30 Torque m. off/on, unclamp beam
14:15 ST on
14:20 ST sync. ok (ST mon. -0.1)
14:31 Readings from alt.m., turbulence

14:36 Flew between two high islands.
15:00:10 ST off, clamp beam
ST sync. ok (mon. -0.1)
End of line.
15:48 Landed in Narsarsuaq
15:50 On apron

End leg 3, start leg 4
==========
16:25 ST off, beam clamped
16:27 Leave apron
16:31 Airborne

Start of line X2E1 before waypoint
==========
16:38:50 ST on, unclamp beam
Flies along the fjord
Alt.m. 250 m., speed 145 knots
16:52 At the coast, foggy
16:52:20 At waypoint X2, no alt.m. reading
16:55 ST sync. ok (mon. -0.1)
17:05 Alt.m. readings.
17:17:20 ST off, beam clamped.
End of line. Slew ST

Start line E1E2
==========
17:21 Torque m. off/on, unclamp beam, ST on
17:22 At waypoint E1
17:30 ST sync. ok (mon. -0.1)
18:31:20 ST off, beam clamped
18:34 Slew ST +1015 to 13698.2
ST sync., mon. -0.2

Start line D2D1
==========
18:40:50 Torque m. off/on, unclamp beam
18:42:10 ST on, at waypoint D2
Alt.m.=240m, speed=110 knots
18:55 Some turbulence, ST sync. ok
19:45 Foggy, no reading of alt.m.
20:13:10 ST off, beam clamped
End of line
20:18 Slew ST -991 to 12914.5
ST sync. ok

Start line C1C2
==========
20:21:50 Torque m. off/on, unclamp beam
20:22:40 At waypoint C1
20:23:00 ST on
20:25 ST sync. ok
21:08 ST off, clamp beam
End of line & end of leg 4
21:35 Landed in Narsarsuaq
21:37 On apron
Base reading
23:05:00 G=13566.7 ST=13566.7

02/08-2000 JD 215 Wednesday

Base reading at Narsarsuaq (UAK)
11:16 G=13566.8 ST=13566.9
14:59 G=13566.4 ST=13566.6

No flights due to bad weather

03/08-2000 JD216 Thursday

Fast reading at Narsarsuaq
10:53:20 G=13566.2 ST=13566.7 (not stable)
10:54 Leave apron
10:55 ST off, clamp beam
10:57 Slew ST to 13285.
11:00:00 Airborne
11:33 At the coast
11:47 Slew ST +150 to 13435.

Start line I3I2
==========
11:48 Torque off/on, unclamp beam
11:49 ST on
11:50 ST sync. ok (mon. -0.1)
13:54:40 At waypoint I2
13:55:50 At the coast
13:57 ST off, clamp beam
End of line & end of leg 5

13:59 ST sync. ok
14:09 Landed at Kulusuk
14:12 At apron

Fast base reading at Kulusuk before fueling
15:25:00 G=13978.6 ST=13978.4
Start leg 1
15:42 ST off, clamp beam
15:42:30 Leave apron
15:45 Airborne
15:46 Slew ST to 13900.
15:53 ST sync. ok

Start line G2G3
==========
16:07 Torque m. off/on, unclamp beam
16:07:30 At waypoint G2
16:08 ST on
16:09 ST sync. ok
16:34 Some turbulence
16:55 Close to land, sea ice
18:00 ST sync. ok
18:07:10 At waypoint G3, continues for 2 min.
18:09:10 ST off, beam clamped
End of line

18:10 Slew ST to 13400.
ST not syncronised. ST mon.=13400,
ST sensor=13401.4
Slew ST +10 to 13410.
ST mon. -1.4 applies to whole line H3H2.

Start line H3H2
==========
18:15 Torque m. off/on, unclamp beam
18:16:10 ST on
18:19 St mon. -1.4
18:30 Alt.m. 136 m, speed 137 knots
18:52 Alt.m. 250 m, speed 250 knots.
20:11 Foggy, no alt.m. reading
20:19:10 ST off, beam clamped
End of line.

ST mon. -1.4
Measure on the way to Kulusuk
20:25:00 Unclamp beam, ST on
20:33 ST off, clamp beam
ST mon. -1.4
End of leg 1
20:35 Landed at Kulusuk Airport
20:38 On apron
Syncronise ST
20:43 Slew ST to 13978.
20:51 ST on, beam unclamped
Base reading at Kulusuk

21:50:00 G=13978.1 ST=13977.6
21:57:00 G=13979.0 ST=13978.6 Not stable yet

04/08-2000 JD 217 Friday

Base reading at Kulusuk Airbort
11:56:20 G=13978.5 ST=13978.7
No flight due to bad weather

05/08-2000 J.day 218 Saturday
Fast reading at Kulusuk before start of Leg 8
10:54:20 G=13977.8 ST=13976.4

10:57 Leave apron
10:59 Slew ST to 13375.
11:01 Airborne
Measure on the way to line P1P3
11:08 Torque m. off/on, unclamp beam
11:10 ST on, ST sync ok
11:32:40 ST off, clamp beam
11:33 Slew ST to 13375

Start line P1P3
==========
11:35 Torque m. off/on , unclamp beam
11:36:10 ST on, at waypoint P1
11:37 ST sync. ok
11:39 Alt.m. 295m, speed 131 knots
14:00 ST sync. ok

14:24:10 Start turning to line P3P2
==========
14:24:40 At waypoint P3
14:27 ST sync. ok
15:12 ST sync. ok
15:14 At waypoint P2
15:15:00 ST off, clamp beam
End of line
Measure on the way to Constable Point
15:16 Torque off/on, unclamp beam
15:17:30 ST on
15:19 ST sync. ok
15:32 At the coast
15:33 Over Scoresbysund
15:35 ST off, clamp beam
15:45 Landed at Constable Point
14:47 At apron
End of leg 8
Base reading on apron
19:26:00 G=14260.8 ST=14260.9

06/08-2000 JD 219 Sunday

No flights due to technical service on OY-POF

07/08-2000 J.day 220 Monday

Base reading on apron at Constable Point
08:40:00 G=14260.8 ST=14260.7
09:21:00 G=14260.8 ST=14260.8

09:51 Leave apron
09:52 Airborne

Measure on the way to line O2O3
==========
10:01 Unclamp beam, ST on
10:15 ST off, clamp beam
10:16 Slew ST to 14337, ST sync. ok

Start line O3O2
==========
10:19 Torque m. off/on, unclamp beam
10:20:10 ST on
10:22 ST sync. ok (mon. -0.1)
11:17 ST sync. ok
11:19:30 Turn towards line O3O1
==========
11:19:50 At waypoint O3
Calm nice weather
11:56 ST sync. ok
14:04 Cloudy, partly readings from alt.m.
14:20 ST sunc. ok
14:27:10 ST off, clamp beam
End of line
14:34 Slew ST to 13400.

Start line N1N2
==========
14:36 Torque m. off/on, unclamp beam
14:37 ST on
14:37:30 At waypoint N1
14:38 ST sync. ok (mon. -0.1)
15:17 ST sync. (mon. -0.2)
15:19:20 At waypoint N2
15:20:30 ST off, clamp beam
End of line & end of leg 7
15:24 Slew ST to 13978.
15:26 Landed in Kulusuk
15:28 On apron

Base reading at Kulusuk
15:56:00 G=13978.1 ST=13978.1
16:00:00 G=13978.1 ST=13977.9

(Arne G left for Norway)

leg 9 KUS-X5-Q1-Q3-Q2-CNP

16:07:20 clamped, st off
ca. 16:11 leave apron
16:13 airborne
16:17 slew st to 13500, torque off/on
16:18 unclamped
16:19 st on, line KUS-X5
16:32:50 sync pc 14150.6 g 14150.6 OK
16:45:20 clamped, st off, high hill
16:47 slew st to 13332
linie X5-Q1 start, 260 km/t Az115
alt:260m spredte isblokke
16:58:20 unclamped
16:59:30 st on
17:00 sync OK 13369.2
17:10 ingen is, laser OK
17:30 sync ok, 13335.6
17:32 lidt tåge, laser dårlig
17:35:50 end of line (eol),clamp, st off
17:38:20 slew st +50 to 13359.2

line Q1-Q3 start, 215 km/t, Az47
alt 237 m, tåge.regn, ingen laser
17:39:30 level, unclamped,
17:40:30 Q1, st on
17:41:40 sync 13435.5 OK,ingen laser, 214 km/t
18:04 sync OK
18:42 222 km/t, alt 250 m lidt laser
19:25 sync OK, 13611.7
20:02 290 km/t alt. 260m '0'-laser
20:23 316 km/t
20:24:50 sync OK, 13568.0
20:30 lidt uro
20:35:50 Q3, start line Q3-Q2

21:04:30 PC 13705.9 G 13706.0, laser OK, 238 m

8/8 2000 CNP JD 221
no flight, bad weather in Kulusuk

07:17 ultrasys started
basereading CNP apron:
08:08 sync pc 14260.7 g 14260.5
set ST 14260.5 (P4)
09:31 basereading start, unclamp, st on
11:14:20 14260.4 14260.4 0 10.0 -0.2
sync pc 14260.4 g 14260.5
st off, clamp
12:48 ultrasys terminated

9/8 2000 CNP JD 222
CNP-N2-N3-N1-KUS

07:20 started ultrasys
09:08 clamp, st off, 14259.8 sync ok
09:20 leave apron
09.22 airborne
09:24 slew st to 13925, sync ok
09:32 slew st to 14310, sync ok
09:41 grav tryk/temp 27.1
09:44 start line N2-N3, level, unclamp,
09:44:40 N2, st on
09:46 sync ok, st 14289, raw beam ca. 800,
laser ok,alt 308 m 266 km/t
09:50 uro pga vind fra land, r b +/- 3000
10:05 rolig, ingen laser pga tege,regn
10:20 uro
10:23 ro igen...
10:30 N3, sync OK, 335 km/t, 285 m
11:32:40 sync pc 14282.8 g 14282.9, 282 km/t
270 m ingen laser, pga taage
12:28:50 sync pc 14157.1 g 14157.2
12:29:20 N1
12:31:20 eol, clamp, st off
12:40 on ground KUS
12:46 unclamp, st on
13:19:40 13977.8 13978.2 0 2. -0.6, blfst
sync pc 13978.2 g 13978.3
13:23 ultrasys stopped, clamp

10/8 2000 KUS JD 223
KUS-J2-J3-UAK

10:27 ultrasys started
11.12:10 13977.4 13977.4 0 10 0
11:13 clamp, st off
sync pc 13985.3 13985.5
11:14 SET st to 13985.5 (p4)
11:25 leave apron
11:28 airborne, slew st to 13907.0
11:34 start line J2-J3, level, unclamp
11:34:40 J2
11:35 st on, 269 km/t alt. 276 m OK
ej trykket på 'ROVE' på trimble ved start
11:47:50 sync pc 13914.9 g 13915.1
11:50:40 sync pc 13924.4 g 13924.6
no laser
12:04 sync :g=pc+0.2
12:42 sync g=pc+0.2, 297 km/t alt. 250 m
13:17:10 sync :g=pc+0.2
13:29:00 J3
13:30:20 eol, clamp, st off, sync g=pc+0.2
13:47 slew st -600 to 13230.1 (9000 ft)
start J3-uak
13:48 st on
14:04 clamp, st off, eol
sync pc 13276.7 g 13276.7
14:21 on ground
14:24 at apron.

August 10, second flight

1600 airborne
1608 BU UAK-Y2, 220m
1635 sync ok
1651 BC
1655 slew 13600, sync ok
1657 BU, Y2-Y3-Y4, 230 m
fog, no laser
1707 laser ok
1725 sync ok
1800? fog no laser for rest of the trip
1856 Y3, small turn towards Y4
1900 sync ok
2010 BC, Y4
2012 slew -262 to 13806, sync ok
2019 BU W4 240 m
2120 BC W3, sync ok
2135 landed

==========

JD 224 August 11

1106 take off. slew 13100, sync ok
1114 BU GOD-X6, 2000 ft. clouds no laser
1125 minor climb
1144 BC, slew 13720, sync ok
1150 BU, X6-C4, 2000 ft
1212 BC C4, slew 13772 sync ok. descent to 800 ft
1218 BU, C4-C3
1251 sync ok
1327 BC C3. slew 13370, sync ok
climb to 2000 ft
1333 BU, C3-X7
1407 BC, X7, slew 13100, sync ok
1409 BU, X7-GOD, 2500 ft
1428 BC
1439 landed

August 11 second flight

1535 take off. slew 13150, sync ok
1550 BU W3-W2
1632 sync ok
1715 BC W2, slew 13900, sync ok
1718 BU W2-B1, 2000 ft
1719 BC, BU
1748 BC B1, slew 12815, sync ok
1755 BU B1-B2
1850? BC B2
platform dumped
file renamed --> bb
1857 BU B2-UAK
1911 BC
1915 landed
1920 baseread start
13565.4 13565.4 .0 -7 -.8
dial 13565.4
basereading=13565.4

AUG 14 - JD227
UAK-X1-F1-F2-K2-KUS

0930 start INS etc, stop 5 min senere pga vejr
0950 start baserdg
1005 13565.3 13565.7 .8 8. -.3 dial 13565.7

1040 13565.3 13565.4 .0 9. .0 dial 13565.4
baserdg 13565.3
1125 Start INS, taxi
1135 takeoff
skyer i fjordene
1141 slew 13760, unclamp, st on
1147 sync OK pc=672.4, g=672.7
1223 beam clamp, X1, descend
1229 unclamp, online, sync pc=730.1, g=730.4
1309 taage, (naesten) ingen laser
1344 end of line, st off, clamp, slew 13103
1349 torque on/off, level, unclamp
store boelger fra NNE, periode 1 sek .. 60 m
1353 turbulens
1430 st sync OK, pc=7.2,g=7.5, mild turbulens
boelger kommmer ind praecis forfra paa
flyveretning
1732 clamp, end of line
1737 landing
1739 stop taxi
1745 start baserdg
1840 13977.0 13977.7 .0 0. -.4
dial 13978.0
baserdg = 13977.3

AUG 15 2nd flt
KUS-L2*-L3-L1-UAK

1752 start taxi
1754 take off, slew 13914
1801 on line, unclamp
1833 st sync, pc=7.0 g=7.0 ok
laser syg
1850 en masse bavl paa laserporten
1934 end of line, BC, slew 13966
1947 on line
1950 power fail (slukket for grav pc ved fejl)
time fil mangler - maa tages fra datalogger
st sync ok
2010 taage
2035 end of line, clamp, climb to cross ice cap
2045 unclamp, line to UAK
2115 beam clamp, descend
2126 on ground
start baserdg
2222 13565.1 13565.2 .0 6. -.2
dial 13565.4
basereading=13565.3

AUG 16 - JD229
UAK-Z2-Z3-Z4-Z5-JEG

1055 start engines. no laser.
1100 take off
1109 unclamp, sync ok g=827.2, pc=827.0
1158 end of line, BC, slew 13597
1202 on line, unclamp
1234 st sync ok, +0.2
1333 Z3, kursændring
1415 st sync ok +.2
1427 Z4, turn uden BC
1519 Z5, fortsaet 3 min
1523 BC, turn
1527 unclamp, line to JEG
1556 BC
1558 landing
1401 stop taxi
1411 start baserdg
1800 baserdg 14119.6 14120.7 1.7
dial 14120.9 baserdg 14119.8

AUG 17 - JD230
JEG-B5-B6-B3-I5-I6-THU

1120 start ultrasys
1130 takeoff
1135 unclamp, level
sync g=59.1, pc=58.9 ok
turbulent, regn
1202 end of line, BC, slew 14007
1208 unclamp, level
1212 sync g=636.5 pc=634.9 skredet 1.6 mgal
1214 sync 77.7, 76.0
1235 sync 115.0 113.4
1257 sync 85.0 83.4
1301 B6, kursændring
1324 sync 06.4 04.4
1342 sync 46.0 44.5
1424 sync 06.8 05.1
1444 clamp, turn, climb to 5000 ft pga skyer
1449 slew 14150
1459 unclamp, sync 297.0 298.6
1548 end of line, BC, descend, slew 14460
1555 unclamp, sync g=78.0, pc=76.3
1612 turbulens fra øer
1614 sync 506.2 504.5
1617 clamp beam
1634 landing
parking in front of hangar just
right of Greenlandair hangar
1800 baserdg 14560.3 14560.7 0 3 -.4
dial 14562.5
basereading=14562.1

18. august JD 231

basereading
1055 14562.2 14562.1 .0 12. -.1
dial 14562.1
basereading=14562.2
1119 take off
slew 14610, sync ok
1133 BU, K3, 160 m
1205 BC, K2
slew -430, sync ok
1208 BU, K2-J5
1228 BC, J5
slew 320, sync ok
1232 BU, J5-J4, 240 m
1259 BC, J4
slew -240, sync ok
1305 BU, I4-I6
1356 BC, I6
1408 landing, refueling

1501 taxi, ins not aligned after 8 min
1504 take off, slew 14493, sync ok
1527 BU, H6-H5
1606 BC, H5, slew 14306, sync ok
1612 BU, G4-G5
1729 BC, G5, slew -120, sync ok
1735 BU, G5-F3
1858 BC, F3, slew 14530, sync ok
1841 BU, F3- L4,240 m
1853 BC, L4, slew 14150, sync ok
1900 BU, L4-L3, 3500 ft
1929 L3
1941 BC, TAB
1947 landing

AUG 21 - JD 234
TAB-H6-H5-E3-E4-E5-JEG

Beam zero = -5, beam gain = 8998, platform level ok
0810 start baserdg
0926 14561.7 14561.7 .0 10 -.1 dial 14561.7
baserdg 14561.7
1100 start INS
1112 take off
1133 unclamp, level, sync g=380.5 pc=380.6 ok
1150 taage, lave skyer
1203 end of line, slew 14104
1208 unclamp, on line, sync g=182.4 pc=182.5 ok
1304 end of line, slew
1310 unclamp, st sync ok
1510 sync ok
1513 E4, bloedt sving
1602 host receive error, sync ok
1620 end of line, turn, slew 13622
1622 level, on line
1657 clamp
1659 landing

1745 base rdg 14119.5 14119.6 .0 .0 .1 dial 14119.4
baserdg 14119.3

AUG 22 - JD235
JEG-A5-A6-A3-Z1-Z6-JQA
JQA-N6-N5-M3-M4-Z6-Z5-JEG

1003 start taxi
1008 take off, slew 14300
1010 unclamp, on line to A5,
sync g=221.9 pc=221.8 ok
1039 clamp, end of line, slew 14024
1045 unclamp, level, st sync ok
INS logging af blended stoppet
1200 st sync ok, taage
1258 st sync g=33.9 pc=33.7 ok
1326 end of line, clamp, slew regn
1334 on line, unclamp, sync 398.7 398.6 ok
1341 isbjerg
1350 isbjerge
1500 st sync ok 0.0 dif
1549 clamp, end of line
1550 unclamp, level, sync g=74.1 pc=74.3 ok
1620 clamped
1620 landing at qaarsut

1718 start taxi, ins ikke navrdy
1723 airborne
1727 ins logging start
1734 on line, unclamp, sync 344.3 344.3 ok
1817 clamp, slew 13805
1826 unclamp, sync g=667.0 pc=667.1 ok
1902 end of line, clamp, slew
1905 isbjerg
1928 unclamp, on line, sync 256.4 256.4 ok
2041 end of line, bloedt sving (60 deg)
2043 beam clamp, beam unclamp (beam excess)
sync g=644.0 pc=644.2 ok
2105 clamp, slew to 14119
2108 landing

2215 baserdg JEG 14119.5 14119.7 .0 -.5 .0
dial 14119.5
baserdg 14119.5

AUG 23 - JD236
JEG-W1-W6-Y1-Y4-W4-W6-JEG
JEG-V1-V4-A4-A5-B5-B4-D3-D4-SFJ
indbrud i flyet - instrumentel tilsyneladende ok!

1110 start taxi, beam clamp
1114 take off, slew 13800, slew rel -100
1139 on line, elev 5000 ft, level, unclamp
sync g=567.9 pc=568.0 ok
1238 clamp, descend, slew 14137, laser on
1247 on line, unclamp, turbulens, sync g=814.6
pc=814.5 ok
1315 turbulens fra Hareoe
1330 sync 142.2 142.2 ok
1505 end of line, slew 13846
1511 unclamp, level, sync g=36.2 pc=36.4 ok
1622 end of line, clamp, slew 13800
sync g=791.6 pc=791.7 ok
1640 clamp beam
1643 on ground JEG

1713 start taxi
1716 airborne
1737 unclamp, online
sync g 238.6 pc 238.7 ok
1847 end of line, clamp
1849 unclamp, tie line to A4
1903 clamp, to line, slew 13873
1907 level, unclamp, sync g 872.9 pc 873.0 ok
1915 st on
2023 end of line, clamp, slew
2029 on line, unclamp
sync g 161.1 pc 161.3 ok
2130 end of line, clamp, slew
2146 on line, unclamp, sync g 345.0 pc 345.1
2205 trimble memory fuldt
2216 end of line, climb, slew rel -250
2221 unclamp, level at 4000 ft
2240 clamp, descend to 600 ft for laser calib
2246 laser overflight SFJ runway 600 ft
2250 landing

0030 baserdg SFJ in front of greenlandair hangar
14012.9 14013.0 0 -4 -.2 dial 14012.9 baserdg
14012.9

Airborne Gravimetry Log Greenland/Svalbard 2001

JD 110 20. april 2001

11.00.00 Basereading:
DG ST CC RB TC:
14018.1 14018.1 .0 1.0 -.1 synkr.: ok
Basereading foretaget mens gravimeteret stod på gulvet ca. 10 m. fra dets plads i flyet. Ingen højdeforskel på gulvet.
17.02.30 Basereading:
DG ST CC RB TC:
14017.7 14017.9 .0 -12.0 -.1 synkr.: ok

JD 111 21. april 2001

10.02.30 Basereading i fly i hangar:
DG ST CC RB TC:
14016.7 14016.9 .0 -1.0 -.1 synkr.: EJ ok
Grav: 14016.7
baserd 14016.5

Testflight from SFJ ud over fjorden:
17.46 Start taxi
17.49 I luften
17.54.40 Unclamp
17.57 Alle GPS'er virker fint - 9 sattelitter modtages på dem alle.
17.59.00 Aflæsning:
DG ST CC RB TC:
14166.1 14224.8 -.1 -128 -322.9
Grav: 14224.4 OFF synkr. -0.4
18.04.10 Aflæsning:
DG ST CC RB TC:
14295.6 13966.9 .8 67 57.6
OFF synkr. -0.4
18.04.30 Clamp
18.05.30 Stiger langsomt for test af laserscanner
18.06.20 Vender om - tilbage mod SFJ
LASERSCANNERTEST (ingen tyngde)
18.24.00 Landingsbanen overfløjet - herefter Grønlandsfly hangaren 2 gange (fra hver side).
18.34.30 Landing
18.39 Stop ved hangar

JD 113 April 23
Efter ca 12 timer uden strøm i SFJ blev grav opvarmet på turen til CNP.
1602 start ultrasys
1604 beam unclamped - bu
163100 st 14267.4 0 -59 -4.0
163540 st 14266.4 g 14225.9 ???? 14265.9 ??
163650 st 14265.9 g 14225.4 ???? fejl aflæsning ??
1638 off bloc
1640 st off bc
1643 take off
1646 slew st to 13075.0
1747 st 13075.1 grav 13074.5
171120 torque off/on flight levet at 12000 ft
1712 bu
1713 st on
171410 st 13225.0 g 13224.4
1718 temp 27.15 enheder ????
172950 st 13314.5 g 13313.9
173140 st 13272.0 g 13271.45
180120 st 13305.7 g 13395.0
180300 st 13296.8 g 13396.2
1828 temp 27.15 OK
182910 st 13343.9 g 13343.3
183310 st 13262.8 g 13262.1
190000 st 13488.7 g 13488.1
193030 st 13356.8 g 13356.1
1943 svag turbulens
200220 st 13426.2 g 13425.6
2031ca st 13522.0 g 13521.4
210230 st 13607.2 g 13606.5
2117 eol bc st off
n81 01 w17 19
2122 slew +1200
st 14763.7 g 14763.1
2134 on ground st nord
2140 bu st on
2155 bc st off
2202 parkering ved tæt ved garagen
2203 bu st on
2242 ultrasys crashed power fail, bc
2243 ultrasys started, base reading
0027 st 14717.9 g 14717.1 (dg 14718.1)
-20 C 20 knob
baserd 14717.3 avo
0030 ulrasys slukket,
grav og gyro med varme.

24-04-2001
NORD - D2-D3-D4-D5-D6-LYR

0645 ultrasys started flere gange
glemt at fjerne skum...
0700 ultrasys ok
0700 off bloc
0704 slew st to 14465
0706 take off
0709 on line nrd-d2 torq off/on
0710 st 14465.1 g 14464.1
0711 bu
0712 st on temp ok
071710 st 14496.0 g 14495.0
072130 åbent vand lidt is polymnia ?

073400 st 14647.7 g 14646.6
074930 eol bc st off
slew st +55

D2-D3
0754 on line torq off/on
075430 bu st on
0757 ultrasys restart power fail pga skærm
075900 bu
080230 st 14596.4 g 14595.5
080420 st 14602.5 g 14691.6
083840 st 14602.5 g 14601.6
083920 st 14593.2 g 14592.4
091720 eol bc st off slew st + 163

D3-D4
0920 st 14697.7 g 14696.9
0923 torq off/on bu
092320 st on
092640 st 14740.8 g 14740.0
100050 st 14701.4 g 14700.5
1026 eol bc st off

D5-D6
1030 slew st
1030 st 14486.8 g 14486.0
1036 torq off/on
1037 bu st on
1045 is/hav 50/50
112700 st 14418.8 g 14418.0
120100 st 14425.9 g 14425.0
1211 eol bc st off sync -0.9 ok
1254 on ground
1257 park på apron foran stor hangar og tårn
133850 st 14612.4 g 14611.6
1407 off bloc
1411 take off
lyr - e4 ingen måling

E4 - E3
slew st to 14650.0
1414 st 14650.0 g 14649.2
1429 on line torq off/on bu
1430 st on
143140 st 15215.8 g 15215.0
150150 st 14812.1 g 14811.2
iskant n79 20 4; e2 29 0
153230 e3 blødt drej ind på ny linie e3-e2

E3-E2
1535 on line
154020 st 14748.8 g 14748.0
163150 st 14749.2 g 14748.4
1713 eol
slew st 21
1715 st 14784.6 g 14784.0 !!! 0.6diff

E2 - NRD
171720 torq off/on bu
171800 st on
173410 st 14858.7 g 14858.2
1801 eol bc st off
slew st to 14717.5
1804 on ground
181250 platform dumped
1814 restart ultrasys bc st off
1830 on bloc bu st on
P ved garage
1912 baseread 14717.7 14718.3 .1 -4 (?.4?) .9
g 14717.1 !! Sync passer ikke !! check rf
from lcr-file:
114 191238 14717.80 14718.32 .04 5.5
baserd 14716.6 avo

25-04-2001 NORD - LYR RUTE C

0635 ultrasys startet
0703 start taxi, slew 14544
0706 take off
0720 st sync pc 584.1 g 583.2
0802 clamp turn
0806 level, unclamp
0807 st on, st pc 751.3 g 750.6
0857 insdisk full
0913 ny ins fil, ikke restart
1020 blødt sving
iskant n 79 24' e? 4 05' tåge
1030 sync pc 402.9 g 402.0
1040 grreenwood gyro temp 24.7
1109 eol, clamp slew to 14612 (basereading)
1141 landing lyr
1250 basereading pc 14611.7 g 14610.9
611.4 1411.7 0 -9 -.5
basereading s-ende af apron
14611.4 14611.7 0 -9 -.5 from lcr-file
baserd 14610.6 avo

LYR - NRD rute g
1307 start taxi
1309 take off slew 14638
1322 skyer, ingen laser
>1342 unclamp, on line
1343 st on press 21.9
st sync pc 746.6 g 745.8
1347 egi stop logging blended
iskant N79 00'; 0 46'
1502 blødt sving, g2, st off
1503 st on
1515 st sync ok + 0.8
is
152230 ny is åbent
152300 lidt ældre is
152500 åben rende
1530 åben rende 10 sec.
1558 store flager med nyis/render
1637 eol clamp
slew to 14717
sync pc 14717.1 g 14716.2 ok
1653 fastis grænse
1710 jonas stunt: platformed dumped!
basereading foran garage med t. punkt
pc 14718.4 0 -6 -0.6
g 14717.6
from file 14717.77 14718.43
baserd 14717.0

26-04-2001 NRD - A2 - A1 - C1 - C3 - NRD

0800ca ultrasys start
0850ca off bloc
0908 take off
0910 slew st 14534
091100 scanner start
091220 torq off/on bu
091340 st on
092340 st 14640.7 g 14640.0
092530 st 14654.8 g 14654.0
100720 st 14631.3 g 14630.6
1008 eol bc st off
blødt drej mod a1

A2-A1
101030 torq off/on
101050 slew st +120

1011 bu
101140 st on
103740 st 14734.3 g 14733.5
110300 st 14817.9 g 14817.1
1147 eol bc st off

C1 - C2
SLEW st -105
1150 st 14697.0 g 14696.3
115710 torq off/on bu
115800 st on
123900 scanner restart, ingen laser
125120 st 14668.4 g 14667.6
laser OK
132300 st 14726.4 g 14725.6
140100 st 14663.5 g 14662.6
1404ca eol svag drej mod c2 - nrd

C2-NRD
140630 bu
1407 bc slew st +166
140800 bu
140820 st on
141200 ny scannerfil startet, gl. fil lukket ca.1406
141700 st 14731.8 g 14731.0
150640 bc st off eol
1508 on ground
1513 on fuel apron, ultrasys end
1518 ultrasys restart
1520 slew 14478
1545 power fail, reboot, kortslutning i 220v
pga ledning i stol !!!!
1559 take off
1602 level, unclamp
1631 f2 clamp slew 14689
1636/37 level, unclamp, st on
pc 14747.5 g 746.5
1640 start scan i grl2001
1658 start logging skyer
1701 startet igen (skyer), lukket 75 mb
1709 start igen - mest tåge
1715 stop
1720 start igen, skyer, stop, lav tåge
1726 start ude af tåge
1754 eol clamp, slew 14578
1758 new scan file
1805 on line, unclamp, st on
sync pc 655.5 g 654.5
1902 tåge starter
1906 stop logging
icing
1930 start logging
1935 greenwood temp 25.8, ude af tåge
1952 eol, climb scanner test, clamp slew 14717,
max scanner ca. 500 (krk i sfj 525 m)
flyvning til nord i 1500 ft
2015 descend
2018 on ground
2047 start base reading
2106 st pc 14716.9 g 14716.0
2141 st pc 14717.9 g 14717.0
dg 14717.8 cc 0 rb -7 tc -0.4 bc
file 116 214225 14717.83 14717.91 .00 12.1
baserd 14716.9

April 27

2138 basereading
14717.6 14717.5 .0 -8. -.1
dial 14716.6
baserd 14716.7 avo

April 28 – Tobias Ø flight

0919 airborne
0919 første scan fil
0957 stiger til 1600 m
095830 lukker scanner
100300 T2 ny scanner fil
1007 tåge under os
1008 tåge væk
102915 ind over isen
1031 land igen
1034 iskrystaller ved 150 m (out of range)
1038 lukket fil
103901 ny scanner fil, lukket
104100 ny scanner fil, ok
104240 79 fjord
105115 T3
110020 T4
111425 T5 tåge ingen laser/scanner
1400 start tobias
computer down
1408 ny Tobias
1437 nyis
1452 ny fil
1509 luk, oven på skyer
1516 ny fil, kPCL ???
154615 T7
1620 over rullebanen
1623 on ground

April 30

1707 basereading
14609.6 14609.3 .0 -6. .4
dial 14609.5
basereading=14609.8

May 01
LYR-H2-H1-I1-I2-LYR

0738 take off. slew 14666, sync ok
0747 bu, H2
0813 scanner on
0825 sync ok
1014 st off, bc, H1
slew -404, sync ok
1028 bu
1029 st on
1031 sync ok
1252 scanner off
1254 bc, I1
1318 landed
1451 basereading
14609.2 14609.1 .0 2. -.1
dial 14609.5
baserd 14609.6

May 02

1300 basereading
14608.8 14608.6 .0 8. -.1
dial 14609.2
baserd 14609.4

May 03
LYR-J2-J1-K1-K2-LYR

0729 take off, slew 14653, sync ok
0800 BU, J2, dial96.8 pc96.6
0809 scanner on
scanner log stopped for appr 10 min

0822 logging again, appr
0851 dial91.8 pc91.6
0920 scanner pc stopped
0925 INS start logging, sorry forgot it at start up
0929 scanner start log
1000 dial27.9 pc27.7
1008 eol, st off, BC
slew -421
dial84.2 pc83.9
1019 BU
1020 st on
1023 new scanner file
1031 dial14.8 pc14.7
1242 dial25.4 pc 25.3
1254 bc, K1
1255 scanner off
1337 landed
1601 basereading
14608.3 14608.4 .0 9. -.2
dial 14608.6
baserd 14608.5
very windy

May 04

0950 take off
1004 bu, XX-L2
1032 bc, slew 208
1037 bu, L2, sync ok
1041 scanner log
1109 sync ok
1128 sync ok
1145? INS PC dead
1200 new scanner file
1211 INS PC restarted logging
1212 sync ok
1244 sync ok
1337 sync ok
1412 bc, L3, sync ok
1414 scan log ended
1423 landed DMH

1523 take off, slew 14210, sync ok
1531 bu
1535 scanner start log
1549 sync ok
1713 scan log ended
1715 new scan file
1806 sync ok
???? scan disk full, no more scanning
1841 sync ok
1856 bc, M2
slew 212, sync ok
1859 bu, M2-XX
1945 Bc, XX, sync ok
2002 landed

May 05
LYR-F5-F4-F3-F2-NRD

0514 take off, slew 14644, sync ok
0543 bu, F5
0538 scanner logging
0707 sync ok
0734 bc, F4, slew –288, sync ok
0737 stop scanner log
0739 bu, F4
0751 new scanner file
0843 sync ok
0848 bc, F3, slew 169
0849 bu, F3. scan log stop
0853 new scan file
0921 sync ok
1021 bc, F2, slew 37
1023 bu ,F2, sync ok
1049 stop scan
1056 bc, NRD
1059 landed NRD
1132 basereading started
1215 14715.1 14715.0 .0 4. .1
dial 14715.0
baserd 14715.1

1244 take off
1248 bu, NRD sync ok
1325 sync ok, bc, A2
1359 bu, A2, sync ok
1501 sync ok
1546 BC, A3, slew 67
1548 bu, A3,
1632 sync ok
1636 bc, A4
1706 landed LYR
1718 baseread started
1757 14609.1 14609.1 .0 -5. .2
dial 14609.1
baserd 14609.1

May 06
basereading
0731 14608.7 14608.7 .0 2.0 .0
dial 14609.0
baserd 14609.0

May 07

0702 take off, slew 14645, sync ok
0705 bu, O3,
0708 scan log started, 8 sec late
0713 sync ok
0820 new scan file
EGI-INS logging stopped just after start
0825 new INS file
0928 bc, O1
0931 bu, O1
0935 new scan file named 05070934.2dd
1130 bc, O2
1131 bu, O2
1231 bc, XX
1238 new scan file
1247 pass over hotel, 500 ft
1251 pass over hotel, 500ft
1254 landed
1404 basereading
14608.1 14607.7 .0 2. .4
dial 14607.7
baserd 14608.1

May 09
LYR-O3-P1-P2-XX-LYR

0648 take off
0651 bu, O3, pc37.9 dial38.0
0700 new scanner file
started 15 sec late
0754 new scanner file
0755 pc58.7 dial58.8
0908 bc, P1,
0910 bu, pc67.4 dial67.5
0918 new scanner file
1037 pc77.8 dial78.0
1046 bc, P2

1047 bu, pc75.2 dila 75.3
1054 new scanner file
1201 bc, XX
1202 bu
1205 new scanner file
1216 bc, O3
121745 runway pass, 500 ft
1224 landed
1333 basereading
14608.4 14608.3 .0 7. .3
dial 14608.4
baserd 14608.5

MAY 10
LYR-O3-XX-N2-N1-N3-DMH

INS not aligned
0823 take off
0828 bu, O3, sync ok
0831 new scan file
15 sec late
0836 bc XX, slew -148
0837 bu, XX, sync ok
0841 AIR2 stopped, started again
0992 bc, N2
0923 bu, N2, pc49.5 dial49.4
1008 sync ok
1010 new scan file 15 sec late
1141 new scan file
1226 sync ok
1306 sync ok
1313 bc, N3
1317 scanner stopped
1330 landed DMH

1335 start baserd
1420 14588.8 14588.2 .0 -2. .6
dial 14588.2
baserd 14588.8
INS won't start
1440 take off DMH
slew 13492
sync ok
1500 bu, DMH, 11000 ft
1600 sync ok
1621 ultrasys stopped logging, gyro no spin
1715 turn off/on power to platform, restart prg
1722 bc, CNP, 11000 ft
1738 landed, CNP
basereading
1835 14259.0 14258.7 .0 -7 .5
dial 14258.7
baserd 14259.0

no INS
1844 take off
slew 13352
sync ok
1911 bu, CNP, 12000 ft
1953 sync OK
2044 sync ok
2140 sync ok
2257 sync ok
0000 bc, SFJ 12000 ft
0019 landed SFJ

May 11
basereading
0114 14013.2 14013.1 .0 -2. .0
dial 14013.1
baserd 14013.2

GPS STATION: LYR1

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 78 14 51.0512 N
15 29 47.5481 E

Elevation (m): 53.876 ell.

Monumentation: none

GPS point on Norsk Polar Institute buildning, Longyearbyen, Svalbard.
Occupied 1999

See photo.

GPS STATION: LYR2

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

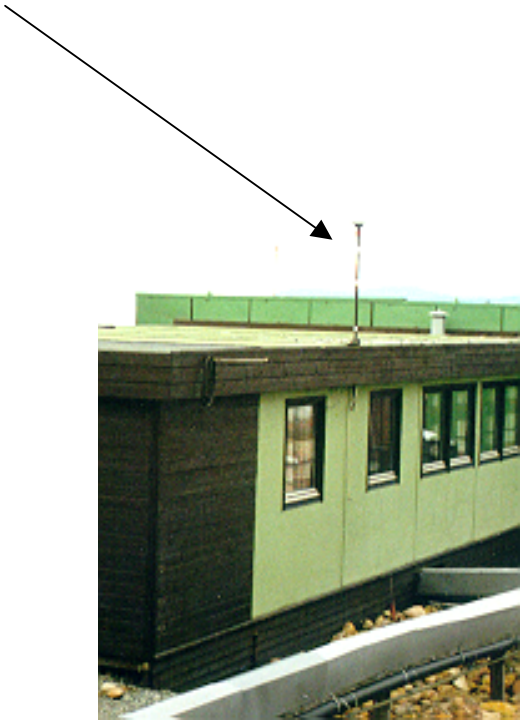
Coordinates (° ' "): 78 14 50.6485 N
15 29 50.1992 E

Elevation (m): 55.050 ell.

Monumentation: none

GPS point on Norsk Polar Institute buildning, Longyearbyen, Svalbard.
Occupied 1999

See photo.



GPS STATION: LYR3

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 78 13 51.6503 N
15 22 51.2544 E

Elevation (m): 486.436 ell.

Monumentation: none

GPS point on Tableau Fjeld, Longyearbyen, Svalbard.
Occupied 1999

See photo.

GPS STATION: 1001

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 81 36 1.4627 N
16 39 19.5929 W

Elevation (m): 68.383 ell.

Monumentation: Astro pillar

KMS point, Station Nord, Greenland.

Occupied: 1999

See photo:

GPS STATION: NORD

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 81 35 49.7624 N
16 39 24.8695 W

Elevation (m): 66.853 ell.

Monumentation: none

GPS point on lodging hut at apron, Station Nord, Greenland.
Occupied 1999

GPS STATION: DMH1

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 76 46 9.7815 N
18 40 5.5447 W

Elevation (m): 47.360 ell.

Monumentation: none

GPS point, Danmarkshavn, Greenland.
Occupied 1999

See photo:

GPS STATION: DMH2

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 76 46 13.4201 N
18 39 29.2062 W

Elevation (m): 53.385 ell.

Monumentation: none

GPS point, Danmarkshavn, Greenland.
Occcupied 1999

See photo:

GPS STATION: CNP1-99

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 70 44 40.2387 N
22 38 53.4770 W

Elevation (m): 70.709 ell.

Monumentation: none

GPS point from the 1999 Greenland campaign, Constable Pynt, Greenland.
Occupied: 1999 and 2000

See photo:

GPS STATION: CNP2

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 70 44 23.9361 N
22 38 27.5040 W

Elevation (m): 57.304 ell.

Monumentation: none

GPS point, Constable Pynt, Greenland.
Occupied 1999

See photo:

GPS STATION: SFJ1

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 67 00 21.6516 N
50 42 09.6756 W

Elevation (m): 72.04 ell.

Monumentation: none

GPS point on former meteorological hut, Kangerlussuaq, Greenland.
Occupied 2000 and 2001

See photo.

GPS STATION: UAKT

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 61 09 26.5109 N
45 26 26.2120 W

Elevation (m): 44.84 ell.

Monumentation:

KMS GPS point, Narsarsuaq, Greenland.
Occupied 2000

See photo:

GPS STATION: UAKJ

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 61 09 25.8950 N
45 26 23.6382 W

Elevation (m): 44.83 ell.

Monumentation:

GPS point, Narsarsuaq, Greenland.
Occupied 2000

See photo:

GPS STATION: THU0

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 76 32 16.5087 N
68 47 47.9490 W

Elevation (m): 43.01 ell.

Monumentation: None

GPS point, Thule Air Base, Greenland.
Occupied 2000

See photo:

GPS STATION: KUS1

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

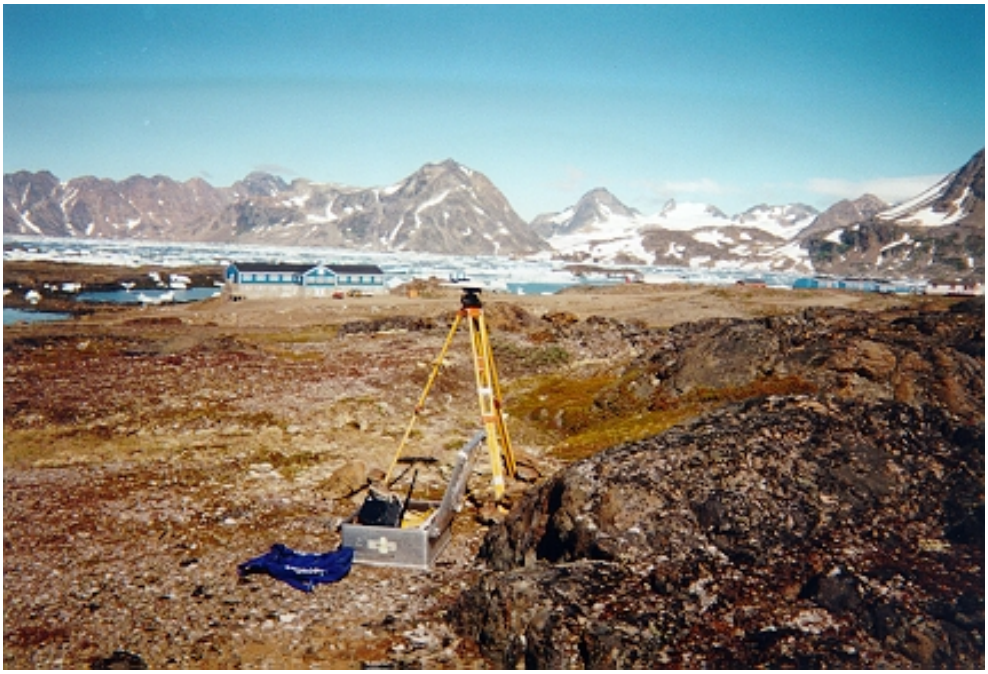
Coordinates (° ' "): 65 34 36.9215 N
37 09 01.3379 W

Elevation (m): 74.42 ell.

Monumentation: None

GPS point, Kulusuk, Greenland.
Occupied 2000

See photo:



GPS STATION: JQA1

Kort & Matrikelstyrelsen
National Survey and Cadastre - Denmark

Coordinates (° ' "): 70 44 03.7276 N
52 41 36.6401 W

Elevation (m): 112.26 ell.

Monumentation: None

GPS point, Qaarsut, Greenland.
Occupied 2000

See photo:

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