Utah 2016 - Forge AOI
QL1 LiDAR Project Report

Contract # AV2408

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Contents

List of Figures

List of Tables

List of Appendices

1. Summary / Scope

1.1. Summary

This report contains a summary of the Utah 2016 - Forge AOI QL1 LiDAR acquisition task order, issued by State of Utah, Department of Technology Services, Division of Integrated Technology, Automated Geographic Reference Center (AGRC) under their contract signed on August 12, 2016. The task order yielded a project area covering approximately 7,536 square kilometers over western Utah and southern Idaho. The intent of this document is only to provide specific validation information for the data acquisition/collection, processing, and production of deliverables completed as specified in the task order.

1.2. Scope

Aerial topographic LiDAR was acquired using state of the art technology along with the necessary surveyed ground control points (GCPs) and airborne GPS and inertial navigation systems. The aerial data collection was designed with the following specifications listed in Table 1 below.

Table 1. Originally Planned LiDAR Specifications

Average Point Density	Flight Altitude (AGL)	Field of View	Minimum Side Overlap	RMSEz
9.8 pts / m^2	1,550 m	40°	63%	≤ 10 cm

1.3. Coverage

The total LiDAR project boundary covers approximately 7,536 square kilometers. This report focuses on the Forge QL1 area of interest, which covers approximately 531 km^2.

A buffer of 100 meters was created to meet task order specifications. LiDAR extents are shown in Figure 1.

1.4. Duration

LiDAR data was acquired from October 26, 2016 to November 3, 2016 in five total lifts. See “Section: 2.5. Time Period” for more details.

1.5. Issues

There were no issues to report for this project.

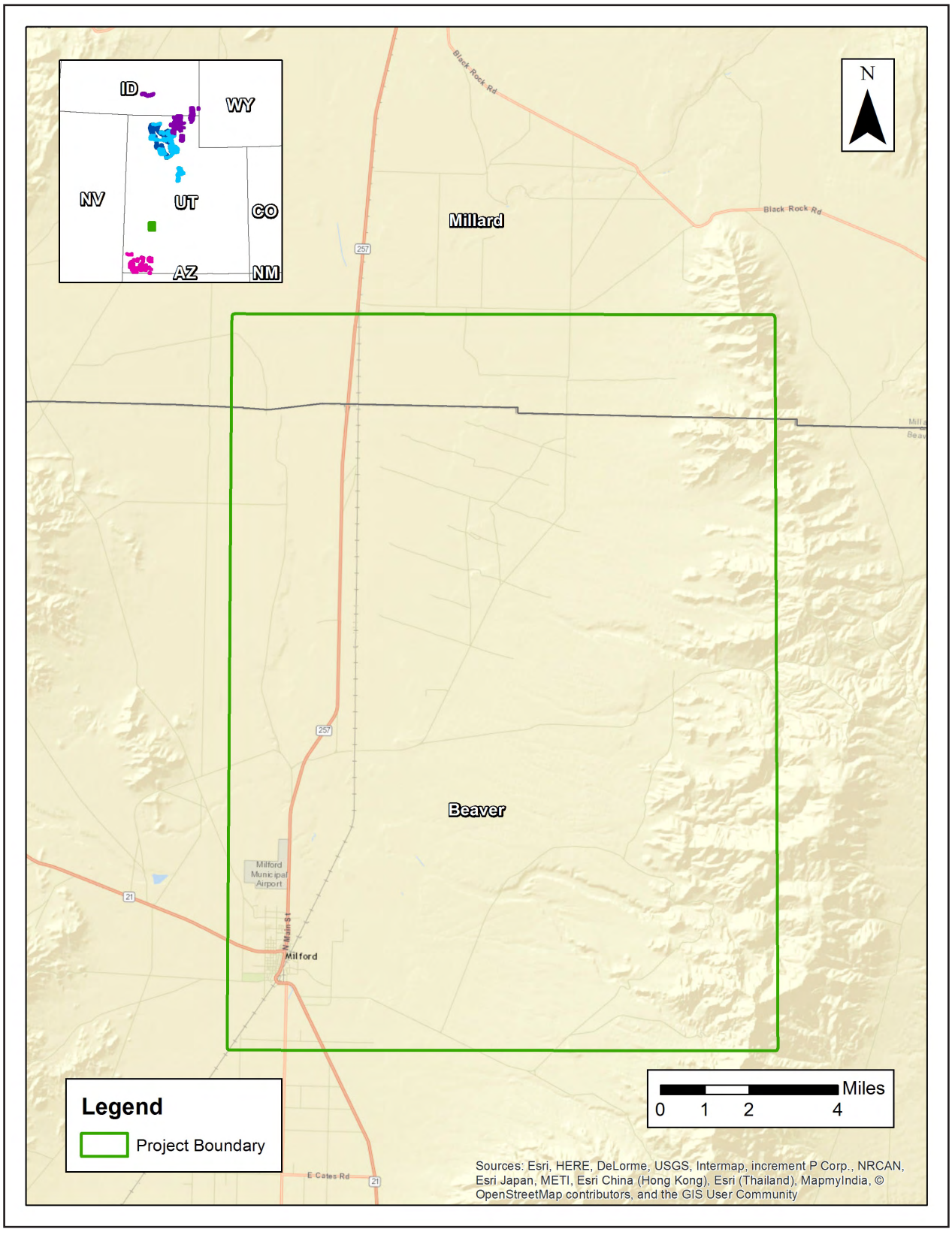
1.6. Deliverables

The following products were produced and delivered:

- Raw LiDAR point cloud data swaths in LAS 1.4 format
- Classified LiDAR point cloud data, tiled, in LAS 1.4 format
- 0.5-meter hydro-flattened bare-earth raster DEM, tiled, in ERDAS .IMG format Hydro-flattened breaklines in Esri shapefile format
- 0.5-meter first return raster DSM, tiled, in ERDAS .IMG format
- 0.5-meter intensity images, tiled, in GeoTIFF format
- Processing boundary in Esri shapefile format
- Tile index in Esri shapefile format
- Calibration and QC checkpoints in Esri shapefile format
- Accuracy assessment in .XLSX format
- Project-, deliverable-, and lift-level metadata in .XML format

All geospatial deliverables were produced in NAD83 UTM Zone 12, meters; NAVD88 (GEOID 12B), meters. All .LAS tiled deliverables have a tile size of 1,000 meters x 1,000 meters. All other tiled deliverables have a tile size of 2,000 meters x 2,000 meters. All tile names follow US National Grid naming conventions. Tile names are based on the southwest corner of the tile.

Figure 1. Project Boundary



2. Planning / Equipment

2.1. Flight Planning

Flight planning was based on the unique project requirements and characteristics of the project site. The basis of planning included: required accuracies, type of development, amount / type of vegetation within project area, required data posting, and potential altitude restrictions for flights in project vicinity.

Detailed project flight planning calculations were performed for the project using Leica MissionPro planning software. The entire target area was comprised of 73 planned flight lines measuring approximately 929.2 total flight line miles (Figure 2).

2.2. LiDAR Sensor

Quantum Spatial utilized a Leica ALS 80 LiDAR sensor (Figure 3), serial number 8227, during the project. The Leica ALS 80 system is capable of collecting data at a maximum frequency of 1,000 kHz. The system utilizes a Multi-Pulse in the Air option (MPIA). The sensor is also equipped with the ability to measure up to 6 returns per outgoing pulse from the laser. The intensity of the returns is also captured during aerial acquisition.

A brief summary of the aerial acquisition parameters for the project are shown in the LiDAR System Specifications in Table 2.

Figure 2. Planned LiDAR Flight Lines

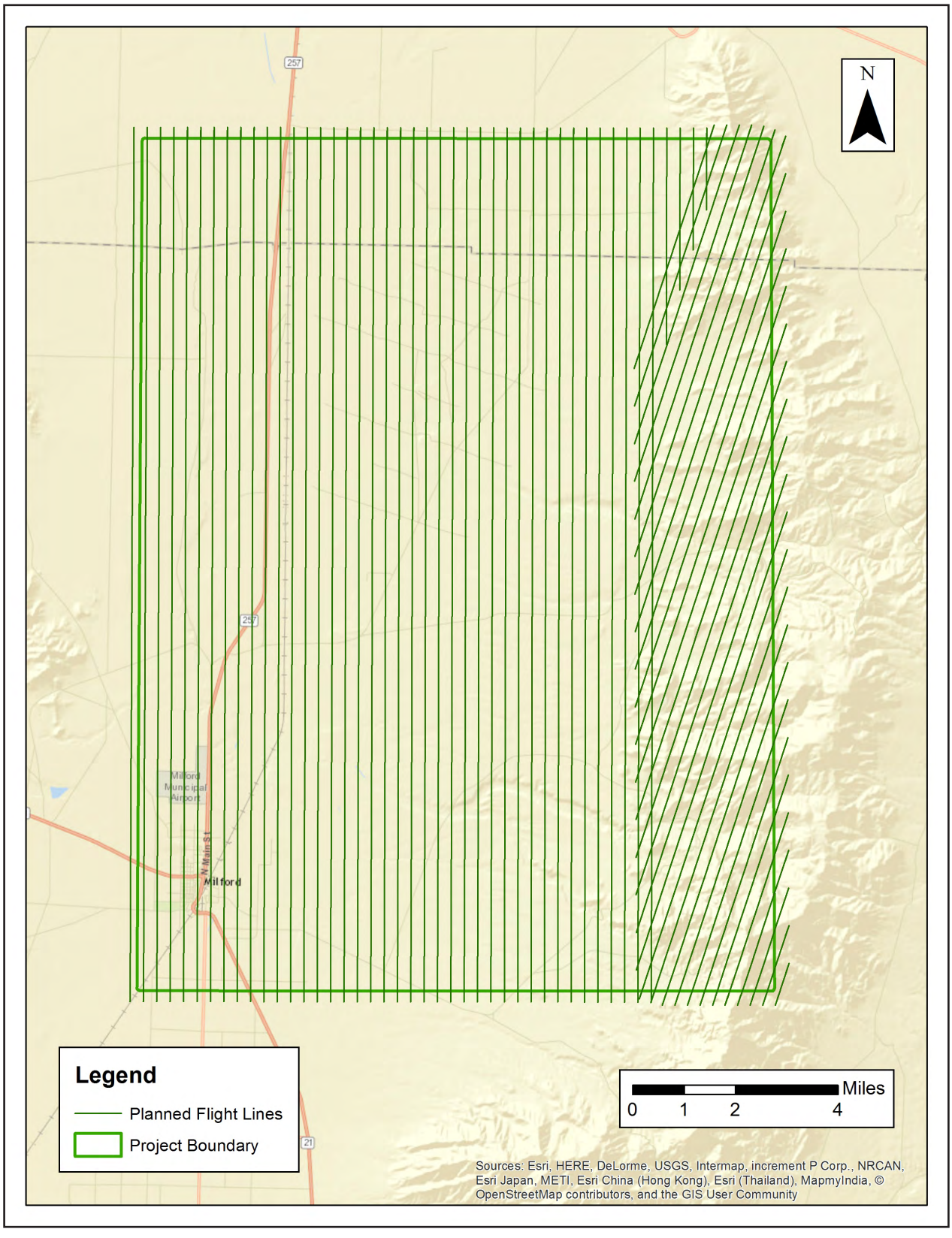


Table 2. Lidar System Specifications

Terrain and Aircraft Scanner	Flying Height	1,550 m
	Recommended Ground Speed	120 kts
Scanner	Field of View	40°
	Scan Rate Setting Used	50 Hz
Laser	Laser Pulse Rate Used	340 kHz
	Multi Pulse in Air Mode	Enabled
Coverage	Full Swath Width	1,128 m
	Line Spacing	1,374 m
Point Spacing and Density	Average Point Density	0.7 m
	Average Point Density	9.7 pts / m^2

Figure 3. Leica ALS 80 LiDAR Sensor

2.3. Aircraft

All flights for the project were accomplished through the use of a customized Cessna Caravan (single-turboprop) plane, tail number N208NR. This aircraft provided an ideal, stable aerial base for LiDAR acquisition. This aerial platform has relatively fast cruise speeds which are beneficial for project mobilization / demobilization while maintaining relatively slow stall speeds which proved ideal for collection of high-density, consistent data posting using a state-of-the-art Leica LiDAR system. Some of Quantum Spatial's operating aircraft can be seen in Figure 4 below.

Figure 4. Some of Quantum Spatial's Planes

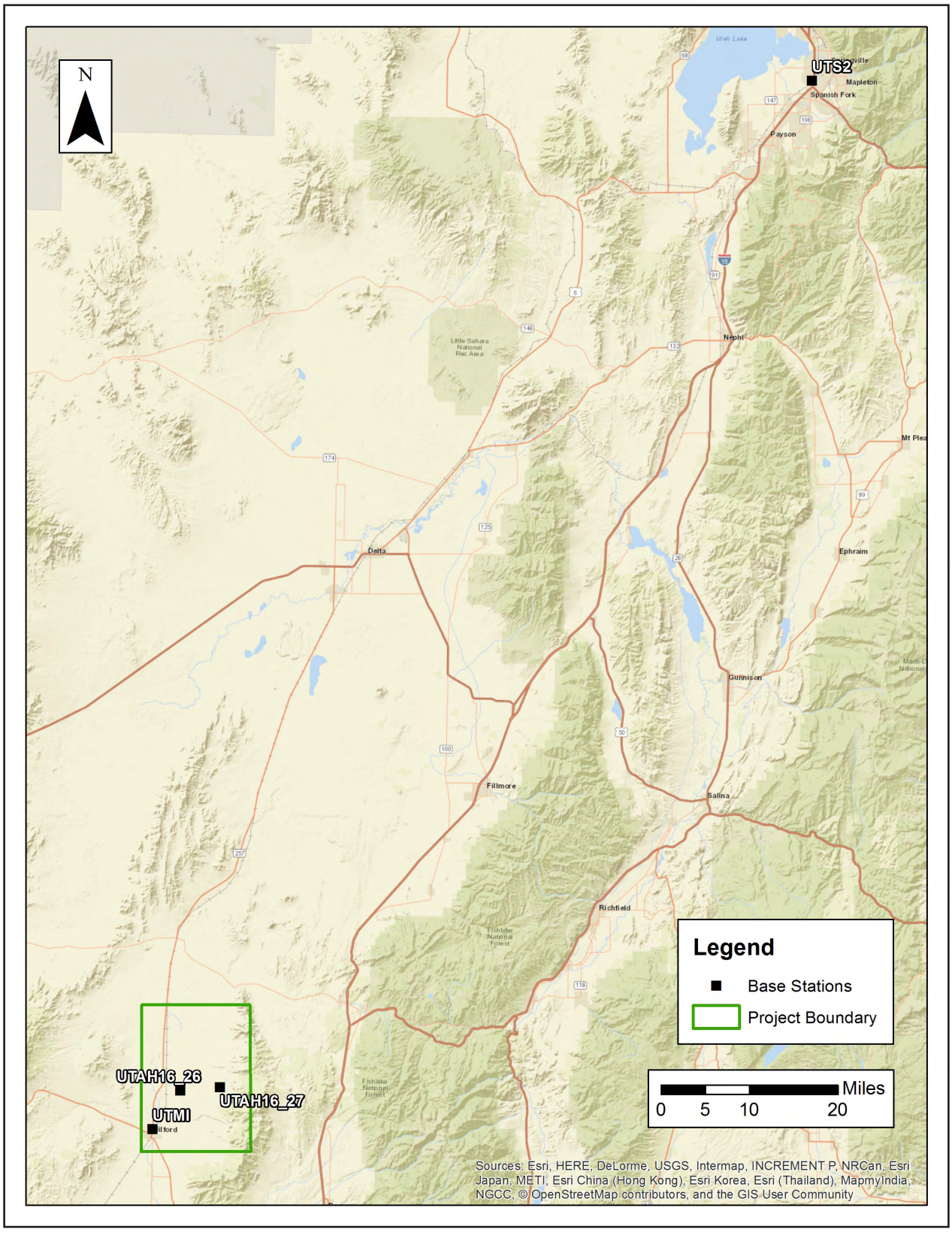
2.4. Base Station Information

GPS base stations were utilized during all phases of flight. The base station locations were verified using NGS OPUS service and subsequent surveys. Base station locations, data sheets, graphical depiction of base station locations or log sheets used during station occupation will be available in Appendix A. See Figure 5 and Table 3.

Table 3. Base Station Locations

Base Station	Longitude	Latitude	Ellipsoid Height (m)
UTAH16_26	112° 57′ 17.21858″	38° 27′ 58.92469″	1535.218
UTAH16_27	112° 52′ 19.23478″	38° 28′ 22.5025″	1754.384
UTMI	113° 0′ 37.18806″	38° 24′ 6.80981″	1506.239
UTS2	111° 39′ 5.50312″	40° 8′ 16.20885″	1371.47

Figure 5. Base Station Locations



2.5. Time Period

Project specific flights were conducted over several days. Five sorties, or aircraft lifts were completed. Accomplished sorties are listed below.

- October 26, 2016-A (N208NR, SN8227)
- October 27, 2016-A (N208NR, SN8227)
- October 28, 2016-A (N208NR, SN8227)
- November 1, 2016-A (N208NR, SN8227)
- November 3, 2016-A (N208NR, SN8227)

3. Processing Summary

3.1. Flight Logs

Flight logs were completed by LIDAR sensor technicians for each mission during acquisition. These logs depict a variety of information, including:

- Job / Project #
- Flight Date / Lift Number
- FOV (Field of View)
- Scan Rate (HZ)
- Pulse Rate Frequency (Hz)
- Ground Speed
- Altitude
- Base Station
- PDOP avoidance times
- Flight Line #
- Flight Line Start and Stop Times
- Flight Line Altitude (AMSL)
- Heading
- Speed
- Returns
- Crab

Notes: (Visibility, winds, ride, weather, temperature, dew point, pressure, etc). Project specific flight logs for each sortie are available in Appendix A.

3.2. LiDAR Processing

Inertial Explorer software was used for post-processing of airborne GPS and inertial data (IMU), which is critical to the positioning and orientation of the LiDAR sensor during all flights. Inertial Explorer combines aircraft raw trajectory data with stationary GPS base station data yielding a "Smoothed Best Estimate Trajectory (SBET) necessary for additional post processing software to develop the resulting geo-referenced point cloud from the LiDAR missions.

During the sensor trajectory processing (combining GPS & IMU datasets) certain statistical graphs and tables are generated within the Inertial Explorer processing environment which are commonly used as indicators of processing stability and accuracy. This data for analysis include: Max horizontal / vertical GPS variance, separation plot, altitude plot, PDOP plot, base station baseline length, processing mode, number of satellite vehicles, and mission trajectory. All relevant graphs produced in the Inertial Explorer processing environment for each sortie during the project mobilization will be available in the full report.

The generated point cloud is the mathematical three dimensional composite of all returns from all laser pulses as determined from the aerial mission. Laser point data are imported into TerraScan and a manual calibration is performed to assess the system offsets for pitch, roll, heading and scale. At this point this data is ready for analysis, classification, and filtering to generate a bare earth surface model in which the above-ground features are removed from the data set. Point clouds were created using the Leica CloudPro software. GeoCue distributive processing software was used in the creation of some files needed in downstream processing, as well as in the tiling of the dataset into more manageable file sizes. TerraScan and TerraModeler software packages were then used for the automated data classification, manual cleanup, and bare earth generation. Project specific macros were developed to classify the ground and remove side overlap between parallel flight lines.

All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. Global Mapper was used as a final check of the bare earth dataset. GeoCue was used to create the deliverable industry-standard LAS files for both the All Point Cloud Data and the Bare Earth. In-house software was then used to perform final statistical analysis of the classes in the LAS files.

3.3. LAS Classification Scheme

The classification classes are determined by the USGS Version 1.2 specifications and are an industry standard for the classification of LIDAR point clouds. All data starts the process as Class 1 (Unclassified), and then through automated classification routines, the classifications are determined using TerraScan macro processing.

The classes used in the dataset are as follows and have the following descriptions:

- Class 1 – Processed, but Unclassified – These points would be the catch all for points that do not fit any of the other deliverable classes. This would cover features such as vegetation, cars, etc.
- Class 2 – Bare-Earth Ground – This is the bare earth surface
- Class 7 – Low Noise – Low points, manually identified below the surface that could be noise points in point cloud.
- Class 9 – In-land Water – Points found inside of inland lake/ponds
- Class 10 – Ignored Ground – Points found to be close to breakline features. Points are moved to this class from the Class 2 dataset. This class is ignored during the DEM creation process in order to provide smooth transition between the ground surface and hydro flattened surface.
- Class 17 – Bridge Decks – Points falling on bridge decks.
- Class 18 – High Noise – High points, manually identified above the surface that could be noise points in point cloud.

3.4. Classified LAS Processing

The point classification is performed as described below. The bare earth surface is then manually reviewed to ensure correct classification on the Class 2 (Ground) points. After the bare-earth surface is finalized, it is then used to generate all hydro-breaklines through heads-up digitization.

All ground (ASPRS Class 2) lidar data inside of the Lake Pond and Double Line Drain hydro-flattened breaklines were then classified to Water (ASPRS Class 9) using TerraScan macro functionality. A buffer of 1 meter was also used around each hydro-flattened feature to classify these ground (ASPRS Class 2) points to Ignored ground (ASPRS Class 10). All Lake Pond Island and Double Line Drain Island features were checked to ensure that the ground (ASPRS Class 2) points were reclassified to the correct classification after the automated classification was completed. All bridge decks were classified to Class 17.

All overlap data was processed through automated functionality provided by TerraScan to classify the overlapping flight line data to approved classes by USGS. The overlap data was classified using standard LAS overlap bit. These classes were created through automated processes only and were not verified for classification accuracy. Due to software limitations within TerraScan, these classes were used to trip the withheld bit within various software packages. These processes were reviewed and accepted by USGS through numerous conference calls and pilot study areas.

All data was manually reviewed and any remaining artifacts removed using functionality

provided by TerraScan and TerraModeler. Global Mapper us used as a final check of the bare earth dataset. GeoCue was then used to create the deliverable industry-standard LAS files for both the All Point Cloud Data and the Bare Earth. Quantum Spatial, Inc. proprietary software was used to perform final statistical analysis of the classes in the LAS files, on a per tile level to verify final classification metrics and full LAS header information.

3.5. Hydro-Flattened Breakline Creation

Class 2 (ground) lidar points was used to create a bare earth surface model. The surface model was then used to heads-up digitize 2D breaklines of inland streams and rivers with a 100-foot nominal width and inland ponds and lakes of 2 acres or greater surface area.

Elevation values were assigned to all Inland Ponds and Lakes, Inland Pond and Lake Islands, Inland Stream and River Islands, using TerraModeler functionality. Elevation values were assigned to all inland streams and rivers using Quantum Spatial, Inc. proprietary software.

All Ground (ASPRS Class 2) lidar data inside of the collected inland breaklines were then classified to Water (ASPRS Class 9) using TerraScan macro functionality. A buffer of 3 feet was also used around each hydro-flattened feature. These points were moved from ground (ASPRS Class 2) to Ignored Ground (ASPRS Class 10).

The breakline files were then translated to Esri file geodatabase format using Esri conversion tools.

Breaklines are reviewed against lidar intensity imagery to verify completeness of capture. All breaklines are then compared to TINs (triangular irregular networks) created from ground only points prior to water classification. The horizontal placement of breaklines is compared to terrain features and the breakline elevations are compared to lidar elevations to ensure all breaklines match the lidar within acceptable tolerances. Some deviation is expected between breakline and lidar elevations due to monotonicity, connectivity, and flattening rules that are enforced on the breaklines. Once completeness, horizontal placement, and vertical variance is reviewed, all breaklines are reviewed for topological consistency and data integrity using a combination of Esri Data Reviewer tools and proprietary tools.

3.6. Hydro-Flattened Raster DEM Creation

Class 2 (Ground) lidar points in conjunction with the hydro breaklines were used to create a 0.5 meter hydro-flattened raster DEM. Using automated scripting routines within ArcMap, an ERDAS Imagine .IMG file was created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

3.7. First Return Raster DEM Creation

First return lidar points were used to create a 0.5 meter first-return raster DEM. Using automated scripting routines within ArcMap, an ERDAS Imagine .IMG file was created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

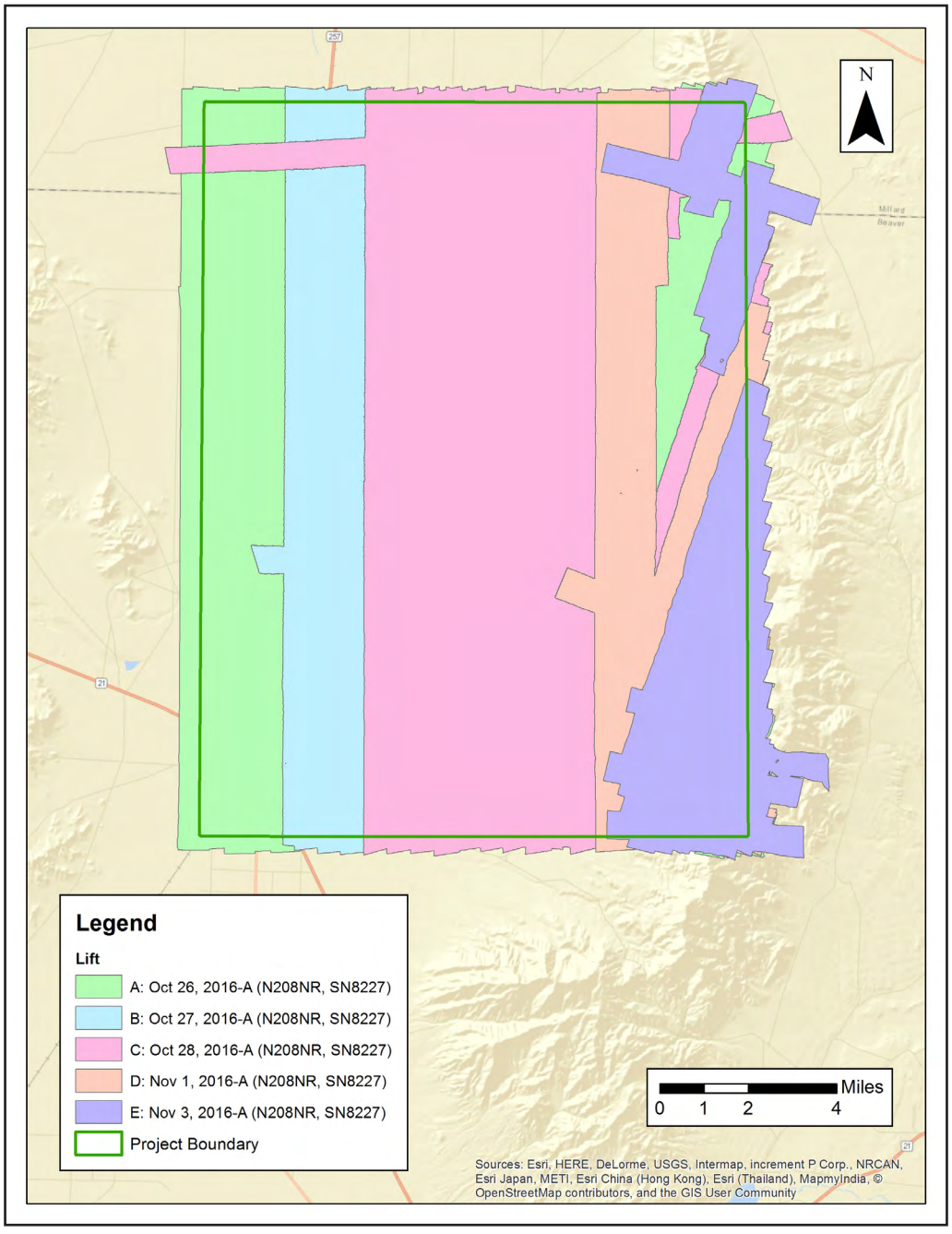
3.8. Intensity Image Creation

GeoCue software was used to create the deliverable Intensity Images. All overlap classes were ignored during this process. This helps to ensure a more aesthetically pleasing image. The GeoCue software was then used to verify full project coverage as well. TIF/TWF files were then provided as the deliverable for this dataset requirement.

4. Project Coverage Verification

Coverage verification was performed by comparing coverage of processed .LAS files captured during project collection to generate project shape files depicting boundaries of specified project areas. Please refer to Figure 6.

Figure 6. Flightline Swath LAS File Coverage



5. Ground Control and Check Point Collection

Quantum Spatial completed a field survey of 42 ground control (calibration) points along with 15 blind QA points in Vegetated and Non-Vegetated land cover classifications (total of 57 points) as an independent test of the accuracy of this project.

A combination of precise GPS surveying methods, including static and RTK observations were used to establish the 3D position of ground calibration points and QA points for the point classes above. GPS was not an appropriate methodology for surveying in the forested areas during the leaf-on conditions for the actual field survey (which was accomplished after the LiDAR acquisition). Therefore the 3D positions for the forested points were acquired using a GPS-derived offset point located out in the open near the forested area, and using precise offset surveying techniques to derive the 3D position of the forested point from the open control point. The explicit goal for these surveys was to develop 3D positions that were three times greater than the accuracy requirement for the elevation surface. In this case of the blind QA points the goal was a positional accuracy of 5 cm in terms of the RMSE.

The required accuracy testing was performed on the LiDAR dataset (both the LiDAR point cloud and derived DEM's) according to the USGS LiDAR Base Specification Version 1.2 (2014).

5.1. Calibration Control Point Testing

Figure 7 shows the location of each bare earth calibration point for the project area. Note that these results of the surface calibration are not an independent assessment of the accuracy of these project deliverables, but the statistical results do provide additional feedback as to the overall quality of the elevation surface.

5.2. Point Cloud Testing

The project specifications require that only Non-Vegetated Vertical Accuracy (NVA) be computed for raw lidar point cloud swath files. The required accuracy (ACCz) is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the "bare earth" and "urban" land cover classes. The NVA was tested with 10 checkpoints located in bare earth and urban (non-vegetated) areas. These check points were not used in the calibration or post processing of the lidar point cloud data. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques.

Elevations from the unclassified lidar surface were measured for the x,y location of each check point. Elevations interpolated from the lidar surface were then compared to the elevation values of the surveyed control points. AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASRPS Guidelines. See Figure 8.

5.3. Digital Elevation Model (DEM) Testing

The project specifications require the accuracy (ACCz) of the derived DEM be calculated and reported in two ways:

1. The required NVA is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the “bare earth” and “urban” land cover classes. This is a required accuracy. The NVA was tested with 10 checkpoints located in bare earth and urban (non-vegetated) areas. See Figure 8.

2. Vegetated Vertical Accuracy (VVA): VVA shall be reported for “forested”, “shrubs”, and “tall weeds” land cover classes. The target VVA is: 29.4 cm at the 95th percentile, derived according to ASPRS Guidelines, Vertical Accuracy Reporting for Lidar Data, i.e., based on the 95th percentile error in all vegetated land cover classes combined. This is a target accuracy. The VVA was tested with 5 checkpoints located in forested and tall grass (vegetated) areas. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques. See Figure 9.

AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ ASRPS Guidelines.

For more information, see the FOCUS on Accuracy report.

	Target	Measured	Point Count
Raw NVA	0.196 m	0.0535 m	10
NVA	0.196 m	0.0528 m	10
VVA	0.294 m	0.1002 m	5

Figure 7. Calibration Control Point Locations

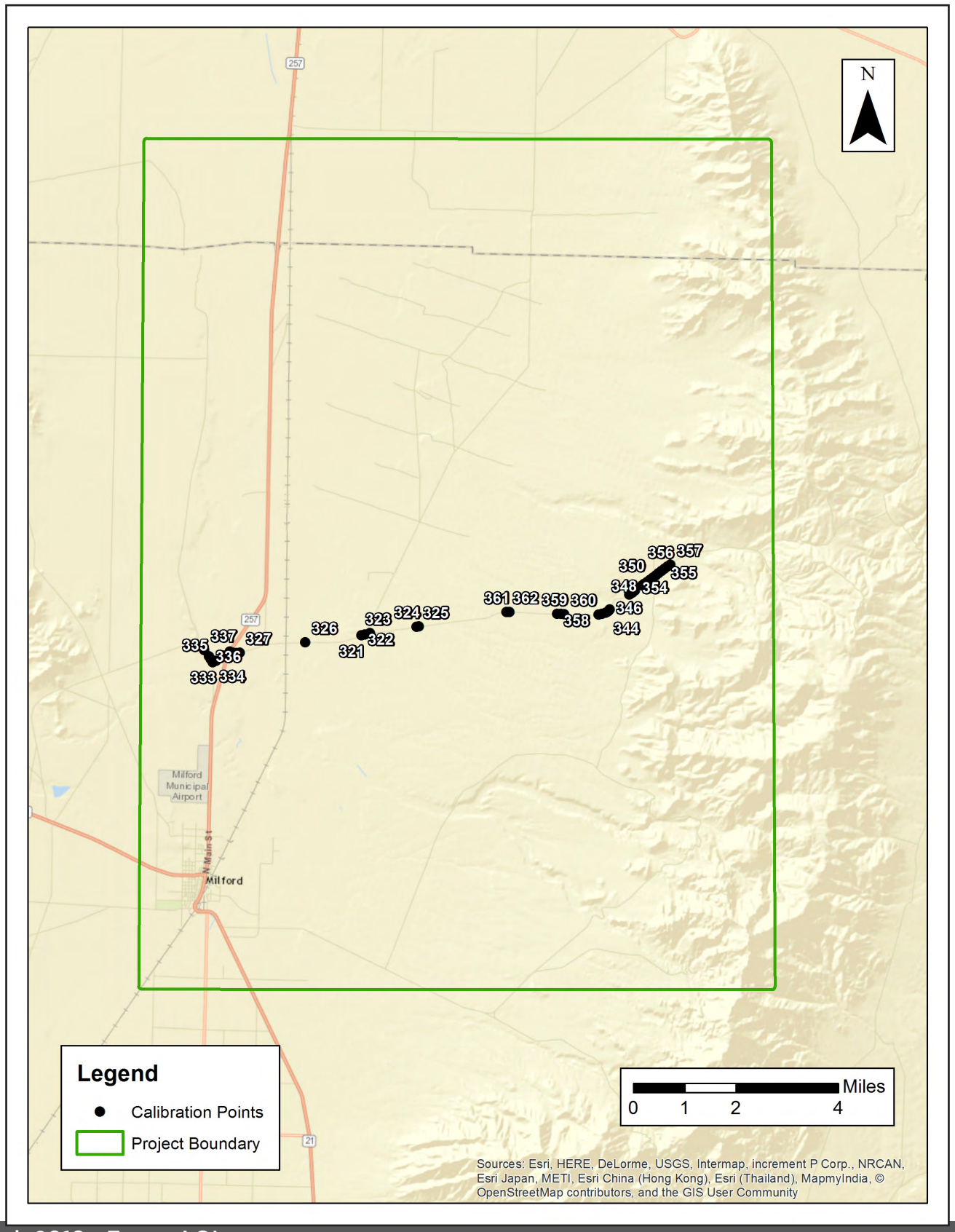


Figure 8. QC Checkpoint Locations - NVA

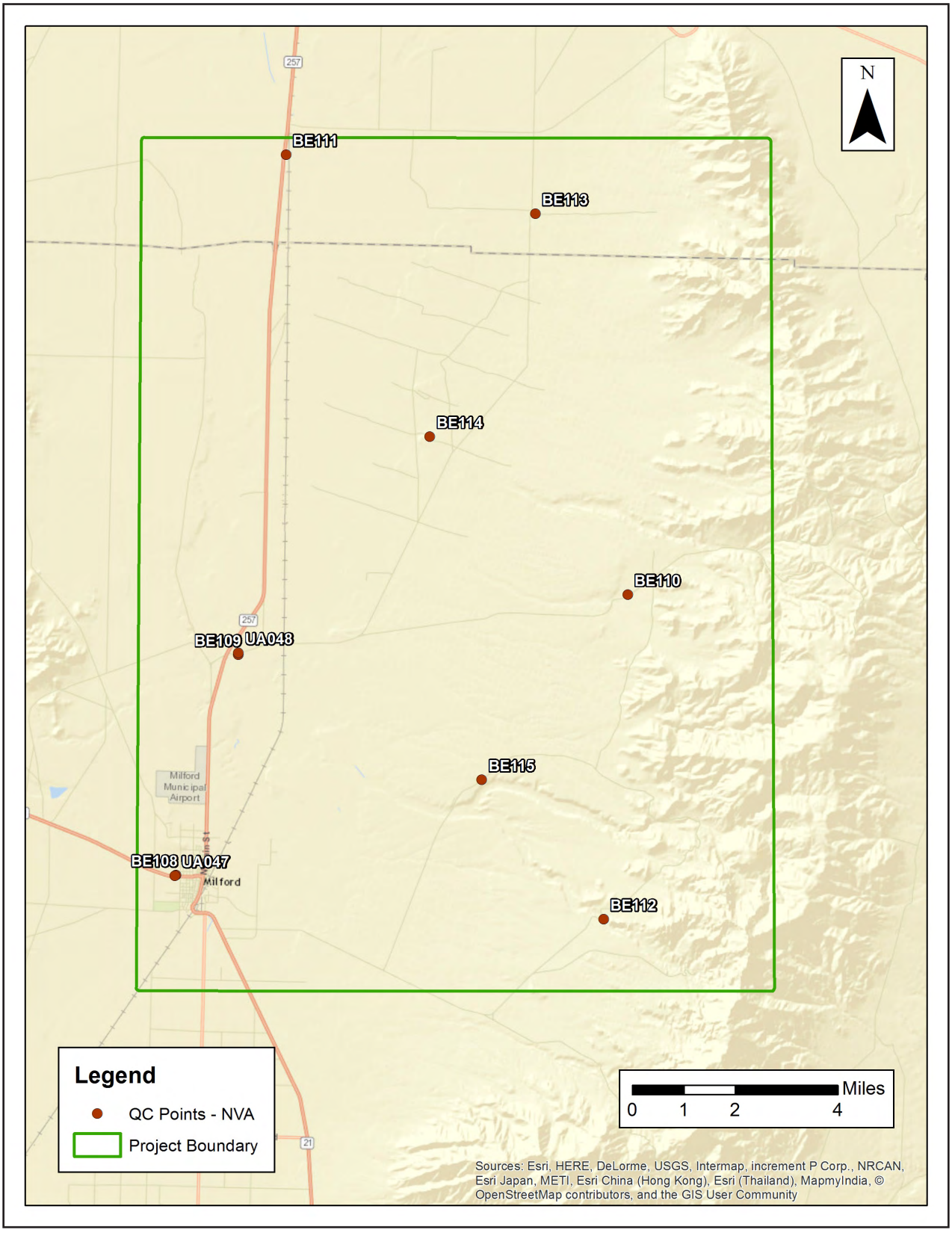
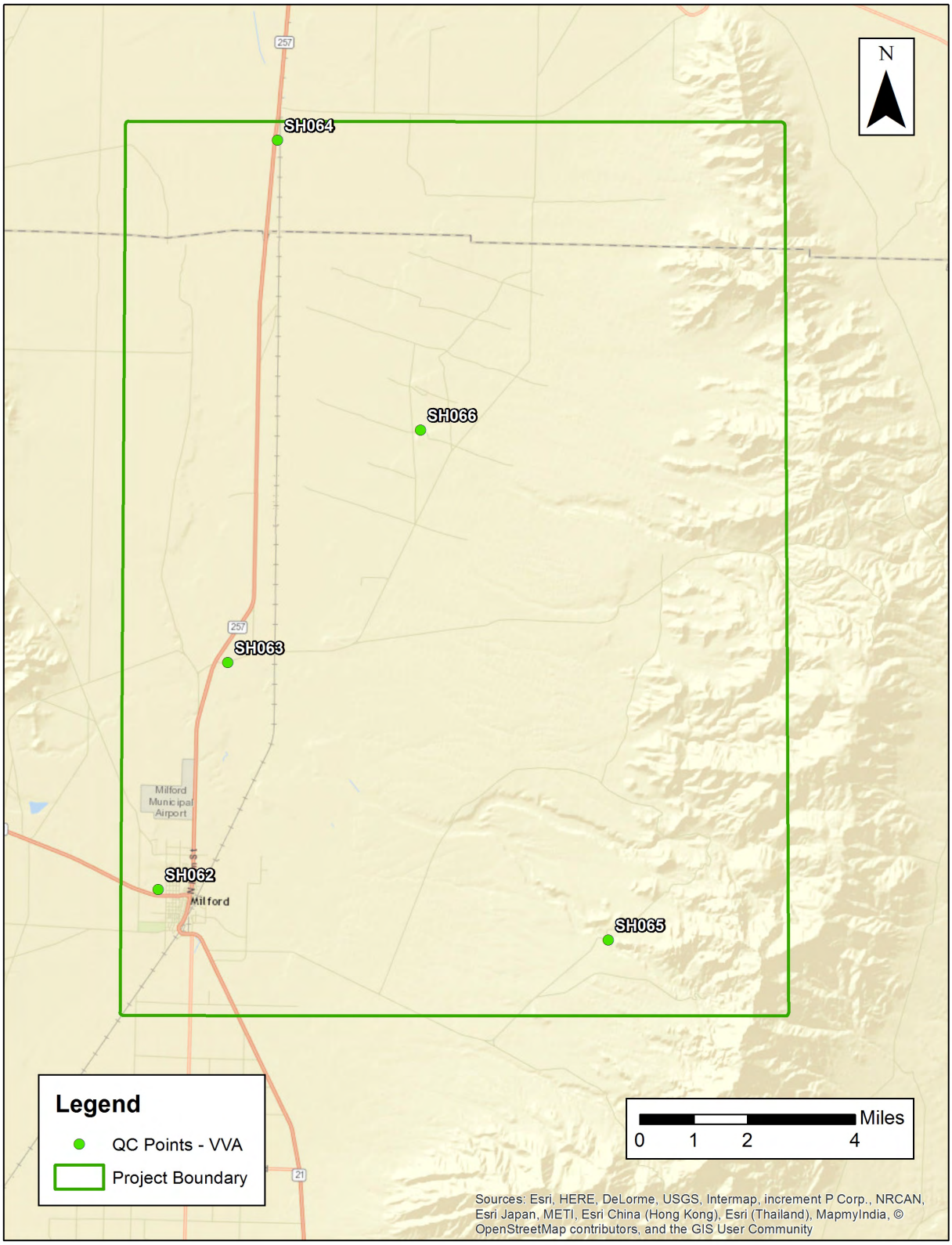


Figure 9. QC Checkpoint Locations - VVA



Project Report Appendices

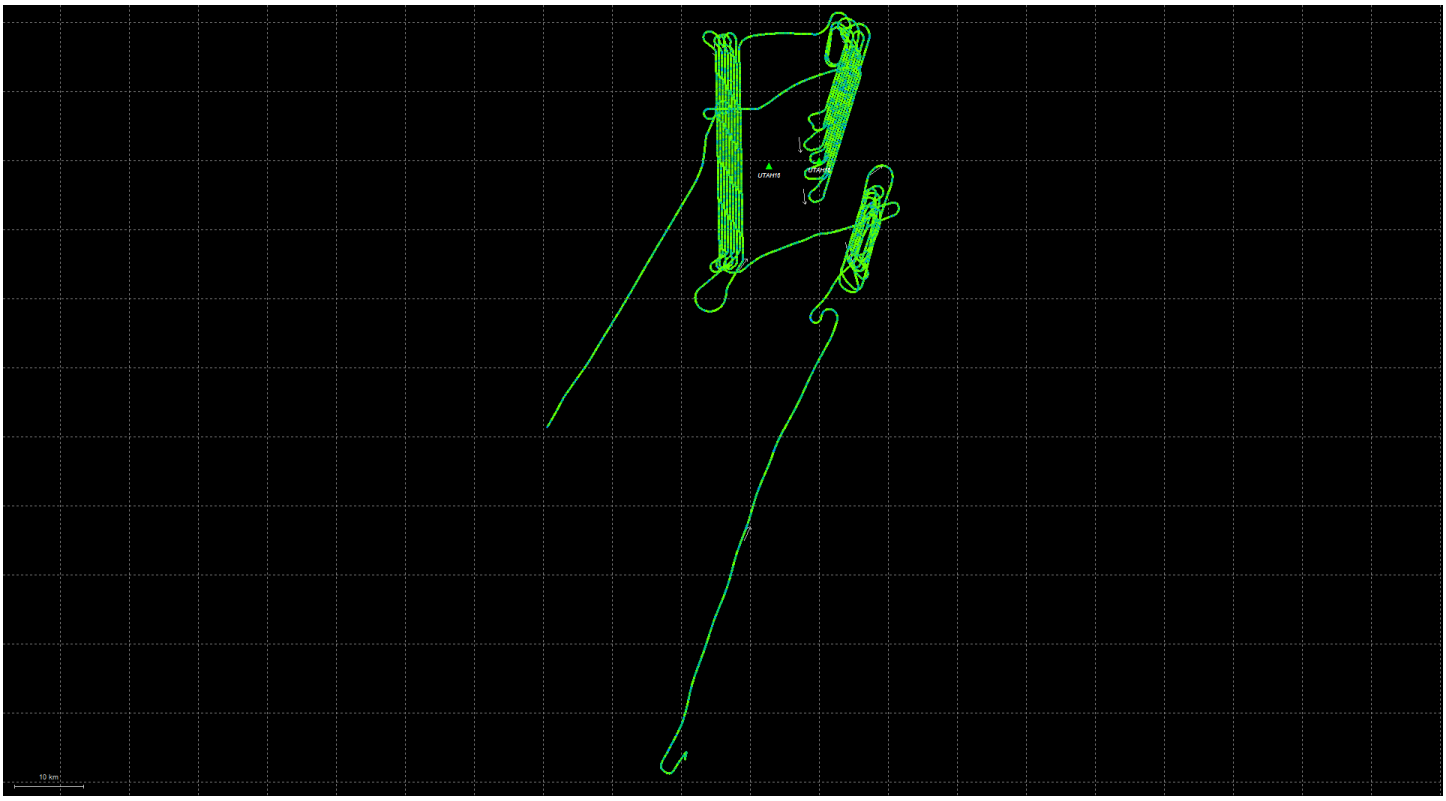
The following section contains the appendices as listed in the Utah 2016 - Forge AOI Project Report.

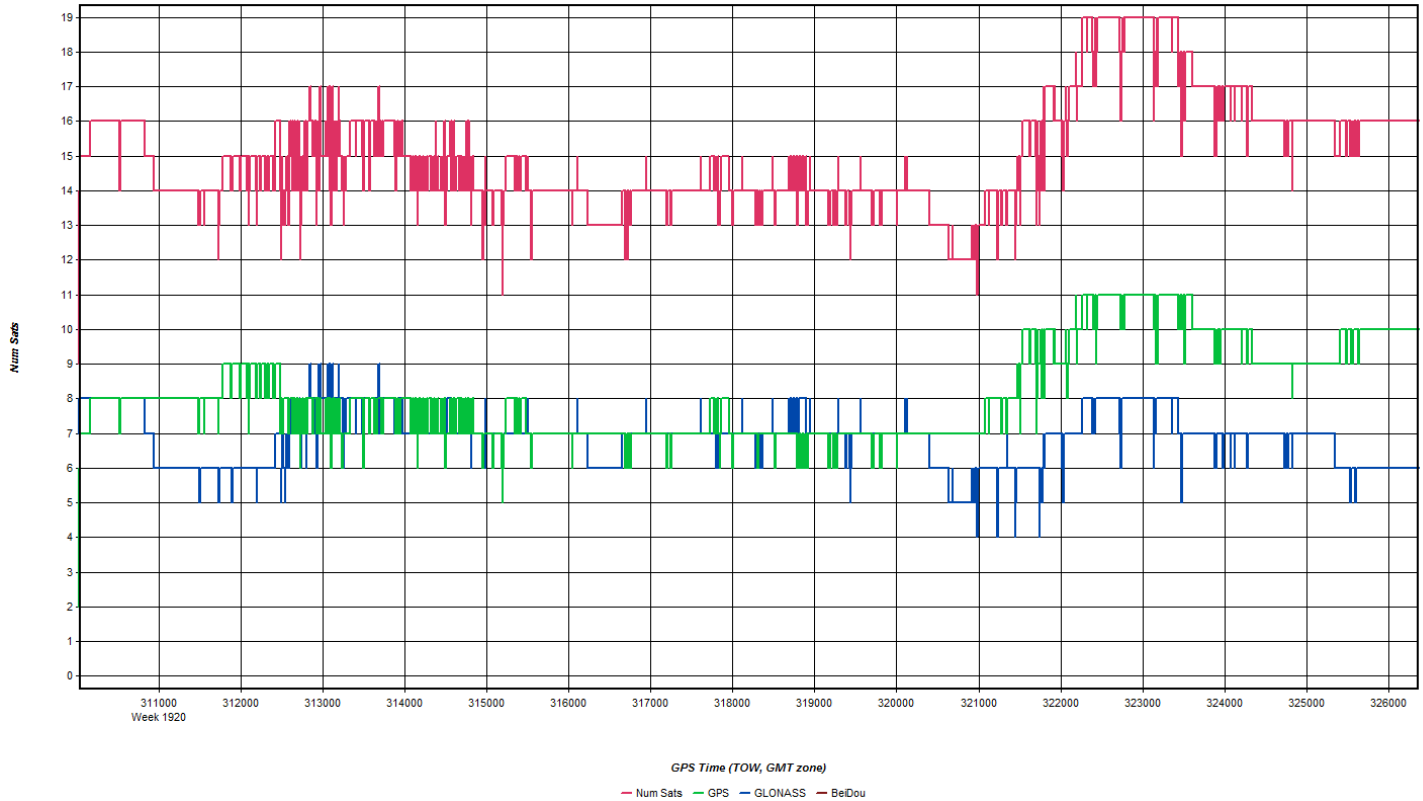
Appendix A

GPS/IMU Statistics
Flight Logs

There were 5 total lifts. Graph reports generated from processing software and flight logs are found on the following pages.

Oct 26, 2016-A (N208NR, SN8227)


UTAH15
10 km


Num Sats
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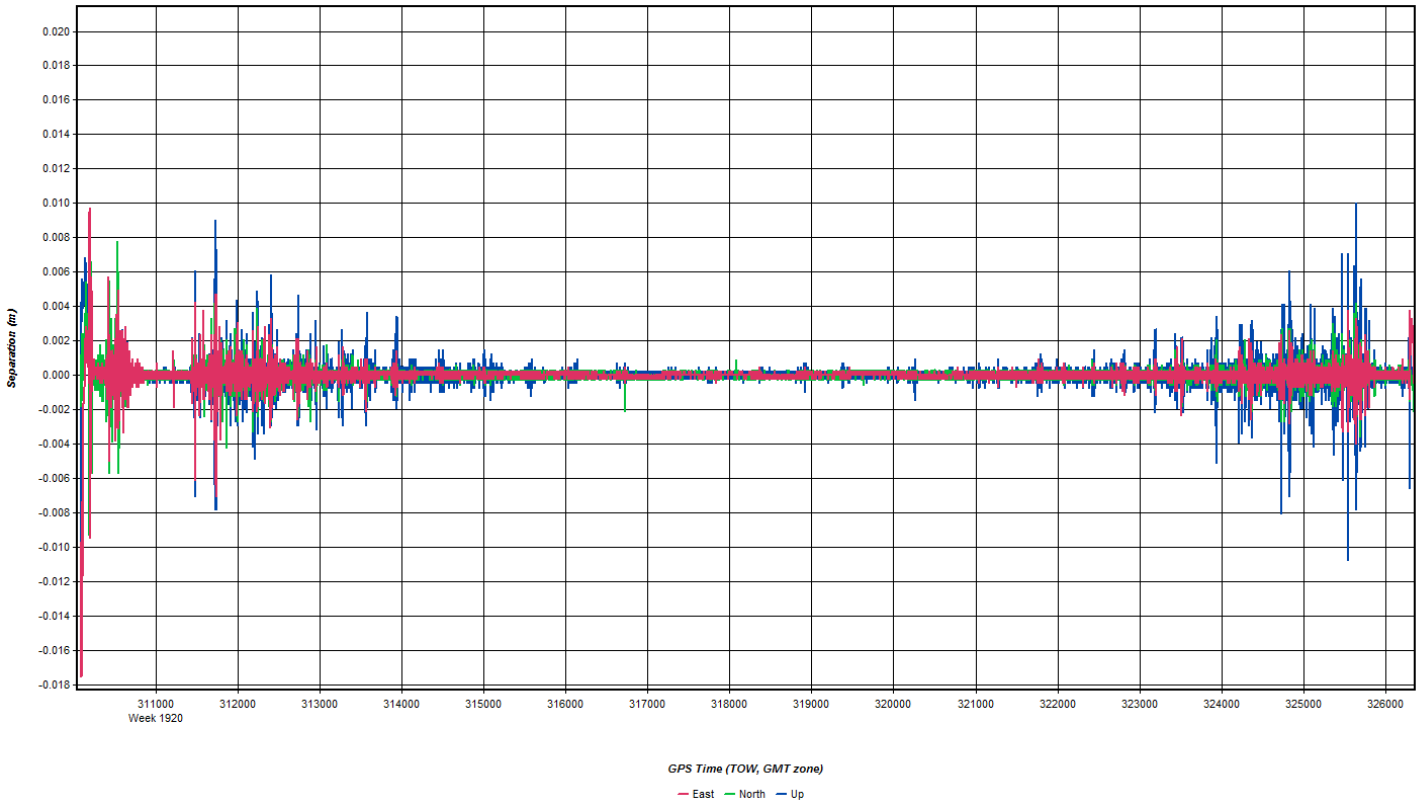
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
311000
Week 1920
312000
313000
314000
315000
316000
317000
318000
319000
320000
321000
322000
323000
324000
325000
326000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou


Separation (m)
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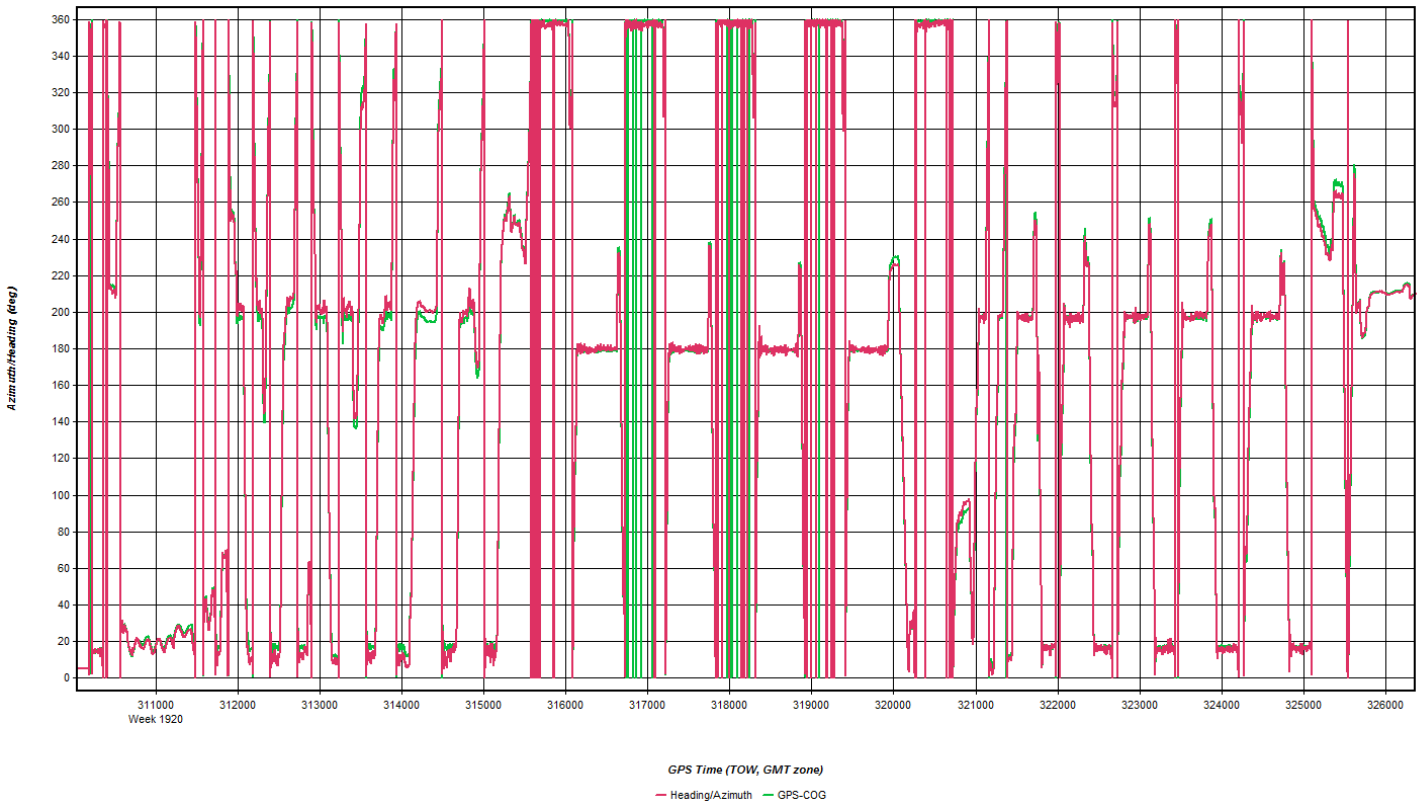
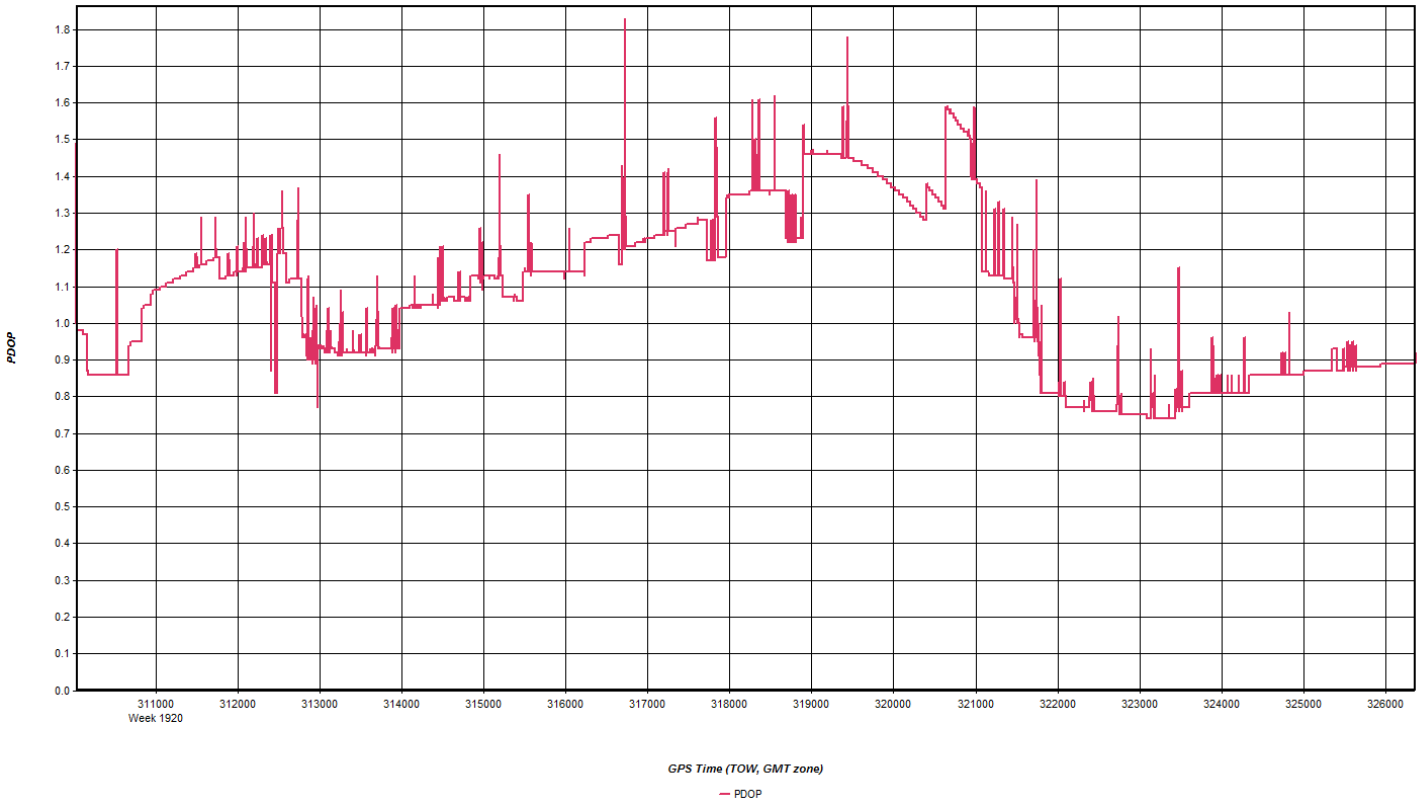
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
-0.010
-0.012
-0.014
-0.016
-0.018
311000
Week 1920
312000
313000
314000
315000
316000
317000
318000
319000
320000
321000
322000
323000
324000
325000
326000
GPS Time (TOW, GMT zone)
East
North
Up


Azimuth/Heading (deg)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
311000
Week 1920
312000
313000
314000
315000
316000
317000
318000
319000
320000
321000
322000
323000
324000
325000
326000
GPS Time (TOW, GMT zone)
Heading/Azimuth
GPS-COG


PDOP
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1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
311000
Week 1920
312000
313000
314000
315000
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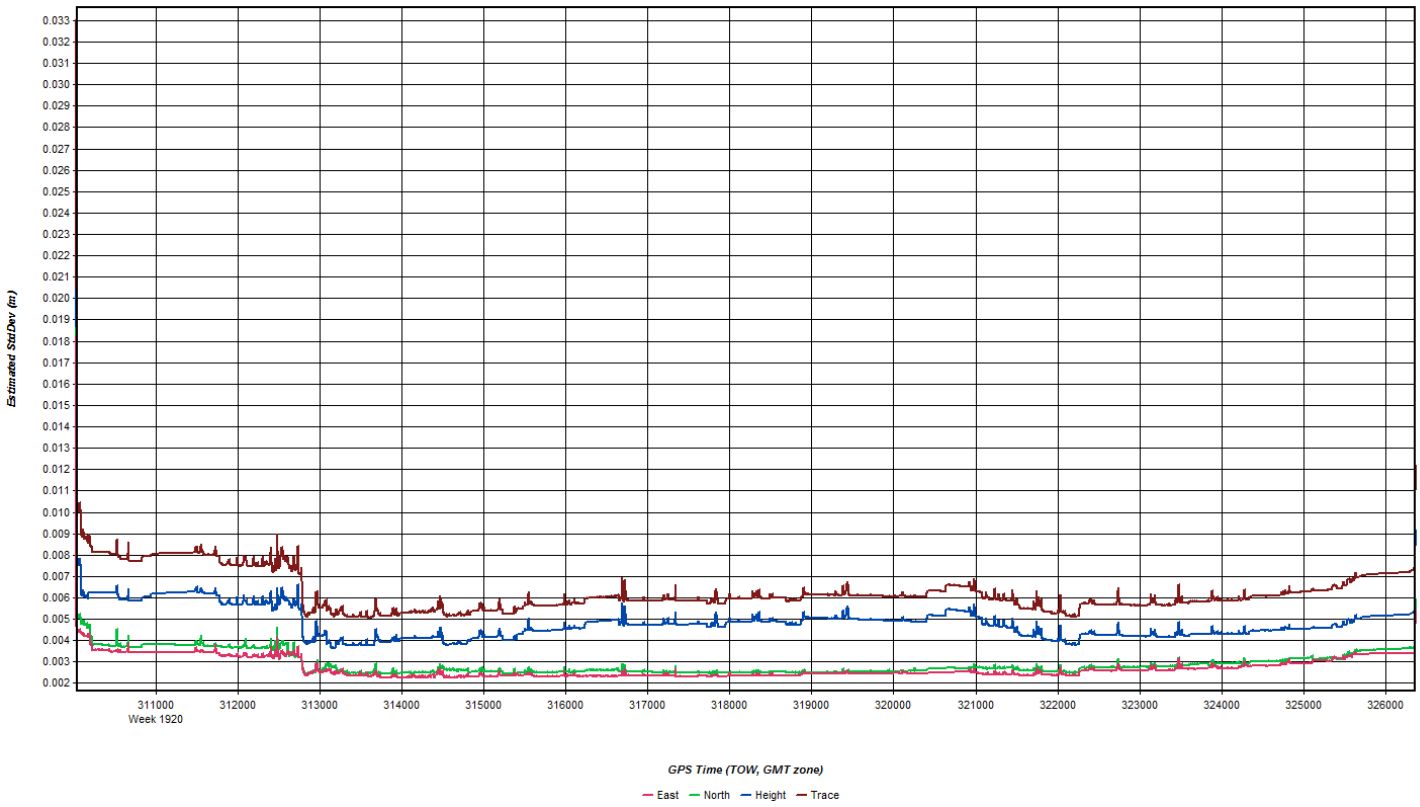
325000
326000
GPS Time (TOW, GMT zone)
PDOP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0.032
0.031
0.030
0.029
0.028
0.027
0.026
0.025
0.024
0.023
0.022
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
311000
Week 1920
312000
313000
314000
315000
316000
317000
318000
319000
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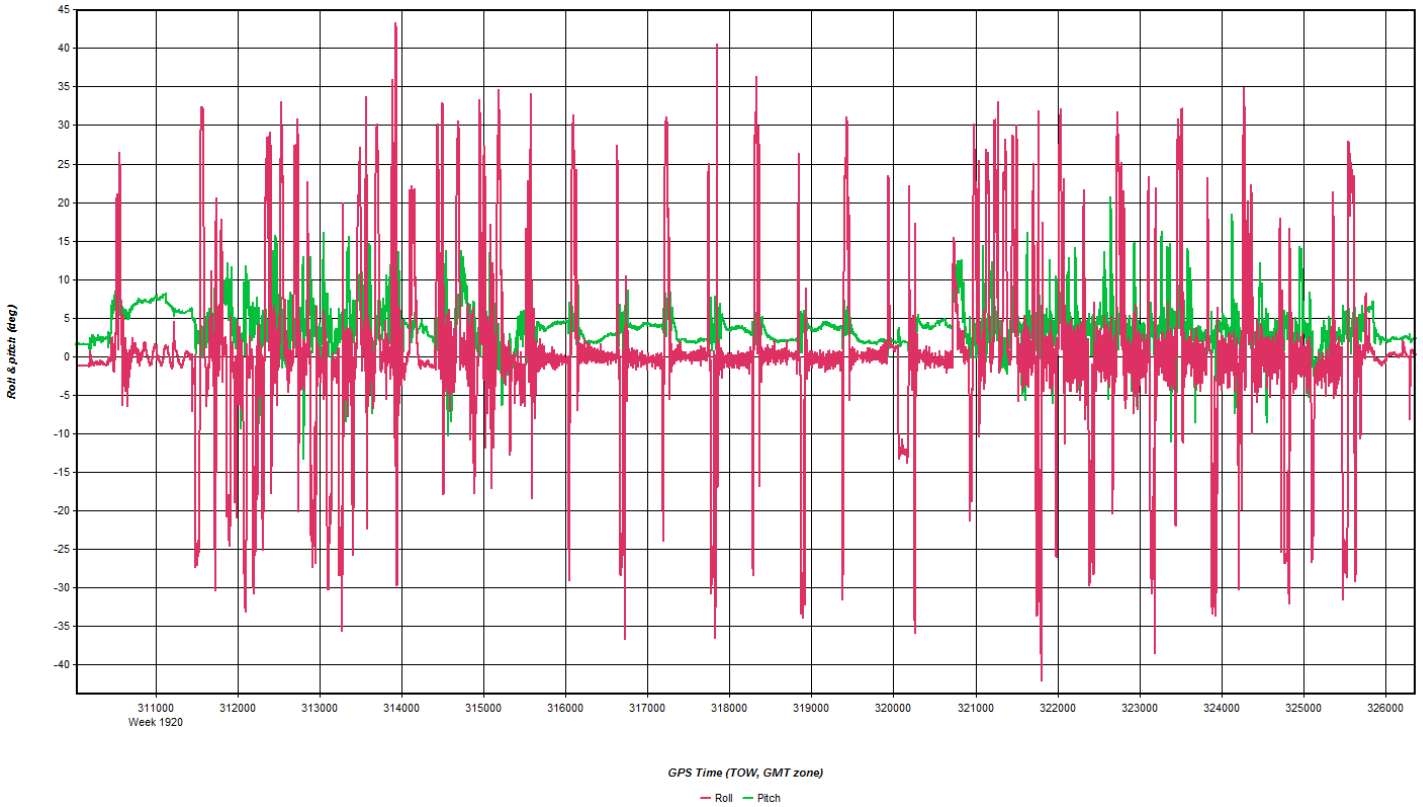
322000
323000
324000
325000
326000
GPS Time (TOW, GMT zone)
East
North
Height
Trace


Roll & pitch (deg)
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40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
311000
Week 1920
312000
313000
314000
315000
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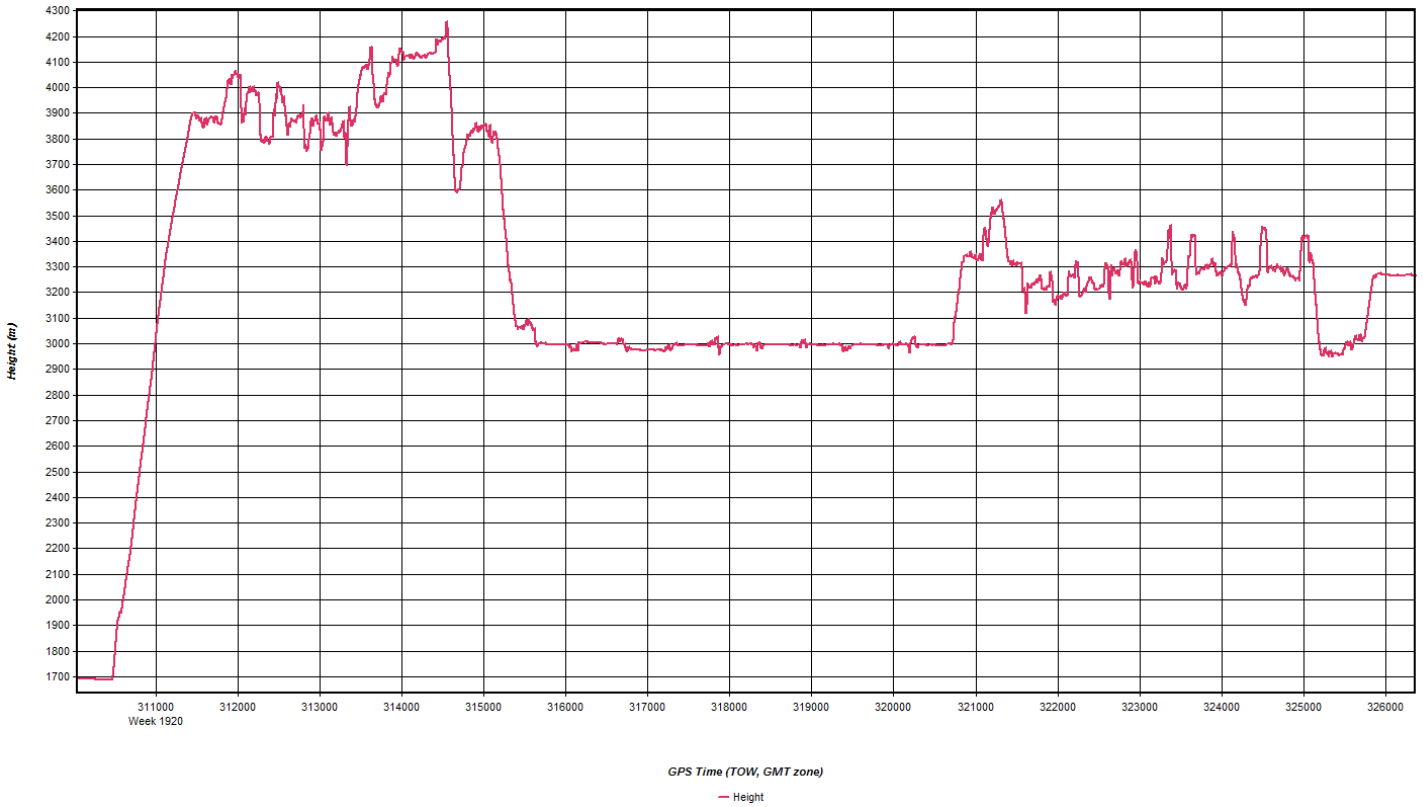
325000
326000
GPS Time (TOW, GMT zone)
Roll
Pitch


Height (m)
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4200
4100
4000
3900
3800
3700
3600
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3400
3300
3200
3100
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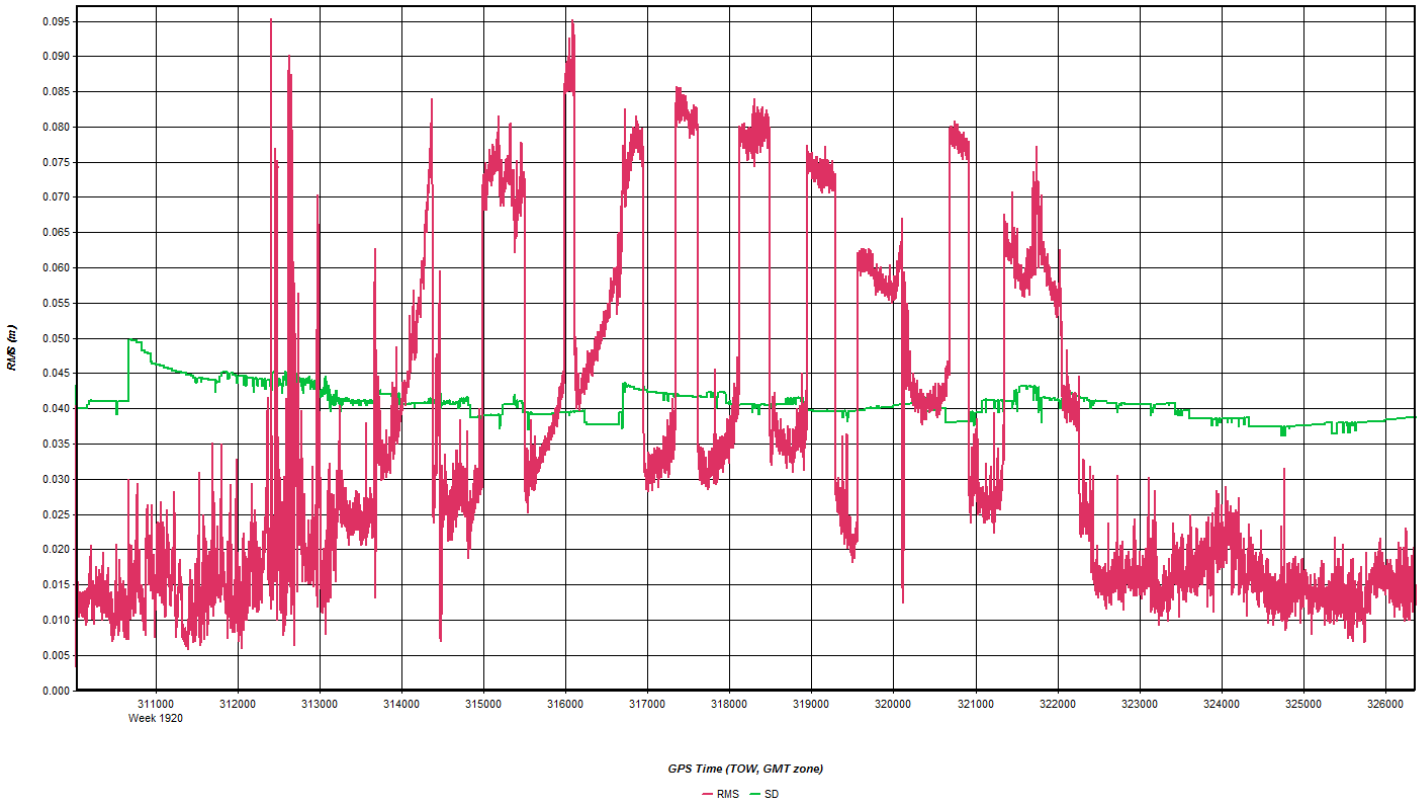
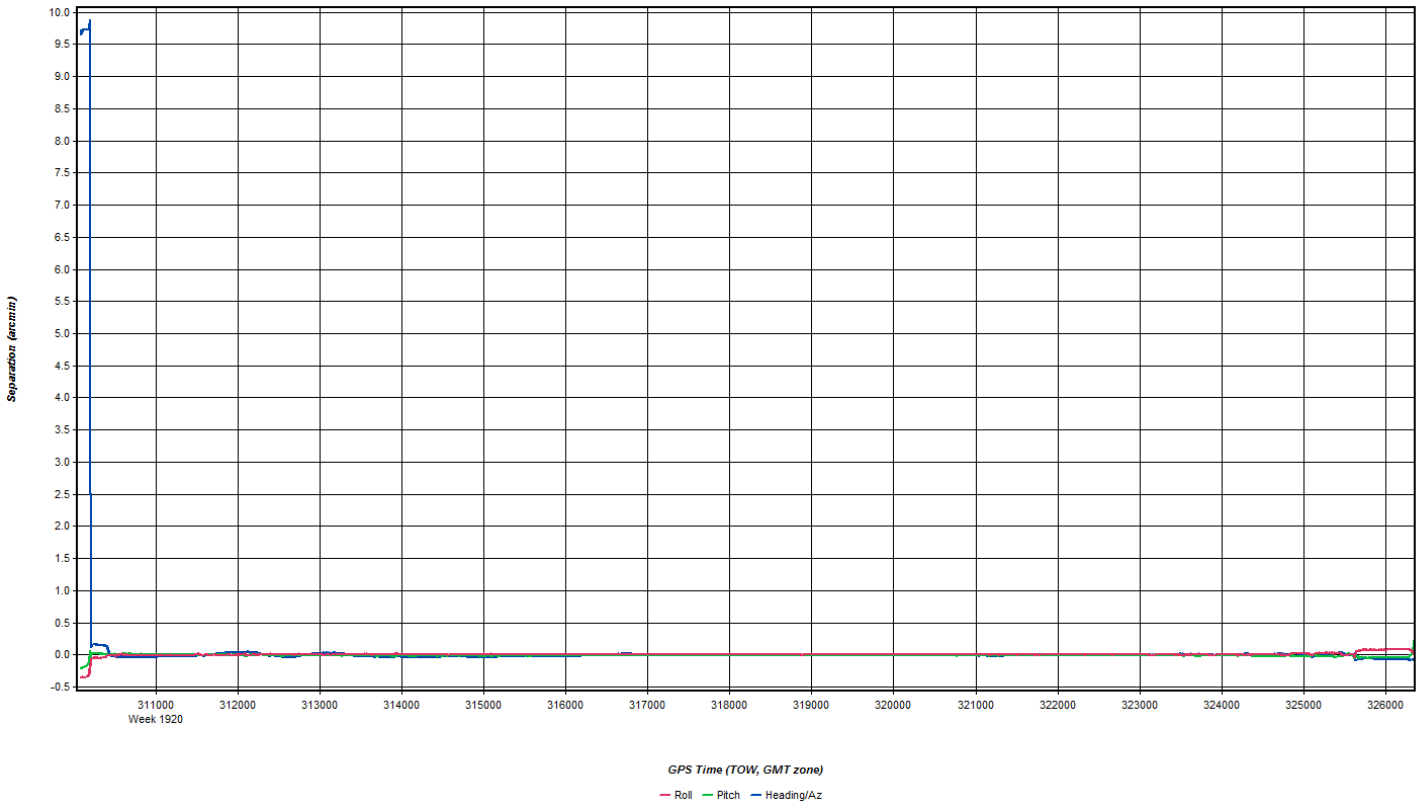
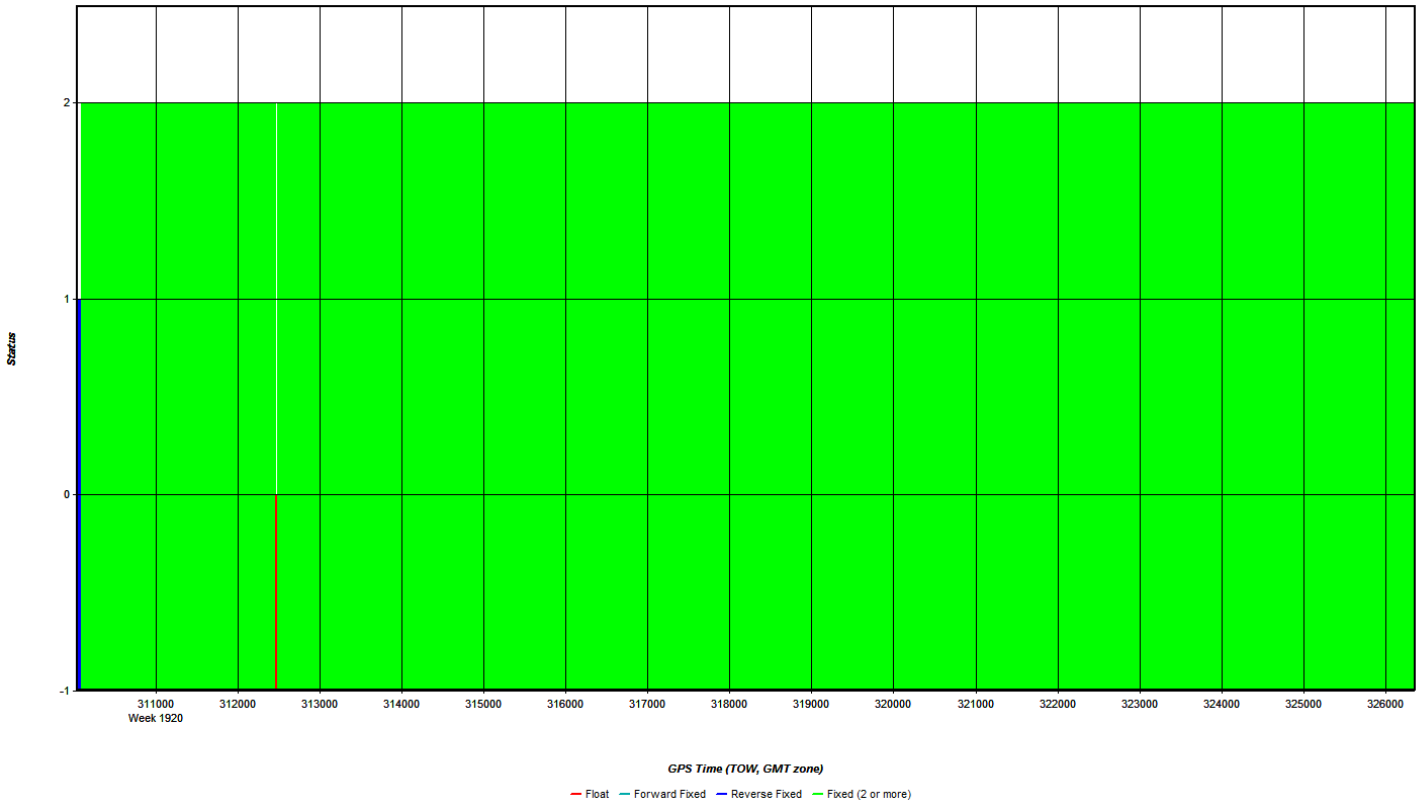
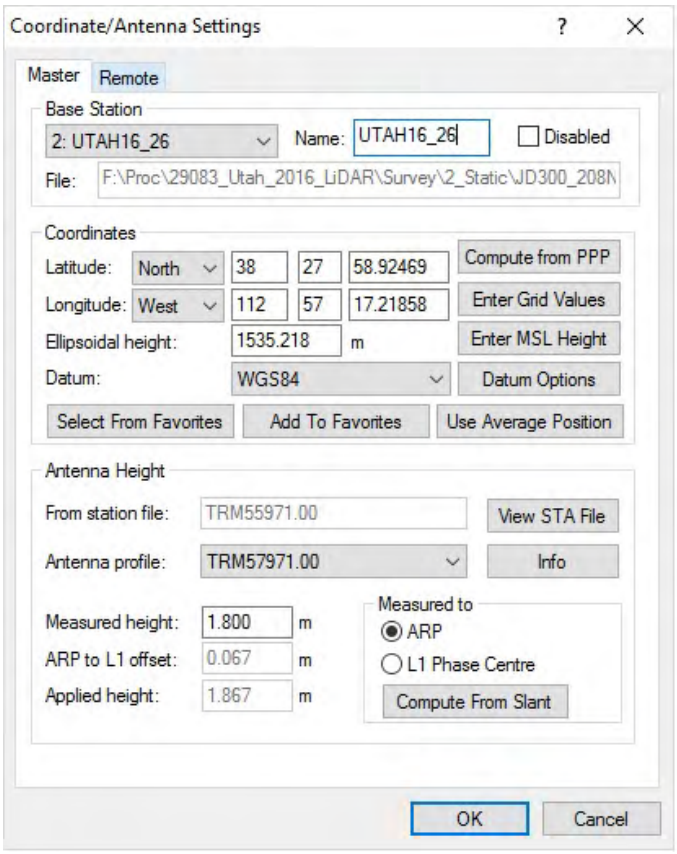
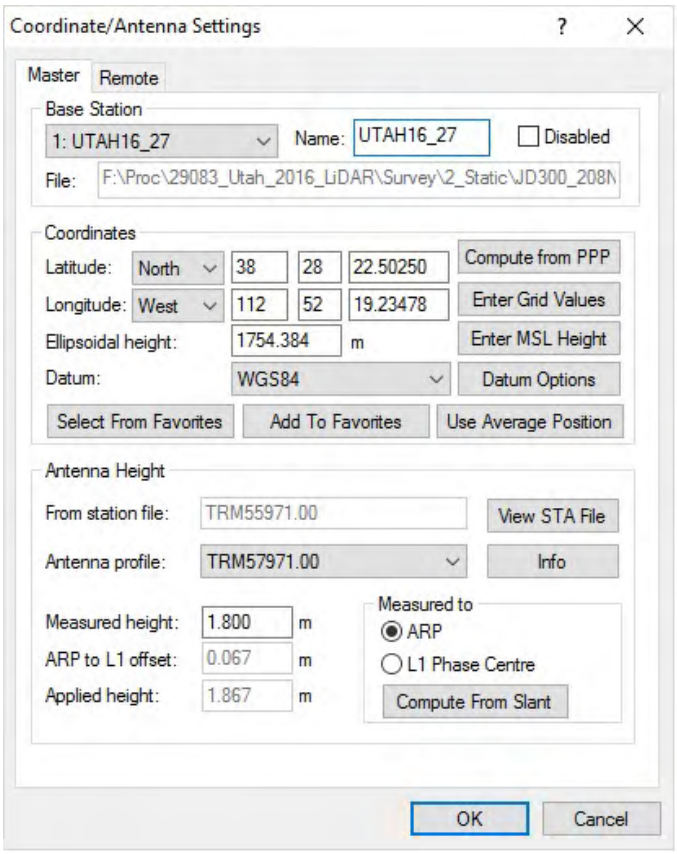
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
311000
Week 1920
312000
313000
314000
315000
316000
317000
318000
319000
320000
321000
322000
323000
324000
325000
326000
GPS Time (TOW, GMT zone)
Height


RMS (m)
0.095
0.090
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
311000
Week 1920
312000
313000
314000
315000
316000
317000
318000
319000
320000
321000
322000
323000
324000
325000
326000
GPS Time (TOW, GMT zone)
RMS
SD


Separation (arcmin)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
311000
Week 1920
312000
313000
314000
315000
316000
317000
318000
319000
320000
321000
322000
323000
324000
325000
326000
GPS Time (TOW, GMT zone)
Roll
Pitch
Heading/Az


Status
2
1
0
-1
311000
Week 1920
312000
313000
314000
315000
316000
317000
318000
319000
320000
321000
322000
323000
324000
325000
326000
GPS Time (TOW, GMT zone)
Float
Forward Fixed
Reverse Fixed
Fixed (2 or more)


Coordinate/Antenna Settings
Master
Remote
Base Station
2: UTAH16_26
Name:
UTAH16_26
Disabled
File:
F:\Proc\29083_Utah_2016_LiDAR\Survey\2_Static\JD300_208N
Coordinates
Latitude:
North
38
27
58.92469
Compute from PPP
Longitude:
West
112
57
17.21858
Enter Grid Values
Ellipsoidal height:
1535.218
m
Enter MSL Height
Datum:
WGS84
Datum Options
Select From Favorites
Add To Favorites
Use Average Position
Antenna Height
From station file:
TRM55971.00
View STA File
Antenna profile:
TRM57971.00
Info
Measured height:
1.800
m
ARP to L1 offset:
0.067
m
Applied height:
1.867
m
Measured to
ARP
L1 Phase Centre
Compute From Slant
OK
Cancel


Coordinate/Antenna Settings
Master
Remote
Base Station
1: UTAH16_27
Name:
UTAH16_27
Disabled
File:
F:\Proc\29083_Utah_2016_LiDAR\Survey\2_Static\JD300_208N
Coordinates
Latitude:
North
38
28
22.50250
Compute from PPP
Longitude:
West
112
52
19.23478
Enter Grid Values
Ellipsoidal height:
1754.384
m
Enter MSL Height
Datum:
WGS84
Datum Options
Select From Favorites
Add To Favorites
Use Average Position
Antenna Height
From station file:
TRM55971.00
View STA File
Antenna profile:
TRM57971.00
Info
Measured height:
1.800
m
ARP to L1 offset:
0.067
m
Applied height:
1.867
m
Measured to
ARP
L1 Phase Centre
Compute From Slant
OK
Cancel

Flight Log

Date: 10/26/2016	**Aircraft:** 208NR	**Sensor:** 8227
Project: Utah 2016 LiDAR		**Project #:** R029083
Flight Mgmt File: FAGL_Forge_2PiA_8227_8ppsm_1550m_1 Unplanned-20161026140711_1		
Pilot: Eric Petersen	**Sensor Operator:** Jon Frech	

	Flight 1	Flight 2	Flight 3	Flight 4
Wheels Up	8:10:00 AM			
Wheels Down	1:46:00 PM			
Begin Hobbs	4364			
End Hobbs	4369.5			

On-line Hobbs: 3.5	**Mob Hobbs:** 2

Notes

Started on SE lines in the hills. Calculated start altitudes as always from GE. Got false ranges and bad returns. Reflew. Tried higher. Started to try lower and turbulence kicked up....20 degree rolls. Headed to the flat land on the west side of the AOI. Calculated start height for a 1550M plan should have put us right around 10100 feet. At 9700 feet TRACGUI was showing us at 1600M. Flew here for an hour and jumped back over to the terrain lines on the N end. Started close to 1000 feet lower than what we should have been according to GE. This worked and we were within the range gate and getting 100 percent returns. Not sure why there is such a discrepency between GE and what we were seeing in Flight Pro but flying 500-1000 feet lower was the ticket. SE lines we flew...45-49 are probably trash and should be reflown. 49 for sure.

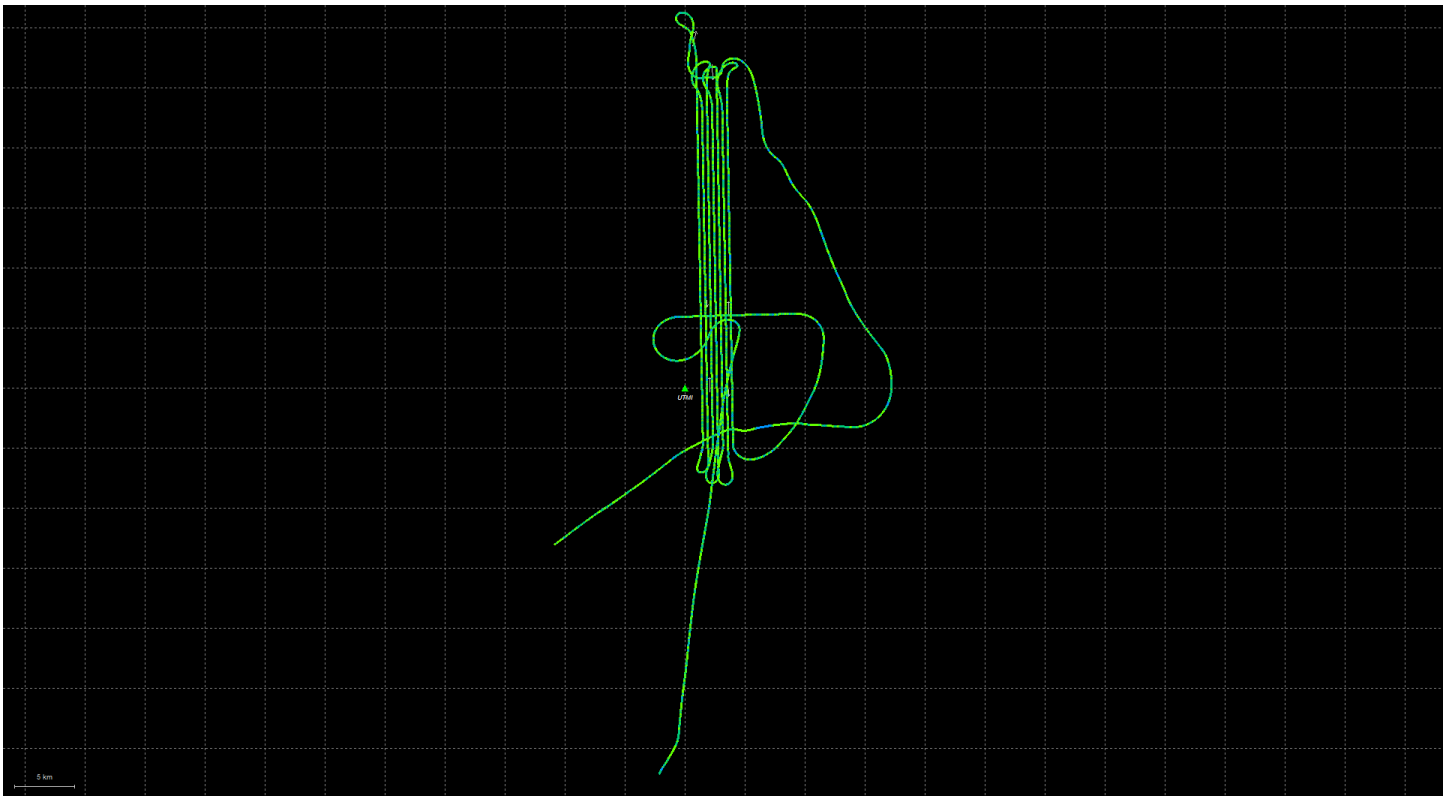
Flt Mgmt File: FAGL_Forge_2PiA_8227_8ppsm_1550m_1

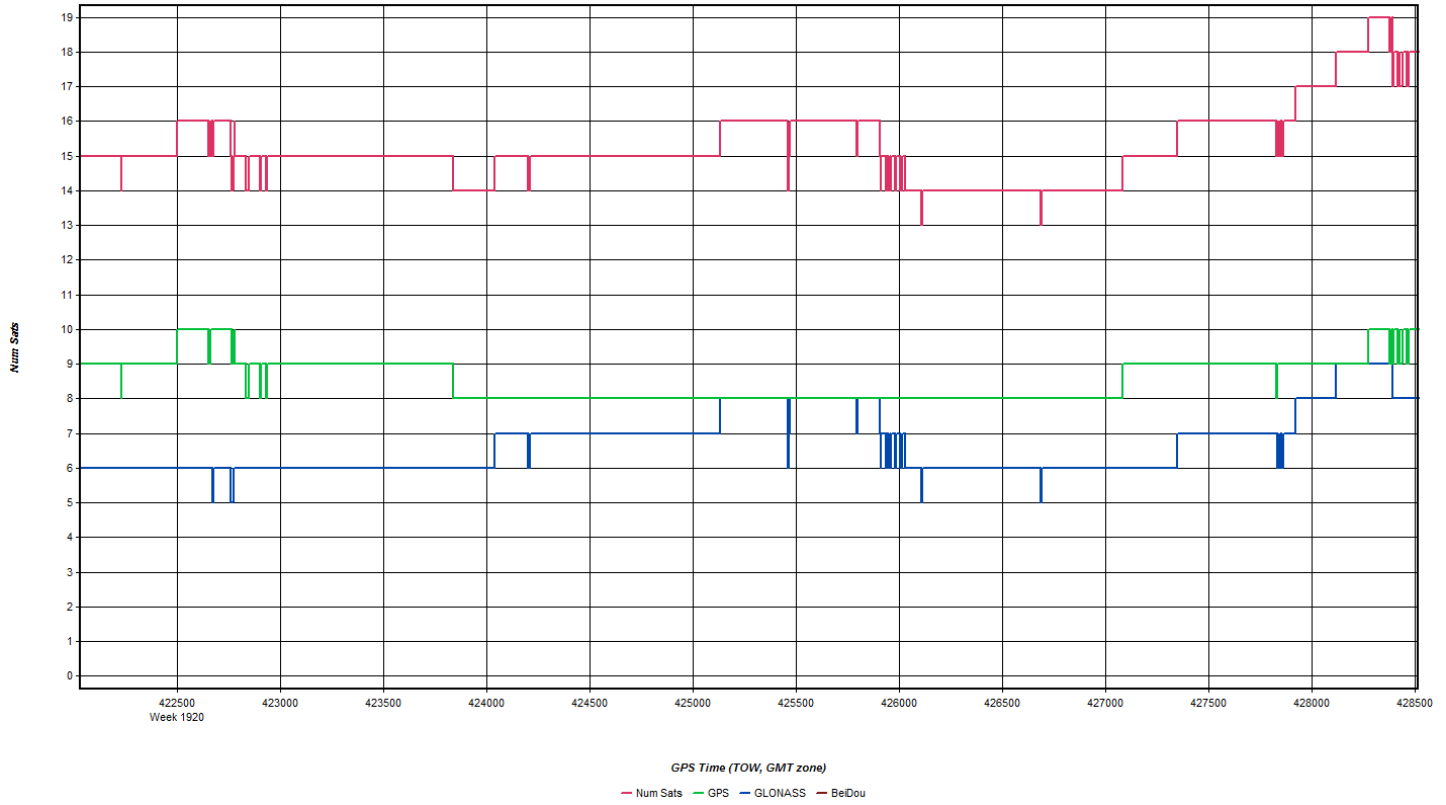
FRG1045	3871.213 m	14:35:40	7.39941361	3854.074 m	14:36:11	7.48982815
FRG1046	4034.965 m	14:39:56	8.1526832	3867.559 m	14:40:44	8.29805228
FRG1046	3975.064 m	14:43:52	8.85030275	3787.219 m	14:44:45	9.01022315
FRG1047	3814.869 m	14:46:53	9.38415377	4002.396 m	14:48:08	9.59940549
FRG1047	3883.129 m	14:52:27	10.36435086	3774.031 m	14:53:35	10.55708122
FRG1048	3862.463 m	14:56:18	11.02737776	3879.258 m	14:57:55	11.3175908
FRG1048	3804.568 m	15:01:29	11.92899817	3855.114 m	15:03:06	12.21815168
FRG1049	4074.317 m	15:06:07	12.73622806	3950.632 m	15:07:37	12.98407873
FRG1049	4091.973 m	15:12:10	13.77422543	4123.601 m	15:13:51	14.04774213
FRG1049	4259.745 m	15:22:14	15.47860424	3609.746 m	15:23:57	15.75127184
FRG1049	3825.786 m	15:31:09	16.96276118	3828.337 m	15:32:03	17.1021126
FRG1001	3051.133 m	15:39:53	18.2544374	2996.326 m	15:47:02	19.25658584
FRG1002	2999.448 m	15:49:20	19.62459463	3000.031 m	15:56:41	20.93133698
FRG1003	2970.461 m	15:58:59	21.29161559	2975.782 m	16:06:09	22.2287964
FRG1004	2978.745 m	16:07:59	22.50851216	2992.559 m	16:15:21	23.77203769
FRG1005	3023.160 m	16:17:21	24.06913756	2996.812 m	16:24:23	24.91356897
FRG1006	2981.724 m	16:26:13	25.17730282	2996.980 m	16:33:41	26.40148626
FRG1007	2993.199 m	16:35:30	26.65443707	2993.665 m	16:42:37	27.43028758
FRG1008	2992.670 m	16:44:35	27.69329631	2994.342 m	16:51:57	28.84012361
FRG1009	2988.868 m	16:57:45	29.57352097	2997.171 m	17:04:59	30.25260782
FRG1073	3394.317 m	17:11:16	31.06274838	3434.843 m	17:11:47	31.13020081
FRG1073	3561.354 m	17:14:52	31.46890274	3523.968 m	17:15:12	31.51316343
FRG1073	3314.439 m	17:18:54	31.91339969	3236.084 m	17:21:25	32.2341034
FRG1072	3214.203 m	17:23:32	32.46843087	3147.890 m	17:26:00	32.66804354
FRG1071	3186.395 m	17:28:16	32.90279643	3206.736 m	17:31:39	33.30974941
FRG1070	3212.843 m	17:34:09	33.56528698	3273.130 m	17:37:29	33.80855056
FRG1069	3315.219 m	17:40:30	34.09177282	3229.325 m	17:44:30	34.54072802
FRG1068	3255.811 m	17:46:29	34.72538785	3280.418 m	17:50:18	34.9550173
FRG1067	3230.857 m	17:52:20	35.12701129	3304.892 m	17:56:48	35.59157227
FRG1066	3268.091 m	17:59:02	35.77457277	3284.116 m	18:03:02	35.96312057
FRG1065	3264.910 m	18:07:04	36.25856931	3299.405 m	18:11:33	36.67148475
FRG1064	3264.804 m	18:13:58	36.83620062	3342.912 m	18:17:56	36.96080809

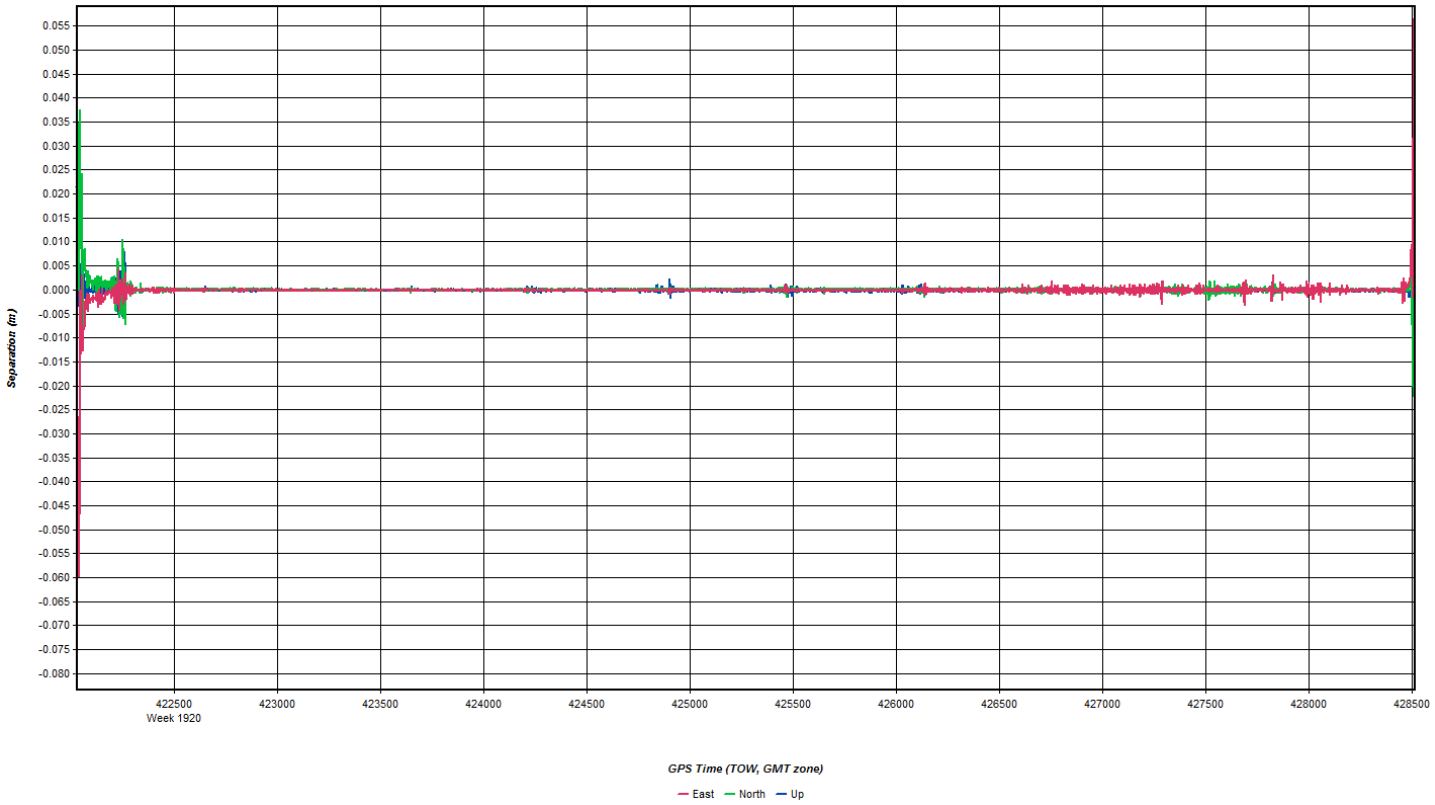
Flt Mgmt File: Unplanned-20161026140711_1

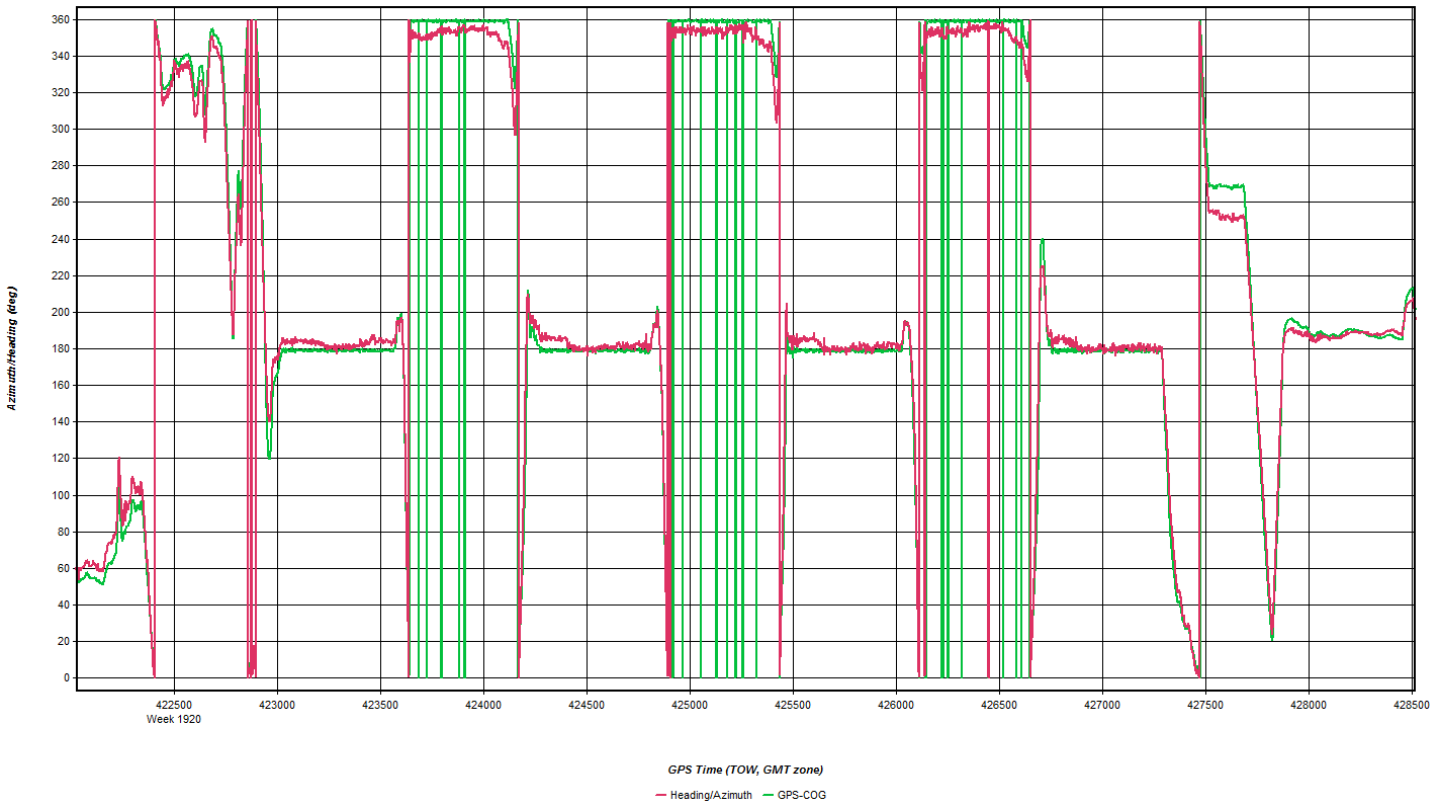
UL001	2963.570 m	18:22:46	37.23269721	2956.908 m	18:24:15	37.29888741

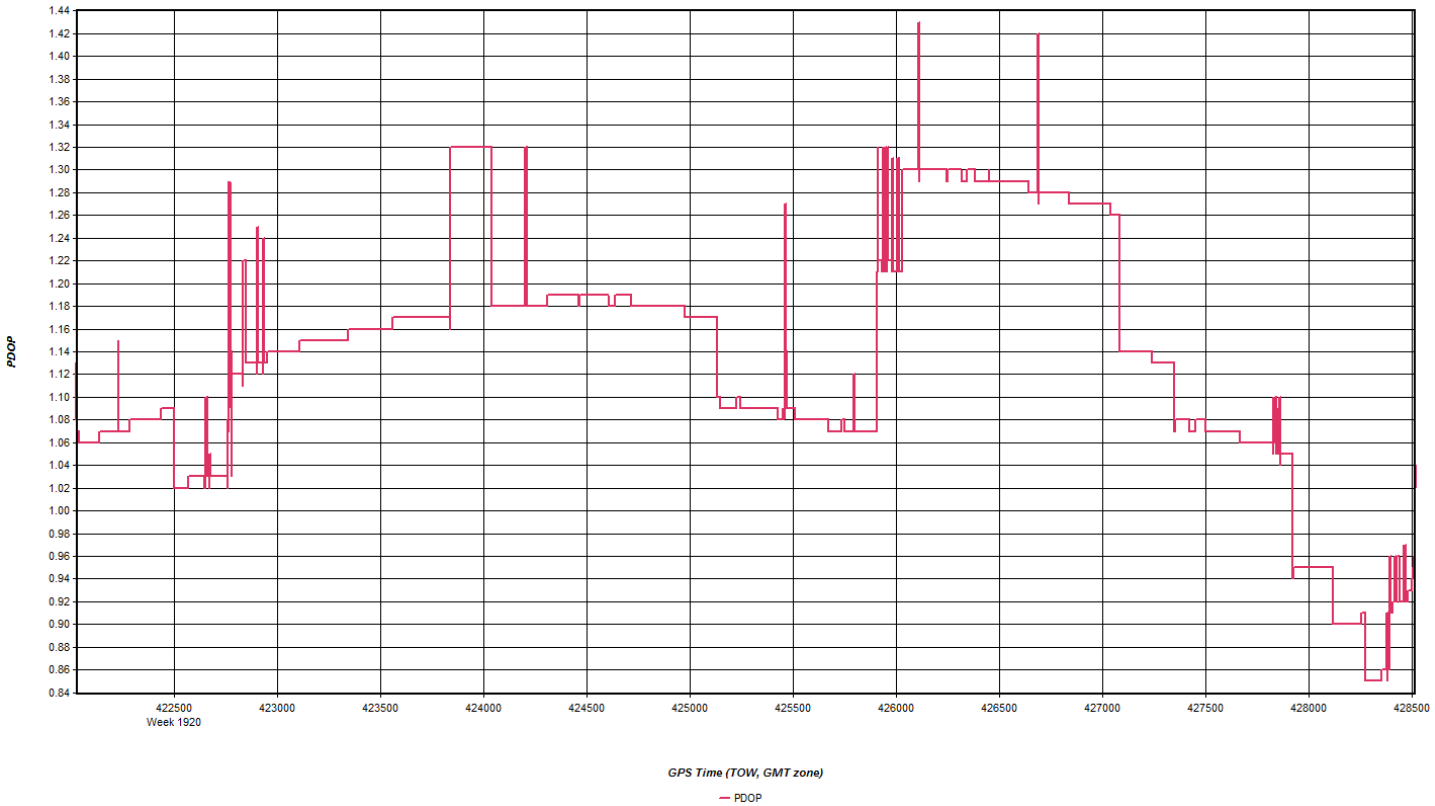
Oct 27, 2016-A (N208NR, SN8227)

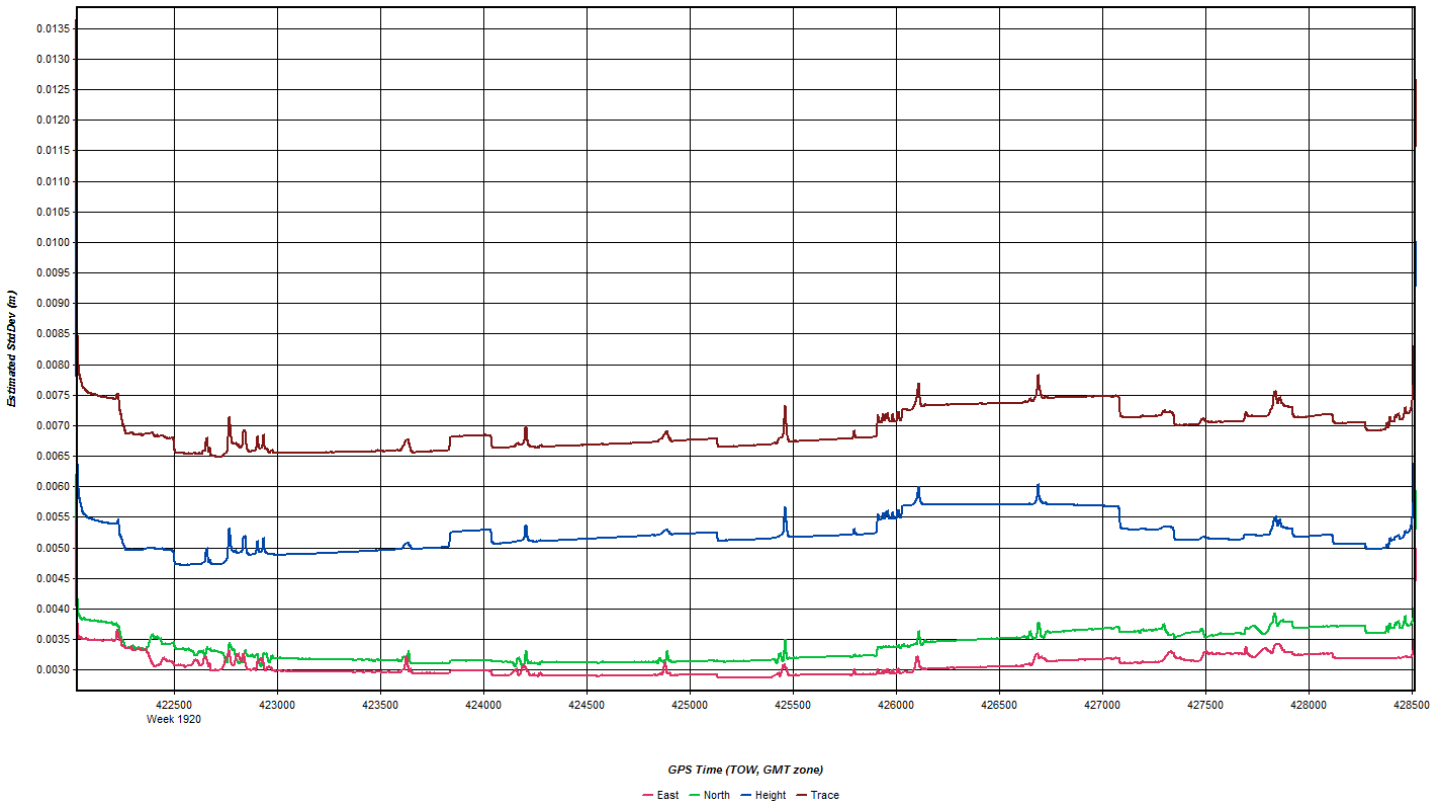

5 km


Num Sats
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
422500
Week 1920
423000
423500
424000
424500
425000
425500
426000
426500
427000
427500
428000
428500
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou

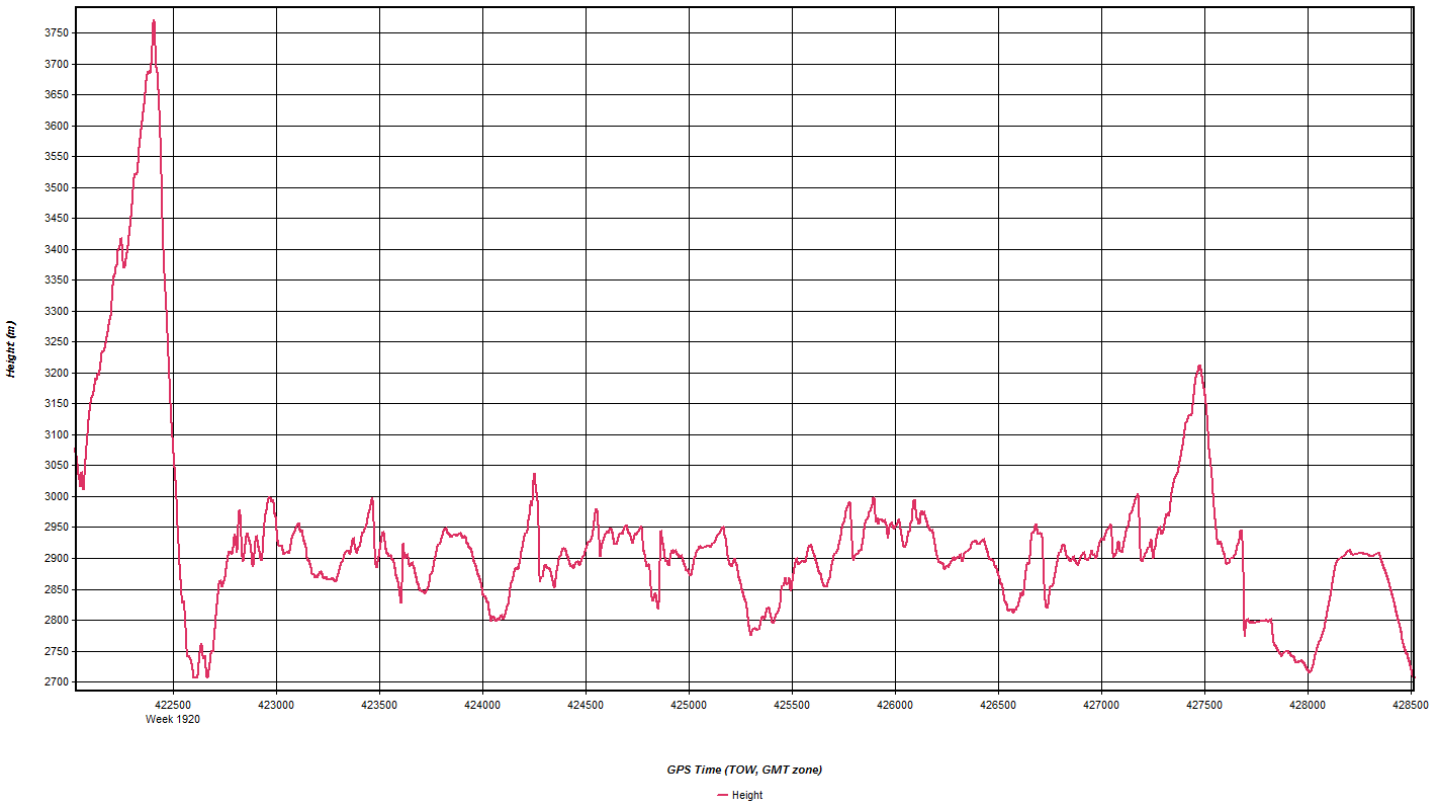

Separation (m)
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
-0.045
-0.050
-0.055
-0.060
-0.065
-0.070
-0.075
-0.080
422500
Week 1920
423000
423500
424000
424500
425000
425500
426000
426500
427000
427500
428000
428500
GPS Time (TOW, GMT zone)
East
North
Up

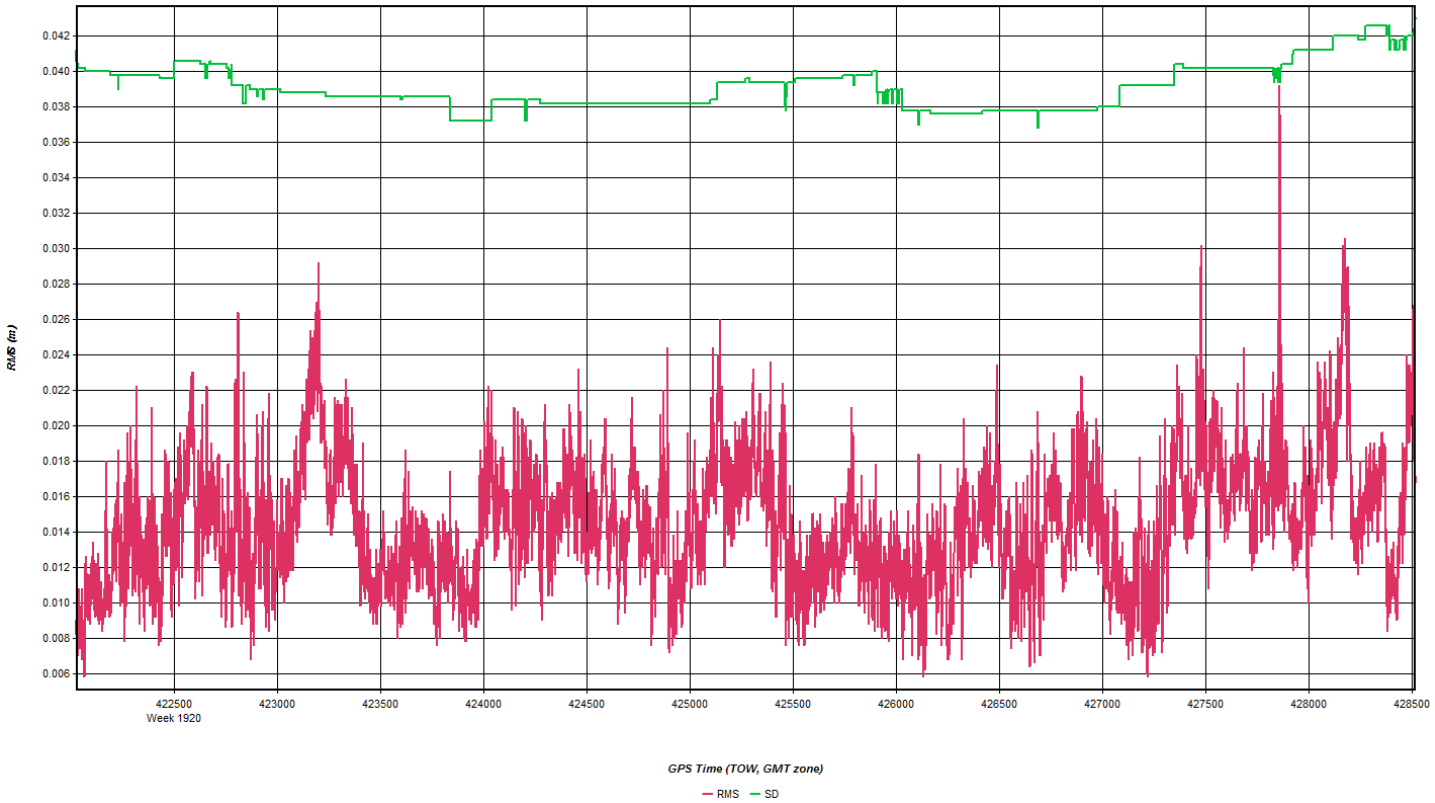

Azimuth/Heading (deg)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
422500
Week 1920
423000
423500
424000
424500
425000
425500
426000
426500
427000
427500
428000
428500
GPS Time (TOW, GMT zone)
Heading/Azimuth
GPS-COG

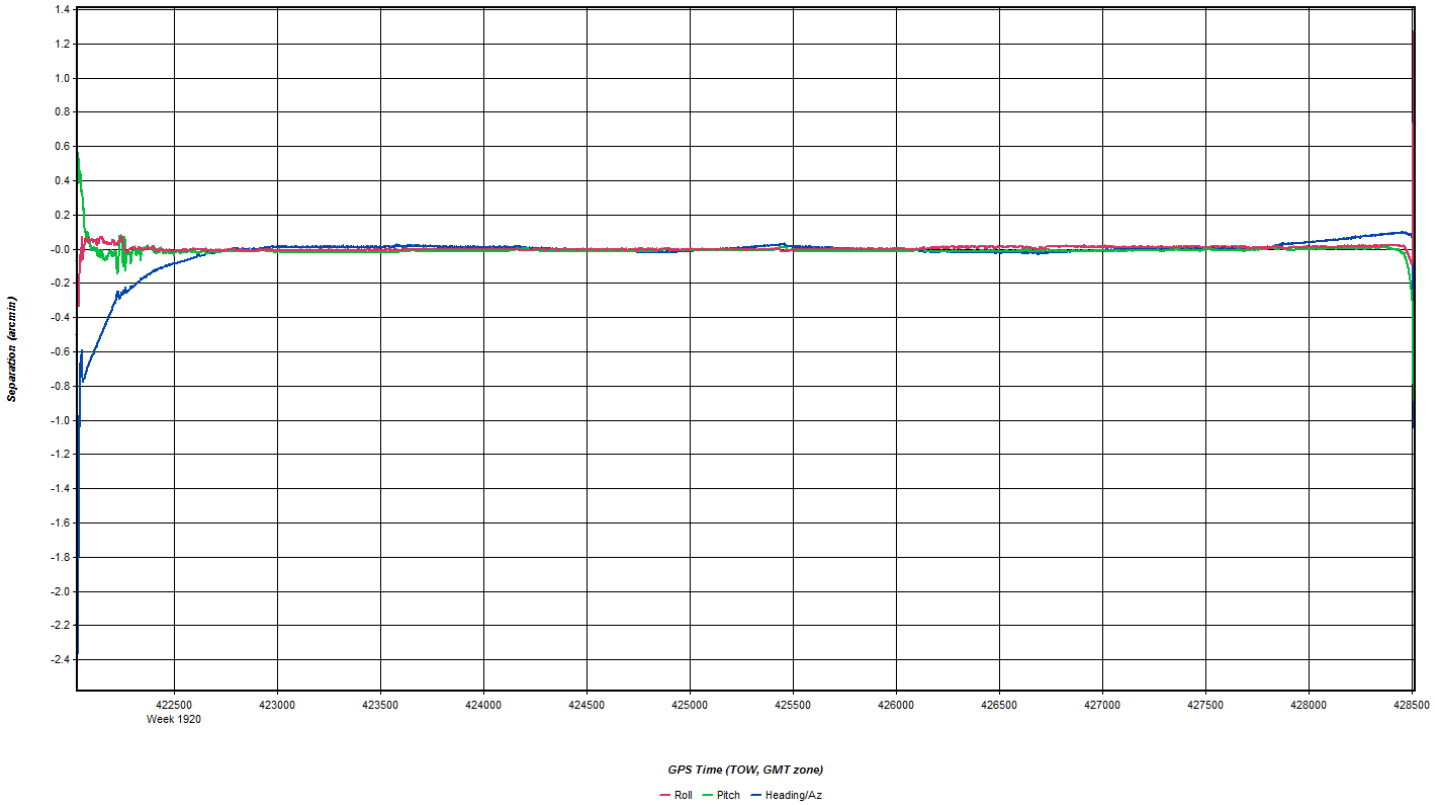

PDOP
1.44
1.42
1.40
1.38
1.36
1.34
1.32
1.30
1.28
1.26
1.24
1.22
1.20
1.18
1.16
1.14
1.12
1.10
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
422500
Week 1920
423000
423500
424000
424500
425000
425500
426000
426500
427000
427500
428000
428500
GPS Time (TOW, GMT zone)
PDOP

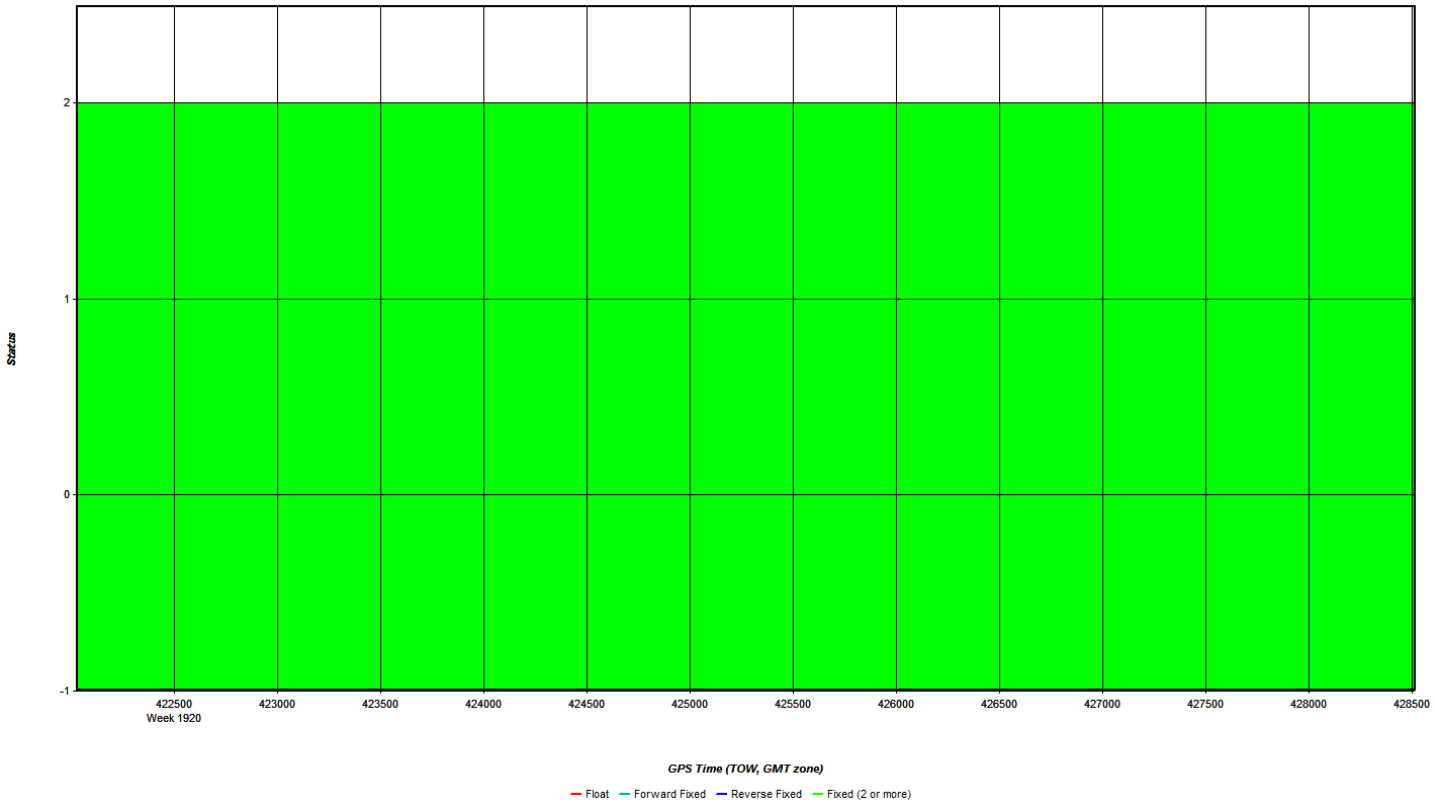

Estimated StdDev (m)
0.0135
0.0130
0.0125
0.0120
0.0115
0.0110
0.0105
0.0100
0.0095
0.0090
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
0.0030
422500
Week 1920
423000
423500
424000
424500
425000
425500
426000
426500
427000
427500
428000
428500
GPS Time (TOW, GMT zone)
East
North
Height
Trace

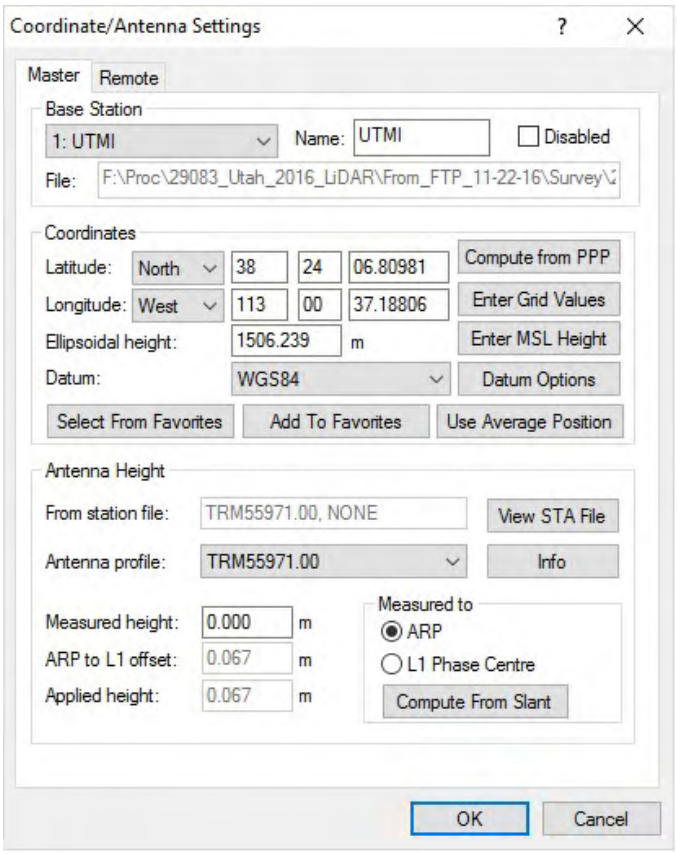

Roll & pitch (deg)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
422500
Week 1920
423000
423500
424000
424500
425000
425500
426000
426500
427000
427500
428000
428500
GPS Time (TOW, GMT zone)
Roll
Pitch


Height (m)
3750
3700
3650
3600
3550
3500
3450
3400
3350
3300
3250
3200
3150
3100
3050
3000
2950
2900
2850
2800
2750
2700
422500
Week 1920
423000
423500
424000
424500
425000
425500
426000
426500
427000
427500
428000
428500
GPS Time (TOW, GMT zone)
Height


RMS (m)
0.042
0.040
0.038
0.036
0.034
0.032
0.030
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
422500
Week 1920
423000
423500
424000
424500
425000
425500
426000
426500
427000
427500
428000
428500
GPS Time (TOW, GMT zone)
RMS
SD


Separation (arcmin)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
-0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
-2.2
-2.4
422500
Week 1920
423000
423500
424000
424500
425000
425500
426000
426500
427000
427500
428000
428500
GPS Time (TOW, GMT zone)
Roll
Pitch
Heading/Az


Status
2
1
0
-1
422500
Week 1920
423000
423500
424000
424500
425000
425500
426000
426500
427000
427500
428000
428500
GPS Time (TOW, GMT zone)
Float
Forward Fixed
Reverse Fixed
Fixed (2 or more)


Coordinate/Antenna Settings
Master
Remote
Base Station
1: UTMI
Name: UTMI
Disabled
File: F:\Proc\29083_Utah_2016_LiDAR\From_FTP_11-22-16\Survey\
Coordinates
Latitude: North 38 24 06.80981
Longitude: West 113 00 37.18806
Ellipsoidal height: 1506.239 m
Datum: WGS84
Compute from PPP
Enter Grid Values
Enter MSL Height
Datum Options
Select From Favorites
Add To Favorites
Use Average Position
Antenna Height
From station file: TRM55971.00, NONE
View STA File
Antenna profile: TRM55971.00
Info
Measured height: 0.000 m
ARP to L1 offset: 0.067 m
Applied height: 0.067 m
Measured to
ARP
L1 Phase Centre
Compute From Slant
OK
Cancel

Flight Log

Date: 10/26/2016	**Aircraft:** 208NR	**Sensor:** 8227
Project: Utah 2016 LiDAR		**Project #:** R029083
Flight Mgmt File: FAGL_Forge_2PiA_8227_8ppsm_1550m_2 Unplanned-20161027203238_2		
Pilot: Travis Peden	**Sensor Operator:** Aaron Mallon	

	Flight 1	Flight 2	Flight 3	Flight 4
Wheels Up				
Wheels Down				
Begin Hobbs	4370.5			
End Hobbs	4374.4			

On-line Hobbs: 3	**Mob Hobbs:** 0.9

Notes

Today we had to wait for clearance to fly the Nellis project which was located near the Air Force base. We had wheels up at 1220 and completed the Nellis project. We then flew North of Cedar City and continued work on the Forge project. We completed lines 10-16. While flying the Forge project we utilized the UTMI COR.

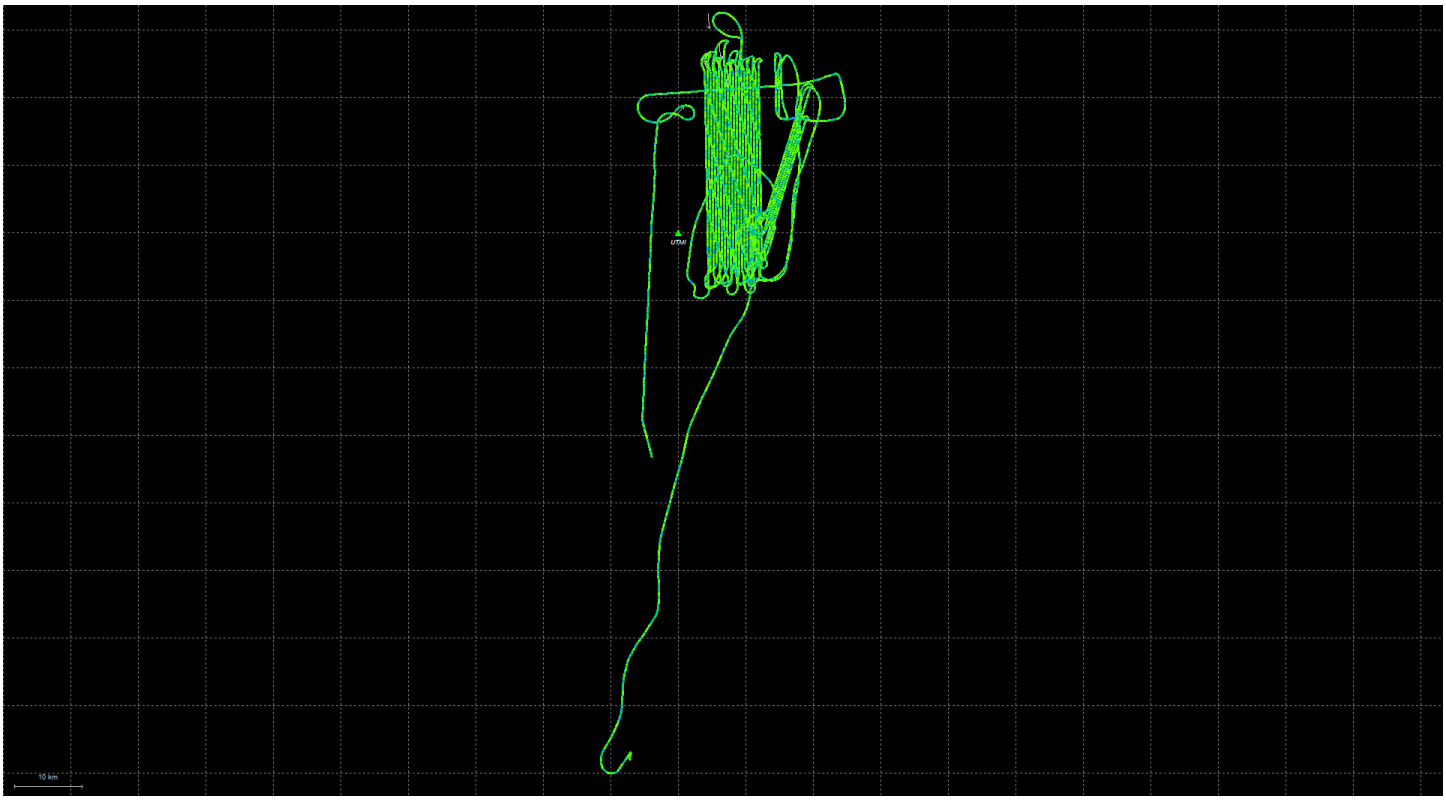
Flt Mgmt File: FAGL_Forge_2PiA_8227_8ppsm_1550m_2

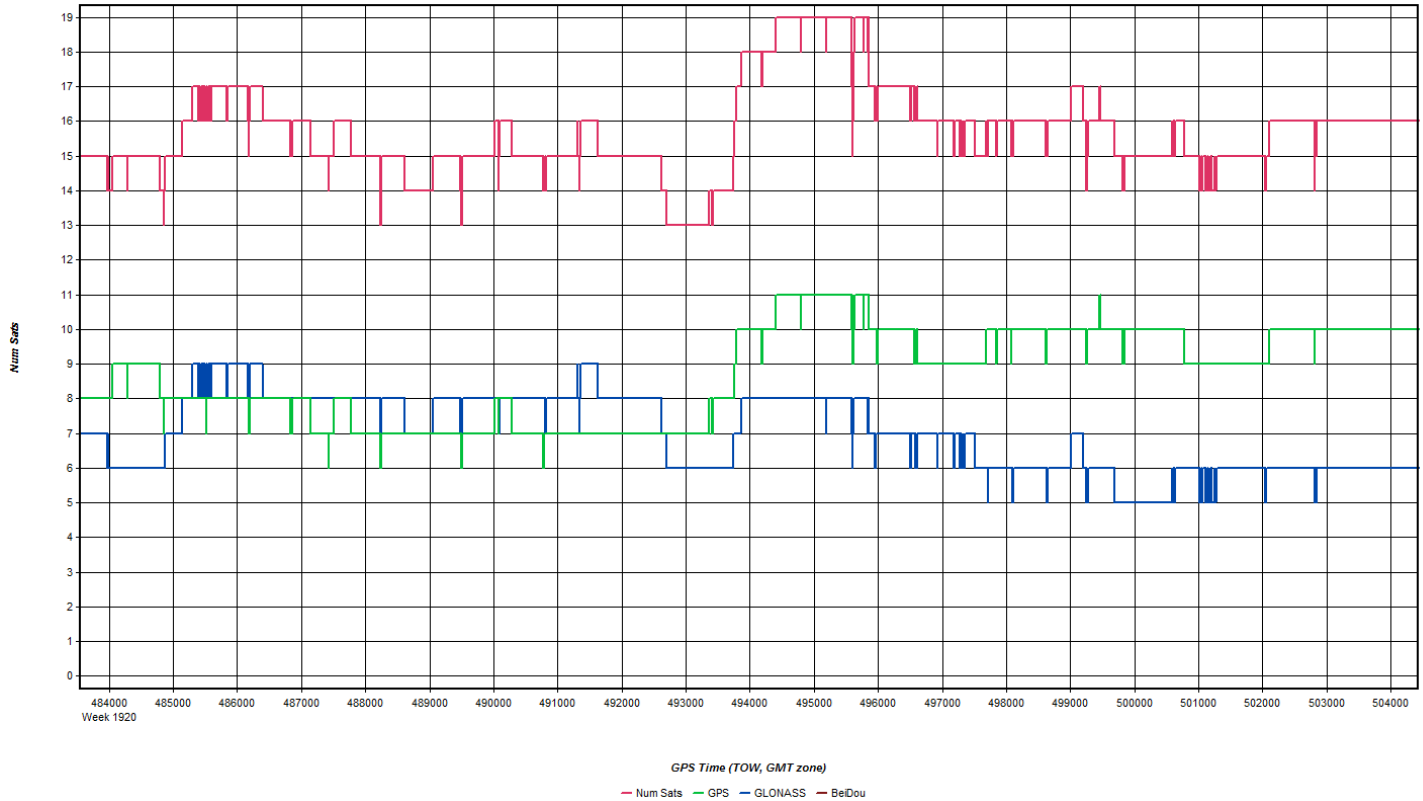
FRG1010	2943.885 m	21:31:14	29.35619503	2885.984 m	21:39:19	28.54069518
FRG1011	2885.850 m	21:40:50	28.34414939	2825.645 m	21:48:26	27.16894826
FRG1012	2883.954 m	21:51:43	26.73008225	2875.466 m	21:59:57	25.7819643
FRG1013	2915.240 m	22:02:00	25.49260906	2815.433 m	22:09:38	24.23912249
FRG1014	2899.838 m	22:12:14	23.8621836	2944.128 m	22:20:15	22.84609942
FRG1015	2960.284 m	22:22:20	22.53109998	2844.928 m	22:30:00	21.21342207
FRG1016	2895.579 m	22:32:48	20.78140107	2945.676 m	22:41:14	19.61251161

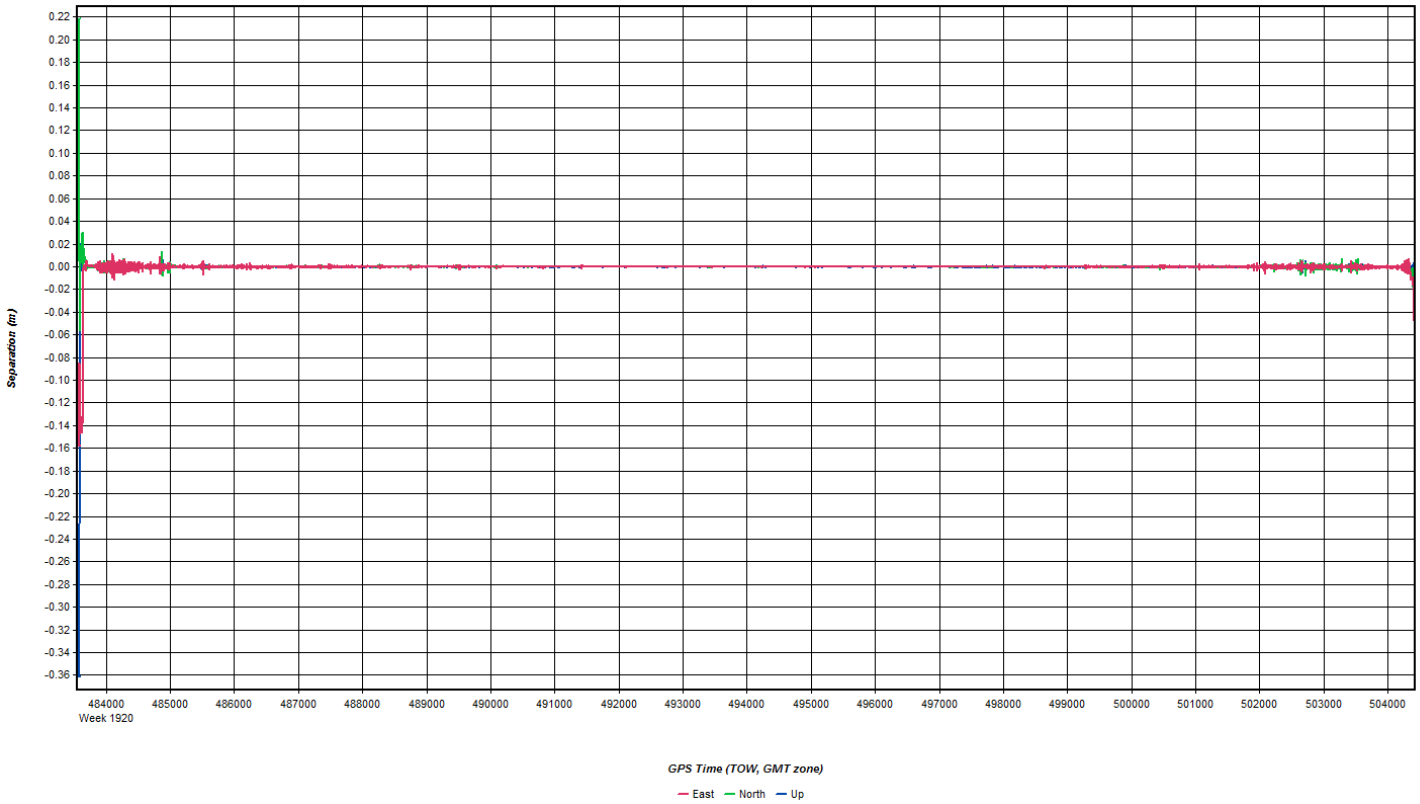
Flt Mgmt File: Unplanned-20161027203238_2

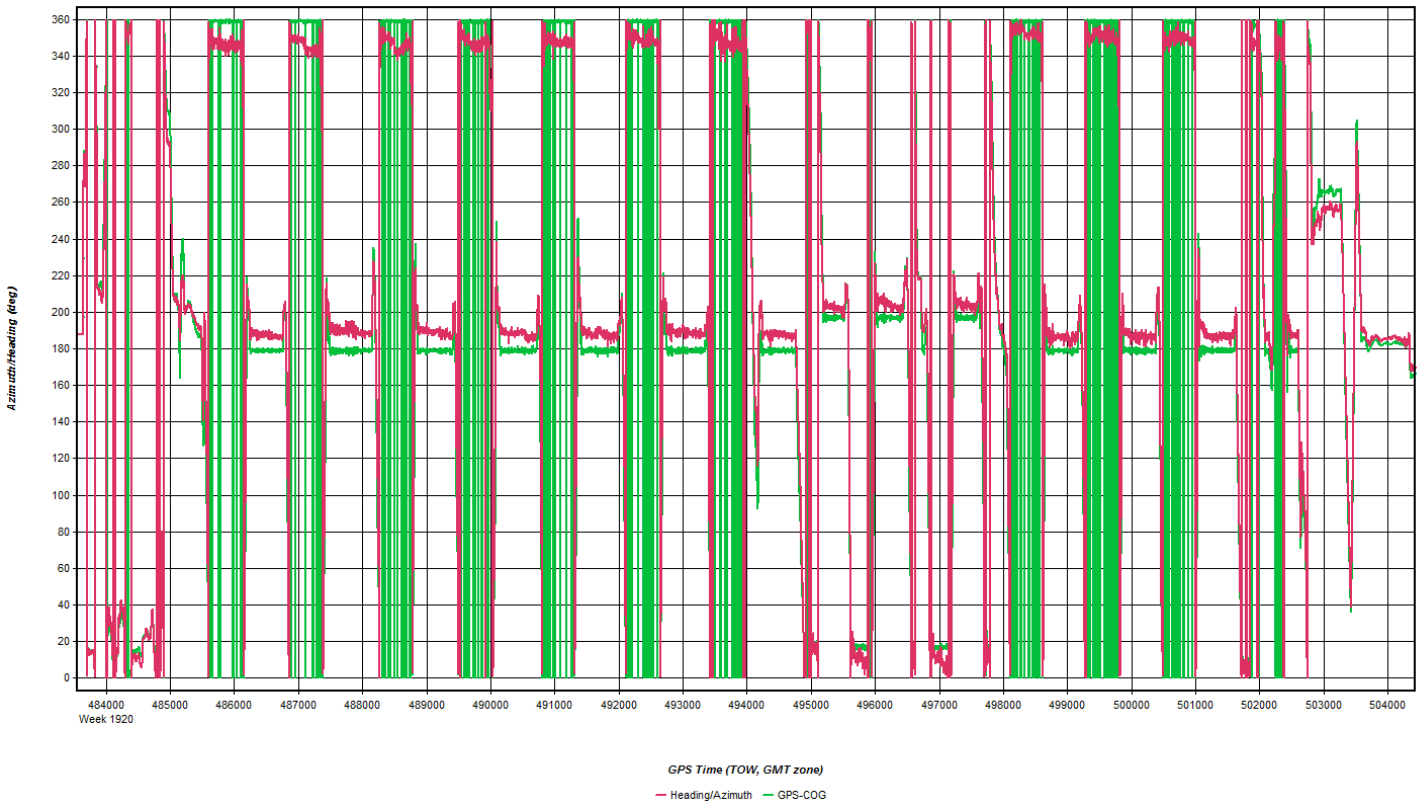
UL001	3051.707 m	22:45:16	18.88340904	2893.457 m	22:47:52	18.53455266

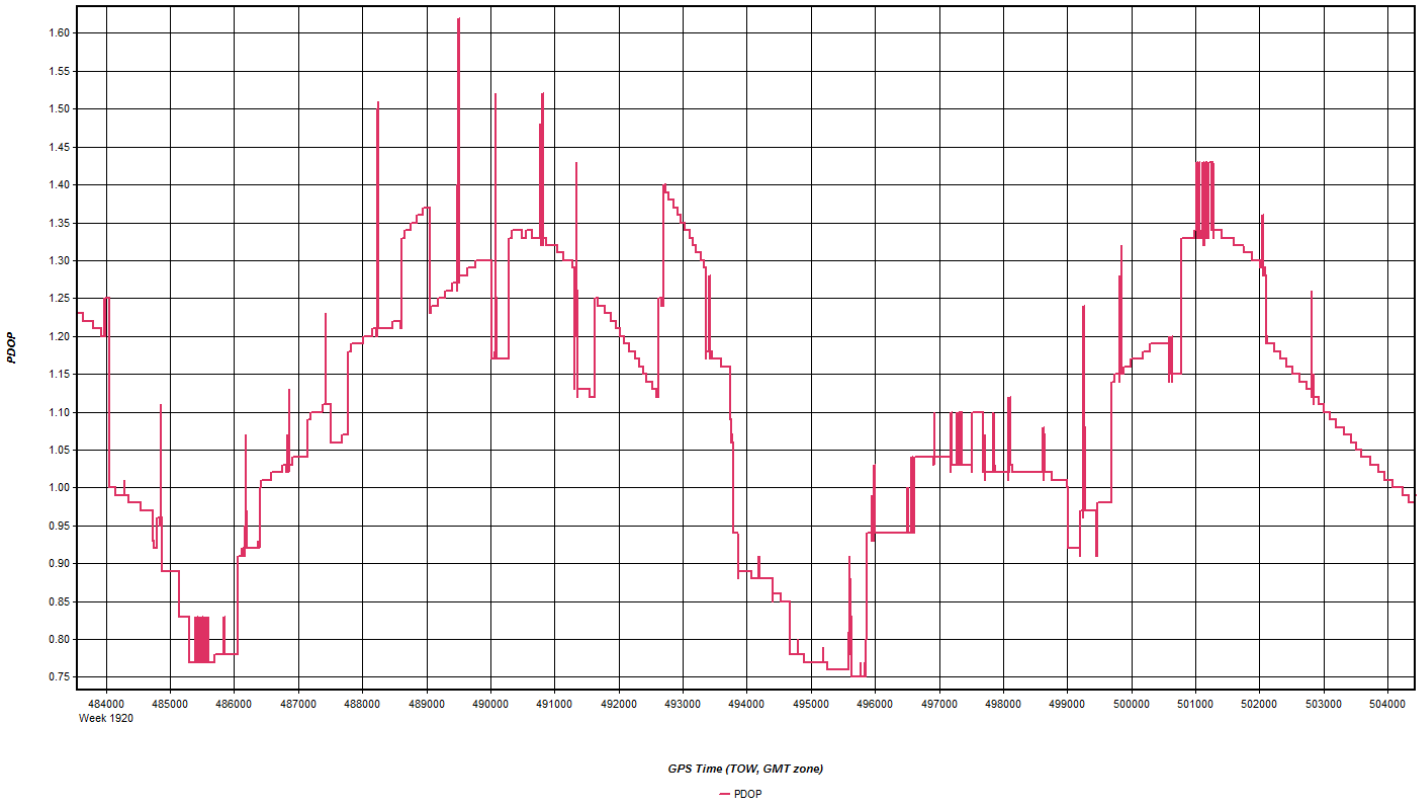
Oct 28, 2016-A (N208NR, SN8227)

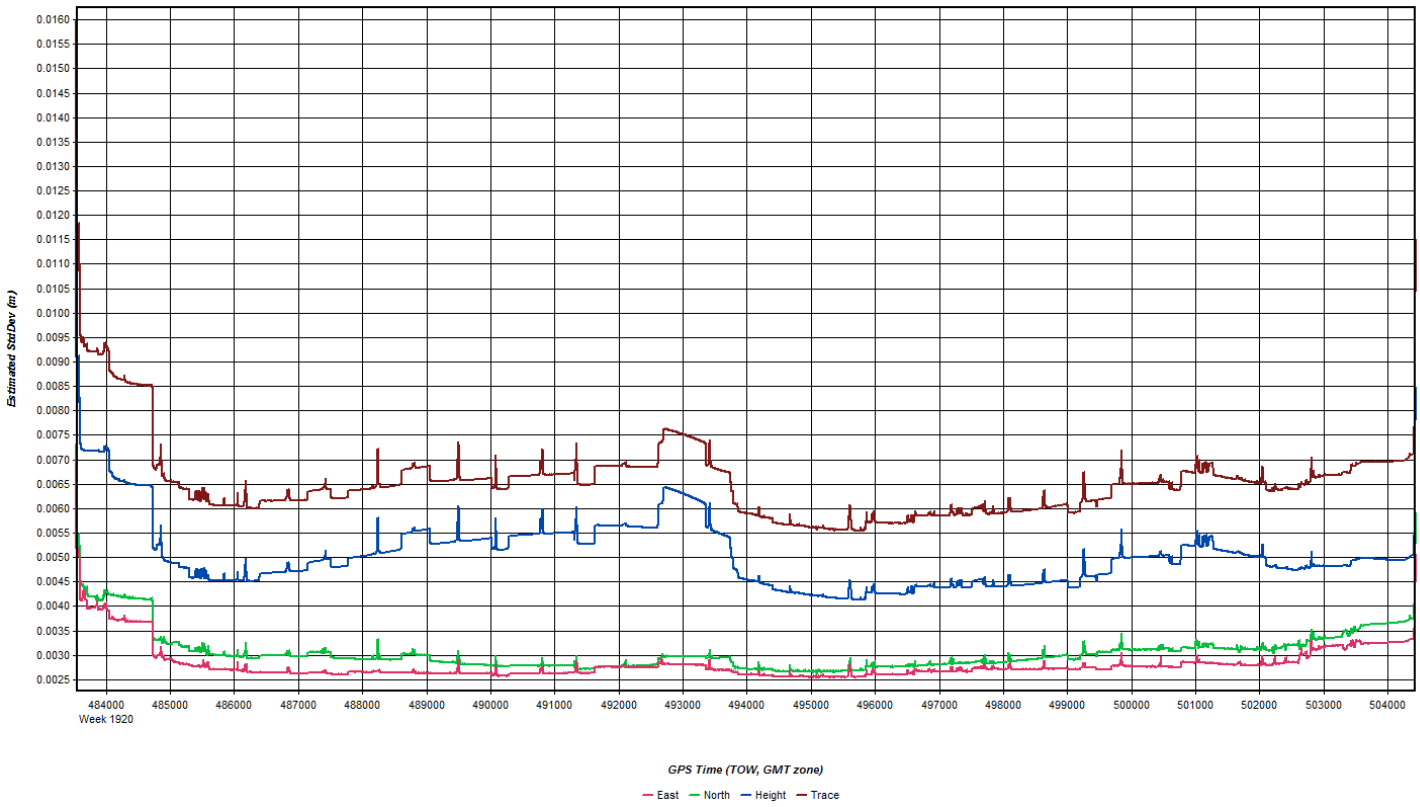

10 km


Num Sats
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
484000
Week 1920
485000
486000
487000
488000
489000
490000
491000
492000
493000
494000
495000
496000
497000
498000
499000
500000
501000
502000
503000
504000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou

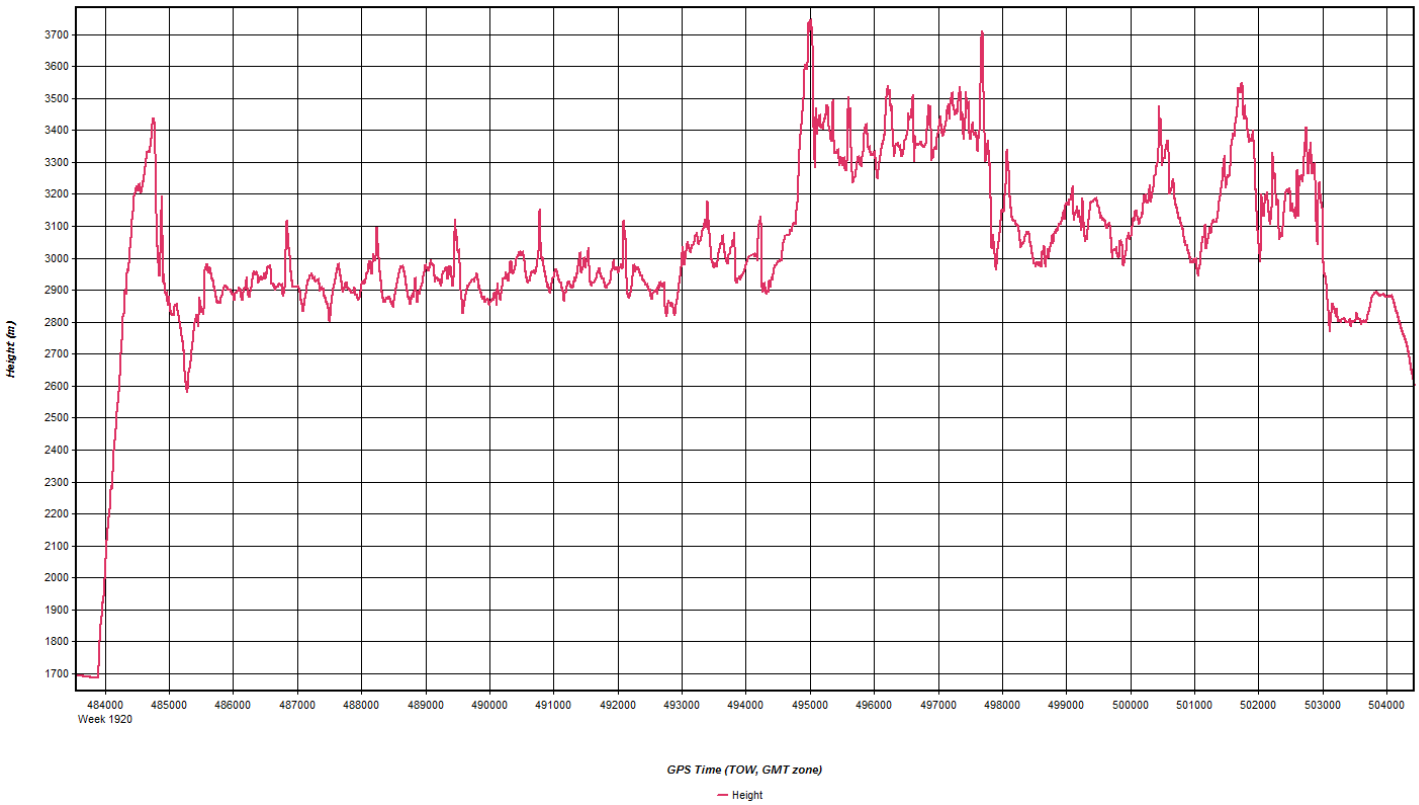

Separation (m)
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24
-0.26
-0.28
-0.30
-0.32
-0.34
-0.36
484000
Week 1920
485000
486000
487000
488000
489000
490000
491000
492000
493000
494000
495000
496000
497000
498000
499000
500000
501000
502000
503000
504000
GPS Time (TOW, GMT zone)
East
North
Up

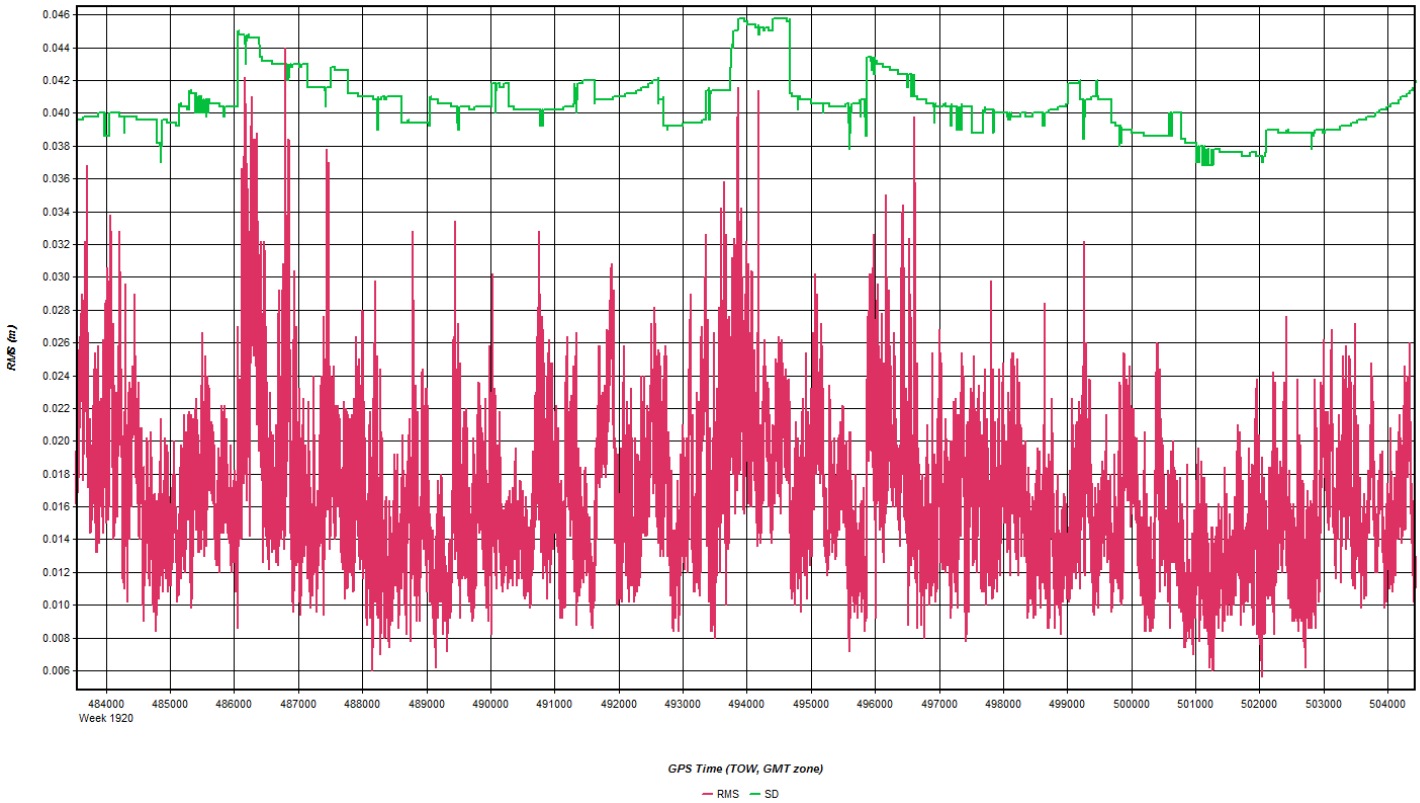

Azimuth/Heading (deg)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
484000
Week 1920
485000
486000
487000
488000
489000
490000
491000
492000
493000
494000
495000
496000
497000
498000
499000
500000
501000
502000
503000
504000
GPS Time (TOW, GMT zone)
Heading/Azimuth
GPS-COG

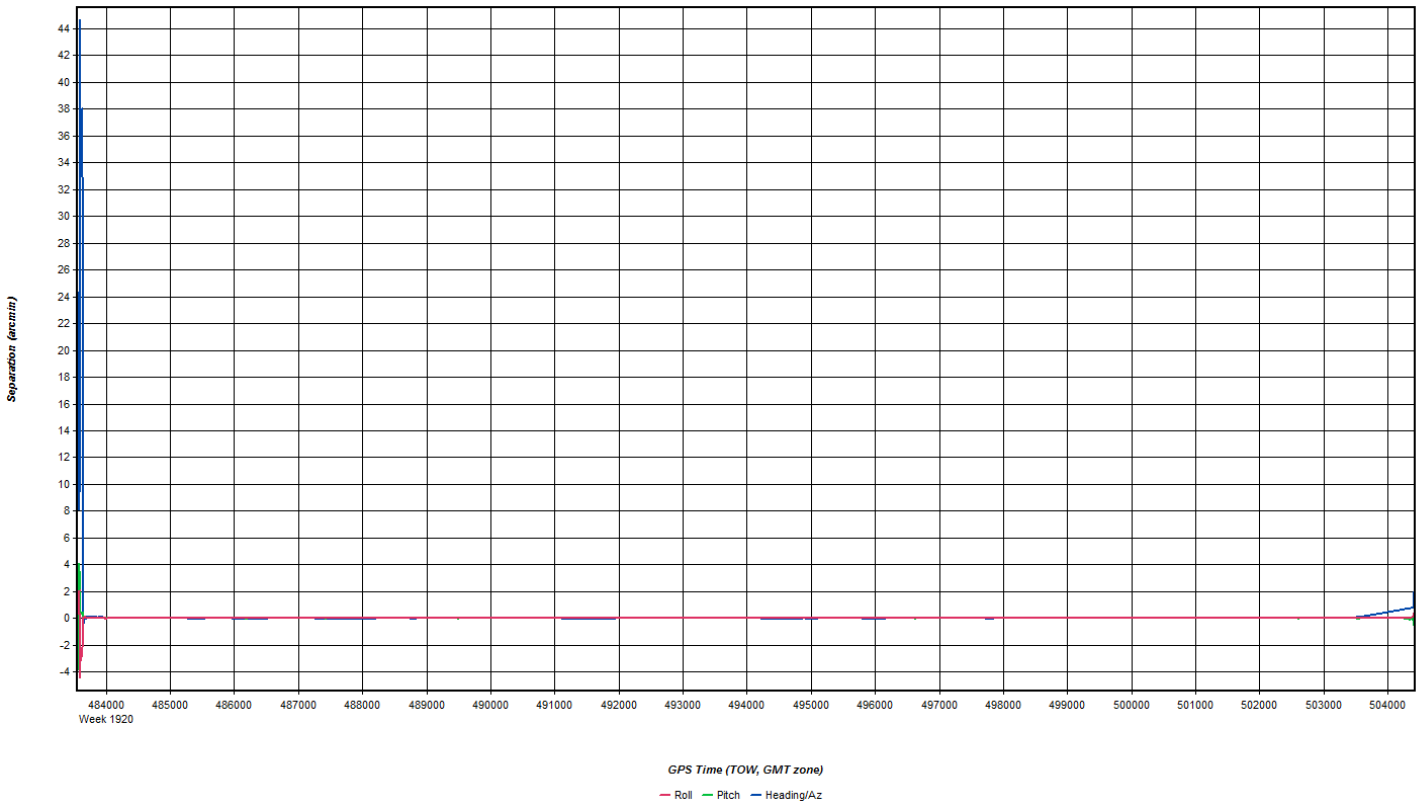

PDOP
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
484000
Week 1920
485000
486000
487000
488000
489000
490000
491000
492000
493000
494000
495000
496000
497000
498000
499000
500000
501000
502000
503000
504000
GPS Time (TOW, GMT zone)
PDOP

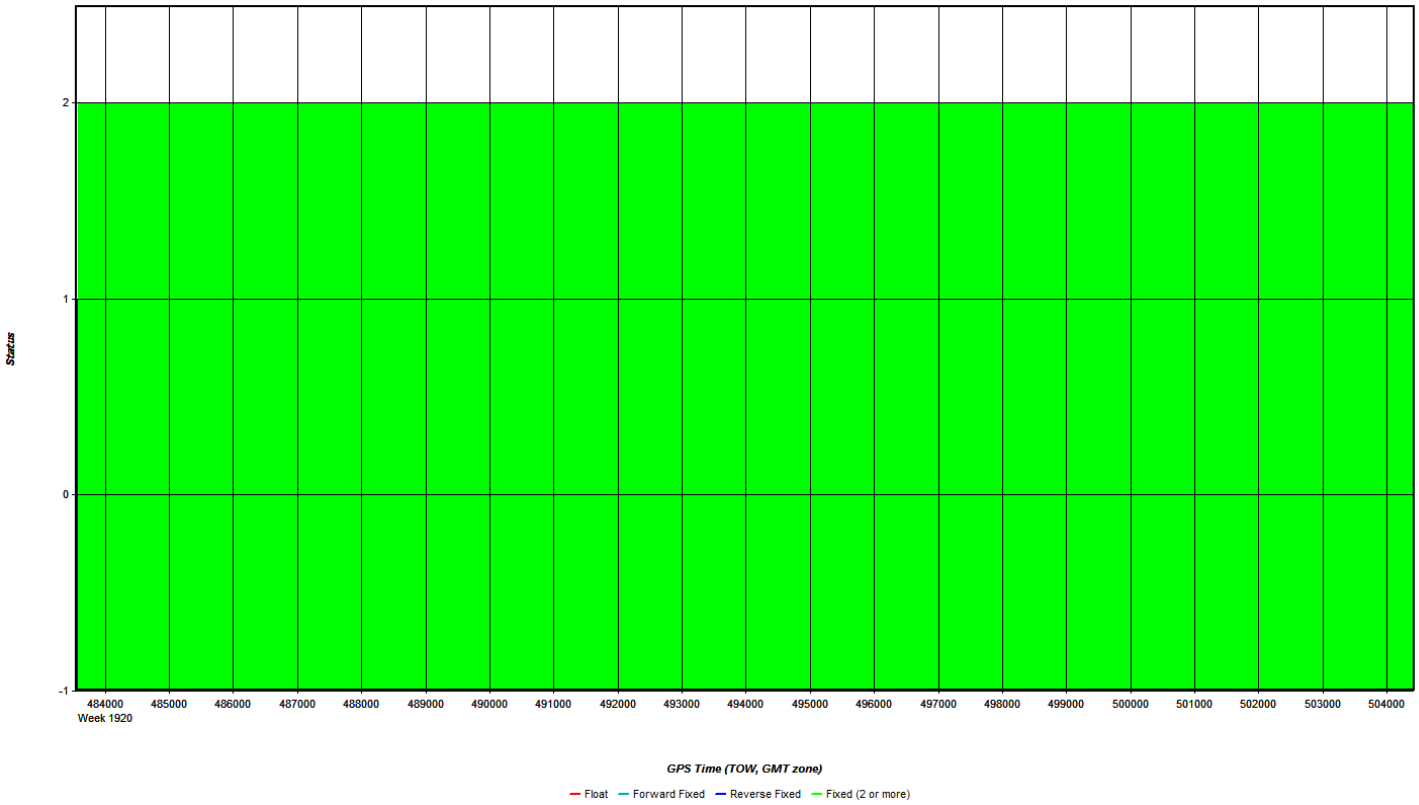

Estimated StdDev (m)
0.0160
0.0155
0.0150
0.0145
0.0140
0.0135
0.0130
0.0125
0.0120
0.0115
0.0110
0.0105
0.0100
0.0095
0.0090
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
484000
Week 1920
485000
486000
487000
488000
489000
490000
491000
492000
493000
494000
495000
496000
497000
498000
499000
500000
501000
502000
503000
504000
GPS Time (TOW, GMT zone)
East
North
Height
Trace

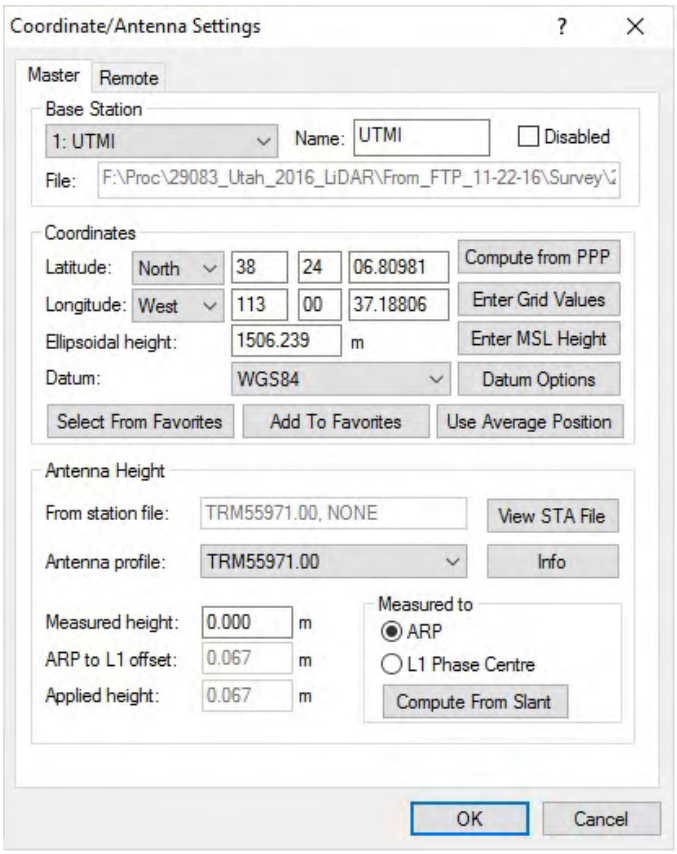

Roll & pitch (deg)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
484000
Week 1920
485000
486000
487000
488000
489000
490000
491000
492000
493000
494000
495000
496000
497000
498000
499000
500000
501000
502000
503000
504000
GPS Time (TOW, GMT zone)
Roll
Pitch


Height (m)
3700
3600
3500
3400
3300
3200
3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
484000
Week 1920
485000
486000
487000
488000
489000
490000
491000
492000
493000
494000
495000
496000
497000
498000
499000
500000
501000
502000
503000
504000
GPS Time (TOW, GMT zone)
Height


RMS (m)
0.046
0.044
0.042
0.040
0.038
0.036
0.034
0.032
0.030
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
484000
Week 1920
485000
486000
487000
488000
489000
490000
491000
492000
493000
494000
495000
496000
497000
498000
499000
500000
501000
502000
503000
504000
GPS Time (TOW, GMT zone)
RMS
SD


Separation (arcmin)
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
484000
Week 1920
485000
486000
487000
488000
489000
490000
491000
492000
493000
494000
495000
496000
497000
498000
499000
500000
501000
502000
503000
504000
GPS Time (TOW, GMT zone)
Roll
Pitch
Heading/Az


Status
2
1
0
-1
484000
Week 1920
485000
486000
487000
488000
489000
490000
491000
492000
493000
494000
495000
496000
497000
498000
499000
500000
501000
502000
503000
504000
GPS Time (TOW, GMT zone)
Float
Forward Fixed
Reverse Fixed
Fixed (2 or more)


Coordinate/Antenna Settings
Master
Remote
Base Station
1: UTMI
Name:
UTMI
Disabled
File:
F:\Proc\29083_Utah_2016_LiDAR\From_FTP_11-22-16\Survey\
Coordinates
Latitude:
North
38
24
06.80981
Compute from PPP
Longitude:
West
113
00
37.18806
Enter Grid Values
Ellipsoidal height:
1506.239
m
Enter MSL Height
Datum:
WGS84
Datum Options
Select From Favorites
Add To Favorites
Use Average Position
Antenna Height
From station file:
TRM55971.00, NONE
View STA File
Antenna profile:
TRM55971.00
Info
Measured height:
0.000
m
ARP to L1 offset:
0.067
m
Applied height:
0.067
m
Measured to
ARP
L1 Phase Centre
Compute From Slant
OK
Cancel

Flight Log

Date: 10/26/2016	**Aircraft:** 208NR	**Sensor:** 8227
Project: Utah 2016 LiDAR		**Project #:** R029083
Flight Mgmt File: FAGL_Forge_2PiA_8227_8ppsm_1550m_3 Unplanned-20161028141918_3		
Pilot: Travis Peden	**Sensor Operator:** Aaron Mallon	

	Flight 1	Flight 2	Flight 3	Flight 4
Wheels Up	8:25:00 AM			
Wheels Down	2:25:00 PM			
Begin Hobbs	4374.4			
End Hobbs	4380.4			

On-line Hobbs: 5.8	**Mob Hobbs:** 0.2

Notes

Today we had wheels up at 0825 and targeted the Forge project. We completed lines 17-36, 42-44, and 59-63. We encountered severe turbulence over the mountains on the Eastern side of the block so we were unable fly those lines.

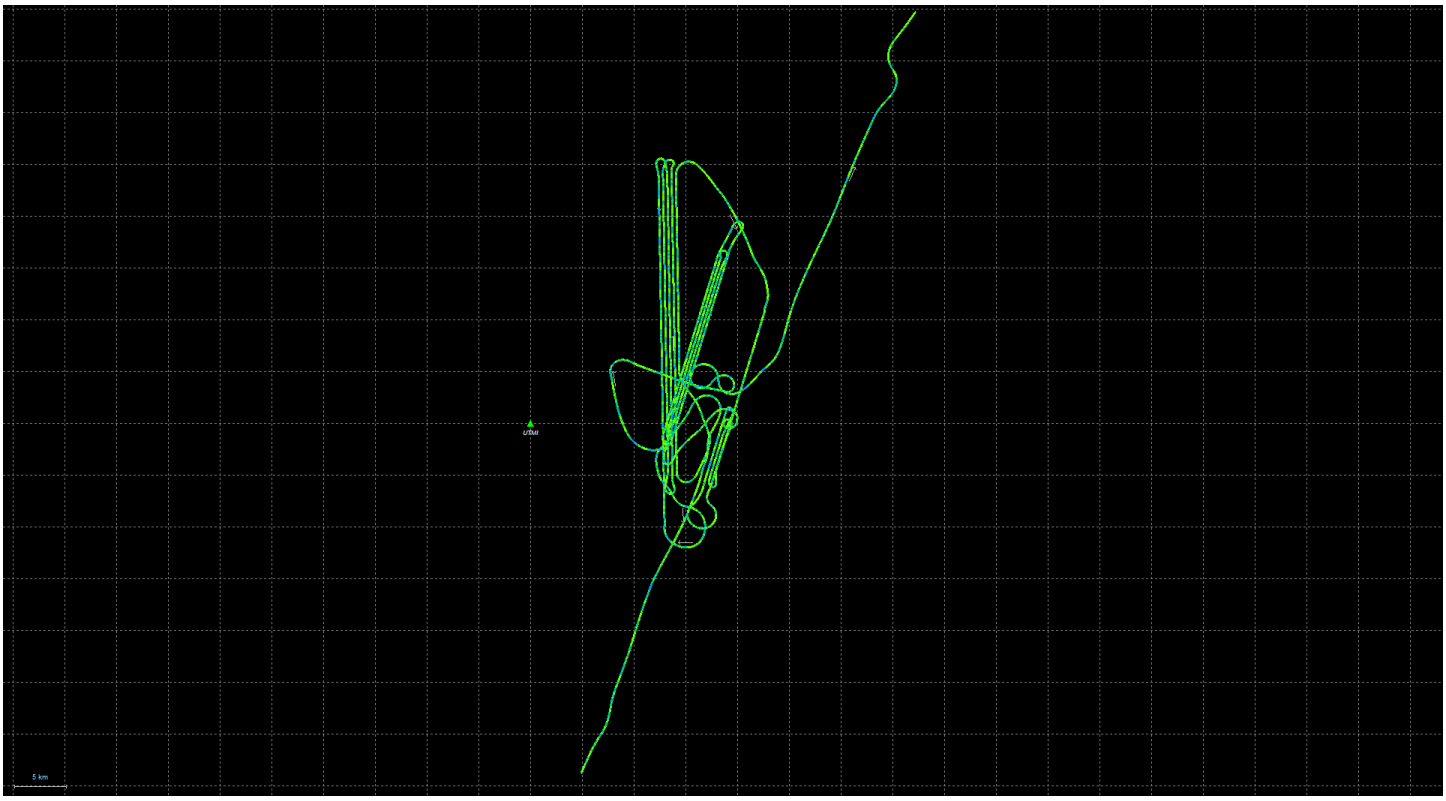
Flt Mgmt File: FAGL_Forge_2PiA_8227_8ppsm_1550m_3

FRG1017	2935.311 m	14:54:08	10.12929221	2888.788 m	15:01:43	11.32603285
FRG1018	2911.919 m	15:04:28	11.80190794	2915.486 m	15:12:25	13.28232157
FRG1019	2955.837 m	15:14:43	13.67561469	2906.589 m	15:22:10	14.79507554
FRG1020	2882.833 m	15:25:28	15.34640691	2951.828 m	15:35:37	17.15014608
FRG1021	2918.654 m	15:38:11	17.5696487	2859.935 m	15:45:40	18.62033967
FRG1022	2890.981 m	15:48:02	18.99768491	2942.902 m	15:56:31	20.47606933
FRG1023	2974.954 m	15:58:39	20.80786892	2871.202 m	16:06:02	21.768447
FRG1024	2937.993 m	16:10:08	22.38287703	2955.364 m	16:18:20	23.75387889
FRG1025	2968.686 m	16:20:34	24.0789407	2908.415 m	16:28:00	24.95534817
FRG1026	2967.556 m	16:30:27	25.29867386	2973.998 m	16:39:34	26.72127194
FRG1027	2881.204 m	16:42:32	27.11834686	2900.344 m	16:49:51	27.87526072
FRG1028	2868.236 m	16:52:56	28.26759154	3095.245 m	17:02:02	29.58189474
FRG1029	2993.067 m	17:04:12	29.84272268	2933.564 m	17:11:39	30.49993478
FRG1030	2911.247 m	17:18:00	31.20556486	3111.453 m	17:25:47	32.24396887
FRG1063	3462.862 m	17:33:54	32.91254253	3311.464 m	17:38:28	33.44259992
FRG1062	3285.994 m	17:40:36	33.64879569	3363.873 m	17:44:47	33.92133183
FRG1061	3368.098 m	17:48:49	34.27829557	3320.781 m	17:53:44	34.78738267
FRG1060	3500.554 m	17:56:24	35.00844023	3336.805 m	17:56:44	35.02523939
FRG1060	3312.877 m	18:01:37	35.40341409	3473.475 m	18:05:52	35.59526944
FRG1059	3484.413 m	18:08:14	35.76718794	3377.760 m	18:12:58	36.18798313
FRG1058	3323.643 m	18:15:36	36.36055772	3299.711 m	18:16:18	36.38215444
FRG1031	3139.293 m	18:22:03	36.7424515	2984.536 m	18:29:39	36.88233442
FRG1032	3012.834 m	18:31:28	36.96713466	3158.334 m	18:39:15	37.53422595
FRG1033	3104.580 m	18:42:02	37.63434829	3015.668 m	18:49:34	37.61489716
FRG1034	2993.261 m	18:51:35	37.66743122	3258.731 m	18:59:27	38.07900955
FRG1035	3311.430 m	19:01:46	38.11409453	2991.208 m	19:09:26	37.93798293
FRG1036	3048.132 m	19:11:41	37.94991059	3389.996 m	19:19:59	38.19279248
FRG1044	3183.174 m	19:28:08	37.86077728	3158.801 m	19:28:59	37.87681951
FRG1043	3165.956 m	19:31:04	37.85501076	3071.614 m	19:32:17	37.79402833
FRG1042	3145.249 m	19:34:50	37.74504996	3216.367 m	19:36:30	37.75862048

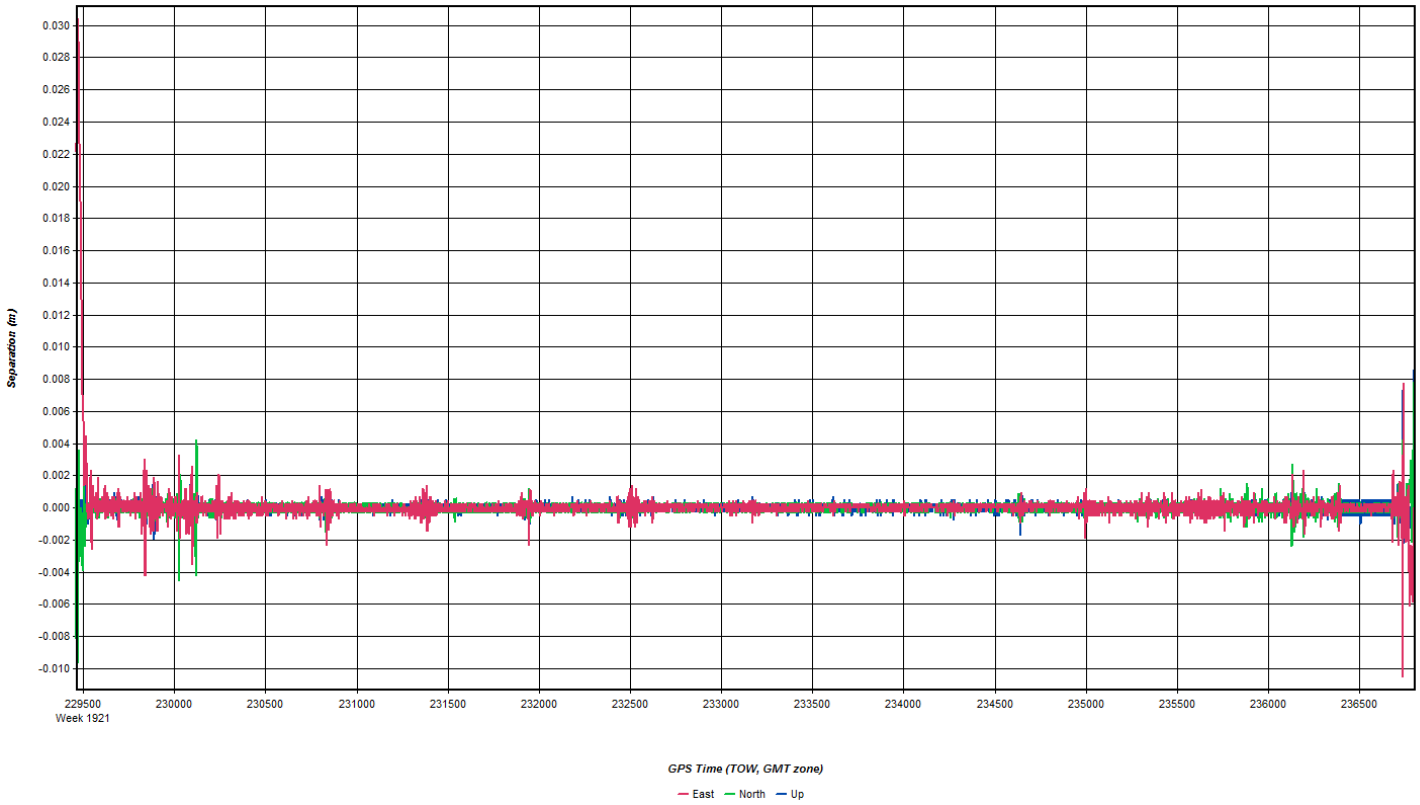
Flt Mgmt File: Unplanned-20161028141918_3

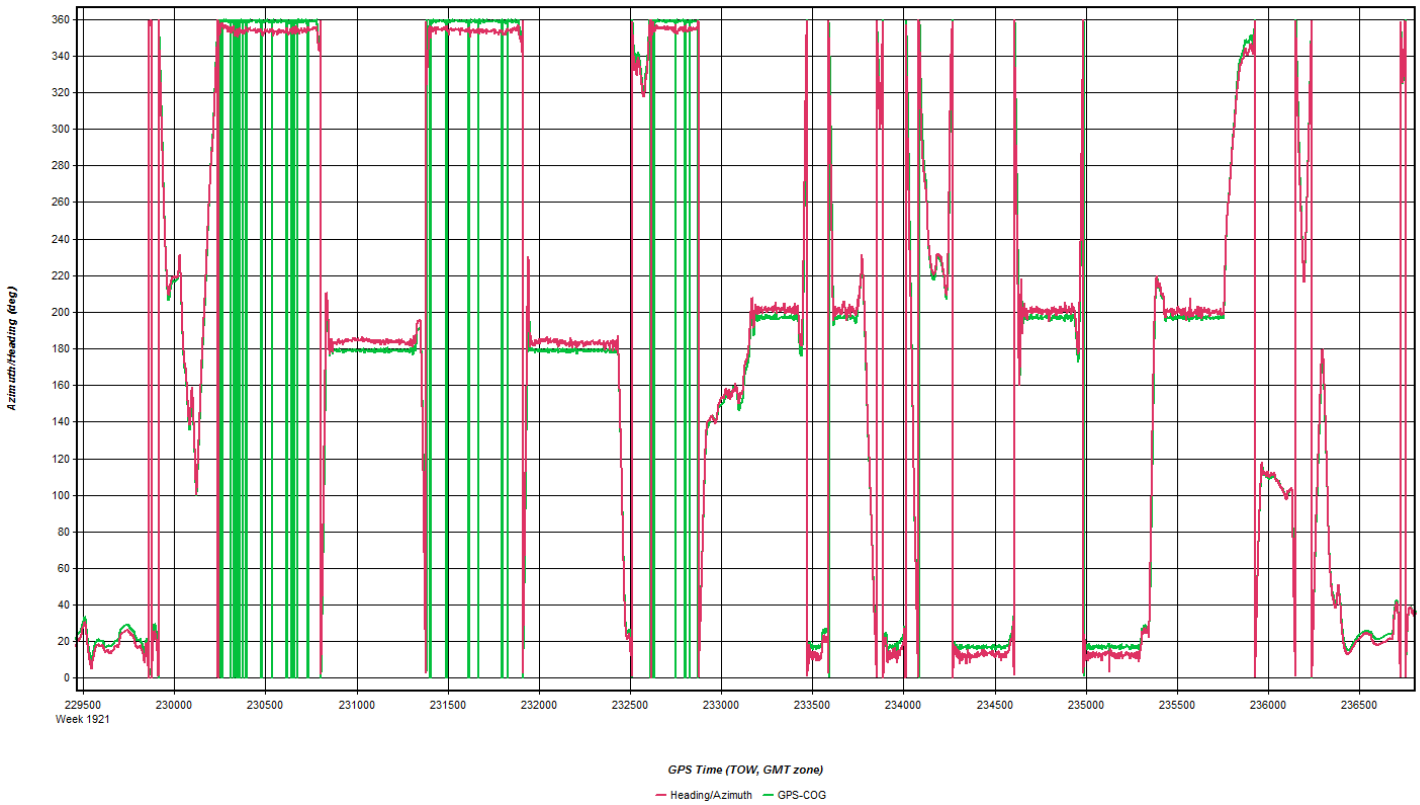
UL001	3160.450 m	19:41:16	37.59612915	2807.825 m	19:47:38	37.44891146

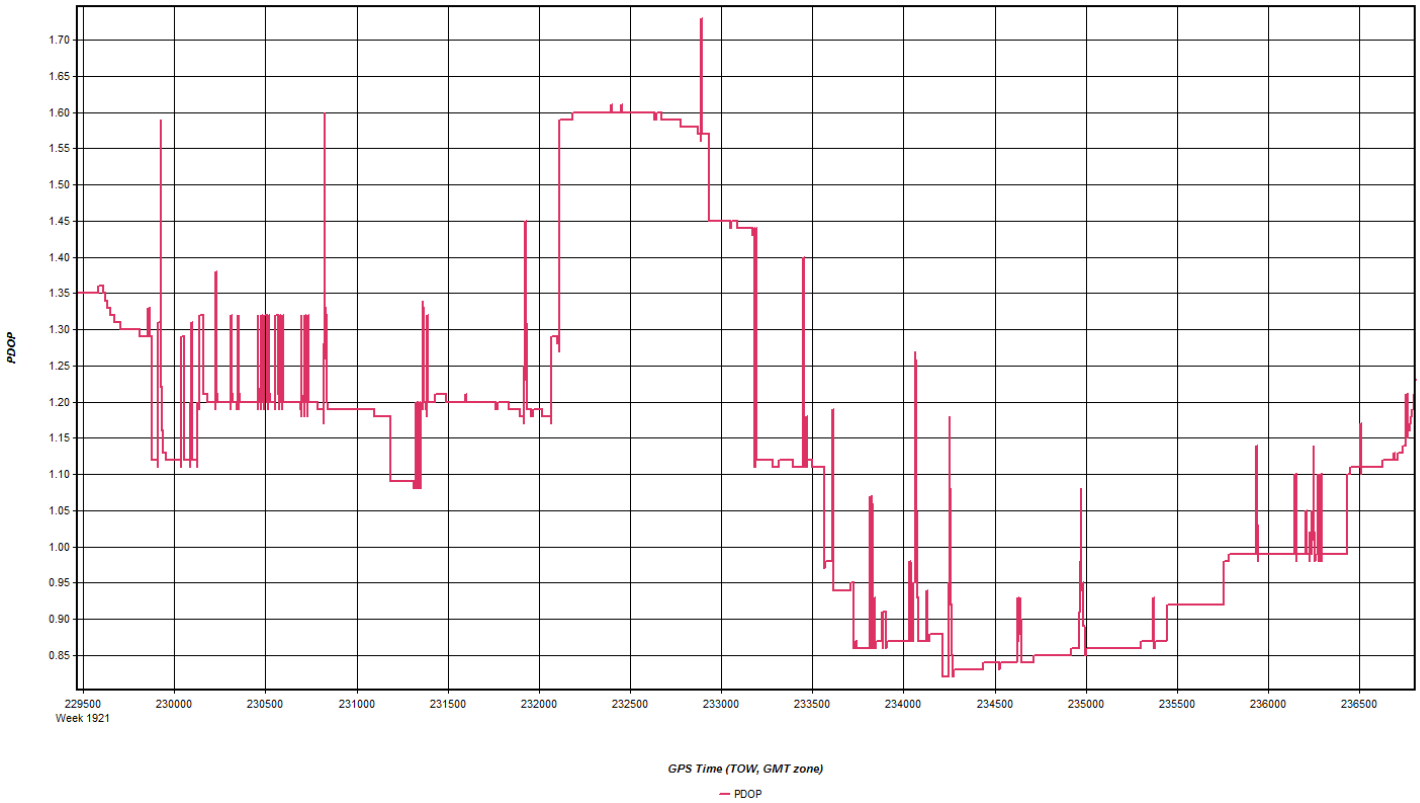
Nov 1, 2016-A (N208NR, SN8227)

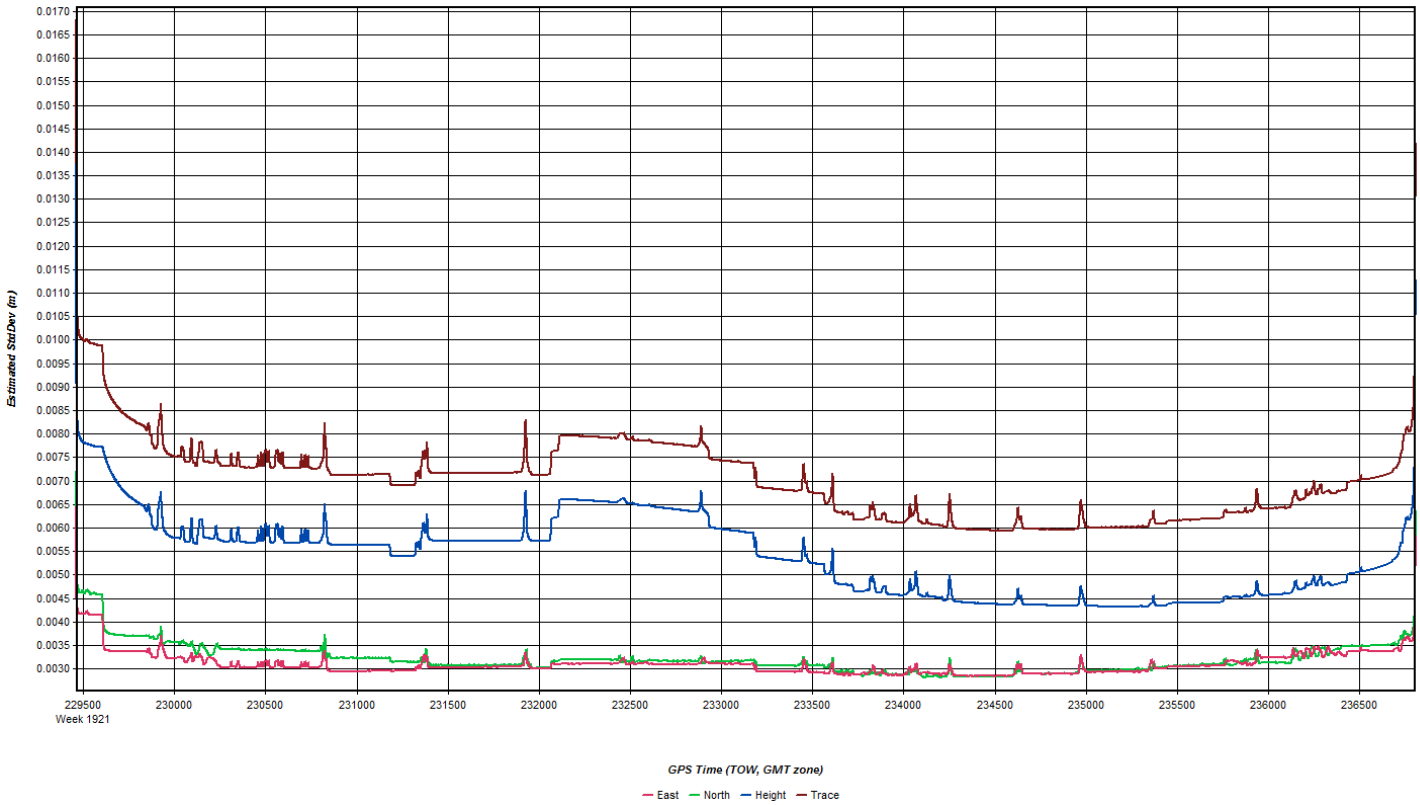

utlui
5 km


Num Sats
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
229500
Week 1921
230000
230500
231000
231500
232000
232500
233000
233500
234000
234500
235000
235500
236000
236500
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou


Separation (m)
0.030
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
-0.010
229500
Week 1921
230000
230500
231000
231500
232000
232500
233000
233500
234000
234500
235000
235500
236000
236500
GPS Time (TOW, GMT zone)
East
North
Up


Azimuth/Heading (deg)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
229500
Week 1921
230000
230500
231000
231500
232000
232500
233000
233500
234000
234500
235000
235500
236000
236500
GPS Time (TOW, GMT zone)
Heading/Azimuth
GPS-COG

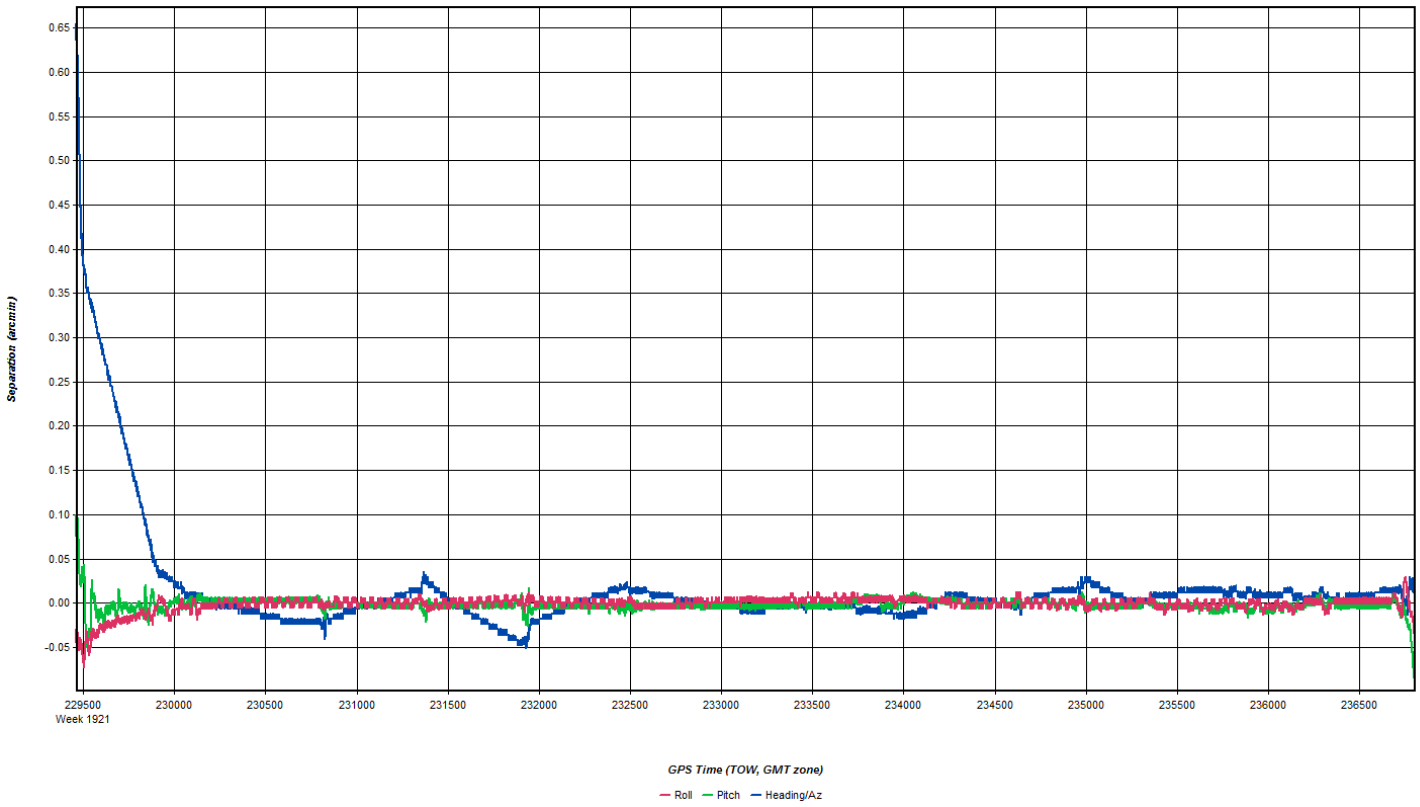

PDOP
1.70
1.65
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
229500
Week 1921
230000
230500
231000
231500
232000
232500
233000
233500
234000
234500
235000
235500
236000
236500
GPS Time (TOW, GMT zone)
PDOP

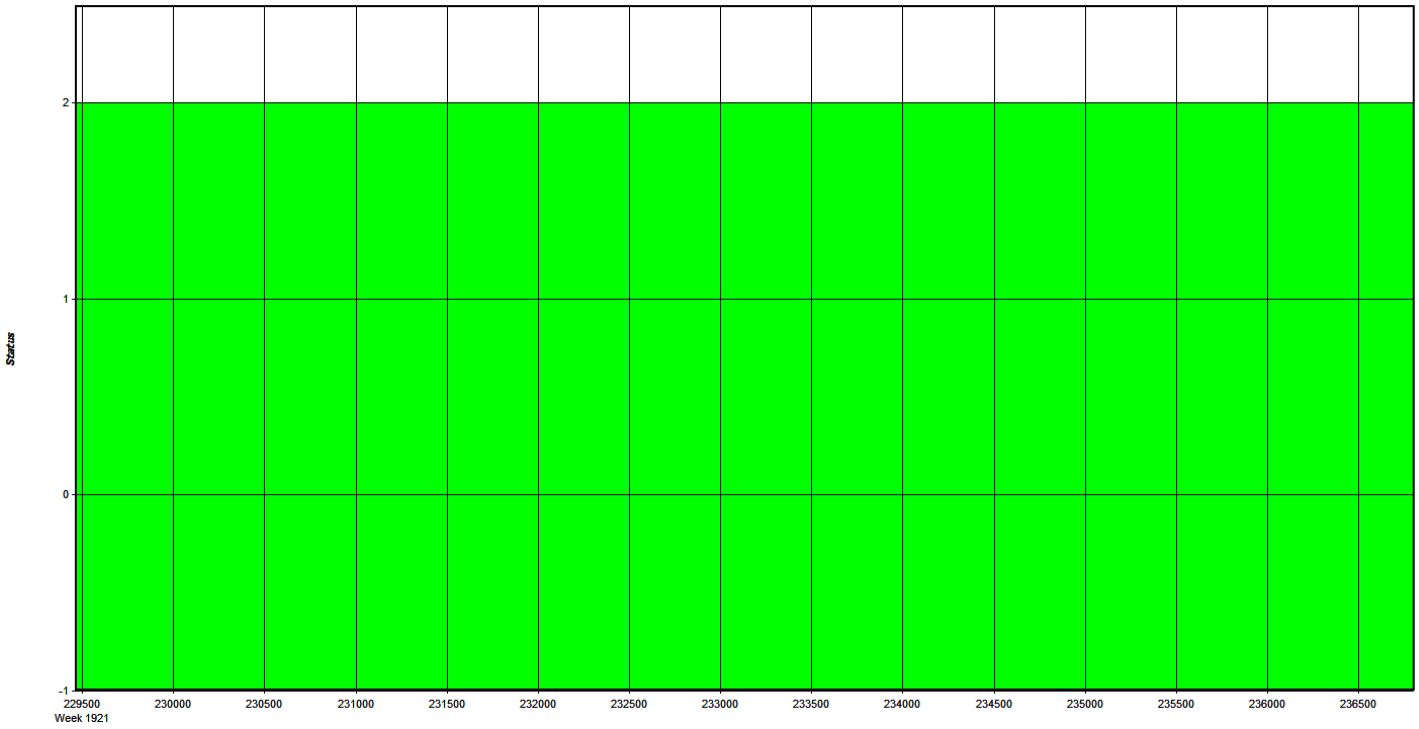

Estimated StdDev (m)
0.0170
0.0165
0.0160
0.0155
0.0150
0.0145
0.0140
0.0135
0.0130
0.0125
0.0120
0.0115
0.0110
0.0105
0.0100
0.0095
0.0090
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
0.0030
229500
Week 1921
230000
230500
231000
231500
232000
232500
233000
233500
234000
234500
235000
235500
236000
236500
GPS Time (TOW, GMT zone)
East
North
Height
Trace

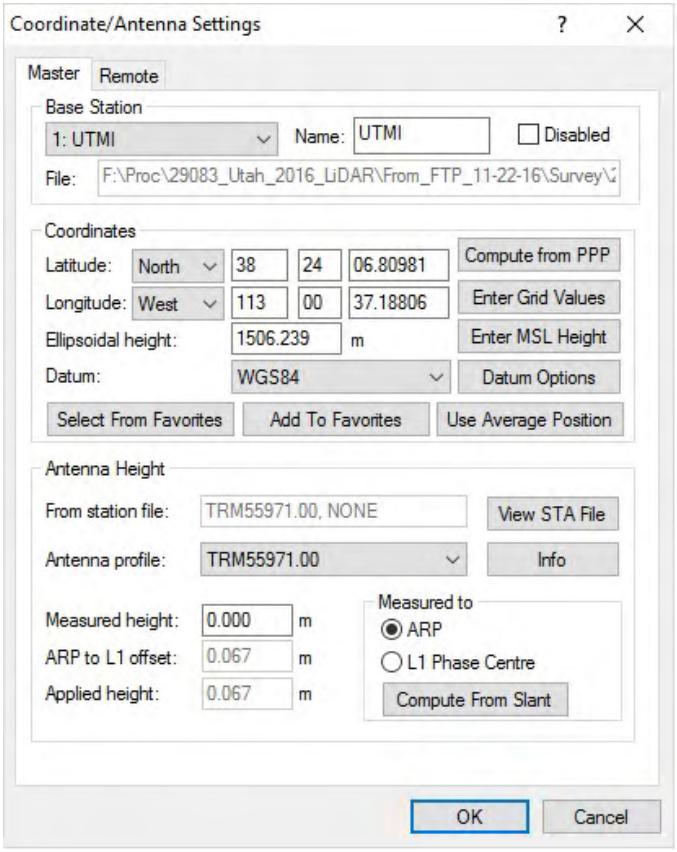

Roll & pitch (deg)
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
229500
Week 1921
230000
230500
231000
231500
232000
232500
233000
233500
234000
234500
235000
235500
236000
236500
GPS Time (TOW, GMT zone)
Roll
Pitch


Height (m)
4400
4350
4300
4250
4200
4150
4100
4050
4000
3950
3900
3850
3800
3750
3700
3650
3600
3550
3500
3450
3400
3350
3300
3250
3200
3150
3100
3050
3000
2950
2900
2850
2800
229500
Week 1921
230000
230500
231000
231500
232000
232500
233000
233500
234000
234500
235000
235500
236000
236500
GPS Time (TOW, GMT zone)
Height


RMS (m)
0.044
0.042
0.040
0.038
0.036
0.034
0.032
0.030
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
229500
Week 1921
230000
230500
231000
231500
232000
232500
233000
233500
234000
234500
235000
235500
236000
236500
GPS Time (TOW, GMT zone)
RMS
SD


Separation (arcmin)
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
229500
Week 1921
230000
230500
231000
231500
232000
232500
233000
233500
234000
234500
235000
235500
236000
236500
GPS Time (TOW, GMT zone)
Roll
Pitch
Heading/Az


Status
2
1
0
-1
229500
Week 1921
230000
230500
231000
231500
232000
232500
233000
233500
234000
234500
235000
235500
236000
236500
GPS Time (TOW, GMT zone)
Float
Forward Fixed
Reverse Fixed
Fixed (2 or more)


Coordinate/Antenna Settings
Master
Remote
Base Station
1: UTMI
Name: UTMI
Disabled
File: F:\Proc\29083_Utah_2016_LiDAR\From_FTP_11-22-16\Survey\
Coordinates
Latitude: North 38 24 06.80981
Longitude: West 113 00 37.18806
Ellipsoidal height: 1506.239 m
Datum: WGS84
Compute from PPP
Enter Grid Values
Enter MSL Height
Datum Options
Select From Favorites
Add To Favorites
Use Average Position
Antenna Height
From station file: TRM55971.00, NONE
View STA File
Antenna profile: TRM55971.00
Info
Measured height: 0.000 m
ARP to L1 offset: 0.067 m
Applied height: 0.067 m
Measured to
ARP
L1 Phase Centre
Compute From Slant
OK
Cancel

Flight Log

Date: 10/26/2016	**Aircraft:** 208NR	**Sensor:** 8227
Project: Utah 2016 LiDAR		**Project #:** R029083
Flight Mgmt File: FAGL_Forge_2PiA_8227_8ppsm_1550m_5 FAGL_Forge_Heavy_Terrain_8227_1850m_1 Unplanned-20161101165607_1		
Pilot: Travis Peden	**Sensor Operator:** Aaron Mallon	

	Flight 1	Flight 2	Flight 3	Flight 4
Wheels Up	9:30:00 AM			
Wheels Down	12:20:00 AM			
Begin Hobbs	4381.5			
End Hobbs	4384.5			

On-line Hobbs: 2	**Mob Hobbs:** 1

Notes

Today we had wheels up at 0930. We completed as much as we could of the Utah Forge block before getting clouded out. We then MOBed to Provo (KPVO) and tried to target the Utah Lake block but there were low clouds in our AOI. We utilized the UTMI COR while flying the Forge block.

Flt Mgmt File: FAGL_Forge_2PiA_8227_8ppsm_1550m_5

FRG1037	3168.089 m	15:58:25	19.83671723	2836.750 m	16:06:05	20.82131537
FRG1038	2826.119 m	16:07:24	21.01878732	3311.274 m	16:15:08	22.31665908
FRG1039	3386.992 m	16:16:38	22.5351722	2878.999 m	16:24:29	23.46793088
FRG1040	2846.129 m	16:25:50	23.65792927	3465.185 m	16:33:34	24.89709309
FRG1041	3080.649 m	16:38:49	25.46135698	3078.481 m	16:40:52	25.67893977
FRG1045	3754.852 m	16:49:32	26.99096252	3662.717 m	16:50:06	27.07158678
FRG1046	3697.885 m	16:51:15	27.21299269	3839.928 m	16:52:08	27.30691658
FRG1047	3887.023 m	16:53:45	27.49805851	3743.989 m	16:55:01	27.67592644

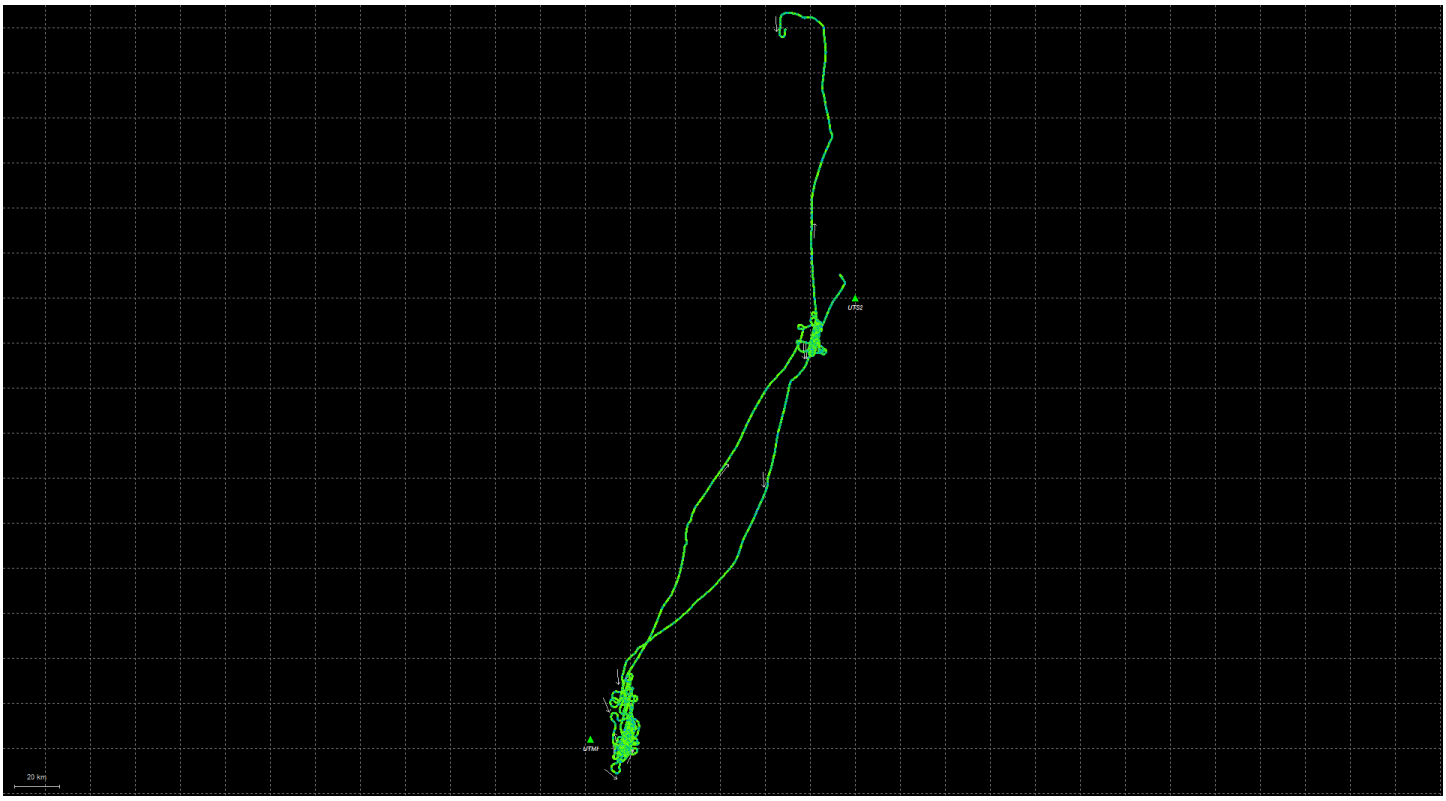
Flt Mgmt File: FAGL_Forge_Heavy_Terrain_8227_1850m_1

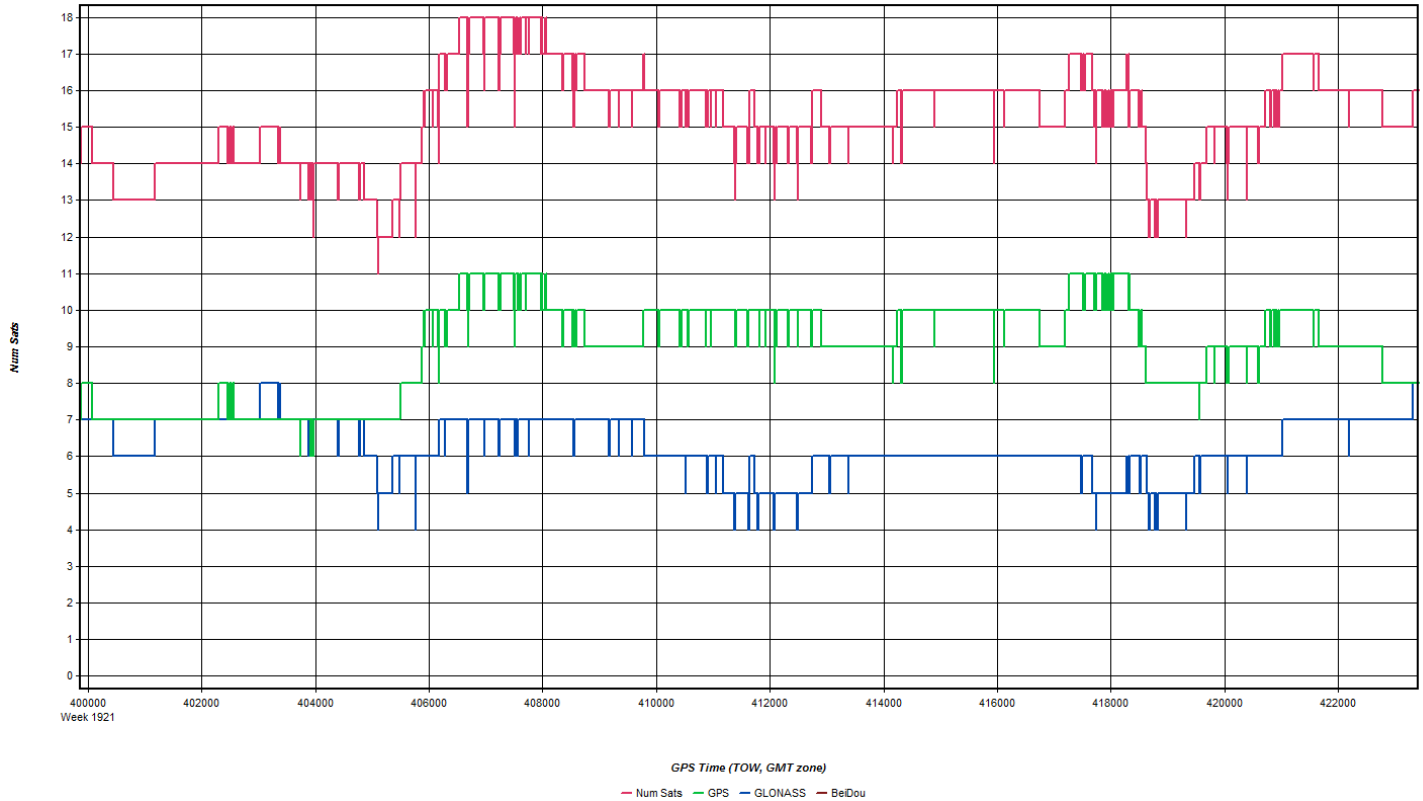
FHT1001	3740.396 m	16:58:39	28.11935451	3775.798 m	16:59:07	28.16610464
FHT1018	3374.016 m	17:04:53	28.80436983	3562.330 m	17:09:11	29.21280211
FHT1019	3596.251 m	17:10:49	29.38868966	3403.412 m	17:15:19	29.96939855
FHT1020	3394.535 m	17:17:00	30.14378731	3477.521 m	17:21:19	30.51170503
FHT1017	3538.707 m	17:24:40	30.8786159	3341.409 m	17:28:59	31.40274634

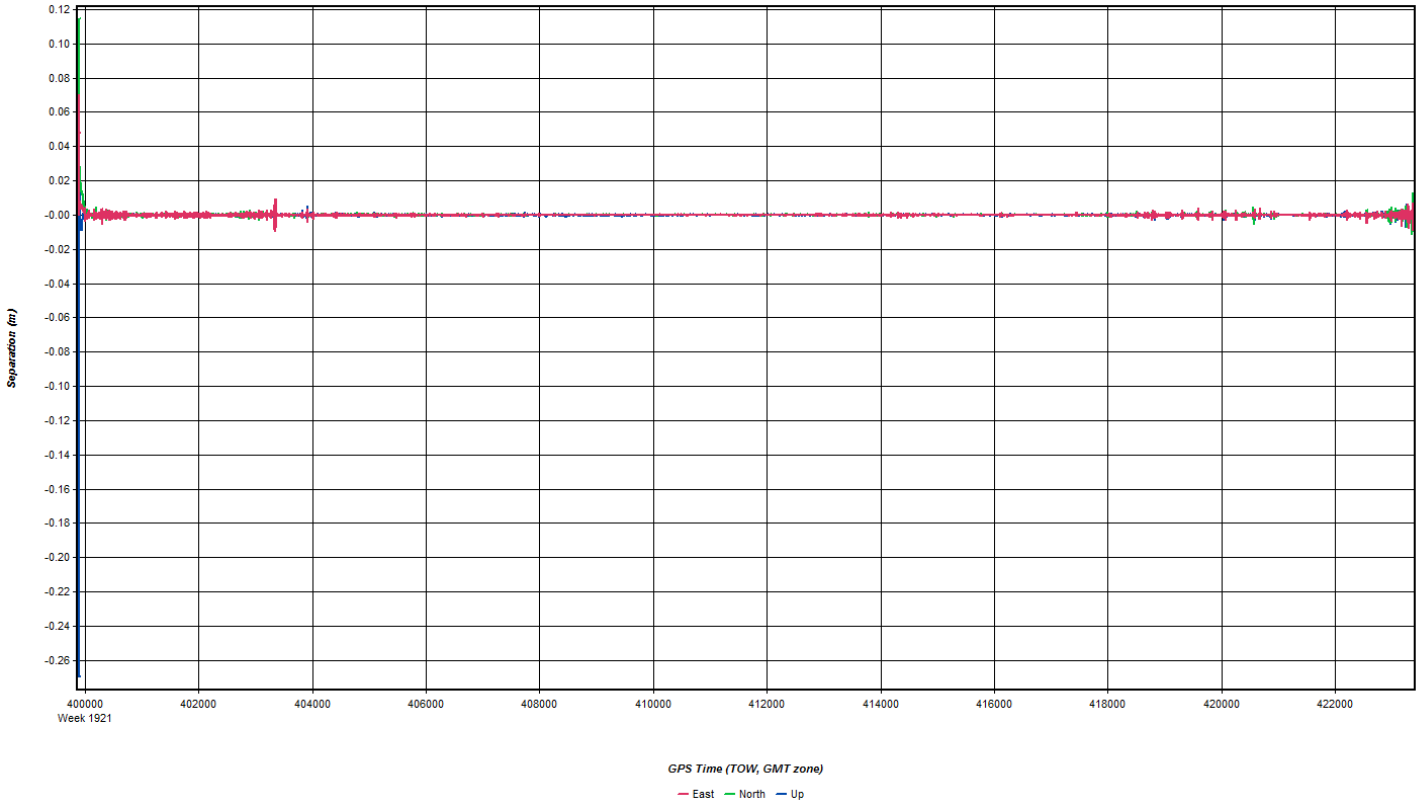
Flt Mgmt File: Unplanned-20161101165607_1

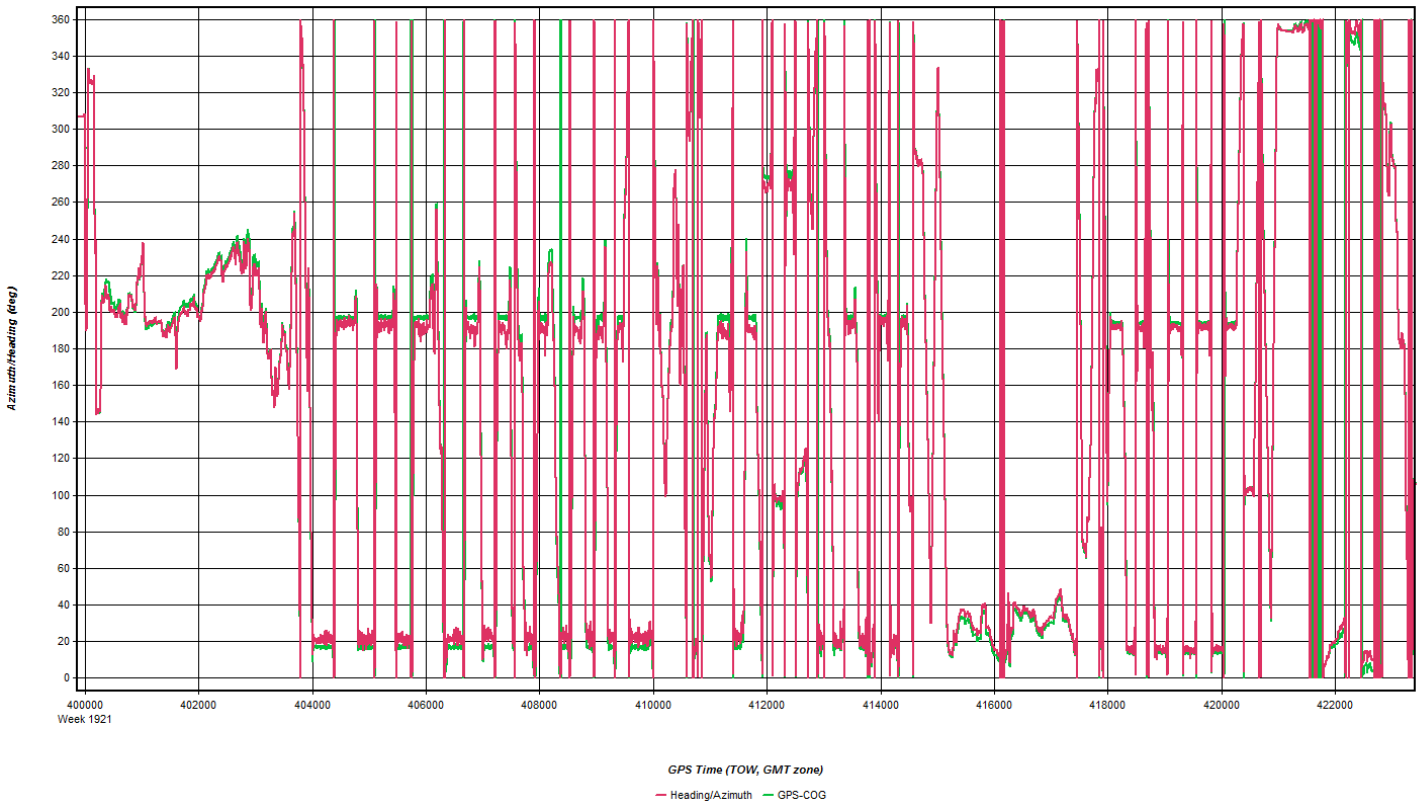
UL001	3327.017 m	17:32:44	31.69905878	3640.532 m	17:35:08	31.97877952

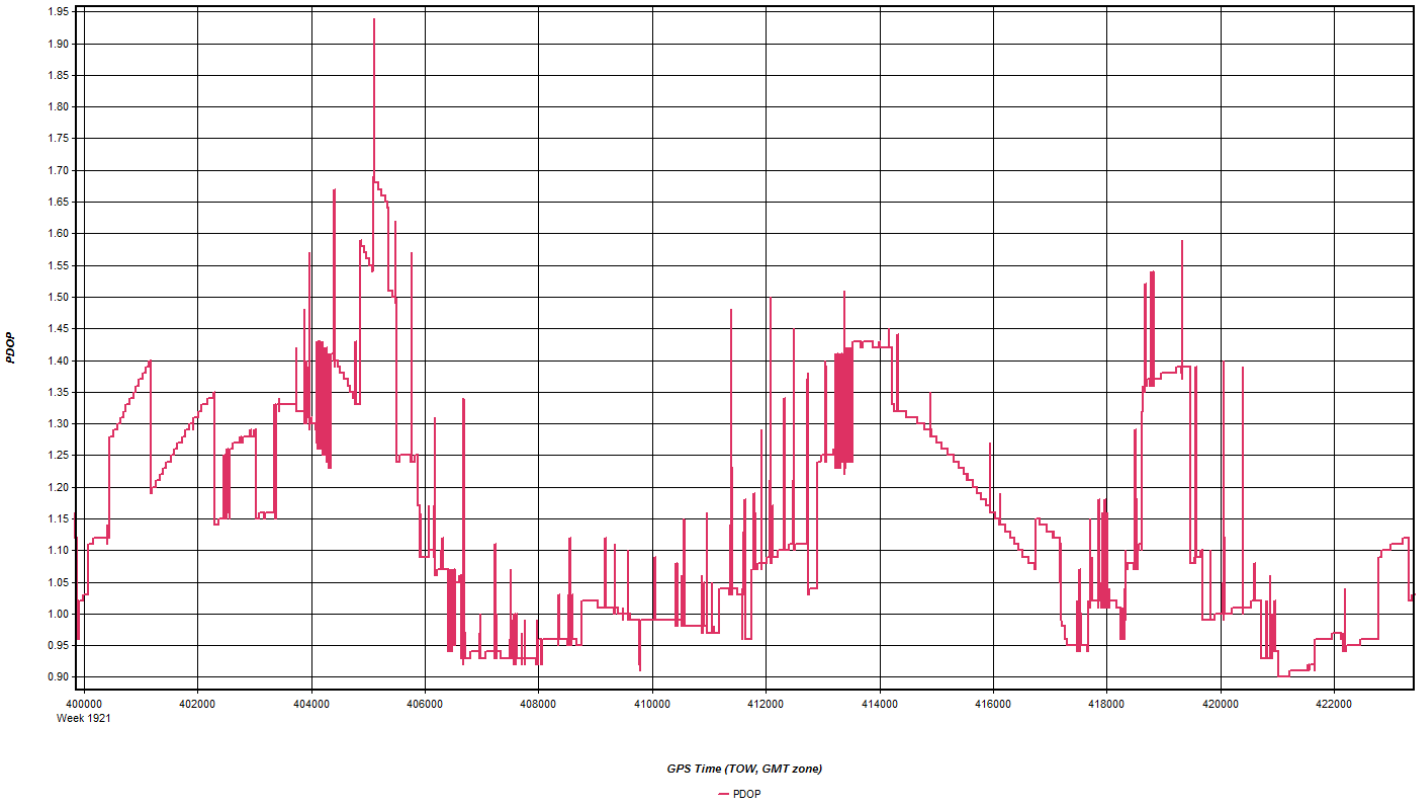
Nov 3, 2016-A (N208NR, SN8227)

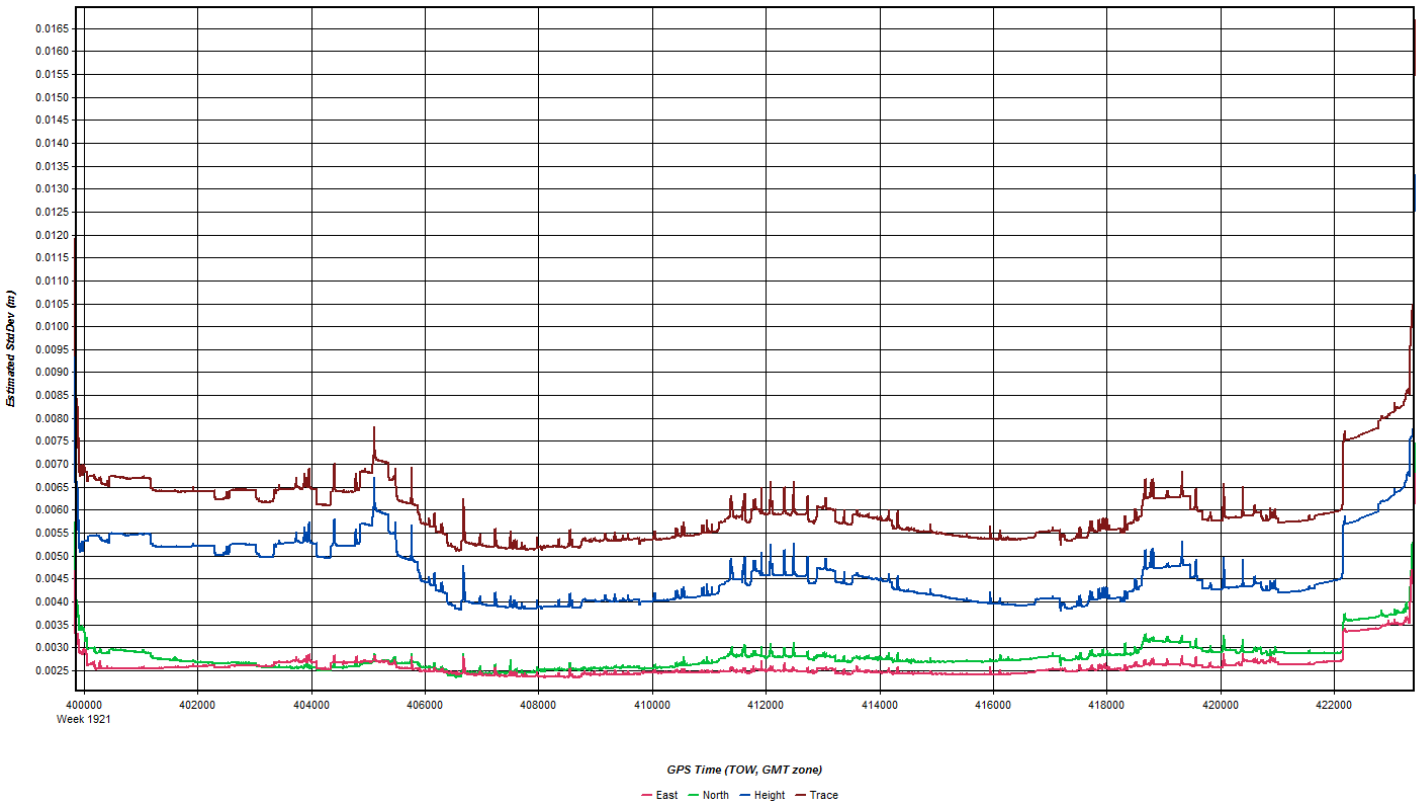

UTS2
UTMF
20 km


Num Sats
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
400000
Week 1921
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou


Separation (m)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24
-0.26
400000
Week 1921
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
GPS Time (TOW, GMT zone)
East
North
Up

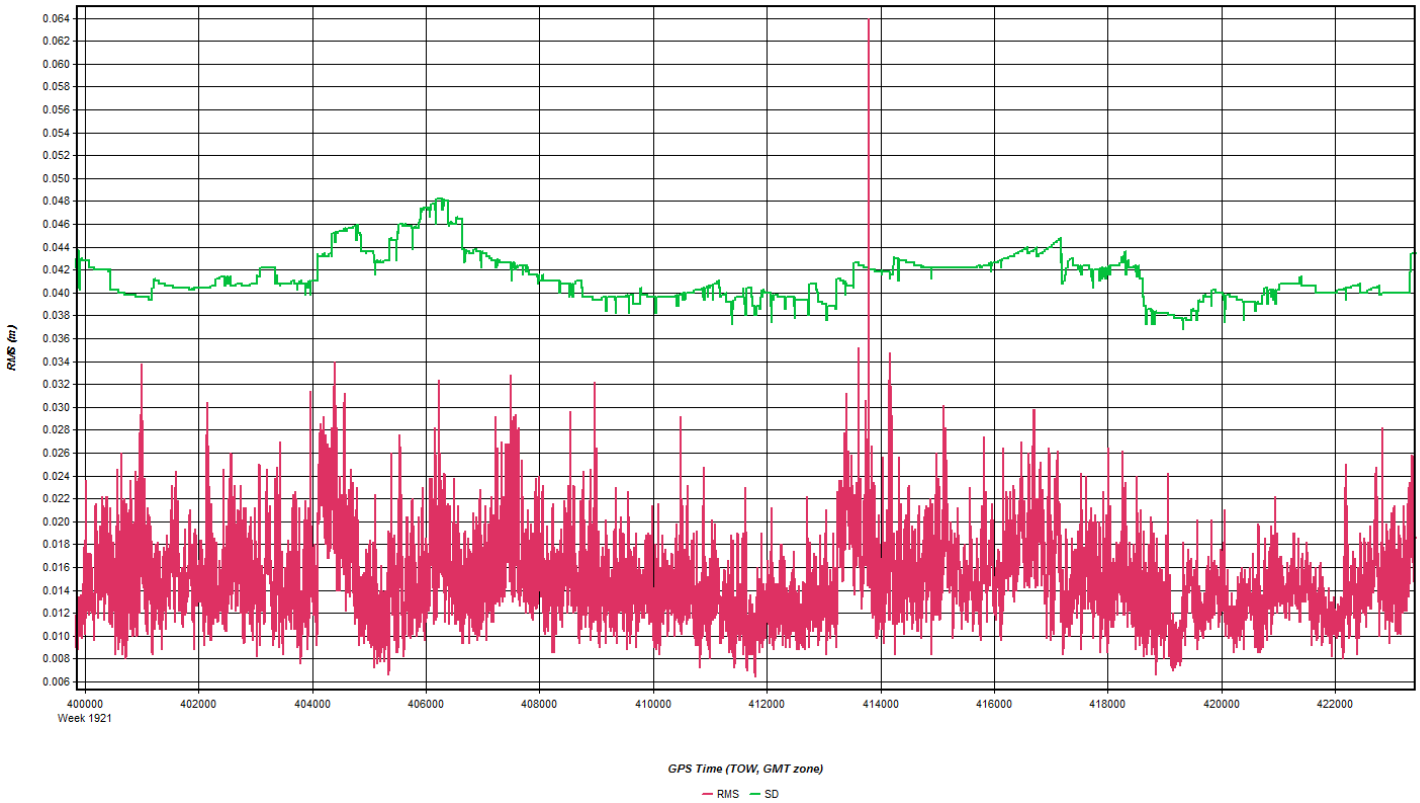

Azimuth/Heading (deg)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
400000
Week 1921
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
GPS Time (TOW, GMT zone)
Heading/Azimuth
GPS-COG

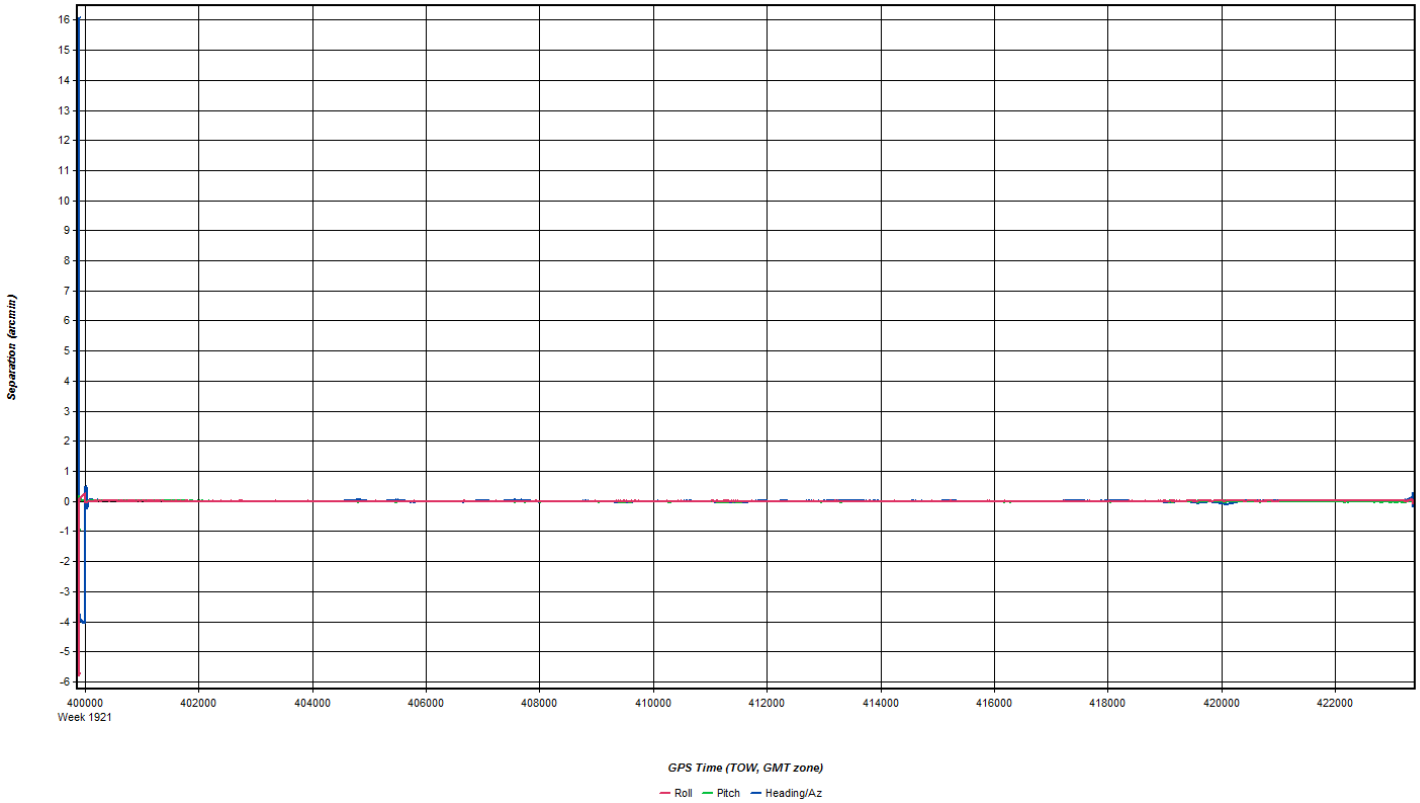

PDOP
1.95
1.90
1.85
1.80
1.75
1.70
1.65
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
400000
Week 1921
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
GPS Time (TOW, GMT zone)
PDOP

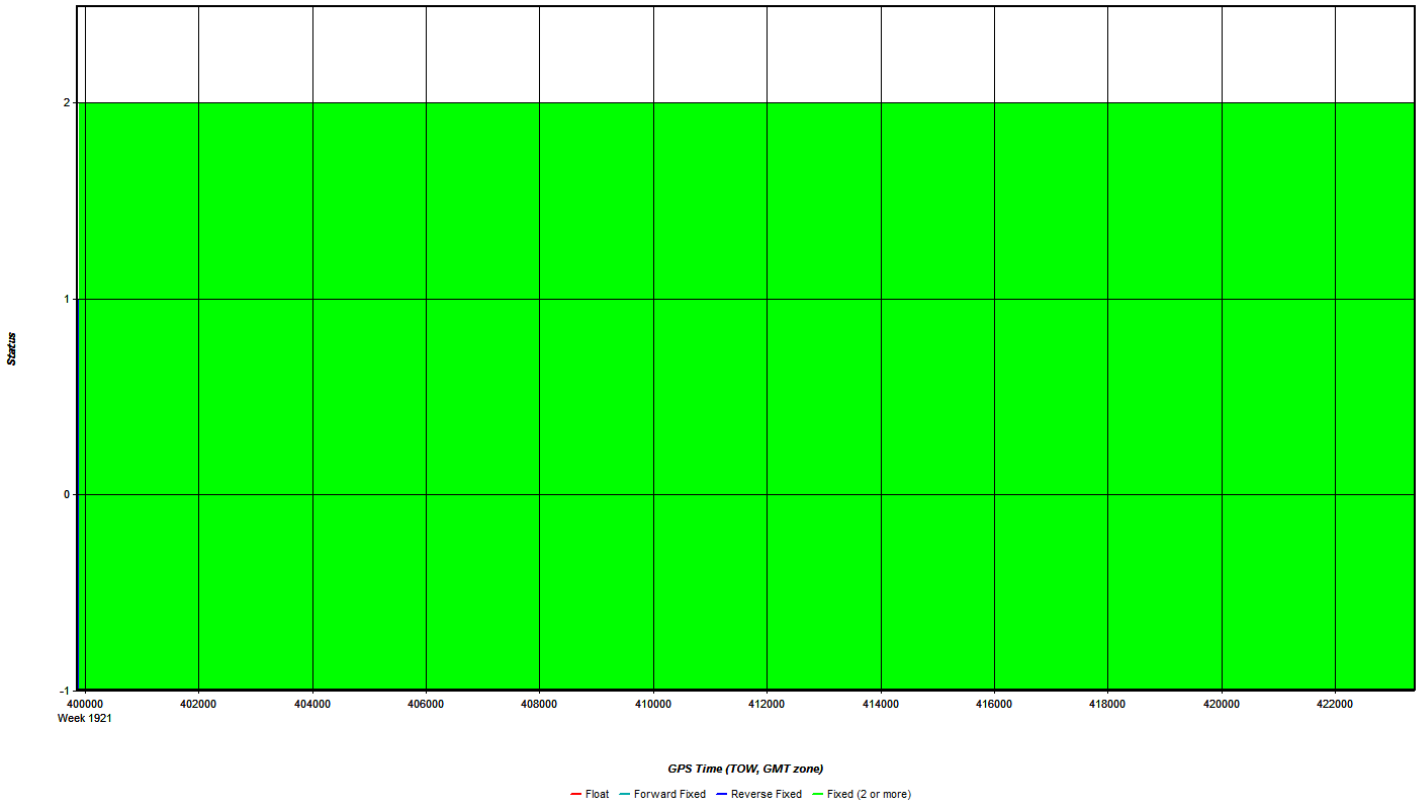

Estimated StdDev (m)
0.0165
0.0160
0.0155
0.0150
0.0145
0.0140
0.0135
0.0130
0.0125
0.0120
0.0115
0.0110
0.0105
0.0100
0.0095
0.0090
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
400000
Week 1921
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
GPS Time (TOW, GMT zone)
East
North
Height
Trace

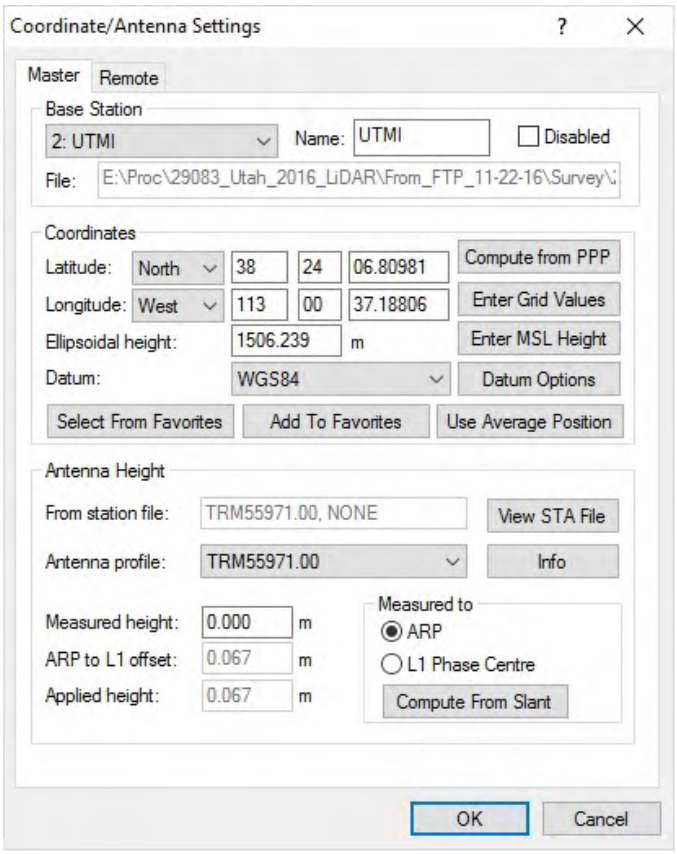

Roll & pitch (deg)
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
400000
Week 1921
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
GPS Time (TOW, GMT zone)
Roll
Pitch

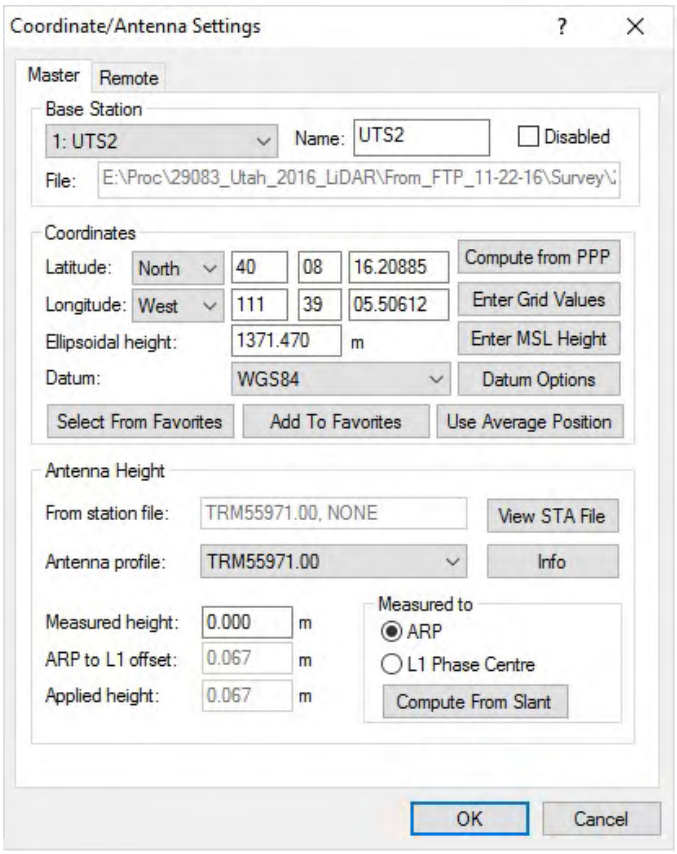

Height (m)
4100
4000
3900
3800
3700
3600
3500
3400
3300
3200
3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
400000
Week 1921
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
GPS Time (TOW, GMT zone)
Height


RMS (m)
0.064
0.062
0.060
0.058
0.056
0.054
0.052
0.050
0.048
0.046
0.044
0.042
0.040
0.038
0.036
0.034
0.032
0.030
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
400000
Week 1921
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
GPS Time (TOW, GMT zone)
RMS
SD


Separation (arcmin)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
400000
Week 1921
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
GPS Time (TOW, GMT zone)
Roll
Pitch
Heading/Az


Status
2
1
0
-1
400000
Week 1921
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
GPS Time (TOW, GMT zone)
Float
Forward Fixed
Reverse Fixed
Fixed (2 or more)


Coordinate/Antenna Settings
Master
Remote
Base Station
2: UTMI
Name: UTMI
Disabled
File: E:\Proc\29083_Utah_2016_LiDAR\From_FTP_11-22-16\Survey\
Coordinates
Latitude: North 38 24 06.80981
Compute from PPP
Longitude: West 113 00 37.18806
Enter Grid Values
Ellipsoidal height: 1506.239 m
Enter MSL Height
Datum: WGS84
Datum Options
Select From Favorites
Add To Favorites
Use Average Position
Antenna Height
From station file: TRM55971.00, NONE
View STA File
Antenna profile: TRM55971.00
Info
Measured height: 0.000 m
ARP to L1 offset: 0.067 m
Applied height: 0.067 m
Measured to
ARP
L1 Phase Centre
Compute From Slant
OK
Cancel


Coordinate/Antenna Settings
Master
Remote
Base Station
1: UTS2
Name: UTS2
Disabled
File: E:\Proc\29083_Utah_2016_LiDAR\From_FTP_11-22-16\Survey\
Coordinates
Latitude: North 40 08 16.20885
Longitude: West 111 39 05.50612
Ellipsoidal height: 1371.470 m
Datum: WGS84
Compute from PPP
Enter Grid Values
Enter MSL Height
Datum Options
Select From Favorites
Add To Favorites
Use Average Position
Antenna Height
From station file: TRM55971.00, NONE
View STA File
Antenna profile: TRM55971.00
Info
Measured height: 0.000 m
ARP to L1 offset: 0.067 m
Applied height: 0.067 m
Measured to
ARP
L1 Phase Centre
Compute From Slant
OK
Cancel

Flight Log

Date: 10/26/2016	**Aircraft:** 208NR	**Sensor:** 8227
Project: Utah 2016 LiDAR		**Project #:** R029083
Flight Mgmt File: FAGL_Forge_Heavy_Terrain_8227_1850m_2 FAGL_Forge_2PiA_8227_8ppsm_1550m_6 Unplanned-20161103180629_6		
Pilot: Travis Peden	**Sensor Operator:** Aaron Mallon	

	Flight 1	Flight 2	Flight 3	Flight 4
Wheels Up	9:10:00 AM			
Wheels Down	3:35:00 PM			
Begin Hobbs	4387.7			
End Hobbs	4394.1			

On-line Hobbs: 3.9	**Mob Hobbs:** 2.5

Notes

Today we were out at the airport ready to take off at 0630 but the deicing trucks broke down so we were not able to take off until 0910. We then flew to the Forge area and completed the remaining lines as well as some reflies. After that we flew back to the Utah Lake area and completed the remaining lines in that block. We eventually had wheels down in Ogden UT and are currently based there.

Flt Mgmt File: FAGL_Forge_Heavy_Terrain_8227_1850m_2

FHT1016	3460.328 m	16:14:35	21.72915982	3445.609 m	16:18:57	22.29020272
FHT1015	3554.159 m	16:21:06	22.59869745	3483.537 m	16:25:31	23.27633697
FHT1014	3637.917 m	16:26:54	23.47186422	3501.944 m	16:31:15	23.99915505
FHT1013	3625.827 m	16:32:29	24.17177581	3487.332 m	16:36:43	24.7980419
FHT1012	3587.539 m	16:38:03	24.97612755	3668.645 m	16:41:50	25.40781185
FHT1011	3702.976 m	16:43:45	25.66072889	3588.038 m	16:47:25	26.18395233
FHT1010	3660.742 m	16:54:06	27.01414778	3726.351 m	16:57:22	27.3520379
FHT1009	3827.228 m	16:58:39	27.51212237	3600.468 m	17:01:42	27.92429393
FHT1008	3731.201 m	17:03:33	28.14100063	3741.443 m	17:06:17	28.40658079
FHT1007	3726.965 m	17:08:17	28.64042902	3795.993 m	17:10:48	28.96511044
FHT1006	3935.950 m	17:12:06	29.1103306	3901.787 m	17:12:25	29.1385829
FHT1006	3833.796 m	17:15:49	29.51467141	3593.358 m	17:17:53	29.69531025
FHT1006	3821.307 m	17:20:02	29.92106807	3777.652 m	17:22:08	30.17899822
FHT1005	4125.686 m	17:26:38	30.63553881	3670.979 m	17:28:18	30.76509392
FHT1005	3747.620 m	17:30:09	30.9455665	3900.836 m	17:32:07	31.17073952
FHT1004	4013.208 m	17:34:02	31.35346573	3706.002 m	17:35:25	31.4515496
FHT1003	3932.734 m	17:37:16	31.62996316	3742.217 m	17:38:26	31.7603511
FHT1002	3676.191 m	17:40:38	31.95849202	3717.353 m	17:41:26	32.01078311
FHT1001	3801.262 m	17:43:20	32.18470611	3697.428 m	17:43:50	32.23938709
FHT1017	3449.274 m	17:46:49	32.45347041	3460.602 m	17:51:36	32.74129801

Flt Mgmt File: FAGL_Forge_2PiA_8227_8ppsm_1550m_6

FRG1048	3572.524 m	18:13:20	34.36225322	3834.759 m	18:15:25	34.52736631
FRG1049	4016.370 m	18:16:55	34.61305662	3527.408 m	18:18:47	34.66633436
FRG1047	3733.159 m	18:21:51	34.85234265	3673.408 m	18:23:13	34.95711878
FRG1064	3257.665 m	18:46:41	35.72581473	3281.831 m	18:48:23	35.72246738
FRG1065	3323.622 m	18:49:54	35.75126834	3295.636 m	18:51:53	35.85141085
FRG1063	3336.415 m	18:53:37	35.90535426	3422.723 m	18:55:16	35.89148937
FRG1070	3340.850 m	19:00:06	35.92800012	3253.811 m	19:01:23	35.98432686
FRG1071	3263.036 m	19:03:08	36.00514727	3428.892 m	19:04:22	35.98136062
FRG1069	3278.747 m	19:06:01	35.9973917	3390.703 m	19:07:29	36.05214048

Flt Mgmt File: Unplanned-20161103180629_6

FRG1048	3572.524 m	18:13:20	34.36225322	3834.759 m	18:15:25	34.52736631
FRG1049	4016.370 m	18:16:55	34.61305662	3527.408 m	18:18:47	34.66633436
FRG1047	3733.159 m	18:21:51	34.85234265	3673.408 m	18:23:13	34.95711878
FRG1064	3257.665 m	18:46:41	35.72581473	3281.831 m	18:48:23	35.72246738
FRG1065	3323.622 m	18:49:54	35.75126834	3295.636 m	18:51:53	35.85141085
FRG1063	3336.415 m	18:53:37	35.90535426	3422.723 m	18:55:16	35.89148937
FRG1070	3340.850 m	19:00:06	35.92800012	3253.811 m	19:01:23	35.98432686
FRG1071	3263.036 m	19:03:08	36.00514727	3428.892 m	19:04:22	35.98136062
FRG1069	3278.747 m	19:06:01	35.9973917	3390.703 m	19:07:29	36.05214048