Block AS03 (Alaska South 03)

GRAV-D Airborne Data Release User Manual

Applies to Data Release BETA, 1/2013

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Introduction to GRAV-D and Data User Manuals

NOAA's National Geodetic Survey (NGS) launched the Gravity for the Redefinition of the American Vertical Datum (GRAV-D) program in 2007. This program is designed to replace the current national vertical datum (NAVD 88) with a datum based upon a gravimetric geoid by 2022. To produce the geoid with 1-2 cm accuracy (where possible), an airborne campaign has been launched to measure the gravity field over all of the US and its holdings.

A more comprehensive description of the GRAV-D project is available in the "GRAV-D General Airborne Gravity Data User Manual." The version of that manual that applies to this release is manual v. 1.X. That manual also describes general details of the nominal airborne field operations, data post-processing software specifics, data naming schemes and distribution, data formats, and how to calculate other commonly-used gravity values from the released data. This manual relates details for this block of data that are in addition to the General User Manual.

GRAV-D uses some specific terminology (e.g. "block" for a geographic area with enough flown data and tie lines to provide error statistics, and "survey" for an occupation by the field team of a particular airport, at a particular time, and with a particular aircraft and instrument suite). For a full list of terminology, refer to the Glossary in the Appendices of the "GRAV-D General Airborne Gravity Data User Manual."

Contents

Figure List

Table List

1. Block Description

GRAV-D Block **AS03** is located in the **A**laska Time Zone, in the **S**outh half (south of 63° latitude). This was the third (**03**) block of data completed in that region. Block AS03 is 480 km by 570 km, covering coastal areas of Alaska and ocean areas from 0 to 125 km offshore (Figure 1). The corner coordinates defining Block AS03 are listed in Table 1.

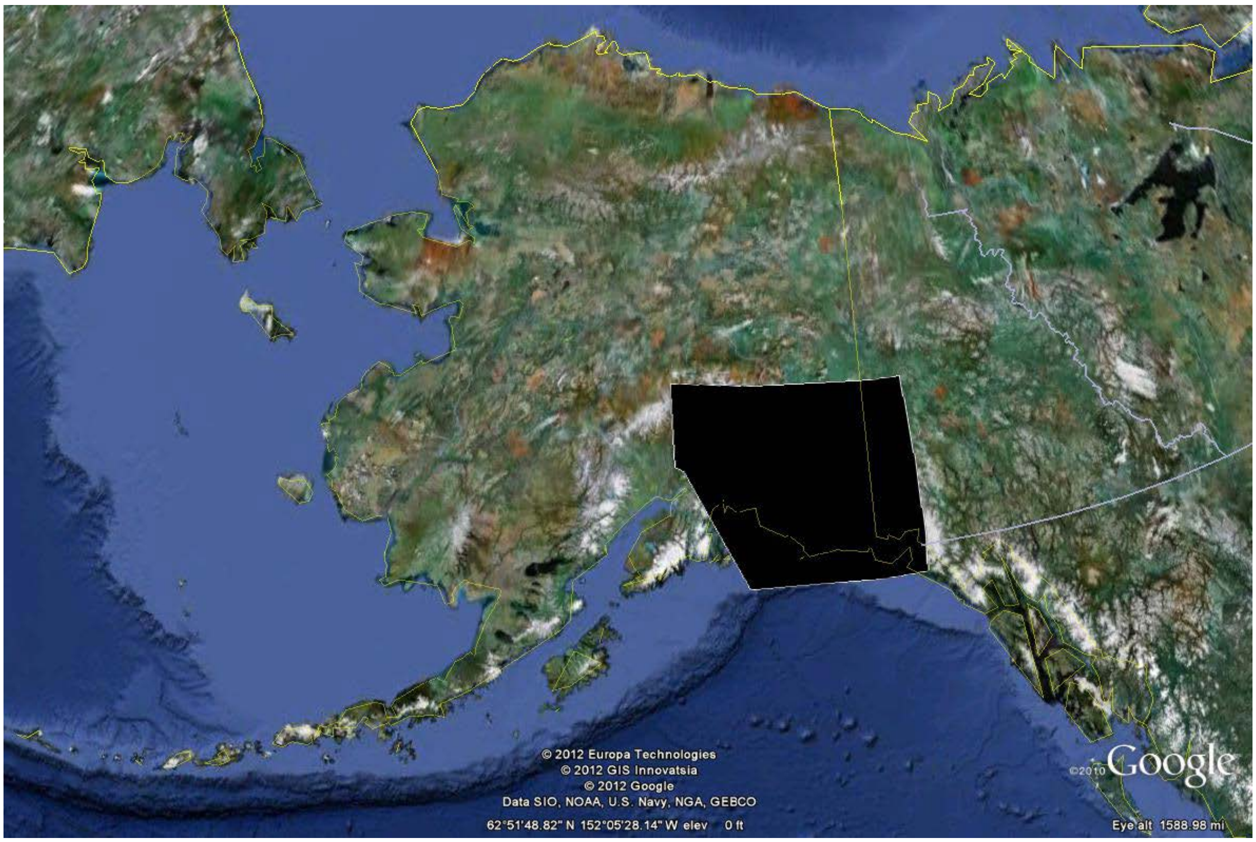


Figure 1: Google Earth Image of the Location of Block AS03 (black rectangle).

Table 1: Latitude and Longitude Coordinates of Corner Points Defining Block AS03

Latitude (decimal degrees)	Longitude (decimal degrees)
63.696343071	-150.041878943
61.909938741	-149.887270399
61.834111998	-149.511391176
59.321091054	-146.529938282
59.368585117	-138.945480370
63.696343071	-138.797577280

2. Survey Design and Execution

Airborne gravity data in Block AS03 were collected during two surveys: AK10-1 (Alaska 2010, first occupation) and AK10-3 (Alaska 2010, third occupation). All data and cross flights were done at 20,000 ft with the same aircraft and instrument suite. Supplementary data from transit (target of opportunity) flights may be made available at a future date. Table 2, Table 3, and Table 4 give a synopsis of survey layout and execution for the data. Figure 2: shows the data coverage, plotted in Google Earth.

In the AS03 all data lines are East-West and cross lines North-South. The block consists of 39 data lines, 10 cross lines from AK10-1; 2 data lines, 8 cross lines from AK10-2; 11 data lines and 0 cross lines from AK10-3; and 7 cross lines from AK12. The usual line numbering scheme used by GRAV-D (see "General User Manual") was used for this survey. In the data file, line numbers are preceded by the block name (i.e. AS03101= block AS03's line 101).

Table 2: Survey Overview (AK10-1/AK10-2/AK10-3/AK12)

Conducting Organization	NOAA- National Geodetic Survey	
Survey Name	AK10-1	AK10-2
Airport Base of Operations	Ted Stevens Anchorage International Airport (ANC) Anchorage, AK FBO: Penn Air	Fort Wainwright Airport (FBK) Fairbanks, AK FBO: Alaska Fire Service
Geographic Location	Southern Alaska	
Dates of Airborne Operations	Jun. 27 – Aug. 26th, 2010	Sep. 18 – Oct. 24th, 2010

Survey Name	AK10-3	AK12
Airport Base of Operations	Ted Stevens Anchorage International Airport (ANC) Anchorage, AK FBO: MillionAir	1. Fort Wainwright Airport (FBK) Fairbanks, AK FBO: Alaska Fire Service 2. Ted Stevens Anchorage International Airport (ANC) Anchorage, AK FBO: MillionAir
Geographic Location	Southern Alaska	
Dates of Airborne Operations	Nov. 9 – Nov. 14th, 2010	Oct. 9 – Oct. 29th, 2012

Table 3: Aircraft and Instrumentation

Aircraft	NOAA Turbo Commander (N45RF) (AK10-1)
Engines, number and type	2, Jet
Gravity Instrumentation	Micro-g LaCoste (MGL) TAGS S-137 (relative) MGL FG-5 102 (absolute) MGL G-81 and D-17 (relative)
GPS Instrumentation	NovAtel DL-4 Plus Applanix POS AV 510 (GPS + IMU)

Aircraft	BLM Pilatus PC-12 (N190PE) (AK10-2, AK10-3, AK12)
Engines, number and type	1, Propeller
Gravity Instrumentation	Micro-g LaCoste (MGL) TAGS S-137 (relative) MGL FG-5 102 (absolute) MGL G-81 and D-17 (relative)
GPS Instrumentation	NovAtel DL-4 Plus Applanix POS AV 510 (GPS + IMU) NovAtel SPAN-SE with Honeywell µIRS (GPS + IMU) (AK12 only)

Table 4: Survey Design and Execution

Line Spacing	Data Lines: 10 km Cross Lines: ~80 km
Type of Layout	Regular data lines & regular cross lines
Nominal Survey Altitude	20,000 ft
Nominal Aircraft Ground Speed	250 knots
Number of Lines Released	Data Lines: 34 (AK10-1), 2 (AK10-2), 11 (AK10-3) Cross Lines: 10 (AK10-1), 8 (AK10-2), 7 (AK12) Repeat Lines: 0
Number of Crossovers	470

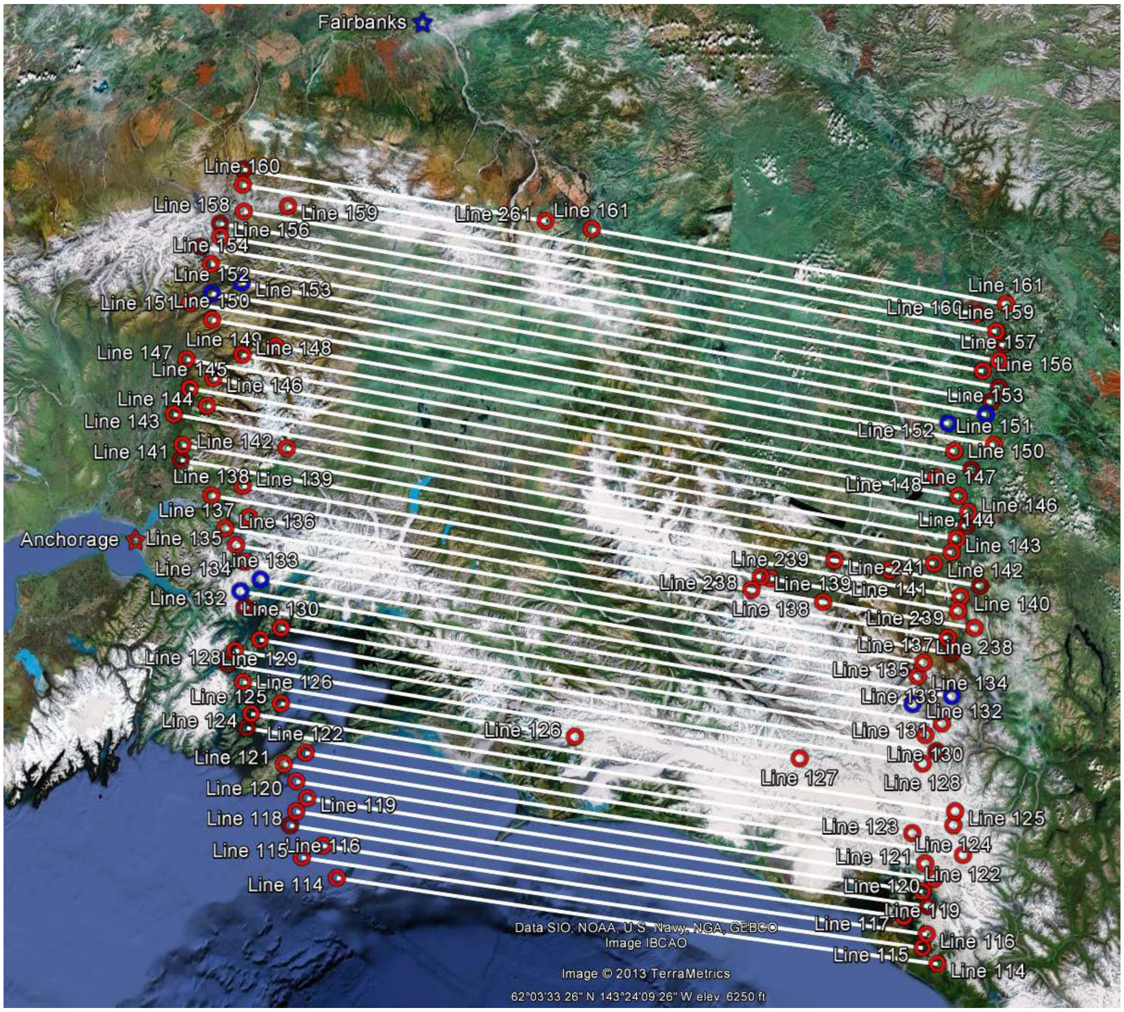


Figure 2: Data Coverage for AS03. Data lines start in the south and range from 114 to 161 (AK10-1, AK10-3, AK12, red from Ted Stevens Anchorage International Airport and AK10-2, AK12 blue from Fort Wainwright Airport in Fairbanks, AK). Airports marked with stars.

2.1 GPS/IMU Instrumentation

The NOAA Turbo Commander and BLM Pilatus PC-12 both had one GPS antenna available for scientific measurements. Three geodetic-quality GPS receivers shared the antenna: two NovAtel DL-4 Plus (included as part of the TAGS gravimeter timing unit) and a Trimble (inside the Applanix POS AV 510 system). The NovAtels had a data rate of 1 Hz and the Trimble of 10Hz. The Applanix POS AV 510 system also contained an Inertial Measurement Unit (IMU) that recorded aircraft orientation information at 200 Hz during the flight, including pitch, roll, yaw, and heading.

On the ground, three Ashtech Z-Surveyor recorded at 1 Hz served as GPS base stations throughout the survey. See Section 3.2.1 for a table of GPS data available for each flight and processing details.

2.2 Gravity Instrumentation

The Micro-g LaCoste TAGS (Turn-key Airborne Gravimetry System) was mounted in the cargo area of the Cessna Citation. The TAGS records data at 1Hz and has a NovAtel timing unit mounted on the gravimeter. The gravimeter also records an environmental file at 0.1 Hz. For more information on the instrument, refer to its user manual (Micro-g LaCoste, 2010).

For both the NOAA Turbo Commander the BLM Pilatus PC-12 the TAGS was mounted to the seat tracks in the center of the fuselage.. The IMU was mounted on top of the TAGS and in the center of the frame. Table 5 and Table 6 lists the lever arm measurements between the TAGS and other instruments (distances are measured along the body of the aircraft: X positive toward the nose, Y positive toward the right, and Z positive down.)

Table 5: Lever Arm Measurements FROM the Center of the Gravimeter's Sensor TO the Other Instruments, for this Installation on the NOAA Turbo Commander

Instrument/Location	X (m)	Y (m)	Z (m)
Aircraft Center of Gravity	0.00	0.00	-0.56
Aircraft GPS Antenna	0.16	0.13	-1.25
Applanix POS AV 510 IMU	0.03	0.00	-0.50

Table 6: Lever Arm Measurements FROM the Center of the Gravimeter's Sensor TO the Other Instruments , for this Installation on the BLM Pilatus PC-12

Instrument/Location	X (m)	Y (m)	Z (m)
Aircraft Center of Gravity	0.27	0.00	0.40
Aircraft GPS Antenna (Front)	0.73	0.03	-1.18
Applanix POS AV 510 IMU	0.03	0.00	-0.50

3. GPS and Gravity Data Processing

3.1 Whole-Survey Applicable Details

3.1.1 GPS

Table 7: GPS High Rate Data Availability (1 Hz or higher) During 20,000 ft Data Collection

Airport	Type	Receiver	Flight Available	2009 Day of Year Available
ANC AK10-1	Kinematic	NovAtel (0009)	F04-f11,f13-f15,f17,f19	178,180,189-191,195-198,201
		NovAtel (0013)	F20-f26,f29-f30,f33	202-203.207,209-210,213,215
		Trimble (mgps)	F03-f11,f13-f15,f17,f19-26,f29-f30,f33	178-180,189-131,195-198,201-203,207,209-210,213,215
	Static	Ashtech ALL1	F03-f05	178-180
		Ashtech PENN	F06-f11,f13-f15,f17,f19-f21,f23-f26,f33	189-191,195-198,201-203.209-210,215
		Ashtech NOR1	F03-f04,f08-f10,f13-f15,f17,f19-f26,f29-f30,f33	178,190-191,196-198,201-203,207,209-210,213,215
		Ashtech SOU1	F05-f10,f13-f15,f17,f19-f26,f29-f30,f33	180,189-131,196-198,201-203,207,209-210,213,215
FBK AK10-2	Kinematic	NovAtel (0013)	F03,f06,f20,f24,f25	261,271,291,297,298
		Trimble (mgps)	F03,f06,f20,f24,f25	261,271,291,297,298
	Static	Ashtech East	F03,f06,f20,f24,f25	261,271,291,297,298
		Ashtech User	F03,f06,f20,f24,f25	261,271,291,297,298
		Ashtech West	F03,f06,f20,f24,f25	261,271,291,297,298
ANC AK10-3	Kinematic	NovAtel (0013)	F01-f02,f04-f06	313-314,316-318
		Trimble (mgps)	F01-f02,f05-f06	313-314,317-318
	Static	Ashtech Curly	F01-f02,f04-f06	313-314,316-318
		Ashtech Larry	F01-f02,f04-f06	313-314,316-318
		Ashtech Moe	F01-f02,f04-f06	313-314,316-318
ANC AK12-1	Kinematic	NovAtel (SPAN)	F01-f05	312-316
		NovAtel (0016)	F01-f05	312-316
	Static	Ashtech 3552	F01-f05	312-316
		Ashtech 3812	F01-f05	312-316

Table 8: NGS GPS Base Station Position(s)

Airport	Base Name	Antenna Type	Latitude (dec deg)	Longitude (dec deg)	Ellipsoidal Height (m)
ANC AK10-1	ALL1	ASH701975.01A	61.197950493	-149.9928743	35.277
	PENN	ASH701975.01A	61.198506386	-149.9989115	46.485
	NOR1	ASH701975.01A	61.202181640	-150.0128334	58.319
	SOU1	ASH701975.01A	61.201282658	-150.0116705	57.773
FBK AK10-2	User	ASH701975.01A	64.841885552	-147.58973806	23.057
	East	ASH701975.01A	64.839318747	-147.58756046	21.547

	West	ASH701975.01A	64.839576342	147.58813172	149.468
ANC AK10-3	Curly	ASH701975.01A	61.165914182	-149.82921993	43.658
	Larry	ASH701975.01A	61.165896668	-149.98315753	43.757
	Moe	ASH701975.01A	611657303842	-149.98283966	45.73
ANC AK12-1	3552	ASH701975.01A	61.165911319	-149.98291825	43.743
	3812	ASH701975.01A	61.159277801	-149.97196217	59.715

After post-processing the GPS-only kinematic data (before processing with coupled IMU), average position accuracy for the data block is calculated. Position standard deviation is estimated by the GPS processing programs for each flight and those numbers are averaged to provide a survey-wide estimate of GPS position accuracy. For the data lines, the average horizontal position accuracy is 0.021 m and the average vertical position accuracy is 0.024 m.

3.1.2 Ground Gravity Tie

Updated absolute gravity measurements were performed by NGS with a Micro-g LaCoste A-10 gravimeter in May of 2011. At both airports the A-10 was set up at the exact location of the aircraft. The positions were determed from the GPS collected during the gravity survey while the plane was parked. In Fairbanks, AK the location is designated as FBK TAGS (64.83982°N, -147.598283°W) and it has an absolute gravity value of 982229.157 ± 0.008 mGal at 163.7 cm above the tarmac. In Anchorage, AK the two measurements were taken, one for each aircraft. For the Turbo Commander (AK10-1) the location is designated as PENN TAGS () and it has an absolute gravity value of 981903.3548 ± 0.008 mGal at 80.6 cm above the tarmac. For the Pilatus PC-12 (used for AK10-2, AK10-3, AK12) the location is designated as MILL TAGS (61.164039833°N, 149.981590028°W) and it has an absolute gravity value of 981905.646 ± 0.009 mGal at 163.7 cm above the tarmac.

3.1.3 Gravity Filtering

For block AS03, flights were accomplished two surveys and were filtered the same way. Newton v1.2 uses a time-domain Gaussian filter that is applied three times to the data during final filtering. The Gaussian filter chosen for this survey has a 6-sigma of 120s, i.e. a 2-sigma of only 40s. Applying the filter three times provides superior noise reduction compared to a single application of the filter. Although the triple application provides better noise reduction, the filter is tailored to best preserve the amplitudes of the long wavelength signal, while allowing some short wavelength noise to remain in the final product. For suggestions on data handling, including on further noise suppression, see Section 4.1 Suggested Data Handling.

3.2 Whole-Block Applicable Details

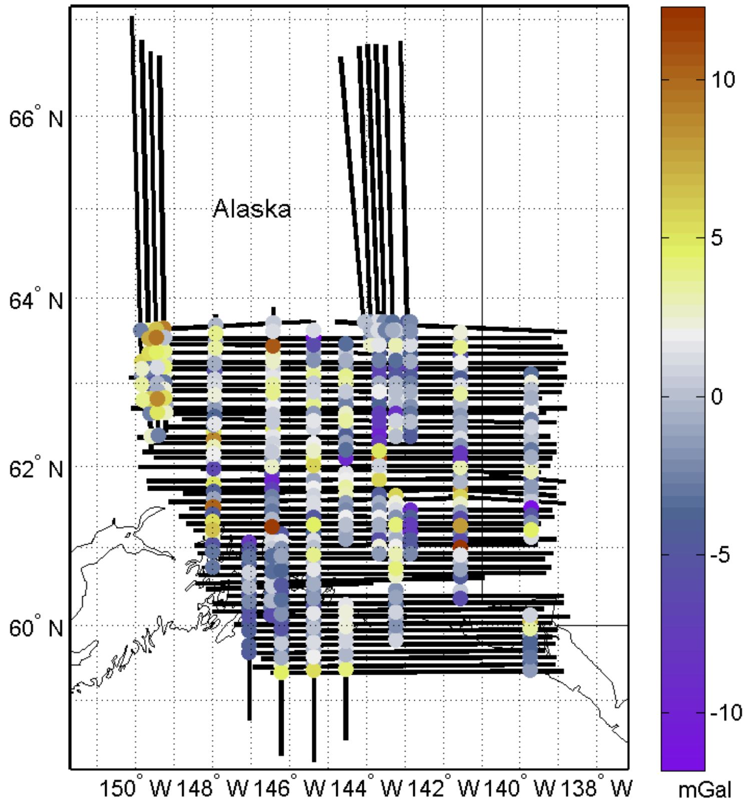
3.2.1 Gravity Error Analysis

Crossover error analysis was done by identifying the crossing points of the data lines and cross lines and then applying the standard free-air correction to bring all points to the average altitude of the block. There was an unidentified bias in all flight lines, so an additional correction was applied before the crossover analysis to adjust each line's median airborne gravity value to the median gravity value of EGM08 along the line. The bias-corrected difference between the cross line gravity value and data line gravity value is the residual. The square root of the RMS of the residuals yields the total RMS error. For AS03, the result of the crossover analysis is shown in Table 9 and in Figure 3.

Table 9: Gravity Crossover Error Analysis for the AS03 block

Nominal Altitude (ft)	Nominal Altitude (m)	Altitude for Analysis (m)	Number of Crossovers	RMS Of Residuals (mGal)	Std. Dev. Of Residuals (mGal)	Mean Crossover Difference (mgal)	RMS Error (mGal)
20,000	6,096	6616	470	3.80	3.80	-0.22	2.69

One assumption of crossover analysis is that the quality of the cross lines are high and that the crossover difference reflects only the error in the data lines. This is not necessarily the case. This means that the crossover statistics do not accurately reflect the quality of the data lines, due to the errors in the cross lines. One way to quantify this problem is by reporting the standard deviation and mean of the crossover residuals for each cross line, as in Table 10. The higher the standard deviation of the residuals, the more likely that the cross line was noisy. Also, a non-zero mean could indicate a cross-line bias with respect to the data lines (unlikely here because of the bias correction applied), which would produce false crossover statistics that indicate poor data line quality.



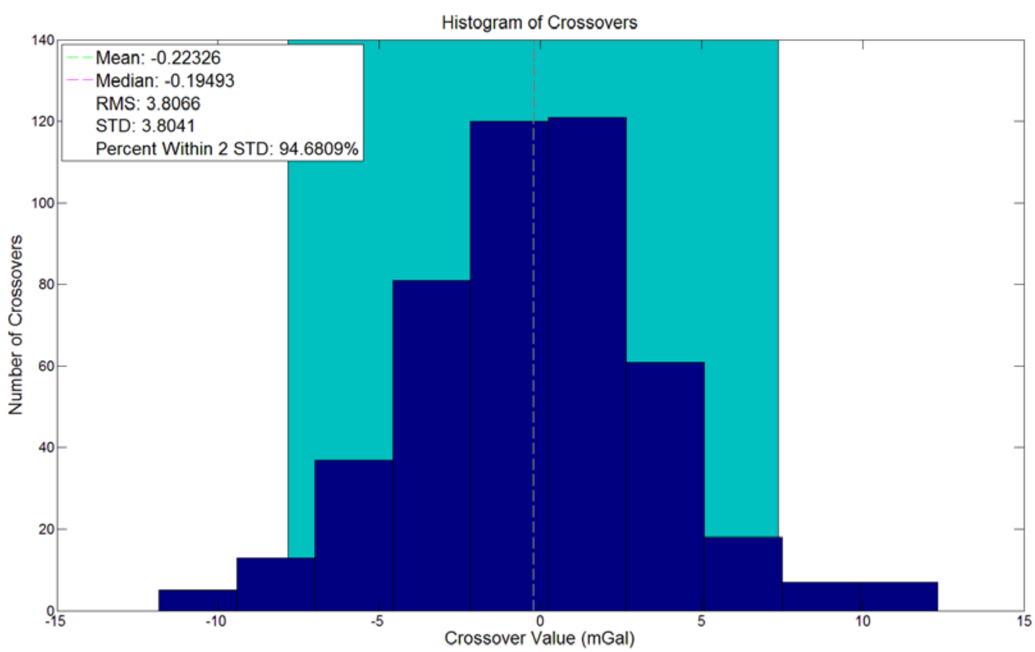


Figure 3: Crossover Residuals, Histogram, and Statistics for Block AS03. Color scale in mGals.

Table 10: Quality of Cross Lines Used in Crossover Analysis

Cross Line Number	Standard Deviation of Residuals Along Line (mGal)	Mean of Residuals Along Line (mGal)
501	4.08	0.81
502	4.03	0.19
504	2.07	-3.61
505	2.73	-1.97
506	2.39	-0.01
507	1.16	1.68
508	2.97	0.08
509	1.64	-2.46
510	3.36	-0.83
511	0.15	-2.46
512	0.52	0.99
513	2.62	-0.66
514	0.00	-4.29
525	3.38	1.87
526	3.99	1.47
527	4.60	2.45
528	3.27	2.45
532	3.56	0.44
533	2.95	-0.27
534	4.69	-1.69
535	2.80	-3.34
605	0.00	0.23
609	4.50	0.03
701	3.68	0.20
702	4.18	0.28

Another way to evaluate the quality of gravity data is to calculate the correlation of the gravity values along two adjacent data lines. Average correlation and statistics on the spread of correlations can yield information about the quality of the data lines (Table 11) This technique works well as a measure of data quality in areas with little lateral variability in the gravity field (such as the Gulf of Mexico). But the technique doesn’t work well when the correlations are not expected to be high, such as in areas with large changes in topography and/or density from data line to data line. Line correlations were calculated for adjacent lines and then averaged to give an overall quality measurement. Correlations > 80% mean the lines are very highly correlated, 70% - 80% mean the lines are highly correlated, 50% - 70% mean the lines are more correlated than not, and <50% are more uncorrelated than correlated.

Table 11: Average Data Line Correlation

Number of Correlations	Average Data Line Correlation	Standard Deviation of Correlations
44	86.84%	9.96%

A fourth way of gauging data quality is by calculating the repeatability of the gravity signal along reflown lines of good quality. Reflight analysis can also help to pinpoint the lightest filtering that produces highly-correlated results. In AS03, however, there were no reflown lines.

3.3 Flight- and Line-Specific Details

3.3.1 GPS processing- by flight

As described in the "GRAV-D General Airborne Gravity Data User Manual", GPS data were processed in POSPac v.4.4 for GPS+IMU position solutions or in GrafNav v.7.80.2315 for GPS-only position solutions. Positions were always obtained as GPS+IMU loosely-coupled solutions if the IMU data were collected. A lever arm correction (to move the position solution from that of the GPS antenna to that of the center of the gravimeter) was applied within the POSPac software and included in the GPS+IMU solution. In the case of the GPS-only solution, no IMU data were available and a translation-only, vertical lever arm correction was instead applied by the Newton gravity code to translate the GPS-only positions to the center of the gravimeter.

NGS has developed an independent method of measuring the quality of GPS position solutions based on information available from both GrafNav and POSPac. For the GPS-only part of the position solution, the quality analysis takes into account the following: whether a fixed or float solution was achieved, the magnitude of the combined separation between forward and reverse solutions (a measure of precision), and the estimated position accuracy. For details on the calculation, please refer to the "GRAV-D General Airborne Gravity Data User Manual."

3.3.2 Gravity processing- by line

All gravity processing was done with NGS' Newton v1.2 software. For a description of the package, refer to the "GRAV-D General Airborne Gravity Data User Manual." The final gravity data file contains full-field gravity at altitude (Figure 5), although other gravity products such as free-air anomalies or free-air disturbances (Figure 6) can be easily calculated by following directions in Section 4 of the "GRAV-D General Airborne Gravity Data User Manual".

Table 12: GPS+IMU and GPS-only Kinematic Processing Results

Survey	Flight Num.	Base GPS Unit(s)	Rover GPS Unit	Solution Type	Elevation Mask (degrees)	Line Num.	NGS Quality Grade
AK10-1 ANC	03	NOR1	Trimble	GPS+IMU	8	130	84.00
						131	88.21
	04	NOR1	Trimble	GPS+IMU	8	128	85.57
						129	84.55
	05	ALL1	Trimble	GPS+IMU	8	134	89.69
						135	85.11
	06	SOU1	Trimble	GPS+IMU	8	132	87.36
						133	84.74
	07	SOU1	Trimble	GPS+IMU	8	136	89.35
						137	81.14
	08	NOR1	Trimble	GPS+IMU	10	144	87.69
						145	83.70
	09	NOR1	Trimble	GPS+IMU	9	142	87.85

						143	83.38
	10	SOU1	Trimble	GPS+IMU	8	148	84.00
						149	86.49
	11	PENN	Trimble	GPS+IMU	9	126	84.36
						127	74.23
	13	SOU1	Trimble	GPS+IMU	8	124	88.08
						125	82.86
	14	SOU1	Trimble	GPS+IMU	10	122	84.19
						123	82.90
	15	NOR1	Trimble	GPS+IMU	9	120	84.27
						121	81.00
	17	SOU1	Trimble	GPS+IMU	9	118	85.29
						119	78.25
	19	NOR1	Trimble	GPS+IMU	9	527	85.66
						528	84.77
	20	NOR1	Trimble	GPS+IMU	8	525	74.20
						526	78.92
	21	SOU1	Trimble	GPS+IMU	8	138	90.53
						139	87.33
	22	SOU1	Trimble	GPS+IMU	8	506	84.44
						507	84.00
	23	NOR1	Trimble	GPS+IMU	8	504	91.15
						505	88.52
	24	NOR1	Trimble	GPS+IMU	8	532	66.47
						533	71.85
	25	NOR1	Trimble	GPS+IMU	8	116	81.28
						117	76.79
	26	NOR1	Trimble	GPS+IMU	8	114	76.16
						115	26.06
	29	SOU1	Trimble	GPS+IMU	9	146	83.07
						147	81.13
	30	NOR1	Trimble	GPS+IMU	10	140	81.20
						141	59.65
	33	SOU1	Trimble	GPS+IMU	7	238*	70.00
						239*	75.63
						241*	75.80
AK10-2 FBK	03	East	Trimble	GPS+IMU	10	152	90.46
						153	80.87
	06	East	NovAtel	GPS Only	8	605*	97.82
	20	East	Trimble	GPS+IMU	9	512	100.00
						511	100.00
						509	100.00
	24	East	Trimble	GPS+IMU	11	534	100.00
						535	91.82
	25	East	Trimble	GPS+IMU	11	514	100.00
						513	100.00
AK10-3 ANC	01	Curly	Trimble	GPS+IMU	11	160	80.59
						161	72.79

	02	Larry	Trimble	GPS+IMU	11	158	100.00
						159	100.00
						261*	100.00
	04	Curly	NovAtel	GPS Only	8	156	97.82
						157	92.19
	05	Curly	Trimble	GPS+IMU	9	154	99.54
						155	100.00
	06	Curly	Trimble	GPS+IMU	9	150	99.53
						151	97.88
AK12-1 ANC	01	3552	SPAN	GPS+IMU	9	609*	100.00
	02	3552	SPAN	GPS+IMU	10	508	100.00
	03	3812	SPAN	GPS+IMU	8	510	100.00
	04	3552	SPAN	GPS+IMU	8	502	100.00
						501	100.00
	05	3552	SPAN	GPS+IMU	9	702*	100.00
						701*	100.00

**All 200, 600, and 700 lines were named to avoid duplication over multiple surveys and are not reflights of previous lines.*

Table 13: Gravity Processing Results

Survey	Flight Num.	Line Num.	Time of Deleted Data Section(s)	Comments
AK10-1 ANC	03	130	None	
		131	None	
	04	128	None	
		129	None	
	05	134	None	
		135	None	
	06	132	None	
		133	None	
	07	136	None	
		137	None	
	08	144	None	
		145	None	
	09	142	80441-80685	
		143	None	
	10	148	None	
		149	None	
	11	126	None	
		127	None	
	13	124	None	
		125	None	
	14	122	None	
		123	None	
	15	120	None	
		121	None	
	17	118	None	
		119	None	
	19	527	None	
		528	None	
	20	525	None	
		526	None	
	21	138	None	
		139	81164-81686	Spike Removed
	22	506	None	
		507	None	
	23	504	None	
		505	None	
	24	532	None	
		533	None	
	25	116	None	
		117	None	
	26	114	None	
		115	None	
	29	146	61180-61637	Spike

				Removed
		147	None	
	30	140	None	
		141	None	
	33	238	None	
		239	None	
		241	None	
AK10-2 FBK	03	152	None	
		153	None	
	06	605	None	
	20	512	None	
		511	None	
		509	None	
	24	534	None	
		535	80845-81520	Spike Removed
	25	514	None	
		513	None	
AK10-3 ANC	01	160	None	
		161	None	
	02	158	None	
		159	74874-75343	Spike Removed
		261	None	
	04	156	None	
		157	None	
	05	154	None	
		155	None	
	06	150	None	
		151	None	
AK12-1 ANC	01	609	None	
	02	508	87046-87607	Spike Removed
	03	510	81010-81737	Spike Removed
	04	502	None	
		501	None	
	05	702	None	
		701	None	

Table 14: Bias from EGM08 by Line

Survey	Flight Num.	Line Num.	Bias from EGM08
AK10-1 ANC	03	130	1.02
		131	3.10
	04	128	1.59
		129	1.86
	05	134	0.53
		135	2.38
	06	132	5.24
		133	5.98
	07	136	2.46
		137	3.41
	08	144	3.85
		145	4.68
	09	142	0.38
		143	2.84
	10	148	3.33
		149	4.87
	11	126	1.45
		127	1.21
	13	124	4.21
		125	3.93
	14	122	2.45
		123	3.75
	15	120	2.18
		121	3.30
	17	118	2.82
		119	3.29
	19	527	6.02
		528	4.83
	20	525	5.00
		526	5.66
	21	138	2.45
		139	3.12
	22	506	4.96
		507	5.48
	23	504	-1.47
		505	2.68
	24	532	2.67
		533	2.25
	25	116	3.81
		117	4.68
	26	114	0.79
		115	2.56
	29	146	2.05
		147	2.37
	30	140	0.07

		141	-0.94
	33	238	-0.63
		239	1.33
		241	2.28
AK10-2 FBK	03	152	2.00
		153	2.82
	06	605	1.75
	20	512	0.75
		511	1.03
		509	1.08
	24	534	1.14
		535	3.44
		514	1.17
		513	-0.24
AK10-3 ANC	01	160	1.41
		161	1.37
	02	158	-0.33
		159	1.13
		261	2.76
	04	156	1.69
		157	1.43
	05	154	5.59
		155	4.38
	06	150	2.00
		151	3.15
AK12-1 ANC	01	609	3.72
	02	508	2.67
	03	510	3.12
	04	502	2.76
		501	3.16
	05	702	2.88
		701	2.48

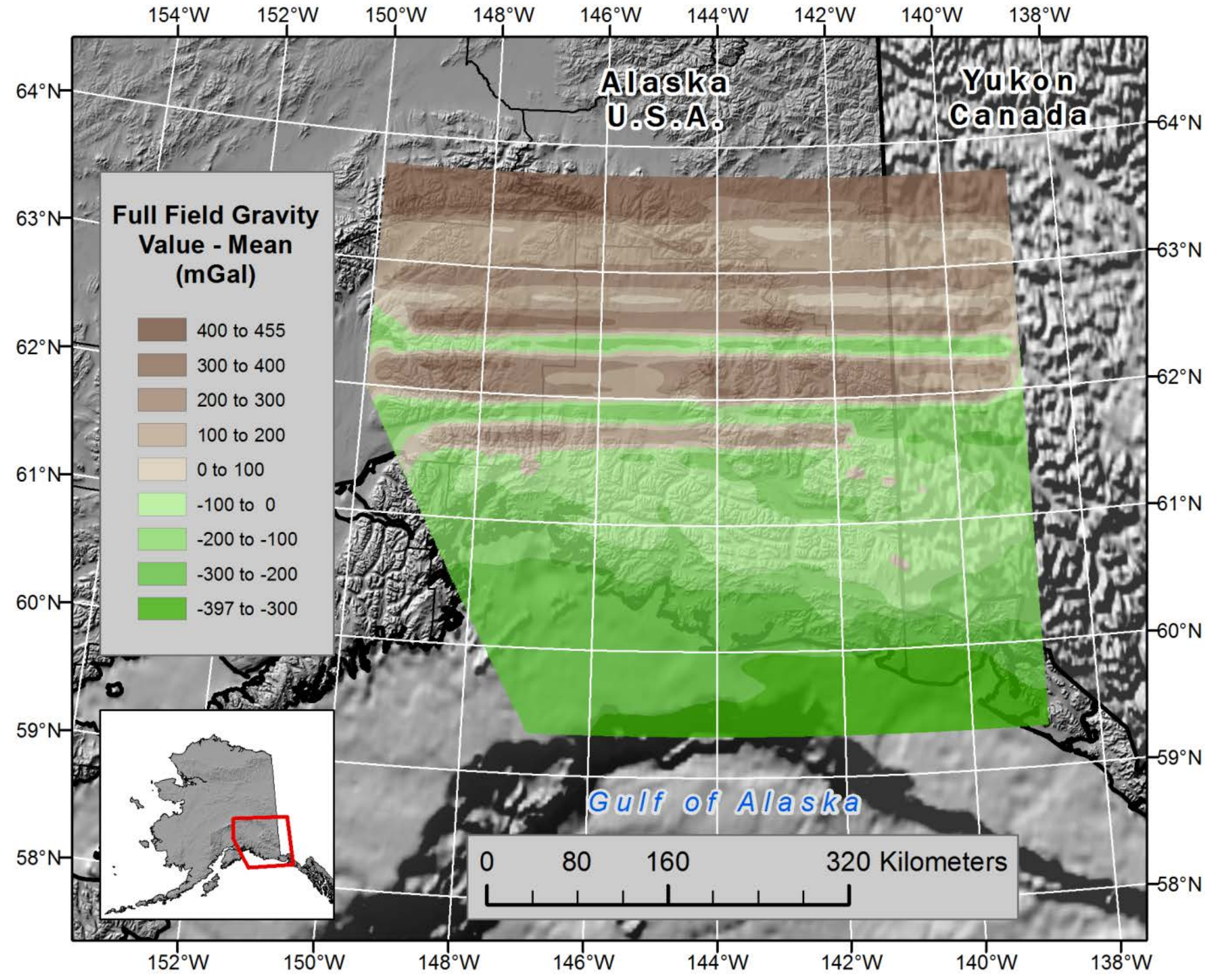


Figure 4: Full-field gravity at altitude (mean removed) for Block AS03. This is the data in the gravity release ".txt" file and includes the effects of differing altitudes along flight lines.

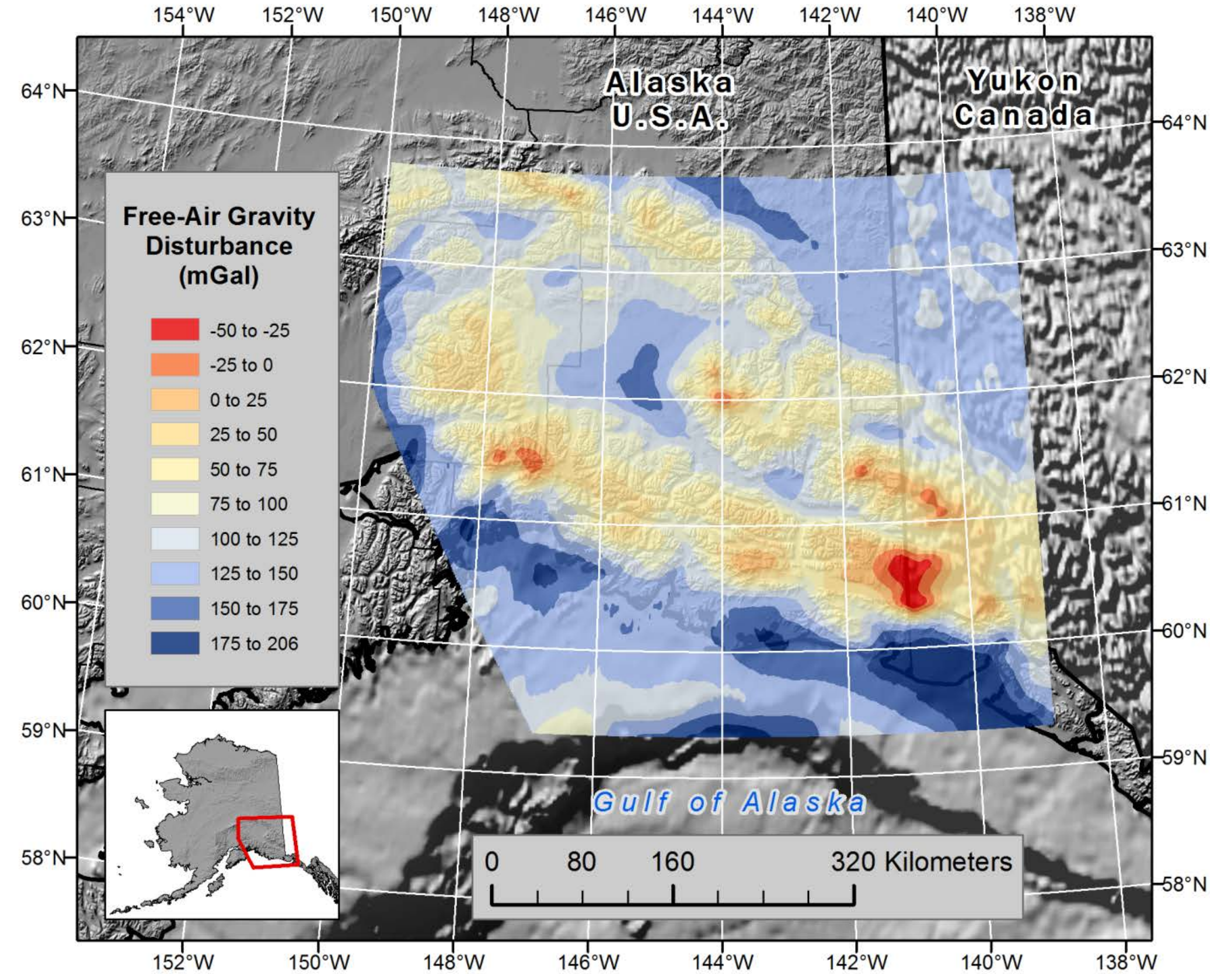


Figure 5: Free-air gravity disturbance for Block AS03 with respect to the WGS-84 ellipsoid.

4. Data Usage Guidelines

4.1 Suggested Data Handling

This data product was purposefully filtered to preserve the amplitude of the long-wavelength gravity signal. As a trade-off, the filter allows some short wavelength noise to remain in the product. Prior to use for geophysical purposes, the data should be run through a frequency-domain low-pass filter to remove that excess short wavelength noise. For geodetic purposes, higher frequencies can be damped during inclusion into a spherical harmonic model. In any case where downward continuation will be done with this data, the high frequency noise should first be filtered out, damped, or otherwise dealt with so that the downward continuation does not amplify the noise.

4.2 Documentation

The survey block User Manual, the general GRAV-D User Manual, and metadata for the block should all be downloaded with the data and kept in the same directory. The contents of the manuals are critical to correctly understanding the quality of the data and using the data properly.

4.3 How to Cite These Data

The following citations should be used in all presentations or publications that reference the GRAV-D work. Please replace the *DATE* tag in the following references with the date you downloaded the data or reports from the NGS website.

The GRAV-D Science Team, in alphabetical order, are: Vicki A. Childers, Theresa M. Diehl, Sandra A. Martinka Preaux, Carly A. Weil, and Monica A. Youngman.

To reference the AS03 data file, reference the webpage:
GRAV-D Science Team (2013). “Gravity for the Redefinition of the American Vertical Datum (GRAV-D) Project, Airborne Gravity Data; Block AS03”. Available *DATE*. Online at: http://www.ngs.noaa.gov/GRAV-D/data_AS03.shtml

To reference the block and survey details, reference the block user manual:
GRAV-D Science Team (2013). “Block AS03 (Alaska South 03); GRAV-D Airborne Gravity Data User Manual.” Theresa Diehl, ed. Version 1. Available *DATE*. Online at: http://www.ngs.noaa.gov/GRAV-D/data_AS03.shtml

To reference the general GRAV-D project operations, reference the General User Manual:
GRAV-D Science Team (2012). “GRAV-D General Airborne Gravity Data User Manual.” Theresa Diehl, ed. Version 1. Available *DATE*. Online at: http://www.ngs.noaa.gov/GRAV-D/data_AS03.shtml

5. References

Micro-g LaCoste, 2010. “TAGS Turnkey Airborne Gravity System AIR III Hardware & Operations Manual.”