



Aerial Lidar Report

16062

USDA Forest Service, Colville & Idaho Panhandle National Forests

January 2017



Table of Contents

Section 1: Lidar Acquisition	2
1.1 Acquisition.....	2
1.2 Acquisition Status Report.....	2
1.3 Acquisition Details.....	2
1.4 Project Purpose	2
1.5 Lidar Flight Line Orientation.....	3
1.6 Acquisition Equipment	4
1.7 Lidar System Acquisition Parameters.....	5
1.8 Airborne GPS Kinematic	6
Section 2: Lidar Processing	7
2.1 Generation of Laser Points.....	7
2.2 Coordinate Reference Systems	8
2.3 Lidar Point Cloud Statistics.....	8
2.4 Lidar Classification.....	8
Section 3: Relative Accuracy Assessment	9
3.1 Expected Horizontal Positional Error	9
3.2 Calibration of Lidar Point Cloud	9
3.3 Relative Vertical Accuracy	9
3.4 Interswath Accuracy Results	11
Section 4: Vertical Accuracy Assessment	23
4.1 Ground Surveyed Control Points.....	23
4.2 Vertical Accuracy.....	23
4.3 Control Point Distribution	24
4.4 Control Point Assessment	25
4.5 Vertical Accuracy Results	31
Section 5: Certification.....	32
5.1 Limitations of Use	32
Section 6: GPS Processing	33



Section 1: Lidar Acquisition

1.1 Acquisition

The Atlantic Group, LLC (Atlantic) has successfully completed lidar acquisition for the Colville and Idaho Panhandle National Forests areas of interest (AOI). Lidar for this AOI was acquired in forty-one (41) flight missions completed on October 12th, 2016. The project area encompasses 1,208,613 acres, 4,891 square kilometers or 1,888 square miles.

1.2 Acquisition Status Report

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

1.3 Acquisition Details

Atlantic acquired one thousand five hundred (1,500) passes of the AOI as a series of perpendicular and/or adjacent flight lines. The flight plan included zigzag flight line collection as a result of the inherent IMU drift associated with all IMU systems. Differential GPS unit in aircraft recorded sample positions at 2 Hz or more frequency. Lidar data was only acquired when GPS PDOP was ≤ 4 and at least 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.

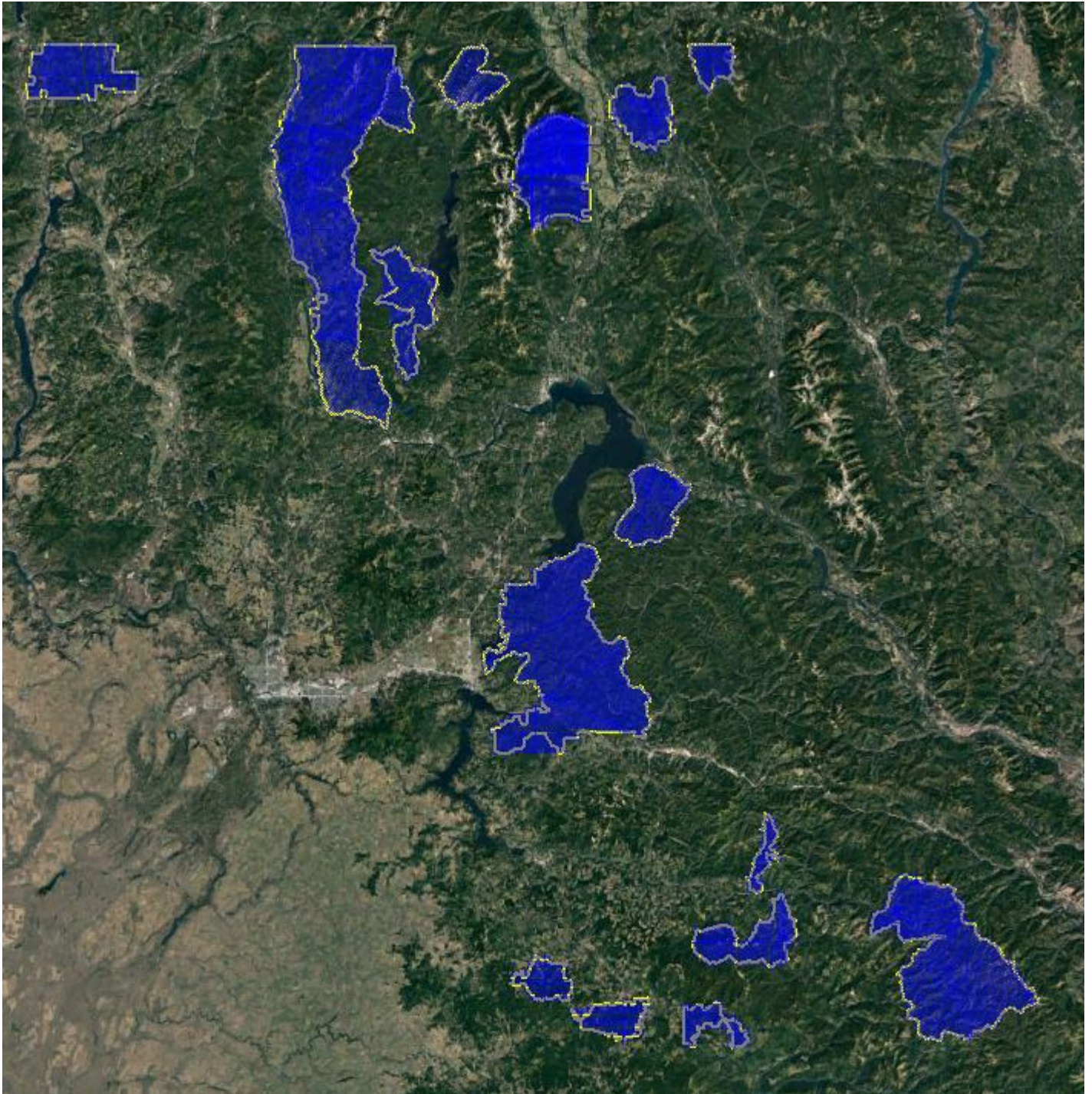


Figure 1: Trajectories as flown by Atlantic

1.6 Acquisition Equipment

Atlantic operated a Cessna T210L (N732JE) and a Partenavia S.P.A. P 68 C/TC (N775MW) outfitted with Leica ALS70-HP lidar systems 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)	0.5
Nominal Pulse Density (pls/m ²)	4.2
Nominal Flight Height (AGL meters)	1965
Nominal Flight Speed (kts)	110
Pass Heading (degree)	0
Sensor Scan Angle (degree)	30
Scan Frequency (Hz)	41.0
Pulse Rate of Scanner (kHz)	278.0
Line Spacing (m)	465
Pulse Duration of Scanner (ns)	4
Pulse Width of Scanner (m)	0.43
Central Wavelength of Sensor Laser (nm)	1064
Sensor Operated with Multiple Pulses	Varies
Beam Divergence (mrad)	0.22
Nominal Swath Width (m)	1098
Nominal Swath Overlap (%)	50
Scan Pattern	Triangle

Table 2: Atlantic Lidar System Acquisition Parameters



1.8 Airborne GPS Kinematic

Differential GPS unit in aircraft collected positions at 2 Hz. Airborne GPS data was processed using the Inertial Explorer (version 8.60.5025) software. Flights were flown with a minimum of 6 satellites in view (10° above the horizon) and with a PDOP of ≤ 4 when the laser was online.

For all flights, the GPS data can be classified as good, with GPS 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 GPS, aircraft trajectory, mission information, and ground control files are reviewed and logged into a database.

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

Section 2: Lidar Processing

2.1 Generation of Laser Points

Atlantic used a combination of Waypoint and Leica software products to extract the lidar swath data from the raw flight records. Waypoint Inertial Explorer is used to extract the raw IPAS ABGPS/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 (*.las) formatted swath point clouds.

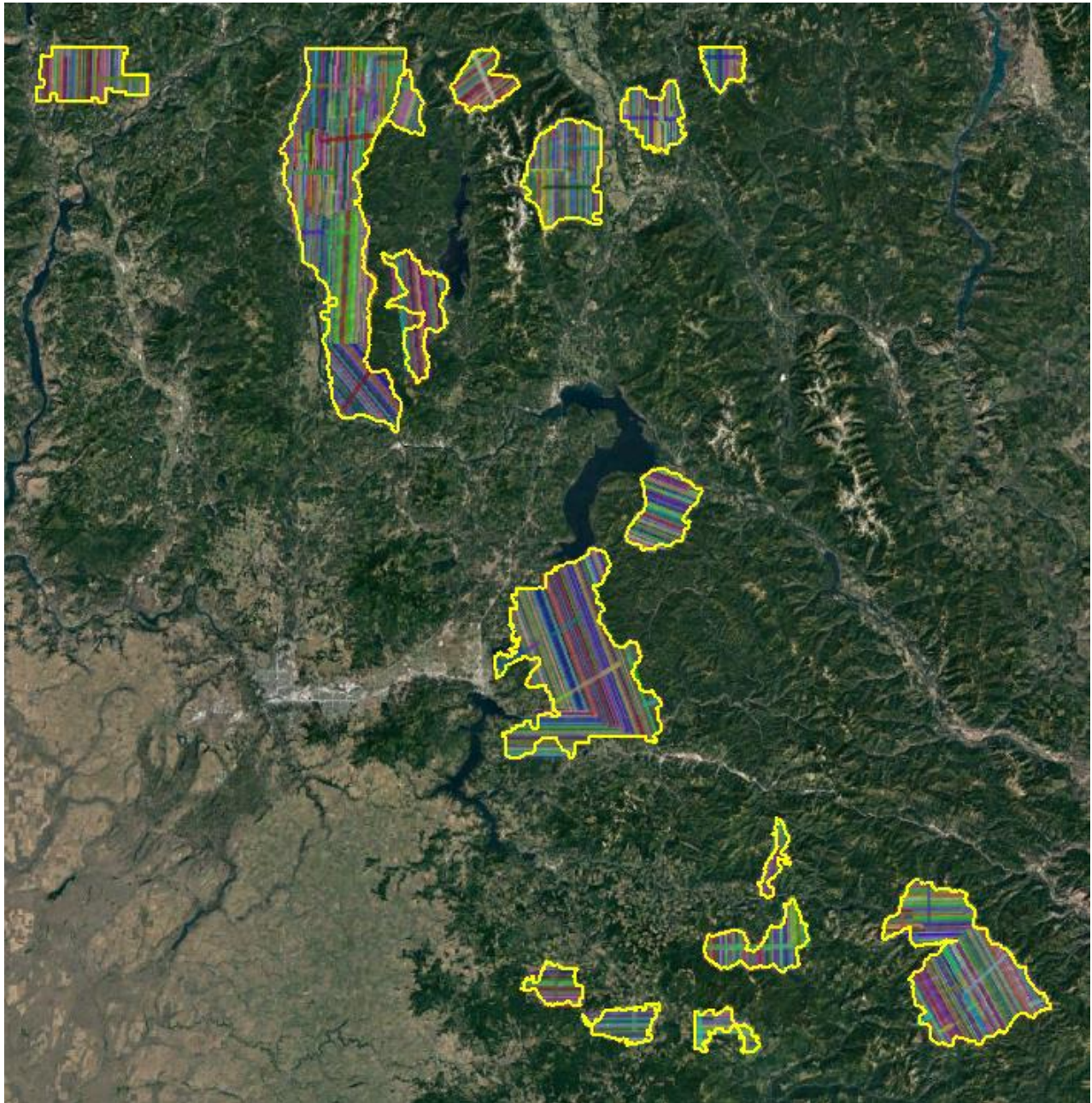


Figure 2: Lidar swath data showing complete coverage

2.2 Coordinate Reference Systems

Horizontal Datum:	North American Datum of 1983
Coordinate System:	United States Forestry Service Region 6 Albers
Vertical Datum:	North American Vertical Datum of 1988
Geoid Model:	Geoid12B
Units of Reference:	Meters
Horizontal Datum:	North American Datum of 1983
Coordinate System:	Universal Transverse Mercator Northern Zone 11
Vertical Datum:	North American Vertical Datum of 1988
Geoid Model:	Geoid12B
Units of Reference:	Meters

2.3 Lidar Point Cloud Statistics

Table 3 illustrates the overall lidar point cloud statistics for this project.

Point Cloud Statistics	
Category	Value
Total Points	105,474,882,332
Nominal Pulse Spacing (m)	0.4857
Nominal Pulse Density (pls/m ²)	4.24
Nominal Pulse Spacing (ft)	1.5936
Nominal Pulse Density (pls/ft ²)	0.39
Total Aggregate Points	91,577,557,817
Aggregate Nominal Pulse Spacing (m)	0.2779
Aggregate Nominal Pulse Density (pls/m ²)	12.95
Aggregate Nominal Pulse Spacing (ft)	0.9116
Aggregate Nominal Pulse Density (pls/ft ²)	1.20

Table 3: Lidar Point Cloud Statistics

2.4 Lidar Classification

The calibrated point cloud data from the laser sensor was merged to produce processed (*.las) file(s) including but not limited to 3D position, intensity, and time-stamp. A filtering methodology was utilized to produce a multi-return surface elevation model dataset with bare-earth conditions. GeoCue, TerraScan, and TerraModeler software was used for the initial batch processing and manual editing of the (*.las) point clouds. Outlined in Table 4 are the classification codes utilized for this project.

ASPRS Standard Lidar Point Classes	
Code	Description
1	Unclassified
2	Ground
7	Low Noise

Table 4: Point Cloud Classification Scheme

Section 3: Relative Accuracy Assessment

3.1 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 1,965m; the expected radial horizontal positional error will be $RMSE_r = 28.5\text{cm}$.

3.2 Calibration of Lidar Point Cloud

LiDAR ranging data were initially calibrated using previous best parameters for this instrument and aircraft. Using a combination of GeoCue, and TerraSolid's 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 2 cm or less. A final analysis of the calibrated LiDAR is preformed using a TerraMatch Tie Line report for an overall statistical model of the project area.

3.3 Relative Vertical Accuracy

Upon completion of the data calibration, Atlantic runs a complete set of Delta-Z (dZ) ortho images. 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 interswath accuracy 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.

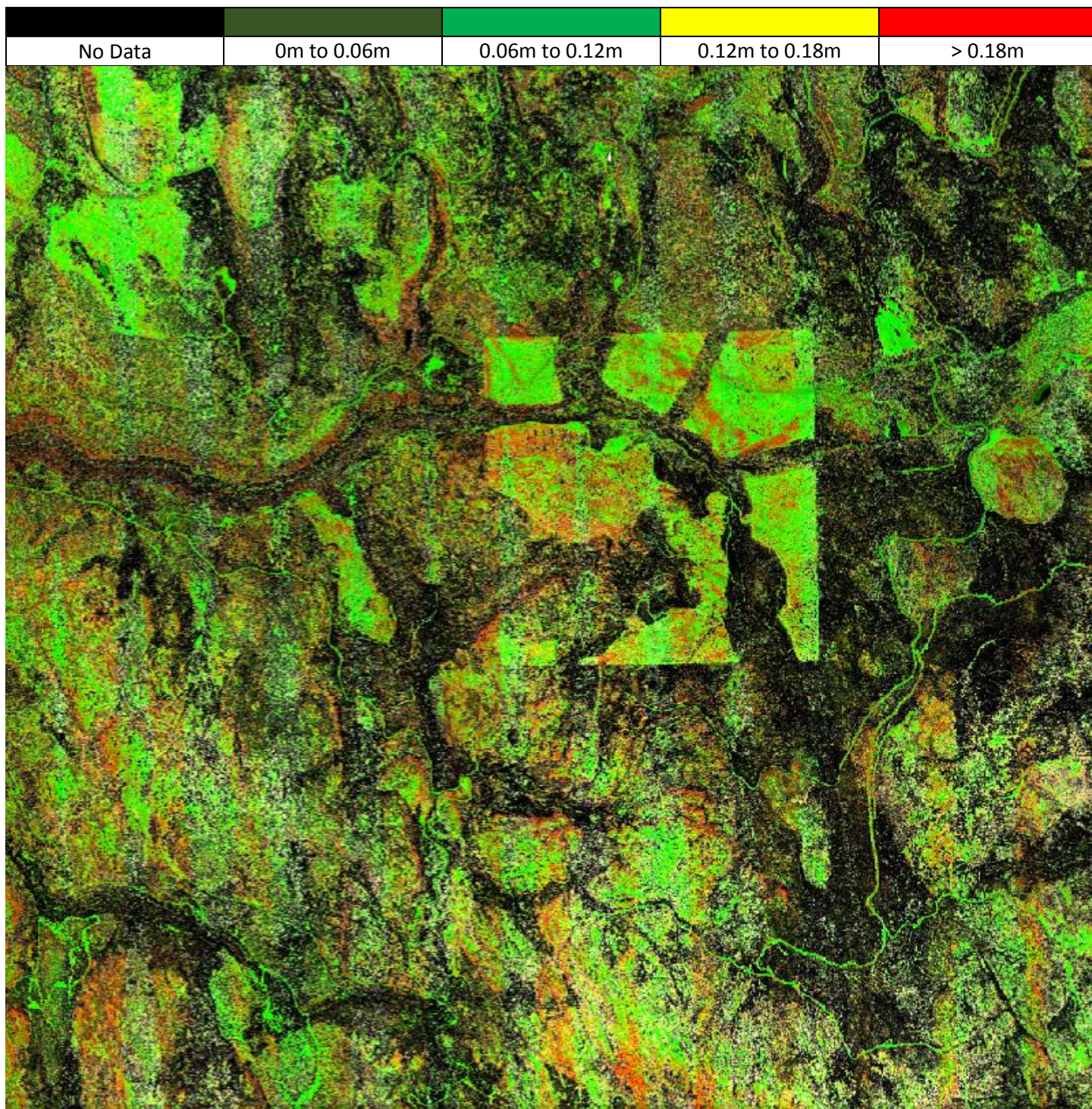


Figure 3: dZ ortho sample



3.4 Interswath Accuracy Results

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.

Average Magnitudes Per Line											
Line	X	Y	Z	Line	X	Y	Z	Line	X	Y	Z
1	-	-	0.017	165	-	-	0.024	328	-	-	0.021
2	-	-	0.019	166	0.050	0.013	0.025	329	-	-	0.022
3	-	-	0.022	167	-	-	0.024	330	-	-	0.027
4	-	-	0.022	168	-	-	0.026	331	-	-	0.026
5	-	-	0.019	169	-	-	0.024	332	-	-	0.024
6	-	-	0.021	170	-	-	0.024	333	-	-	0.025
7	-	-	0.021	171	-	-	0.023	334	-	-	0.021
8	-	-	0.020	172	-	-	0.024	335	-	-	0.028
9	-	-	0.019	173	-	-	0.022	336	-	-	0.024
10	-	-	0.022	174	-	-	0.025	337	-	-	0.024
11	0.005	0.003	0.021	175	-	-	0.025	338	-	-	0.025
12	0.018	0.004	0.023	176	-	-	0.024	339	-	-	0.024
13	0.008	0.013	0.020	177	-	-	0.027	340	-	-	0.026
14	0.031	0.027	0.023	178	0.031	0.061	0.025	341	-	-	0.024
15	0.002	0.012	0.023	179	0.032	0.062	0.023	342	-	-	0.017
16	0.039	0.076	0.021	180	-	-	0.024	343	-	-	0.024
17	0.011	0.019	0.020	181	-	-	0.025	344	-	-	0.027
18	0.022	0.016	0.019	182	-	-	0.021	345	-	-	0.024
19	0.022	0.021	0.021	183	-	-	0.024	346	-	-	0.022
20	0.024	0.028	0.020	184	-	-	0.027	347	-	-	0.017
21	0.017	0.026	0.021	185	-	-	0.029	348	-	-	0.027
22	0.030	0.040	0.019	186	-	-	0.026	349	-	-	0.032
23	0.023	0.033	0.021	187	-	-	0.027	350	-	-	0.034
24	0.026	0.021	0.021	188	0.000	0.000	0.025	351	-	-	0.032
25	0.024	0.020	0.021	189	0.006	0.029	0.027	352	-	-	0.028
26	0.025	0.023	0.019	190	0.013	0.020	0.023	353	-	-	0.027
27	0.021	0.025	0.019	191	0.022	0.018	0.021	354	-	-	0.030
28	0.028	0.029	0.021	192	0.031	0.030	0.021	355	-	-	0.032
29	0.029	0.036	0.024	193	0.045	0.016	0.020	356	-	-	0.030
30	0.012	0.019	0.022	194	0.009	0.001	0.019	357	-	-	0.024
31	0.017	0.013	0.019	195	0.033	0.004	0.021	358	-	-	0.023
32	0.025	0.016	0.018	196	0.137	0.013	0.021	359	-	-	0.028
33	0.026	0.019	0.018	197	0.037	0.020	0.028	360	-	-	0.037
34	0.015	0.014	0.019	198	-	-	0.030	361	-	-	0.027
35	0.022	0.016	0.018	199	-	-	0.025	362	-	-	0.030
36	0.019	0.017	0.017	200	-	-	0.024	363	-	-	0.028
37	0.017	0.016	0.017	201	-	-	0.025	364	-	-	0.028



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

38	0.023	0.024	0.019	202	-	-	0.025	365	-	-	0.029
39	0.021	0.027	0.017	203	-	-	0.025	366	-	-	0.031
40	0.021	0.030	0.018	204	-	-	0.025	367	-	-	0.029
41	0.026	0.040	0.016	205	-	-	0.023	368	-	-	0.031
42	0.024	0.020	0.023	206	-	-	0.026	369	-	-	0.032
43	-	-	0.025	207	-	-	0.026	370	-	-	0.027
44	0.056	0.023	0.020	208	-	-	0.024	371	-	-	0.030
45	0.021	0.013	0.021	209	-	-	0.027	372	-	-	0.033
46	-	-	0.021	210	-	-	0.031	373	-	-	0.032
47	-	-	0.023	211	-	-	0.031	374	-	-	0.033
48	-	-	0.022	212	-	-	0.031	375	-	-	0.030
49	-	-	0.022	213	-	-	0.033	376	-	-	0.030
50	-	-	0.025	214	-	-	0.027	377	-	-	0.029
51	-	-	0.024	215	-	-	0.028	378	-	-	0.030
52	-	-	0.026	216	-	-	0.030	379	-	-	0.030
53	-	-	0.023	217	-	-	0.027	380	-	-	0.070
54	-	-	0.021	218	-	-	0.026	381	-	-	0.021
55	-	-	0.022	219	-	-	0.029	382	-	-	0.022
56	0.028	0.027	0.021	220	-	-	0.027	383	-	-	0.024
57	0.026	0.033	0.020	221	-	-	0.027	384	-	-	0.020
58	0.021	0.027	0.020	222	-	-	0.028	385	-	-	0.023
59	0.021	0.021	0.018	223	-	-	0.028	386	-	-	0.022
60	0.019	0.017	0.018	224	-	-	0.029	387	-	-	0.023
61	0.021	0.020	0.019	225	0.035	0.037	0.026	388	-	-	0.024
62	0.022	0.023	0.018	226	-	-	0.029	389	-	-	0.023
63	0.019	0.021	0.019	227	-	-	0.027	390	-	-	0.026
64	0.023	0.018	0.017	228	-	-	0.029	391	-	-	0.024
65	0.069	0.013	0.021	229	-	-	0.025	392	-	-	0.025
66	0.017	0.021	0.022	230	-	-	0.025	393	-	-	0.024
67	0.019	0.021	0.023	231	-	-	0.028	394	-	-	0.025
68	0.019	0.018	0.022	232	0.053	0.111	0.028	395	-	-	0.026
69	0.028	0.019	0.023	233	-	-	0.027	396	-	-	0.030
70	0.028	0.016	0.023	234	-	-	0.024	397	-	-	0.036
71	0.019	0.014	0.023	235	-	-	0.026	398	-	-	0.030
72	0.020	0.020	0.019	236	0.056	0.108	0.022	399	-	-	0.023
73	0.026	0.022	0.022	237	-	-	0.025	400	0.011	0.008	0.018
74	0.025	0.026	0.022	238	-	-	0.024	401	-	-	0.019
75	0.023	0.019	0.020	239	-	-	0.024	402	-	-	0.018
76	0.027	0.037	0.022	240	-	-	0.024	403	0.007	0.021	0.022
77	0.050	0.081	0.022	241	-	-	0.025	404	0.007	0.031	0.021
78	0.018	0.018	0.019	242	-	-	0.023	405	0.012	0.008	0.021
79	0.025	0.020	0.020	243	-	-	0.027	406	0.028	0.010	0.022
80	0.030	0.023	0.020	244	-	-	0.025	407	0.018	0.028	0.021
81	0.029	0.023	0.020	245	-	-	0.026	408	0.012	0.013	0.020



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

82	0.025	0.020	0.020	246	-	-	0.026	409	0.020	0.025	0.021
83	0.023	0.020	0.023	247	-	-	0.025	410	0.012	0.019	0.021
84	0.034	0.022	0.022	248	-	-	0.025	411	0.035	0.009	0.021
85	0.019	0.025	0.021	249	-	-	0.024	412	-	-	0.022
86	0.026	0.032	0.021	250	-	-	0.025	413	-	-	0.022
87	0.020	0.018	0.022	251	-	-	0.022	414	-	-	0.025
88	0.018	0.009	0.021	252	-	-	0.024	415	0.025	0.009	0.020
89	0.013	0.020	0.020	253	-	-	0.022	416	0.025	0.009	0.023
90	-	-	0.021	254	-	-	0.021	417	-	-	0.022
91	0.022	0.026	0.020	255	-	-	0.020	418	-	-	0.022
92	0.015	0.023	0.020	256	-	-	0.024	419	-	-	0.021
93	0.015	0.016	0.021	257	-	-	0.026	420	-	-	0.022
94	0.015	0.025	0.022	258	-	-	0.021	421	-	-	0.022
95	0.041	0.038	0.018	259	-	-	0.024	422	-	-	0.023
96	0.027	0.025	0.024	260	-	-	0.022	423	-	-	0.023
97	0.089	0.035	0.027	261	-	-	0.022	424	-	-	0.022
98	-	-	0.024	262	-	-	0.022	425	-	-	0.022
99	-	-	0.018	263	-	-	0.022	426	-	-	0.025
100	-	-	0.022	264	-	-	0.024	427	-	-	0.022
101	-	-	0.021	265	-	-	0.022	428	-	-	0.023
102	-	-	0.019	266	-	-	0.023	429	-	-	0.025
103	-	-	0.022	267	-	-	0.025	430	-	-	0.021
104	-	-	0.022	268	-	-	0.024	431	-	-	0.021
105	-	-	0.022	269	-	-	0.024	432	-	-	0.021
106	-	-	0.021	270	-	-	0.022	433	-	-	0.023
107	-	-	0.022	271	-	-	0.021	434	-	-	0.021
108	-	-	0.019	272	-	-	0.022	435	-	-	0.022
109	-	-	0.022	273	-	-	0.022	436	-	-	0.021
110	-	-	0.024	274	-	-	0.022	437	-	-	0.024
111	-	-	0.021	275	-	-	0.024	438	-	-	0.021
112	-	-	0.024	276	-	-	0.022	439	0.179	0.117	0.023
113	-	-	0.024	277	-	-	0.024	440	0.217	0.121	0.022
114	-	-	0.024	278	-	-	0.023	441	-	-	0.023
115	-	-	0.021	279	-	-	0.027	442	-	-	0.021
116	-	-	0.024	280	-	-	0.023	443	-	-	0.023
117	-	-	0.024	281	-	-	0.026	444	-	-	0.022
118	-	-	0.026	282	-	-	0.025	445	-	-	0.024
119	-	-	0.025	283	-	-	0.027	446	-	-	0.023
120	-	-	0.026	284	-	-	0.026	447	-	-	0.022
121	-	-	0.023	285	-	-	0.022	448	0.007	0.002	0.021
122	-	-	0.025	286	-	-	0.027	449	0.007	0.002	0.023
123	0.051	0.011	0.025	287	0.083	0.006	0.019	450	-	-	0.021
124	-	-	0.025	288	-	-	0.022	451	-	-	0.022
125	0.044	0.008	0.024	289	-	-	0.020	452	-	-	0.021



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

126	-	-	0.027	290	-	-	0.019	453	-	-	0.023
127	-	-	0.025	291	-	-	0.022	454	-	-	0.024
128	-	-	0.026	292	-	-	0.024	455	-	-	0.024
130	-	-	0.026	293	-	-	0.020	456	0.018	0.038	0.023
131	0.028	0.027	0.019	294	-	-	0.019	457	0.012	0.038	0.022
132	0.027	0.026	0.019	295	-	-	0.019	458	0.001	0.034	0.022
133	0.031	0.023	0.022	296	-	-	0.025	459	0.000	0.029	0.022
134	0.030	0.041	0.022	297	-	-	0.022	460	-	-	0.023
135	-	-	0.021	298	-	-	0.022	461	-	-	0.020
136	0.037	0.001	0.021	299	-	-	0.021	462	0.032	0.001	0.020
137	0.027	0.009	0.021	300	-	-	0.024	463	-	-	0.023
138	0.022	0.013	0.022	301	-	-	0.020	464	0.032	0.001	0.024
139	-	-	0.022	302	-	-	0.022	465	-	-	0.024
140	-	-	0.022	303	-	-	0.024	466	-	-	0.024
141	-	-	0.023	304	-	-	0.021	467	-	-	0.024
142	-	-	0.022	305	-	-	0.020	468	-	-	0.024
143	-	-	0.024	306	-	-	0.023	469	-	-	0.024
144	-	-	0.025	307	-	-	0.022	470	-	-	0.024
145	0.019	0.026	0.022	308	-	-	0.023	471	-	-	0.025
146	0.036	0.045	0.022	309	-	-	0.022	472	-	-	0.024
147	0.040	0.039	0.023	310	-	-	0.025	473	-	-	0.023
148	-	-	0.017	311	-	-	0.024	474	-	-	0.023
149	-	-	0.020	312	-	-	0.024	475	-	-	0.018
150	0.029	0.023	0.020	313	-	-	0.028	476	-	-	0.025
151	0.015	0.015	0.021	314	-	-	0.025	477	-	-	0.013
152	0.021	0.022	0.022	315	-	-	0.027	478	-	-	0.019
153	0.023	0.020	0.022	316	-	-	0.020	479	-	-	0.019
154	0.023	0.023	0.022	317	-	-	0.020	480	-	-	0.022
155	0.034	0.027	0.022	318	-	-	0.022	481	-	-	0.028
156	0.027	0.029	0.024	319	-	-	0.024	482	-	-	0.023
157	0.027	0.015	0.023	320	-	-	0.022	483	-	-	0.028
158	0.054	0.025	0.024	321	-	-	0.021	484	-	-	0.020
159	0.057	0.031	0.023	322	-	-	0.023	485	-	-	0.024
160	0.019	0.011	0.025	323	-	-	0.023	486	-	-	0.026
161	0.059	0.029	0.024	324	-	-	0.022	487	-	-	0.024
162	0.023	0.023	0.023	325	-	-	0.025	488	-	-	0.016
163	0.027	0.026	0.022	326	-	-	0.023	489	-	-	0.024
164	0.021	0.022	0.024	327	-	-	0.020				
1	0.039	0.035	0.028	343	-	-	0.021	683	-	-	0.031
2	-	-	0.018	344	-	-	0.021	684	-	-	0.028
3	0.005	0.001	0.019	345	-	-	0.022	685	-	-	0.029
4	0.005	0.001	0.021	346	-	-	0.023	686	-	-	0.027
5	-	-	0.022	347	-	-	0.022	687	-	-	0.023
6	0.024	0.014	0.021	348	-	-	0.021	688	-	-	0.028



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

7	0.018	0.023	0.021	349	-	-	0.024	689	-	-	0.027
8	0.013	0.004	0.021	350	-	-	0.024	690	-	-	0.027
9	0.015	0.027	0.021	351	-	-	0.024	691	-	-	0.034
10	-	-	0.022	352	-	-	0.022	692	-	-	0.025
11	-	-	0.021	353	-	-	0.022	693	-	-	0.027
12	-	-	0.021	354	-	-	0.021	694	-	-	0.023
13	0.019	0.040	0.022	355	-	-	0.021	695	-	-	0.024
14	0.030	0.011	0.021	356	-	-	0.020	696	-	-	0.022
15	0.017	0.032	0.022	357	-	-	0.023	697	-	-	0.023
16	0.021	0.018	0.020	358	-	-	0.021	698	-	-	0.025
17	0.023	0.015	0.022	359	-	-	0.021	699	-	-	0.025
18	0.023	0.015	0.022	360	-	-	0.021	700	-	-	0.026
19	0.024	0.022	0.023	361	-	-	0.020	701	-	-	0.028
20	0.029	0.040	0.026	362	-	-	0.021	702	-	-	0.025
21	0.021	0.021	0.018	363	-	-	0.022	703	-	-	0.027
22	0.008	0.002	0.016	364	-	-	0.021	704	-	-	0.025
23	0.005	0.002	0.016	365	-	-	0.021	705	-	-	0.025
24	0.011	0.008	0.017	366	-	-	0.020	706	-	-	0.025
25	0.010	0.008	0.017	367	-	-	0.020	707	-	-	0.023
26	0.012	0.013	0.017	368	-	-	0.020	708	-	-	0.027
27	0.004	0.009	0.018	369	-	-	0.020	709	-	-	0.026
28	0.023	0.048	0.017	370	-	-	0.021	710	-	-	0.024
29	0.006	0.018	0.019	371	-	-	0.020	711	-	-	0.025
30	0.013	0.025	0.018	372	-	-	0.020	712	-	-	0.025
31	0.013	0.020	0.017	373	-	-	0.019	713	-	-	0.024
32	0.015	0.018	0.018	374	-	-	0.021	714	-	-	0.023
33	0.012	0.017	0.018	375	-	-	0.023	715	-	-	0.022
34	-	-	0.020	376	-	-	0.021	716	-	-	0.022
35	-	-	0.016	377	-	-	0.022	717	-	-	0.020
36	-	-	0.025	378	-	-	0.021	718	-	-	0.026
37	-	-	0.023	379	-	-	0.021	719	-	-	0.023
38	-	-	0.015	380	-	-	0.018	720	-	-	0.022
39	-	-	0.014	381	-	-	0.020	721	-	-	0.024
40	0.010	0.008	0.014	382	-	-	0.019	722	-	-	0.023
41	0.012	0.010	0.017	383	-	-	0.019	723	-	-	0.024
42	0.012	0.010	0.017	384	-	-	0.017	724	-	-	0.022
43	0.010	0.014	0.015	385	-	-	0.018	725	-	-	0.023
44	0.009	0.012	0.017	386	-	-	0.019	726	-	-	0.021
45	0.011	0.015	0.019	387	-	-	0.019	727	-	-	0.025
46	0.013	0.014	0.017	388	-	-	0.019	728	-	-	0.024
47	0.012	0.011	0.017	389	-	-	0.020	729	-	-	0.024
48	0.024	0.019	0.018	390	-	-	0.019	730	-	-	0.026
49	0.024	0.020	0.019	391	-	-	0.020	731	-	-	0.024
50	0.027	0.026	0.018	392	-	-	0.020	732	-	-	0.019



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

51	0.031	0.022	0.019	393	-	-	0.020	733	-	-	0.024
52	0.022	0.018	0.017	394	-	-	0.019	734	-	-	0.024
53	0.023	0.021	0.018	395	-	-	0.019	735	-	-	0.023
54	0.021	0.019	0.016	396	-	-	0.020	736	-	-	0.023
55	0.022	0.017	0.013	397	-	-	0.022	737	-	-	0.025
56	0.006	0.009	0.019	398	-	-	0.026	738	-	-	0.025
57	0.004	0.015	0.019	399	-	-	0.023	739	-	-	0.024
58	0.016	0.015	0.014	400	-	-	0.025	740	-	-	0.022
59	0.014	0.014	0.015	401	-	-	0.027	741	-	-	0.021
60	0.011	0.017	0.020	402	-	-	0.027	742	-	-	0.024
61	0.009	0.005	0.018	403	-	-	0.017	743	-	-	0.023
62	0.010	0.009	0.015	404	-	-	0.020	744	-	-	0.024
63	0.012	0.011	0.017	405	-	-	0.022	745	-	-	0.025
64	-	-	0.020	406	-	-	0.018	746	-	-	0.021
65	-	-	0.019	407	-	-	0.021	747	-	-	0.023
66	0.012	0.013	0.018	408	-	-	0.022	748	-	-	0.023
67	0.012	0.014	0.018	409	-	-	0.022	749	-	-	0.024
68	0.017	0.015	0.018	410	-	-	0.022	750	-	-	0.022
70	0.013	0.015	0.021	411	-	-	0.022	751	0.027	0.004	0.022
71	0.004	0.017	0.021	412	-	-	0.022	752	-	-	0.034
72	0.015	0.019	0.020	413	-	-	0.022	753	-	-	0.027
73	0.019	0.020	0.020	414	-	-	0.023	754	-	-	0.025
74	0.009	0.009	0.020	415	-	-	0.023	755	-	-	0.025
75	0.017	0.018	0.020	416	-	-	0.023	756	-	-	0.025
76	0.016	0.015	0.020	417	-	-	0.024	757	-	-	0.025
77	0.017	0.021	0.020	418	-	-	0.024	758	-	-	0.025
78	0.012	0.023	0.021	419	-	-	0.026	759	-	-	0.024
79	-	-	0.017	420	-	-	0.022	760	-	-	0.024
80	0.031	0.039	0.022	421	-	-	0.022	761	-	-	0.025
81	-	-	0.026	422	-	-	0.022	762	-	-	0.025
83	-	-	0.028	423	-	-	0.023	763	-	-	0.027
84	-	-	0.024	424	-	-	0.023	764	-	-	0.027
85	-	-	0.023	425	-	-	0.023	765	-	-	0.026
86	-	-	0.021	426	-	-	0.022	766	-	-	0.027
87	-	-	0.022	427	-	-	0.022	767	-	-	0.025
88	-	-	0.022	428	-	-	0.022	768	-	-	0.027
89	0.014	0.059	0.023	429	-	-	0.021	769	-	-	0.026
90	0.010	0.021	0.024	430	-	-	0.023	770	-	-	0.033
91	-	-	0.023	431	-	-	0.023	771	-	-	0.027
92	-	-	0.023	432	-	-	0.022	772	-	-	0.026
93	-	-	0.022	433	-	-	0.022	773	-	-	0.026
94	-	-	0.021	434	-	-	0.022	774	-	-	0.027
95	-	-	0.022	435	-	-	0.023	775	-	-	0.025
96	-	-	0.023	436	-	-	0.020	776	-	-	0.023



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

97	-	-	0.024	437	-	-	0.022	777	-	-	0.024
98	-	-	0.022	438	-	-	0.020	778	-	-	0.025
99	-	-	0.022	439	-	-	0.022	779	-	-	0.023
100	-	-	0.022	440	0.028	0.004	0.021	780	-	-	0.022
101	-	-	0.023	441	-	-	0.020	781	-	-	0.023
102	-	-	0.022	442	0.028	0.004	0.020	782	-	-	0.025
103	-	-	0.023	443	-	-	0.022	783	-	-	0.025
104	0.003	0.007	0.022	444	-	-	0.020	784	-	-	0.024
105	0.002	0.007	0.023	445	-	-	0.021	785	-	-	0.023
106	-	-	0.023	446	-	-	0.021	786	-	-	0.027
107	-	-	0.023	447	-	-	0.022	787	-	-	0.032
108	-	-	0.023	448	-	-	0.023	788	-	-	0.026
109	-	-	0.022	449	0.015	0.011	0.020	789	-	-	0.027
110	-	-	0.026	450	0.018	0.017	0.022	790	-	-	0.022
111	-	-	0.023	451	0.012	0.009	0.020	791	-	-	0.025
112	-	-	0.022	452	0.009	0.010	0.021	792	-	-	0.026
113	-	-	0.020	453	-	-	0.020	793	-	-	0.025
114	-	-	0.020	454	-	-	0.022	794	-	-	0.027
115	-	-	0.022	455	-	-	0.023	795	-	-	0.027
116	-	-	0.020	456	-	-	0.021	796	-	-	0.029
117	-	-	0.021	457	-	-	0.023	797	-	-	0.027
118	-	-	0.021	458	-	-	0.021	798	-	-	0.027
119	0.031	0.043	0.021	459	-	-	0.023	799	-	-	0.023
120	0.018	0.024	0.022	460	-	-	0.024	800	-	-	0.026
121	0.042	0.048	0.021	461	-	-	0.022	801	-	-	0.026
122	0.033	0.010	0.022	462	-	-	0.018	802	-	-	0.027
123	0.012	0.004	0.022	463	-	-	0.019	803	-	-	0.026
124	0.011	0.009	0.021	464	0.025	0.020	0.027	804	-	-	0.032
125	0.016	0.014	0.021	465	0.007	0.040	0.019	805	-	-	0.029
126	0.015	0.011	0.021	466	0.008	0.044	0.022	806	-	-	0.023
127	0.019	0.027	0.021	467	0.014	0.034	0.019	807	-	-	0.021
128	0.022	0.033	0.021	468	0.019	0.023	0.022	808	-	-	0.022
129	0.016	0.010	0.022	469	0.017	0.019	0.022	809	-	-	0.022
130	0.022	0.015	0.022	470	0.019	0.026	0.022	810	-	-	0.026
131	-	-	0.023	471	0.022	0.028	0.023	811	-	-	0.030
132	0.049	0.010	0.022	472	0.021	0.030	0.021	812	-	-	0.025
133	0.009	0.000	0.021	473	0.018	0.033	0.022	813	-	-	0.026
134	0.011	0.015	0.022	474	0.005	0.008	0.022	814	-	-	0.028
135	0.010	0.034	0.023	475	-	-	0.020	815	-	-	0.030
136	-	-	0.023	476	-	-	0.022	816	-	-	0.035
137	-	-	0.021	477	0.020	0.021	0.023	817	-	-	0.029
138	0.016	0.002	0.021	478	0.003	0.007	0.023	818	-	-	0.030
139	0.017	0.010	0.020	479	0.011	0.018	0.023	819	-	-	0.031
140	0.015	0.018	0.020	480	0.002	0.004	0.022	820	-	-	0.031



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

141	0.012	0.022	0.020	481	0.012	0.017	0.023	821	-	-	0.036
142	0.013	0.016	0.020	482	0.021	0.039	0.023	822	-	-	0.035
143	0.011	0.017	0.021	483	0.008	0.026	0.023	823	-	-	0.033
144	0.017	0.026	0.021	484	0.006	0.029	0.023	824	-	-	0.029
145	-	-	0.023	485	0.024	0.041	0.023	825	-	-	0.029
146	0.023	0.024	0.026	486	0.013	0.022	0.025	826	-	-	0.027
147	-	-	0.024	487	0.016	0.013	0.024	827	-	-	0.027
148	-	-	0.023	488	0.003	0.018	0.023	828	-	-	0.027
149	0.012	0.018	0.023	489	0.013	0.022	0.024	829	-	-	0.026
150	-	-	0.022	490	-	-	0.023	830	-	-	0.030
152	-	-	0.027	491	-	-	0.024	831	-	-	0.032
153	-	-	0.020	492	-	-	0.023	832	-	-	0.032
154	-	-	0.024	493	-	-	0.022	833	-	-	0.023
155	-	-	0.020	494	-	-	0.023	834	-	-	0.025
156	-	-	0.020	495	-	-	0.025	835	-	-	0.022
157	-	-	0.021	496	-	-	0.022	836	-	-	0.023
158	-	-	0.016	497	-	-	0.021	837	-	-	0.020
159	-	-	0.026	498	-	-	0.022	838	-	-	0.022
160	-	-	0.023	499	-	-	0.025	839	-	-	0.021
161	-	-	0.022	500	-	-	0.025	840	-	-	0.025
162	-	-	0.023	501	-	-	0.025	841	-	-	0.024
163	-	-	0.023	502	-	-	0.024	842	-	-	0.024
164	-	-	0.023	503	-	-	0.025	843	-	-	0.024
165	-	-	0.018	504	-	-	0.025	844	-	-	0.035
166	-	-	0.022	505	-	-	0.027	845	-	-	0.023
167	-	-	0.021	506	-	-	0.026	846	-	-	0.026
168	-	-	0.022	507	-	-	0.021	847	-	-	0.024
169	-	-	0.022	508	-	-	0.024	848	-	-	0.020
170	-	-	0.023	509	0.007	0.023	0.016	849	-	-	0.024
171	0.022	0.019	0.021	510	0.011	0.025	0.018	850	-	-	0.022
172	0.020	0.017	0.022	511	0.008	0.018	0.021	851	-	-	0.024
173	0.017	0.015	0.020	512	0.022	0.027	0.018	852	-	-	0.020
174	0.028	0.025	0.022	513	0.019	0.028	0.020	853	-	-	0.022
175	0.020	0.016	0.022	514	0.018	0.031	0.021	854	-	-	0.020
176	0.026	0.025	0.023	515	-	-	0.022	855	-	-	0.022
177	-	-	0.022	516	0.028	0.015	0.024	856	-	-	0.021
178	-	-	0.024	517	-	-	0.024	857	-	-	0.023
179	-	-	0.019	518	-	-	0.024	858	-	-	0.021
180	-	-	0.021	519	-	-	0.024	859	-	-	0.023
181	-	-	0.022	520	-	-	0.025	860	-	-	0.021
182	-	-	0.024	521	-	-	0.025	861	-	-	0.025
183	-	-	0.023	522	-	-	0.024	862	-	-	0.024
184	-	-	0.021	523	-	-	0.029	863	-	-	0.024
185	-	-	0.021	524	-	-	0.026	864	-	-	0.023



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

186	-	-	0.022	525	-	-	0.022	865	-	-	0.025
187	-	-	0.022	526	0.004	0.035	0.028	866	-	-	0.023
188	-	-	0.023	527	0.008	0.022	0.023	867	-	-	0.026
189	-	-	0.022	528	0.042	0.097	0.028	868	-	-	0.024
190	-	-	0.023	529	-	-	0.022	869	-	-	0.025
191	-	-	0.023	530	0.017	0.026	0.020	870	-	-	0.024
192	-	-	0.023	531	0.014	0.027	0.023	871	-	-	0.024
193	-	-	0.022	532	-	-	0.024	872	-	-	0.024
194	-	-	0.023	533	0.010	0.025	0.024	873	-	-	0.024
195	-	-	0.023	534	0.021	0.028	0.024	874	-	-	0.024
196	-	-	0.023	535	0.078	0.026	0.024	875	-	-	0.026
197	-	-	0.023	536	0.010	0.058	0.023	876	-	-	0.024
198	-	-	0.022	537	0.062	0.043	0.024	877	-	-	0.025
199	-	-	0.022	538	0.053	0.081	0.027	878	-	-	0.024
200	-	-	0.022	539	0.034	0.031	0.025	879	-	-	0.029
201	-	-	0.022	540	0.048	0.023	0.015	880	-	-	0.023
202	-	-	0.023	541	0.039	0.027	0.019	881	-	-	0.024
203	-	-	0.022	542	0.023	0.021	0.019	882	-	-	0.025
204	-	-	0.024	543	0.018	0.041	0.021	883	-	-	0.027
205	-	-	0.023	544	0.020	0.047	0.022	884	-	-	0.026
206	-	-	0.024	545	0.034	0.041	0.020	885	-	-	0.024
207	-	-	0.016	546	-	-	0.025	886	-	-	0.024
208	0.034	0.028	0.019	547	-	-	0.023	887	-	-	0.024
209	0.029	0.029	0.016	548	-	-	0.022	888	-	-	0.027
210	0.022	0.024	0.018	549	-	-	0.022	889	-	-	0.023
211	0.010	0.016	0.018	550	-	-	0.022	890	-	-	0.023
212	0.011	0.013	0.018	551	-	-	0.024	891	-	-	0.021
213	0.007	0.017	0.016	552	-	-	0.022	892	-	-	0.022
214	0.018	0.021	0.018	553	-	-	0.023	893	-	-	0.020
215	0.029	0.016	0.019	554	-	-	0.024	894	-	-	0.028
216	0.028	0.021	0.021	555	-	-	0.019	895	-	-	0.021
217	-	-	0.023	556	-	-	0.023	896	-	-	0.023
218	-	-	0.023	557	-	-	0.024	897	-	-	0.025
219	-	-	0.022	558	-	-	0.026	898	-	-	0.024
220	-	-	0.021	559	-	-	0.022	899	-	-	0.022
221	-	-	0.022	560	-	-	0.022	900	-	-	0.025
222	-	-	0.020	561	-	-	0.021	901	-	-	0.025
223	-	-	0.022	562	-	-	0.021	902	-	-	0.023
224	-	-	0.023	563	0.017	0.014	0.017	903	-	-	0.023
225	-	-	0.022	564	0.007	0.037	0.020	904	-	-	0.023
226	-	-	0.023	565	0.018	0.012	0.022	905	-	-	0.023
227	-	-	0.021	566	0.008	0.029	0.021	906	-	-	0.022
228	-	-	0.021	567	0.014	0.026	0.021	907	-	-	0.026
229	-	-	0.022	568	0.008	0.029	0.024	908	-	-	0.025



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

230	-	-	0.022	569	0.007	0.028	0.020	909	-	-	0.023
231	0.030	0.007	0.022	570	0.011	0.034	0.024	910	-	-	0.022
232	-	-	0.023	571	0.030	0.079	0.024	911	-	-	0.022
233	0.021	0.007	0.022	572	0.005	0.037	0.025	912	-	-	0.027
234	0.024	0.010	0.021	573	0.024	0.023	0.025	913	-	-	0.025
235	0.024	0.012	0.023	574	0.064	0.062	0.027	914	-	-	0.026
236	-	-	0.022	575	-	-	0.023	915	-	-	0.023
237	-	-	0.022	576	-	-	0.028	916	-	-	0.024
238	-	-	0.022	577	-	-	0.027	917	-	-	0.022
239	-	-	0.022	578	-	-	0.025	918	-	-	0.026
240	-	-	0.022	579	0.080	0.070	0.024	919	-	-	0.022
241	-	-	0.022	580	0.044	0.047	0.028	920	-	-	0.029
242	-	-	0.023	581	0.014	0.039	0.028	921	-	-	0.023
243	-	-	0.022	582	0.020	0.013	0.027	922	-	-	0.023
244	-	-	0.021	583	0.012	0.033	0.026	923	-	-	0.023
245	-	-	0.027	584	0.026	0.024	0.028	924	-	-	0.022
246	-	-	0.024	585	0.017	0.017	0.026	925	-	-	0.024
247	-	-	0.029	586	0.035	0.017	0.024	926	-	-	0.023
248	-	-	0.023	587	0.055	0.047	0.028	927	-	-	0.024
249	-	-	0.019	588	0.046	0.050	0.027	928	-	-	0.023
250	-	-	0.018	591	-	-	0.025	929	-	-	0.024
251	-	-	0.023	592	-	-	0.023	930	-	-	0.023
252	-	-	0.024	593	-	-	0.026	931	-	-	0.023
253	-	-	0.025	594	-	-	0.023	932	-	-	0.023
254	-	-	0.024	595	-	-	0.022	933	-	-	0.022
255	-	-	0.024	596	-	-	0.024	934	-	-	0.022
256	0.018	0.019	0.019	597	-	-	0.024	935	-	-	0.022
257	0.012	0.022	0.020	598	-	-	0.022	936	-	-	0.022
258	0.022	0.019	0.020	599	-	-	0.025	937	-	-	0.022
259	-	-	0.018	600	-	-	0.023	938	-	-	0.022
260	-	-	0.017	601	-	-	0.025	939	-	-	0.022
261	0.079	0.075	0.018	602	-	-	0.022	940	-	-	0.022
263	-	-	0.021	603	-	-	0.023	941	-	-	0.024
264	-	-	0.019	604	-	-	0.026	942	-	-	0.022
265	-	-	0.018	605	0.020	0.023	0.014	943	-	-	0.021
266	-	-	0.019	606	0.034	0.020	0.025	944	-	-	0.022
267	0.003	0.057	0.021	607	-	-	0.024	945	-	-	0.021
268	0.001	0.028	0.023	608	-	-	0.027	946	-	-	0.021
269	0.001	0.030	0.022	609	-	-	0.026	947	-	-	0.020
270	-	-	0.021	610	-	-	0.029	948	-	-	0.023
271	-	-	0.020	611	-	-	0.024	949	-	-	0.023
272	-	-	0.020	612	-	-	0.025	950	-	-	0.023
273	-	-	0.022	613	-	-	0.025	951	-	-	0.023
274	0.001	0.016	0.024	614	-	-	0.026	952	-	-	0.022



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

275	-	-	0.026	615	-	-	0.025	953	-	-	0.021
276	-	-	0.027	616	-	-	0.025	954	-	-	0.024
277	-	-	0.027	617	-	-	0.026	955	-	-	0.027
278	-	-	0.031	618	-	-	0.024	956	-	-	0.025
279	0.030	0.022	0.016	619	-	-	0.019	957	-	-	0.025
280	0.025	0.019	0.019	620	-	-	0.024	958	-	-	0.026
281	0.022	0.016	0.018	621	-	-	0.022	959	-	-	0.030
282	0.029	0.021	0.018	622	-	-	0.025	960	-	-	0.027
283	0.033	0.028	0.019	623	-	-	0.026	961	-	-	0.027
284	0.028	0.008	0.020	624	-	-	0.024	962	-	-	0.030
285	0.020	0.020	0.020	625	-	-	0.025	963	-	-	0.030
286	0.011	0.014	0.020	626	-	-	0.024	964	-	-	0.023
287	0.012	0.012	0.019	627	-	-	0.024	965	-	-	0.022
288	0.016	0.006	0.021	628	-	-	0.024	966	-	-	0.022
289	-	-	0.020	629	-	-	0.025	967	-	-	0.023
290	-	-	0.022	630	-	-	0.027	968	-	-	0.026
291	-	-	0.023	631	-	-	0.026	969	-	-	0.023
292	-	-	0.023	632	-	-	0.026	970	-	-	0.024
293	-	-	0.020	633	-	-	0.024	971	-	-	0.024
294	0.007	0.013	0.021	634	-	-	0.025	972	-	-	0.022
295	0.007	0.013	0.020	635	-	-	0.028	973	0.057	0.087	0.022
296	-	-	0.023	636	-	-	0.028	974	0.026	0.031	0.023
297	-	-	0.021	637	-	-	0.028	975	0.024	0.028	0.023
298	-	-	0.023	638	-	-	0.028	976	-	-	0.031
299	-	-	0.022	639	-	-	0.026	977	-	-	0.044
300	-	-	0.022	640	-	-	0.026	978	-	-	0.032
301	-	-	0.020	641	-	-	0.026	979	-	-	0.015
302	-	-	0.021	642	-	-	0.024	980	-	-	0.022
303	-	-	0.021	643	-	-	0.025	981	-	-	0.019
304	-	-	0.020	644	-	-	0.025	982	-	-	0.021
305	-	-	0.022	645	-	-	0.025	983	-	-	0.024
306	-	-	0.018	646	-	-	0.023	984	-	-	0.023
307	0.041	0.010	0.020	647	-	-	0.025	985	-	-	0.021
308	0.014	0.012	0.021	648	-	-	0.022	986	-	-	0.022
309	0.016	0.041	0.020	649	-	-	0.021	987	-	-	0.021
310	0.011	0.018	0.021	650	-	-	0.020	988	-	-	0.020
311	0.023	0.016	0.021	651	-	-	0.024	989	-	-	0.020
312	0.022	0.018	0.021	652	0.009	0.017	0.021	990	-	-	0.022
313	0.023	0.021	0.020	653	0.009	0.017	0.023	991	-	-	0.025
314	0.003	0.014	0.020	654	-	-	0.023	992	-	-	0.023
315	0.030	0.057	0.020	655	0.041	0.069	0.027	993	-	-	0.021
316	0.022	0.005	0.020	656	0.002	0.003	0.019	994	-	-	0.021
317	0.019	0.005	0.020	657	0.041	0.069	0.025	995	-	-	0.021
318	0.037	0.007	0.021	658	-	-	0.023	996	0.032	0.057	0.021



319	0.037	0.011	0.020	659	-	-	0.024	997	0.032	0.057	0.021
320	0.004	0.011	0.022	660	-	-	0.021	998	-	-	0.021
321	0.018	0.026	0.020	661	-	-	0.026	999	-	-	0.022
322	0.021	0.026	0.021	662	-	-	0.027	1000	-	-	0.024
323	0.041	0.009	0.022	663	-	-	0.030	1001	-	-	0.024
324	-	-	0.022	664	-	-	0.029	1002	-	-	0.025
325	-	-	0.016	665	-	-	0.021	1003	-	-	0.024
326	-	-	0.018	666	-	-	0.026	1004	0.047	0.032	0.024
327	-	-	0.019	667	-	-	0.021	1005	0.023	0.039	0.024
328	-	-	0.019	668	-	-	0.022	1006	0.013	0.032	0.025
329	-	-	0.019	669	-	-	0.022	1007	0.019	0.028	0.026
330	-	-	0.020	670	-	-	0.021	1008	0.001	0.002	0.025
331	-	-	0.020	671	-	-	0.021	1009	-	-	0.026
332	-	-	0.019	672	-	-	0.025	1010	-	-	0.026
333	-	-	0.021	673	-	-	0.023	1011	-	-	0.024
334	-	-	0.018	674	-	-	0.019	1012	0.016	0.052	0.025
335	-	-	0.020	675	-	-	0.023	1013	-	-	0.024
336	-	-	0.020	676	-	-	0.024	1014	-	-	0.022
337	-	-	0.022	677	-	-	0.024	1015	0.015	0.044	0.024
338	-	-	0.021	678	-	-	0.021	1016	-	-	0.026
339	-	-	0.023	679	-	-	0.021	1017	-	-	0.020
340	-	-	0.024	680	-	-	0.021	1018	-	-	0.019
341	-	-	0.022	681	-	-	0.023				
342	-	-	0.022	682	-	-	0.026				

Table 5: Average Tie Line Magnitudes per Line

Internal Observation Statistics			
Category	X	Y	Z
Average Magnitude	0.020	0.021	0.022
RMS Values	0.032	0.034	0.030
Maximum Values	0.241	0.242	0.175
Observation Weight	10534.0	10534.0	2964734.0

Table 6: Tie Line Observation Statistics

Overall Relative Accuracy	
Category	Mismatch
Average 3D Mismatch	0.02252
Average XY Mismatch	0.03231
Average Z Mismatch	0.02240

Table 7: Relative Accuracy Results

TerraMatch Tie Lines	
Category	Observations
Section Lines	1,212,905
Roof Lines	4,383

Table 8: Total Tie Lines

Section 4: Vertical Accuracy Assessment

4.1 Ground Surveyed Control Points

A total of two hundred and fifty-five (255) control points were collected for this project. 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.

4.2 Vertical Accuracy

Below are the vertical accuracy reporting requirements for this project:

Vertical Accuracy Reporting Requirements in Meters:

$RMSE_z \leq 10.0\text{cm}$ (Bare-Earth)

$FVA \leq 19.6\text{cm}$ 95% Confidence Level (Bare-Earth)

Vertical Accuracy Reporting Requirements in Feet:

$RMSE_z \leq 0.328\text{ft}$ (Bare-Earth)

$FVA \leq 0.643\text{ft}$ 95% Confidence Level (Bare-Earth)

*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).

4.3 Control Point Distribution

The following graphic depicts the location and distribution of the control points established for this project.

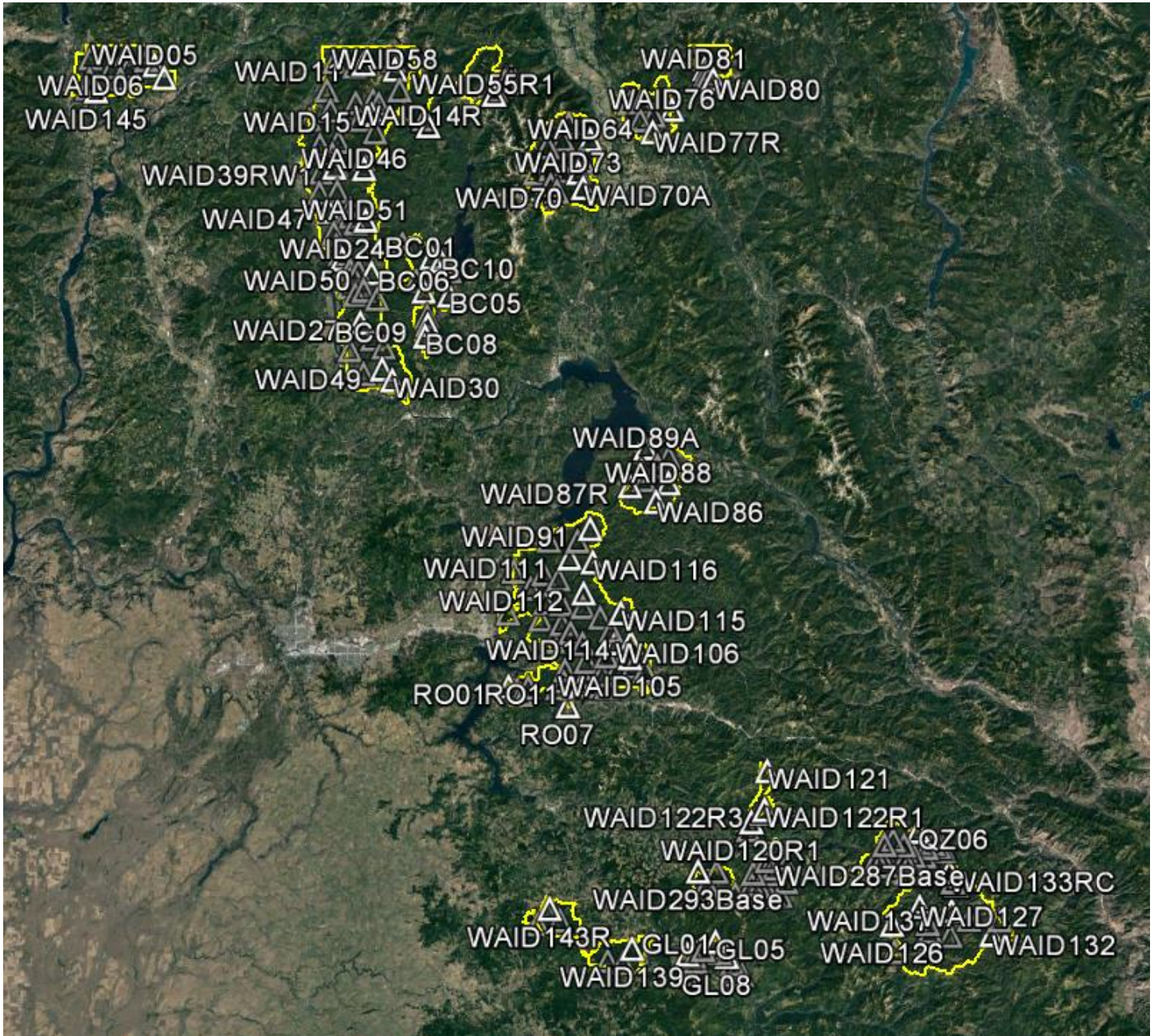


Figure 4: Control Point Distribution



4.4 Control Point Assessment

A vertical accuracy assessment of the control points against the lidar point cloud bare-earth can be found in Tables 9 and 10 below. The coordinates provided are in NAD83, USFS R6 Albers, NAVD88 (Geoid12B), Meters as well as NAD83, UTM Zone 11N, NAVD88 (Geoid12B), Meters.

Control Point Assessment						
PointID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
1070	736898.838	1658142.244	762.762	762.770	Control Point	0.008
1071	745761.866	1659451.955	987.737	987.640	Control Point	-0.097
1072	746571.086	1656228.779	995.355	995.290	Control Point	-0.065
1073	750828.408	1658094.110	677.724	677.660	Control Point	-0.064
1074	752979.335	1656938.214	652.444	652.460	Control Point	0.016
1075	755521.490	1653884.985	903.689	903.760	Control Point	0.071
1076	742466.976	1656066.360	1086.111	1086.010	Control Point	-0.101
1077	744597.865	1653263.053	947.927	947.870	Control Point	-0.057
1078	736911.196	1652886.274	652.458	652.420	Control Point	-0.038
1079	797668.328	1659375.707	909.810	909.710	Control Point	-0.100
1090	804856.805	1659127.132	1290.567	1290.530	Control Point	-0.037
1101	802688.256	1658372.630	1033.532	1033.600	Control Point	0.068
1119	814093.506	1652932.912	1268.238	1268.290	Control Point	0.052
1140	738693.469	1649963.747	1037.441	1037.400	Control Point	-0.041
1141	736516.746	1650643.004	618.476	618.500	Control Point	0.024
1143	807465.645	1646662.545	953.274	953.210	Control Point	-0.064
1144	803391.763	1649432.594	1602.762	1602.710	Control Point	-0.052
1145	796118.677	1652233.427	773.651	773.620	Control Point	-0.031
1146	797227.678	1647256.912	764.689	764.580	Control Point	-0.109
1147	795039.961	1638693.293	1604.471	1604.420	Control Point	-0.051
1148	795614.082	1631872.411	869.739	869.700	Control Point	-0.039
1149	799866.936	1627311.334	1376.362	1376.300	Control Point	-0.062
1150	803391.969	1621281.526	973.111	973.080	Control Point	-0.031
1151	799481.350	1617067.116	746.861	746.910	Control Point	0.049
1152	801857.790	1610737.831	733.251	733.200	Control Point	-0.051
1153	803798.405	1603987.567	1024.587	1024.530	Control Point	-0.057
1154	803941.194	1608208.052	833.640	833.640	Control Point	0.000
1155	805499.258	1602181.481	1080.354	1080.280	Control Point	-0.074
1156	807022.862	1595327.096	944.970	944.940	Control Point	-0.030
1157	804739.324	1588512.592	641.954	641.950	Control Point	-0.004
1164	808373.919	1582799.763	655.019	654.880	Control Point	-0.139
1175	815547.610	1581509.614	844.468	844.410	Control Point	-0.058
1176	813043.143	1589529.815	1137.671	1137.640	Control Point	-0.031
1177	810145.262	1591457.288	1156.227	1156.190	Control Point	-0.037
1178	810942.610	1601360.311	1386.616	1386.500	Control Point	-0.116



1179	807486.998	1603248.255	1177.768	1177.730	Control Point	-0.038
1180	806012.135	1607975.565	922.442	922.410	Control Point	-0.032
1181	801205.004	1611933.000	727.626	727.660	Control Point	0.034
1182	804804.992	1619759.702	900.311	900.300	Control Point	-0.011
1183	803298.904	1623238.906	1074.399	1074.390	Control Point	-0.009
1184	798865.934	1633202.824	1436.978	1436.780	Control Point	-0.198
1185	799409.020	1633764.666	1370.063	1369.970	Control Point	-0.093
1186	798218.301	1636501.628	875.086	875.050	Control Point	-0.036
1187	799529.457	1639650.534	791.538	791.520	Control Point	-0.018
1188	804533.148	1645280.572	893.925	893.970	Control Point	0.045
1189	809119.738	1649426.453	1285.855	1285.840	Control Point	-0.015
1190	808507.841	1642311.729	1454.728	1454.780	Control Point	0.052
1191	805873.719	1635565.503	1259.306	1259.280	Control Point	-0.026
1192	806248.220	1633202.571	1303.025	1302.970	Control Point	-0.055
1193	798066.776	1622353.670	763.021	762.980	Control Point	-0.041
1194	812304.959	1660214.364	2064.612	2064.560	Control Point	-0.052
1195	812921.285	1584121.694	884.475	884.300	Control Point	-0.175
1196	809234.631	1607661.580	996.171	996.120	Control Point	-0.051
1197	807228.560	1620535.639	930.305	930.270	Control Point	-0.035
1198	800208.852	1614059.202	731.814	731.820	Control Point	0.006
1199	795451.675	1626834.903	817.359	817.320	Control Point	-0.039
1200	792132.020	1644834.413	648.361	648.380	Control Point	0.019
1208	812700.600	1658009.822	1546.656	1546.640	Control Point	-0.016
1209	807658.476	1650180.400	1476.806	1476.830	Control Point	0.024

Table 9: NAD83, USFS R6 Albers, NAVD88 (Geoid12B), Meters

Control Point Assessment						
PointID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
1001	502260.418	5375427.346	791.577	791.590	Control Point	0.013
1002	495055.780	5378814.520	1265.336	1265.360	Control Point	0.024
1003	506734.124	5372129.657	774.137	774.060	Control Point	-0.077
1004	498508.242	5369718.885	779.899	779.910	Control Point	0.011
1005	506676.337	5366166.844	770.084	770.050	Control Point	-0.034
1006	506429.228	5366203.534	773.961	773.870	Control Point	-0.091
1007	500415.492	5367140.892	761.634	761.540	Control Point	-0.094
1008	501262.800	5361000.615	760.086	760.020	Control Point	-0.066
1009	500818.502	5356099.629	742.197	742.250	Control Point	0.053
1010	501449.698	5358959.431	747.540	747.480	Control Point	-0.060
1011	504557.690	5374629.734	783.715	783.610	Control Point	-0.105
1012	581721.062	5222196.818	1482.920	1482.910	Control Point	-0.010
1013	581993.538	5219931.934	1628.506	1628.380	Control Point	-0.126
1014	584858.383	5219229.126	1316.392	1316.340	Control Point	-0.052
1015	583437.568	5221707.896	1174.419	1174.370	Control Point	-0.049



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

1016	582053.163	5225007.801	1398.995	1398.940	Control Point	-0.055
1017	585280.720	5224885.141	1174.848	1174.840	Control Point	-0.008
1018	584823.892	5222012.207	1130.877	1130.920	Control Point	0.043
1019	588790.959	5219543.997	1502.293	1502.320	Control Point	0.027
1020	590159.864	5222954.188	1559.468	1559.470	Control Point	0.002
1021	587135.501	5226237.489	917.683	917.630	Control Point	-0.053
1022	589285.572	5228676.624	1305.894	1305.820	Control Point	-0.074
1023	585402.018	5228131.597	1252.533	1252.560	Control Point	0.027
1024	589865.055	5226653.419	1536.733	1536.710	Control Point	-0.023
1025	586908.861	5220148.097	1341.287	1341.210	Control Point	-0.077
1026	565955.576	5205039.253	1311.415	1311.380	Control Point	-0.035
1027	565771.149	5200195.240	1242.789	1242.720	Control Point	-0.069
1028	565397.749	5200119.349	1255.187	1255.160	Control Point	-0.027
1029	567954.918	5203258.089	1422.497	1422.510	Control Point	0.013
1030	567736.283	5204655.269	1515.493	1515.460	Control Point	-0.033
1031	572879.044	5208168.113	1797.349	1797.370	Control Point	0.021
1032	569862.094	5206198.356	1658.308	1658.170	Control Point	-0.138
1033	573882.140	5205476.624	1800.740	1800.690	Control Point	-0.050
1034	575656.564	5204490.040	1741.363	1741.360	Control Point	-0.003
1035	577414.940	5200083.898	1323.869	1323.850	Control Point	-0.019
1036	579413.890	5200078.621	1273.556	1273.500	Control Point	-0.056
1037	577028.350	5202725.961	1638.734	1638.770	Control Point	0.036
1038	501429.765	5358980.898	746.530	746.340	Control Point	-0.190
1039	613135.479	5226883.379	1345.661	1345.700	Control Point	0.039
1040	612294.118	5228642.561	910.949	910.850	Control Point	-0.099
1041	612336.257	5228607.433	911.241	911.180	Control Point	-0.061
1042	614263.901	5232130.534	1061.081	1061.090	Control Point	0.009
1043	616390.942	5233267.814	1177.573	1177.490	Control Point	-0.083
1044	628954.254	5230645.794	1813.922	1813.880	Control Point	-0.042
1045	622529.209	5235364.529	1928.069	1928.020	Control Point	-0.049
1046	626137.439	5232453.690	1518.112	1518.160	Control Point	0.048
1047	627585.701	5231767.807	1713.795	1713.830	Control Point	0.035
1048	623214.964	5226130.927	1098.531	1098.540	Control Point	0.009
1049	619526.008	5225245.202	995.450	995.350	Control Point	-0.100
1050	619087.312	5232042.733	1424.841	1424.900	Control Point	0.059
1051	621469.859	5229437.708	1323.349	1323.280	Control Point	-0.069
1052	624080.167	5229374.008	1169.799	1169.790	Control Point	-0.009
1053	619254.459	5228435.914	1485.752	1485.680	Control Point	-0.072
1054	622784.171	5225025.534	1072.890	1072.820	Control Point	-0.070
1055	624611.386	5231400.918	1226.751	1226.690	Control Point	-0.061
1056	620629.860	5228099.113	1426.219	1426.120	Control Point	-0.099
1057	614530.059	5227052.424	933.914	933.880	Control Point	-0.034
1058	521780.959	5270477.919	1105.282	1105.290	Control Point	0.008



1059	523902.762	5269665.189	1281.055	1280.980	Control Point	-0.075
1060	524904.746	5268509.614	1141.598	1141.570	Control Point	-0.028
1061	526617.094	5270263.703	769.673	769.570	Control Point	-0.103
1062	533728.808	5270192.344	1036.546	1036.510	Control Point	-0.036
1063	535638.031	5274547.601	930.578	930.550	Control Point	-0.028
1064	536335.759	5265758.185	891.659	891.480	Control Point	-0.179
1065	540765.627	5276653.248	1220.552	1220.520	Control Point	-0.032
1066	541085.254	5270799.935	700.154	700.120	Control Point	-0.034
1067	544714.565	5273429.740	1222.813	1222.780	Control Point	-0.033
1068	539482.368	5270573.323	687.214	687.170	Control Point	-0.044
1069	545915.438	5270465.107	686.612	686.540	Control Point	-0.072
1080	536949.922	5283724.449	1440.014	1440.020	Control Point	0.006
1081	539909.428	5281035.291	1368.372	1368.350	Control Point	-0.022
1082	545769.602	5278018.163	752.013	751.970	Control Point	-0.043
1083	548551.176	5275171.152	719.158	719.230	Control Point	0.072
1084	555231.981	5274420.333	673.594	673.560	Control Point	-0.034
1085	551560.765	5277601.017	1144.790	1144.750	Control Point	-0.040
1086	547885.231	5281229.422	748.572	748.520	Control Point	-0.052
1087	546886.881	5284310.513	779.481	779.540	Control Point	0.059
1088	539931.523	5290039.273	853.185	853.200	Control Point	0.015
1089	534653.152	5290756.874	936.117	936.030	Control Point	-0.087
1091	533911.406	5296794.934	1097.386	1097.190	Control Point	-0.196
1092	536612.298	5301936.122	1084.998	1085.050	Control Point	0.052
1093	540098.502	5293379.935	934.580	934.480	Control Point	-0.100
1094	544204.144	5287439.193	796.724	796.680	Control Point	-0.044
1095	551749.290	5281432.210	1143.176	1143.160	Control Point	-0.016
1096	549248.642	5288584.504	928.829	928.820	Control Point	-0.009
1097	542315.657	5300968.294	1370.488	1370.460	Control Point	-0.028
1098	532575.832	5281626.793	894.825	894.820	Control Point	-0.005
1099	521543.562	5288348.486	783.350	783.400	Control Point	0.050
1100	580762.613	5235644.264	1049.182	1049.200	Control Point	0.018
1102	581528.305	5237546.518	1194.938	1195.030	Control Point	0.092
1103	581511.647	5237520.018	1193.535	1193.560	Control Point	0.025
1104	584133.330	5239673.229	1611.069	1611.020	Control Point	-0.049
1105	585344.820	5250108.516	1618.766	1618.740	Control Point	-0.026
1106	584740.432	5240607.902	1626.308	1626.240	Control Point	-0.068
1107	584730.324	5240579.210	1626.199	1626.150	Control Point	-0.049
1108	570641.689	5222220.586	1531.108	1531.090	Control Point	-0.018
1109	573066.546	5225405.764	1368.912	1368.910	Control Point	-0.002
1110	577679.214	5219896.941	1589.746	1589.720	Control Point	-0.026
1111	616251.021	5212506.931	1495.388	1495.430	Control Point	0.042
1112	623041.293	5217024.863	1115.125	1115.120	Control Point	-0.005
1113	632029.739	5222242.659	1452.625	1452.530	Control Point	-0.095



1114	632041.634	5222228.290	1452.040	1451.960	Control Point	-0.080
1115	632033.427	5222232.941	1452.327	1452.260	Control Point	-0.067
1116	631178.628	5223038.090	1549.584	1549.590	Control Point	0.006
1117	631172.089	5222972.205	1546.895	1546.880	Control Point	-0.015
1118	631179.937	5222941.275	1546.378	1546.370	Control Point	-0.008
1120	635206.877	5213802.290	1430.659	1430.640	Control Point	-0.019
1121	642700.824	5213671.804	1971.133	1970.950	Control Point	-0.183
1122	640802.461	5210048.297	1535.874	1535.740	Control Point	-0.134
1123	630671.264	5209805.790	1902.134	1902.030	Control Point	-0.104
1124	630384.206	5225580.052	1595.997	1595.990	Control Point	-0.007
1125	630364.357	5225567.999	1595.463	1595.500	Control Point	0.037
1126	630283.409	5225565.846	1594.179	1594.160	Control Point	-0.019
1127	616872.998	5205858.133	1800.417	1800.270	Control Point	-0.147
1128	625601.966	5210851.806	1144.933	1144.790	Control Point	-0.143
1129	625100.256	5212757.266	1129.684	1129.670	Control Point	-0.014
1130	630921.013	5215982.262	2060.331	2060.200	Control Point	-0.131
1131	571729.573	5219092.634	1364.022	1364.040	Control Point	0.018
1132	571710.286	5219097.031	1363.817	1363.750	Control Point	-0.067
1133	552361.698	5206354.180	952.128	952.030	Control Point	-0.098
1134	500215.282	5409604.741	885.866	885.970	Control Point	0.104
1135	546388.061	5203391.335	1062.013	1062.050	Control Point	0.037
1136	550174.989	5202964.050	1090.100	1090.130	Control Point	0.030
1137	534600.735	5213210.071	939.157	939.120	Control Point	-0.037
1138	532056.748	5216056.128	881.894	881.830	Control Point	-0.064
1139	529175.342	5212256.416	1204.295	1204.300	Control Point	0.005
1142	501191.031	5407912.290	871.991	872.080	Control Point	0.089
1158	535204.537	5271928.612	1044.248	1044.350	Control Point	0.102
1159	535185.169	5271925.465	1043.961	1044.180	Control Point	0.219
1160	585293.557	5224914.153	1175.016	1174.990	Control Point	-0.026
1161	587155.155	5226279.316	921.717	921.750	Control Point	0.033
1162	622641.731	5224615.000	1104.888	1104.870	Control Point	-0.018
1163	628530.395	5231595.565	1772.382	1772.290	Control Point	-0.092
1165	622788.671	5225031.924	1072.590	1072.590	Control Point	0.000
1166	580740.436	5235653.730	1048.647	1048.810	Control Point	0.163
1167	568502.678	5225440.319	913.206	913.180	Control Point	-0.026
1168	568501.829	5225434.446	911.094	911.140	Control Point	0.046
1169	552277.450	5275454.108	686.401	686.440	Control Point	0.039
1170	536890.222	5283708.361	1439.482	1439.570	Control Point	0.088
1171	538516.012	5306130.971	1277.821	1277.970	Control Point	0.149
1172	558126.850	5324552.289	1549.173	1549.170	Control Point	-0.003
1173	554167.083	5323411.565	1505.978	1505.930	Control Point	-0.048
1174	554181.480	5323394.505	1503.997	1504.020	Control Point	0.023
1201	522448.848	5419008.549	1317.398	1317.430	Control Point	0.032



USDA Forest Service, Colville & Idaho Panhandle National Forests
Aerial Lidar Report, 16062
January 2017

1202	517379.995	5415708.023	1521.535	1521.520	Control Point	-0.015
1203	517369.958	5415710.045	1521.833	1521.810	Control Point	-0.023
1204	517773.851	5416732.747	1437.416	1437.370	Control Point	-0.046
1205	517762.023	5416699.405	1439.008	1438.960	Control Point	-0.048
1206	521595.466	5418679.101	1259.437	1259.400	Control Point	-0.037
1207	521582.133	5418689.064	1260.501	1260.470	Control Point	-0.031
1210	520309.772	5419852.583	1459.006	1458.900	Control Point	-0.106
1211	520036.263	5419055.040	1307.789	1307.740	Control Point	-0.049
1212	519991.149	5419054.425	1308.614	1308.530	Control Point	-0.084
1213	535833.723	5408576.788	1286.335	1286.280	Control Point	-0.055
1214	534283.936	5404672.820	1281.160	1281.120	Control Point	-0.040
1215	541121.736	5404661.501	822.477	822.510	Control Point	0.033
1216	539177.431	5399307.841	1445.307	1445.230	Control Point	-0.077
1217	531463.753	5397324.172	1241.286	1241.270	Control Point	-0.016
1218	530620.970	5402784.758	1372.728	1372.600	Control Point	-0.128
1219	527582.269	5396390.154	1325.444	1325.370	Control Point	-0.074
1220	531460.935	5393391.577	1573.273	1573.260	Control Point	-0.013
1221	531452.386	5393431.966	1575.314	1575.260	Control Point	-0.054
1222	539452.193	5392735.137	955.230	955.170	Control Point	-0.060
1223	539461.555	5392744.087	955.387	955.390	Control Point	0.003
1224	534529.280	5396866.810	1157.651	1157.670	Control Point	0.019
1225	532984.318	5391824.825	1432.859	1432.810	Control Point	-0.049
1226	533003.939	5391847.023	1431.819	1431.790	Control Point	-0.029
1227	538257.834	5396451.171	1047.897	1047.860	Control Point	-0.037
1228	550792.762	5413838.332	1051.165	1051.170	Control Point	0.005
1229	553384.724	5409492.592	974.575	974.570	Control Point	-0.005
1230	561185.927	5412137.747	755.985	755.960	Control Point	-0.025
1231	556481.527	5406539.520	863.353	863.240	Control Point	-0.113
1232	556660.126	5410701.317	1448.849	1448.700	Control Point	-0.149
1233	553513.661	5413911.697	1231.875	1231.800	Control Point	-0.075
1234	571301.389	5419677.162	1849.333	1849.330	Control Point	-0.003
1235	569135.984	5422168.831	1496.361	1496.350	Control Point	-0.011
1236	566477.386	5424672.962	1807.790	1807.770	Control Point	-0.020
1237	569978.146	5419981.575	1734.119	1734.120	Control Point	0.001
1238	569505.319	5420852.012	1581.432	1581.380	Control Point	-0.052
1239	558096.764	5324559.269	1549.889	1549.800	Control Point	-0.089
1240	560783.180	5326700.399	1435.897	1435.900	Control Point	0.003
1241	557730.355	5315793.510	1050.820	1050.880	Control Point	0.060
1242	551355.280	5319635.917	1434.855	1434.770	Control Point	-0.085
1243	560778.994	5320380.214	1377.601	1377.560	Control Point	-0.041
1244	555220.495	5329066.106	973.918	973.870	Control Point	-0.048
1245	555159.733	5328971.870	973.351	973.330	Control Point	-0.021
1246	554781.538	5321165.792	1388.926	1388.820	Control Point	-0.106

1247	541632.600	5309125.537	818.757	818.760	Control Point	0.003
1248	538559.416	5306150.132	1281.829	1281.880	Control Point	0.051
1249	531522.829	5306199.684	844.589	844.530	Control Point	-0.059
1250	530256.488	5298037.123	920.653	920.700	Control Point	0.047
1251	522915.350	5298636.978	796.838	796.850	Control Point	0.012
1252	527111.430	5294490.551	888.597	888.640	Control Point	0.043
1253	530733.308	5291070.910	1221.148	1221.120	Control Point	-0.028
1254	529538.281	5286955.677	1233.151	1233.160	Control Point	0.009
1255	534783.116	5285883.158	1314.450	1314.460	Control Point	0.010

Table 10: NAD83, UTM Zone 11N, NAVD88 (Geoid12B), Meters

4.5 Vertical Accuracy Results

An overall statistical assessment of the check points can be found in Tables 11 and 12 below. The values provided are in meters.

Control Points Error Statistics								
Land Cover Category	# of points	Min	Max	Mean	Median	Skew	Std Dev	RMSE _z
Control Points	255	-0.198	0.219	-0.029	-0.031	0.165	0.060	0.066

Table 11: Control Points Error Statistics

Control Points Vertical Accuracy Assessment				
Land Cover Category	# of Points	FVA — Fundamental Vertical Accuracy (RMSE _z x 1.9600)	CVA — Consolidated Vertical Accuracy (95th Percentile)	SVA — Supplemental Vertical Accuracy (95th Percentile)
Control Points	255	0.130	0.059	N/A

Table 12: Control Points Vertical Accuracy Assessment

Section 5: Certification

5.1 Limitations of Use

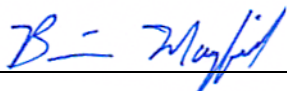
The accuracy assessment confirms that the data may be used for the intended applications stated in the **Project Purpose** section of this document. The dataset may also be used as a topographic input for other applications but the user should be aware that this lidar dataset was designed with a specific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

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 6: GPS Processing

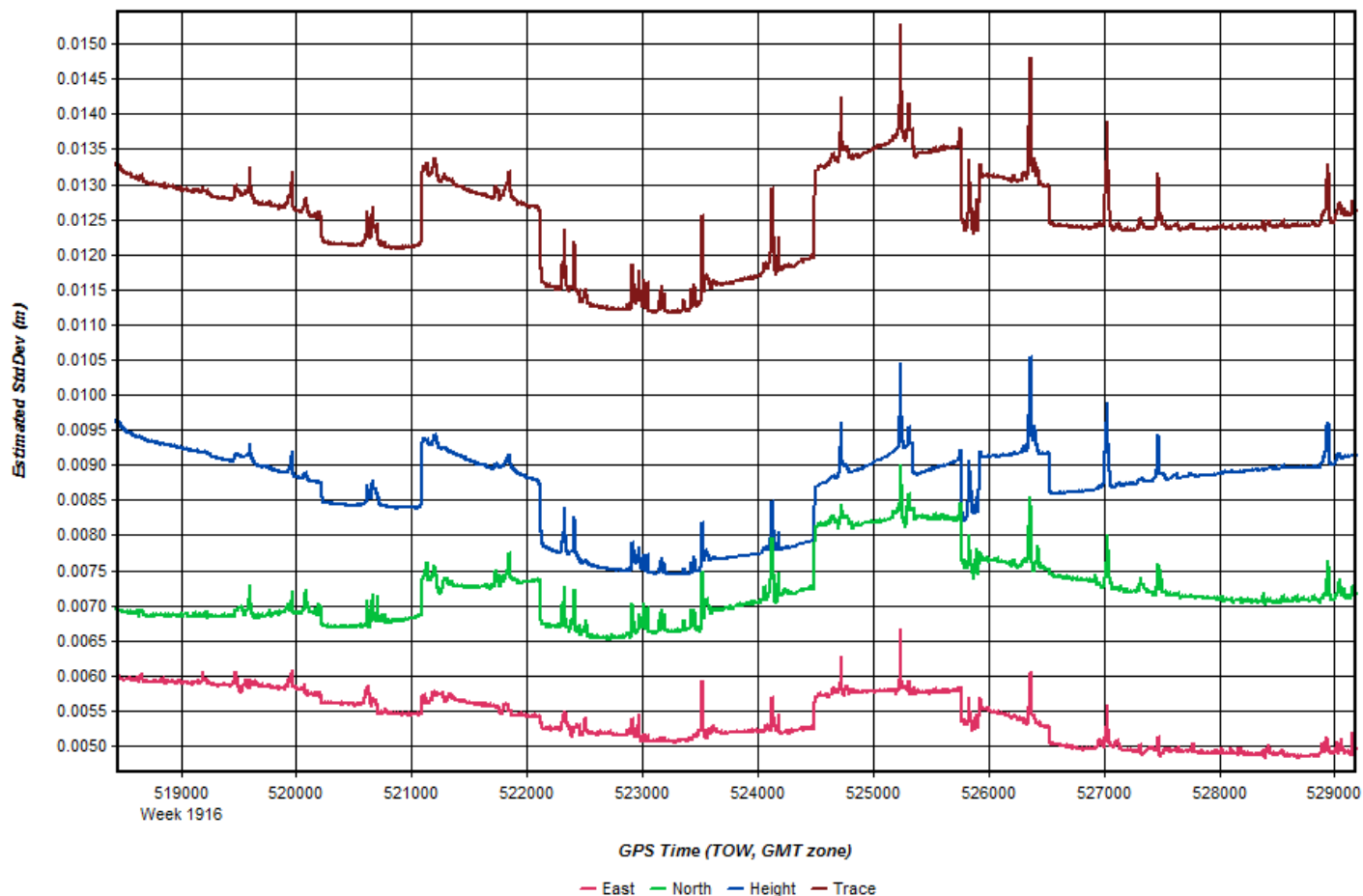
Inertial Explorer Version 8.60.5025

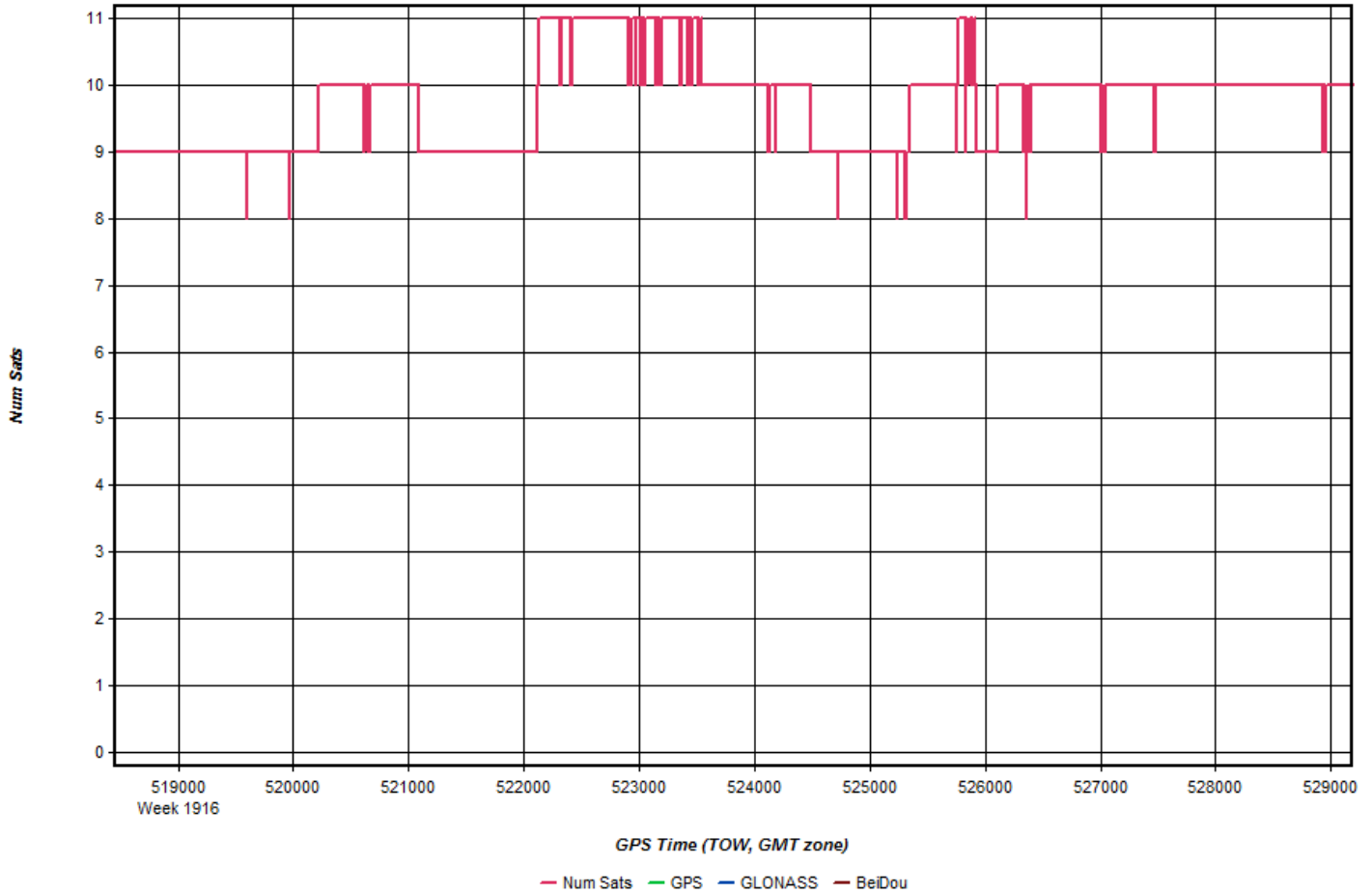
Plots by Mission: Coverage Map, Estimated Position Accuracy, Number of Satellites, Combined Separation, and PDOP.

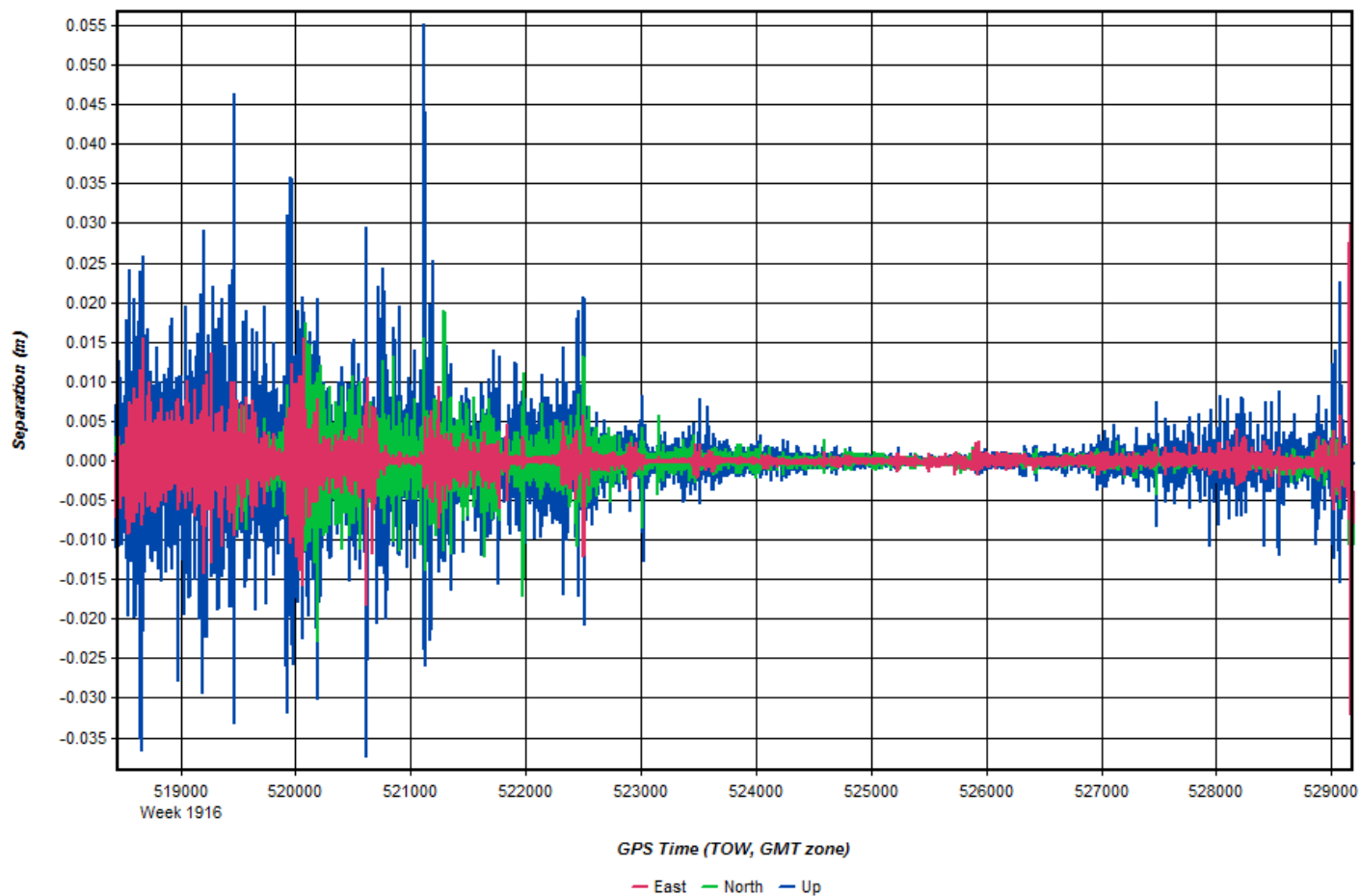
Coverage Map	The Coverage Map plot shows the Aircraft GPS-IMU Trajectory in reference to localized GPS Reference Stations.
Estimated Position Accuracy	The Estimated Position Accuracy plot shows the standard deviations of the east, north, and up directions versus time for the solution. The total standard 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 where the antenna angle is unfavorable, these spikes while aesthetically unfavorable do not generally reduce the accuracy of the acquired data.

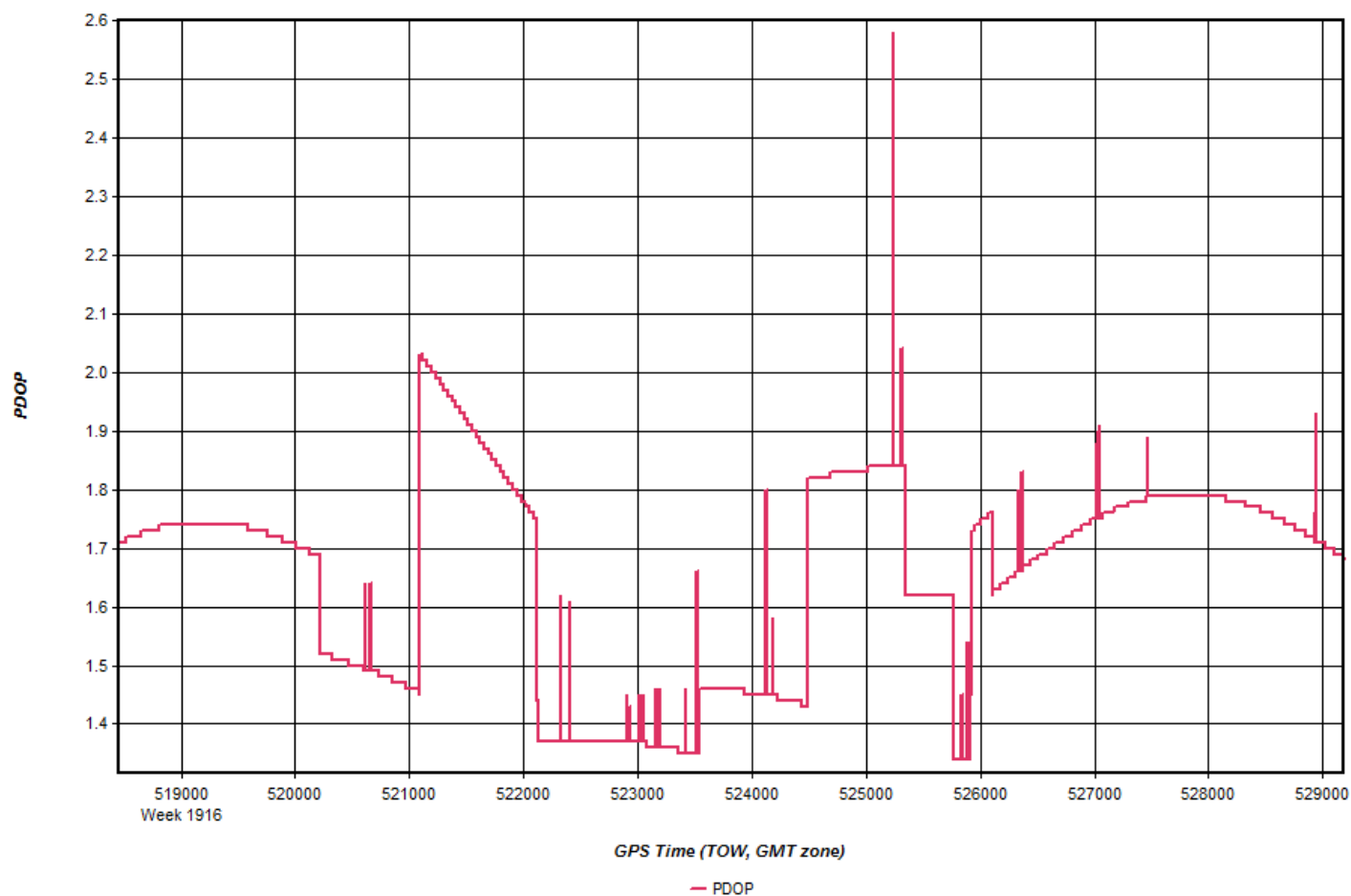
123_20160930_1





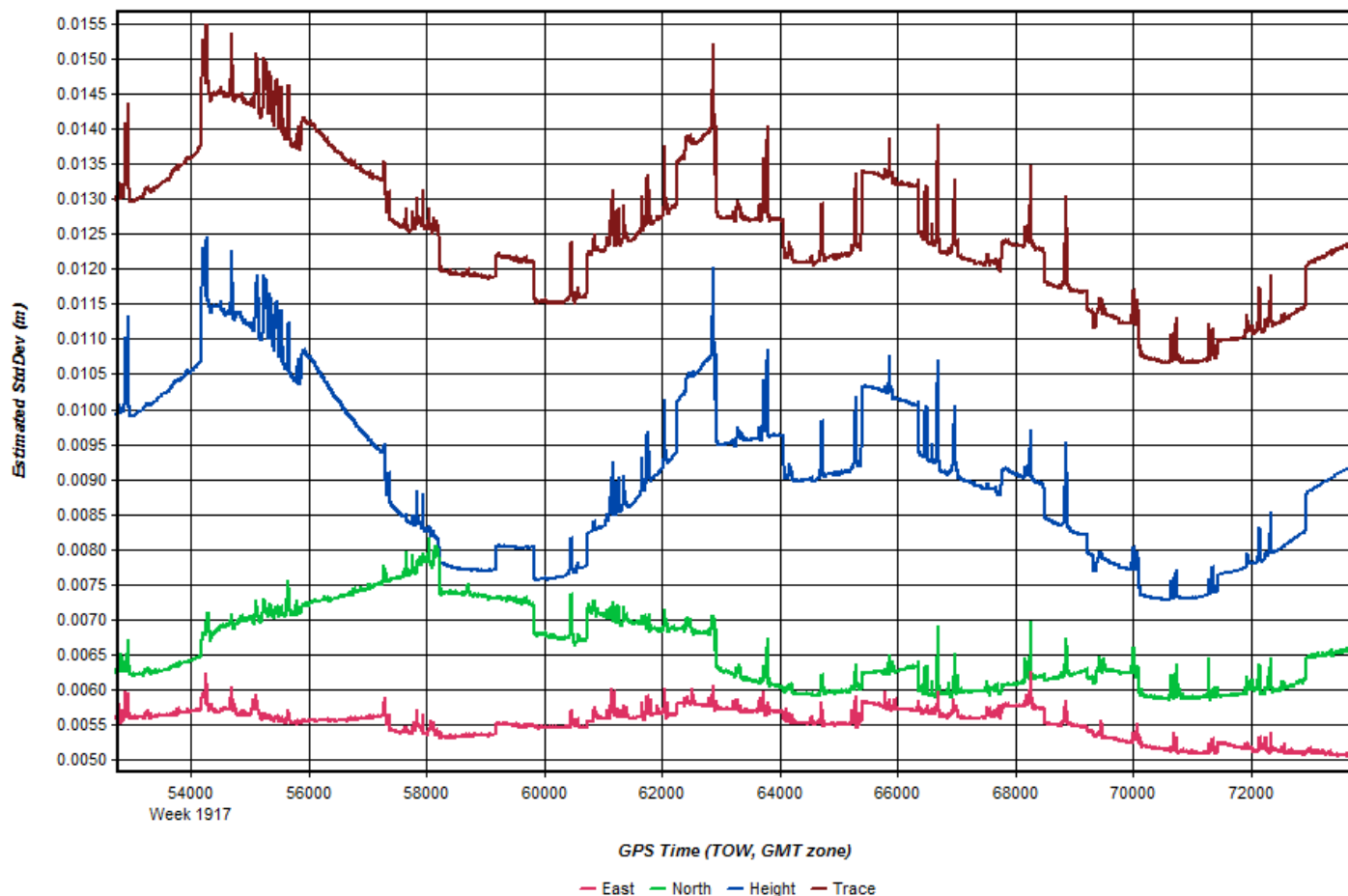


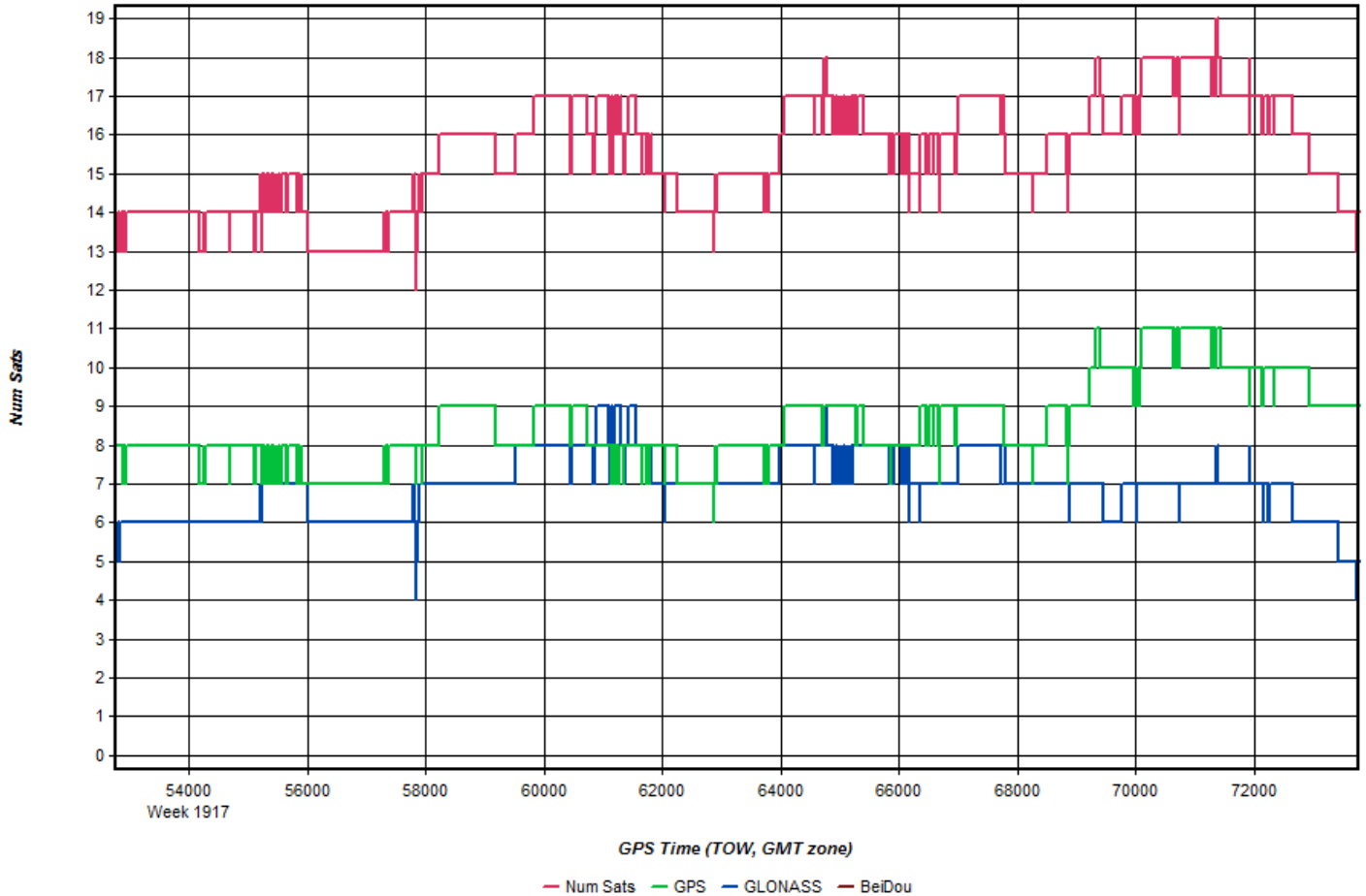


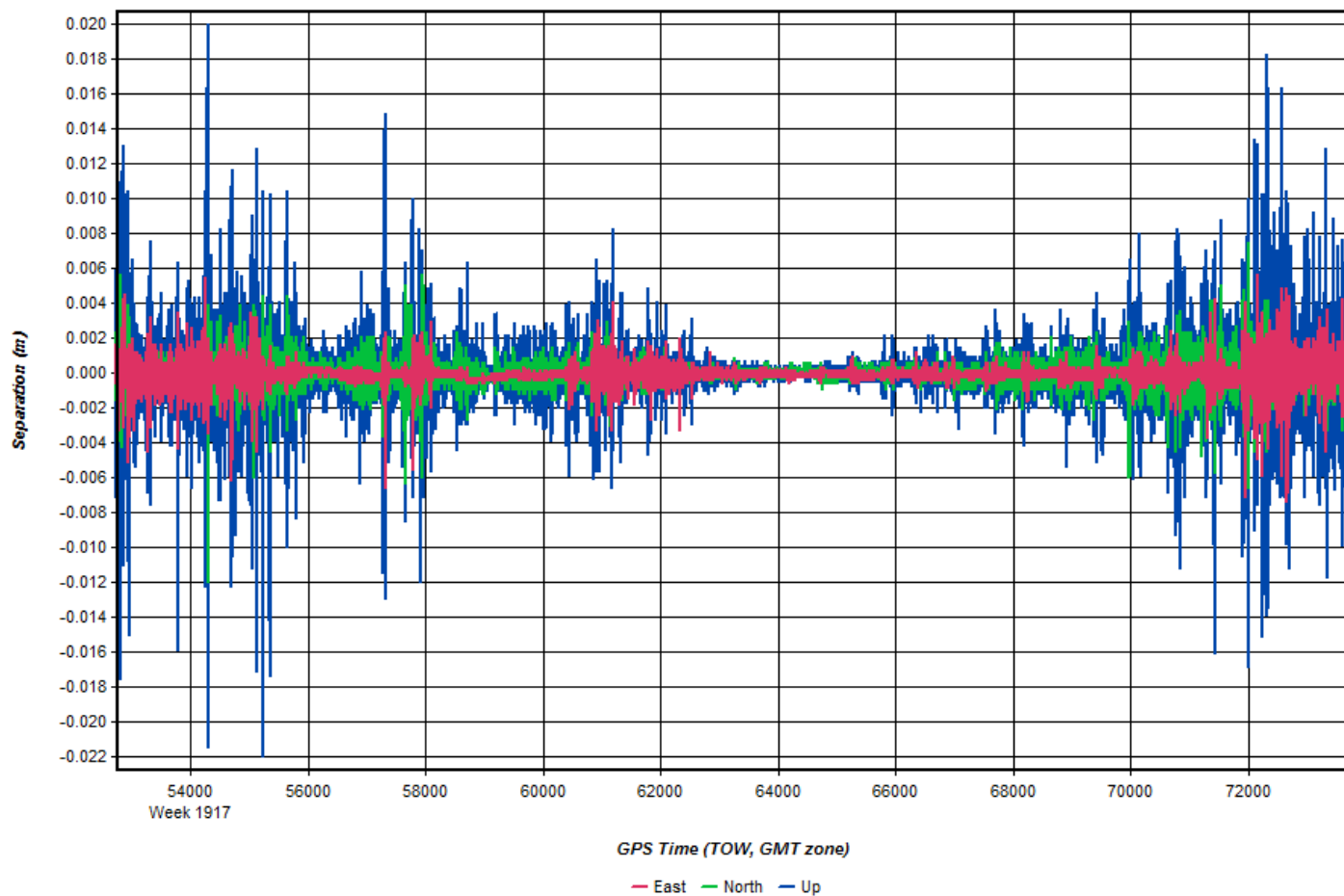


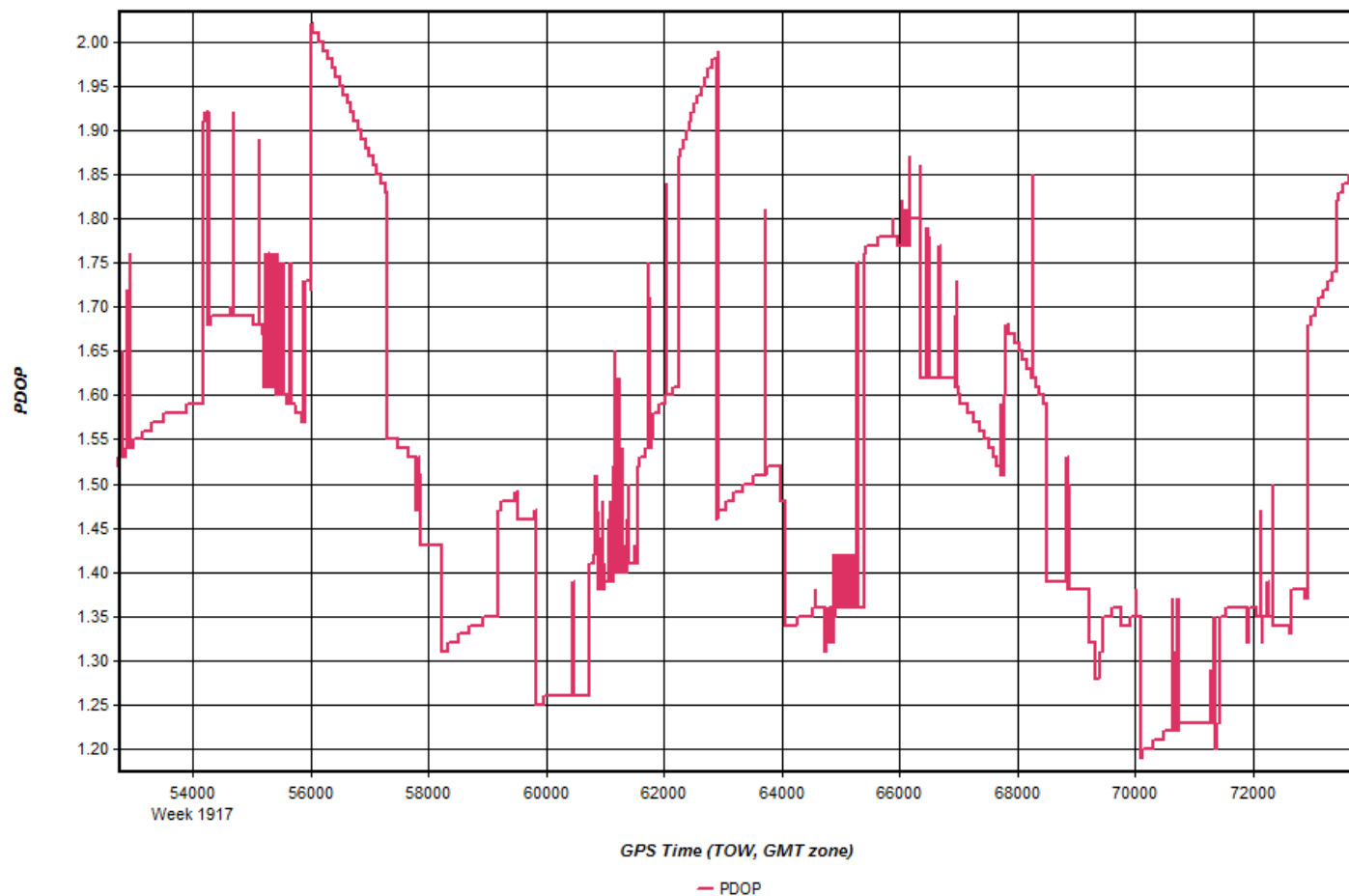
123_20161002_1





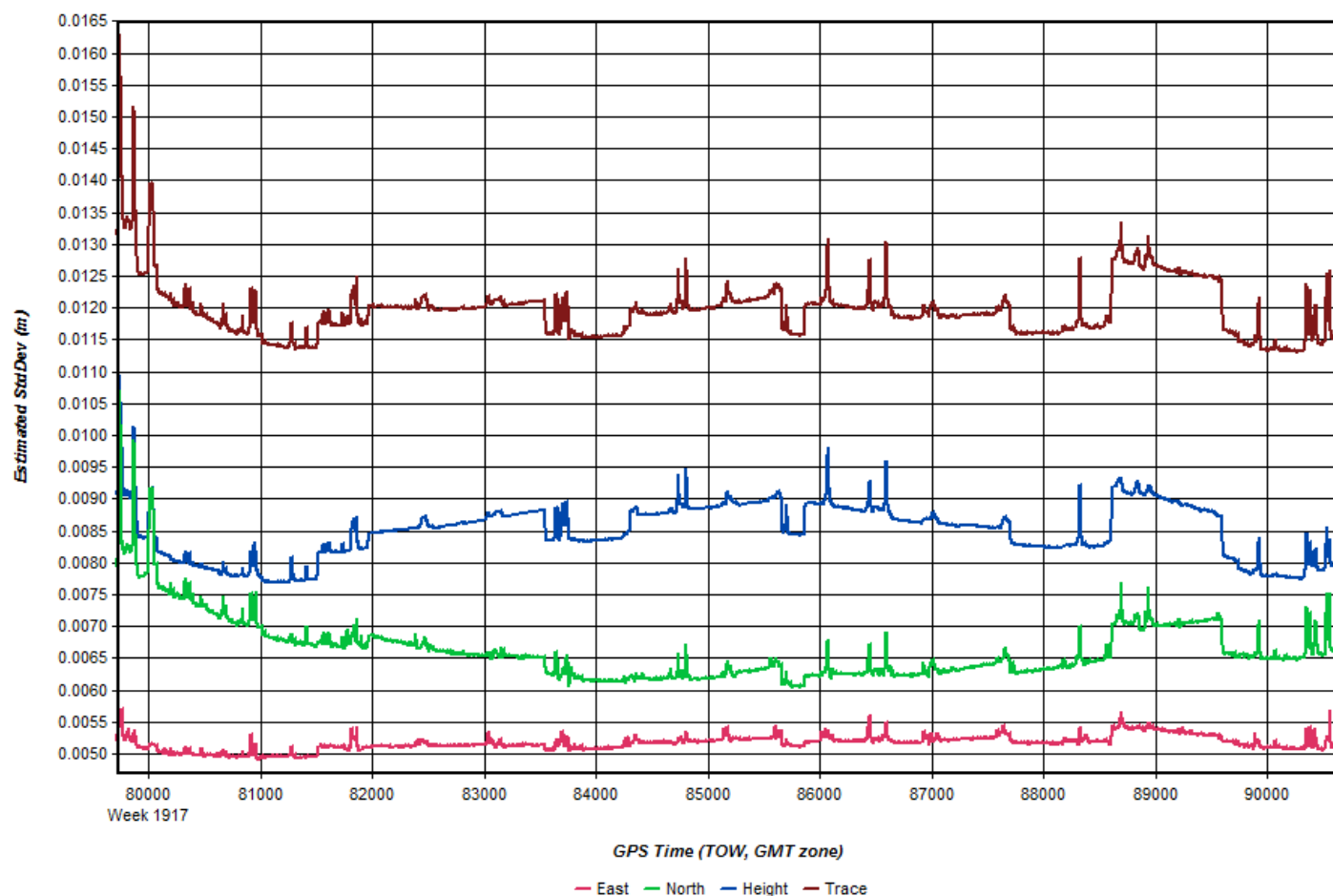




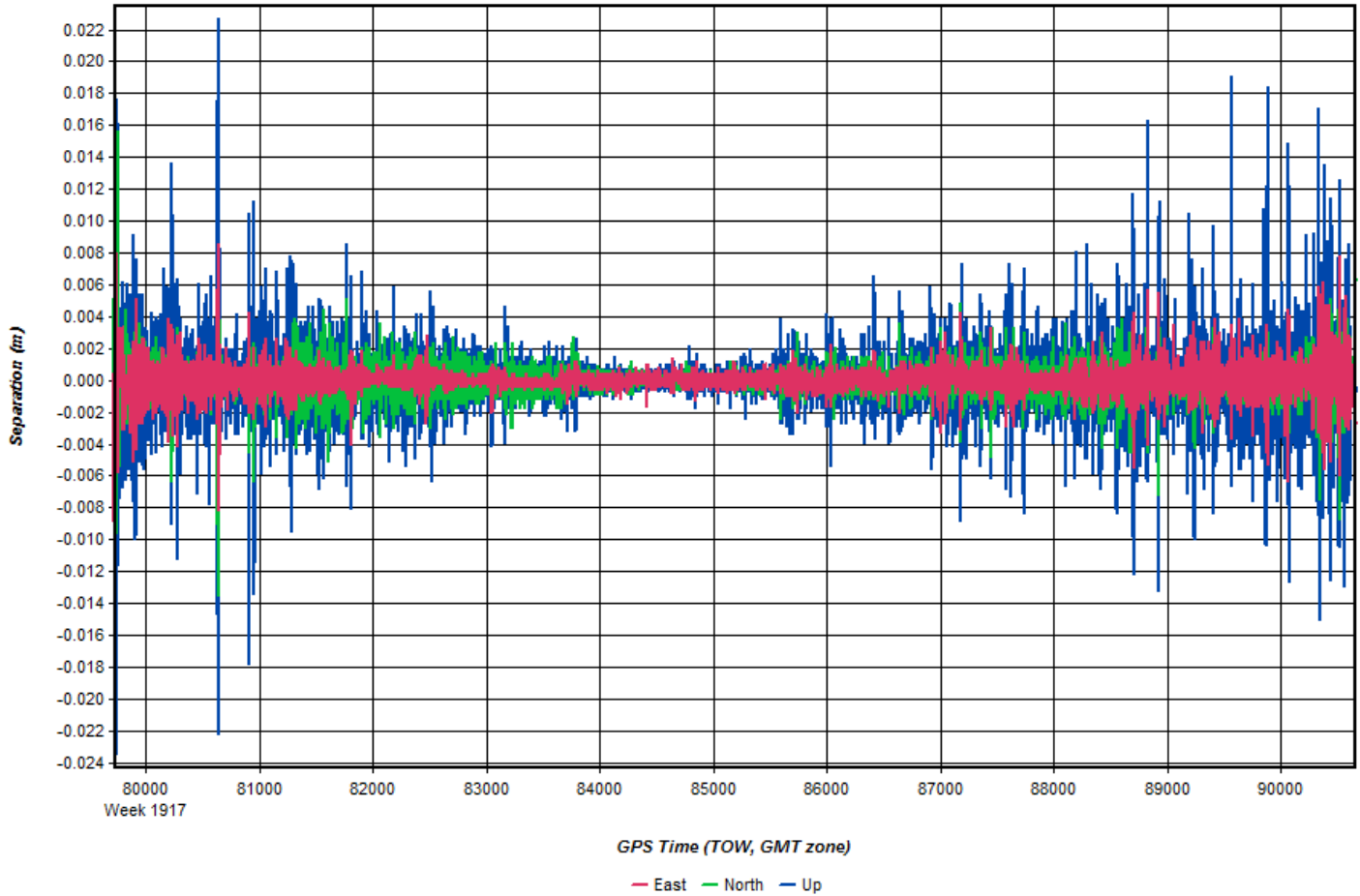


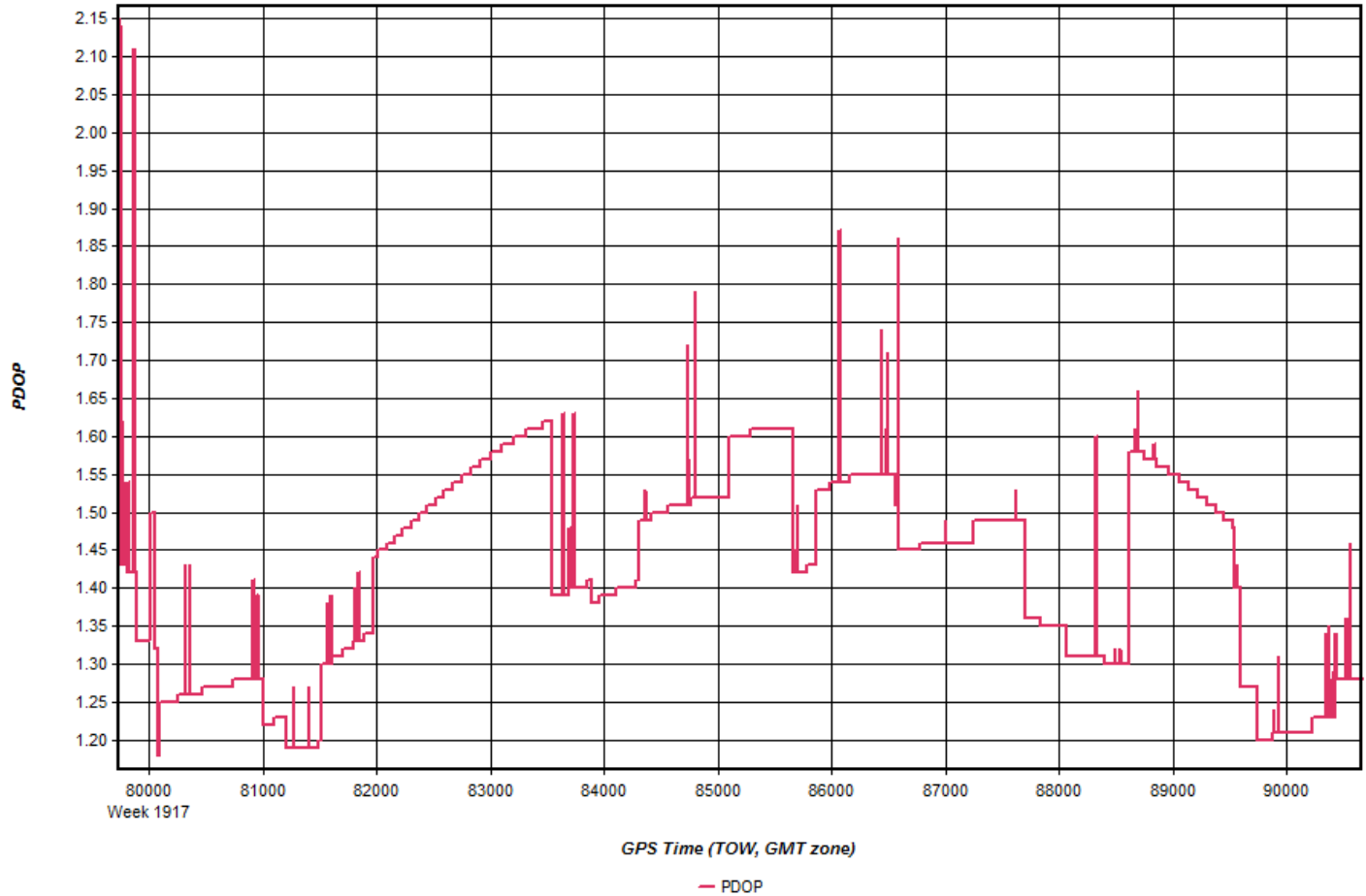
123_20161002_2





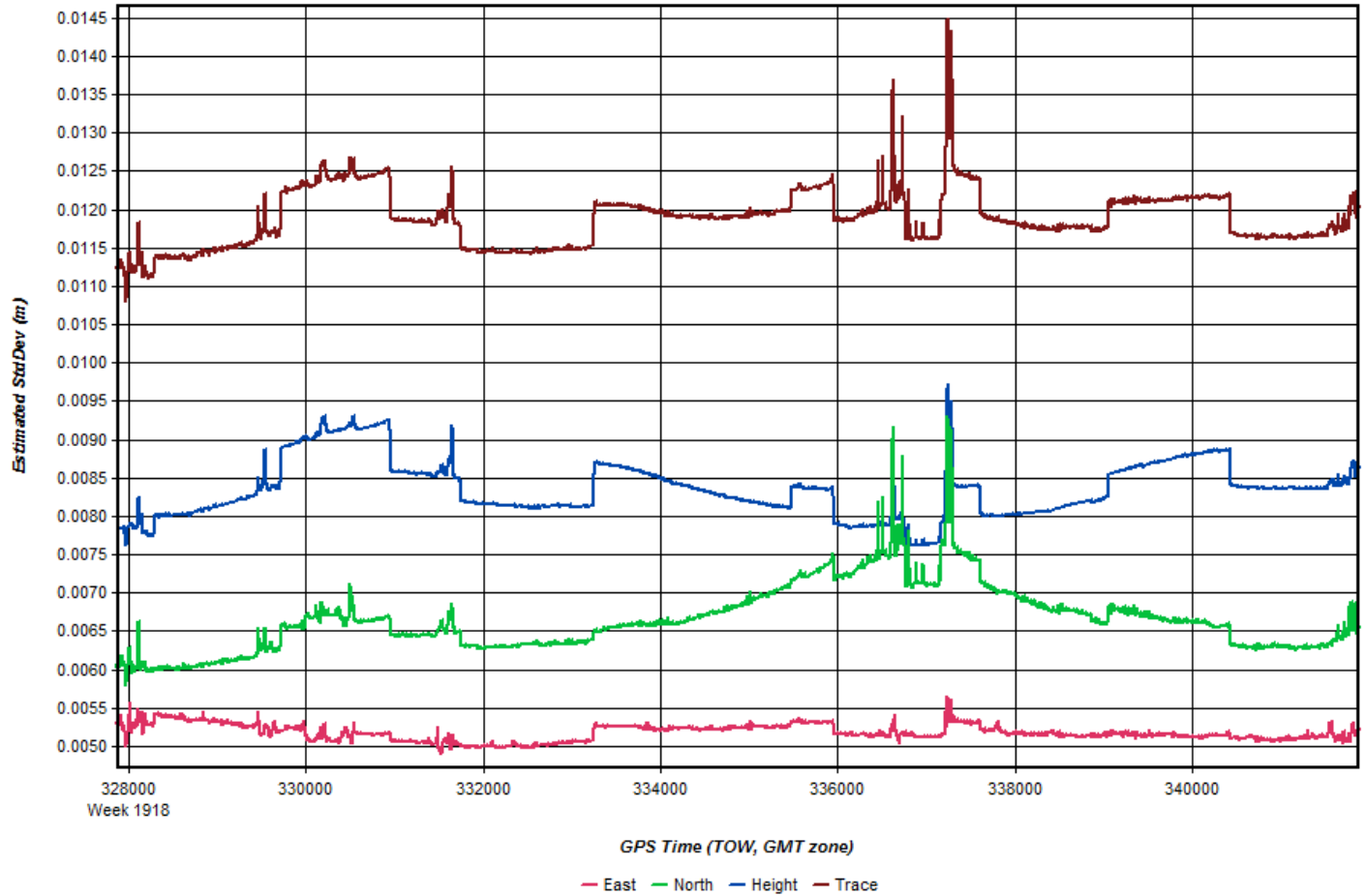


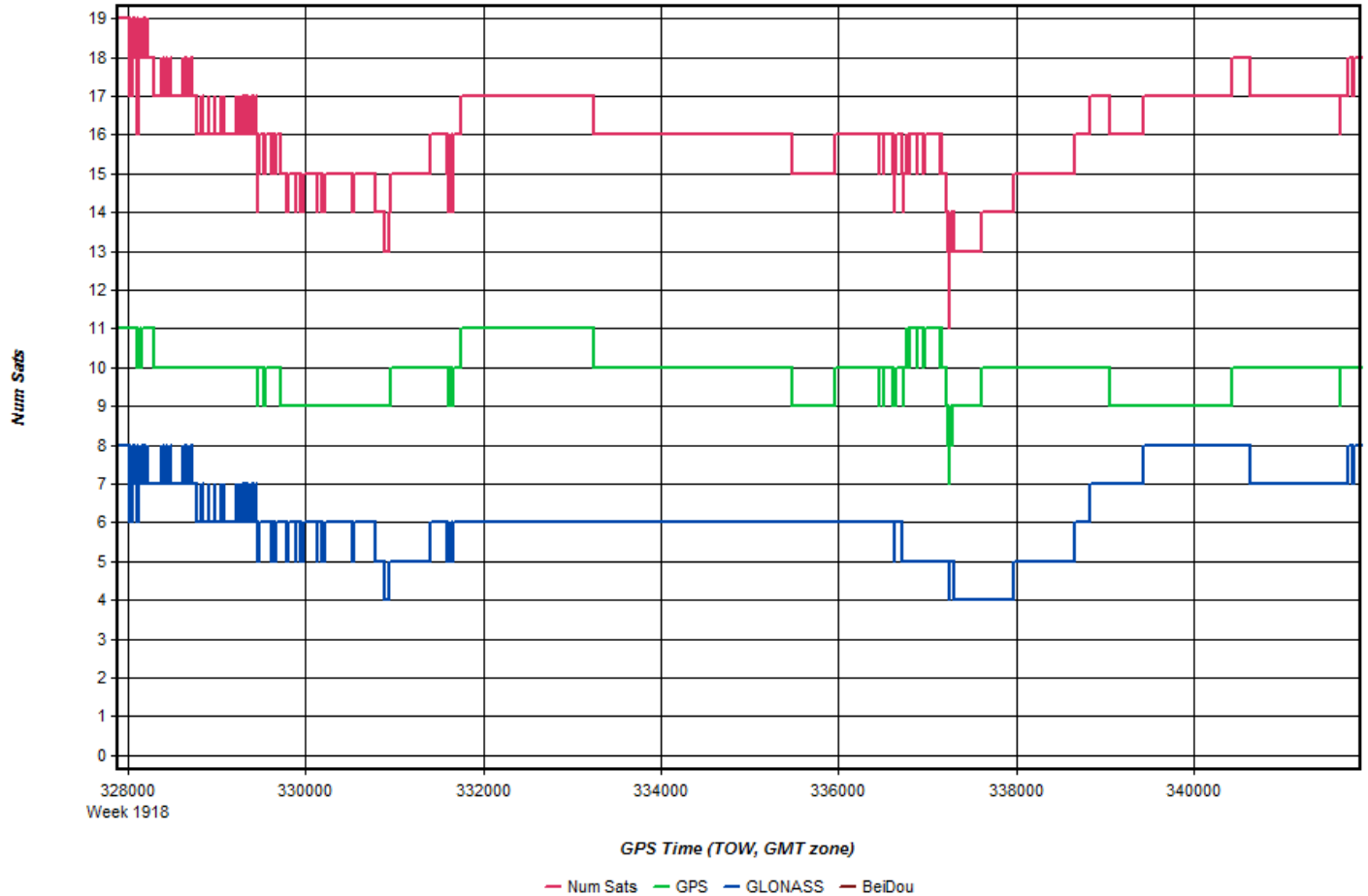


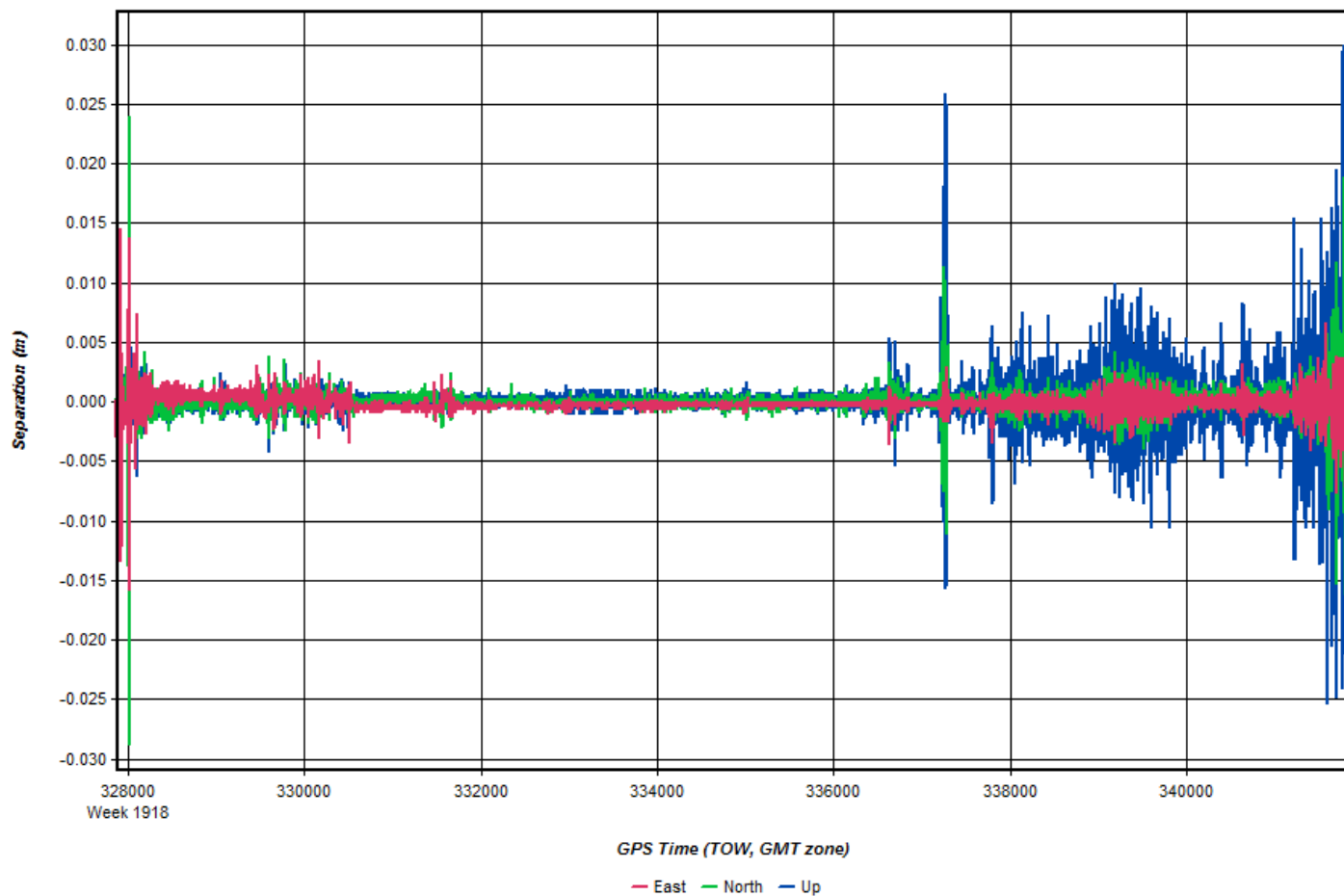


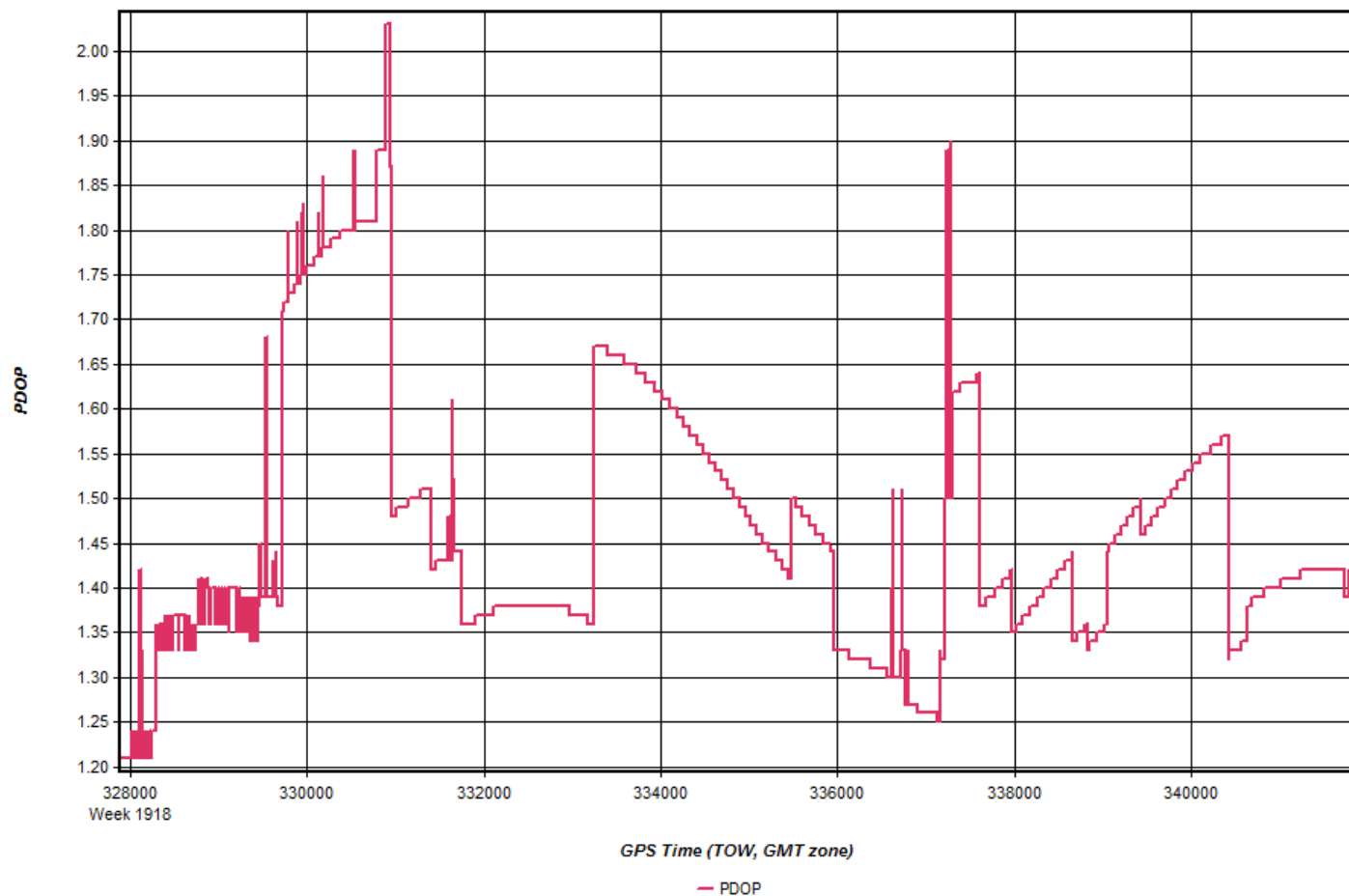
123_20161012_1



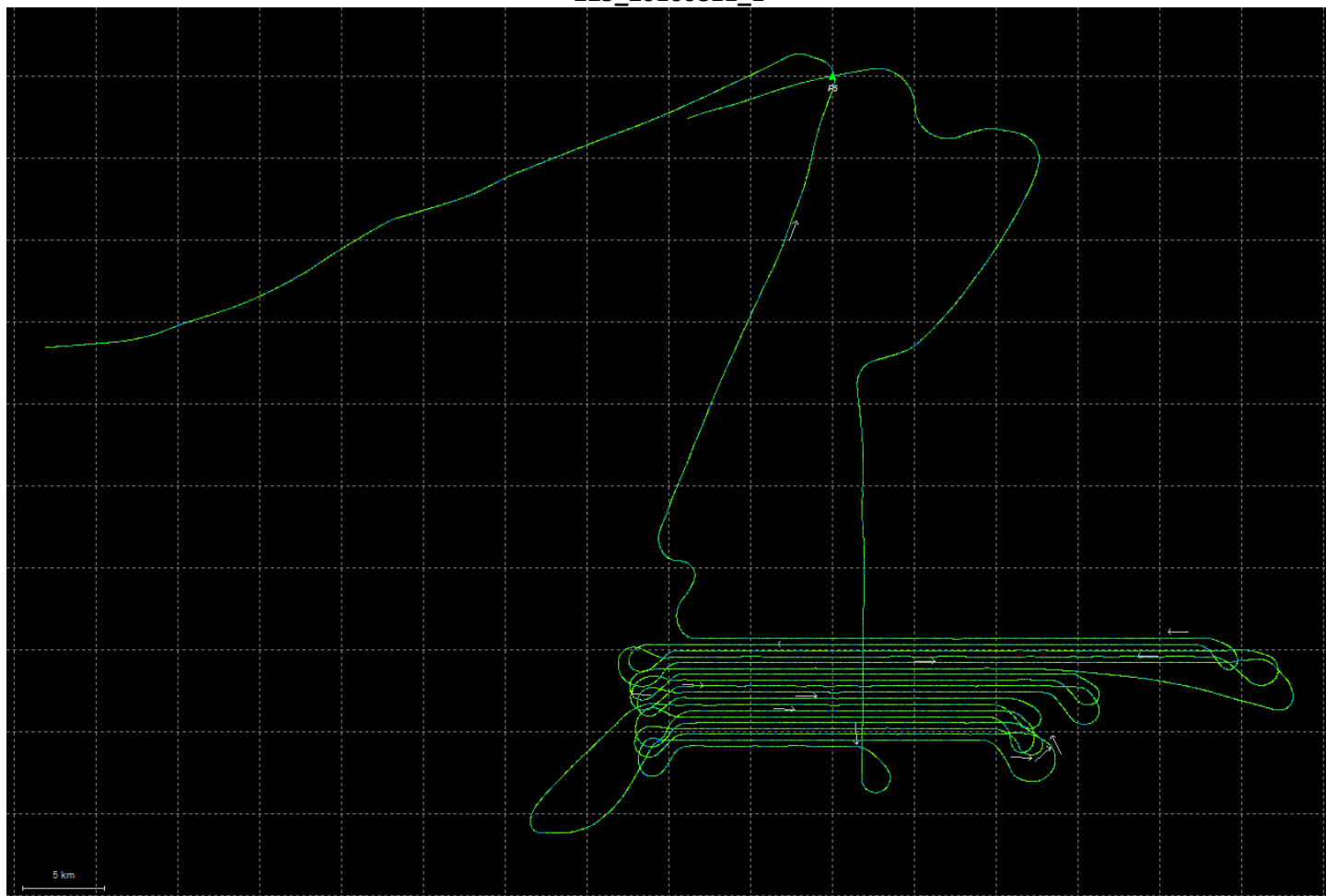


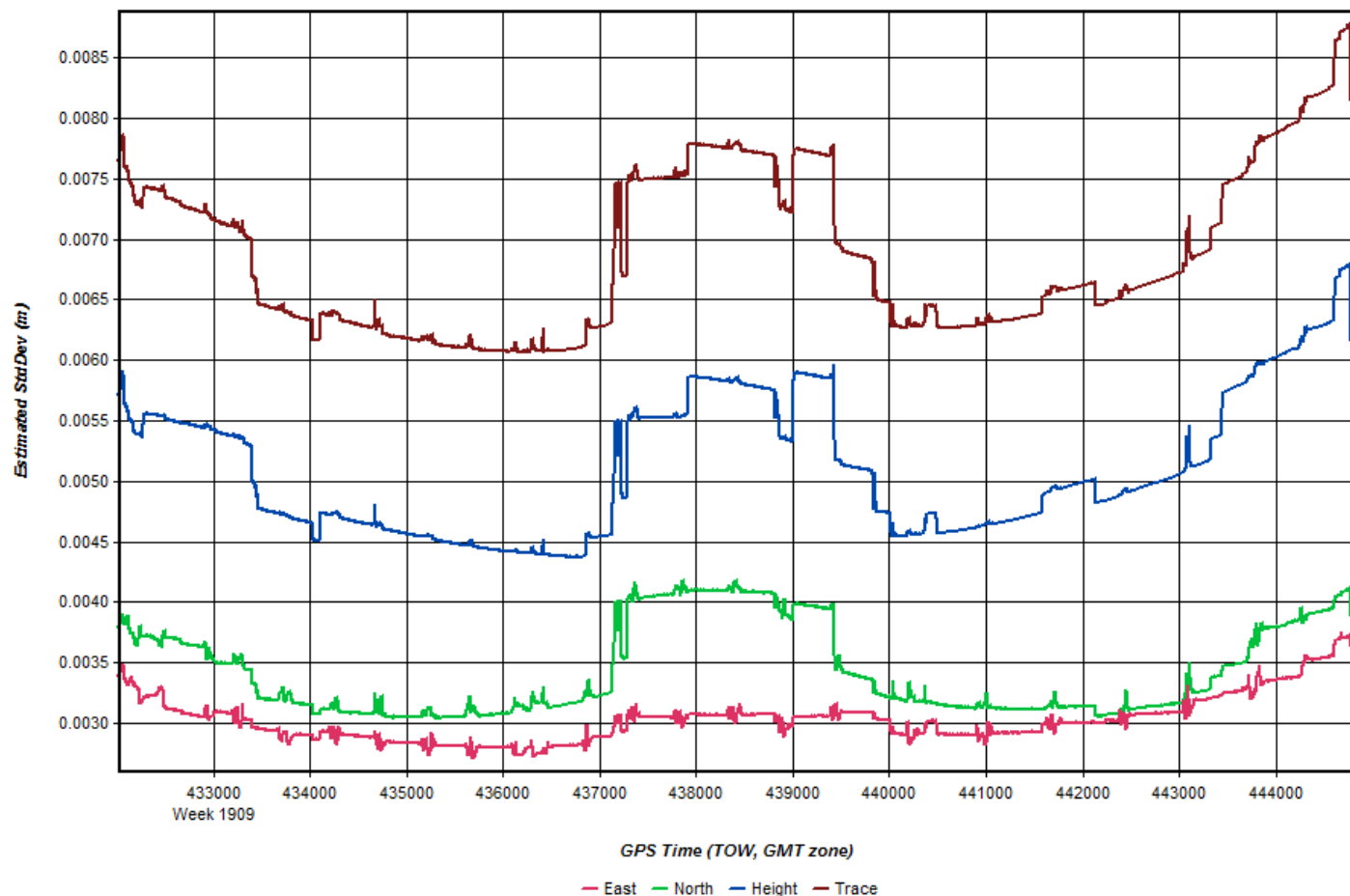


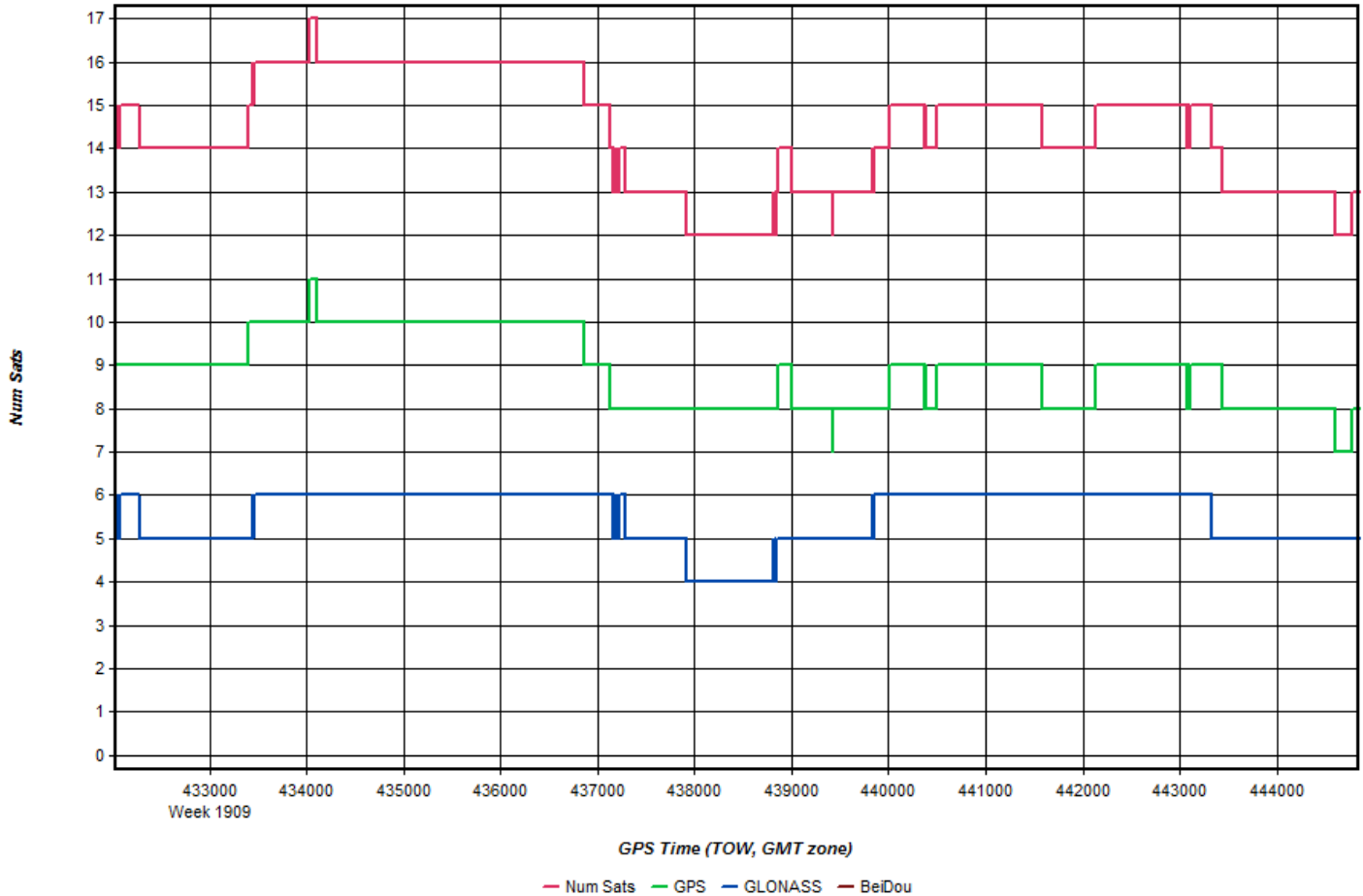


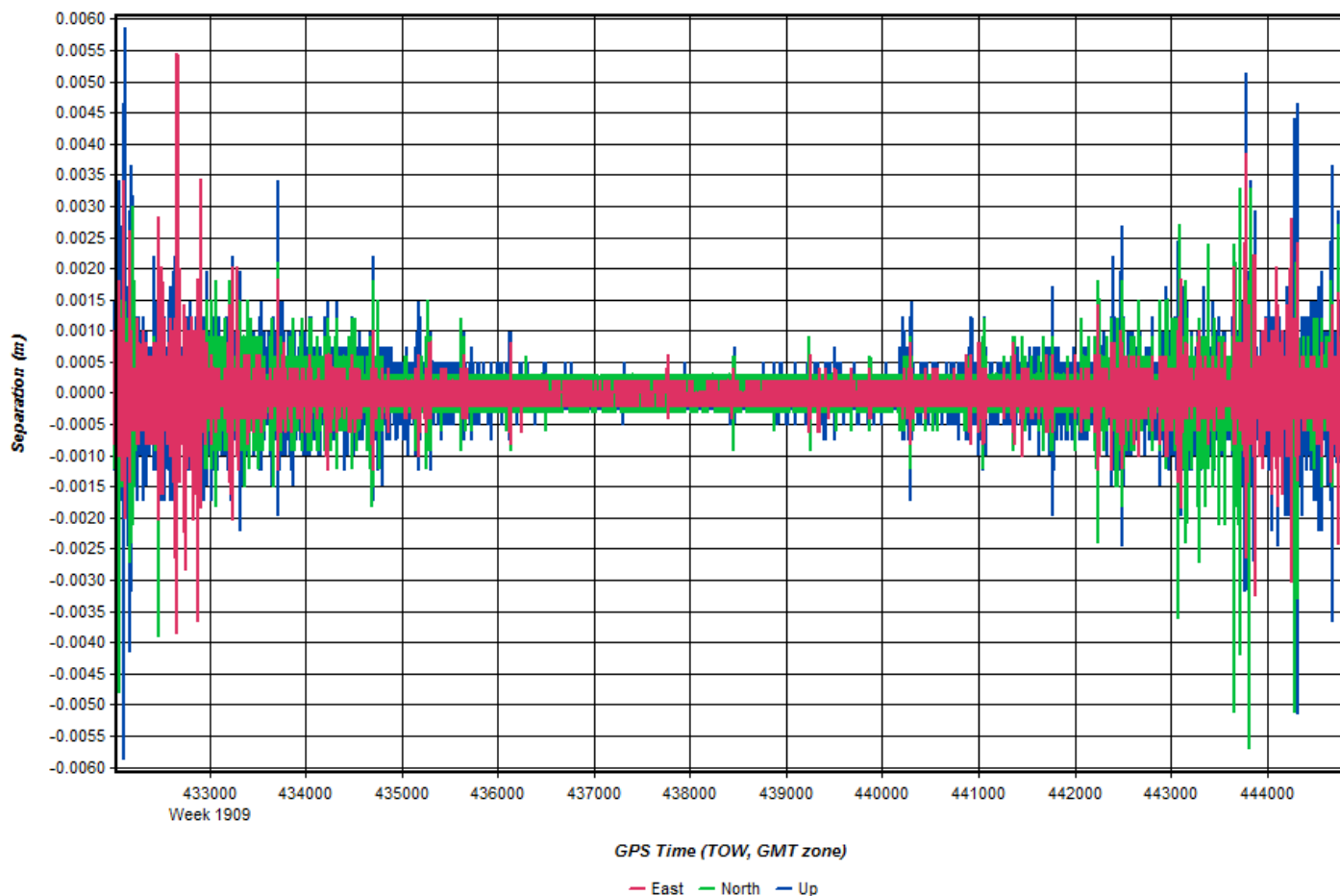


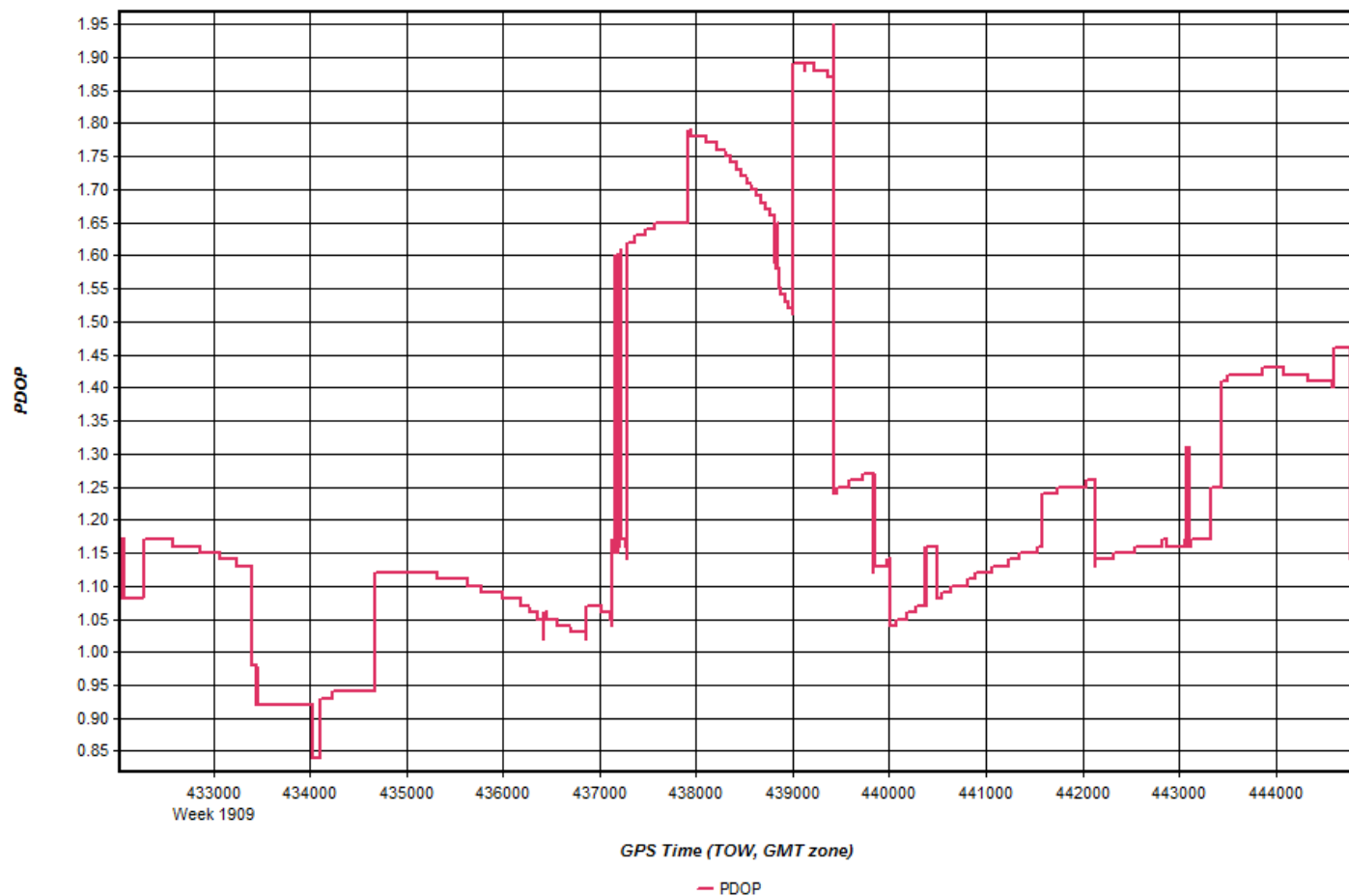
225_20160811_1



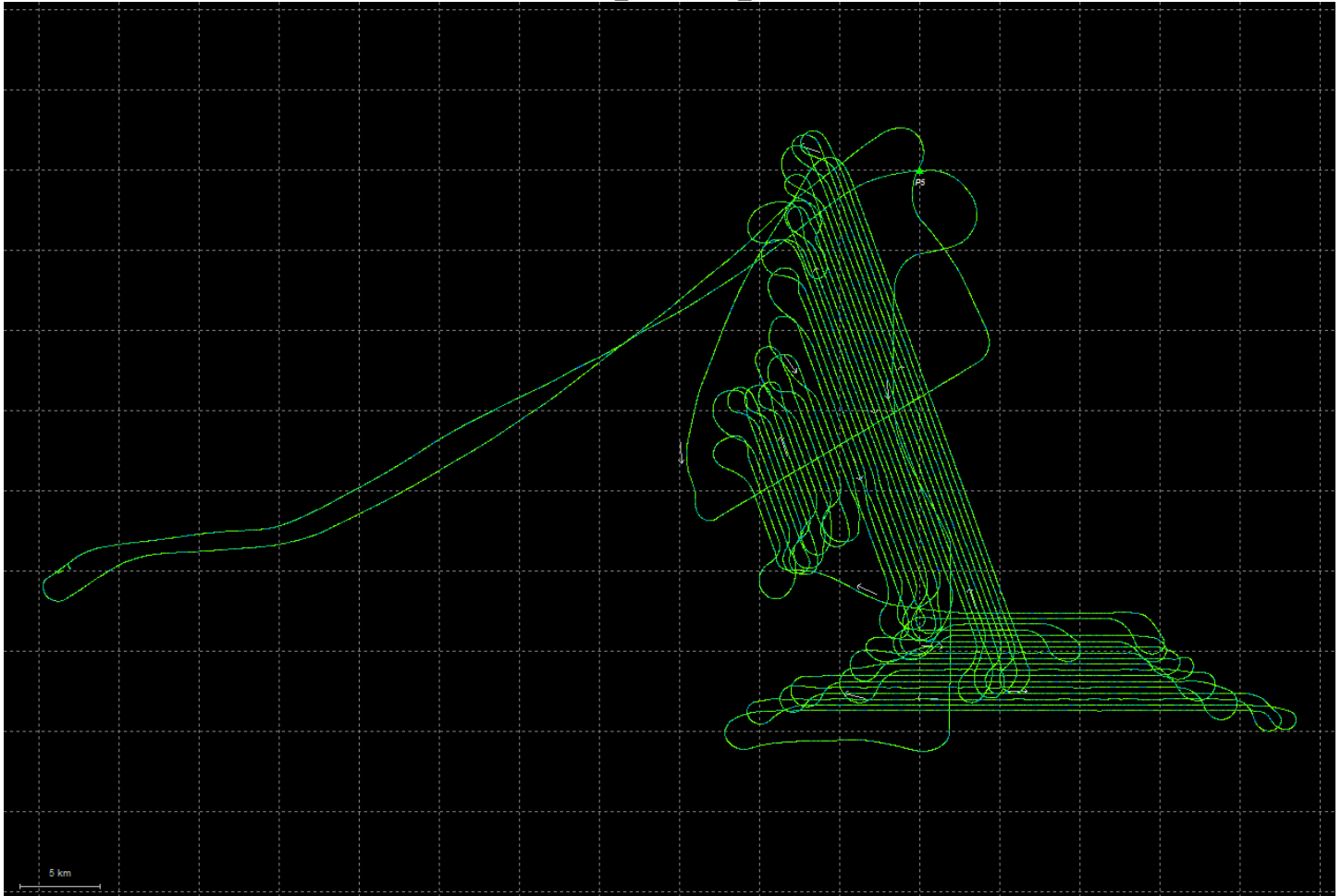


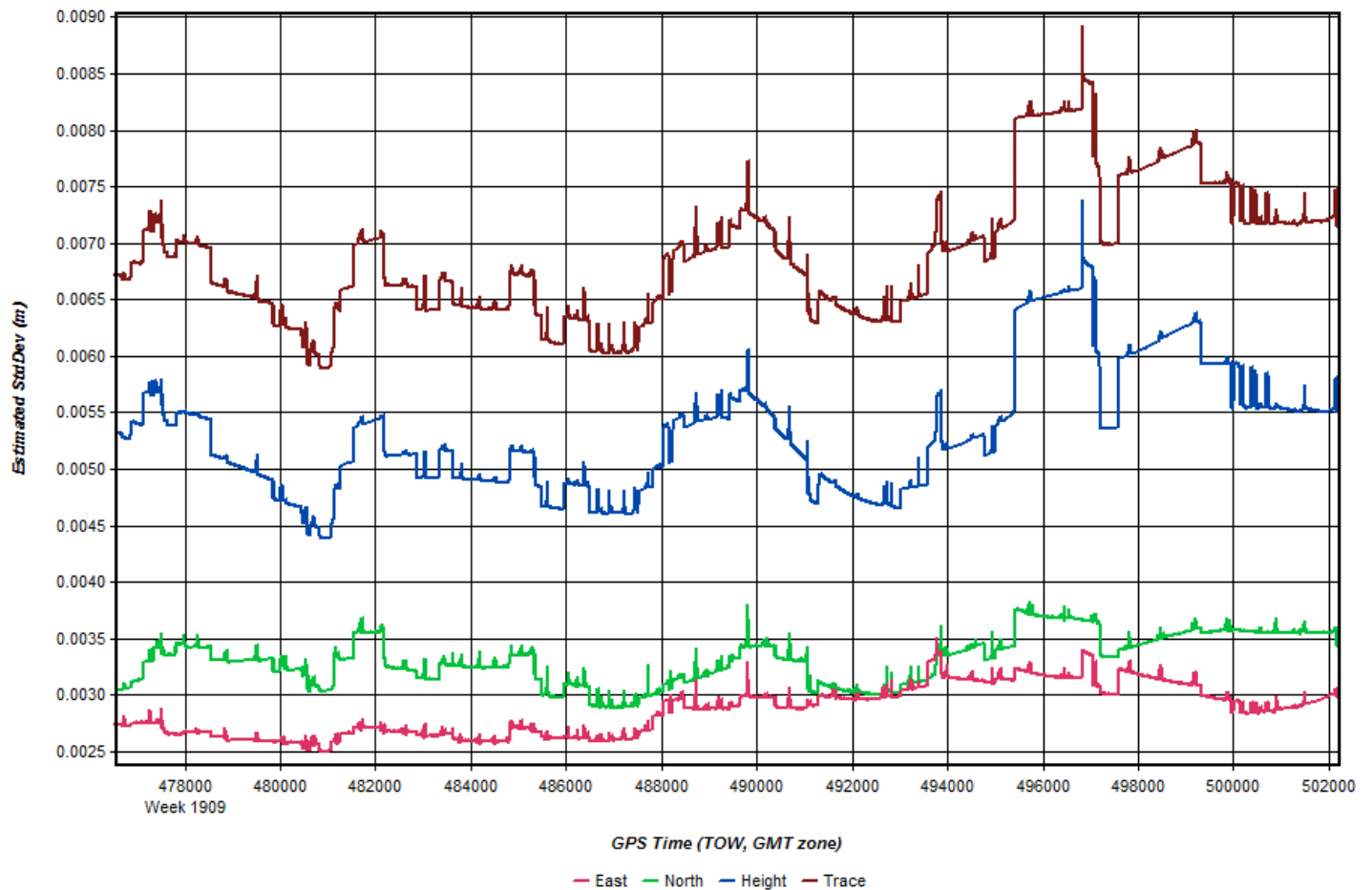


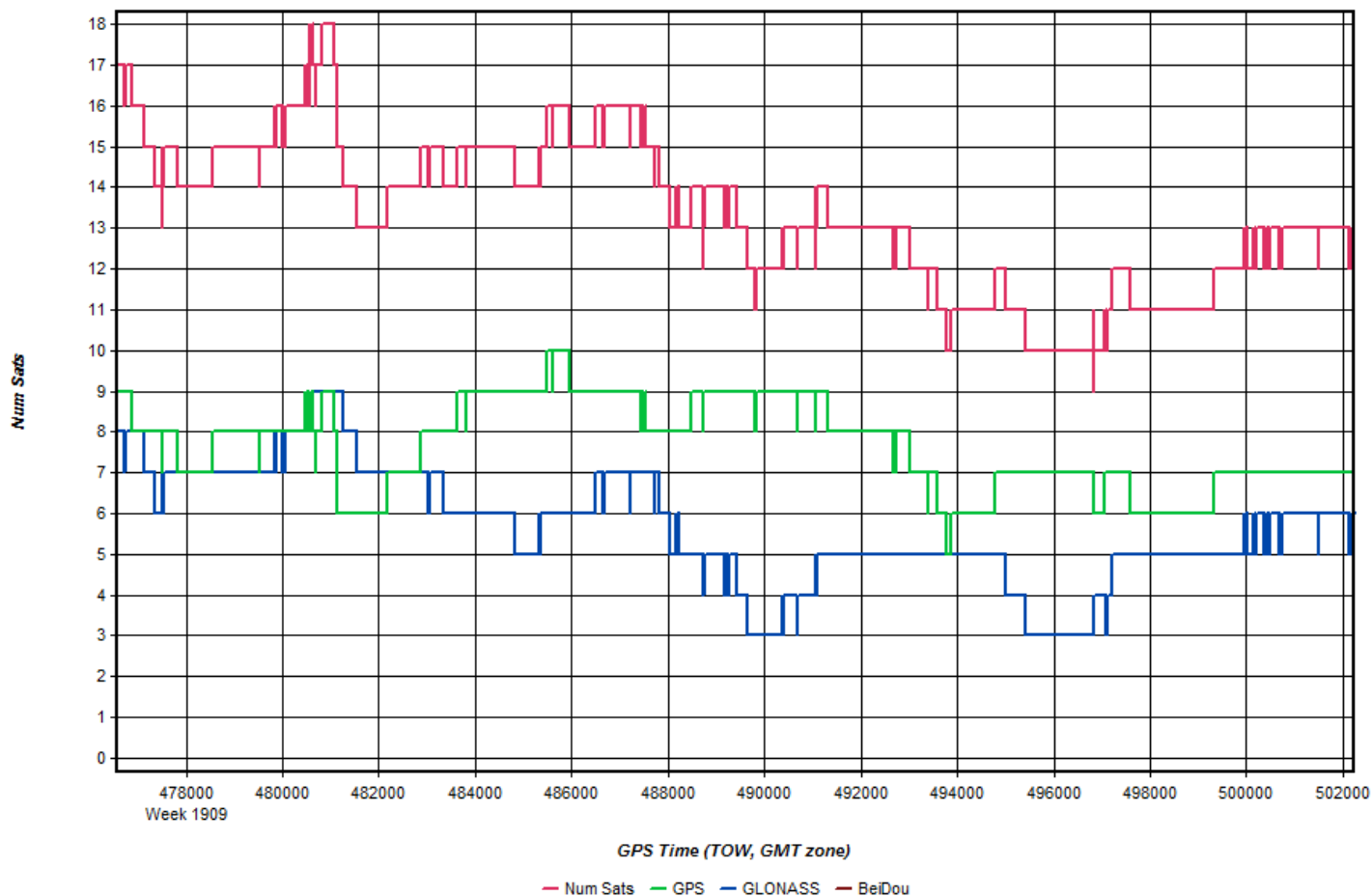


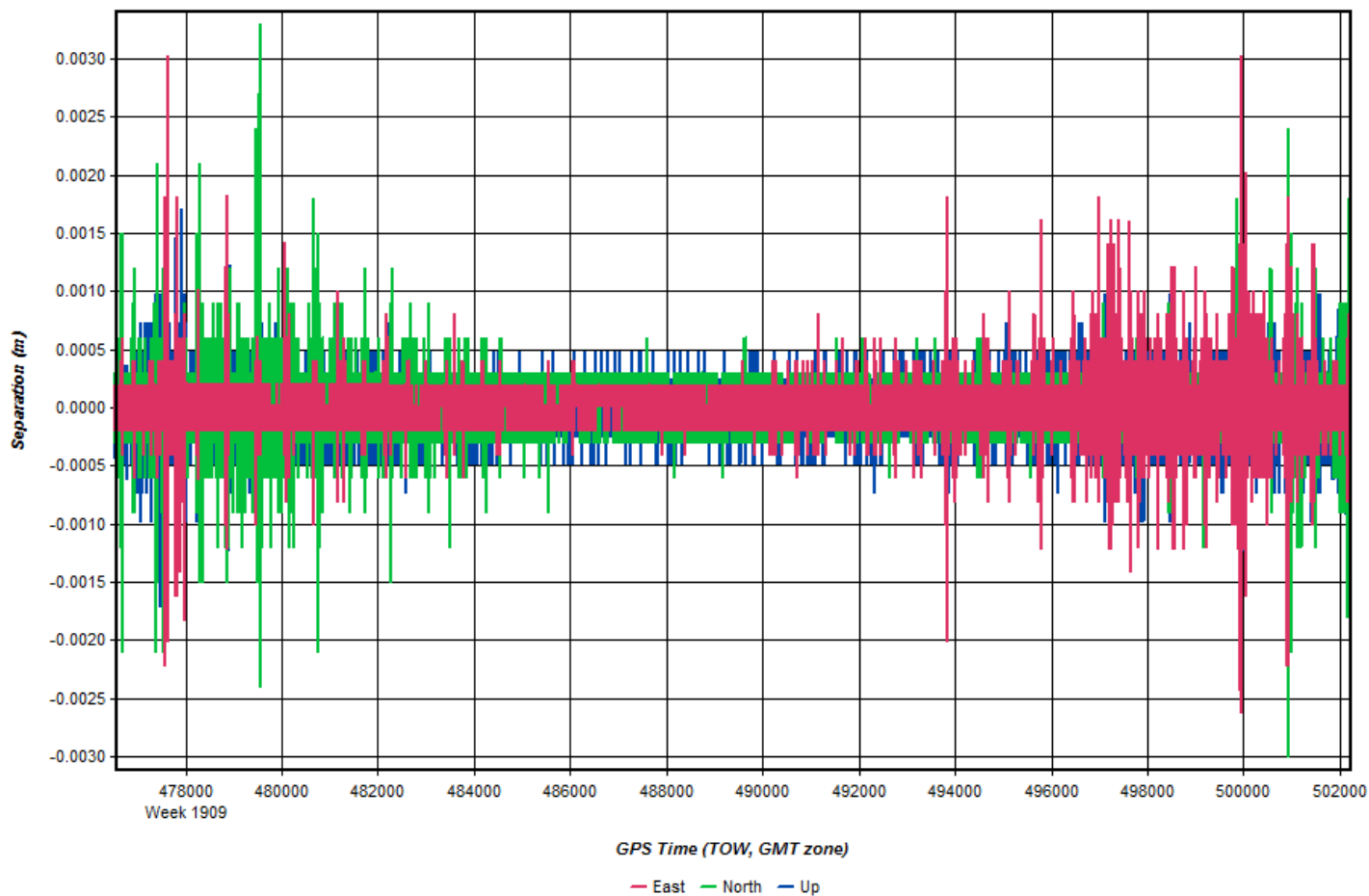


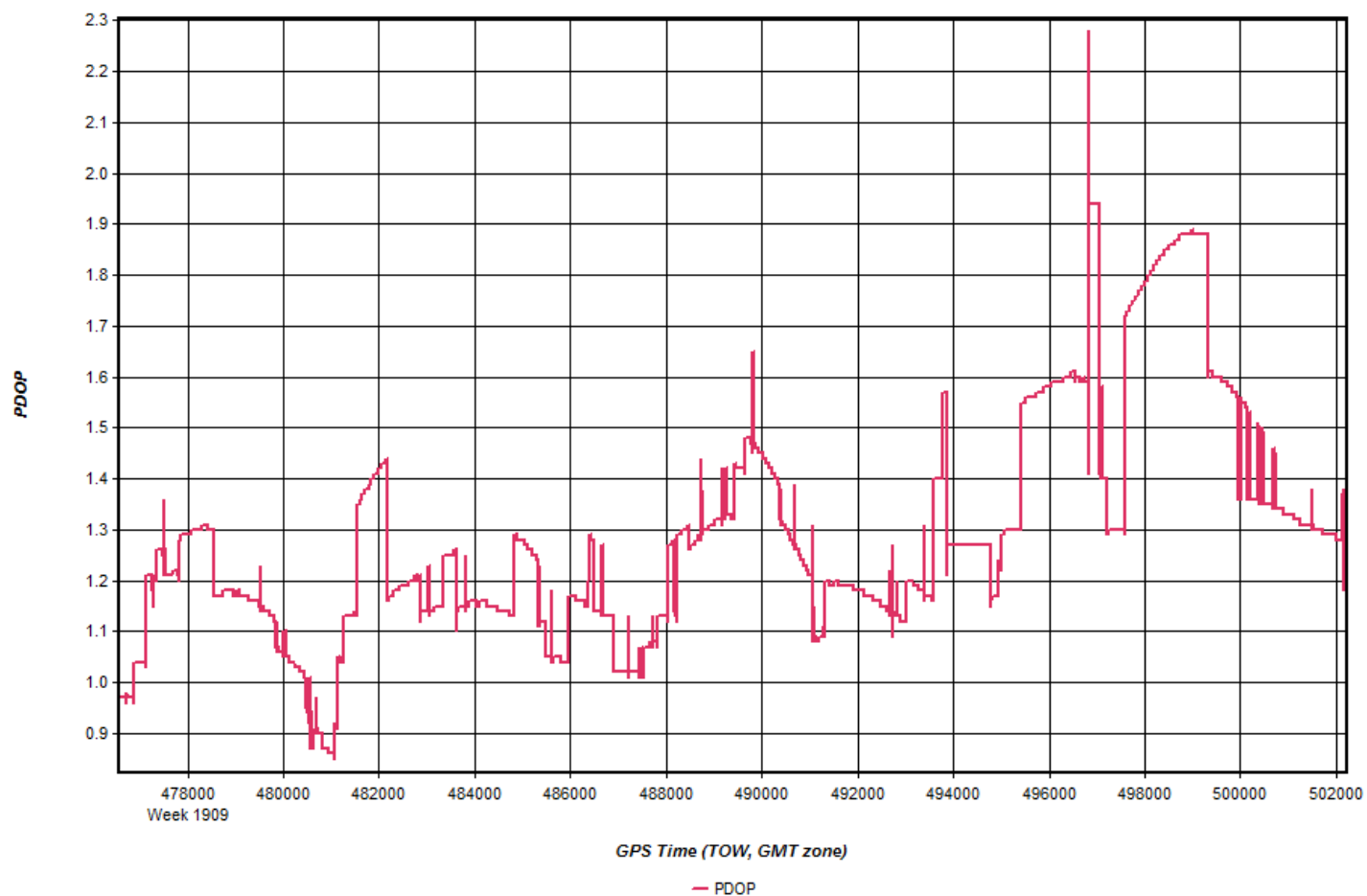
225_20160812_1



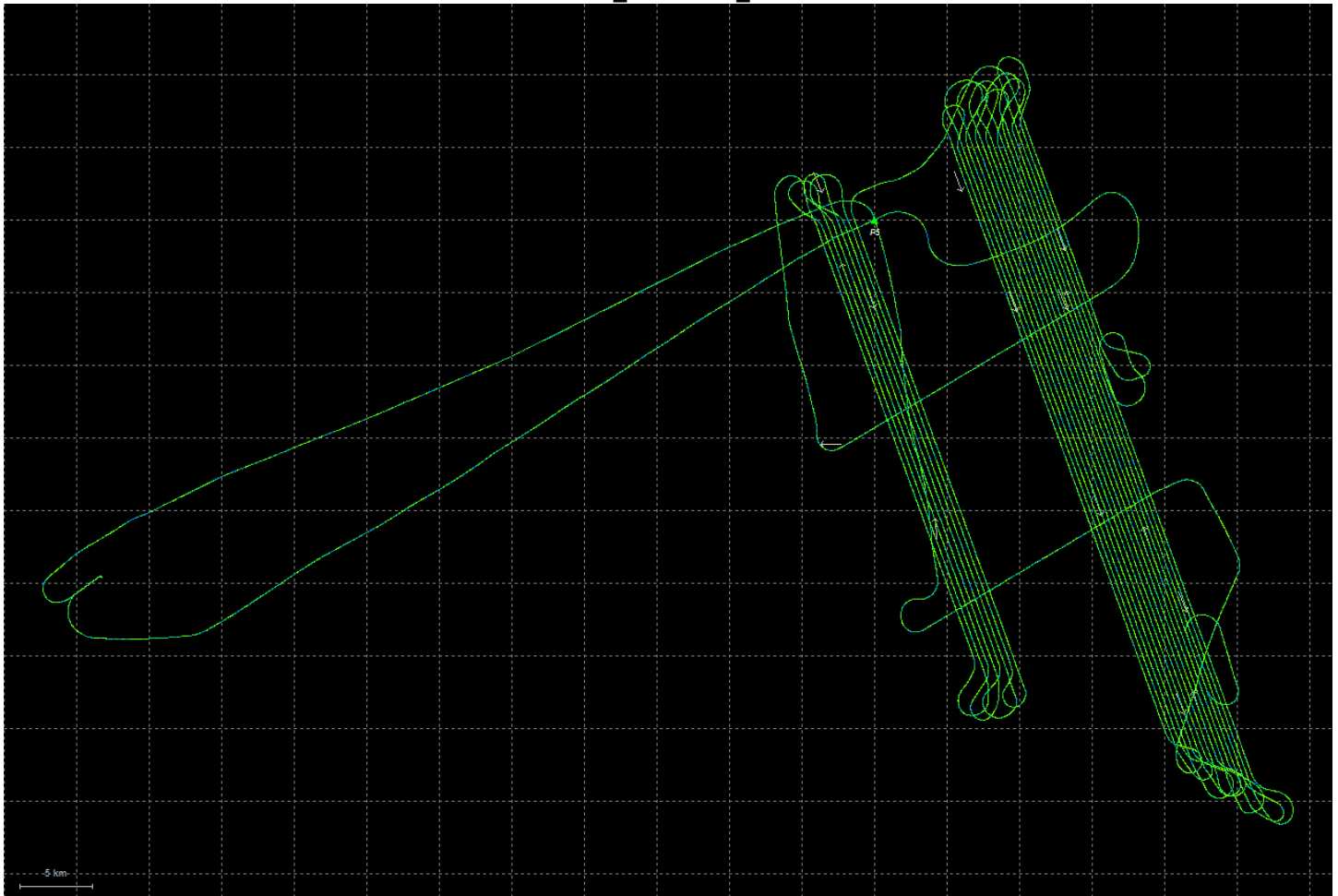


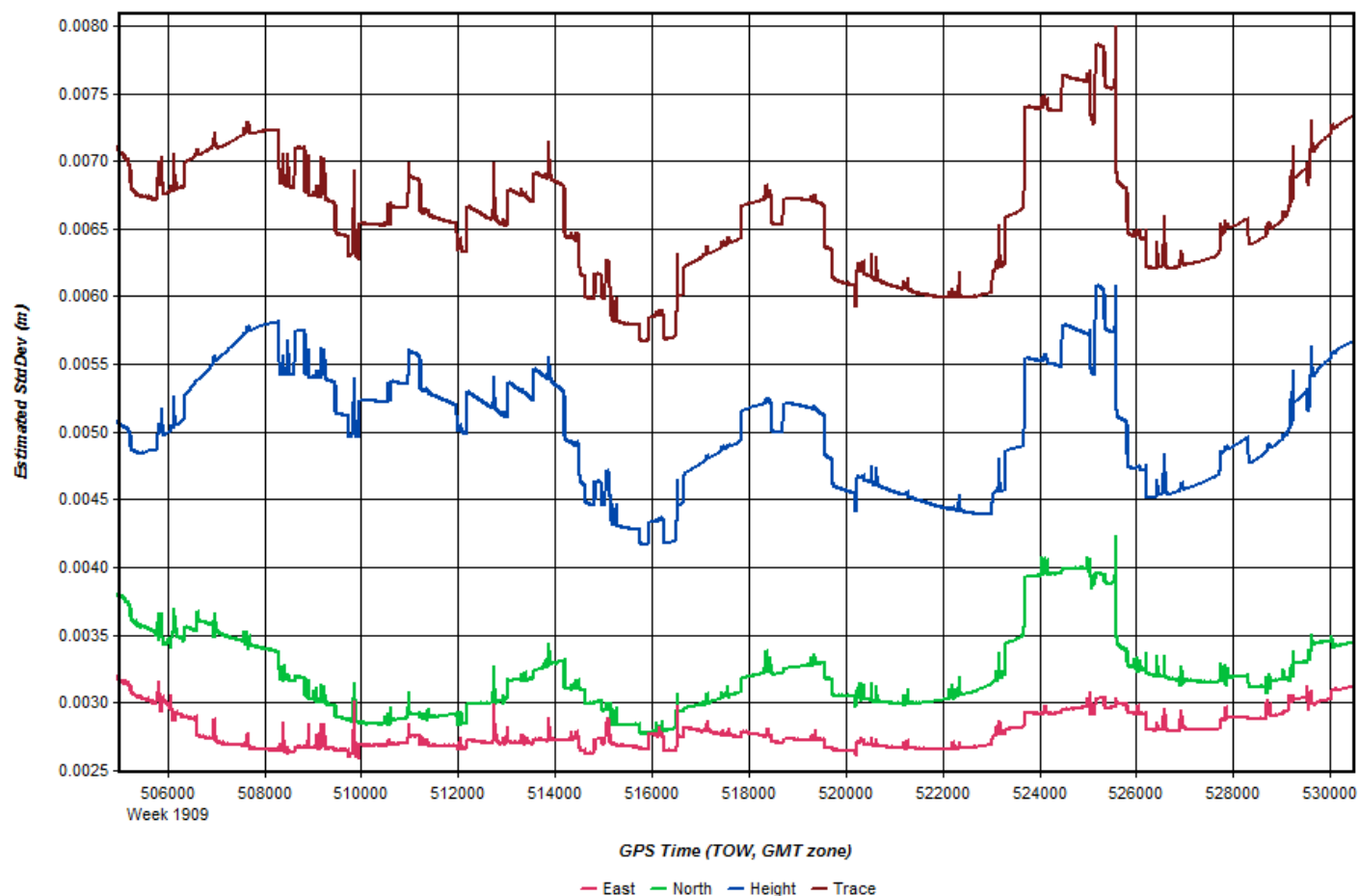


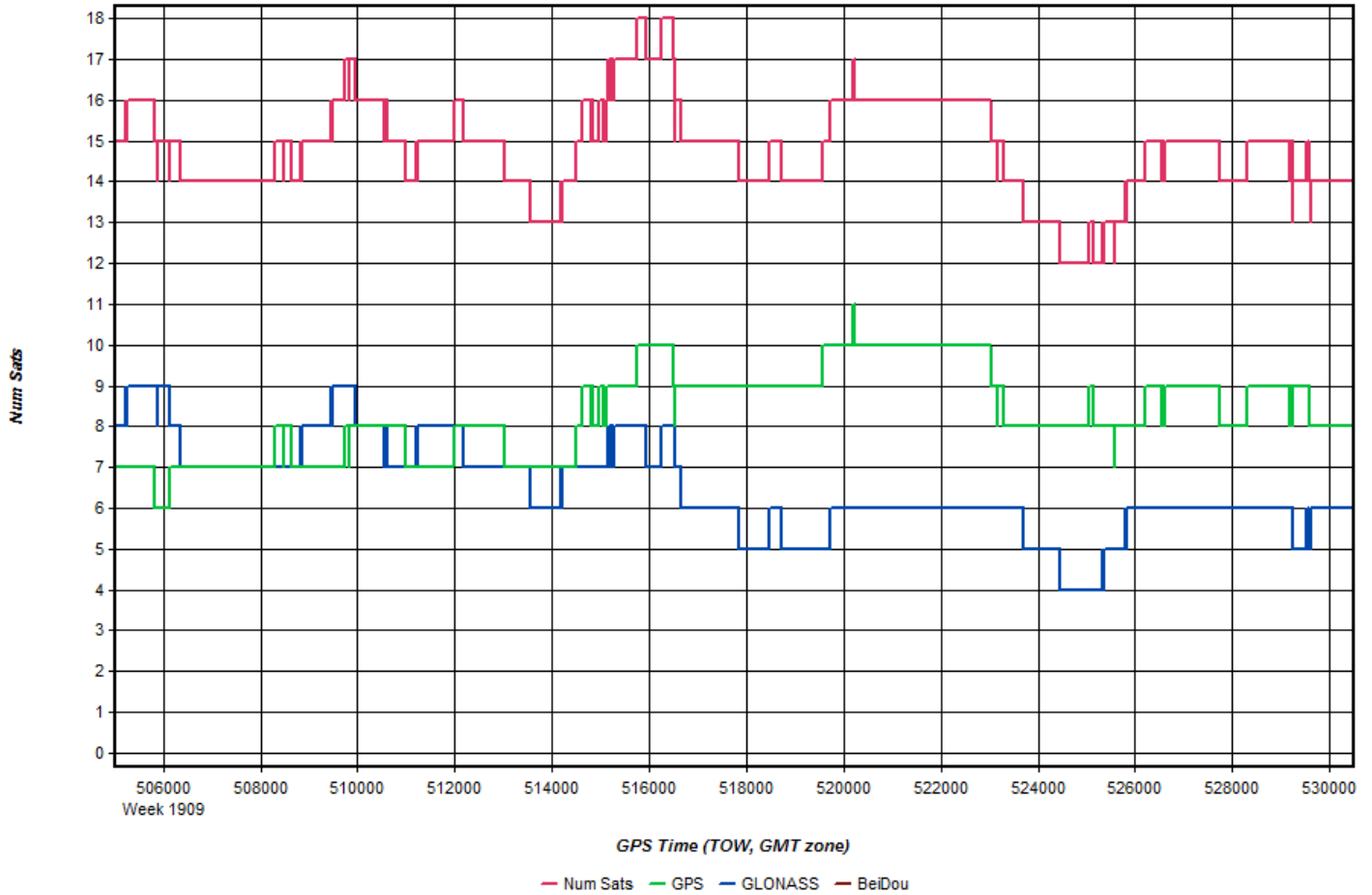


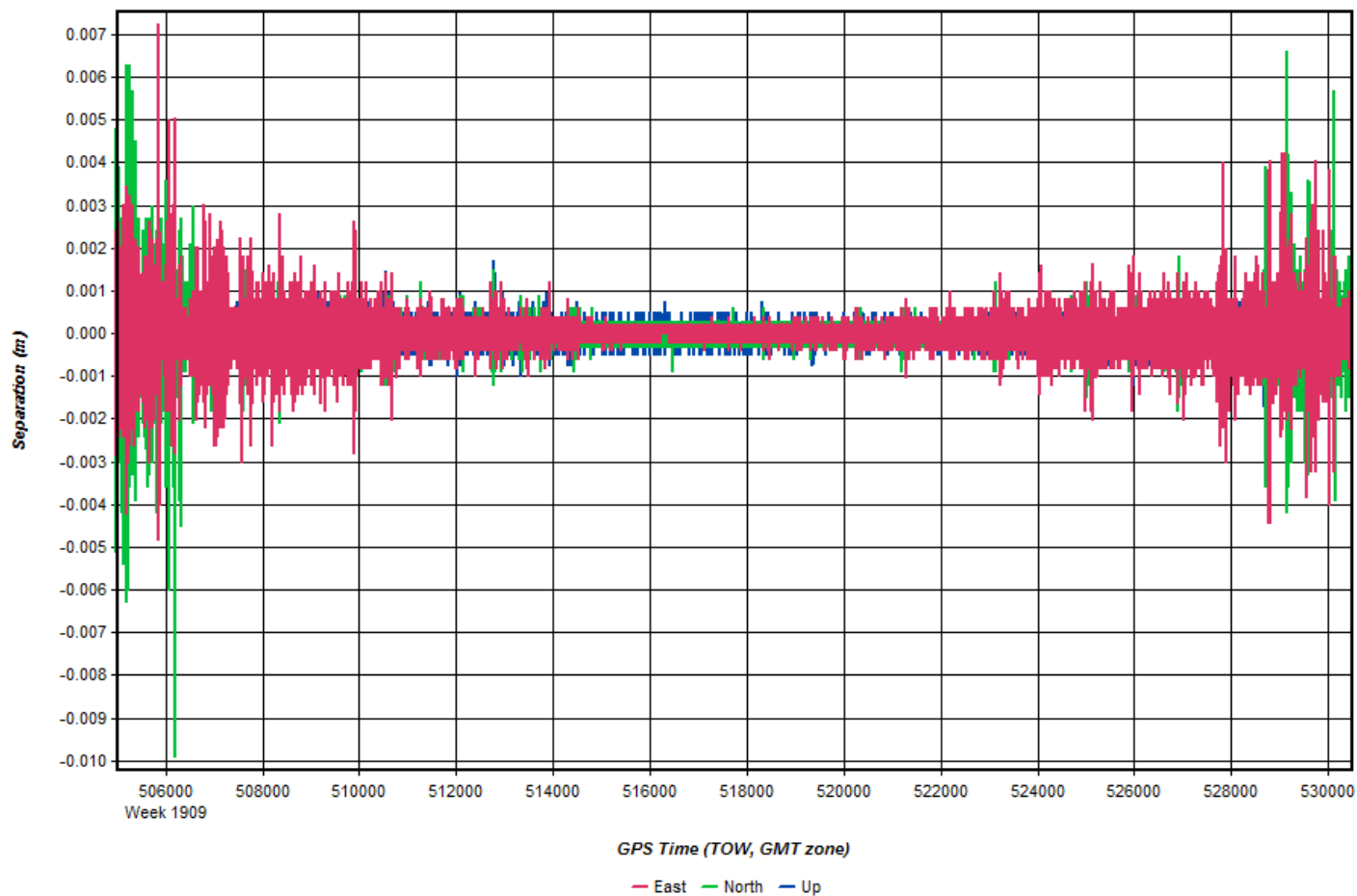


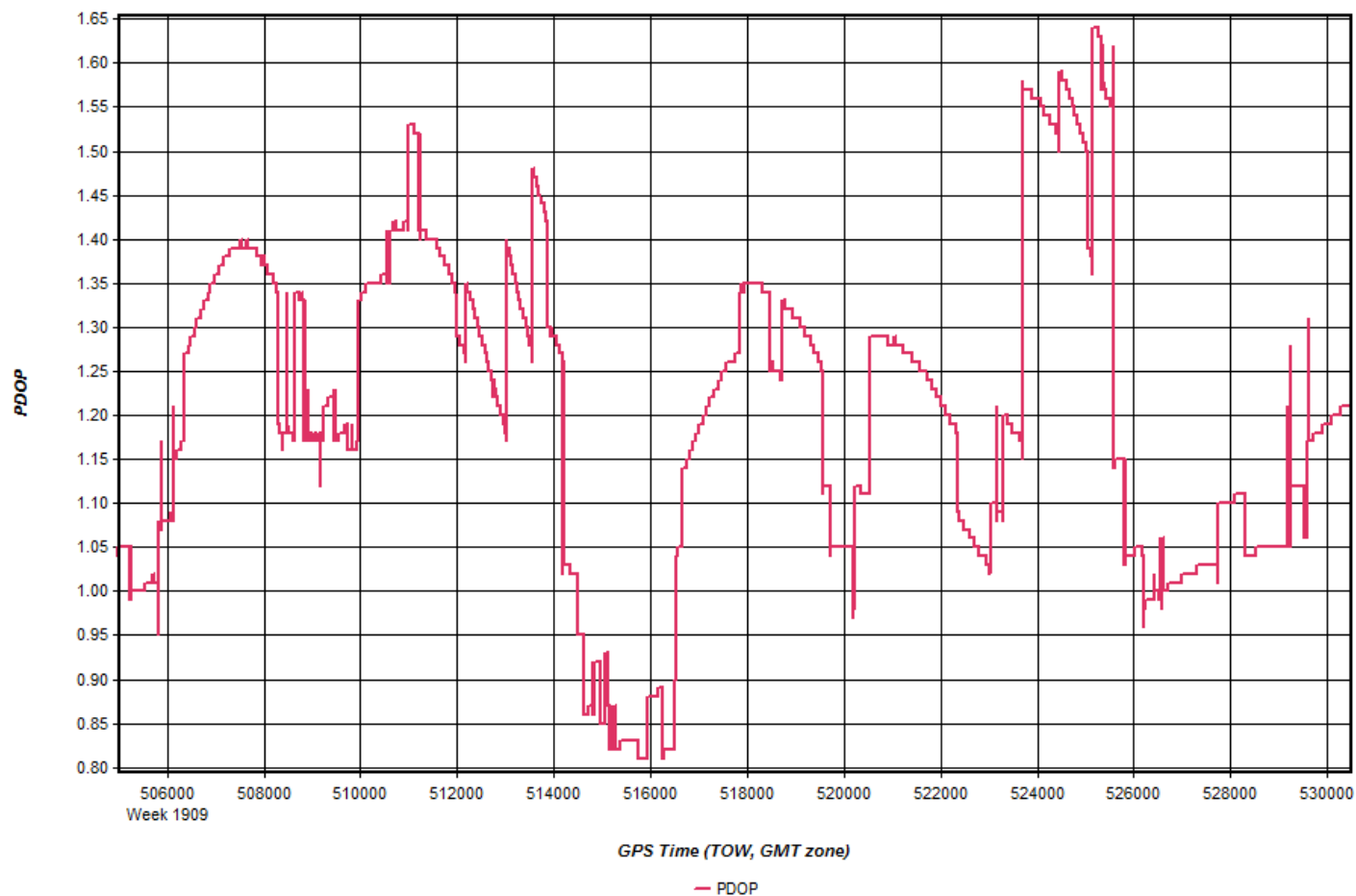
225_20160812_2



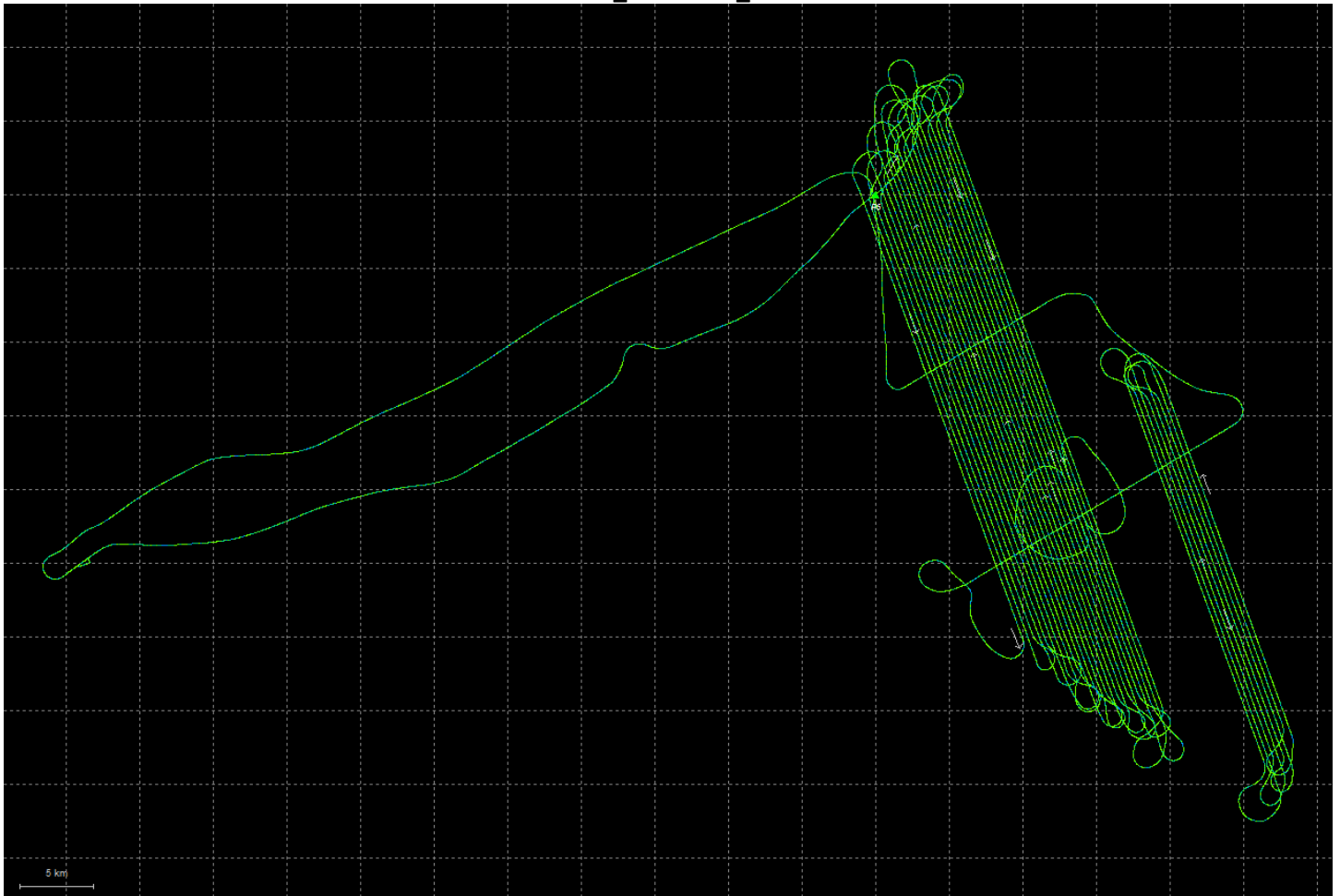


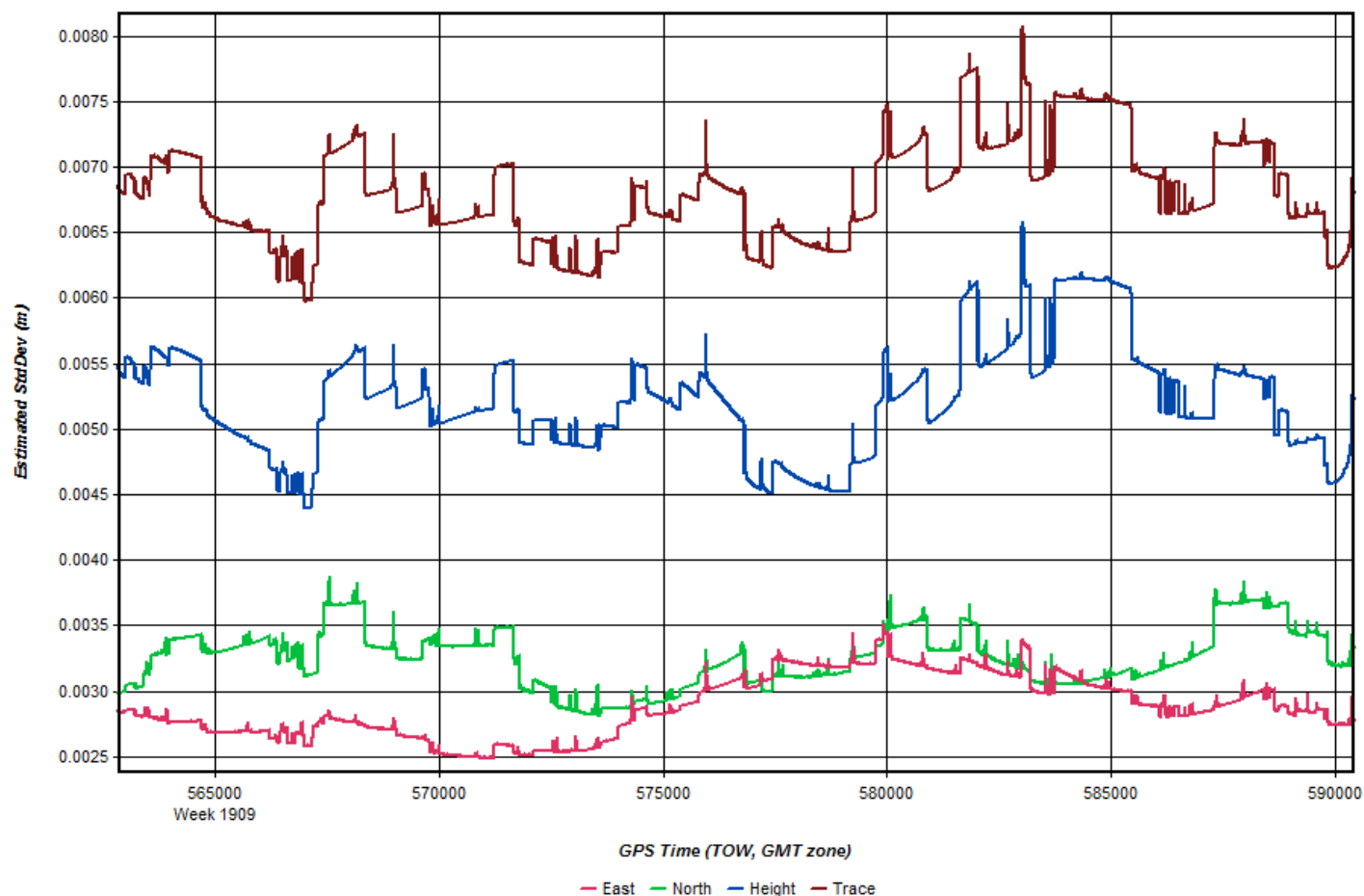


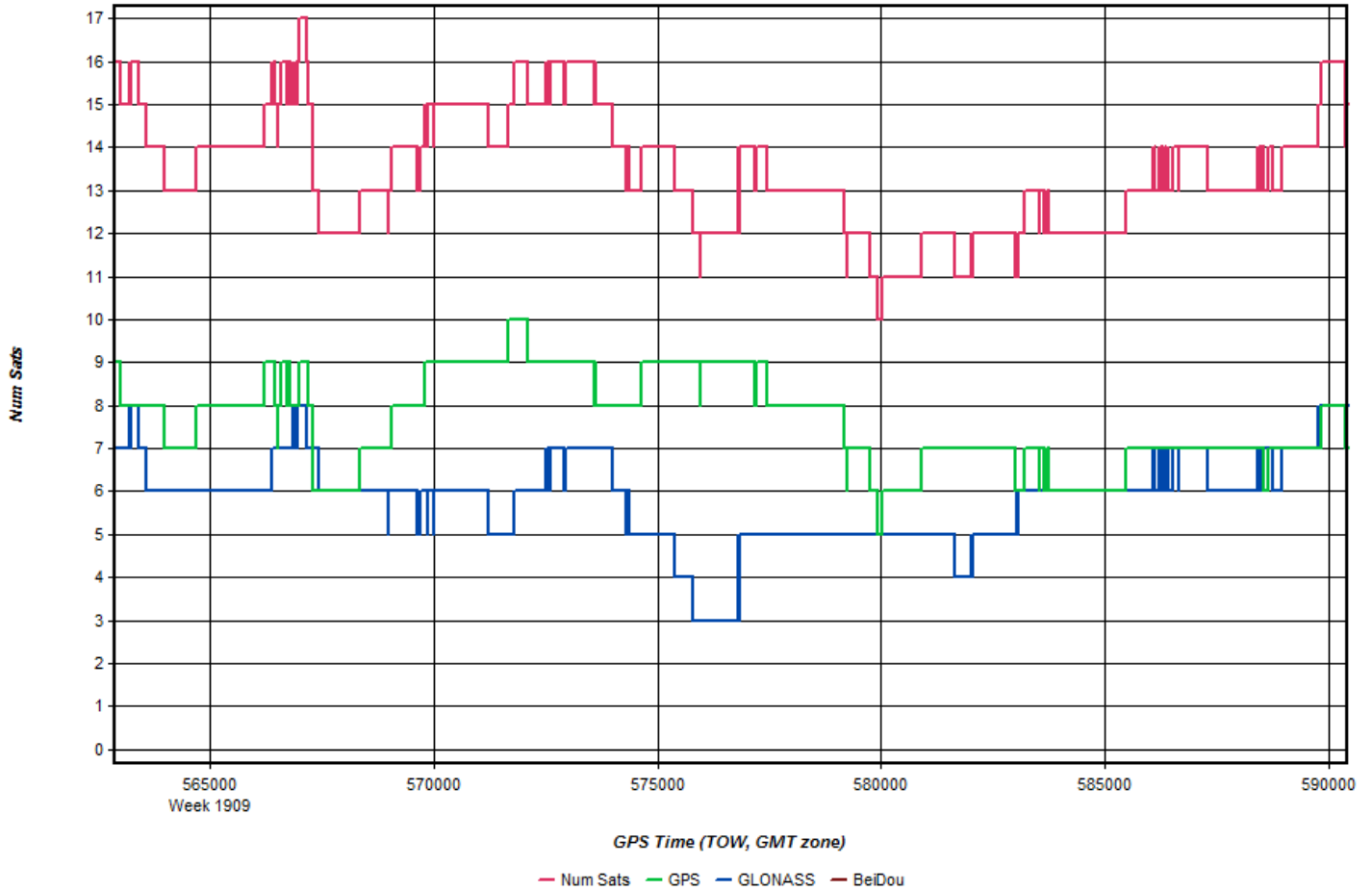


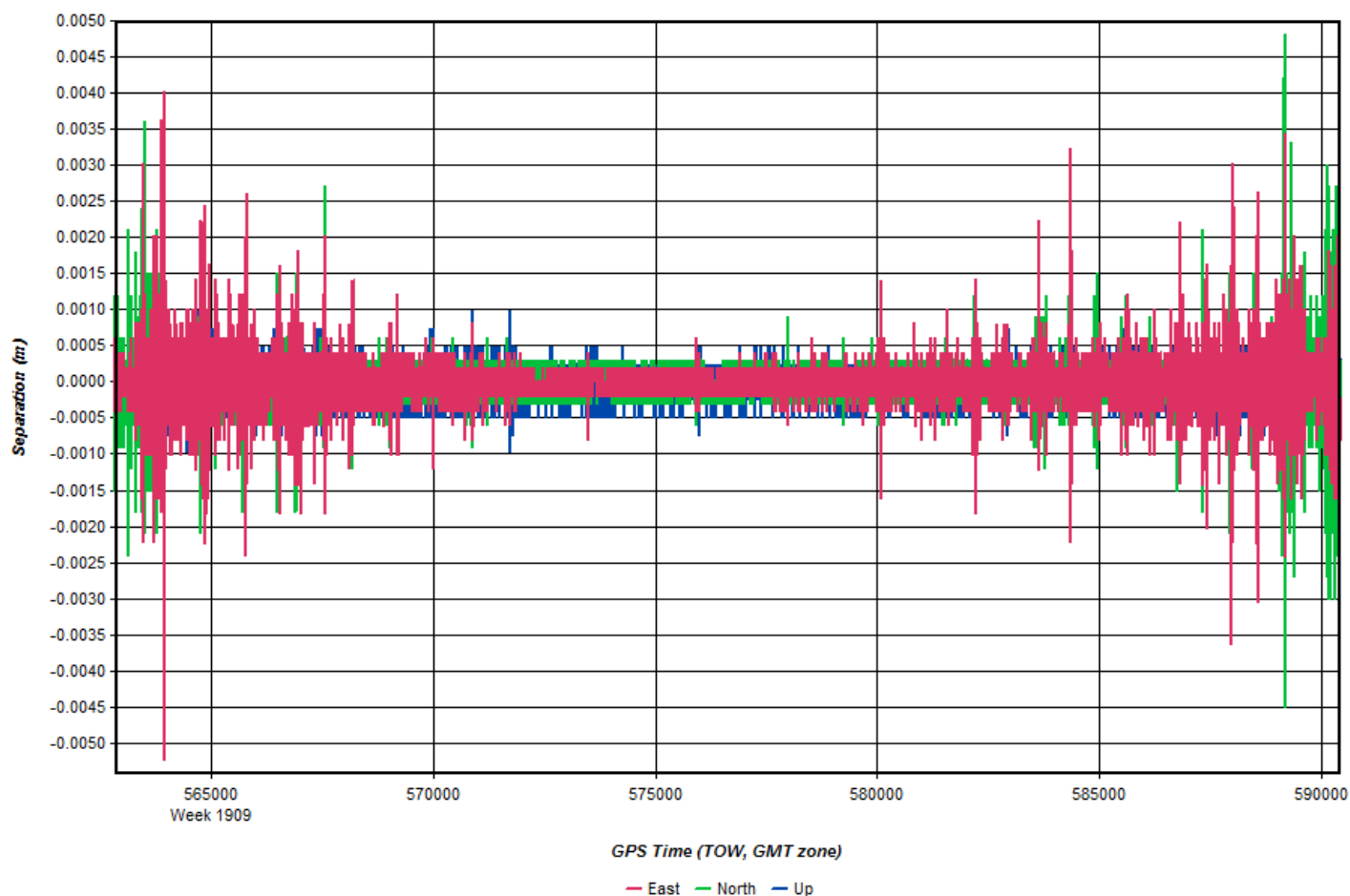


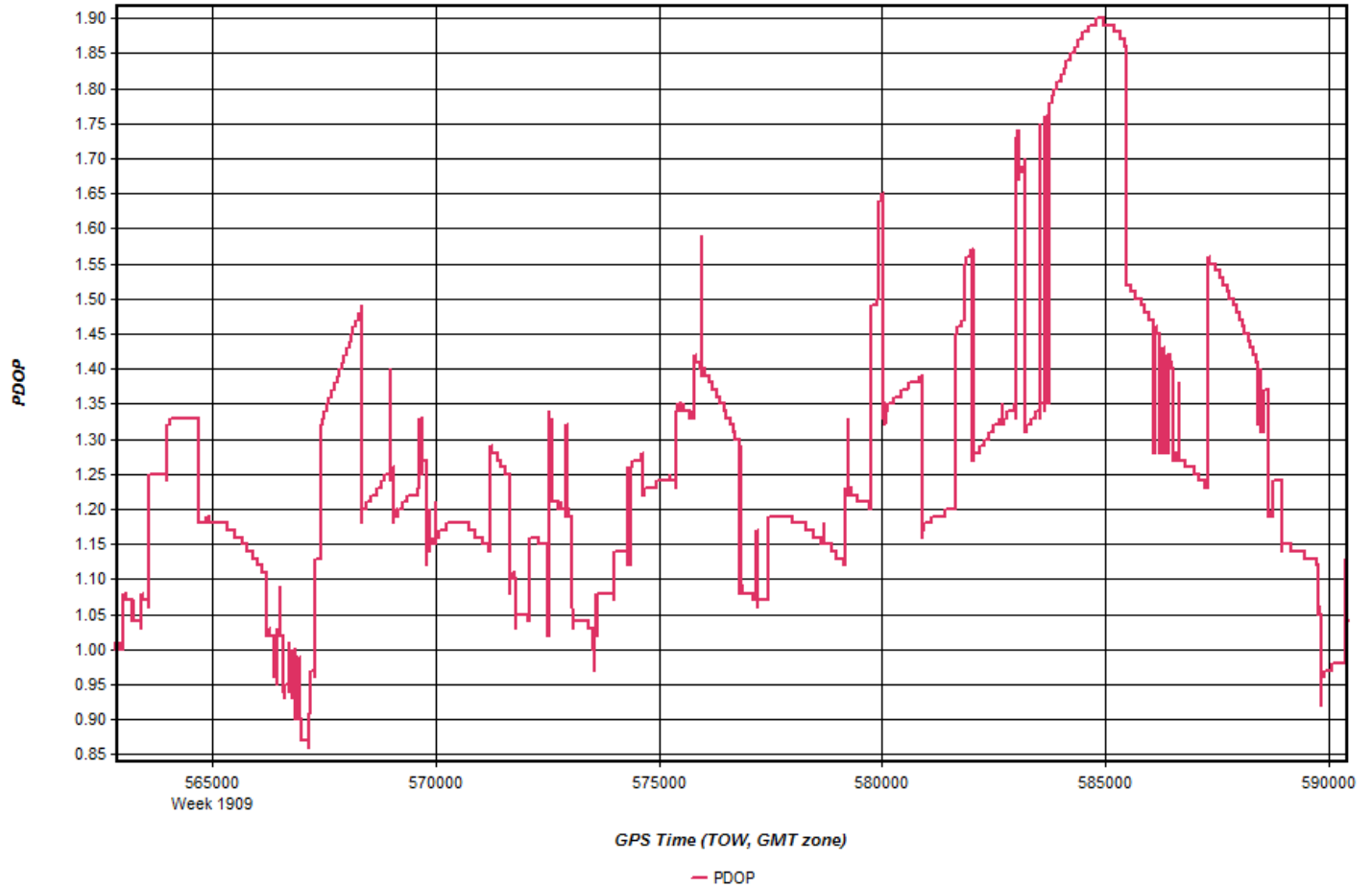
225_20160813_1





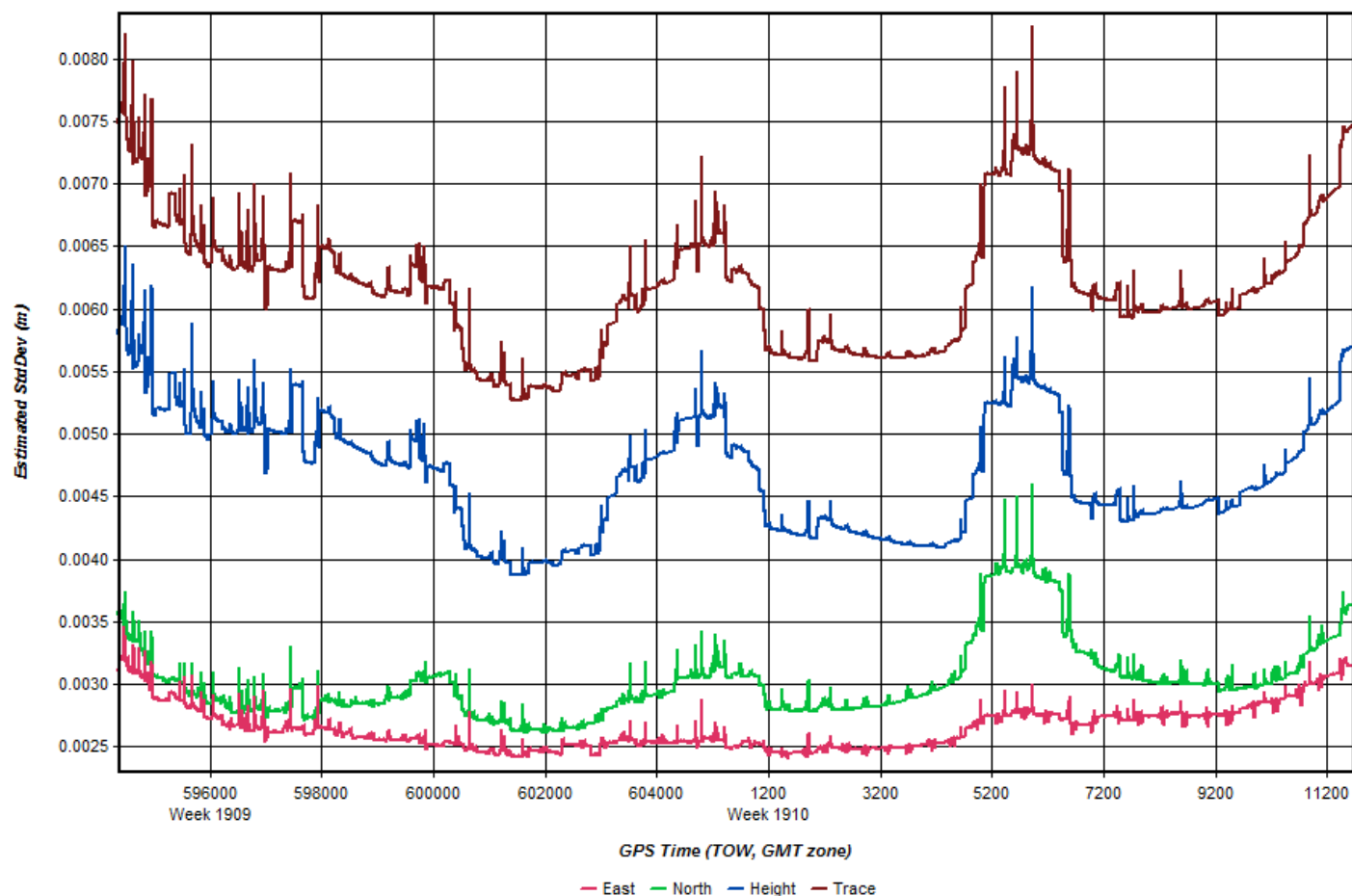


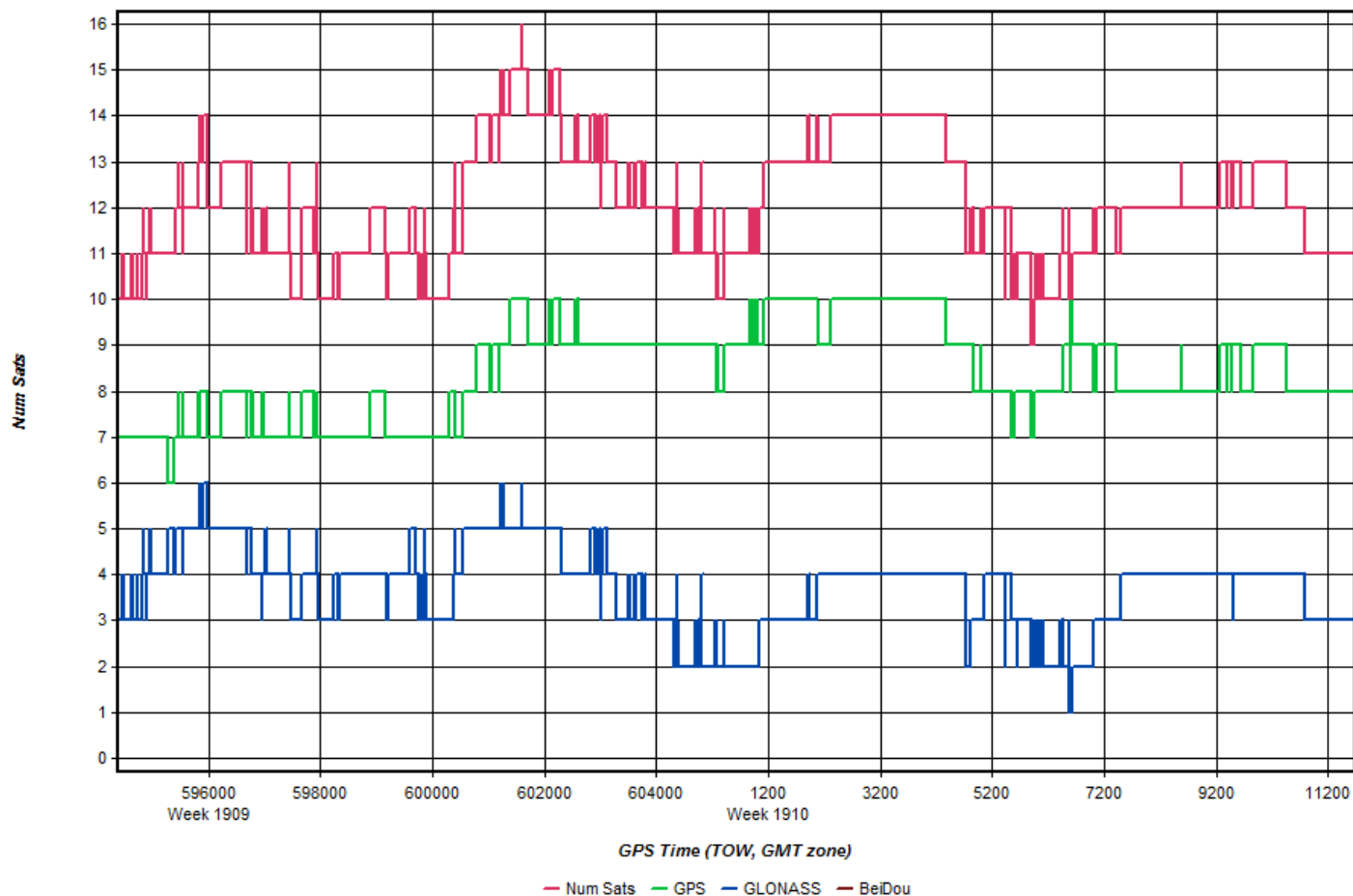


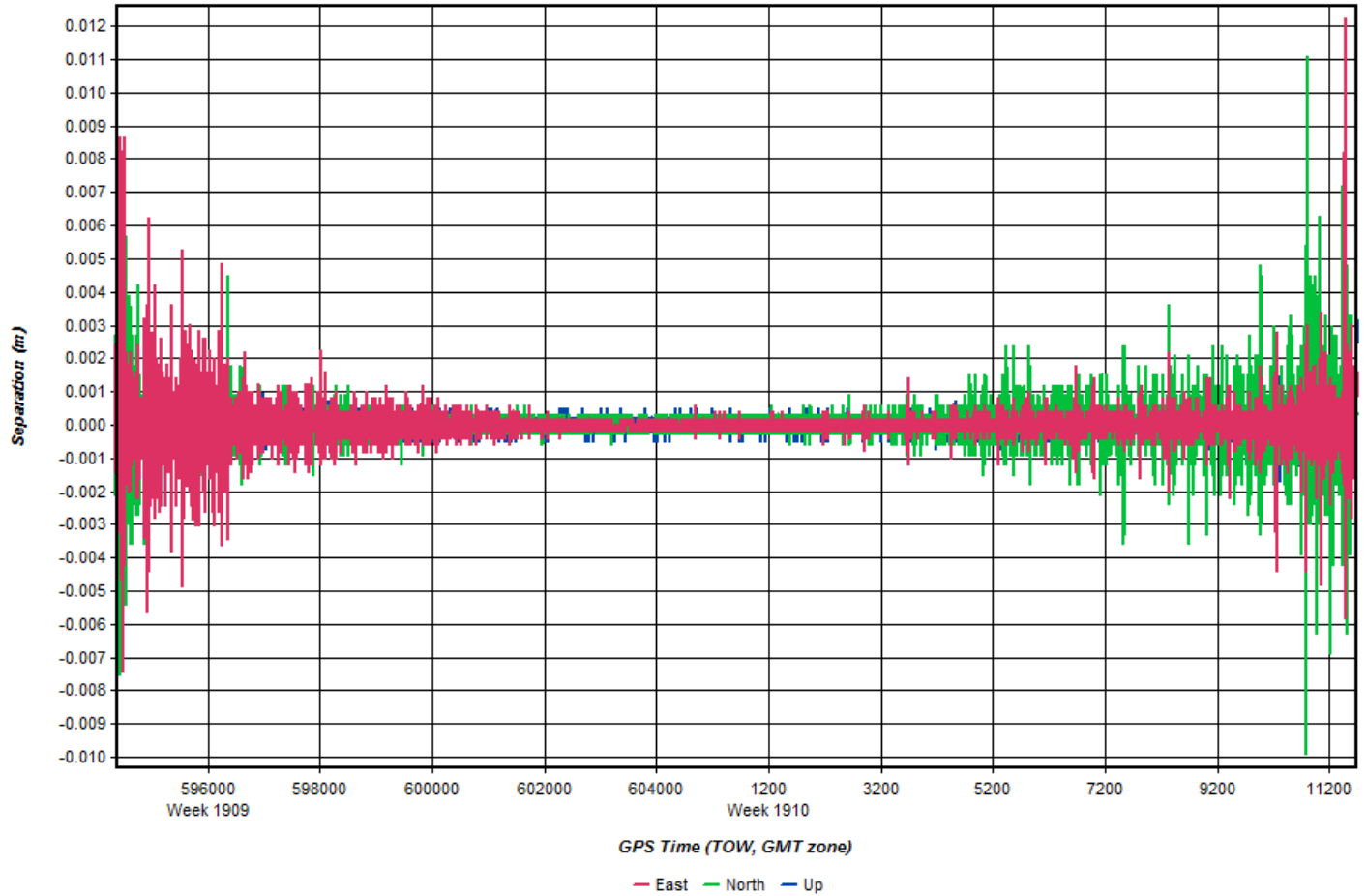


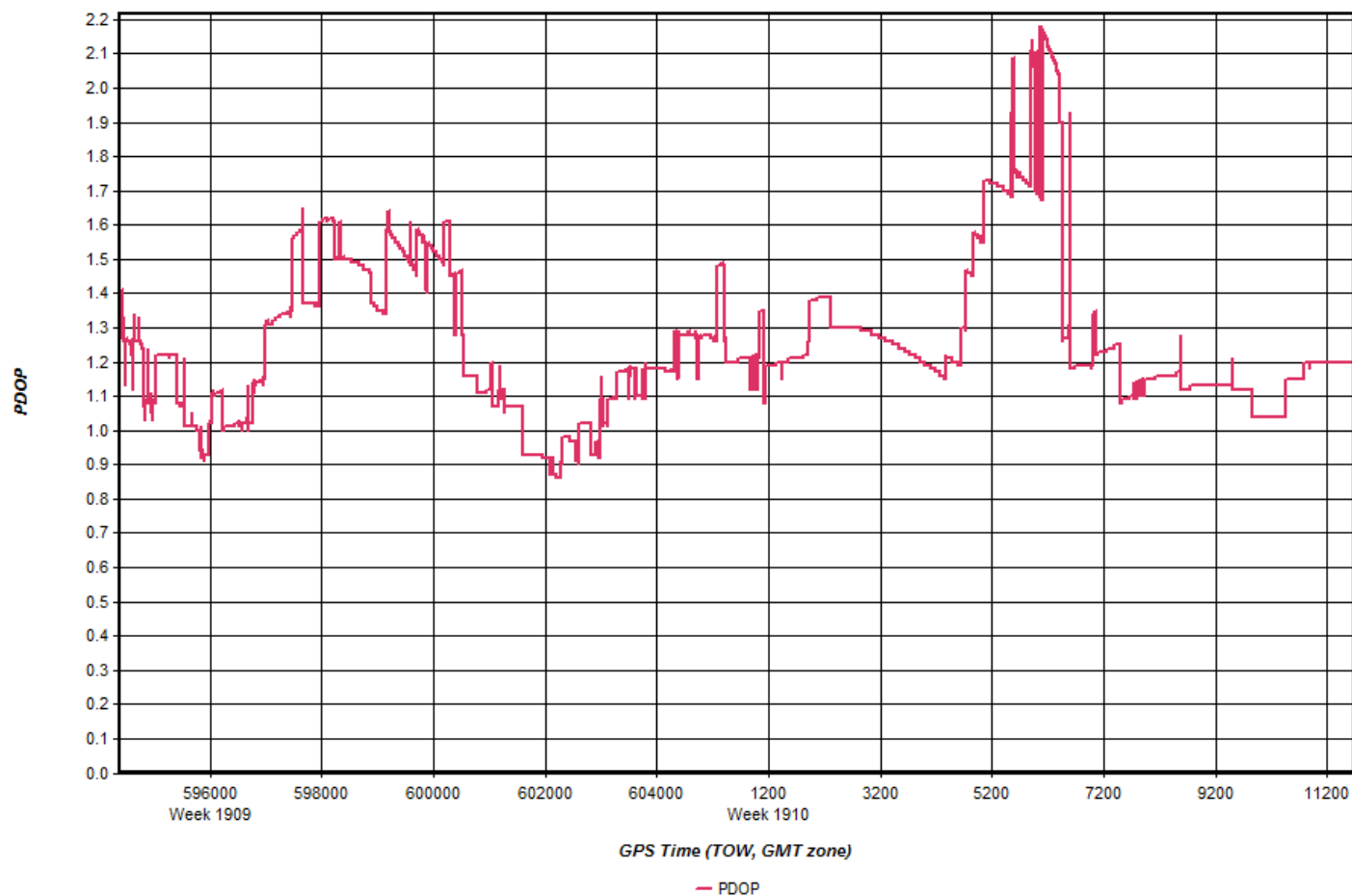
225_20160813_2



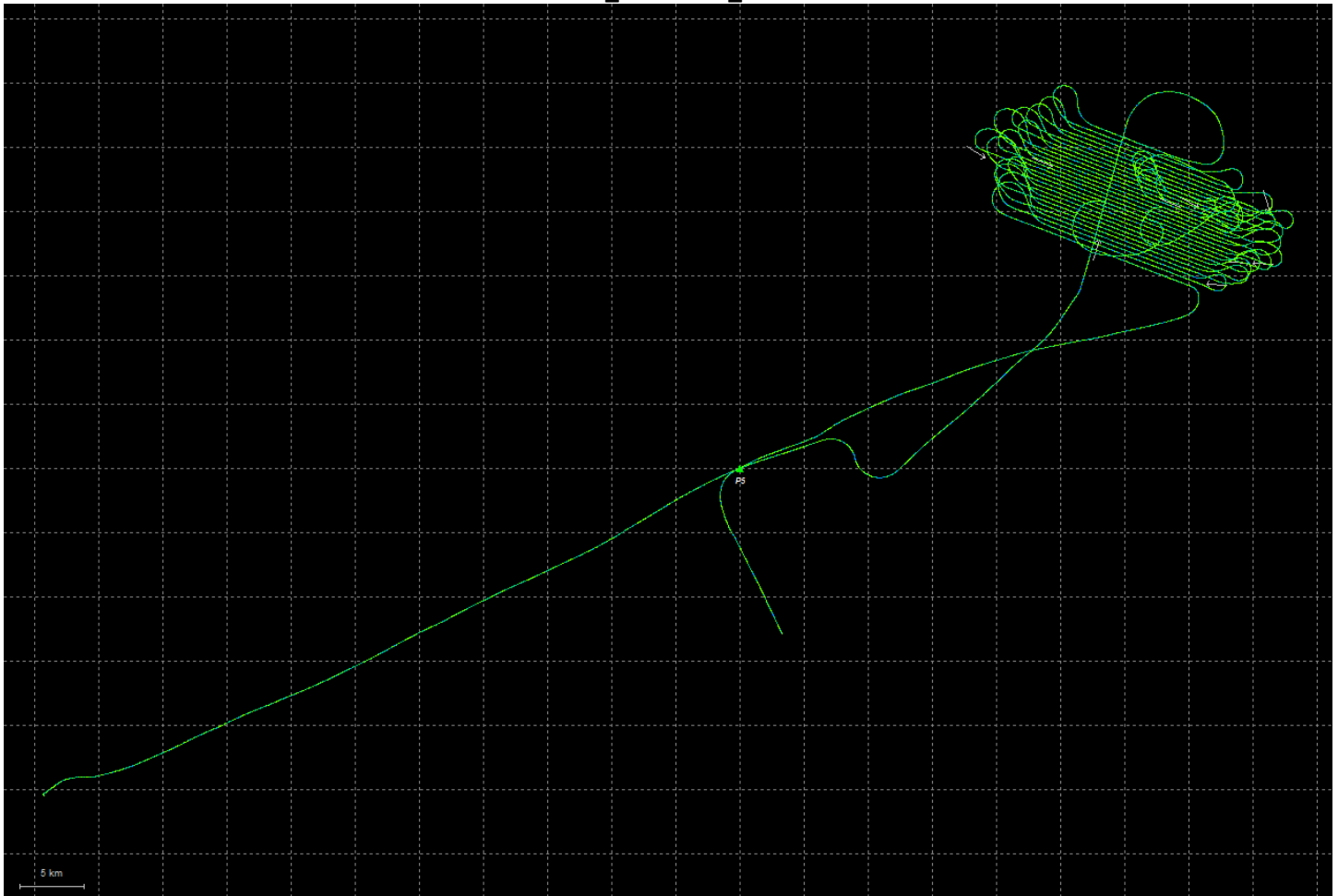


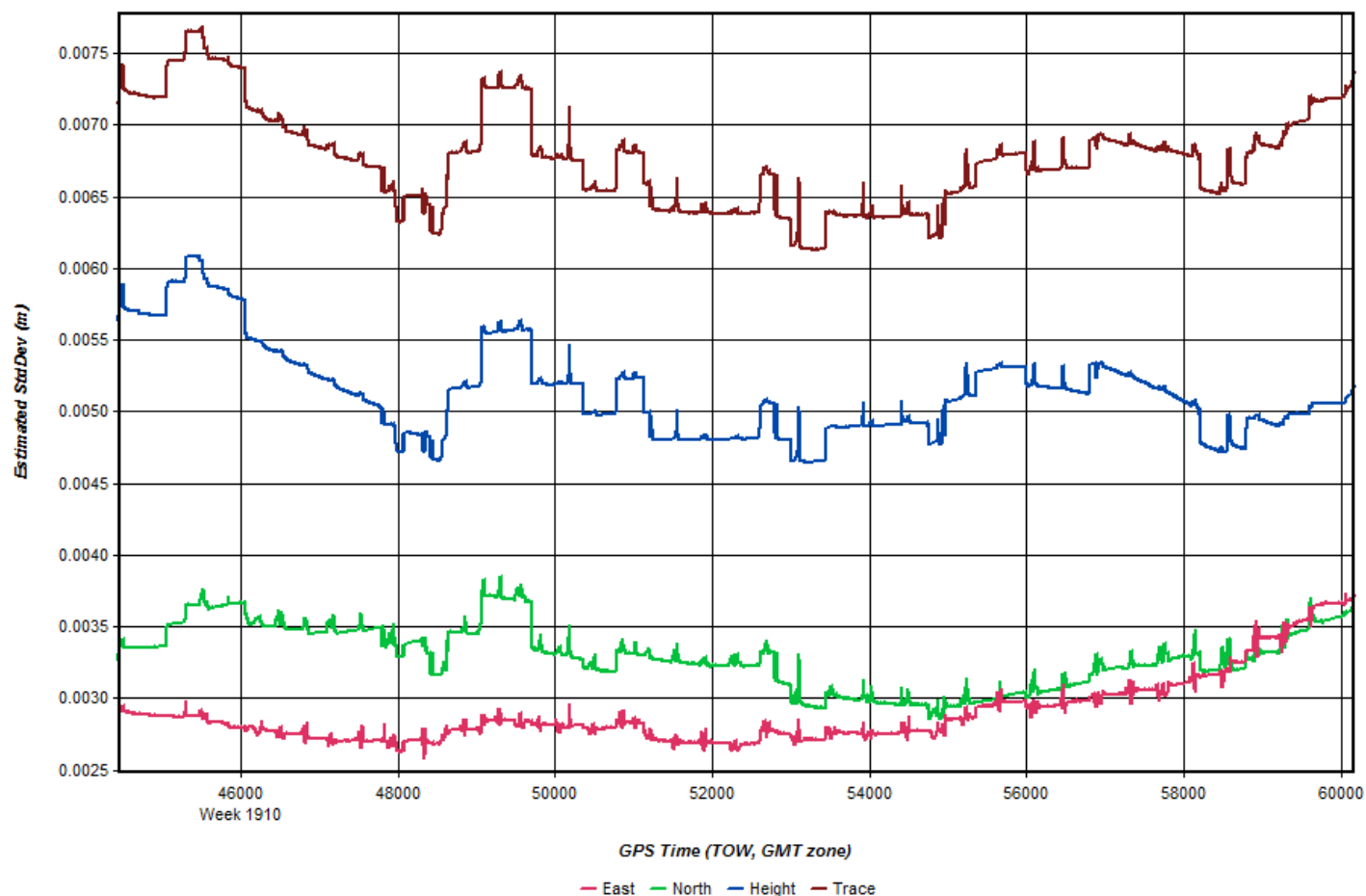


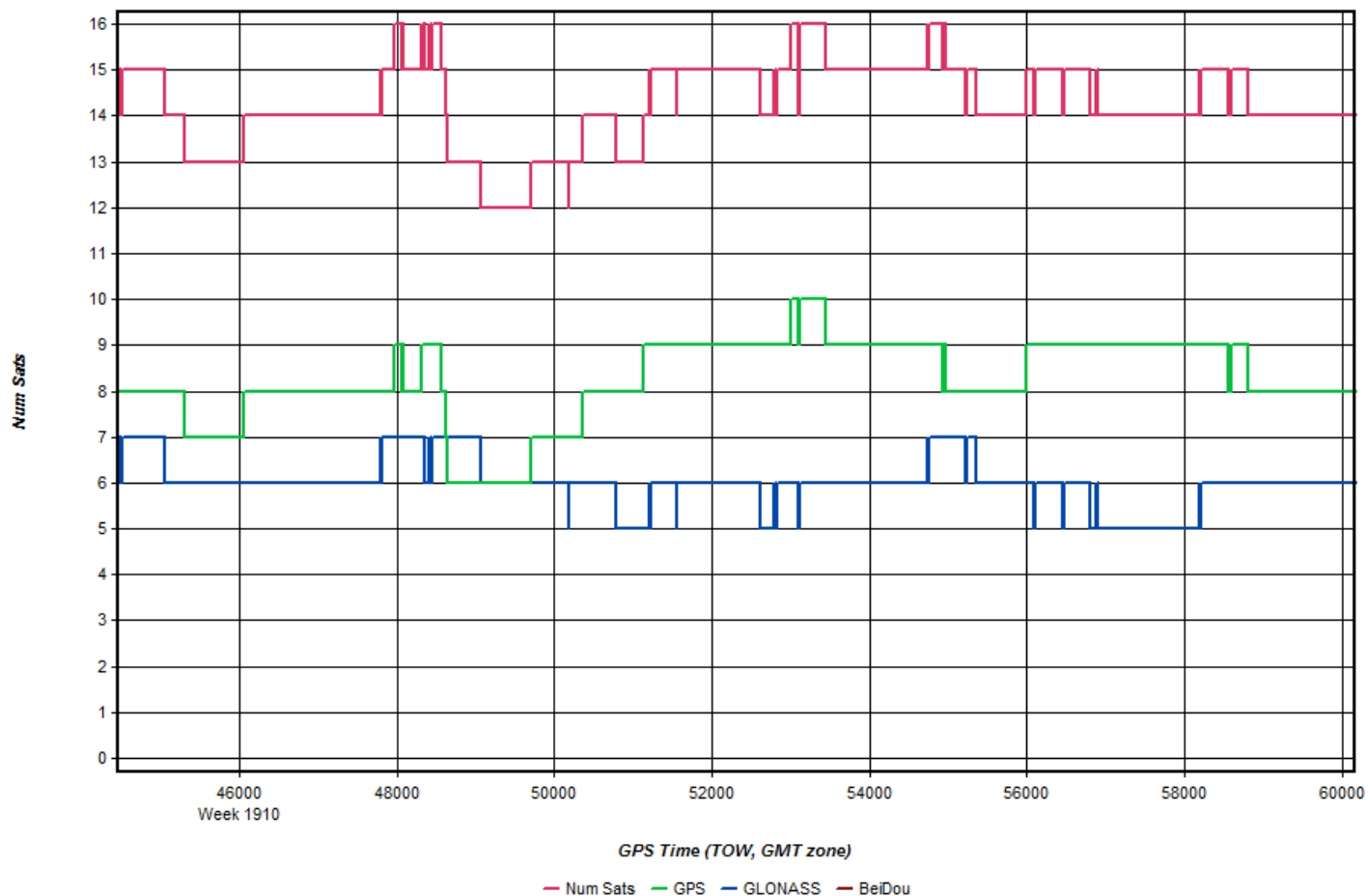


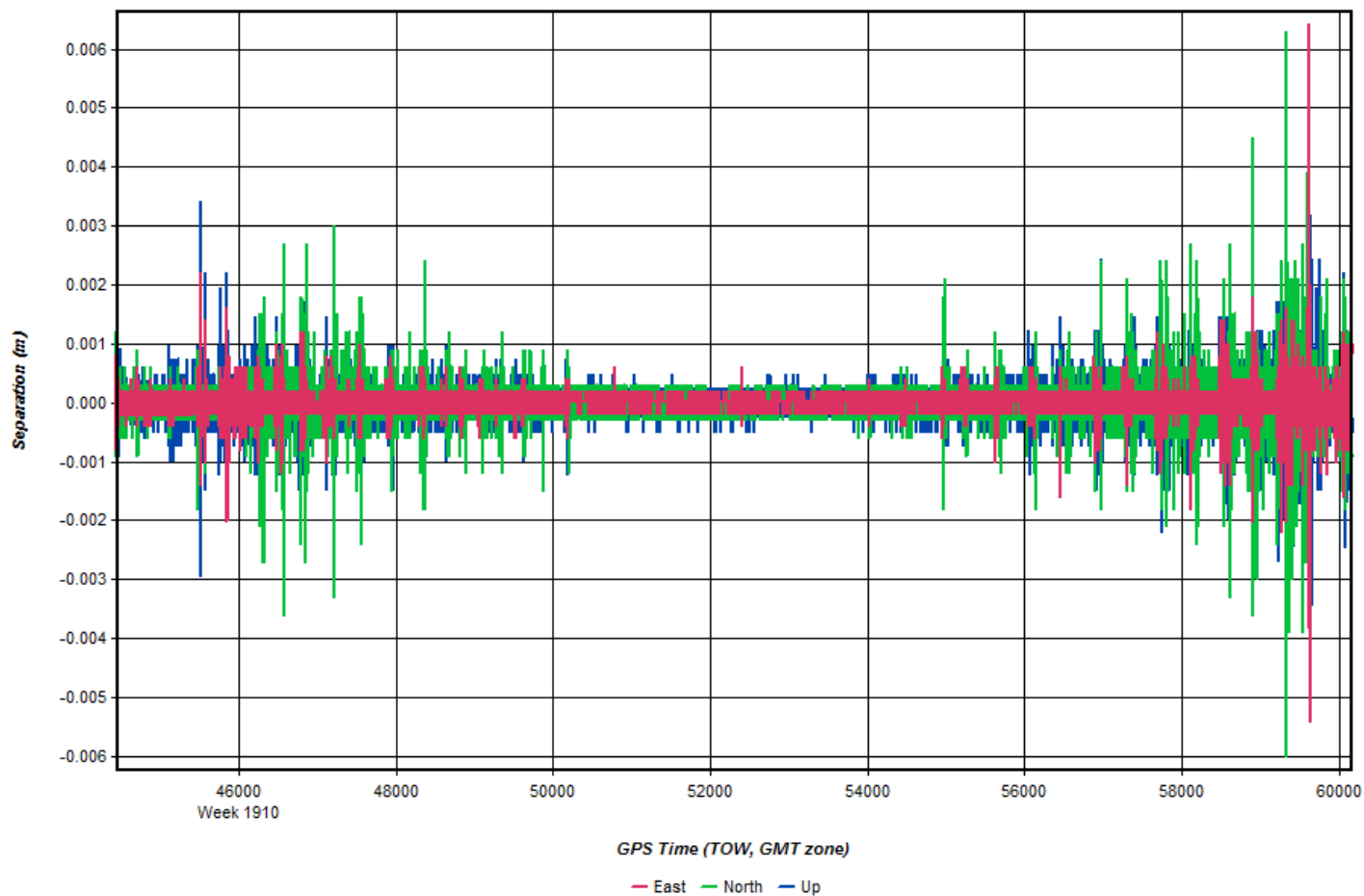


225_20160814_1A





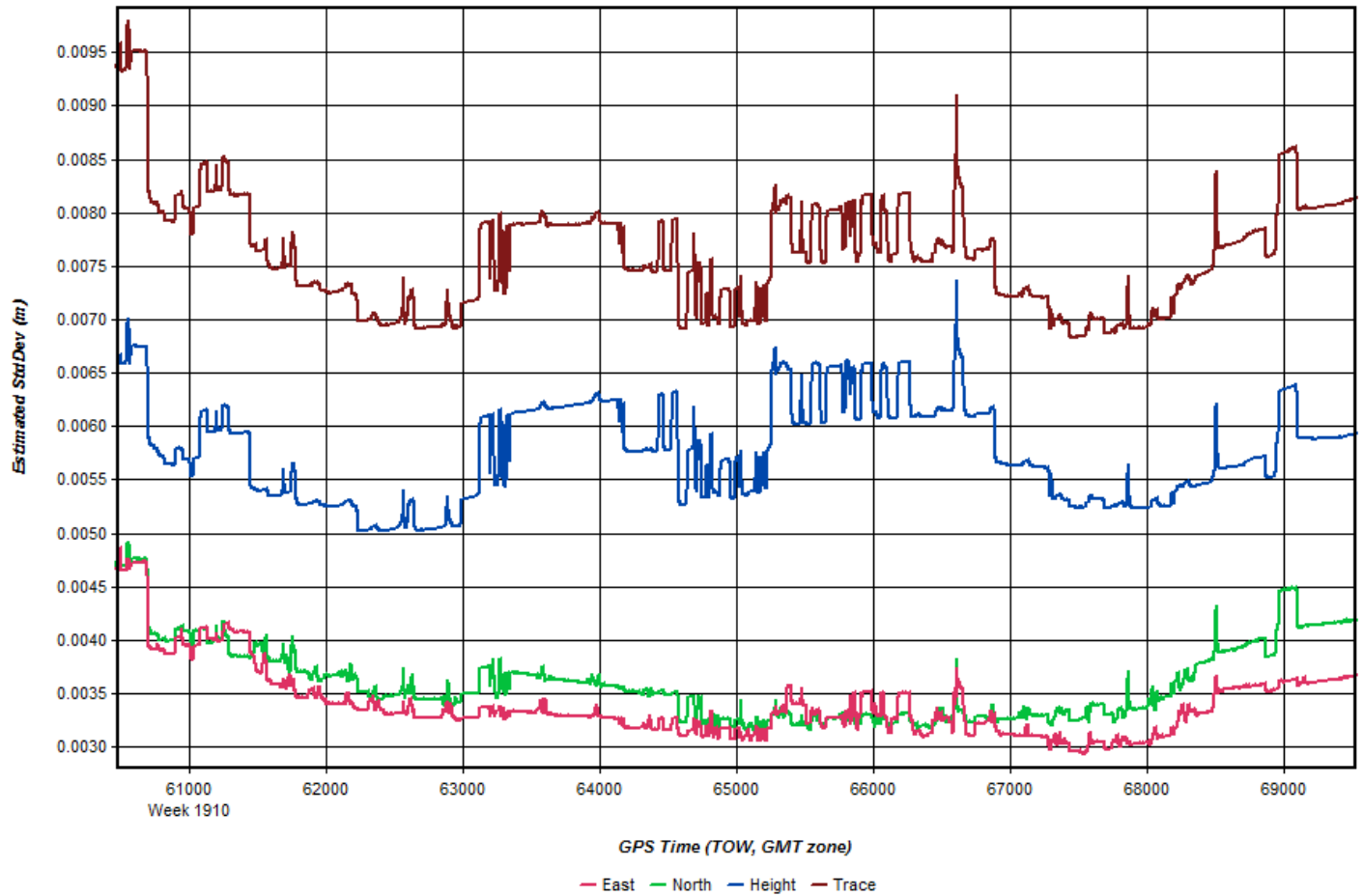


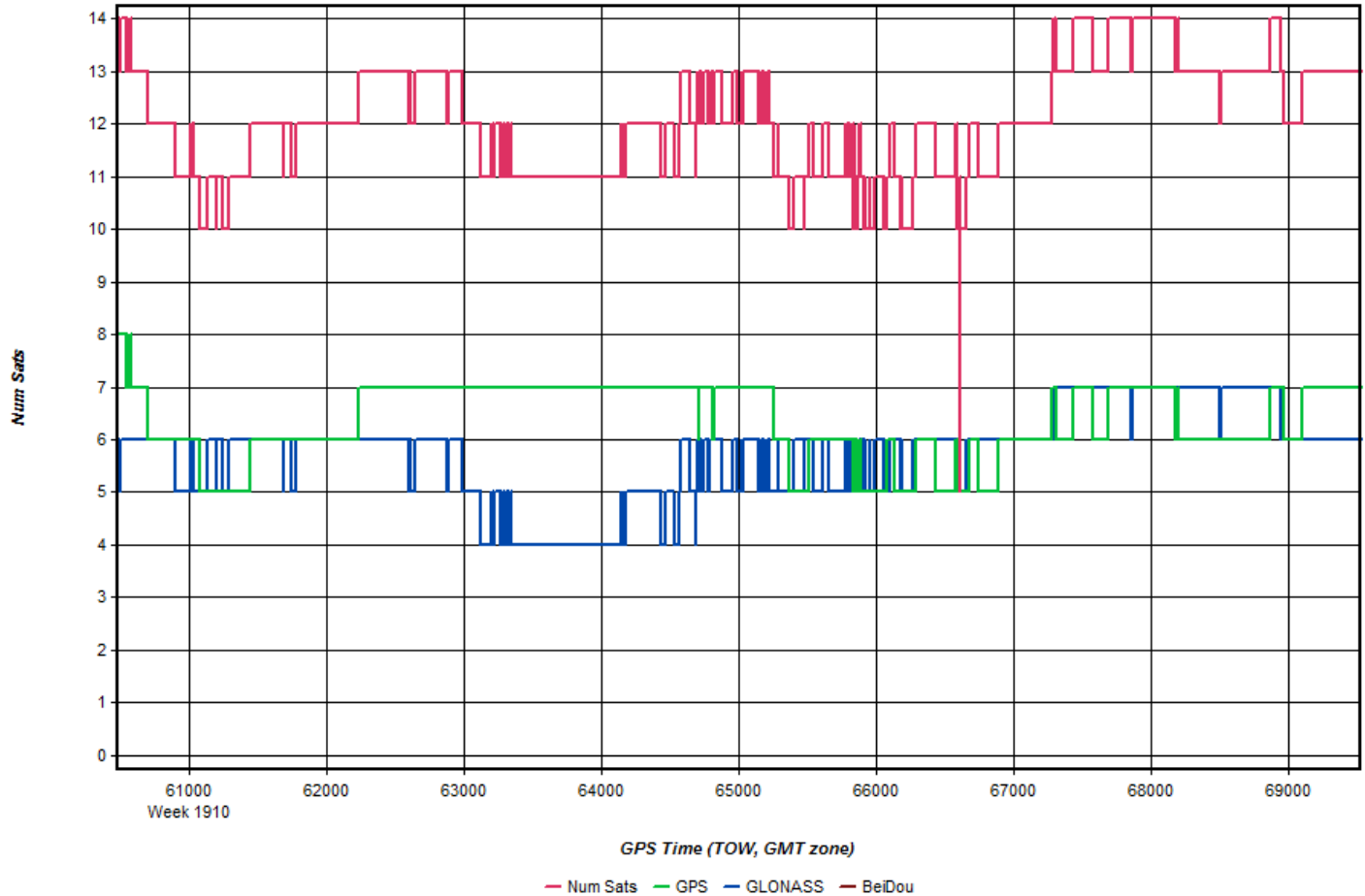


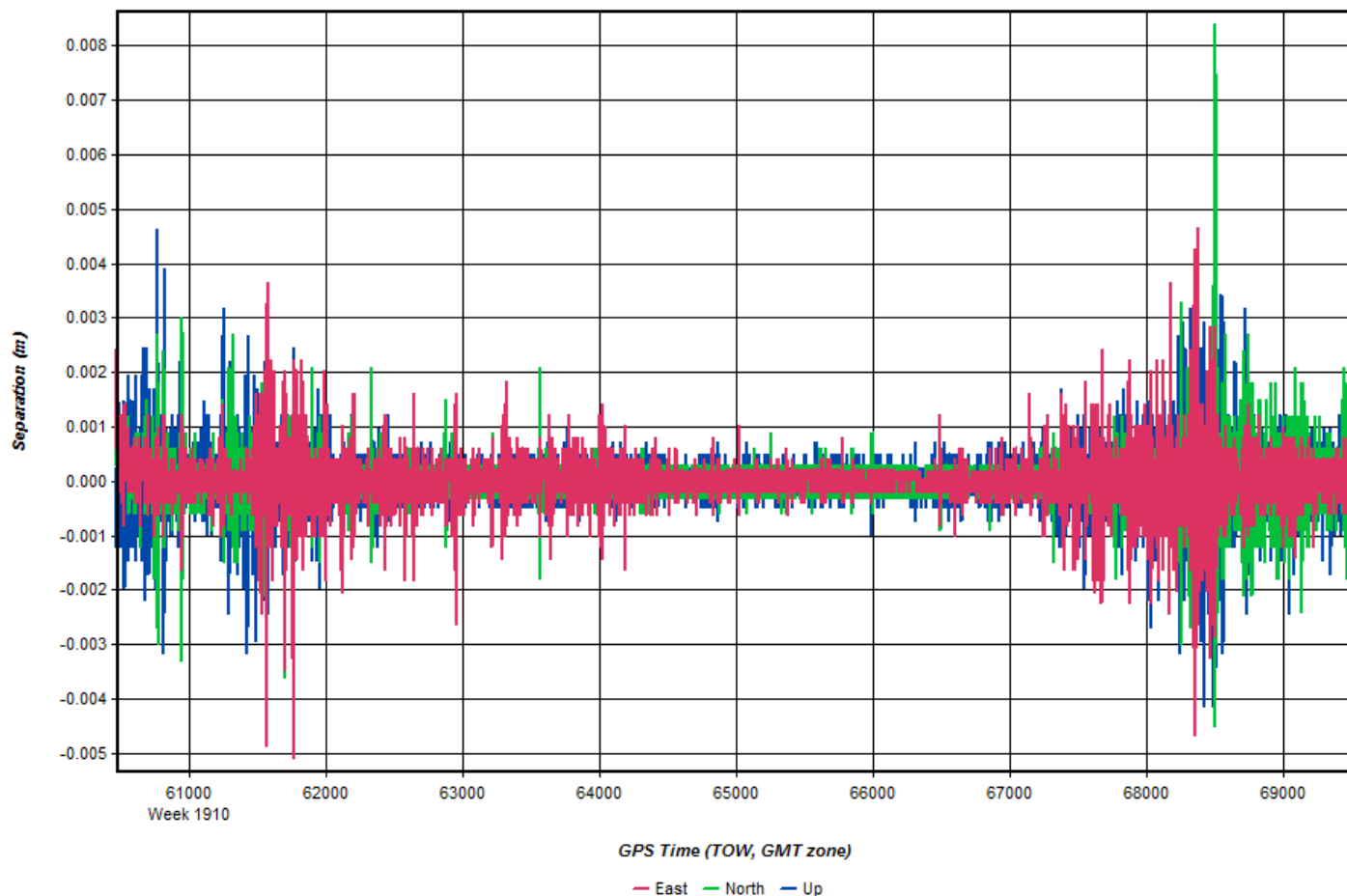


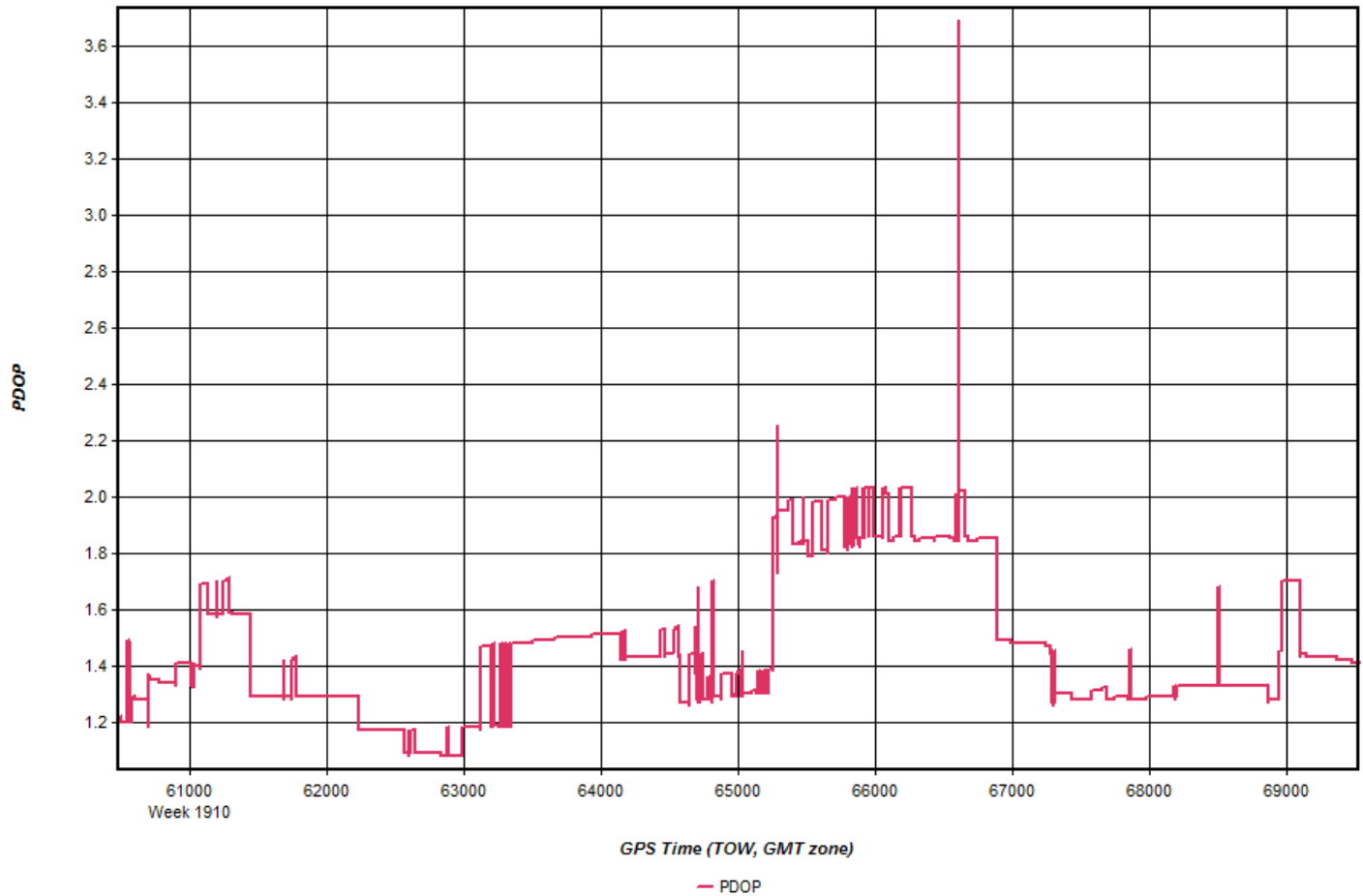
225_20160814_1B





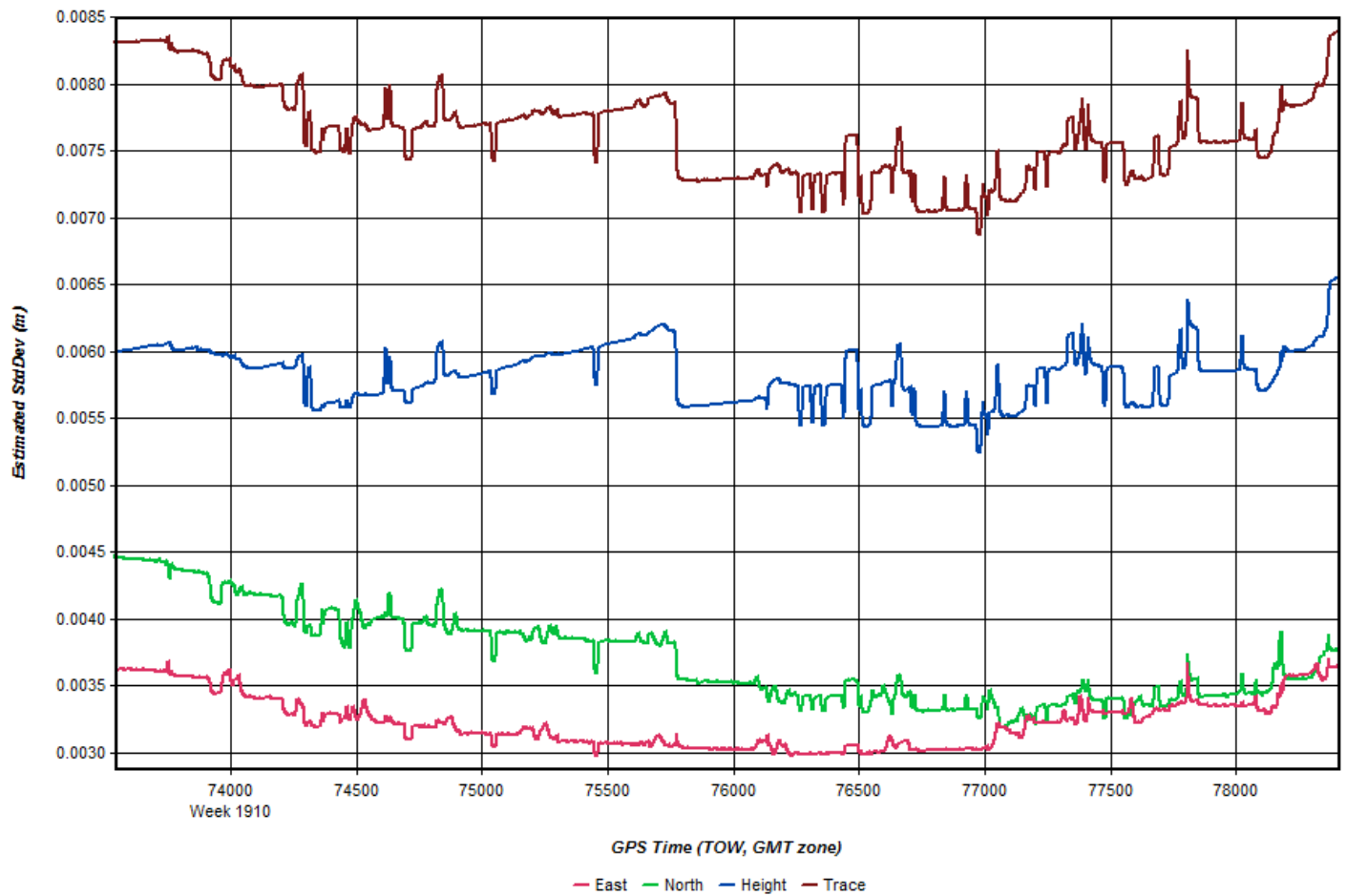


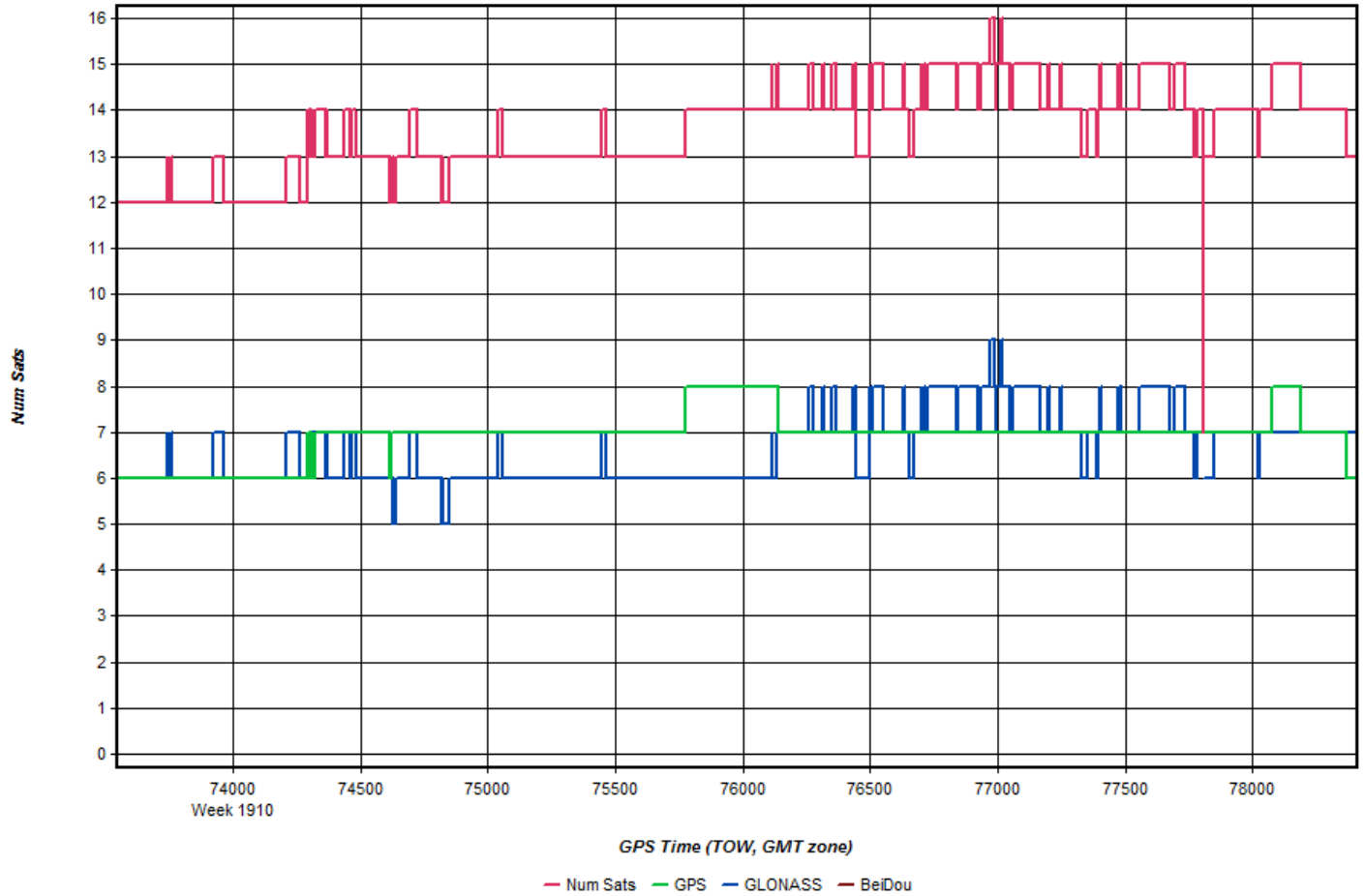


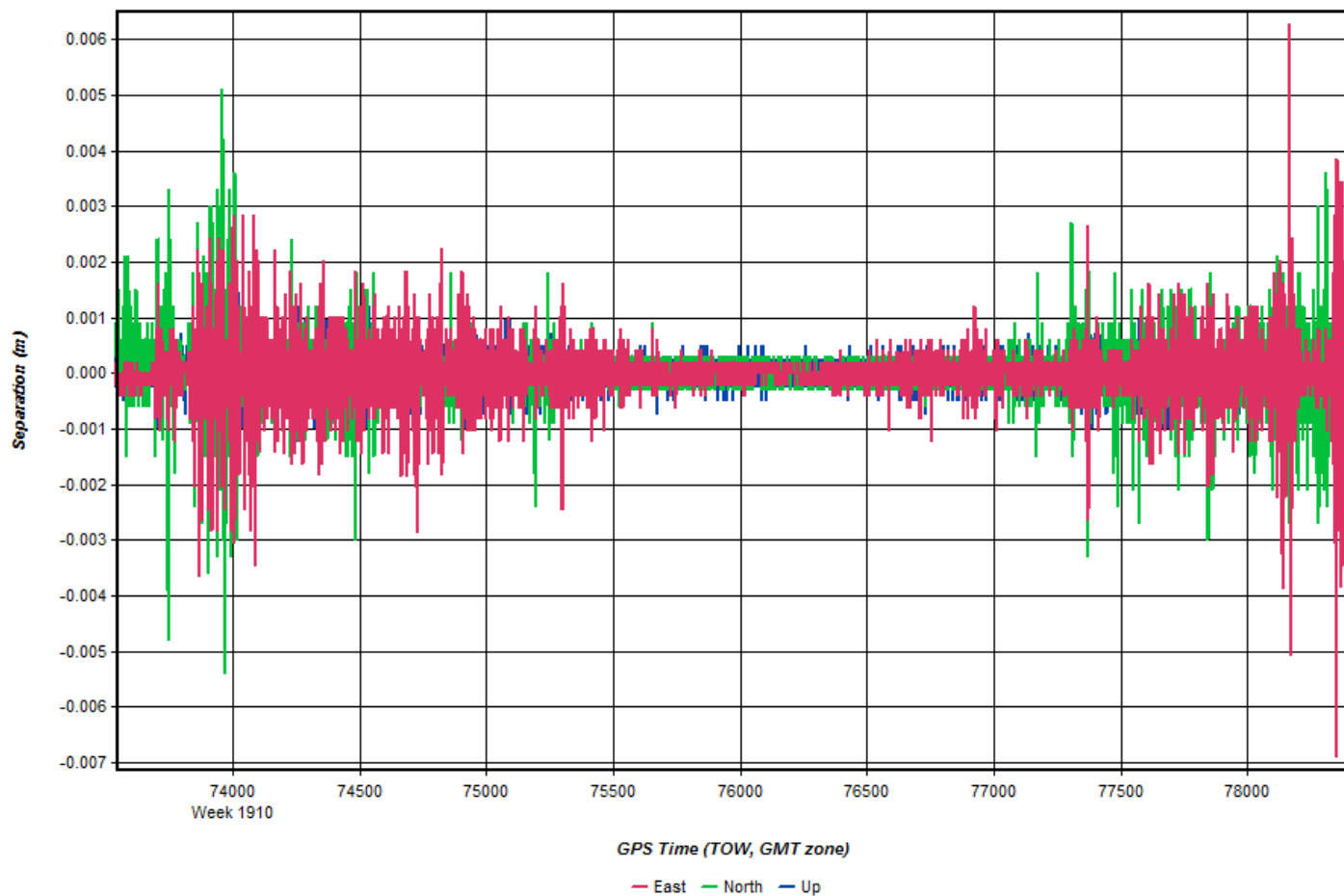


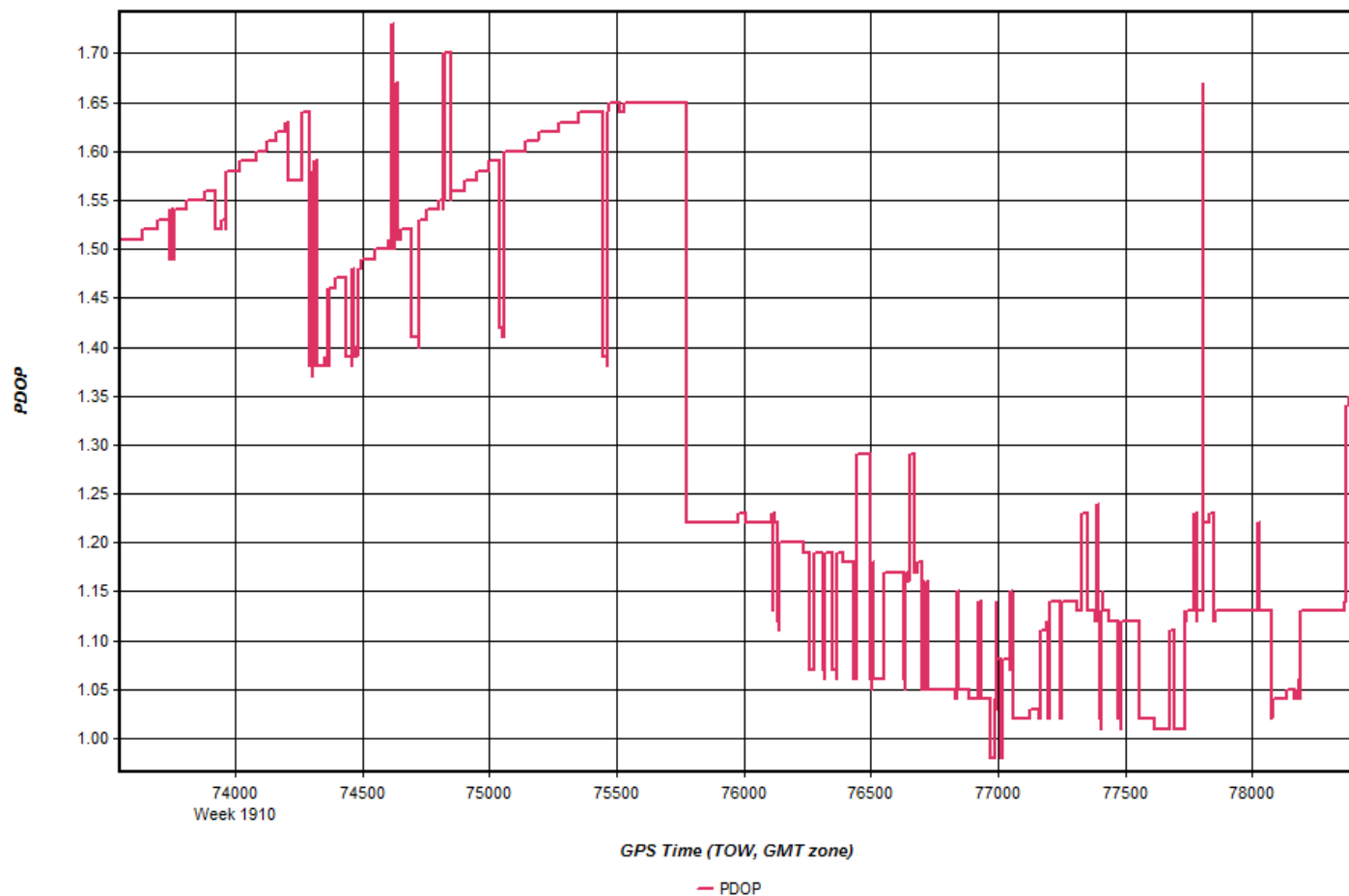
225_20160814_2A



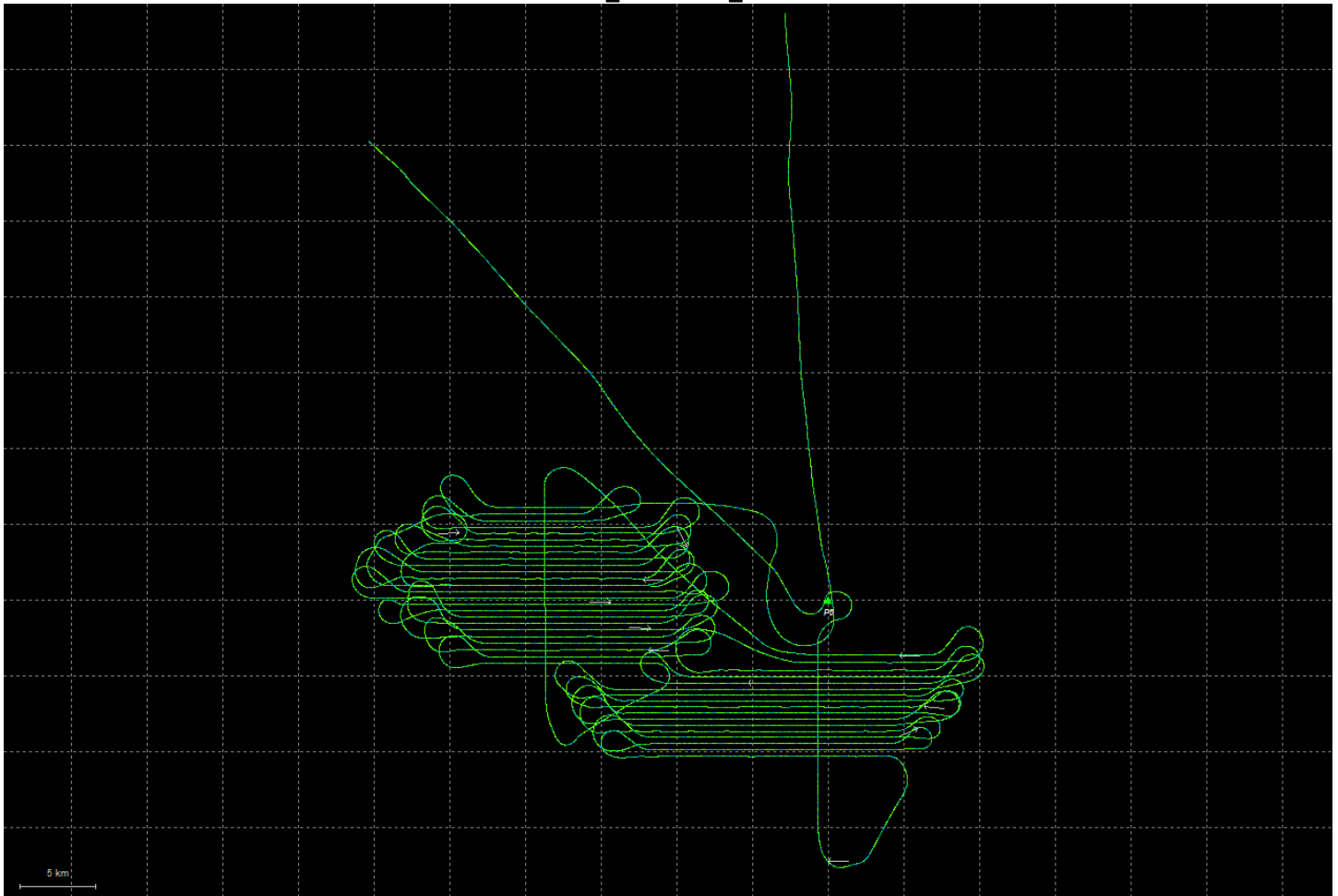


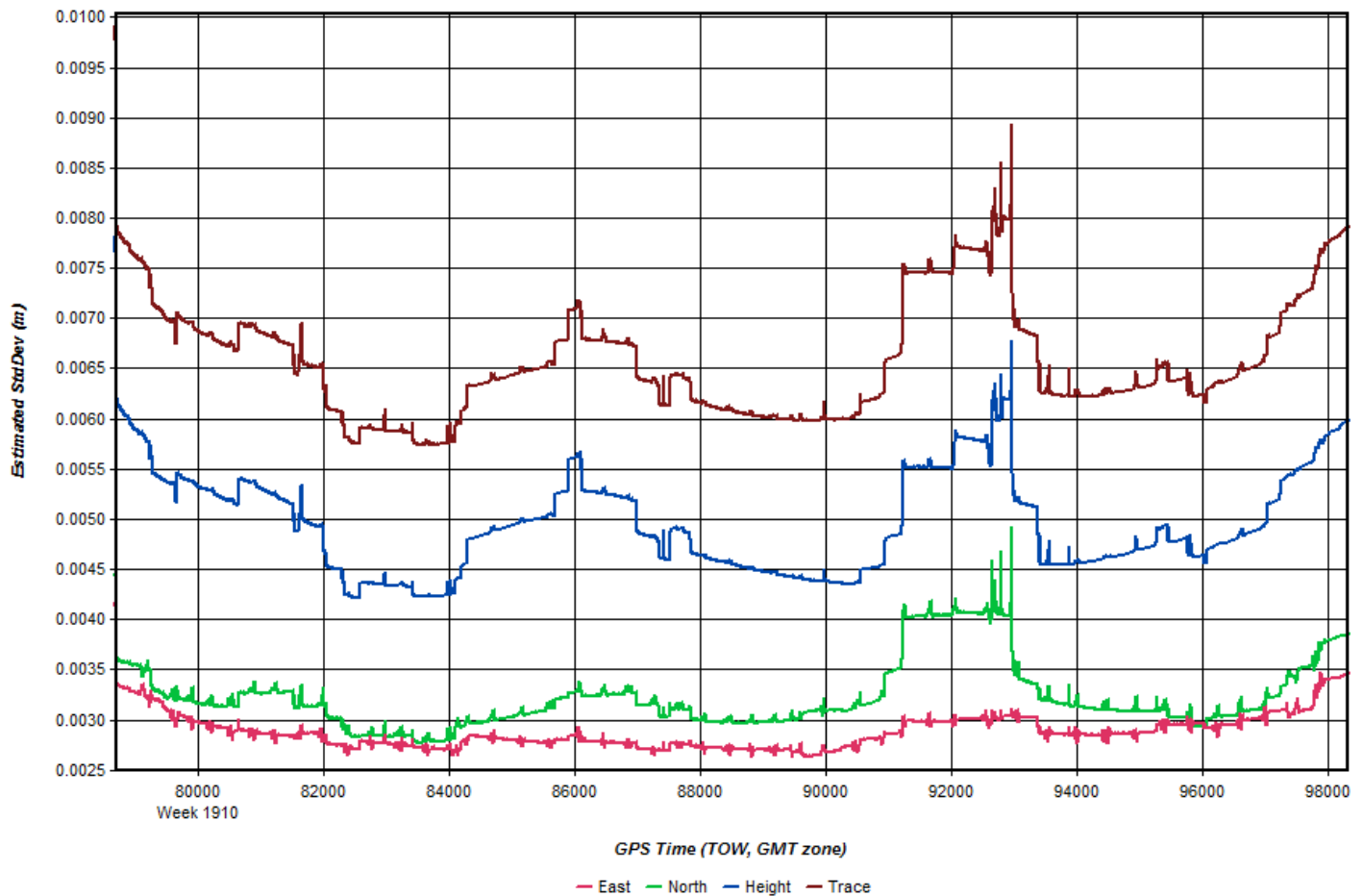


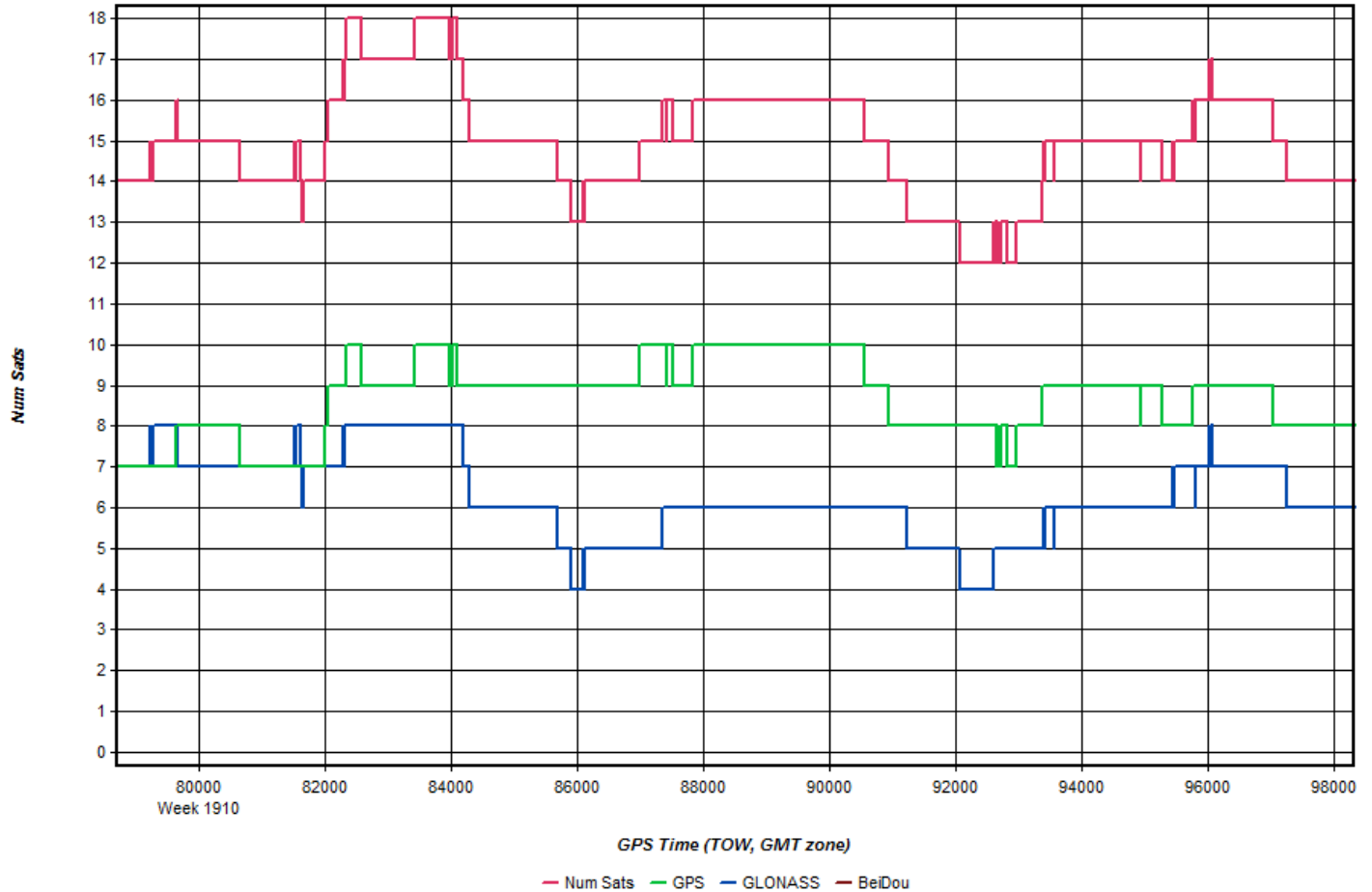


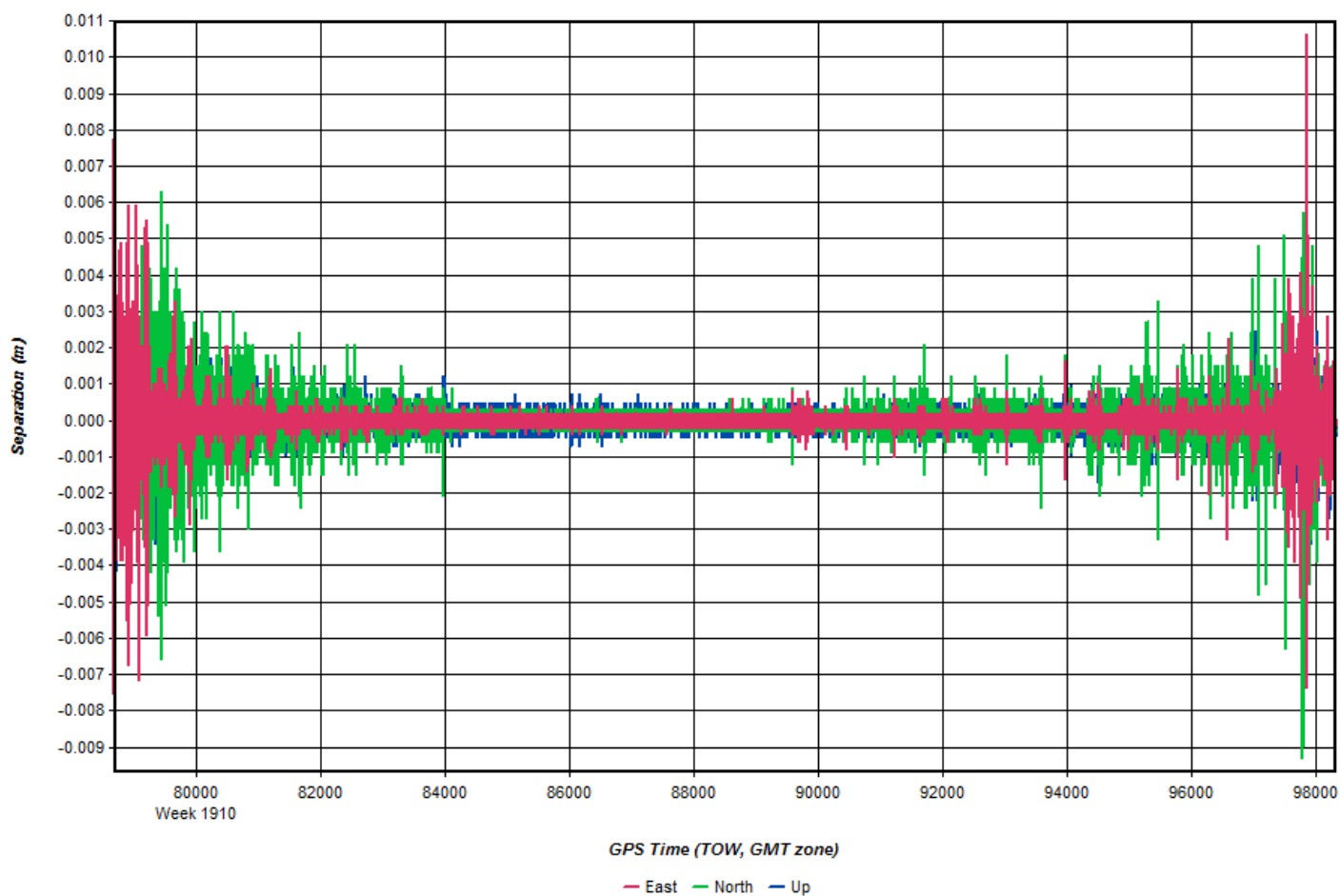


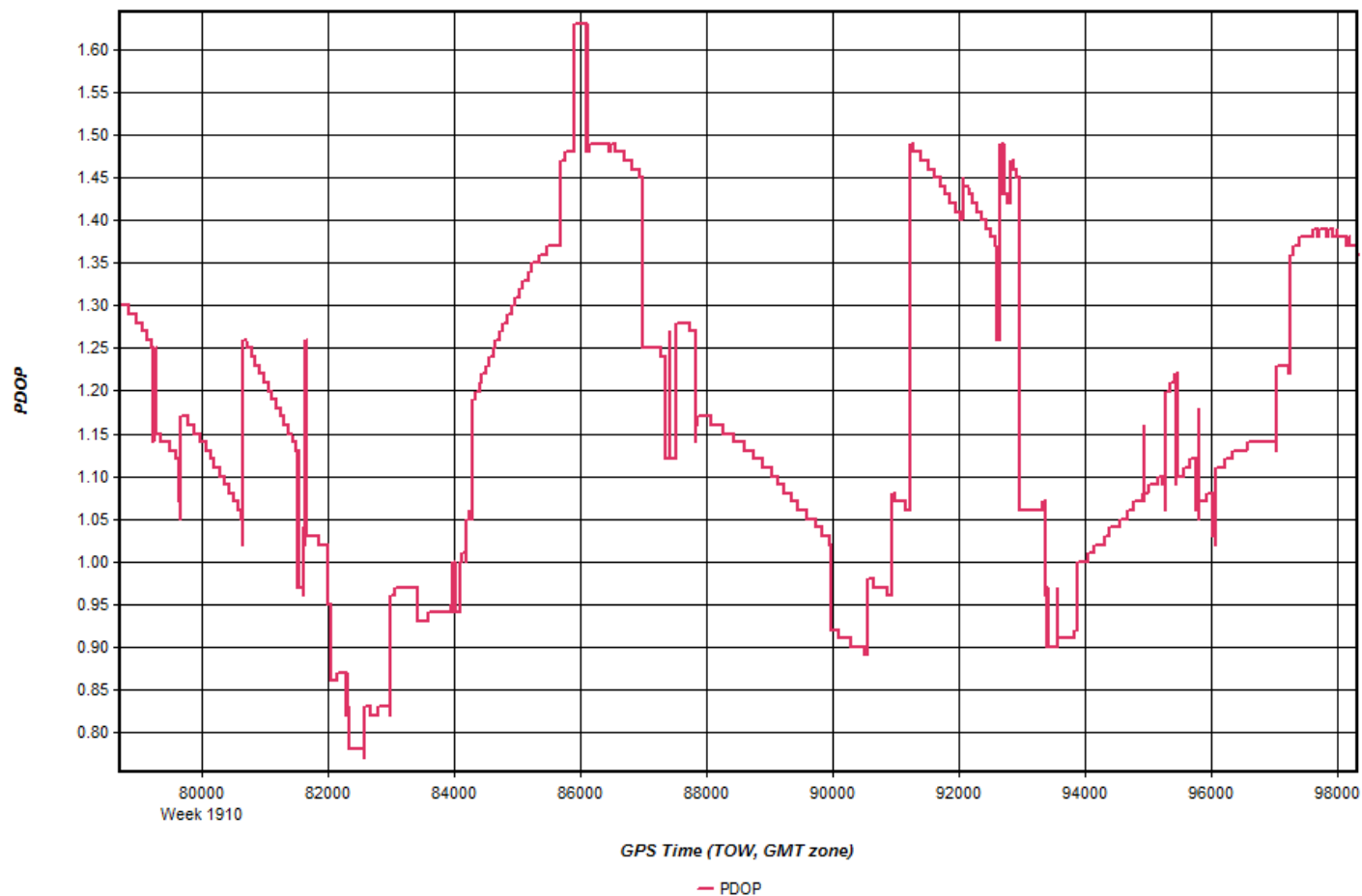
225_20160814_2B



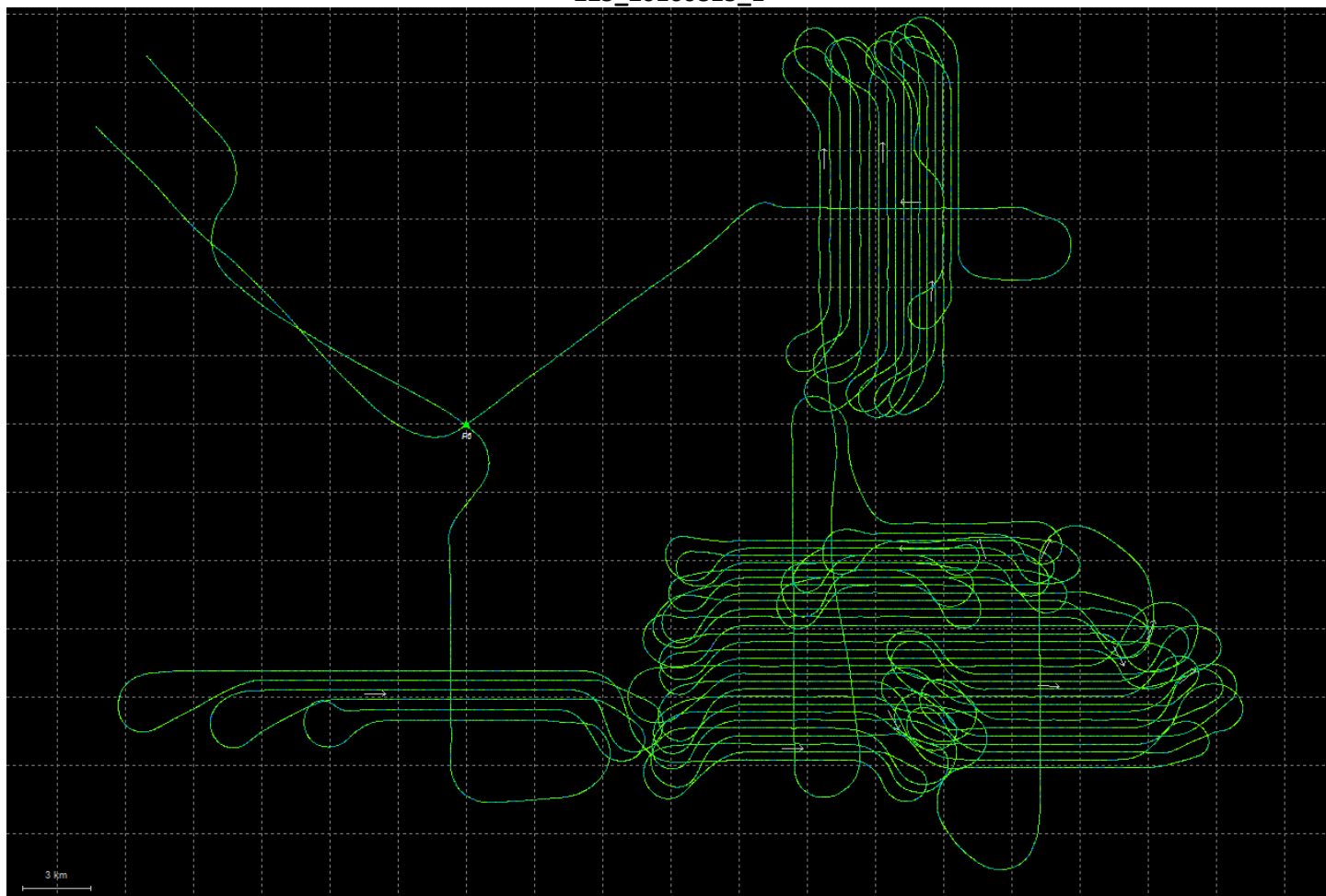


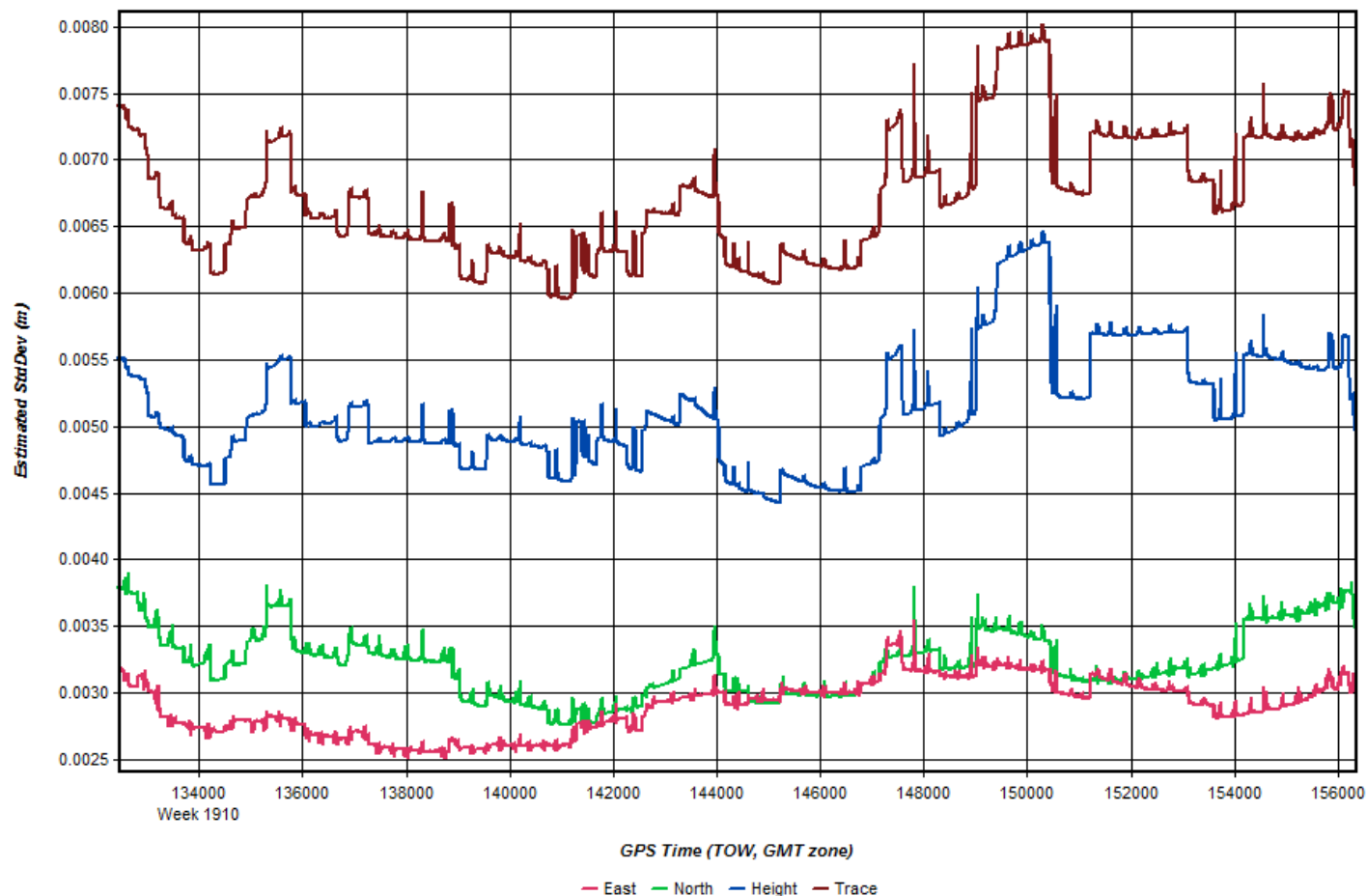


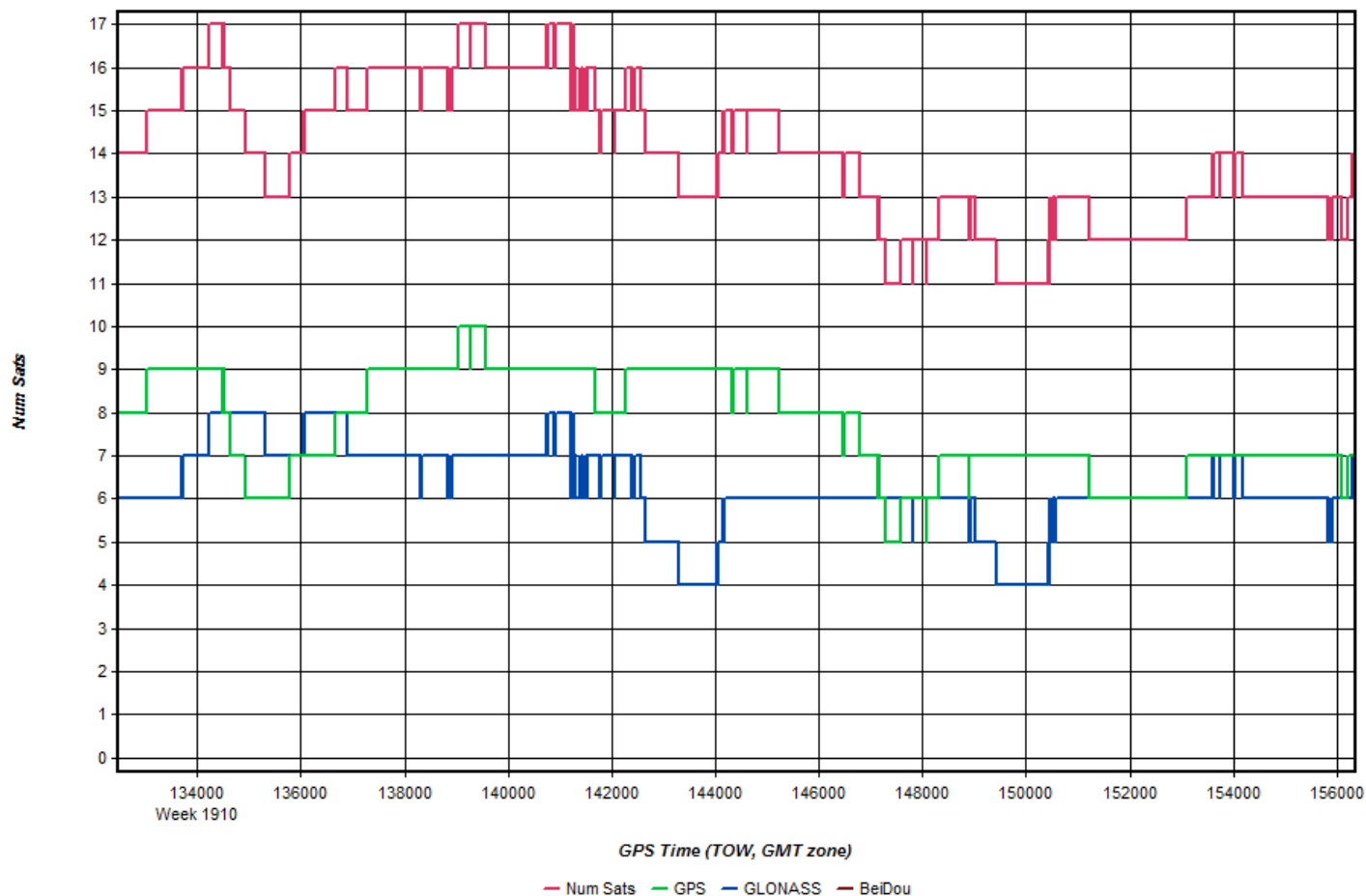


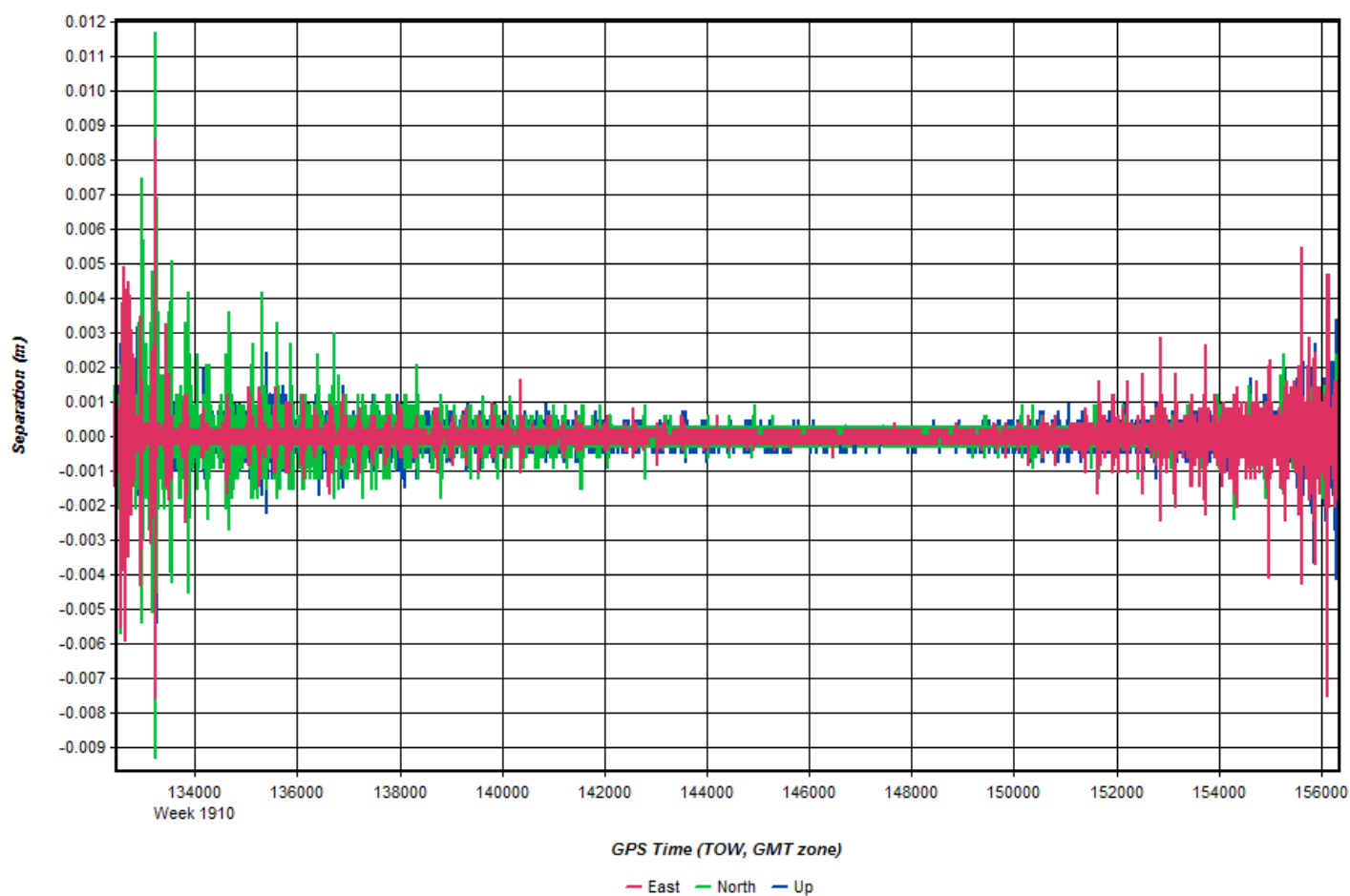


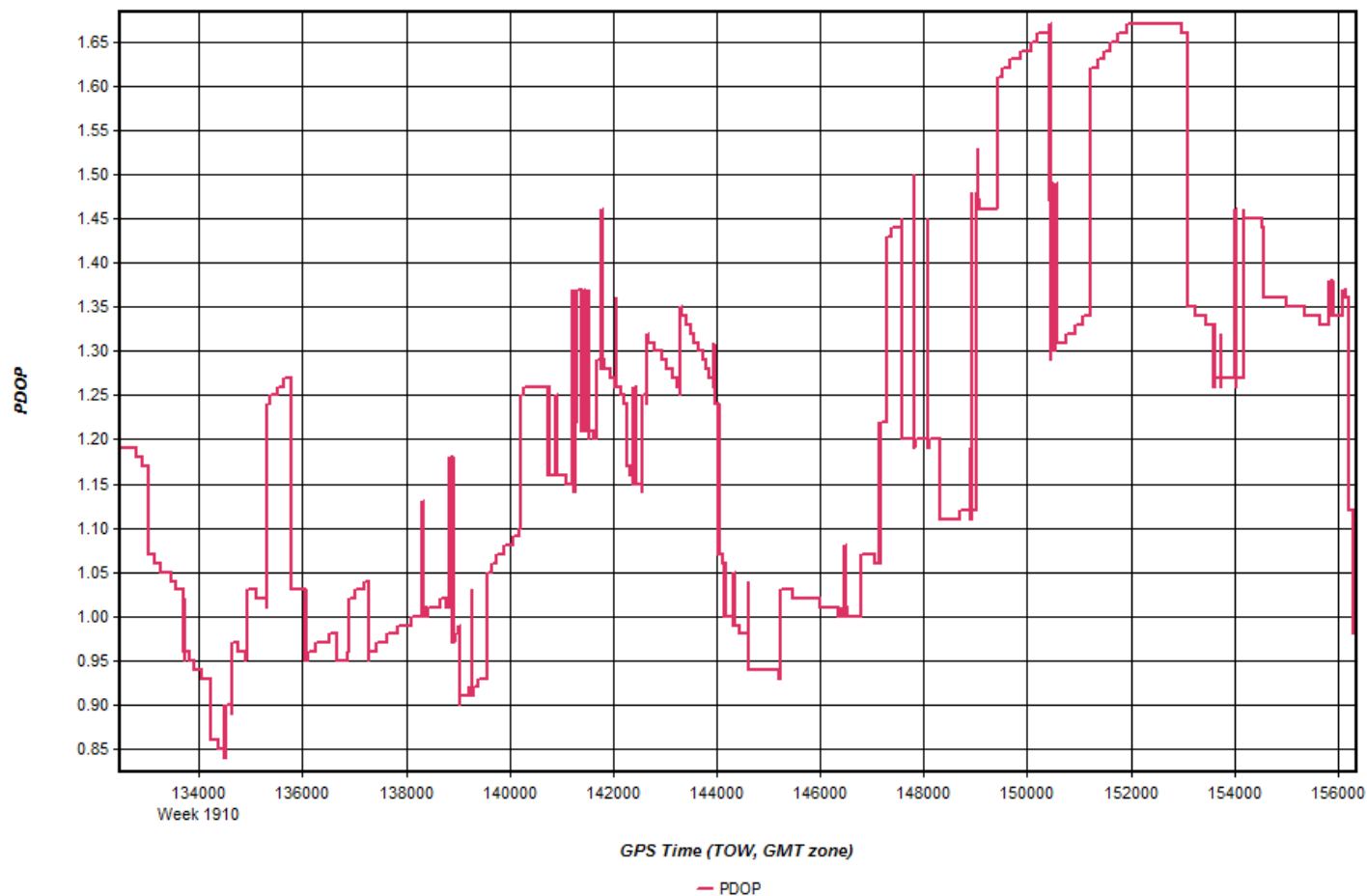
225_20160815_1



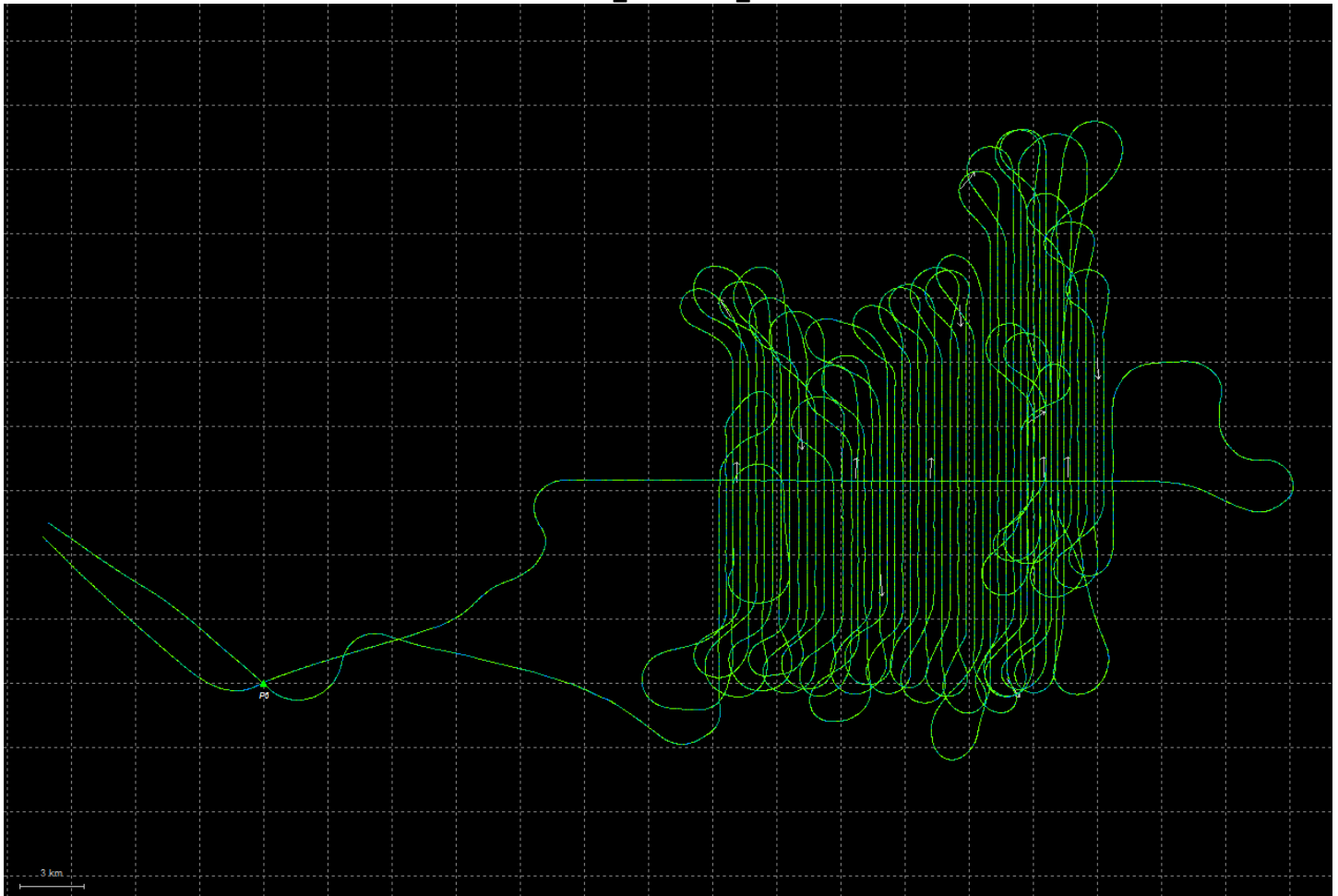


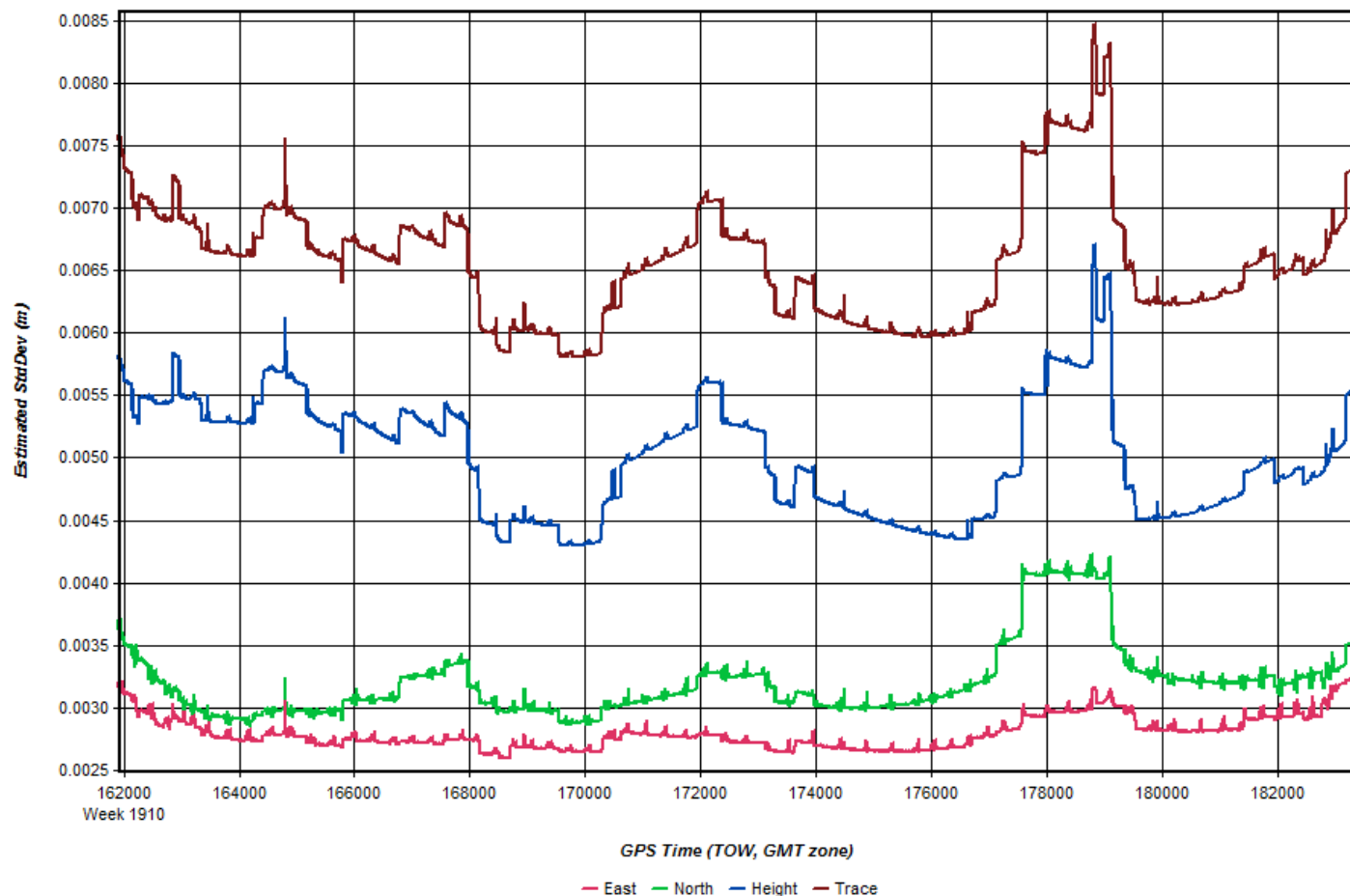


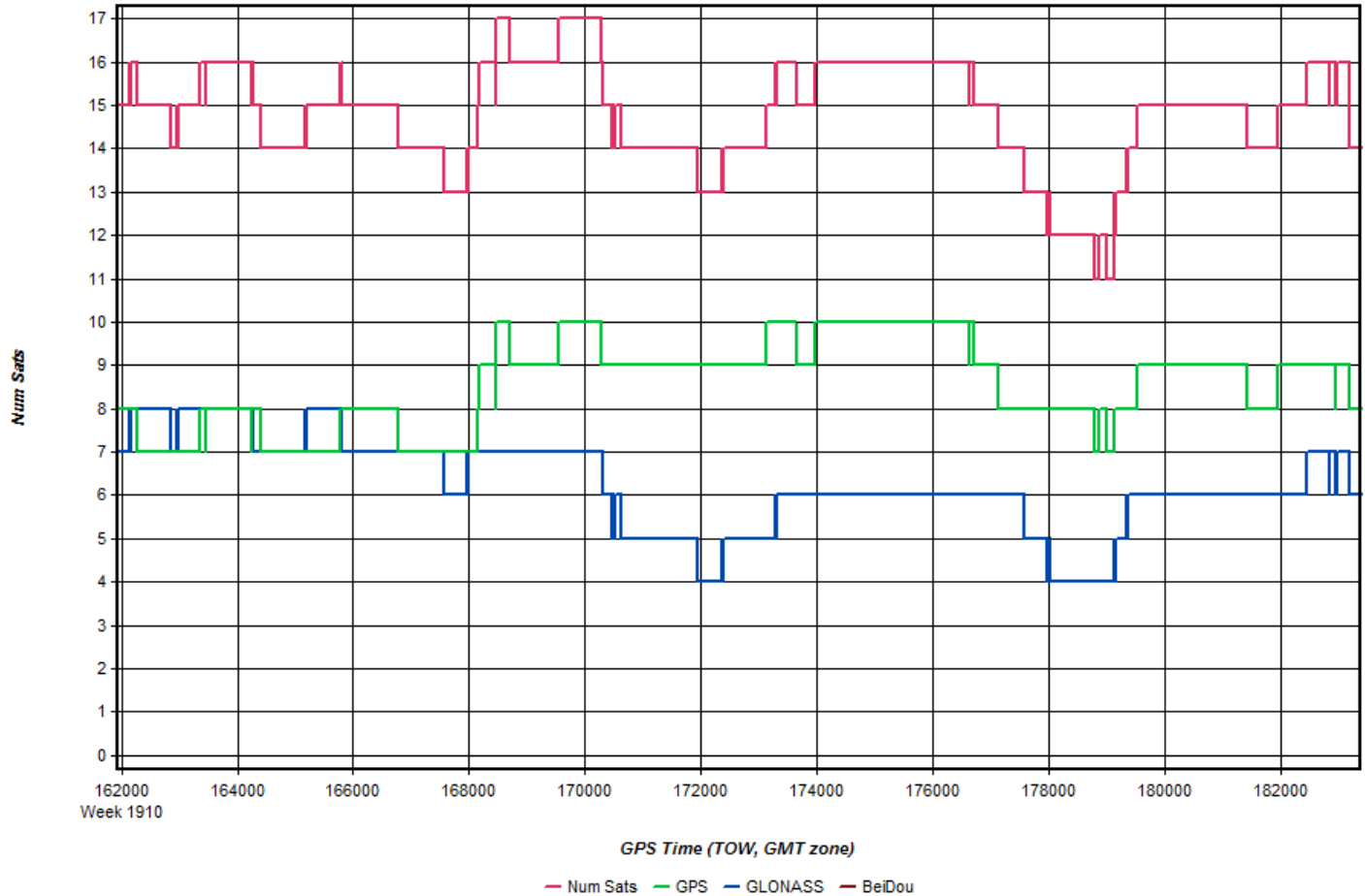


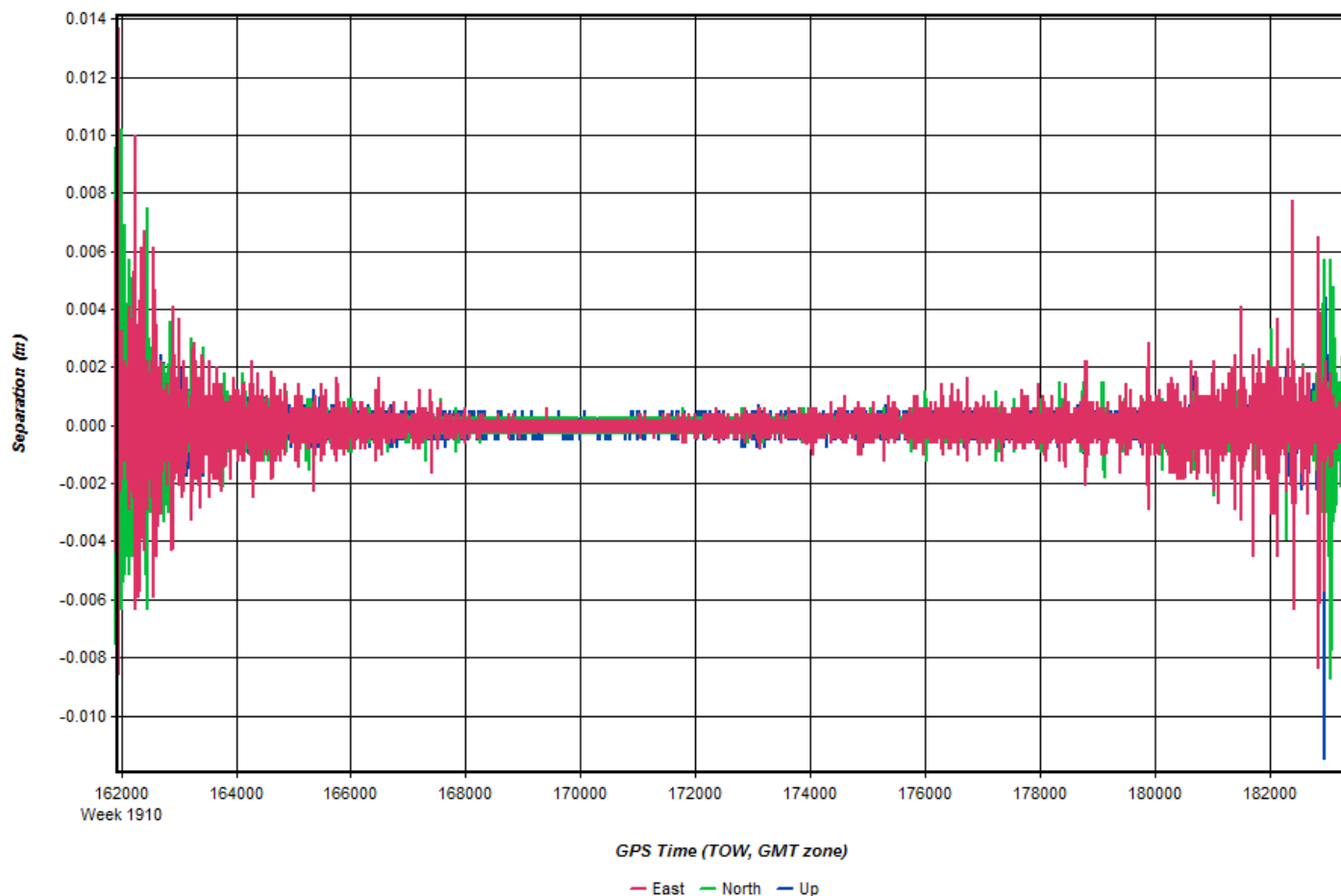


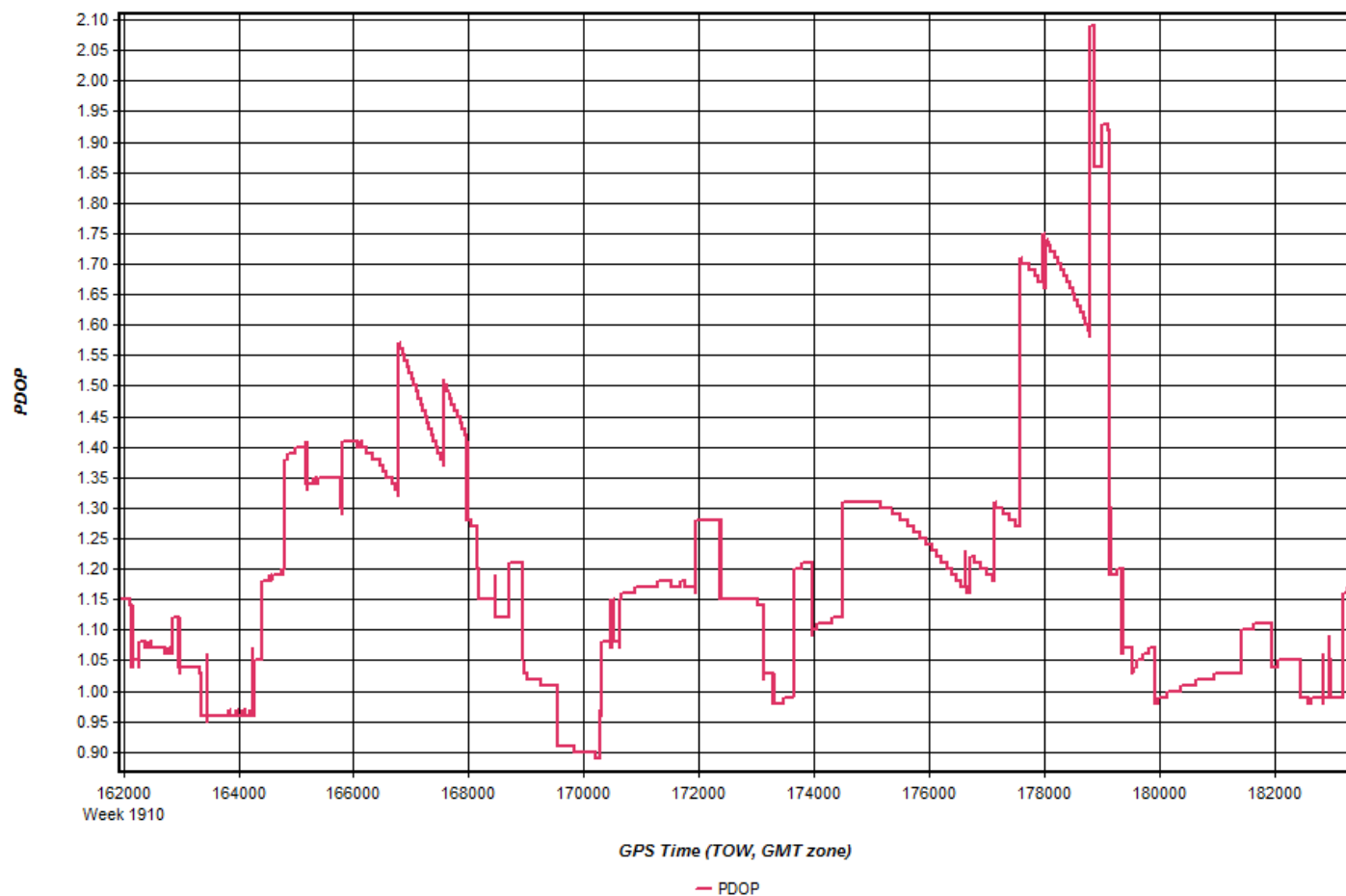
225_20160815_2



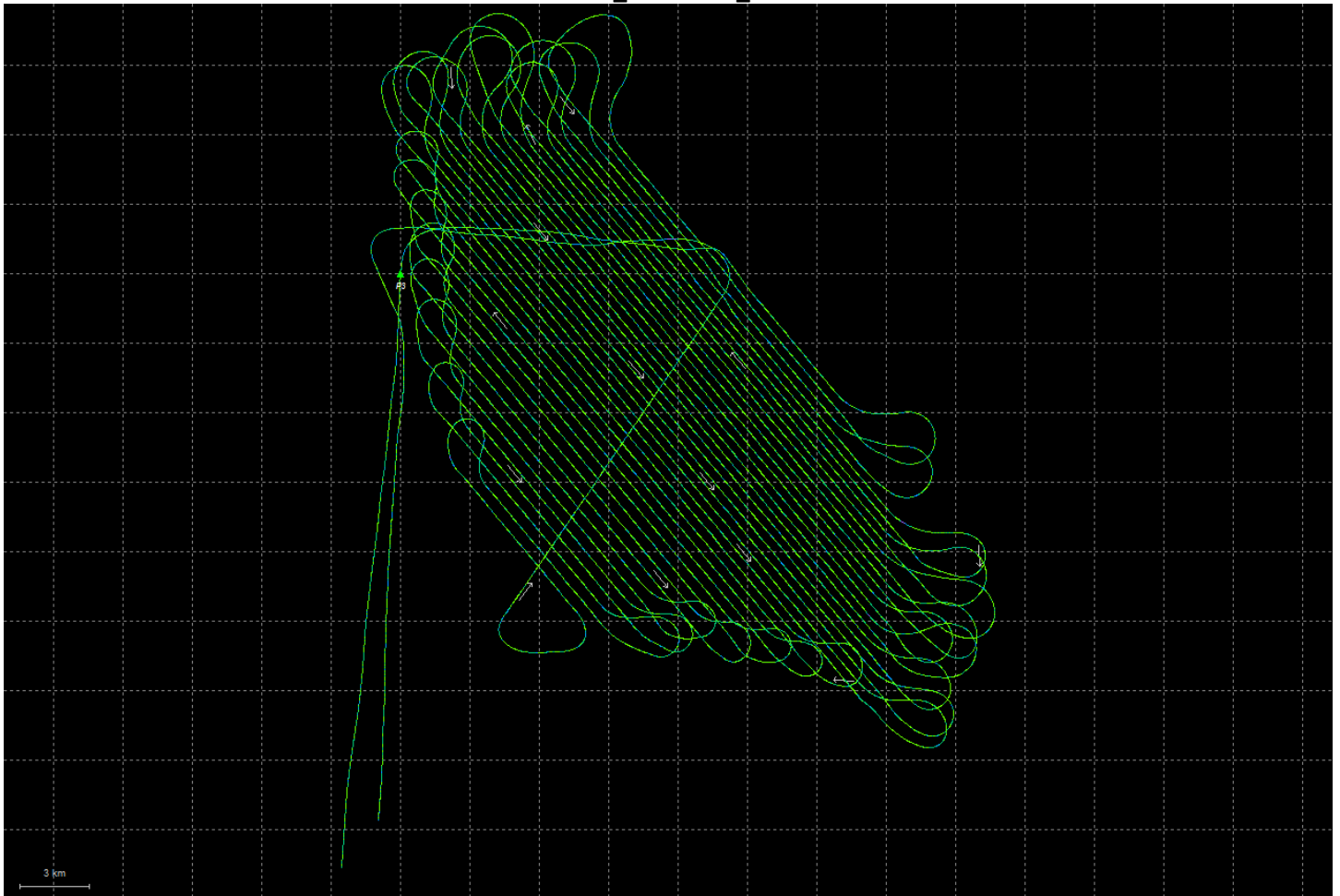


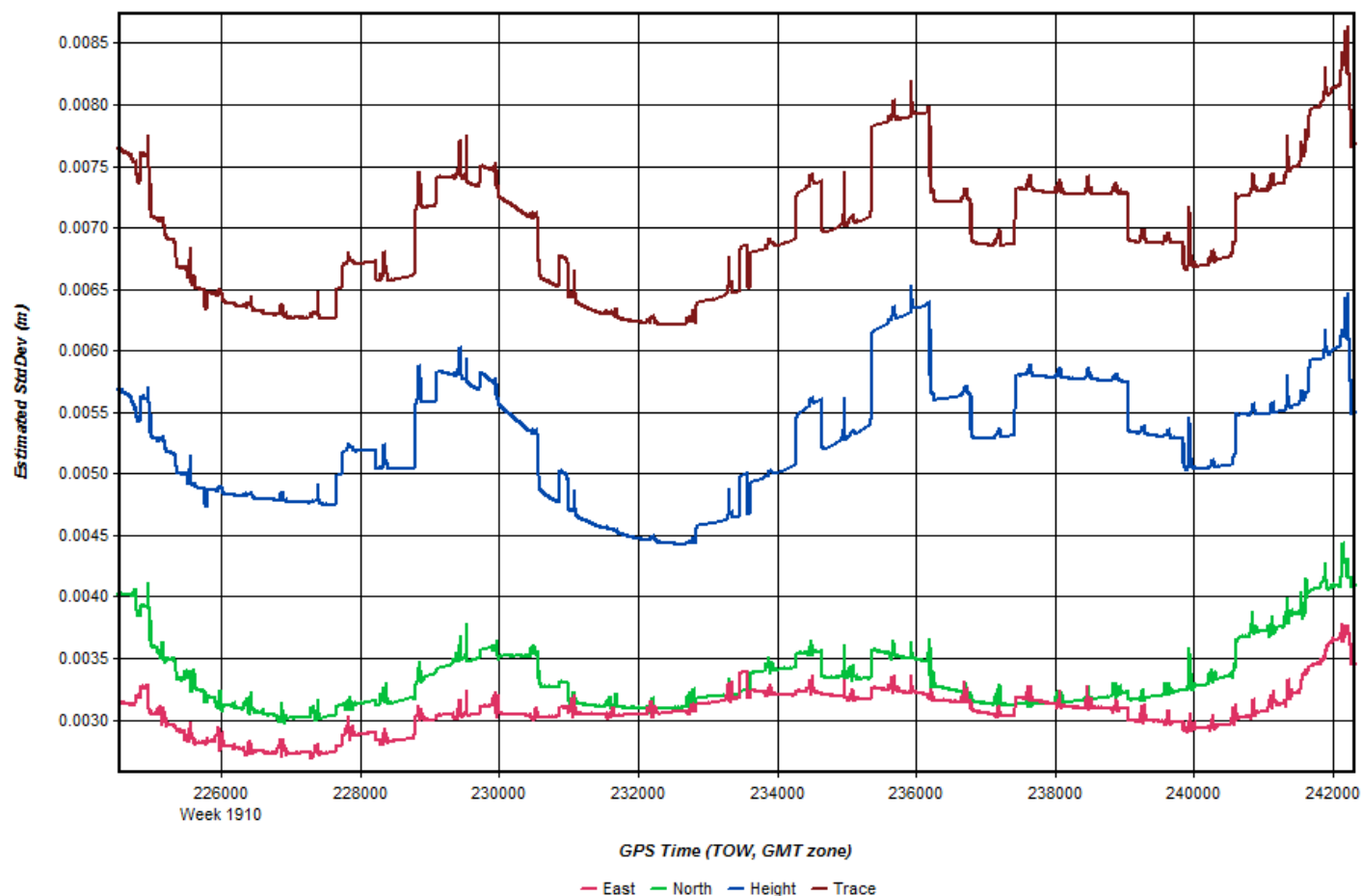


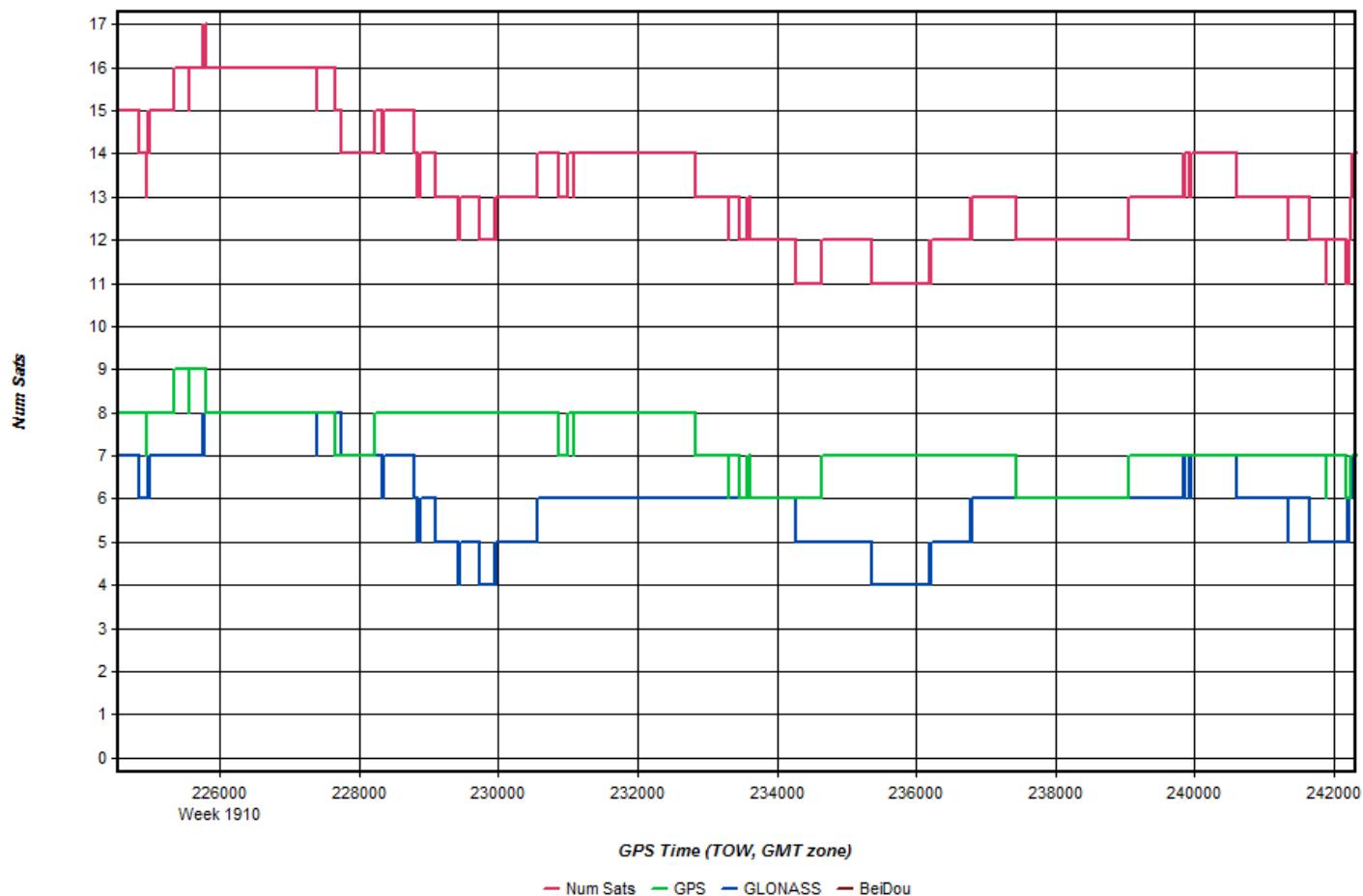


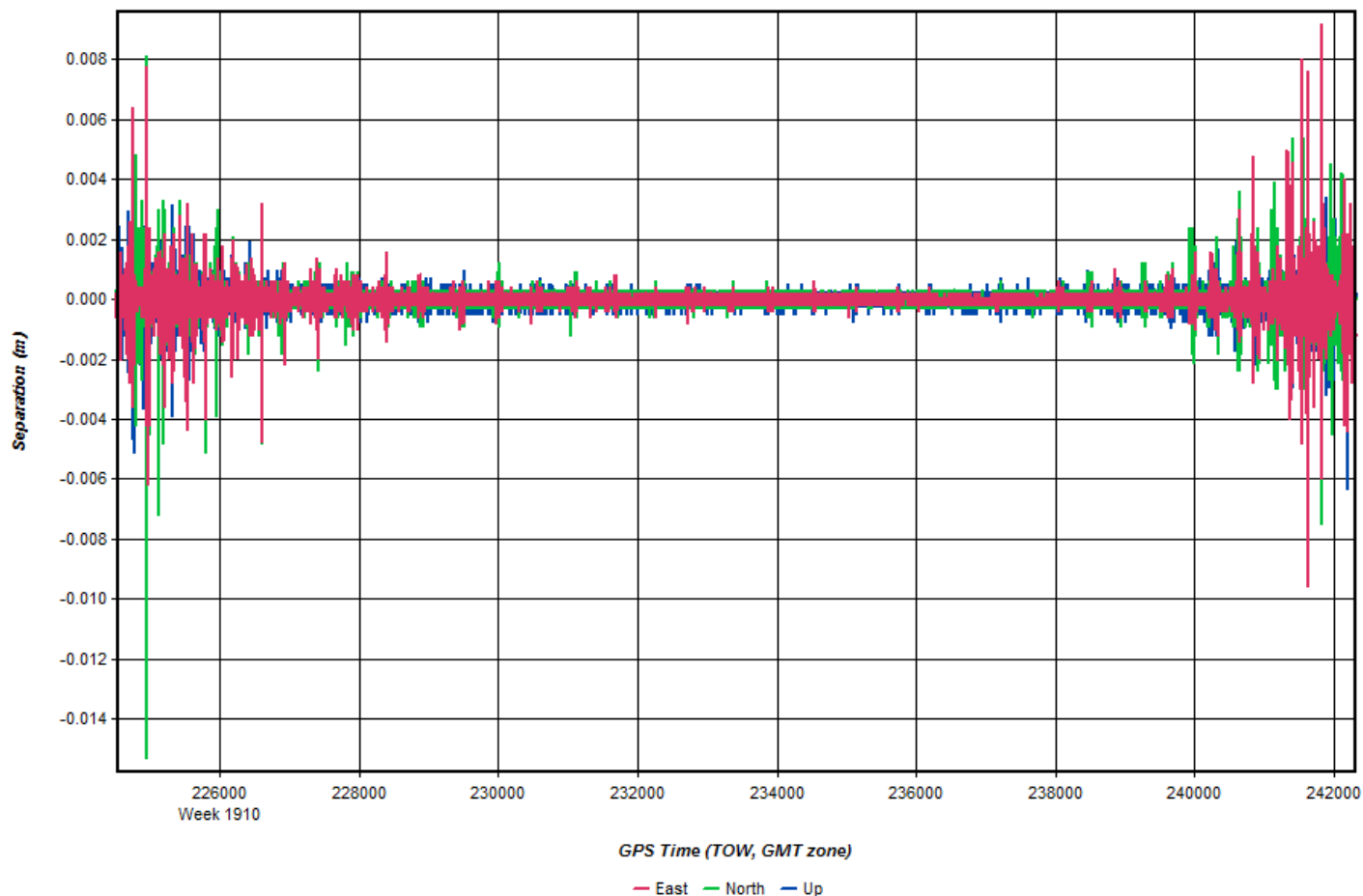


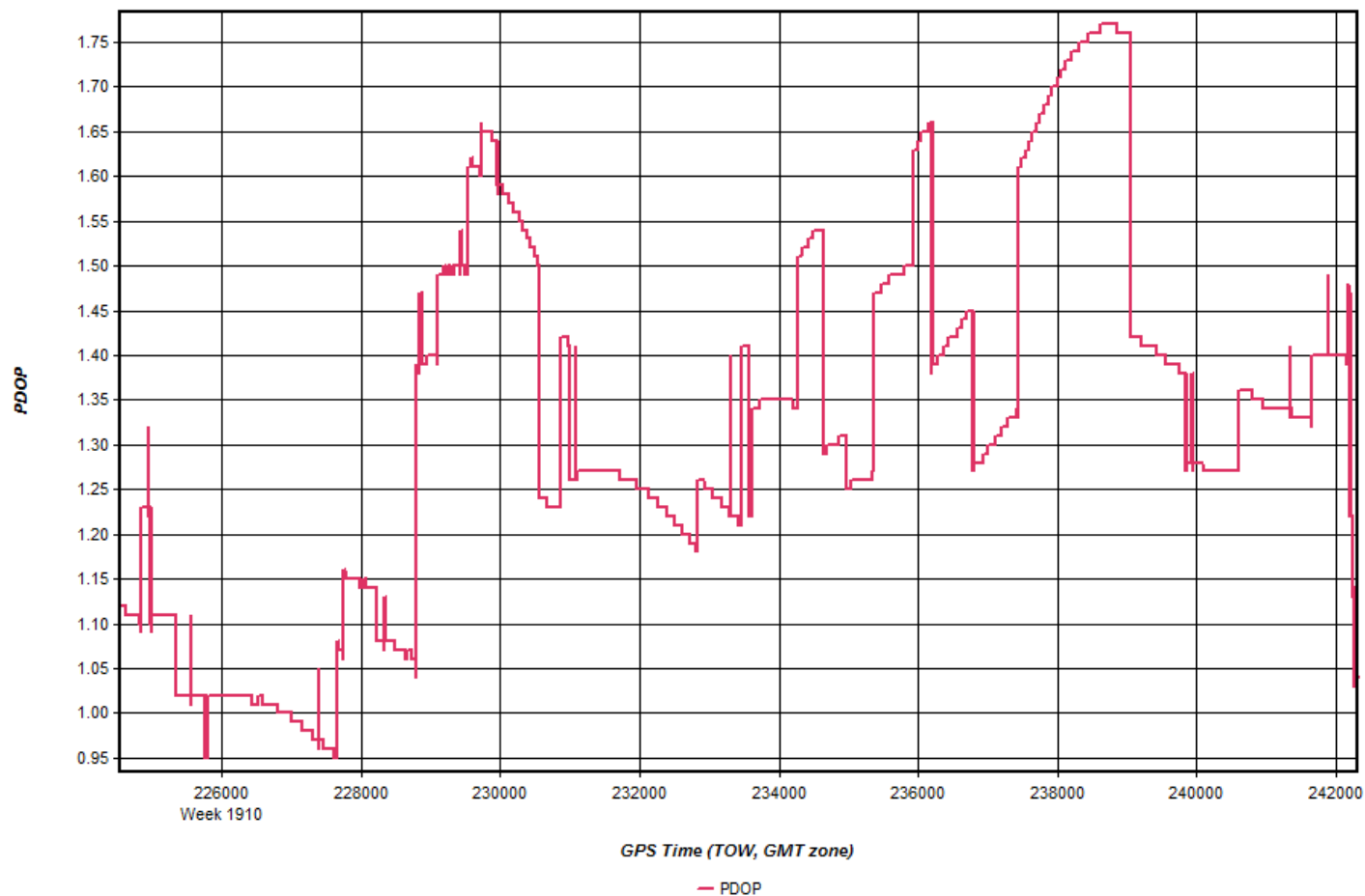
225_20160816_1



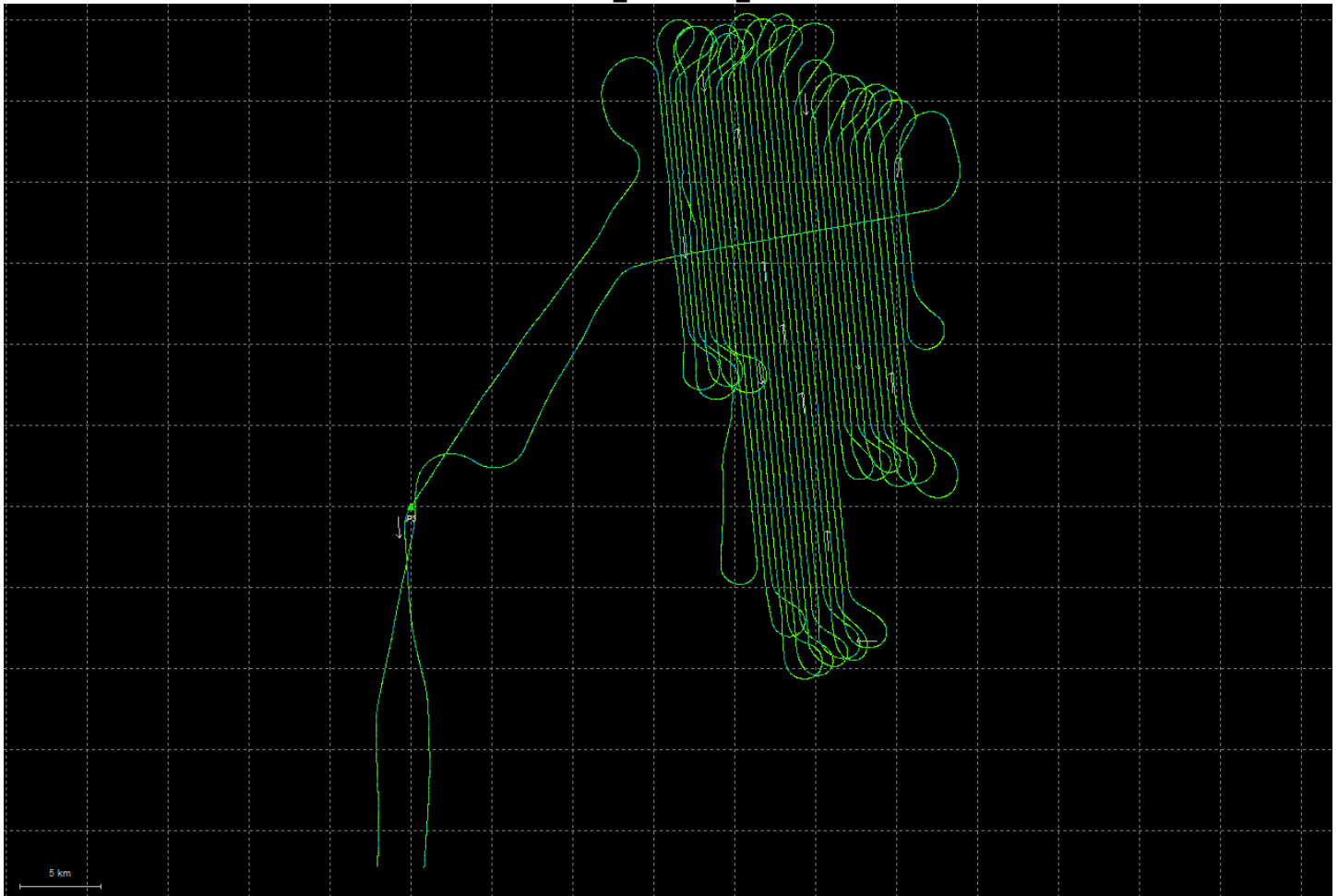




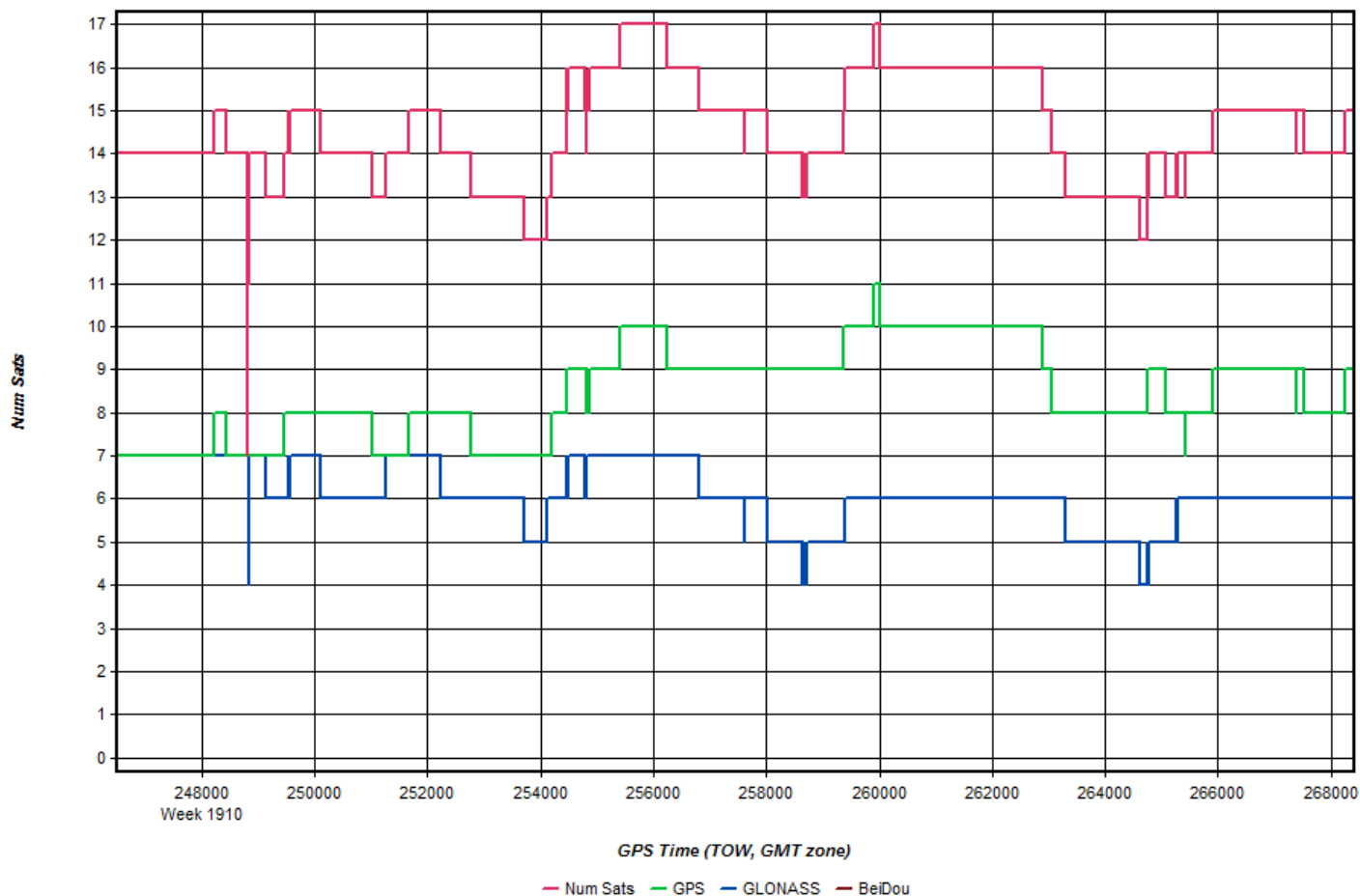


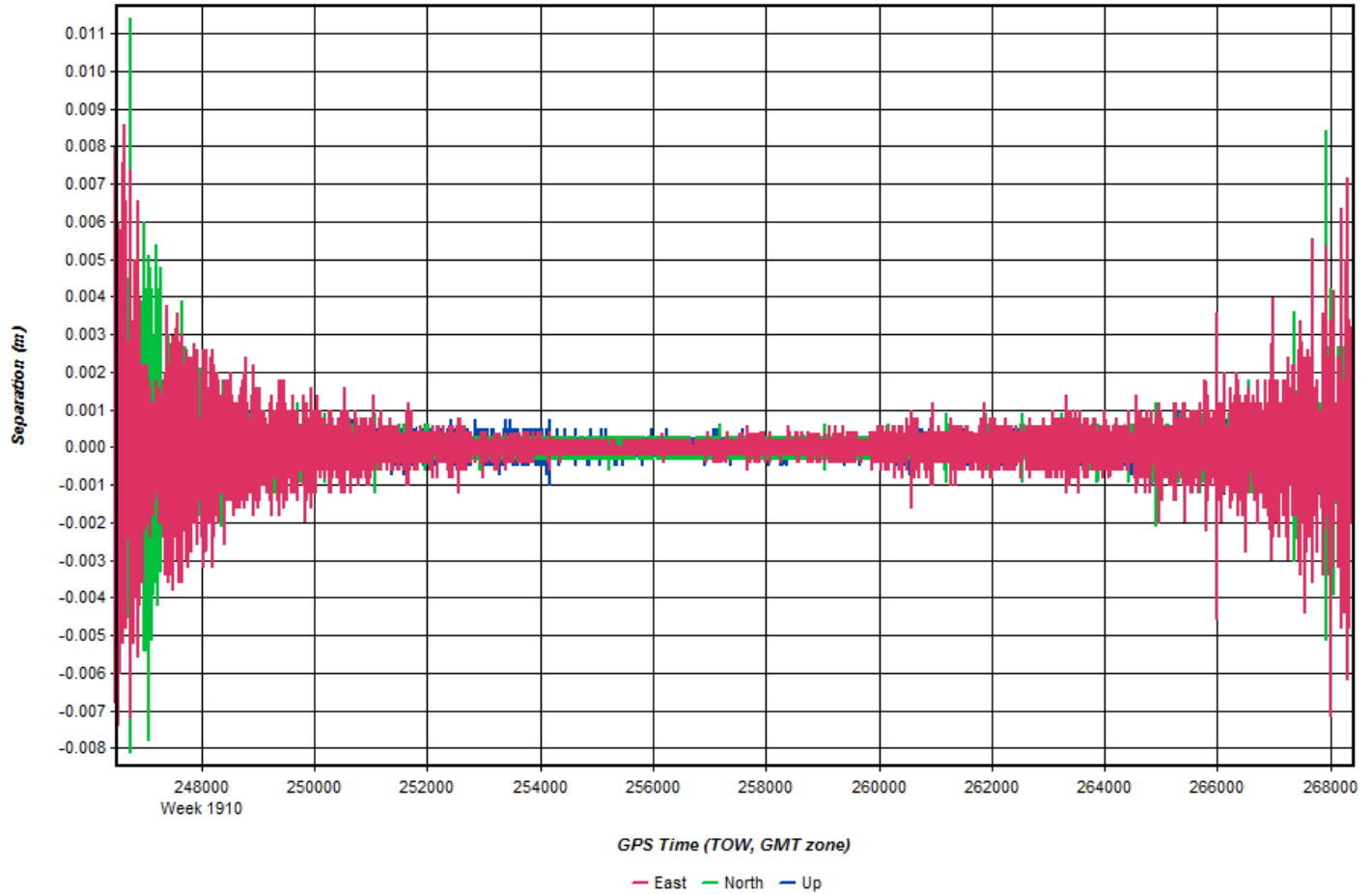


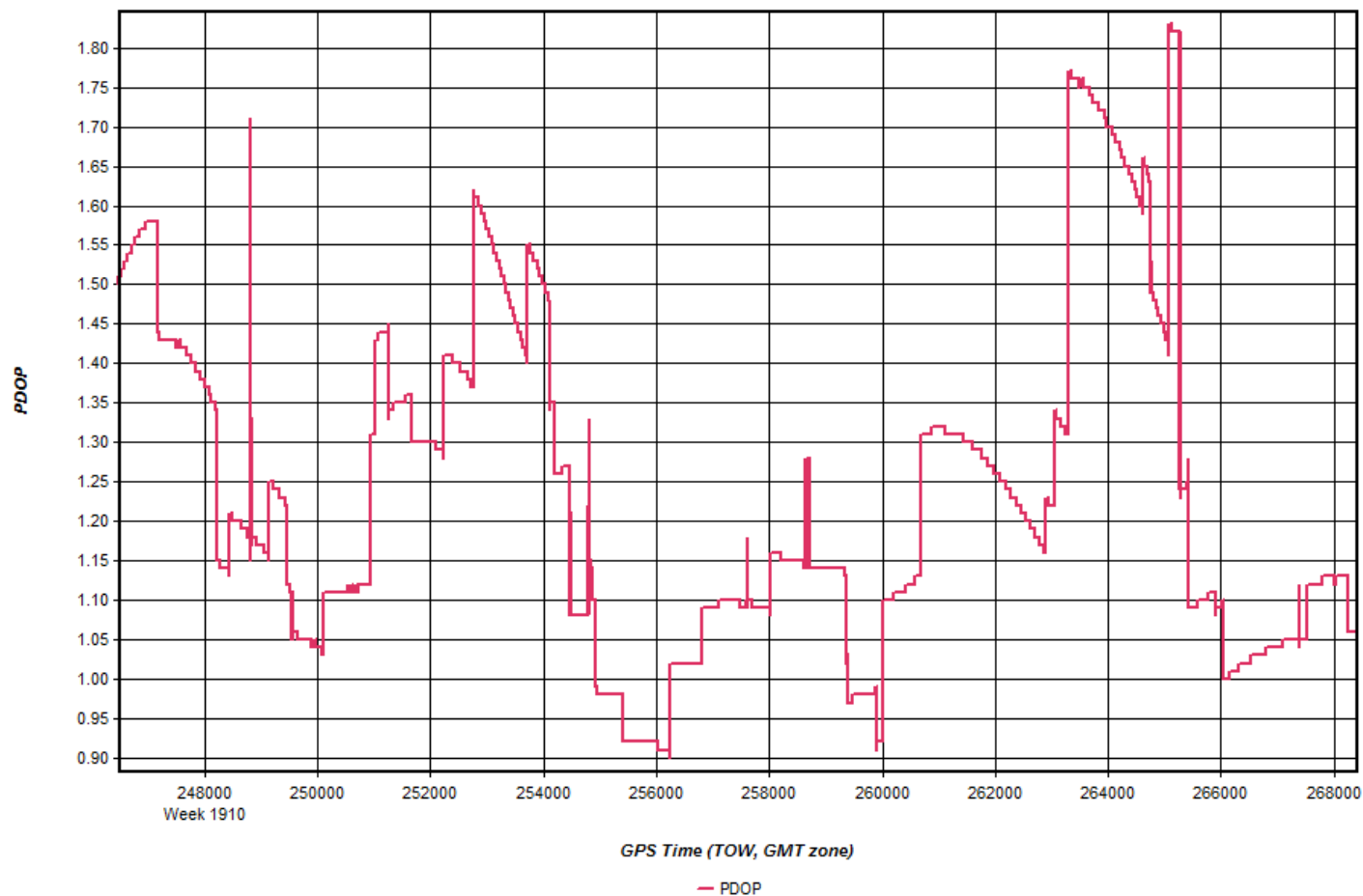
225_20160816_2



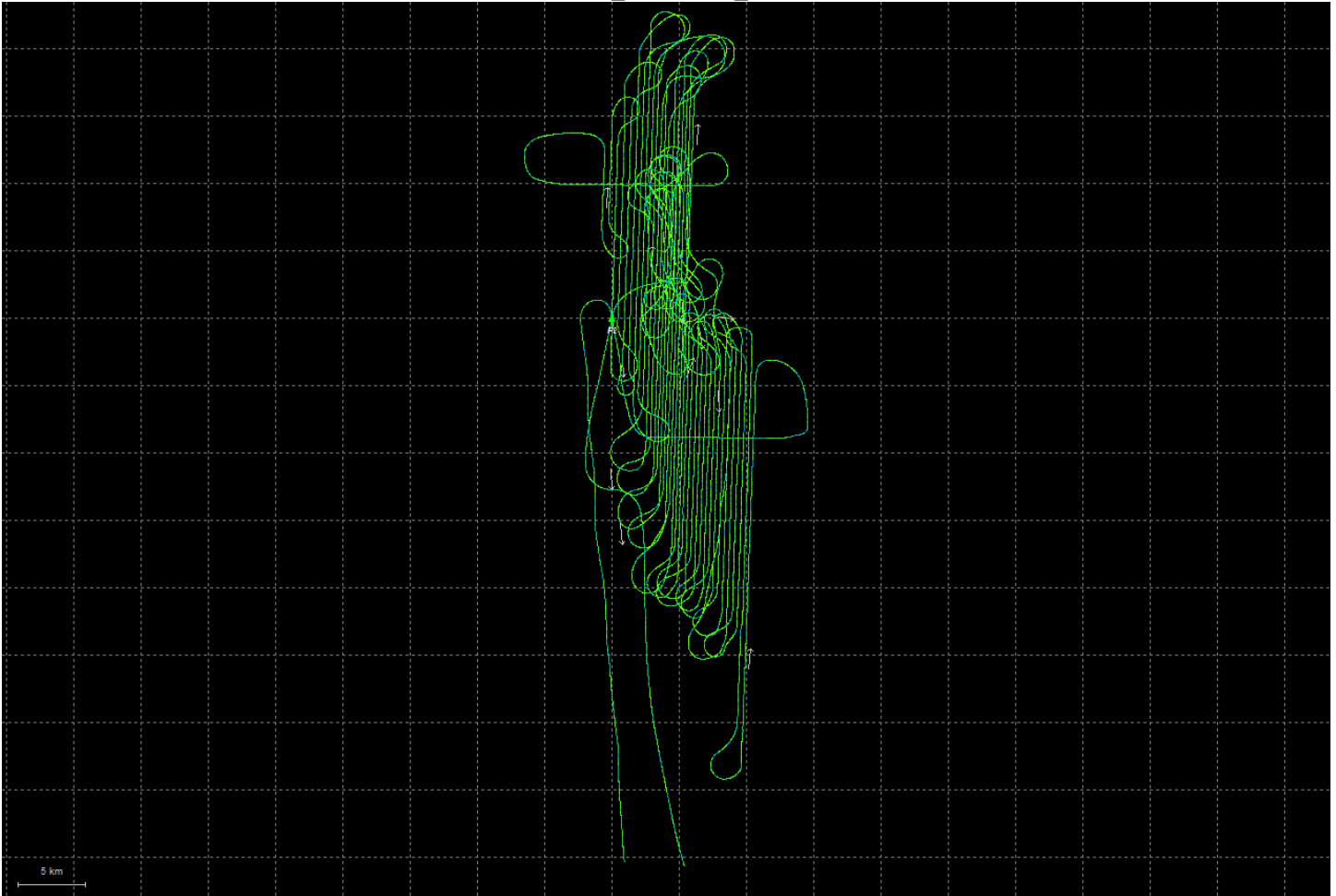


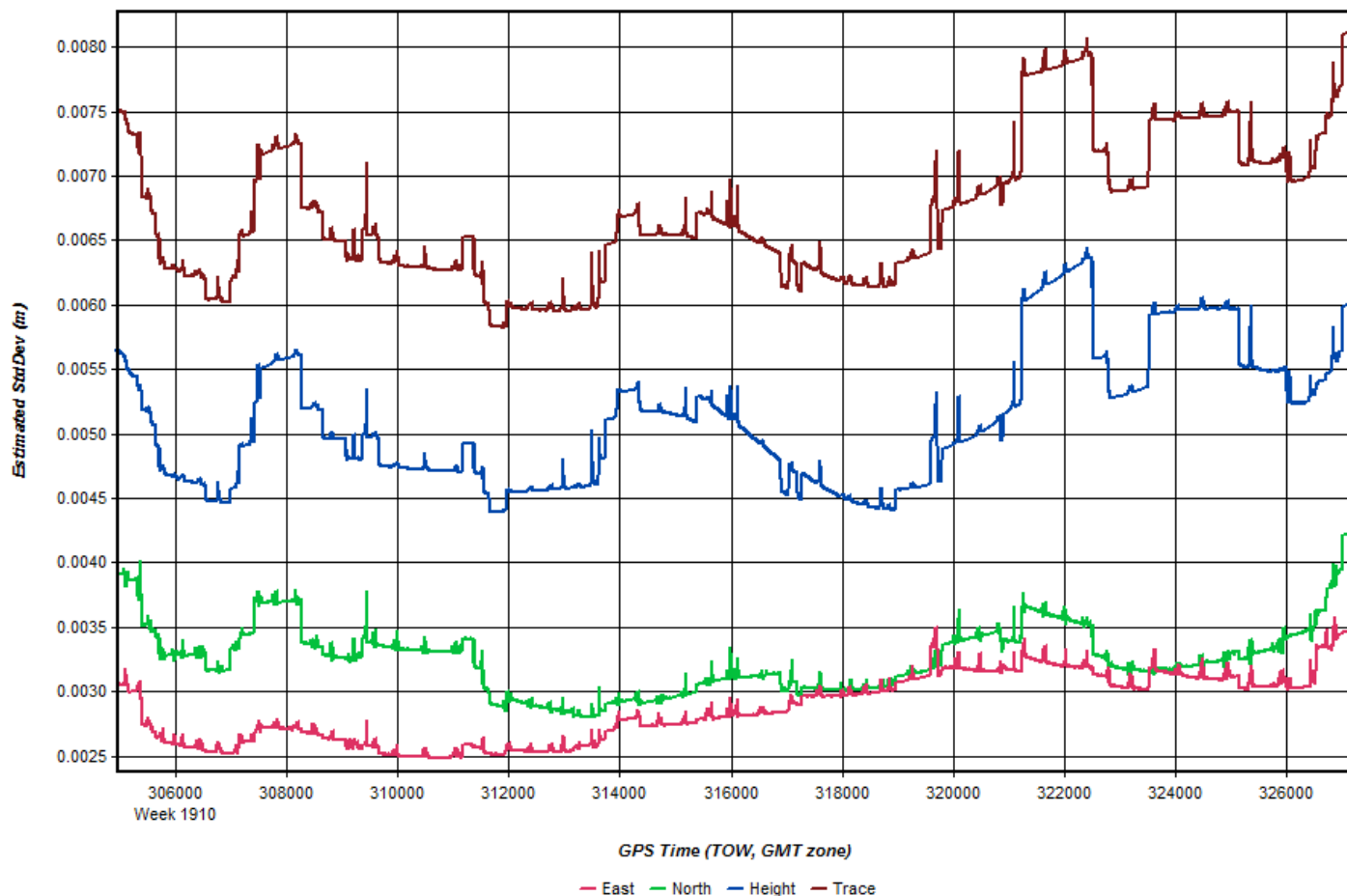


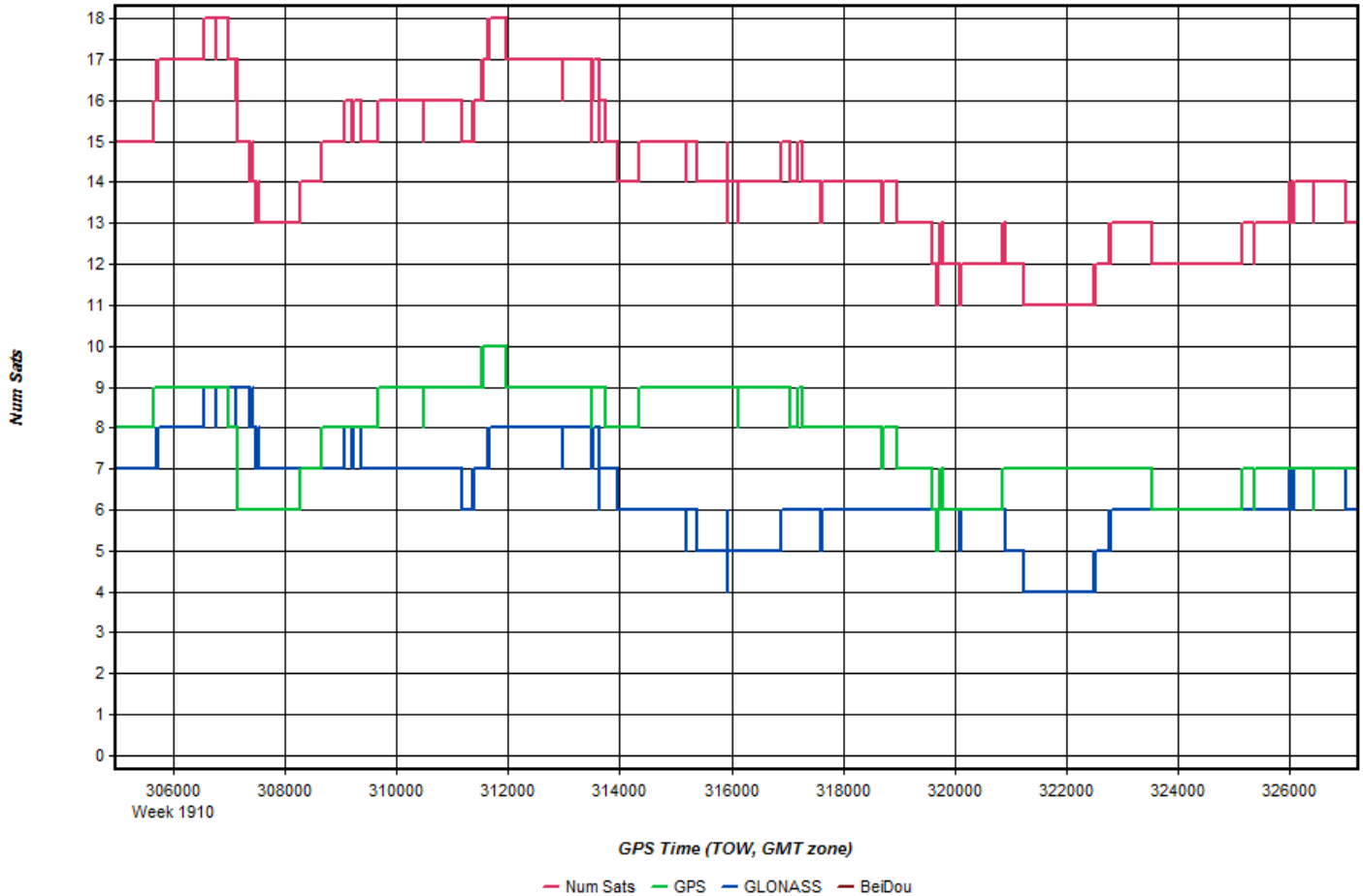


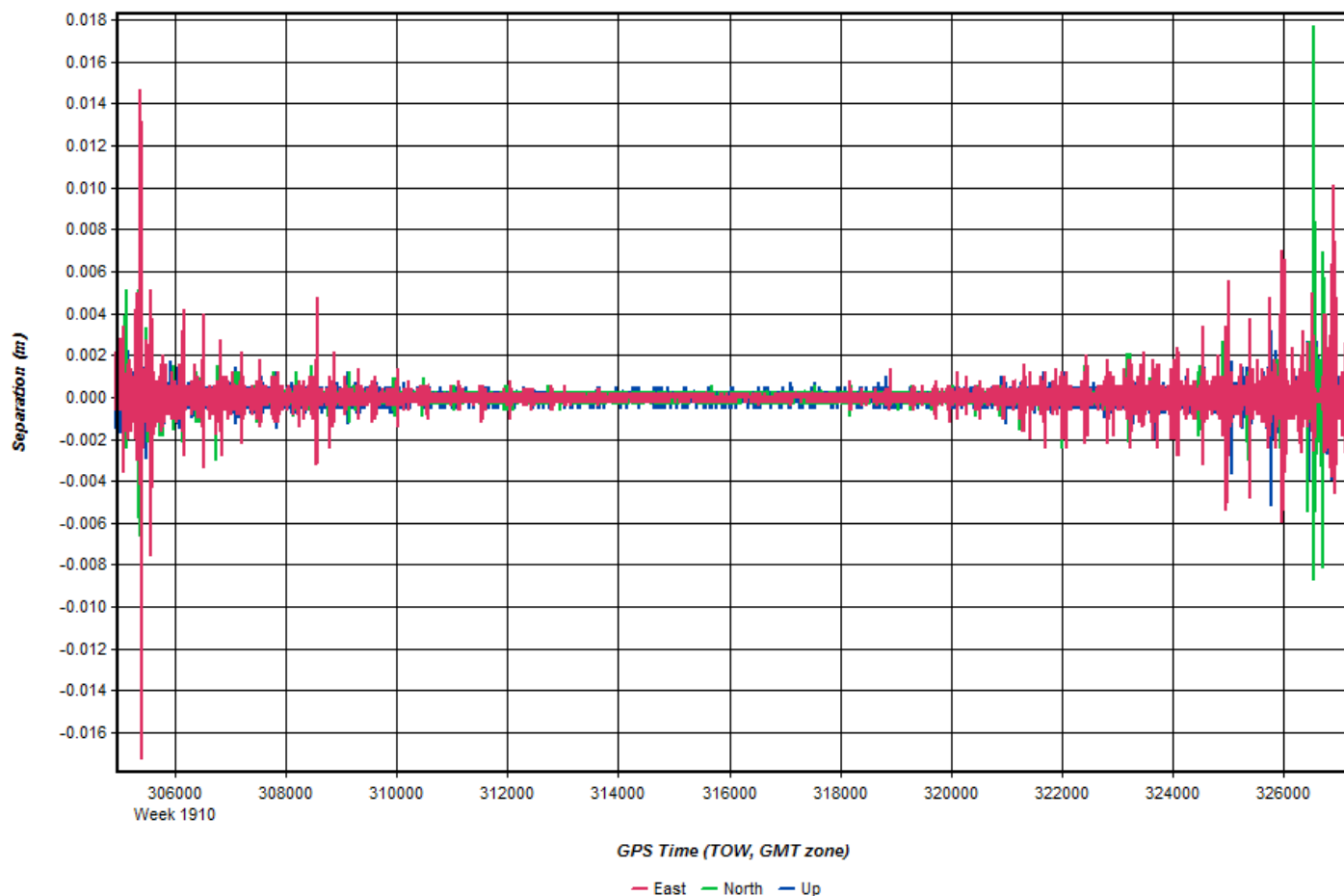


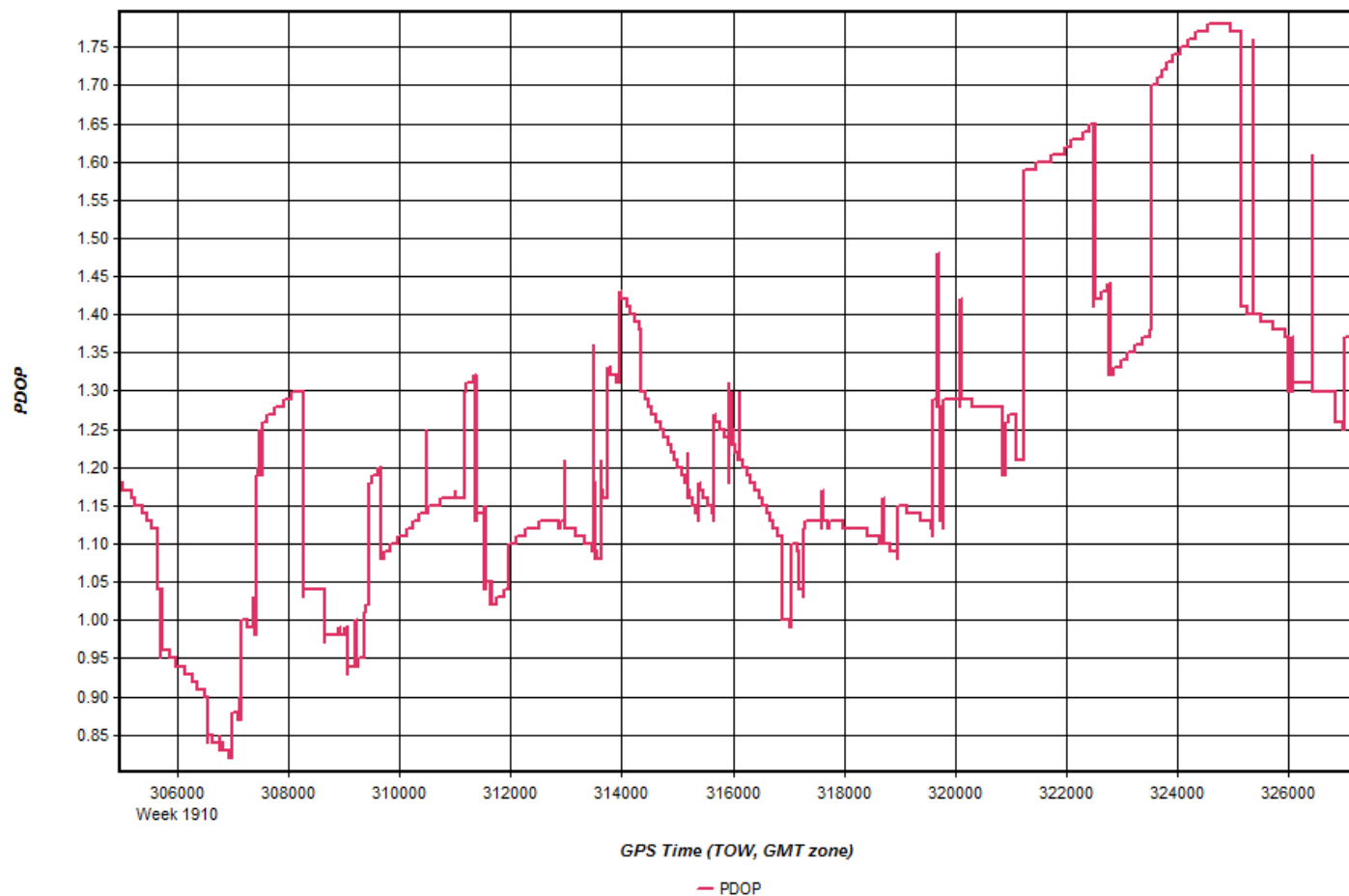
225_20160817_1





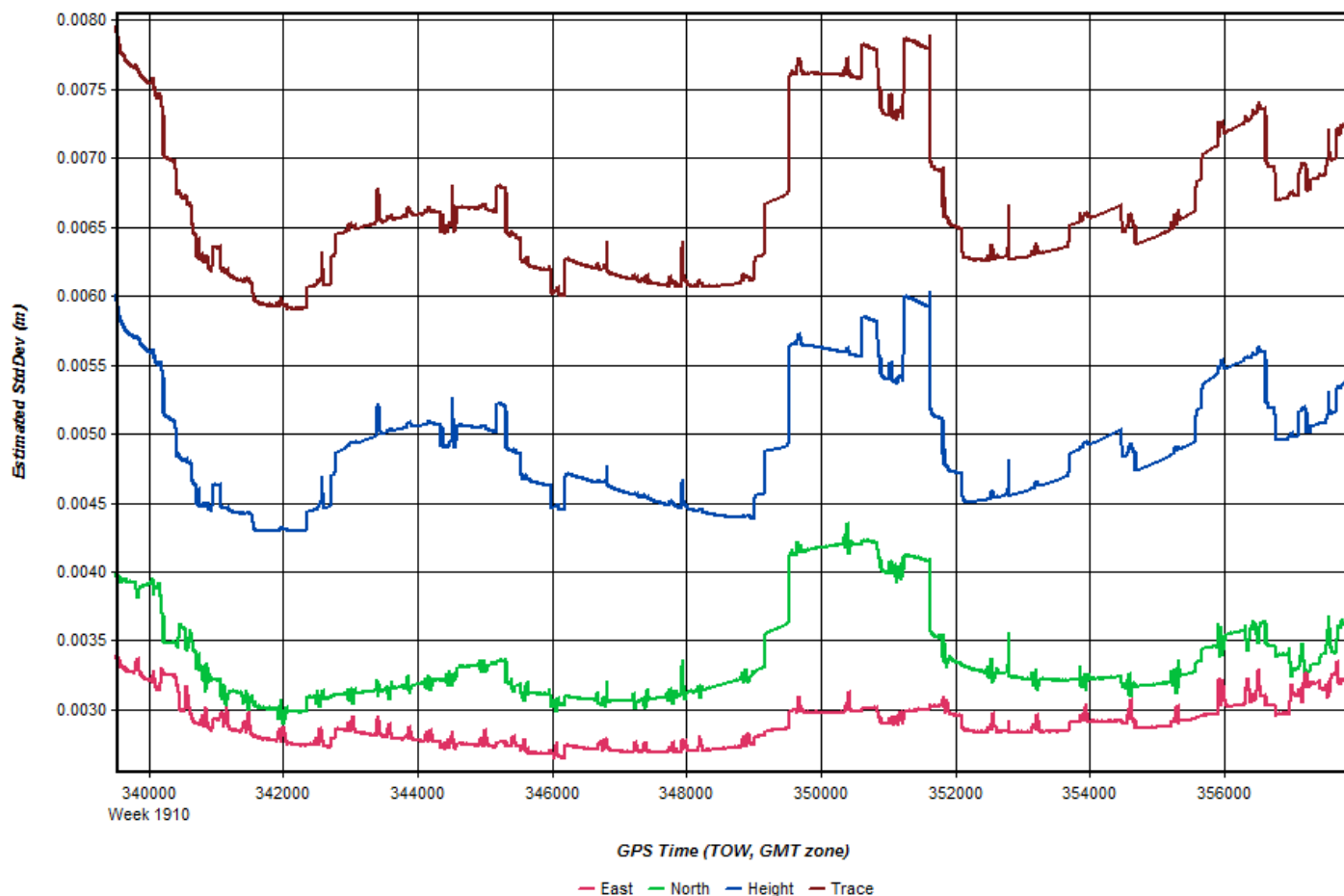




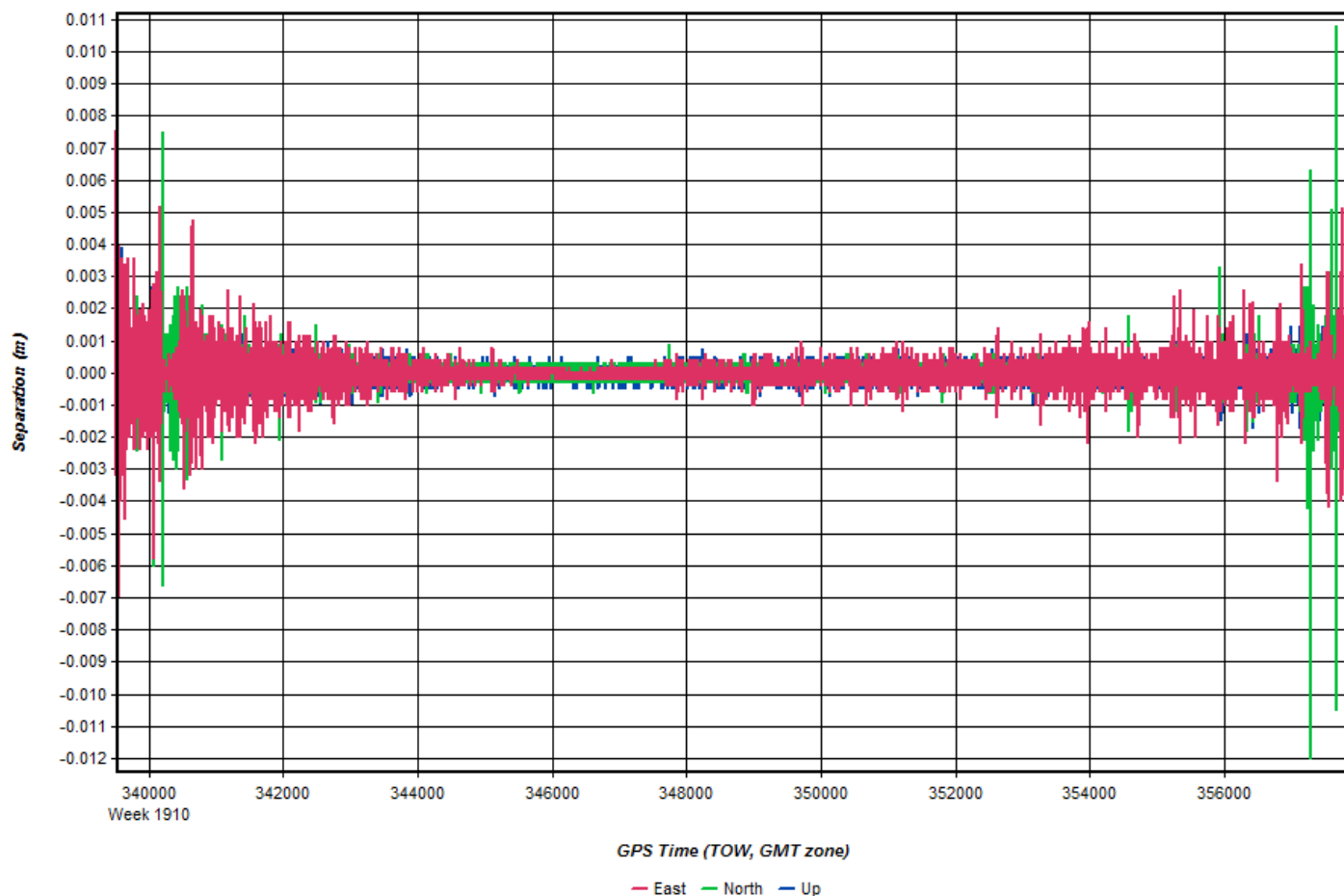


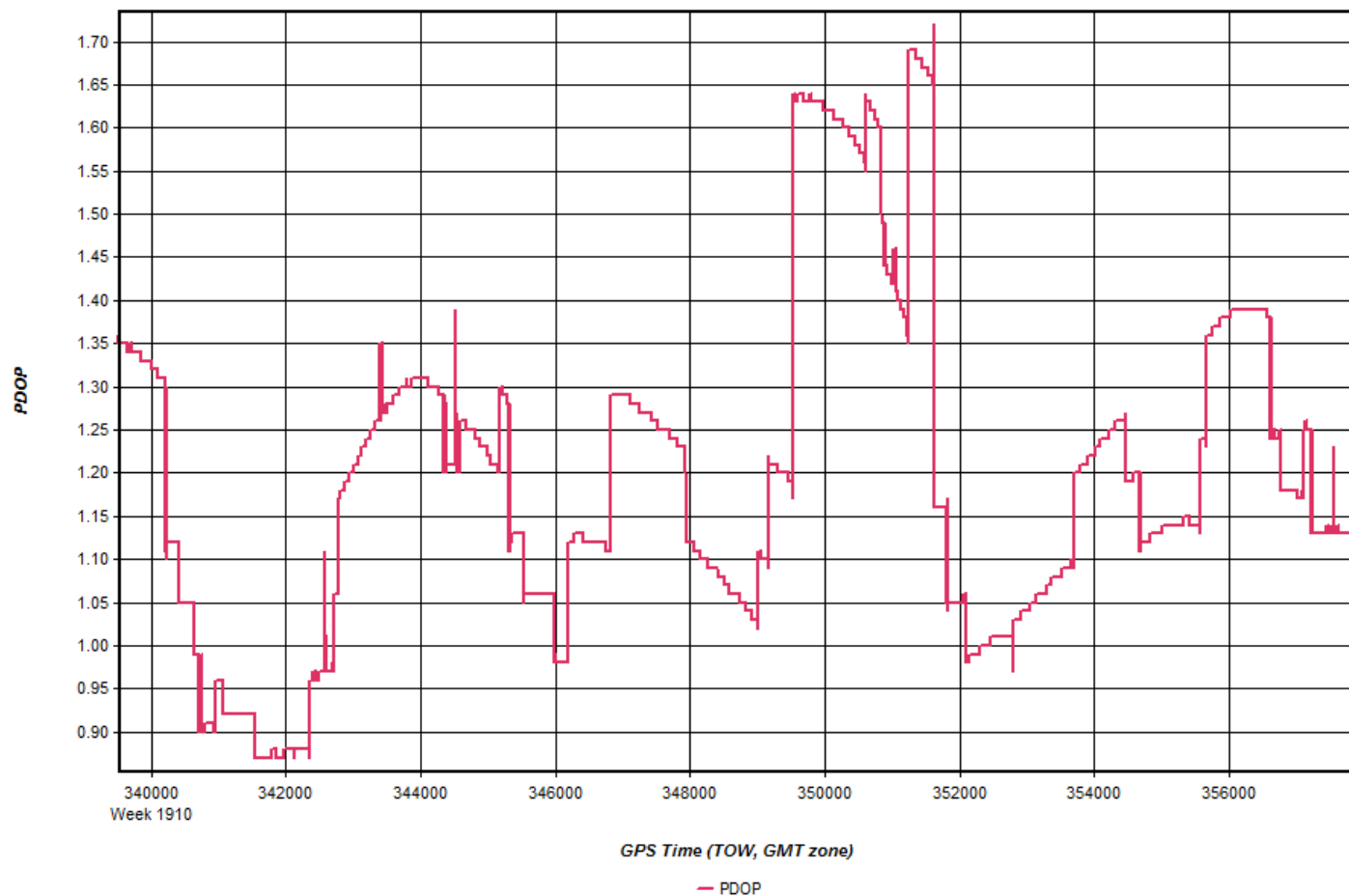
225_20160817_2



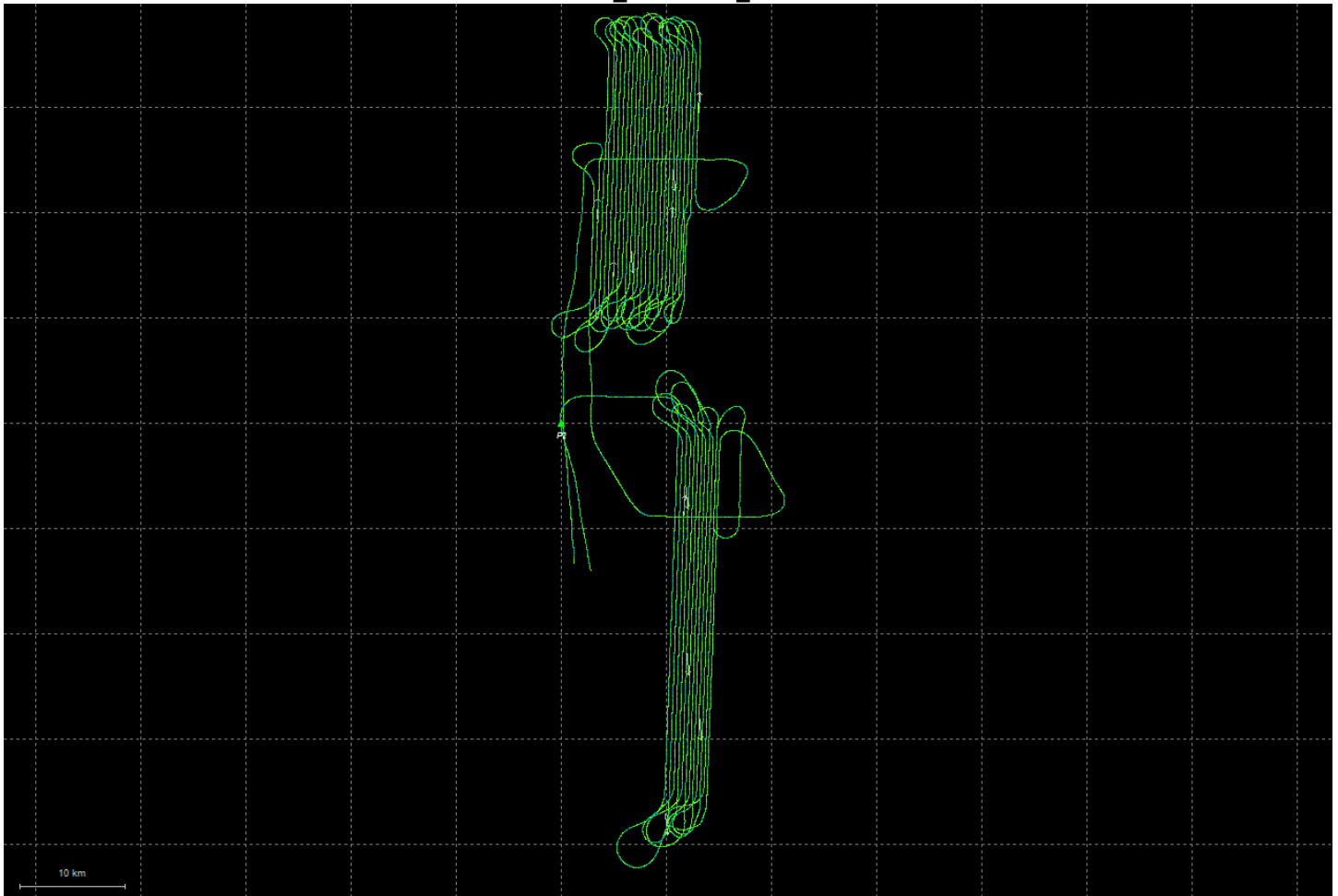


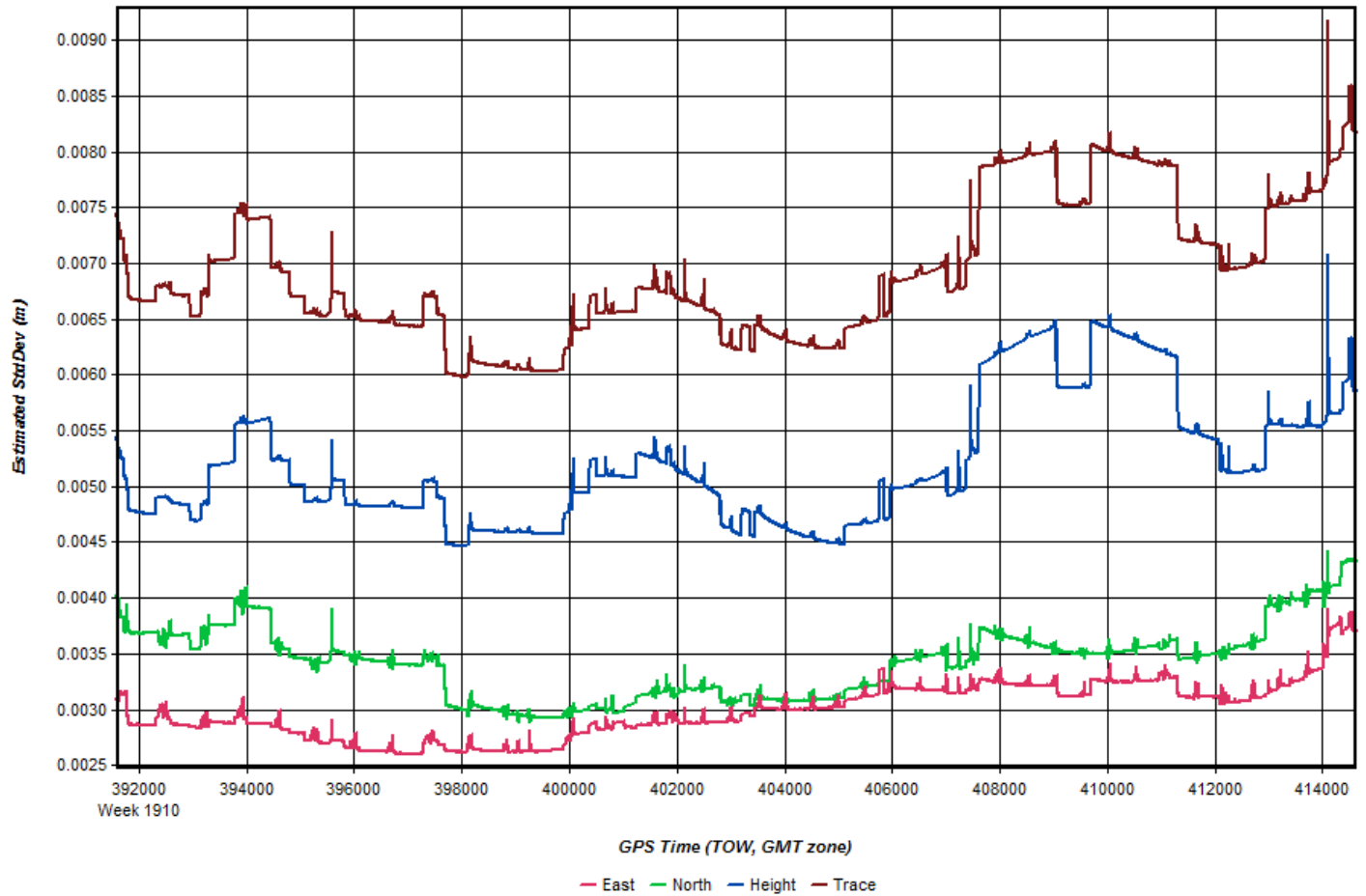


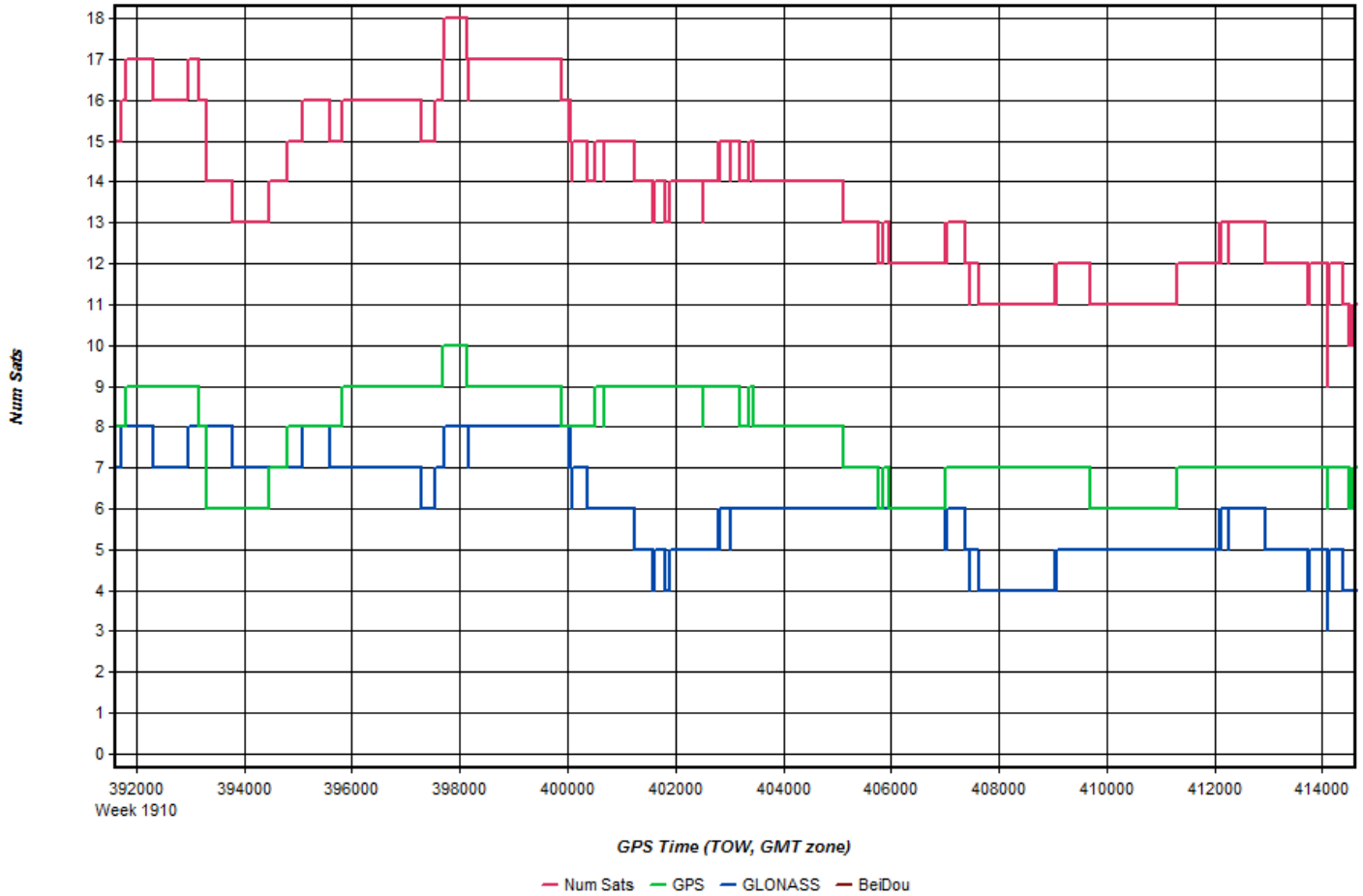


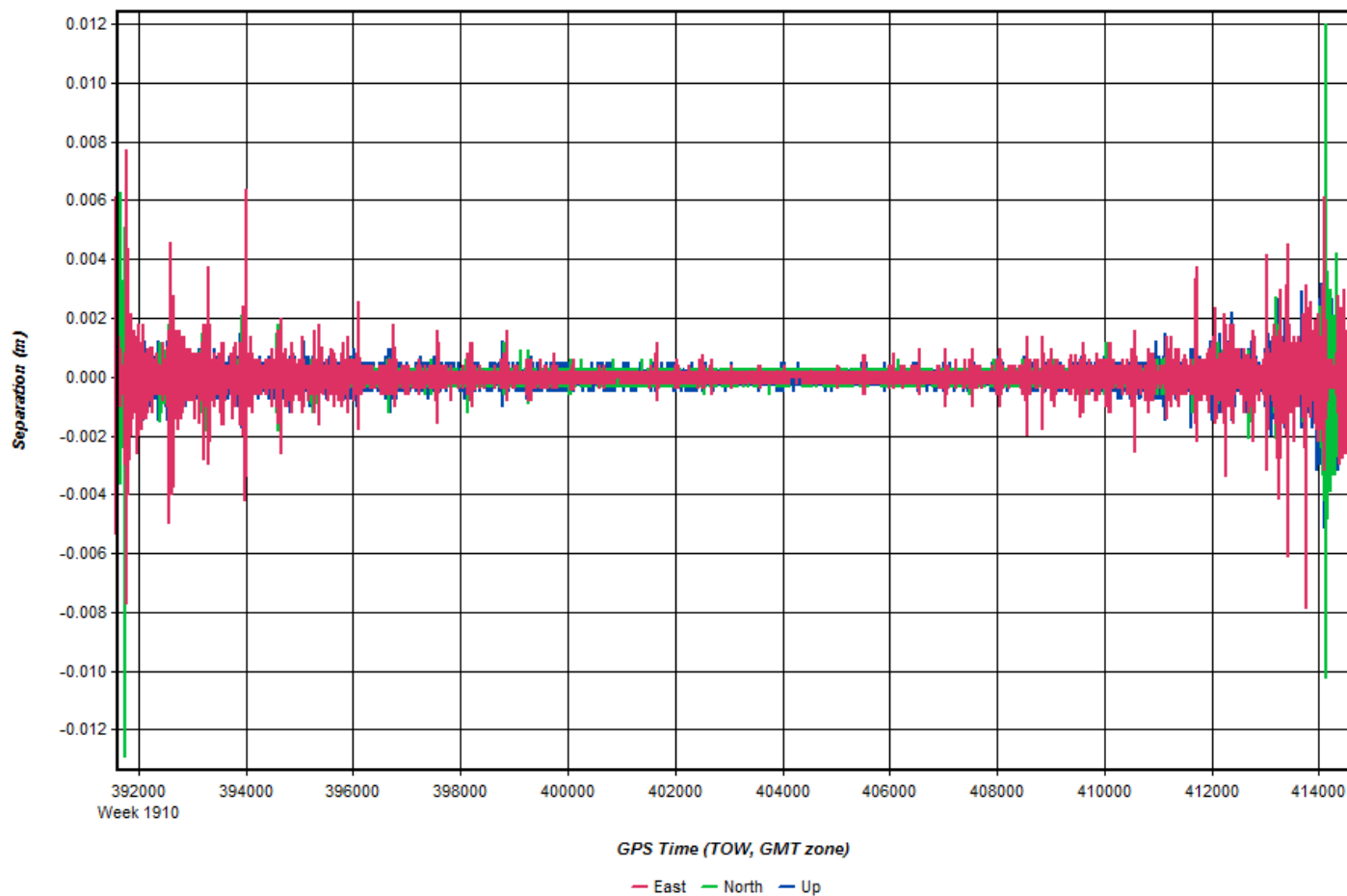


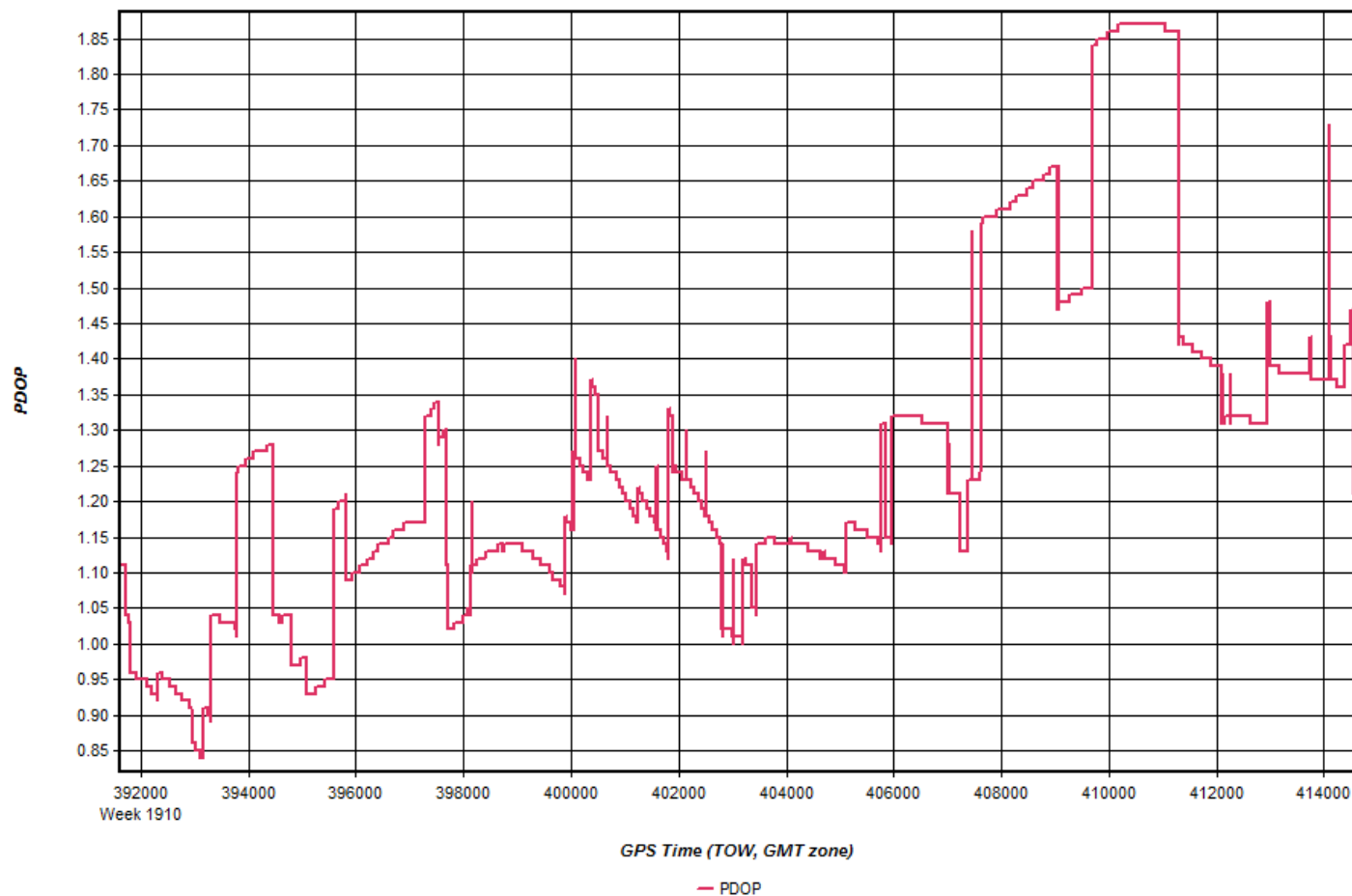
225_20160818_1



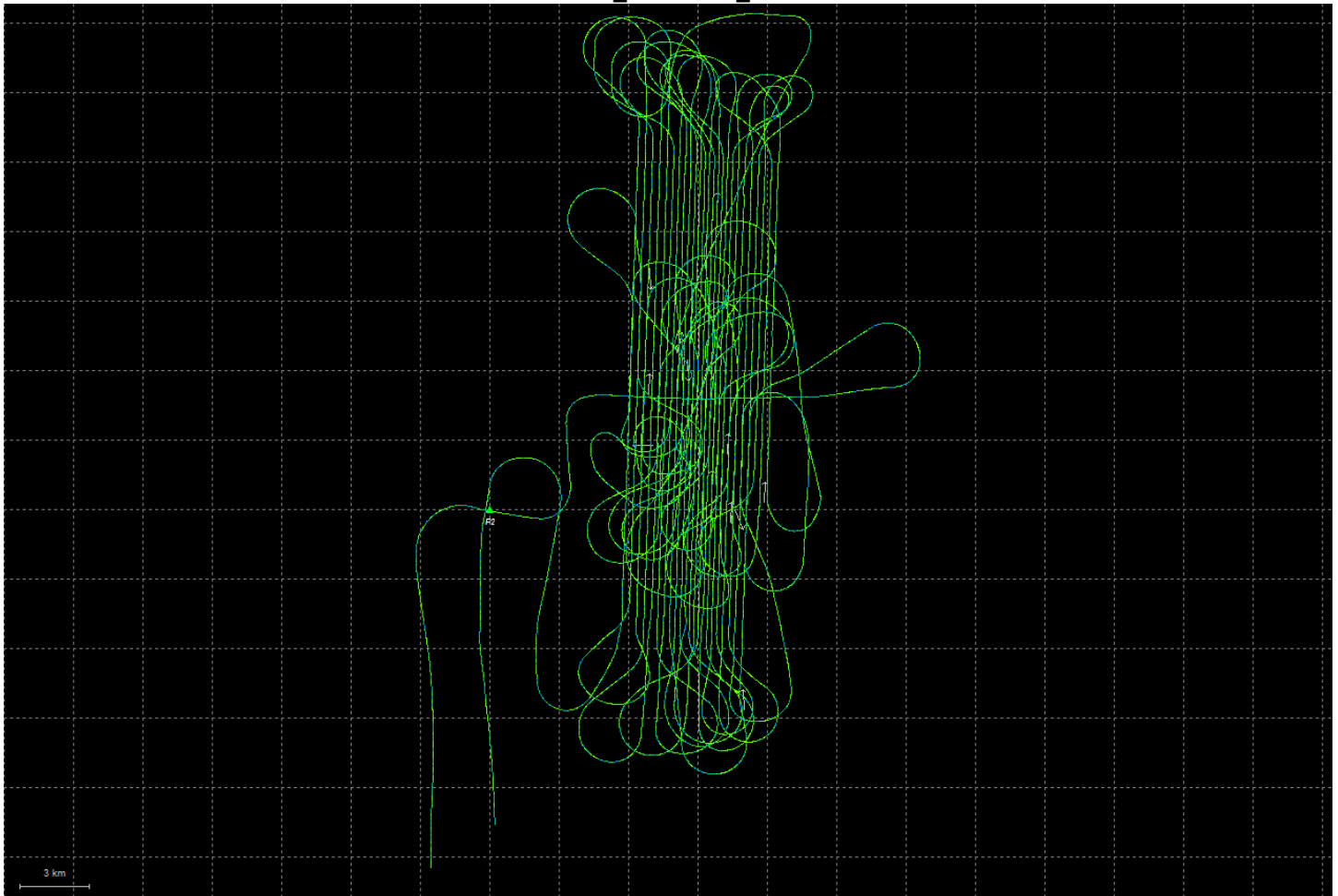


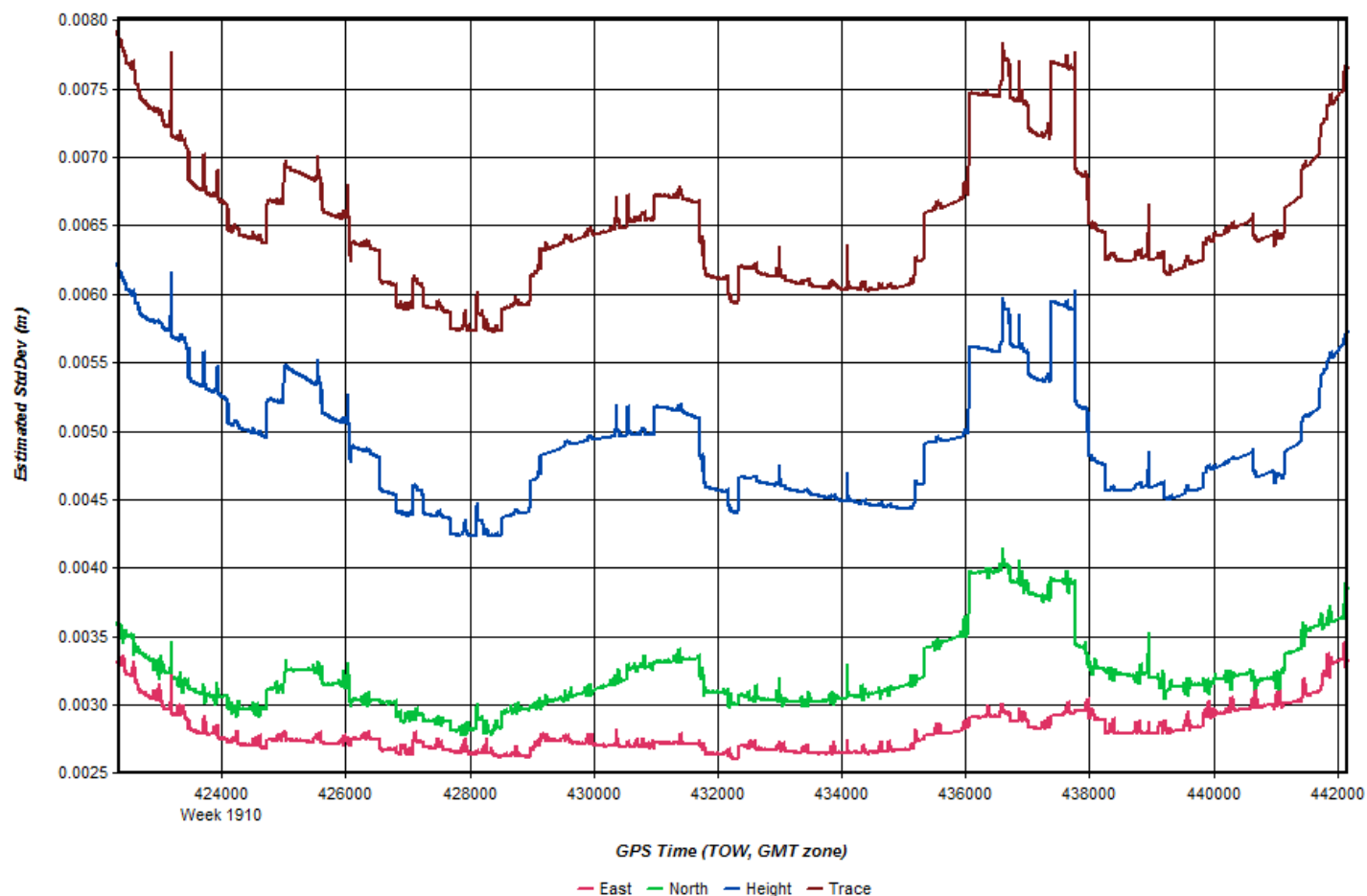


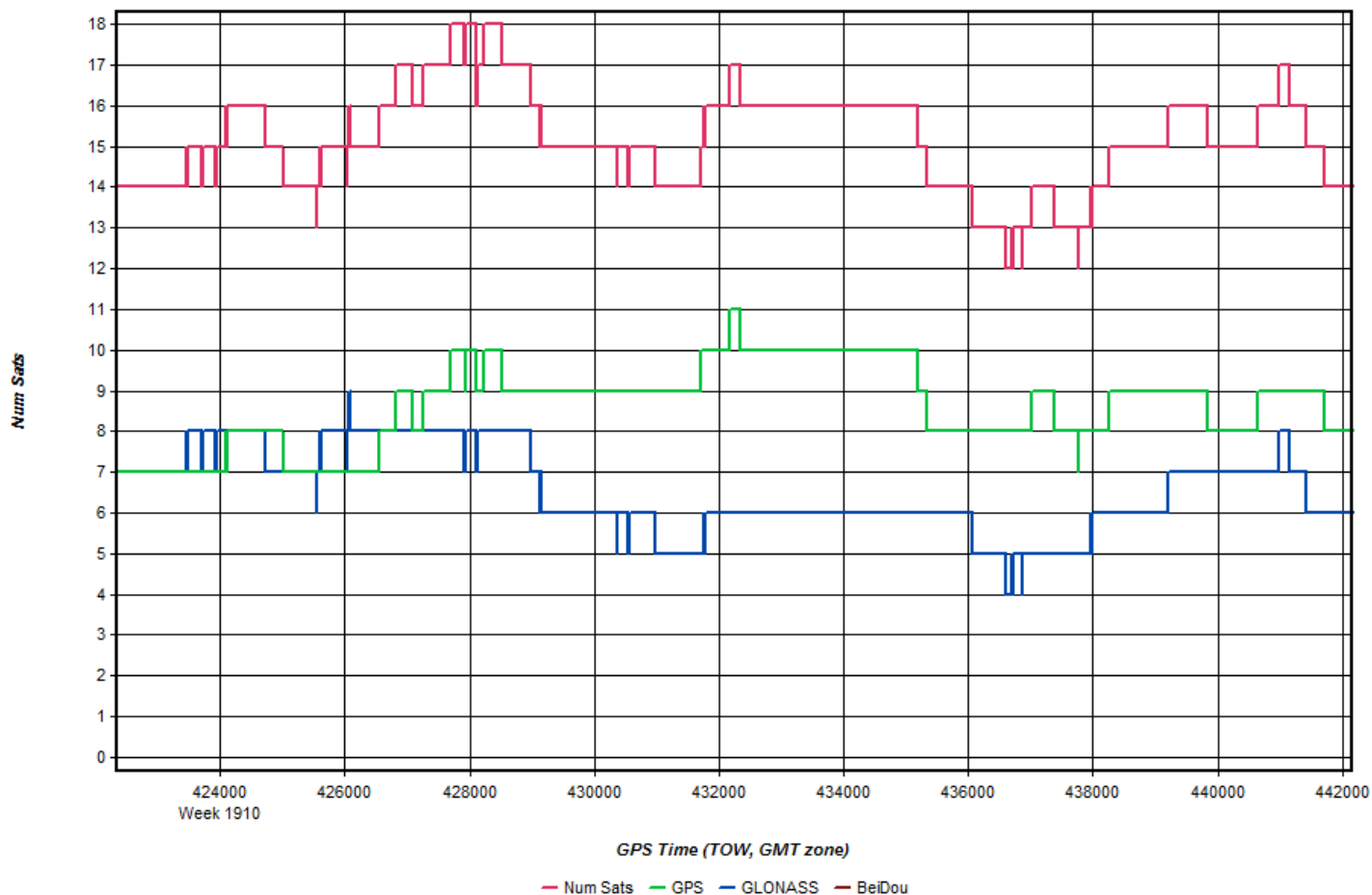


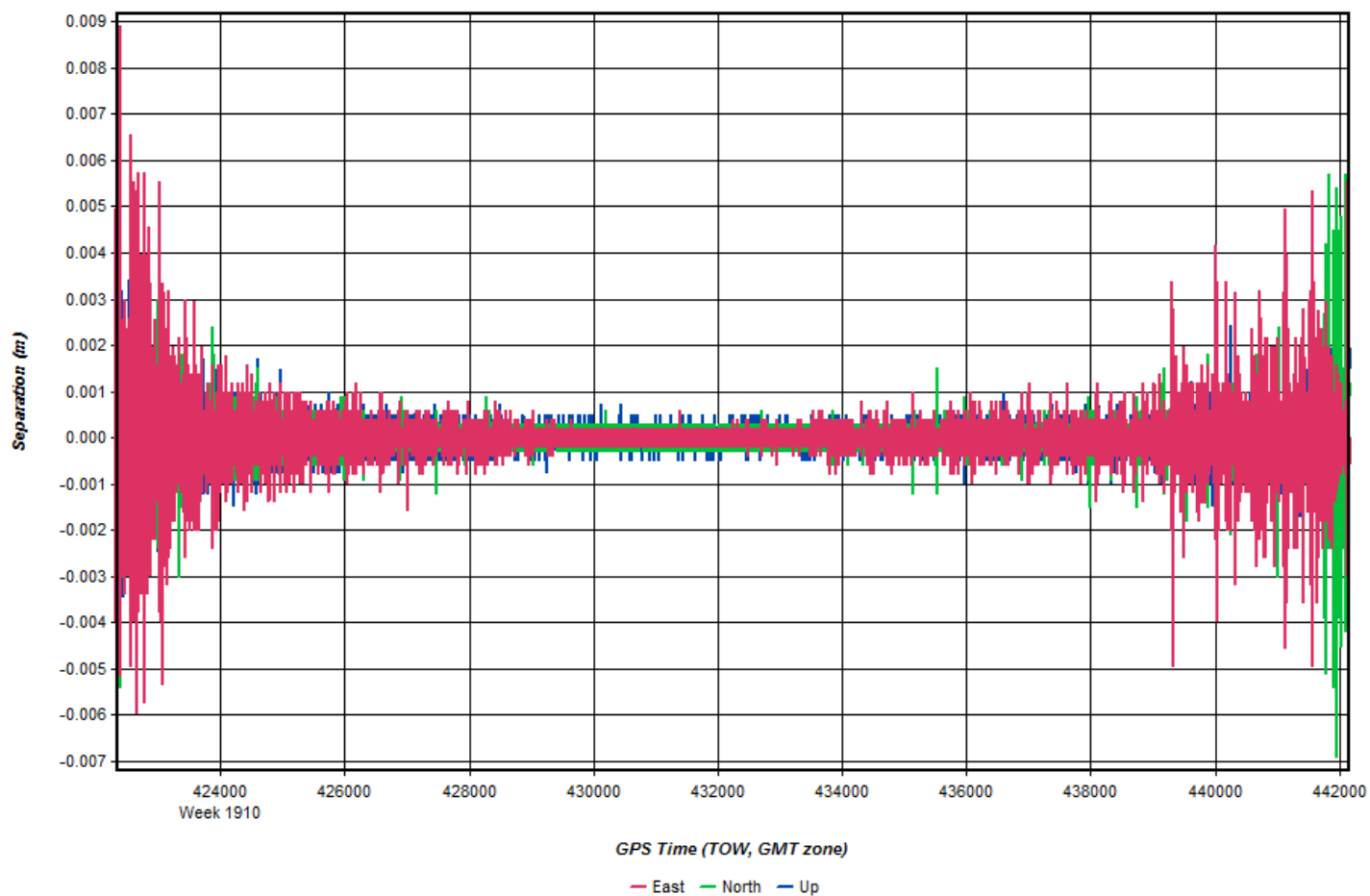


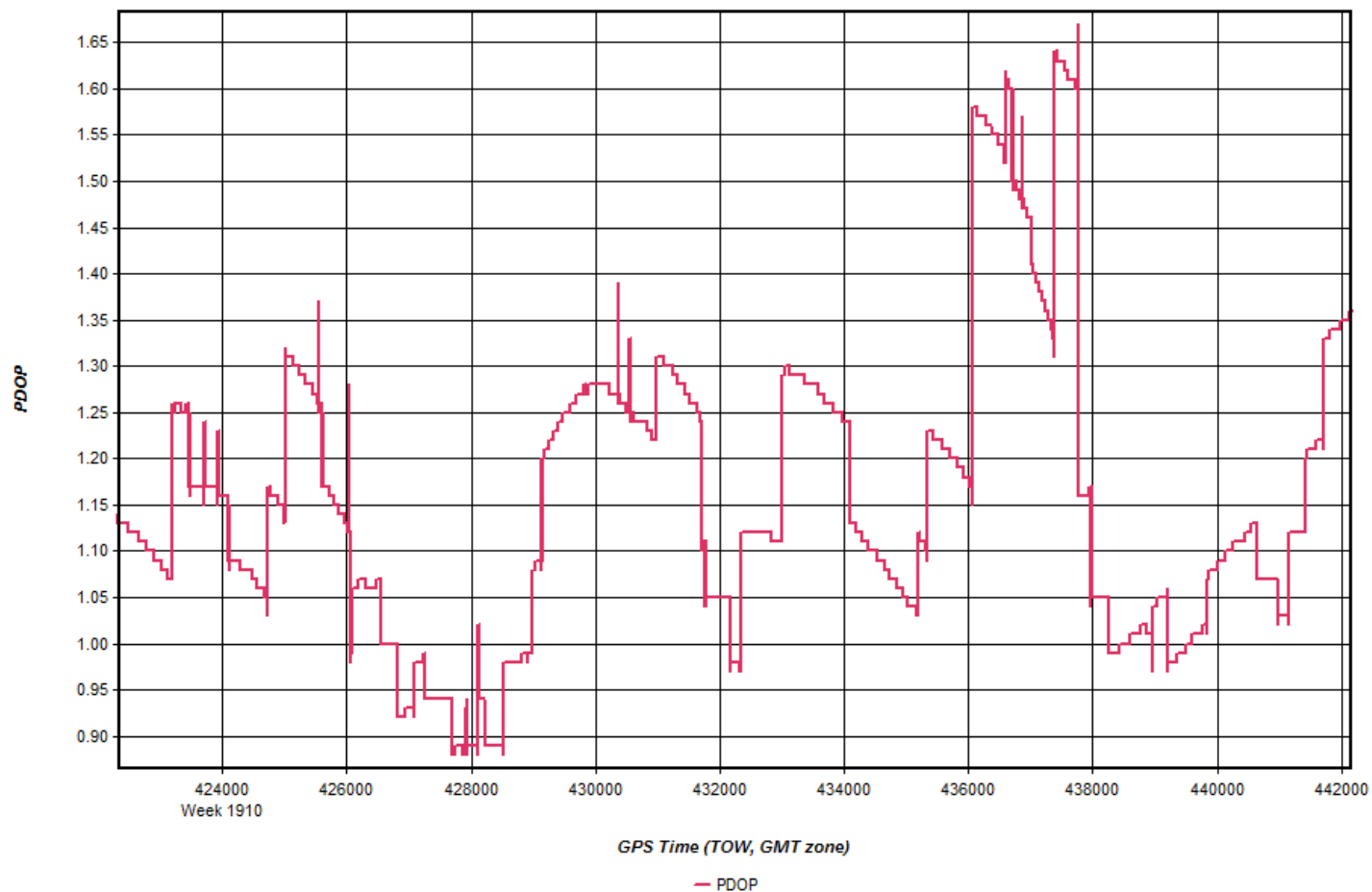
225_20160818_2



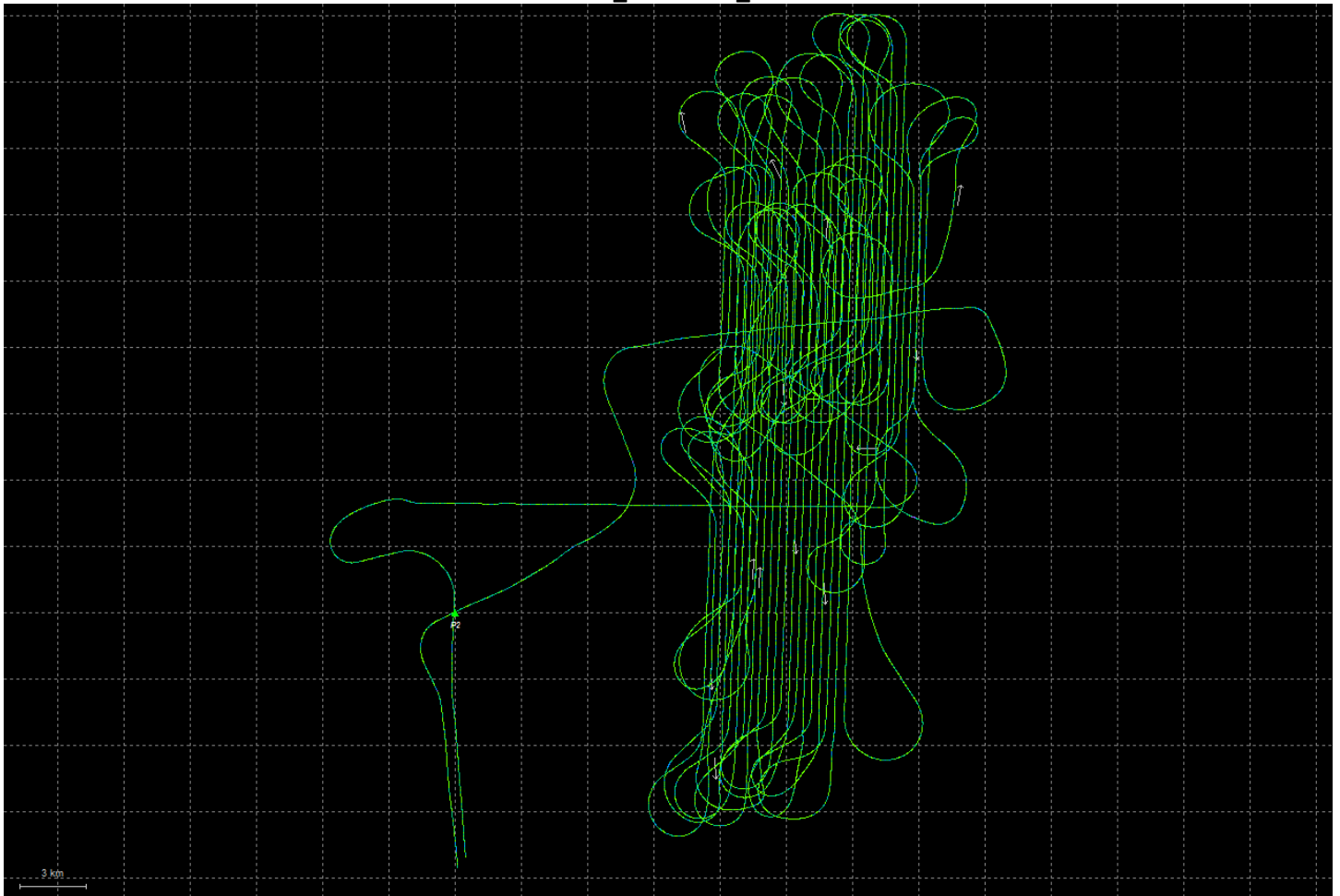


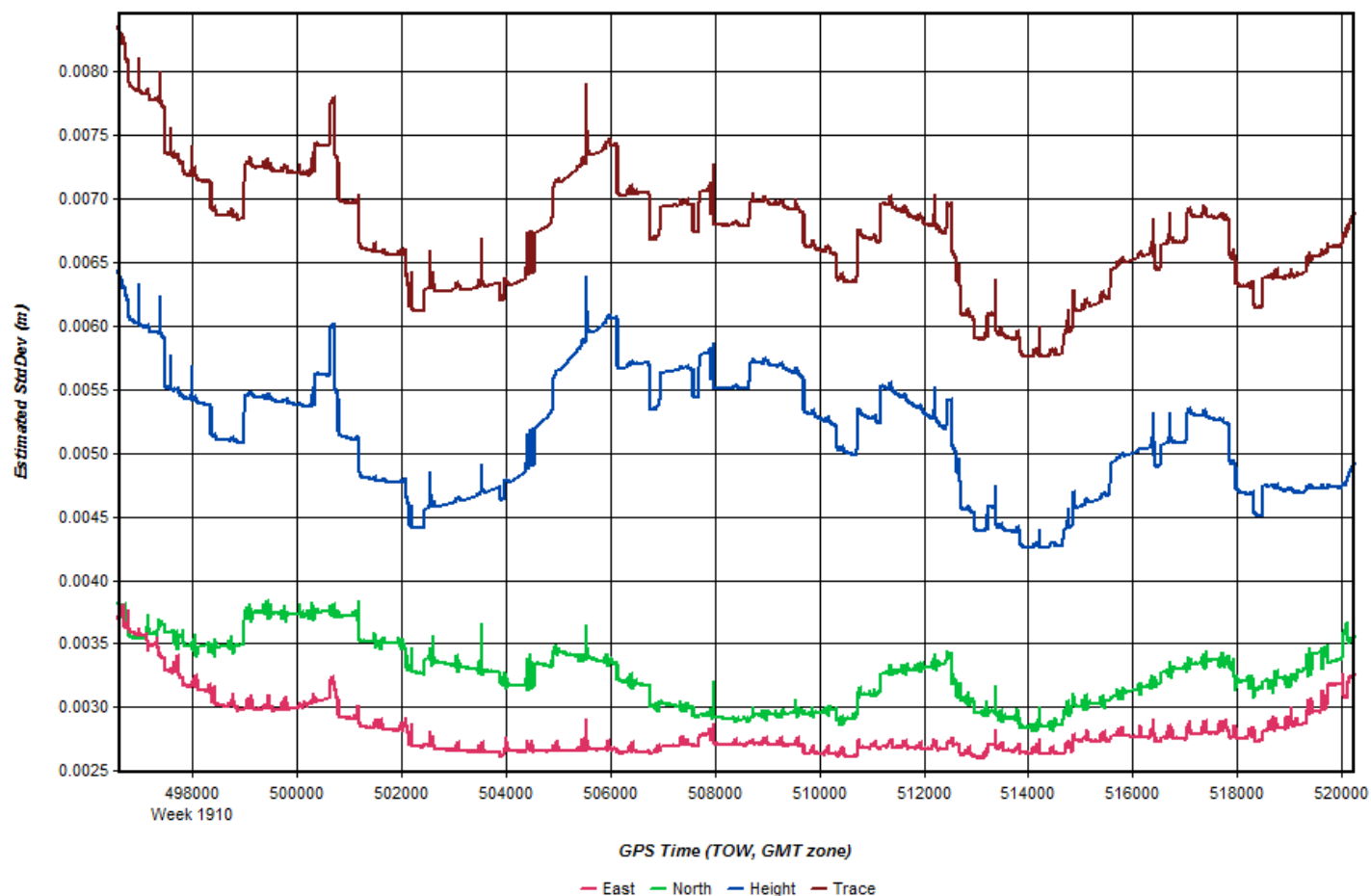


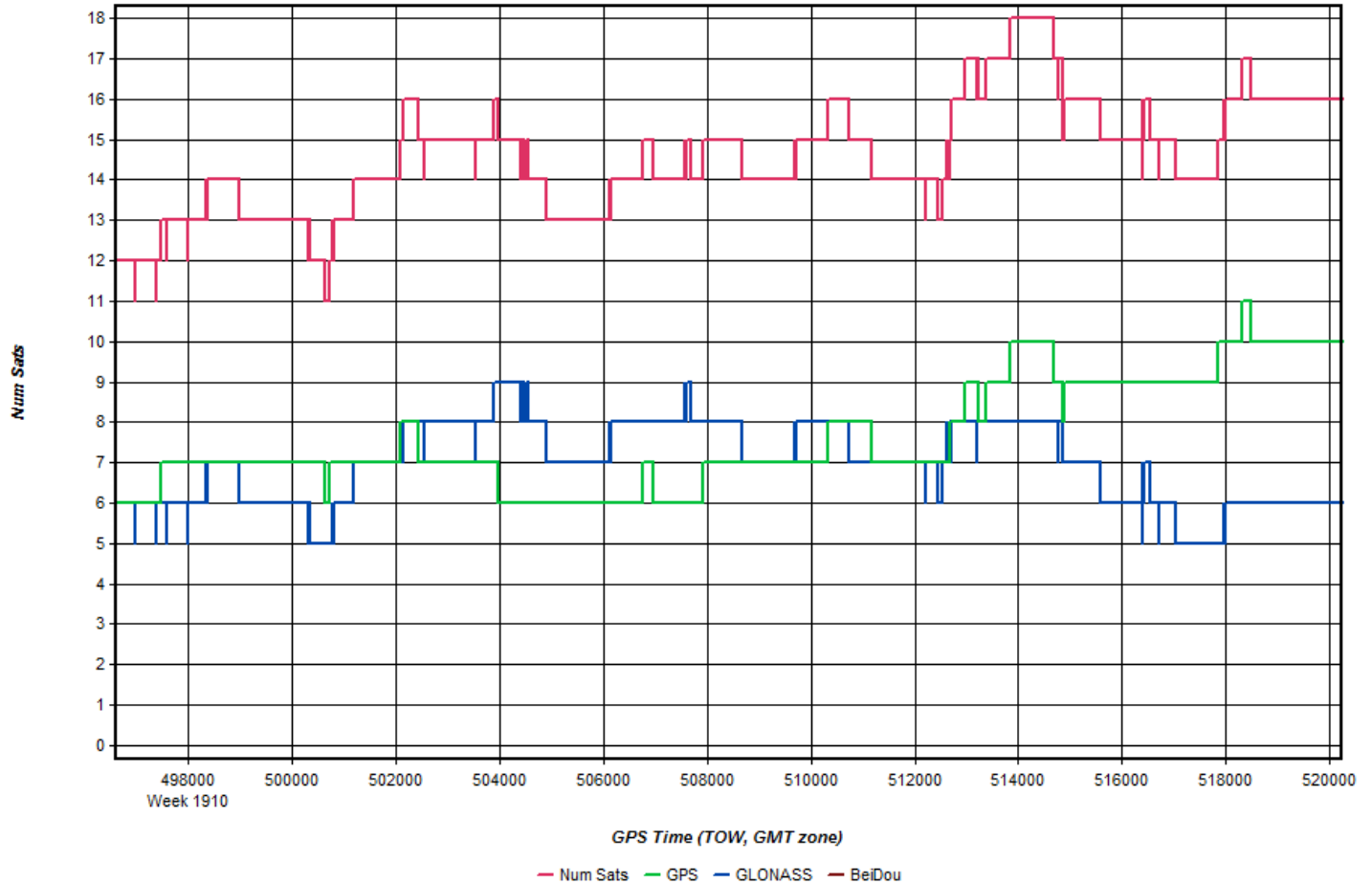


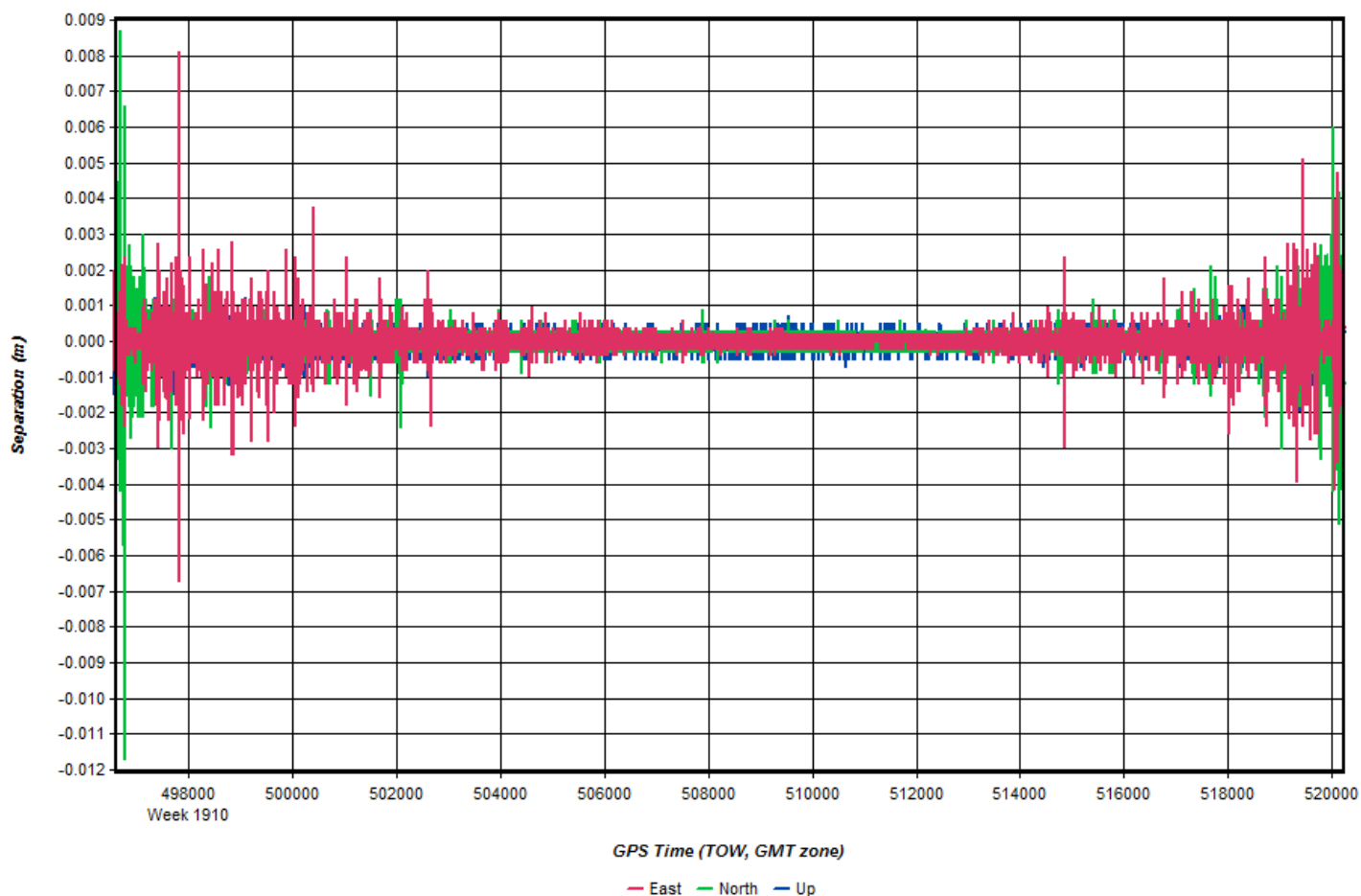


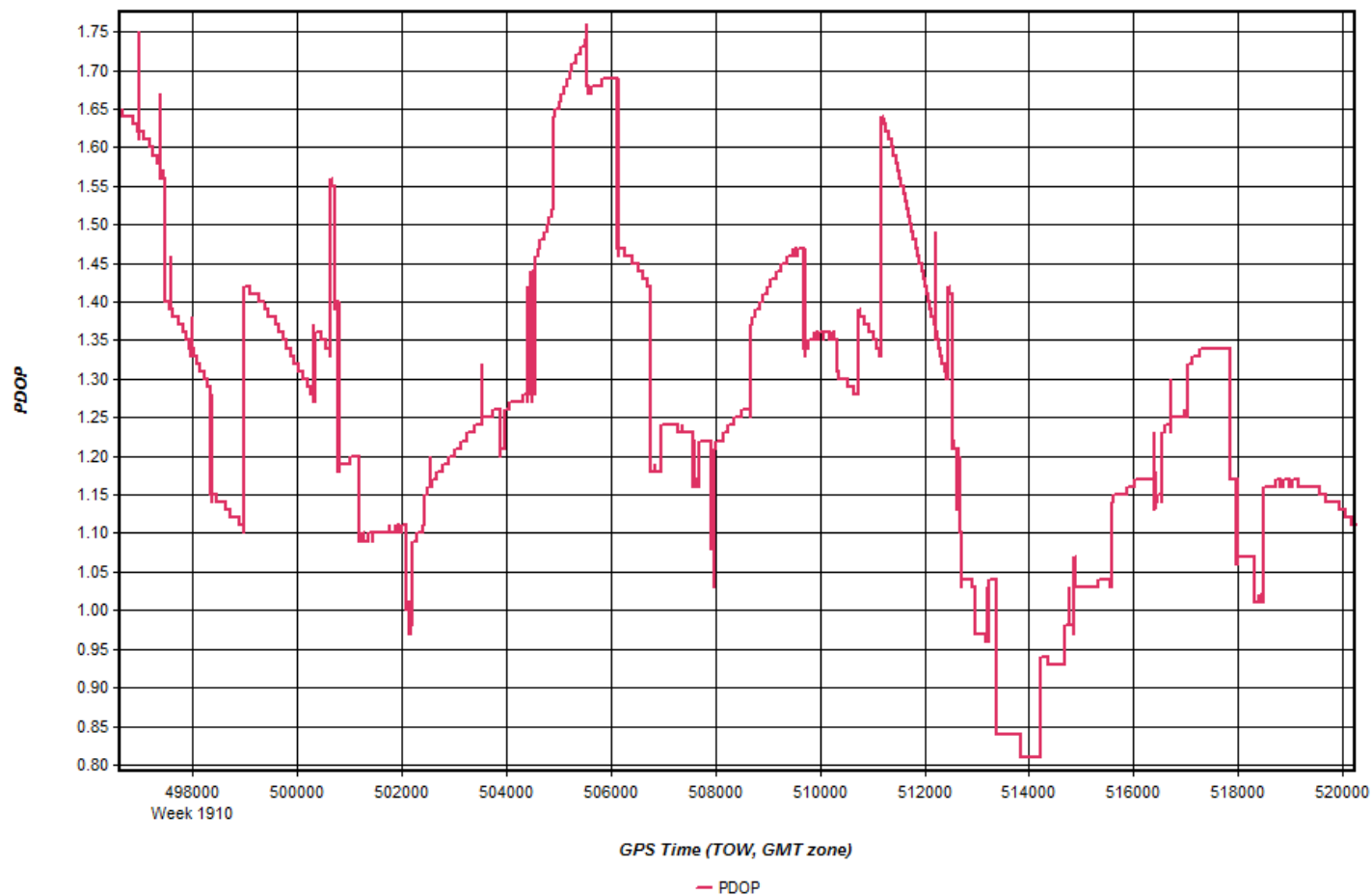
225_20160819_1



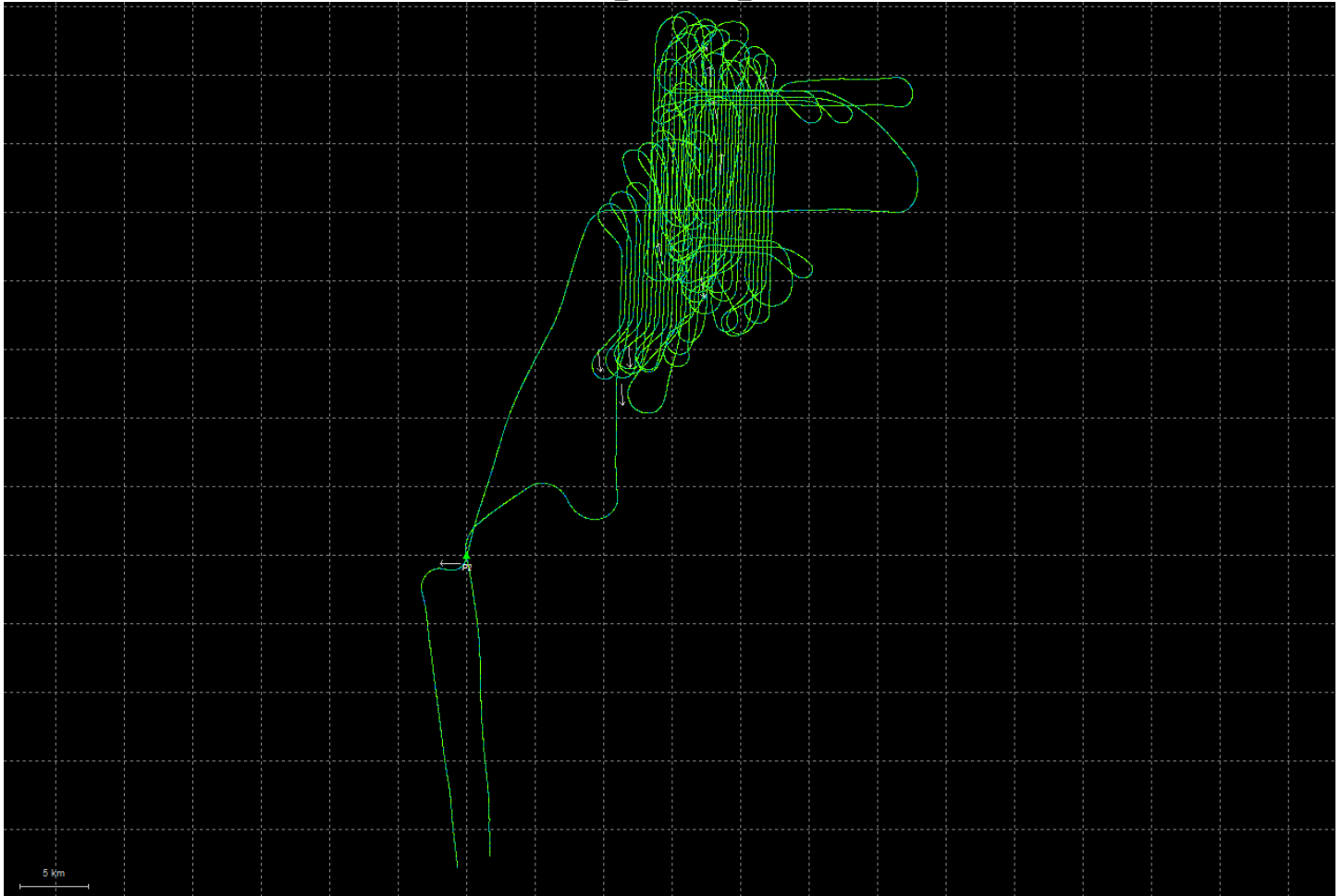


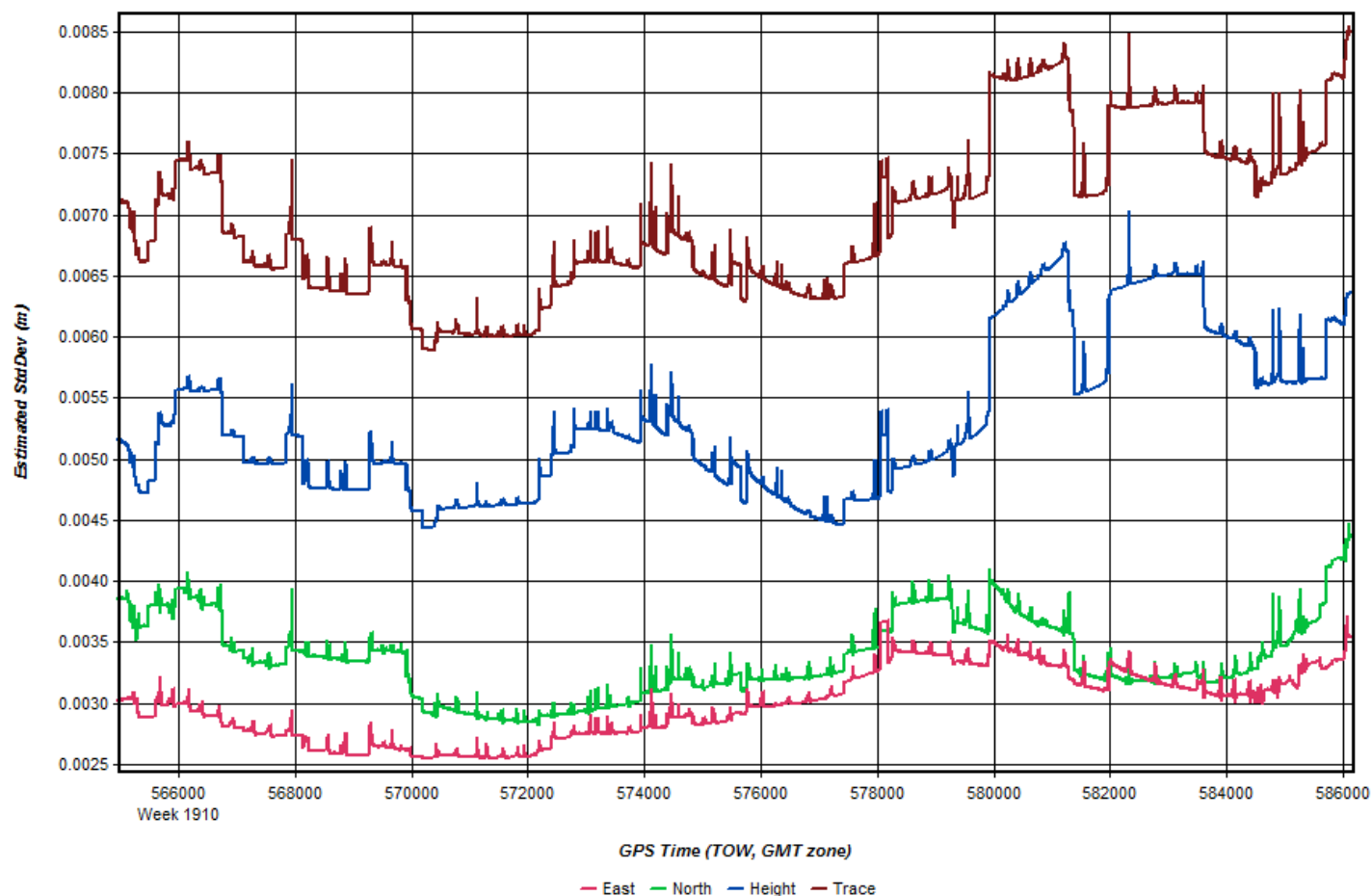


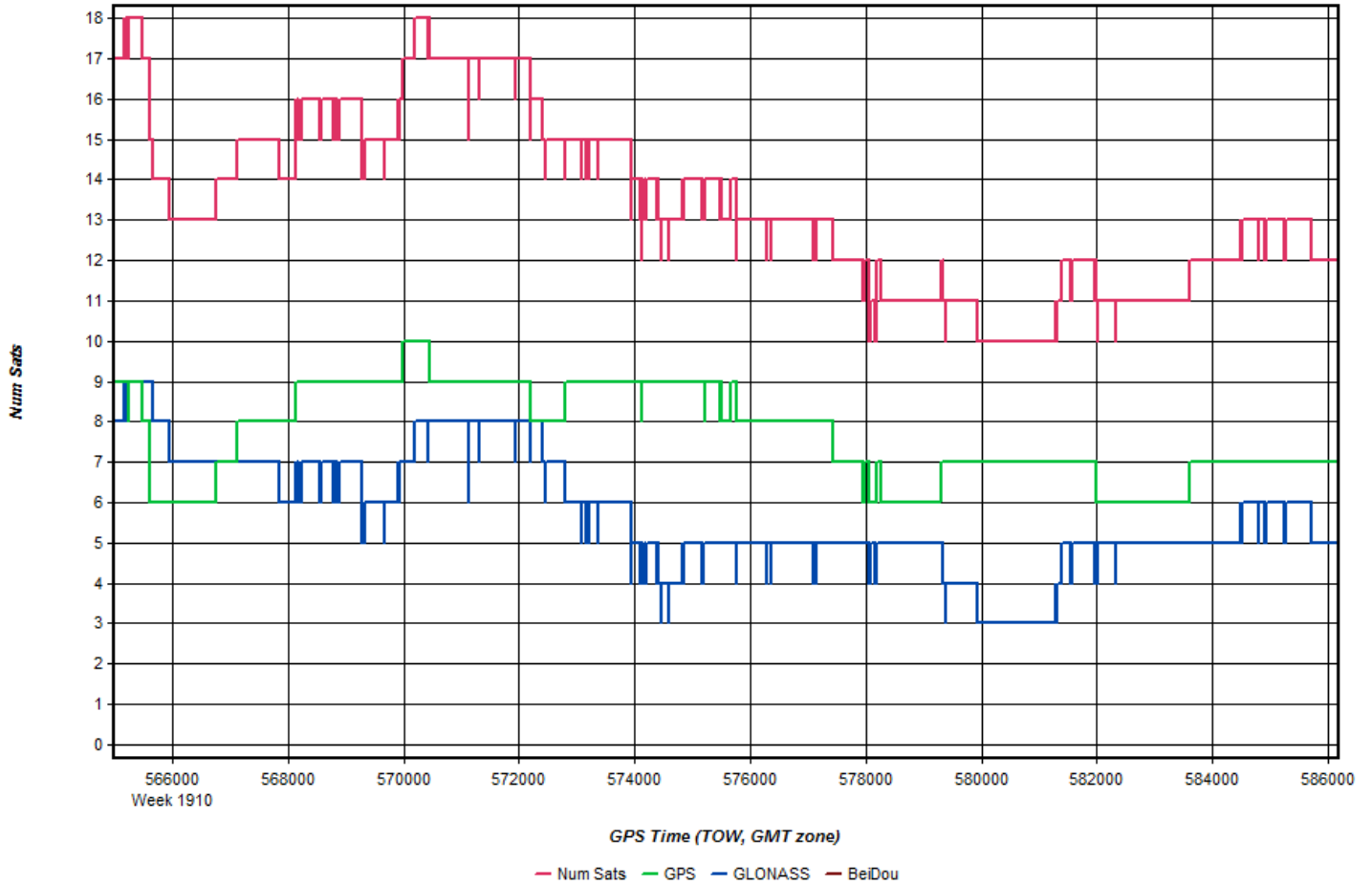


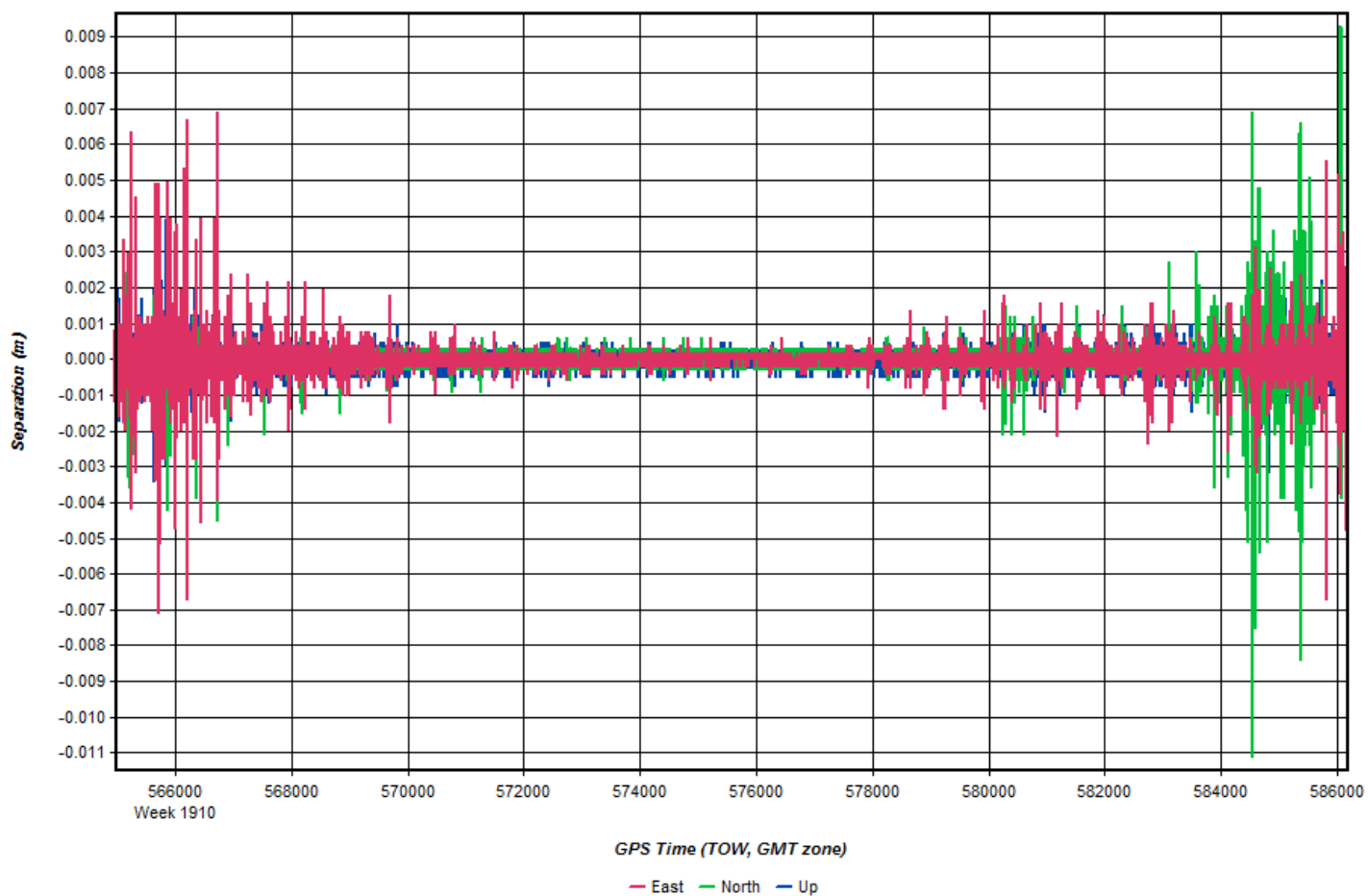


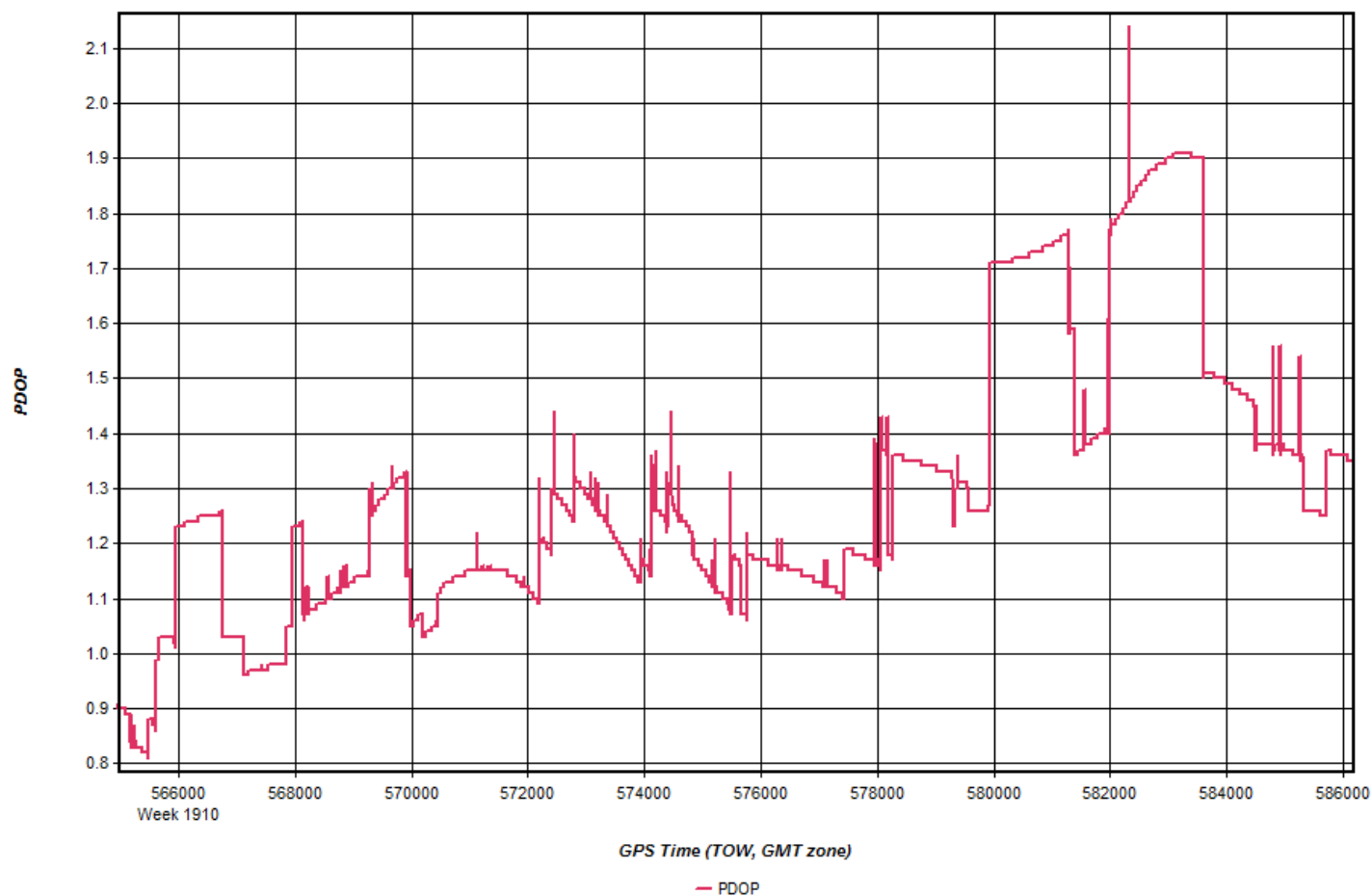
225_20160820_1





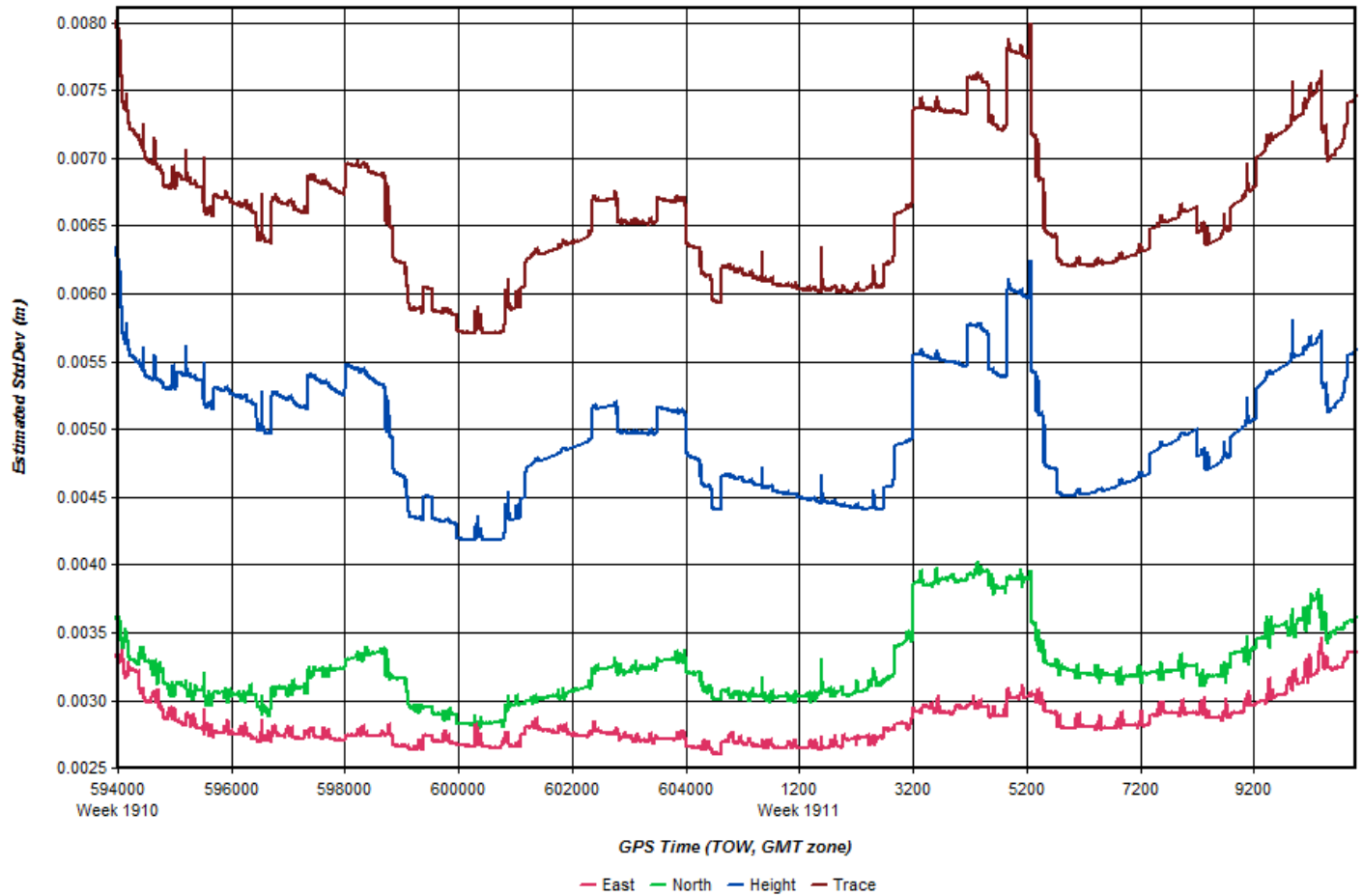


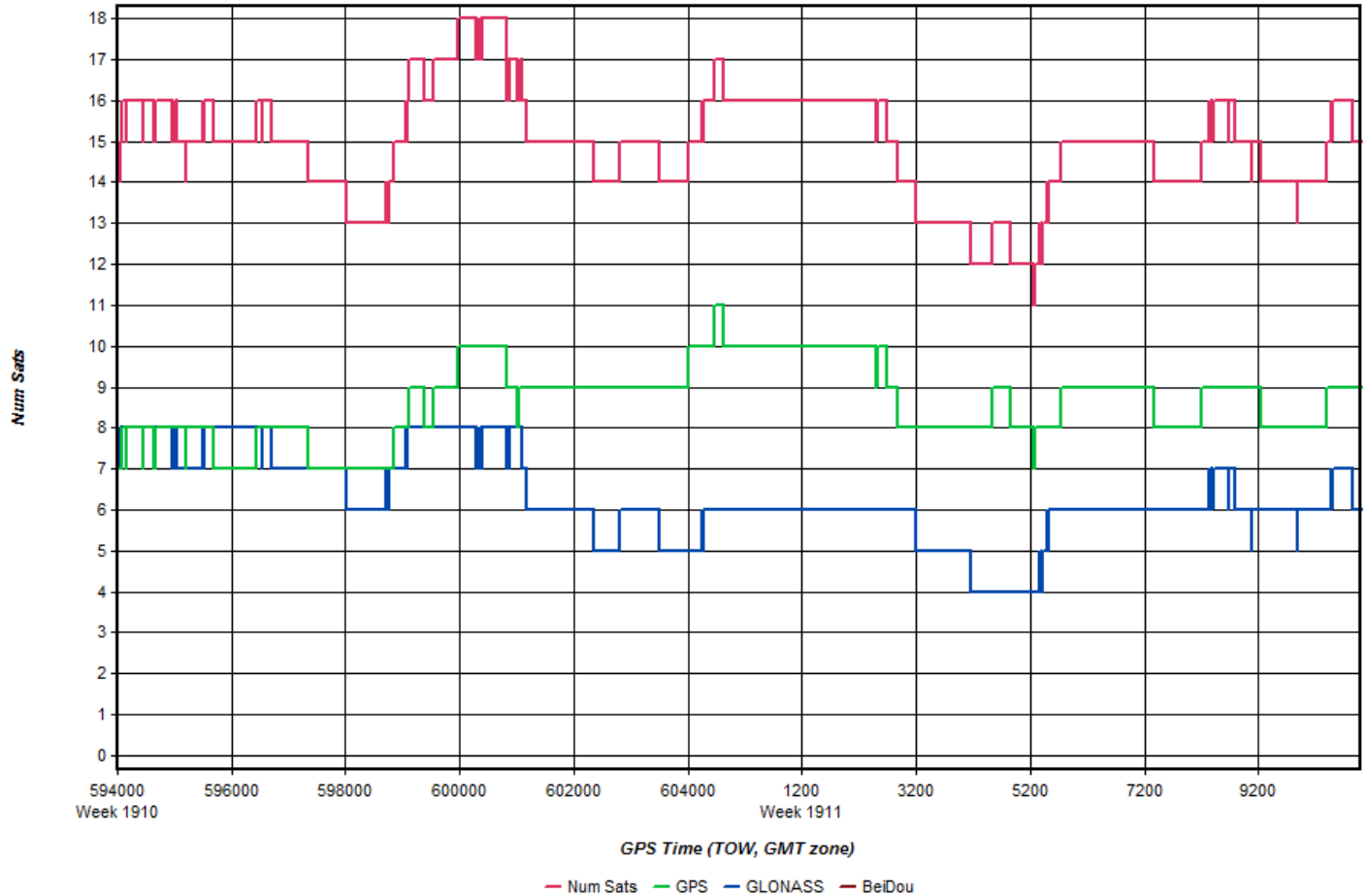


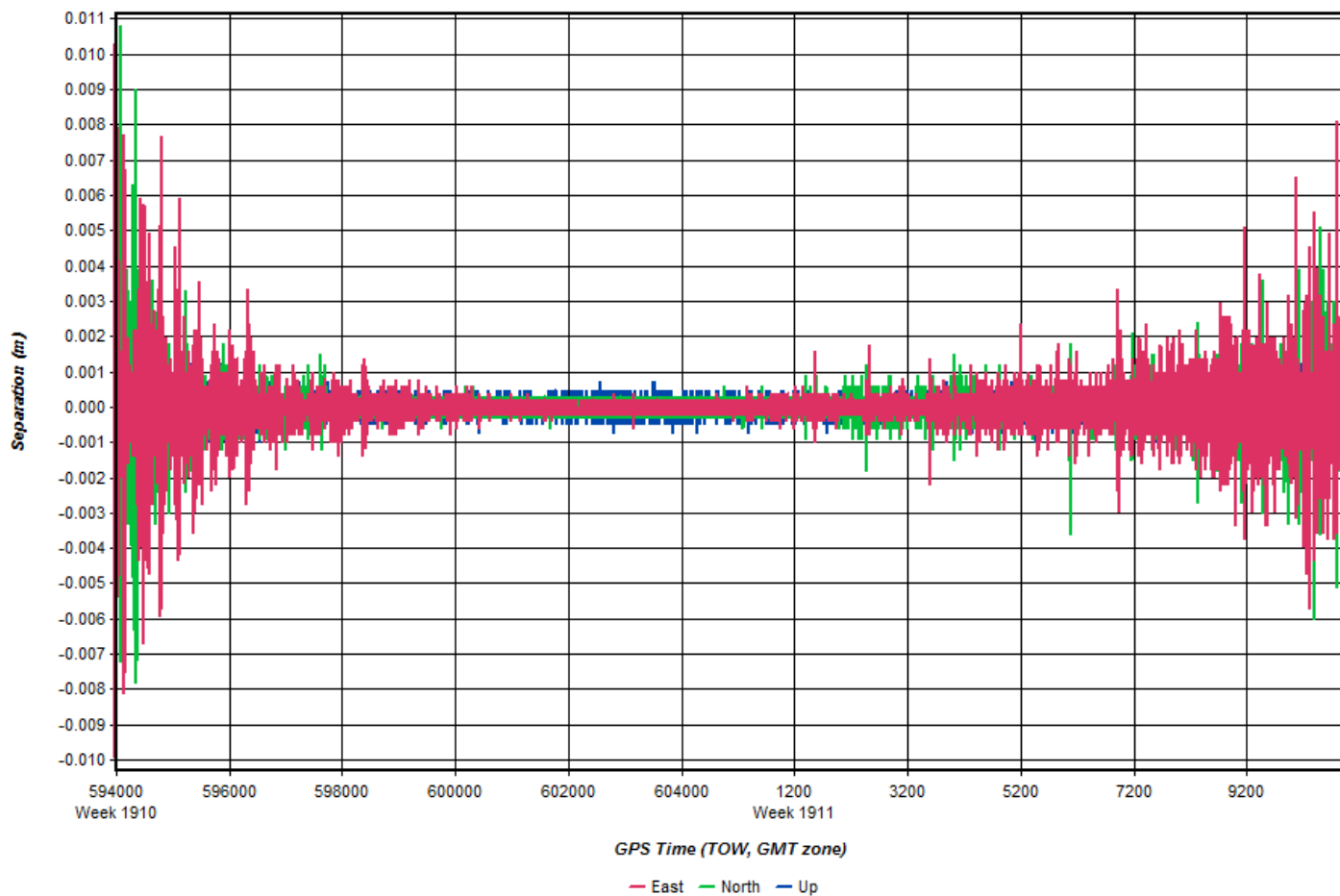


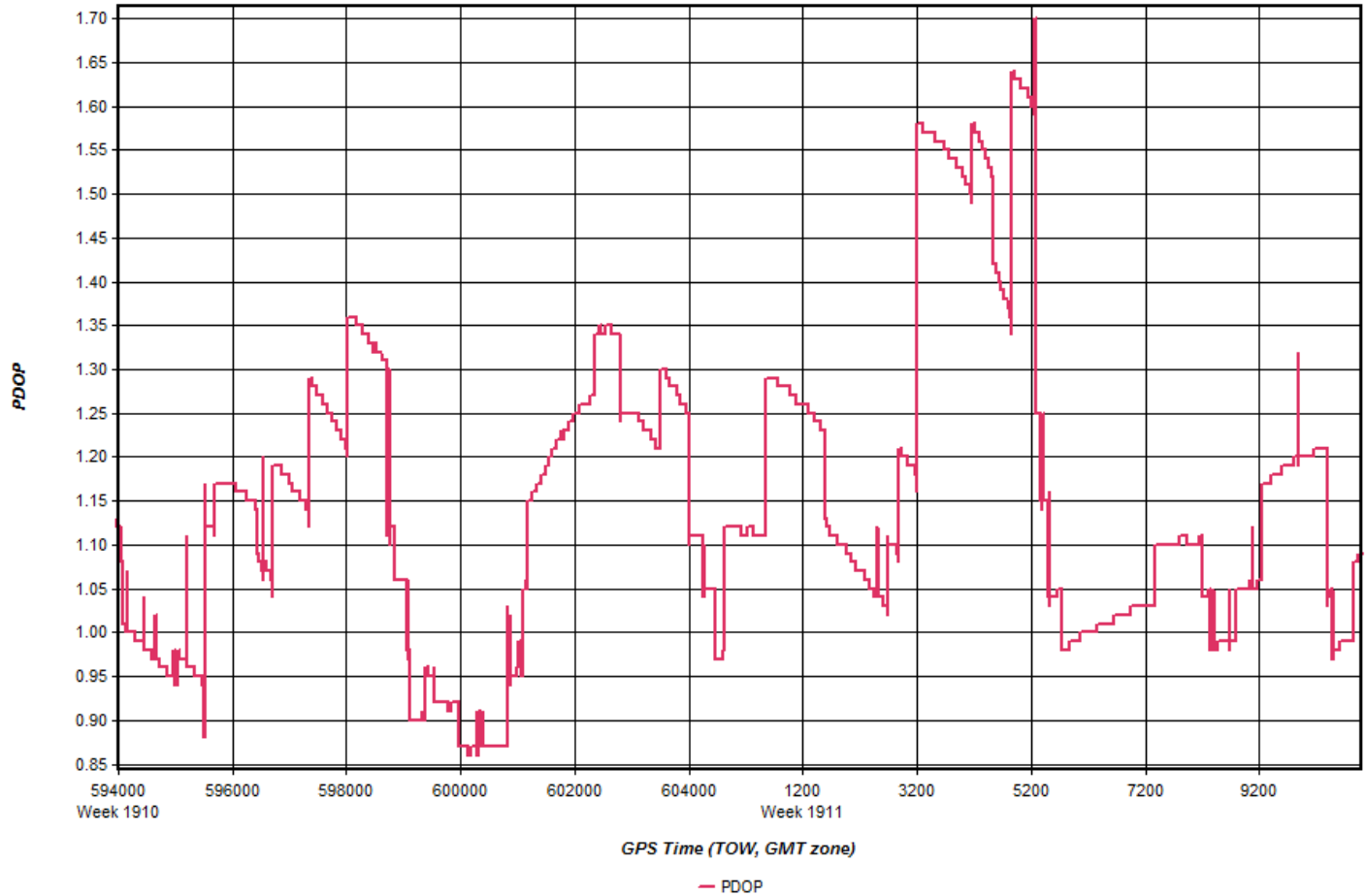
225_20160820_2





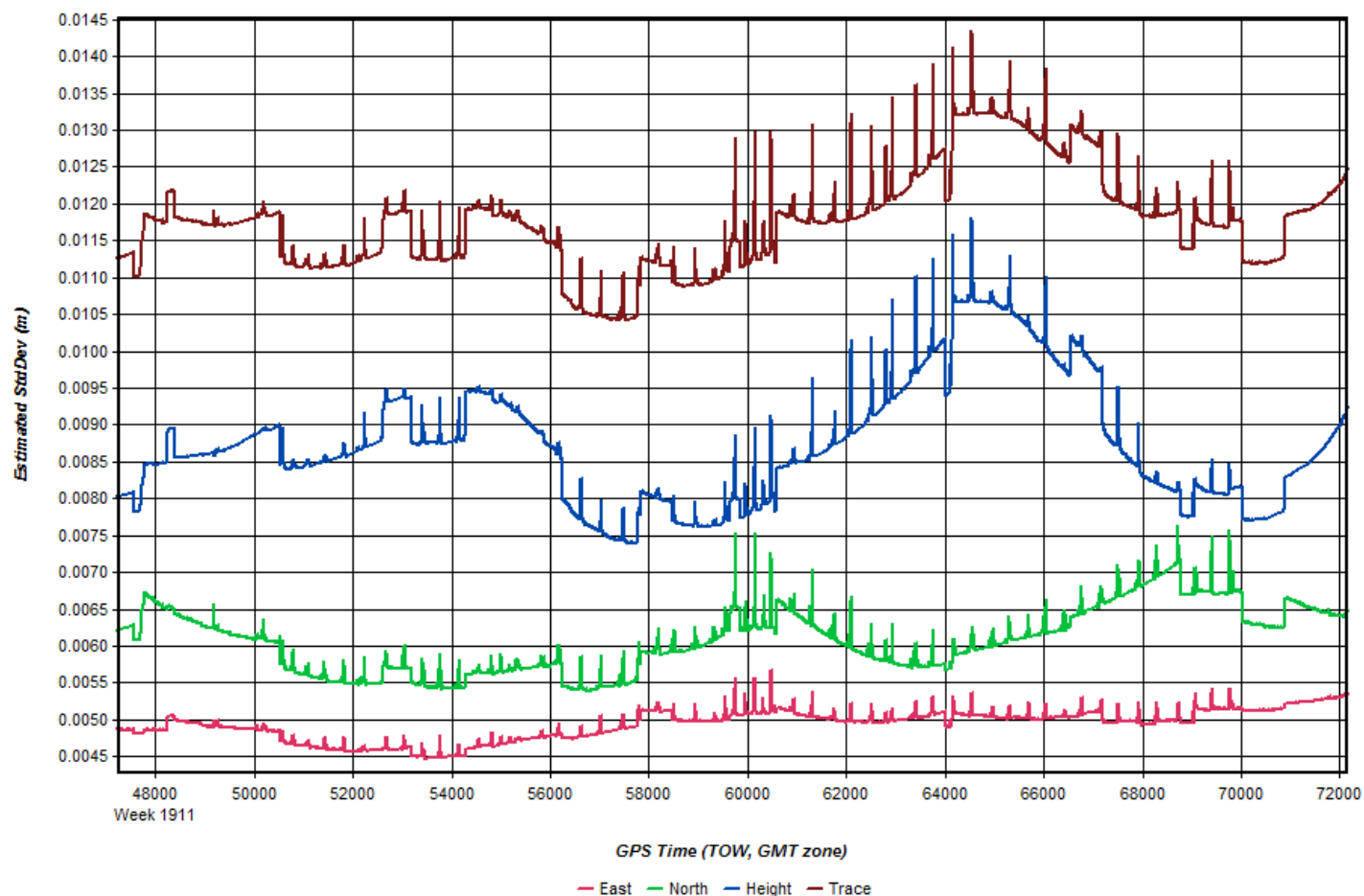


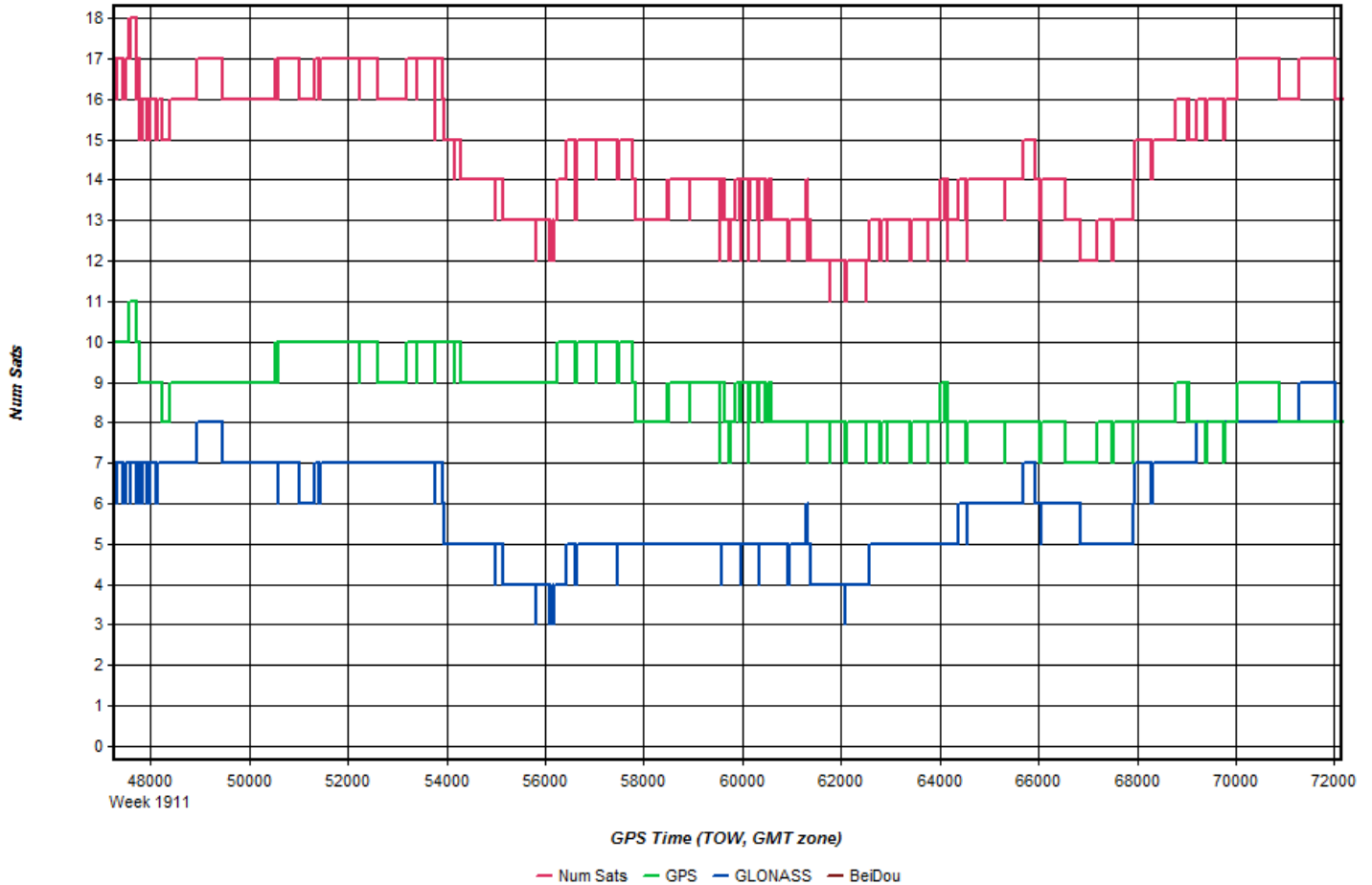


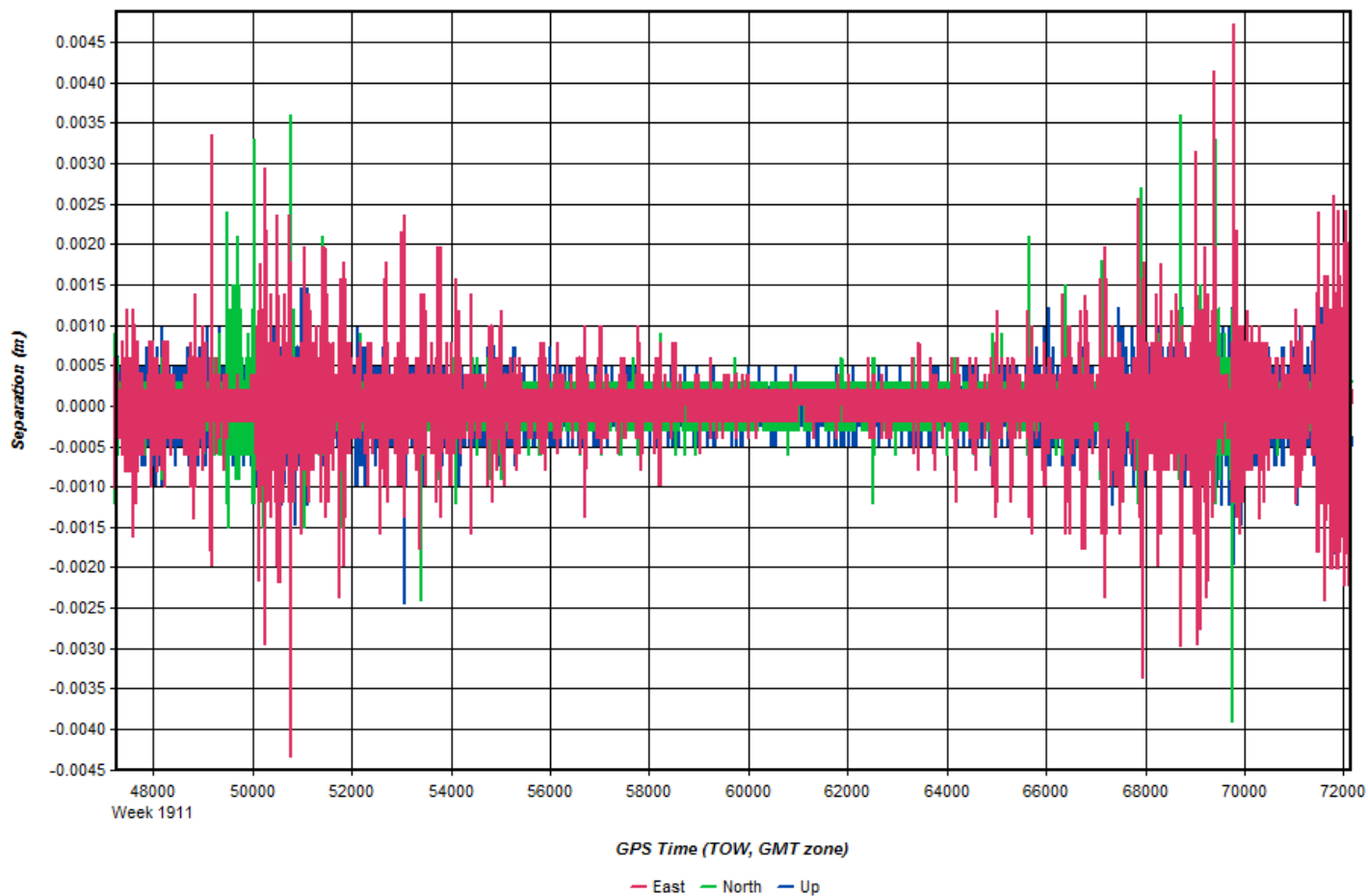


225_20160821_1





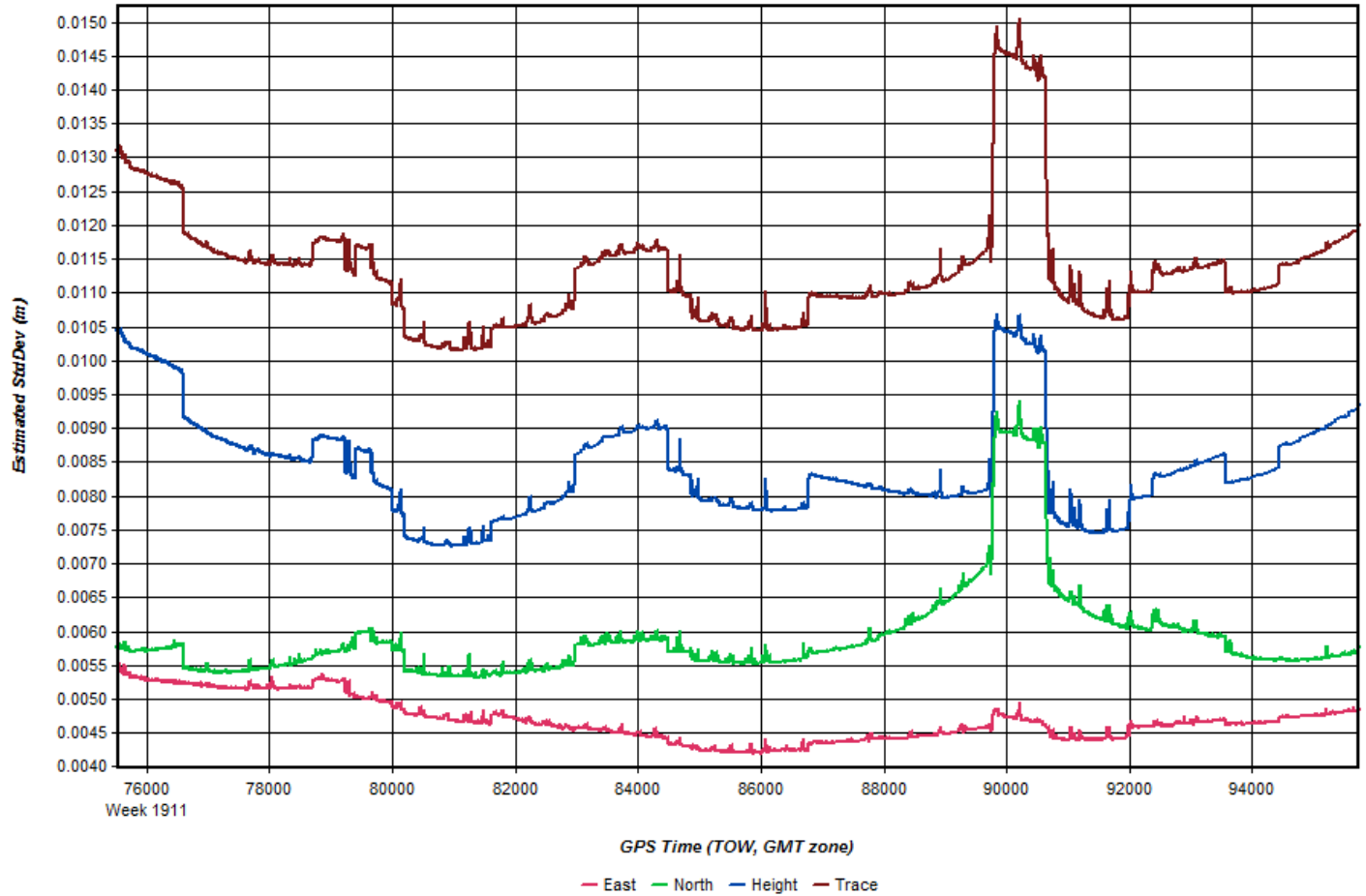


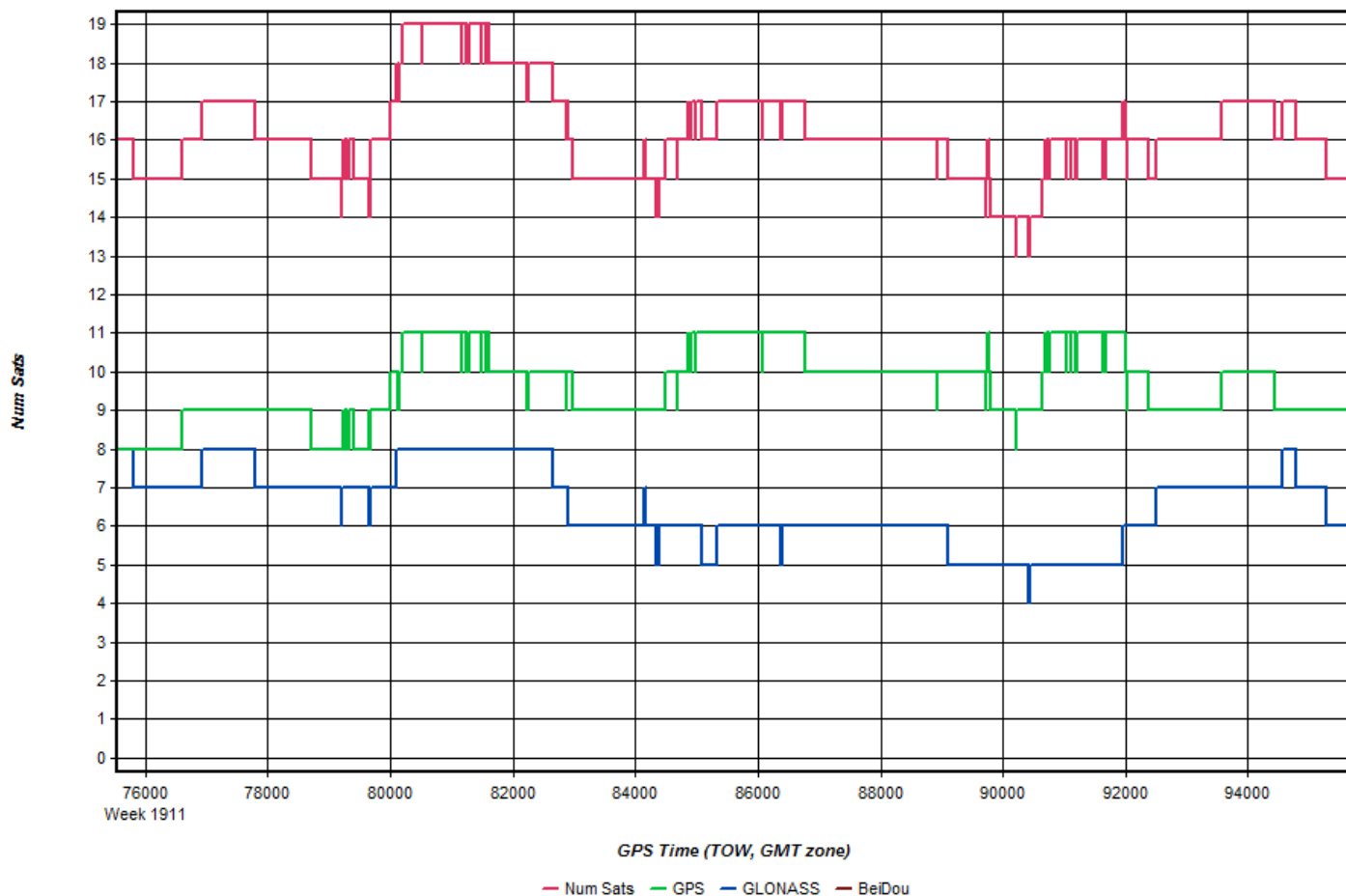


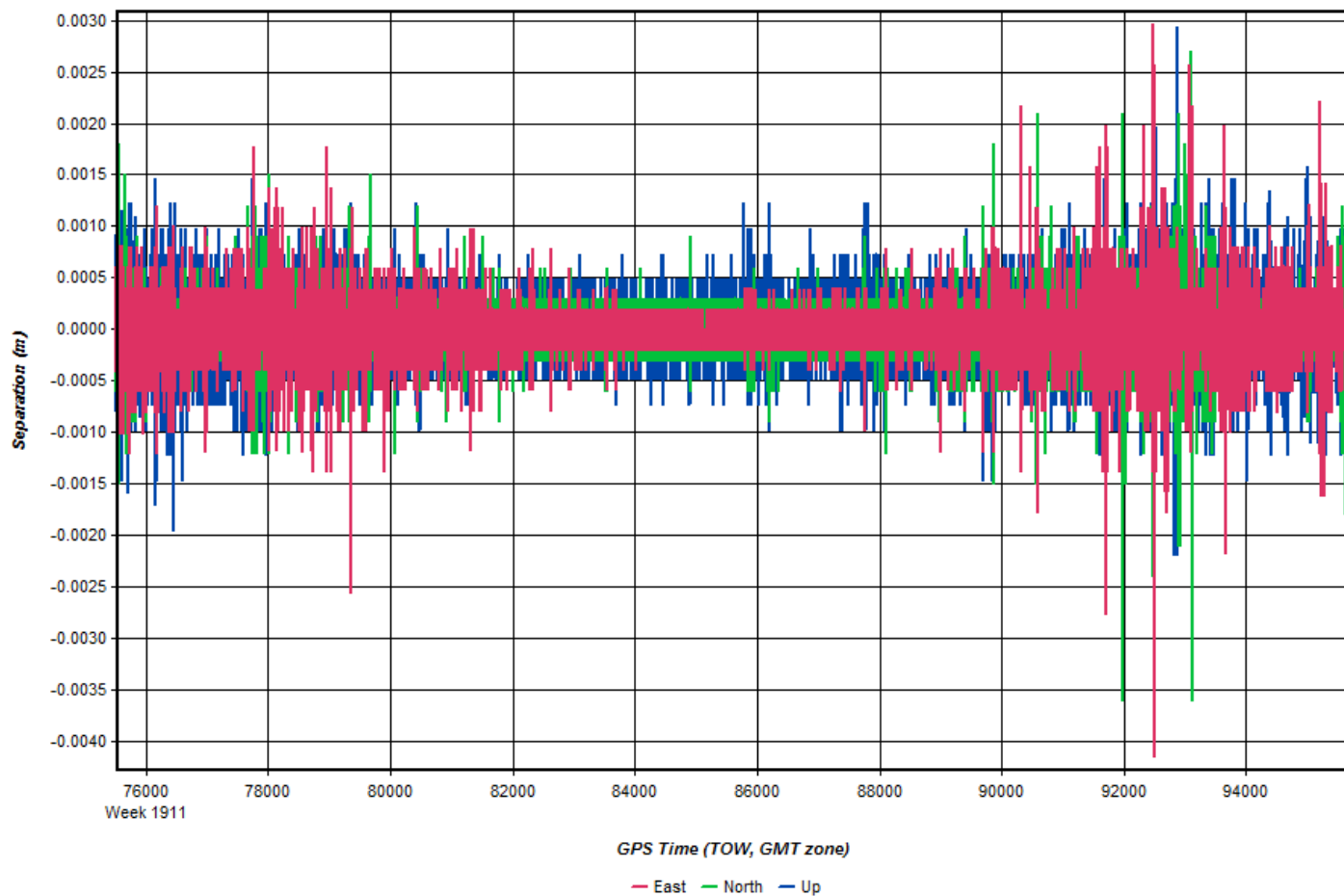


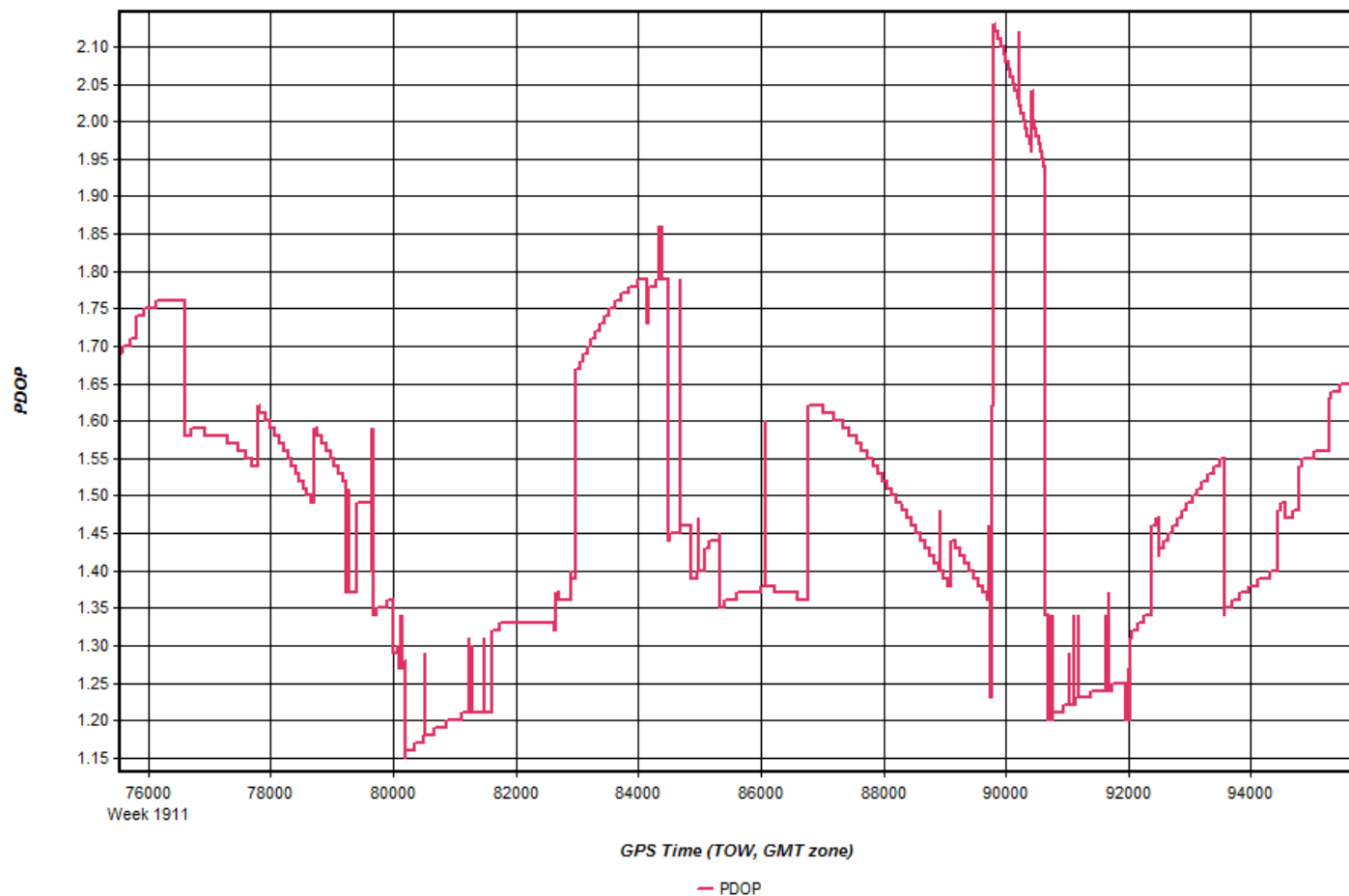
225_20160821_2



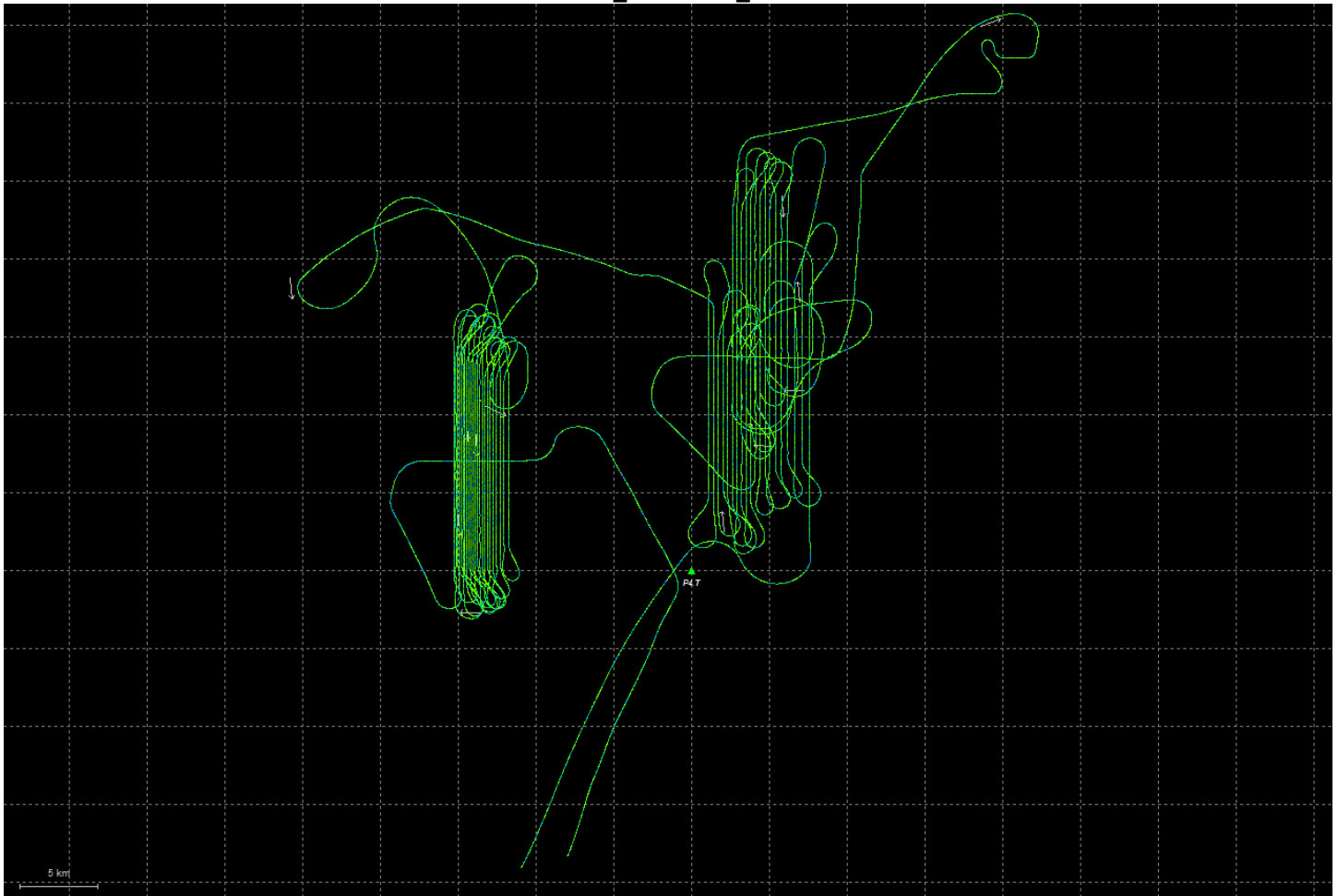


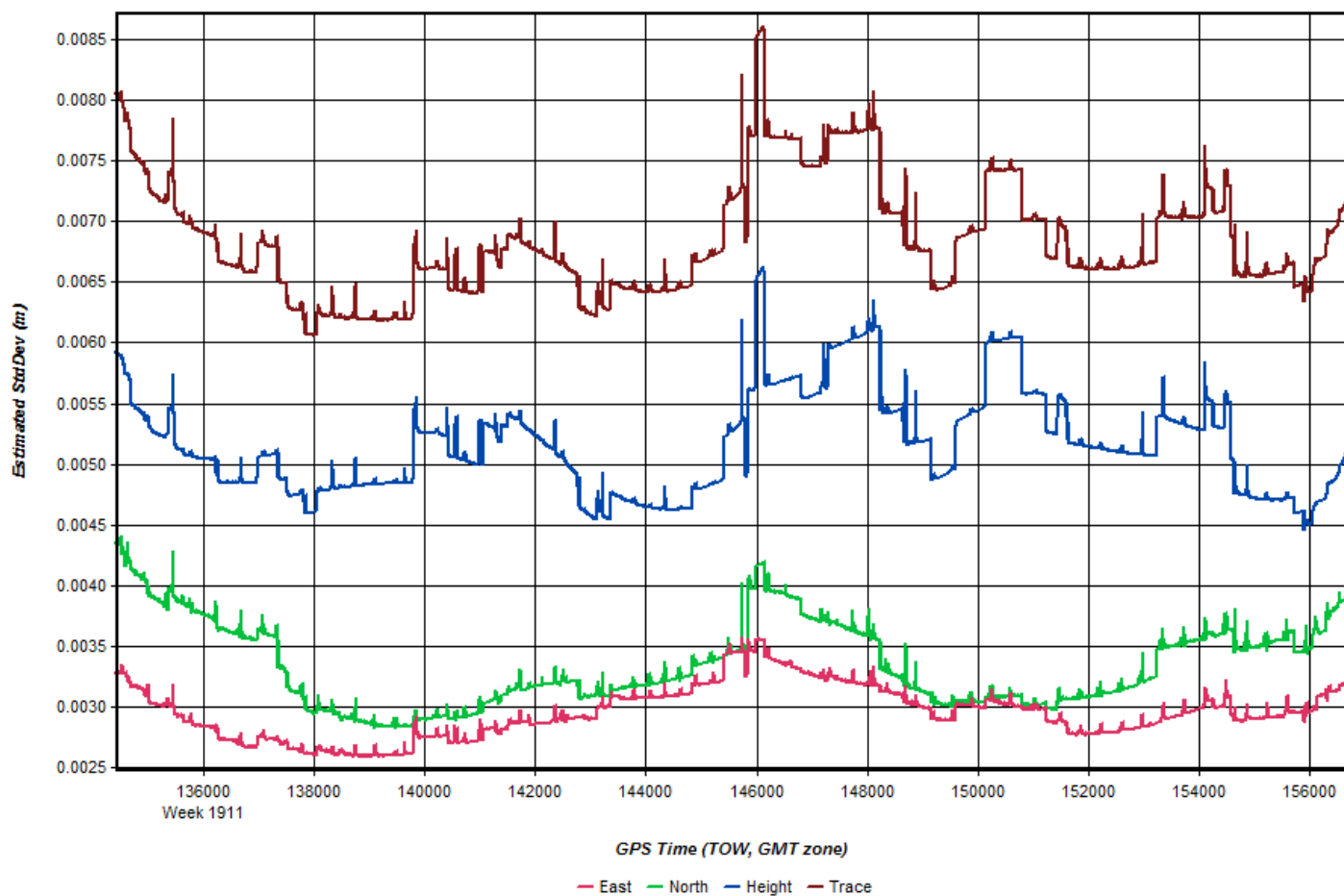


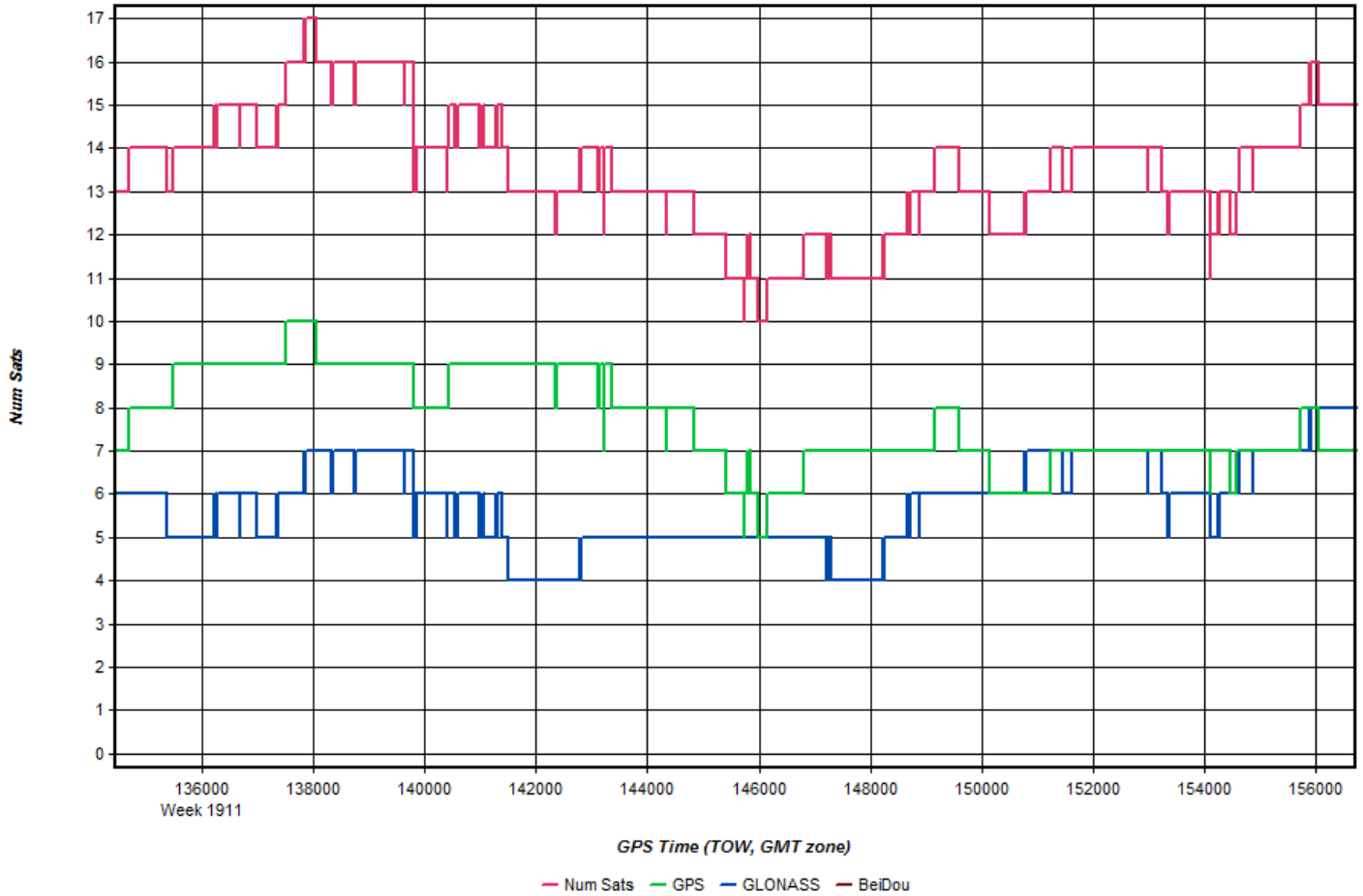


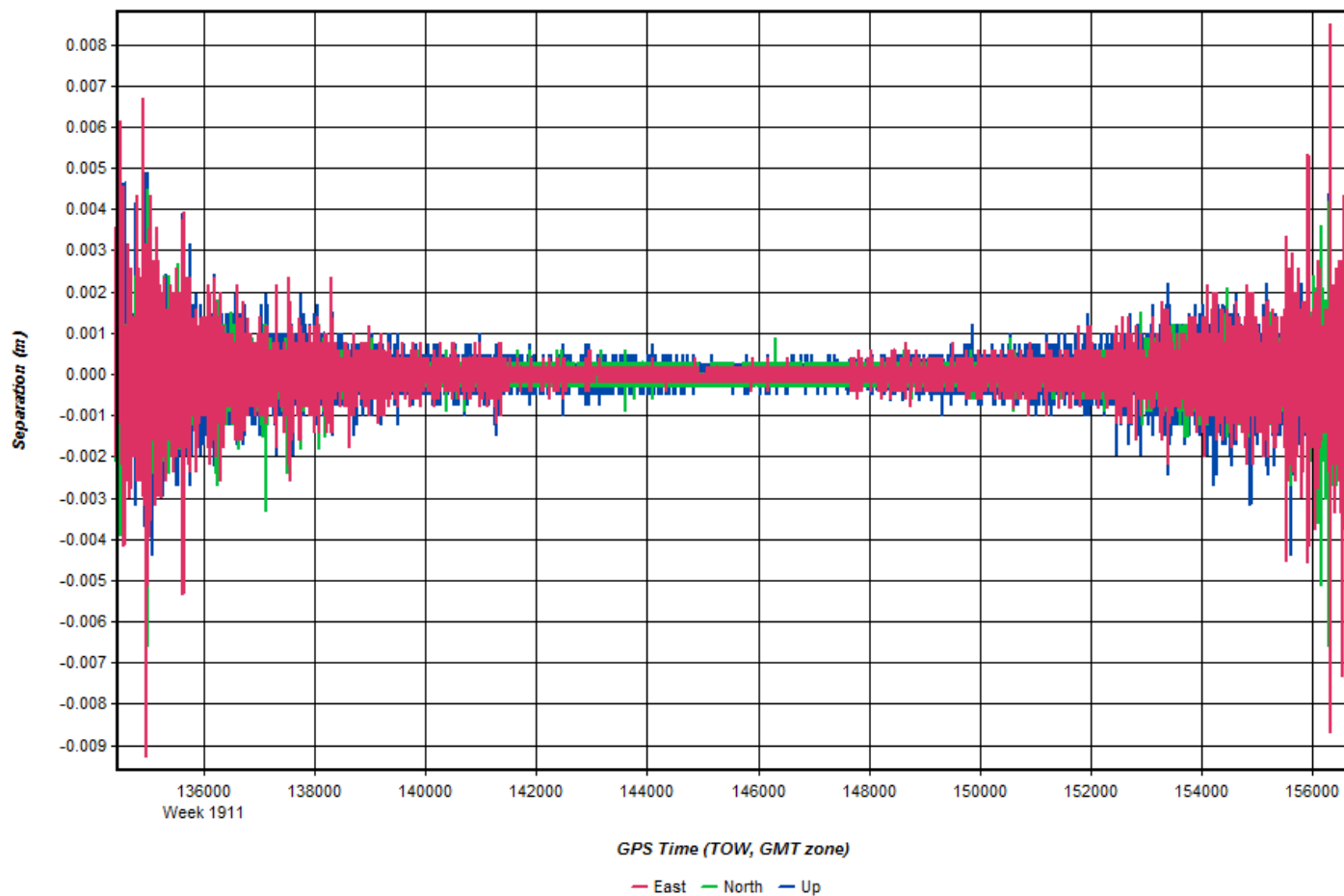


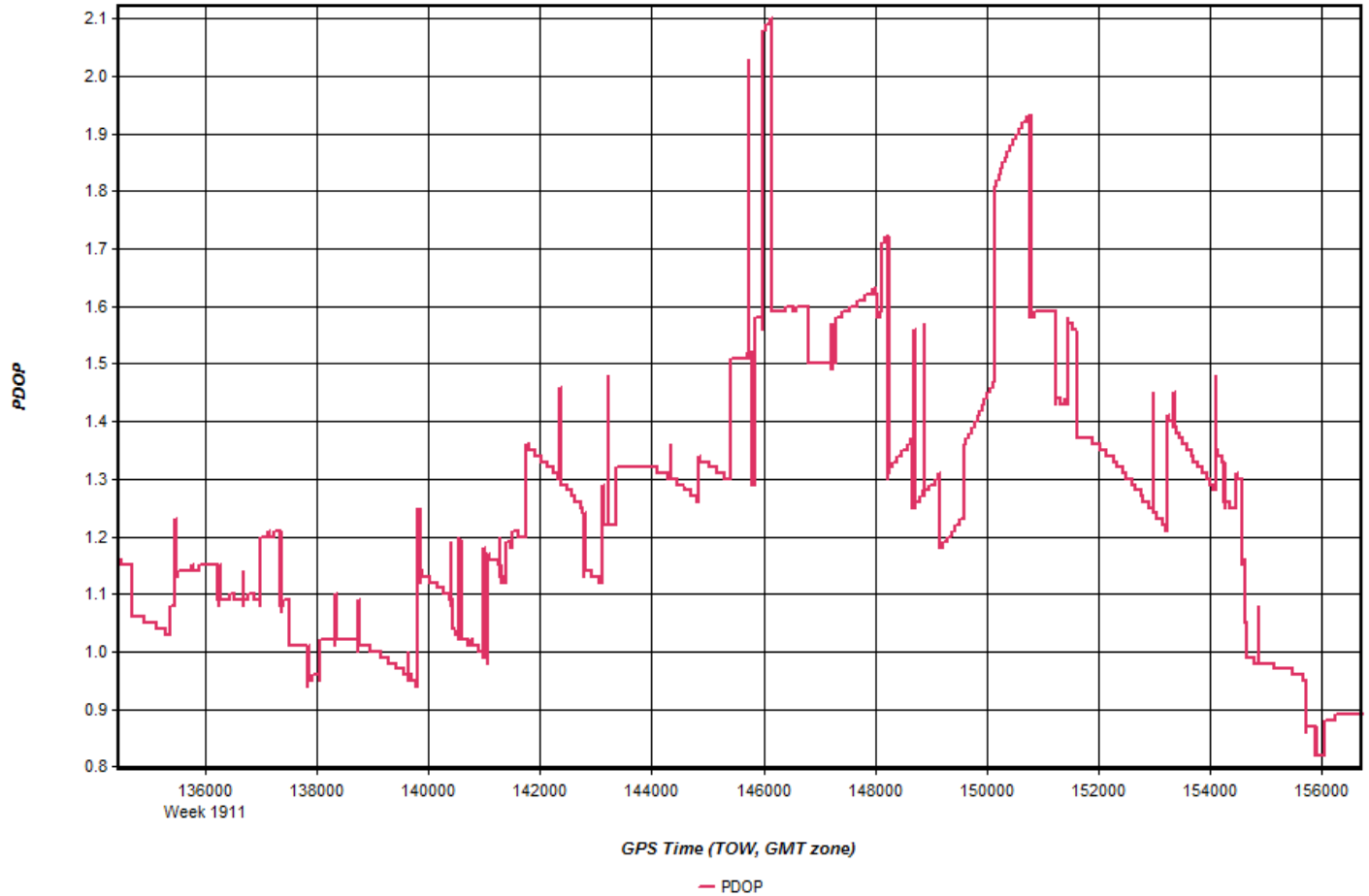
225_20160822_1



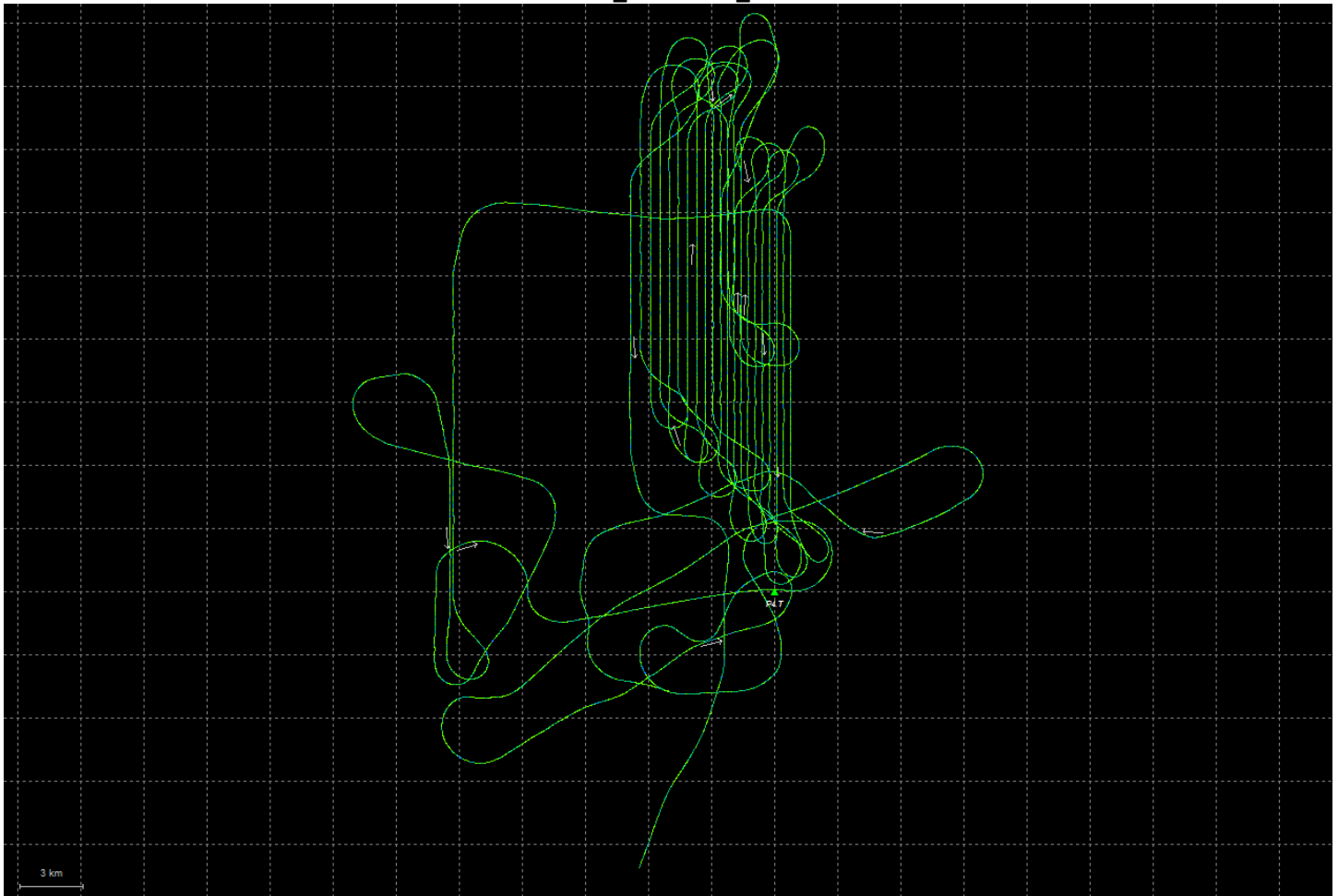


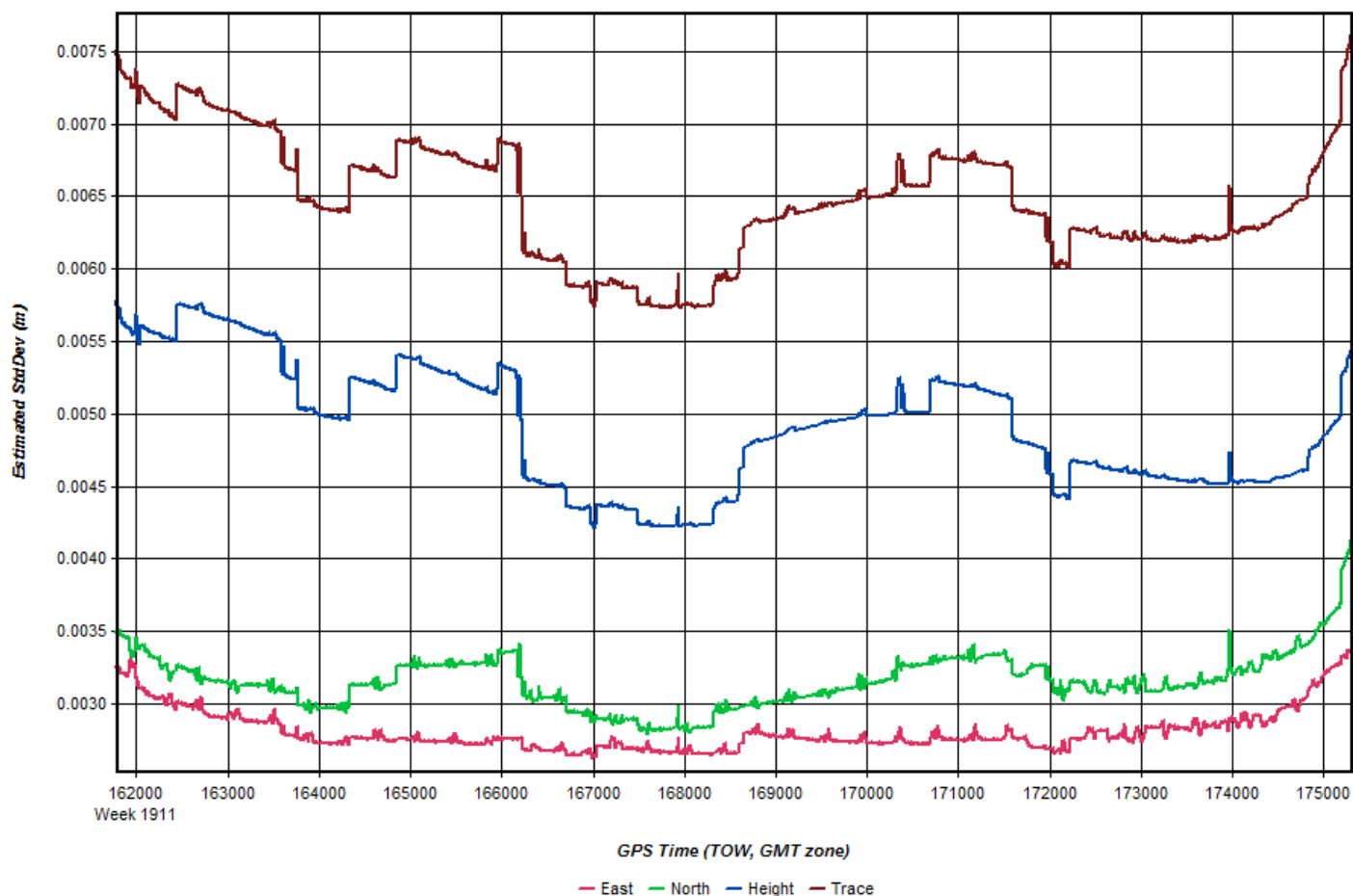


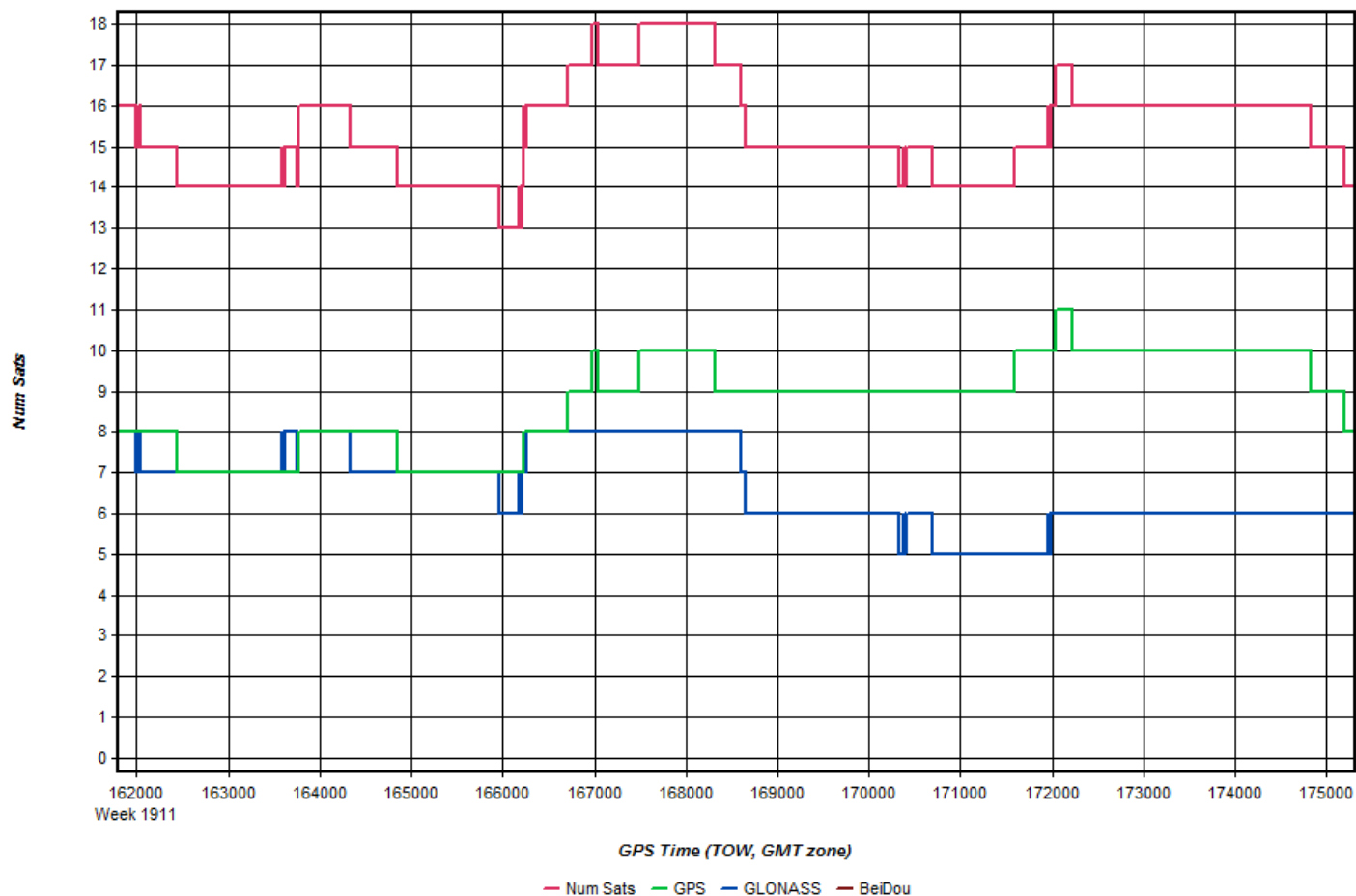


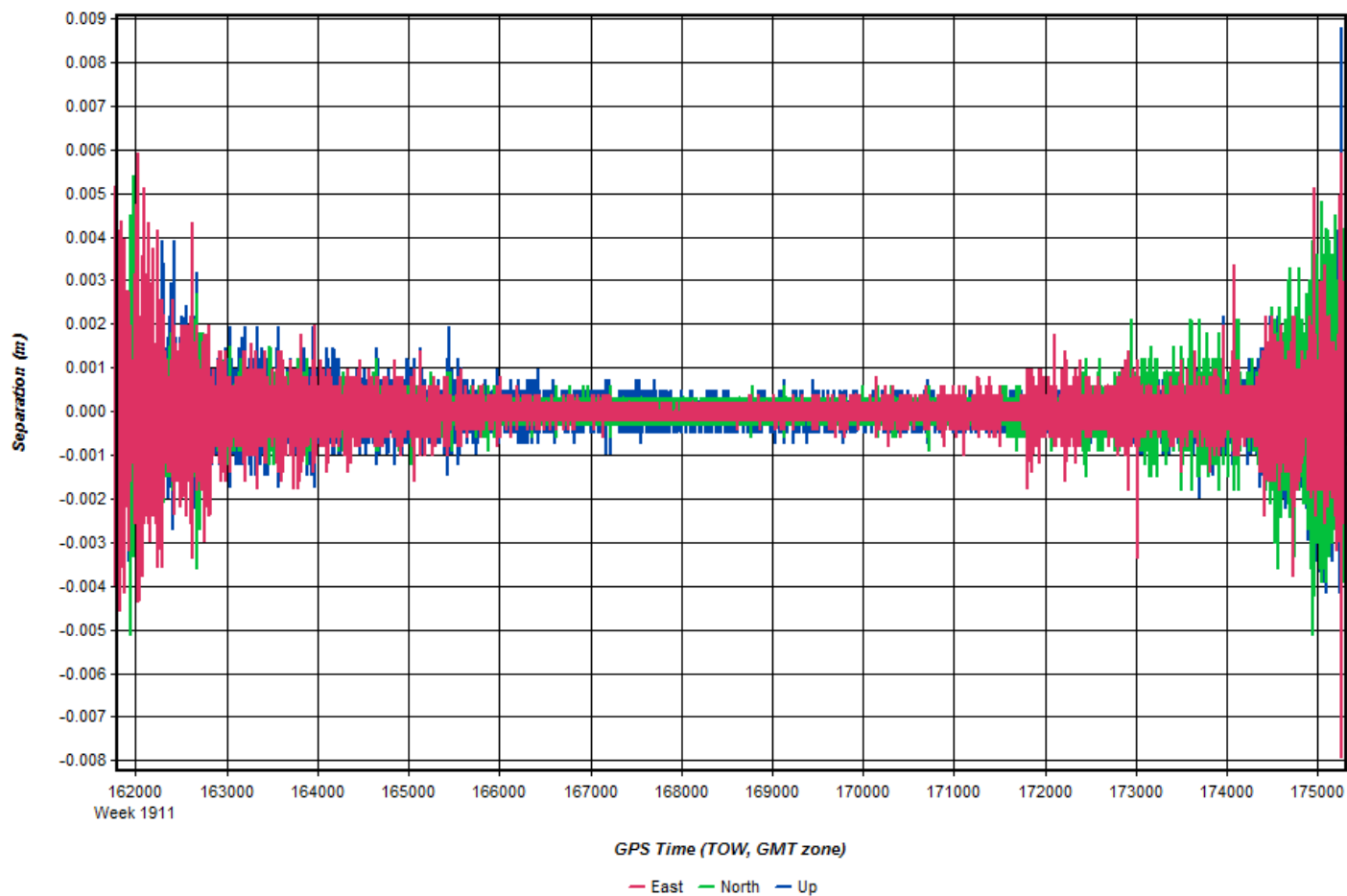


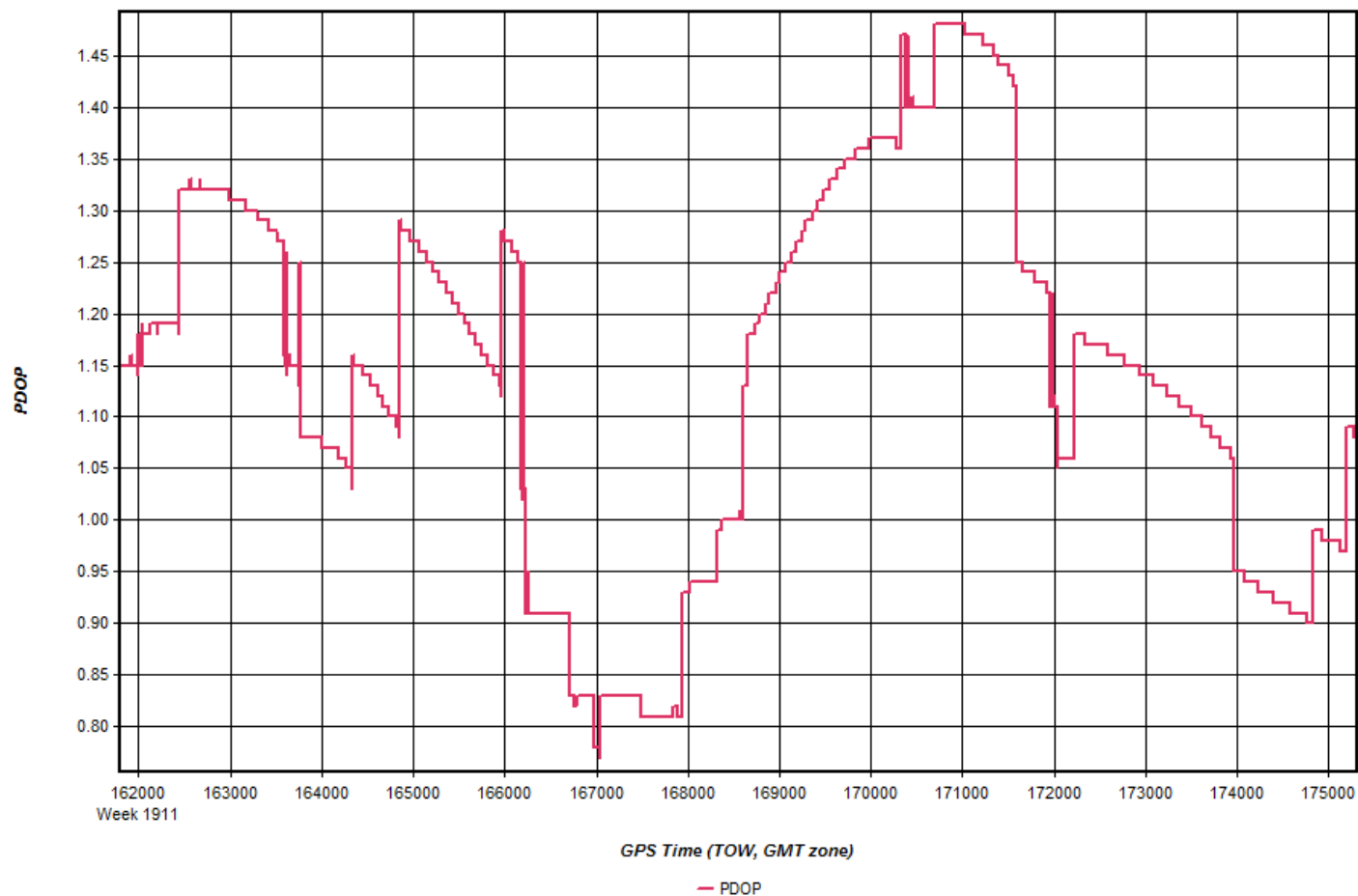
225_20160822_2



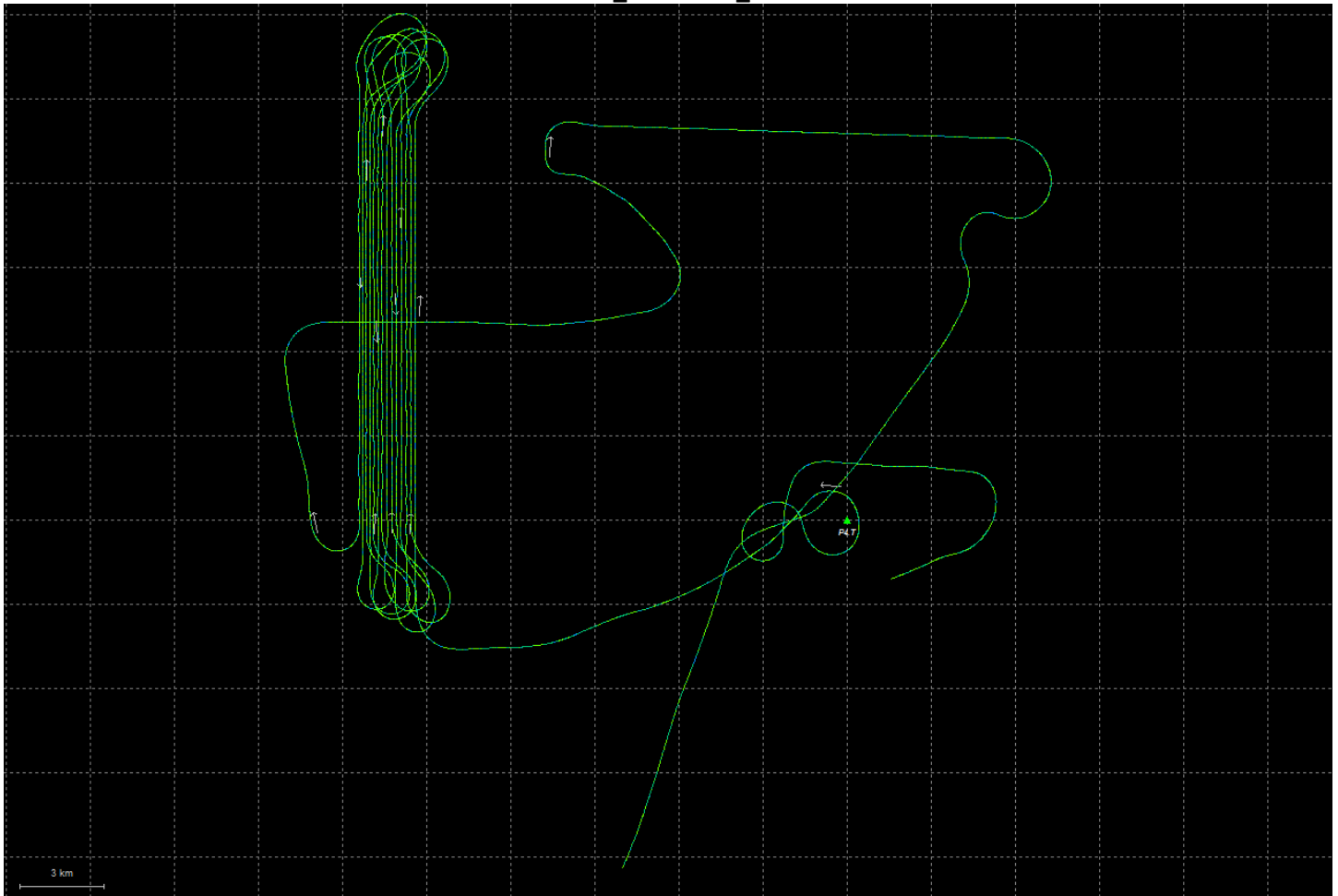


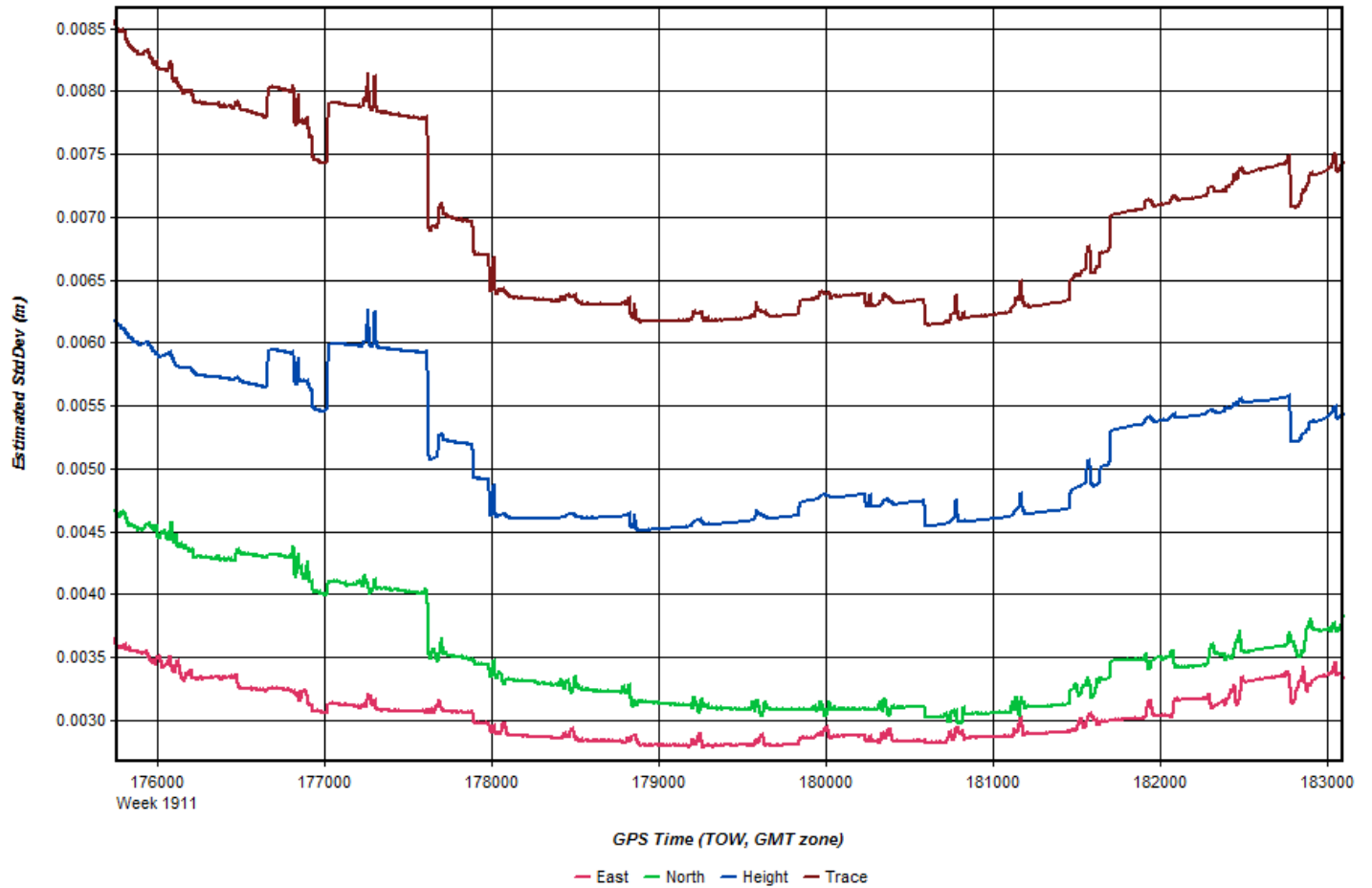


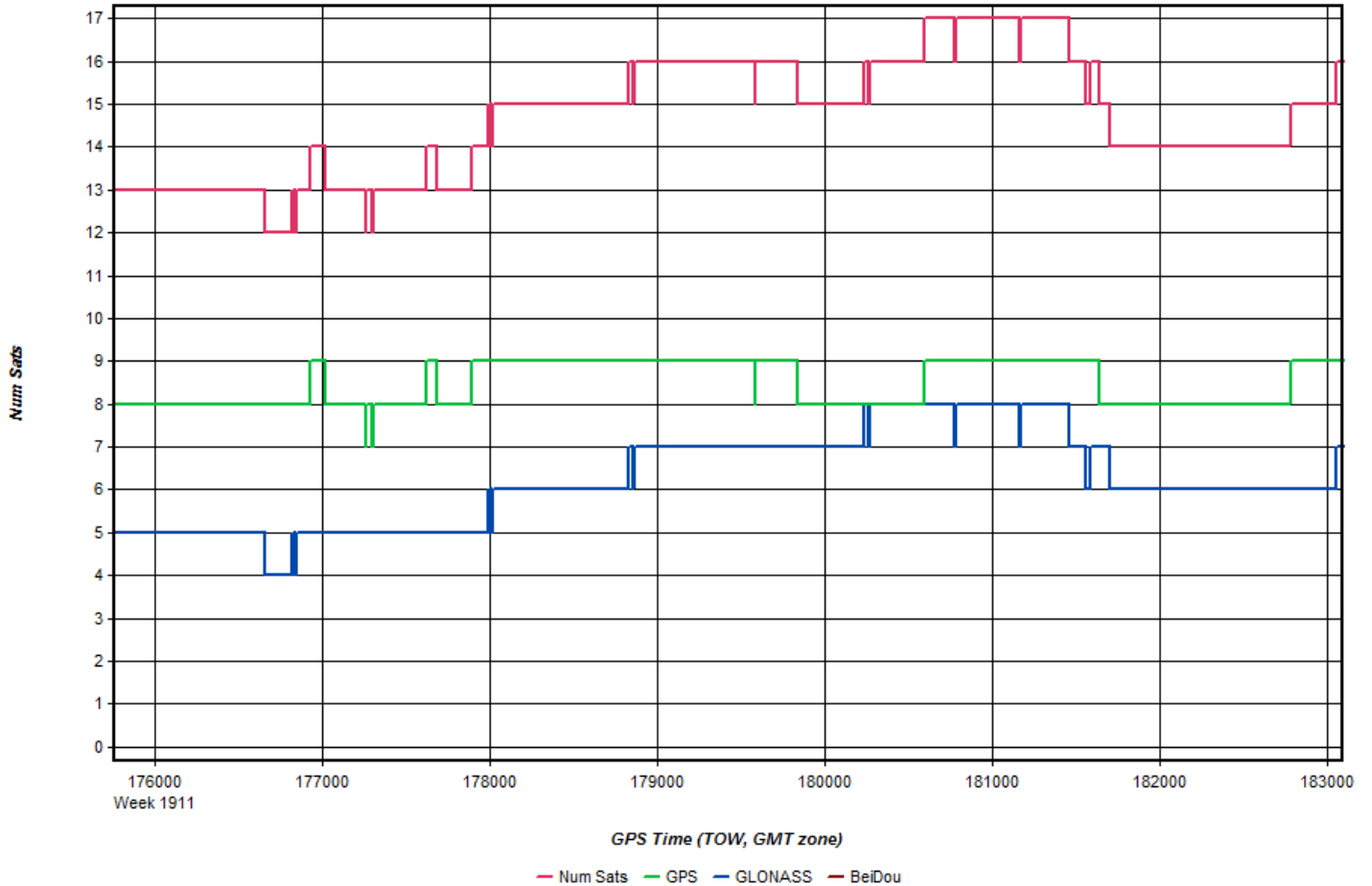


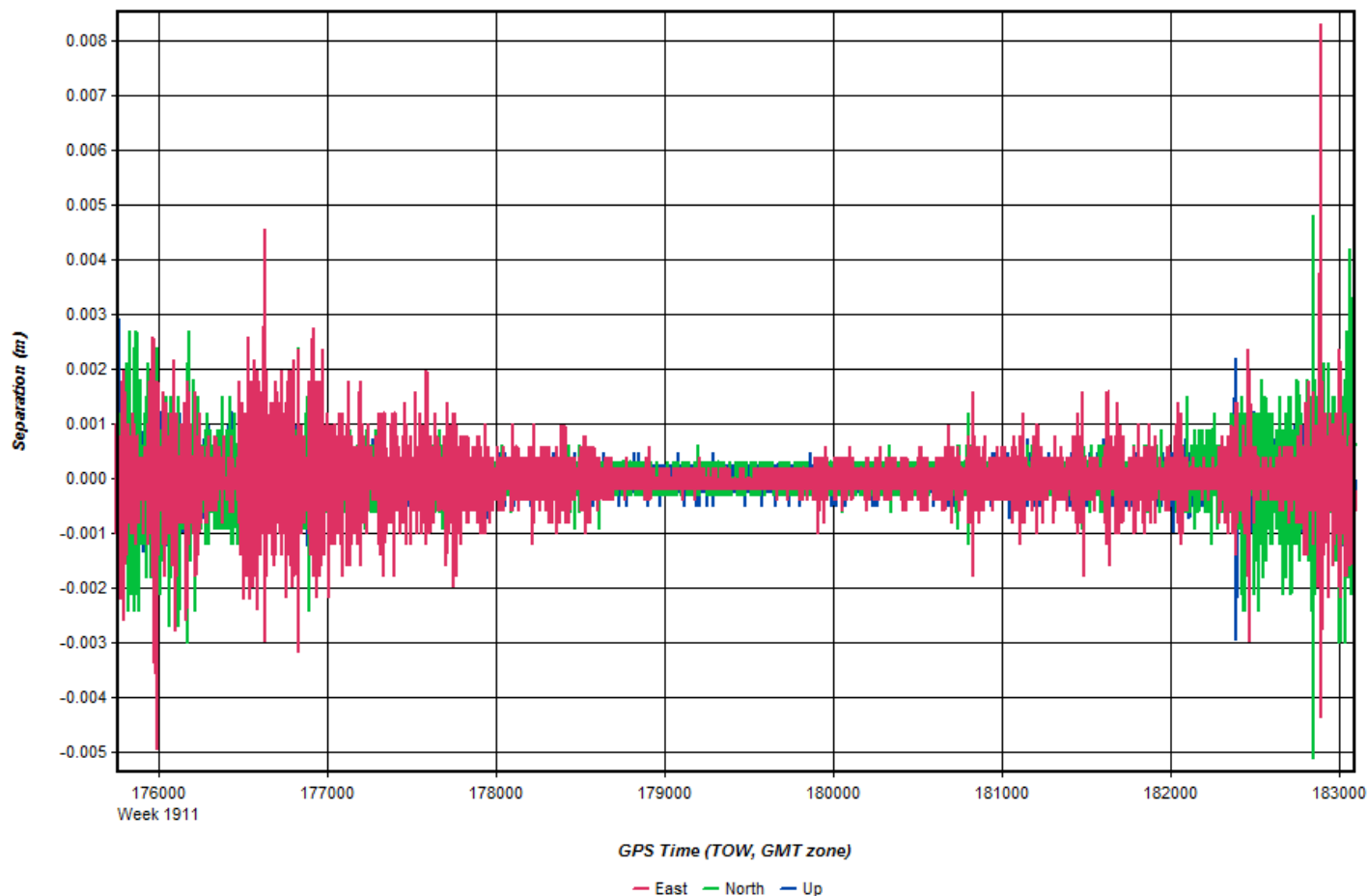


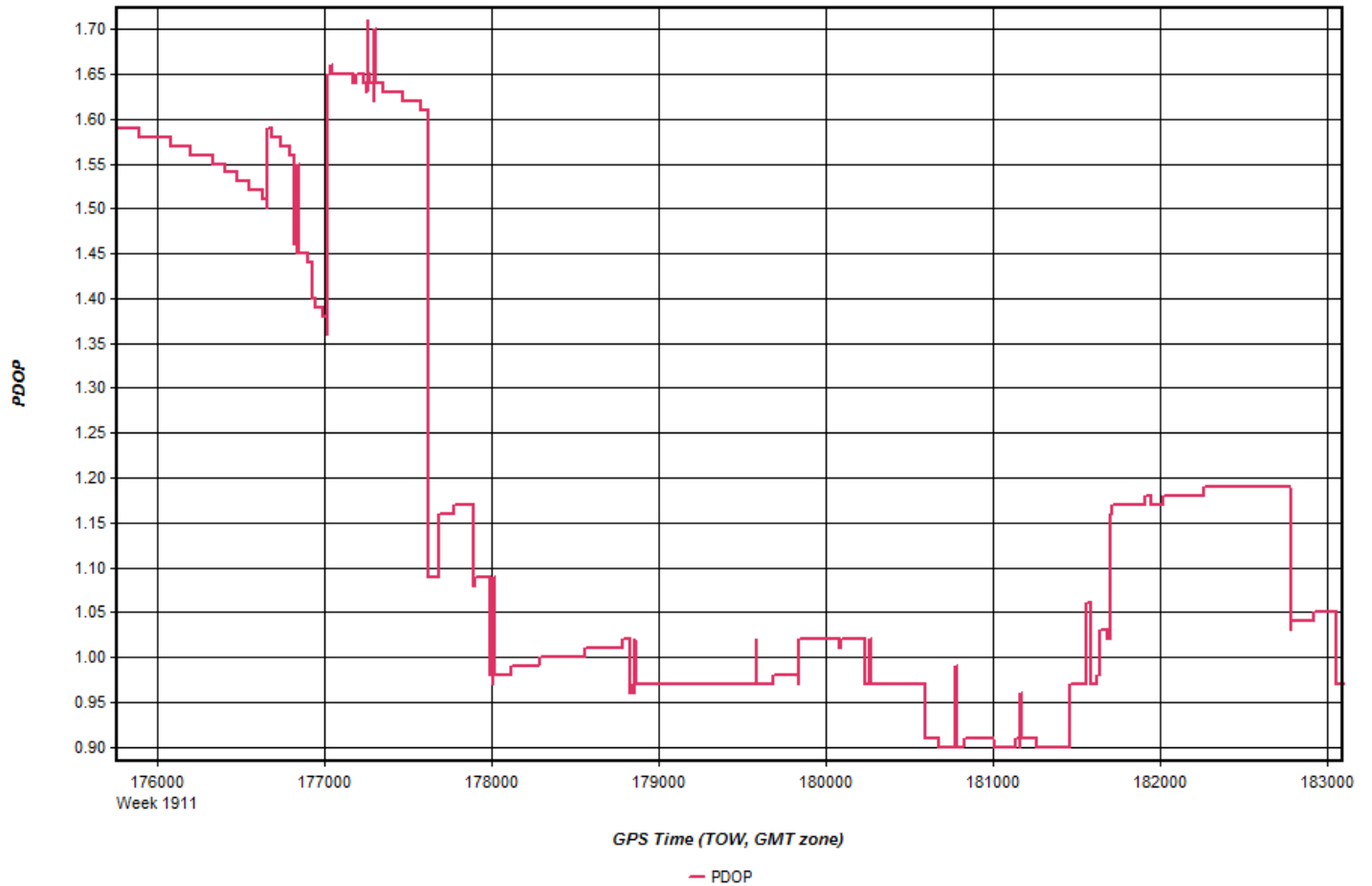
225_20160822_3



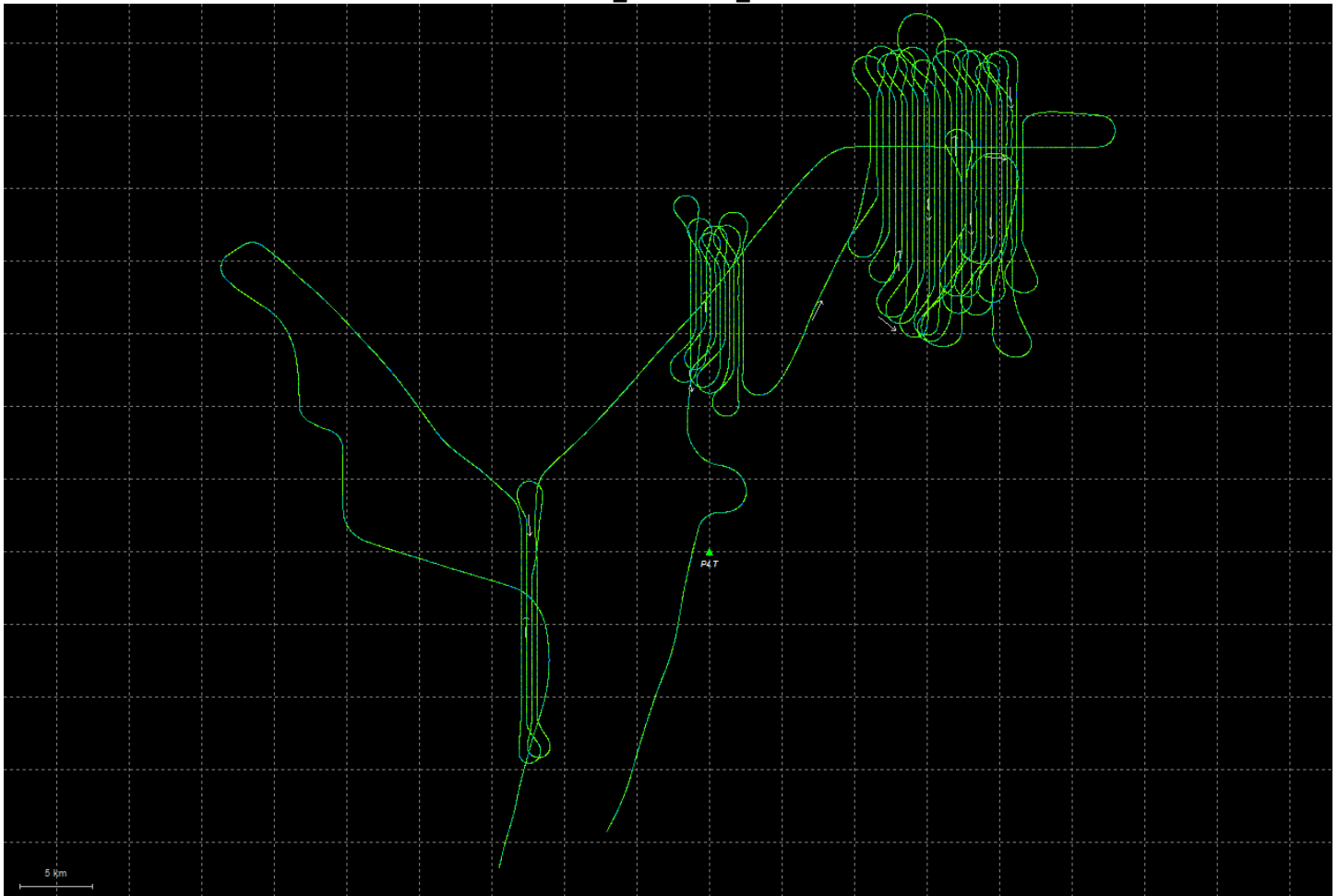


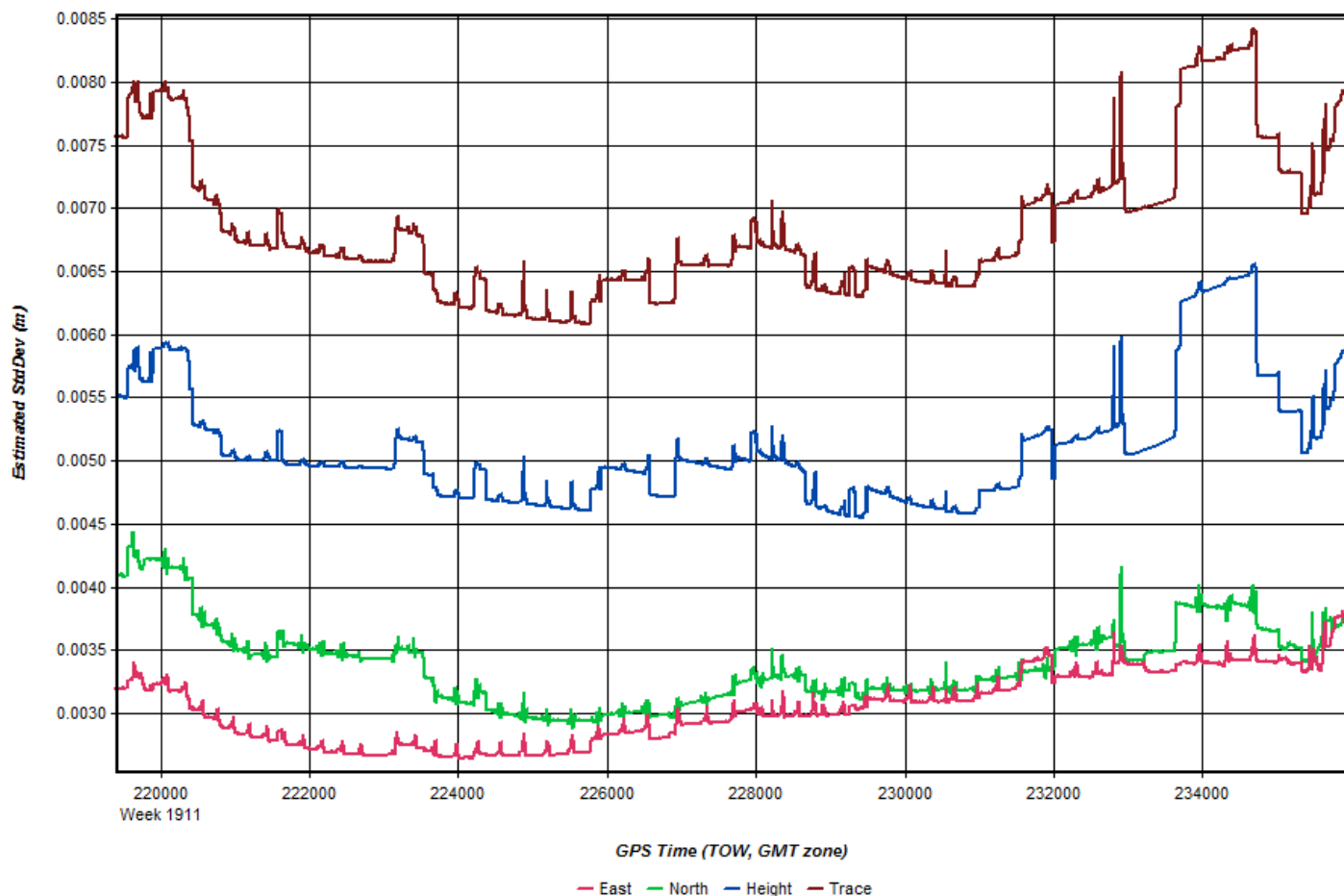


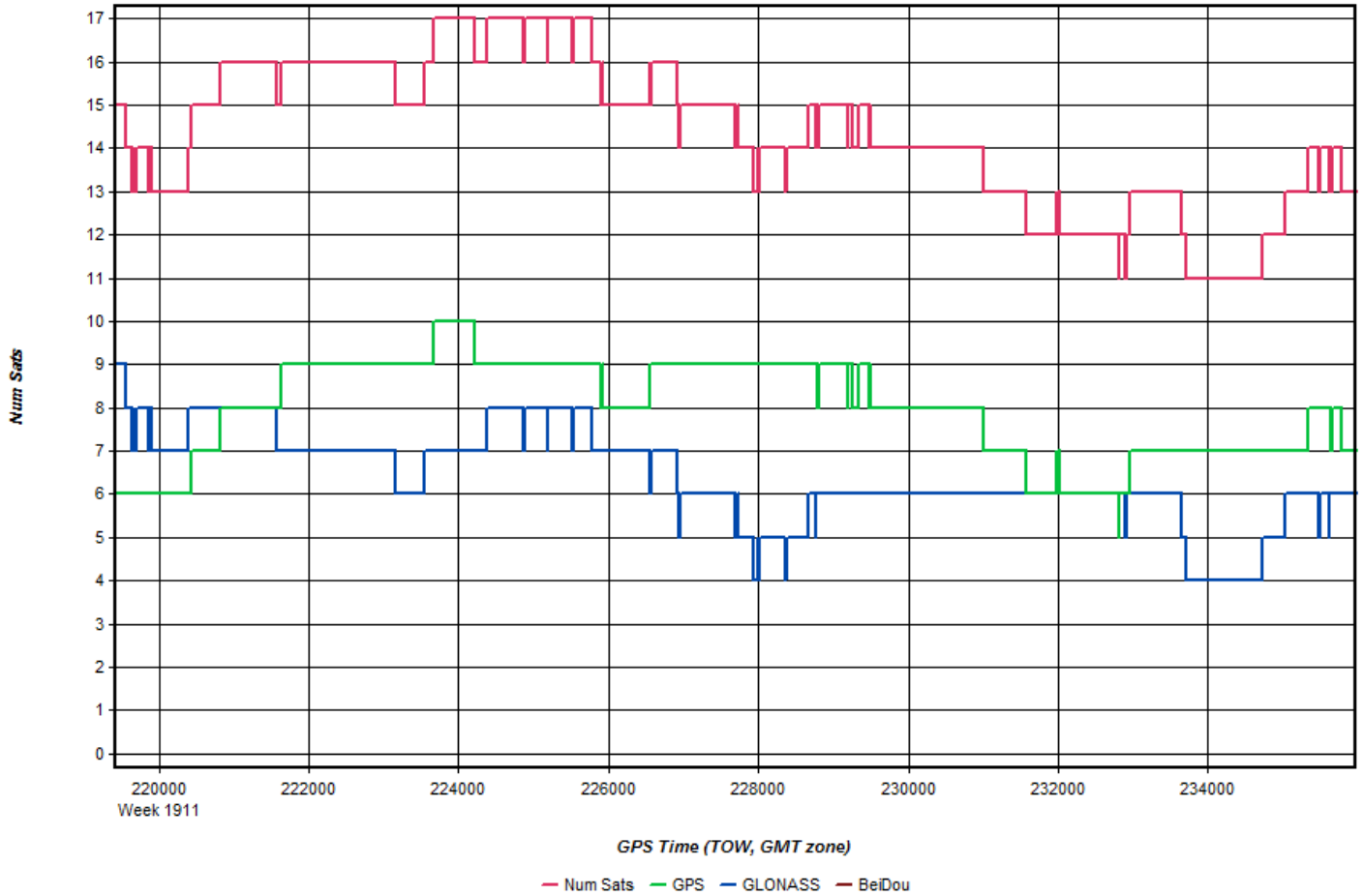


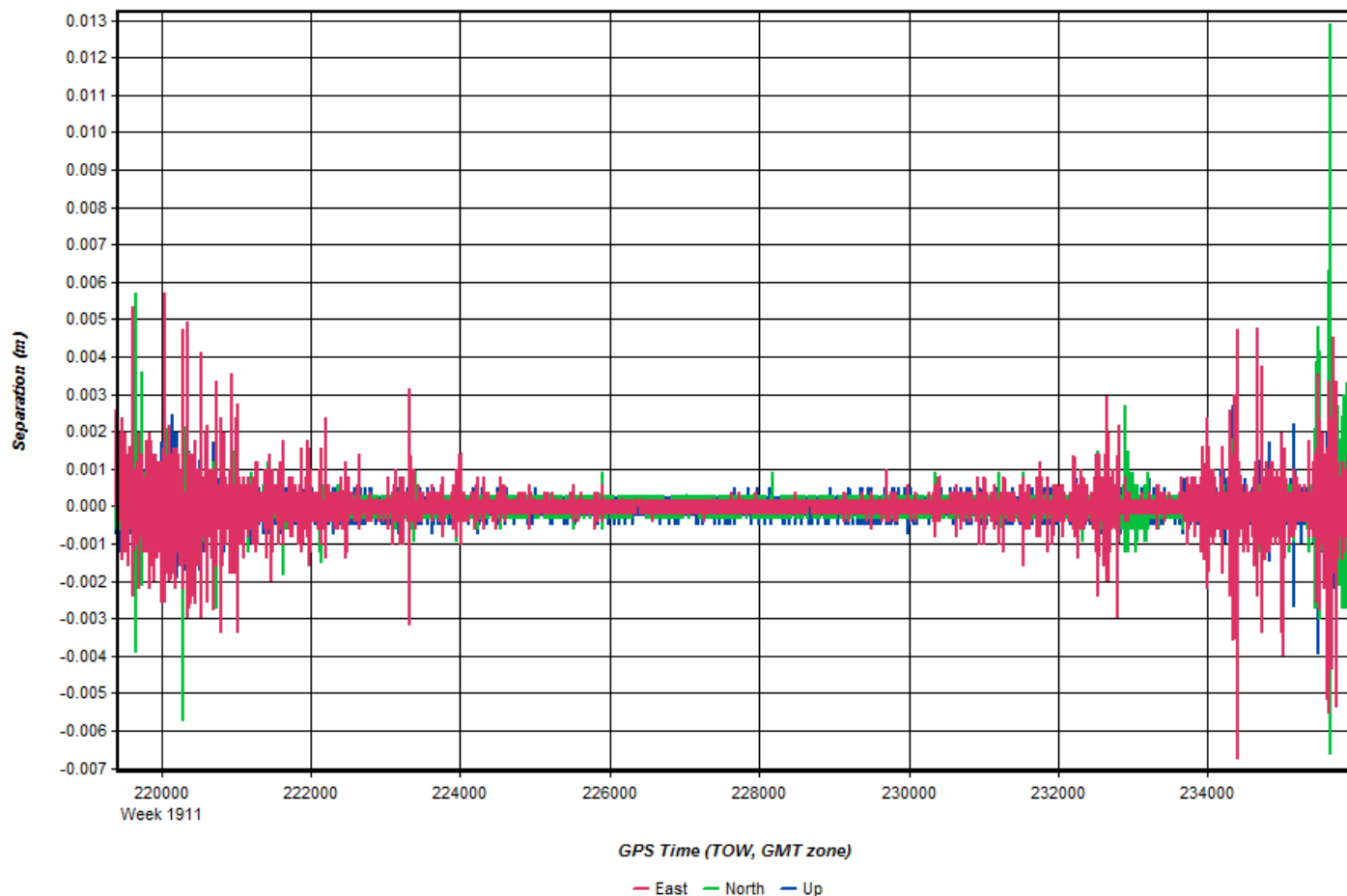


225_20160823_1



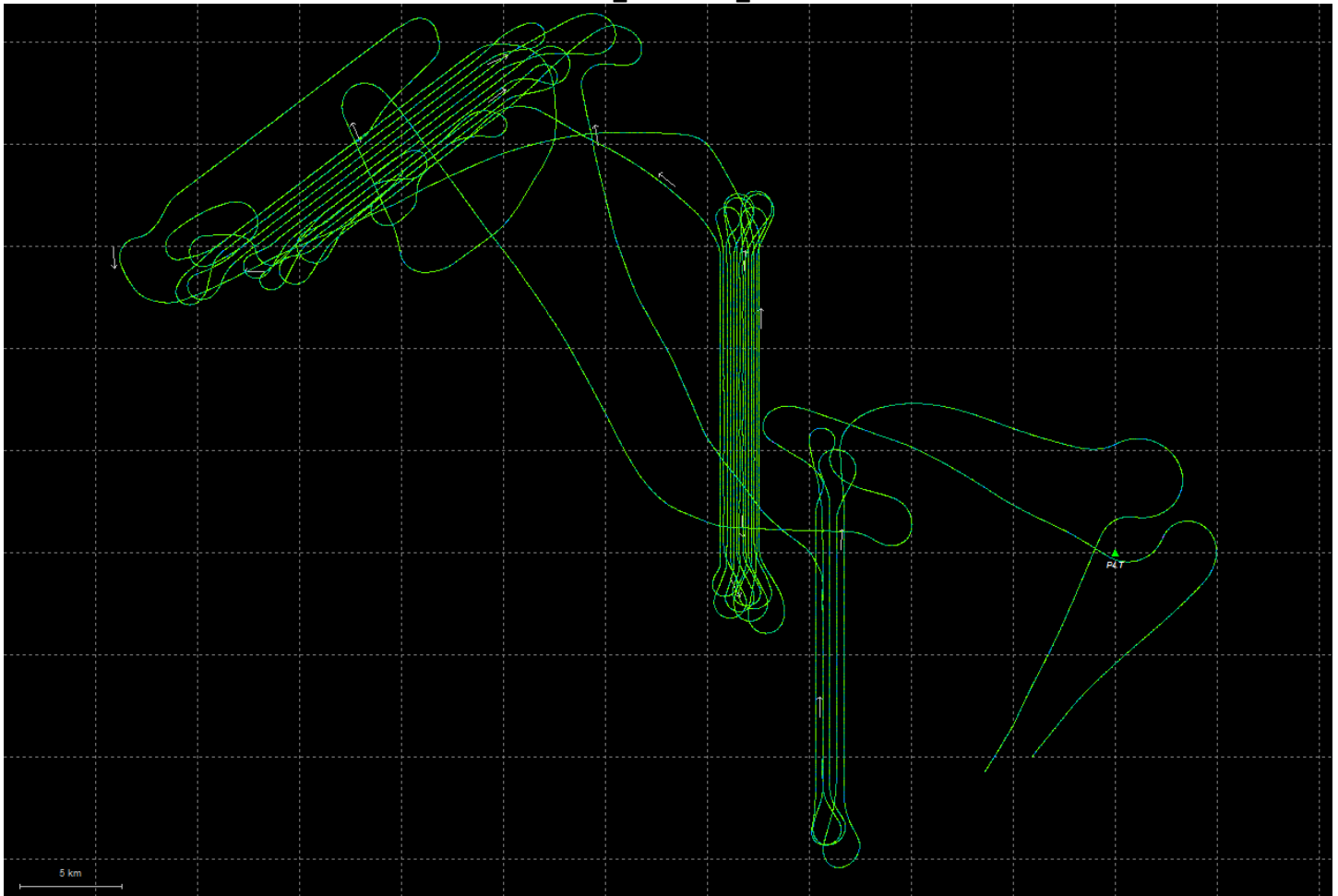


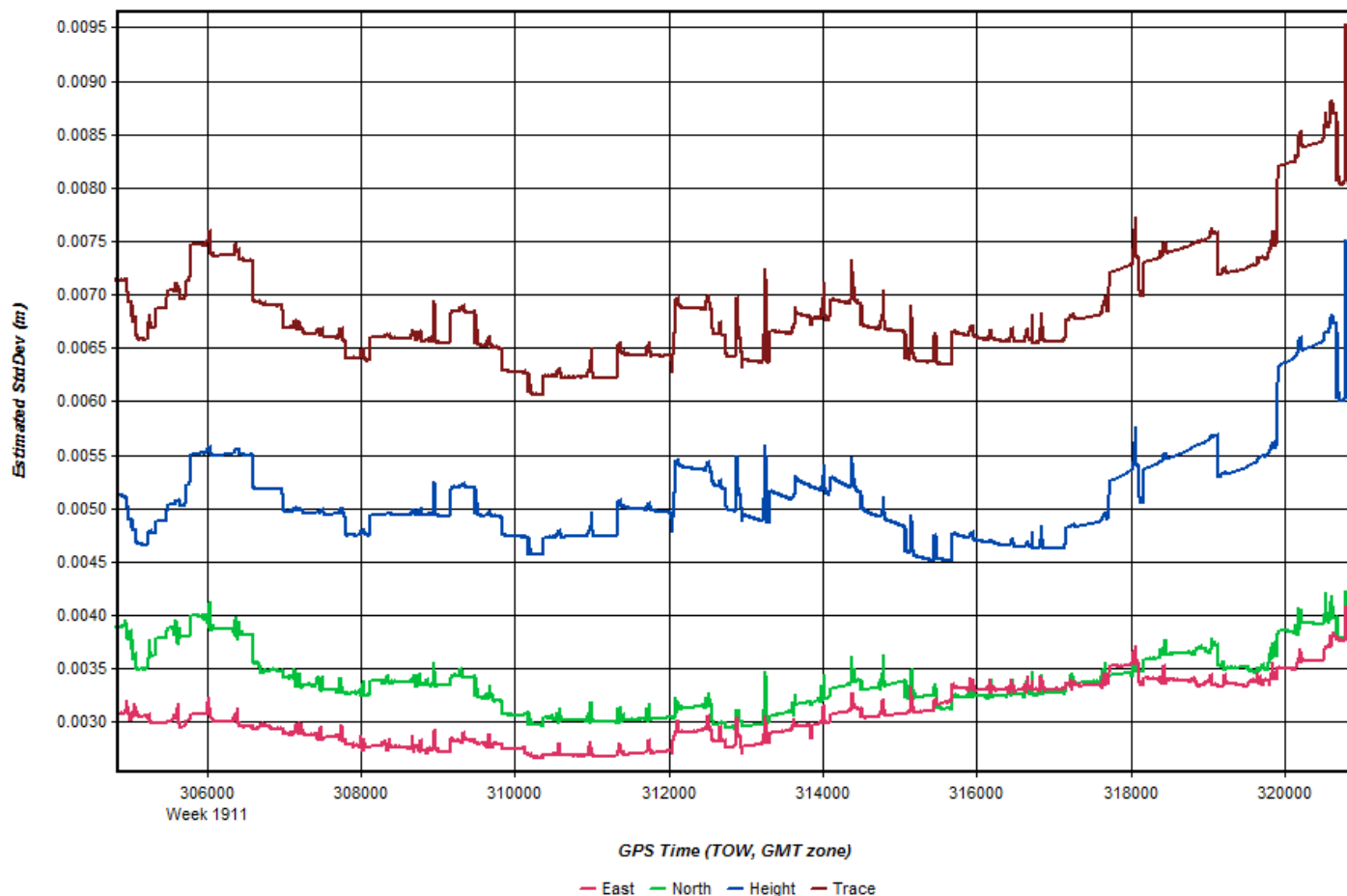


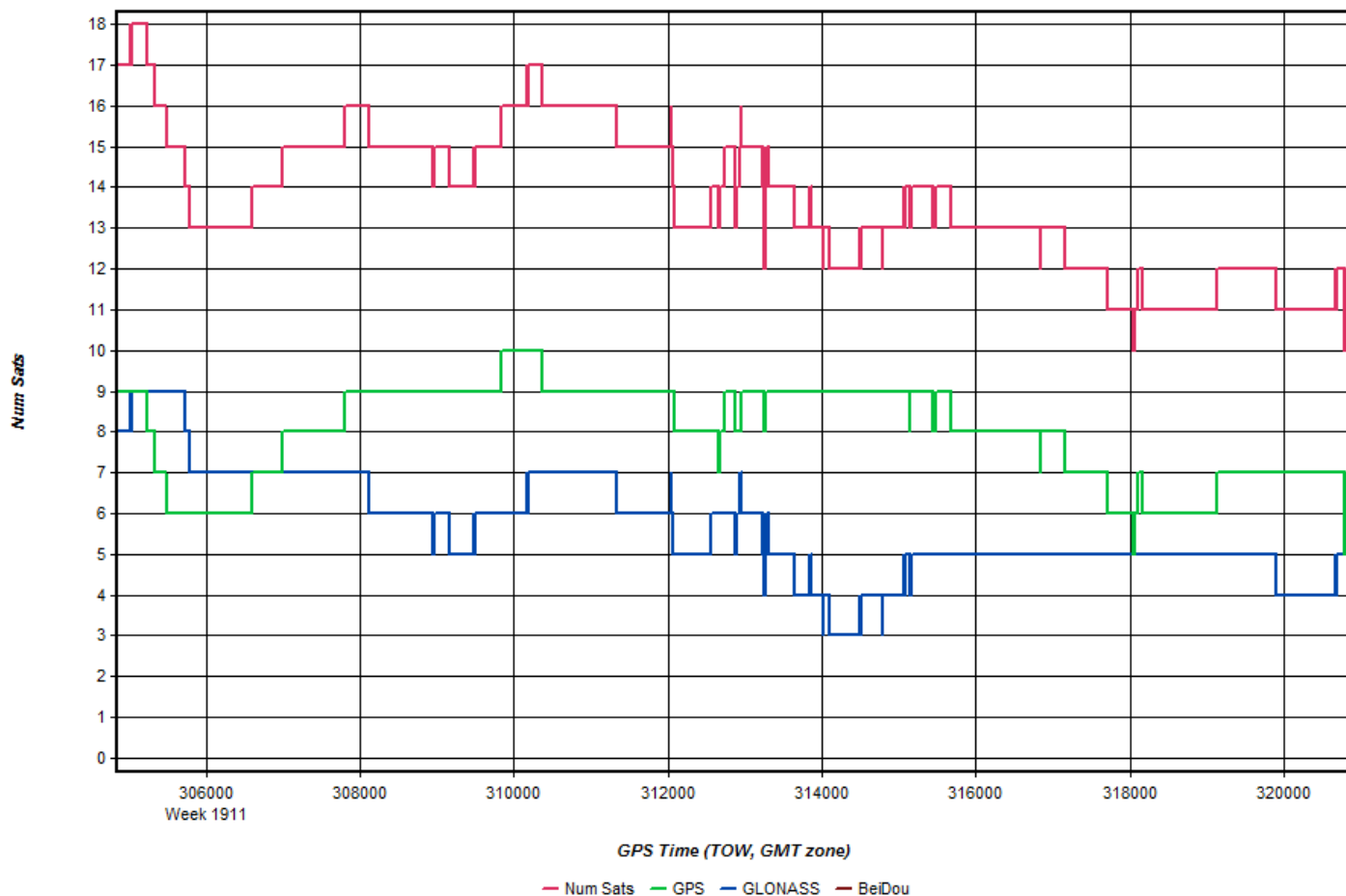


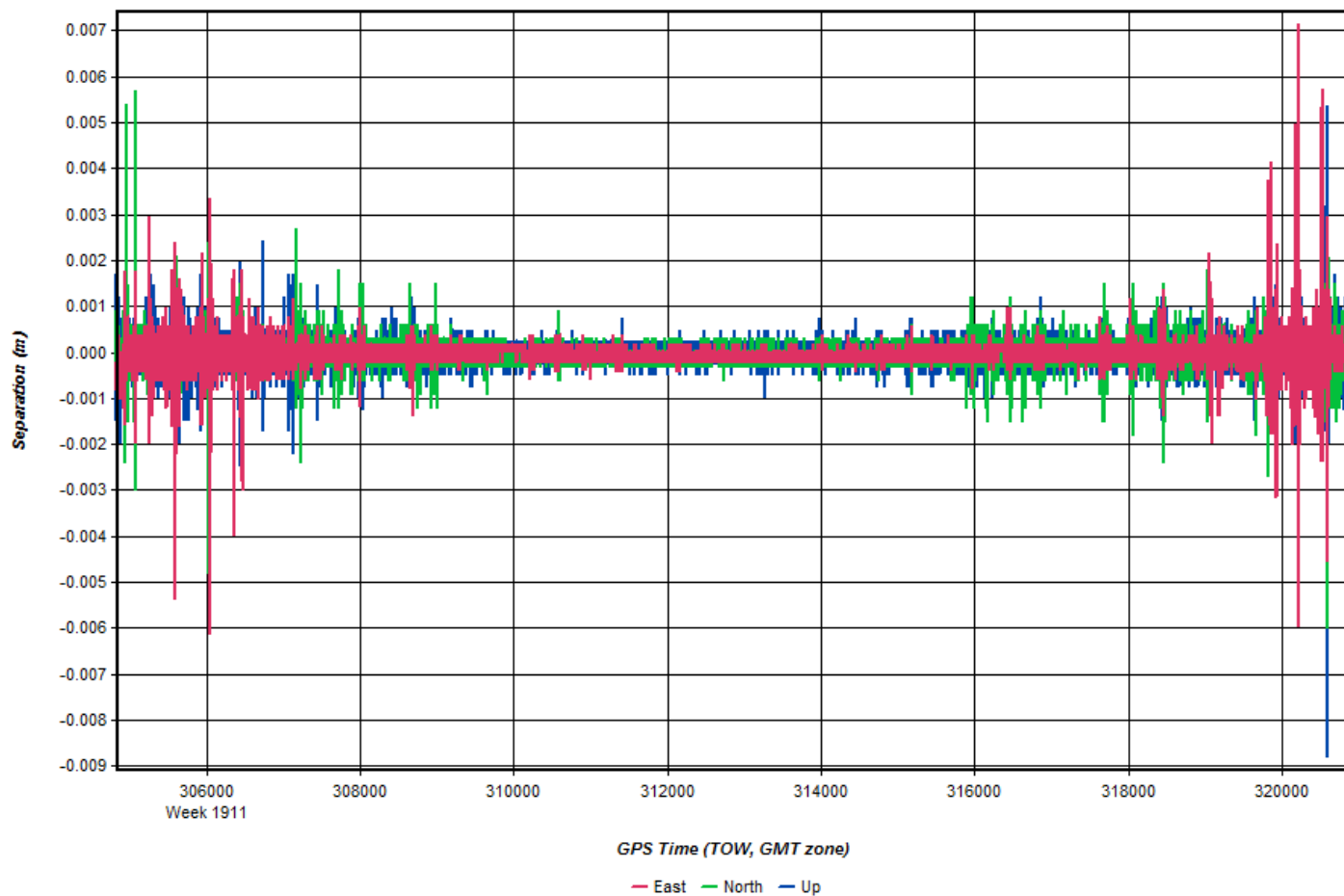


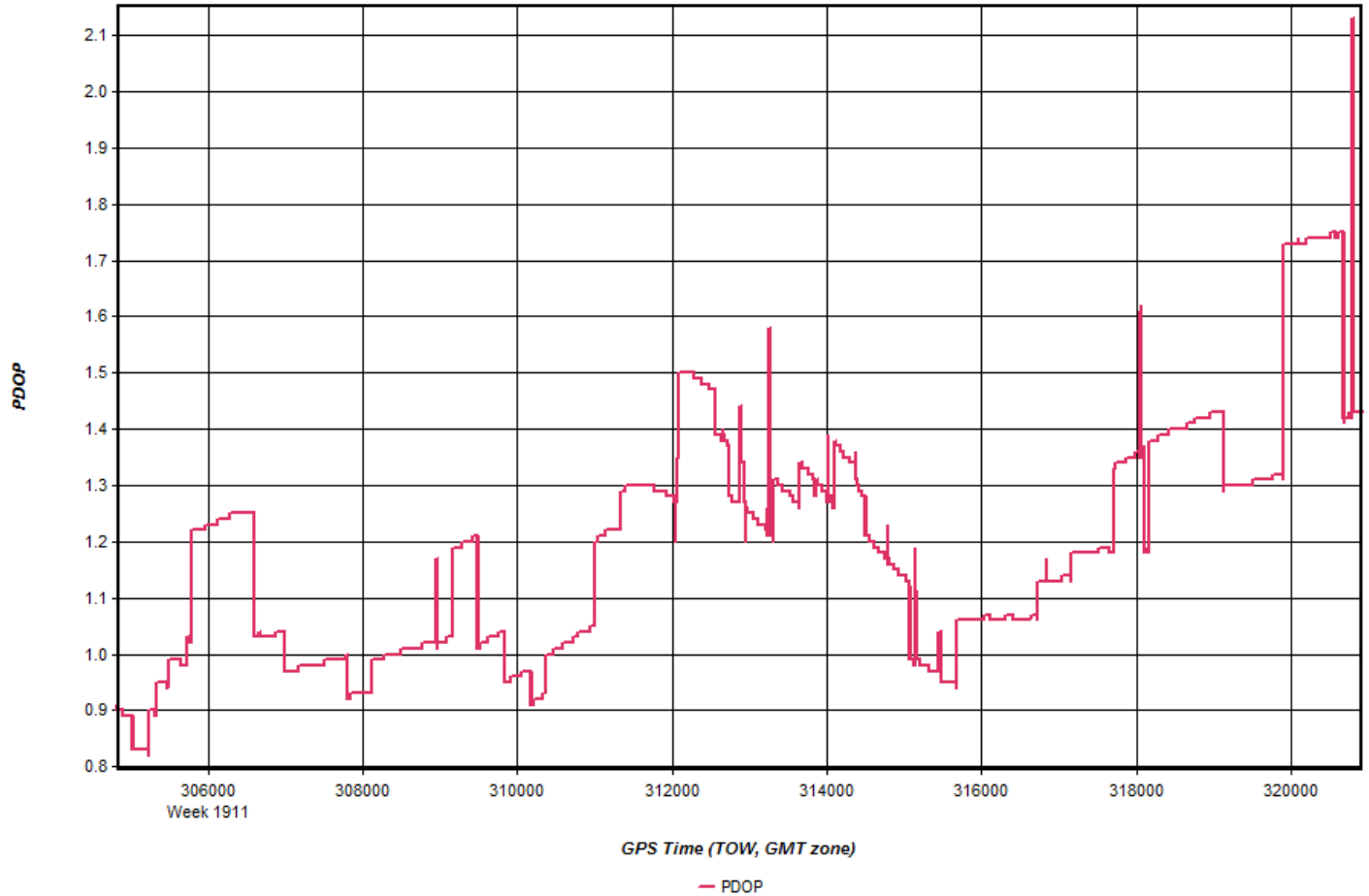
225_20160824_1



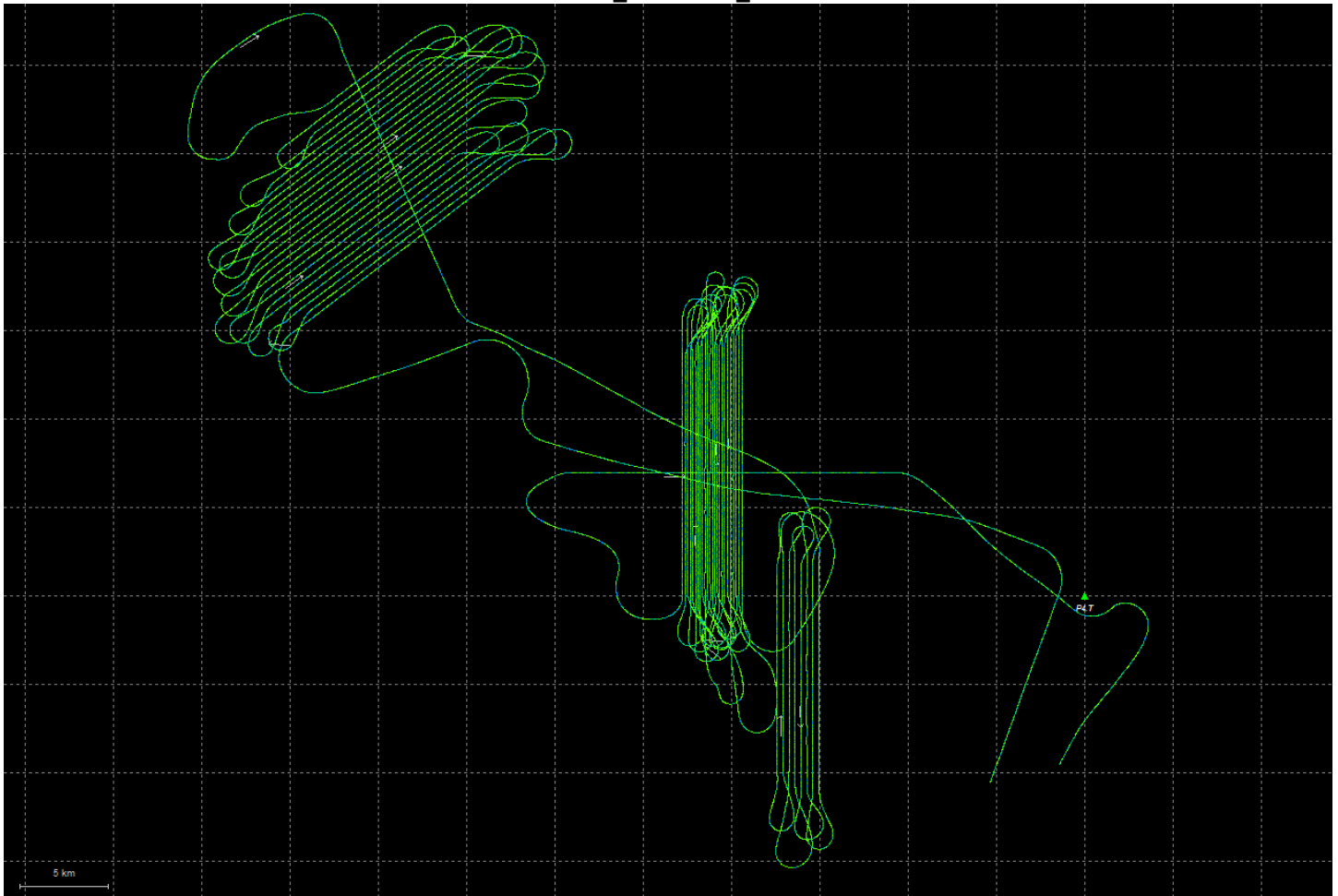


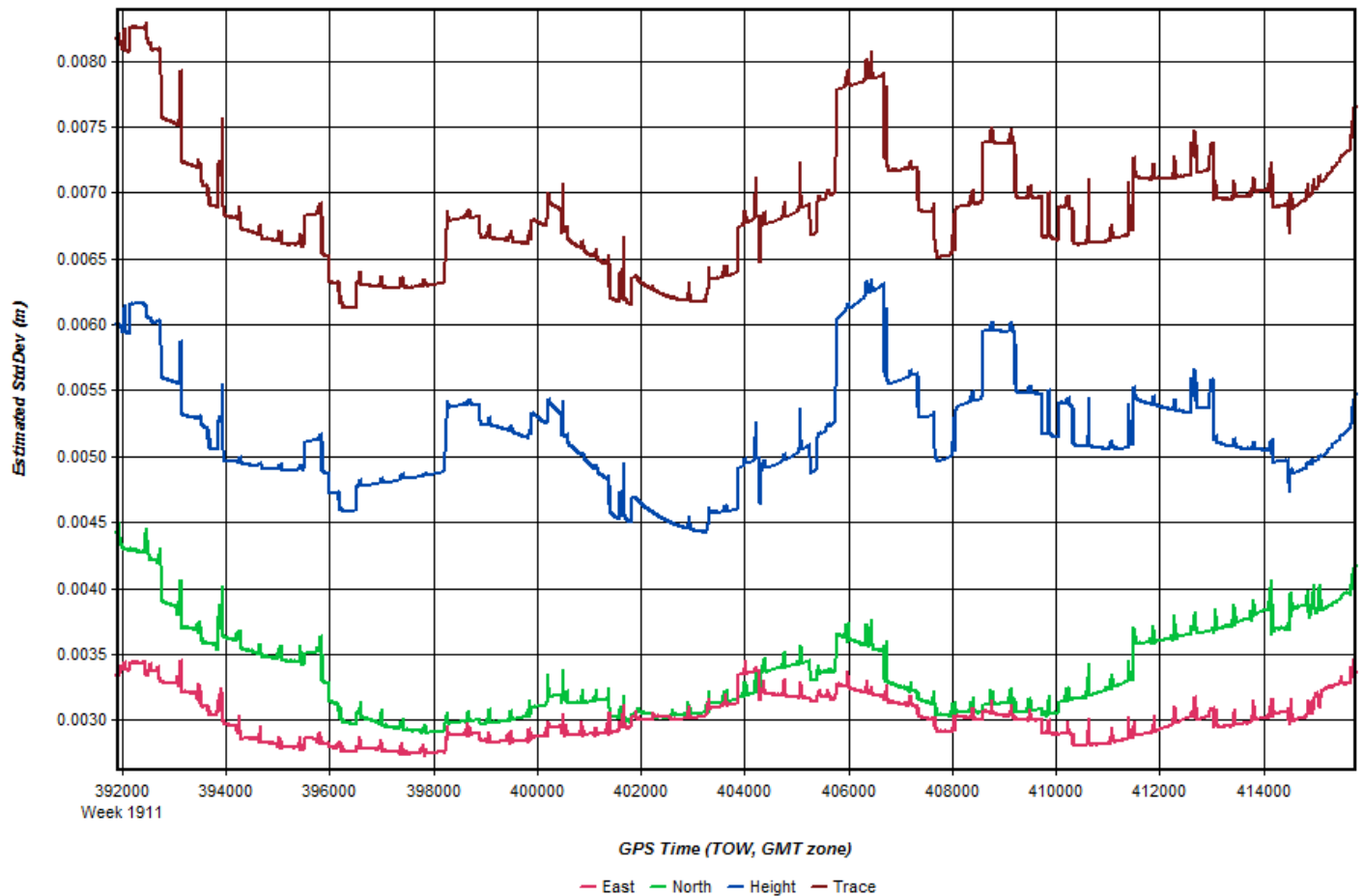


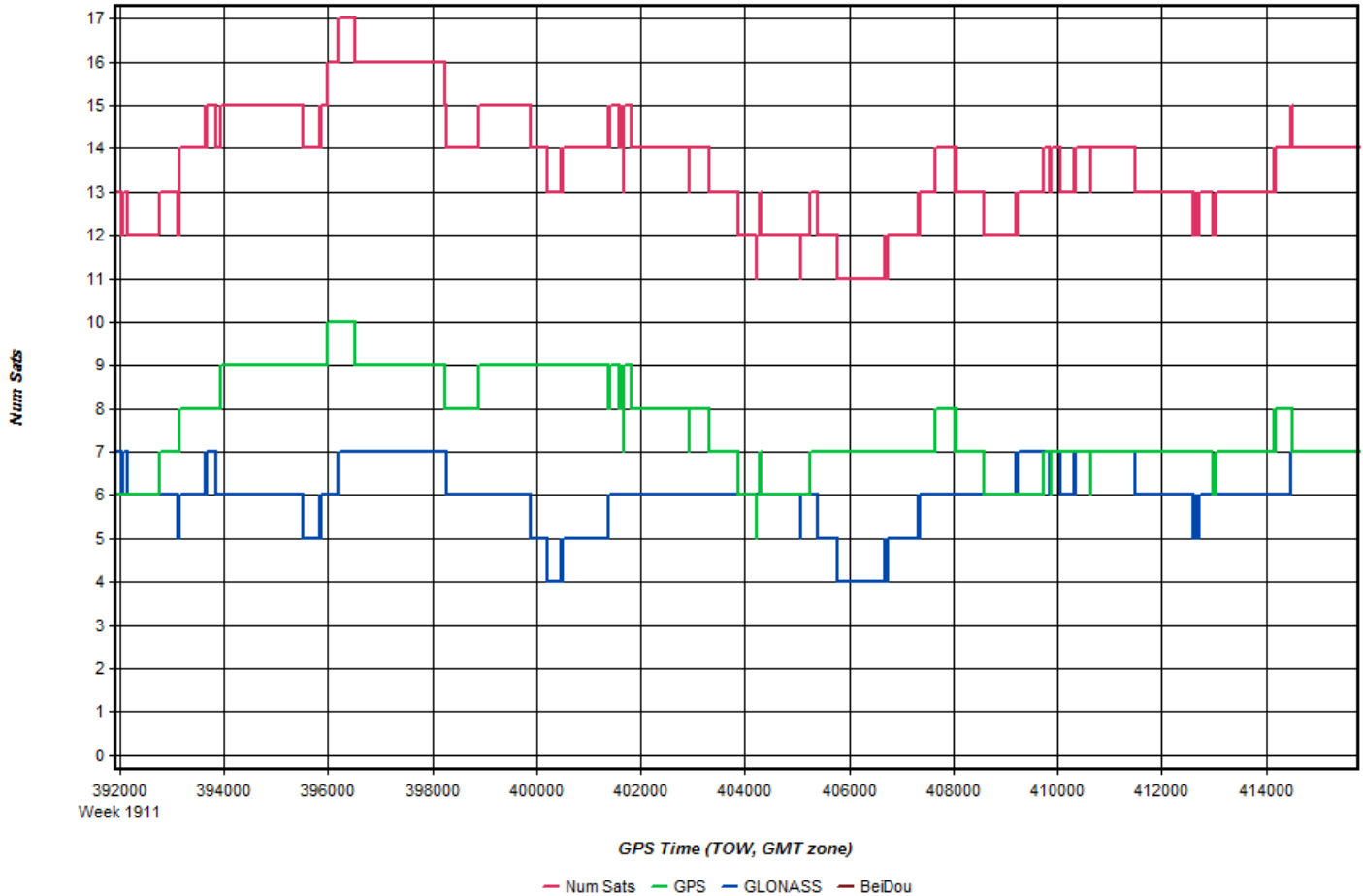


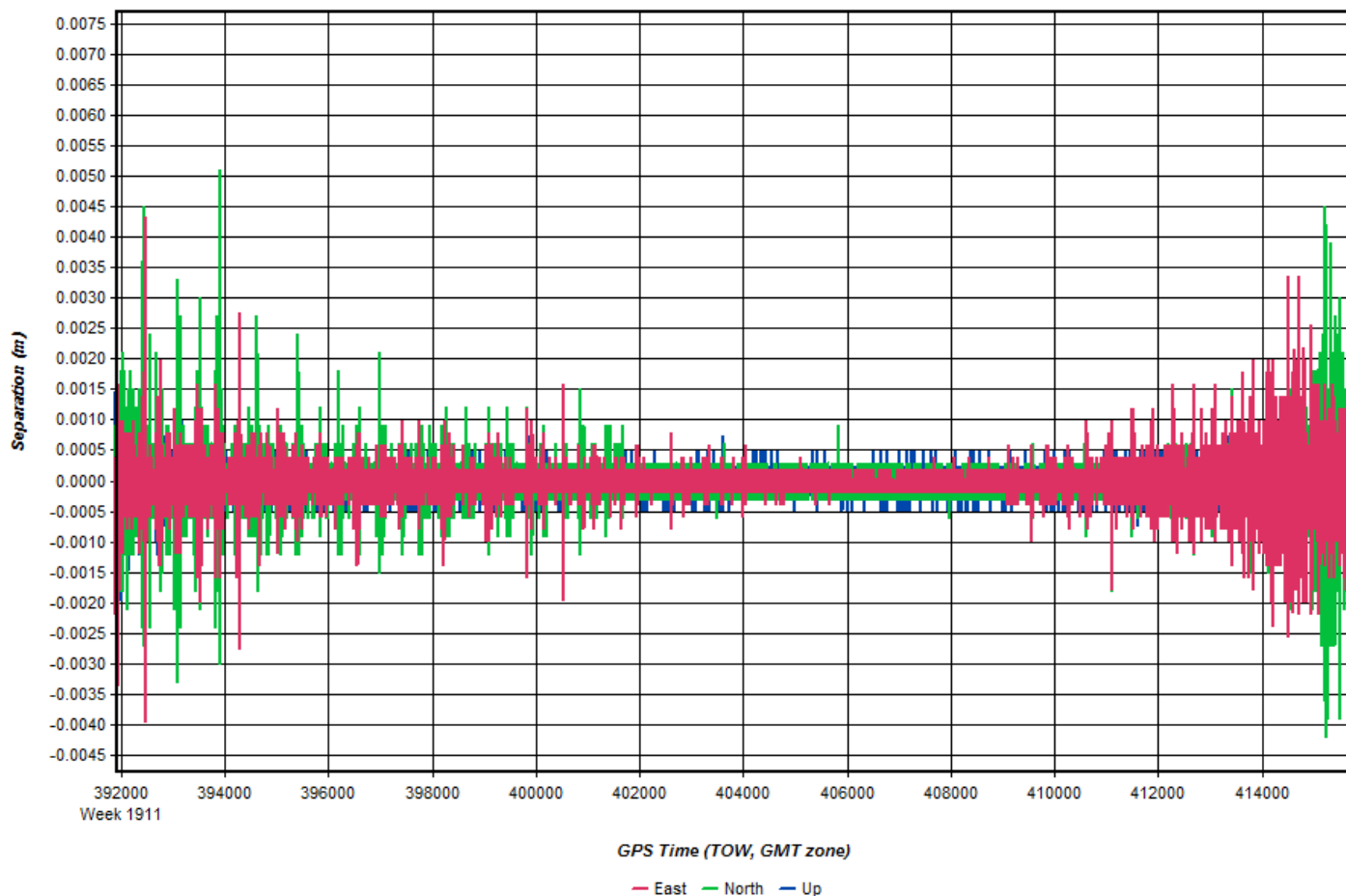


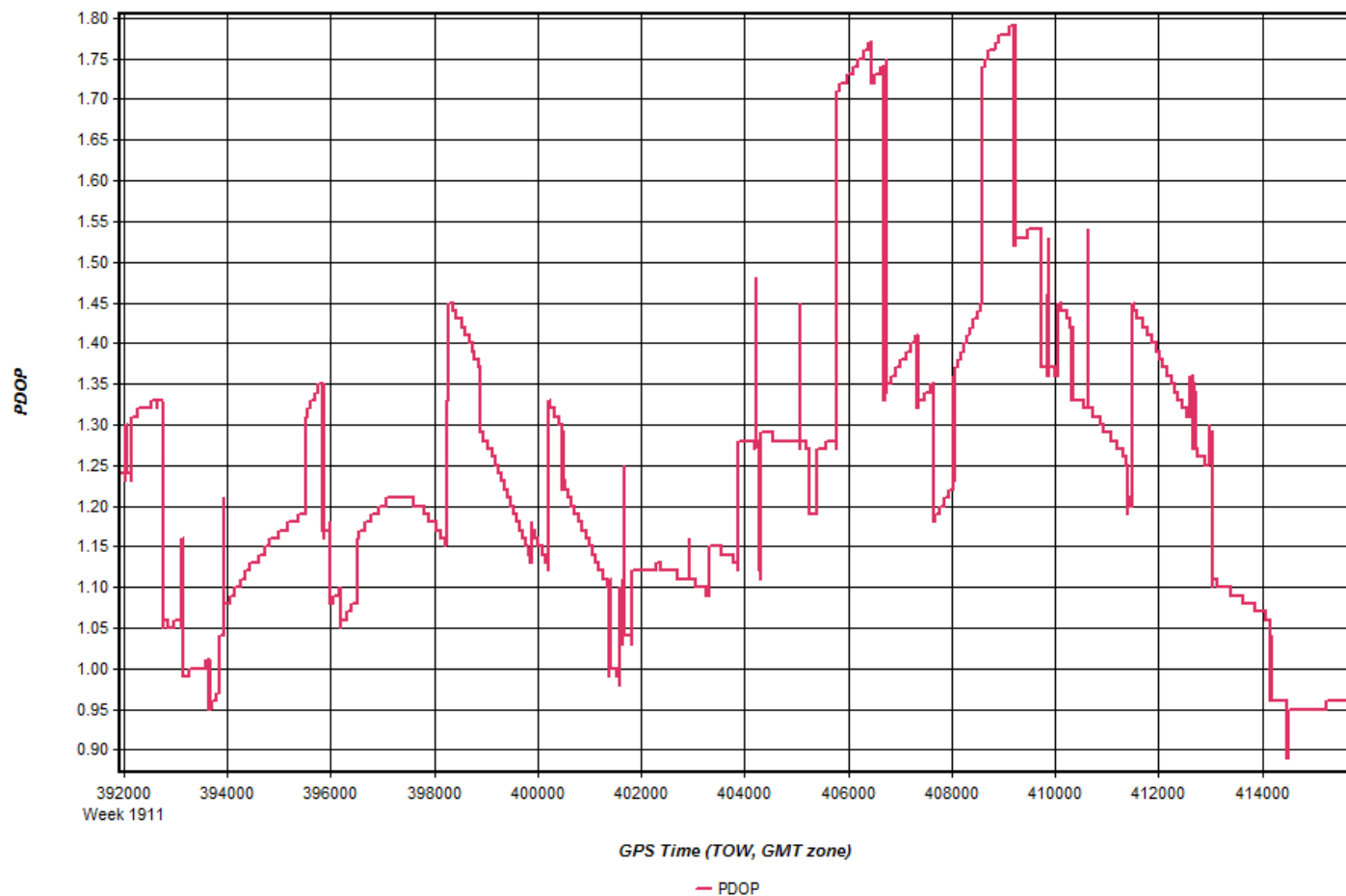
225_20160825_1



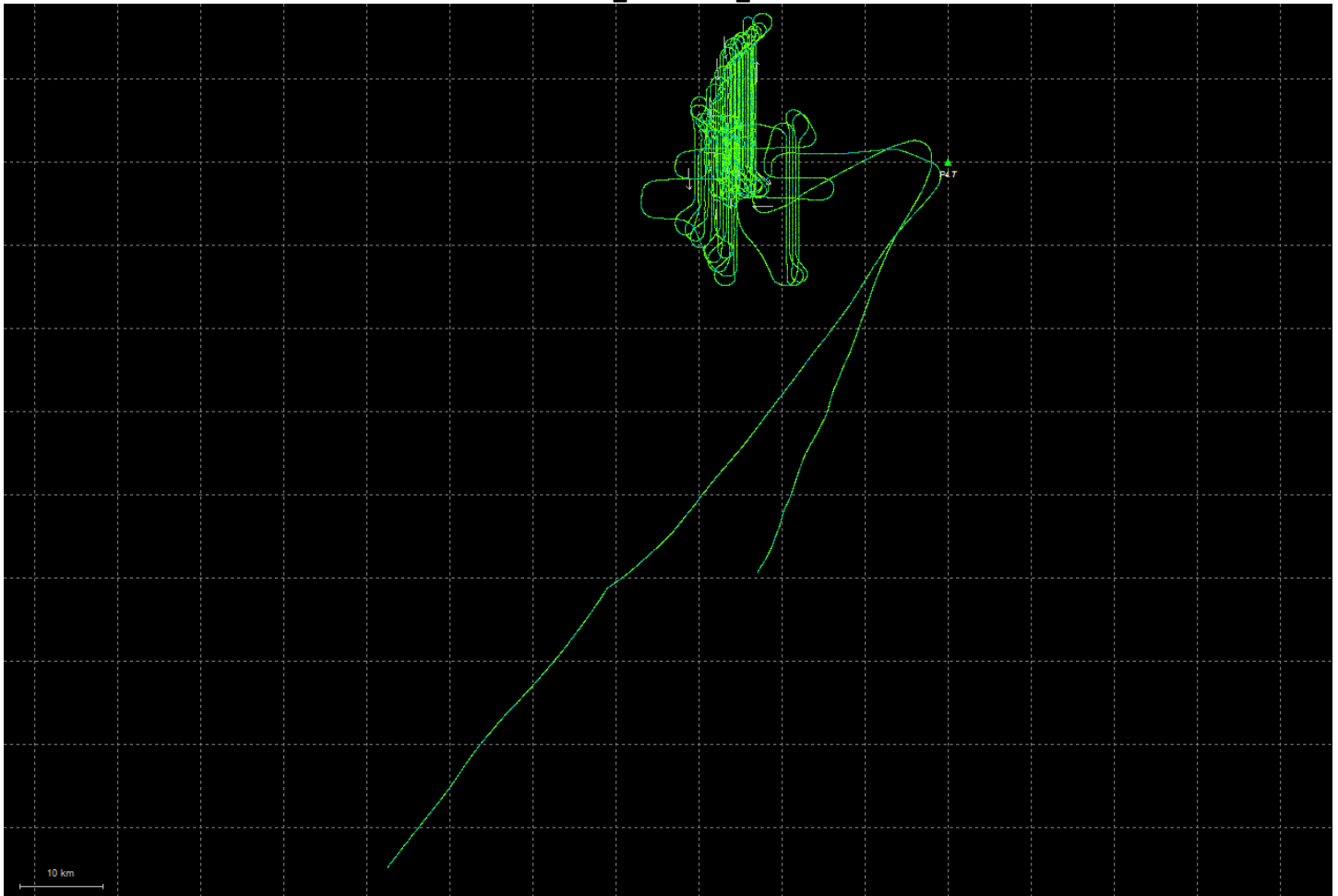


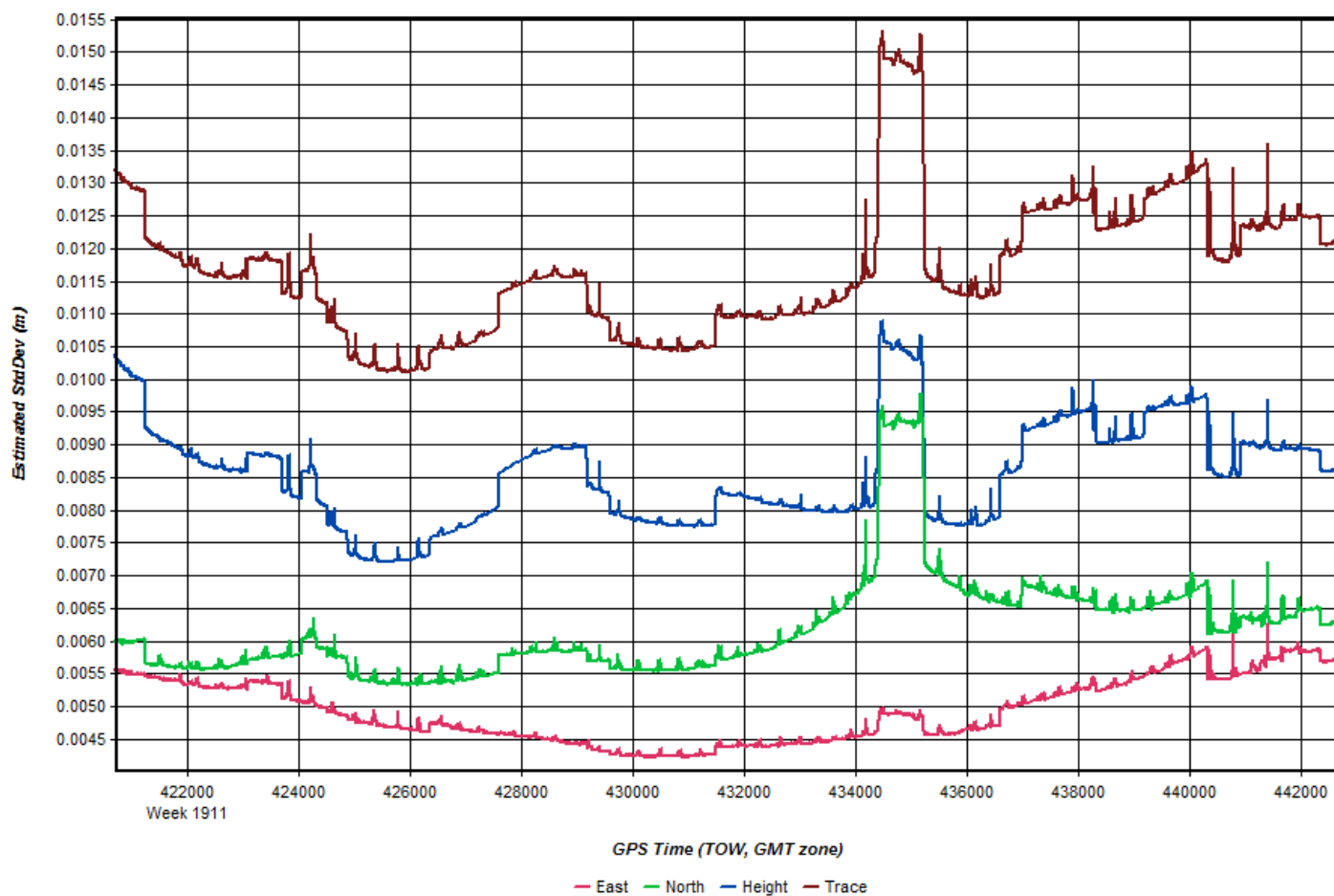


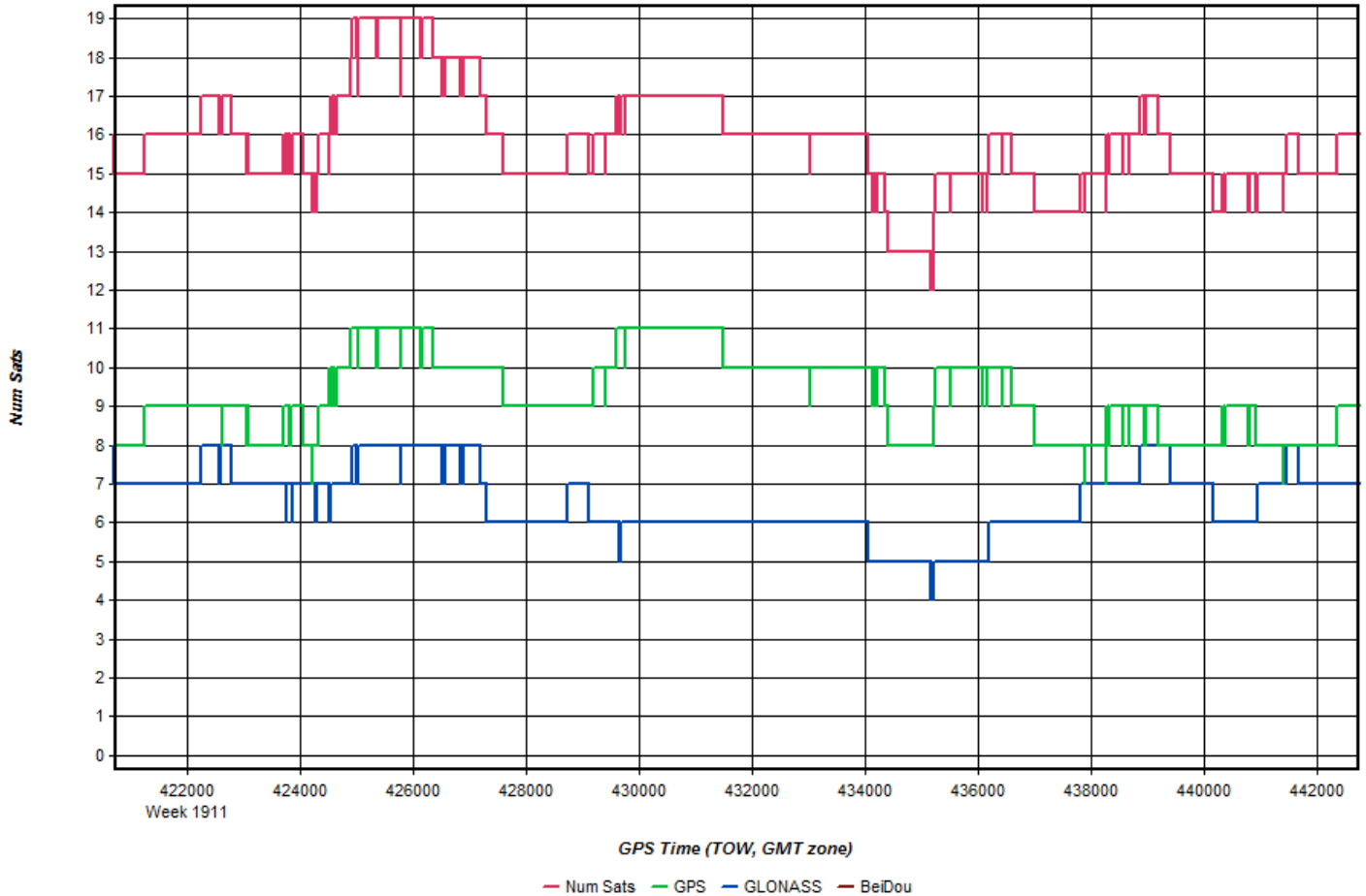


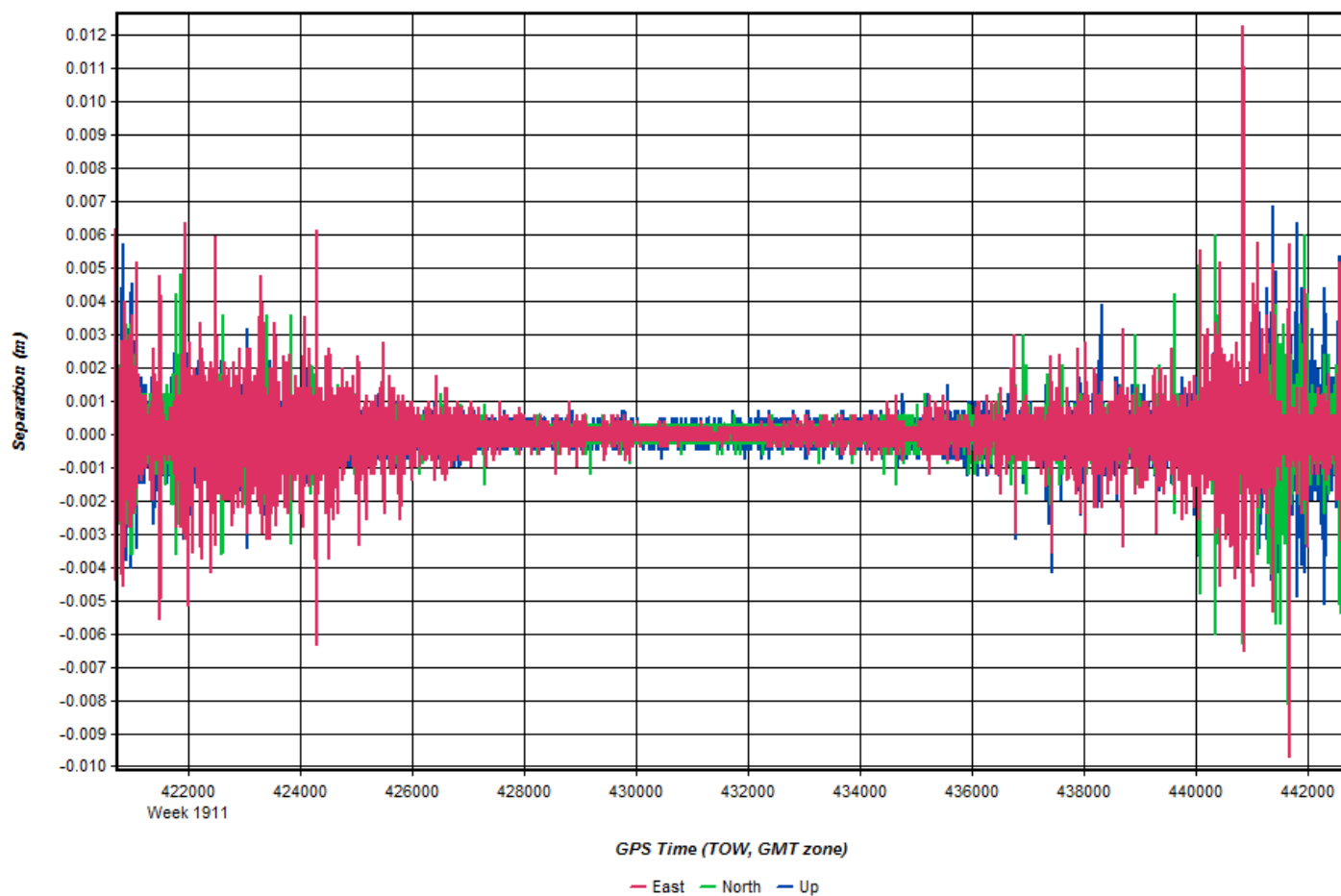


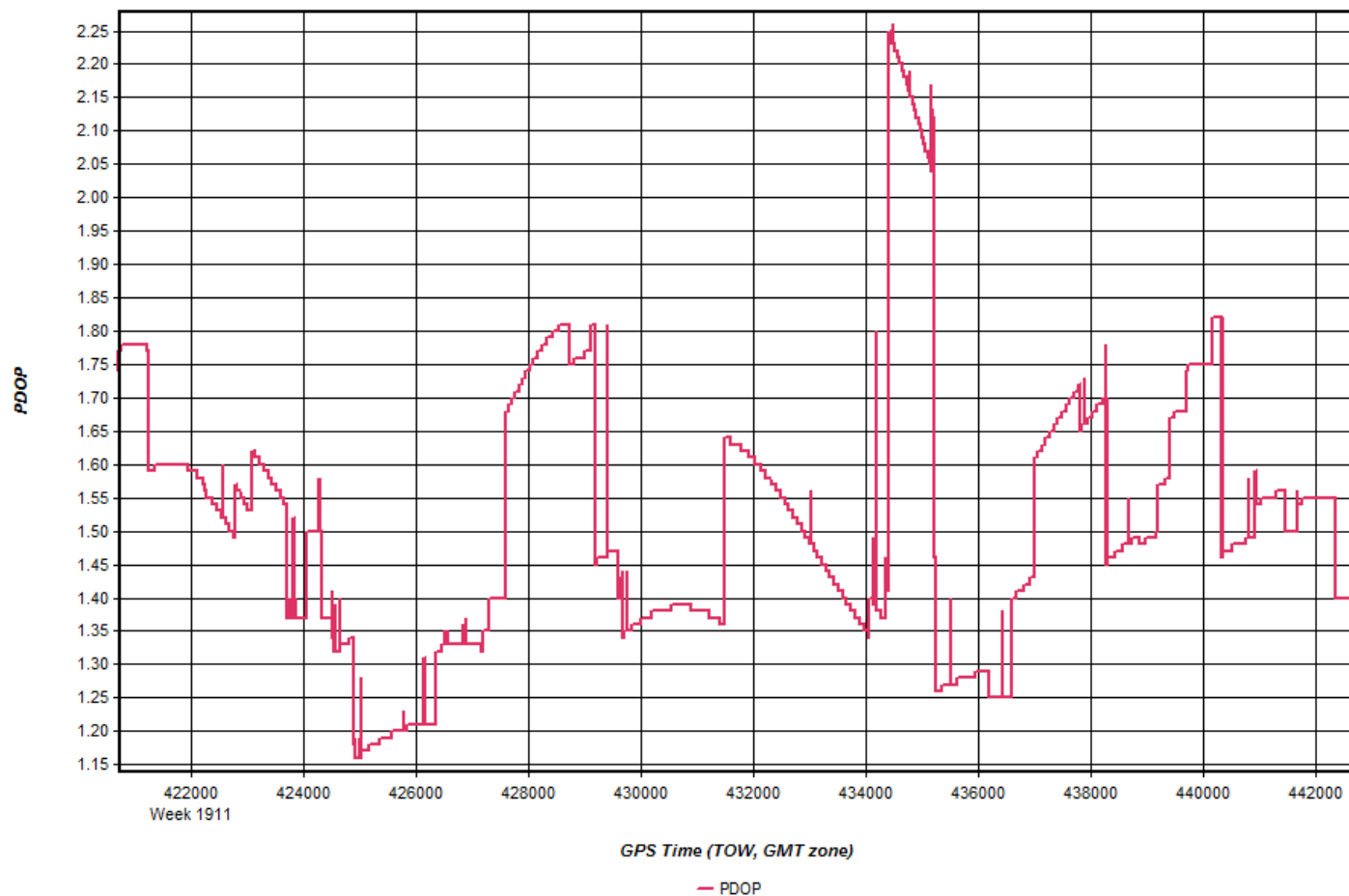
225_20160825_2



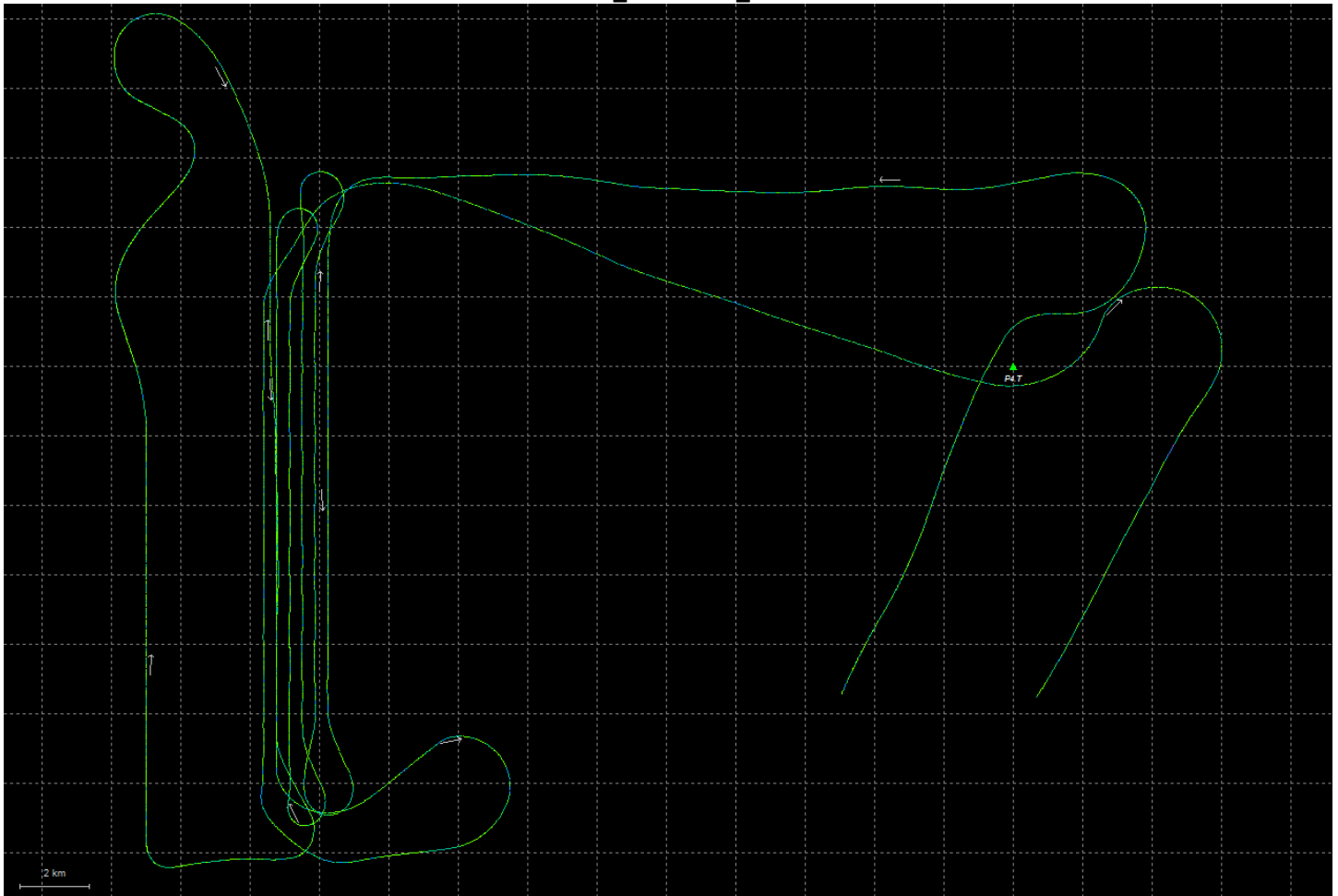


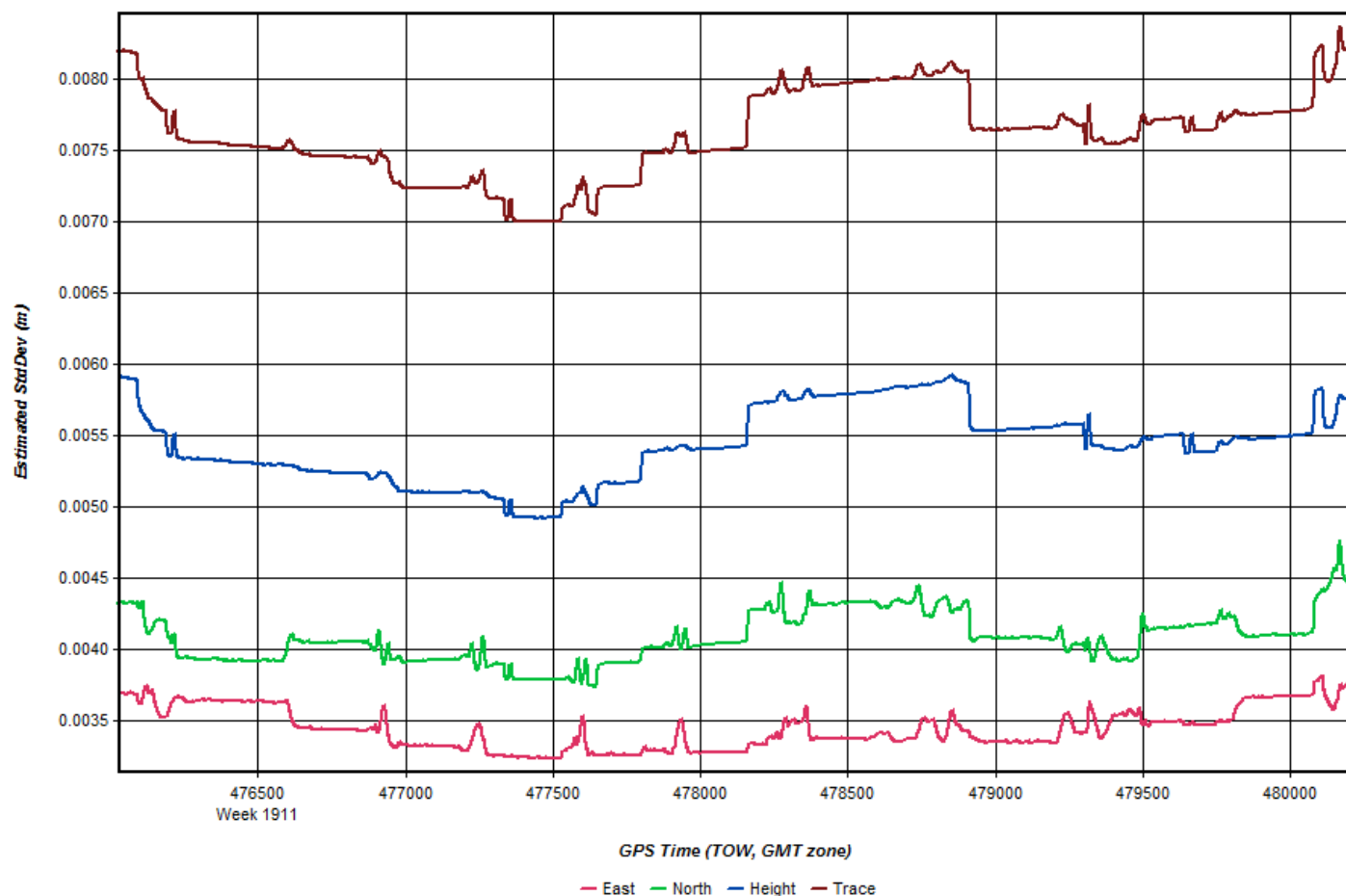


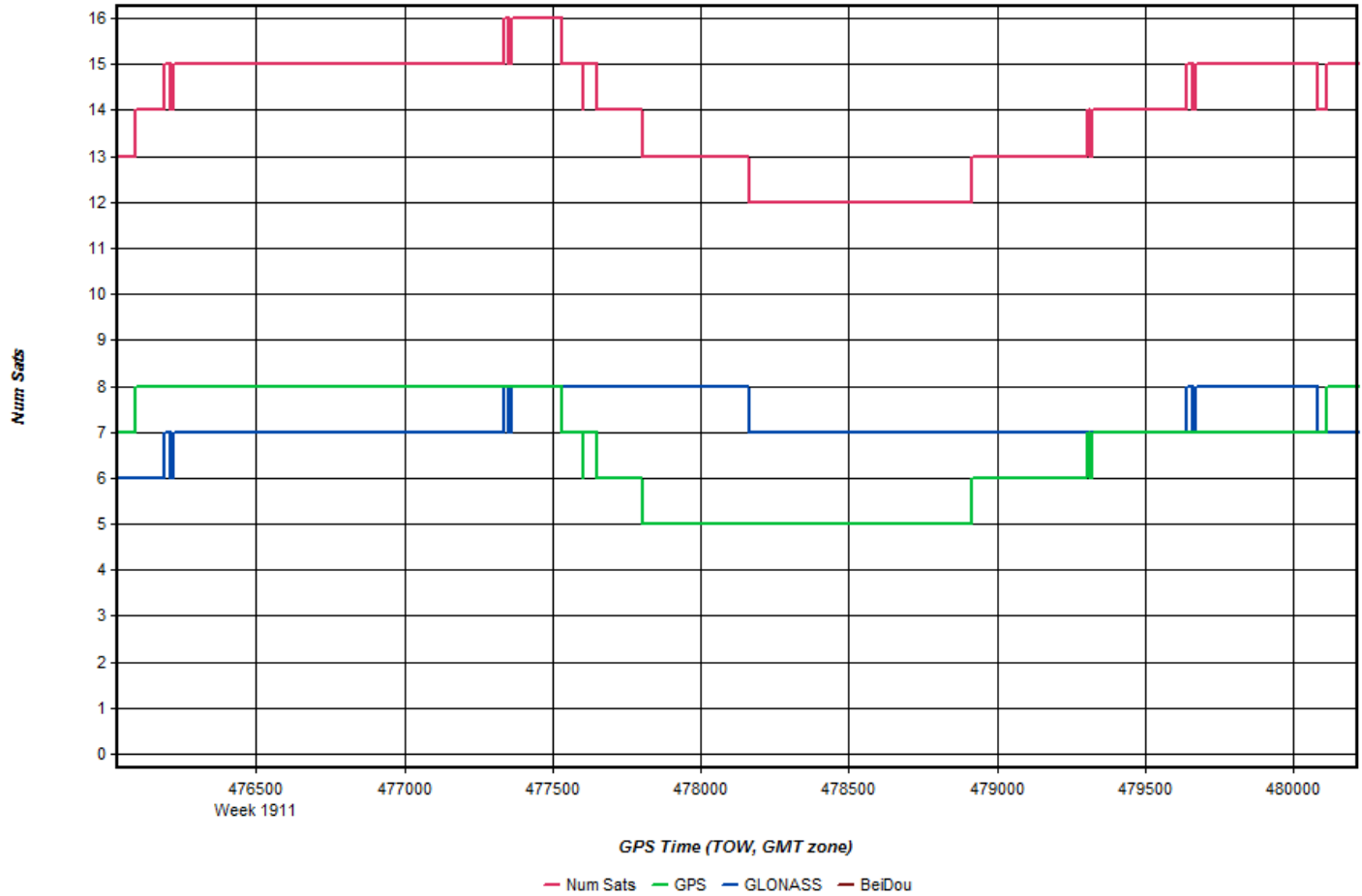


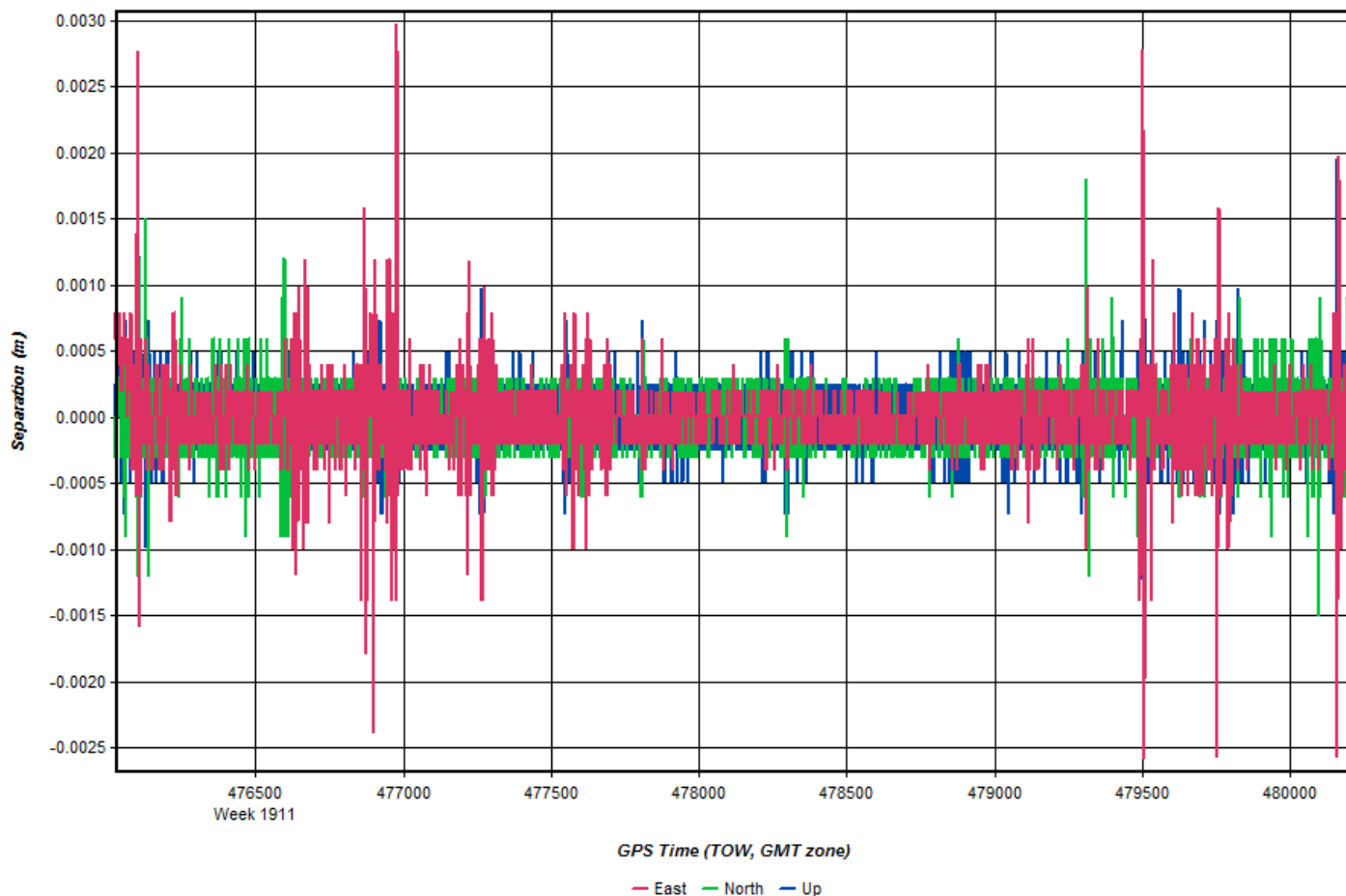


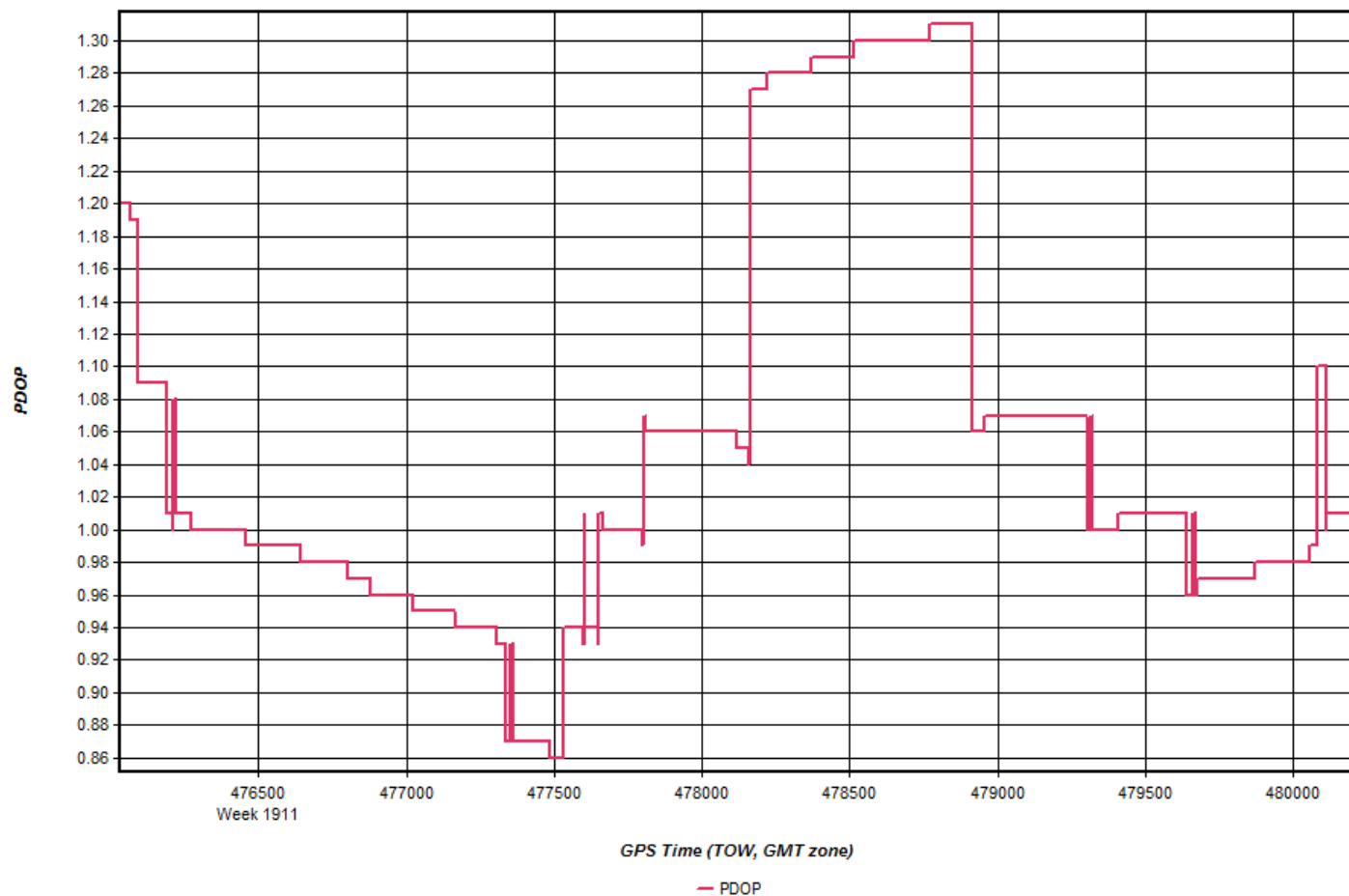
225_20160826_1



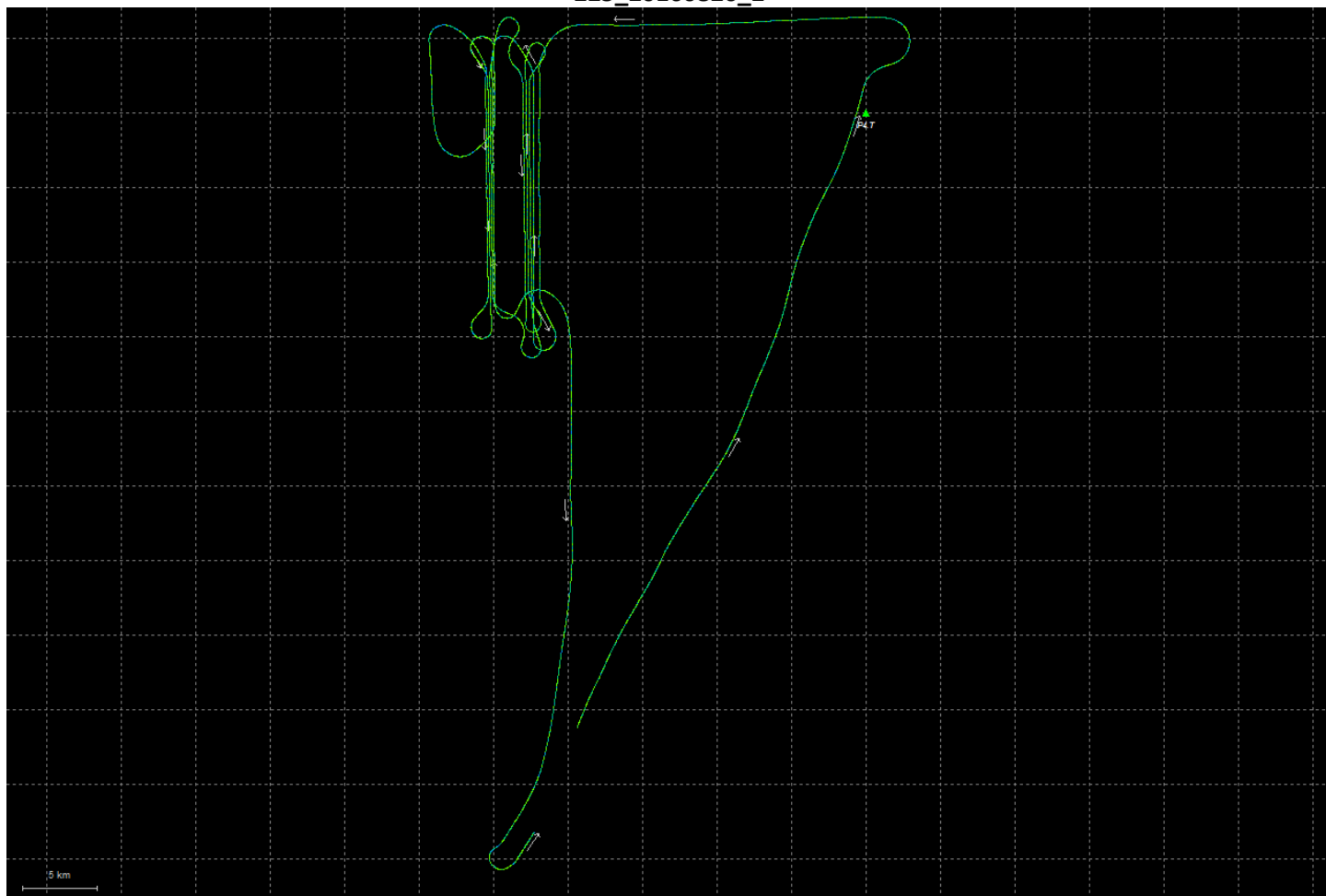


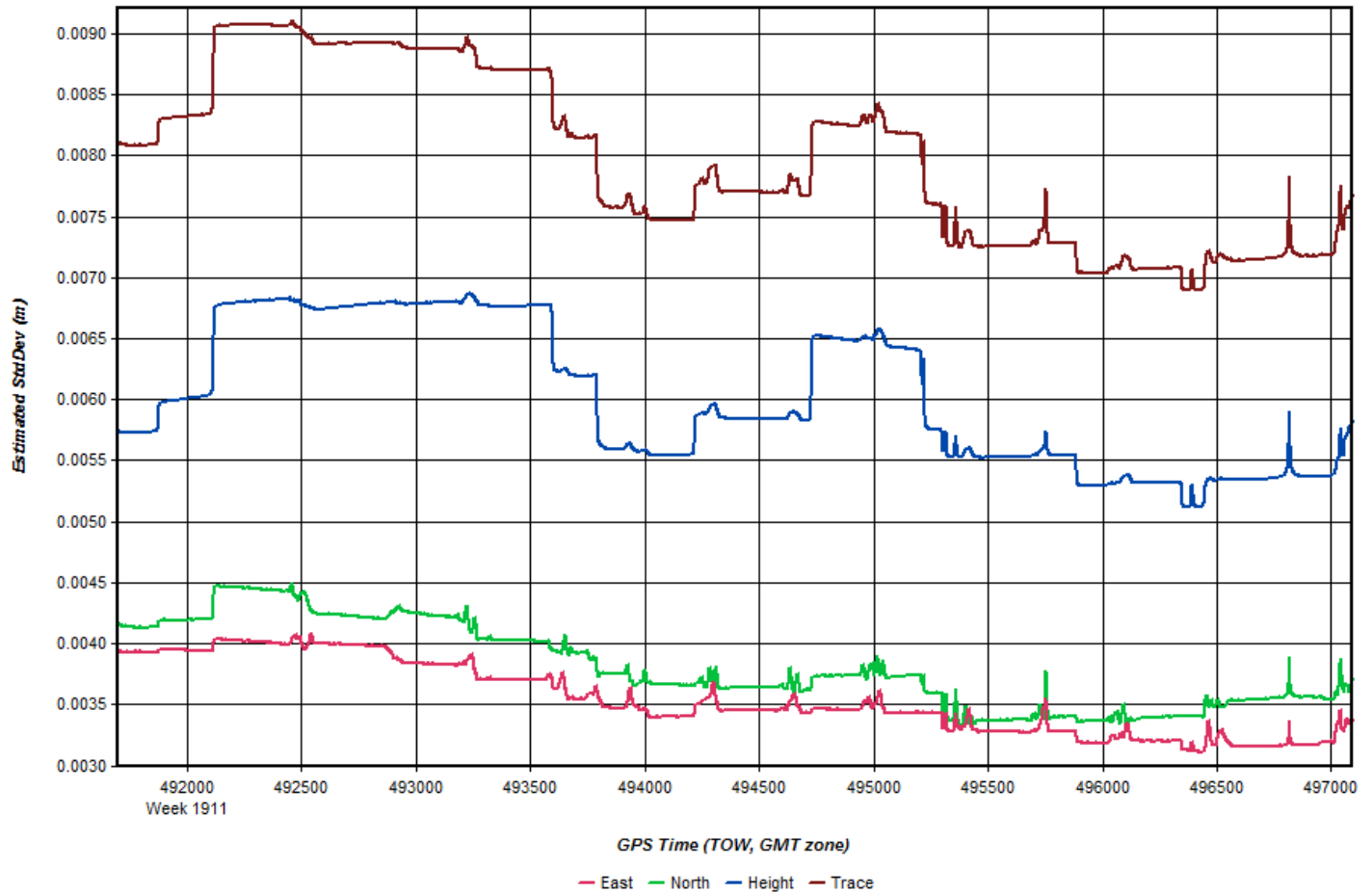


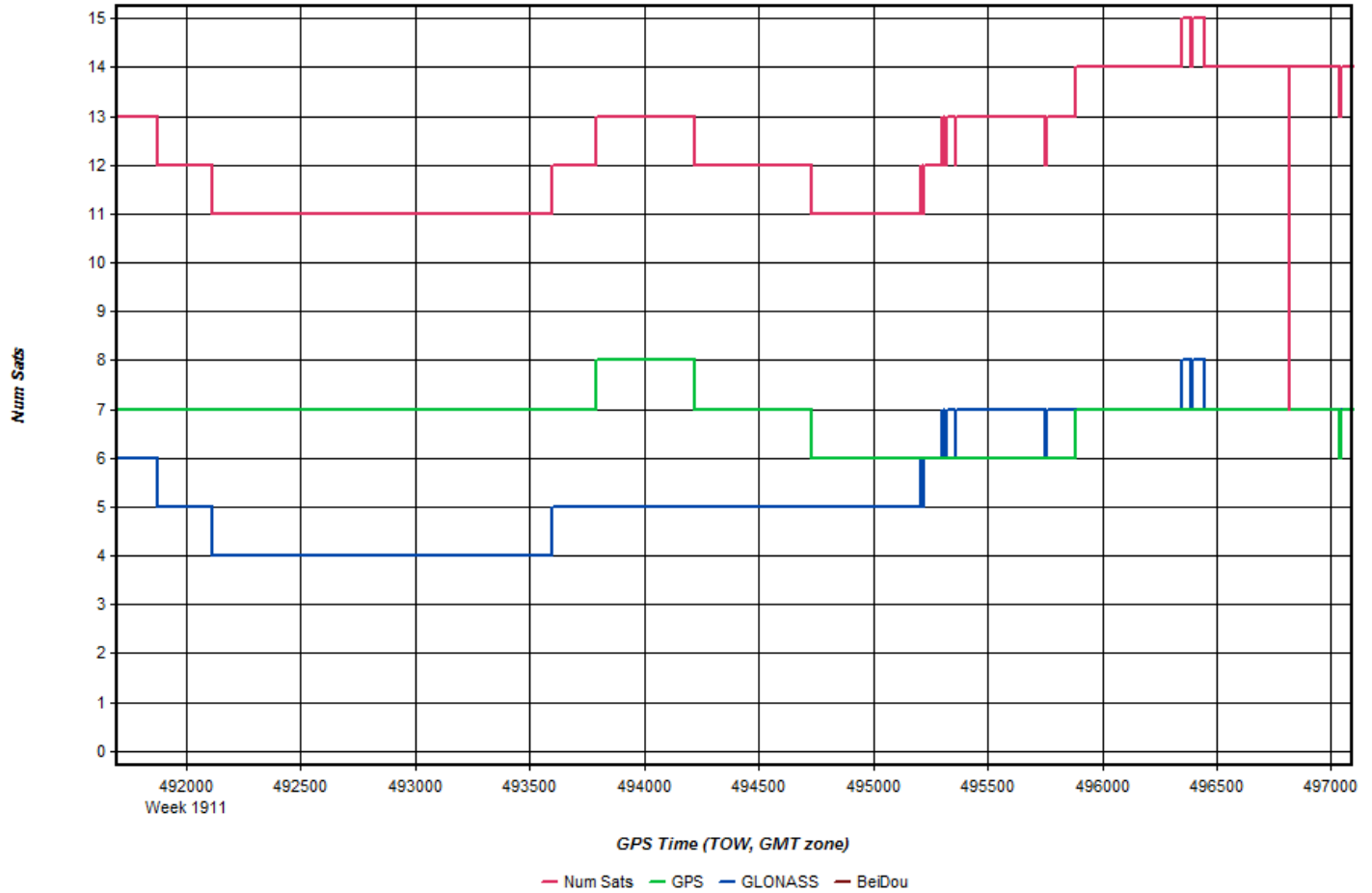




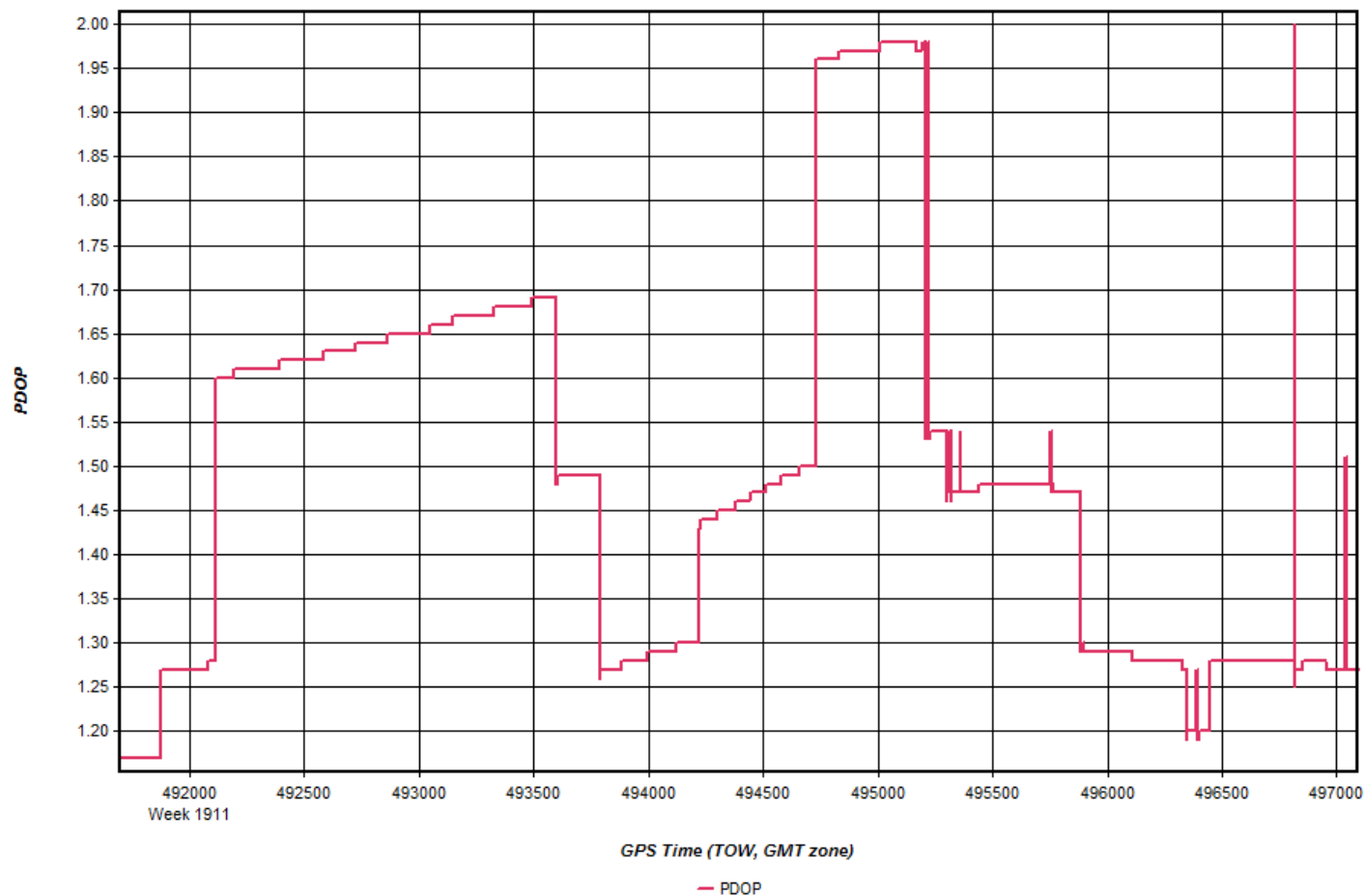
225_20160826_2



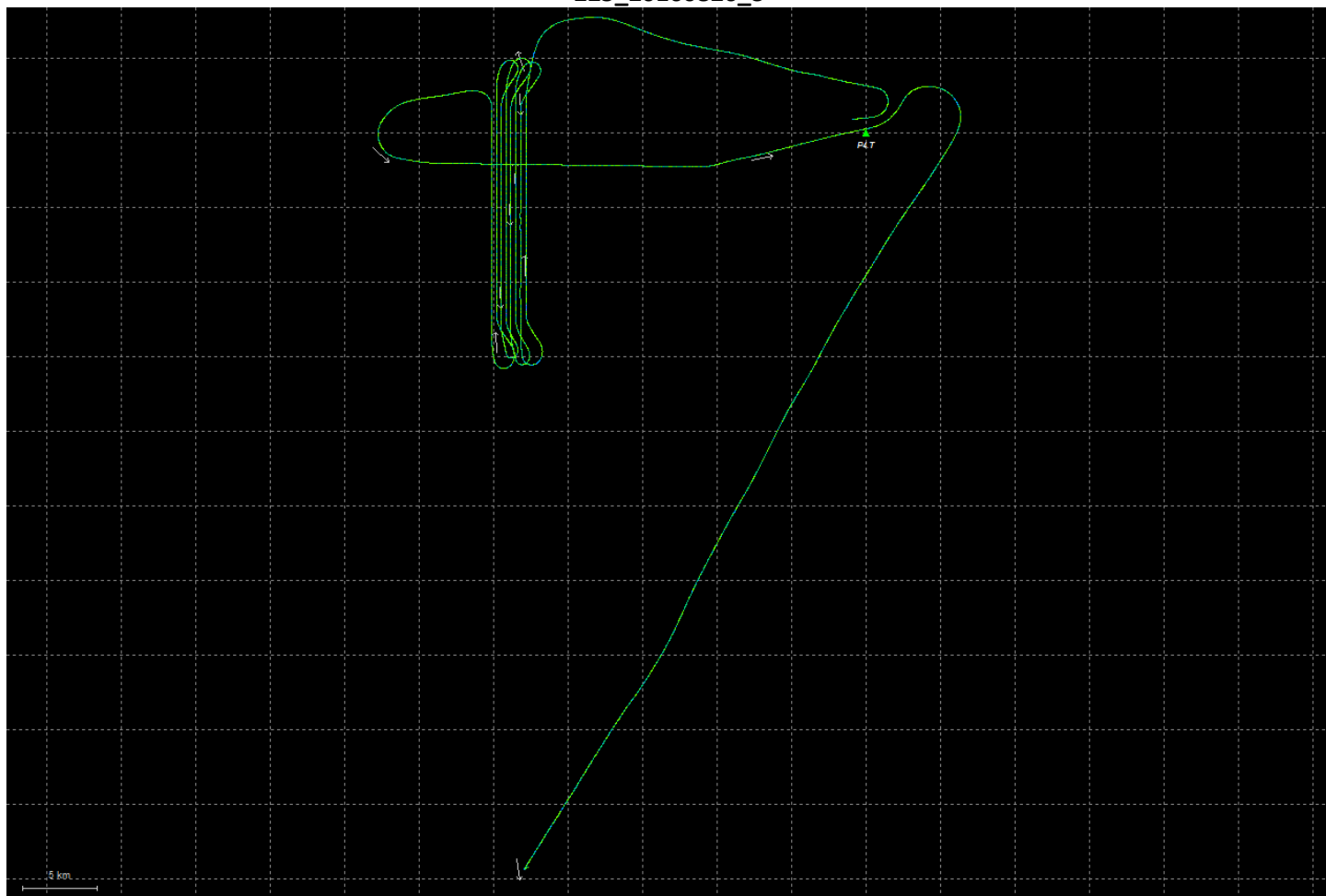


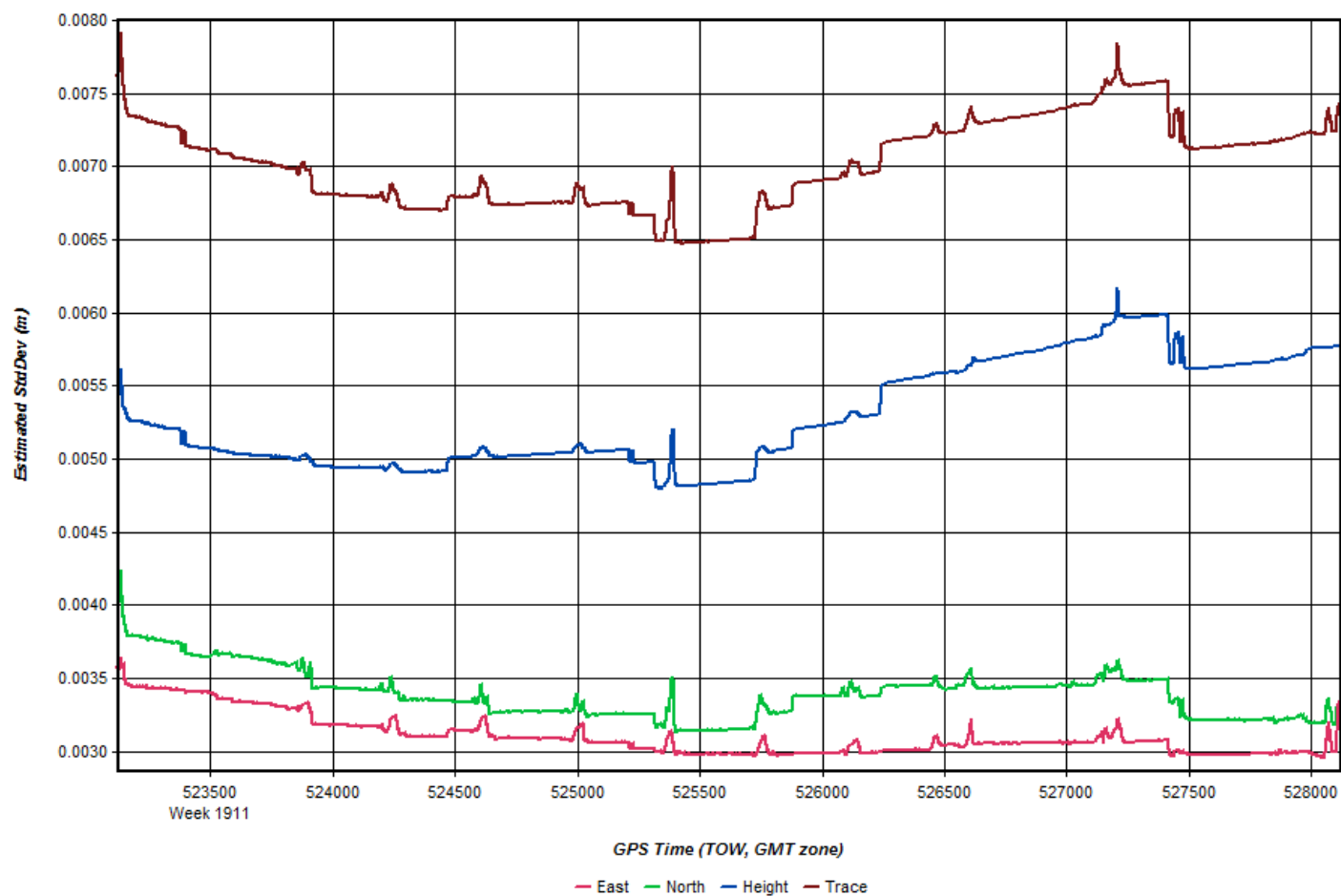


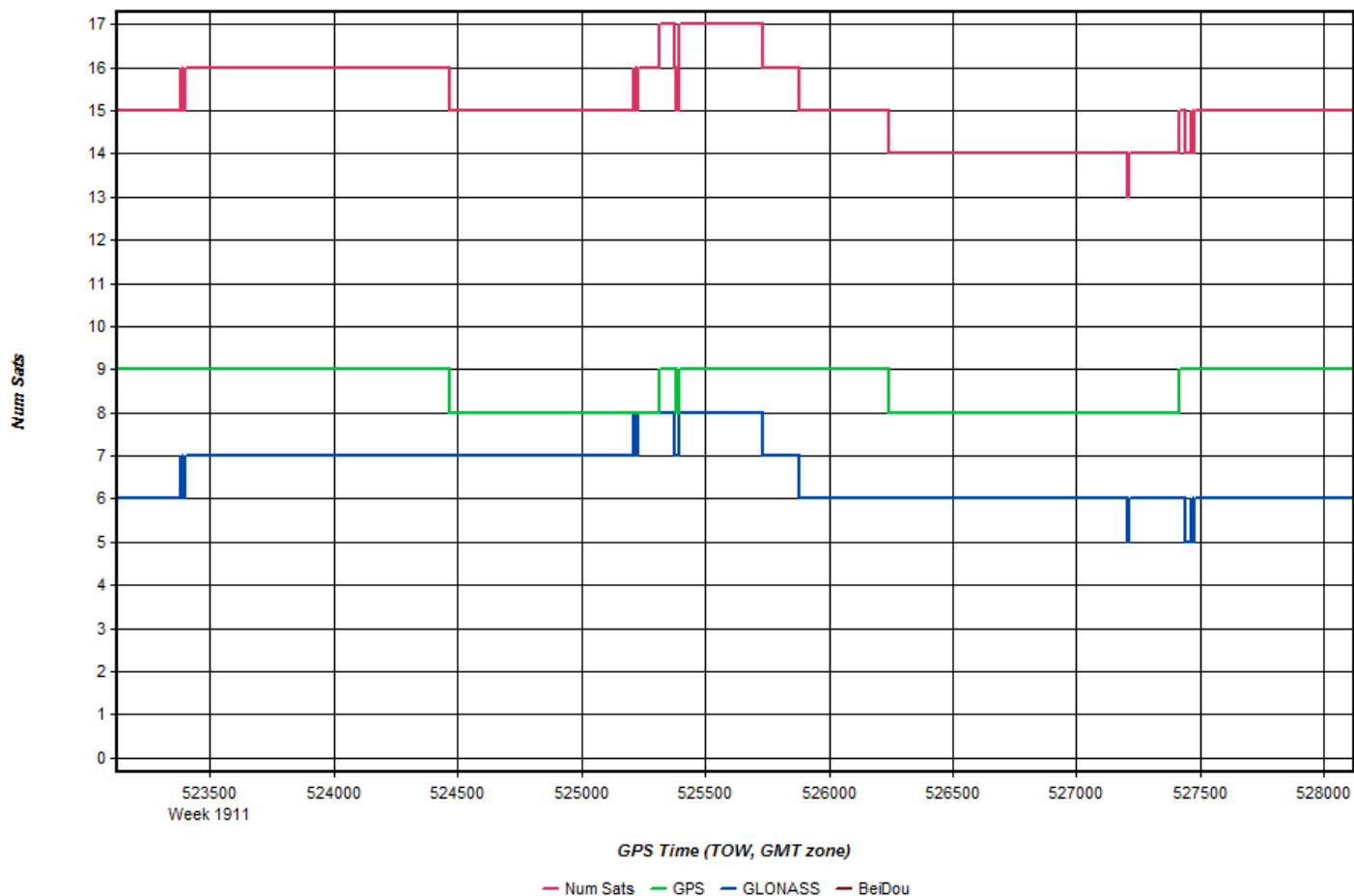


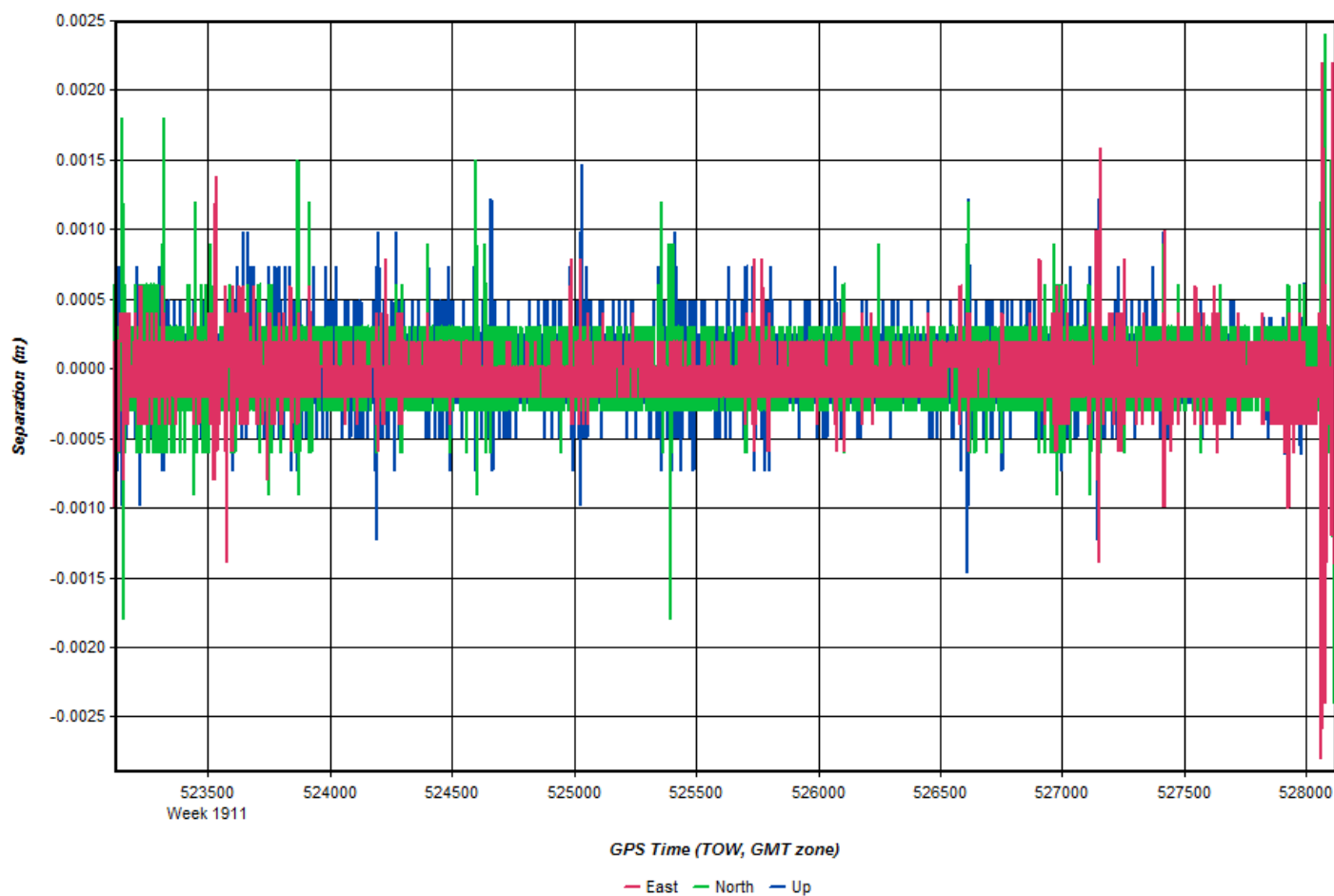


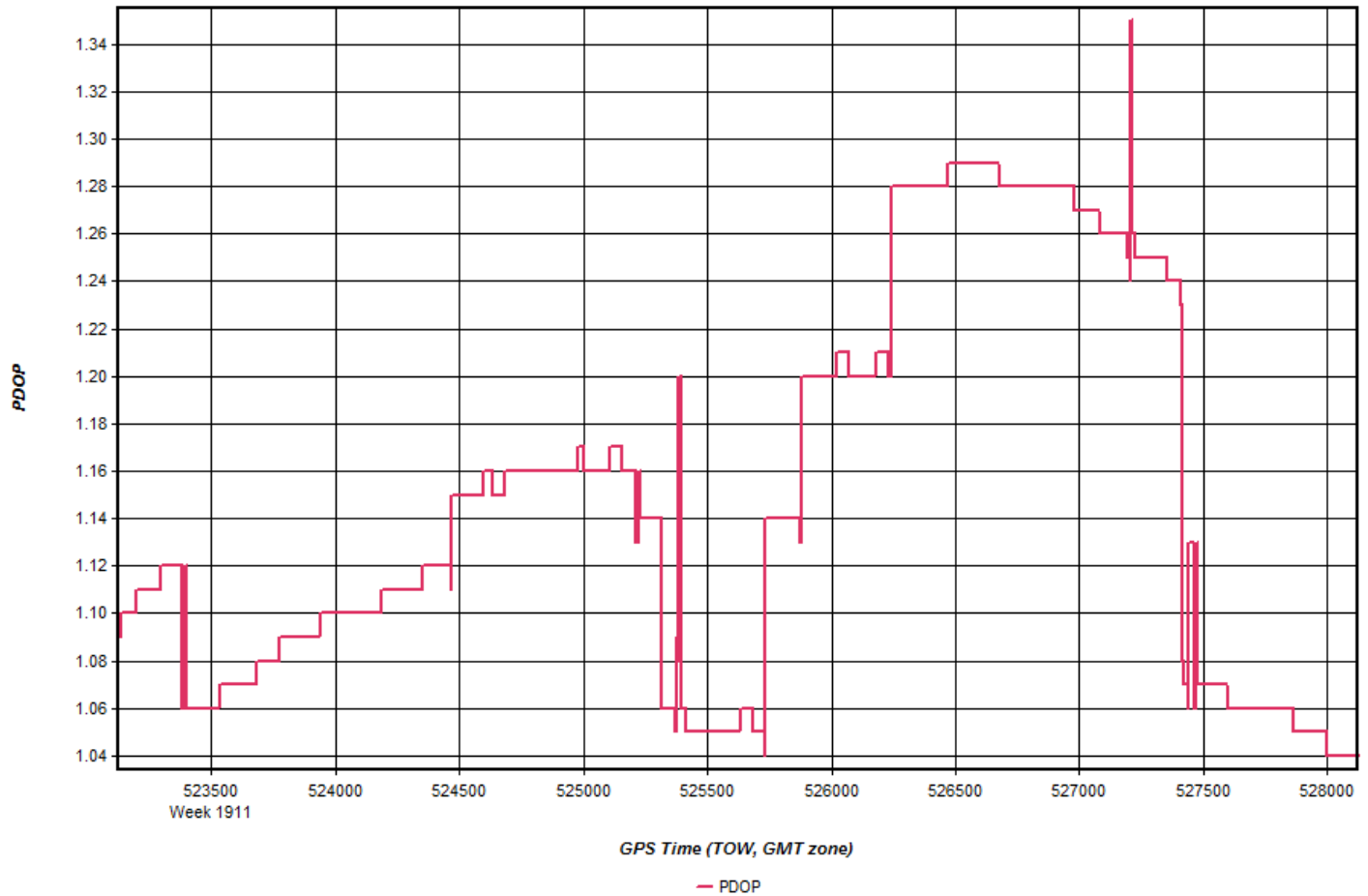
225_20160826_3



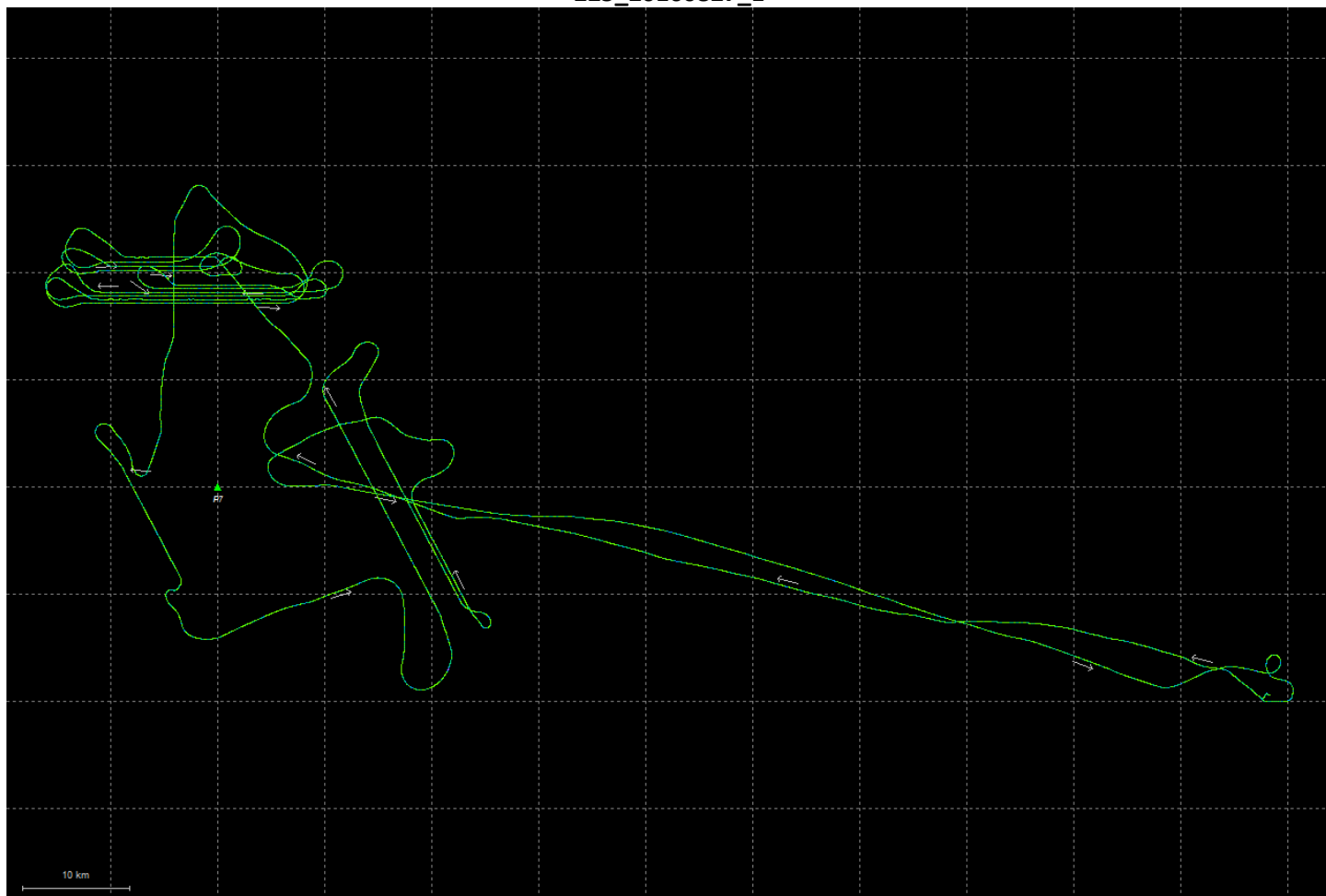


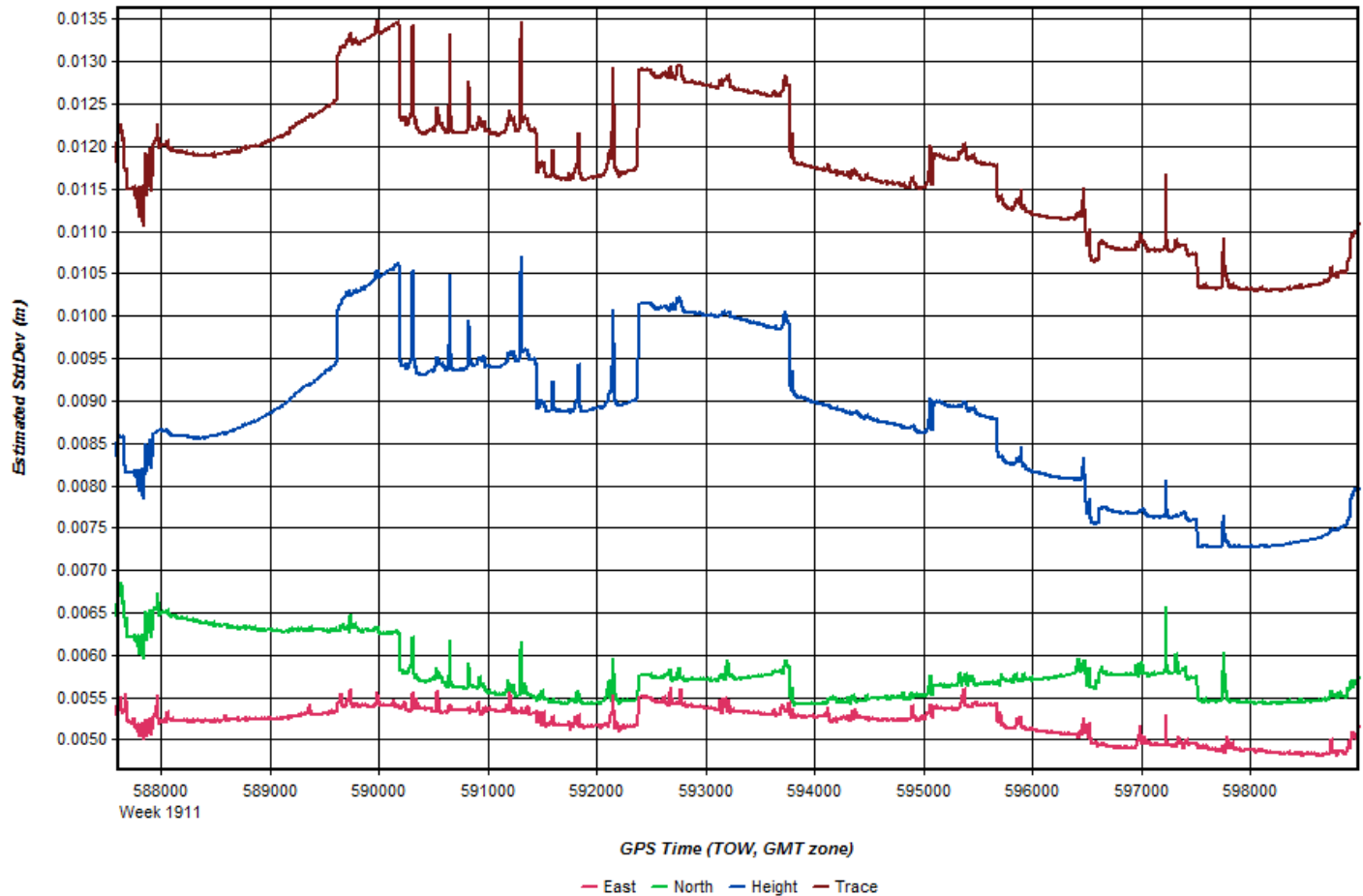


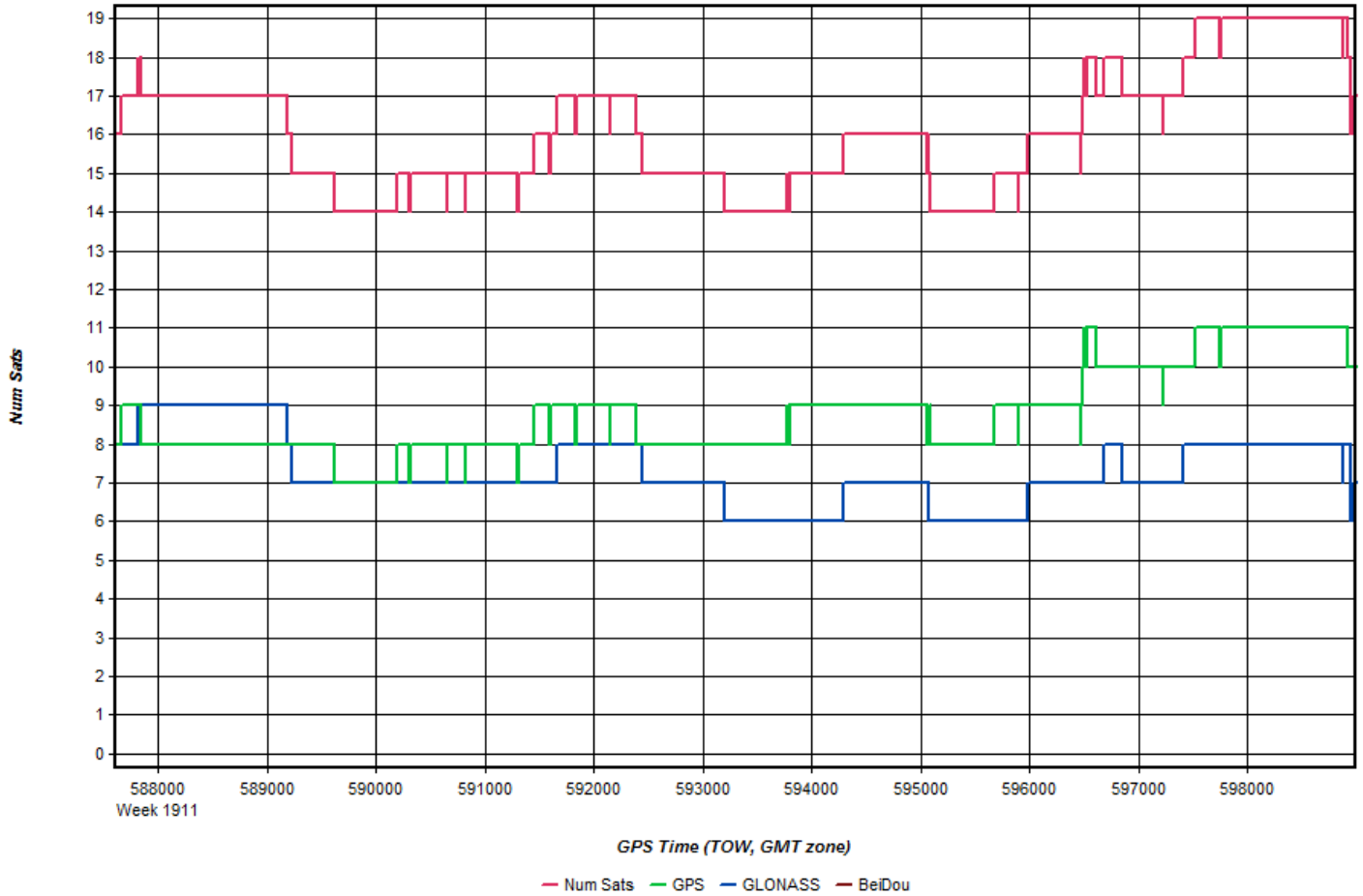


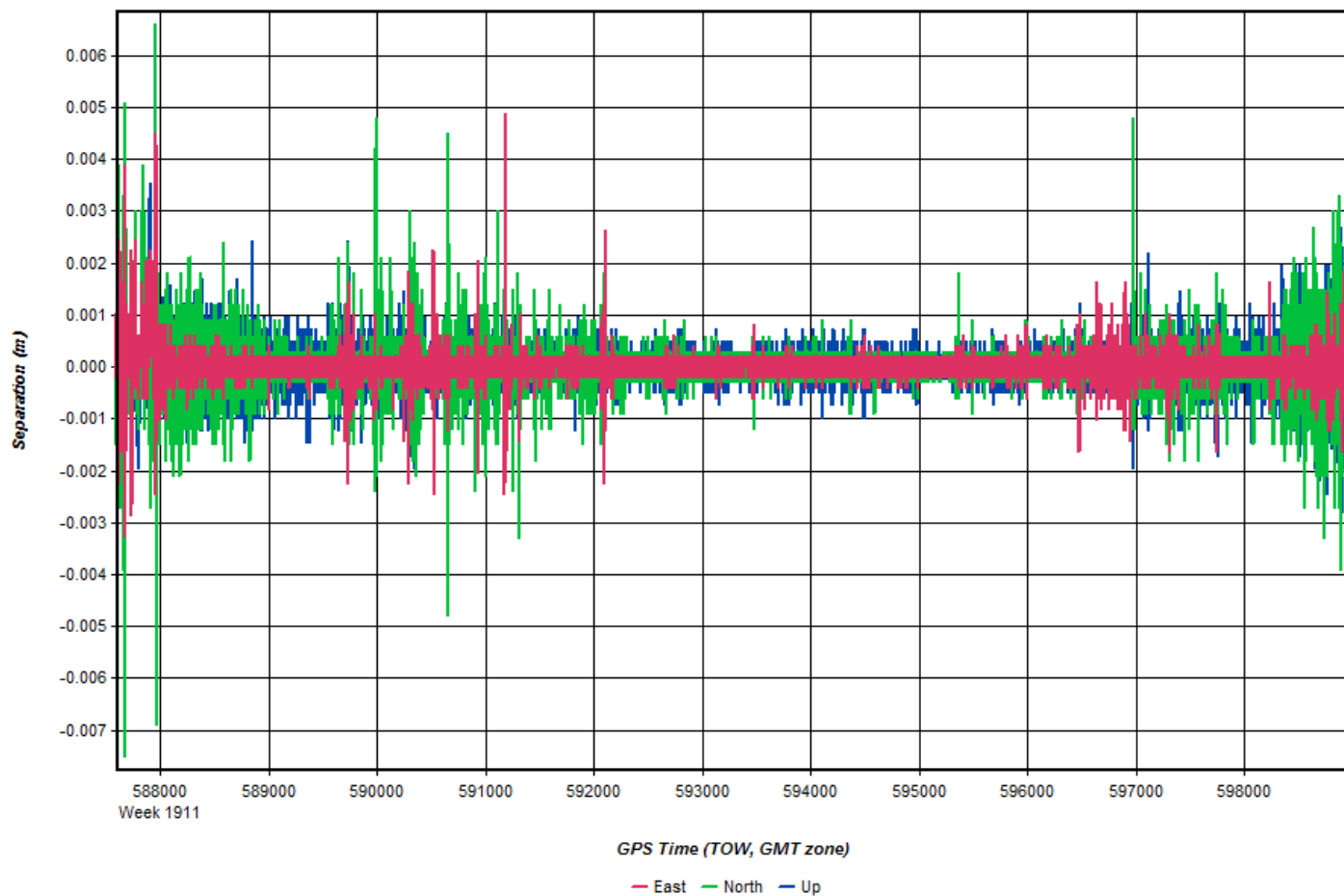


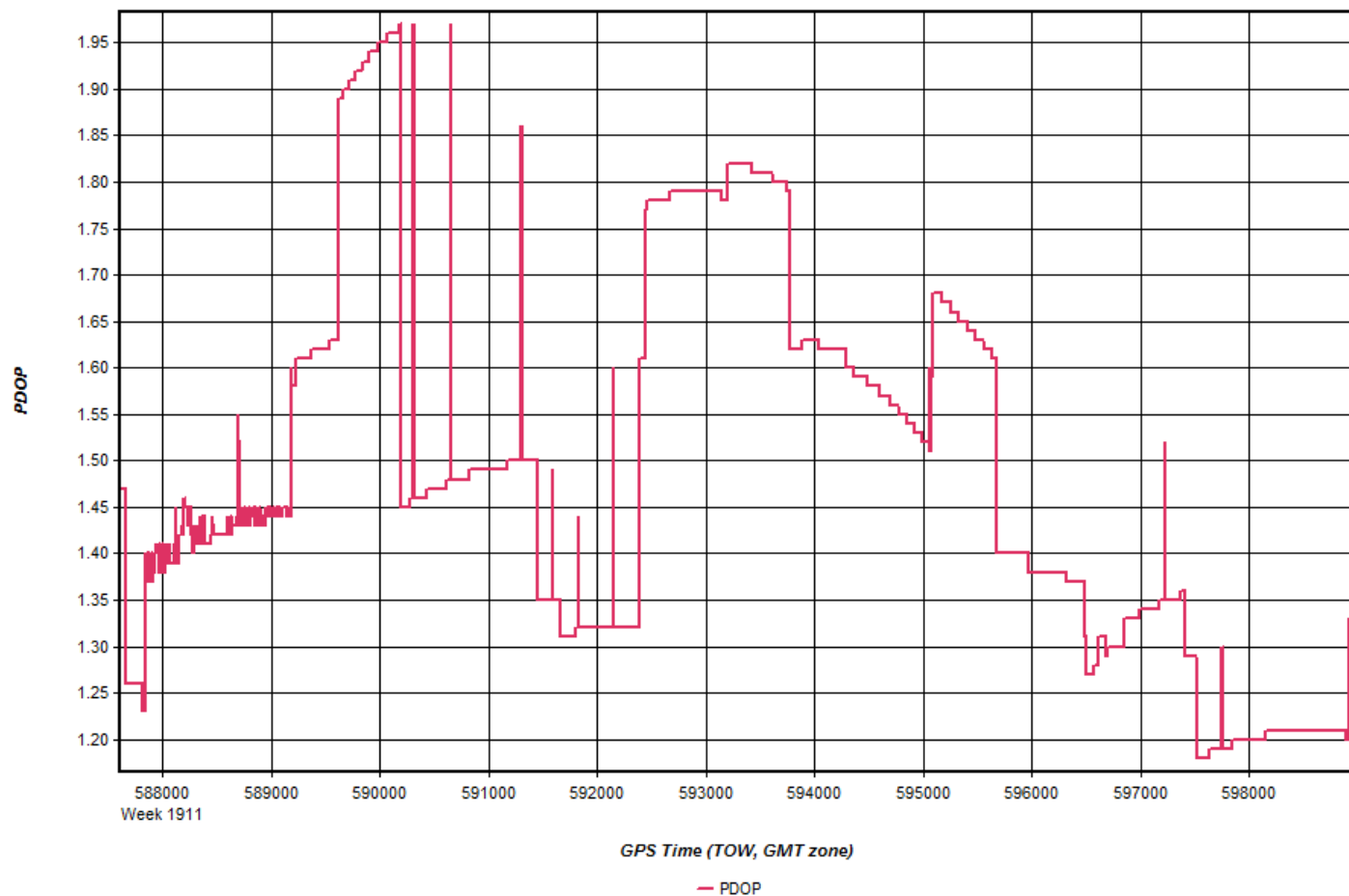
225_20160827_1



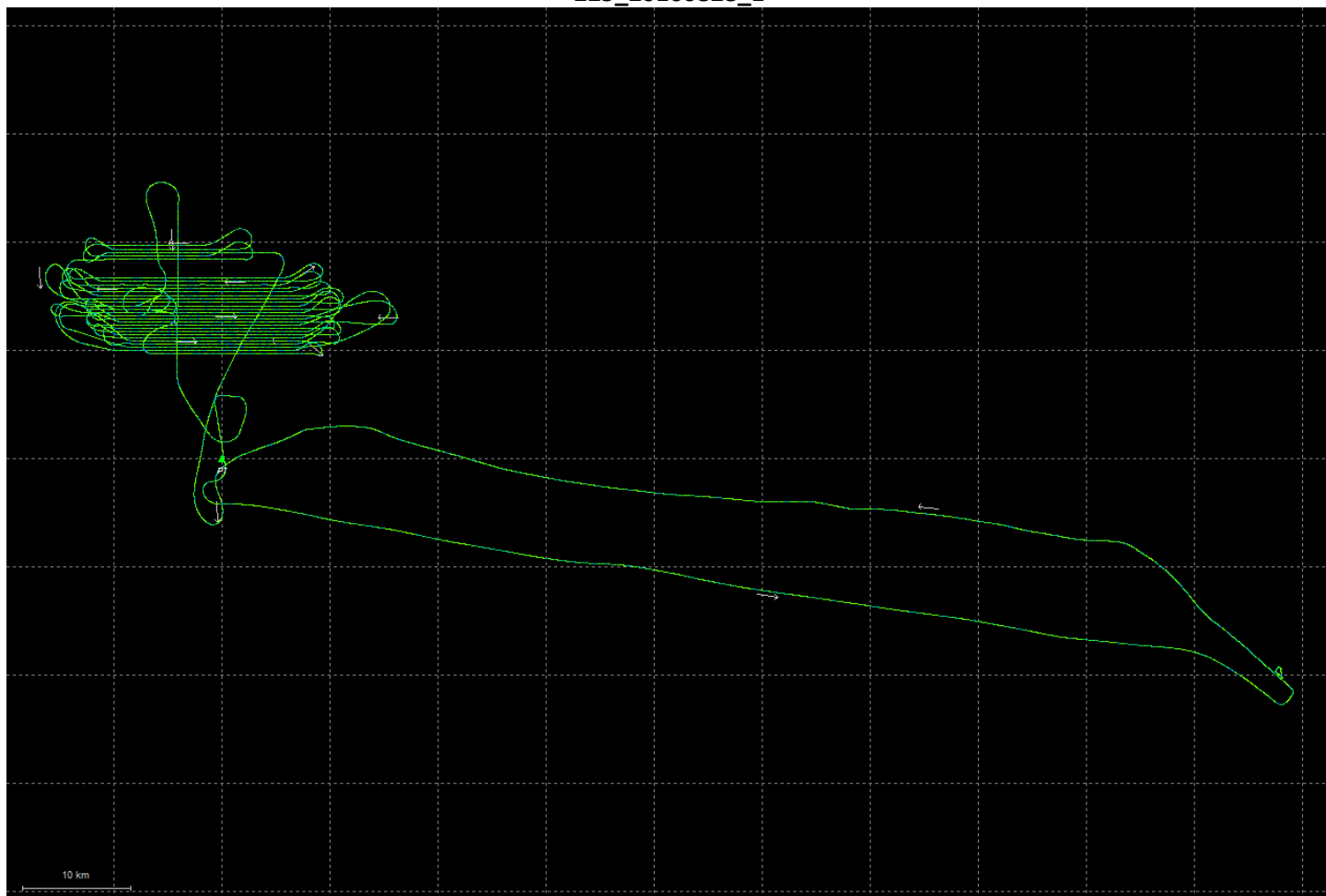


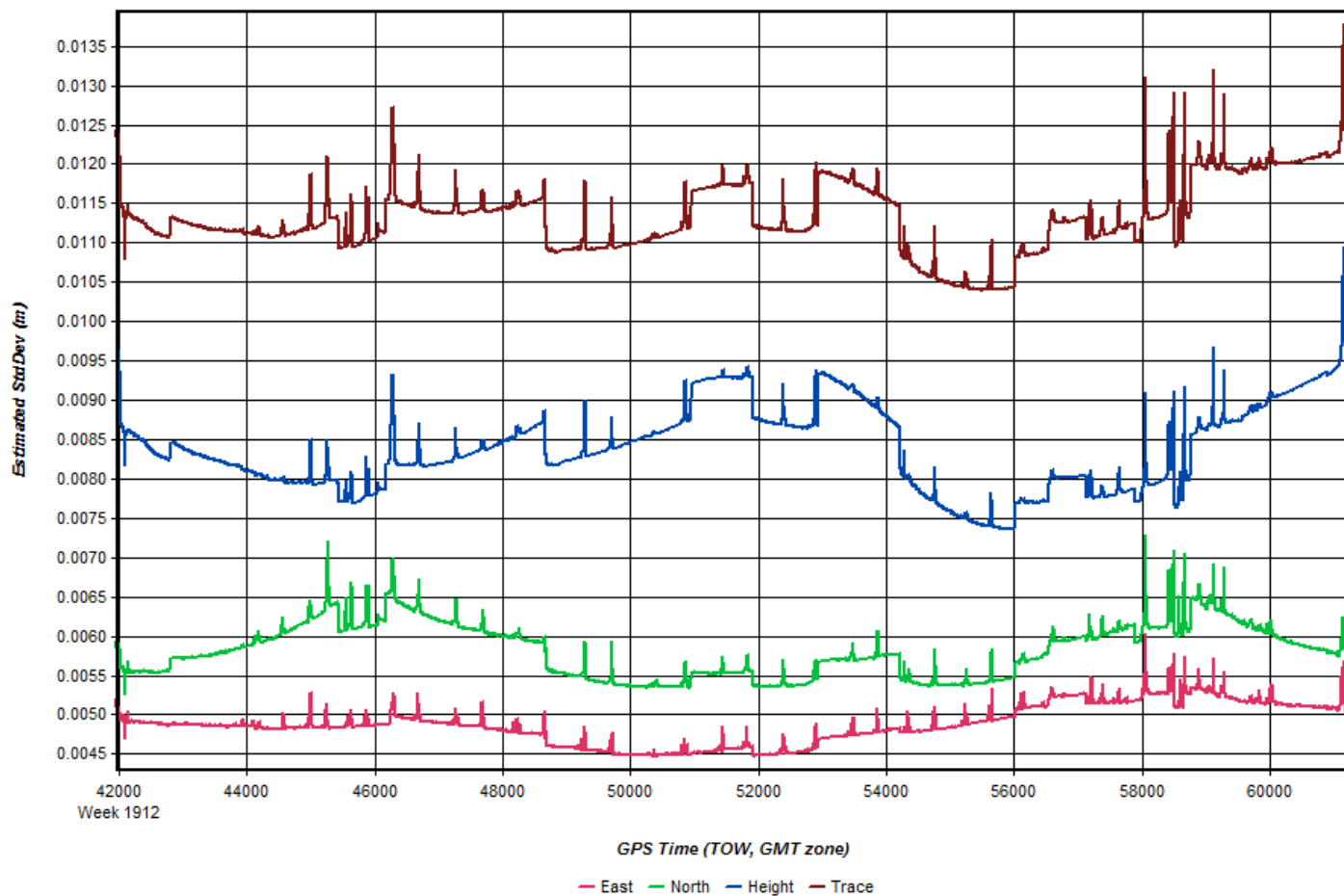


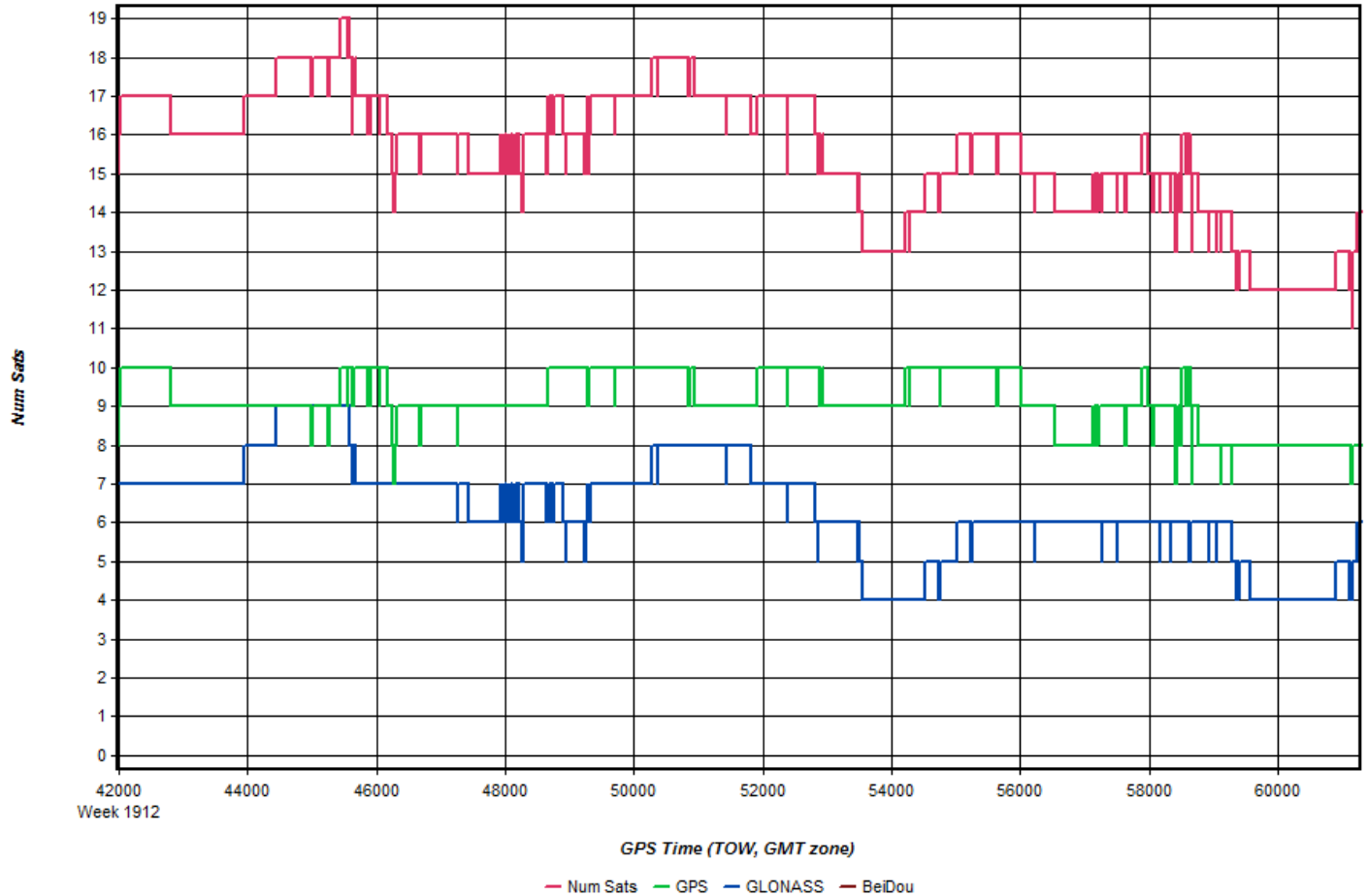




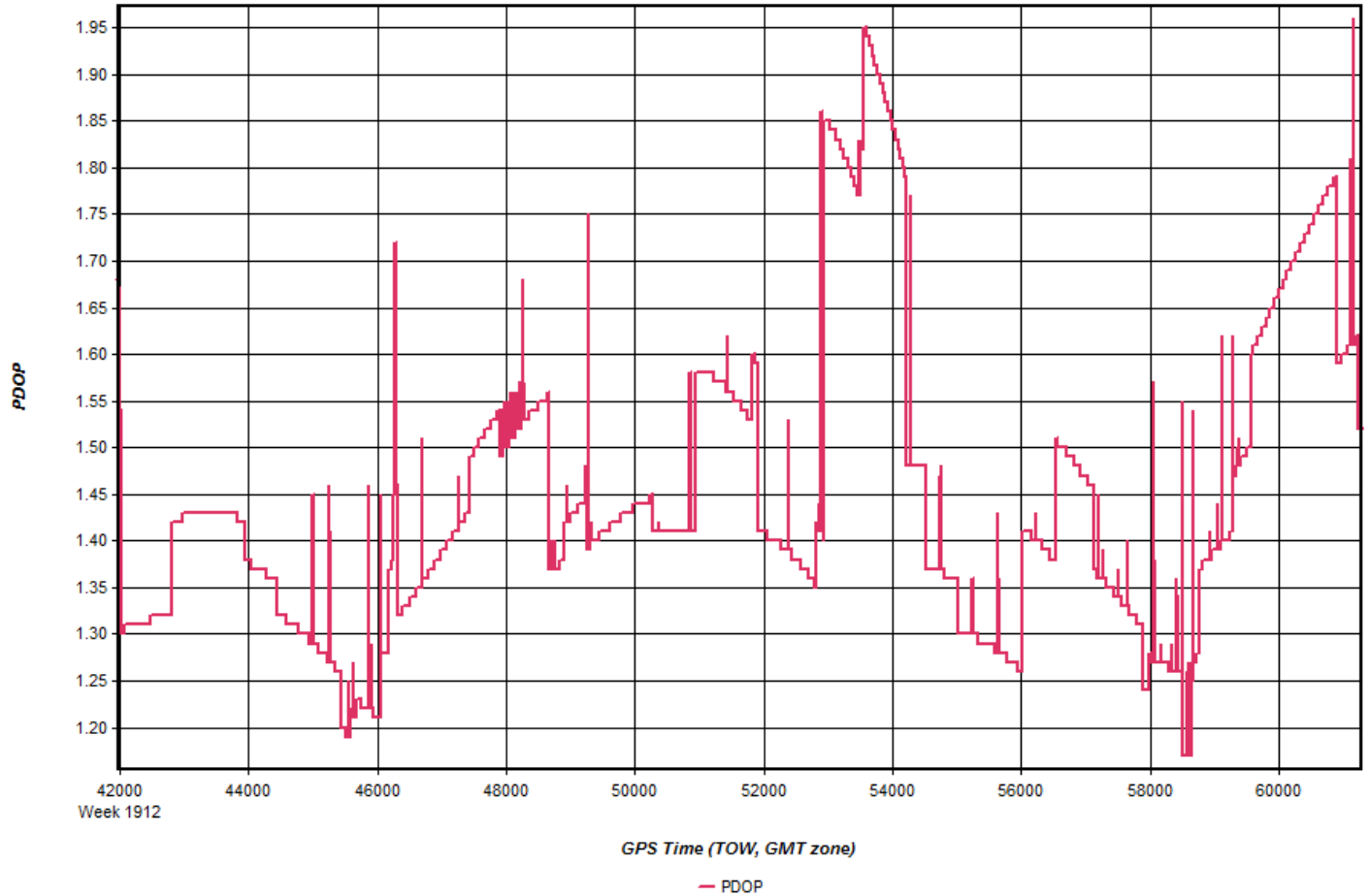
225_20160828_1



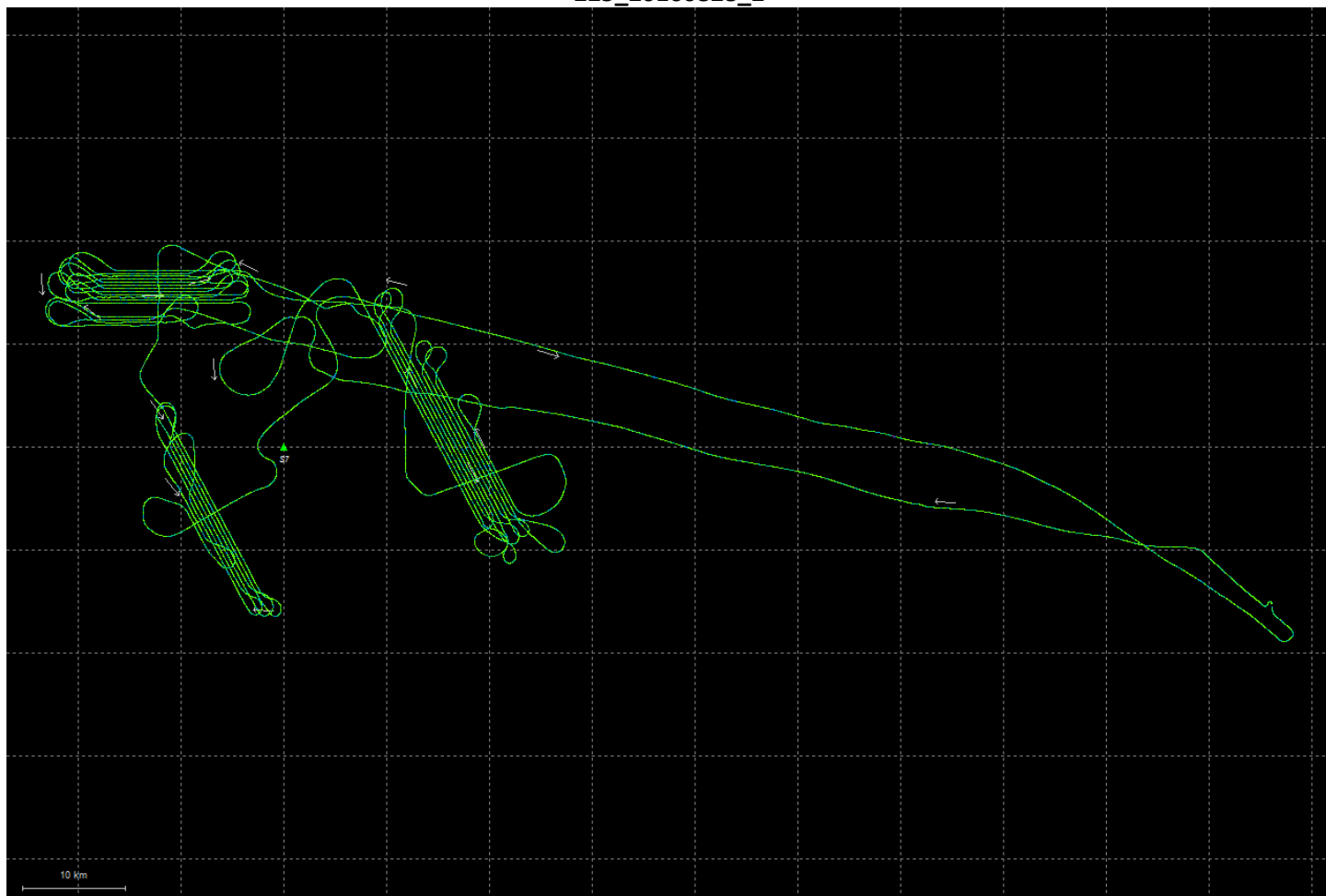


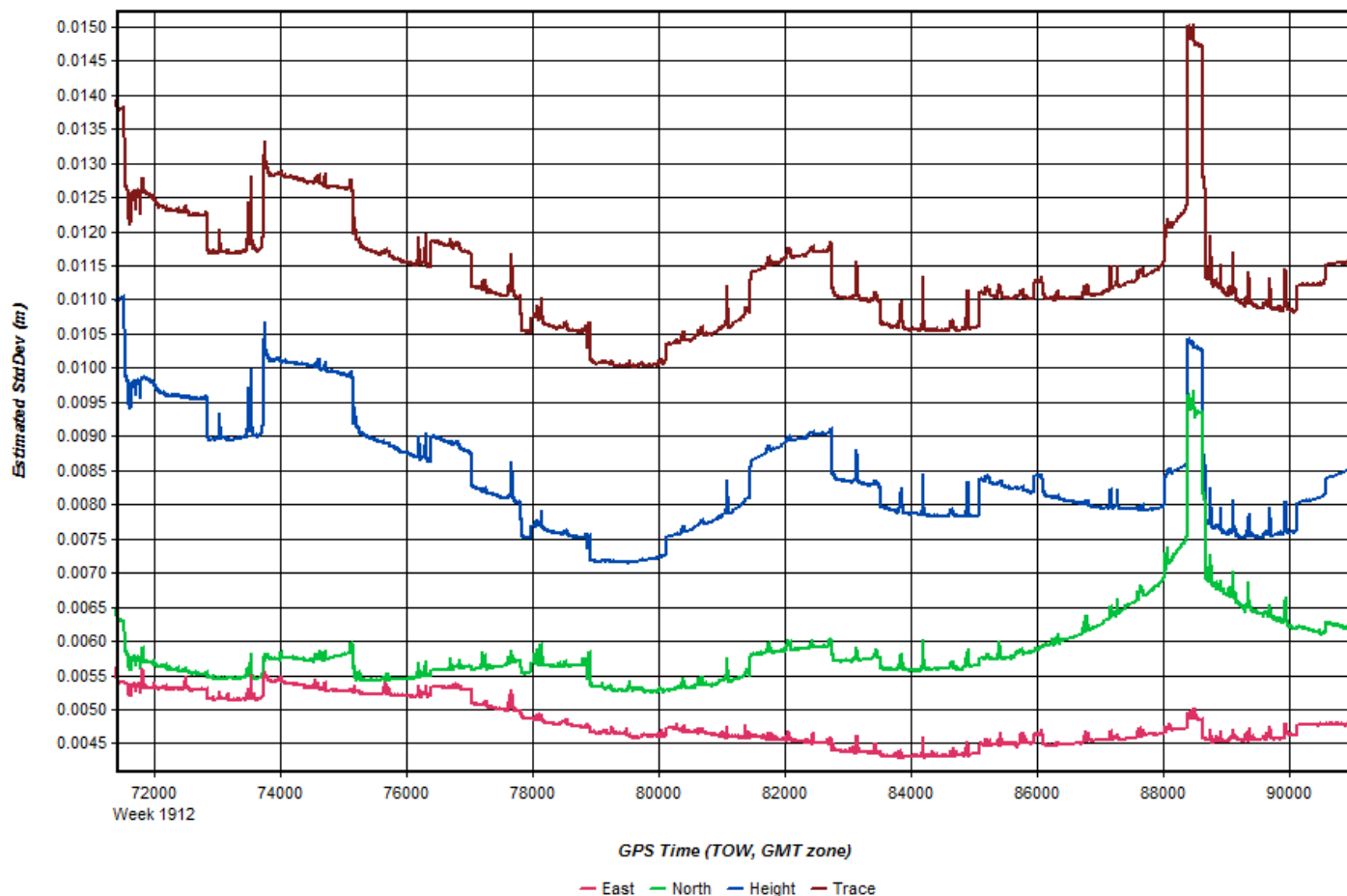




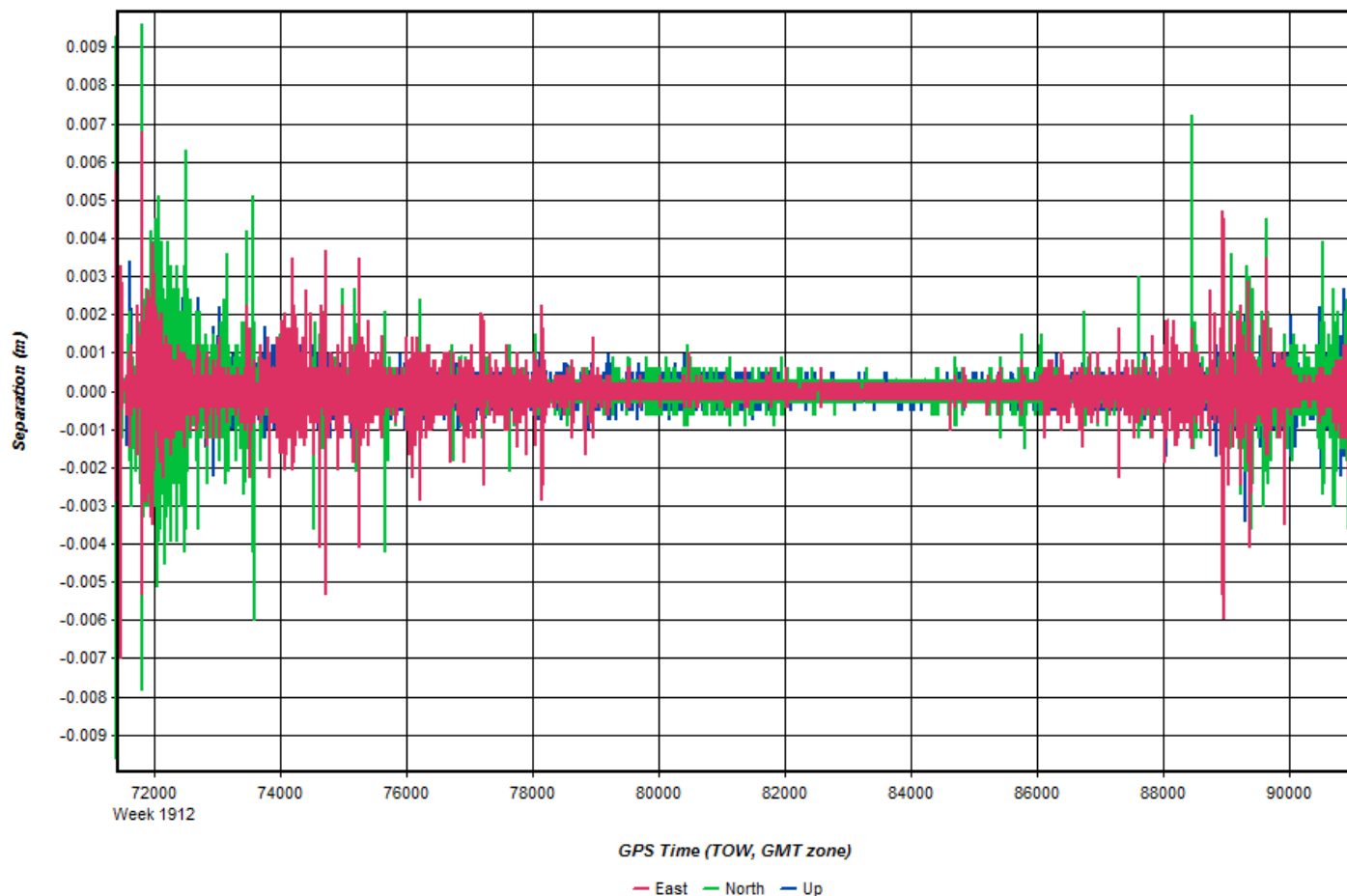


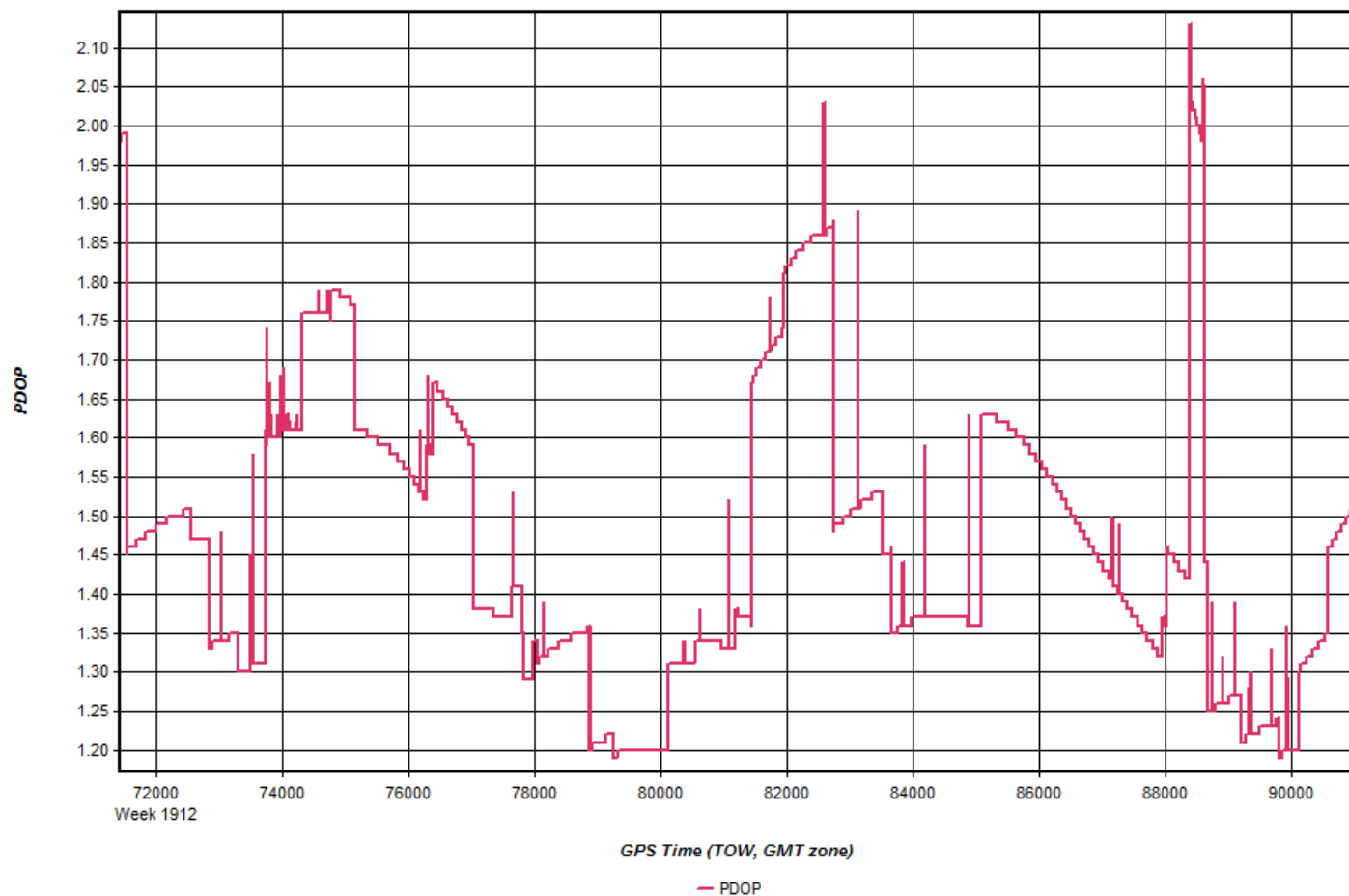
225_20160828_2



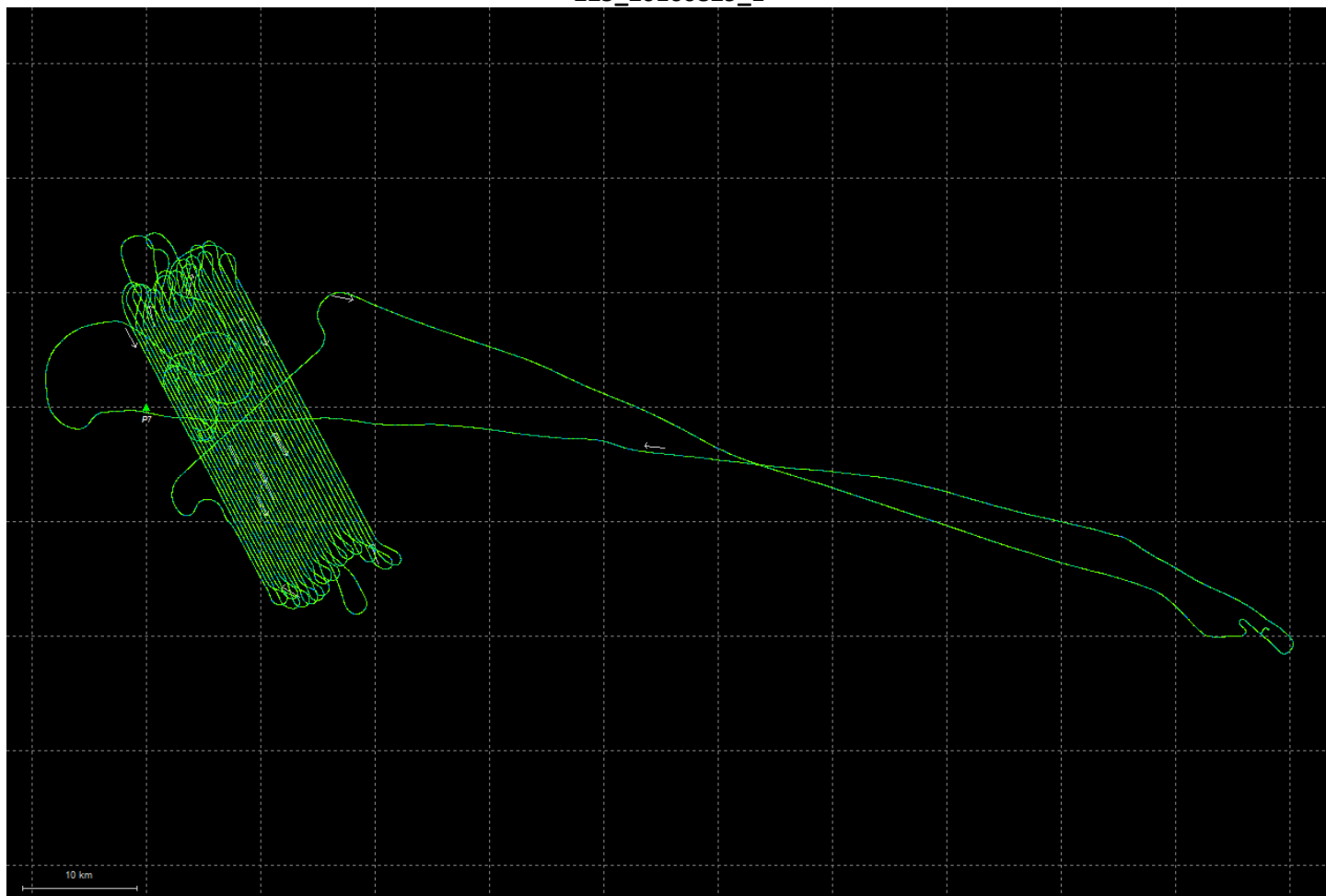


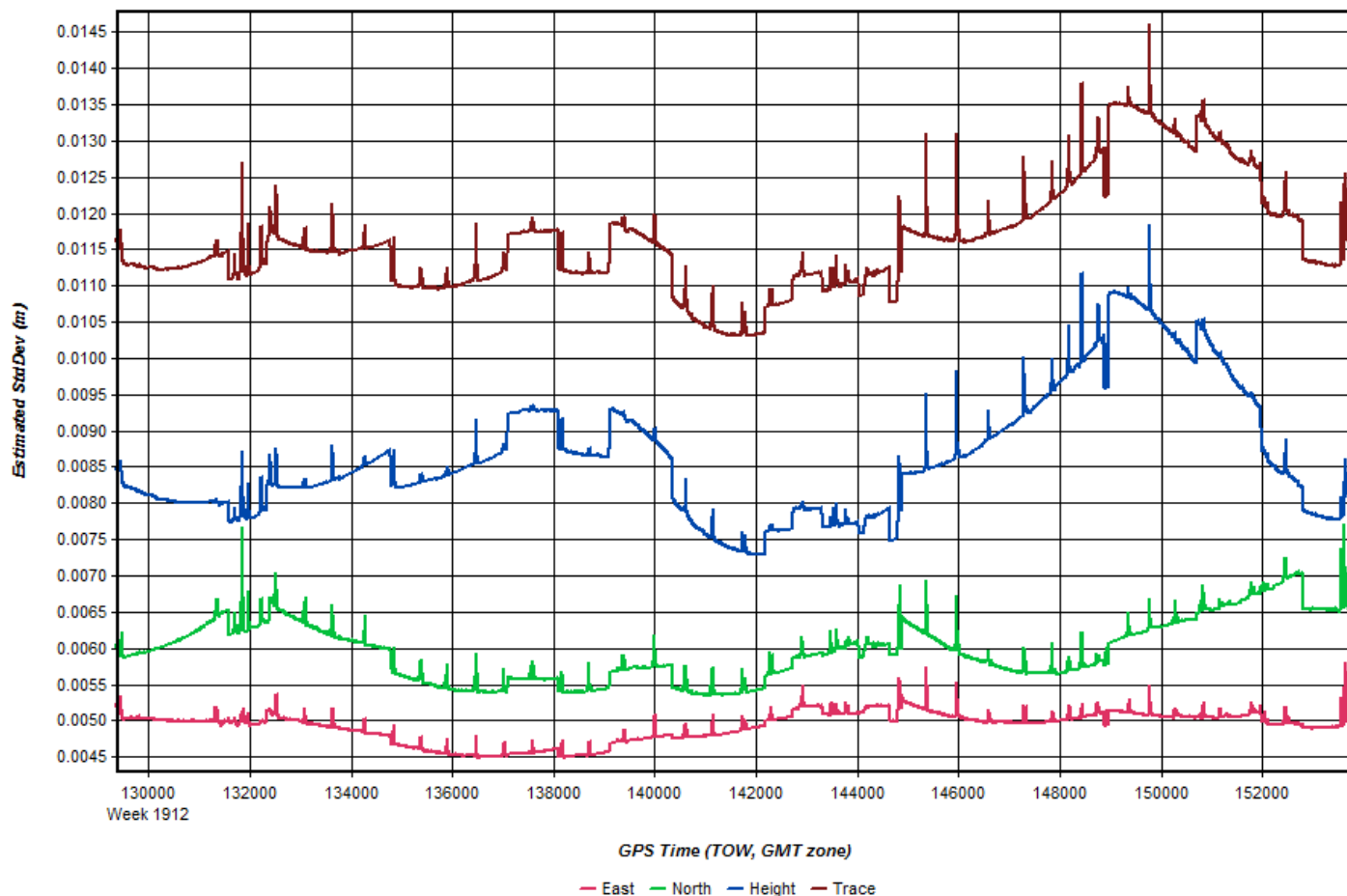


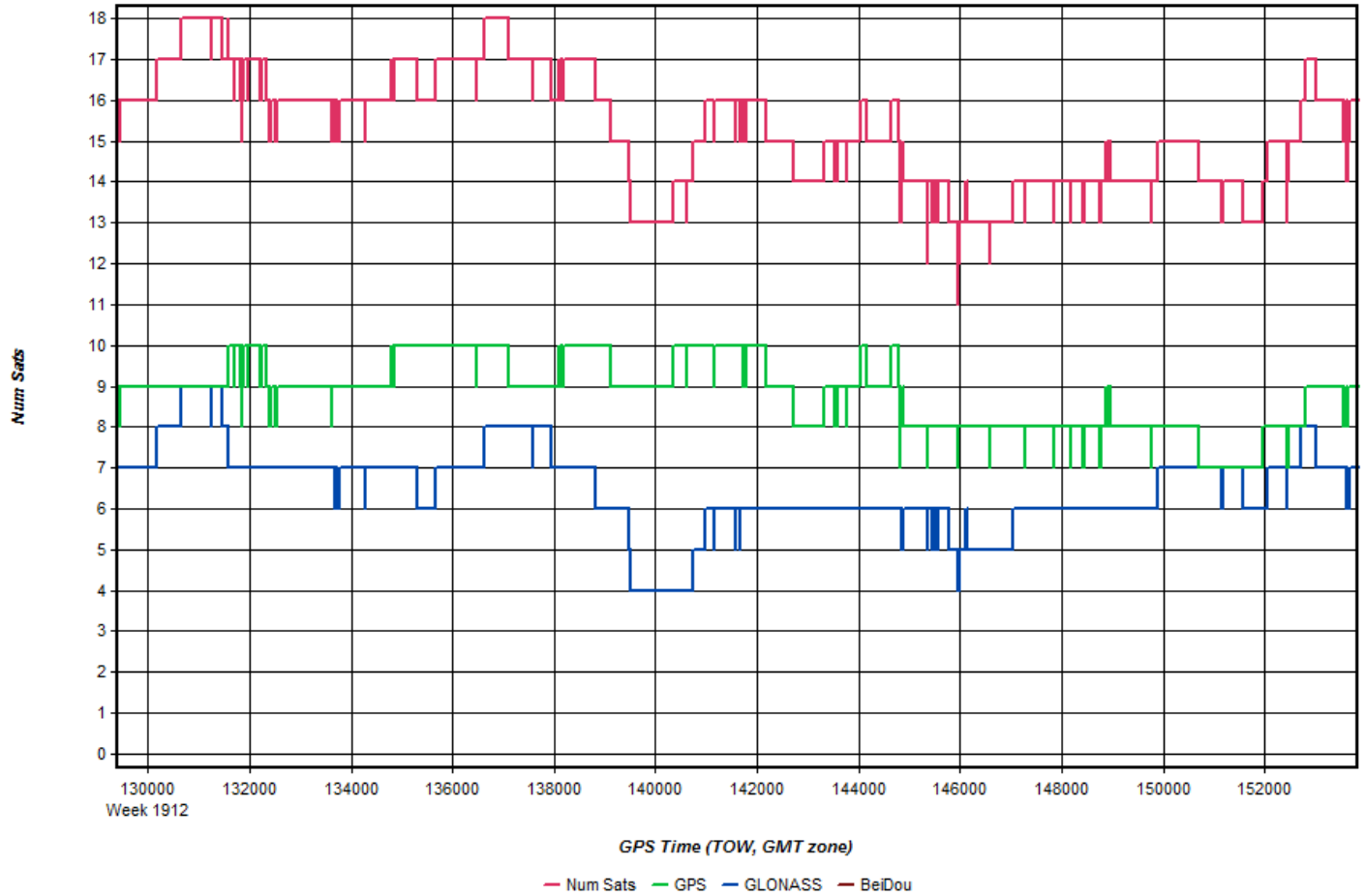


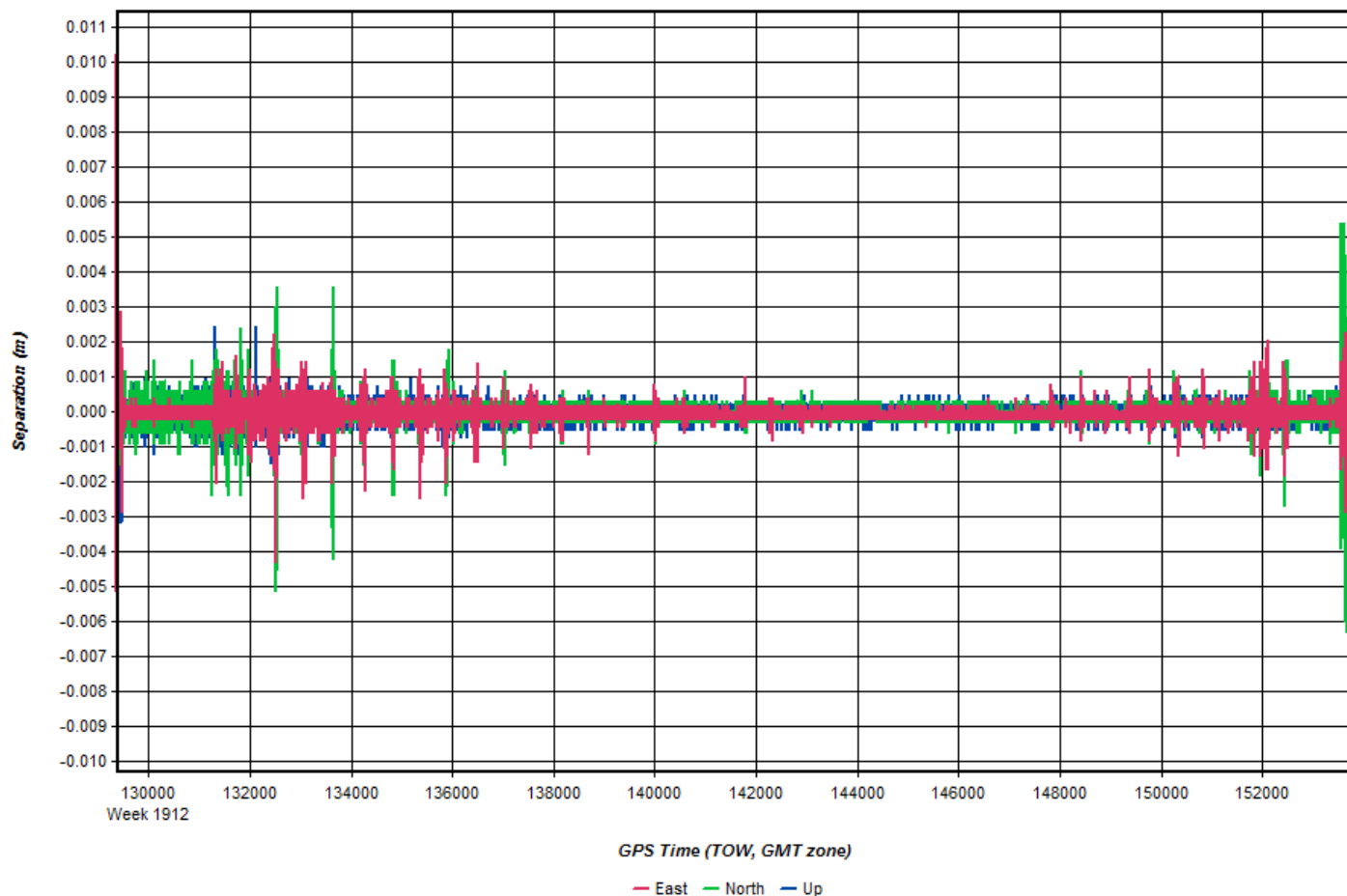


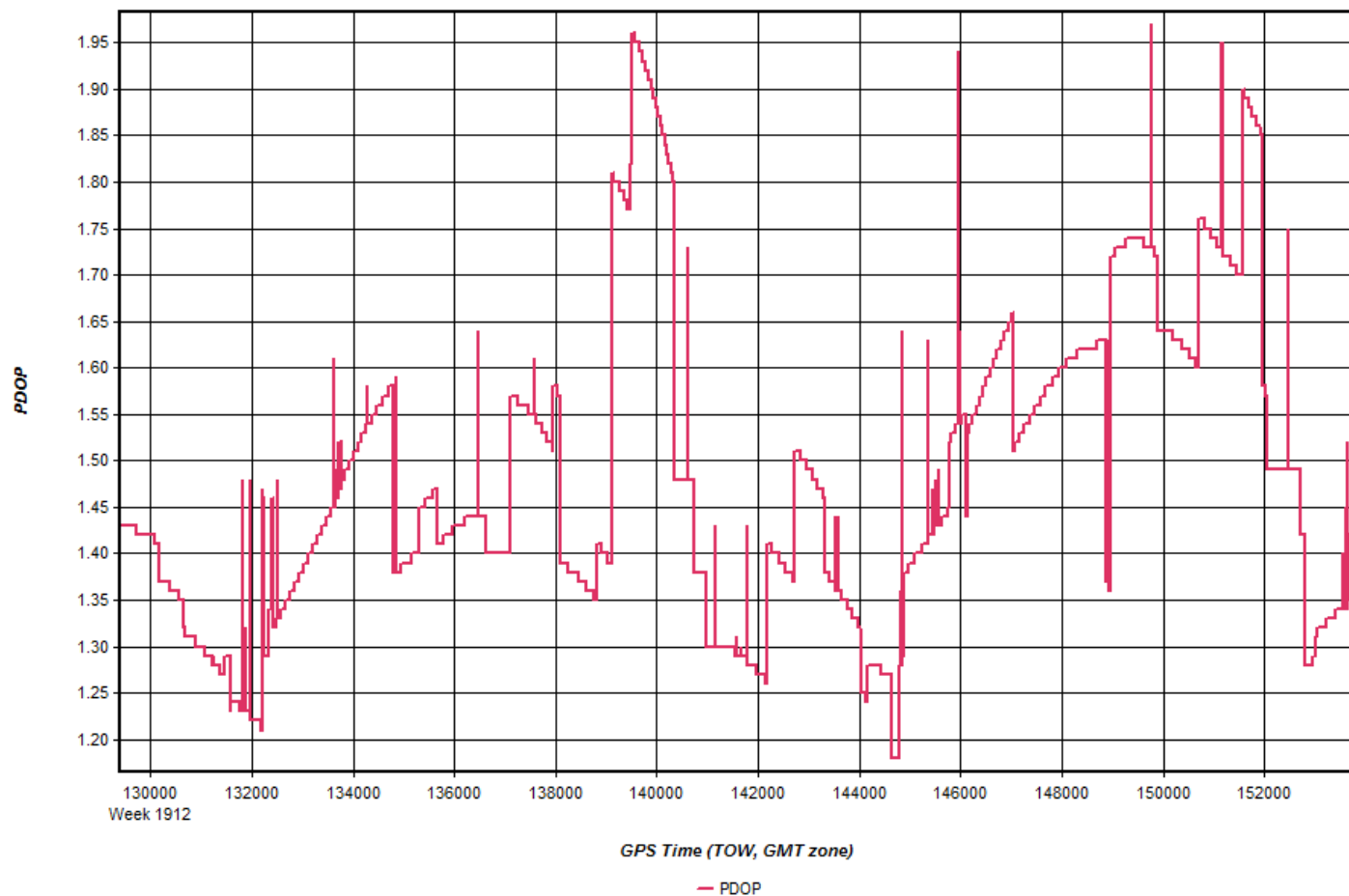
225_20160829_1











225_20160829_2



