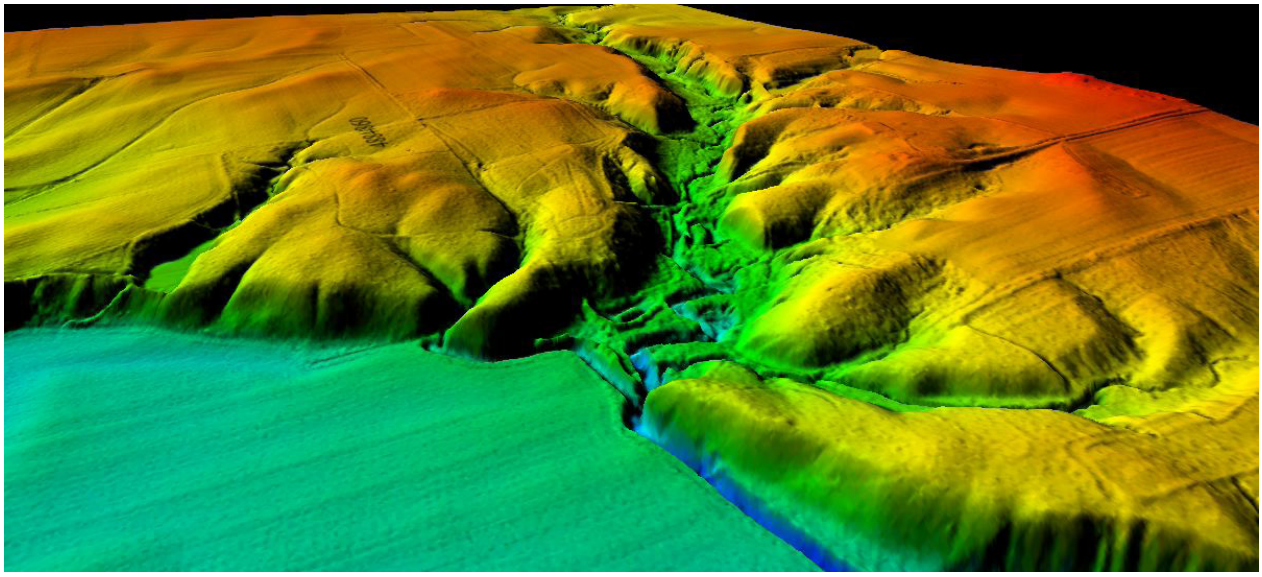
2014 Kankakee County, Illinois
1 PPSM
LiDAR Report



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Quantum Spatial Project No: 1140310.01

Table of Contents

1 PPSM LiDAR Survey

Kankakee County, Illinois

1. Introduction

This report contains a summary of the Light Detection and Ranging (LiDAR) data acquisition and processing for the project area to include Kankakee County, Illinois.

1.1 Contact Info

Questions regarding the technical aspects of this report should be addressed to:

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Sheboygan, WI 53083
Attention: Sonja Ellefson (Certified Photogrammetrist)
Phone: (920) 803-5825
Email: sellefson@quantumspatial.com

1.2 Purpose

Quantum Spatial acquired high accuracy LiDAR data of Kankakee County, Illinois in accordance with needs outlined by the Facilities and Services, Planning Division of the University of Illinois at Urbana-Champaign. Data provided to Facilities and Services will aid in analysis, planning and management of Kankakee County.

1.3 Project Locations

This project consisted of Kankakee County, Illinois. The area of acquisition is approximately 677 square miles, located in northeastern Illinois. Image 1.3 on the following page shows the relative location of this area.

1.4 Time Period

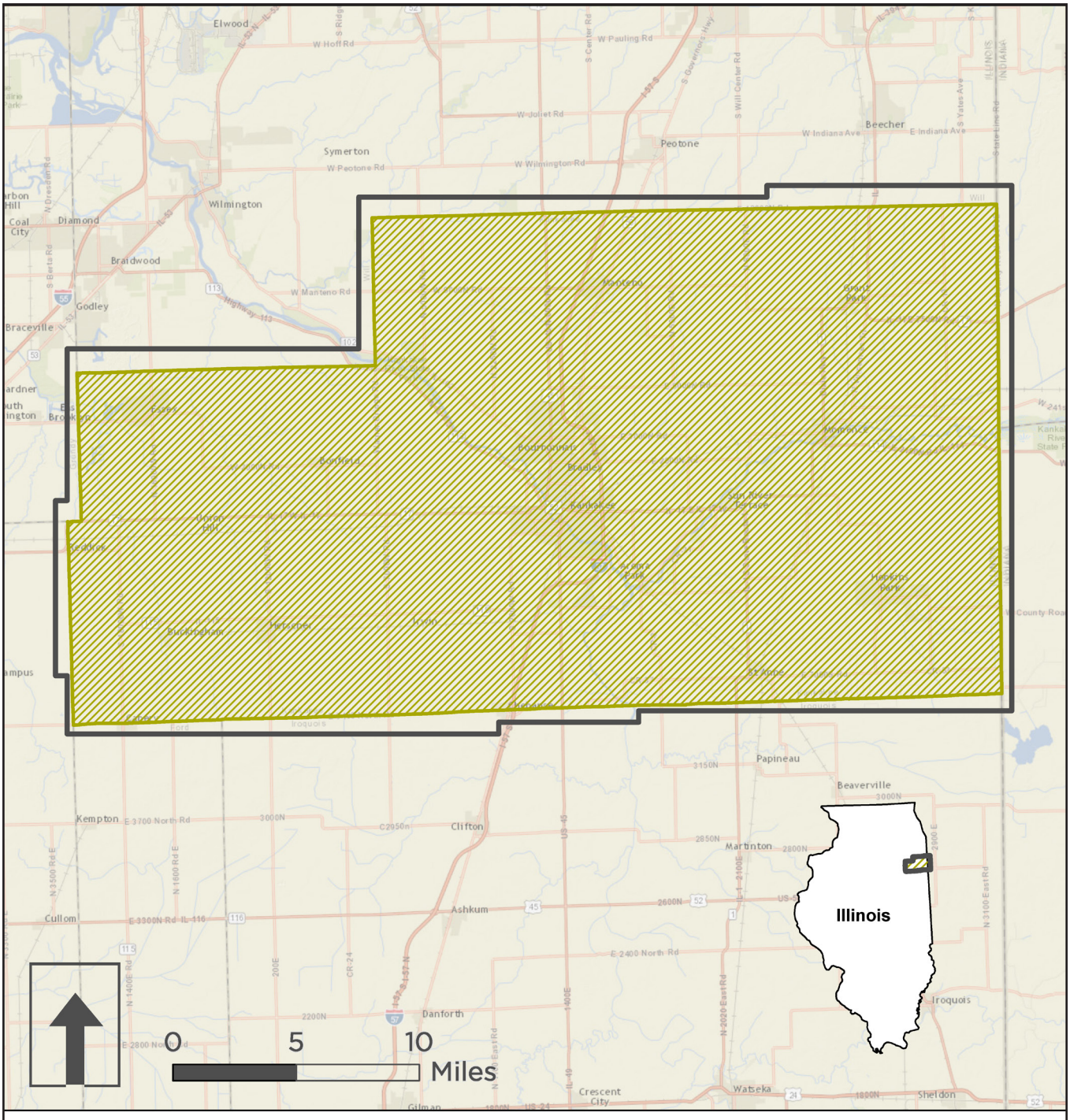
LiDAR data acquisition for complete coverage of the project occurred between April 12th and April 19th, 2014. Data collection was completed in five (5) flight missions totaling one hundred forty-nine (149) flight lines, including cross flights.

1.5 Project Scope

Data acquired with aircraft and LiDAR sensor operated by Quantum Spatial, Inc. is high accuracy LiDAR topographic data and is complete for the surface of Kankakee County. The project area is approximately 677 square miles.

As documented in the Task Order, collected data was to achieve a Fundamental Vertical Accuracy (FVA) of 18.13cm (0.59 ft) at a 95% confidence level, and have an RSME of 9.25cm (0.30 ft) in the open terrain land cover category based on a Triangulated Integrated Network (TIN) of the LiDAR points and from values of the Digital Elevation Models (DEM) derived from LiDAR data.

Image 1.3: The image below shows the Kankakee County study area.



KANKAKEE COUNTY LIDAR SURVEY
PROJECT OVERVIEW

Kankakee County LiDAR Project Area

Kankakee County

2. Geodetic Control

Ground surveys were conducted to provide control points for LiDAR dataset indexing. Additional ground control points were collected in represented ground cover categories to provide for vertical accuracy assessment of the dataset pursuant to Federal Emergency Management Agency (FEMA) guidelines.

3. LiDAR Acquisition and Procedures

Image 3.1: Underbelly of QSI aircraft

3.1 Acquisition Time Period

LiDAR data acquisition and Airborne GPS control were completed between April 12th and April 19th, 2014. Data from the five (5) flight missions are included in the project.

3.2 LiDAR Planning

The LiDAR data for this project was collected with an aircraft operated by Quantum Spatial. The aircraft was equipped with LiDAR sensor systems as well as systems to collect GPS and IMU positioning data during flight. All flight planning was completed using Leica MissionPro software and data collection was completed using a Leica ALS70 sensor.

3.3 LiDAR Acquisition

Data acquired from five (5) flight missions were utilized to provide project area coverage. Refer to Table 3.0 for acquisition parameters. Acquired swaths can be seen in Image 3.0 on the following page. Section 7 contains the flight logs.

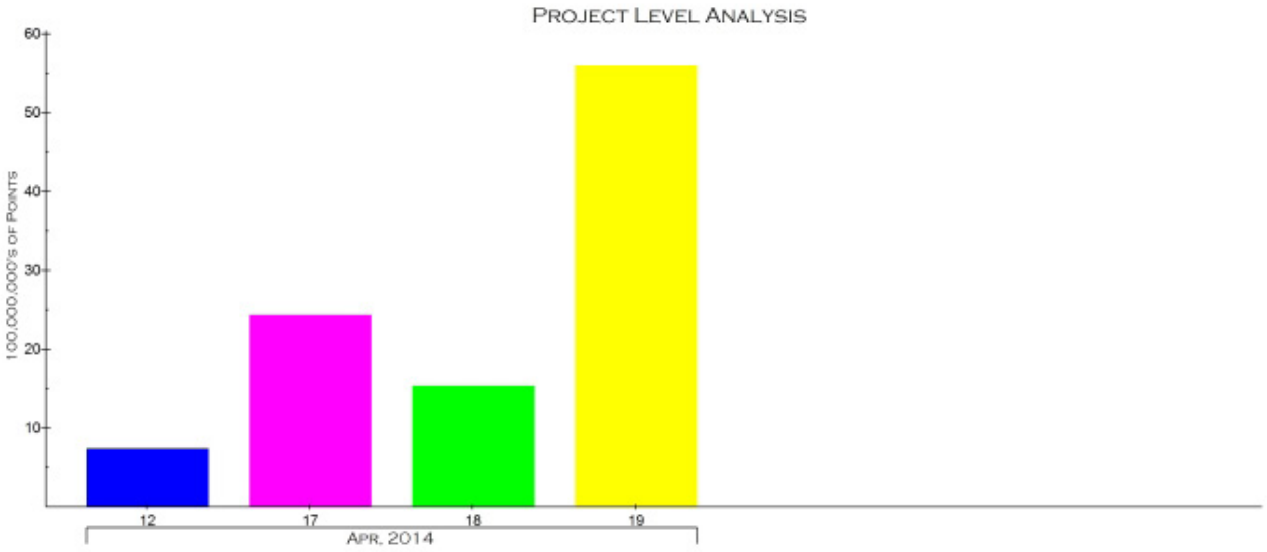
A Leica ALS70 sensor was used on board a fixed-wing aircraft. Airborne GPS and IMU position and trajectory data of the LiDAR sensor were also acquired during the time of flight.

Before take-off, the LiDAR system and the Airborne GPS and IMU system were initialized for a period of five minutes and continued in operation after landing for another five minutes. The missions acquired data according to the planned flight lines and included a minimum of one (usually two) cross flights. The cross flights were flown perpendicular to the planned flight lines and their was data used in the in-situ calibration of the sensor.

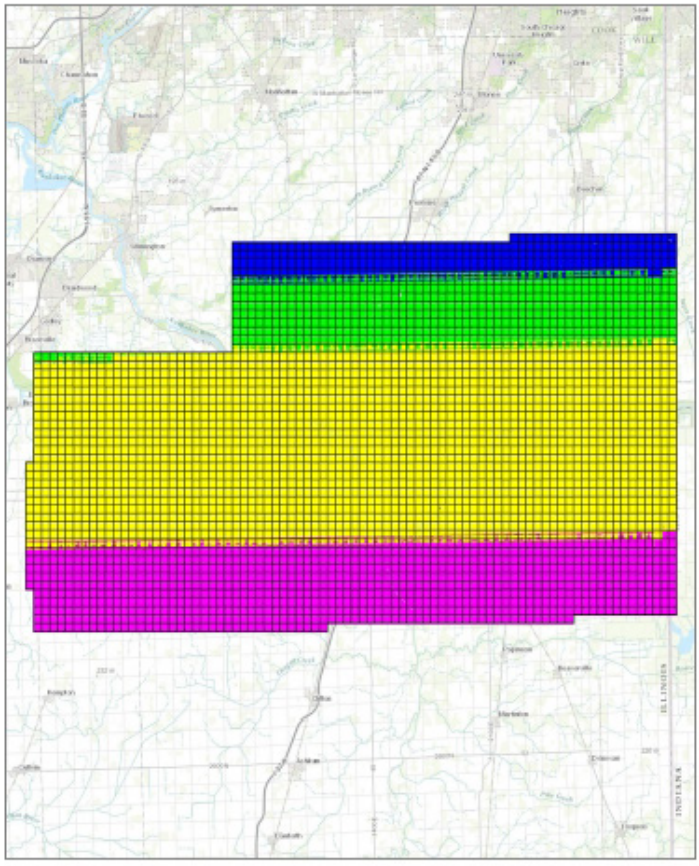
Table 3.0: Acquisition Parameters
1 point per square meter (ppsm)

Sensor Type	Leica ALS - 70
Sensor ID	SN7161
Field of View	+/- 20 degrees
Flying Height (Above Ground Level)	1,900 meters
Pulse Rate Frequency	273 kHz
Scan Angle (degrees)	40 degrees
Ground Speed	150 kts
Targeted Pulse Density	1.0 ppsm
Minimum Overlap	55%

Image 3.3a: Swaths for 1 point per square meter (ppsm) data, colored by mission date.



APRIL, 2014			
Day	Key	# of Points	% of Overall
12		735,570,602	7.2%
17		2,429,255,174	23.6%
18		1,528,651,505	14.9%
19		5,578,334,281	54.3%



4. Quality Control Surveys

Ground survey points were collected by Quantum Spatial, Inc. The point measurements were used in calibration and evaluation of LiDAR data position.

See Section 9 for further details of the ground survey control data.

5. LiDAR Calibration and Processing

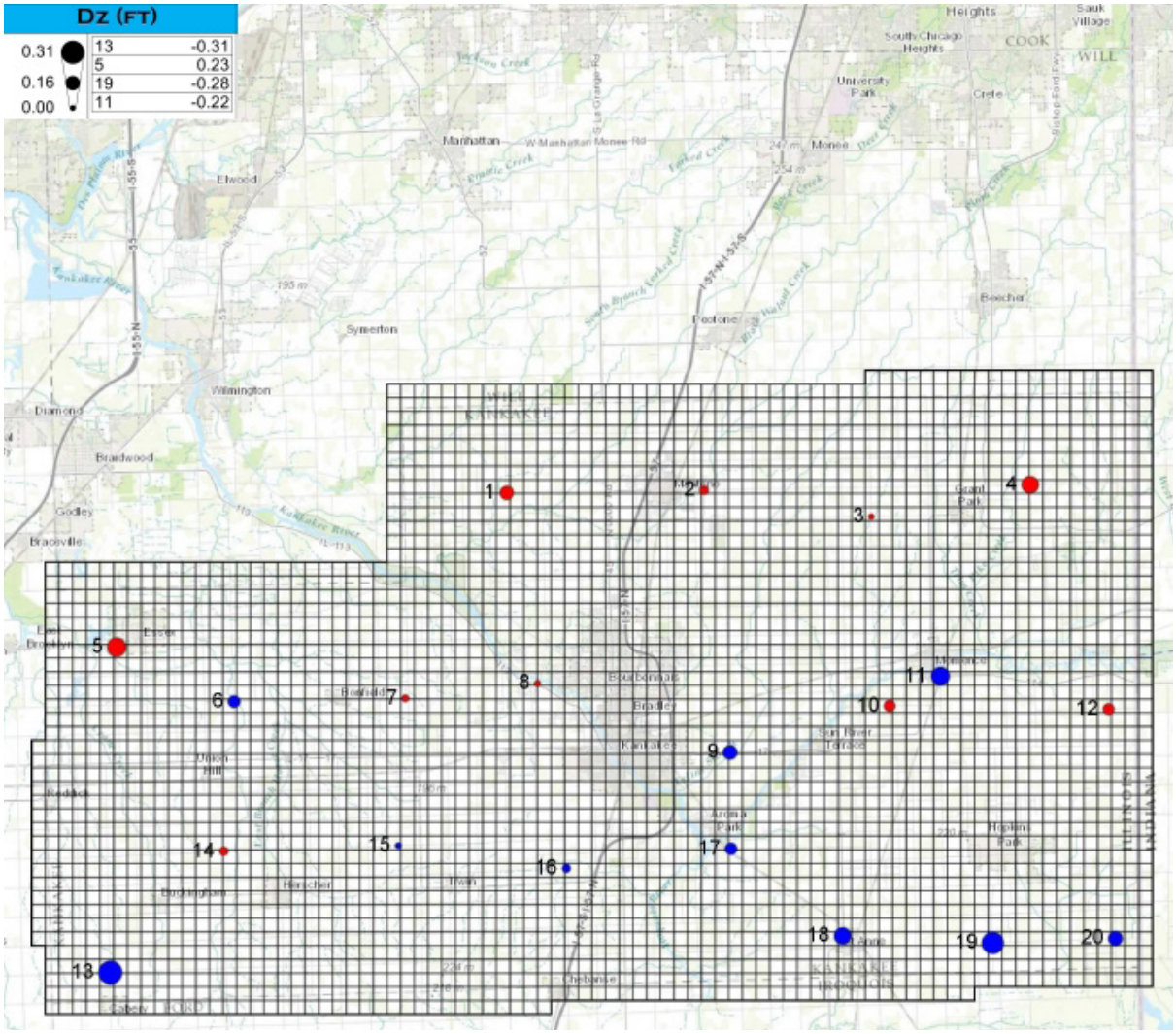
5.1 LiDAR Calibration

Table 5.1 LiDAR Calibration Steps	Software Used
Resolve GPS kinematic corrections for aircraft position and aligns all source data by time and filters. Smoothes the data, and provides a trajectory file indicating the latitude, longitude, ellipsoidal height, roll, pitch and heading of the scanner at intervals of 1/200 second in .sol format.	**Leica IPAS TC v. 3.2**
Calculate laser point position by associating .sol file information to each laser point return time, with offsets relative to scan angle, intensity, etc. included. As part of this process, correction for atmospheric refraction (bending) of the light path and correction for variations in the speed of light over the path are made. The post processor also provides inputs for various alignment coefficients (e.g., roll, pitch, heading, range offsets, etc.).This process creates the raw laser point cloud data for the entire survey in *.las (ASPRS v1.2) format, in which each point maintains the corresponding scan angle, return number (echo), intensity, and x, y, z information.	**Leica ALS Post Processor v. 2.75 Build #25**
Import .las strips from ALS Post Processer into GeoCue for calibration. Populate relative bin layout of mission extent. Filter bins for noise and run ground by flight line macro for calibration.	**GeoCue v. 2013.1.45.1**
Test relative accuracy using ground classified points per each flight line. Perform automated line-to-line calibrations for system attitude parameters (pitch, roll, heading), mirror flex (scale). Calibrations are performed on ground-classified points from paired flight lines. Every flight line is used for relative accuracy calibration.	**TerraMatch v. 14, TerraScann v.14, GeoCue v. 2013.1.45.1**
QC each mission line-to-line calibration by running DZ-orthos for each mission and after each mission is merged together for final project coverage	**GeoCue v. 2013.1.45.1**
Assess Fundamental vertical accuracy via direct comparisons of LiDAR data points to ground survey data.	**TerraScan v.13**
Assess vertical accuracy via direct comparisons of Digital Elevation Models to ground survey data.	**TopoAnalyst**

5.2 LiDAR Processing

The LAS files are imported, verified, and parsed into manageable, tiled grids using GeoCue version 2012.1.27.7. GeoCue allows for ease of data management and process tracking. Relative accuracy of flight-line to flightline alignment is assessed. Image 5.2a illustrates relative vertical alignment of flightlines.

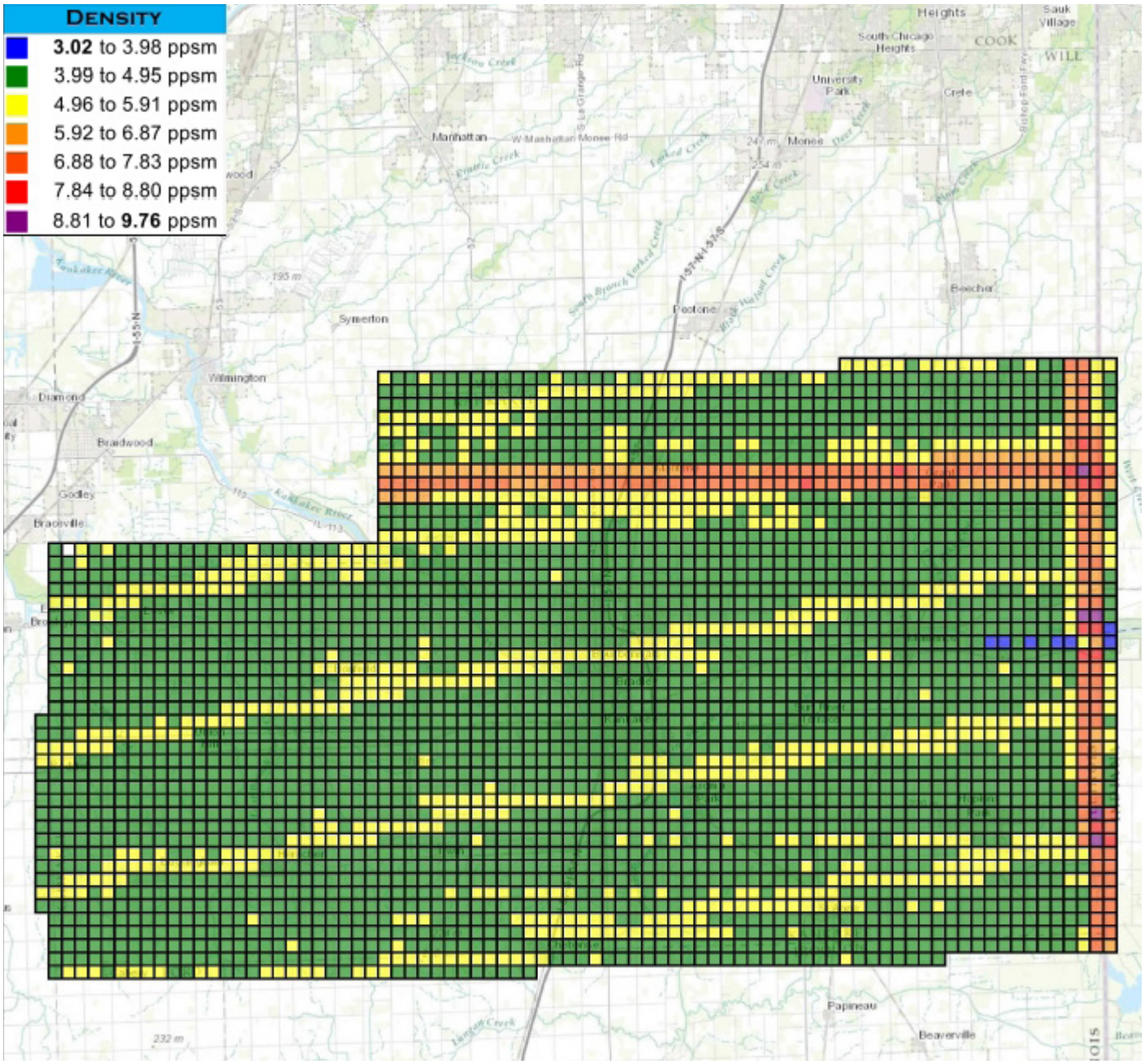
Image 5.2a: Relative Accuracy Assessment



Areas containing dense vegetation coverage or inundation from water will show a greater elevation offset than is actually present in the ground data. This is due to these regions having a high number of returns from vegetation or non-ground objects and few returns from the ground causing the elevation offset to be exaggerated.

Each tile within the study area is evaluated to ensure that the desired point density has been met. Image 5.2b illustrates the results of the point density analysis. Quantum Spatial utilizes proprietary software to complete this task. A grid, sized according to the USGS version 13 specifications, based on the nominal post spacing, is used for point analysis. The USGS version 13 specification allows that a grid size up to 2 times the nominal post spacing be used. Point density is analyzed on the basis of this grid space size or cell and the result indicates the point density of the sampled tiles.

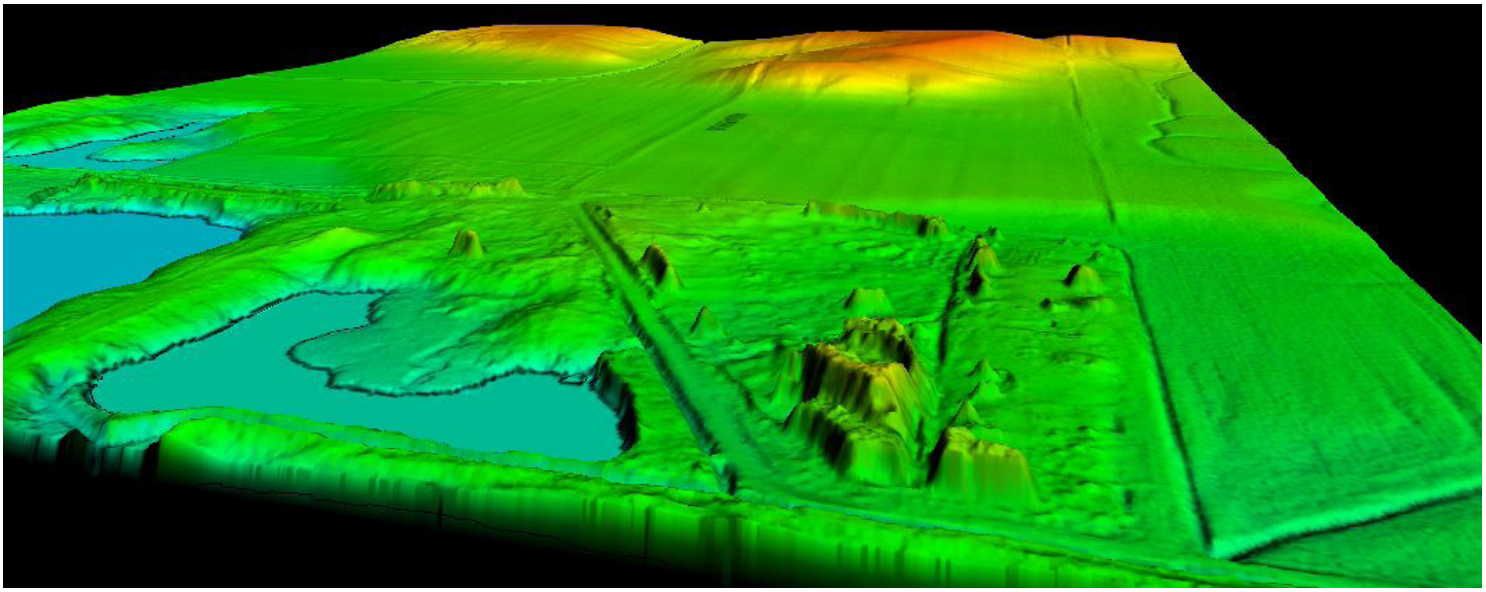
Image 5.2b: Point density analysis



Once both the accuracy between swaths and data density is accepted an automated classification algorithm is performed using TerraSolid's TerraScan, version 013.011. This produces the majority of the bare-earth datasets. Further, the data is processed to classify specific vegetation classes and man-made structures.

The remainder of the data is classified using manual classification techniques. The majority of the manual editing involves changing points initially classified as ground (class 2), to unclassified or non-ground (class 1). Erroneous low points and high points, including clouds, are classified to Noise (class 7).

Image 5.2c: Bare earth ground model representation of LiDAR points.



5.3 Check Point Validation

To ensure position of the assembled data it is verified against surveyed ground control data. TerraScan computes the vertical differences between surveyed ground control points and LiDAR collected points.

Check points are surveyed within the project area to provide calibration checks of the LiDAR point cloud. A report indicating comparative positional statistics is produced when LiDAR has been adjusted to control and can be found in Section 9 of this report.

Twenty (20) ground check points were made across the project area to be used in adjusting the data to position. These twenty points were collected by Quantum Spatial, as part of the ninety nine (99) control points collected for the project as described in Section 4, acquired from May 13th to May 15th, 2014.

5.4 Vertical Accuracy Assessment

Vertical accuracy assessment is conducted by comparing ground survey check point z values to processed LiDAR data z values by horizontal proximity. Differences in z values are calculated to express an RMSEz value.

The Fundamental Vertical Accuracy (FVA) of the LAS data achieved 10.30 cm at a 95% confidence level with an RMSE of 5.26 cm utilizing twenty (20) Open Terrain ground survey check points compared to a Triangulated Integrated Network (TIN) of the LiDAR points.

See attached "Final_Delivery_Report" and Section 10-Accuracy Assessment for details of the ground survey control data.

Table 5.1: FVA Data Compared to TIN

	Ground Cover Category	Number of Checkpoints	Result cm (ft.)
FVA	Open Terrain	20	10.30 cm (0.34 ft.)
RMSEz	Open Terrain	20	5.26 cm (0.17 ft.)

The Supplemental Vertical Accuracy (SVA) and Consolidated Vertical Accuracy (CVA) results are in the following table. Ground survey check points made in various ground cover categories are compared to Digital Elevation Models (DEM) derived from the LiDAR data.

Table 5.2: Accuracy Results

	Ground Cover Category	Number of Checkpoints	Result cm (ft.)
FVA	Open Terrain	20	10.30 cm (0.34 ft.)
CVA	All Categories	99	13.85 cm (0.45 ft.)
SVA	Urban	19	5.52 cm (0.18 ft.)
SVA	Tall Grass	20	13.21 cm (0.43 ft.)
SVA	Brush	20	17.94 cm (0.59 ft.)
SVA	Forest	20	10.71 cm (0.35 ft.)

5.5 LiDAR Data Delivery

Point cloud data supplied is in the following format:

- LAS, version 1.2
- GPS times adjusted to Adjusted Standard GPS time

Classified point cloud data is also being supplied using the following criteria.

- LAS, version 1.2 in 2,500 foot grid
- Classification scheme:
    1 - Unclassified
    2 - Ground
    3 - Low Vegetation
    4 - Medium Vegetation
    5 - High Vegetation
    6 - Building
    7 - Low Point (noise)
    8 - Model Key-point
    9 - Water
    10 - Ignored Ground

LiDAR-derived products:

- 2.5 ft resolution hydro-flattened DEM in *.img format
- TIN surface provided in *.TIN format, by tile
- DAT, output with TIN from Geopack, in *.dat format

Shapefiles:

- Hydro breaklines (Microstation *.dgn and ESRI geodatabase format)
- *Las delivery tile index (Microstation *dgn and ESRI geodatabase format)

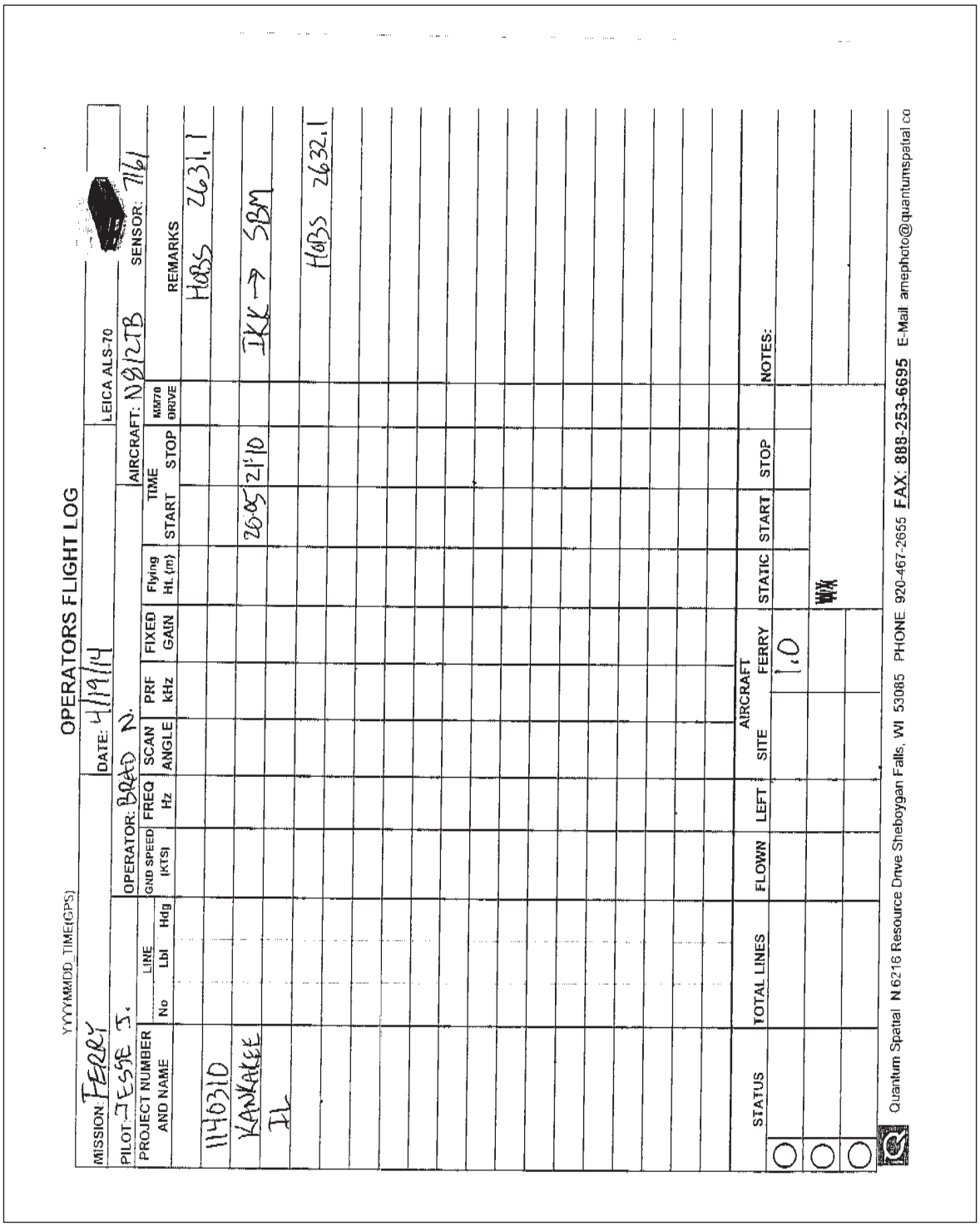
USGS-compliant metadata for delivered products

6. Conclusion

Sound procedures and use of new technologies ensure this project data and derivative products will serve as reliable information and models for the University of Illinois Urbana - Champaign. The models produced are accurate and representative of surface conditions at the time of data acquisition.

7. Flight Logs

Image 7.1 a: Mission Ferry



OPERATORS FLIGHT LOG

YYYYMMDD_TIME(GPS)

MISSION: FERRY | DATE: 4/19/14 | LEICA ALS-70

PILOT: JESSE S. | OPERATOR: BRAD N. | AIRCRAFT: N8128 | SENSOR: 761

PROJECT NUMBER AND NAME	LINE No	LINE Lbl	LINE Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	Flying Ht. (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
1140310 KANKAKEE IL													HOBS 26311
										20:05	21:10		IK → SBM
													HOBS 26321

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP	NOTES:
○					1.0				
○						WX			
○									

Quantum Spatial N 6216 Resource Drive Sheboygan Falls, WI 53085 PHONE 920-467-2655 FAX: 888-253-6695 E-Mail amephoto@quantumspatial co

YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG 2 of 2

MISSION: 20140411_225147 | DATE: 20140411 B | LEICA ALS-70

PILOT: Jesse J | OPERATOR: Jonathan S | AIRCRAFT: N812TB | SENSOR: 7161

PROJECT NUMBER AND NAME	LINE No.	LINE Lbl	LINE Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	Flying Ht. (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
1140310	[redacted]	[redacted]	[redacted]	150	41	40	274	12:3	6952	2306		016	CS6→Site Hobbs 2594.3
Kan Will Co IL	524	64	270	148					6926	2313	2327		Reflight
	525	65	90	155					6930	2330	2344		Reflight
	526	66	270	144					6962	2347	0001		
	527	67	90	153					6860	0003	0017		
	528	68	270	154					6902	0020	0034		
	529	69	90	153					6864	0037	0051		
	530	70	270	148					6899	0053	0107		
	531	71	90	157					6886	0111	0124		
	532	72	270	149					6923	0127	0141		
	533	73	90	152					6917	0144	0158		
	534	74	270	148					6914	0200	0214		
	535	75	90	157					6903	0218	0231		
	536	76	270	158					6931	0235	0248		
	537	77	90	155					6912	0251	0305		
	X	Flight		149					6937	0308	0311		UL001
											0322		Site→CS6 Hobbs 2598.5

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP		NOTES
○		14		4.0	0.2		2259 0323	2304 0328		FWF=256@2ns 120kHz
○						[redacted]				
○										

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Apr. 12. 2014 11:50AM KANA HOTEL No. 8036 P. 2

www.QuantumSpatial.com

Image 7.1i: Mission 20140411_225147

YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG

MISSION: 20140417~ | DATE: 4-17-14 | LEICA ALS-70  | JS1

PILOT: JOSEY | OPERATOR: JIM/EMILY | AIRCRAFT: N812TB | SENSOR: 7161

PROJECT NUMBER AND NAME	LINE No.	LINE Lbl	LINE Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	Flying Ht. (m)	UTC TIME START	UTC TIME STOP	MM70 DRIVE	REMARKS
1140310										12:45	14:06	017	FERRY: SBM → IKK 1.3
KANAWHEE-FULL										14:42	14:57		FERRY: IKK → SITE .3
	583	123	270	150	41	40	274	12-3	2000	14:57	15:10		
	582	122	89	↓	↓	↓	↓	↓	↓	15:13	15:25		
	581	121	270							15:28	15:42		
	580	120	89							15:44	15:54		
	579	119	270							15:59	16:13		
	578	118	89							16:15	16:28		
	577	117	270							16:30	16:45		
	576	116	89							16:47	16:59		
	575	115	270							17:02	17:16		
10	574	114	89							17:18	17:30		
	573	113	270							17:33	17:47		
	572	112	89							17:49	18:02		
	X	OL01	5	↓	↓	↓	↓	↓	↓	18:04	18:07		
											18:24		FERRY: SITE → IKK .3
											19:06		FERRY: IKK → SITE .7

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP		NOTES:
⊘ 1140310	123	74/12	37	3.1	2.6	3.7	14:42	18:24		
○				5.7		WX HIGH CIRRUS VIS 15				
○										

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p.1
9204671220
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PAGE # 16

Image 7.1j: Mission 20140417

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YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG

MISSION: 20140417-233633 DATE: 4/17/14 → 4/18/14 LEICA ALS-70

PILOT: JESSE J. OPERATOR: BRAD N AIRCRAFT: N812TB SENSOR: 7161

PROJECT NUMBER AND NAME	LINE No.	LINE Lbl	LINE Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	Flying Ht. (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
1140310				150	41	40	274		6985	22:00		018	SBM → HOBS 2616.3
KANKAKEE											23:10		IKK
IL.													
										23:50			IKK → SITE
	538	078	270	147					6970	00:03	00:17		
	539	079	90	152					6950	00:20	00:33		
	540	080	270	147					7000	00:37	00:51		
	541	081	90	153					6950	00:54	01:07		
	542	082	270	147					6975	01:11	1:24		LT RAIN 15.15 nmi
	X	FLT	0	160					6975	01:26	1:27		CROSS FLIGHT
											01:40		SITE → IKK

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP	NOTES: CORS KA18
○				1.5	1.7		23:40	01:43	KA18 23:52 ; 01:37
○						WX WSW WINDS 20 KNOTS			-USE GPS BASE IKK-
○									FWF 256@2 NAD

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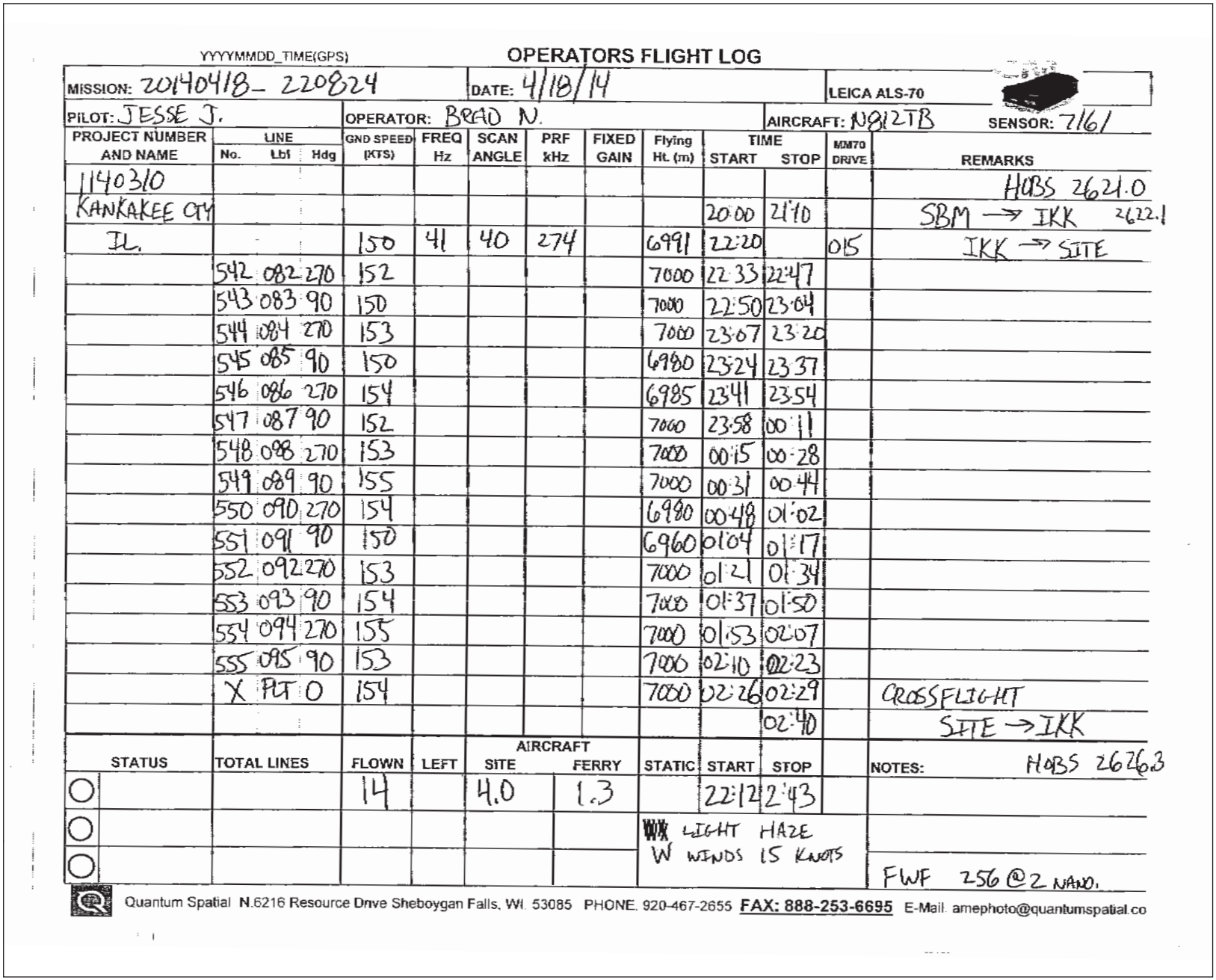
Image 7.1k: Mission 20140417_233633



YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG

MISSION: 20140418_220824 | DATE: 4/18/14 | LEICA ALS-70 SENSOR: 7161

PILOT: JESSE J. | OPERATOR: BRAD N. | AIRCRAFT: N812TB

PROJECT NUMBER AND NAME	LINE No.	LINE Lbl	LINE Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	Flying Ht. (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
1140310													HOBS 2621.0
KANKAKEE CTY										20:00	21:10		SBM → IKK 2622.1
IL.				150	41	40	274		6991	22:20		015	IKK → SITE
	542	082	270	152					7000	22:33	22:47		
	543	083	90	150					7000	22:50	23:04		
	544	084	270	153					7000	23:07	23:20		
	545	085	90	150					6980	23:24	23:37		
	546	086	270	154					6985	23:41	23:54		
	547	087	90	152					7000	23:58	00:11		
	548	088	270	153					7000	00:15	00:28		
	549	089	90	155					7000	00:31	00:44		
	550	090	270	154					6980	00:48	01:02		
	551	091	90	150					6960	01:04	01:17		
	552	092	270	153					7000	01:21	01:34		
	553	093	90	154					7000	01:37	01:50		
	554	094	270	155					7000	01:53	02:07		
	555	095	90	153					7006	02:10	02:23		
	X	PLT	0	154					7000	02:26	02:29		CROSSFLIGHT
											02:40		SITE → IKK

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP	
○		14		4.0	1.3		22:12	2:43	
○						WX LIGHT HAZE			
○						W WINDS 15 KNOTS			

NOTES: HOBS 2626.3

FWF 256 @ 2 NANO.

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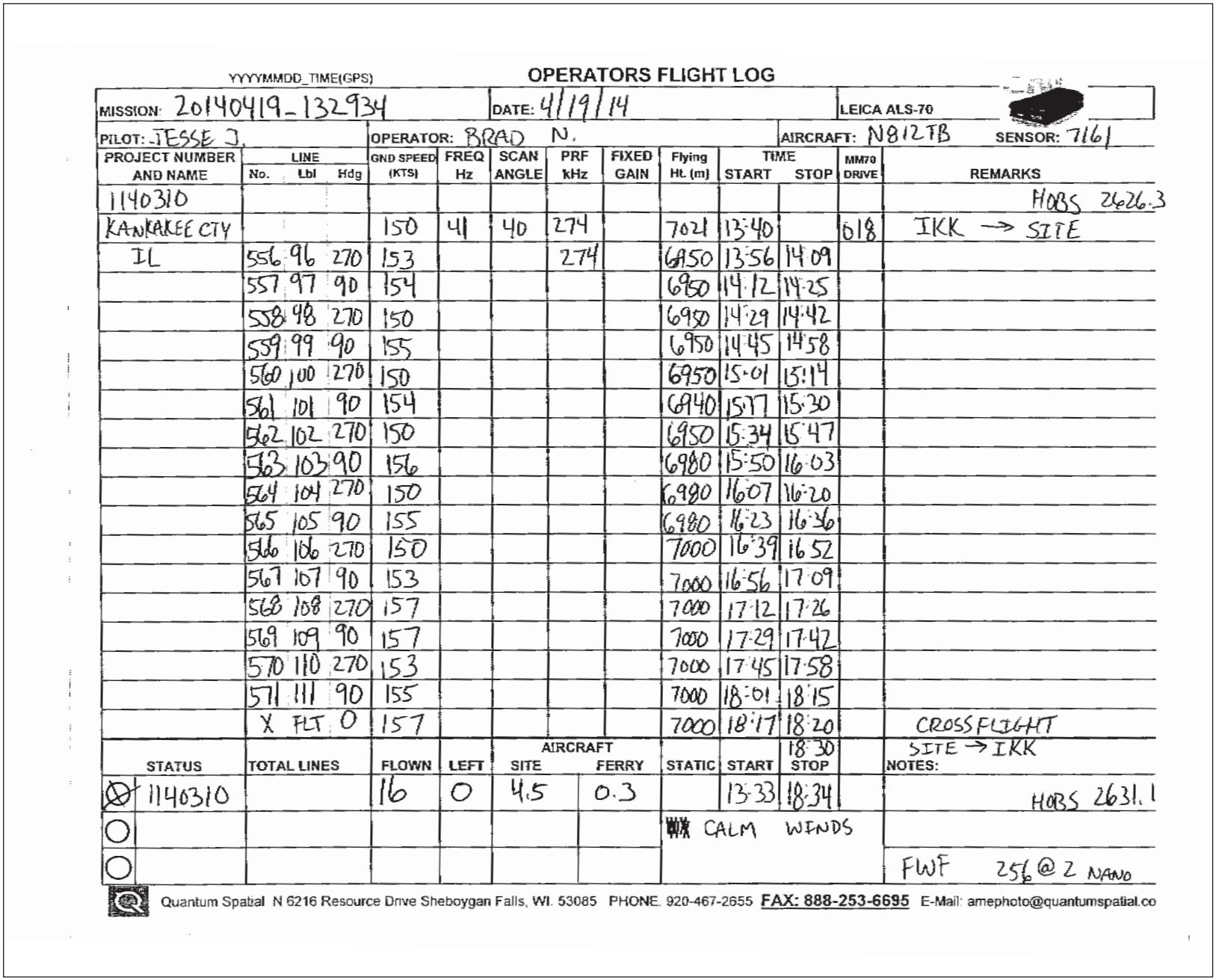
Image 7.1i: Mission 20140418_220824



YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG

MISSION: 20140419_132934 DATE: 4/19/14 LEICA ALS-70

PILOT: JESSE J. OPERATOR: BRAD N. AIRCRAFT: N812TB SENSOR: 7161

PROJECT NUMBER AND NAME	LINE No.	LINE Lbl	LINE Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	Flying Ht. (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
1140310													HOBS 2626.3
KANKAKEE CTY				150	41	40	274		7021	13:40		618	IKK → SITE
IL	556	96	270	153			274		6950	13:56	14:09		
	557	97	90	154					6950	14:12	14:25		
	558	98	270	150					6950	14:29	14:42		
	559	99	90	155					6950	14:45	14:58		
	560	100	270	150					6950	15:01	15:14		
	561	101	90	154					6940	15:17	15:30		
	562	102	270	150					6950	15:34	15:47		
	563	103	90	156					6980	15:50	16:03		
	564	104	270	150					6980	16:07	16:20		
	565	105	90	155					6980	16:23	16:36		
	566	106	270	150					7000	16:39	16:52		
	567	107	90	153					7000	16:56	17:09		
	568	108	270	157					7000	17:12	17:26		
	569	109	90	157					7000	17:29	17:42		
	570	110	270	153					7000	17:45	17:58		
	571	111	90	155					7000	18:01	18:15		
	X	FLT	0	157					7000	18:17	18:20		CROSS FLIGHT
											18:30		SITE → IKK

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP	NOTES:
⊘ 1140310		16	0	4.5	0.3		13:33	18:34	HOBS 2631.1
○						CALM WINDS			
○									FWF 256 @ 2 NANO

Quantum Spatial N 6216 Resource Drive Sheboygan Falls, WI. 53085 PHONE. 920-467-2655 FAX: 888-253-6695 E-Mail: amephoto@quantumspatial.co

8 LiDAR GPS Processing Plots

Image 8.0m: PDOP Plot for mission 20140411_213448

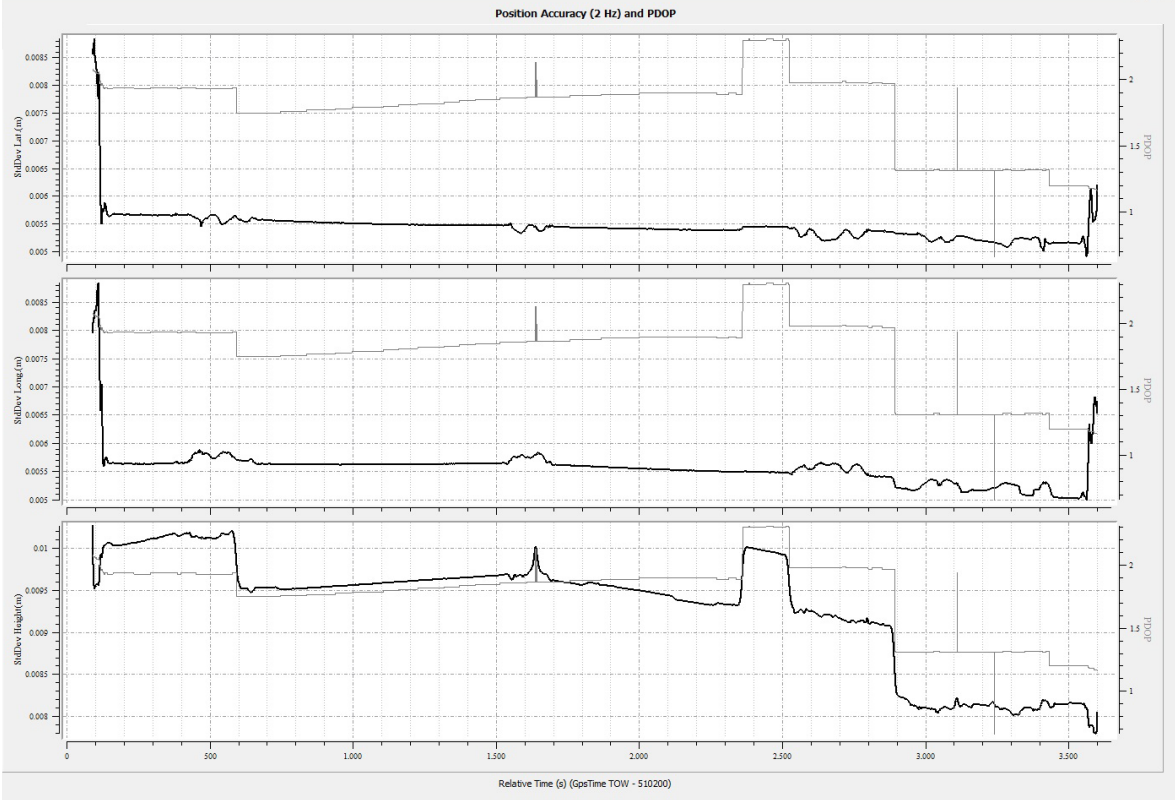


Image 8.0n: Separation Plot for mission 20140411_213448

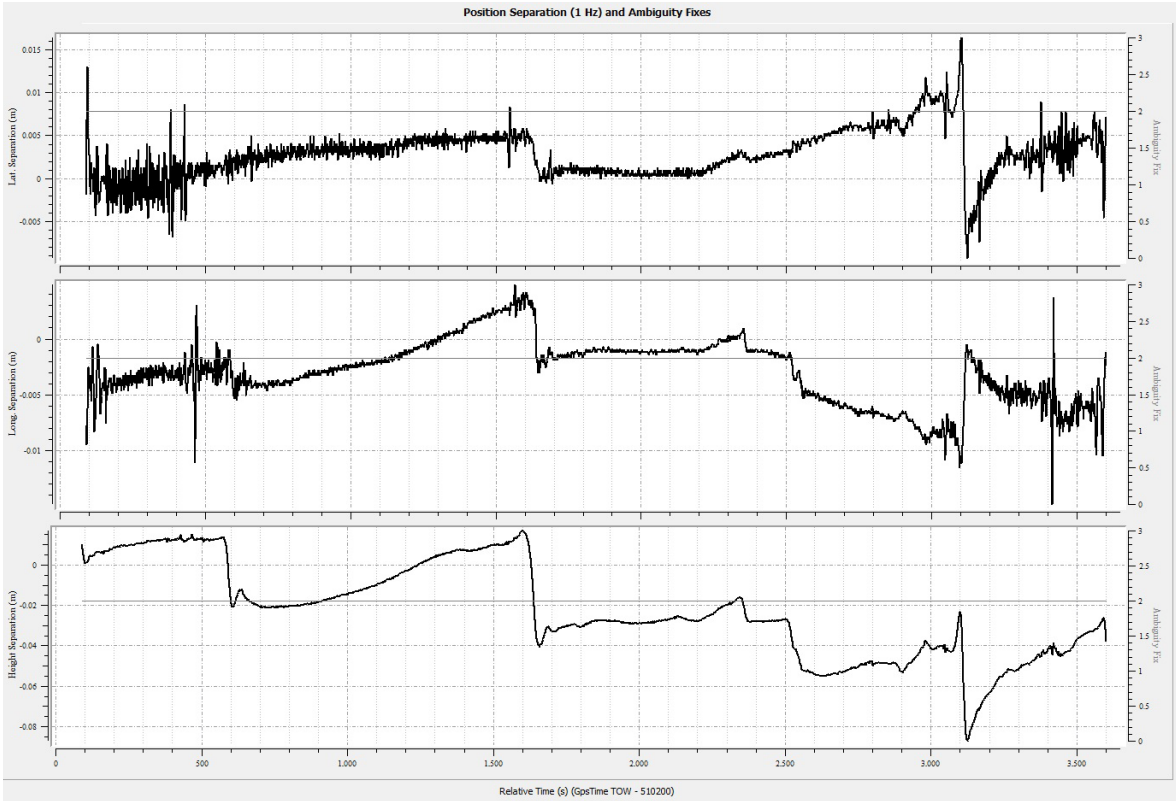


Image 8.0o: PDOP Plot for mission 20140417_143501

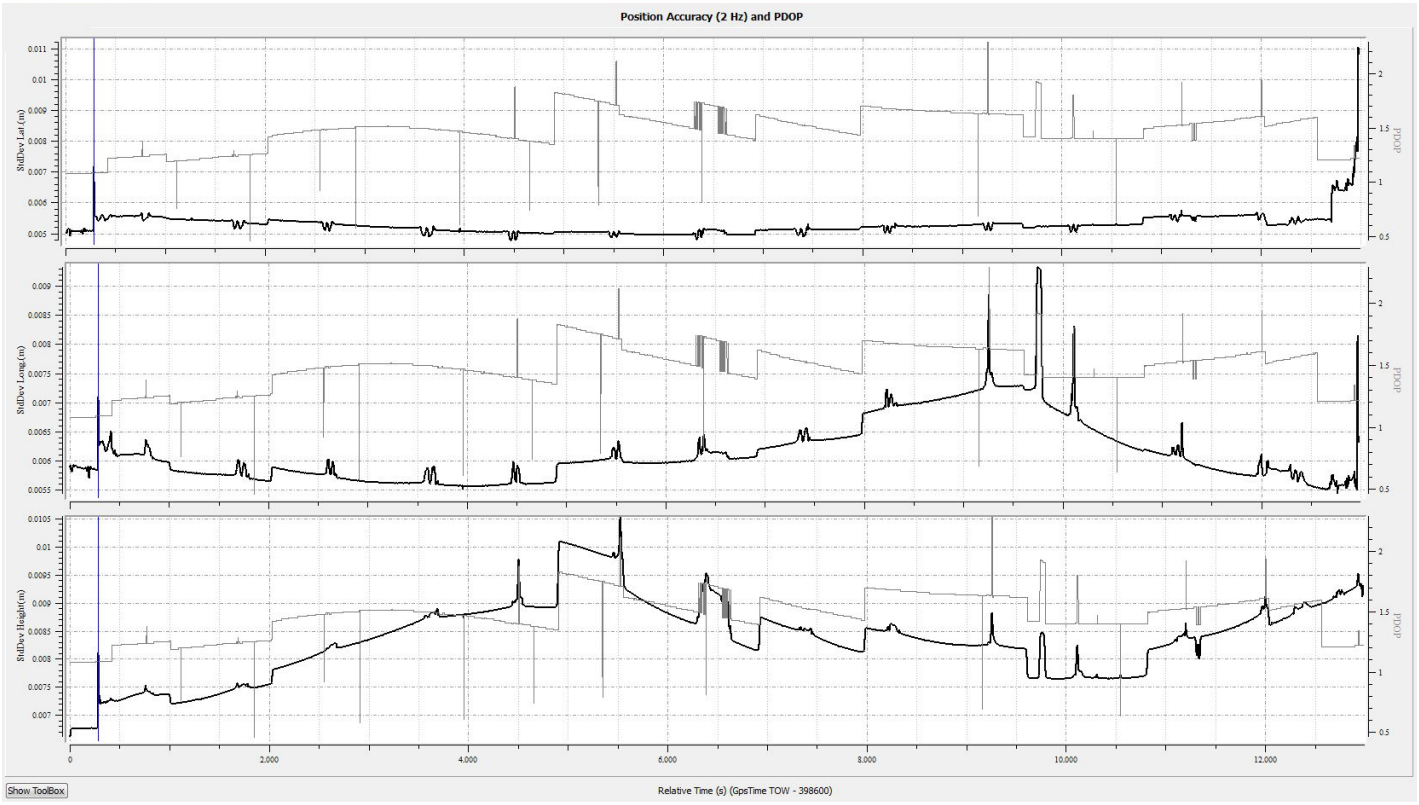


Image 8.0p: Separation Plot for mission 20140417_143501

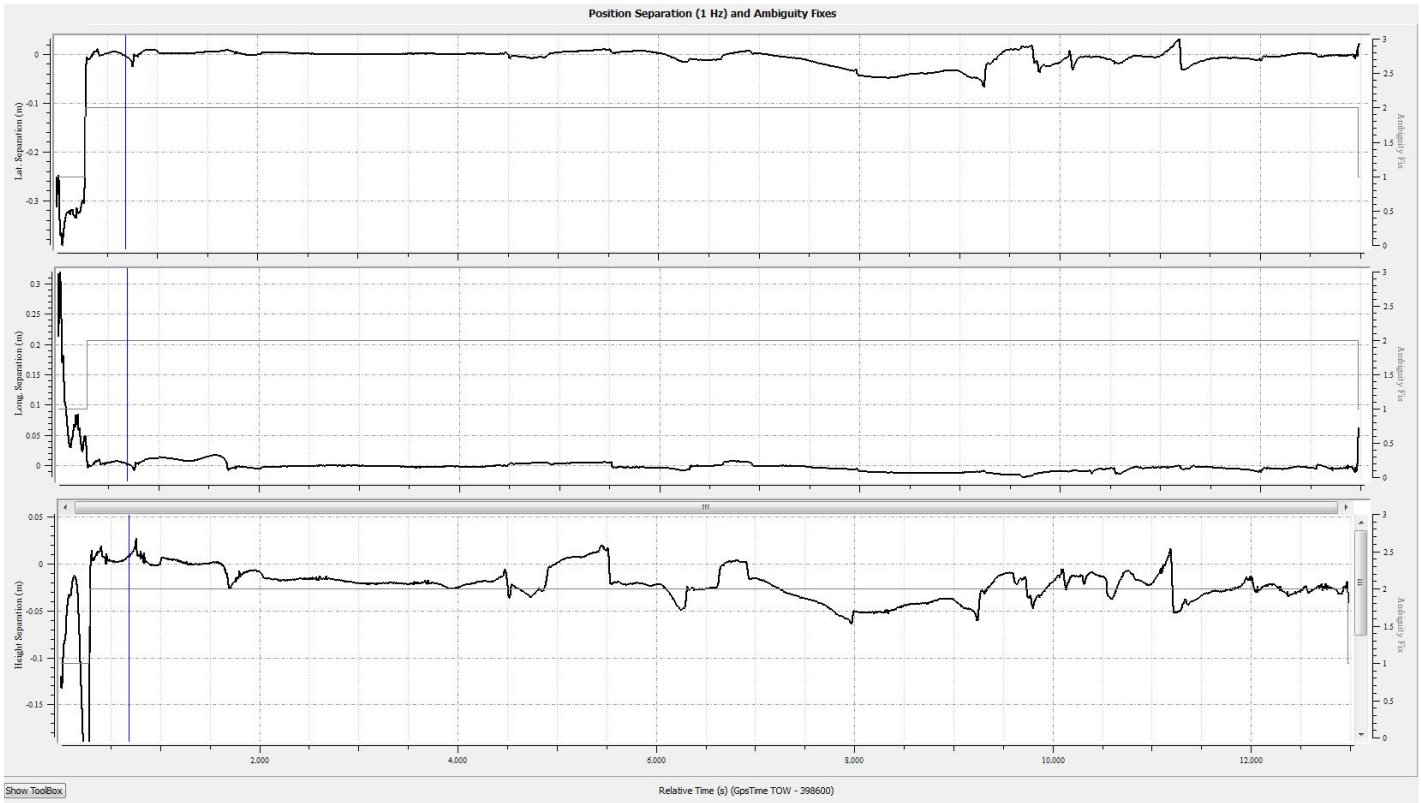


Image 8.0q: PDOP Plot for mission 20140417_233633

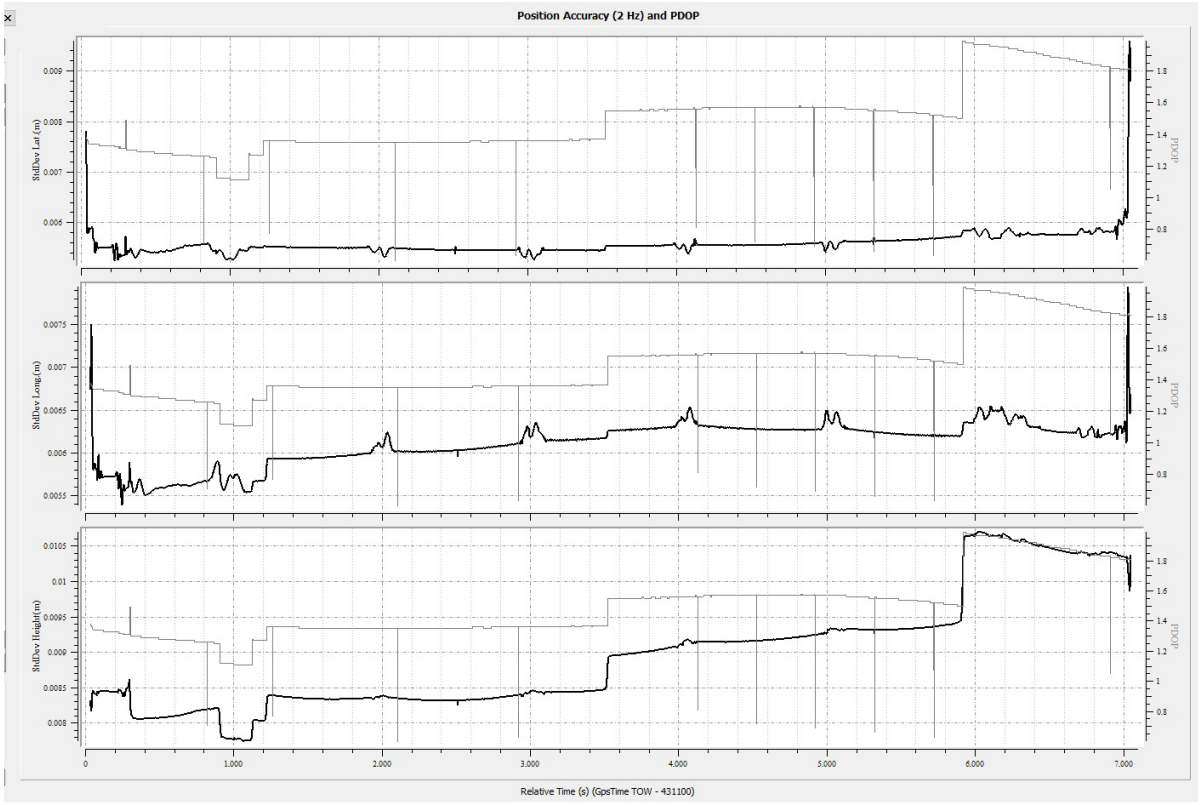


Image 8.0r: Separation Plot for mission 20140417_233633

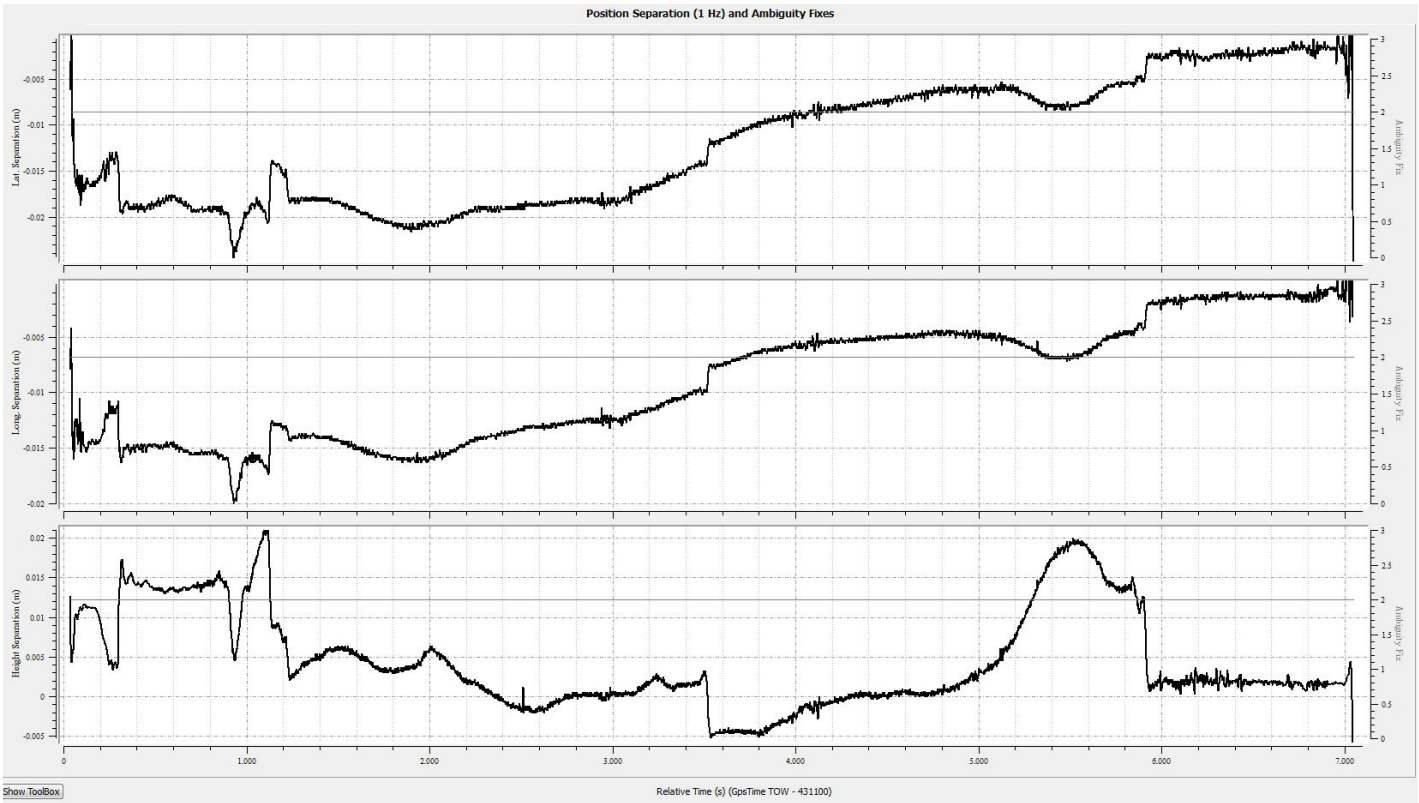


Image 8.0s: PDOP Plot for mission 20140418_220824

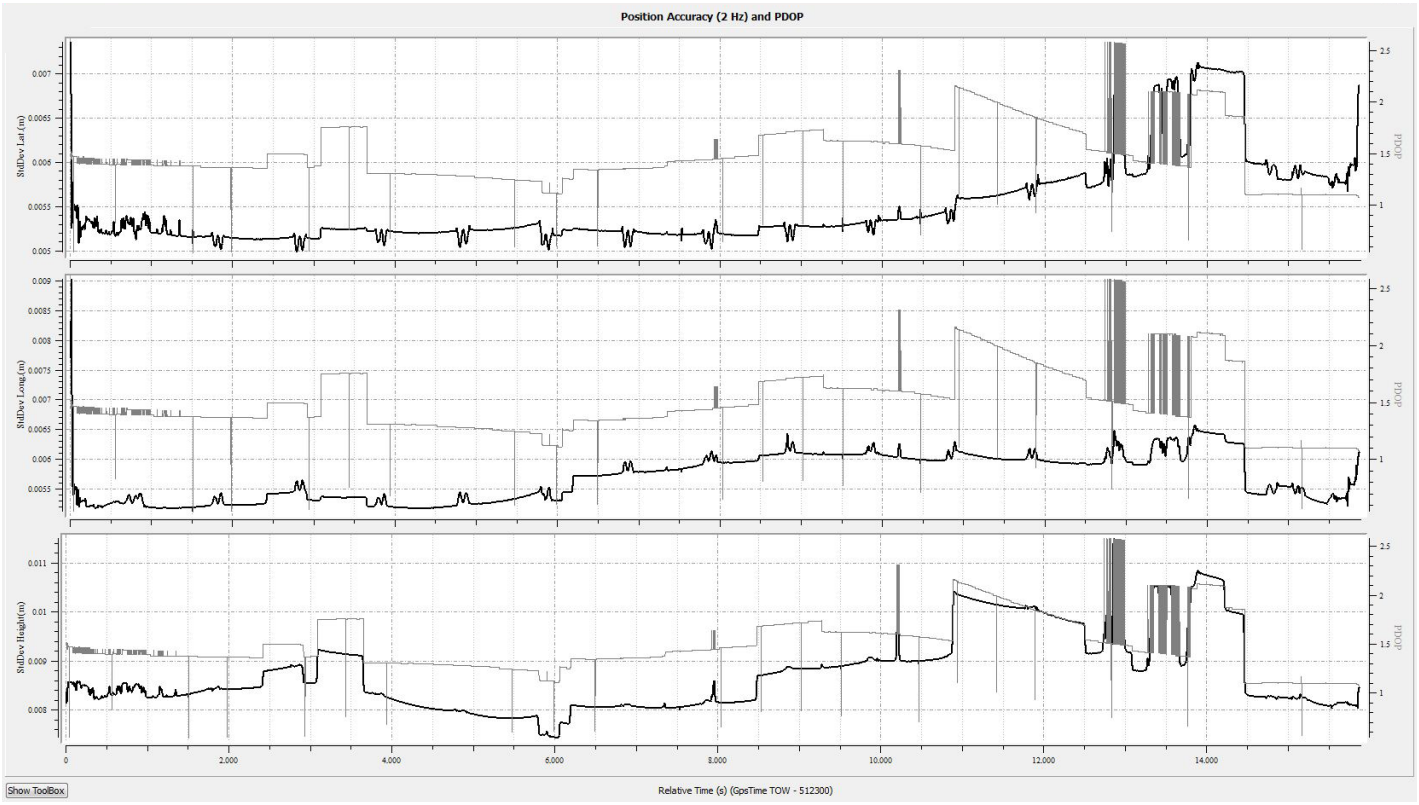


Image 8.0t: Separation Plot for mission 20140418_220824

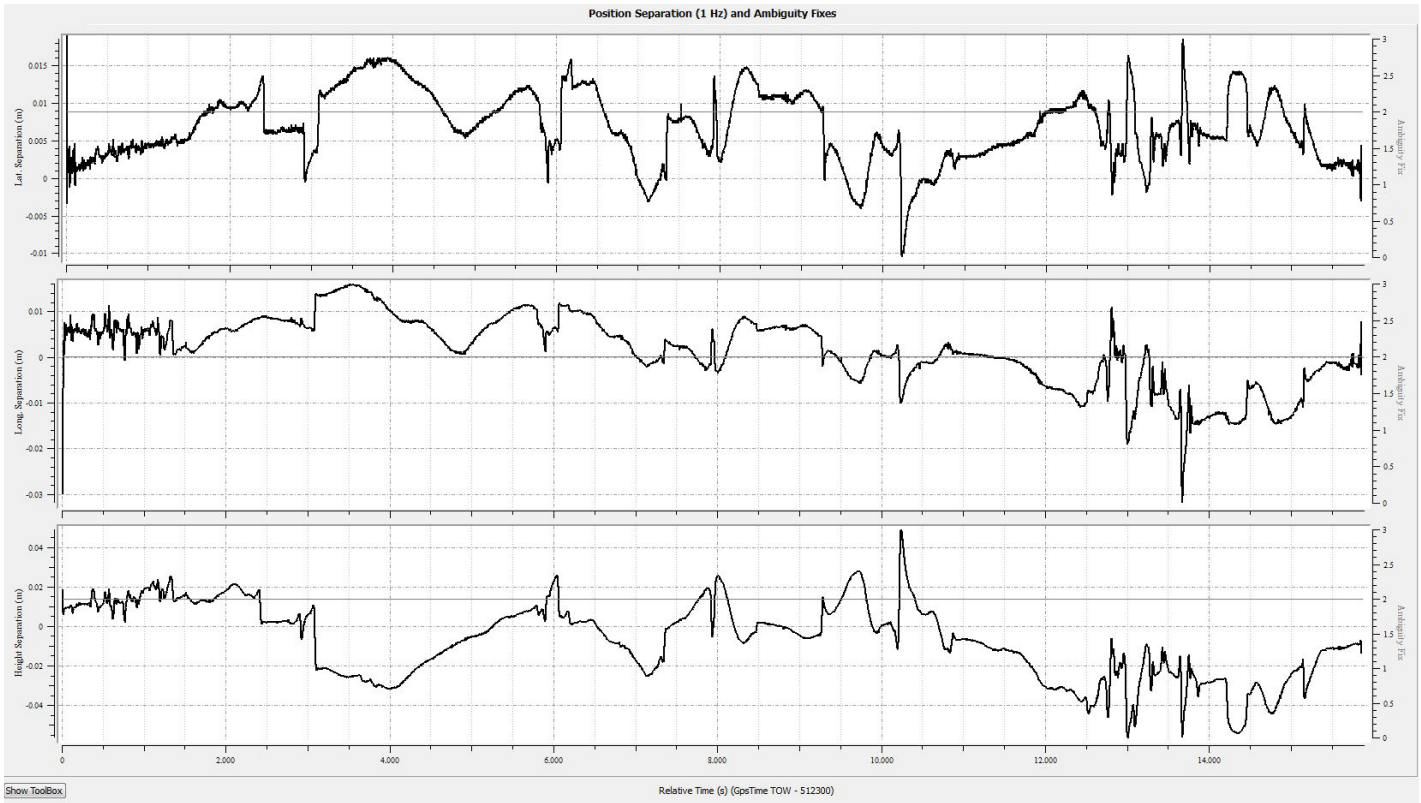


Image 8.0u: PDOP Plot for mission 20140419_132934

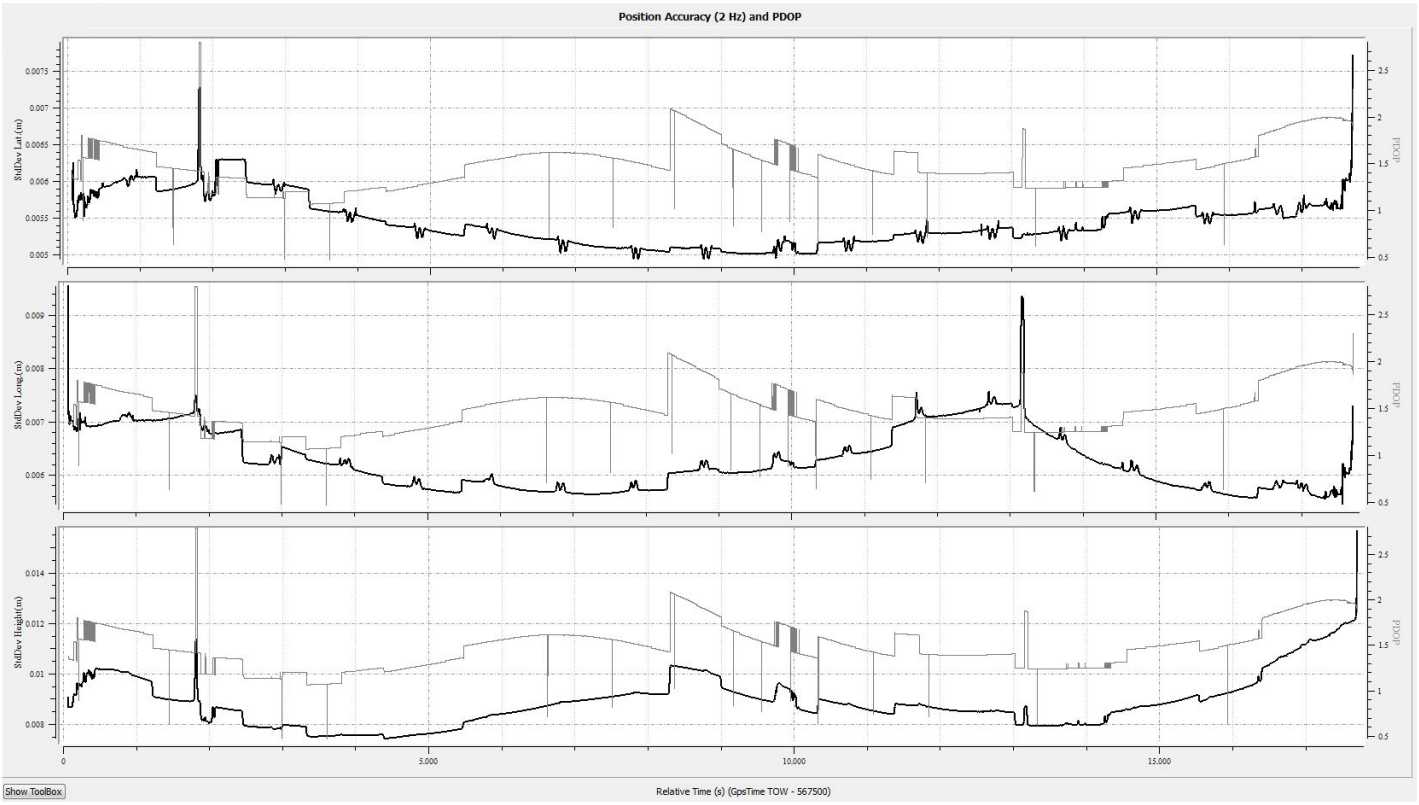
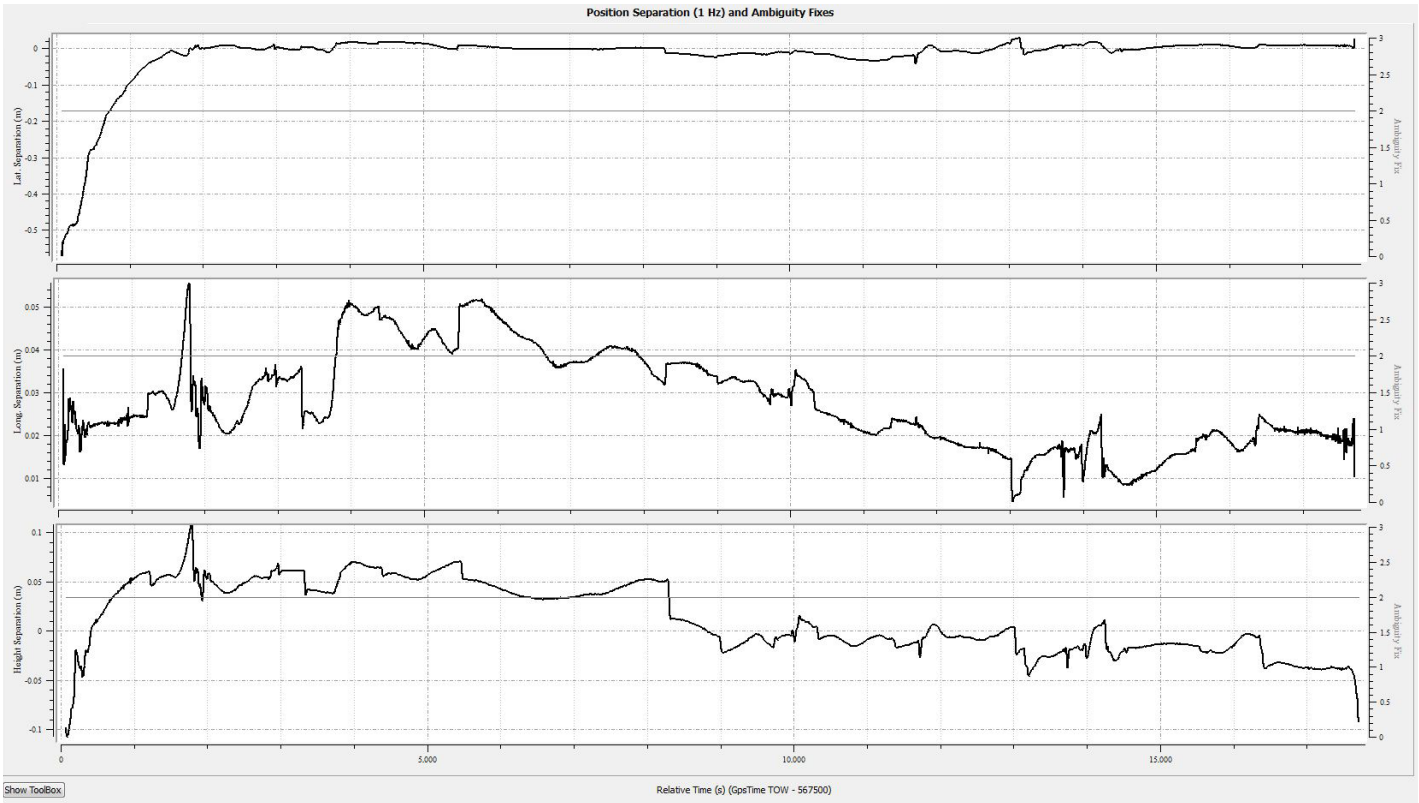


Image 8.0v: Separation Plot for mission 20140419_132934



9 QA/QC Output Control Report

Output Control Report on check points collected across the Kankakee County project area and used to calibrate LiDAR data position.

Image 9.1: Kankakee Control Report

Kankakee County Control Report					
Number	Easting	Northing	Known Z	Laser Z	Dz
1	1091039.975	1669506.857	644.343	644.480	0.137
2	1127156.591	1669960.004	665.626	665.680	0.054
3	1157728.178	1665156.049	695.019	695.020	0.001
4	1186799.075	1670974.522	696.642	696.840	0.198
5	1019707.757	1641347.321	582.042	582.270	0.228
6	1041173.802	1631406.550	608.189	608.080	-0.109
7	1072501.024	1631990.784	644.369	644.390	0.021
8	1096670.519	1634744.081	635.614	635.620	0.006
9	1131921.598	1622128.815	617.314	617.170	-0.144
10	1161082.341	1630629.178	626.076	626.170	0.094
11	1170393.889	1636063.314	629.707	629.490	-0.217
12	1201143.744	1630063.446	629.817	629.910	0.093
13	1018552.832	1581967.081	677.130	676.820	-0.310
14	1039303.493	1604103.021	636.763	636.810	0.047
15	1071232.767	1605126.080	665.883	665.880	-0.003
16	1101960.590	1600988.531	626.118	626.070	-0.048
17	1132093.203	1604553.276	613.206	613.100	-0.106
18	1152487.897	1588633.811	676.523	676.330	-0.193
19	1179979.269	1587355.271	642.599	642.320	-0.279
20	1202422.130	1588180.015	681.118	680.970	-0.148

Average dz	-0.03 ft
Minimum dz	-0.31 ft
Maximum dz	0.23 ft
Average magnitude	0.12 ft
Root mean square	0.15 ft
Std deviation	0.15 ft

10 Imagery of Control Locations

Image 10.0a: Control Location 1

Image 10.0b: Control Location 2

Image 10.0c: Control Location 3

Image 10.0d: Control Location 4

Image 10.0e: Control Location 5

Image 10.0f: Control Location 6

Image 10.0g: Control Location 7

Image 10.0h: Control Location 8

Image 10.0i: Control Location 9

Image 10.0j: Control Location 10

Image 10.0k: Control Location 11

Image 10.0l: Control Location 12

Image 10.0m: Control Location 13

Image 10.0n: Control Location 14

Image 10.0o: Control Location 15

Image 10.0p: Control Location 16

Image 10.0q: Control Location 17

Image 10.0r: Control Location 18

Image 10.0s: Control Location 19

Image 10.0t: Control Location 20

11 Accuracy Assessment

Image 11.0a: Vertical Accuracy Assessment

	LC Class	Count	Minimum	Maximum	St. Dev.	RMSE	95%	95th	Mean	Median	Skew
SVA	-	79	-0.54	0.60	0.23	0.25	-	0.48	0.09	0.12	-0.12
CVA	-	99	-0.54	0.60	0.22	0.23	-	0.45	0.07	0.08	0.06
Bare Earth (FVA)	1	20	-0.32	0.44	0.18	0.17	0.34	-	-0.02	-0.05	0.66
Tall Weeds	2	20	-0.17	0.48	0.17	0.23	-	0.43	0.16	0.18	-0.02
Brush Lands	3	20	-0.27	0.60	0.22	0.31	-	0.59	0.22	0.15	0.07
Forested	4	20	-0.54	0.49	0.23	0.23	-	0.35	0.04	0.07	-0.45
Urban Areas	5	19	-0.41	0.26	0.19	0.20	-	0.18	-0.07	-0.09	-0.13

Image 11.0b: Ground check points used for accuracy assessment

Point #	Easting	Northing	Known Z	LIDAR Z	DZ	LC Class
1	1091125.68	1669556.77	643.50	643.56	0.06	1
2	1127740.59	1669649.99	666.56	666.64	0.08	1
3	1157804.78	1665089.07	693.60	693.69	0.09	1
4	1194388.32	1676156.85	700.60	700.68	0.08	1
5	1022764.22	1642072.95	584.25	584.69	0.44	1
6	1041205.97	1631507.22	605.85	605.73	-0.12	1
7	1072451.15	1632047.90	642.58	642.32	-0.26	1
8	1100945.63	1631913.95	622.46	622.59	0.13	1
9	1129038.08	1621780.09	657.94	657.73	-0.21	1
10	1158325.79	1630681.69	620.73	620.66	-0.07	1
11	1171427.81	1636239.81	627.51	627.50	-0.01	1
12	1201115.28	1633672.35	629.28	629.43	0.15	1
13	1019594.13	1577606.91	689.12	689.06	-0.06	1
14	1039392.26	1601491.42	640.00	639.97	-0.03	1
15	1071274.92	1605029.40	663.77	663.89	0.12	1
16	1102176.25	1603781.75	627.66	627.57	-0.09	1
17	1131347.13	1605295.92	609.64	609.52	-0.12	1
18	1154692.84	1588767.67	660.70	660.57	-0.13	1
19	1172965.70	1587258.43	636.97	636.65	-0.32	1
20	1198399.87	1588452.27	667.11	666.89	-0.22	1
21	1086497.52	1669157.07	656.26	656.36	0.11	2
22	1127319.04	1666270.22	676.90	677.10	0.20	2
23	1156964.22	1670561.38	706.70	706.69	-0.01	2
24	1186714.66	1670836.62	697.53	697.69	0.16	2
25	1019446.34	1646386.06	586.28	586.76	0.48	2
26	1041064.82	1635475.98	592.51	592.74	0.23	2
27	1076787.17	1631908.78	660.57	660.81	0.24	2
28	1095528.79	1632935.96	654.22	654.50	0.28	2
29	1129168.35	1621702.60	657.70	657.64	-0.06	2
30	1160493.07	1630686.09	626.33	626.70	0.38	2
31	1170331.75	1635068.33	628.91	628.98	0.07	2
32	1201330.11	1628656.18	631.52	631.95	0.43	2
33	1023911.78	1577178.29	681.98	682.20	0.22	2

Point #	Easting	Northing	Known Z	LIDAR Z	DZ	LC Class
34	1071272.35	1604735.27	663.41	663.48	0.07	2
35	1040523.76	1604238.08	633.20	633.25	0.05	2
36	1102288.00	1603720.07	627.27	627.52	0.25	2
37	1132303.89	1604634.49	613.13	613.07	-0.06	2
38	1152744.74	1589339.66	670.84	671.09	0.25	2
39	1181439.31	1587302.86	645.88	646.02	0.14	2
40	1202354.10	1588020.20	682.98	682.81	-0.17	2
41	1086436.12	1669283.62	657.78	658.03	0.25	3
42	1127087.47	1669276.94	667.17	667.32	0.15	3
43	1155551.86	1665010.82	707.45	707.57	0.12	3
44	1194613.00	1674140.37	690.44	690.59	0.15	3
45	1022131.46	1641301.38	584.04	584.63	0.59	3
46	1040747.66	1636582.98	589.78	590.18	0.40	3
47	1076874.79	1631920.52	661.73	662.27	0.55	3
48	1095640.39	1632589.52	661.28	661.61	0.33	3
49	1129787.29	1622616.11	658.37	658.47	0.10	3
50	1160527.01	1630809.39	626.29	626.57	0.28	3
51	1171675.41	1635909.32	628.66	628.97	0.31	3
52	1201769.75	1623165.56	646.29	646.74	0.45	3
53	1019488.49	1577460.01	690.71	691.31	0.60	3
54	1041533.96	1598927.45	641.80	641.94	0.14	3
55	1068298.78	1610420.22	655.37	655.36	-0.01	3
56	1100177.45	1600376.68	626.44	626.57	0.13	3
57	1132403.57	1604685.38	612.79	612.83	0.05	3
58	1152730.38	1589480.13	670.62	670.65	0.03	3
59	1182907.72	1587522.43	655.33	655.06	-0.27	3
60	1202329.68	1588286.43	684.42	684.39	-0.03	3
61	1086307.91	1669194.95	655.56	655.66	0.11	4
62	1127038.61	1664002.53	675.76	676.00	0.25	4
63	1158550.13	1659763.35	687.25	687.37	0.12	4
64	1186682.30	1672868.73	699.98	699.90	-0.08	4
65	1022147.23	1641232.40	584.00	584.49	0.49	4
66	1041289.11	1632372.35	603.19	603.34	0.15	4
67	1074298.61	1631923.50	647.65	647.99	0.34	4
68	1095525.58	1632409.13	662.87	662.91	0.04	4
69	1129036.96	1621637.13	653.28	653.45	0.17	4
70	1158080.18	1630622.65	621.31	621.17	-0.14	4
71	1170367.94	1631917.37	639.46	639.47	0.01	4
72	1201164.47	1633708.51	629.17	629.09	-0.08	4
73	1022852.56	1582072.60	682.90	682.71	-0.19	4
74	1039142.34	1608039.90	632.55	632.42	-0.13	4
75	1070778.95	1605165.45	666.33	666.27	-0.06	4
76	1096737.75	1599076.95	626.87	627.00	0.13	4

Point #	Easting	Northing	Known Z	LIDAR Z	DZ	LC Class
77	1131971.02	1604829.01	614.53	614.78	0.25	4
78	1154558.44	1588699.83	661.16	660.94	-0.22	4
79	1183373.59	1589063.51	657.01	656.47	-0.54	4
80	1202462.98	1588127.92	682.07	682.32	0.25	4
81	1091091.81	1670303.08	644.69	644.81	0.12	5
82	1127318.98	1665164.83	680.40	680.19	-0.21	5
83	1158114.47	1670395.43	709.63	709.47	-0.16	5
84	1194489.53	1676204.94	703.02	702.69	-0.33	5
85	1022354.27	1641603.48	583.48	583.73	0.26	5
86	1041409.75	1632341.66	603.09	603.16	0.07	5
87	1071276.64	1626613.53	641.69	641.82	0.13	5
88	1100988.55	1631795.04	627.75	627.71	-0.04	5
89	1129678.20	1622473.55	658.42	658.28	-0.14	5
90	1160981.25	1629956.82	633.36	633.48	0.12	5
91	1170396.50	1635680.84	630.20	630.09	-0.11	5
92	1200755.51	1626339.19	635.95	635.65	-0.30	5
94	1042086.83	1604122.80	635.21	635.12	-0.09	5
95	1069683.54	1610691.97	651.15	651.05	-0.10	5
96	1100098.87	1600575.91	627.36	627.02	-0.34	5
97	1131110.06	1605312.44	612.66	612.61	-0.05	5
98	1153189.77	1588640.78	677.62	677.67	0.05	5
99	1173019.10	1587315.31	639.29	638.88	-0.41	5
100	1198455.66	1588416.41	667.25	667.42	0.17	5

Thank You

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