Report on GNSS Training

Course ID: T151-40

Team No: 16

Team Members:

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Training held at GIC/AIT, Thailand

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1. TEAM 16

1.1. EXECUTIVE SUMMARY

Starting from the theoretical portion of GNSS, the whole idea with terms, concepts, family of constellation and other related association, it was very informative among all of us. Performing in fields using tools with the help of resource person was very fruitful. Converting the files from one format to another, processing and analyzing the result using RTKLIV software really helped to better understand the dynamics of the GNSS.

Also, RtkDroid which is a mobile application for android was found to be more time efficient to conduct GNSS related survey. Our group members are privileged to gain such facilitation and knowledge within small span of the time frame.

1.2. Team Members

Four members were involved in this group in training from two nationals and the details of members are listed below.

Table 1.1

Name	Affiliation	e-mail
Theerapong Chumsangsri	Faculty of Forestry, Kasetsart University, Thailand	terapong58@gmail.com
Niroj Karmacharya	NEA Engineering Company Ltd., Nepal	nirojkarma@gmail.com
Divakar Thapaliya	Asian Institute of Technology (AIT), Thailand	divakar.thapaliya@ait.asia
Piyaparn Khasuwan	Geo-informatics and Space Technology Development Agency (GISTDA), Thailand	piyaparn@gistda.or.th

1.3. Introduction

Global Navigation Satellite System (GNSS) has been adopted for various applications due to its accuracy and its reliability. GNSS have significantly improve its reliability by adding more satellites in the constellation, the receiver can receive data from multiple satellite constellations, the software can process data from multi frequency, multi constellation, which is improve the performance of positioning, navigation and timing (PNT). Not only the more data to provide more precise result but also processing technique.

1.3.1. Data capture

GNSS system uses communication system between the satellite (space unit) and the receiver (ground units) for capturing GNSS data using multiple constellation and features, various data sets can be obtained for the multiple paradigm of surveying. Latest technologies making easier for a better seizing of targeted and required data sets.

Equipment used for logging the data:

GNSS Receiver: M8T u-blox

Antenna: Single Frequency

Figure 1: Low Cost M8T u-blox receiver for logging GNSS Data

Figure 2: Data logging at field from M8T receiver using u-center

1.3.2. Post processing methods and result

1.3.2.1. Single point Positioning (SPP)

Single Point Positioning (SPP) is data capturing and processing technique in which a single observation at a specific location is performed and processed independent from other GNSS data. No base station is established and observed and the data is processed without the base station data.

Software: RTKLIB

Figure 3: RTKLIB interface

In where the following interface is embedded along with cited software.

- Rtkplot
- Rtkconv
- Rtkpost

SPP Processing was carried for various data.

- **Condition I: Data logged from M8T for 15 minutes of Observation**

Input file:

Static Observation: G16_day3.20o, G16_day3.20n Data logged for 15 minutes in RINEX3.02 GEJSC)

G16_day3.20o plot

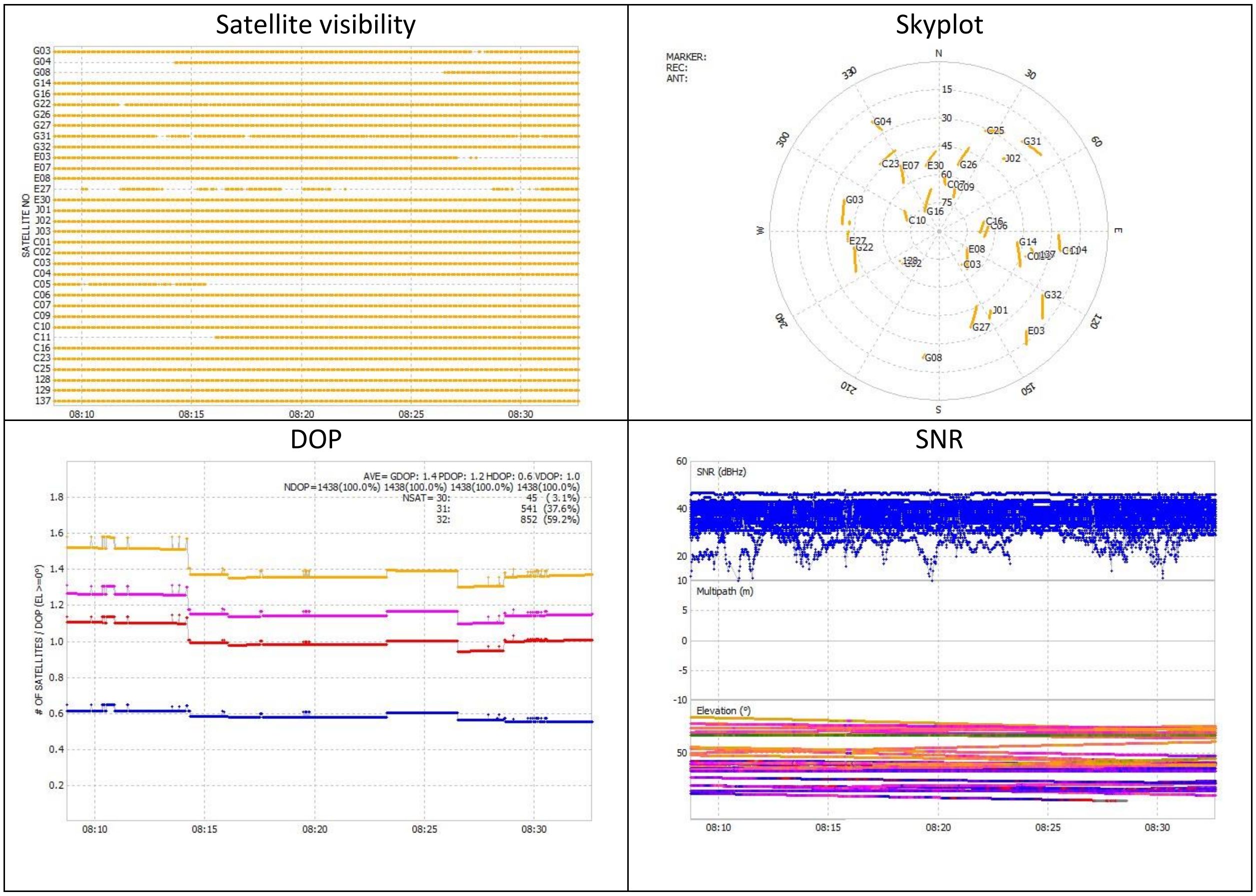


Figure 4:Data plot of logged by Team 16 showing in different formats

__Single point position (SPP) setting:__

1. Press options button then setting as following picture then click OK

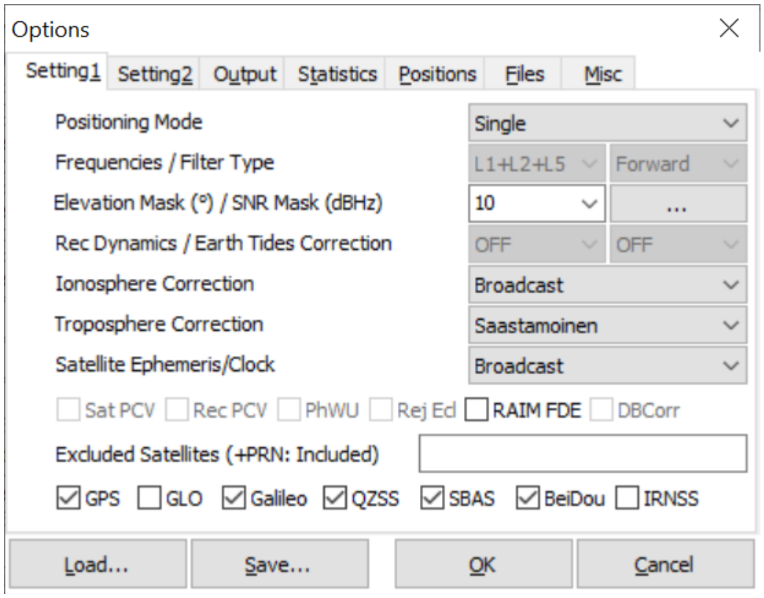


Figure 5: Setup in Setting 1 for SPP Processing

Note: Unchecked the GLO and IRNSS constellations because we don't have any satellite in the input file.

2. Selected the **G16_day3.20o** file for RINEX OBS and **G16_day3.20n** file for RINEX NAV and rename the output file then click on Execute button as shown the following figure.

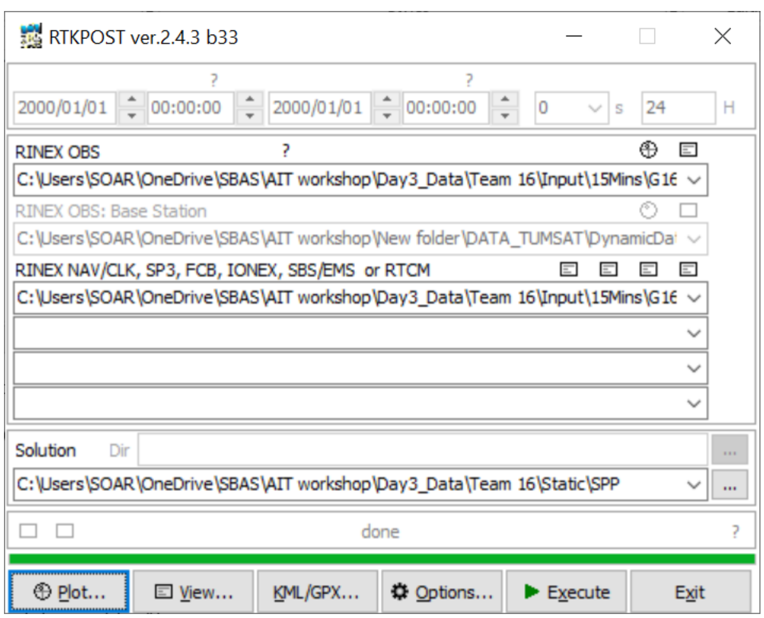


Figure 6: Setup in Setting 2 for SPP processing

- **Condition II: Data logged from M8T and R9 with zero baseline for 24 hours of Observation**

Input file :

Station 1 file: 01022920B.19o(observation file) and 01022920B.19n(navigation file) observed from NET R9

Station 2 file:20191019.0bs (observation file) and 20191019.nav(navigation file) observed from M8T

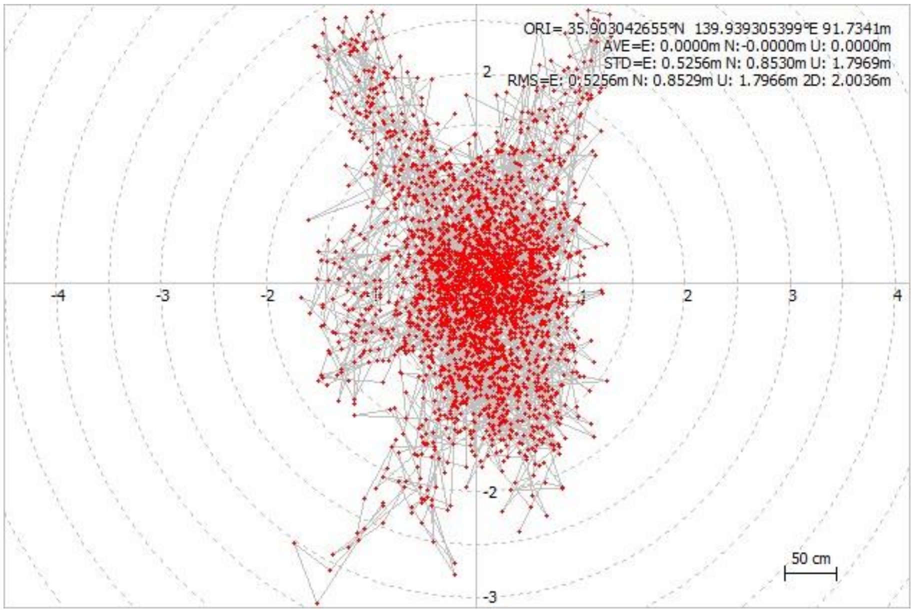


Figure 7: SPP result of NET R98

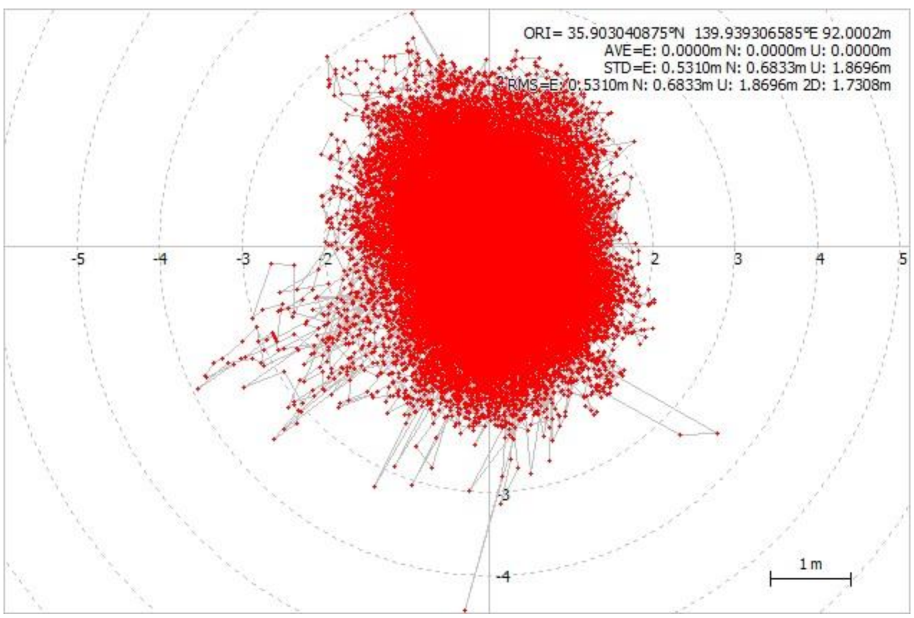


Figure 8: SPP result of M8T

1.3.2.2. DGPS Processing Method

DGPS processing method using the continuously observing base station data for processing the rover data. The DGPS processing method uses various correcting like ionospheric error, tropospheric error e.t.c.

Input file :

Base Station file: 01022920B.19o(observation file) and 01022920B.19n (navigation file) observed from NET R9

Rover Station file:20191019.0bs (observation file) and 20191019.nav (navigation file) observed from M8T

<u>Differential Global Position System (DGPS) setting:</u>

1. Press options button then change the positioning mode to DGPS/DGNSS as following picture.

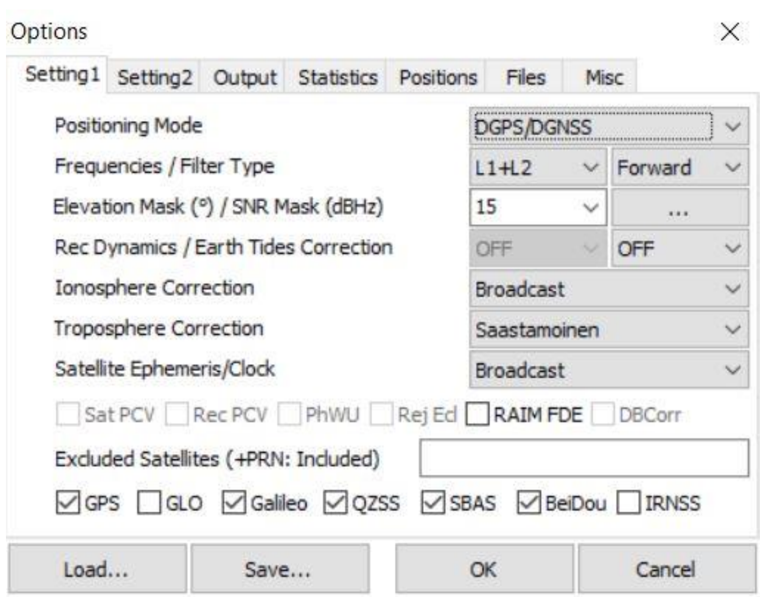


Figure 9: Setting1 for DGPS/DGNSS processing

2. Selected on Setting2 tab change the Integer Ambiguity Res to continuous or instantaneous menu

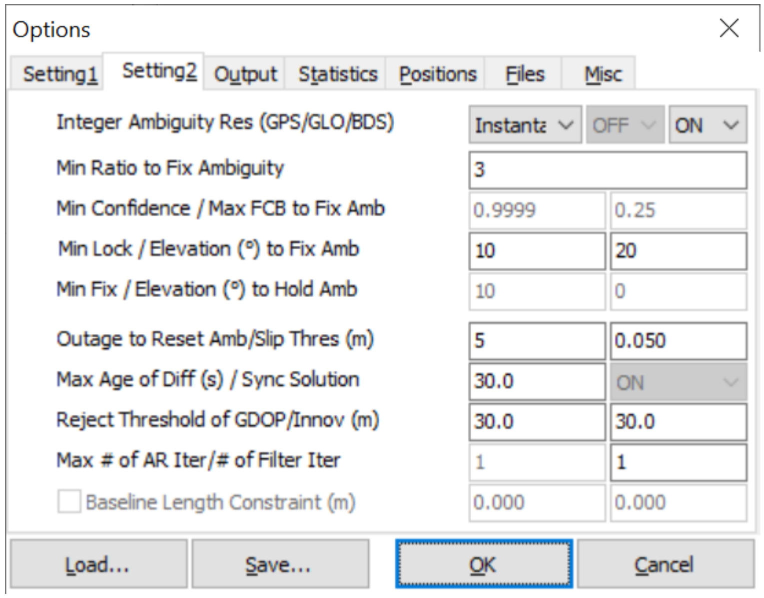


Figure 10: Setting 2 for DGPS.DGNSS processing

3. Selected on Positions tab for input the Base station coordinate then click OK

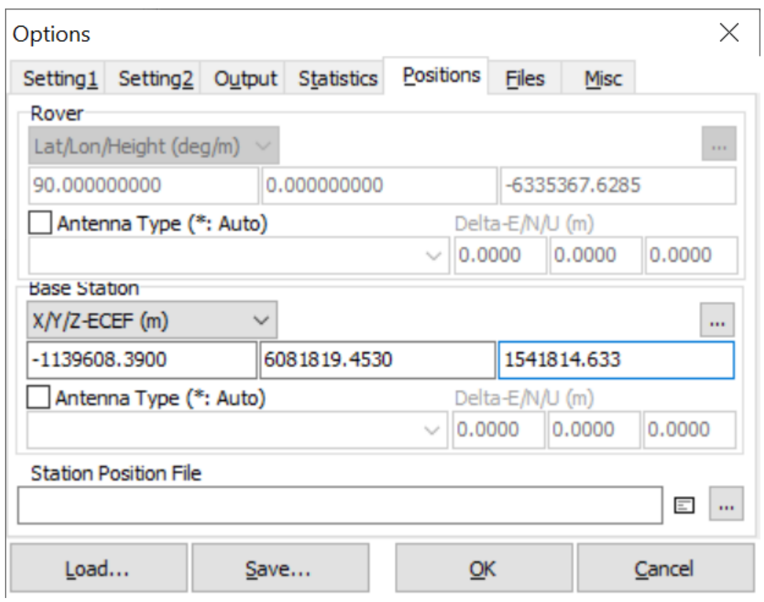
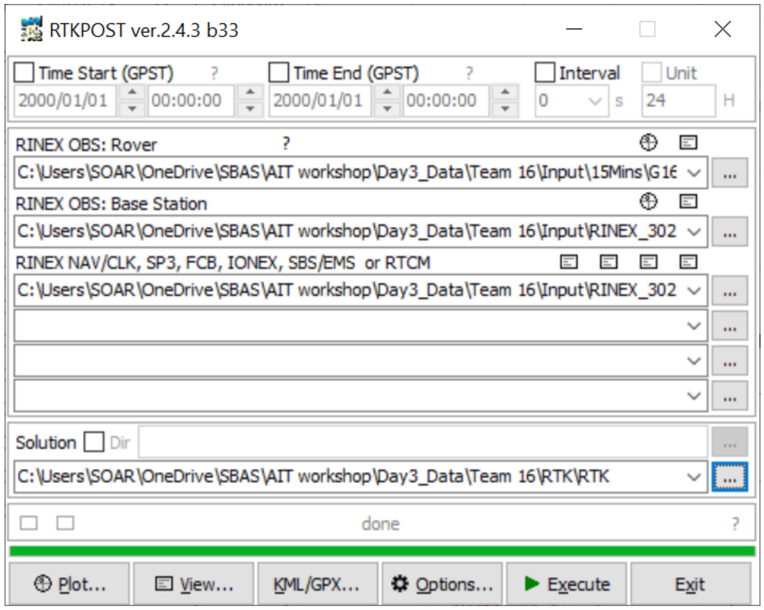


Figure 11: Positions setting for DGPS/DGNSS

4. Selected the **G16_day3.20o** file for RINEX OBS: ROVER, **5423R48741202001080754F.20o** file for RINEX OBS: Base station and **5423R48741202001080754F.20*** file for RINEX NAV and rename the output file then click on Execute button as shown the following figure



Note: If there are several navigation files for specific constellations, selected one file and change the c,g,h,l,n,q into (*) to use all of the navigation files.

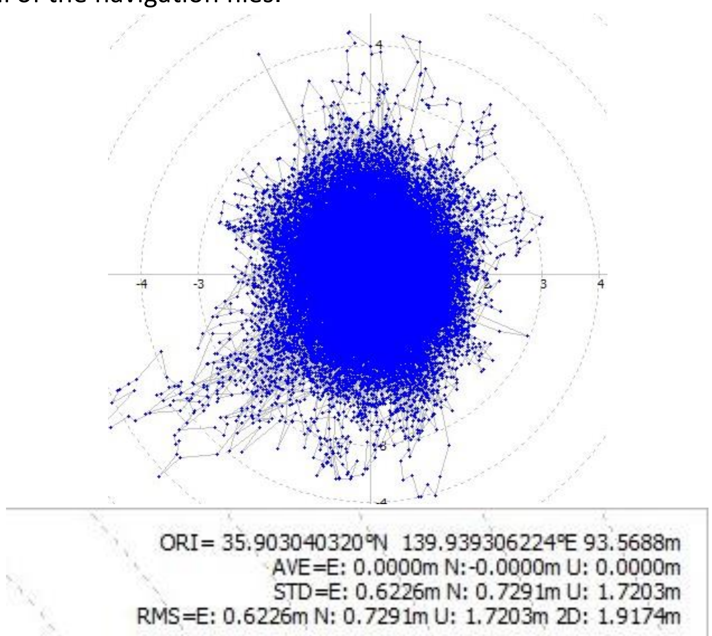


Figure 12: Result of DGPS/DGNSS processing

1.3.2.3. RTK Processing Method

RTK processing method using the continuously observing base station data for processing the rover data. The RTK processing method provides real time correction data for correcting various correcting like ionospheric error, tropospheric error e.t.c.

Input file :

Base Station file: 01022920B.19o(observation file) and 01022920B.19n (navigation file) observed from NET R9

Rover Station file:20191019.0bs (observation file) and 20191019.nav (navigation file) observed from M8T

Kinematic (RTK) setting:

1. Press options button then change the positioning mode to Kinematic as following picture

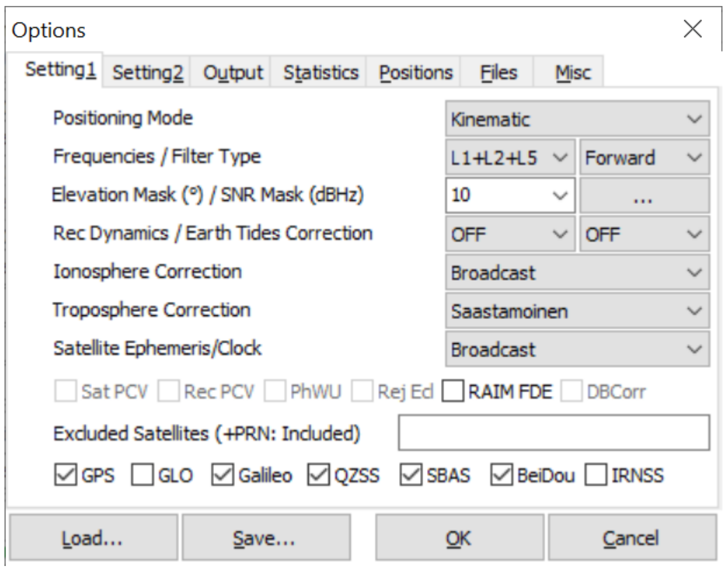


Figure 13: Setting 1 for Kinematic (RTK) processing

2. Selected on Setting2 tab change the Integer Ambiguity Res to Instantaneous menu

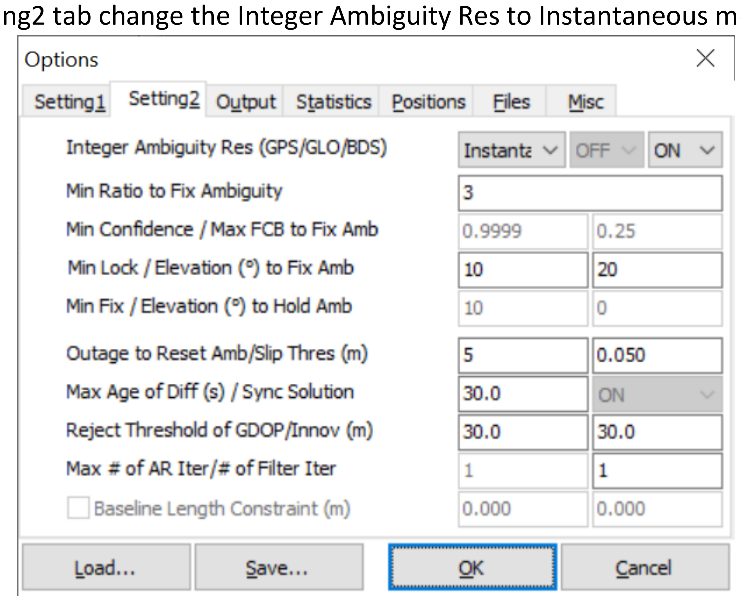


Figure 14:Setting 2 for Kinematic (RTK) processing

5. Selected on Positions tab for input the Base station coordinate then click OK

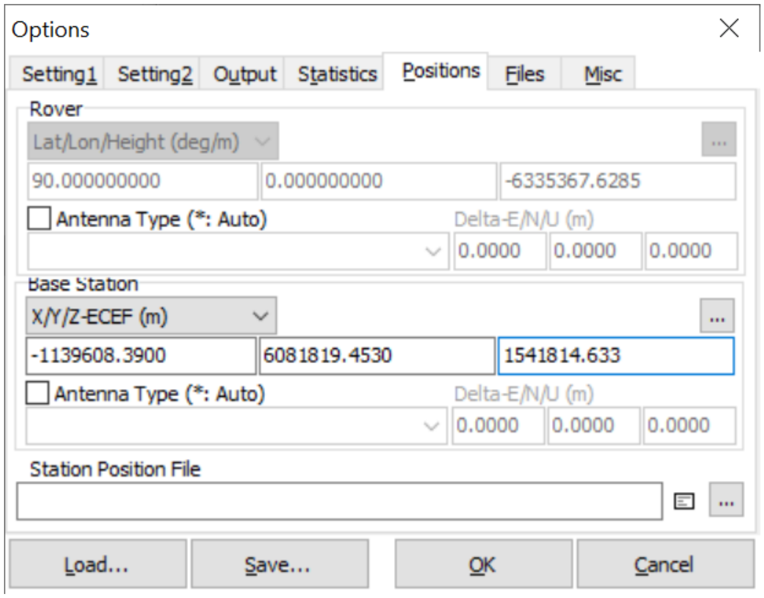


Figure 15:Position Setting for Kinematic (RTK) processing

6. Selected the **G16_day3.20o** file for RINEX OBS: ROVER, **5423R48741202001080754F.20o** file for RINEX OBS: Base station and **5423R48741202001080754F.20*** file for RINEX NAV and rename the output file then click on Execute button as shown the following figure

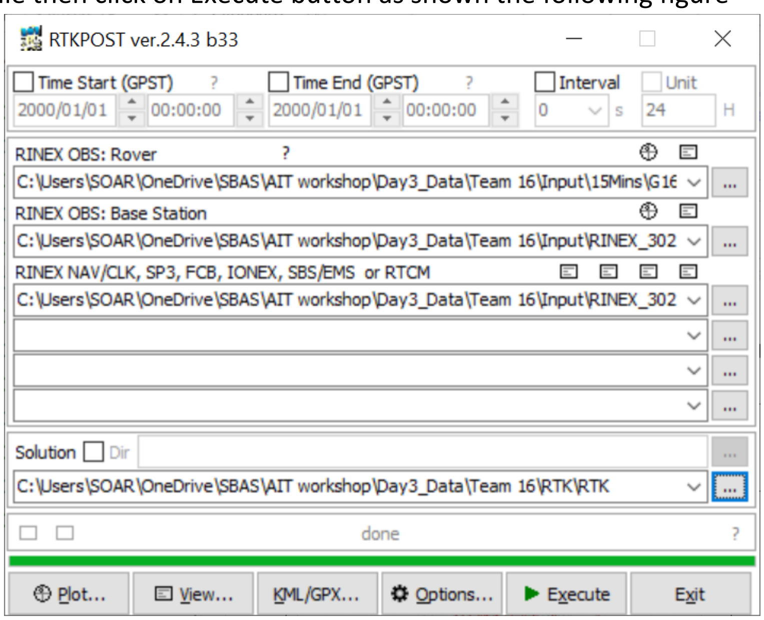


Figure 16: Selection of Base and Rover station for RTK processing

Note: If there are several navigation files for specific constellations, selected one file and change the c,g,h,l,n,q into (*) to use all of the navigation files.

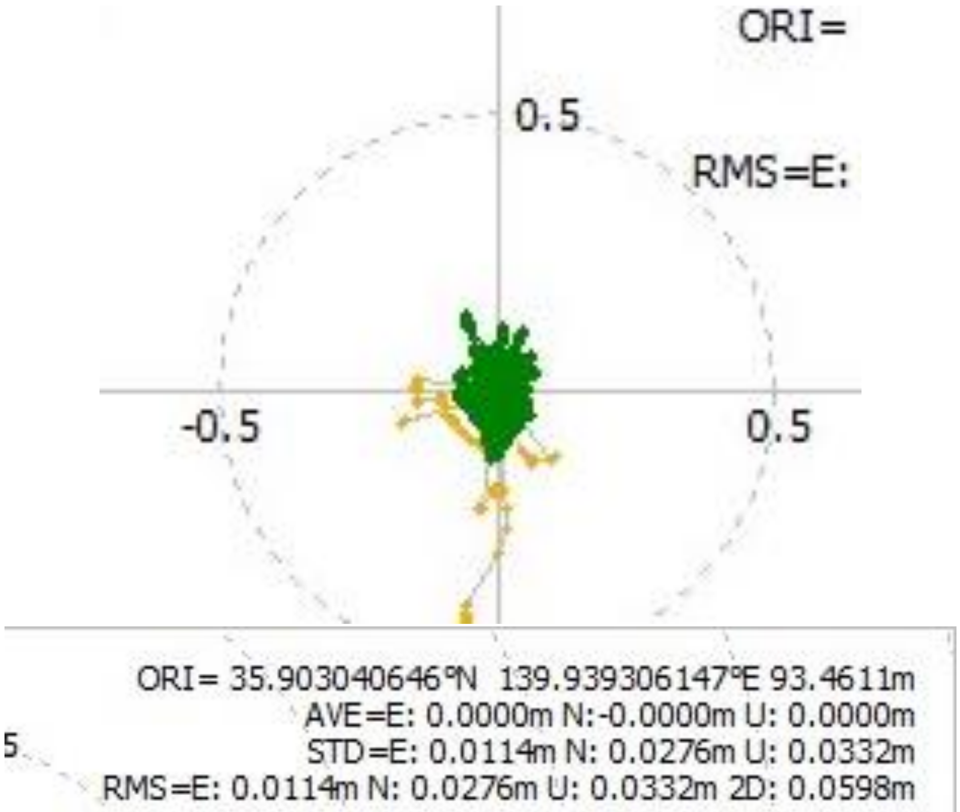
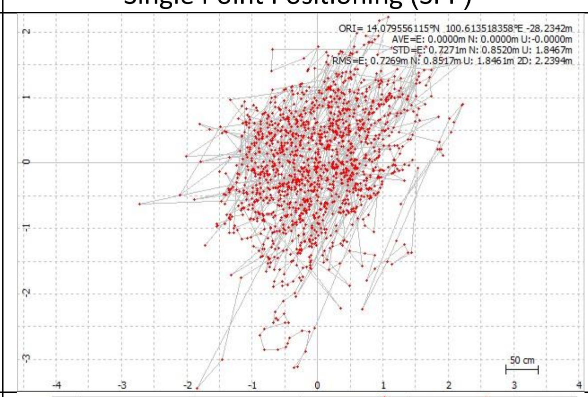
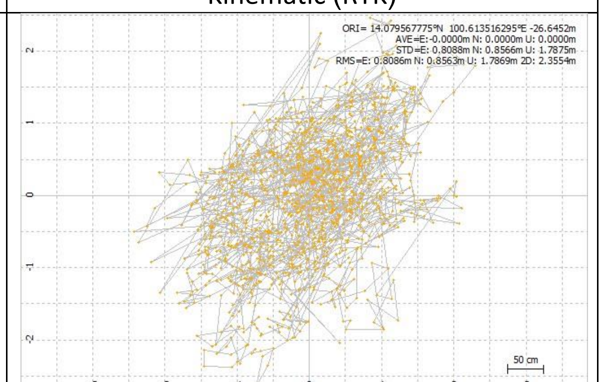
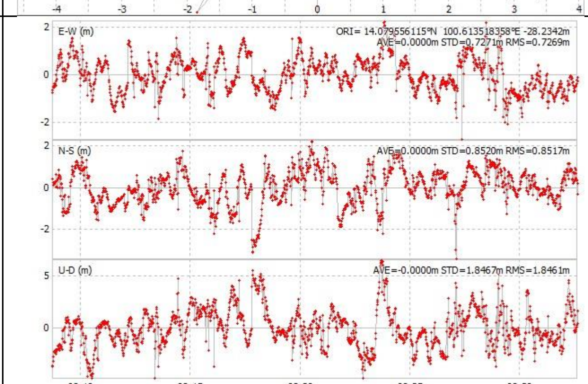
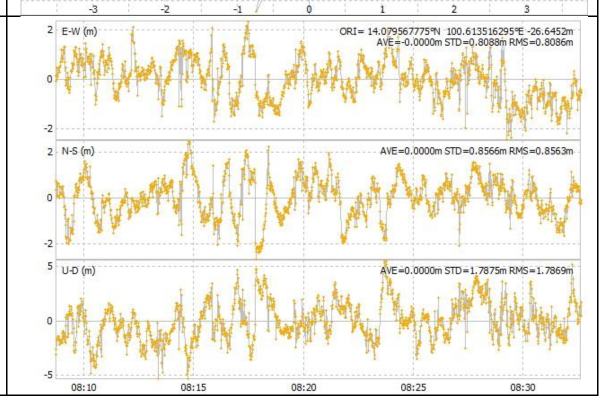


Figure 17:Result of RTK processing

	Single Point Positioning (SPP)	Kinematic (RTK)
Ground track		
Position		

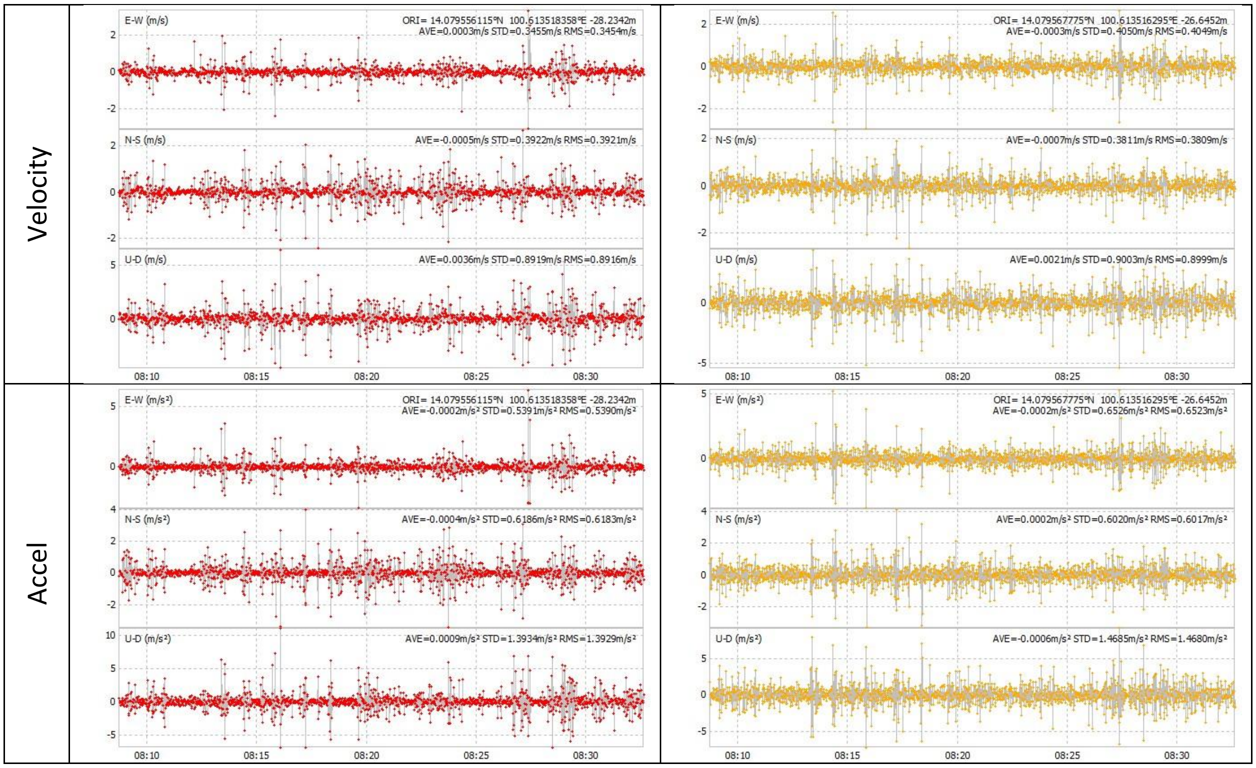


Figure 18: Comparison between SPP and RTK

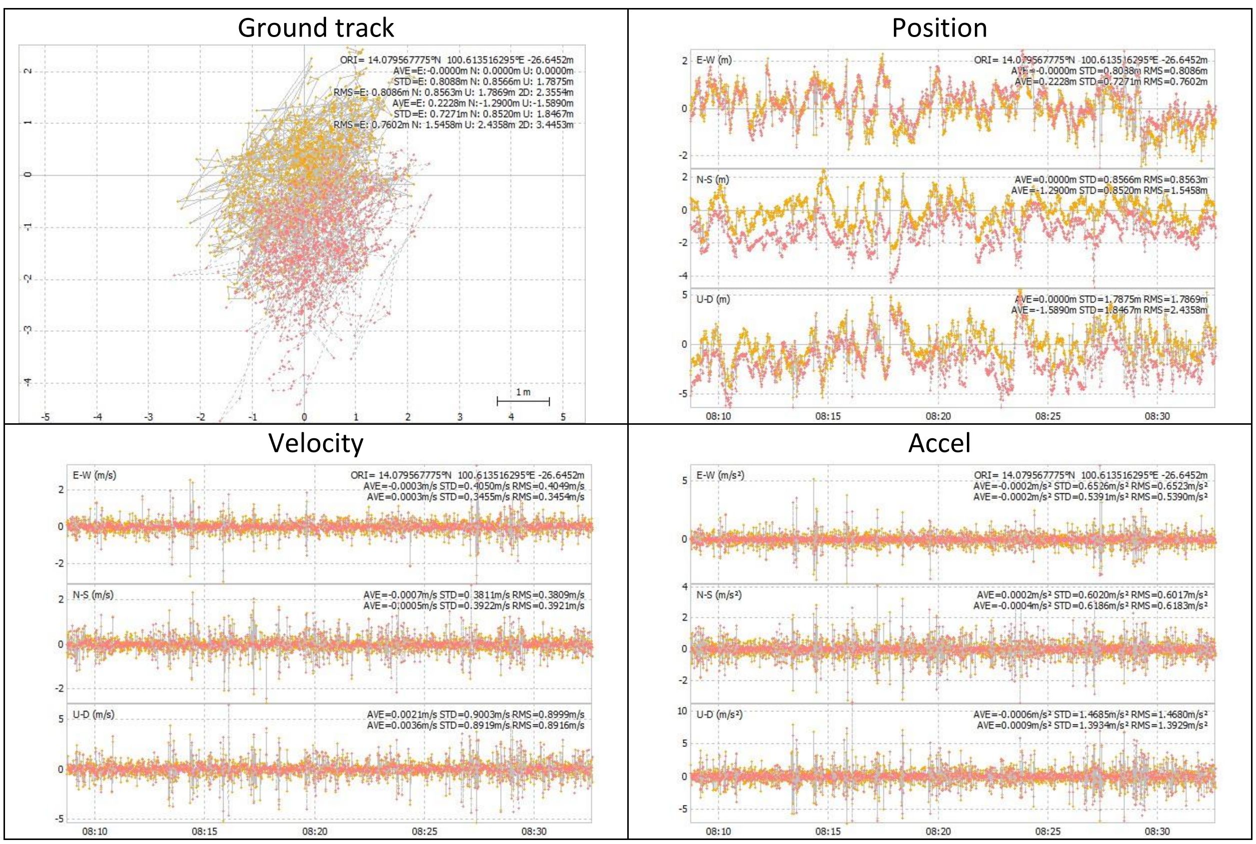


Figure 19: Comparison of Results

1.3.2.4. SINGLE FREQUENCY VS DUAL FREQUENCY RECEIVER

Input file:

Single frequency receiver: M8P_181215_static.20o,n (RINEX3.02 GJC)

Dual frequency receiver: F9P_181215_static.20o,n (RINEX3.02 GEJSC)

Base station: NetR9_181215_static.20o,n (RINEX3.02 GRJCE)

Base station coordinate (ECEF): RINEX header file

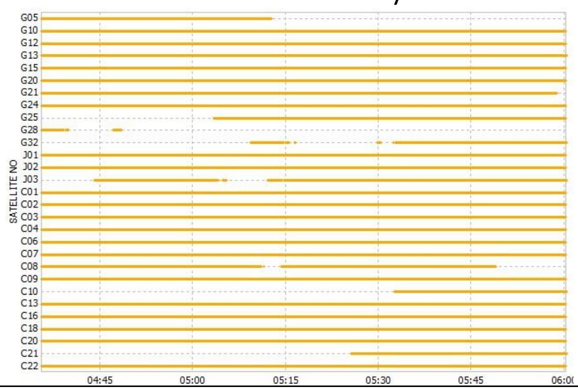
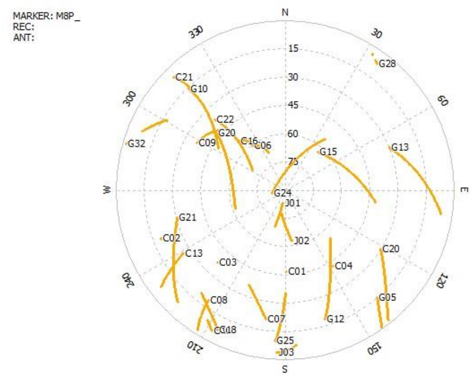
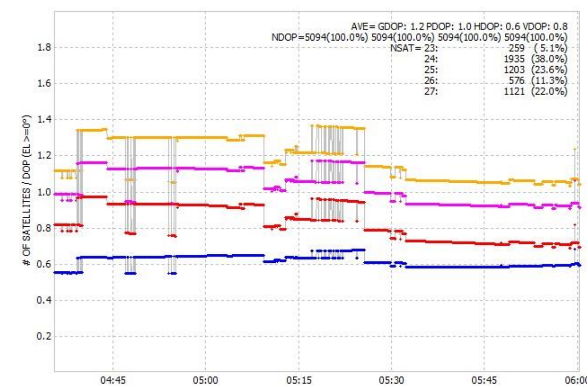
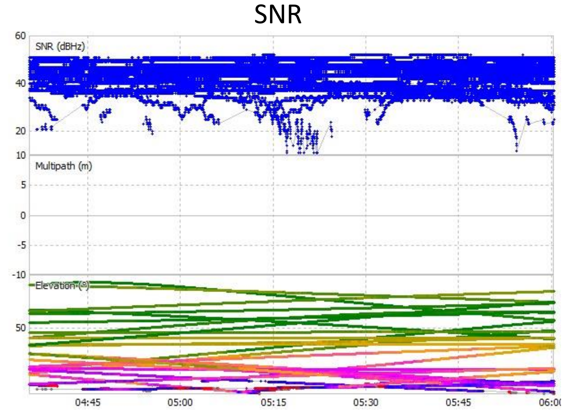
Satellite visibility	Skyplot
	
DOP	SNR
	

Figure 20: Data of M8T Single Frequency Receiver

Satellite visibility	Skyplot

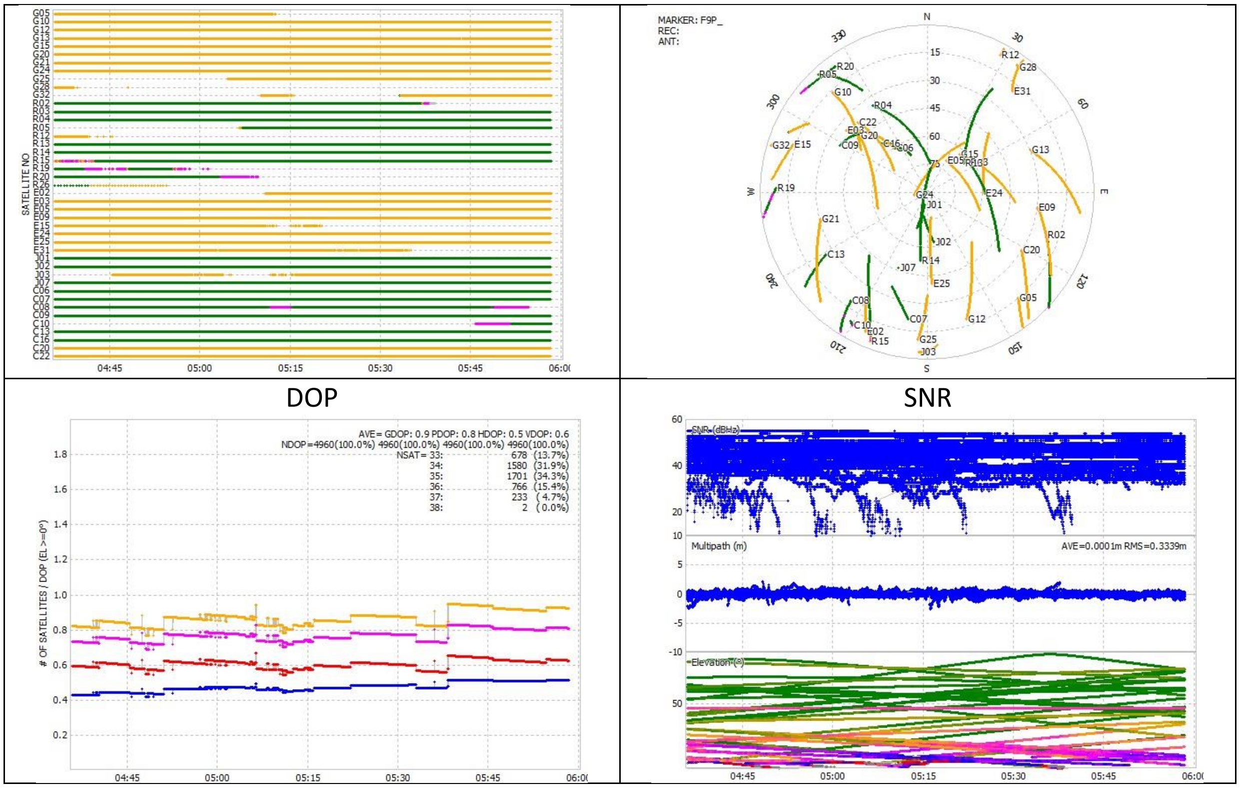


Figure 21: Data of F9P Dual Frequency Receiver

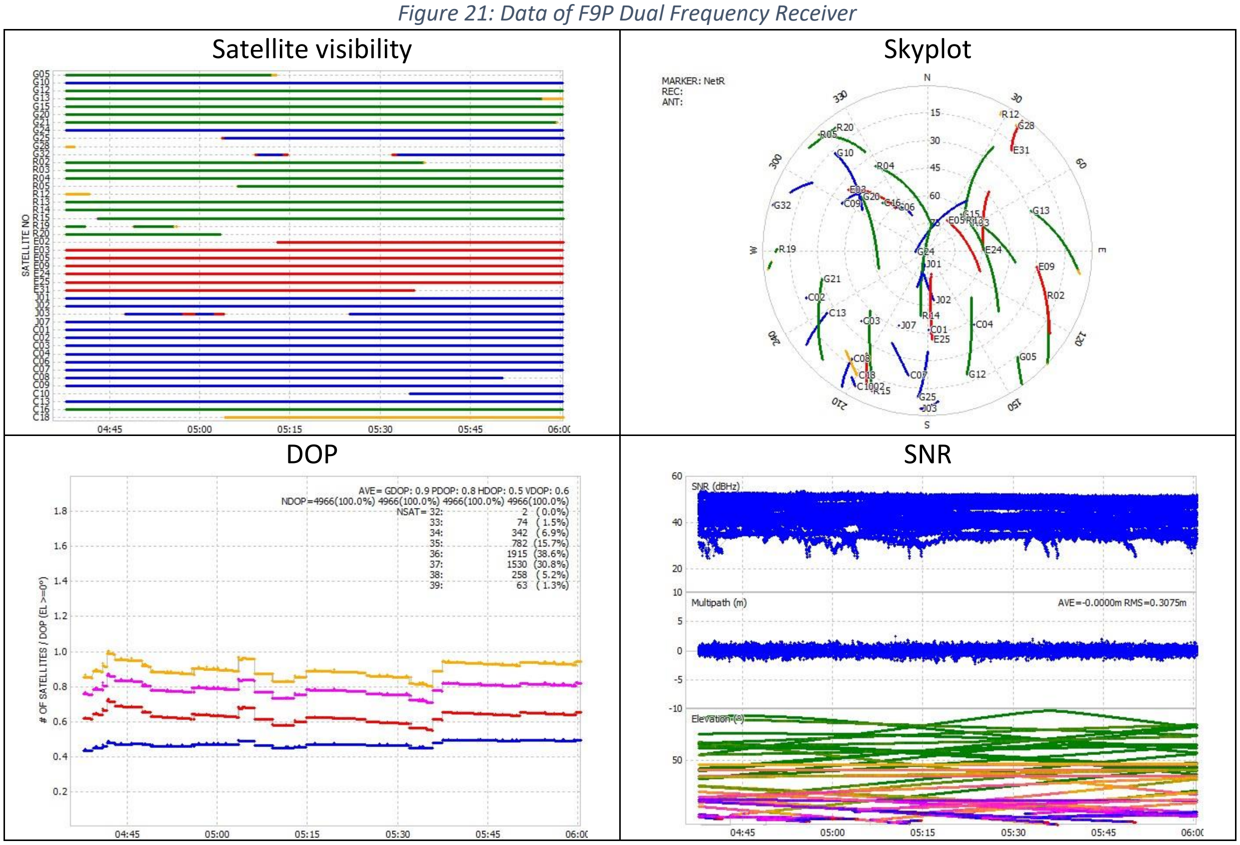


Figure 22: Data of NetR9 Dual frequency receiver

Single frequency setting:

1. Press options button then setting as following picture then click OK

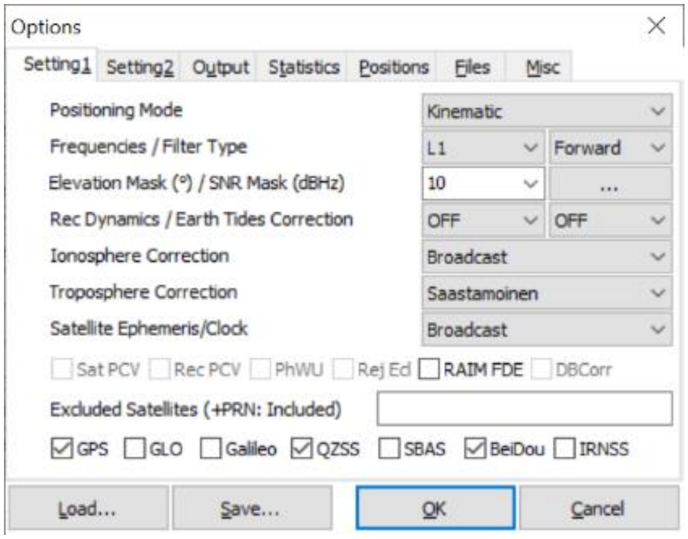


Figure 23: Setting1 for Kinematic Processing

Note: Unchecked the GLO, Galileo, SBAS and IRNSS constellations because we don't have any satellite in the input file.

2. Selected the **M8P_181215_static.20o** file for RINEX OBS: ROVER, **NetR9_181215_static.20o** file for RINEX OBS: Base station and **NetR9_181215_static.20n** file for RINEX NAV and rename the output file then click on Execute button as shown the following figure

3. Selected on Positions tab for input the Base station coordinate then click OK

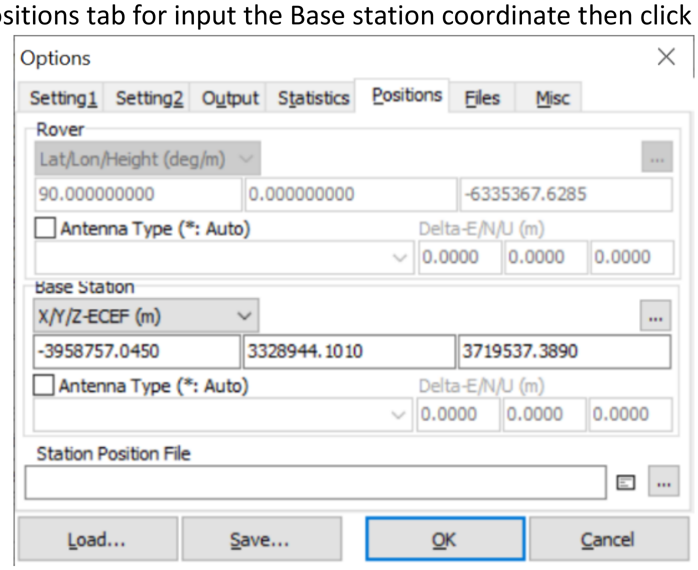


Figure 24: Setting the coordinates values for post processing

Dual frequency setting:

1. Press options button then setting as following picture then click OK

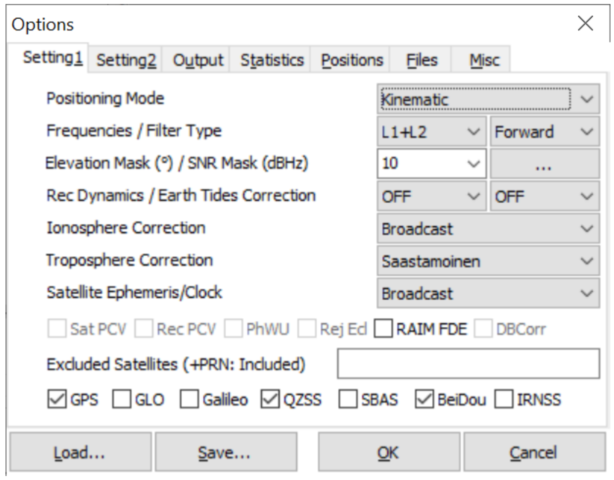


Figure 25: Setting the parameters for dual frequency GNSS Data

2. Selected the **F9P_181215_static.20o** file for RINEX OBS: ROVER, **NetR9_181215_static.20o** file for RINEX OBS: Base station and **NetR9_181215_static.20n** file for RINEX NAV and rename the output file then click on Execute button as shown the following figure

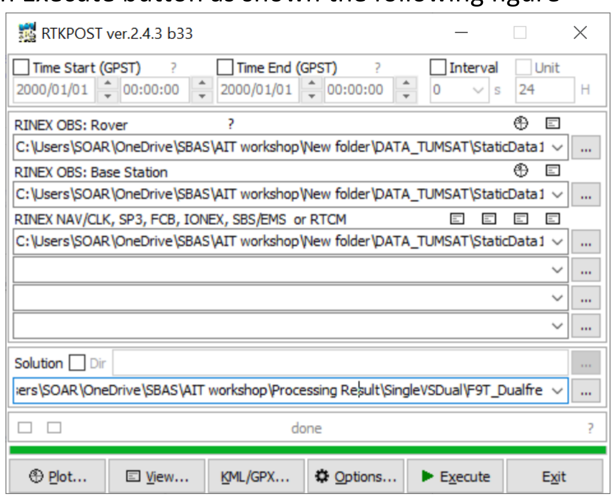


Figure 26: Defining the base file, rover file and output file during post processing

Results :

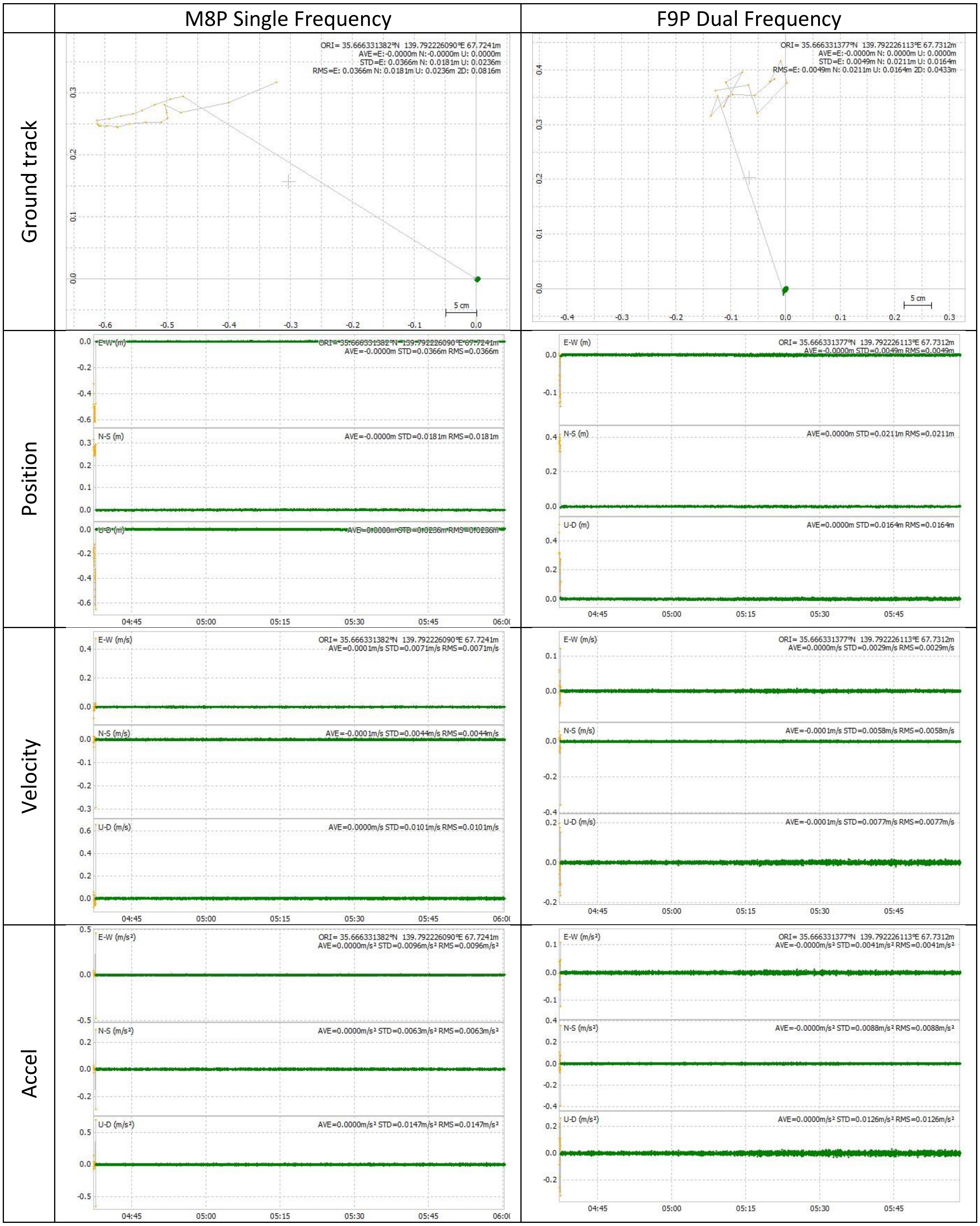


Figure 27: Comparison between the results of single frequency receivers and dual frequency receivers

1.3.2.5. Low cost VS High end receiver

Input file:

Low cost receiver: 20191019.19o,n (RINEX3.02 GREJSC)

High end receiver: 01022920B.19o,n (RINEX2.11 GERS)

20191019.19o

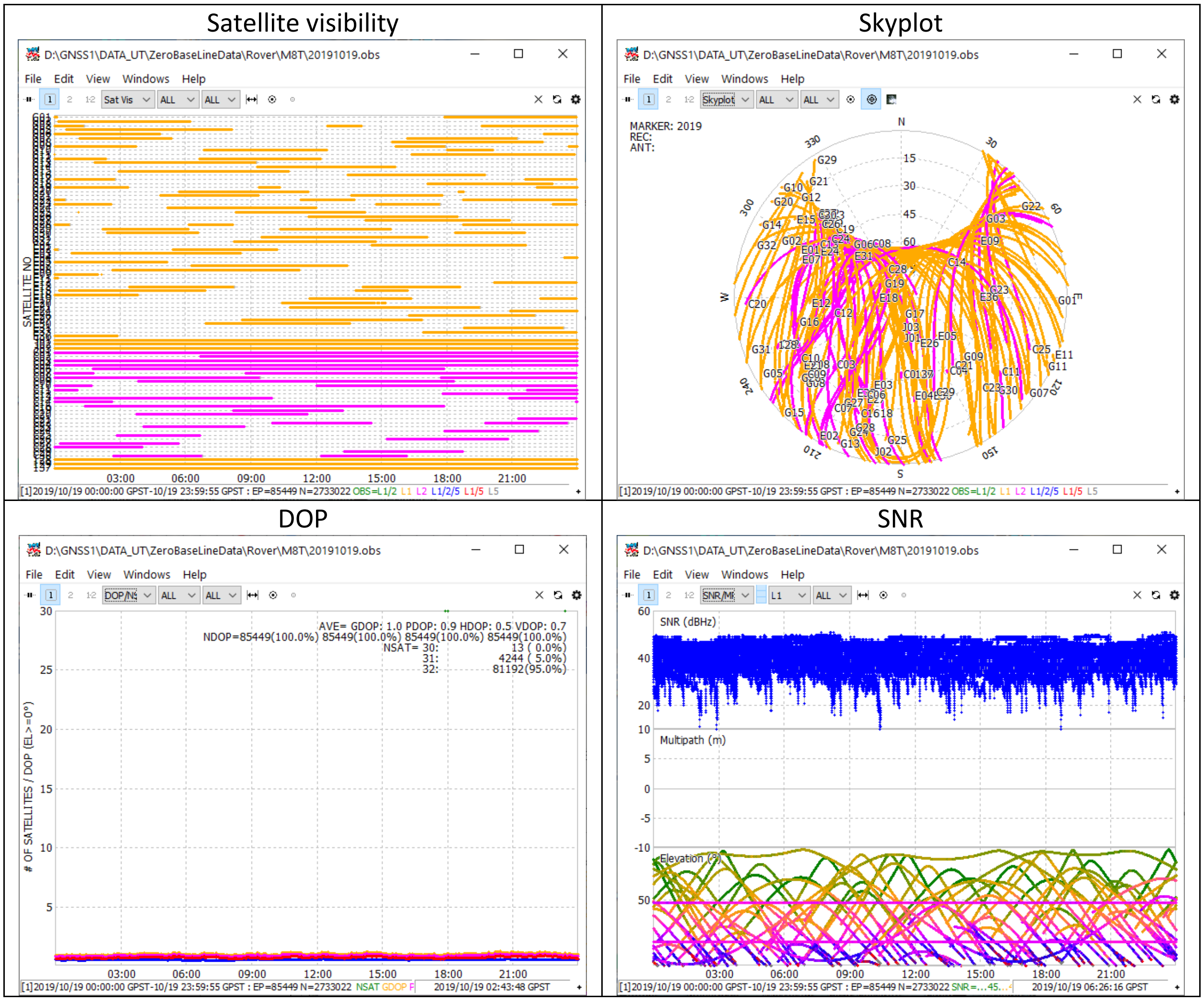


Figure 28: Data visualization in different forms logged in low cost receiver

01022920B.19o

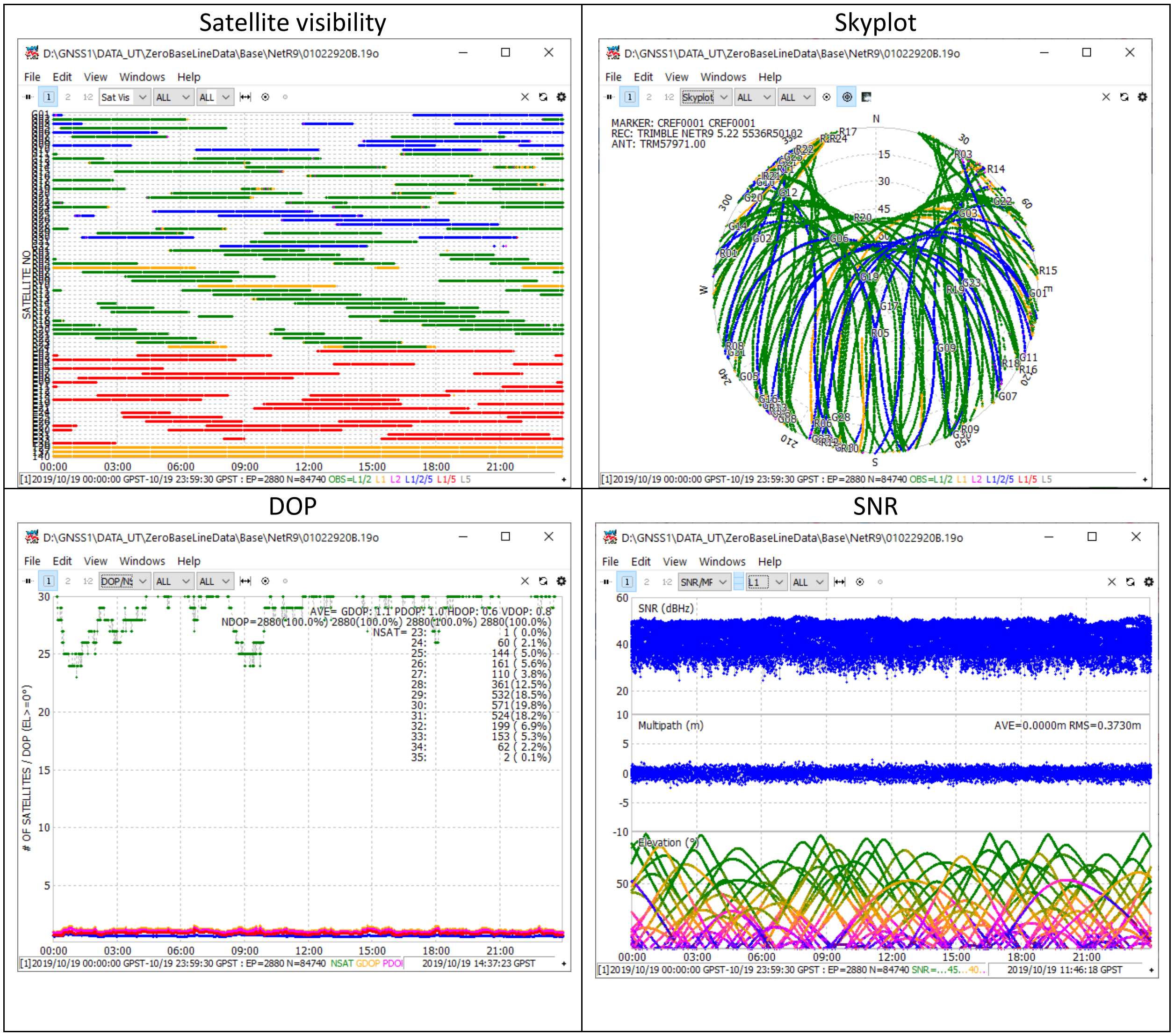


Figure 29: Data visualization in different forms logged in high end receiver

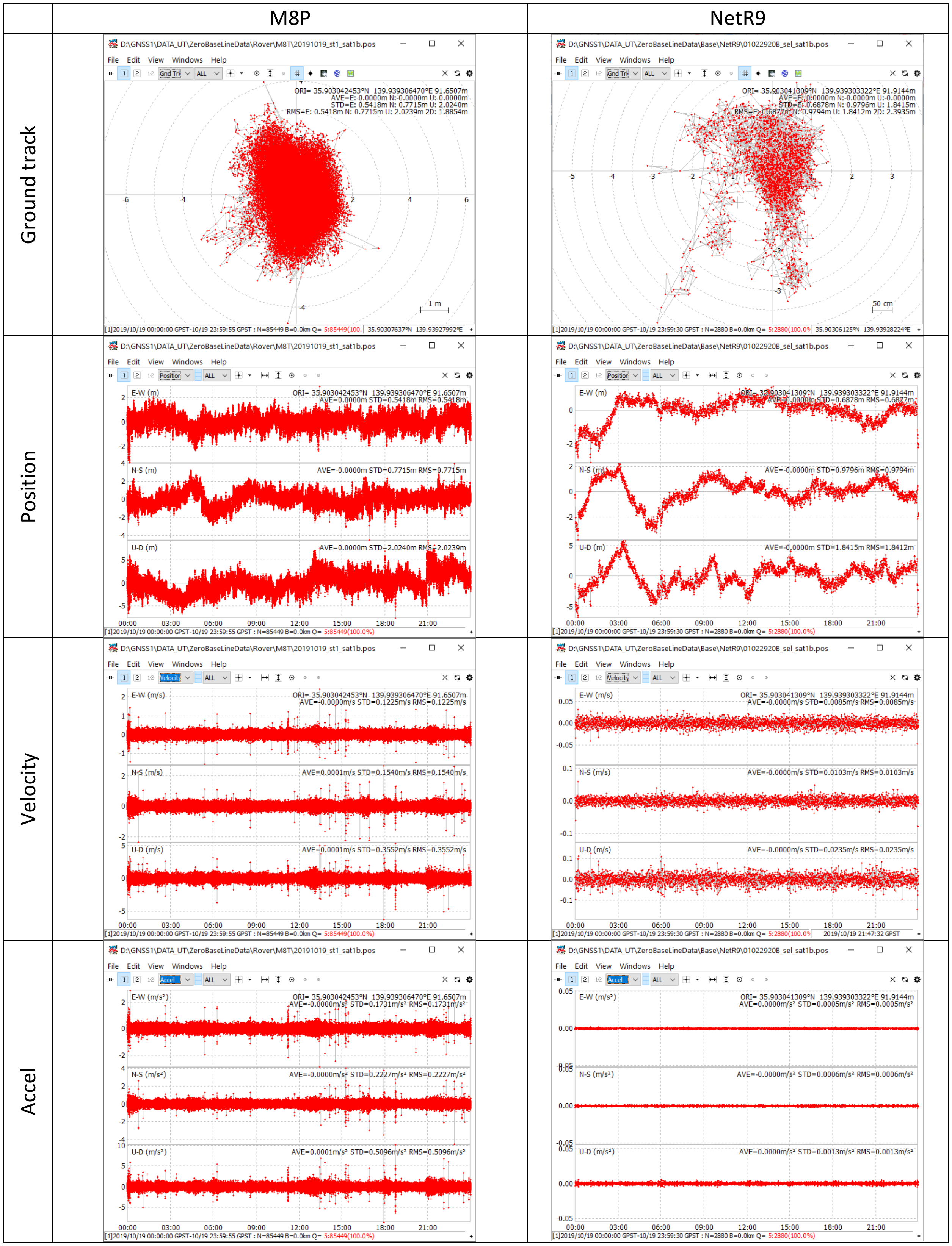


Figure 30: Comparison of Data logged in M8T(Low Cost Receiver) and Net R9 (High End Receiver)

1.3.2.6. INTEGER AMBIGUITY RESOLUTION

Input file:

For Static:

Rover : F9P_181215_static.20o,n (RINEX3.02 GREJC)

Base station: BASE_NetR9_190522.20o,n (RINEX3.02 GREJC)

Base station coordinate (ECEF): -3958757.045 3328944.101 3719537.389

F9P_181215_static.20o

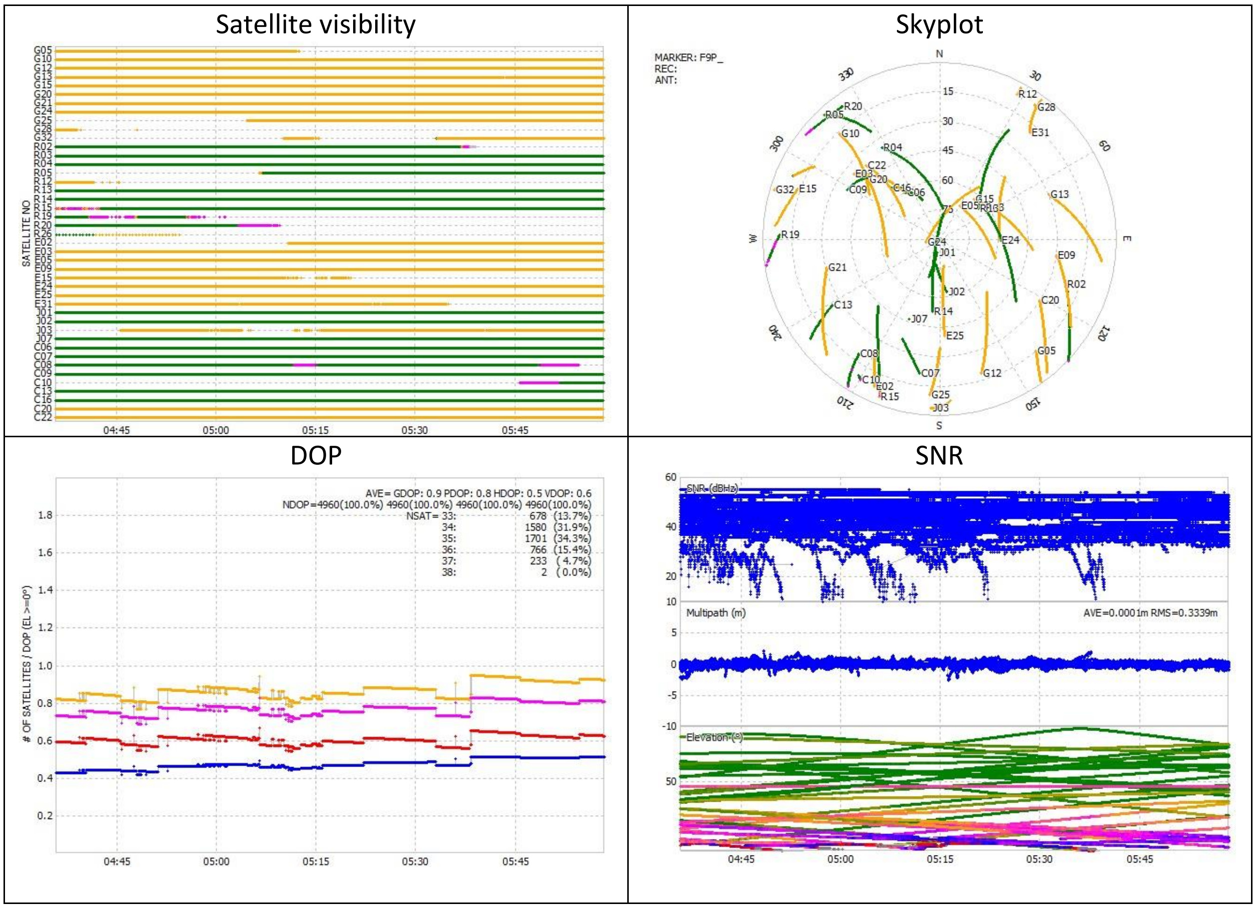


Figure 31: Detail of Rover file: F9P_181215_static.20o, n (RINEX3.02 GREJC)

BASE_NetR9_190522.20o

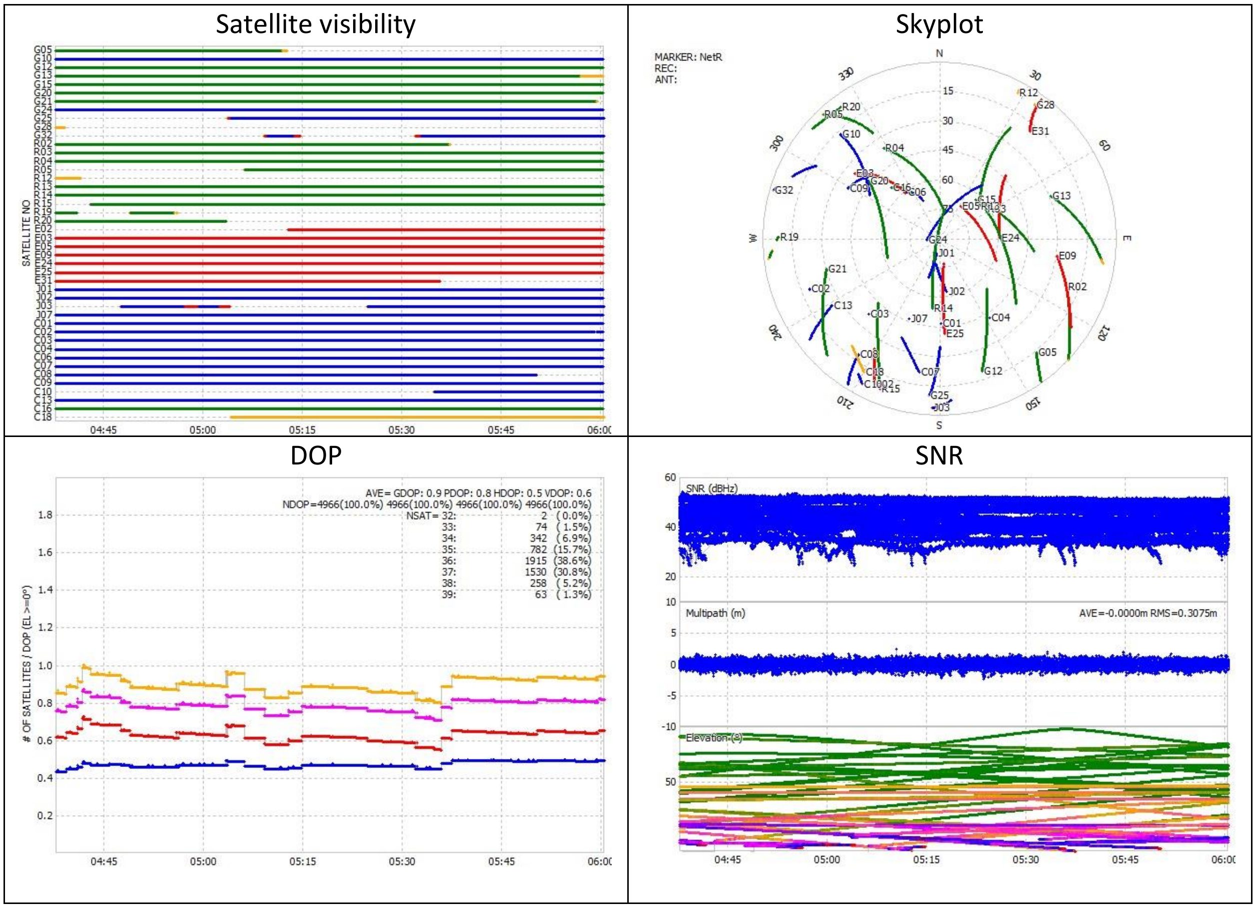


Figure 32: Detail of Base station file: BASE_NetR9_190522.20o,n (RINEX3.02 GREJC)

For Dynamic:

Rover: ROVER_F9P_190522_062135.20o,n (RINEX3.02 GREJC)

Base station: NetR9_181215_static.20o,n (RINEX3.02 GREJC)

Base station coordinate (ECEF): -3958757.045 3328944.101 3719537.389

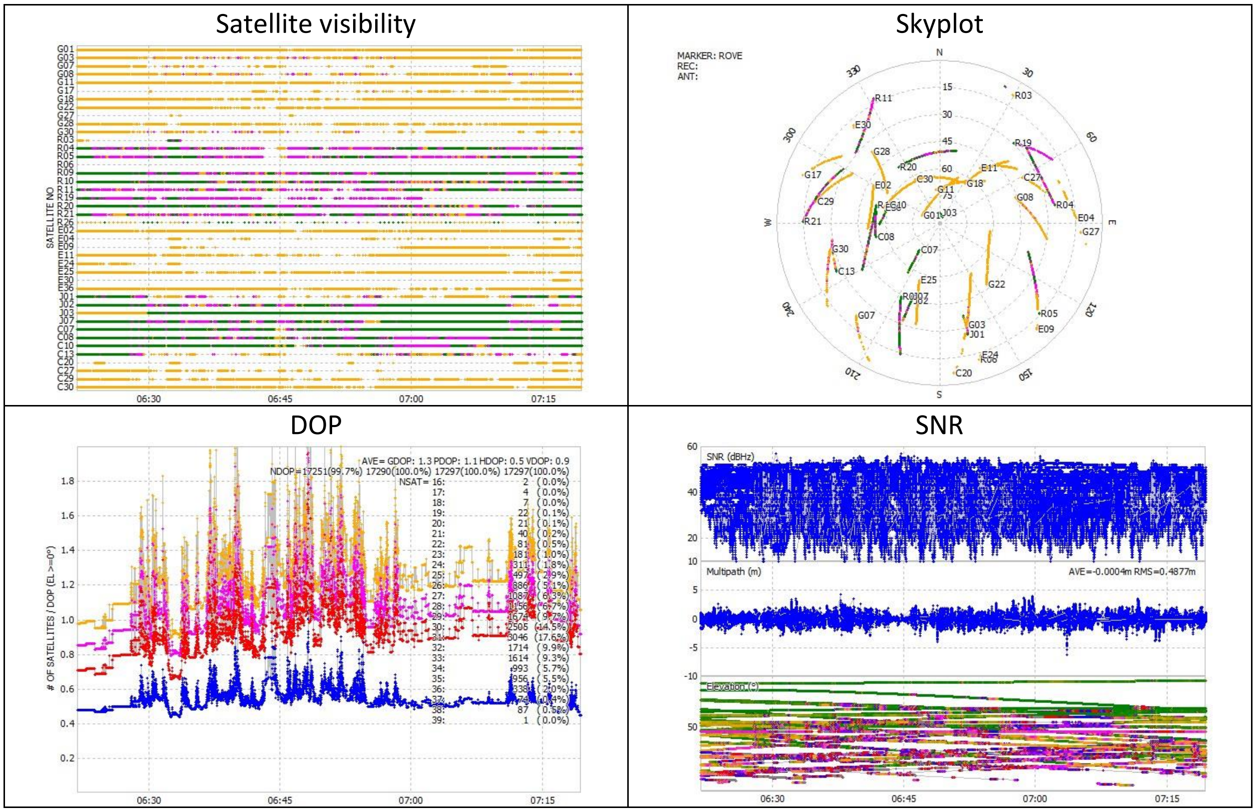


Figure 33: Detail of Rover file: ROVER_F9P_190522_062135.20o,n (RINEX3.02 GREJC)

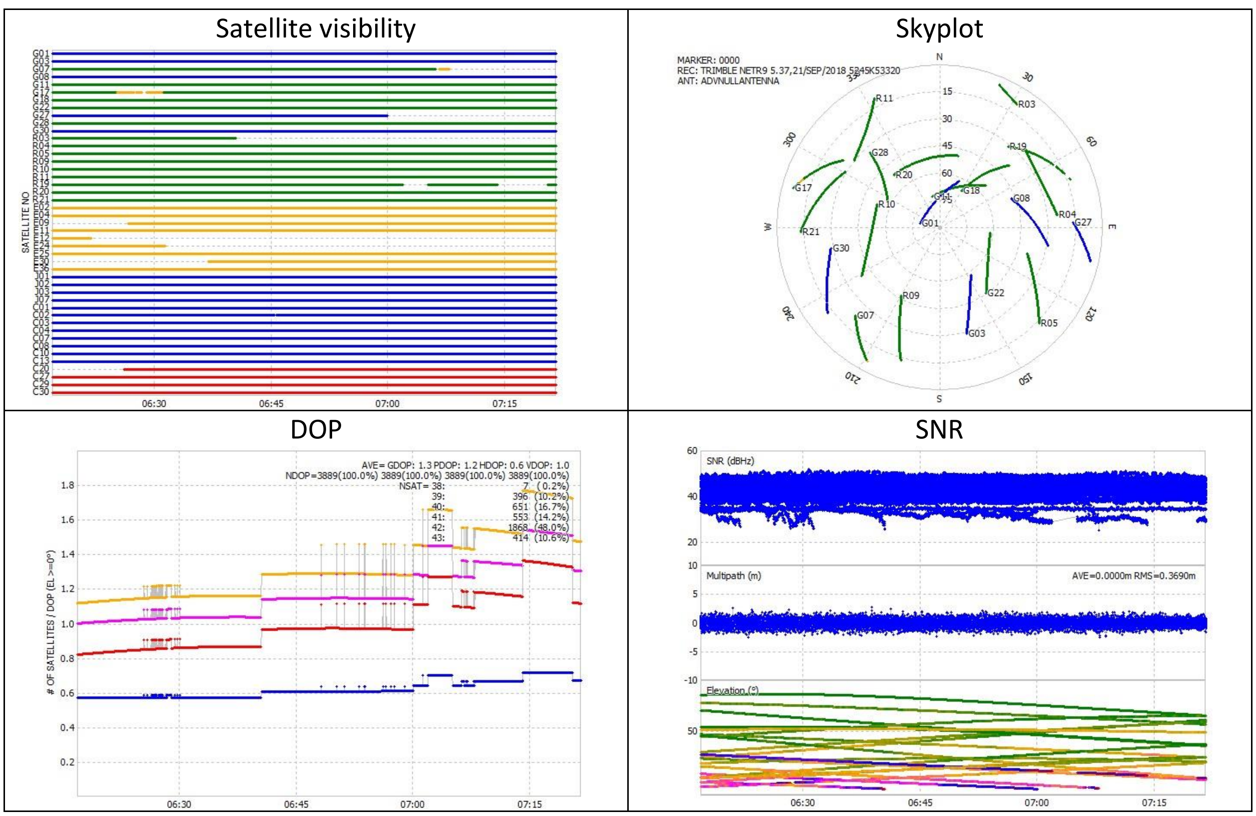


Figure 34: Detail of Base station file: NetR9_181215_static.20o,n (RINEX3.02 GREJC)

1) For Static data

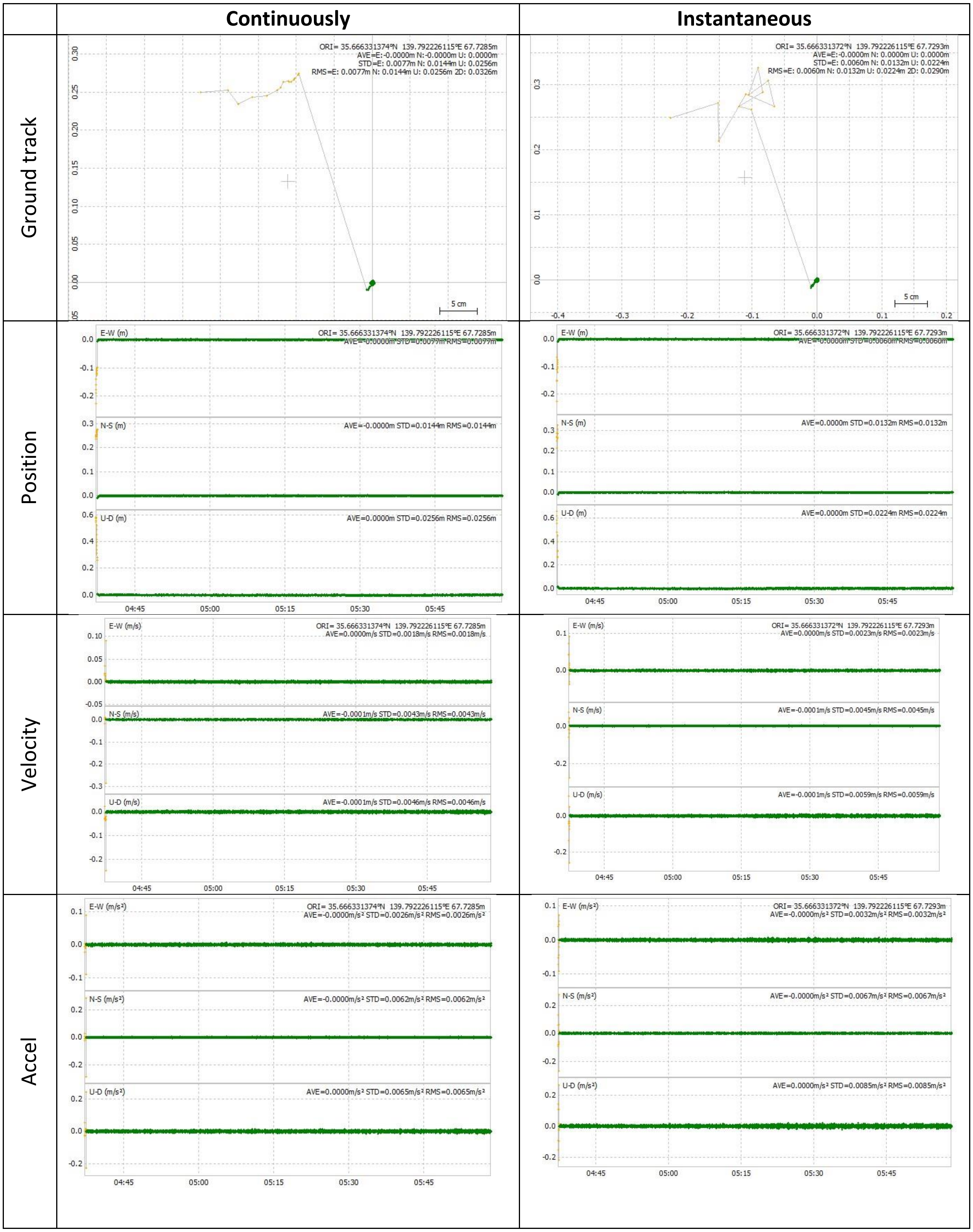


Figure 35: The comparison of Continuous (Yellow) and Instantaneous (Green)

2) For Dynamics data

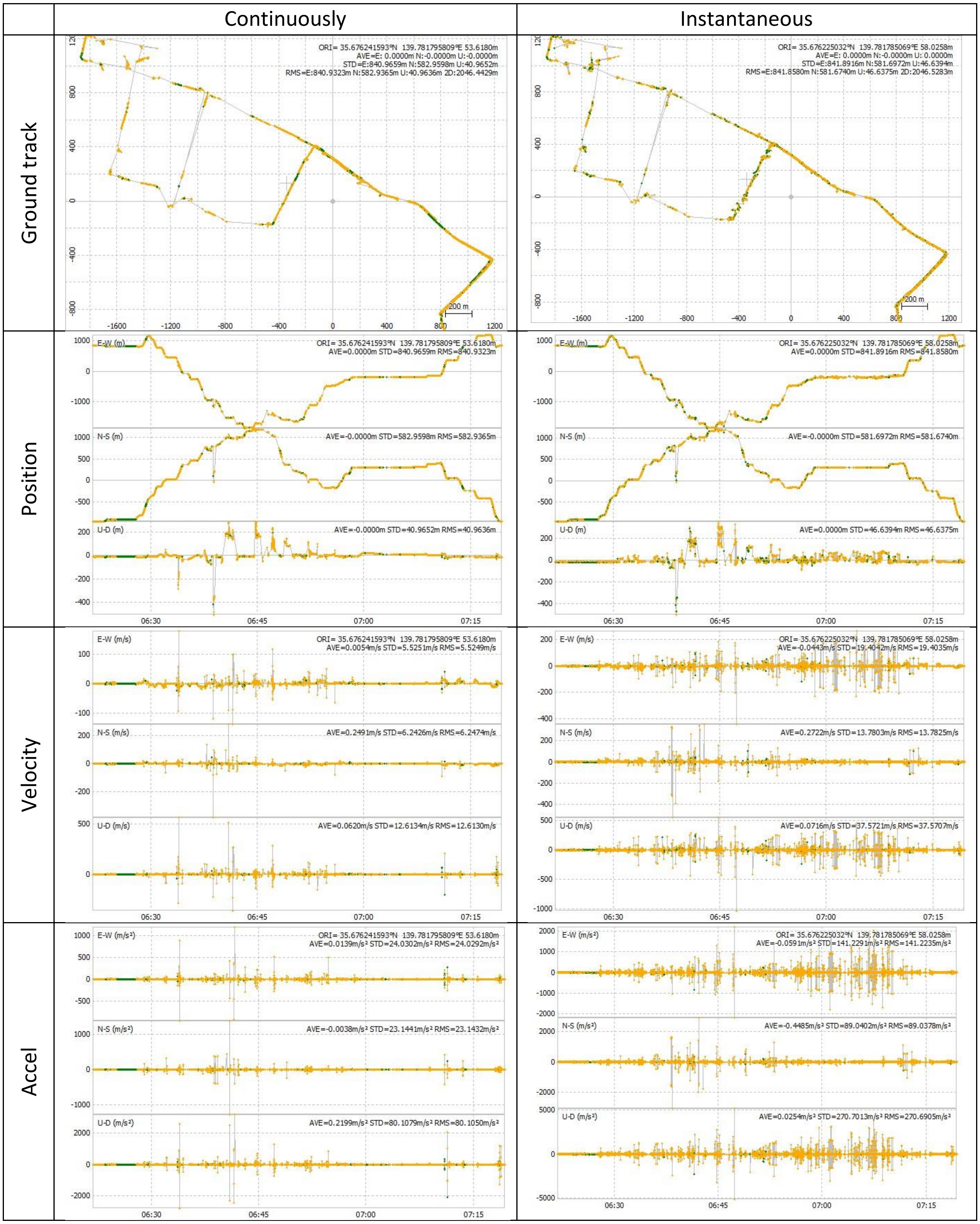


Figure 36: The comparison of Continuous (Yellow) and Instantaneous (Green)

1.3.3. Position errors

ORI= 35.903040875°N 139.939306585°E 92.0002m
AVE=E: 0.0000m N: 0.0000m U: 0.0000m
STD=E: 0.5310m N: 0.6833m U: 1.8696m
RMS=E: 0.5310m N: 0.6833m U: 1.8696m 2D: 1.7308m

Result of SPP Processing

ORI= 35.903040320°N 139.939306224°E 93.5688m
AVE=E: 0.0000m N:-0.0000m U: 0.0000m
STD=E: 0.6226m N: 0.7291m U: 1.7203m
RMS=E: 0.6226m N: 0.7291m U: 1.7203m 2D: 1.9174m

Result of DGPS Processing

ORI= 35.903040646°N 139.939306147°E 93.4611m
AVE=E: 0.0000m N:-0.0000m U: 0.0000m
STD=E: 0.0114m N: 0.0276m U: 0.0332m
RMS=E: 0.0114m N: 0.0276m U: 0.0332m 2D: 0.0598m

Result of RTK Processing

Figure 37: The position errors of three different processing (SPP, DGPS, and RTK)

The 3 different types of GNSS Data Post Processing System (SPP, DGPS/DGNSS and RTK) showed that RTK GNSS post processing results provide more accurate and more precise results than SPP and DGPS/DGNSS post processing result using RTKLIB post processing software. The low cost GNSS receivers are also able to provide much more accurate data in comparison to high end receivers when used for shorter baselines and through appropriate method of post processing.

1.4. Summary

Global Navigation Satellite System (GNSS) provides accurate and precise data which can be used in the various field for instance: Navigation, Land Surveying, Military and so on. Using low cost receiver can also give the better and precise data instead of looking into an expensive and highly calibrated equipment's for positioning. Both static and dynamic methods used in the training hence to compare the results and accuracy. Receiver named M8T and F9P data sets were used to plot the raw data, convert into other formats and ultimately processing the data sets to get precise data. Single Point Processing (SPP), Real Time Kinematics (RTK) and Differential Global Positioning System (DGPS) these three techniques were used and results found to be scattered depending upon dynamics of techniques. Static method found to be better RMS result whereas dynamic method gives less precise accuracy in terms of standard deviation and root mean square error.

1.5. RECOMMENDATIONS

The followings points are highlighted which can be the potential recommendations:

1. Using multiple receivers to obtain various datasets to analyze the results.
2. Eliminating errors and enhancing RMS technique and focus on that would be a great idea.