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Tallahassee-Leon County GIS Landbase Update Project

Report Produced for Tallahassee-Leon County

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Table of Contents

Executive Summary

The primary purpose of this project was to develop a consistent and accurate surface elevation dataset derived from high-accuracy Light Detection and Ranging (lidar) technology for the Tallahassee Leon County Project Area.

The lidar data were processed and classified according to project specifications. Detailed breaklines and bare-earth Digital Elevation Models (DEMs) were produced for the project area. Data was formatted according to tiles with each tile covering an area of 5000 ft by 5000 ft. A total of 876 tiles were produced for the project encompassing an area of approximately 785.55 sq. miles.

THE PROJECT TEAM

Dewberry served as the prime contractor for the project. In addition to project management, Dewberry was responsible for LAS classification, all lidar products, breakline production, Digital Elevation Model (DEM) production, and quality assurance.

Dewberry's Frederick C. Rankin completed ground surveying for the project and delivered surveyed checkpoints. His task was to acquire surveyed checkpoints for the project to use in independent testing of the vertical accuracy of the lidar-derived surface model. He also verified the GPS base station coordinates used during lidar data acquisition to ensure that the base station coordinates were accurate. Please see Appendix A to view the separate Survey Report that was created for this portion of the project.

Digital Aerial Solutions, LLC completed lidar data acquisition and data calibration for the project area.

SURVEY AREA

The project area addressed by this report falls within the Florida county of Leon.

DATE OF SURVEY

The lidar aerial acquisition was conducted from February 05, 2018 thru April 25, 2018.

COORDINATE REFERENCE SYSTEM

Data produced for the project were delivered in the following reference system.

Horizontal Datum: The horizontal datum for the project is North American Datum of 1983 with the 2011 Adjustment (NAD 83 (2011))
Vertical Datum: The Vertical datum for the project is North American Vertical Datum of 1988 (NAVD88)
Coordinate System: NAD83 (2011) State Plane Florida North (US survey feet)
Units: Horizontal units are in U.S. Survey Feet, Vertical units are in U.S. Survey Feet.
Geiod Model: Geoid12B (Geoid 12B) was used to convert ellipsoid heights to orthometric heights).

LIDAR VERTICAL ACCURACY

For the Tallahassee-Leon County GIS Landbase Update Project, the tested $RMSE_z$ of the classified lidar data for checkpoints in non-vegetated terrain equaled **4 cm (0.12 ft)** compared with the **5 cm (0.16 ft)** specification; and the NVA of the classified lidar data computed using $RMSE_z$ x 1.9600 was equal to **7.0 cm (0.24 ft),** compared with the **9.8 cm (0.32 ft)** specification.

For the Tallahassee-Leon County GIS Landbase Update Project, the tested VVA of the classified lidar data computed using the 95^{th} percentile was equal to **8.6 cm (0.28 ft),** compared with the **14.7 cm (0.48 ft)** specification.

Additional accuracy information and statistics for the classified lidar data, raw swath data, and bare earth DEM data are found in the following sections of this report.

PROJECT DELIVERABLES

The deliverables for the project are listed below.

1. Classified Point Cloud Data (Tiled)
2. Bare Earth Surface (Raster DEM – IMG Format)
3. Intensity Images (8-bit gray scale, tiled, GeoTIFF format)
4. Breakline Data (File GDB)
5. Independent Survey Checkpoint Data (Report, Photos, & Points)
6. Calibration Points
7. Metadata
8. Project Report (Acquisition, Processing, QC)
9. Project Extents, Including a shapefile derived from the lidar deliverable

PROJECT TILING FOOTPRINT

Eight hundred seventy five (876) tiles were delivered for the project. Each tile's extent is 5000 feet by 5000 feet (see Appendix B for a complete listing of delivered tiles).

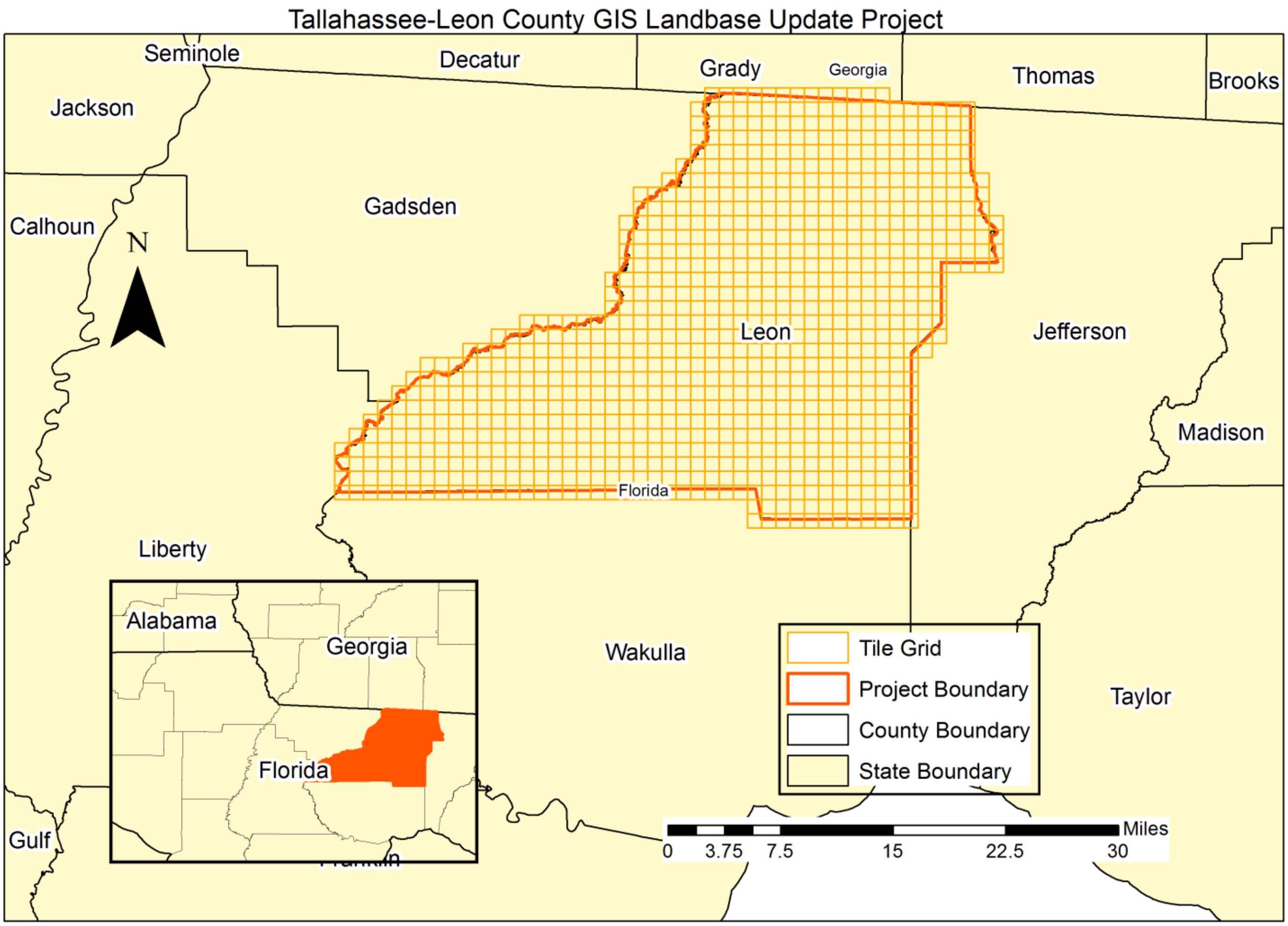


Figure 1 - Project Map

Lidar Acquisition Report

Dewberry elected to subcontract the lidar acquisition and calibration activities to Digital Aerial Solutions. Digital Aerial Solutions was responsible for providing lidar acquisition, calibration and delivery of lidar data files to Dewberry.

Dewberry received calibrated swath data from Digital Aerial Solutions on February 05, 2018 and April 25, 2018.

LIDAR ACQUISITION DETAILS

Digital Aerial Solutions planned 218 passes for the project area as a series of parallel flight lines with cross flightlines for the purposes of quality control. The flight plan included zigzag flight line collection as a result of the inherent IMU drift associated with all IMU systems. In order to reduce any margin for error in the flight plan, Digital Aerial Solutions followed FEMA's Appendix A "guidelines" for flight planning and, at a minimum, includes the following criteria:

- A digital flight line layout using LEICA MISSION PRO flight design software for direct integration into the aircraft flight navigation system.
- Planned flight lines; flight line numbers; and coverage area.
- Lidar coverage extended by a predetermined margin beyond all project borders to ensure necessary over-edge coverage appropriate for specific task order deliverables.
- Local restrictions related to air space and any controlled areas have been investigated so that required permissions can be obtained in a timely manner with respect to schedule. Additionally, Digital Aerial Solutions will file our flight plans as required by local Air Traffic Control (ATC) prior to each mission.

Digital Aerial Solutions monitored weather and atmospheric conditions and conducted lidar missions only when no conditions exist below the sensor that will affect the collection of data. These conditions include leaf-off for hardwoods, no snow, rain, fog, smoke, mist and low clouds. Lidar systems are active sensors, not requiring light, thus missions may be conducted during night hours when weather restrictions do not prevent collection. Digital Aerial Solutions accesses reliable weather sites and indicators (webcams) to establish the highest probability for successful collection in order to position our sensor to maximize successful data acquisition.

Within 72-hours prior to the planned day(s) of acquisition, Digital Aerial Solutions closely monitored the weather, checking all sources for forecasts at least twice daily. As soon as weather conditions were conducive to acquisition, our aircraft mobilized to the project site to begin data collection. Once on site, the acquisition team took responsibility for weather analysis.

Digital Aerial Solutions lidar sensors are calibrated at a designated site located at the Plant City Airport, Florida and are periodically checked and adjusted to minimize corrections at project sites.

LIDAR SYSTEM PARAMETERS

Digital Aerial Solutions operated a CESSNA 421 (Tail # N13RF and Tail # N112MJ) outfitted with a LEICA ALS80 H lidar system during the collection of the study area. Table 1 illustrates Digital Aerial Solutions system parameters for lidar acquisition on this project.

Item	Parameter
System	Leica ALS80 HP SN8137 & SN8235
Altitude (AGL meters)	3829
Approx. Flight Speed (knots)	155
Scanner Pulse Rate (kHz)	480.0
Scan Frequency (hz)	61.6
Pulse Duration of the Scanner (nanoseconds)	0.003
Pulse Width of the Scanner (m)	0.30

Item	Parameter
Swath width (m)	517.48
Central Wavelength of the Sensor Laser (nanometers)	1064
Did the Sensor Operate with Multiple Pulses in The Air? (yes/no)	Yes
Beam Divergence (milliradians)	0.15-0.25
Nominal Swath Width on the Ground (m)	517.48
Swath Overlap (%)	30
Total Sensor Scan Angle (degree)	25.0°
Computed Down Track spacing (m) per beam	0.65
Computed Cross Track Spacing (m) per beam	0.31
Nominal Pulse Spacing (single swath), (m)	0.35
Nominal Pulse Density (single swath) (ppsm), (m)	8
Aggregate NPS (m) (if ANPS was designed to be met through single coverage, ANPS and NPS will be equal)	0.35
Aggregate NPD (m) (if ANPD was designed to be met through single coverage, ANPD and NPD will be equal)	8
Maximum Number of Returns per Pulse	8

Table 1: Digital Aerial Solutions lidar system parameters

ACQUISITION STATUS REPORT AND FLIGHTLINES

Upon notification to proceed, the flight crew loaded the flight plans and validated the flight parameters. The Acquisition Manager contacted air traffic control and coordinated flight pattern requirements. Lidar acquisition began immediately upon notification that control base stations were in place. During flight operations, the flight crew monitored weather and atmospheric conditions. Lidar missions were flown only when no condition existed below the sensor that would affect the collection of data. The pilot constantly monitored the aircraft course, position, pitch, roll, and yaw of the aircraft. The sensor operator monitored the sensor, the status of PDOPs, and performed the first Q/C review during acquisition. The flight crew constantly reviewed weather and cloud locations. Any flight lines impacted by unfavorable conditions were marked as invalid and re-flown immediately or at an optimal time.

Figure 2 shows the combined trajectory of the flightlines.

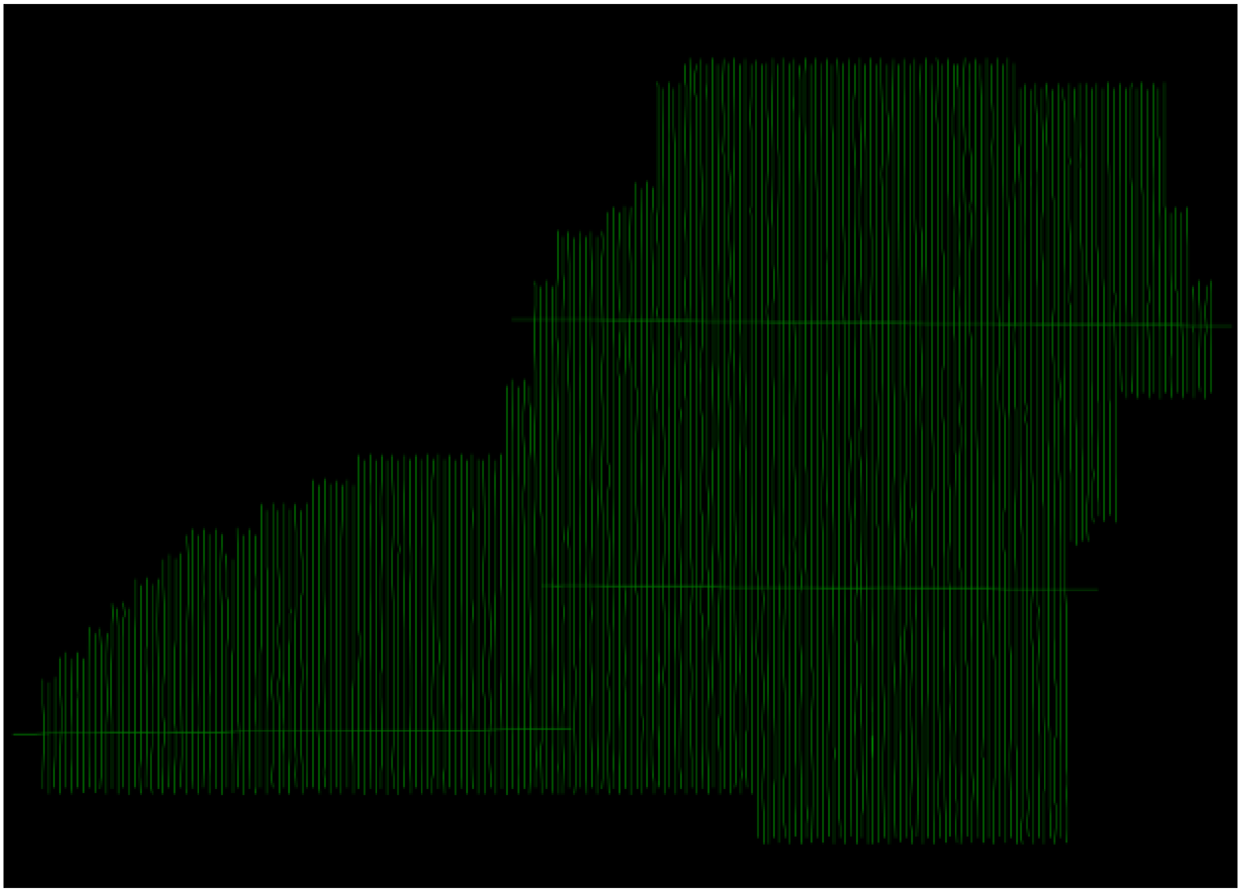


Figure 2: Trajectories as flown by Digital Aerial Solutions

LIDAR CONTROL

Digital Aerial Solutions conducted the survey which provided the 1 newly established base station that were used to control the LiDAR acquisition for the Leon County LiDAR project area. The coordinates of all used base stations are provided in the table below. All control and calibration points are also provided in shapefile format as part of the final deliverables.

Name	NAD83(2011) State Plane Florida North		Orthometric Ht (NAVD88 Geoid12B, ft)
	Easting X (ft)	Northing Y (ft)	
TALH	2013949.1	507908.07	71.87
TLH_A	2023924.41	505797.1	65.17
TLH_B	2023850.27	505847.7	63.39
BD2674	2164606.59	691108.37	246.37

Table 2 – Base stations used to control lidar acquisition

AIRBORN GPS KINEMATIC

Airborne GPS data was processed using the Inertial Explorer software suite. Flights were flown with a minimum of 6 satellites in view (13° above the horizon) and with a PDOP of better than 4. Distances from base station to aircraft were kept to a maximum of 55 km.

For all flights, the GPS data can be classified as excellent, with GPS residuals of 3 cm average or better but no larger than 10 cm being recorded.

GPS processing reports for each mission are included in Appendix C.

GENERATION AND CALIBRATION OF LASER POINTS (RAW DATA)

The initial step of calibration is to verify availability and status of all needed GPS and Laser data against field notes and compile any data if not complete.

Subsequently the mission points are output using Leica CloudPro, initially with default values from CloudPro or the last mission calibrated for the system. The initial point generation for each mission calibration is verified within Microstation/Terrascan for calibration errors. If a calibration error greater than specification is observed within the mission, the roll, pitch and scanner scale corrections that need to be applied are calculated. The missions with the new calibration values are regenerated and validated internally once again to ensure quality.

Data collected by the lidar unit is reviewed for completeness, acceptable density and to make sure all data is captured without errors or corrupted values. In addition, all GPS, aircraft trajectory, mission information, and ground control files are reviewed and logged into a database.

On a project level, a supplementary coverage check is carried out to ensure no data voids unreported by Field Operations are present.

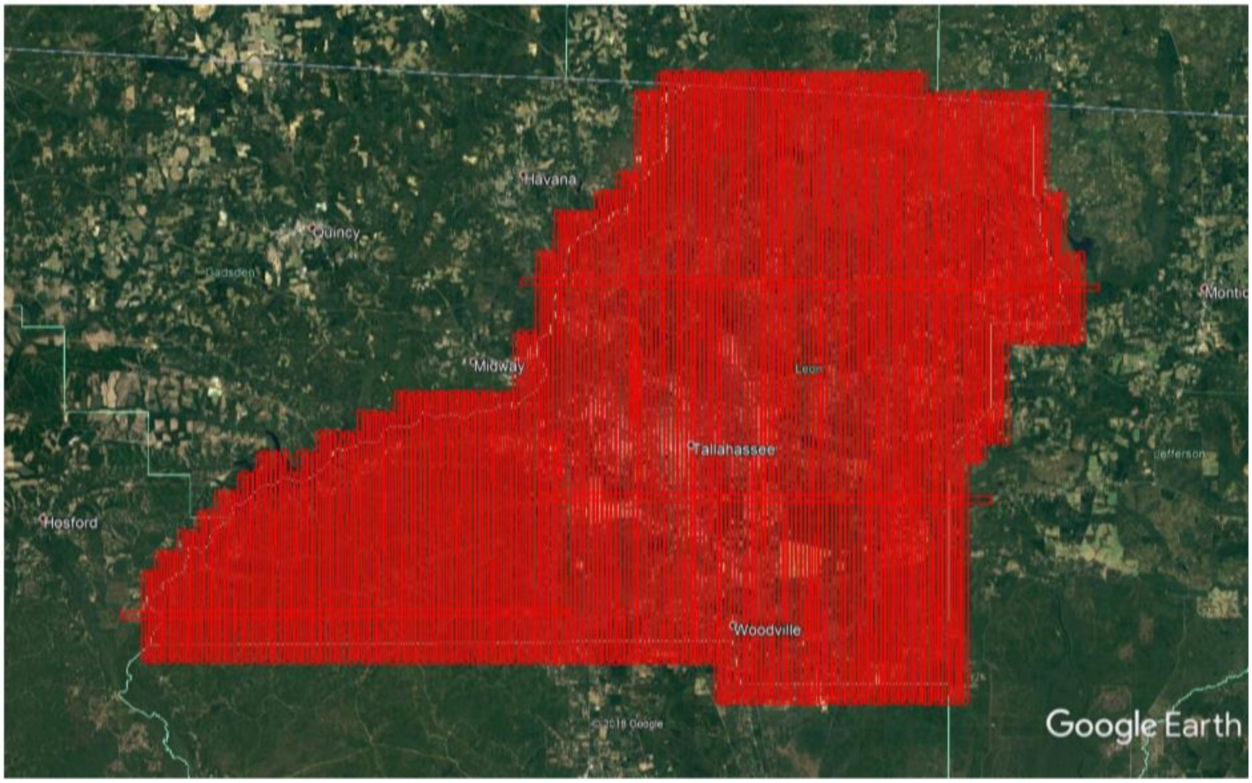


Figure 3 – Lidar swath output showing complete coverage.

BORESIGHT AND RELATIVE ACCURACY

The initial points for each mission calibration are inspected for flight line errors, flight line overlap, slivers or gaps in the data, point data minimums, or issues with the lidar unit or GPS. Roll, pitch and scanner scale are optimized during the calibration process until the relative accuracy is met.

Relative accuracy and internal quality are checked using at least 3 regularly spaced QC blocks in which points from all lines are loaded and inspected. Vertical differences between ground surfaces of each line are displayed. Color scale is adjusted so that errors greater than the specifications are flagged. Cross sections are visually inspected across each block to validate point to point, flight line to flight line and mission to mission agreement.

For this project the specifications used are as follow:
Relative accuracy <= 3 cm maximum difference within individual swaths and <= 4 cm RMSDz between adjacent and overlapping swaths.

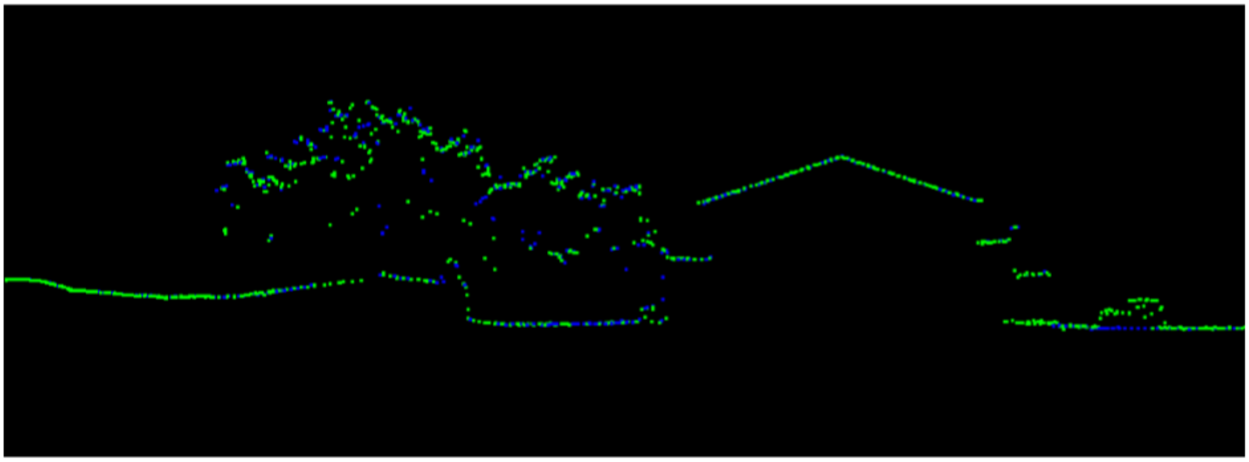


Figure 4 – Profile views showing correct roll and pitch adjustments.

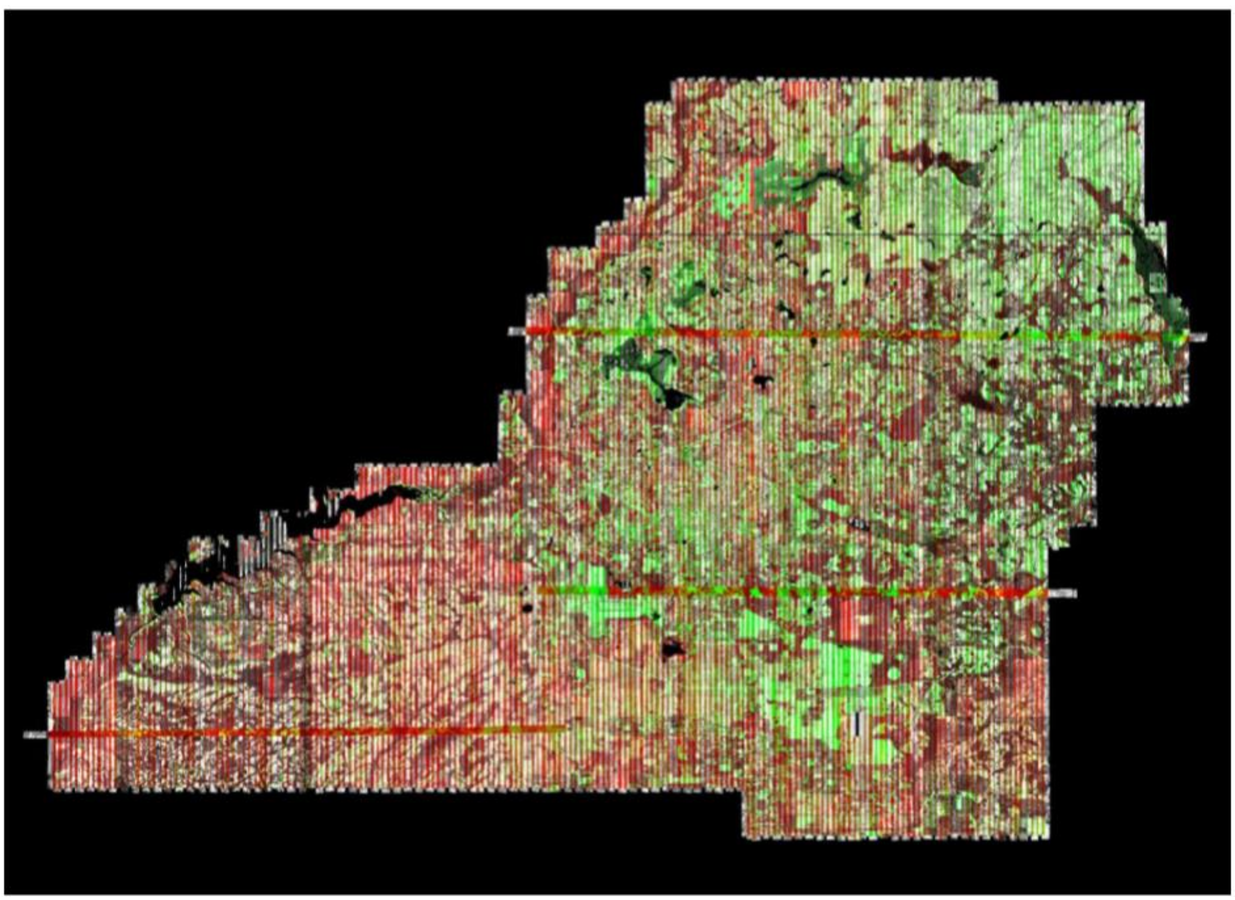


Figure 5 – QC block colored by distance to ensure accuracy at swath edges.

A different set of QC blocks are generated for final review after all transformations have been applied.

PRELIMINARY VERTICAL ACCURACY ASSESSMENT

The preliminary Vertical Accuracy Assessment was conducted by Dewberry. See the Swath Vertical Accuracy Assessment for further information.

Lidar Processing & Qualitative Assessment

INITIAL PROCESSING

Once Dewberry receives the calibrated swath data from the acquisition provider, Dewberry performs several validations on the dataset prior to starting full-scale production on the project. These validations include vertical accuracy of the swath data, inter-swath (between swath) relative accuracy validation, intra-swath (within a single swath) relative accuracy validation, verification of horizontal alignment between swaths, and confirmation of point density and spatial distribution. This initial assessment allows Dewberry to determine if the data are suitable for full-scale production. Addressing issues at this stage allows the data to be corrected while imposing the least disruption possible on the overall production workflow and overall schedule.

Final Swath Vertical Accuracy Assessment

Once Dewberry received the calibrated swath data from Digital Aerial Solutions, Dewberry tested the vertical accuracy of the non-vegetated terrain swath data prior to additional processing. Dewberry tested the vertical accuracy of the swath data using the ninety non-vegetated (open terrain and urban) independent survey check points. The vertical accuracy is tested by comparing survey checkpoints in non-vegetated terrain to a triangulated irregular network (TIN) that is created from the raw swath points. Only checkpoints in non-vegetated terrain can be tested against raw swath data because the data has not undergone classification techniques to remove vegetation, buildings, and other artifacts from the ground surface. Checkpoints are always compared to interpolated surfaces from the lidar point cloud because it is unlikely that a survey checkpoint will be located at the location of a discrete lidar point. Dewberry typically uses LP360 software to test the swath lidar vertical accuracy, Terrascan software to test the classified lidar vertical accuracy, and Esri ArcMap to test the DEM vertical accuracy so that three different software programs are used to validate the vertical accuracy for each project. Project specifications require a NVA of 19.6 cm based on the $RMSE_z$ (10 cm) x 1.96. The dataset for the Tallahassee-Leon County GIS Landbase Update Project satisfies this criteria. This raw lidar swath data set was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 5 cm (0.16 ft) $RMSE_z$ Vertical Accuracy Class. Actual NVA accuracy was found to be $RMSE_z$ = 3.6 cm (0.12 ft), equating to +/- 7.1 cm (0.23 ft) at 95% confidence level. The table below shows all calculated statistics for the raw swath data.

100 % of Totals	# of Points	$RMSE_z$ NVA Spec=0.16 ft	NVA –Non-vegetated Vertical Accuracy ($RMSE_z$ x 1.9600) Spec=0.32 ft	Mean (ft)	Median (ft)	Skew	Std Dev (ft)	Min (ft)	Max (ft)	Kurtosis

Non-Vegetated Terrain	87	0.12	0.23	-0.02	-0.03	0.24	0.12	-0.31	0.30	0.32

Table 3: NVA at 95% Confidence Level for Raw Swaths

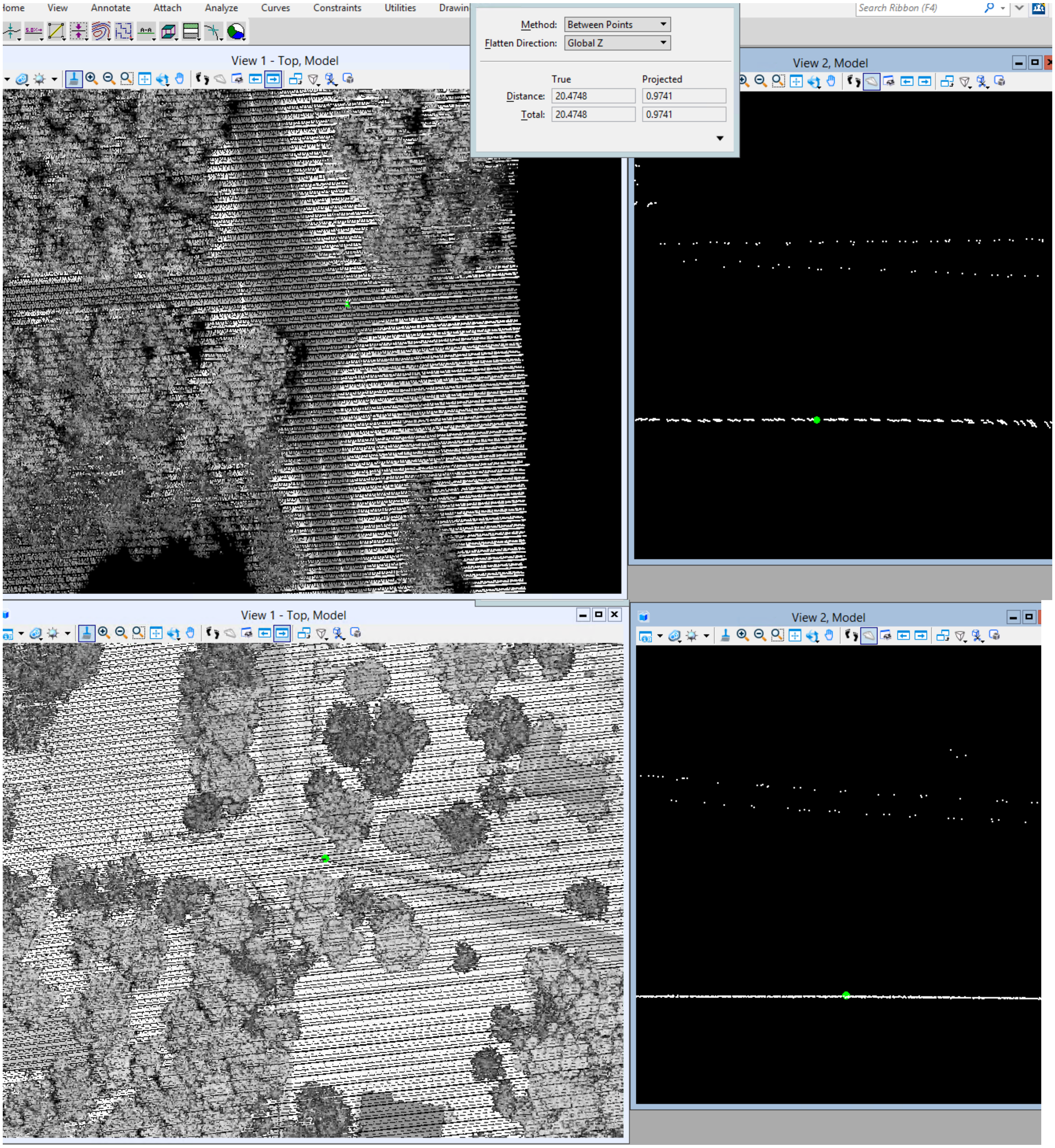
Three checkpoints (NVA-24, NVA-28, and NVA-39) were removed from the raw swath vertical accuracy testing due to their locations near obstructions. NVA-24 and NVA-28 were removed because of their locations under power lines, and NVA-39 was removed due to its location under a car at the time of the flight. Only non-vegetated terrain checkpoints are used to test the raw swath data because the raw swath data has not been classified to remove vegetation, structures, and other above ground features from the ground classification. While NVA-24 and NVA-28 are located in open terrain, the overhead power lines are modeled by the lidar point cloud. These high points caused erroneous high values during the swath vertical accuracy testing so these points were removed from the final calculations. Once the data underwent the classification process, the power lines and the car were removed from the final ground classification and these points could be used in the final vertical accuracy testing for the fully classified lidar data. Table 4, below, provides the coordinates for these checkpoints and the vertical accuracy results from the raw swath data. Table 5, below, provides the usable vertical accuracy results of this checkpoint from the fully classified lidar. The differences in the tables show how above ground features can cause erroneous vertical accuracy results in the raw swath data. Figure 6, below, shows a 3D model of the lidar point cloud and the location of the checkpoints beneath power lines and beneath a car.

Point ID	NAD83 (2011) State Plane Florida North		NAVD88 (Geoid 12B)	Lidar Z (ft)	Delta Z	AbsDeltaZ
	Easting X (ft)	Northing Y (ft)	Survey Z (ft)			
NVA-24	2047084.00	483975.04	22.86	23.81	0.96	0.96
NVA-39	2008209.89	522155.63	96.47	100.18	3.72	3.72
NVA-28	2001632.31	489230.81	89.83	93.35	3.52	3.52

Table 4: Checkpoints removed from raw swath vertical accuracy testing

Point ID	NAD83 (2011) State Plane Florida North		NAVD88 (Geoid 12B)	Lidar Z (ft)	Delta Z	AbsDeltaZ
	Easting X (ft)	Northing Y (ft)	Survey Z (ft)			
NVA-24	2047084.00	483975.04	22.86	22.92	0.06	0.06
NVA-28	2001632.31	489230.81	89.83	89.71	-0.12	0.12
NVA-39	2008209.89	522155.63	96.47	96.31	-0.16	0.16

Table 5: Final tested vertical accuracy for NVA-24, NVA-28, NVA-39 post ground classification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Annotate
Attach
Analyze
Curves
Constraints
Utilities
Drawin
Search Ribbon (F4)
Method: Between Points
Flatten Direction: Global Z
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Projected
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View 1 - Top, Model
View 2, Model
View 1 - Top, Model
View 2, Model

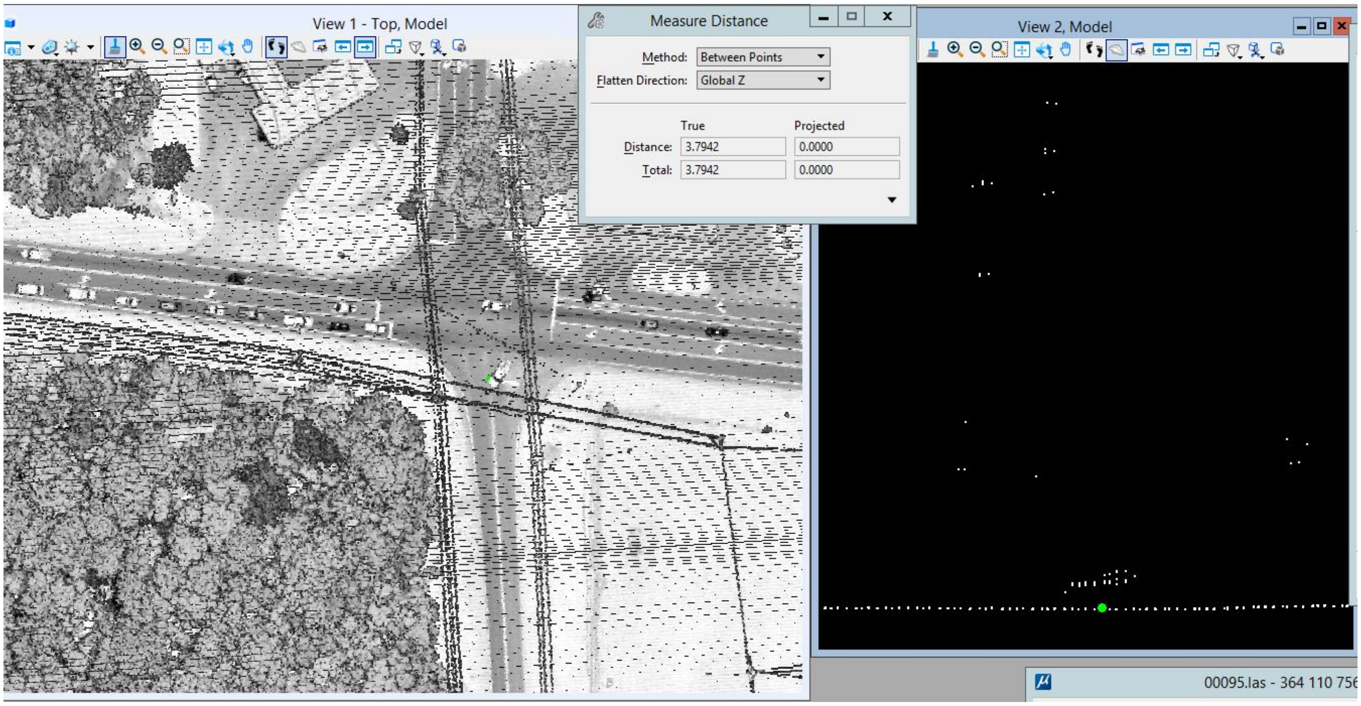


Figure 6 – Non-Vegetated checkpoints (from top to bottom) 24, 28, and 39, shown as the green points, are located underneath power line features (24, 28) and located under a car (39). These points were removed from raw swath vertical accuracy testing because above ground features, including power lines, have not been separated from the ground classification yet.

Inter-Swath (Between Swath) Relative Accuracy

Dewberry verified inter-swath or between swath relative accuracy of the dataset by creating Delta-Z (DZ) orthos. According to the SOW, USGS Lidar Base Specifications v1.3, and ASPRS Positional Accuracy Standards for Digital Geospatial Data, 5 cm (0.16 ft) Vertical Accuracy Class or QL0 data must meet inter-swath relative accuracy of 4 cm RMSDz or less. These measurements are to be taken in non-vegetated and flat open terrain using single or only returns from all classes. Measurements are calculated in the DZ orthos on 1-meter pixels or cell sizes. Areas in the dataset where overlapping flight lines are within 4 cm of each other within each pixel are colored green, areas in the dataset where overlapping flight lines have elevation differences in each pixel between 4 cm to 8 cm are colored yellow, and areas in the dataset where overlapping flight lines have elevation differences in each pixel greater than 8 cm are colored red. Pixels that do not contain points from overlapping flight lines are colored according to their intensity values. Areas of vegetation and steep slopes (slopes with 16 cm or more of valid elevation change across 1 linear meter) are expected to appear yellow or red in the DZ orthos. If the project area is heavily vegetated, Dewberry may also create DZ Orthos from the initial ground classification only, while keeping all other parameters consistent. This allows Dewberry to review the ground classification relative accuracy beneath vegetation and to ensure flight line ridges or other issues do not exist in the final classified data.

Flat, open areas are expected to be green in the DZ orthos. Large or continuous sections of yellow or red pixels can indicate the data was not calibrated correctly or that there were issues during acquisition that could affect the usability of the data, especially when these yellow/red sections follow the flight lines and not the terrain or areas of vegetation. The DZ orthos for Tallahassee-Leon County GIS Landbase Update Project are shown in the figure below; this project meets inter-swath relative accuracy specifications.

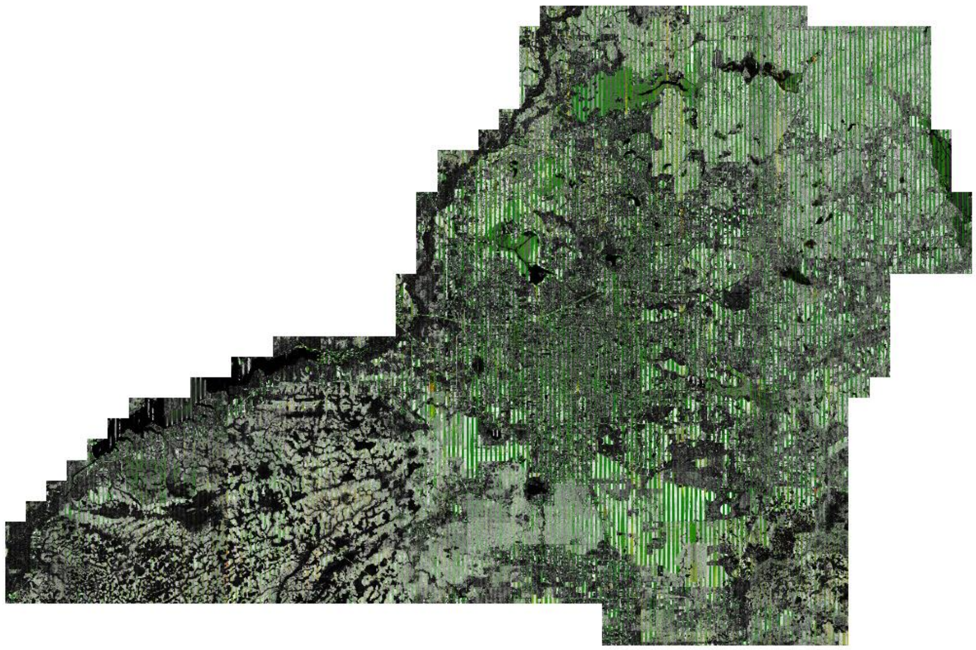
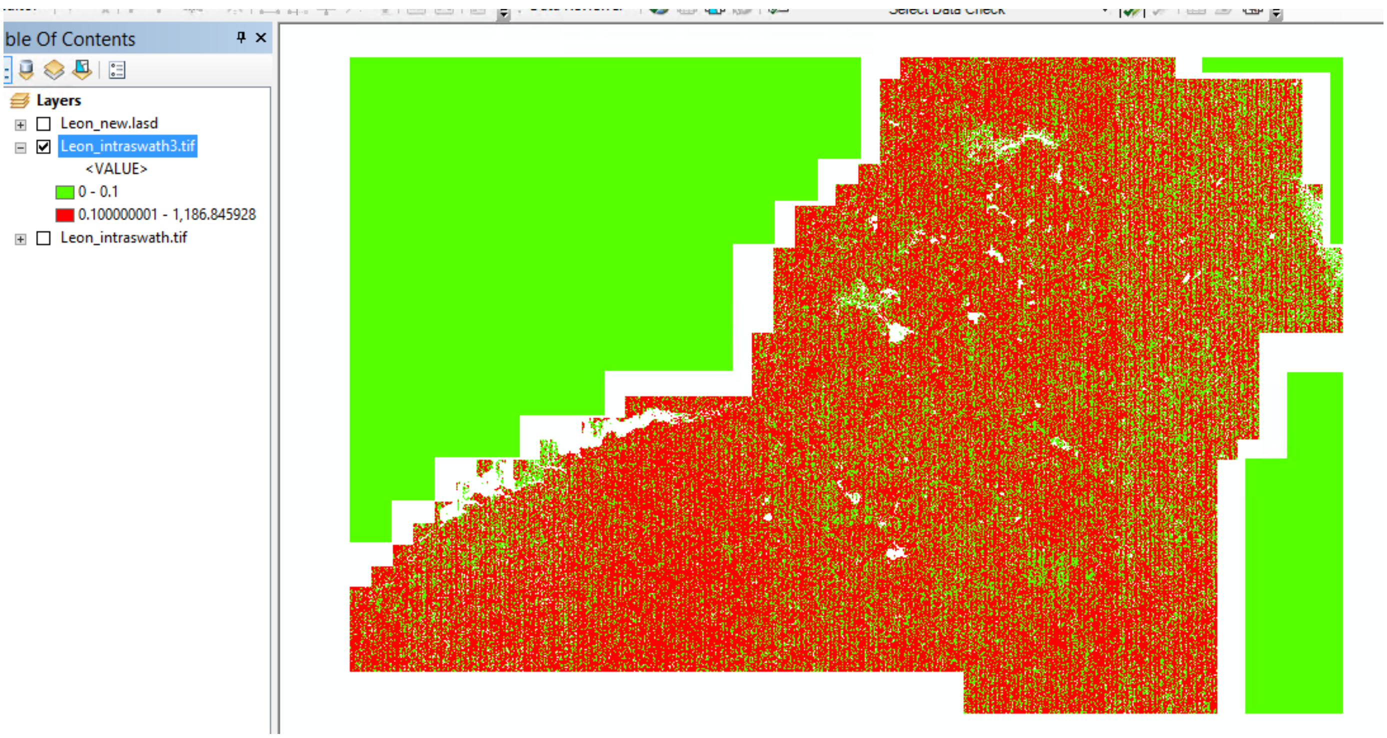


Figure 7– Single return DZ Orthos for the Tallahassee-Leon County GIS Landbase Update Project. Inter-swath relative accuracy passes specifications.

Intra-Swath (Within a Single Swath) Relative Accuracy

Dewberry verifies the intra-swath or within swath relative accuracy by using Quick Terrain Modeler (QTM) scripting and visual reviews. QTM scripting is used to calculate the maximum difference of all points within each 1-meter pixel/cell size of each swath. Dewberry analysts then identify planar surfaces acceptable for repeatability testing and analysts review the QTM results in those areas. According to the SOW, USGS Lidar Base Specifications v1.3, and ASPRS Positional Accuracy Standards for Digital Geospatial Data, 5 cm Vertical Accuracy Class or QL0 data must meet intra-swath relative accuracy of 3 cm maximum difference or less. The image below shows two examples of the intra-swath relative accuracy of Tallahassee-Leon County GIS Landbase Update Project; this project meets intra-swath relative accuracy specifications.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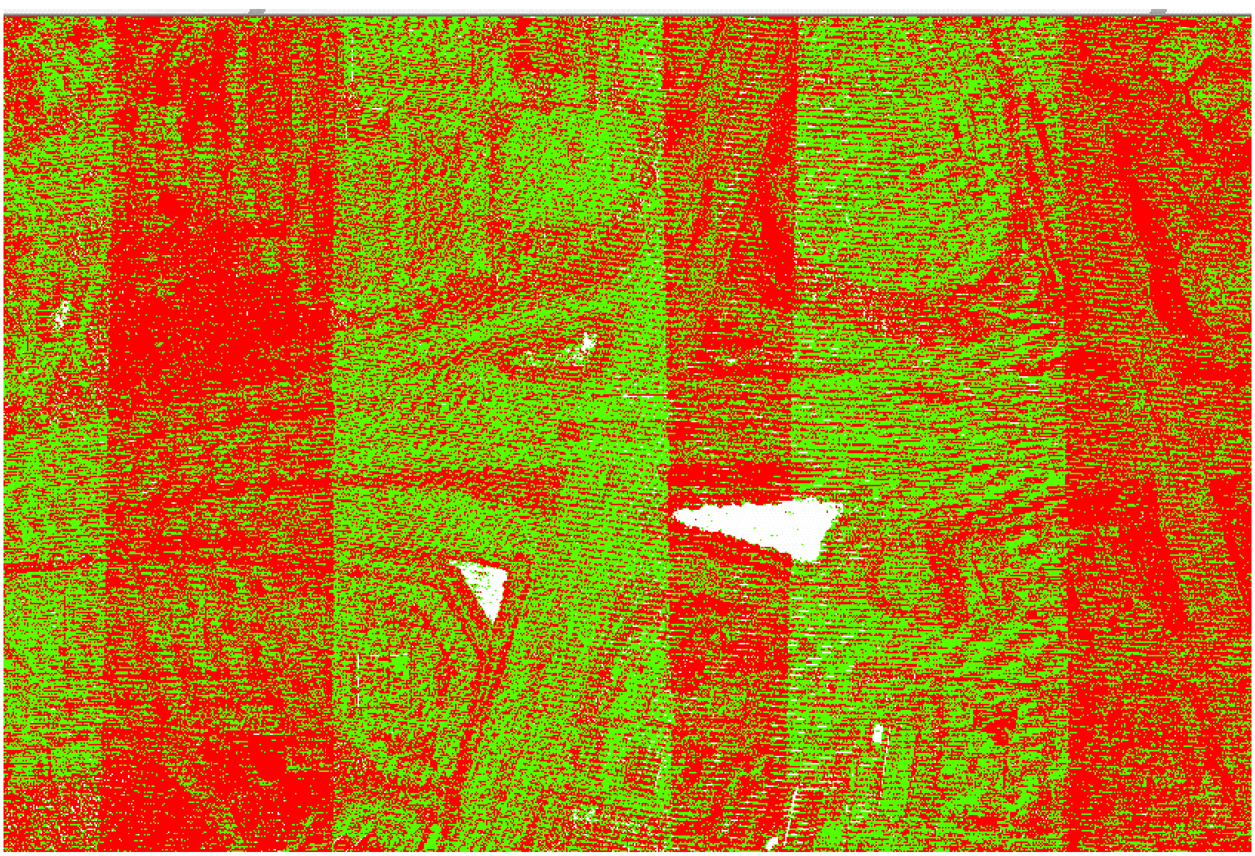


Figure 8–Intra-swath relative accuracy. The top image shows the full project area; areas where the maximum difference is ≤3 cm (0.1 ft) per pixel within each swath are colored green and areas exceeding 3 cm (0.1 ft) are colored red. The bottom image is a close-up of a road interchange, showing flat road surfaces pass specifications.

Horizontal Alignment

To ensure horizontal alignment between adjacent or overlapping flight lines, Dewberry uses QTM scripting and visual reviews. QTM scripting is used to create files similar to DZ orthos for each swath but this process highlights planar surfaces, such as roof tops. In particular, horizontal shifts or misalignments between swaths on roof tops and other elevated planar surfaces are highlighted. Visual reviews of these features, including additional profile verifications, are used to confirm the results of this process. The image below shows an example of the horizontal alignment between swaths for the Tallahassee-Leon County GIS Landbase Update Project; no horizontal alignment issues were identified.

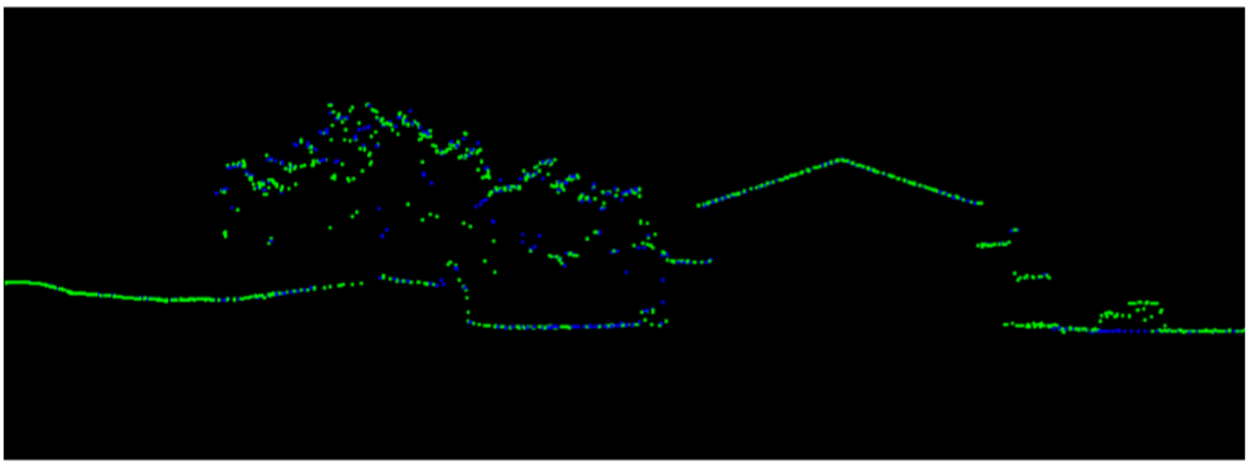


Figure 9– Horizontal Alignment. Two separate flight lines differentiated by color (Green/Blue) are shown in this profile. There is no visible offset between these two flight lines. No horizontal alignment issues were identified.

Point Density and Spatial Distribution

The required Aggregate Nominal Point Spacing (ANPS) for this project is no greater than 0.35 meters, which equates to an Aggregate Nominal Point Density (ANPD) of 8.16 points per square meter or greater. Density calculations were performed using first return data only located in the geometrically usable center portion (typically ~90%) of each swath. By utilizing statistics, the project area was determined to have an ANPS of 0.31 meters or an ANPD of 10.55 points per square meter which satisfies the project requirements. A visual review of a 1-square meter density grid (figure below) shows that there are some 1-meter cells that do not contain 2 points per square meter (red areas) due to the irregular spacing of lidar point cloud data. Most 1-sqaure meter cells contain at least 2 points per square meter (green areas) and when density is viewed/analyzed by representative 1-square kilometer areas (to account for the irregular spacing of lidar point clouds), density passes with no issues.

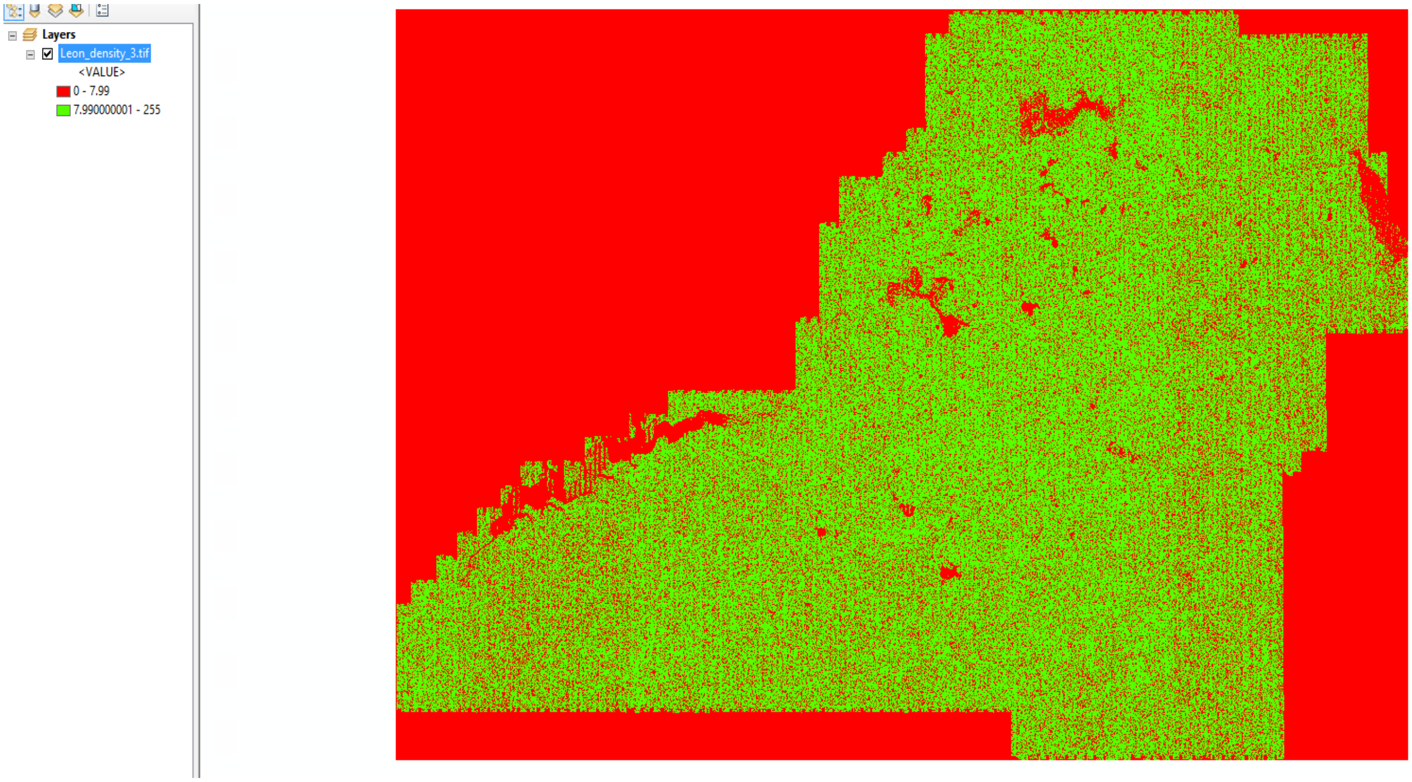


Figure 10– 1-square meter density grid. There are some 1-meter cells that do not contain 8 points per square meter (red areas) due to the irregular spacing of lidar point cloud data. Most 1-sqaure meter cells contain at least 8 points per square meter (green areas) showing there are no systematic density issues. When density is viewed/analyzed by representative 1-square kilometer areas, density passes with no issues.

The spatial distribution of points must be uniform and free of clustering. This specification is tested by creating a grid with cell sizes equal to the design NPS*2. ArcGIS tools are then used to calculate the number of first return points of each swath within each grid cell. At least 90% of the cells must contain 1 lidar point, excluding acceptable void areas such as water or low NIR reflectivity features, i.e. some asphalt and roof composition materials. This project passes spatial distribution requirements, as shown in the image below.

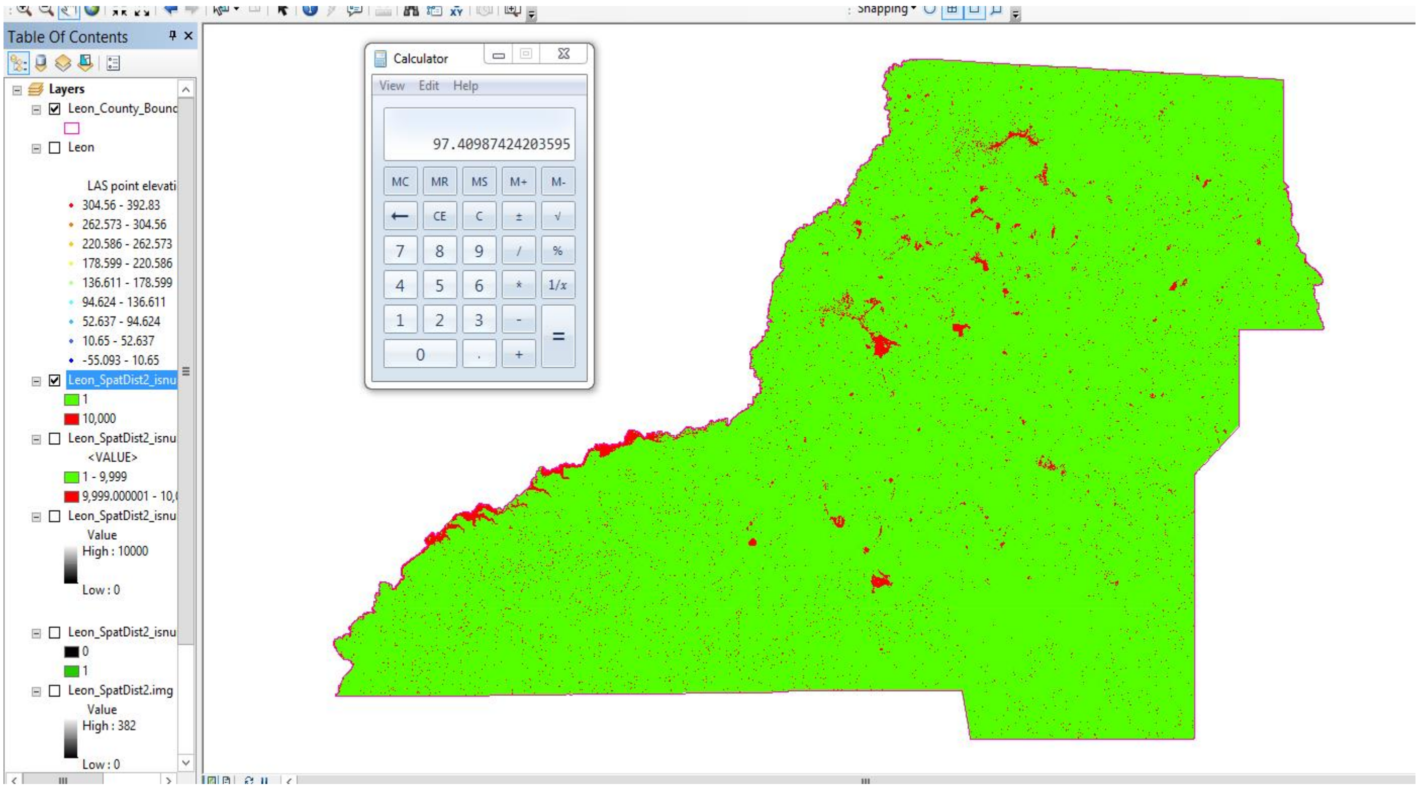


Figure 11– Spatial Distribution. All cells (2*NPS cellsize) containing at least one lidar point are colored green. Cells that do not contain a lidar point, including water bodies which are acceptable NoData area, are colored red. Without removing acceptable NoData areas due to water, 97.4% of cells contain at least one lidar point.

DATA CLASSIFICATION AND EDITING

Once the calibration, absolute swath vertical accuracy, and relative accuracy of the data was confirmed, Dewberry utilized a variety of software suites for data processing. The data was processed using GeoCue and TerraScan software. The initial step is the setup of the GeoCue project, which is done by importing a project defined tile boundary index encompassing the entire project area. The acquired 3D laser point clouds, in LAS binary format, were imported into the GeoCue project and tiled according to the project tile grid. Once tiled, the laser points were classified using a proprietary routine in TerraScan. This routine classifies any obvious low outliers in the dataset to class 7 and high outliers in the dataset to class 18. Points along flight line edges that are geometrically unusable are identified as withheld and classified to a separate class so that they will not be used in the initial ground algorithm. After points that could negatively affect the ground are removed from class 1, the ground layer is extracted from this remaining point cloud. The ground extraction process encompassed in this routine takes place by building an iterative surface model.

This surface model is generated using three main parameters: building size, iteration angle and iteration distance. The initial model is based on low points being selected by a "roaming window" with the assumption that these are the ground points. The size of this roaming window is determined by the building size parameter. The low points are triangulated and the remaining points are evaluated and subsequently added to the model if they meet the iteration angle and distance constraints. This process is repeated until no additional points are added within iterations. A second critical parameter is the maximum terrain angle constraint, which determines the maximum terrain angle allowed within the classification model.

Each tile was then imported into Terrascan and a surface model was created to examine the ground classification. Dewberry analysts visually reviewed the ground surface model and corrected errors in the ground classification such as vegetation, buildings, and bridges that were present following the initial processing conducted by Dewberry. Dewberry analysts employ 3D visualization techniques to view the point cloud at multiple angles and in profile to ensure that non-ground points are removed from the ground classification. Bridge decks are classified to class 17 using bridge breaklines compiled by Dewberry. After the ground classification corrections were completed, the dataset was processed through a water classification routine that utilizes breaklines compiled by Dewberry to automatically classify hydro features. The water classification routine selects ground points within the breakline polygons and automatically classifies them as class 9, water. During this water classification routine, points that are within 1x NPS or less of the hydrographic features are moved to class 20, an ignored ground due to breakline proximity. After the water classification routine, buildings are classified by moving non-isolated, last-return points to a temporary class and running an automated building classification routine on those points. After the automated building classification, points that are within a short distance of added building points are moved from the temporary class to class 6. After building classification was completed, points remaining the temporary class were moved back to class 1. To classify vegetation, unclassified points were moved to their respective vegetation class based on their height from the ground. Overage points are then identified in Terrascan and GeoCue is used to set the overlap bit for the overage points and the withheld bit is set on the withheld points previously identified in Terrascan before the ground classification routine was performed.

The lidar tiles were classified to the following classification schema:

- Class 1 = Unclassified, used for all other features that do not fit into the Classes 2, 7, 9, 10, 17, or 18, including vegetation, buildings, etc.
- Class 2 = Bare-Earth Ground
- Class 3 = Low Vegetation (<=5')
- Class 4 = Medium Vegetation (>5' = <=15')
- Class 5 = High Vegetation (>15')
- Class 6 = Automated Building Rooftops (95% accuracy rate)
- Class 7 = Low Noise
- Class 9 = Water, points located within collected breaklines
- Class 17 = Bridge Decks
- Class 18 = High Noise
- Class 20 = Ignored Ground due to breakline proximity

After manual classification, the LAS tiles were peer reviewed and then underwent a final QA/QC. After the final QA/QC and corrections, all headers, appropriate point data records, and variable length records, including spatial reference information, are updated in GeoCue software and then verified using proprietary Dewberry tools.

Lidar Qualitative Assessment

Dewberry's qualitative assessment utilizes a combination of statistical analysis and interpretative methodology or visualization to assess the quality of the data for a bare-earth digital terrain model (DTM). This includes creating pseudo image products such as lidar orthos produced from the intensity returns, Triangular Irregular Network (TIN)'s, Digital Elevation Models (DEM) and 3-dimensional models as well as reviewing the actual point cloud data. This process looks for anomalies in the data, areas where man-made structures or vegetation points may not have been classified properly to produce a bare-earth model, and other classification errors. This report will present representative examples where the lidar and post processing had issues as well as examples of where the lidar performed well.

VISUAL REVIEW

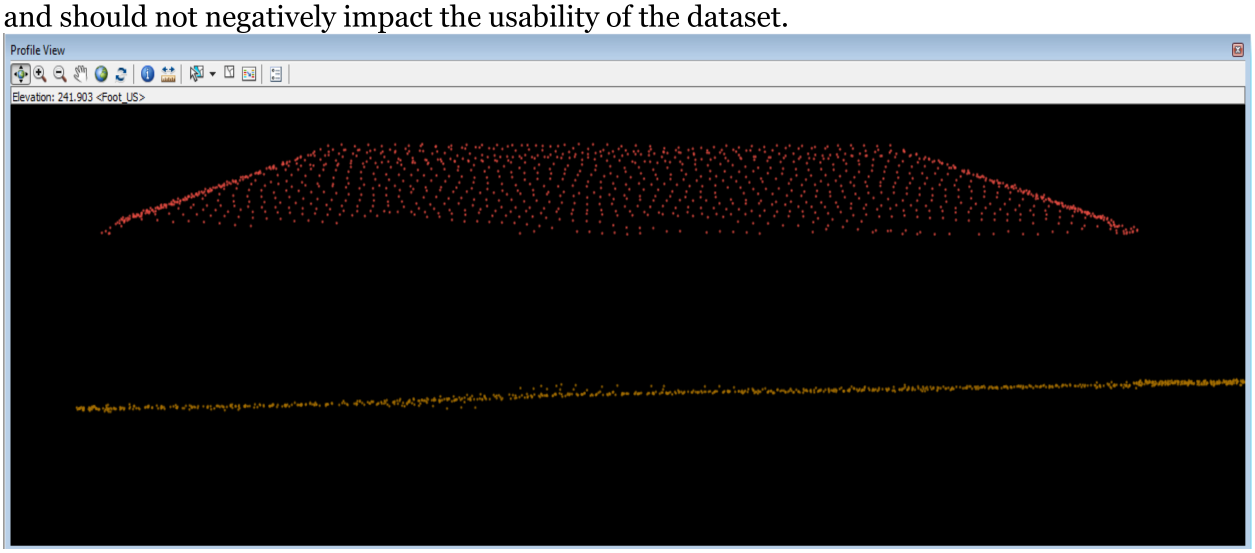
The following sections describe common types of issues identified in lidar data and the results of the visual review for Tallahassee-Leon County GIS Landbase Update Project.

Data Voids

The LAS files are used to produce density grids using the commercial software package QT Modeler (QTM) which creates a 3-dimensional data model derived from Class 2 (ground) points in the LAS files. Grid spacing is based on the project density deliverable requirement for un-obscured areas. Acceptable voids (areas with no lidar returns in the LAS files) that are present in the majority of lidar projects include voids caused by bodies of water. No unacceptable voids are present in the Tallahassee-Leon County GIS Landbase Update Project.

Artifacts

Artifacts are caused by the misclassification of ground points and usually represent vegetation and/or man-made structures. The artifacts identified are usually low lying structures, such as porches or low vegetation used as landscaping in neighborhoods and other developed areas. These low lying features are extremely difficult for the automated algorithms to detect as non-ground and must be removed manually. The vast majority of these features have been removed but a small number of these features are still in the ground classification. The limited numbers of features remaining in the ground are usually 0.3 meters or less above the actual ground surface, and should not negatively impact the usability of the dataset.



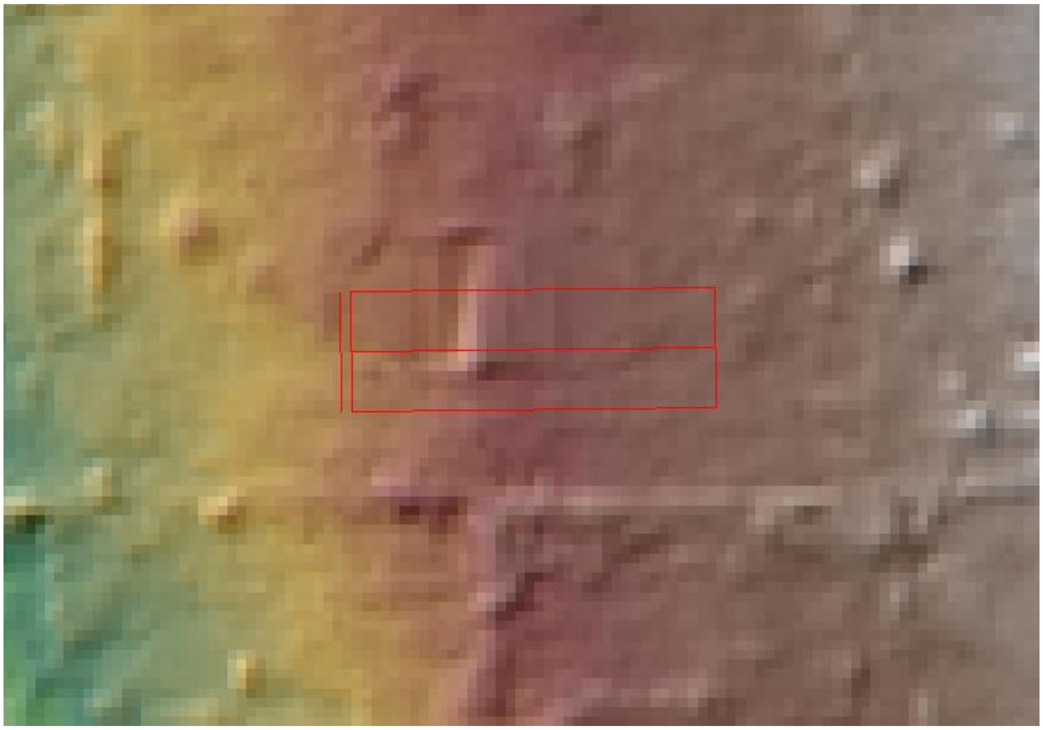
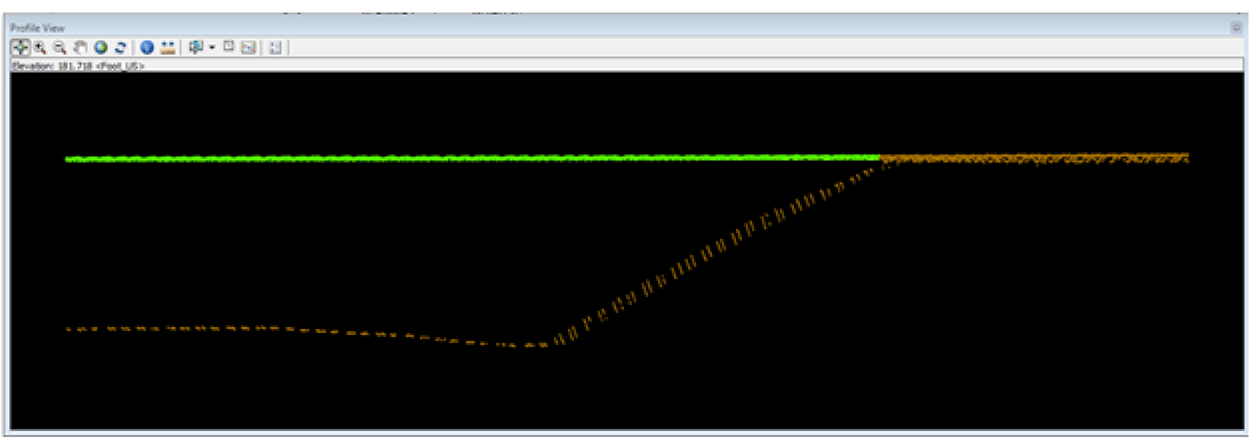


Figure 12 – Tile number 046135_N. Profile with points colored by class (Building class 6=red, Ground class 2=orange) is shown in the top view and a TIN of the surface is shown in the bottom view. The arrow identifies low vegetation points. A limited number of these small features are still classified as ground but do not impact the usability of the dataset.

Bridge Removal Artifacts

The DEM surface models are created from TINs or Terrains. TIN and Terrain models create continuous surfaces from the inputs. Because a continuous surface is being created, the TIN or Terrain will use interpolation to continue the surface beneath the bridge where no lidar data was acquired. Locations where bridges were removed will generally contain less detail in the bare-earth surface because these areas are interpolated.



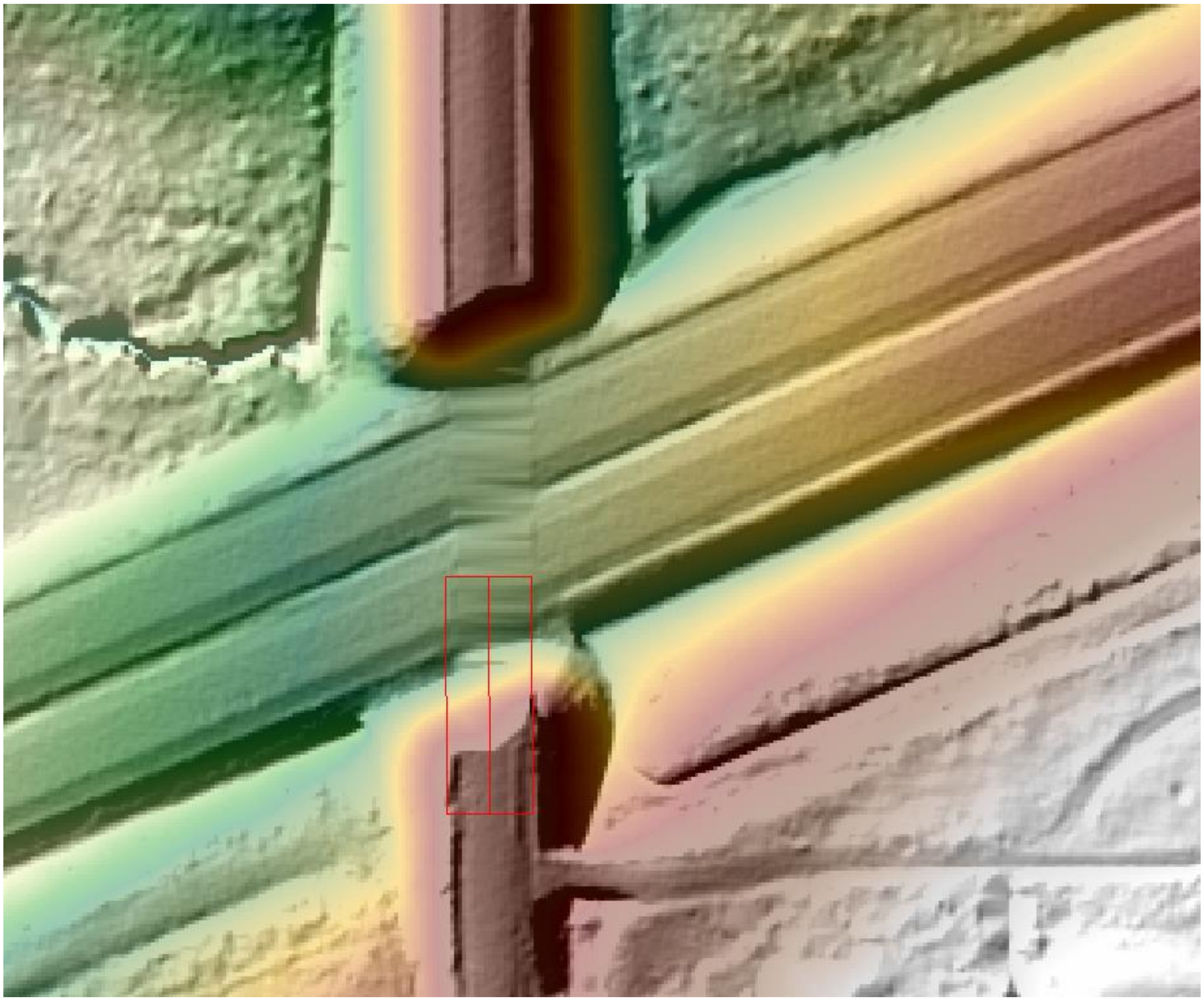
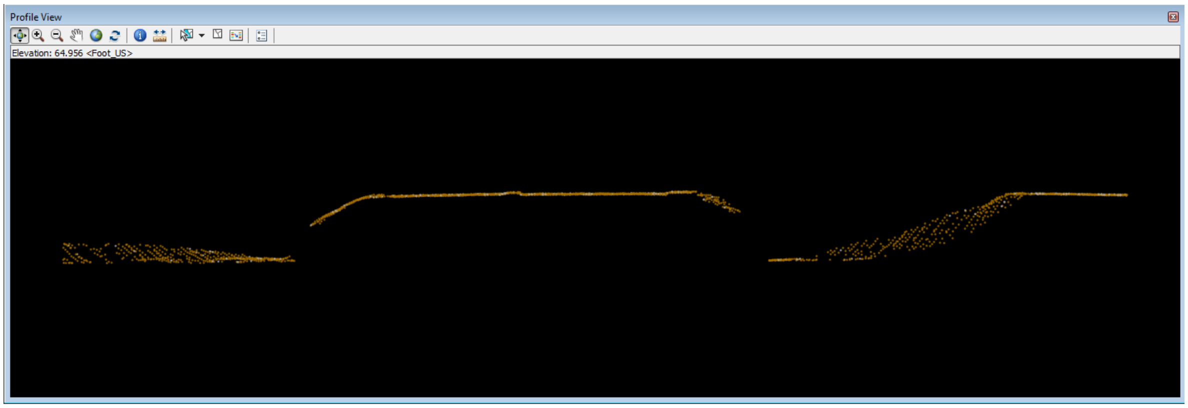


Figure 13 – Tile number 046137_N. The DEM in the bottom view shows an area where a bridge has been removed from ground. The surface model must make a continuous model and in order to do so, points are connected through interpolation. This results in less detail where the surface must be interpolated. The profile in the top view shows the lidar points of this particular feature colored by class. All bridge points have been removed from ground (orange) and are classified as bridge deck (green).

Culverts and Bridges

Bridges have been removed from the bare earth surface while culverts remain in the bare earth surface. In instances where it is difficult to determine if the feature is a culvert or bridge, such as with some small bridges, Dewberry erred on assuming they would be culverts especially if they are on secondary or tertiary roads. Below is an example of a culvert that has been left in the ground surface.



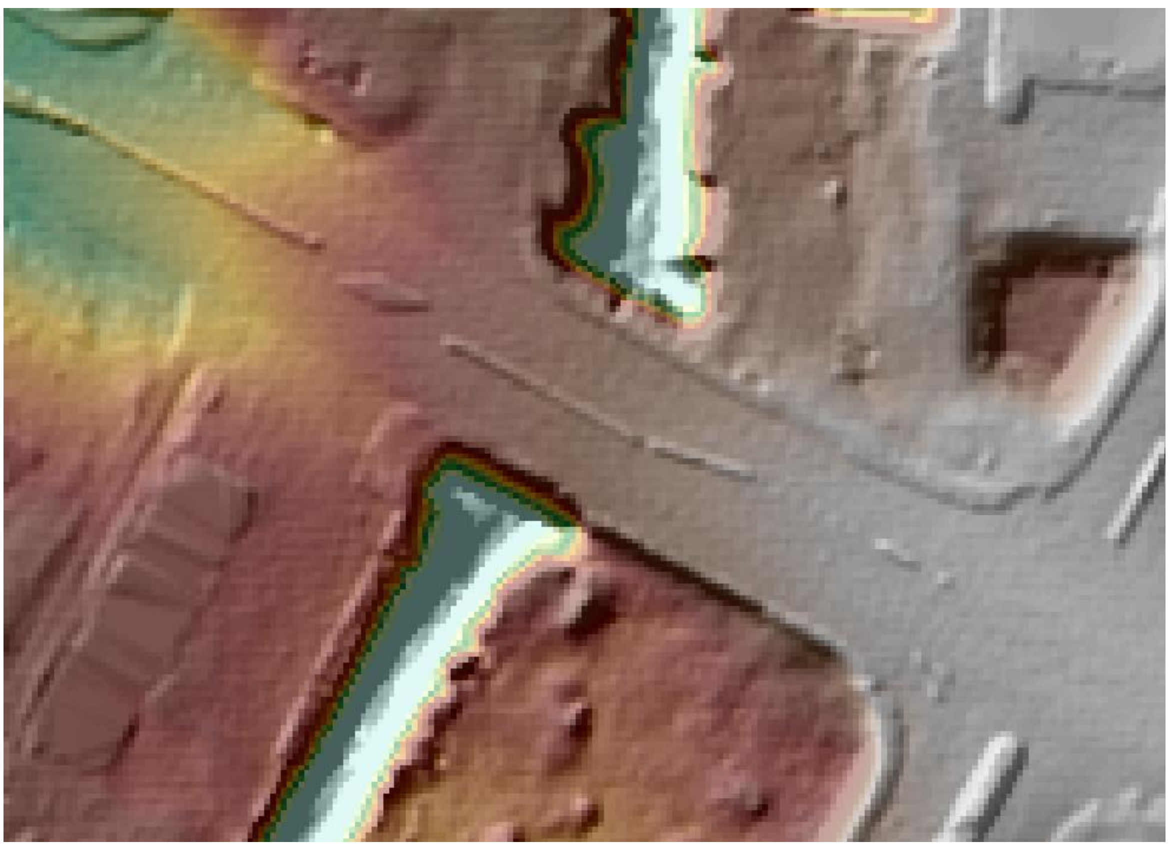


Figure 14– Tile number 047754_N. Profile with points colored by class (class 1=gray, class 2=orange) is shown in the top view and the DEM is shown in the bottom view. This culvert remains in the bare earth surface. Bridges have been removed from the bare earth surface and classified to class 17.

In Ground Low Structures

Underground structures exist within the project area. These features are correctly included in the ground classification.

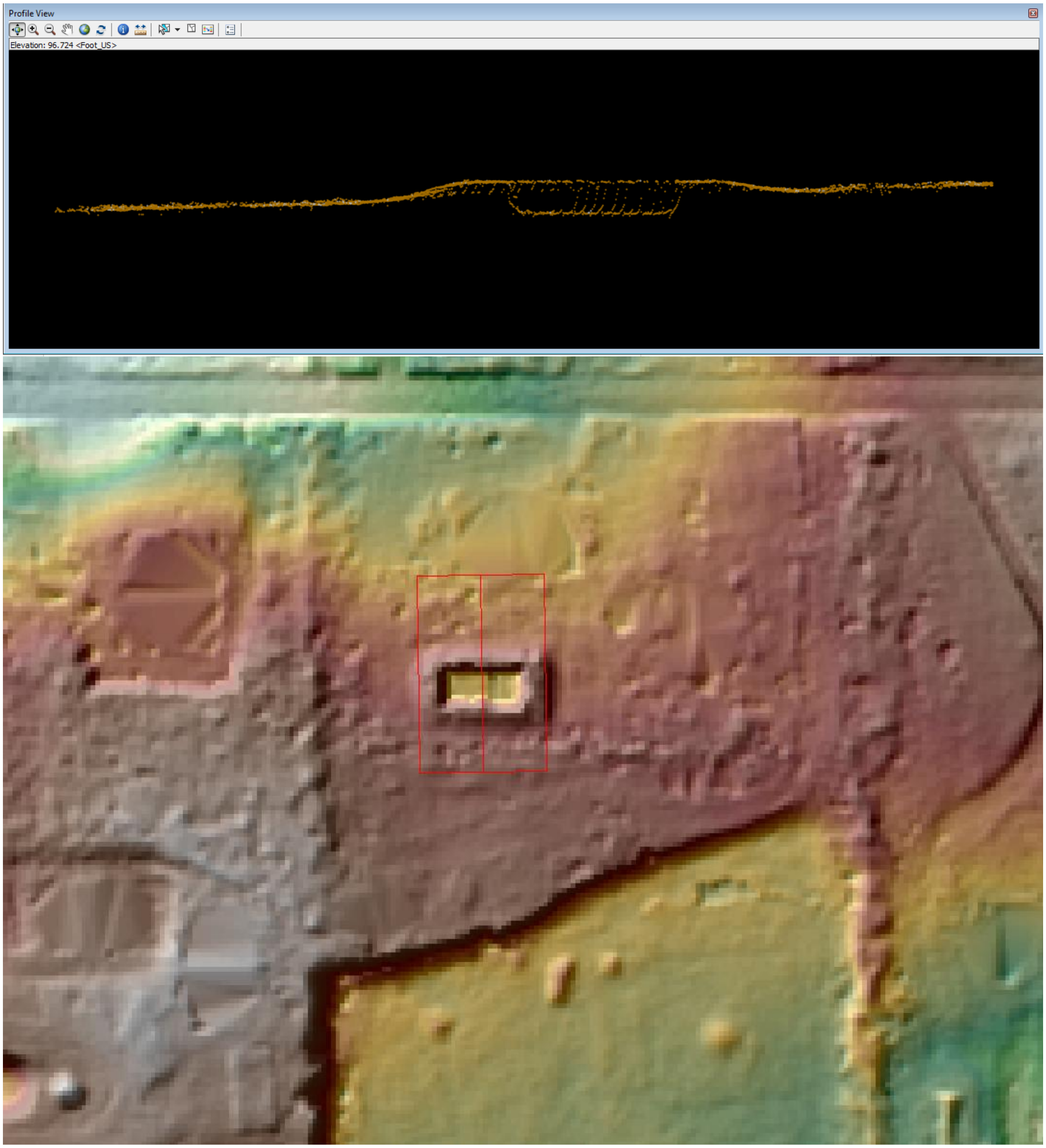


Figure 15 – Tile number 047215_N. Profile with the points colored by class (class 2=orange) is shown in the top view and a DEM of the surface is shown in the bottom view. These features are correctly included in the ground classification.

Dirt Mounds

Irregularities in the natural ground exist and may be misinterpreted as artifacts that should be removed. Small hills and dirt mounds are present throughout the project area. These features are correctly included in the ground.

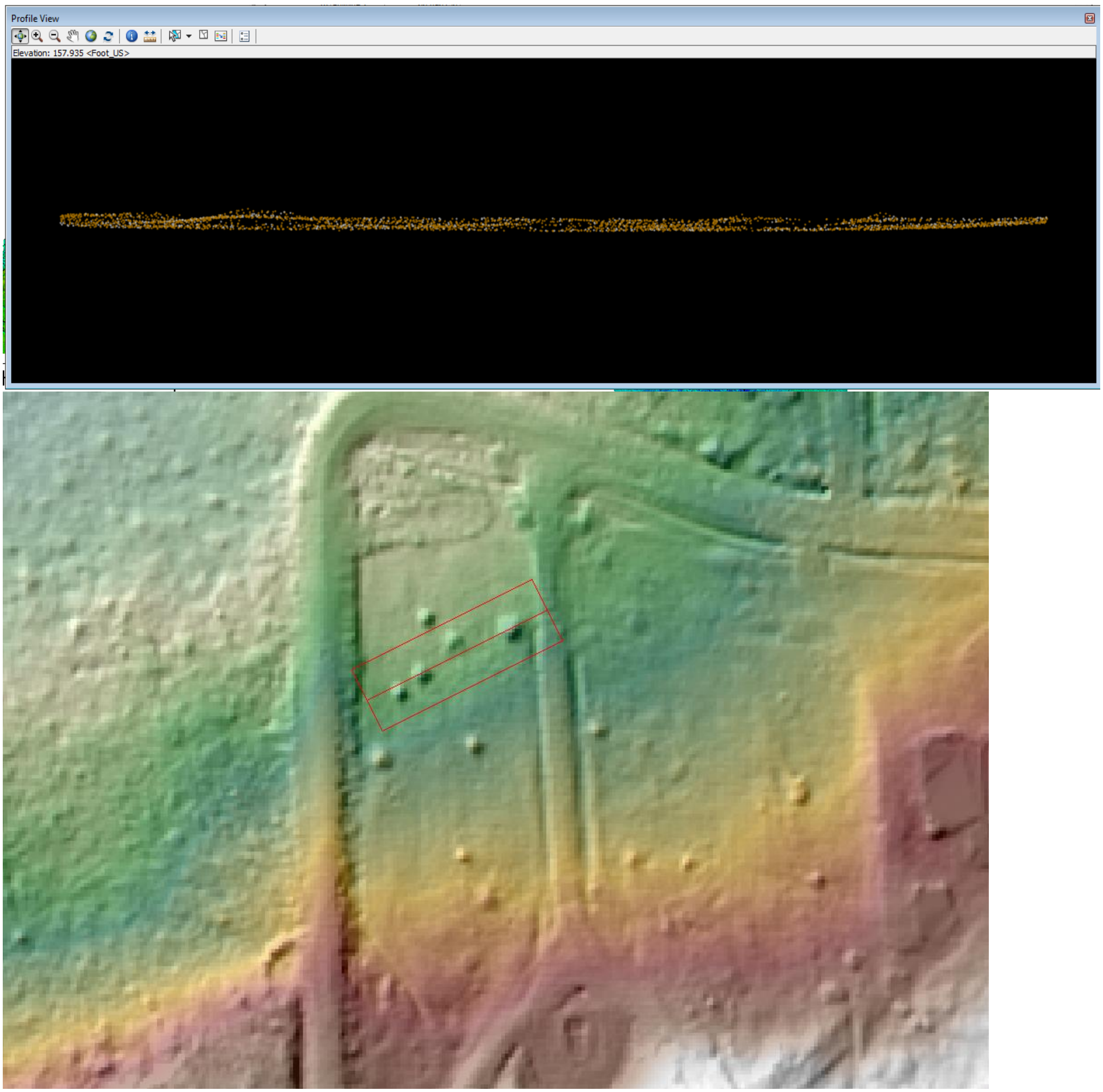


Figure 16 - Tile 041818_N. Profile with the points colored by class (class 2=orange) is shown in the top view and a DEM of the surface is shown in the bottom view. These features are correctly included in the ground classification.

Elevation Change Within Breaklines

While water bodies are flattened in the final DEMs, other features such as linear hydrographic features can have significant changes in elevation within a small distance. In linear hydrographic features, this is often due to the presence of a structure that affects flow such as a dam or spillway. Dewberry has reviewed the DEMs to ensure that changes in elevation are shown from bank to bank. These changes are often shown as steps to reduce the presence of artifacts while ensuring consistent downhill flow. An example is shown below.

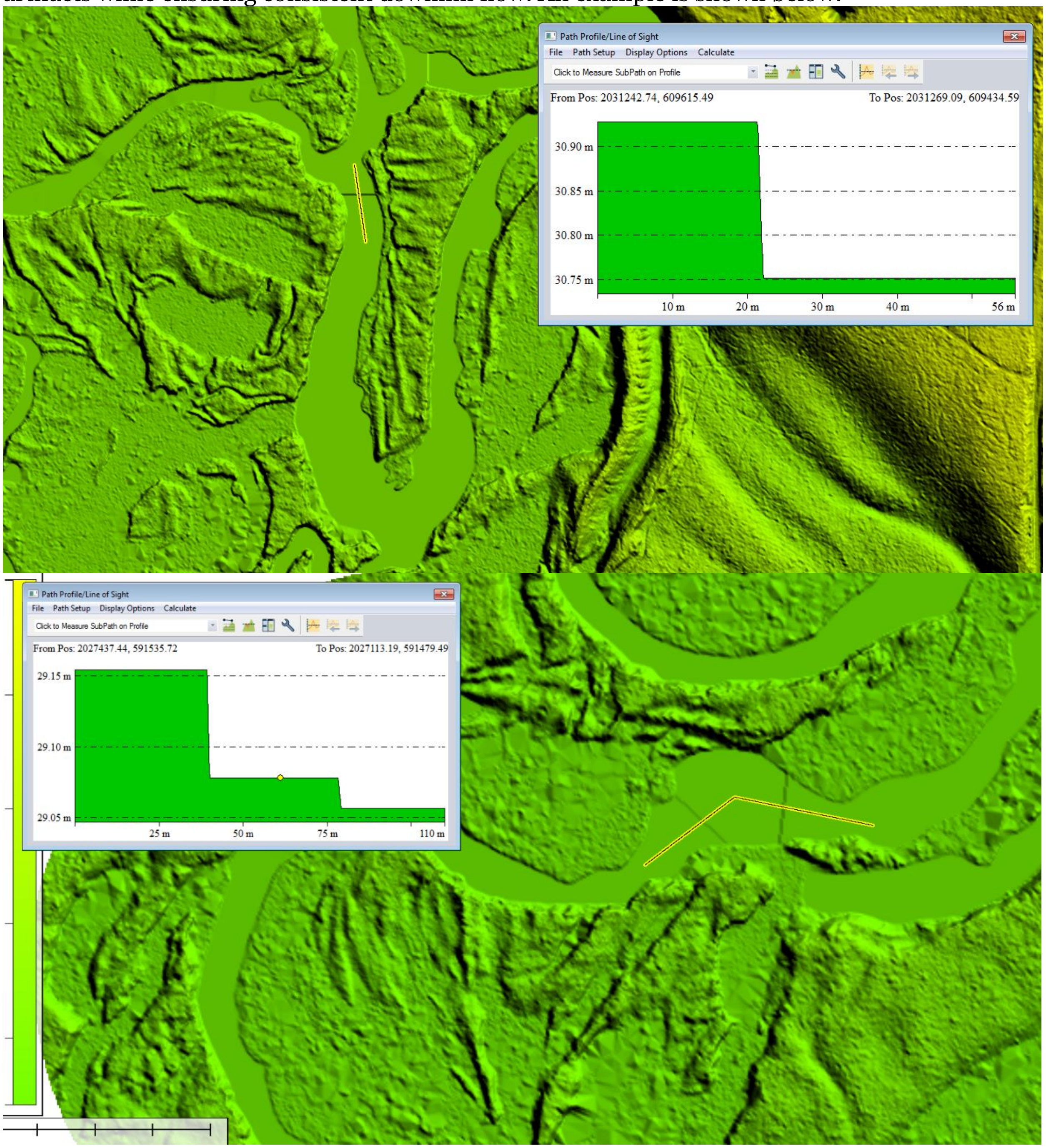


Figure 17 – Tiles number 039117_N and 040736_N. Elevation change has been stair stepped. The steps are flat from bank to bank and flow consistently downhill.

Temporal Changes

There is one temporal difference between an area collected at different times. One flight line was collected on 2/22/2018 and the other overlapping flightline was collected on 2/5/2018 causing an offset in the surface model. A temporal shapefile has been included with the final deliverables for the client to quickly locate this area.

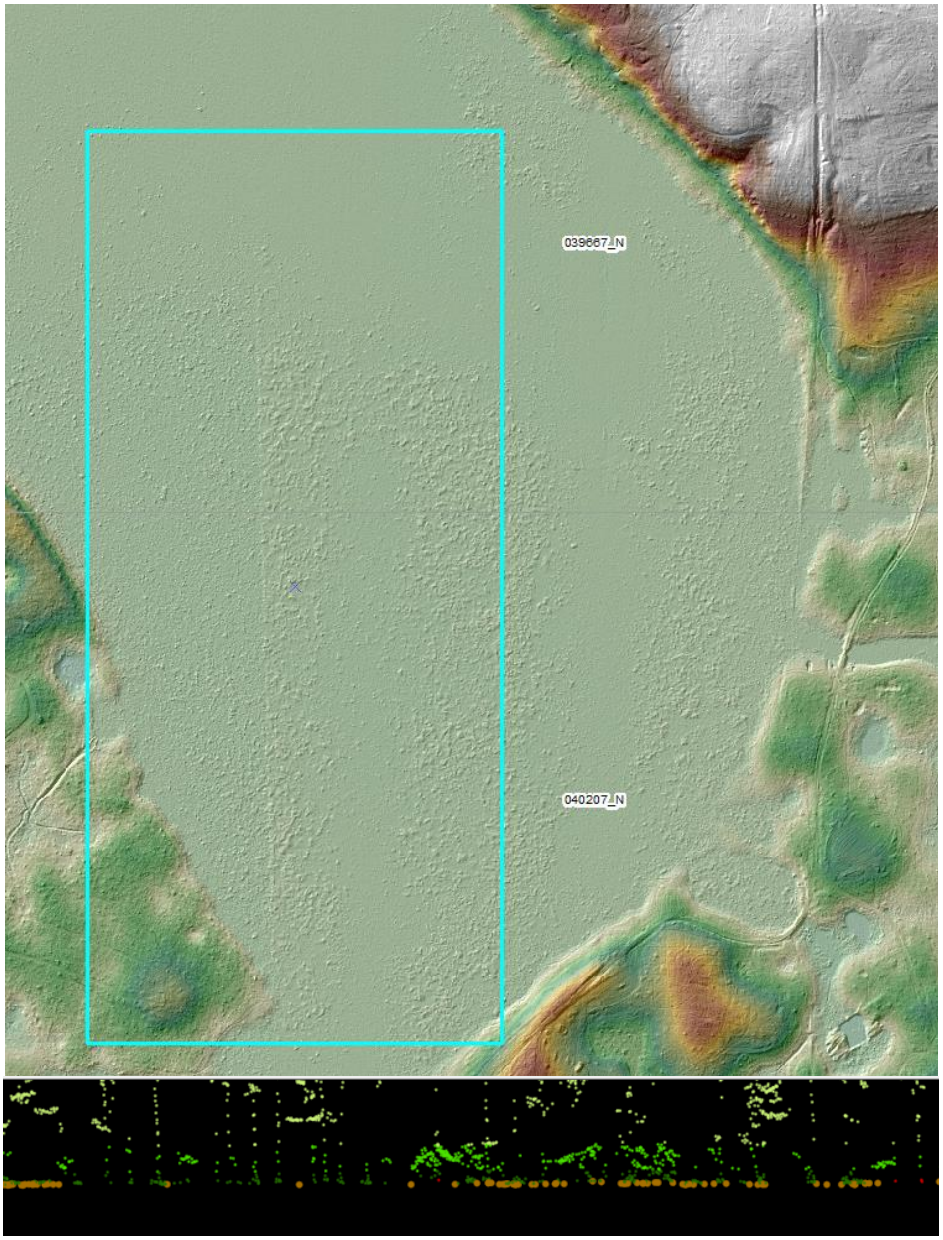


Figure 18 - Tiles 039667_N and 040207_N. The flight line ridge above is located within a marsh area. Overall, the Leon County Lidar data meets the project specifications for RMSDz relative accuracy.

Small Depressions

Small clusters of depressions exist, and may resemble divots, but they are valid ground.

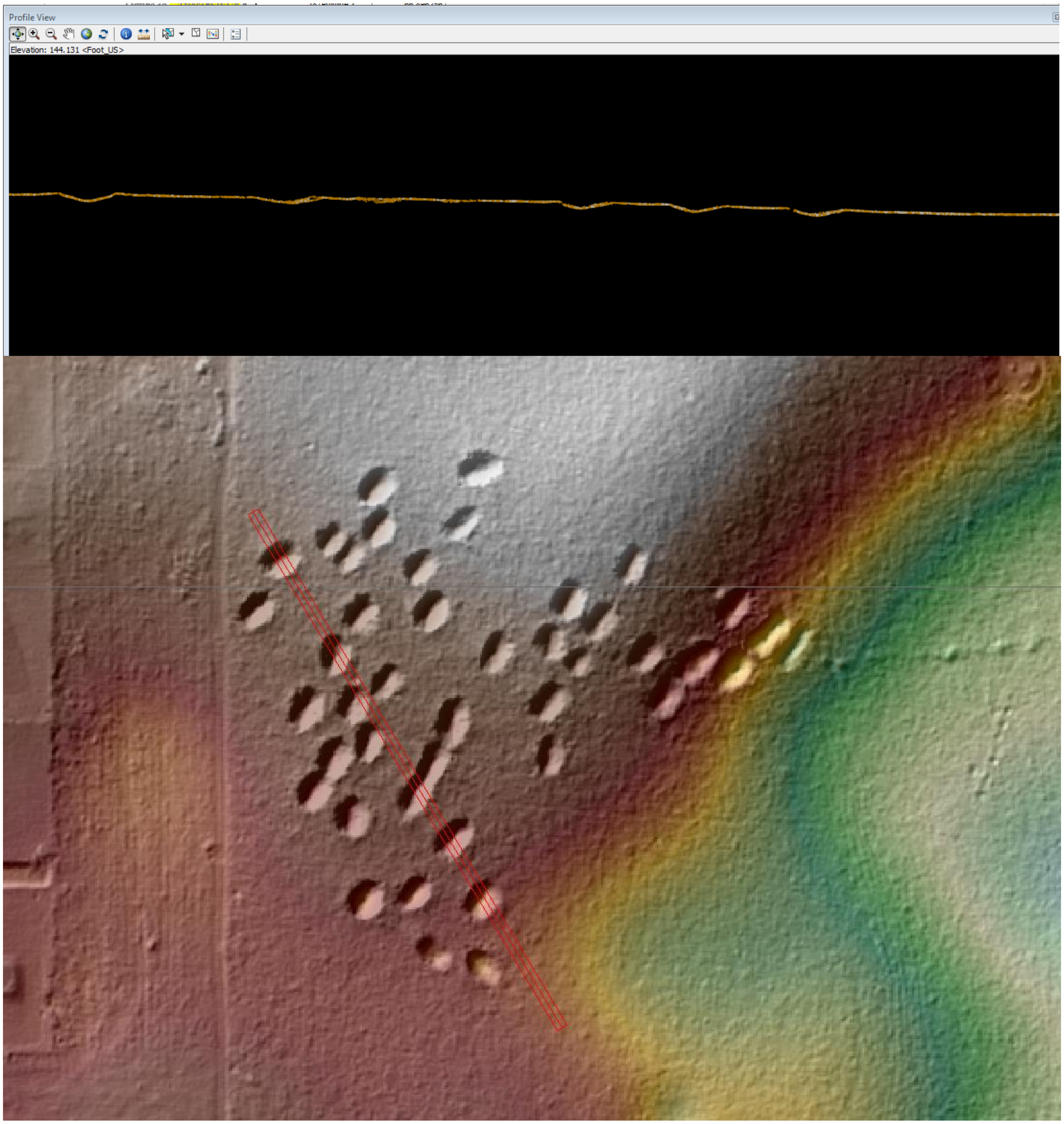


Figure 19 – Tiles 049374_N and 049914_N small clusters of depressions exist, and may resemble divots, but they are valid ground.

FORMATTING

After the final QA/QC is performed and all corrections have been applied to the dataset, all lidar files are updated to the final format requirements and the final formatting, header information, point data records, and variable length records are verified using Dewberry proprietary tools. The table below lists some of the main lidar header fields that are updated and verified.

Classified Lidar Formatting		
Parameter	**Requirement**	**Pass/Fail**
LAS Version	1.4	Pass
Point Data Format	Format 6	Pass
Coordinate Reference System	NAD83 (2011) State Plane Florida North (US survey feet) in WKT Format	Pass
Global Encoder Bit	Should be set to 17 for Adjusted GPS Time	Pass
Time Stamp	Adjusted GPS Time (unique timestamps)	Pass
System ID	Should be set to the processing system/software and is set to NIIRS10 for GeoCue software	Pass
Multiple Returns	The sensor shall be able to collect multiple returns per pulse and the return numbers are recorded	Pass
Intensity	16 bit intensity values are recorded for each pulse	Pass
Classification	Required Classes include: Class 1: Unclassified Class 2: Bare-Earth Ground Class 3: Low Vegetation Class 4: Medium Vegetation Class 5: High Vegetation Class 6: Automated Building Rooftops Class 7: Low Noise Class 9: Water Class 17: Bridge Decks Class 18: High Noise Class 20: Ignored Ground	Pass
Overlap and Withheld Points	Overlap (Overage) and Withheld points are set to the Overlap and Withheld bits	Pass
Scan Angle	Recorded for each pulse	Pass
XYZ Coordinates	Unique Easting, Northing, and Elevation coordinates are recorded for each pulse	Pass

Lidar Positional Accuracy

BACKGROUND

Dewberry quantitatively tested the dataset by testing the vertical accuracy of the lidar. The vertical accuracy is tested by comparing the discreet measurement of the survey checkpoints to that of the interpolated value within the three closest lidar points that constitute the vertices of a three-dimensional triangular face of the TIN. Therefore, the end result is that only a small sample of the lidar data is actually tested. However there is an increased level of confidence with lidar data due to the relative accuracy. This relative accuracy in turn is based on how well one lidar point "fits" in comparison to the next contiguous lidar measurement, and is verified as part of the initial processing. If the relative accuracy of a dataset is within specifications and the dataset passes vertical accuracy requirements at the location of survey checkpoints, the vertical accuracy results can be applied to the whole dataset with high confidence due to the passing relative accuracy. Dewberry typically uses LP360 software to test the swath lidar vertical accuracy, Terrascan software to test the classified lidar vertical accuracy, and Esri ArcMap to test the DEM vertical accuracy so that three different software programs are used to validate the vertical accuracy for each project.

Dewberry also tests the horizontal accuracy of lidar datasets when checkpoints are photo-identifiable in the intensity imagery. Photo-identifiable checkpoints in intensity imagery typically include checkpoints located at the ends of paint stripes on concrete or asphalt surfaces or checkpoints located at 90 degree corners of different reflectivity, e.g. a sidewalk corner adjoining a grass surface. The XY coordinates of checkpoints, as defined in the intensity imagery, are compared to surveyed XY coordinates for each photo-identifiable checkpoint. These differences are used to compute the tested horizontal accuracy of the lidar. As not all projects contain photo-identifiable checkpoints, the horizontal accuracy of the lidar cannot always be tested.

SURVEY VERTICAL ACCURACY CHECKPOINTS

For the vertical accuracy assessment, one hundred eighty-nine (189) check points were surveyed for the project and are located within bare earth/open terrain, grass/weeds/crops, and forested/fully grown land cover categories. Please see appendix A to view the survey report which details and validates how the survey was completed for this project.

Checkpoints were evenly distributed throughout the project area so as to cover as many flight lines as possible using the “dispersed method” of placement.

All checkpoints surveyed for vertical accuracy testing purposes are listed in the following table.

Point ID	NAD83 (2011) State Plane Florida North		NAVD88 (Geoid 12B)
	Easting X (ft)	Northing Y (ft)	Elevation (ft)
NVA-01	2011989.63	557127.57	122.15
NVA-02	2043511.28	605843.16	198.70
NVA-03	2111609.36	567058.48	166.66
NVA-04	2089407.92	581335.78	157.76
NVA-05	2013047.04	575744.74	104.26
NVA-06	2076082.89	569886.20	158.48

NVA-07	1952979.83	514830.01	117.87
NVA-08	2022310.05	508454.29	65.41
NVA-09	2072632.45	594454.77	145.29
NVA-10	2112852.68	580296.71	219.60
NVA-11	2039562.84	568311.10	228.13
NVA-12	2086565.90	500218.86	99.77
NVA-13	1988368.65	524215.90	146.96
NVA-14	1999817.81	474823.32	73.84
NVA-15	2029028.00	491249.46	30.07
NVA-16	2028005.57	481796.14	22.93
NVA-17	2096965.18	560336.63	172.91
NVA-18	2113665.04	583810.65	137.48
NVA-19	2120793.05	564412.45	197.26
NVA-20	1965113.96	522784.43	153.38
NVA-21	2075868.47	512671.14	93.15
NVA-22	1997424.34	510664.99	86.32
NVA-23	2037118.95	481984.61	27.88
NVA-24	2047084.00	483975.04	22.86
NVA-25	2030651.12	523773.45	66.66
NVA-26	2054760.31	531481.79	110.14
NVA-27	2073941.18	606508.74	166.91
NVA-28	2001632.31	489230.81	89.83
NVA-29	2048399.26	576563.60	232.86
NVA-30	1993253.07	473801.49	85.62
NVA-31	1934989.16	507986.01	109.82
NVA-32	2056543.77	568257.05	226.25
NVA-33	2034857.54	534211.47	164.76
NVA-34	2011109.92	536897.06	108.17
NVA-35	2128823.72	556384.86	133.70
NVA-36	2097034.37	532527.36	55.67
NVA-37	2088931.48	522361.02	53.37
NVA-38	2050484.77	541177.66	110.02
NVA-39	2008209.89	522155.63	96.47
NVA-40	2037366.48	513875.66	55.63
NVA-41	2033578.50	500508.51	52.44
NVA-42	2075760.32	466870.04	19.33
NVA-43	2063319.18	465737.73	23.25
NVA-44	1958068.82	519231.06	126.78
NVA-45	2050604.60	504672.47	53.69
NVA-46	2045103.22	521738.18	193.73
NVA-47	2000089.93	524869.28	157.24
NVA-48	2017562.56	514441.80	68.45
NVA-49	2056768.40	513691.93	125.35
NVA-50	2022996.06	513704.99	37.76
NVA-51	2108888.76	553250.09	125.22
NVA-52	2077552.52	540977.66	76.55
NVA-53	1926150.48	504917.11	93.50

NVA-54	2100570.02	550861.07	113.43
NVA-55	2112665.68	567402.53	201.35
NVA-56	2038698.26	564657.12	229.68
NVA-57	2089013.44	522352.05	52.63
NVA-58	2051835.90	510018.68	142.40
NVA-59	1976956.71	484531.04	77.56
NVA-60	1933442.47	493904.20	122.94
NVA-61	1940063.26	504892.45	116.07
NVA-62	1916169.36	491758.71	120.93
NVA-63	1907146.11	479234.76	80.02
NVA-64	1961807.70	476468.08	103.70
NVA-65	2098660.83	498312.65	39.59
NVA-66	2077794.85	571158.40	156.27
NVA-67	1998105.92	475051.87	71.24
NVA-68	2077699.64	512436.09	106.54
NVA-69	2030846.81	521836.20	63.46
NVA-70	2058171.44	532001.27	158.61
NVA-71	2057572.00	567770.86	218.33
NVA-72	2101065.58	546249.58	82.87
NVA-73	2126988.24	556092.60	157.29
NVA-74	2006497.76	521780.56	165.55
NVA-75	2039421.51	513929.03	57.68
NVA-76	2034484.75	501087.93	50.84
NVA-77	2063797.67	463695.97	27.96
NVA-78	1961958.09	522424.51	133.44
NVA-79	2045283.82	527271.94	149.60
NVA-80	2059099.85	513169.42	120.46
NVA-81	2023244.81	517633.00	72.82
NVA-82	2109498.02	552975.73	120.68
NVA-83	2079076.05	541045.90	114.84
NVA-84	2022422.72	579122.24	165.51
NVA-85	2058689.59	526334.57	105.60
NVA-86	2078250.04	516398.83	128.75
NVA-87	2070631.37	606533.92	149.04
NVA-88	2070797.67	559398.76	126.81
NVA-89	2032398.93	532215.76	222.74
NVA-90	2014720.88	530533.62	63.93
VVA-01	2038624.88	564882.12	231.04
VVA-02	2038264.44	564241.02	232.81
VVA-03	2037118.96	565400.28	241.65
VVA-04	2088272.55	522593.50	49.92
VVA-05	2089079.49	522270.57	48.37
VVA-06	2088966.72	522244.15	49.10
VVA-07	2049307.29	500137.38	42.71
VVA-08	2052464.93	506768.20	78.55
VVA-09	2046979.89	500625.72	27.50
VVA-10	1996857.65	508556.34	116.30

VVA-11	1980729.21	481761.67	82.37
VVA-12	1940121.40	494939.90	123.17
VVA-13	1946538.57	498814.68	120.65
VVA-14	1915354.55	493393.78	119.69
VVA-15	1906495.77	476396.55	68.12
VVA-16	1960008.08	483778.89	110.32
VVA-17	1986326.27	524299.18	153.39
VVA-18	2098571.73	499015.78	41.07
VVA-19	2098374.09	498437.28	31.05
VVA-20	2099222.22	498397.42	37.86
VVA-21	2012654.88	556267.94	97.16
VVA-22	2077198.04	571002.70	146.91
VVA-23	2076321.24	570341.45	142.50
VVA-24	1956445.51	510846.92	122.87
VVA-25	2039820.47	569071.84	185.84
VVA-26	1986880.61	525508.46	145.65
VVA-27	1987062.07	528126.74	113.20
VVA-28	2000252.17	479233.76	65.05
VVA-29	2024729.65	485759.96	27.28
VVA-30	1965989.39	522801.03	161.12
VVA-31	2075104.49	514041.80	78.09
VVA-32	1997289.21	506387.15	130.13
VVA-33	1997056.79	500835.77	90.01
VVA-34	2038813.97	482985.24	27.55
VVA-35	2039991.80	487858.42	27.18
VVA-36	2004446.96	485972.70	87.08
VVA-37	2002959.55	485527.27	87.71
VVA-38	2047309.22	575696.76	198.45
VVA-39	1991868.25	474486.67	89.77
VVA-40	2011659.53	540877.69	100.54
VVA-41	2011341.37	539456.60	110.77
VVA-42	2126856.22	553369.03	83.65
VVA-43	2093891.90	532356.23	55.98
VVA-44	2006936.66	516392.63	73.28
VVA-45	2036848.47	495155.27	23.91
VVA-46	2035694.53	500180.89	47.15
VVA-47	2071178.53	466763.20	18.79
VVA-48	2065974.65	467493.39	29.29
VVA-49	2072975.18	465801.81	22.06
VVA-50	1996492.07	524975.20	156.18
VVA-51	2059623.61	511448.65	129.34
VVA-52	2053767.30	513808.00	148.13
VVA-53	1924578.49	499469.22	114.02
VVA-54	2016122.14	576273.72	119.28
VVA-55	1970986.98	487380.91	96.28
VVA-56	2078669.43	481029.50	22.40
VVA-57	2046969.51	606113.63	198.37

VVA-58	1972726.27	508499.73	119.29
VVA-59	1960904.78	507467.91	124.95
VVA-60	1930960.86	478491.70	105.15
VVA-61	2094497.16	545710.15	130.53
VVA-62	2058532.32	524164.92	85.37
VVA-63	2027250.14	545924.66	104.66
VVA-64	2008173.48	560254.00	155.21
VVA-65	2010026.91	559315.68	144.94
VVA-66	2057950.81	547370.83	173.64
VVA-67	2066213.23	554876.17	72.08
VVA-68	1931696.64	499887.09	117.39
VVA-69	2099344.01	563725.79	140.17
VVA-70	2119987.71	580215.02	160.73
VVA-71	2120551.86	580702.15	135.56
VVA-72	2112372.78	601950.21	99.90
VVA-73	2091032.95	581639.34	168.74
VVA-74	2071180.17	588562.86	121.35
VVA-75	2072617.86	590834.04	103.07
VVA-76	2033006.50	610233.35	137.65
VVA-77	1958899.34	494986.80	111.87
VVA-78	1914135.44	491599.40	112.58
VVA-79	2092148.67	467999.97	30.70
VVA-80	1947427.78	509914.21	119.50
VVA-81	1932712.12	484827.50	106.60
VVA-82	2080087.73	483925.74	21.30
VVA-83	2115808.32	567142.26	181.13
VVA-84	2111345.55	597451.65	98.13
VVA-85	2072227.36	594351.22	139.27
VVA-86	2096111.50	559564.83	184.75
VVA-87	2037609.46	599334.79	193.95
VVA-88	2064578.47	604299.60	145.34
VVA-89	2026816.62	489004.04	22.00
VVA-90	2039097.64	489971.61	37.04
VVA-91	2094536.54	546051.37	131.28
VVA-92	2094145.70	543188.68	167.93
VVA-93	2012022.71	538906.45	136.61
VVA-94	2109433.44	578923.67	236.11
VVA-95	2109741.49	577329.27	239.19
VVA-96	2094424.33	590976.27	148.13
VVA-97	2092931.67	590361.13	155.99
VVA-98	2027770.71	545484.31	101.20
VVA-99	2027633.19	546491.81	97.45
VVA-100	2028505.39	517551.44	68.81

Table 6: NAD83 (2011) State Plane Florida North surveyed accuracy checkpoints

The figure below shows the location of the QA/QC checkpoints used to test the positional accuracy of the dataset.

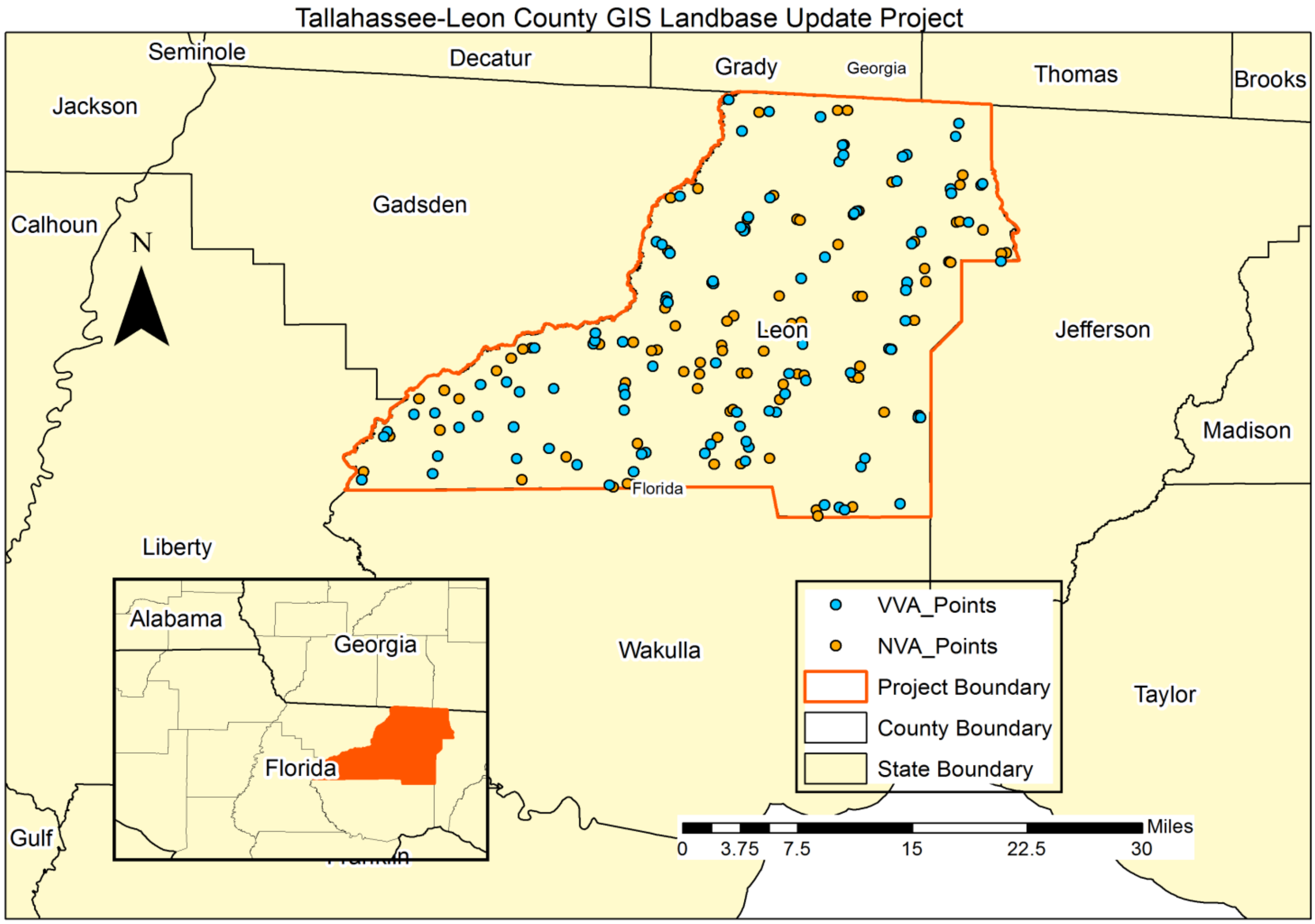


Figure 20 – Location of QA/QC Checkpoints

VERTICAL ACCURACY TEST PROCEDURES

NVA (Non-vegetated Vertical Accuracy) is determined with check points located only in non-vegetated terrain, including open terrain (grass, dirt, sand, and/or rocks) and urban areas, where there is a very high probability that the lidar sensor will have detected the bare-earth ground surface and where random errors are expected to follow a normal error distribution. The NVA determines how well the calibrated lidar sensor performed. With a normal error distribution, the vertical accuracy at the 95% confidence level is computed as the vertical root mean square error ($RMSE_z$) of the checkpoints x 1.9600. For the Tallahassee-Leon County GIS Landbase Update Project, vertical accuracy must be 9.8 cm or less based on an $RMSE_z$ of 5 cm x 1.9600.

VVA (Vegetated Vertical Accuracy) is determined with all checkpoints in vegetated land cover categories, including tall grass, weeds, crops, brush and low trees, and fully forested areas, where there is a possibility that the lidar sensor and post-processing may yield elevation errors that do not follow a normal error distribution. VVA at the 95% confidence level equals the 95^{th} percentile error for all checkpoints in all vegetated land cover categories combined. The Tallahassee-Leon County GIS Landbase Update Project VVA standard is 14.7 cm based on the 95^{th} percentile. The

VVA is accompanied by a listing of the 5% outliers that are larger than the 95th percentile used to compute the VVA; these are always the largest outliers that may depart from a normal error distribution. Here, $Accuracy_z$ differs from VVA because $Accuracy_z$ assumes elevation errors follow a normal error distribution where RMSE procedures are valid, whereas VVA assumes lidar errors may not follow a normal error distribution in vegetated categories, making the RMSE process invalid.

The relevant testing criteria are summarized in Table 7.

Quantitative Criteria	Measure of Acceptability
Non-Vegetated Vertical Accuracy (NVA) in open terrain and urban land cover categories using $RMSE_z$ *1.9600	9.8 cm (based on $RMSE_z$ (5 cm) * 1.9600)
Vegetated Vertical Accuracy (VVA) in all vegetated land cover categories combined at the 95% confidence level	14.7 cm (based on combined 95th percentile)

Table 7 — Acceptance Criteria

The primary QA/QC vertical accuracy testing steps used by Dewberry are summarized as follows:

1. Dewberry's team surveyed QA/QC vertical checkpoints in accordance with the project's specifications.
2. Next, Dewberry interpolated the bare-earth lidar DTM to provide the z-value for every checkpoint.
3. Dewberry then computed the associated z-value differences between the interpolated z-value from the lidar data and the ground truth survey checkpoints and computed NVA, VVA, and other statistics.
4. The data were analyzed by Dewberry to assess the accuracy of the data. The review process examined the various accuracy parameters as defined by the scope of work. The overall descriptive statistics of each dataset were computed to assess any trends or anomalies. This report provides tables, graphs and figures to summarize and illustrate data quality.

VERTICAL ACCURACY RESULTS

The table below summarizes the tested vertical accuracy resulting from a comparison of the surveyed checkpoints to the elevation values present within the fully classified lidar LAS files.

Land Cover Category	# of Points	NVA — Non-vegetated Vertical Accuracy ($RMSE_z$ x 1.9600) Spec= 0.32 ft	VVA — Vegetated Vertical Accuracy (95th Percentile) Spec=0.48 ft
NVA	90	0.24	
VVA	99		0.28

Table 8 — Tested NVA and VVA

Out of the 189 checkpoints received from the surveyor, one was determined to be located outside of the project boundary.

Point ID	NAD83 (2011) State Plane Florida North		NAVD88 (Geoid 12B)	DEM Z (m)	Delta Z	AbsDeltaZ
	Easting X (m)	Northing Y (m)	Survey Z (m)			
VVA-42	2126856.22	553369.03	83.65	0.00	-83.654	83.65

Table 9 — Checkpoint omitted from the Vertical Accuracy Testing.

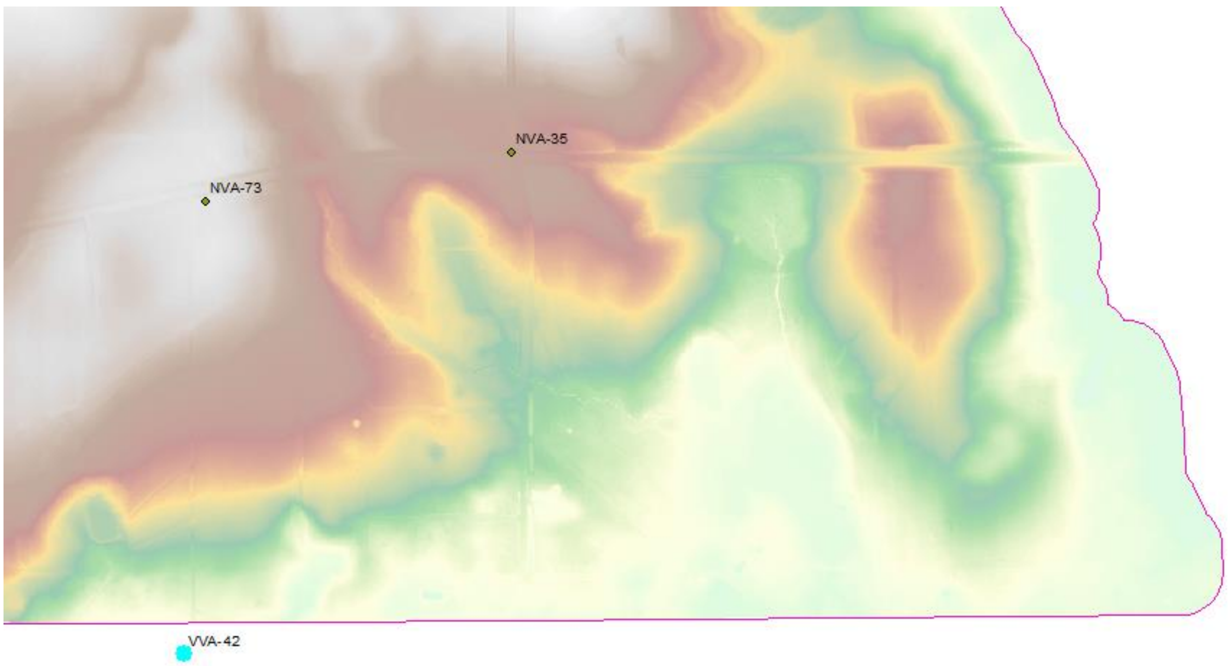


Figure 21 – Shows the location of the excluded point (VVA-42). The project boundary is represented by the purple line.

This lidar dataset was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 5 cm (0.16 ft) RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to be $RMSE_z$ = 3.7 cm (0.12 ft), equating to +/- 7.3 cm (0.24 ft) at 95% confidence level. Actual VVA accuracy was found to be +/- 9 cm (0.28 ft) at the 95th percentile.

The figure below illustrates the magnitude of the differences between the QA/QC checkpoints and lidar data. This shows that the majority of lidar elevations were within +/- 6.1 cm (0.2 ft) of the checkpoints elevations, but there were some outliers where lidar and checkpoint elevations differed by up to + 12.5 cm (0.41 ft).

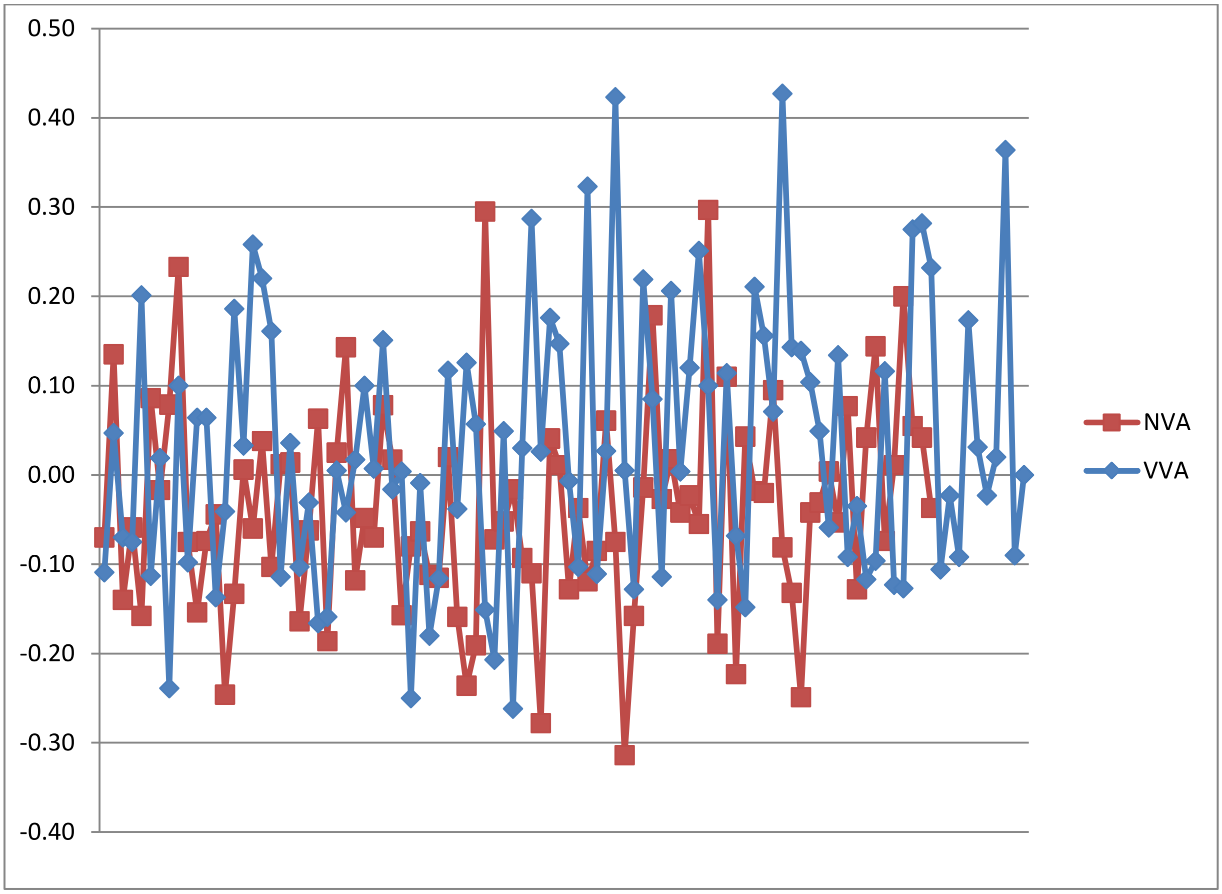


Figure 22 – Magnitude of elevation discrepancies per land cover category

Table 10 lists the 5% outliers that are larger than the VVA 95th percentile.

Point ID	NAD83 (2011) State Plane Florida North		NAVD88 (Geoid 12B)	Lidar Z (ft)	Delta Z	AbsDeltaZ
	Easting X (ft)	Northing Y (ft)	Survey Z (ft)			
VVA-82	2080087.73	483925.74	21.30	21.62	0.32	0.32
VVA-85	2072227.36	594351.22	139.27	139.69	0.42	0.42
VVA-97	2092931.67	590361.13	155.986	156.35	0.36	0.36
VVA-19	2098374.09	498437.28	31.053	31.48	0.43	0.43
VVA-51	2059623.61	511448.65	129.343	129.63	0.29	0.29

Table 10 — 5% Outliers

Table 11 provides overall descriptive statistics.

100 % of Totals	# of Points	RMSEz (ft) NVA Spec=0.16 ft	Mean (ft)	Median (ft)	Skew	Std Dev (ft)	Kurtosis	Min (ft)	Max (ft)
Bare Ground	90	0.12	-0.04	-0.05	0.41	0.12	0.67	-0.31	0.30
NVA	**90.00**	**0.12**	**-0.04**	**-0.05**	**0.41**	**0.12**	**0.67**	**-0.31**	**0.30**
Forested	35.00	0.12	0.00	0.00	0.15	0.13	-0.35	-0.25	0.26
Short Brush	33.00	0.16	0.05	0.03	0.62	0.16	-0.43	-0.15	0.43
Tall Brush	31.00	0.17	0.04	0.03	0.24	0.16	-0.34	-0.26	0.42
VVA	**99.00**	**N/A**	**0.03**	**0.02**	**0.44**	**0.15**	**-0.19**	**-0.26**	**0.43**

Table 11 — Overall Descriptive Statistics

The figure below illustrates a histogram of the associated elevation discrepancies between the QA/QC checkpoints and elevations interpolated from the lidar triangulated irregular network (TIN). The frequency shows the number of discrepancies within each band of elevation differences. Although the discrepancies vary between a low of -0.31 feet (9.5 cm) and a high of +0.43 feet (13.1 cm), the histogram shows that the majority of the discrepancies are skewed on the negative side. The vast majority of points are within the ranges of -0.12 (3.7 cm) feet to +0.12 feet (3.7 cm).

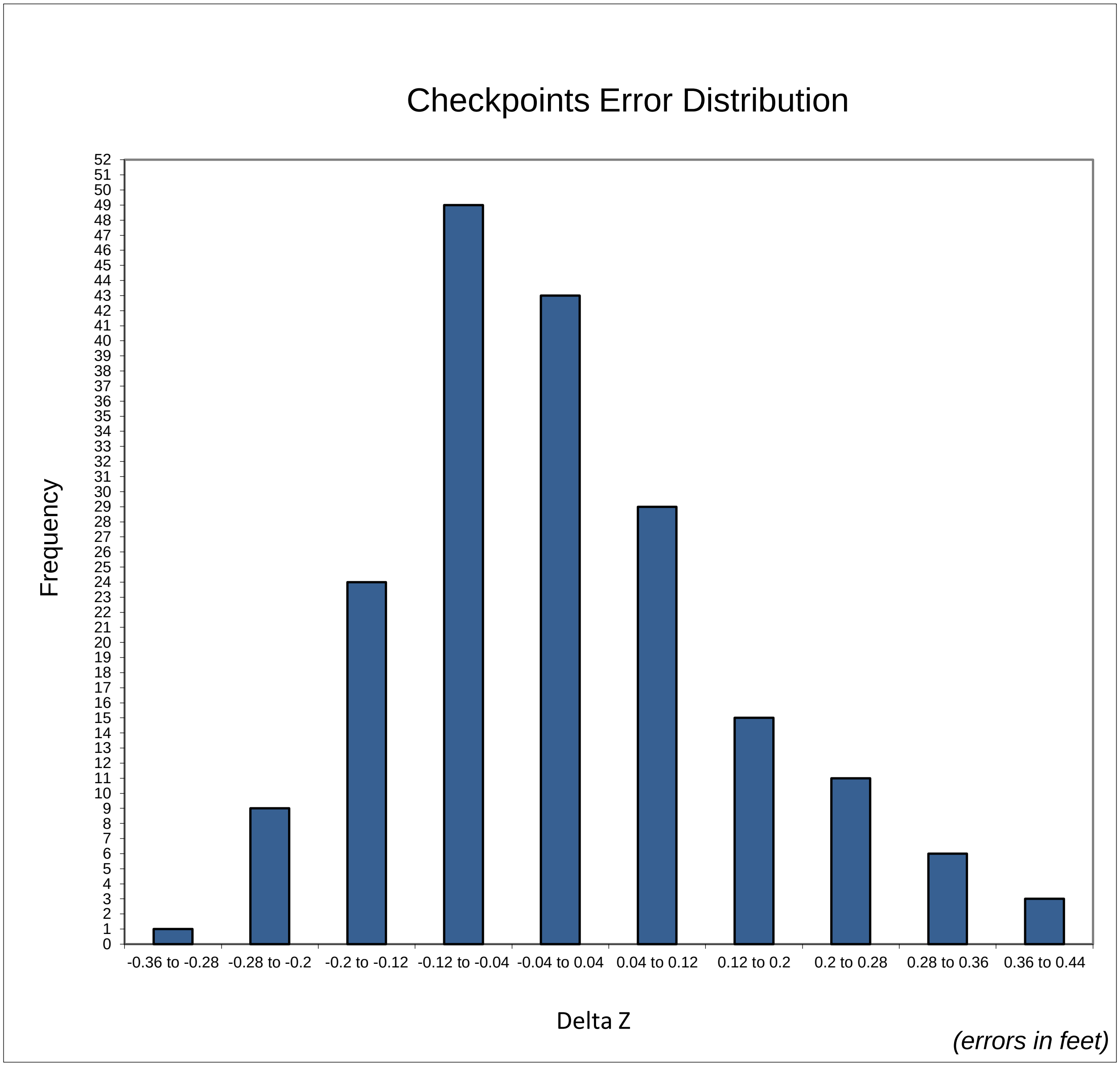


Figure 23 – Histogram of Elevation Discrepancies with errors in feet

Based on the vertical accuracy testing conducted by Dewberry, the lidar dataset for the Tallahassee-Leon County GIS Landbase Update Project satisfies the project's pre-defined vertical accuracy criteria.

HORIZONTAL ACCURACY TEST PROCEDURES

Horizontal accuracy testing requires well-defined checkpoints that can be identified in the dataset. Elevation datasets, including lidar datasets, do not always contain well-defined checkpoints suitable for horizontal accuracy assessment. However, the ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) recommends at least half of the NVA vertical check points should be located at the ends of paint stripes or other point features visible on the lidar intensity image, allowing them to double as horizontal check points.

Dewberry reviews all NVA checkpoints to determine which, if any, of these checkpoints are located on photo-identifiable features in the intensity imagery. This subset of checkpoints are then used for horizontal accuracy testing.

The primary QA/QC horizontal accuracy testing steps used by Dewberry are summarized as follows:

1. Dewberry's team surveyed QA/QC vertical checkpoints in accordance with the project's specifications and tried to locate half of the NVA checkpoints on features photo-identifiable in the intensity imagery.
2. Next, Dewberry identified the well-defined features in the intensity imagery.
3. Dewberry then computed the associated xy-value differences between the coordinates of the well-defined feature in the lidar intensity imagery and the ground truth survey checkpoints.
4. The data were analyzed by Dewberry to assess the accuracy of the data. Horizontal accuracy was assessed using NSSDA methodology where horizontal accuracy is calculated at the 95% confidence level. This report provides the results of the horizontal accuracy testing.

HORIZONTAL ACCURACY RESULTS

Fourty checkpoints were determined to be photo-identifiable in the intensity imagery and were used to test the horizontal accuracy of the lidar dataset. As (40) checkpoints were photo-identifiable, the results are statistically significant enough to report as a final tested value, and the results of the testing are shown in the Table below.

Using NSSDA methodology (endorsed by the ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014)), horizontal accuracy at the 95% confidence level (called ACCURACYr) is computed by the formula RMSEr * 1.7308 or RMSExy * 2.448.

This project was required to meet a horizontal accuracy of 3.28 ft (1 m) or less at the 95% confidence level.

# of Points	$RMSE_x$ (Spec=1.34 ft)	$RMSE_y$ (Spec =1.34 ft)	$RMSE_r$ (Spec =1.9 ft)	$ACCURACY_r$ ($RMSE_r$ x 1.7308) Spec =3.28 ft
40	0.50	0.44	0.67	1.15

Table 12-Tested horizontal accuracy at the 95% confidence level

This data set was produced to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 41 cm RMSEx/RMSEy Horizontal Accuracy Class which equates to Positional Horizontal Accuracy = +/- 1 meter at a 95% confidence level. Forty (40) checkpoints were photo-identifiable but do not produce a statistically significant tested horizontal accuracy value. Using this statistically significant sample set of photo-identifiable checkpoints, positional accuracy of this dataset was found to be RMSEx = 0.5 ft (15.2 cm) and RMSEy = 0.44 ft (13.4 cm) which equates to +/- 1.15 ft (35 cm) at 95% confidence level.

Breakline Production & Qualitative Assessment Report

BREAKLINE PRODUCTION METHODOLOGY

Dewberry used a combination of lidargrammetry and automated techniques to collect breaklines for this project. The delineation of lakes and ponds, or other water bodies at a constant elevation, was achieved using eCognition software. Dewberry produced full point cloud intensity imagery, bare earth ground models, density models, and slope models. These files were ingested into eCognition, segmented into polygons, and training samples were created to identify water. eCognition used the training samples and defined parameters to identify water segments throughout the project area. Water segments were then reviewed for completeness. Segments identified as lakes and ponds were merged and smoothed. 3D elevations were then applied to these breakline features.

Lidargrammetry was used to monotonically collect streams and rivers, or features that have gradient 3D elevations. Features were first collected in 2D, then had elevations applied to them through conflation of the lidar-derived terrain.

All drainage breaklines are monotonically enforced to show downhill flow. Water bodies are at a constant elevation where the lowest elevation of the water body has been applied to the entire water body.

BREAKLINE QUALITATIVE ASSESSMENT

Dewberry completed breakline qualitative assessments according to a defined workflow. The following workflow diagram represents the steps taken by Dewberry to provide a thorough qualitative assessment of the breakline data.

Completeness and horizontal placement is verified through visual reviews against lidar intensity imagery. Automated checks are applied on all breakline features to validate topology, including the 3D connectivity of features, enforced monotonicity on linear hydrographic breaklines, and flatness on water bodies.

The next step is to compare the elevation of the breakline vertices against the ground elevation extracted from the ESRI Terrain built from the lidar ground points, keeping in mind that a discrepancy is expected because of the hydro-enforcement applied to the breaklines and because of the interpolated imagery used to acquire the breaklines. A given tolerance is used to validate if the elevations differ too much from the lidar.

After all corrections and edits to the breakline features, the breaklines are imported into the final GDB and verified for correct formatting.

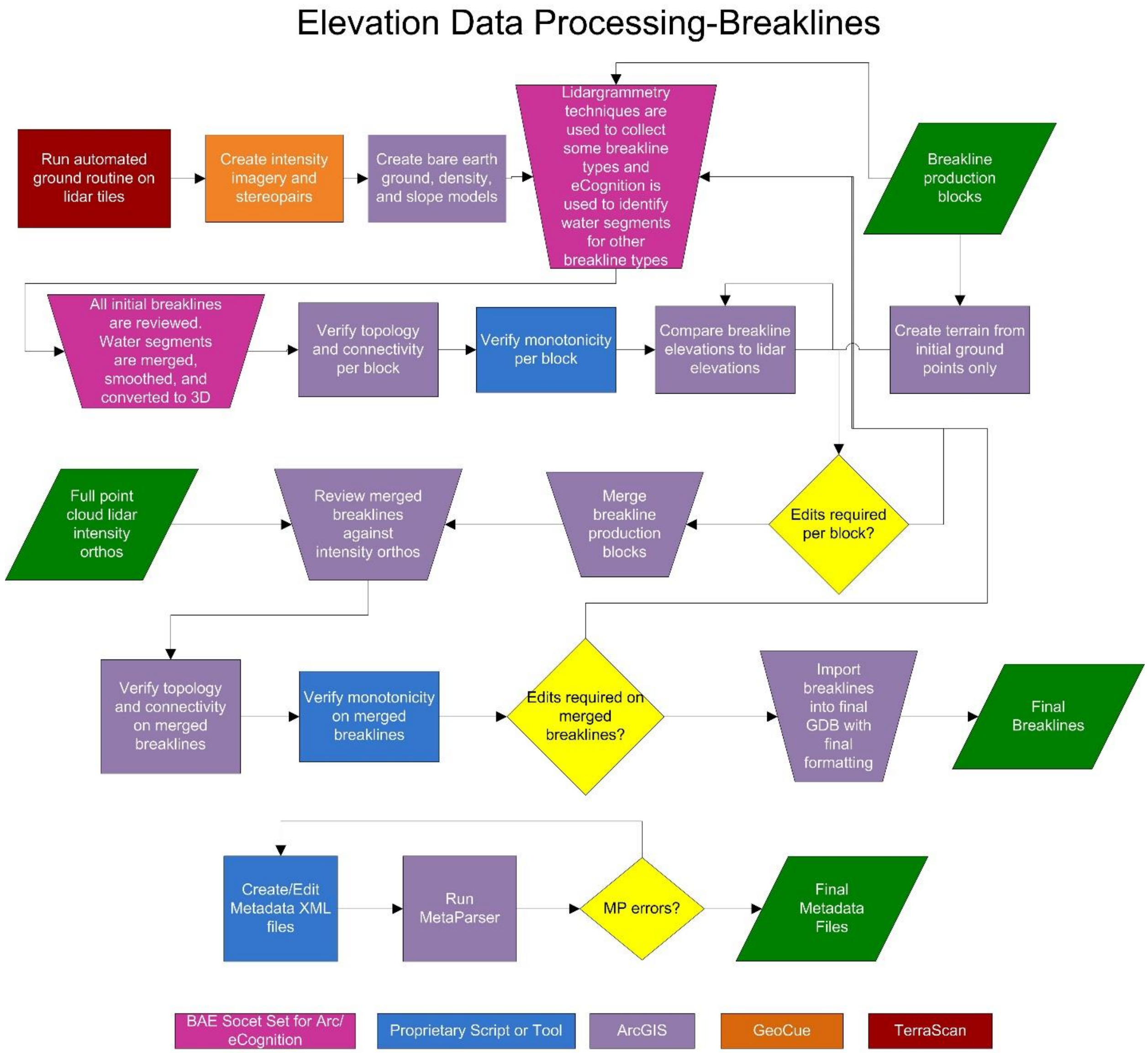


Figure 24-Breakline QA/QC workflow

BREAKLINE CHECKLIST

The following table represents a portion of the high-level steps in Dewberry's Production and QA/QC checklist that were performed for this project.

Pass/Fail	Validation Step
Pass	Use lidar-derived data, which may include intensity imagery, stereo pairs, bare earth ground models, density models, slope models, and terrains, to collect breaklines according to project specifications.
Pass	In areas of heavy vegetation or where the exact shoreline is hard to delineate, it is better to err on placing the breakline *slightly* inside or seaward of the shoreline (breakline can be inside shoreline by 1x-2x NPS).

Pass	After each producer finishes breakline collection for a block, each producer must perform a completeness check, breakline variance check, and all automated checks on their block before calling that block complete and ready for the final merge and QC
Pass	After breaklines are completed for production blocks, all production blocks should be merged together and completeness and automated checks should be performed on the final, merged GDB. Ensure correct snapping-horizontal (x,y) and vertical (z)-between all production blocks.
Pass	Check entire dataset for missing features that were not captured, but should be to meet baseline specifications or for consistency. Features should be collected consistently across tile bounds. Check that the horizontal placement of breaklines is correct. Breaklines should be compared to full point cloud intensity imagery and terrains
Pass	Breaklines are correctly edge-matched to adjoining datasets in completion, coding, and horizontal placement.
Pass	Using a terrain created from lidar ground (all ground including 2, 8, and 20) and water points (class 9), compare breakline Z values to interpolated lidar elevations.
Pass	Perform all Topology and Data Integrity Checks
Pass	Perform hydro-flattening and hydro-enforcement checks including monotonicity and flatness from bank to bank on linear hydrographic features and flatness of water bodies. Tidal waters should preserve as much ground as possible and can include variations or be non-monotonic.

Table 13-A subset of the high-level steps from Dewberry's Production and QA/QC checklist performed for this project.

Hydrographic Network

SINGLE LINE STREAMS

Single line drains (SLD) will be generated from the bare ground DEM. The Single line drains will connect to the rivers, lakes, and ponds at locations similar to the 2015 breakline data where applicable to complete the county-wide hydrographic network.

HYDRO POLYGONS

Hydro_Polys includes compiled rivers with a width greater than 10 feet, compiled water bodies, and hidden rivers greater than 10 feet in width.

Features are attributed with River, Stream, Lake, Hidden River, or Hidden Stream in the TYPE field and the DXF_LAYER field.

HYDRO LINES

Hydro_Lines includes compiled rivers with a width greater than 10 feet, compiled water bodies, single line streams, and hidden streams and rivers.

Features are attributed with River, Stream, Lake, Hidden River, or Hidden Stream in the TYPE field and the DXF_LAYER field.

Data Dictionary

The following data dictionary was used for this project.

HORIZONTAL AND VERTICAL DATUM

The horizontal datum shall be North American Datum of 1983(2011), Units in U.S. Survey Feet. The vertical datum shall be referenced to the North American Vertical Datum of 1988 (NAVD 88), Units in U.S. Survey Feet. Geoid12B shall be used to convert ellipsoidal heights to orthometric heights.

COORDINATE SYSTEM AND PROJECTION

All data shall be projected to Florida State Plane North (U.S. Survey Feet).

INLAND STREAMS AND RIVERS

Feature Dataset: Breaklines
Feature Type: Polygon
Contains Z Values: Yes
XY Resolution: Accept Default Setting
XY Tolerance: 0.003

Feature Class: Rivers_Streams
Contains M Values: No
Annotation Subclass: None
Z Resolution: Accept Default Setting
Z Tolerance: 0.001

Description

This polygon feature class will depict linear hydrographic features with a width greater than 10 feet.

Table Definition

Field Name	Data Type	Allow Null Values	Default Value	Domain	Precision	Scale	Length	Responsibility
OBJECTID	Object ID							Assigned by Software
SHAPE	Geometry							Assigned by Software
SHAPE_LENGTH	Double	Yes			0	0		Calculated by Software
SHAPE_AREA	Double	Yes			0	0		Calculated by Software

Feature Definition

Description	Definition	Capture Rules
Streams and Rivers	Linear hydrographic features such as streams, rivers, canals, etc. with an average width greater than 10 feet. In the case of embankments, if the feature forms a natural dual line channel, then capture it consistent with the capture rules. Other natural or manmade embankments will not qualify for this project.	Capture features showing dual line (one on each side of the feature). Average width shall be greater than 10 feet to show as a double line. Each vertex placed should maintain vertical integrity. Generally both banks shall be collected to show consistent downhill flow. There are exceptions to this rule where a small branch or offshoot of the stream or river is present. The banks of the stream must be captured at the same elevation to ensure flatness of the water feature. If the elevation of the banks appears to be different see the task manager or PM for further guidance. Breaklines must be captured at or just below the elevations of the immediately surrounding terrain. Under no circumstances should a feature be elevated above the

		surrounding lidar points. Acceptable variance in the negative direction will be defined for each project individually. These instructions are only for docks or piers that follow the coastline or water's edge, not for docks or piers that extend perpendicular from the land into the water. If it can be reasonably determined where the edge of water most probably falls, beneath the dock or pier, then the edge of water will be collected at the elevation of the water where it can be directly measured. If there is a clearly-indicated headwall or bulkhead adjacent to the dock or pier and it is evident that the waterline is most probably adjacent to the headwall or bulkhead, then the water line will follow the headwall or bulkhead at the elevation of the water where it can be directly measured. If there is no clear indication of the location of the water's edge beneath the dock or pier, then the edge of water will follow the outer edge of the dock or pier as it is adjacent to the water, at the measured elevation of the water. Every effort should be made to avoid breaking a stream or river into segments. Dual line features shall break at road crossings (culverts). In areas where a bridge is present the dual line feature shall continue through the bridge. Islands: The double line stream shall be captured around an island if the island is greater than 1 acre. In this case a segmented polygon shall be used around the island in order to allow for the island feature to remain as a "hole" in the feature.

INLAND PONDS AND LAKES

Feature Dataset: Breaklines
Feature Type: Polygon
Contains Z Values: Yes
XY Resolution: Accept Default Setting
XY Tolerance: 0.003

Feature Class: Ponds_Lakes
Contains M Values: No
Annotation Subclass: None
Z Resolution: Accept Default Setting
Z Tolerance: 0.001

Description

This polygon feature class will depict closed water body features that are at a constant elevation.

Table Definition

Field Name	Data Type	Allow Null Values	Default Value	Domain	Precision	Scale	Length	Responsibility
OBJECTID	Object ID							Assigned by Software
SHAPE	Geometry							Assigned by Software
SHAPE_LENGTH	Double	Yes			0	0		Calculated by Software
SHAPE_AREA	Double	Yes			0	0		Calculated by Software

Feature Definition

Description	Definition	Capture Rules
Ponds and Lakes	Land/Water boundaries of constant elevation water bodies such as lakes, reservoirs, ponds, etc. Features shall be defined as closed polygons and contain an elevation value that reflects the best estimate of the water elevation at the time of data capture. Water body features will be captured for features 0.25 acres in size or greater. “Donuts” will exist where there are islands within a closed water body feature.	Water bodies shall be captured as closed polygons with the water feature to the right. The compiler shall take care to ensure that the z-value remains consistent for all vertices placed on the water body. Breaklines must be captured at or just below the elevations of the immediately surrounding terrain. Under no circumstances should a feature be elevated above the surrounding lidar points. Acceptable variance in the negative direction will be defined for each project individually. An Island within a Closed Water Body Feature that is 0.25 acres in size or greater will also have a “donut polygon” compiled. These instructions are only for docks or piers that follow the coastline or water’s edge, not for docks or piers that extend perpendicular from the land into the water. If it can be reasonably determined where the edge of water most probably falls, beneath the dock or pier, then the edge of water will be collected at the elevation of the water where it can be directly measured. If there is a clearly-indicated headwall or bulkhead adjacent to the dock or pier and it is evident that the waterline is most probably adjacent to the headwall or bulkhead, then the water line

		will follow the headwall or bulkhead at the elevation of the water where it can be directly measured. If there is no clear indication of the location of the water's edge beneath the dock or pier, then the edge of water will follow the outer edge of the dock or pier as it is adjacent to the water, at the measured elevation of the water.

BENEATH BRIDGE BREAKLINES

Feature Dataset: Breaklines
Feature Type: Polyline
Contains Z Values: Yes
XY Resolution: Accept Default Setting
XY Tolerance: 0.003

Feature Class: Bridge_Saddle_Breaklines
Contains M Values: No
Annotation Subclass: None
Z Resolution: Accept Default Setting
Z Tolerance: 0.001

Description

This polyline feature class is used to enforce terrain beneath bridge decks where ground data may not have been acquired. Enforcing the terrain beneath bridge decks prevents bridge saddles.

Table Definition

Field Name	Data Type	Allow Null Values	Default Value	Domain	Precision	Scale	Length	Responsibility
OBJECTID	Object ID							Assigned by Software
SHAPE	Geometry							Assigned by Software
SHAPE_LENGTH	Double	Yes			0	0		Calculated by Software

Feature Definition

Description	Definition	Capture Rules
Bridge Saddle Breaklines	Bridge Saddle Breaklines should be used where necessary to enforce terrain beneath bridge decks and to prevent bridge saddles in the bare earth DEMs.	Bridge saddle breaklines should be collected beneath bridges where bridge saddles exist or are likely to exist in the bare earth DEMs. Bridge saddle breaklines should be collected perpendicular to the bridge deck so that the endpoints are on either side of the bridge deck. Typically two bridge saddle breaklines are collected per bridge deck, one at either end of the bridge deck to enforce the terrain under the full bridge deck. The endpoints of the bridge breaklines will match the elevation of the ground at their xy position to enforce the ground/bare earth elevations beneath the bridge deck and prevent bridge saddles from forming.

HYDRO_POLYS

Feature Dataset: Planimetric
Feature Type: Polygon
Contains Z Values: No
XY Resolution: Accept Default Setting
XY Tolerance: 0.003

Feature Class: Hydro_Polys
Contains M Values: No
Annotation Subclass: None
Z Resolution: Accept Default Setting
Z Tolerance: 0.001

Description

This polygon feature class will depict all hydrographic features as 2D polygons.

Table Definition

Field Name	Data Type	Allow Null Values	Default Value	Domain	Precision	Scale	Length	Responsibility
OBJECTID	Object ID							Assigned by Software
SHAPE	Geometry							Assigned by Software
TYPE	String	No	River					Assigned by Analyst
DXF_LAYER	String	No	RIVER					Assigned by Analyst
ELEV	Double	Yes						Assigned by Analyst
MAP_DATE	String	Yes						Assigned by Analyst
SHAPE_LENGTH	Double	Yes			0	0		Calculated by Software
SHAPE_AREA	Double	Yes			0	0		Calculated by Software

Feature Definition

Description	Definition	Capture Rules
Hydro_Polys	Land/Water boundaries of constant elevation water bodies such as lakes, reservoirs, ponds, etc. Linear hydrographic features such as streams, rivers, canals, etc. with an average width greater than 10 feet. Hidden rivers/streams that pass through culverts. Features shall be defined as closed polygons and lakes contain an elevation value that reflects the best estimate of the water elevation at the time of data capture in the ELEV field. Lake features will be captured for features 0.25 acres in size or greater.	Water bodies, streams and rivers shall be captured as closed polygons with the water feature to the right. An Island within a Closed Water Body Feature that is 0.25 acres in size or greater will also have a “donut polygon” compiled. These instructions are only for docks or piers that follow the coastline or water’s edge, not for docks or piers that extend perpendicular from the land into the water. If it can be reasonably determined where the edge of water most probably falls, beneath the dock or pier, then the edge of water will be collected at the elevation of the water where it can be directly measured. If there is a clearly-indicated headwall or bulkhead adjacent to the dock or pier and it is evident that the waterline is most probably adjacent to the headwall or bulkhead, then the water line

	"Donuts" will exist where there are islands within a closed water body feature.	will follow the headwall or bulkhead at the elevation of the water where it can be directly measured. If there is no clear indication of the location of the water's edge beneath the dock or pier, then the edge of water will follow the outer edge of the dock or pier as it is adjacent to the water, at the measured elevation of the water.

HYDRO_LINES

Feature Dataset: Planimetric
Feature Type: Polyline
Contains Z Values: No
XY Resolution: Accept Default Setting
XY Tolerance: 0.003

Feature Class: Hydro_Lines
Contains M Values: No
Annotation Subclass: None
Z Resolution: Accept Default Setting
Z Tolerance: 0.001

Description

This line feature class will depict all hydrographic features as 2D lines.

Table Definition

Field Name	Data Type	Allow Null Values	Default Value	Domain	Precision	Scale	Length	Responsibility
OBJECTID	Object ID							Assigned by Software
SHAPE	Geometry							Assigned by Software
TYPE	String	No	River					Assigned by Analyst
DXF_LAYER	String	No	RIVER					Assigned by Analyst
MAP_DATE	String	Yes						Assigned by Analyst
SHAPE_LENGTH	Double	Yes			0	0		Calculated by Software

Feature Definition

Description	Definition	Capture Rules
Hydro_Lines	Land/Water boundaries of constant elevation water bodies such as lakes, reservoirs, ponds, etc. Linear hydrographic features such as streams, rivers, canals, etc. with an average width greater than 10 feet. Hidden rivers/streams that pass through culverts. Features shall be defined as closed lines. Lake features will be captured for features 0.25 acres in size or greater.	Water bodies, streams and rivers shall be captured as closed lines. An Island within a Closed Water Body Feature that is 0.25 acres in size or greater will also have a "donut polygon" compiled. These instructions are only for docks or piers that follow the coastline or water's edge, not for docks or piers that extend perpendicular from the land into the water. If it can be reasonably determined where the edge of water most probably falls, beneath the dock or pier, then the edge of water will be collected at the elevation of the water

	"Donuts" will exist where there are islands within a closed water body feature.	where it can be directly measured. If there is a clearly-indicated headwall or bulkhead adjacent to the dock or pier and it is evident that the waterline is most probably adjacent to the headwall or bulkhead, then the water line will follow the headwall or bulkhead at the elevation of the water where it can be directly measured. If there is no clear indication of the location of the water's edge beneath the dock or pier, then the edge of water will follow the outer edge of the dock or pier as it is adjacent to the water, at the measured elevation of the water.

BREAKLINES

Feature Dataset: Topographic
Feature Type: Polyline Z
Contains Z Values: Yes
XY Resolution: Accept Default Setting
XY Tolerance: 0.003

Feature Class: Breaklines
Contains M Values: No
Annotation Subclass: None
Z Resolution: Accept Default Setting
Z Tolerance: 0.001

Description

This line feature class will depict all hydrographic features as lines at their compiled elevation.

Table Definition

Field Name	Data Type	Allow Null Values	Default Value	Domain	Precision	Scale	Length	Responsibility
OBJECTID	Object ID							Assigned by Software
SHAPE	Geometry							Assigned by Software
DXF_LAYER	String	No	RIVER					Assigned by Analyst
MAP_DATE	String	Yes						Assigned by Analyst
SHAPE_LENGTH	Double	Yes			0	0		Calculated by Software

Feature Definition

Description	Definition	Capture Rules
Breaklines	Land/Water boundaries of constant elevation water bodies such as lakes, reservoirs, ponds, etc. Linear hydrographic features such as streams, rivers, canals, etc. with an average width greater than 10 feet. Hidden rivers/streams that pass through culverts. Features shall be defined as closed lines. Lake features will be captured for features 0.25 acres in size or greater.	Water bodies, streams and rivers shall be captured as closed lines. An Island within a Closed Water Body Feature that is 0.25 acres in size or greater will also have a "donut polygon" compiled. These instructions are only for docks or piers that follow the coastline or water's edge, not for docks or piers that extend perpendicular from the land into the water. If it can be reasonably determined where the edge of water most probably falls, beneath the dock or pier, then the edge of water will be collected at the elevation of the water

	"Donuts" will exist where there are islands within a closed water body feature.	where it can be directly measured. If there is a clearly-indicated headwall or bulkhead adjacent to the dock or pier and it is evident that the waterline is most probably adjacent to the headwall or bulkhead, then the water line will follow the headwall or bulkhead at the elevation of the water where it can be directly measured. If there is no clear indication of the location of the water's edge beneath the dock or pier, then the edge of water will follow the outer edge of the dock or pier as it is adjacent to the water, at the measured elevation of the water.

DEM Production & Qualitative Assessment

DEM PRODUCTION METHODOLOGY

Dewberry utilized ESRI software and Global Mapper for the DEM production and QC process. ArcGIS software is used to generate the products and the QC is performed in both ArcGIS and Global Mapper. The figure below shows the entire process necessary for bare earth DEM production, starting from the lidar swath processing.

The final bare-earth lidar points are used to create a terrain. The final 3D breaklines collected for the project are also enforced in the terrain. The terrain is then converted to raster format using linear interpolation. For most projects, a single terrain/DEM can be created for the whole project. For very large projects, multiple terrains/DEMs may be created. The DEM(s) is reviewed for any issues requiring corrections, including remaining lidar mis-classifications, erroneous breakline elevations, poor hydro-flattening or hydro-enforcement, and processing artifacts. After corrections are applied, the DEM(s) is then split into individual tiles following the project tiling scheme. The tiles are verified for final formatting and then loaded into Global Mapper to ensure no missing or corrupt tiles and to ensure seamlessness across tile boundaries.

Figure 25-DEM Production Workflow

DEM QUALITATIVE ASSESSMENT

Dewberry performed a comprehensive qualitative assessment of the bare earth DEM deliverables to ensure that all tiled DEM products were delivered with the proper extents, were free of processing artifacts, and contained the proper referencing information. This process was performed in ArcGIS software with the use of a tool set Dewberry has developed to verify that the raster extents match those of the tile grid and contain the correct projection information. The DEM data was reviewed at a scale of 1:5000 to review for artifacts caused by the DEM generation process and to review the hydro-flattened features. To perform this review Dewberry creates HillShade models and overlays a partially transparent colorized elevation model to review for these issues. All corrections are completed using Dewberry's proprietary correction workflow. Upon completion of the corrections, the DEM data is loaded into Global Mapper for its second review and to verify corrections. Once the DEMs are tiled out, the final tiles are again loaded into Global Mapper to ensure coverage, extents, and that the final tiles are seamless.

The images below show an example of a bare earth DEM.

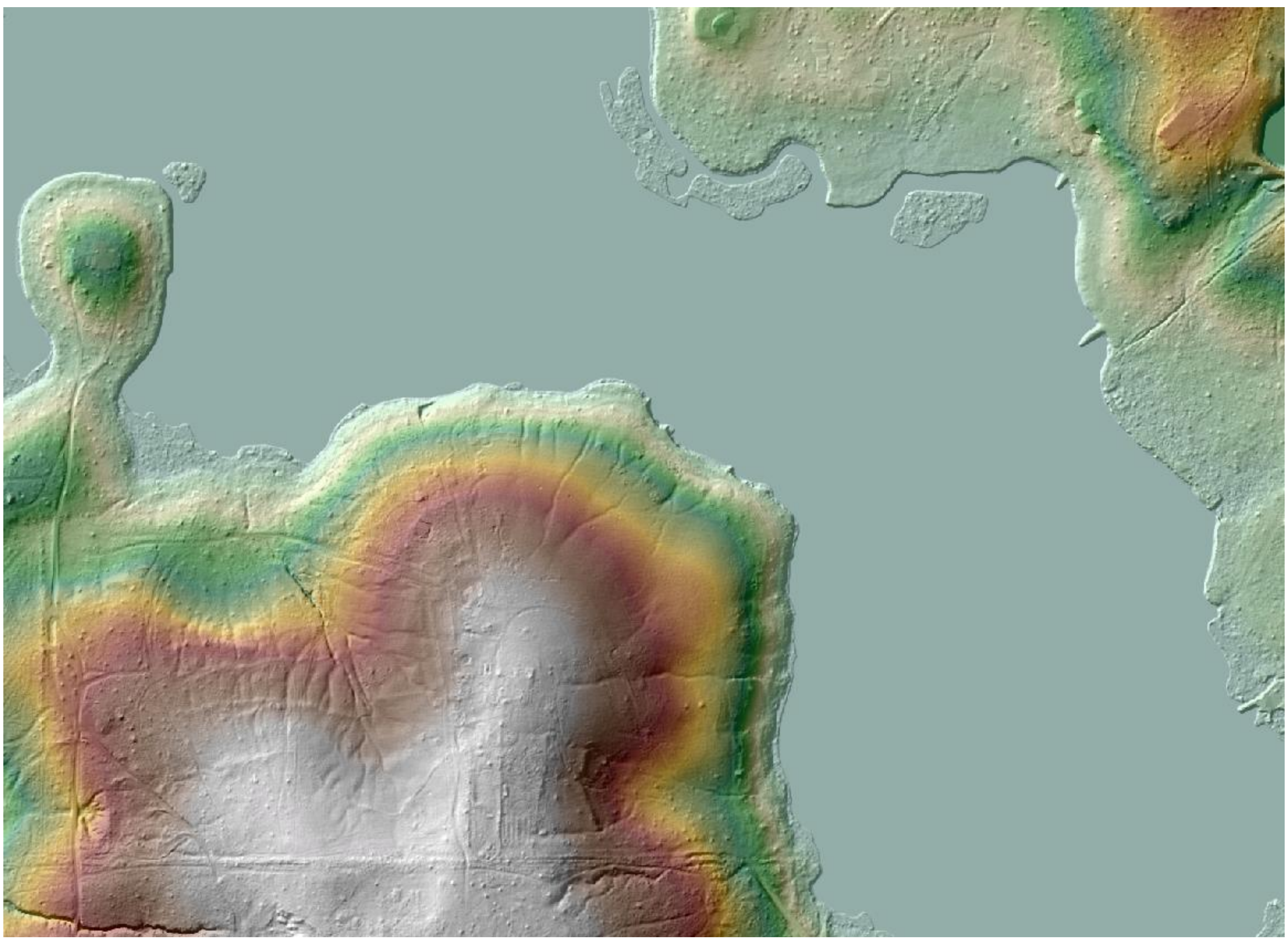


Figure 26-Tile 043441_N. The bare earth DEM is shown on the image above.

When some bridges are removed from the ground surface, the distance from bridge abutment to bridge abutment is small enough that the DEM interpolates across the entire bridge opening, forming 'bridge saddles.' Dewberry collected 3D bridge breaklines in locations where bridge saddles were present and enforced these breaklines in the final DEM creation to help mitigate the bridge saddle artifacts. The image below on the left shows a bridge saddle while the image below on the right shows the same bridge after bridge breaklines have been enforced.

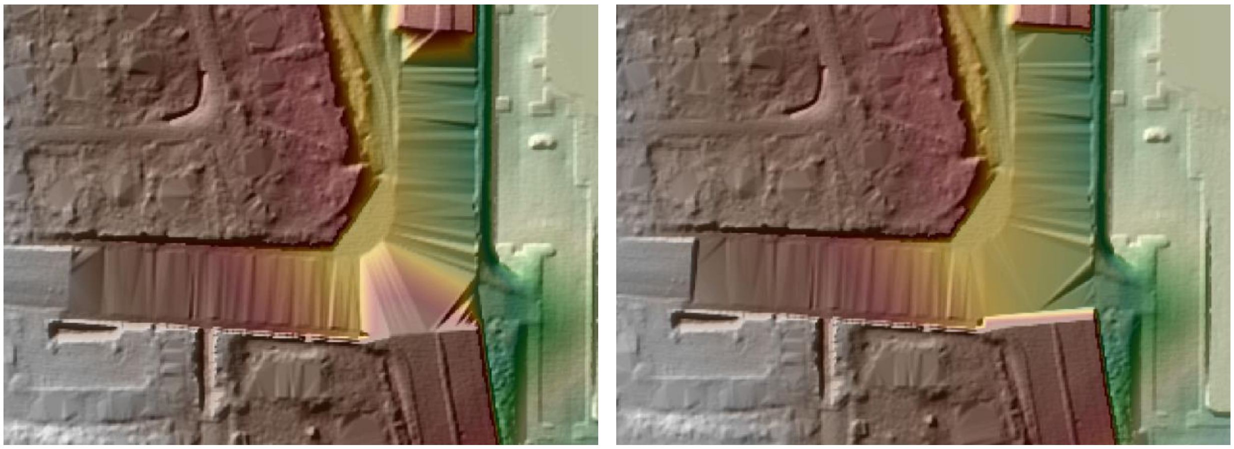


Figure 27-Tile 048296_N. The DEM on the left shows a bridge saddle artifact while the DEM on the right shows the same location after bridge breaklines have been enforced.

DEM VERTICAL ACCURACY RESULTS

The same 189 checkpoints that were used to test the vertical accuracy of the lidar were used to validate the vertical accuracy of the final DEM products as well, aside from one point which was removed. Accuracy results may vary between the source lidar and final DEM deliverable. DEMs are created by averaging several lidar points within each pixel which may result in slightly different elevation values at each survey checkpoint when compared to the source LAS, which does not average several lidar points together but may interpolate (linearly) between two or three points to derive an elevation value. The vertical accuracy of the DEM is tested by extracting the elevation of the pixel that contains the x/y coordinates of the checkpoint and comparing these DEM elevations to the surveyed elevations. Dewberry typically uses LP360 software to test the swath lidar vertical accuracy, Terrascan software to test the classified lidar vertical accuracy, and Esri ArcMap to test the DEM vertical accuracy so that three different software programs are used to validate the vertical accuracy for each project.

Out of the 190 checkpoints received from the surveyor, one was determined to be located outside of the project boundary.

Point ID	NAD83 (2011) State Plane Florida North		NAVD88 (Geoid 12B)	DEM Z (m)	Delta Z	AbsDeltaZ
	Easting X (ft)	Northing Y (m)	Survey Z (m)			
VVA-42	2126856.22	553369.03	83.65	0.00	-83.654	83.65

Table 14 – Checkpoint omitted from the DEM accuracy testing.

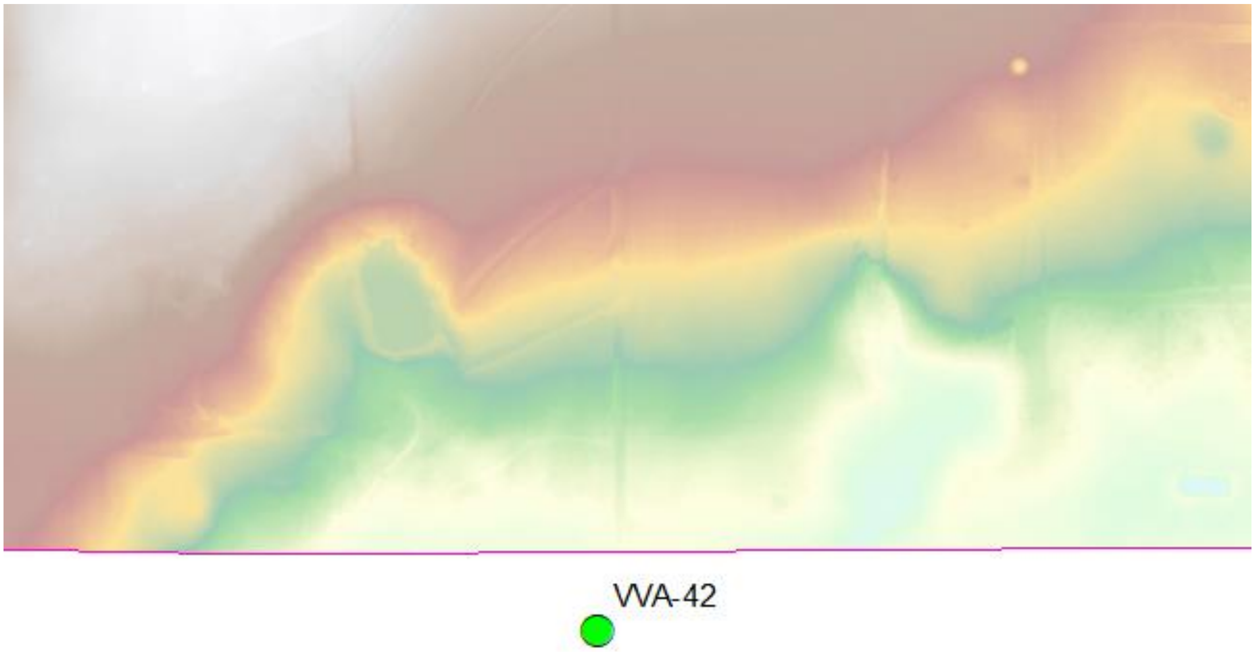


Figure 28 – Shows the extent of the final bare earth DEM, and the location of the excluded point (VVA-42). The project boundary is represented by the purple line.

Table 15 summarizes the tested vertical accuracy results from a comparison of the surveyed checkpoints to the elevation values present within the final DEM dataset.

Land Cover Category	# of Points	NVA – Non-vegetated Vertical Accuracy ($RMSE_z$ x 1.9600) Spec=0.32 ft	VVA – Vegetated Vertical Accuracy (95th Percentile) Spec=0.48 ft
NVA	90	0.24	
VVA	99		0.29

Table 15 – DEM tested NVA and VVA

This lidar dataset was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 5 cm (0.16 ft) RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to be $RMSE_z$ = 3.7 cm (0.12 ft), equating to +/- 7 cm (0.24 ft) at 95% confidence level. Actual VVA accuracy was found to be +/- 9 cm (0.29 ft) at the 95th percentile.

Table 16 lists the 5% outliers that are larger than the VVA 95th percentile.

Point ID	NAD83(2011) State Plane Florida North		NAVD88 (Geoid 12B)	DEM Z (ft)	Delta Z	AbsDeltaZ
	Easting X (ft)	Northing Y (ft)	Survey Z (ft)			
VVA-85	2072227.36	594351.22	139.27	139.66	0.40	0.40
VVA-97	2092931.67	590361.13	155.99	156.35	0.36	0.36
VVA-51	2059623.61	511448.67	129.34	129.63	0.29	0.29
VVA-82	2080087.73	483925.74	21.30	21.67	0.37	0.37
VVA-19	2098374.09	498437.29	31.05	31.59	0.54	0.54
VVA-49	2072975.18	465801.81	22.06	22.37	0.32	0.32

Table 16 — 5% Outliers

Table 17 provides overall descriptive statistics.

DEM Descriptive Statistics									
100 % of Totals	# of Points	RMSEz (ft) NVA Spec=0.16 ft	Mean (ft)	Median (ft)	Skew	Std Dev (ft)	Kurtosis	Min (ft)	Max (ft)
Bare Ground	90	0.12	-0.04	-0.04	0.32	0.12	0.37	-0.29	0.30
NVA	90.00	0.12	-0.04	-0.04	0.32	0.12	0.37	-0.29	0.30
Forested	35	N/A	0.00	0.01	0.16	0.13	-0.59	-0.24	0.28
Tall Brush	33	N/A	0.07	0.05	0.87	0.16	0.54	-0.14	0.54
Short Brush	31	N/A	0.06	0.05	0.13	0.12	2.28	-0.28	0.30
VVA	99.00	N/A	0.04	0.03	0.52	0.15	0.15	-0.24	0.54

Table 17 — Overall Descriptive Statistics

Based on the vertical accuracy testing conducted by Dewberry, the DEM dataset for the Tallahassee-Leon County GIS Landbase Update Project **satisfies the project's pre-defined vertical accuracy criteria.**

DEM CHECKLIST

The following table represents a portion of the high-level steps in Dewberry's bare earth DEM Production and QA/QC checklist that were performed for this project.

Pass/Fail	Validation Step
Pass	Masspoints (LAS to multipoint) are created from ground points only (class 2 and class 8 if model key points created, but no class 20 ignored ground points or class 9 water points
Pass	Create a terrain for each production block using the final bare earth lidar points and final breaklines.
Pass	Convert terrains to rasters using project specifications for grid type, formatting, and cell size
Pass	Create hillshades for all DEMs
Pass	Manually review bare-earth DEMs in ArcMap with hillshades to check for issues
Pass	DEMs should be hydro-flattened or hydro-enforced as required by project specifications

Pass	DEMs should be seamless across tile boundaries
Pass	Water should be flowing downhill without excessive water artifacts present
Pass	Water features should NOT be floating above surrounding
Pass	Bridges should NOT be present in bare-earth DEMs.
Pass	Any remaining bridge saddles where below bridge breaklines were not used need to be fixed by adding below bridge breaklines and re-processing.
Pass	All qualitative issues present in the DEMs as a result of lidar processing and editing issues must be marked for corrections in the lidar These DEMs will need to be recreated after the lidar has been corrected.
Pass	Calculate DEM Vertical Accuracy including NVA, VVA, and other statistics
Pass	Split the DEMs into tiles according to the project tiling scheme
Pass	Verify all properties of the tiled DEMs, including coordinate reference system information, cell size, cell extents, and that compression has not been applied to the tiled DEMs
Pass	Load all tiled DEMs into Global Mapper to verify complete coverage to the (buffered) project boundary and that no tiles are corrupt.

Table 18-A subset of the high-level steps from Dewberry's bare earth DEM Production and QA/QC checklist performed for this project.

Appendix A: Survey Report

1. INTRODUCTION

1.1 *Project Summary*

Dewberry|Preble-Rish is under subcontract to Dewberry Consultants, LLC, to provide 90 Non-vegetated Vertical Accuracy (NVA), and 100 Vegetated Vertical Accuracy (VVA) check points that will be used to evaluate vertical accuracy on the bare-earth terrain derived from the LiDAR. A total of 55 of the NVA points shall also be horizontal accuracy check points, and 35 shall be Grass/Bare Ground points.

Existing NGS Control Points were recovered and surveyed to verify the accuracy of the RTK/GPS survey equipment with the results shown in Section 2.4 and Appendix 1 of this report.

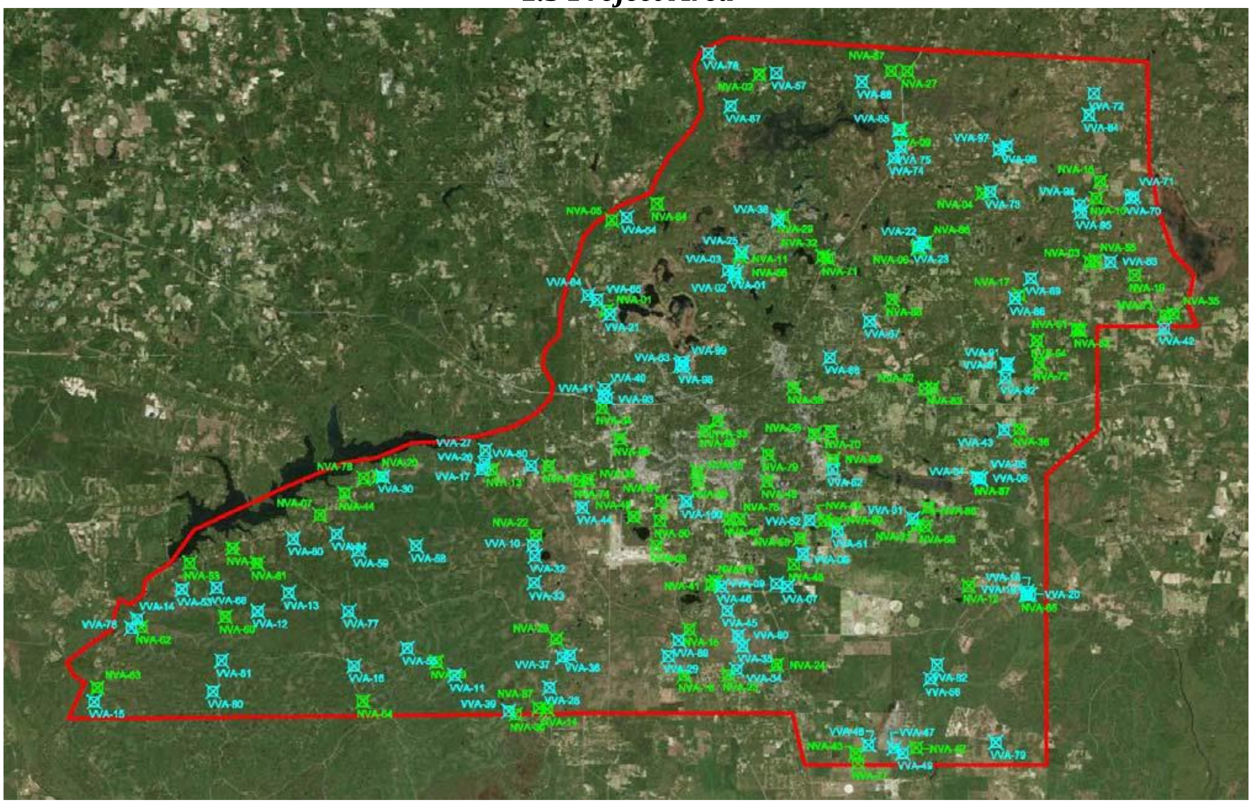
As an internal QA/QC procedure, and to verify that the LiDAR check points meet the 95% confidence level, 89 of the NVA check points, and 96 of the VVA check points were re-surveyed and are shown in Section 5 of this report. For check points that were surveyed twice, an average of the two observations was computed to generate final coordinates and elevations. Final horizontal coordinates are referenced to the Florida State Plane Coordinate System, NAD83, North Zone, U.S Survey Feet. Final vertical elevations are referenced to NAVD88 in Feet using Geoid model 2012B (Geoid12B).

1.2 *Points of Contact*

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

Dewberry|Preble-Rish
Frederick C. Rankin, P.S.M.
Professional Surveyor & Mapper
203 Aberdeen Parkway
Panama City, Florida 32405
(850) 522-0644 office
(850) 522-1011 fax

1.3 *Project Area*



2. PROJECT DETAILS

2.1 *Survey Equipment*

In performing the GPS observations, Spectra Precision Epoch 80 GNSS RTK GPS receiver/antenna attached to a 6.56 foot (2 meter) fixed height pole was used, together with a Spectra Precision Ranger Data Collector equipped with SurveyPro Software (version 5.5.2), to collect GPS raw data for the field surveys.

2.2 *Survey Point Detail*

90 Non-vegetated Check Points, and 100 Vegetated Check Points were distributed throughout the project area. Approximate locations were provided to Dewberry|Preble-Rish prior to field survey.

A sketch was made for each location and a nail was set at the point where possible, unless said point was already located at a photo identifiable point. The LiDAR calibration point locations are detailed on the “Ground Control Point Documentation Report”, which is delivered via electronic transfer, see appendix 5a on sheet 2.

2.3 *Network Design*

The GPS survey performed by Dewberry|Preble-Rish was tied to the Trimble VRS Now Permanent Reference Network, a Real Time Network (RTN) managed by the Trimble Company. The Trimble VRS Now Network provides instant access to real-time kinematic (RTK) corrections utilizing a network of continuously operating permanent reference stations located throughout the United States, Europe, and Australia. Each site provides Global Positioning System (GPS) carrier phase and code range measurements in support of 3-dimensional positioning activities through Florida and surrounding states. All of the reference stations have been linked together, creating a Virtual Reference Station System (VRS).

2.4 *Field Survey Procedures and Analysis*

Dewberry|Preble-Rish field surveyors used Spectra Precision Epoch 80 GNSS RTK GPS systems, which is a geodetic quality dual frequency GPS receiver, to collect data at each check point location.

A total of twelve (12) existing NGS monuments were located as an additional QA/QC procedure, for the purpose of verifying the accuracy of the VRS network. All NGS monuments used are published in the NSRS database, and represent the primary project control for this survey. Field GPS observations are detailed in the “Project Network Control Monument Report”, see appendix 1 on sheets 8-9.

A total of 89 of the NVA check point locations, and 96 of the VVA check point locations were occupied twice. If re-observations matched the initially derived station positions within the allowable tolerance of ± 3cm or within the 95% confidence level, then no further occupations were performed. If re-observations did not match the initially derived positions, a static GPS session was collected and processed through NOAA’s Online Positioning User Service (OPUS). Each VRS occupation utilized the Trimble VRS Now Network, was occupied for approximately 3 to 6 minutes in duration, and measured to 180 - 360 epochs. All static sessions were occupied for a minimum of 45 minutes, and up to 100 minutes. Field GPS observations are detailed in the “Ground Control Point Documentation Report”, and delivered via electronic transfer, see appendix 5a on sheet 2.

2.5 *Adjustment*

Most survey data was collected using Virtual Reference Stations (VRS) methodology within a Virtual Reference System (VRS). The system is designed to provide a true Network RTK performance. The RTK software enables high-accuracy positioning in real time across a geographic region. The RTK software package uses real-time data streams from the GPS system user and generates correction models for high-accuracy RTK GPS corrections throughout the network. Therefore, corrections were applied to the points as they were being collected, thus negating the need for a post process adjustment.

Some survey data was collected using Rapid Static GPS Surveying methodology. Rapid Static methodology is similar to conventional static GPS, except for the benefit of needing shorter occupation times due to shorter baselines, favorable satellite geometry, and minimal signal disturbances. Once data was collected, static sessions were processed through NOAA's Online Positioning User Service (OPUS). This service provides simplified access to high accuracy National Spatial Reference System (NSRS) coordinates and elevations. OPUS uses software which computes coordinates and elevations for NGS' Continuously Operating Reference Station (CORS) network. The resulting positions are accurate and consistent with other National Spatial Reference System users.

2.6 ***Data Processing Procedures***

After field data is collected (and processed through OPUS for static observations) the information is downloaded into the office software. Text files are created that show the point number, northing, easting, elevation, and description (PNEZD format) for each point surveyed. Points are then entered into a Microsoft Excell spreadsheet, which contains formulas for calculating differences between published and field survey data, as well as, comparing differences between points surveyed multiple times. This data is used to confirm point accuracy and precision.

After review of the point data, an "ASCII" or "txt" file (PNEZD format) is created, which is the industry standard. Point files are loaded into our CADD program (AutoCAD Civil 3D) to make a visual check of the point data (Pt. #, Coordinates, Elev. and Description). For check points that were surveyed twice, an average of the two observations was computed to generate final northings, eastings, and elevations. The data can now be imported into the final product.

Appendix 1:

Project Network Control Monument Report

TLC 2 5 1N1E											
Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
2/5/2018	548380.7490	2048304.8550	211.2000	548380.8000	2048304.8700	211.2700	0.05	0.02	0.07	$rmse_N$	0.047
2/6/2018	548380.742	2048304.837	211.177	548380.8000	2048304.8700	211.2700	0.06	0.03	0.09	$rmse_E$	0.054
2/7/2018	548380.73	2048304.812	211.225	548380.8000	2048304.8700	211.2700	0.07	0.06	0.05	**$Hrmse_r$**	**0.071**
2/7/2018	548380.745	2048304.841	211.18	548380.8000	2048304.8700	211.2700	0.06	0.03	0.09	Vrmse	0.060
2/8/2018	548380.7490	2048304.8600	211.2340	548380.8000	2048304.8700	211.2700	0.05	0.01	0.04		
2/9/2018	548380.7290	2048304.8220	211.1730	548380.8000	2048304.8700	211.2700	0.07	0.05	0.10		
2/9/2018	548380.8150	2048304.8180	211.2560	548380.8000	2048304.8700	211.2700	-0.01	0.05	0.01		
2/13/2018	548380.7860	2048304.8050	211.2590	548380.8000	2048304.8700	211.2700	0.01	0.07	0.01		
2/13/2018	548380.7270	2048304.8230	211.1760	548380.8000	2048304.8700	211.2700	0.07	0.05	0.09		
2/13/2018	548380.7290	2048304.7890	211.2990	548380.8000	2048304.8700	211.2700	0.07	0.08	-0.03		
2/13/2018	548380.7550	2048304.8170	211.2820	548380.8000	2048304.8700	211.2700	0.05	0.05	-0.01		
2/14/2018	548380.7980	2048304.8090	211.2420	548380.8000	2048304.8700	211.2700	0.00	0.06	0.03		
2/16/2018	548380.7890	2048304.8230	211.1720	548380.8000	2048304.8700	211.2700	0.01	0.05	0.10		
2/19/2018	548380.8100	2048304.8290	211.1950	548380.8000	2048304.8700	211.2700	-0.01	0.04	0.08		
2/19/2018	548380.7960	2048304.8170	211.2470	548380.8000	2048304.8700	211.2700	0.00	0.05	0.02		
2/20/2018	548380.7790	2048304.8210	211.1930	548380.8000	2048304.8700	211.2700	0.02	0.05	0.08		
2/21/2018	548380.7860	2048304.7580	211.2840	548380.8000	2048304.8700	211.2700	0.01	0.11	-0.01		
2/21/2018	548380.7020	2048304.8070	211.2030	548380.8000	2048304.8700	211.2700	0.10	0.06	0.07		
2/21/2018	548380.7300	2048304.7770	211.2410	548380.8000	2048304.8700	211.2700	0.07	0.09	0.03		
2/21/2018	548380.7810	2048304.8810	211.2400	548380.8000	2048304.8700	211.2700	0.02	-0.01	0.03		
2/27/2018	548380.7970	2048304.8050	211.2200	548380.8000	2048304.8700	211.2700	0.00	0.07	0.05		
2/27/2018	548380.8140	2048304.8960	211.2610	548380.8000	2048304.8700	211.2700	-0.01	-0.03	0.01		
2/28/2018	548380.7650	2048304.8720	211.2020	548380.8000	2048304.8700	211.2700	0.04	0.00	0.07		
3/5/2018	548380.7730	2048304.8670	211.1940	548380.8000	2048304.8700	211.2700	0.03	0.00	0.08		

TLC 1023											
Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
2/5/2018	546355.6500	2101008.3630	86.5560	546355.7100	2101008.3400	86.64	0.06	-0.02	0.08	$rmse_N$	0.064
2/6/2018	546355.671	2101008.343	86.644	546355.7100	2101008.3400	86.64	0.04	0.00	0.00	$rmse_E$	0.016
2/7/2018	546355.6090	2101008.3140	86.5980	546355.7100	2101008.3400	86.64	0.10	0.03	0.04	**$Hrmse_r$**	**0.065**
2/7/2018	546355.6840	2101008.3250	86.6060	546355.7100	2101008.3400	86.64	0.03	0.01	0.03	Vrmse	0.070
2/8/2018	546355.6380	2101008.3360	86.5410	546355.7100	2101008.3400	86.64	0.07	0.00	0.10		
3/27/2018	546355.6550	2101008.3350	86.5420	546355.7100	2101008.3400	86.64	0.05	0.00	0.10		

TALLAHASSEE											
Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
2/13/2018	529684.5560	2036847.7950	220.5210	529684.5500	2036847.8200	220.5700	-0.01	0.03	0.05	$rmse_N$	0.006
							0.00	0.00	0.00	$rmse_E$	0.025
							0.00	0.00	0.00	**$Hrmse_r$**	**0.026**
							0.00	0.00	0.00	Vrmse	0.049

TLC 1020											
Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
2/13/2018	533471.1990	2059682.0480	150.2920	533471.1900	2059681.9800	150.3600	-0.01	-0.07	0.07	$rmse_N$	0.018
2/14/2018	533471.2030	2059682.0130	150.2890	533471.1900	2059681.9800	150.3600	-0.01	-0.03	0.07	$rmse_E$	0.054
2/14/2018	533471.2140	2059682.0620	150.2950	533471.1900	2059681.9800	150.3600	-0.02	-0.08	0.07	**$Hrmse_r$**	**0.057**
2/15/2018	533471.1830	2059682.0160	150.2910	533471.1900	2059681.9800	150.3600	0.01	-0.04	0.07	Vrmse	0.076
2/19/2018	533471.1420	2059682.0400	150.2740	533471.1900	2059681.9800	150.3600	0.05	-0.06	0.09		
2/23/2018	533471.2030	2059682.0220	150.3190	533471.1900	2059681.9800	150.3600	-0.01	-0.04	0.04		
2/26/2018	533471.2060	2059682.0430	150.2680	533471.1900	2059681.9800	150.3600	-0.02	-0.06	0.09		
2/27/2018	533471.1820	2059682.0610	150.2870	533471.1900	2059681.9800	150.3600	0.01	-0.08	0.07		
2/28/2018	533471.1690	2059682.0030	150.2920	533471.1900	2059681.9800	150.3600	0.02	-0.02	0.07		
3/1/2018	533471.1800	2059682.0020	150.2930	533471.1900	2059681.9800	150.3600	0.01	-0.02	0.07		
3/1/2018	533471.1850	2059682.0000	150.3140	533471.1900	2059681.9800	150.3600	0.00	-0.02	0.05		
3/2/2018	533471.2170	2059682.0360	150.2710	533471.1900	2059681.9800	150.3600	-0.03	-0.06	0.09		
3/2/2018	533471.1990	2059682.0260	150.2970	533471.1900	2059681.9800	150.3600	-0.01	-0.05	0.06		
3/2/2018	533471.2340	2059682.0070	150.2900	533471.1900	2059681.9800	150.3600	-0.04	-0.03	0.07		
3/5/2018	533471.1970	2059682.0270	150.2840	533471.1900	2059681.9800	150.3600	-0.01	-0.05	0.08		
3/6/2018	533471.1690	2059682.0070	150.2670	533471.1900	2059681.9800	150.3600	0.02	-0.03	0.09		
3/6/2018	533471.1800	2059682.0310	150.2600	533471.1900	2059681.9800	150.3600	0.01	-0.05	0.10		
3/7/2018	533471.1870	2059682.0370	150.2630	533471.1900	2059681.9800	150.3600	0.00	-0.06	0.10		
3/7/2018	533471.1900	2059682.0330	150.2840	533471.1900	2059681.9800	150.3600	0.00	-0.05	0.08		
3/7/2018	533471.1870	2059682.0250	150.2890	533471.1900	2059681.9800	150.3600	0.00	-0.04	0.07		
3/7/2018	533471.1840	2059682.0530	150.2850	533471.1900	2059681.9800	150.3600	0.01	-0.07	0.08		
3/8/2018	533471.1740	2059682.0300	150.2700	533471.1900	2059681.9800	150.3600	0.02	-0.05	0.09		
3/8/2018	533471.1890	2059682.0290	150.2700	533471.1900	2059681.9800	150.3600	0.00	-0.05	0.09		
3/8/2018	533471.1670	2059682.0310	150.3060	533471.1900	2059681.9800	150.3600	0.02	-0.05	0.05		
3/8/2018	533471.2130	2059682.0270	150.2890	533471.1900	2059681.9800	150.3600	-0.02	-0.05	0.07		
3/9/2018	533471.1790	2059682.0490	150.2840	533471.1900	2059681.9800	150.3600	0.01	-0.07	0.08		
3/9/2018	533471.1810	2059682.0260	150.28	533471.1900	2059681.9800	150.3600	0.01	-0.05	0.08		
3/9/2018	533471.1790	2059682.0480	150.288	533471.1900	2059681.9800	150.3600	0.01	-0.07	0.07		
3/15/2018	533471.2140	2059682.0520	150.26	533471.1900	2059681.9800	150.3600	-0.02	-0.07	0.10		
3/27/2018	533471.1710	2059682.0430	150.312	533471.1900	2059681.9800	150.3600	0.02	-0.06	0.05		

GINGER WETHERELL											
Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
2/13/2018	518181.2030	2047286.4880	199.0540	518181.1900	2047286.4700	199.1500	-0.01	-0.02	0.10	$rmse_N$	0.013
										$rmse_E$	0.018
										$Hrmse_r$	**0.022**
										Vrmse	0.096

Appendix 1:

Project Network Control Monument Report (Cont.)

LONG

Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
2/8/2018	553013.9040	2109660.1990	116.0890	553014.0500	2109659.9200	116.1800	0.15	-0.28	0.09	$rmse_N$	0.131
2/8/2018	553013.9350	2109660.1740	116.2020	553014.0500	2109659.9200	116.1800	0.11	-0.25	-0.02	$rmse_E$	0.267
										$Hrmse_r$	**0.297**
										Vrmse	0.066

TLC 1051

Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
2/14/2018	508450.8510	2022801.5070	61.3280	508450.8400	2022801.4800	61.4800	-0.01	-0.03	0.15	$rmse_N$	0.033
2/15/2018	508450.7870	2022801.4950	61.3840	508450.8400	2022801.4800	61.4800	0.05	-0.02	0.10	$rmse_E$	0.025
2/15/2018	508450.7740	2022801.5050	61.3870	508450.8400	2022801.4800	61.4800	0.07	-0.02	0.09	**$Hrmse_r$**	**0.041**
2/15/2018	508450.7908	2022801.456	61.3450	508450.8400	2022801.4800	61.4800	0.05	0.02	0.13	**Vrmse**	0.079
2/16/2018	508450.8401	2022801.4728	61.4270	508450.8400	2022801.4800	61.4800	0.00	0.01	0.05		
2/19/2018	508450.8310	2022801.5030	61.4990	508450.8400	2022801.4800	61.4800	0.01	-0.02	-0.02		
2/20/2018	508450.8080	2022801.5220	61.4040	508450.8400	2022801.4800	61.4800	0.03	-0.04	0.08		
2/20/2018	508450.8270	2022801.4720	61.4330	508450.8400	2022801.4800	61.4800	0.01	0.01	0.05		
2/21/2018	508450.8260	2022801.4950	61.4450	508450.8400	2022801.4800	61.4800	0.01	-0.02	0.03		
2/21/2018	508450.8290	2022801.4970	61.4190	508450.8400	2022801.4800	61.4800	0.01	-0.02	0.06		
2/22/2018	508450.8290	2022801.5040	61.4800	508450.8400	2022801.4800	61.4800	0.01	-0.02	0.00		
2/22/2018	508450.8210	2022801.5050	61.3880	508450.8400	2022801.4800	61.4800	0.02	-0.02	0.09		
2/23/2018	508450.8360	2022801.4890	61.4130	508450.8400	2022801.4800	61.4800	0.00	-0.01	0.07		
2/26/2018	508450.7700	2022801.5450	61.4510	508450.8400	2022801.4800	61.4800	0.07	-0.06	0.03		
2/27/2018	508450.8590	2022801.5200	61.4070	508450.8400	2022801.4800	61.4800	-0.02	-0.04	0.07		
2/28/2018	508450.7940	2022801.4730	61.3860	508450.8400	2022801.4800	61.4800	0.05	0.01	0.09		
2/28/2018	508450.8270	2022801.4920	61.3810	508450.8400	2022801.4800	61.4800	0.01	-0.01	0.10		
3/1/2018	508450.8730	2022801.4650	61.4570	508450.8400	2022801.4800	61.4800	-0.03	0.01	0.02		
3/2/2018	508450.8040	2022801.4960	61.4160	508450.8400	2022801.4800	61.4800	0.04	-0.02	0.06		
3/5/2018	508450.8350	2022801.5090	61.3950	508450.8400	2022801.4800	61.4800	0.01	-0.03	0.08		
3/5/2018	508450.8440	2022801.4870	61.3990	508450.8400	2022801.4800	61.4800	0.00	-0.01	0.08		
3/6/2018	508450.8140	2022801.5140	61.3860	508450.8400	2022801.4800	61.4800	0.03	-0.03	0.09		
3/6/2018	508450.8100	2022801.4770	61.4280	508450.8400	2022801.4800	61.4800	0.03	0.00	0.05		
3/7/2018	508450.8470	2022801.4610	61.3910	508450.8400	2022801.4800	61.4800	-0.01	0.02	0.09		
3/8/2018	508450.8030	2022801.5040	61.3920	508450.8400	2022801.4800	61.4800	0.04	-0.02	0.09		
3/9/2018	508450.7790	2022801.4770	61.4320	508450.8400	2022801.4800	61.4800	0.06	0.00	0.05		

TLC 1005

Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
2/14/2018	567805.5170	2057485.9180	222.5320	567805.5700	2057485.9900	222.5000	0.05	0.07	-0.03	$rmse_N$	0.038
2/14/2018	567805.5180	2057485.9090	222.4220	567805.5700	2057485.9900	222.5000	0.05	0.08	0.08	$rmse_E$	0.094
2/15/2018	567805.5710	2057485.8660	222.4150	567805.5700	2057485.9900	222.5000	0.00	0.12	0.09	**$Hrmse_r$**	**0.101**
2/15/2018	567805.5430	2057485.9010	222.4800	567805.5700	2057485.9900	222.5000	0.03	0.09	0.02	**Vrmse**	0.064
2/15/2018	567805.5220	2057485.9910	222.4510	567805.5700	2057485.9900	222.5000	0.05	0.00	0.05		
2/16/2018	567805.5990	2057485.8930	222.5270	567805.5700	2057485.9900	222.5000	-0.03	0.10	-0.03		
2/19/2018	567805.5730	2057485.8510	222.4050	567805.5700	2057485.9900	222.5000	0.00	0.14	0.09		
2/19/2018	567805.5690	2057485.8890	222.5420	567805.5700	2057485.9900	222.5000	0.00	0.10	-0.04		
2/28/2018	567805.6310	2057485.9200	222.5880	567805.5700	2057485.9900	222.5000	-0.06	0.07	-0.09		

TLC 1 7 2N 1E											
Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
2/19/2018	578401.3440	2044285.0550	201.8080	578401.3600	2044285.0700	201.8200	0.02	0.02	0.01	$rmse_N$	0.051
2/20/2018	578401.2900	2044285.0240	201.7600	578401.3600	2044285.0700	201.8200	0.07	0.05	0.06	$rmse_E$	0.034
							0.00	0.00	0.00	**$Hrmse_r$**	**0.061**
							0.00	0.00	0.00	**Vrmse**	0.043

TALLPORT											
Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
2/21/2018	563982.7330	2007618.0650	154.4050	563982.7400	2007618.0400	154.3700	0.01	-0.02	-0.03	$rmse_N$	0.035
2/22/2018	563982.7580	2007618.0250	154.2900	563982.7400	2007618.0400	154.3700	-0.02	0.02	0.08	$rmse_E$	0.019
2/22/2018	563982.6690	2007618.0650	154.3280	563982.7400	2007618.0400	154.3700	0.07	-0.02	0.04	**$Hrmse_r$**	**0.040**
2/23/2018	563982.7400	2007618.0540	154.3720	563982.7400	2007618.0400	154.3700	0.00	-0.01	0.00	**Vrmse**	0.043
2/23/2018	563982.7640	2007618.0520	154.3650	563982.7400	2007618.0400	154.3700	-0.02	-0.01	0.00		

TLC 1014											
Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
3/1/2018	498184.7930	2068100.5070	58.7160	498184.7500	2068100.4700	58.8200	-0.04	-0.04	0.10	$rmse_N$	0.043
							0.00	0.00	0.00	$rmse_E$	0.037
										$Hrmse_r$	**0.057**
										Vrmse	0.104

TLC 1 22 1S1E											
Date	Field Survey Data (F)			Published Data (F)			Differences (F)			RMSE	
	Northing	Easting	Elevation	Northing	Easting	Elevation	Delta N	Delta E	Delta Z		
3/1/2018	500240.3910	2059450.3180	66.3270	500240.3700	2059450.4300	66.4100	-0.02	0.11	0.08	$rmse_N$	0.021
3/1/2018	500240.3490	2059450.3620	66.3800	500240.3700	2059450.4300	66.4100	0.02	0.07	0.03	$rmse_E$	0.093
							0.00	0.00	0.00	**$Hrmse_r$**	**0.095**
							0.00	0.00	0.00	**Vrmse**	0.062

Appendix 2:
Final Check Point Coordinates

Leon County, FL QL0 LiDAR & Imagery Project 2018			
POINT #	NORTHING (F)	EASTING (F)	ELEV. (F)
NVA-01	557127.572	2011989.630	122.150
NVA-02	605843.164	2043511.277	198.695
NVA-03	567058.479	2111609.356	166.660
NVA-04	581335.780	2089407.923	157.759
NVA-05	575744.736	2013047.038	104.258
NVA-06	569886.200	2076082.888	158.484
NVA-07	514830.010	1952979.827	117.867
NVA-08	508454.292	2022310.054	65.411
NVA-09	594454.772	2072632.448	145.287
NVA-10	580296.708	2112852.678	219.595
NVA-11	568311.099	2039562.837	228.134
NVA-12	500218.861	2086565.895	99.774
NVA-13	524215.899	1988368.651	146.964
NVA-14	474823.315	1999817.809	73.836
NVA-15	491249.460	2029028.003	30.073
NVA-16	481796.137	2028005.568	22.934
NVA-17	560336.628	2096965.184	172.910
NVA-18	583810.648	2113665.043	137.482
NVA-19	564412.450	2120793.051	197.263
NVA-20	522784.425	1965113.962	153.378
NVA-21	512671.142	2075868.466	93.146
NVA-22	510664.990	1997424.338	86.324
NVA-23	481984.610	2037118.952	27.882
NVA-24	483975.043	2047084.002	22.857
NVA-25	523773.454	2030651.118	66.656
NVA-26	531481.788	2054760.314	110.135
NVA-27	606508.737	2073941.184	166.907
NVA-28	489230.811	2001632.309	89.828
NVA-29	576563.600	2048399.260	232.858
NVA-30	473801.487	1993253.069	85.620
NVA-31	507986.008	1934989.158	109.822
NVA-32	568257.045	2056543.769	226.253
NVA-33	534211.468	2034857.539	164.757
NVA-34	536897.058	2011109.917	108.170
NVA-35	556384.862	2128823.719	133.703
NVA-36	532527.356	2097034.365	55.672
NVA-37	522361.019	2088931.481	53.365
NVA-38	541177.661	2050484.774	110.020
NVA-39	522155.631	2008209.887	96.469
NVA-40	513875.659	2037366.476	55.626
NVA-41	500508.508	2033578.495	52.441
NVA-42	466870.041	2075760.315	19.325
NVA-43	465737.725	2063319.180	23.252
NVA-44	519231.061	1958068.823	126.782
NVA-45	504672.472	2050604.597	53.686
NVA-46	521738.181	2045103.219	193.733
NVA-47	524869.284	2000089.926	157.240
NVA-48	514441.801	2017562.558	68.448
NVA-49	513691.926	2056768.396	125.349
NVA-50	513704.986	2022996.064	37.759

Appendix 2:

Final Check Point Coordinates (Cont.)

Leon County, FL QL0 LiDAR & Imagery Project 2018			
POINT #	NORTHING (F)	EASTING (F)	ELEV. (F)
NVA-51	553250.093	2108888.756	125.218
NVA-52	540977.664	2077552.522	76.547
NVA-53	504917.105	1926150.484	93.499
NVA-54	550861.068	2100570.016	113.425
NVA-55	567402.532	2112665.683	201.345
NVA-56	564657.123	2038698.255	229.684
NVA-57	522352.051	2089013.440	52.628
NVA-58	510018.678	2051835.900	142.404
NVA-59	484531.042	1976956.709	77.561
NVA-60	493904.201	1933442.470	122.937
NVA-61	504892.445	1940063.258	116.072
NVA-62	491758.710	1916169.362	120.929
NVA-63	479234.762	1907146.111	80.022
NVA-64	476468.083	1961807.700	103.703
NVA-65	498312.645	2098660.826	39.585
NVA-66	571158.402	2077794.847	156.273
NVA-67	475051.867	1998105.919	71.239
NVA-68	512436.088	2077699.642	106.540
NVA-69	521836.199	2030846.814	63.463
NVA-70	532001.267	2058171.436	158.607
NVA-71	567770.860	2057572.003	218.328
NVA-72	546249.579	2101065.579	82.870
NVA-73	556092.601	2126988.240	157.285
NVA-74	521780.563	2006497.764	165.551
NVA-75	513929.030	2039421.511	57.682
NVA-76	501087.931	2034484.749	50.839
NVA-77	463695.970	2063797.671	27.962
NVA-78	522424.507	1961958.094	133.441
NVA-79	527271.939	2045283.816	149.596
NVA-80	513169.418	2059099.852	120.463
NVA-81	517632.997	2023244.809	72.823
NVA-82	552975.733	2109498.024	120.678
NVA-83	541045.902	2079076.051	114.838
NVA-84	579122.236	2022422.715	165.506
NVA-85	526334.571	2058689.589	105.604
NVA-86	516398.826	2078250.035	128.749
NVA-87	606533.920	2070631.366	149.040
NVA-88	559398.763	2070797.671	126.805
NVA-89	532215.761	2032398.930	222.738
NVA-90	530533.620	2014720.878	63.927

Appendix 2:
Final Check Point Coordinates (Cont.)

Leon County, FL QL0 LiDAR & Imagery Project 2018			
POINT #	NORTHING (F)	EASTING (F)	ELEV. (F)
VVA-01	564882.122	2038624.880	231.039
VVA-02	564241.019	2038264.437	232.810
VVA-03	565400.278	2037118.961	241.650
VVA-04	522593.500	2088272.547	49.923
VVA-05	522270.566	2089079.490	48.366
VVA-06	522244.149	2088966.721	49.096
VVA-07	500137.380	2049307.286	42.713
VVA-08	506768.197	2052464.931	78.550
VVA-09	500625.717	2046979.892	27.498
VVA-10	508556.341	1996857.652	116.298
VVA-11	481761.665	1980729.209	82.369
VVA-12	494939.901	1940121.403	123.174
VVA-13	498814.679	1946538.574	120.645
VVA-14	493393.778	1915354.550	119.689
VVA-15	476396.548	1906495.773	68.119
VVA-16	483778.892	1960008.076	110.318
VVA-17	524299.181	1986326.269	153.393
VVA-18	499015.784	2098571.725	41.071
VVA-19	498437.281	2098374.087	31.053
VVA-20	498397.415	2099222.215	37.864
VVA-21	556267.939	2012654.883	97.163
VVA-22	571002.697	2077198.035	146.907
VVA-23	570341.451	2076321.244	142.501
VVA-24	510846.919	1956445.506	122.866
VVA-25	569071.840	2039820.468	185.841
VVA-26	525508.462	1986880.609	145.649
VVA-27	528126.738	1987062.072	113.201
VVA-28	479233.758	2000252.170	65.049
VVA-29	485759.955	2024729.645	27.276
VVA-30	522801.032	1965989.387	161.122
VVA-31	514041.802	2075104.492	78.090
VVA-32	506387.146	1997289.214	130.128
VVA-33	500835.769	1997056.788	90.007
VVA-34	482985.237	2038813.971	27.545
VVA-35	487858.423	2039991.799	27.176
VVA-36	485972.698	2004446.963	87.077
VVA-37	485527.269	2002959.550	87.706
VVA-38	575696.763	2047309.218	198.454
VVA-39	474486.670	1991868.249	89.773
VVA-40	540877.693	2011659.533	100.536
VVA-41	539456.602	2011341.374	110.767
VVA-42	553369.030	2126856.223	83.654
VVA-43	532356.226	2093891.902	55.981
VVA-44	516392.627	2006936.656	73.281
VVA-45	495155.270	2036848.470	23.912
VVA-46	500180.892	2035694.532	47.147
VVA-47	466763.201	2071178.531	18.785
VVA-48	467493.388	2065974.651	29.294
VVA-49	465801.807	2072975.176	22.058
VVA-50	524975.204	1996492.068	156.180

Appendix 2:

Final Check Point Coordinates (Cont.)

Leon County, FL QL0 LiDAR & Imagery Project 2018			
POINT #	NORTHING (F)	EASTING (F)	ELEV. (F)
VVA-51	511448.647	2059623.607	129.343
VVA-52	513807.996	2053767.299	148.128
VVA-53	499469.215	1924578.488	114.016
VVA-54	576273.716	2016122.138	119.283
VVA-55	487380.909	1970986.975	96.277
VVA-56	481029.498	2078669.431	22.402
VVA-57	606113.632	2046969.510	198.370
VVA-58	508499.734	1972726.265	119.289
VVA-59	507467.907	1960904.783	124.954
VVA-60	478491.696	1930960.861	105.154
VVA-61	545710.147	2094497.161	130.533
VVA-62	524164.916	2058532.317	85.371
VVA-63	545924.660	2027250.137	104.656
VVA-64	560253.997	2008173.484	155.212
VVA-65	559315.676	2010026.905	144.939
VVA-66	547370.834	2057950.810	173.635
VVA-67	554876.167	2066213.230	72.082
VVA-68	499887.090	1931696.639	117.393
VVA-69	563725.785	2099344.008	140.170
VVA-70	580215.023	2119987.708	160.727
VVA-71	580702.152	2120551.864	135.563
VVA-72	601950.211	2112372.783	99.899
VVA-73	581639.336	2091032.954	168.736
VVA-74	588562.859	2071180.173	121.349
VVA-75	590834.041	2072617.855	103.066
VVA-76	610233.352	2033006.502	137.650
VVA-77	494986.797	1958899.344	111.874
VVA-78	491599.399	1914135.437	112.584
VVA-79	467999.967	2092148.673	30.703
VVA-80	509914.208	1947427.775	119.497
VVA-81	484827.496	1932712.118	106.603
VVA-82	483925.739	2080087.733	21.297
VVA-83	567142.256	2115808.319	181.131
VVA-84	597451.646	2111345.553	98.133
VVA-85	594351.221	2072227.359	139.267
VVA-86	559564.828	2096111.497	184.745
VVA-87	599334.793	2037609.455	193.948
VVA-88	604299.595	2064578.469	145.341
VVA-89	489004.035	2026816.619	21.995
VVA-90	489971.609	2039097.639	37.044
VVA-91	546051.367	2094536.539	131.284
VVA-92	543188.675	2094145.704	167.933
VVA-93	538906.450	2012022.713	136.606
VVA-94	578923.673	2109433.444	236.110
VVA-95	577329.271	2109741.490	239.190
VVA-96	590976.273	2094424.334	148.129
VVA-97	590361.126	2092931.666	155.986
VVA-98	545484.313	2027770.711	101.200
VVA-99	546491.813	2027633.185	97.450
VVA-100	517551.435	2028505.386	68.809

Appendix 3:

GPS Observation & Re-Observation Schedule

Leon County, FL QL0 LiDAR & Imagery Project 2018					
POINT #	SURVEY DATE	JULIAN DATE	TIME	RE-SURVEY DATE	RE-SURVEY TIME
NVA-01	2/22/2018	53	10:54	2/23/2018	10:11
NVA-02	2/15/2018	46	17:12	2/16/2018	14:05
NVA-03	2/6/2018	37	9:10	N.A.	N.A.
NVA-04	2/28/2018	59	13:44	3/9/2018	10:32
NVA-05	2/19/2018	50	12:45	2/20/2018	11:13
NVA-06	2/27/2018	58	8:16	2/28/2018	16:15
NVA-07	3/5/2018	64	13:55	3/6/2018	13:08
NVA-08	2/14/2018	45	18:21	2/15/2018	9:38
NVA-09	2/15/2018	46	14:30	2/21/2018	9:20
NVA-10	2/5/2018	36	13:53	2/6/2018	8:20
NVA-11	2/20/2018	51	16:05	2/22/2018	14:53
NVA-12	3/1/2018	60	13:40	3/2/2018	13:03
NVA-13	2/19/2018	50	11:16	2/20/2018	11:38
NVA-14	2/20/2018	51	16:24	2/21/2018	11:19
NVA-15	2/22/2018	53	15:55	2/23/2018	8:46
NVA-16	2/22/2018	53	14:23	2/23/2018	9:09
NVA-17	2/13/2018	44	10:50	2/14/2018	10:30
NVA-18	2/6/2018	37	17:03	2/8/2018	16:30
NVA-19	2/5/2018	36	8:35	2/6/2018	10:35
NVA-20	3/5/2018	64	16:30	3/7/2018	7:29
NVA-21	3/1/2018	60	10:51	3/2/2018	11:46
NVA-22	2/19/2018	50	15:43	2/20/2018	9:50
NVA-23	2/22/2018	53	14:02	2/23/2018	9:20
NVA-24	2/26/2018	57	10:00	2/27/2018	11:17
NVA-25	2/26/2018	57	15:52	2/27/2018	7:15
NVA-26	2/13/2018	44	13:27	2/14/2018	8:57
NVA-27	2/15/2018	46	14:59	2/16/2018	13:14
NVA-28	2/21/2018	52	16:59	2/22/2018	8:36
NVA-29	2/19/2018	50	14:38	2/20/2018	9:00
NVA-30	2/20/2018	51	15:21	2/21/2018	11:36
NVA-31	3/5/2018	64	12:23	3/6/2018	12:44
NVA-32	2/14/2018	45	13:45	2/15/2018	8:27
NVA-33	2/13/2018	44	8:06	2/14/2018	15:19
NVA-34	2/14/2018	45	17:22	2/15/2018	15:38
NVA-35	2/8/2018	39	14:09	2/9/2018	8:25
NVA-36	3/5/2018	64	10:49	3/6/2018	11:28
NVA-37	3/5/2018	64	12:41	3/6/2018	10:09
NVA-38	2/13/2018	44	15:32	2/14/2018	11:49
NVA-39	2/15/2018	46	12:48	2/16/2018	13:47
NVA-40	2/26/2018	57	14:40	2/27/2018	7:55
NVA-41	2/22/2018	53	11:33	2/23/2018	11:05
NVA-42	3/7/2018	66	12:38	3/8/2018	8:43
NVA-43	3/7/2018	66	11:45	3/8/2018	10:20
NVA-44	3/5/2018	64	14:14	3/6/2018	13:18
NVA-45	2/26/2018	57	12:40	2/27/2018	9:07
NVA-46	2/13/2018	44	10:15	2/14/2018	13:56
NVA-47	2/15/2018	46	14:09	2/19/2018	10:28
NVA-48	2/16/2018	47	11:39	2/21/2018	9:00
NVA-49	2/13/2018	44	16:22	2/14/2018	10:18
NVA-50	2/15/2018	46	10:06	3/6/2018	7:25

Appendix 3:
GPS Observation & Re-Observation Schedule (Cont.)

Leon County, FL QL0 LiDAR & Imagery Project 2018					
POINT #	SURVEY DATE	JULIAN DATE	TIME	RE-SURVEY DATE	RE-SURVEY TIME
NVA-51	2/8/2018	39	11:56	2/9/2018	10:15
NVA-52	2/7/2018	38	12:52	2/8/2018	7:48
NVA-53	3/2/2018	61	10:04	3/5/2018	9:12
NVA-54	2/8/2018	39	11:14	2/9/2018	10:26
NVA-55	2/5/2018	36	11:00	2/6/2015	10:01
NVA-56	2/20/2018	51	15:15	2/21/2018	12:38
NVA-57	3/5/2018	64	12:59	3/6/2018	9:55
NVA-58	2/26/2018	57	13:29	2/27/2018	8:33
NVA-59	2/20/2018	51	13:12	2/21/2018	12:20
NVA-60	2/28/2018	59	12:19	3/1/2018	15:27
NVA-61	3/2/2018	61	9:01	3/6/2018	11:50
NVA-62	3/5/2018	64	10:44	3/6/2018	11:28
NVA-63	3/1/2018	60	8:54	3/8/2018	13:22
NVA-64	2/27/2018	58	16:22	2/28/2018	10:17
NVA-65	3/1/2018	60	15:15	3/2/2018	14:36
NVA-66	2/27/2018	58	9:15	2/28/2018	15:41
NVA-67	2/21/2018	52	14:41	3/8/2018	11:53
NVA-68	3/2/2018	61	12:38	3/8/2018	13:30
NVA-69	2/26/2018	57	13:27	2/27/2018	7:25
NVA-70	2/13/2018	44	14:19	2/14/2018	8:35
NVA-71	2/14/2018	45	8:13	2/16/2018	16:20
NVA-72	2/8/2018	39	10:50	2/9/2018	10:45
NVA-73	2/8/2018	39	13:30	2/9/2018	8:50
NVA-74	2/15/2018	46	13:07	2/19/2018	10:12
NVA-75	2/26/2018	57	14:22	2/27/2018	8:05
NVA-76	2/22/2018	53	11:51	2/23/2018	10:56
NVA-77	3/7/2018	66	12:15	3/8/2018	8:45
NVA-78	3/5/2018	64	16:08	3/7/2018	8:05
NVA-79	2/13/2018	44	9:50	2/14/2018	14:30
NVA-80	2/13/2018	44	17:05	2/14/2018	10:03
NVA-81	2/15/2018	46	10:29	2/16/2018	10:38
NVA-82	2/8/2018	39	12:13	2/9/2018	9:50
NVA-83	2/7/2018	38	13:20	2/8/2018	7:57
NVA-84	2/19/2018	50	11:00	2/20/2018	10:35
NVA-85	2/13/2018	44	12:59	2/14/2018	11:24
NVA-86	3/2/2018	61	10:53	3/8/2018	15:20
NVA-87	2/15/2018	46	15:39	2/16/2018	12:07
NVA-88	2/14/2018	45	11:45	2/15/2018	8:40
NVA-89	2/13/2018	44	8:33	2/14/2018	15:07
NVA-90	2/14/2018	45	16:25	2/15/2018	16:05

Appendix 3:

GPS Observation & Re-Observation Schedule (Cont.)

Leon County, FL QL0 LiDAR & Imagery Project 2018					
POINT #	SURVEY DATE	JULIAN DATE	TIME	RE-SURVEY DATE	RE-SURVEY TIME
VVA-01	2/20/2018	51	15:45	3/7/2018	15:35
VVA-02	2/20/2018	51	14:20	2/21/2018	13:04
VVA-03	2/20/2018	51	14:55	2/21/2018	13:15
VVA-04	3/5/2018	64	14:35	3/8/2018	15:48
VVA-05	3/5/2018	64	13:30	3/6/2018	9:48
VVA-06	3/5/2018	64	14:00	3/6/2018	9:35
VVA-07	2/26/2018	57	12:21	2/27/2018	9:19
VVA-08	2/26/2018	57	13:06	2/27/2018	8:57
VVA-09	2/26/2018	57	11:23	2/27/2018	9:47
VVA-10	2/19/2018	50	16:06	2/20/2018	9:40
VVA-11	2/20/2018	51	14:07	2/21/2018	12:01
VVA-12	2/28/2018	59	12:54	3/1/2018	14:44
VVA-13	3/2/2018	61	8:10	3/5/2018	7:53
VVA-14	3/2/2018	61	11:09	3/5/2018	10:01
VVA-15	2/28/2018	59	15:13	3/6/2018	10:54
VVA-16	2/28/2018	59	8:55	3/6/2018	9:21
VVA-17	2/19/2018	50	11:38	2/20/2018	11:27
VVA-18	3/1/2018	60	14:42	3/2/2018	14:29
VVA-19	3/8/2018	37	13:07	N.A.	N.A.
VVA-20	3/1/2018	60	15:34	3/2/2018	14:23
VVA-21	2/22/2018	53	10:27	2/23/2018	10:40
VVA-22	2/27/2018	58	8:55	2/28/2018	15:51
VVA-23	2/27/2018	58	8:35	2/28/2018	16:00
VVA-24	3/5/2018	64	15:37	3/7/2018	8:22
VVA-25	2/19/2018	50	16:15	2/20/2018	9:59
VVA-26	2/19/2018	50	11:58	2/20/2018	11:17
VVA-27	2/19/2018	50	12:31	2/20/2018	11:04
VVA-28	2/20/2018	51	14:10	2/21/2018	10:47
VVA-29	2/26/2018	57	8:17	2/27/2018	12:27
VVA-30	2/19/2018	50	13:31	2/20/2018	10:23
VVA-31	3/1/2018	60	11:30	3/2/2018	11:05
VVA-32	2/19/2018	50	16:28	2/20/2018	9:27
VVA-33	2/19/2018	50	16:05	2/20/2018	9:15
VVA-34	2/22/2018	53	13:36	2/23/2018	9:31
VVA-35	2/23/2018	54	9:50	2/26/2018	7:12
VVA-36	2/21/2018	52	16:31	2/22/2018	8:54
VVA-37	2/21/2018	52	15:51	2/22/2018	9:16
VVA-38	2/20/2018	51	8:35	2/21/2018	9:54
VVA-39	2/20/2018	51	15:01	2/21/2018	11:47
VVA-40	2/22/2018	53	12:01	2/23/2018	11:15
VVA-41	2/22/2018	53	11:20	2/23/2018	11:37
VVA-42	2/8/2018	39	13:53	2/13/2018	11:58
VVA-43	3/5/2018	64	11:13	3/6/2018	11:09
VVA-44	2/15/2018	46	13:40	2/19/2018	9:16
VVA-45	2/22/2018	53	12:58	2/23/2018	10:24
VVA-46	2/22/2018	53	12:31	2/23/2018	10:37
VVA-47	3/7/2018	66	15:01	3/8/2018	10:16
VVA-48	3/7/2018	66	13:33	3/8/2018	9:25
VVA-49	3/7/2018	66	14:42	3/8/2018	10:26
VVA-50	2/15/2018	46	14:44	2/19/2018	10:40

Appendix 3:

GPS Observation & Re-Observation Schedule (Cont.)

Leon County, FL QL0 LiDAR & Imagery Project 2018					
POINT #	SURVEY DATE	JULIAN DATE	TIME	RE-SURVEY DATE	RE-SURVEY TIME
VVA-51	2/14/2018	45	9:46	2/15/2018	18:02
VVA-52	2/14/2018	45	10:36	2/15/2018	18:13
VVA-53	3/2/2018	61	10:25	3/5/2018	9:36
VVA-54	2/19/2018	50	12:25	2/20/2018	11:00
VVA-55	2/20/2018	51	13:42	2/21/2018	13:02
VVA-56	3/7/2018	66	10:46	3/8/2018	9:55
VVA-57	2/15/2018	46	16:50	2/16/2018	13:50
VVA-58	3/6/2018	65	8:36	3/7/2018	9:05
VVA-59	3/5/2018	64	15:00	3/7/2018	8:44
VVA-60	2/28/2018	59	13:50	N.A.	N.A.
VVA-61	2/9/2018	40	12:10	3/9/2018	9:21
VVA-62	2/13/2018	44	12:26	2/14/2018	11:03
VVA-63	2/21/2018	52	15:40	3/9/2018	13:07
VVA-64	2/22/2018	53	8:44	2/23/2018	9:17
VVA-65	2/22/2018	53	9:30	N.A.	N.A.
VVA-66	2/13/2018	44	8:02	2/14/2018	9:20
VVA-67	2/14/2018	45	11:13	2/15/2018	9:15
VVA-68	3/5/2018	64	11:40	3/6/2018	12:26
VVA-69	2/9/2018	40	11:50	2/13/2018	10:20
VVA-70	2/6/2018	37	12:45	2/8/2018	16:47
VVA-71	2/6/2018	37	15:10	2/7/2018	9:00
VVA-72	3/27/2018	86	11:50	N.A.	N.A.
VVA-73	3/5/2018	64	15:37	3/9/2018	9:44
VVA-74	2/14/2018	45	16:00	2/15/2018	13:00
VVA-75	2/14/2018	45	16:12	2/15/2018	11:48
VVA-76	2/16/2018	47	14:25	2/19/2018	9:30
VVA-77	2/27/2018	58	14:35	2/28/2018	8:22
VVA-78	3/5/2018	64	10:25	3/6/2018	11:19
VVA-79	3/7/2018	66	11:43	3/8/2018	8:20
VVA-80	3/5/2018	64	13:41	3/6/2018	12:57
VVA-81	2/28/2018	59	11:57	3/1/2018	15:06
VVA-82	3/7/2018	66	10:30	3/8/2018	9:30
VVA-83	2/5/2018	36	10:27	2/6/2018	10:12
VVA-84	3/9/2018	68	9:51	3/15/2018	12:00
VVA-85	2/14/2018	45	16:40	3/9/2018	10:20
VVA-86	2/13/2018	44	11:34	2/14/2018	9:51
VVA-87	2/16/2018	47	15:25	2/19/2018	9:48
VVA-88	2/15/2018	46	16:00	2/16/2018	12:16
VVA-89	2/26/2018	57	7:48	2/27/2018	13:00
VVA-90	2/23/2018	54	10:07	2/26/2018	6:54
VVA-91	2/7/2018	38	14:58	2/8/2018	9:00
VVA-92	2/7/2018	38	16:15	2/8/2018	10:29
VVA-93	2/22/2018	53	11:42	2/23/2018	11:05
VVA-94	2/5/2018	36	12:02	2/6/2018	8:33
VVA-95	2/5/2018	36	15:25	2/6/2018	8:40
VVA-96	2/27/2018	58	13:18	2/28/2018	12:48
VVA-97	2/27/2018	58	12:52	2/28/2018	13:22
VVA-98	2/21/2018	52	15:05	2/22/2018	14:00
VVA-99	2/21/2018	52	14:40	2/22/2018	14:12
VVA-100	2/27/2018	58	18:51	2/28/2018	6:46

Appendix 4:
Point Comparison Report

Leon County, FL QL0 LiDAR & Imagery Project 2018				
POINT ID	POINT CHK	DELTA N (F)	DELTA E (F)	VERT DIFF (F)
NVA-01	NVA-01CHK	0.025	-0.102	-0.066
NVA-02	NVA-02CHK	0.019	0.053	-0.109
NVA-03	N.A.	N.A.	N.A.	N.A.
NVA-04	NVA-04CHK	-0.026	0.003	-0.072
NVA-05	NVA-05CHK	-0.053	0.007	-0.065
NVA-06	NVA-06CHK	-0.053	-0.014	0.011
NVA-07	NVA-07CHK	0.073	0.023	-0.043
NVA-08	NVA-08CHK	0.010	-0.012	-0.017
NVA-09	NVA-09CHK	-0.055	0.013	-0.038
NVA-10	NVA-10CHK	-0.002	0.004	-0.030
NVA-11	NVA-11CHK	-0.052	-0.022	0.091
NVA-12	NVA-12CHK	-0.001	-0.052	0.042
NVA-13	NVA-13CHK	-0.034	0.046	-0.040
NVA-14	NVA-14CHK	0.002	-0.008	0.088
NVA-15	NVA-15CHK	-0.006	0.024	0.002
NVA-16	NVA-16CHK	-0.006	-0.024	0.020
NVA-17	NVA-17CHK	0.074	-0.012	-0.066
NVA-18	NVA-18CHK	-0.049	-0.003	-0.063
NVA-19	NVA-19CHK	0.031	0.050	0.000
NVA-20	NVA-20CHK	-0.035	0.038	-0.094
NVA-21	NVA-21CHK	-0.015	-0.033	0.046
NVA-22	NVA-22CHK	0.010	0.011	0.034
NVA-23	NVA-23CHK	0.005	-0.019	-0.067
NVA-24	NVA-24CHK	0.004	0.018	0.064
NVA-25	NVA-25CHK	0.016	0.002	-0.015
NVA-26	NVA-26CHK	-0.009	0.013	0.009
NVA-27	NVA-27CHK	0.033	-0.004	-0.048
NVA-28	NVA-28CHK	0.025	-0.006	-0.014
NVA-29	NVA-29CHK	-0.044	-0.019	0.091
NVA-30	NVA-30CHK	0.025	-0.049	0.060
NVA-31	NVA-31CHK	-0.013	-0.055	0.042
NVA-32	NVA-32CHK	0.008	0.025	-0.034
NVA-33	NVA-33CHK	-0.026	0.000	0.033
NVA-34	NVA-34CHK	-0.011	-0.061	0.032
NVA-35	NVA-35CHK	0.088	0.011	-0.002
NVA-36	NVA-36CHK	-0.017	0.023	-0.048
NVA-37	NVA-37CHK	0.042	-0.010	-0.062
NVA-38	NVA-38CHK	0.004	-0.044	0.002
NVA-39	NVA-39CHK	0.004	0.012	0.044
NVA-40	NVA-40CHK	-0.010	-0.017	0.069
NVA-41	NVA-41CHK	0.003	0.004	0.033
NVA-42	NVA-42CHK	0.005	-0.006	-0.052
NVA-43	NVA-43CHK	0.024	0.027	0.007
NVA-44	NVA-44CHK	0.042	0.036	0.035
NVA-45	NVA-45CHK	-0.029	0.011	-0.105
NVA-46	NVA-46CHK	-0.016	-0.016	0.067
NVA-47	NVA-47CHK	-0.025	0.055	0.010
NVA-48	NVA-48CHK	-0.029	0.029	-0.032
NVA-49	NVA-49CHK	-0.010	0.009	0.013
NVA-50	NVA-50CHK	-0.025	-0.009	-0.046

Appendix 4:

Point Comparison Report (Cont.)

Leon County, FL QL0 LiDAR & Imagery Project 2018				
POINT ID	POINT CHK	DELTA N (F)	DELTA E (F)	VERT DIFF (F)
NVA-51	NVA-51CHK	-0.030	0.009	0.034
NVA-52	NVA-52CHK	0.025	-0.007	-0.006
NVA-53	NVA-53CHK	0.002	-0.033	-0.009
NVA-54	NVA-54CHK	-0.003	0.041	0.070
NVA-55	NVA-55CHK	0.024	-0.011	-0.080
NVA-56	NVA-56CHK	0.059	0.017	-0.006
NVA-57	NVA-57CHK	-0.017	0.031	0.010
NVA-58	NVA-58CHK	0.037	-0.006	-0.037
NVA-59	NVA-59CHK	-0.039	0.000	0.020
NVA-60	NVA-60CHK	0.055	-0.062	-0.037
NVA-61	NVA-61CHK	0.027	-0.055	0.031
NVA-62	NVA-62CHK	-0.003	-0.017	-0.065
NVA-63	NVA-63CHK	0.036	0.051	-0.023
NVA-64	NVA-64CHK	-0.004	0.062	0.088
NVA-65	NVA-65CHK	0.029	0.018	-0.073
NVA-66	NVA-66CHK	0.029	-0.019	0.086
NVA-67	NVA-67CHK	-0.005	-0.047	0.088
NVA-68	NVA-68CHK	-0.064	0.004	-0.006
NVA-69	NVA-69CHK	-0.016	0.009	0.017
NVA-70	NVA-70CHK	0.023	0.003	-0.011
NVA-71	NVA-71CHK	-0.005	0.032	-0.035
NVA-72	NVA-72CHK	0.020	0.009	0.008
NVA-73	NVA-73CHK	0.038	0.004	0.038
NVA-74	NVA-74CHK	-0.009	-0.030	0.023
NVA-75	NVA-75CHK	0.009	0.011	-0.002
NVA-76	NVA-76CHK	-0.010	0.023	-0.002
NVA-77	NVA-77CHK	0.067	-0.045	-0.068
NVA-78	NVA-78CHK	0.042	0.029	-0.104
NVA-79	NVA-79CHK	-0.006	0.017	0.018
NVA-80	NVA-80CHK	0.013	0.006	0.010
NVA-81	NVA-81CHK	0.006	0.033	0.015
NVA-82	NVA-82CHK	-0.024	-0.015	0.058
NVA-83	NVA-83CHK	-0.060	0.036	-0.053
NVA-84	NVA-84CHK	-0.041	0.002	0.027
NVA-85	NVA-85CHK	-0.037	-0.018	0.033
NVA-86	NVA-86CHK	0.020	0.016	0.023
NVA-87	NVA-87CHK	-0.010	0.024	-0.011
NVA-88	NVA-88CHK	-0.040	-0.022	0.018
NVA-89	NVA-89CHK	-0.007	-0.007	-0.041
NVA-90	NVA-90CHK	0.010	-0.051	-0.062

Appendix 4:
Point Comparison Report (Cont.)

Leon County, FL QL0 LiDAR & Imagery Project 2018				
POINT ID	POINT CHK	DELTA N (F)	DELTA E (F)	VERT DIFF (F)
VVA-01	VVA-01CHK	-0.031	-0.029	0.101
VVA-02	VVA-02CHK	-0.057	-0.002	0.015
VVA-03	VVA-03CHK	0.032	0.028	-0.097
VVA-04	VVA-04CHK	-0.073	0.021	0.015
VVA-05	VVA-05CHK	-0.003	0.043	-0.076
VVA-06	VVA-06CHK	0.004	0.086	-0.096
VVA-07	VVA-07CHK	-0.043	-0.042	0.027
VVA-08	VVA-08CHK	0.021	0.092	-0.024
VVA-09	VVA-09CHK	0.086	0.065	-0.043
VVA-10	VVA-10CHK	0.018	0.023	0.070
VVA-11	VVA-11CHK	0.001	-0.088	-0.027
VVA-12	VVA-12CHK	0.017	-0.043	-0.002
VVA-13	VVA-13CHK	-0.027	0.000	-0.073
VVA-14	VVA-14CHK	0.054	0.047	0.061
VVA-15	VVA-15CHK	0.046	-0.095	-0.001
VVA-16	VVA-16CHK	0.053	0.062	0.068
VVA-17	VVA-17CHK	-0.034	-0.037	-0.011
VVA-18	VVA-18CHK	0.023	0.010	-0.016
VVA-19	N.A.	N.A.	N.A.	N.A.
VVA-20	VVA-20CHK	-0.020	-0.026	0.027
VVA-21	VVA-21CHK	0.002	-0.022	0.059
VVA-22	VVA-22CHK	-0.086	0.009	0.037
VVA-23	VVA-23CHK	-0.057	-0.044	0.054
VVA-24	VVA-24CHK	-0.007	0.022	-0.044
VVA-25	VVA-25CHK	0.024	-0.007	-0.097
VVA-26	VVA-26CHK	0.023	0.025	0.003
VVA-27	VVA-27CHK	0.009	0.025	0.051
VVA-28	VVA-28CHK	-0.056	-0.047	0.050
VVA-29	VVA-29CHK	0.028	-0.061	-0.062
VVA-30	VVA-30CHK	-0.010	-0.037	0.047
VVA-31	VVA-31CHK	-0.013	0.046	-0.046
VVA-32	VVA-32CHK	0.007	0.005	-0.053
VVA-33	VVA-33CHK	-0.020	0.015	-0.025
VVA-34	VVA-34CHK	0.007	0.053	-0.073
VVA-35	VVA-35CHK	-0.014	0.073	0.046
VVA-36	VVA-36CHK	-0.015	0.009	-0.065
VVA-37	VVA-37CHK	-0.001	0.007	-0.087
VVA-38	VVA-38CHK	-0.028	0.044	0.054
VVA-39	VVA-39CHK	0.011	0.003	0.036
VVA-40	VVA-40CHK	0.013	-0.052	0.088
VVA-41	VVA-41CHK	0.023	0.024	0.051
VVA-42	VVA-42CHK	0.017	-0.012	0.006
VVA-43	VVA-43CHK	0.049	-0.042	-0.064
VVA-44	VVA-44CHK	0.096	-0.018	-0.079
VVA-45	VVA-45CHK	0.025	0.031	-0.080
VVA-46	VVA-46CHK	0.025	0.029	0.079
VVA-47	VVA-47CHK	-0.042	-0.027	-0.099
VVA-48	VVA-48CHK	0.014	0.045	-0.055
VVA-49	VVA-49CHK	-0.011	-0.015	-0.023
VVA-50	VVA-50CHK	-0.041	0.007	0.084

Appendix 4:
Point Comparison Report (Cont.)

Leon County, FL QL0 LiDAR & Imagery Project 2018				
POINT ID	POINT CHK	DELTA N (F)	DELTA E (F)	VERT DIFF (F)
VVA-51	VVA-51CHK	-0.010	-0.014	129.343
VVA-52	VVA-52CHK	-0.046	0.031	-0.073
VVA-53	VVA-53CHK	-0.012	0.035	0.099
VVA-54	VVA-54CHK	-0.019	0.014	-0.080
VVA-55	VVA-55CHK	0.027	-0.043	0.002
VVA-56	VVA-56CHK	0.056	0.057	-0.067
VVA-57	VVA-57CHK	-0.100	0.008	0.076
VVA-58	VVA-58CHK	-0.006	-0.008	0.056
VVA-59	VVA-59CHK	0.004	-0.089	-0.043
VVA-60	N.A.	N.A.	N.A.	N.A.
VVA-61	VVA-61CHK	-0.011	0.029	-0.095
VVA-62	VVA-62CHK	0.012	0.003	0.014
VVA-63	VVA-63CHK	0.022	0.062	0.092
VVA-64	VVA-64CHK	-0.015	-0.035	-0.029
VVA-65	N.A.	N.A.	N.A.	N.A.
VVA-66	VVA-66CHK	-0.044	-0.029	0.085
VVA-67	VVA-67CHK	-0.049	0.001	-0.016
VVA-68	VVA-68CHK	-0.037	-0.005	0.041
VVA-69	VVA-69CHK	-0.037	-0.052	-0.023
VVA-70	VVA-70CHK	-0.077	0.009	-0.030
VVA-71	N.A.	N.A.	N.A.	N.A.
VVA-72	N.A.	N.A.	N.A.	N.A.
VVA-73	VVA-73CHK	0.012	-0.080	0.048
VVA-74	VVA-74CHK	0.006	-0.001	-0.020
VVA-75	VVA-75CHK	-0.026	0.063	0.090
VVA-76	VVA-76CHK	0.023	-0.026	0.012
VVA-77	VVA-77CHK	-0.059	-0.053	0.073
VVA-78	VVA-78CHK	-0.026	-0.059	0.032
VVA-79	VVA-79CHK	0.072	0.012	-0.079
VVA-80	VVA-80CHK	-0.051	-0.020	-0.093
VVA-81	VVA-81CHK	0.033	-0.016	0.091
VVA-82	VVA-82CHK	0.007	0.009	-0.063
VVA-83	VVA-83CHK	-0.010	-0.004	-0.086
VVA-84	VVA-84CHK	-0.020	0.003	-0.032
VVA-85	VVA-85CHK	0.029	0.104	0.013
VVA-86	VVA-86CHK	-0.023	0.012	-0.012
VVA-87	VVA-87CHK	0.006	-0.045	-0.097
VVA-88	VVA-88CHK	0.025	0.066	-0.104
VVA-89	VVA-89CHK	0.026	0.086	-0.052
VVA-90	VVA-90CHK	0.005	-0.011	-0.025
VVA-91	VVA-91CHK	0.006	0.020	-0.040
VVA-92	VVA-92CHK	-0.026	0.005	0.042
VVA-93	VVA-93CHK	0.026	0.015	0.054
VVA-94	VVA-94CHK	0.037	-0.030	-0.055
VVA-95	VVA-95CHK	0.042	-0.015	0.005
VVA-96	VVA-96CHK	0.045	0.070	0.086
VVA-97	VVA-97CHK	0.003	0.053	-0.105
VVA-98	VVA-98CHK	0.029	0.085	0.073
VVA-99	VVA-99CHK	0.046	0.043	0.090
VVA-100	VVA-100CHK	-0.022	-0.028	0.048

Appendix B: Complete List of Delivered Tiles

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047211_N
047212_N
047213_N
047214_N
047215_N
047216_N
047217_N
047218_N
052068_N
052069_N
053131_N
050990_N
050991_N
050992_N
050993_N
050994_N
050995_N
053148_N
053149_N
053150_N
053151_N
053152_N
050996_N
050997_N
050998_N
050999_N
051000_N
051001_N
051002_N
051003_N
051004_N
049378_N
049379_N
049380_N
049381_N
049382_N
049383_N
049384_N
053153_N
053154_N
053155_N
053156_N
053157_N
053158_N
053159_N
049356_N
049357_N
049358_N
049359_N
049385_N
049386_N
049387_N
049388_N
049389_N
049390_N
049391_N
050973_N
050974_N
050975_N
050976_N
050977_N
049360_N
049361_N
049362_N
049363_N
049364_N
049365_N
049366_N
049367_N
049368_N
049369_N
049370_N
049371_N
049372_N
051005_N
051006_N
051007_N
051008_N
051009_N
051010_N
051011_N
050978_N
050979_N
050980_N
050981_N
050982_N
050983_N
050984_N
050985_N
050986_N
050987_N
050988_N
047232_N
047233_N
053160_N
053161_N
053162_N
053163_N
053164_N
053165_N
053166_N
053167_N
053168_N
053169_N
053170_N
053171_N
053132_N
053133_N
053134_N
053135_N
053136_N
053137_N
053138_N
053139_N
053140_N
053141_N
053142_N
053143_N
053144_N
053145_N
053146_N
053147_N
048829_N
048830_N
048831_N
048832_N
048833_N
048834_N
048835_N
048295_N
048296_N
048297_N
048298_N
047228_N
047229_N
047230_N
047231_N
048821_N
048822_N
048823_N
048824_N
048825_N
048826_N
048827_N
048828_N
049373_N
049374_N
049375_N
048817_N
048819_N
048820_N
052051_N
052052_N
052053_N
048841_N
048842_N
048843_N
048844_N
048845_N
048846_N
048836_N
048837_N
048838_N
048839_N
048840_N
045604_N
048280_N
048281_N
048282_N
048283_N
046670_N
046671_N
046672_N
046673_N
046674_N
048284_N
048285_N
048286_N
048847_N
048848_N
048849_N
048850_N
048851_N
045605_N
045606_N
045607_N
045608_N

045609_N
045610_N
045611_N
045612_N
045613_N
048287_N
048288_N
048289_N
048290_N
048291_N
048292_N
048293_N
048294_N
048302_N
048303_N
048304_N
048305_N
048306_N
045596_N
045597_N
045598_N
045599_N
045600_N
045601_N
045602_N
045603_N
046130_N
046131_N
046132_N
046133_N
046134_N
046135_N
046136_N
048307_N
048308_N
048309_N
048310_N
048311_N
048312_N
048299_N
048300_N
048301_N
046137_N
046138_N
046139_N
046140_N
046141_N
046142_N
046143_N
046144_N
046145_N
046146_N
046147_N
046148_N
046149_N
046150_N
046151_N
046152_N
046153_N
045590_N
045591_N
045592_N
045593_N
045594_N
045595_N
039656_N
048818_N

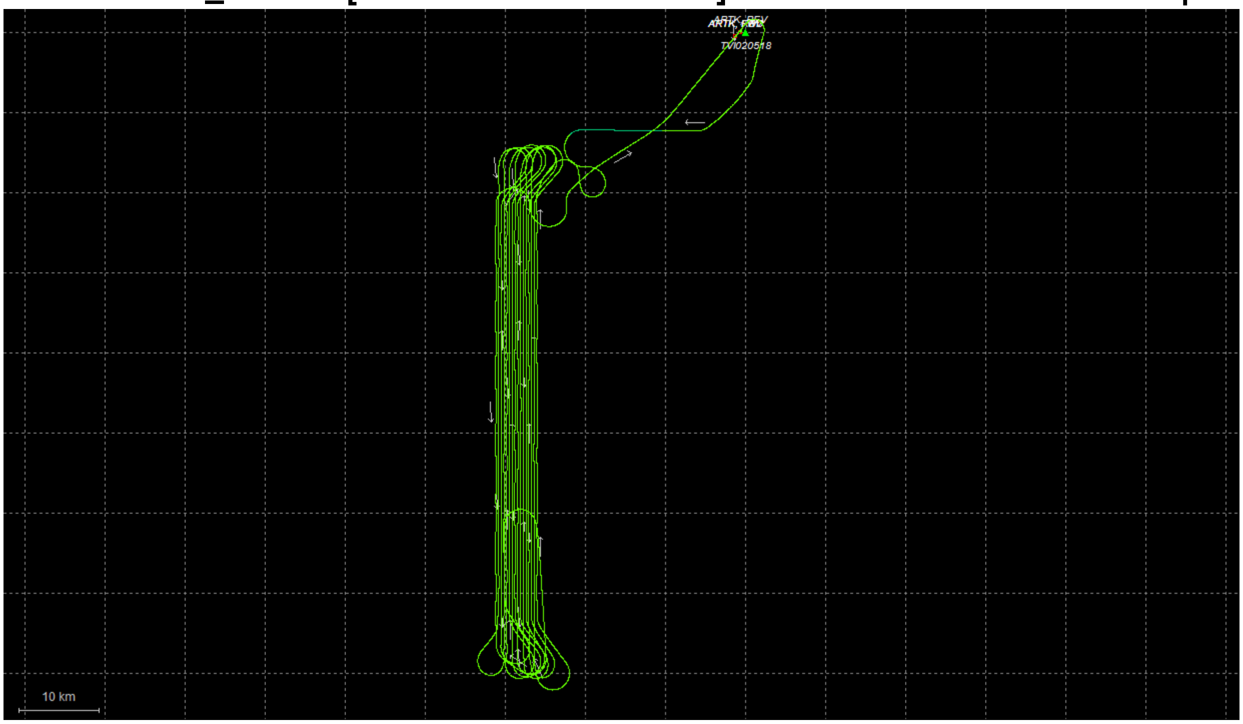
Appendix C: GPS Processing

Program:	Inertial Explorer
Version:	8.60.6129

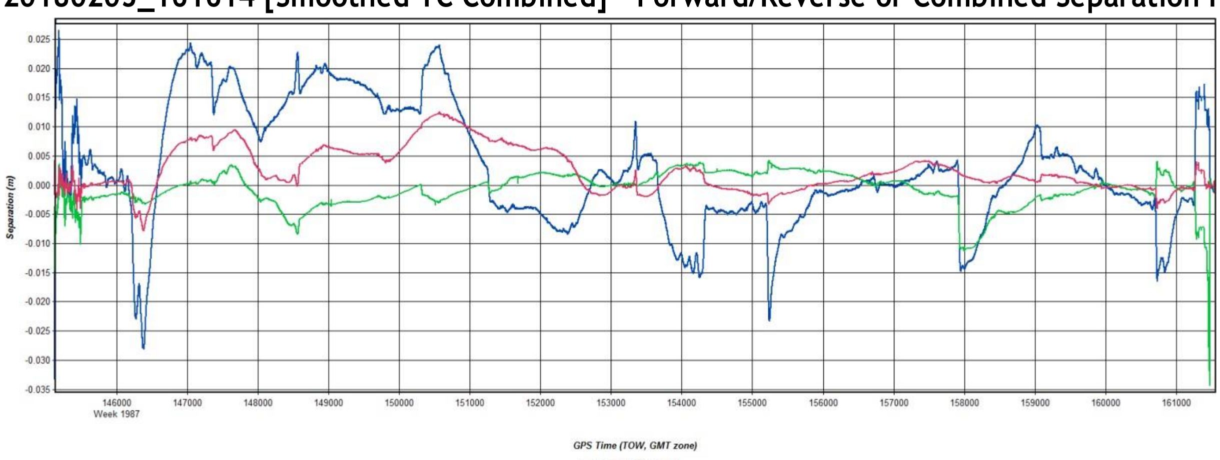
ALS 80 SN8137

MISSION 02/05/2018 A

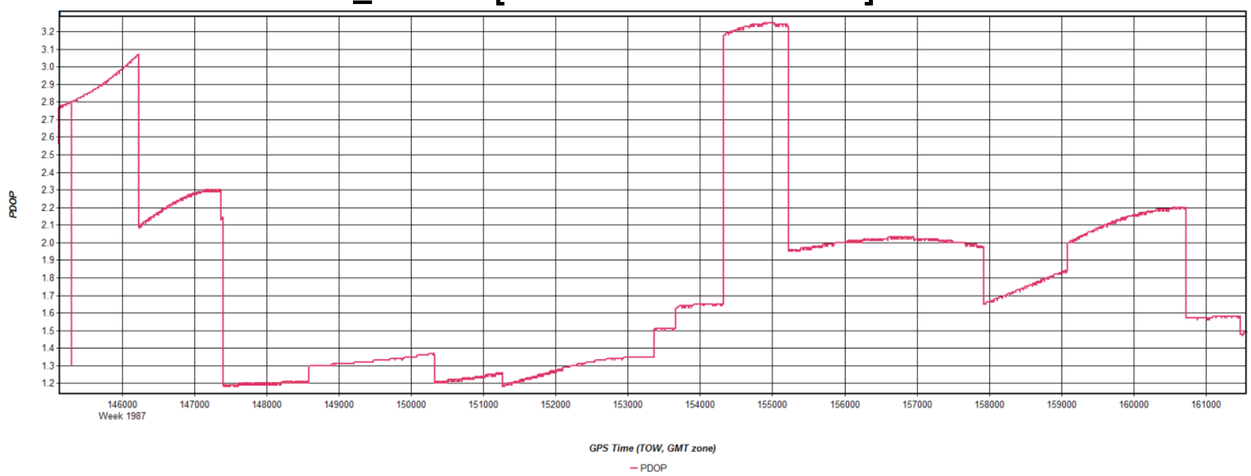
20180205_161614 [Smoothed TC Combined] - Smoothed TC Combined - Map



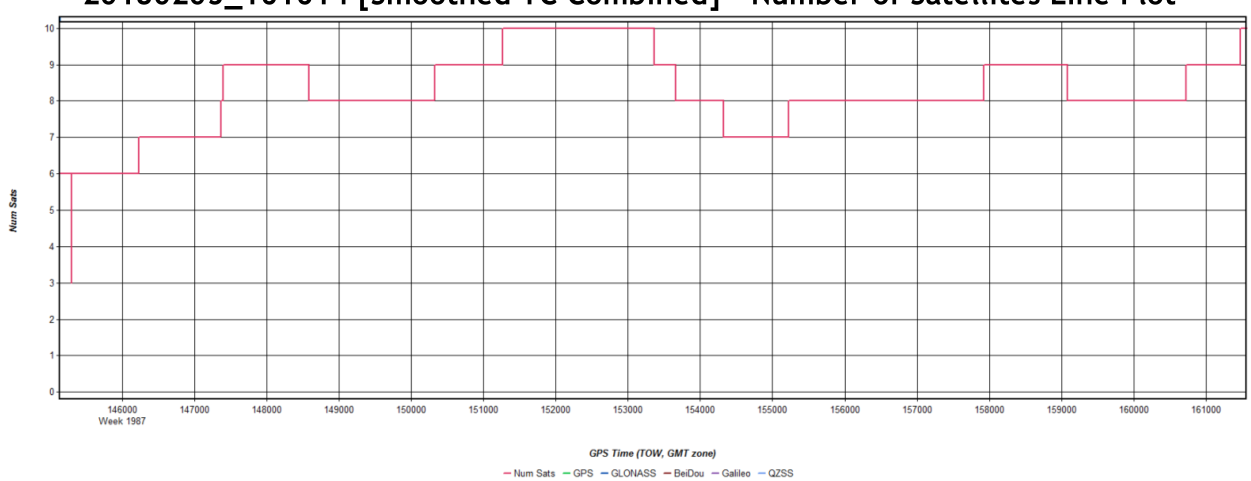
20180205_161614 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot



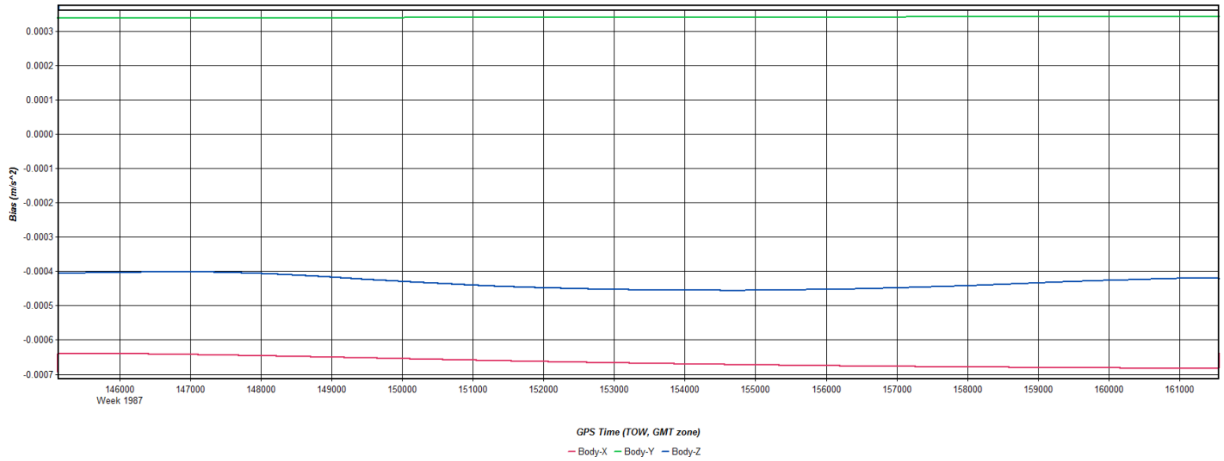
20180205_161614 [Smoothed TC Combined] - PDOP Plot

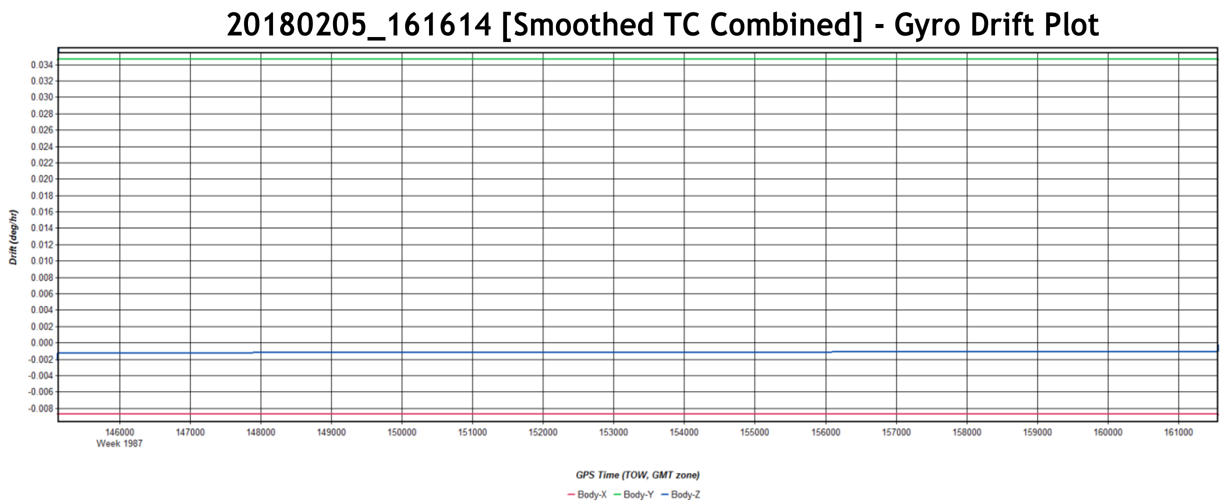


20180205_161614 [Smoothed TC Combined] - Number of Satellites Line Plot



20180205_161614 [Smoothed TC Combined] - Accelerometer Bias Plot


0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
Bias (m/s^2)
146000
Week 1987
147000
148000
149000
150000
151000
152000
153000
154000
155000
156000
157000
158000
159000
160000
161000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180205_161614 [Smoothed TC Combined] - Gyro Drift Plot
Drift (deg/hr)
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
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
146000
Week 1987
147000
148000
149000
150000
151000
152000
153000
154000
155000
156000
157000
158000
159000
160000
161000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8137\20180205_161614\GnssImu\20180205_161614.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	32885
No processed position:	2
Missing Fwd or Rev:	2
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0139	(m)
C/A Code:	0.38	(m)
L1 Doppler:	0.028	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.004	(m)
North:	0.003	(m)
Height:	0.011	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (32846 occurrences):

East:	0.004	(m)
North:	0.003	(m)
Height:	0.011	(m)

Quality Number Percentages:

Q 1:	99.1 %
Q 2:	0.9 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

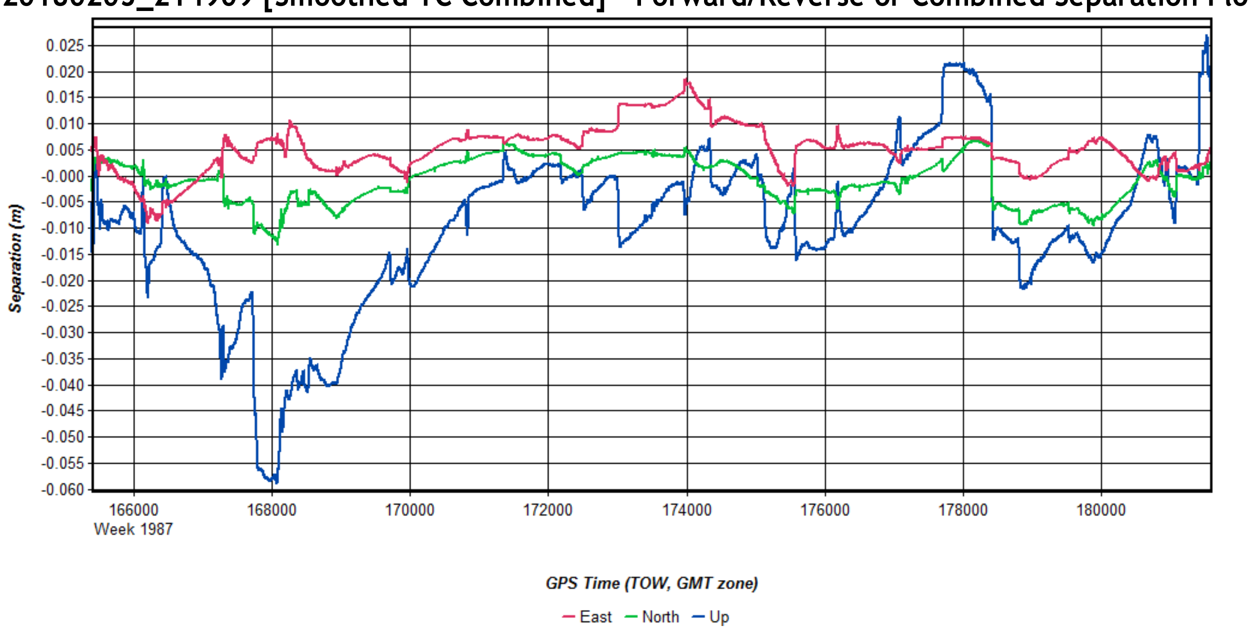
Baseline Distances:

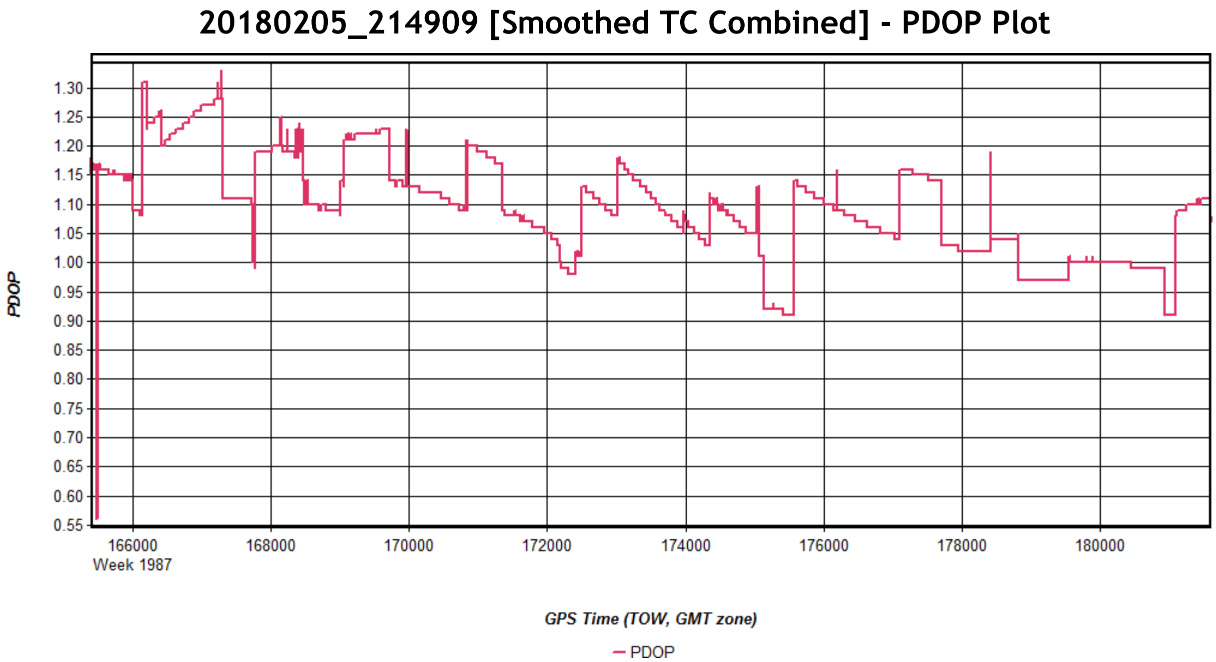
Maximum:	85.243	(km)
Minimum:	0.537	(km)
Average:	50.687	(km)
First Epoch:	1.322	(km)
Last Epoch:	0.631	(km)

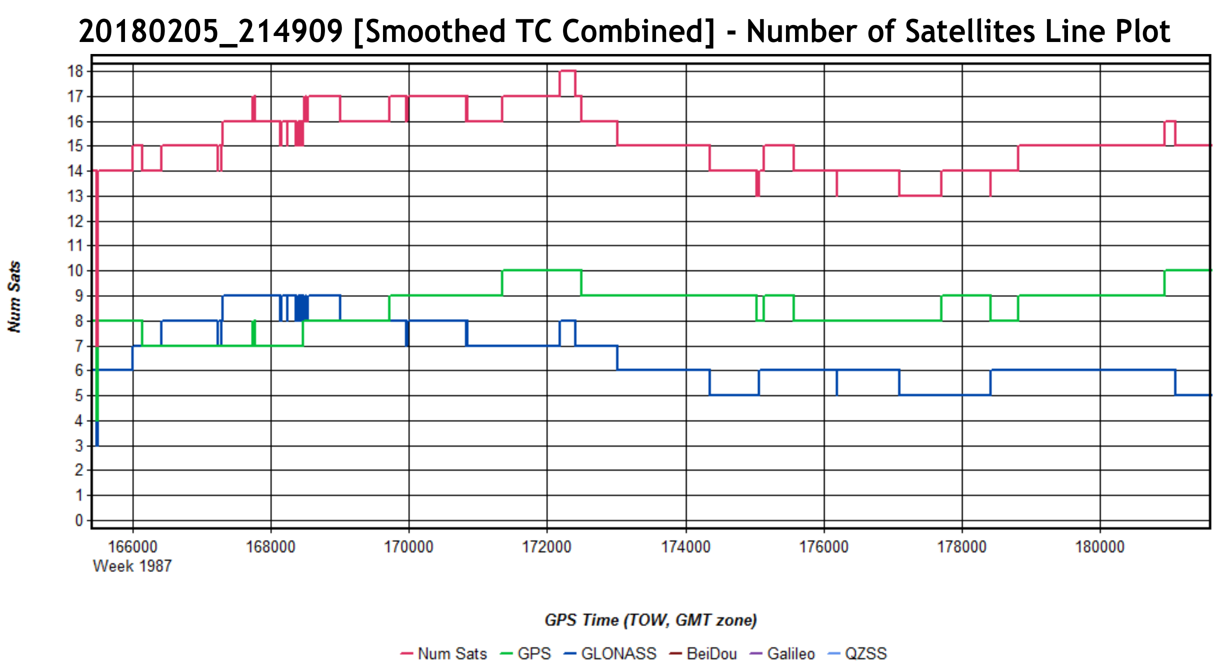
MISSION 02/05/2018 B

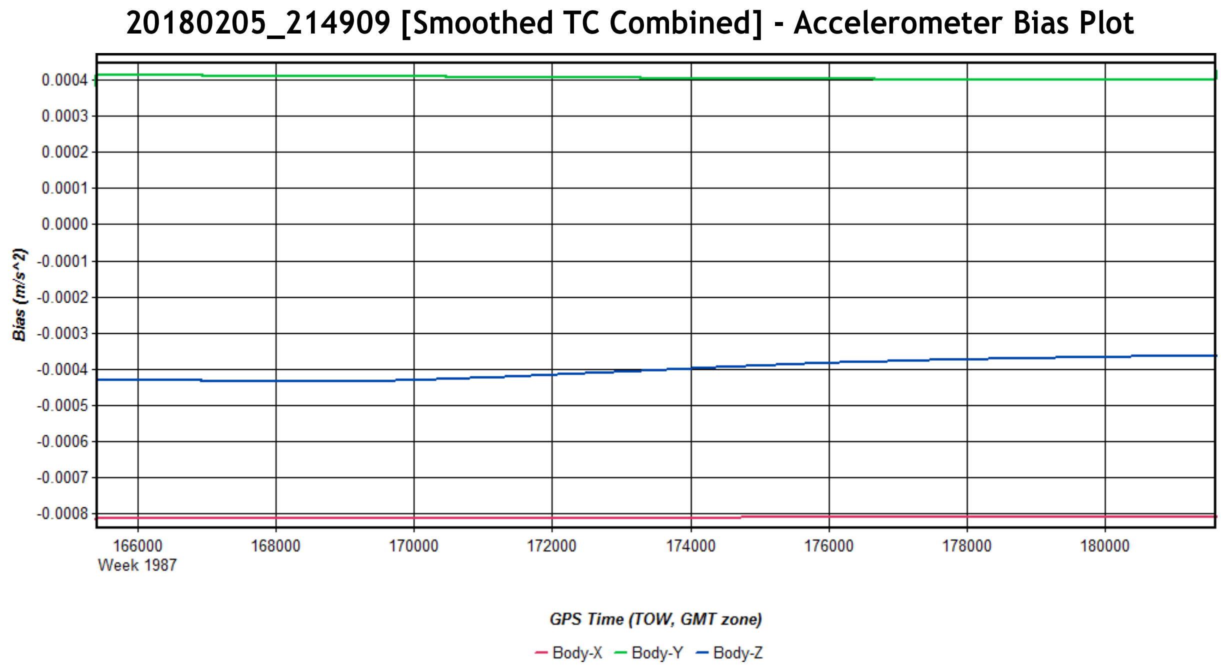
20180205_214909 [Smoothed TC Combined] - Smoothed TC Combined - Map

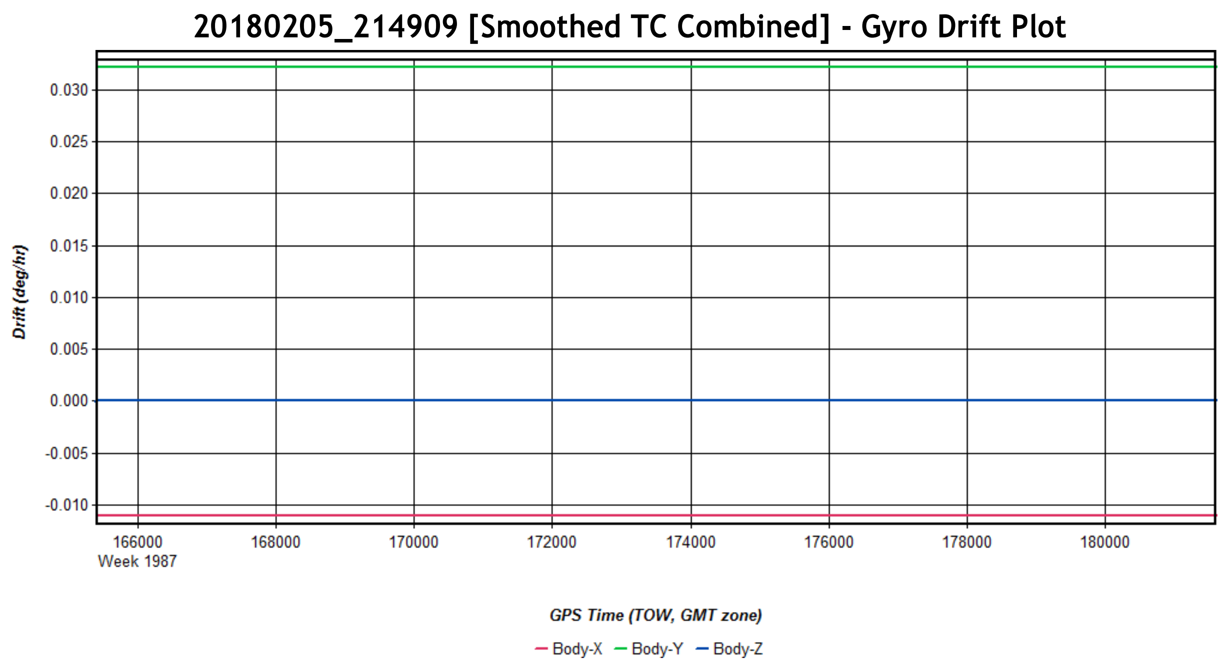
20180205_214909 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot




20180205_214909 [Smoothed TC Combined] - PDOP Plot
PDOP
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
166000
Week 1987
168000
170000
172000
174000
176000
178000
180000
GPS Time (TOW, GMT zone)
PDOP


20180205_214909 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
166000
Week 1987
168000
170000
172000
174000
176000
178000
180000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou
Galileo
QZSS


20180205_214909 [Smoothed TC Combined] - Accelerometer Bias Plot
0.0004
0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
Bias (m/s^2)
166000
Week 1987
168000
170000
172000
174000
176000
178000
180000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180205_214909 [Smoothed TC Combined] - Gyro Drift Plot
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
Drift (deg/hr)
166000
Week 1987
168000
170000
172000
174000
176000
178000
180000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8137\20180205_214909\GnssImu\20180205_214909.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	32426
No processed position:	3
Missing Fwd or Rev:	2
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0159	(m)
C/A Code:	0.35	(m)
L1 Doppler:	0.029	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.007	(m)
North:	0.004	(m)
Height:	0.018	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (32421 occurrences):

East:	0.007	(m)
North:	0.004	(m)
Height:	0.018	(m)

Quality Number Percentages:

Q 1:	100.0 %
Q 2:	0.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum:	88.538	(km)
Minimum:	0.573	(km)
Average:	53.548	(km)
First Epoch:	1.366	(km)
Last Epoch:	0.573	(km)

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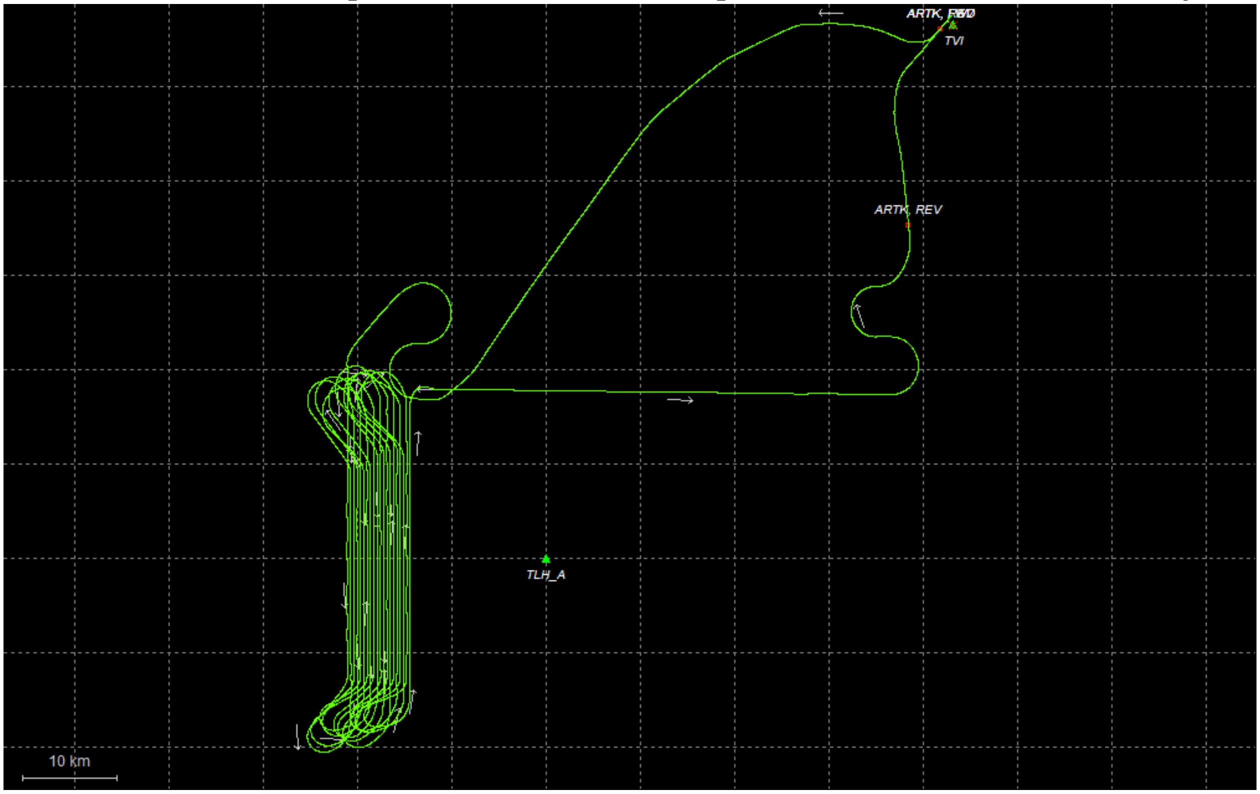
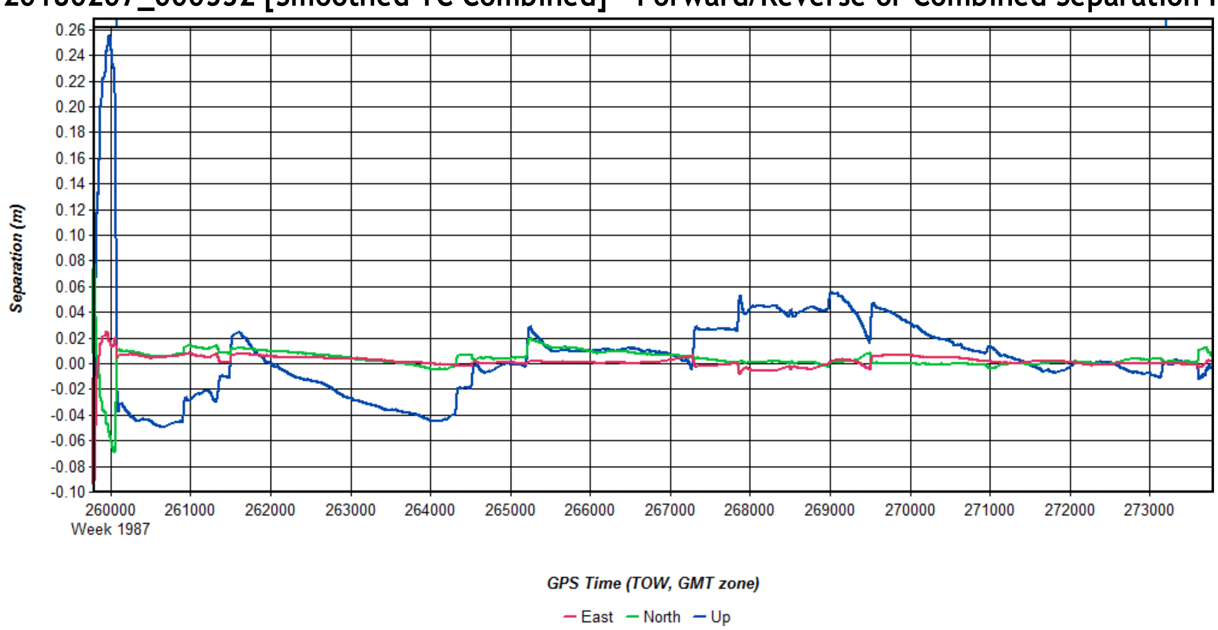
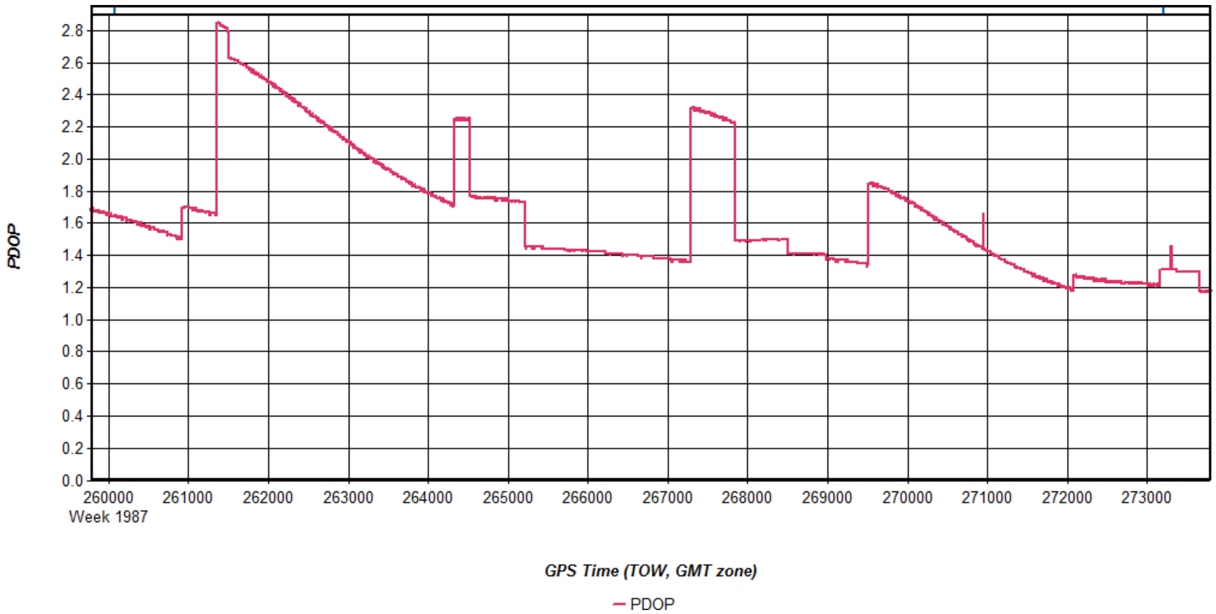
20180207_000532 [Smoothed TC Combined] - Smoothed TC Combined - Map



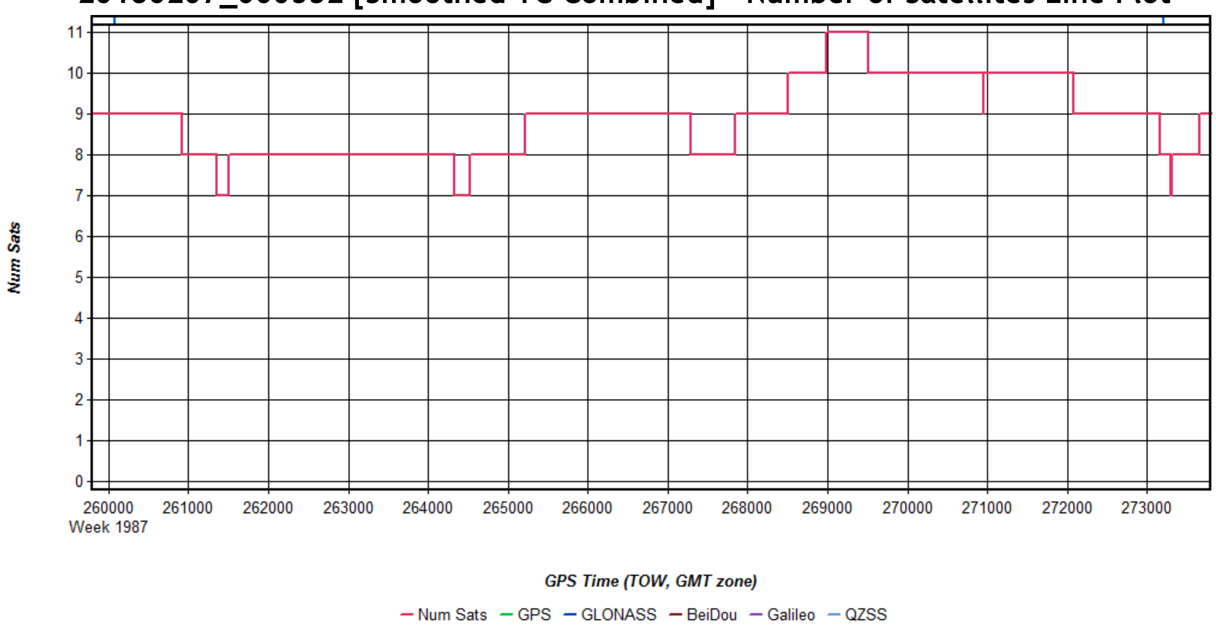
20180207_000532 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot

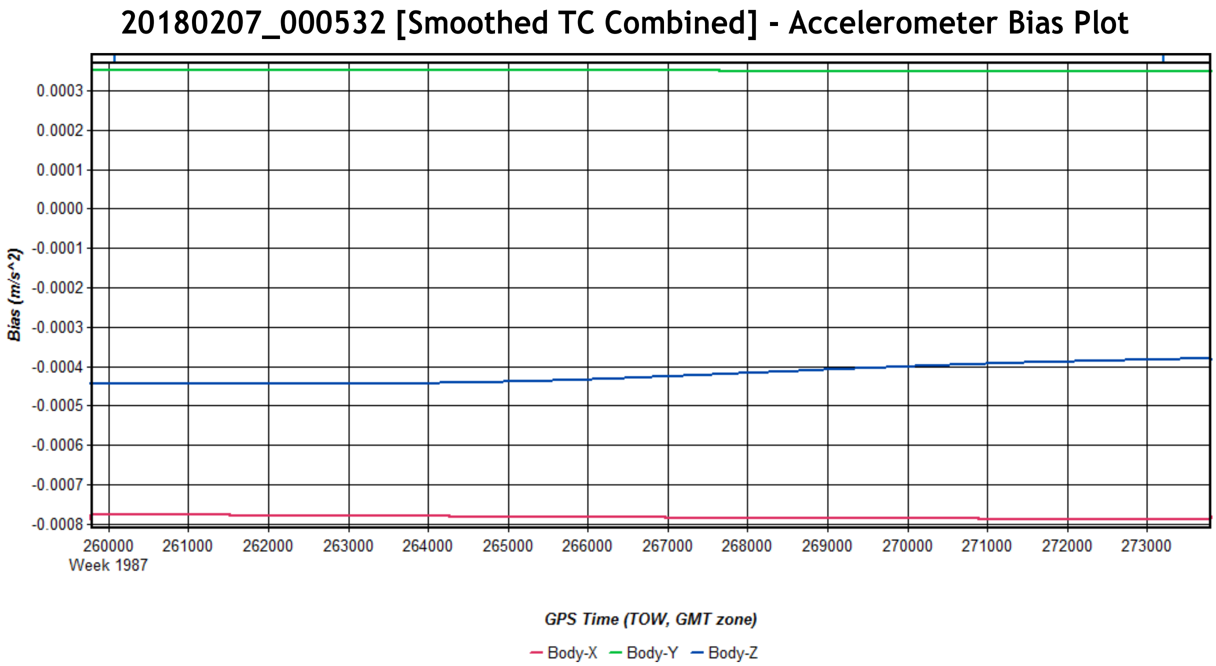


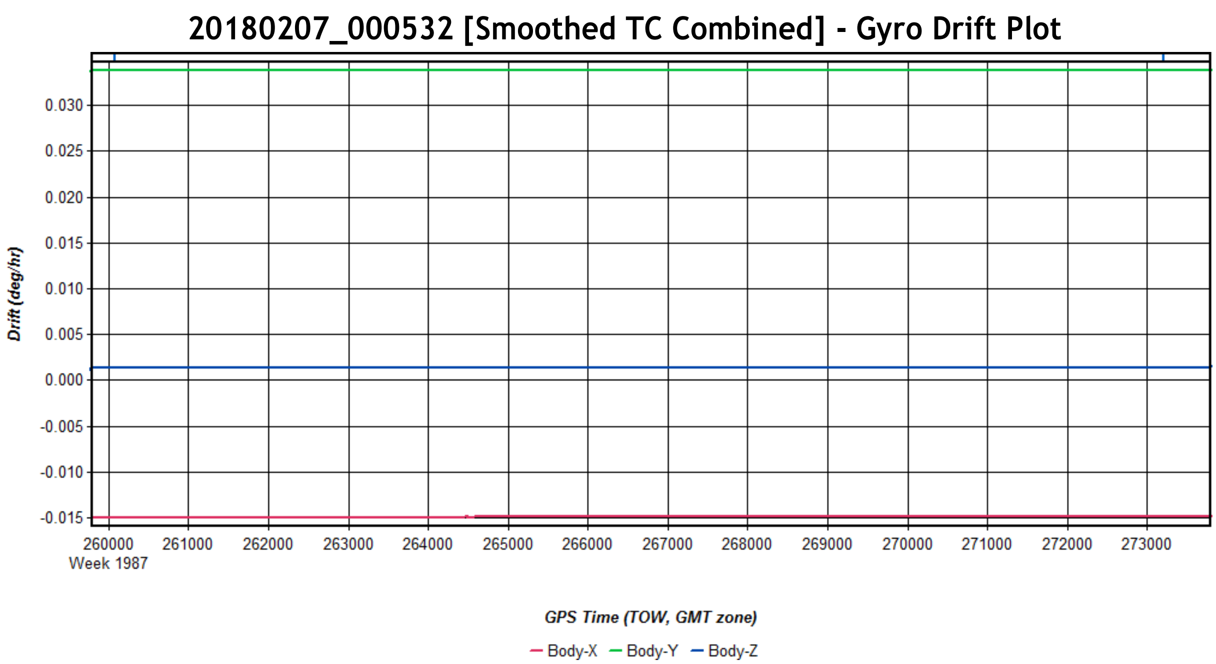
20180207_000532 [Smoothed TC Combined] - PDOP Plot



20180207_000532 [Smoothed TC Combined] - Number of Satellites Line Plot




20180207_000532 [Smoothed TC Combined] - Accelerometer Bias Plot
Bias (m/s^2)
0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
260000 261000 262000 263000 264000 265000 266000 267000 268000 269000 270000 271000 272000 273000
Week 1987
GPS Time (TOW, GMT zone)
Body-X Body-Y Body-Z


20180207_000532 [Smoothed TC Combined] - Gyro Drift Plot
Drift (deg/h)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
260000 261000 262000 263000 264000 265000 266000 267000 268000 269000 270000 271000 272000 273000
Week 1987
GPS Time (TOW, GMT zone)
Body-X Body-Y Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8137\20180207_000532\GnssImu\20180207_000532.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	28058
No processed position:	3
Missing Fwd or Rev:	2
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0178	(m)
C/A Code:	0.35	(m)
L1 Doppler:	0.030	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.006	(m)
North:	0.009	(m)
Height:	0.038	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (27452 occurrences):

East:	0.004	(m)
North:	0.006	(m)
Height:	0.026	(m)

Quality Number Percentages:

Q 1:	100.0 %
Q 2:	0.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum:	71.530	(km)
Minimum:	14.507	(km)
Average:	27.045	(km)
First Epoch:	71.524	(km)
Last Epoch:	70.801	(km)

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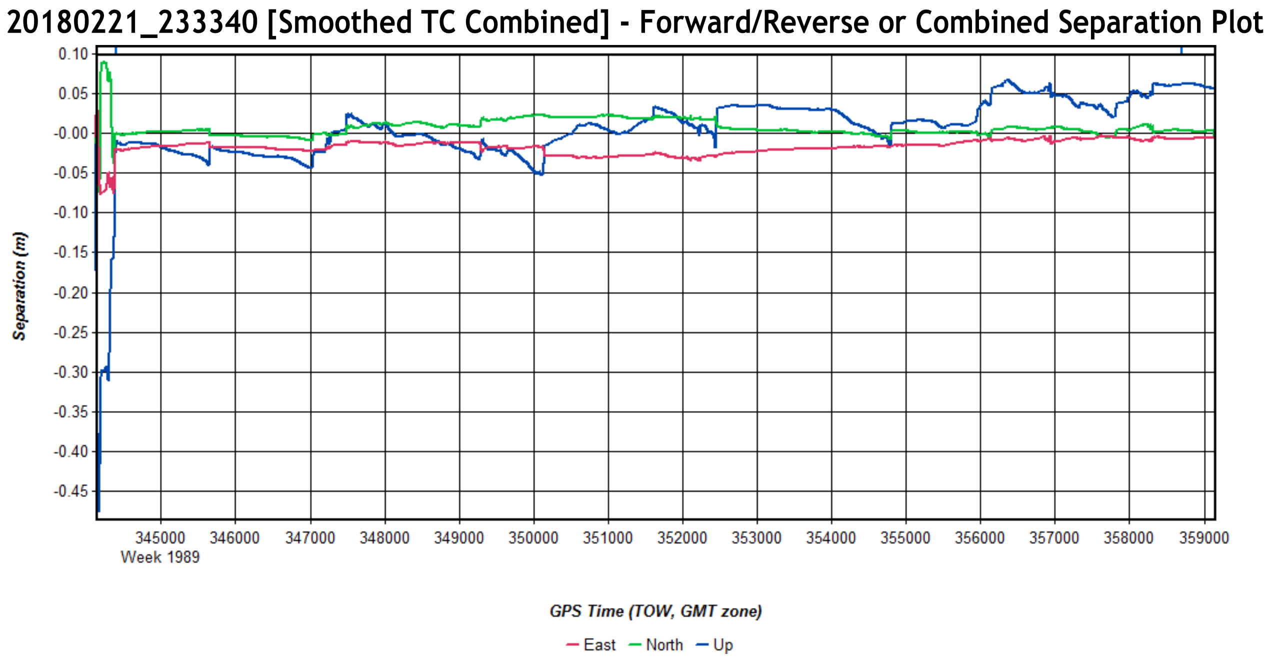
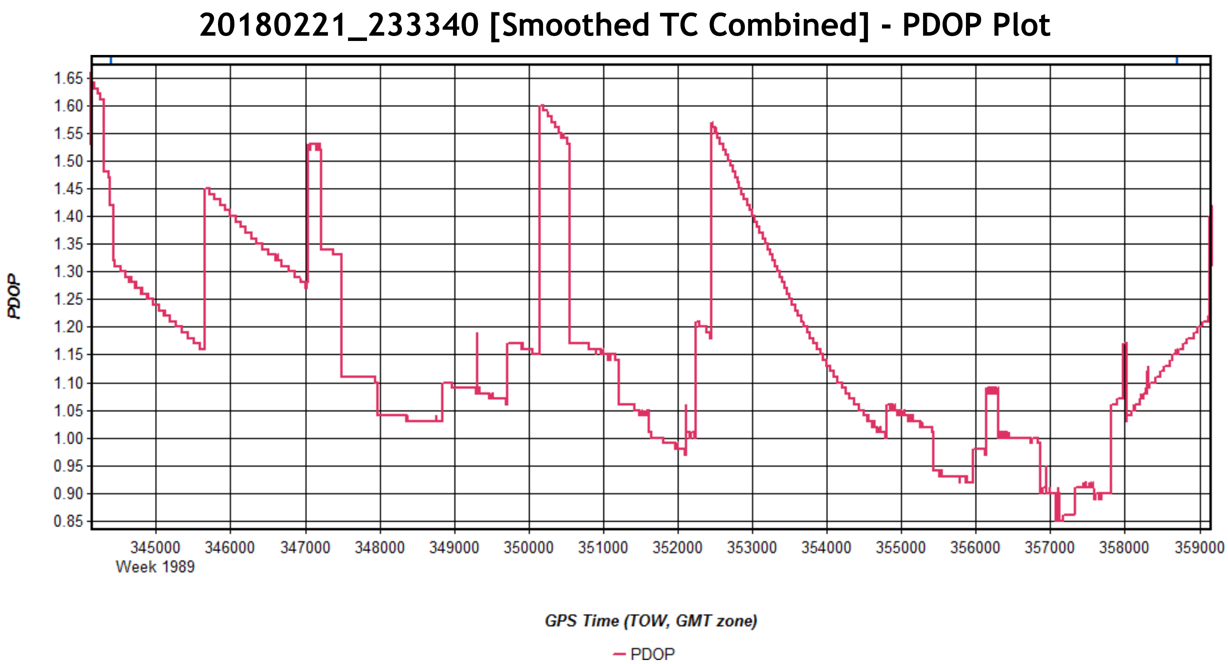
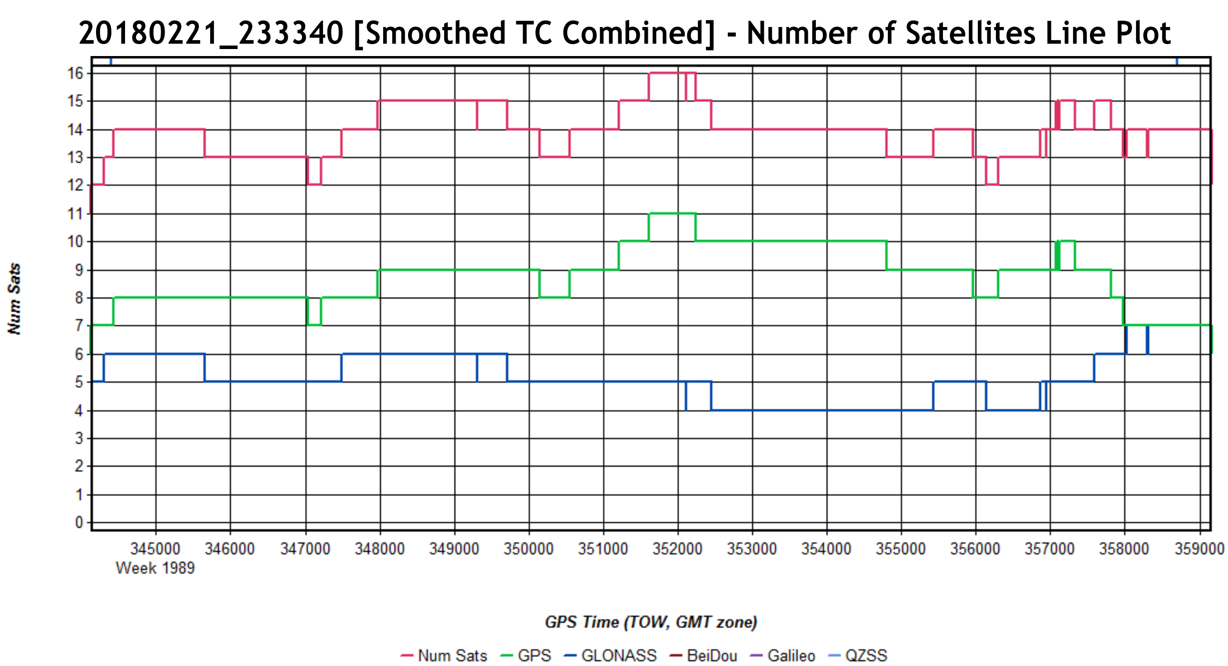
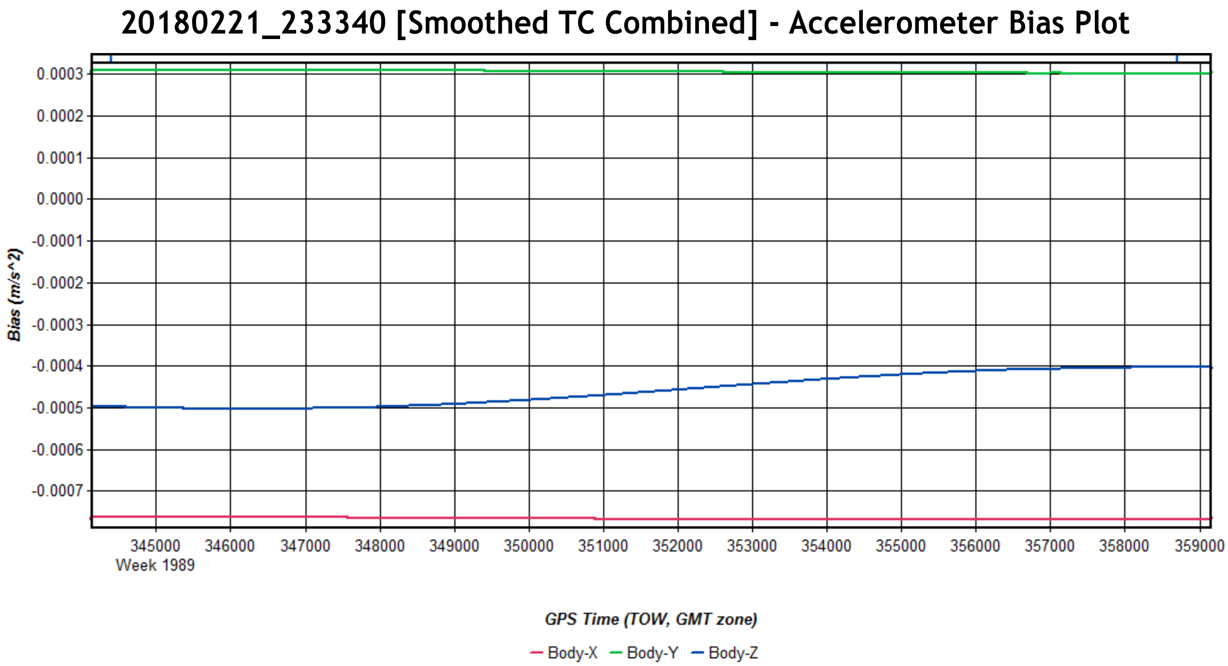
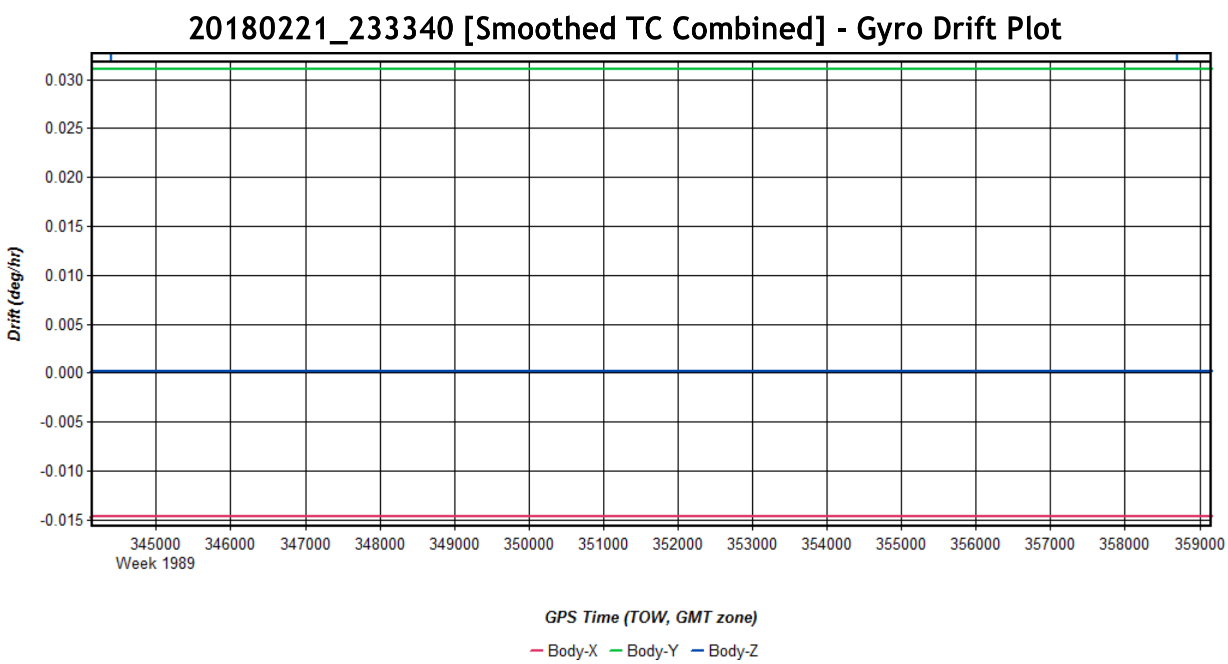
20180221_233340 [Smoothed TC Combined] - Smoothed TC Combined - Map


20180221_233340 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot
Separation (m)
0.10
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
345000
346000
347000
348000
349000
350000
351000
352000
353000
354000
355000
356000
357000
358000
359000
Week 1989
GPS Time (TOW, GMT zone)
East
North
Up


20180221_233340 [Smoothed TC Combined] - PDOP Plot
PDOP
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
345000 346000 347000 348000 349000 350000 351000 352000 353000 354000 355000 356000 357000 358000 359000
Week 1989
GPS Time (TOW, GMT zone)
PDOP


20180221_233340 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
345000 346000 347000 348000 349000 350000 351000 352000 353000 354000 355000 356000 357000 358000 359000
Week 1989
GPS Time (TOW, GMT zone)
Num Sats GPS GLONASS BeiDou Galileo QZSS


20180221_233340 [Smoothed TC Combined] - Accelerometer Bias Plot
Bias (m/s^2)
0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
345000
346000
347000
348000
349000
350000
351000
352000
353000
354000
355000
356000
357000
358000
359000
Week 1989
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180221_233340 [Smoothed TC Combined] - Gyro Drift Plot
Drift (deg/hr)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
345000
346000
347000
348000
349000
350000
351000
352000
353000
354000
355000
356000
357000
358000
359000
Week 1989
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8137\20180221_233340\GnssImu\20180221_233340.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	30093
No processed position:	2
Missing Fwd or Rev:	322
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0166	(m)
C/A Code:	0.33	(m)
L1 Doppler:	0.028	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.019	(m)
North:	0.011	(m)
Height:	0.036	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (29519 occurrences):

East:	0.019	(m)
North:	0.010	(m)
Height:	0.030	(m)

Quality Number Percentages:

Q 1:	100.0 %
Q 2:	0.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

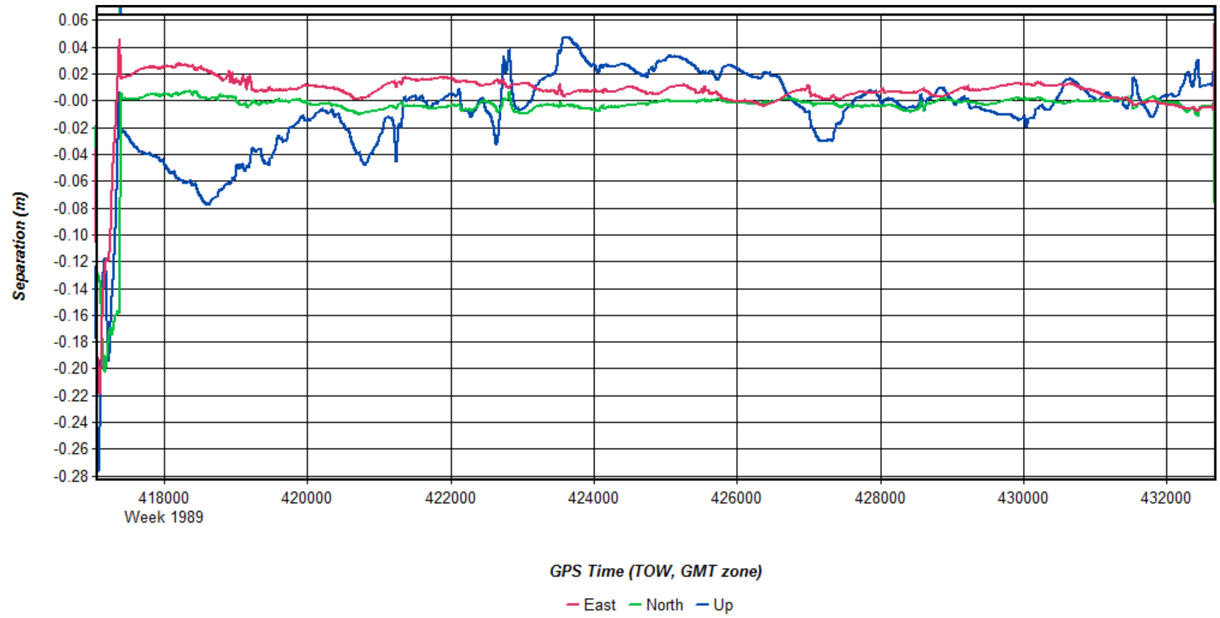
Baseline Distances:

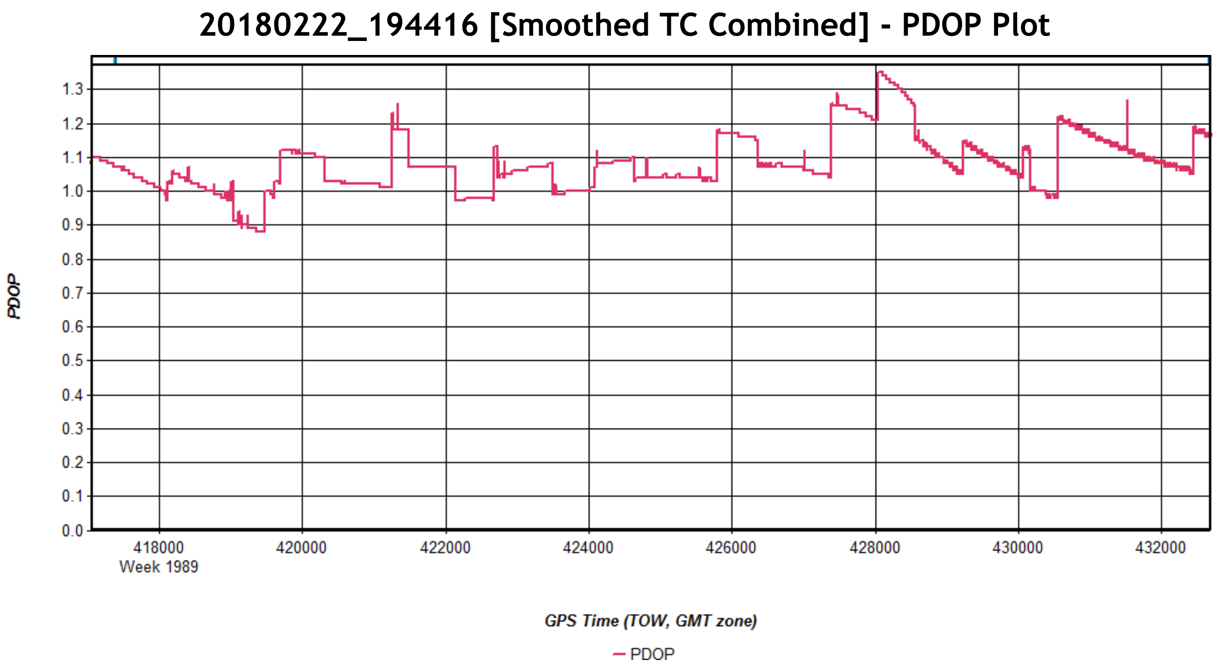
Maximum:	71.529 (km)
Minimum:	1.781 (km)
Average:	18.746 (km)
First Epoch:	70.929 (km)
Last Epoch:	51.650 (km)

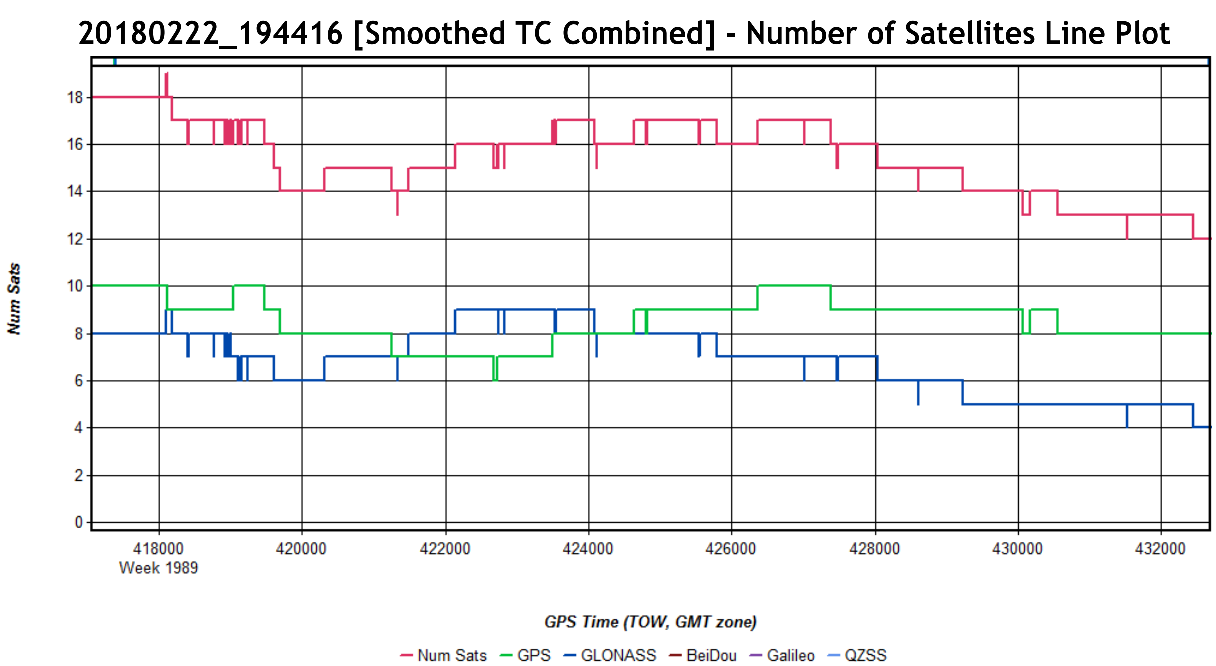
MISSION 02/22/2018 B

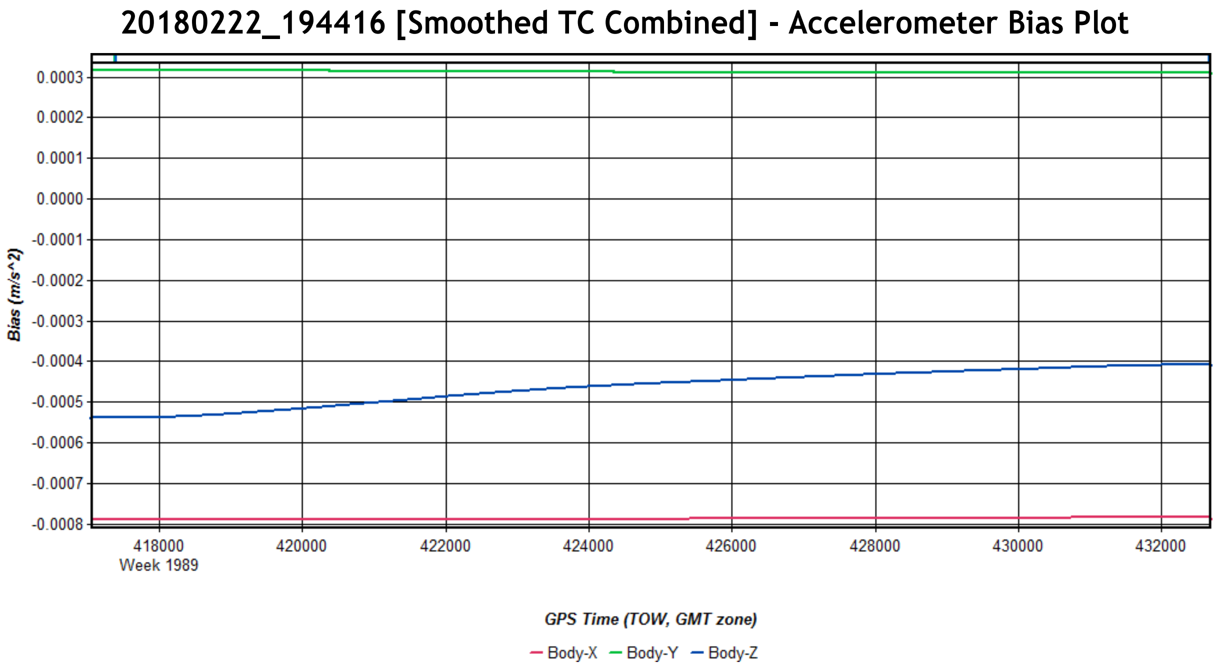
20180222_194416 [Smoothed TC Combined] - Smoothed TC Combined –Map

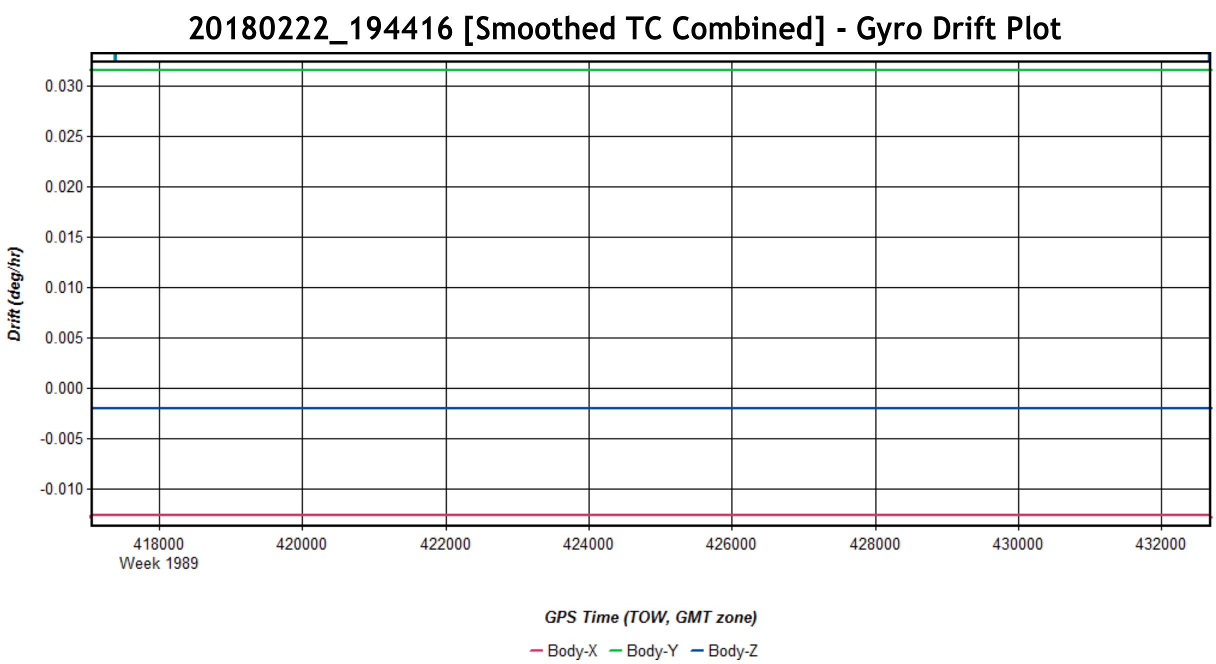
20180222_194416 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot




20180222_194416 [Smoothed TC Combined] - PDOP Plot
PDOP
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
418000
Week 1989
420000
422000
424000
426000
428000
430000
432000
GPS Time (TOW, GMT zone)
PDOP


20180222_194416 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
18
16
14
12
10
8
6
4
2
0
418000
Week 1989
420000
422000
424000
426000
428000
430000
432000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou
Galileo
QZSS


20180222_194416 [Smoothed TC Combined] - Accelerometer Bias Plot
0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
Bias (m/s^2)
418000
Week 1989
420000
422000
424000
426000
428000
430000
432000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180222_194416 [Smoothed TC Combined] - Gyro Drift Plot
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
Drift (deg/hr)
418000
Week 1989
420000
422000
424000
426000
428000
430000
432000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8137\20180222_194416\GnssImu\20180222_194416.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	31931
No processed position:	617
Missing Fwd or Rev:	86
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0175	(m)
C/A Code:	0.34	(m)
L1 Doppler:	0.029	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.020	(m)
North:	0.024	(m)
Height:	0.033	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (30559 occurrences):

East:	0.011	(m)
North:	0.004	(m)
Height:	0.026	(m)

Quality Number Percentages:

Q 1:	99.8 %
Q 2:	0.2 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

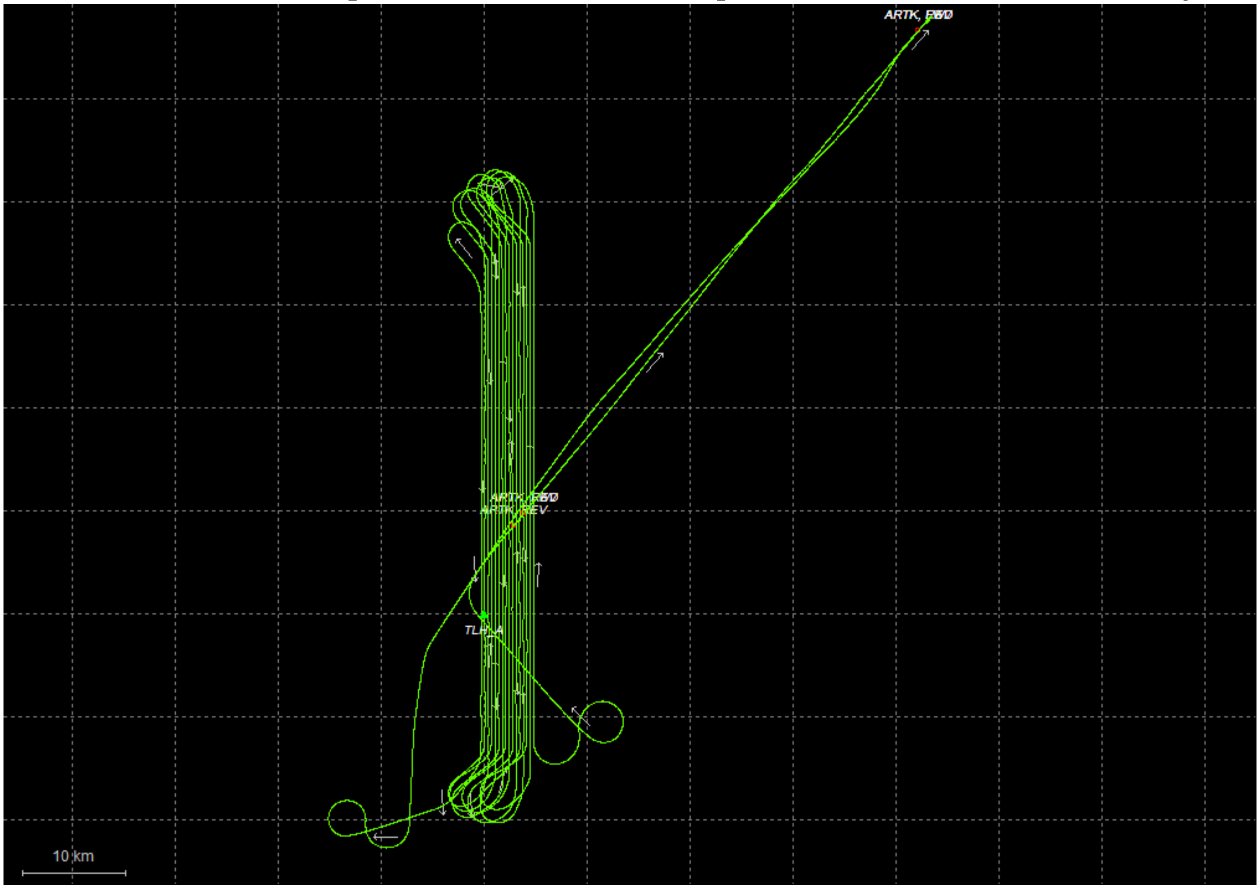
DOP over Tol: 0.0 %

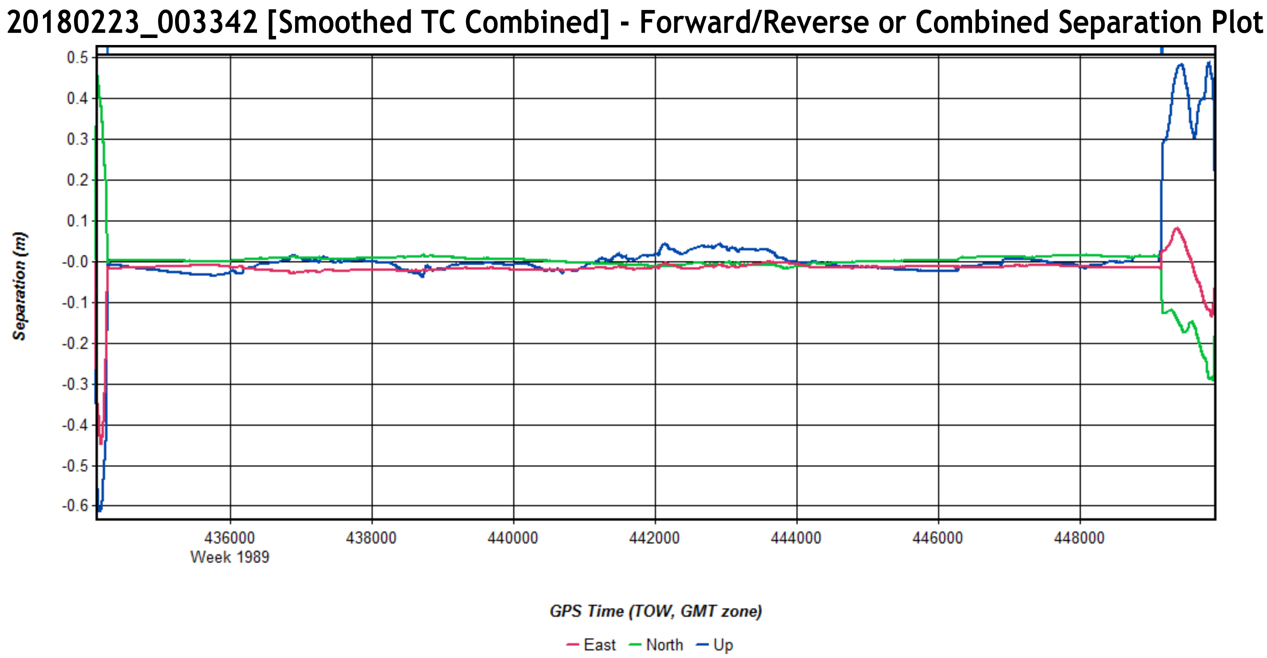
Baseline Distances:

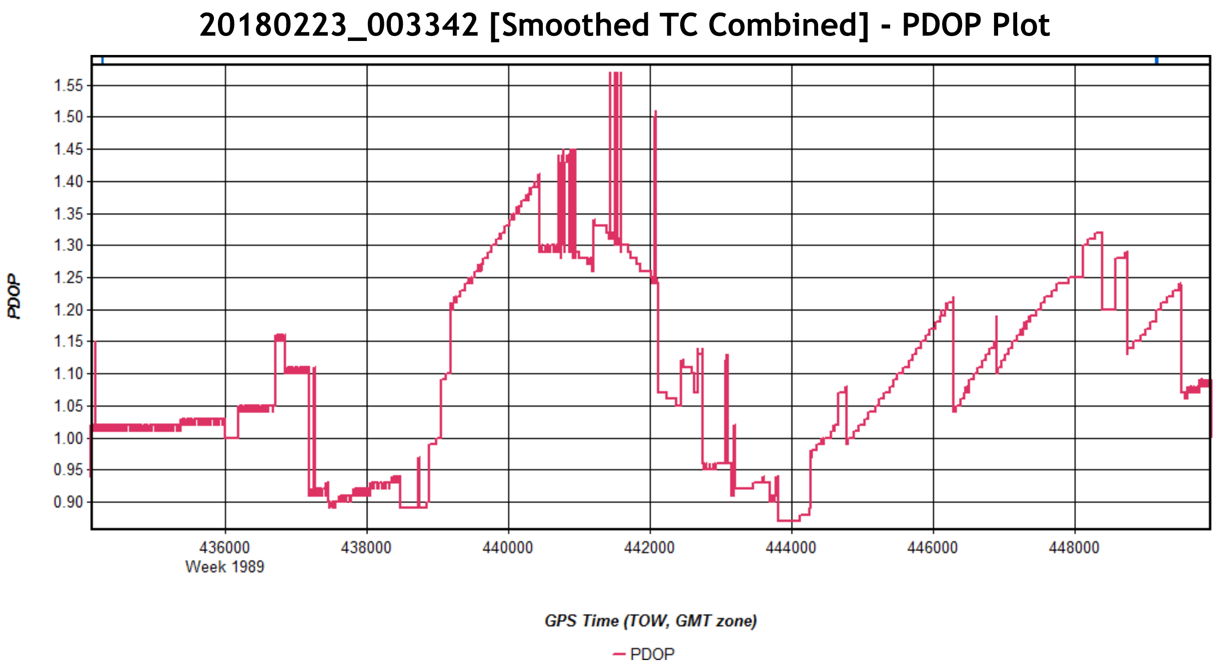
Maximum:	70.742 (km)
Minimum:	0.608 (km)
Average:	17.005 (km)
First Epoch:	57.455 (km)
Last Epoch:	70.742 (km)

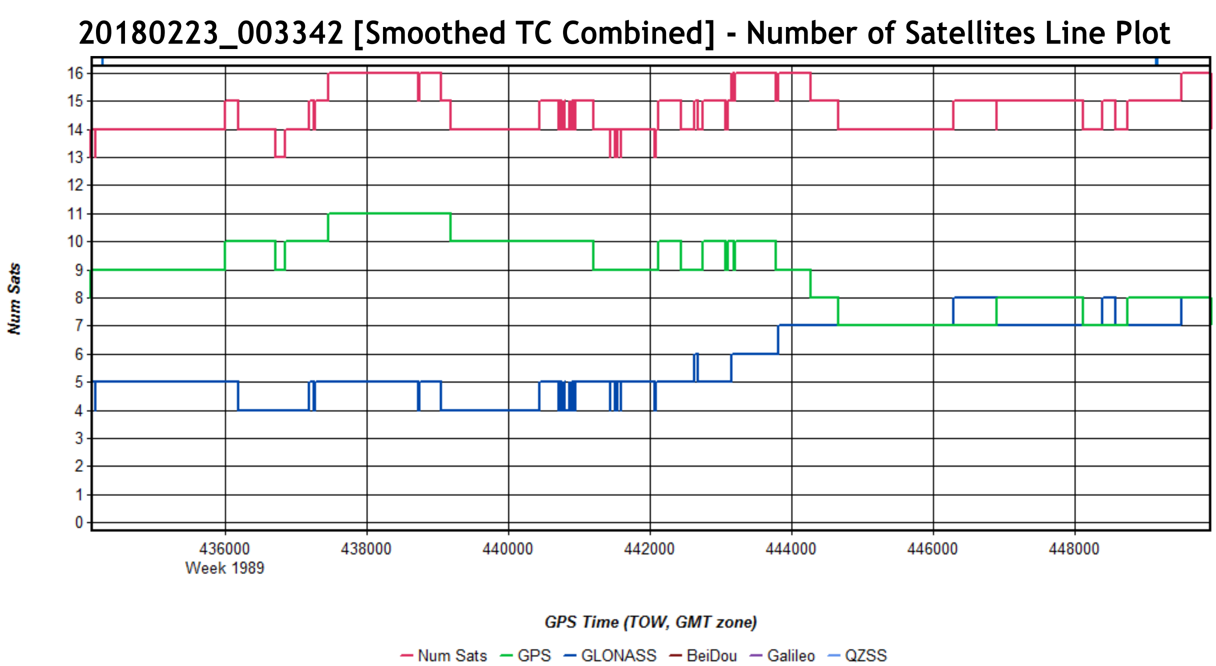
MISSION 02/23/2018 A

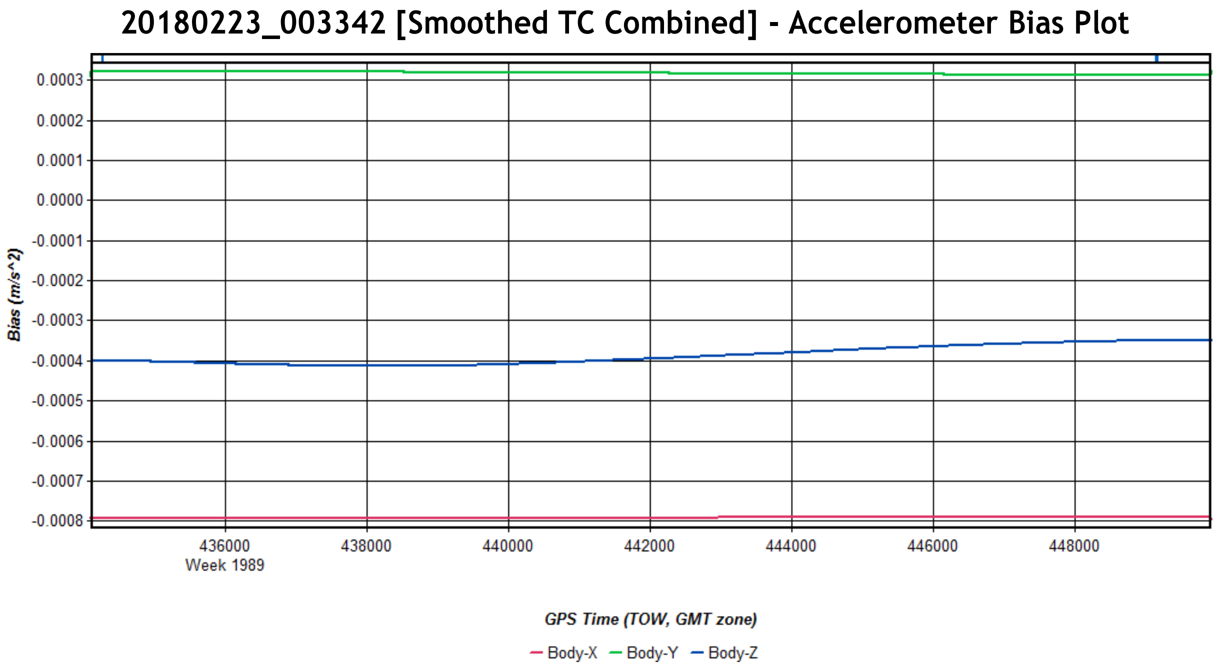
20180223_003342 [Smoothed TC Combined] - Smoothed TC Combined - Map

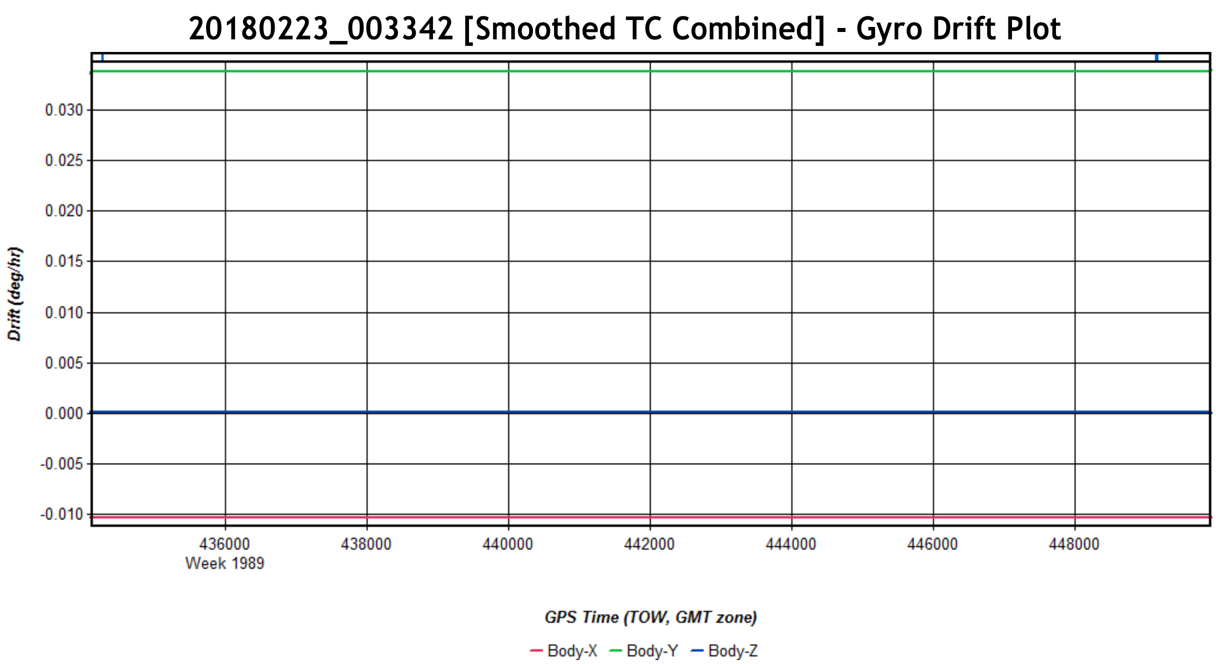



20180223_003342 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot
Separation (m)
0.5
0.4
0.3
0.2
0.1
-0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
436000
Week 1989
438000
440000
442000
444000
446000
448000
GPS Time (TOW, GMT zone)
East
North
Up


20180223_003342 [Smoothed TC Combined] - PDOP Plot
PDOP
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
436000
Week 1989
438000
440000
442000
444000
446000
448000
GPS Time (TOW, GMT zone)
PDOP


20180223_003342 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
436000
Week 1989
438000
440000
442000
444000
446000
448000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou
Galileo
QZSS


20180223_003342 [Smoothed TC Combined] - Accelerometer Bias Plot
0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
Bias (m/s^2)
436000
Week 1989
438000
440000
442000
444000
446000
448000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180223_003342 [Smoothed TC Combined] - Gyro Drift Plot
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
Drift (deg/h)
436000
Week 1989
438000
440000
442000
444000
446000
448000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8137\20180223_003342\GnssImu\20180223_003342.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	31675
No processed position:	2
Missing Fwd or Rev:	42
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0174	(m)
C/A Code:	0.37	(m)
L1 Doppler:	0.032	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.042	(m)
North:	0.053	(m)
Height:	0.103	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (29799 occurrences):

East:	0.016	(m)
North:	0.008	(m)
Height:	0.018	(m)

Quality Number Percentages:

Q 1:	100.0 %
Q 2:	0.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

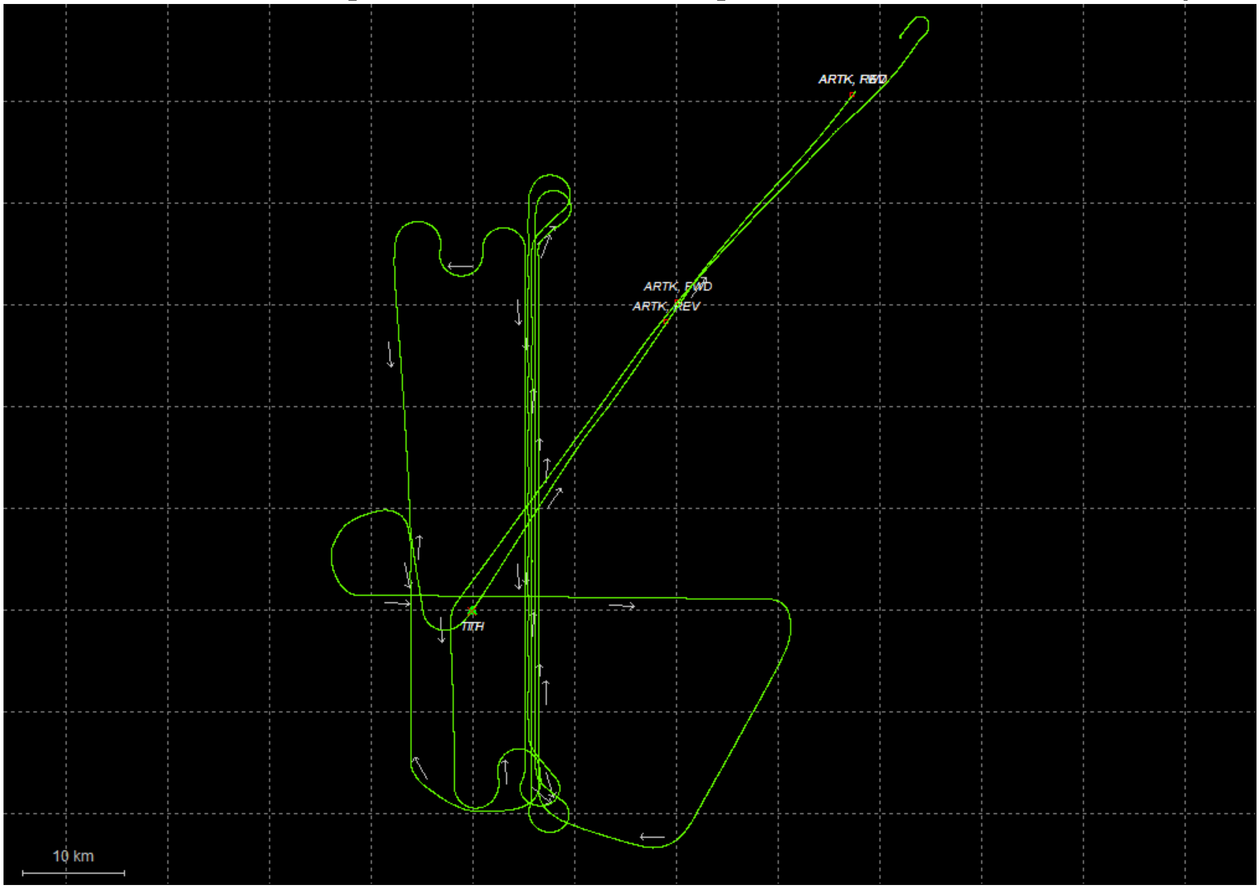
DOP over Tol: 0.0 %

Baseline Distances:

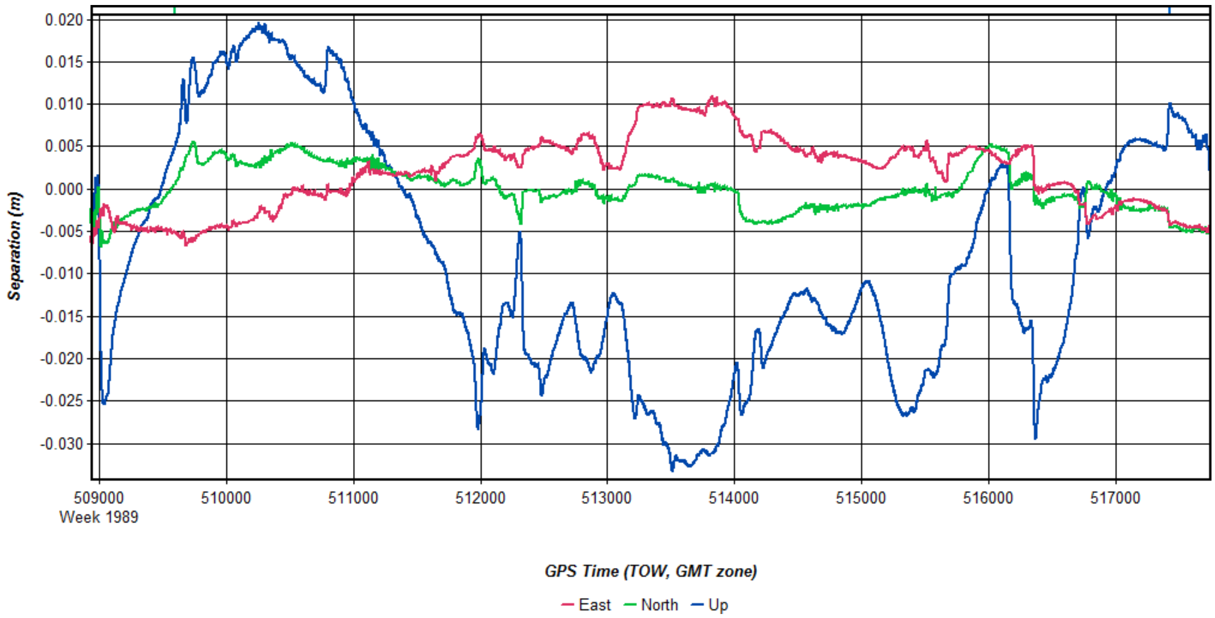
Maximum:	71.529 (km)
Minimum:	0.056 (km)
Average:	20.628 (km)
First Epoch:	70.768 (km)
Last Epoch:	71.220 (km)

MISSION 02/23/2018 C

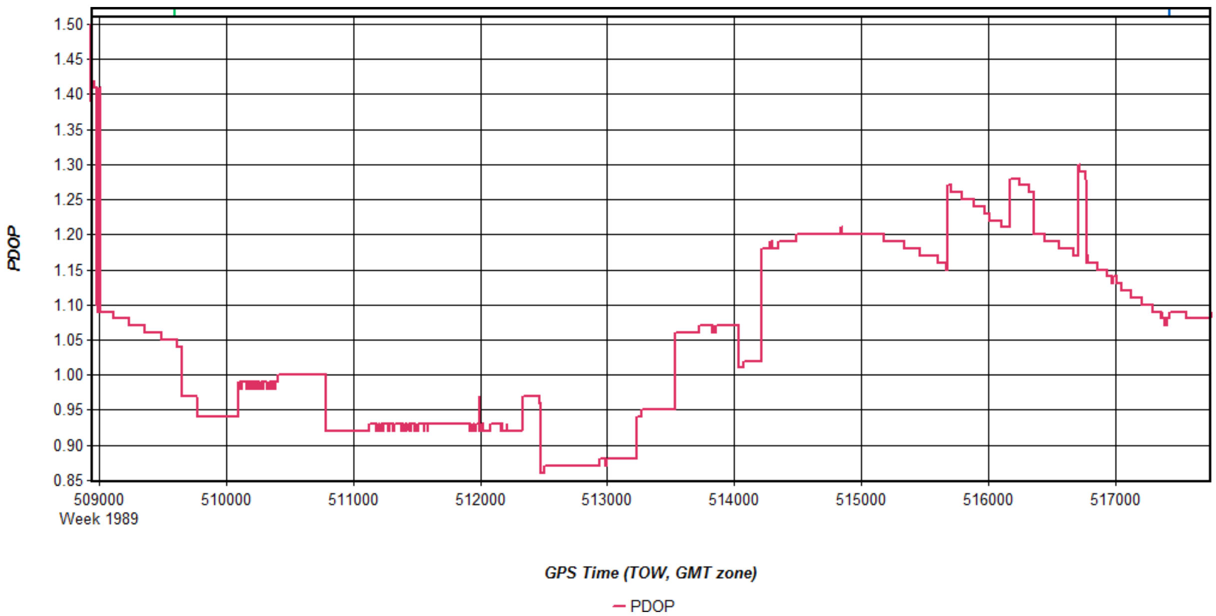
20180223_212057 [Smoothed TC Combined] - Smoothed TC Combined - Map



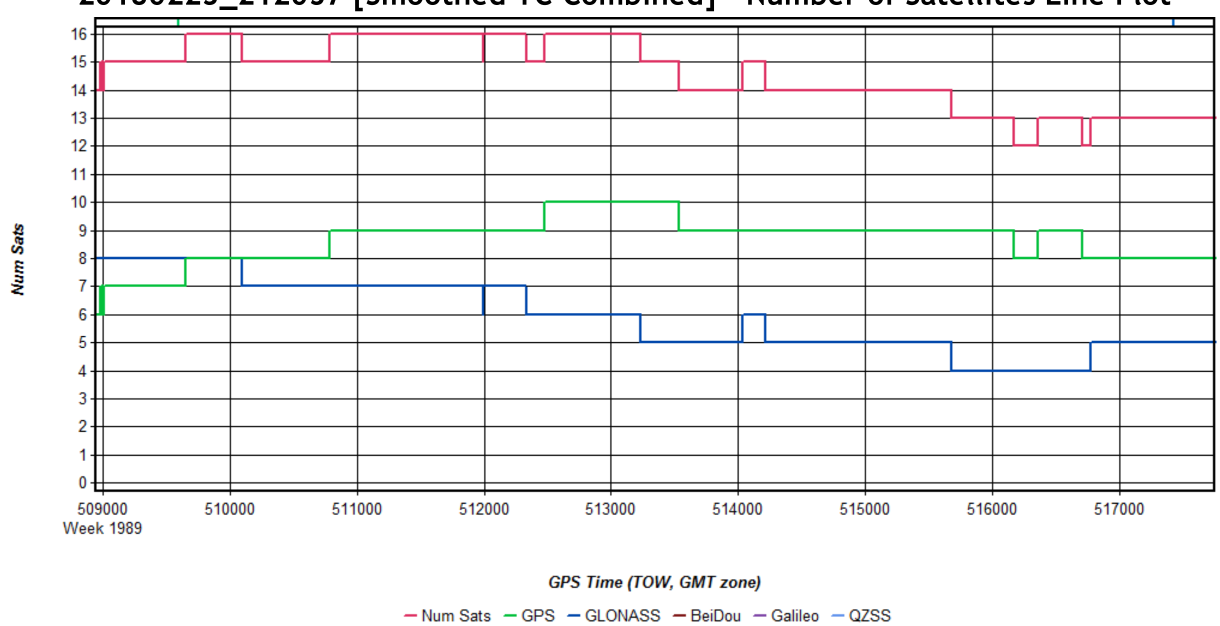
20180223_212057 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot

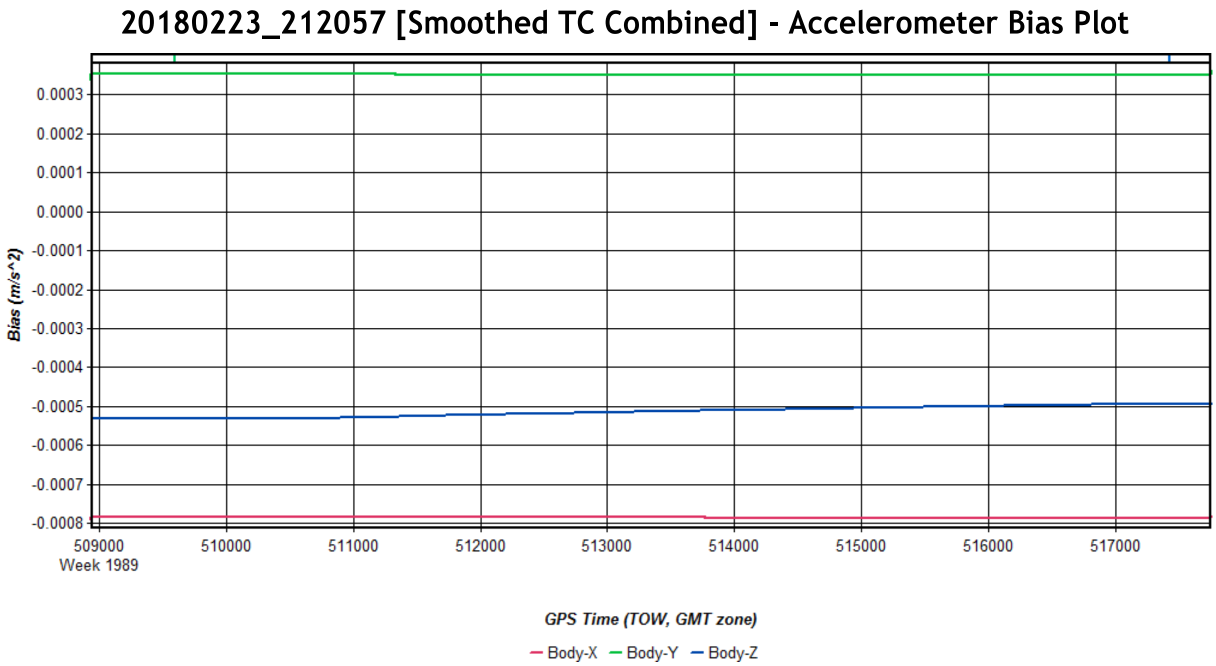


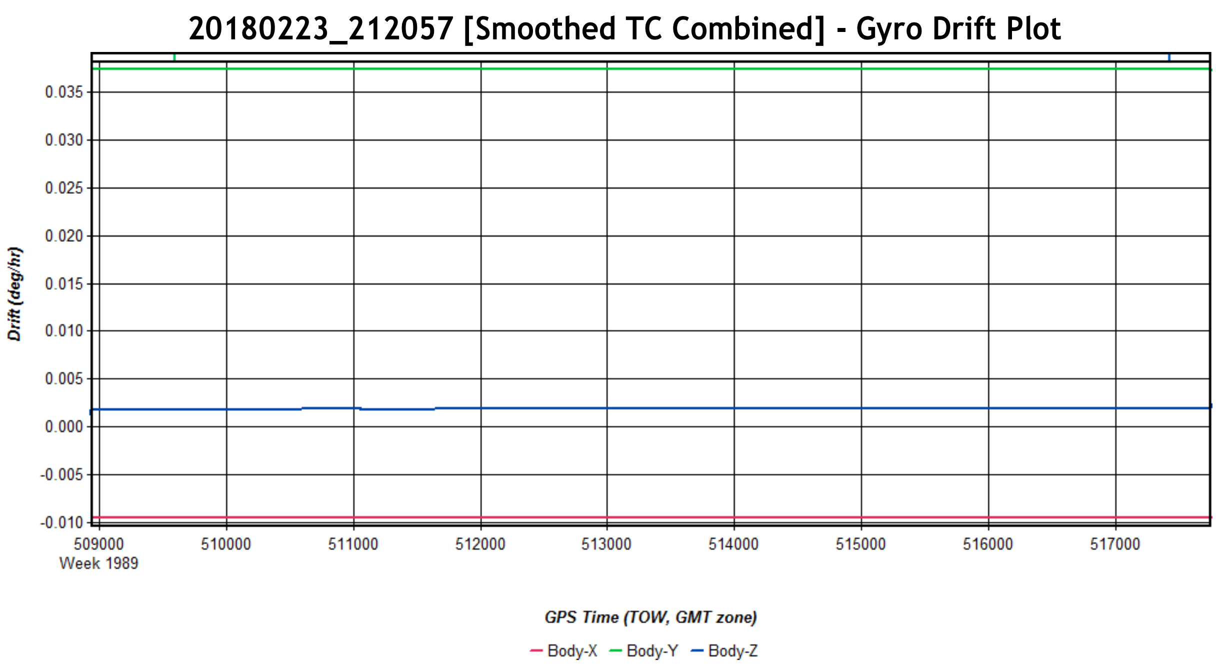
20180223_212057 [Smoothed TC Combined] - PDOP Plot



20180223_212057 [Smoothed TC Combined] - Number of Satellites Line Plot




20180223_212057 [Smoothed TC Combined] - Accelerometer Bias Plot
Bias (m/s^2)
0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
509000
Week 1989
510000
511000
512000
513000
514000
515000
516000
517000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180223_212057 [Smoothed TC Combined] - Gyro Drift Plot
Drift (deg/hr)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
509000
Week 1989
510000
511000
512000
513000
514000
515000
516000
517000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8137\20180223_212057\GnssImu\20180223_212057.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	17983
No processed position:	338
Missing Fwd or Rev:	2
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0170	(m)
C/A Code:	0.36	(m)
L1 Doppler:	0.029	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.005	(m)
North:	0.003	(m)
Height:	0.016	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (17634 occurrences):

East:	0.005	(m)
North:	0.003	(m)
Height:	0.016	(m)

Quality Number Percentages:

Q 1:	100.0 %
Q 2:	0.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

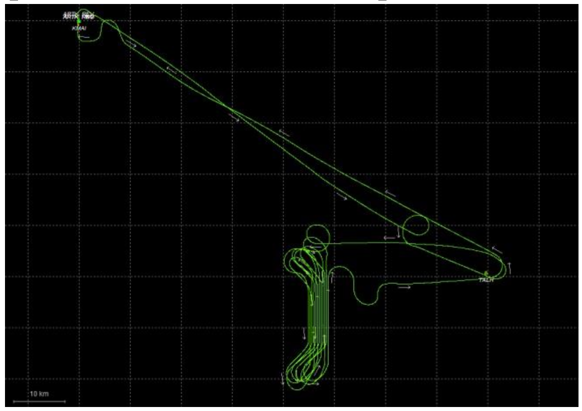
DOP over Tol: 0.0 %

Baseline Distances:

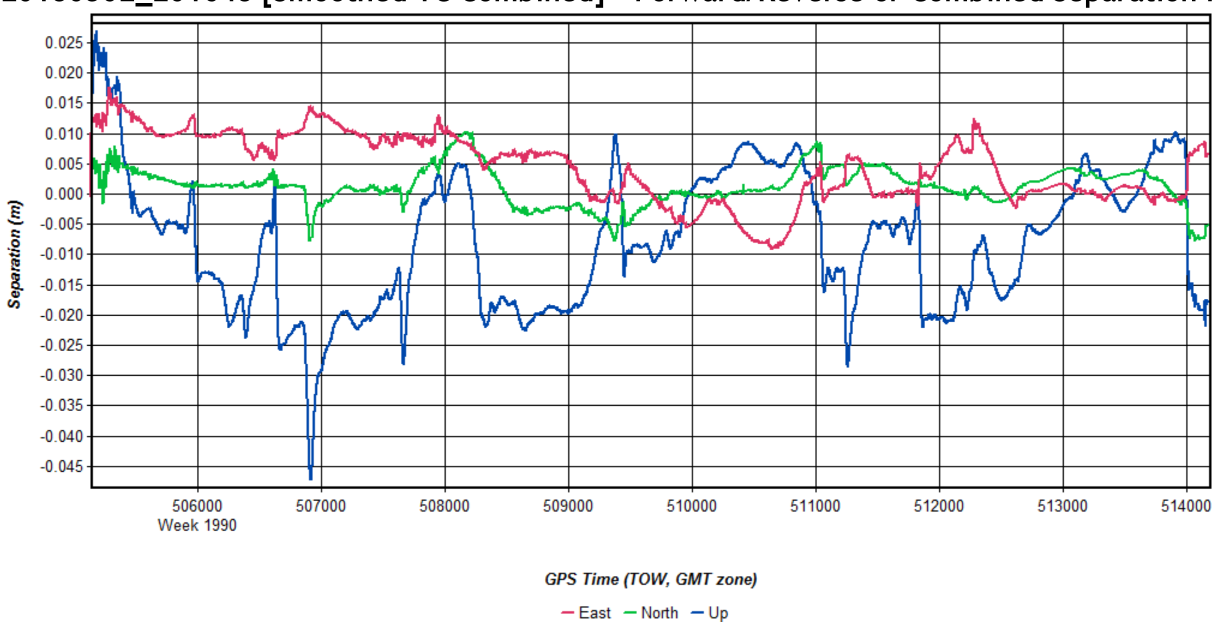
Maximum:	72.745 (km)
Minimum:	0.020 (km)
Average:	22.805 (km)
First Epoch:	69.894 (km)
Last Epoch:	62.919 (km)

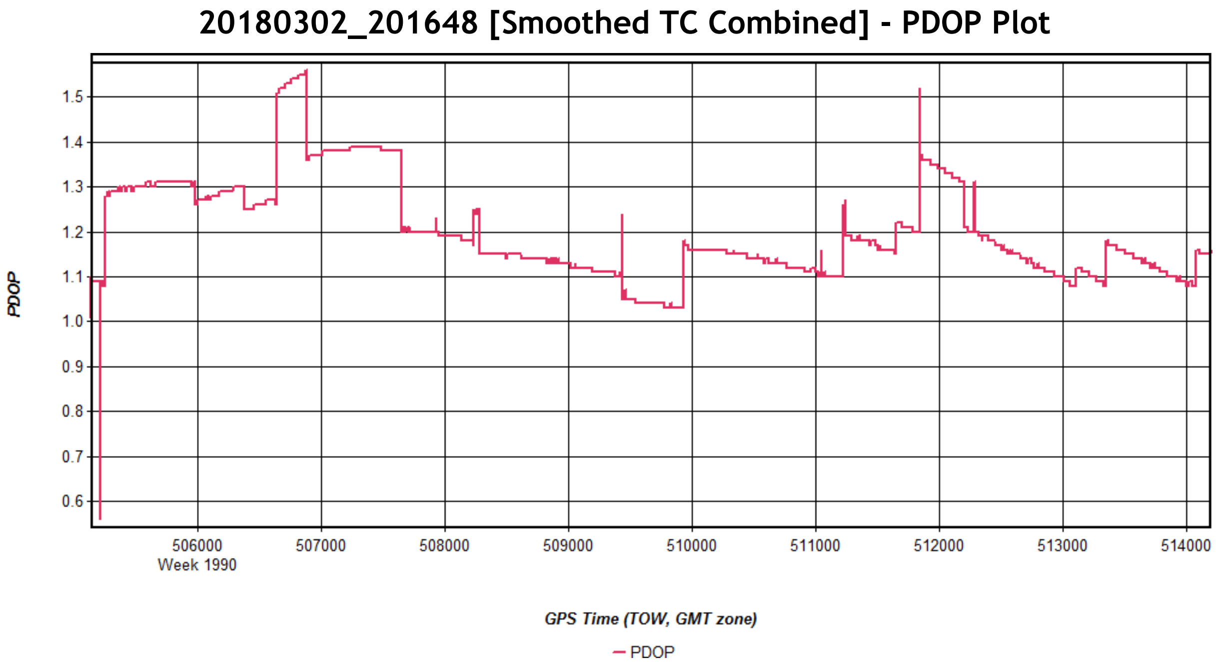
MISSION 03/02/2018 A

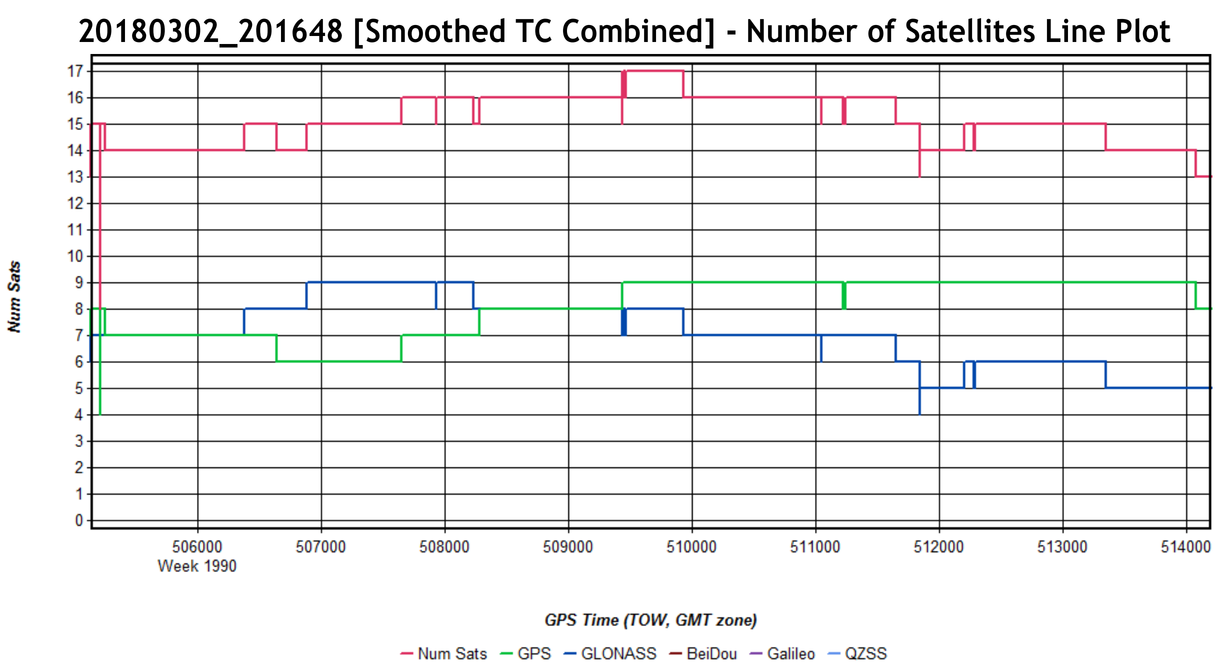
20180302_201648 [Smoothed TC Combined] - Smoothed TC Combined – Map

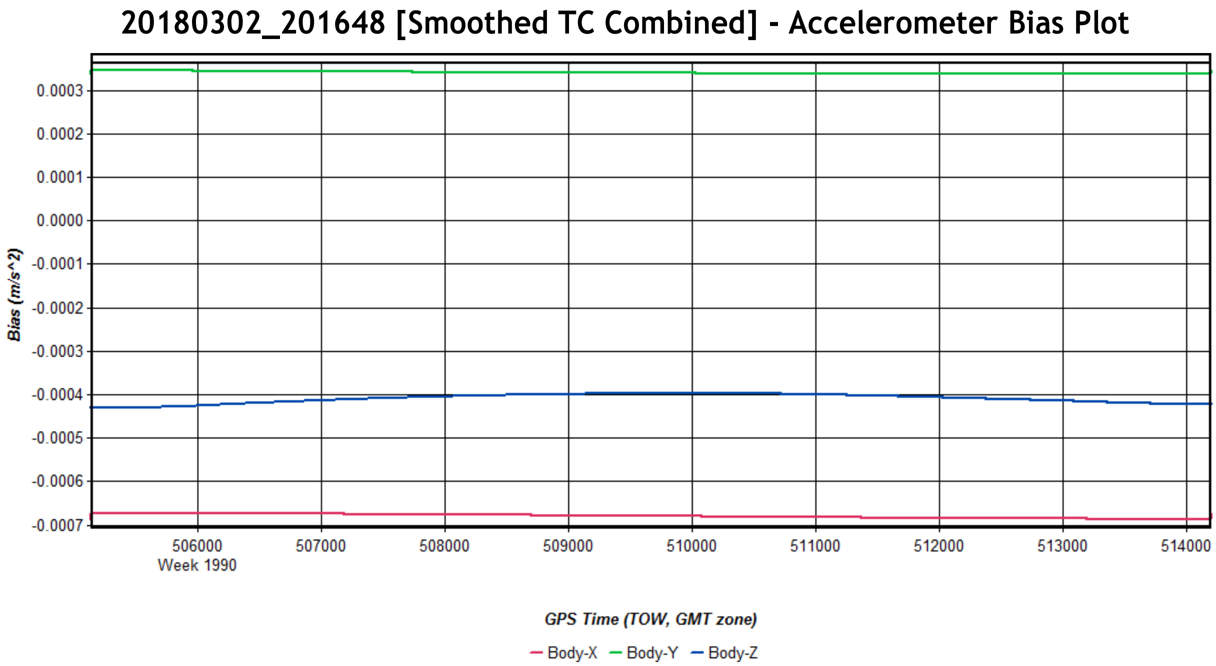


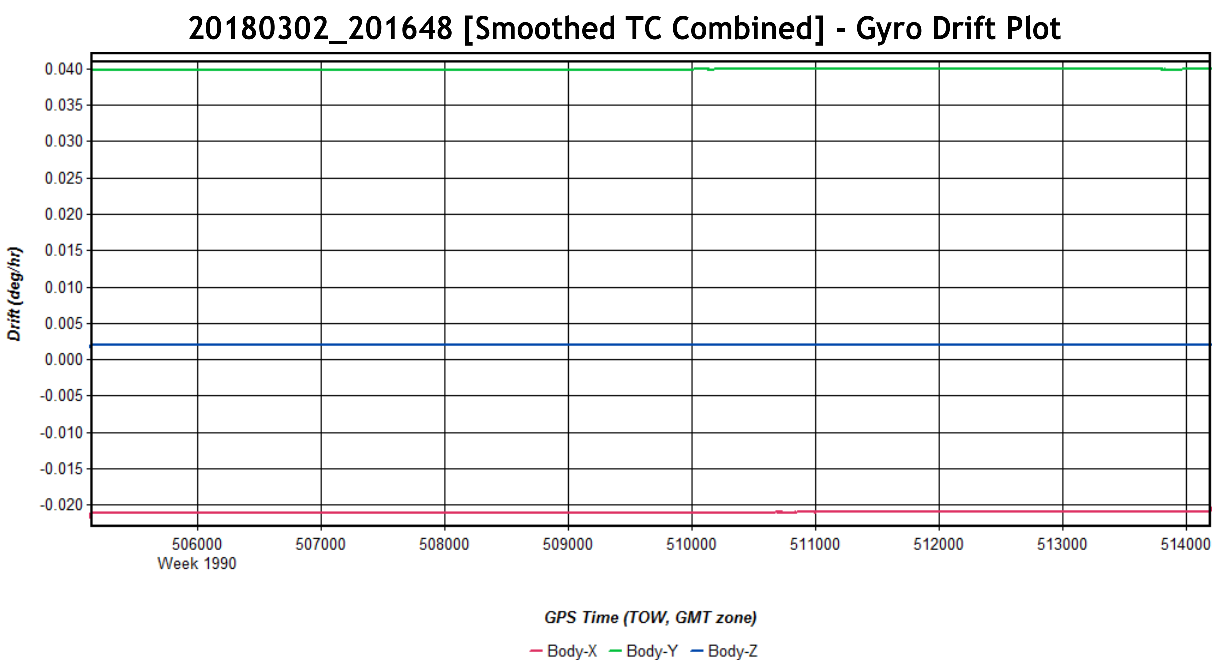
20180302_201648 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot




20180302_201648 [Smoothed TC Combined] - PDOP Plot
PDOP
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
506000
Week 1990
507000
508000
509000
510000
511000
512000
513000
514000
GPS Time (TOW, GMT zone)
PDOP


20180302_201648 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
506000
Week 1990
507000
508000
509000
510000
511000
512000
513000
514000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou
Galileo
QZSS


20180302_201648 [Smoothed TC Combined] - Accelerometer Bias Plot
Bias (m/s^2)
0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
506000
Week 1990
507000
508000
509000
510000
511000
512000
513000
514000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180302_201648 [Smoothed TC Combined] - Gyro Drift Plot
Drift (deg/h)
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
506000
Week 1990
507000
508000
509000
510000
511000
512000
513000
514000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8137\20180302_201648\GnssImu\20180302_201648.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	18145
No processed position:	2
Missing Fwd or Rev:	2
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0148	(m)
C/A Code:	0.30	(m)
L1 Doppler:	0.030	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.007	(m)
North:	0.003	(m)
Height:	0.014	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (18140 occurrences):

East:	0.007	(m)
North:	0.003	(m)
Height:	0.014	(m)

Quality Number Percentages:

Q 1:	100.0 %
Q 2:	0.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

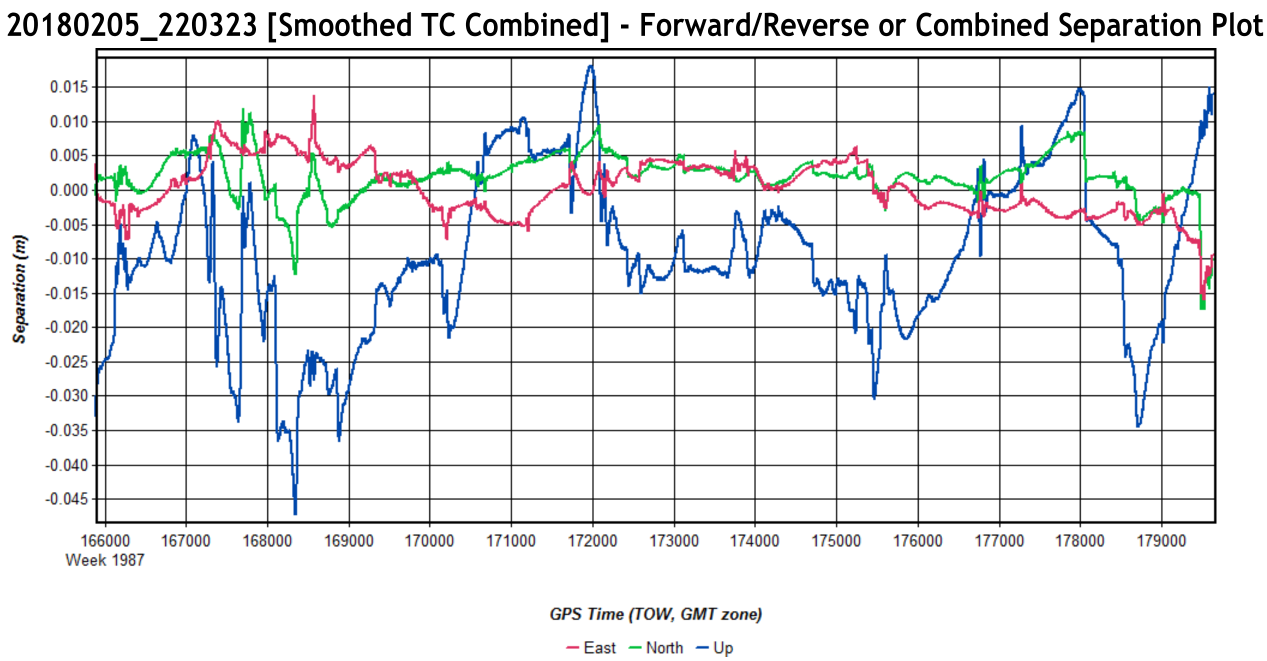
DOP over Tol: 0.0 %

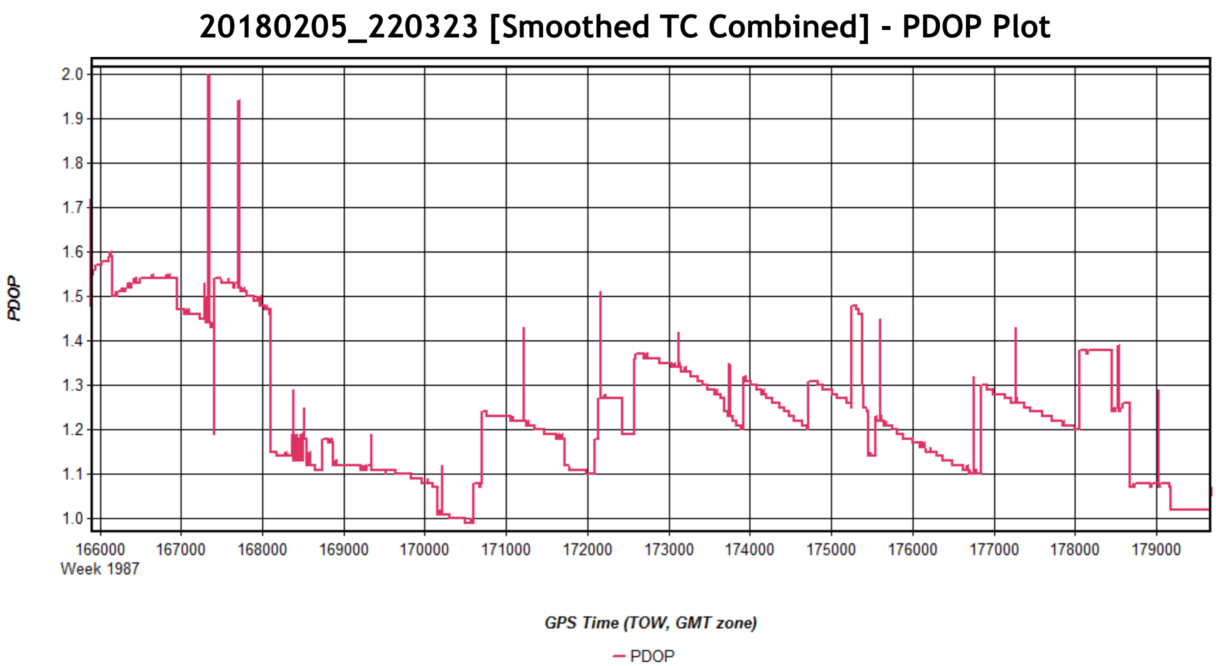
Baseline Distances:

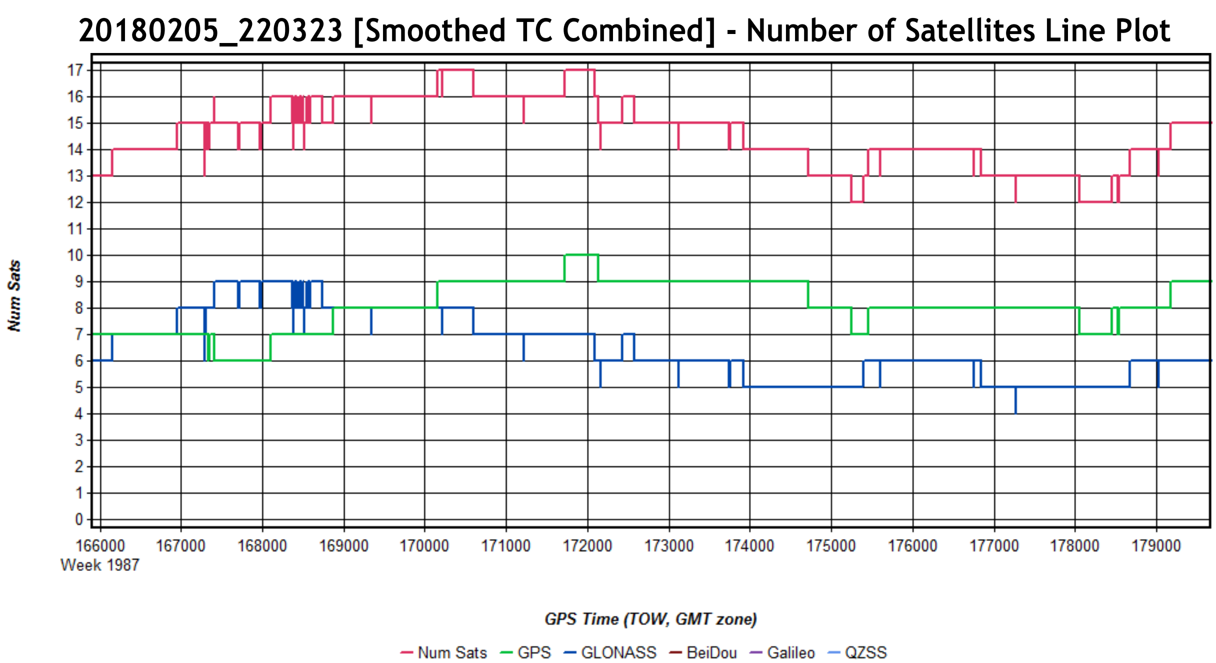
Maximum:	96.413	(km)
Minimum:	0.083	(km)
Average:	60.913	(km)
First Epoch:	0.629	(km)
Last Epoch:	0.083	(km)

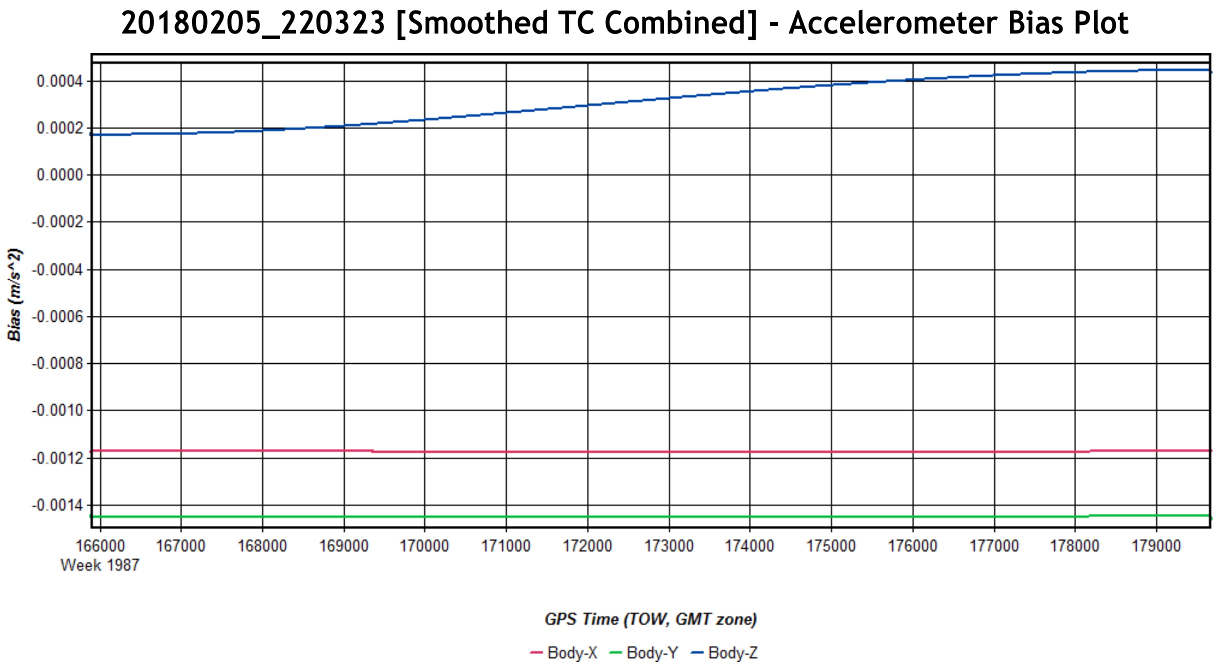
ALS 80 SN8235
MISSION 02/05/2018 C

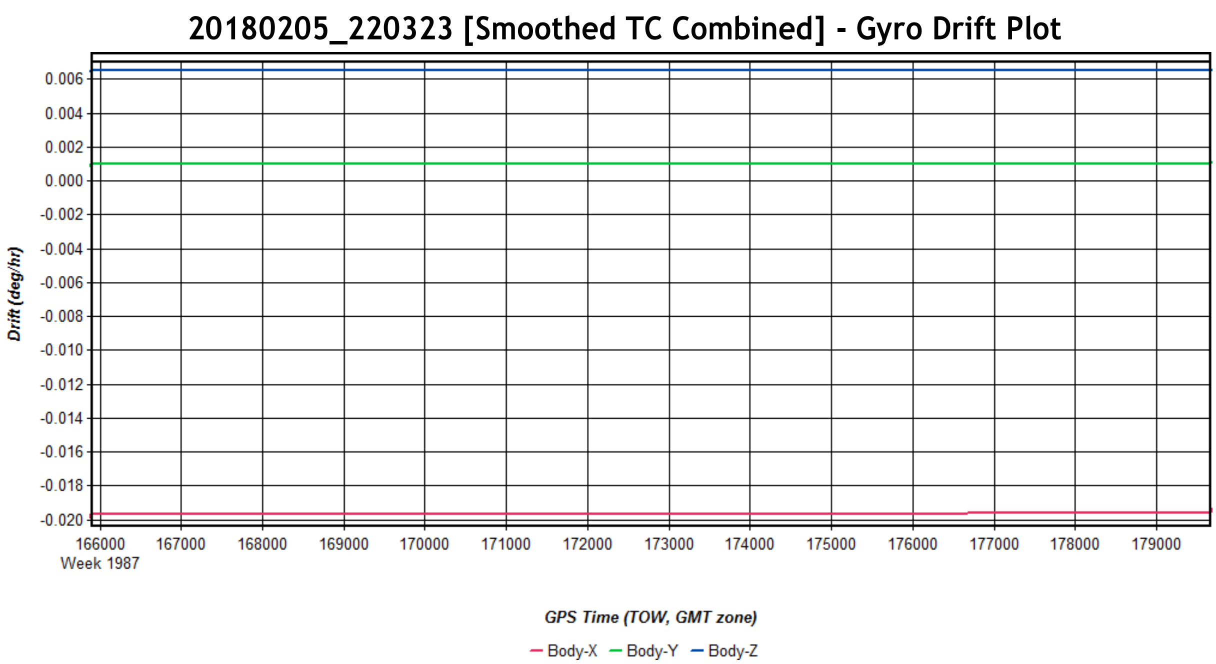
20180205_220323 [Smoothed TC Combined] - Smoothed TC Combined - Map


20180205_220323 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot
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
Separation (m)
166000
Week 1987
167000
168000
169000
170000
171000
172000
173000
174000
175000
176000
177000
178000
179000
GPS Time (TOW, GMT zone)
East
North
Up


20180205_220323 [Smoothed TC Combined] - PDOP Plot
PDOP
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
166000
Week 1987
167000
168000
169000
170000
171000
172000
173000
174000
175000
176000
177000
178000
179000
GPS Time (TOW, GMT zone)
PDOP


20180205_220323 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
166000
Week 1987
167000
168000
169000
170000
171000
172000
173000
174000
175000
176000
177000
178000
179000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou
Galileo
QZSS


20180205_220323 [Smoothed TC Combined] - Accelerometer Bias Plot
Bias (m/s^2)
0.0004
0.0002
0.0000
-0.0002
-0.0004
-0.0006
-0.0008
-0.0010
-0.0012
-0.0014
166000
Week 1987
167000
168000
169000
170000
171000
172000
173000
174000
175000
176000
177000
178000
179000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180205_220323 [Smoothed TC Combined] - Gyro Drift Plot
Drift (deg/hr)
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
-0.020
166000
Week 1987
167000
168000
169000
170000
171000
172000
173000
174000
175000
176000
177000
178000
179000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8235\20180205_220323\GnssImu\20180205_220323.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	27584
No processed position:	3
Missing Fwd or Rev:	2
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0152	(m)
C/A Code:	0.30	(m)
L1 Doppler:	0.030	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.004	(m)
North:	0.004	(m)
Height:	0.015	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (27579 occurrences):

East:	0.004	(m)
North:	0.004	(m)
Height:	0.015	(m)

Quality Number Percentages:

Q 1:	100.0 %
Q 2:	0.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

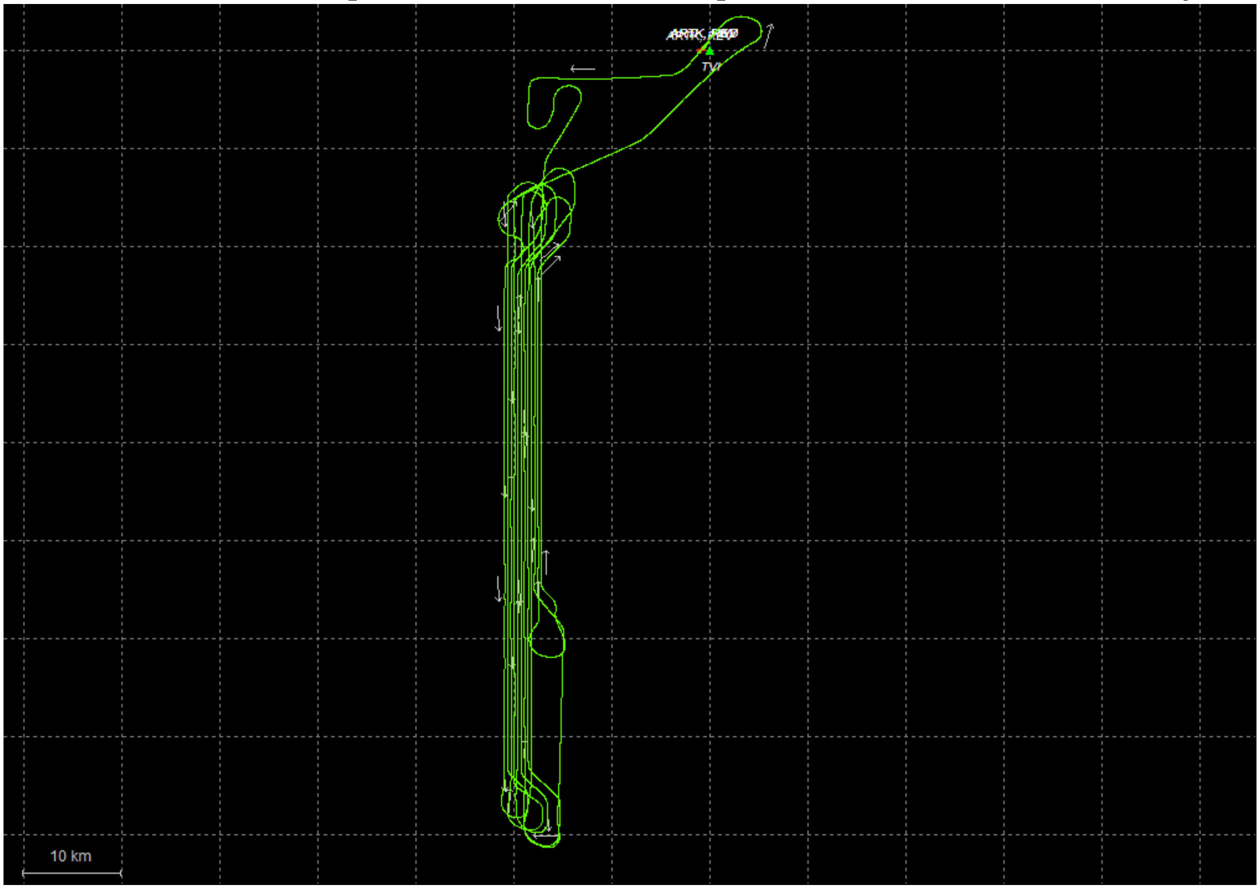
DOP over Tol: 0.0 %

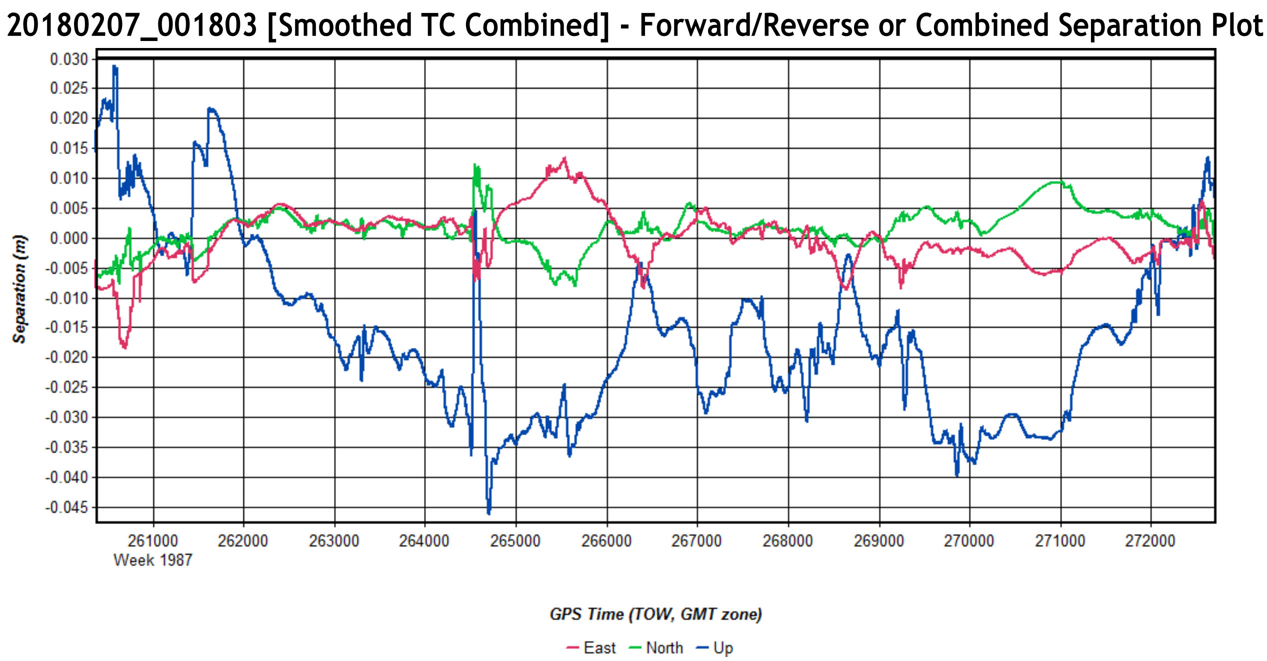
Baseline Distances:

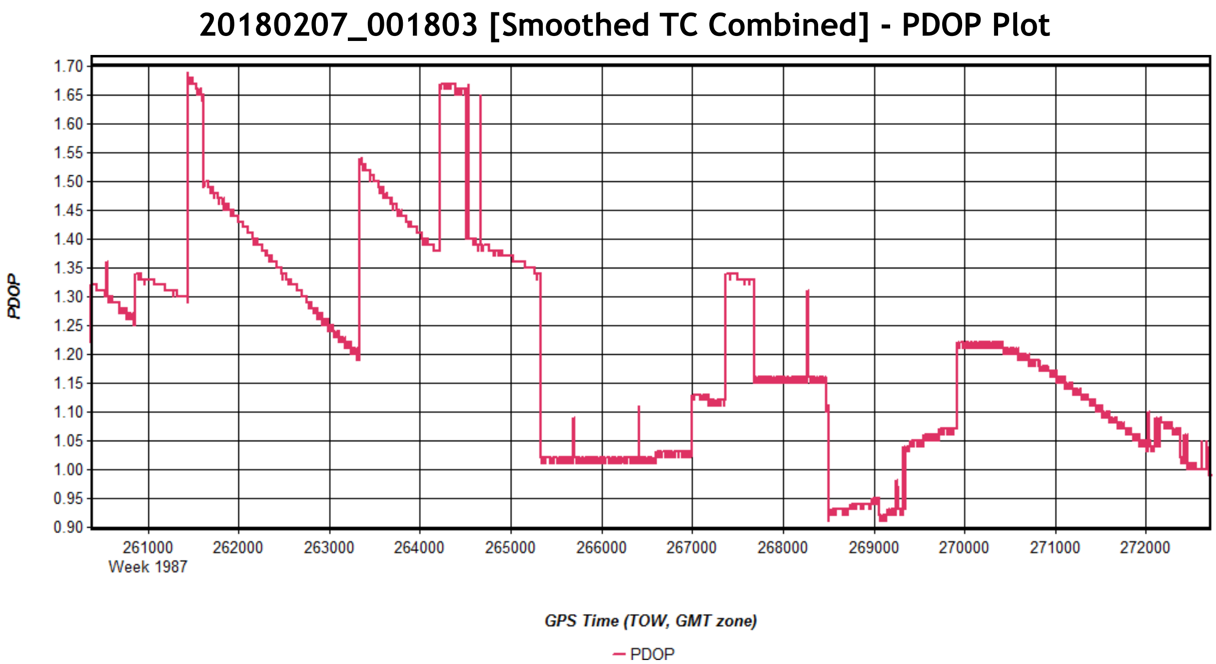
Maximum:	61.648	(km)
Minimum:	0.508	(km)
Average:	34.229	(km)
First Epoch:	0.642	(km)
Last Epoch:	0.516	(km)

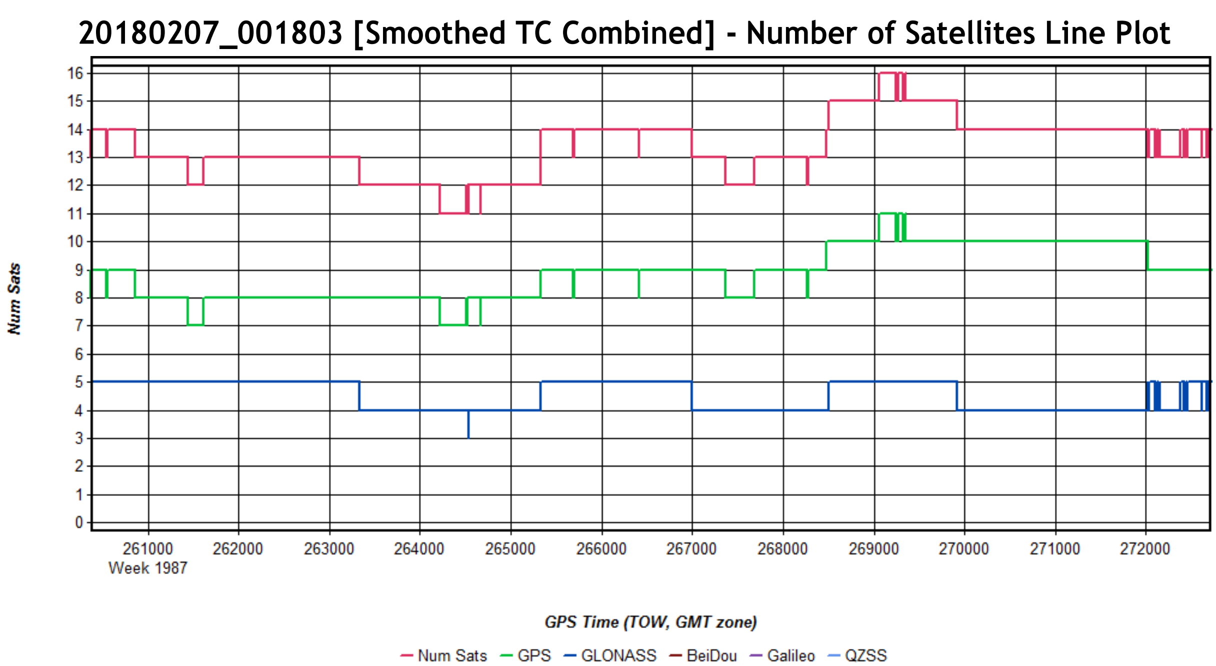
MISSION 02/07/2018 B

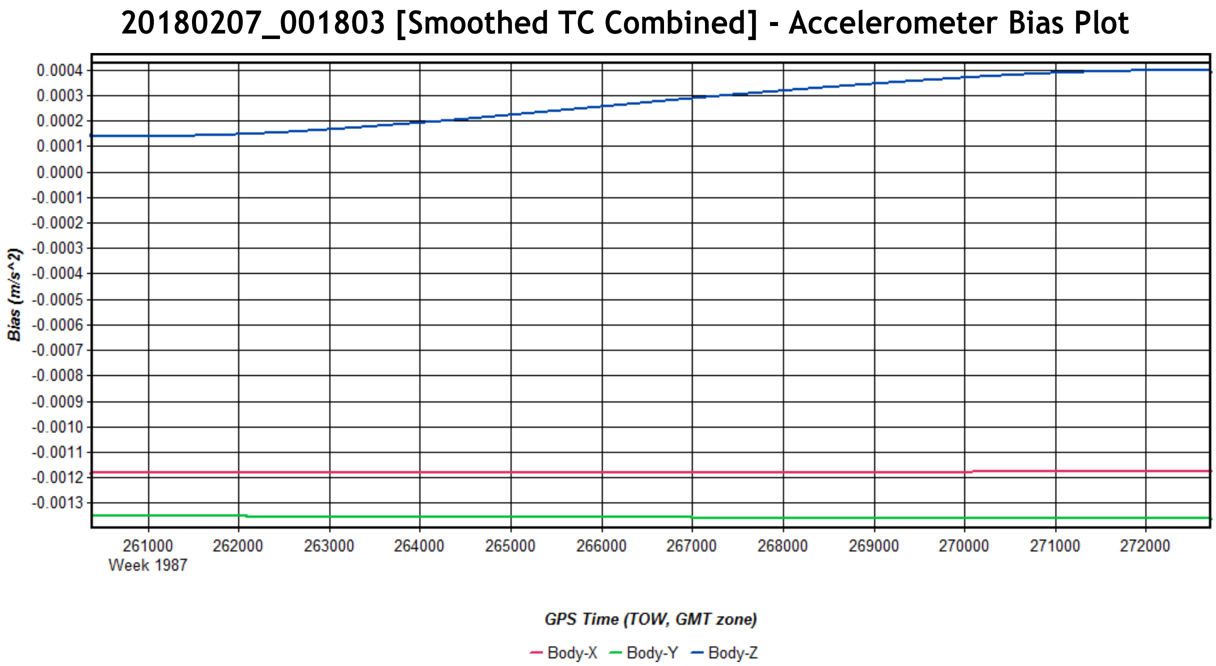
20180207_001803 [Smoothed TC Combined] - Smoothed TC Combined - Map

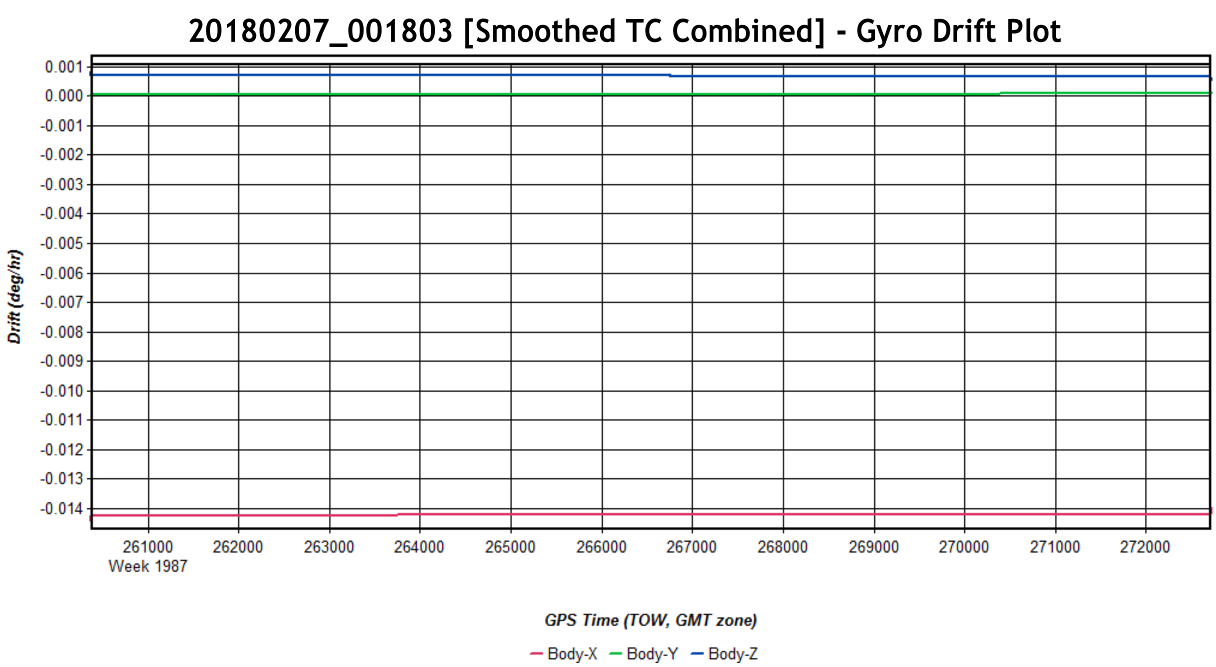



20180207_001803 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
-0.045
Separation (m)
261000
Week 1987
262000
263000
264000
265000
266000
267000
268000
269000
270000
271000
272000
GPS Time (TOW, GMT zone)
East
North
Up


20180207_001803 [Smoothed TC Combined] - PDOP Plot
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
261000
Week 1987
262000
263000
264000
265000
266000
267000
268000
269000
270000
271000
272000
GPS Time (TOW, GMT zone)
PDOP


20180207_001803 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
261000
Week 1987
262000
263000
264000
265000
266000
267000
268000
269000
270000
271000
272000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou
Galileo
QZSS


20180207_001803 [Smoothed TC Combined] - Accelerometer Bias Plot
Bias (m/s^2)
0.0004
0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
-0.0009
-0.0010
-0.0011
-0.0012
-0.0013
261000
Week 1987
262000
263000
264000
265000
266000
267000
268000
269000
270000
271000
272000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180207_001803 [Smoothed TC Combined] - Gyro Drift Plot
Drift (deg/hr)
0.001
0.000
-0.001
-0.002
-0.003
-0.004
-0.005
-0.006
-0.007
-0.008
-0.009
-0.010
-0.011
-0.012
-0.013
-0.014
261000
Week 1987
262000
263000
264000
265000
266000
267000
268000
269000
270000
271000
272000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8235\20180207_001803\GnssImu\20180207_001803.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	24708
No processed position:	3
Missing Fwd or Rev:	2
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0149	(m)
C/A Code:	0.33	(m)
L1 Doppler:	0.028	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.005	(m)
North:	0.004	(m)
Height:	0.022	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (24702 occurrences):

East:	0.005	(m)
North:	0.004	(m)
Height:	0.022	(m)

Quality Number Percentages:

Q 1:	100.0 %
Q 2:	0.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

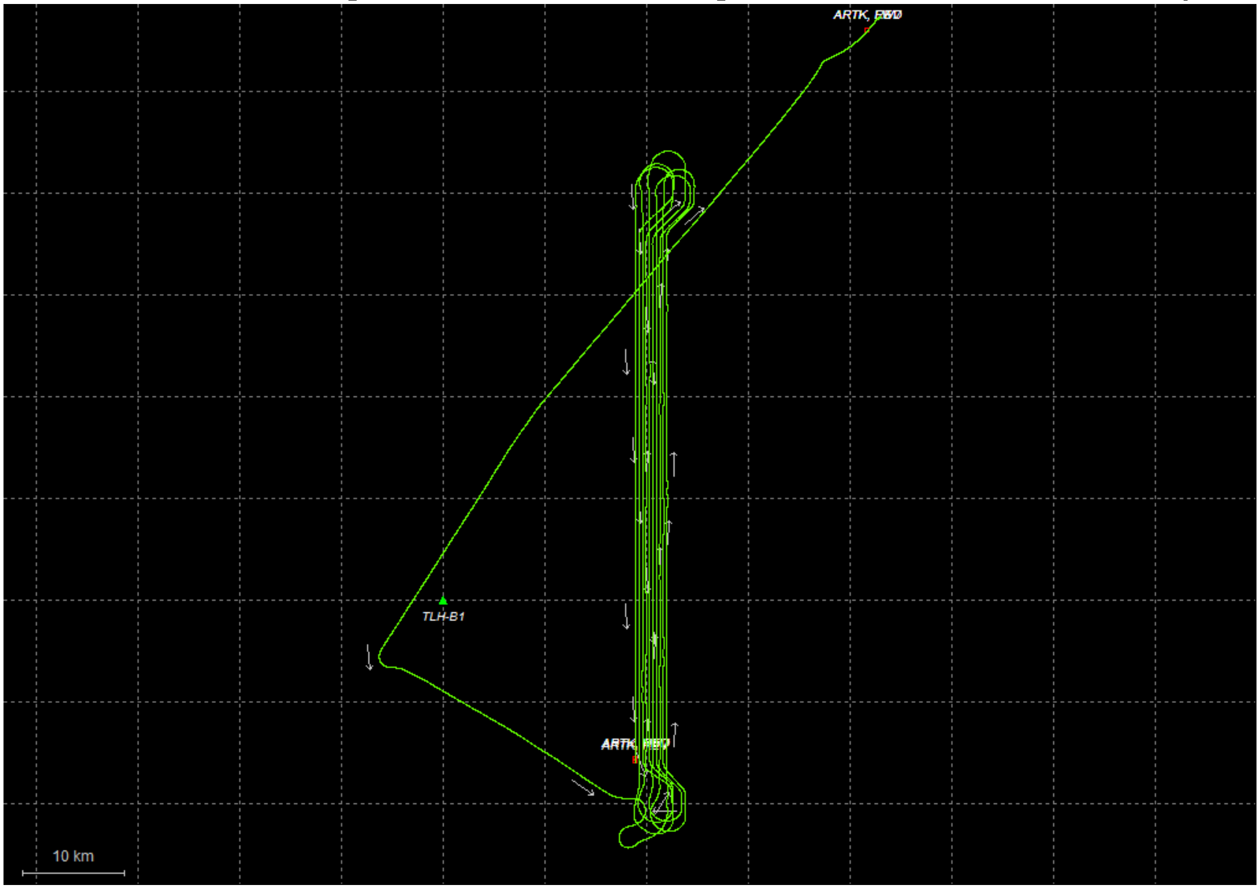
DOP over Tol: 0.0 %

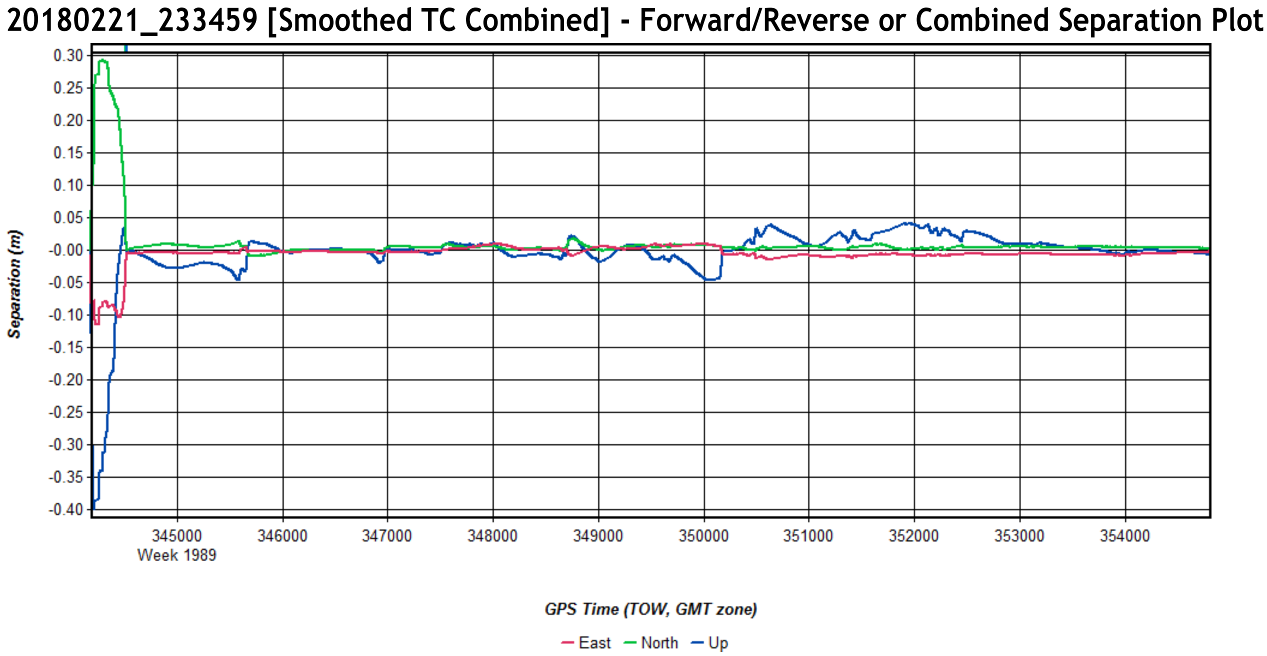
Baseline Distances:

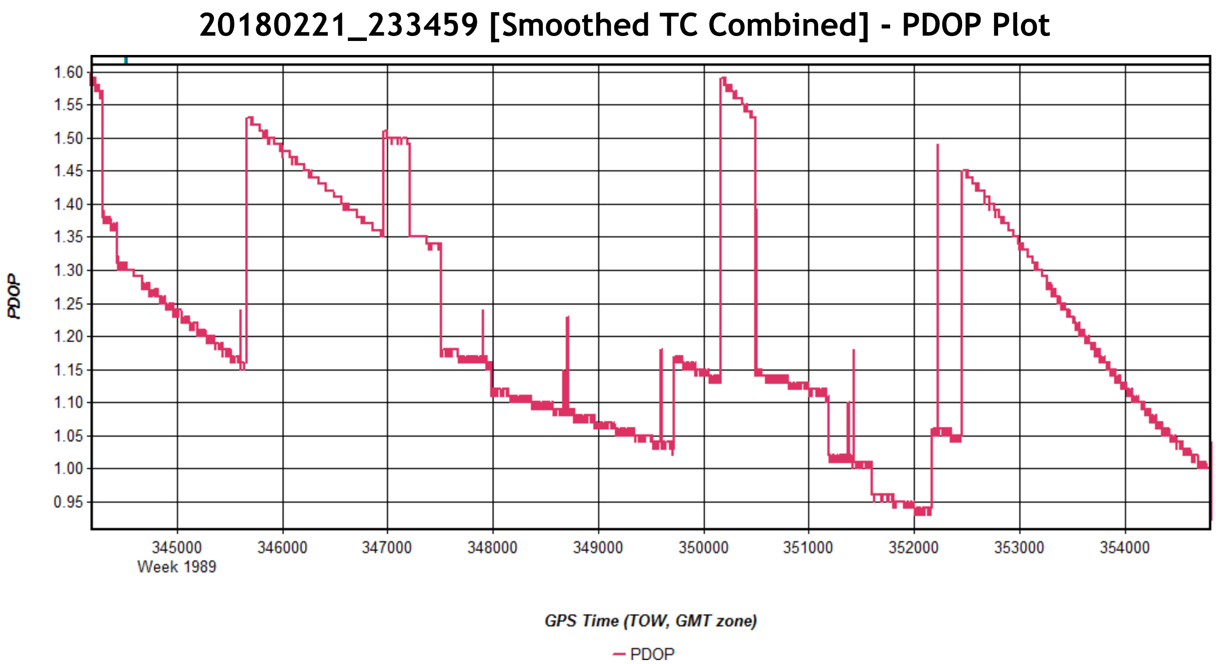
Maximum:	82.009	(km)
Minimum:	0.557	(km)
Average:	42.955	(km)
First Epoch:	0.644	(km)
Last Epoch:	0.922	(km)

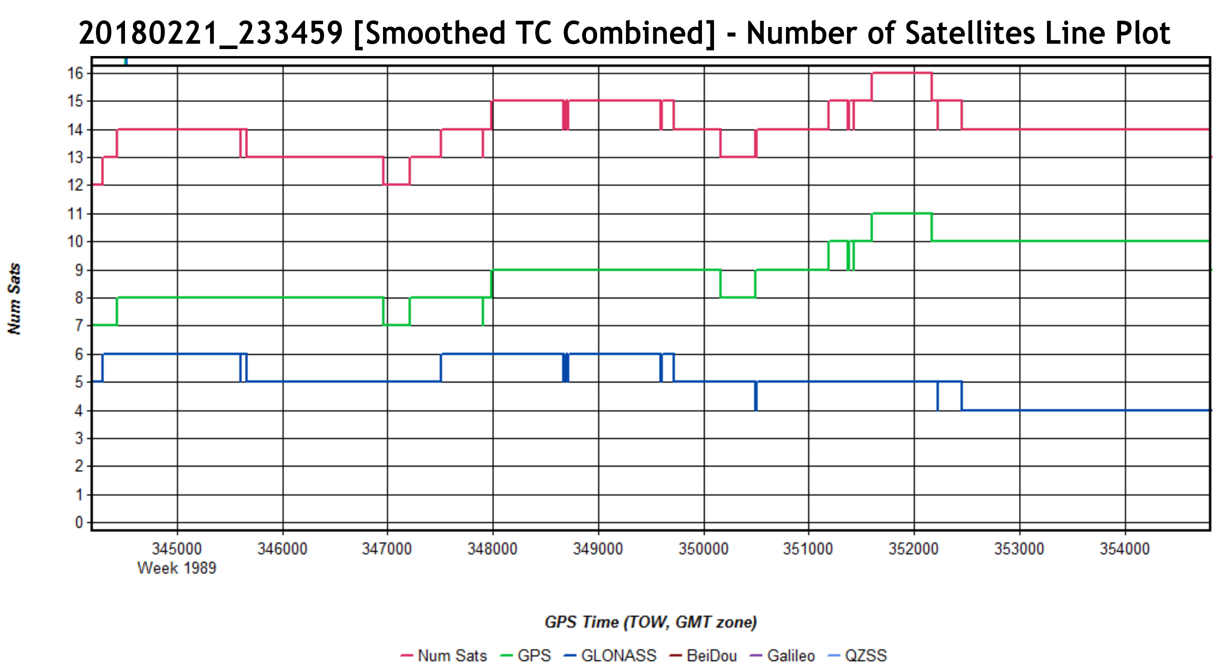
MISSION 02/21/2018 B

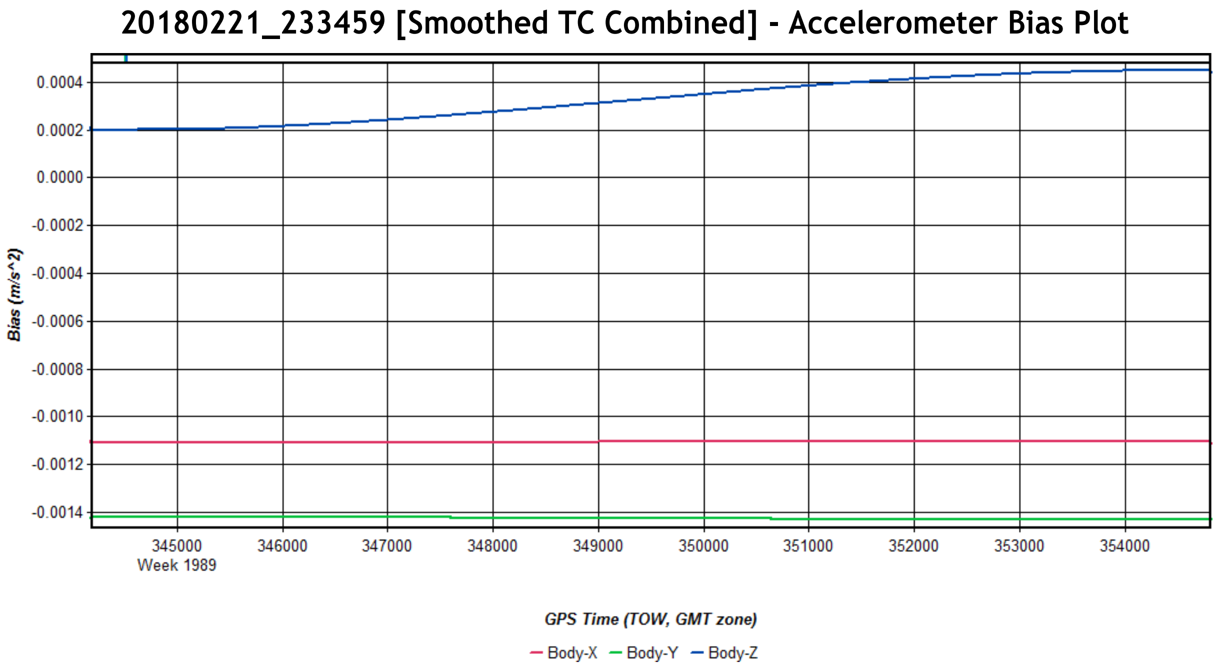
20180221_233459 [Smoothed TC Combined] - Smoothed TC Combined – Map

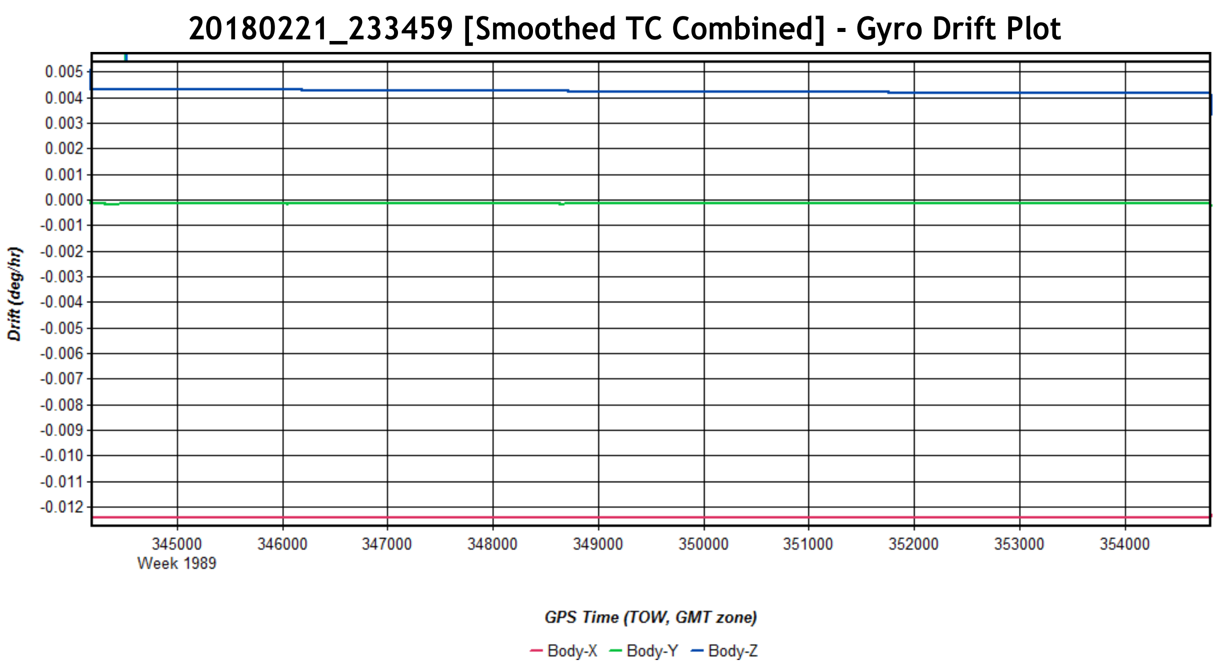



20180221_233459 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot
0.30
0.25
0.20
0.15
0.10
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
Separation (m)
345000
Week 1989
346000
347000
348000
349000
350000
351000
352000
353000
354000
GPS Time (TOW, GMT zone)
East
North
Up


20180221_233459 [Smoothed TC Combined] - PDOP Plot
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
345000
Week 1989
346000
347000
348000
349000
350000
351000
352000
353000
354000
GPS Time (TOW, GMT zone)
PDOP


20180221_233459 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
345000
Week 1989
346000
347000
348000
349000
350000
351000
352000
353000
354000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou
Galileo
QZSS


20180221_233459 [Smoothed TC Combined] - Accelerometer Bias Plot
Bias (m/s^2)
0.0004
0.0002
0.0000
-0.0002
-0.0004
-0.0006
-0.0008
-0.0010
-0.0012
-0.0014
345000
Week 1989
346000
347000
348000
349000
350000
351000
352000
353000
354000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180221_233459 [Smoothed TC Combined] - Gyro Drift Plot
Drift (deg/hr)
0.005
0.004
0.003
0.002
0.001
0.000
-0.001
-0.002
-0.003
-0.004
-0.005
-0.006
-0.007
-0.008
-0.009
-0.010
-0.011
-0.012
345000
Week 1989
346000
347000
348000
349000
350000
351000
352000
353000
354000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8235\20180221_233459\GnssImu\20180221_233459.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	21296
No processed position:	3
Missing Fwd or Rev:	24
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0162	(m)
C/A Code:	0.35	(m)
L1 Doppler:	0.029	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.017	(m)
North:	0.041	(m)
Height:	0.047	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (20607 occurrences):

East:	0.007	(m)
North:	0.005	(m)
Height:	0.017	(m)

Quality Number Percentages:

Q 1:	100.0 %
Q 2:	0.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

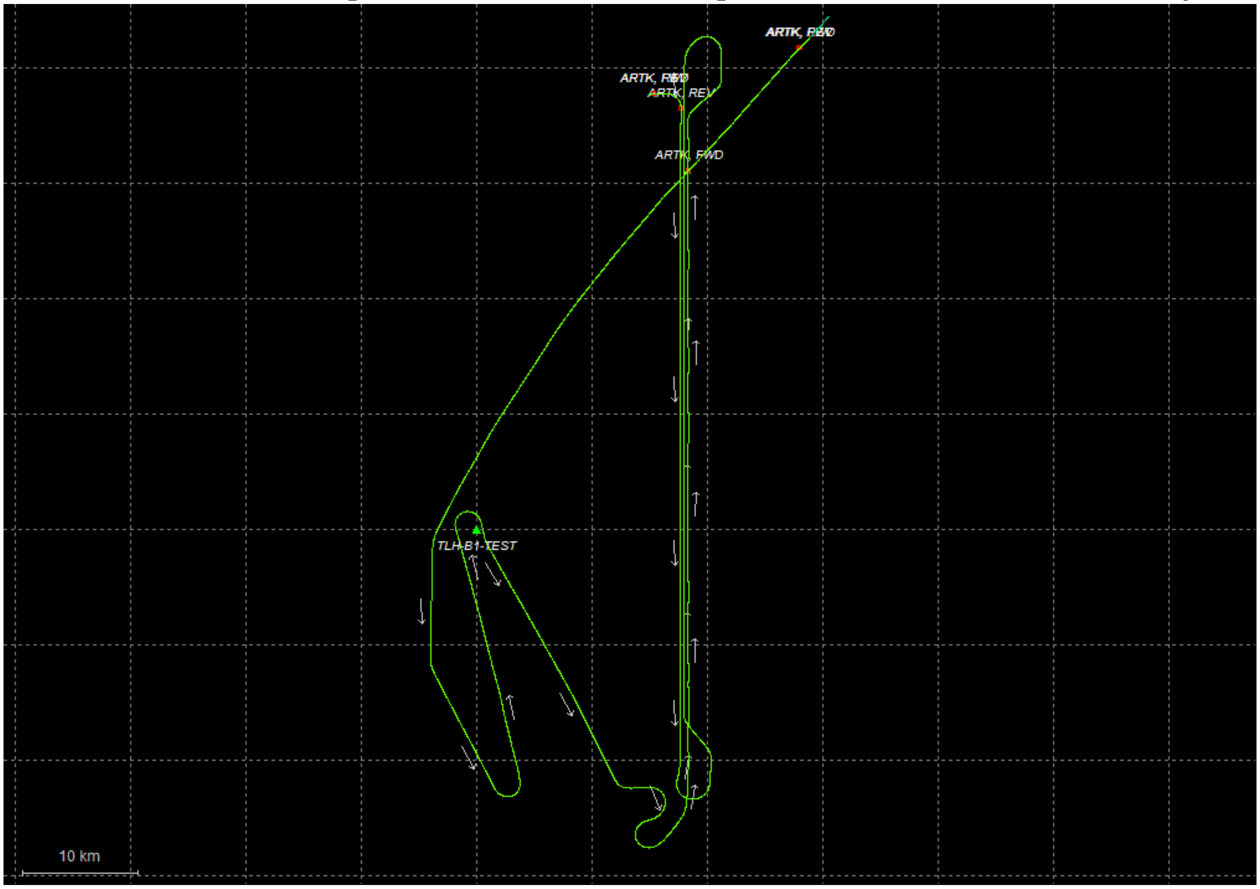
DOP over Tol: 0.0 %

Baseline Distances:

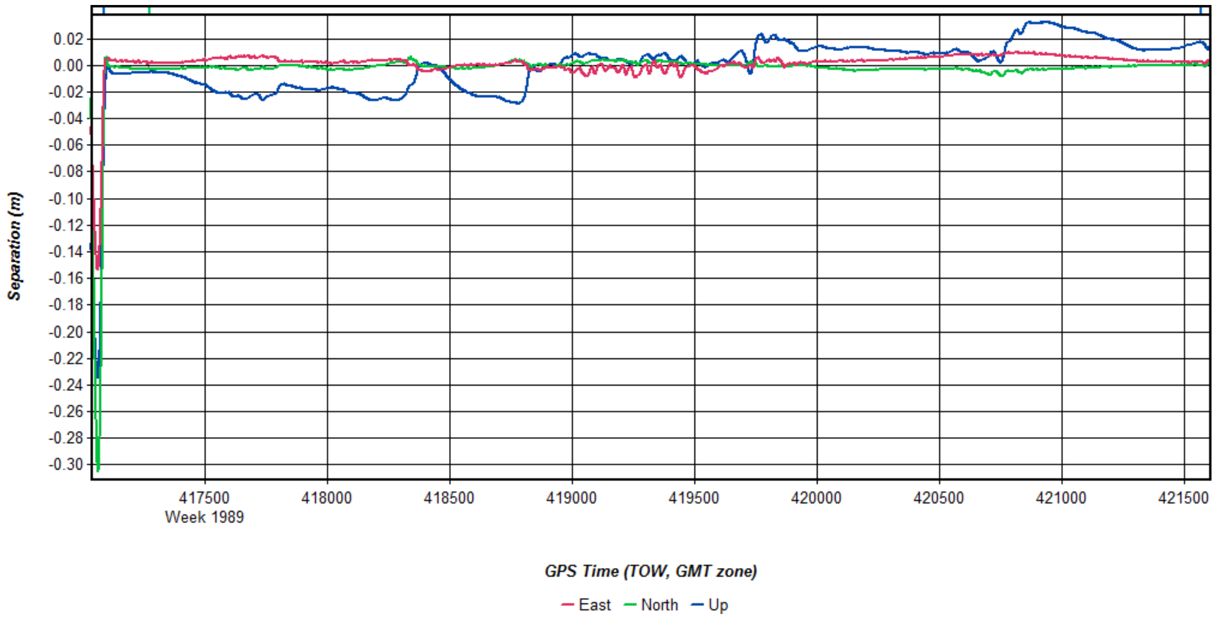
Maximum:	71.527 (km)
Minimum:	2.512 (km)
Average:	30.380 (km)
First Epoch:	71.162 (km)
Last Epoch:	24.755 (km)

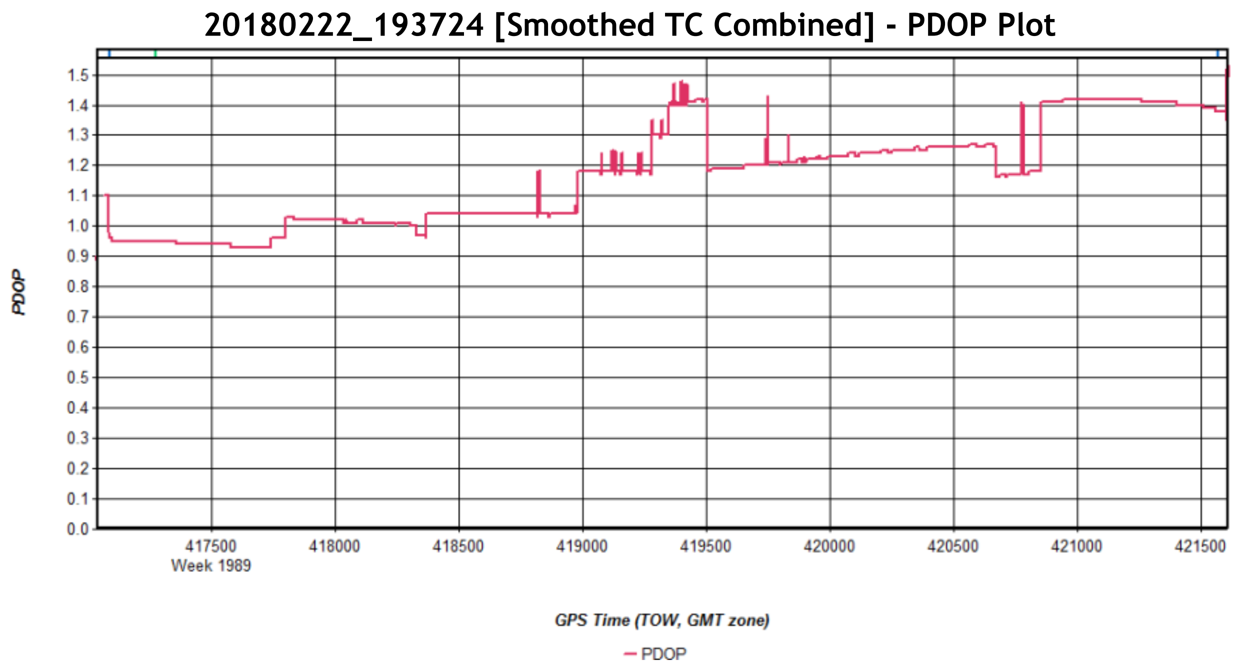
MISSION 02/22/2018 A

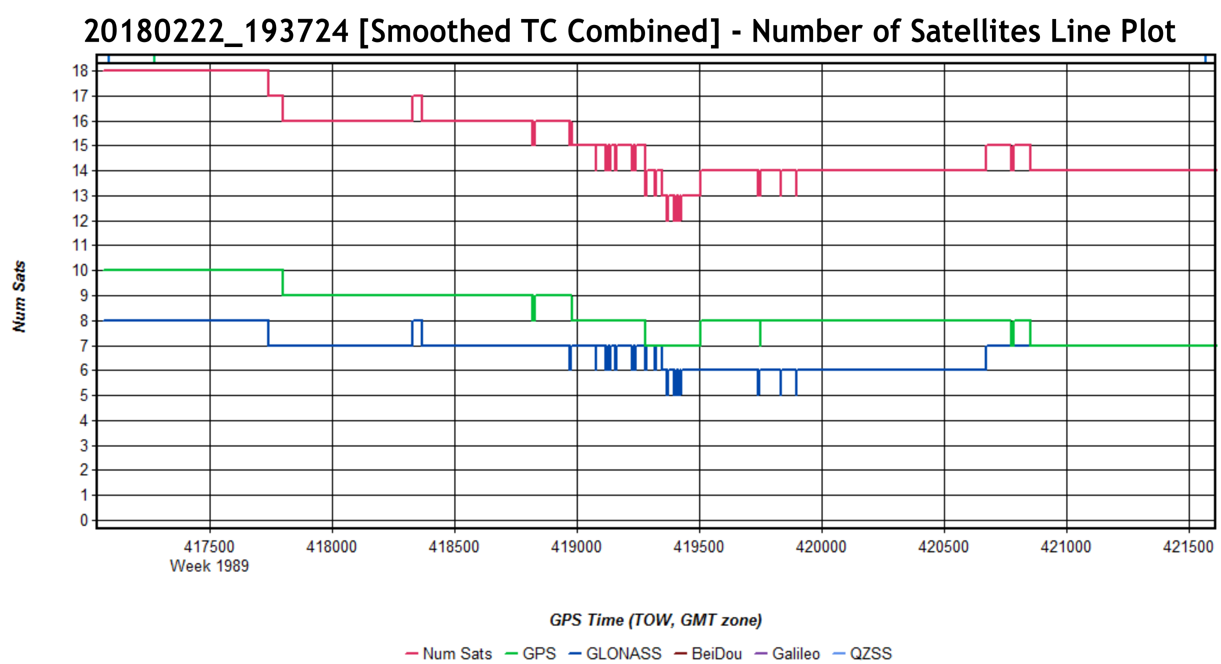
20180222_193724 [Smoothed TC Combined] - Smoothed TC Combined - Map



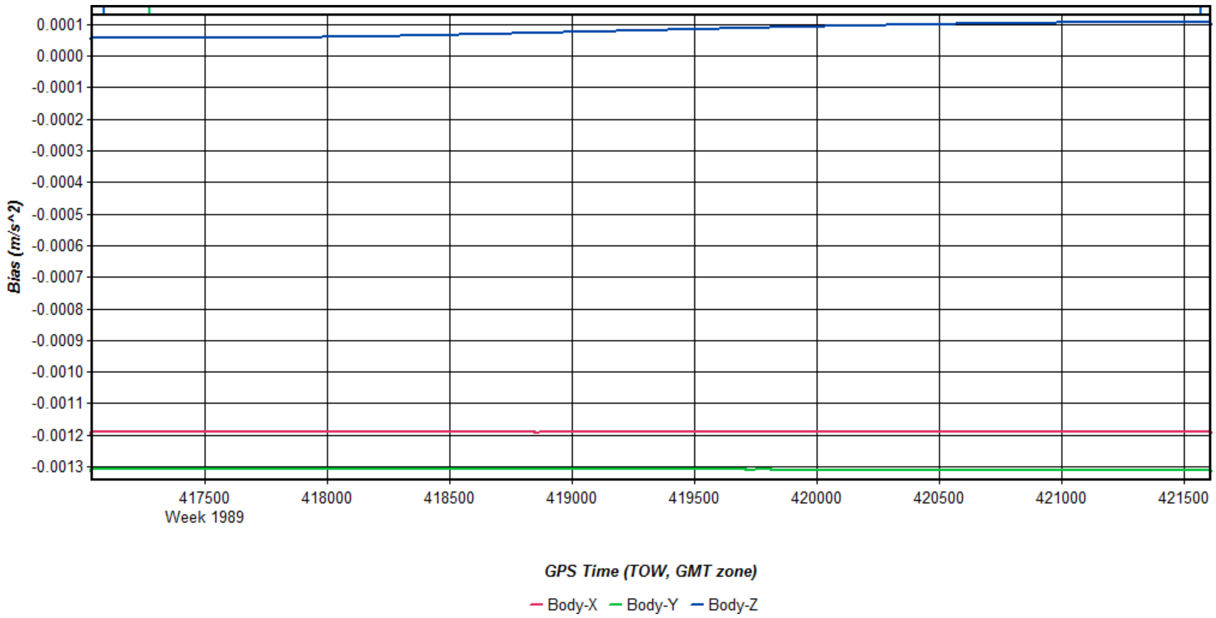
20180222_193724 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot



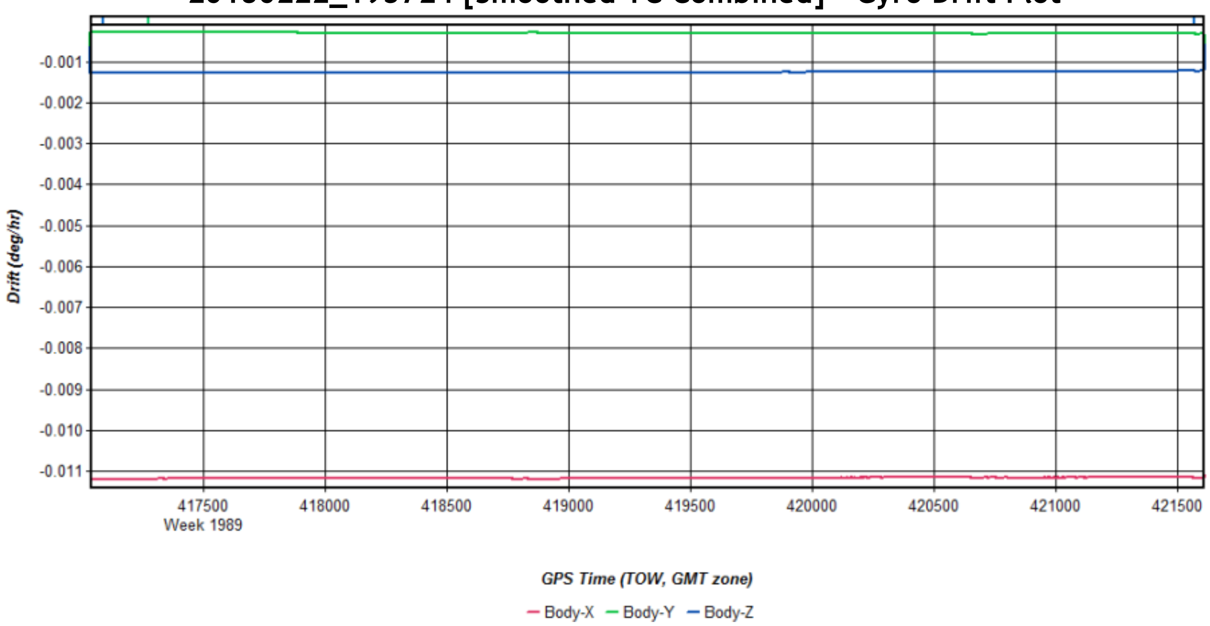

20180222_193724 [Smoothed TC Combined] - PDOP Plot
PDOP
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
417500
Week 1989
418000
418500
419000
419500
420000
420500
421000
421500
GPS Time (TOW, GMT zone)
PDOP


20180222_193724 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
417500
Week 1989
418000
418500
419000
419500
420000
420500
421000
421500
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou
Galileo
QZSS

20180222_193724 [Smoothed TC Combined] - Accelerometer Bias Plot



20180222_193724 [Smoothed TC Combined] - Gyro Drift Plot



Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8235\20180222_193724\GnssImu\20180222_193724.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	10535
No processed position:	1387
Missing Fwd or Rev:	62
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0182	(m)
C/A Code:	0.28	(m)
L1 Doppler:	0.030	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.007	(m)
North:	0.010	(m)
Height:	0.020	(m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (9033 occurrences):

East:	0.004	(m)
North:	0.003	(m)
Height:	0.016	(m)

Quality Number Percentages:

Q 1:	99.3 %
Q 2:	0.7 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

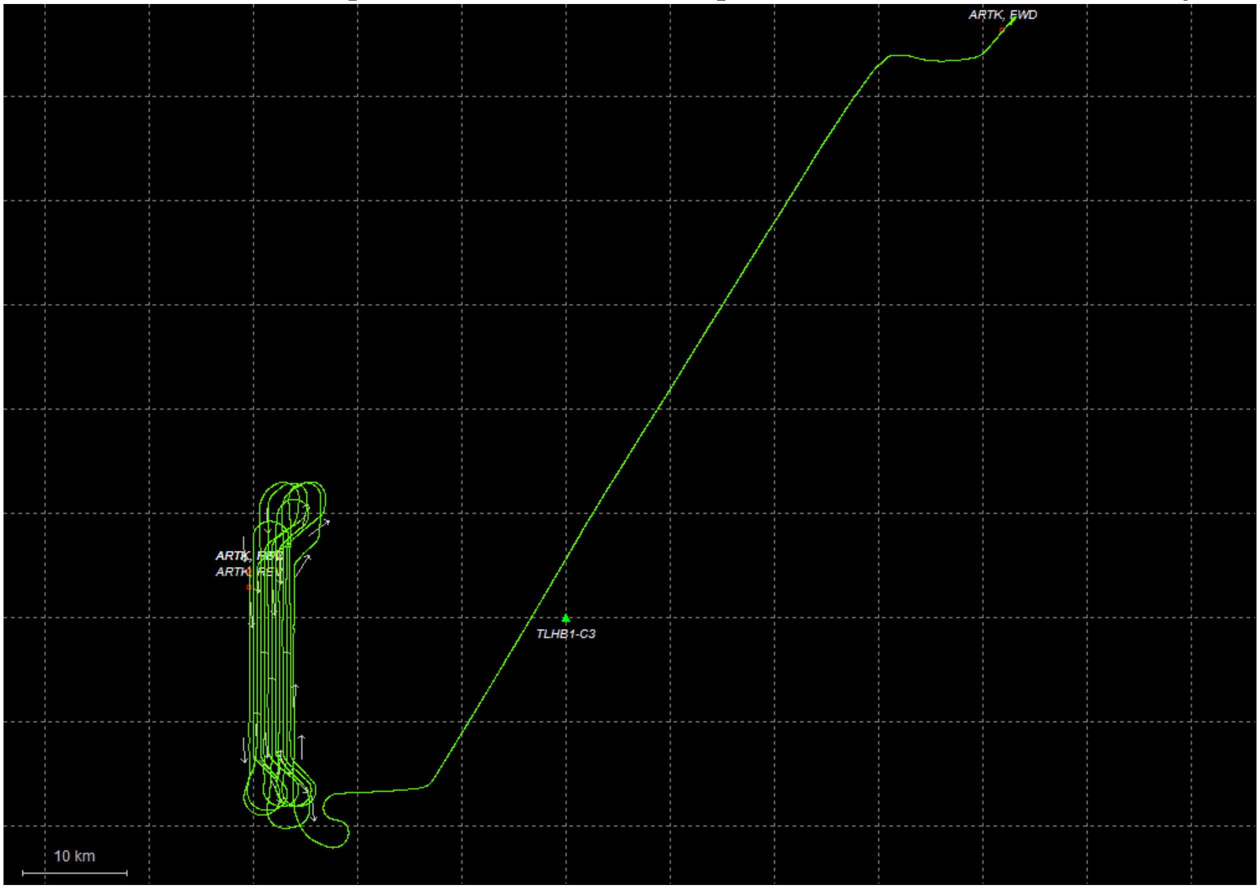
DOP over Tol: 0.0 %

Baseline Distances:

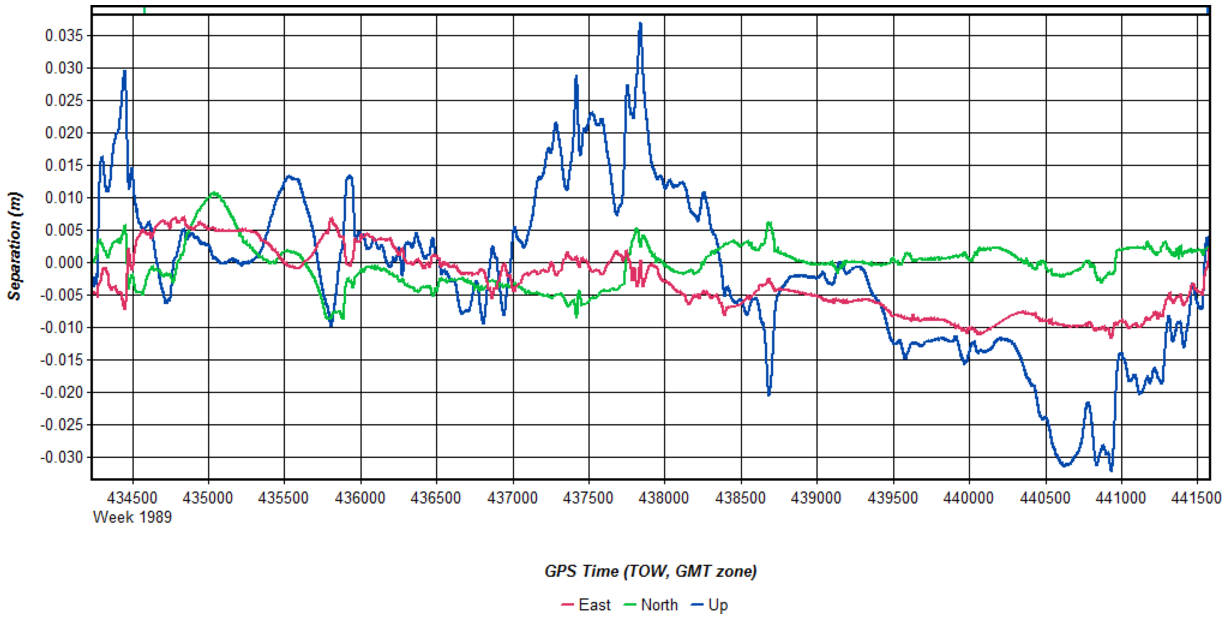
Maximum:	53.723 (km)
Minimum:	0.483 (km)
Average:	23.683 (km)
First Epoch:	53.723 (km)
Last Epoch:	40.338 (km)

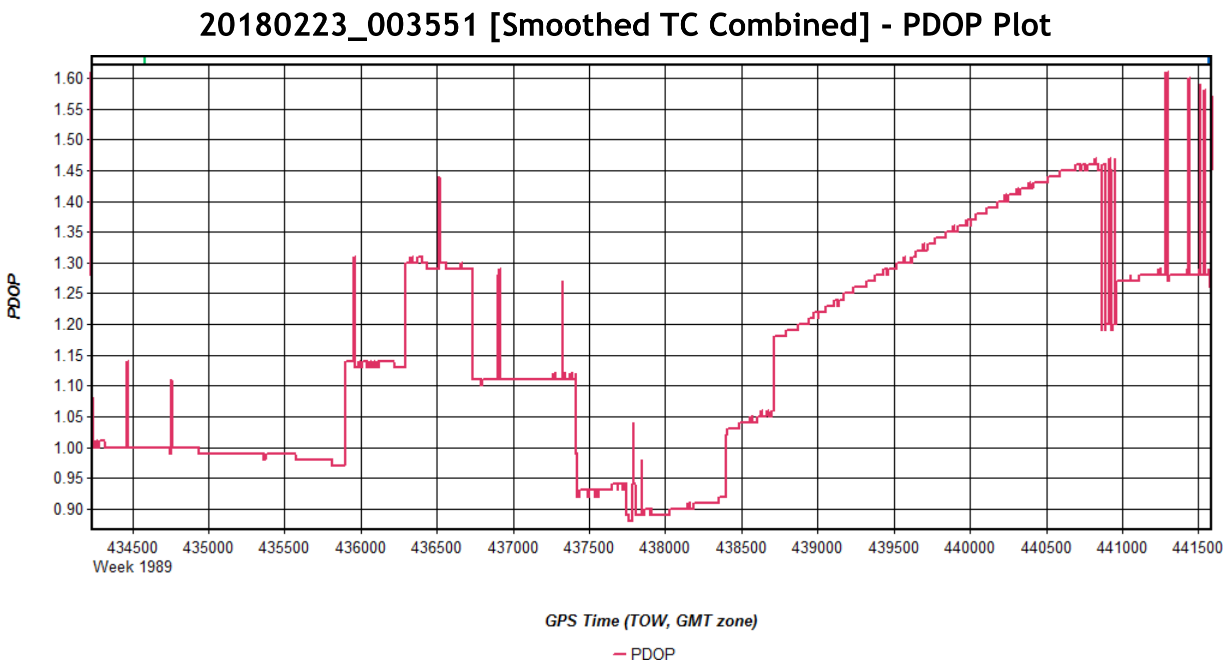
MISSION 02/23/2018 B

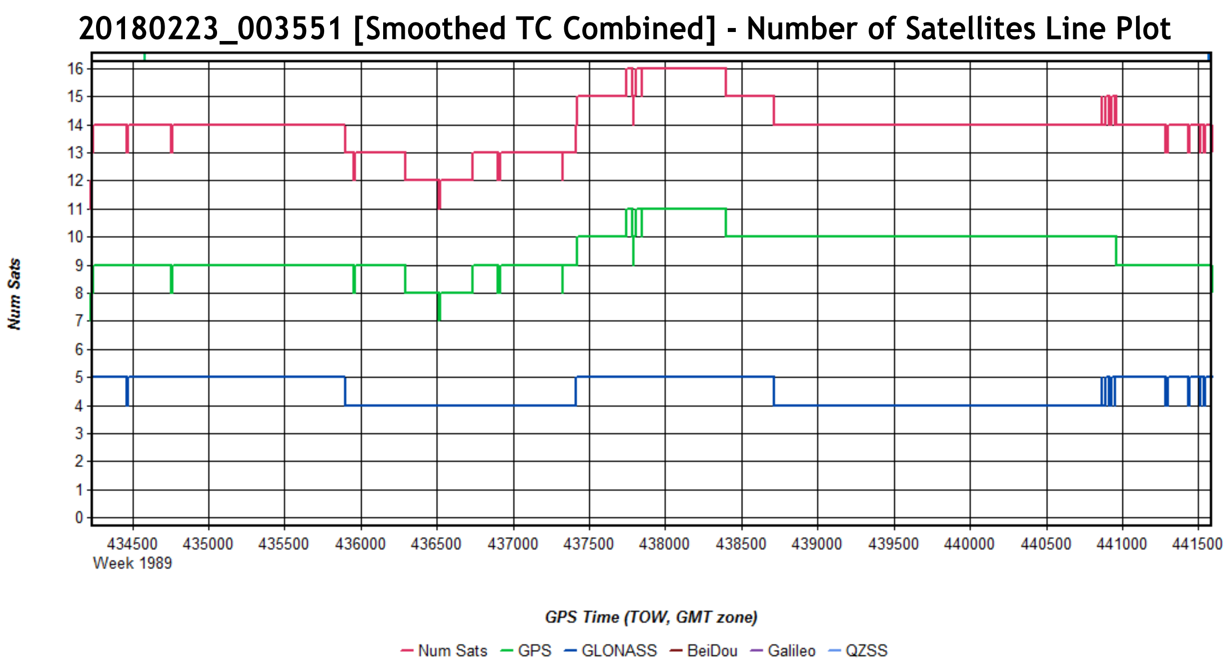
20180223_003551 [Smoothed TC Combined] - Smoothed TC Combined - Map

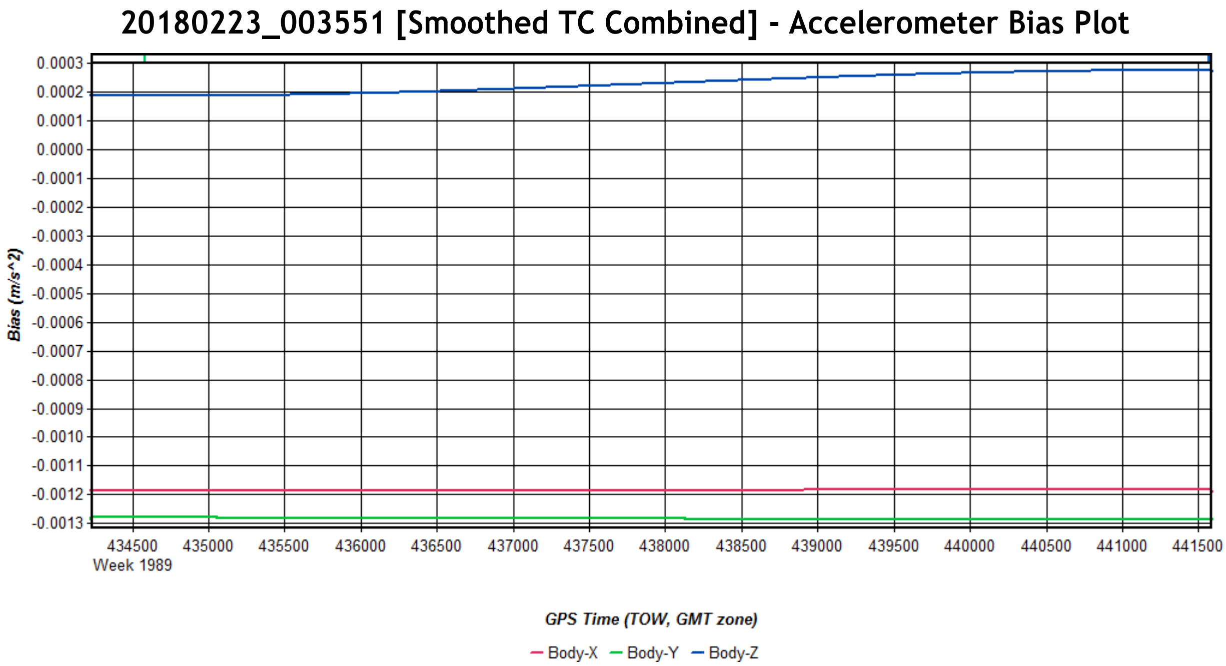


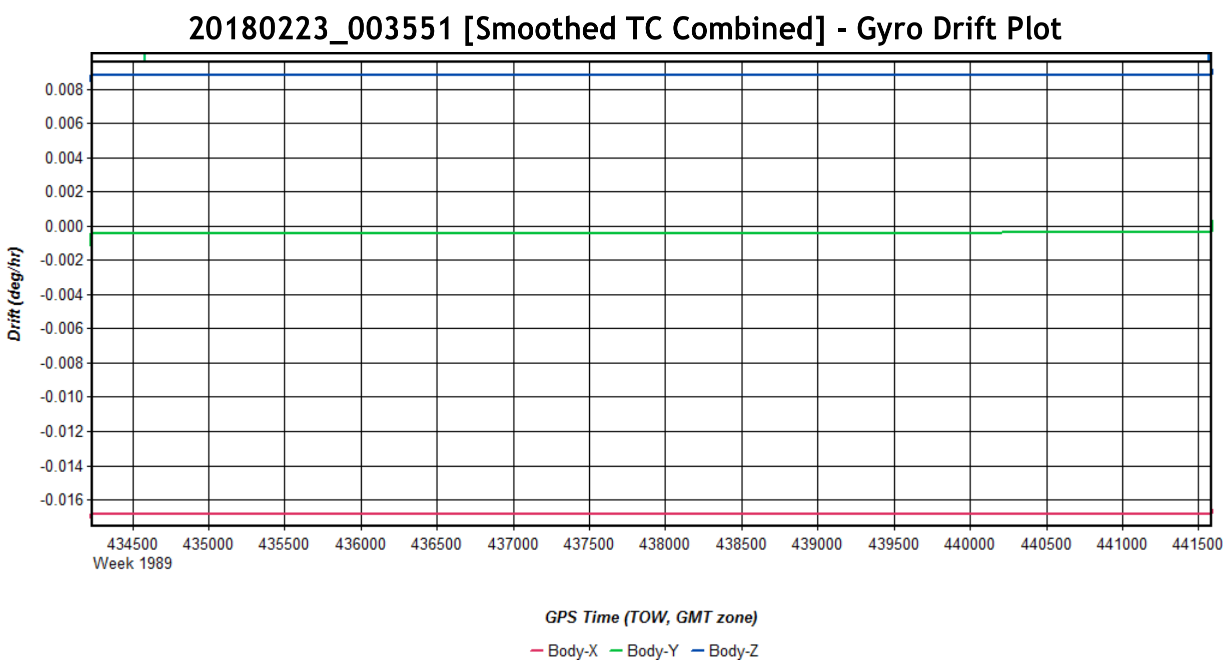
20180223_003551 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot




20180223_003551 [Smoothed TC Combined] - PDOP Plot
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
434500 435000 435500 436000 436500 437000 437500 438000 438500 439000 439500 440000 440500 441000 441500
Week 1989
GPS Time (TOW, GMT zone)
PDOP


20180223_003551 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
434500 435000 435500 436000 436500 437000 437500 438000 438500 439000 439500 440000 440500 441000 441500
Week 1989
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou
Galileo
QZSS


20180223_003551 [Smoothed TC Combined] - Accelerometer Bias Plot
Bias (m/s^2)
0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
-0.0009
-0.0010
-0.0011
-0.0012
-0.0013
434500 435000 435500 436000 436500 437000 437500 438000 438500 439000 439500 440000 440500 441000 441500
Week 1989
GPS Time (TOW, GMT zone)
Body-X Body-Y Body-Z


20180223_003551 [Smoothed TC Combined] - Gyro Drift Plot
Drift (deg/hr)
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
434500 435000 435500 436000 436500 437000 437500 438000 438500 439000 439500 440000 440500 441000 441500
Week 1989
GPS Time (TOW, GMT zone)
Body-X Body-Y Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8235\20180223_003551\GnssImu\20180223_003551.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file: 14730
No processed position: 3
Missing Fwd or Rev: 2
With bad C/A code: 0
With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0141 (m)
C/A Code: 0.29 (m)
L1 Doppler: 0.029 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.006 (m)
North: 0.003 (m)
Height: 0.013 (m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (14716 occurrences):

East: 0.006 (m)
North: 0.003 (m)
Height: 0.013 (m)

Quality Number Percentages:

Q 1: 100.0 %
Q 2: 0.0 %
Q 3: 0.0 %
Q 4: 0.0 %
Q 5: 0.0 %
Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %
0.10 - 0.30 m: 0.0 %
0.30 - 1.00 m: 0.0 %
1.00 - 5.00 m: 0.0 %
5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

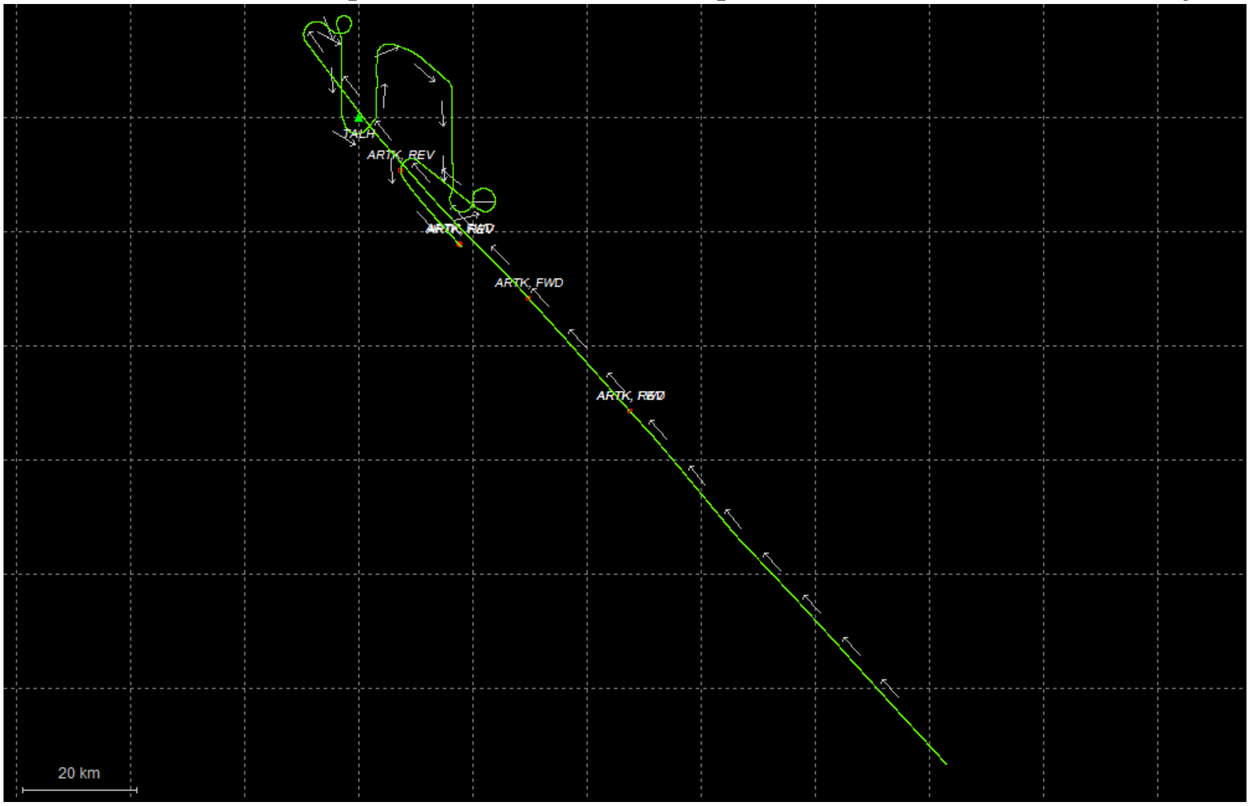
DOP over Tol: 0.0 %

Baseline Distances:

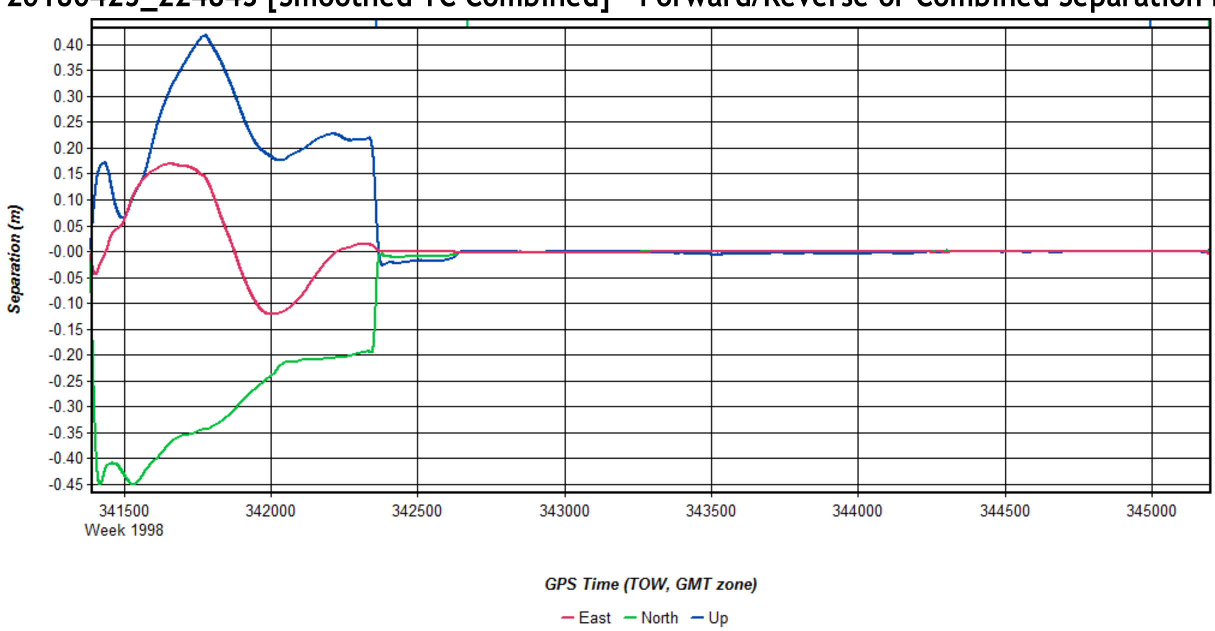
Maximum: 71.529 (km)
Minimum: 2.847 (km)
Average: 31.856 (km)
First Epoch: 70.604 (km)
Last Epoch: 30.660 (km)

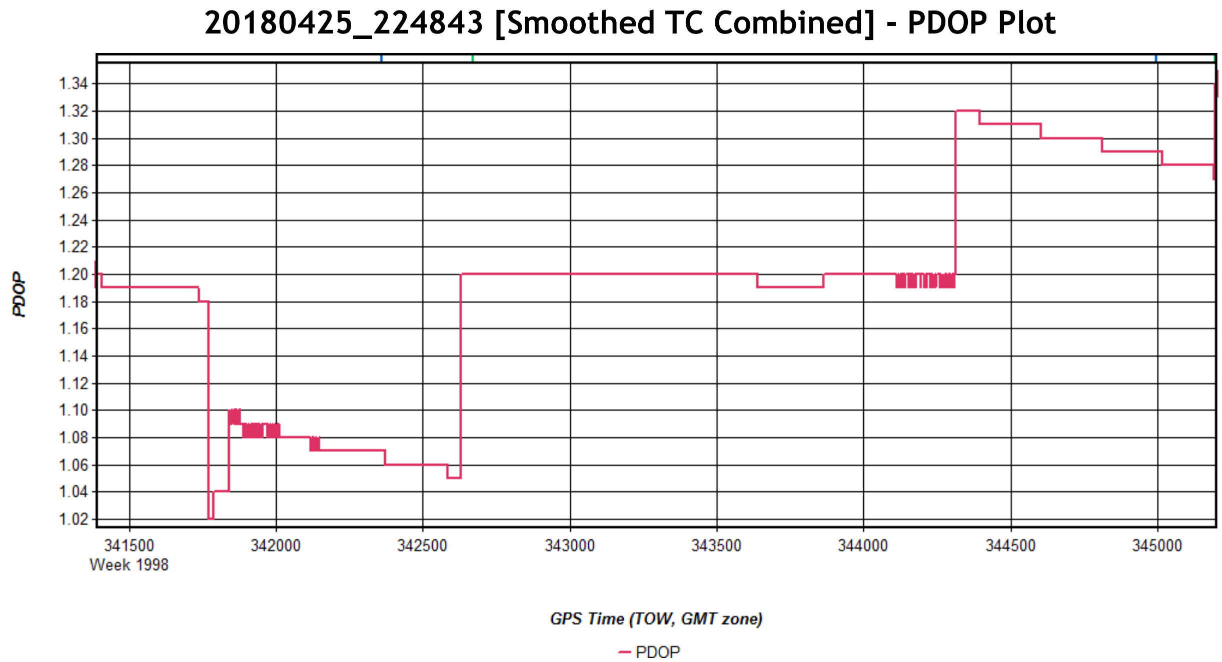
MISSION 04/25/2018 A

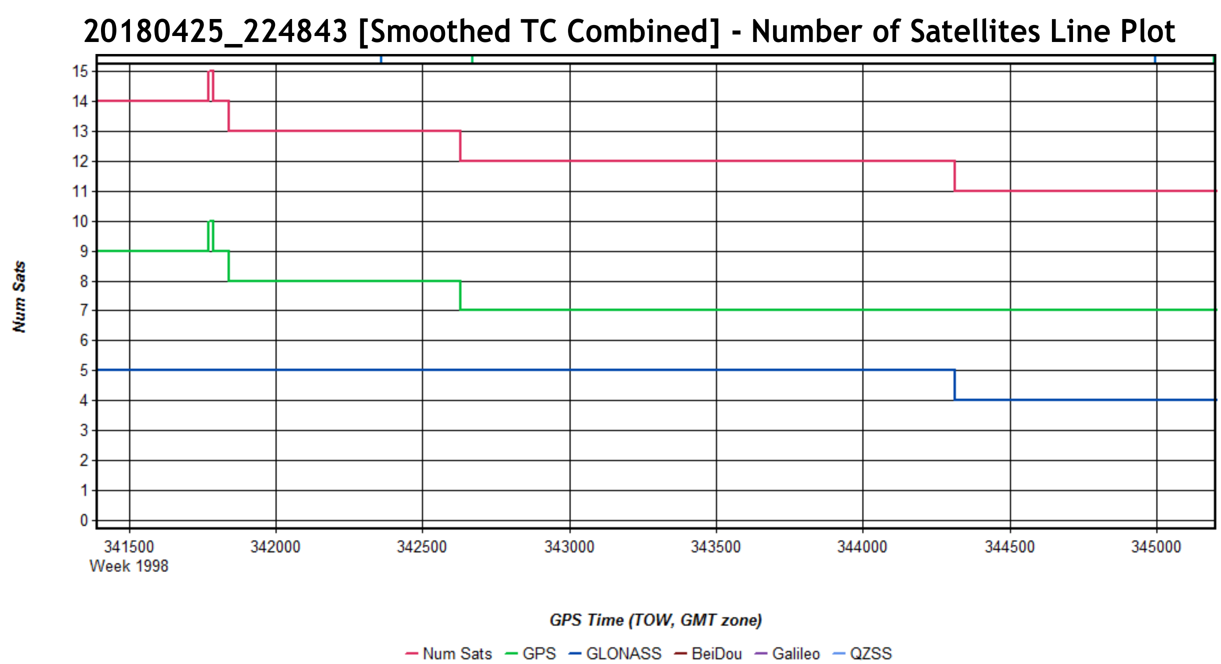
20180425_224843 [Smoothed TC Combined] - Smoothed TC Combined - Map

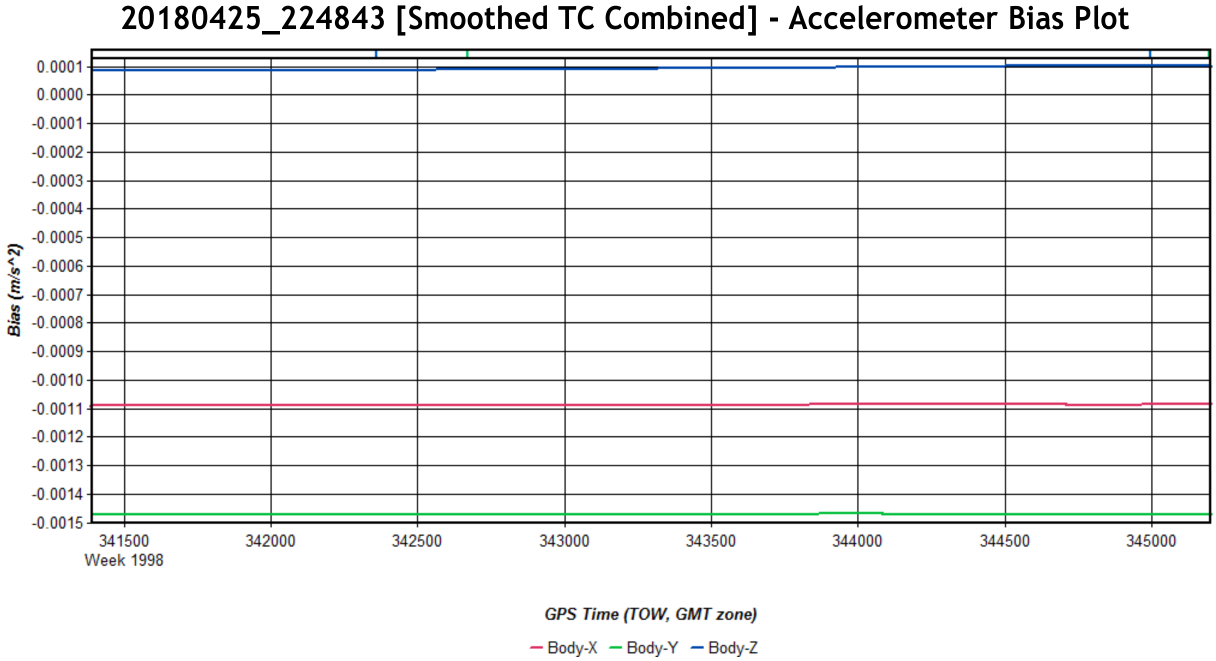


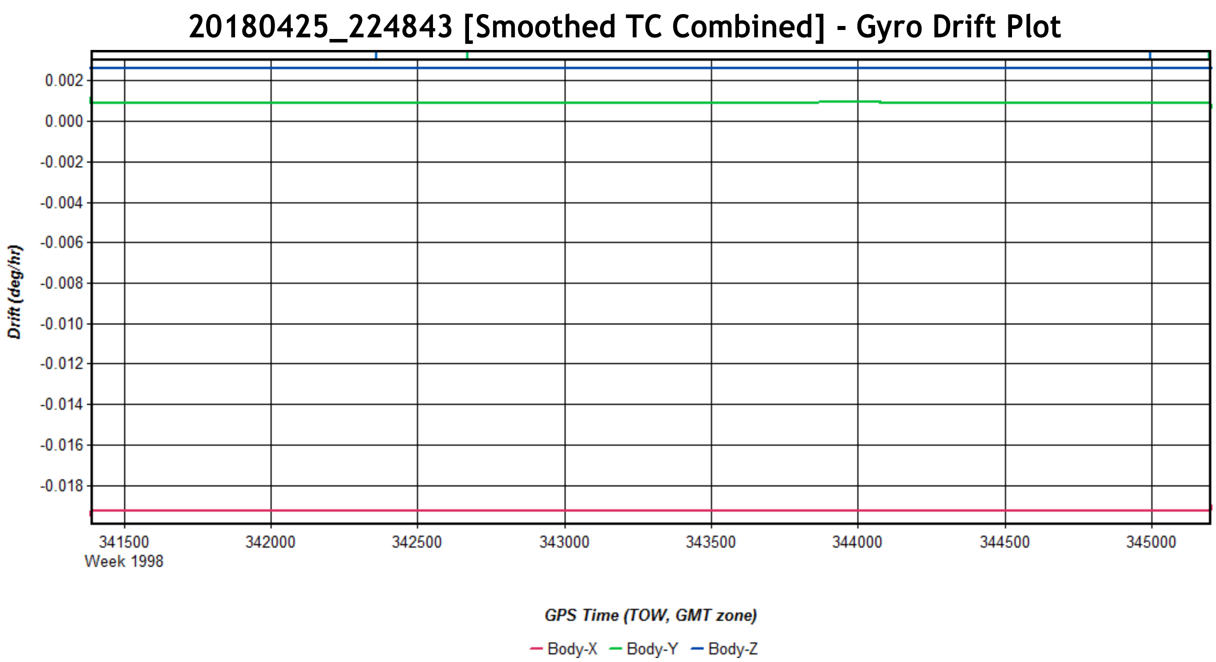
20180425_224843 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot




20180425_224843 [Smoothed TC Combined] - PDOP Plot
PDOP
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
341500
Week 1998
342000
342500
343000
343500
344000
344500
345000
GPS Time (TOW, GMT zone)
PDOP


20180425_224843 [Smoothed TC Combined] - Number of Satellites Line Plot
Num Sats
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
341500
Week 1998
342000
342500
343000
343500
344000
344500
345000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou
Galileo
QZSS


20180425_224843 [Smoothed TC Combined] - Accelerometer Bias Plot
Bias (m/s^2)
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
-0.0009
-0.0010
-0.0011
-0.0012
-0.0013
-0.0014
-0.0015
341500
Week 1998
342000
342500
343000
343500
344000
344500
345000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z


20180425_224843 [Smoothed TC Combined] - Gyro Drift Plot
Drift (deg/h)
0.002
0.000
-0.002
-0.004
-0.006
-0.008
-0.010
-0.012
-0.014
-0.016
-0.018
341500
Week 1998
342000
342500
343000
343500
344000
344500
345000
GPS Time (TOW, GMT zone)
Body-X
Body-Y
Body-Z

Processing Summery Information

Project:
N:\Production\LiDAR_Projects\18005_Leon_County\Flight_Raw\SN8235\20180425_224843\GnssImu\20180425_224843.cfg

Solution Type: Combined
Number of Epochs:

Total in GPB file:	7643
No processed position:	4
Missing Fwd or Rev:	18
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0152	(m)
C/A Code:	0.40	(m)
L1 Doppler:	0.021	(m/s)

Fwd/Rev Separation RMS Values:

East:	0.050	(m)
North:	0.158	(m)
Height:	0.126	(m)

Quality Number Percentages:

Q 1:	100.0 %
Q 2:	0.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

Fwd/Rev Sep. RMS for dual FWD/REV fixes (5681 occurrences):

East:	0.001	(m)
North:	0.004	(m)
Height:	0.007	(m)

DOPoverTol: 0.0 %

Baseline Distances:

Maximum: 151.767(km) Minimum: 0.623 (km)

Average: 43.657 (km) First Epoch: 151.767(km) Last Epoch: 28.647 (km)