Aerial Lidar Report

Alabama ADECA 6 County Lidar 2016 B16

October 2017

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Section 1: Lidar Acquisition

1.1   Acquisition

The Atlantic Group, LLC (Atlantic) has successfully completed lidar acquisition for the Alabama AGIO & ADECA 12 County Lidar Area of Interest (AOI). Lidar for this AOI was acquired in thirty-eight (38) flight missions completed on March 15th, 2017. The project area encompasses 5,661,039 acres, 22,909 square kilometers or 8845 square miles.

1.2   Acquisition Status Report

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

1.3   Acquisition Details

Atlantic acquired thirty-Eight (38) passes of the AOI as a series of perpendicular and/or adjacent flight-lines. Differential GNSS unit in aircraft recorded sample positions at 2 Hz or more frequency. Lidar data was only acquired when a minimum of 6 satellites were in view.

Atlantic lidar sensors are calibrated at a designated site located at the Fayetteville Municipal Airport (FYM) in Fayetteville, TN and are periodically checked and adjusted to minimize corrections at project sites.

1.4   Project Purpose

The primary purpose of the lidar survey was to establish measurements of the bare earth surface, as well as top surface feature data for providing geometric inputs for modeling, other numerical modeling and economic related assessments.

1.5   Lidar Flight-line Orientation

The following graphic represents the alignment of the project area of interest (AOI) and the flight-lines executed to provide AOI coverage.
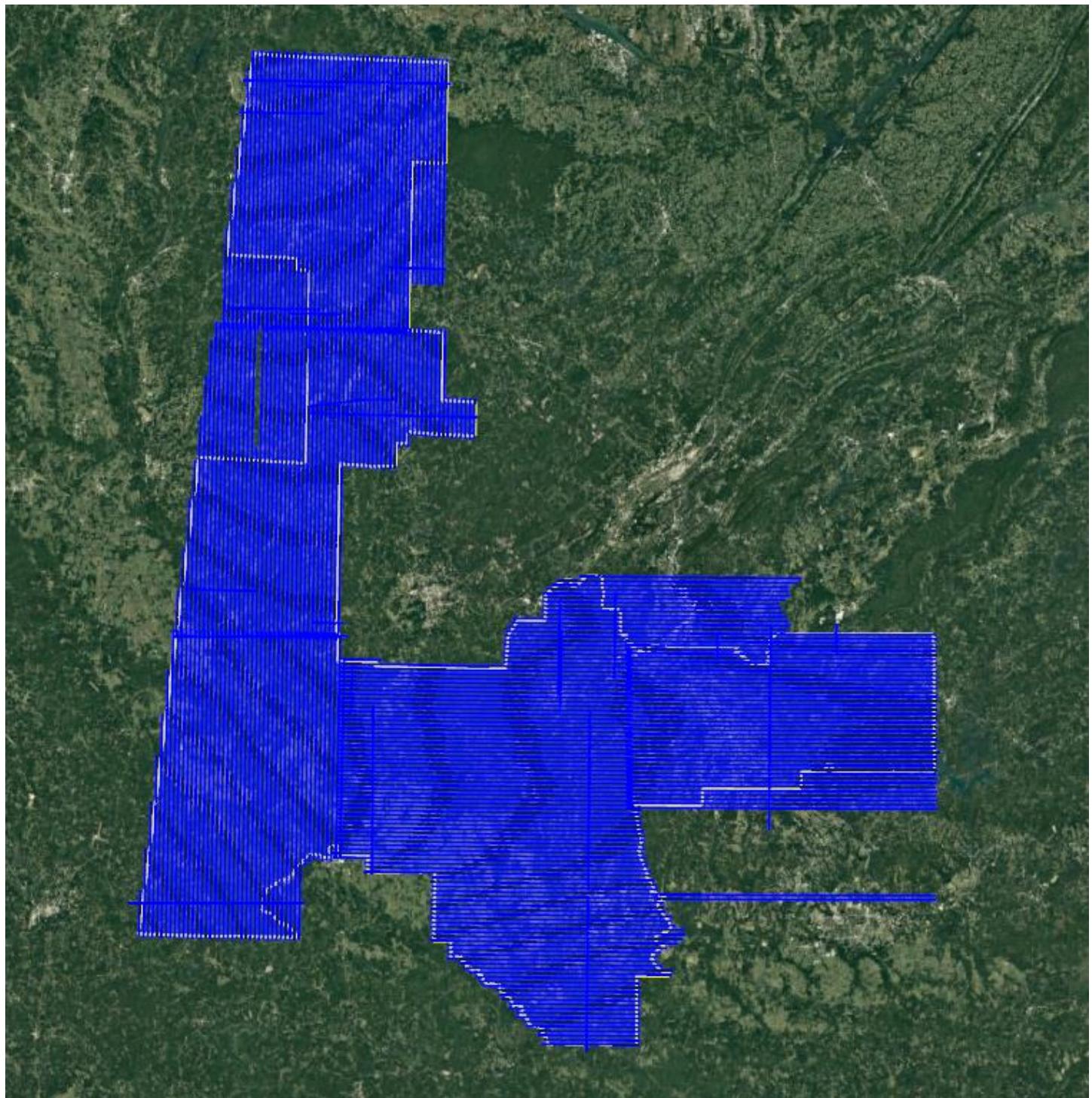

Figure 1: Trajectories as flown by Atlantic

1.6   Acquisition Equipment

Atlantic operated a Partenavia S.P.A P 68 C/TC (N775MW) outfitted with a Leica ALS70-HP lidar system during the collection of the project area. Table 1 represents a list of the features and characteristics for the Leica ALS70-HP lidar system:

Atlantic's Sensor Characteristics		
Leica ALS70-HP		
Manufacturer	Leica	
Model	ALS70 - HP	
Platform	Fixed-Wing	
Scan Pattern	Sine, Triangle, Raster	
Maximum Scan Rate (Hz)	Sine	200
	Triangle	158
	Raster	120
Field of View (°)	0 - 75 (Full Angle, User Adjustable)	
Maximum Pulse rate (kHz)	500	
Maximum Flying height (m AGL)	3500	
Number of returns	Unlimited	
Number of Intensity Measurements	3 (First, Second, Third)	
Roll Stabilization (Automatic Adaptive, °)	75 - Active FOV	
Storage Media	Removable 500 GB SSD	
Storage Capacity (Hours @ Max Pulse Rate)	6	
Size (cm)	Scanner	37 W x 68 L x 26 H
	Control Electronics	45 W x 47 D x 36 H
Weight (kg)	Scanner	43
	Control Electronics	45
Operating Temperature	0 - 40 °C	
Flight Management	FCMS	
Power Consumption	927 @ 22.0 - 30.3 VDC	

Table 1: Atlantic Sensor Characteristics

1.7 Lidar System Acquisition Parameters

Table 2 illustrates Atlantic's system parameters for lidar acquisition on this project.

Lidar System Acquisition Parameters	
Item	**Parameter**
System	Leica ALS-70 HP
Nominal Pulse Spacing (m)	0.64
Nominal Pulse Density (pls/m²)	2.47
Nominal Flight Height (AGL meters)	2300
Nominal Flight Speed (kts)	120
Pass Heading (degree)	0
Sensor Scan Angle (degree)	45
Scan Frequency (Hz)	32.
Pulse Rate of Scanner (kHz)	253.4
Line Spacing (m)	1,318
Pulse Duration of Scanner (ns)	4
Pulse Width of Scanner (m)	0.44
Central Wavelength of Sensor Laser (nm)	1064
Sensor Operated with Multiple Pulses	Yes
Beam Divergence (mrad)	0.22
Nominal Swath Width (m)	1740
Nominal Swath Overlap (%)	20
Scan Pattern	Triangle

Table 2: Atlantic Lidar System Acquisition Parameters

1.8   GNSS Reference Station(s)

Twenty (20) Continuously Operating Reference Stations (CORS) and fourteen (14) Alabama Department of Transportation (ALDOT) station was used to control the lidar acquisition for the project area. The coordinates provided in Table 3 below are in NAD83 (2011), Geographic Coordinate System, Ellipsoid, Meters.

GPS Reference Station Coordinates					
Designation	Type	PID	Latitude (N)	Longitude (W)	Elevation
AL10	ALDOT		34 26 05.97429	086 16 05.44101	168.471
AL13	ALDOT		34 36 12.74060	085 55 50.73908	388.895
AL15	ALDOT		33 59 24.87943	086 04 46.40518	144.121
AL20	CORS	DI2224	34 42 37.12915	087 39 45.73609	133.182
AL23	ALDOT		34 08 54.84687	087 57 13.02166	142.491
AL30	CORS	DI2226	33 31 56.44064	086 51 12.26529	149.807
AL35	CORS	DL7329	33 09 54.40826	086 45 24.56420	147.703
AL46	ALDOT		32 19 32.45950	085 09 37.96872	118.768
AL4A	ALDOT		32 57 43.53871	086 00 24.52759	210.037
AL50	CORS	DI2228	33 10 04.68517	087 30 05.42637	99.220
AL55	ALDOT		32 42 41.33436	087 36 56.10296	63.554
AL60	CORS	DI3824	32 24 40.92351	086 16 13.94708	46.063
AL81	CORS	DN9085	32 34 32.54496	088 10 54.29720	22.463
AL82	CORS	DM3483	32 15 26.78467	087 37 32.93023	27.118
AL83	ALDOT		31 59 40.69655	087 19 59.87789	45.648
ALBE	CORS	DM3487	34 28 31.49761	087 51 52.36634	227.761
ALBU	CORS	DM5367	32 04 53.89574	088 13 59.33198	18.222
ALC1	ALDOT		33 15 44.17849	088 05 43.40437	59.277
ALCE	CORS	DM3489	32 56 45.62114	087 09 02.27419	57.583
ALCH	ALDOT		31 27 03.54641	088 11 45.15225	24.221
ALCU	CORS	DM3965	34 10 47.51409	086 50 41.52983	224.150
ALDS	CORS	DM5960	34 08 53.40799	087 24 17.49204	227.554
ALFA	CORS	DM3493	33 41 06.74504	087 49 45.50930	90.500
ALGR	ALDOT		31 49 44.48244	086 37 02.74060	116.337
ALJA	CORS	DM3971	33 49 54.79664	087 16 39.26514	85.633
ALNC	CORS	DM2662	34 40 52.58348	087 18 33.99419	158.085
ALSE	CORS	DM3975	32 26 50.68920	087 00 42.37672	31.121
ALSP	ALDOT		34 25 05.08146	087 10 19.32663	175.120
ALWB	ALDOT		30 24 56.51310	087 49 35.37471	-21.941
GTAC	CORS	DG5771	34 42 39.82636	086 39 12.28466	194.331
HGIS	CORS	DK7412	34 43 41.17629	086 35 12.06178	177.731
MSBV	CORS	DP1253	34 39 56.46132	088 33 51.48409	129.908
MSME	CORS	DL7333	32 22 03.02207	088 43 56.77907	103.230
MSPE	CORS	DO8516	33 47 52.33113	088 39 30.10859	76.640

Table 3: GNSS Reference Station Coordinates
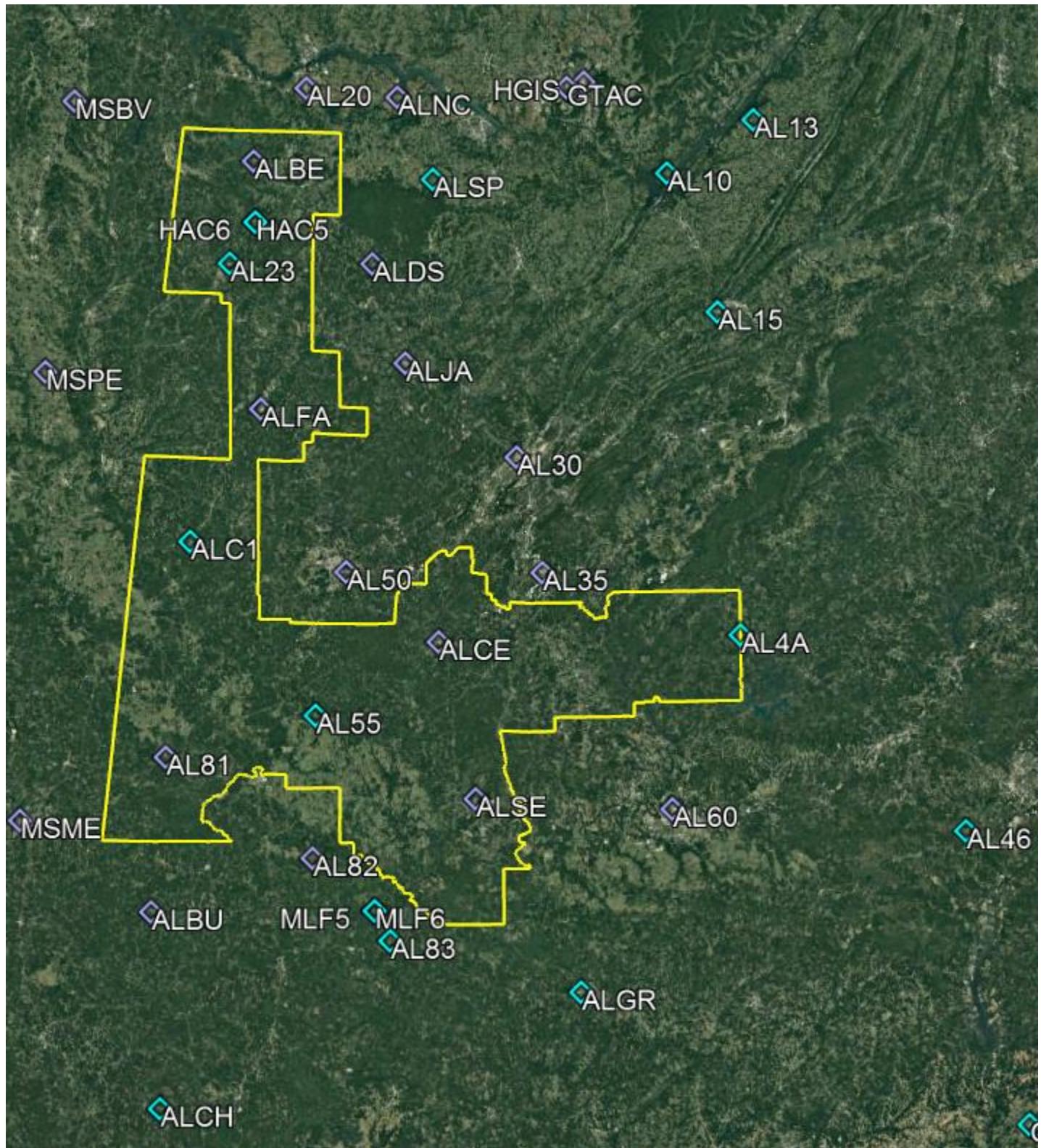
Figure 2: GNSS Reference Station(s)

1.9 Airborne GNSS Kinematic

Differential GNSS unit in aircraft collected positions at 2 Hz. Airborne GNSS data was processed using the Inertial Explorer (version 8.60.6717) software. Flights were flown with a minimum of 6 satellites in view (10° above the horizon).

For all flights, the GNSS data can be classified as good, with residuals of 3cm average or better but none larger than 10cm being recorded.

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

GNSS processing results for each lift are included in **Section 5: GNSS Processing**.

Section 2: Lidar Processing

2.1   Lidar Point Cloud Generation

Atlantic used Leica software products to download the IPAS ABGNSS/IMU data and raw laser scan files from the airborne system. Waypoint Inertial Explorer is used to extract the raw IPAS ABGNSS/IMU data, which is further processed in combination with controlled base stations to provide the final Smoothed Best Estimate Trajectory (SBET) for each mission. The SBET's are combined with the raw laser scan files to export the Lidar ASCII Standard (*.las) formatted swath point clouds.
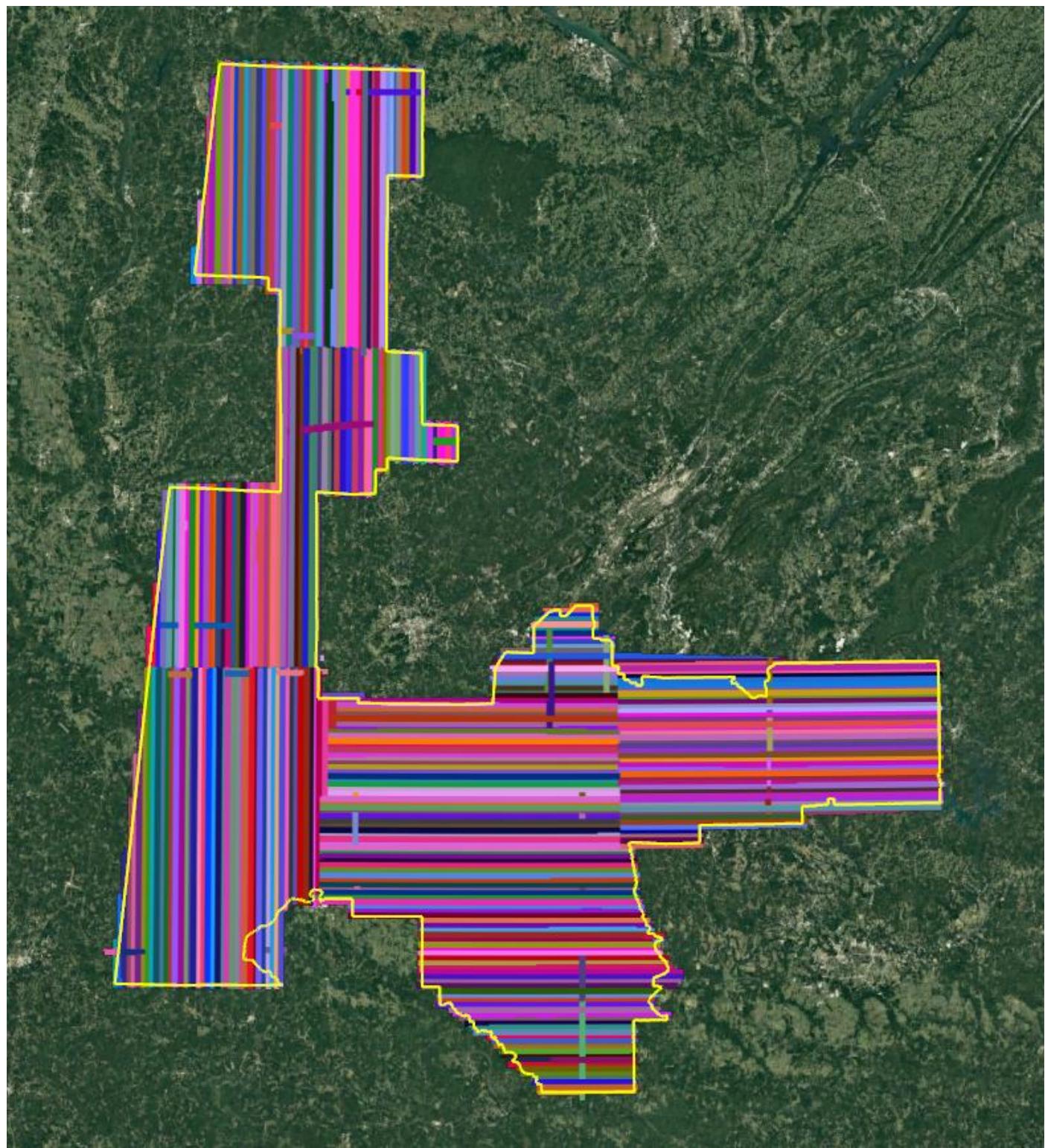
Figure 3: Lidar swath data showing complete coverage

2.2   Coordinate Reference System

Horizontal Datum:	North American Datum of 1983 (2011)
Coordinate System:	Universal Transverse Mercator Zone 16 North
Vertical Datum:	North American Vertical Datum of 1988
Geoid Model:	Geoid12B
Units of Reference:	Meters

2.3   Lidar Point Cloud Statistics

Table 4 illustrates the overall lidar point cloud statistics for this project.

Point Cloud Statistics	
Category	**Value**
Total Points	131,424,407,666
Nominal Pulse Spacing (m)	0.6361
Nominal Pulse Density (pls/m²)	2.47
Nominal Pulse Spacing (ft)	2.0869
Nominal Pulse Density (pls/ft²)	0.23
Total Aggregate Points	118,817,113,422
Aggregate Nominal Pulse Spacing (m)	0.5528
Aggregate Nominal Pulse Density (pls/m²)	3.27
Aggregate Nominal Pulse Spacing (ft)	1.8135
Aggregate Nominal Pulse Density (pls/ft²)	0.30

Table 4: Lidar Point Cloud Statistics

2.4   Expected Horizontal Positional Error

As described in Section 7.5 of the ASPRS Positional Accuracy Standards for Digital Geospatial Data the horizontal errors in lidar data are largely a function of GNSS positional error, INS angular error, and flying altitude. Therefore, lidar data collected with GNSS error of 8cm and the IMU error of 0.00427 degrees at an altitude of 2,000m; the expected radial horizontal positional error will be $RMSE_z$ = 29.0cm.

2.5   Smooth Surface Repeatability (Intraswath)

Departures from planarity of first returns within single swaths in non-vegetated areas were assessed at multiple locations with hard surface areas (parking lots or large rooftops) inside the project area. Each area was evaluated using signed difference rasters (maximum elevation – minimum elevation) at a cell size equal to 2 x ANPS, rounded to the next integer. The following graphic depicts a sample of the assessment.
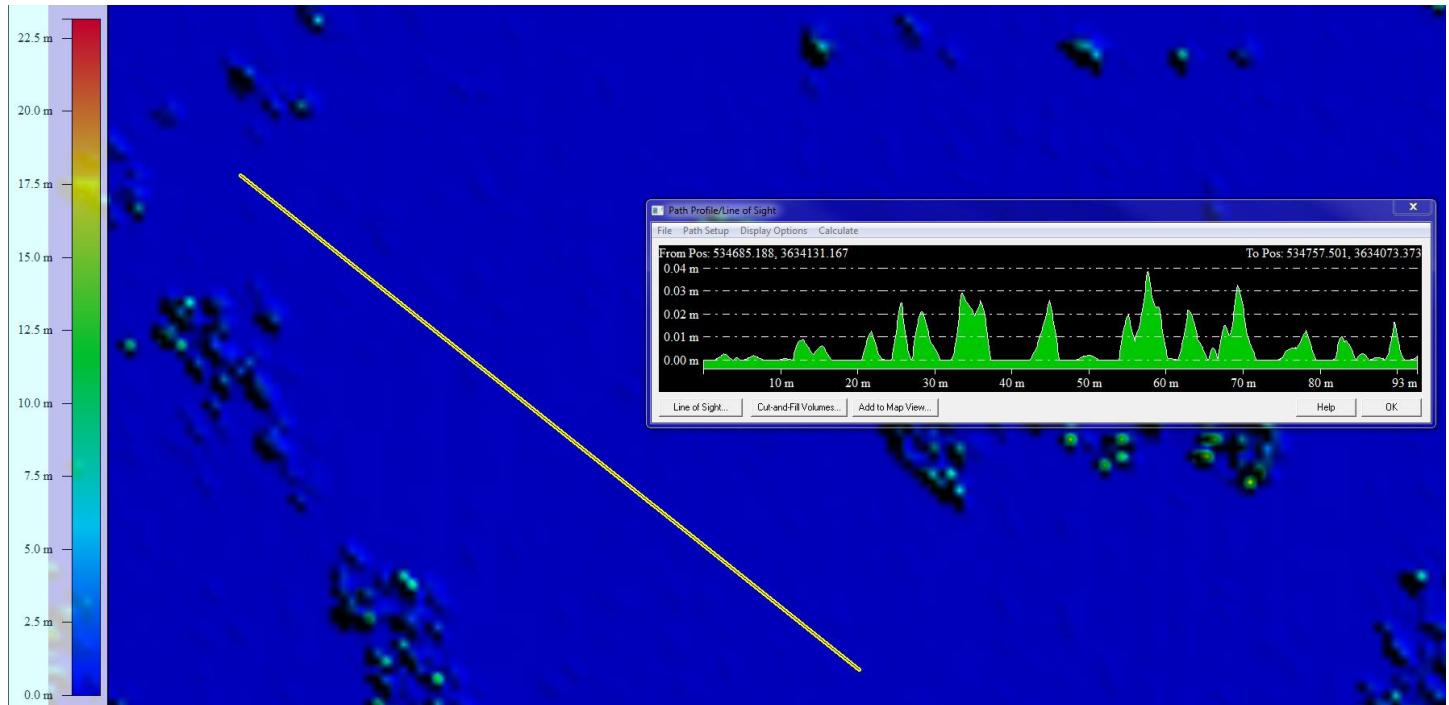

Figure 4: Smooth Surface Repeatability of ≤6cm

2.6   Lidar Calibration

Lidar ranging data were initially calibrated using previous best parameters for this instrument and aircraft. Using a combination of GeoCue, TerraScan and TerraMatch; the overlapping swath point clouds are corrected for any orientation or linear deviations to obtain the best fit swath-to-swath calibration. Relative calibration was evaluated using advanced plane-matching analysis and parameter corrections derived. This process was repeated interactively until residual errors between overlapping swaths, across all project missions, was reduced to ≤2cm. A final analysis of the calibrated lidar is preformed using a TerraMatch Tie Line report for an overall statistical model of the project area.

Upon completion of the data calibration, Atlantic runs a complete set of elevation difference intensity rasters (dZ Orthos). A user-defined color ramp is applied depicting the offsets between overlapping swaths based on project specifications. The dZ orthos provide an opportunity to review the data calibration in a qualitative manner. Atlantic assigns green to all offset values that fall below the required RMSDz requirement of the project. A yellow color is assigned for offsets that fall between the RMSDz value and 1.5x of that value. Finally, red values are assigned to all values that fall beyond 1.5x of the RMSDz requirements of the project.

No Data	0m to 0.04m	0.04m to 0.08m	0.08m to 0.12m	> 0.12m
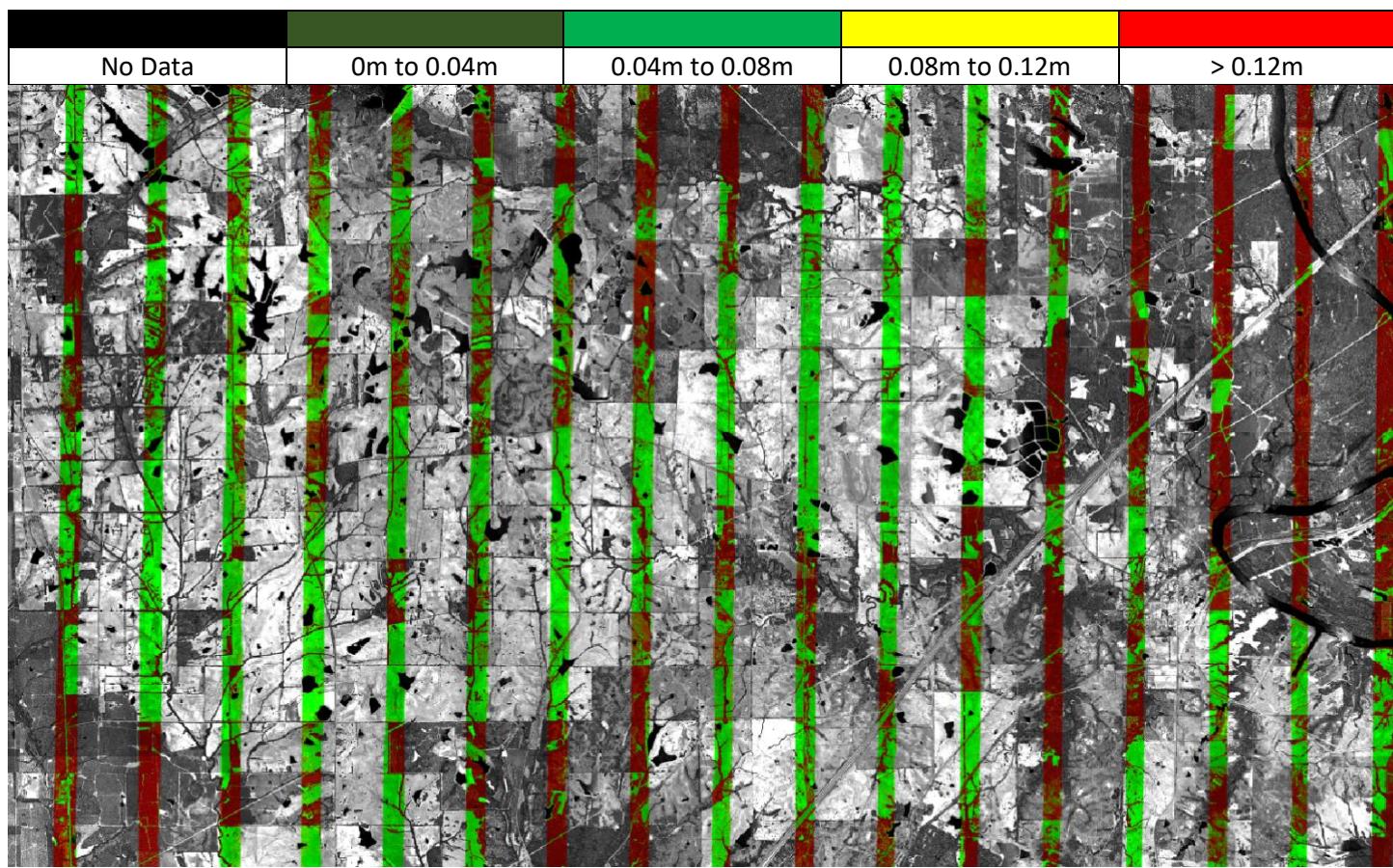
Figure 5: Swath Overlap Difference of ≤8cm, Maximum of ±16cm

2.7 Overlap Consistency (Interswath)

An overall statistical assessment of the relative accuracy using TerraMatch Tie Line Report between lidar swaths can be found in Tables 5, 6, 7, and 8 below. The values provided are in meters.

Line	X	Y	Z	Line	X	Y	Z	Line	X	Y	Z
Average Magnitudes Per Line											
1	0.024	0.021	0.025	144	0.03	0.027	0.017	289	0.006	0.022	0.014
2	0.009	0.018	0.018	145	0.024	0.024	0.02	290	0.017	0.029	0.028
3	0.016	0.029	0.017	146	0.017	0.022	0.02	291	0.018	0.057	0.015
4	0.015	0.03	0.016	147	0.023	0.025	0.02	292	0.025	0.027	0.019
5	0.018	0.03	0.019	148	0.028	0.03	0.025	293	0.013	0.033	0.016
6	0.016	0.031	0.019	149	0.015	0.019	0.013	294	0.02	0.019	0.014
7	0.016	0.029	0.022	150	0.024	0.023	0.016	295	0.022	0.029	0.018
8	0.013	0.026	0.02	151	0.023	0.025	0.015	296	0.029	0.027	0.017
9	0.013	0.033	0.017	152	0.022	0.025	0.016	297	0.03	0.027	0.017
10	0.017	0.042	0.017	153	0.023	0.028	0.014	298	0.024	0.036	0.016
11	0.019	0.035	0.018	154	0.026	0.035	0.017	298	0.018	0.016	0.016
12	0.017	0.024	0.019	155	0.02	0.02	0.017	299	0.025	0.035	0.017
13	0.018	0.023	0.019	157	0.017	0.02	0.016	299	0.022	0.018	0.018
14	0.023	0.021	0.019	158	0.02	0.016	0.017	300	0.026	0.027	0.016
15	0.024	0.023	0.023	159	0.023	0.019	0.017	300	0.025	0.02	0.02
16	0.027	0.029	0.024	160	0.019	0.019	0.016	301	0.024	0.039	0.013
17	0.035	0.031	0.024	161	0.02	0.021	0.017	301	0.028	0.025	0.025
18	0.032	0.033	0.028	162	0.019	0.02	0.016	302	0.03	0.028	0.024
19	0.031	0.023	0.021	163	0.019	0.016	0.018	303	0.033	0.032	0.032
20	0.034	0.022	0.019	164	0.02	0.019	0.017	304	0.027	0.04	0.022
21	0.039	0.028	0.018	165	0.02	0.027	0.017	305	-	-	0.041
22	0.043	0.031	0.016	166	0.02	0.023	0.016	306	0.021	0.034	0.02
23	0.047	0.029	0.016	167	0.015	0.015	0.015	307	-	-	0.03
24	0.049	0.035	0.017	168	0.022	0.026	0.015	308	0.018	0.023	0.025
25	0.038	0.028	0.018	169	0.019	0.024	0.015	309	0.024	0.024	0.022
26	0.036	0.023	0.015	170	0.008	0.007	0.014	310	0.024	0.022	0.017
27	0.041	0.028	0.015	171	0.017	0.016	0.016	311	0.029	0.029	0.016
28	0.042	0.032	0.017	172	0.022	0.022	0.016	312	0.028	0.027	0.017
29	0.042	0.03	0.018	173	0.005	0.007	0.013	313	0.03	0.033	0.016
30	0.038	0.045	0.03	174	0.015	0.021	0.019	314	0.041	0.034	0.023
31	0.065	0.02	0.019	176	0.024	0.026	0.025	315	0.026	0.028	0.033
32	0.038	0.028	0.019	177	0.024	0.025	0.025	316	0.034	0.058	0.02
33	0.054	0.038	0.02	178	0.047	0.054	0.019	317	0.029	0.027	0.021
34	0.055	0.025	0.018	179	0.051	0.048	0.022	318	0.031	0.03	0.02
35	0.059	0.033	0.019	180	0.045	0.038	0.022	319	0.02	0.028	0.024

36	0.057	0.038	0.019	181	0.035	0.034	0.023	320	-	-	0.031
37	0.048	0.035	0.021	182	0.035	0.04	0.022	321	0.027	0.034	0.024
38	0.045	0.038	0.021	183	0.033	0.046	0.022	322	0.015	0.017	0.019
39	0.026	0.017	0.019	184	0.065	0.046	0.024	323	0.015	0.018	0.017
40	0.025	0.028	0.024	185	0.037	0.03	0.038	324	0.019	0.023	0.021
41	0.027	0.021	0.02	186	0.059	0.04	0.028	325	0.02	0.023	0.018
42	0.036	0.039	0.033	187	0.036	0.03	0.037	326	0.02	0.023	0.025
43	0.04	0.045	0.022	188	0.02	0.018	0.033	327	0.019	0.019	0.016
44	0.021	0.024	0.018	189	0.024	0.027	0.016	328	0.014	0.022	0.019
45	0.022	0.022	0.017	190	0.028	0.03	0.026	329	0.017	0.022	0.016
46	0.024	0.027	0.017	191	0.03	0.032	0.019	330	0.019	0.03	0.019
47	0.03	0.032	0.018	192	0.03	0.034	0.019	331	0.021	0.021	0.042
48	0.029	0.03	0.018	193	0.027	0.031	0.019	332	0.015	0.018	0.016
49	0.025	0.024	0.018	194	0.038	0.036	0.022	333	0.019	0.024	0.027
50	0.023	0.021	0.018	195	0.047	0.041	0.025	334	0.019	0.025	0.016
51	0.02	0.021	0.018	196	0.031	0.04	0.022	335	0.017	0.025	0.018
52	0.02	0.02	0.019	197	0.034	0.041	0.02	336	0.018	0.036	0.015
53	0.017	0.014	0.017	198	0.031	0.04	0.02	337	0.022	0.042	0.017
54	0.027	0.019	0.021	199	0.029	0.033	0.02	338	0.024	0.035	0.019
55	0.012	0.009	0.031	200	0.028	0.036	0.02	339	0.034	0.049	0.018
56	0.044	0.043	0.032	201	0.025	0.029	0.022	340	0.022	0.019	0.037
57	0.036	0.032	0.024	202	0.025	0.026	0.016	341	0.033	0.049	0.016
58	0.022	0.046	0.016	203	0.032	0.027	0.016	342	0.022	0.021	0.025
59	-	-	0.013	204	0.027	0.025	0.018	343	0.028	0.034	0.016
60	-	-	0.013	205	0.013	0.012	0.015	344	0.022	0.03	0.015
61	0.014	0.034	0.017	206	0.002	0.029	0.013	345	0.021	0.037	0.015
62	0.036	0.037	0.017	207	0.016	0.021	0.02	346	0.03	0.047	0.015
63	0.017	0.034	0.019	208	0.039	0.042	0.031	347	0.028	0.046	0.015
64	0.029	0.054	0.019	209	0.036	0.036	0.016	348	0.031	0.043	0.015
65	-	-	0.015	210	0.037	0.019	0.018	349	0.035	0.046	0.015
66	-	-	0.015	211	0.038	0.066	0.017	350	0.023	0.033	0.015
67	-	-	0.015	212	0.05	0.044	0.019	351	0.018	0.029	0.016
68	0.021	0.046	0.017	213	0.069	0.045	0.015	352	0.02	0.024	0.015
69	0.031	0.028	0.016	214	0.059	0.049	0.015	353	0.023	0.024	0.015
70	0.003	0.027	0.019	215	0.052	0.076	0.012	354	0.024	0.023	0.036
71	0.022	0.033	0.036	216	0.05	0.021	0.014	355	0.023	0.025	0.017
72	0.05	0.034	0.026	217	0.054	0.022	0.014	356	0.024	0.028	0.018
73	0.019	0.024	0.02	218	0.051	0.034	0.02	357	0.027	0.035	0.018
74	0.019	0.022	0.019	219	0.049	0.038	0.019	358	0.026	0.029	0.017
75	0.021	0.026	0.022	220	0.052	0.05	0.015	359	0.02	0.025	0.016

76	-	-	0.014	221	-	-	0.012	360	0.022	0.031	0.017
77	-	-	0.014	222	-	-	0.013	361	0.023	0.026	0.018
78	0.022	0.047	0.015	223	-	-	0.012	362	0.01	0.01	0.014
79	0.022	0.039	0.017	224	0.069	0.034	0.013	363	0.025	0.035	0.025
80	0.026	0.028	0.019	225	0.053	0.035	0.018	364	0.019	0.015	0.026
81	0.038	0.04	0.017	226	0.056	0.032	0.019	365	0.023	0.024	0.021
82	0.029	0.026	0.017	227	0.068	0.027	0.017	366	0.013	0.018	0.017
83	0.034	0.023	0.018	228	0.036	0.019	0.019	367	0.016	0.024	0.018
84	0.029	0.026	0.018	229	0.022	0.018	0.016	368	0.024	0.03	0.017
85	0.03	0.033	0.018	230	0.034	0.025	0.015	369	0.024	0.024	0.016
86	0.04	0.034	0.017	231	0.051	0.03	0.017	370	0.021	0.022	0.017
87	0.048	0.033	0.018	232	0.029	0.025	0.017	371	0.015	0.014	0.015
88	0.032	0.026	0.019	233	0.028	0.018	0.024	372	0.026	0.03	0.028
89	0.027	0.024	0.018	234	0.03	0.033	0.022	373	0.038	0.027	0.019
90	0.047	0.026	0.02	235	0.026	0.028	0.021	374	0.029	0.025	0.017
91	0.042	0.042	0.02	236	0.025	0.03	0.02	375	0.025	0.023	0.019
92	0.042	0.034	0.019	237	0.022	0.029	0.017	376	0.027	0.037	0.017
93	0.049	0.023	0.019	238	0.027	0.032	0.017	377	0.029	0.029	0.016
94	0.041	0.022	0.019	239	0.029	0.033	0.017	378	0.029	0.015	0.016
95	0.036	0.024	0.02	240	0.027	0.032	0.017	379	0.023	0.019	0.017
96	0.035	0.034	0.02	241	0.029	0.034	0.024	380	0.025	0.024	0.017
97	0.033	0.035	0.02	242	0.039	0.045	0.032	381	0.028	0.021	0.017
98	0.019	0.029	0.021	243	0.023	0.05	0.017	382	0.029	0.024	0.017
99	0.026	0.02	0.02	244	0.039	0.029	0.025	383	0.023	0.028	0.018
100	0.033	0.041	0.027	245	0.002	0.046	0.02	384	0.024	0.044	0.017
101	0.045	0.031	0.023	246	0.024	0.022	0.021	385	0.018	0.023	0.015
102	0.026	0.016	0.021	247	0.021	0.015	0.019	386	0.019	0.019	0.016
103	0.027	0.025	0.019	248	0.017	0.046	0.015	387	0.019	0.012	0.015
104	0.031	0.017	0.017	249	0.018	0.043	0.016	388	0.01	0.014	0.016
105	0.025	0.018	0.016	250	0.025	0.038	0.015	389	0.019	0.025	0.016
106	0.023	0.015	0.017	251	0.013	0.036	0.014	390	0.03	0.023	0.019
107	0.021	0.016	0.018	252	0.01	0.037	0.014	391	0.042	0.005	0.018
108	0.023	0.019	0.018	253	0.015	0.036	0.014	392	0.025	0.028	0.029
109	0.019	0.019	0.018	254	0.026	0.031	0.018	393	-	-	0.024
110	0.02	0.022	0.018	255	0.007	0.033	0.014	394	0.029	0.015	0.033
111	0.023	0.022	0.018	256	0.006	0.03	0.014	404	0.027	0.032	0.017
112	0.026	0.025	0.017	257	0.029	0.037	0.015	405	0.027	0.035	0.017
113	0.02	0.019	0.017	258	0.031	0.023	0.015	406	0.021	0.029	0.02
114	0.02	0.018	0.016	259	0.032	0.025	0.021	407	0.022	0.025	0.018
115	0.04	0.029	0.021	260	0.015	0.024	0.017	408	0.022	0.025	0.018

116	0.018	0.018	0.018	261	0.005	0.036	0.016	409	0.021	0.026	0.017
117	0.023	0.026	0.02	262	0.017	0.024	0.016	410	0.029	0.034	0.018
118	0.026	0.027	0.026	263	0.034	0.037	0.015	411	0.023	0.022	0.018
119	0.016	0.02	0.023	264	0.016	0.031	0.015	412	0.021	0.02	0.017
120	0.015	0.038	0.019	265	0.017	0.041	0.015	413	0.02	0.019	0.018
121	0.019	0.054	0.018	266	0.018	0.042	0.015	414	0.022	0.023	0.032
122	0.018	0.053	0.019	267	0.015	0.041	0.015	415	0.027	0.037	0.028
123	0.018	0.028	0.018	268	0.023	0.036	0.015	416	0.023	0.03	0.016
124	0.02	0.032	0.018	269	0.041	0.021	0.024	417	0.024	0.033	0.018
125	0.02	0.035	0.023	270	0.055	0.02	0.016	418	0.023	0.034	0.018
126	0.013	0.031	0.018	271	0.027	0.029	0.014	419	0.03	0.051	0.018
127	0.013	0.032	0.018	272	0.036	0.03	0.021	420	0.033	0.054	0.018
128	0.019	0.024	0.018	273	0.015	0.029	0.014	421	0.028	0.051	0.017
129	0.025	0.038	0.017	274	0.017	0.031	0.015	422	0.026	0.044	0.018
130	0.017	0.015	0.022	275	0.021	0.037	0.013	423	0.022	0.032	0.017
131	0.037	0.039	0.022	276	0.02	0.018	0.016	424	0.029	0.029	0.029
132	0.029	0.037	0.021	277	0.024	0.042	0.026	425	0.027	0.036	0.018
133	0.037	0.048	0.02	278	0.022	0.036	0.014	426	0.027	0.036	0.017
134	0.034	0.037	0.022	279	0.024	0.021	0.018	427	0.031	0.042	0.017
135	0.029	0.039	0.029	280	0.036	0.024	0.016	428	0.019	0.02	0.026
136	0.036	0.027	0.02	281	0.006	0.033	0.013	437	0.025	0.02	0.029
137	0.046	0.037	0.018	282	0.007	0.045	0.012	438	0.024	0.02	0.02
138	0.043	0.031	0.019	283	-	-	0.013	439	0.024	0.023	0.018
139	0.039	0.026	0.019	284	-	-	0.012	440	0.024	0.021	0.016
140	0.039	0.025	0.019	285	-	-	0.013	441	0.03	0.028	0.017
141	0.048	0.031	0.019	286	0.014	0.037	0.014	442	0.017	0.016	0.018
142	0.045	0.031	0.019	287	0.009	0.034	0.015	443	0.024	0.019	0.017
143	0.043	0.037	0.019	288	0.014	0.037	0.016	444	0.02	0.023	0.017

Table 5: Average Tie Line Magnitudes per Line

Internal Observation Statistics			
Category	**X**	**Y**	**Z**
Average Magnitude	0.027	0.028	0.019
RMS Values	0.041	0.043	0.026
Maximum Values	0.159	0.163	0.160
Observation Weight	83214.0	83214.0	1581886.0

Table 6: Tie Line Observation Statistics

Overall Relative Accuracy	
Category	**Mismatch**
Average 3D Mismatch	0.02068
Average XY Mismatch	0.04584
Average Z Mismatch	0.01886

Table 7: Relative Accuracy Results

TerraMatch Tie Lines	
Category	**Observations**
Section Lines	645,200
Roof Lines	38,492

Table 8: Total Tie Lines

2.8 Lidar Classification

Atlantic uses multiple automated filtering routines on the calibrated lidar point cloud identifying and extracting bare-earth and above ground features. GeoCue, TerraScan, and TerraModeler software was used for the initial batch processing and manual editing of the lidar point clouds. Atlantic utilized collected breakline data to preform classification for classes' 9-Water and 10-Ignored Ground in LP360. Outlined in Table 9 are the classification codes utilized for this project.

ASPRS Standard Lidar Point Classes	
Code	**Description**
1	Unclassified
2	Ground
7	Low Noise
9	Water
10	Ignored Ground
17	Bridges
18	High Noise
Flags	Overlap & Withheld

Table 9: Point Cloud Classification Scheme

Section 3: Lidar Accuracy

3.1   Ground Surveyed Check Points

Atlantic established a total of three hundred and ninety-five (395) check points for this project (227 NVA + 168 VVA). Point cloud data accuracy was tested against a Triangulated Irregular Network (TIN) constructed from lidar points in clear and open areas. A clear and open area can be characterized with respect to topographic and ground cover variation such that a minimum of 5 times the NPS exists with less than 1/3 of the $RMSE_z$ deviation from a low-slope plane. Slopes that exceed 10 percent were avoided. Each land cover type representing 10 percent or more of the total project area were tested and reported with a VVA. In land cover categories other than dense urban areas, the tested points did not have obstructions 45 degrees above the horizon to ensure a sufficient TIN surface. The VVA value is provided as a target. It is understood that in areas of dense vegetation, swamps, or extremely difficult terrain, this value may be exceeded. The NVA value is a requirement that must be met, regardless of any allowed "busts" in the VVA(s) for individual land cover types within the project. Checkpoints for each assessment (NVA & VVA) are required to be well-distributed throughout the land cover type, for the entire project area.

3.2 Vertical Accuracy

Below are the vertical accuracy reporting requirements for this project:

Vertical Accuracy Reporting Requirements in Meters:
$RMSE_Z \leq$ 10.0cm (Non-Vegetated Swath, DEM)
NVA $\leq$ 19.6cm 95% Confidence Level (Swath, DEM)
VVA $\leq$ 29.4cm 95th Percentile (DEM)

Vertical Accuracy Reporting Requirements in Feet:
$RMSE_Z \leq$ 0.328ft (Non-Vegetated Swath, DEM)
NVA $\leq$ 0.643ft 95% Confidence Level (Swath, DEM)
VVA $\leq$ 0.965ft 95th Percentile (DEM)

*The terms FVA (Fundamental Vertical Accuracy), SVA (Supplemental Vertical Accuracy) and CVA (Consolidated Vertical Accuracy) are from the National Digital Elevation Program (NDEP) Guidelines for Digital Elevation Data (2004). The term FVA refers to open terrain, urban and levee classes; the term SVA refers to classes tested that are in addition or supplemental to the open terrain; the term CVA refers to the consolidated accuracy of the data from all classes (FVA + SVA).

*The terms NVA (Non-vegetated Vertical Accuracy) and VVA (Vegetated Vertical Accuracy) are from the ASPRS Positional Accuracy Standards for Digital Geospatial Data v1.0 (2014). The term NVA refers to assessments in clear, open areas (which typically produce only single lidar returns); the term VVA refers to assessments in vegetated areas (typically characterized by multiple return lidar).

3.3 Check Point Distribution

The following graphics depict the location and distribution of NVA and VVA check points established for this project.
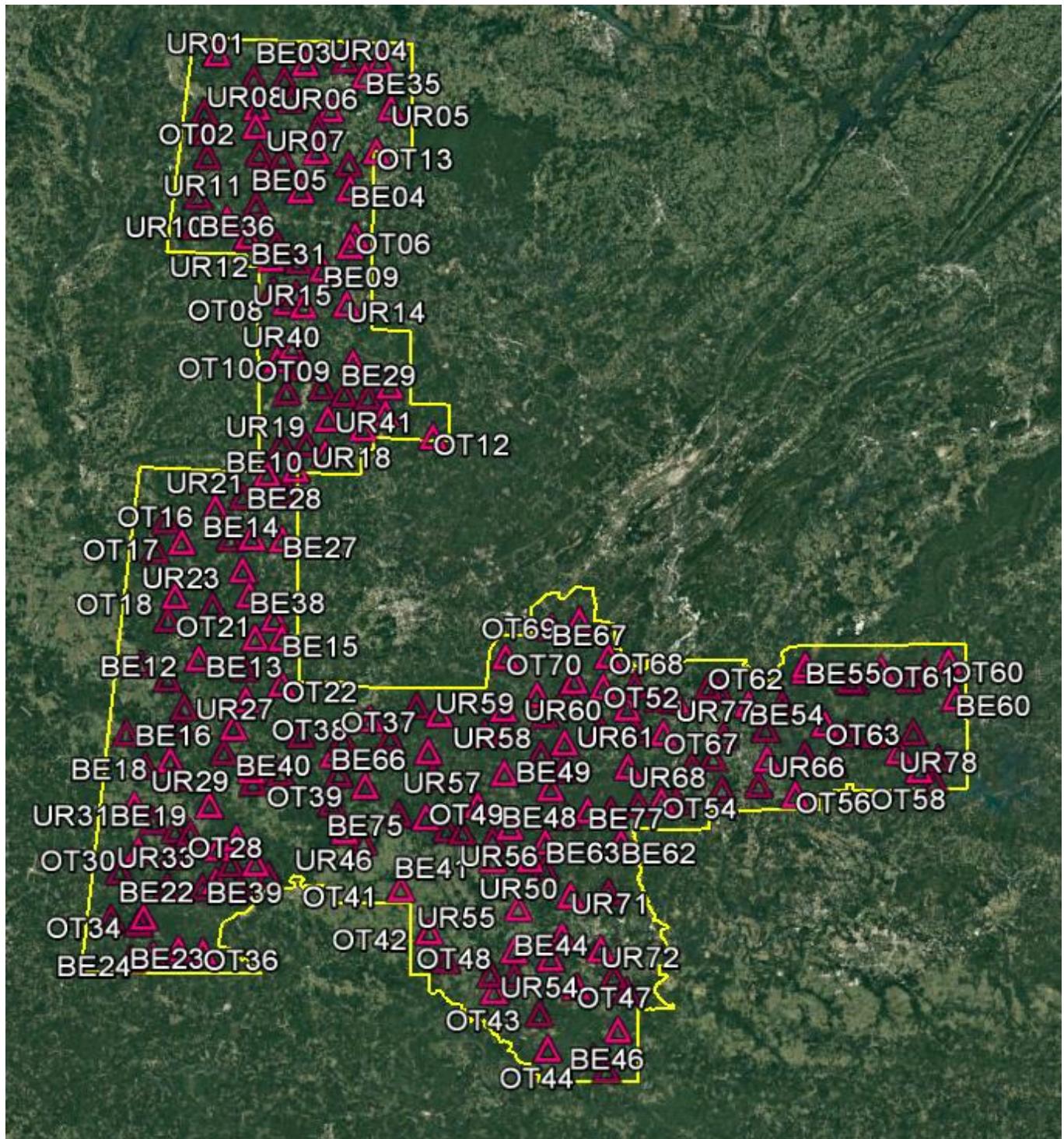
Figure 6: Non-vegetated Vertical Accuracy (NVA) Check Point Distribution
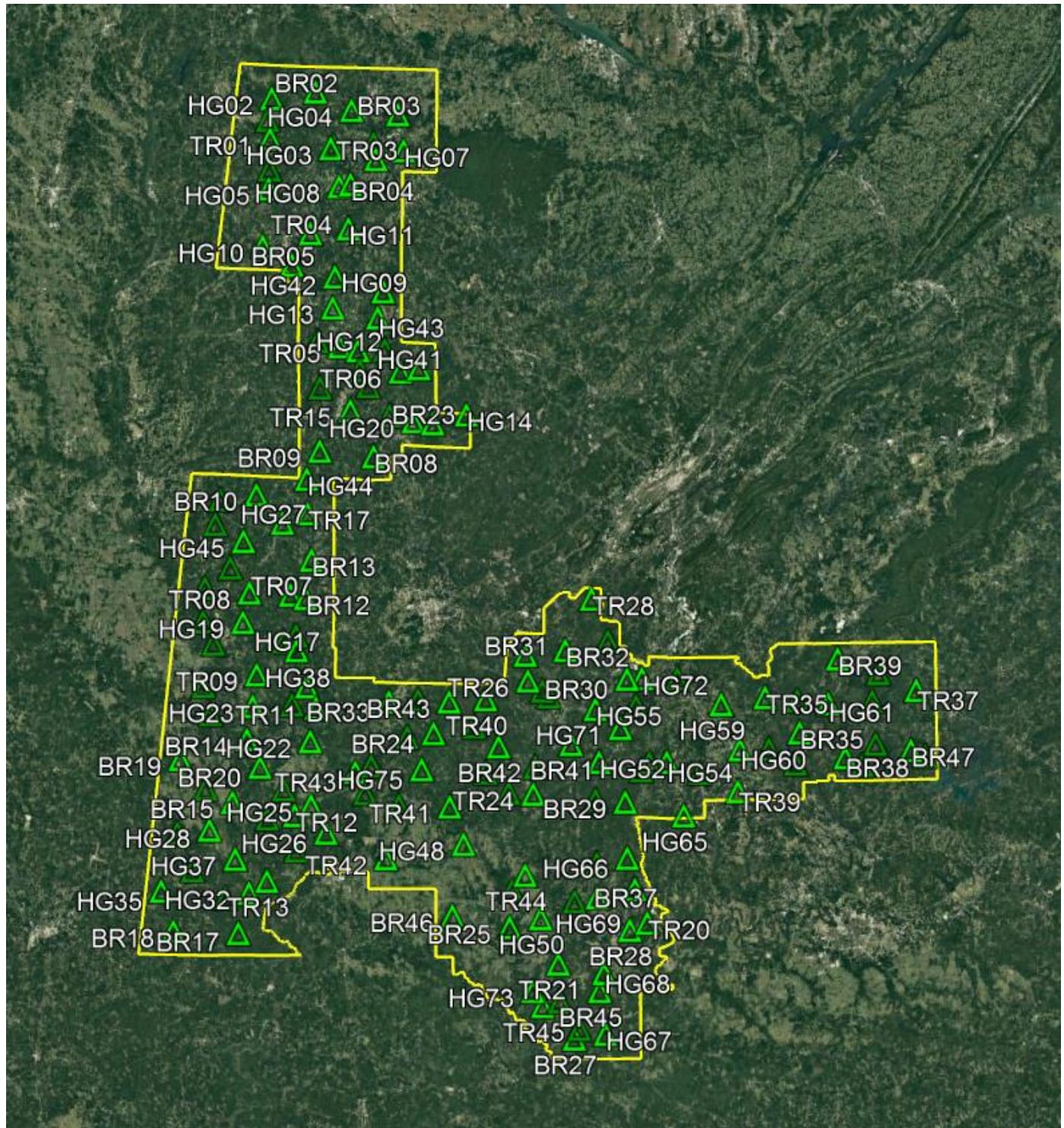
Figure 7: Vegetated Vertical Accuracy (VVA) Check Point Distribution

3.4   Vertical Accuracy Results

An overall statistical assessment of the check points can be found in Tables 10 and 11 below. The values provided are in meters.

Non-vegetated Vertical Accuracy (NVA) and Vegetated Vertical Accuracy (VVA)				
Broad Land Cover Type	**# of Points**	**RMSEz**	**95% Confidence Level**	**95th Percentile**
NVA of Lidar Point Cloud	227	0.064	0.126	
NVA of Bare-Earth Lidar	227	0.065	0.128	
NVA of Bare-Earth DEM	0	#DIV/0!	#DIV/0!	
VVA of Bare-Earth Lidar	168	0.080		0.146

Table 10: Non-vegetated Vertical Accuracy (NVA) and Vegetated Vertical Accuracy (VVA)

Point Collected Outside of BPA						
PointID	**Easting**	**Northing**	**KnownZ**	**LaserZ**	**Description**	**DeltaZ**
OT13	442347.787	3796216.550	278.830	278.795	Open Terrain/Bare Earth	-0.035

Table 11: Point Collected Outside of AOI

Vegetated Vertical Accuracy (VVA) 5% Outliers > 95th Percentile (0.146m)						
PointID	**Easting**	**Northing**	**KnownZ**	**LaserZ**	**Description**	**DeltaZ**
BR25	471645.296	3583006.526	51.550	51.717	Brush	0.167
BR43	454612.051	3646716.698	85.502	85.649	Brush	0.147
HG09	436122.170	3762383.711	205.948	206.115	High Grass	0.167
HG23	398981.763	3645497.038	70.600	70.749	High Grass	0.149
HG36	407681.757	3621989.514	66.030	66.185	High Grass	0.155
HG60	536945.174	3633053.160	186.907	187.057	High Grass	0.150
TR12	410771.744	3614708.622	35.966	36.112	Trees	0.146
TR23	496362.359	3600988.439	125.714	125.878	Trees	0.164
TR38	589591.879	3631035.041	202.234	202.386	Trees	0.152

Table 12: 5% Outlier Check Points

3.5   Check Point Assessment

A vertical accuracy assessment of the NVA & VVA check points against the lidar point cloud and bare-earth lidar can be found in Tables 12, 13, 14, and 15 below. The coordinates provided are in NAD83 (2011), UTM Zone 16 North, NAVD88 (Geoid12B), Meters.

Non-vegetated Vertical Accuracy (NVA) Check Point Assessment (Point Cloud)						
PointID	**Easting**	**Northing**	**KnownZ**	**LaserZ**	**Description**	**DeltaZ**
BE01	398104.087	3801609.537	219.913	219.857	Open Terrain/Bare Earth	-0.056
BE02	420495.434	3810094.924	271.220	271.265	Open Terrain/Bare Earth	0.045
BE03	424070.492	3820075.627	244.670	244.736	Open Terrain/Bare Earth	0.066
BE04	435589.854	3786111.377	252.660	252.704	Open Terrain/Bare Earth	0.044
BE05	422943.889	3785695.796	266.274	266.211	Open Terrain/Bare Earth	-0.063
BE06	411598.875	3781892.066	212.338	212.458	Open Terrain/Bare Earth	0.120

BE07	395858.266	3776105.873	136.341	136.335	Open Terrain/Bare Earth	-0.006
BE08	396666.292	3784354.505	163.861	164.009	Open Terrain/Bare Earth	0.148
BE09	428693.825	3764462.843	163.975	164.012	Open Terrain/Bare Earth	0.037
BE10	429201.388	3714711.693	95.960	95.964	Open Terrain/Bare Earth	0.004
BE11	385648.100	3688986.216	87.362	87.374	Open Terrain/Bare Earth	0.012
BE12	396789.304	3659919.913	54.092	54.135	Open Terrain/Bare Earth	0.043
BE13	411280.461	3665413.693	66.779	66.775	Open Terrain/Bare Earth	-0.004
BE14	410462.471	3692378.902	105.798	105.731	Open Terrain/Bare Earth	-0.067
BE15	418022.702	3665237.148	61.171	61.127	Open Terrain/Bare Earth	-0.044
BE16	405650.429	3641341.615	55.524	55.616	Open Terrain/Bare Earth	0.092
BE17	391766.215	3642211.793	36.156	36.202	Open Terrain/Bare Earth	0.046
BE18	389389.716	3632627.476	31.980	31.972	Open Terrain/Bare Earth	-0.008
BE19	399381.000	3620472.453	30.248	30.295	Open Terrain/Bare Earth	0.047
BE20	376382.997	3602659.886	70.126	70.100	Open Terrain/Bare Earth	-0.026
BE21	389835.015	3606733.779	48.817	48.944	Open Terrain/Bare Earth	0.127
BE22	400996.897	3599968.146	70.970	70.995	Open Terrain/Bare Earth	0.025
BE23	391359.601	3581650.212	64.985	65.020	Open Terrain/Bare Earth	0.035
BE24	384938.674	3579952.682	97.901	97.922	Open Terrain/Bare Earth	0.021
BE25	414482.838	3601571.447	42.748	42.624	Open Terrain/Bare Earth	-0.124
BE26	417505.133	3629076.713	47.242	47.369	Open Terrain/Bare Earth	0.127
BE27	418261.312	3691850.562	116.082	116.098	Open Terrain/Bare Earth	0.016
BE28	421614.809	3710616.019	110.229	110.329	Open Terrain/Bare Earth	0.100
BE29	445698.036	3732960.758	182.384	182.398	Open Terrain/Bare Earth	0.014
BE30	419407.610	3731379.472	101.697	101.729	Open Terrain/Bare Earth	0.032
BE31	435618.311	3770656.386	224.186	224.224	Open Terrain/Bare Earth	0.038
BE32	412418.615	3795737.729	251.036	251.099	Open Terrain/Bare Earth	0.063
BE33	427302.765	3802569.432	287.899	287.978	Open Terrain/Bare Earth	0.079
BE34	418741.847	3815769.078	224.139	224.088	Open Terrain/Bare Earth	-0.051
BE35	439416.102	3816628.675	230.682	230.665	Open Terrain/Bare Earth	-0.017
BE36	409524.872	3773288.604	117.042	116.986	Open Terrain/Bare Earth	-0.056
BE37	434060.041	3730862.437	147.294	147.289	Open Terrain/Bare Earth	-0.005
BE38	409761.159	3676902.071	72.790	72.781	Open Terrain/Bare Earth	-0.009
BE39	411203.780	3604737.800	43.401	43.442	Open Terrain/Bare Earth	0.041
BE40	431177.715	3633946.443	48.081	48.131	Open Terrain/Bare Earth	0.050
BE41	471815.565	3605678.206	87.851	88.000	Open Terrain/Bare Earth	0.149
BE42	485031.957	3603377.662	88.521	88.602	Open Terrain/Bare Earth	0.081
BE43	505975.707	3570287.562	76.558	76.597	Open Terrain/Bare Earth	0.039
BE44	489416.610	3585207.361	38.943	38.856	Open Terrain/Bare Earth	-0.087
BE45	477241.225	3574568.232	58.274	58.297	Open Terrain/Bare Earth	0.023
BE46	503645.561	3559805.918	111.405	111.397	Open Terrain/Bare Earth	-0.008

BE47	459747.885	3578761.202	78.593	78.576	Open Terrain/Bare Earth	-0.017
BE48	486523.865	3624875.329	137.436	137.493	Open Terrain/Bare Earth	0.057
BE49	490154.847	3637094.212	128.521	128.573	Open Terrain/Bare Earth	0.052
BE50	518555.224	3621382.186	156.519	156.447	Open Terrain/Bare Earth	-0.072
BE51	508337.332	3640151.366	169.256	169.338	Open Terrain/Bare Earth	0.082
BE52	514164.799	3648844.051	157.974	158.002	Open Terrain/Bare Earth	0.028
BE53	539624.392	3625725.944	165.270	165.251	Open Terrain/Bare Earth	-0.019
BE54	537057.659	3647406.309	170.960	170.958	Open Terrain/Bare Earth	-0.002
BE55	551598.404	3657745.632	175.838	175.820	Open Terrain/Bare Earth	-0.018
BE56	558833.539	3631093.306	155.474	155.443	Open Terrain/Bare Earth	-0.031
BE57	563045.163	3653684.287	218.742	218.751	Open Terrain/Bare Earth	0.009
BE58	572606.559	3639418.249	222.887	222.948	Open Terrain/Bare Earth	0.061
BE59	578191.115	3653719.366	238.110	238.085	Open Terrain/Bare Earth	-0.025
BE60	590020.079	3649009.338	220.562	220.504	Open Terrain/Bare Earth	-0.058
BE61	584489.129	3626830.332	222.411	222.301	Open Terrain/Bare Earth	-0.110
BE62	504460.790	3610278.607	151.114	151.240	Open Terrain/Bare Earth	0.126
BE63	485161.758	3610445.906	80.347	80.358	Open Terrain/Bare Earth	0.011
BE64	463894.666	3613201.756	115.771	115.737	Open Terrain/Bare Earth	-0.034
BE65	469816.772	3639820.594	122.655	122.665	Open Terrain/Bare Earth	0.010
BE66	455374.389	3634825.554	121.412	121.437	Open Terrain/Bare Earth	0.025
BE67	486948.589	3668093.330	194.653	194.771	Open Terrain/Bare Earth	0.118
BE68	490772.576	3650557.619	126.005	126.064	Open Terrain/Bare Earth	0.059
BE69	484096.143	3634179.859	85.148	85.175	Open Terrain/Bare Earth	0.027
BE70	501930.435	3618833.469	94.904	94.981	Open Terrain/Bare Earth	0.077
BE71	527942.766	3633088.244	190.816	190.896	Open Terrain/Bare Earth	0.080
BE72	526839.371	3652042.942	174.699	174.660	Open Terrain/Bare Earth	-0.039
BE73	456579.088	3628243.930	94.131	94.175	Open Terrain/Bare Earth	0.044
BE74	430743.868	3620926.238	52.320	52.376	Open Terrain/Bare Earth	0.056
BE75	454702.631	3617105.059	106.516	106.588	Open Terrain/Bare Earth	0.072
BE76	471684.032	3611103.663	71.316	71.338	Open Terrain/Bare Earth	0.022
BE77	496021.102	3618901.689	141.777	141.828	Open Terrain/Bare Earth	0.051
OT01	398244.433	3807057.422	172.773	172.794	Open Terrain/Bare Earth	0.021
OT02	411527.239	3803089.938	240.028	240.094	Open Terrain/Bare Earth	0.066
OT03	418316.041	3794643.110	264.021	264.136	Open Terrain/Bare Earth	0.115
OT04	416799.745	3771429.931	236.109	236.089	Open Terrain/Bare Earth	-0.020
OT05	435242.076	3792806.244	249.113	249.217	Open Terrain/Bare Earth	0.104
OT06	436907.830	3773426.611	224.956	225.094	Open Terrain/Bare Earth	0.138
OT07	415942.893	3758683.061	136.122	136.043	Open Terrain/Bare Earth	-0.079
OT08	419244.272	3755538.208	210.575	210.579	Open Terrain/Bare Earth	0.004
OT09	436343.833	3739106.135	189.627	189.641	Open Terrain/Bare Earth	0.014

OT10	416951.323	3740014.820	153.830	153.820	Open Terrain/Bare Earth	-0.010
OT11	428432.043	3732743.030	107.120	107.059	Open Terrain/Bare Earth	-0.061
OT12	456737.451	3719302.830	186.577	186.523	Open Terrain/Bare Earth	-0.054
OT13	442347.787	3796216.550	278.830	278.795	Open Terrain/Bare Earth	-0.035
OT14	419462.243	3704903.874	172.599	172.584	Open Terrain/Bare Earth	-0.015
OT15	408137.370	3703398.730	102.377	102.359	Open Terrain/Bare Earth	-0.018
OT16	401136.705	3700482.724	97.026	96.998	Open Terrain/Bare Earth	-0.028
OT17	392516.408	3691206.023	69.564	69.612	Open Terrain/Bare Earth	0.048
OT18	390792.084	3676638.439	95.374	95.421	Open Terrain/Bare Earth	0.047
OT19	381840.792	3658343.693	57.634	57.741	Open Terrain/Bare Earth	0.107
OT20	408506.652	3657211.938	62.904	62.941	Open Terrain/Bare Earth	0.037
OT21	416149.371	3670540.940	96.598	96.640	Open Terrain/Bare Earth	0.042
OT22	418036.483	3653038.072	102.195	102.329	Open Terrain/Bare Earth	0.134
OT23	393041.329	3646722.243	41.563	41.546	Open Terrain/Bare Earth	-0.017
OT24	378212.388	3639879.664	54.395	54.424	Open Terrain/Bare Earth	0.029
OT25	390718.004	3627841.715	49.737	49.784	Open Terrain/Bare Earth	0.047
OT26	403149.269	3634685.534	54.035	54.163	Open Terrain/Bare Earth	0.128
OT27	410645.451	3626600.669	58.763	58.851	Open Terrain/Bare Earth	0.088
OT28	406304.867	3611543.824	43.433	43.401	Open Terrain/Bare Earth	-0.032
OT29	384982.839	3616162.785	57.893	57.885	Open Terrain/Bare Earth	-0.008
OT30	381168.840	3608374.343	42.034	42.068	Open Terrain/Bare Earth	0.034
OT31	394421.909	3612975.196	80.120	80.117	Open Terrain/Bare Earth	-0.003
OT32	404755.926	3604591.278	48.535	48.658	Open Terrain/Bare Earth	0.123
OT33	397530.185	3598272.404	55.795	55.896	Open Terrain/Bare Earth	0.101
OT34	382420.690	3590273.276	83.929	83.942	Open Terrain/Bare Earth	0.013
OT35	374067.447	3589972.141	55.624	55.561	Open Terrain/Bare Earth	-0.063
OT36	397596.625	3580877.591	49.400	49.400	Open Terrain/Bare Earth	0.000
OT37	458153.945	3644834.798	120.016	120.075	Open Terrain/Bare Earth	0.059
OT38	440560.471	3643505.812	62.872	63.005	Open Terrain/Bare Earth	0.133
OT39	439262.968	3625575.557	57.986	58.082	Open Terrain/Bare Earth	0.096
OT40	438778.847	3610542.273	57.956	58.016	Open Terrain/Bare Earth	0.060
OT41	448274.892	3597982.096	65.821	65.851	Open Terrain/Bare Earth	0.030
OT42	455457.082	3586374.372	79.363	79.344	Open Terrain/Bare Earth	-0.019
OT43	472063.432	3570292.804	36.325	36.351	Open Terrain/Bare Earth	0.026
OT44	485691.932	3554707.715	44.915	44.789	Open Terrain/Bare Earth	-0.126
OT45	497385.914	3552512.294	124.430	124.381	Open Terrain/Bare Earth	-0.049
OT46	502529.325	3574394.140	54.884	54.900	Open Terrain/Bare Earth	0.016
OT47	493105.018	3571427.881	33.685	33.712	Open Terrain/Bare Earth	0.027
OT48	477138.333	3581277.079	49.154	49.250	Open Terrain/Bare Earth	0.096
OT49	467941.883	3620405.862	72.259	72.297	Open Terrain/Bare Earth	0.038

OT50	474978.196	3639922.629	136.942	136.867	Open Terrain/Bare Earth	-0.075
OT51	485054.099	3644510.396	76.915	76.918	Open Terrain/Bare Earth	0.003
OT52	499994.195	3652088.179	129.182	129.192	Open Terrain/Bare Earth	0.010
OT53	499308.833	3640762.642	119.028	119.125	Open Terrain/Bare Earth	0.097
OT54	514827.526	3621607.043	149.511	149.499	Open Terrain/Bare Earth	-0.012
OT55	530260.223	3624586.332	200.901	200.827	Open Terrain/Bare Earth	-0.074
OT56	548979.513	3623006.895	147.330	147.314	Open Terrain/Bare Earth	-0.016
OT57	569120.977	3638967.187	200.228	200.300	Open Terrain/Bare Earth	0.072
OT58	580755.070	3629511.593	204.283	204.163	Open Terrain/Bare Earth	-0.120
OT59	585545.780	3632642.208	226.044	226.112	Open Terrain/Bare Earth	0.068
OT60	588206.803	3658709.868	257.103	257.162	Open Terrain/Bare Earth	0.059
OT61	570937.385	3656744.450	246.490	246.571	Open Terrain/Bare Earth	0.081
OT62	551530.972	3656247.814	180.616	180.688	Open Terrain/Bare Earth	0.072
OT63	556627.797	3641999.494	205.614	205.529	Open Terrain/Bare Earth	-0.085
OT64	541500.208	3640724.783	202.683	202.758	Open Terrain/Bare Earth	0.075
OT65	529397.431	3651364.181	203.656	203.747	Open Terrain/Bare Earth	0.091
OT66	530781.968	3638809.131	183.684	183.700	Open Terrain/Bare Earth	0.016
OT67	515338.358	3639599.185	179.540	179.501	Open Terrain/Bare Earth	-0.039
OT68	501367.498	3660409.928	148.647	148.693	Open Terrain/Bare Earth	0.046
OT69	493930.132	3669896.318	127.015	127.020	Open Terrain/Bare Earth	0.005
OT70	475178.908	3660209.150	158.016	157.966	Open Terrain/Bare Earth	-0.050
UR01	401504.154	3822790.191	170.175	170.201	Urban Terrain	0.026
UR02	410945.795	3816057.060	234.610	234.510	Urban Terrain	-0.100
UR03	434301.438	3820872.548	246.515	246.556	Urban Terrain	0.041
UR04	443186.730	3820741.349	194.845	194.840	Urban Terrain	-0.005
UR05	446051.441	3807847.916	317.976	318.025	Urban Terrain	0.049
UR06	430478.655	3807541.442	311.800	311.746	Urban Terrain	-0.054
UR07	427049.608	3796255.174	268.061	268.093	Urban Terrain	0.032
UR08	411757.404	3808177.659	237.446	237.425	Urban Terrain	-0.021
UR09	399069.551	3795022.208	136.809	136.810	Urban Terrain	0.001
UR10	404081.550	3778057.680	195.970	195.884	Urban Terrain	-0.086
UR11	414030.764	3789191.362	259.546	259.462	Urban Terrain	-0.084
UR12	415302.175	3767288.755	222.403	222.348	Urban Terrain	-0.055
UR13	422475.546	3766623.514	244.253	244.150	Urban Terrain	-0.103
UR14	434684.157	3754993.345	152.136	152.141	Urban Terrain	0.005
UR15	423659.263	3754645.204	159.014	159.055	Urban Terrain	0.041
UR16	423317.593	3737949.194	172.344	172.384	Urban Terrain	0.040
UR17	440184.137	3730023.507	163.784	163.802	Urban Terrain	0.018
UR18	438825.994	3721561.125	113.976	113.941	Urban Terrain	-0.035
UR19	429890.143	3724162.272	156.459	156.431	Urban Terrain	-0.028

UR20	424351.220	3717559.555	92.055	92.047	Urban Terrain	-0.008
UR21	414395.628	3709523.985	160.249	160.209	Urban Terrain	-0.040
UR22	404998.369	3692165.811	76.320	76.316	Urban Terrain	-0.004
UR23	408066.755	3683631.090	80.727	80.683	Urban Terrain	-0.044
UR24	400356.084	3674076.844	63.635	63.549	Urban Terrain	-0.086
UR25	388851.817	3670439.180	88.834	88.833	Urban Terrain	-0.001
UR26	388745.624	3654510.004	43.317	43.345	Urban Terrain	0.028
UR27	408841.799	3648749.898	81.490	81.470	Urban Terrain	-0.020
UR28	422863.879	3639303.910	63.007	63.048	Urban Terrain	0.041
UR29	410229.373	3629756.805	46.794	46.734	Urban Terrain	-0.060
UR30	382987.042	3631077.423	60.729	60.654	Urban Terrain	-0.075
UR31	380162.912	3620517.939	80.016	79.999	Urban Terrain	-0.017
UR32	390617.479	3613692.564	91.057	91.061	Urban Terrain	0.004
UR33	401552.853	3608873.591	33.357	33.343	Urban Terrain	-0.014
UR34	407084.117	3598195.355	36.726	36.669	Urban Terrain	-0.057
UR35	388586.093	3598378.916	34.464	34.452	Urban Terrain	-0.012
UR36	381101.298	3588643.931	105.364	105.297	Urban Terrain	-0.067
UR37	379031.669	3578797.067	70.126	69.981	Urban Terrain	-0.145
UR38	409525.672	3773294.462	117.132	117.010	Urban Terrain	-0.122
UR39	421846.141	3757859.458	150.300	150.178	Urban Terrain	-0.122
UR40	420836.866	3743409.009	119.018	119.008	Urban Terrain	-0.010
UR41	444625.392	3725702.044	164.992	165.126	Urban Terrain	0.134
UR42	418090.572	3717410.732	162.683	162.649	Urban Terrain	-0.034
UR43	388426.805	3696895.270	88.302	88.225	Urban Terrain	-0.077
UR44	433669.547	3638096.565	40.690	40.633	Urban Terrain	-0.057
UR45	432506.024	3628764.616	82.996	82.969	Urban Terrain	-0.027
UR46	433969.795	3613486.385	52.143	52.009	Urban Terrain	-0.134
UR47	447722.492	3618116.098	89.548	89.559	Urban Terrain	0.011
UR48	445528.413	3638463.120	119.578	119.519	Urban Terrain	-0.059
UR49	452458.326	3647035.343	76.935	76.845	Urban Terrain	-0.090
UR50	481225.752	3605770.067	49.463	49.597	Urban Terrain	0.134
UR51	460070.988	3613950.246	110.380	110.373	Urban Terrain	-0.007
UR52	471199.509	3574816.260	46.458	46.476	Urban Terrain	0.018
UR53	483577.238	3564222.055	52.555	52.554	Urban Terrain	-0.001
UR54	486437.275	3579185.589	65.629	65.720	Urban Terrain	0.091
UR55	478233.082	3592695.789	69.145	69.130	Urban Terrain	-0.015
UR56	476140.156	3614506.797	54.035	54.022	Urban Terrain	-0.013
UR57	474757.262	3628940.084	60.664	60.627	Urban Terrain	-0.037
UR58	474592.178	3646226.392	84.973	84.922	Urban Terrain	-0.051
UR59	483160.145	3649881.327	100.553	100.566	Urban Terrain	0.013

UR60	492619.630	3653634.591	98.915	98.897	Urban Terrain	-0.018
UR61	506182.022	3646375.246	136.241	136.155	Urban Terrain	-0.086
UR62	545723.382	3647300.030	128.880	128.788	Urban Terrain	-0.092
UR63	564109.859	3653321.018	198.677	198.572	Urban Terrain	-0.105
UR64	562204.333	3639161.822	168.838	168.853	Urban Terrain	0.015
UR65	551497.724	3633779.773	125.247	125.250	Urban Terrain	0.003
UR66	541825.721	3632603.050	173.472	173.510	Urban Terrain	0.038
UR67	522671.166	3630854.439	136.226	136.164	Urban Terrain	-0.062
UR68	506291.260	3630623.692	172.695	172.584	Urban Terrain	-0.111
UR69	489742.706	3629869.174	119.950	120.043	Urban Terrain	0.093
UR70	490767.577	3617131.251	77.730	77.684	Urban Terrain	-0.046
UR71	491622.957	3596024.865	52.722	52.712	Urban Terrain	-0.010
UR72	499269.285	3581583.829	37.526	37.537	Urban Terrain	0.011
UR73	501276.692	3596985.348	112.758	112.751	Urban Terrain	-0.007
UR74	508923.892	3620550.076	85.661	85.534	Urban Terrain	-0.127
UR75	579176.024	3639660.079	241.969	241.942	Urban Terrain	-0.027
UR76	582081.415	3655542.976	210.574	210.508	Urban Terrain	-0.066
UR77	518448.858	3648400.159	193.417	193.322	Urban Terrain	-0.095
UR78	575534.659	3634545.410	214.141	214.220	Urban Terrain	0.079
UR79	500720.972	3549073.696	54.711	54.662	Urban Terrain	-0.049
UR80	508076.752	3652415.234	146.459	146.431	Urban Terrain	-0.028

Table 13: Lidar Point Cloud NVA Assessment

Vegetated Vertical Accuracy (VVA) Check Point Assessment (Bare Earth)						
PointID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
BR01	403296.463	3811109.828	172.810	172.875	Brush	0.065
BR02	416919.654	3819094.355	188.014	187.999	Brush	-0.015
BR03	440359.897	3812541.603	224.063	224.095	Brush	0.032
BR04	426894.557	3792783.885	252.937	253.036	Brush	0.099
BR05	410265.181	3769971.061	124.034	124.160	Brush	0.126
BR06	436566.259	3745954.387	171.677	171.718	Brush	0.041
BR07	437951.183	3727388.017	143.246	143.212	Brush	-0.034
BR08	433349.760	3715811.062	152.846	152.904	Brush	0.058
BR09	418104.145	3717419.663	163.509	163.524	Brush	0.015
BR10	400114.617	3705192.724	123.890	123.751	Brush	-0.139
BR11	392652.445	3684585.402	121.489	121.477	Brush	-0.012
BR12	413991.714	3675902.122	77.502	77.557	Brush	0.055
BR13	415704.687	3686714.974	76.098	76.236	Brush	0.138
BR14	397287.813	3636149.976	44.060	44.167	Brush	0.107

BR15	393130.122	3618451.010	45.277	45.308	Brush	0.031
BR16	391027.975	3591375.905	31.638	31.730	Brush	0.092
BR17	394648.337	3581391.952	59.504	59.621	Brush	0.117
BR18	376177.984	3581968.530	64.197	64.179	Brush	-0.018
BR19	378307.923	3630562.352	43.419	43.424	Brush	0.005
BR20	400972.601	3628355.116	36.304	36.394	Brush	0.090
BR21	411198.658	3604747.745	42.701	42.762	Brush	0.061
BR22	429442.961	3740179.299	136.867	137.008	Brush	0.141
BR23	450122.475	3725091.501	152.625	152.705	Brush	0.080
BR24	450208.822	3637792.096	80.743	80.844	Brush	0.101
BR25	471645.296	3583006.526	51.550	51.717	Brush	0.167
BR26	485848.751	3561990.469	33.853	33.942	Brush	0.089
BR27	489971.960	3551399.190	82.540	82.492	Brush	-0.048
BR28	505701.912	3582151.782	38.442	38.558	Brush	0.116
BR29	504451.369	3618348.625	99.399	99.399	Brush	0.000
BR30	504992.341	3653002.590	162.342	162.272	Brush	-0.070
BR31	476236.239	3659854.301	133.532	133.669	Brush	0.137
BR32	487506.869	3661143.221	139.757	139.760	Brush	0.003
BR33	437554.459	3646735.702	39.120	39.204	Brush	0.084
BR34	430719.174	3620904.681	52.060	52.199	Brush	0.139
BR35	553890.314	3637757.092	134.153	134.273	Brush	0.120
BR36	519241.410	3653106.991	208.092	208.128	Brush	0.036
BR37	507155.636	3593684.226	89.538	89.642	Brush	0.104
BR38	566867.828	3630720.944	204.807	204.797	Brush	-0.010
BR39	564712.336	3658588.619	216.421	216.435	Brush	0.014
BR40	574544.634	3646629.215	153.750	153.718	Brush	-0.032
BR41	489126.358	3634645.549	114.262	114.389	Brush	0.127
BR42	468604.697	3634041.179	87.072	87.216	Brush	0.144
BR43	454612.051	3646716.698	85.502	85.649	Brush	0.147
BR44	490050.126	3590267.731	46.632	46.625	Brush	-0.007
BR45	497164.369	3564873.706	42.346	42.338	Brush	-0.008
BR46	455407.369	3586345.241	79.260	79.248	Brush	-0.012
BR47	585564.399	3632671.767	226.972	227.043	Brush	0.071
HG01	403864.446	3797018.739	218.479	218.522	High Grass	0.043
HG02	404523.481	3817308.098	158.033	157.985	High Grass	-0.048
HG03	421287.557	3802993.340	275.530	275.585	High Grass	0.055
HG04	427185.071	3813805.600	200.391	200.430	High Grass	0.039
HG05	403660.502	3791636.743	218.881	218.962	High Grass	0.081
HG06	433429.729	3804401.557	307.542	307.553	High Grass	0.011

HG07	441951.041	3802285.125	299.595	299.623	High Grass	0.028
HG08	423651.178	3792197.476	276.643	276.595	High Grass	-0.048
HG09	436122.170	3762383.711	205.948	206.115	High Grass	0.167
HG10	401926.105	3775354.125	198.582	198.663	High Grass	0.081
HG11	426281.967	3780257.936	186.244	186.246	High Grass	0.002
HG12	428965.981	3745768.159	160.518	160.576	High Grass	0.058
HG13	421840.540	3757856.061	149.349	149.389	High Grass	0.040
HG14	459643.220	3727543.533	99.883	99.898	High Grass	0.015
HG15	417574.187	3748389.727	135.331	135.321	High Grass	-0.010
HG16	418196.689	3735272.359	112.896	112.896	High Grass	0.000
HG17	411429.827	3661230.855	54.522	54.559	High Grass	0.037
HG18	431906.448	3735610.020	150.518	150.604	High Grass	0.086
HG19	396247.217	3669210.068	49.185	49.158	High Grass	-0.027
HG20	444622.512	3725706.681	164.851	164.915	High Grass	0.064
HG21	384901.707	3669388.334	44.212	44.221	High Grass	0.009
HG22	415244.091	3635570.635	74.184	74.110	High Grass	-0.074
HG23	398981.763	3645497.038	70.600	70.749	High Grass	0.149
HG24	388423.741	3696894.133	88.292	88.310	High Grass	0.018
HG25	415427.288	3617528.968	37.359	37.386	High Grass	0.027
HG26	419629.791	3609730.850	39.848	39.977	High Grass	0.129
HG27	407504.179	3697148.496	78.983	78.911	High Grass	-0.072
HG28	386549.685	3610611.896	57.874	57.961	High Grass	0.087
HG29	407809.122	3663757.802	87.851	87.895	High Grass	0.044
HG30	403030.876	3613813.598	34.801	34.940	High Grass	0.139
HG31	387824.190	3663088.890	44.721	44.789	High Grass	0.068
HG32	397739.423	3592754.158	41.396	41.517	High Grass	0.121
HG33	386950.363	3643287.022	55.457	55.570	High Grass	0.113
HG34	410113.568	3645956.280	54.141	54.071	High Grass	-0.070
HG35	372765.792	3593369.313	74.806	74.759	High Grass	-0.047
HG36	407681.757	3621989.514	66.030	66.185	High Grass	0.155
HG37	393878.547	3602375.300	57.194	57.178	High Grass	-0.016
HG38	414264.690	3651029.106	108.804	108.691	High Grass	-0.113
HG39	385563.600	3622237.138	64.445	64.462	High Grass	0.017
HG40	381645.696	3599137.797	55.255	55.177	High Grass	-0.078
HG41	446287.492	3740657.553	143.033	143.060	High Grass	0.027
HG42	422475.120	3766617.038	243.859	243.779	High Grass	-0.080
HG43	434562.319	3755006.073	149.805	149.849	High Grass	0.044
HG44	414399.505	3709527.653	159.936	160.026	High Grass	0.090
HG45	396430.896	3692026.125	65.760	65.701	High Grass	-0.059

HG46	442705.520	3636772.021	133.224	133.292	High Grass	0.068
HG47	440308.324	3617383.554	55.394	55.492	High Grass	0.098
HG48	458621.547	3606535.471	82.400	82.449	High Grass	0.049
HG49	472339.744	3593337.801	64.698	64.836	High Grass	0.138
HG50	480429.529	3585523.962	65.786	65.686	High Grass	-0.100
HG51	496018.159	3618895.013	141.567	141.675	High Grass	0.108
HG52	497004.141	3629598.056	114.350	114.447	High Grass	0.097
HG53	509010.721	3627230.815	168.337	168.284	High Grass	-0.053
HG54	516223.976	3629552.580	111.058	111.055	High Grass	-0.003
HG55	496003.182	3644512.140	98.723	98.758	High Grass	0.035
HG56	481034.563	3649716.212	124.045	124.148	High Grass	0.103
HG57	464865.597	3626703.796	130.545	130.537	High Grass	-0.008
HG58	471399.030	3621001.431	97.062	97.109	High Grass	0.047
HG59	531673.231	3645797.982	210.383	210.380	High Grass	-0.003
HG60	536945.174	3633053.160	186.907	187.057	High Grass	0.150
HG61	561980.544	3645933.270	159.745	159.640	High Grass	-0.105
HG62	576292.576	3654418.692	231.809	231.785	High Grass	-0.024
HG63	575515.364	3634524.655	213.564	213.651	High Grass	0.087
HG64	571724.810	3628550.966	132.285	132.249	High Grass	-0.036
HG65	521025.330	3614452.561	170.032	170.040	High Grass	0.008
HG66	504995.767	3602510.937	131.793	131.834	High Grass	0.041
HG67	498781.891	3552711.412	109.818	109.697	High Grass	-0.121
HG68	498372.800	3569943.637	75.024	75.122	High Grass	0.098
HG69	496466.957	3591380.150	62.423	62.536	High Grass	0.113
HG70	478961.856	3628217.953	74.364	74.469	High Grass	0.105
HG71	503081.560	3639142.288	170.678	170.754	High Grass	0.076
HG72	509210.822	3653134.772	161.943	162.000	High Grass	0.057
HG73	478168.891	3564935.322	60.868	60.728	High Grass	-0.140
HG74	432527.573	3628750.375	82.642	82.670	High Grass	0.028
HG75	446812.079	3627609.332	104.315	104.391	High Grass	0.076
TR01	404019.544	3805805.741	228.852	228.855	Trees	0.003
TR02	422109.327	3803666.985	279.401	279.468	Trees	0.067
TR03	434103.767	3799845.411	296.987	296.985	Trees	-0.002
TR04	415491.420	3778905.705	162.547	162.487	Trees	-0.060
TR05	423760.340	3746895.945	144.128	144.157	Trees	0.029
TR06	440949.503	3739678.871	216.657	216.773	Trees	0.116
TR07	409767.130	3676884.488	72.169	72.289	Trees	0.120
TR08	398090.684	3677510.994	56.970	57.035	Trees	0.065
TR09	400106.563	3654439.655	86.925	86.896	Trees	-0.029

TR10	385007.145	3651189.433	60.564	60.692	Trees	0.128
TR11	416922.440	3644980.359	97.410	97.419	Trees	0.009
TR12	410771.744	3614708.622	35.966	36.112	Trees	0.146
TR13	402854.513	3596179.762	68.905	68.926	Trees	0.021
TR14	377454.252	3609769.254	56.966	56.951	Trees	-0.015
TR15	426794.347	3728811.430	137.098	137.185	Trees	0.087
TR16	389914.888	3703770.387	96.184	96.268	Trees	0.084
TR17	414593.285	3699802.052	124.651	124.594	Trees	-0.057
TR18	385475.315	3678858.736	64.539	64.498	Trees	-0.041
TR19	411270.625	3665395.216	66.259	66.250	Trees	-0.009
TR20	510648.754	3584133.867	42.688	42.784	Trees	0.096
TR21	485437.074	3572646.405	74.446	74.492	Trees	0.046
TR22	491385.791	3554189.000	48.313	48.416	Trees	0.103
TR23	496362.359	3600988.439	125.714	125.878	Trees	0.164
TR24	478383.561	3620642.960	56.511	56.582	Trees	0.071
TR25	482868.866	3648067.267	108.246	108.376	Trees	0.130
TR26	476944.740	3652586.036	88.685	88.730	Trees	0.045
TR27	445813.020	3647268.585	71.198	71.148	Trees	-0.050
TR28	494961.393	3675559.011	131.112	131.257	Trees	0.145
TR29	499577.249	3663666.768	191.206	191.168	Trees	-0.038
TR30	507557.709	3645426.513	165.634	165.544	Trees	-0.090
TR31	511276.428	3629348.064	113.396	113.287	Trees	-0.109
TR32	525612.922	3626532.136	202.591	202.588	Trees	-0.003
TR33	545217.548	3633159.529	178.118	178.118	Trees	0.000
TR34	552751.687	3629000.462	101.002	101.064	Trees	0.062
TR35	544123.803	3647733.346	122.681	122.682	Trees	0.001
TR36	553220.246	3646820.805	199.071	199.129	Trees	0.058
TR37	587069.593	3649656.755	224.828	224.828	Trees	0.000
TR38	589591.879	3631035.041	202.234	202.386	Trees	0.152
TR39	536371.604	3621229.015	201.876	201.820	Trees	-0.056
TR40	464972.242	3647324.598	136.069	136.037	Trees	-0.032
TR41	454725.417	3617086.097	107.158	107.169	Trees	0.011
TR42	436615.469	3602531.845	44.382	44.350	Trees	-0.032
TR43	428016.645	3626918.618	64.582	64.667	Trees	0.085
TR44	476061.974	3597777.660	67.567	67.547	Trees	-0.020
TR45	480960.300	3560650.580	34.947	34.903	Trees	-0.044
TR46	461675.804	3639659.203	125.477	125.462	Trees	-0.015

Table 14: Bare-Earth Lidar NVA Assessment

		Non-vegetated Vertical Accuracy (NVA) Check Point Assessment (DEM)				
PointID	**Easting**	**Northing**	**KnownZ**	**DEMZ**	**Description**	**DeltaZ**
BE01	398104.087	3801609.537	219.913	219.821	Open Terrain/Bare Earth	0.092
BE02	420495.434	3810094.924	271.220	271.252	Open Terrain/Bare Earth	-0.032
BE03	424070.492	3820075.627	244.670	244.725	Open Terrain/Bare Earth	-0.055
BE04	435589.854	3786111.377	252.660	252.699	Open Terrain/Bare Earth	-0.039
BE05	422943.889	3785695.796	266.274	266.154	Open Terrain/Bare Earth	0.120
BE06	411598.875	3781892.066	212.338	212.380	Open Terrain/Bare Earth	-0.042
BE07	395858.266	3776105.873	136.341	136.325	Open Terrain/Bare Earth	0.016
BE08	396666.292	3784354.505	163.861	163.894	Open Terrain/Bare Earth	-0.033
BE09	428693.825	3764462.843	163.975	163.993	Open Terrain/Bare Earth	-0.018
BE10	429201.388	3714711.693	95.960	95.900	Open Terrain/Bare Earth	0.060
BE11	385648.100	3688986.216	87.362	87.335	Open Terrain/Bare Earth	0.027
BE12	396789.304	3659919.913	54.092	54.119	Open Terrain/Bare Earth	-0.027
BE13	411280.461	3665413.693	66.779	66.780	Open Terrain/Bare Earth	-0.001
BE14	410462.471	3692378.902	105.798	105.742	Open Terrain/Bare Earth	0.056
BE15	418022.702	3665237.148	61.171	61.094	Open Terrain/Bare Earth	0.077
BE16	405650.429	3641341.615	55.524	55.575	Open Terrain/Bare Earth	-0.051
BE17	391766.215	3642211.793	36.156	36.195	Open Terrain/Bare Earth	-0.039
BE18	389389.716	3632627.476	31.980	31.909	Open Terrain/Bare Earth	0.071
BE19	399381.000	3620472.453	30.248	30.277	Open Terrain/Bare Earth	-0.029
BE20	376382.997	3602659.886	70.126	70.057	Open Terrain/Bare Earth	0.069
BE21	389835.015	3606733.779	48.817	48.895	Open Terrain/Bare Earth	-0.078
BE22	400996.897	3599968.146	70.970	70.980	Open Terrain/Bare Earth	-0.010
BE23	391359.601	3581650.212	64.985	65.017	Open Terrain/Bare Earth	-0.032
BE24	384938.674	3579952.682	97.901	97.890	Open Terrain/Bare Earth	0.011
BE25	414482.838	3601571.447	42.748	42.616	Open Terrain/Bare Earth	0.132
BE26	417505.133	3629076.713	47.242	47.394	Open Terrain/Bare Earth	-0.152
BE27	418261.312	3691850.562	116.082	116.088	Open Terrain/Bare Earth	-0.006
BE28	421614.809	3710616.019	110.229	110.310	Open Terrain/Bare Earth	-0.081
BE29	445698.036	3732960.758	182.384	182.402	Open Terrain/Bare Earth	-0.018
BE30	419407.610	3731379.472	101.697	101.685	Open Terrain/Bare Earth	0.012
BE31	435618.311	3770656.386	224.186	224.180	Open Terrain/Bare Earth	0.006
BE32	412418.615	3795737.729	251.036	251.063	Open Terrain/Bare Earth	-0.027
BE33	427302.765	3802569.432	287.899	287.965	Open Terrain/Bare Earth	-0.066
BE34	418741.847	3815769.078	224.139	224.088	Open Terrain/Bare Earth	0.051
BE35	439416.102	3816628.675	230.682	230.642	Open Terrain/Bare Earth	0.040
BE36	409524.872	3773288.604	117.042	116.960	Open Terrain/Bare Earth	0.082
BE37	434060.041	3730862.437	147.294	147.272	Open Terrain/Bare Earth	0.022
BE38	409761.159	3676902.071	72.790	72.784	Open Terrain/Bare Earth	0.006
BE39	411203.780	3604737.800	43.401	43.429	Open Terrain/Bare Earth	-0.028
BE40	431177.715	3633946.443	48.081	47.988	Open Terrain/Bare Earth	0.093
BE41	471815.565	3605678.206	87.851	87.924	Open Terrain/Bare Earth	-0.073

BE42	485031.957	3603377.662	88.521	88.595	Open Terrain/Bare Earth	-0.074
BE43	505975.707	3570287.562	76.558	76.592	Open Terrain/Bare Earth	-0.034
BE44	489416.610	3585207.361	38.943	38.845	Open Terrain/Bare Earth	0.098
BE45	477241.225	3574568.232	58.274	58.301	Open Terrain/Bare Earth	-0.027
BE46	503645.561	3559805.918	111.405	111.399	Open Terrain/Bare Earth	0.006
BE47	459747.885	3578761.202	78.593	78.560	Open Terrain/Bare Earth	0.033
BE48	486523.865	3624875.329	137.436	137.483	Open Terrain/Bare Earth	-0.047
BE49	490154.847	3637094.212	128.521	128.558	Open Terrain/Bare Earth	-0.037
BE50	518555.224	3621382.186	156.519	156.446	Open Terrain/Bare Earth	0.073
BE51	508337.332	3640151.366	169.256	169.332	Open Terrain/Bare Earth	-0.076
BE52	514164.799	3648844.051	157.974	158.015	Open Terrain/Bare Earth	-0.041
BE53	539624.392	3625725.944	165.270	165.260	Open Terrain/Bare Earth	0.010
BE54	537057.659	3647406.309	170.960	170.956	Open Terrain/Bare Earth	0.004
BE55	551598.404	3657745.632	175.838	175.798	Open Terrain/Bare Earth	0.040
BE56	558833.539	3631093.306	155.474	155.413	Open Terrain/Bare Earth	0.061
BE57	563045.163	3653684.287	218.742	218.752	Open Terrain/Bare Earth	-0.010
BE58	572606.559	3639418.249	222.887	222.898	Open Terrain/Bare Earth	-0.011
BE59	578191.115	3653719.366	238.110	238.080	Open Terrain/Bare Earth	0.030
BE60	590020.079	3649009.338	220.562	220.498	Open Terrain/Bare Earth	0.064
BE61	584489.129	3626830.332	222.411	222.312	Open Terrain/Bare Earth	0.099
BE62	504460.790	3610278.607	151.114	151.214	Open Terrain/Bare Earth	-0.100
BE63	485161.758	3610445.906	80.347	80.361	Open Terrain/Bare Earth	-0.014
BE64	463894.666	3613201.756	115.771	115.733	Open Terrain/Bare Earth	0.038
BE65	469816.772	3639820.594	122.655	122.636	Open Terrain/Bare Earth	0.019
BE66	455374.389	3634825.554	121.412	121.401	Open Terrain/Bare Earth	0.011
BE67	486948.589	3668093.330	194.653	194.729	Open Terrain/Bare Earth	-0.076
BE68	490772.576	3650557.619	126.005	126.064	Open Terrain/Bare Earth	-0.059
BE69	484096.143	3634179.859	85.148	85.174	Open Terrain/Bare Earth	-0.026
BE70	501930.435	3618833.469	94.904	94.982	Open Terrain/Bare Earth	-0.078
BE71	527942.766	3633088.244	190.816	190.889	Open Terrain/Bare Earth	-0.073
BE72	526839.371	3652042.942	174.699	174.642	Open Terrain/Bare Earth	0.057
BE73	456579.088	3628243.930	94.131	94.055	Open Terrain/Bare Earth	0.076
BE74	430743.868	3620926.238	52.320	52.395	Open Terrain/Bare Earth	-0.075
BE75	454702.631	3617105.059	106.516	106.591	Open Terrain/Bare Earth	-0.075
BE76	471684.032	3611103.663	71.316	71.331	Open Terrain/Bare Earth	-0.015
BE77	496021.102	3618901.689	141.777	141.805	Open Terrain/Bare Earth	-0.028
OT01	398244.433	3807057.422	172.773	172.685	Open Terrain/Bare Earth	0.088
OT02	411527.239	3803089.938	240.028	240.037	Open Terrain/Bare Earth	-0.009
OT03	418316.041	3794643.110	264.021	264.062	Open Terrain/Bare Earth	-0.041
OT04	416799.745	3771429.931	236.109	236.065	Open Terrain/Bare Earth	0.044
OT05	435242.076	3792806.244	249.113	249.218	Open Terrain/Bare Earth	-0.105
OT06	436907.830	3773426.611	224.956	225.087	Open Terrain/Bare Earth	-0.131
OT07	415942.893	3758683.061	136.122	136.045	Open Terrain/Bare Earth	0.077

OT08	419244.272	3755538.208	210.575	210.529	Open Terrain/Bare Earth	0.046
OT09	436343.833	3739106.135	189.627	189.664	Open Terrain/Bare Earth	-0.037
OT10	416951.323	3740014.820	153.830	153.780	Open Terrain/Bare Earth	0.050
OT11	428432.043	3732743.030	107.120	107.075	Open Terrain/Bare Earth	0.045
OT12	456737.451	3719302.830	186.577	186.521	Open Terrain/Bare Earth	0.056
OT14	419462.243	3704903.874	172.599	172.567	Open Terrain/Bare Earth	0.032
OT15	408137.370	3703398.730	102.377	102.297	Open Terrain/Bare Earth	0.080
OT16	401136.705	3700482.724	97.026	96.973	Open Terrain/Bare Earth	0.053
OT17	392516.408	3691206.023	69.564	69.553	Open Terrain/Bare Earth	0.011
OT18	390792.084	3676638.439	95.374	95.384	Open Terrain/Bare Earth	-0.010
OT19	381840.792	3658343.693	57.634	57.724	Open Terrain/Bare Earth	-0.090
OT20	408506.652	3657211.938	62.904	62.917	Open Terrain/Bare Earth	-0.013
OT21	416149.371	3670540.940	96.598	96.635	Open Terrain/Bare Earth	-0.037
OT22	418036.483	3653038.072	102.195	102.324	Open Terrain/Bare Earth	-0.129
OT23	393041.329	3646722.243	41.563	41.521	Open Terrain/Bare Earth	0.042
OT24	378212.388	3639879.664	54.395	54.410	Open Terrain/Bare Earth	-0.015
OT25	390718.004	3627841.715	49.737	49.766	Open Terrain/Bare Earth	-0.029
OT26	403149.269	3634685.534	54.035	54.092	Open Terrain/Bare Earth	-0.057
OT27	410645.451	3626600.669	58.763	58.730	Open Terrain/Bare Earth	0.033
OT28	406304.867	3611543.824	43.433	43.387	Open Terrain/Bare Earth	0.046
OT29	384982.839	3616162.785	57.893	57.815	Open Terrain/Bare Earth	0.078
OT30	381168.840	3608374.343	42.034	42.042	Open Terrain/Bare Earth	-0.008
OT31	394421.909	3612975.196	80.120	80.104	Open Terrain/Bare Earth	0.016
OT32	404755.926	3604591.278	48.535	48.674	Open Terrain/Bare Earth	-0.139
OT33	397530.185	3598272.404	55.795	55.836	Open Terrain/Bare Earth	-0.041
OT34	382420.690	3590273.276	83.929	83.948	Open Terrain/Bare Earth	-0.019
OT35	374067.447	3589972.141	55.624	55.534	Open Terrain/Bare Earth	0.090
OT36	397596.625	3580877.591	49.400	49.378	Open Terrain/Bare Earth	0.022
OT37	458153.945	3644834.798	120.016	120.057	Open Terrain/Bare Earth	-0.041
OT38	440560.471	3643505.812	62.872	62.964	Open Terrain/Bare Earth	-0.092
OT39	439262.968	3625575.557	57.986	58.063	Open Terrain/Bare Earth	-0.077
OT40	438778.847	3610542.273	57.956	58.042	Open Terrain/Bare Earth	-0.086
OT41	448274.892	3597982.096	65.821	65.855	Open Terrain/Bare Earth	-0.034
OT42	455457.082	3586374.372	79.363	79.302	Open Terrain/Bare Earth	0.061
OT43	472063.432	3570292.804	36.325	36.269	Open Terrain/Bare Earth	0.056
OT44	485691.932	3554707.715	44.915	44.815	Open Terrain/Bare Earth	0.100
OT45	497385.914	3552512.294	124.430	124.363	Open Terrain/Bare Earth	0.067
OT46	502529.325	3574394.140	54.884	54.906	Open Terrain/Bare Earth	-0.022
OT47	493105.018	3571427.881	33.685	33.695	Open Terrain/Bare Earth	-0.010
OT48	477138.333	3581277.079	49.154	49.249	Open Terrain/Bare Earth	-0.095
OT49	467941.883	3620405.862	72.259	72.289	Open Terrain/Bare Earth	-0.030
OT50	474978.196	3639922.629	136.942	136.853	Open Terrain/Bare Earth	0.089
OT51	485054.099	3644510.396	76.915	76.949	Open Terrain/Bare Earth	-0.034

OT52	499994.195	3652088.179	129.182	129.178	Open Terrain/Bare Earth	0.004
OT53	499308.833	3640762.642	119.028	119.079	Open Terrain/Bare Earth	-0.051
OT54	514827.526	3621607.043	149.511	149.495	Open Terrain/Bare Earth	0.016
OT55	530260.223	3624586.332	200.901	200.834	Open Terrain/Bare Earth	0.067
OT56	548979.513	3623006.895	147.330	147.317	Open Terrain/Bare Earth	0.013
OT57	569120.977	3638967.187	200.228	200.280	Open Terrain/Bare Earth	-0.052
OT58	580755.070	3629511.593	204.283	204.156	Open Terrain/Bare Earth	0.127
OT59	585545.780	3632642.208	226.044	226.069	Open Terrain/Bare Earth	-0.025
OT60	588206.803	3658709.868	257.103	257.169	Open Terrain/Bare Earth	-0.066
OT61	570937.385	3656744.450	246.490	246.601	Open Terrain/Bare Earth	-0.111
OT62	551530.972	3656247.814	180.616	180.659	Open Terrain/Bare Earth	-0.043
OT63	556627.797	3641999.494	205.614	205.522	Open Terrain/Bare Earth	0.092
OT64	541500.208	3640724.783	202.683	202.735	Open Terrain/Bare Earth	-0.052
OT65	529397.431	3651364.181	203.656	203.744	Open Terrain/Bare Earth	-0.088
OT66	530781.968	3638809.131	183.684	183.680	Open Terrain/Bare Earth	0.004
OT67	515338.358	3639599.185	179.540	179.462	Open Terrain/Bare Earth	0.078
OT68	501367.498	3660409.928	148.647	148.684	Open Terrain/Bare Earth	-0.037
OT69	493930.132	3669896.318	127.015	127.008	Open Terrain/Bare Earth	0.007
OT70	475178.908	3660209.150	158.016	157.933	Open Terrain/Bare Earth	0.083
UR01	401504.154	3822790.191	170.175	170.137	Urban Terrain	0.038
UR02	410945.795	3816057.060	234.610	234.492	Urban Terrain	0.118
UR03	434301.438	3820872.548	246.515	246.552	Urban Terrain	-0.037
UR04	443186.730	3820741.349	194.845	194.839	Urban Terrain	0.006
UR05	446051.441	3807847.916	317.976	317.971	Urban Terrain	0.005
UR06	430478.655	3807541.442	311.800	311.755	Urban Terrain	0.045
UR07	427049.608	3796255.174	268.061	268.089	Urban Terrain	-0.028
UR08	411757.404	3808177.659	237.446	237.415	Urban Terrain	0.031
UR09	399069.551	3795022.208	136.809	136.747	Urban Terrain	0.062
UR10	404081.550	3778057.680	195.970	195.878	Urban Terrain	0.092
UR11	414030.764	3789191.362	259.546	259.466	Urban Terrain	0.080
UR12	415302.175	3767288.755	222.403	222.330	Urban Terrain	0.073
UR13	422475.546	3766623.514	244.253	244.140	Urban Terrain	0.113
UR14	434684.157	3754993.345	152.136	152.141	Urban Terrain	-0.005
UR15	423659.263	3754645.204	159.014	158.906	Urban Terrain	0.108
UR16	423317.593	3737949.194	172.344	172.320	Urban Terrain	0.024
UR17	440184.137	3730023.507	163.784	163.771	Urban Terrain	0.013
UR18	438825.994	3721561.125	113.976	113.947	Urban Terrain	0.029
UR19	429890.143	3724162.272	156.459	156.420	Urban Terrain	0.039
UR20	424351.220	3717559.555	92.055	92.040	Urban Terrain	0.015
UR21	414395.628	3709523.985	160.249	160.198	Urban Terrain	0.051
UR22	404998.369	3692165.811	76.320	76.305	Urban Terrain	0.015
UR23	408066.755	3683631.090	80.727	80.666	Urban Terrain	0.061
UR24	400356.084	3674076.844	63.635	63.520	Urban Terrain	0.115

UR25	388851.817	3670439.180	88.834	88.782	Urban Terrain	0.052
UR26	388745.624	3654510.004	43.317	43.342	Urban Terrain	-0.025
UR27	408841.799	3648749.898	81.490	81.421	Urban Terrain	0.069
UR28	422863.879	3639303.910	63.007	62.967	Urban Terrain	0.040
UR29	410229.373	3629756.805	46.794	46.743	Urban Terrain	0.051
UR30	382987.042	3631077.423	60.729	60.638	Urban Terrain	0.091
UR31	380162.912	3620517.939	80.016	80.004	Urban Terrain	0.012
UR32	390617.479	3613692.564	91.057	91.062	Urban Terrain	-0.005
UR33	401552.853	3608873.591	33.357	33.268	Urban Terrain	0.089
UR34	407084.117	3598195.355	36.726	36.673	Urban Terrain	0.053
UR35	388586.093	3598378.916	34.464	34.443	Urban Terrain	0.021
UR36	381101.298	3588643.931	105.364	105.264	Urban Terrain	0.100
UR37	379031.669	3578797.067	70.126	69.994	Urban Terrain	0.132
UR38	409525.672	3773294.462	117.132	117.013	Urban Terrain	0.119
UR39	421846.141	3757859.458	150.300	150.175	Urban Terrain	0.125
UR40	420836.866	3743409.009	119.018	118.988	Urban Terrain	0.030
UR41	444625.392	3725702.044	164.992	164.946	Urban Terrain	0.046
UR42	418090.572	3717410.732	162.683	162.623	Urban Terrain	0.060
UR43	388426.805	3696895.270	88.302	88.184	Urban Terrain	0.118
UR44	433669.547	3638096.565	40.690	40.632	Urban Terrain	0.058
UR45	432506.024	3628764.616	82.996	82.964	Urban Terrain	0.032
UR46	433969.795	3613486.385	52.143	52.005	Urban Terrain	0.138
UR47	447722.492	3618116.098	89.548	89.493	Urban Terrain	0.055
UR48	445528.413	3638463.120	119.578	119.508	Urban Terrain	0.070
UR49	452458.326	3647035.343	76.935	76.843	Urban Terrain	0.092
UR50	481225.752	3605770.067	49.463	49.579	Urban Terrain	-0.116
UR51	460070.988	3613950.246	110.380	110.337	Urban Terrain	0.043
UR52	471199.509	3574816.260	46.458	46.452	Urban Terrain	0.006
UR53	483577.238	3564222.055	52.555	52.516	Urban Terrain	0.039
UR54	486437.275	3579185.589	65.629	65.686	Urban Terrain	-0.057
UR55	478233.082	3592695.789	69.145	69.140	Urban Terrain	0.005
UR56	476140.156	3614506.797	54.035	54.017	Urban Terrain	0.018
UR57	474757.262	3628940.084	60.664	60.618	Urban Terrain	0.046
UR58	474592.178	3646226.392	84.973	84.914	Urban Terrain	0.059
UR59	483160.145	3649881.327	100.553	100.557	Urban Terrain	-0.004
UR60	492619.630	3653634.591	98.915	98.907	Urban Terrain	0.008
UR61	506182.022	3646375.246	136.241	136.163	Urban Terrain	0.078
UR62	545723.382	3647300.030	128.880	128.776	Urban Terrain	0.104
UR63	564109.859	3653321.018	198.677	198.548	Urban Terrain	0.129
UR64	562204.333	3639161.822	168.838	168.828	Urban Terrain	0.010
UR65	551497.724	3633779.773	125.247	125.251	Urban Terrain	-0.004
UR66	541825.721	3632603.050	173.472	173.499	Urban Terrain	-0.027
UR67	522671.166	3630854.439	136.226	136.127	Urban Terrain	0.099

UR68	506291.260	3630623.692	172.695	172.576	Urban Terrain	0.119
UR69	489742.706	3629869.174	119.950	119.947	Urban Terrain	0.003
UR70	490767.577	3617131.251	77.730	77.682	Urban Terrain	0.048
UR71	491622.957	3596024.865	52.722	52.677	Urban Terrain	0.045
UR72	499269.285	3581583.829	37.526	37.539	Urban Terrain	-0.013
UR73	501276.692	3596985.348	112.758	112.762	Urban Terrain	-0.004
UR74	508923.892	3620550.076	85.661	85.520	Urban Terrain	0.141
UR75	579176.024	3639660.079	241.969	241.932	Urban Terrain	0.037
UR76	582081.415	3655542.976	210.574	210.472	Urban Terrain	0.102
UR77	518448.858	3648400.159	193.417	193.307	Urban Terrain	0.110
UR78	575534.659	3634545.410	214.141	214.223	Urban Terrain	-0.082
UR79	500720.972	3549073.696	54.711	54.659	Urban Terrain	0.052
UR80	508076.752	3652415.234	146.459	146.450	Urban Terrain	0.009

Table 15: Bare=Earth DEM NVA Assessment

Vegetated Vertical Accuracy (VVA) Check Point Assessment (Bare Earth)						
PointID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
BR01	403296.463	3811109.828	172.810	172.875	Brush	0.065
BR02	416919.654	3819094.355	188.014	187.999	Brush	-0.015
BR03	440359.897	3812541.603	224.063	224.095	Brush	0.032
BR04	426894.557	3792783.885	252.937	253.036	Brush	0.099
BR05	410265.181	3769971.061	124.034	124.160	Brush	0.126
BR06	436566.259	3745954.387	171.677	171.718	Brush	0.041
BR07	437951.183	3727388.017	143.246	143.212	Brush	-0.034
BR08	433349.760	3715811.062	152.846	152.904	Brush	0.058
BR09	418104.145	3717419.663	163.509	163.524	Brush	0.015
BR10	400114.617	3705192.724	123.890	123.751	Brush	-0.139
BR11	392652.445	3684585.402	121.489	121.477	Brush	-0.012
BR12	413991.714	3675902.122	77.502	77.557	Brush	0.055
BR13	415704.687	3686714.974	76.098	76.236	Brush	0.138
BR14	397287.813	3636149.976	44.060	44.167	Brush	0.107
BR15	393130.122	3618451.010	45.277	45.308	Brush	0.031
BR16	391027.975	3591375.905	31.638	31.730	Brush	0.092
BR17	394648.337	3581391.952	59.504	59.621	Brush	0.117
BR18	376177.984	3581968.530	64.197	64.179	Brush	-0.018
BR19	378307.923	3630562.352	43.419	43.424	Brush	0.005
BR20	400972.601	3628355.116	36.304	36.394	Brush	0.090
BR21	411198.658	3604747.745	42.701	42.762	Brush	0.061
BR22	429442.961	3740179.299	136.867	137.008	Brush	0.141
BR23	450122.475	3725091.501	152.625	152.705	Brush	0.080

BR24	450208.822	3637792.096	80.743	80.844	Brush	0.101
BR25	471645.296	3583006.526	51.550	51.717	Brush	0.167
BR26	485848.751	3561990.469	33.853	33.942	Brush	0.089
BR27	489971.960	3551399.190	82.540	82.492	Brush	-0.048
BR28	505701.912	3582151.782	38.442	38.558	Brush	0.116
BR29	504451.369	3618348.625	99.399	99.399	Brush	0.000
BR30	504992.341	3653002.590	162.342	162.272	Brush	-0.070
BR31	476236.239	3659854.301	133.532	133.669	Brush	0.137
BR32	487506.869	3661143.221	139.757	139.760	Brush	0.003
BR33	437554.459	3646735.702	39.120	39.204	Brush	0.084
BR34	430719.174	3620904.681	52.060	52.199	Brush	0.139
BR35	553890.314	3637757.092	134.153	134.273	Brush	0.120
BR36	519241.410	3653106.991	208.092	208.128	Brush	0.036
BR37	507155.636	3593684.226	89.538	89.642	Brush	0.104
BR38	566867.828	3630720.944	204.807	204.797	Brush	-0.010
BR39	564712.336	3658588.619	216.421	216.435	Brush	0.014
BR40	574544.634	3646629.215	153.750	153.718	Brush	-0.032
BR41	489126.358	3634645.549	114.262	114.389	Brush	0.127
BR42	468604.697	3634041.179	87.072	87.216	Brush	0.144
BR43	454612.051	3646716.698	85.502	85.649	Brush	0.147
BR44	490050.126	3590267.731	46.632	46.625	Brush	-0.007
BR45	497164.369	3564873.706	42.346	42.338	Brush	-0.008
BR46	455407.369	3586345.241	79.260	79.248	Brush	-0.012
BR47	585564.399	3632671.767	226.972	227.043	Brush	0.071
HG01	403864.446	3797018.739	218.479	218.522	High Grass	0.043
HG02	404523.481	3817308.098	158.033	157.985	High Grass	-0.048
HG03	421287.557	3802993.340	275.530	275.585	High Grass	0.055
HG04	427185.071	3813805.600	200.391	200.430	High Grass	0.039
HG05	403660.502	3791636.743	218.881	218.962	High Grass	0.081
HG06	433429.729	3804401.557	307.542	307.553	High Grass	0.011
HG07	441951.041	3802285.125	299.595	299.623	High Grass	0.028
HG08	423651.178	3792197.476	276.643	276.595	High Grass	-0.048
HG09	436122.170	3762383.711	205.948	206.115	High Grass	0.167
HG10	401926.105	3775354.125	198.582	198.663	High Grass	0.081
HG11	426281.967	3780257.936	186.244	186.246	High Grass	0.002
HG12	428965.981	3745768.159	160.518	160.576	High Grass	0.058
HG13	421840.540	3757856.061	149.349	149.389	High Grass	0.040
HG14	459643.220	3727543.533	99.883	99.898	High Grass	0.015
HG15	417574.187	3748389.727	135.331	135.321	High Grass	-0.010

HG16	418196.689	3735272.359	112.896	112.896	High Grass	0.000
HG17	411429.827	3661230.855	54.522	54.559	High Grass	0.037
HG18	431906.448	3735610.020	150.518	150.604	High Grass	0.086
HG19	396247.217	3669210.068	49.185	49.158	High Grass	-0.027
HG20	444622.512	3725706.681	164.851	164.915	High Grass	0.064
HG21	384901.707	3669388.334	44.212	44.221	High Grass	0.009
HG22	415244.091	3635570.635	74.184	74.110	High Grass	-0.074
HG23	398981.763	3645497.038	70.600	70.749	High Grass	0.149
HG24	388423.741	3696894.133	88.292	88.310	High Grass	0.018
HG25	415427.288	3617528.968	37.359	37.386	High Grass	0.027
HG26	419629.791	3609730.850	39.848	39.977	High Grass	0.129
HG27	407504.179	3697148.496	78.983	78.911	High Grass	-0.072
HG28	386549.685	3610611.896	57.874	57.961	High Grass	0.087
HG29	407809.122	3663757.802	87.851	87.895	High Grass	0.044
HG30	403030.876	3613813.598	34.801	34.940	High Grass	0.139
HG31	387824.190	3663088.890	44.721	44.789	High Grass	0.068
HG32	397739.423	3592754.158	41.396	41.517	High Grass	0.121
HG33	386950.363	3643287.022	55.457	55.570	High Grass	0.113
HG34	410113.568	3645956.280	54.141	54.071	High Grass	-0.070
HG35	372765.792	3593369.313	74.806	74.759	High Grass	-0.047
HG36	407681.757	3621989.514	66.030	66.185	High Grass	0.155
HG37	393878.547	3602375.300	57.194	57.178	High Grass	-0.016
HG38	414264.690	3651029.106	108.804	108.691	High Grass	-0.113
HG39	385563.600	3622237.138	64.445	64.462	High Grass	0.017
HG40	381645.696	3599137.797	55.255	55.177	High Grass	-0.078
HG41	446287.492	3740657.553	143.033	143.060	High Grass	0.027
HG42	422475.120	3766617.038	243.859	243.779	High Grass	-0.080
HG43	434562.319	3755006.073	149.805	149.849	High Grass	0.044
HG44	414399.505	3709527.653	159.936	160.026	High Grass	0.090
HG45	396430.896	3692026.125	65.760	65.701	High Grass	-0.059
HG46	442705.520	3636772.021	133.224	133.292	High Grass	0.068
HG47	440308.324	3617383.554	55.394	55.492	High Grass	0.098
HG48	458621.547	3606535.471	82.400	82.449	High Grass	0.049
HG49	472339.744	3593337.801	64.698	64.836	High Grass	0.138
HG50	480429.529	3585523.962	65.786	65.686	High Grass	-0.100
HG51	496018.159	3618895.013	141.567	141.675	High Grass	0.108
HG52	497004.141	3629598.056	114.350	114.447	High Grass	0.097
HG53	509010.721	3627230.815	168.337	168.284	High Grass	-0.053
HG54	516223.976	3629552.580	111.058	111.055	High Grass	-0.003

HG55	496003.182	3644512.140	98.723	98.758	High Grass	0.035
HG56	481034.563	3649716.212	124.045	124.148	High Grass	0.103
HG57	464865.597	3626703.796	130.545	130.537	High Grass	-0.008
HG58	471399.030	3621001.431	97.062	97.109	High Grass	0.047
HG59	531673.231	3645797.982	210.383	210.380	High Grass	-0.003
HG60	536945.174	3633053.160	186.907	187.057	High Grass	0.150
HG61	561980.544	3645933.270	159.745	159.640	High Grass	-0.105
HG62	576292.576	3654418.692	231.809	231.785	High Grass	-0.024
HG63	575515.364	3634524.655	213.564	213.651	High Grass	0.087
HG64	571724.810	3628550.966	132.285	132.249	High Grass	-0.036
HG65	521025.330	3614452.561	170.032	170.040	High Grass	0.008
HG66	504995.767	3602510.937	131.793	131.834	High Grass	0.041
HG67	498781.891	3552711.412	109.818	109.697	High Grass	-0.121
HG68	498372.800	3569943.637	75.024	75.122	High Grass	0.098
HG69	496466.957	3591380.150	62.423	62.536	High Grass	0.113
HG70	478961.856	3628217.953	74.364	74.469	High Grass	0.105
HG71	503081.560	3639142.288	170.678	170.754	High Grass	0.076
HG72	509210.822	3653134.772	161.943	162.000	High Grass	0.057
HG73	478168.891	3564935.322	60.868	60.728	High Grass	-0.140
HG74	432527.573	3628750.375	82.642	82.670	High Grass	0.028
HG75	446812.079	3627609.332	104.315	104.391	High Grass	0.076
TR01	404019.544	3805805.741	228.852	228.855	Trees	0.003
TR02	422109.327	3803666.985	279.401	279.468	Trees	0.067
TR03	434103.767	3799845.411	296.987	296.985	Trees	-0.002
TR04	415491.420	3778905.705	162.547	162.487	Trees	-0.060
TR05	423760.340	3746895.945	144.128	144.157	Trees	0.029
TR06	440949.503	3739678.871	216.657	216.773	Trees	0.116
TR07	409767.130	3676884.488	72.169	72.289	Trees	0.120
TR08	398090.684	3677510.994	56.970	57.035	Trees	0.065
TR09	400106.563	3654439.655	86.925	86.896	Trees	-0.029
TR10	385007.145	3651189.433	60.564	60.692	Trees	0.128
TR11	416922.440	3644980.359	97.410	97.419	Trees	0.009
TR12	410771.744	3614708.622	35.966	36.112	Trees	0.146
TR13	402854.513	3596179.762	68.905	68.926	Trees	0.021
TR14	377454.252	3609769.254	56.966	56.951	Trees	-0.015
TR15	426794.347	3728811.430	137.098	137.185	Trees	0.087
TR16	389914.888	3703770.387	96.184	96.268	Trees	0.084
TR17	414593.285	3699802.052	124.651	124.594	Trees	-0.057
TR18	385475.315	3678858.736	64.539	64.498	Trees	-0.041

TR19	411270.625	3665395.216	66.259	66.250	Trees	-0.009
TR20	510648.754	3584133.867	42.688	42.784	Trees	0.096
TR21	485437.074	3572646.405	74.446	74.492	Trees	0.046
TR22	491385.791	3554189.000	48.313	48.416	Trees	0.103
TR23	496362.359	3600988.439	125.714	125.878	Trees	0.164
TR24	478383.561	3620642.960	56.511	56.582	Trees	0.071
TR25	482868.866	3648067.267	108.246	108.376	Trees	0.130
TR26	476944.740	3652586.036	88.685	88.730	Trees	0.045
TR27	445813.020	3647268.585	71.198	71.148	Trees	-0.050
TR28	494961.393	3675559.011	131.112	131.257	Trees	0.145
TR29	499577.249	3663666.768	191.206	191.168	Trees	-0.038
TR30	507557.709	3645426.513	165.634	165.544	Trees	-0.090
TR31	511276.428	3629348.064	113.396	113.287	Trees	-0.109
TR32	525612.922	3626532.136	202.591	202.588	Trees	-0.003
TR33	545217.548	3633159.529	178.118	178.118	Trees	0.000
TR34	552751.687	3629000.462	101.002	101.064	Trees	0.062
TR35	544123.803	3647733.346	122.681	122.682	Trees	0.001
TR36	553220.246	3646820.805	199.071	199.129	Trees	0.058
TR37	587069.593	3649656.755	224.828	224.828	Trees	0.000
TR38	589591.879	3631035.041	202.234	202.386	Trees	0.152
TR39	536371.604	3621229.015	201.876	201.820	Trees	-0.056
TR40	464972.242	3647324.598	136.069	136.037	Trees	-0.032
TR41	454725.417	3617086.097	107.158	107.169	Trees	0.011
TR42	436615.469	3602531.845	44.382	44.350	Trees	-0.032
TR43	428016.645	3626918.618	64.582	64.667	Trees	0.085
TR44	476061.974	3597777.660	67.567	67.547	Trees	-0.020
TR45	480960.300	3560650.580	34.947	34.903	Trees	-0.044
TR46	461675.804	3639659.203	125.477	125.462	Trees	-0.015

Table 16: Bare-Earth Lidar VVA Assessment

Section 4: Certification

4.1 Limitations of Use

The accuracy assessment confirms that the data may be used for the intended applications stated in the **Project Purpose** section of this document. The dataset may also be used as a topographic input for other applications but the user should be aware that this lidar dataset was designed with a specific purpose and was not intended to meet specifications and/or requirements of users outside of the U.S. Geological Survey.

It should also be noted that lidar points do not represent a continuous surface model. Lidar points are discrete measurements of the surface and any values derived within a triangle of three lidar points are interpolated. As such, the user should not use the resultant lidar dataset for vertical placement of a planimetric feature such as a headwall, building footprint or any other planimetric feature unless there is an associated lidar point that can be reasonably located on this structure.

Consideration should be given by the end user of this dataset to the fact that this lidar dataset was developed differently and that previous lidar datasets that may be available for this geographic location. It is likely that the data in this project was created using different geodetic control, a different Geoid, newer lidar technology and more up-to-date processing techniques. As such, any direct comparative analysis performed between this dataset and previous datasets could result in misleading or inaccurate results. Users are encouraged to proceed with caution while performing this type of comparative analysis and to completely understand the variables that make each of these datasets unique and not corollary.

It is encouraged that the user refers to the full FGDC Metadata and project reports for a complete understanding on the content of this dataset.

I, hereby, certify to the extent of my knowledge that the statements and statistics represented in this document are true and factual.
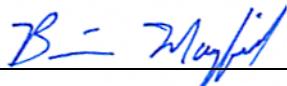
Brian J. Mayfield, ASPRS Certified Photogrammetrist #R1276
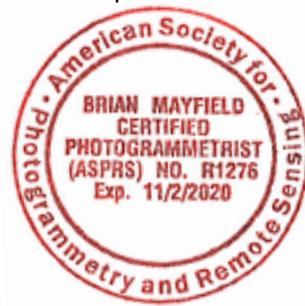
Section 5: GNSS Processing

Inertial Explorer version 8.60.6717

Plots by Mission: Coverage Map, Estimated Position Accuracy, Number of Satellites, Combined Separation, and PDOP.

Coverage Map	The Coverage Map plot shows the Aircraft GNSS-IMU Trajectory in reference to localized GNSS Reference Stations.
Estimated Position Accuracy	The Estimated Position Accuracy plot shows the standard deviations of the east, north, and up directions versus time for the solution. The total standard deviation with a distance dependent component is also plotted.
Number of Satellites	Plots the number of satellites used in the solution as a function of time. The number of GPS satellites, GLONASS satellites, and the total number of satellites are distinguished with separate lines.
Combined Separation	Plots the north, east, and height position difference between any two solutions loaded into the project. This is most often the forward and reverse processing results, unless other solutions have been loaded from the Combine Solutions dialog. Plotting the difference between forward and reverse solutions can be very helpful in quality checking. When processing both directions, no information is shared between forward and reverse processing. Thus both directions are processed independently of each other. When forward and reverse solutions agree closely, it helps provide confidence in the solution. To a lesser extent, this plot can also help gauge solution accuracy.
PDOP	PDOP is a unit less number which indicates how favorable the satellite geometry is to 3D positioning accuracy. A strong satellite geometry, where the PDOP is low, occurs when satellites are well distributed in each direction (north, south, east and west) as well as directly overhead. Values in the range of 1-2 indicate very good satellite geometry, 2-3 are adequate in the sense that they do not generally, by themselves, limit positioning accuracy. Values between 3 and 4 are considered marginal, and values approaching or exceeding 5 can be considered poor. PDOP spikes can occur on aircraft turns were the antenna angle is unfavorable, these spikes while aesthetically unfavorable do not generally reduce the accuracy of the acquired data.
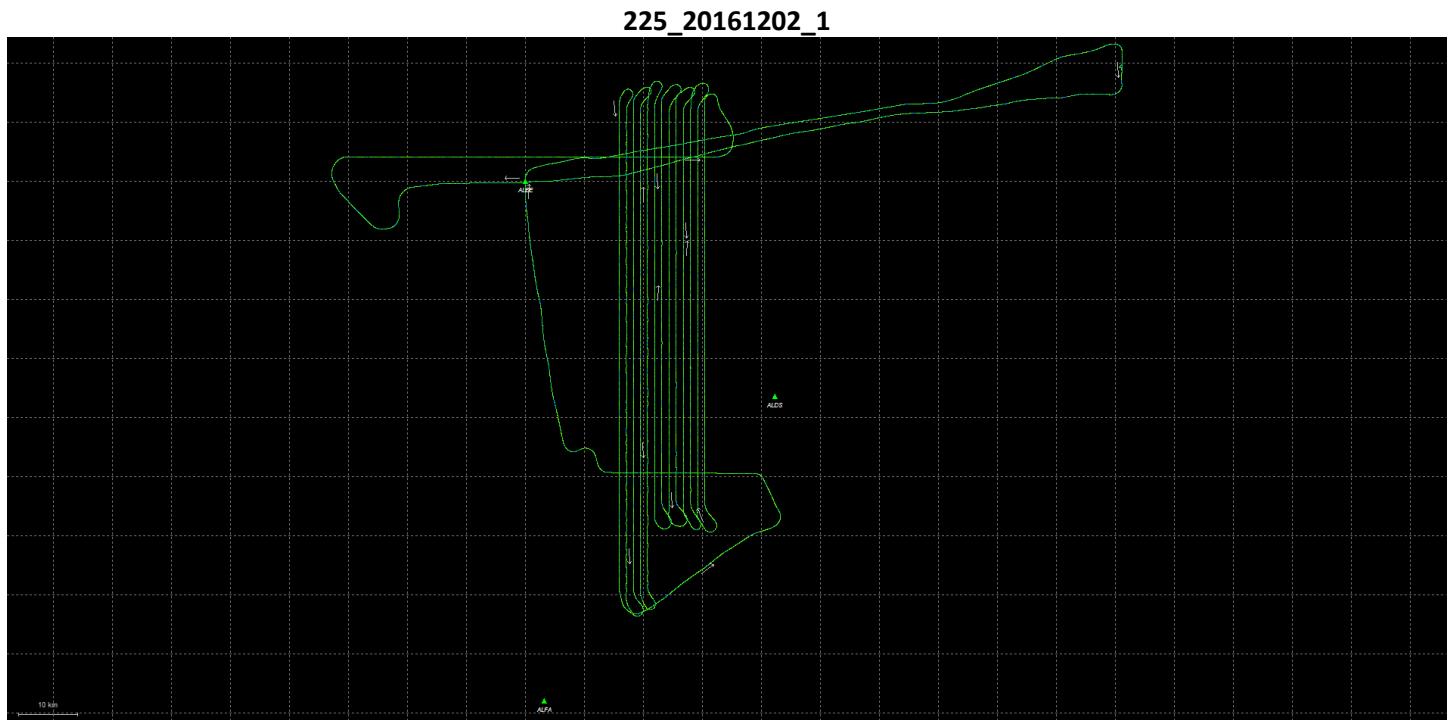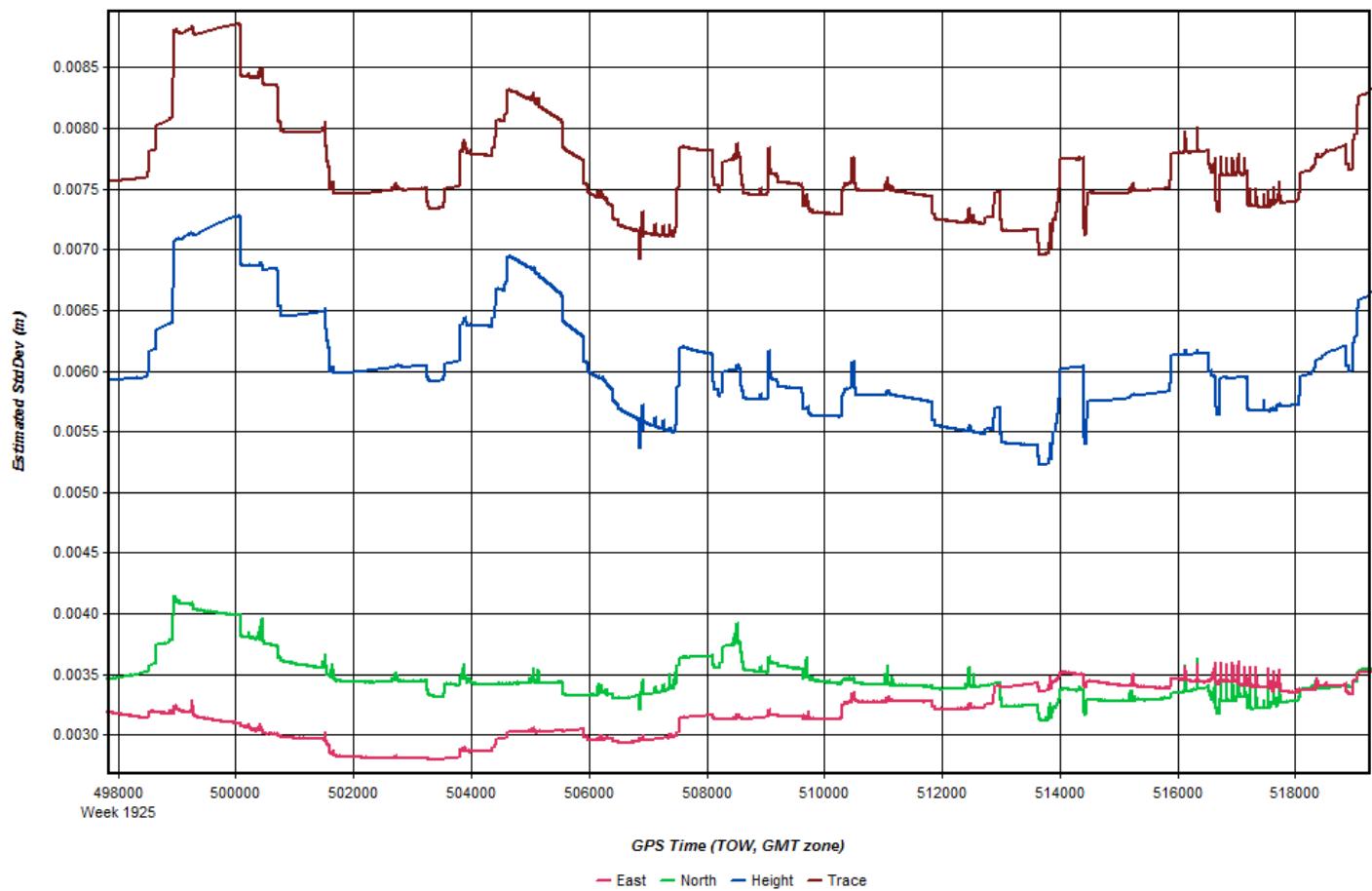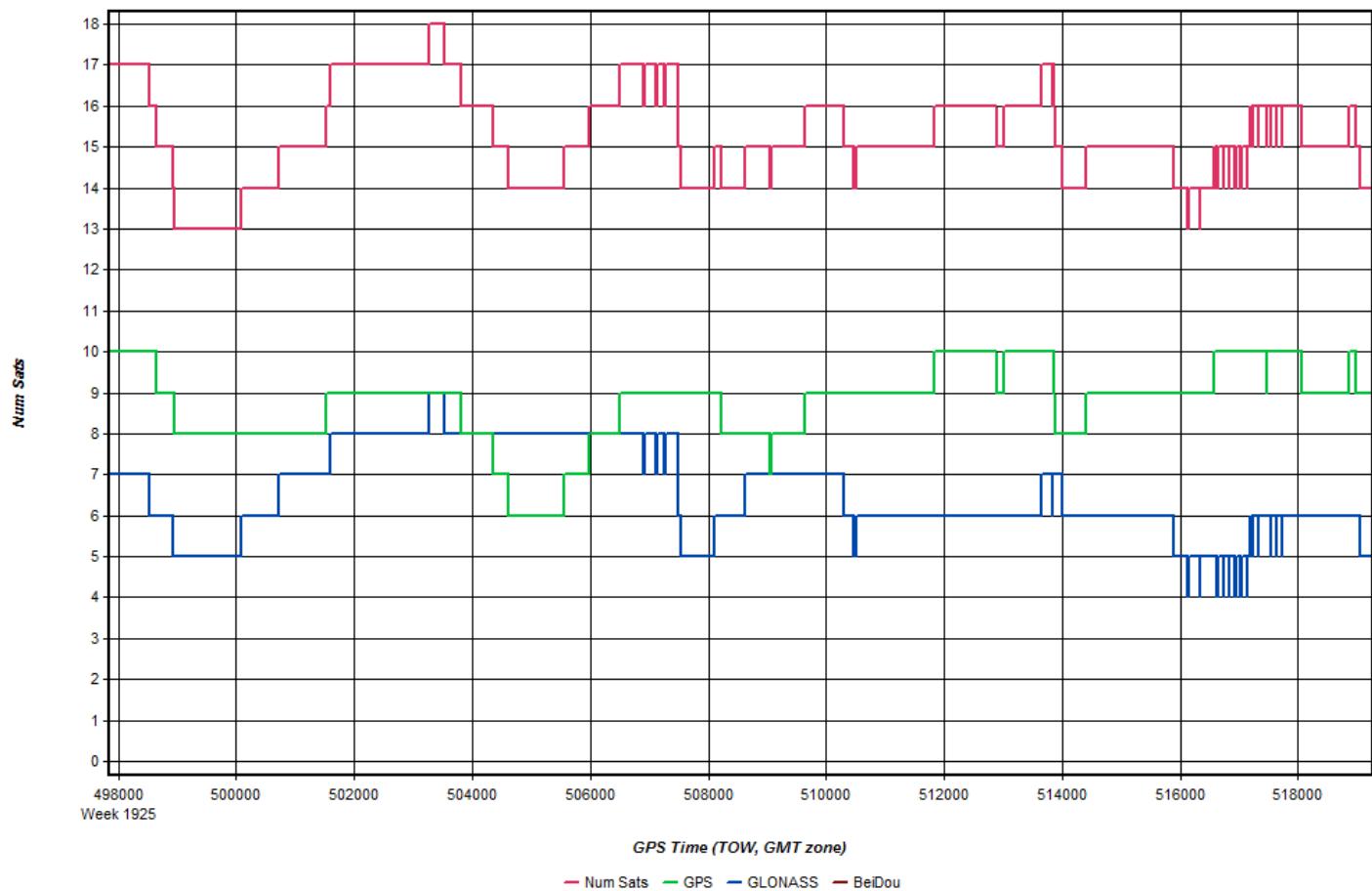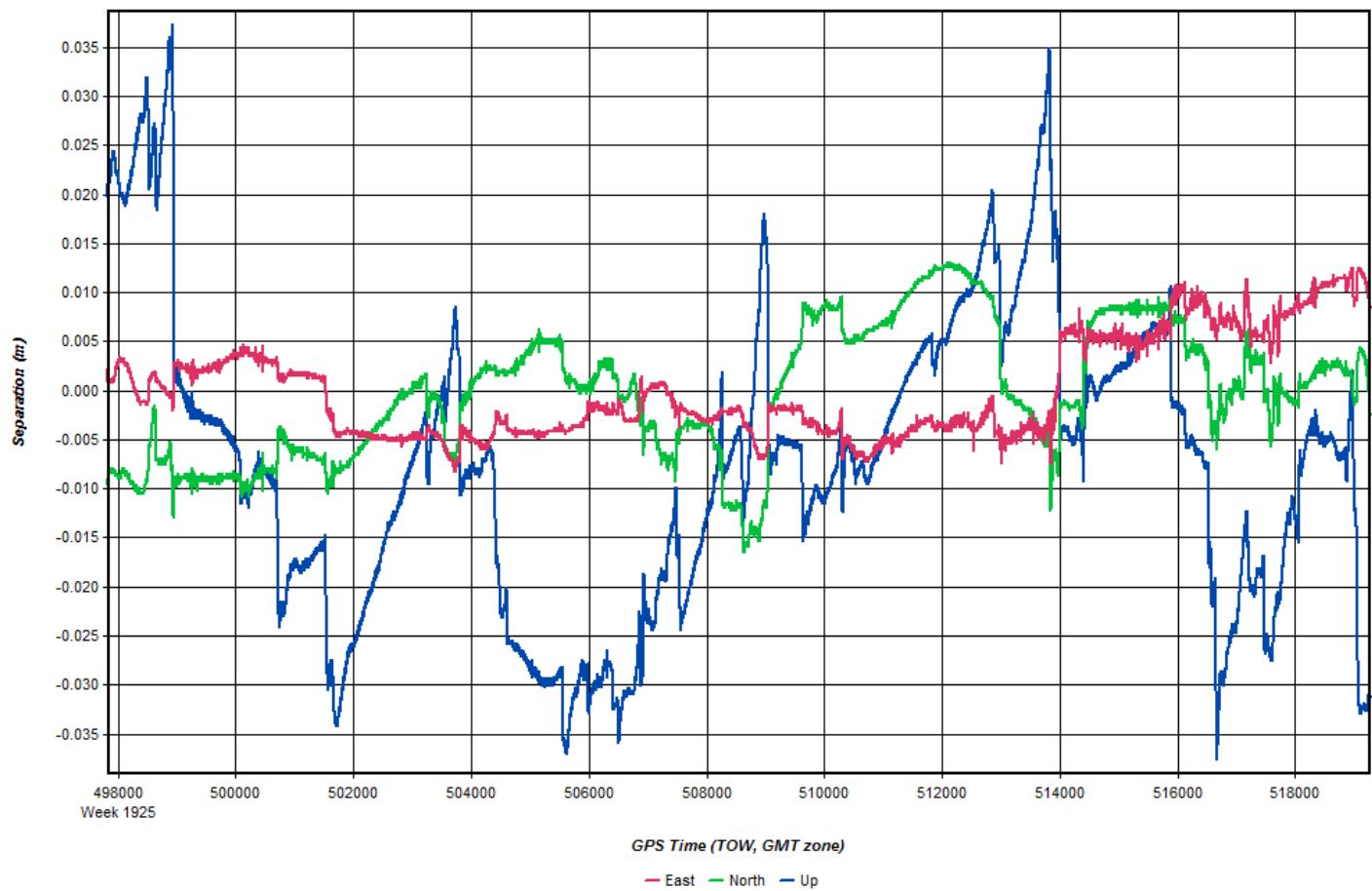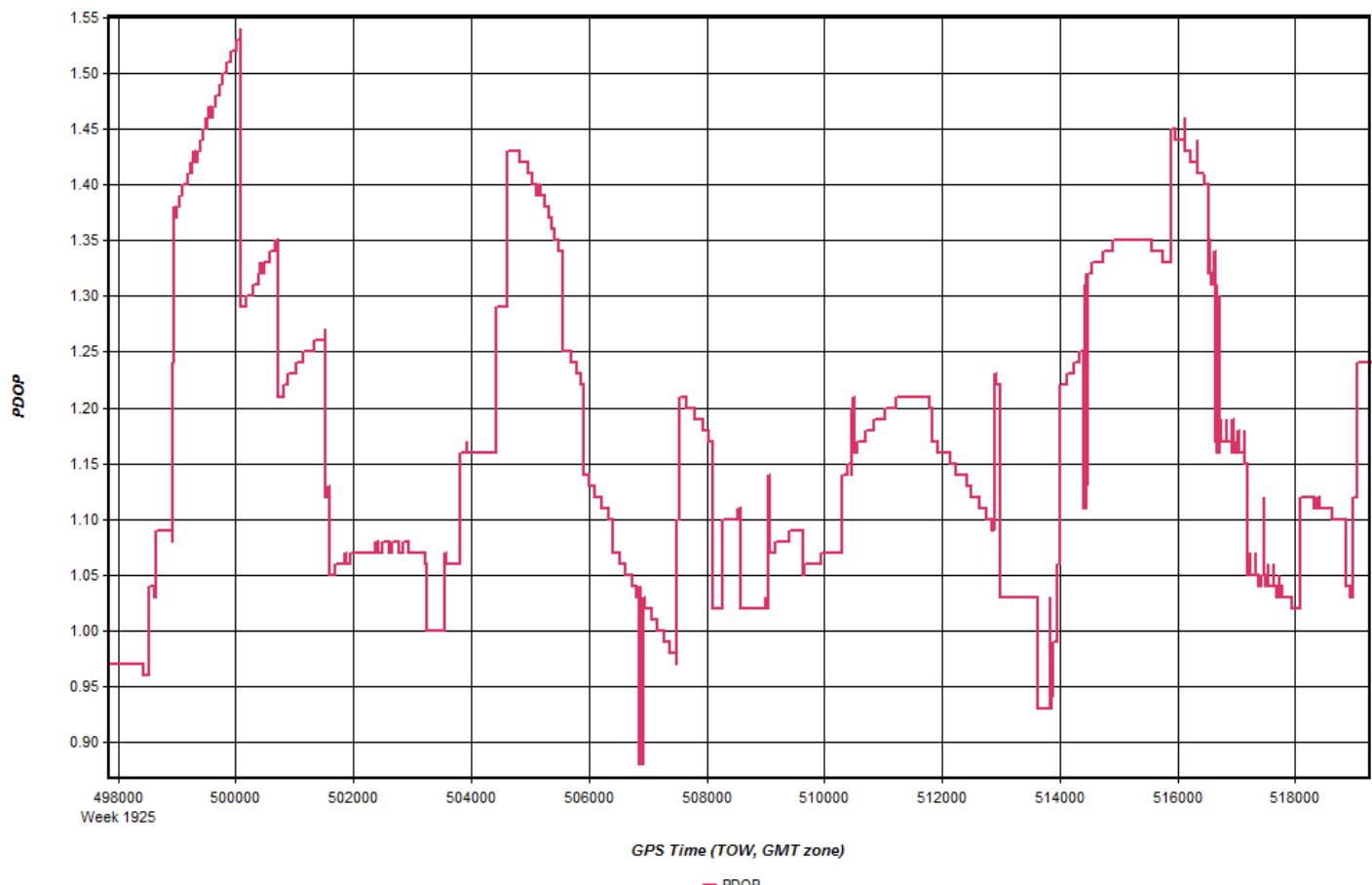
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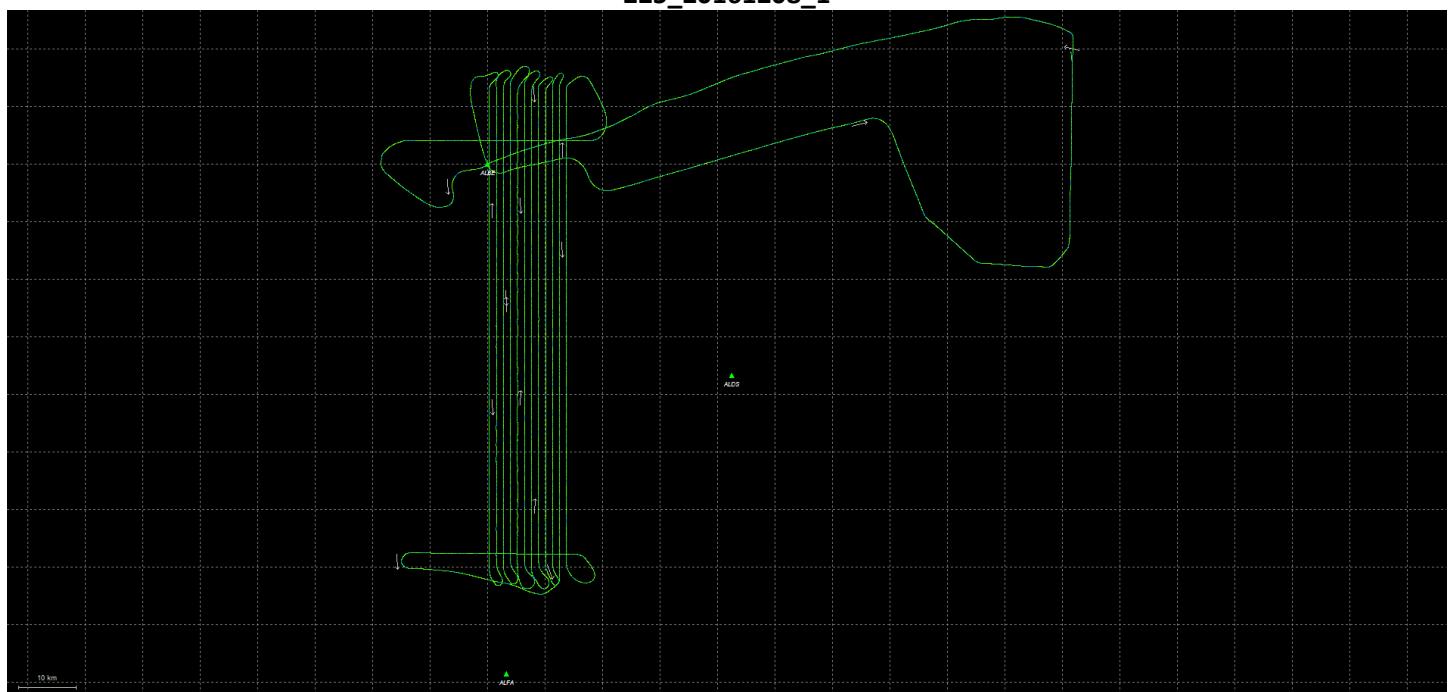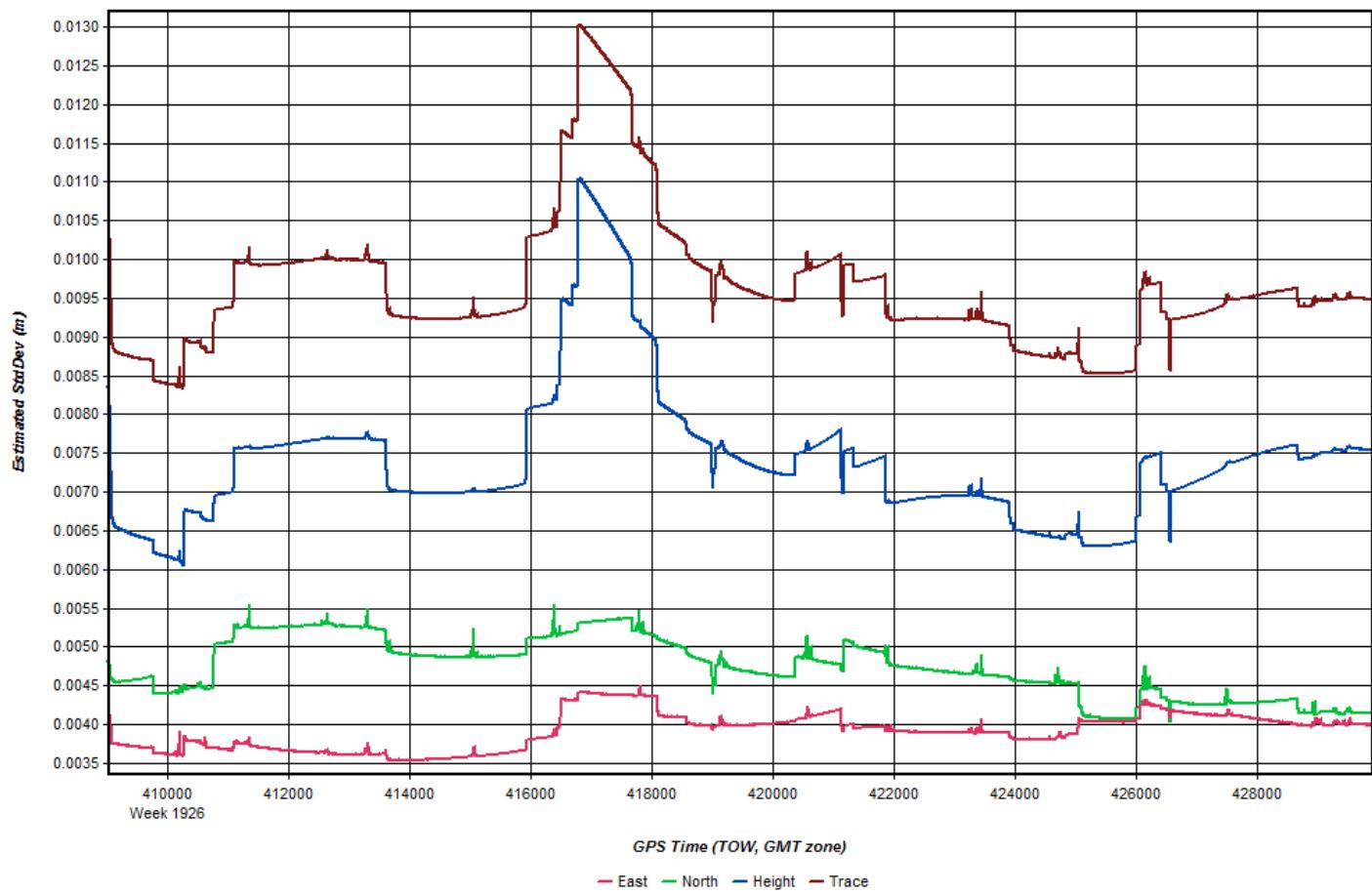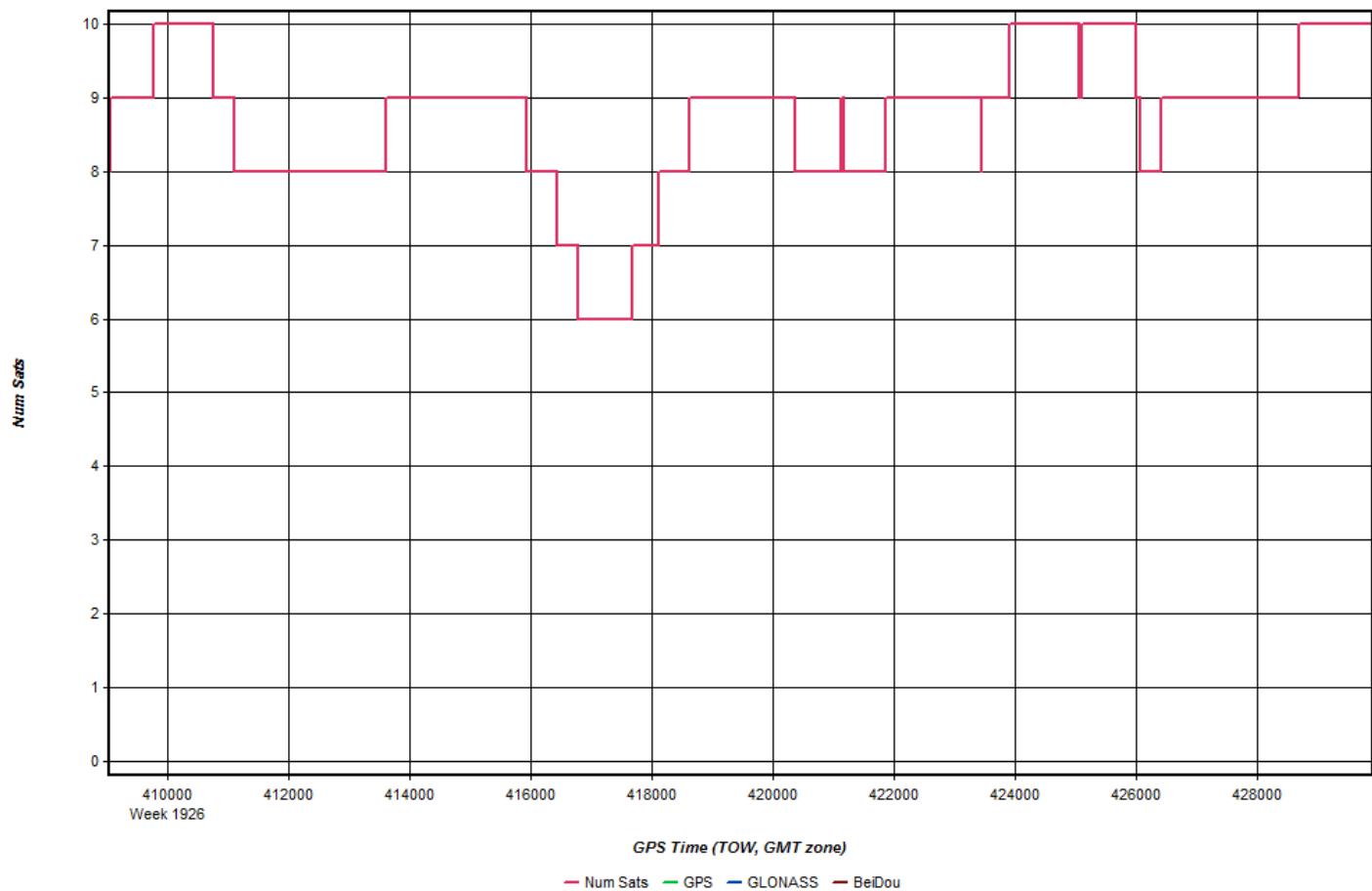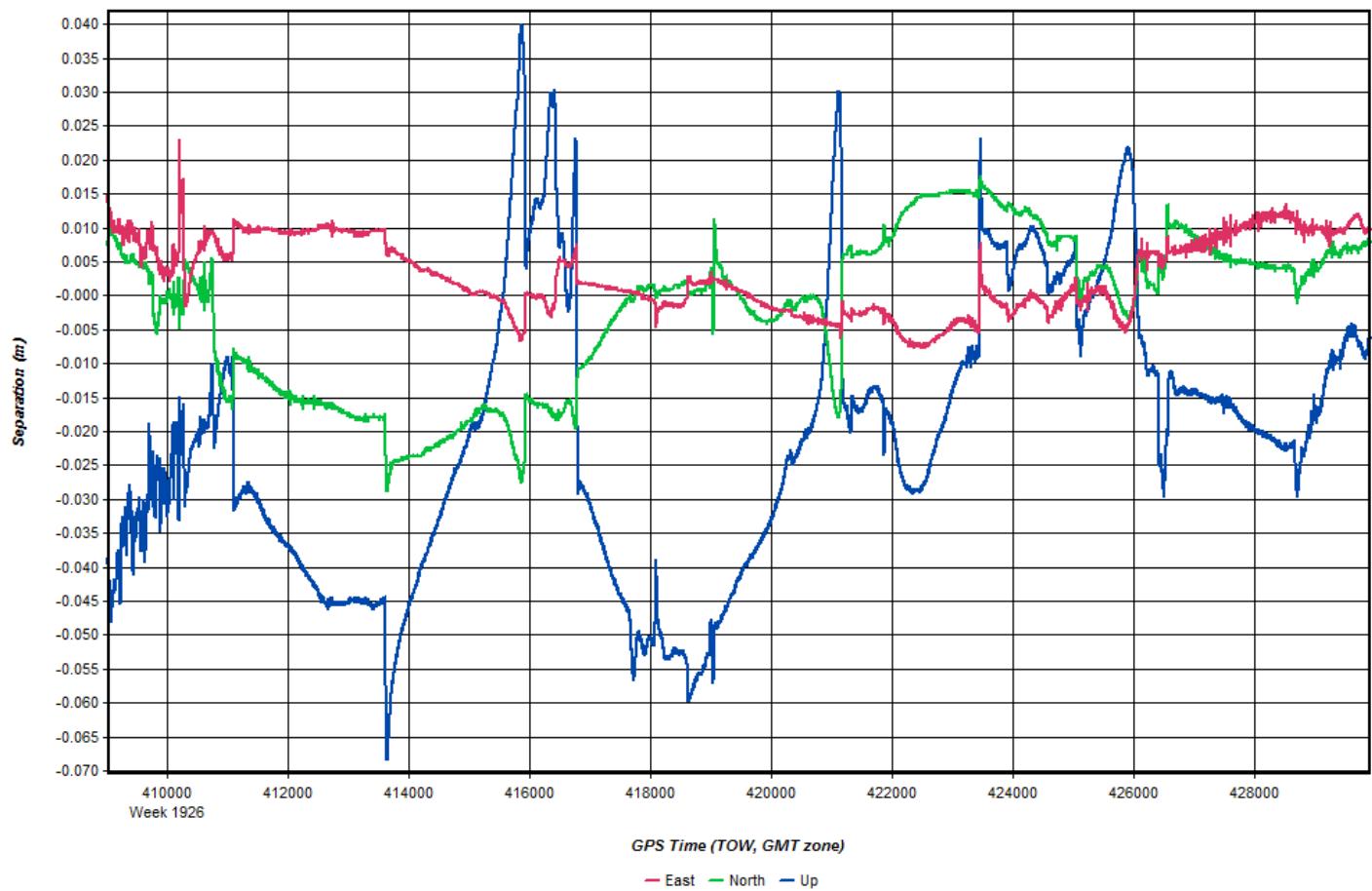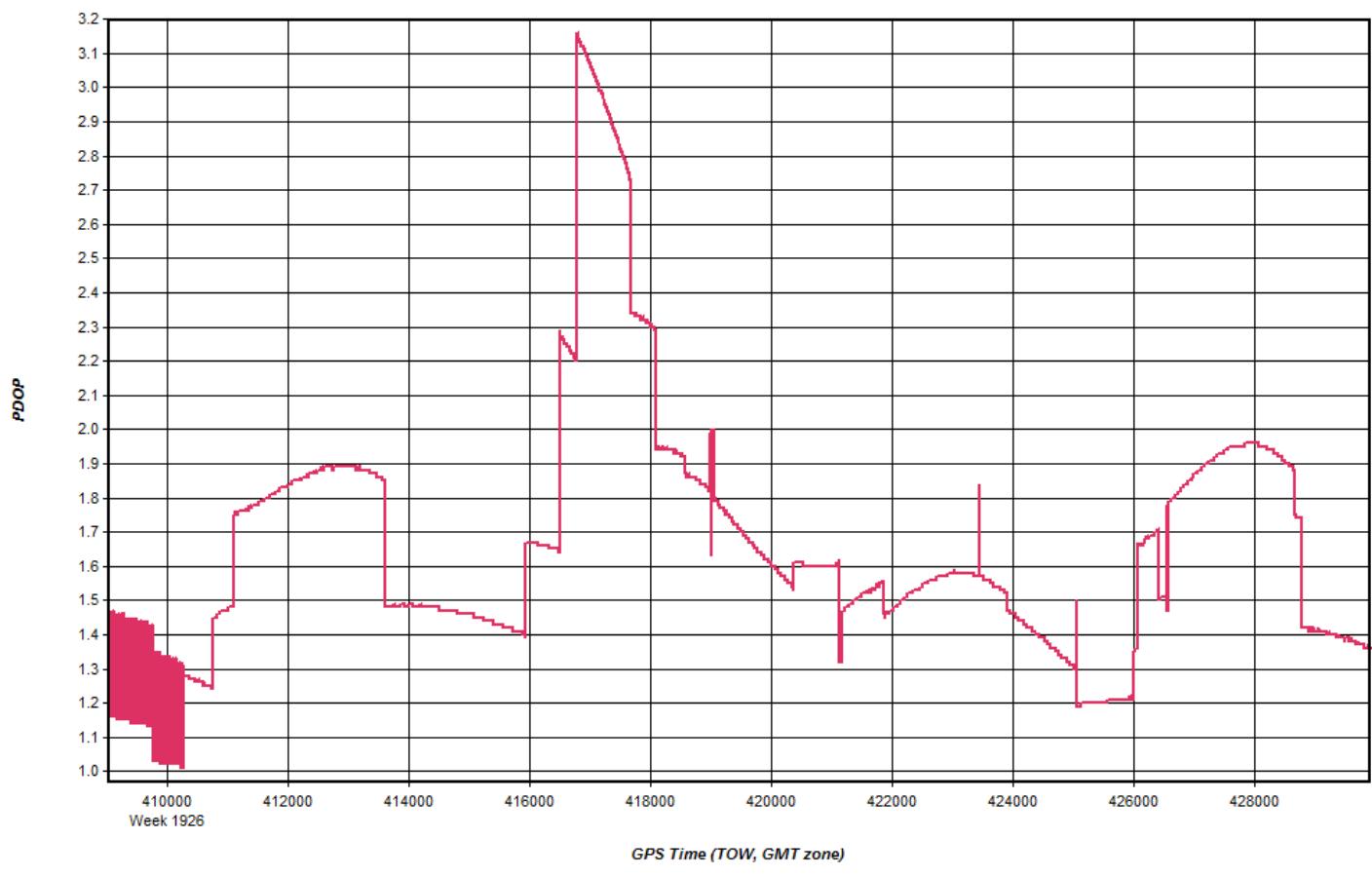
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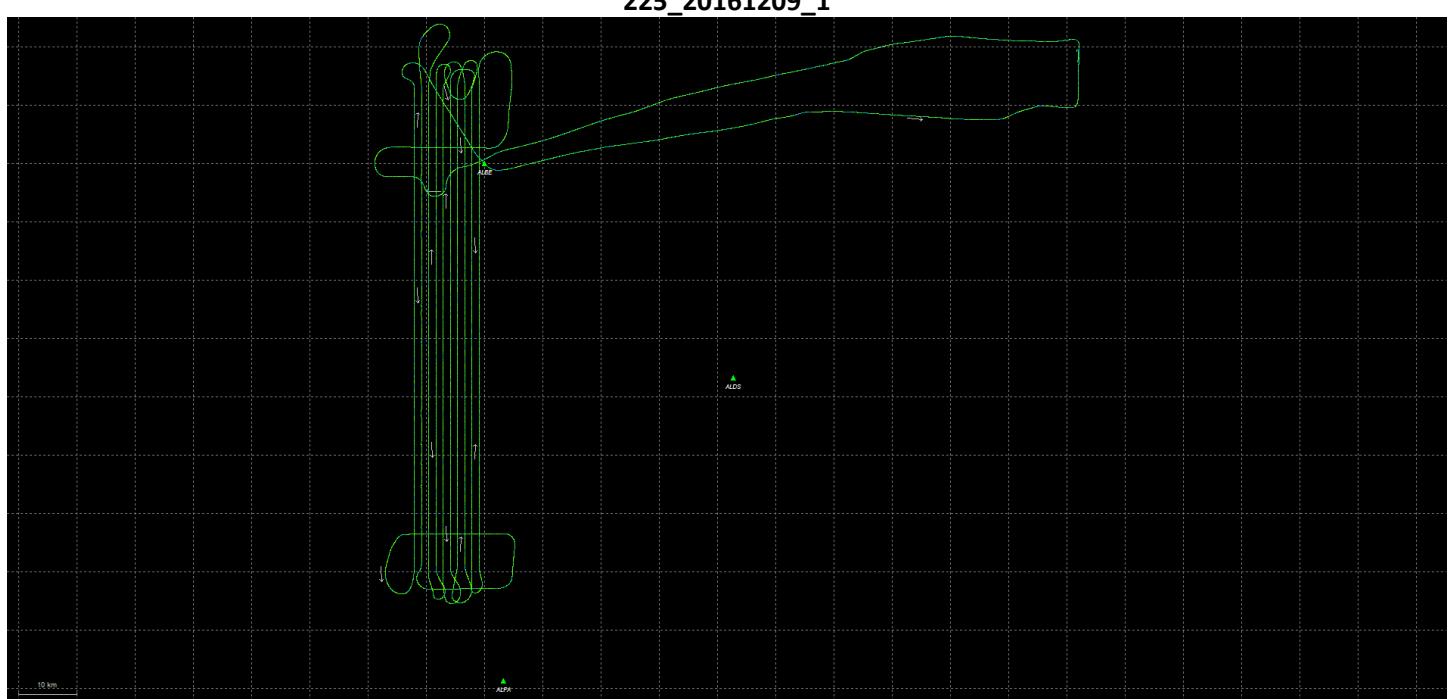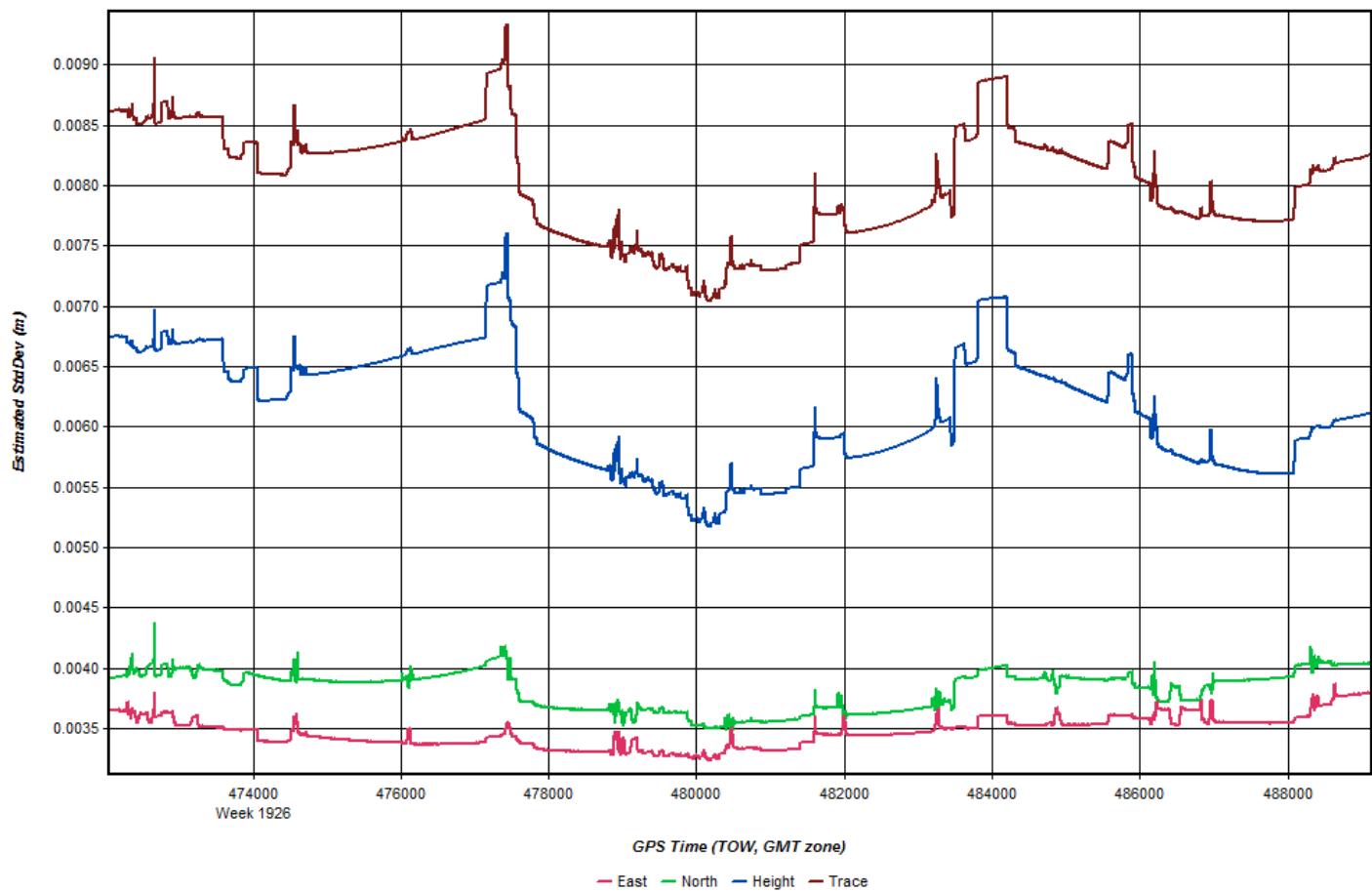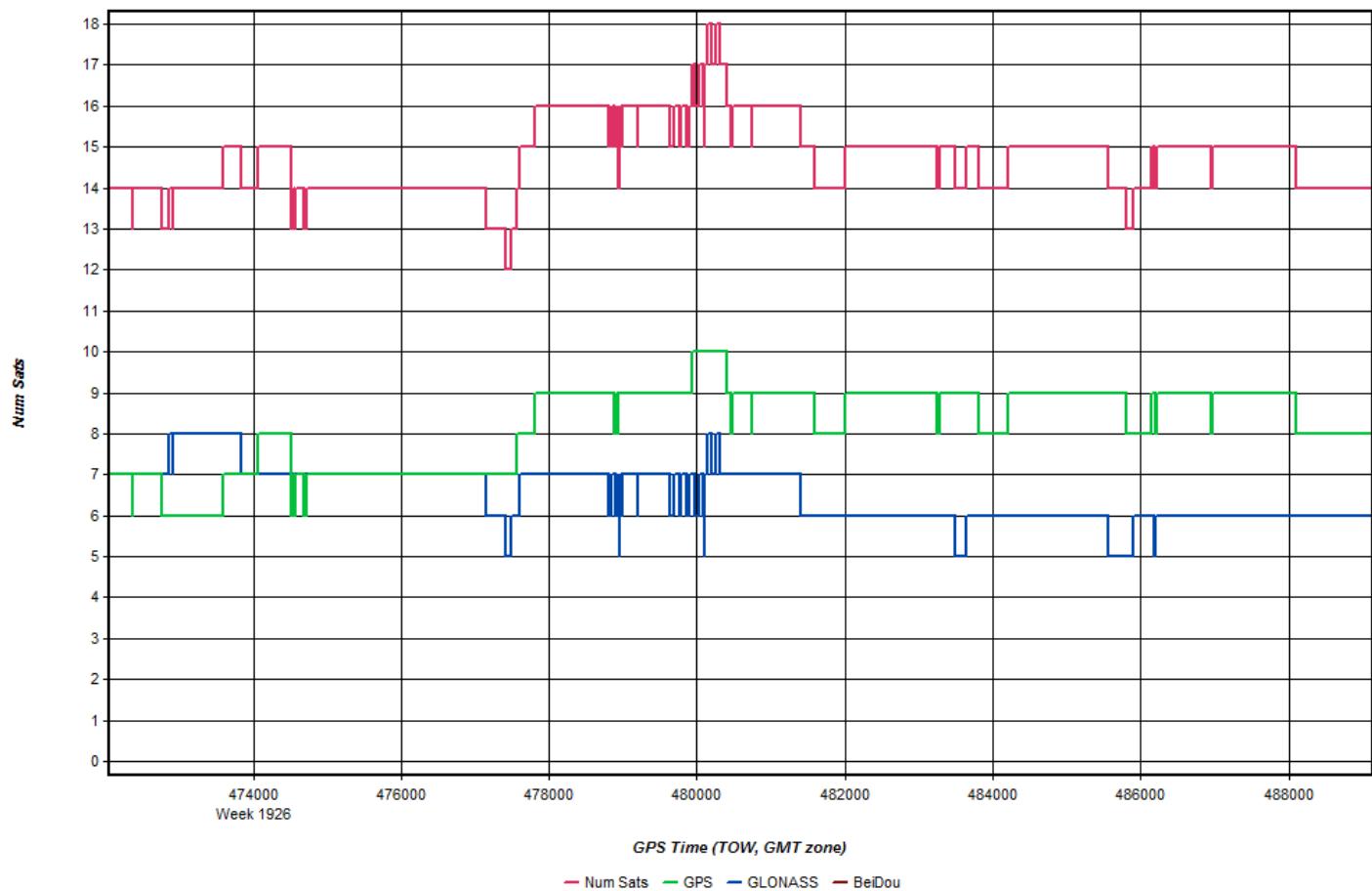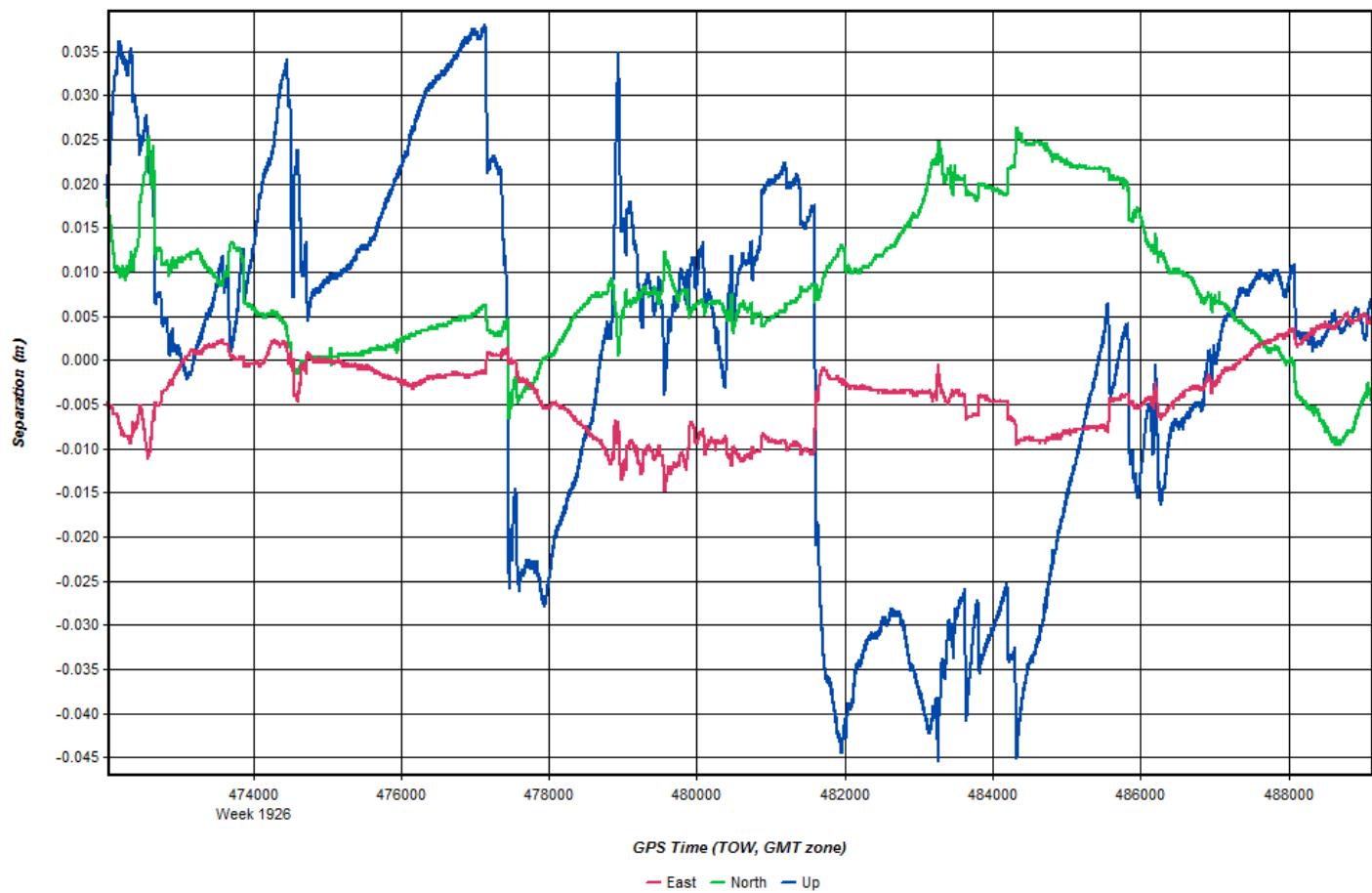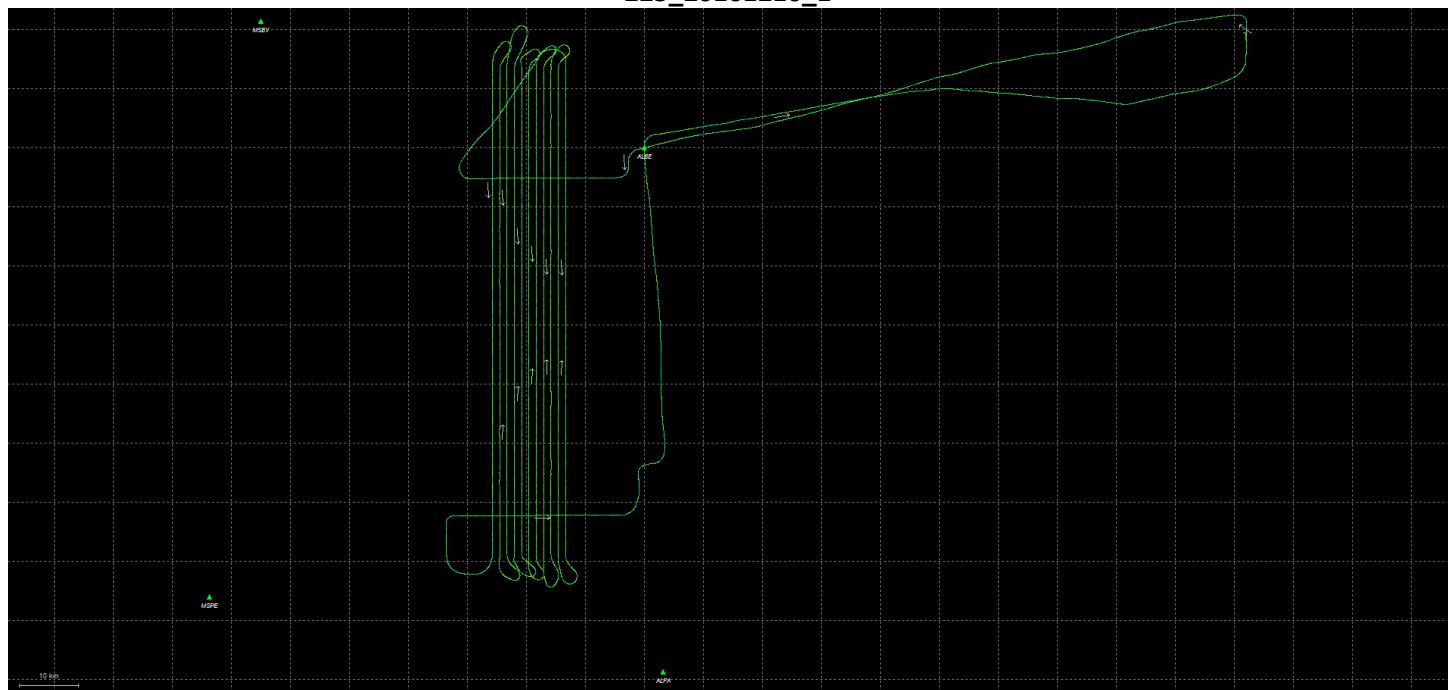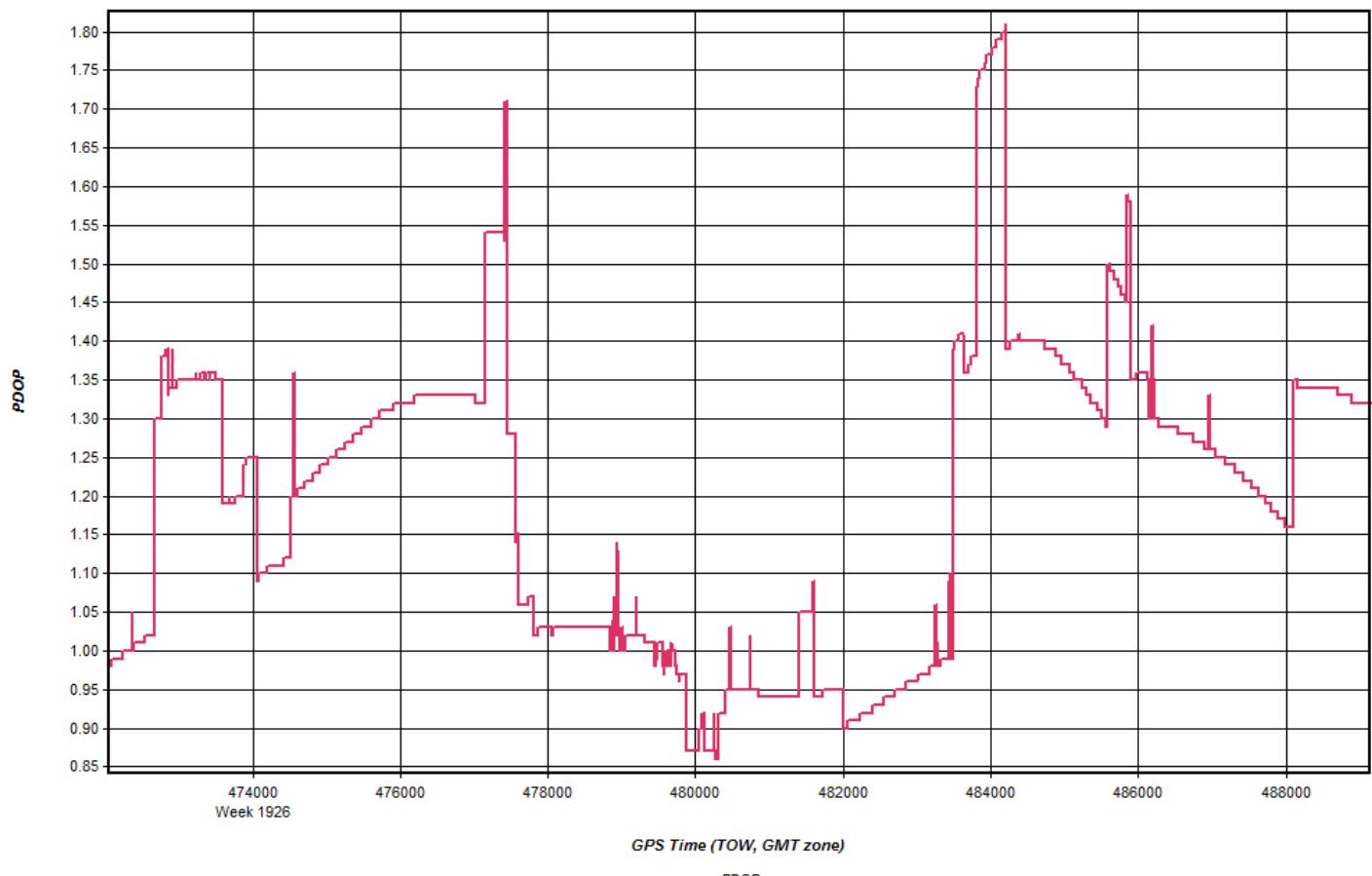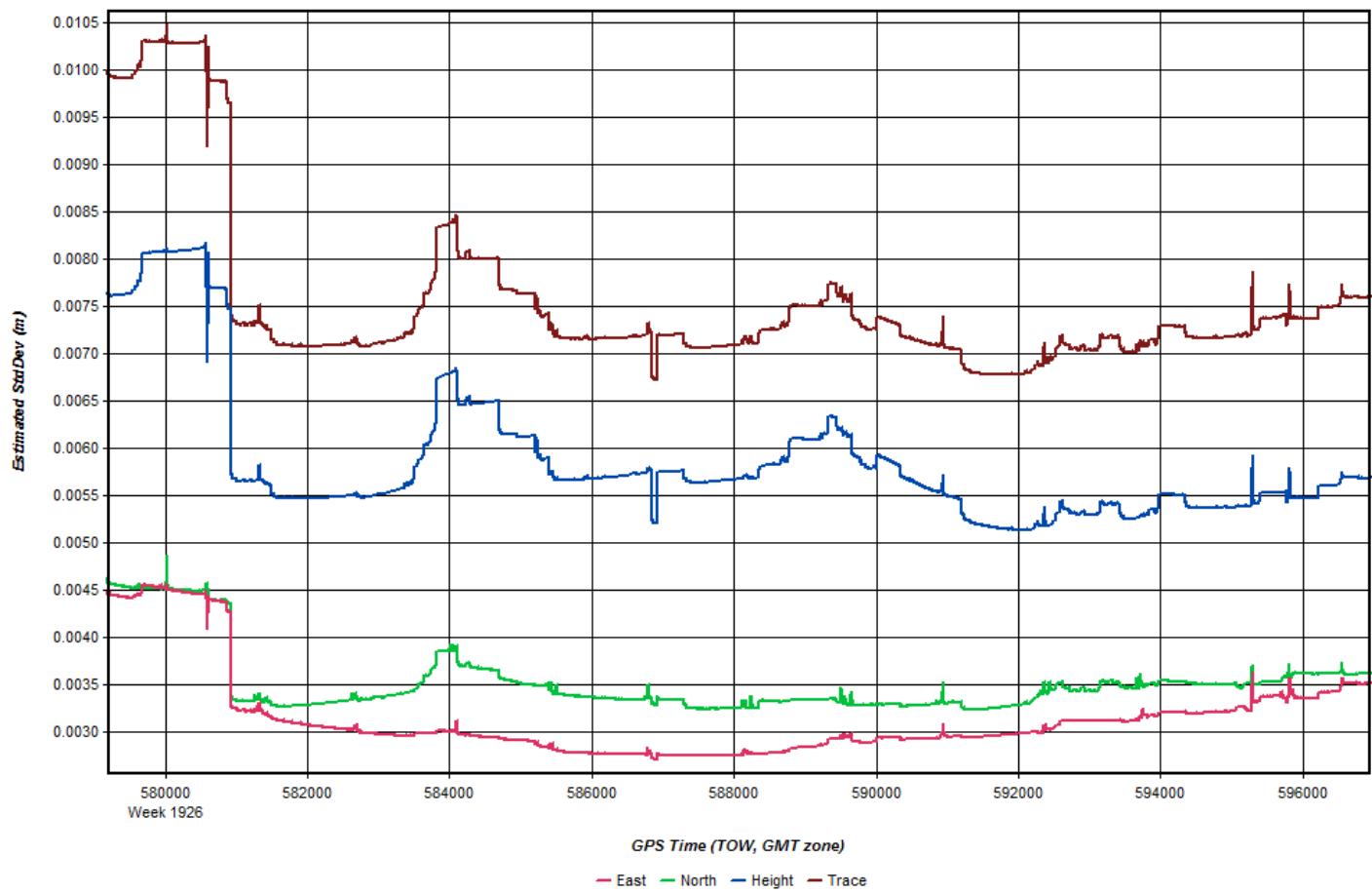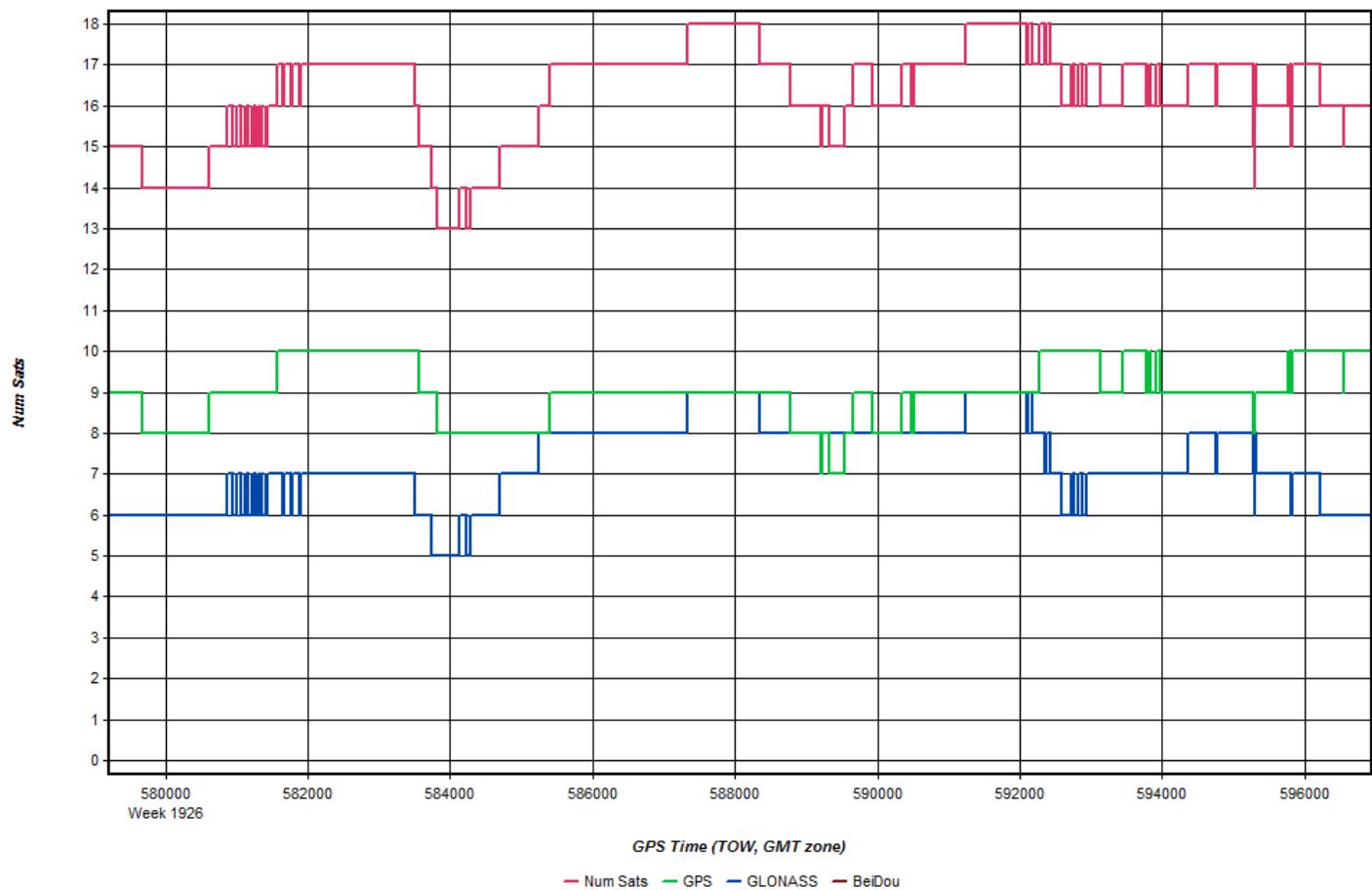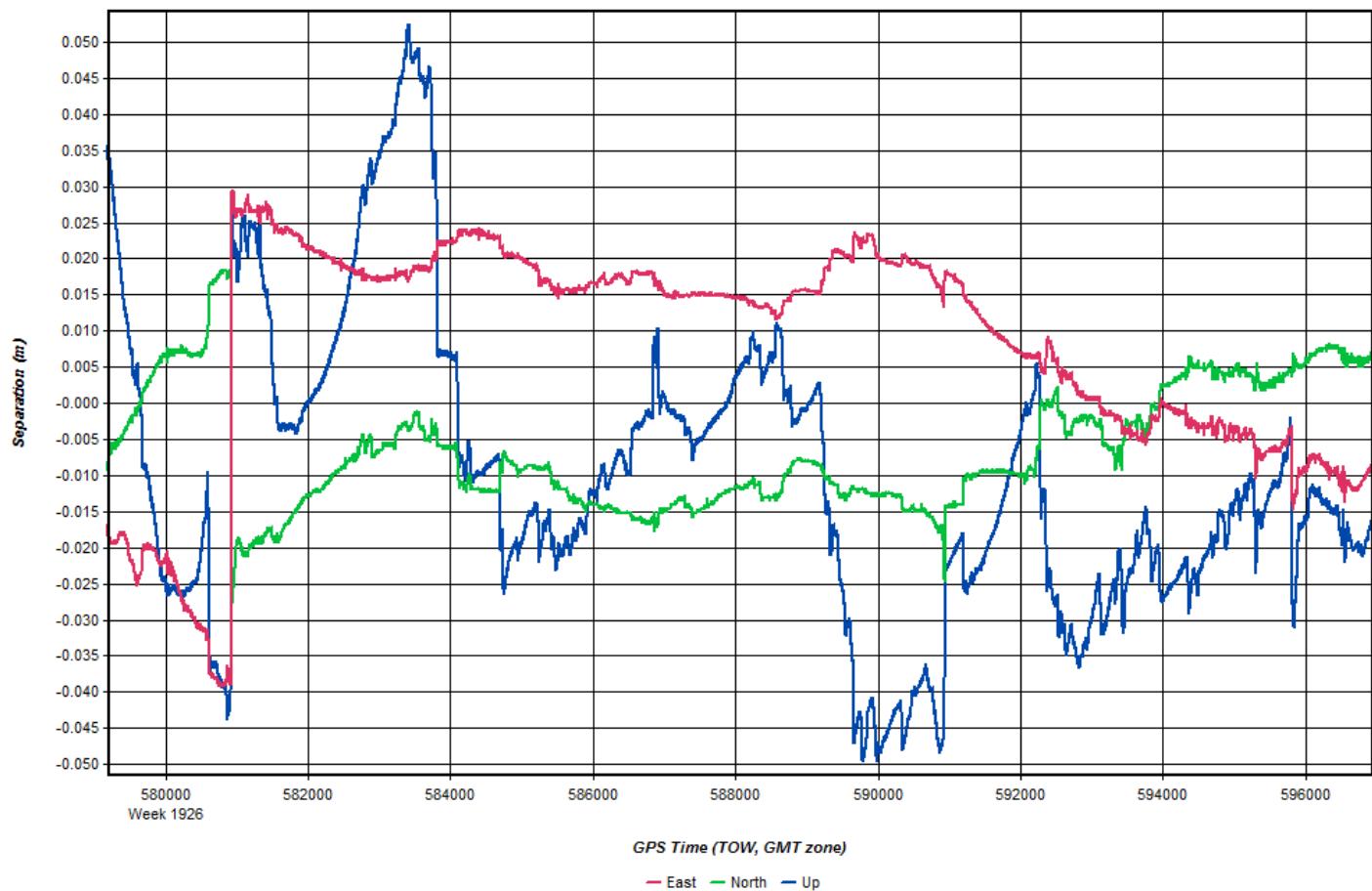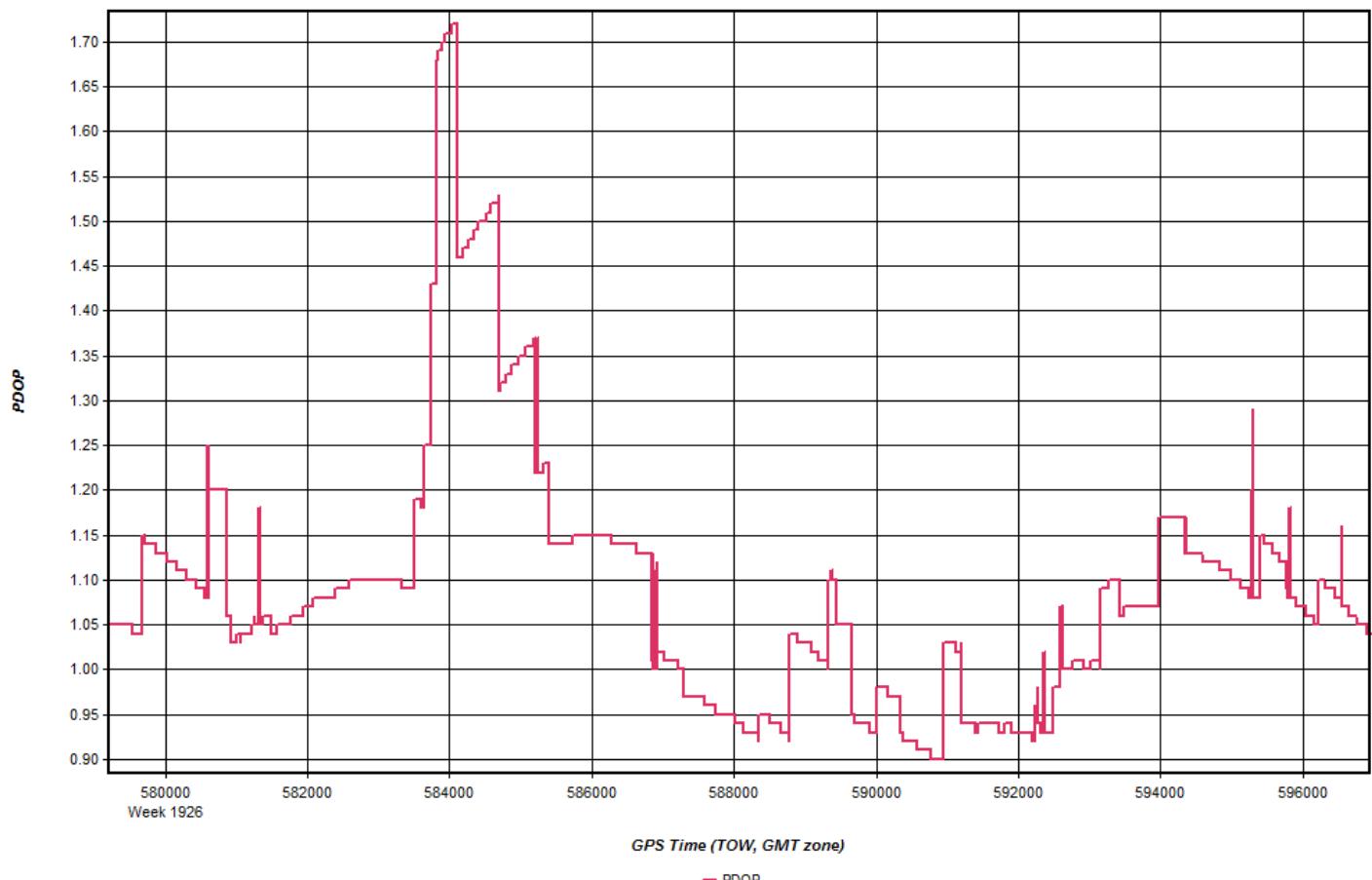
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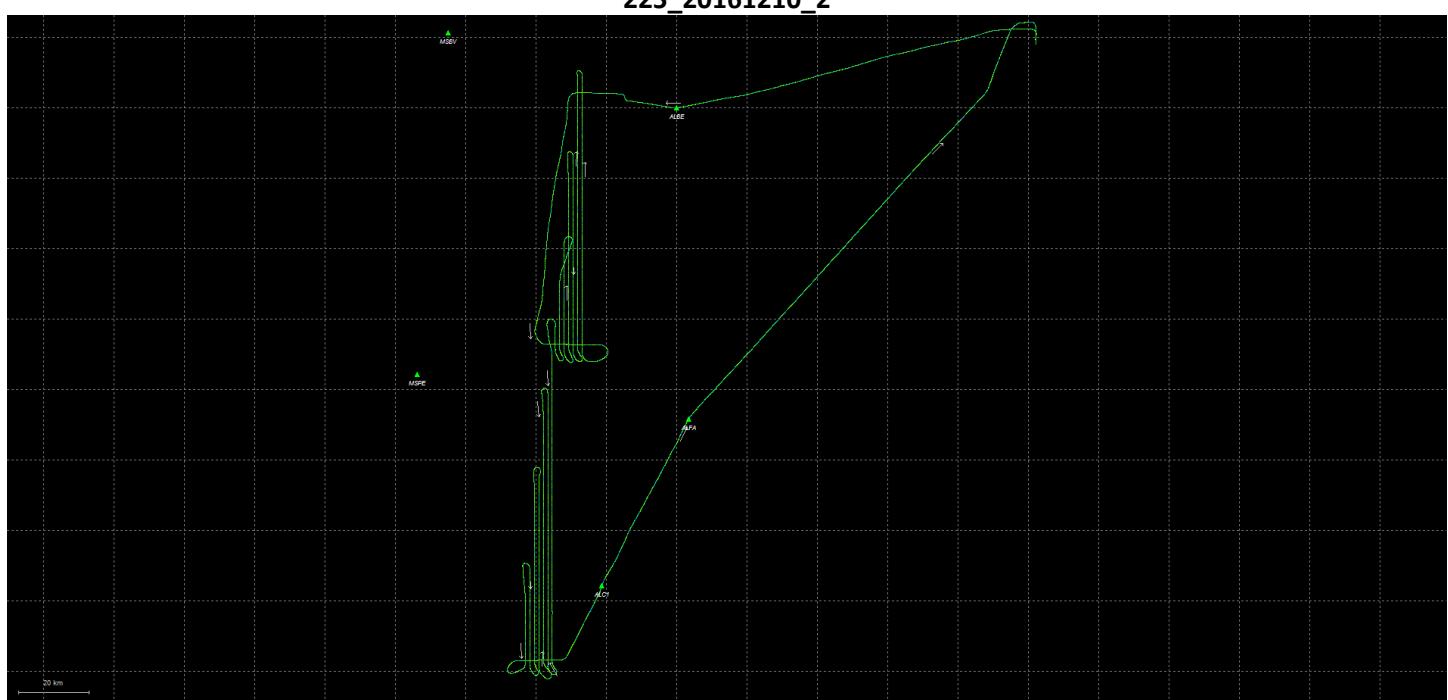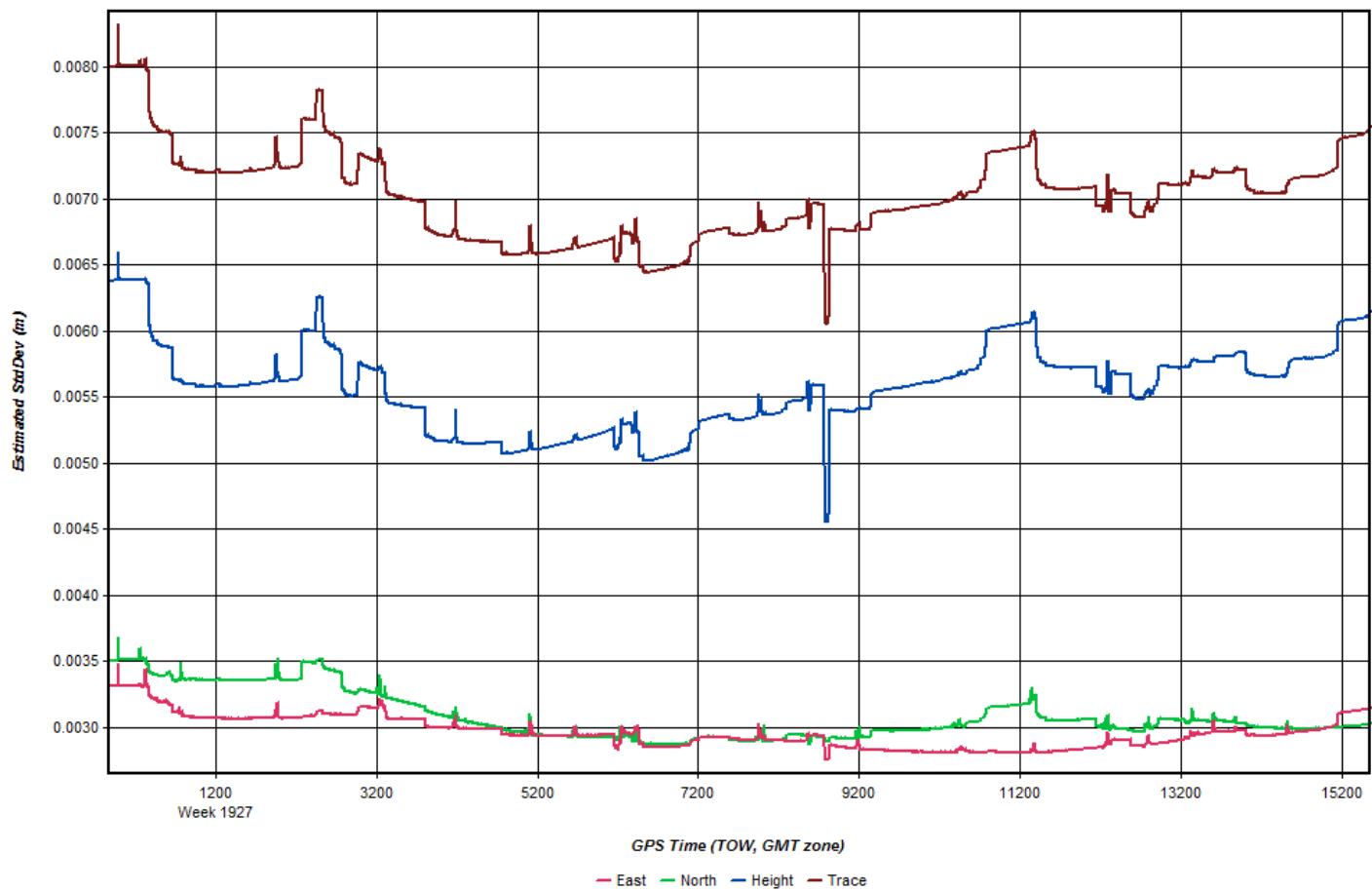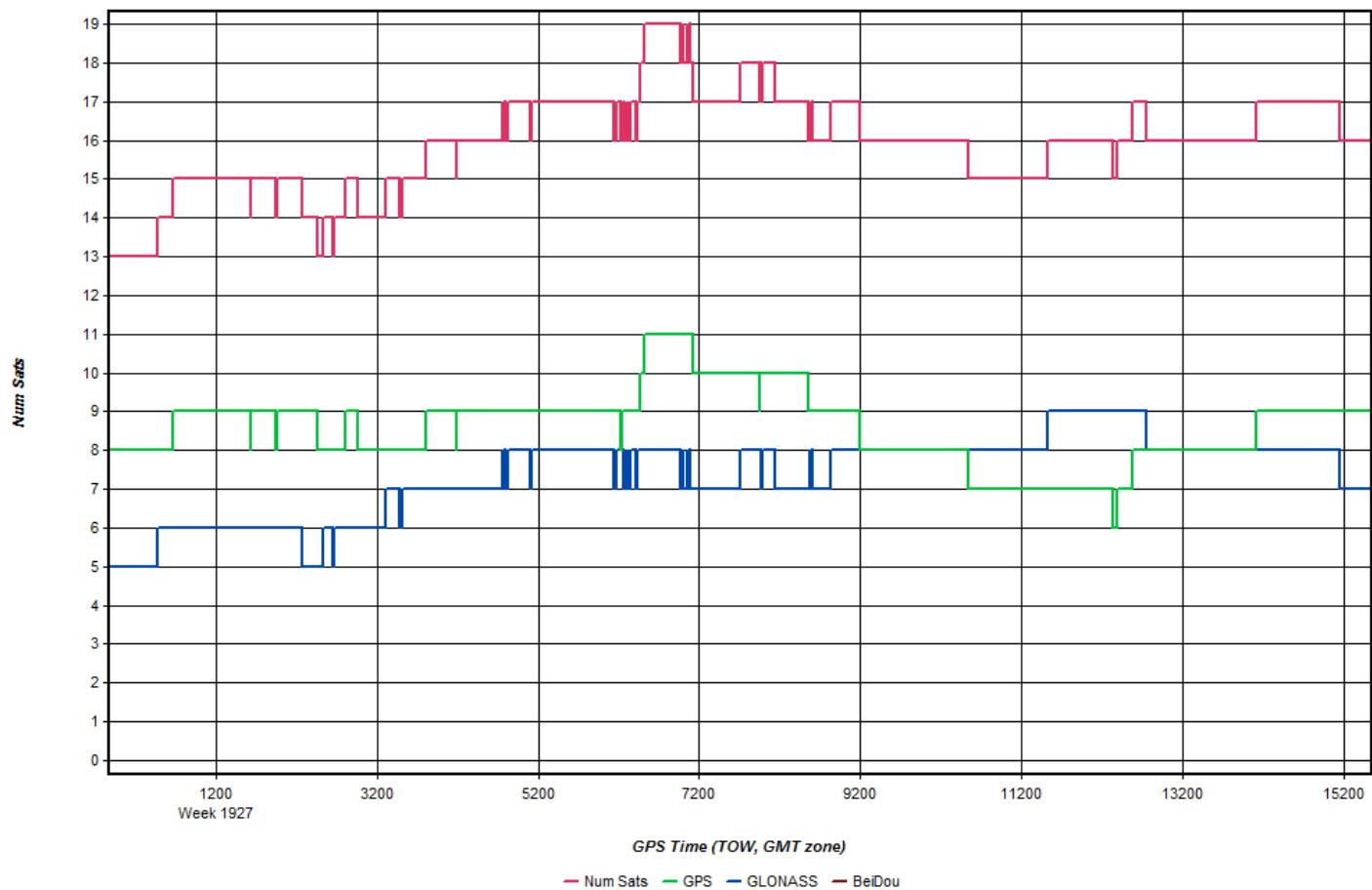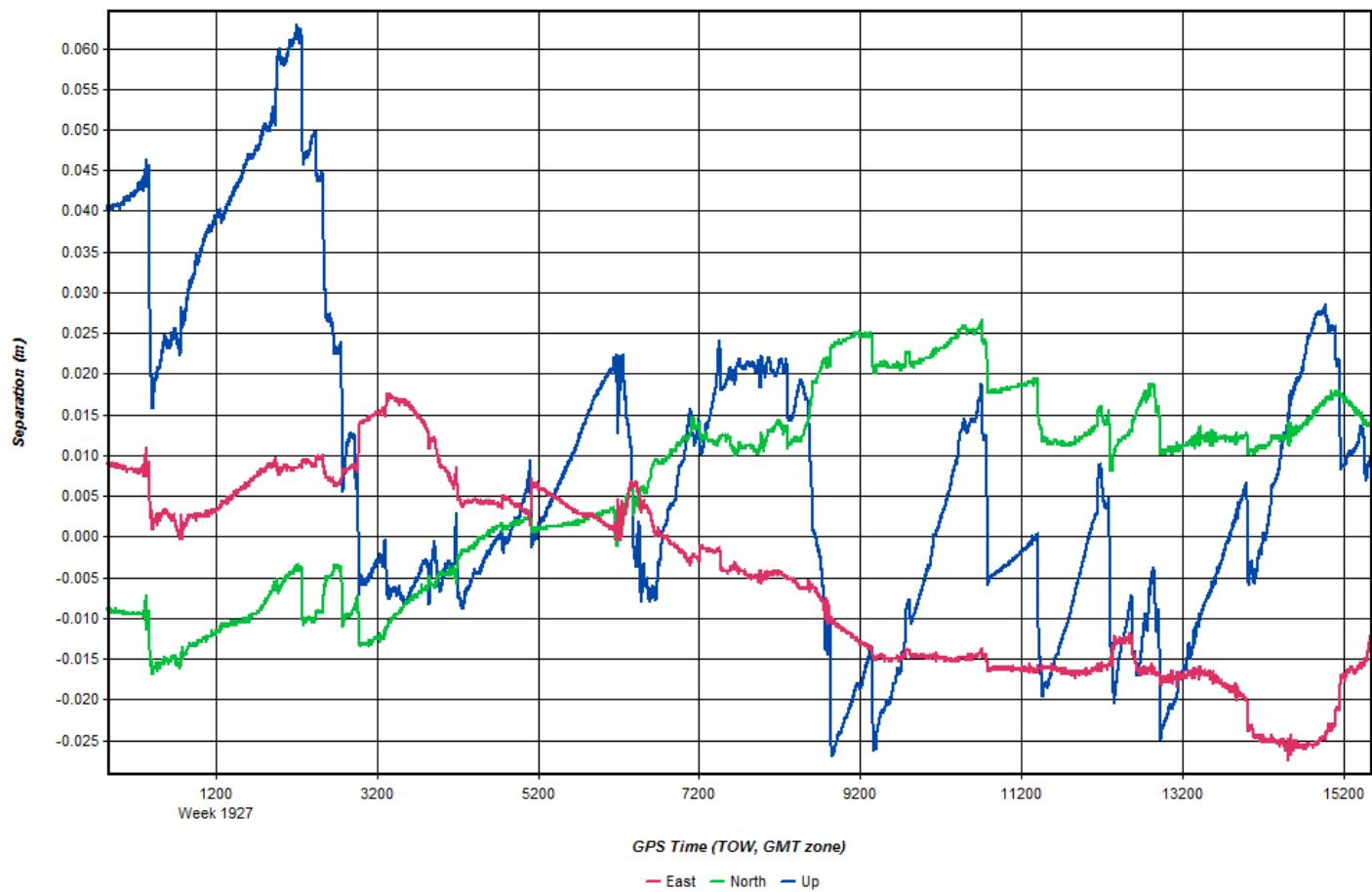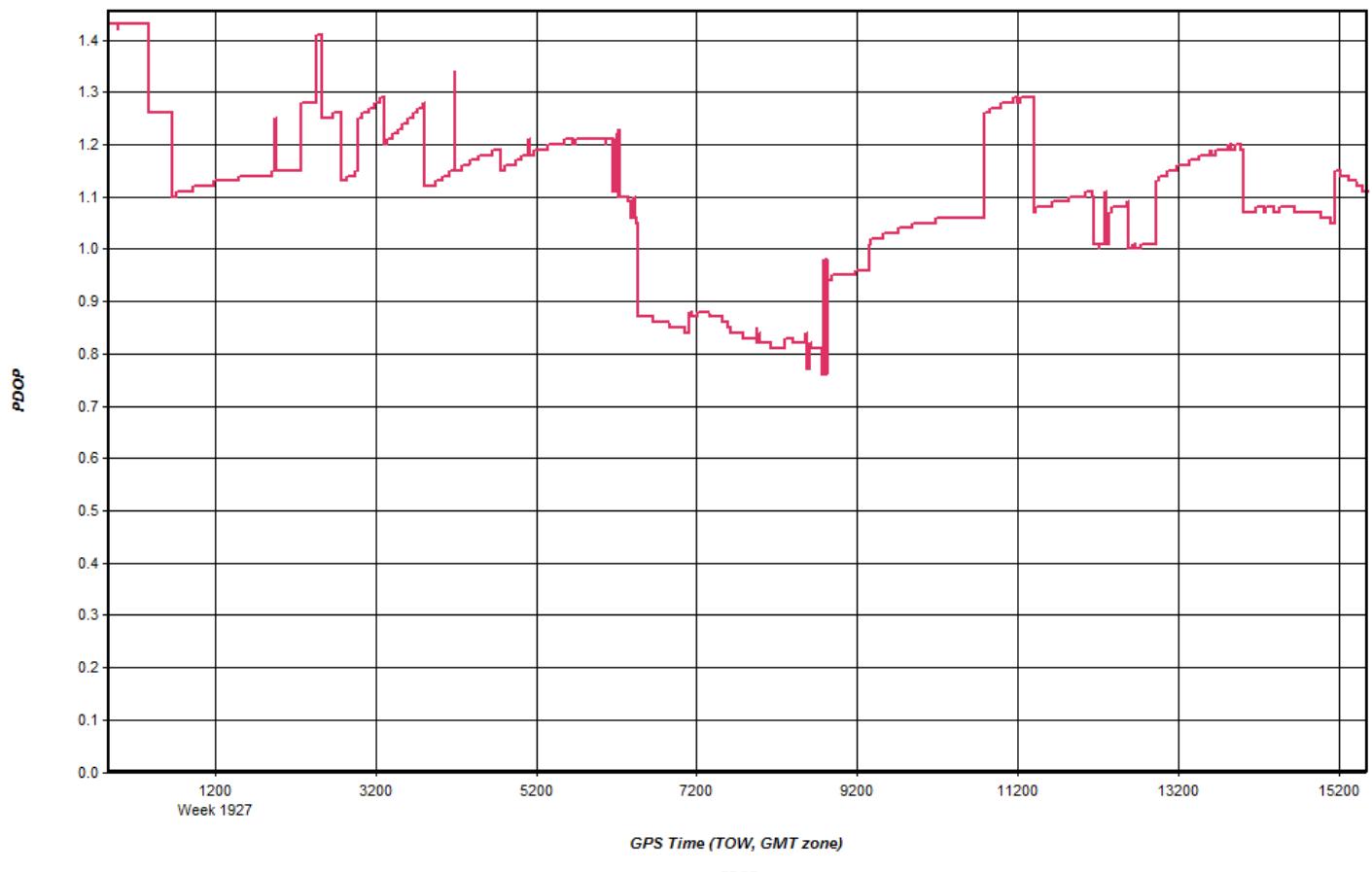
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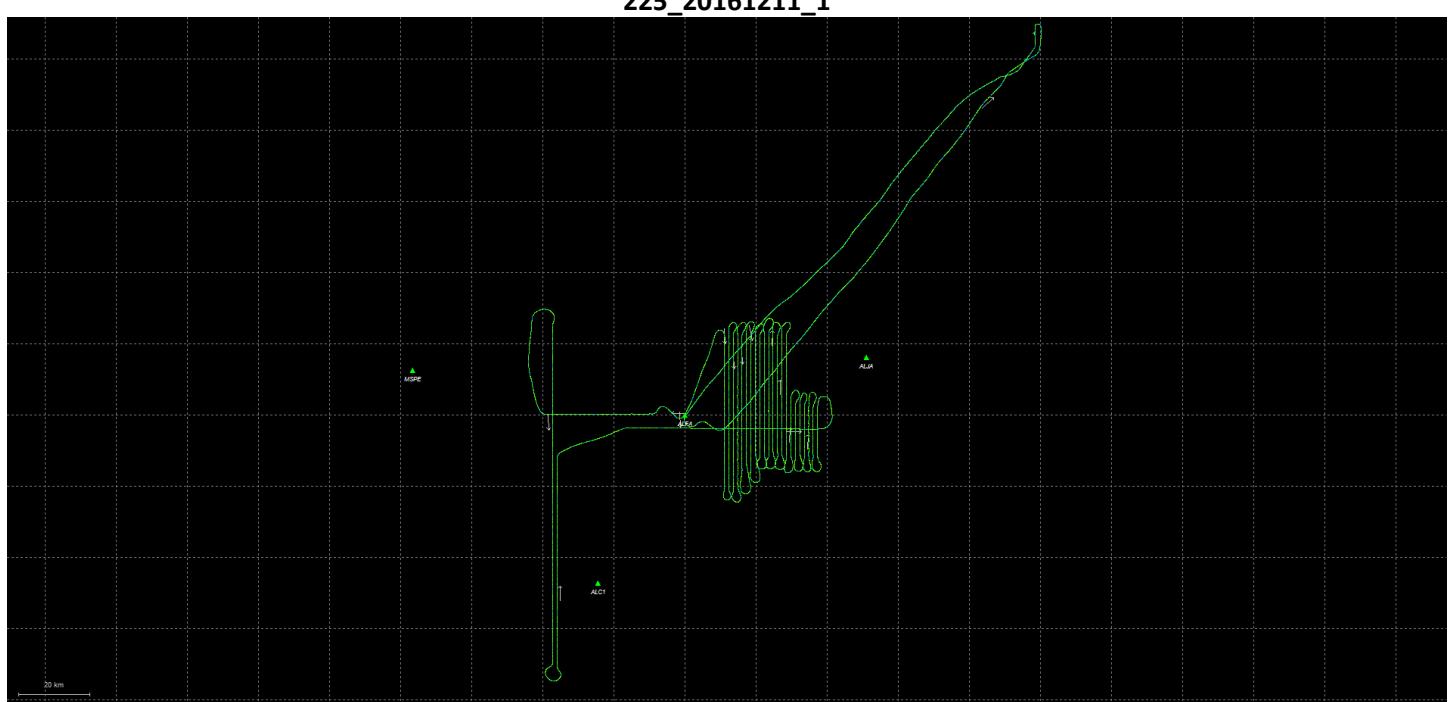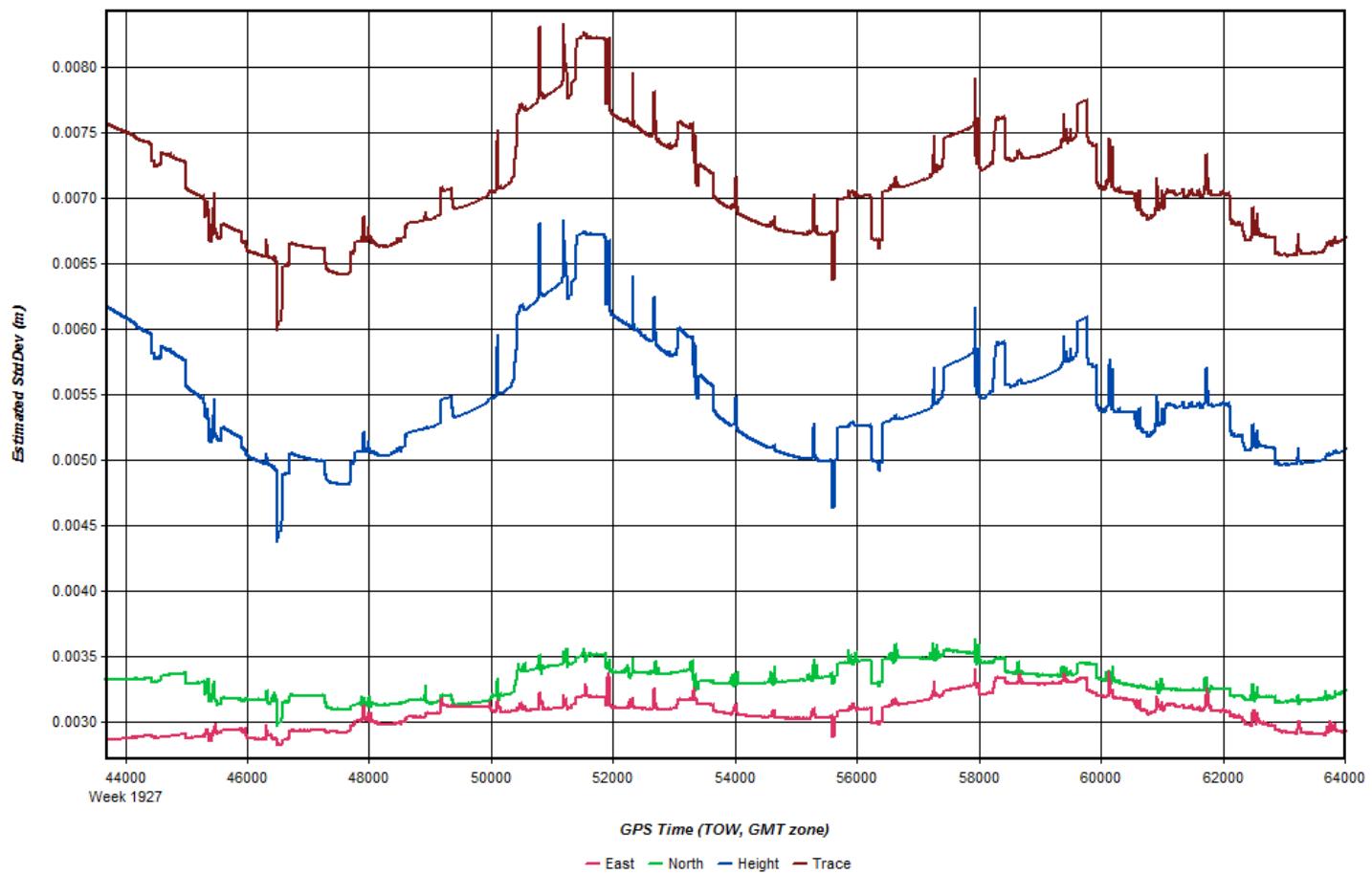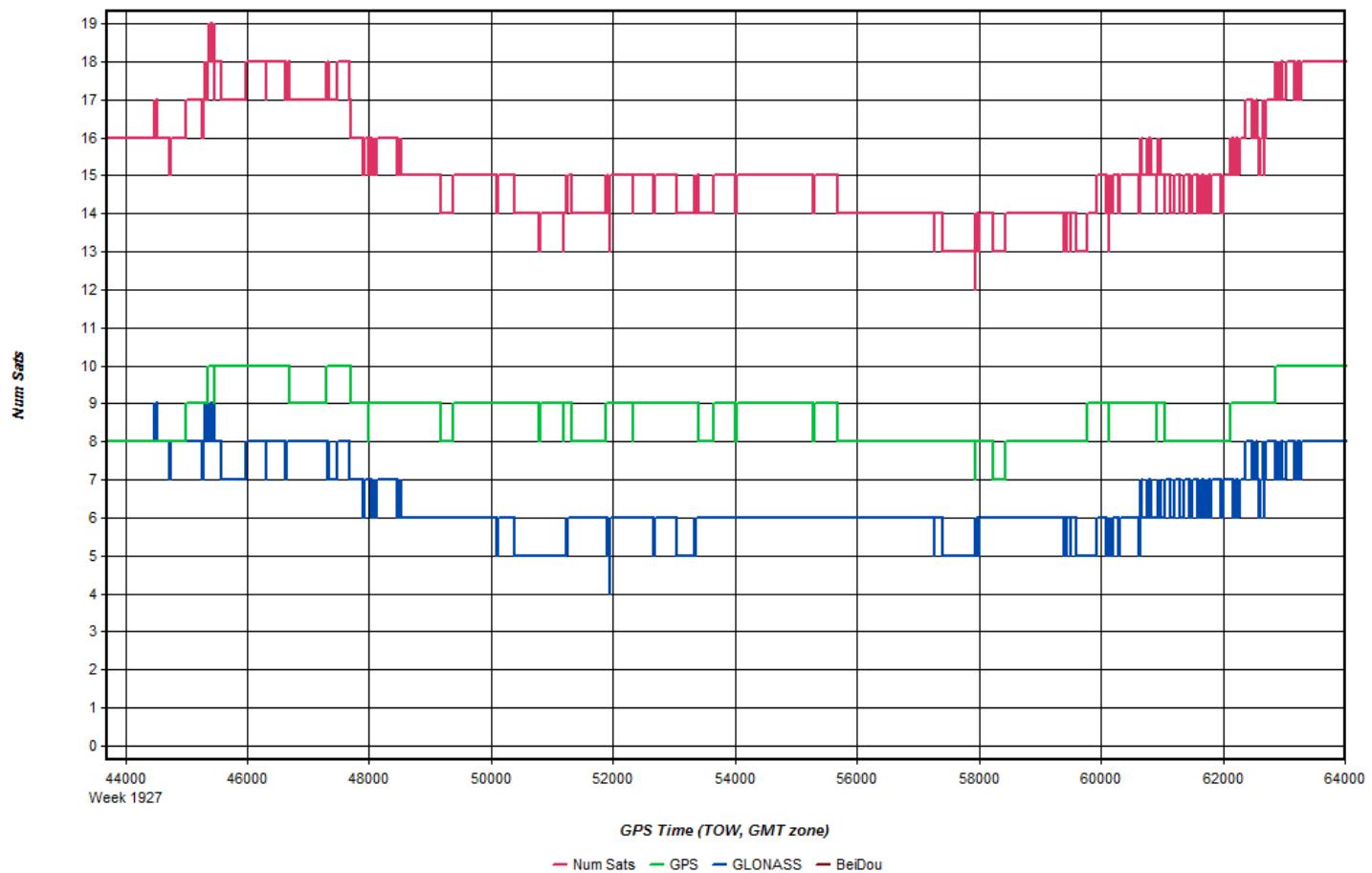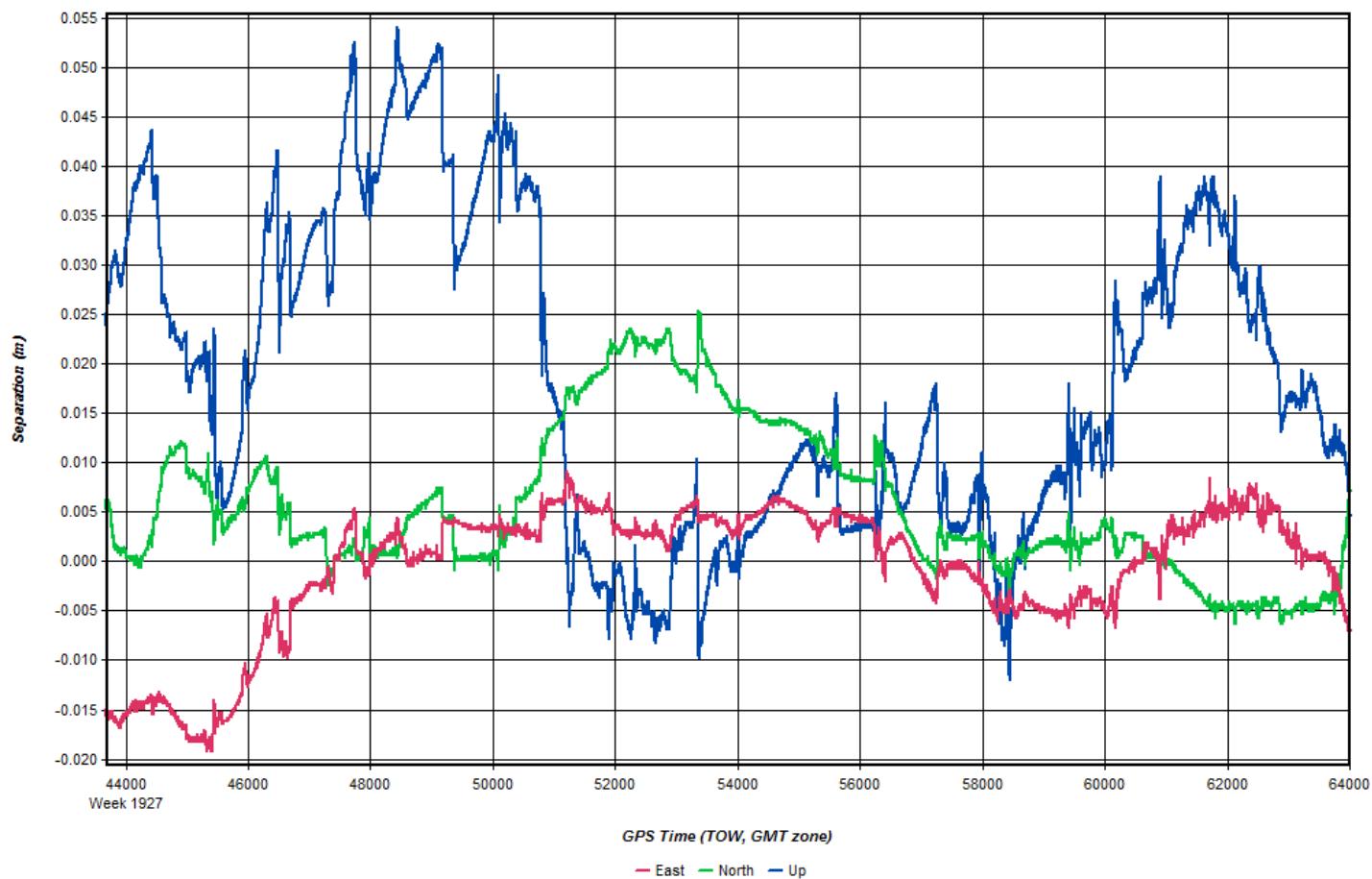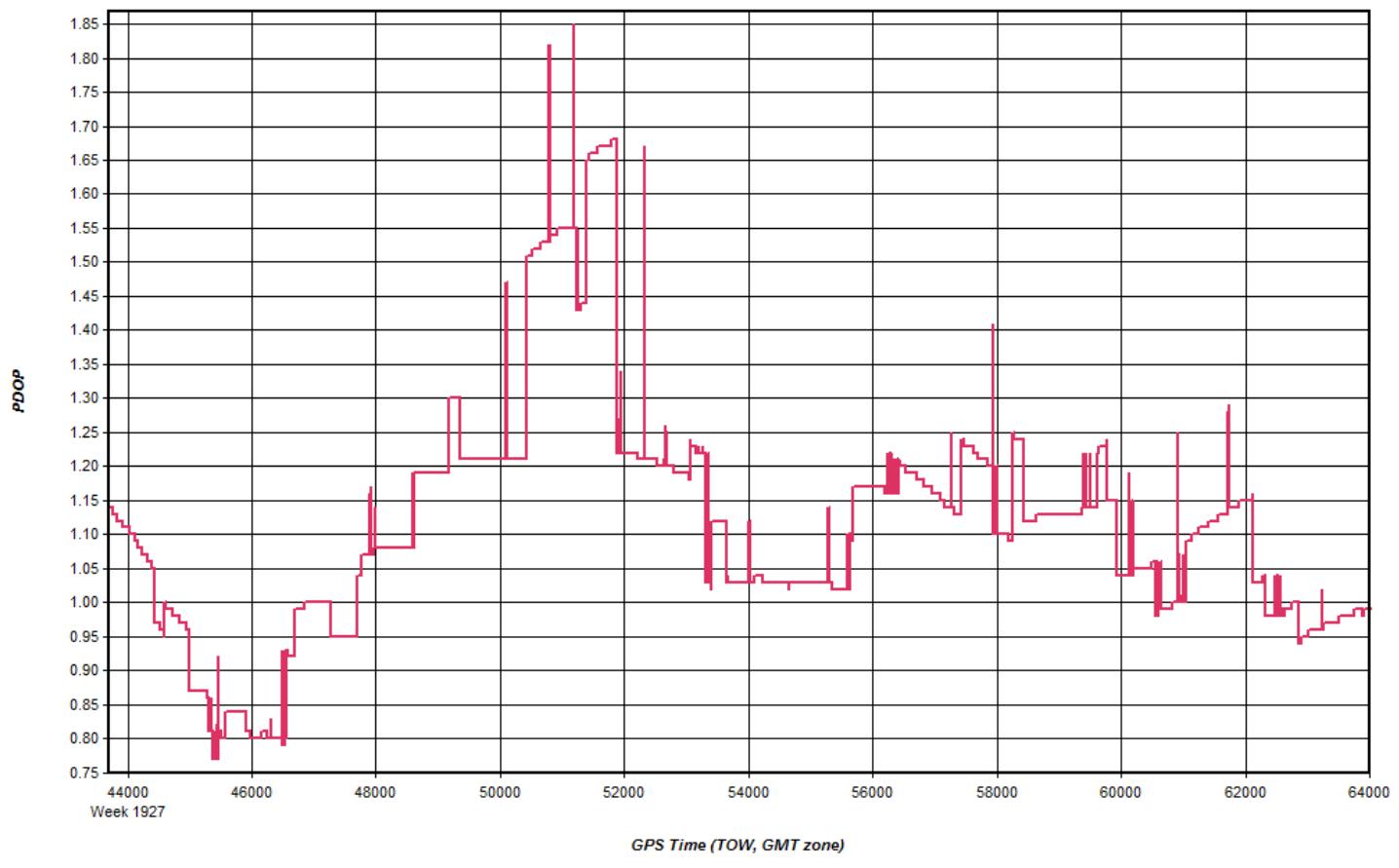
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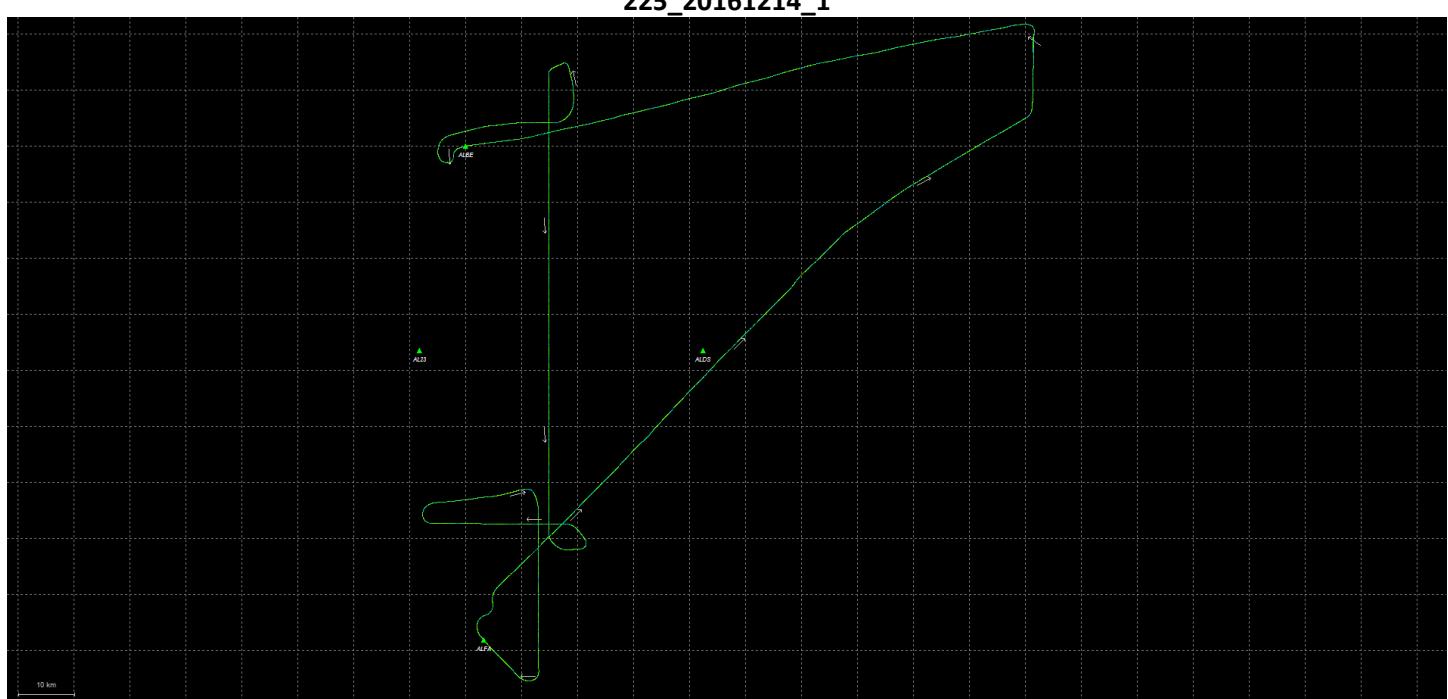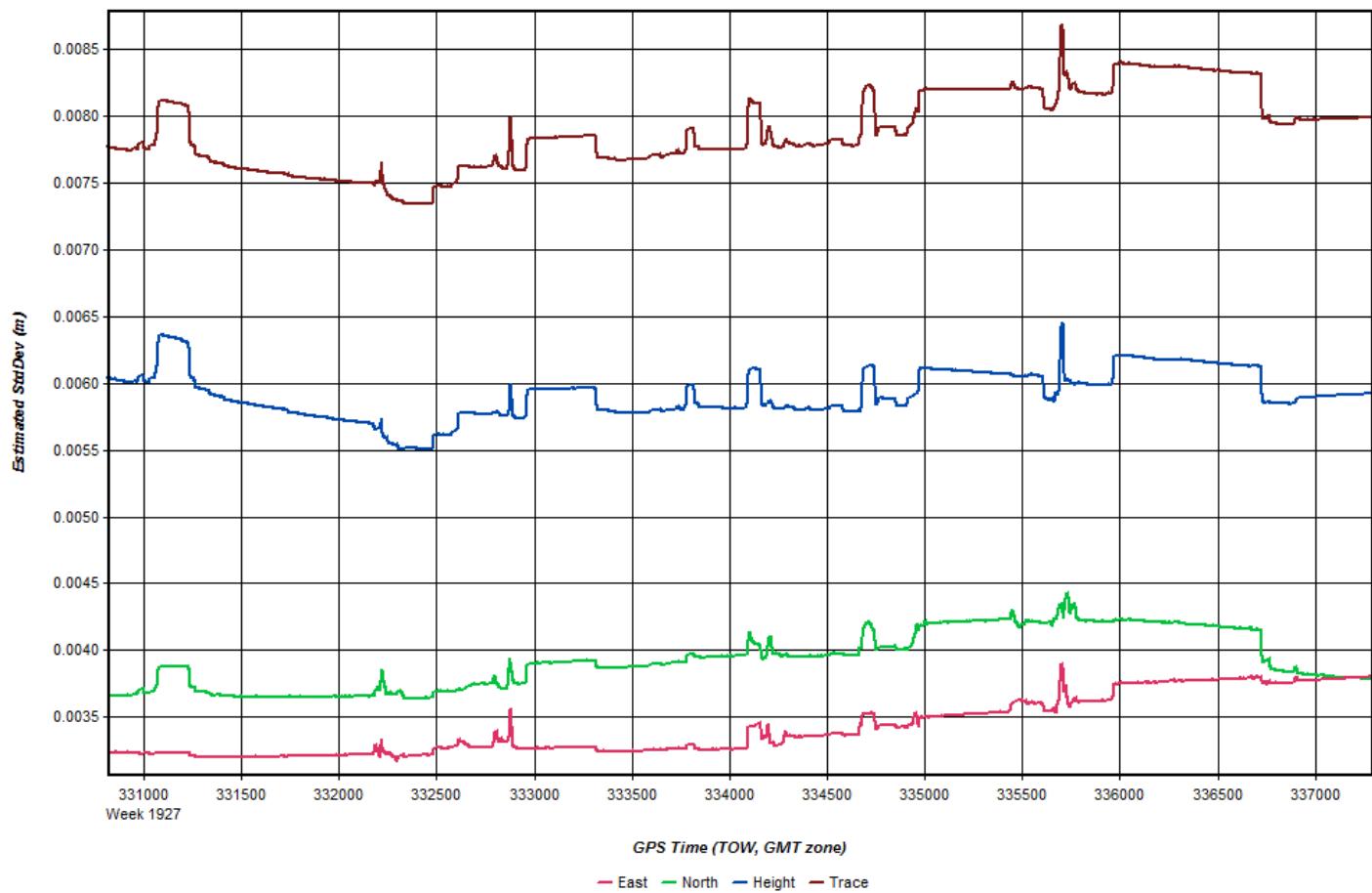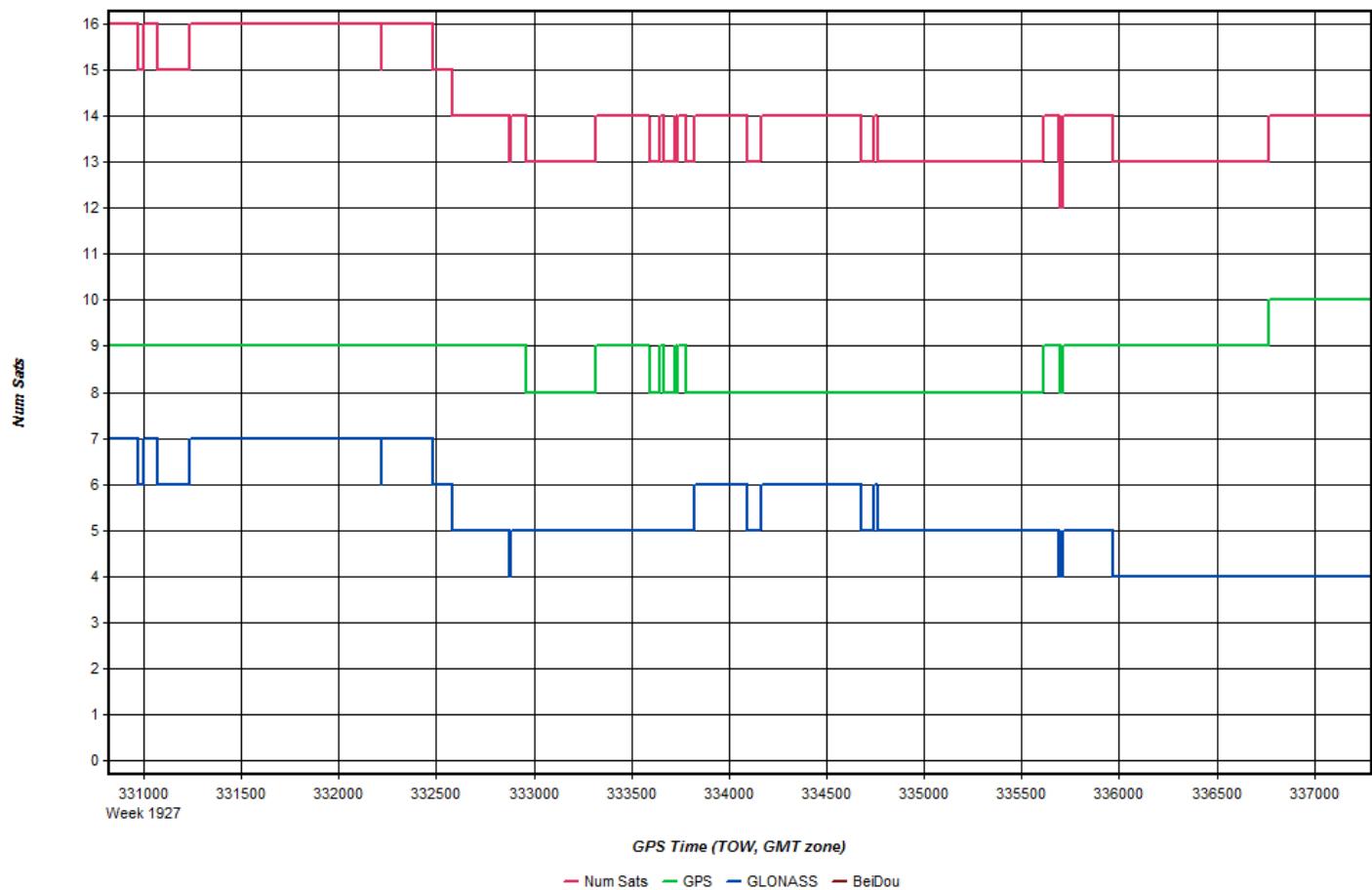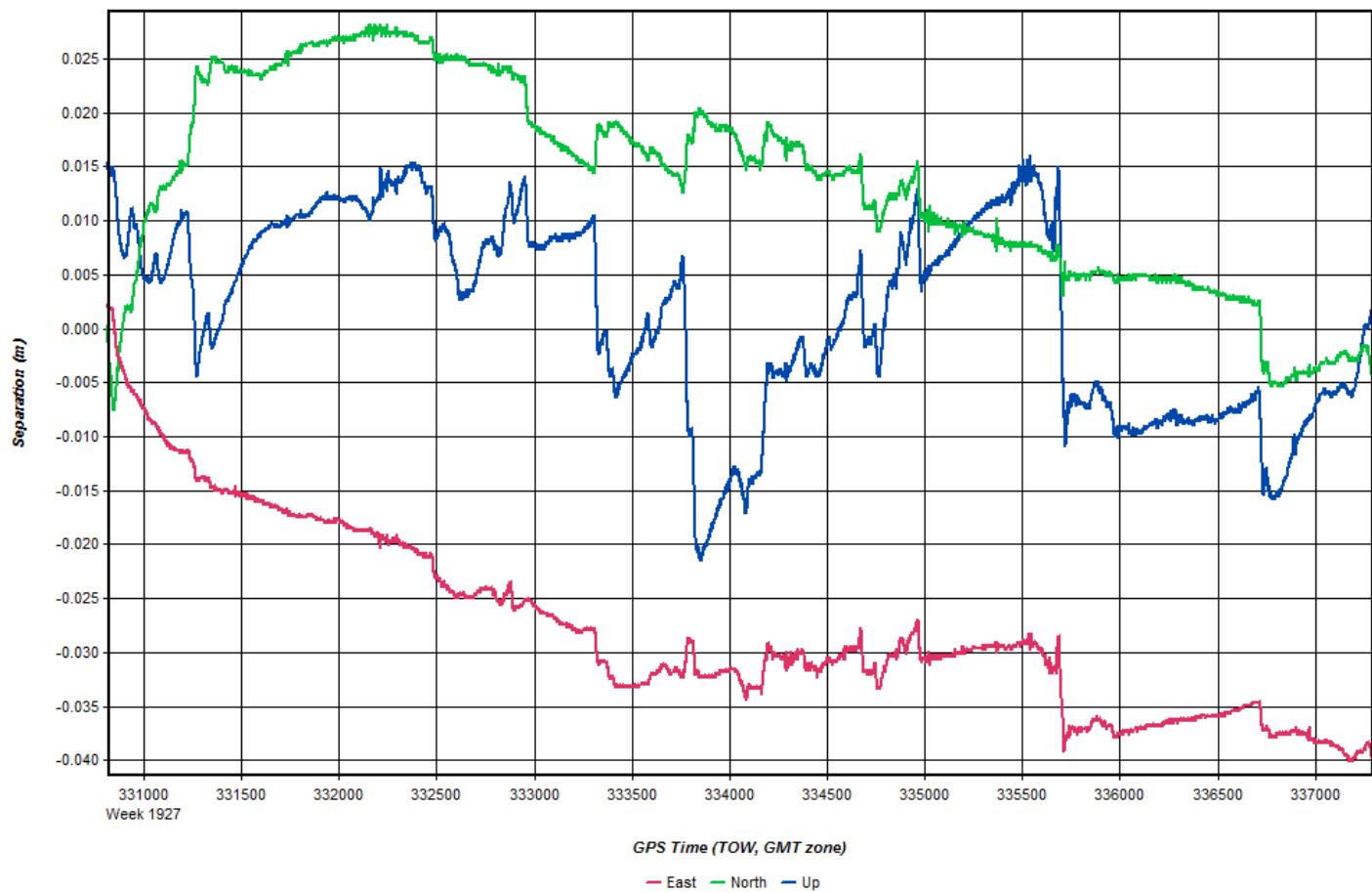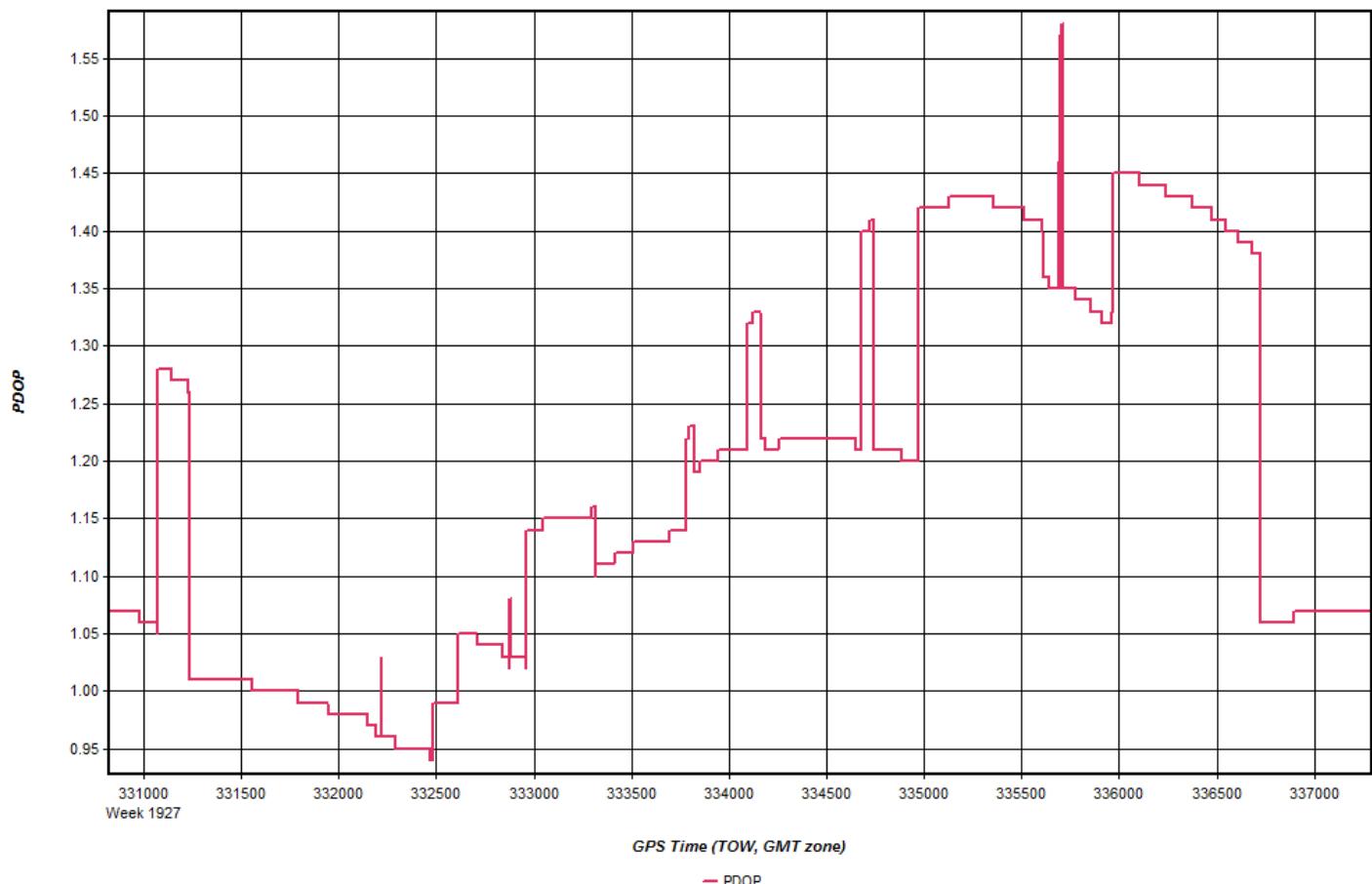
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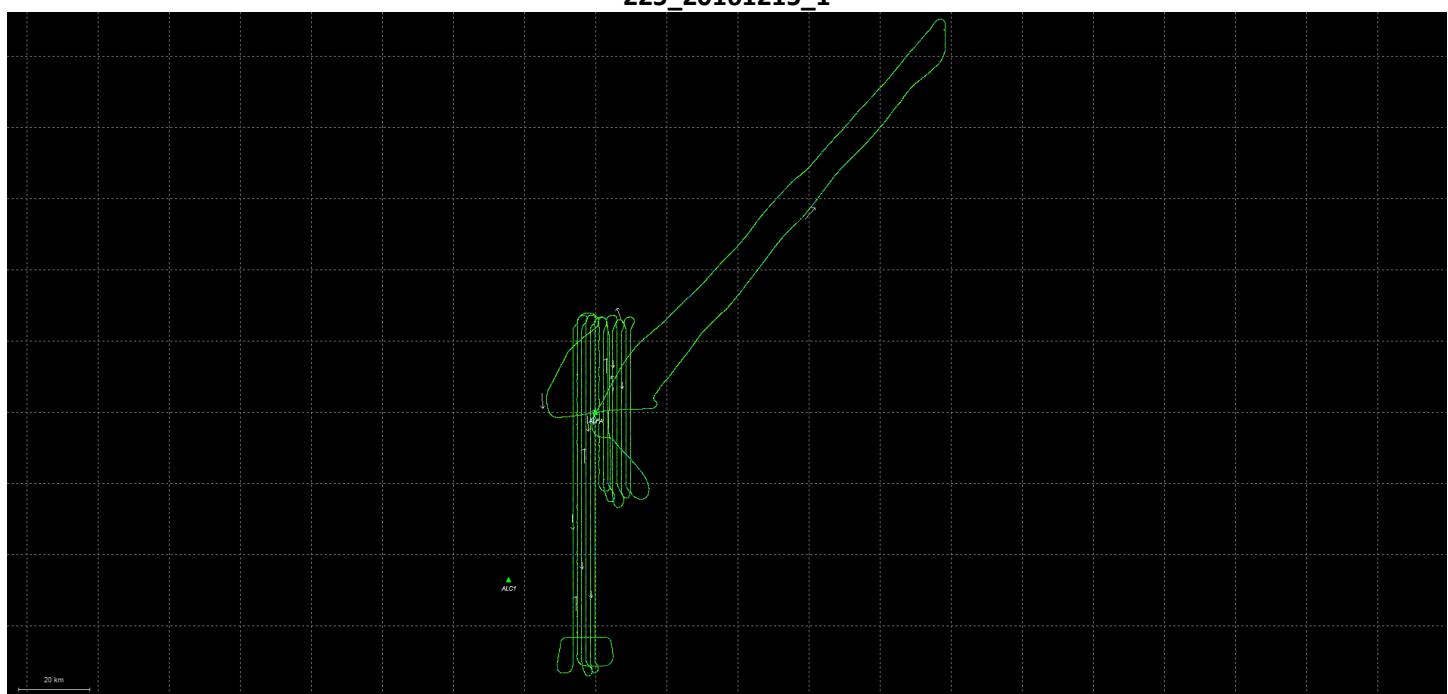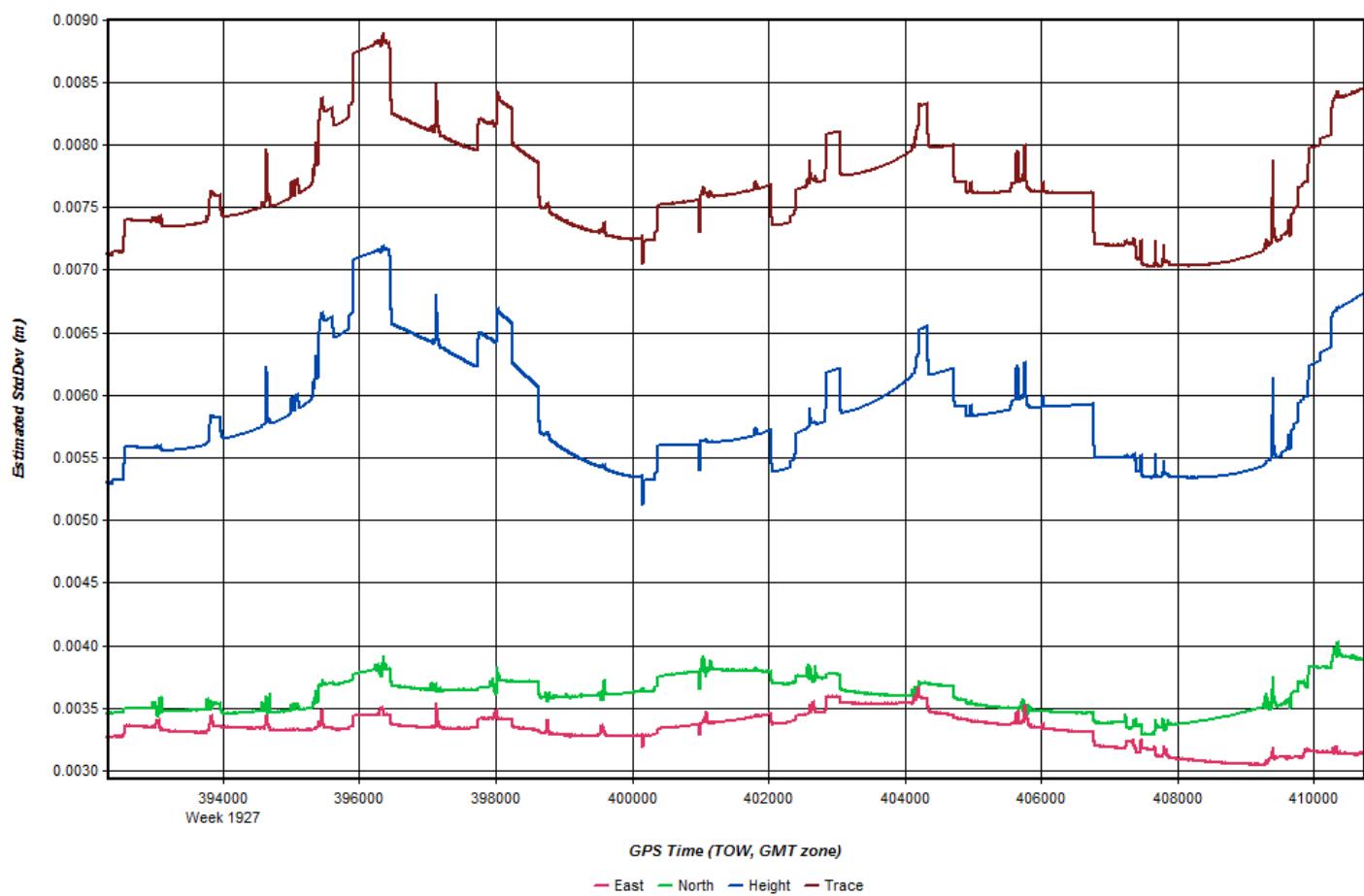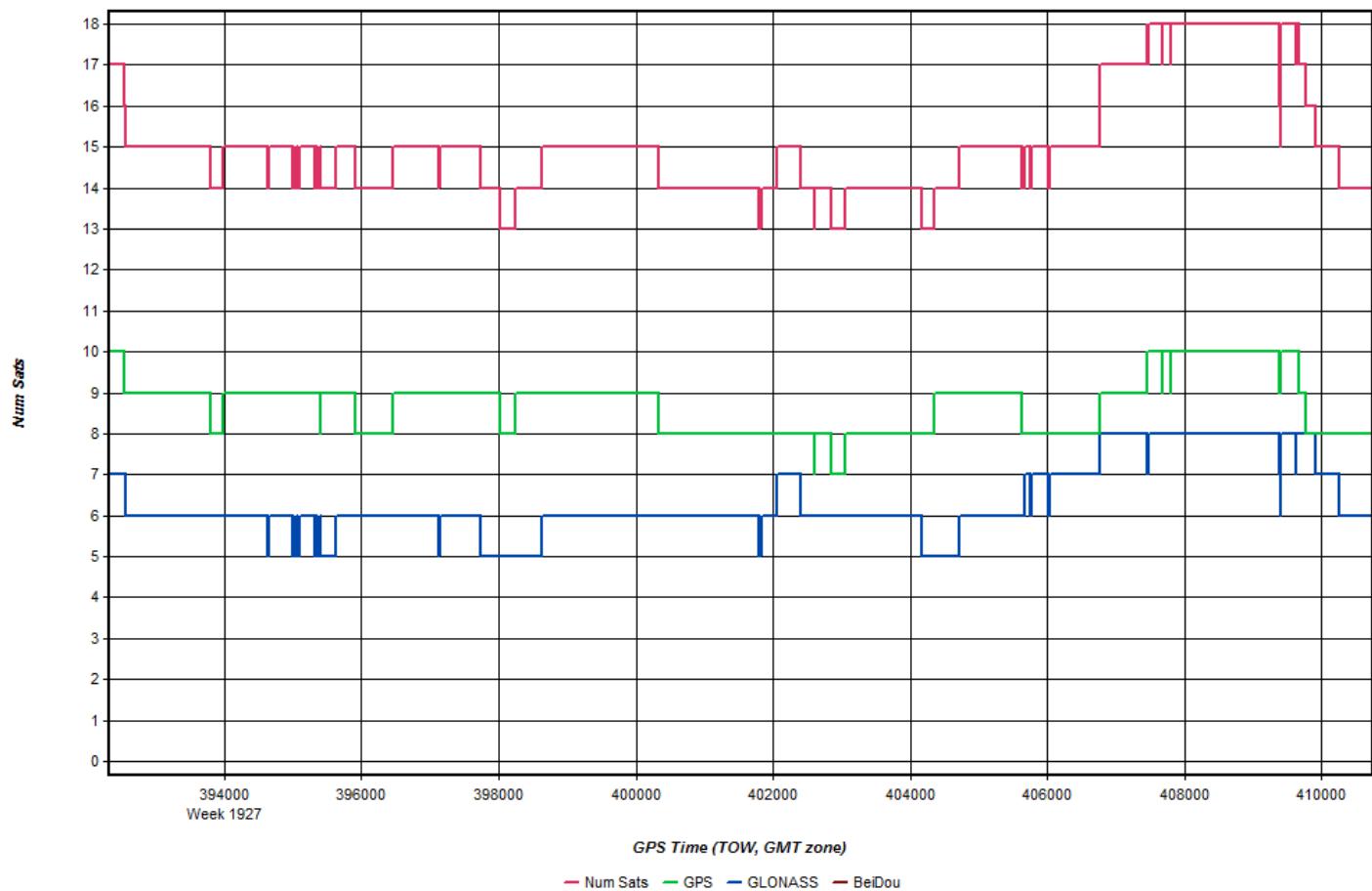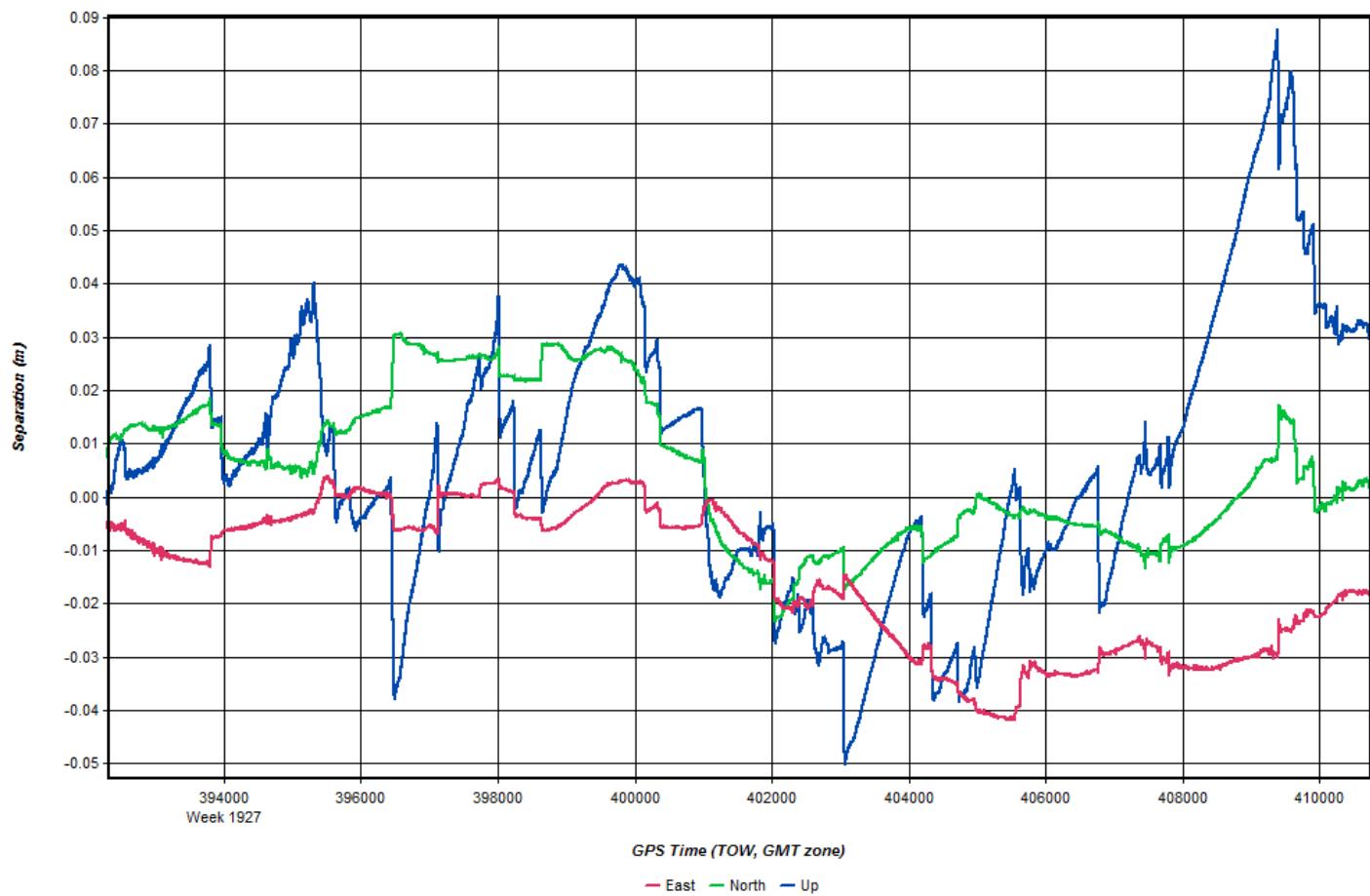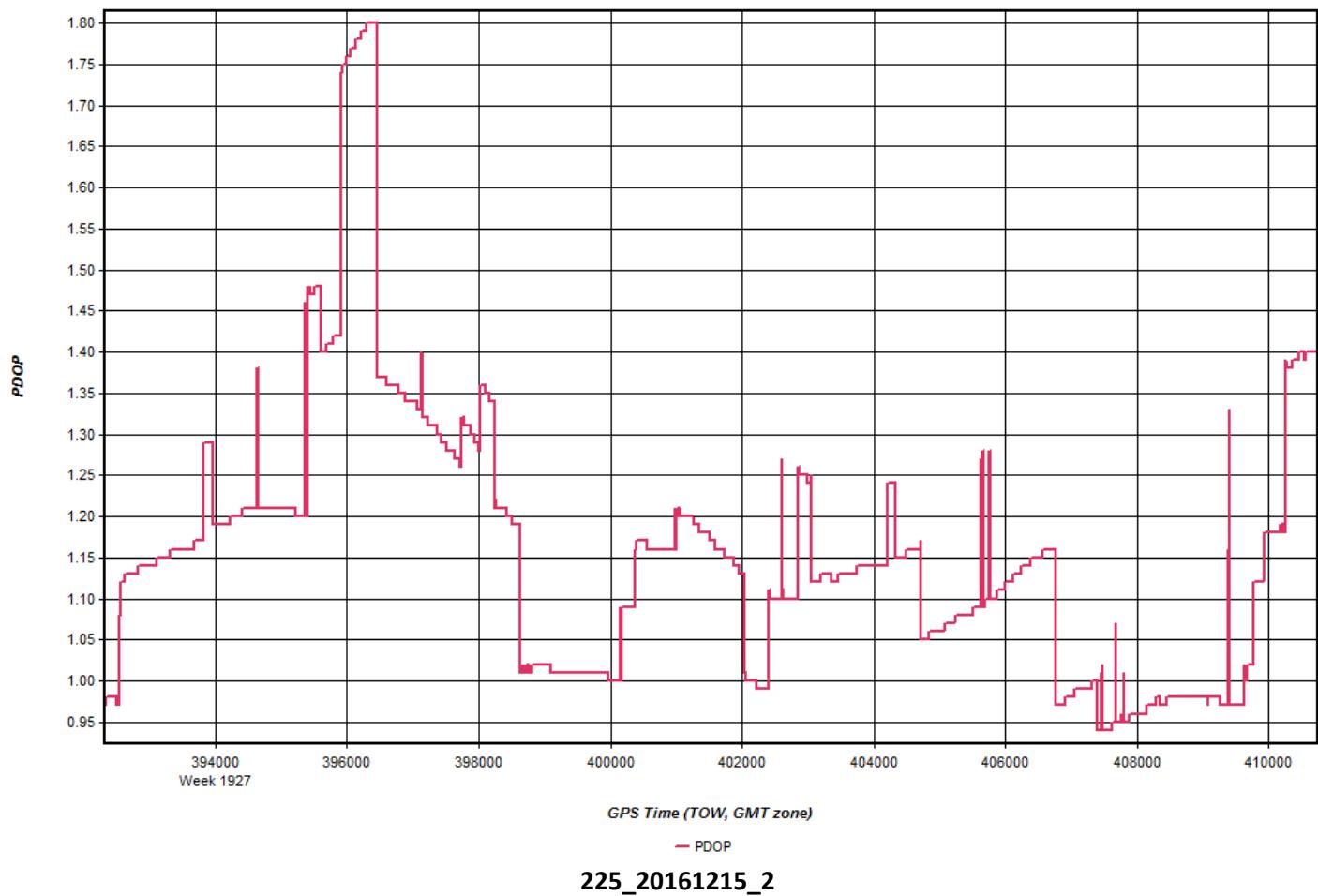
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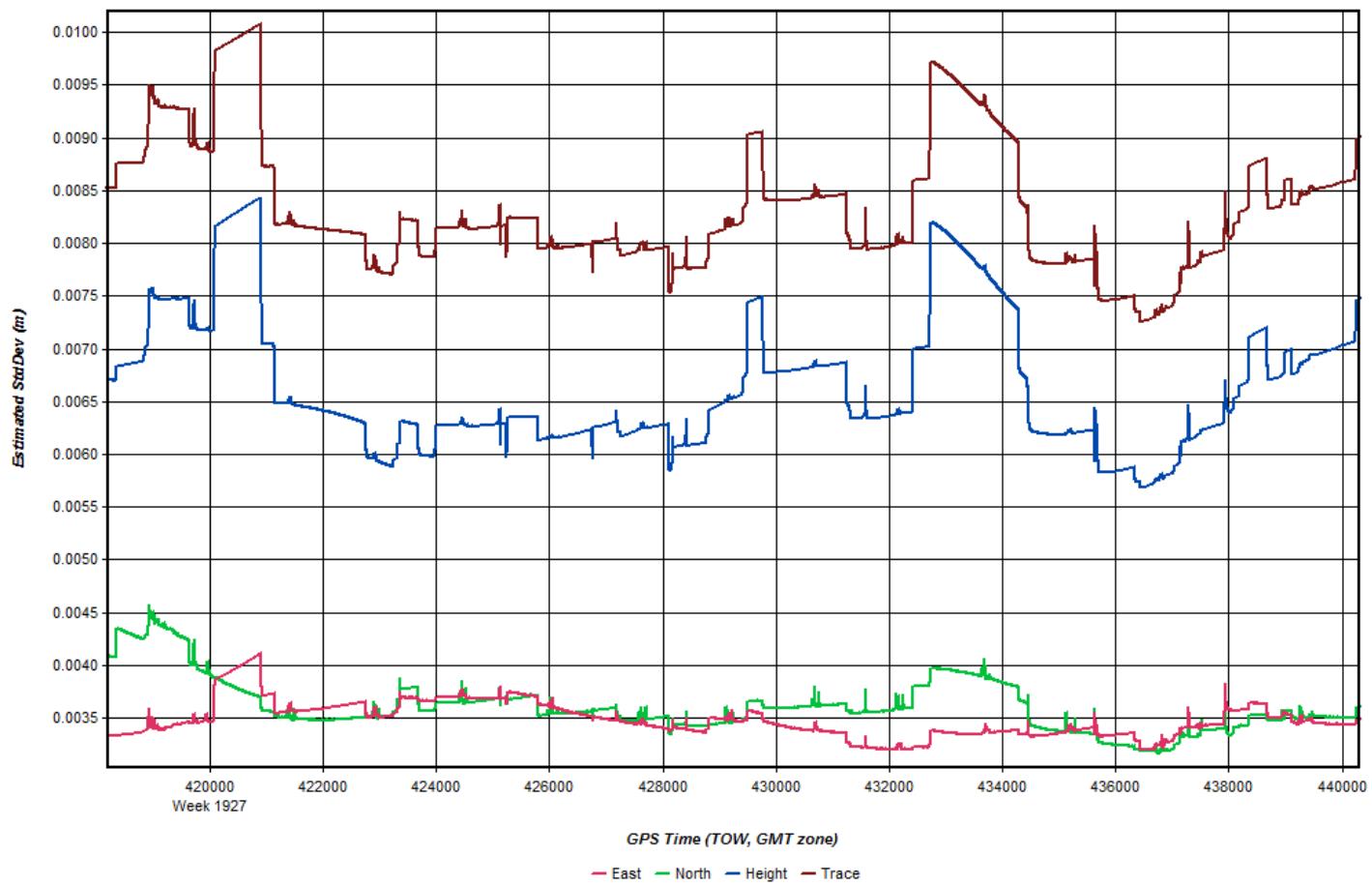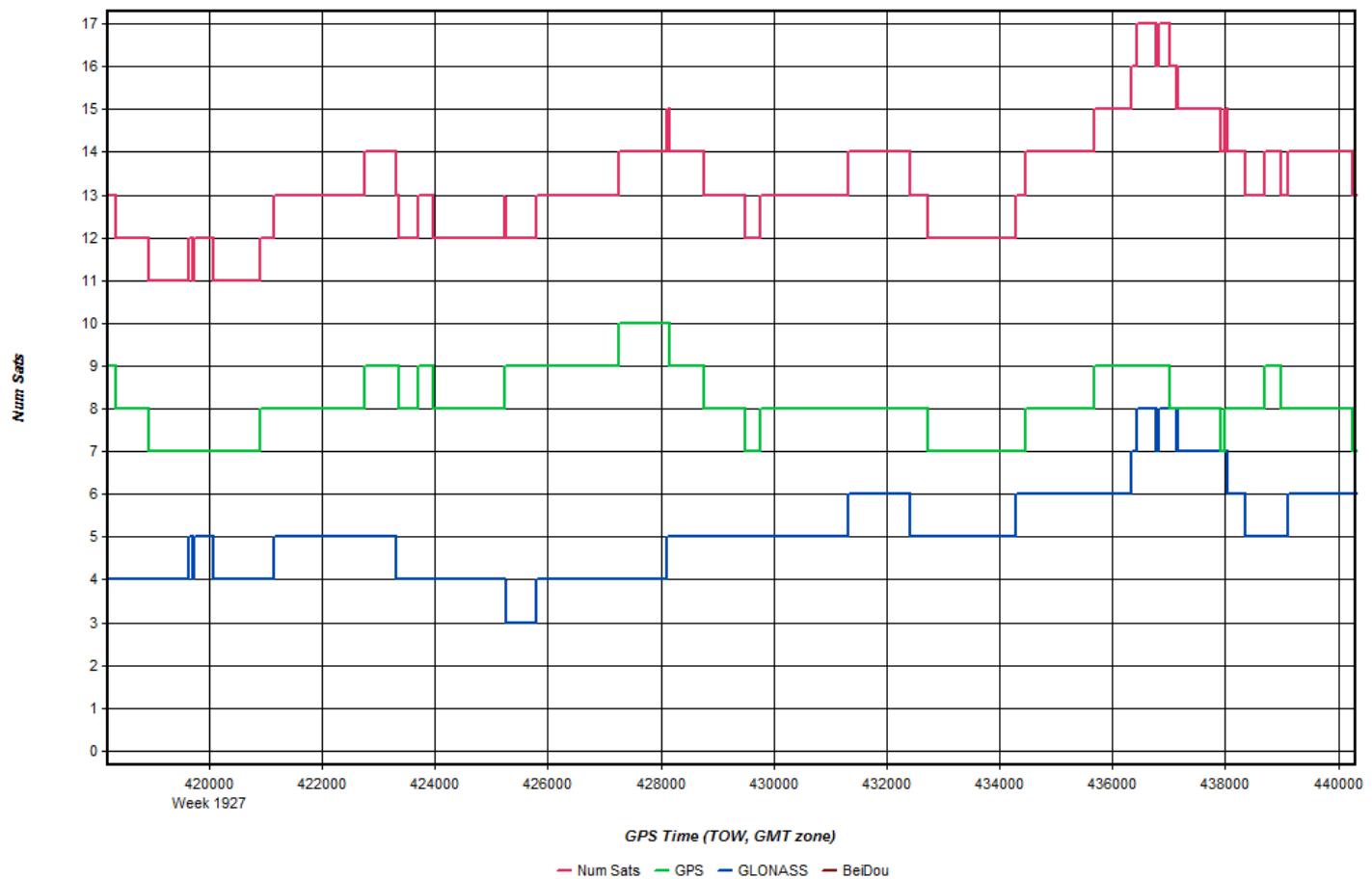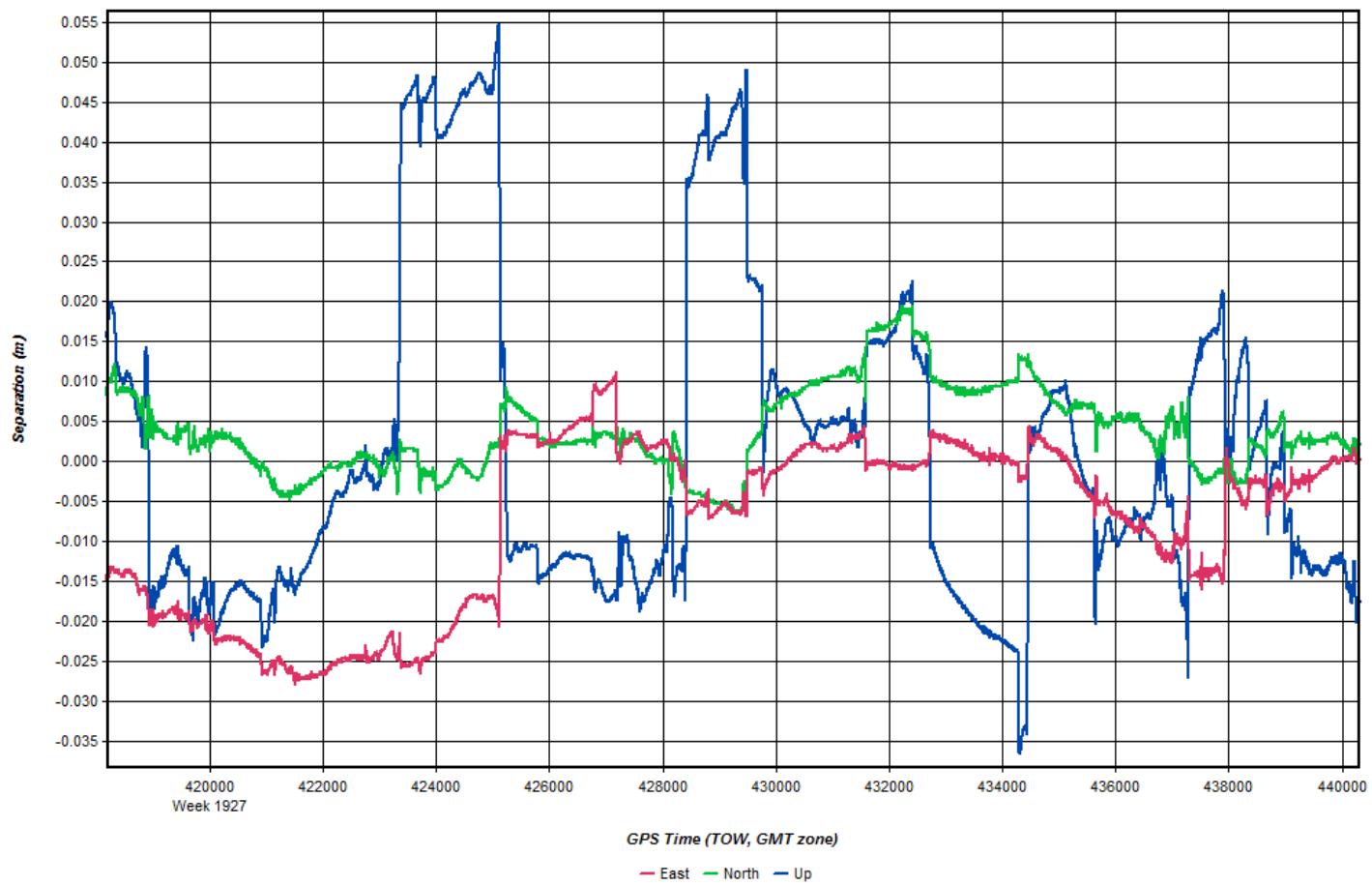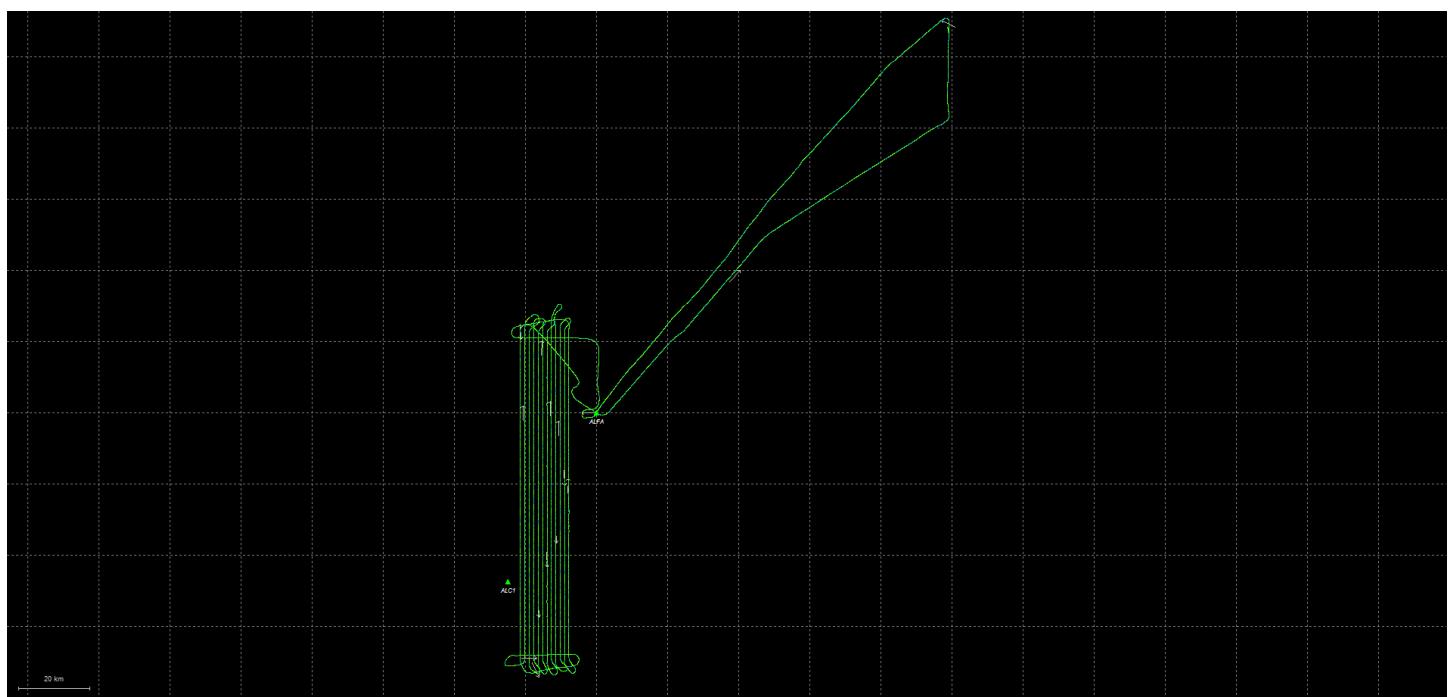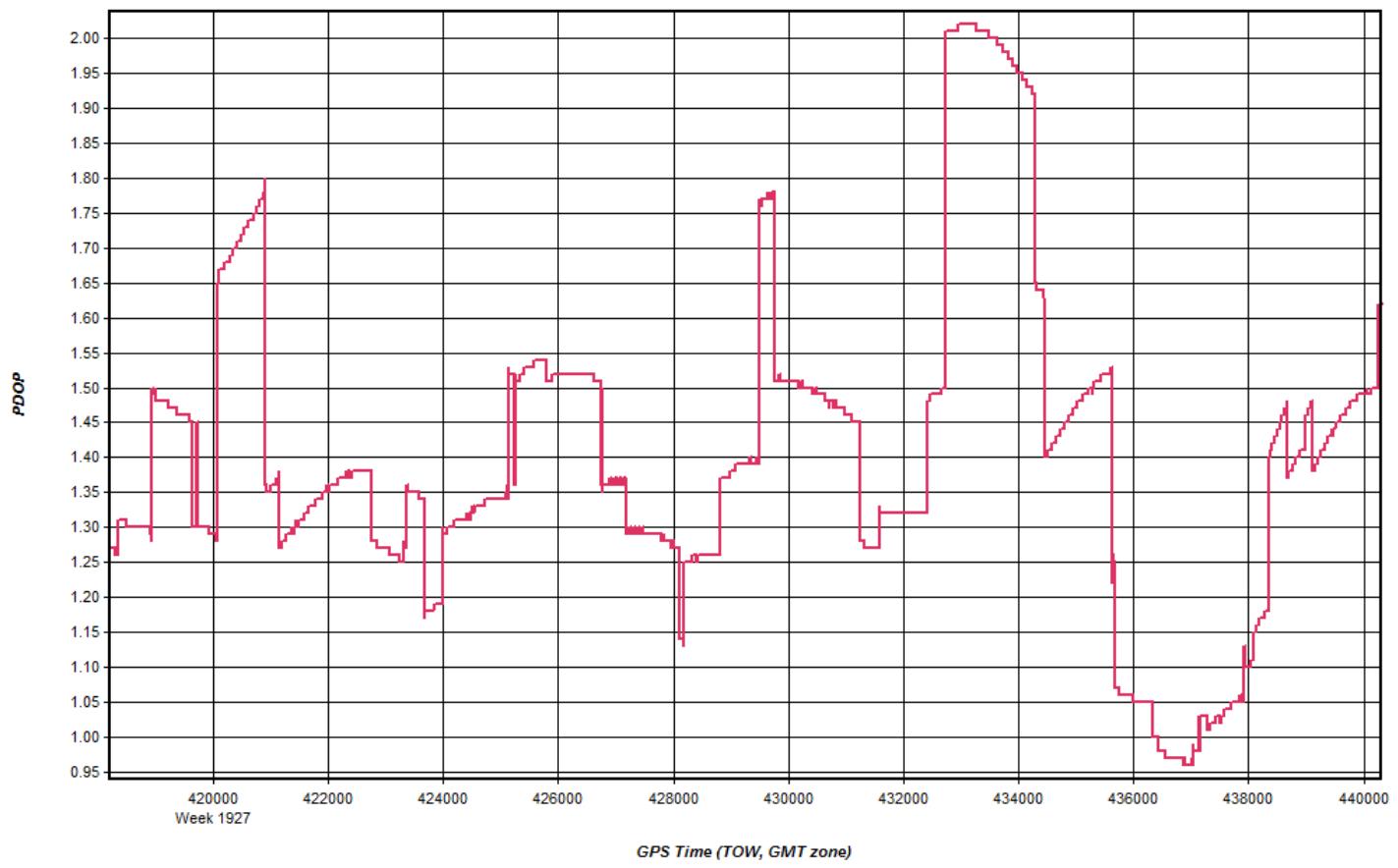
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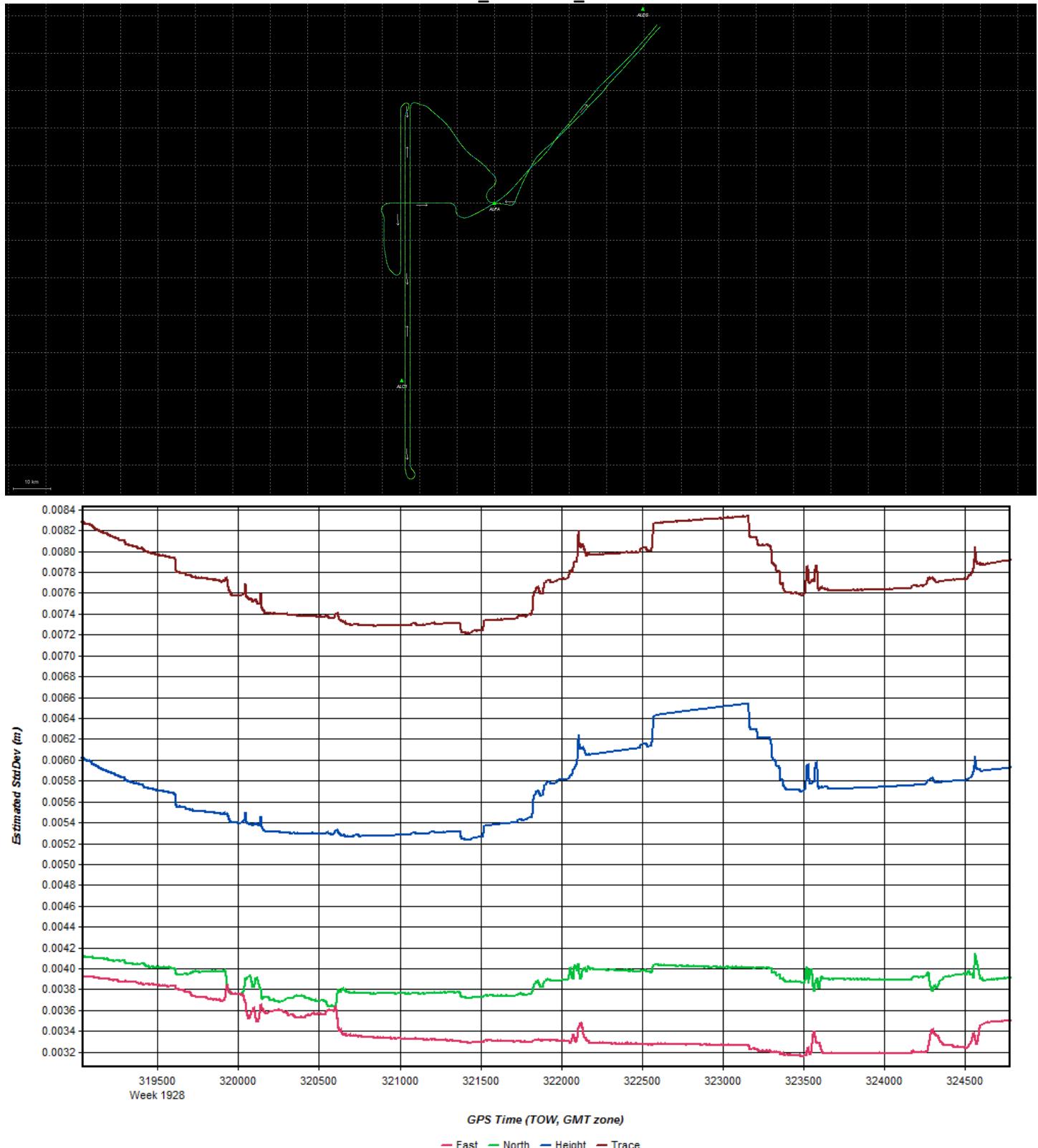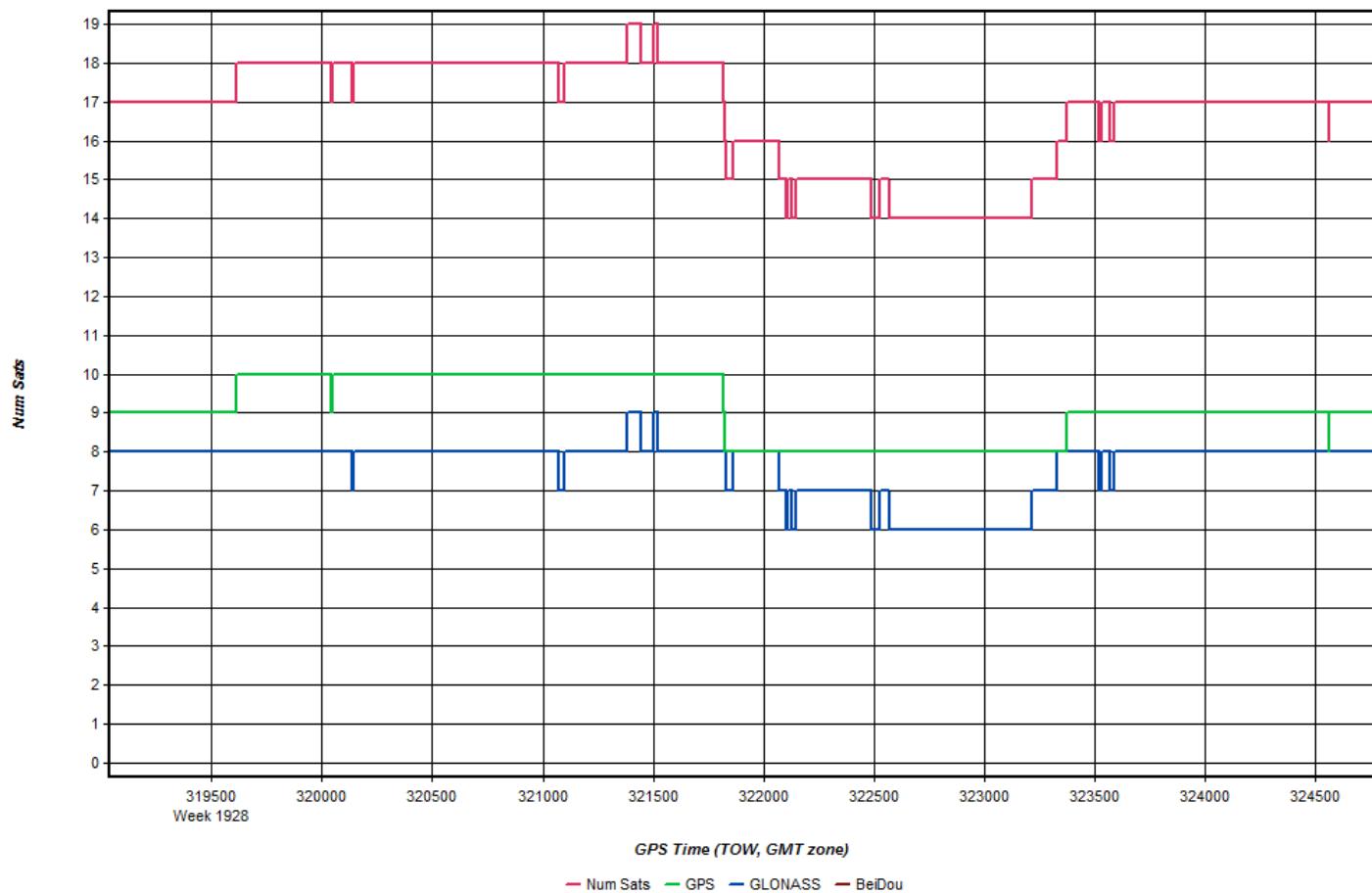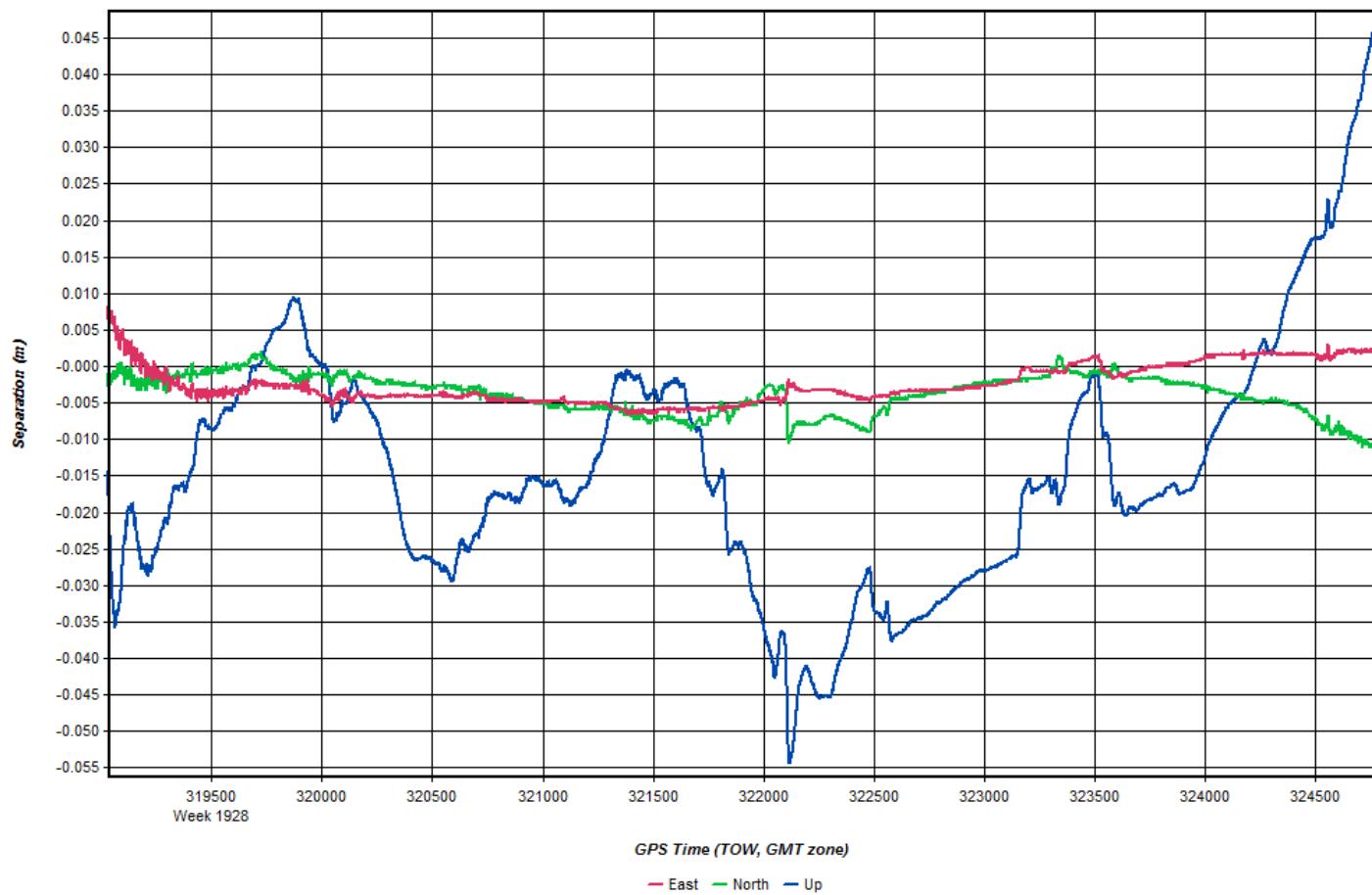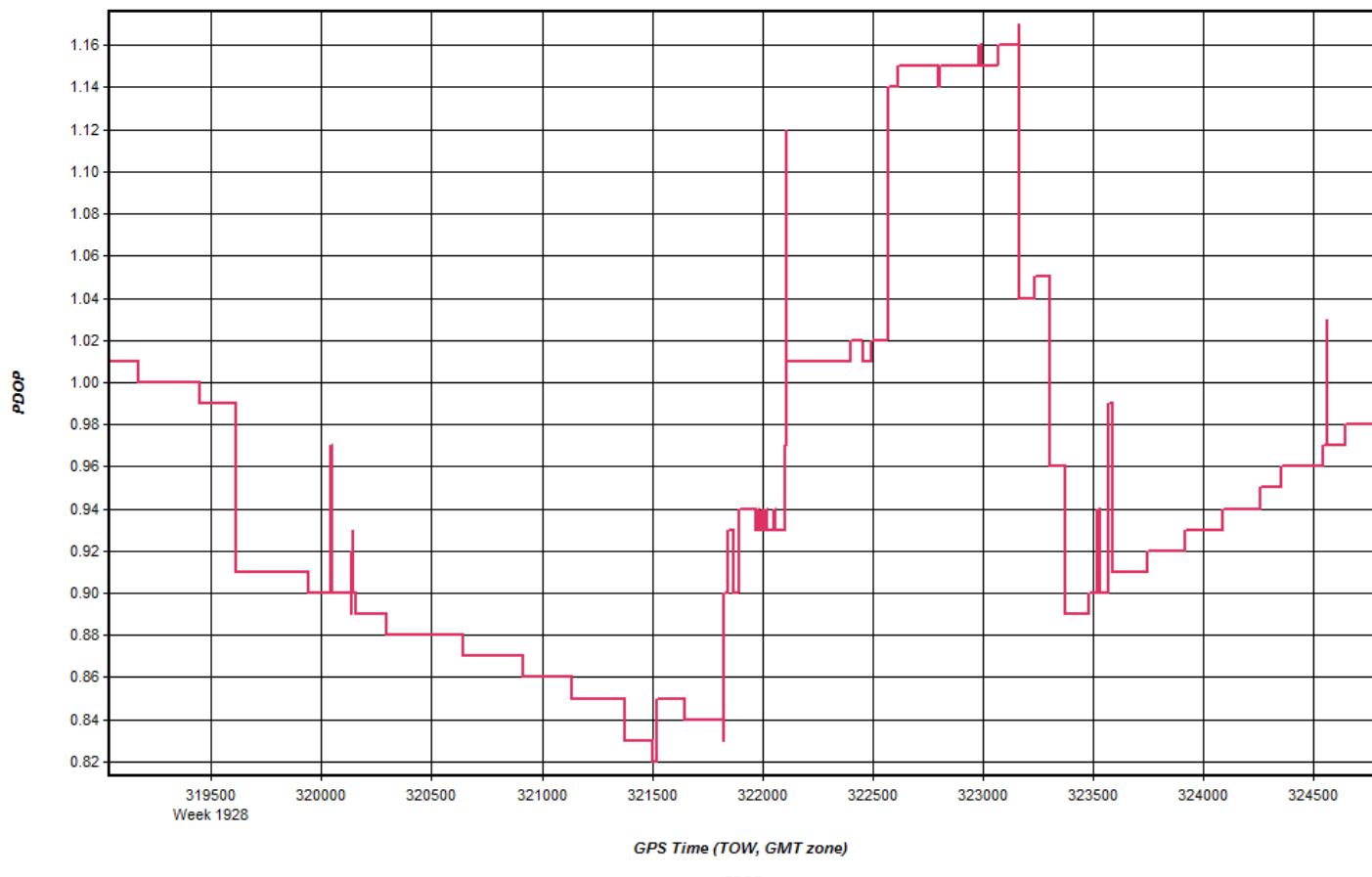
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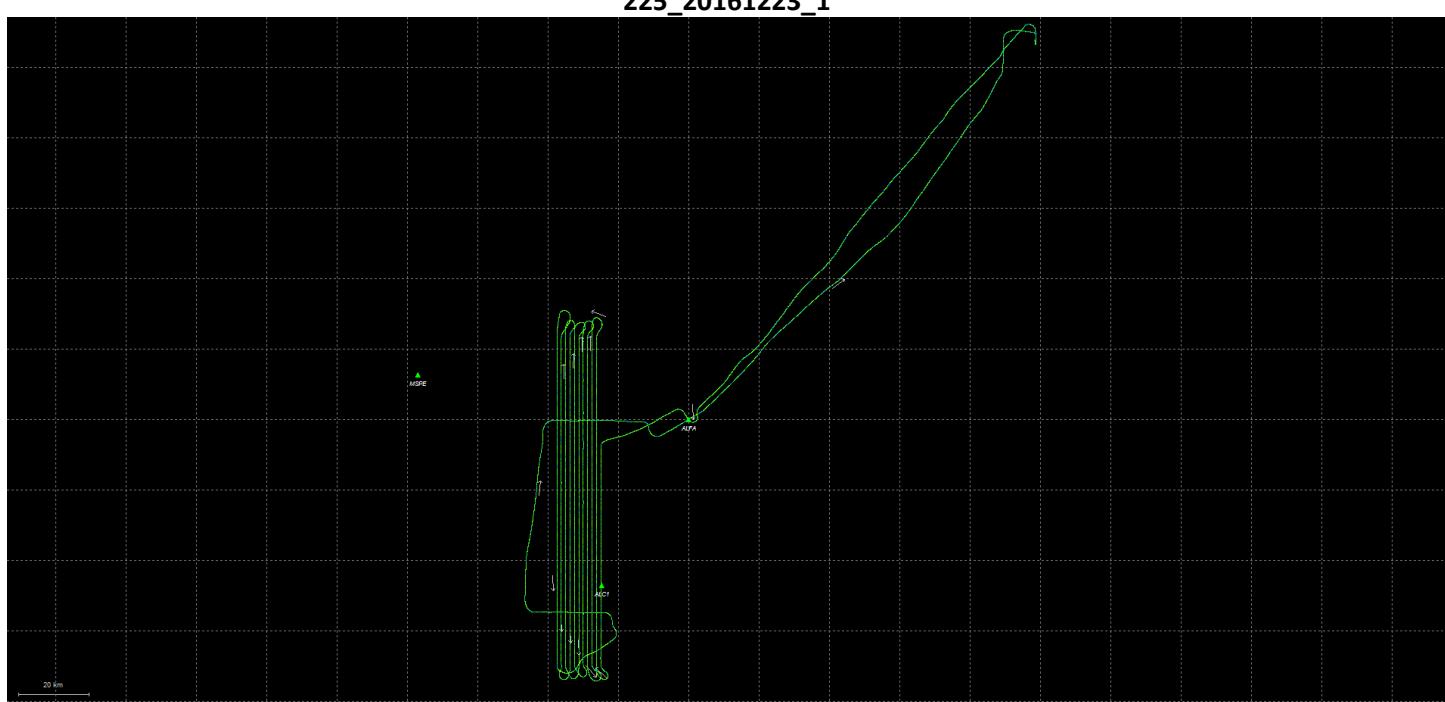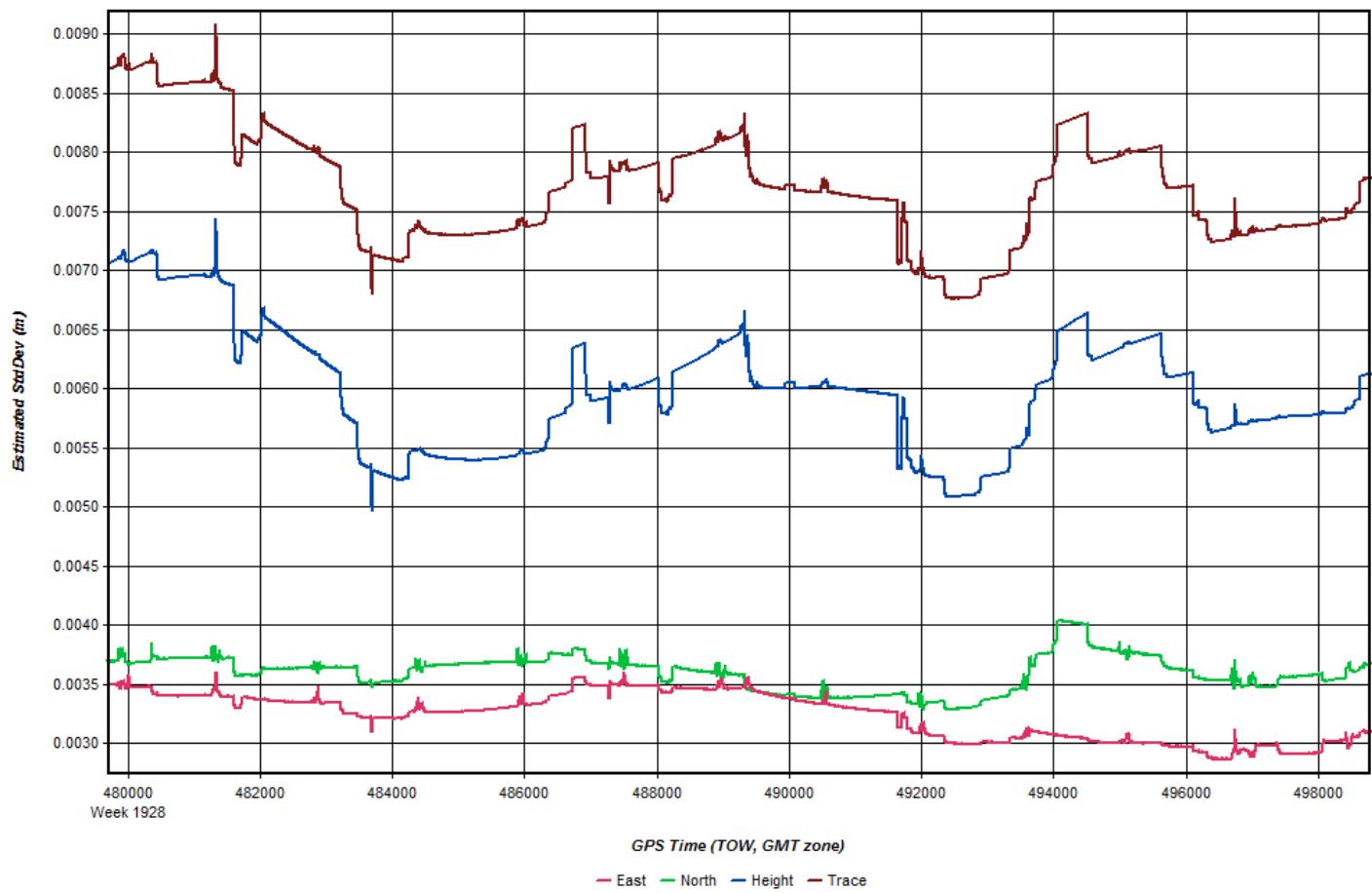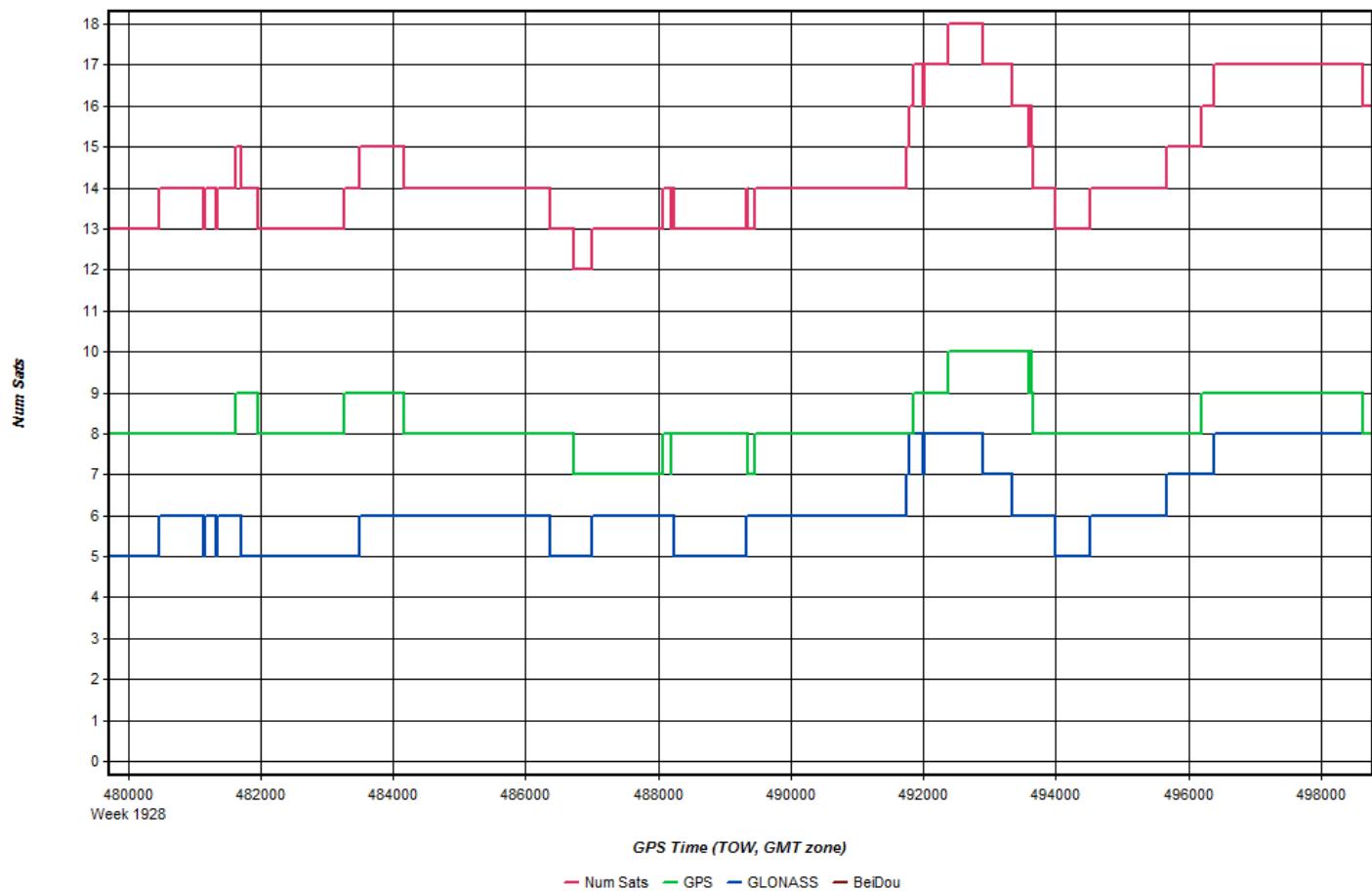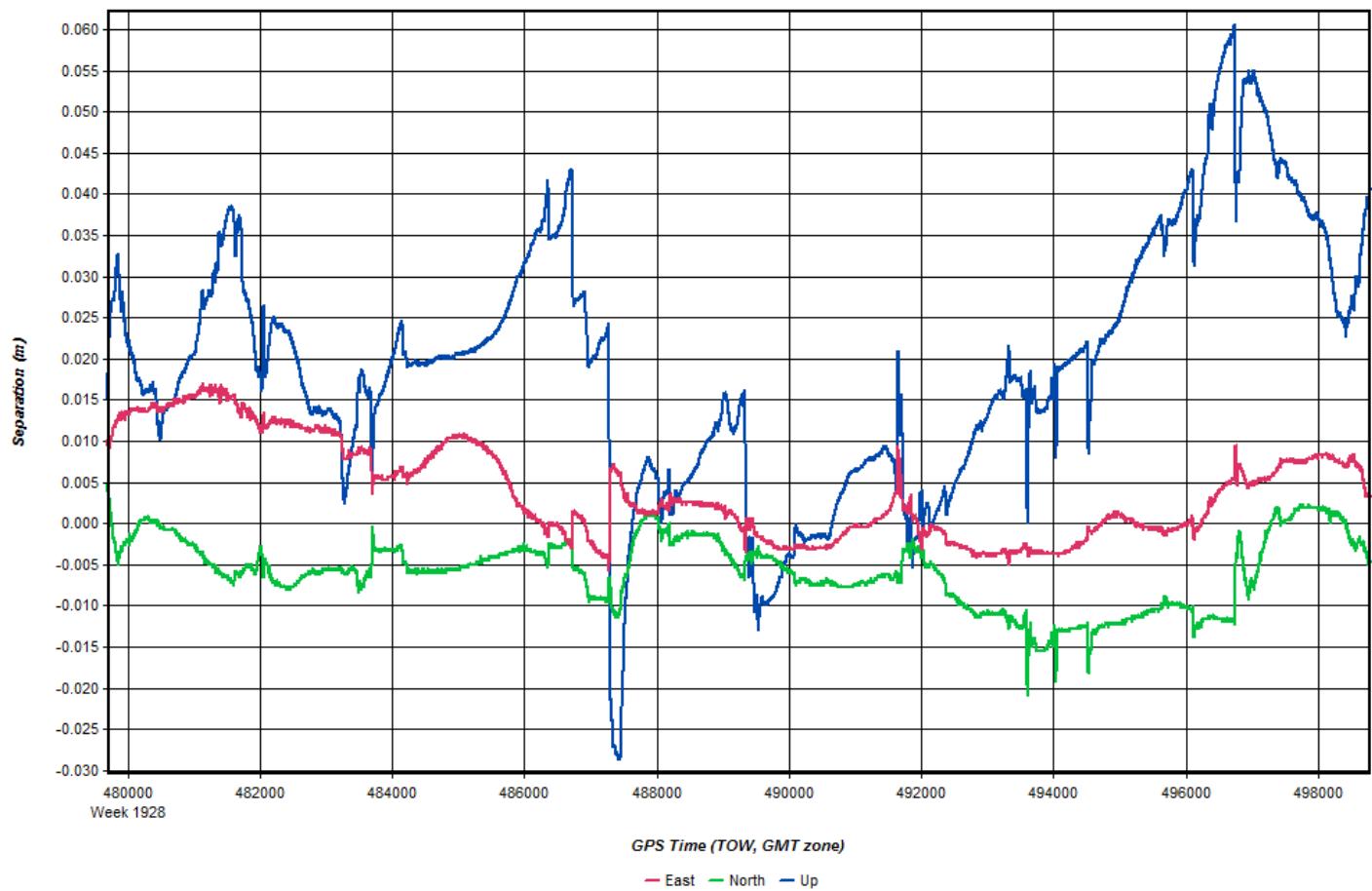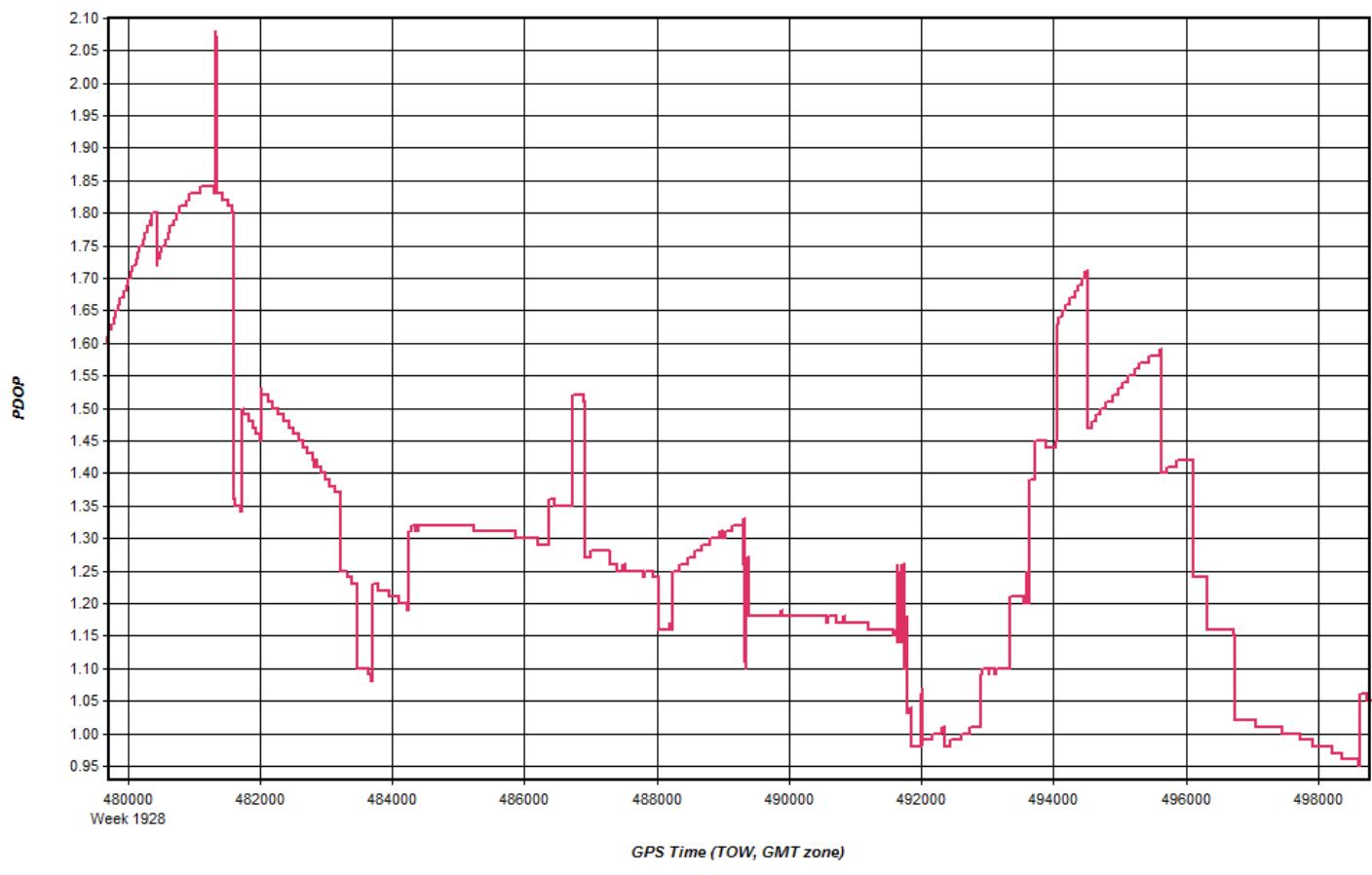
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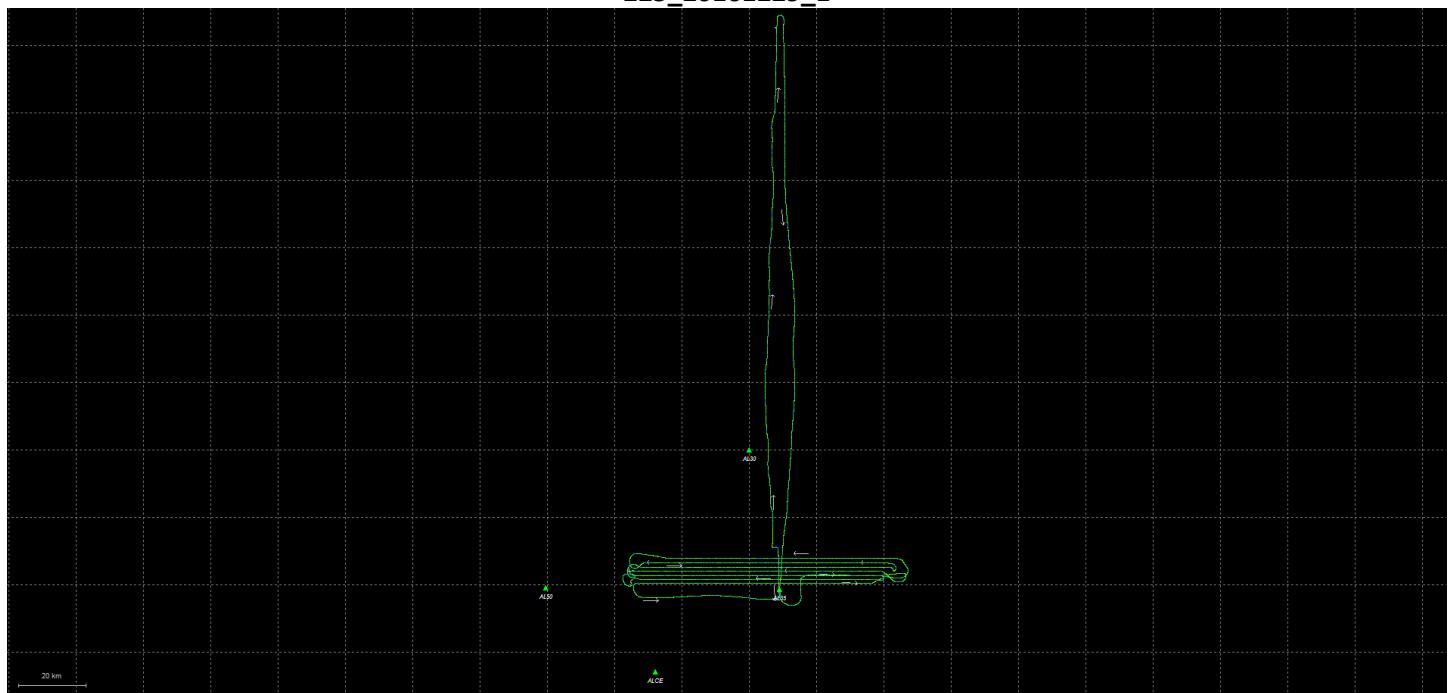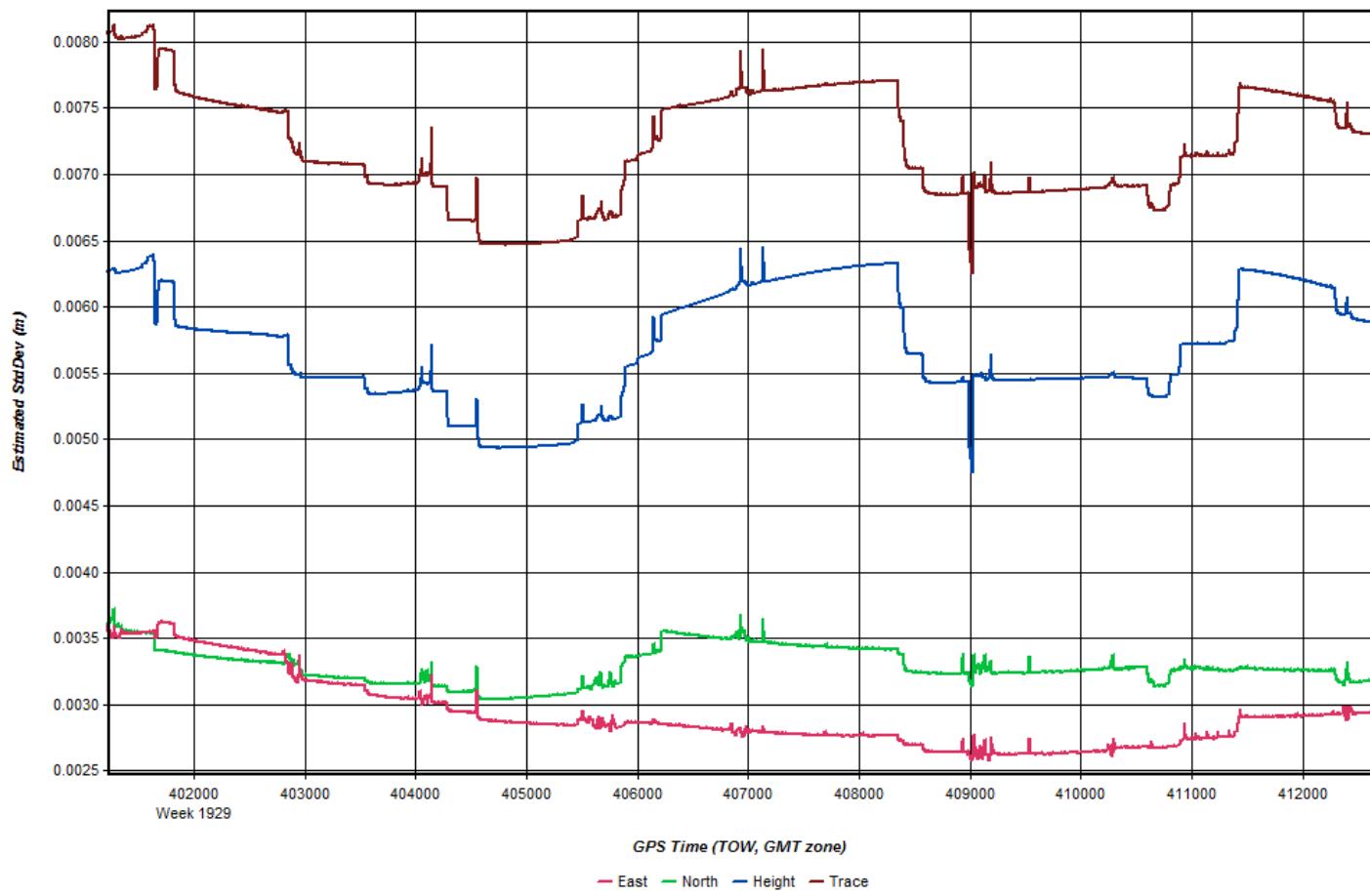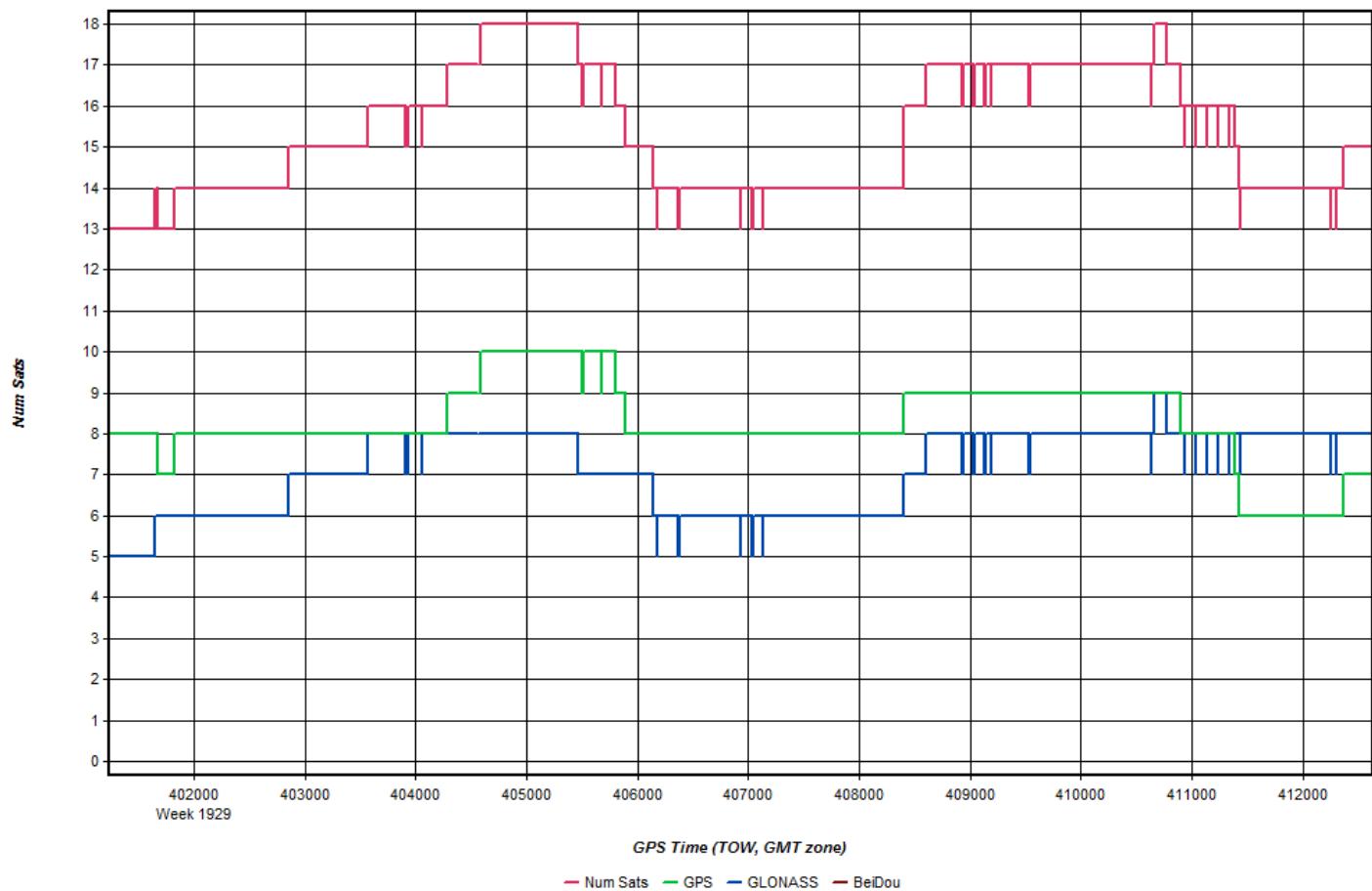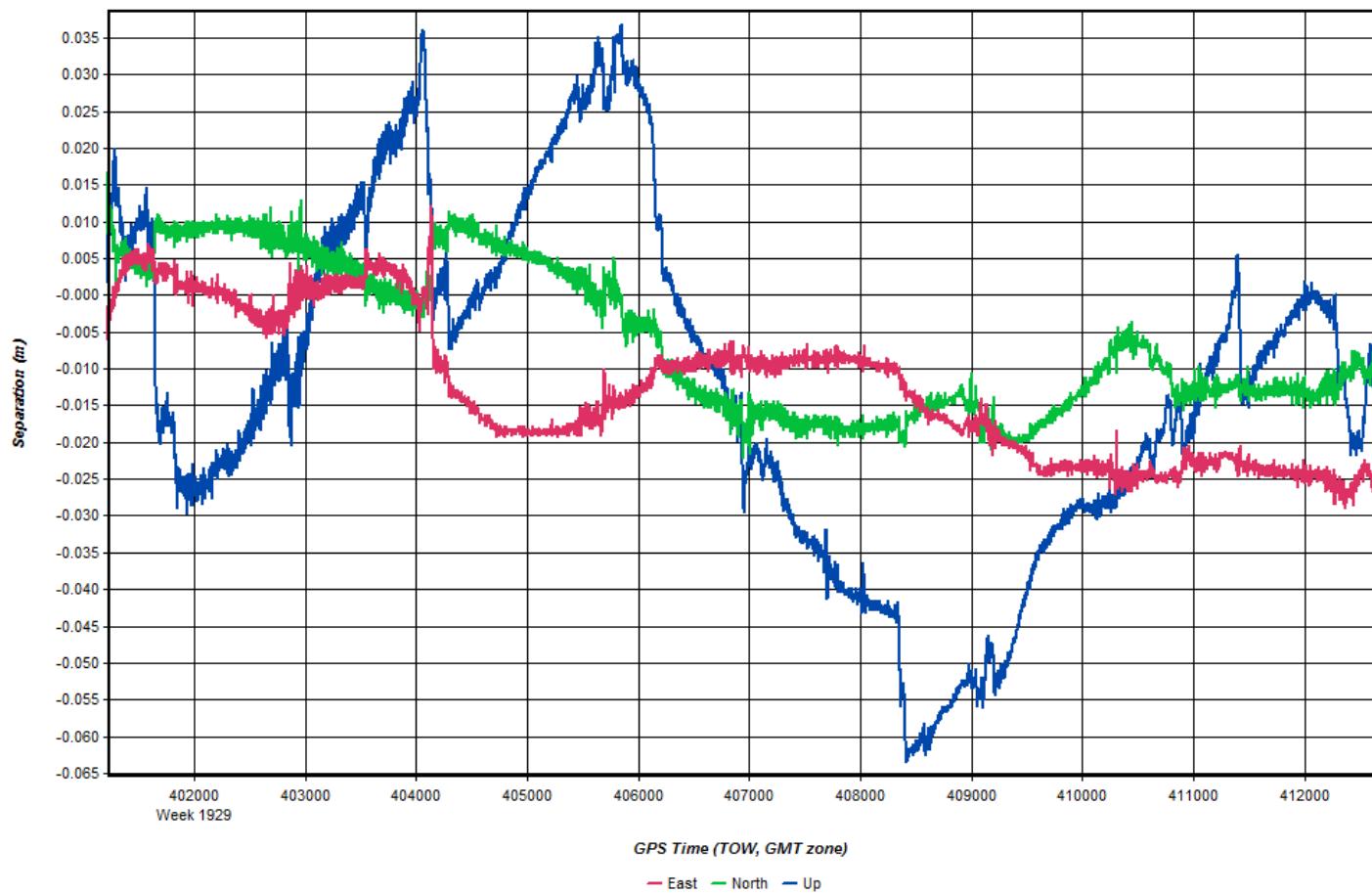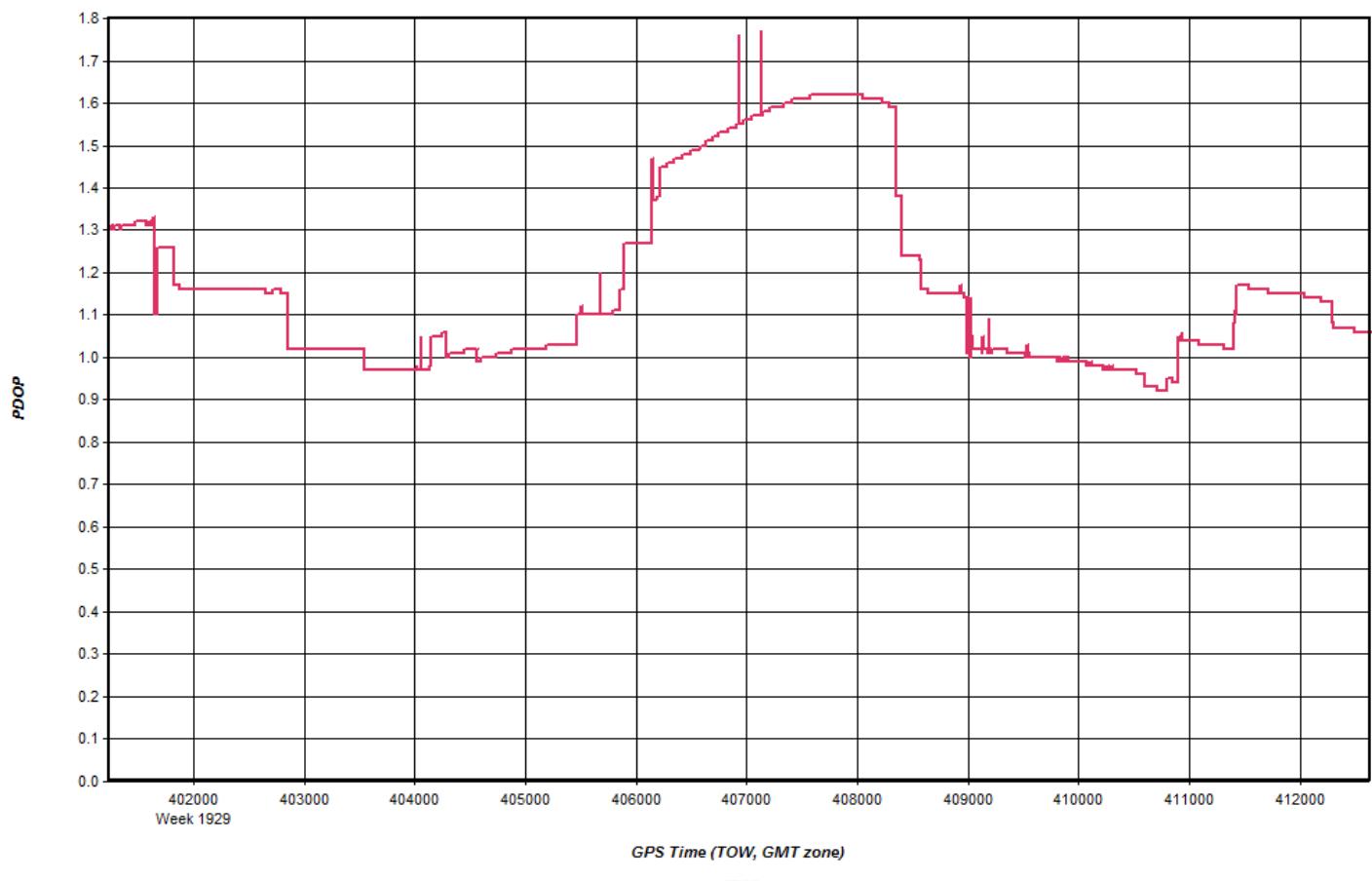
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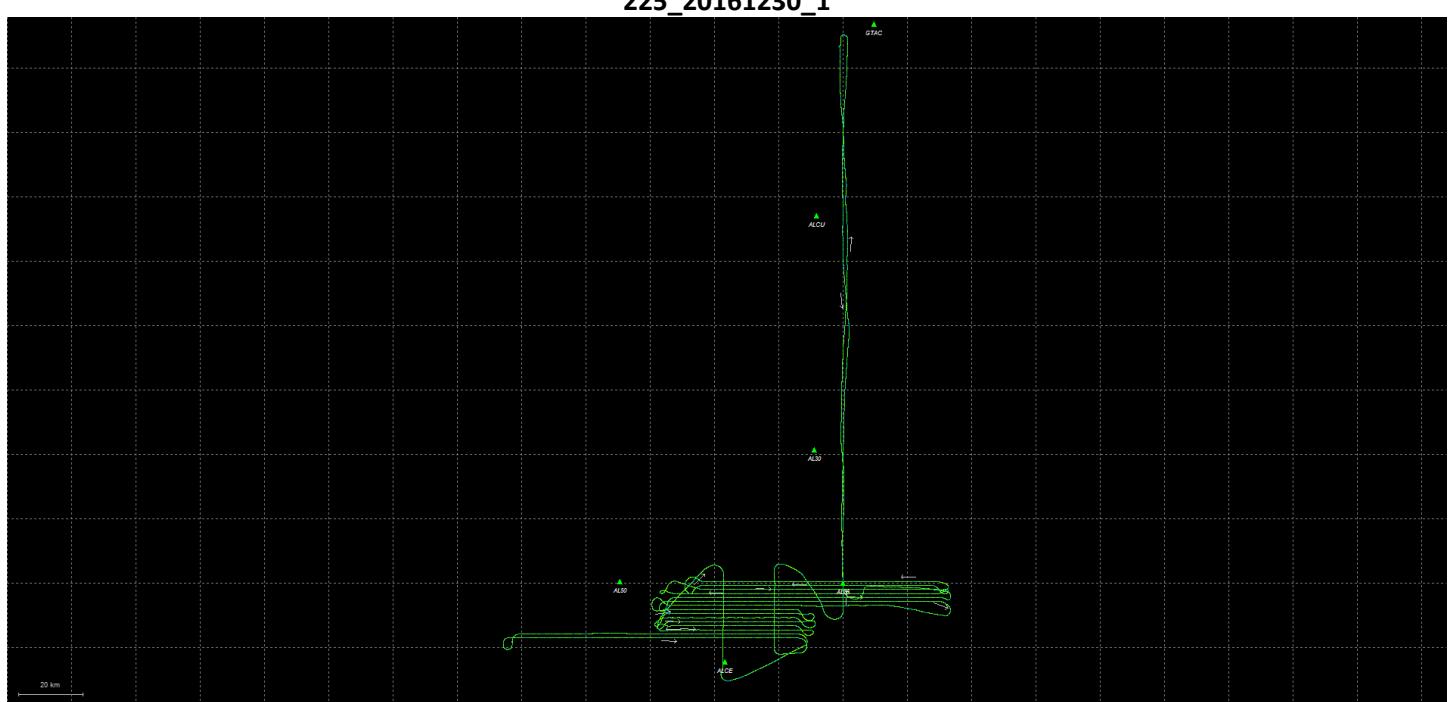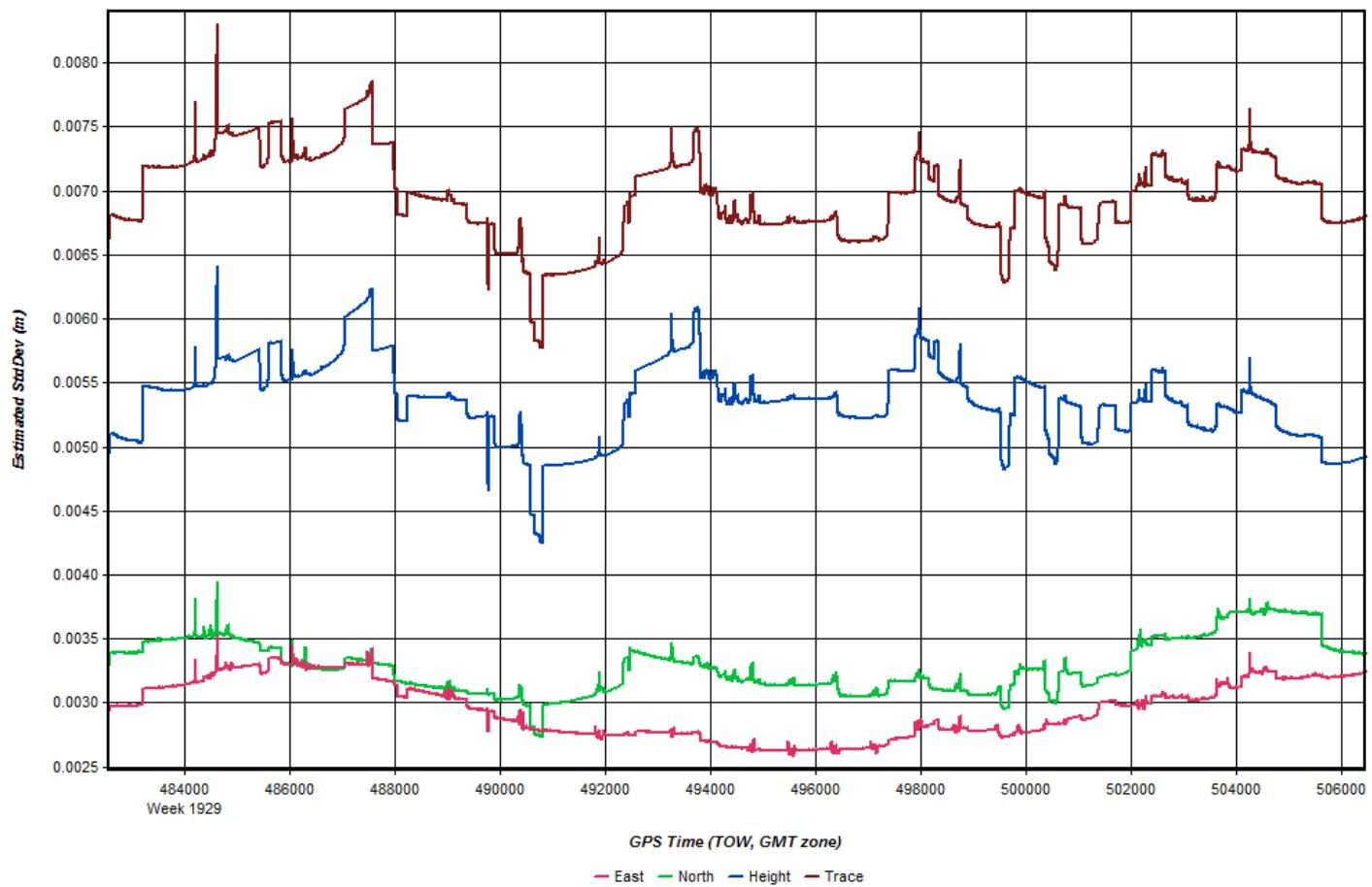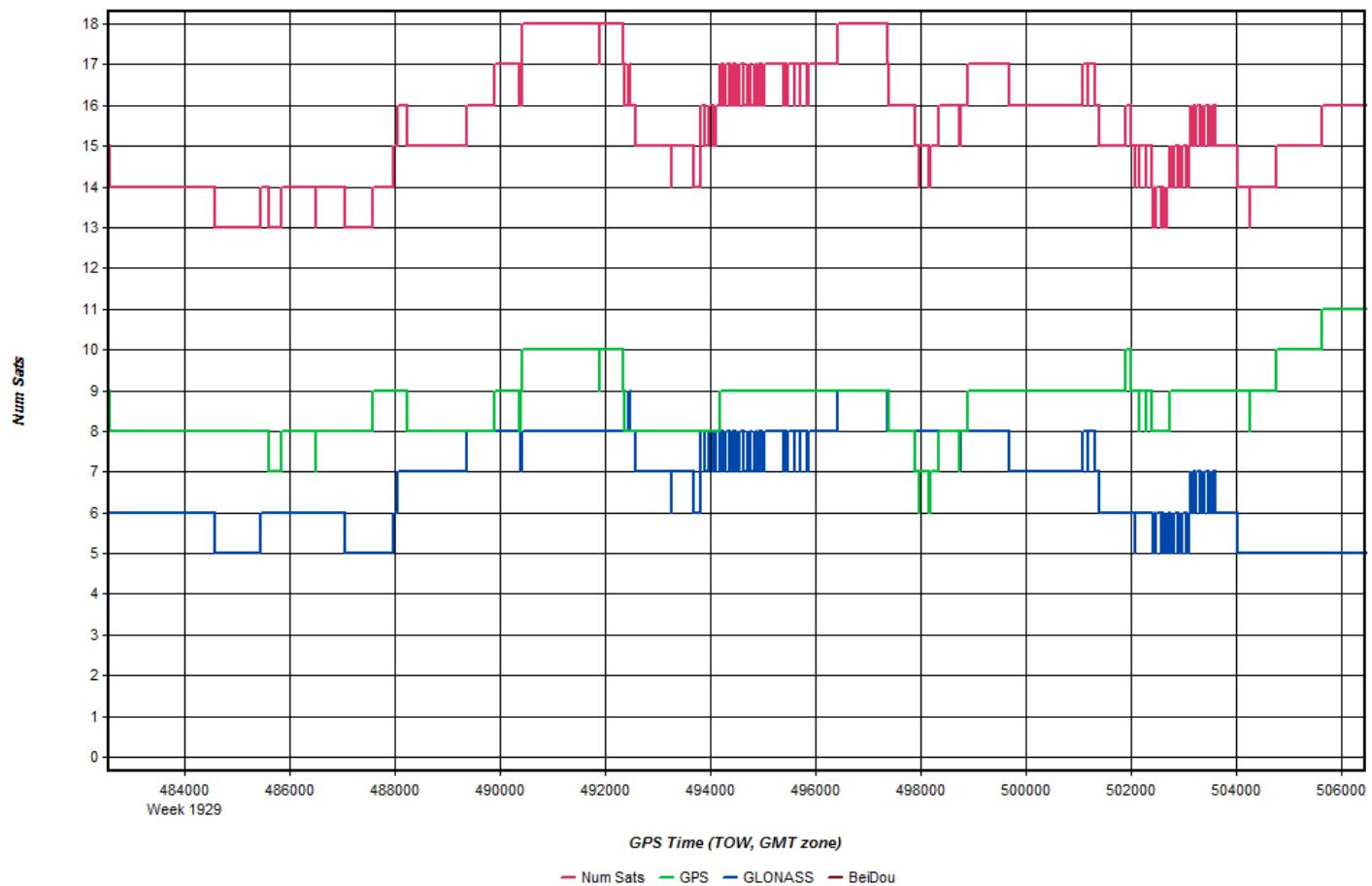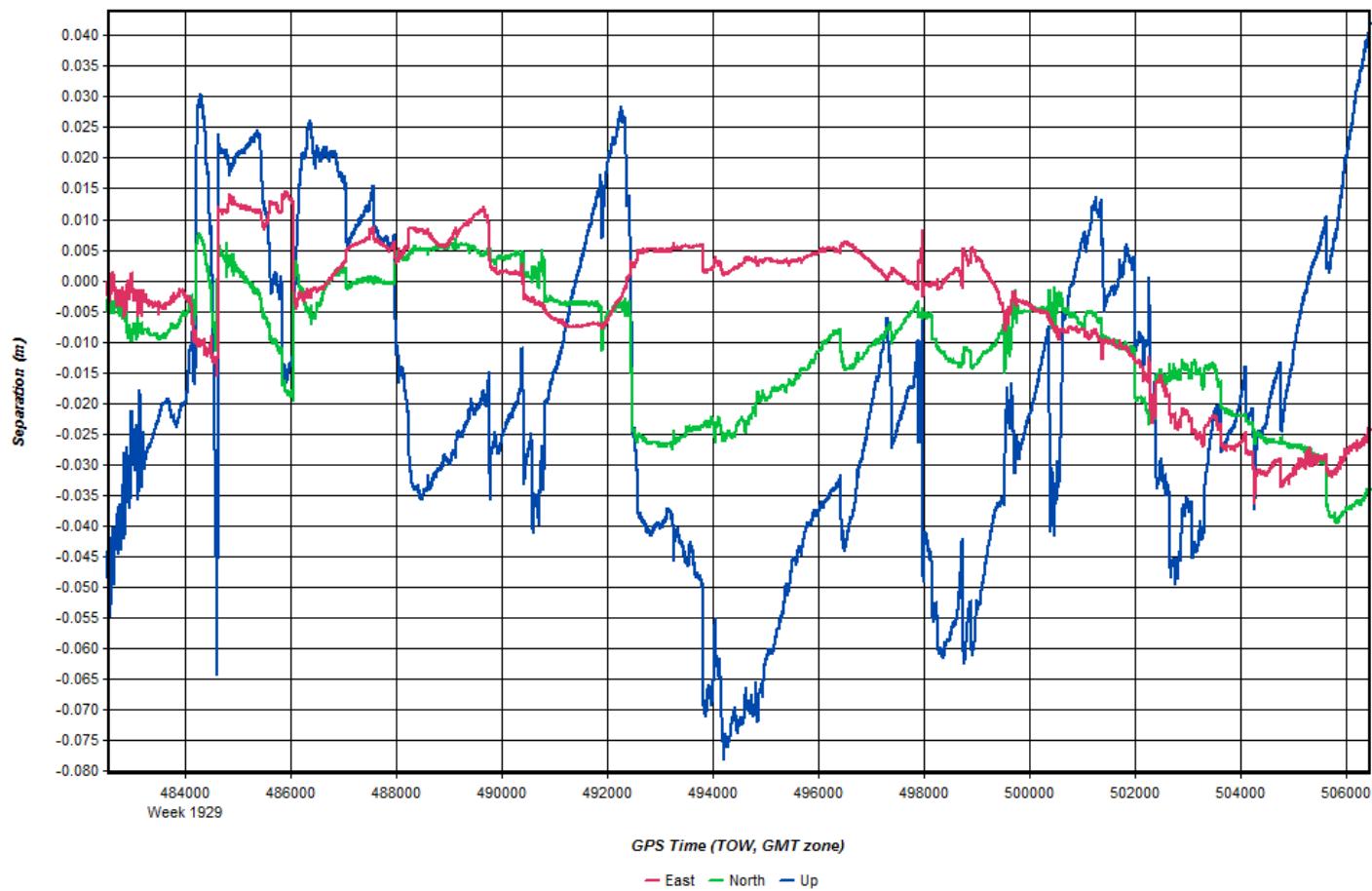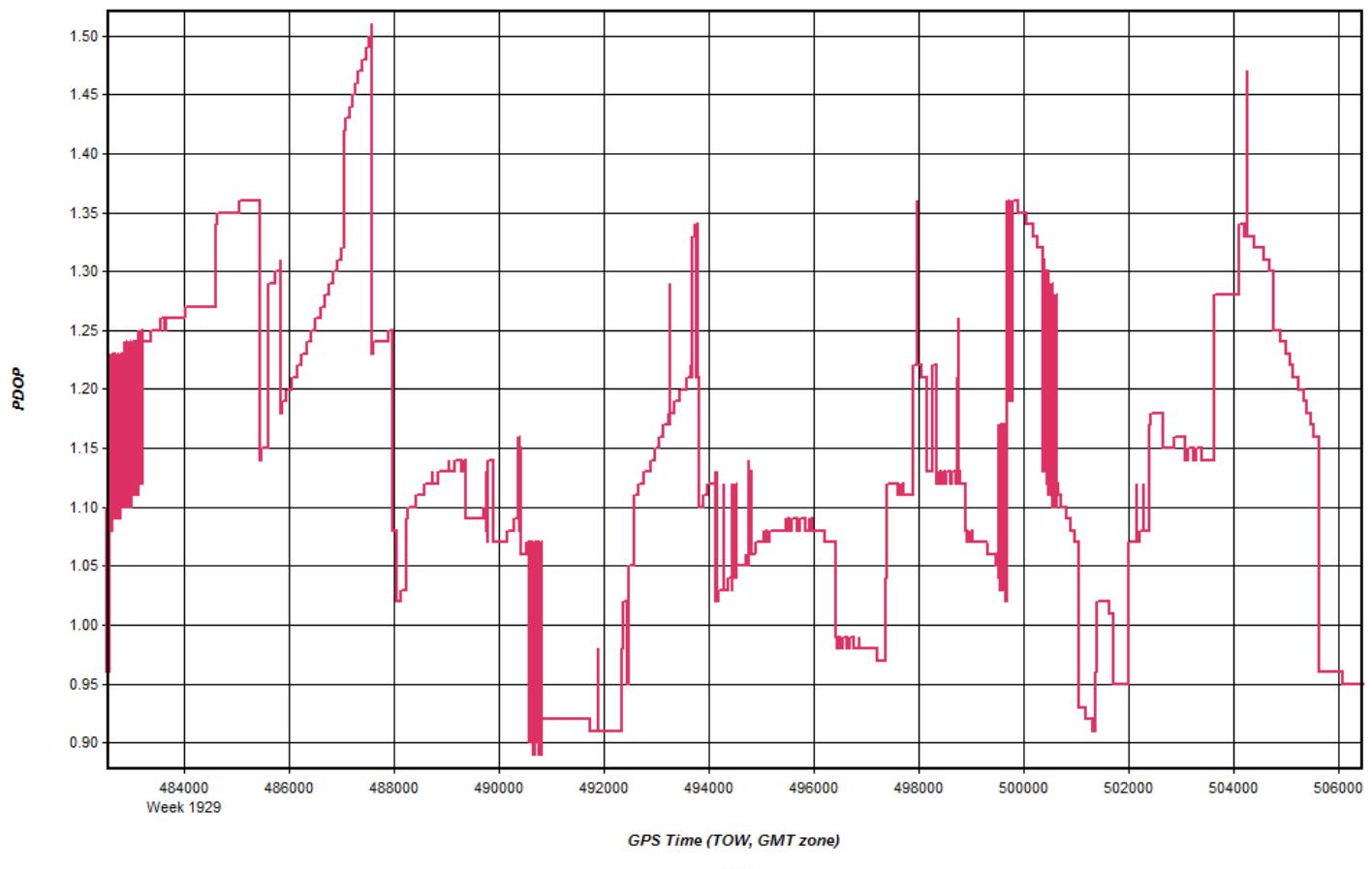
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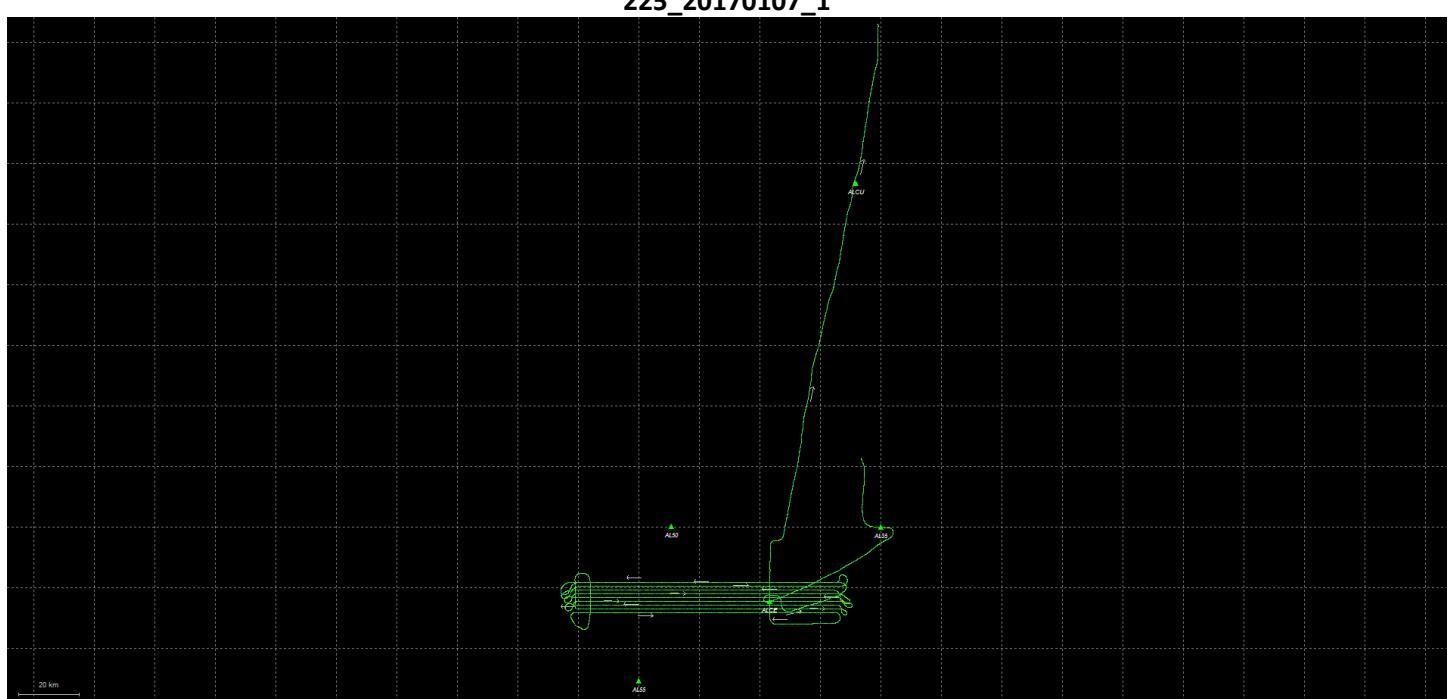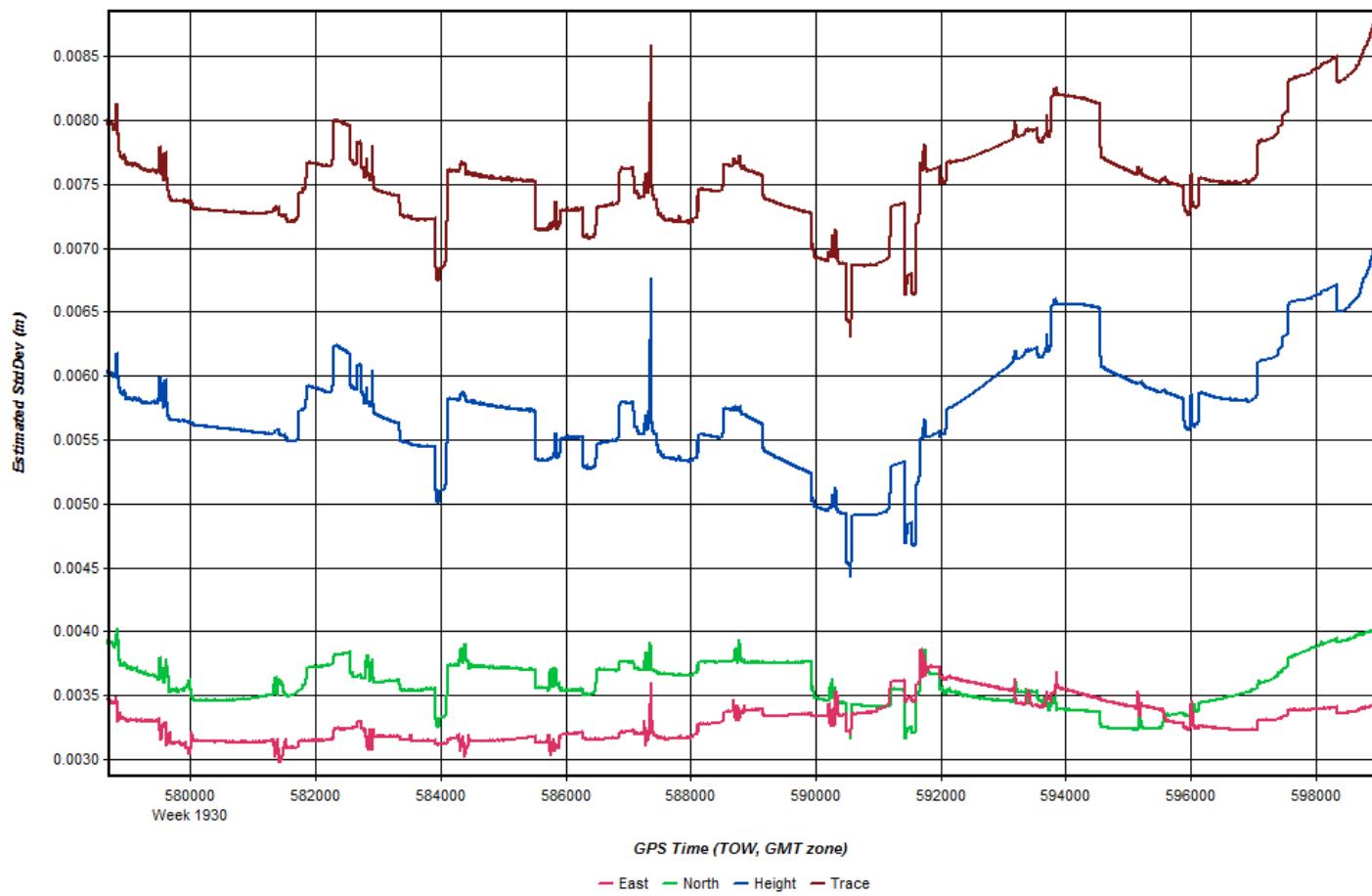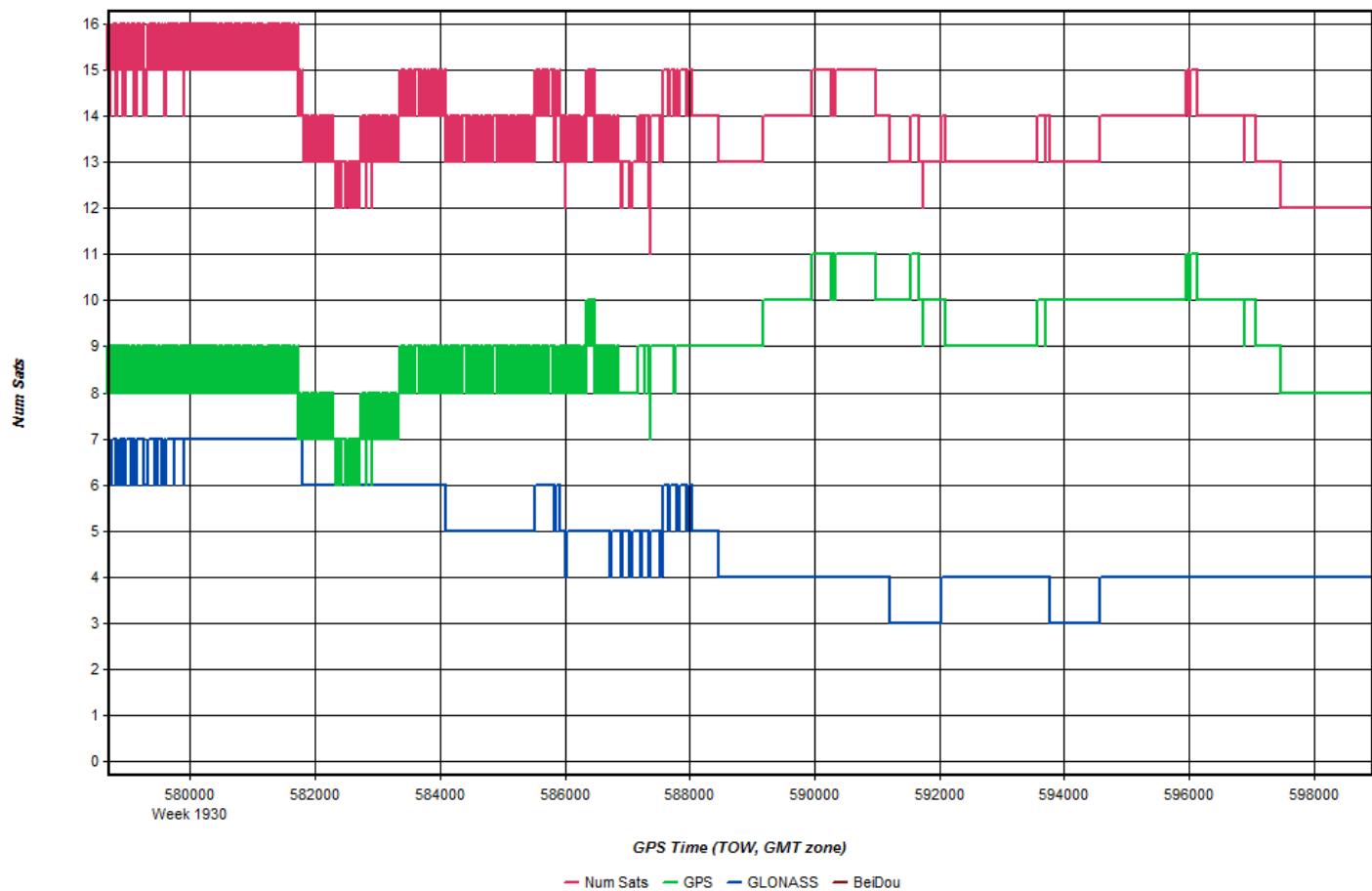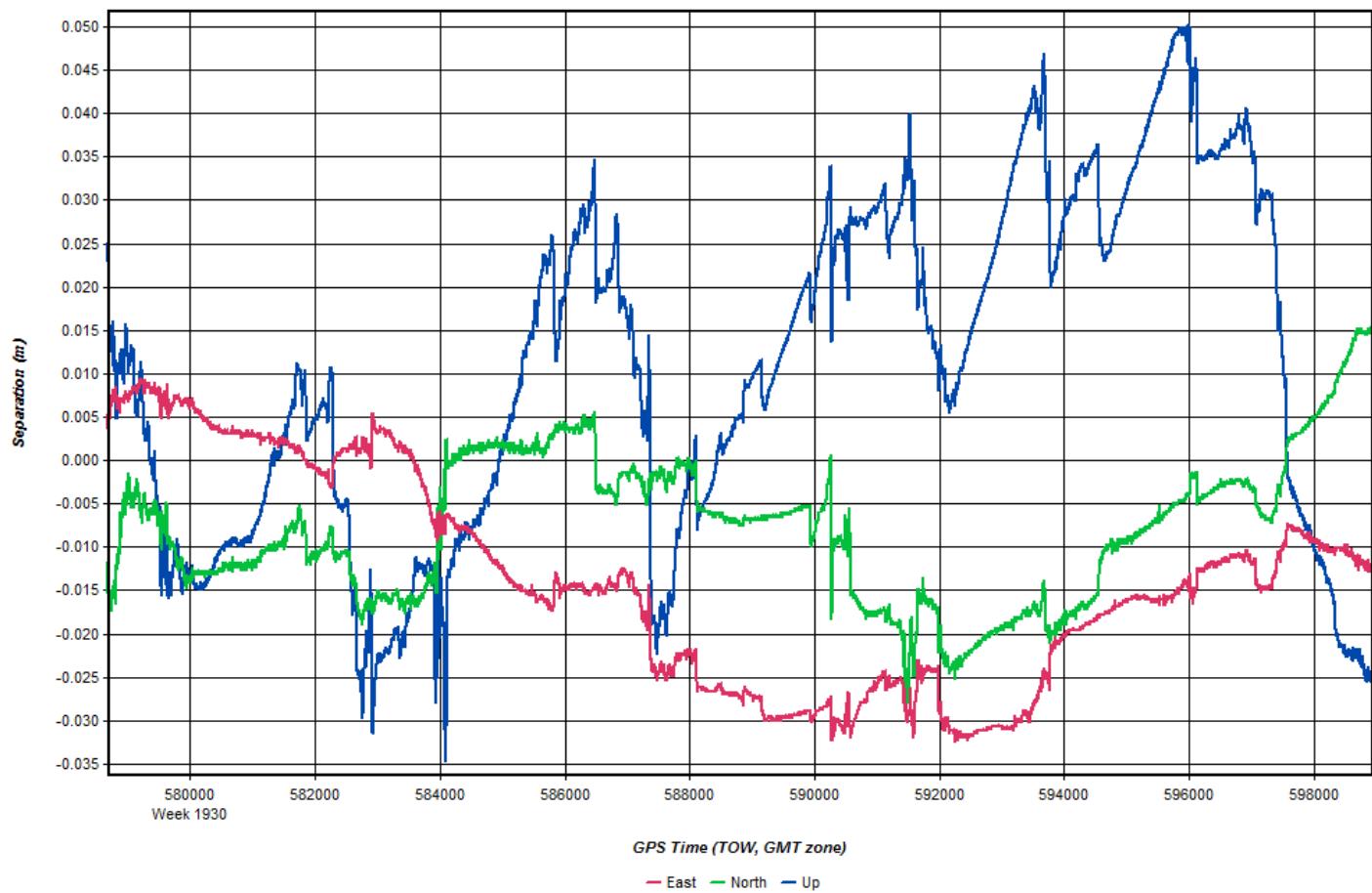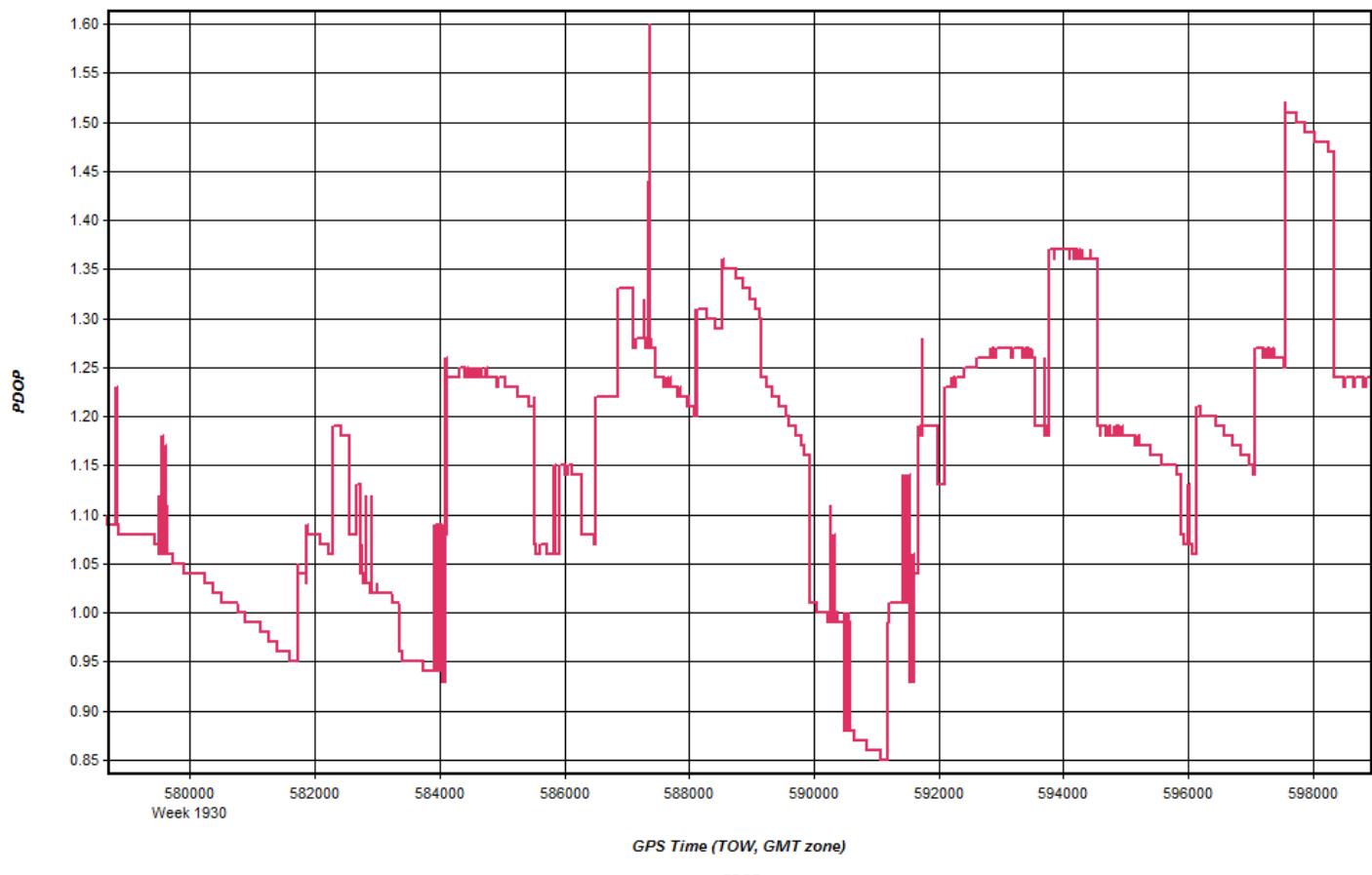
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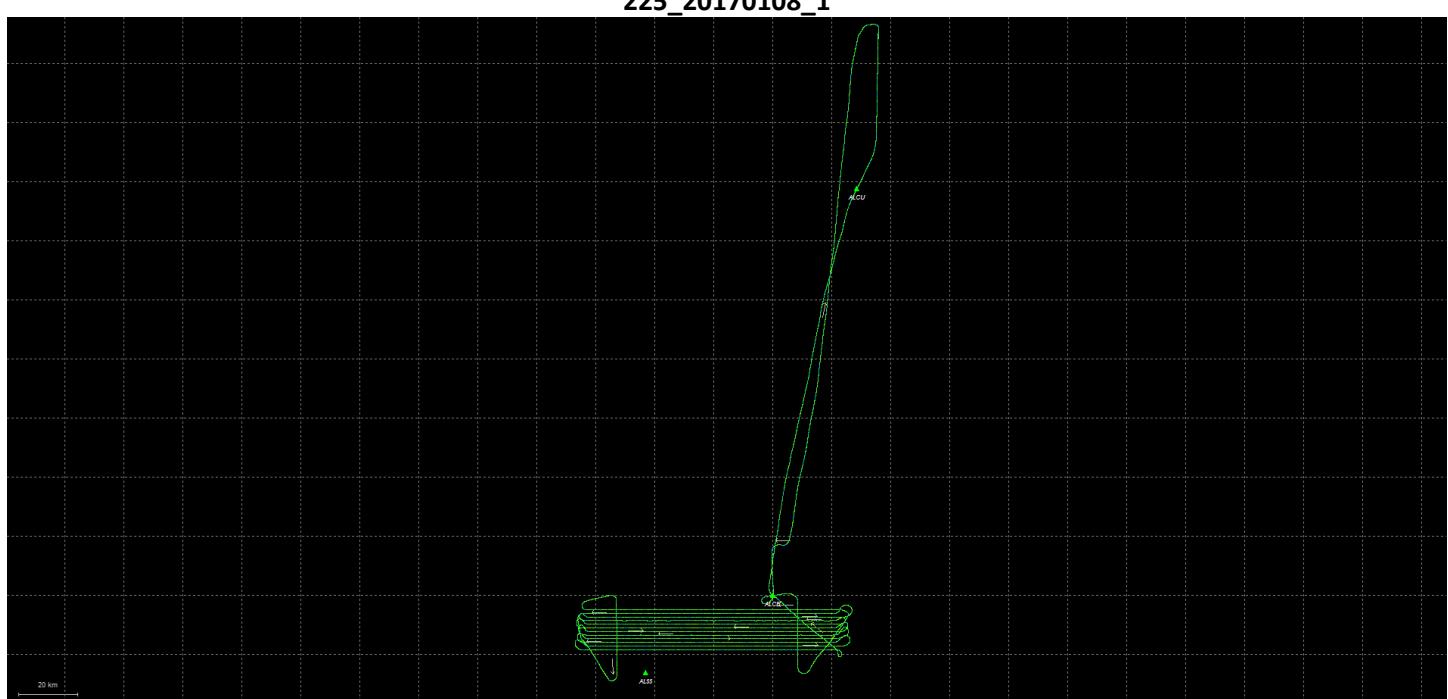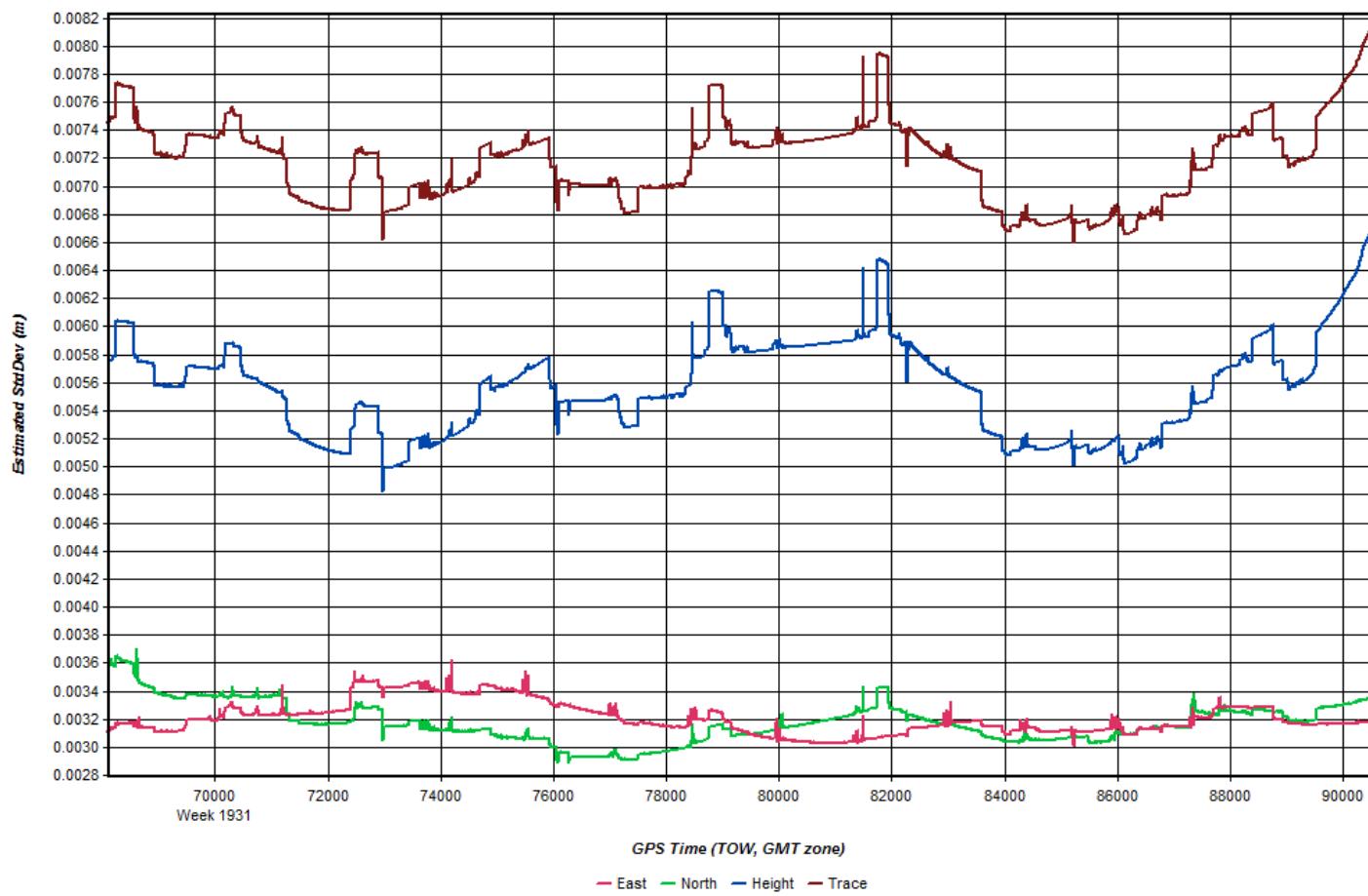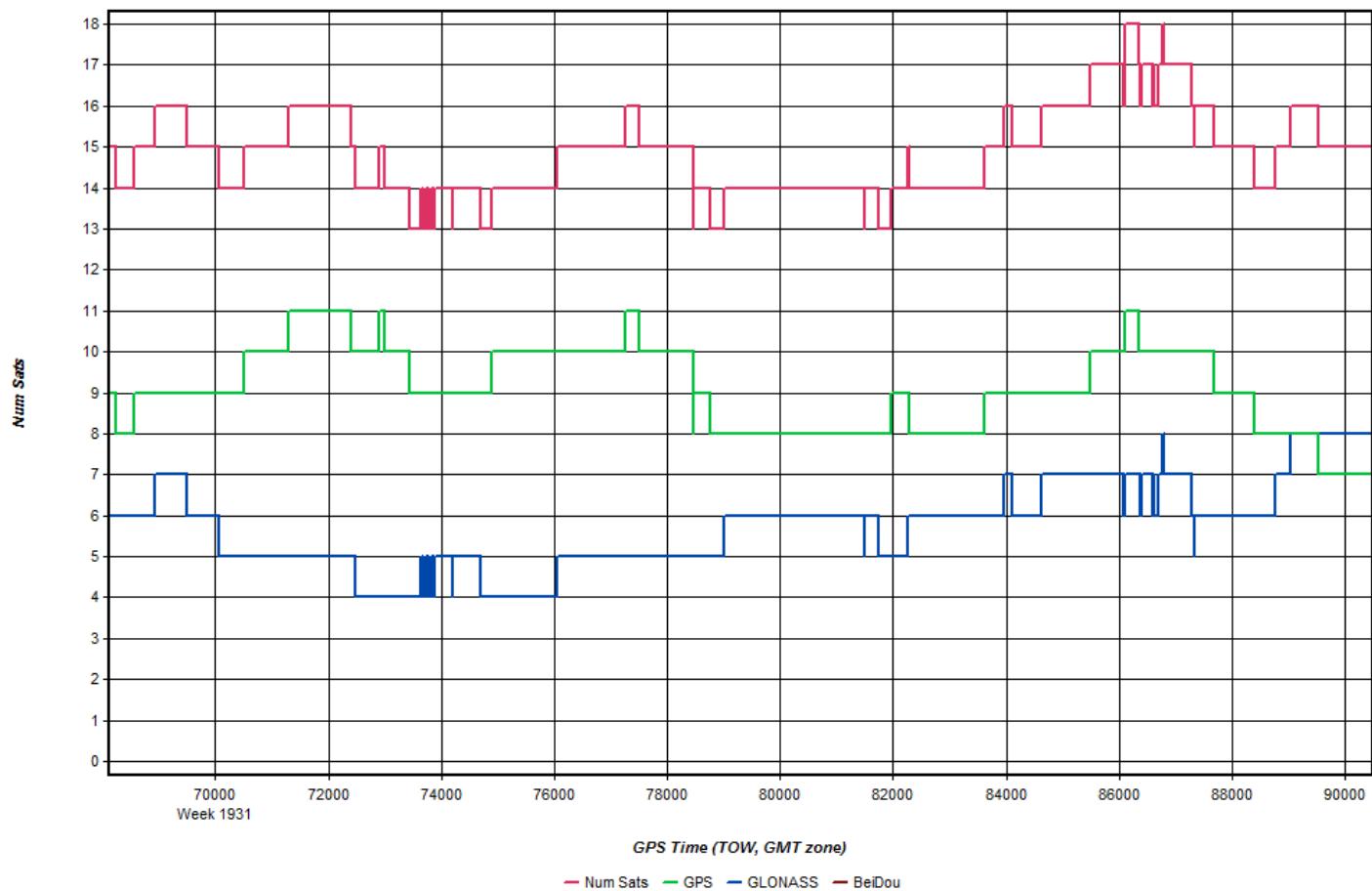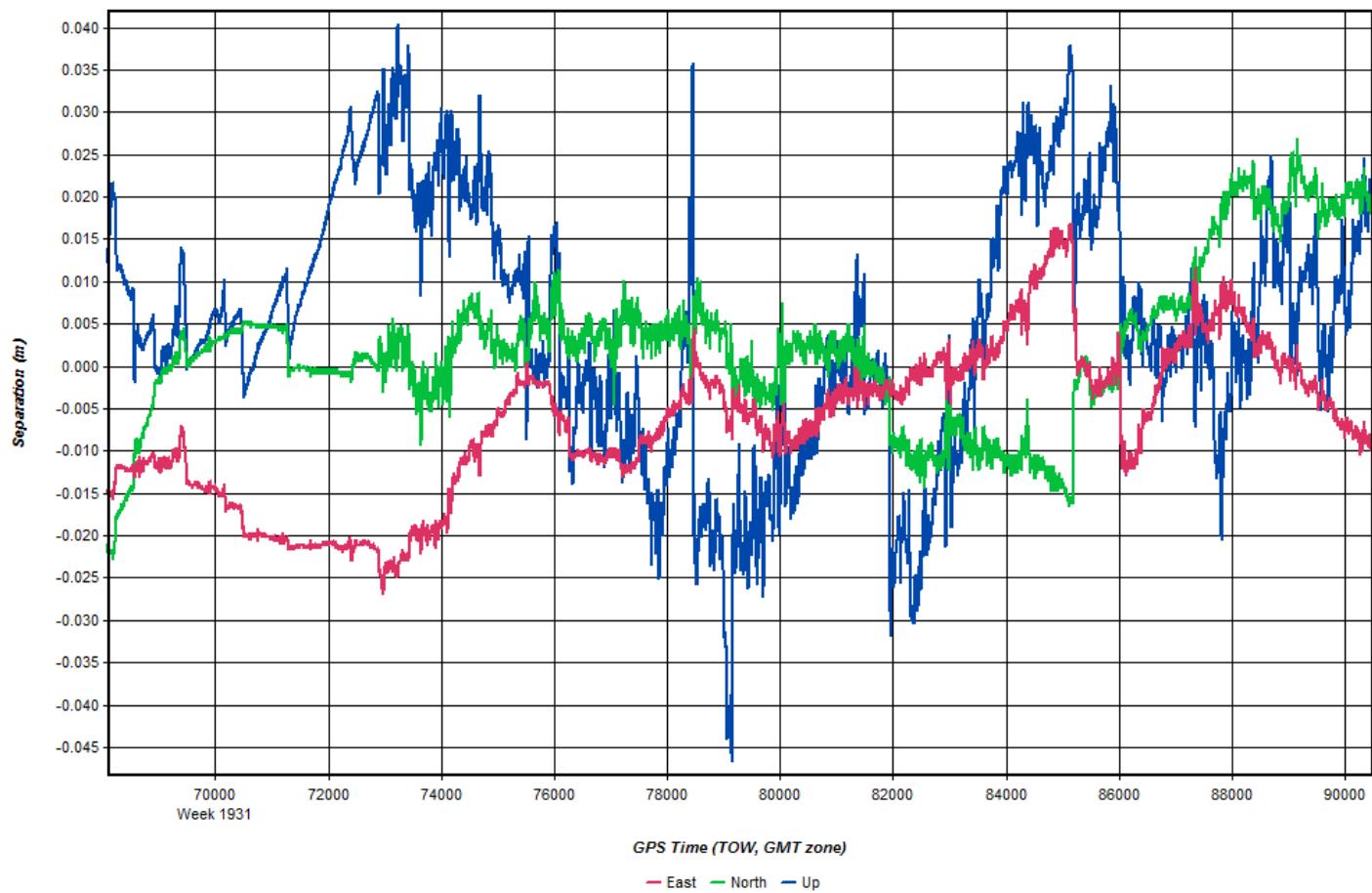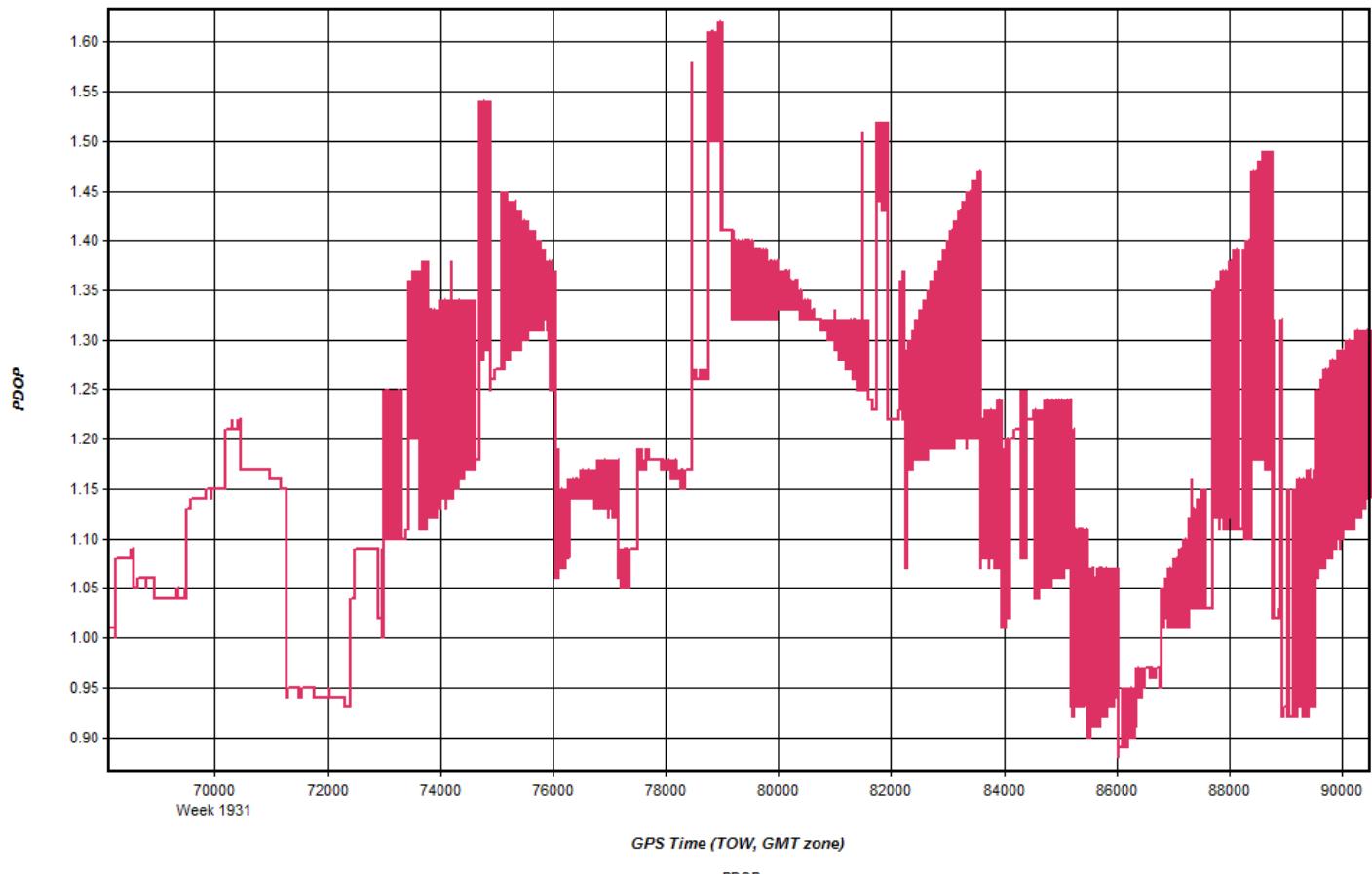
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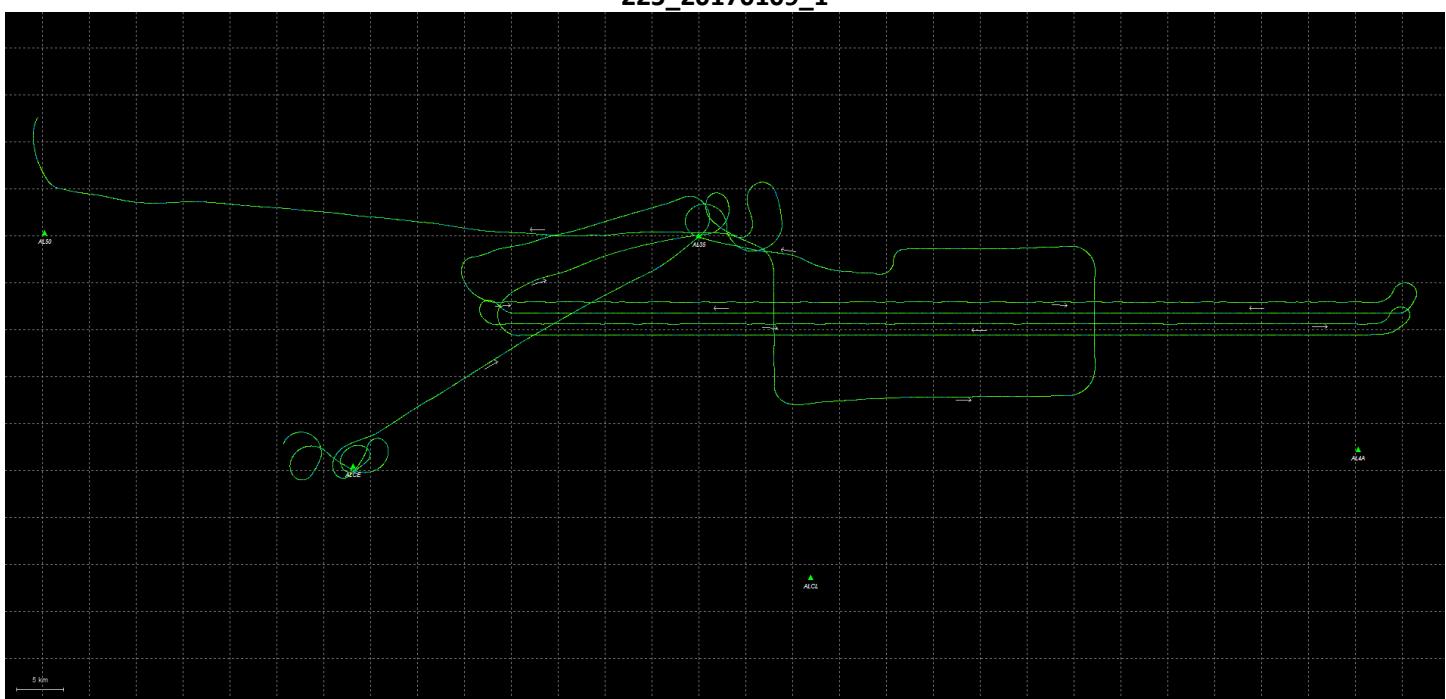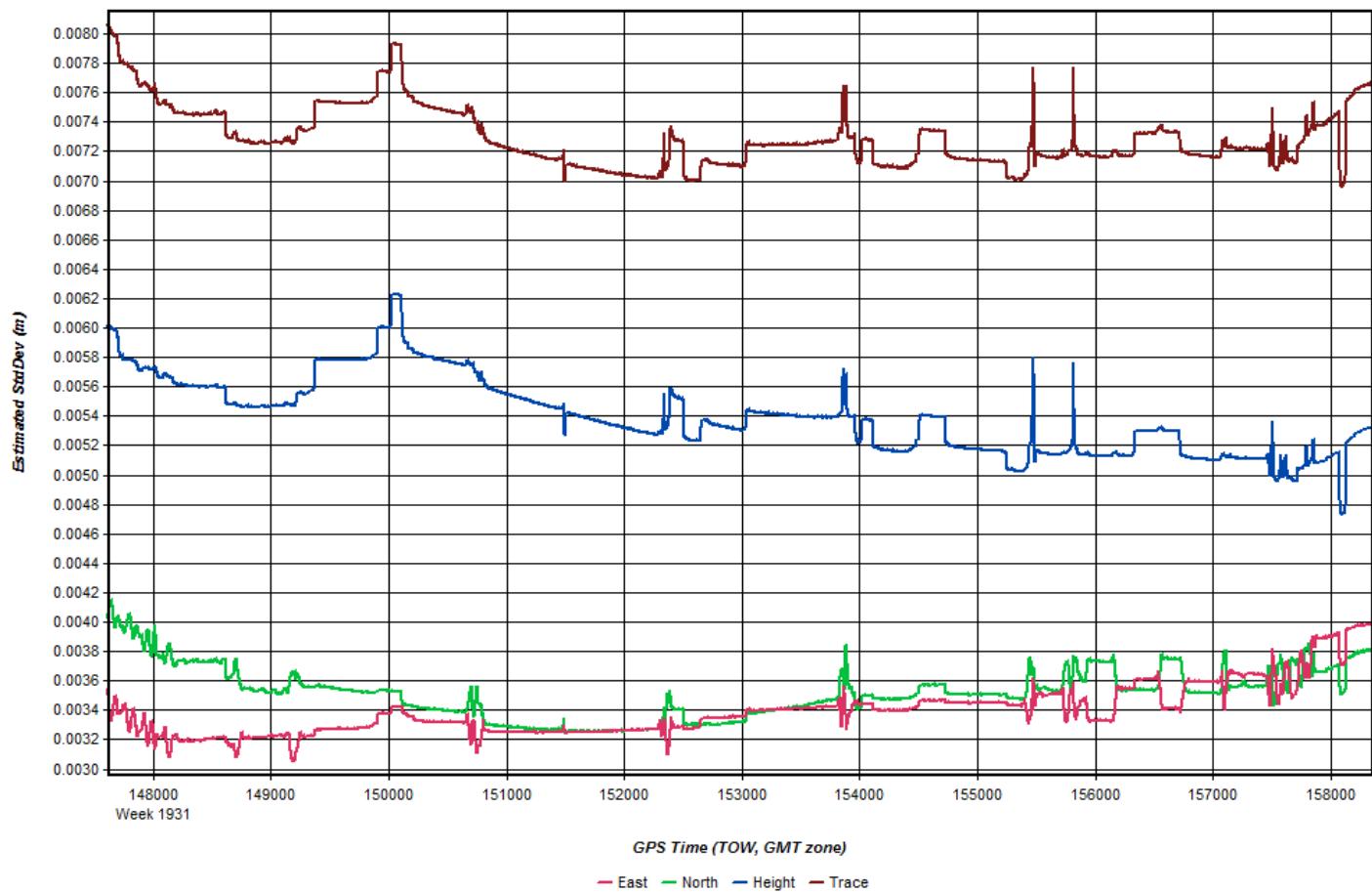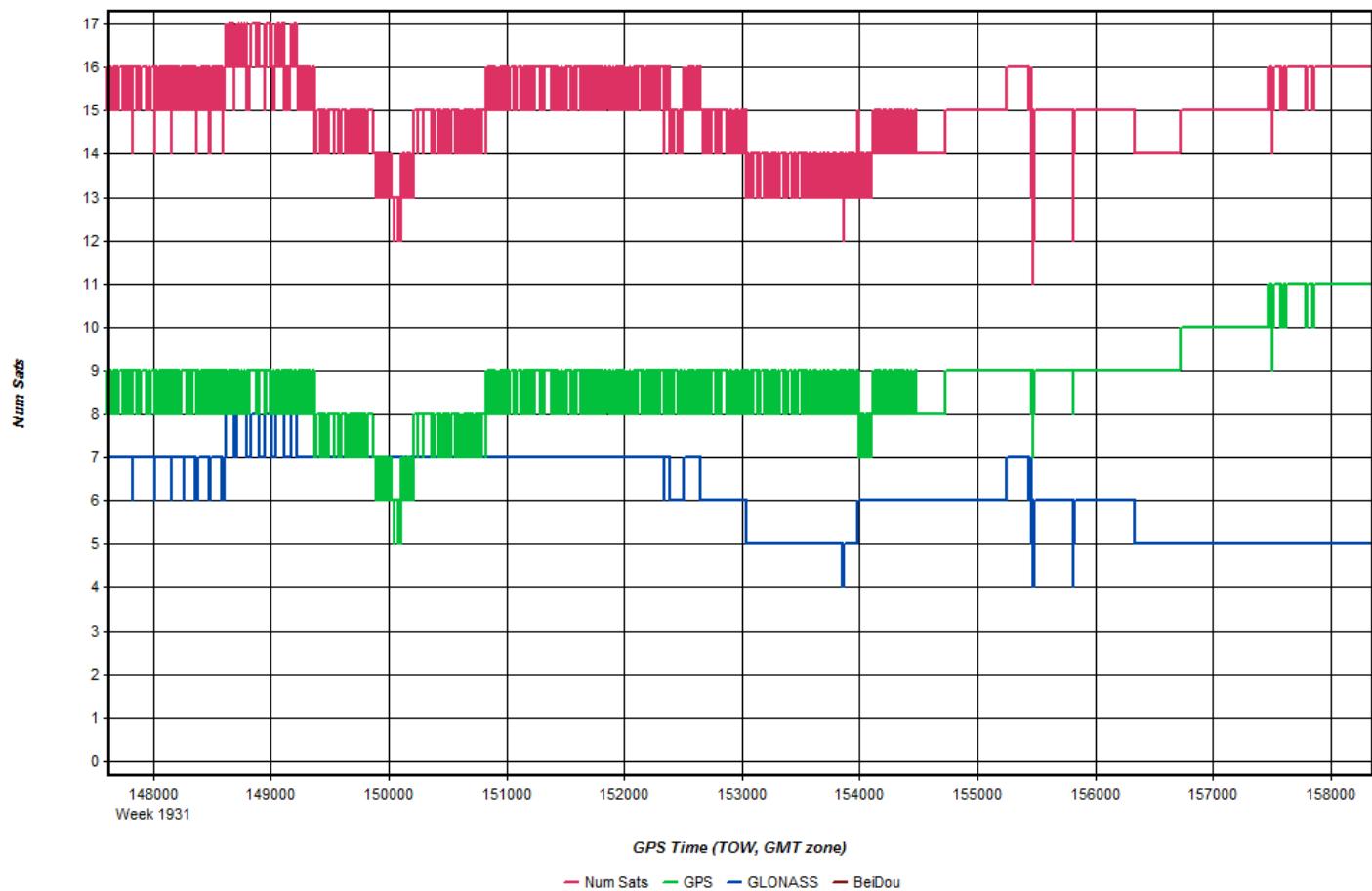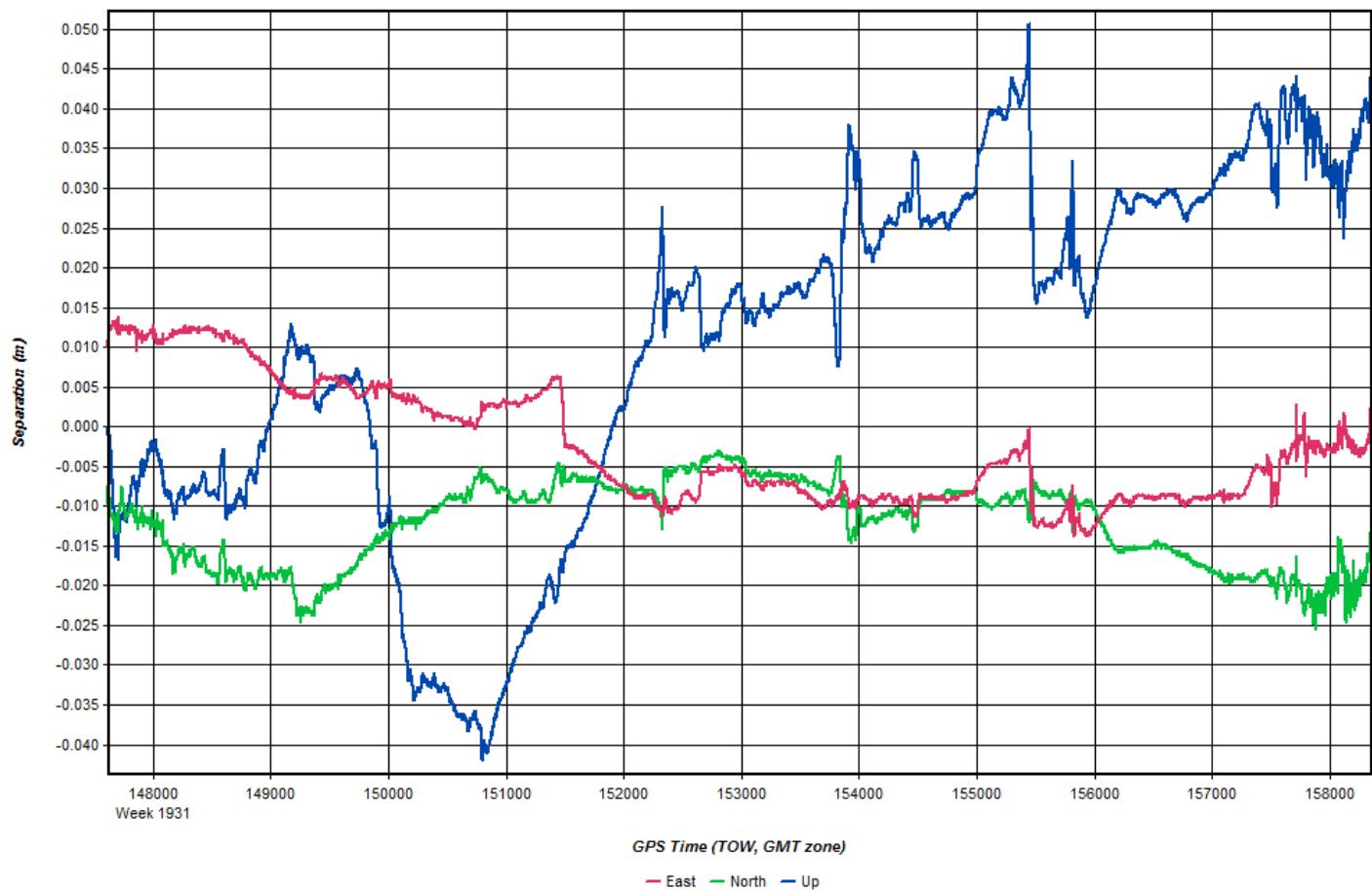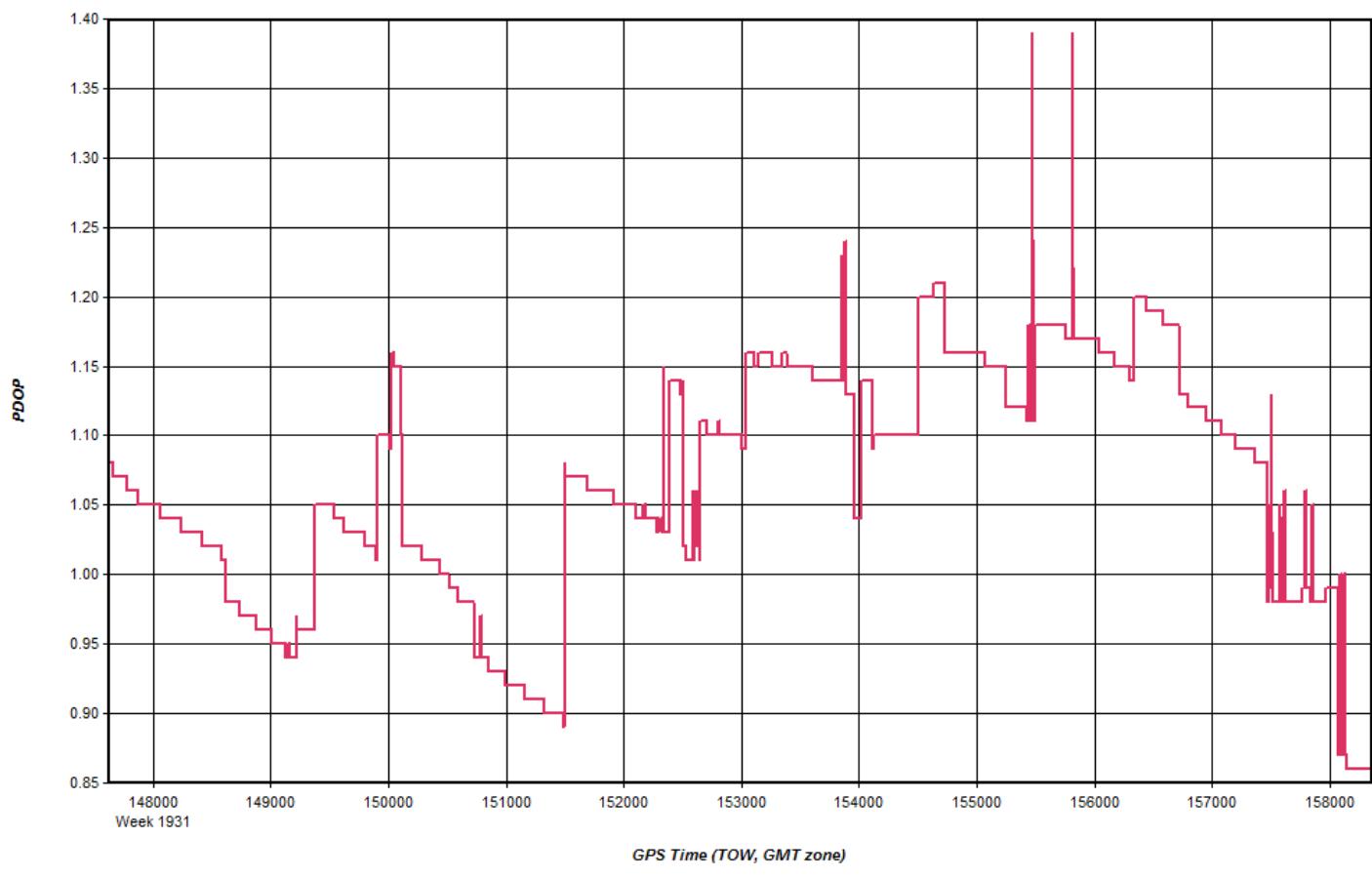
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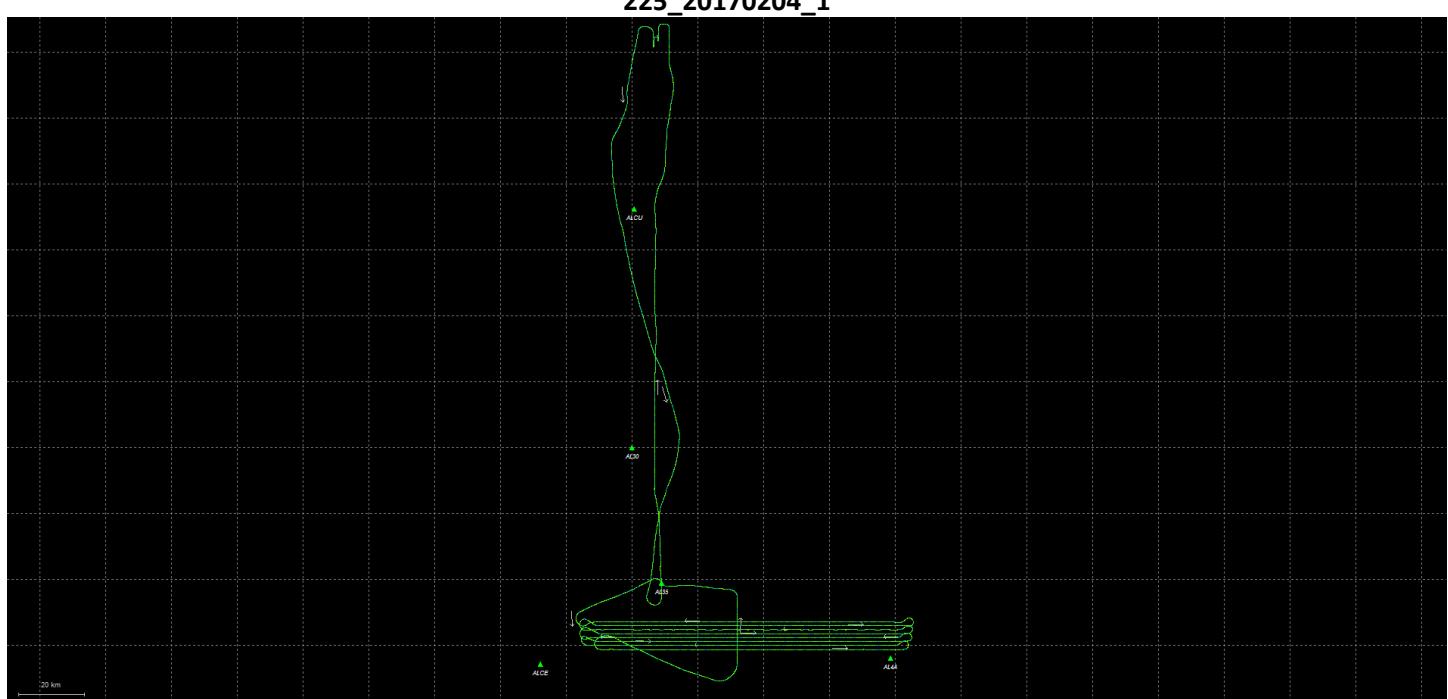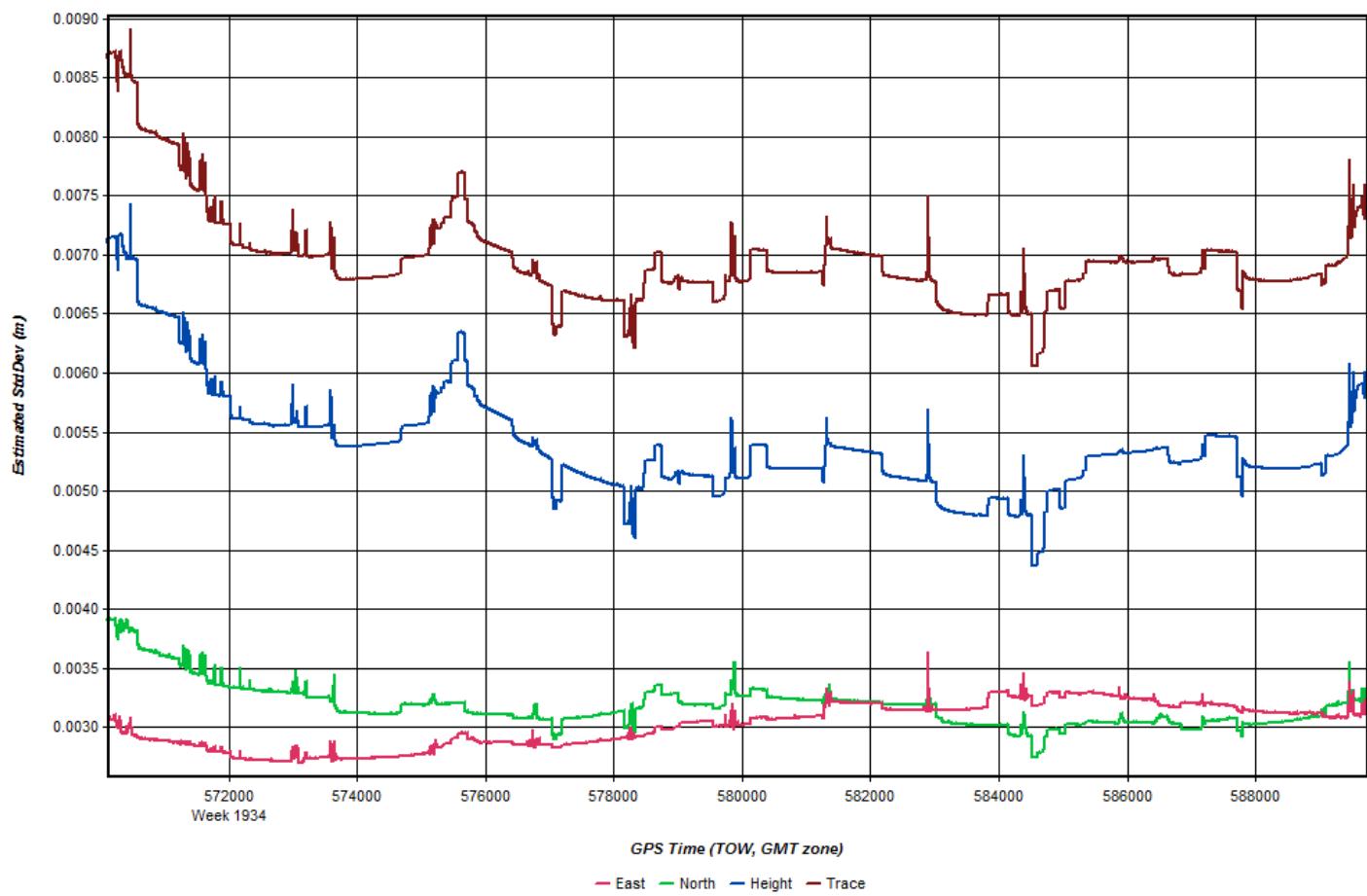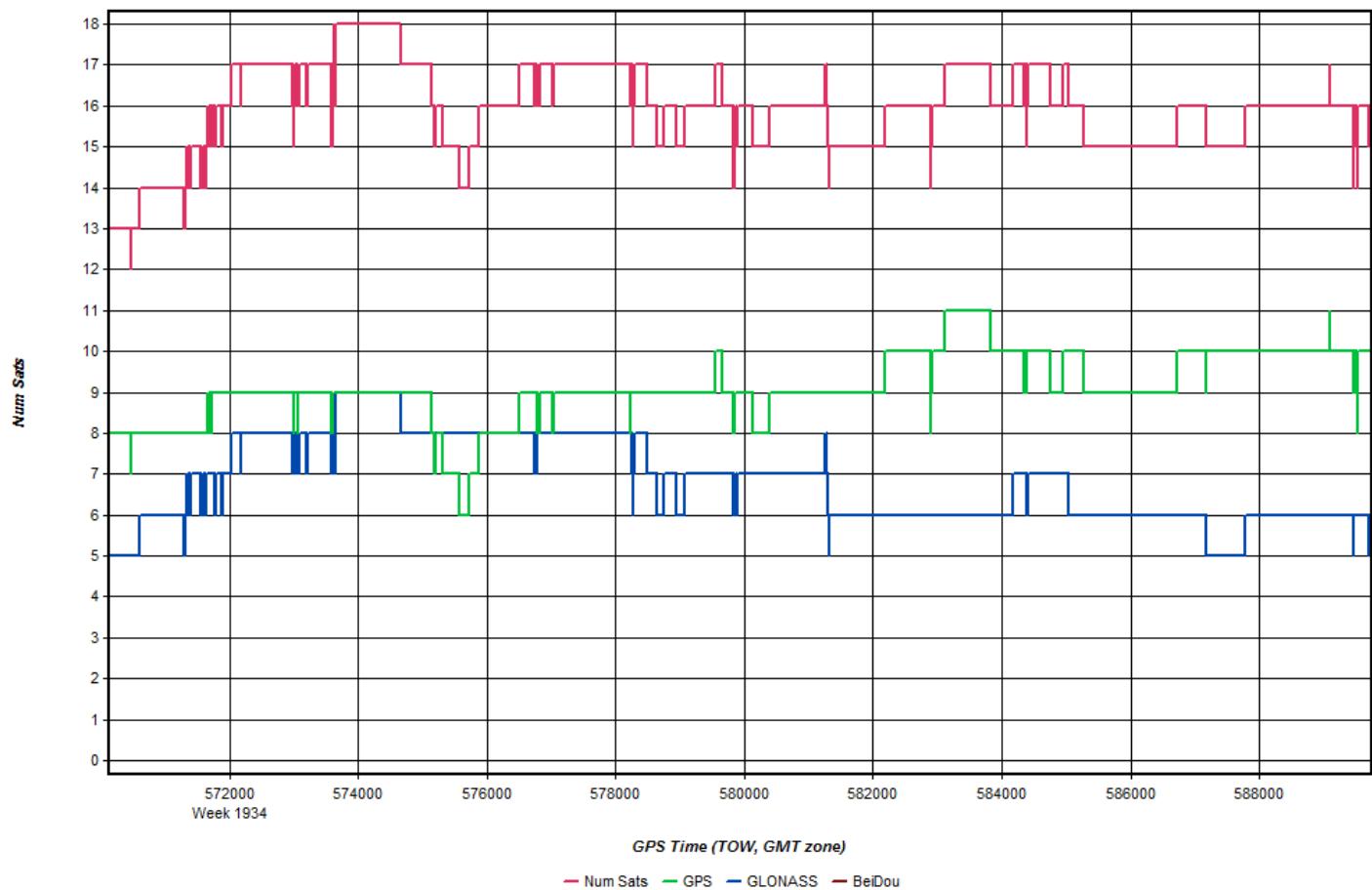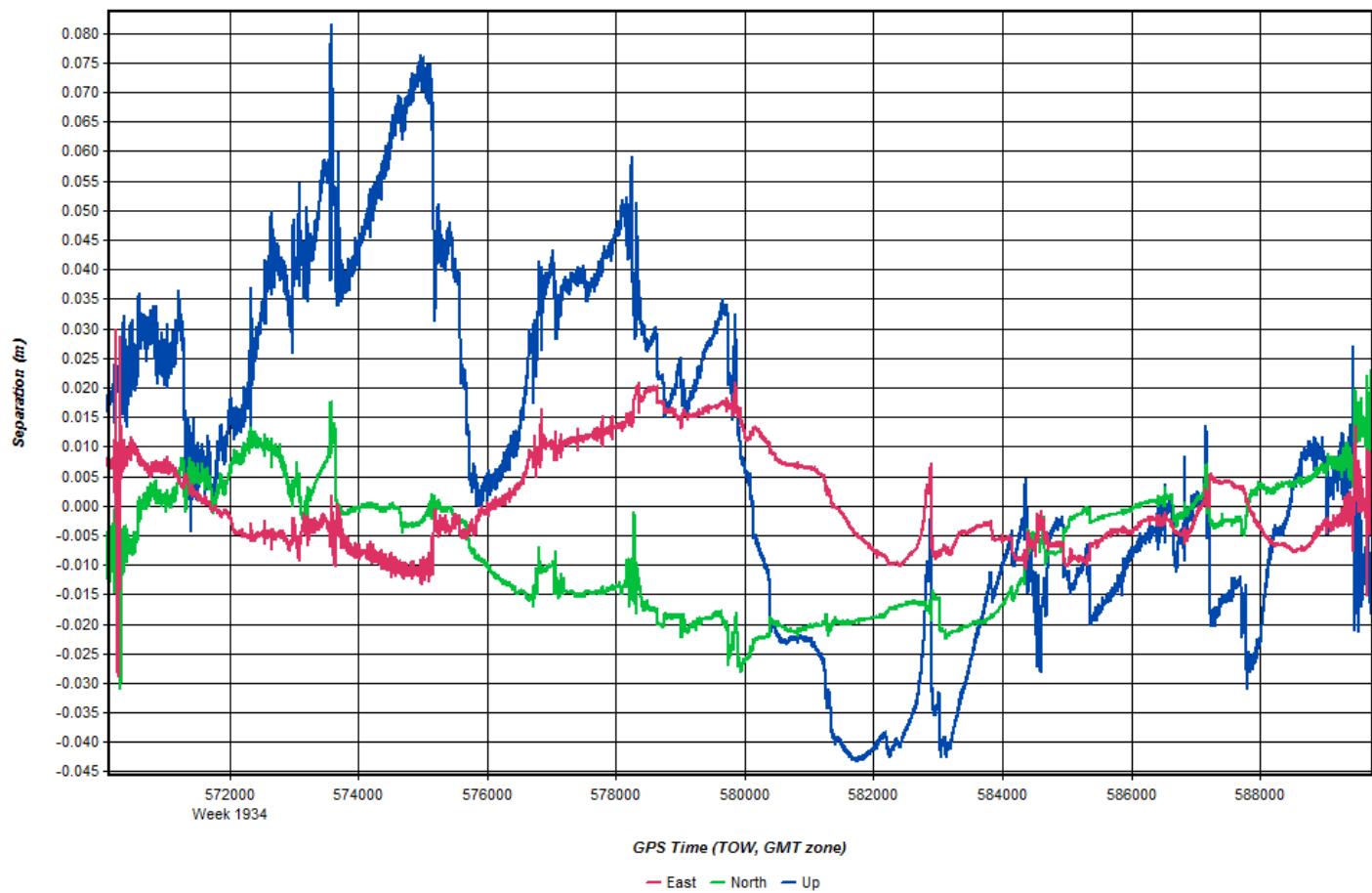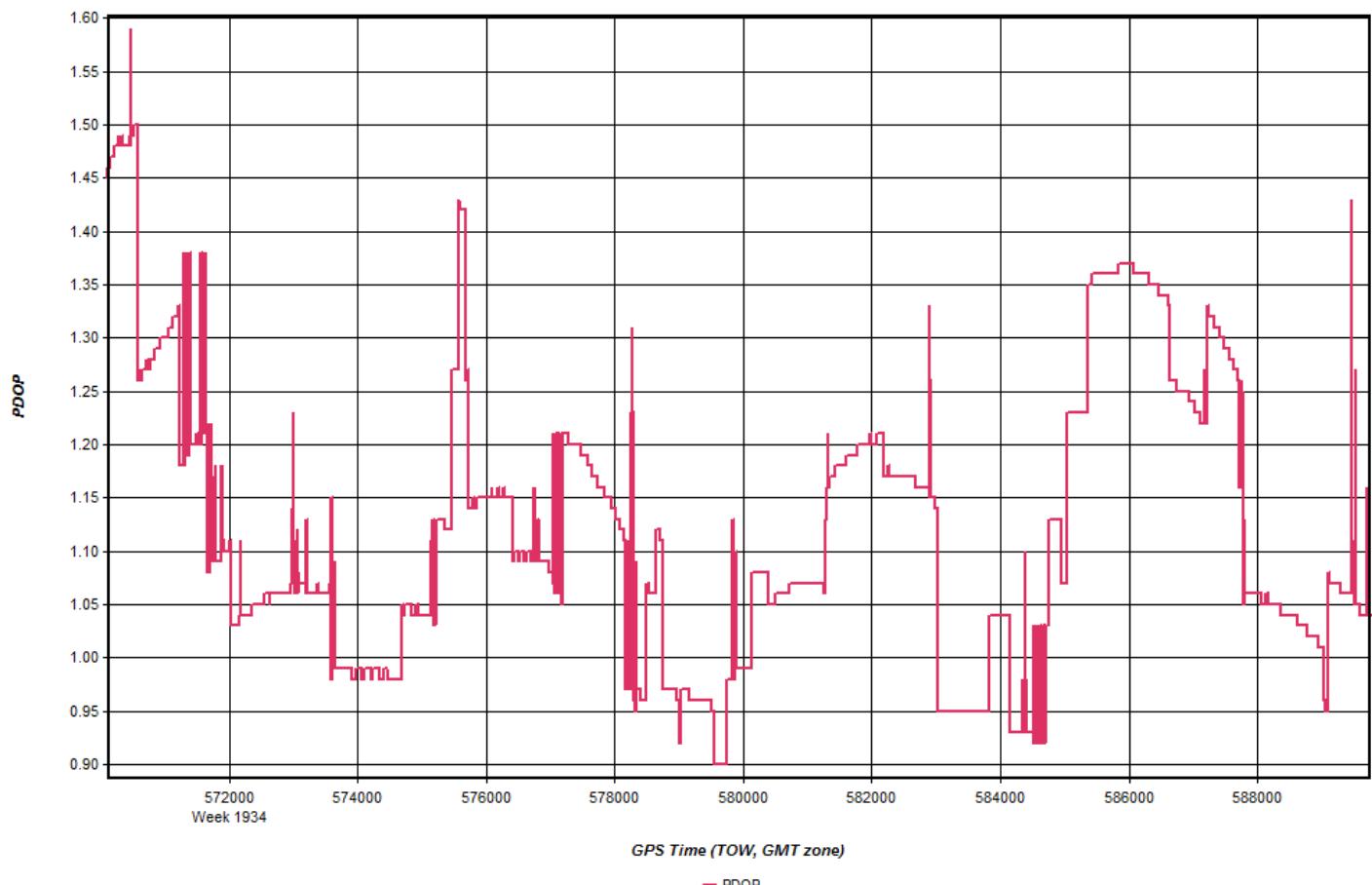
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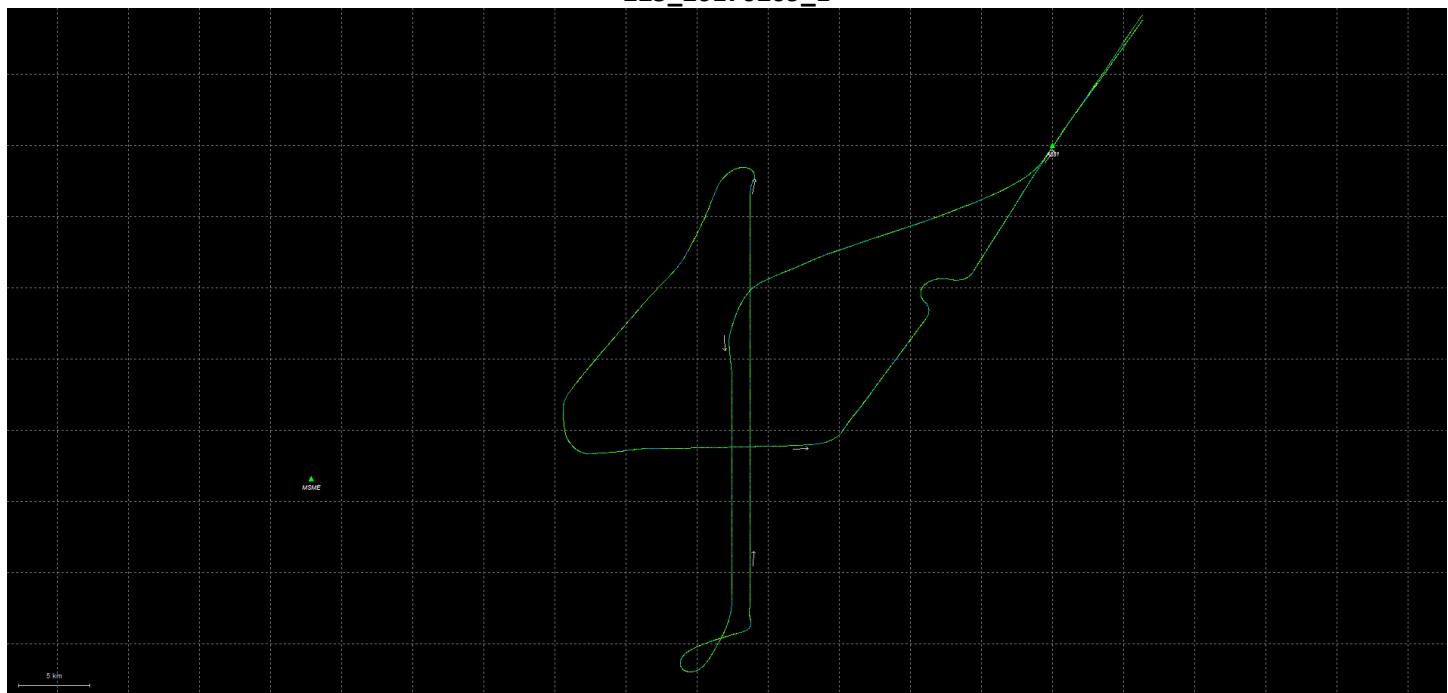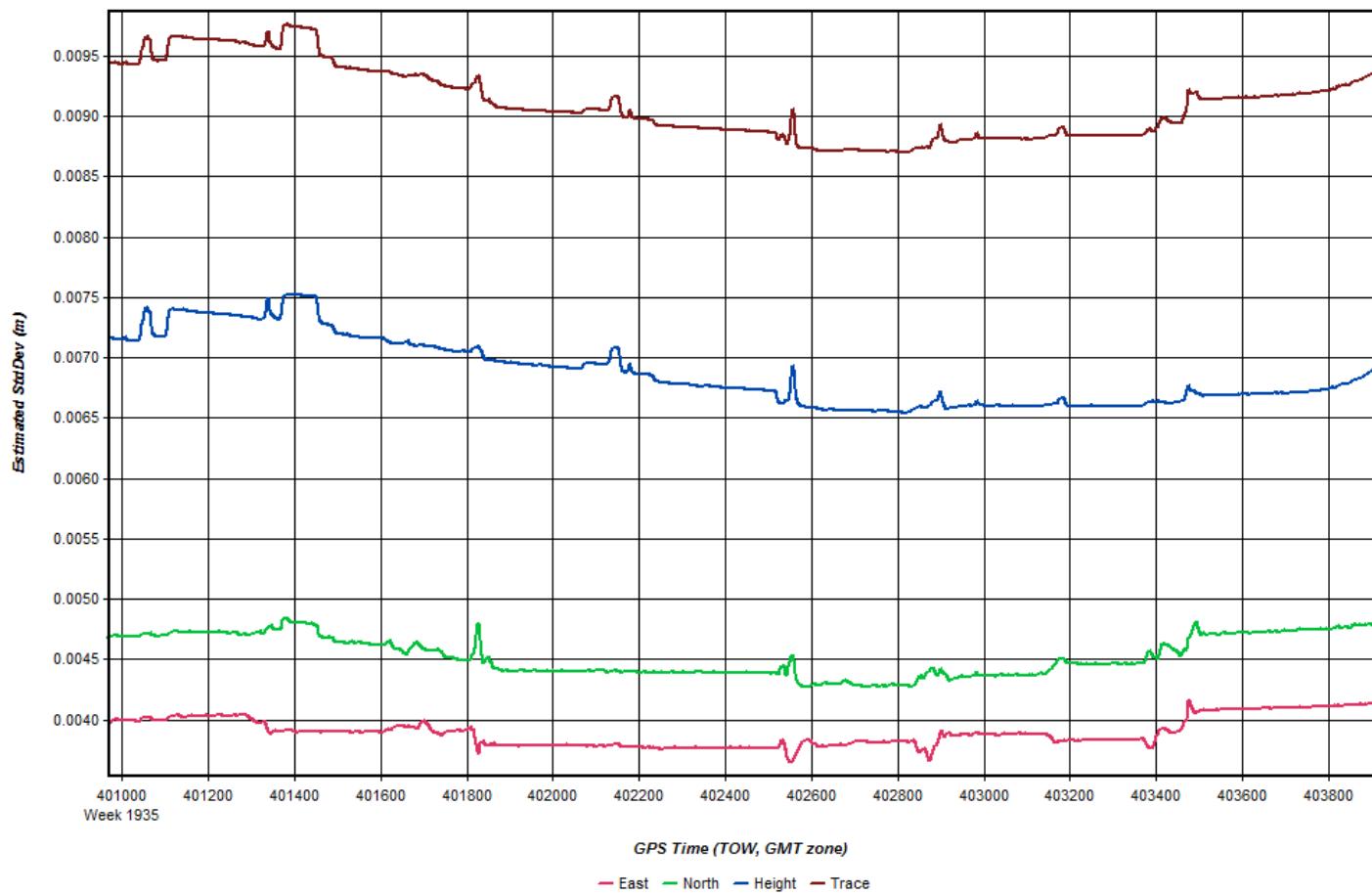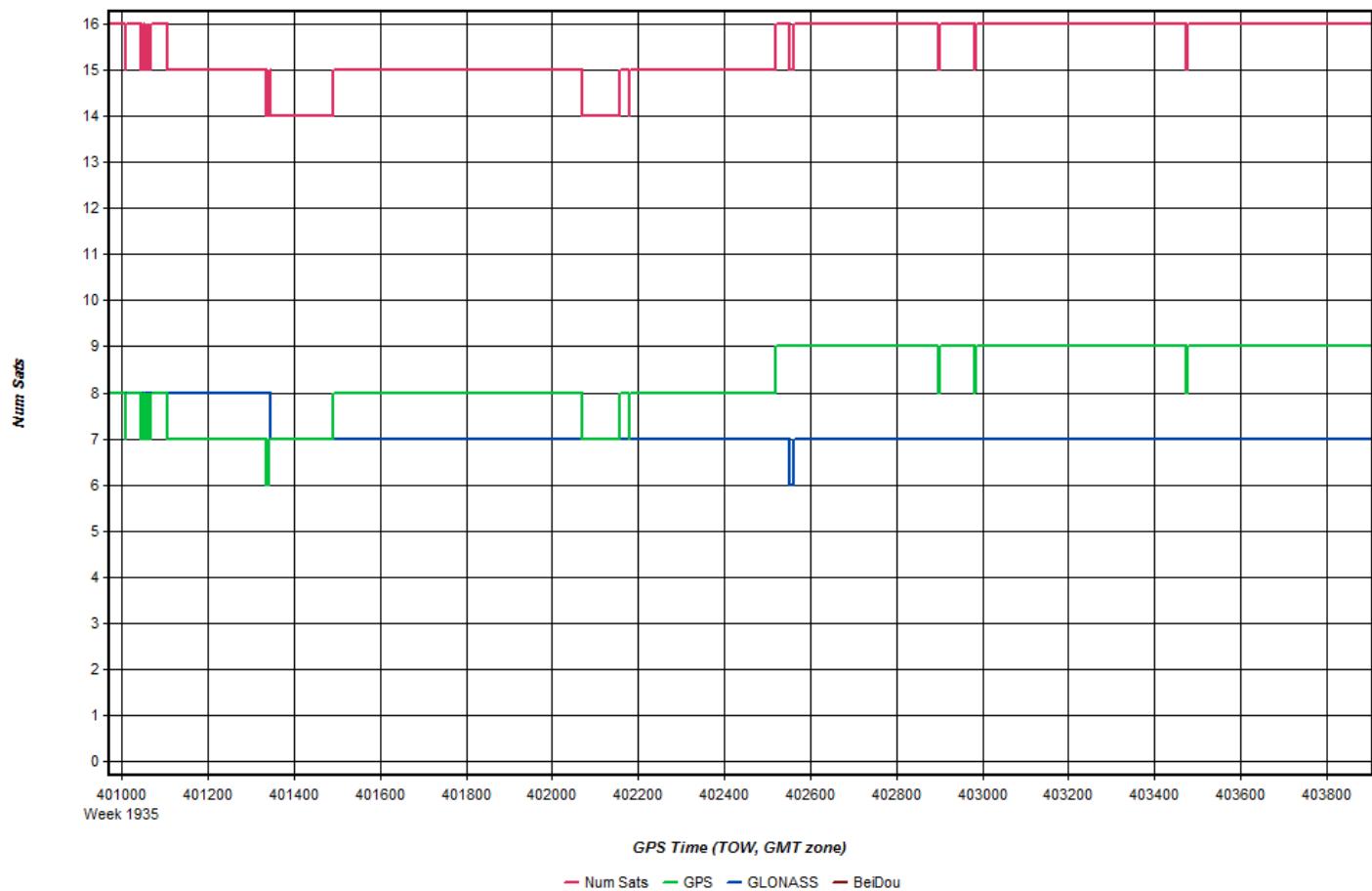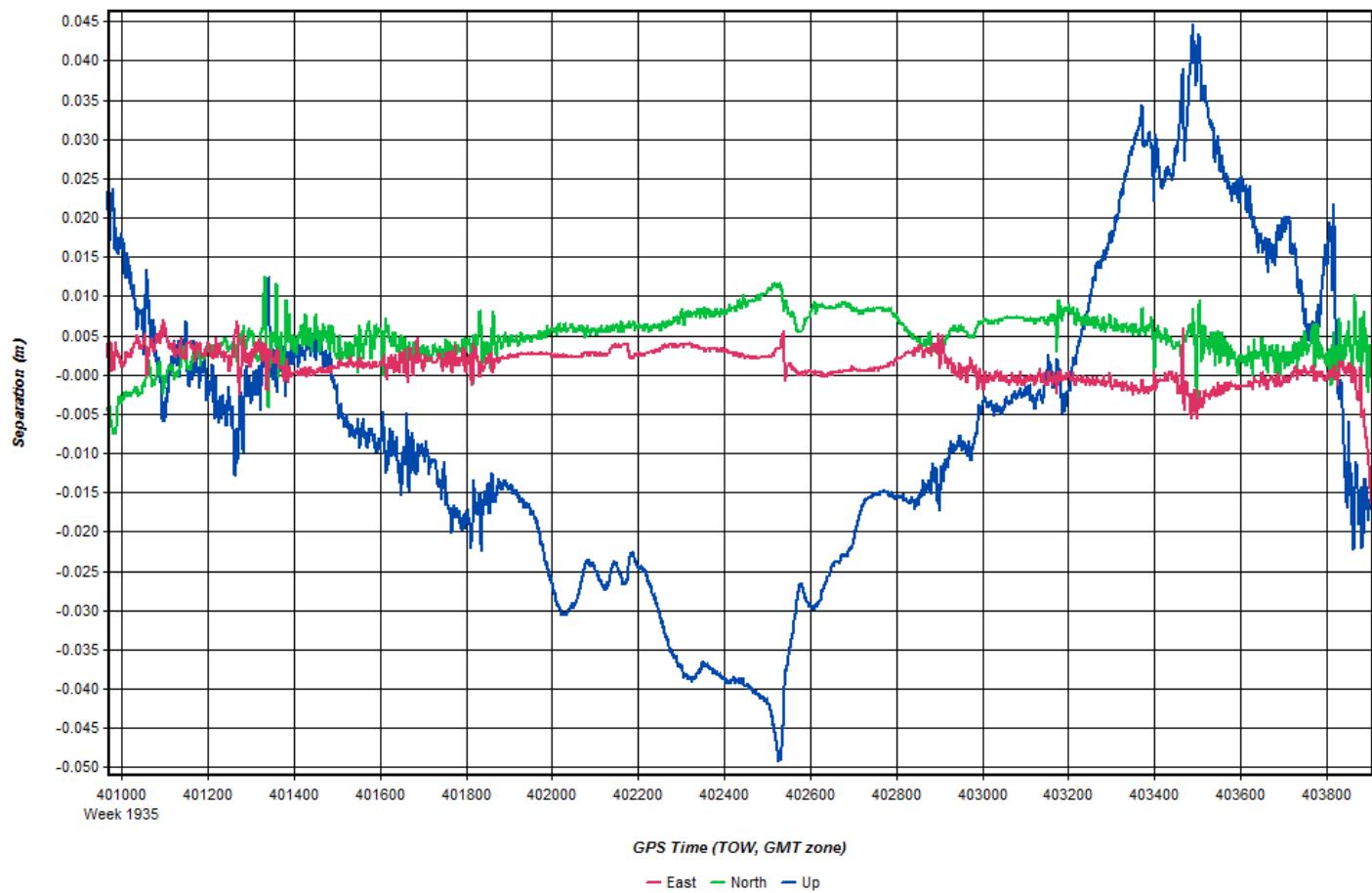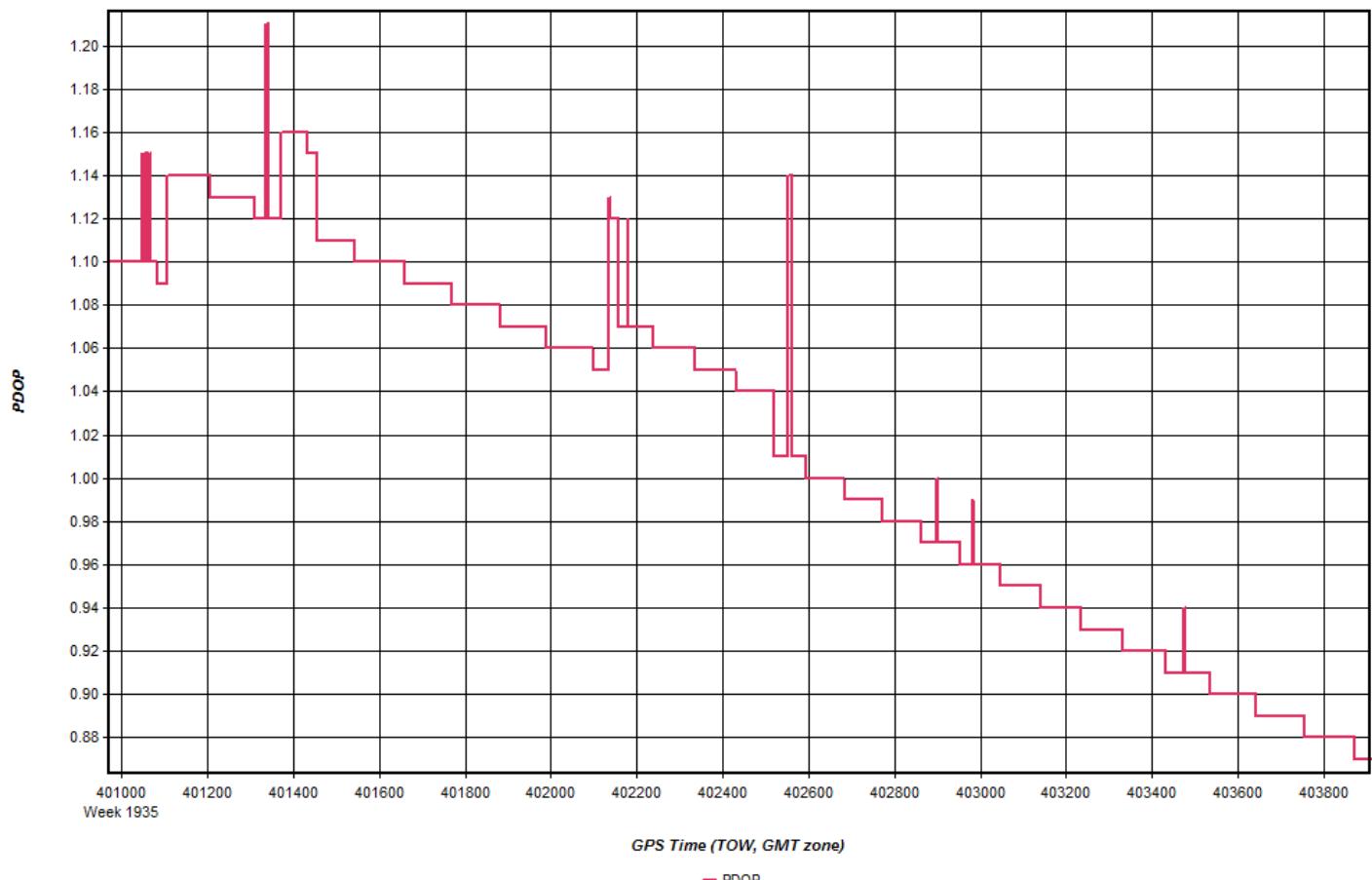
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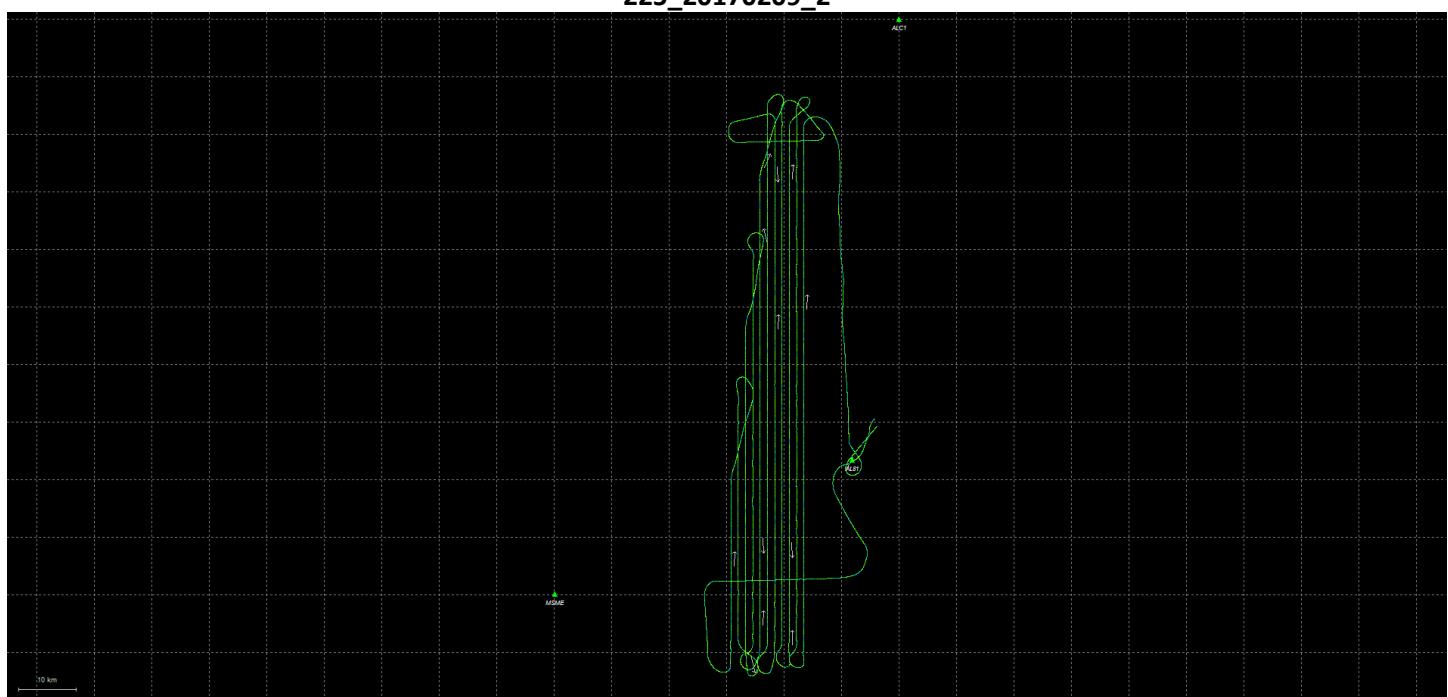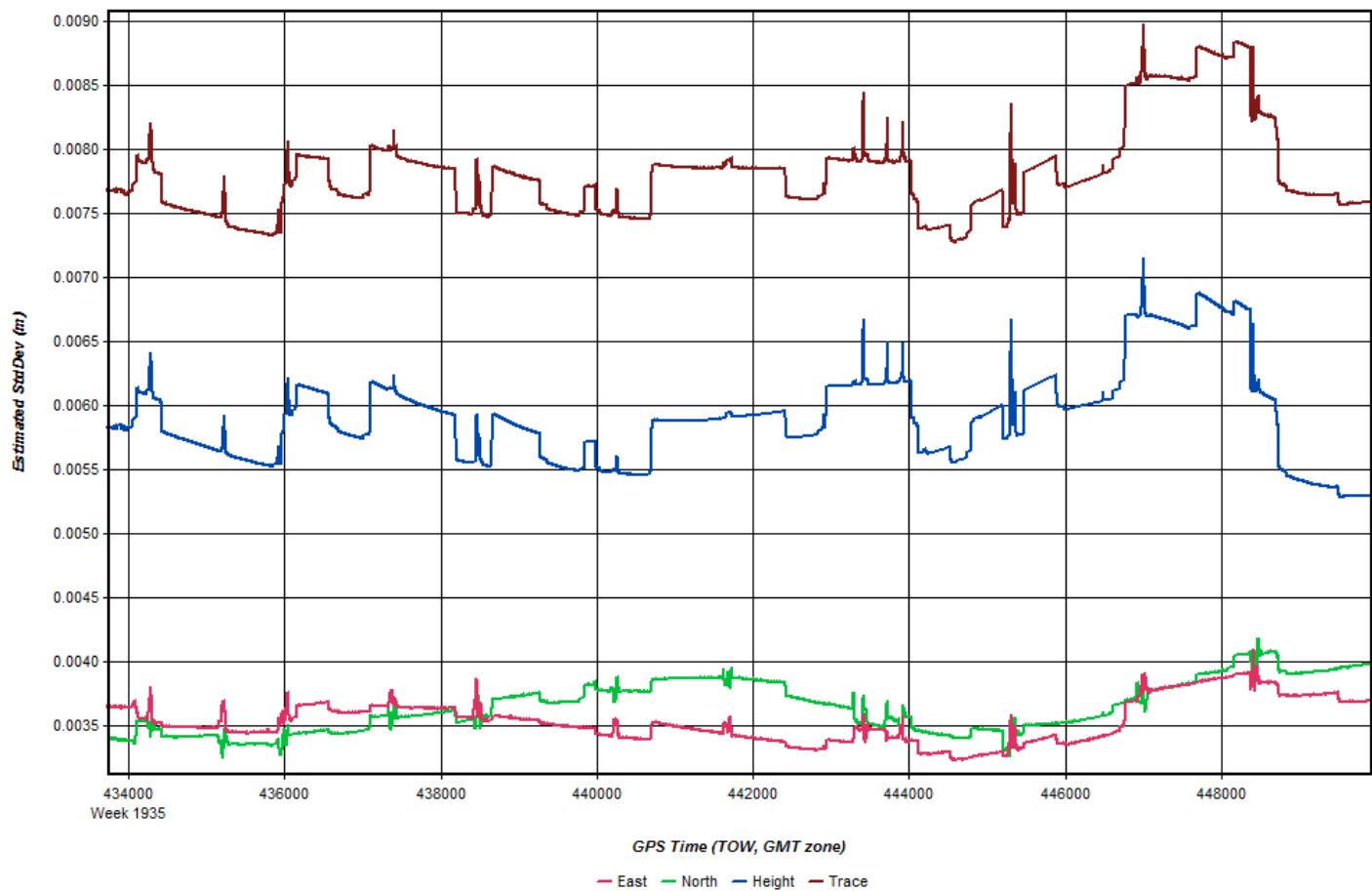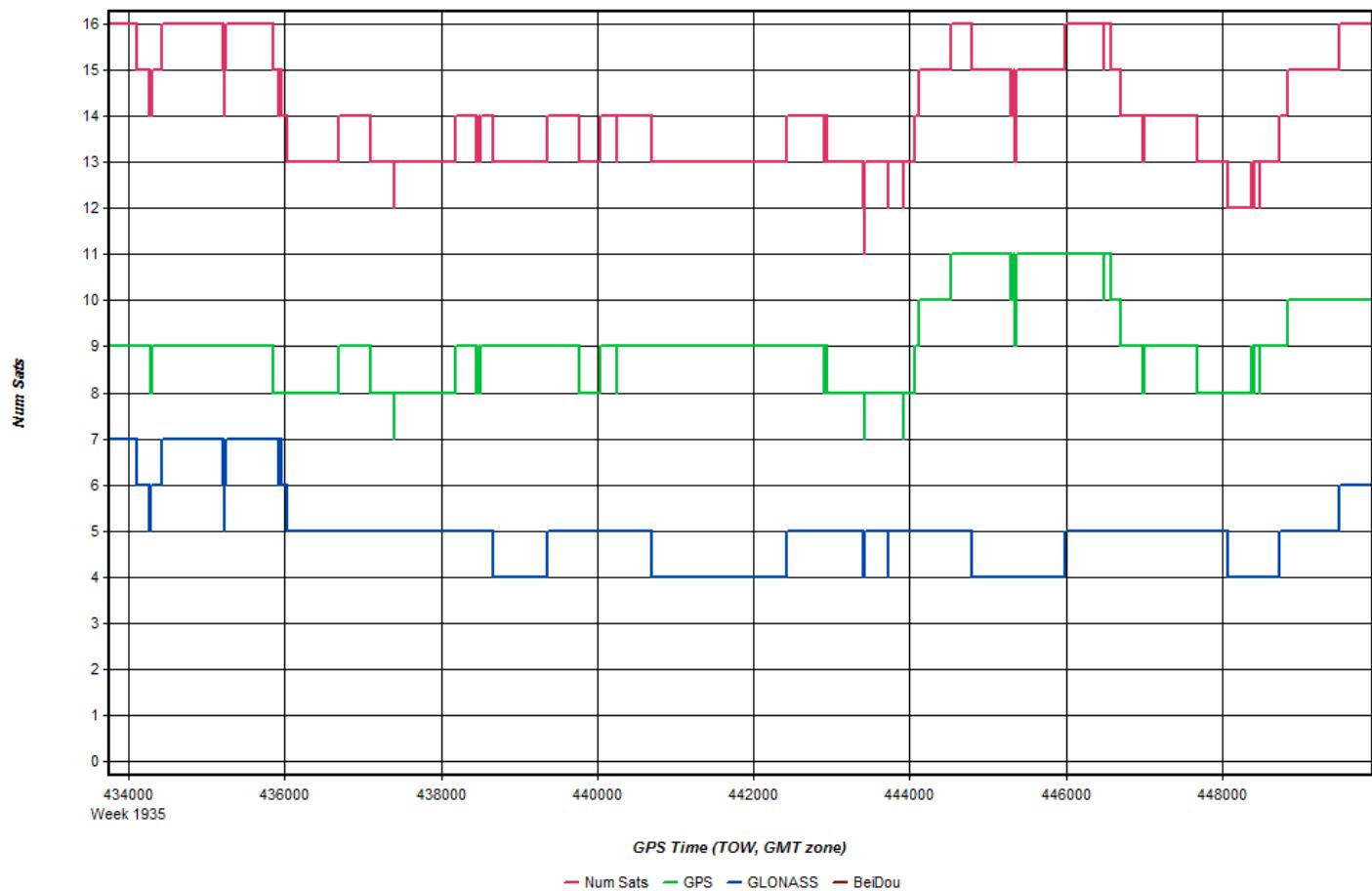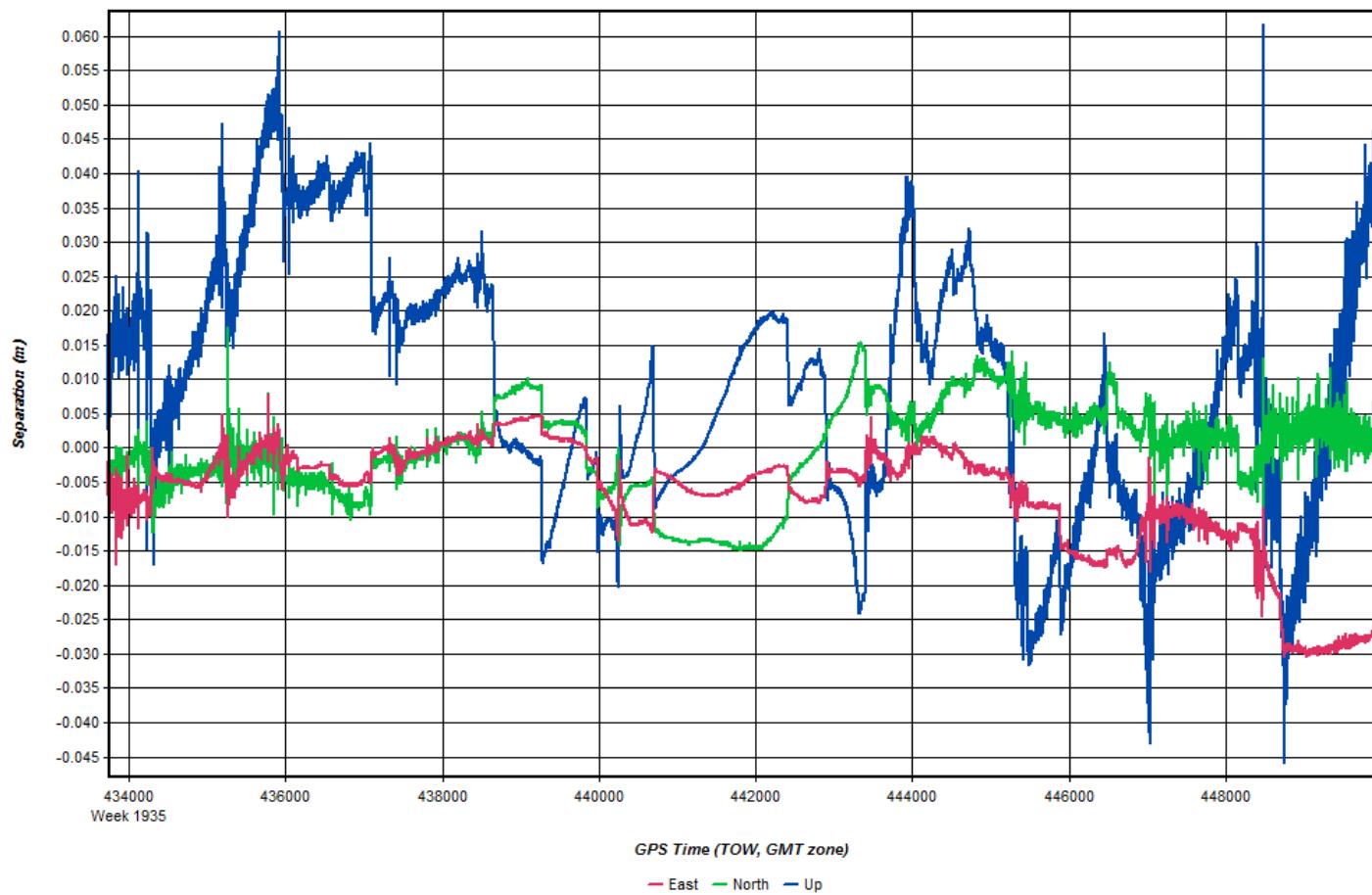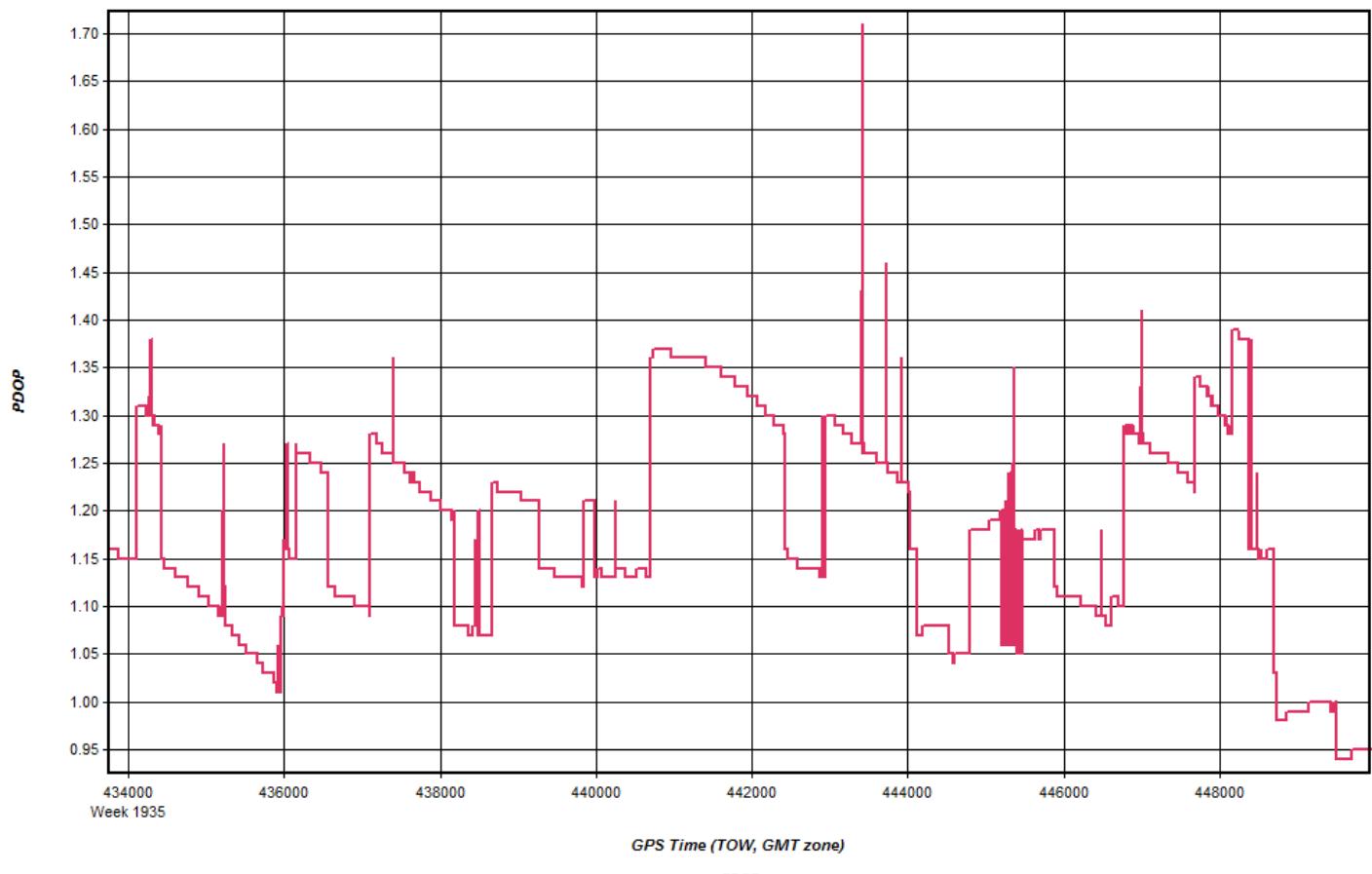
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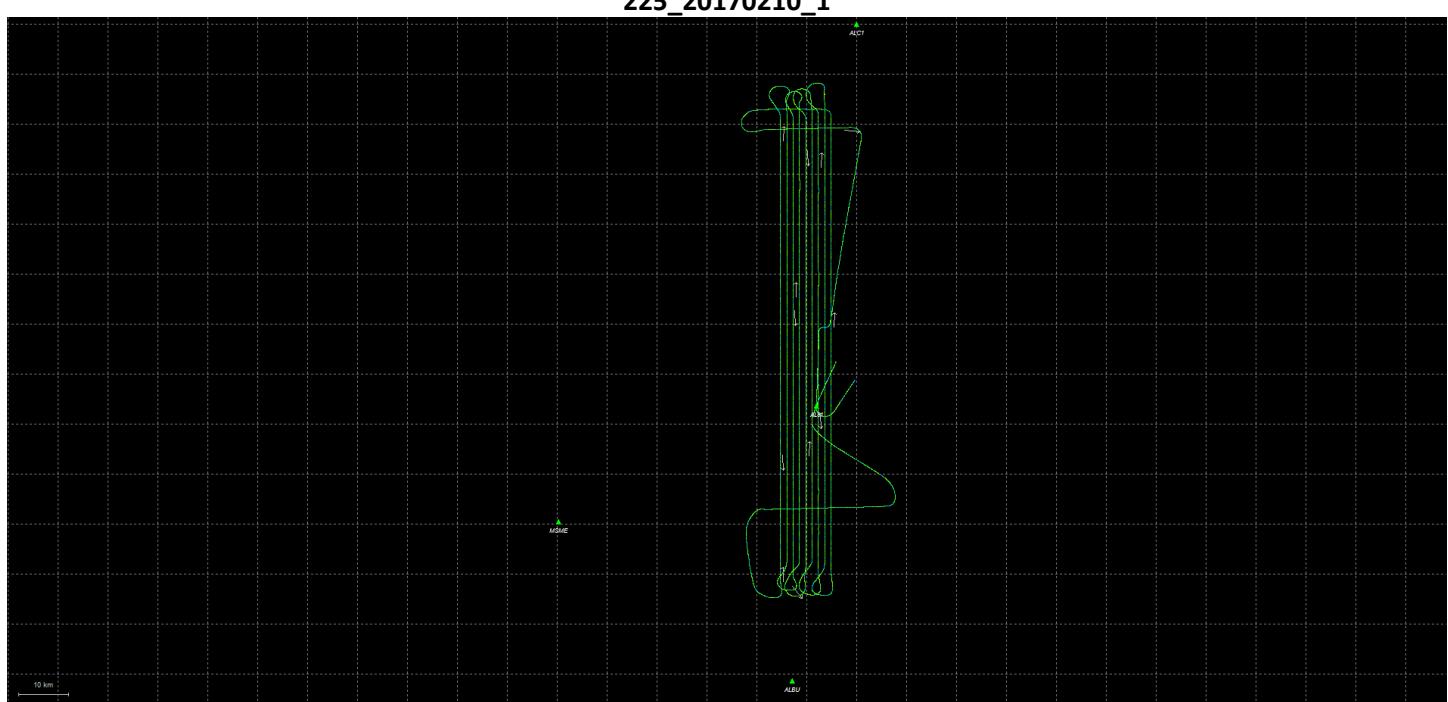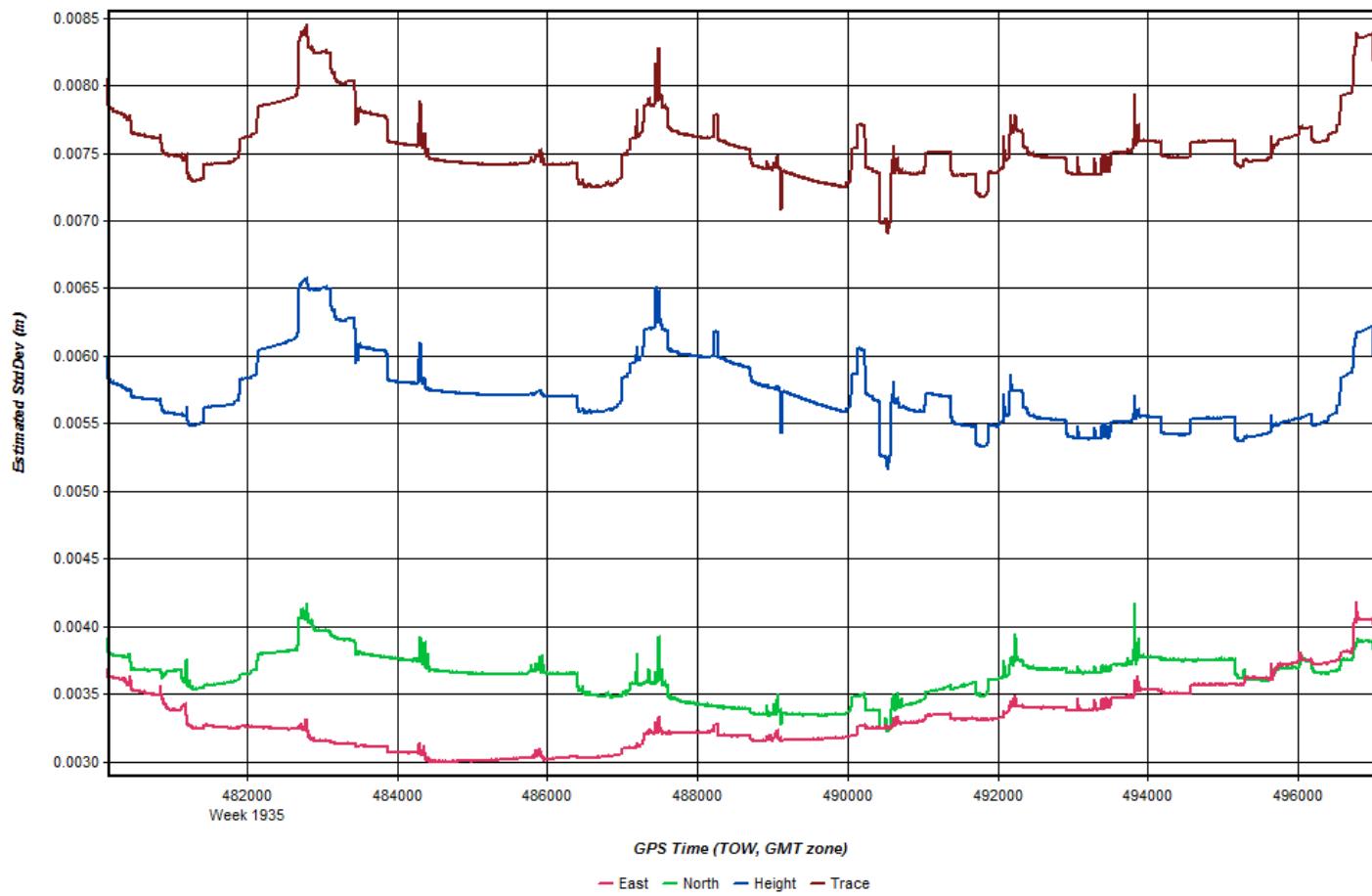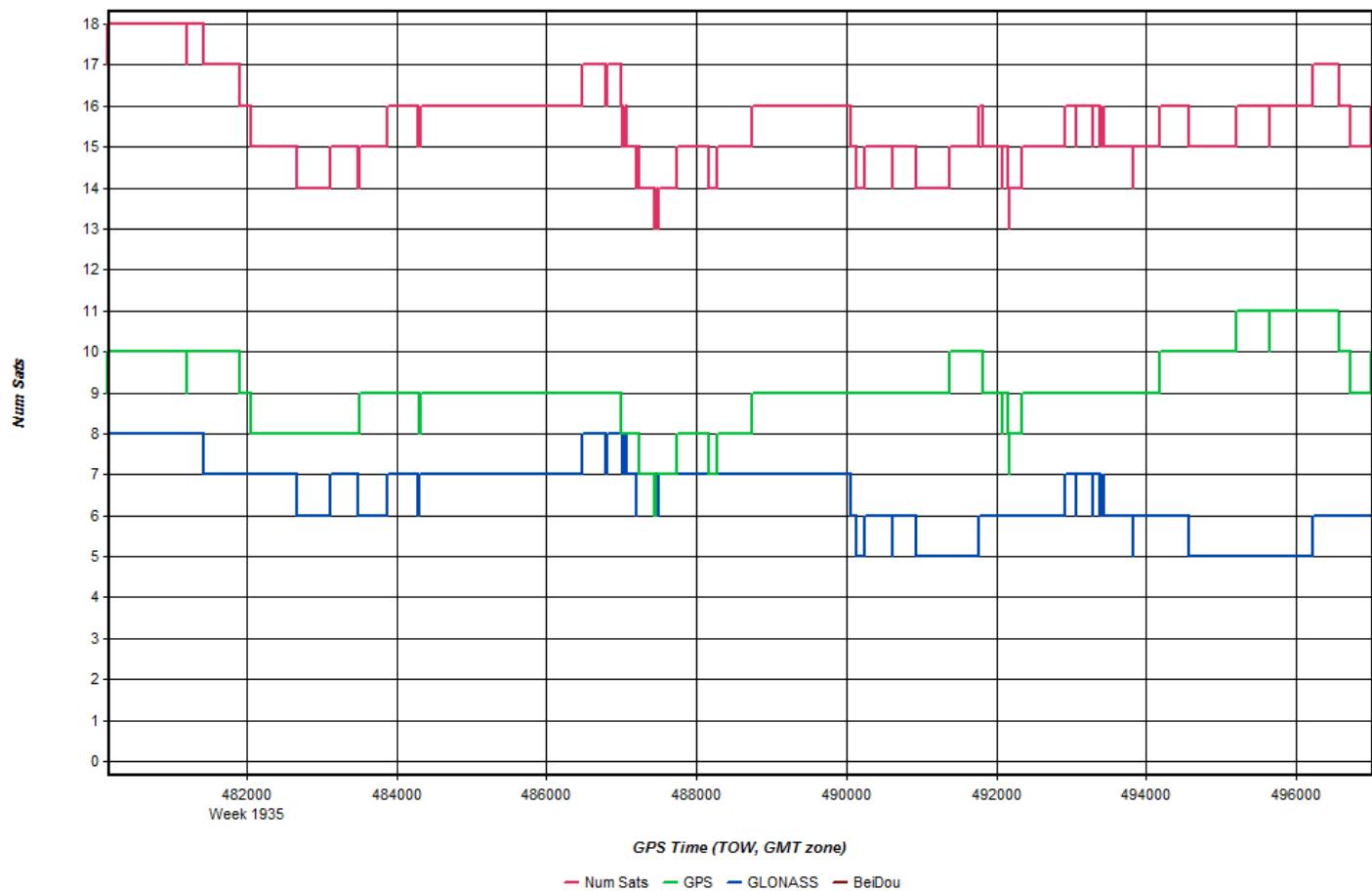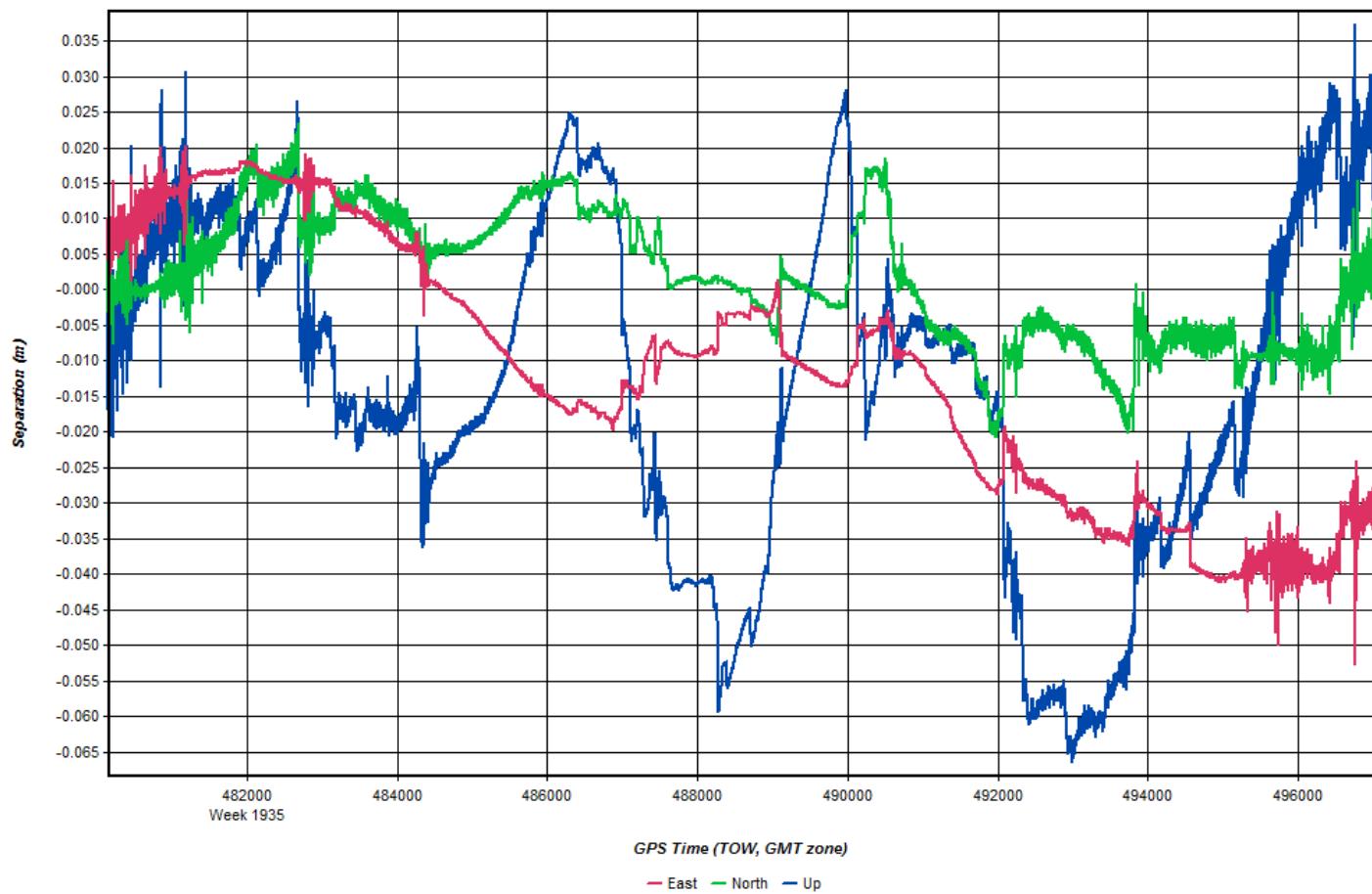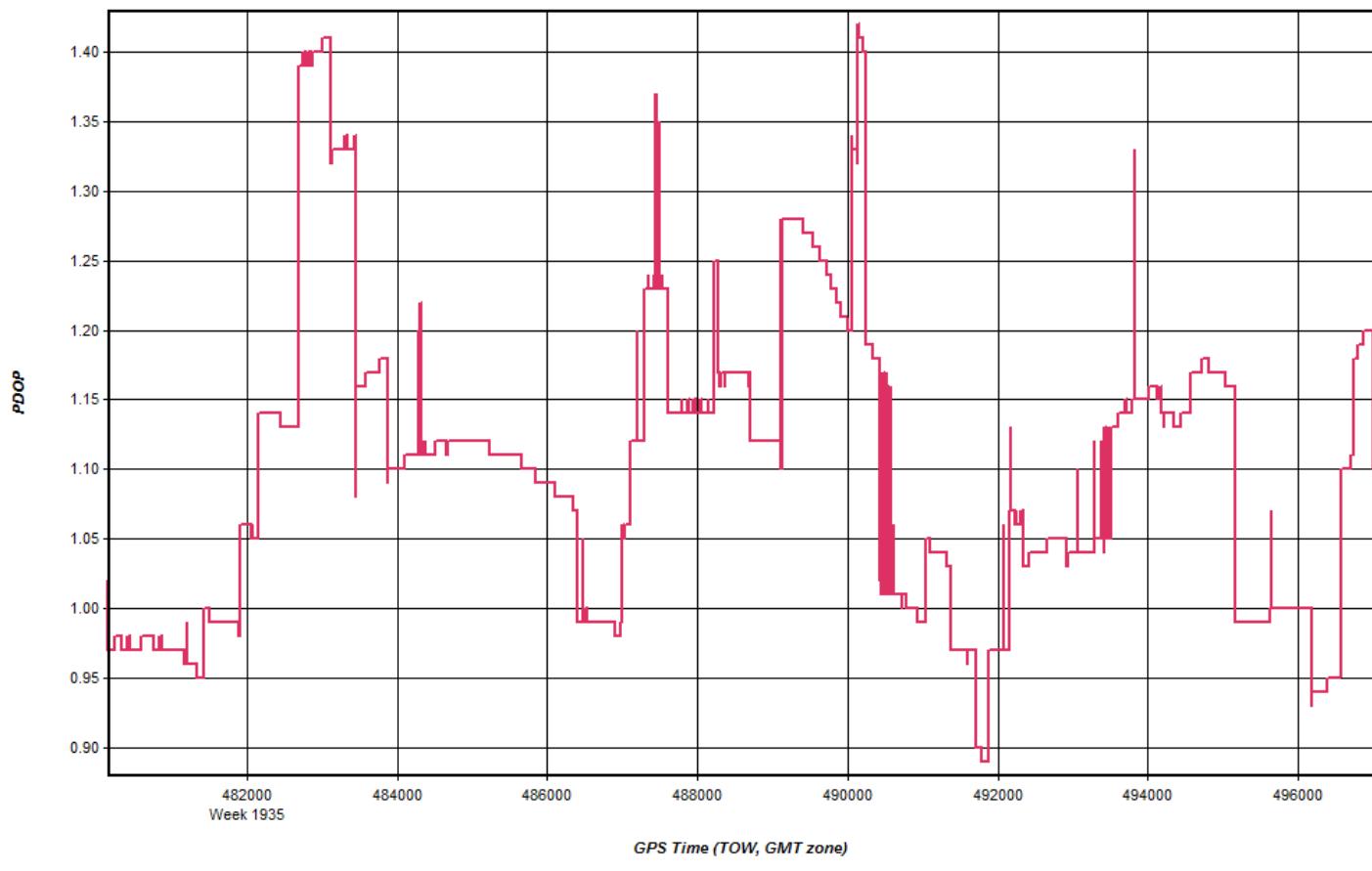
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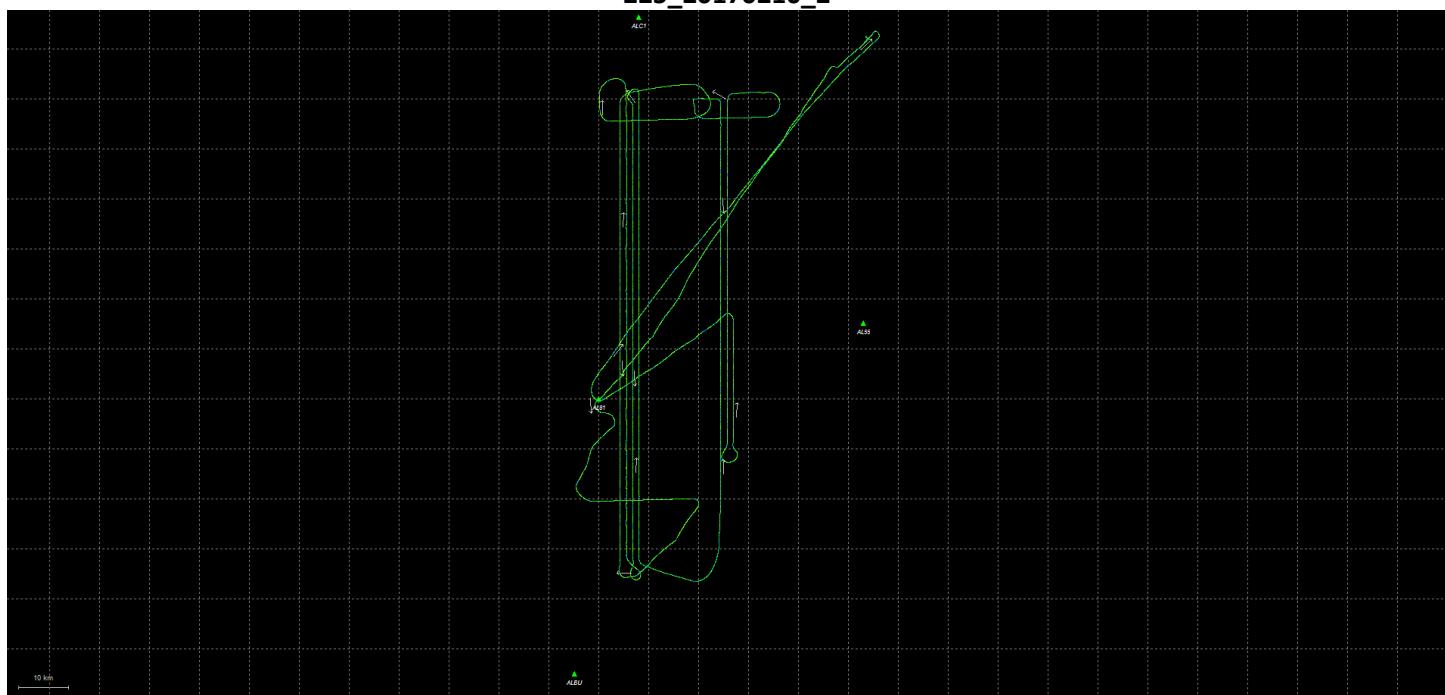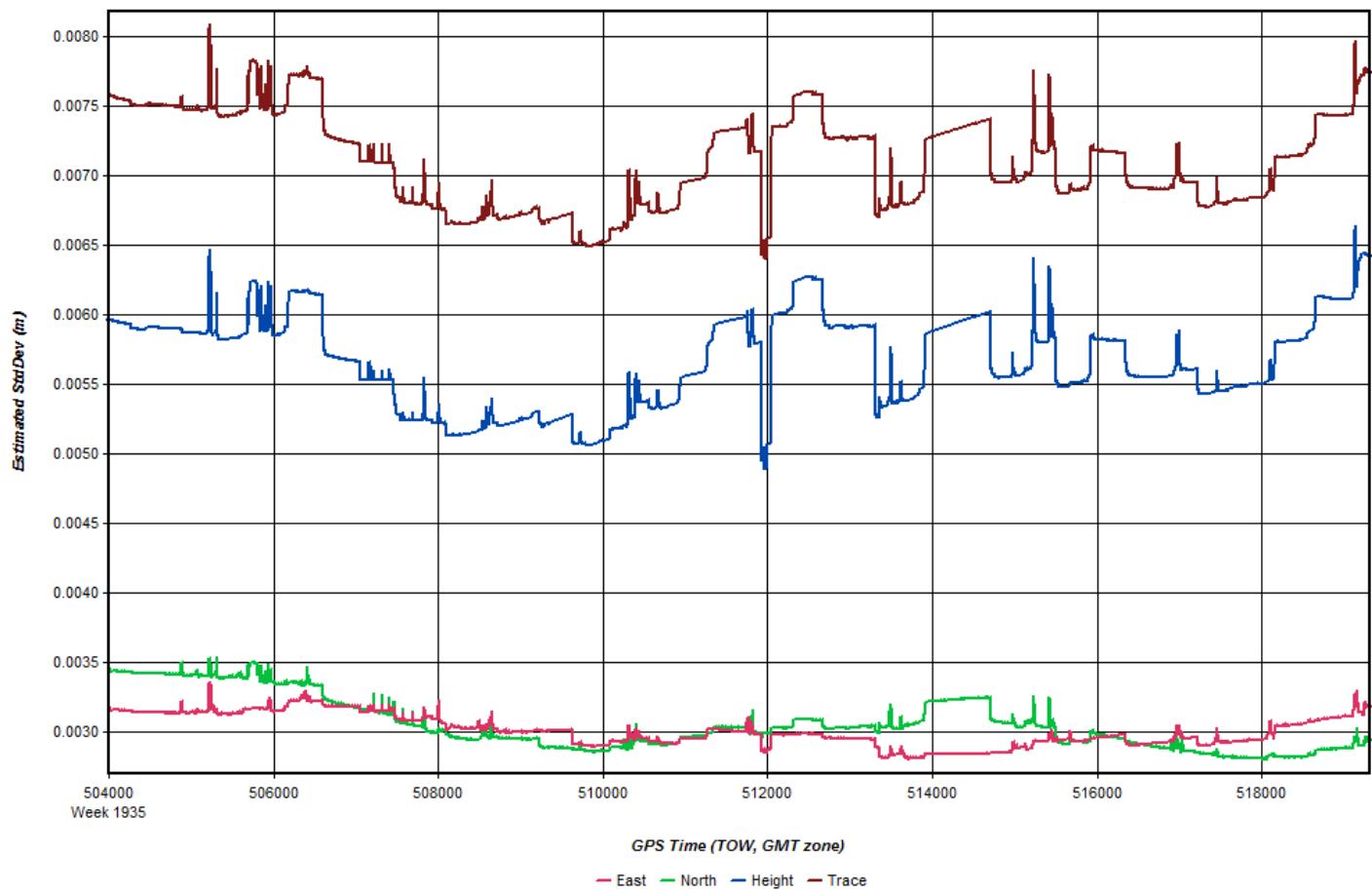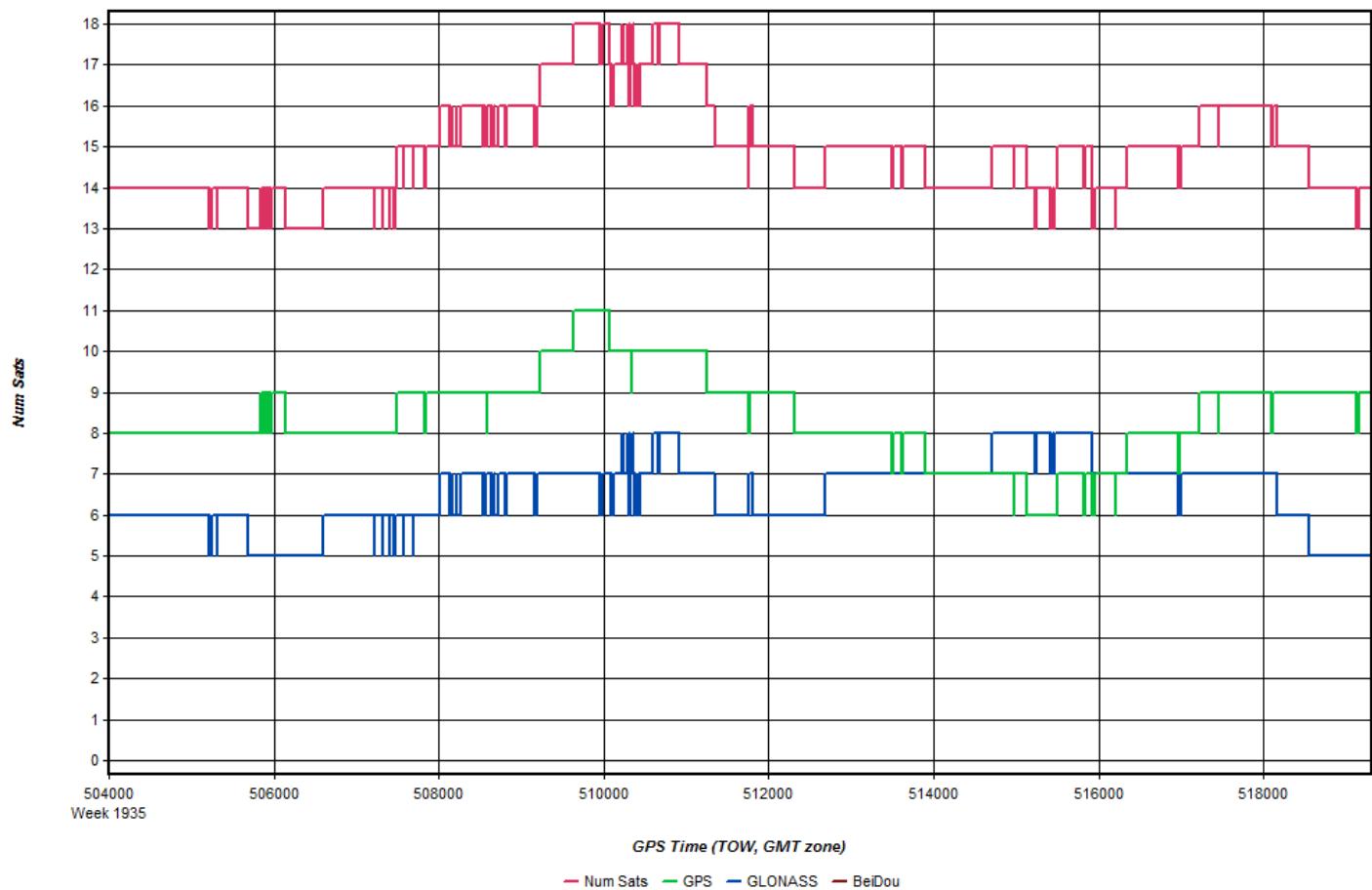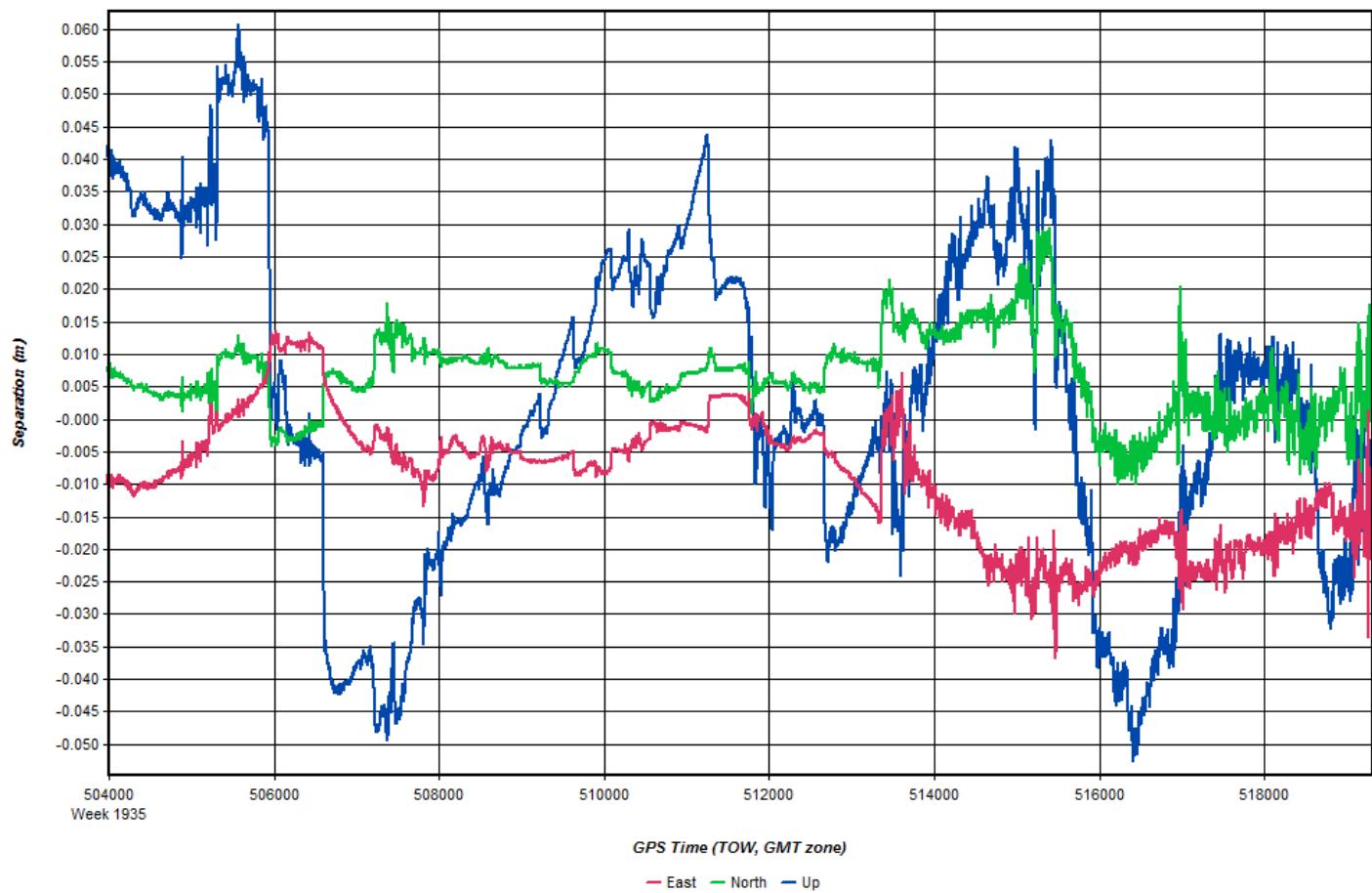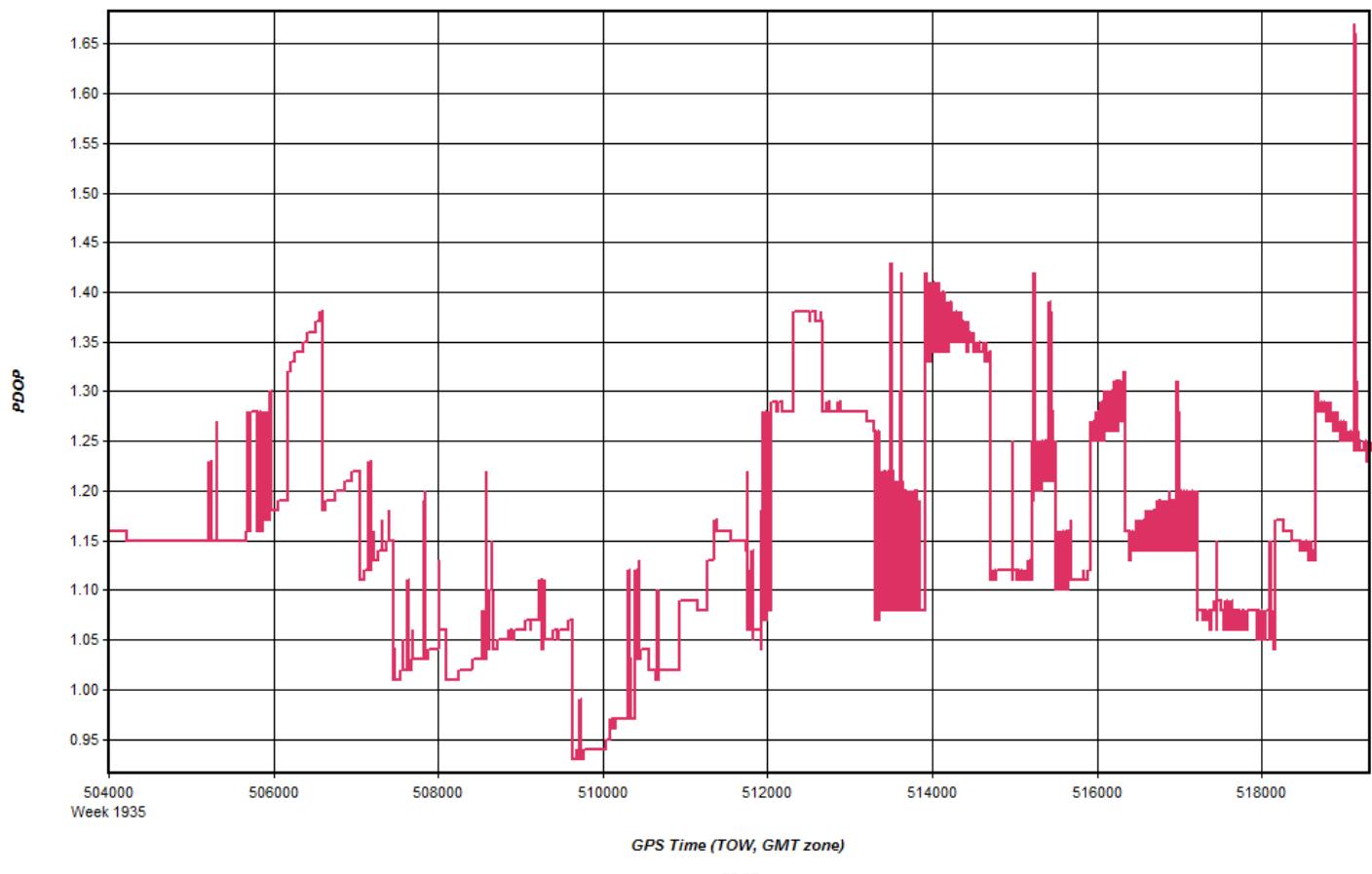
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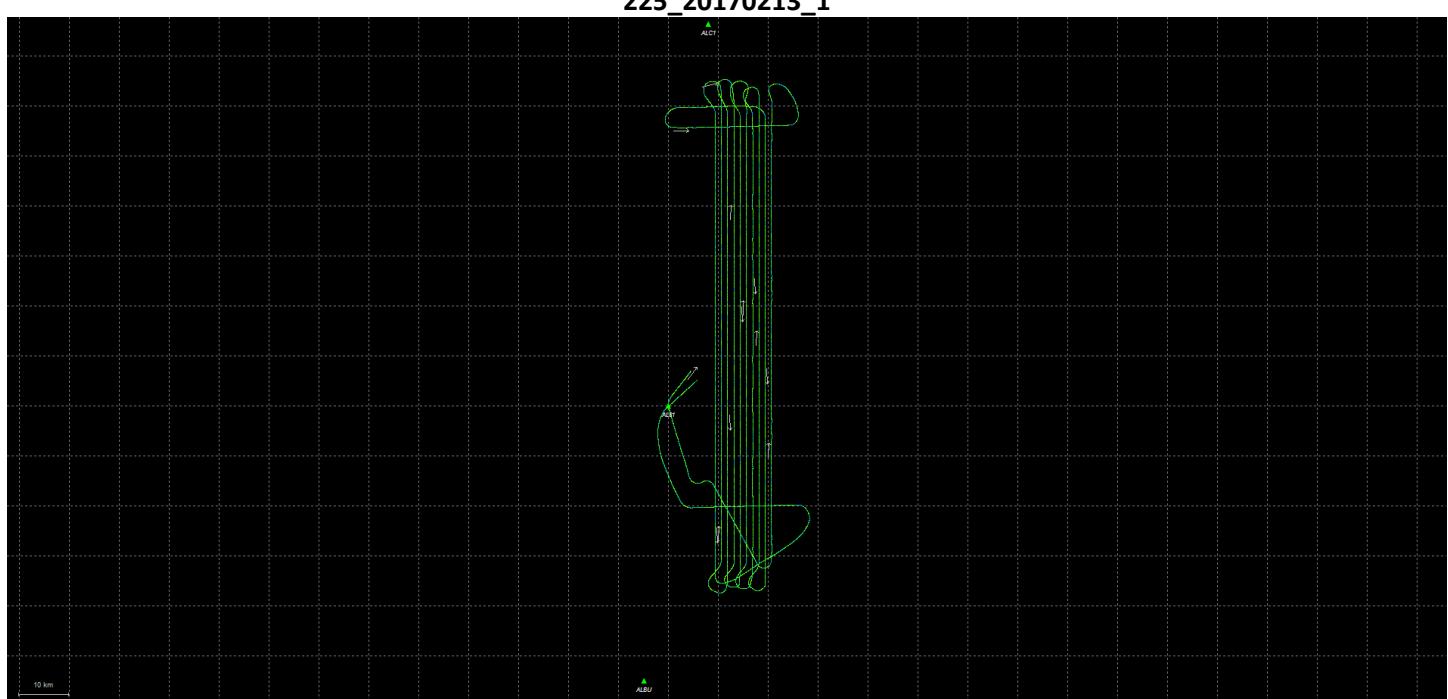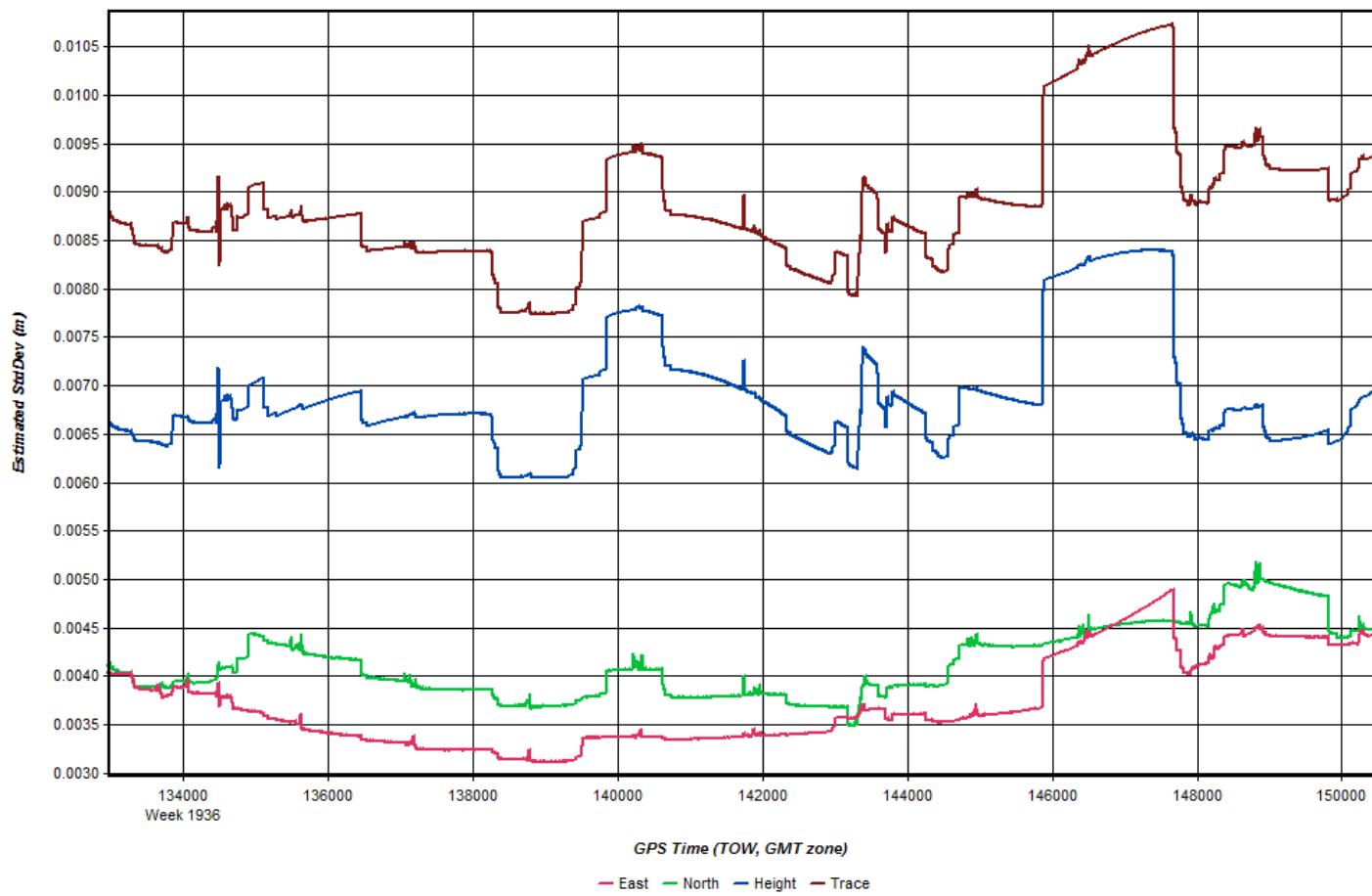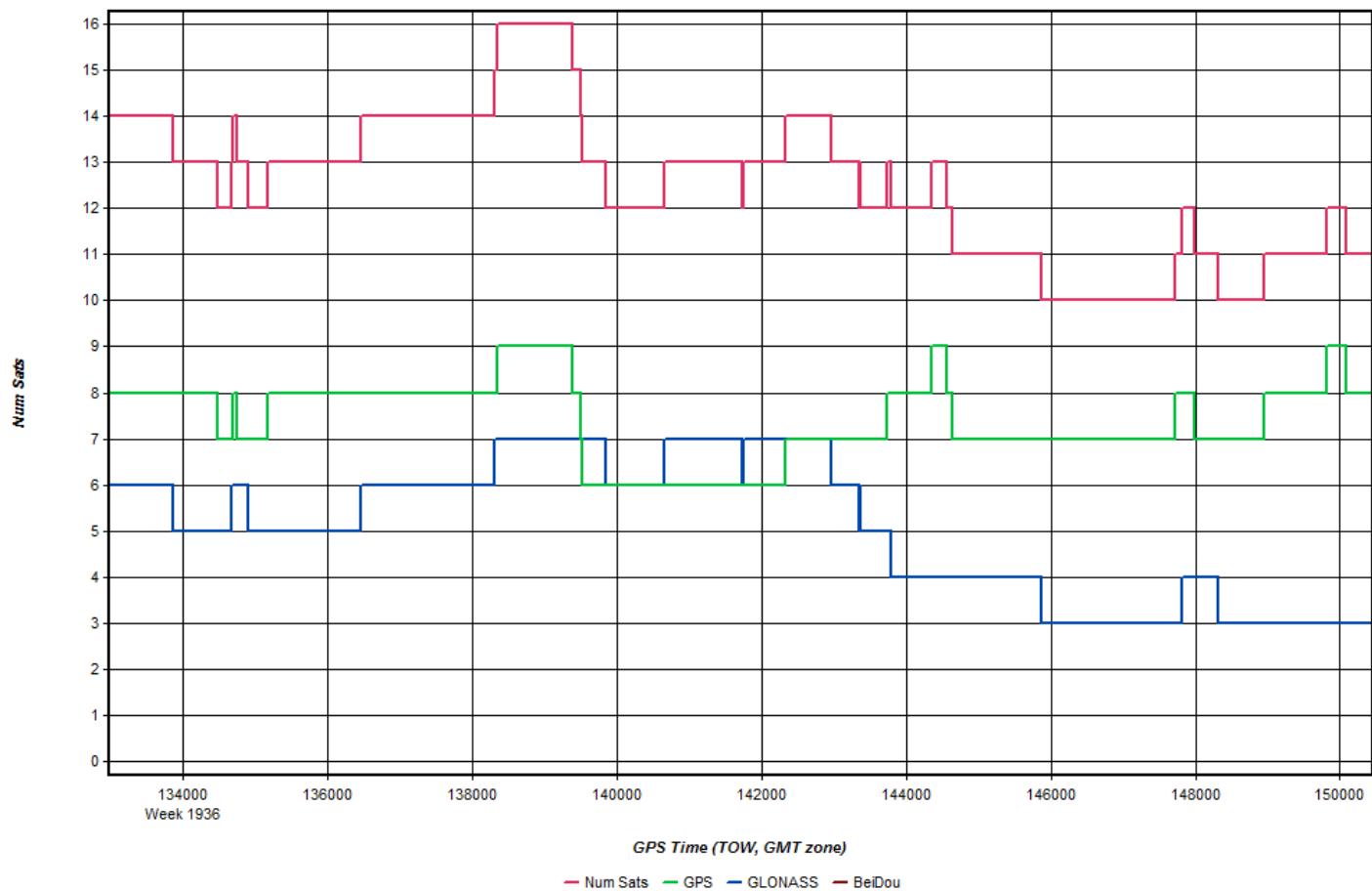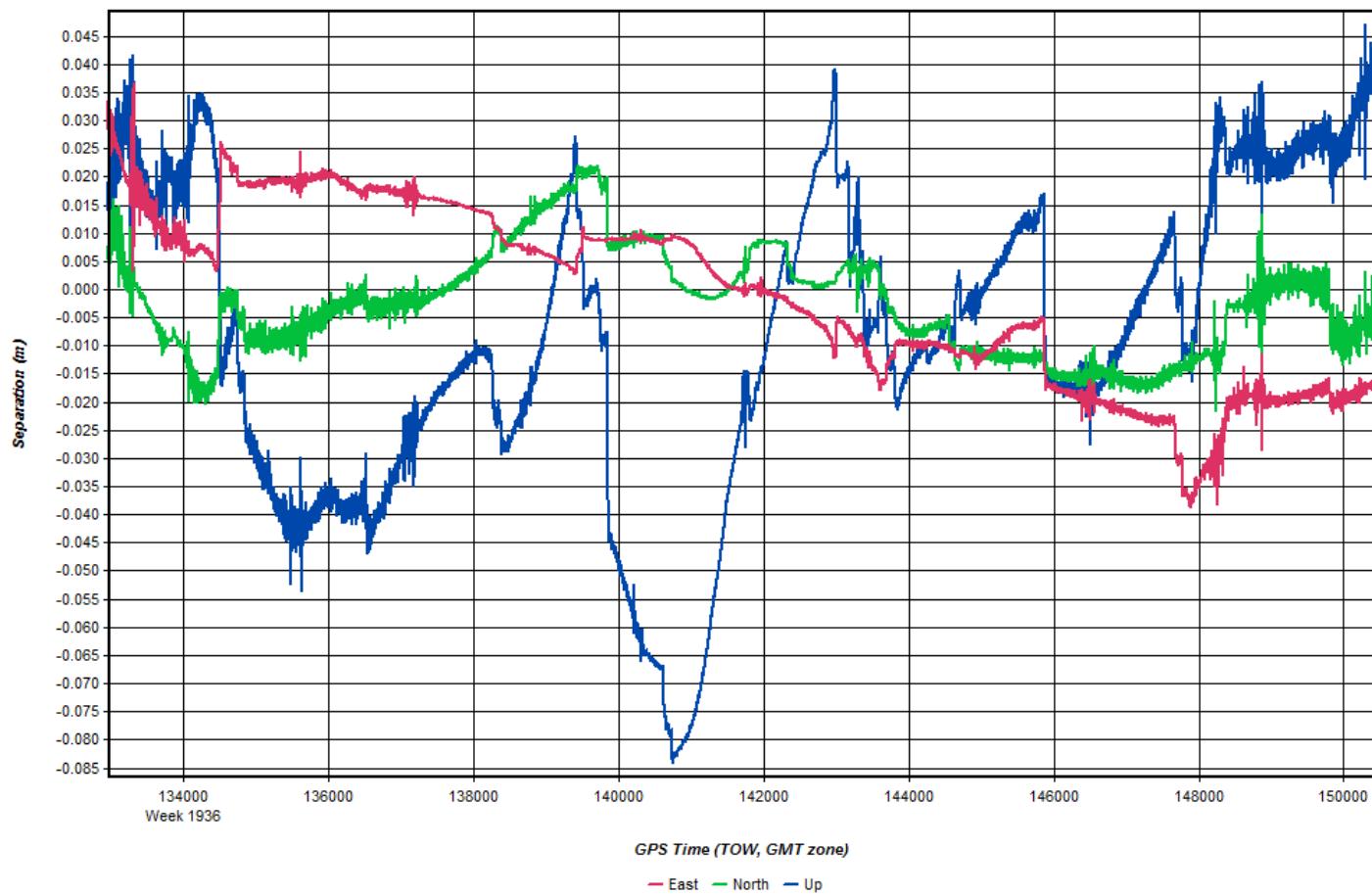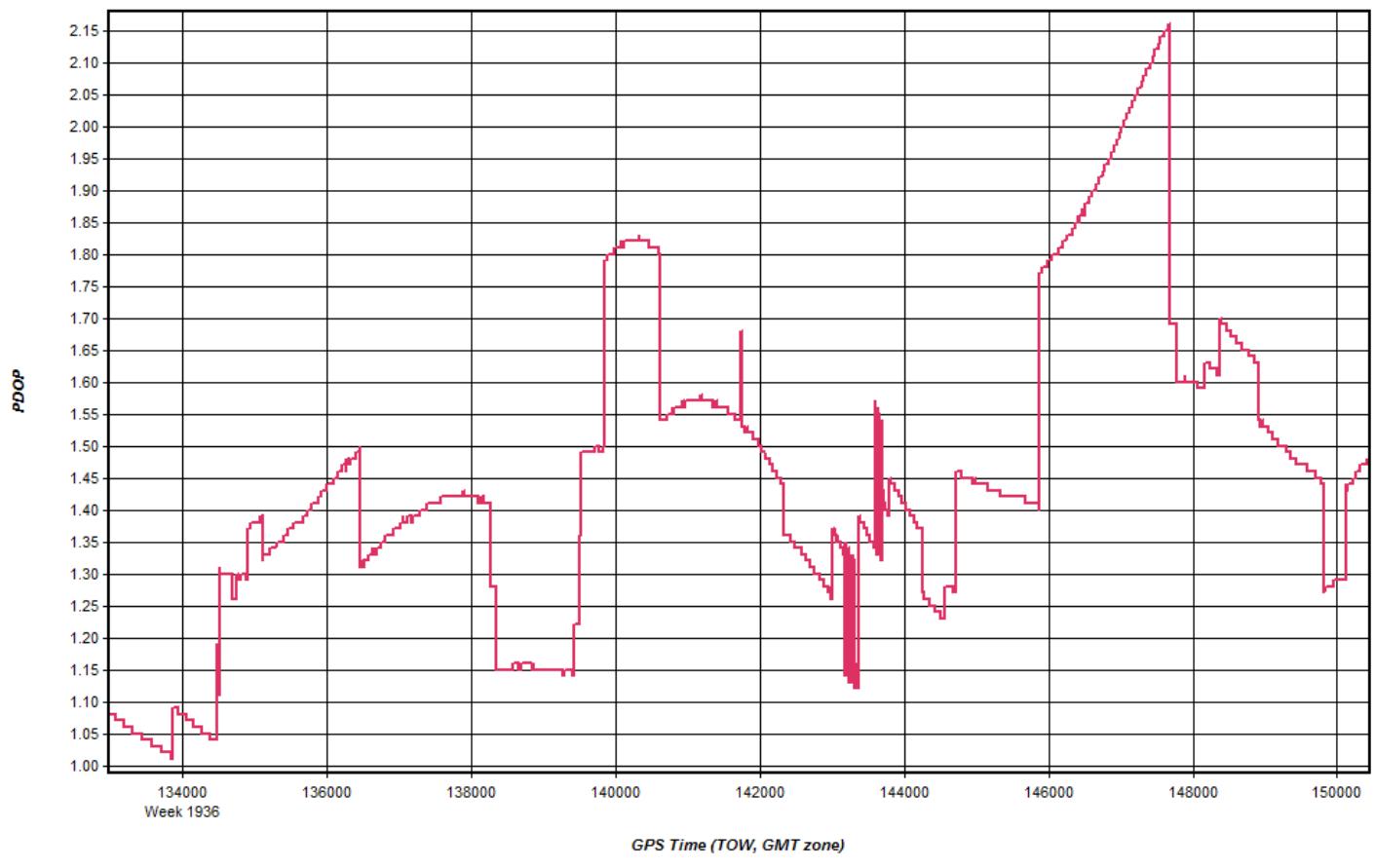
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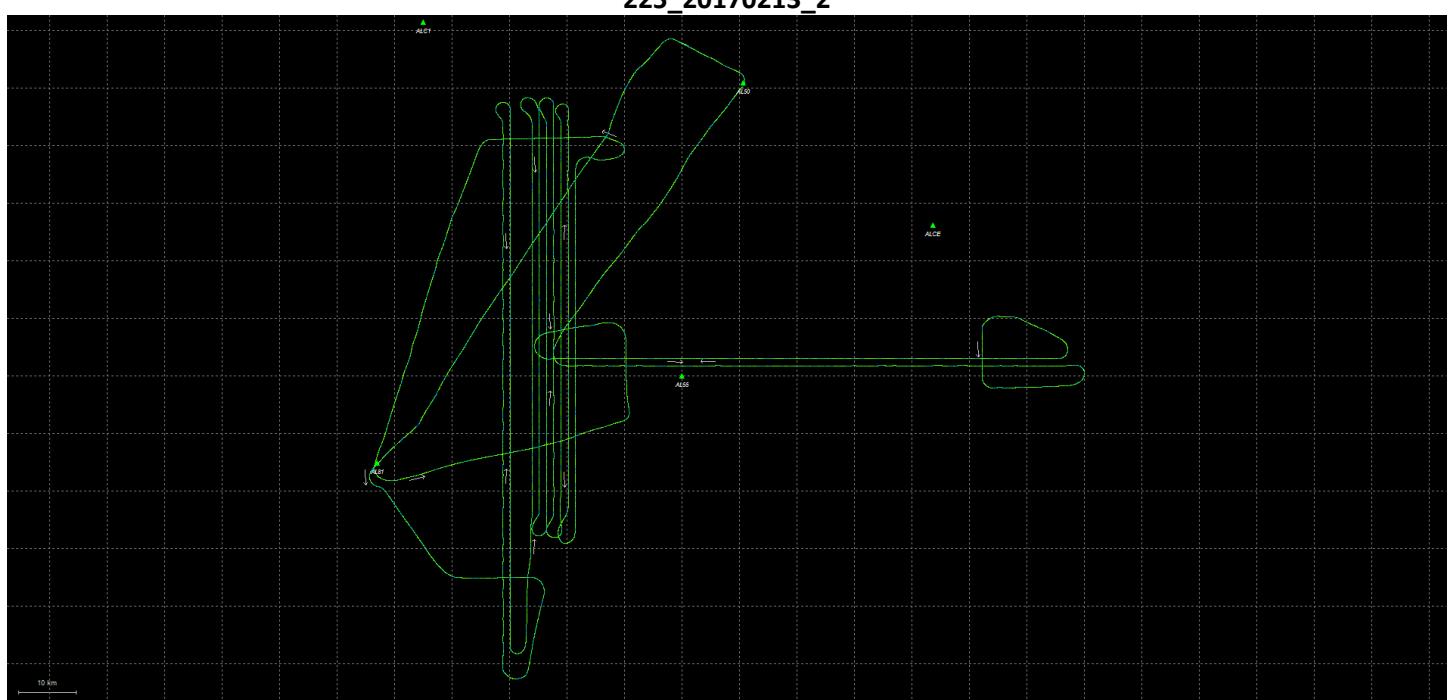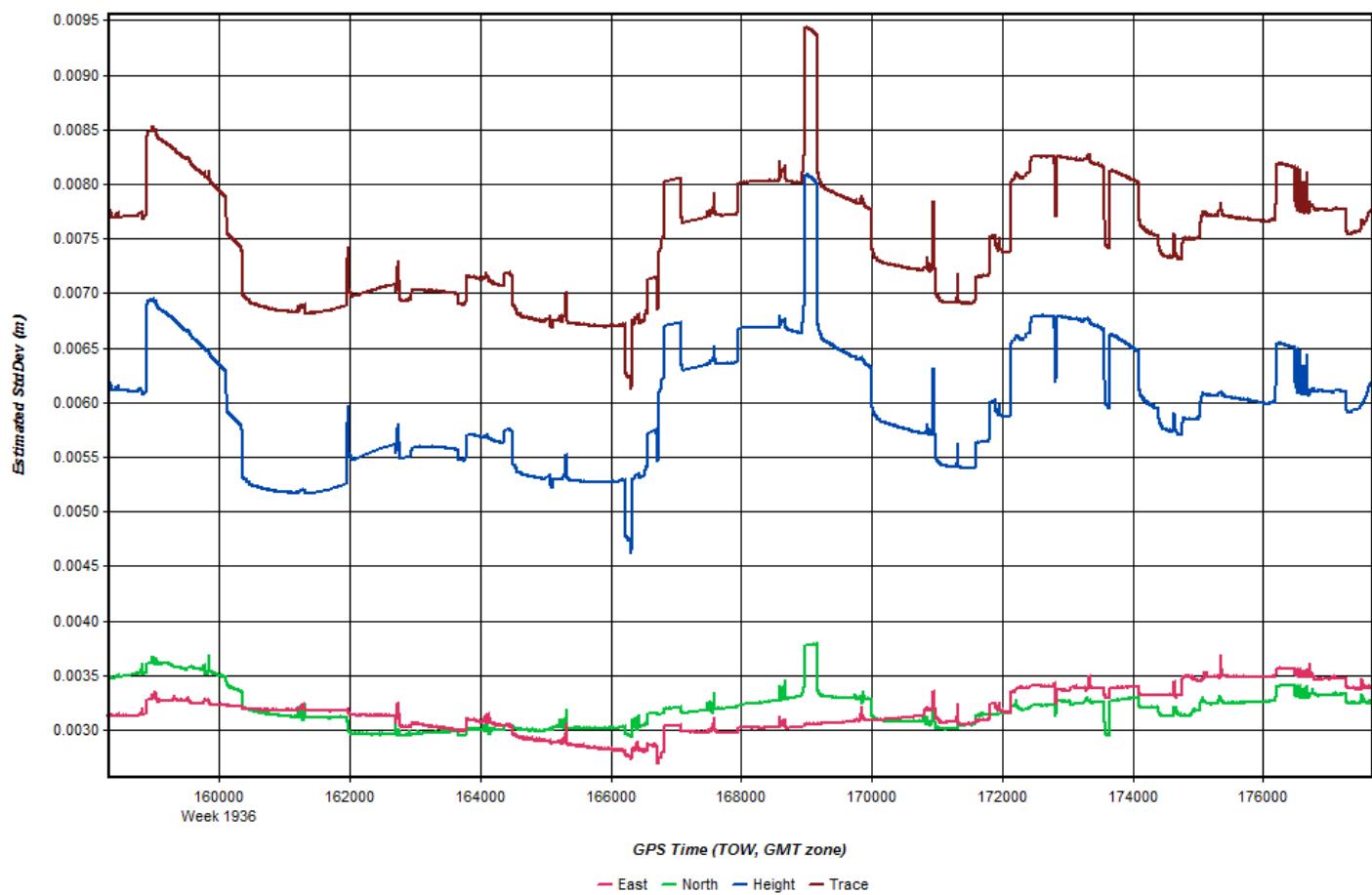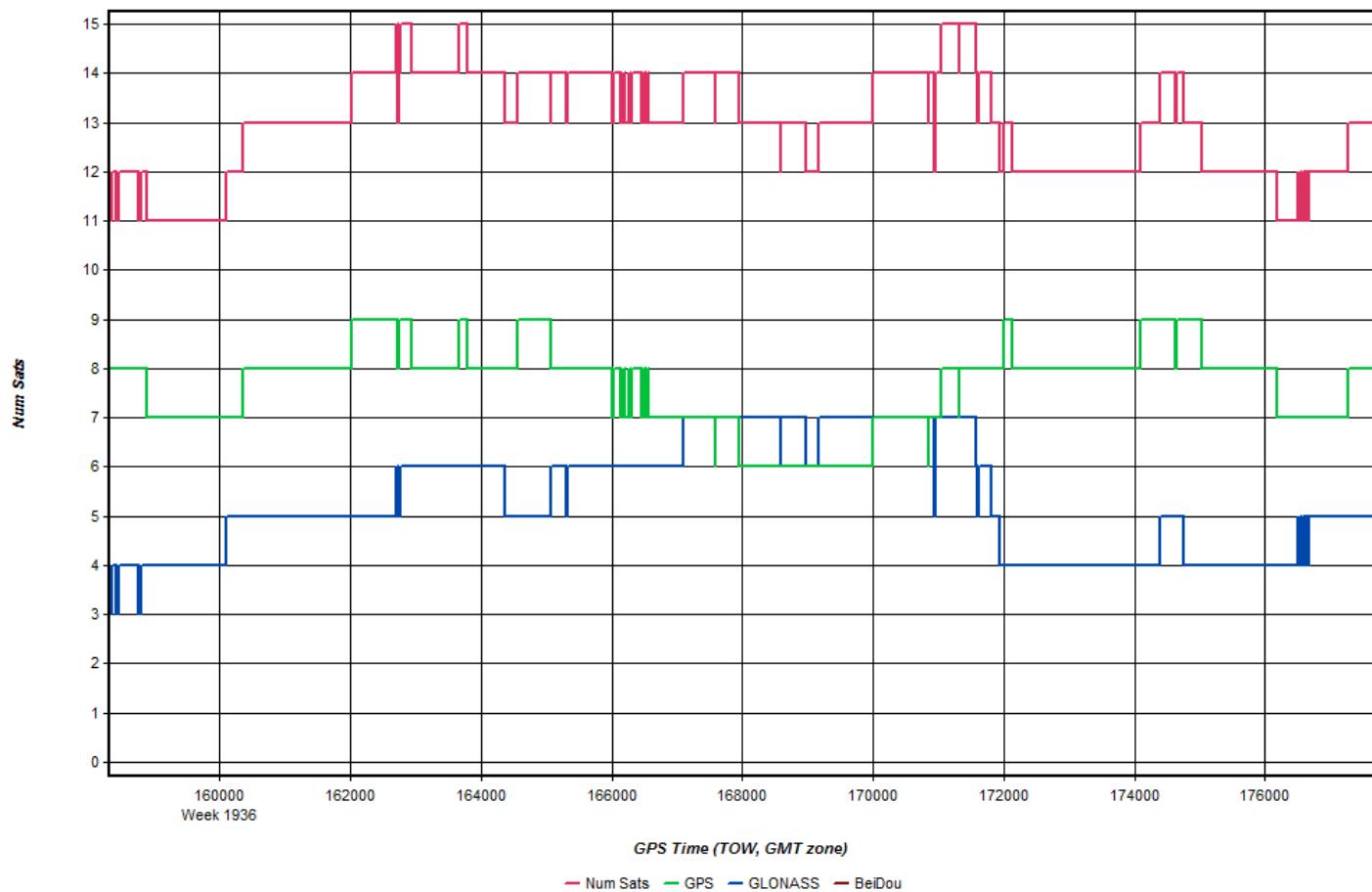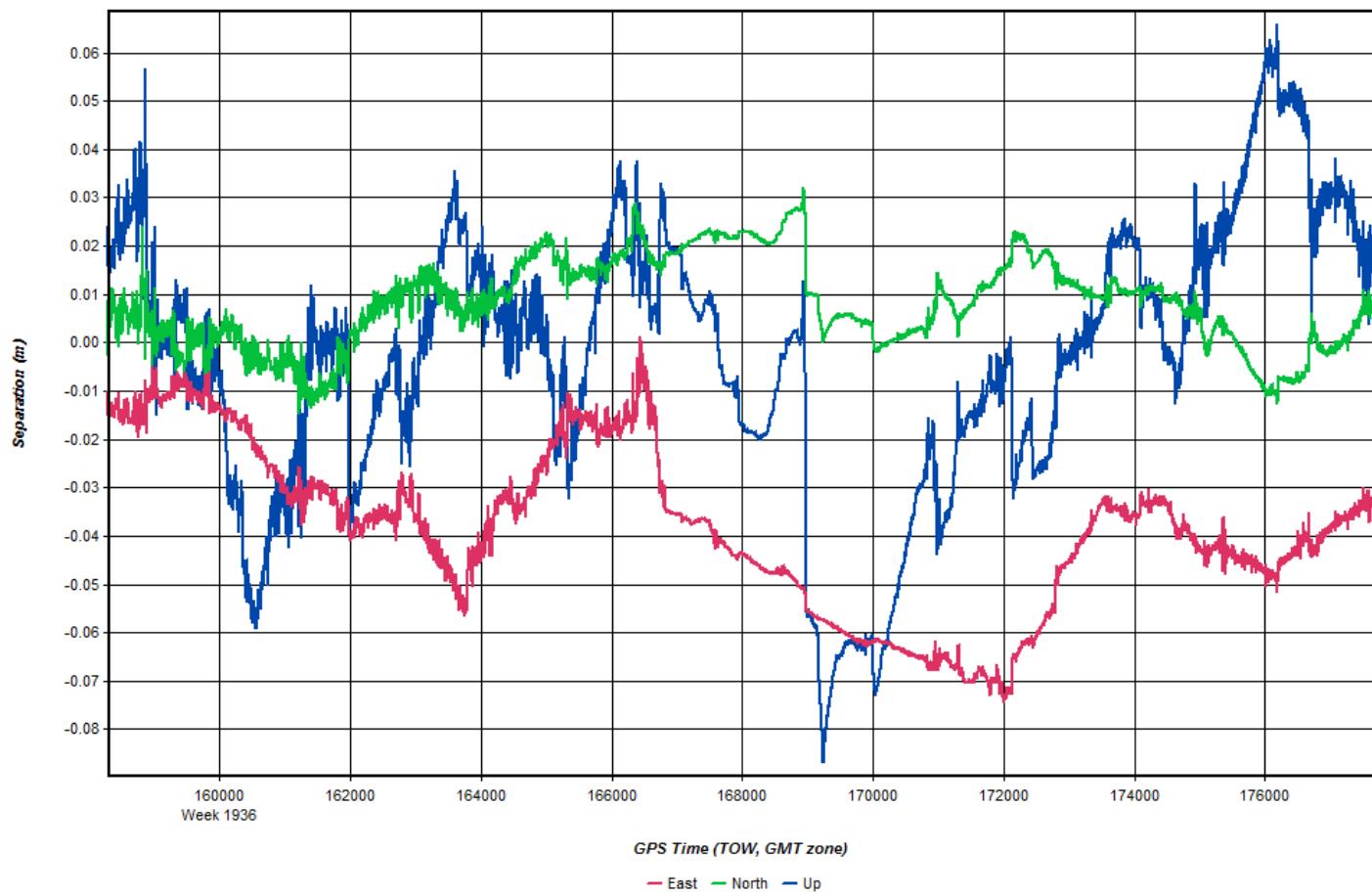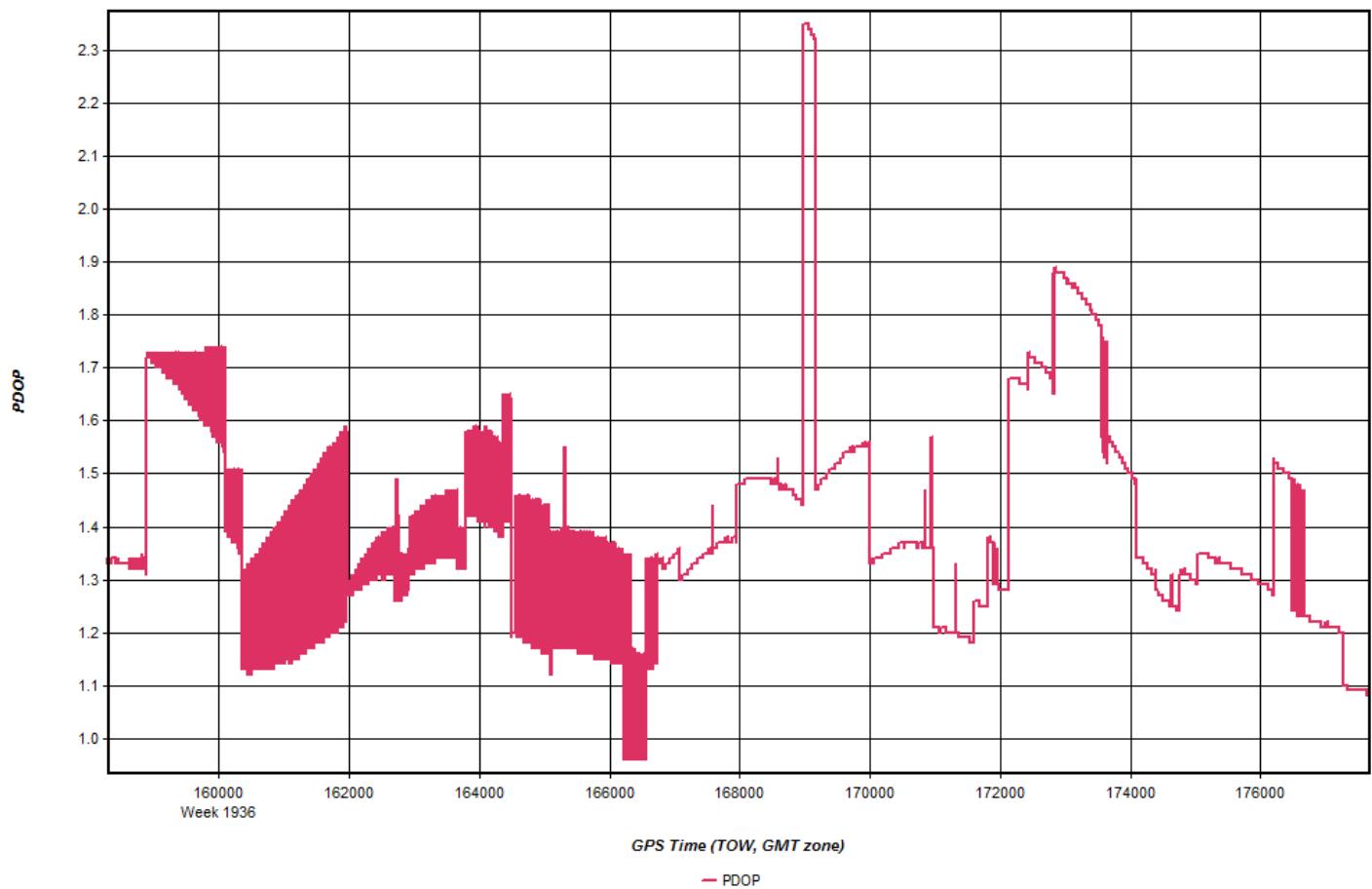
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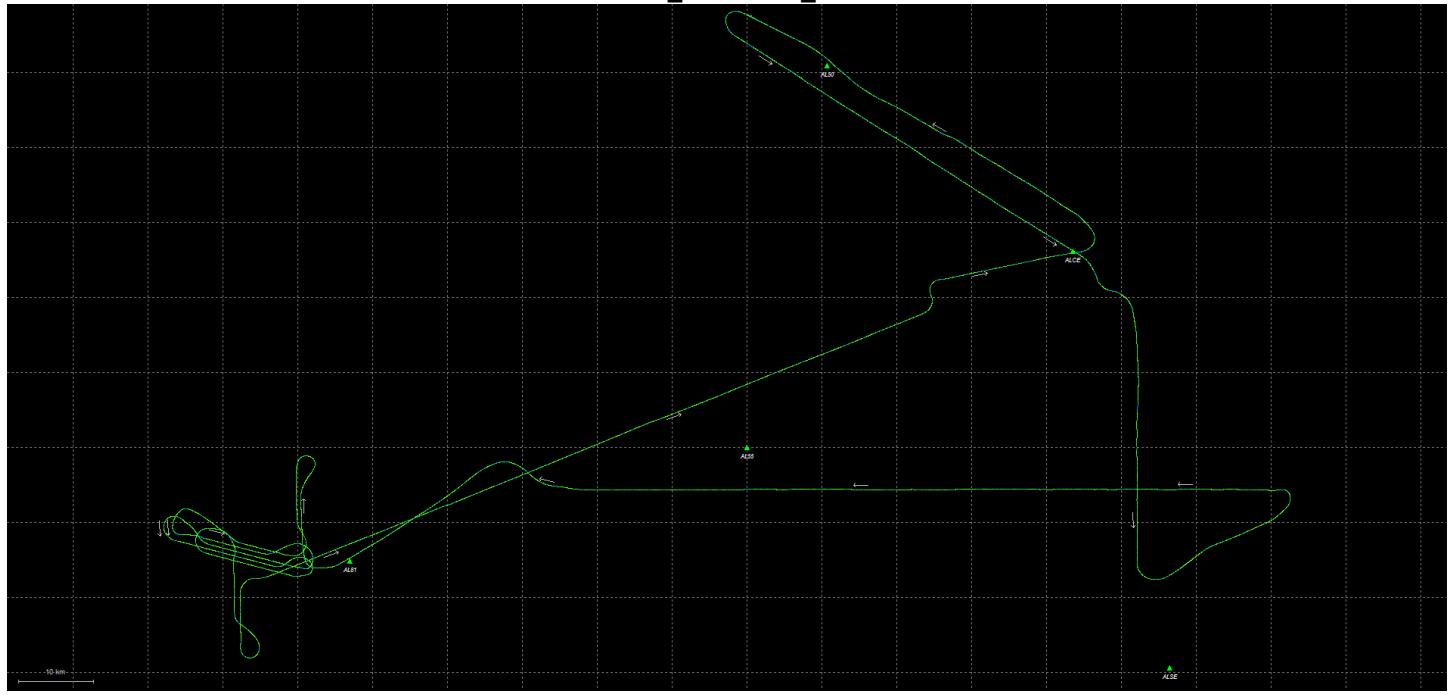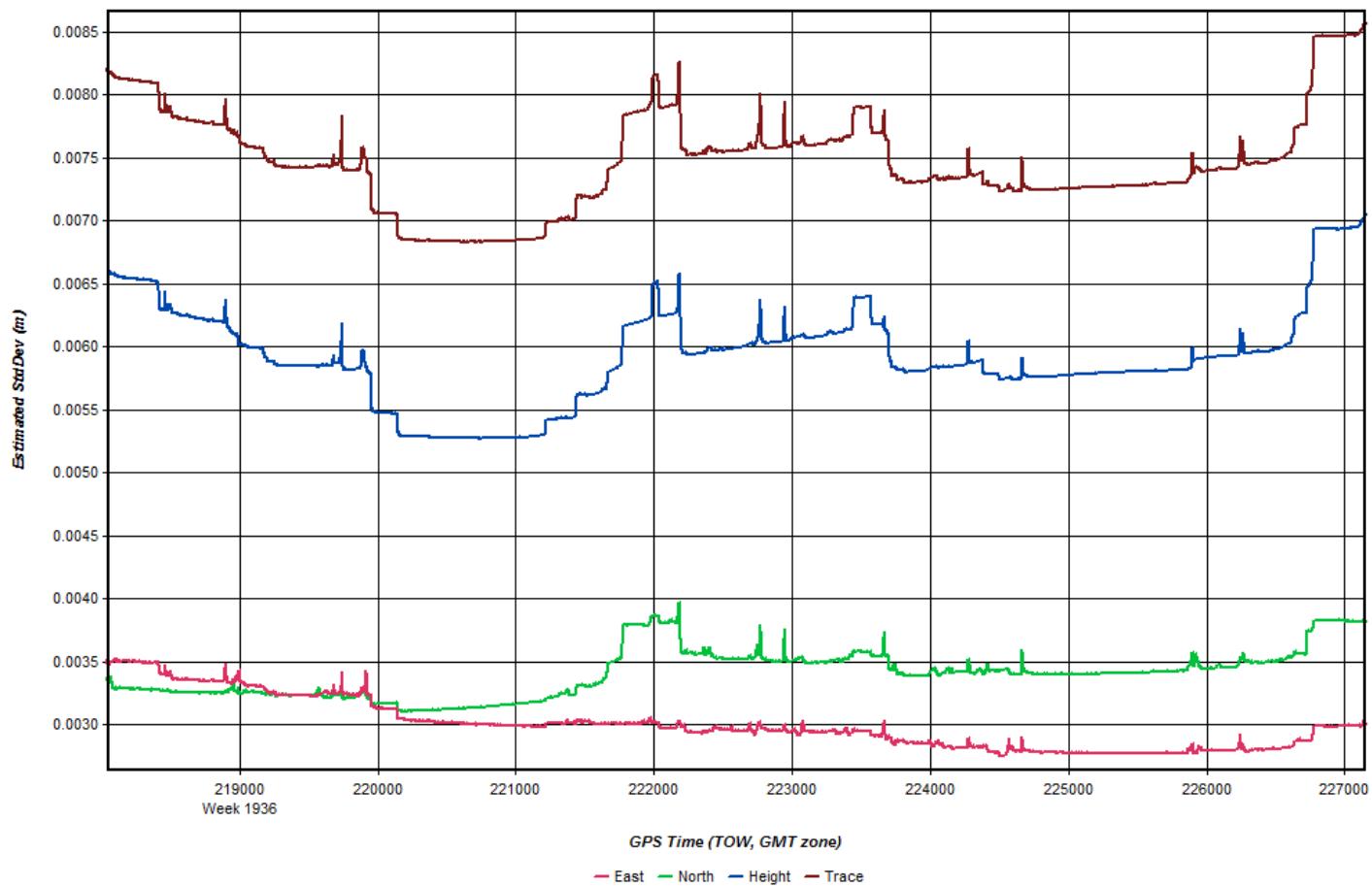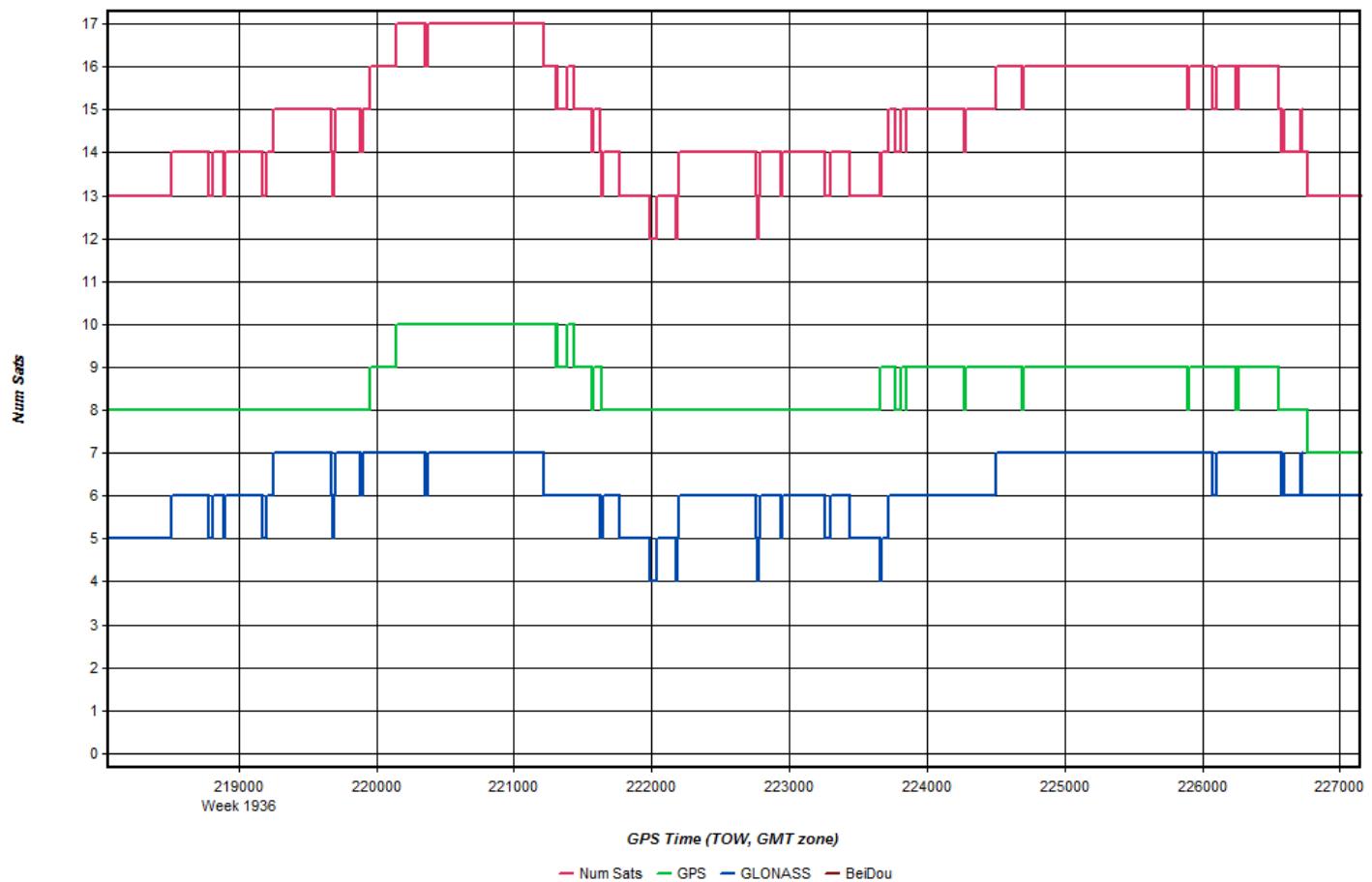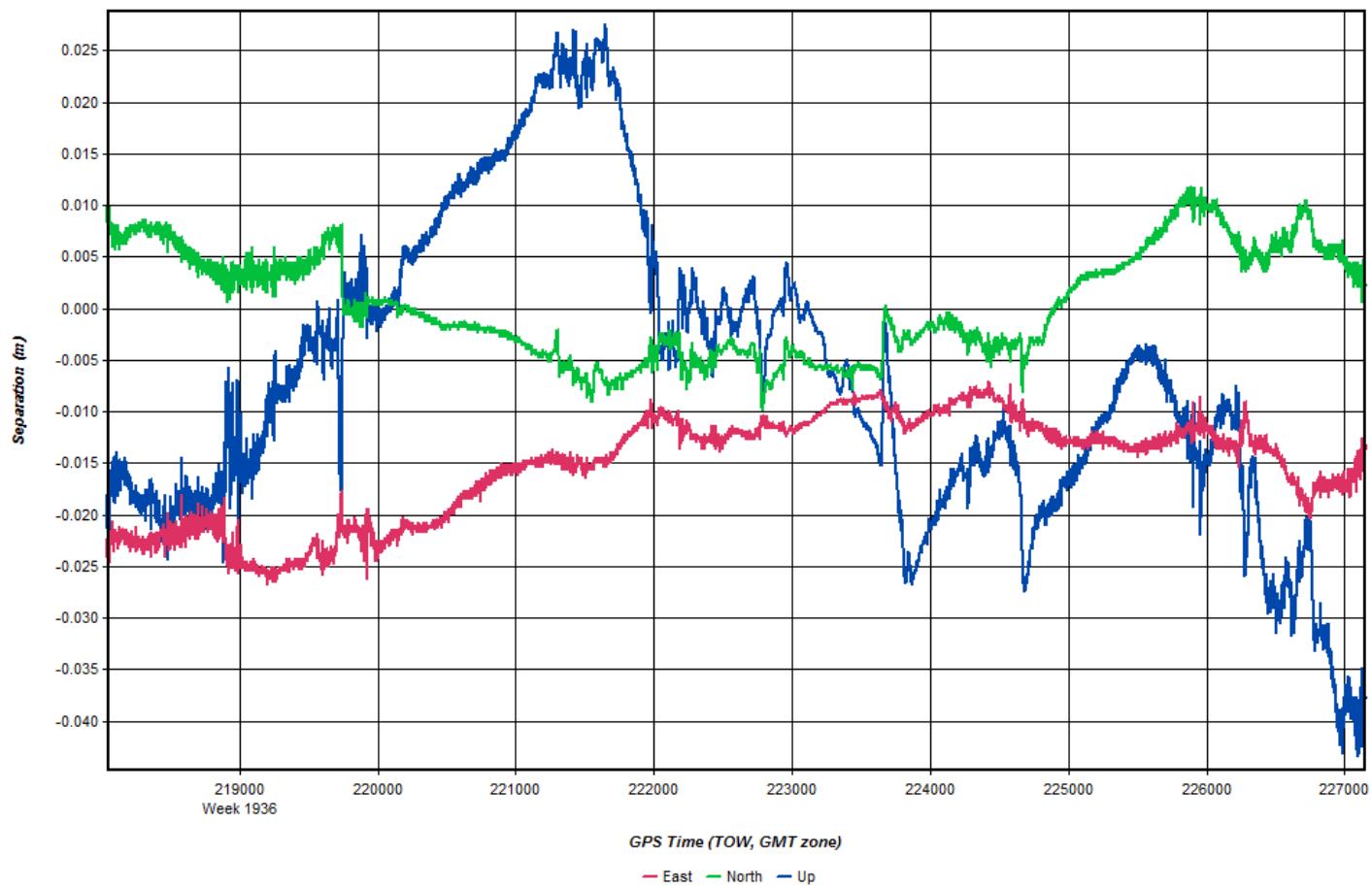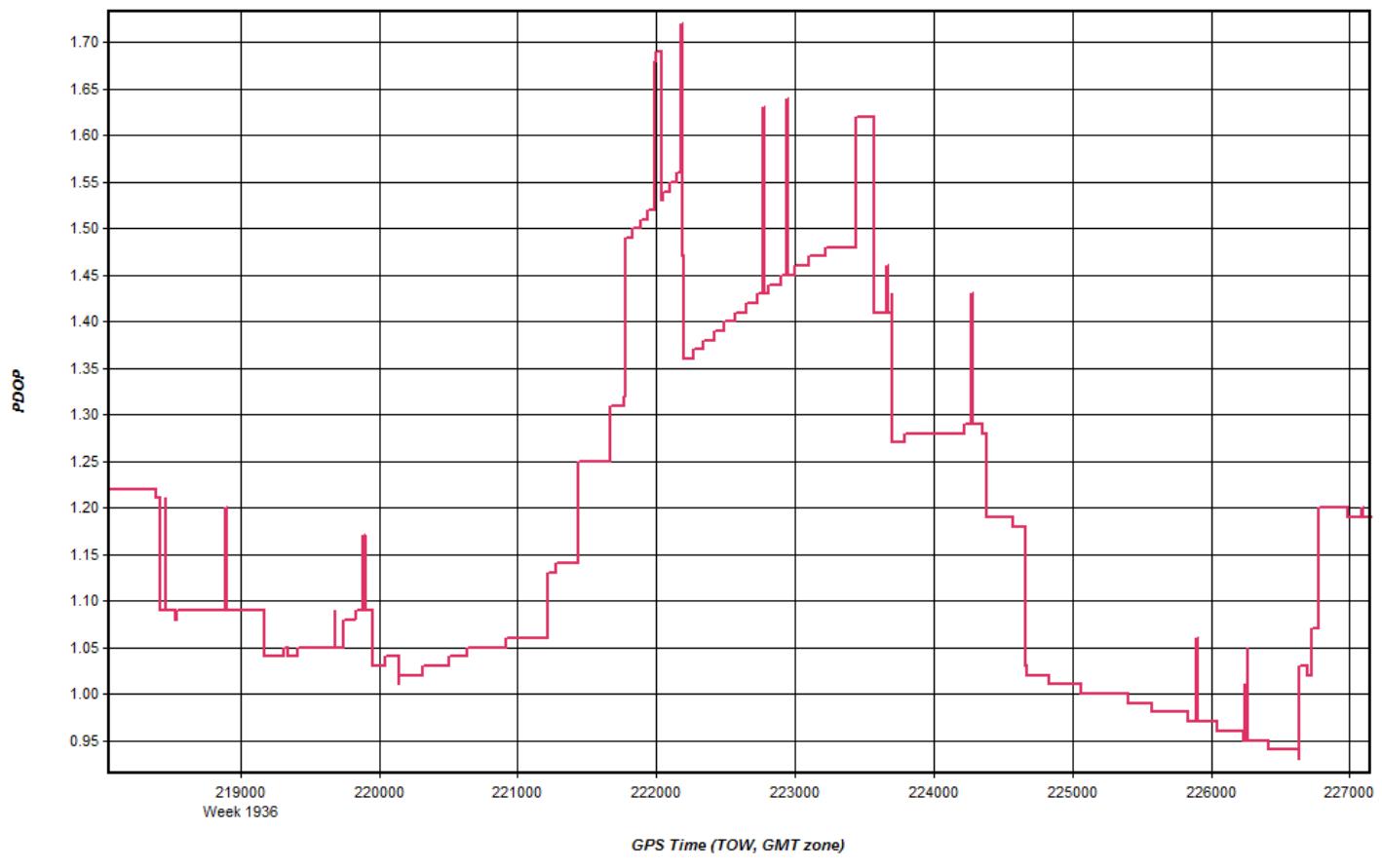
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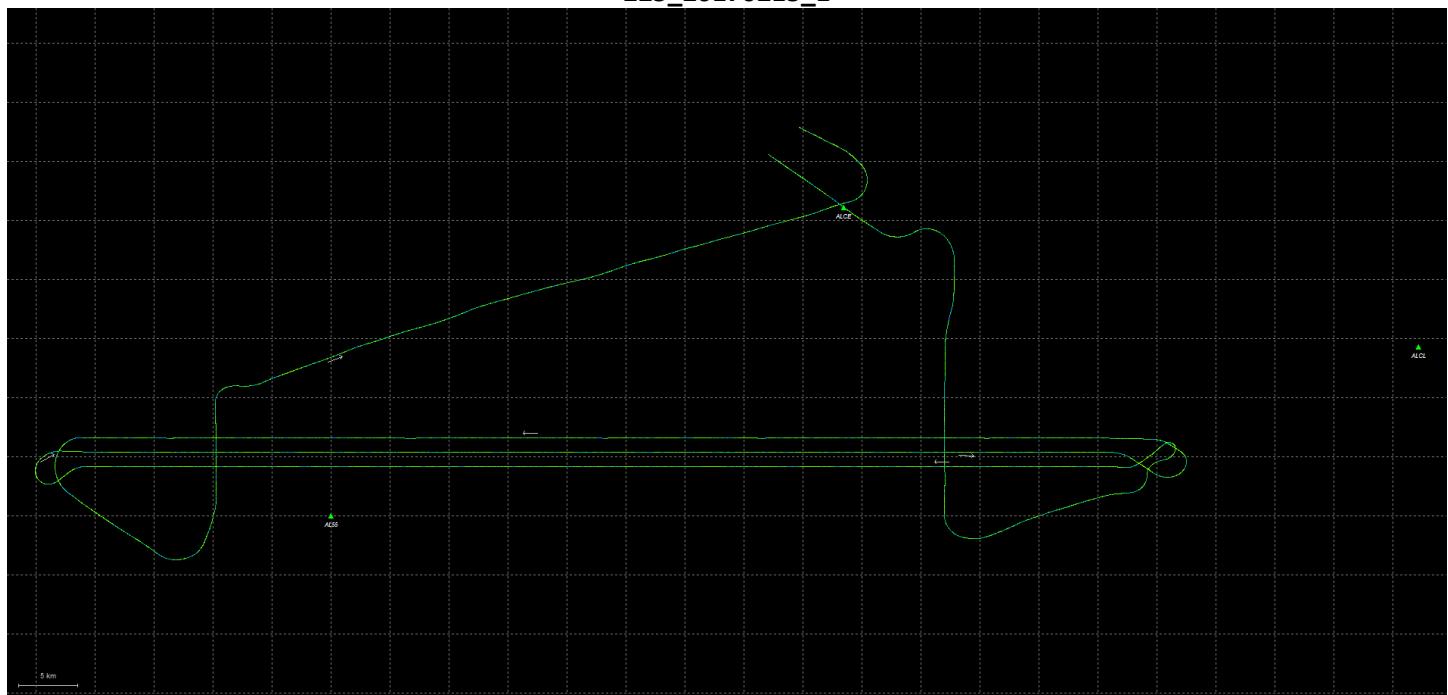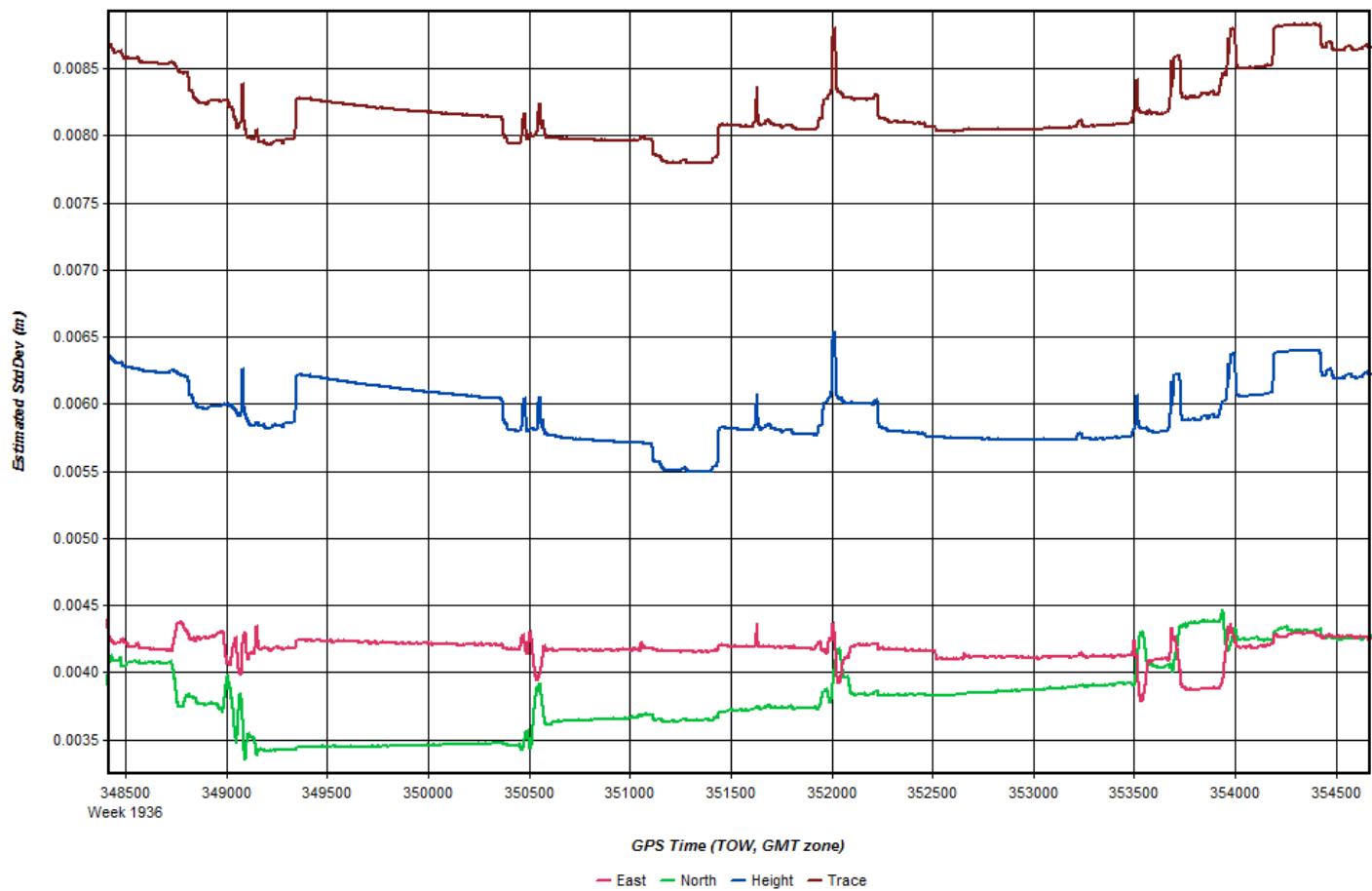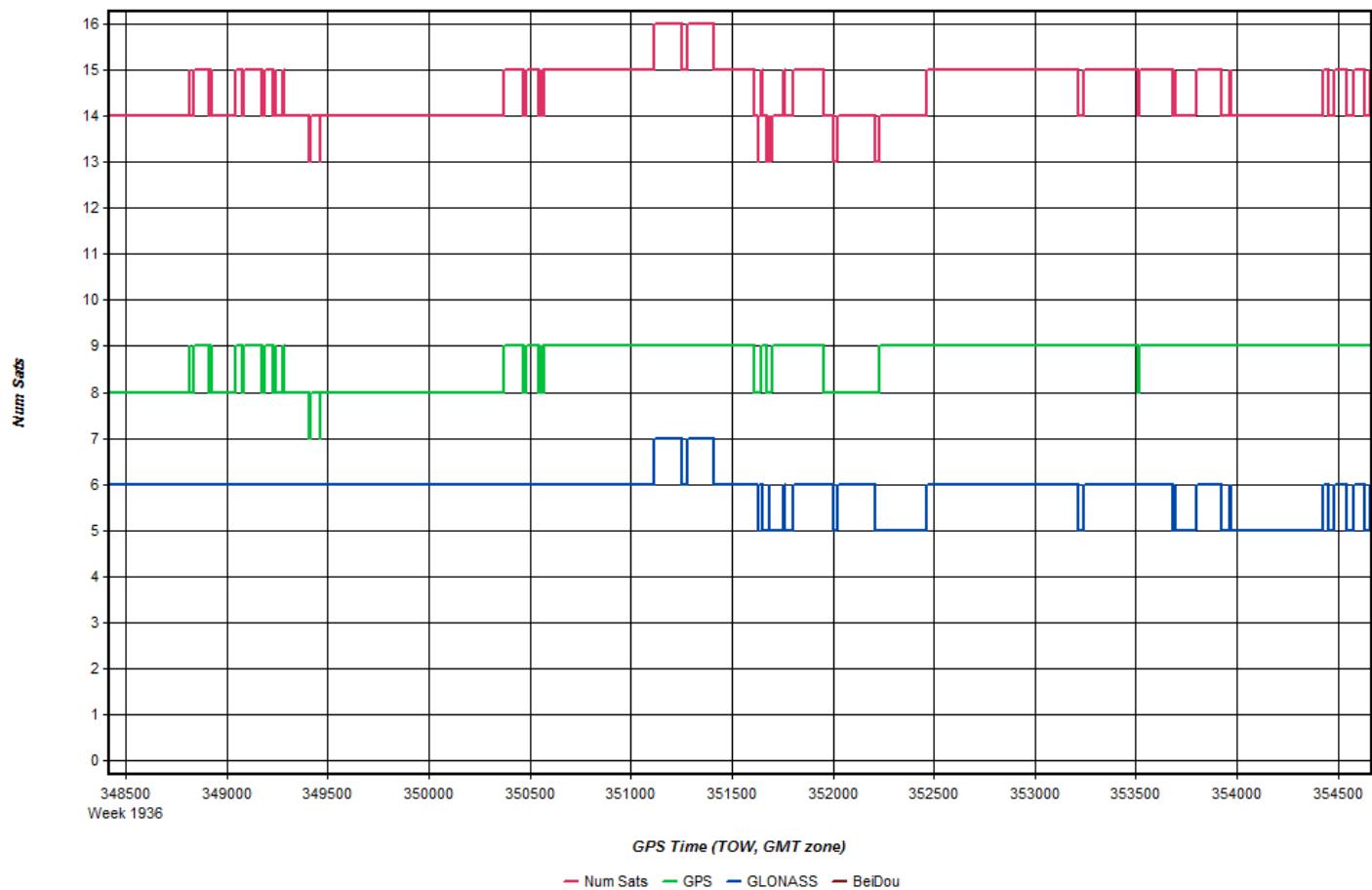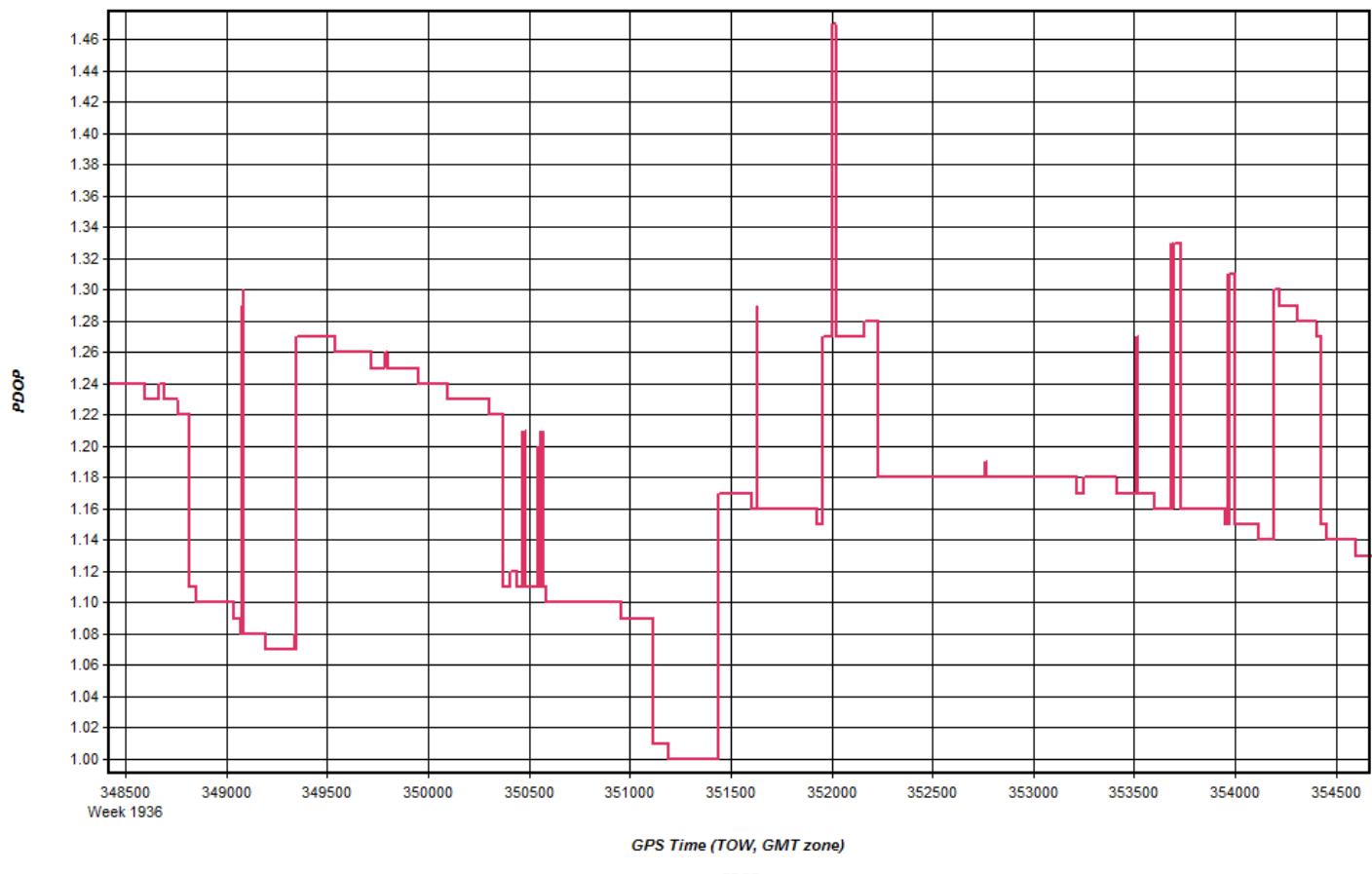
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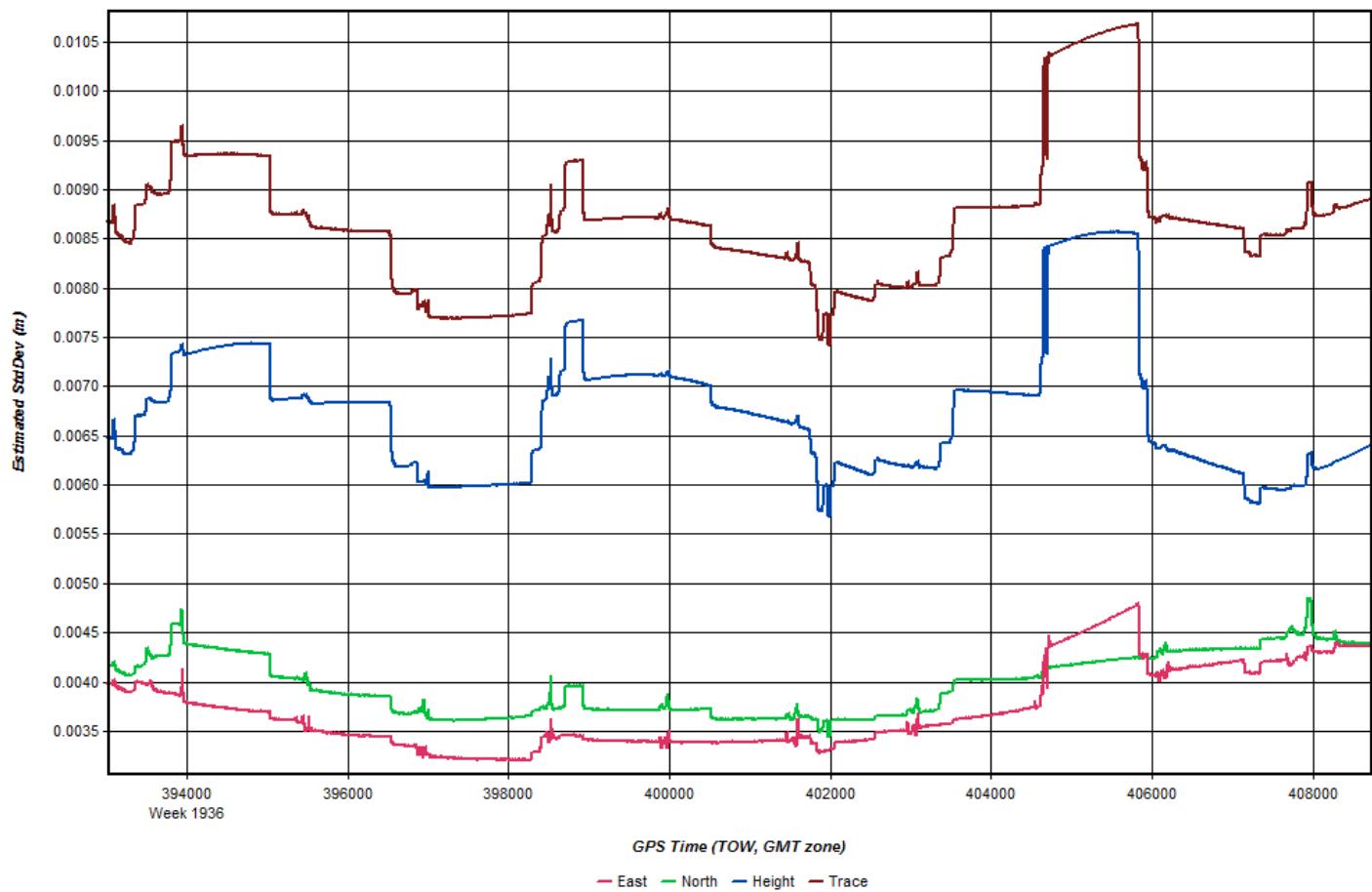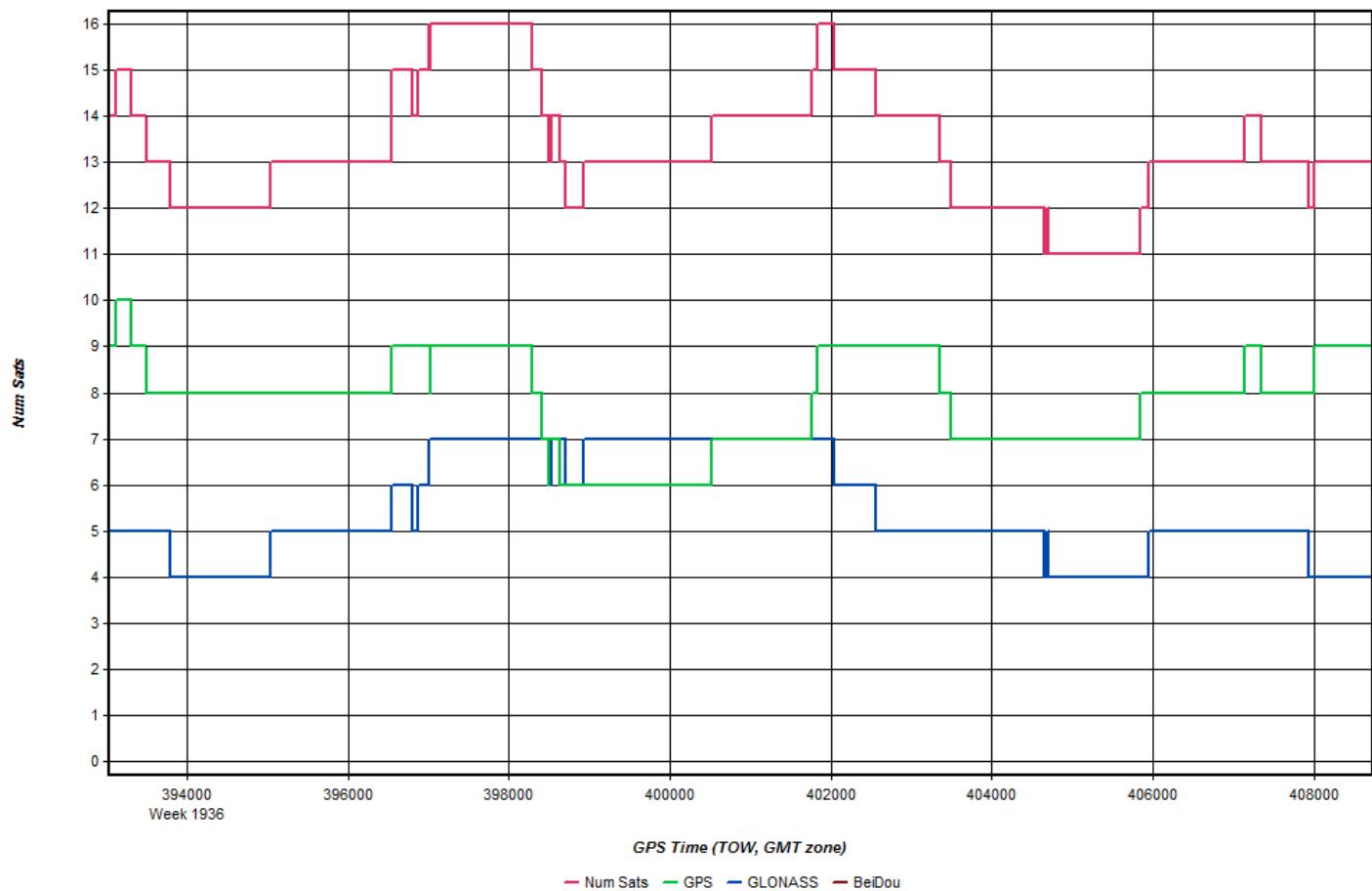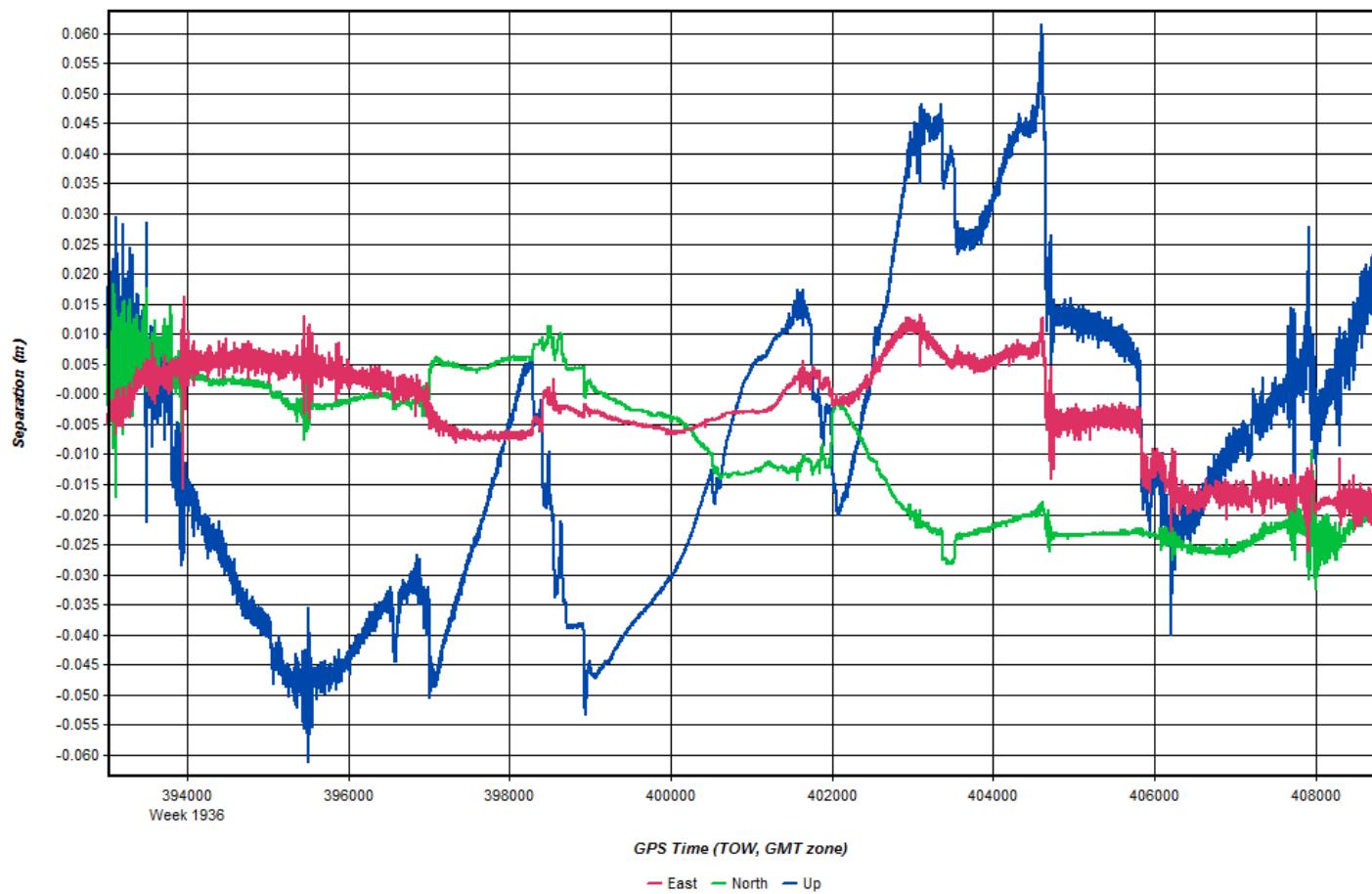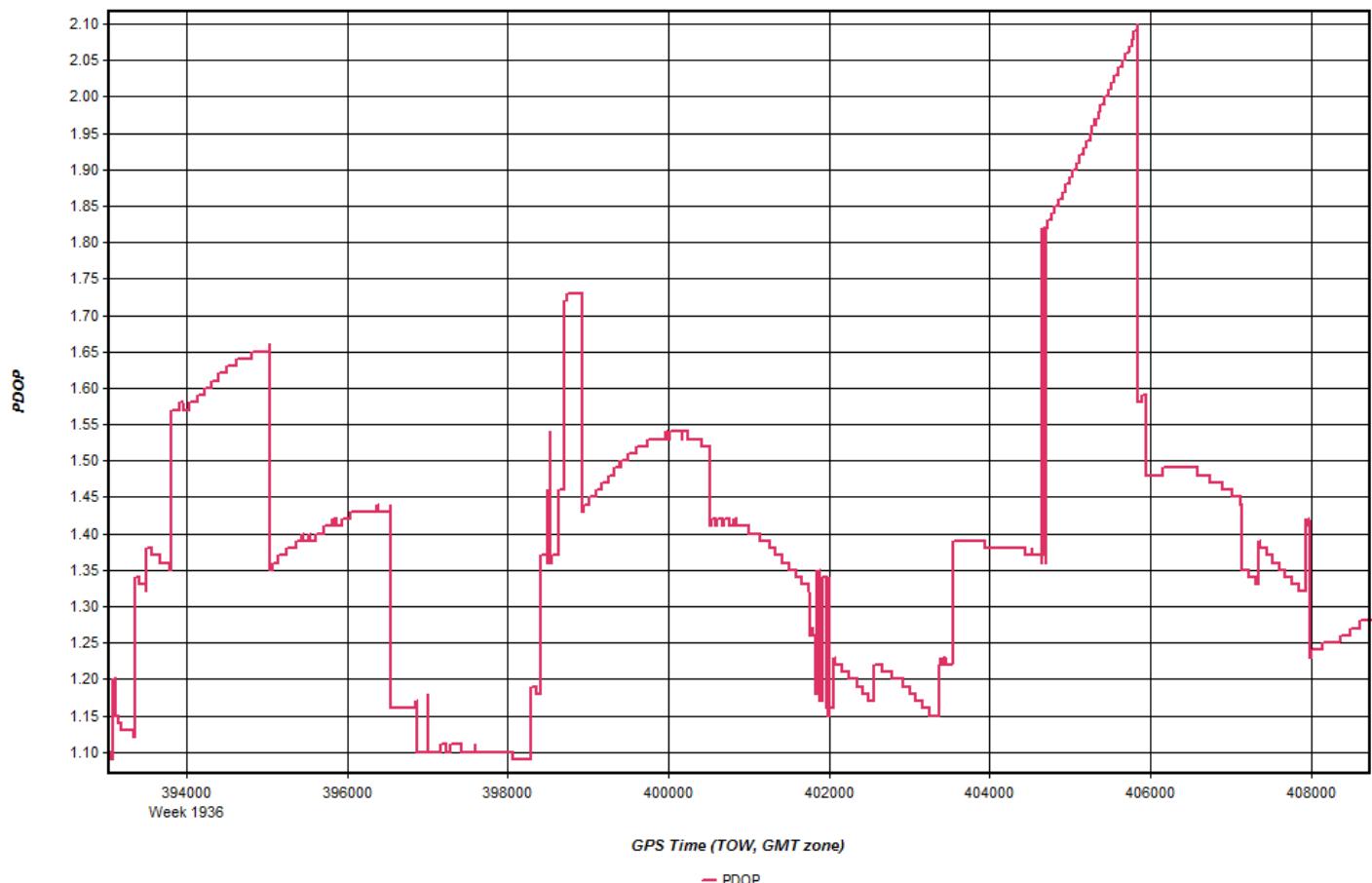
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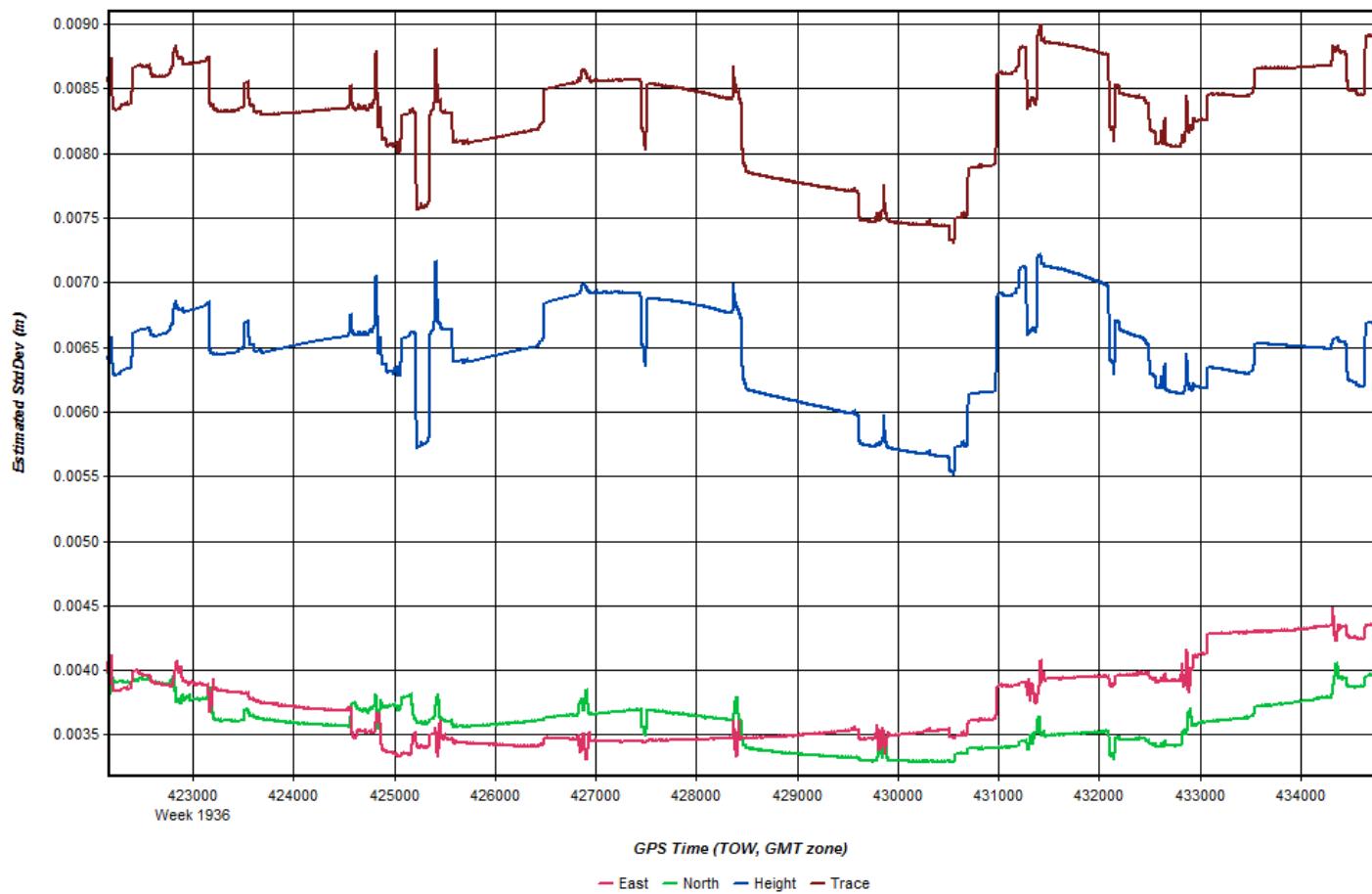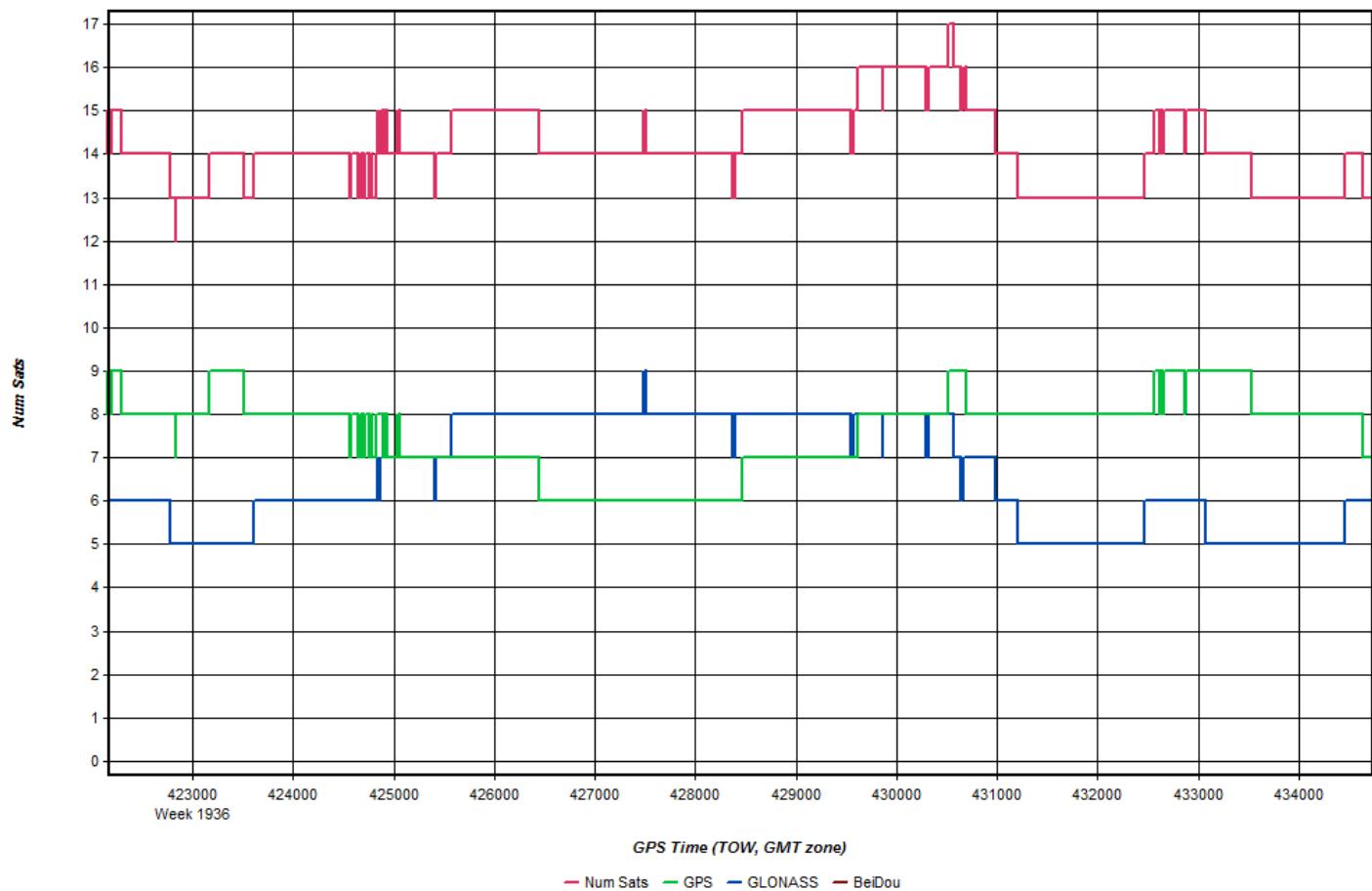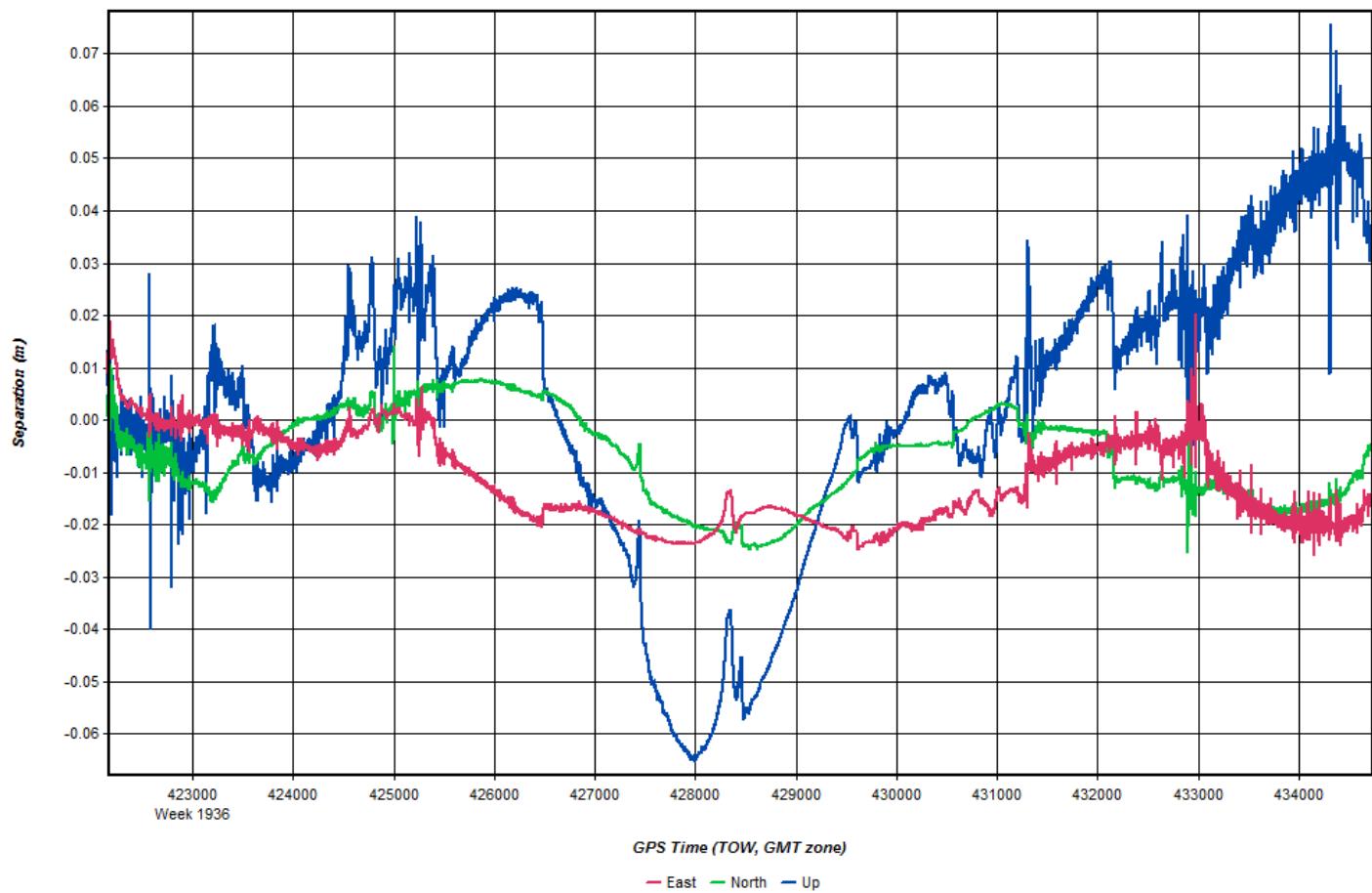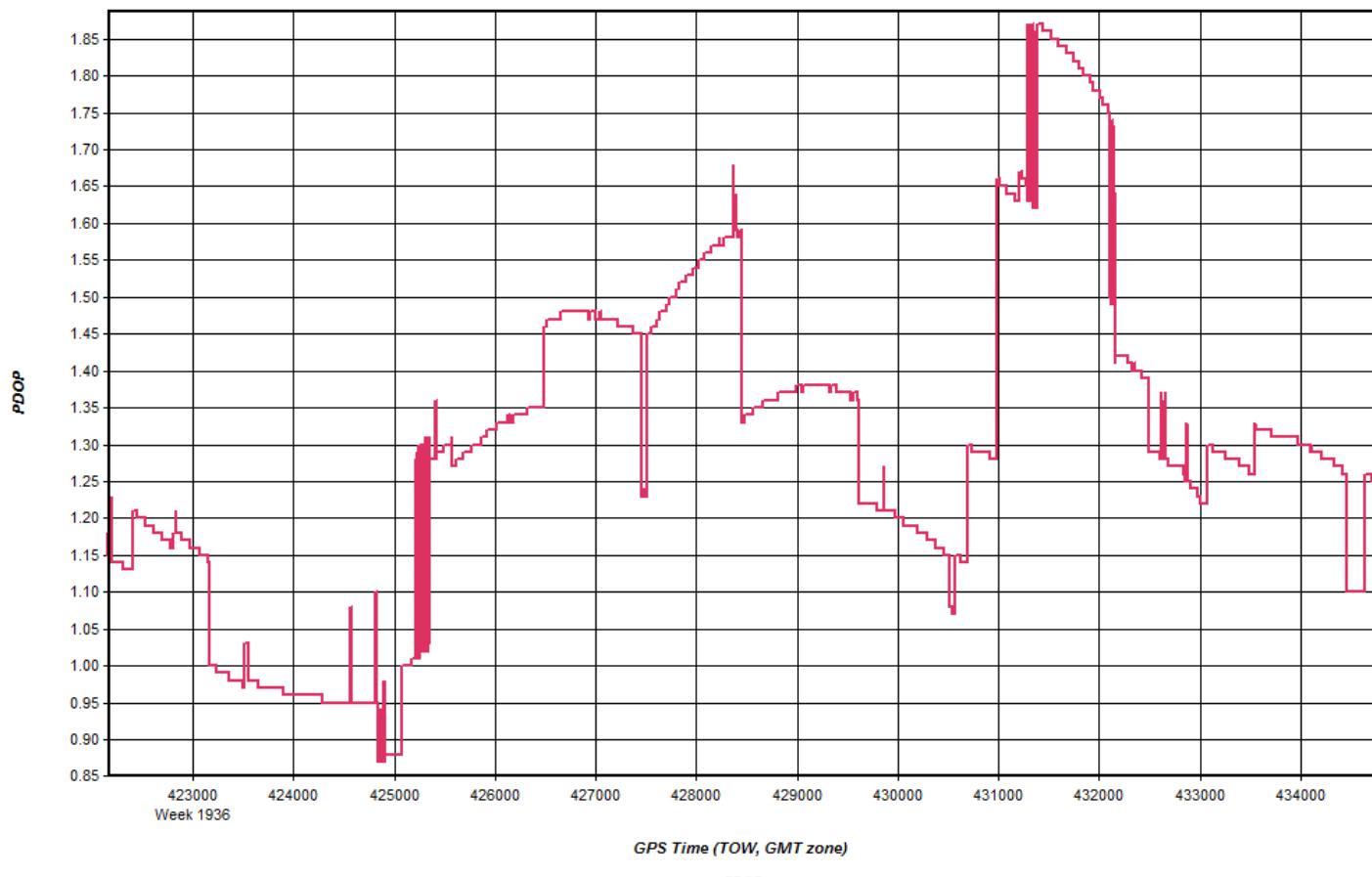
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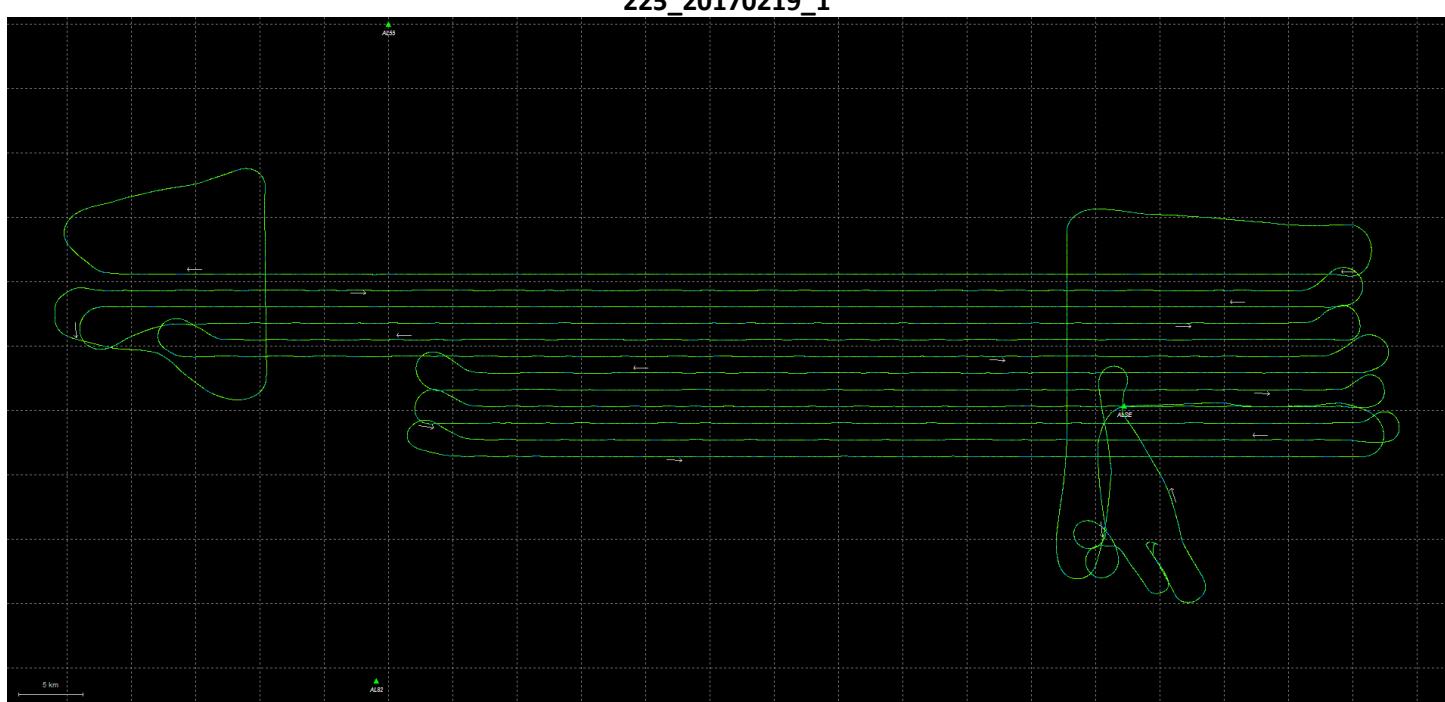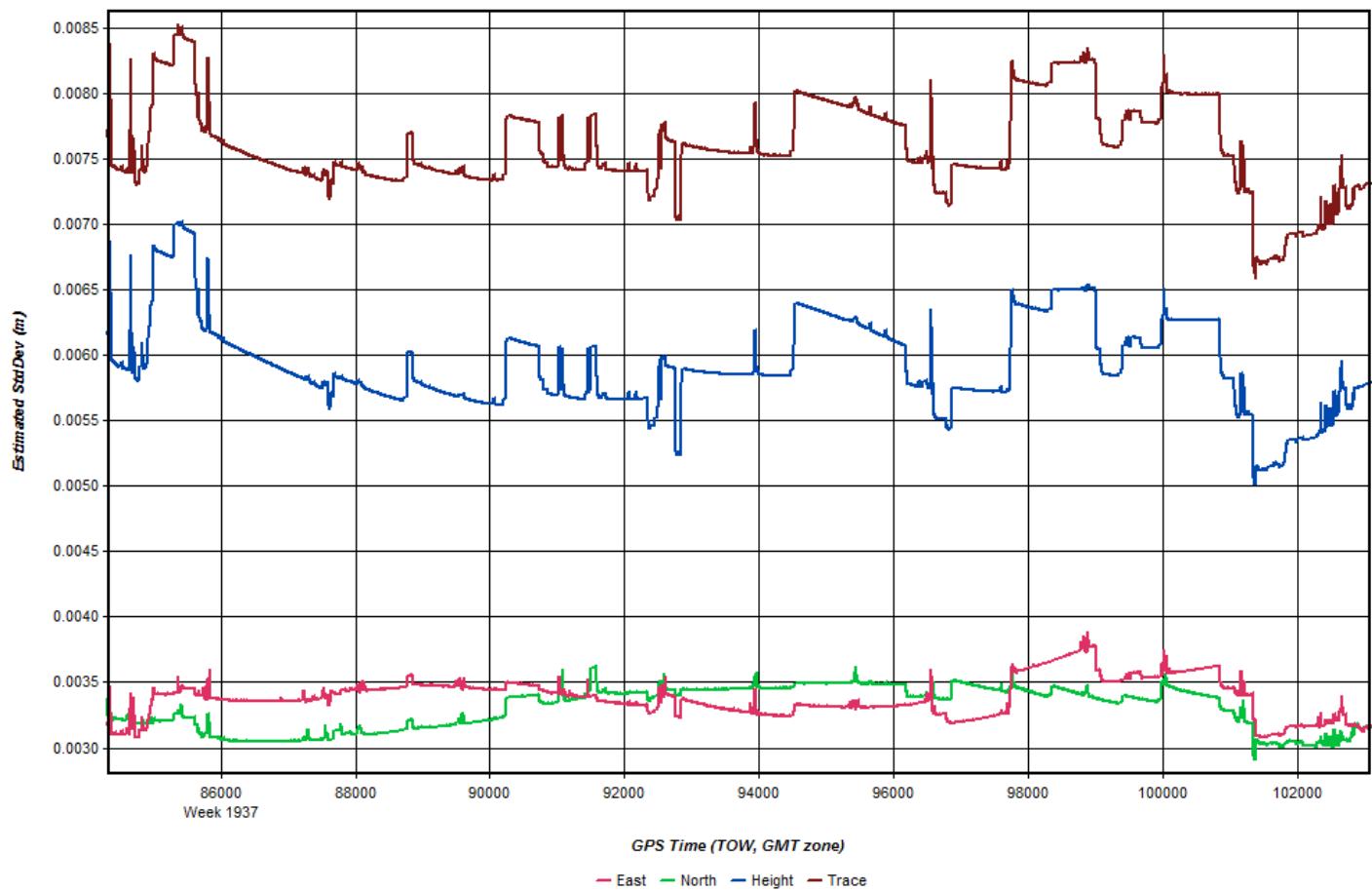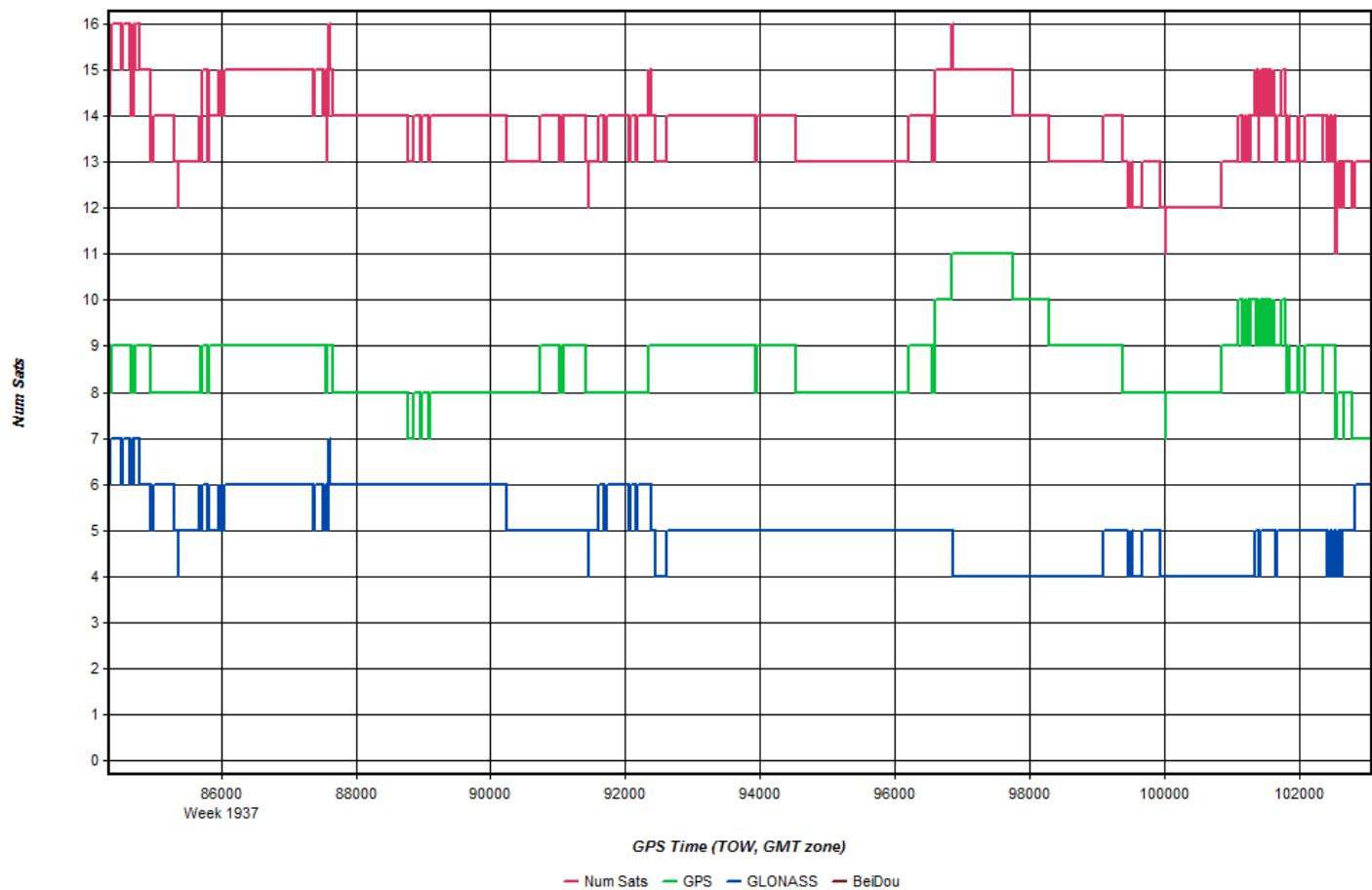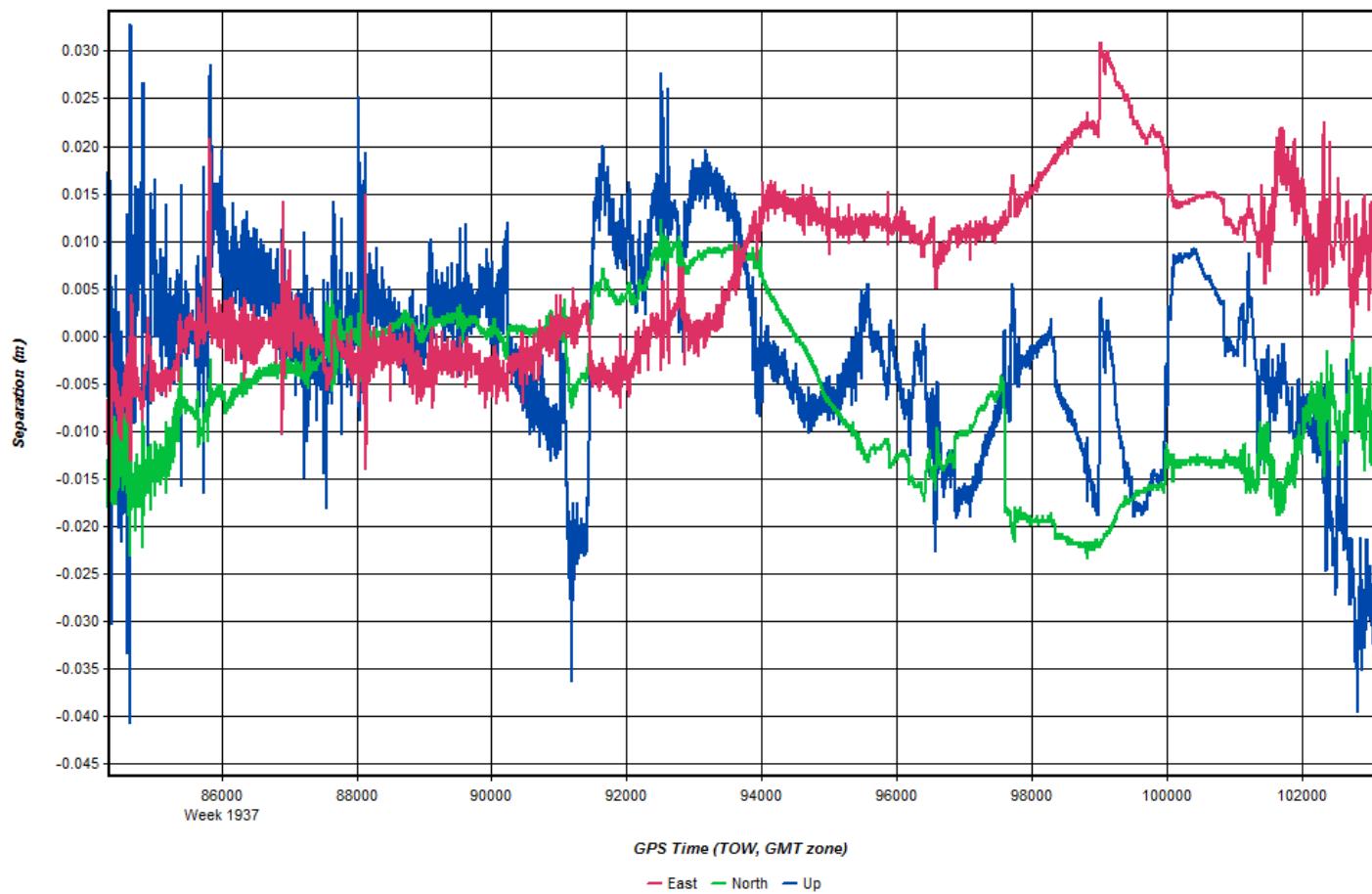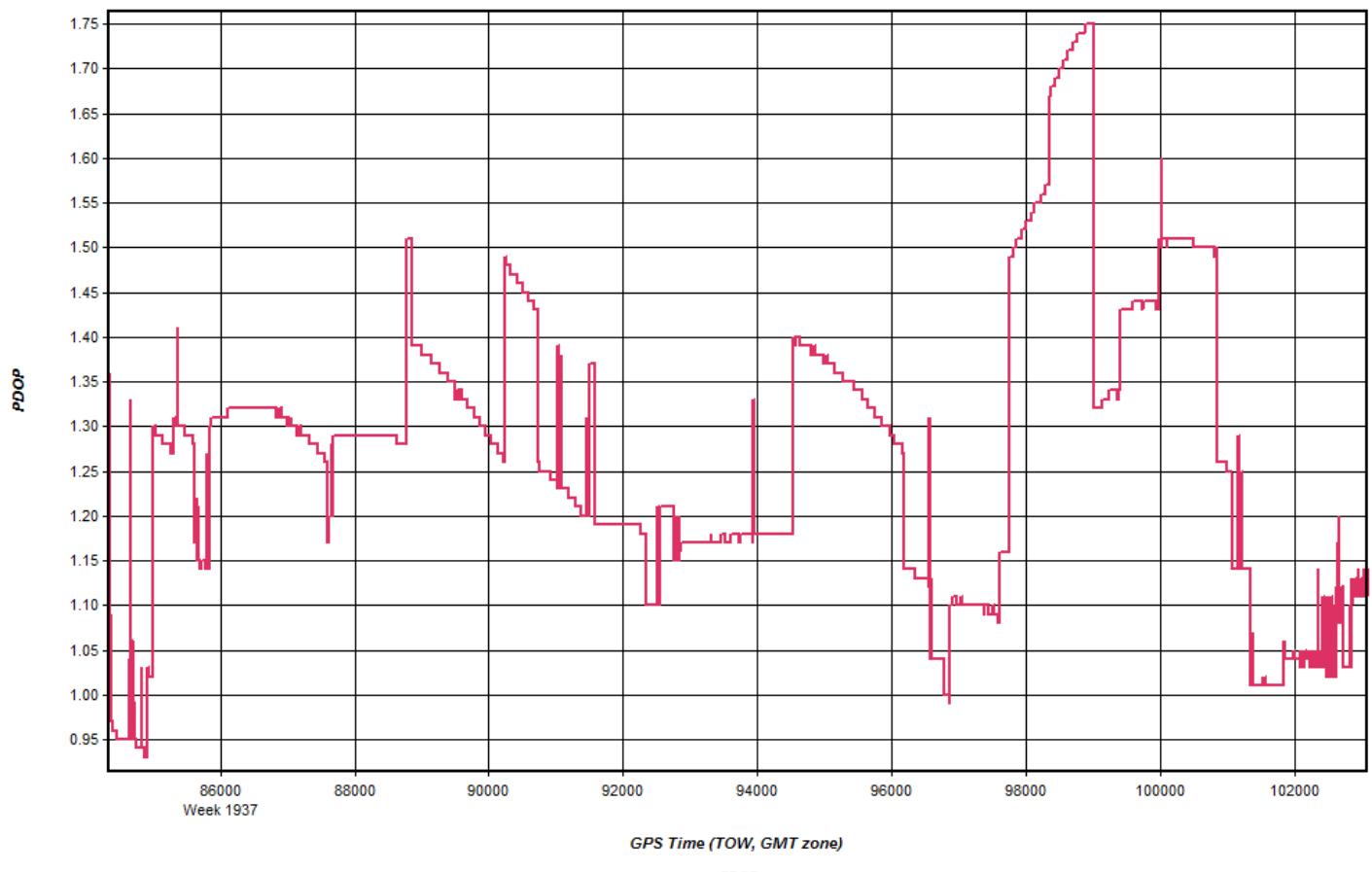
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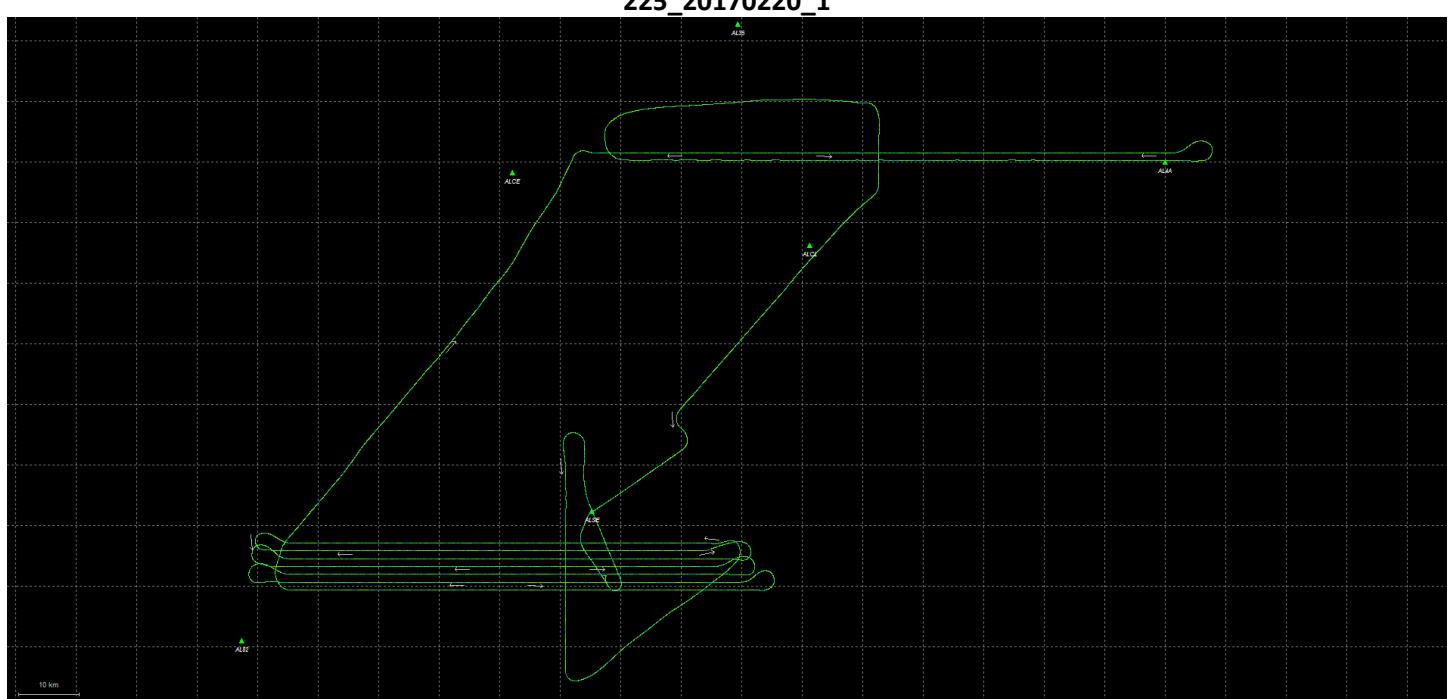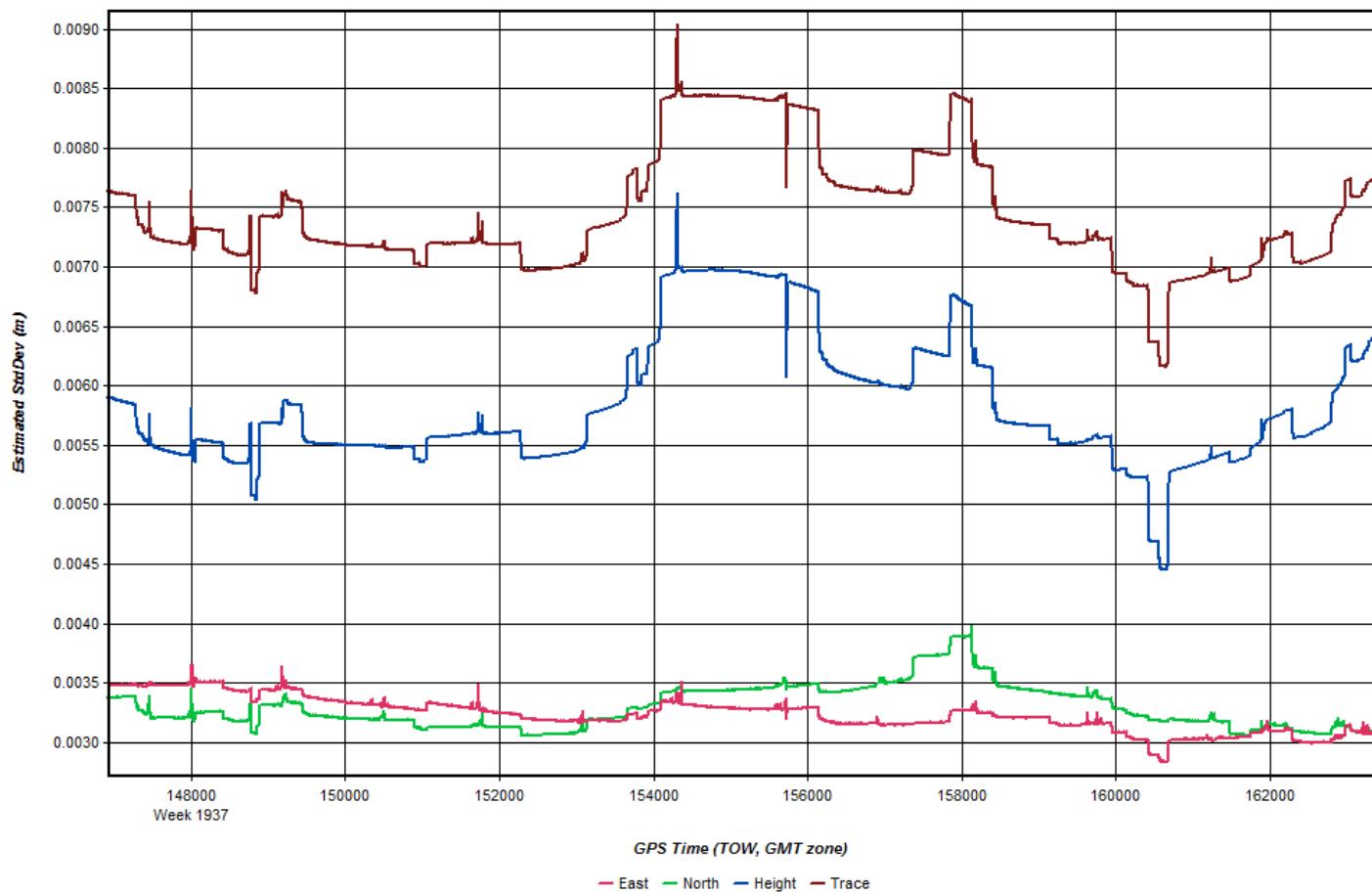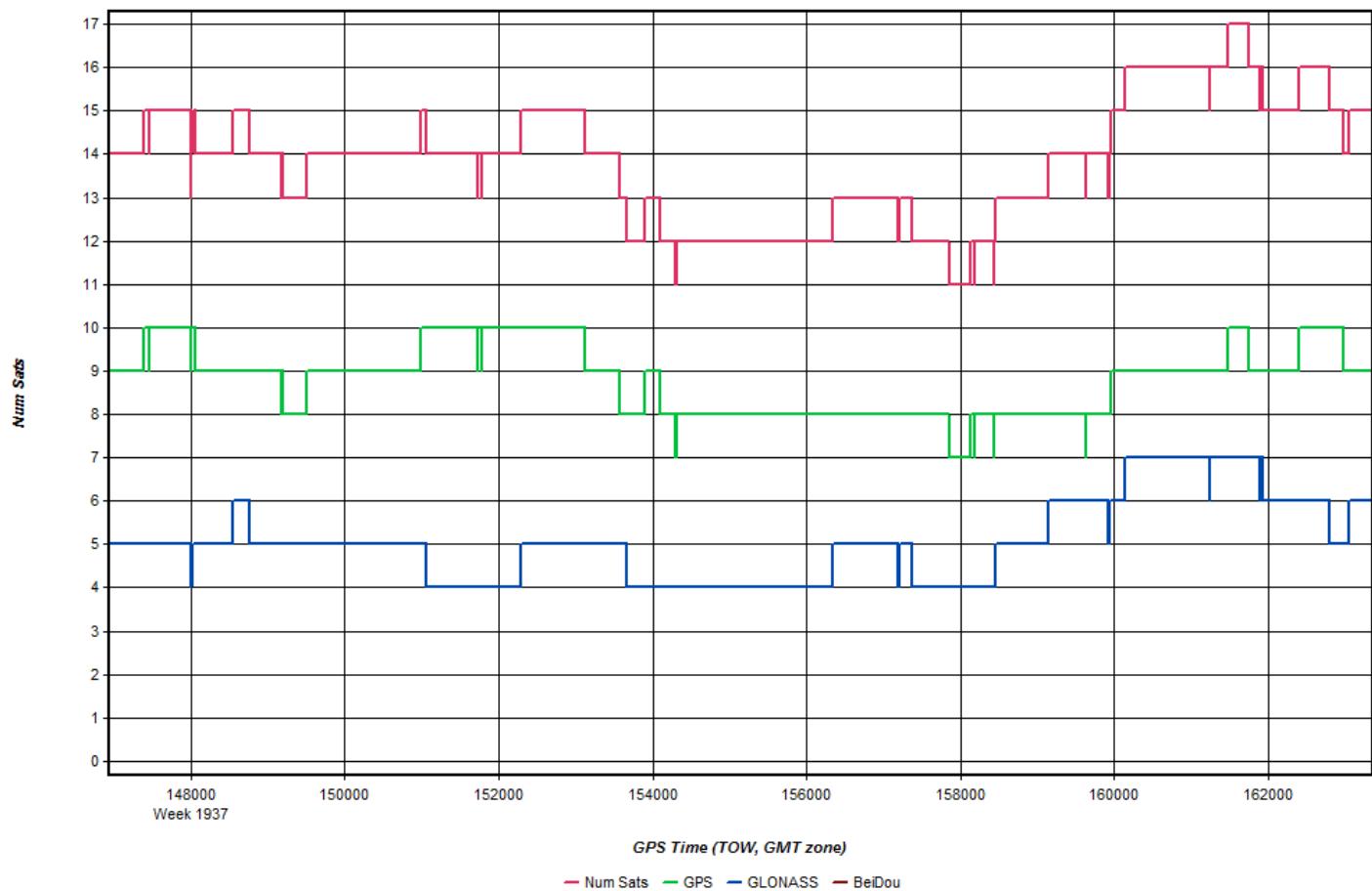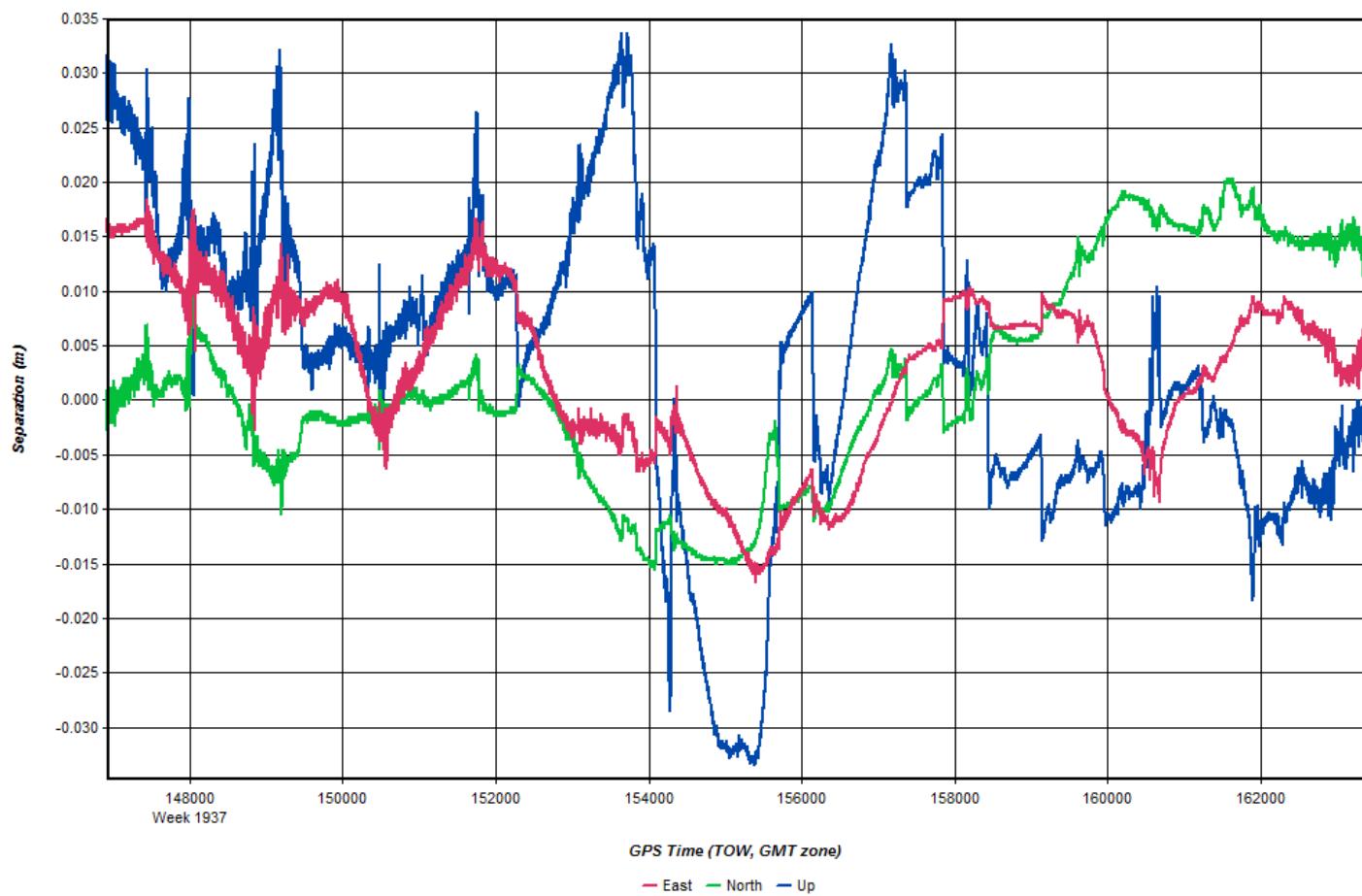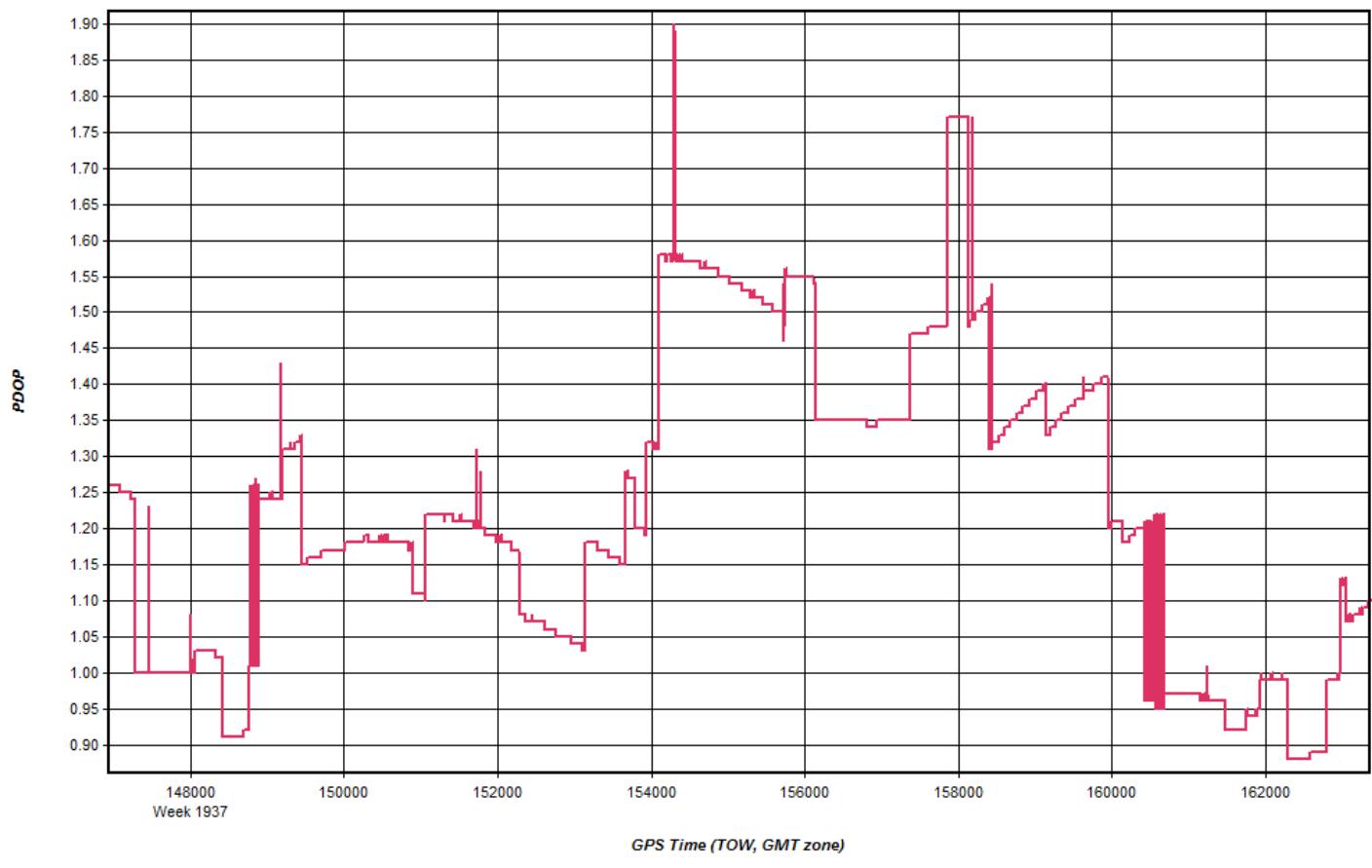
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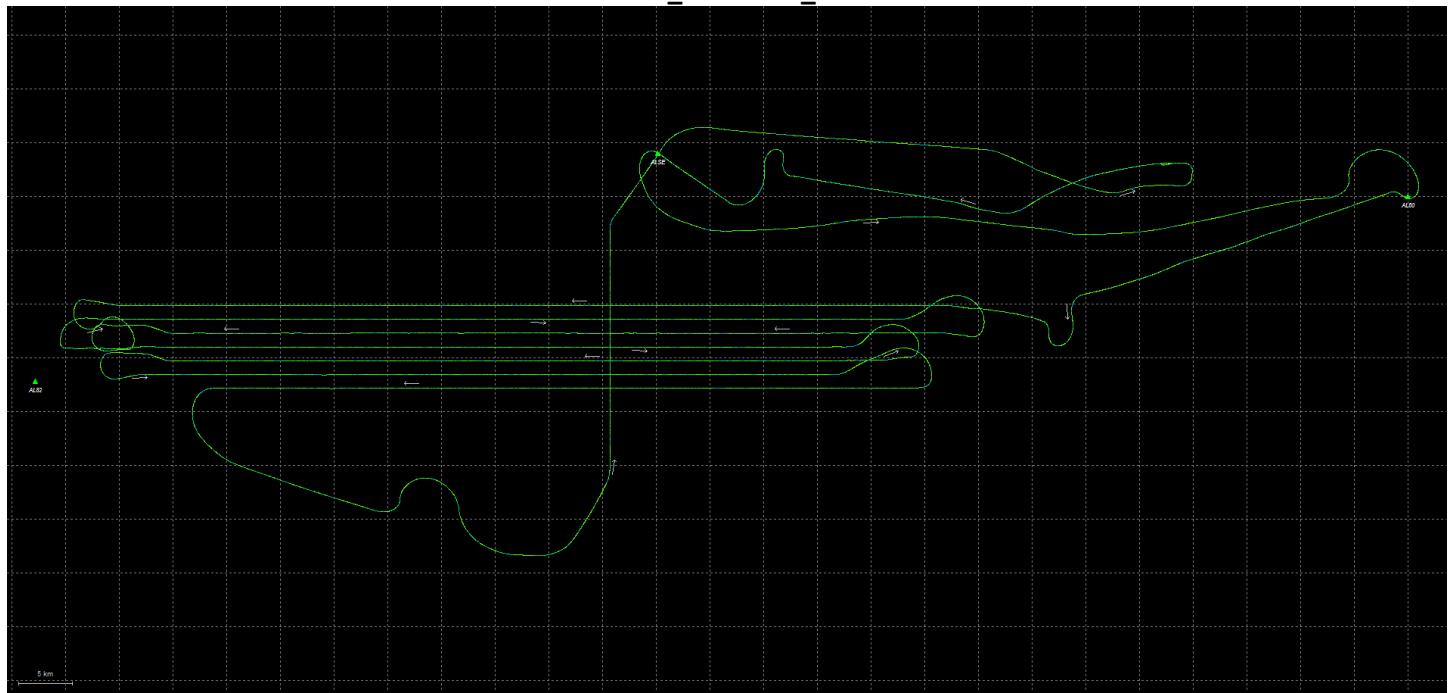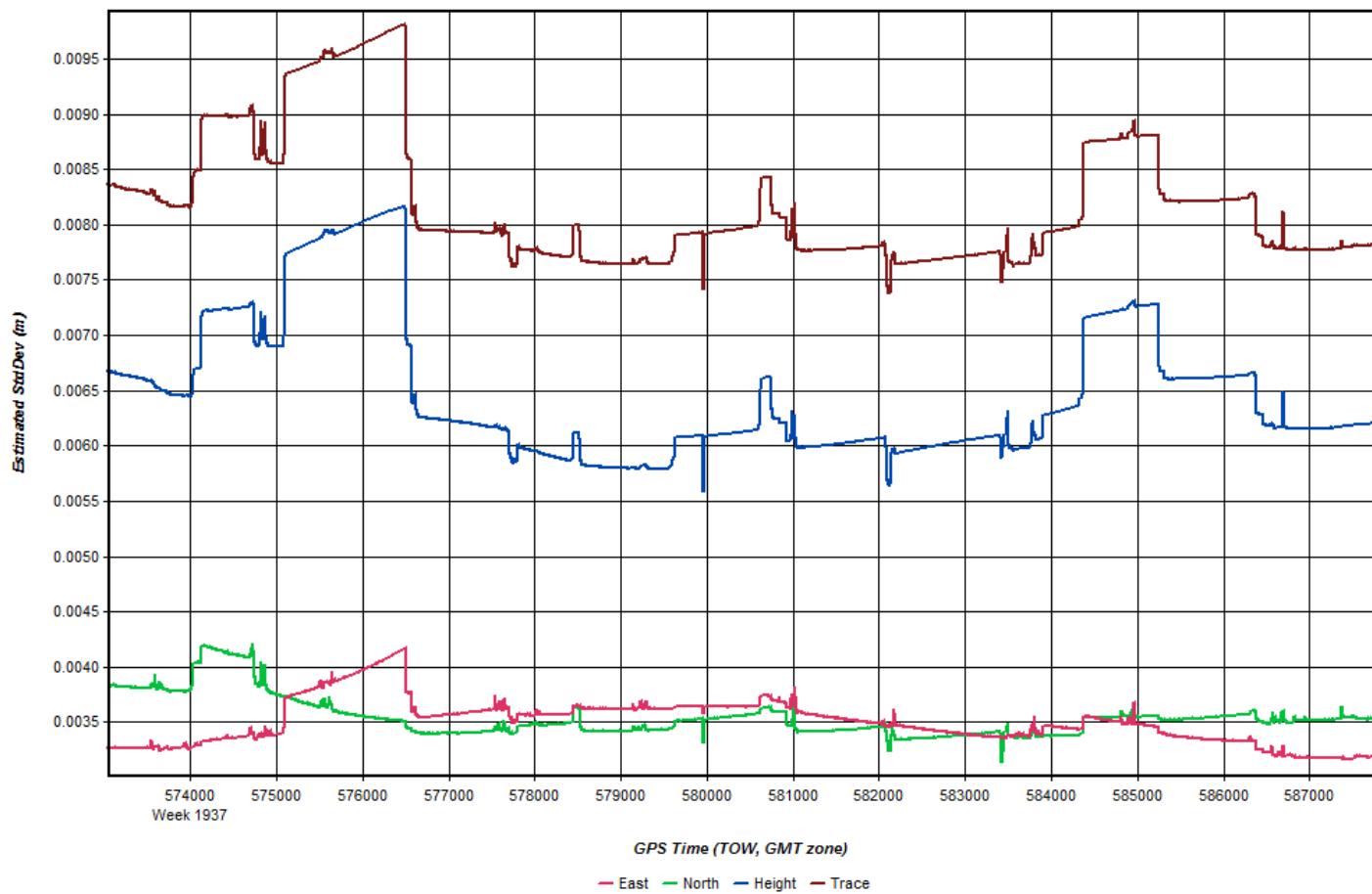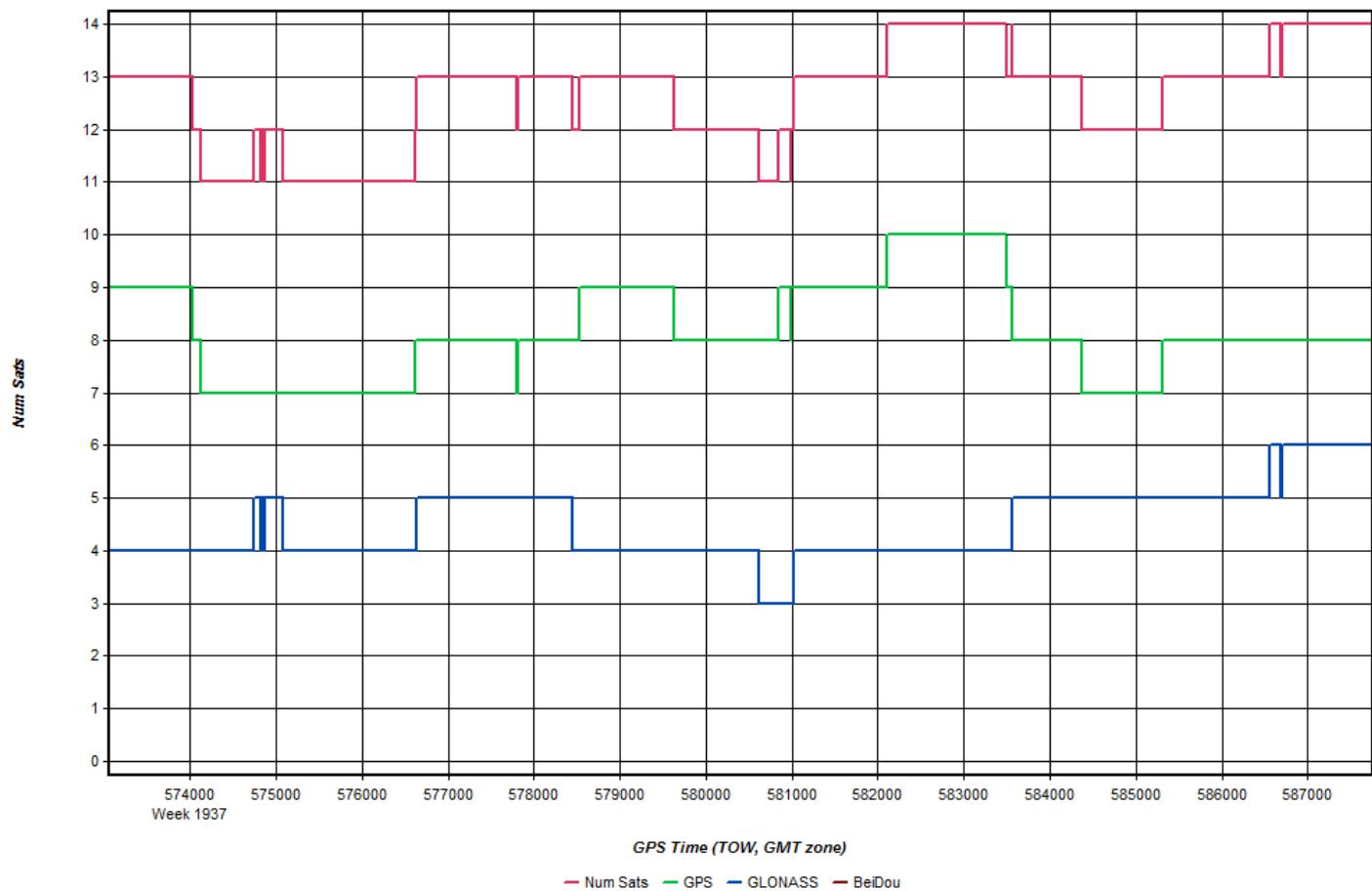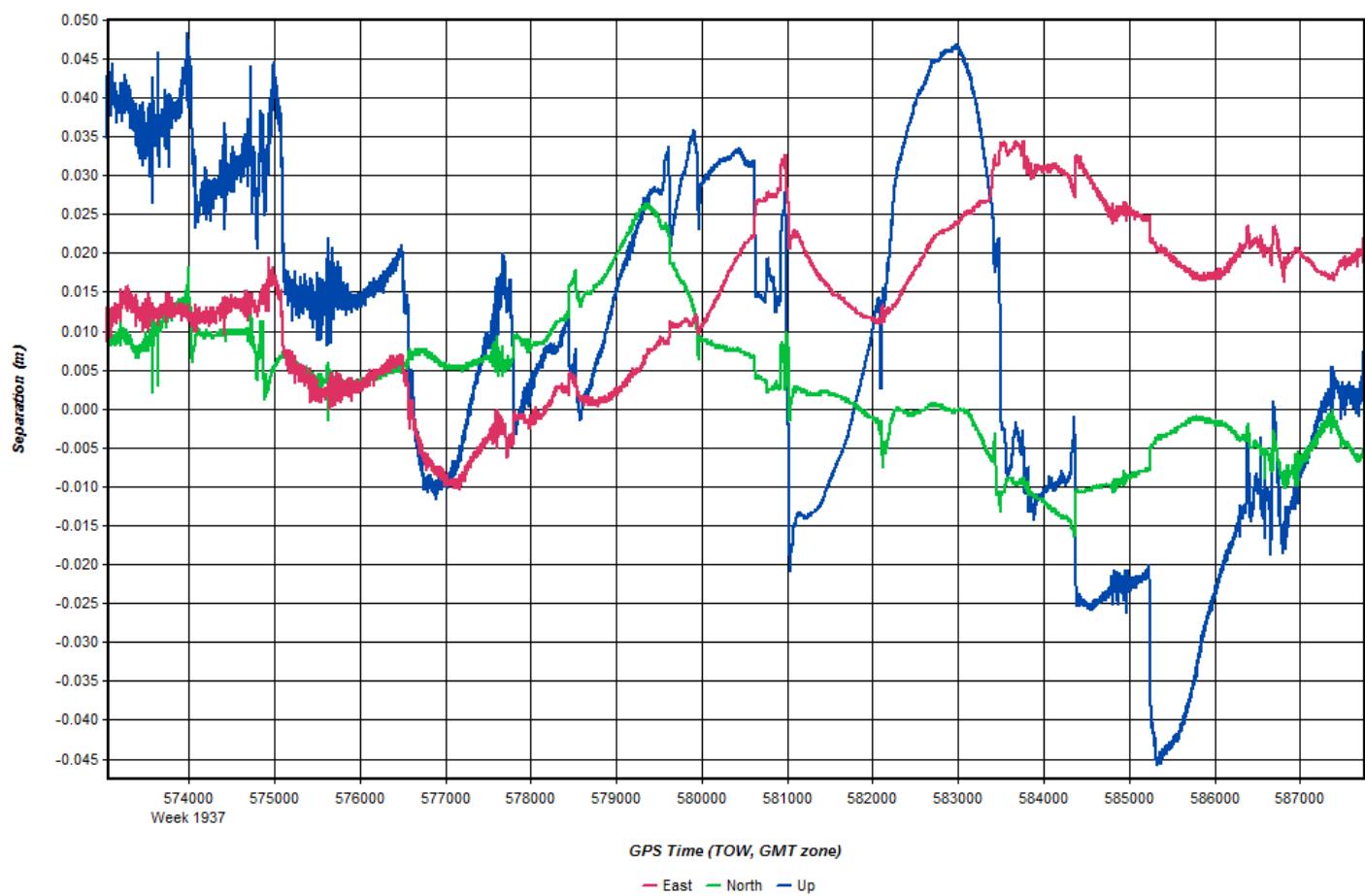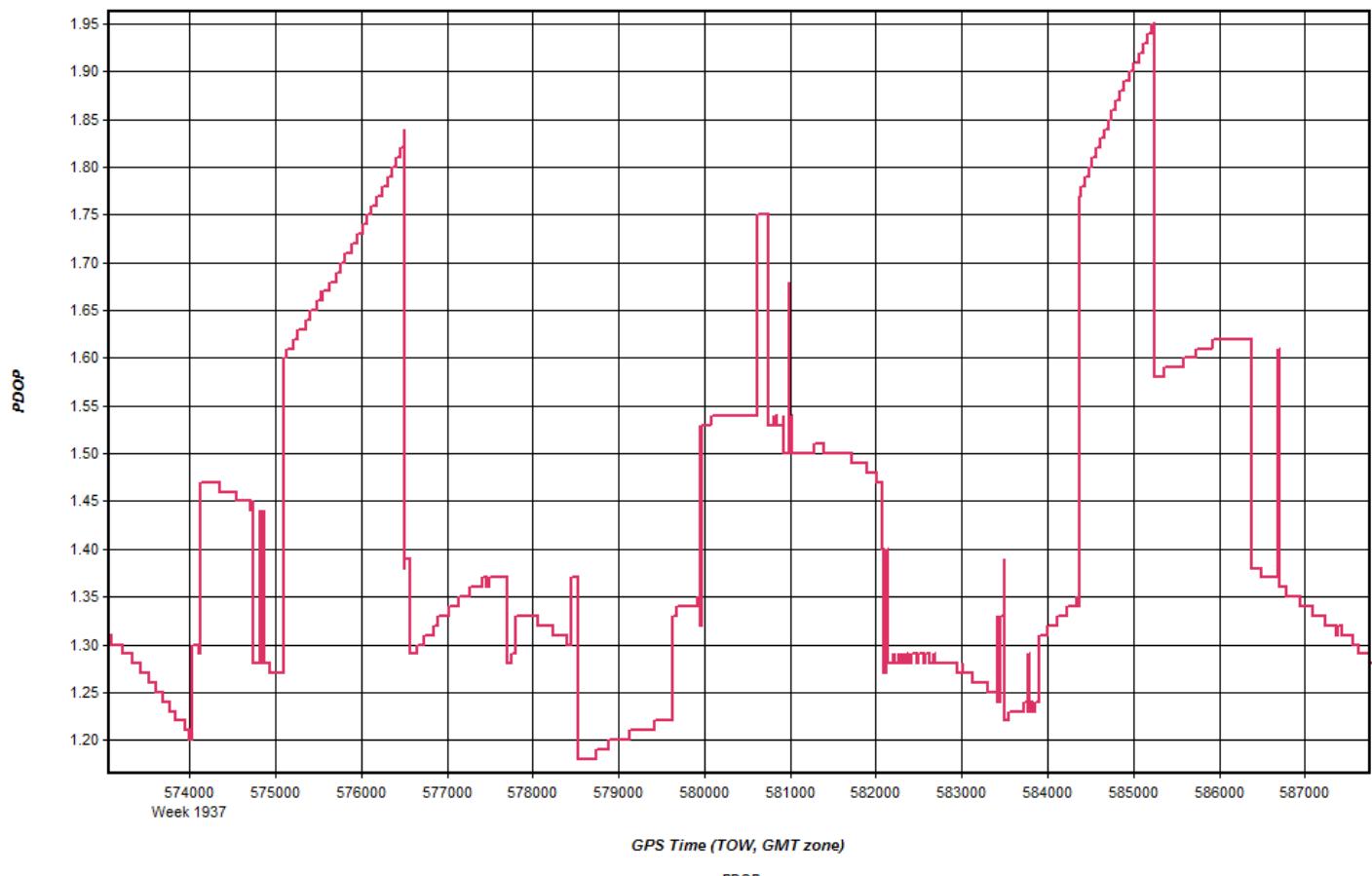
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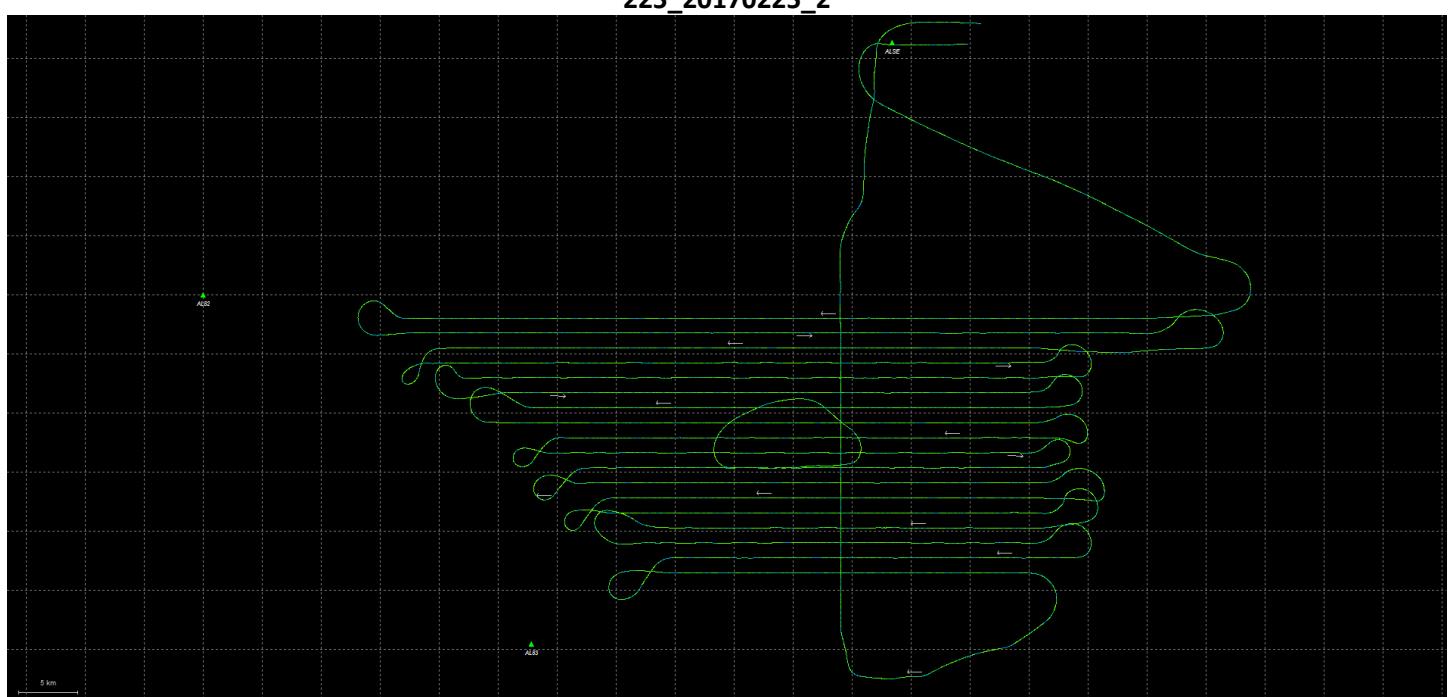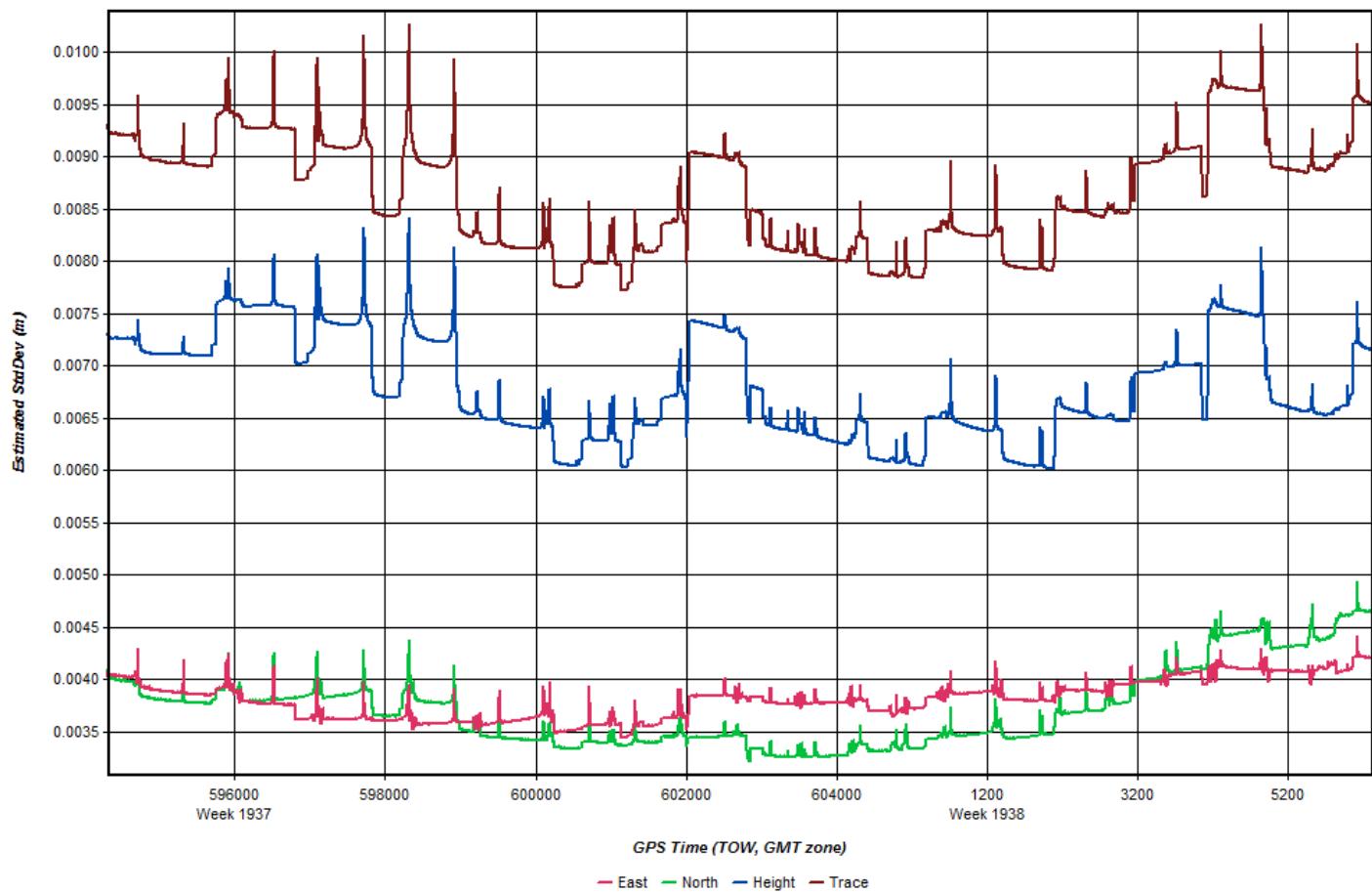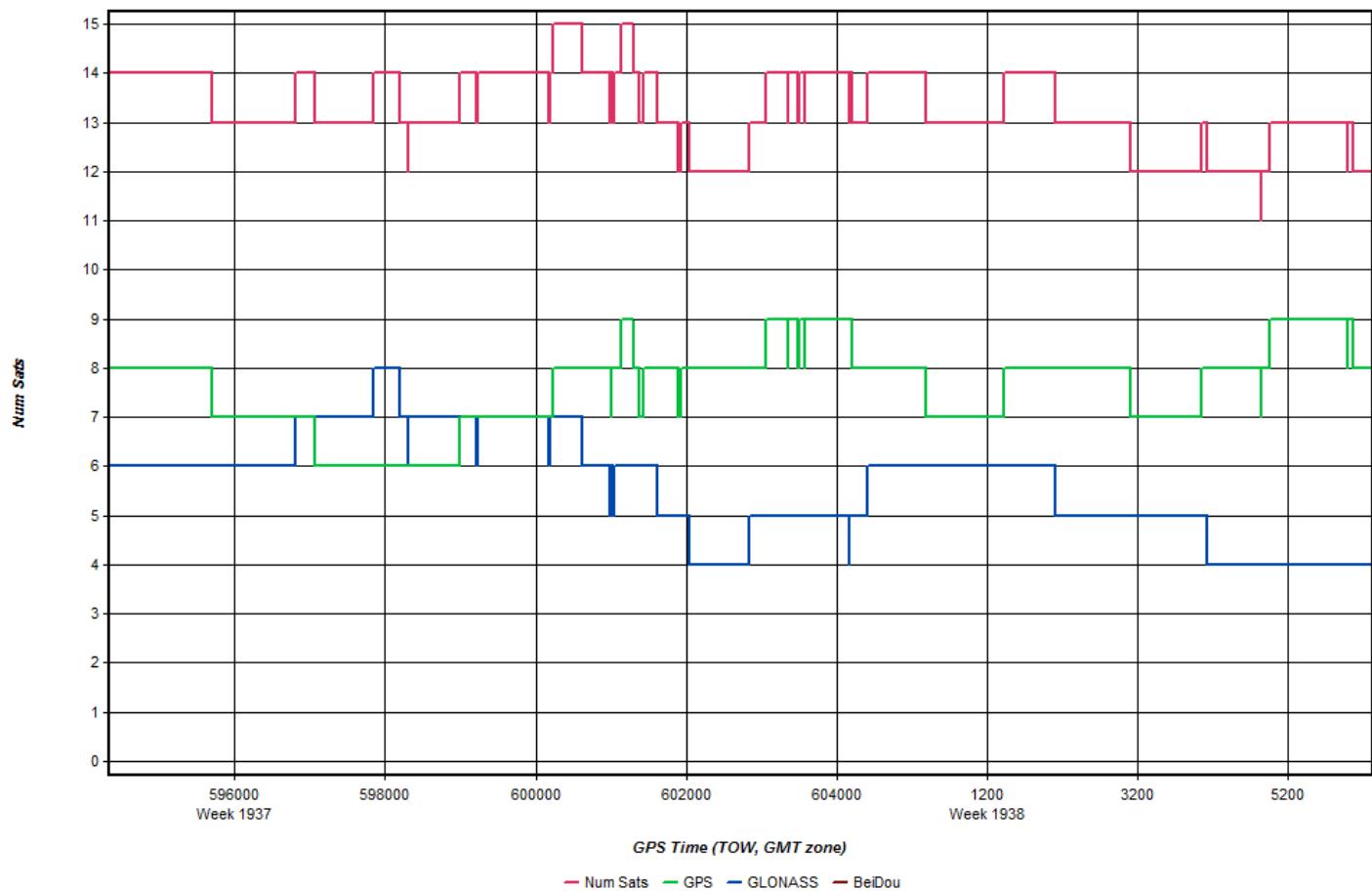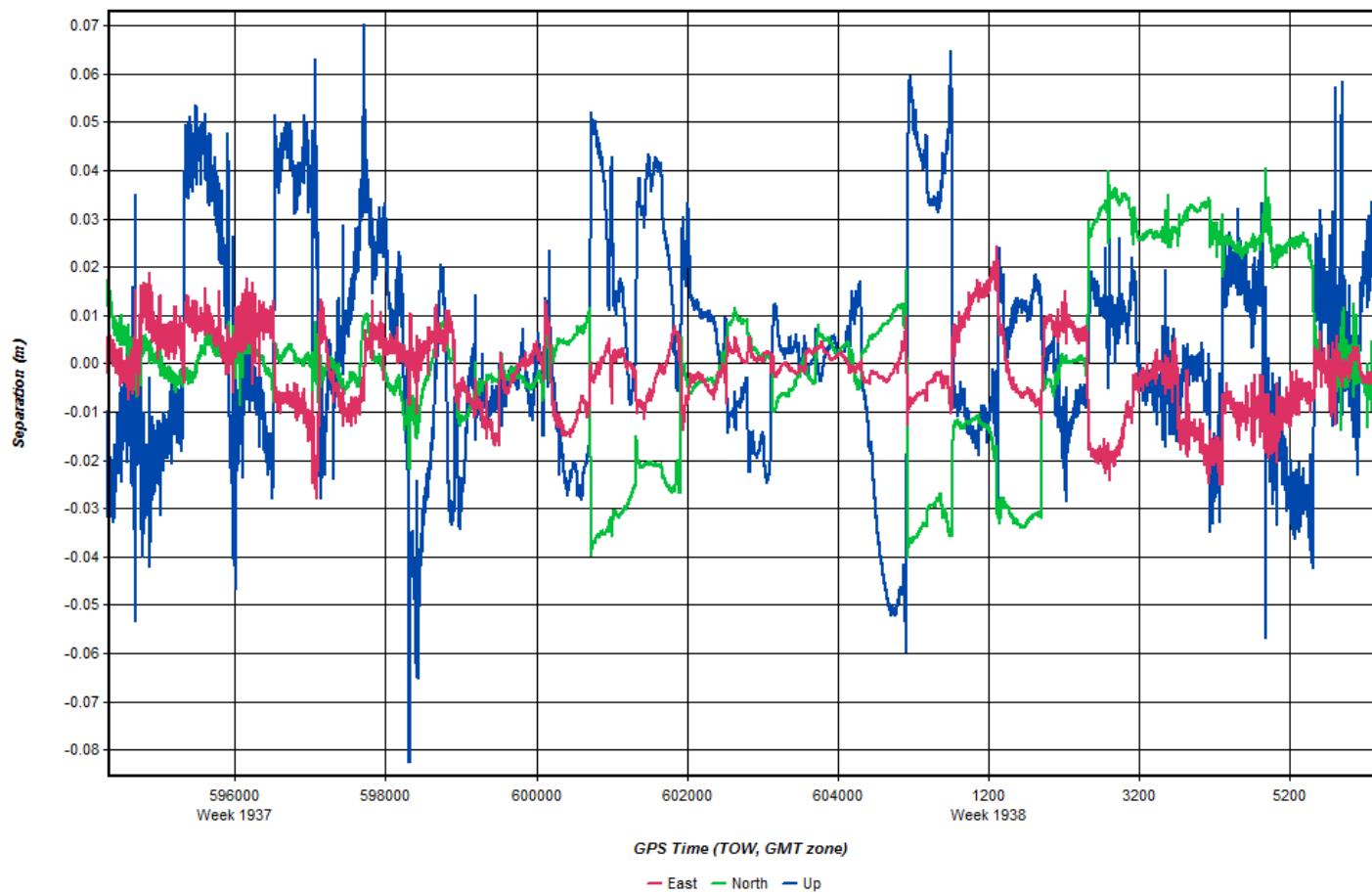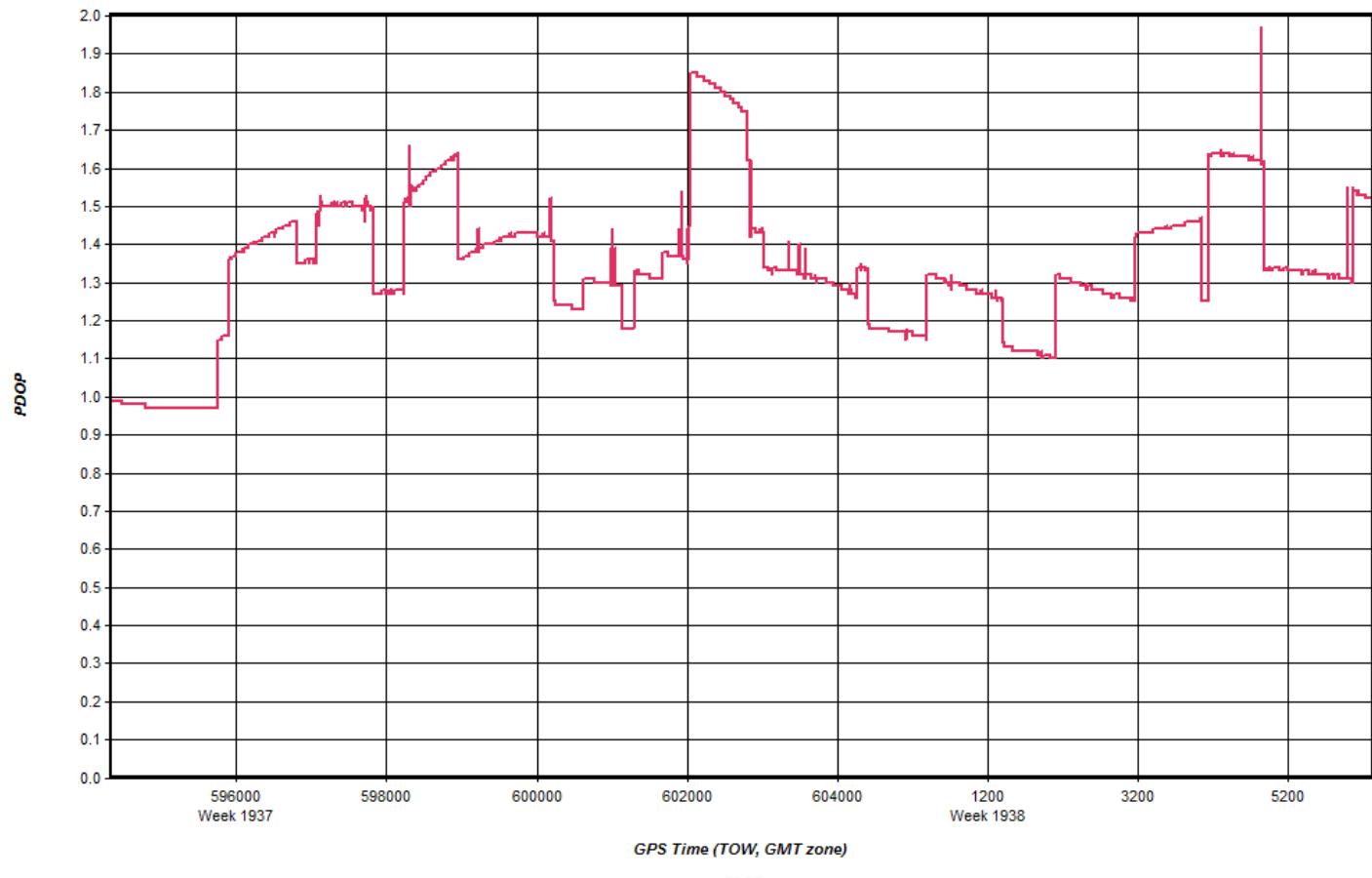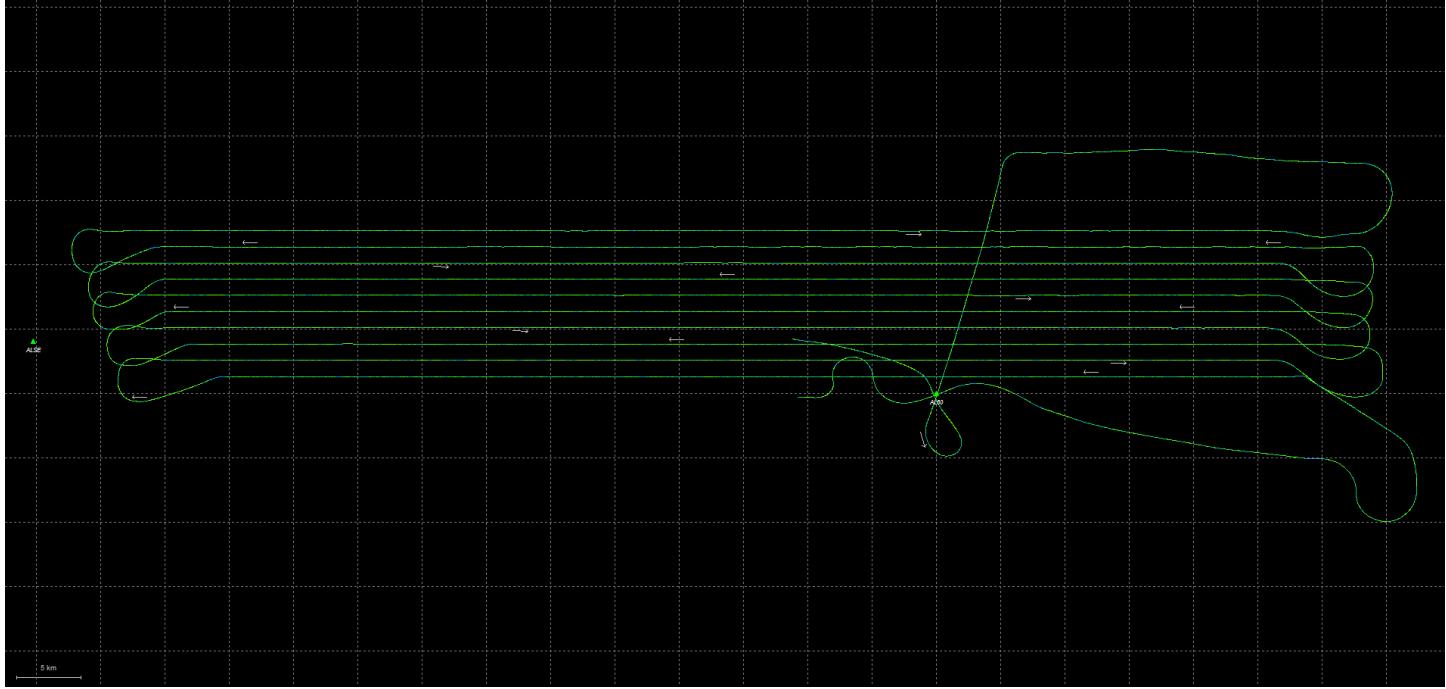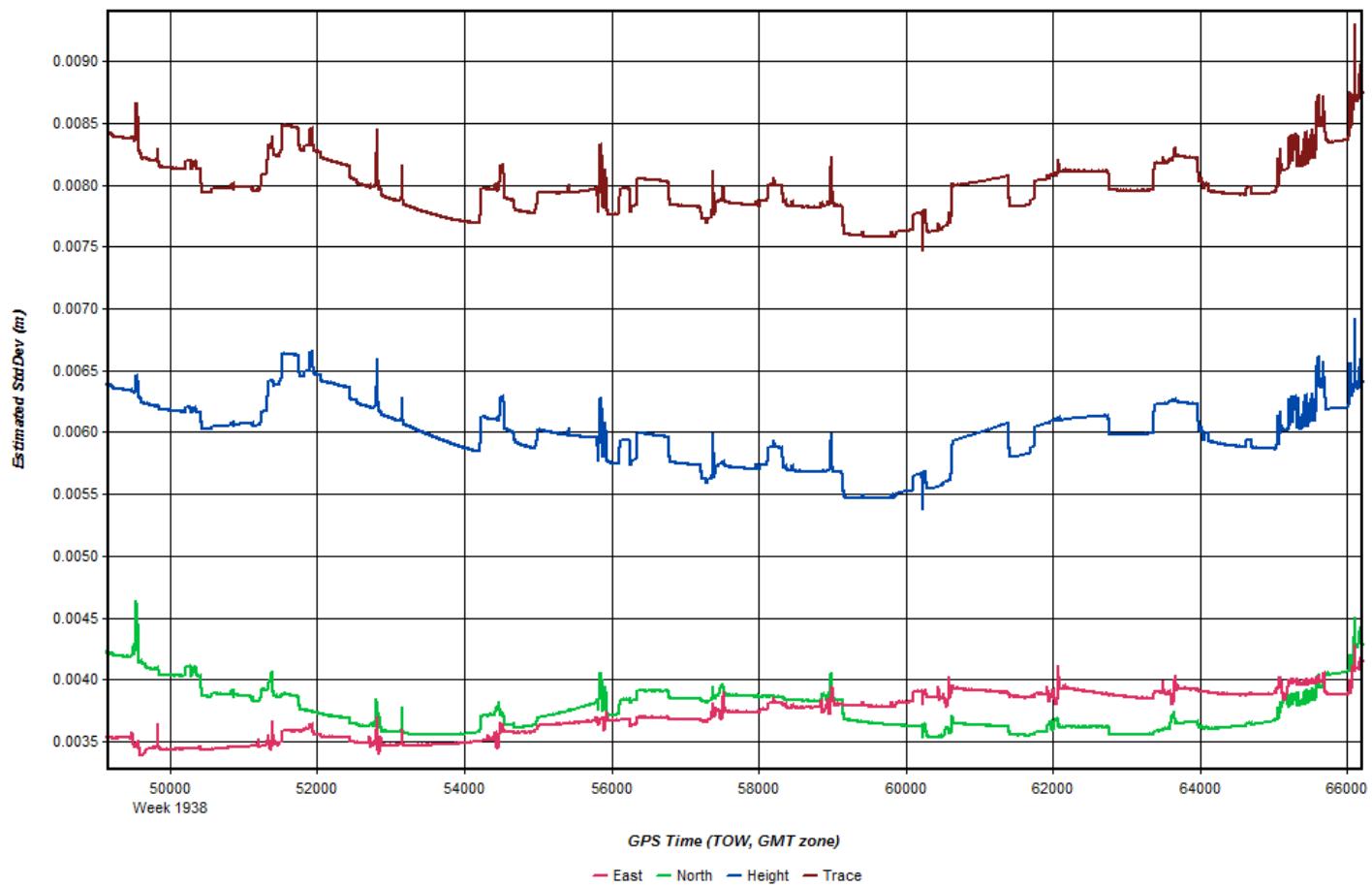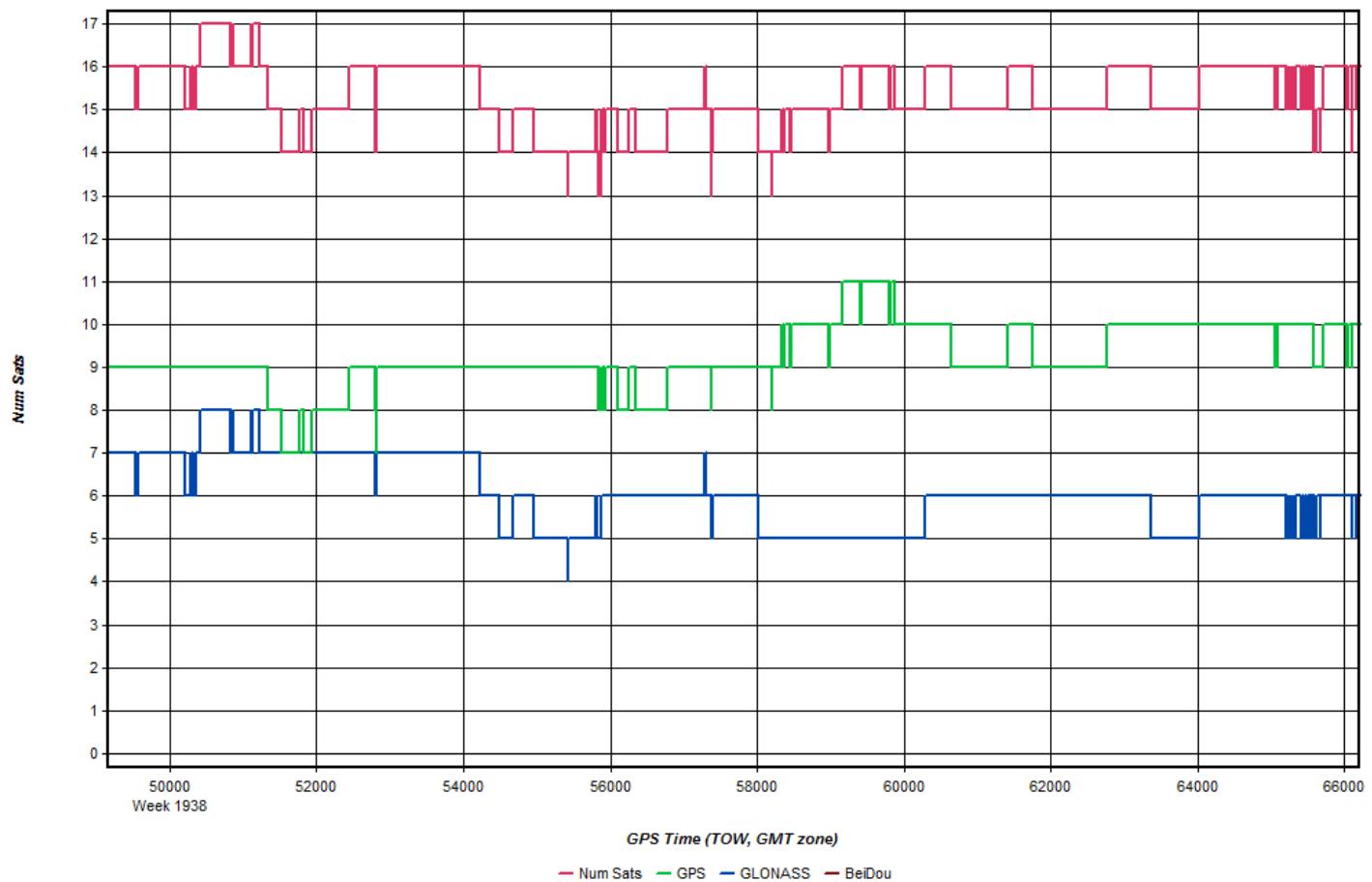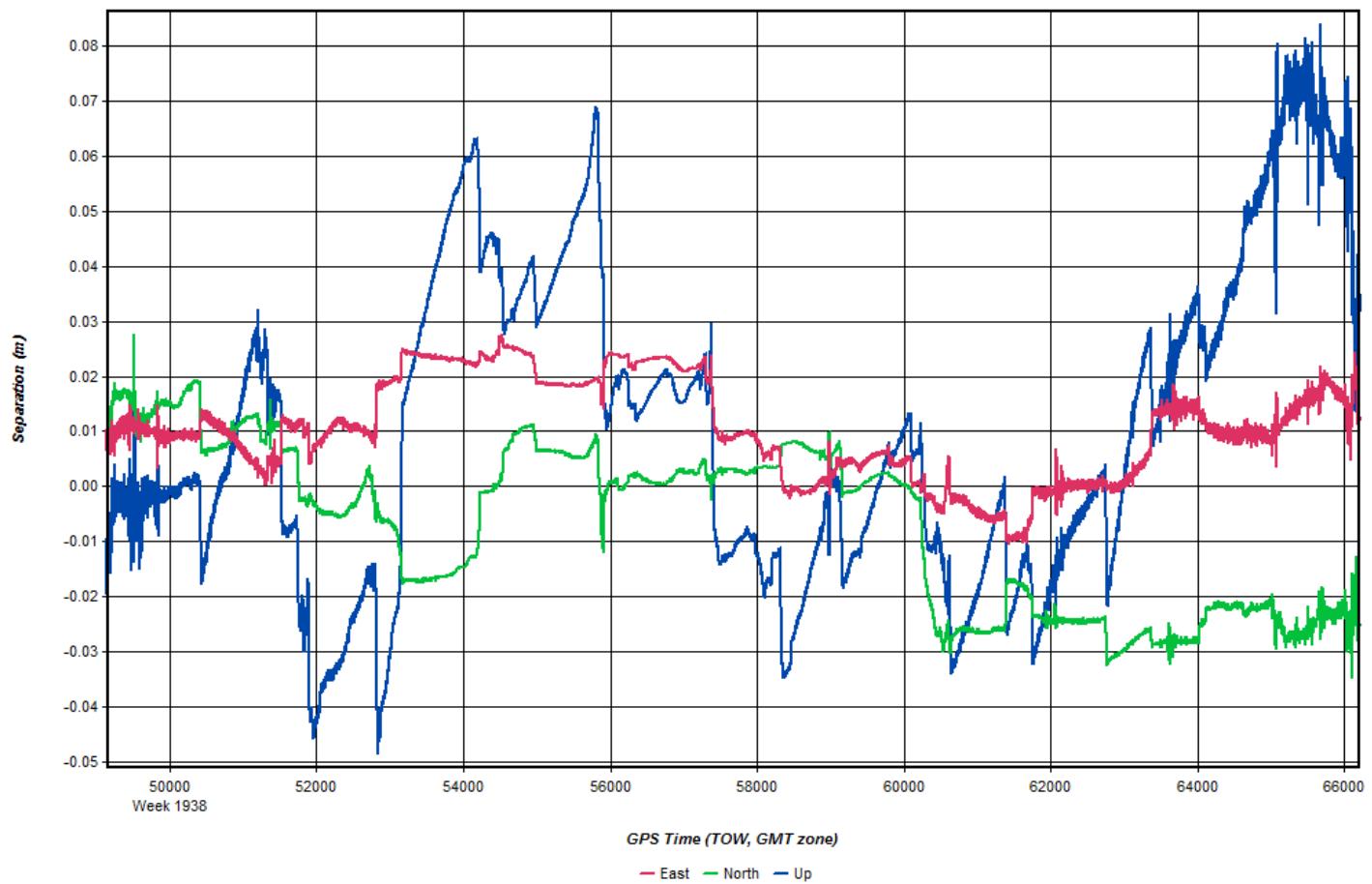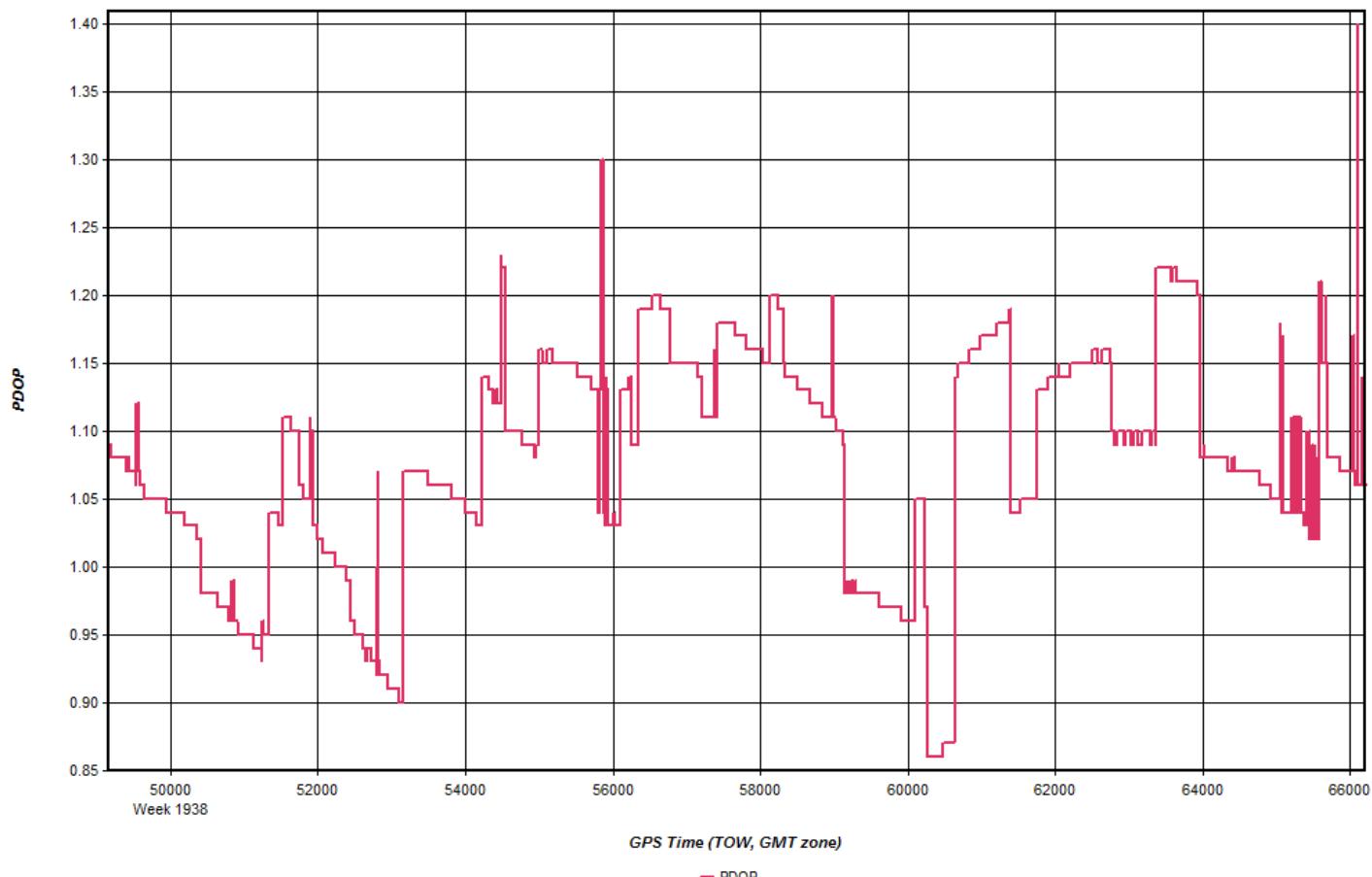
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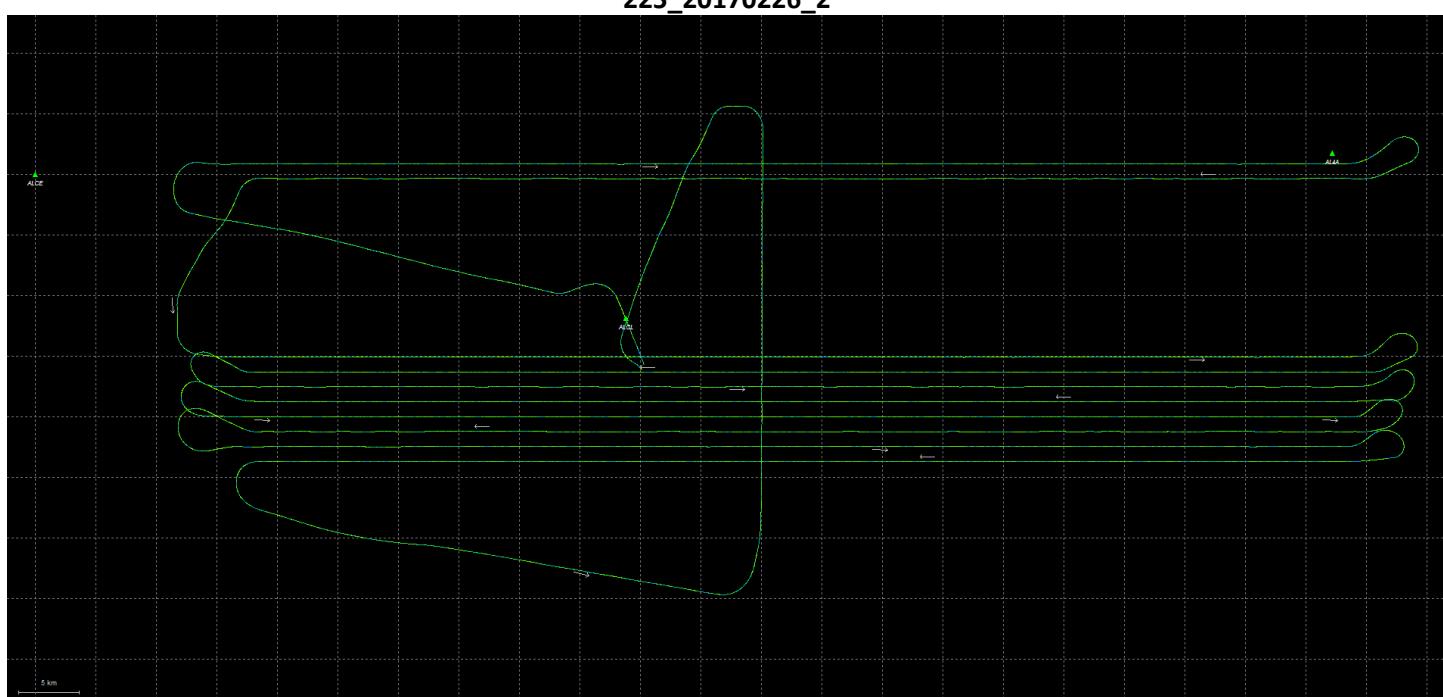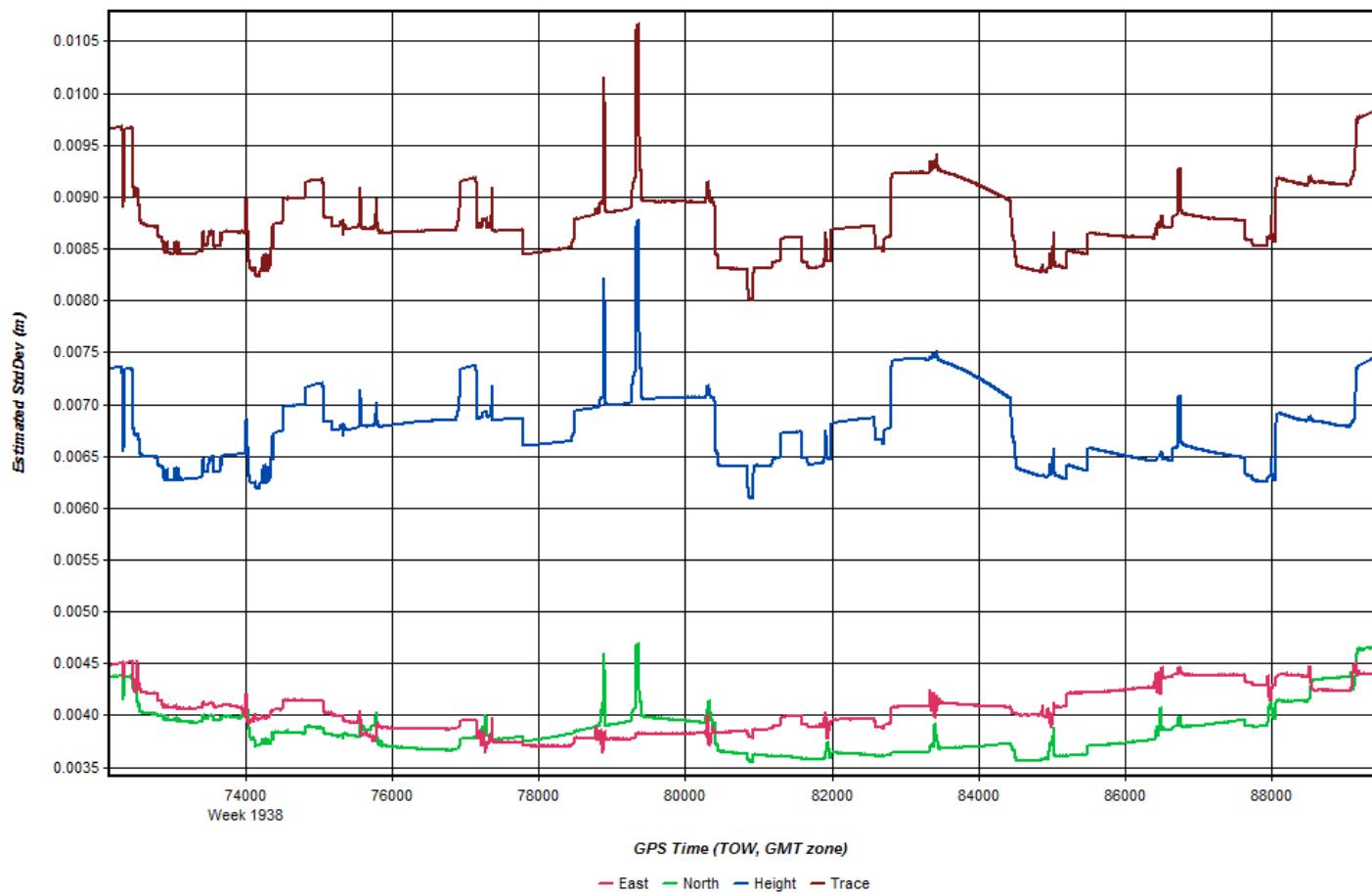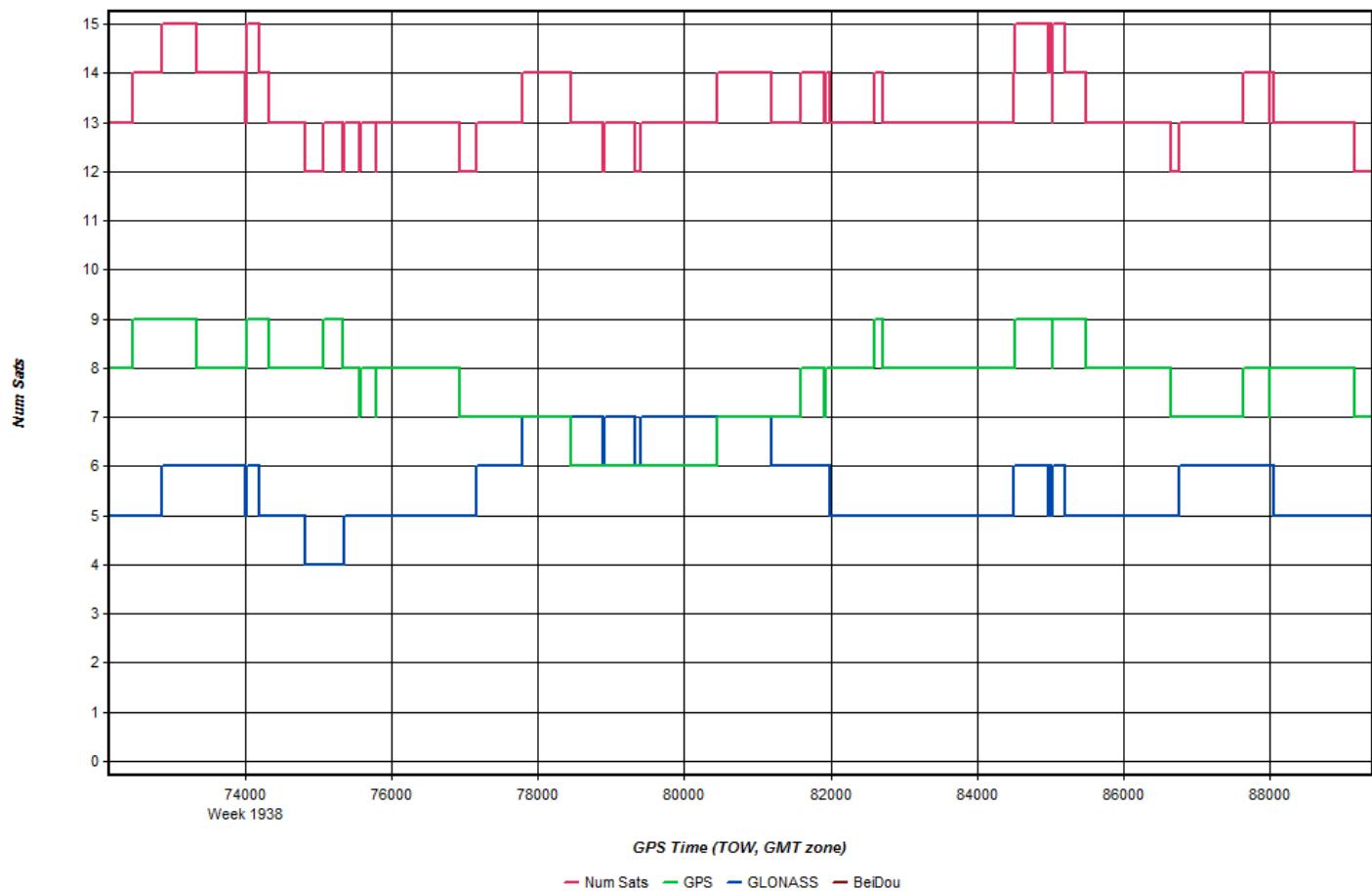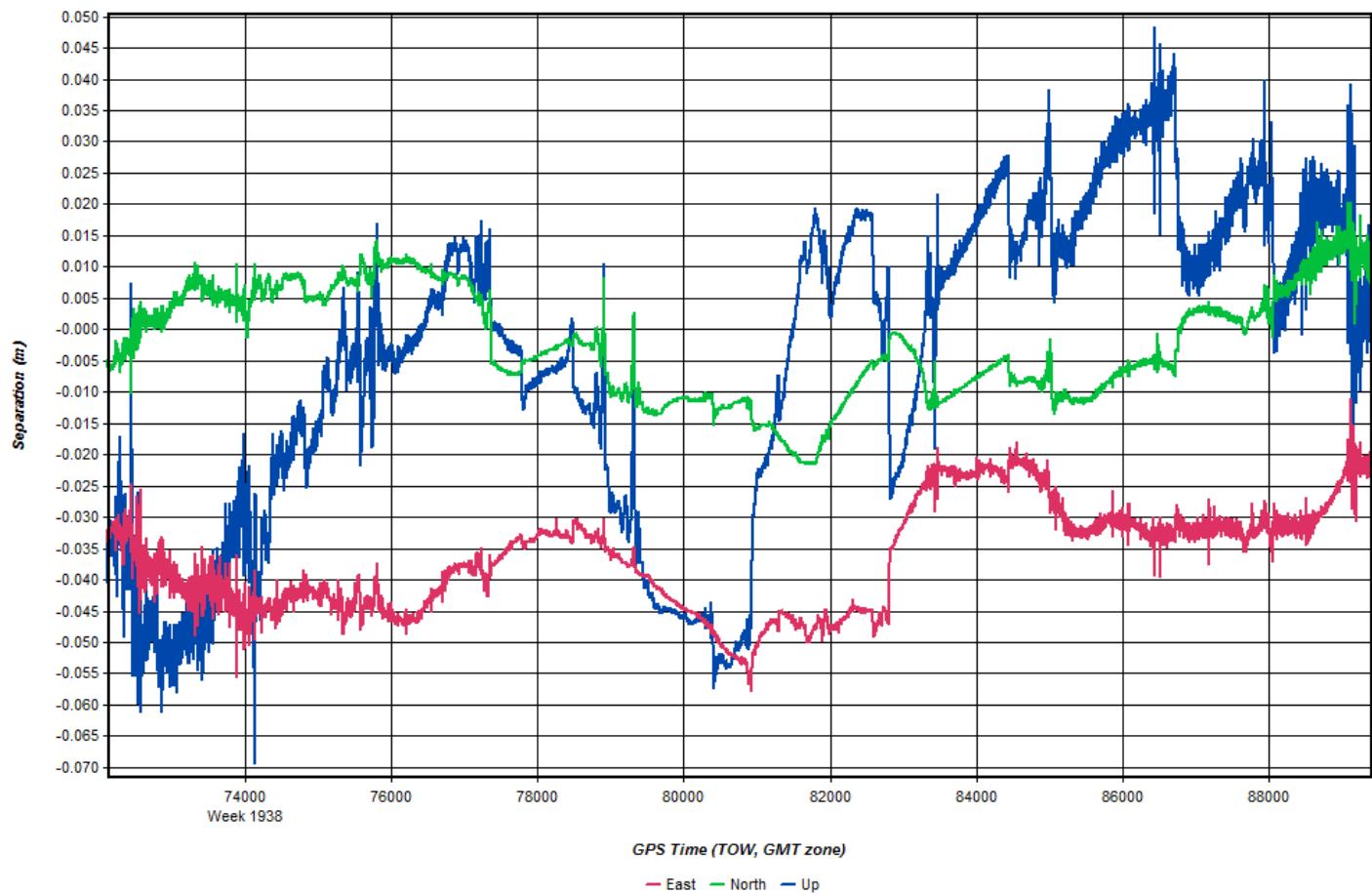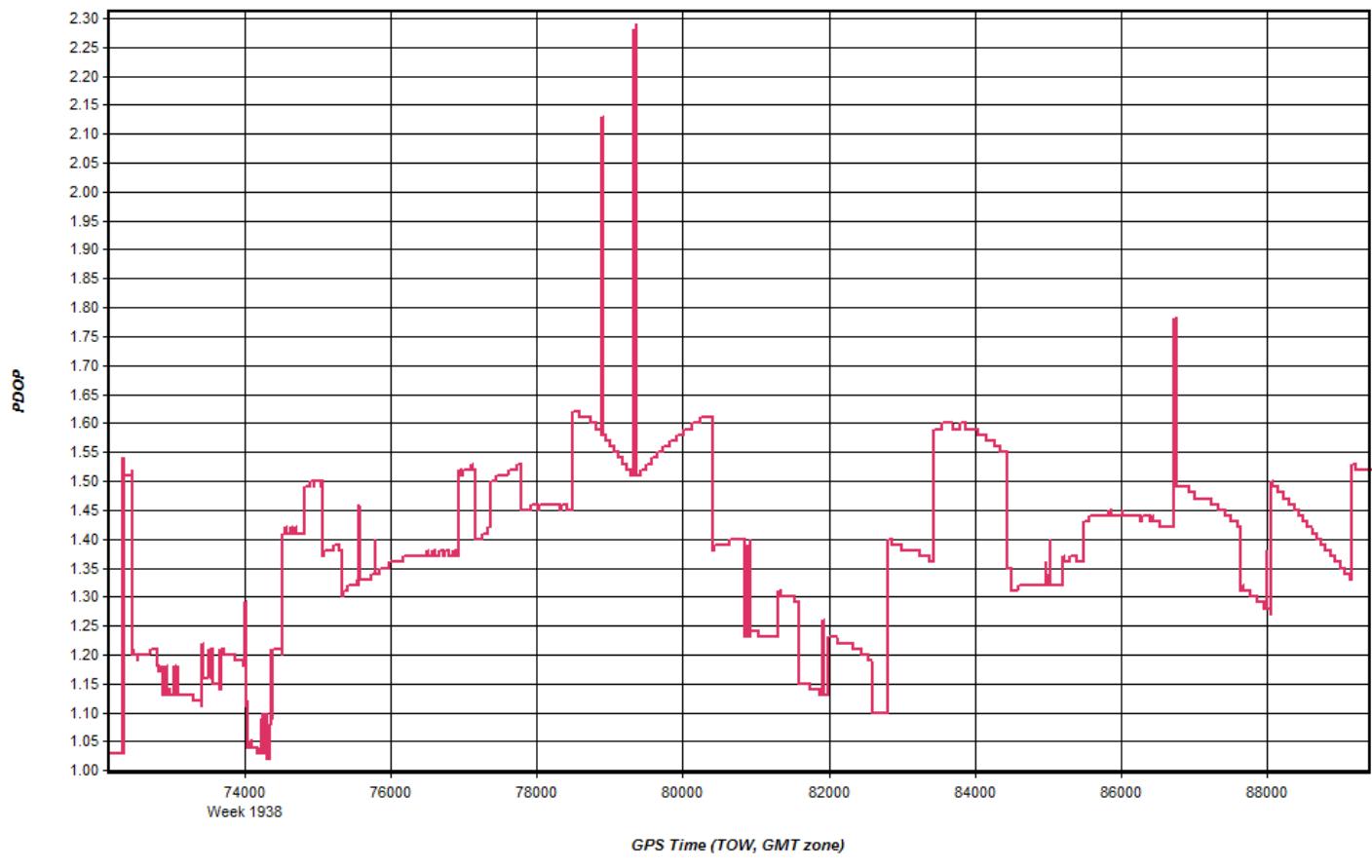
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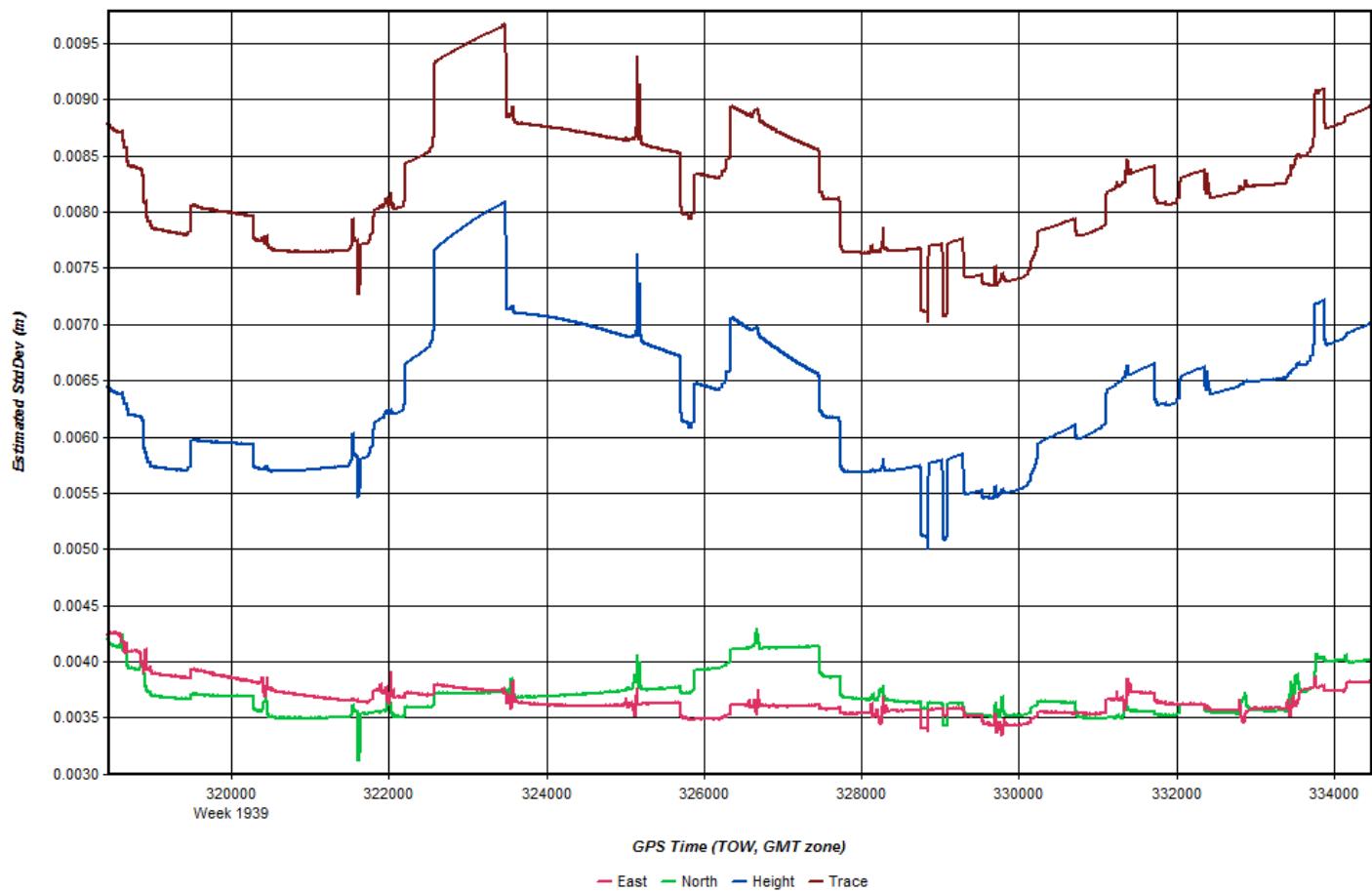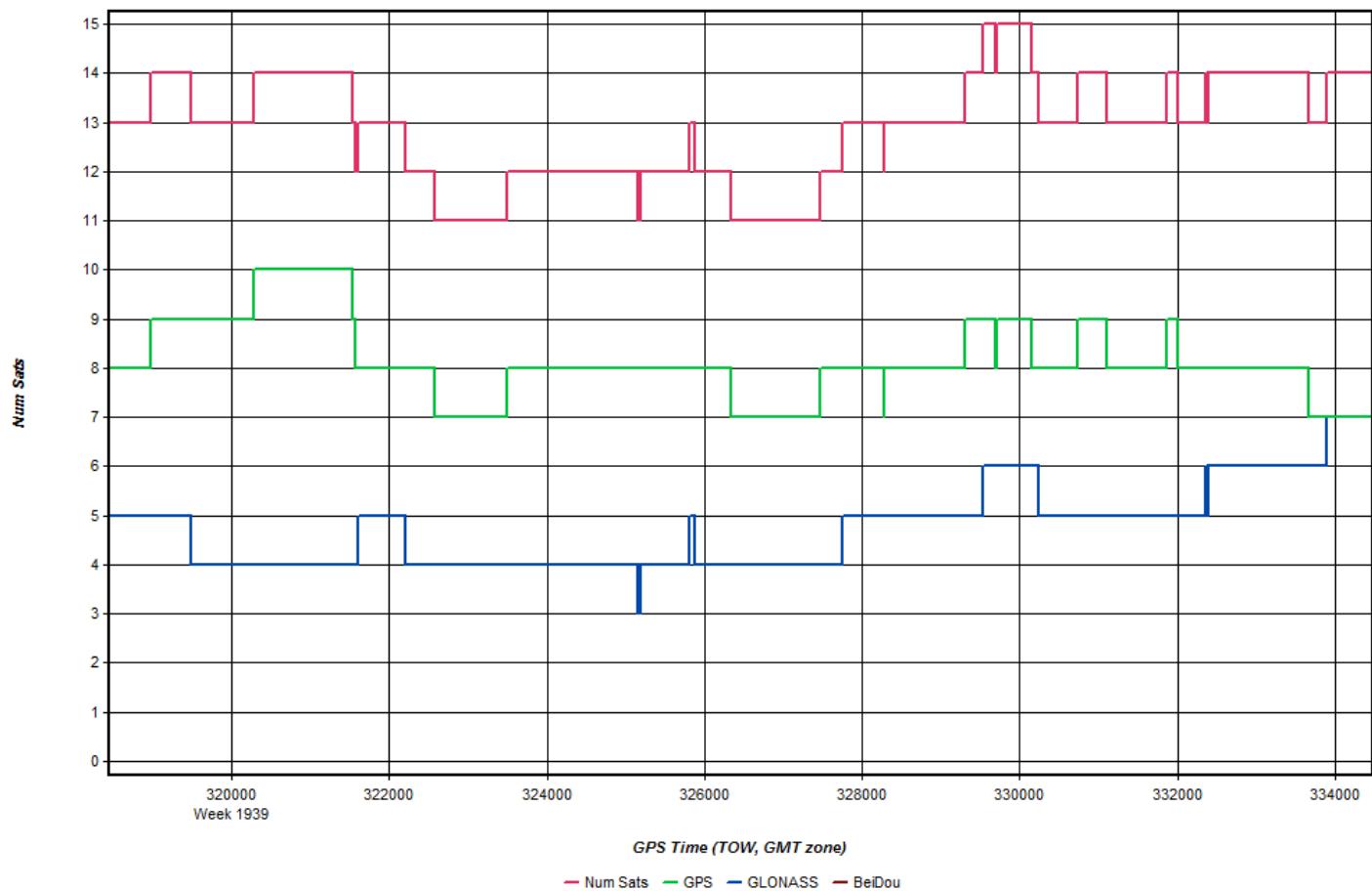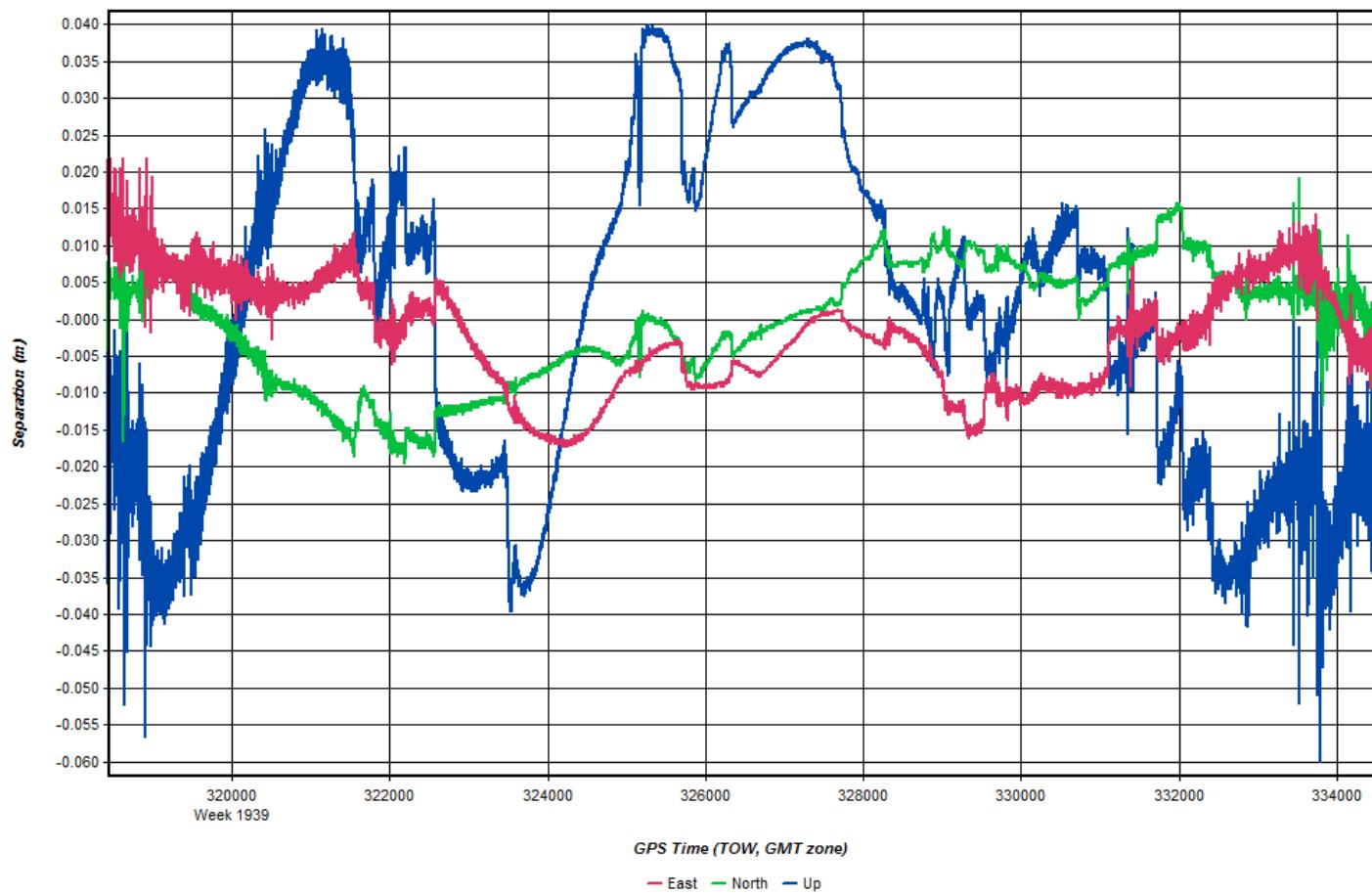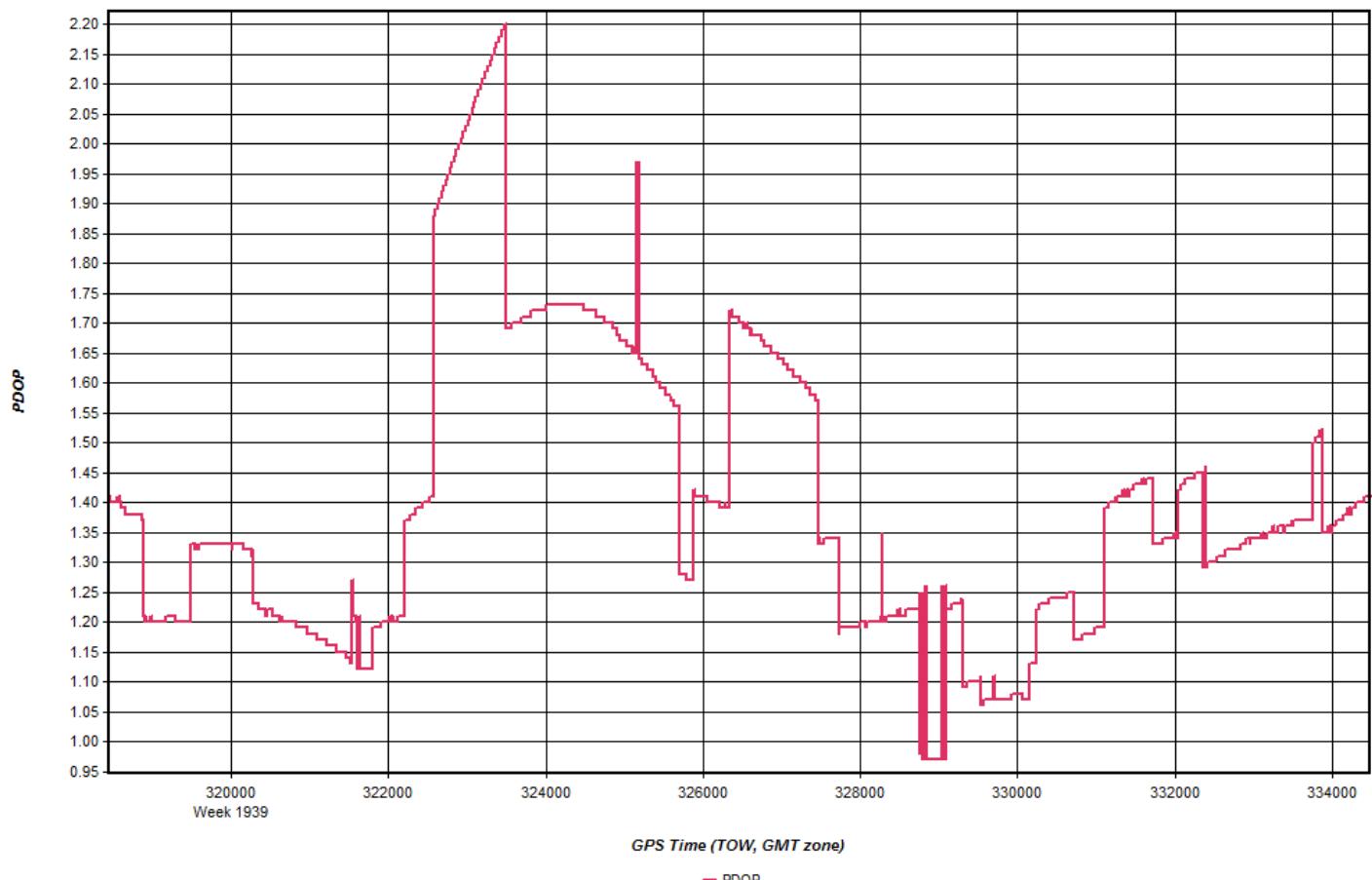
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