



An introduction to RTKLIB open source GNSS processing software

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Resources

- RTKLIB homepage <http://www.rtklib.com>
- GIT repository <https://github.com/tomokitakasu/RTKLIB/>
- Windows binaries https://github.com/tomokitakasu/RTKLIB_bin
- Tutorial files ftp://ftp.ga.gov.au/geodesy-outgoing/gnss/pub/RFIP_2018/

GNSS Analysis Software

Commercial

Scientific

Online



What is RTKLIB?



- An open source package for GNSS positioning and analysis.
- Developed by Mr Tomoji Takasu of the Tokyo University of Marine Science and Technology.
- Support for multi-GNSS.
- Positioning modes for both real-time and post-processing.
- Supports standard formats and protocols.
- GUI and CUI on Windows and CUI on Linux.
- Freely distributed from www.rtklib.com under a BSD license.

Uses Cases for RTKLIB

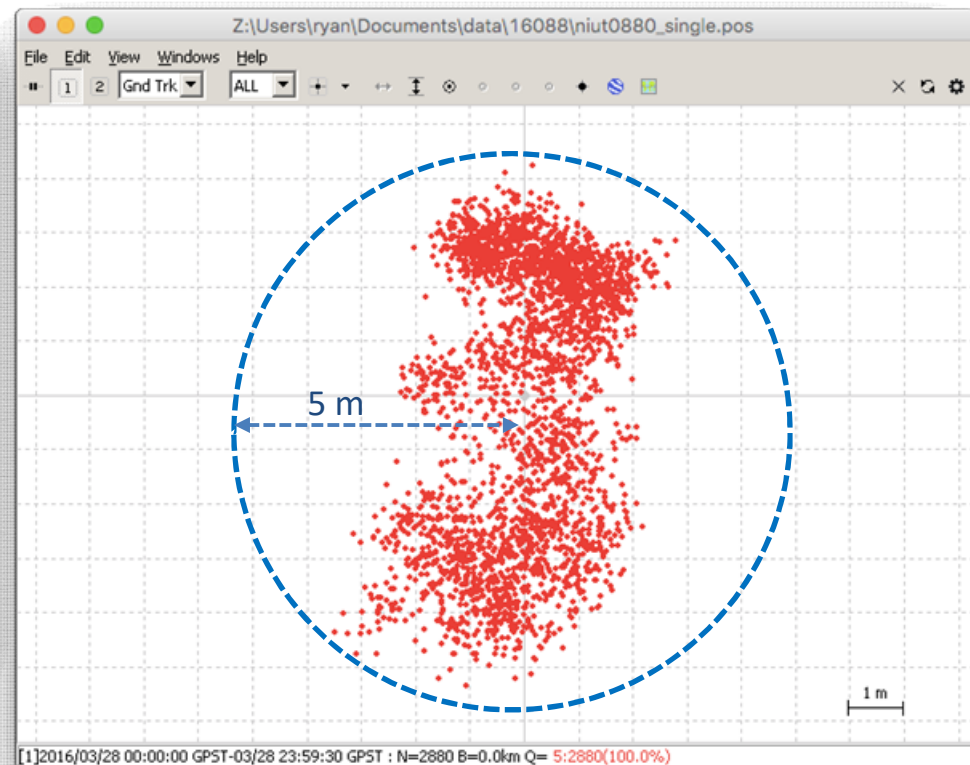


...?

Use Case – Static Post-Processing

- RTKPOST
- RTKPLOTT

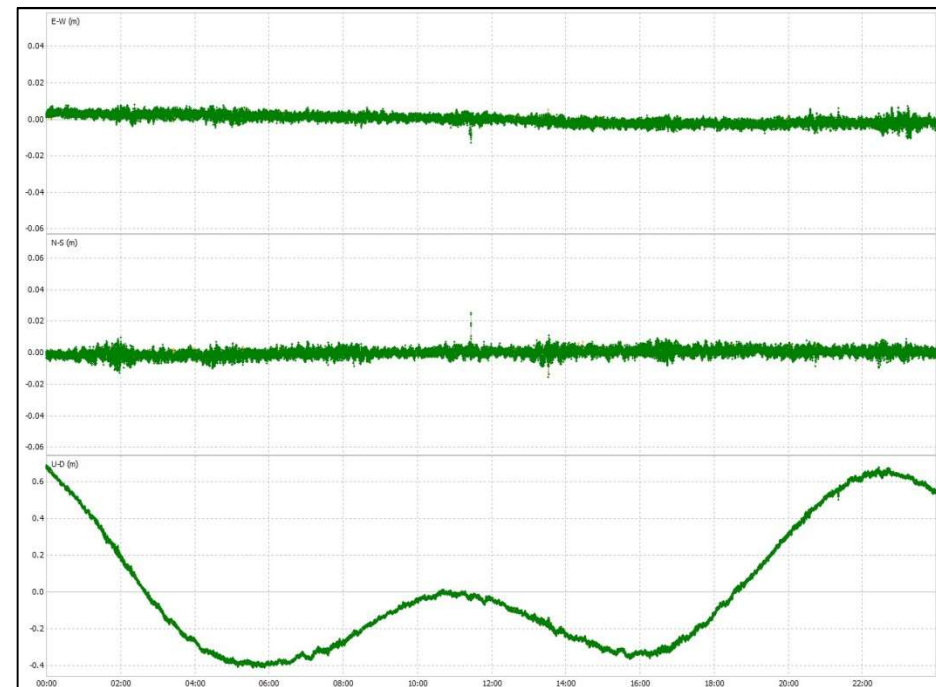
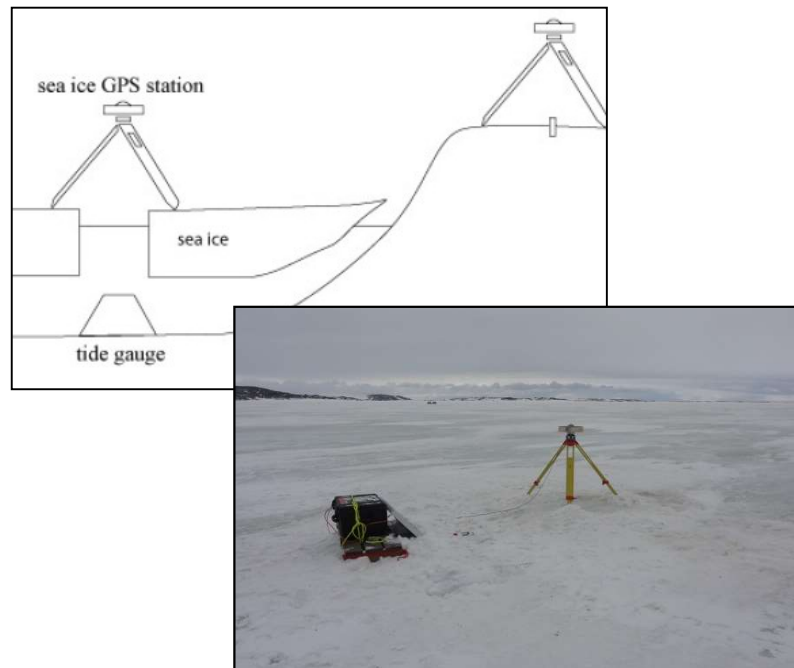
```
Z:\Users\ryan\Documents\data\16088\niut0880_L1.pos
Find Read... Option... Close
% program : RTKPOST ver. 2.4.3 b8
% inp file : Z:\Users\ryan\Documents\data\16088\niut0880.16d
% inp file : Z:\Users\ryan\Documents\data\16088\niut0880.16n
% obs start : 2016/03/28 00:00:00.0 GPST (week1890 86400.0s)
% obs end : 2016/03/28 23:59:30.0 GPST (week1890 172770.0s)
% pos mode : single
% elev mask : 10.0 deg
% ionos opt : broadcast
% tropo opt : saastamoinen
% ephemeris : broadcast
%
% (lat/lon/height=WGS84/ellipsoidal,Q=1:fix,2:float,3:sbas,4:dgps,5:single,6:ppp,ns=#
% GPST latitude(d'') longitude(d'') height(m) Q ns sdn(m)
2016/03/28 00:00:00.000 -19 03 10.97845 -169 55 14.31895 41.7279 5 10 3.5082
2016/03/28 00:00:30.000 -19 03 10.97041 -169 55 14.31620 41.2188 5 10 3.5108
2016/03/28 00:01:00.000 -19 03 10.96182 -169 55 14.32376 40.7426 5 10 3.5135
2016/03/28 00:01:30.000 -19 03 10.98085 -169 55 14.32642 40.2948 5 10 3.5161
2016/03/28 00:02:00.000 -19 03 10.96608 -169 55 14.31260 41.3207 5 10 3.5187
2016/03/28 00:02:30.000 -19 03 10.96779 -169 55 14.32320 40.7788 5 10 3.5212
2016/03/28 00:03:00.000 -19 03 10.98283 -169 55 14.31291 41.5010 5 10 3.5238
2016/03/28 00:03:30.000 -19 03 10.96841 -169 55 14.30076 42.9595 5 10 3.5264
2016/03/28 00:04:00.000 -19 03 10.99227 -169 55 14.33142 41.8662 5 10 3.5289
2016/03/28 00:04:30.000 -19 03 10.97354 -169 55 14.33392 41.1253 5 10 3.5314
2016/03/28 00:05:00.000 -19 03 10.97997 -169 55 14.30762 41.1892 5 10 3.5339
2016/03/28 00:05:30.000 -19 03 10.98362 -169 55 14.33030 40.4177 5 10 3.5364
2016/03/28 00:06:00.000 -19 03 10.97031 -169 55 14.33254 41.4383 5 10 3.5389
2016/03/28 00:06:30.000 -19 03 10.96438 -169 55 14.32813 40.2563 5 10 3.5413
2016/03/28 00:07:00.000 -19 03 10.97472 -169 55 14.32589 41.4575 5 10 3.5437
2016/03/28 00:07:30.000 -19 03 10.97057 -169 55 14.32013 41.3052 5 10 3.5461
2016/03/28 00:08:00.000 -19 03 10.98224 -169 55 14.32967 41.9397 5 10 3.5485
```



Use Case – Kinematic Processing

Floating Tide Gauge

- RTKPOST in Kinematic mode.
- RTKPLOTT to view the results.

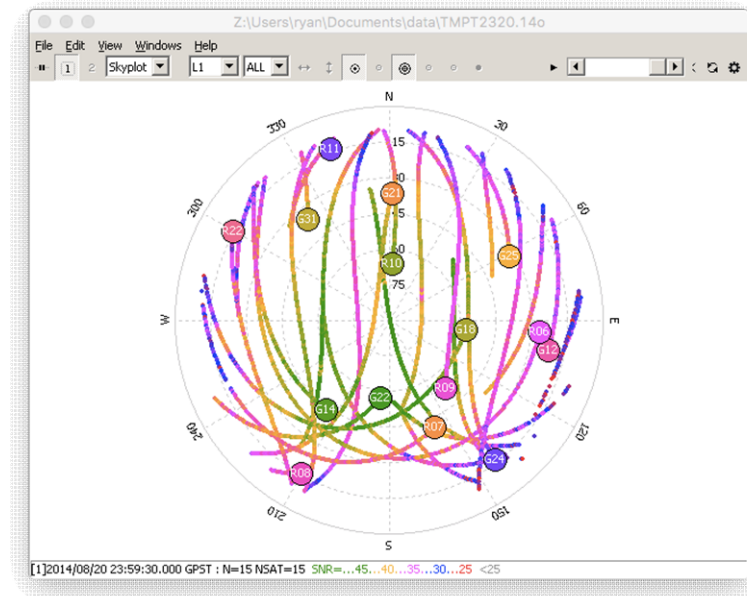


Use Case – Observation Data Quality

RTKPLOT can be used to assess the quality of RINEX observation data and to assist in planning the ideal time to undertake a GNSS occupation.

Visual analysis includes:

- Satellite availability
- Dilution of Precision (DOP)
- Signal to Noise ratio (SNR)
- Multipath



Installation of RTKLib (Windows)

If you would like to follow the tutorial please download the latest RTKLib Windows binary files from:

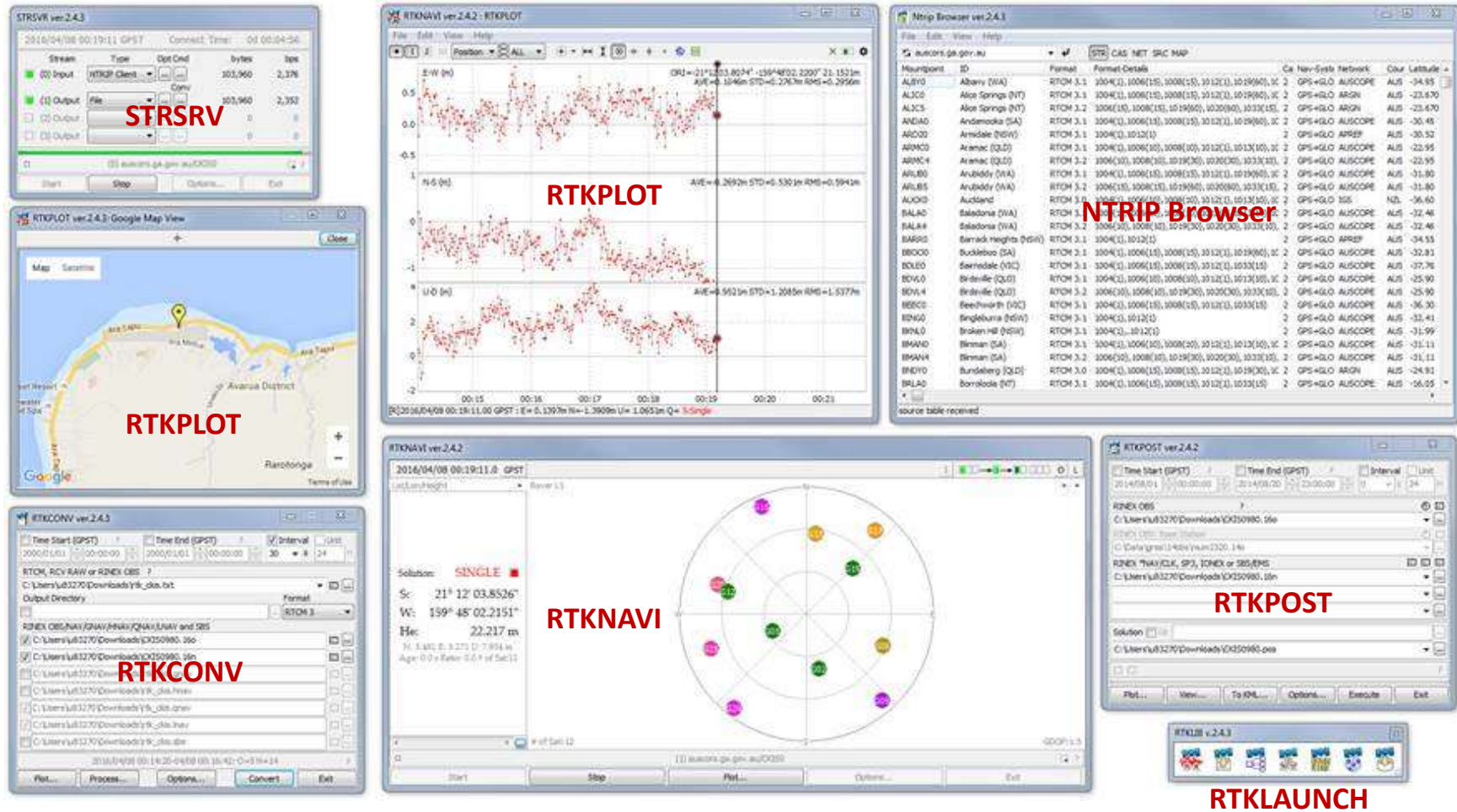
https://github.com/tomojitakasu/RTKLIB_bin/archive/master.zip

To open unzip and open the **RTKLIB_bin-master** directory.

bin (contains the executables)

To begin, double click on the executable **rtklaunch.exe**.

RTKLib Applications (Windows GUI)





Post processing tutorial



Tutorial Scenario (1)

Task: Generate Geocentric Datum of Australia 2020 (GDA2020) coordinates for the survey mark CA16.

Steps

- 1) Using **RTKLib** process a short baseline between CA16 and the Continuously Operating Reference Station *MENA*.
- 2) Using **SNAP** combine a GDA2020 SINEX file with the processed baseline to obtain GDA2020 coordinates.

Tutorial Scenario (2)





Required Files

Observation Data (*.o)

- ca160670.17o (campaign/rover station)
- mena0670.17o (reference/base station)

Navigation Data (*.n)

- brdc0670.17n (broadcast)

Precise Satellite Orbits (*.sp3)

- igs19393.sp3

Antenna Phase Centre Model (*.atx)

- igs14.atx

Reference Station Data

<http://www.igs.org>





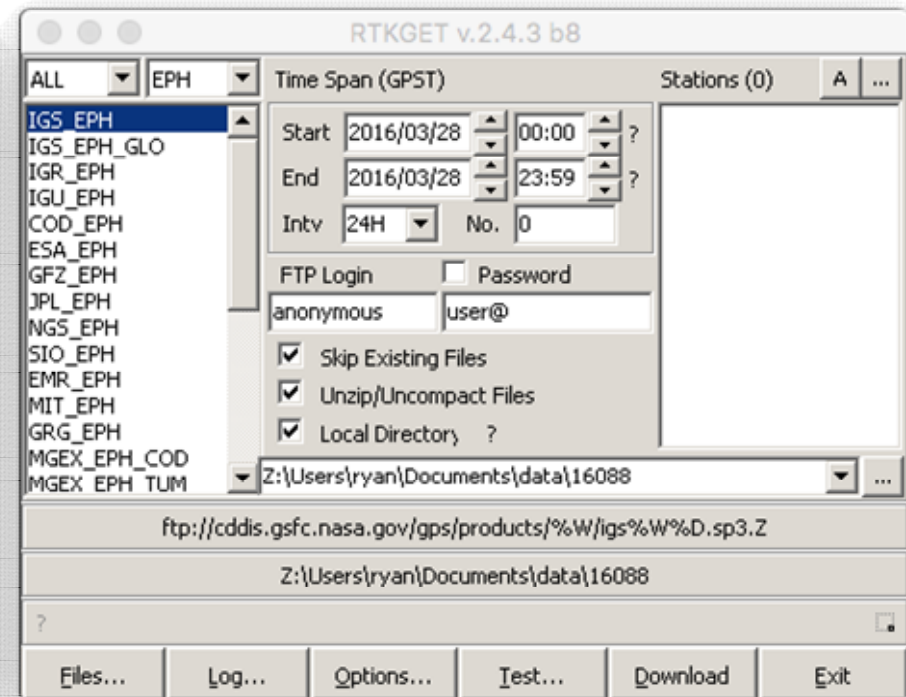
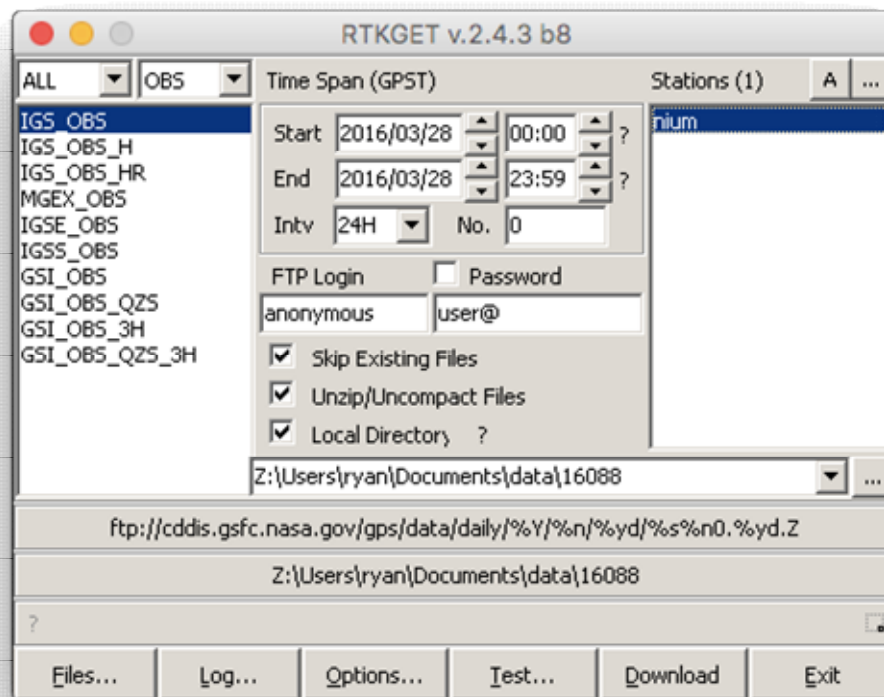
Precise Satellite Orbits

Type	Accuracy	Latency	Updates	Sample Interval
Broadcast	~100 cm	Real-time	-	daily
Ultra-Rapid (predicted half)	~5 cm	Real-time	at 03,09,15,21 UTC	15 min
Ultra-Rapid (observed half)	~3 cm	3 – 9 hours	at 03,09,15,21 UTC	15 min
Rapid	~2.5 cm	17 – 41 hours	at 17 UTC daily	15 min
Final	~2.5 cm	12 – 18 days	every Thursday	15 min

<ftp://cddis.gsfc.nasa.gov/gps/products/>

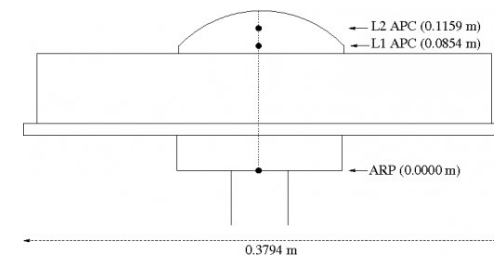
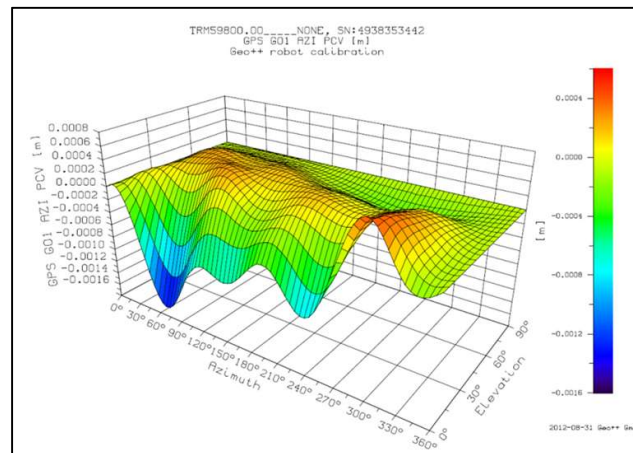
RTKGET

RTKGET can be used to download IGS products, such as reference station data, satellite orbits, clock files and Earth orientation parameters.



Antenna Phase Centre Variation Models

- The antenna PC is the part of the antenna that receives the signal.
- Due to manufacturing differences and satellite geometry PC's vary between antennas.
- Robotic antenna calibrations are available that provide models to correct for the PC variation.
- <ftp://ftp.igs.org/pub/station/general/igs14.atx>





Questions?

Data

- Rover station: CA16
- Base station: MENA
- Dates: 08/03/2017 (DOY067, GPS Week 19393)
 07/03/2018 (DOY066, GPS Week 19913)
- 24 hours static observation
- GPS L1+L2

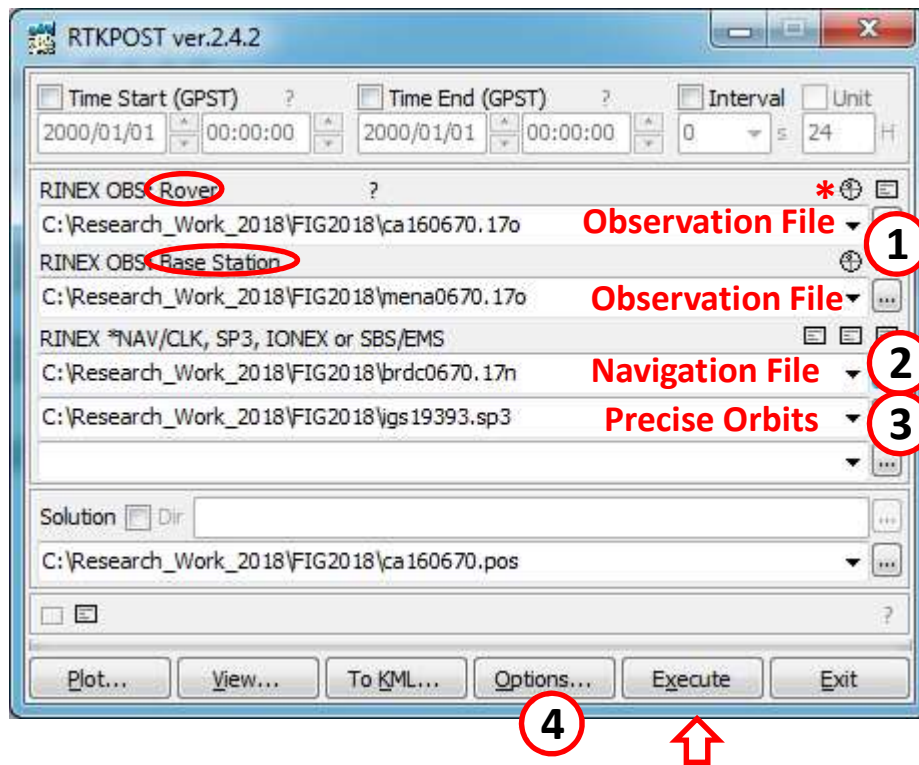


Base Station Coordinates

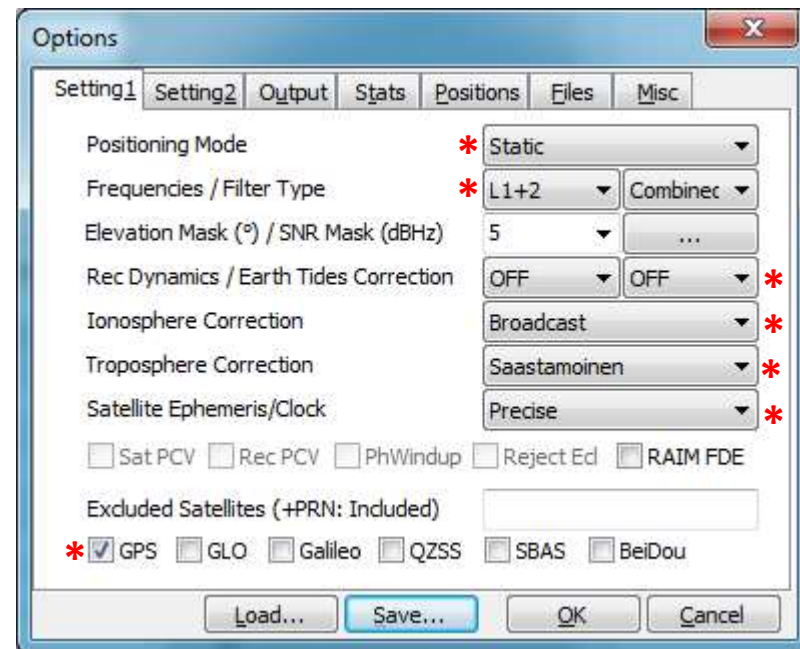
Point (GDA 2020)	X (m)	Y (m)	Z (m)
MENA (DOY 067 2017)	-4611310.958 ± 11 mm	2583118.192 ± 11 mm	-3558095.376 ± 14 mm
MENA (DOY 066 2018)	-4611310.955 ± 11 mm	2583118.193 ± 11 mm	-3558095.379 ± 13 mm

Static Post-Processing – Options (RTKPOST)

- Import data, set up processing configuration and execute processing.

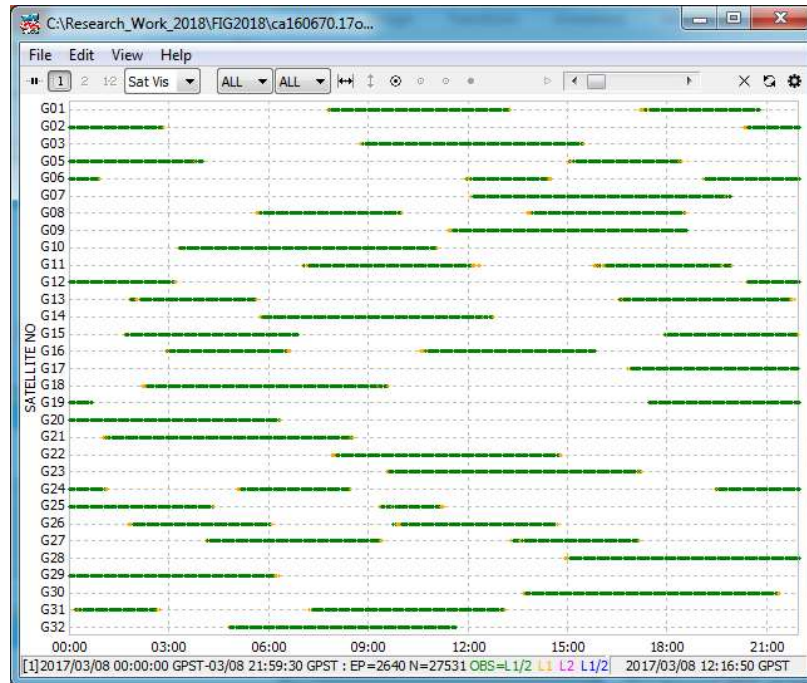


Setting 1

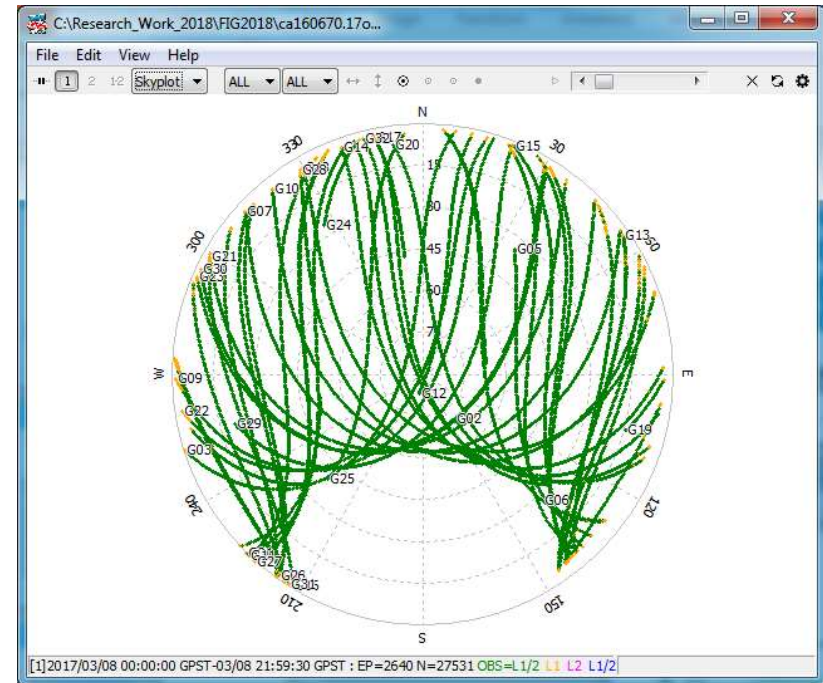


Observation Data Quality

Satellite Visibility

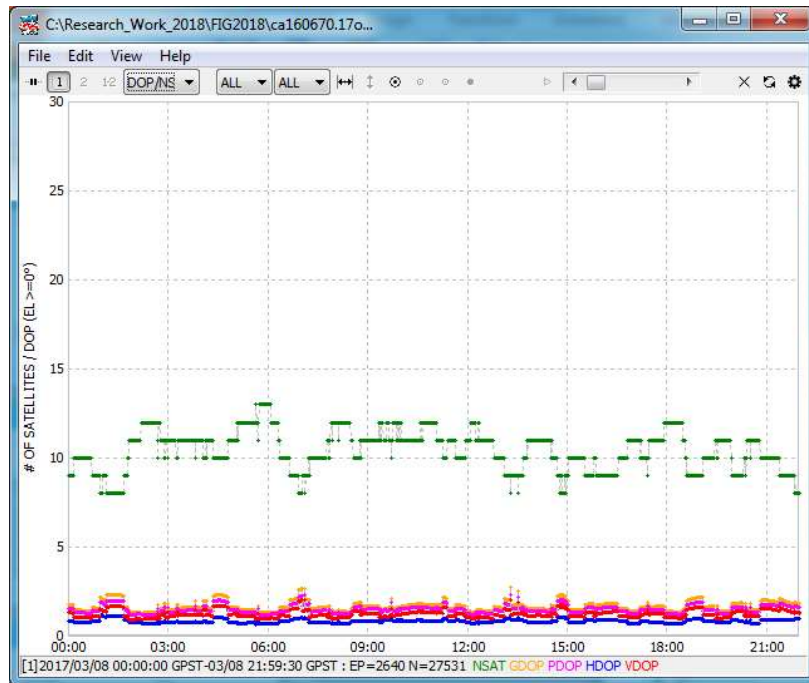


Skyplot

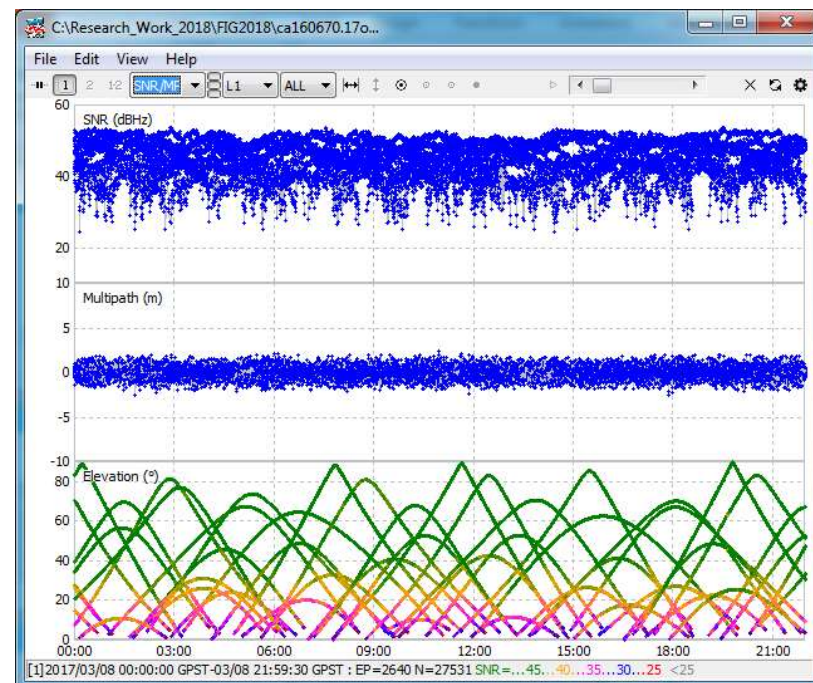


Observation Data Quality

Number of Satellites and DOP



SNR, Multipath, Elevation



Static Post-Processing – Options (RTKPOST)

Setting 2

Options

Setting1 Setting2 Output Stats Positions Files Misc

Integer Ambiguity Res (GPS/GLO/BDS) Conti ON ON *

Min Ratio to Fix Ambiguity 3

Min Confidence / Max FCB to Fix Amb 0.9999 0.25

Min Lock / Elevation (°) to Fix Amb 0 0

Min Fix / Elevation (°) to Hold Amb 10 0

Outage to Reset Amb/Slip Thres (m) 5 0.050

Max Age of Diff (s) / Sync Solution 30.0 ON

Reject Threshold of GDOP/Innov (m) 30.0 30.0

Number of Filter Iteration 1

Baseline Length Constraint (m) 0.000 0.000

Load... Save... OK Cancel

Output

Options

Setting1 Setting2 Output Stats Positions Files Misc

Solution Format E/N/U-Baseline *

Output Header/Processing Options ON ON

Time Format / # of Decimals hh:mm:ss GPST 3

Latitude / Longitude Format ddd.ddddddd

Field Separator

Datum/Height WGS84 Ellipsoidal

Geoid Model Internal

Solution for Static Mode All *

NMEA Interval (s) RMC/GGA, GSA/GSV 0 0

Output Solution Status / Debug Trace OFF OFF

Load... Save... OK Cancel

Stats

Options

Setting1 Setting2 Output Stats Positions Files Misc

Measurement Errors (1-sigma)

Code/Carrier-Phase Error Ratio L1/L2	100.0	100.0
Carrier-Phase Error a+b/sinE1 (m)	0.003	0.003
Carrier-Phase Error/Baseline (m/10km)	0.000	
Doppler Frequency (Hz)	10.000	

Process Noises (1-sigma/sqrt(s))

Receiver Accel Horiz/Vertical (m/s ²)	1.00E+01	1.00E+01
Carrier-Phase Bias (cycle)	1.00E-04	
Vertical Ionospheric Delay (m/10km)	1.00E-03	
Zenith Tropospheric Delay (m)	1.00E-04	
Satellite Clock Stability (s/s)	5.00E-12	

Load... Save... OK Cancel

Positions

Options

Setting1 Setting2 Output Stats Positions Files Misc

Rover

Lat/Lon/Height (deg/m) ...

90.000000000 0.000000000 -6335367.6285

Antenna Type (*: Auto) Delta-E/N/U (m)

TRM57971.00	0.0000	0.0000	1.5000
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Base Station

X/Y/Z-ECEF (m) ...

-4611310.9584	2583118.1924	-3558095.3761
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Antenna Type (*: Auto) Delta-E/N/U (m)

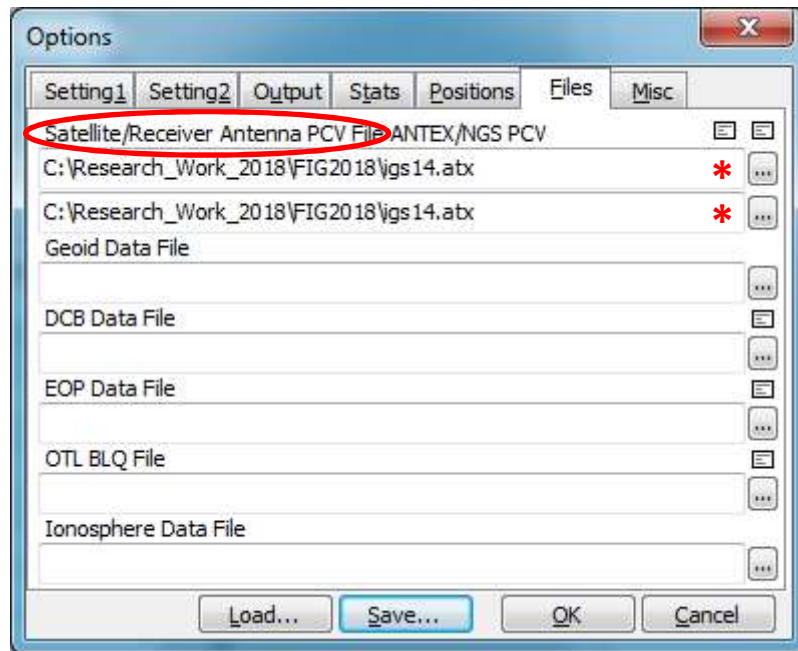
ASH701945E_M	0.0000	0.0000	0.0000
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Station Position File ...

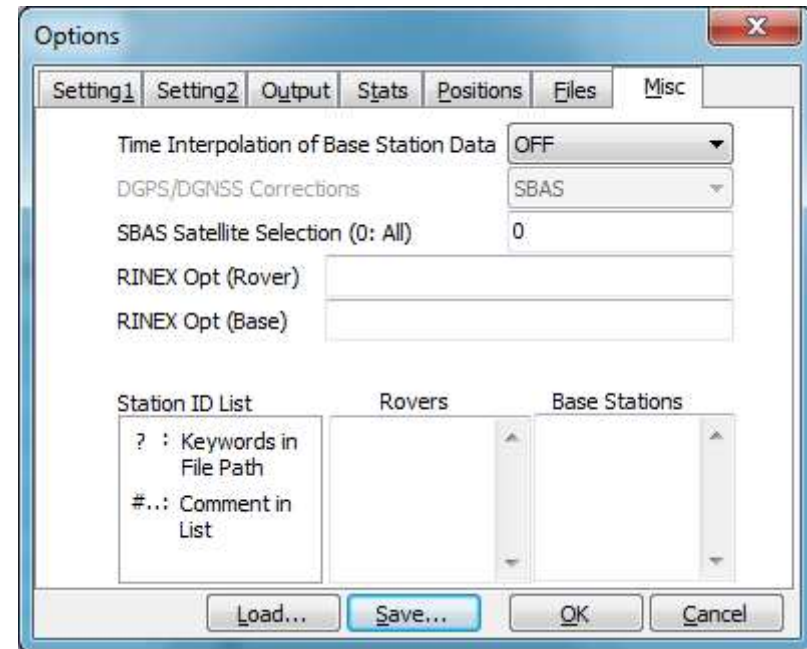
Load... Save... OK Cancel

Static Post-Processing – Options (RTKPOST)

Files

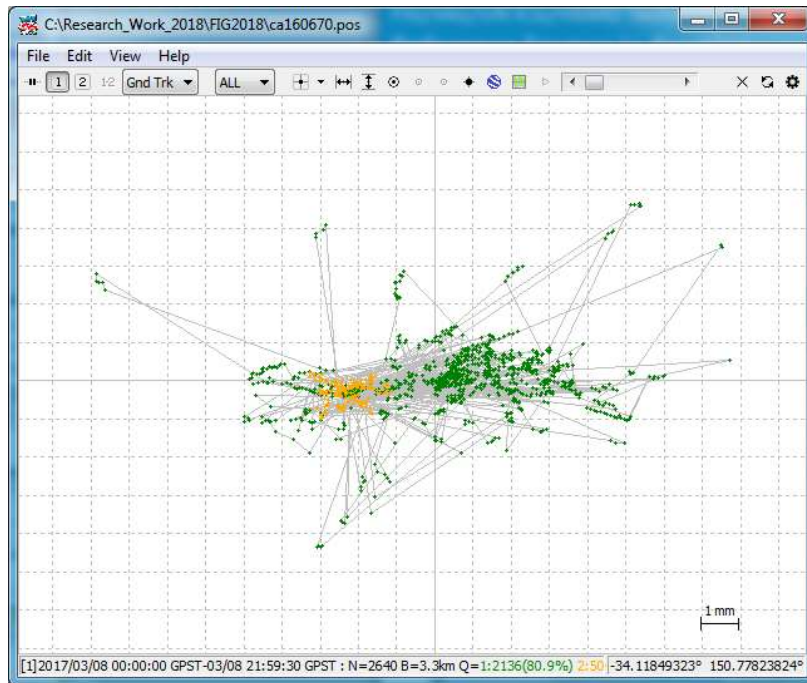


Misc

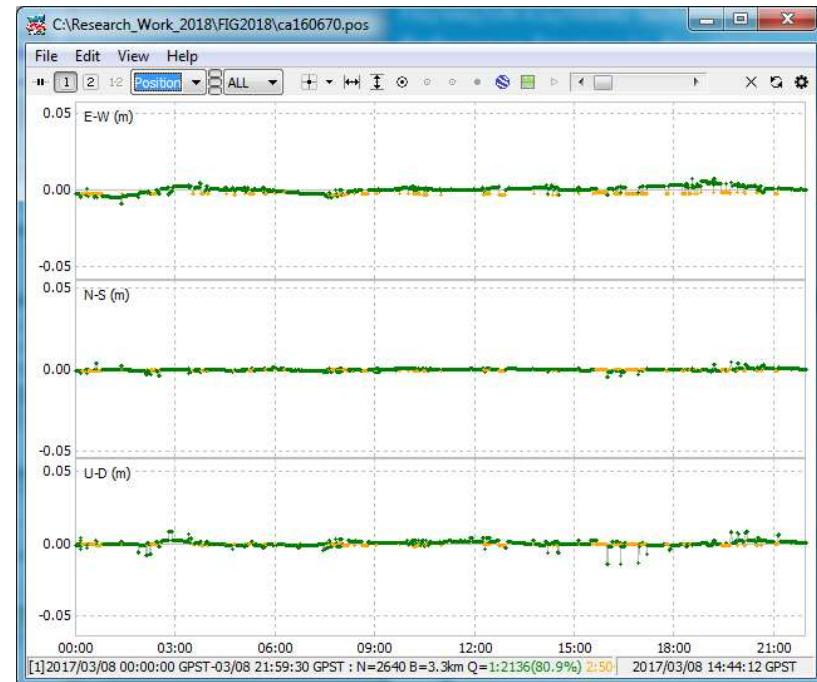


Plot (RTKPLOT)

Ground Track



Position





Comparison of Solutions (RTKPLOTT)

DOY 067 2017

Point (GDA 2020)	X (m)	Y (m)	Z (m)
CA16 (RTKLIB)	-4613300.916 ± 4 mm	2580586.721 ± 4 mm	-3557416.539 ± 3 mm
CA16 (AUSPOS)	-4613300.917 ± 11 mm	2580586.721 ± 11 mm	-3557416.542 ± 14 mm
	ΔX 1 mm	ΔY 0 mm	ΔZ 3 mm

DOY 066 2018

Point (GDA 2020)	X (m)	Y (m)	Z (m)
CA16 (RTKLIB)	-4613300.918 ± 10 mm	2580586.720 ± 8 mm	-3557416.535 ± 8 mm
CA16 (AUSPOS)	-4613300.918 ± 11 mm	2580586.723 ± 11 mm	-3557416.544 ± 13 mm
	ΔX 0 mm	ΔY 3 mm	ΔZ 9 mm



Questions?



Overview

- Introduction and installation of RTKLIB.

Tutorial

- Files required for post-processing
- Looking at observation data quality
- Baseline post-processing

Static Post-Processing – Options (RTKPOST)

Setting 2

Options

Setting1 Setting2 Output Stats Positions Files Misc

Integer Ambiguity Res (GPS/GLO) Continuo ON *

Min Ratio to Fix Ambiguity 3

Min Confidence / Max FCB to Fix Amb 0.9999 0.25

Min Lock / Elevation (°) to Fix Amb 0 0

Min Fix / Elevation (°) to Hold Amb 10 0

Outage to Reset Amb/Slip Thres (m) 5 0.050

Max Age of Diff (s) / Sync Solution 30.0 ON

Reject Threshold of GDOP/Innov (m) 30.0 30.0

Number of Filter Iteration 1

Baseline Length Constraint (m) 0.000 0.000

Load... Save... OK Cancel

Output

Options

Setting1 Setting2 Output Stats Positions Files Misc

Solution Format X/Y/Z-ECEF *

Output Header/Processing Options ON ON

Time Format / # of Decimals hh:mm:ss GPST 3

Latitude / Longitude Format ddd.ddddddd

Field Separator

Datum/Height WGS84 Ellipsoidal

Geoid Model Internal

Solution for Static Mode All *

NMEA Interval (s) RMC/GGA, GSA/GSV 0 0

Output Solution Status / Debug Trace OFF Level2

Load... Save... OK Cancel

Stats

Options

Setting1 Setting2 Output Stats Positions Files Misc

Measurement Errors (1-sigma)

Code/Carrier-Phase Error Ratio L1/L2	100.0	100.0
Carrier-Phase Error a+b/sinE1 (m)	0.003	0.003
Carrier-Phase Error/Baseline (m/10km)	0.000	
Doppler Frequency (Hz)	10.000	

Process Noises (1-sigma/sqrt(s))

Receiver Accel Horiz/Vertical (m/s ²)	1.00E+01	1.00E+01
Carrier-Phase Bias (cycle)	1.00E-04	
Vertical Ionospheric Delay (m/10km)	1.00E-03	
Zenith Tropospheric Delay (m)	1.00E-04	
Satellite Clock Stability (s/s)	5.00E-12	

Load... Save... OK Cancel

Positions

Options

Setting1 Setting2 Output Stats Positions Files Misc

Rover

Lat/Lon/Height (deg/m) ...

90.000000000 0.000000000 -6335367.6285

Antenna Type (*: Auto) Delta-E/N/U (m)

TRM57971.00 0.0000 0.0000 1.5000 *

Base Station

X/Y/Z-ECEF (m) ...

* -4611310.9584 2583118.1924 -3558095.3761

* Antenna Type (*: Auto) Delta-E/N/U (m)

* ASH701945E_M 0.0000 0.0000 0.0000

Station Position File ...

Load... Save... OK Cancel