LiDAR Mapping Report: MO_SouthernMO_D22

LiDAR Collection, Processing, and QA/QC

140G0222F0224-MO_SOUTHERNMO_D22

QL2 LiDAR

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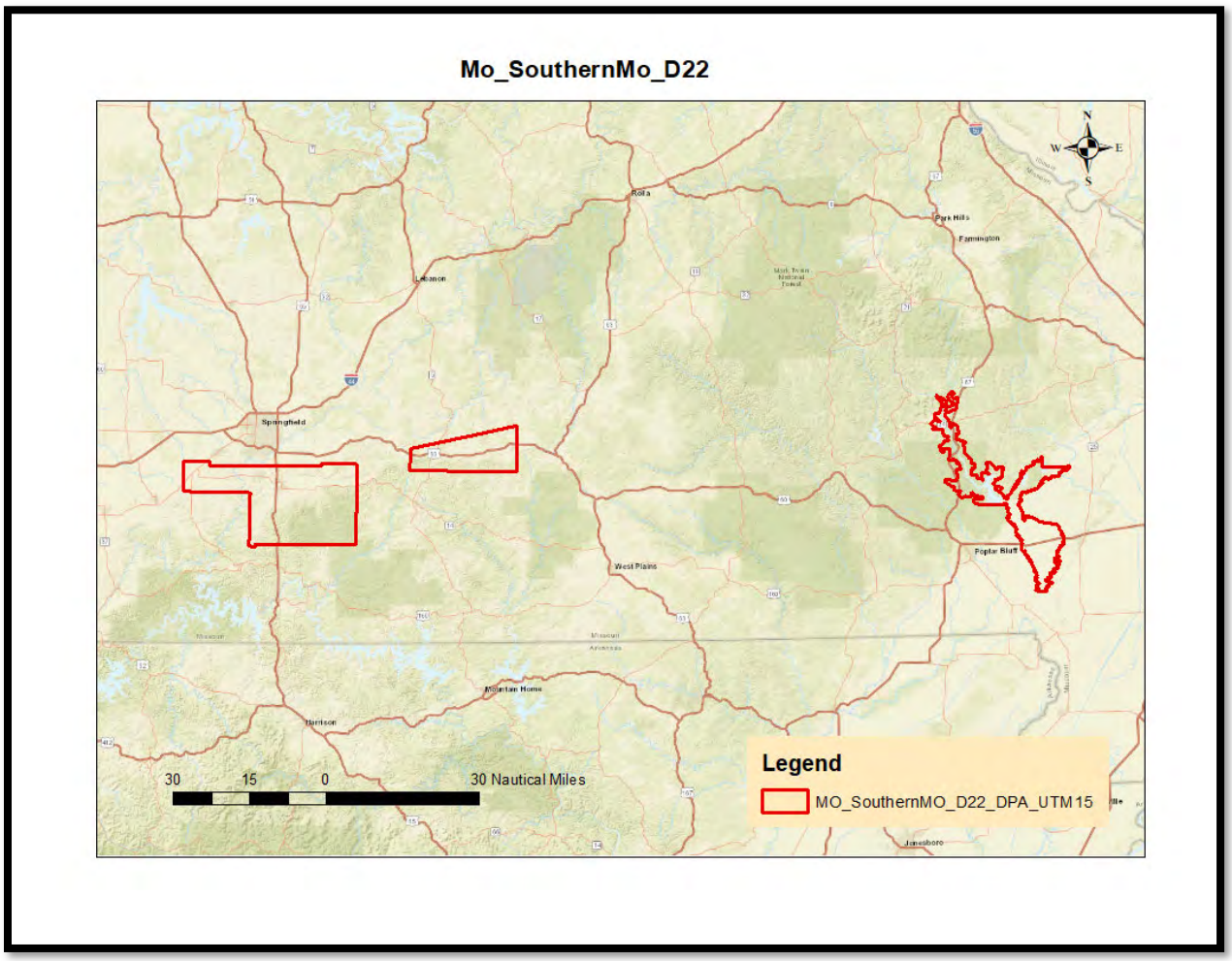

Figure 1 a. Define Project Area UTM15 (DPA)

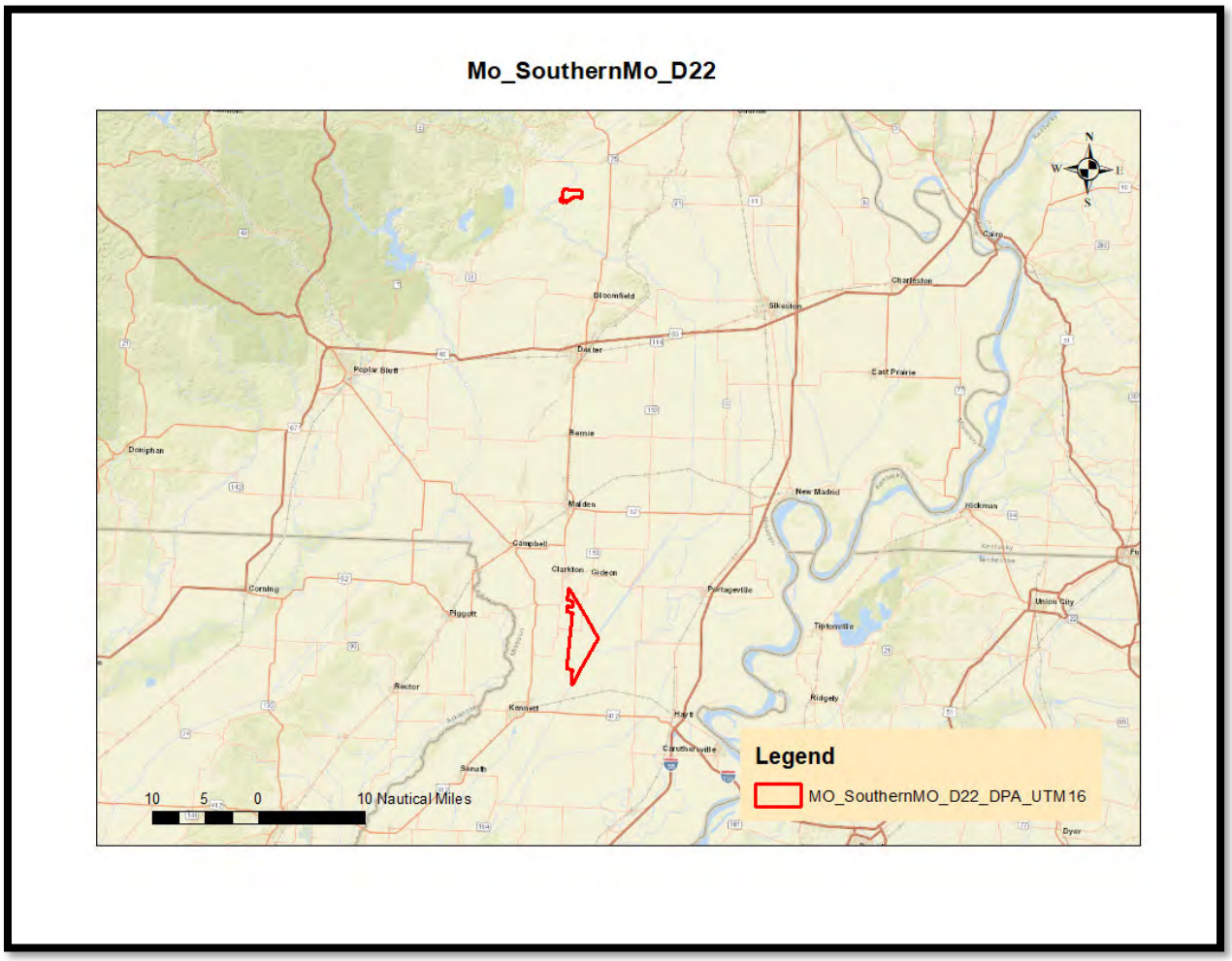

Figure 2 b. Define Project Area UTM16 (DPA)

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1 Data Acquisition and Processing

1.1 Introduction

Digital Aerial Solutions, LLC (DAS) was tasked with planning, acquiring, processing, and deriving elevation products for Light Detection and Ranging (LiDAR) for the **140G0222F0224-MO_SouthernMO_D22**. This task order requests a Fall/Winter leaf-off 2022 lidar survey to be collected over approximately 1,025 square miles in Southern Missouri. LiDAR survey to be collected at an aggregate nominal pulse spacing (ANPS) < 0.71 meters (QL2) including overlap, with up to 2 discrete returns per pulse along with intensity values of each return. Aerial LiDAR was collected over approximately 1,025 square miles of Christian, New Madrid, Pemiscot, Stoddard, Wayne, and Wright counties in the state of Missouri using the Leica Terrain Mapper as shown in Figure 1's Defined Project Area (DPA) for delivery.

LiDAR dataset were post processed to generate elevation point cloud swaths for each flight lines. Deliverables include tiled point cloud classified by land cover type, breaklines to support hydro-flattening of digital elevations models (DEM), intensity image and bare-earth DEM. Swath separation raster and Maximum Surface Height Raster (MSHR) are also delivered as ancillary data.

The point cloud deliverables are stored in the LAS Version 1.4-point data record format 6. The tiling scheme for the tiled deliverables is a **1,500 x 1,500 meters** grid. Tile naming convection is based on the US National Grid (USNG) format. All deliverables were generated in compliance with the U.S Geological Survey National Geospatial Program Guidelines and Base Specifications, Version 2022 Revision A. The spatial reference of the data is as follows;

Horizontal Spatial Reference

– Coordinates: UTM, Zone 15 & 16 North Meters (to 2 decimal places)

– Datum: North American Datum 1983 (2011), Meters (to 2 decimal places)

Vertical Spatial Reference

All datasets are available with orthometric elevation; point cloud datasets are also available with ellipsoid heights.

– Datum: North American Vertical Datum of 1988 (GEOID18)

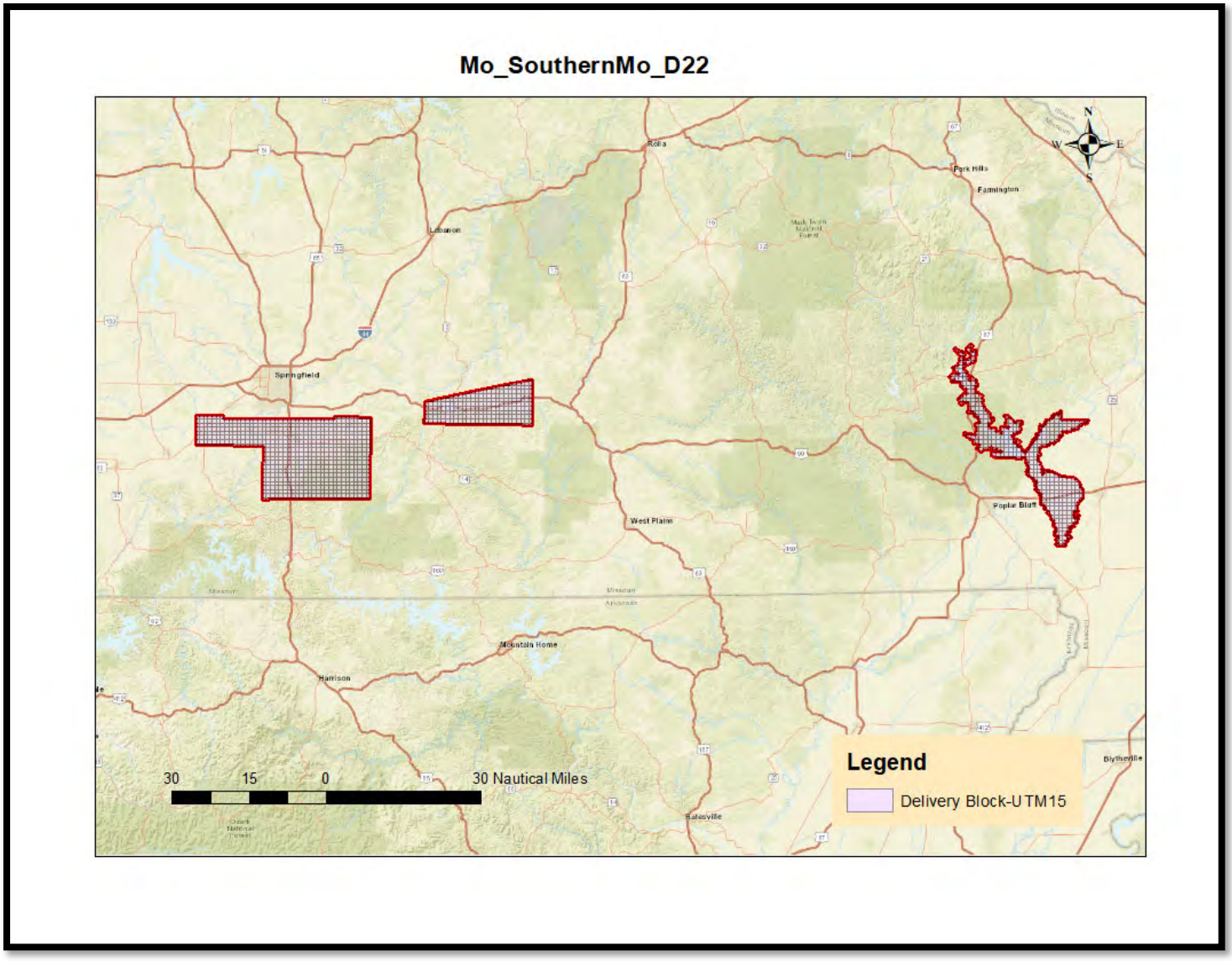

Figure 3 a. MO_MO_SOUTHERNMO_D22 UTM15 Delivery Blocks

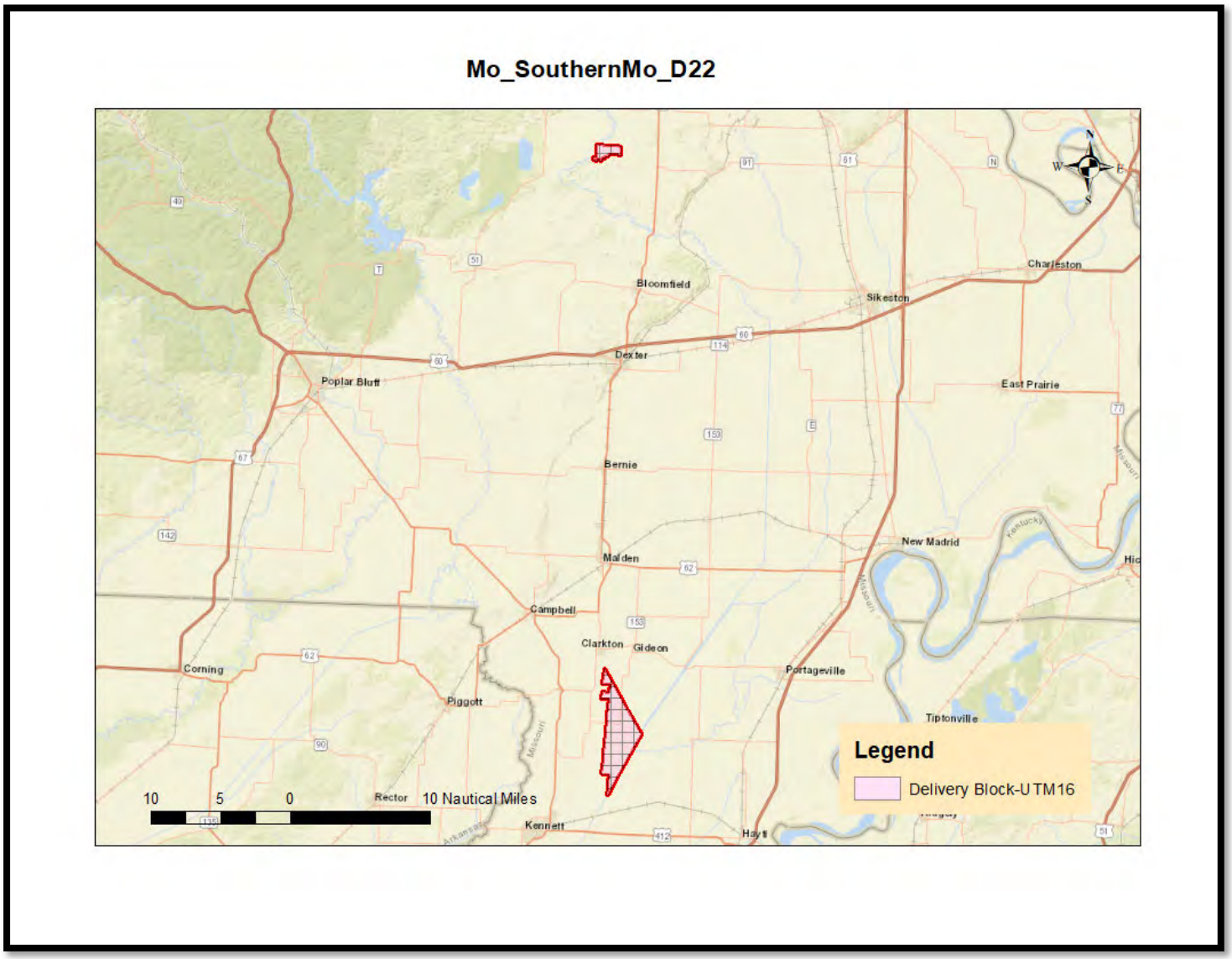

Figure 4 b. MO_SOUTHERNMO_D22 UTM16 Delivery Blocks

1.2 Mission Acquisition

Mission acquisition for **140G0221D0017 MO_SouthernMO_D22** survey was done using Monett Regional Airport (KHFJ), West Plains Regional Airport (KUNO), and Poplar Bluff Municipal Airport (KPOF) as base airports. A Leica Terrain Mapper (TM) was used for data collection. Ground GPS base stations were established to collect data at half (0.5) second epoch in support of all airborne acquisitions. All acquisition was completed in 6 missions between March 15, 2023 – March 20, 2023. There was a total of 118 planned flightlines covering the entire Delivery Block, approximately 1,025 square miles of Christian, New Madrid, Pemiscot, Stoddard, Wayne, and Wright counties in the state of Missouri. All mission flight logs and GPS Session forms can be found in Appendix A and B.

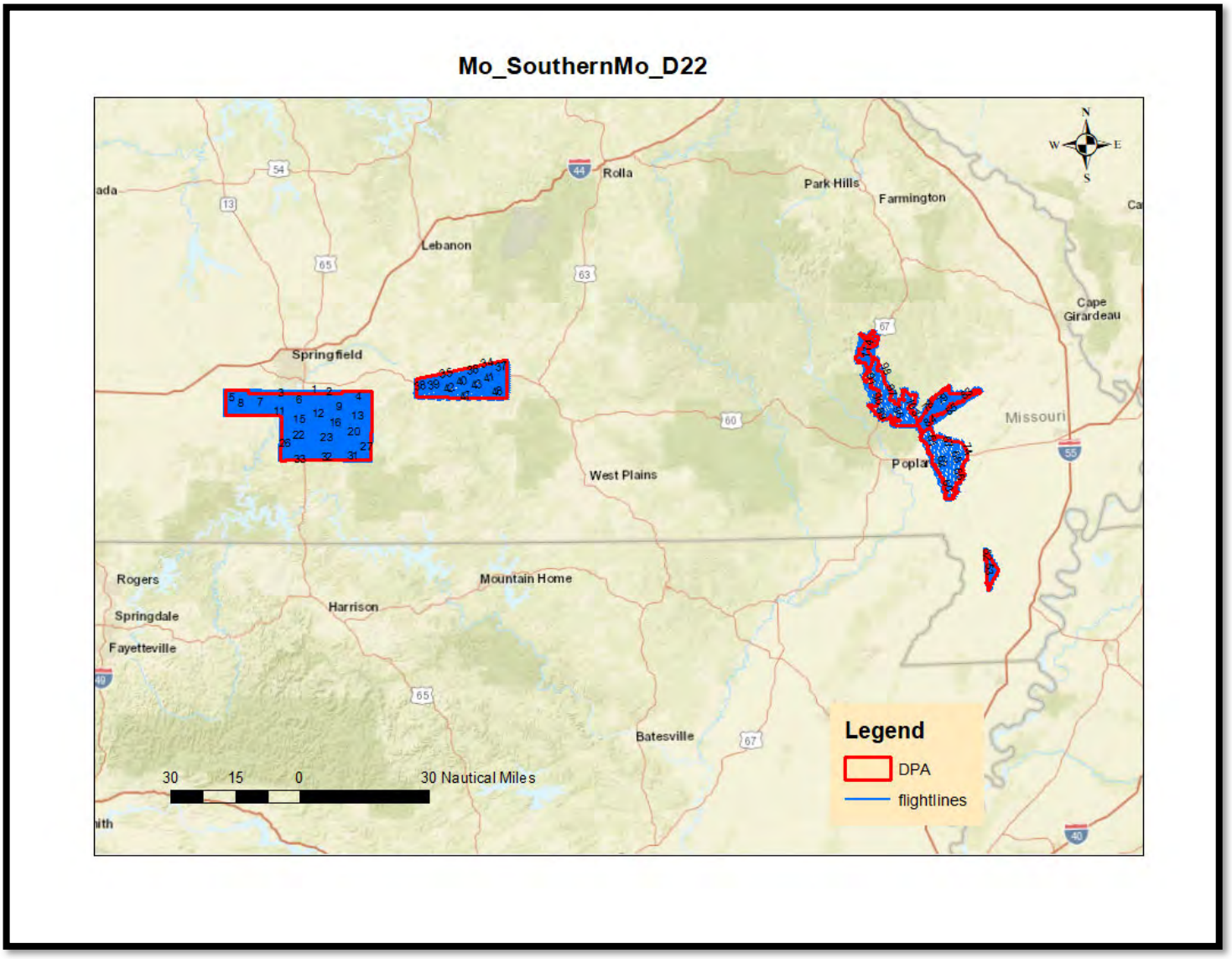

Figure 5 MO_SOUTHERNMO_D22 Flightlines

1.3 Acquisition Parameters

Acquisition parameters are designed to meet the project task order requirements. The sensor configuration and the flight plan characteristics are selected based on a number of project specific criteria. These include data accuracy, land cover types within the project area and the required nominal pulse spacing. Aggregate Nominal Pulse Density (ANPD) for QL2 is no less than 2ppm. Table 1 summarizes the planned project parameters for **MO_SouthernMO_D22**.

IMU Misalignment estimation was performed for the Terrain Mapper sensor to correct angular offset in roll, pitch and heading between IMU measurement frame and mapping sensor measurement frame. Flight line design for measurement estimation includes, double cross lines at 200 meters, AGL (4 total strips) flown twice in opposite directions. The misalignment estimation steps include; Trajectory processing (smooth best estimate of trajectory) in Inertial Explorer software, followed by misalignment estimation in HxMap (Leica Propriety) software for roll, pitch and heading. Quality control report is created and analyzed to ensure the new calibration parameters computed is accurate to implement into LiDAR workflow.

Parameter (QL2)	Terrain Mapper (SN90524)
Flying Height Above Ground Level:	6500 feet
Nominal Sidelap:	30 %
Nominal Speed Over Ground:	155 Knots
Field of View:	40°
Laser Rate:	650.00 kHz
Scan Rate:	150.00 Hz
Average Point Spacing:	0.440 meters

Table 1 Flight Parameters

1.4 Mission Conditions

The acquisition mission for **140G0221D0017 MO_SouthernMO_D22** survey was conducted under optimal collection conditions.

2 ABGNSS-inertial Processing

2.1 Airborne GPS/IMU

Aircraft	Sensor	GPS Lever Arm (m)	IMU Lever Arm (m)
C441_N207SS	TM_90524	X: -0.043, Y: -0.169, Z: -1.083	X: 0.124, Y: -0.025, Z: 0.014

Table 2 Aircraft and Lever Arms

GPS Base Station Coordinates: North American Datum 1983 (2011), Vertical Ellipsoid, Meters

Name	Latitude (N)	Longitude (W)	Ellipsoid (m)
Monett Regional Airport -KHFJ	36°54' 39.63924"	94° 0' 40.03160"	369.484
West Plains Municipal Airport -KUNO	36°52' 39.79024"	91° 54' 15.00538"	341.858
Poplar Bluff Municipal Airport-KPOF	36°45' 58.58305"	90° 19' 25.08150"	69.161

Table 3 Base station Locations

2.2 SMOOTH BEST ESTIMATE OF TRAJECTORY (SBET)

Inertial Explorer 8.90 software was used to compute inertial solution file (*.sol) for each mission using ground GPS base station (KHFL, KUNO & KPOF) and OPUS position coordinate in table 3 above. The resulting solution was checked to ensure a minimum accuracy of +/- 0.10m, combined separation, for horizontal and vertical positions respectively. Inertial Explorer methodology integrates Inertial Navigation Solution by processing the GPS data and Inertial Measurement Unit (IMU). The software applies the reference lever arms for the GPS and IMU, in table 2, during the process to determine the trajectory (position and orientation) of the LiDAR sensor during the acquisition mission. Inertial Explorer generated graphical results were reviewed to ensure that the IMU data was healthy. Graphical results for all lifts can be found in Appendix D.

2.3 Point Cloud Creation

Raw LiDAR sensor ranging data and the final solution sensor trajectory (*.sol), from Inertial Explorer, were processed in Leica's HxMap software to produce LiDAR point cloud swath for each flight line in LAS version 1.4 file format. Quality control of the swath point cloud was performed to validate proper functioning of the sensor system, full coverage of the project area and point density of the LiDAR data. Swath point clouds were assigned unique file source identification. The data was found to be complete and consistent with the sensor calibration parameters.

Point Cloud statistics analyses to determine Nominal Point Spacing (NPS) and Point Density for the MO_SouthernMO_D22 dataset was performed using LP360 (Advanced 64-bit) v2021.1.47.0 software. A total of ninety-three (93) sample point cloud tiles, carefully selected and well distributed in the defined project area (DPA) were used to determine the average point cloud statistics for the project. LP360 "Point Cloud Statistics Extractor" point cloud task (module) enables a summary statistic for a point cloud to be exported for all active dataset loaded into the software.

The procedure involved;

1) Adding all selected Point Cloud data into the software
2) Open the point cloud task command

3) Select the “Point Cloud Statistics Extractor” task
4) Define the point cloud statistics to report for each active point cloud
5) Apply and execute command to export an ASCII text report.

For the MO_SouthernMO_D22 point cloud, the computed average NPS is 0.440 (target <=0.71) and the average point density is 6.105 (target >=2ppm). Detailed summary report is shown in the table below.

Number of Sample Tiles	Average Point Density	Average Point Density Class 1	Average Point Density Class 2	Average NPS
76	6.105	3.823	2.267	0.440

Tile	Total Point Count	Point Count Class_1	Point Count Class_2	Point Density	Point Density Class_1	Point Density Class_2	NPS
15SVA452098.las	14412645	7046576	7366069	6.406	3.132	3.274	0.40
15SVA458098.las	14703192	7796962	6905666	6.535	3.465	3.069	0.39
15SVA470097.las	21051603	15192042	5859561	9.356	6.752	2.604	0.33
15SVA473080.las	16547012	9945333	6601679	7.354	4.420	2.934	0.37
15SVA473094.las	18706329	12081209	6621717	8.314	5.369	2.943	0.35
15SVA474086.las	21066016	15002997	6063019	9.363	6.668	2.695	0.33
15SVA479080.las	25161123	18575610	6585513	11.183	8.256	2.927	0.30
15SVA479088.las	16865291	10758929	6101127	7.496	4.782	2.712	0.37
15SVA479095.las	18563725	11981517	6576109	8.251	5.325	2.923	0.35
15SVA482097.las	21719190	16375194	5333080	9.653	7.278	2.370	0.32
15SVA494095.las	11667055	5265473	6392500	5.185	2.340	2.841	0.44
15SVA495088.las	26352891	20155929	6196962	11.713	8.958	2.754	0.29
15SVA498077.las	20702999	15087178	5615007	9.201	6.706	2.496	0.33
15SVA498080.las	24113490	18531725	5581765	10.717	8.236	2.481	0.31
15SVA498089.las	25262148	18997393	6264334	11.228	8.443	2.784	0.30
15SVB447101.las	15622552	9377998	6244554	6.943	4.168	2.775	0.38
15SVB468100.las	22120780	15016062	7104718	9.832	6.674	3.158	0.32
15SVB480103.las	11745878	6006996	5737464	5.976	3.056	2.919	0.41
15SWA500095.las	22561214	15912428	6648786	10.027	7.072	2.955	0.32
15SWA503094.las	28908832	21498809	7410023	12.848	9.555	3.293	0.28
15SWA506095.las	26691541	20058401	6633140	11.863	8.915	2.948	0.29
15SWB537107.las	19594383	13456945	6133642	8.709	5.981	2.726	0.34
15SWB546107.las	15405130	8579736	6820065	6.847	3.813	3.031	0.38
15SWB551107.las	15345765	8162240	7178547	6.820	3.628	3.191	0.38
15SYA741089.las	8772286	6097806	2652915	7.537	5.239	2.279	0.36
15SYA743092.las	17399171	13364085	4034104	8.775	6.740	2.035	0.34
15SYA746089.las	15142314	8809370	6326797	6.730	3.915	2.812	0.39
15SYA755074.las	14348133	9333097	5015036	6.377	4.148	2.229	0.40
15SYA759076.las	12304534	7404134	4891591	5.469	3.291	2.174	0.43
15SYA761071.las	11088653	6661650	4427003	4.928	2.961	1.968	0.45
15SYB719122.las	15410030	11650607	3759067	6.849	5.178	1.671	0.38
15SYB720118.las	22065811	16758994	5304256	9.807	7.448	2.357	0.32
15SYB723106.las	15146260	11048703	4097557	9.905	7.225	2.680	0.32
15SYB725116.las	23499922	17529843	5966237	10.445	7.791	2.652	0.31

15SYB726109.las	19773960	13497188	6244417	8.789	5.999	2.775	0.34
15SYB726112.las	20336645	13960757	6375888	9.039	6.205	2.834	0.33
16SBF234019.las	2144760	1299628	732709	3.950	2.394	1.350	0.50
16SBF234020.las	3168745	1687473	1456362	4.054	2.159	1.863	0.50
16SBF234022.las	7669951	3905571	3763661	3.798	1.934	1.864	0.51
16SBF234023.las	8553463	4278295	4274696	4.567	2.284	2.283	0.47
16SBF234025.las	7740942	3754529	3985508	4.671	2.266	2.405	0.46
16SBF234026.las	6853363	3442763	3410600	4.752	2.387	2.365	0.46
16SBF234028.las	5781862	2943389	2837480	4.713	2.399	2.313	0.46
16SBF234029.las	4315592	2168645	2146947	4.266	2.143	2.122	0.48
16SBF234031.las	3878896	1998791	1880105	1.837	0.947	0.890	0.74
16SBF234032.las	5318292	2743207	2575085	2.529	1.305	1.225	0.63
16SBF234034.las	6356074	3169894	3186180	3.477	1.734	1.743	0.54
16SBF234035.las	1980159	987640	992519	2.764	1.379	1.386	0.60
16SBF236019.las	30305	21394	8911	3.535	2.496	1.039	0.53
16SBF236020.las	4050215	2271758	1580114	2.969	1.665	1.158	0.58
16SBF236022.las	9289842	4726834	4386489	4.129	2.101	1.950	0.49
16SBF236023.las	10950065	5221310	5727817	4.867	2.321	2.546	0.45
16SBF236025.las	11131529	5412757	5717474	4.947	2.406	2.541	0.45
16SBF236026.las	11336934	5757253	5579681	5.039	2.559	2.480	0.45
16SBF236028.las	11664154	5983912	5679056	5.184	2.660	2.524	0.44
16SBF236029.las	11504950	6088571	5415769	5.113	2.706	2.407	0.44
16SBF236031.las	11606657	6501221	5105436	5.159	2.889	2.269	0.44
16SBF236032.las	7208942	4122319	3085414	3.496	1.999	1.496	0.53
16SBF236034.las	1099914	543806	556108	2.373	1.173	1.200	0.65
16SBF237022.las	383693	223006	128510	3.401	1.976	1.139	0.54
16SBF237023.las	5576618	2918688	2515521	3.407	1.783	1.537	0.54
16SBF237025.las	10737587	5088439	5541781	4.772	2.262	2.463	0.46
16SBF237026.las	10883961	5165196	5718765	4.837	2.296	2.542	0.45
16SBF237028.las	10627401	4478281	6149120	4.723	1.990	2.733	0.46
16SBF237029.las	8224572	3575301	4649271	3.655	1.589	2.066	0.52
16SBF237031.las	2127441	806031	1321410	2.355	0.892	1.462	0.65
16SBF239025.las	489602	198491	261823	1.479	0.599	0.791	0.82
16SBF239026.las	5534065	2625458	2787113	3.409	1.617	1.717	0.54
16SBF239028.las	3499815	1525423	1974390	2.548	1.110	1.437	0.63
16SBF239029.las	11091	2189	8902	1.717	0.339	1.378	0.76
16SBG233103.las	5137045	3532335	1604710	5.260	3.617	1.643	0.44
16SBG233104.las	3795825	2076226	1717329	5.776	3.159	2.613	0.42
16SBG234103.las	5120620	3058864	2061756	3.148	1.880	1.267	0.56
16SBG234104.las	9250190	4343451	4906739	5.034	2.364	2.670	0.45
16SBG236103.las	1504289	843273	661016	3.859	2.163	1.696	0.51
16SBG236104.las	9386973	5528903	3856233	5.945	3.501	2.442	0.41

Table 4 Point Density Statistics

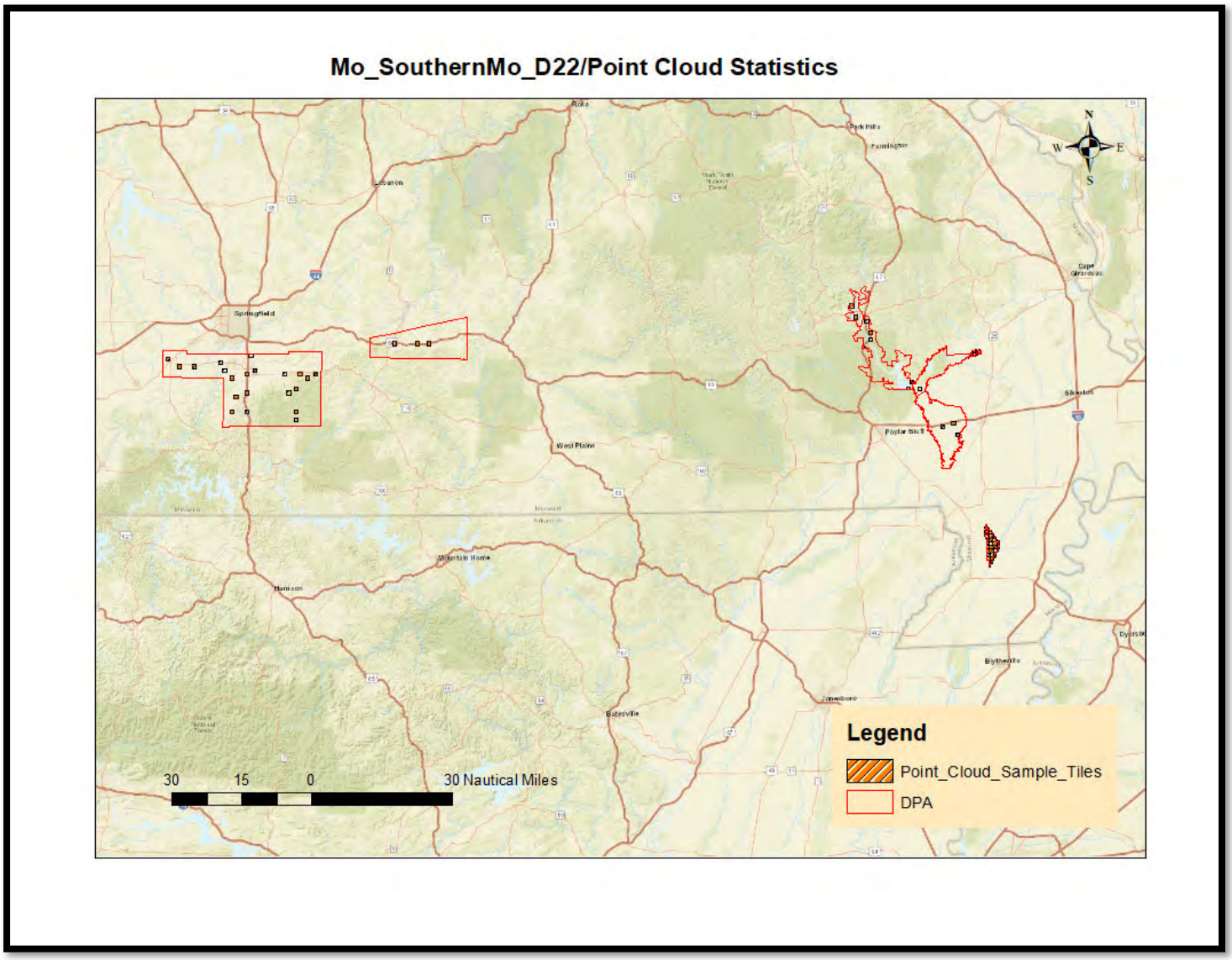

Figure 6 MO_SOUTHERNMO_D22 Point Cloud Sample Statistics

2.4 Geometric Calibration

LiDAR data calibration was done using Leica HxMap v3.6.0 software. HxMap is the common workflow platform for Leica airborne sensors. The processing workflow involves; Ingest, Block Creation, LiDAR Matching, Quality Assurance (QA) and Product Generation. LiDAR is processed in HxMap by generating point clouds from raw sensor data during the Ingest step. Noise filtering, sensor installation calibration and atmospheric condition parameters are also applied during the ingest process. Once all data is processed through ingest, they are assembled into a block for LiDAR Matching. The LiDAR Matching step resolves LiDAR registration errors which remain in the point clouds after sensor and installation calibration parameters are applied in the ingest step.

After LiDAR Matching is complete, QA tool is run on the Block to verify quality of results. QA Tool measurements are 2D patches with vertical statistics computed, therefore patches are only found on open terrain with moderate slope. Patches are not expected in areas of forest or crop, or on mountainous slopes. The QA results are reviewed to ensure that, 95% of patches<5cm for Vertical Scan Direction and Vertical Line Separation. Ground control points are also included to assess absolute accuracy for the point cloud data. HxMap's detailed QA results can be found in Appendix E.

LiDAR products are finally generated in the Product Generation step as LAS swaths (LAS 1.4). Vertical (Z) shift (calculated from QA step) is also applied during the product generation. The exported LAS 1.4 swath data from HxMap is imported into GeoCue Group's product workflow management software, GeoCue v2017. The full point cloud is tiled into a manageable size for processing in TerraScan. The final geometrically calibrated swath point cloud was compared to the bare-earth profile survey data. The data fit the profile surveys within the vertical accuracy tolerance specified for the project. Full documentation of the vertical accuracy checks maybe found in section 3.2 For **140G0222F0224 MO_SouthernMO_D22** QL2 LiDAR project, the control points listed below were used in data adjustment.

Point Id	Easting	Northing	Ortho_Height
GS0005	452276.198	4099372.487	415.117
GS0008	468521.528	4100123.878	356.776
GS0019	479578.475	4081233.307	388.485
GS0022	478880.133	4088653.495	414.023
GS0031	481596.675	4097358.661	350.371
GS0040	498091.692	4081386.134	352.687
GS0043	495156.806	4087543.967	420.141
GS0051	499820.735	4096449.418	454.448
GS0073	759557.032	4075664.622	106.989
GS0076	755624.484	4075447.499	100.583
GS0085	725060.862	4116256.622	122.290
GS0091	718982.875	4122090.310	127.352
GS0100	726469.921	4111580.339	128.990
GS0101	723846.873	4106650.798	129.993
GS0109	746854.016	4089346.806	105.027
GS0116	537645.993	4107486.335	430.554
GS0124	551776.684	4107507.103	452.552
GS0132	546121.459	4107255.050	464.087
GS0063	236145.954	4025361.990	79.225
GS0072	236950.492	4030913.839	80.553

Table 5 Ground Control Points

3. Geometric Quality

3.1 Point Cloud

This refers to the internal geometric quality of the lidar dataset without regard to surveyed ground control. Two primary factors are considered in the lidar data vertical accuracy; Intraswath Precision (Smooth Surface Precision) & Interswath (Overlap) consistency, along with absolute accuracy assessments against project ground control.

Swath Separation Images (SSI) depicts interswath accuracy using color coding to illustrate differences in elevation (z) values where swaths overlap. The semi-coded images are semi-transparent and overlay the lidar intensity image. The SSI are ancillary metadata used as visual aids to identify regions more easily within point cloud dataset that may have suspect interswath alignment or other geometric issues. For this project, the SSI creation involved using; all returns lidar point cloud, excluding noise classes (7 & 18). The images are derived from TINs and consist of 50 percent transparent RGB layer overlaying the lidar intensity images. The image uses three color levels (0-8cm: GREEN, 8-16cm: YELLOW, >16cm: RED) within a pixel, where two or more swaths overlap. The SSI are shown in figures below and are also delivered as GeoTIFF images at cell size equal to 2.5m.

Intraswath Precision (Smooth Surface Precision): Digital Aerial Solutions utilizes a Terrain Mapper LiDAR sensor that is calibrated to meet the relative vertical accuracy standards listed in the Lidar base specification. Smooth Surface Precision results was generated using Leica HxMap software v4.20, in accordance the criteria listed below for determining Intraswath precision, over a calibration site at Lakeland Regional Airport, in Florida. The result is shown in Appendix E.

Precision = *Range* - (*Slope* x *CellSize* x 1.414) where:

Precision, *Range*, and *Slope* are rasters (square cells assumed);

- *Range* is the difference between the highest and lowest lidar points in each pixel;
- *Slope* is the maximum slope of the cell to its 8 neighbors, expressed as a decimal value, calculated from the minimum elevation in each cell; and
- *CellSize* is the edge dimension of the cell. 1.414 is the factor to compute the diagonal dimension of the pixel.
- *CellSize* is set to the ANPS, rounded up to the next integer, and then doubled:
- *CellSize* = *CEILING(ANPS)* × 2
- where:
    - *CEILING* is a function to round *ANPS* up to the next integer
    -
- Assessment of precision will be made on hard surfaced areas (for example, parking lots or large rooftops) containing only single return lidar points.
- Sample areas for assessment of precision will be approximately 100 pixels.
- To the degree allowed by the data and the project environment, multiple sample areas representing the full width of the swath(s) (left, center, and right) will be examined.
- Multiple single swaths from a single lift may be used if needed to sample the full swath width.
- At a minimum, precision shall be assessed against for each lift of each aircraft/instrument combination used on the project. Additional areas may be checked at the discretion of the USGS–NGP.
- Each test area will be evaluated using a signed difference raster with a cell size equal to the ANPS, rounded up to the next integer, then doubled (*CellSize*=*CEILING*(*ANPS*)×2).

- The difference rasters will be statistically summarized to verify that root mean square difference in the z - direction ($RMSD_z$) values do not exceed the limits set forth in table 2 for the QL of information that is being collected.
- Precision shall be reported by way of a polygon shapefile delineating the sample areas checked and, using the cells within each polygon as sample values, attributed with:
    - minimum slope-corrected range (numeric),
    - maximum slope-corrected range (numeric), and
    - $RMSD_z$ of the slope-corrected range (numeric)

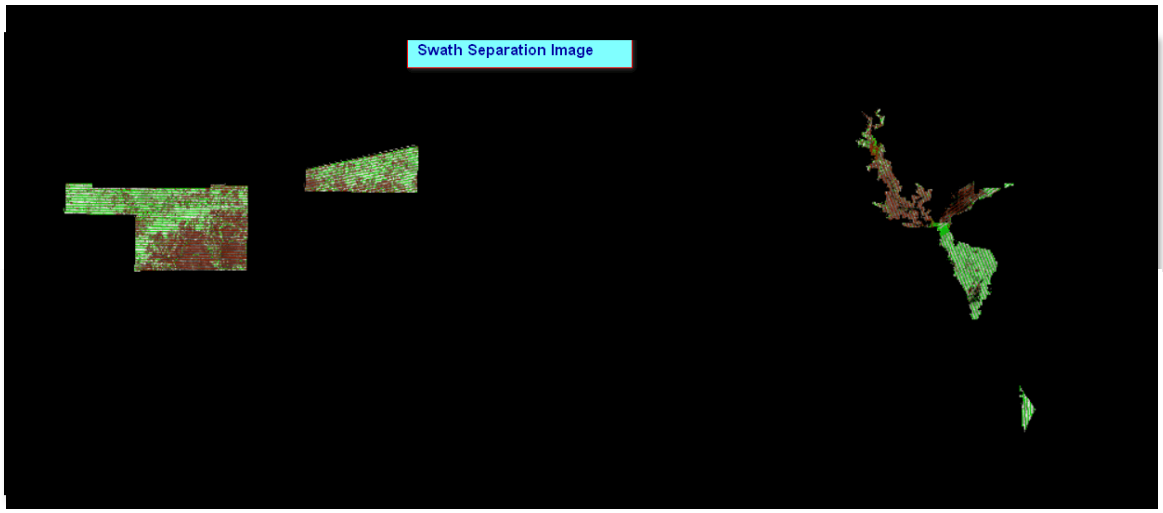

Figure 5 Swath Separation Image

3.2 Accuracy Assessment

This data set was produced to meet **ASPRS "Positional Accuracy Standards for Digital Geospatial Data" (2014)** for a 36.0 (cm) RMSEx / RMSEy Horizontal Accuracy Class which equates to Positional Horizontal Accuracy =+/- 71.0 cm at a 95%

The absolute vertical accuracy of the point cloud data is assessed against ground check point data. For the **140G0222F0224 MO_SouthernMO_D22** project, ground check point data were surveyed using RTK- GPS techniques.

Local TIN models of the elevation points are built around each ground check points. The tin model elevation is sampled at the horizontal position of the ground check point. The TIN model elevation and ground check point survey elevation values were used to calculate the Non-vegetated Vertical Accuracy (NVA) of the swath point clouds. Calculations were produced to meet ASPRS "Positional Accuracy Standards for Digital Geospatial Data" (2014).

The tiled point cloud products were reviewed for full coverage of the AOI and proper classification. As part of the QC process, TINs are built in the Terramodeler software for each tile using the ground class and the hydro-flattening breaklines. The TINs are reviewed for non-ground features, and edited where necessary to remove any remaining non-ground features. Points were also reviewed for absolute elevation, and points falling below the selected orthometric elevation for water were removed from the ground class.

Tested Accuracy	$RMSE_Z$	NVA	VVA
Classified LiDAR	0.038	65	53
Digital Elevation Model	0.038	65	53

Table 6 Tested $RMSE_Z$ of NVA and VVA of LiDAR Point Cloud and Digital Elevation Model

Total #	# NVA	# VVA
116	65	53

Table 7 Number of Survey Points used to calculate accuracy of data.

4. Production

4.1 Point Cloud Classification

Georeferenced information was applied to the swath point cloud LAS files. Geometrically calibrated swath point cloud was cut into **1,500-meter x 1,500-meter** LAS 1.4 format tiles for point cloud classification. Tiled point cloud data was processed in Terrasolid's TerraScan software to assign initial classification values. The TerraScan software provides a number of automated routines to algorithmically detect and assign points to their appropriate classes. Points left

unclassified by the algorithmic routine remain as Class 1– Processed, but unclassified. Automated classification routines assigned points to one of the following classes:

Class 1- Processed, but unclassified

Class 2- Bare-earth ground

Class 7- Low Noise (low, manually identified, if necessary)

Class 9- Water

Class 17- Bridge Decks

Class 18- High Noise (high, manually identified, if necessary)

Class 20- Ignored Ground (Breakline Proximity)

Automated classification results were reviewed for each tiled point cloud, and manual edits were made where necessary to correct for misclassified points.

4.2 Breakline Collection

Hydrographic breakline features were compiled in ArcGIS Desktop v10.7.0, using LiDAR intensity ortho and surface terrain model of the entire project area. The 2D features were checked to ensure they had no geometric or topological errors. Three-dimensional (3D) breakline conflation was done using a fully automated elevation conflation method in GeoCue LP360 v.2021.1.47.0 software. QA/QC procedure was done in ArcGIS Desktop using python scripts to check for monotonicity and vertical variance, to ensure that the 3D breakline features met 3DEP requirements.

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4.3 DEM Generation

Bare earth Digital Elevation Model (DEM) was created using LP360 v.2021.1.47.0 software. Input data for DEM creation include classified LAS point cloud (bare earth, class2), 3D hydrographic breaklines, and project tile index. The breakline features were used to classify water (class 9) and ignored ground (class 20) in the point cloud. These points (classes 9 & 20) are excluded in the DEM generation. Raster (DEM) production methodology include, hydro breakline enforcement and bilinear interpolation resample. Final DEM are exported in GEOTIFF format and tiled to USNG tile extent. GDAL V2.4.2 was used to write final header information for all DEM products.

Appendix A. Flight Logs

Digital Aerial Solutions Flight Log

Project/Flight Plan:	22008_MO_SOUTHERNMO_D22	Lift	Temp °C Before	Temp °C After	Pressure (kPa)	Sensor Operator
		1	15	13	101.69	Everett Meyer

Date/Julian:	3/15/2023	Disk Drive	Sensor	Pilot
Hobbs End	777.1	TM MM30 (101, 102)	TM_90524	Jim Crouch

Hobbs ST	774.3	TARGET MSL	Target AIRSPD	Base Name	PID	Base Name	PID	Base Height	Aircraft	Airport Identifcation:
Flight Time	2.8	7,500	155	HFJ3		HFJ4		1.500	C441-N207SS	KHFJ

∠	Flight Line	Mission Line	UTC time:		Direction	GPS Altitude	Speed	Available	S/Vs	Position Acc.		Comments and Conditions:
			Begin:	End:				MM Space		AVG PDOP	AVG HDOP	
	1	1-E	21:22	21:35	90°	7518	155	5740	14	1.5	0.8	Abnormal Reflections
	2	2-W	21:41	21:55	270°	7499	162	5731	15	1.3	0.8	Abnormal Reflections
	3	3-E	21:59	22:13	90°	7513	157	5722	16	1.3	0.7	Abnormal Reflections
	4	4-W	22:17	22:31	270°	7487	157	5712	17	1.3	0.7	Abnormal Reflections
	5	5-E	22:35	22:50	90°	7487	157	5702	16	1.2	0.7	Abnormal Reflections
	6	6-W	22:54	23:07	271°	7475	157	5692	18	1.2	0.6	Abnormal Reflections
	7	7-E	23:12	23:26	91°	7497	157	5683	18	1.2	0.6	Abnormal Reflections, Smoke
	8	8-W	23:31	23:44	271°	7493	152	5673	20	1.1	0.6	Abnormal Reflections, Smoke

Digital Aerial Solutions Flight Log

Project/Flight Plan:	22008_MO_SOUTHERNMO_D22		Lift	Temp °C Before	Temp °C After	Pressure (kPa)	Sensor Operator	
			2	-2	4	102.07	Everett Meyer	
Date/Julian:	3/17/2023	Disk Drive		Sensor			Pilot	
Hobbs End	782.6	TM MM30 (101, 102)		TM_90524			Jim Crouch	
Hobbs ST	777.1	TARGET MSL	Target AIRSPD	Base Name	PID	Base Name	PID	Base Height	Aircraft	Airport Identifcation:
Flight Time	5.5	7,500	155	HFJ3		HFJ4		1.500	C441-N207SS	KHFJ

∠	Flight Line	Mission Line	UTC time:		Direction	GPS Altitude	Speed	Available	S/Vs	Position Acc.		Comments and Conditions:
			Begin:	End:				MM Space		AVG PDOP	AVG HDOP	
	9	9-E	14:53	15:06	92°	7542	157	5663	17	1.2	0.7	
	10	10-W	15:12	15:26	270°	7520	150	5653	17	1.5	0.7	
	11	11_E	15:30	15:43	91°	7549	154	5644	16	1.5	0.7	
	12	12-W	15:48	16:01	270°	7527	157	5633	17	1.3	0.6	
	13	13-E	16:06	16:19	89°	7564	155	5623	16	1.4	0.7	
	14	14-W	16:23	16:32	270°	7553	160	5614	19	1.2	0.6	
	15	15-E	16:36	16:46	91°	7562	160	5607	19	1.2	0.6	
	16	16-W	16:50	16:59	270°	7564	161	5600	21	1.1	0.6	
	17	17-E	17:03	17:12	91°	7570	154	5592	19	1.2	0.6	
	18	18-W	17:16	17:24	270°	7557	155	5586	19	1.2	0.6	
	19	19-E	17:28	17:37	91°	7412	163	5580	17	1.4	0.7	
	20	20-W	17:41	17:50	270°	7404	159	5572	18	1.3	0.7	
	21	21-E	17:54	18:03	89°	7414	158	5566	18	1.2	0.7	
	22	22-W	18:07	18:16	270°	7401	156	5559	18	1.2	0.7	
	23	23-E	18:20	18:28	90°	7425	159	5550	17	1.2	0.7	
	24	24-W	18:32	18:41	270°	7395	160	5545	17	1.2	0.7	
	25	25-E	18:45	18:54	90°	7407	157	5538	14	1.4	0.8	
	26	26-W	18:58	19:07	271°	7383	157	5531	17	1.1	7	
	27	27-E	19:11	19:20	91°	7412	155	5523	17	1.1	0.7	
	28	28-W	19:24	19:33	270°	7395	158	5517	17	1.1	0.6	
	29	29-E	19:36	19:45	91°	7388	160	5510	17	1.1	0.6	
	30	30-W	19:49	19:58	270°	7361	156	5503	16	1.2	0.7	Cloud 13 Miles from end

Digital Aerial Solutions Flight Log

Project/Flight Plan:	22008_MO_SOUTHERNMO_D22			Lift	Temp °C Before		Temp °C After		Pressure (kPa)		Sensor Operator	
				3	3		1		102.03		Everett Meyer	
Date/Julian:	3/17/2023		Disk Drive		Sensor						Pilot	
Hobbs End	783.9		TM MM30 (101, 102)		TM_90524						Mike Wasielewski	
Hobbs ST	782.6		TARGET MSL	Target AIRSPD	Base Name	PID	Base Name	PID	Base Height		Aircraft	Airport Identifcation:
Flight Time	1.3		7,500	155	HFJ3		HFJ4		1.500		C441-N207SS	KHFJ

∠	Flight Line	Mission Line	UTC time:		Direction	GPS Altitude	Speed	Available	S/Vs	Position Acc.		Comments and Conditions:
			Begin:	End:				MM Space		AVG PDOP	AVG HDOP	
	31	31-E	1:53	1:53	90°	7290	157	5495	17	1.5	0.7	Abnormal Reflections
	32	32-W	1:58	2:07	271°	7272	155	5488	17	1.4	0.7	Abnormal Reflections
	33	33-E	2:12	2:21	90°	7302	157	5482	19	1.2	0.6	Abnormal Reflections

Digital Aerial Solutions Flight Log

Project/Flight Plan:	22008_MO_SOUTHERNMO_D22		Lift	Temp °C Before	Temp °C After	Pressure (kPa)	Sensor Operator	
			4	-3	3	103.22	Chuck Harris	
Date/Julian:	3/19/2023	Disk Drive		Sensor			Pilot	
Hobbs End	7789.2	TM MM30 (103, 104)		TM_90524			Jim Crouch	
Hobbs ST	7784.7	TARGET MSL	Target AIRSPD	Base Name	PID	Base Name	PID	Base Height	Aircraft	Airport Identifcation:
Flight Time	4.5	6,500	155	KPOF1		KPOF2		1.500	C441-N207SS	KPOF

∠	Flight Line	Mission Line	UTC time:		Direction	GPS Altitude	Speed	Available	S/Vs	Position Acc.		Comments and Conditions:
			Begin:	End:				MM Space		AVG PDOP	AVG HDOP	
	98	98 N	14:03	14:11	341°	6712	151	6228	16	1.4	0.8	Abnormal Reflections
	97	97 S	14:16	14:22	162°	6750	158	6222	16	1.4	0.8	Abnormal Reflections
	96	96 N	14:27	14:34	341°	6740	159	6215	17	1.1	0.7	Abnormal Reflections
	95	95 S	14:39	14:46	161°	6772	156	6208	17	1.4	0.8	Abnormal Reflections
	94	94 N	14:51	14:58	341°	6773	158	6203	17	1.4	0.7	Abnormal Reflections
	93	93 S	15:02	15:09	161°	6783	160	6198	16	1.6	0.7	Abnormal Reflections
	92	92 N	15:13	15:19	341°	6753	160	6194	17	1.3	0.7	Abnormal Reflections
	91	91 S	15:23	15:28	162°	6779	154	6189	17	1.3	0.6	Abnormal Reflections
	90	90 N	15:32	15:38	340°	6757	162	6184	17	1.3	0.6	Abnormal Reflections
	89	89 S	15:42	15:47	161°	6780	158	6178	18	1.4	0.6	Abnormal Reflections
	88	88 N	15:51	15:56	340°	6775	158	6175	18	1.3	0.6	Abnormal Reflections
	87	87 S	16:01	16:02	160°	6804	156	6173	18	1.4	0.6	Abnormal Reflections
	86	86 N	16:07	16:09	340°	6792	158	6171	18	1.3	0.6	Abnormal Reflections
	109	109 N	16:12	16:15	13°	6784	160	6170	18	1.3	0.6	Abnormal Reflections
	110	110 S	16:20	16:23	193°	6784	158	6167	19	1.2	0.6	Abnormal Reflections
	111	111 N	16:27	16:30	13°	6779	158	6165	20	1.1	0.6	Abnormal Reflections
	112	112 S	16:34	16:37	195°	6800	156	6162	19	1.2	0.6	Abnormal Reflections
	113	113 N	16:42	16:46	13°	6785	160	6158	19	1.1	0.6	Abnormal Reflections
	114	114 S	16:50	16:55	194°	6790	158	6156	18	1.2	0.6	Abnormal Reflections
	115	115N	16:59	17:04	13°	6790	156	6152	19	1.1	0.6	Abnormal Reflections
	116	116 S	17:08	17:15	194°	6787	153	6150	18	1.1	0.6	Abnormal Reflections
	117	117 N	17:17	17:20	14°	6777	161	6148	17	1.4	0.6	Abnormal Reflections
	118	118 S	17:24	17:25	194°	6785	155	6145	17	1.4	0.7	Abnormal Reflections
	99	99 S	17:29	17:33	161°	6808	161	6143	17	1.3	0.7	Abnormal Reflections
	100	100 N	17:38	17:41	341°	6812	161	6141	18	1.2	0.7	Abnormal Reflections
	101	101 S	17:45	17:49	161°	6780	160	6137	17	1.3	0.7	Abnormal Reflections

Digital Aerial Solutions Flight Log

Project/Flight Plan:	22008_MO_SOUTHERNMO_D22	Lift	Temp °C Before	Temp °C After	Pressure (kPa)	Sensor Operator
		4	-3	3	103.22	Chuck Harris

Date/Julian:	3/19/2023	Disk Drive	Sensor	Pilot
Hobbs End	7789.2	TM MM30 (103, 104)	TM_90524	Jim Crouch

Hobbs ST	7784.7	TARGET MSL	Target AIRSPD	Base Name	PID	Base Name	PID	Base Height	Aircraft	Airport Identifcation:
Flight Time	4.5	6,500	155	KPOF1		KPOF2		1.500	C441-N207SS	KPOF

∠	Flight Line	Mission Line	UTC time:		Direction	GPS Altitude	Speed	Available	S/Vs	Position Acc.		Comments and Conditions:
			Begin:	End:				MM Space		AVG PDOP	AVG HDOP	
	102	102 N	17:53	17:57	340°	6780	156	6134	16	1.4	0.7	Abnormal reflection
	103	103 S	18:01	18:05	161°	6795	160	6131	16	1.4	0.8	Abnormal reflection
	104	104 N	18:10	18:14	341°	6751	6128	6128	16	1.4	0.8	Abnormal reflection
	105	105 S	18:19	18:21	161°	6756	6124	6124	17	1.3	0.8	Abnormal reflection

Digital Aerial Solutions Flight Log

Project/Flight Plan:	22008_MO_SOUTHERNMO_D22		Lift	Temp °C Before	Temp °C After	Pressure (kPa)	Sensor Operator	
			5	4	3	102.03	Everett Meyer	
Date/Julian:	3/19/2023	Disk Drive		Sensor			Pilot	
Hobbs End	794.8	TM MM30 (107, 108)		TM_90524			Mike Wasielewski	
Hobbs ST	789.2	TARGET MSL	Target AIRSPD	Base Name	PID	Base Name	PID	Base Height	Aircraft	Airport Identifcation:
Flight Time	5.6	6,800	155	POF01		POF02		1.500	C441-N207SS	KPOF

∠	Flight Line	Mission Line	UTC time:		Direction	GPS Altitude	Speed	Available	S/Vs	Position Acc.		Comments and Conditions:
			Begin:	End:				MM Space		AVG PDOP	AVG HDOP	
	85	85-NE	19:16	19:23	60°	6715	155	5513	16	1.2	0.7	
	84	84-SW	19:27	29:34	240°	6752	157	5508	16	1.2	0.7	
	83	83-NE	19:38	19:45	60°	6776	157	5503	17	1.1	0.7	
	82	82-SW	19:49	19:56	240°	6790	155	5499	16	1.2	0.7	
	81	81-NE	19:59	20:05	59°	6750	154	5493	16	1.3	0.7	
	80	80-SW	20:09	20:14	240°	6750	153	5490	15	1.2	0.7	
	79	79-NE	20:18	20:23	60°	6740	153	5486	15	1.2	0.7	
	78	78-SW	20:27	20:31	240°	6764	157	5483	16	1.1	0.7	
	77	77-NE	20:35	20:39	60°	6761	158	5480	16	1.1	0.7	
	76	76-SW	20:42	20:45	240°	6750	151	5477	16	1.1	0.7	
	75	75-NE	20:49	20:52	59°	6736	151	5476	16	1.1	0.7	
	108	108-NNE	20:58	20:59	342°	6847	155	5475	13	1.5	0.9	
	107	107-SSW	21:03	21:05	161°	6827	156	5475	14	1.4	0.8	
	106	106-NNE	21:08	21:10	341°	6824	156	5474	16	1.2	0.7	
	58	58-SSW	21:14	21:22	161°	6800	158	5473	16	1.3	0.7	
	59	59-NNE	21:25	21:32	342°	6750	156	5469	16	1.4	0.7	
	60	60-SSW	21:36	21:43	162°	6750	153	5464	16	1.2	0.7	
	61	61-NNE	21:47	21:54	342°	6750	155	5459	17	1.2	0.6	
	62	62-SSW	21:58	22:05	162°	6740	160	5454	17	1.3	0.6	
	63	63-NNE	22:10	22:17	342°	6750	157	5450	17	1.3	0.7	
	64	64-SSW	22:21	22:28	161°	6748	158	5446	18	1.1	0.6	
	65	65-NNE	22:33	22:39	342°	6739	154	5441	18	1.1	0.6	
	66	66-SSW	22:42	22:48	162°	6765	157	5439	18	1.1	0.6	
	67	67-NNE	22:52	22:57	341°	6761	155	5434	19	1.1	0.6	
	68	68-SSW	23:00	23:05	161°	6752	156	5432	19	1.1	0.6	
	69	69-NNE	23:09	23:14	341°	6755	152	5427	19	1.1	0.6	

Digital Aerial Solutions Flight Log

Project/Flight Plan:	22008_MO_SOUTHERNMO_D22		Lift	Temp °C Before	Temp °C After	Pressure (kPa)	Sensor Operator	
			5	4	3	102.03	Everett Meyer	
Date/Julian:	3/19/2023	Disk Drive		Sensor			Pilot	
Hobbs End	794.8	TM MM30 (107, 108)		TM_90524			Mike Wasielewski	
Hobbs ST	789.2	TARGET MSL	Target AIRSPD	Base Name	PID	Base Name	PID	Base Height	Aircraft	Airport Identifcation:
Flight Time	5.6	6,800	155	POF01		POF02		1.500	C441-N207SS	KPOF

∠	Flight Line	Mission Line	UTC time:		Direction	GPS Altitude	Speed	Available	S/Vs	Position Acc.		Comments and Conditions:
			Begin:	End:				MM Space		AVG PDOP	AVG HDOP	
	70	70-SSW	23:17	23:21	162°	6763	158	5425	18	1.3	0.6	
	71	71-NNE	23:26	23:29	342°	6751	155	5420	19	1.2	0.6	
	72	72-SSW	23:32	23:35	162°	6764	159	5420	19	1.1	0.6	
	73	73-NNE	23:39	23:41	342°	6754	154	5415	20	1.1	0.6	
	74	74-SSW	23:45	23:48	160°	6759	156	5414	20	1.1	0.6	
	52	52-S	23:54	23:58	180°	6733	159	5414	18	1.2	0.6	
	53	53-N	24:02	24:06	360°	6688	161	5411	18	1.3	0.6	
	54	54-S	24:10	24:13	180°	6640	160	5409	18	1.3	0.6	
	55	55-N	24:17	24:20	360°	6630	155	5407	19	1.2	0.6	
	56	56-S	24:24	24:26	180°	6642	158	5404	19	1.2	0.6	
	57	57-N	24:30	24:32	360°	6632	155	5402	19	1.2	0.6	

Digital Aerial Solutions Flight Log

Project/Flight Plan:	22008_MO_SOUTHERNMO_D22		Lift	Temp °C Before	Temp °C After	Pressure (kPa)	Sensor Operator	
			6	5	11	102.57	Chuck Harris	
Date/Julian:	3/20/2023	Disk Drive		Sensor			Pilot	
Hobbs End	99	TM MM30 (101, 102)		TM_90524			Jim Crouch	
Hobbs ST	95.3	TARGET MSL	Target AIRSPD	Base Name	PID	Base Name	PID	Base Height	Aircraft	Airport Identifcation:
Flight Time	3.7	6,500	155	KUNO1		KUNO2		1.500	C441-N207SS	KUNO

∠	Flight Line	Mission Line	UTC time:		Direction	GPS Altitude	Speed	Available	S/Vs	Position Acc.		Comments and Conditions:
			Begin:	End:				MM Space		AVG PDOP	AVG HDOP	
	51	51 W	15:26	15:28	260°	7503	153	5474	17	1.3	0.6	Abnormal Reflections
	50	50 E	15:33	15:35	80°	7518	163	5474	17	1.3	0.6	Abnormal Reflections
	49	49 W	15:39	15:42	258°	7511	155	5471	18	1.3	0.6	Abnormal Reflections
	48	48 E	15:48	15:51	78°	7521	158	5469	18	1.3	0.6	Abnormal Reflections
	47	47 W	15:56	16:01	259°	7512	165	5465	17	1.4	0.6	Abnormal Reflections
	46	46 E	16:06	16:12	78°	7529	158	5461	18	1.3	0.6	Abnormal Reflections
	45	45 W	16:16	16:23	289°	7524	152	5457	19	1.2	0.6	Abnormal Reflections
	44	44 E	16:27	16:35	78°	7531	155	5452	19	1.2	0.6	Abnormal Reflections
	43	43 W	16:40	16:49	258°	7644	155	5447	19	1.1	0.6	Abnormal Reflections
	42	42 E	16:53	17:02	76°	7652	154	5439	17	1.2	0.6	Abnormal Reflections
	41	41 W	17:06	17:15	258°	7636	157	5432	16	1.5	0.7	Abnormal Reflections
	40	40 E	17:20	17:28	80°	7645	159	5425	16	1.4	0.7	Abnormal Reflections
	39	39 W	17:33	17:42	258°	7623	154	5420	17	1.3	0.7	Abnormal Reflections
	38	38 E	17:46	17:55	78°	7632	155	5413	17	1.3	0.7	Abnormal Reflections
	37	37 W	17:59	18:07	260°	7632	154	5406	17	1.3	0.8	Abnormal Reflections
	36	36 E	18:11	18:20	78°	7641	158	5397	18	1.2	0.7	Abnormal Reflections
	35	35 W	18:25	18:34	258°	7621	159	5391	18	1.1	0.7	Abnormal Reflections
	34	34 E	18:37	18:46	78°	7643	158	5385	16	1.2	0.7	Abnormal Reflections

Appendix B. Base Station GPS Session Forms

GPS SESSION FORM

Contract # / TO #	Client / Project Name	Date
140G0221D0017	USGS MO_SOUTHERNMO_D22	**3/15/2023**

DAS Project No.	Survey Firm	Operator Name
22008	DAS	**Everett Meyer**

Monument Name/Designation	Exact Stamping *(include photo in survey report)*
KHFJ3	

Monument No./PID	Collection Type *(circle one)*	File Name *(receiver generated)*
	ABGPS **STATIC** RTK	6674_0315_160446.m00

Receiver Manufacturer	Receiver Model	Receiver Serial No.
N/A	N/A	**N/A**

Data Collector Manufacturer	Data Collector Model	Data Collector Serial No.
Leica	GS15	1516674

Antenna Part No.	Antenna Model	Antenna Serial No.
6194452	**N/A**	**N/A**

Starting Antenna Height in Feet				Starting Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

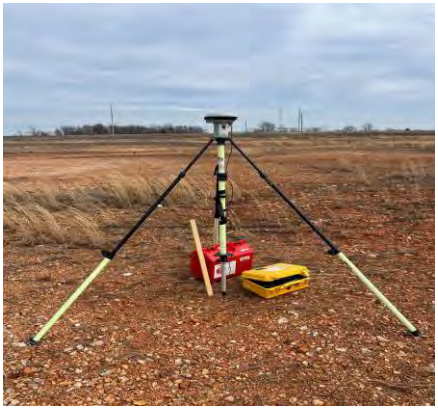
Ending Antenna Height in Feet				Ending Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

Antenna Reference Point *(include and reference a dimensional diagram in Survey Report)*
(e.g., bottom edge of notch in ground plane, Page 5, Figure 2)

Start Date (UTC)	Start Time (UTC)	Approx. Lat. *(if available)*
3/15/2023	**20:05**	**36 54 39.63924 N**
End Date (UTC)	**End Time (UTC)**	**Approx. Long.** *(if available)*
3/16/2023	**0:12**	**94 0 40.03160 W**

Describe any abnormalites and/or problems encountered during the session, include time of occurance and duration.

Site Diagram/Setup-Photo



GPS SESSION FORM

Contract # / TO #	Client / Project Name	Date
140G0221D0017	USGS MO_SOUTHERNMO_D22	**3/15/2023**

DAS Project No.	Survey Firm	Operator Name
22008	DAS	**Everett Meyer**

Monument Name/Designation	Exact Stamping *(include photo in survey report)*
KHFJ4	

Monument No./PID	Collection Type *(circle one)*	File Name *(receiver generated)*
	ABGPS **STATIC** RTK	1514_0315_160040.m00

Receiver Manufacturer	Receiver Model	Receiver Serial No.
N/A	N/A	**N/A**

Data Collector Manufacturer	Data Collector Model	Data Collector Serial No.
Leica	GS15	1501514

Antenna Part No.	Antenna Model	Antenna Serial No.
3725413	**N/A**	**N/A**

Starting Antenna Height in Feet				Starting Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

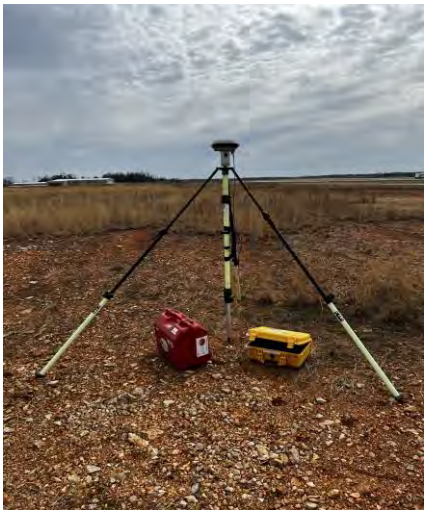
Ending Antenna Height in Feet				Ending Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

Antenna Reference Point *(include and reference a dimensional diagram in Survey Report)*
(e.g., bottom edge of notch in ground plane, Page 5, Figure 2)

Start Date (UTC)	Start Time (UTC)	Approx. Lat. *(if available)*
3/15/2023	**20:01**	**36 54 39.60047 N**
End Date (UTC)	**End Time (UTC)**	**Approx. Long.** *(if available)*
3/16/2023	**0:13**	**94 0 40.62042 W**

Describe any abnormalites and/or problems encountered during the session, include time of occurance and duration.

Site Diagram/Setup-Photo



GPS SESSION FORM

Contract # / TO #	Client / Project Name	Date
140G0221D0017	USGS MO_SOUTHERNMO_D22	**3/17/2023**

DAS Project No.	Survey Firm	Operator Name
22008	DAS	**Everett Meyer**

Monument Name/Designation	Exact Stamping *(include photo in survey report)*
KHFJ3	

Monument No./PID	Collection Type *(circle one)*	File Name *(receiver generated)*
	ABGPS **STATIC** RTK	6674_0317_095858.m00

Receiver Manufacturer	Receiver Model	Receiver Serial No.
N/A	N/A	**N/A**

Data Collector Manufacturer	Data Collector Model	Data Collector Serial No.
Leica	GS15	1516674

Antenna Part No.	Antenna Model	Antenna Serial No.
6194452	**N/A**	**N/A**

Starting Antenna Height in Feet				Starting Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

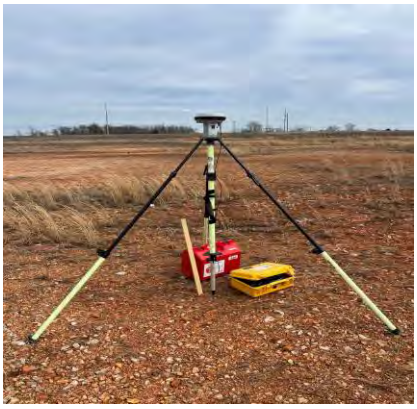
Ending Antenna Height in Feet				Ending Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

Antenna Reference Point *(include and reference a dimensional diagram in Survey Report)*
(e.g., bottom edge of notch in ground plane, Page 5, Figure 2)

Start Date (UTC)	Start Time (UTC)	Approx. Lat. *(if available)*
3/17/2023	**13:59**	**36 54 39.63924 N**
End Date (UTC)	**End Time (UTC)**	**Approx. Long.** *(if available)*
3/18/2023	**3:03**	**94 0 40.03160 W**

Describe any abnormalites and/or problems encountered during the session, include time of occurance and duration.

Site Diagram/Setup-Photo



GPS SESSION FORM

Contract # / TO #	Client / Project Name	Date
140G0221D0017	USGS MO_SOUTHERNMO_D22	**3/17/2023**

DAS Project No.	Survey Firm	Operator Name
22008	DAS	**Everett Meyer**

Monument Name/Designation	Exact Stamping *(include photo in survey report)*
KHFJ4	

Monument No./PID	Collection Type *(circle one)*	File Name *(receiver generated)*
	ABGPS **STATIC** RTK	1514_0317_095612.m00

Receiver Manufacturer	Receiver Model	Receiver Serial No.
N/A	N/A	**N/A**

Data Collector Manufacturer	Data Collector Model	Data Collector Serial No.
Leica	GS15	1501514

Antenna Part No.	Antenna Model	Antenna Serial No.
3725413	**N/A**	**N/A**

Starting Antenna Height in Feet				Starting Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

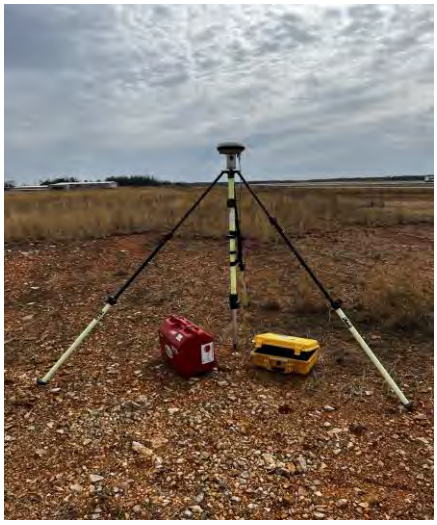
Ending Antenna Height in Feet				Ending Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

Antenna Reference Point *(include and reference a dimensional diagram in Survey Report)*
(e.g., bottom edge of notch in ground plane, Page 5, Figure 2)

Start Date (UTC)	Start Time (UTC)	Approx. Lat. *(if available)*
3/17/2023	**13:56**	**36 54 39.63924 N**
End Date (UTC)	**End Time (UTC)**	**Approx. Long.** *(if available)*
3/18/2023	**3:03**	**94 0 40.03160 W**

Describe any abnormalites and/or problems encountered during the session, include time of occurance and duration.

Site Diagram/Setup-Photo



GPS SESSION FORM

Contract # / TO #	Client / Project Name	Date
140G0221D0017	USGS MO_SOUTHERNMO_D22	**3/19/2023**

DAS Project No.	Survey Firm	Operator Name
22008	DAS	**Everett Meyer**

Monument Name/Designation	Exact Stamping *(include photo in survey report)*
KPOF1	

Monument No./PID	Collection Type *(circle one)*	File Name *(receiver generated)*
	ABGPS **STATIC** RTK	6674_0319_092704.m00

Receiver Manufacturer	Receiver Model	Receiver Serial No.
N/A	N/A	**N/A**

Data Collector Manufacturer	Data Collector Model	Data Collector Serial No.
Leica	GS15	1516674

Antenna Part No.	Antenna Model	Antenna Serial No.
6194452	**N/A**	**N/A**

Starting Antenna Height in Feet				Starting Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	
							1.5	**TRUE VERTICAL** ARP
Ending Antenna Height in Feet				**Ending Antenna Height in Meters**				**Type of Measurement** *(circle one)*
1	2	3	AVG	1	2	3	AVG	
							1.5	**TRUE VERTICAL** ARP

Antenna Reference Point *(include and reference a dimensional diagram in Survey Report)*
(e.g., bottom edge of notch in ground plane, Page 5, Figure 2)

Start Date (UTC)	Start Time (UTC)	Approx. Lat. *(if available)*
3/19/2023	**13:27**	**36 45 58.58305 N**
End Date (UTC)	**End Time (UTC)**	**Approx. Long.** *(if available)*
3/20/2023	**1:05**	**90 19 25.08150 W**

Describe any abnormalites and/or problems encountered during the session, include time of occurance and duration.

Site Diagram/Setup-Photo

GPS SESSION FORM

Contract # / TO #	Client / Project Name	Date
140G0221D0017	USGS MO_SOUTHERNMO_D22	**3/19/2023**

DAS Project No.	Survey Firm	Operator Name
22008	DAS	**Everett Meyer**

Monument Name/Designation	Exact Stamping *(include photo in survey report)*
KPOF2	

Monument No./PID	Collection Type *(circle one)*	File Name *(receiver generated)*
	ABGPS **STATIC** RTK	1514_0319_092534.m00

Receiver Manufacturer	Receiver Model	Receiver Serial No.
N/A	N/A	**N/A**

Data Collector Manufacturer	Data Collector Model	Data Collector Serial No.
Leica	GS15	1501514

Antenna Part No.	Antenna Model	Antenna Serial No.
3725413	**N/A**	**N/A**

Starting Antenna Height in Feet				Starting Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

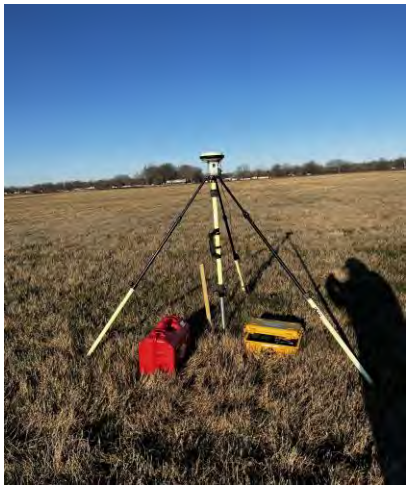
Ending Antenna Height in Feet				Ending Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

Antenna Reference Point *(include and reference a dimensional diagram in Survey Report)*
(e.g., bottom edge of notch in ground plane, Page 5, Figure 2)

Start Date (UTC)	Start Time (UTC)	Approx. Lat. *(if available)*
3/19/2023	**13:26**	**36 45 58.95457 N**
End Date (UTC)	**End Time (UTC)**	**Approx. Long.** *(if available)*
3/20/2023	**1:02**	**90 19 25.05976 W**

Describe any abnormalites and/or problems encountered during the session, include time of occurance and duration.

Site Diagram/Setup-Photo



GPS SESSION FORM

Contract # / TO #	Client / Project Name	Date
140G0221D0017	USGS MO_SOUTHERNMO_D22	**3/20/2023**

DAS Project No.	Survey Firm	Operator Name
22008	DAS	**Chuck Harris**

Monument Name/Designation	Exact Stamping *(include photo in survey report)*
KUNO1	

Monument No./PID	Collection Type *(circle one)*	File Name *(receiver generated)*
	ABGPS **STATIC** RTK	6674_0320_104024.m00

Receiver Manufacturer	Receiver Model	Receiver Serial No.
N/A	N/A	**N/A**

Data Collector Manufacturer	Data Collector Model	Data Collector Serial No.
Leica	GS15	1516674

Antenna Part No.	Antenna Model	Antenna Serial No.
6194452	**N/A**	**N/A**

Starting Antenna Height in Feet				Starting Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

Ending Antenna Height in Feet				Ending Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

Antenna Reference Point *(include and reference a dimensional diagram in Survey Report)*
(e.g., bottom edge of notch in ground plane, Page 5, Figure 2)

Start Date (UTC)	Start Time (UTC)	Approx. Lat. *(if available)*
3/21/2023	**14:41**	**36 52 39.79024 N**
End Date (UTC)	**End Time (UTC)**	**Approx. Long.** *(if available)*
3/21/2023	**19:13**	**91 54 15.00538 W**

Describe any abnormalites and/or problems encountered during the session, include time of occurance and duration.

Site Diagram/Setup-Photo

GPS SESSION FORM

Contract # / TO #	Client / Project Name	Date
140G0221D0017	USGS MO_SOUTHERNMO_D22	**3/20/2023**

DAS Project No.	Survey Firm	Operator Name
22008	DAS	**Chuck Harris**

Monument Name/Designation	Exact Stamping *(include photo in survey report)*
KUNO2	

Monument No./PID	Collection Type *(circle one)*	File Name *(receiver generated)*
	ABGPS **STATIC** RTK	1514_0320_103905.m00

Receiver Manufacturer	Receiver Model	Receiver Serial No.
N/A	N/A	**N/A**

Data Collector Manufacturer	Data Collector Model	Data Collector Serial No.
Leica	GS15	1501514

Antenna Part No.	Antenna Model	Antenna Serial No.
3725413	**N/A**	**N/A**

Starting Antenna Height in Feet				Starting Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

Ending Antenna Height in Feet				Ending Antenna Height in Meters				Type of Measurement *(circle one)*
1	2	3	AVG	1	2	3	AVG	**TRUE VERTICAL** ARP
							1.5	

Antenna Reference Point *(include and reference a dimensional diagram in Survey Report)*
(e.g., bottom edge of notch in ground plane, Page 5, Figure 2)

Start Date (UTC)	Start Time (UTC)	Approx. Lat. *(if available)*
3/21/2023	**14:39**	**36 52 39.83390 N**
End Date (UTC)	**End Time (UTC)**	**Approx. Long.** *(if available)*
3/21/2023	**19:13**	**91 54 15.48194 W**

Describe any abnormalites and/or problems encountered during the session, include time of occurance and duration.

Site Diagram/Setup-Photo

Appendix C. Vertical Accuracy Calculations

Project Information

Prepared By: RY
Project Name: Mo_SouthernMo_D22
Sensor Info: TM
Required Nominal Pulse Spacing: 0.71
Vendor Name: Digital Aerial Solutions, LLC
Units: Meters
Percent of Extent Tolerance: Extents Not Checked
Date of Aquisition: Start: 3/15/2023 Finish: 3/20/2023

Metadata Information

Tile Index:
- Filename: MO_SouthernMO_D22_DPA_MTI_UTM15.shp
- Number of Polys: 0

Intensity:
- Tile Index Attribute: Not Specified
- Data Filename: Not Specified
- Number of Data Files Matching Attribute: Not Specified

DEM:
- Tile Index Attribute: Name
- Data Filename: UTM15N
- Number of Data Files Matching Attribute: 36 out of 1385

LAS:
- Tile Index Attribute: Name
- Data Filename: UTM15N
- Number of Data Files Matching Attribute: 36 out of 1385

Tiled-Data Area

LiDAR Accuracy Assessment Summary

LC Type	# Points	NVA	VVA	RMSE Z
LAS		95% Confidence	95 Percentile	
Bare Earth	32	0.083		0.042
High Vegetation	20		0.143	0.230
Low Vegetation	17		0.091	0.066
Medium Vegetation	12		0.055	0.038
Urban Terrain	23	0.063		0.032
NVA Total:	55	0.075		0.038
VVA Total:	49		0.133	0.153
Total:	104			0.109
DEM		95% Confidence	95 Percentile	
Bare Earth	32	0.077		0.039
High Vegetation	20		0.133	0.232
Low Vegetation	17		0.099	0.068
Medium Vegetation	12		0.071	0.049
Urban Terrain	23	0.073		0.037
NVA Total:	55	0.075		0.038
VVA Total:	49		0.133	0.156
Total:	104			0.109
			Units:	Meters

Coordinates and Offsets of Analyzed Locations

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
1)	☑	**GS0001**					
			447844.914	4101823.601	392.209	392.241	392.233
					Urban Terrain	0.032	0.024
2)	☑	**GS0002**					
			447842.611	4101800.566	392.641	392.666	392.666
					Urban Terrain	0.025	0.025
3)	☑	**GS0006**					
			458178.066	4098278.382	426.165	426.214	426.214
					Urban Terrain	0.049	0.049
4)	☑	**GS0010**					
			468475.341	4100112.578	354.672	354.69	354.69
					Bare Earth	0.018	0.018
5)	☑	**GS0011**					
			470053.93	4096820.62	359.344	359.294	359.271
					Bare Earth	-0.05	-0.073
6)	☑	**GS0013**					
			473219.699	4094966.384	379.496	379.494	379.495
					Bare Earth	-0.002	-0.001
7)	☑	**GS0015**					
			474749.426	4087398.407	410.813	410.784	410.78
					Urban Terrain	-0.029	-0.033

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
8)	☑	**GS0017**					
			473231.312	4080622.128	412.146	412.106	412.11
					Bare Earth	-0.04	-0.036
9)	☑	**GS0020**					
			479601.733	4081232.406	388.353	388.321	388.319
					Urban Terrain	-0.032	-0.034
10)	☑	**GS0023**					
			478863.876	4088633.118	413.61	413.61	413.59
					Urban Terrain	0	-0.02
11)	☑	**GS0024**					
			478918.028	4088602.033	411.69	411.601	411.625
					Urban Terrain	-0.089	-0.065
12)	☑	**GS0027**					
			474619.999	4086943.912	408.444	408.411	408.423
					Bare Earth	-0.033	-0.021
13)	☑	**GS0028**					
			479637.808	4095167.471	381.126	381.168	381.173
					Urban Terrain	0.042	0.047
14)	☑	**GS0030**					
			479623.592	4095139.754	380.473	380.514	380.509
					Urban Terrain	0.041	0.036

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
15)	GS0032					
		481613.464	4097342.428	351.398	351.449	351.479
				Bare Earth	0.051	0.081
16)	GS0034					
		480089.801	4102643.422	393.759	393.81	393.814
				Bare Earth	0.051	0.055
17)	GS0035					
		480093.749	4102622.079	393.428	393.475	393.47
				Urban Terrain	0.047	0.042
18)	GS0038					
		498436.427	4077463.905	267.786	267.775	267.779
				Urban Terrain	-0.011	-0.007
19)	GS0041					
		498069.516	4081379.709	352.586	352.584	352.602
				Bare Earth	-0.002	0.016
20)	GS0045					
		495127.999	4087541.687	419.831	419.805	419.813
				Bare Earth	-0.026	-0.018
21)	GS0046					
		499369.463	4090131.028	323.369	323.406	323.428
				Bare Earth	0.037	0.059

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
22)	☑	**GS0047**					
			503771.559	4094369.191	469.788	469.795	469.785
					Urban Terrain	0.007	-0.003
23)	☑	**GS0049**					
			503733.802	4094353.977	469.749	469.745	469.745
					Bare Earth	-0.004	-0.004
24)	☑	**GS0050**					
			503714.754	4094346.401	469.567	469.554	469.561
					Bare Earth	-0.013	-0.006
25)	☑	**GS0052**					
			499815.016	4096427.028	454.697	454.648	454.636
					Bare Earth	-0.049	-0.061
26)	☑	**GS0053**					
			499836.795	4096439.323	455.155	455.059	455.07
					Bare Earth	-0.096	-0.085
27)	☑	**GS0055**					
			493832.234	4095061.791	432.073	432.072	432.079
					Urban Terrain	-0.001	0.006
28)	☑	**GS0057**					
			506137.944	4096368.465	470.078	470.053	470.057
					Urban Terrain	-0.025	-0.021

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
29)	☑	**GS0058**					
			506135.236	4096351.068	469.889	469.852	469.84
					Urban Terrain	-0.037	-0.049
30)	☑	**GS0075**					
			755621.175	4075463.516	100.519	100.527	100.524
					Urban Terrain	0.008	0.005
31)	☑	**GS0077**					
			755602.949	4075452.878	100.29	100.33	100.296
					Bare Earth	0.04	0.006
32)	☑	**GS0079**					
			760519.588	4071573.888	99.097	99.116	99.109
					Bare Earth	0.019	0.012
33)	☑	**GS0080**					
			760539.932	4071577.463	98.86	98.87	98.861
					Bare Earth	0.01	0.001
34)	☑	**GS0081**					
			760562.258	4071578.294	98.962	98.989	99.004
					Bare Earth	0.027	0.042
35)	☑	**GS0082**					
			760584.43	4071579.352	98.978	98.996	99.005
					Bare Earth	0.018	0.027

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
36)	GS0083					
		760606.4	4071582.547	98.733	98.783	98.79
				Bare Earth	0.05	0.057
37)	GS0084					
		760516.83	4071596.02	99.112	99.115	99.107
				Bare Earth	0.003	-0.005
38)	GS0088					
		725053.538	4116325.095	123.075	123.058	123.047
				Bare Earth	-0.017	-0.028
39)	GS0090					
		725062.231	4116219.222	121.75	121.74	121.728
				Bare Earth	-0.01	-0.022
40)	GS0092					
		718962.112	4122094.569	127.454	127.381	127.383
				Bare Earth	-0.073	-0.071
41)	GS0094					
		720848.636	4118889.554	121.509	121.486	121.48
				Bare Earth	-0.023	-0.029
42)	GS0105					
		726407.669	4108666.716	113.766	113.729	113.744
				Urban Terrain	-0.037	-0.022

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
43)	**GS0106**					
		726390.913	4108652.099	113.286	113.313	113.31
				Bare Earth	0.027	0.024
44)	**GS0107**					
		726369.965	4108645.868	113.169	113.135	113.157
				Urban Terrain	-0.034	-0.012
45)	**GS0108**					
		726360.202	4108627.096	113.105	113.089	113.081
				Urban Terrain	-0.016	-0.024
46)	**GS0111**					
		742655.056	4092405.548	135.569	135.654	135.628
				Urban Terrain	0.085	0.059
47)	**GS0114**					
		741894.207	4090243.367	128.404	128.494	128.495
				Bare Earth	0.09	0.091
48)	**GS0117**					
		537658.394	4107484.988	430.169	430.164	430.168
				Urban Terrain	-0.005	-0.001
49)	**GS0118**					
		537671.367	4107482.589	429.839	429.842	429.843
				Urban Terrain	0.003	0.004

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
50)	☑	**GS0119**					
			537682.845	4107480.671	429.579	429.56	429.555
					Urban Terrain	-0.019	-0.024
51)	☑	**GS0125**					
			551775.752	4107491.25	452.315	452.345	452.33
					Bare Earth	0.03	0.015
52)	☑	**GS0126**					
			551761.061	4107490.524	452.253	452.287	452.288
					Bare Earth	0.034	0.034
53)	☑	**GS0127**					
			551756.756	4107508.168	452.167	452.199	452.208
					Bare Earth	0.032	0.041
54)	☑	**GS0133**					
			546107.786	4107252.305	464.059	464.04	464.054
					Bare Earth	-0.019	-0.005
55)	☑	**GS0134**					
			546095.576	4107252.718	463.895	463.91	463.904
					Bare Earth	0.015	0.009
56)	☑	**GS0003**					
			452254.285	4099355.388	415.073	415.081	415.082
					Low Vegetation	0.008	0.009

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
57)	☑	**GS0004**					
			452254.386	4099375.584	415.282	415.251	415.267
					Low Vegetation	-0.031	-0.015
58)	☑	**GS0007**					
			458156.695	4098283.411	425.94	426.031	426.035
					High Vegetation	0.091	0.095
59)	☑	**GS0009**					
			468517.656	4100103.509	355.519	355.575	355.572
					High Vegetation	0.056	0.053
60)	☑	**GS0012**					
			470057.159	4096798.167	358.991	358.863	358.848
					High Vegetation	-0.128	-0.143
61)	☑	**GS0014**					
			473233.253	4094950.206	380.126	380.048	380.06
					High Vegetation	-0.078	-0.066
62)	☑	**GS0016**					
			474715.113	4087386.968	410.596	410.562	410.609
					High Vegetation	-0.034	0.013
63)	☑	**GS0018**					
			473252.912	4080643.907	411.682	411.717	411.723
					Medium Vegetation	0.035	0.041

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
64)	☑	**GS0021**					
			479600.364	4081211.175	388.853	388.844	388.849
					High Vegetation	-0.009	-0.004
65)	☑	**GS0025**					
			474594.056	4086936.7	408.282	408.311	408.306
					Medium Vegetation	0.029	0.024
66)	☑	**GS0026**					
			474612.385	4086923.971	408.438	408.396	408.394
					Medium Vegetation	-0.042	-0.044
67)	☑	**GS0029**					
			479628.808	4095198.381	381.894	381.958	381.953
					High Vegetation	0.064	0.058
68)	☑	**GS0033**					
			481604.816	4097318.967	351.517	351.605	351.61
					High Vegetation	0.088	0.093
69)	☑	**GS0039**					
			498435.349	4077437.748	267.879	267.861	267.867
					Medium Vegetation	-0.018	-0.012
70)	☑	**GS0042**					
			498111.251	4081393.893	352.223	352.298	352.257
					Medium Vegetation	0.075	0.034

Coordinates and Offsets of Analyzed Locations (Continued)

	ID	Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
71)	**GS0044**					
		495171.007	4087533.1	420.116	420.26	420.249
				Low Vegetation	0.144	0.133
72)	**GS0048**					
		503751.004	4094365.05	469.735	469.822	469.804
				Low Vegetation	0.087	0.069
73)	**GS0054**					
		499844.786	4096459.126	454.73	454.709	454.726
				Low Vegetation	-0.021	-0.004
74)	**GS0056**					
		493852.935	4095070.557	432.249	432.247	432.237
				High Vegetation	-0.002	-0.012
75)	**GS0074**					
		759563.542	4075683.965	106.925	107	106.992
				High Vegetation	0.075	0.067
76)	**GS0078**					
		755642.813	4075463.026	100.068	100.116	100.123
				Low Vegetation	0.048	0.055
77)	**GS0086**					
		725062.349	4116286.937	123.087	123.186	123.177
				Low Vegetation	0.099	0.09

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
78)	☑	**GS0087**					
			725062.415	4116306.396	123.286	123.333	123.335
					Low Vegetation	0.047	0.049
79)	☑	**GS0089**					
			725051.829	4116236.24	121.878	121.914	121.918
					Low Vegetation	0.036	0.04
80)	☑	**GS0093**					
			720832.246	4118862.037	121.297	121.293	121.263
					High Vegetation	-0.004	-0.034
81)	☑	**GS0095**					
			720855.029	4118869.532	121.536	121.489	121.479
					High Vegetation	-0.047	-0.057
82)	☑	**GS0096**					
			720830.919	4118882.048	121.865	121.859	121.834
					Low Vegetation	-0.006	-0.031
83)	☑	**GS0097**					
			726489.089	4111576.712	129.333	129.404	129.389
					Medium Vegetation	0.071	0.056
84)	☑	**GS0098**					
			726506.308	4111566.657	130.571	130.636	130.604
					Medium Vegetation	0.065	0.033

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
85)	☑	**GS0099**					
			726524.245	4111556.184	131.902	131.967	131.931
					Medium Vegetation	0.065	0.029
86)	☑	**GS0102**					
			723846.871	4106631.291	128.945	129.927	129.916
					High Vegetation	0.982	0.971
87)	☑	**GS0103**					
			723847.397	4106610.08	130.244	130.15	130.148
					High Vegetation	-0.094	-0.097
88)	☑	**GS0104**					
			723849.109	4106589.112	130.29	130.241	130.247
					High Vegetation	-0.049	-0.043
89)	☑	**GS0110**					
			746849.877	4089367.527	104.755	104.827	104.81
					High Vegetation	0.072	0.055
90)	☑	**GS0112**					
			742658.706	4092428.127	135.863	135.969	135.968
					High Vegetation	0.106	0.105
91)	☑	**GS0113**					
			741878.427	4090263.558	128.08	128.197	128.19
					High Vegetation	0.117	0.11

Coordinates and Offsets of Analyzed Locations (Continued)

	ID	Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
92)	**GS0115**					
		741884.363	4090207.729	128.248	128.381	128.374
				High Vegetation	0.133	0.126
93)	**GS0120**					
		537645.816	4107481.414	430.034	430.132	430.125
				Low Vegetation	0.098	0.091
94)	**GS0121**					
		537635.052	4107481.159	430.499	430.559	430.589
				Low Vegetation	0.06	0.09
95)	**GS0122**					
		537624.592	4107481.586	430.979	431.055	431.054
				Low Vegetation	0.076	0.075
96)	**GS0123**					
		537616.542	4107472.807	431.363	431.411	431.417
				Low Vegetation	0.048	0.054
97)	**GS0128**					
		551771.899	4107550.594	452.215	452.232	452.235
				Medium Vegetation	0.017	0.02
98)	**GS0129**					
		551783.154	4107541.276	452.325	452.359	452.352
				Medium Vegetation	0.034	0.027

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
99)	☑	**GS0130**					
			551799.275	4107510.761	452.611	452.654	452.666
					Medium Vegetation	0.043	0.055
100)	☑	**GS0131**					
			551802.112	4107490.945	452.216	452.225	452.277
					High Vegetation	0.009	0.061
101)	☑	**GS0135**					
			546088.335	4107243.103	464.04	464.097	464.089
					Low Vegetation	0.057	0.049
102)	☑	**GS0136**					
			546082.371	4107232.433	463.669	463.739	463.735
					Low Vegetation	0.07	0.066
103)	☑	**GS0137**					
			546072.345	4107229.541	463.543	463.602	463.6
					Low Vegetation	0.059	0.057
104)	☑	**GS0138**					
			546061.758	4107240.788	463.638	463.592	463.59
					Medium Vegetation	-0.046	-0.048

LAS

Nonvegetated Vertical Accuracy

LandCover Type: Bare Earth, Urban Terrain

Minimum DZ: -0.085

Maximum DZ: 0.091

Mean DZ: 0.002

Mean Magnitude DZ: 0.174

Number Observations: 55

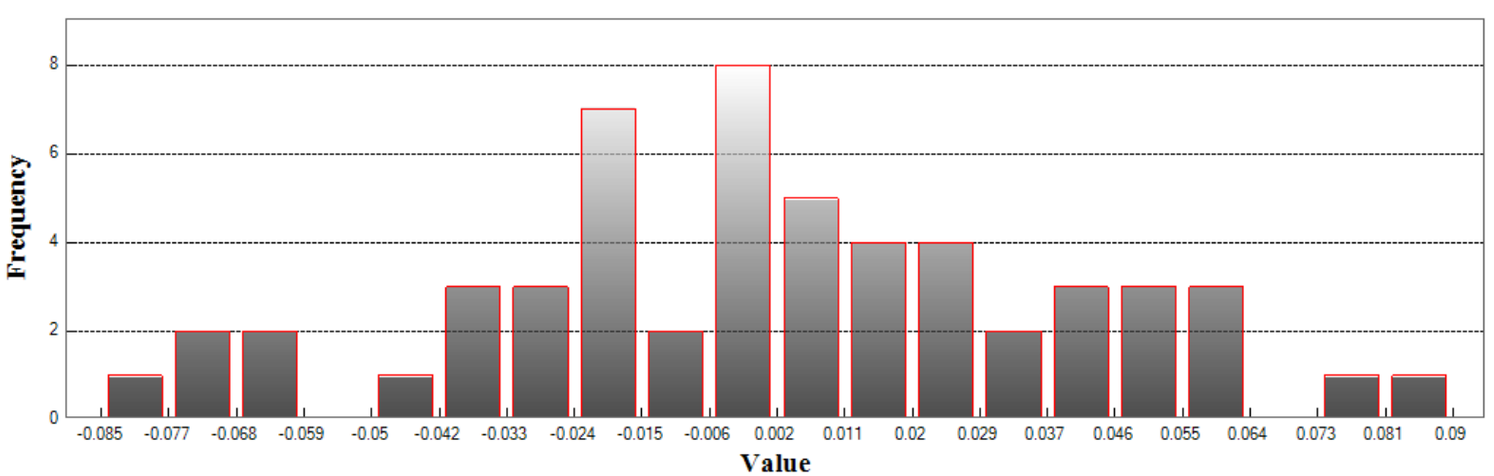
Standard Deviation DZ: 0.039

RMSE Z: 0.038

95% Confidence Level Z: 0.075

Units: Meters

Histogram



Min: -0.085

Max: 0.091

Number Of Bins: 20

Bin Interval: 0.009

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: High Vegetation

Minimum DZ: -0.143

Maximum DZ: 0.971

Mean DZ: 0.068

Mean Magnitude DZ: 0.336

Number Observations: 20

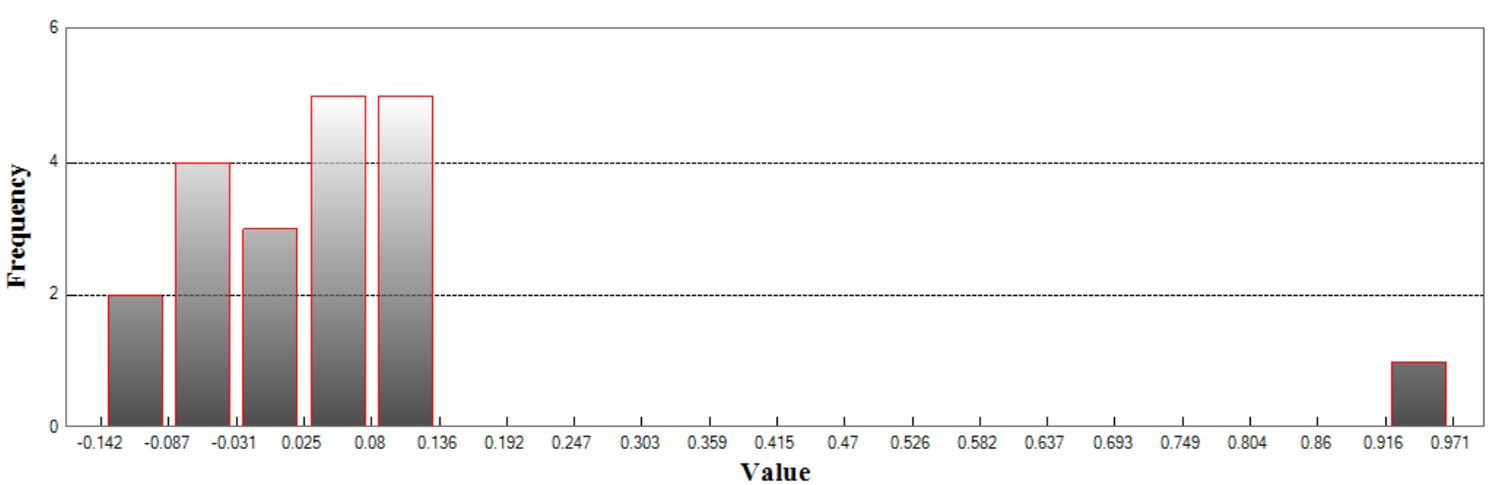
Standard Deviation DZ: 0.226

RMSE Z: 0.23

95th Percentile: 0.143

Units: Meters

Histogram



Min: -0.143

Max: 0.971

Number Of Bins: 20

Bin Interval: 0.056

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: Low Vegetation

Minimum DZ: -0.031

Maximum DZ: 0.133

Mean DZ: 0.052

Mean Magnitude DZ: 0.24

Number Observations: 17

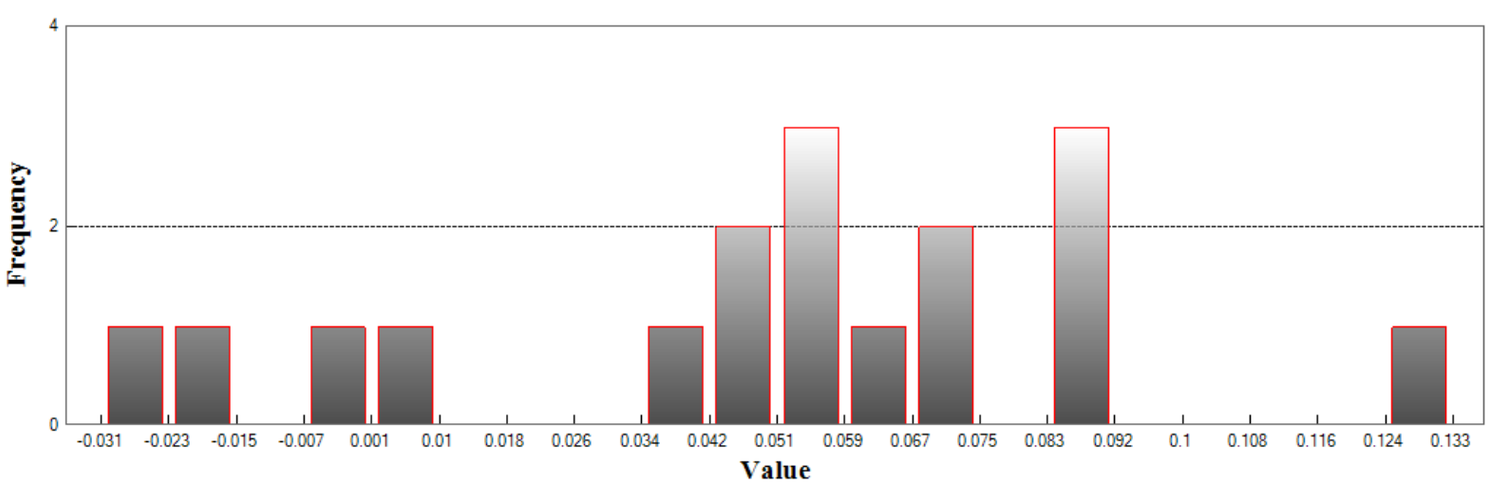
Standard Deviation DZ: 0.042

RMSE Z: 0.066

95th Percentile: 0.091

Units: Meters

Histogram



Min: -0.031

Max: 0.133

Number Of Bins: 20

Bin Interval: 0.008

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: Medium Vegetation

Minimum DZ: -0.048

Maximum DZ: 0.056

Mean DZ: 0.018

Mean Magnitude DZ: 0.187

Number Observations: 12

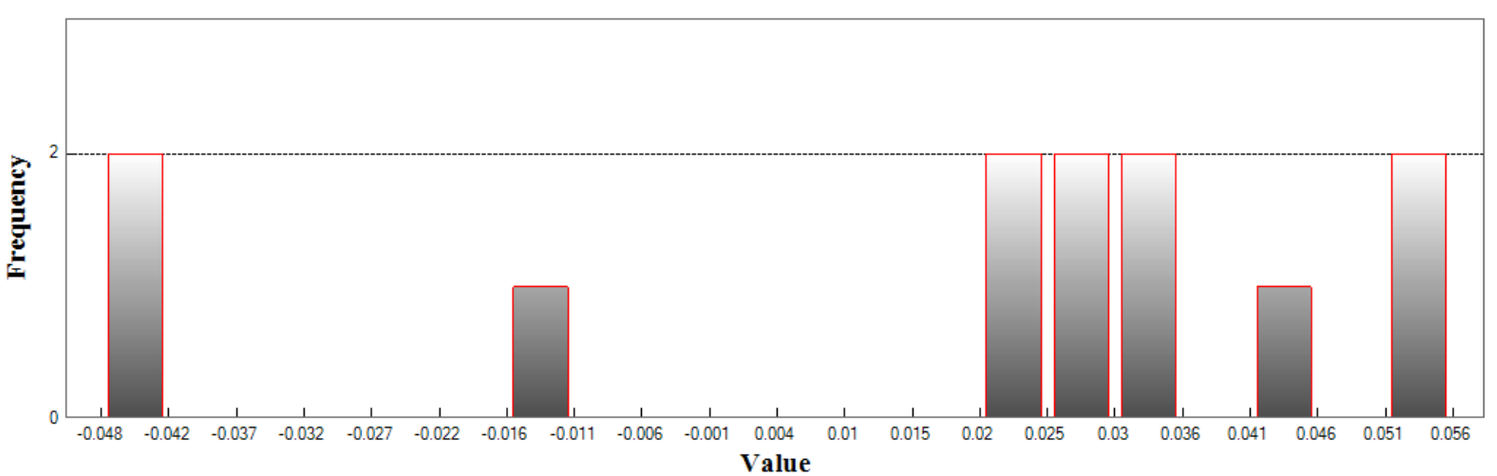
Standard Deviation DZ: 0.035

RMSE Z: 0.038

95th Percentile: 0.055

Units: Meters

Histogram



Min: -0.048

Max: 0.056

Number Of Bins: 20

Bin Interval: 0.005

DEM

Nonvegetated Vertical Accuracy

LandCover Type: Bare Earth, Urban Terrain

Minimum DZ: -0.096

Maximum DZ: 0.09

Mean DZ: 0.002

Mean Magnitude DZ: 0.175

Number Observations: 55

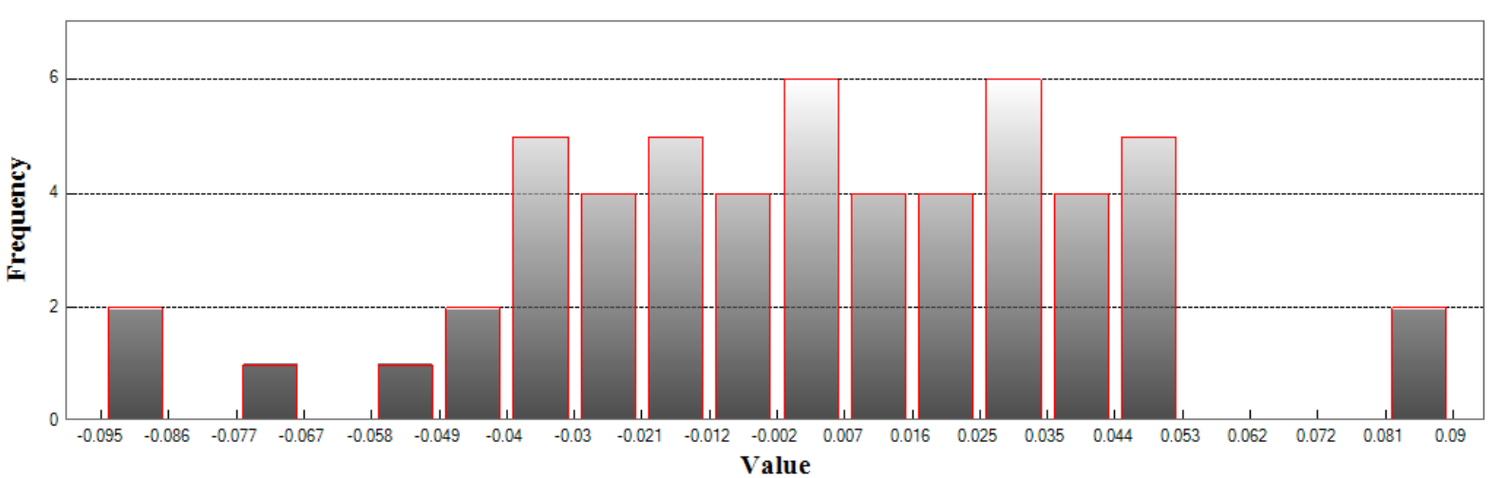
Standard Deviation DZ: 0.039

RMSE Z: 0.038

95% Confidence Level Z: 0.075

Units: Meters

Histogram



Min: -0.096

Max: 0.09

Number Of Bins: 20

Bin Interval: 0.009

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: High Vegetation

Minimum DZ: -0.128

Maximum DZ: 0.982

Mean DZ: 0.068

Mean Magnitude DZ: 0.335

Number Observations: 20

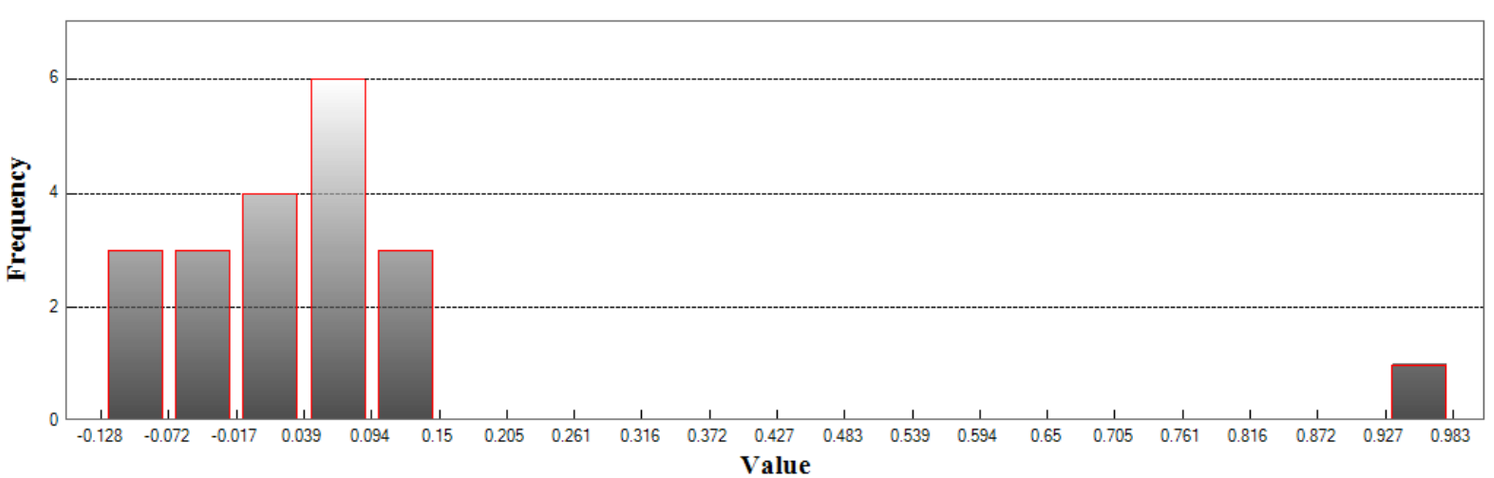
Standard Deviation DZ: 0.228

RMSE Z: 0.232

95th Percentile: 0.133

Units: Meters

Histogram



Min: -0.128

Max: 0.982

Number Of Bins: 20

Bin Interval: 0.056

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: Low Vegetation

Minimum DZ: -0.031

Maximum DZ: 0.144

Mean DZ: 0.052

Mean Magnitude DZ: 0.242

Number Observations: 17

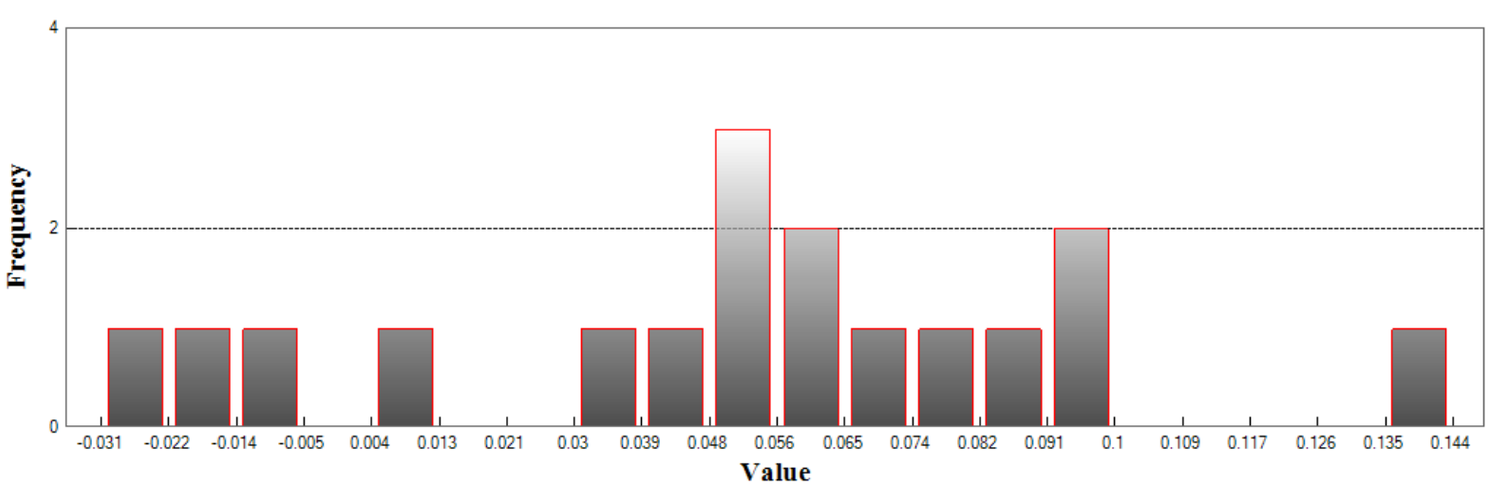
Standard Deviation DZ: 0.045

RMSE Z: 0.068

95th Percentile: 0.099

Units: Meters

Histogram



Min: -0.031

Max: 0.144

Number Of Bins: 20

Bin Interval: 0.009

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: Medium Vegetation

Minimum DZ: -0.046

Maximum DZ: 0.075

Mean DZ: 0.027

Mean Magnitude DZ: 0.212

Number Observations: 12

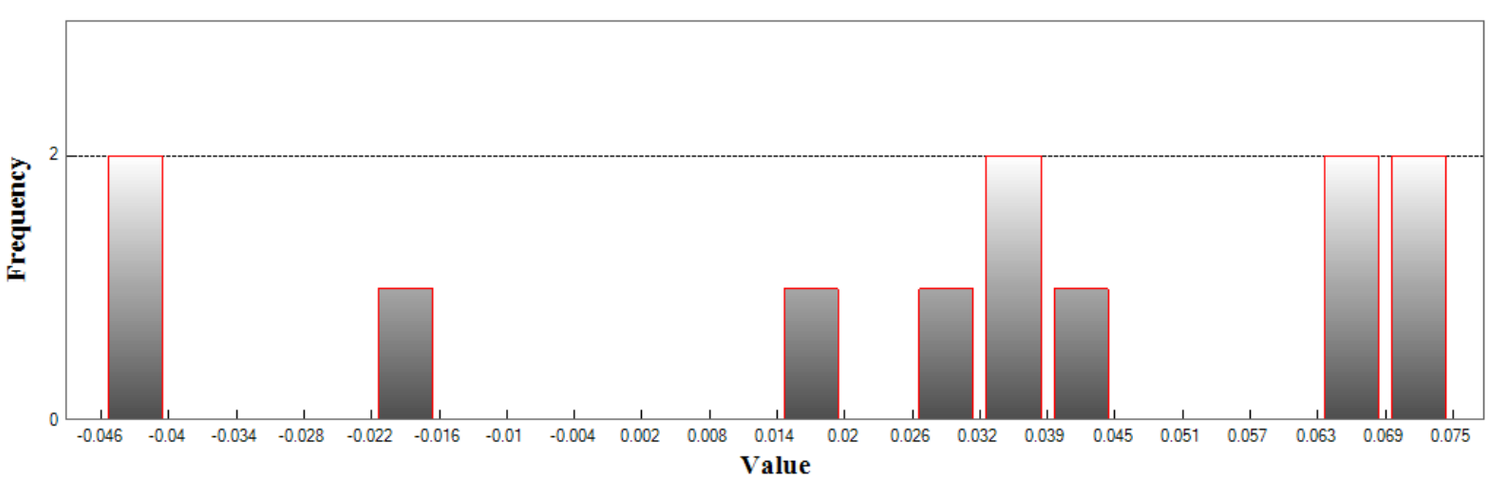
Standard Deviation DZ: 0.042

RMSE Z: 0.049

95th Percentile: 0.071

Units: Meters

Histogram



Min: -0.046

Max: 0.075

Number Of Bins: 20

Bin Interval: 0.006

Point: GS0001

Survey X: 447844.91, Survey Y: 4101823.6, Z1: 392.21, Z DEM: 392.24, Z LAS: 392.23, ΔZ DEM: 0.03, ΔZ LAS: 0.02

North

South

East

West

Point: GS0002

Survey X: 447842.61, Survey Y: 4101800.57, Z1: 392.64, Z DEM: 392.67, Z LAS: 392.67, ΔZ DEM: 0.02, ΔZ LAS: 0.02

North

South

East

West

Point: GS0006

Survey X: 458178.07, Survey Y: 4098278.38, Z1: 426.17, Z DEM: 426.21, Z LAS: 426.21, ΔZ DEM: 0.05, ΔZ LAS: 0.05

North

South

East

West

Point: GS0010

Survey X: 468475.34, Survey Y: 4100112.58, Z1: 354.67, Z DEM: 354.69, Z LAS: 354.69, ΔZ DEM: 0.02, ΔZ LAS: 0.02

North

South

East

West

Point: GS0011

Survey X: 470053.93, Survey Y: 4096820.62, Z1: 359.34, Z DEM: 359.29, Z LAS: 359.27, ΔZ DEM: -0.05, ΔZ LAS: -0.07

North

South

East

West

Point: GS0013

Survey X: 473219.7, Survey Y: 4094966.38, Z1: 379.5, Z DEM: 379.49, Z LAS: 379.49, ΔZ DEM: 0, ΔZ LAS: 0

North

South

East

West

Point: GS0015

Survey X: 474749.43, Survey Y: 4087398.41, Z1: 410.81, Z DEM: 410.78, Z LAS: 410.78, ΔZ DEM: -0.03, ΔZ LAS: -0.03

North

South

East

West

Point: GS0017

Survey X: 473231.31, Survey Y: 4080622.13, Z1: 412.15, Z DEM: 412.11, Z LAS: 412.11, ΔZ DEM: -0.04, ΔZ LAS: -0.04

North

South

East

West

Point: GS0020

Survey X: 479601.73, Survey Y: 4081232.41, Z1: 388.35, Z DEM: 388.32, Z LAS: 388.32, ΔZ DEM: -0.03, ΔZ LAS: -0.03

North

South

East

West

Point: GS0023

Survey X: 478863.88, Survey Y: 4088633.12, Z1: 413.61, Z DEM: 413.61, Z LAS: 413.59, ΔZ LAS: -0.02

North

South

East

West

Point: GS0024

Survey X: 478918.03, Survey Y: 4088602.03, Z1: 411.69, Z DEM: 411.6, Z LAS: 411.63, ΔZ DEM: -0.09, ΔZ LAS: -0.06

North

South

East

West

Point: GS0027

Survey X: 474620, Survey Y: 4086943.91, Z1: 408.44, Z DEM: 408.41, Z LAS: 408.42, ΔZ DEM: -0.03, ΔZ LAS: -0.02

North

South

East

West

Point: GS0028

Survey X: 479637.81, Survey Y: 4095167.47, Z1: 381.13, Z DEM: 381.17, Z LAS: 381.17, ΔZ DEM: 0.04, ΔZ LAS: 0.05

North

South

East

West

Point: GS0030

Survey X: 479623.59, Survey Y: 4095139.75, Z1: 380.47, Z DEM: 380.51, Z LAS: 380.51, ΔZ DEM: 0.04, ΔZ LAS: 0.04

North

South

East

West

Point: GS0032

Survey X: 481613.46, Survey Y: 4097342.43, Z1: 351.4, Z DEM: 351.45, Z LAS: 351.48, ΔZ DEM: 0.05, ΔZ LAS: 0.08

North

South

East

West

Point: GS0034

Survey X: 480089.8, Survey Y: 4102643.42, Z1: 393.76, Z DEM: 393.81, Z LAS: 393.81, ΔZ DEM: 0.05, ΔZ LAS: 0.05

North

South

East

West

Point: GS0035

Survey X: 480093.75, Survey Y: 4102622.08, Z1: 393.43, Z DEM: 393.48, Z LAS: 393.47, ΔZ DEM: 0.05, ΔZ LAS: 0.04

North

South

East

West

Point: GS0038

Survey X: 498436.43, Survey Y: 4077463.91, Z1: 267.79, Z DEM: 267.77, Z LAS: 267.78, ΔZ DEM: -0.01, ΔZ LAS: -0.01

North

South

East

West

Point: GS0041

Survey X: 498069.52, Survey Y: 4081379.71, Z1: 352.59, Z DEM: 352.58, Z LAS: 352.6, ΔZ DEM: 0, ΔZ LAS: 0.02

North

South

East

West

Point: GS0045

Survey X: 495128, Survey Y: 4087541.69, Z1: 419.83, Z DEM: 419.81, Z LAS: 419.81, ΔZ DEM: -0.03, ΔZ LAS: -0.02

North

South

East

West

Point: GS0046

Survey X: 499369.46, Survey Y: 4090131.03, Z1: 323.37, Z DEM: 323.41, Z LAS: 323.43, ΔZ DEM: 0.04, ΔZ LAS: 0.06

North

South

East

West

Point: GS0047

Survey X: 503771.56, Survey Y: 4094369.19, Z1: 469.79, Z DEM: 469.79, Z LAS: 469.79, ΔZ DEM: 0.01, ΔZ LAS: 0

North

South

East

West

Point: GS0049

Survey X: 503733.8, Survey Y: 4094353.98, Z1: 469.75, Z DEM: 469.74, Z LAS: 469.75, ΔZ DEM: 0, ΔZ LAS: 0

North

South

East

West

Point: GS0050

Survey X: 503714.75, Survey Y: 4094346.4, Z1: 469.57, Z DEM: 469.55, Z LAS: 469.56, ΔZ DEM: -0.01, ΔZ LAS: -0.01

North

South

East

West

Point: GS0052

Survey X: 499815.02, Survey Y: 4096427.03, Z1: 454.7, Z DEM: 454.65, Z LAS: 454.64, ΔZ DEM: -0.05, ΔZ LAS: -0.06

North

South

East

West

Point: GS0053

Survey X: 499836.8, Survey Y: 4096439.32, Z1: 455.16, Z DEM: 455.06, Z LAS: 455.07, ΔZ DEM: -0.1, ΔZ LAS: -0.08

North

South

East

West

Point: GS0055

Survey X: 493832.23, Survey Y: 4095061.79, Z1: 432.07, Z DEM: 432.07, Z LAS: 432.08, ΔZ DEM: 0, ΔZ LAS: 0.01

North

South

East

West

Point: GS0057

Survey X: 506137.94, Survey Y: 4096368.47, Z1: 470.08, Z DEM: 470.05, Z LAS: 470.06, ΔZ DEM: -0.02, ΔZ LAS: -0.02

North

South

East

West

Point: GS0058

Survey X: 506135.24, Survey Y: 4096351.07, Z1: 469.89, Z DEM: 469.85, Z LAS: 469.84, ΔZ DEM: -0.04, ΔZ LAS: -0.05

North

South

East

West

Point: GS0075

Survey X: 755621.18, Survey Y: 4075463.52, Z1: 100.52, Z DEM: 100.53, Z LAS: 100.52, ΔZ DEM: 0.01, ΔZ LAS: 0.01

North

South

East

West

Point: GS0077

Survey X: 755602.95, Survey Y: 4075452.88, Z1: 100.29, Z DEM: 100.33, Z LAS: 100.3, ΔZ DEM: 0.04, ΔZ LAS: 0.01

North

South

East

West

Point: GS0079

Survey X: 760519.59, Survey Y: 4071573.89, Z1: 99.1, Z DEM: 99.12, Z LAS: 99.11, ΔZ DEM: 0.02, ΔZ LAS: 0.01

North

South

East

West

Point: GS0080

Survey X: 760539.93, Survey Y: 4071577.46, Z1: 98.86, Z DEM: 98.87, Z LAS: 98.86, ΔZ DEM: 0.01, ΔZ LAS: 0

North

South

East

West

Point: GS0081

Survey X: 760562.26, Survey Y: 4071578.29, Z1: 98.96, Z DEM: 98.99, Z LAS: 99, ΔZ DEM: 0.03, ΔZ LAS: 0.04

North

South

East

West

Point: GS0082

Survey X: 760584.43, Survey Y: 4071579.35, Z1: 98.98, Z DEM: 99, Z LAS: 99.01, ΔZ DEM: 0.02, ΔZ LAS: 0.03

North

South

East

West

Point: GS0083

Survey X: 760606.4, Survey Y: 4071582.55, Z1: 98.73, Z DEM: 98.78, Z LAS: 98.79, ΔZ DEM: 0.05, ΔZ LAS: 0.06

North

South

East

West

Point: GS0084

Survey X: 760516.83, Survey Y: 4071596.02, Z1: 99.11, Z DEM: 99.12, Z LAS: 99.11, ΔZ DEM: 0, ΔZ LAS: 0

North

South

East

West

Point: GS0088

Survey X: 725053.54, Survey Y: 4116325.1, Z1: 123.08, Z DEM: 123.06, Z LAS: 123.05, ΔZ DEM: -0.02, ΔZ LAS: -0.03

North

South

East

West

Point: GS0090

Survey X: 725062.23, Survey Y: 4116219.22, Z1: 121.75, Z DEM: 121.74, Z LAS: 121.73, ΔZ DEM: -0.01, ΔZ LAS: -0.02

North

South

East

West

Point: GS0092

Survey X: 718962.11, Survey Y: 4122094.57, Z1: 127.45, Z DEM: 127.38, Z LAS: 127.38, ΔZ DEM: -0.07, ΔZ LAS: -0.07

North

South

East

West

Point: GS0094

Survey X: 720848.64, Survey Y: 4118889.55, Z1: 121.51, Z DEM: 121.49, Z LAS: 121.48, ΔZ DEM: -0.02, ΔZ LAS: -0.03

North

South

East

West

Point: GS0105

Survey X: 726407.67, Survey Y: 4108666.72, Z1: 113.77, Z DEM: 113.73, Z LAS: 113.74, ΔZ DEM: -0.04, ΔZ LAS: -0.02

North

South

East

West

Point: GS0106

Survey X: 726390.91, Survey Y: 4108652.1, Z1: 113.29, Z DEM: 113.31, Z LAS: 113.31, ΔZ DEM: 0.03, ΔZ LAS: 0.02

North

South

East

West

Point: GS0107

Survey X: 726369.97, Survey Y: 4108645.87, Z1: 113.17, Z DEM: 113.14, Z LAS: 113.16, ΔZ DEM: -0.03, ΔZ LAS: -0.01

North

South

East

West

Point: GS0108

Survey X: 726360.2, Survey Y: 4108627.1, Z1: 113.11, Z DEM: 113.09, Z LAS: 113.08, ΔZ DEM: -0.02, ΔZ LAS: -0.02

North

South

East

West

Point: GS0111

Survey X: 742655.06, Survey Y: 4092405.55, Z1: 135.57, Z DEM: 135.65, Z LAS: 135.63, ΔZ DEM: 0.08, ΔZ LAS: 0.06

North

South

East

West

Point: GS0114

Survey X: 741894.21, Survey Y: 4090243.37, Z1: 128.4, Z DEM: 128.49, Z LAS: 128.49, ΔZ DEM: 0.09, ΔZ LAS: 0.09

North

South

East

West

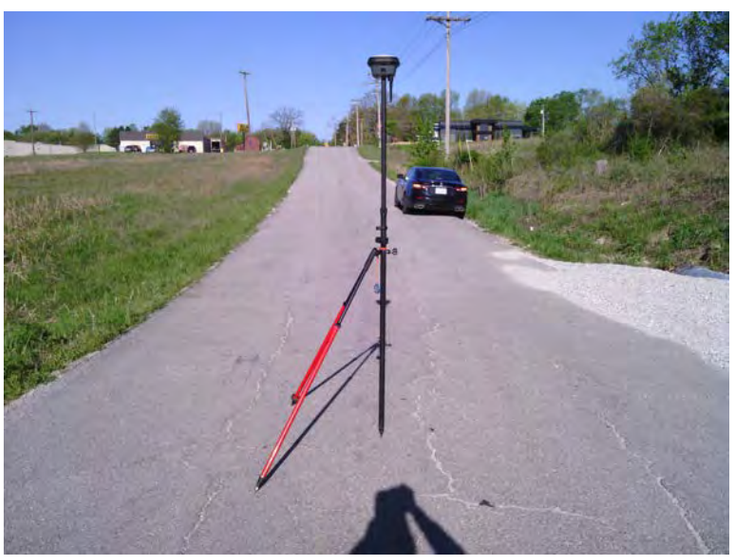
Point: GS0117

Survey X: 537658.39, Survey Y: 4107484.99, Z1: 430.17, Z DEM: 430.16, Z LAS: 430.17, ΔZ DEM: -0.01, ΔZ LAS: 0

North

South

East



West

Point: GS0118

Survey X: 537671.37, Survey Y: 4107482.59, Z1: 429.84, Z DEM: 429.84, Z LAS: 429.84, ΔZ DEM: 0, ΔZ LAS: 0

North

South

East

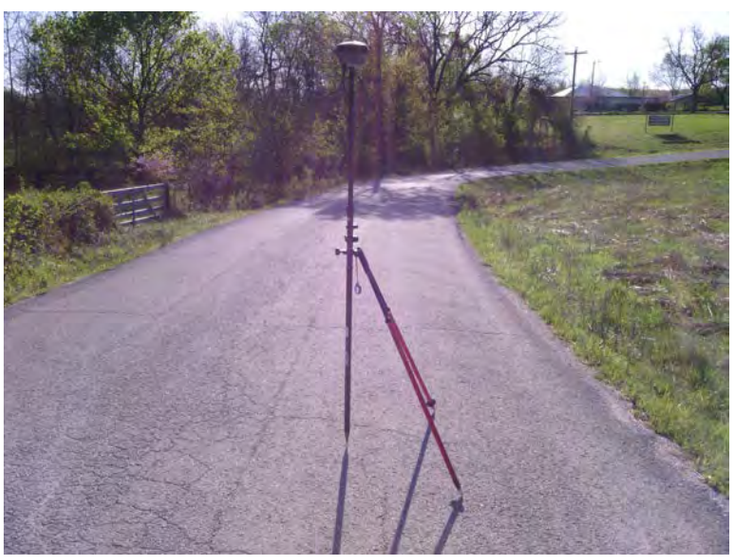
West

Point: GS0119

Survey X: 537682.85, Survey Y: 4107480.67, Z1: 429.58, Z DEM: 429.56, Z LAS: 429.56, ΔZ DEM: -0.02, ΔZ LAS: -0.02

North

South



East

West

Point: GS0125

Survey X: 551775.75, Survey Y: 4107491.25, Z1: 452.32, Z DEM: 452.34, Z LAS: 452.33, ΔZ DEM: 0.03, ΔZ LAS: 0.02

North

South

East

West

Point: GS0126

Survey X: 551761.06, Survey Y: 4107490.52, Z1: 452.25, Z DEM: 452.29, Z LAS: 452.29, ΔZ DEM: 0.03, ΔZ LAS: 0.03

North

South

East

West

Point: GS0127

Survey X: 551756.76, Survey Y: 4107508.17, Z1: 452.17, Z DEM: 452.2, Z LAS: 452.21, ΔZ DEM: 0.03, ΔZ LAS: 0.04

North

South

East

West

Point: GS0133

Survey X: 546107.79, Survey Y: 4107252.31, Z1: 464.06, Z DEM: 464.04, Z LAS: 464.05, ΔZ DEM: -0.02, ΔZ LAS: 0

North

South

East

West

Point: GS0134

Survey X: 546095.58, Survey Y: 4107252.72, Z1: 463.9, Z DEM: 463.91, Z LAS: 463.9, ΔZ DEM: 0.01, ΔZ LAS: 0.01

North

South

East

West

Point: GS0003

Survey X: 452254.29, Survey Y: 4099355.39, Z1: 415.07, Z DEM: 415.08, Z LAS: 415.08, ΔZ DEM: 0.01, ΔZ LAS: 0.01

North

South

East

West

Point: GS0004

Survey X: 452254.39, Survey Y: 4099375.58, Z1: 415.28, Z DEM: 415.25, Z LAS: 415.27, ΔZ DEM: -0.03, ΔZ LAS: -0.02

North

South

East

West

Point: GS0007

Survey X: 458156.7, Survey Y: 4098283.41, Z1: 425.94, Z DEM: 426.03, Z LAS: 426.04, ΔZ DEM: 0.09, ΔZ LAS: 0.09

North

South

East

West

Point: GS0009

Survey X: 468517.66, Survey Y: 4100103.51, Z1: 355.52, Z DEM: 355.58, Z LAS: 355.57, ΔZ DEM: 0.06, ΔZ LAS: 0.05

North

South

East

West

Point: GS0012

Survey X: 470057.16, Survey Y: 4096798.17, Z1: 358.99, Z DEM: 358.86, Z LAS: 358.85, ΔZ DEM: -0.13, ΔZ LAS: -0.14

North

South

East

West

Point: GS0014

Survey X: 473233.25, Survey Y: 4094950.21, Z1: 380.13, Z DEM: 380.05, Z LAS: 380.06, ΔZ DEM: -0.08, ΔZ LAS: -0.07

North

South

East

West

Point: GS0016

Survey X: 474715.11, Survey Y: 4087386.97, Z1: 410.6, Z DEM: 410.56, Z LAS: 410.61, ΔZ DEM: -0.03, ΔZ LAS: 0.01

North

South

East

West

Point: GS0018

Survey X: 473252.91, Survey Y: 4080643.91, Z1: 411.68, Z DEM: 411.72, Z LAS: 411.72, ΔZ DEM: 0.03, ΔZ LAS: 0.04

North

South

East

West

Point: GS0021

Survey X: 479600.36, Survey Y: 4081211.18, Z1: 388.85, Z DEM: 388.84, Z LAS: 388.85, ΔZ DEM: -0.01, ΔZ LAS: 0

North

South

East

West

Point: GS0025

Survey X: 474594.06, Survey Y: 4086936.7, Z1: 408.28, Z DEM: 408.31, Z LAS: 408.31, ΔZ DEM: 0.03, ΔZ LAS: 0.02

North

South

East

West

Point: GS0026

Survey X: 474612.39, Survey Y: 4086923.97, Z1: 408.44, Z DEM: 408.4, Z LAS: 408.39, ΔZ DEM: -0.04, ΔZ LAS: -0.04

North

South

East

West

Point: GS0029

Survey X: 479628.81, Survey Y: 4095198.38, Z1: 381.89, Z DEM: 381.96, Z LAS: 381.95, ΔZ DEM: 0.06, ΔZ LAS: 0.06

North

South

East

West

Point: GS0033

Survey X: 481604.82, Survey Y: 4097318.97, Z1: 351.52, Z DEM: 351.6, Z LAS: 351.61, ΔZ DEM: 0.09, ΔZ LAS: 0.09

North

South

East

West

Point: GS0039

Survey X: 498435.35, Survey Y: 4077437.75, Z1: 267.88, Z DEM: 267.86, Z LAS: 267.87, ΔZ DEM: -0.02, ΔZ LAS: -0.01

North

South

East

West

Point: GS0042

Survey X: 498111.25, Survey Y: 4081393.89, Z1: 352.22, Z DEM: 352.3, Z LAS: 352.26, ΔZ DEM: 0.07, ΔZ LAS: 0.03

North

South

East

West

Point: GS0044

Survey X: 495171.01, Survey Y: 4087533.1, Z1: 420.12, Z DEM: 420.26, Z LAS: 420.25, ΔZ DEM: 0.14, ΔZ LAS: 0.13

North

South

East

West

Point: GS0048

Survey X: 503751, Survey Y: 4094365.05, Z1: 469.74, Z DEM: 469.82, Z LAS: 469.8, ΔZ DEM: 0.09, ΔZ LAS: 0.07

North

South

East

West

Point: GS0054

Survey X: 499844.79, Survey Y: 4096459.13, Z1: 454.73, Z DEM: 454.71, Z LAS: 454.73, ΔZ DEM: -0.02, ΔZ LAS: 0

North

South

East

West

Point: GS0056

Survey X: 493852.94, Survey Y: 4095070.56, Z1: 432.25, Z DEM: 432.25, Z LAS: 432.24, ΔZ DEM: 0, ΔZ LAS: -0.01

North

South

East

West

Point: GS0074

Survey X: 759563.54, Survey Y: 4075683.97, Z1: 106.93, Z DEM: 107, Z LAS: 106.99, ΔZ DEM: 0.07, ΔZ LAS: 0.07

North

South

East

West

Point: GS0078

Survey X: 755642.81, Survey Y: 4075463.03, Z1: 100.07, Z DEM: 100.12, Z LAS: 100.12, ΔZ DEM: 0.05, ΔZ LAS: 0.05

North

South

East

West

Point: GS0086

Survey X: 725062.35, Survey Y: 4116286.94, Z1: 123.09, Z DEM: 123.19, Z LAS: 123.18, ΔZ DEM: 0.1, ΔZ LAS: 0.09

North

South

East

West

Point: GS0087

Survey X: 725062.42, Survey Y: 4116306.4, Z1: 123.29, Z DEM: 123.33, Z LAS: 123.34, ΔZ DEM: 0.05, ΔZ LAS: 0.05

North

South

East

West

Point: GS0089

Survey X: 725051.83, Survey Y: 4116236.24, Z1: 121.88, Z DEM: 121.91, Z LAS: 121.92, ΔZ DEM: 0.04, ΔZ LAS: 0.04

North

South

East

West

Point: GS0093

Survey X: 720832.25, Survey Y: 4118862.04, Z1: 121.3, Z DEM: 121.29, Z LAS: 121.26, ΔZ DEM: 0, ΔZ LAS: -0.03

North

South

East

West

Point: GS0095

Survey X: 720855.03, Survey Y: 4118869.53, Z1: 121.54, Z DEM: 121.49, Z LAS: 121.48, ΔZ DEM: -0.05, ΔZ LAS: -0.06

North

South

East

West

Point: GS0096

Survey X: 720830.92, Survey Y: 4118882.05, Z1: 121.87, Z DEM: 121.86, Z LAS: 121.83, ΔZ DEM: -0.01, ΔZ LAS: -0.03

North

South

East

West

Point: GS0097

Survey X: 726489.09, Survey Y: 4111576.71, Z1: 129.33, Z DEM: 129.4, Z LAS: 129.39, ΔZ DEM: 0.07, ΔZ LAS: 0.06

North

South

East

West

Point: GS0098

Survey X: 726506.31, Survey Y: 4111566.66, Z1: 130.57, Z DEM: 130.64, Z LAS: 130.6, ΔZ DEM: 0.06, ΔZ LAS: 0.03

North

South

East

West

Point: GS0099

Survey X: 726524.25, Survey Y: 4111556.18, Z1: 131.9, Z DEM: 131.97, Z LAS: 131.93, ΔZ DEM: 0.06, ΔZ LAS: 0.03

North

South

East

West

Point: GS0102

Survey X: 723846.87, Survey Y: 4106631.29, Z1: 128.95, Z DEM: 129.93, Z LAS: 129.92, ΔZ DEM: 0.98, ΔZ LAS: 0.97

North

South

East

West

Point: GS0103

Survey X: 723847.4, Survey Y: 4106610.08, Z1: 130.24, Z DEM: 130.15, Z LAS: 130.15, ΔZ DEM: -0.09, ΔZ LAS: -0.1

North

South

East

West

Point: GS0104

Survey X: 723849.11, Survey Y: 4106589.11, Z1: 130.29, Z DEM: 130.24, Z LAS: 130.25, ΔZ DEM: -0.05, ΔZ LAS: -0.04

North

South

East

West

Point: GS0110

Survey X: 746849.88, Survey Y: 4089367.53, Z1: 104.76, Z DEM: 104.83, Z LAS: 104.81, ΔZ DEM: 0.07, ΔZ LAS: 0.06

North

South

East

West

Point: GS0112

Survey X: 742658.71, Survey Y: 4092428.13, Z1: 135.86, Z DEM: 135.97, Z LAS: 135.97, ΔZ DEM: 0.11, ΔZ LAS: 0.1

North

South

East

West

Point: GS0113

Survey X: 741878.43, Survey Y: 4090263.56, Z1: 128.08, Z DEM: 128.2, Z LAS: 128.19, ΔZ DEM: 0.12, ΔZ LAS: 0.11

North

South

East

West

Point: GS0115

Survey X: 741884.36, Survey Y: 4090207.73, Z1: 128.25, Z DEM: 128.38, Z LAS: 128.37, ΔZ DEM: 0.13, ΔZ LAS: 0.13

North

South

East

West

Point: GS0120

Survey X: 537645.82, Survey Y: 4107481.41, Z1: 430.03, Z DEM: 430.13, Z LAS: 430.13, ΔZ DEM: 0.1, ΔZ LAS: 0.09

North

South

East

West

Point: GS0121

Survey X: 537635.05, Survey Y: 4107481.16, Z1: 430.5, Z DEM: 430.56, Z LAS: 430.59, ΔZ DEM: 0.06, ΔZ LAS: 0.09

North

South

East

West

Point: GS0122

Survey X: 537624.59, Survey Y: 4107481.59, Z1: 430.98, Z DEM: 431.06, Z LAS: 431.05, ΔZ DEM: 0.08, ΔZ LAS: 0.08

North

South

East

West

Point: GS0123

Survey X: 537616.54, Survey Y: 4107472.81, Z1: 431.36, Z DEM: 431.41, Z LAS: 431.42, ΔZ DEM: 0.05, ΔZ LAS: 0.05

North

South

East

West

Point: GS0128

Survey X: 551771.9, Survey Y: 4107550.59, Z1: 452.22, Z DEM: 452.23, Z LAS: 452.24, ΔZ DEM: 0.02, ΔZ LAS: 0.02

North

South

East

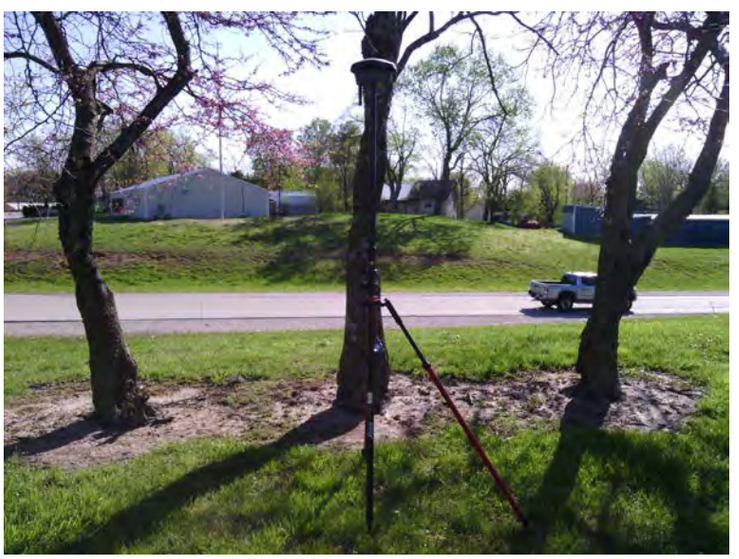
West

Point: GS0129

Survey X: 551783.15, Survey Y: 4107541.28, Z1: 452.33, Z DEM: 452.36, Z LAS: 452.35, ΔZ DEM: 0.03, ΔZ LAS: 0.03

North

South



East

West

Point: GS0130

Survey X: 551799.28, Survey Y: 4107510.76, Z1: 452.61, Z DEM: 452.65, Z LAS: 452.67, ΔZ DEM: 0.04, ΔZ LAS: 0.06

North

South

East

West

Point: GS0131

Survey X: 551802.11, Survey Y: 4107490.95, Z1: 452.22, Z DEM: 452.23, Z LAS: 452.28, ΔZ DEM: 0.01, ΔZ LAS: 0.06

North

South

East

West

Point: GS0135

Survey X: 546088.34, Survey Y: 4107243.1, Z1: 464.04, Z DEM: 464.1, Z LAS: 464.09, ΔZ DEM: 0.06, ΔZ LAS: 0.05

North

South

East

West

Point: GS0136

Survey X: 546082.37, Survey Y: 4107232.43, Z1: 463.67, Z DEM: 463.74, Z LAS: 463.74, ΔZ DEM: 0.07, ΔZ LAS: 0.07

North

South

East

West

Point: GS0137

Survey X: 546072.35, Survey Y: 4107229.54, Z1: 463.54, Z DEM: 463.6, Z LAS: 463.6, ΔZ DEM: 0.06, ΔZ LAS: 0.06

North

South

East

West

Point: GS0138

Survey X: 546061.76, Survey Y: 4107240.79, Z1: 463.64, Z DEM: 463.59, Z LAS: 463.59, ΔZ DEM: -0.05, ΔZ LAS: -0.05

North

South

East

West

Project Information

Prepared By: R.Y
Project Name: Mo_SouthernMo_D22
Sensor Info: TM
Required Nominal Pulse Spacing: 0.71
Vendor Name: Digital Aerial Solutions, LLC
Units: Meters
Percent of Extent Tolerance: Extents Not Checked
Date of Aquisition: Start: 3/15/2023 Finish: 4/19/2023

Metadata Information

Tile Index:
- Filename: MO_SouthernMO_D22_DPA_MTI_UTM16N.shp
- Number of Polys: 0

Intensity:
- Tile Index Attribute: Not Specified
- Data Filename: Not Specified
- Number of Data Files Matching Attribute: Not Specified

DEM:
- Tile Index Attribute: Name
- Data Filename: UTM16N
- Number of Data Files Matching Attribute: 40 out of 40

LAS:
- Tile Index Attribute: Name
- Data Filename: UTM16N
- Number of Data Files Matching Attribute: 40 out of 40

Tiled-Data Area

LiDAR Accuracy Assessment Summary

LC Type	# Points	NVA	VVA	RMSE Z
LAS		95% Confidence	95 Percentile	
Bare Earth	9	0.035		0.018
High Vegetation	1		0.082	0.082
Low Vegetation	3		0.057	0.046
Urban Terrain	1	0.016		0.008
NVA Total:	10	0.034		0.017
VVA Total:	4		0.082	0.057
Total:	14			0.034
DEM		95% Confidence	95 Percentile	
Bare Earth	9	0.041		0.021
High Vegetation	1		0.061	0.061
Low Vegetation	3		0.060	0.043
Urban Terrain	1	0.007		0.004
NVA Total:	10	0.039		0.020
VVA Total:	4		0.061	0.048
Total:	14			0.034
			Units:	Meters

Coordinates and Offsets of Analyzed Locations

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
1)	☑	**GS0059**					
			236803.66	4028498.321	80.214	80.21	80.206
					Urban Terrain	-0.004	-0.008
2)	☑	**GS0060**					
			236829.889	4028499.625	80.166	80.216	80.208
					Bare Earth	0.05	0.042
3)	☑	**GS0061**					
			236130.861	4025322.778	79.215	79.197	79.209
					Bare Earth	-0.018	-0.006
4)	☑	**GS0062**					
			236130.842	4025344.241	79.28	79.256	79.255
					Bare Earth	-0.024	-0.025
5)	☑	**GS0063**					
			236145.954	4025361.99	79.225	79.223	79.219
					Bare Earth	-0.002	-0.006
6)	☑	**GS0064**					
			236193.818	4025354.483	78.968	78.989	78.999
					Low Vegetation	0.021	0.031
7)	☑	**GS0065**					
			236190.25	4025335.675	79.023	79.02	79.026
					Bare Earth	-0.003	0.003

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
8)	☑	**GS0066**					
			236169.546	4025324.316	79.109	79.17	79.191
					High Vegetation	0.061	0.082
9)	☑	**GS0067**					
			236837.322	4030917.417	80.054	80.114	80.111
					Low Vegetation	0.06	0.057
10)	☑	**GS0068**					
			236860.277	4030922.852	80.871	80.86	80.855
					Bare Earth	-0.011	-0.016
11)	☑	**GS0069**					
			236881.276	4030921.154	81.303	81.29	81.298
					Bare Earth	-0.013	-0.005
12)	☑	**GS0070**					
			236908.452	4030910.094	80.181	80.222	80.228
					Low Vegetation	0.041	0.047
13)	☑	**GS0071**					
			236930.804	4030915.744	80.528	80.513	80.538
					Bare Earth	-0.015	0.01
14)	☑	**GS0072**					
			236950.492	4030913.839	80.553	80.549	80.56
					Bare Earth	-0.004	0.007

LAS

Nonvegetated Vertical Accuracy

LandCover Type: Bare Earth, Urban Terrain

Minimum DZ: -0.025

Maximum DZ: 0.042

Mean DZ: 0

Mean Magnitude DZ: 0.114

Number Observations: 10

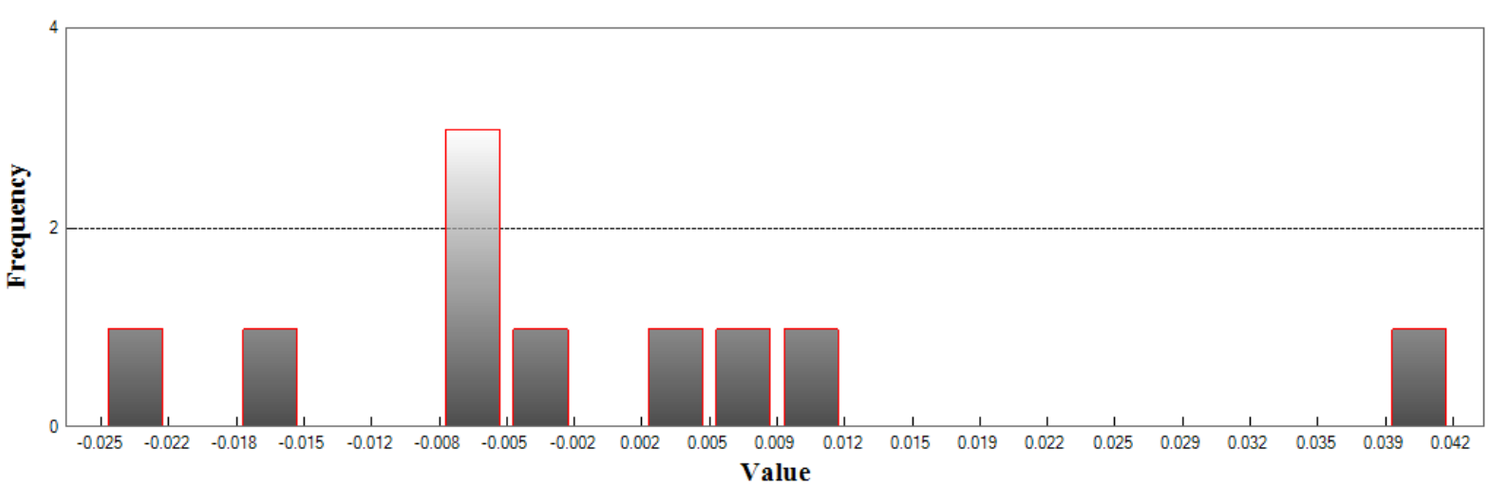
Standard Deviation DZ: 0.018

RMSE Z: 0.017

95% Confidence Level Z: 0.034

Units: Meters

Histogram



Min: -0.025

Max: 0.042

Number Of Bins: 20

Bin Interval: 0.003

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: High Vegetation

Minimum DZ: 0.082

Maximum DZ: 0.082

Mean DZ: 0.082

Mean Magnitude DZ: 0.286

Number Observations: 1

Standard Deviation DZ: NaN

RMSE Z: 0.082

95th Percentile: 0.082

Units: Meters

Histogram

Min: -0.025

Max: 0.042

Number Of Bins: 20

Bin Interval: 0.003

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: Low Vegetation

Minimum DZ: 0.031

Maximum DZ: 0.057

Mean DZ: 0.045

Mean Magnitude DZ: 0.212

Number Observations: 3

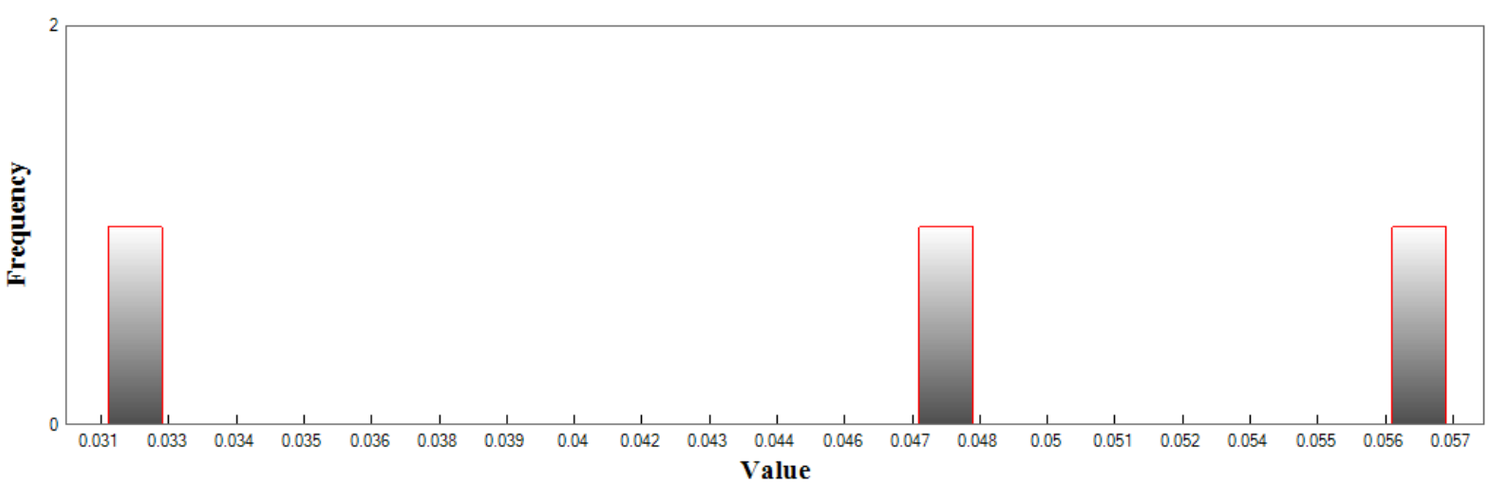
Standard Deviation DZ: 0.013

RMSE Z: 0.046

95th Percentile: 0.057

Units: Meters

Histogram



Min: 0.031

Max: 0.057

Number Of Bins: 20

Bin Interval: 0.001

DEM

Nonvegetated Vertical Accuracy

LandCover Type: Bare Earth, Urban Terrain

Minimum DZ: -0.024

Maximum DZ: 0.05

Mean DZ: -0.004

Mean Magnitude DZ: 0.12

Number Observations: 10

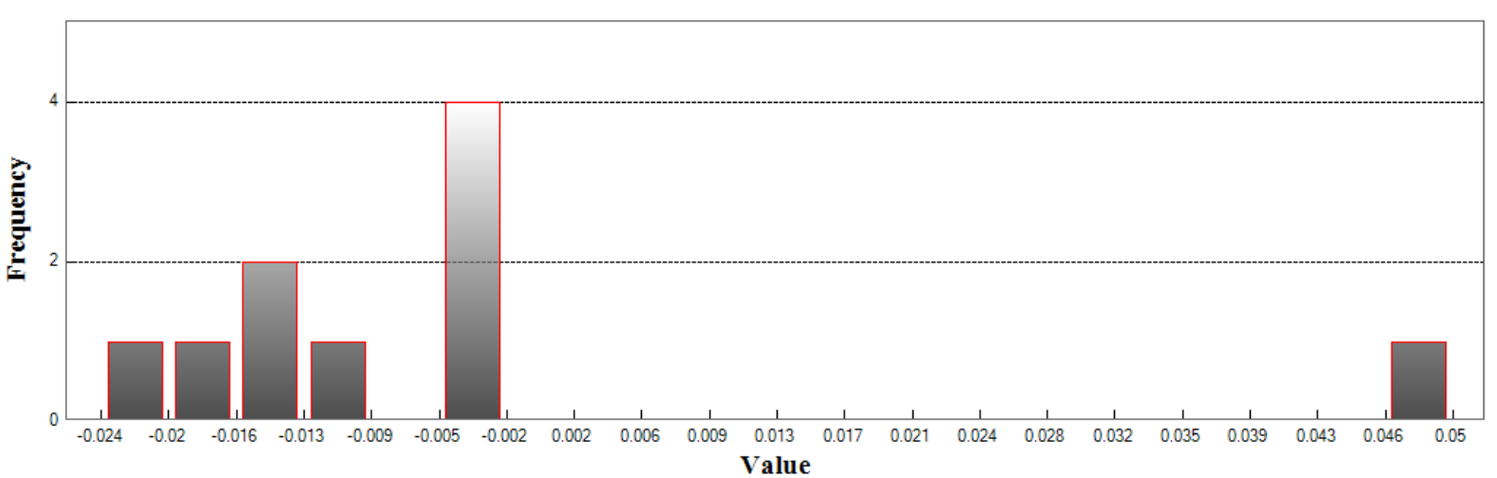
Standard Deviation DZ: 0.02

RMSE Z: 0.02

95% Confidence Level Z: 0.039

Units: Meters

Histogram



Min: -0.024

Max: 0.05

Number Of Bins: 20

Bin Interval: 0.004

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: High Vegetation

Minimum DZ: 0.061

Maximum DZ: 0.061

Mean DZ: 0.061

Mean Magnitude DZ: 0.247

Number Observations: 1

Standard Deviation DZ: NaN

RMSE Z: 0.061

95th Percentile: 0.061

Units: Meters

Histogram

Min: -0.024

Max: 0.05

Number Of Bins: 20

Bin Interval: 0.004

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: Low Vegetation

Minimum DZ: 0.021

Maximum DZ: 0.06

Mean DZ: 0.04

Mean Magnitude DZ: 0.201

Number Observations: 3

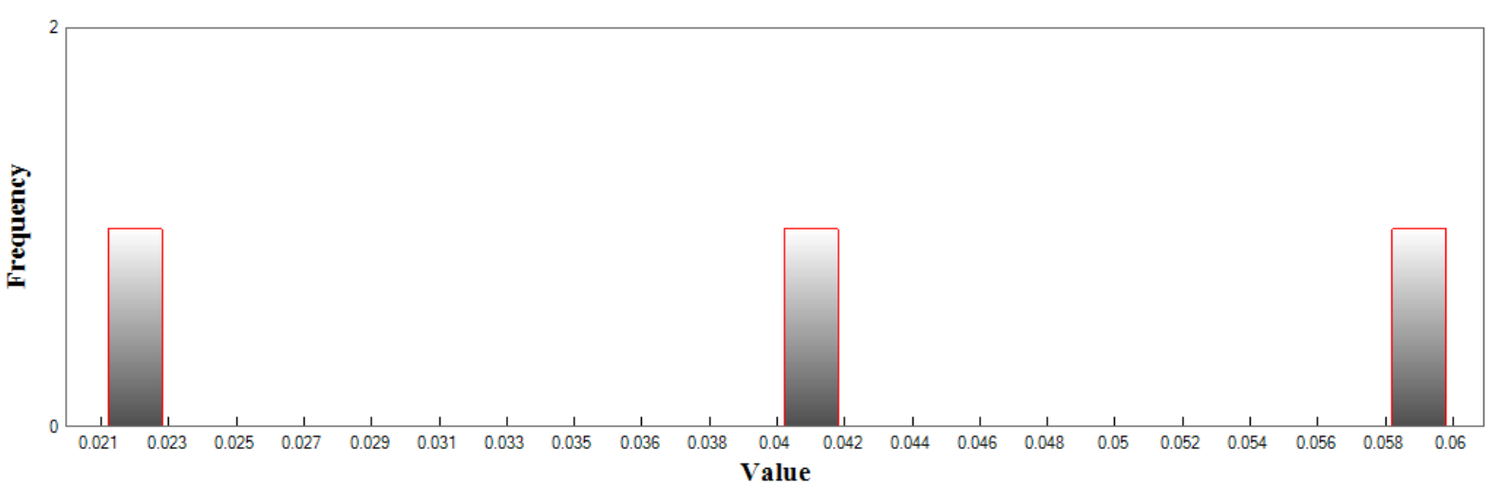
Standard Deviation DZ: 0.019

RMSE Z: 0.043

95th Percentile: 0.06

Units: Meters

Histogram



Min: 0.021

Max: 0.06

Number Of Bins: 20

Bin Interval: 0.002

Point: GS0059

Survey X: 236803.66, Survey Y: 4028498.32, Z1: 80.21, Z DEM: 80.21, Z LAS: 80.21, ΔZ DEM: 0, ΔZ LAS: -0.01

North

South

East

West

Point: GS0060

Survey X: 236829.89, Survey Y: 4028499.63, Z1: 80.17, Z DEM: 80.22, Z LAS: 80.21, ΔZ DEM: 0.05, ΔZ LAS: 0.04

North

South

East

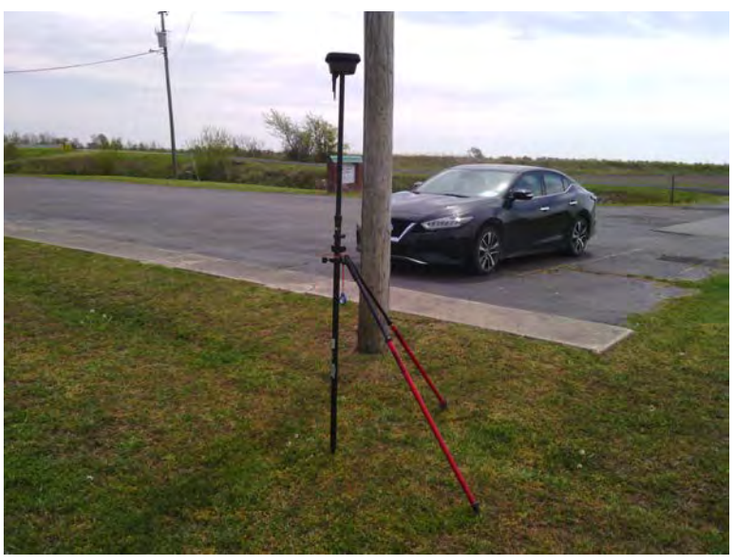
West

Point: GS0061

Survey X: 236130.86, Survey Y: 4025322.78, Z1: 79.22, Z DEM: 79.2, Z LAS: 79.21, ΔZ DEM: -0.02, ΔZ LAS: -0.01

North

South



East

West

Point: GS0062

Survey X: 236130.84, Survey Y: 4025344.24, Z1: 79.28, Z DEM: 79.26, Z LAS: 79.25, ΔZ DEM: -0.02, ΔZ LAS: -0.03

North

South

East

West

Point: GS0063

Survey X: 236145.95, Survey Y: 4025361.99, Z1: 79.22, Z DEM: 79.22, Z LAS: 79.22, ΔZ DEM: 0, ΔZ LAS: -0.01

North

South

East

West

Point: GS0064

Survey X: 236193.82, Survey Y: 4025354.48, Z1: 78.97, Z DEM: 78.99, Z LAS: 79, ΔZ DEM: 0.02, ΔZ LAS: 0.03

North

South

East

West

Point: GS0065

Survey X: 236190.25, Survey Y: 4025335.68, Z1: 79.02, Z DEM: 79.02, Z LAS: 79.03, ΔZ DEM: 0, ΔZ LAS: 0

North

South

East

West

Point: GS0066

Survey X: 236169.55, Survey Y: 4025324.32, Z1: 79.11, Z DEM: 79.17, Z LAS: 79.19, ΔZ DEM: 0.06, ΔZ LAS: 0.08

North

South

East

West

Point: GS0067

Survey X: 236837.32, Survey Y: 4030917.42, Z1: 80.05, Z DEM: 80.11, Z LAS: 80.11, ΔZ DEM: 0.06, ΔZ LAS: 0.06

North

South

East

West

Point: GS0068

Survey X: 236860.28, Survey Y: 4030922.85, Z1: 80.87, Z DEM: 80.86, Z LAS: 80.86, ΔZ DEM: -0.01, ΔZ LAS: -0.02

North

South

East

West

Point: GS0069

Survey X: 236881.28, Survey Y: 4030921.15, Z1: 81.3, Z DEM: 81.29, Z LAS: 81.3, ΔZ DEM: -0.01, ΔZ LAS: -0.01

North

South

East

West

Point: GS0070

Survey X: 236908.45, Survey Y: 4030910.09, Z1: 80.18, Z DEM: 80.22, Z LAS: 80.23, ΔZ DEM: 0.04, ΔZ LAS: 0.05

North

South

East

West

Point: GS0071

Survey X: 236930.8, Survey Y: 4030915.74, Z1: 80.53, Z DEM: 80.51, Z LAS: 80.54, ΔZ DEM: -0.02, ΔZ LAS: 0.01

North

South

East

West

Point: GS0072

Survey X: 236950.49, Survey Y: 4030913.84, Z1: 80.55, Z DEM: 80.55, Z LAS: 80.56, ΔZ DEM: 0, ΔZ LAS: 0.01

North

South

East

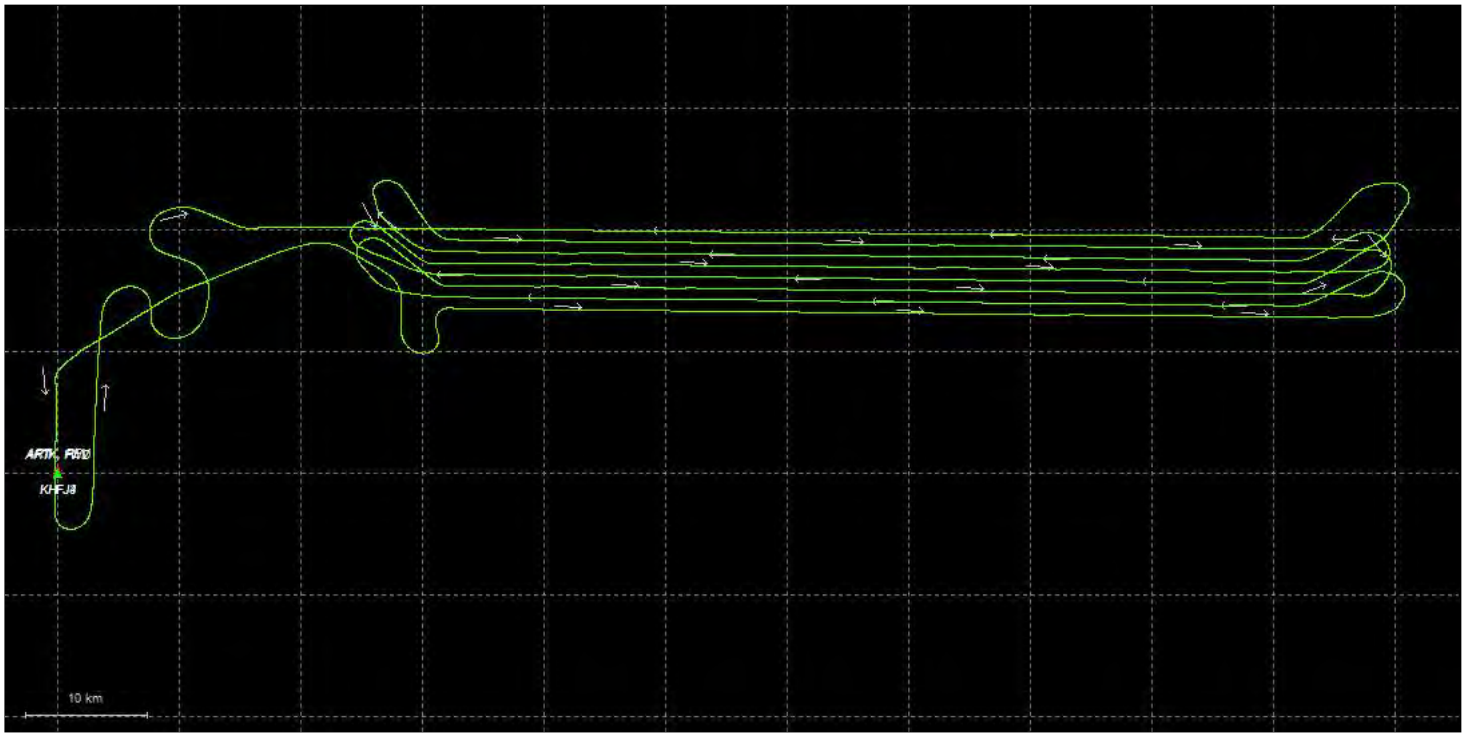
West

Appendix D. Inertial Explorer

Output Results for 20230315205732_1

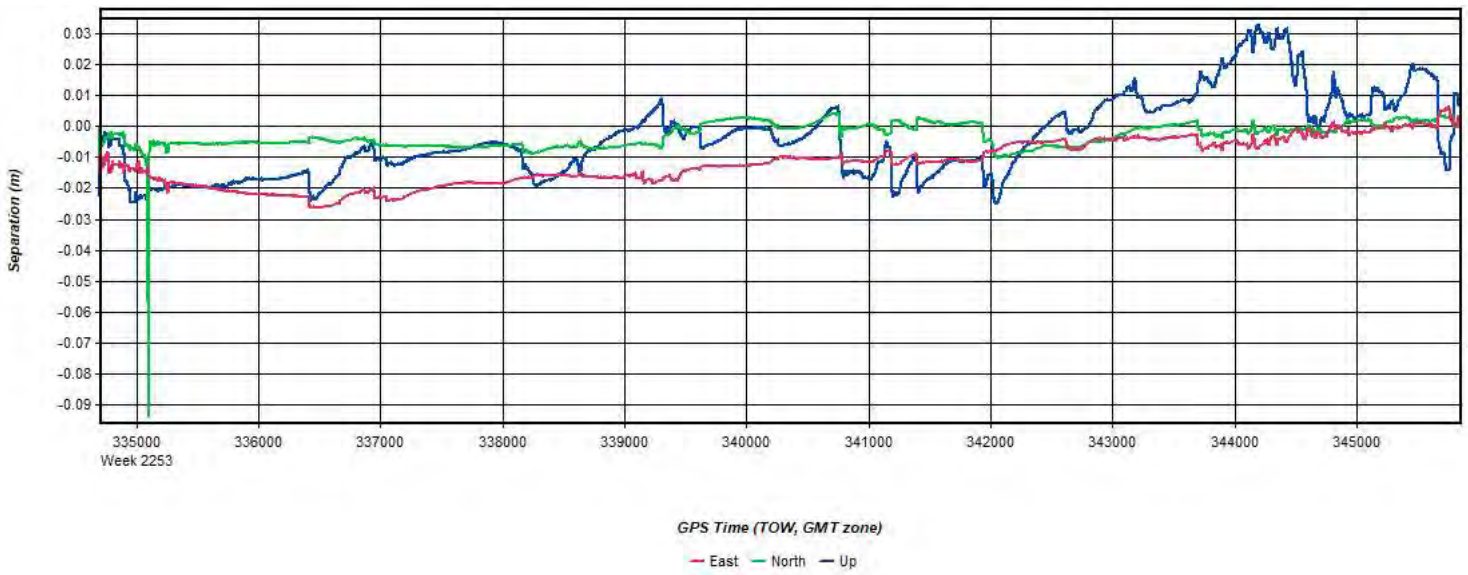
Inertial Explorer Version 8.90.6611
06/01/2023

Figure 1: Smoothed TC Combined - Map



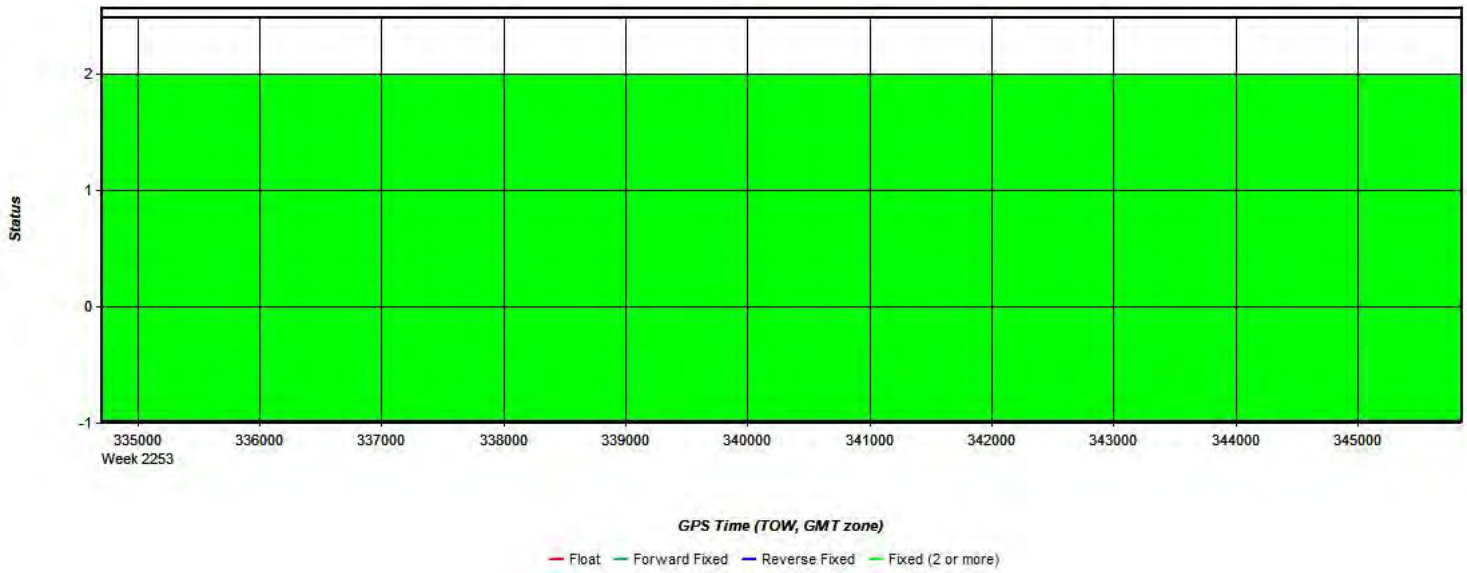
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 2: 20230315205732_1 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot



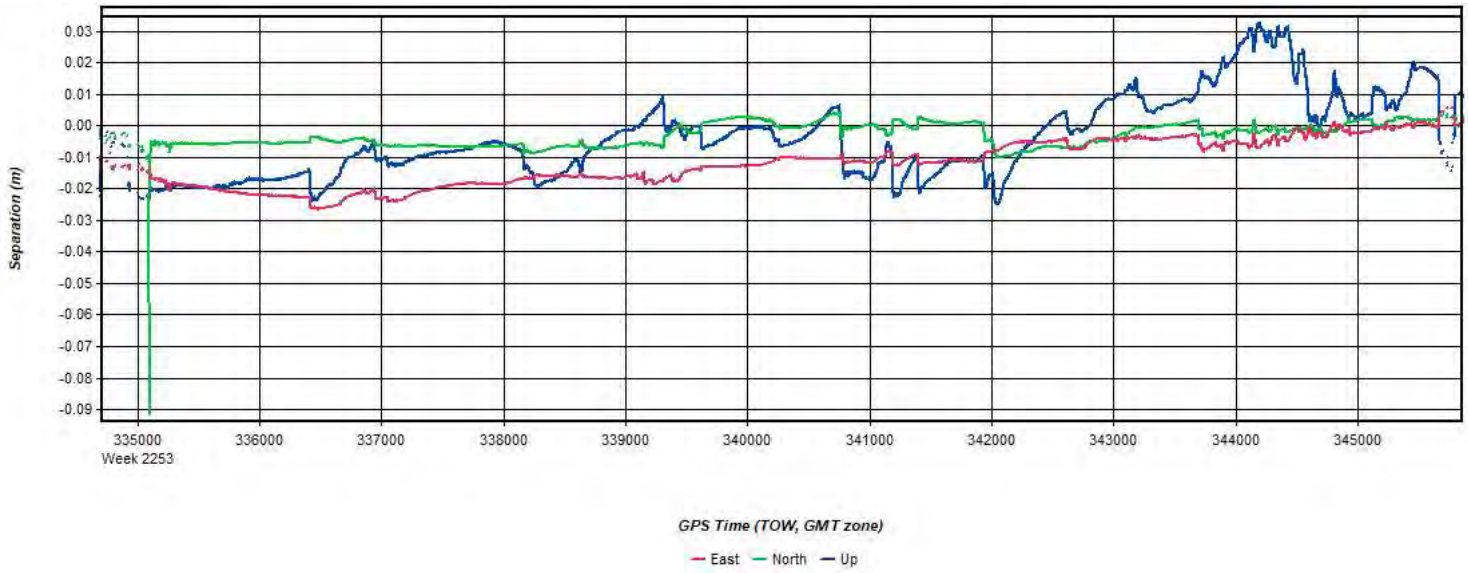
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 3: 20230315205732_1 [Smoothed TC Combined] - Float or Fixed Ambiguity



Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 4: 20230315205732_1 [Smoothed TC Combined] - Forward/Reverse Separation Plot (Fixed)



Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

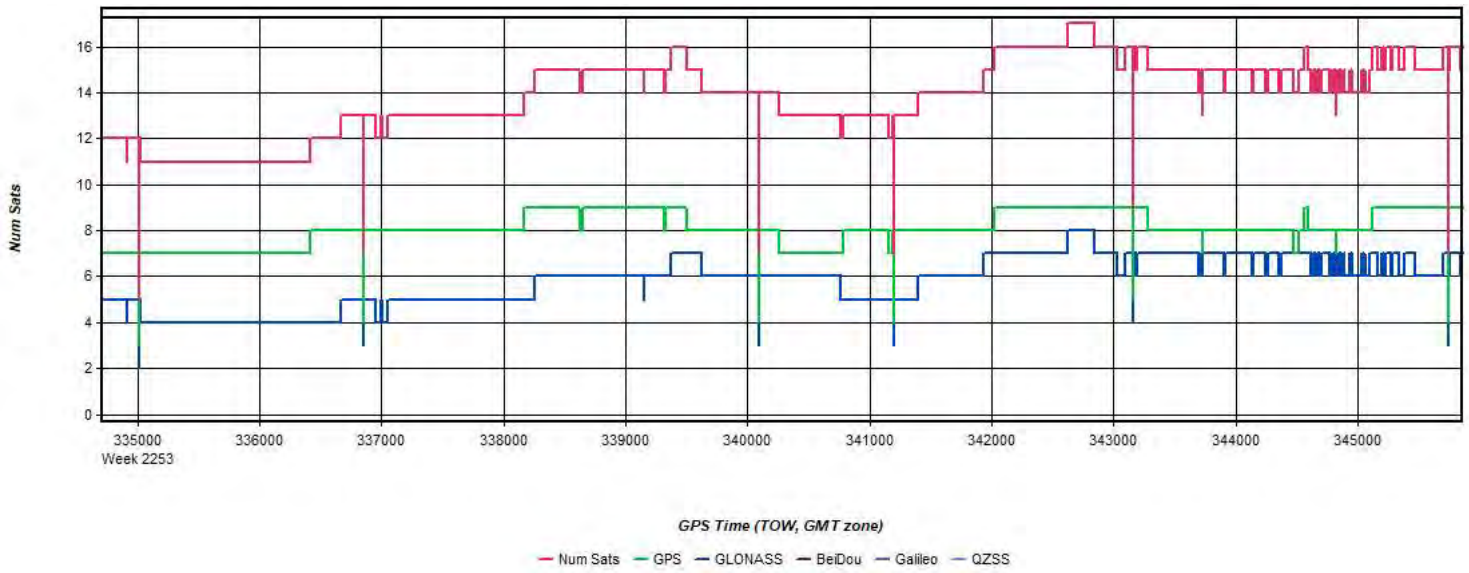
Figure 5: 20230315205732_1 [Smoothed TC Combined] - Estimated Position Accuracy Plot

Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 6: 20230315205732_1 [Smoothed TC Combined] - PDOP Plot

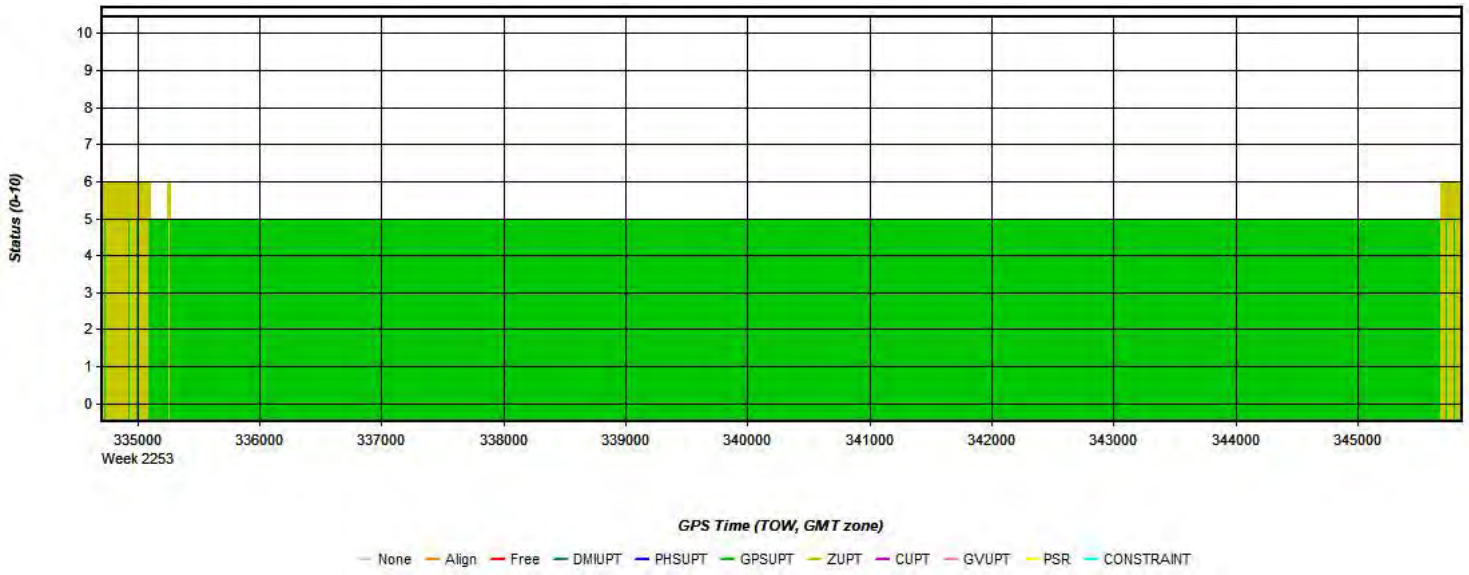
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 7: 20230315205732_1 [Smoothed TC Combined] - Number of Satellites Line Plot



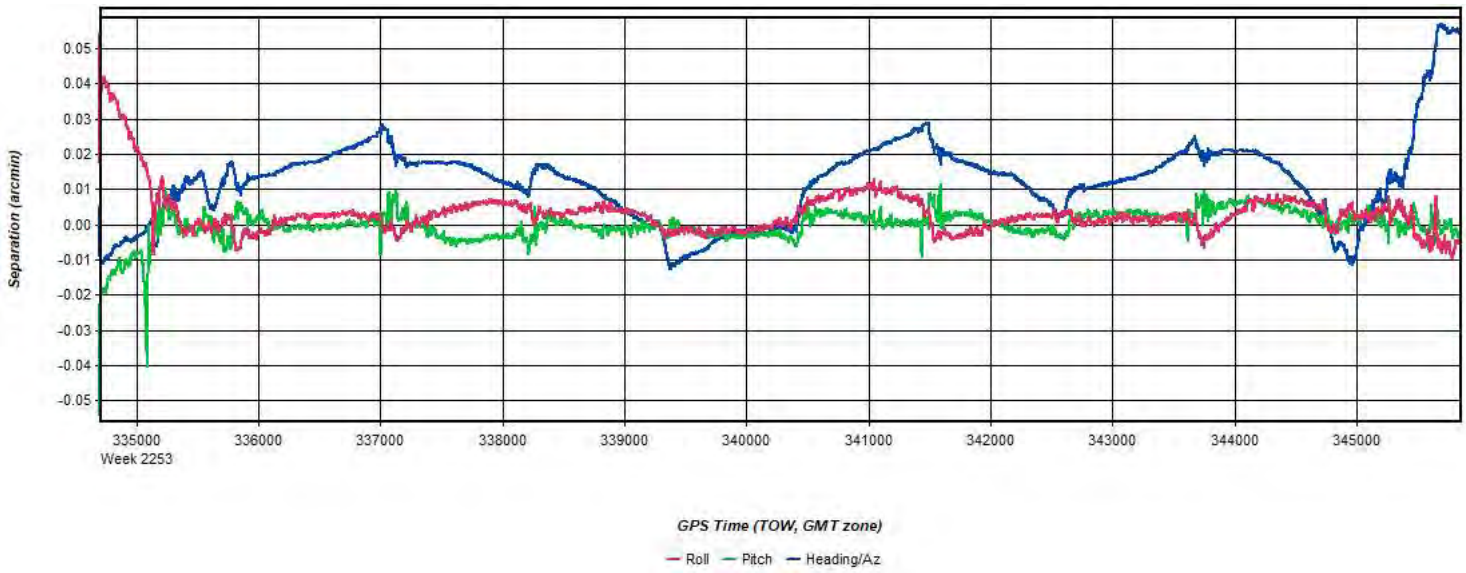
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 8: 20230315205732_1 [Smoothed TC Combined] - Status flag for IMU processing



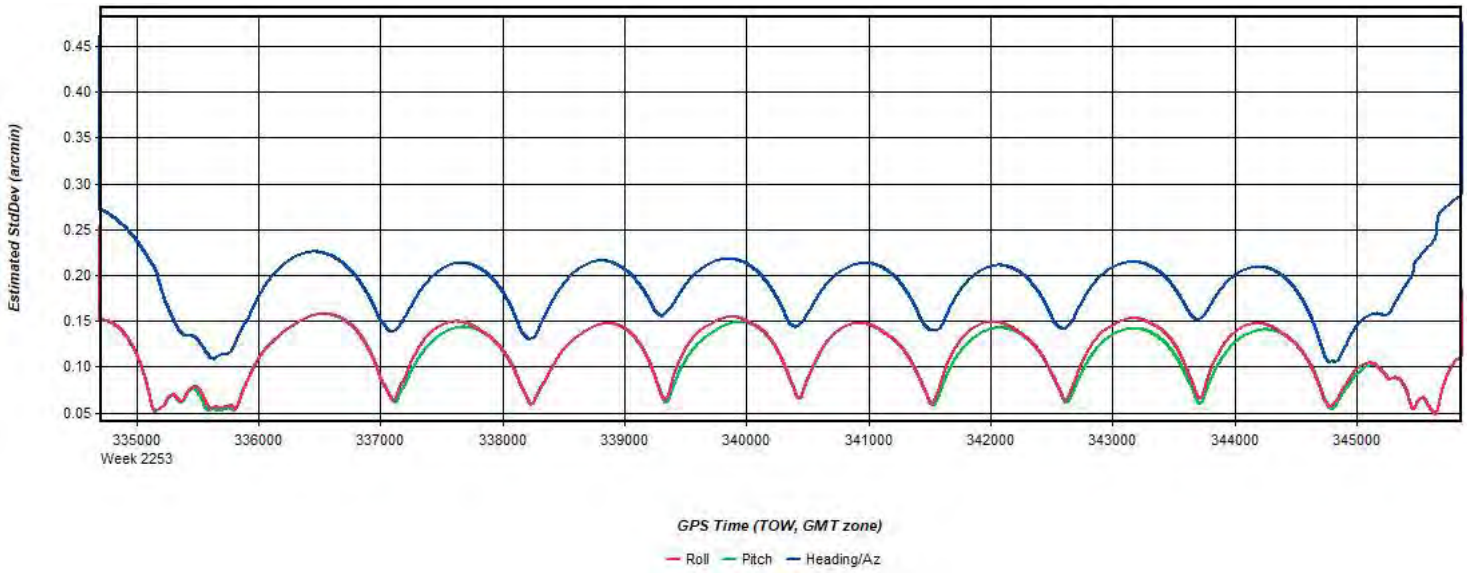
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 9: 20230315205732_1 [Smoothed TC Combined] - Fwd/Rev Attitude Separation Plot



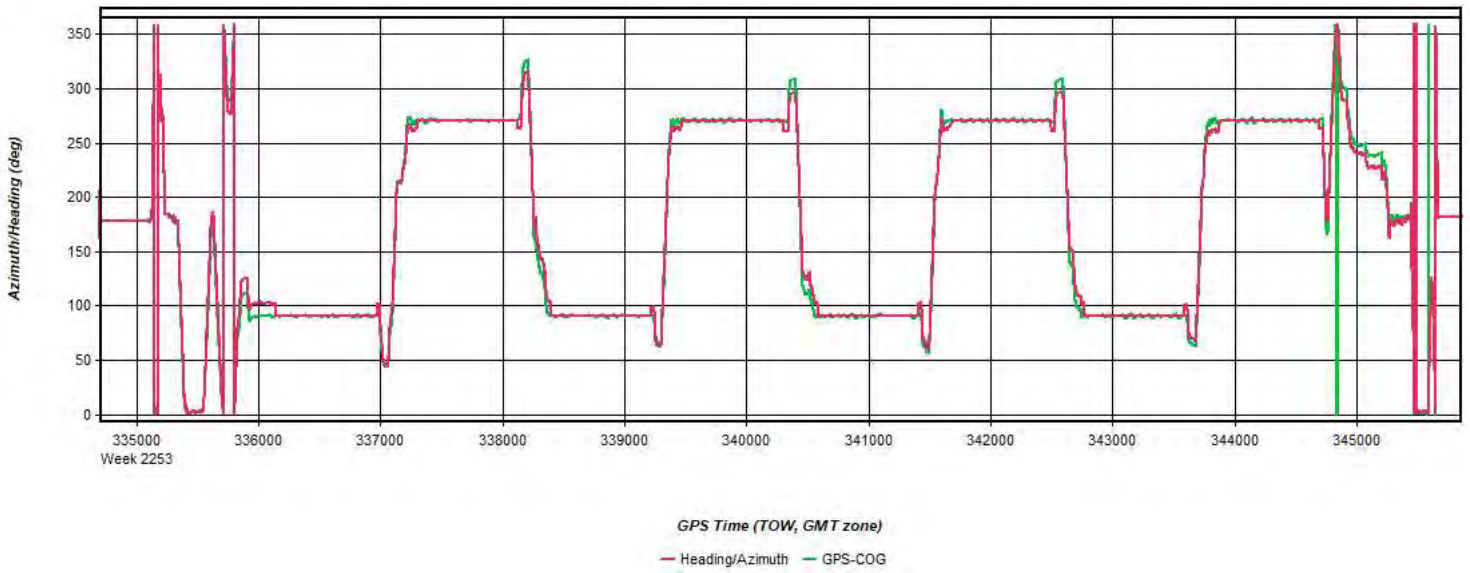
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 10: 20230315205732_1 [Smoothed TC Combined] - Estimated Attitude Accuracy Plot



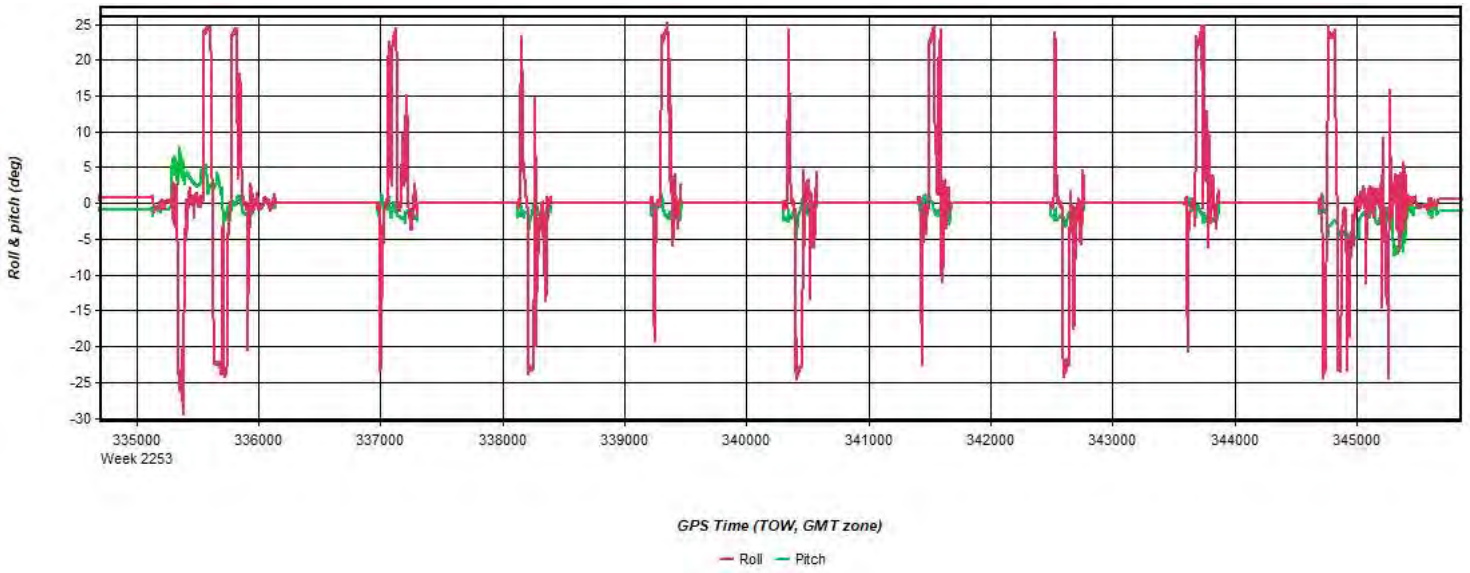
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 11: 20230315205732_1 [Smoothed TC Combined] - Azimuth Plot



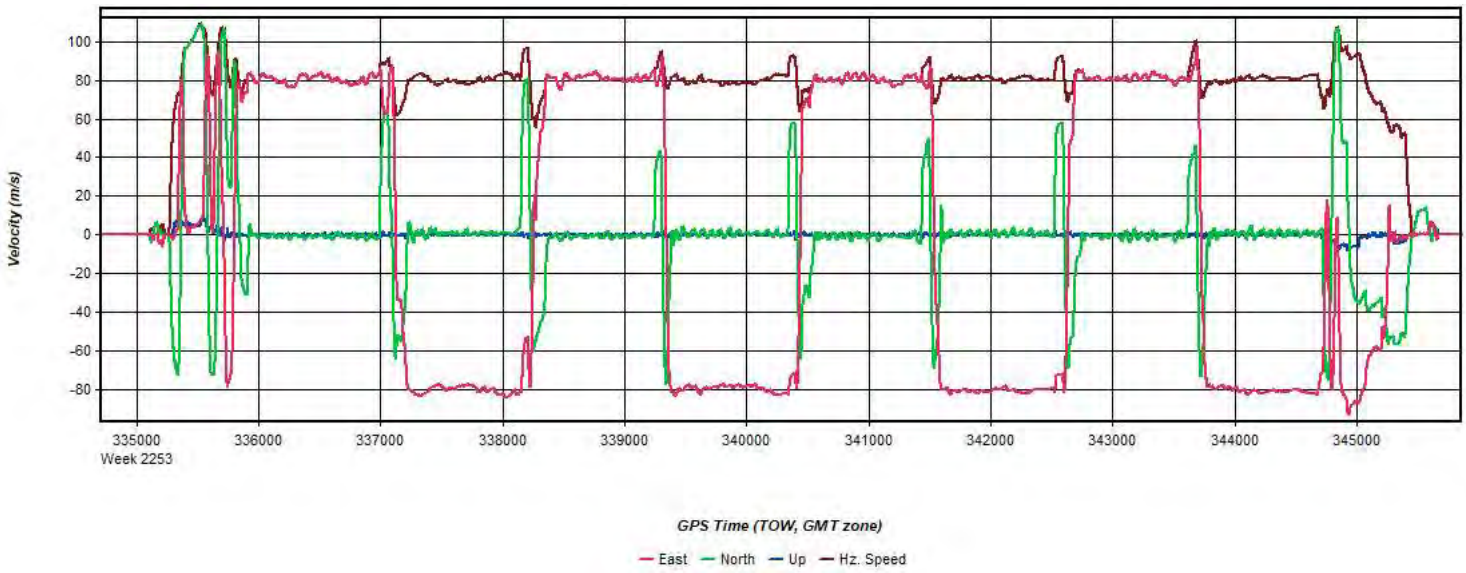
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 12: 20230315205732_1 [Smoothed TC Combined] - Roll & Pitch Plot



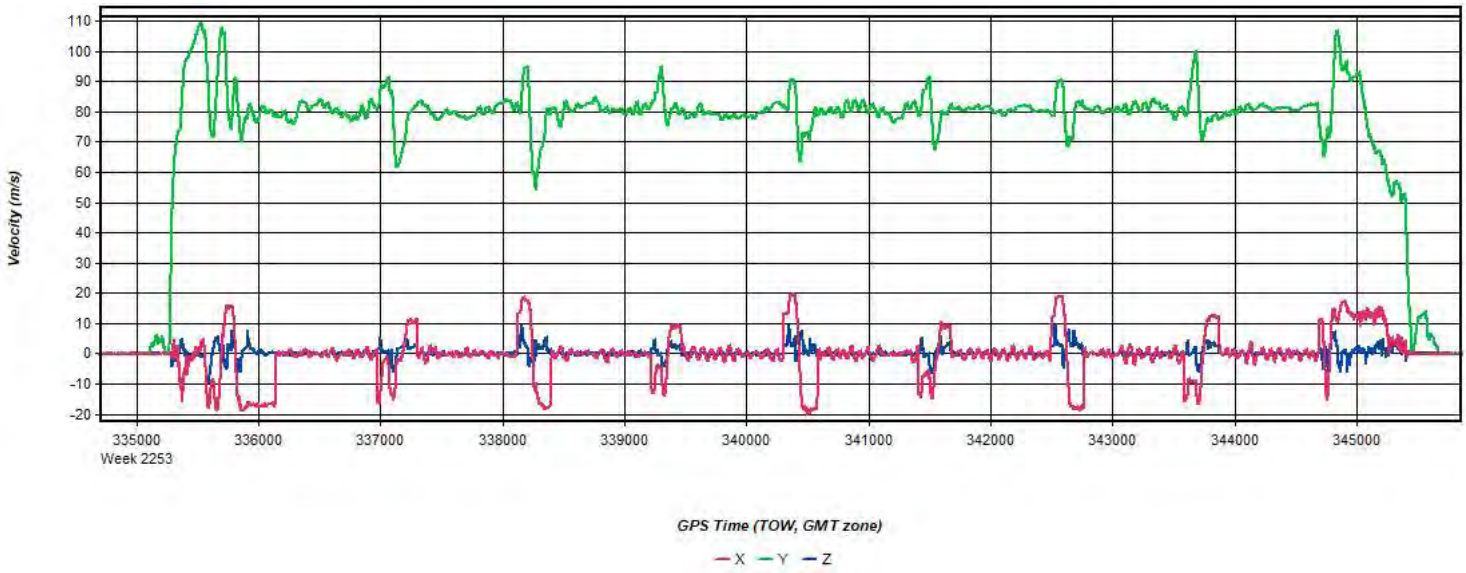
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 13: 20230315205732_1 [Smoothed TC Combined] - Velocity Profile Plot



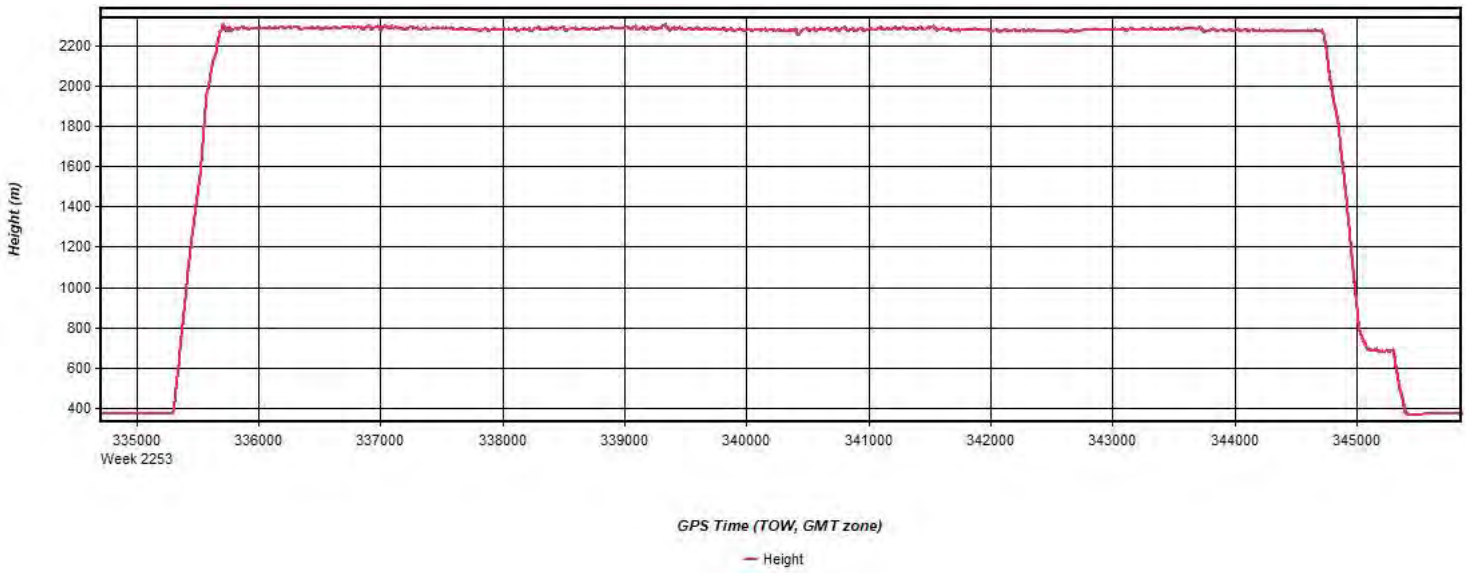
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 14: 20230315205732_1 [Smoothed TC Combined] - Body Frame Velocity Plot



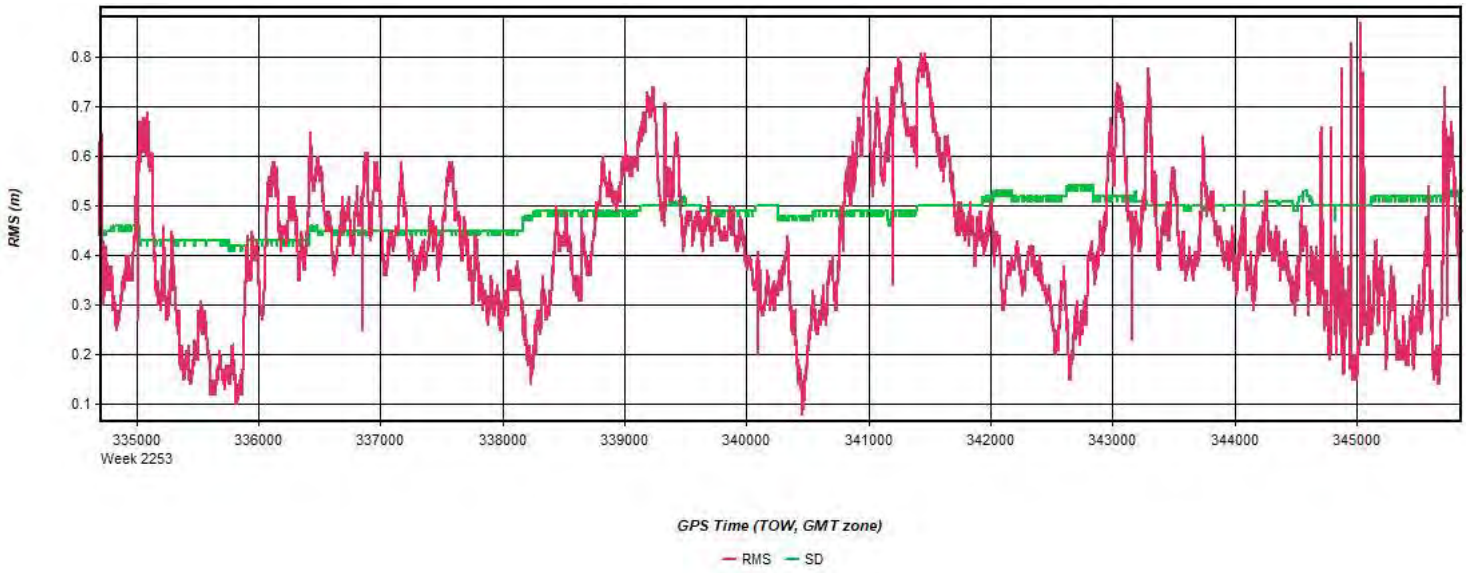
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 15: 20230315205732_1 [Smoothed TC Combined] - Height Profile Plot



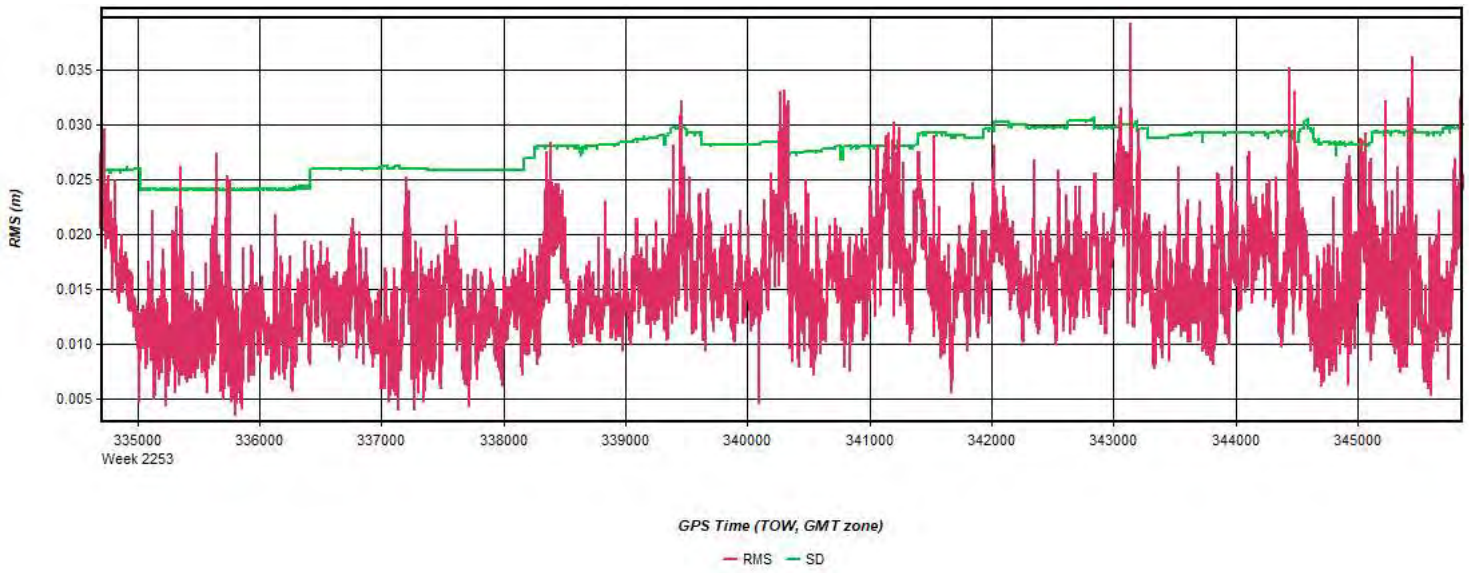
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 16: 20230315205732_1 [Smoothed TC Combined] - C/A Code Residual RMS Plot



Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 17: 20230315205732_1 [Smoothed TC Combined] - Carrier Residual RMS Plot

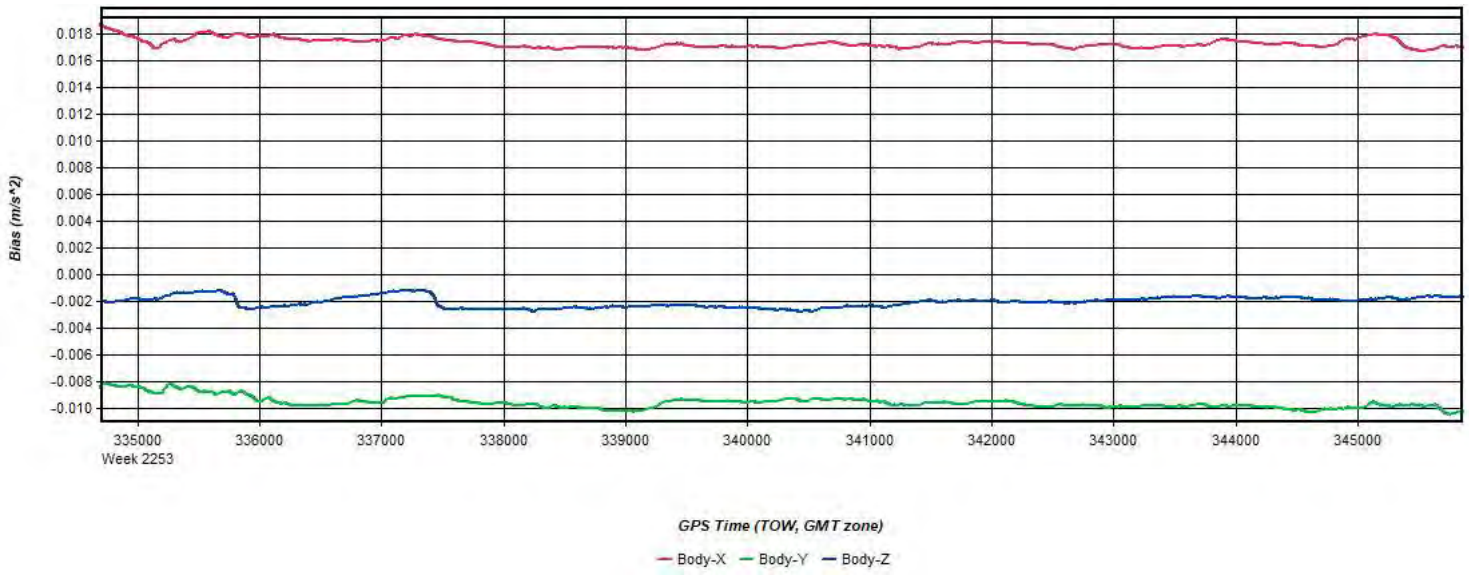


Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 18: 20230315205732_1 [Smoothed TC Combined] - L1 Doppler Residual RMS Plot

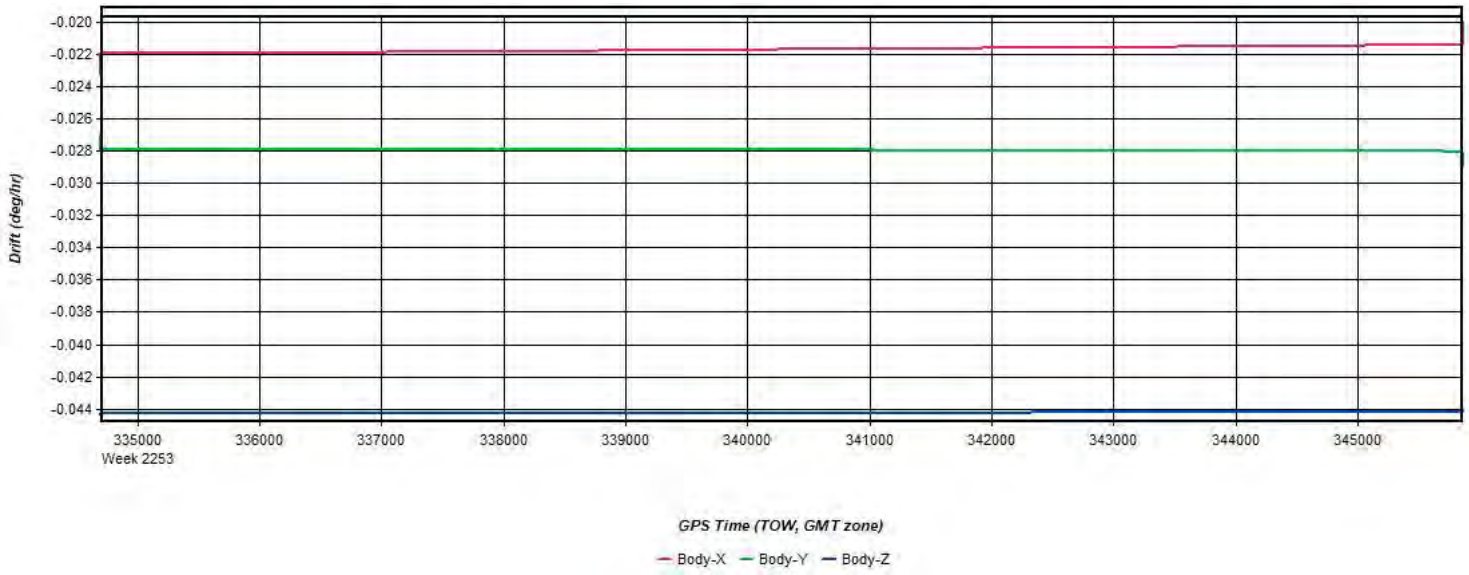
Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 19: 20230315205732_1 [Smoothed TC Combined] - Accelerometer Bias Plot



Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Figure 20: 20230315205732_1 [Smoothed TC Combined] - Gyro Drift Plot

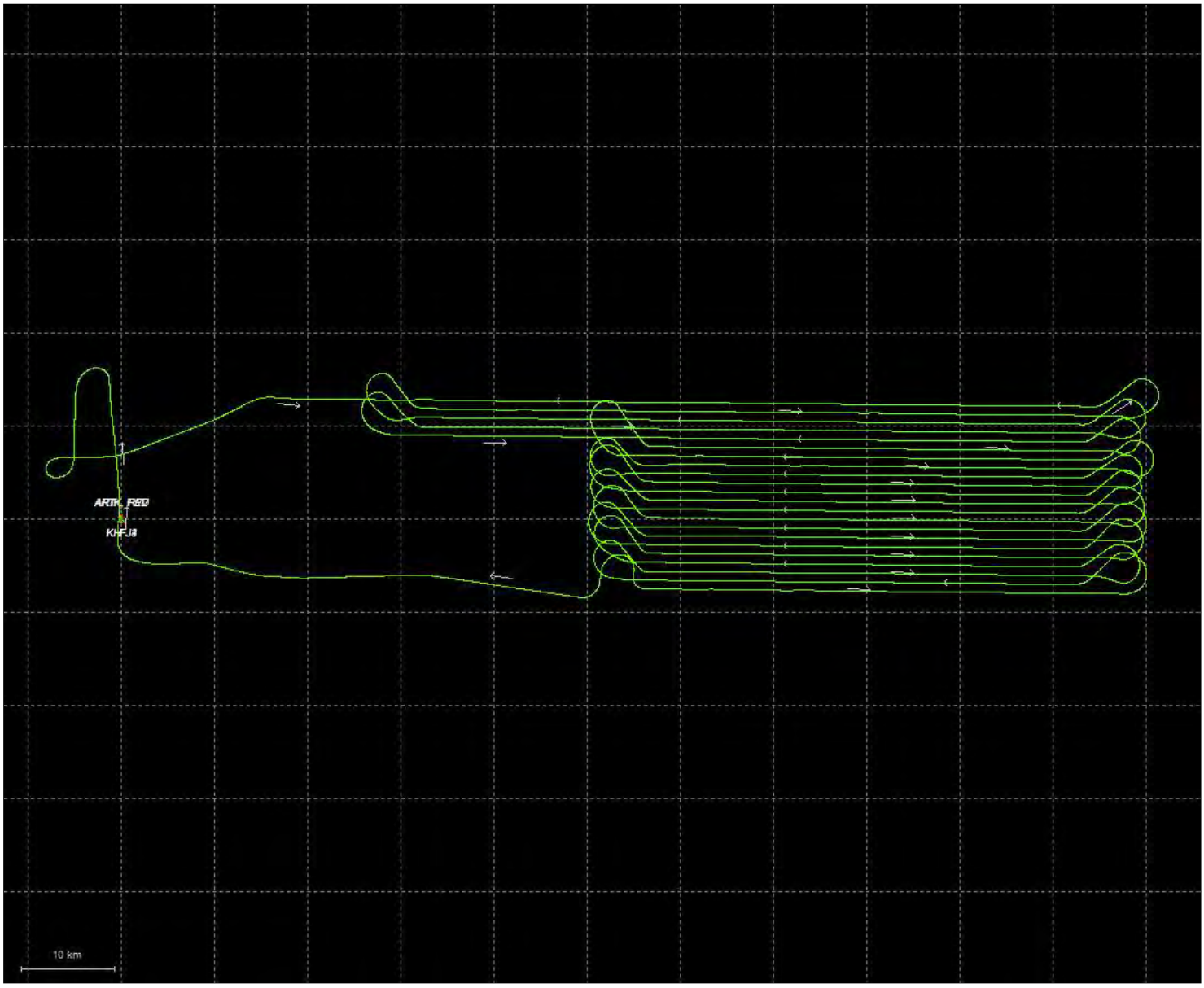


Process	20230315205732_1	by Unknown	on 3/23/2023	at 10:44:23

Output Results for 20230317142513_2

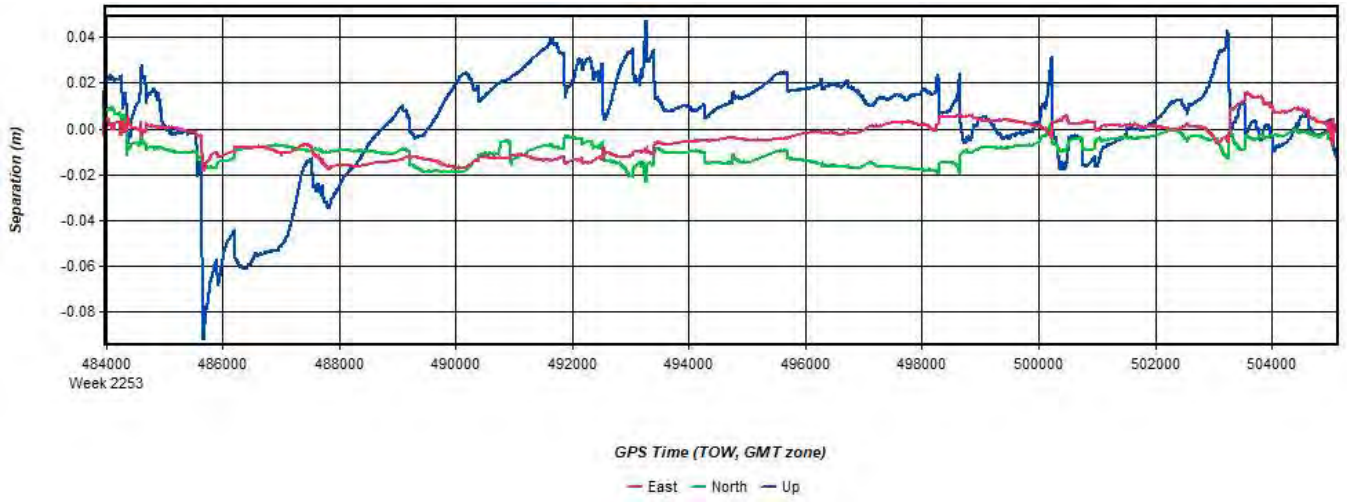
Inertial Explorer Version 8.90.2124
03/24/2023

Figure 1: Smoothed TC Combined - Map



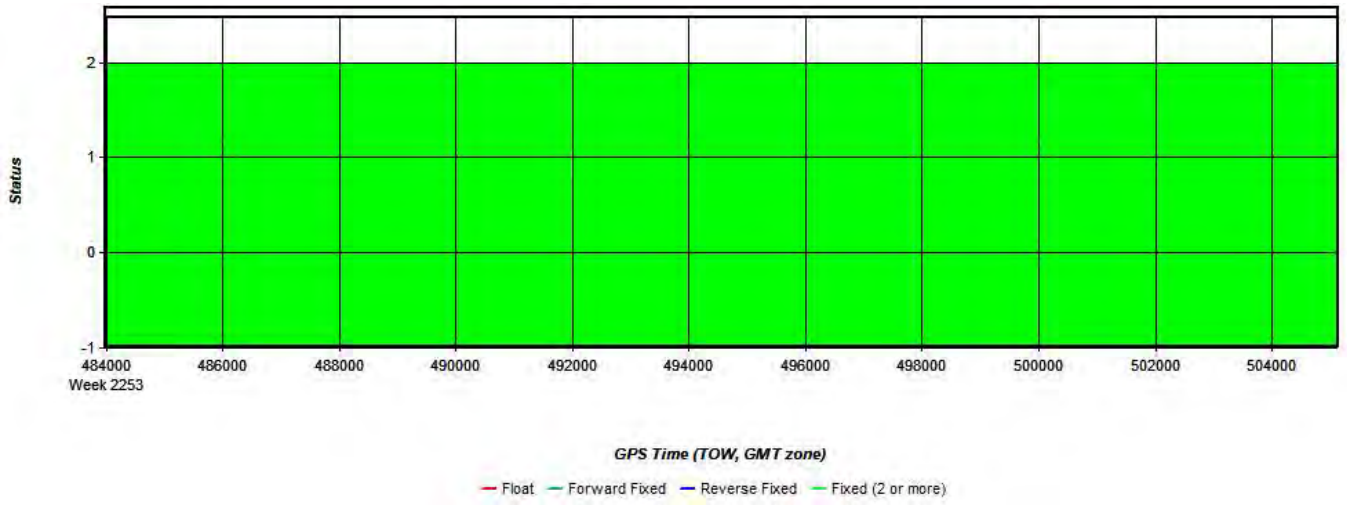
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 2: 20230317142513_2 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot



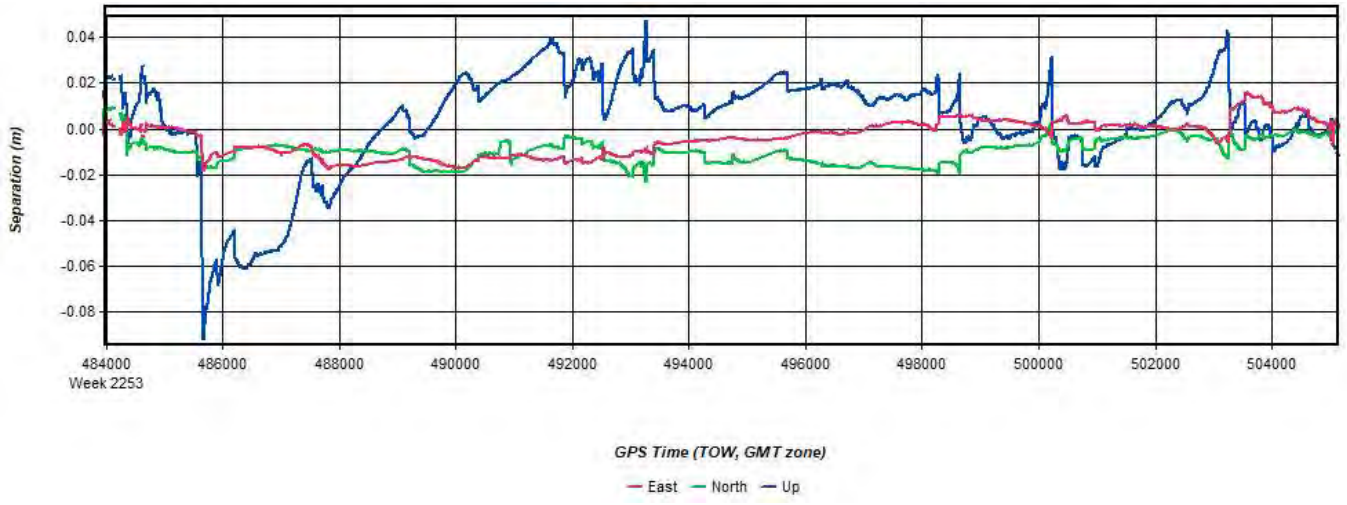
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 3: 20230317142513_2 [Smoothed TC Combined] - Float or Fixed Ambiguity



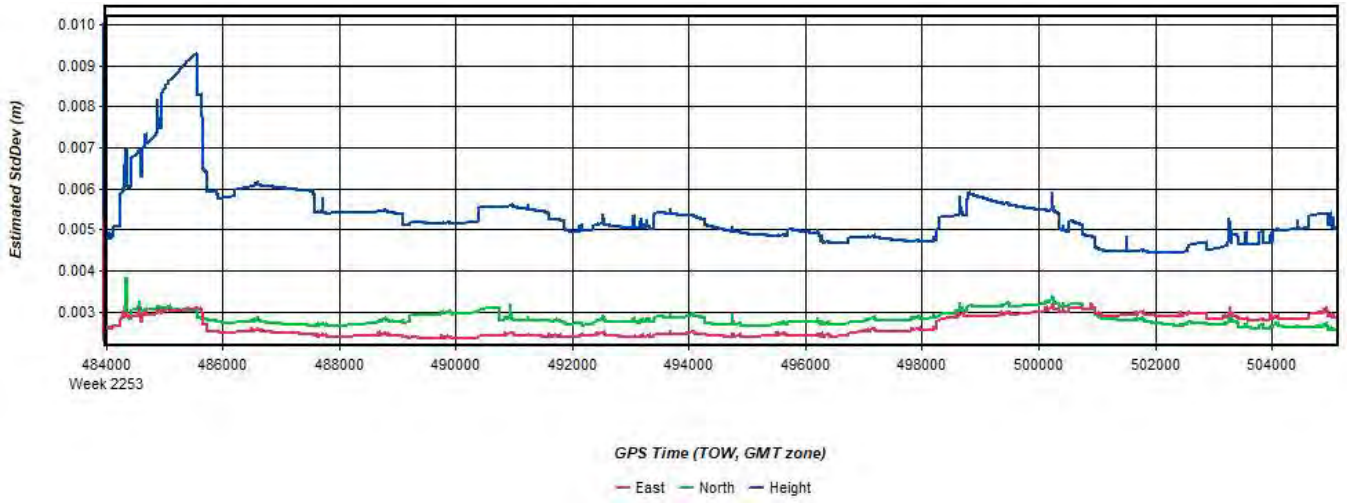
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 4: 20230317142513_2 [Smoothed TC Combined] - Forward/Reverse Separation Plot (Fixed)



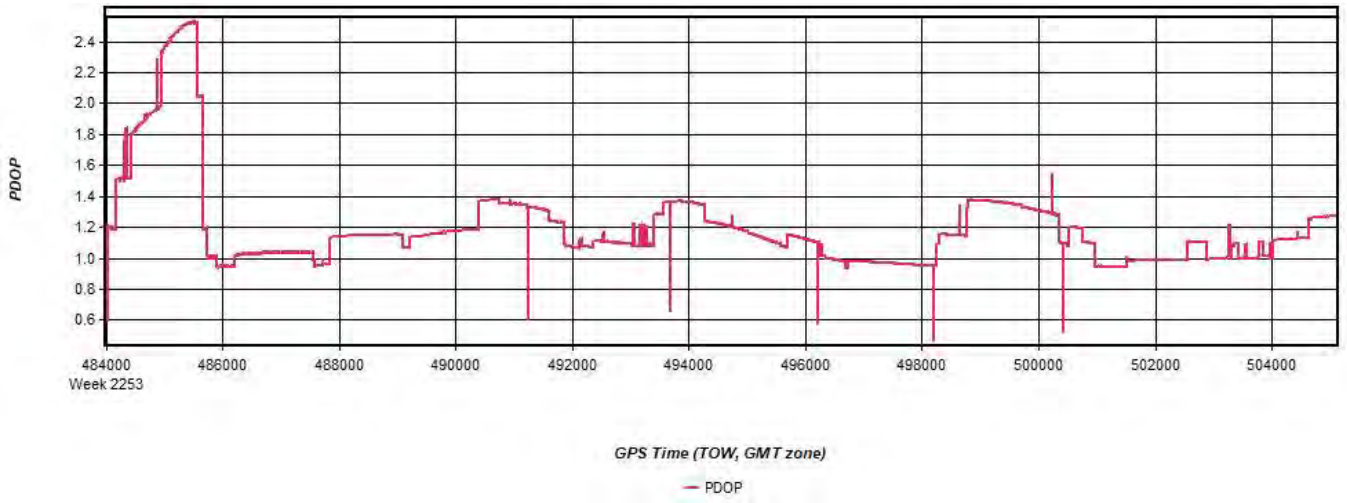
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 5: 20230317142513_2 [Smoothed TC Combined] - Estimated Position Accuracy Plot



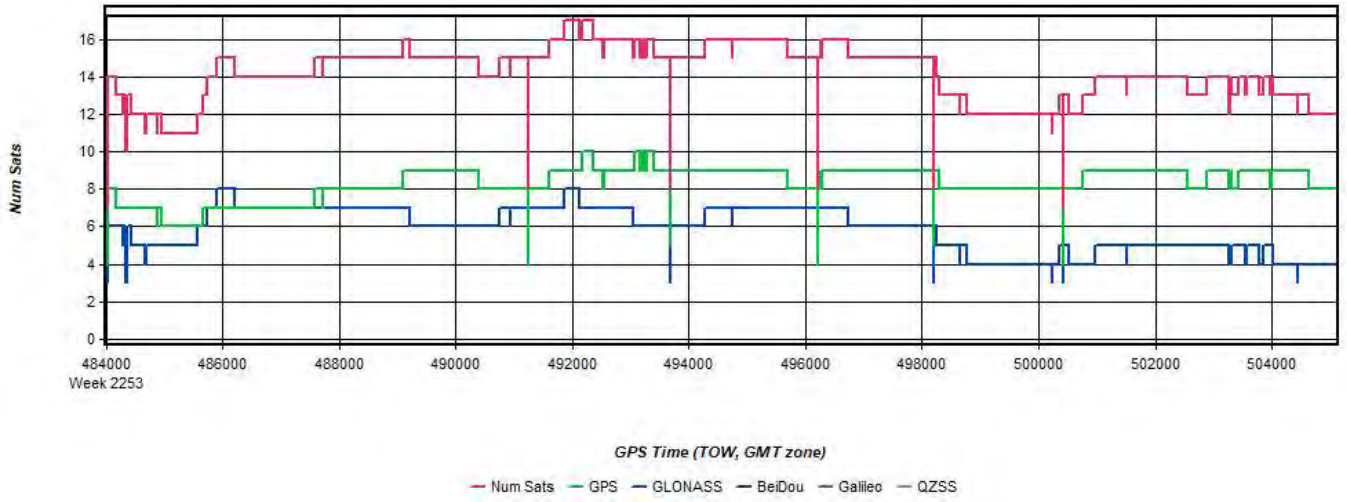
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 6: 20230317142513_2 [Smoothed TC Combined] - PDOP Plot



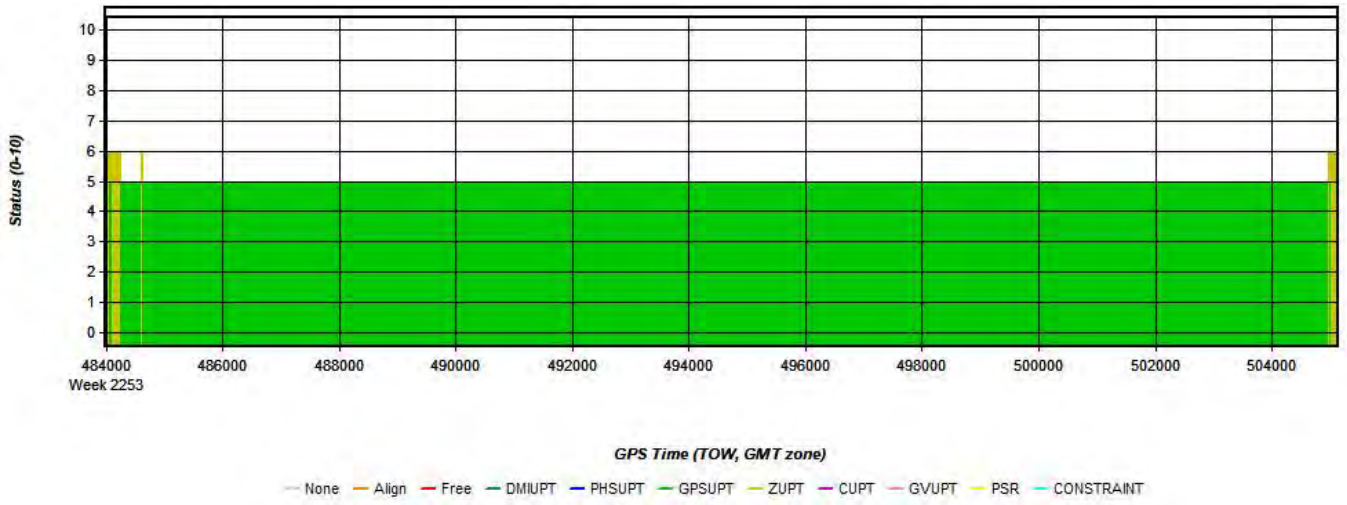
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 7: 20230317142513_2 [Smoothed TC Combined] - Number of Satellites Line Plot



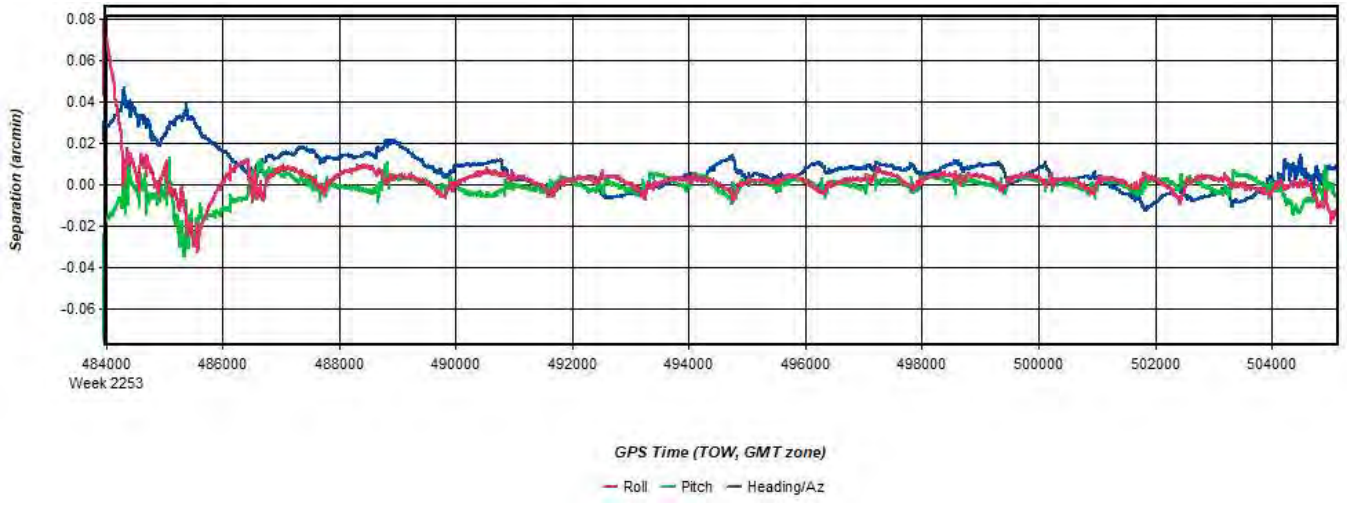
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 8: 20230317142513_2 [Smoothed TC Combined] - Status flag for IMU processing



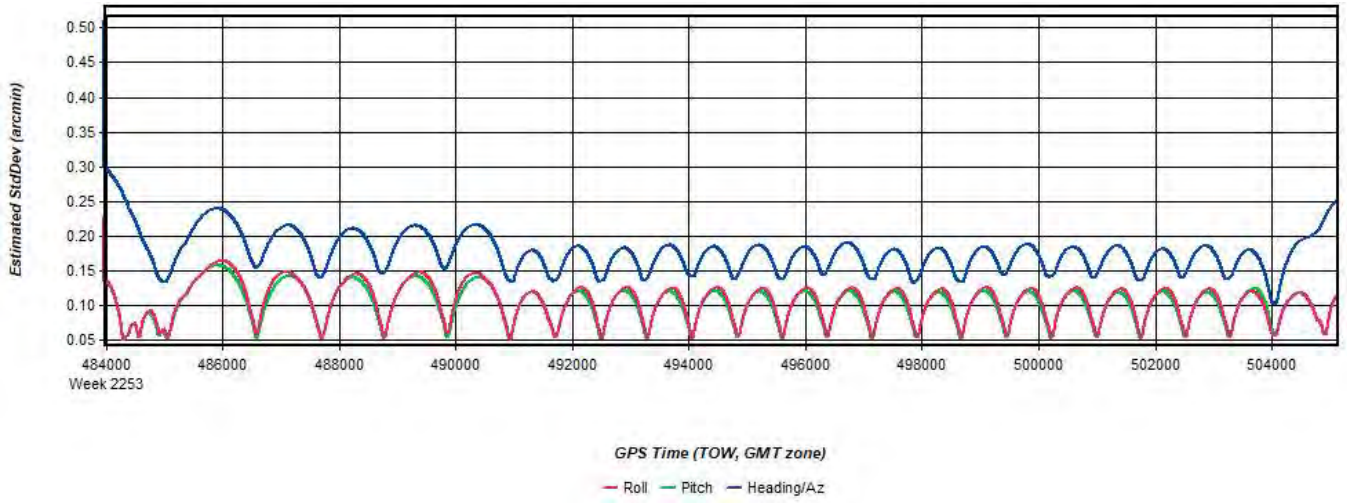
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 9: 20230317142513_2 [Smoothed TC Combined] - Fwd/Rev Attitude Separation Plot



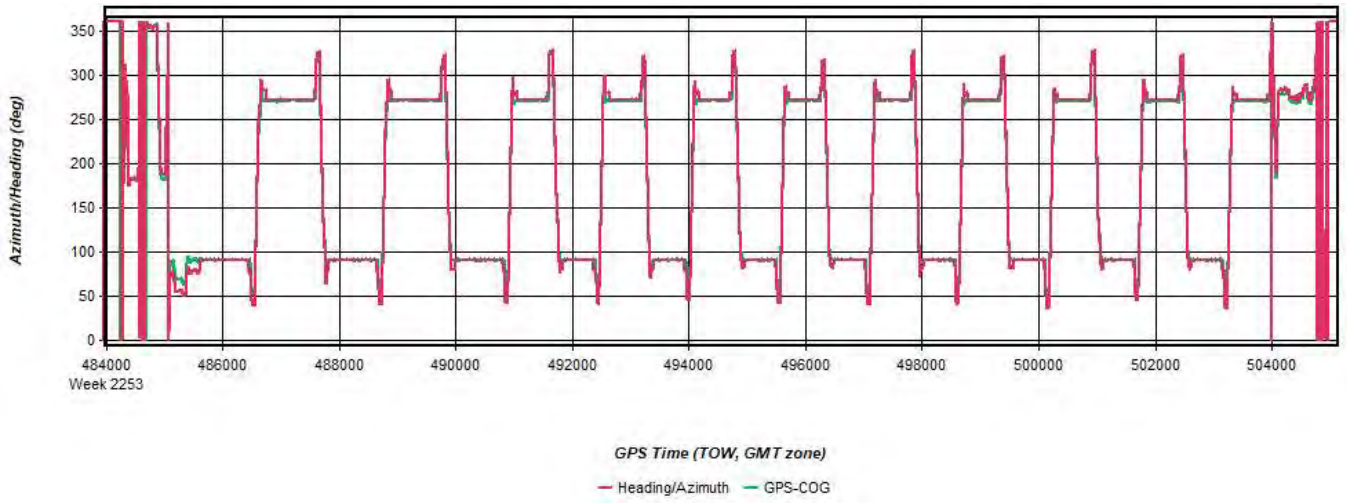
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 10: 20230317142513_2 [Smoothed TC Combined] - Estimated Attitude Accuracy Plot



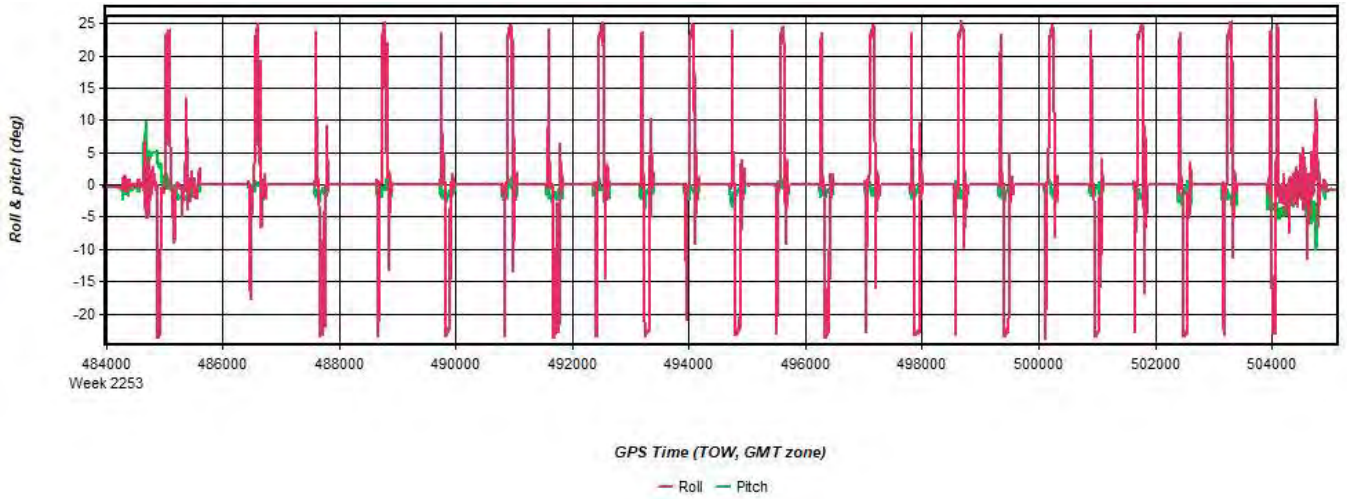
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 11: 20230317142513_2 [Smoothed TC Combined] - Azimuth Plot



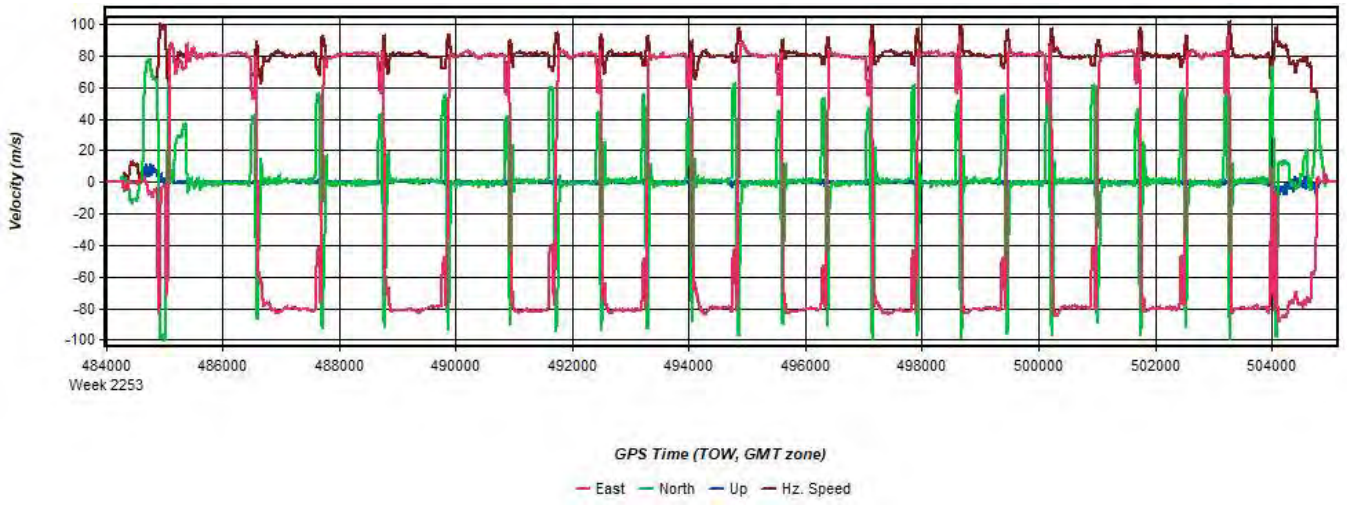
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 12: 20230317142513_2 [Smoothed TC Combined] - Roll & Pitch Plot



Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 13: 20230317142513_2 [Smoothed TC Combined] - Velocity Profile Plot



Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 14: 20230317142513_2 [Smoothed TC Combined] - Body Frame Velocity Plot

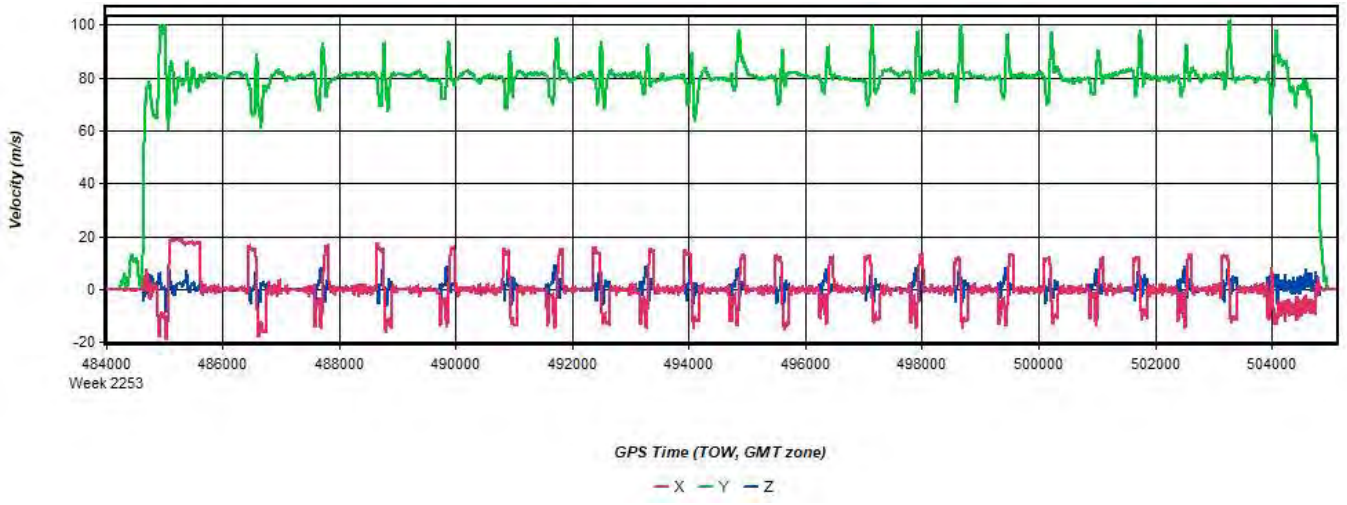


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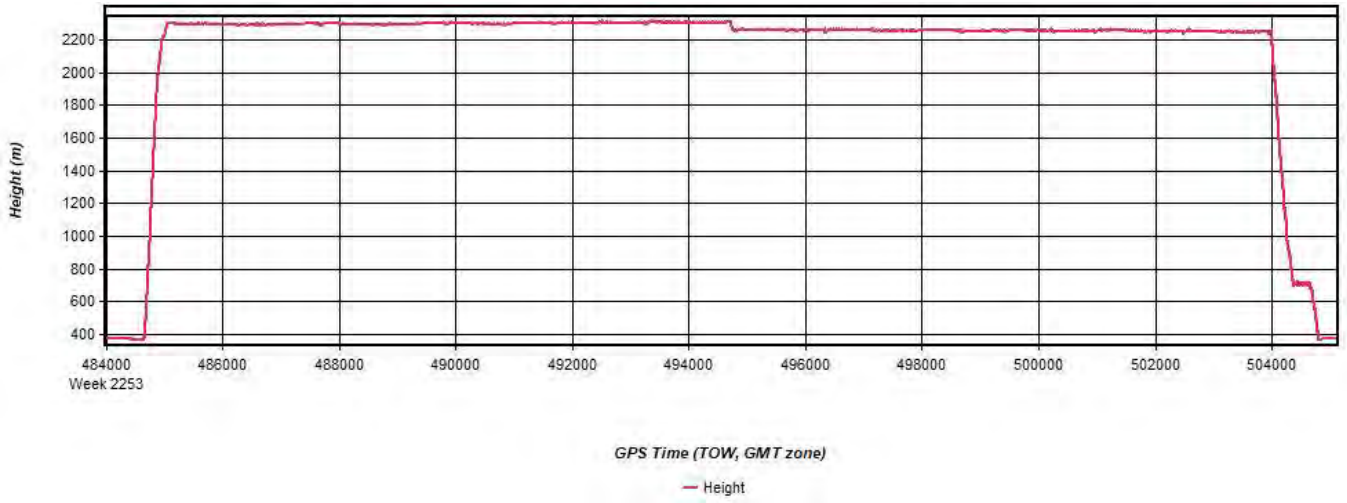
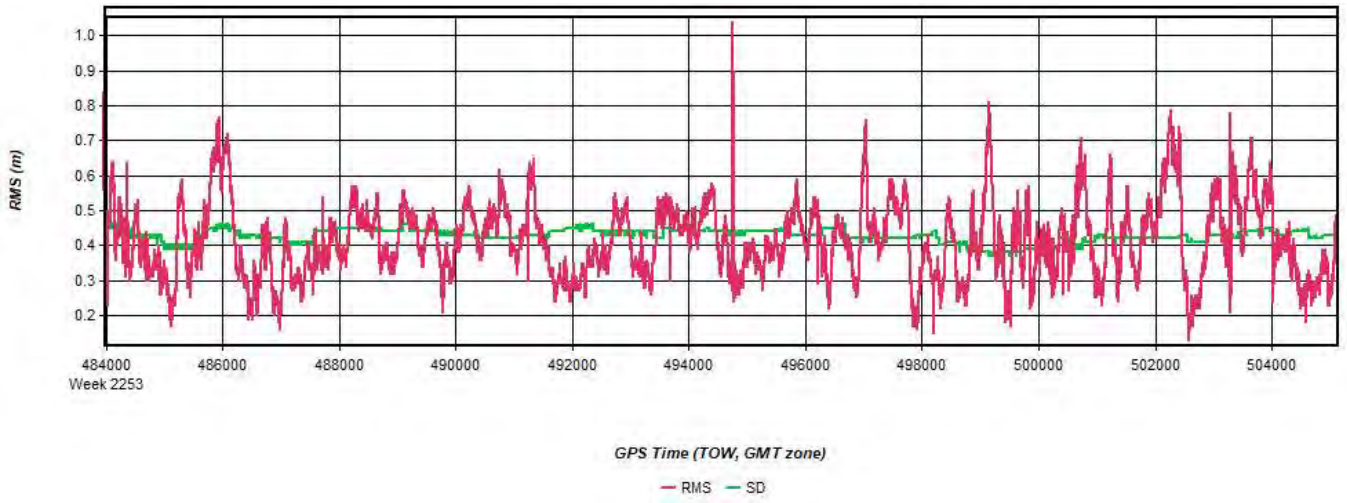
Figure 15: 20230317142513_2 [Smoothed TC Combined] - Height Profile Plot



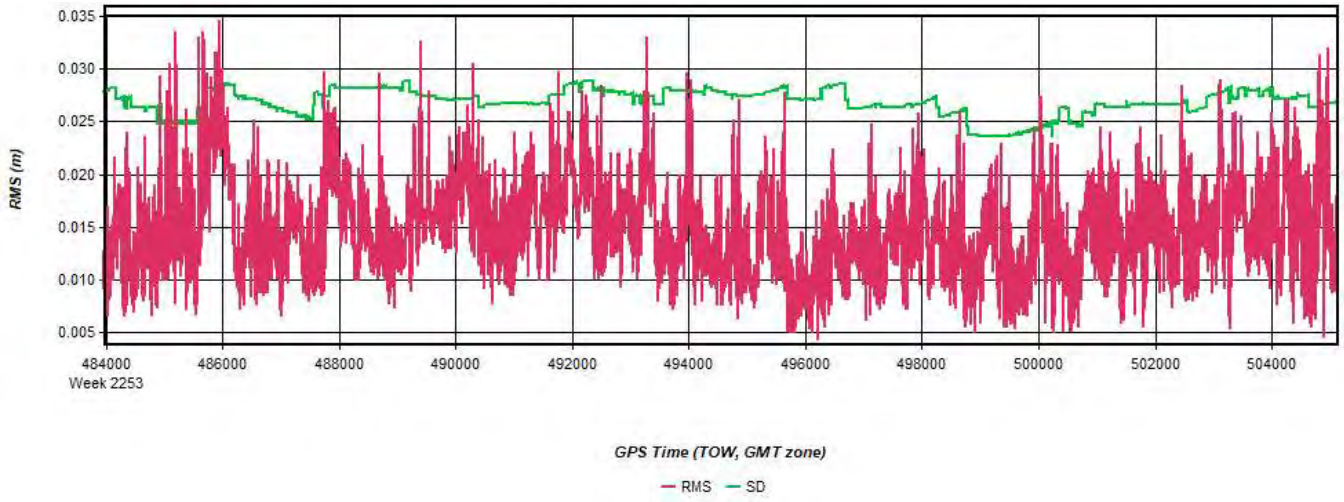
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 16: 20230317142513_2 [Smoothed TC Combined] - C/A Code Residual RMS Plot



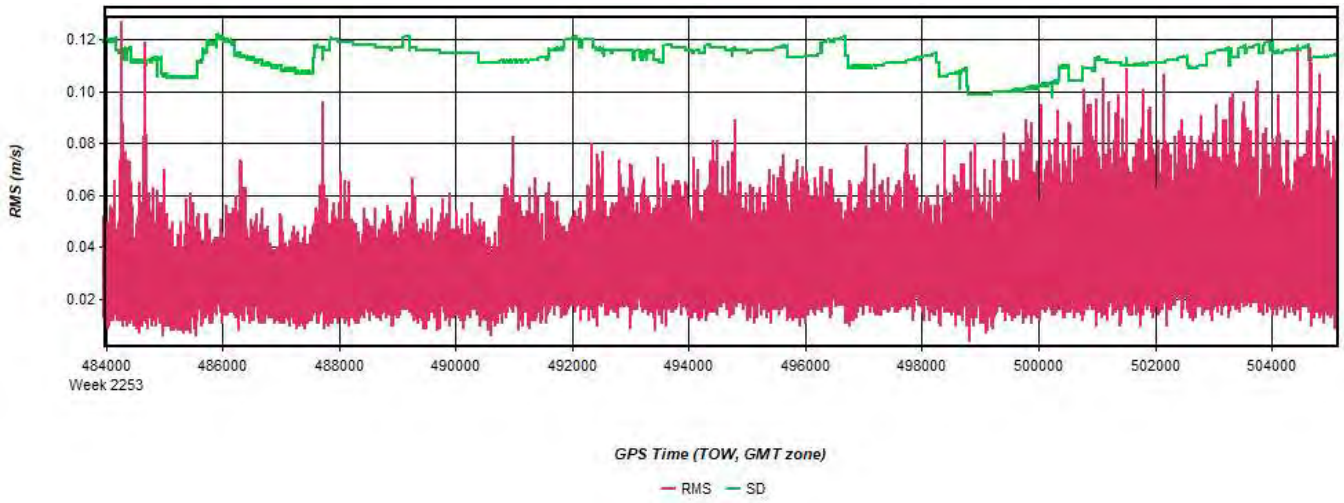
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 17: 20230317142513_2 [Smoothed TC Combined] - Carrier Residual RMS Plot



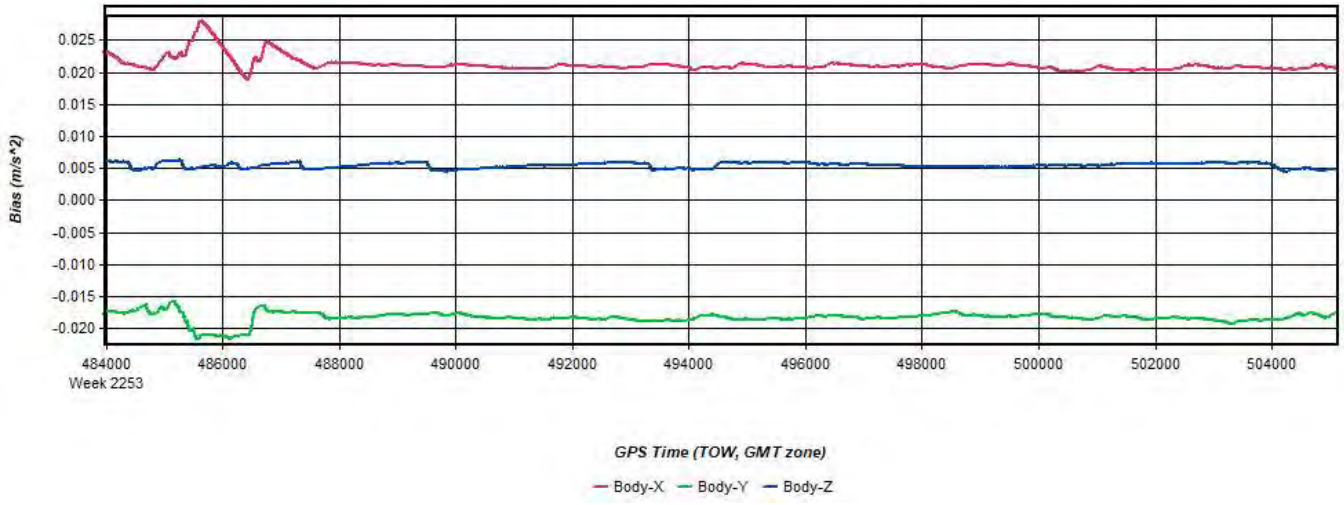
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 18: 20230317142513_2 [Smoothed TC Combined] - L1 Doppler Residual RMS Plot



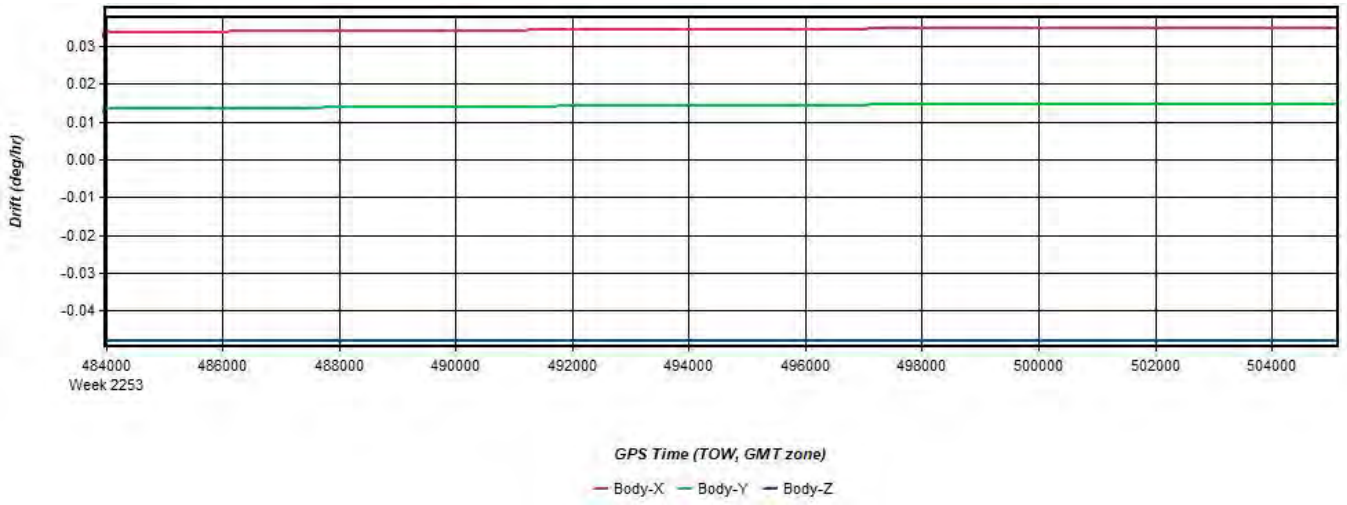
Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 19: 20230317142513_2 [Smoothed TC Combined] - Accelerometer Bias Plot



Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Figure 20: 20230317142513_2 [Smoothed TC Combined] - Gyro Drift Plot

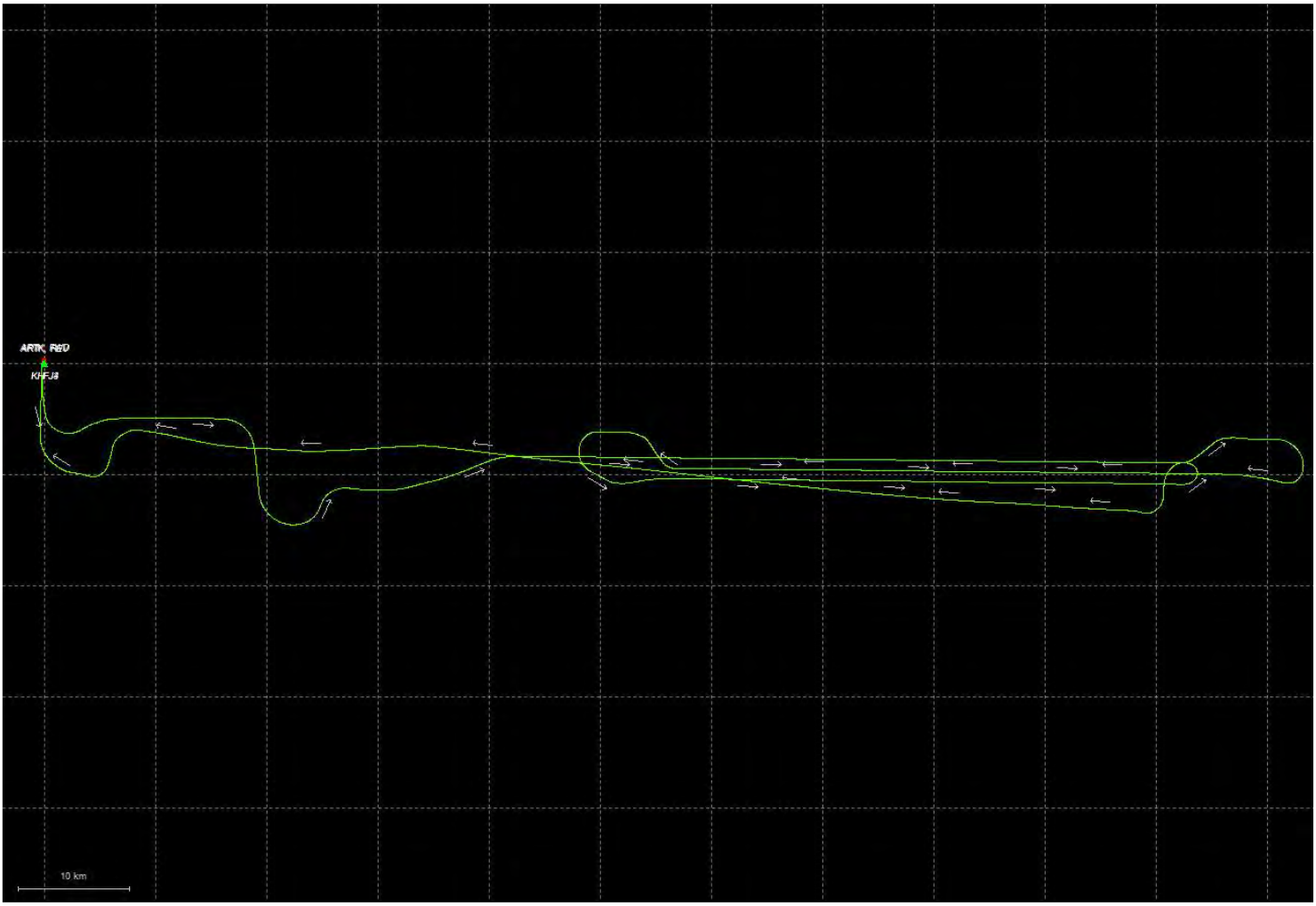


Process	20230317142513_2	by Unknown	on 3/22/2023	at 15:16:48

Output Results for 20230318012422_3

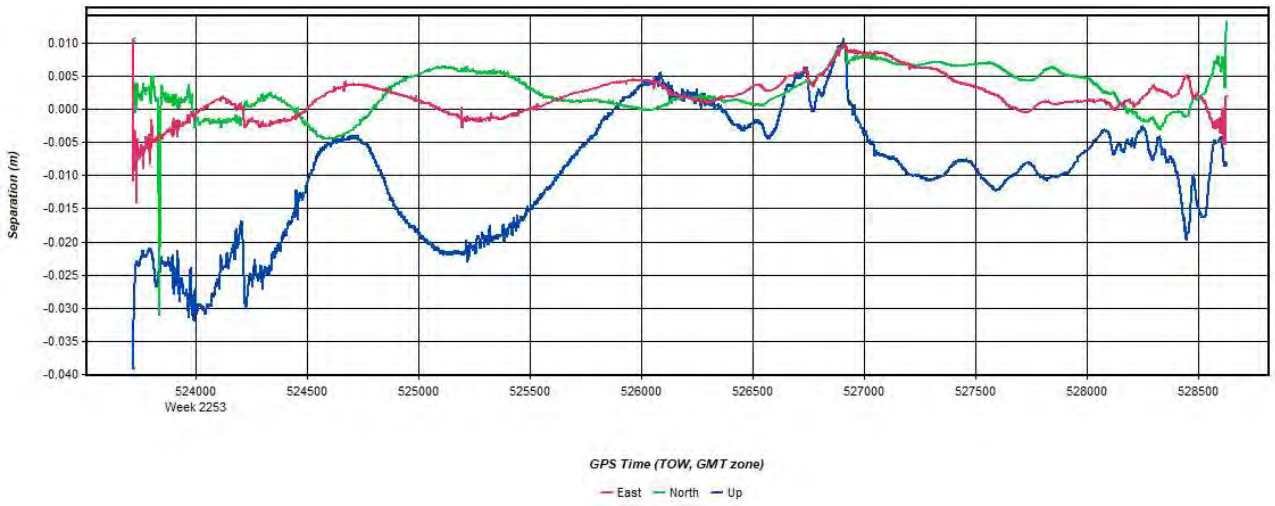
Inertial Explorer Version 8.90.6611
03/23/2023

Figure 1: Smoothed TC Combined - Map



Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 2: 20230318012422_3 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot



Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 3: 20230318012422_3 [Smoothed TC Combined] - Float or Fixed Ambiguity

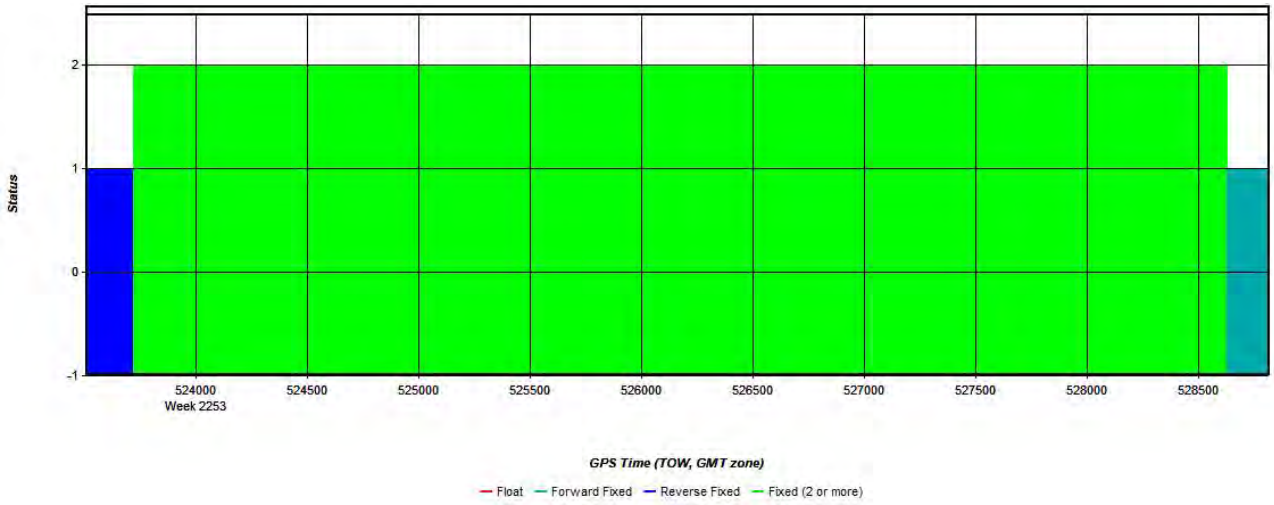


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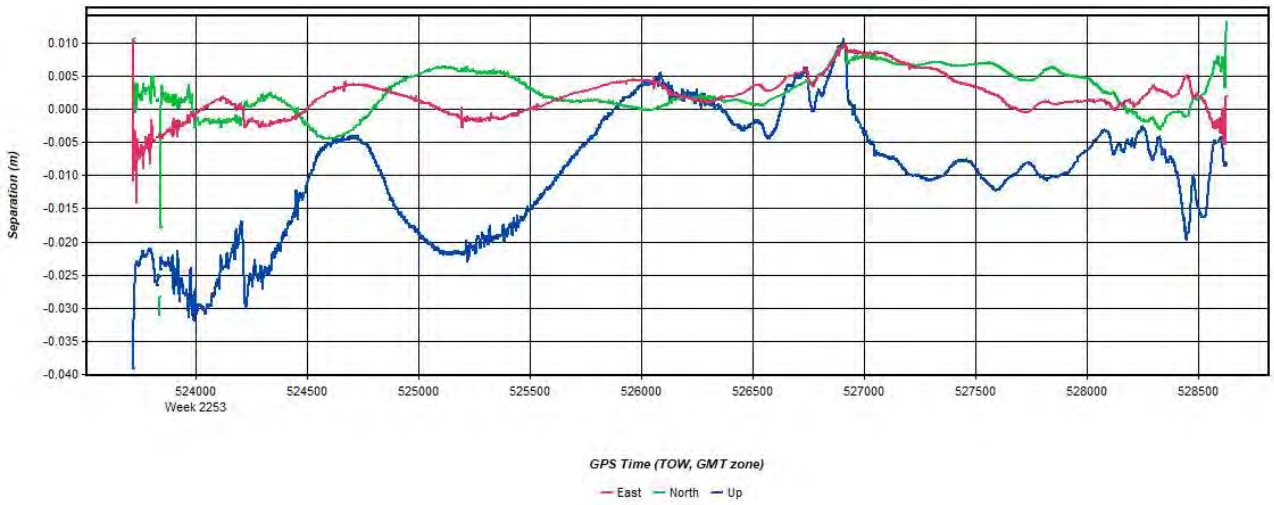
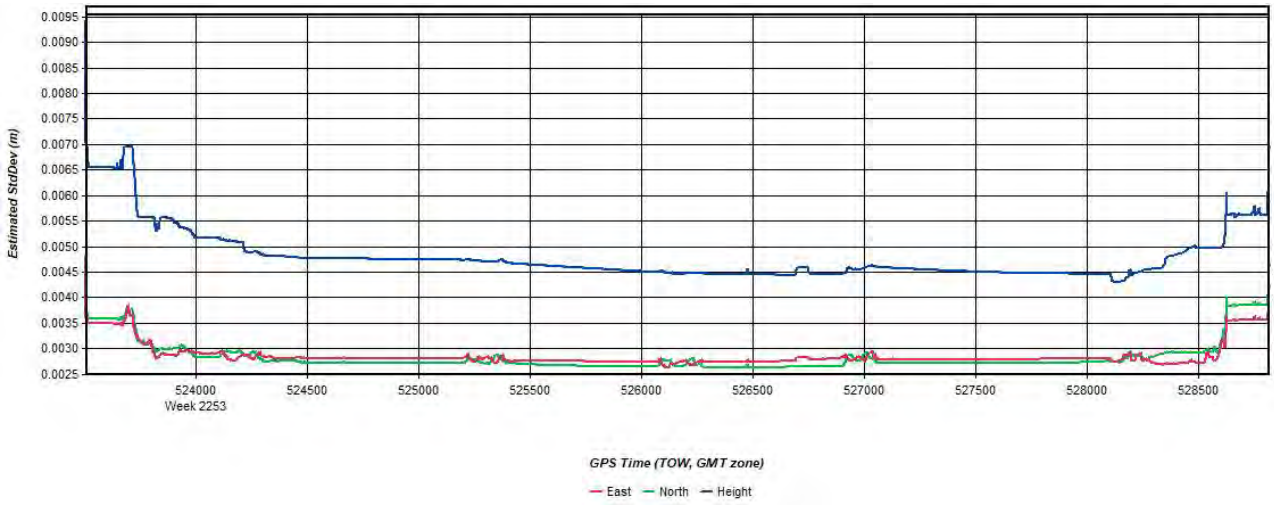
Figure 4: 20230318012422_3 [Smoothed TC Combined] - Forward/Reverse Separation Plot (Fixed)



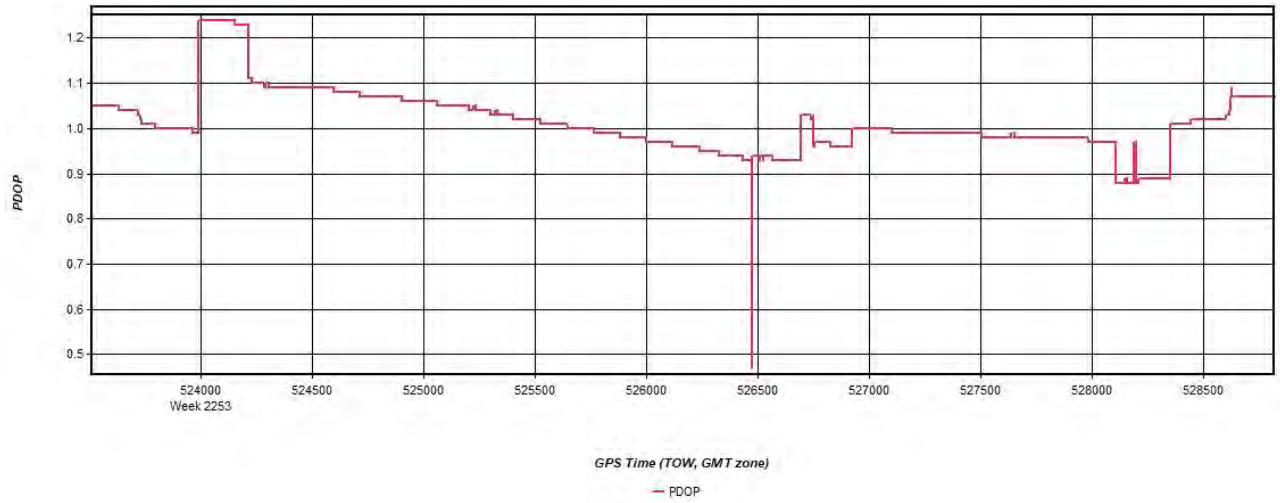
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 5: 20230318012422_3 [Smoothed TC Combined] - Estimated Position Accuracy Plot



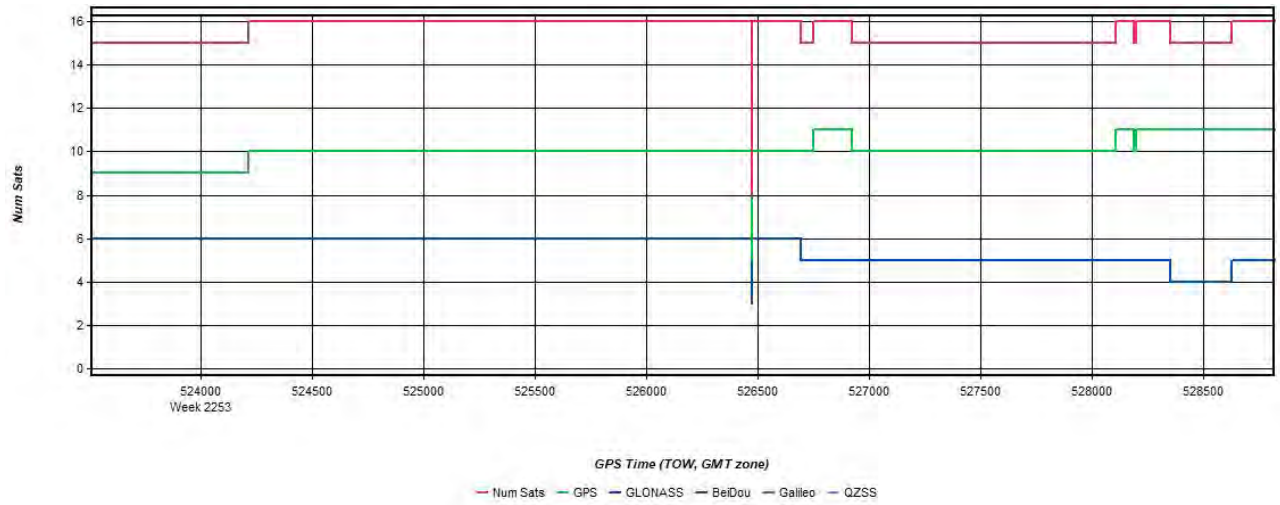
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 6: 20230318012422_3 [Smoothed TC Combined] - PDOP Plot



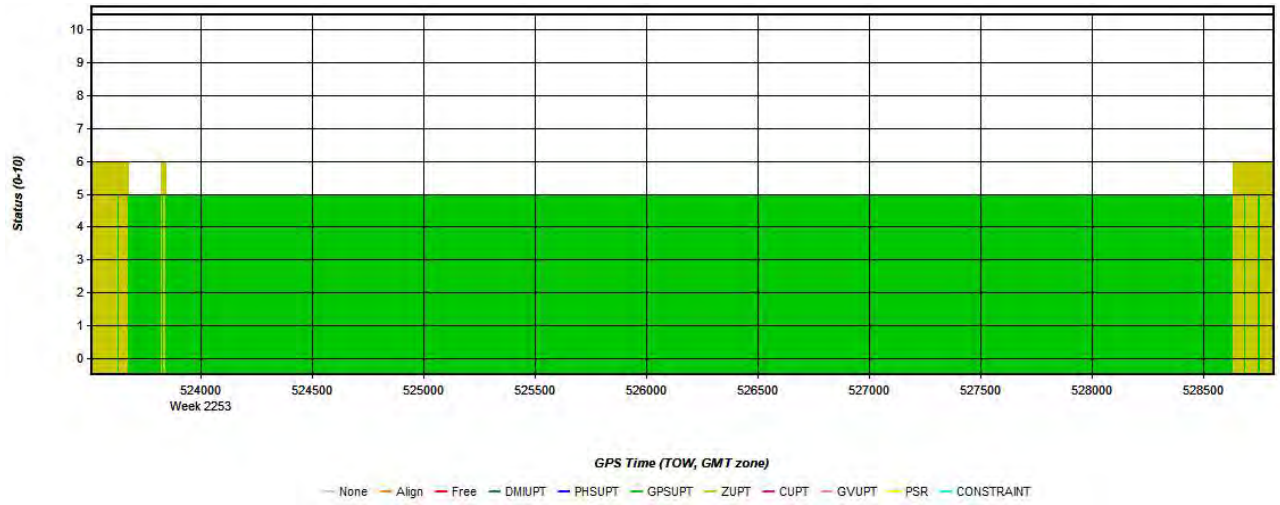
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 7: 20230318012422_3 [Smoothed TC Combined] - Number of Satellites Line Plot



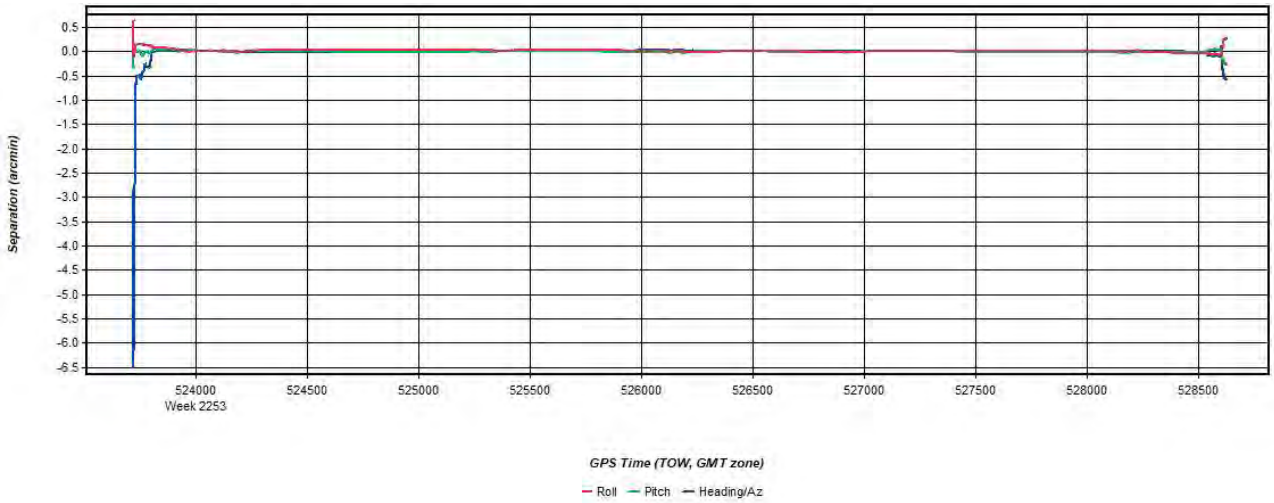
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 8: 20230318012422_3 [Smoothed TC Combined] - Status flag for IMU processing



Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 9: 20230318012422_3 [Smoothed TC Combined] - Fwd/Rev Attitude Separation Plot



Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 10: 20230318012422_3 [Smoothed TC Combined] - Estimated Attitude Accuracy Plot

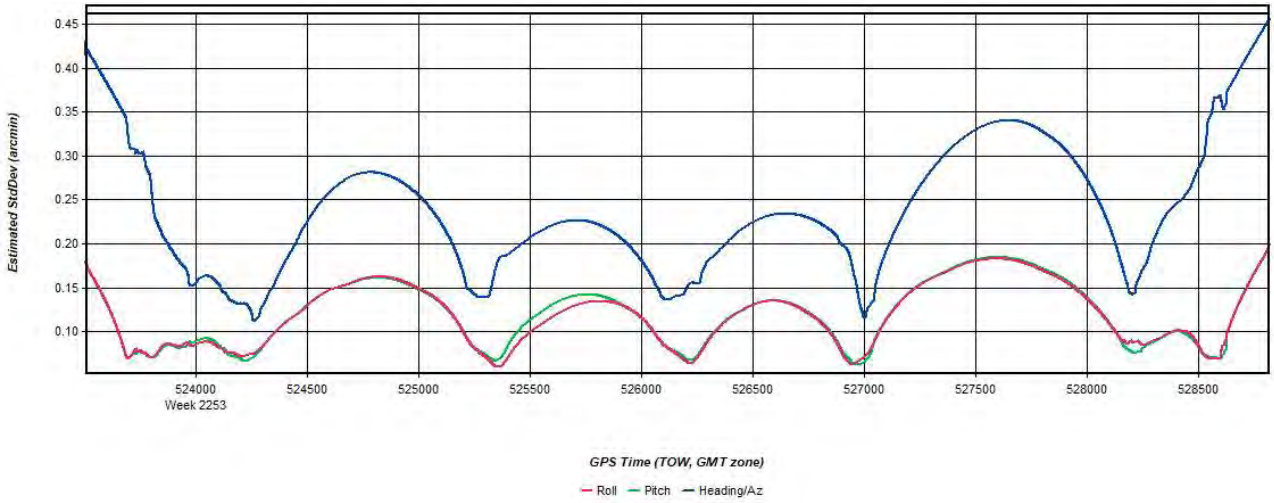


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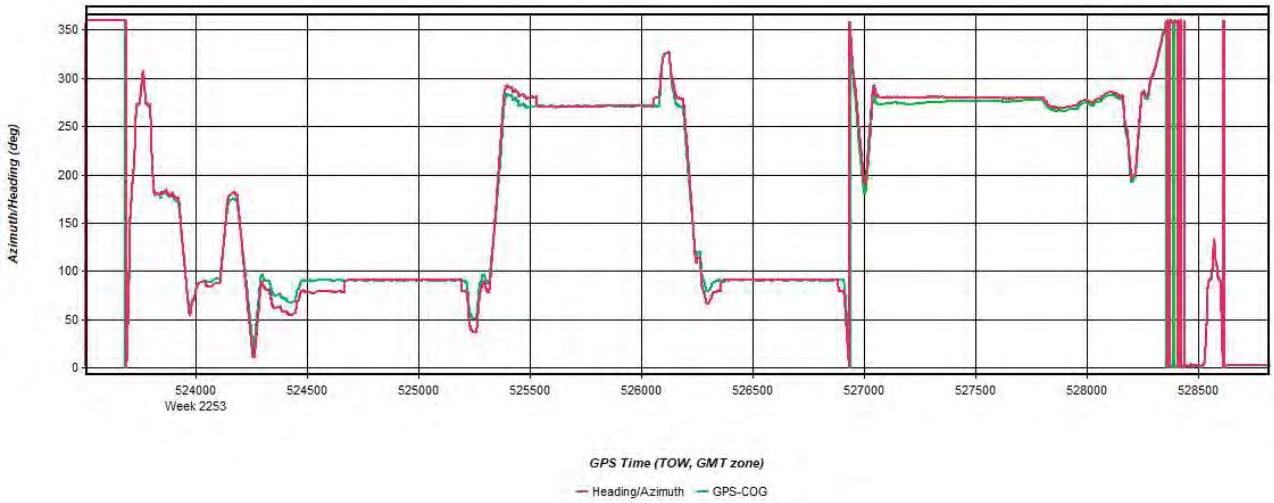
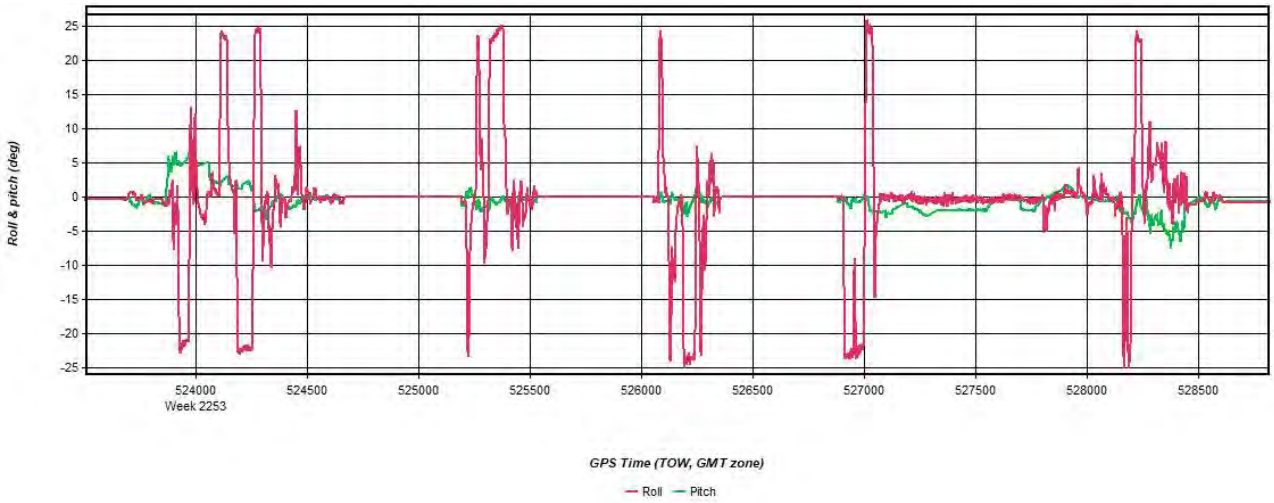
Figure 11: 20230318012422_3 [Smoothed TC Combined] - Azimuth Plot



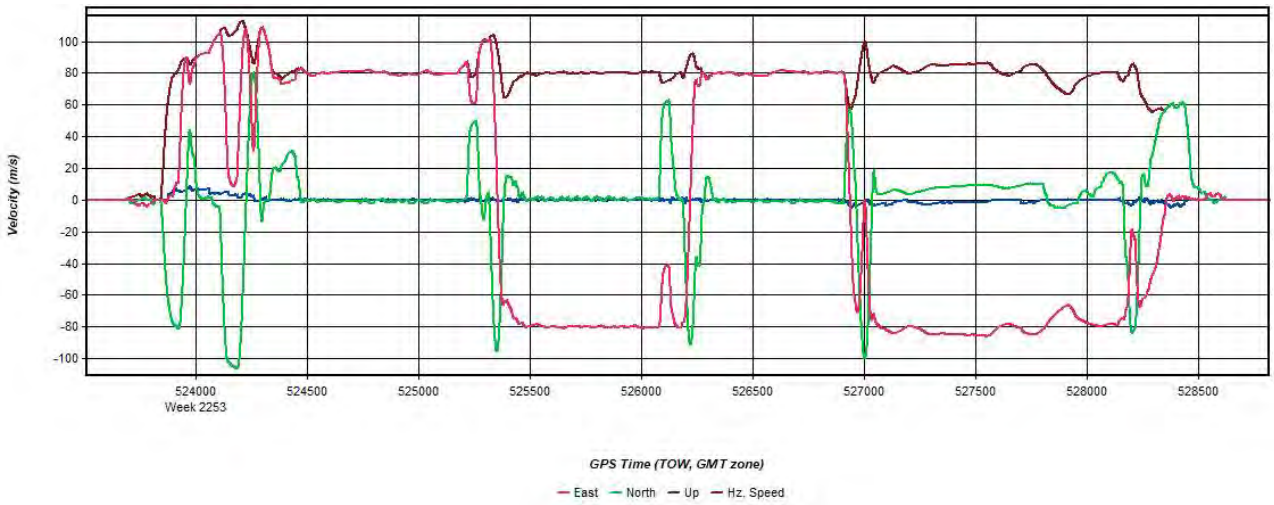
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 12: 20230318012422_3 [Smoothed TC Combined] - Roll & Pitch Plot



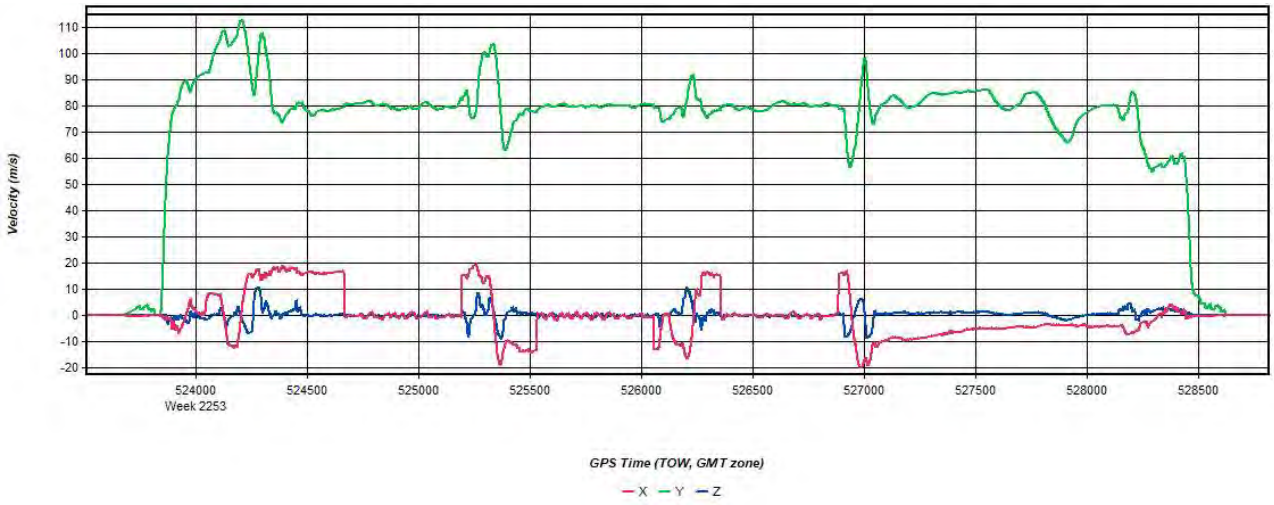
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 13: 20230318012422_3 [Smoothed TC Combined] - Velocity Profile Plot



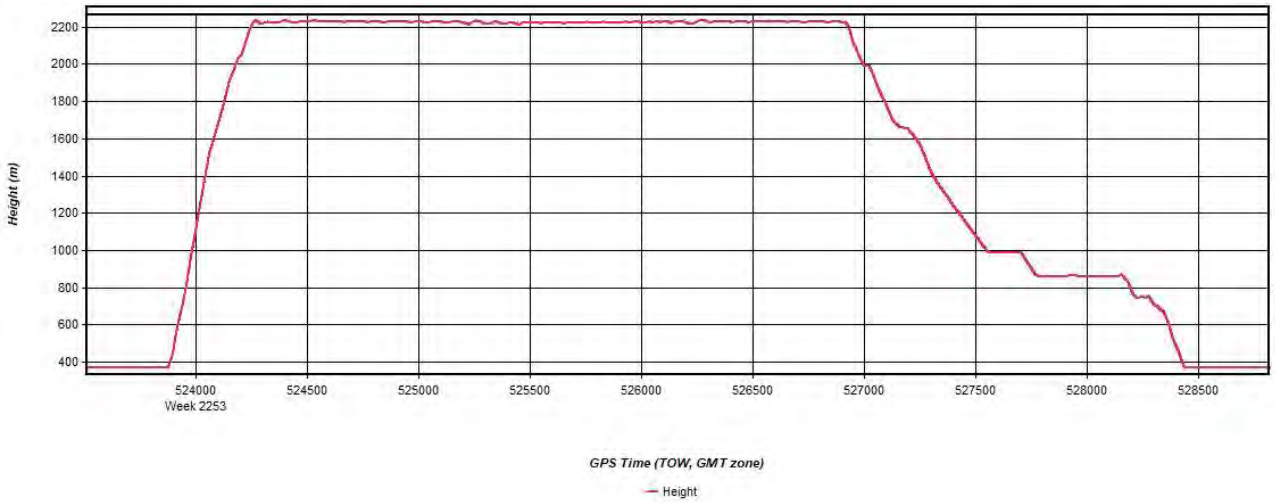
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 14: 20230318012422_3 [Smoothed TC Combined] - Body Frame Velocity Plot



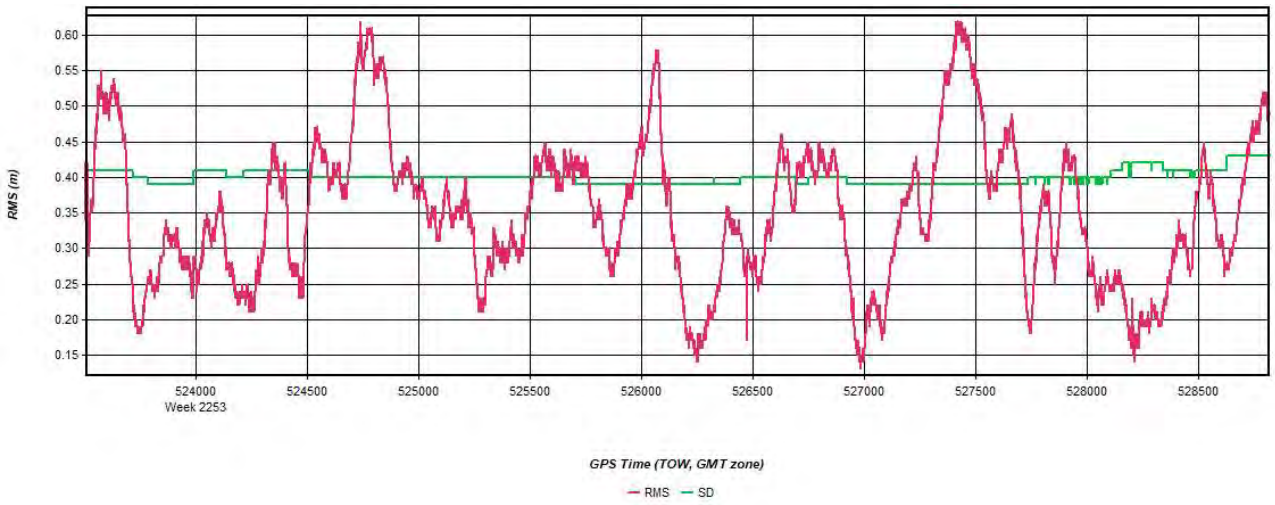
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 15: 20230318012422_3 [Smoothed TC Combined] - Height Profile Plot



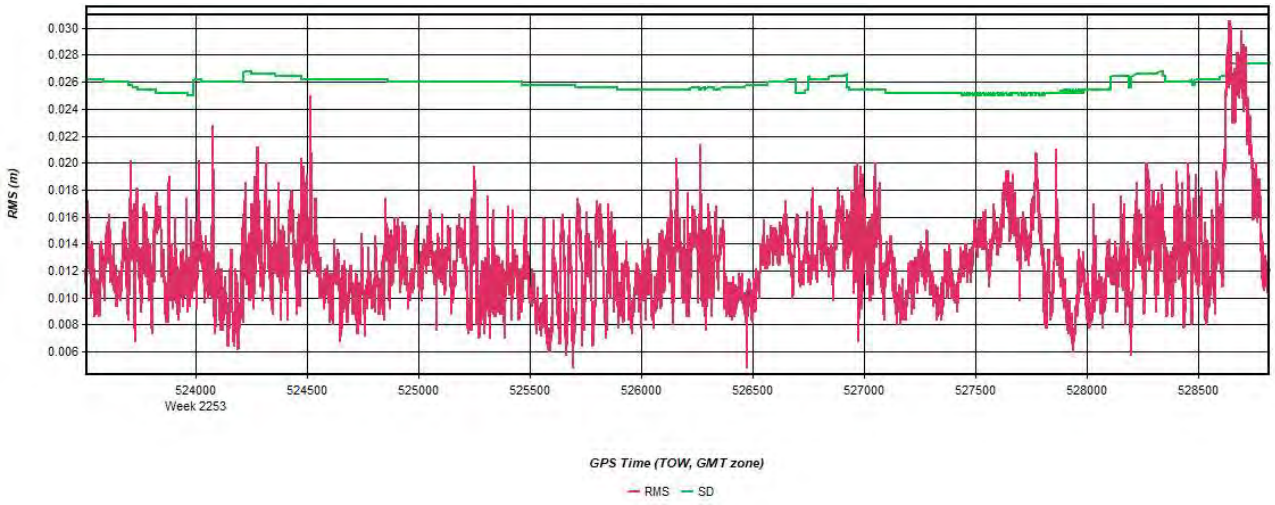
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 16: 20230318012422_3 [Smoothed TC Combined] - C/A Code Residual RMS Plot



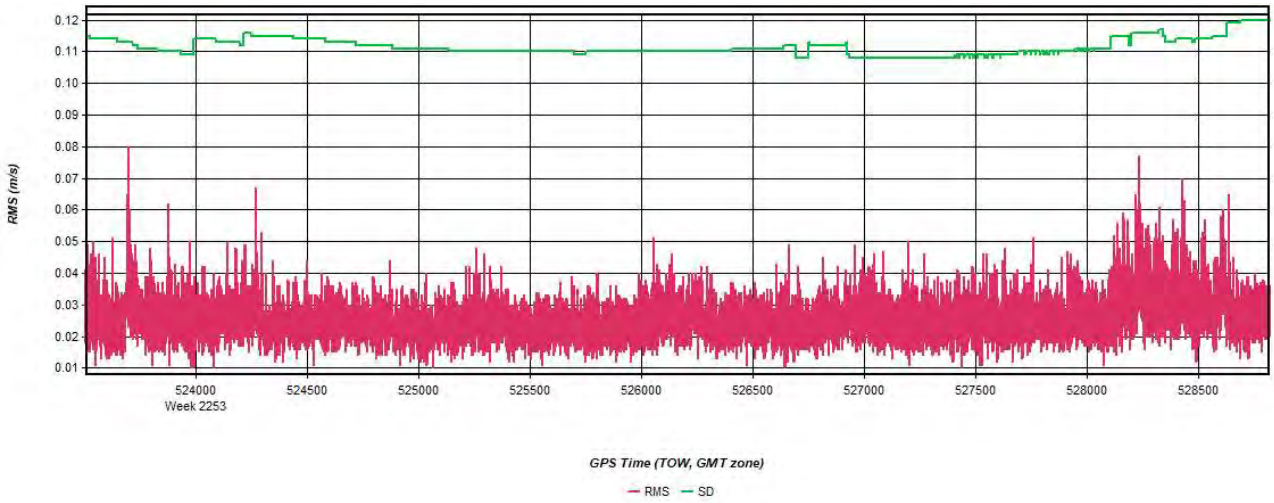
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 17: 20230318012422_3 [Smoothed TC Combined] - Carrier Residual RMS Plot



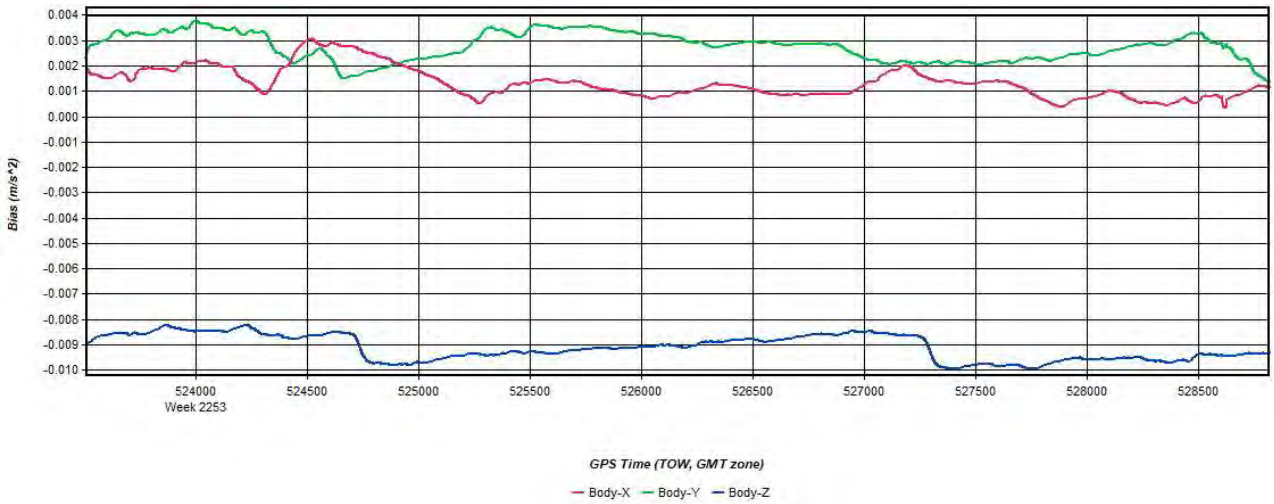
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 18: 20230318012422_3 [Smoothed TC Combined] - L1 Doppler Residual RMS Plot



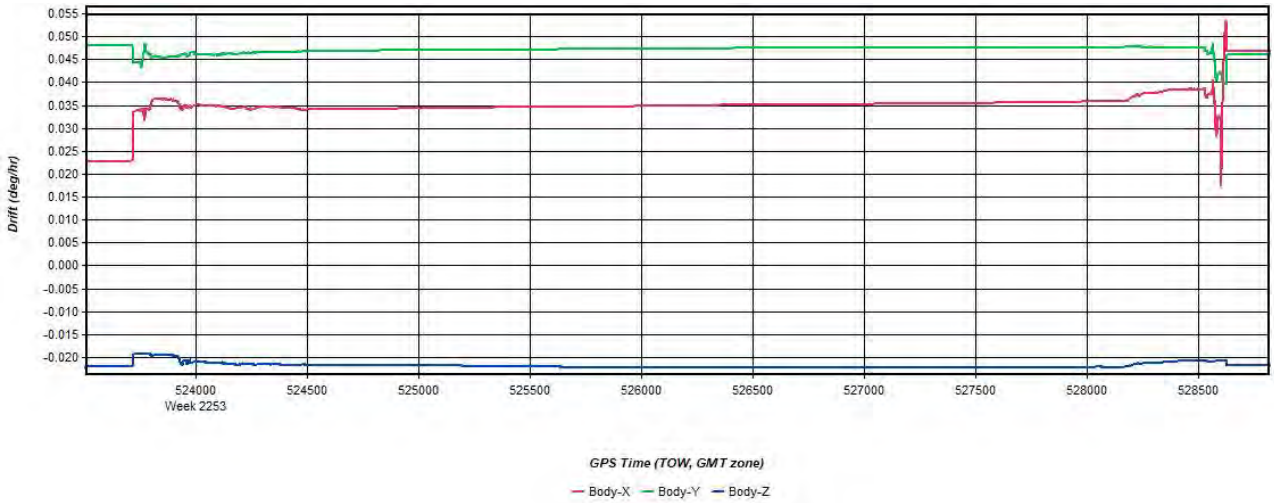
Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 19: 20230318012422_3 [Smoothed TC Combined] - Accelerometer Bias Plot



Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Figure 20: 20230318012422_3 [Smoothed TC Combined] - Gyro Drift Plot

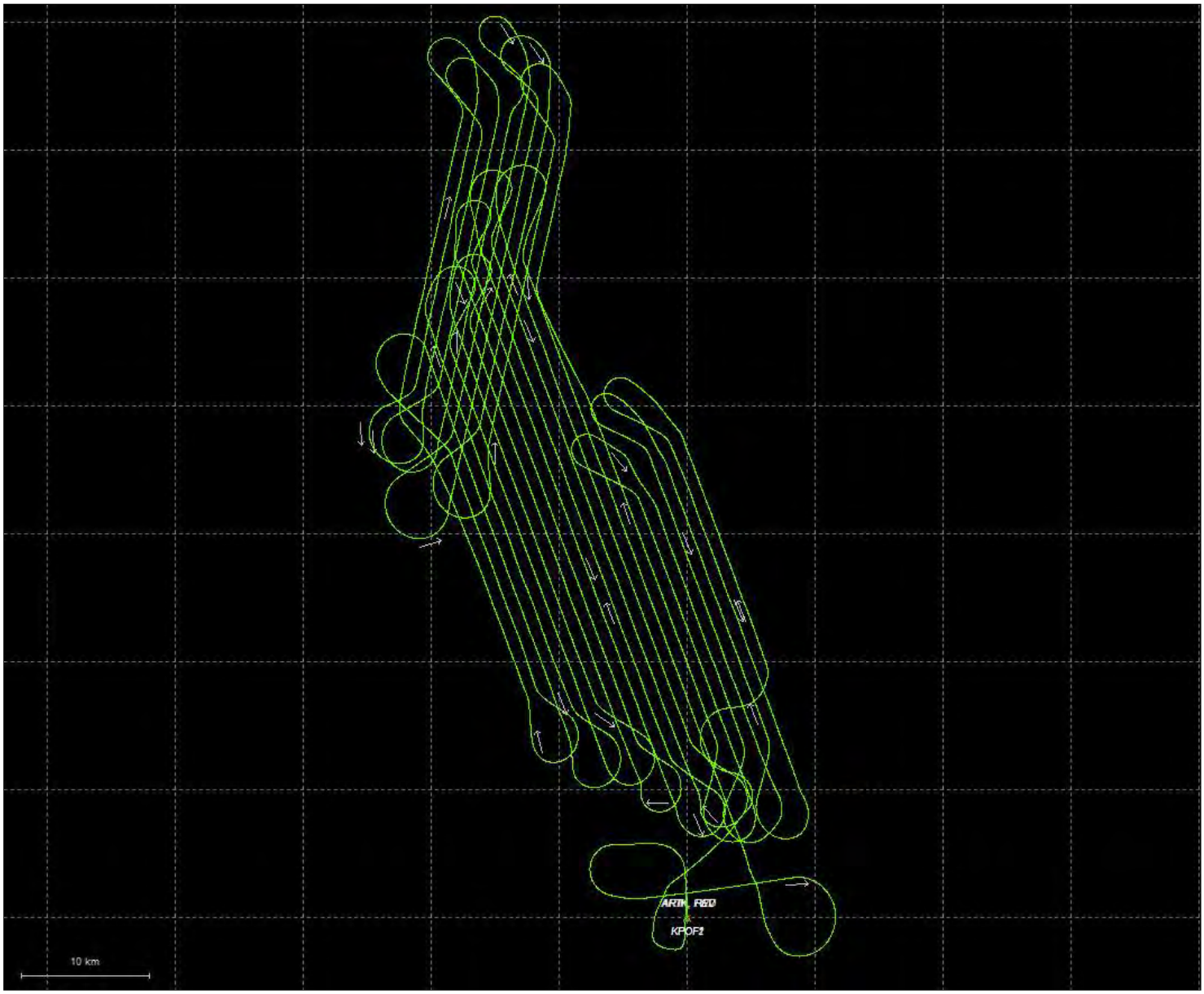


Process	20230318012422_3	by Unknown	on 3/23/2023	at 11:40:12

Output Results for 20230319134519_4

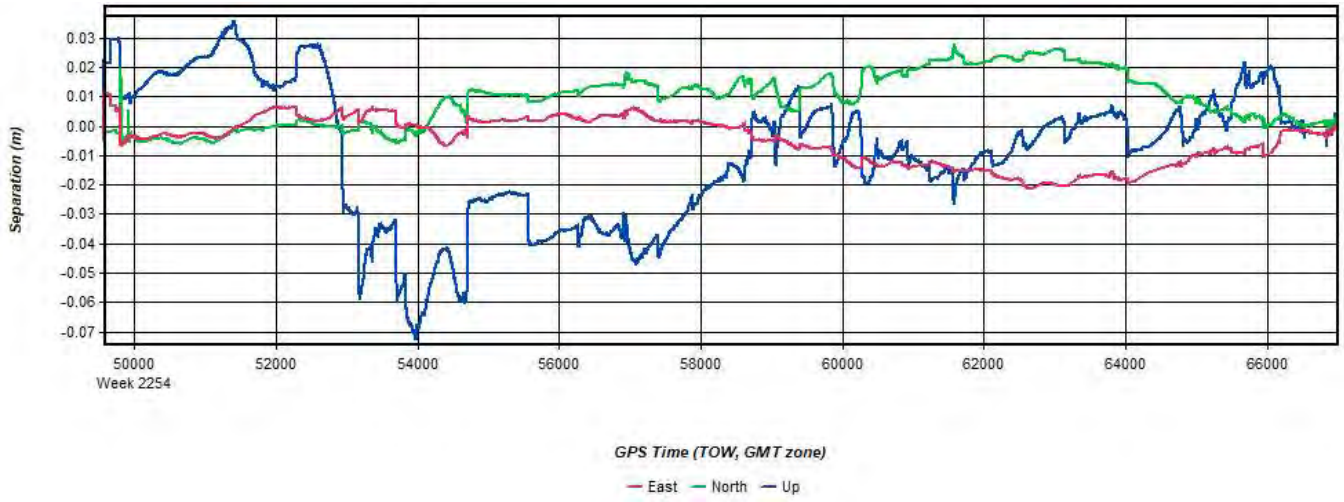
Inertial Explorer Version 8.90.2124
03/22/2023

Figure 1: Smoothed TC Combined - Map



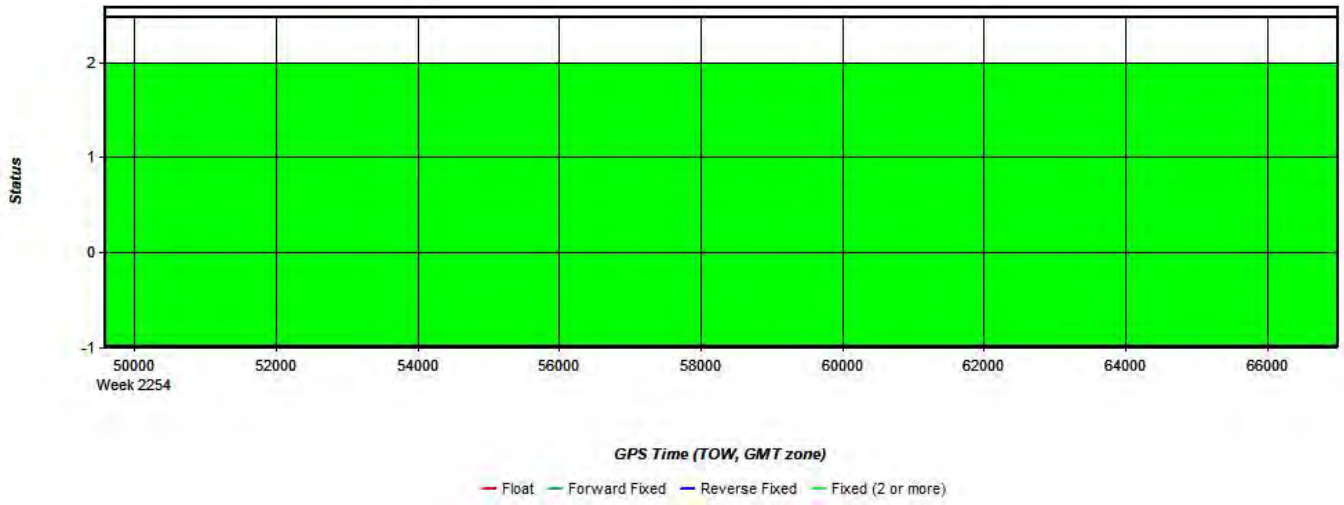
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 2: 20230319134519_4 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot



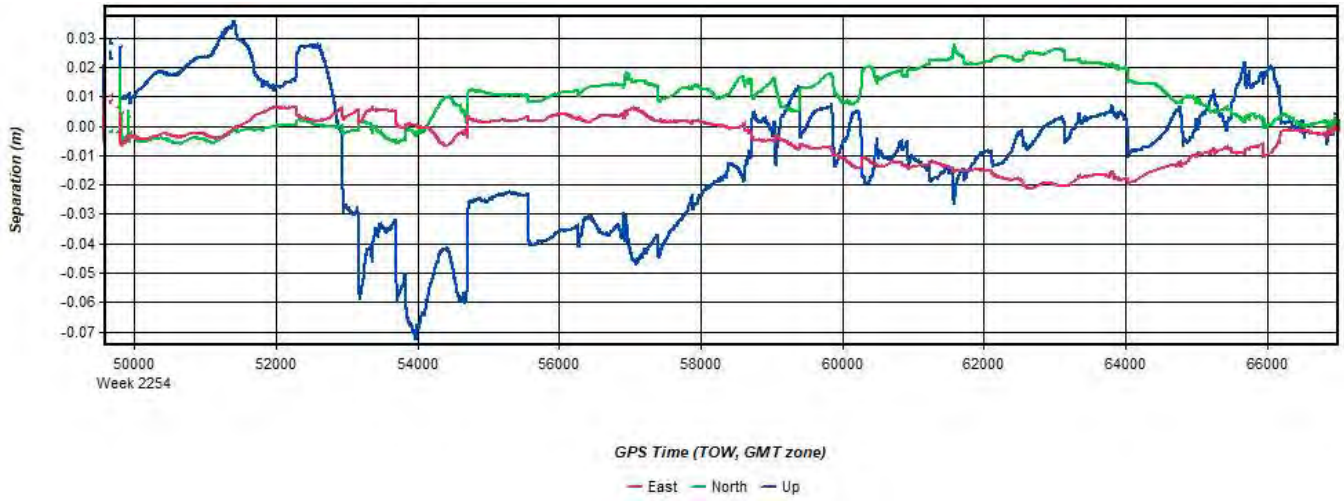
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 3: 20230319134519_4 [Smoothed TC Combined] - Float or Fixed Ambiguity



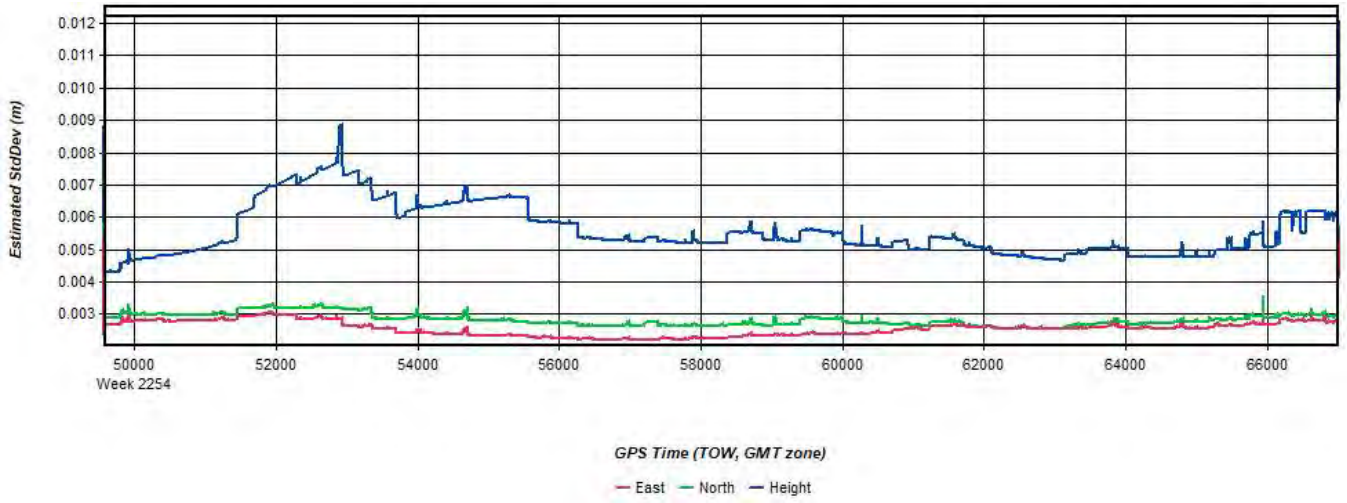
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 4: 20230319134519_4 [Smoothed TC Combined] - Forward/Reverse Separation Plot (Fixed)



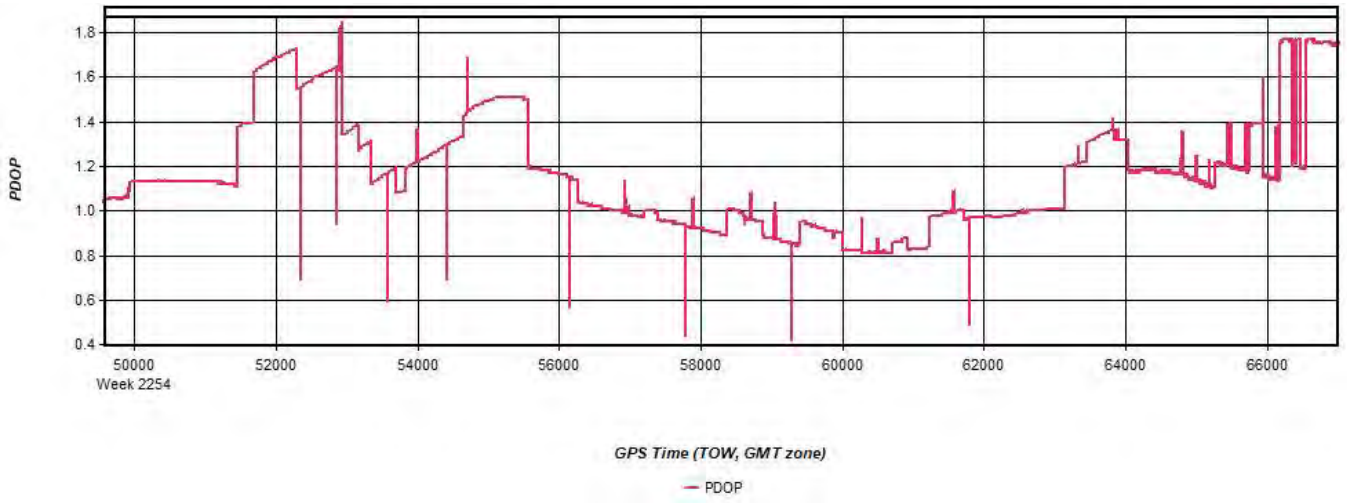
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 5: 20230319134519_4 [Smoothed TC Combined] - Estimated Position Accuracy Plot



Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 6: 20230319134519_4 [Smoothed TC Combined] - PDOP Plot



Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 7: 20230319134519_4 [Smoothed TC Combined] - Number of Satellites Line Plot

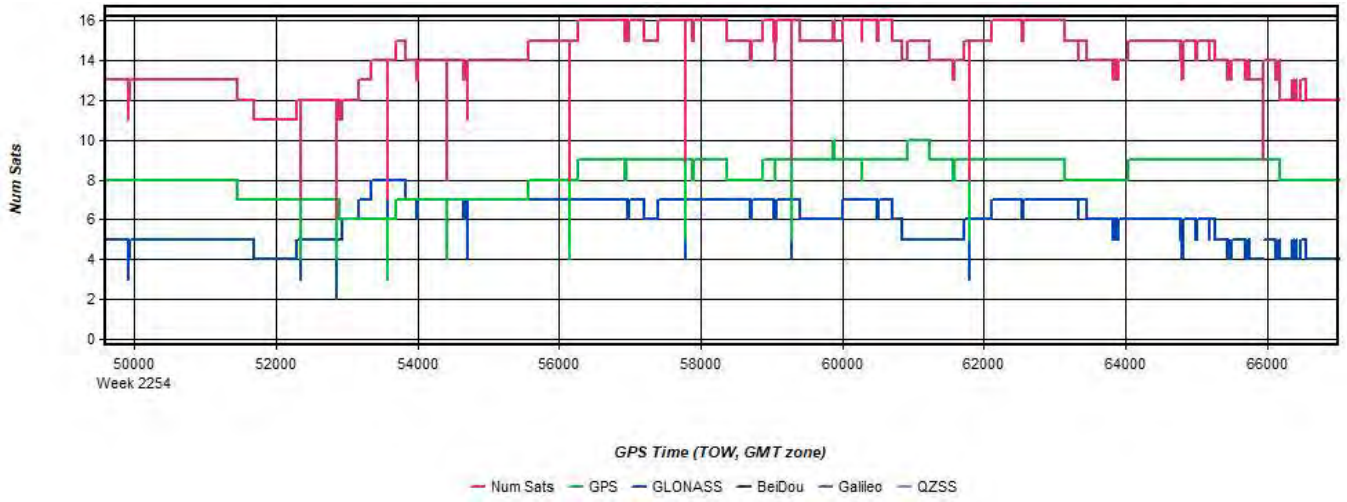


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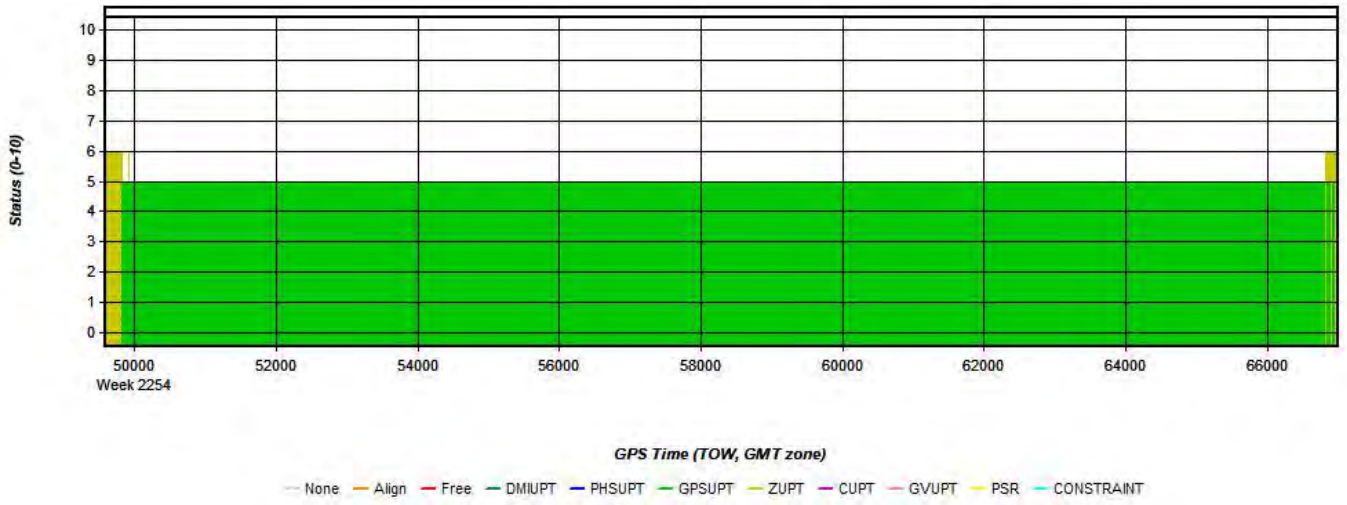
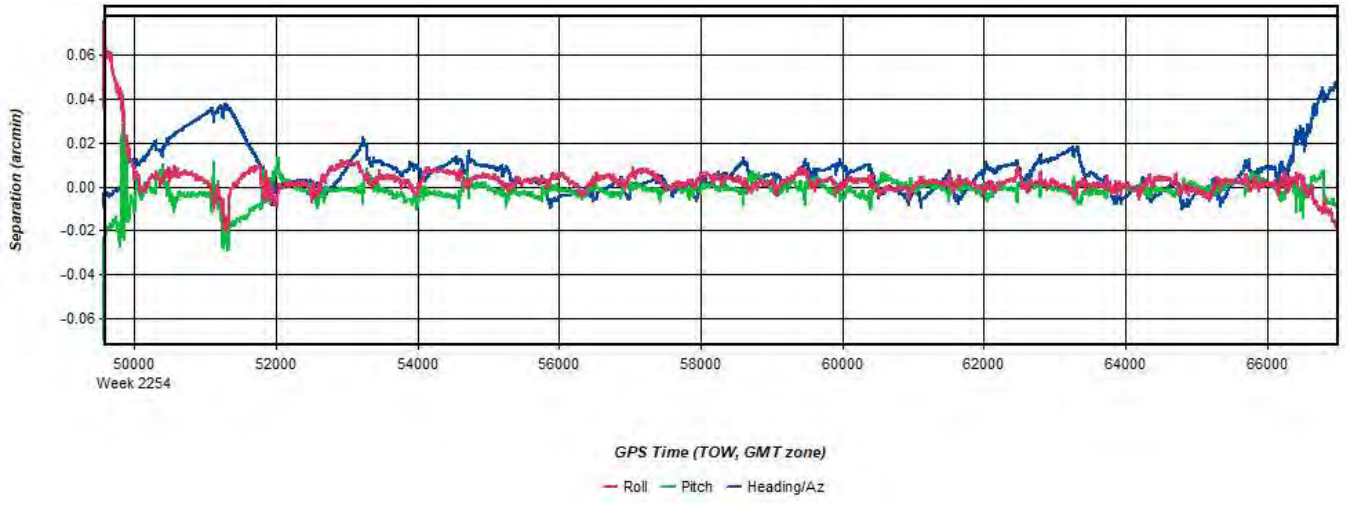
Figure 8: 20230319134519_4 [Smoothed TC Combined] - Status flag for IMU processing



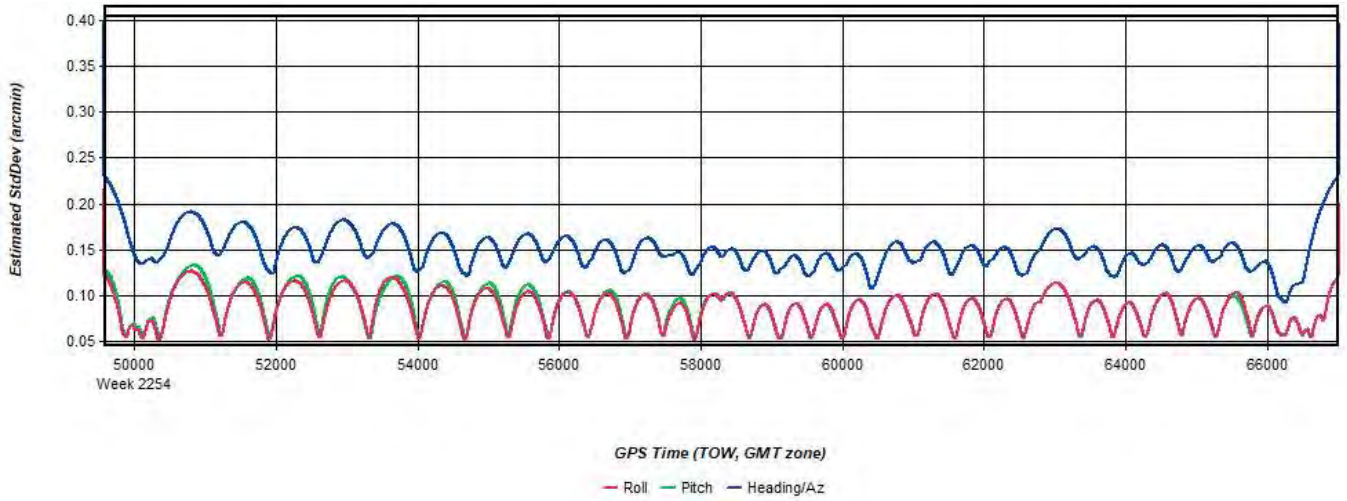
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 9: 20230319134519_4 [Smoothed TC Combined] - Fwd/Rev Attitude Separation Plot



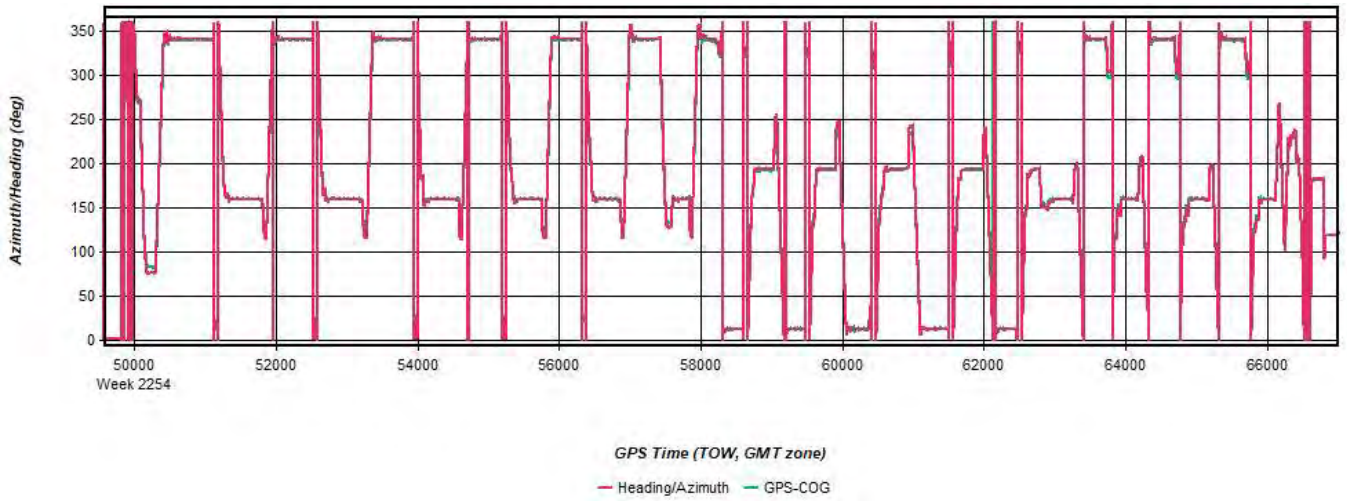
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 10: 20230319134519_4 [Smoothed TC Combined] - Estimated Attitude Accuracy Plot



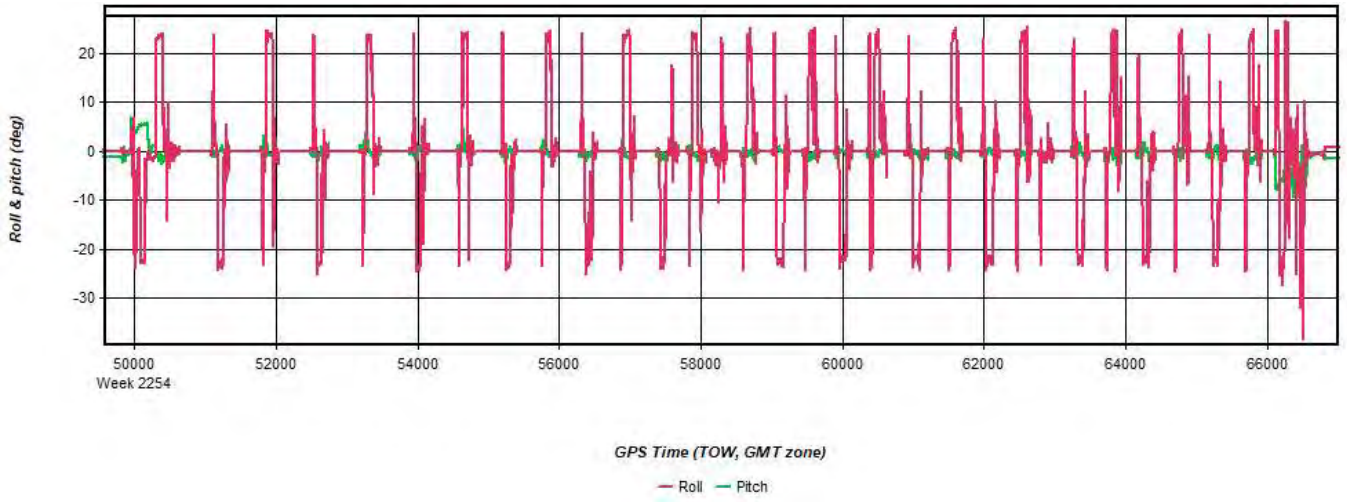
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 11: 20230319134519_4 [Smoothed TC Combined] - Azimuth Plot



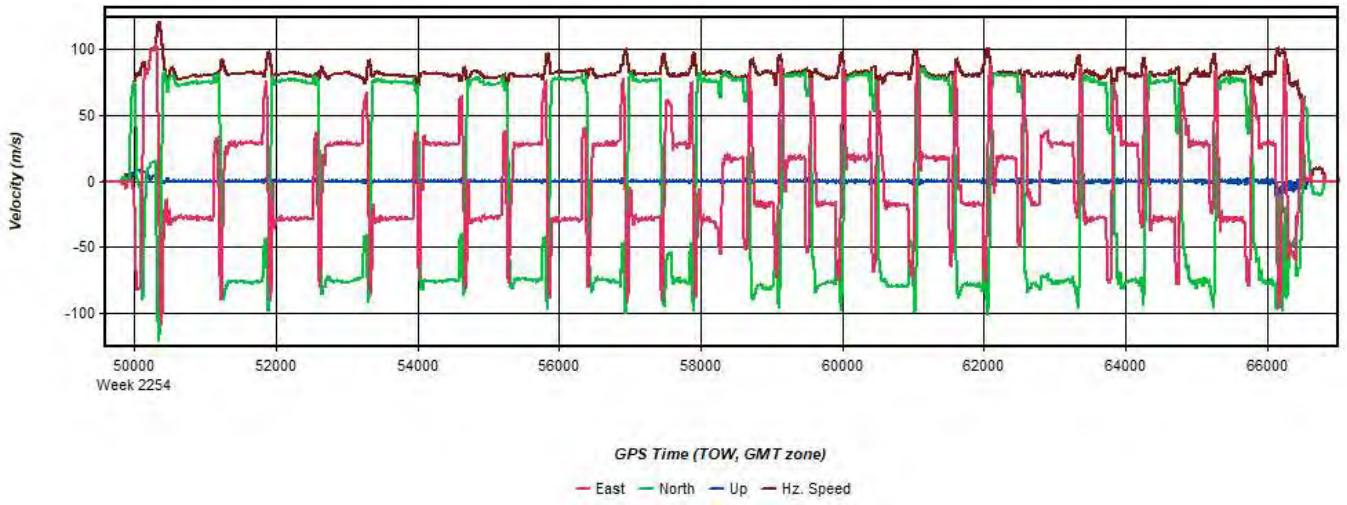
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 12: 20230319134519_4 [Smoothed TC Combined] - Roll & Pitch Plot



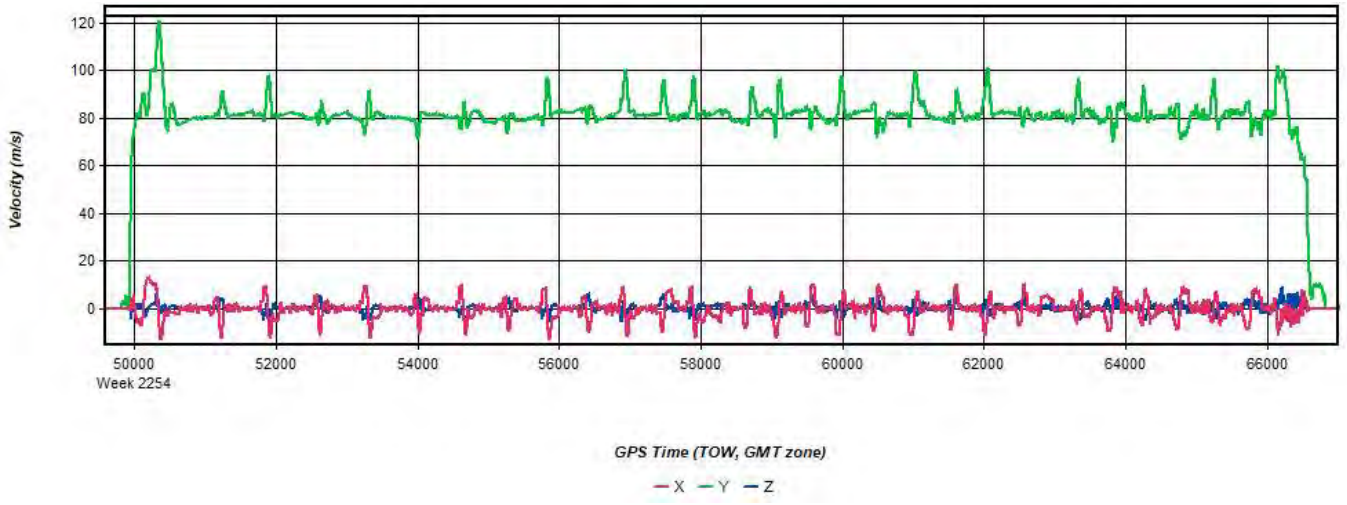
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 13: 20230319134519_4 [Smoothed TC Combined] - Velocity Profile Plot



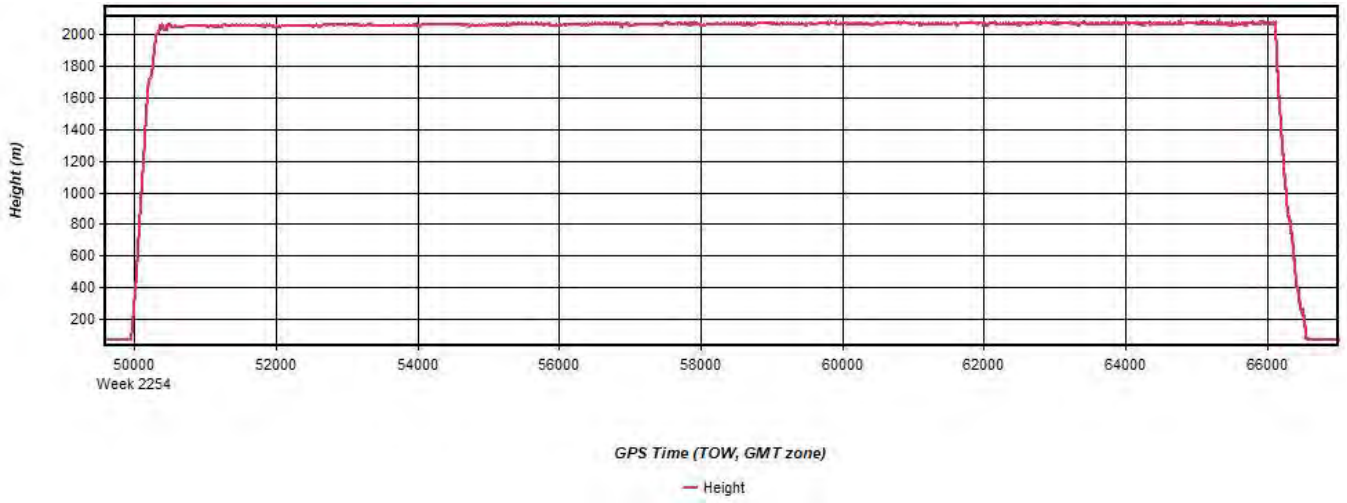
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 14: 20230319134519_4 [Smoothed TC Combined] - Body Frame Velocity Plot



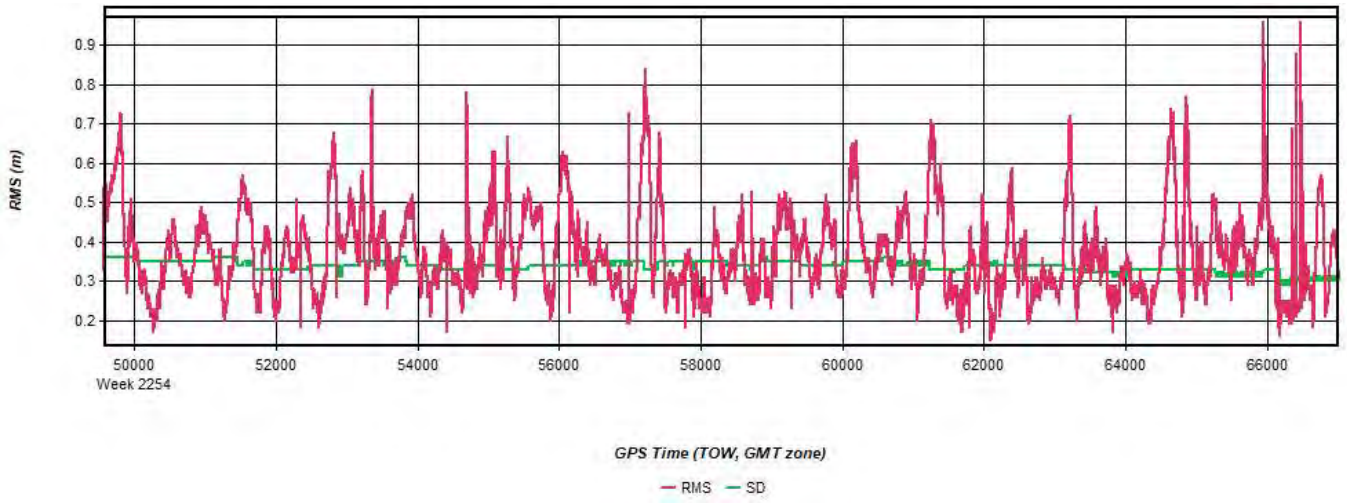
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 15: 20230319134519_4 [Smoothed TC Combined] - Height Profile Plot



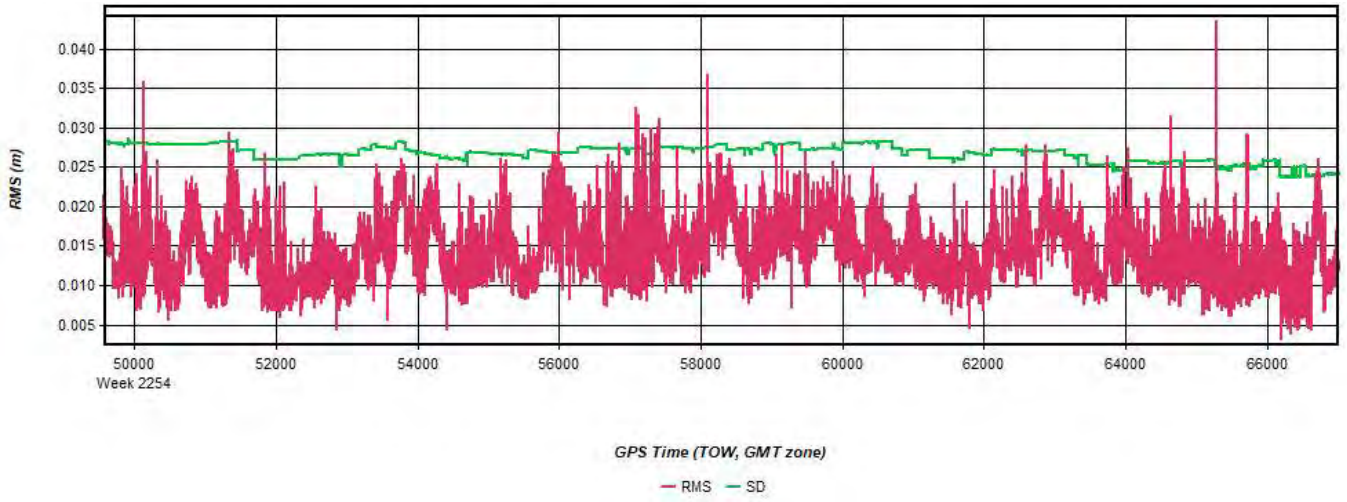
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 16: 20230319134519_4 [Smoothed TC Combined] - C/A Code Residual RMS Plot



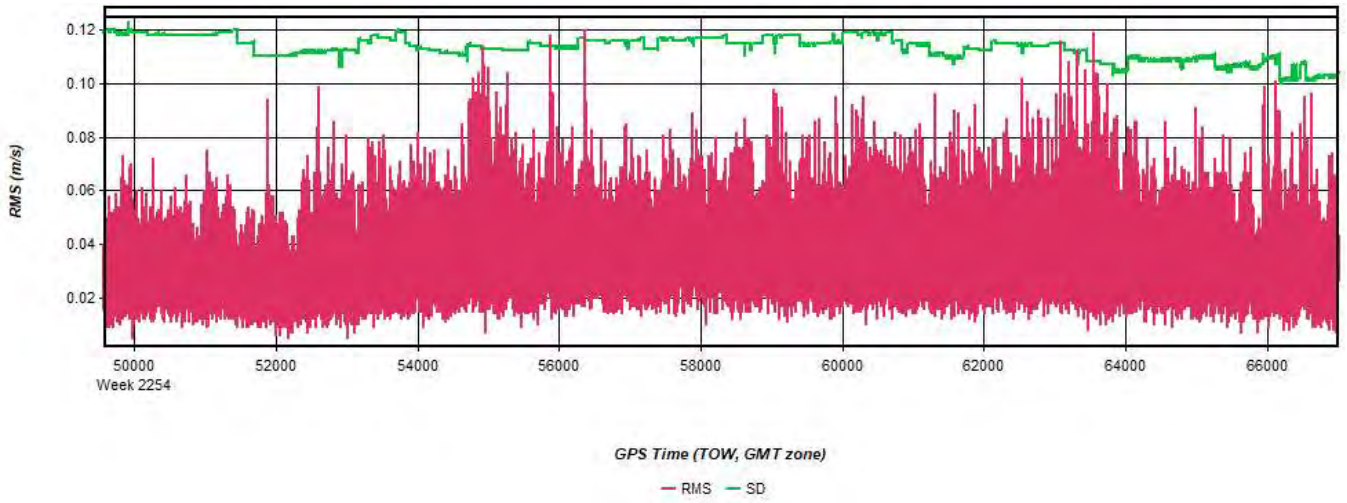
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 17: 20230319134519_4 [Smoothed TC Combined] - Carrier Residual RMS Plot



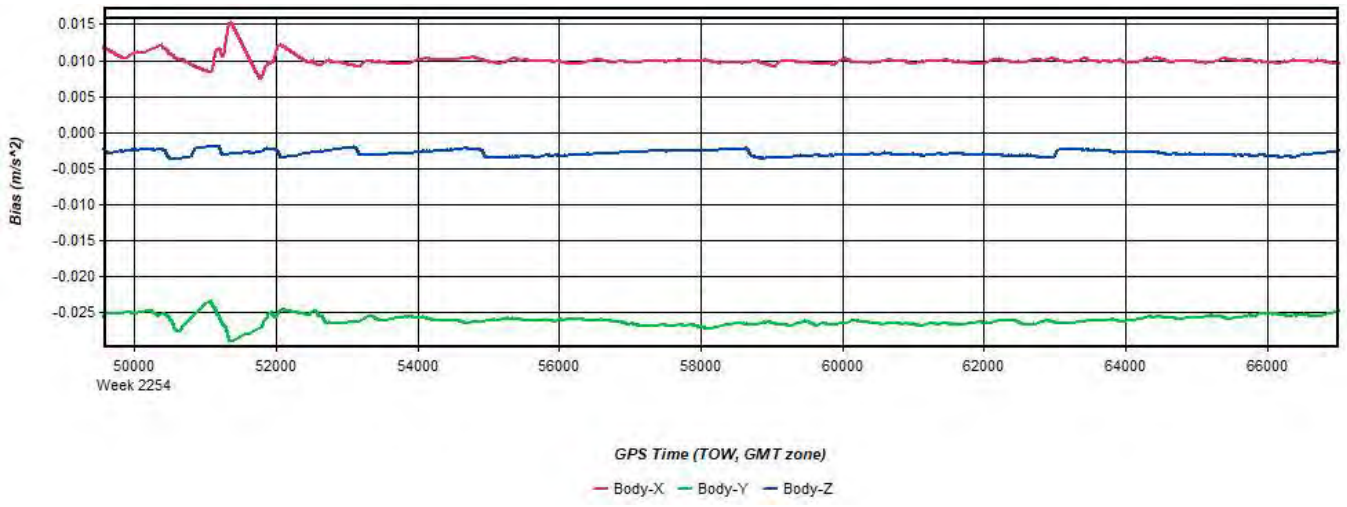
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 18: 20230319134519_4 [Smoothed TC Combined] - L1 Doppler Residual RMS Plot



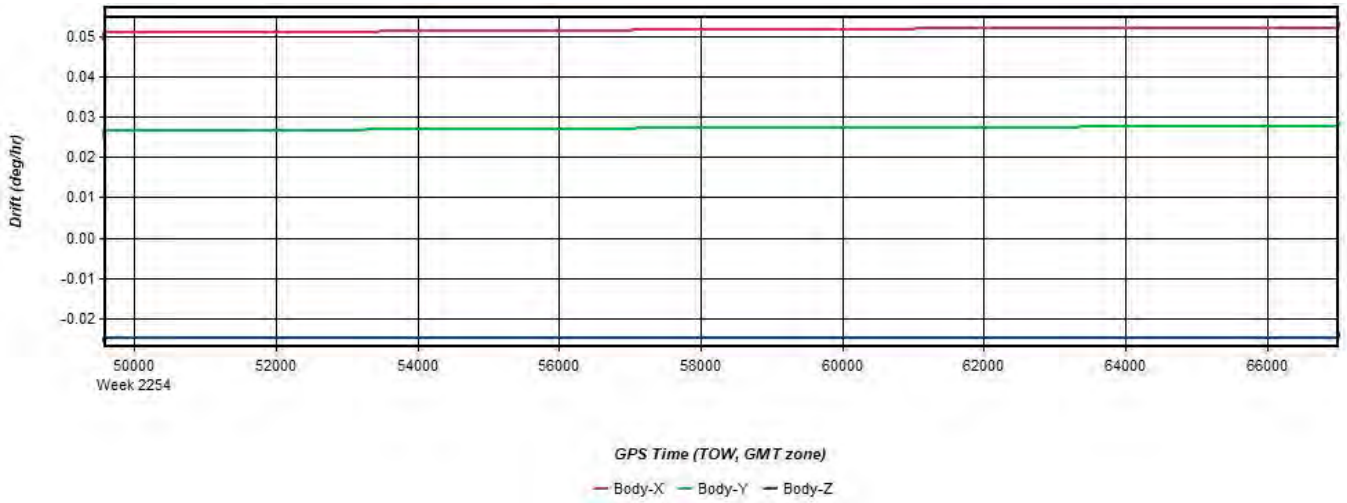
Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 19: 20230319134519_4 [Smoothed TC Combined] - Accelerometer Bias Plot



Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Figure 20: 20230319134519_4 [Smoothed TC Combined] - Gyro Drift Plot

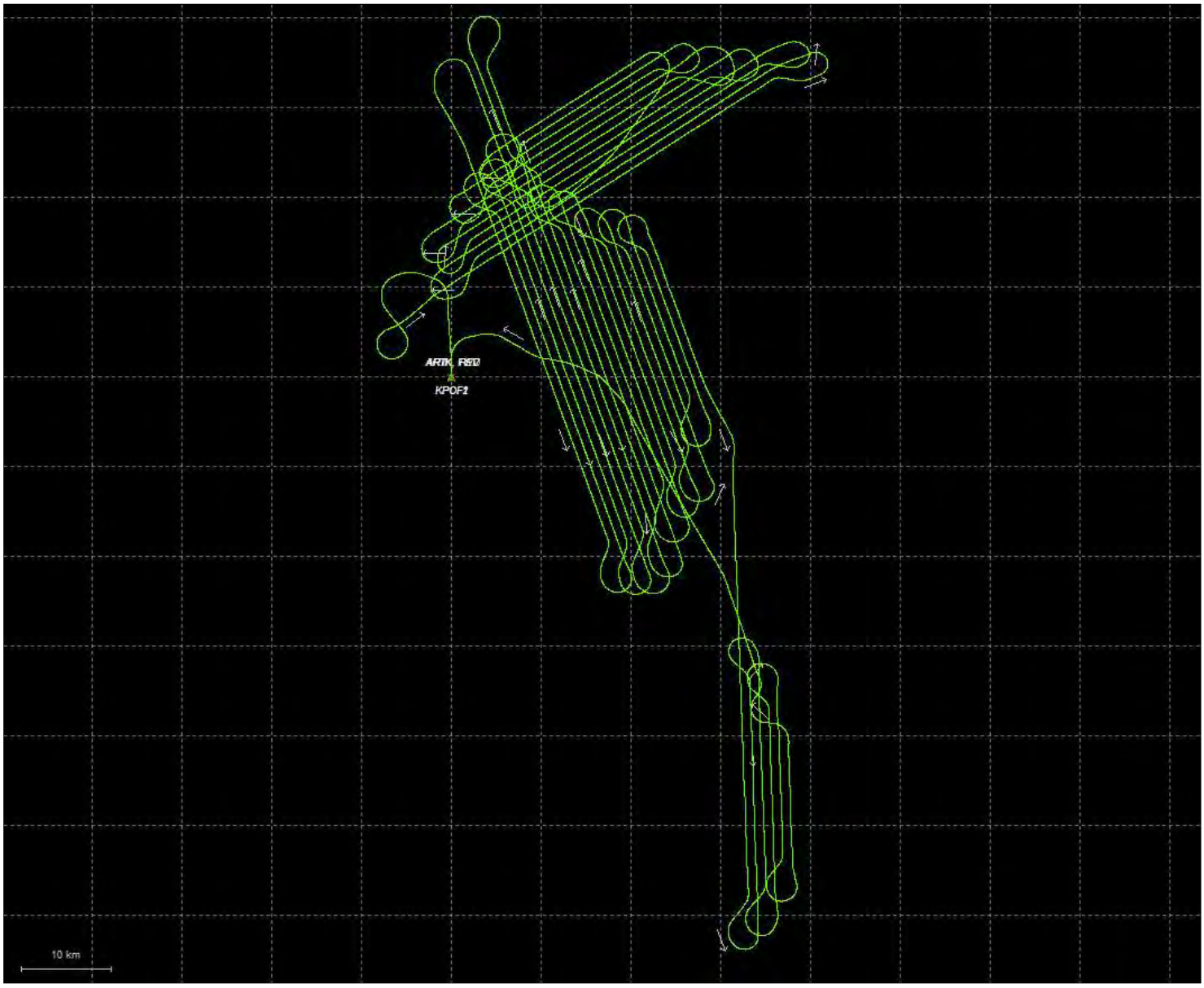


Process	20230319134519_4	by Unknown	on 3/22/2023	at 14:57:40

Output Results for 20230319190108_5

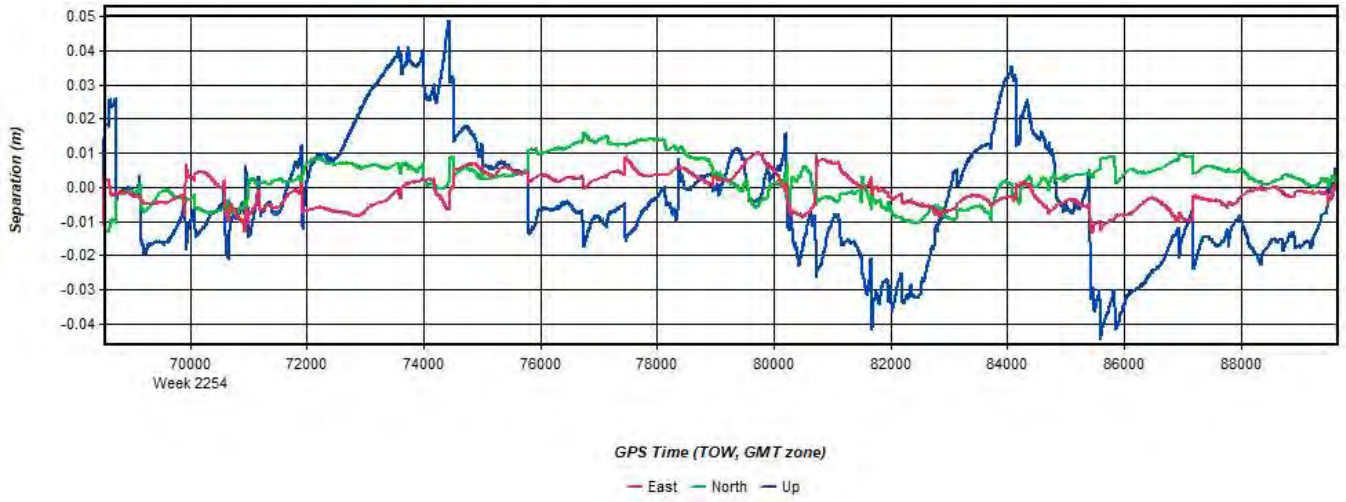
Inertial Explorer Version 8.90.2124
03/24/2023

Figure 1: Smoothed TC Combined - Map



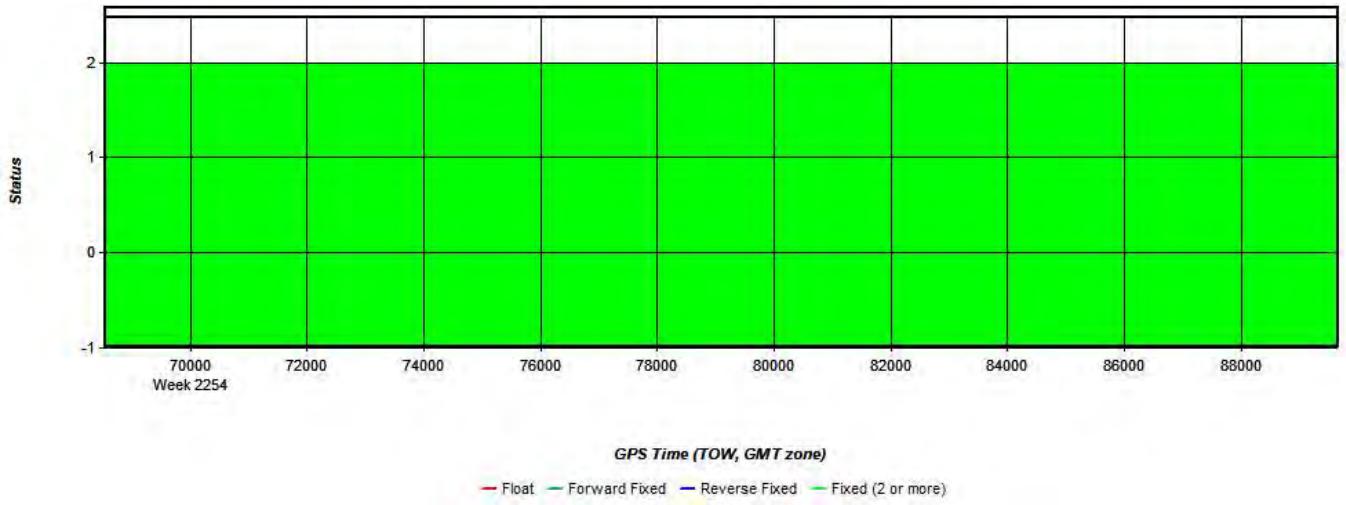
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 2: 20230319190108_5 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot



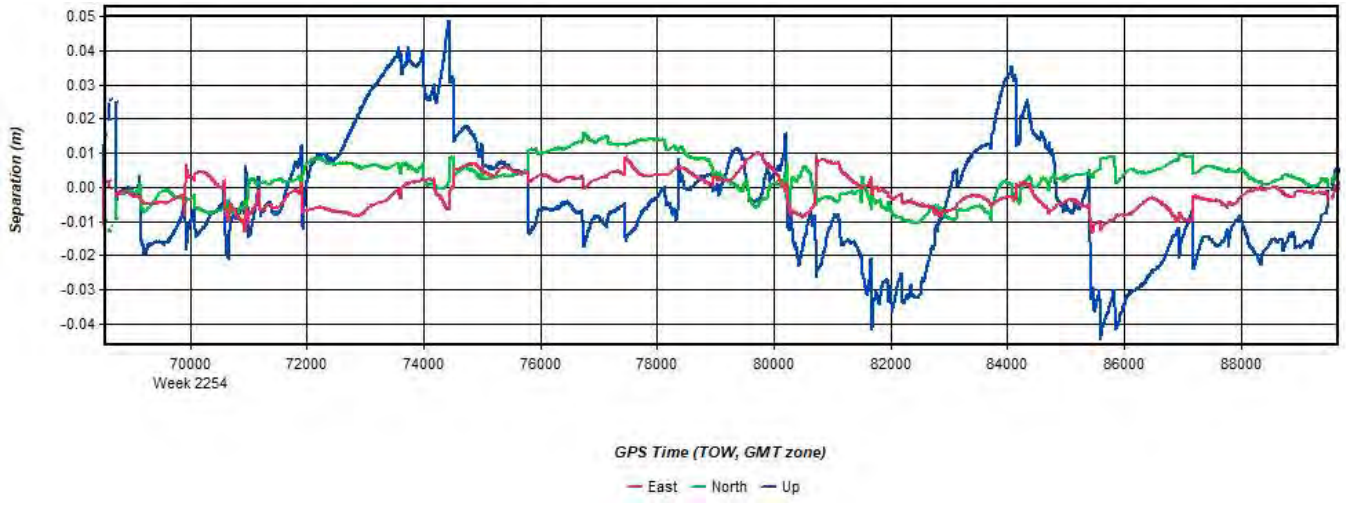
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 3: 20230319190108_5 [Smoothed TC Combined] - Float or Fixed Ambiguity



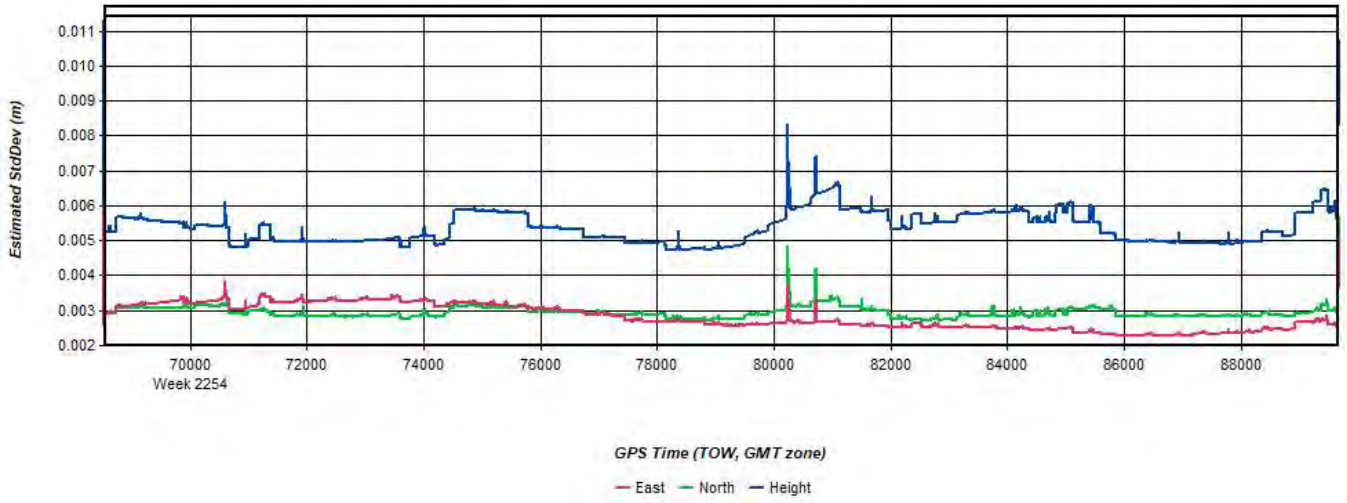
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 4: 20230319190108_5 [Smoothed TC Combined] - Forward/Reverse Separation Plot (Fixed)



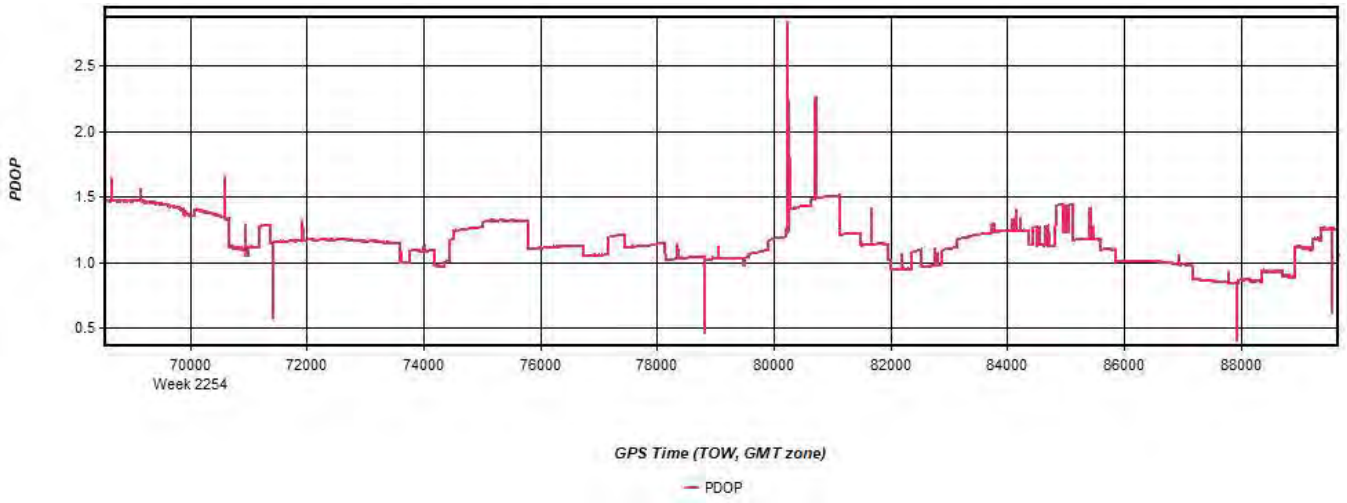
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 5: 20230319190108_5 [Smoothed TC Combined] - Estimated Position Accuracy Plot



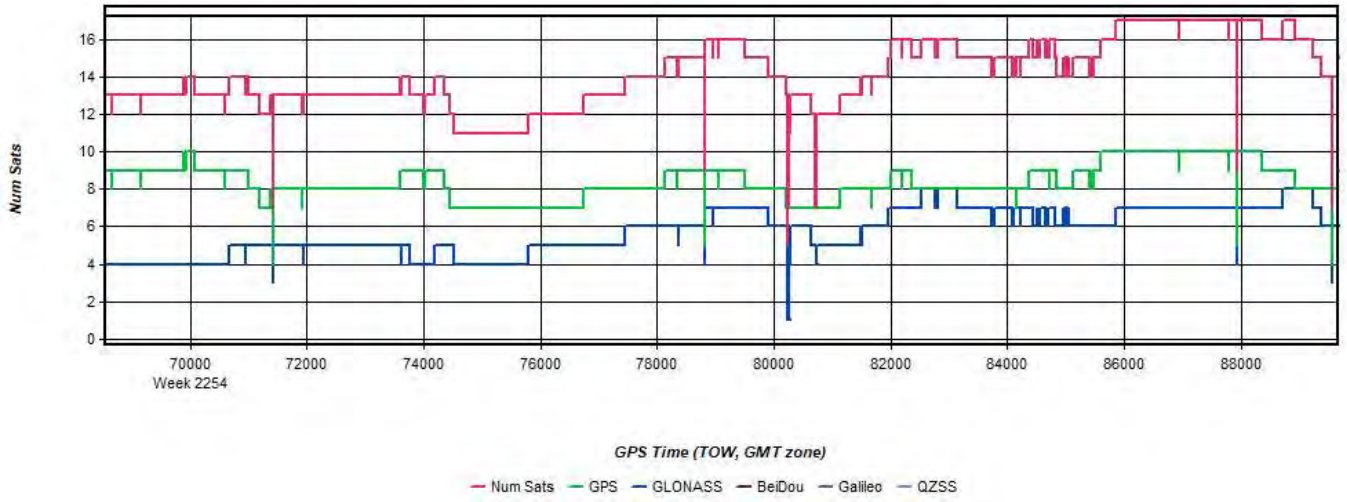
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 6: 20230319190108_5 [Smoothed TC Combined] - PDOP Plot



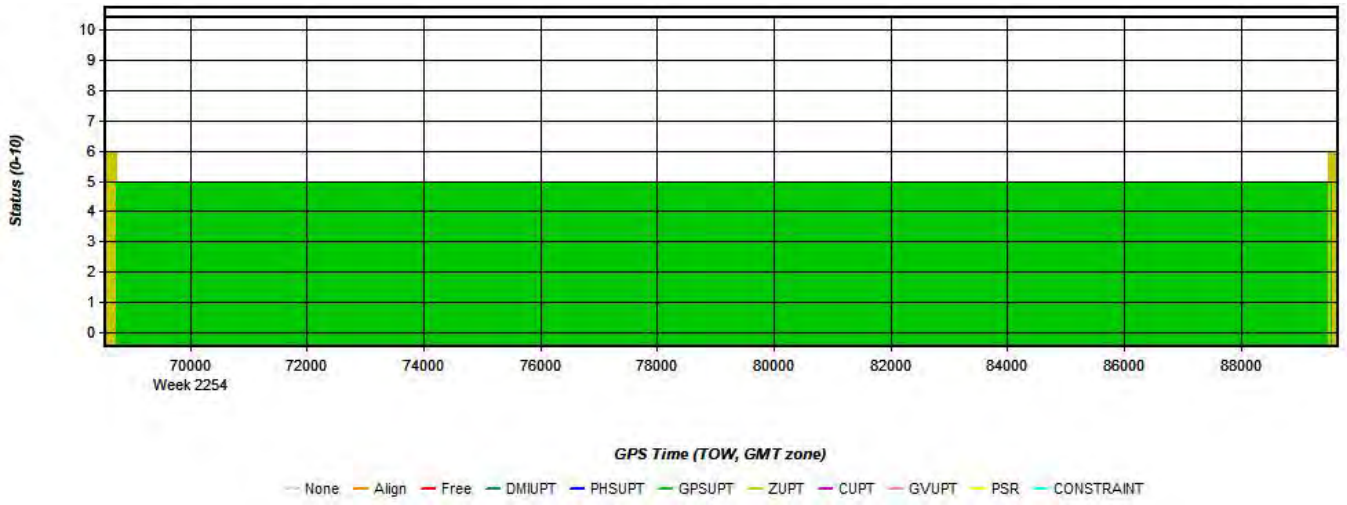
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 7: 20230319190108_5 [Smoothed TC Combined] - Number of Satellites Line Plot



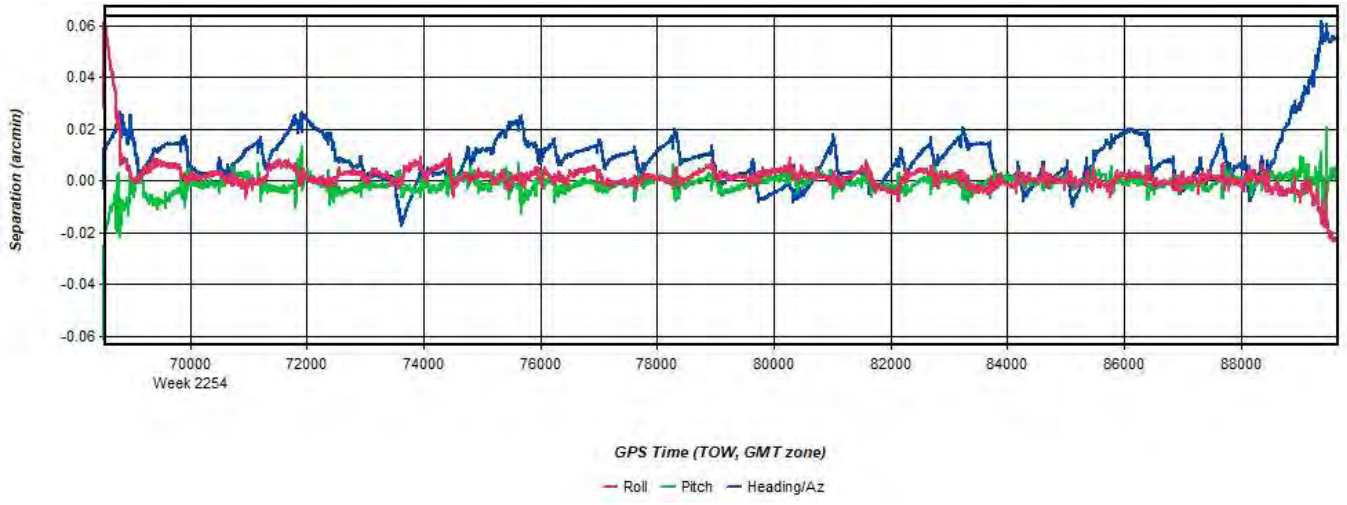
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 8: 20230319190108_5 [Smoothed TC Combined] - Status flag for IMU processing



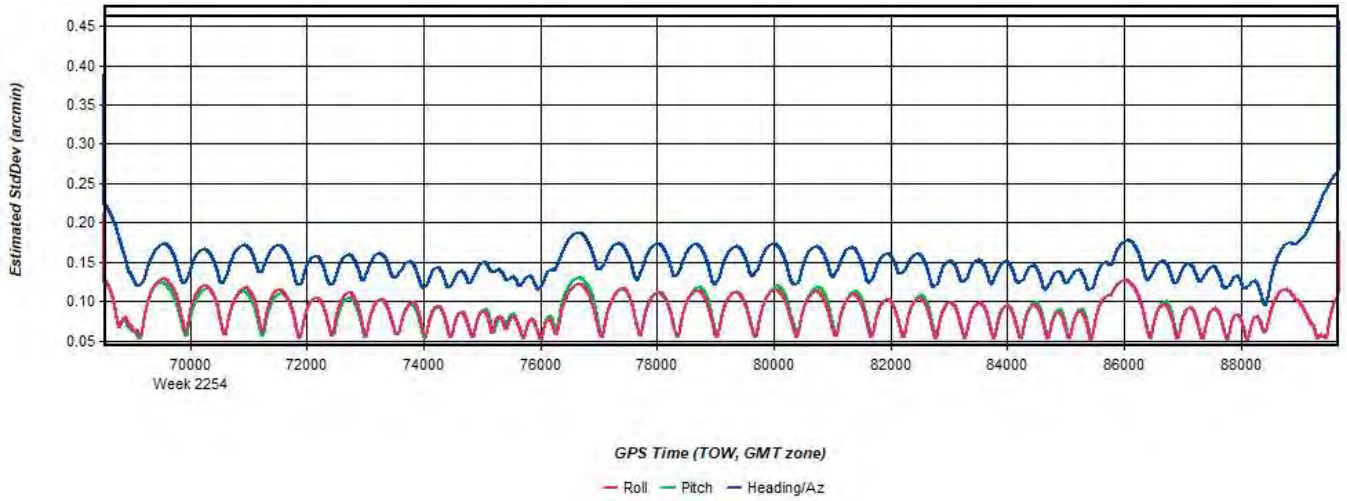
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 9: 20230319190108_5 [Smoothed TC Combined] - Fwd/Rev Attitude Separation Plot



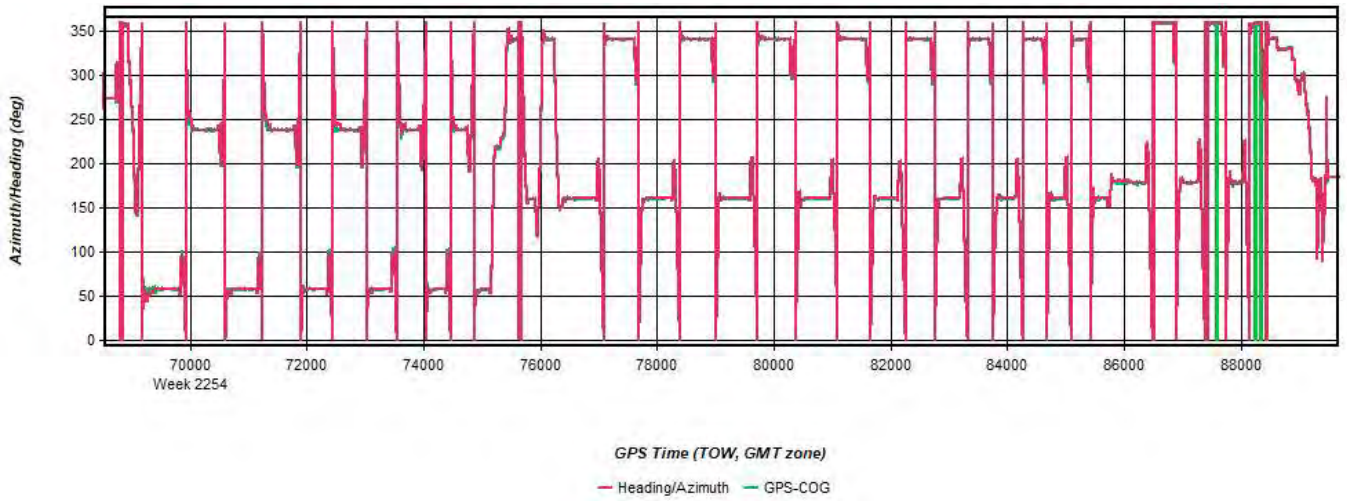
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 10: 20230319190108_5 [Smoothed TC Combined] - Estimated Attitude Accuracy Plot



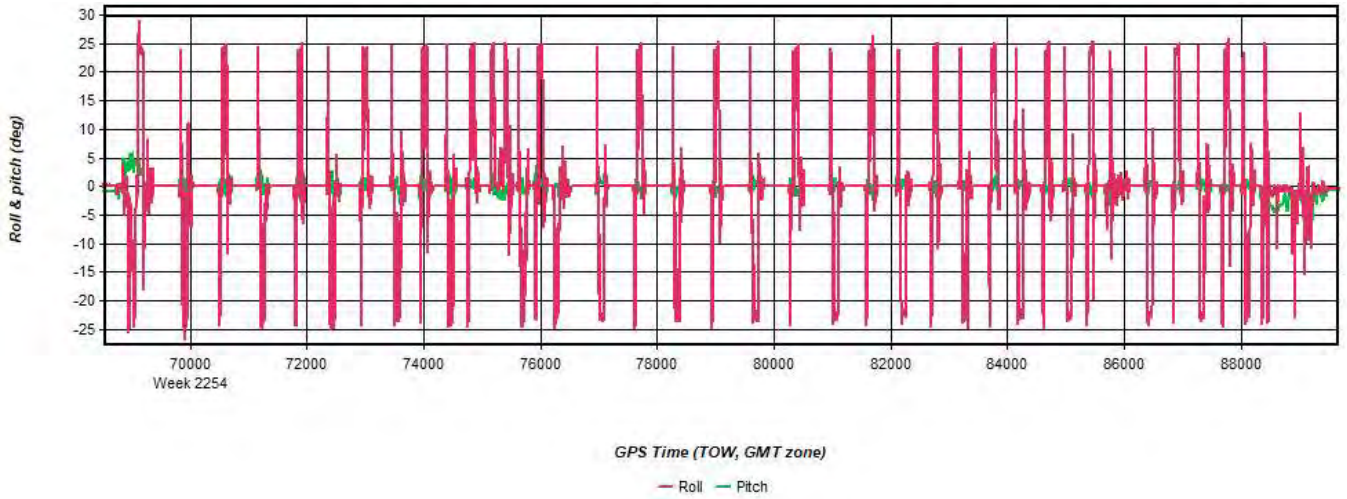
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 11: 20230319190108_5 [Smoothed TC Combined] - Azimuth Plot



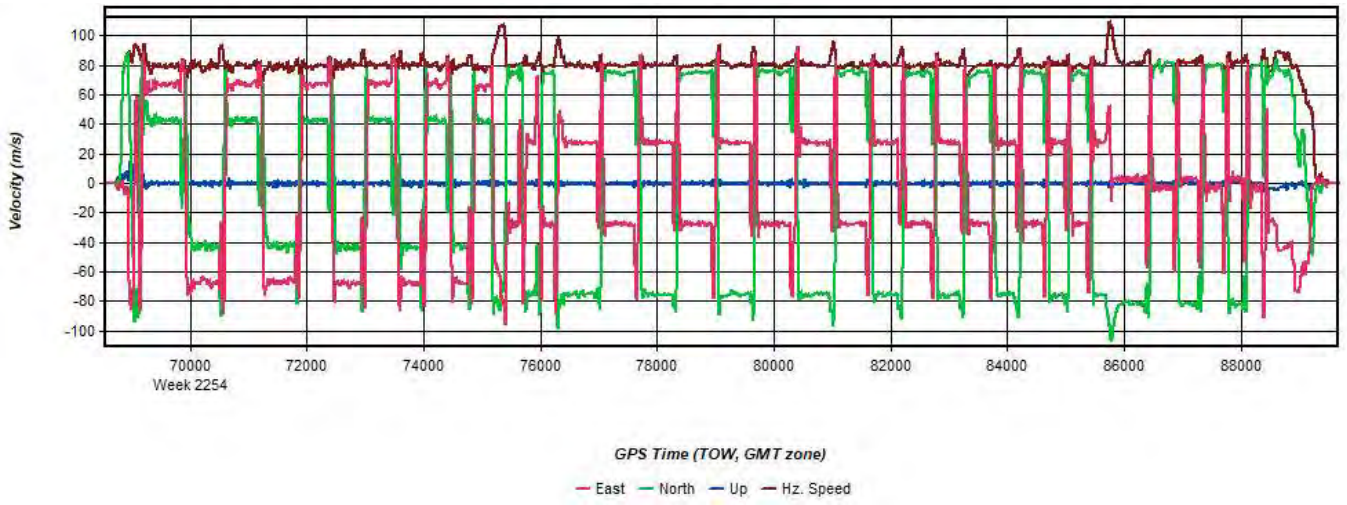
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 12: 20230319190108_5 [Smoothed TC Combined] - Roll & Pitch Plot



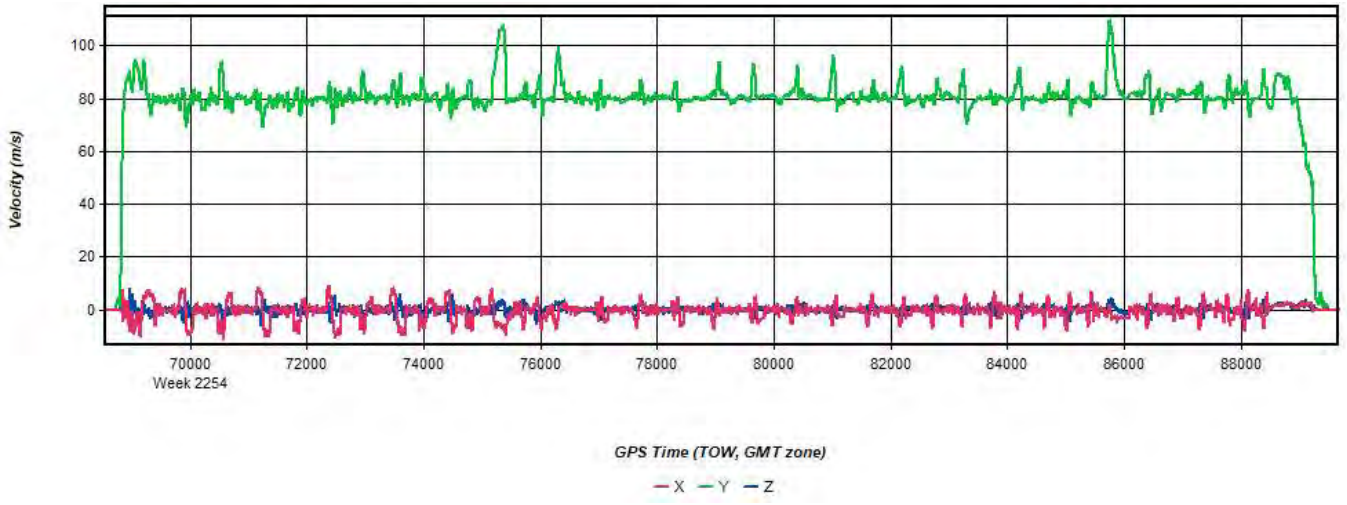
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 13: 20230319190108_5 [Smoothed TC Combined] - Velocity Profile Plot



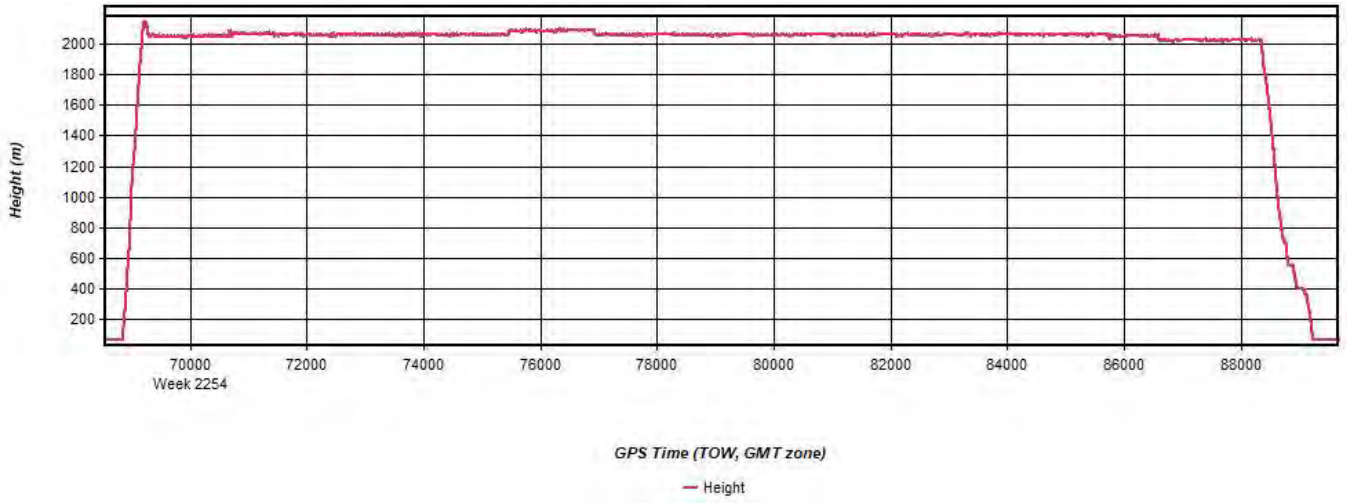
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 14: 20230319190108_5 [Smoothed TC Combined] - Body Frame Velocity Plot



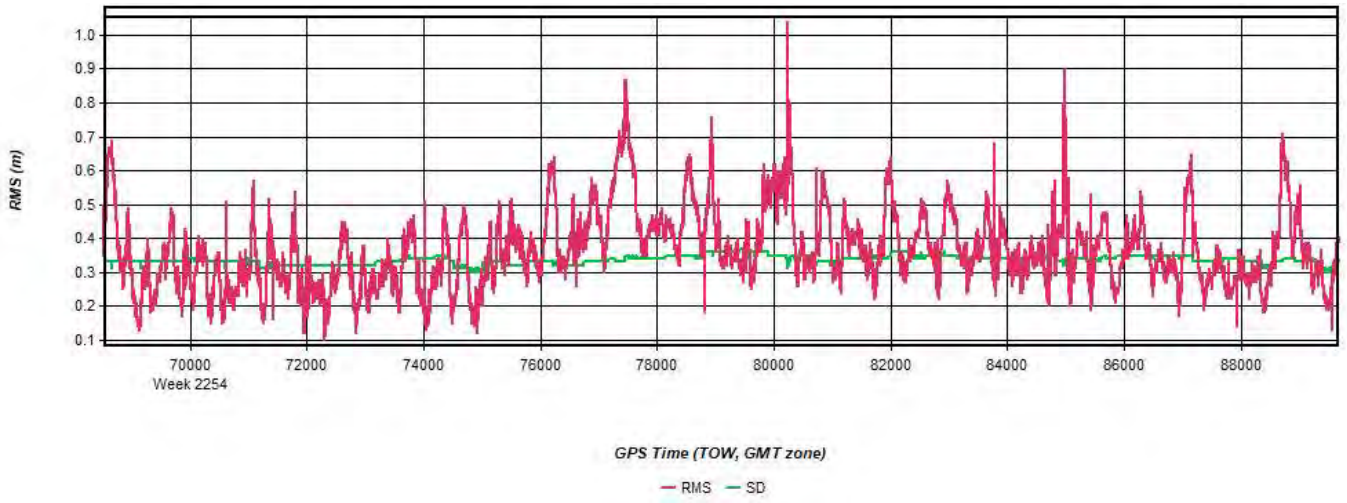
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 15: 20230319190108_5 [Smoothed TC Combined] - Height Profile Plot



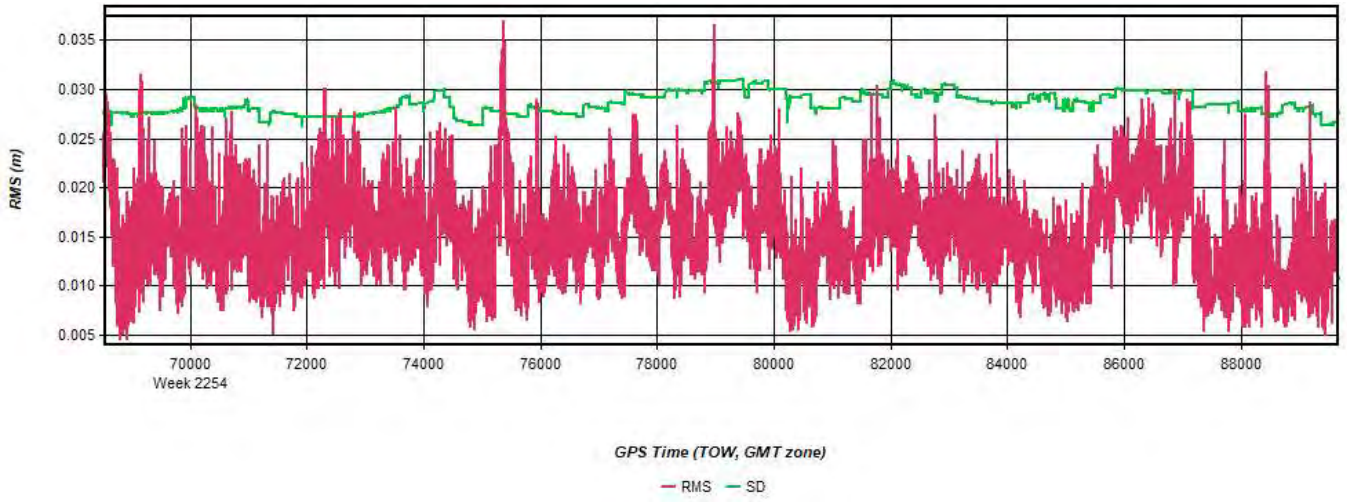
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 16: 20230319190108_5 [Smoothed TC Combined] - C/A Code Residual RMS Plot



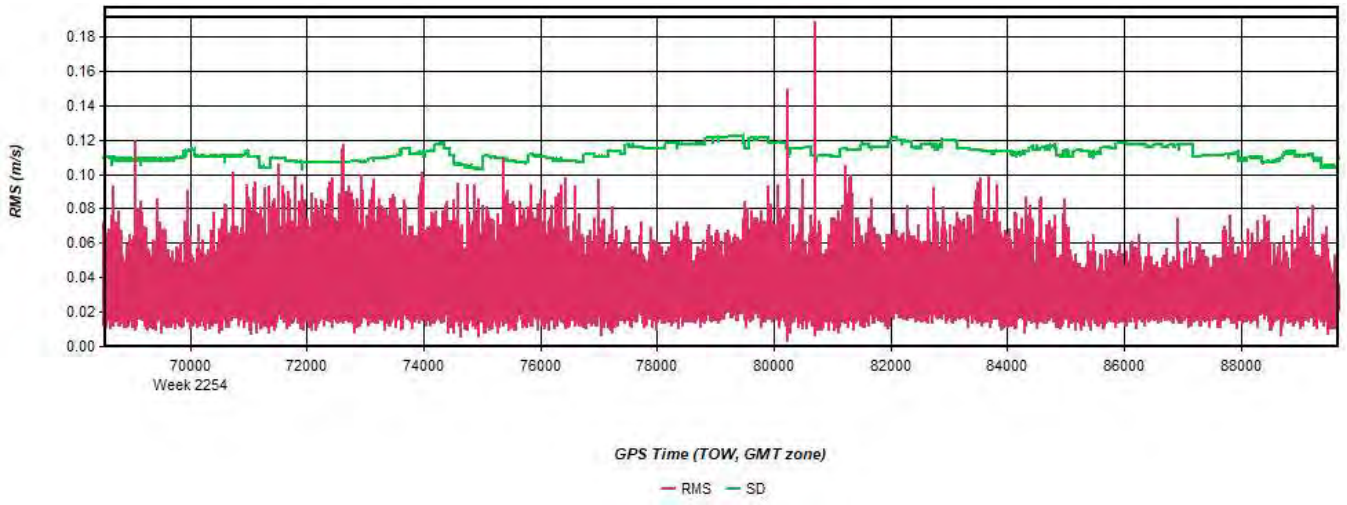
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 17: 20230319190108_5 [Smoothed TC Combined] - Carrier Residual RMS Plot



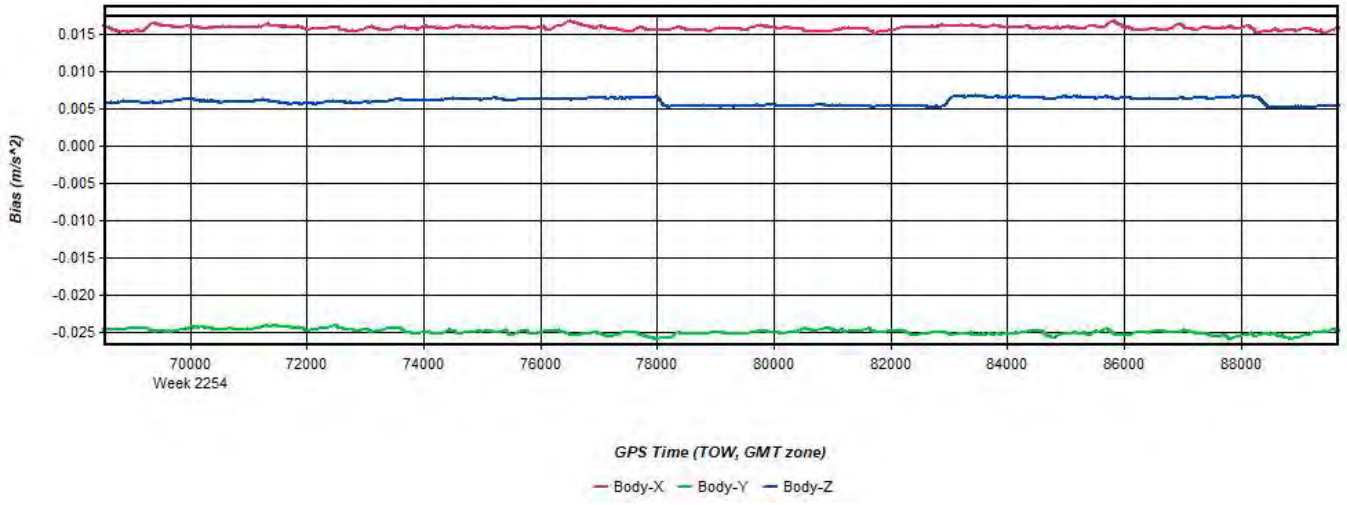
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 18: 20230319190108_5 [Smoothed TC Combined] - L1 Doppler Residual RMS Plot



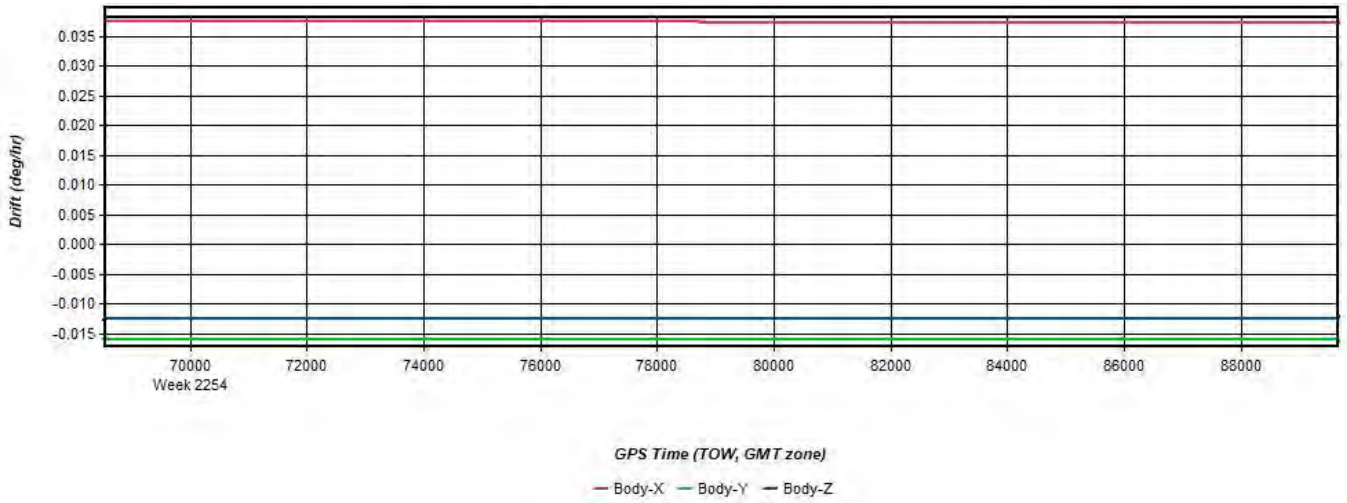
Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 19: 20230319190108_5 [Smoothed TC Combined] - Accelerometer Bias Plot



Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Figure 20: 20230319190108_5 [Smoothed TC Combined] - Gyro Drift Plot

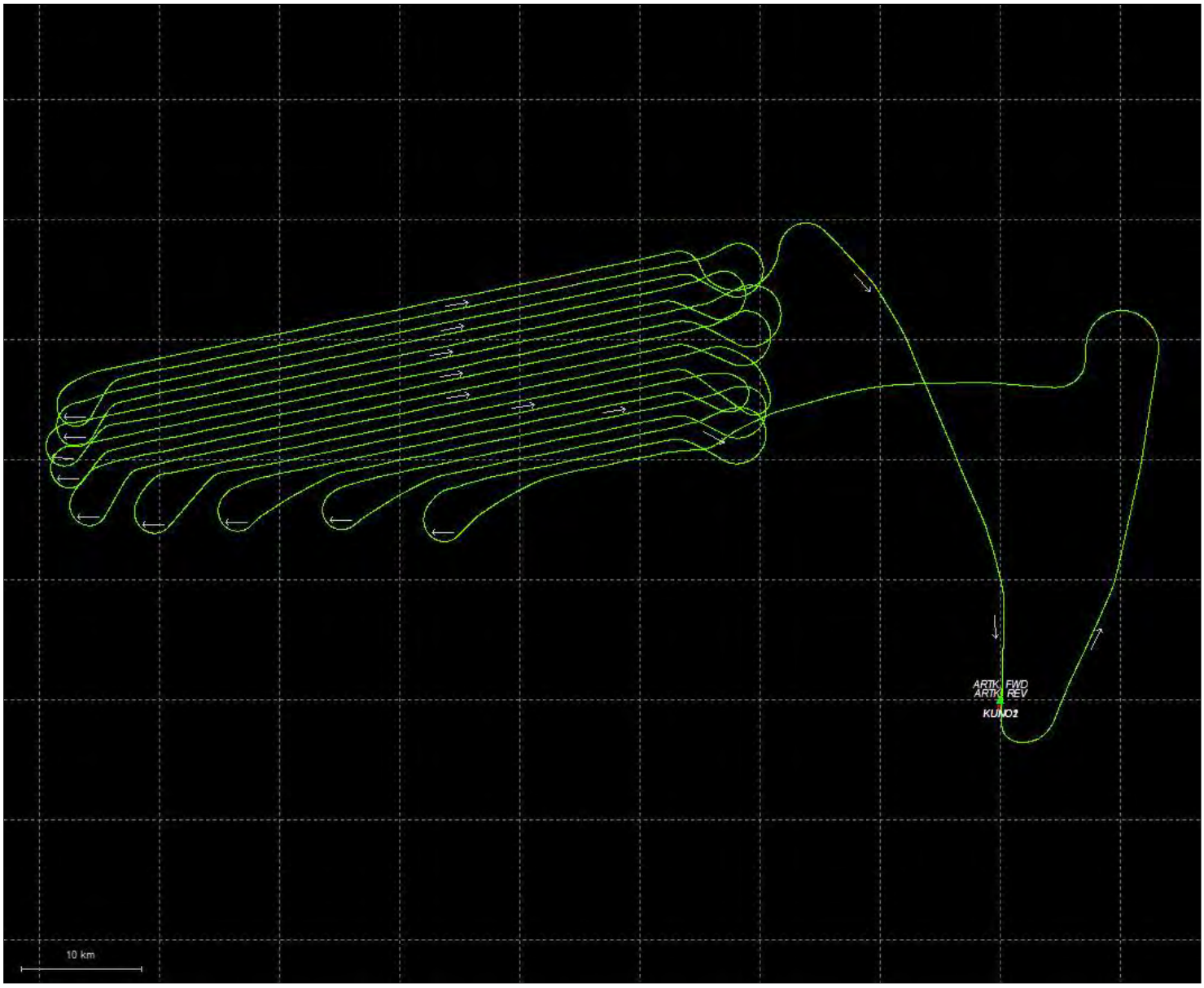


Process	20230319190108_5	by Unknown	on 3/24/2023	at 08:36:09

Output Results for 20230320150200_6

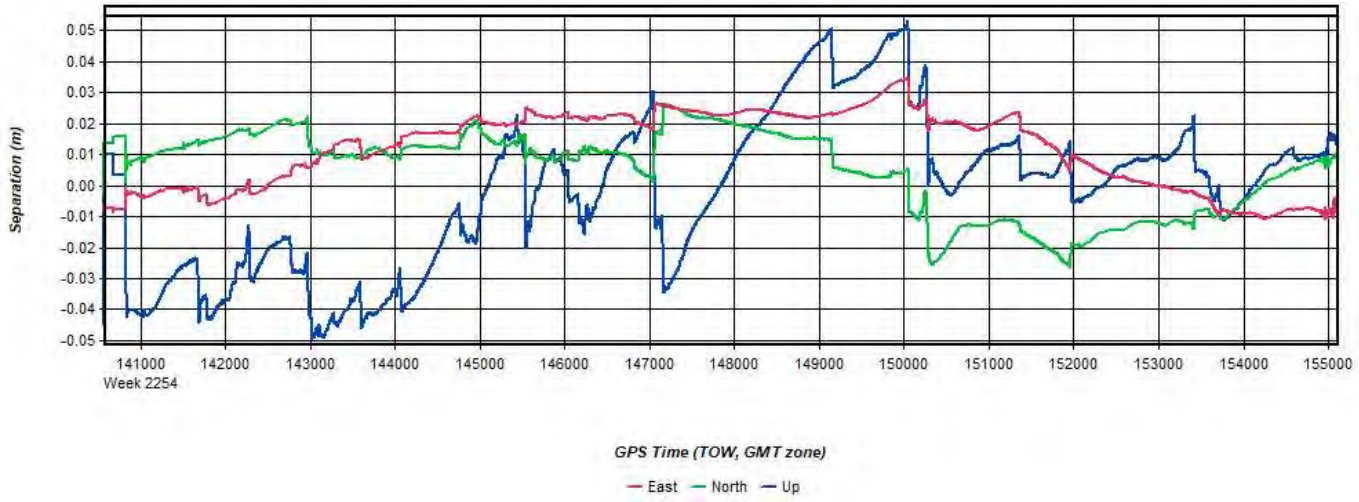
Inertial Explorer Version 8.90.2124
03/22/2023

Figure 1: Smoothed TC Combined - Map



Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 2: 20230320150200_6 [Smoothed TC Combined] - Forward/Reverse or Combined Separation Plot



Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 3: 20230320150200_6 [Smoothed TC Combined] - Float or Fixed Ambiguity

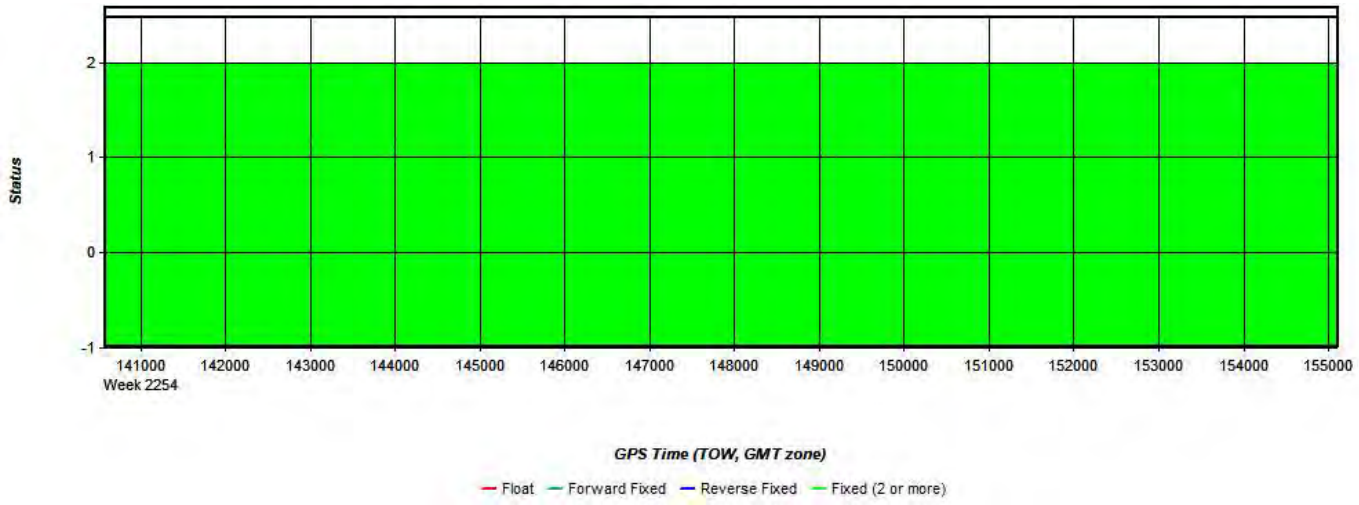


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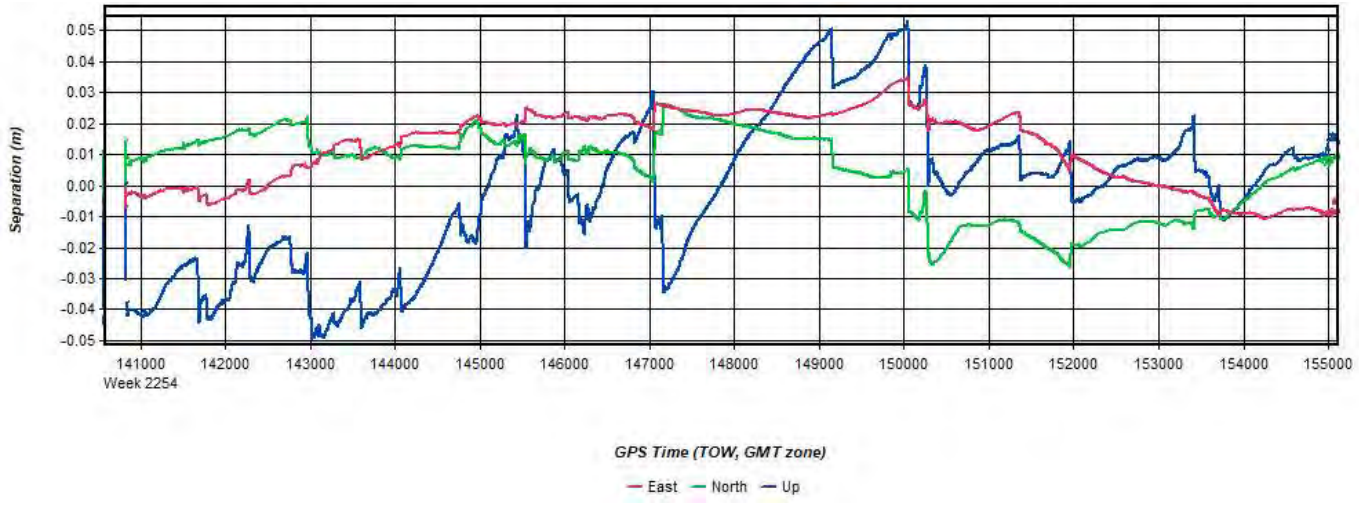
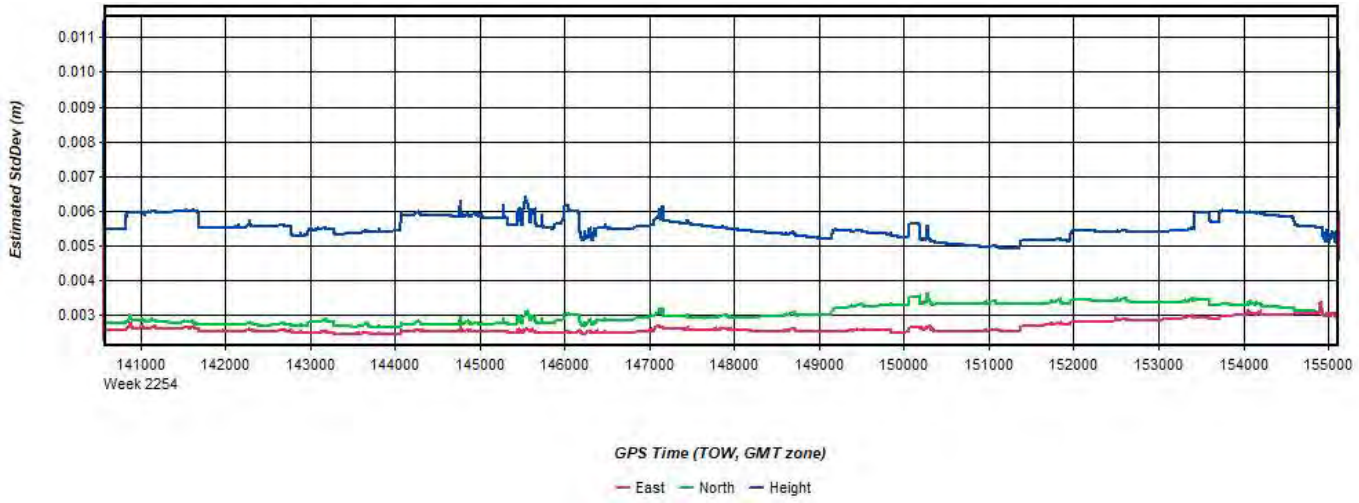
Figure 4: 20230320150200_6 [Smoothed TC Combined] - Forward/Reverse Separation Plot (Fixed)



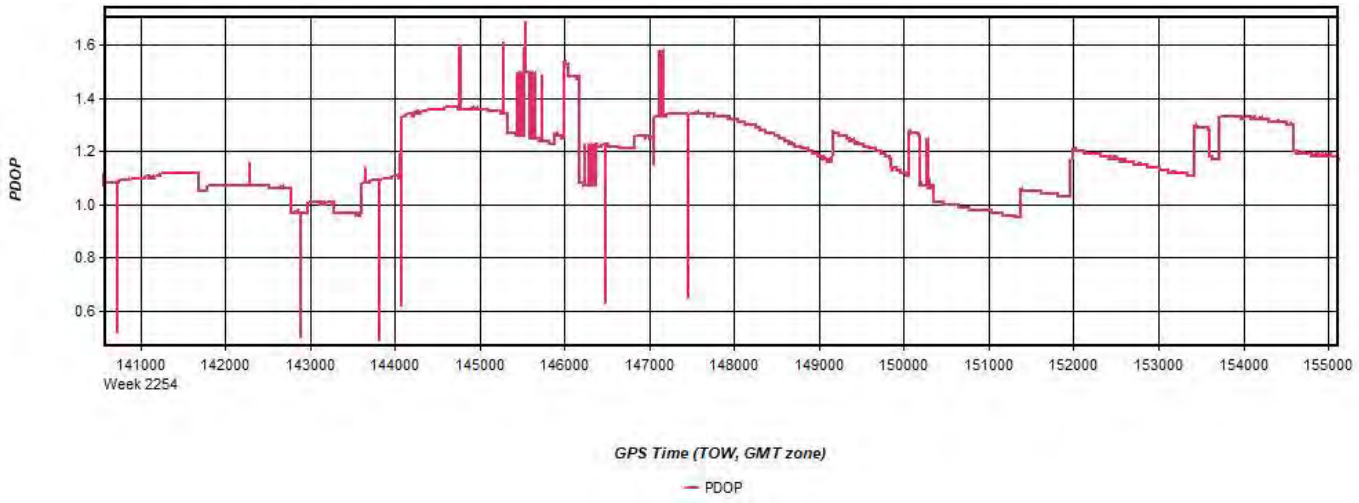
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 5: 20230320150200_6 [Smoothed TC Combined] - Estimated Position Accuracy Plot



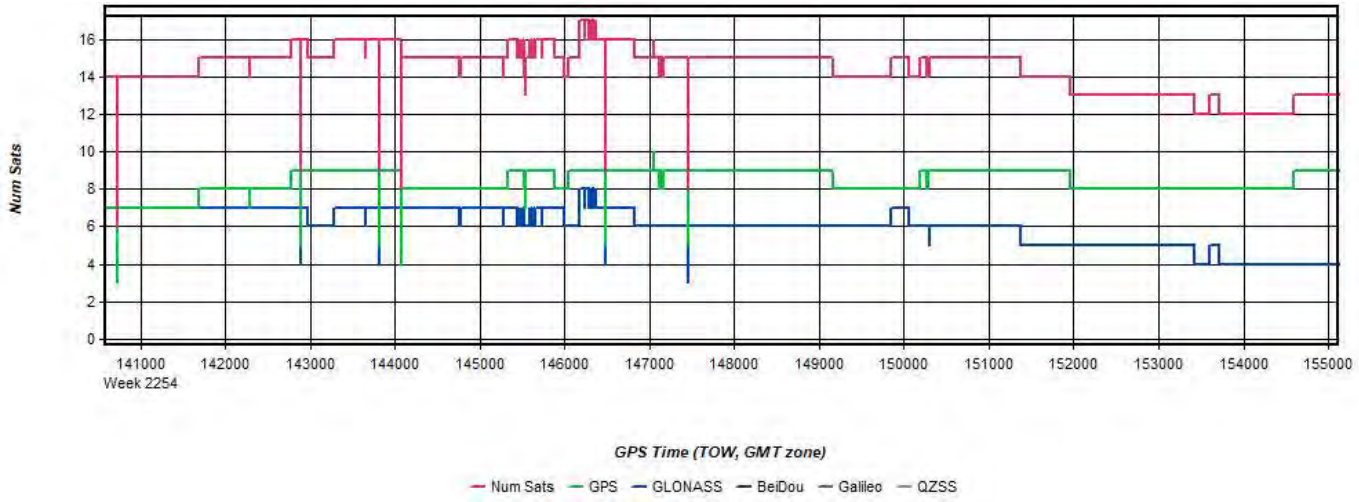
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 6: 20230320150200_6 [Smoothed TC Combined] - PDOP Plot



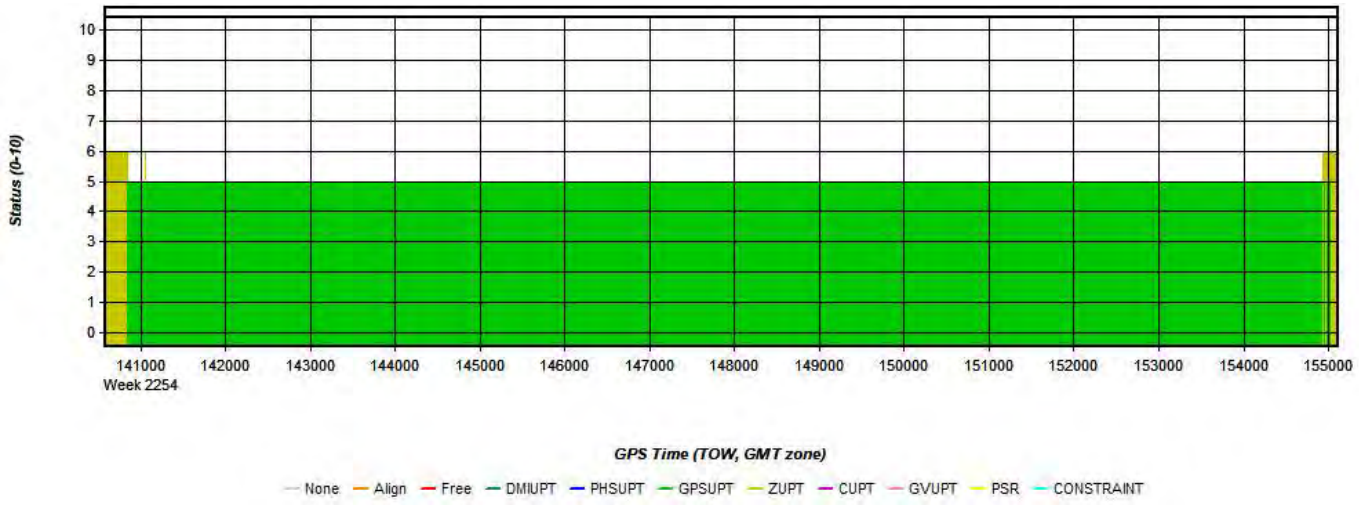
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 7: 20230320150200_6 [Smoothed TC Combined] - Number of Satellites Line Plot



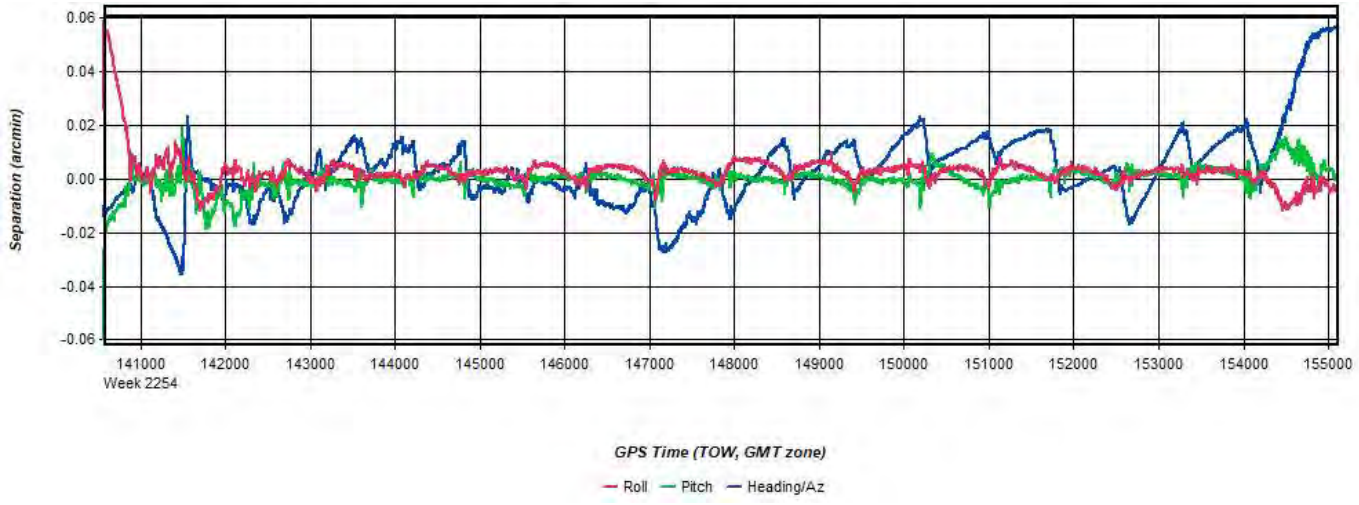
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 8: 20230320150200_6 [Smoothed TC Combined] - Status flag for IMU processing



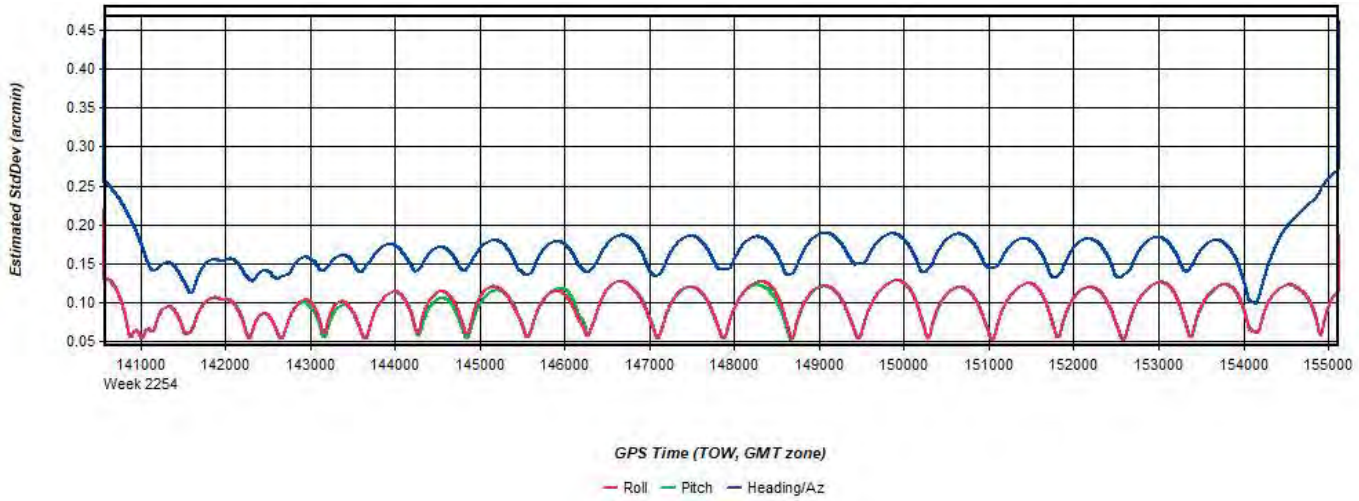
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 9: 20230320150200_6 [Smoothed TC Combined] - Fwd/Rev Attitude Separation Plot



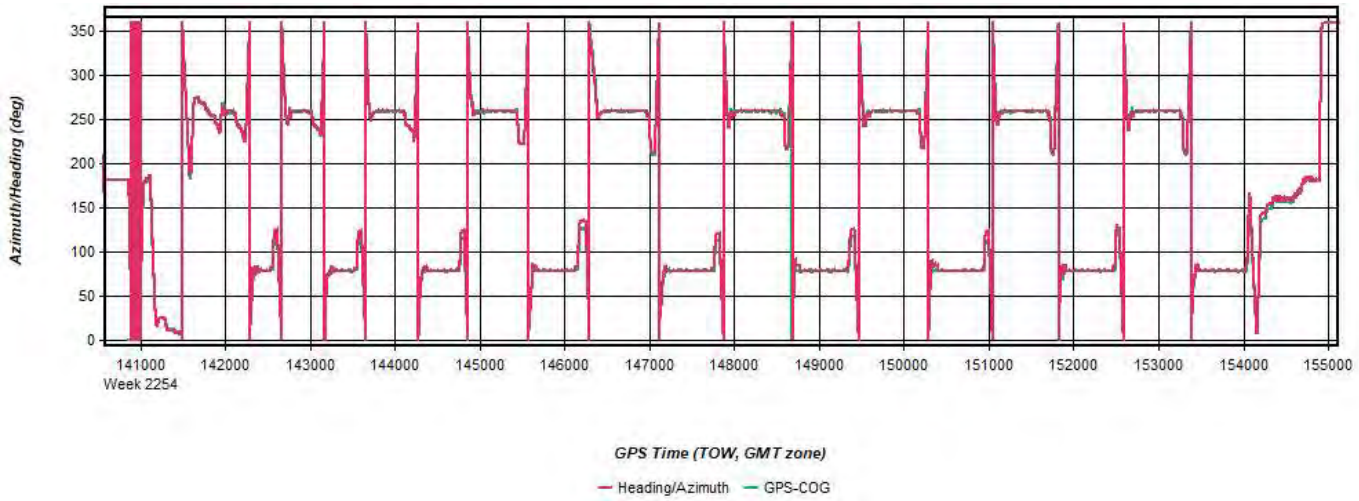
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 10: 20230320150200_6 [Smoothed TC Combined] - Estimated Attitude Accuracy Plot



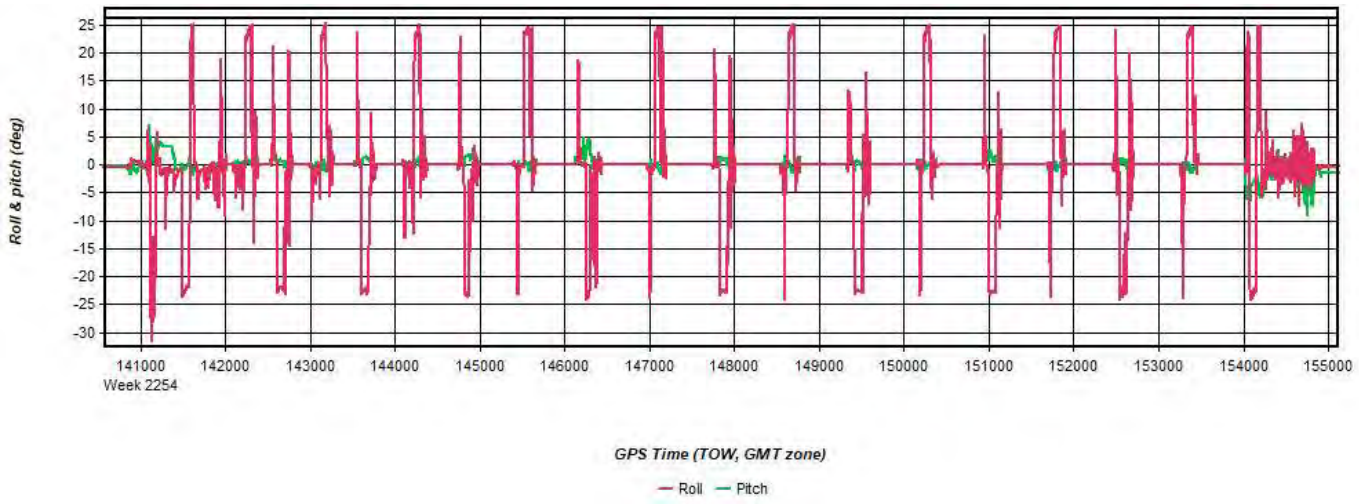
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 11: 20230320150200_6 [Smoothed TC Combined] - Azimuth Plot



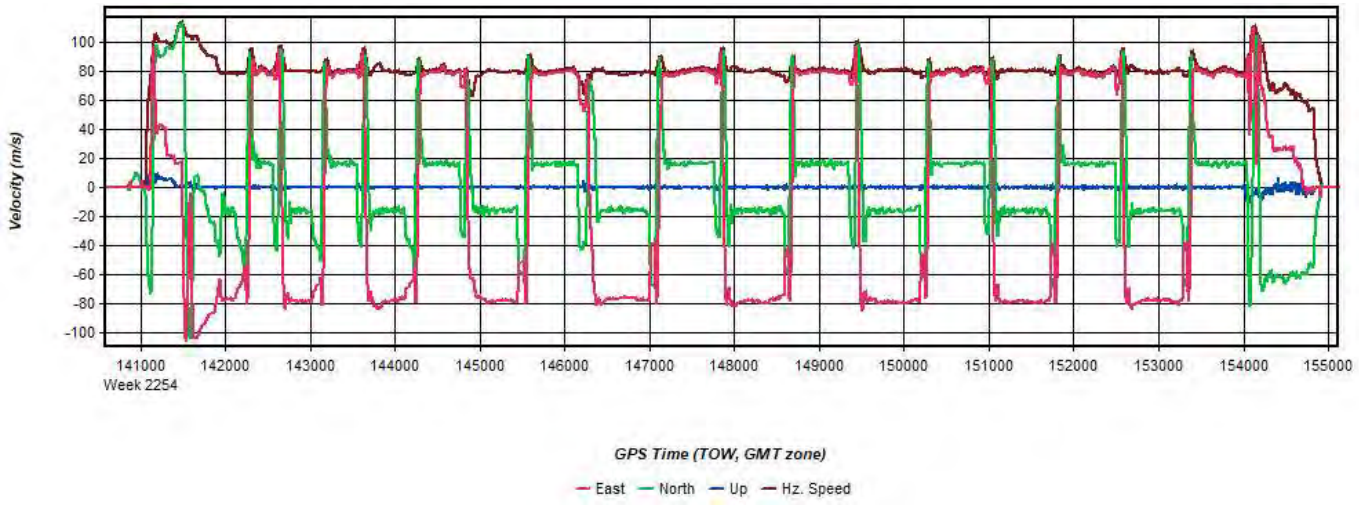
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 12: 20230320150200_6 [Smoothed TC Combined] - Roll & Pitch Plot



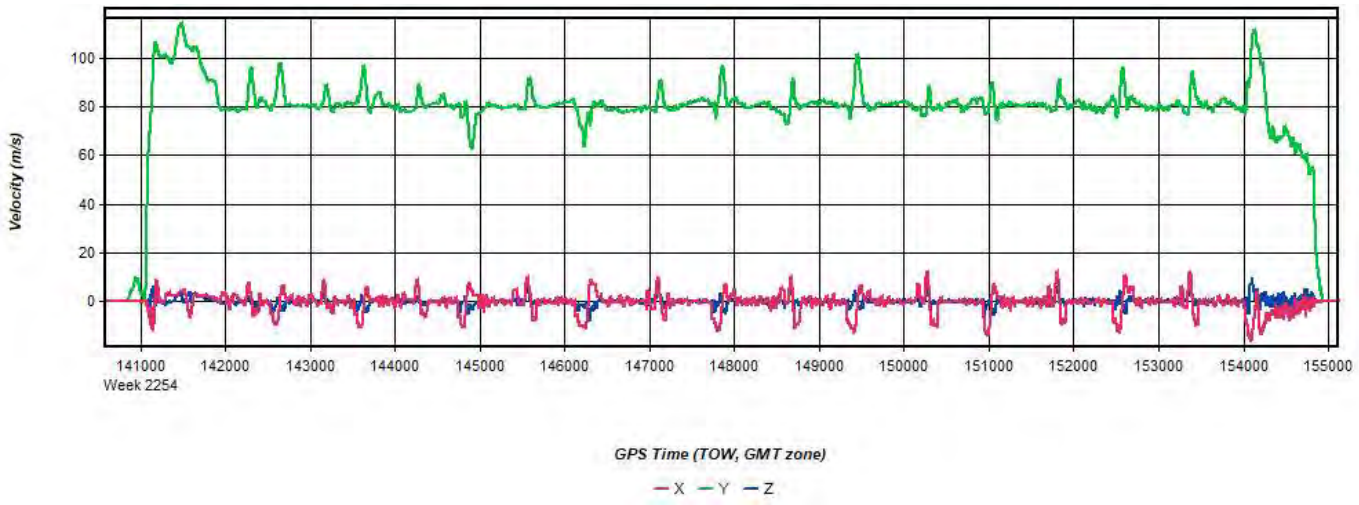
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 13: 20230320150200_6 [Smoothed TC Combined] - Velocity Profile Plot



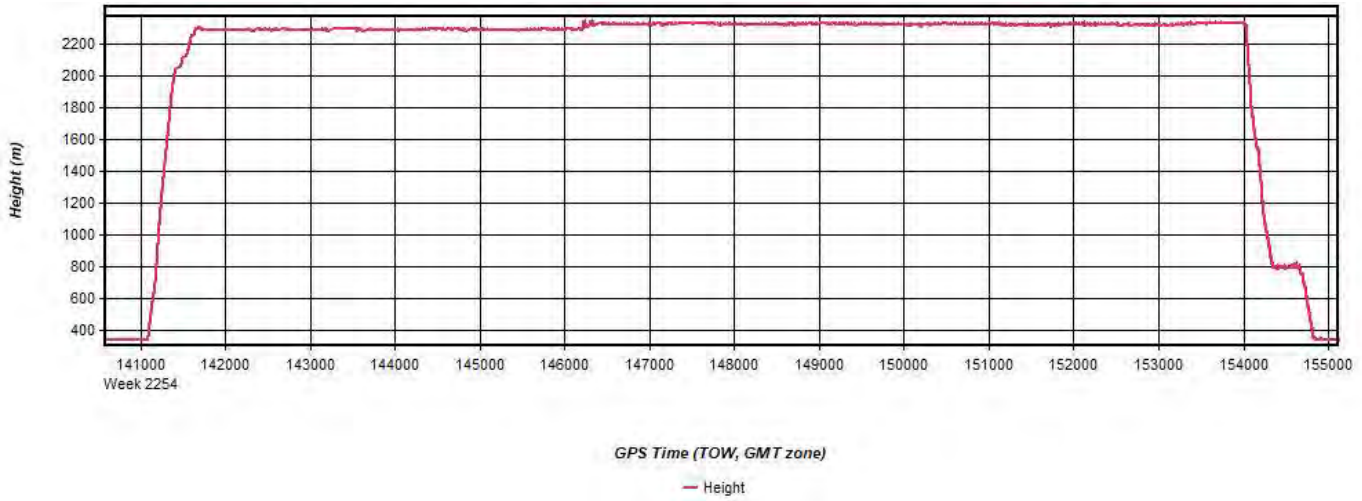
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 14: 20230320150200_6 [Smoothed TC Combined] - Body Frame Velocity Plot



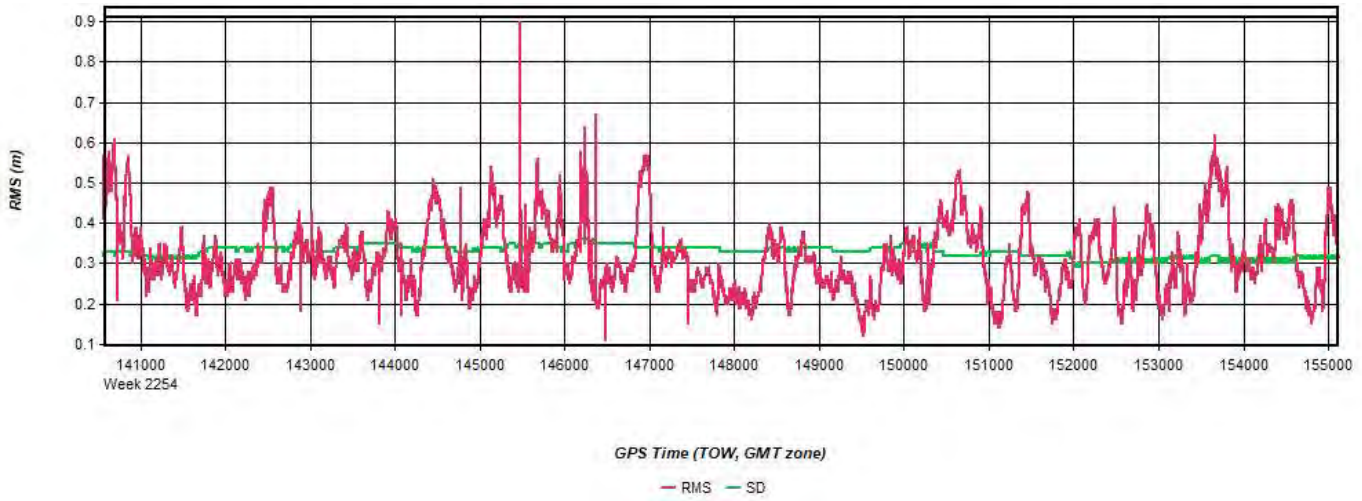
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 15: 20230320150200_6 [Smoothed TC Combined] - Height Profile Plot



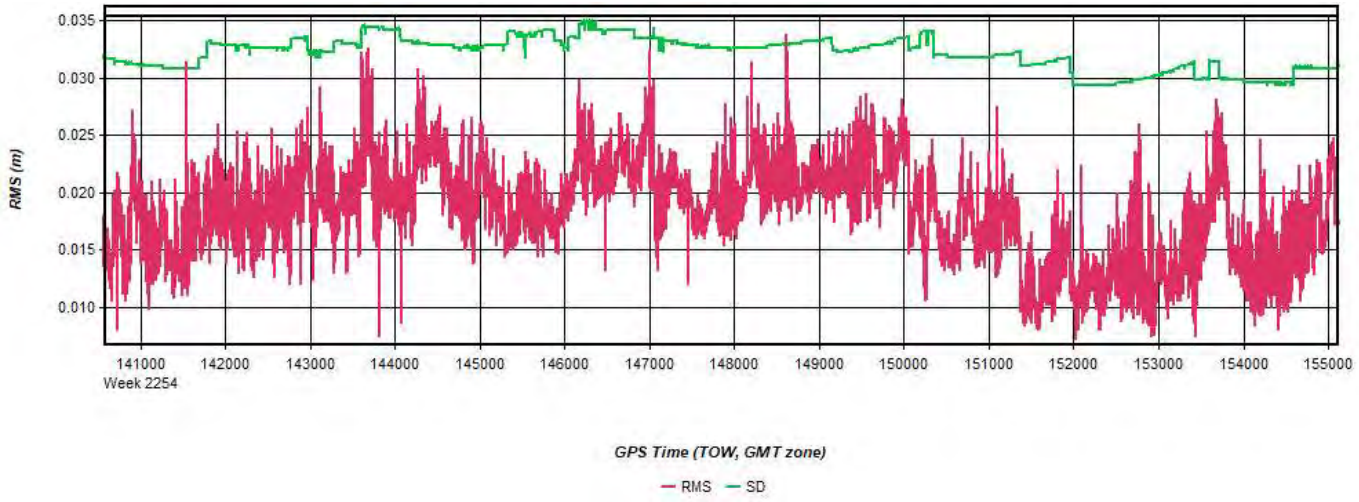
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 16: 20230320150200_6 [Smoothed TC Combined] - C/A Code Residual RMS Plot



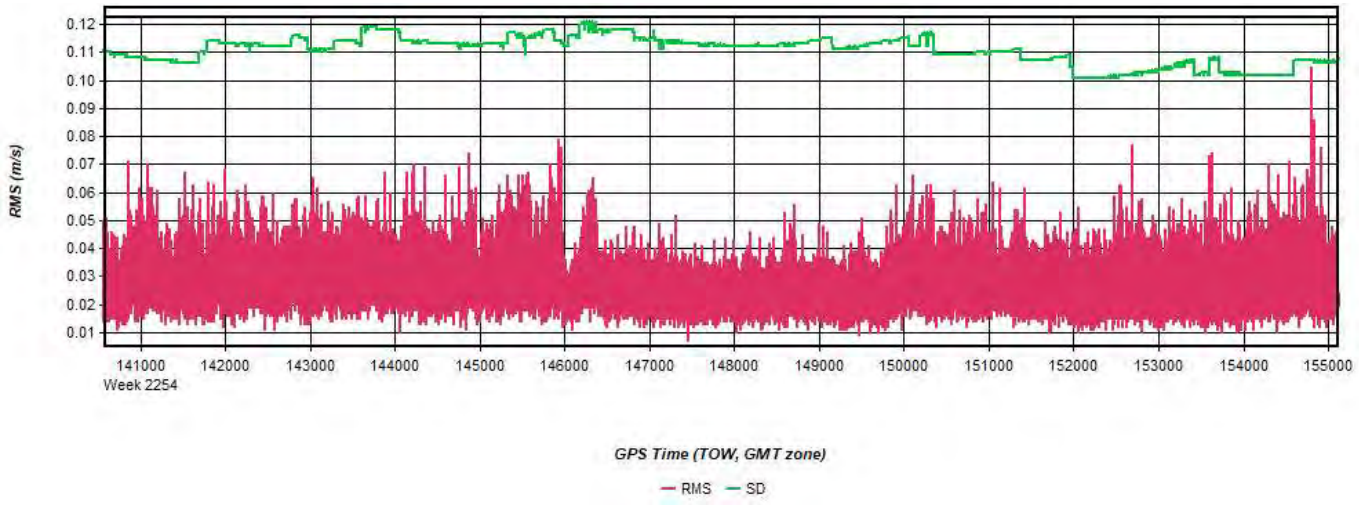
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 17: 20230320150200_6 [Smoothed TC Combined] - Carrier Residual RMS Plot



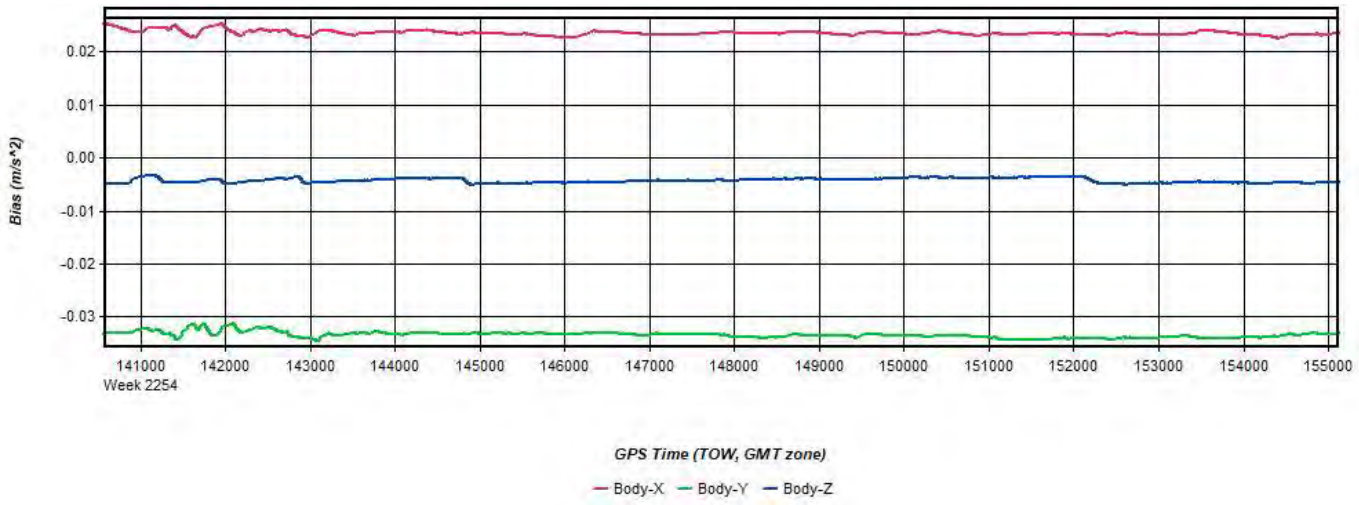
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 18: 20230320150200_6 [Smoothed TC Combined] - L1 Doppler Residual RMS Plot



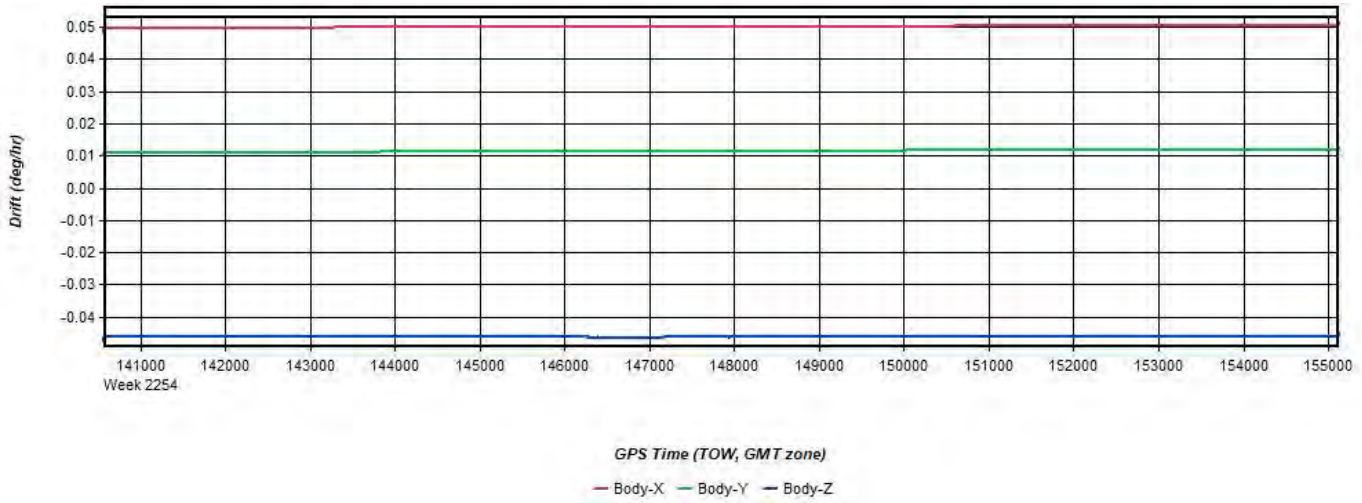
Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 19: 20230320150200_6 [Smoothed TC Combined] - Accelerometer Bias Plot



Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

Figure 20: 20230320150200_6 [Smoothed TC Combined] - Gyro Drift Plot



Process	20230320150200_6	by Unknown	on 3/22/2023	at 17:21:21

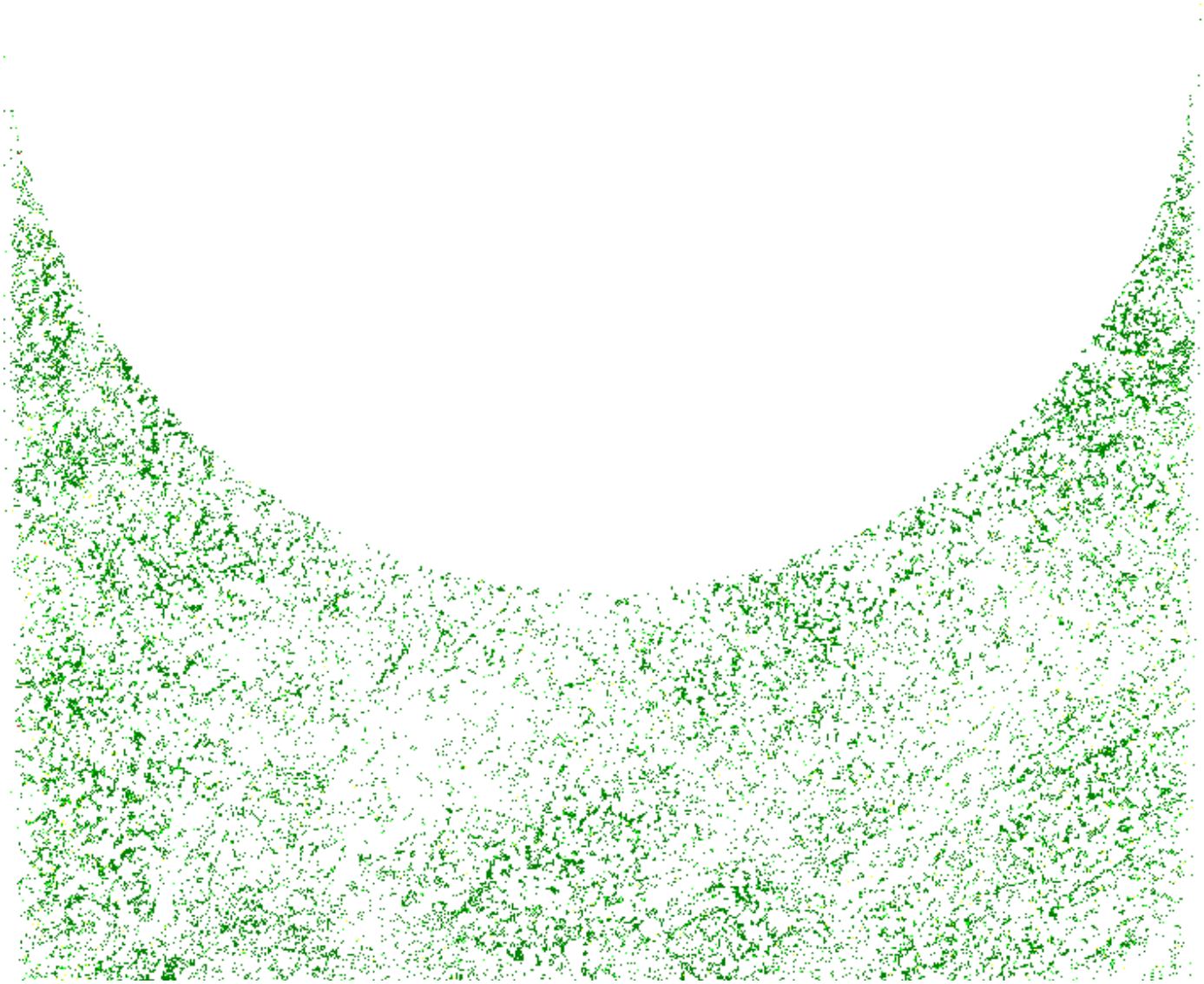
Appendix E. Geometric Quality & Smooth Surface Precision

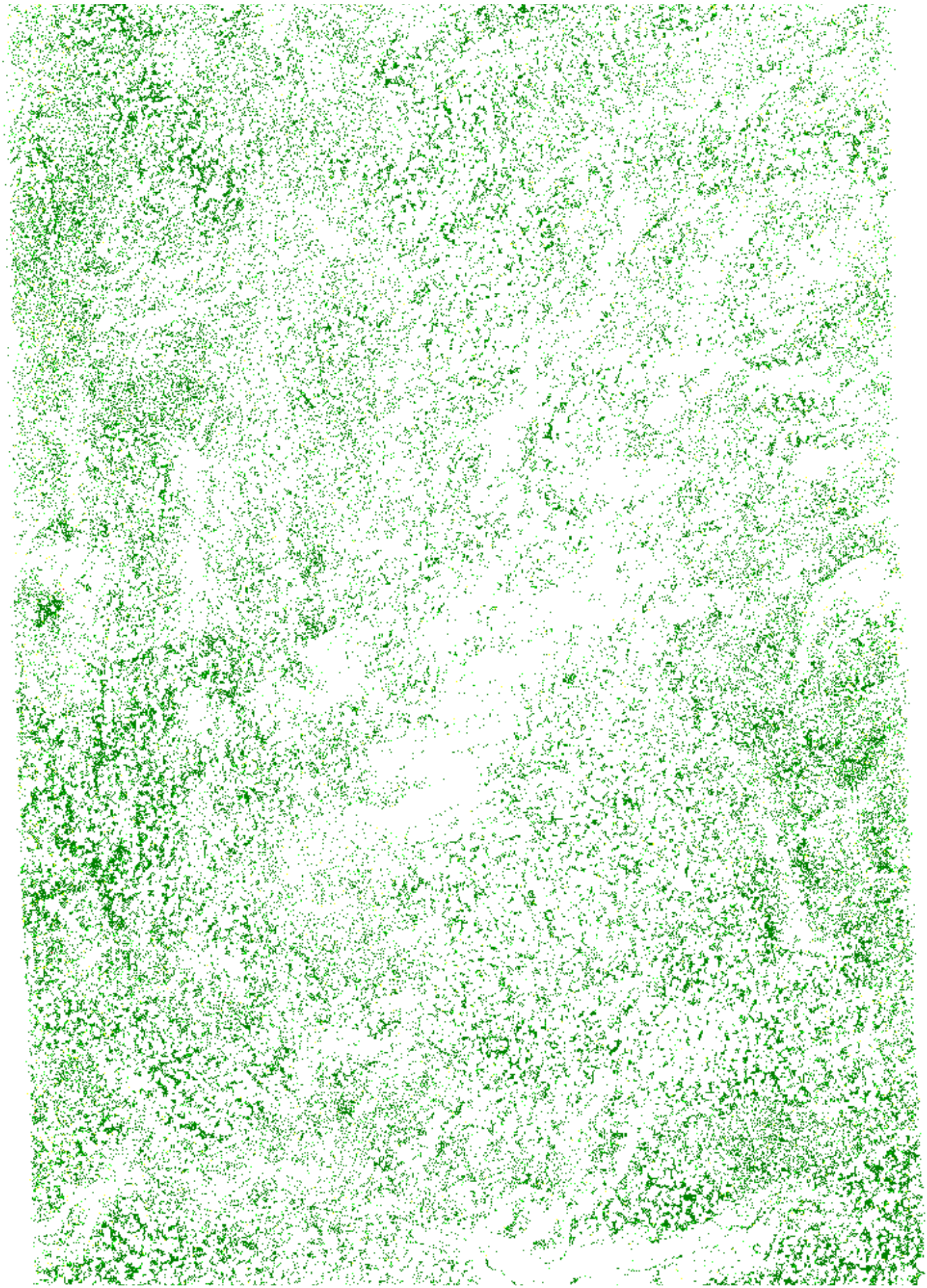
Vertical Accuracy Scan Direction Comparison-20230308_162054

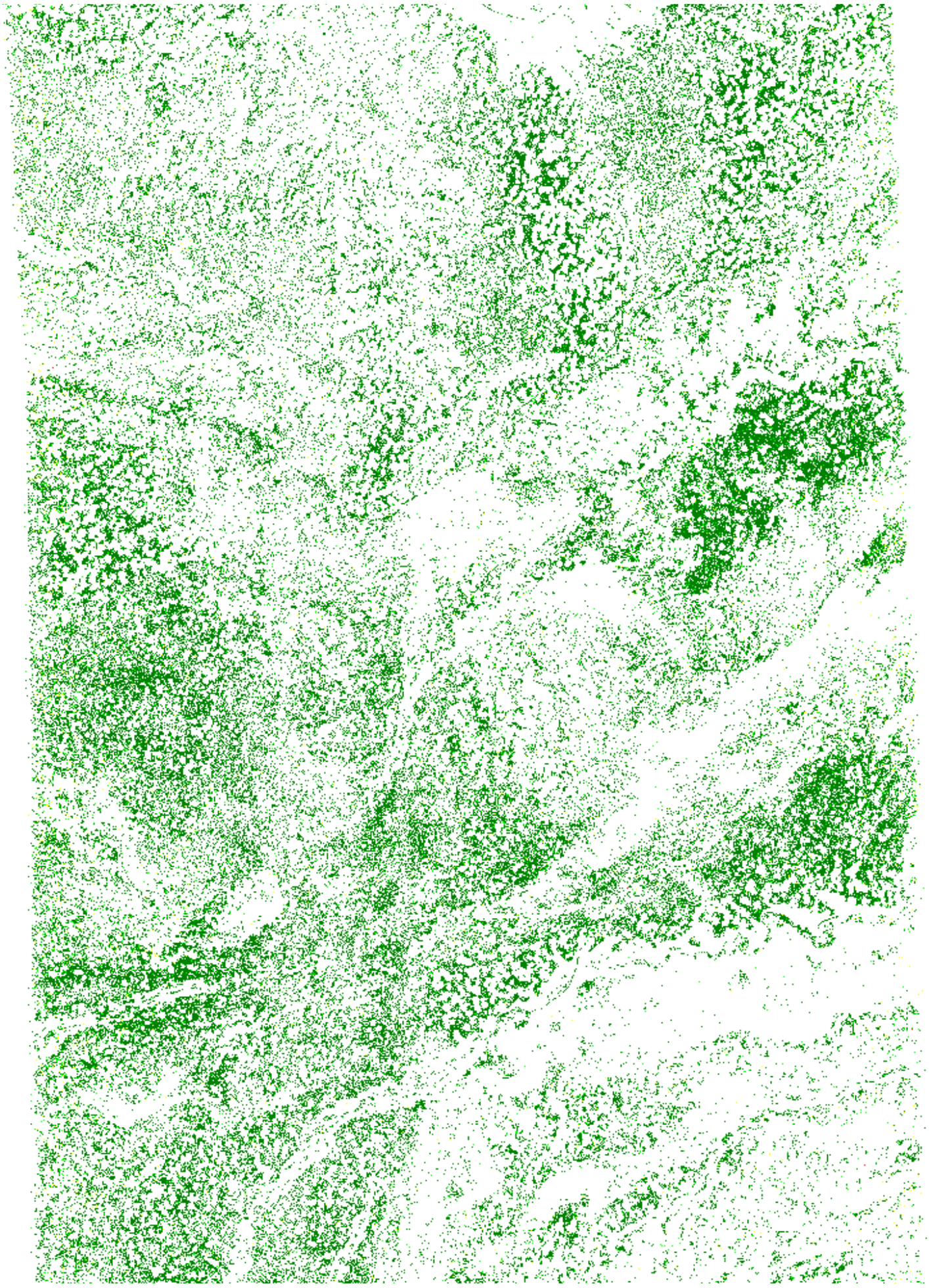
394_153343

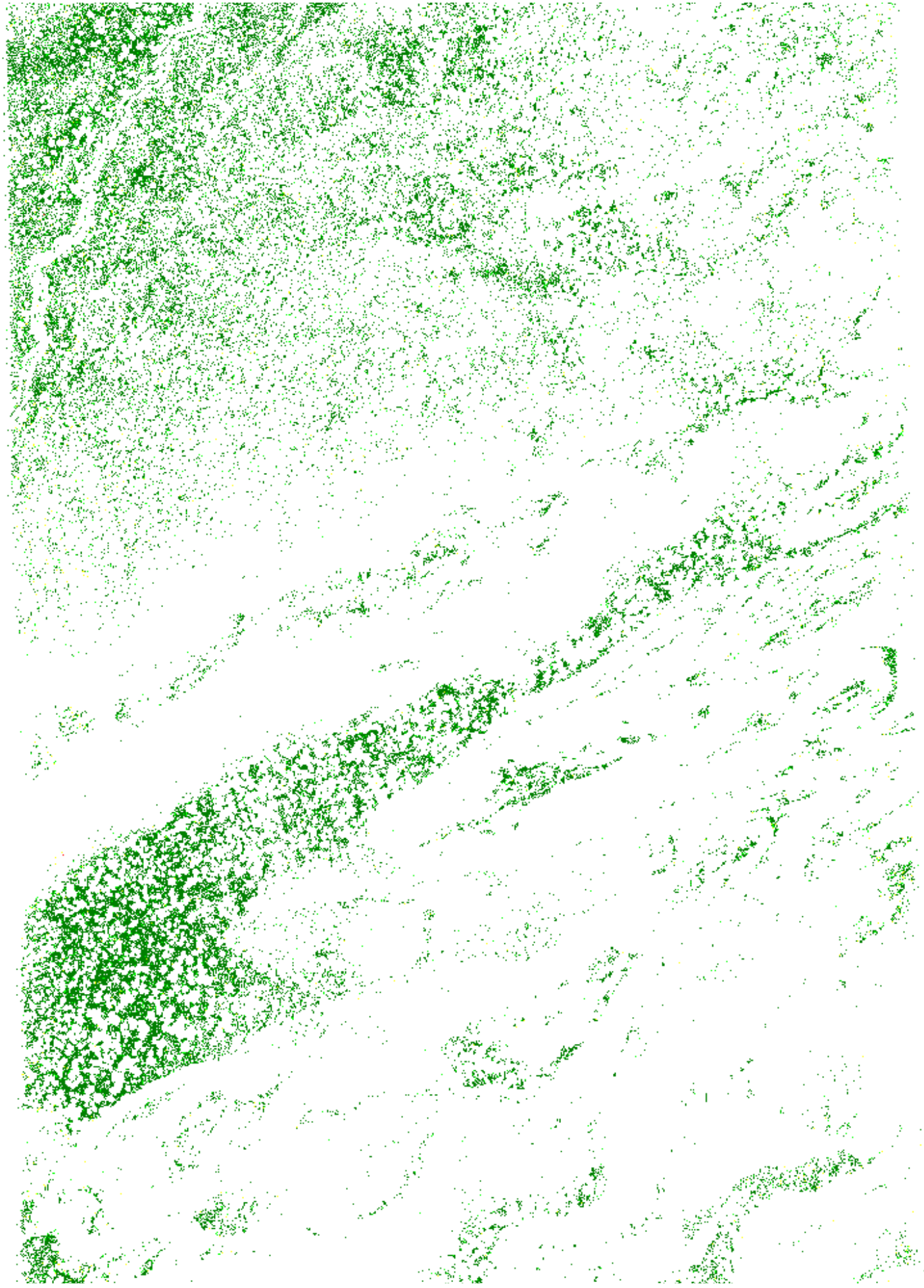
618634 valid patches with size of 2 m found. Only patches with standard deviation < 0.05 m and minimum of 5 points are included.

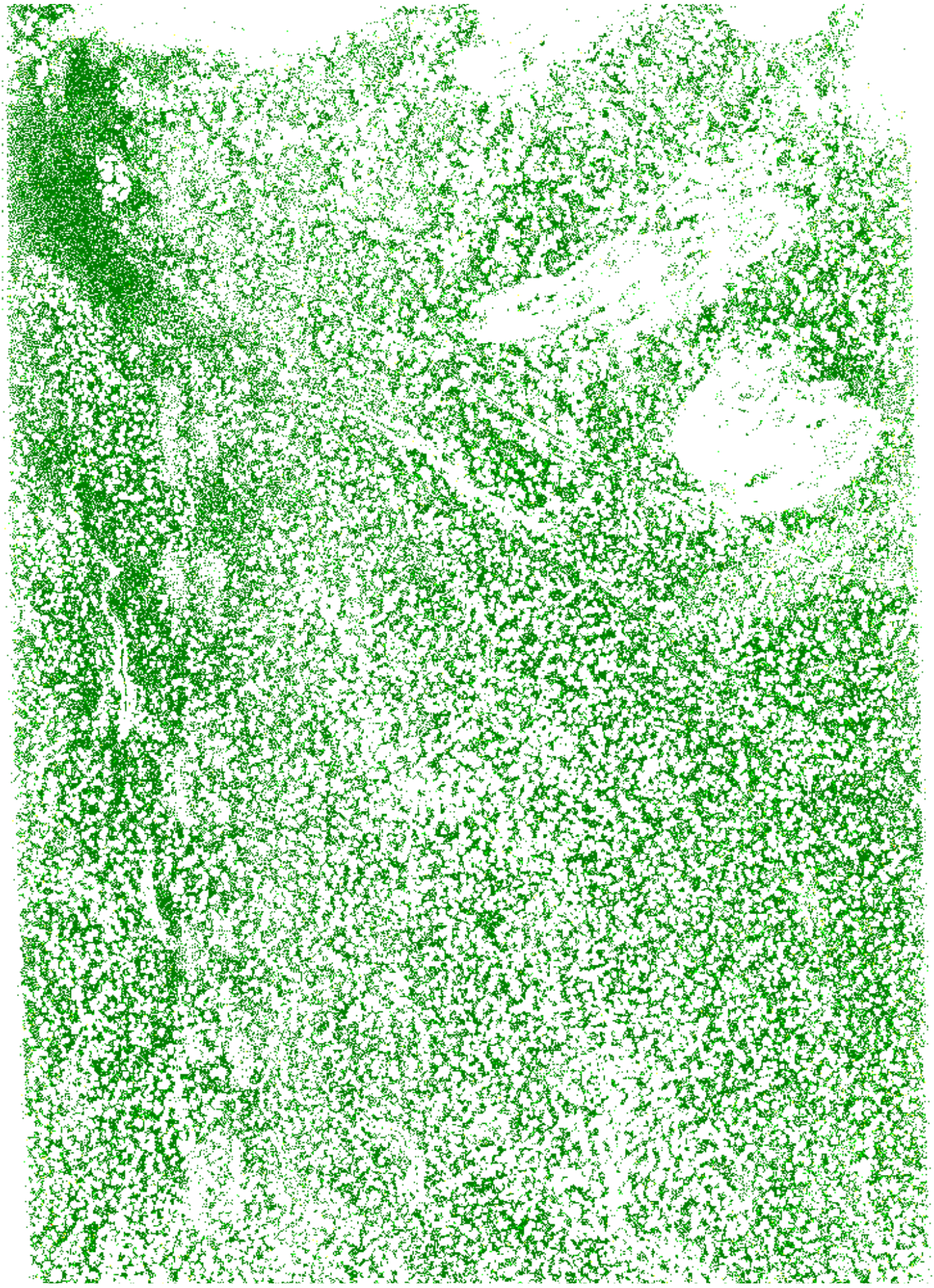
Color	Limits [m]	Number of patches	Proportion of total number of patches [%]
	<=0.03	559347	90.42
	0.03-0.05	51129	8.26
	0.05-0.1	8121	1.31
	>0.1	37	0.01

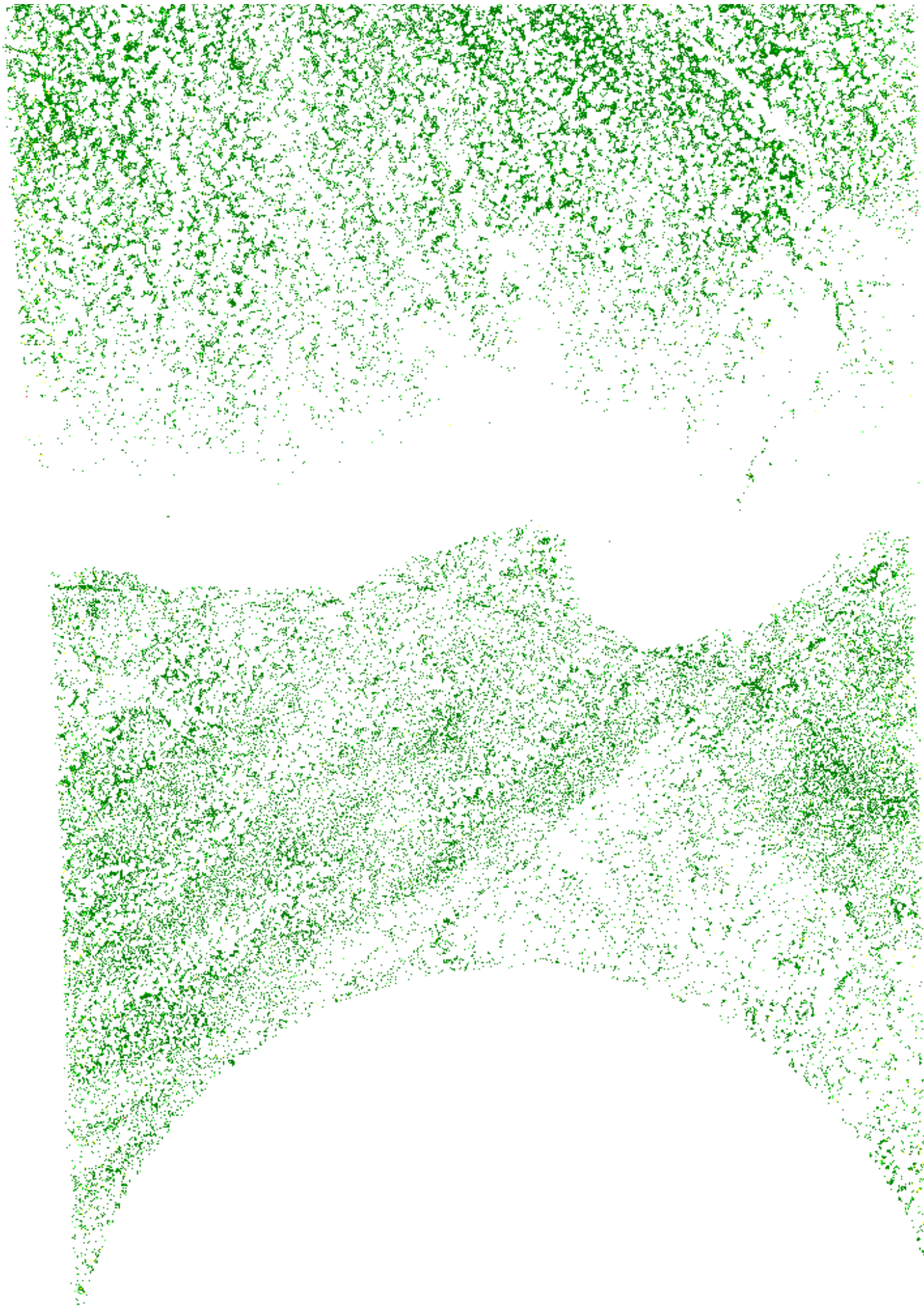










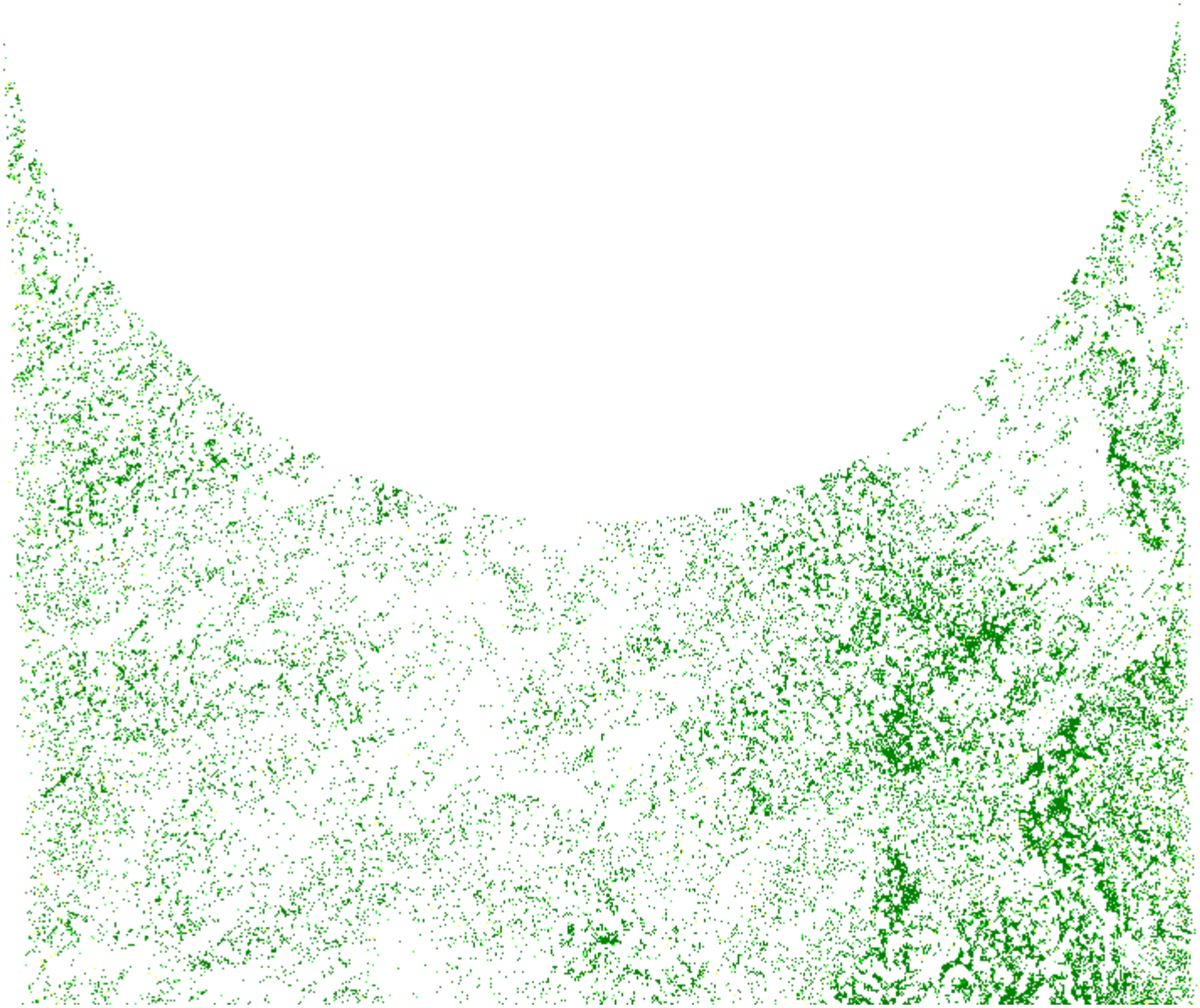


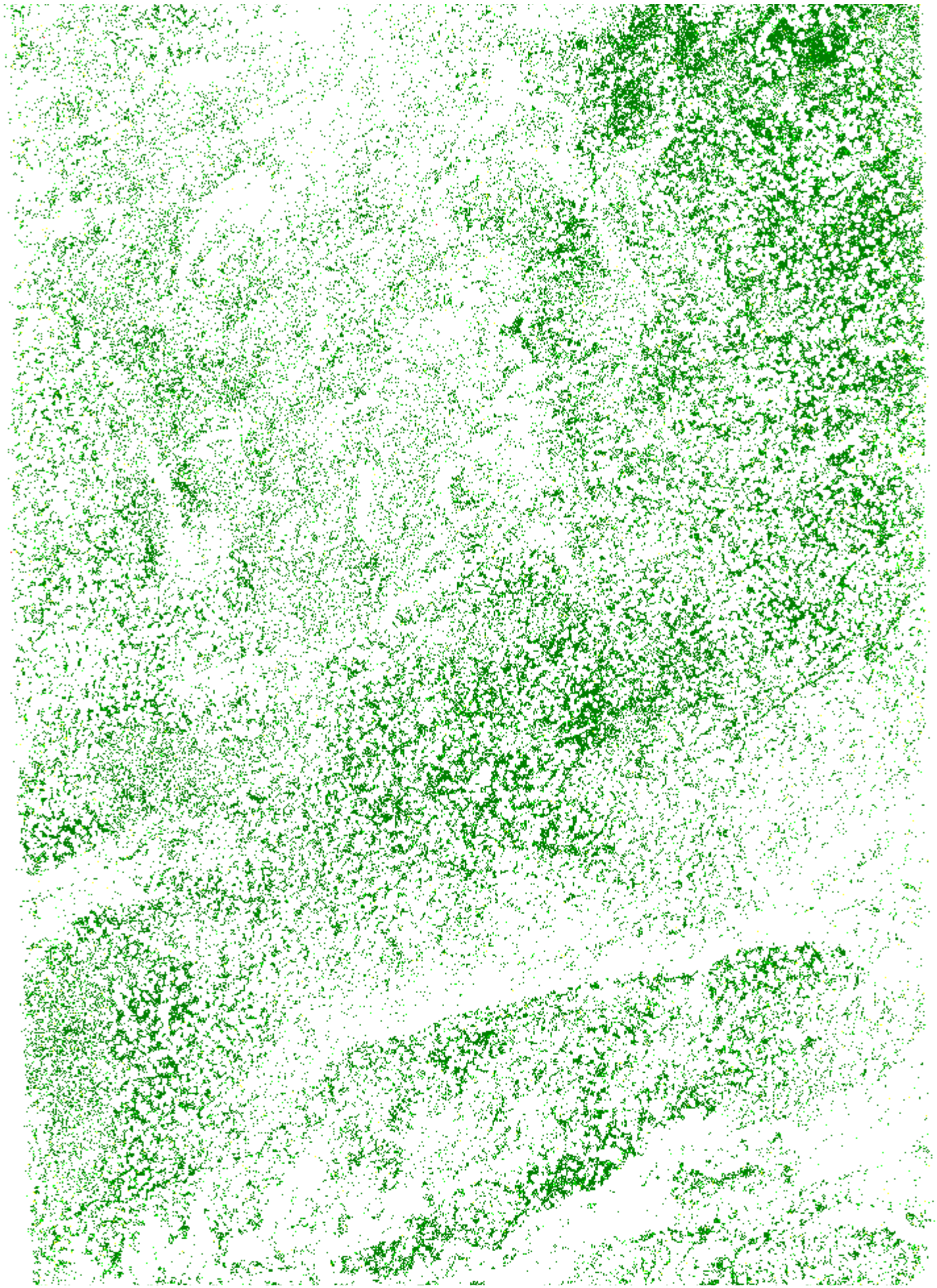
Vertical difference

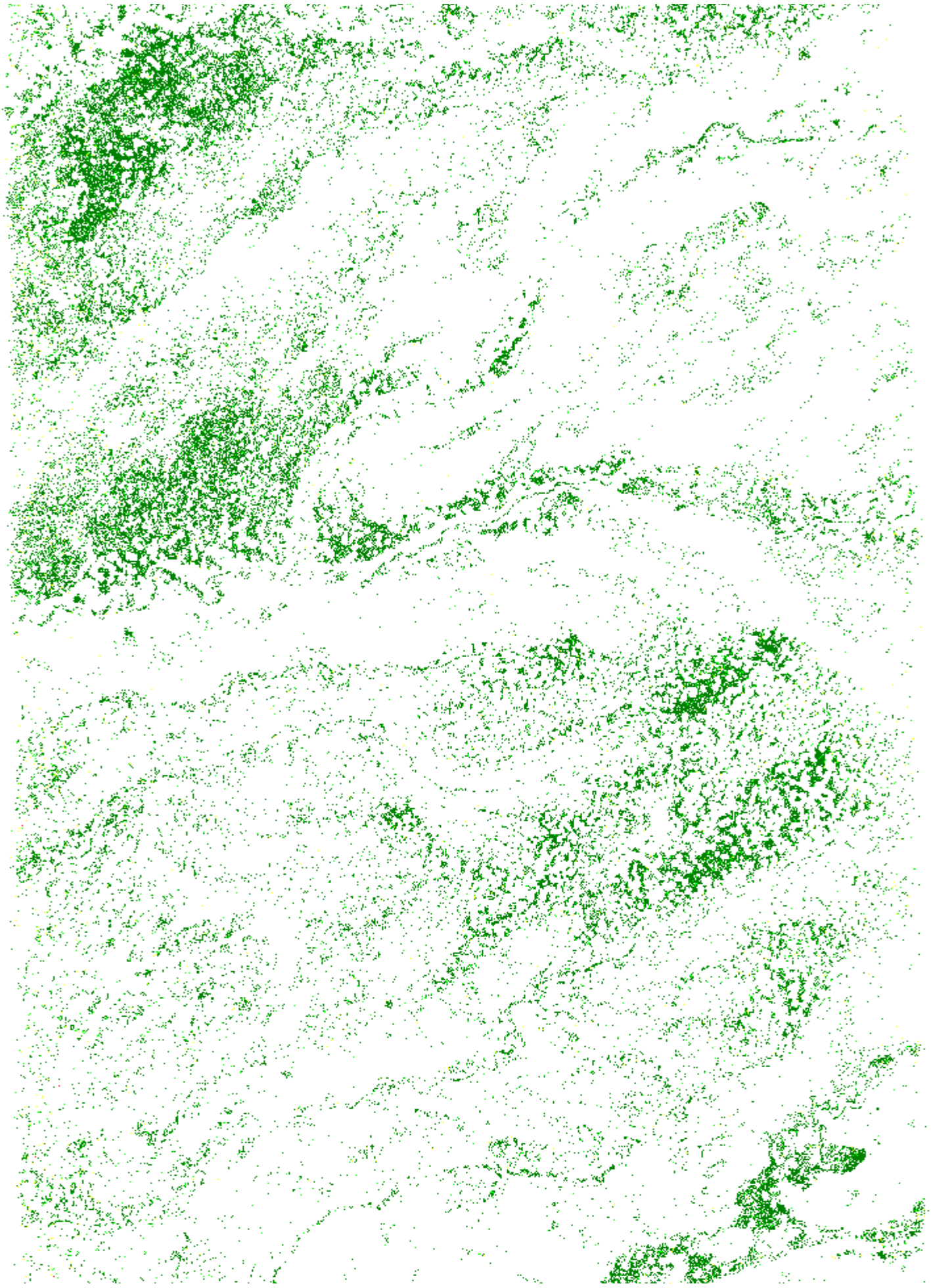
395_154254

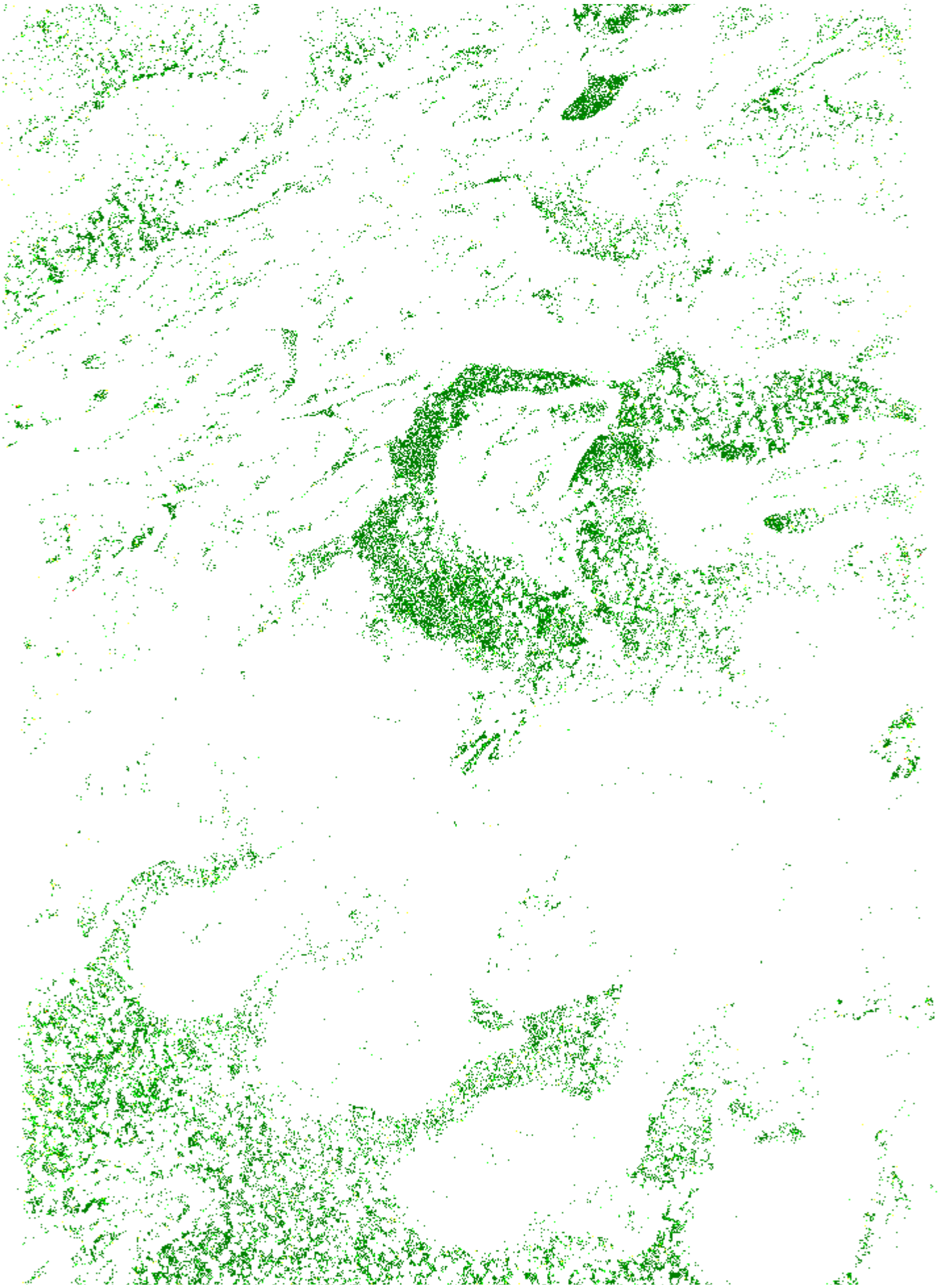
444552 valid patches with size of 2 m found. Only patches with standard deviation < 0.05 m and minimum of 5 points are included.

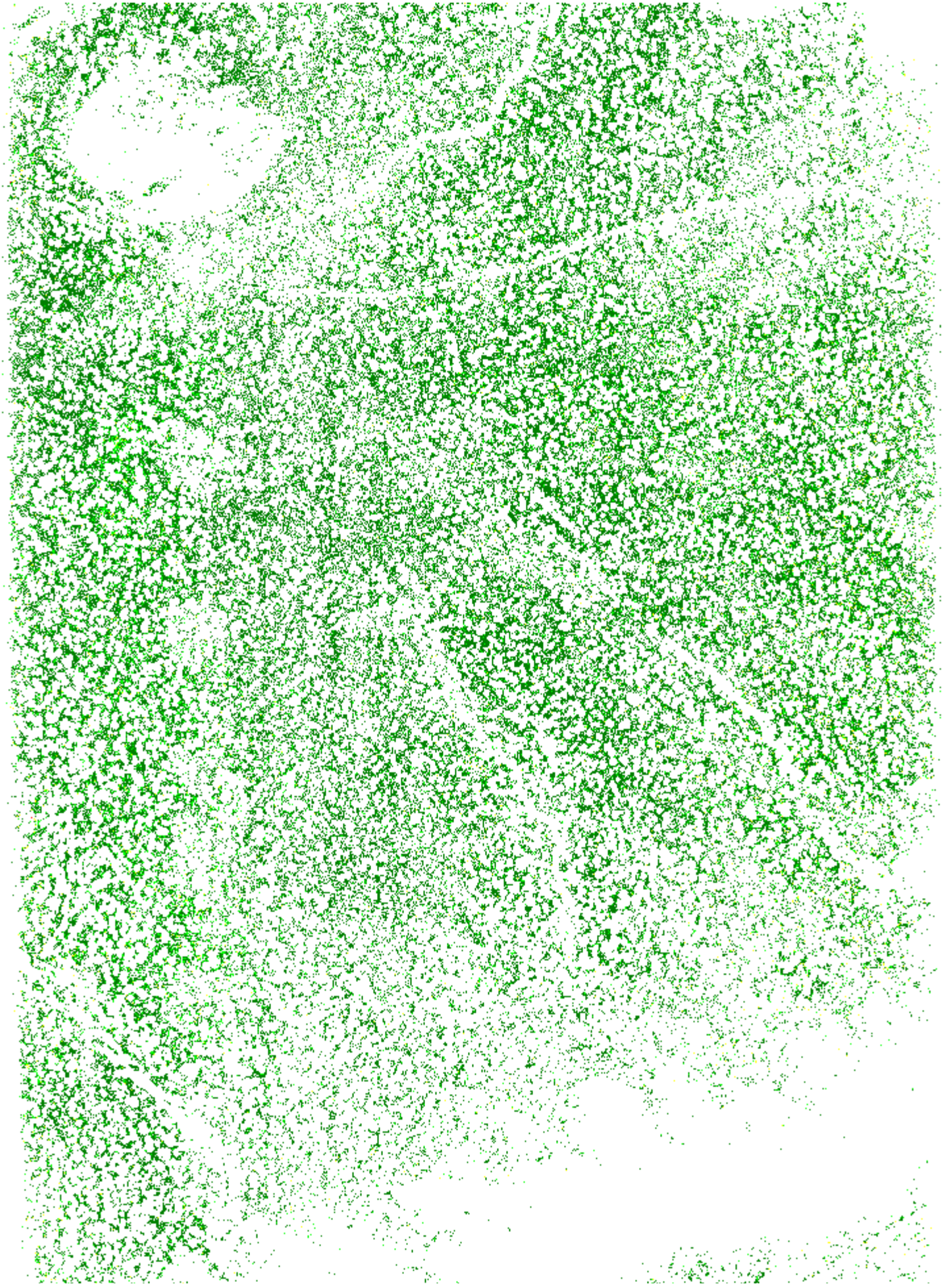
Color	Limits [m]	Number of patches	Proportion of total number of patches [%]
	<=0.03	389062	87.52
	0.03-0.05	47887	10.77
	0.05-0.1	7564	1.70
	>0.1	39	0.01

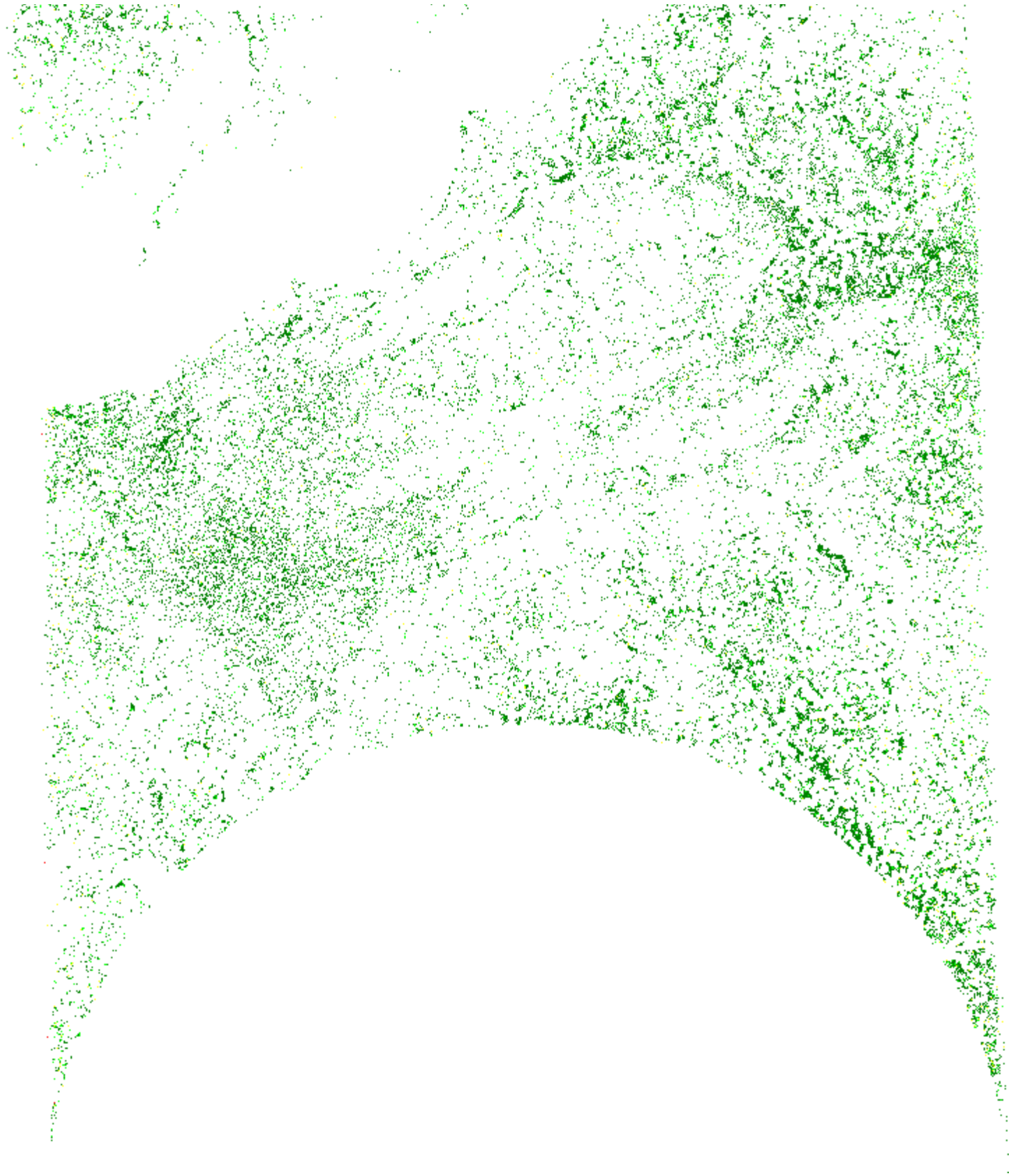










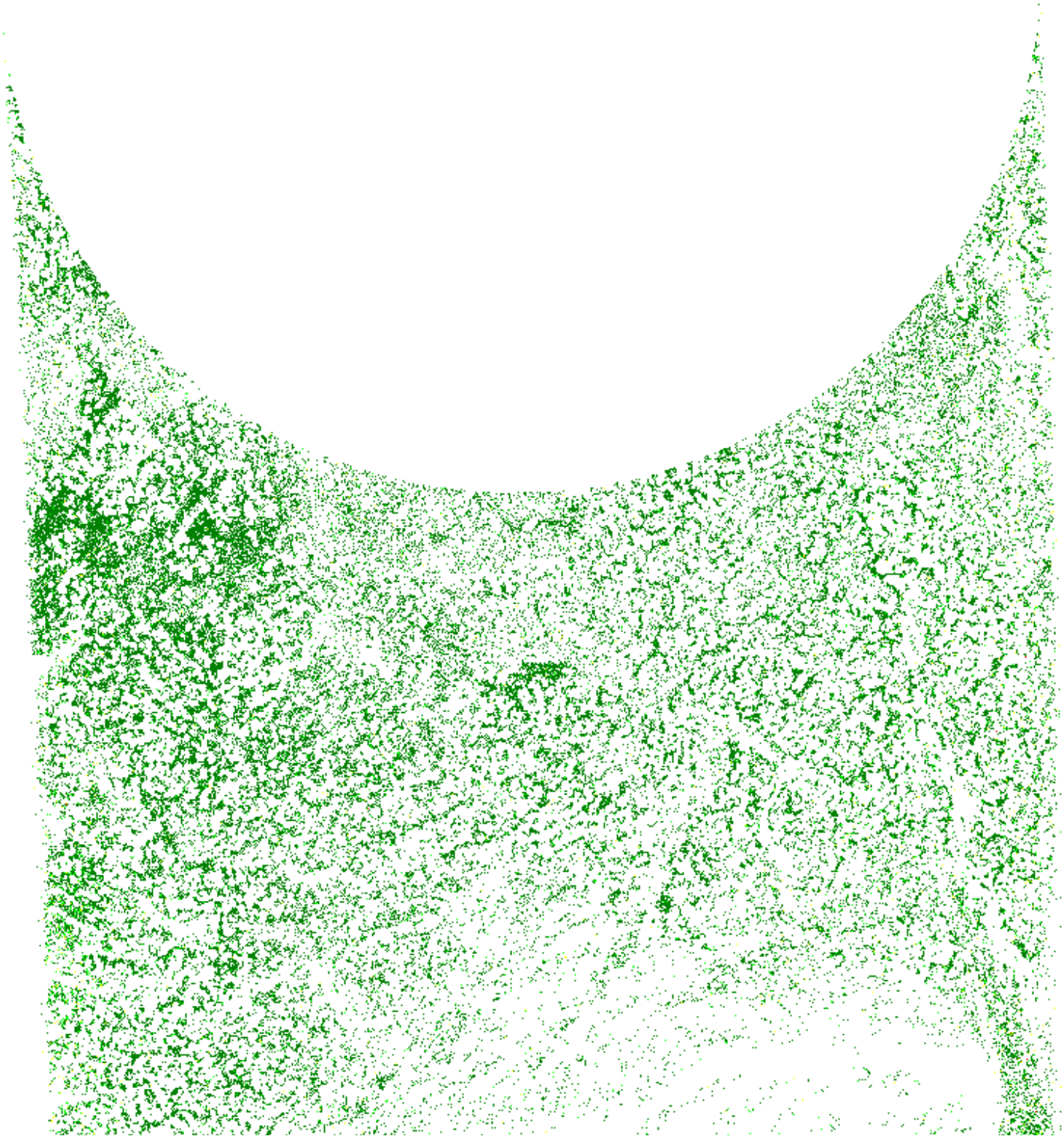


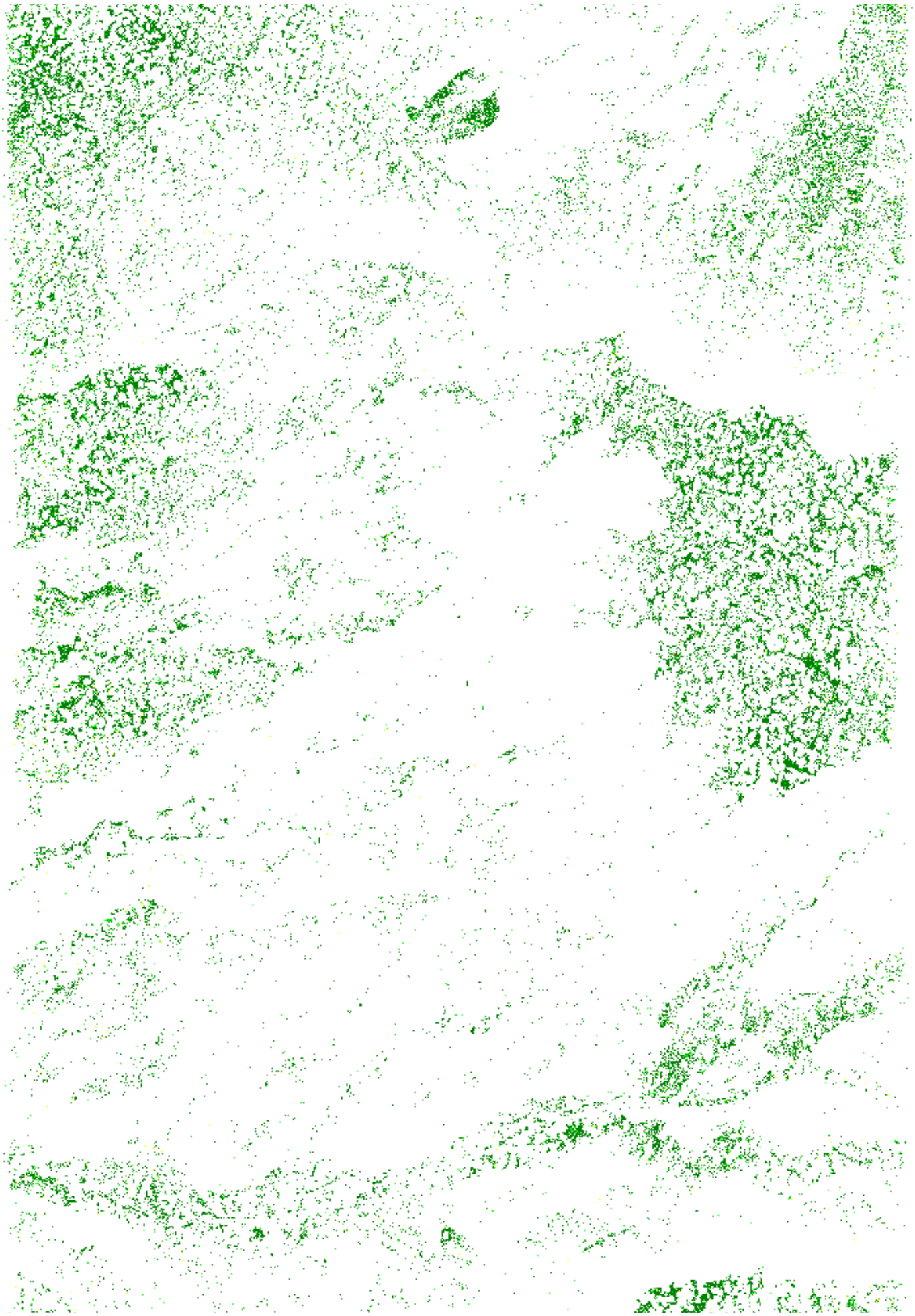
Vertical difference

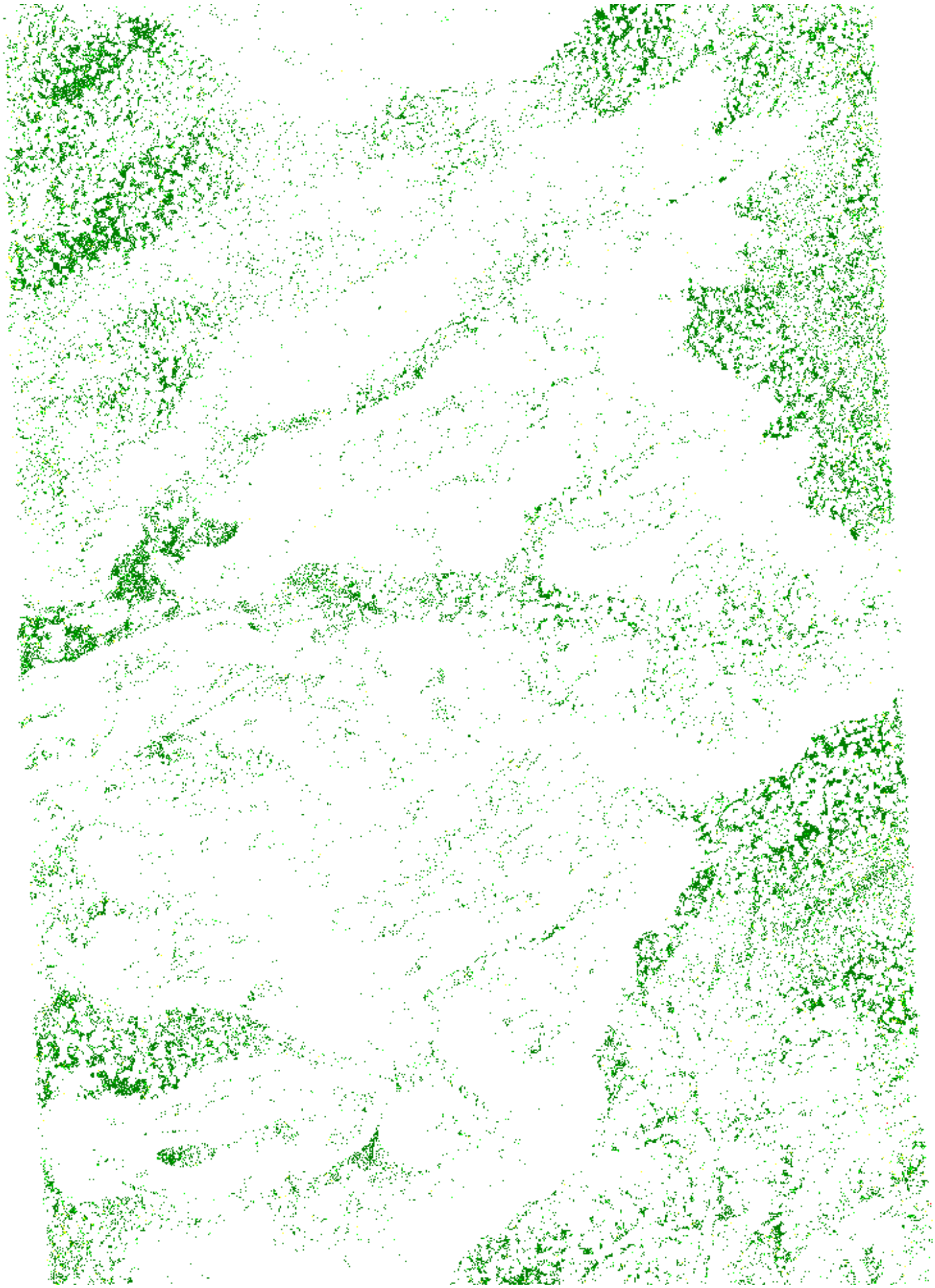
396_155156

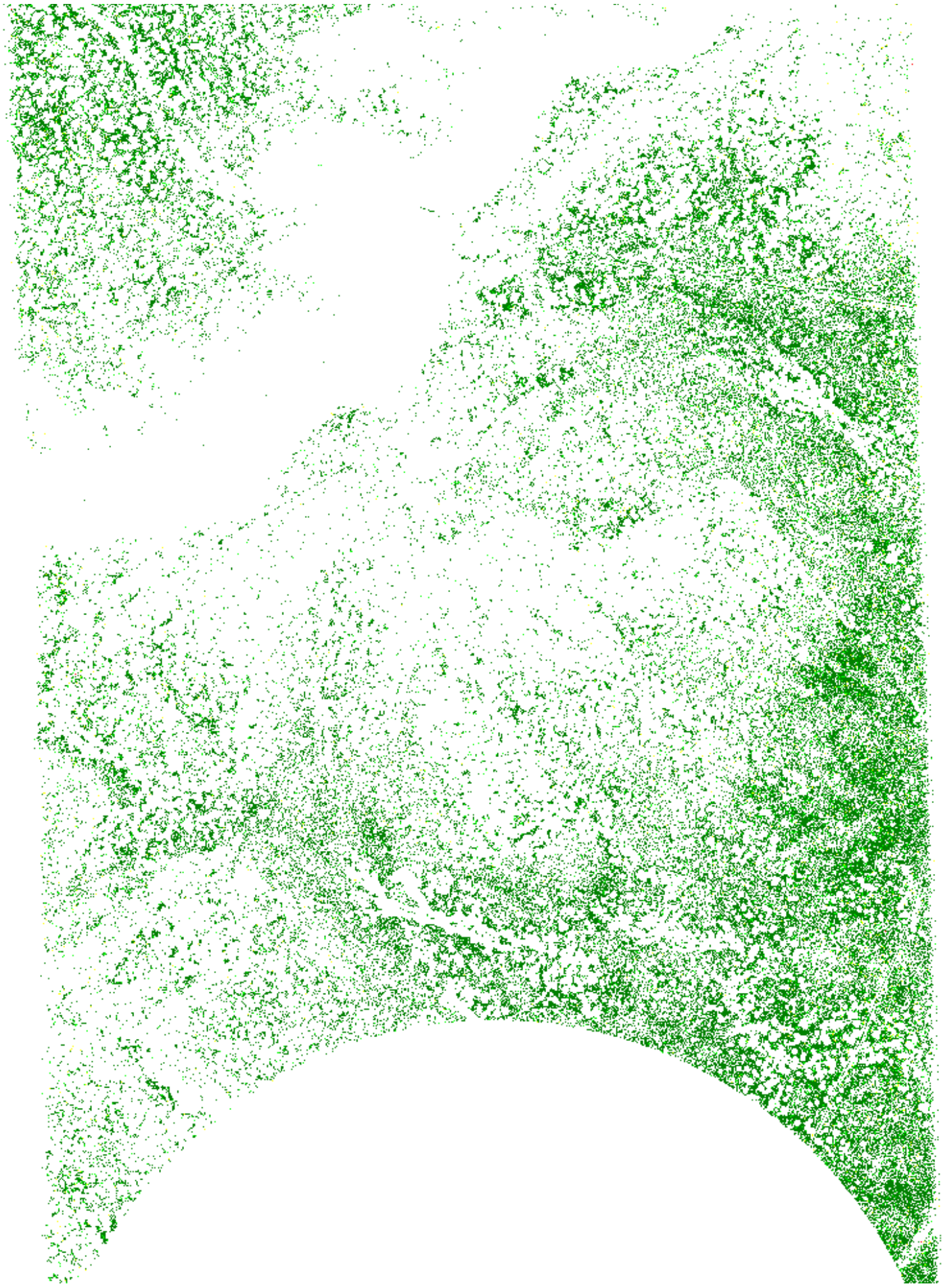
338031 valid patches with size of 2 m found. Only patches with standard deviation < 0.05 m and minimum of 5 points are included.

Color	Limits [m]	Number of patches	Proportion of total number of patches [%]
	<=0.03	299486	88.60
	0.03-0.05	32874	9.73
	0.05-0.1	5637	1.67
	>0.1	34	0.01







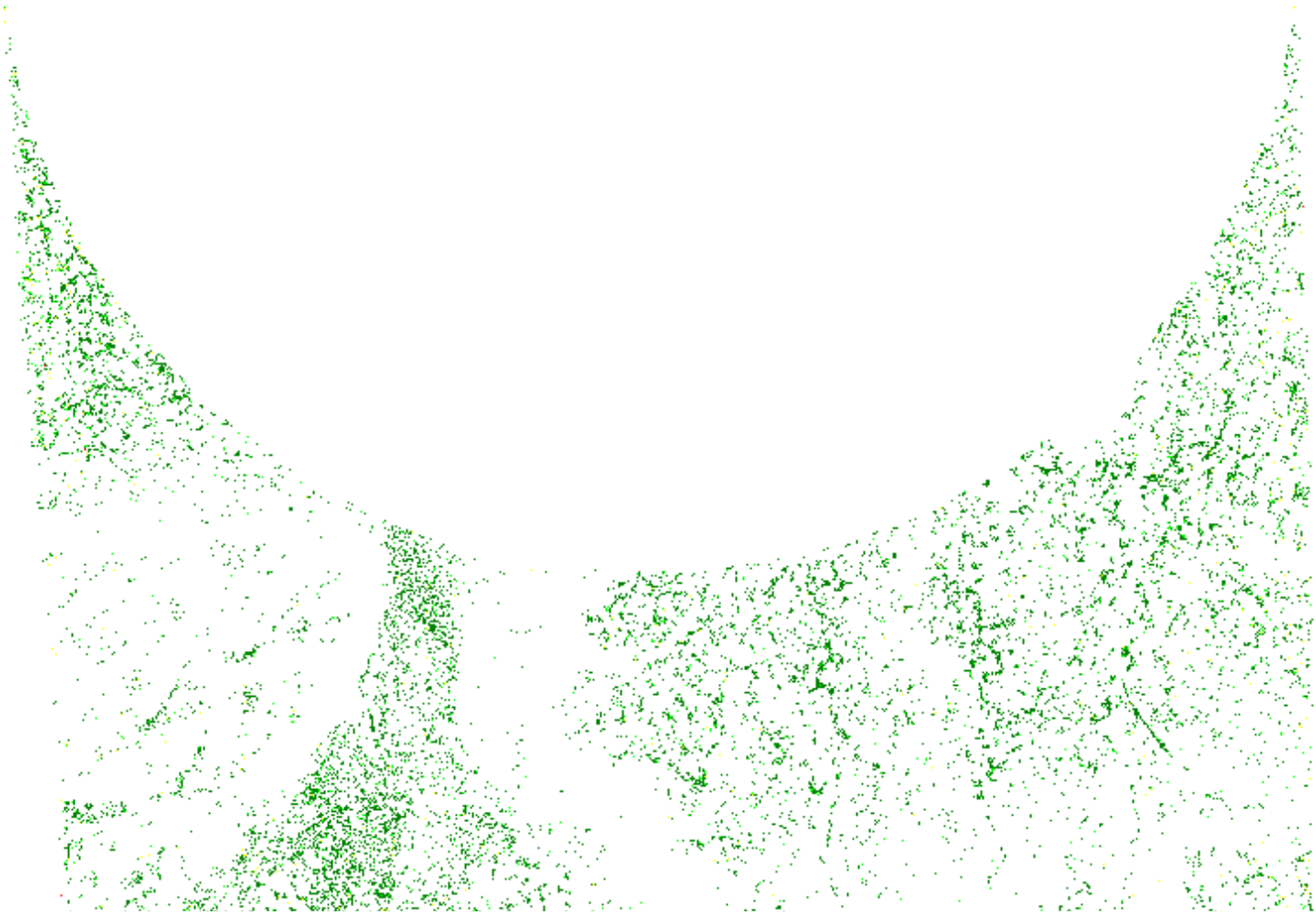


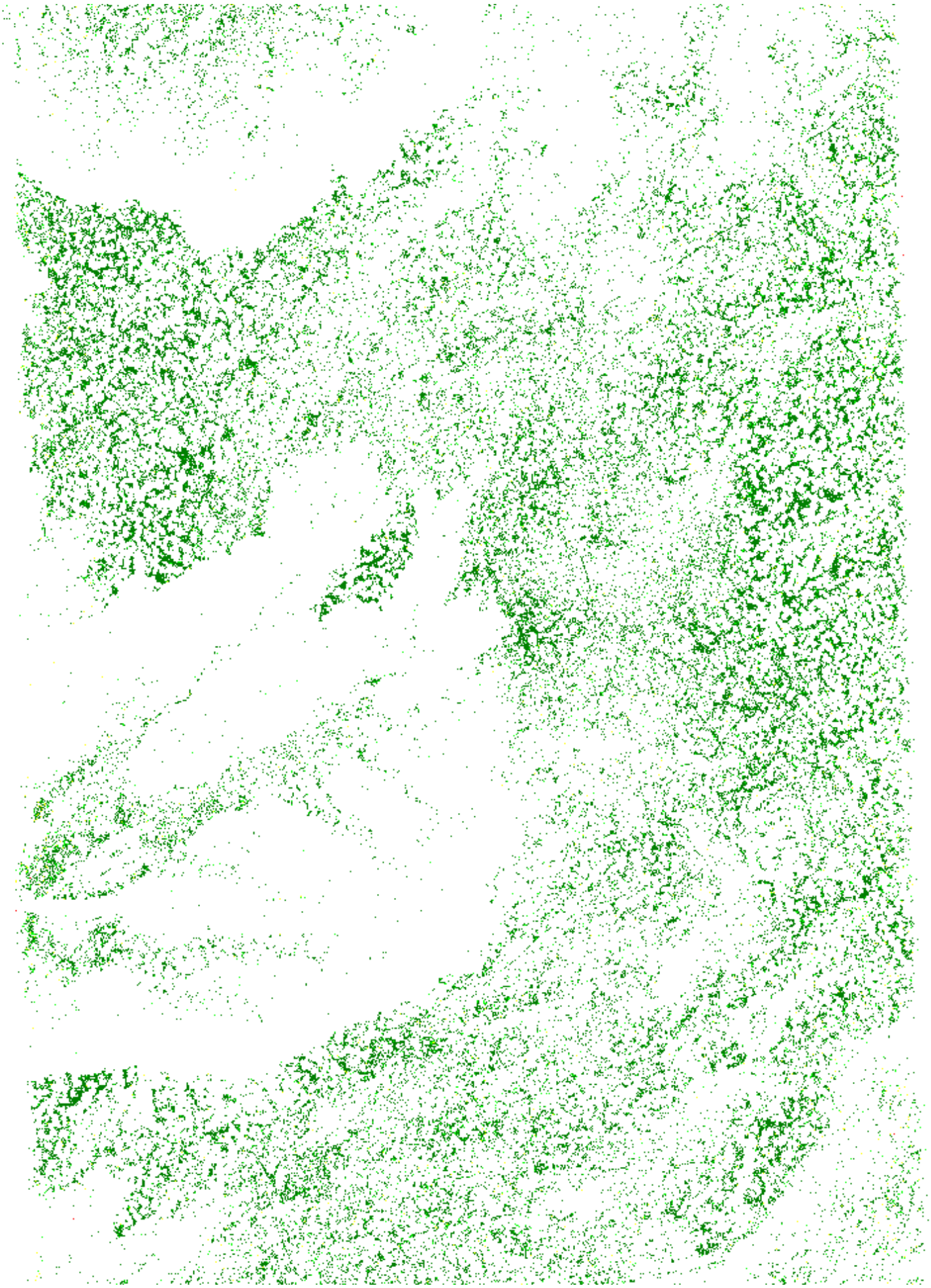
Vertical difference

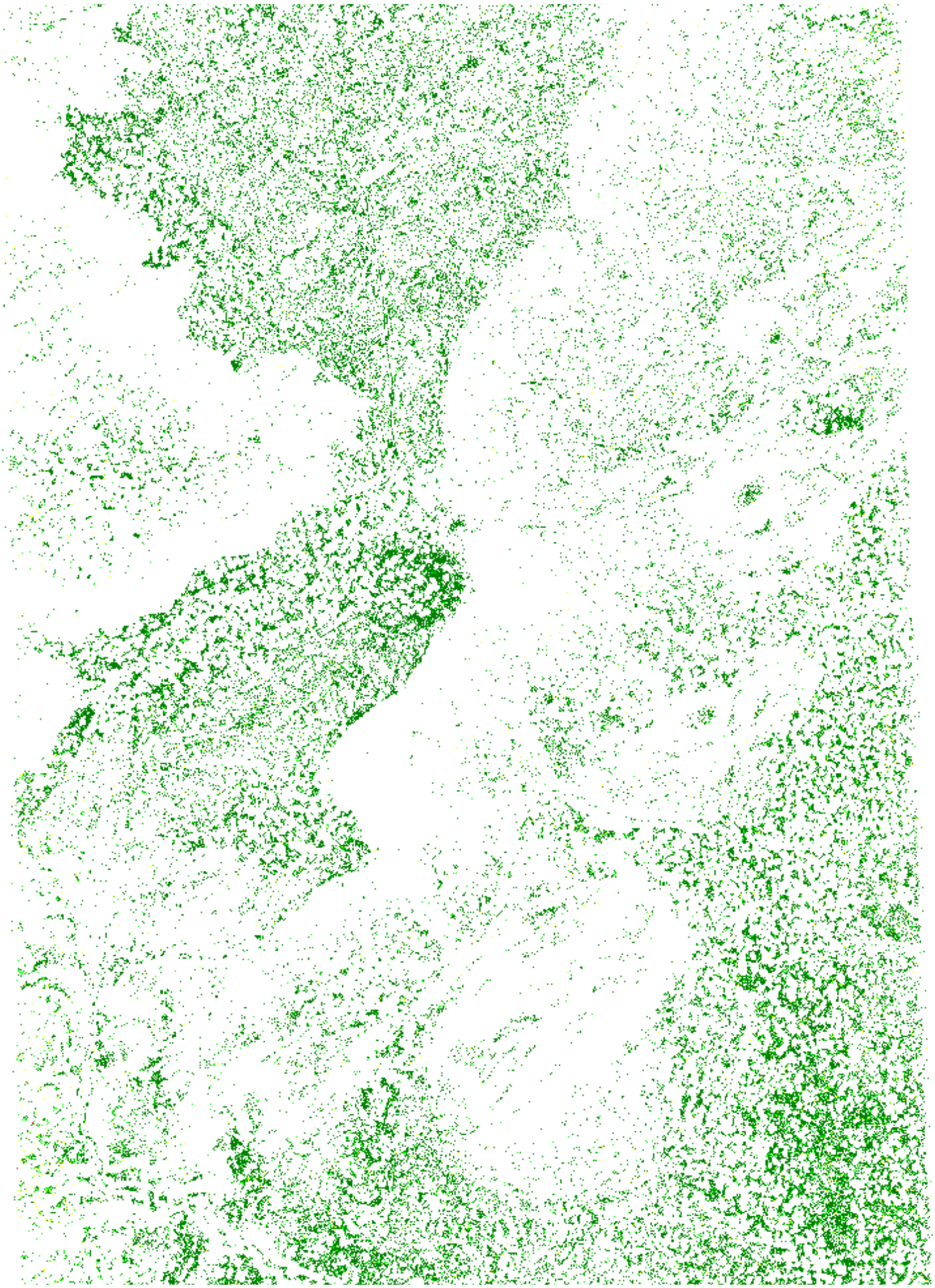
397_155845

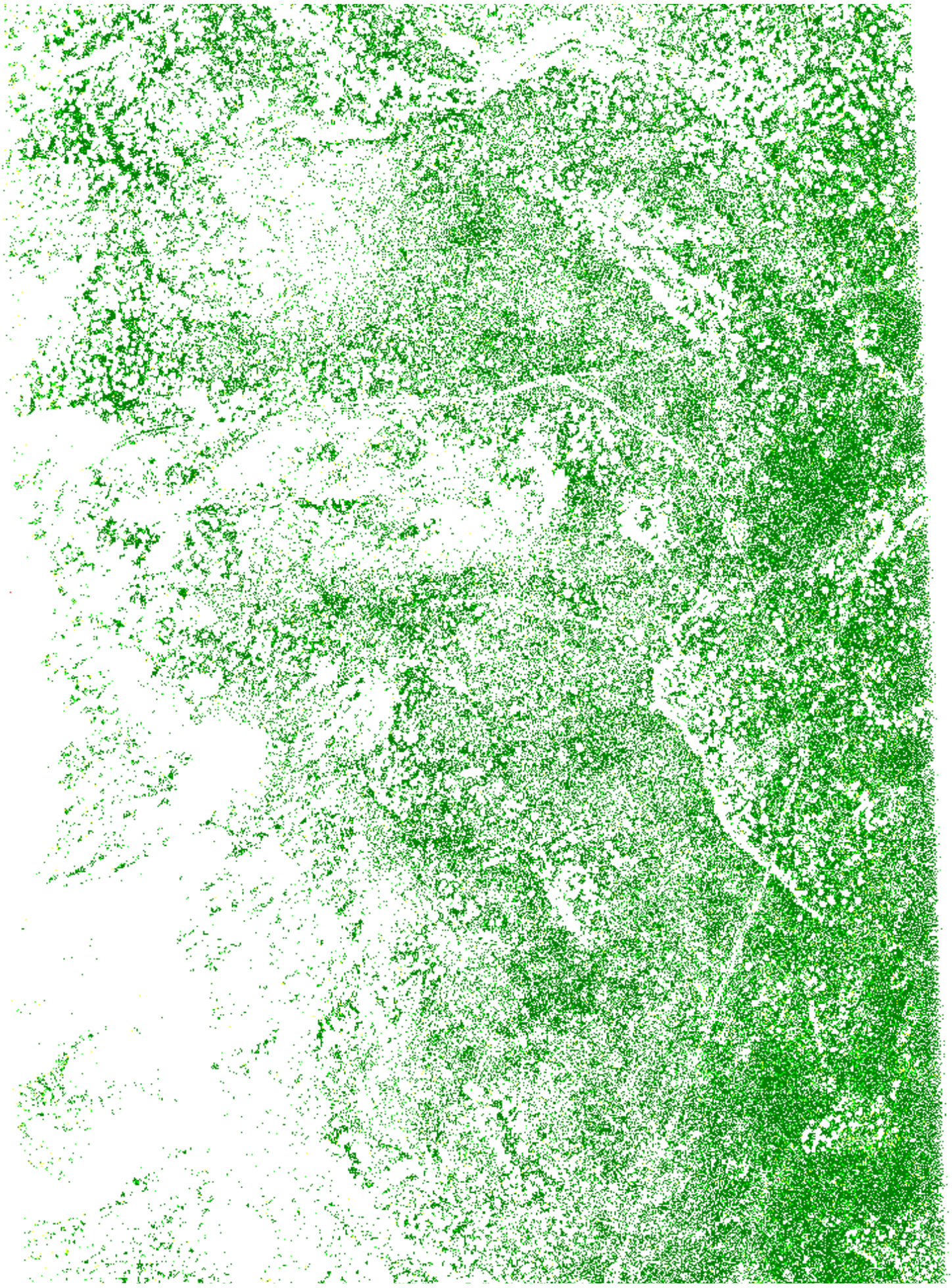
509726 valid patches with size of 2 m found. Only patches with standard deviation < 0.05 m and minimum of 5 points are included.

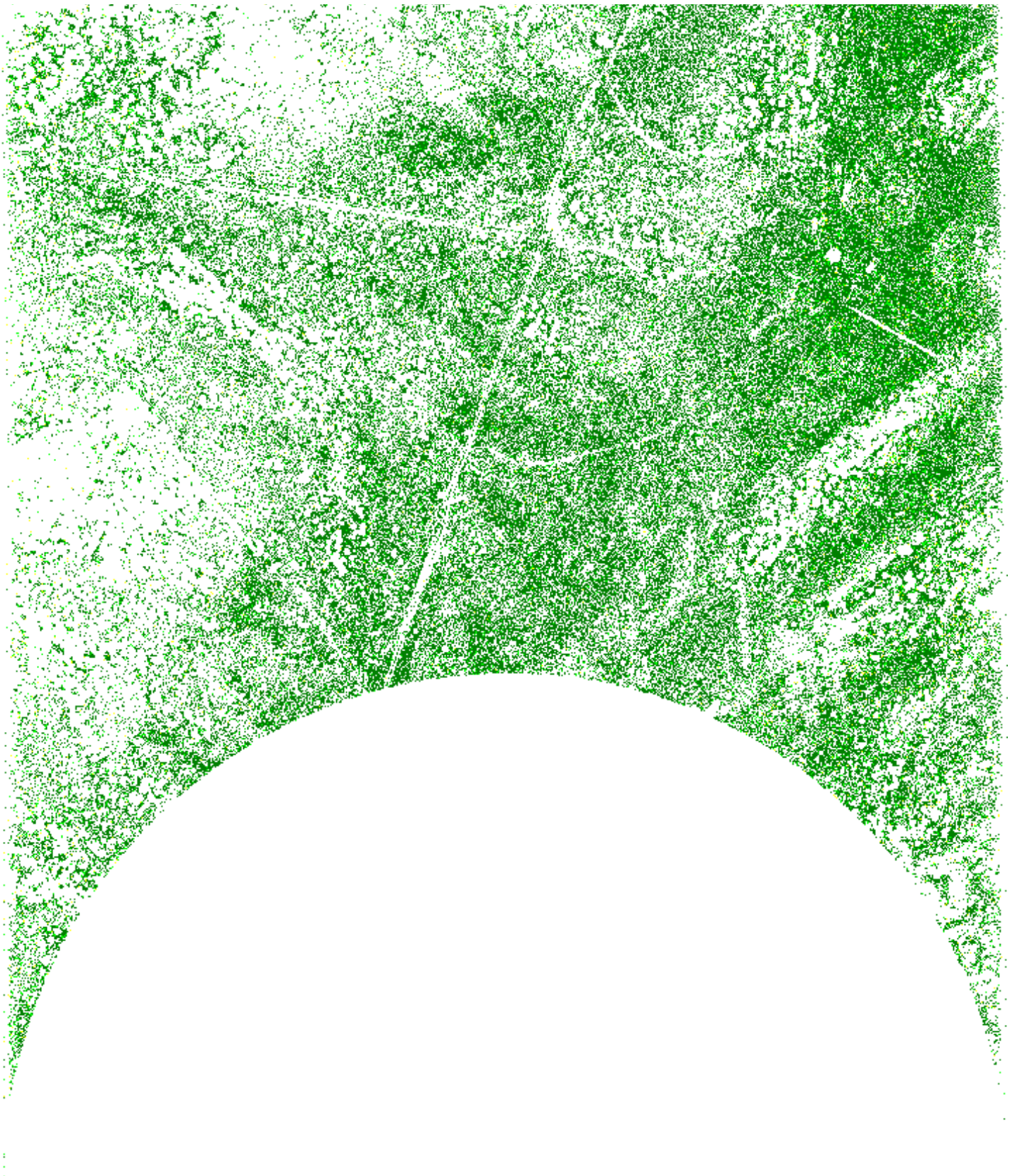
Color	Limits [m]	Number of patches	Proportion of total number of patches [%]
	<=0.03	446668	87.63
	0.03-0.05	54550	10.70
	0.05-0.1	8476	1.66
	>0.1	32	0.01











Vertical difference

Intra Take Elevation Difference Map

Table of Contents

20230908105421

VAL_SNC_14_111619

VAL_NSC_14_112250

20230908105421

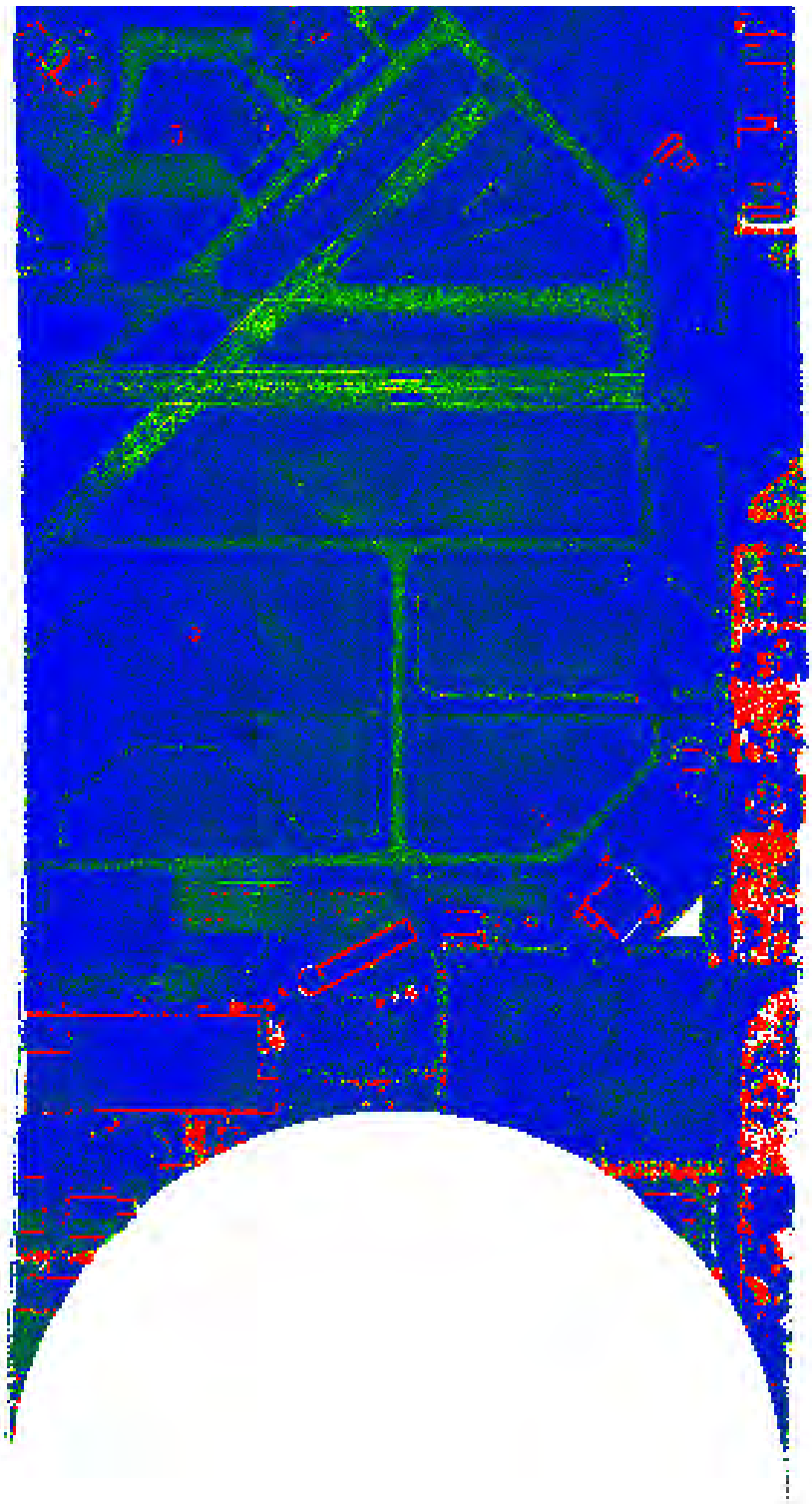
VAL_SNC_14_111619

Return Type: SINGLE

Statistics

Range(metres)	Counts	Percentage(%)
0 - 0.04	516689	88.15
0.04 - 0.06	28242	4.82
0.06 - 0.08	9140	1.56
0.08 - 0.16	7547	1.29
0.16 - 1	24562	4.19
>1	0	0.00

Legend



VAL_NSC_14_112250

Return Type: SINGLE

Statistics

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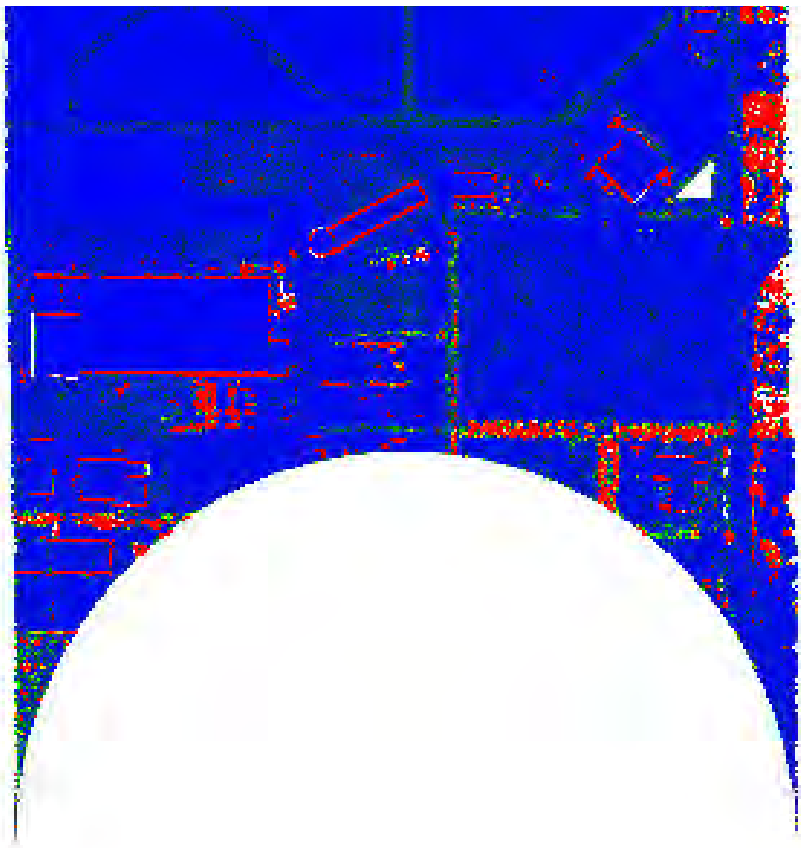
0.16 - 1	19125	3.29
>1	0	0.00

Legend