

Static Post Processing

Module for processing GNSS data in static mode, consists of two parts:

1. One vector
2. Grid equalization

One vector calculates rover coordinates from base station by one vector. The measurement requires rover and base station files as well as a navigation file. Supported observation file formats: *.ubx, *.obs, *.rnx and *.*O.

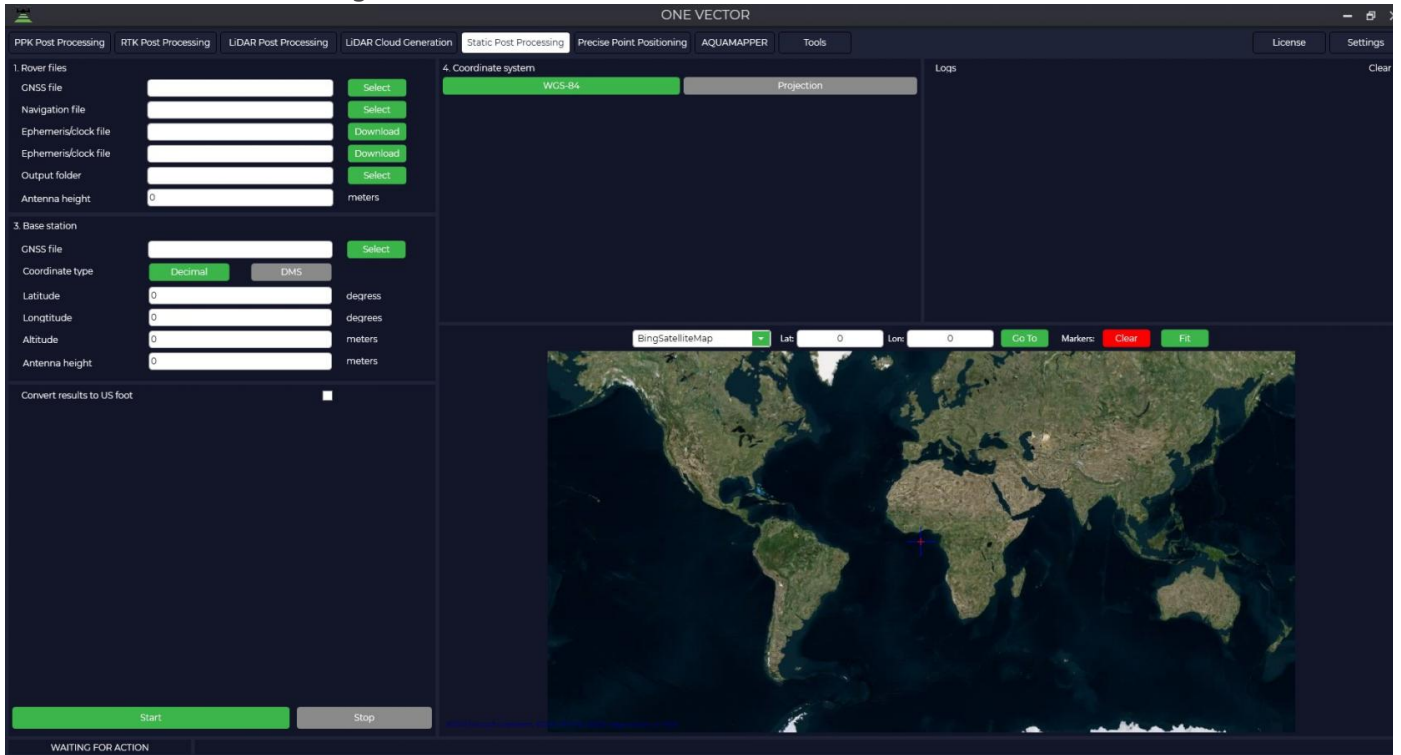
For more accurate results also upload your own or download an accurate ephemeris file from NASA server. Supported formats of navigation ephemeris files: *.nav, *.rnx, *.n, *.p, *.g, *.h, *.q, *.c and *.l. Supported formats of precision ephemeris files: *.eph, *.sp3.

The distance from the base station to the rover, using accurate ephemeris and NASA navigation file, is practically unlimited, daily rinex files give RMS of about 5 centimeters at a distance of 5 thousand km. In the module it is possible to perform measurement in the selected projection at once.

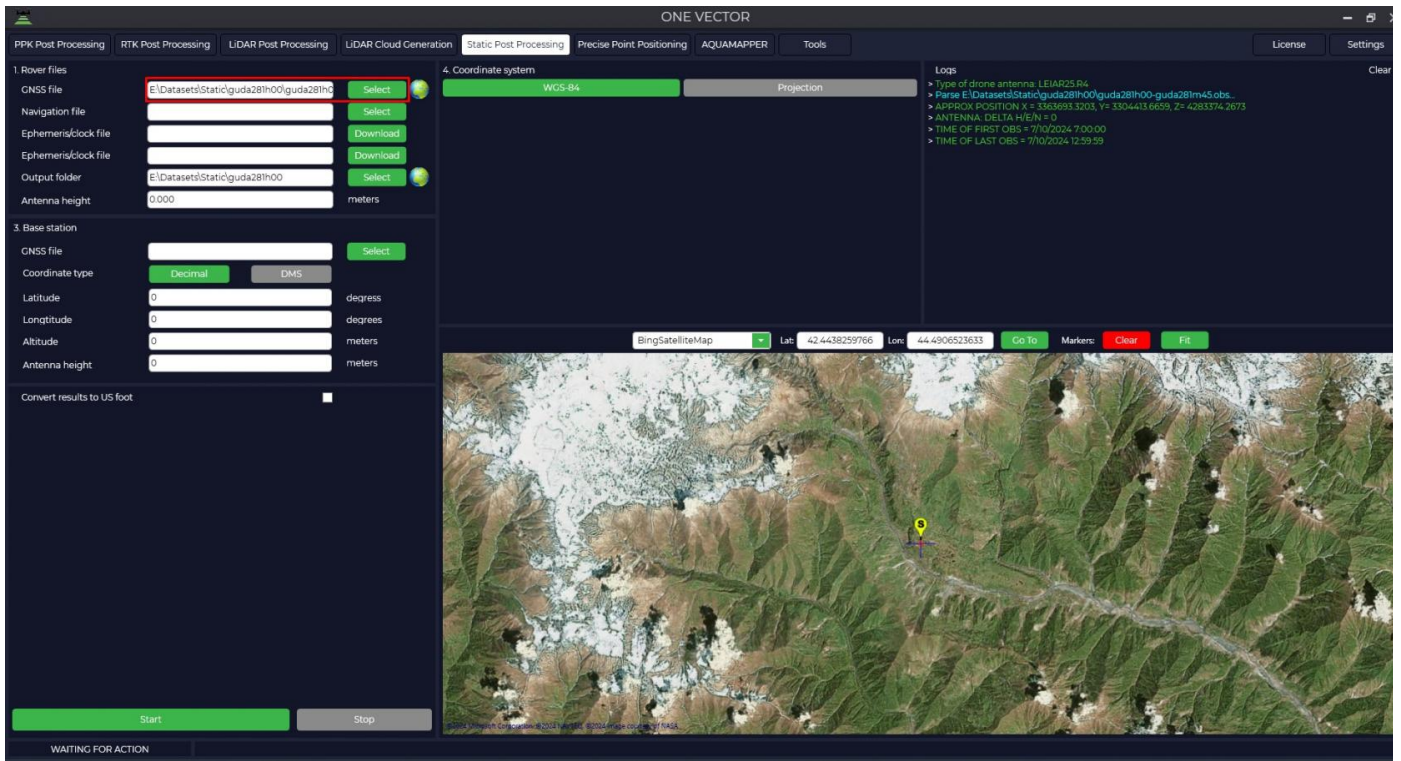
- [One vector](#)
- [Grid equalization](#)

One vector

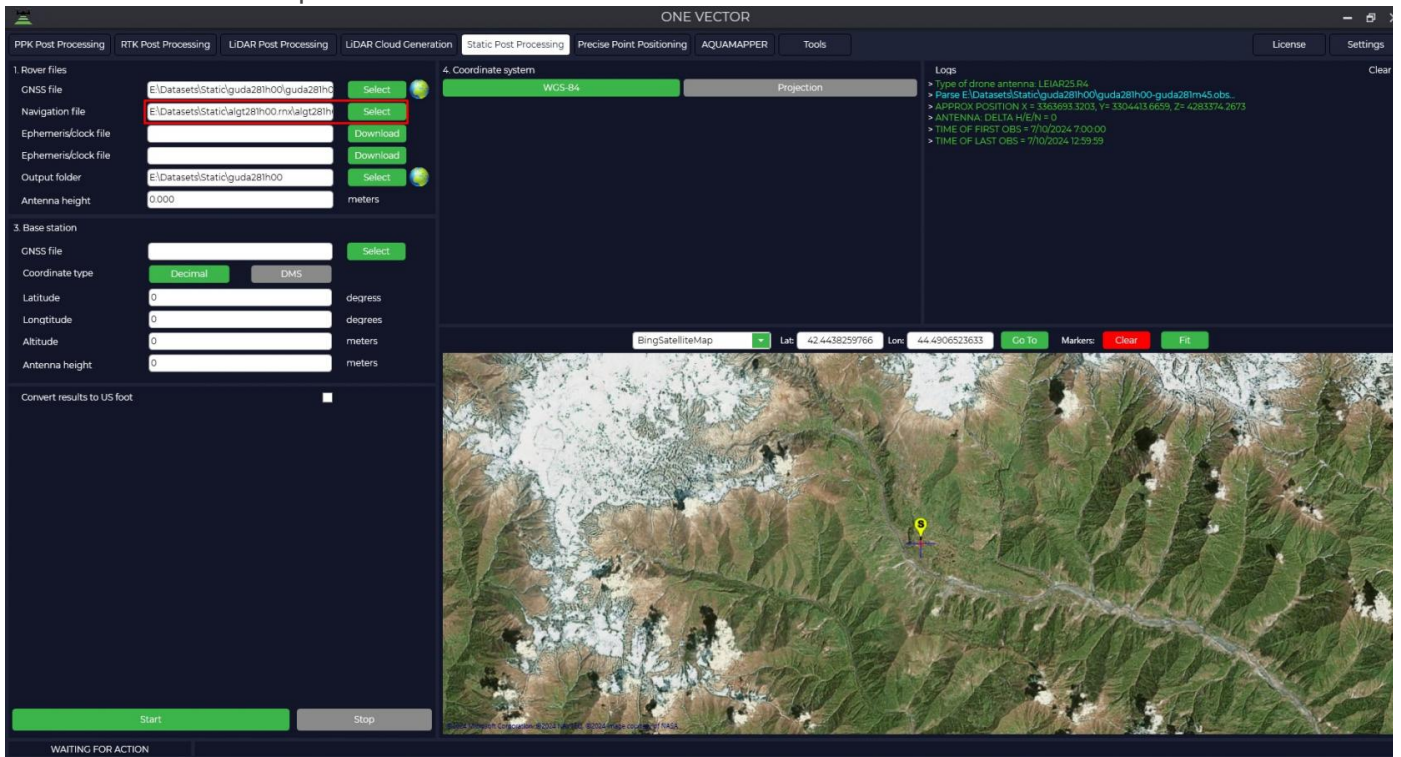
1. To start this module it is necessary to open the TOPODRONE Post Processing program, go to the Static Post Processing tab and click on the "One vector" button.



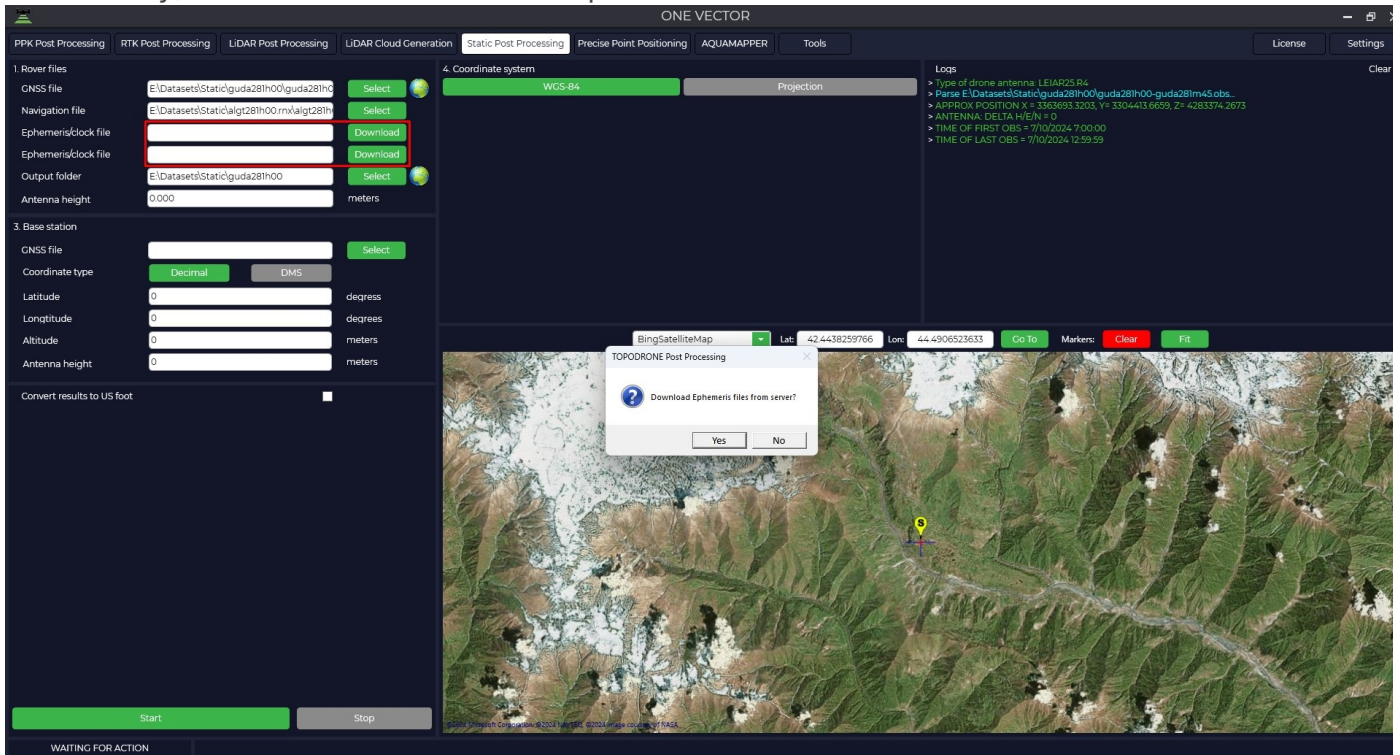
2. Load measurement data from the rover.



3. Download airborne ephemeris data.

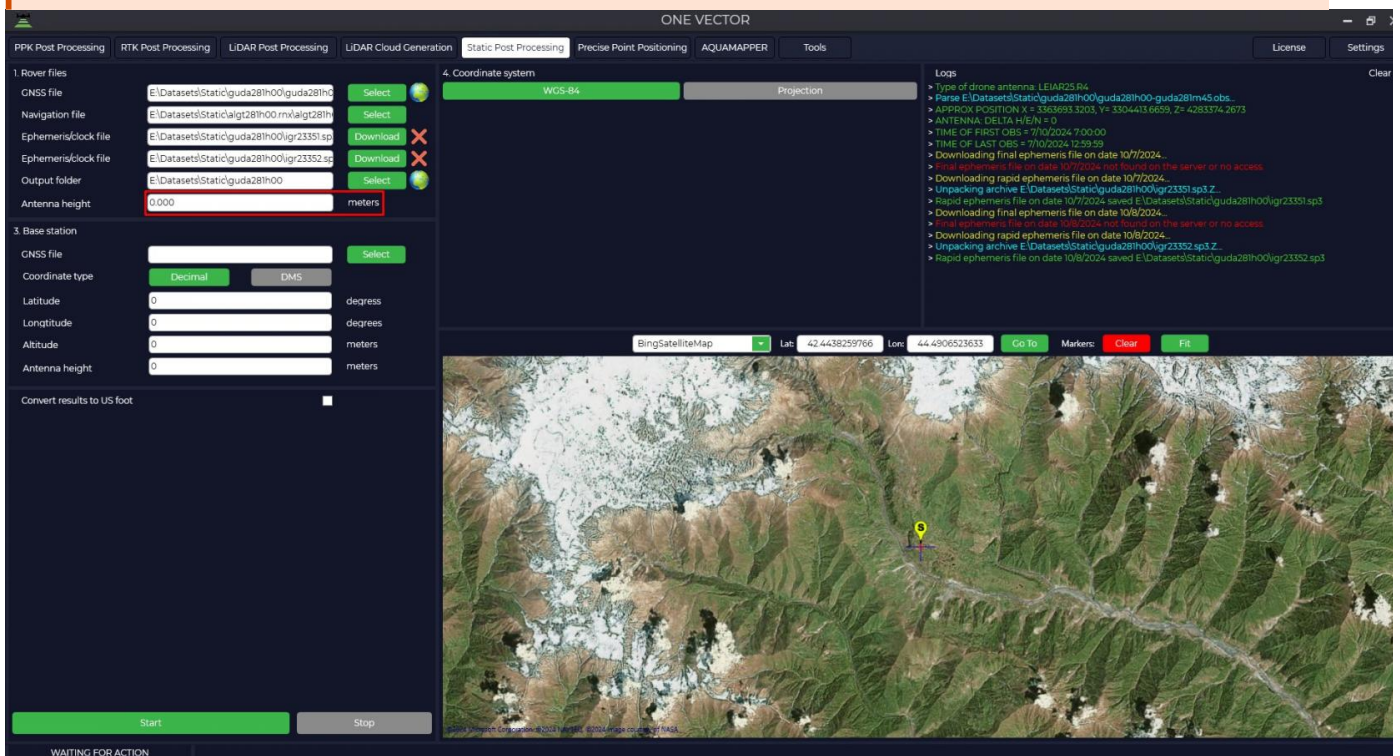


4. If necessary, download files of accurate ephemeris.

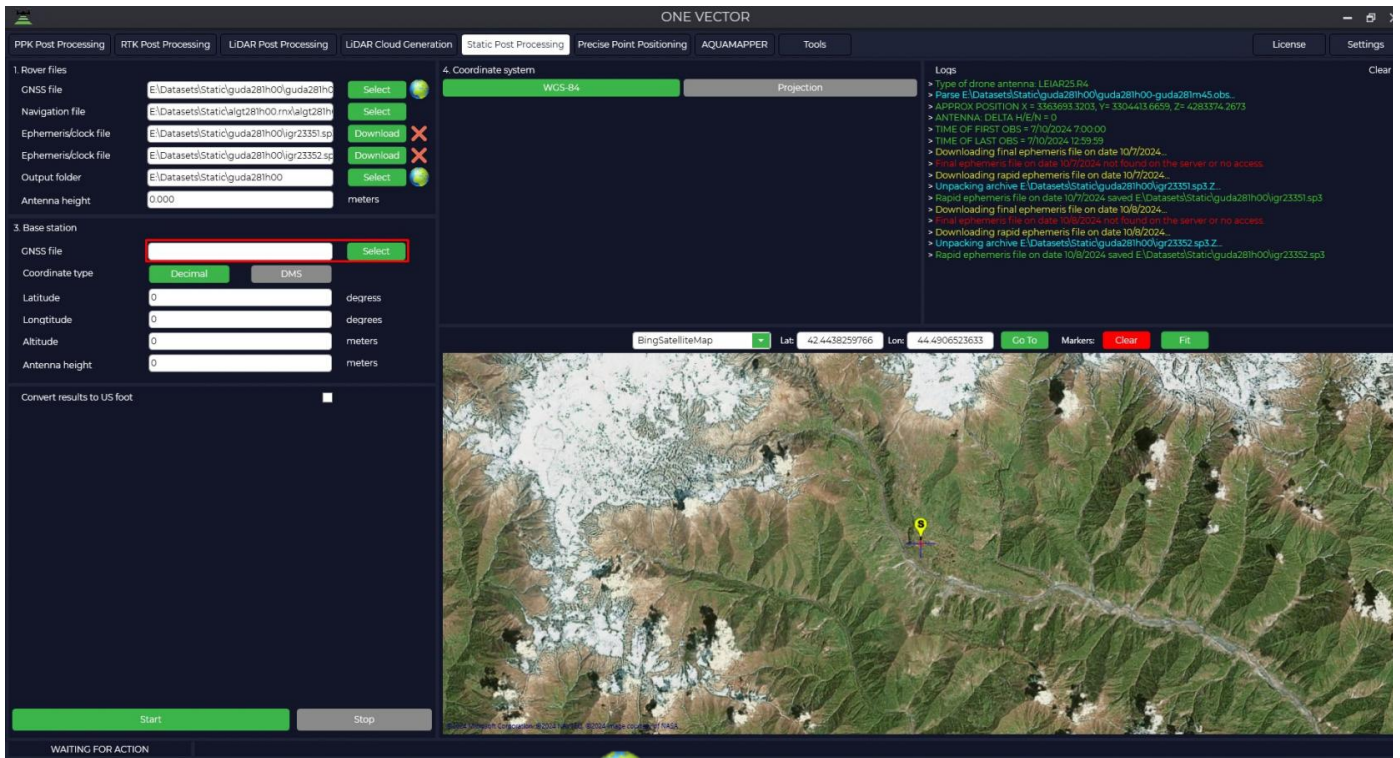



5. Enter the height of the rover antenna.

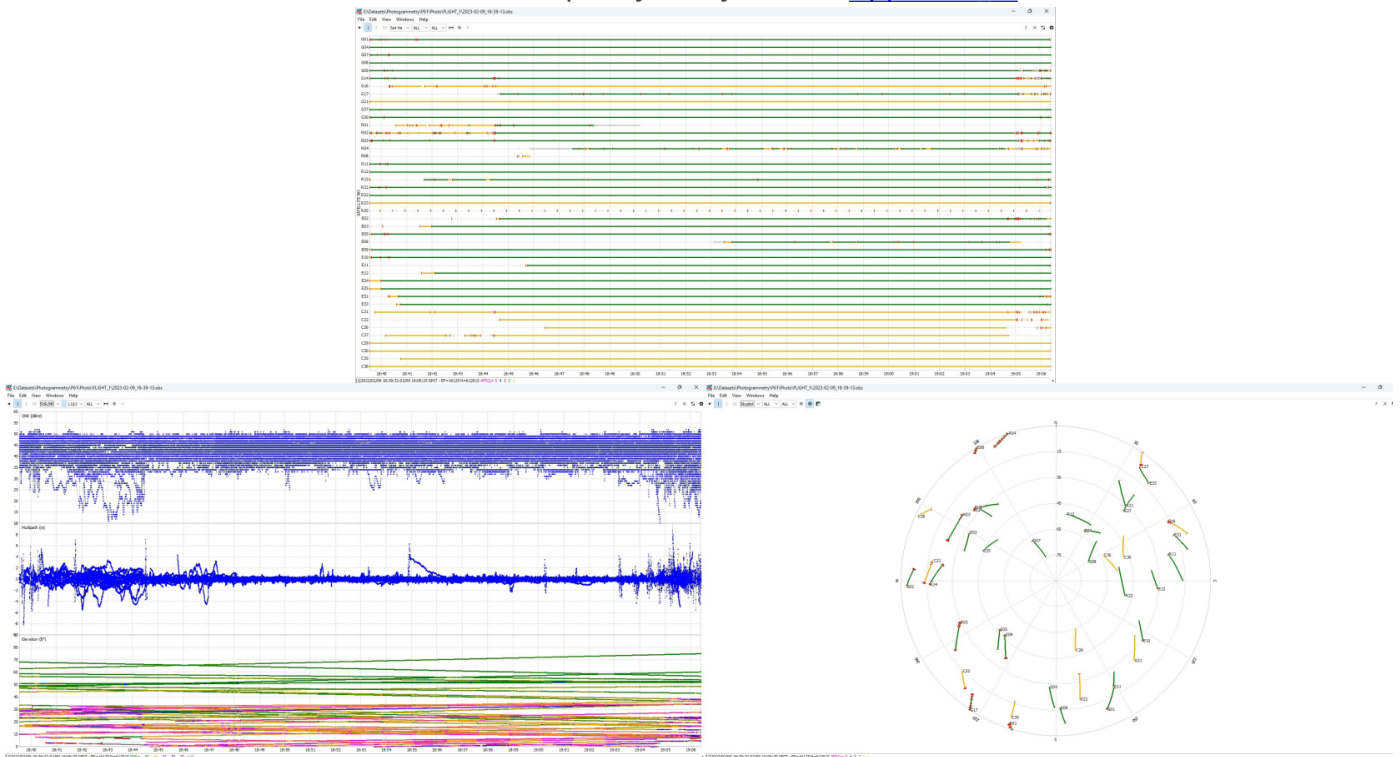
The height of the antenna includes the height of the milestone or tripod from the measuring point to the bottom of the receiver mount and the height from the bottom of the receiver mount to the phase center.



6. Download measurement data from the base station.



7. After the files are uploaded, pressing the  button allows you to analyze the quality of the data. For more information about data quality analysis, see [Appendix B](#).



8. The program will automatically load the coordinates and height of the base antenna from the Rinex file, taking into account that it was entered during measurement and display the location on the map.

3. Base station

GNSS file	E:\Datasets\Static\algt281h00.rnx\algt281h	Select 
Coordinate type	<input checked="" type="button" value="Decimal"/> <input type="button" value="DMS"/>	
Latitude	41.3861281141	degrees
Longitude	45.0368662161	degrees
Altitude	328.865	meters
Antenna height	0.000	meters

9. In case your coordinate system is different from WGS-84, you need to click "Projection" button and select your coordinate system from the list or enter the coordinate system name in the search line, if necessary, select the geoid model. If your coordinate system is not in the list, you can add it to TOPODRONE Post Processing program.

4. Coordinate system

<input type="button" value="WGS-84"/>	<input checked="" type="button" value="Projection"/>
Calibration	Not used <input type="button" value="v"/>
Elevation type	GEOID (EGM2008) <input type="button" value="v"/>
Projection 	32638
World-WGS 84-UTM-zone 38N (m) EPSG 32638	

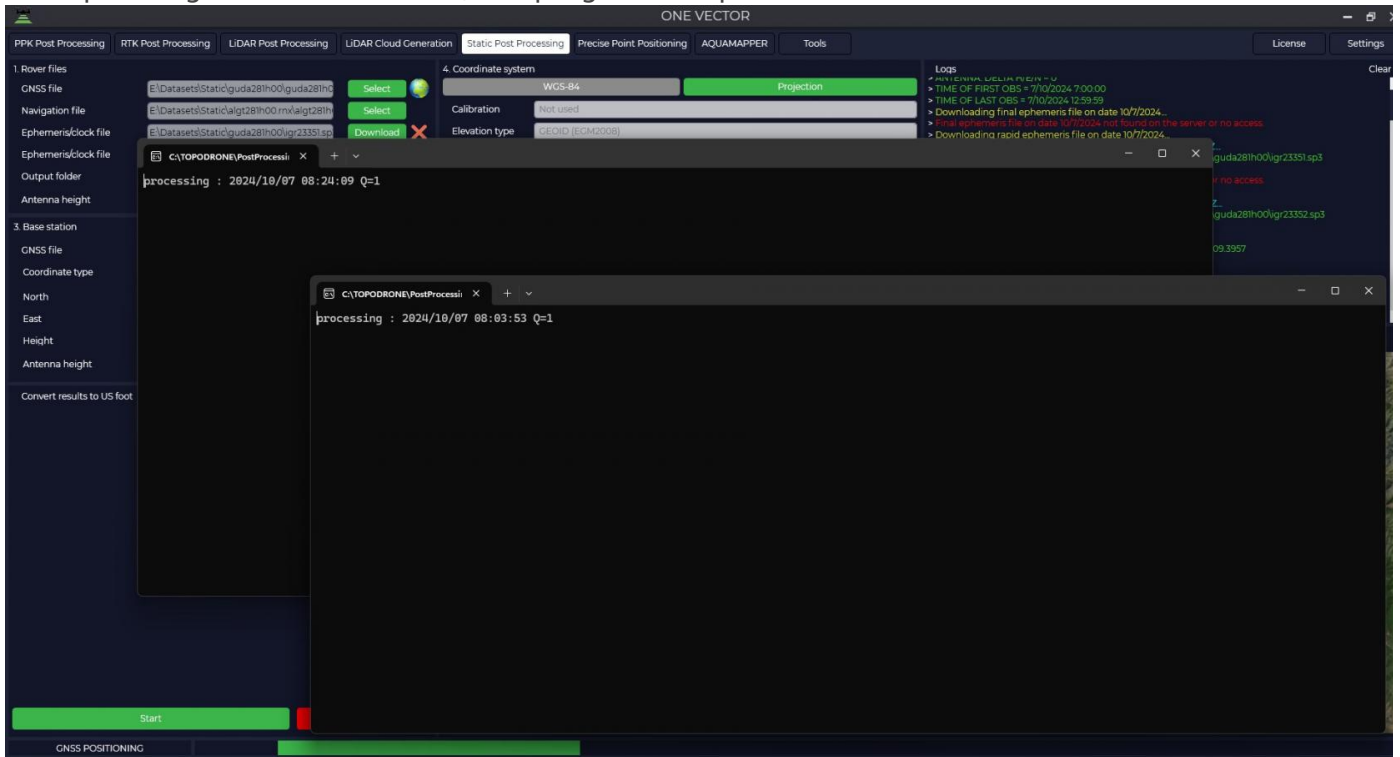
10. Selecting a coordinate system will convert from WGS-84 to the projection of your choice. If necessary, correct the coordinates of the base station.

The height of the antenna includes the height of the milestone or tripod from the point of known coordinates to the bottom of the receiver mount and the height from the bottom of the receiver mount to the phase center.

3. Base station

GNSS file	E:\Datasets\Static\algt281h00.rnx\algt281h	Select 
Coordinate type	<input checked="" type="button" value="Decimal"/> <input type="button" value="DMS"/>	
North	4581623.042440653	meters
East	503082.3403912924	meters
Height	313.5478820884881	meters
Antenna height	0.000	meters

After pressing the "Start" button, the program will proceed to calculations.



11. Upon completion of calculations the program will display a window with coordinates of base station and rover in WGS-84 coordinate system and local coordinate system and will offer to save these data to observation files for further use of these data. Also in the output data folder the file with the calculation results will be saved.

Caption

TOPODRONE Post Processing

 PRJ: World-WGS 84-UTM-zone 38N (m) EPSG 32638
Elevation type: GEOID (EGM2008)

Base:

----- WGS-84 -----
Latitude: 41.38612811 degrees
Longitude: 45.03686622 degrees
Altitude: 328.865 meters

----- PRJ -----
North: 4581623.0424 meters
East: 503082.3404 meters
Height: 313.5479 meters

Rover:

----- WGS-84 -----
Latitude: 42.4438271 degrees
Longitude: 44.49065247 degrees
Altitude: 1869.817 meters

----- Accuracy -----
Accuracy Latitude: 0.0493 meters
Accuracy Longitude: 0.0124 meters
Accuracy Altitude: 0.0688 meters

----- PRJ -----
North: 4699181.4077 meters
East: 458111.3929 meters
Height: 1849.2161 meters

Update coordinates in rinex files of rover and base?

PRJ: World-WGS 84-UTM-zone 38N (m) EPSG 32638
Elevation type: GEOID (EGM2008)

Base:

----- WGS-84 -----
Latitude: 41.38612811 degrees
Longitude: 45.03686622 degrees
Altitude: 328.865 meters

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----- PRJ -----
North: 4699181.4077 meters
East: 458111.3929 meters
Height: 1849.2161 meters

Grid equalization

1. To start this module, go to the Static Post Processing tab and click on the Network Equalization button.

NETWORK EQUALIZATION

PPK Post Processing RTK Post Processing LIDAR Post Processing LIDAR Cloud Generation **Static Post Processing** Precise Point Positioning AQUAMAPPER Tools License Settings

Elevation type [Search] [Search] Logs [Clear]

> 1_nrsk (t65)
> Afghanistan
> Albania
> Algeria Morocco Tunisia
> Algeria
> American Samoa
> Amnate (Arabian)

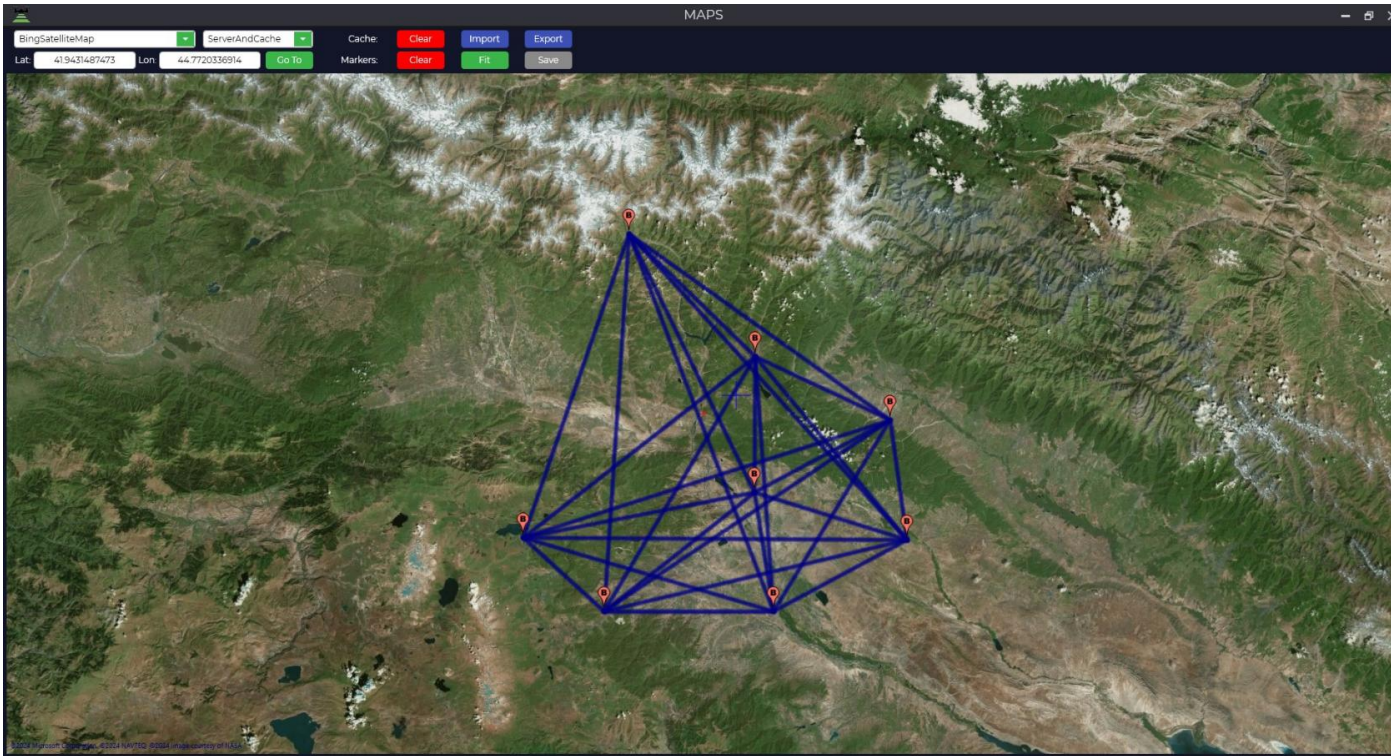
INITIAL POINT NAME	R	N	E	E	PROJECTION			ITRF-14			DISTORTION OF CS BY SXGNS			DENSITY WEIGHT
					NORTH	EAST	HEIGHT	NORTH	EAST	HEIGHT	NORTH	EAST	HEIGHT	

MEASURED POINT NAME	R	N	E	E	PROJECTION			ITRF-14			DISTORTION OF CS BY SXGNS			DENSITY WEIGHT
					NORTH	EAST	HEIGHT	NORTH	EAST	HEIGHT	NORTH	EAST	HEIGHT	

Open project New project Initial table Open catalog Add point Delete point Measured table Add point Delete point Off distortion Stop Calculate Recalculate

WAITING FOR ACTION

2. To display the points where observations were made, the map window must be open at the time of file upload.



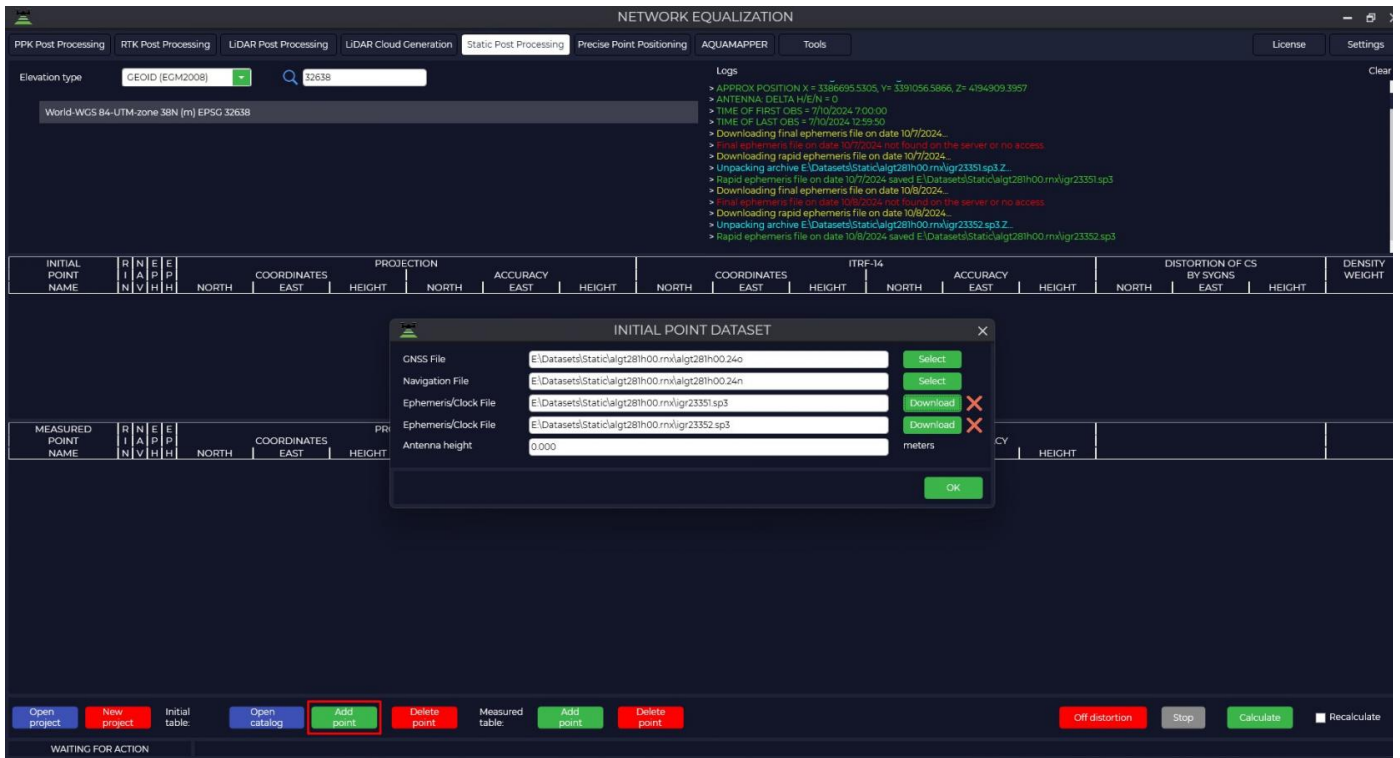
- The bottom panel has a number of tools: open or create a new project, open the source point catalog, add or delete source point files, add or delete measured point files, remove projection distortions, stop processing, and calculate.



- The first thing to do is to select the required projection and the type of elevation to be used.



- When we click on the "Add Point" button next to the "Start Table" item, we need to load the data for the starting points.



GNSS file - a GNSS receiver measurement file in *.obs, *.rnx or *.*o formats.

Navigation file - navigation file of measurements in *.nav, *.rnx, *.n, *.p, *.g, *.h, *.q, *.c and *.l format.

Ephemeris file - file of final ephemeris in *.sp3, *.eph format, you can also upload a file of accurate flight clock *.clk. When you click on the Download button, if the data are available on the NASA server, the program will automatically download these data.

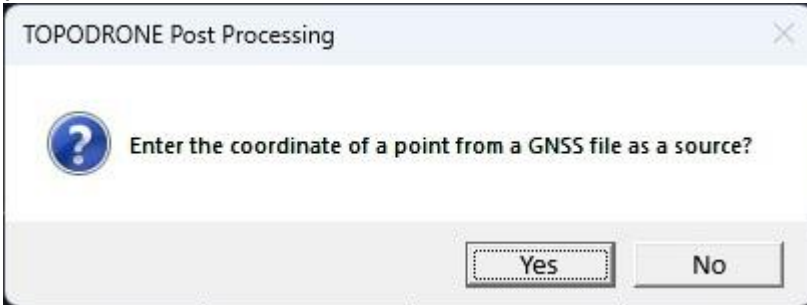
When processing the Grid Equation, the program uses the method of obtaining Precise Point Positioning (PPP) coordinates of the terrain using global navigation satellite systems by obtaining corrections to the orbital ephemeris and on-board clocks of all visible spacecraft. For the best calculation it is recommended to add daily measurements from the nearest reference base station or IGS.

Antenna height is the height from the center of the point to the phase center of the GNSS receiver.

Type	Accuracy of orbits and clocks	Accessibility	Note
Broadcast	~100 cm ~5 ns RMS ~2.5 ns σ	In real time	GLONASS (.YYg) and GPS (.YYn) on-board ephemeris for a day in RINEX format summarized in the TsUP
UltraRapid	~3 cm ~150 ns RMS ~50 ns σ	In 3-9 hours	Refined ephemeris and corrections of airborne clocks

Rapid	~2.5 cm ~75 ns RMS ~25 ns σ	After 17-41 hours	Ephemeris and corrections of onboard clocks obtained on the interval of last days
Final	~2.5 cm ~75 ns RMS ~20 ns σ	After 12-18 days	Final ephemeris and flight clock corrections

6. When adding initial data to the program, a window will appear on entering coordinates of the point from the loaded file, click the "Yes" button.



7. Then, if necessary, load the coordinate catalog of the source points or enter the coordinates and their accuracy manually.

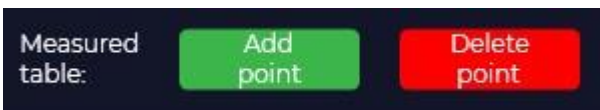


If you do not know with what accuracy they have been determined, you should provide the following recommended accuracies:

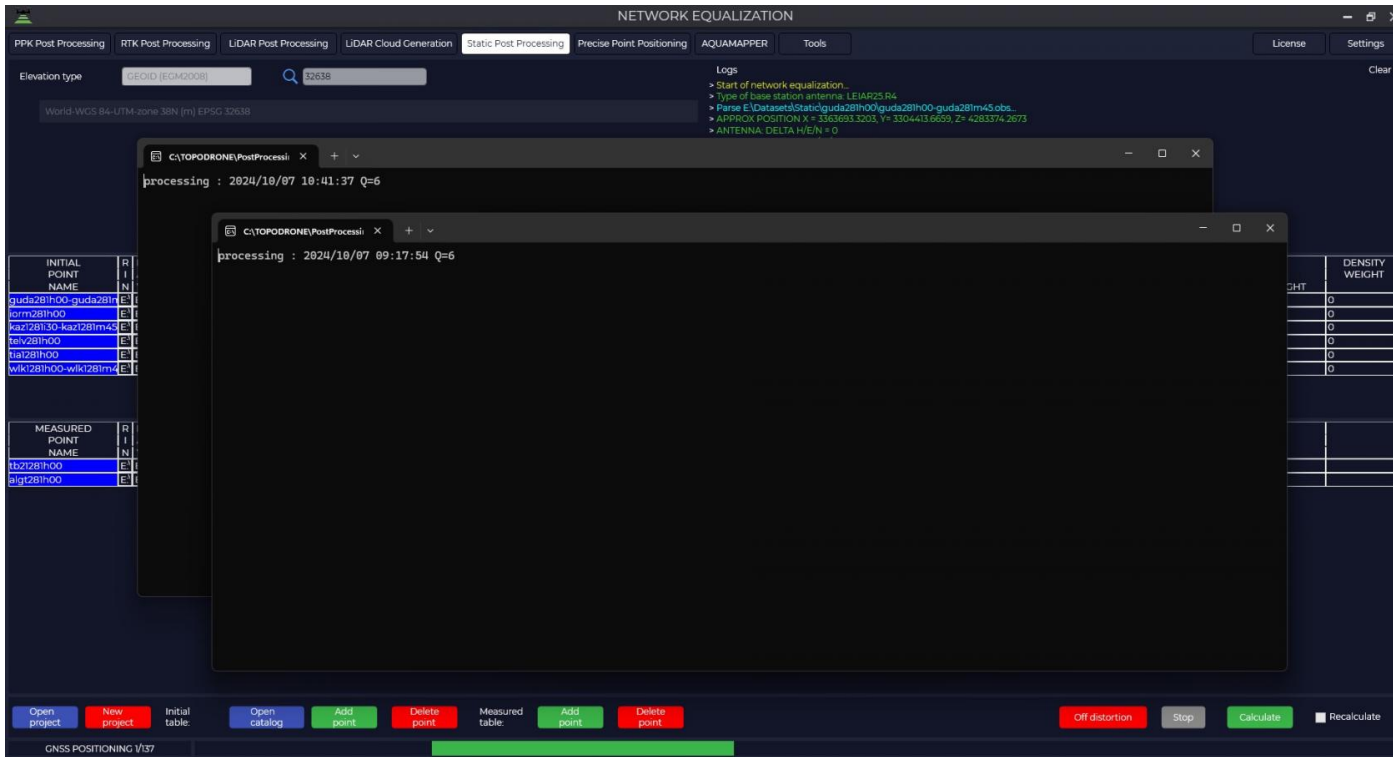
- FAGS 20 mm north/east, 30 mm high;
- HCV 30mm north/east, 40mm high;
- AGS and GHS 40mm north/east, 50mm high;
- GGS 60mm north/east, 110mm high.

INITIAL POINT NAME	R	I	N	A	P	E	COORDINATES			PROJECTION		
							NORTH	EAST	HEIGHT	NORTH	ACCURACY EAST	HEIGHT
guda281h00-guda281m4	E	A	E	A	E	E	4699181.283	458111.383	1849.657	0.1	0.1	0.1
iorm281h00	E	A	E	A	E	E	4604366.669	544910.346	472.488	0.1	0.1	0.1
kazi281i30-kazi281m45	E	A	E	A	E	E	4581903.89	449661.655	738.876	0.1	0.1	0.1
telv281h00	E	A	E	A	E	E	4641467.537	539362.13	688.629	0.1	0.1	0.1
tia1281h00	E	A	E	A	E	E	4661182.914	497386.002	1107.1	0.1	0.1	0.1
wki1281h00-wki1281m4	E	A	E	A	E	E	4605246.306	424369.707	1482.701	0.1	0.1	0.1

8. To load the data for measured points, you must use "Add point" against the item "Measurement table" and perform the loading by analogy with the original points.



- Once all items have been loaded, click on the "Start" button and the program will begin the calculation. The number of operations and the total number of calculations to be performed will be displayed on the bottom left.



The calculation of the network follows the following algorithm:

- 1) Calculation of coordinates of all points in ITRF2014 coordinate system by Precise Point Positioning - PPP method. After this step in the ITRF-14 window you will see the calculated coordinates and their accuracy.

ITRF-14					
COORDINATES			ACCURACY		
NORTH	EAST	HEIGHT	NORTH	EAST	HEIGHT
42.44382723	44.49065605	1870.4226	0.0268	0.0375	0.0813
41.58973548	45.53883621	484.2329	0.0159	0.0175	0.0327
41.38708975	44.39792722	759.4489	0.0284	0.0465	0.094
41.92418625	45.47472764	701.7525	0.0197	0.0297	0.0546
42.10273277	44.96839056	1123.427	0.0109	0.0119	0.0187
41.59533954	44.09252067	1504.3975	0.0268	0.0291	0.0684

ITRF-14					
COORDINATES			ACCURACY		
NORTH	EAST	HEIGHT	NORTH	EAST	HEIGHT
41.72130046	44.96460467	718.0741	0.0136	0.0084	0.0172
41.38613005	45.03687088	328.8085	0.0124	0.0085	0.0159

- 2) In the next step, the program performs Precise Point Positioning and static measurement of all possible vectors, performs point coordinates calculation by precision weighting.
- 3) Then, using the coordinate system and coordinates of the initial points, taking into account

the weighting accuracies of the points, the program calculates the total displacement from the parameters of the selected projection and creates a grid of residual distortion corrections.

- In the DISTORTION OF CS BY SYGNS window you can see the residual distortions of the coordinate system relative to the original points. In the DENSITY WEIGHT window Density of points, it is needed to increase/decrease the weight of distortions, a single point has a higher weight than a point that is next to others.

DISTORTION OF CS BY SYGNS			DENSITY WEIGHT
NORTH	EAST	HEIGHT	
0.022	0.057	-0.084	0.822
-0.011	0.001	0.022	1.171
0.043	-0.02	-0.05	0.877
-0.026	-0.005	0.027	1.098
-0.039	-0.033	0.04	0.822
0.011	0	0.045	1.21

- As a result of calculations you will get a catalog of coordinates of points in the coordinate system that was specified, accuracy of determination of these coordinates and distortion grid for use in the TOPODRONE Post Processing program. The calibration file can be opened through the "Tools" module, "Calibration" tab. In addition, a report of the processing results will be saved in the document folder.

The screenshot shows the NETWORK EQUALIZATION software interface. At the top, there are tabs for PPK Post Processing, RTK Post Processing, LIDAR Post Processing, LIDAR Cloud Generation, Static Post Processing, Precise Point Positioning, AQUAMAPPER, Tools, License, and Settings. The main window displays a table with columns for INITIAL POINT NAME, COORDINATES (NORTH, EAST, HEIGHT), PROJECTION, ACCURACY (NORTH, EAST, HEIGHT), ITRF-14 (NORTH, EAST, HEIGHT), and DISTORTION OF CS BY SYGNS (NORTH, EAST, HEIGHT). A 'DENSITY WEIGHT' column is also present. The table contains several rows of data, with some rows highlighted in blue. A red box highlights a 'Logs' window on the right side of the interface, which contains a list of log entries detailing coordinate updates and file operations. At the bottom of the interface, there is a toolbar with buttons for 'Open project', 'New project', 'Initial table', 'Open catalog', 'Add point', 'Delete point', 'Measured table', 'Add point', 'Delete point', 'Off distortion', 'Stop', 'Calculate', and 'Recalculate'.

- When you click the "Correct Distortion" button, the program distributes the errors to the source items and re-runs the processing.

Recalculate

13. The table below summarizes the results of processing
Caption

Until distortion is eliminated			After removing distortion		
NORTH	EAST	HEIGHT	NORTH	EAST	HEIGHT
4618833.7264	497055.5201	702.9914	4618833.7333	497055.5256	702.9762
4581623.0958	503082.3648	313.4231	4581623.0978	503082.369	313.4111