FUGRO GEOSPATIAL, INC.

Collection Report – USGS Lidar Acquisition

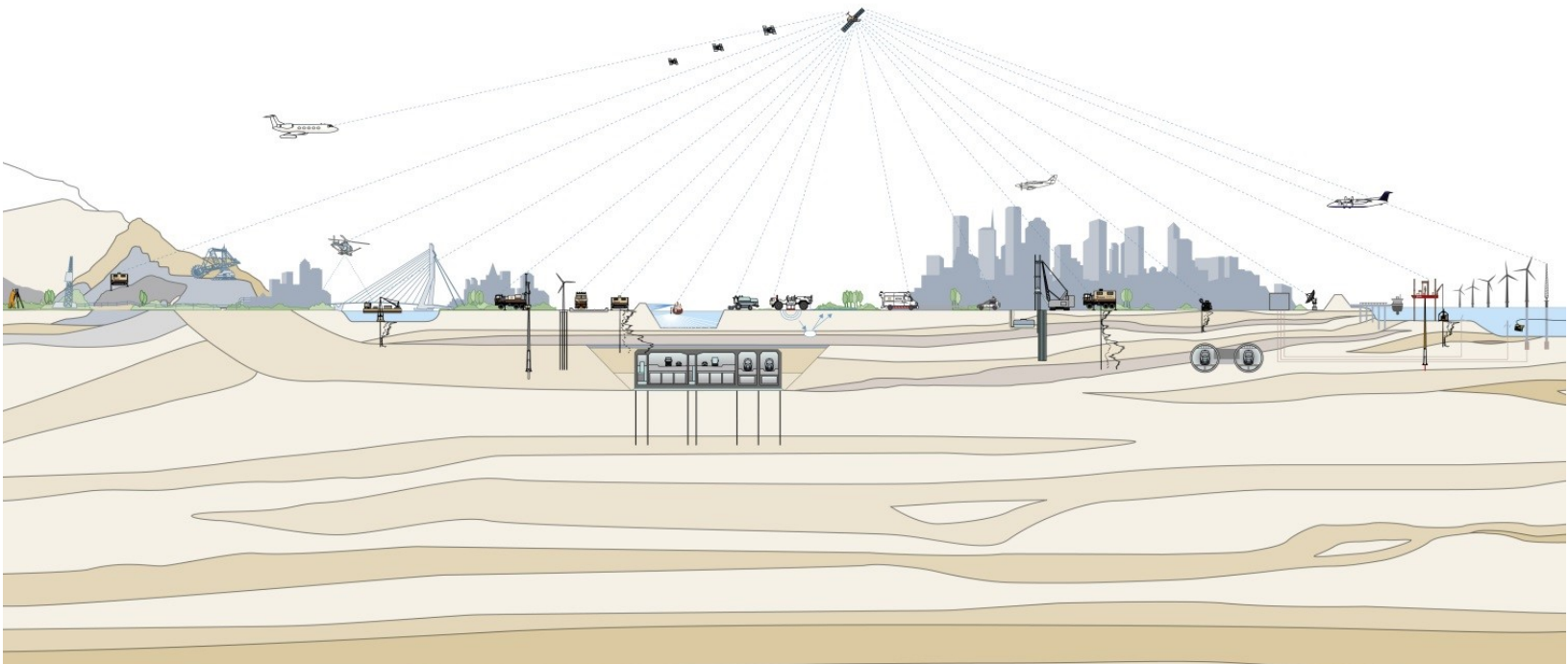
VA_UpperMiddleNeck_2018_D18

Prepared for:

United States Geological Survey
1400 Independence Road
Rolla, MO 65401
(573) 308-3689

July 12, 2019

USGS Contract: G17PC00015
USGS Task Order: 140G0218F0449



Fugro was tasked with planning, acquiring, processing, and producing derivative products of high resolution lidar data (QL2) collected at an aggregate nominal pulse spacing (ANPS) of 0.71 meters (2ppsm), including overlap, over Howard County, MD and VA Counties. The area of interest (AOI) covers approximately 4,114 square miles.

Lidar data, and derivative products produced in compliance with the task order will be based on the **"U.S. Geological Survey National Geospatial Program Lidar Base Specification Version 1.3**.

The acquisition occurred during the acceptable collection windows that existed between December 7 and December 11, 2018.

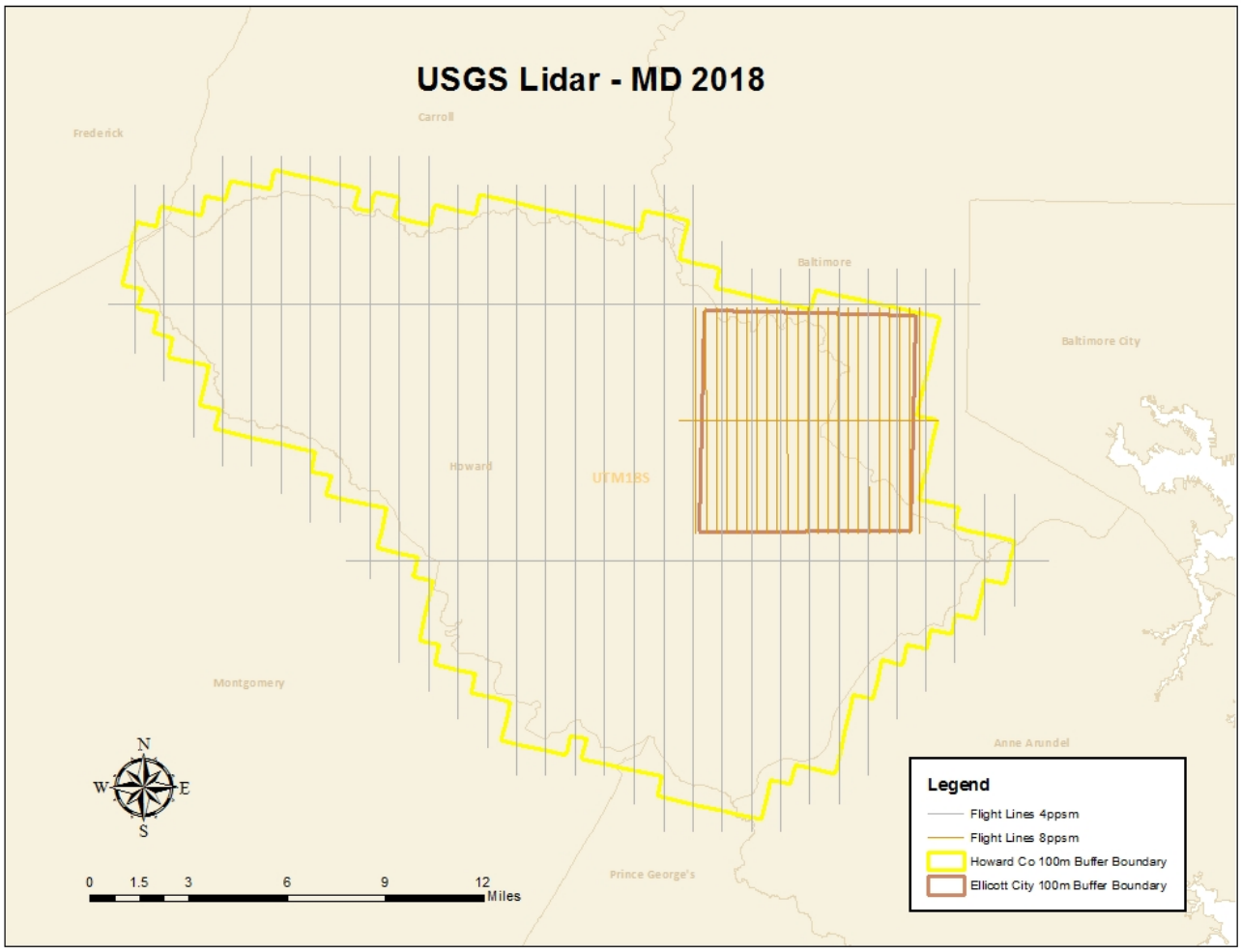


Figure 1: Flight plan

The following is detail on the **2018** lidar acquisition covering the Howard County, MD Lidar buffered boundary.

Collections:	3
Collection Dates:	December 7rd – December 11th, 2018
Field of View (FOV):	26.5 / 42 degrees
Average Point Density (planned):	4 ppsm
Flight Level(s) AMT:	2300 & 2650 m
Sensor Type(s):	Leica ALS80-HP
Sensor Serial Number(s):	SN-8133

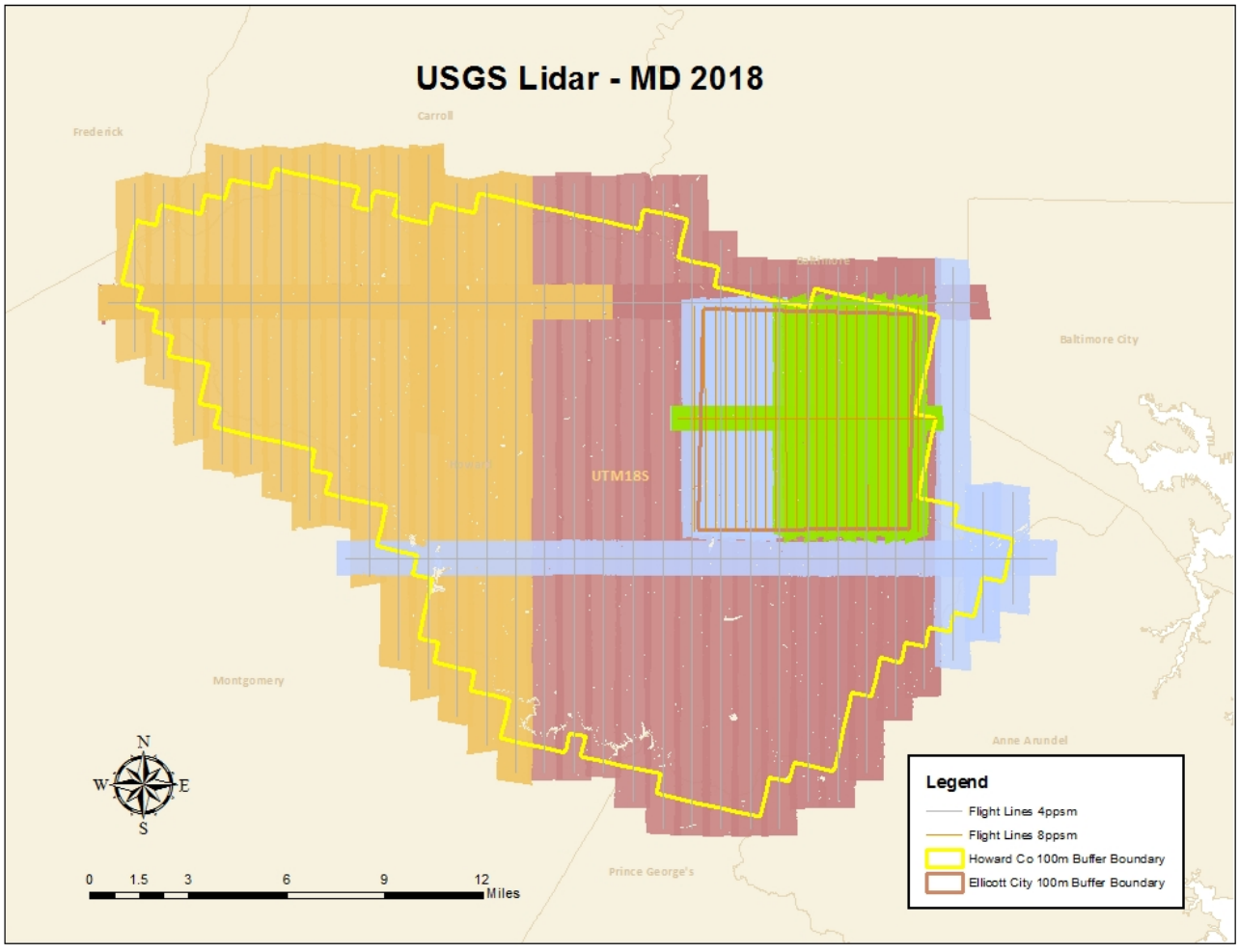


Figure 2: Executed Collection Footprints

All acquired lidar data was QC'd and accepted for processing.

Below are the acquisition logs and GPS plots from Howard County, MD collections:

Acquisition and Processing details ----- 181207_133_33780088_02 (December 7, 2018)

Log:

Menu 18.165

Fugro USA Land, Inc.

ALS Flight Log AC80-44-00-02

	Lift Begin			Lift End			Flt	Flt	Hobbs	
	Airport	Chocks	Hobbs	Airport	Chocks	Hobbs	Duration	Hrs	Hrs	Actvity
1	KMRB	13:05	8080.5	KMRB	17:04	8084.4	3:58	4.00	3.9	0900-Production
2										
3										

FGI Job #	Project Name	System	Unit	IMU	PIA	SW1	SW2-Gain	Aper	AutoScan	Ground Temp°C		Min Range Gate	Data Logger Drive
33780088	USGS FY18 MD final	ALS80	133	uIRS	5		255	60°	Yes	-1.0	2.0	8020	MM70-04

Flight Date	GPS Day	Lift			Sun°	Solar Times (UTC)	Laser Power	Pattern	Flying Temp °C		Max Range Gate	Download Drive
7-Dec-18	18-341	2			NA	NA	100%	Triangle	-11.0	-9.0	9147	NS1TB-105

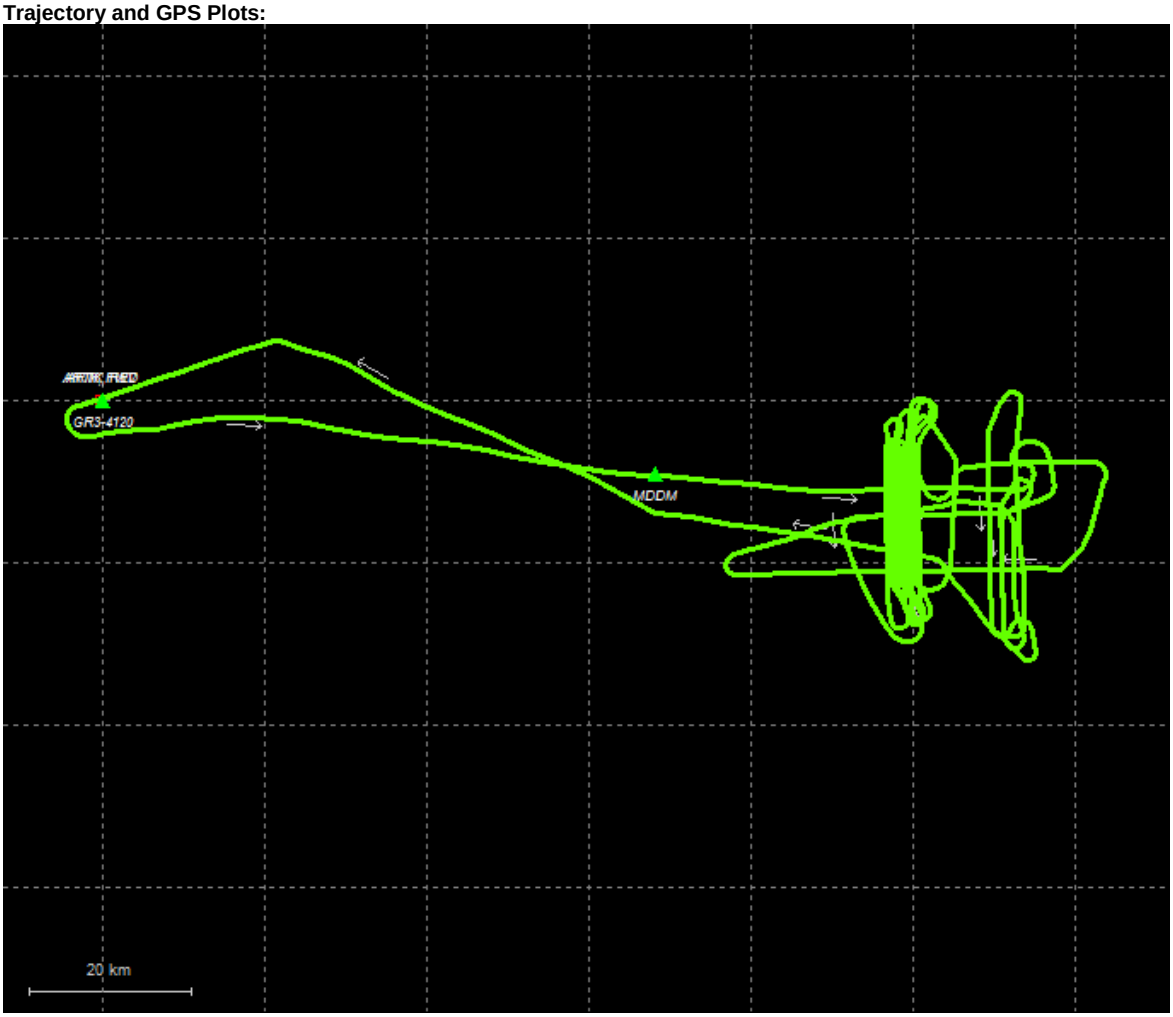
Mission ID (yymmdd_Sen_Job_Lift)	Aircraft	Airport ID	FMS	UTC	AMT (ft)	Speed	Scan Hz	Pulse Rate	FOV	km/WPT	Altm Setting		Shipping Track
181207_133_33780088_02	N76JN	KMRB	FCMS		8,700	150	52.0	534,200	27	1.595	30.41	30.44	773914251881

Pilot #1	Pilot #2	Operator #1	Operator #2
Grant Cassell	Jeff Faulkner	Adam Mueller	

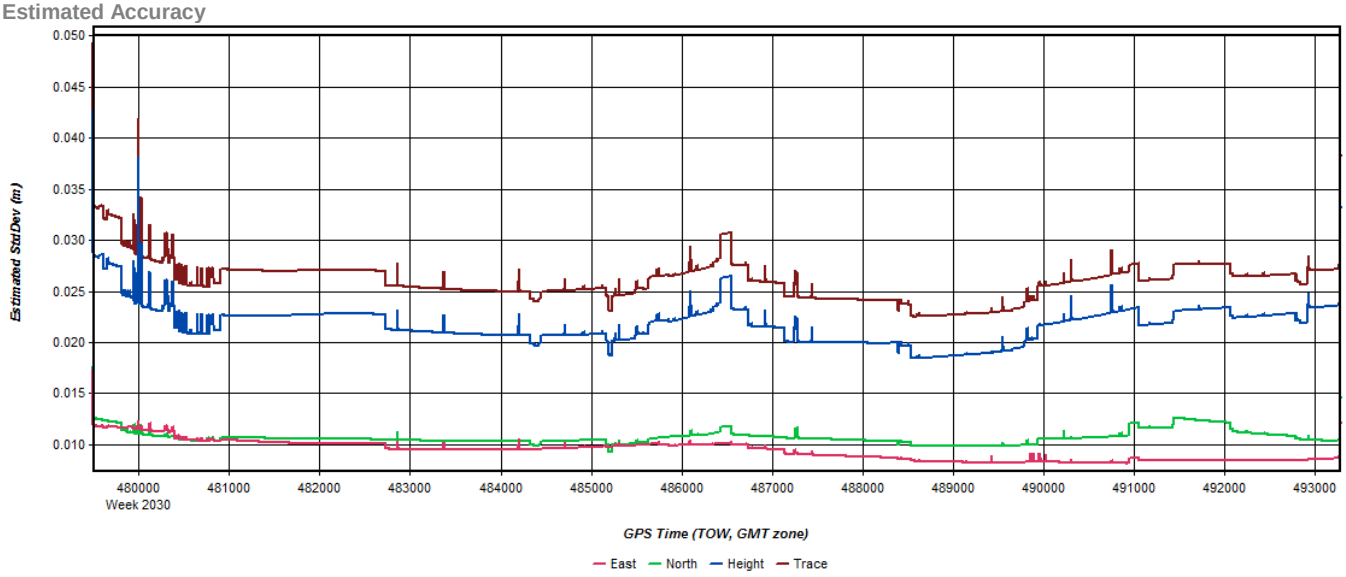
Base 1 ID	Location	Rec ID	Ant ID	ARP (m)	Start Time (UTC)	Stop Time (UTC)	GPS Filename	Operator	Data
FEDI 1019	KMRB	Unit 4	4	1.8	07-Dec-18 17:53	07-Dec-18 16:10	GR3-41207m	Adam Mueller	With AB
Base 2 ID	Location	Rec ID	Ant ID	ARP (m)	Start Time (UTC)	Stop Time (UTC)	GPS Filename	Operator	Data
MDDM	MD	CORS			CORS		CORS		CORS

Area	Flight # FGI	Flight # Client's	Wpt From	Wpt To	Distance Begin	Distance End	UTC Start	UTC End	Flt Dir	Altitude (GPS)	Speed (knots)	Scan Rate	Comments and Conditions	SVs	PDOP
							13:12:31	13:17:31					Ground Static	18	1.1
							13:42:51	13:47:51					Over flight MDDM CORS	16	1.4
							13:54:02	13:56:21					S Turn	16	1.5
MD4ppsm	24		9	1	12.8	0	14:00:23	14:03:52	W	8746	126	52.0	**Cross line**	16	1.3
	9		1	8	0	11.2	14:10:49	14:13:29	N	8795	140	52.0	1079 GB left	16	1.4
	8		8	1	11.2	0	14:17:32	14:20:20	S	8844	140	52.0	**1077 GB left**	17	1.4
	7		1	8	0	11.2	14:24:08	14:27:00	N	8844	135	52.0	1075 GB left	18	1.2
	7		8	1	11.2	0	14:31:31	14:34:13	S	8844	140	52.0	**Calibration**	18	1.2
	6		8	1	11.2	0	14:43:14	14:45:56	S	8844	144	52.0	1071 GB left	17	1.3
	5		1	8	0	11.2	14:49:53	14:52:49	N	8795	130	52.0		19	1.2
	4		8	1	11.2	0	14:56:39	14:59:30	S	8844	137	52.0		19	1.3
	3		1	8	0	11.2	15:04:03	15:06:54	N	8844	130	52.0		19	1.1
	2		8	1	11.2	0	15:09:54	15:12:49	S	8894	140	52.0		20	1.0
	1		1	8	0	11.2	15:17:01	15:19:57	N	8894	125	52.0	1058 GB left	18	1.2
							15:20:31	15:23:35					S Turn	18	1.2
													Switch to Area MD2ppsm; checked settings		
MD2ppsm	32		26	1	39.9	0	15:31:32	15:40:32	W	7444	130	35.0	Cross line	20	1.1
	31		5	1	6.4	0	15:49:42	15:51:12	S	7444	130	35.0		20	1.1
	30		1	6	0	8	15:54:30	15:56:27	N	7444	138	35.0	Clouds forming in area	20	1.1
	30		6	1	8	0	16:00:36	16:03:00	S	7444	140	35.0	Calibration line; Possible clouds on line	19	1.2
	29		15	1	22.3	0	16:13:08	16:17:53	S	7444	145	35.0	Clouds forming in area; possible cloud km 17, 8, and 6	18	1.2
							16:18:02	16:19:50					S Turn	18	1.2
							16:55:50	17:00:50					Ground Static	17	1.2

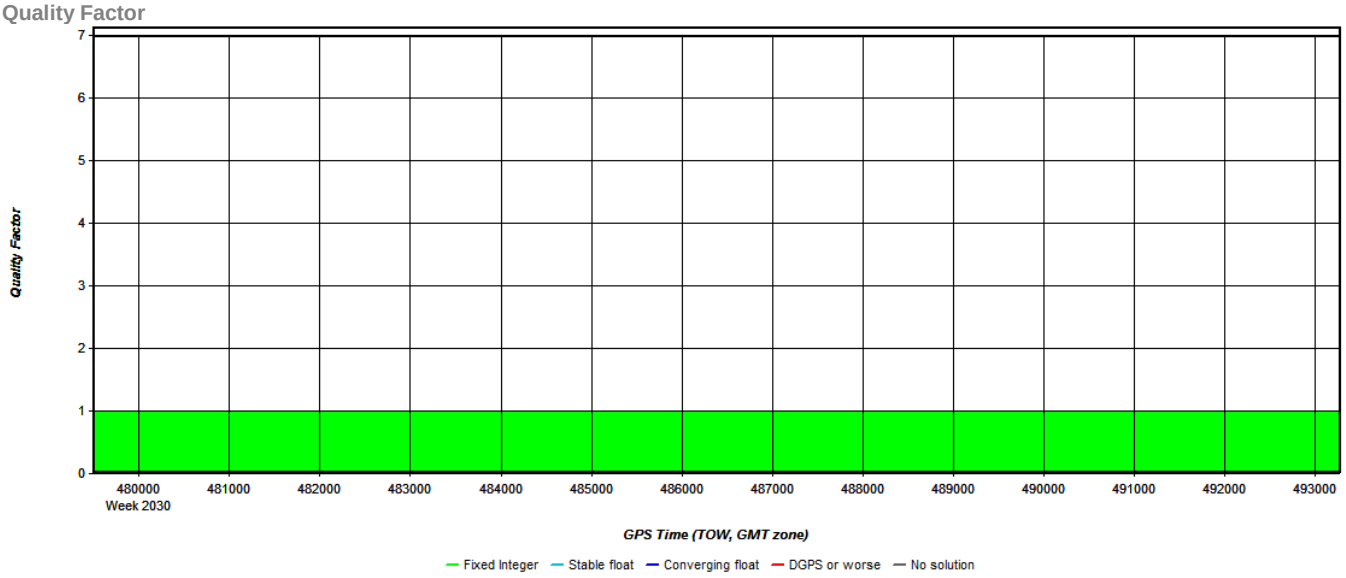
Trajectory and GPS Plots:



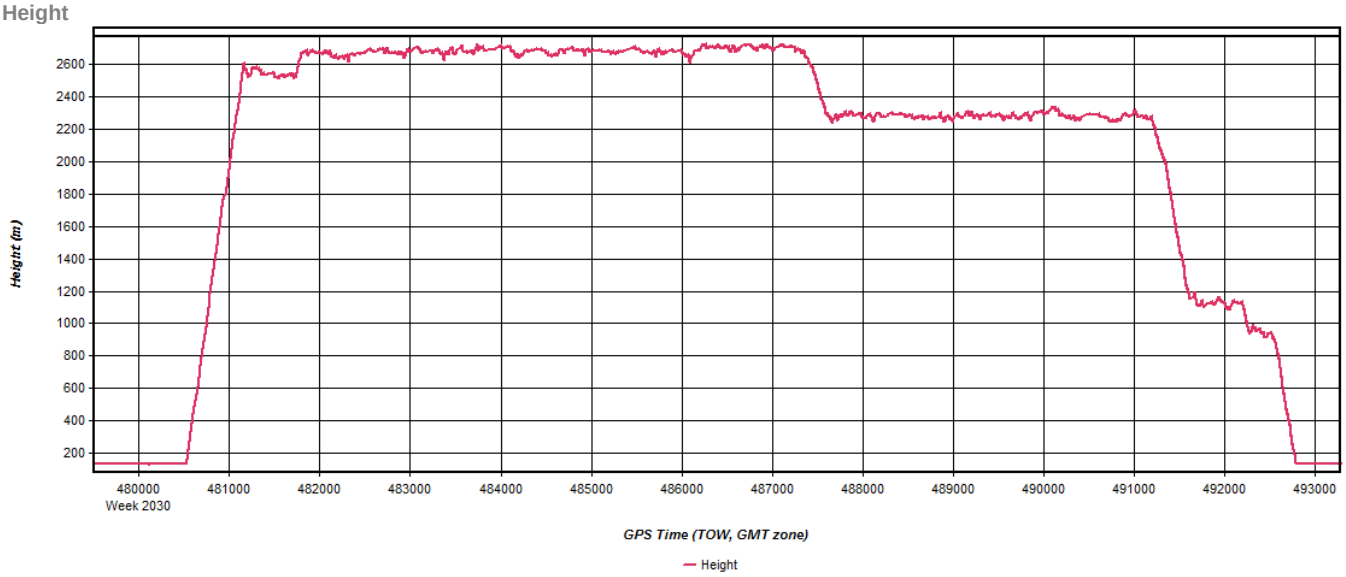
Estimated Accuracy



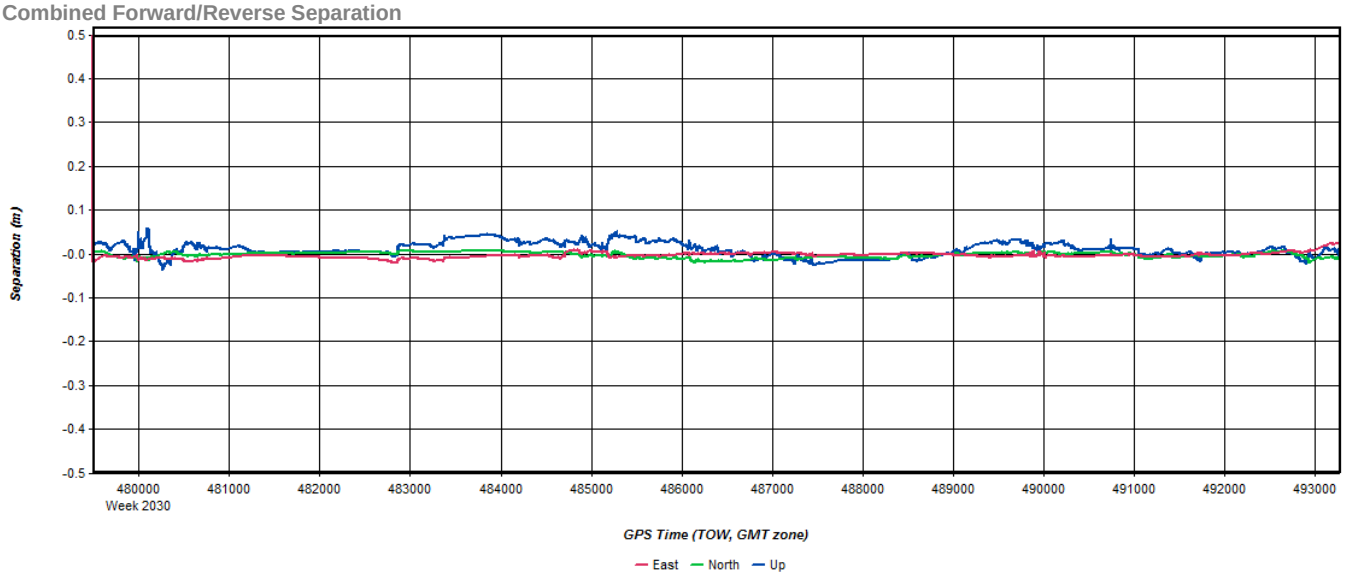
Quality Factor



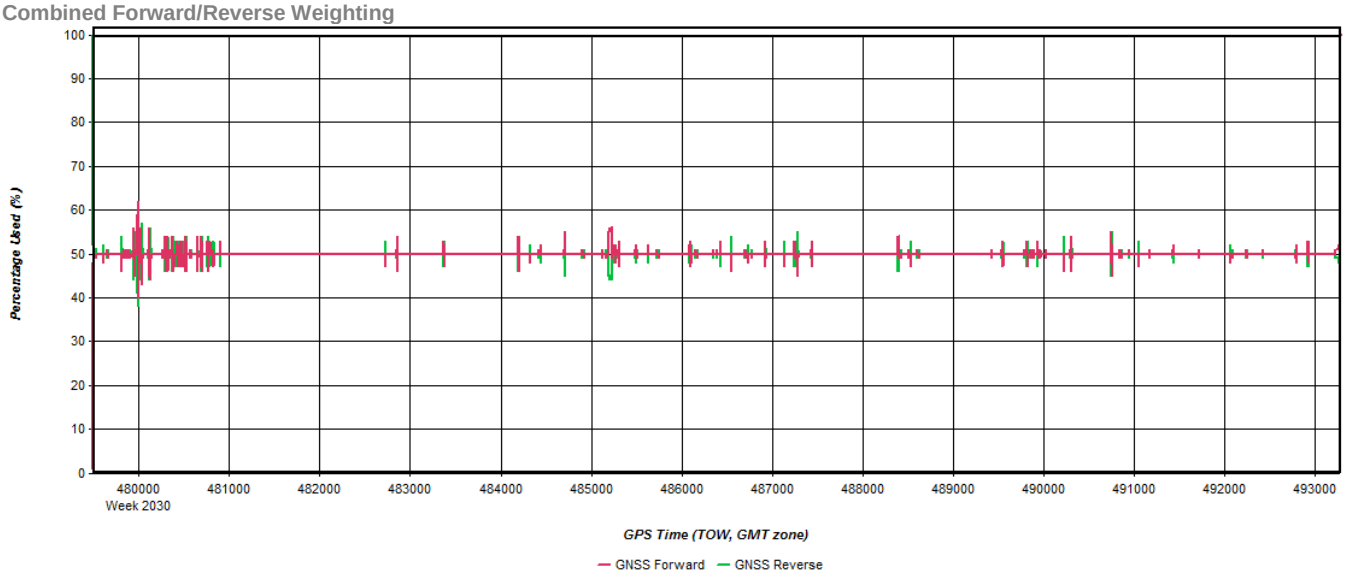
Height



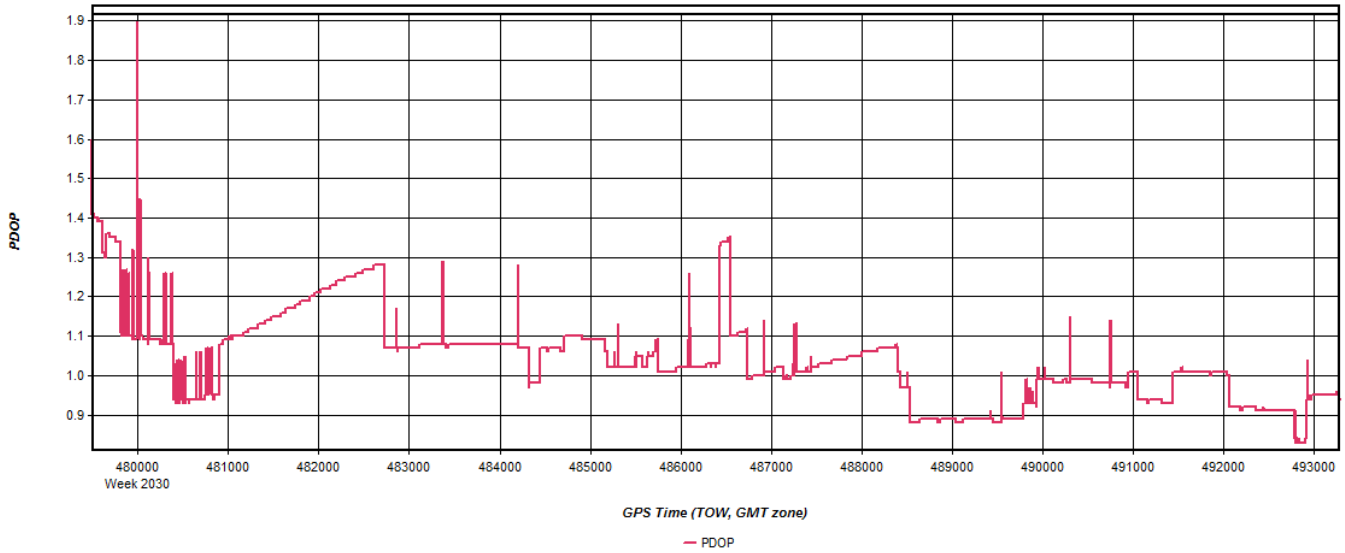
Combined Forward/Reverse Separation



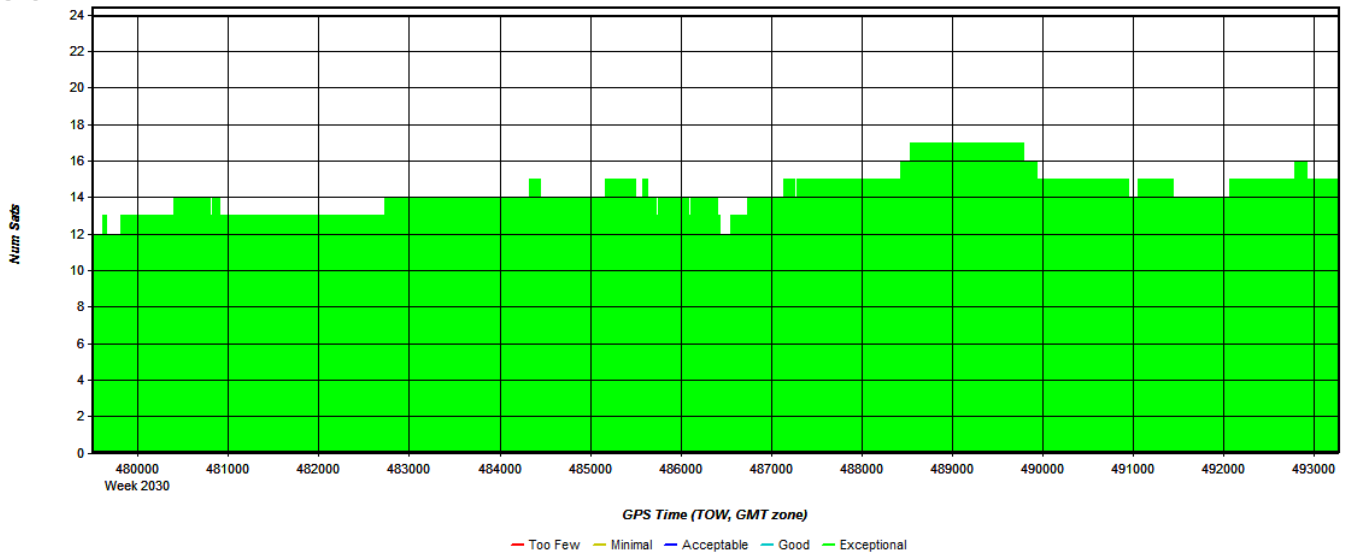
Combined Forward/Reverse Weighting



PDOP


PDOP
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
480000
Week 2030
481000
482000
483000
484000
485000
486000
487000
488000
489000
490000
491000
492000
493000
GPS Time (TOW, GMT zone)
PDOP

SVs


Num Sats
24
22
20
18
16
14
12
10
8
6
4
2
0
480000
Week 2030
481000
482000
483000
484000
485000
486000
487000
488000
489000
490000
491000
492000
493000
GPS Time (TOW, GMT zone)
Too Few
Minimal
Acceptable
Good
Exceptional

Acquisition and Processing details ----- 181210_133_33780088_03 (December 10, 2018)

Log:

Menu 18.165

Fugro USA Land, Inc.

ALS Flight Log AC80-44-00-02

	Lift Begin			Lift End			Flt	Flt	Hobbs	
	Airport	Chocks	Hobbs	Airport	Chocks	Hobbs	Duration	Hrs	Hrs	Actvity
1	KMRB	14:09	8085.7	KMRB	19:07	8090.6	4:58	5.00	4.9	0900-Production
2										
3										

FGI Job #	Project Name	System	Unit	IMU	PIA	SW1	SW2-Gain	Aper	AutoScan	Ground Temp°C		Min Range Gate	Data Logger Drive
33780088	USGS FY18 MD final	ALS80	133	uIRS	3		255	60°	Yes	-5.6	2.2	6244	MM70-04

Flight Date	GPS Day	Lift			Sun°	Solar Times (UTC)	Laser Power	Pattern	Flying Temp °C		Max Range Gate	Download Drive
10-Dec-18	18-344	3			NA	NA	100%	Triangle	-3.0	-3.0	8323	NS1TB-63

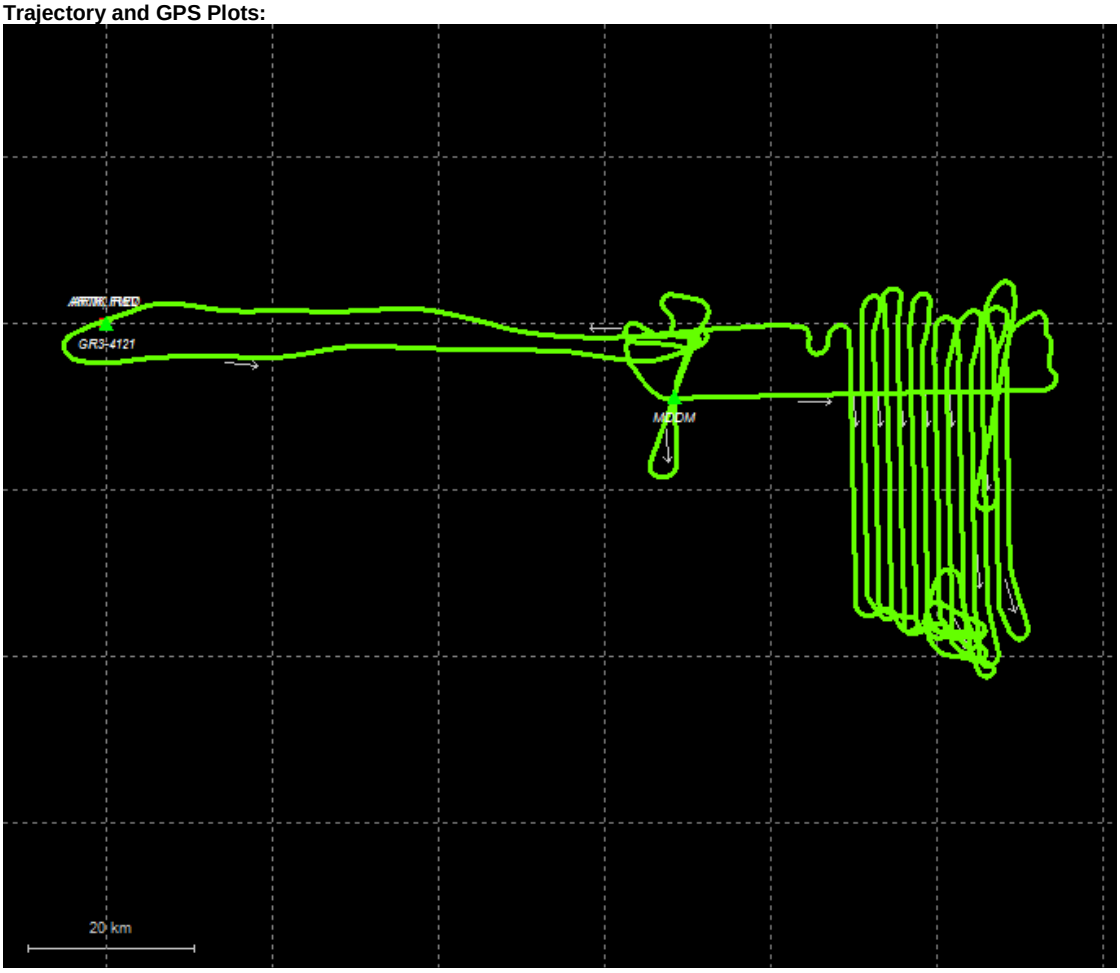
Mission ID (yymmdd_Sen_Job_Lift)	Aircraft	Airport ID	FMS	UTC	AMT (ft)	Speed	Scan Hz	Pulse Rate	FOV	km/WPT	Altm Setting		Shipping Track
181210_133_33780088_03	N76JN	KMRB	FCMS		7,550	150	35.0	352,000	42	1.384	30.18	30.14	773930718070

Pilot #1	Pilot #2	Operator #1	Operator #2
Russell Mason	Jeff Faulkner	Adam Mueller	

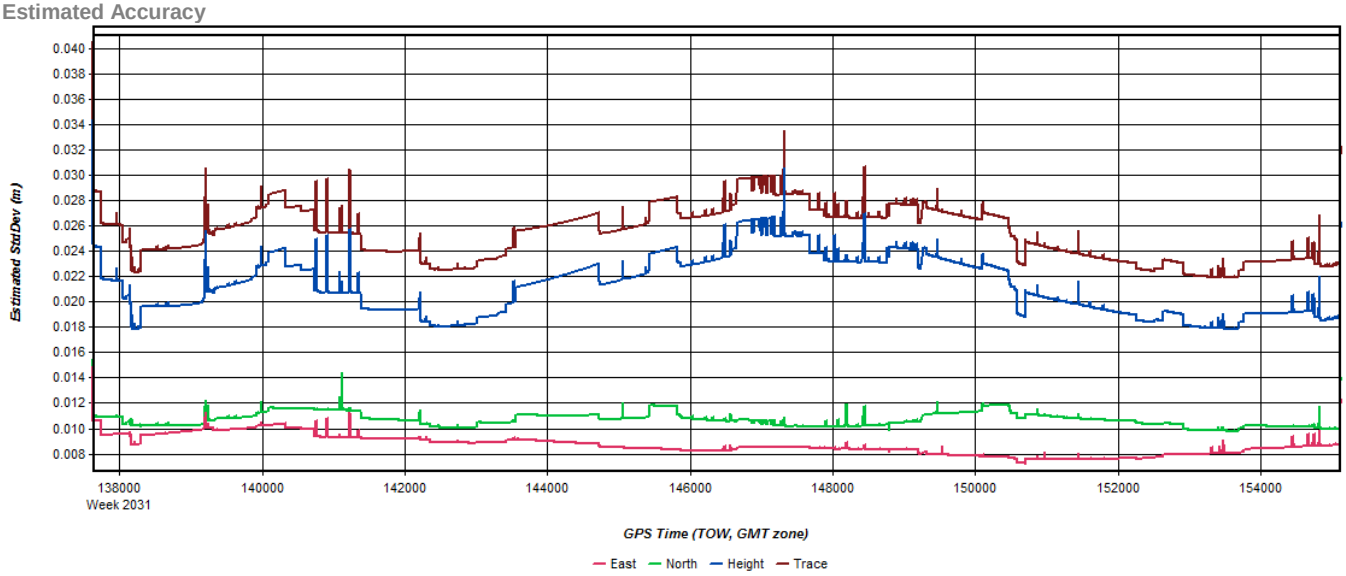
Base 1 ID	Location	Rec ID	Ant ID	ARP (m)	Start Time (UTC)	Stop Time (UTC)	GPS Filename	Operator	Data
FEDI 1019	KMRB	Unit 4	4	1.8	10-Dec-18 13:05	10-Dec-18 19:13	GR3-41210n	Adam Mueller	With AB
Base 2 ID	Location	Rec ID	Ant ID	ARP (m)	Start Time (UTC)	Stop Time (UTC)	GPS Filename	Operator	Data
MDDM	MD	CORS			CORS		CORS		CORS

Area	Flight # FGI	Flight # Client's	Wpt From	Wpt To	Distance Begin	Distance End	UTC Start	UTC End	Flt Dir	Altitude (GPS)	Speed (knots)	Scan Rate	Comments and Conditions	SVs	PDOP
							14:14:57	14:19:57					Ground Static	17	1.4
							14:58:19	15:03:19					Over Flight MDDM CORS	18	1.1
							15:05:21	15:07:03					S Turn	15	1.4
MD2ppsm	33		1	32	0	42.9	15:15:34	15:26:25	E	7644	130	35.0		17	1.2
	28		16	1	20.8	0	15:32:03	15:36:57	S	7493	145	35.0		19	1.1
	27		1	17	0	22.1	15:42:44	15:49:21	N	7493	110	35.0		19	1.1
	27		17	8	22.1	9.7	15:53:42	15:56:24	S	7493	145	35.0	Calibration line	19	1.1
	26		19	1	24.9	0	16:09:18	16:15:04	S	7493	141	35.0		17	1.1
	25		1	20	0	26.3	16:19:48	16:27:44	N	7543	110	35.0		18	1.3
	24		20	1	26.3	0	16:32:09	16:38:24	S	7543	135	35.0		18	1.3
	23		1	21	0	27.7	16:43:47	16:52:19	N	7493	110	35.0		19	1.2
	22		21	1	27.7	0	16:56:18	17:02:55	S	7543	140	35.0		19	1.3
	21		1	22	0	29.1	17:19:22	17:28:01	N	7543	110	35.0	Altitude at start	21	1.1
	20		24	1	31.8	0	17:32:04	17:39:24	S	7595	145	35.0		20	1.1
	19		1	24	0	31.8	17:43:12	17:51:56	N	7644	110	35.0	Off line at start due to airspace	20	1.3
	18		23	1	30.4	0	17:55:24	18:02:24	S	7694	148	35.0		19	1.3
	17		1	22	0	29.1	18:05:53	18:14:12	N	7694	110	35.0		19	1.3
	16		22	1	29.1	0	18:17:18	18:24:15	S	7743	145	35.0		21	1.1
	15		1	22	0	29.1	18:27:41	18:35:40	N	7694	130	35.0	Possible clouds North end	21	1.1
							18:35:54	18:37:50					S Turn	20	1.1
							18:59:13	19:04:13					Ground Static	20	1.1

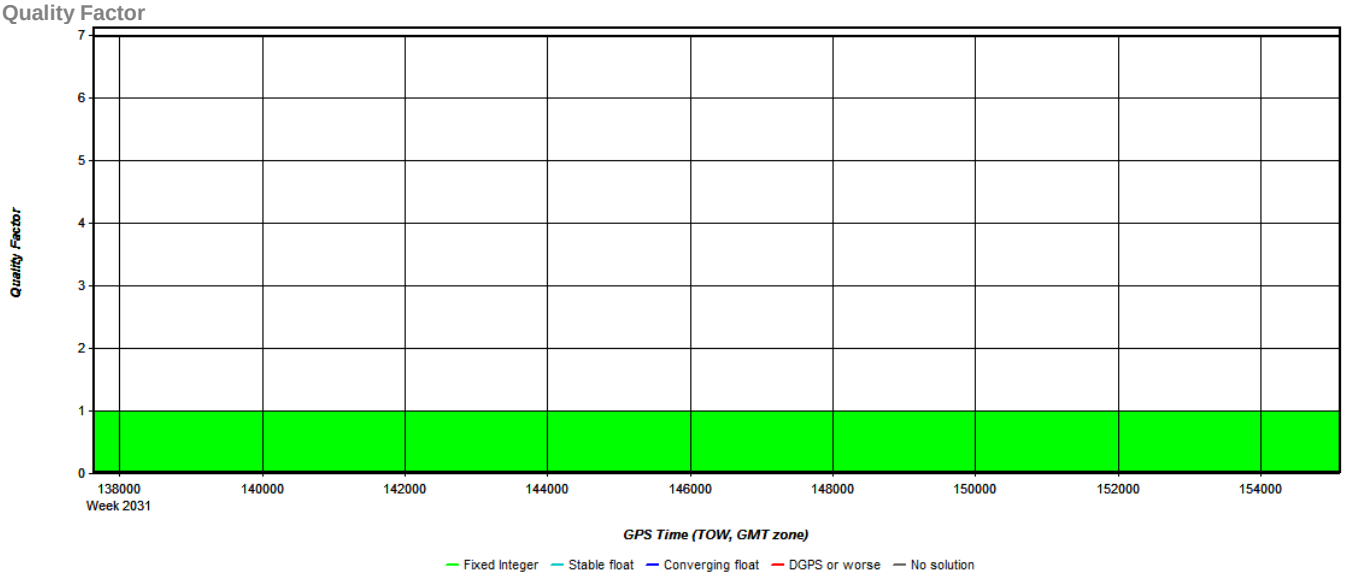
Trajectory and GPS Plots:



Estimated Accuracy



Quality Factor



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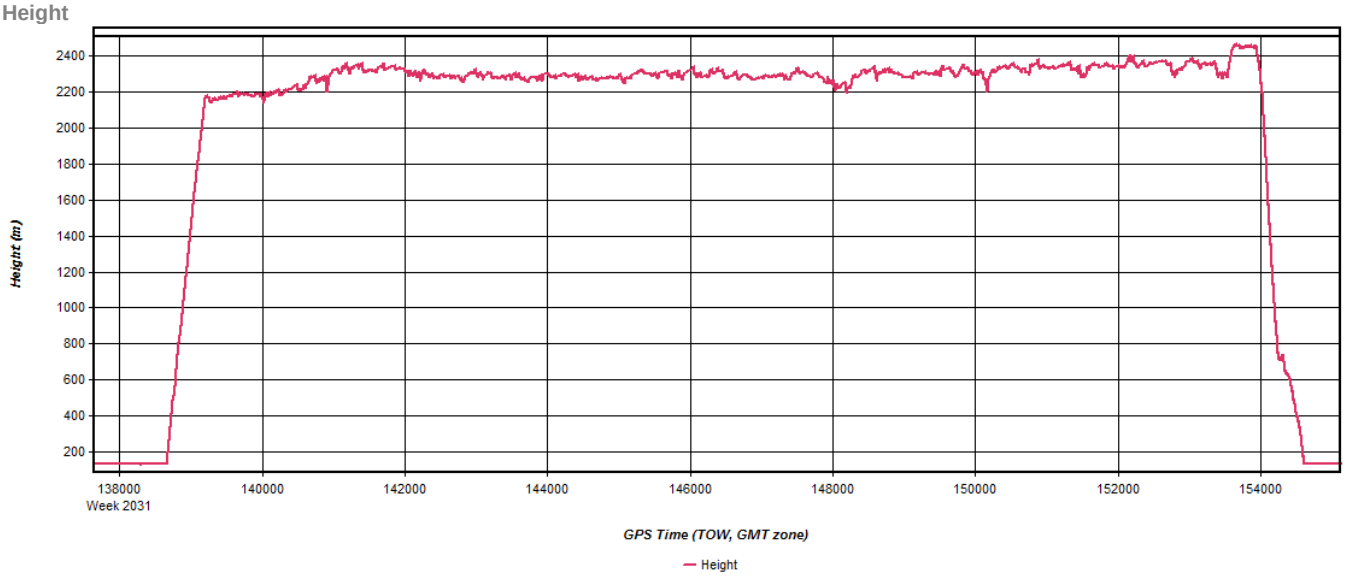
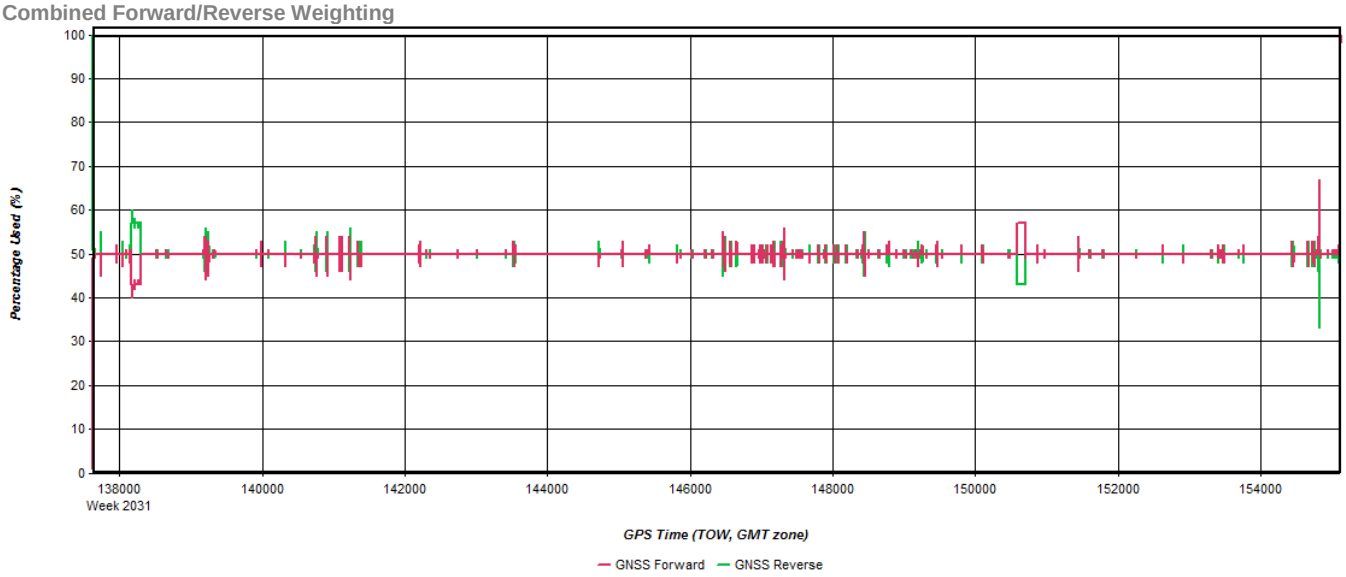
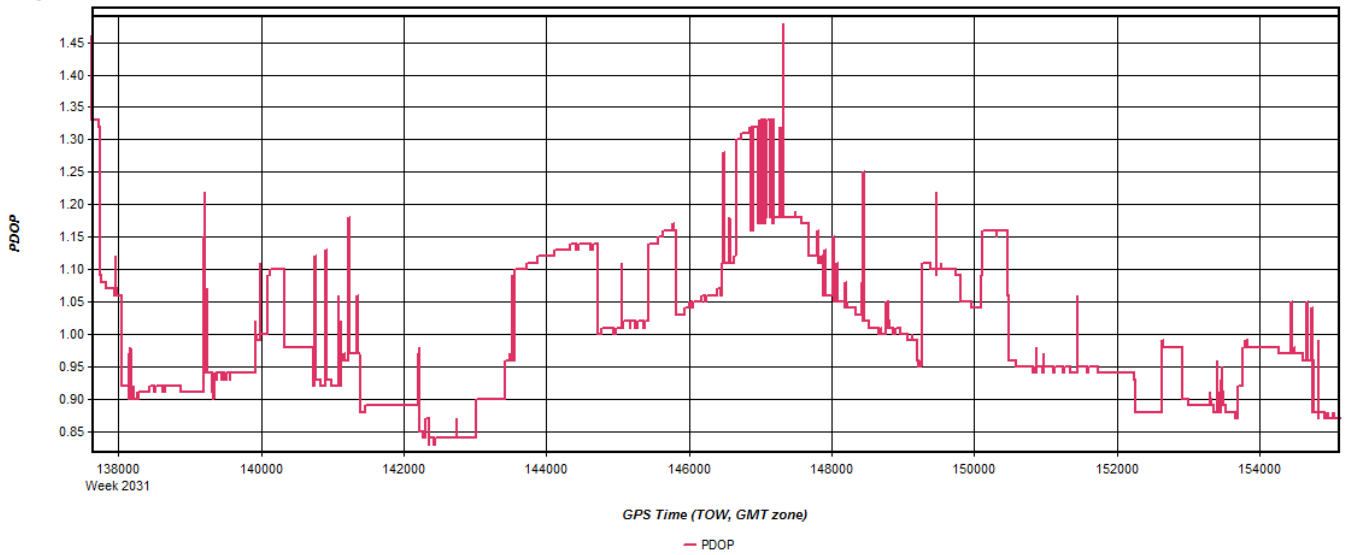


Combined Forward/Reverse Separation

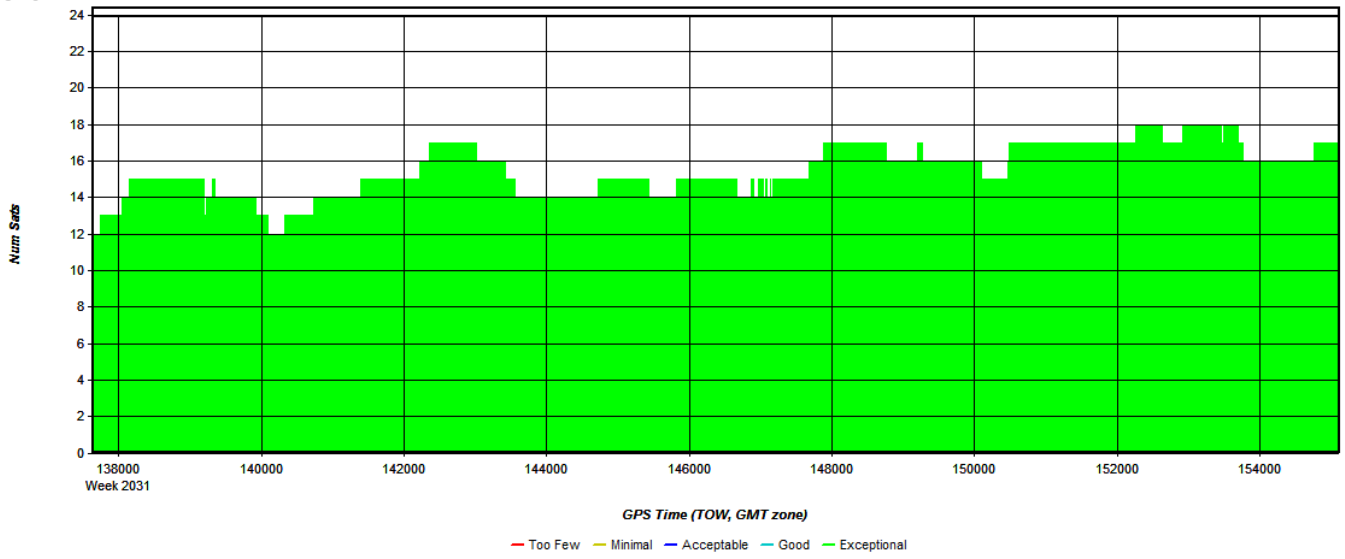
Combined Forward/Reverse Weighting



PDOP


PDOP
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
138000
Week 2031
140000
142000
144000
146000
148000
150000
152000
154000
GPS Time (TOW, GMT zone)
PDOP

SVs


Num Sats
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18
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12
10
8
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4
2
0
138000
Week 2031
140000
142000
144000
146000
148000
150000
152000
154000
GPS Time (TOW, GMT zone)
Too Few
Minimal
Acceptable
Good
Exceptional

Acquisition and Processing details ----- 181211_133_33780088_04 (December 11, 2018)

Log:

Menu 18.165

Fugro USA Land, Inc.

ALS Flight Log AC80-44-00-02

	Lift Begin			Lift End			Flt	Flt	Hobbs	
	Airport	Chocks	Hobbs	Airport	Chocks	Hobbs	Duration	Hrs	Hrs	Actvity
1	KMRB	14:54	8090.6	KMRB	18:21	8094.0	3:26	3.50	3.4	0900-Production
2										
3										

FGI Job #	Project Name	System	Unit	IMU	PIA	SW1	SW2-Gain	Aper	AutoScan	Ground Temp°C		Min Range Gate	Data Logger Drive
33780088	USGS FY18 MD final	ALS80	133	uIRS	3		255	60°	Yes	-6.0	7.0	6244	MM70-04

Flight Date	GPS Day	Lift	Sun°	Solar Times (UTC)	Laser Power	Pattern	Flying Temp °C		Max Range Gate	Download Drive
11-Dec-18	18-345	4	NA	NA	100%	Triangle	-4.0	-6.0	8323	NS1TB-48

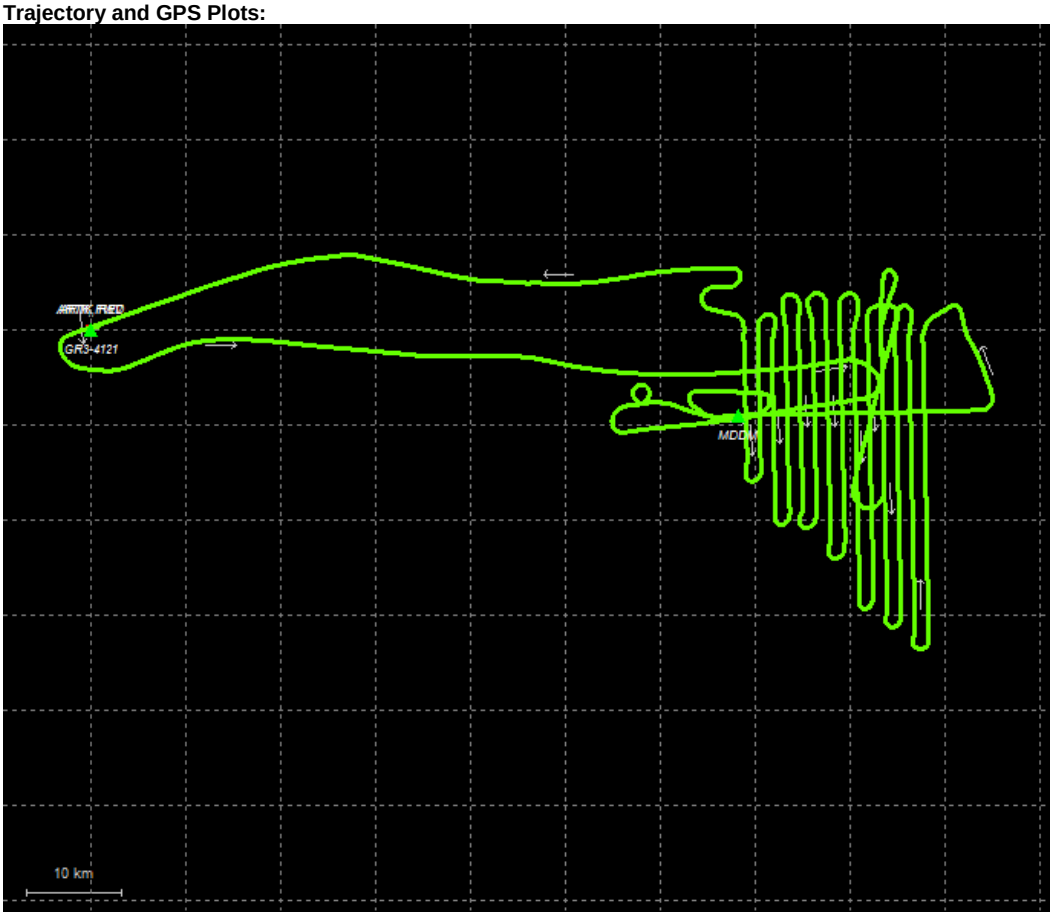
Mission ID (yymmdd_Sen_Job_Lift)	Aircraft	Airport ID	FMS	UTC	AMT (ft)	Speed	Scan Hz	Pulse Rate	FOV	km/WPT	Altm Setting		Shipping Track
181211_133_33780088_04	N76JN	KMRB	FCMS		7,550	150	35.0	352,000	42	1.384	30.16	30.04	773942403006

Pilot #1	Pilot #2	Operator #1	Operator #2
Russell Mason	Jeff Faulkner	Adam Mueller	

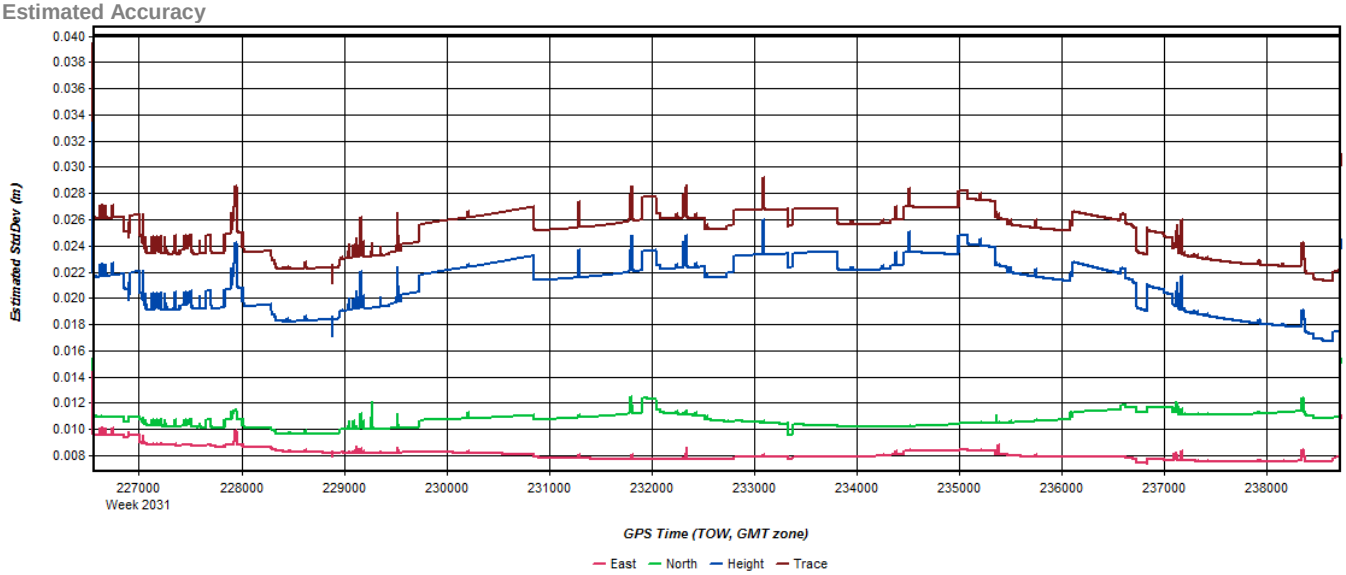
Base 1 ID	Location	Rec ID	Ant ID	ARP (m)	Start Time (UTC)	Stop Time (UTC)	GPS Filename	Operator	Data
FEDI 1019	KMRB	Unit 4	4	1.8	11-Dec-18 12:15	11-Dec-18 18:29	GR3-41211m	Adam Mueller	With AB
Base 2 ID	Location	Rec ID	Ant ID	ARP (m)	Start Time (UTC)	Stop Time (UTC)	GPS Filename	Operator	Data
MDDM	MD	CORS			CORS		CORS		CORS

Area	Flight # FGI	Flight # Client's	Wpt From	Wpt To	Distance Begin	Distance End	UTC Start	UTC End	Flt Dir	Altitude (GPS)	Speed (knots)	Scan Rate	Comments and Conditions	SVs	PDOP
							14:56:40	15:01:40					Ground Static	19	1.3
							15:31:57	15:36:57					Over Flight MDDM	22	1.1
							15:37:24	15:40:02					S Turn	22	1.1
MD2ppsm	33		1	19	0	24.9	15:41:30		E	7644			**Cross line; altitude high and speed high will restart**		
	33		1	19	0	24.9	15:46:22	15:52:04	E	7644	144	35.0	Cross line	22	1.1
	14		22	1	29.1	0	15:57:55	16:05:00	S	7694	145	35.0		18	1.4
	13		1	21	0	27.7	16:06:13	16:13:07	N	7743	135	35.0	Altitude at start	19	1.3
	12		20	1	26.3	0	16:15:49	16:22:24	S	7743	130	35.0		19	1.3
	11		1	20	0	26.3	16:23:49	16:30:11	N	7743	135	35.0		20	1.2
	11		20	10	26.3	12.5	16:33:37	16:36:39	S	7743	145	35.0	Calibration line	20	1.2
	10		19	1	24.9	0	16:45:15	16:51:35	S	7795	135	35.0		20	1.2
	9		1	16	0	20.8	16:54:12	16:59:51	N	7795	120	35.0		19	1.2
	8		14	1	18	0	17:02:30	17:06:53	S	7844	145	35.0		19	1.4
	7		1	14	0	18	17:09:17	17:14:17	N	7844	125	35.0		20	1.2
	6		13	1	16.6	0	17:17:25	17:21:42	S	7844	130	35.0		21	1.2
	5		1	12	0	15.2	17:23:28	17:27:22	N	7894	133	35.0		20	1.2
	4		12	1	15.2	0	17:29:57	17:33:36	S	7894	141	35.0		21	1.1
	3		1	10	0	12.5	17:35:52	17:39:38	N	7943	115	35.0		22	1.1
	2		8	1	9.7	0	17:42:35	17:45:03	S	7995	135	35.0		21	1.3
	1		1	7	0	8.3	17:47:04	17:49:27	N	8045	120	35.0		22	1.1
							17:51:21	17:53:16					S Turn	21	1.2
							18:12:51	18:17:51					Ground Static	23	1.1

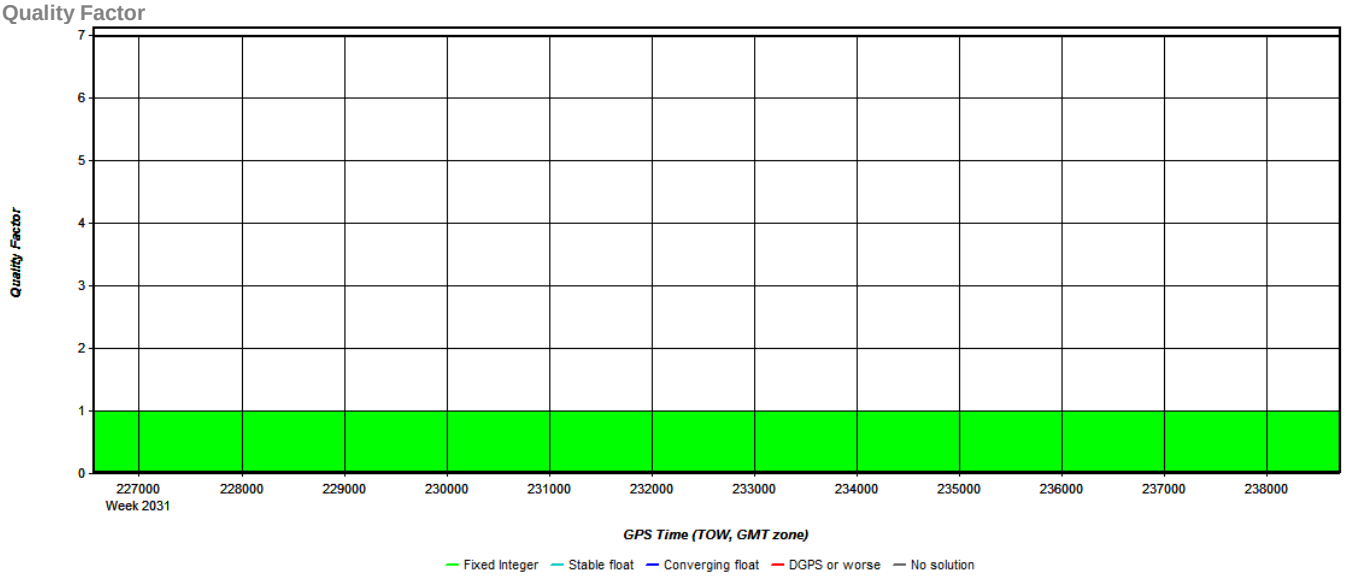
Trajectory and GPS Plots:



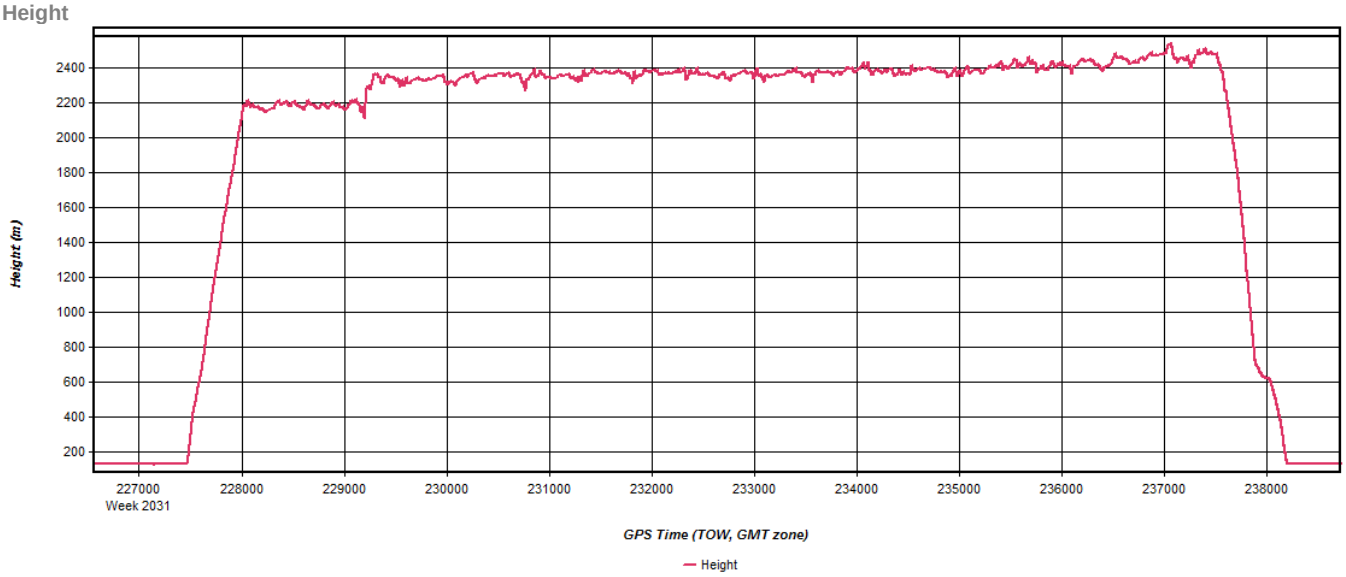
Estimated Accuracy



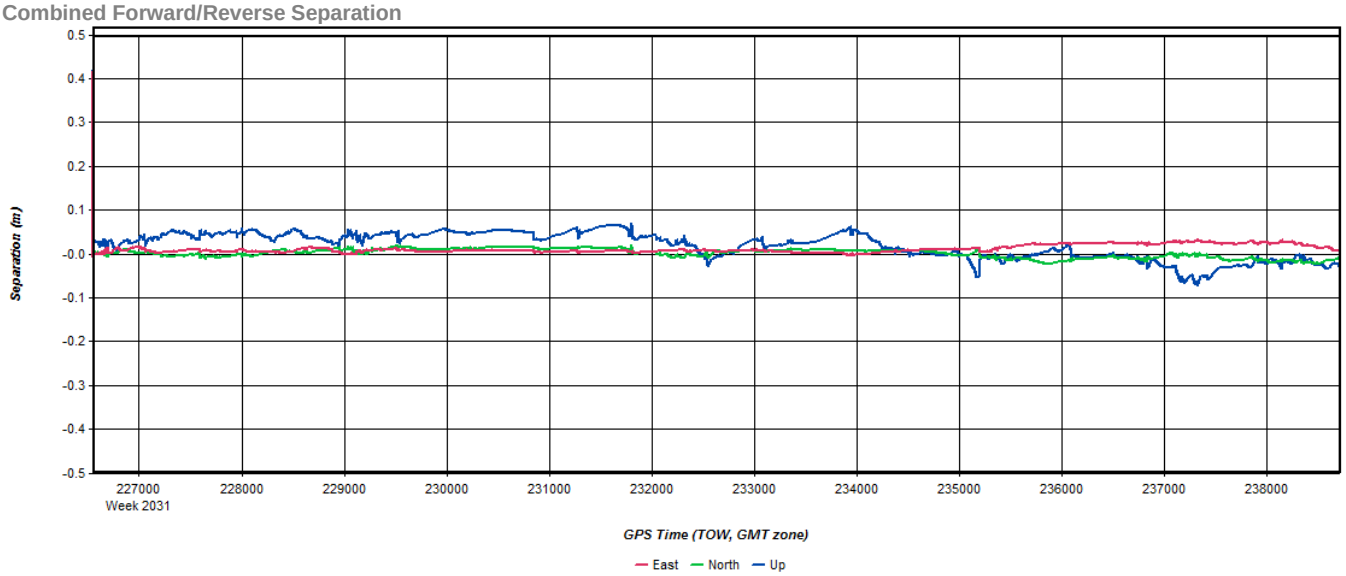
Quality Factor



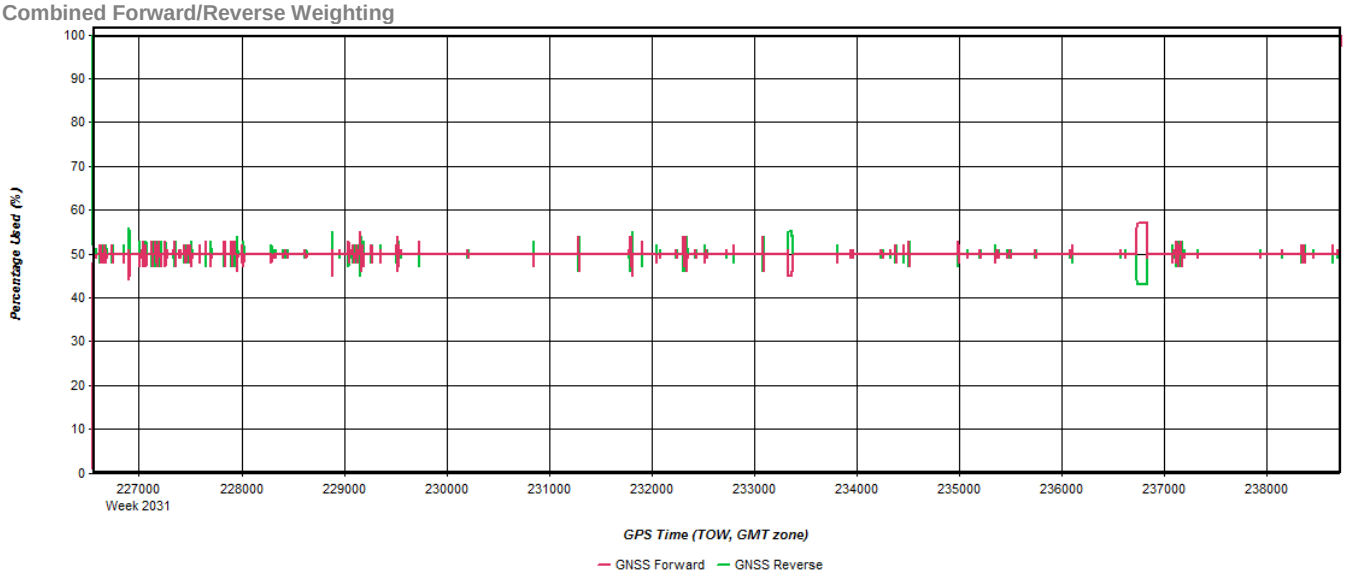
Height



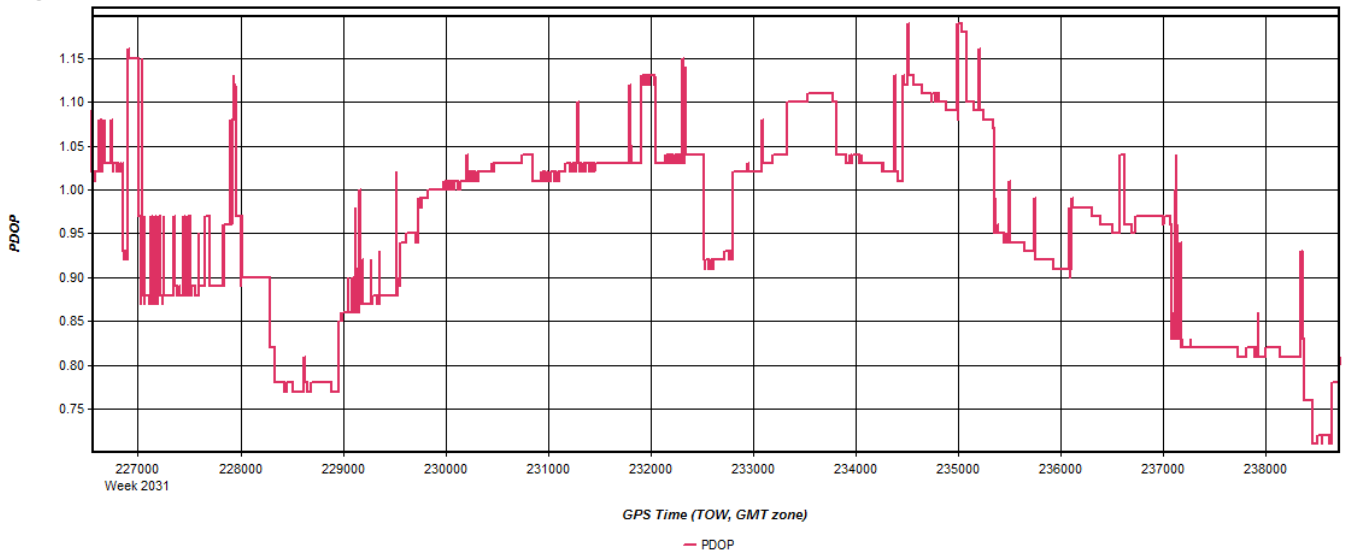
Combined Forward/Reverse Separation



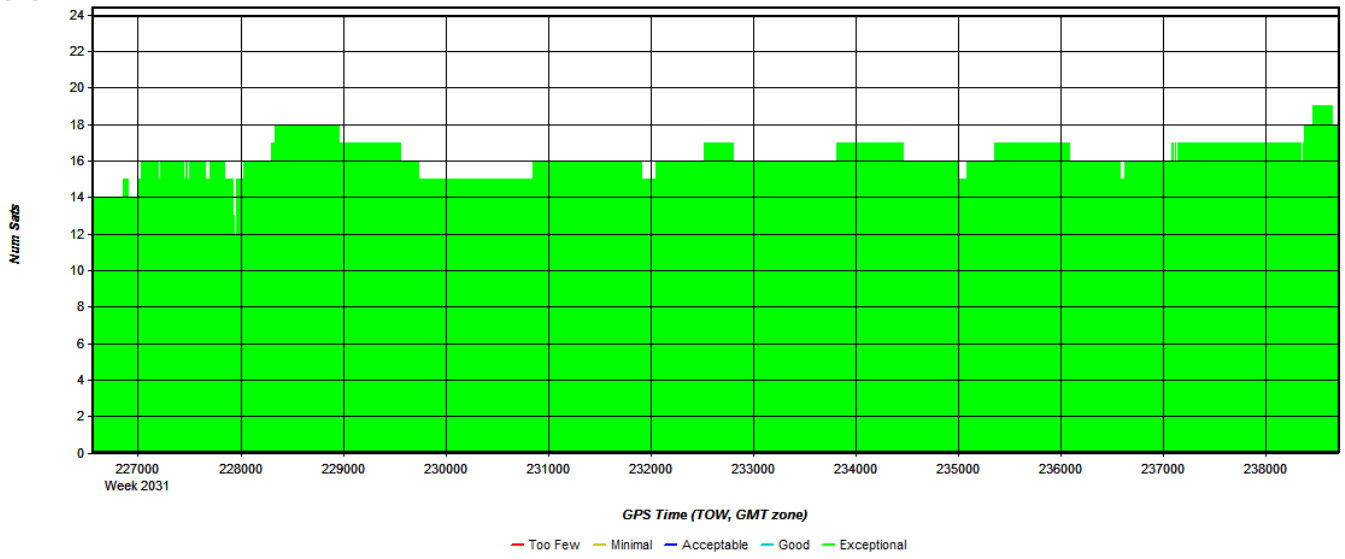
Combined Forward/Reverse Weighting



PDOP


PDOP
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
227000
Week 2031
228000
229000
230000
231000
232000
233000
234000
235000
236000
237000
238000
GPS Time (TOW, GMT zone)
PDOP

SVs


Num Sats
24
22
20
18
16
14
12
10
8
6
4
2
0
227000
Week 2031
228000
229000
230000
231000
232000
233000
234000
235000
236000
237000
238000
GPS Time (TOW, GMT zone)
Too Few
Minimal
Acceptable
Good
Exceptional