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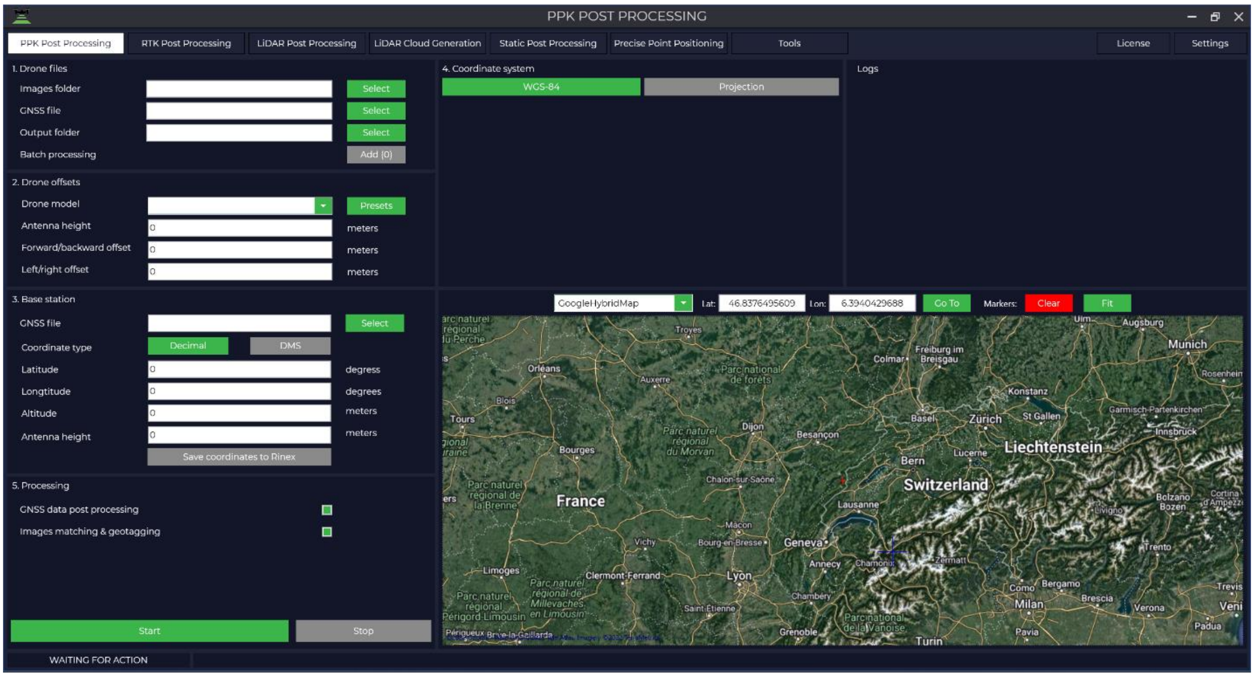

TOPODRONE Post Processing is a professional tool for automatic processing of the raw GNSS measurements at any coordinate system.

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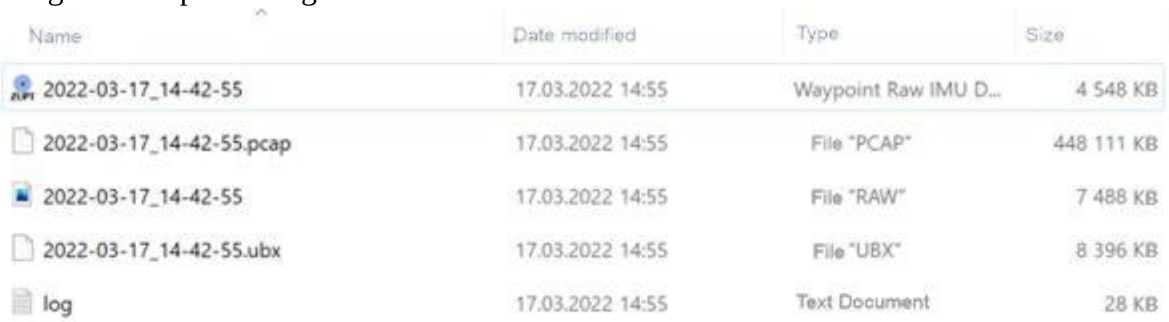
Table of content

1. Preparation of the raw input data

- Download the dataset to a Workstation. (Images, Drone UBX files, GPS base station file, GCP coordinates list, files obtained during the LiDAR mission)
- Group all the data according to each executed flight. For example, Flight 1, Flight 2 and etc.
- Data obtained during the LiDAR mission is saved in an archive, which should be unpacked. It is necessary to have the 4 components in a LiDAR dataset: *.pcap file (LiDAR raw data), *.imr file (IMU data), *.ubx file (LiDARs GNSS receiver data). .log file should not be used during the data processing.



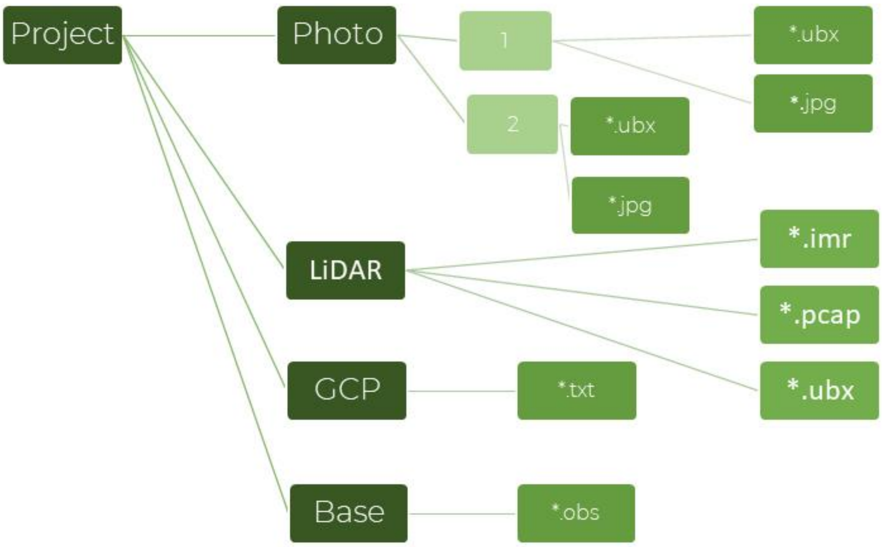
Name	Date modified	Type	Size
2022-03-17_14-42-55	17.03.2022 14:55	Waypoint Raw IMU D...	4 548 KB
2022-03-17_14-42-55.pcap	17.03.2022 14:55	File "PCAP"	448 111 KB
2022-03-17_14-42-55	17.03.2022 14:55	File "RAW"	7 488 KB
2022-03-17_14-42-55.ubx	17.03.2022 14:55	File "UBX"	8 396 KB
log	17.03.2022 14:55	Text Document	28 KB

Pic.1-1.

Attention!
DJI Drone filesystem is naming the images from 1 to 999 by default (for example, DJI_0001.jpg и DJI_0999.jpg), it means that if there's more than 1000 images per flight, it is necessary to check the new image folder, which is created by default

Once the flight mission is finished - copy the ubx. file from GNSS receiver SD card to a separate folder on your PC (for example: Rover, Drone UBX, etc.)

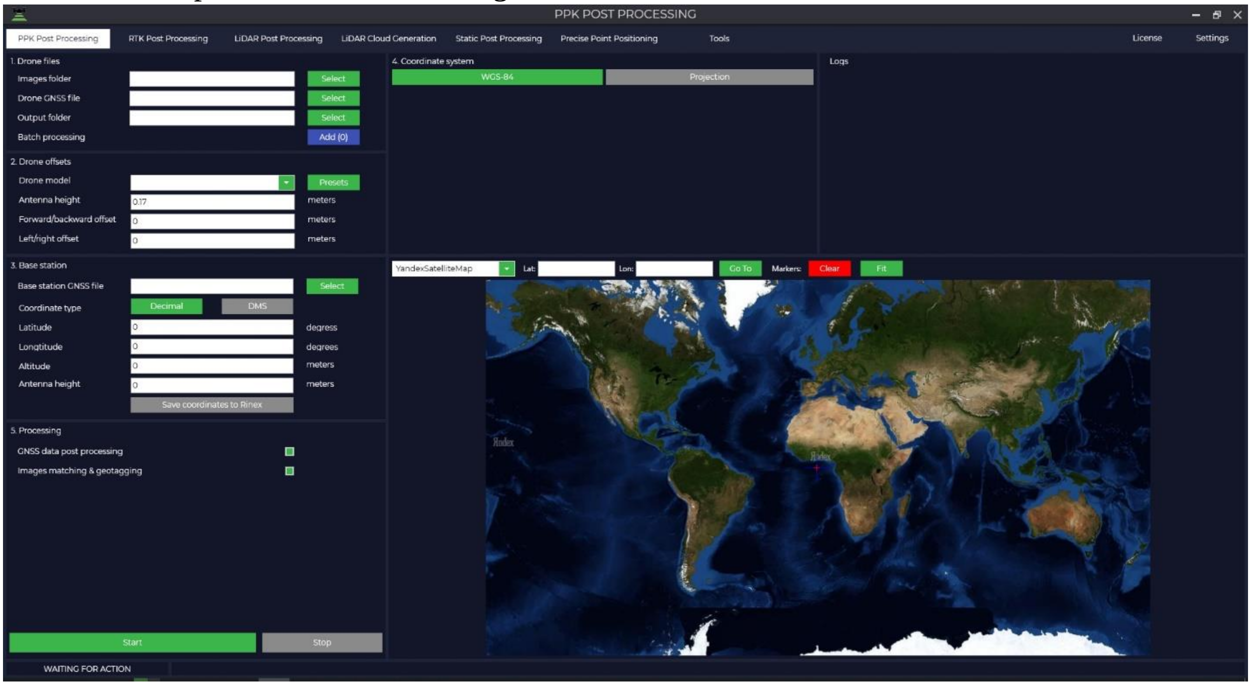
Convert the Base station file to a RINEX format and copy to a separate folder on your PC (for example: Base, Base RINEX, etc.)



Pic. 1-2.

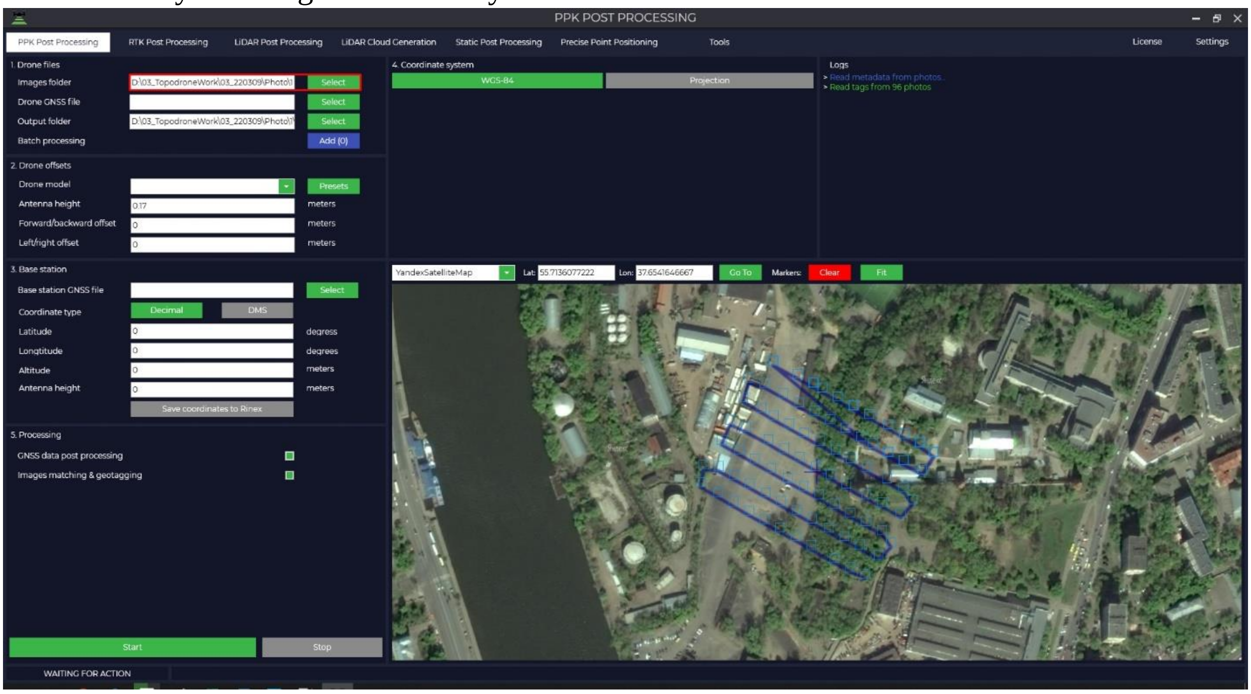
2. PPK Post Processing Module.

PPK module is aimed to process the GNSS data obtained from rover U-Blox chip.
Run the Topodrone Post Processing software.



Pic. 2-1.

Choose the folder containing images. Output folder will be created automatically. Path and/or folder may be changed if necessary.



Pic. 2-2.

Choose the drone UBX file, this step will run an automatic .ubx to .obs conversion.

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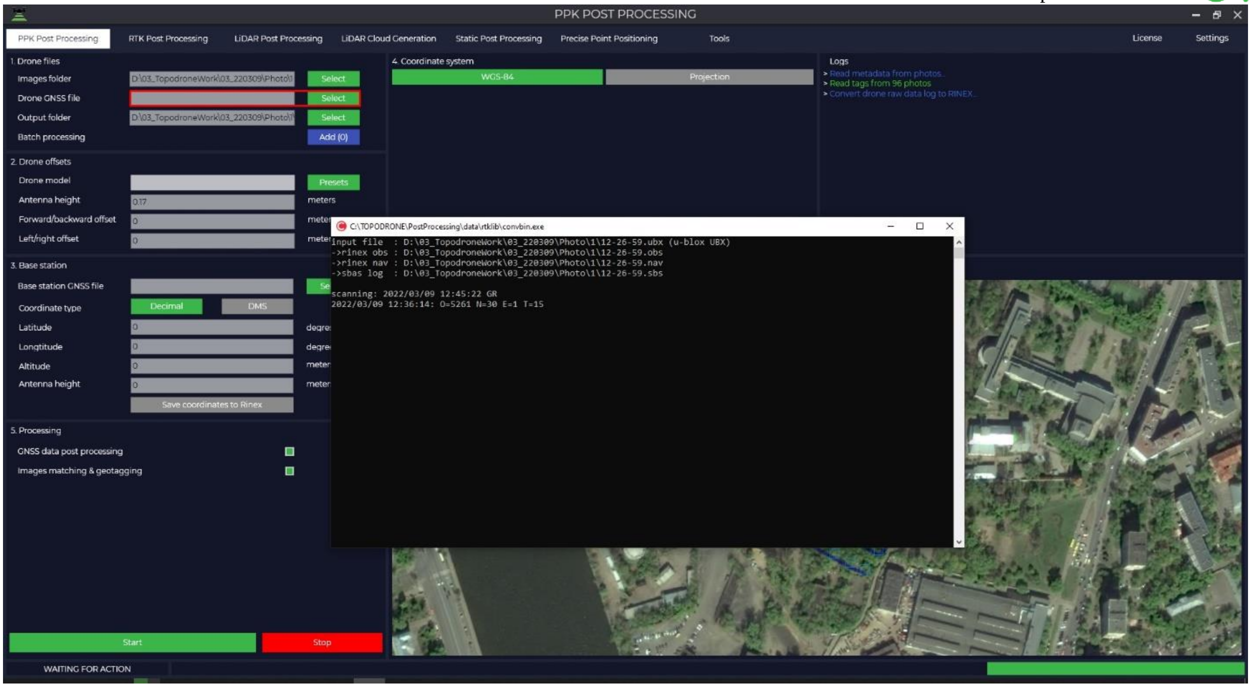
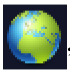
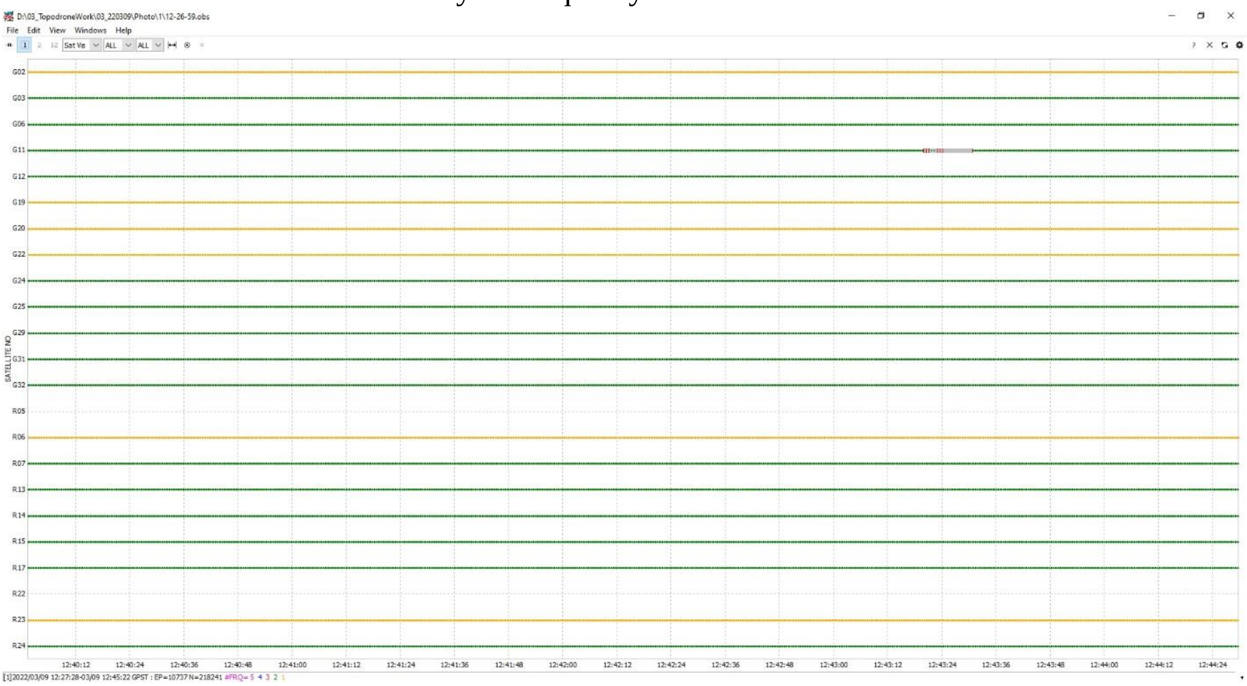


Pic. 2-3.

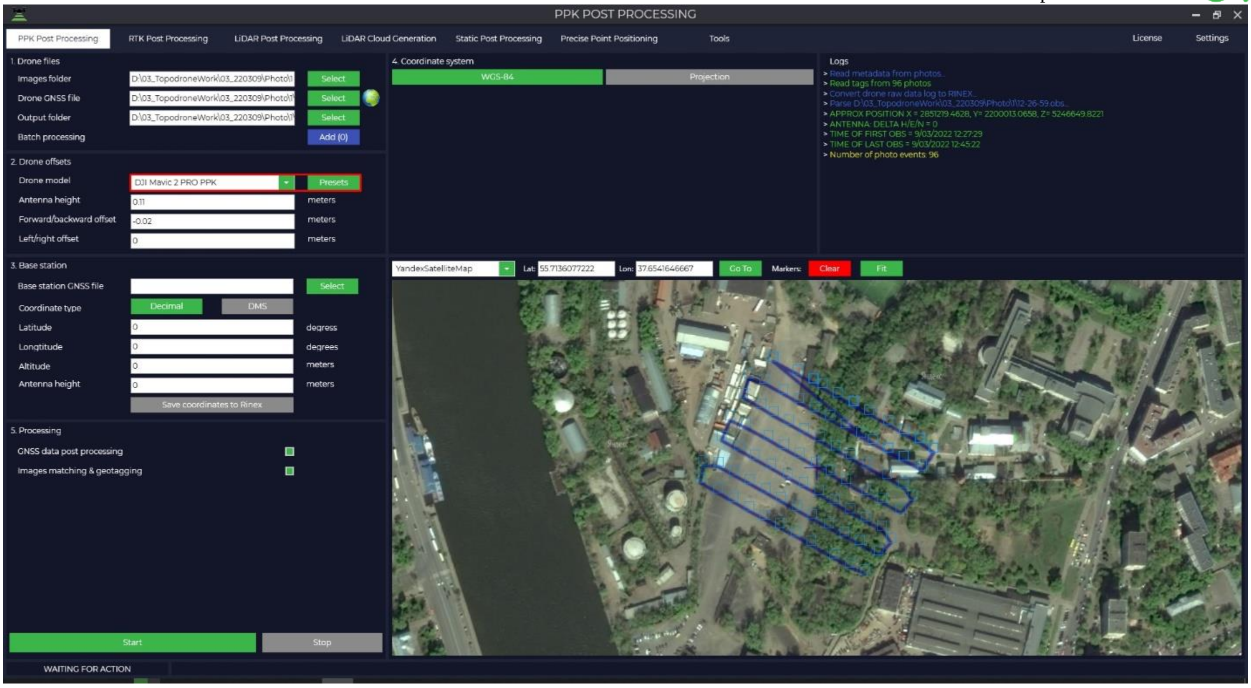
Press the “” button to analyze the quality of the obtained data.



Pic. 2-4.

Select antenna offset for your drone from the dropdown list.

If necessary, it is possible to add your own “Preset”, press the button and fill the form with offsets.

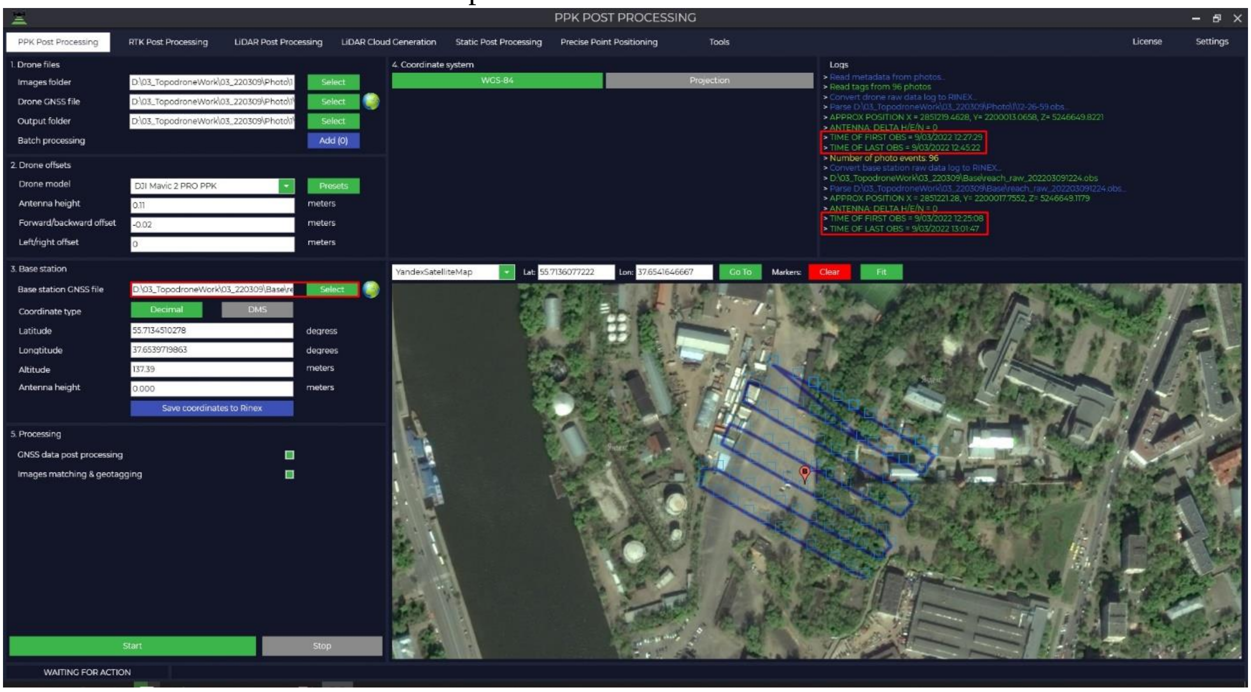


Pic. 2-5.

Select the base station file (*.ubx, *.obs, *.rnx, *.o). When *.rnx and *.ubx file formats are chosen, the software runs automatic conversion to *.obs format.

Attention!

The “Logs” window displays information about the actions that the software performs, you need to pay attention to the time the file from the rover and from the base station was recorded. The base station file must overlap the files from the rover.



Pic. 2-6.

The base station X,Y coordinates and the Height of the phase center will be loaded automatically from Rinex file, if it was filled during the measurements.

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The WGS-84 Lat\Long\Ellipsoid height is used by default, in case if you need to choose another one, press the "Projection" button and use any coordinate system from the list, also you may use "Search" option.

Pic. 2-7.

If your coordinate system is not included in the list, you can add it in Topodrone Post Processing software manually. After choosing the optional coordinate system conversion from WGS-84 will be performed automatically. You may correct the precise base station coordinates, if necessary.

Attention!

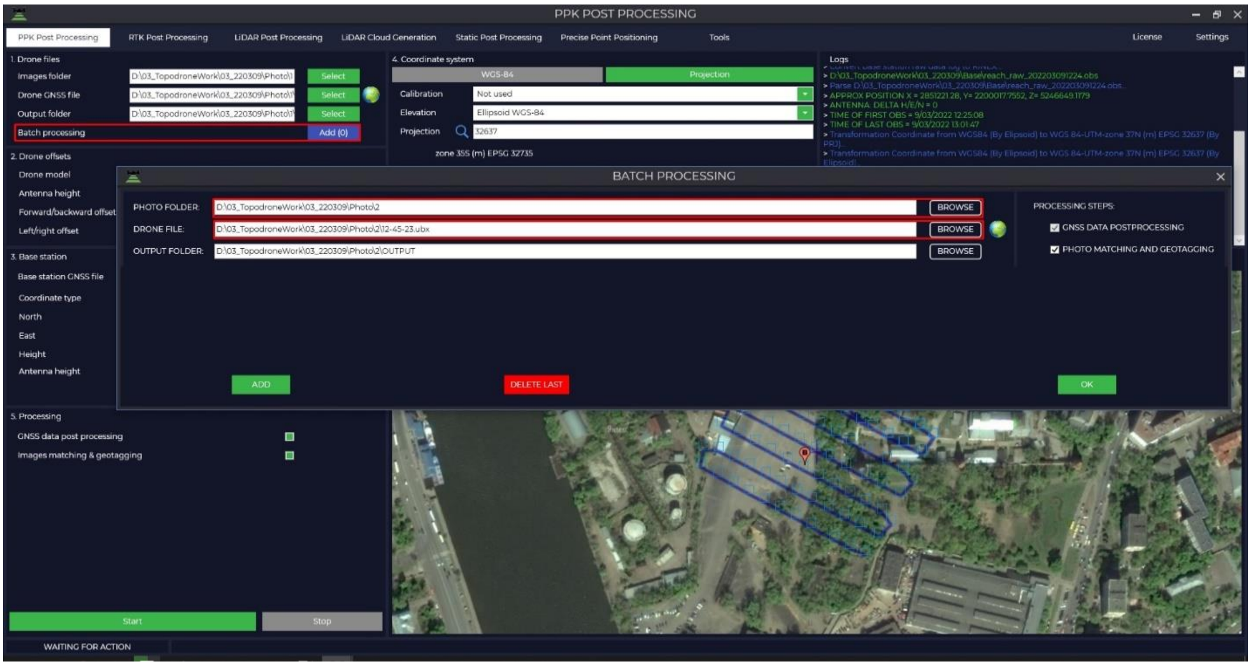
The height of the antenna includes the height of the pole or tripod from a point with known coordinates to the bottom of the receiver mount and the height from the bottom of the receiver mount to the phase center.

Pic. 2-8.

The Topodrone Post Processing software is working with 3 types of height calculation, by default, H parameter conversion is performed automatically after choosing an option.

Pic. 2-9

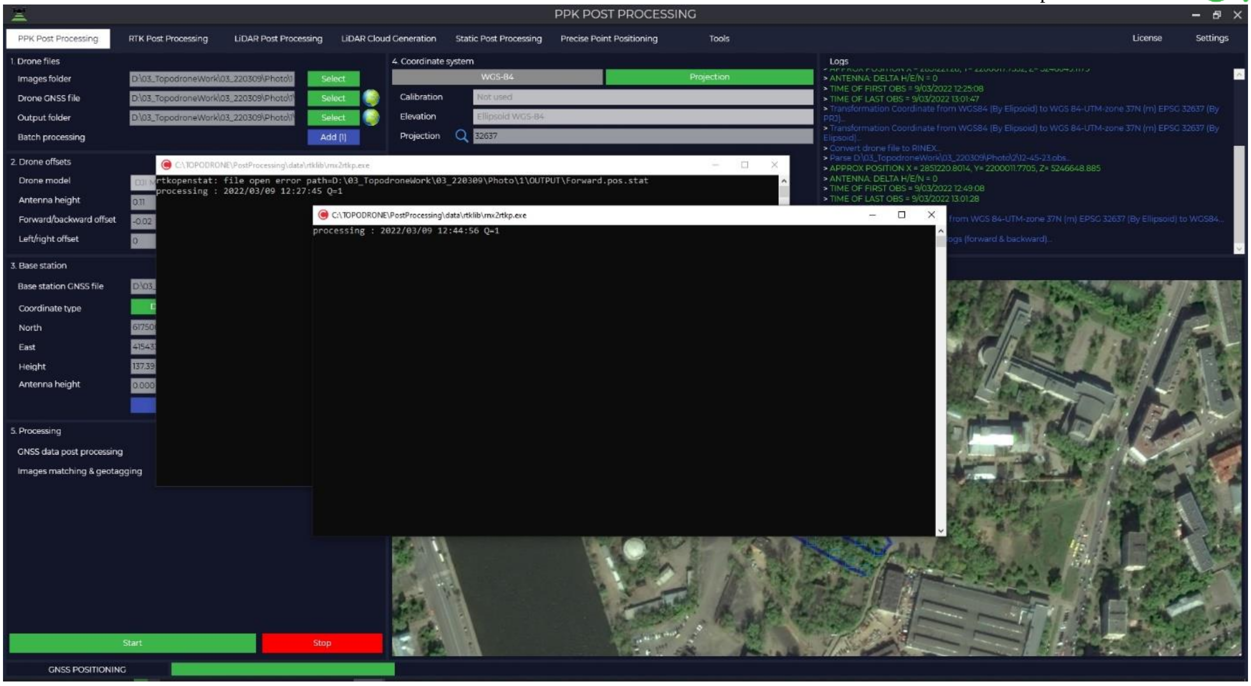
The Topodrone Post Processing software allows to perform the batch processing within one observe session. To use batch processing algorithm, press the “Add (0)” button and in a popup window you can add the directories with other flights data, .ubx files and images and press “OK”.



Pic. 2-10

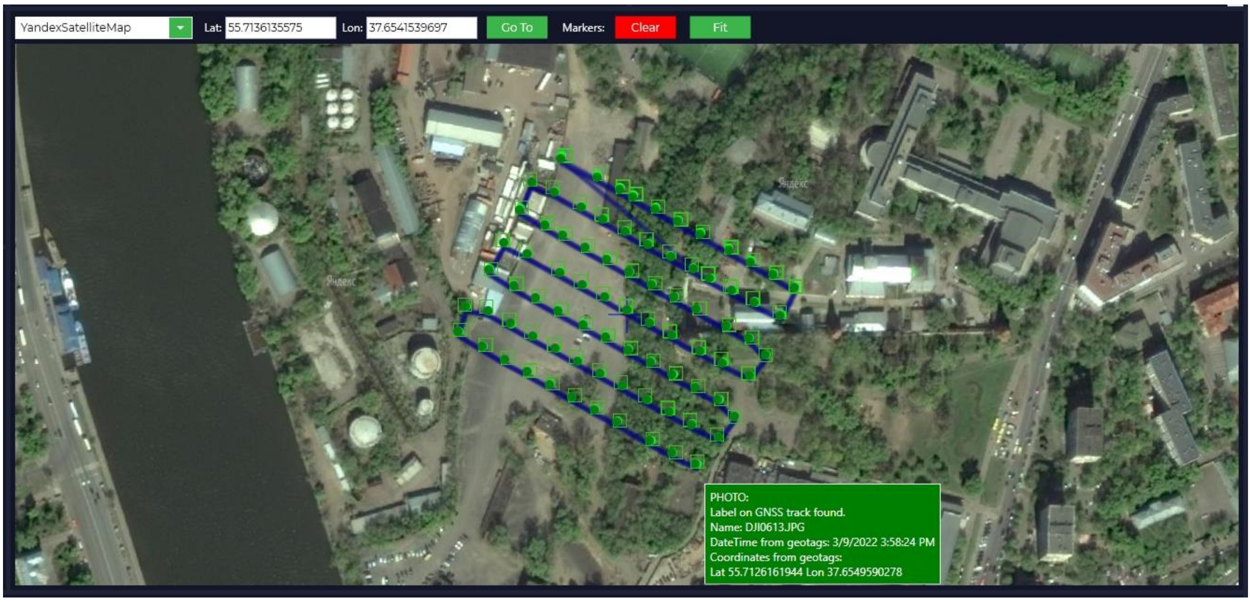
To run the processing just press the “Start” button. Data processing is being performed simultaneously Forward and Backward and solution type is shown marked with Q symbol:

- **Q1** – Fix solution
- **Q2** – Float solution
- **Q5** – Single solution/No solution



Pic. 2-11

As a result of data processing will be displayed a window in which you can see the rover's trajectory, the number of photos, the number of time marks, the number of alignments and the accuracy of the obtained photo centers, where the marks obtained with a fixed solution are highlighted in green, and the marks obtained with a float solution are yellow.



Pic. 2-12

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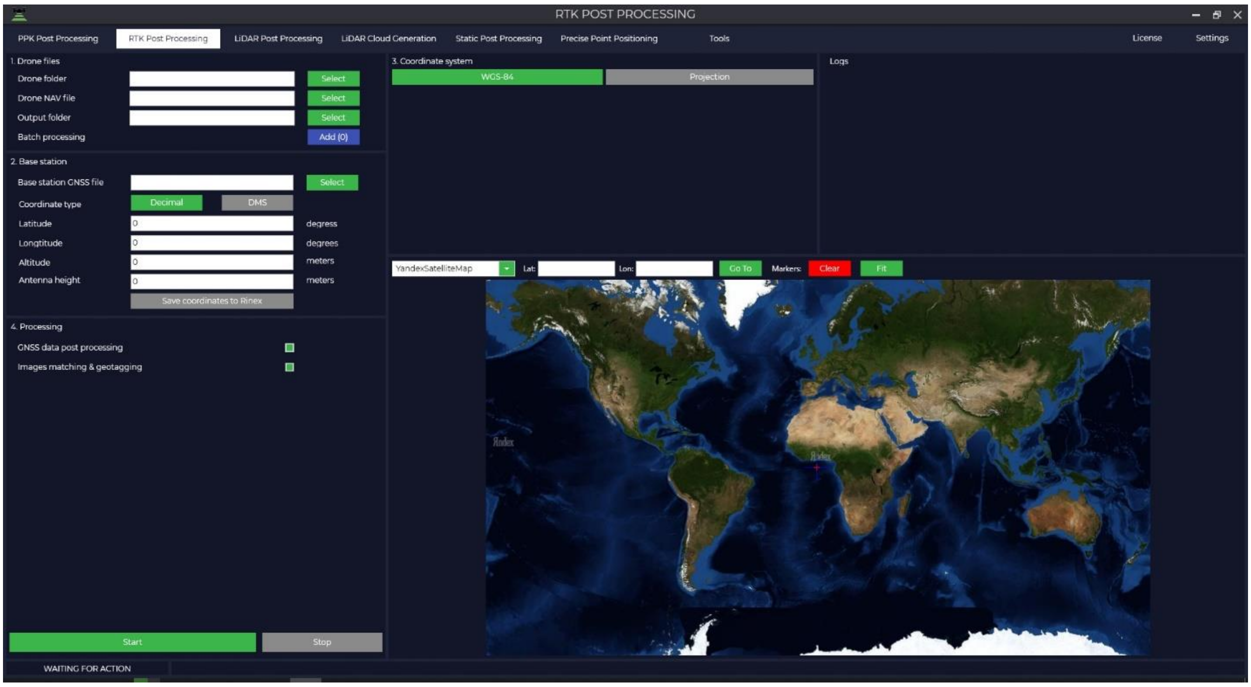
3. RTK Post Processing module.

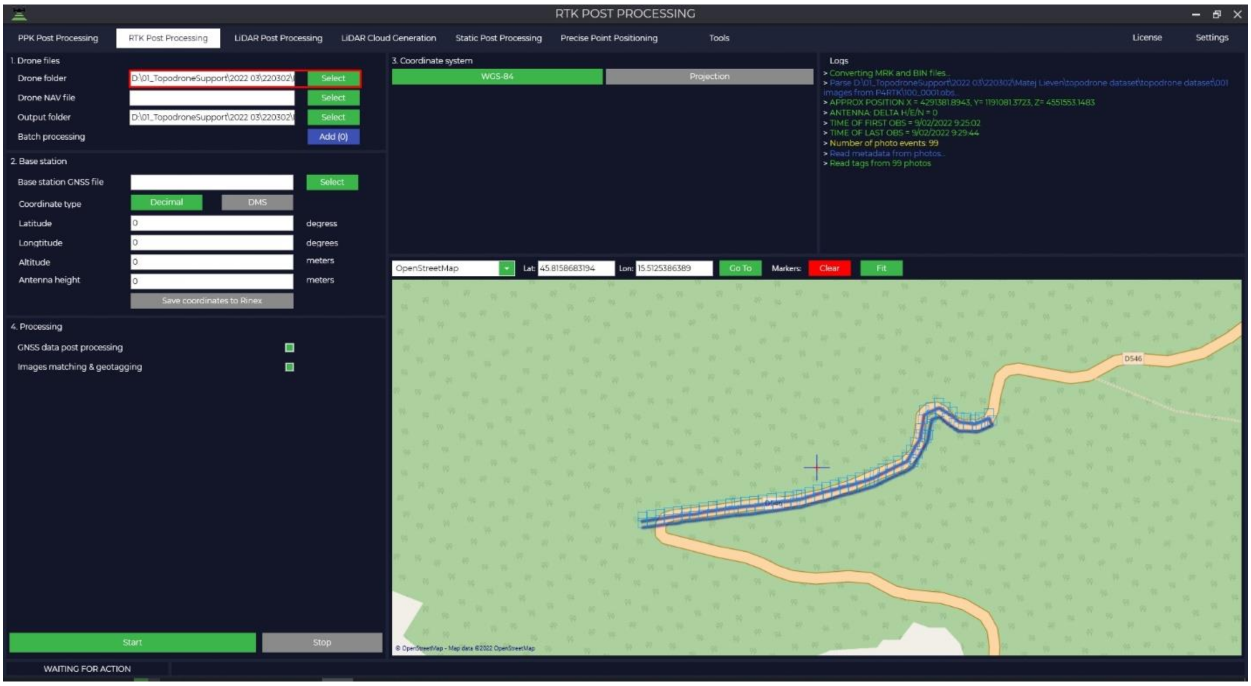
That module is aimed to process DJI Phantom 4 RTK, DJI P1 RTK, Autel Evo II PRO RTK data.

Run the Topodrone Post Processing software and go to RTK Post Processing tab.



Pic. 3-1.

Choose the folder with obtained flight data. The folder should contain the following types of files: all of the images (not renamed and/or removed), * _EVENTLOG.bin, * _PPKRAW.bin, *_PPKRAW.sig, *.obs and * _PPKRAW.sig. Output folder will be created automatically. Path and/or folder may be changed if necessary.



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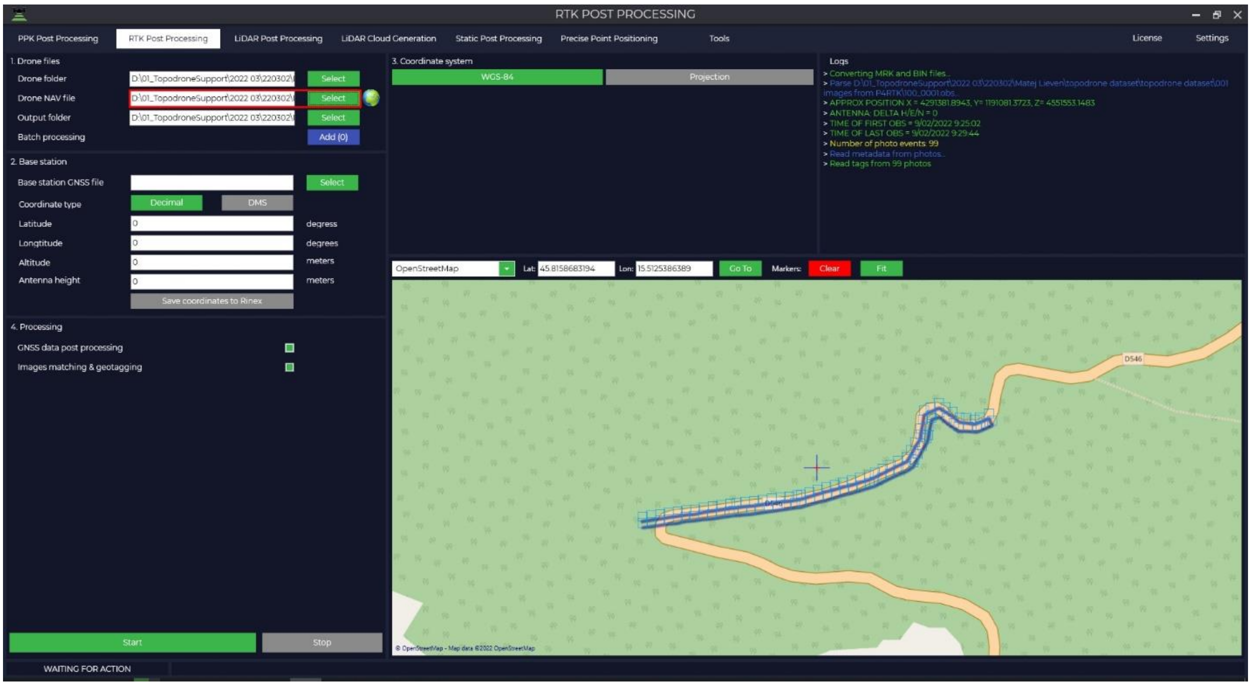
Pic. 3-2.

Choose the * _PPKRAW.nav file from drone folder.

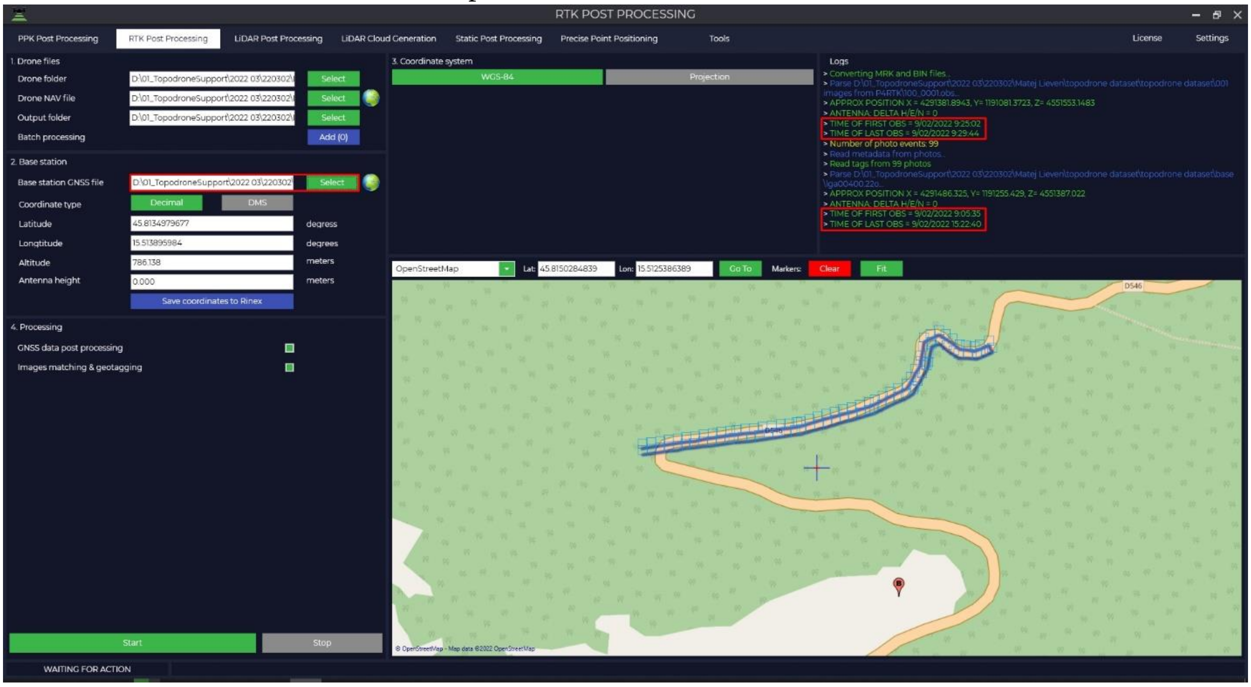


Pic. 3-3.

Choose the base station file (*.ubx, *.obs, *.rnx, *.o). When *.rnx and *.ubx file formats are chosen, the software runs automatic conversion to *.obs format.

Attention!

The “Logs” window displays information about the actions that the software performs, you need to pay attention to the time the file from the rover and from the base station was recorded. The base station file must overlap the files from the rover.



Pic. 3-4.

The base station X,Y coordinates and the Height of the phase center will be loaded automatically from Rinex file, if it was filled during the measurements.

The WGS-84 is used by default, in case if you need to choose another one, press the “Pojection” button and use any coordinate system from the list, also you may use “Search” option.

Pic. 3-5.

If your coordinate is not included in the list, you can add it in Topodrone Post Processing software manually. Если вашей системы координат нет в списке, то вы сами можете её добавить в программу Topodrone Post Processing. After choosing the optional coordinate system conversion from WGS-84 will be performed automatically. You may correct the precise base station coordinates, if necessary.

Attention!

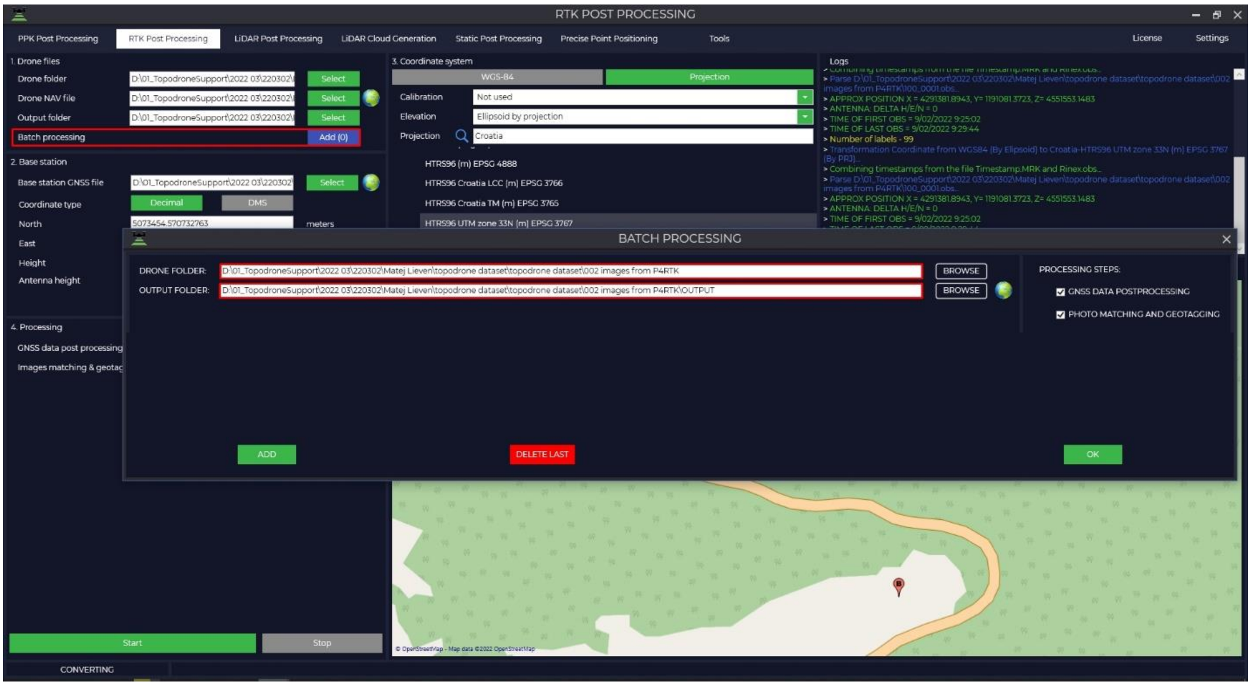
The height of the antenna includes the height of the pole or tripod from a point with known coordinates to the bottom of the receiver mount and the height from the bottom of the receiver mount to the phase center.

Pic. 3-6.

The Topodrone Post Processing software allows to process 3 types of height parameters, by default, H parameter conversion is performed automatically after choosing an option.

Pic. 3-7

The Topodrone Post Processing software allows to perform the batch processing within one observe session. To use batch processing algorithm, press the “Add (0)” button and in a popup window you can add the directories with other flights data, .ubx files and images and press “OK”.

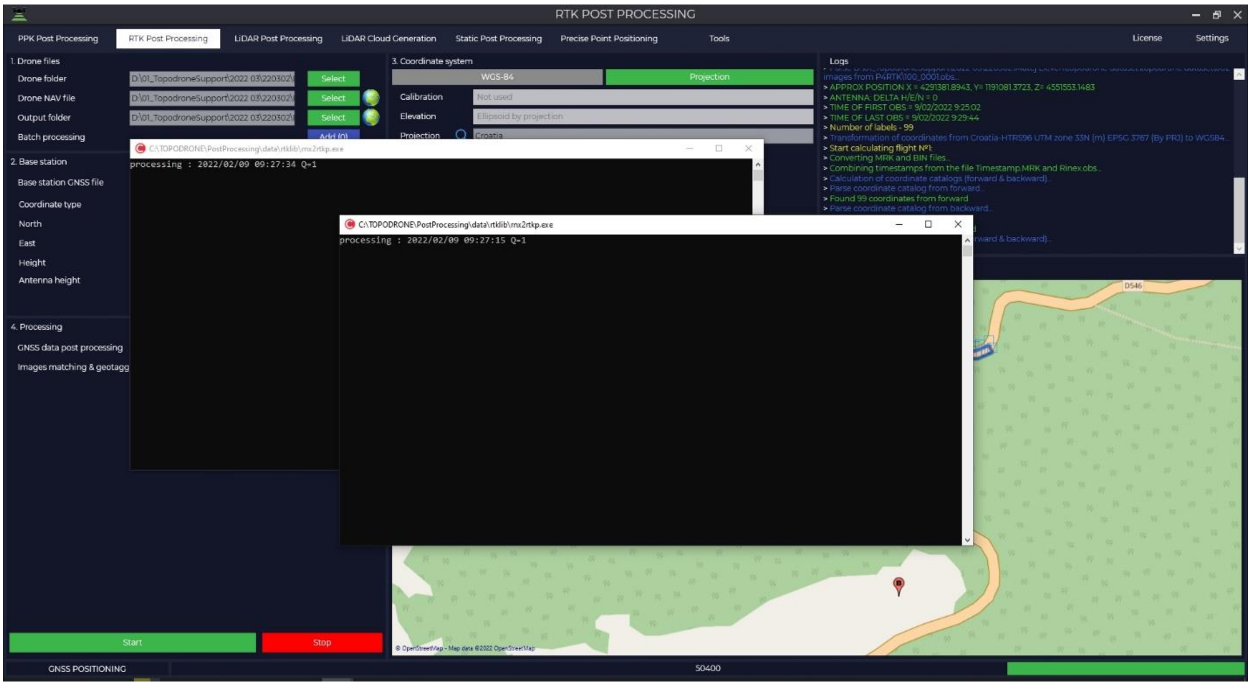


Pic. 3-8

To run the processing just press the “Start” button. Data processing is being performed simultaneously Forward and Backward and solution type is shown marked with Q symbol:

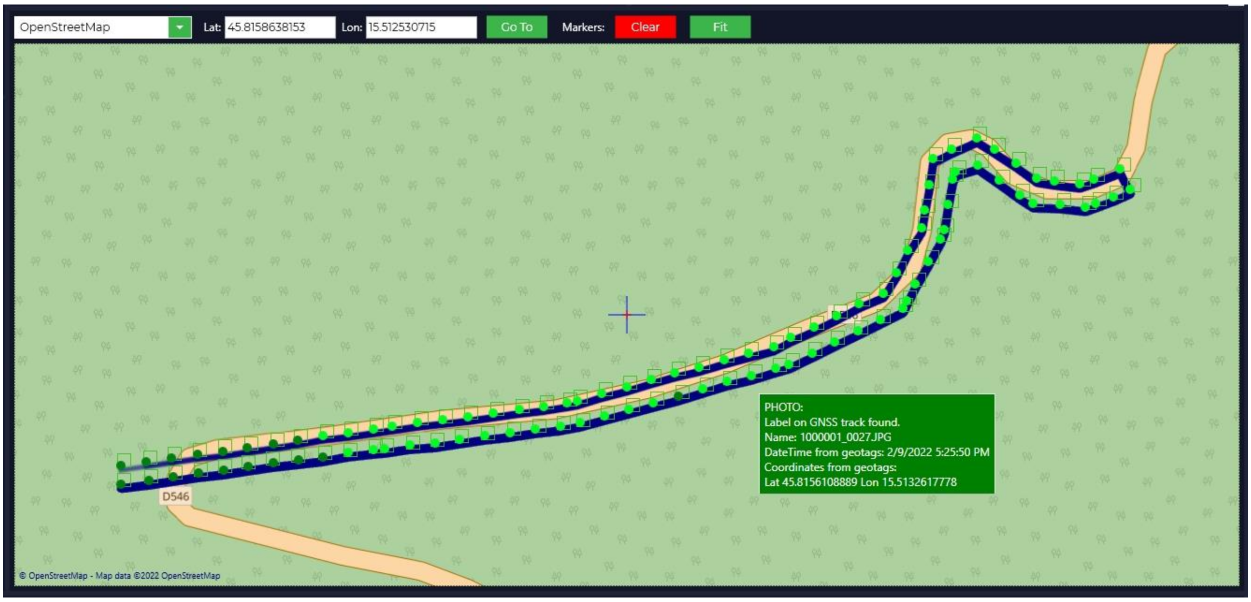
- **Q1** – Fix solution

- Q2 – Float solution
- **Q5** – Single solution/No solution



Pic. 3-9

As a result of data processing will be displayed a window in which you can see the rover's trajectory, the number of photos, the number of time marks, the number of alignments and the accuracy of the obtained photo centers, where the marks obtained with a fixed solution are highlighted in green, and the marks obtained with a float solution are yellow.



Pic. 3-10

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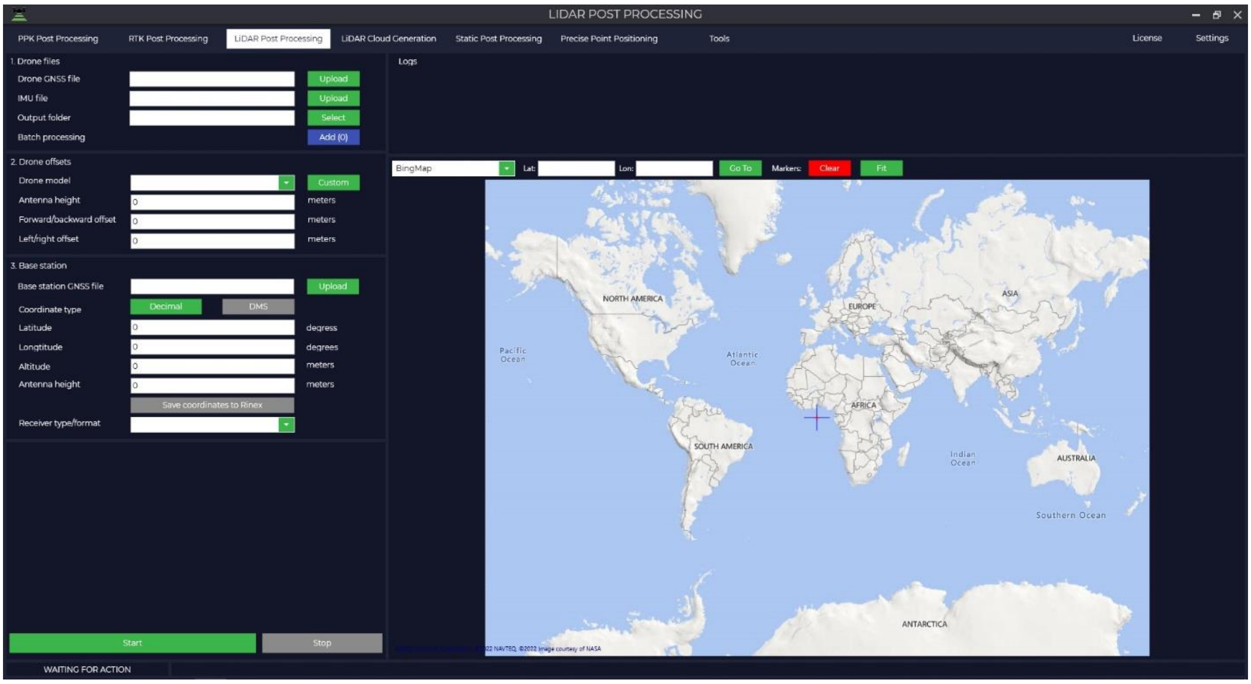
4. LiDAR Post Processing

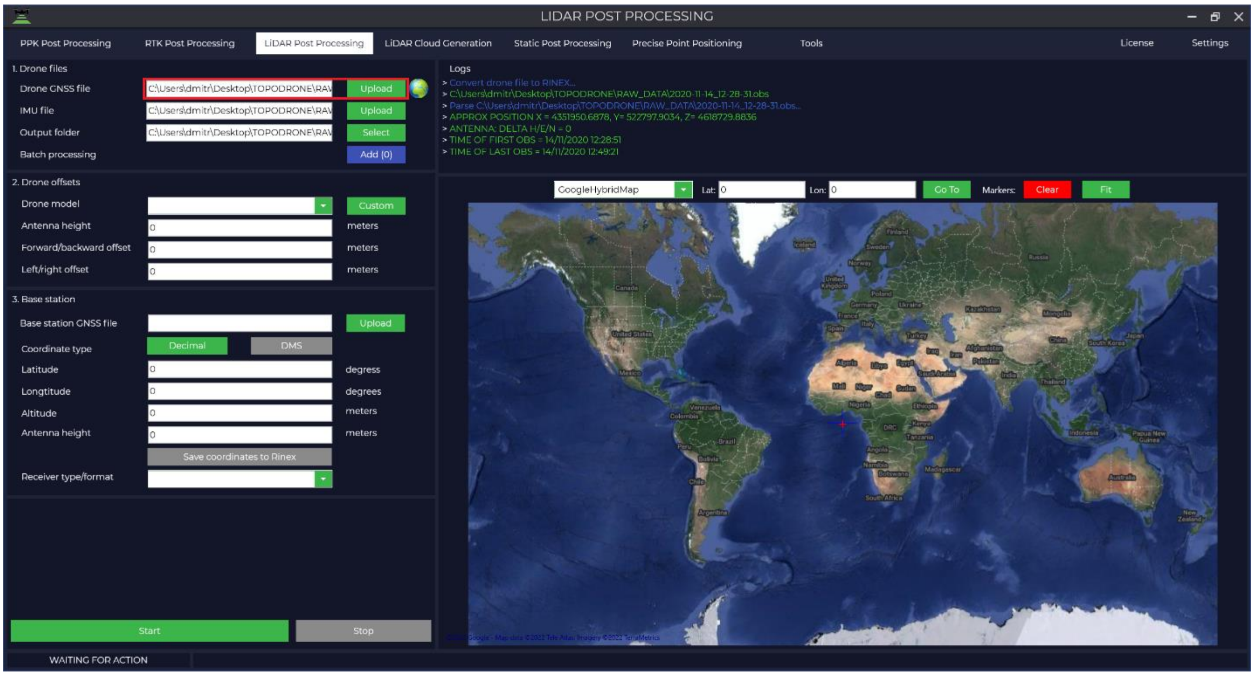
That module is aimed to process the LiDAR trajectory jointly with IMU (Inertial Measurement Unit) data using the Topodrone developed Cloud solution, in order to avoid overloading the user's PC.

Run the Topodrone Post Processing software and go to Lidar Post Processing tab.



Pic. 4-1

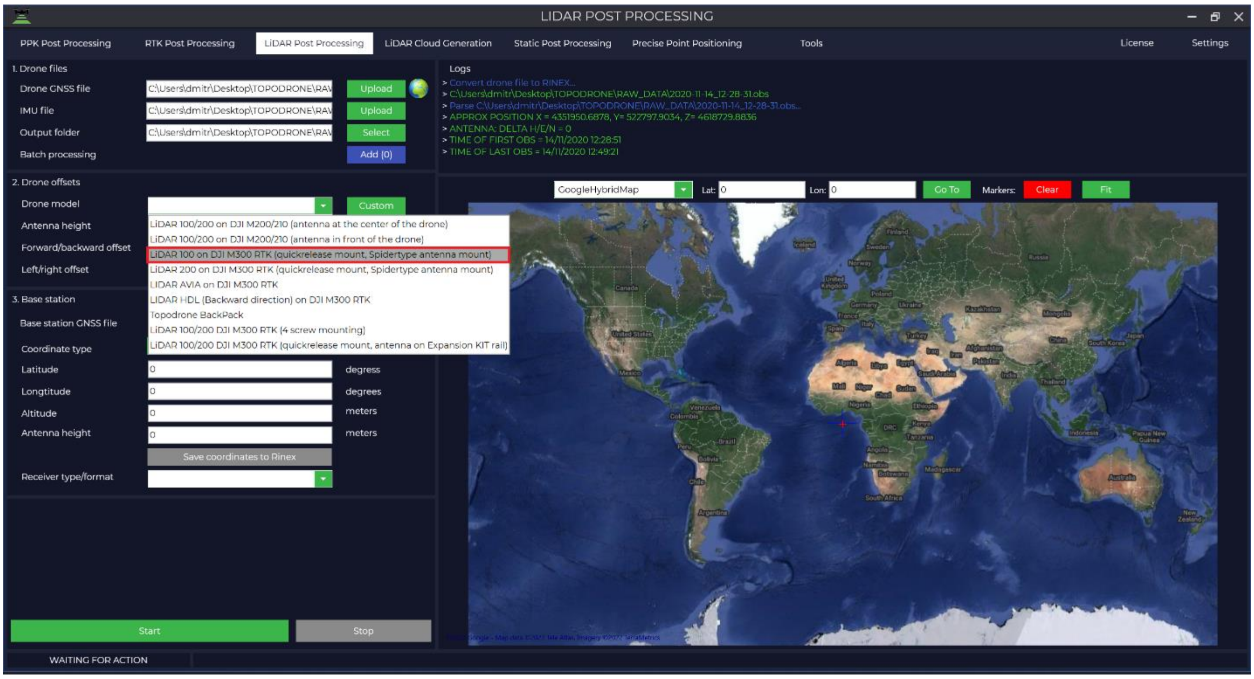
Choose the path to GNSS measurements data in "Drone GNSS file" field, IMU data will be loaded automatically in "IMU file" field. As an output folder will be used previously selected directory. Path and/or folder may be changed if necessary.



Pic. 4-2

NOTE: In the right part of interface, you can see the start and end time of the TOPODRONE receiver data recording.

Choose the model of your LiDAR sensor and a type of mount from the list.

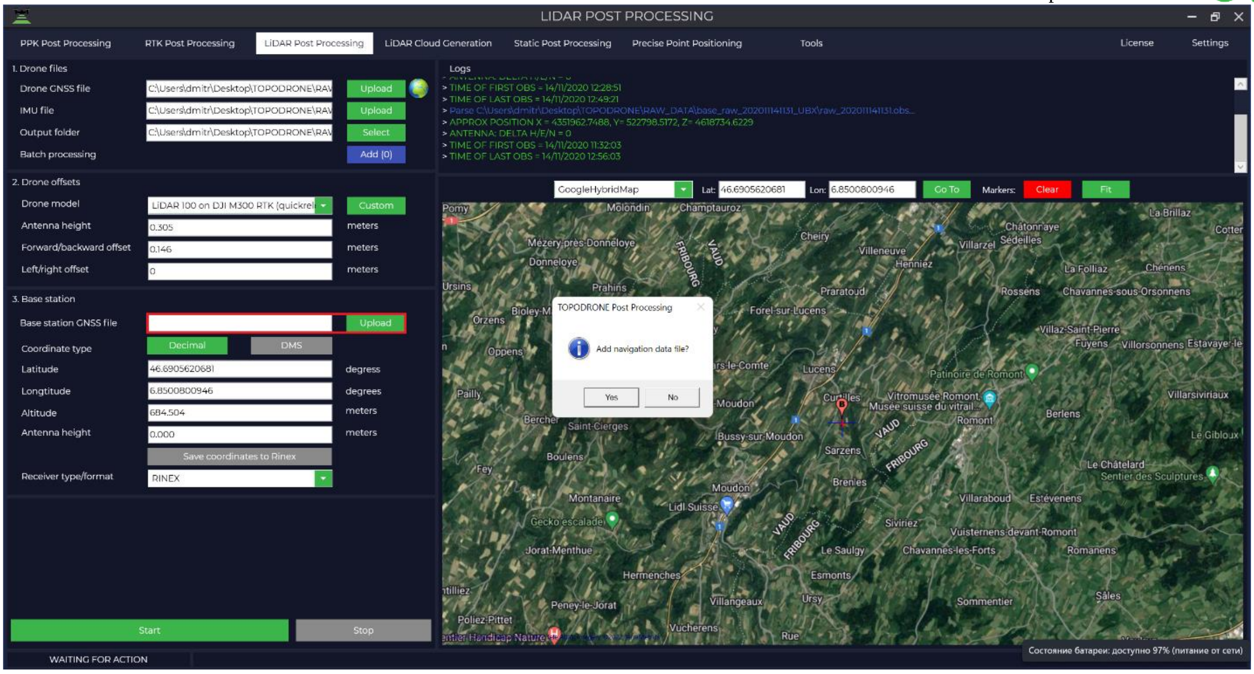


Pic. 4-3

Offsets will be loaded from library automatically.

Pic. 4-4

Choose the base station file in the “Base station GNSS file” field.

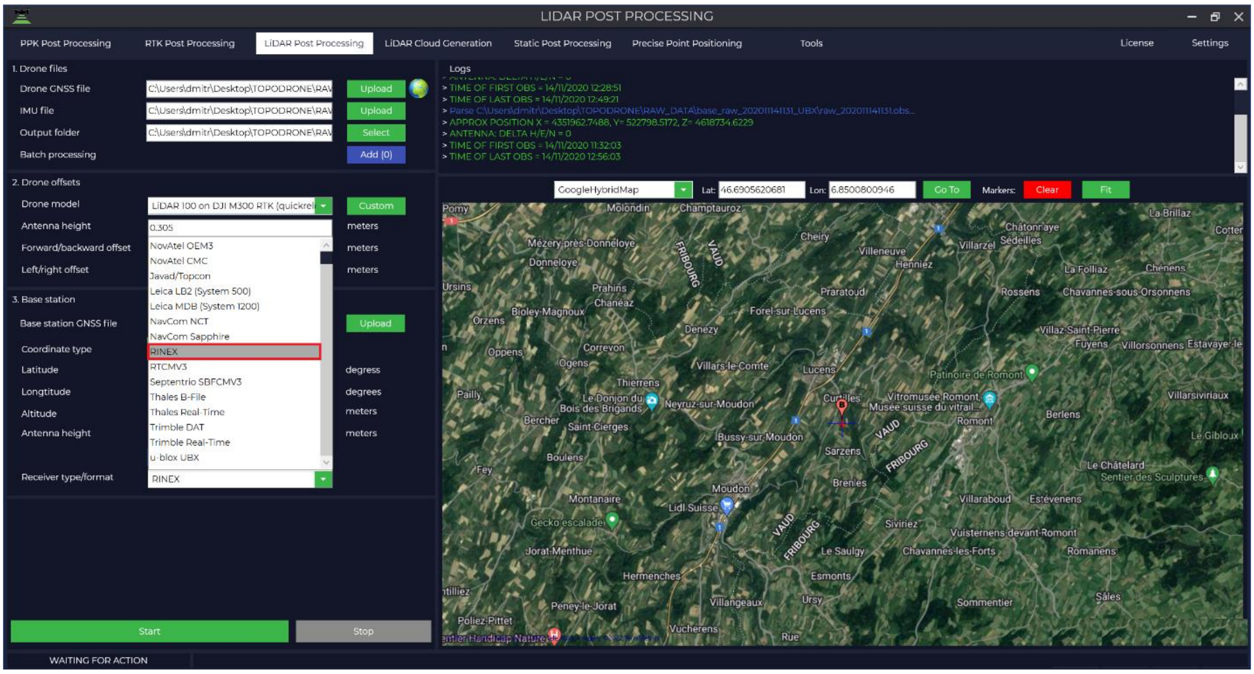


Pic. 4-5

While loading base station RINEX file, it is necessary to download the ephemeris, you can load it from Topodrone receiver which is built-in your LiDAR.

It is necessary to choose the reciever which is supported by TOPODRONE Post Processing

NOTE: TOPODRONE Post Processing software supports data from different types of receivers, if your GPS isn't shown in the list, you can convert static data to universal RINEX format.



Pic. 4-6

Enter precise base station coordinates.

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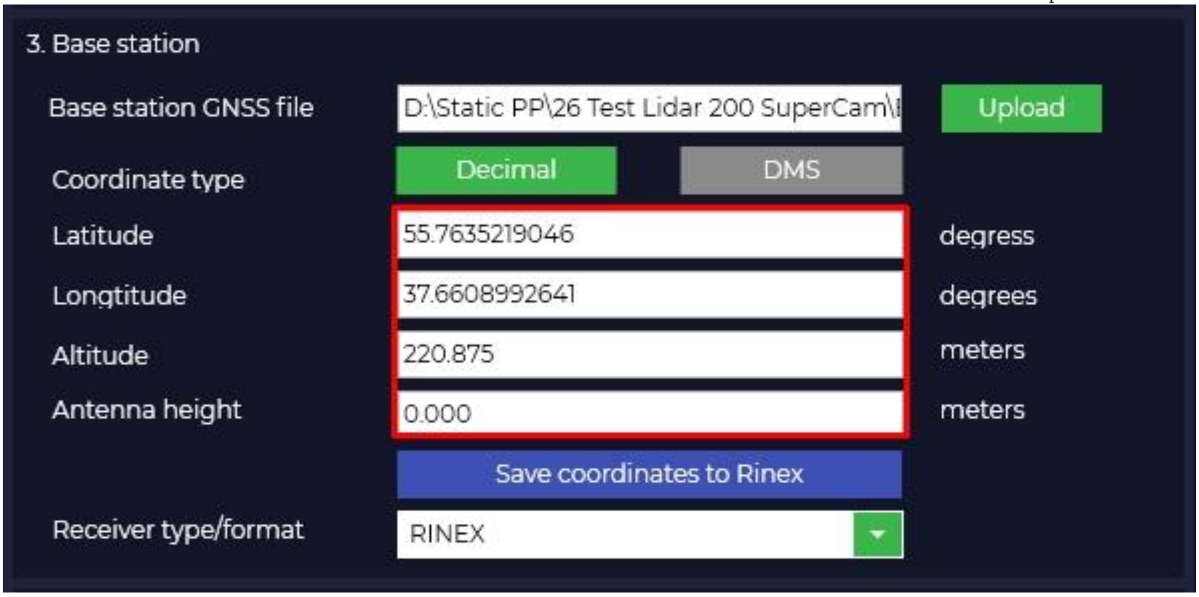
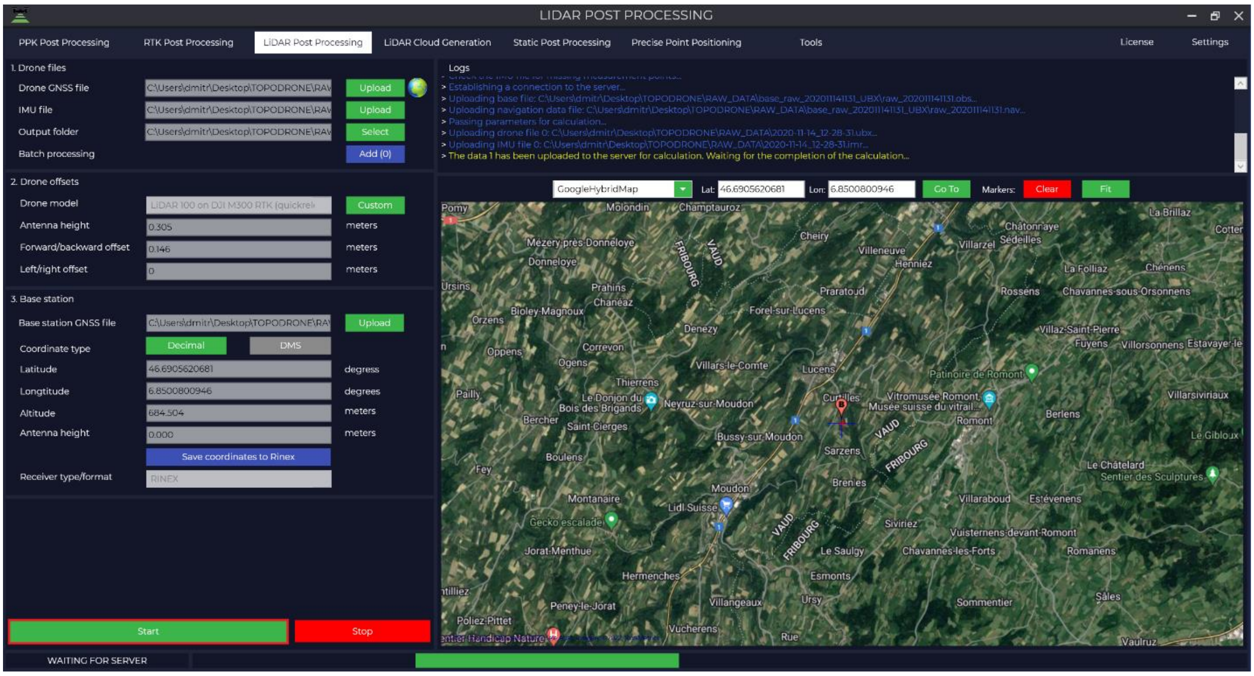


Pic. 4-7

NOTE: It is necessary to enter base station coordinates in following consequence: latitude, longitude and height on the ellipsoid of WGS84 system.

Start the processing by pressing the “Start” button.



Pic. 4-8

NOTE: Once the processing is started the dataset will be uploaded to the Topodrone server for calculation the trajectory file from the GNSS and IMU data. For this processing step the internet connection should be stable, otherwise the calculation process will be interrupted and the procedure should be repeated.

As a result of the calculation the high precision trajectory file will be downloaded to your PC and in Map field of the software interface you will see the trajectory visual and its accuracy. Green color means that trajectory was calculated with Fix solution. Yellow color means that trajectory was calculated with Float solution.

Red color means that trajectory was calculated with Single solution. The trajectory file itself will be saved in Project default folder.

Pic. 4-9

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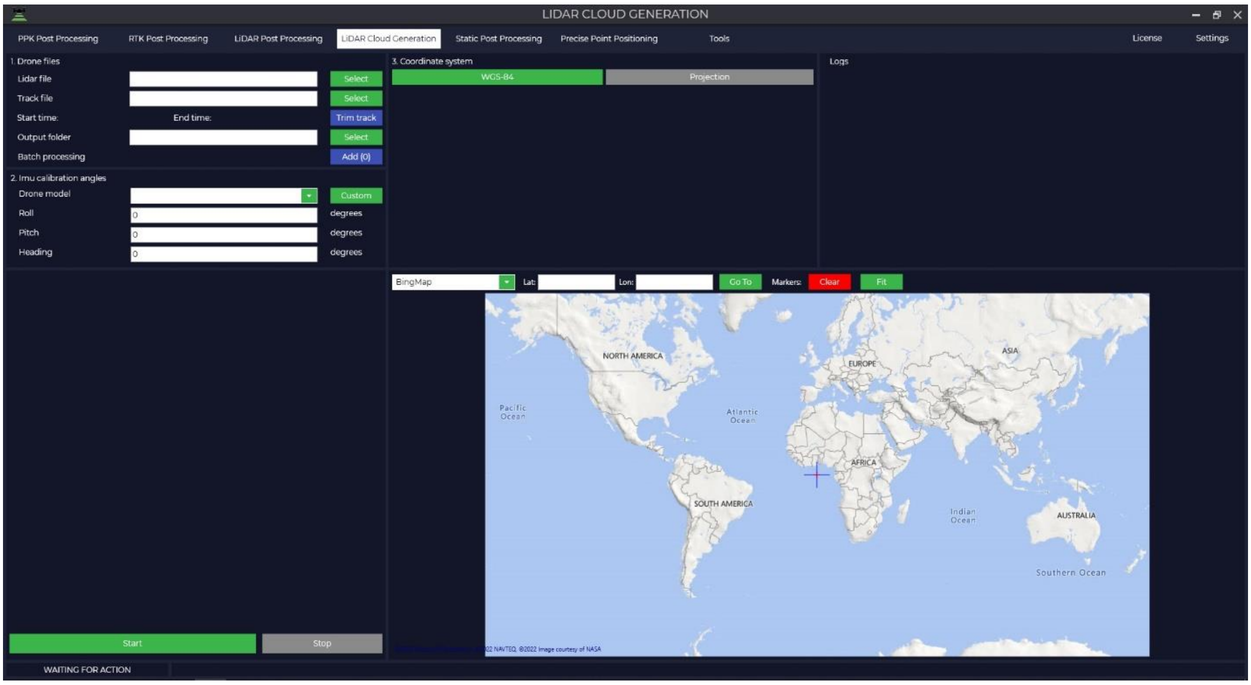
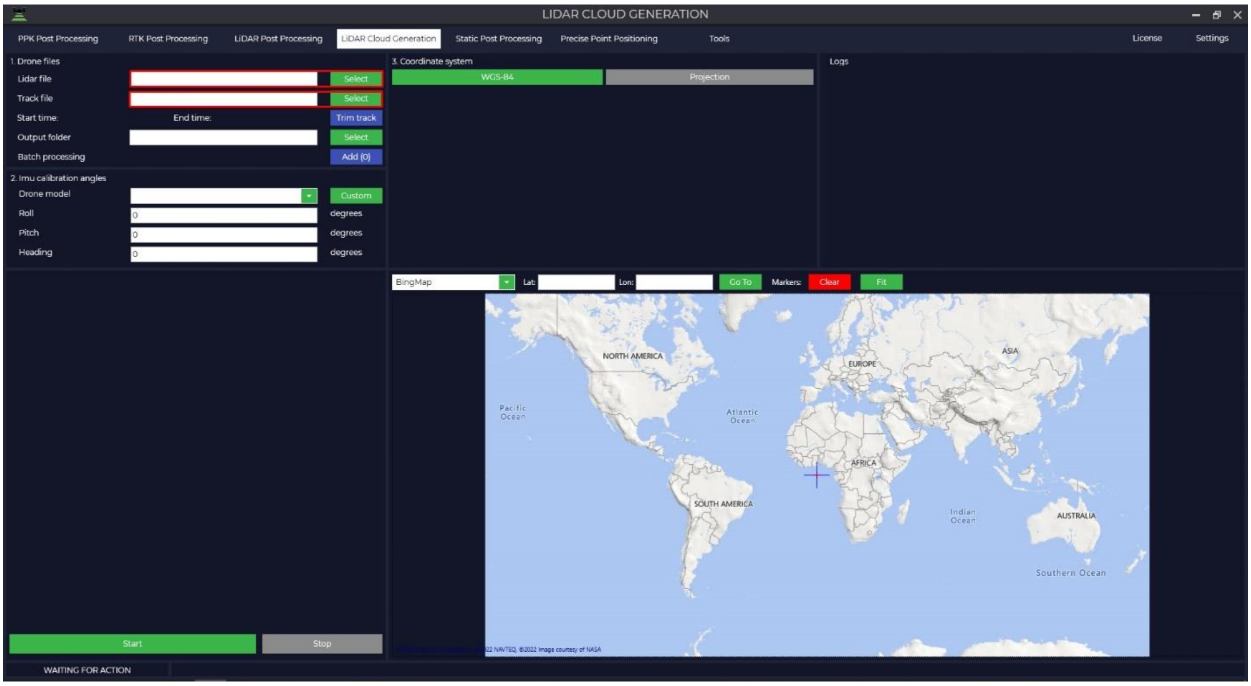
5. LiDAR Cloud Generation

Run the Topodrone Post Processing software and go to LiDAR Cloud Generation tab.



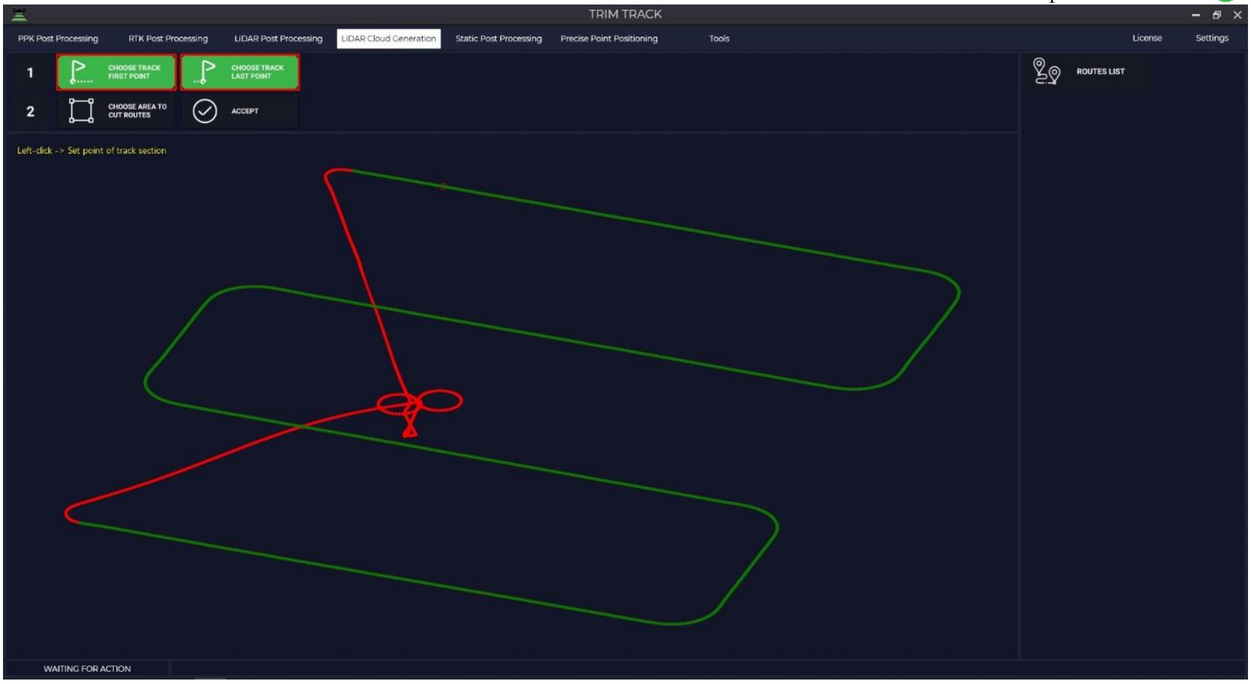
Pic. 5-1

Choose the path to your dataset, *.pcap file "Lidar file" field, in the "Track file" field choose the path to a track_*.pos trajectory file, the output file will be saved to Output folder in the Project path by default. To change the default folder, please fill the "Output folder" field.



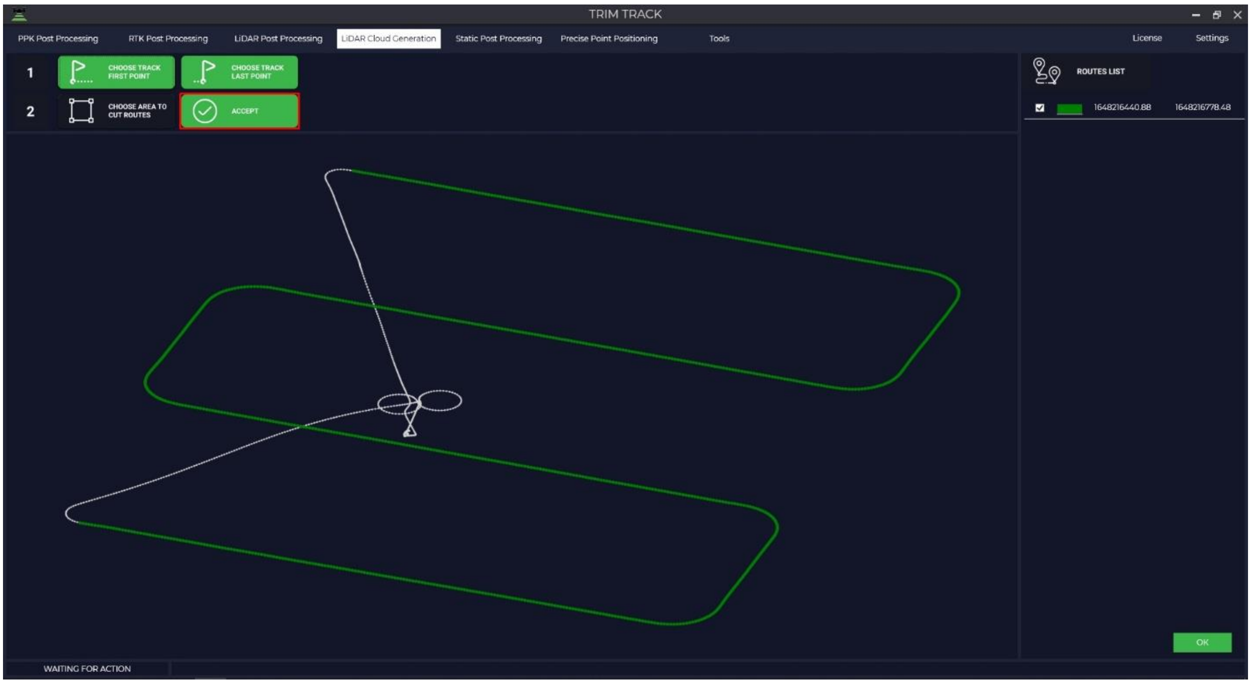
Pic. 5-2

Press the "Trim Track" button if you want to choose the part of trajectory for Point cloud generation.



Pic. 5-3

Press the “ACCEPT” button to cut unselected trajectory data and press “OK” to confirm.



Pic. 5-4

NOTE: Additionally, you can use “Choose area to cut routes tool”.

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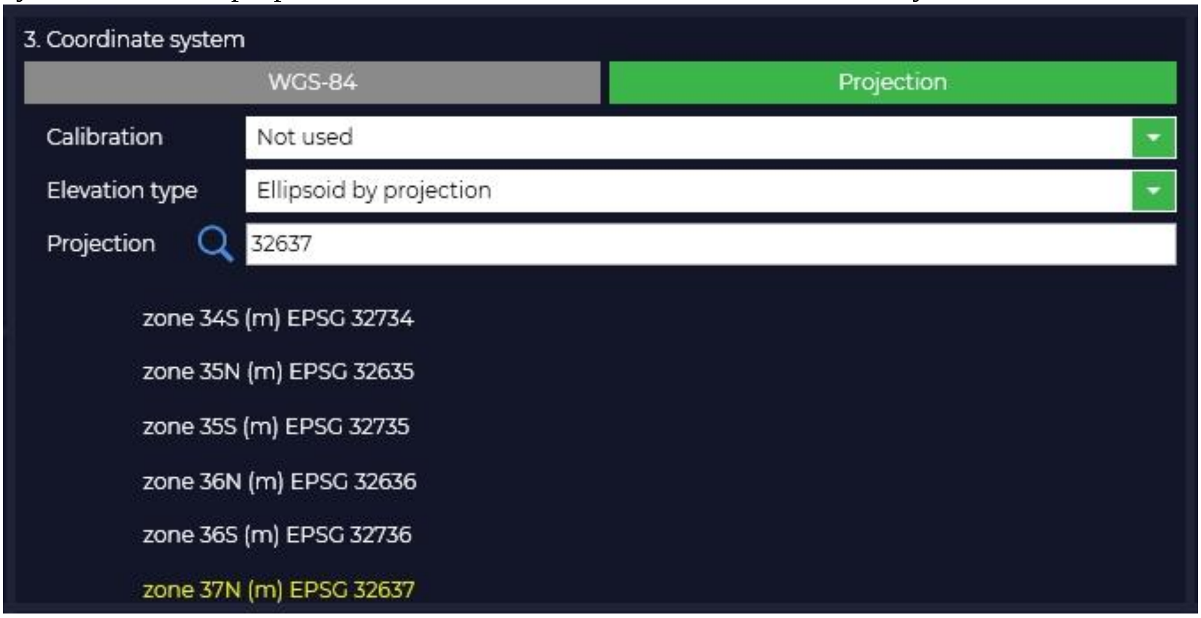
To choose the correct coordinate system, press the "Projection" button and select your coordinate system from the proposed list or enter the name of the coordinate system in the search bar.

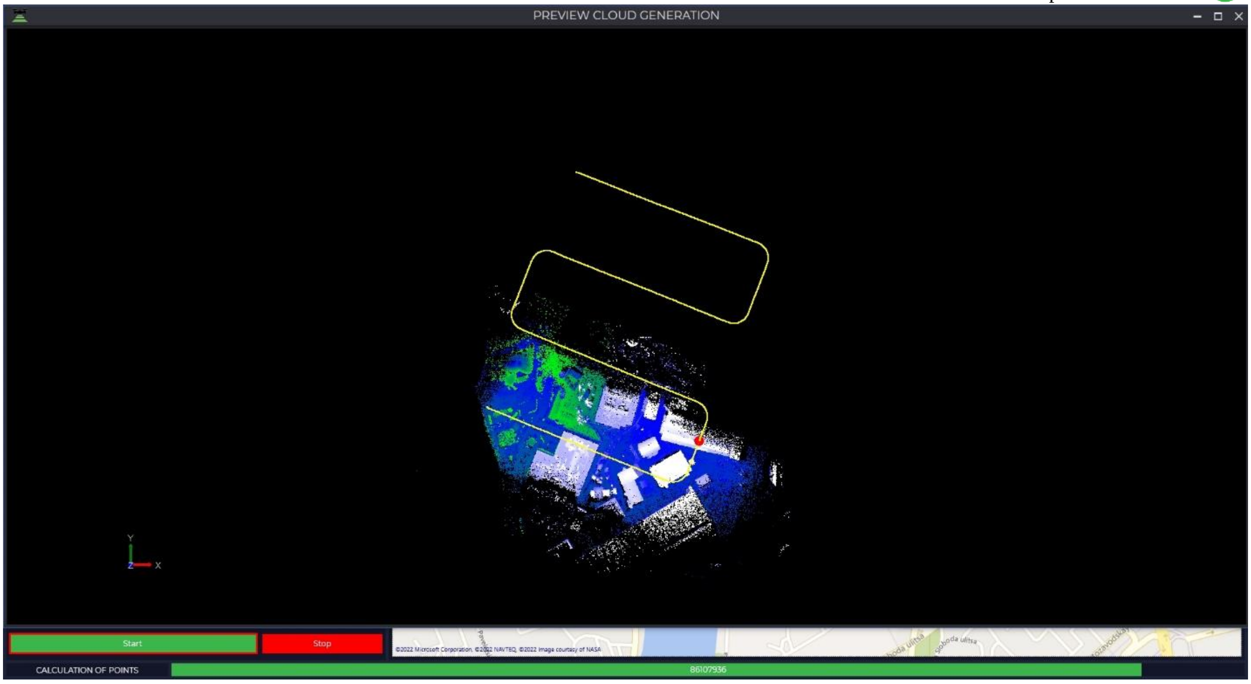


Pic. 5-5

The Topodrone Post Processing software is allows to process 3 types of height parameters, by default, H parameter conversion is performed automatically after choosing an option.

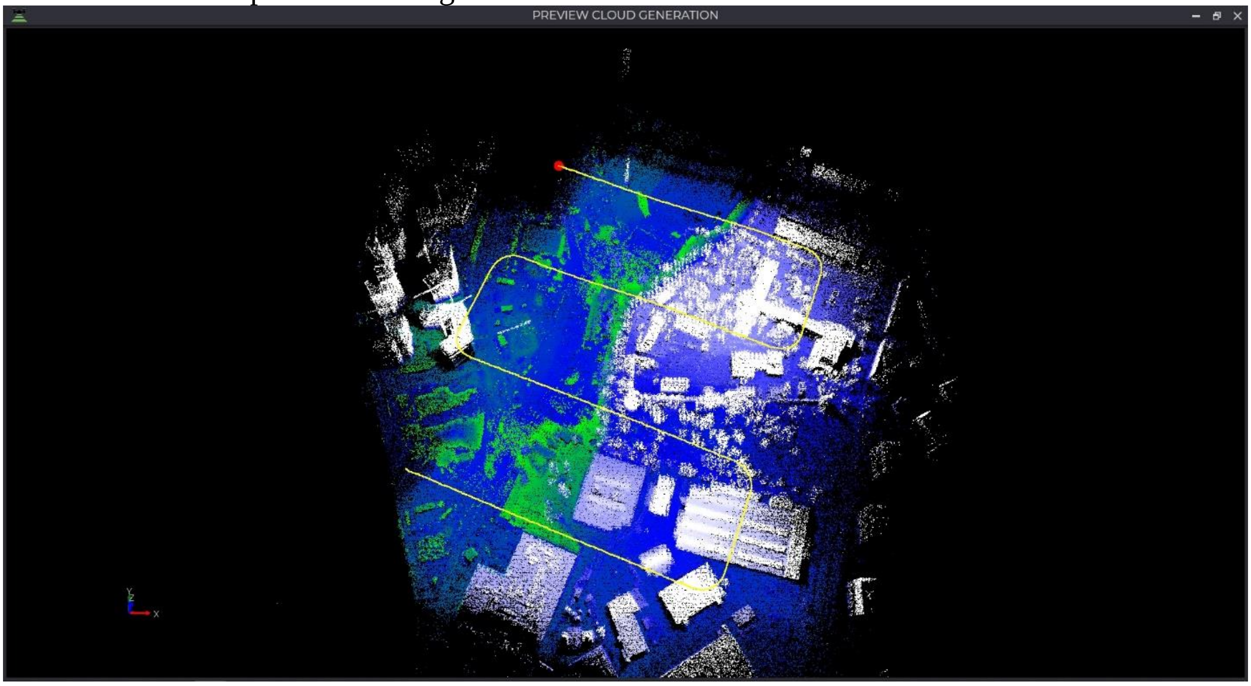
Pic. 5-6

Press the "Start" button to run Point loud generation process.



Pic. 5-7

NOTE: On this step the software generates the Point cloud in .LAS/.LAZ file format.



Pic. 5-8

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6. Static Post Processing

Static GNSS measurements data calculation module.

This module includes 2 parts:

1. One vector
2. Equalizing networks

One vector module calculates rover coordinates relatively to base station using one vector. To begin the calculation process we need load Base station file, Rover file and navigation file. Supported formats of the observation files are: *.ubx, *.obs, *.rnx and *.*O.

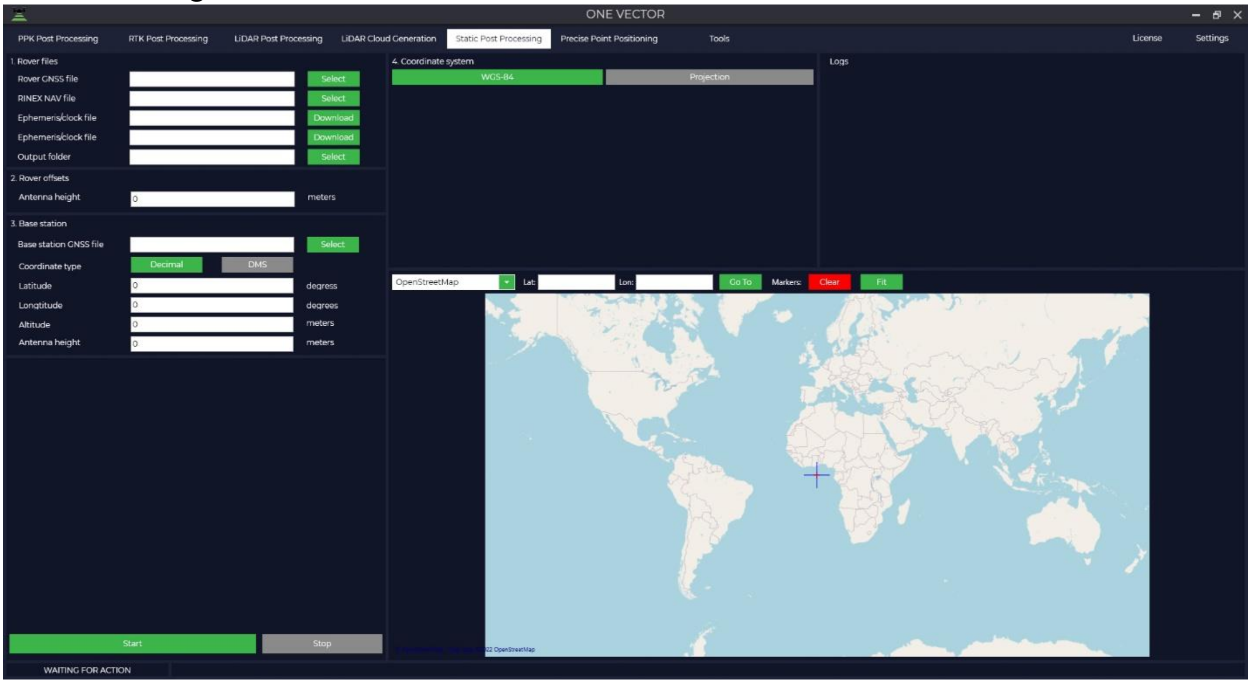
For the most accurate calculation it is high recommended to load the ephemeris file, own or downloaded from NASA server. Supported formats of the observation files are: *.nav, *.rnx, *.n, *.p, *.g, *.h, *.q, *.c and *.l.

The distance from the base station to the rover, when using accurate ephemeris and the NASA navigation file, is practically unlimited, daily RINEX files give an RMS of about 5 centimeters at a distance of 5 thousand km.

The module has the ability to perform a measurement immediately in the selected projection.

6.1. One vector

To run this module, you need to open the Topodrone Post Processing software, go to the Static Post Processing tab and click on the “One vector” button.



Pic. 6-1-1

Loading Rover data files.

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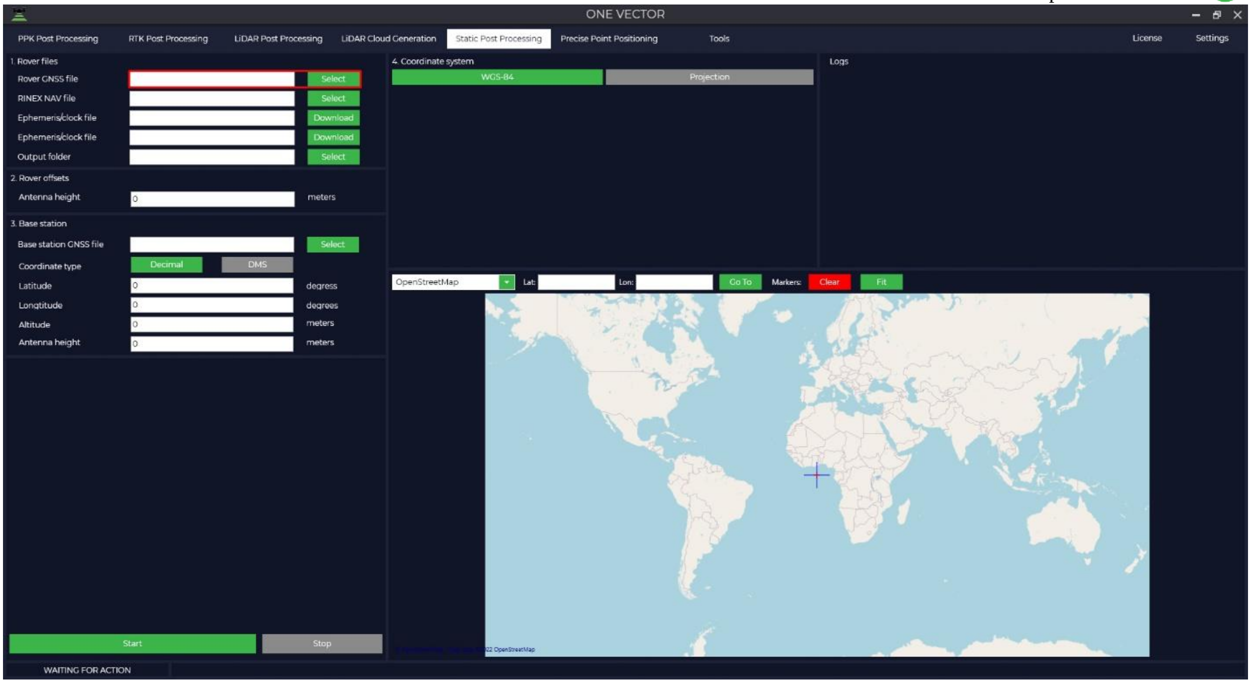
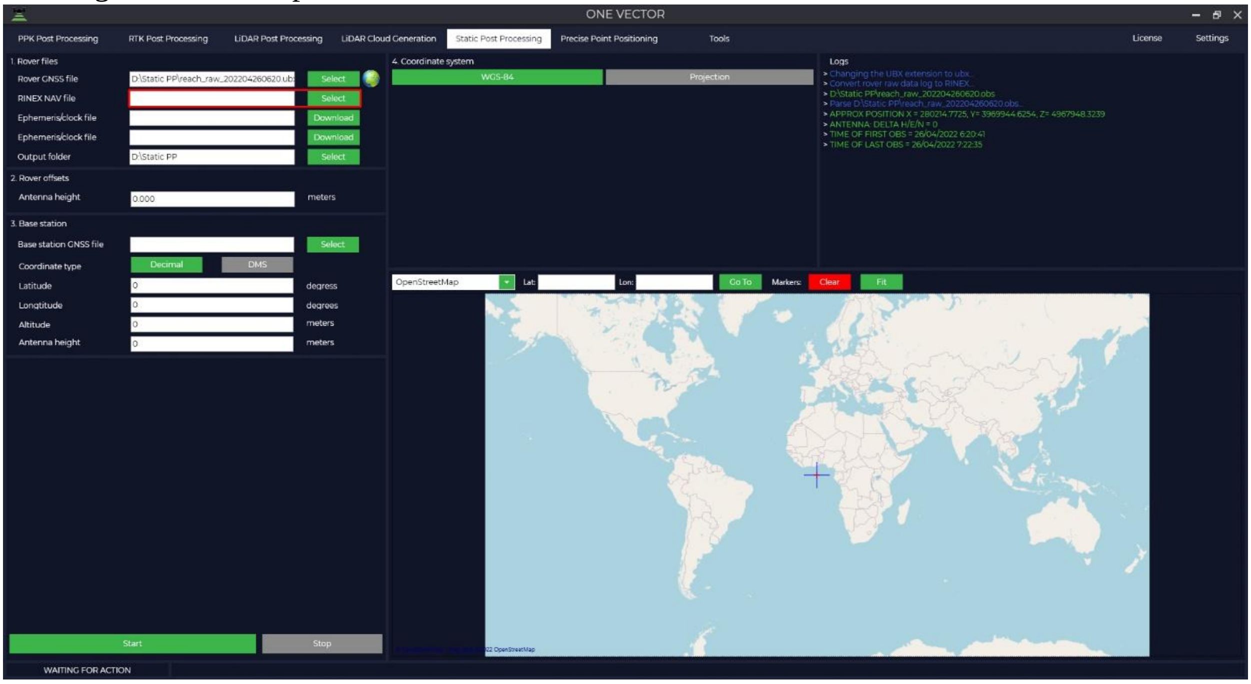


Pic. 6-1-2

Loading the onboard ephemeris data files.



Pic. 6-1-3

Loading high precision ephemeris data files (if necessary).

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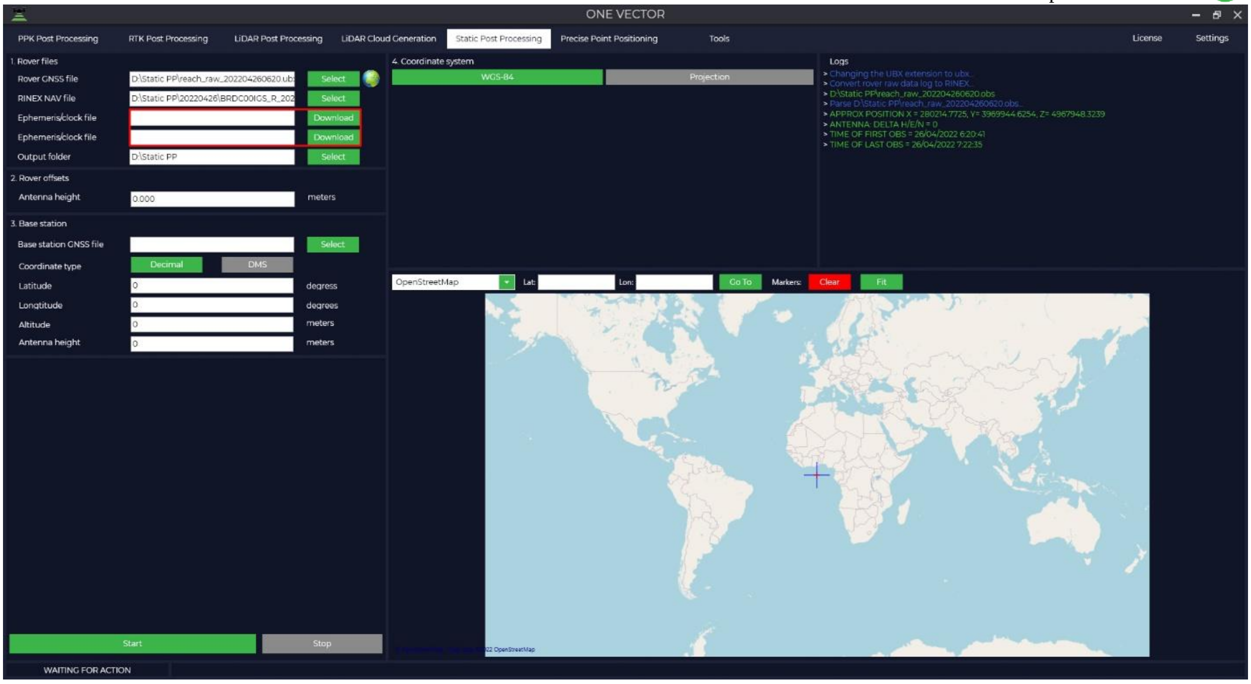
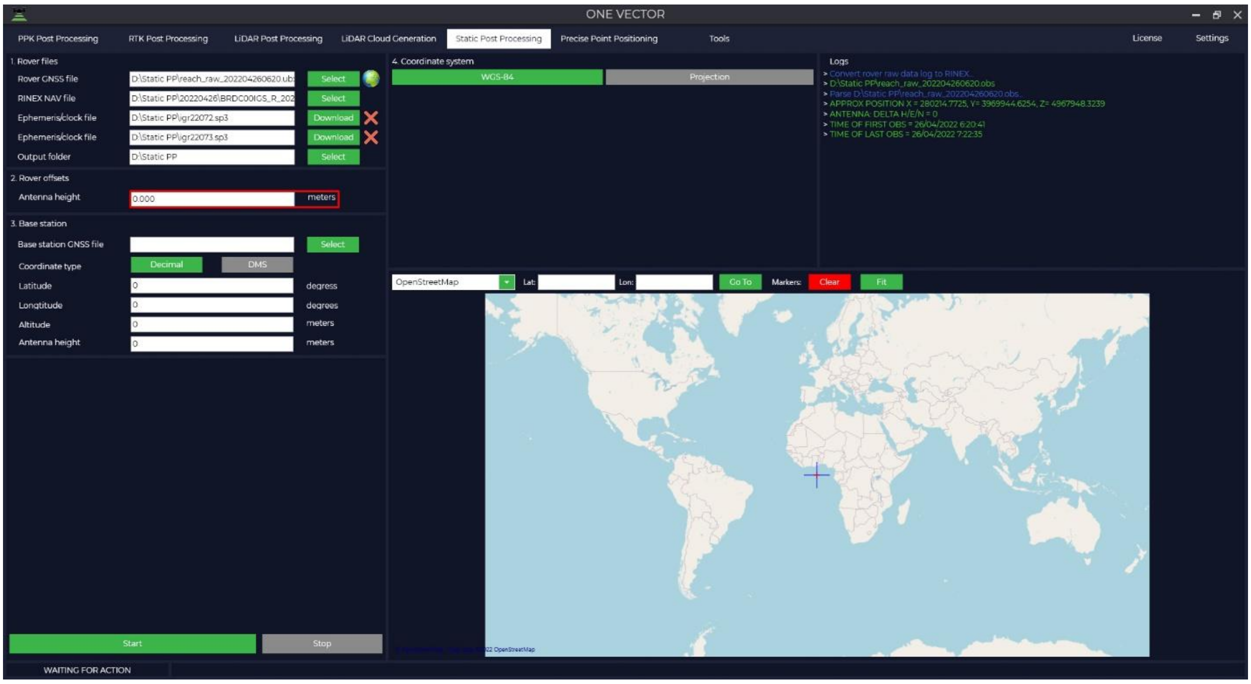


Pic. 6-1-4

Fill the Rover antenna height.

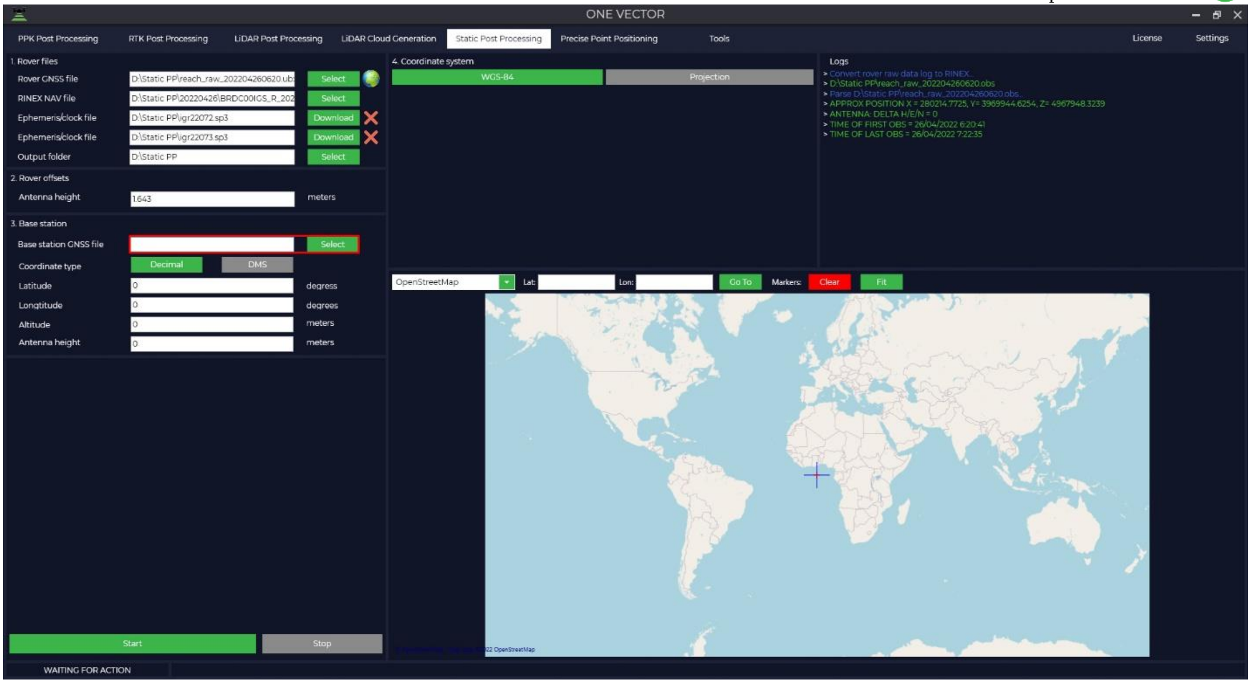
Attention!

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



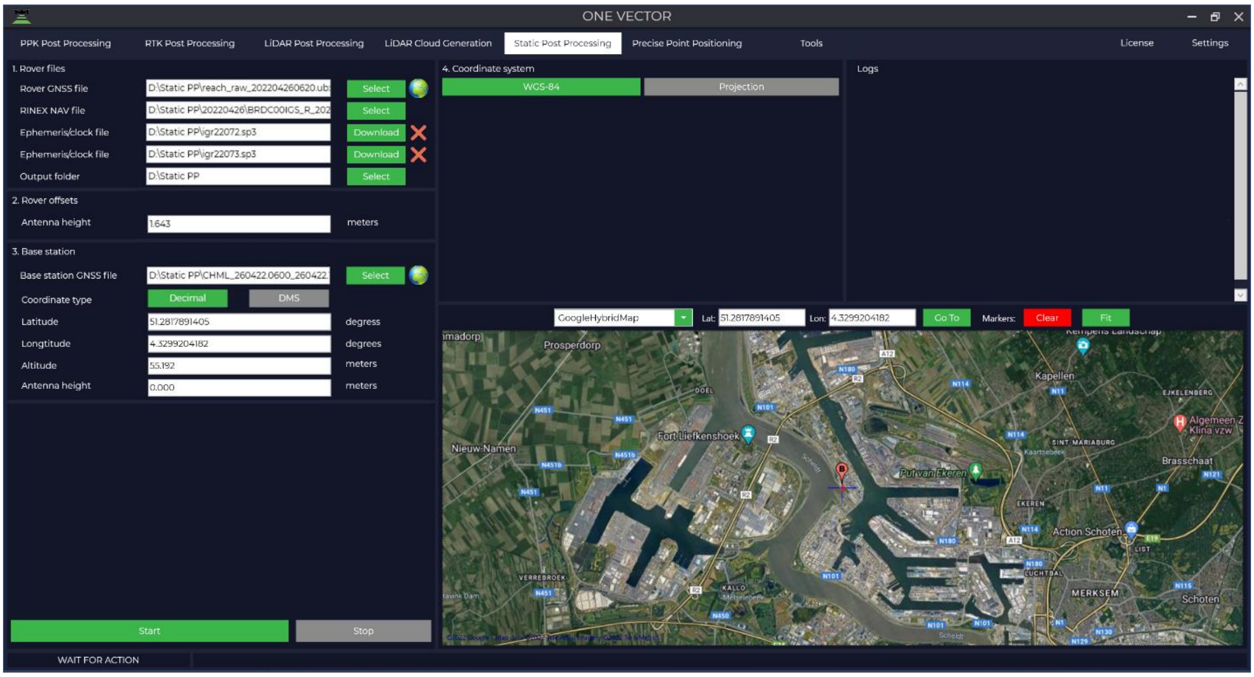
Pic. 6-1-5

Load base station measurements data files.



Pic. 6-1-6

The base station X,Y coordinates and the Height of the phase center will be loaded automatically from Rinex file, if it was filled during the measurements.



Pic. 6-1-7

The WGS-84 coordinate system is used by default, in case if you need to choose another one, press the “Projection” button and use any coordinate system from the list, also you may use “Search” option or add your own .prj file.

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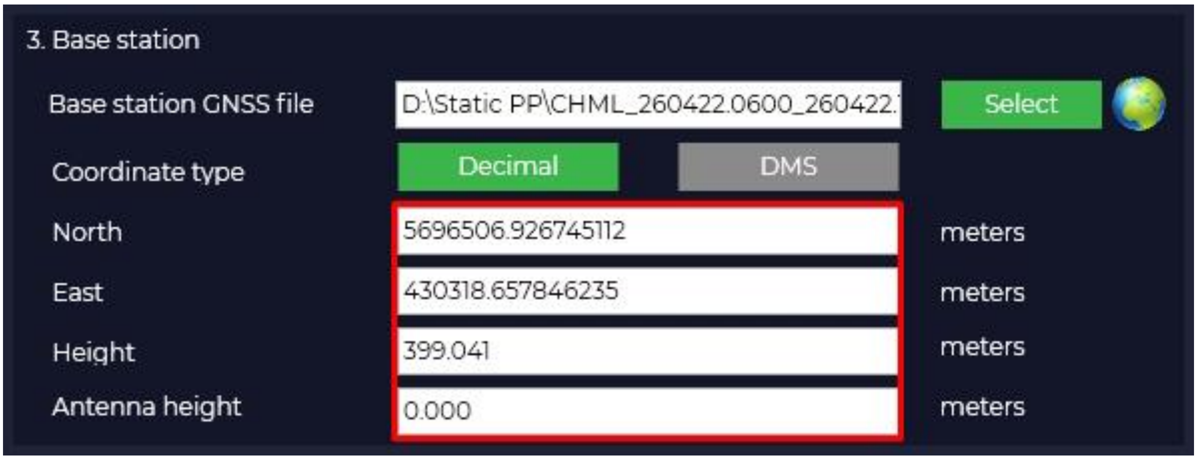
Pic. 6-1-8

При Selected coordinate system will be automatically converted from WGS-84 to user chosen projection. Adjust the base station coordinates if necessary.

Attention!

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



Pic. 6-1-9

Press the “Start” button and software will begin calculation.

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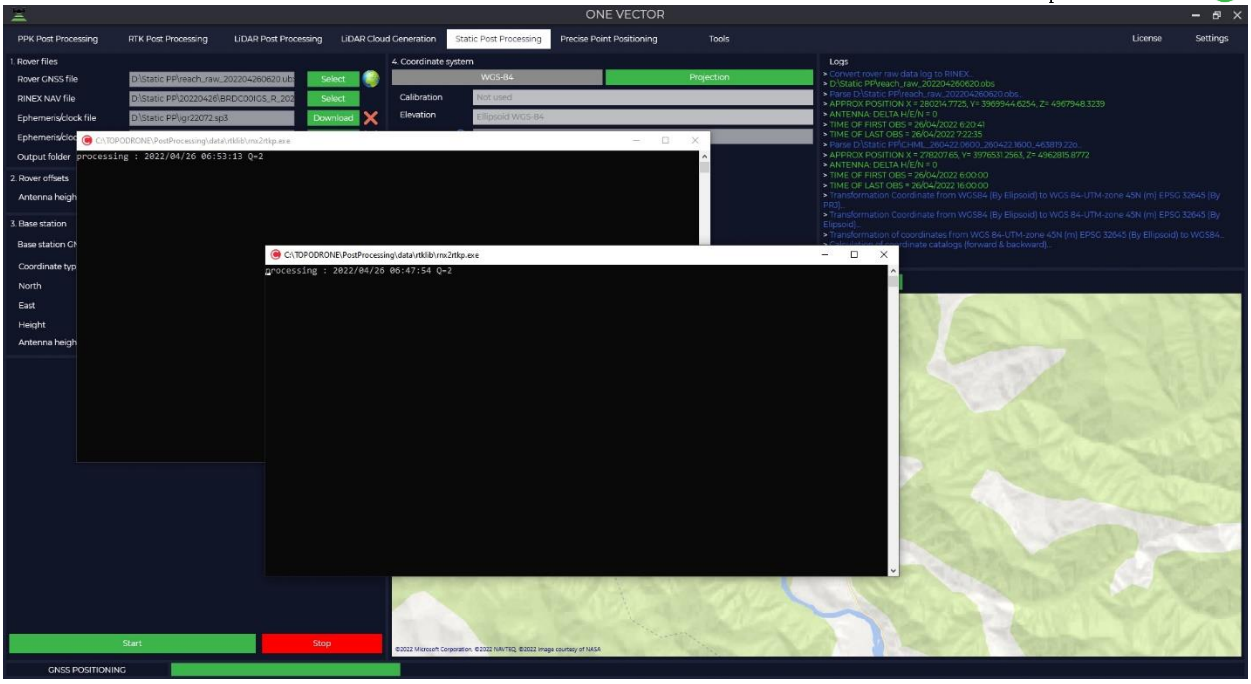
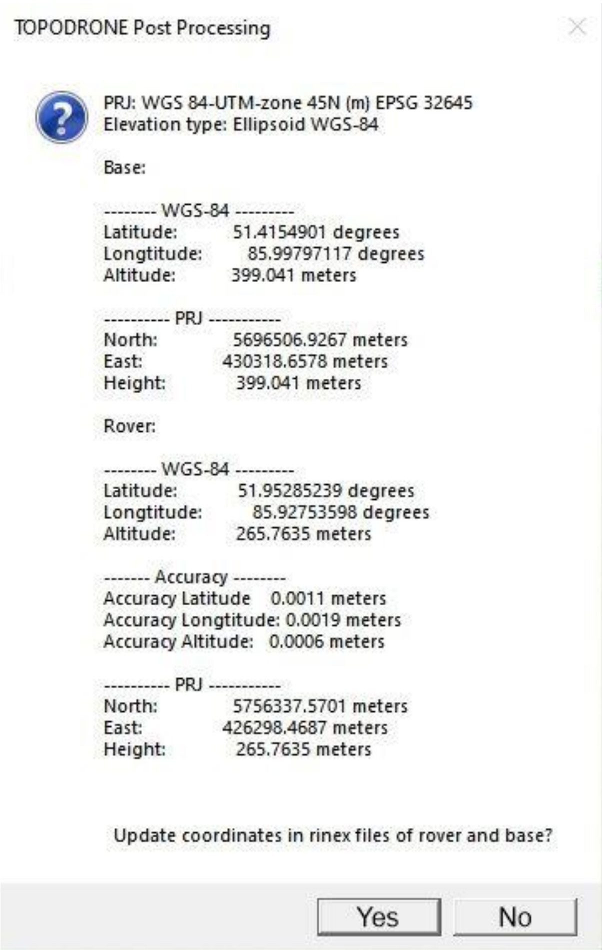


Pic. 6-1-10

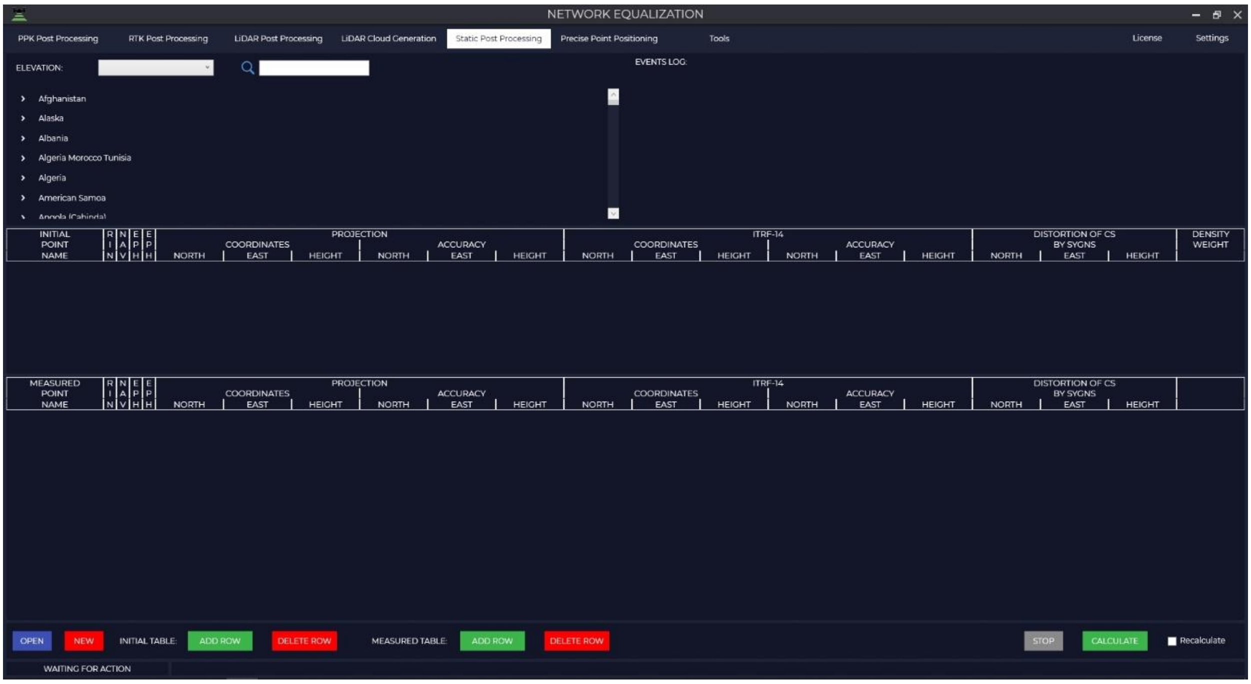
After completion of the calculations, the program will display a window with the coordinates of the base station and the rover in the WGS-84 coordinate system and the local coordinate system and offer to save these data to observation files for further use. Also, a file with the results of the calculation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



Pic. 6-1-11

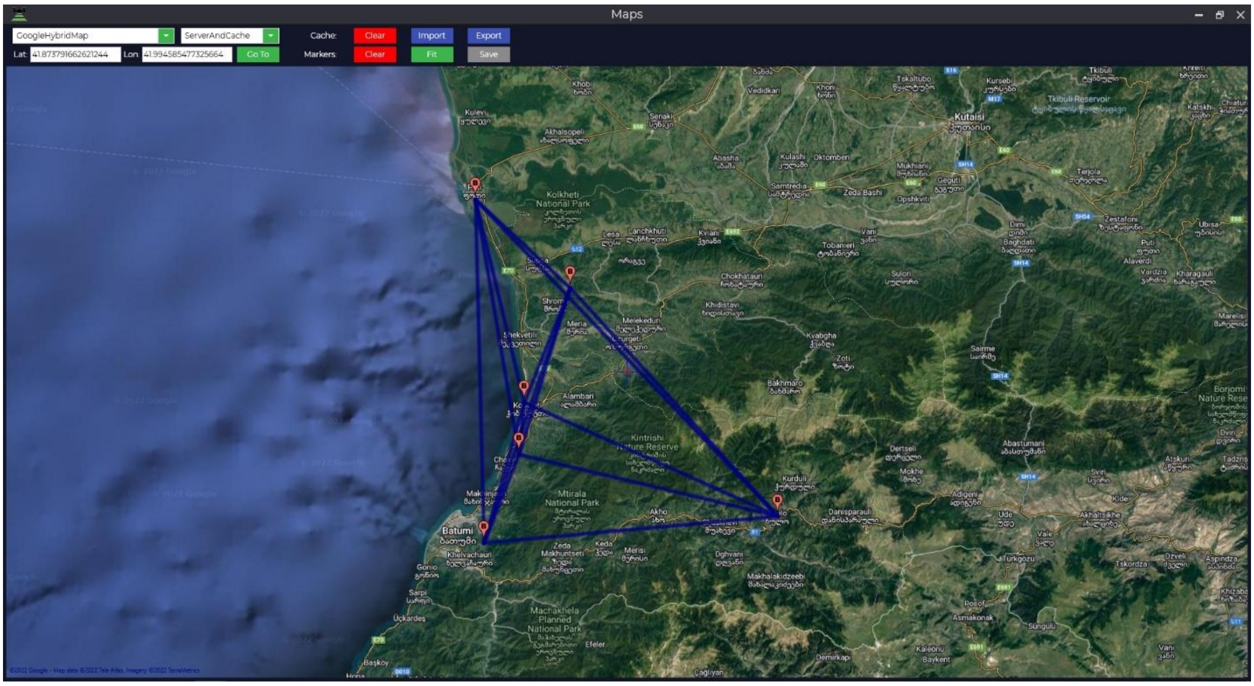
6.2. Equalizing networks

To run this module, go to the Static Post Processing tab and click on the “Equalizing networks” button.



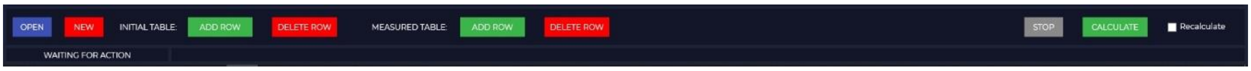
Pic. 6-2-1

For the visual displaying of observation points, it is necessary to have “Maps” window opened, while data files are being loaded to the software.



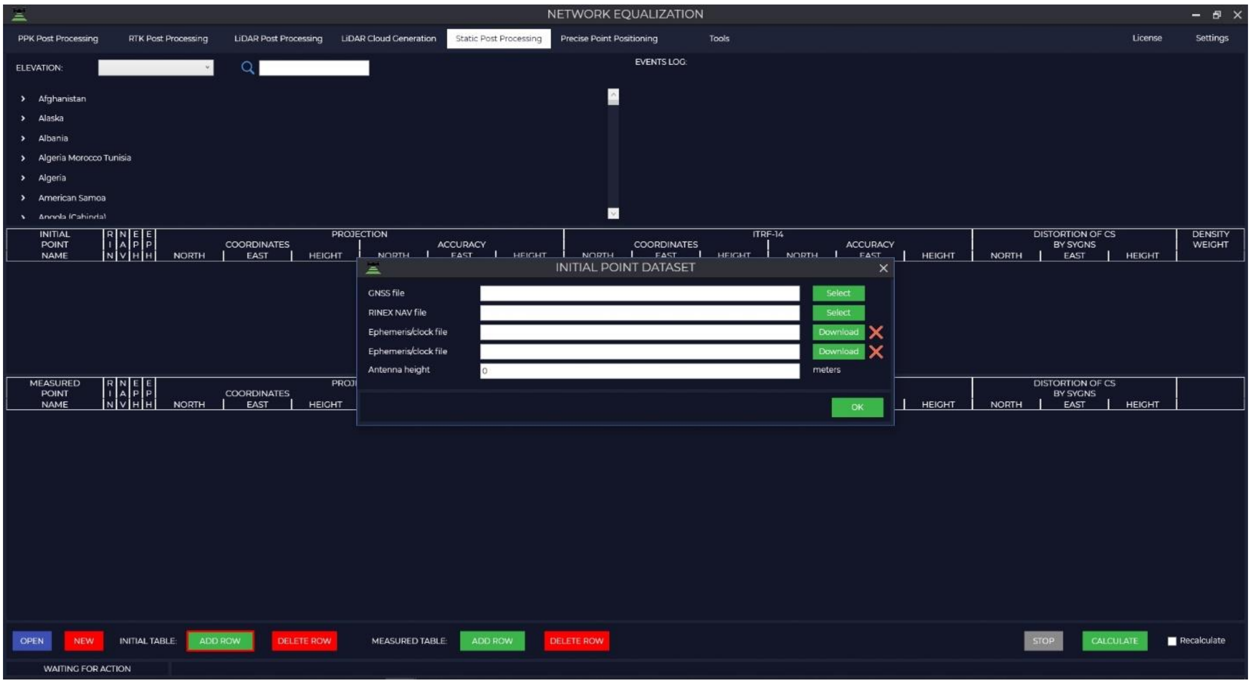
Pic. 6-2-2

On the bottom panel, user can find some necessary tools:
Open or Create a new Project, Add or Remove the data files of the input points, Add or Remove the measured points, Start or Stop processing.



Pic. 6-2-3

Pressing the "ADD ROW" button will initiate the loading of the input points.



Pic. 6-2-4

GNSS file – measurements data from GNSS receiver, file formats: *.obs, *.rnx or *.*o.

RINEX NAV file – navigation measurements data, file formats: *.nav, *.rnx, *.n, *.p, *.g, *.h, *.q, *.c and *.l.

Ephemeris/clock file – final ephemeris file in *.sp3, *.eph format, you can also upload the accurate onboard clock *.clk file. When you click on the Download button, if there is data on the NASA server, the software will automatically download this data

Attention!
When processing Equalizing networks, the software uses the method of obtaining high-precision coordinates of the area (Precise Point Positioning - PPP) using global navigation satellite systems by obtaining corrections to the orbit 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.

Type	Orbit and clock accuracy	Accessibility	Note
Broadcast	~100 cm	Real time	GLONASS (.YYg) and GPS (.YYn) onboard ephemeris generalized in the MCC per day in RINEX format
	~5 ns RMS		
	~2.5 ns σ		

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UltraRapid	~3 cm ~150 ps RMS ~50 ps σ	3-9 hours later	Precise ephemeris and on-board clock corrections
Rapid	~2.5 cm ~75 ps RMS ~25 ps σ	17-41 hours later	Ephemeris and on-board clock corrections obtained on the interval of the last day
Final	~2.5 cm ~75 ps RMS ~20 ps σ	12-18 days later	Final ephemeris and on-board corrections

Then it is necessary to enter the coordinates of the initial points and the accuracy of their determination. If you do not know with what accuracy they were determined, then you need to indicate the following recommended accuracy:

Fundamental astronomical geodetic network 20 mm north/east, 30 mm height

High-precision fundamental geodetic network 30 mm north/east, 40 mm height

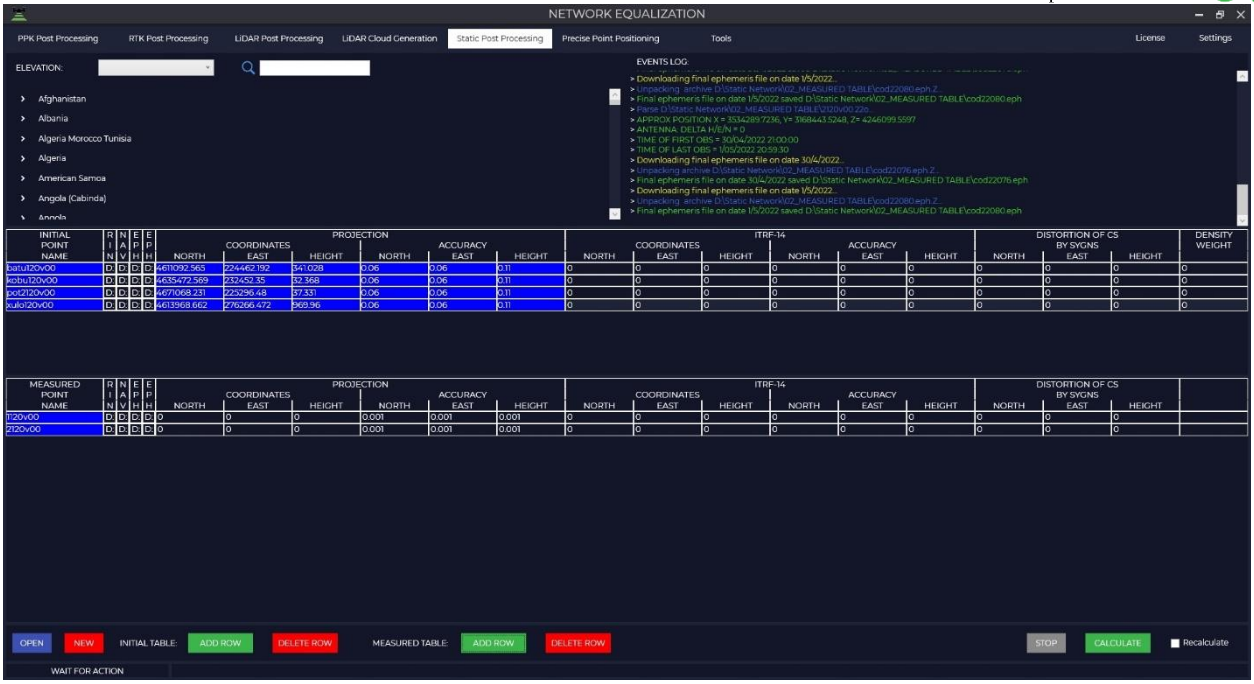
Satellite geodetic network and astronomical geodetic network 40 mm north/east, 50 mm height

Government geodetic network 60 mm north/east, 110 mm height

INITIAL POINT NAME	RIN	NAV	EPH	EPH	PROJECTION COORDINATES NORTH	EAST	HEIGHT	ACCURACY NORTH	EAST	HEIGHT	
batu120v00	D:	D:	D:	D:	4611092.565	224462.192	341.028	0.06	0.06	0.11	0
kobu120v00	D:	D:	D:	D:	4635472.569	232452.35	32.368	0.06	0.06	0.11	0
pot2120v00	D:	D:	D:	D:	4671068.231	225296.48	37.331	0.06	0.06	0.11	0
xulo120v00	D:	D:	D:	D:	4613968.662	276266.472	969.96	0.06	0.06	0.11	0

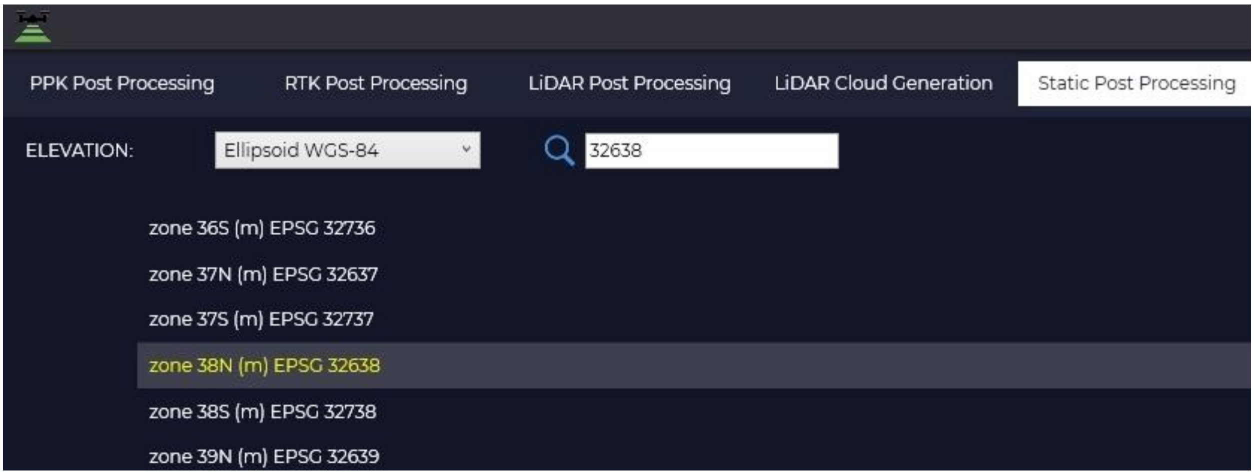
Pic. 6-2-5

To load data on measured points, you must use "ADD ROW" opposite the "MEASURED TABLE" item and, by analogy with the initial points, perform the download.



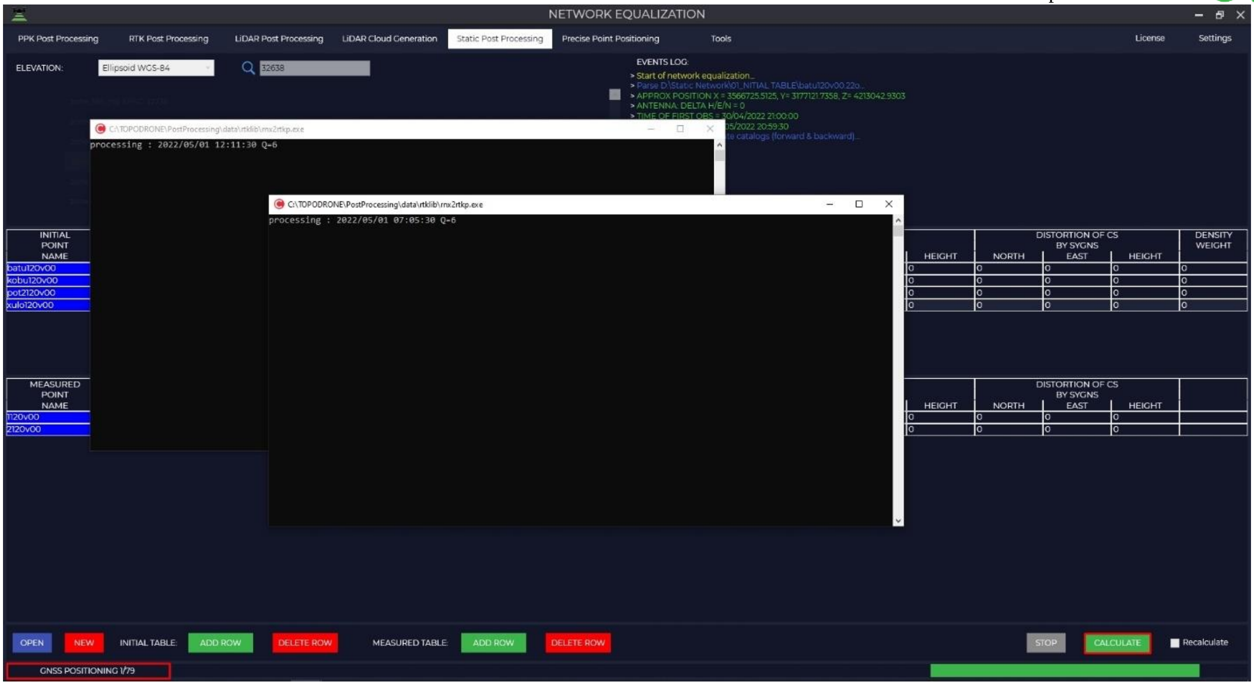
Pic. 6-2-6

Select the coordinate system and preferred height type.



Pic. 6-2-7

By pressing a “CALCULATE” button the software will run the calculation process. In the bottom left corner will be displayed which calculation is in progress and how many calculations need to be performed.



Pic. 6-2-8

The calculation process uses the following algorithm:

1. Calculation of the coordinates of all points in the ITRF2014 coordinate system using the Precise Point Positioning - PPP method. After this step, in the ITRF-14 window you will see the calculated coordinates and the accuracy with which they were obtained.

ITRF-14					
COORDINATES			ACCURACY		
NORTH	EAST	HEIGHT	NORTH	EAST	HEIGHT
41.60400389	41.69360185	341.0316	0.0055	0.0042	0.0073
41.82596701	41.77839375	32.397	0.0195	0.0066	0.0177
42.14358073	41.67573877	37.3276	0.0044	0.0031	0.0078
41.64607682	42.31343561	969.977	0.0046	0.0028	0.0086

ITRF-14					
COORDINATES			ACCURACY		
NORTH	EAST	HEIGHT	NORTH	EAST	HEIGHT
41.7432263	41.76681853	341.0236	0.0242	0.0179	0.0285
42.00570439	41.87580552	37.33	0.0224	0.0186	0.027

Pic. 6-2-9

2. At the next stage, the software calculates the coordinates of the points using the Precise Point Positioning method and statically measures all possible vectors, calculates the coordinates of the points by accuracy using weighting method.

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3. Then, using the coordinate system and coordinates of the original ones, taking into account the weighting accuracy of the points, the software calculates the total offset from the parameters of the selected projection and creates a grid of residual distortion correction.

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

DISTORTION OF CS BY SYGNS			DENSITY WEIGHT
NORTH	EAST	HEIGHT	
-0.006	0.007	0.008	0.746
0.006	-0.015	-0.017	0.725
0.006	0.008	0.015	0.726
-0.006	-0.001	-0.005	1.803

Pic. 6-2-10

As a result of the calculations, you will receive a catalog of point coordinates in the coordinate system that was specified, the accuracy of determining these coordinates and a distortion grid for use in the Topodrone Post Processing program and open the CALIBRATION tab through the TOOLS module.

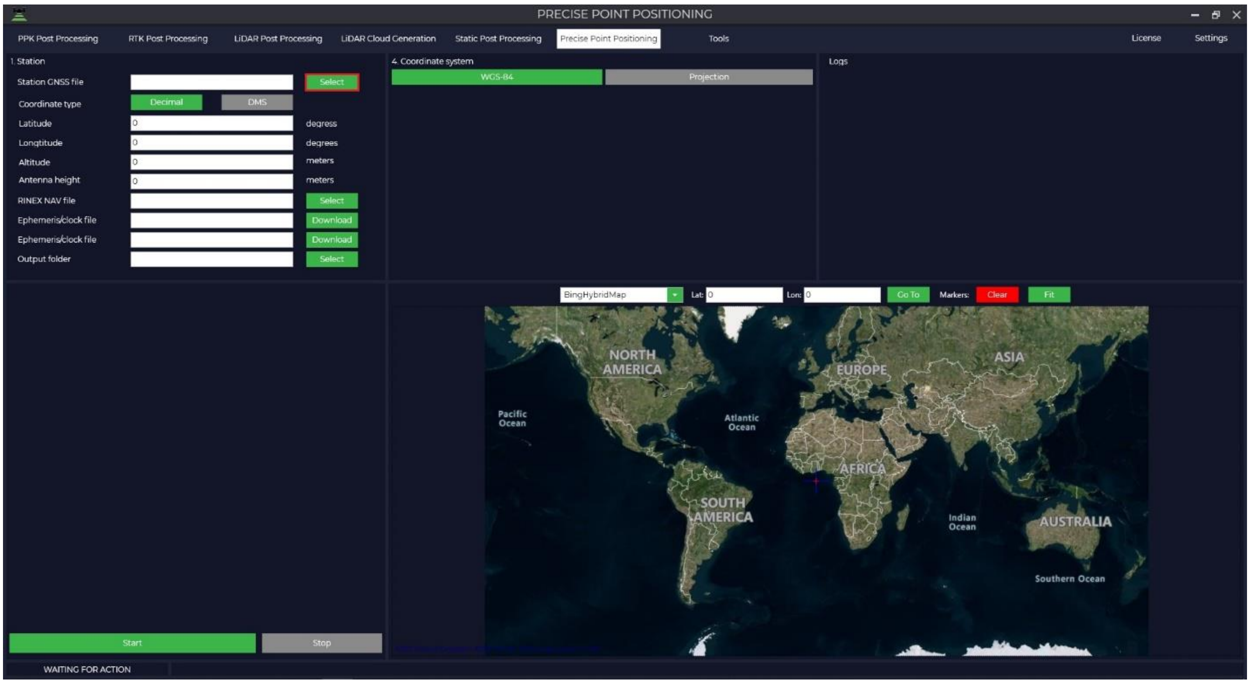
MEASURED POINT NAME	RIN	NAV	EPH	EPH	PROJECTION COORDINATES			PROJECTION ACCURACY		
					NORTH	EAST	HEIGHT	NORTH	EAST	HEIGHT
1120v00	D:	D:	D:	D:	4626320.797	231145.1071	341.007	0.0842	0.0771	0.1453
2120v00	D:	D:	D:	D:	4655132.4376	241270.8679	37.3174	0.0776	0.0727	0.1369

Pic. 6-2-11

7. Precise Point Positioning

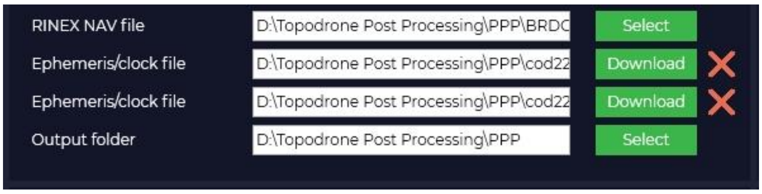
Precise Point Positioning (PPP) is a global navigation satellite system positioning method that calculates coordinates with an error of only a few centimeters under good conditions. PPP is a combination of several relatively sophisticated GNSS positioning techniques. Unlike the RTK method, which uses a base station, a rover and relatively small distances between them, the PPP method uses a single GNSS receiver.

Go to the Precise Point Position tab to and click on the “Select” button to download data from the GNSS receiver. Supported formats: *.ubx, *.obs, *.rnx and *.*o.



Pic. 7-1

Next, we need to load the rest of the data.



Pic. 7-2

RINEX NAV file – navigation measurement file, supported formats *.nav, *.rnx, *.n, *.p, *.g, *.h, *.q, *.c and *.l.

Ephemeris/clock file – final ephemeris file in *.sp3, *.eph format, you can also upload the exact onboard clock *.clk file. When you click on the “Download” button, if there is data on the NASA server, the software will automatically download this data.

Output folder – folder with output data, if necessary, it can be changed.

BIt is necessary to select the preferred coordinate system and height type in which we need to get the coordinates of the point.

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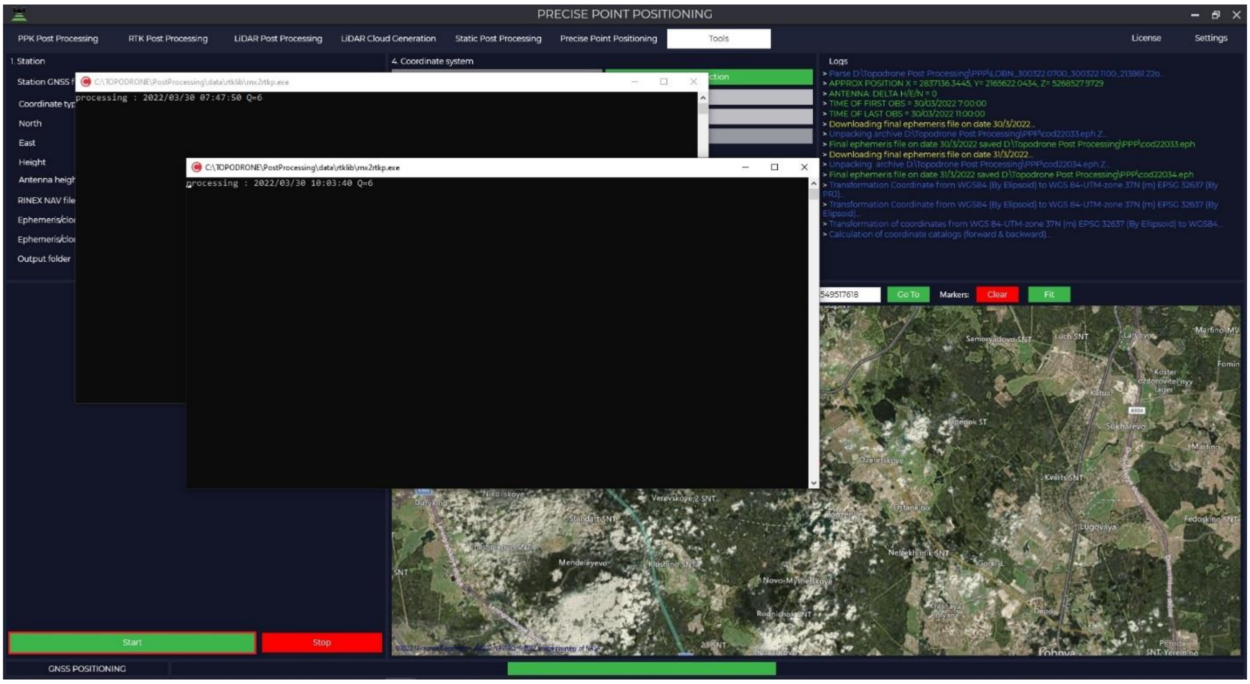
Pic. 7-3

Then, if data is available, enter the coordinates of the base station and the height of the antenna, taking into account the phase center.

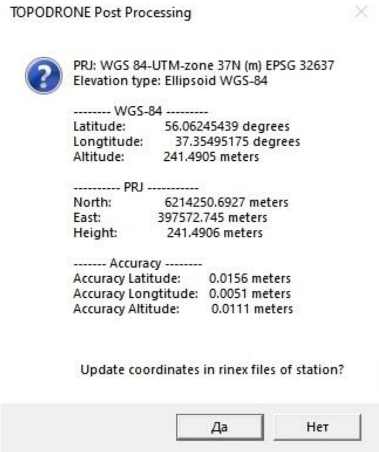
Pic. 7-4

By pressing the “Start” button the software will run the calculation.



Pic. 7-5

As a result of the calculations, a window will appear indicating the coordinates of the point in the WGS-84 coordinate system, in the selected coordinate system and the accuracy of determining these coordinates. Also, by clicking the "Yes" button, the software will write the calculated coordinates to the header of the RINEX file.



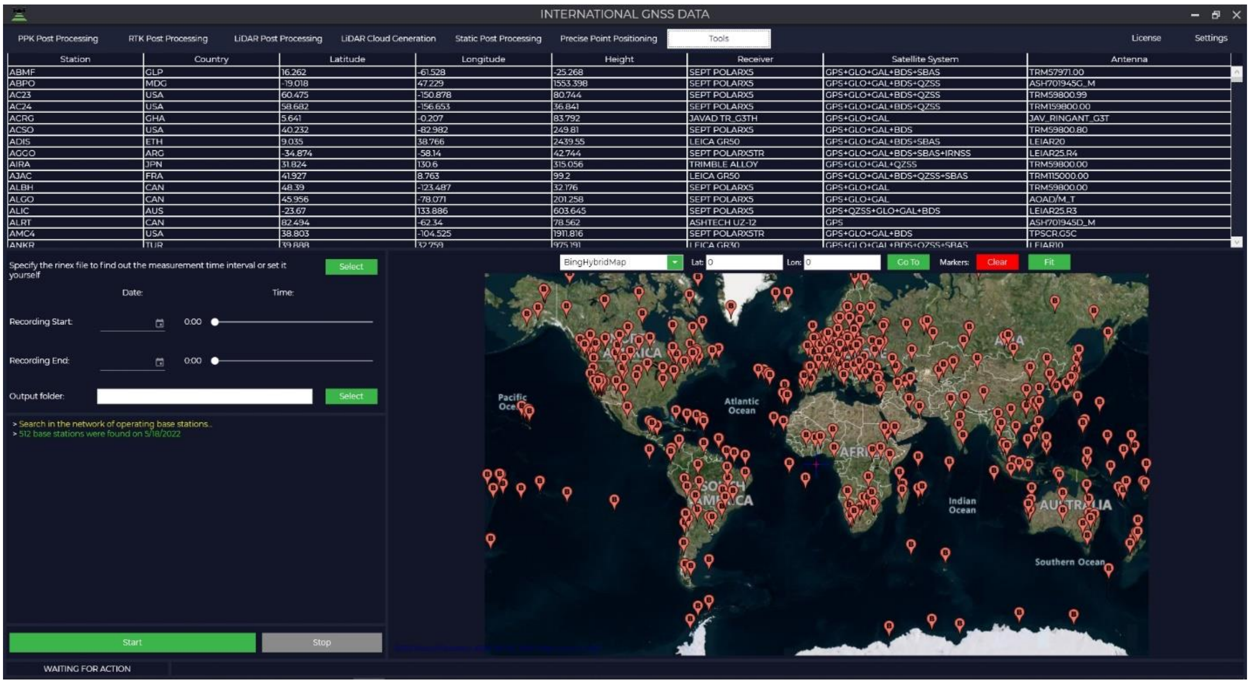
Pic. 7-6

8. Tools

8.1. GNSS Data Archive

This module allow to download rinex static data from open CORS networs. The module is divided into IGS - all available base stations, and RGS - base stations located on the territory of the Russian Federation. At the beginning of 2022, the database contains more than 500 base stations, while 56 base stations are located on the territory of the Russian Federation. Of all the base stations, more than half support several satellite constellations.

To launch the module, go to the Tools tab, then GNSS Data Archive and select the database you need.

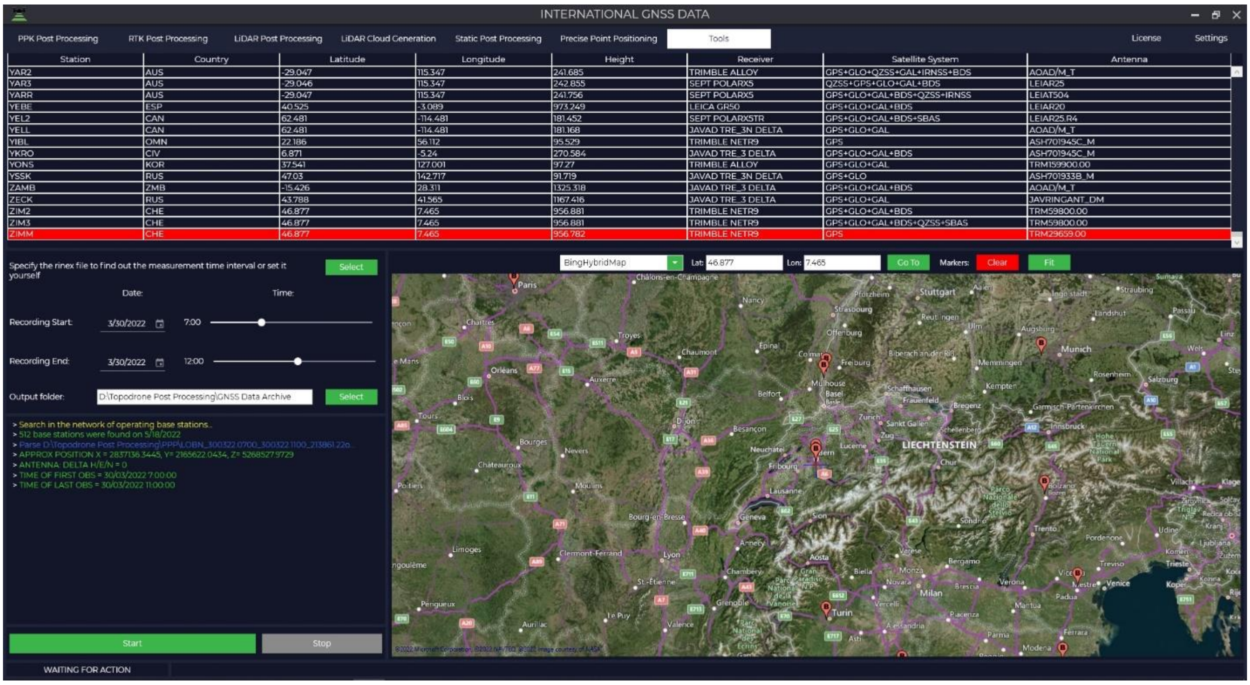


Pic. 8-1-1

Then upload rinex/ubx data from your drone or GNSS receiver and software imports time of observation, or enter time interval manually. Specify the folder where you want to save the result.

Pic. 8-1-2

In the table or on the map, select the base station from which you want to download data and click the “Start” button, the data will be downloaded to the specified folder.



Pic. 8-1-3

8.2. Maps

The Maps module is used to display loaded static observations and vectors during processing. To launch the module, go to the Tools tab and click the “MAPS” button. To display the points at which observations were made, it is necessary that the map window be open at the time the files are loaded. If this condition was not met, then the data must be loaded again.

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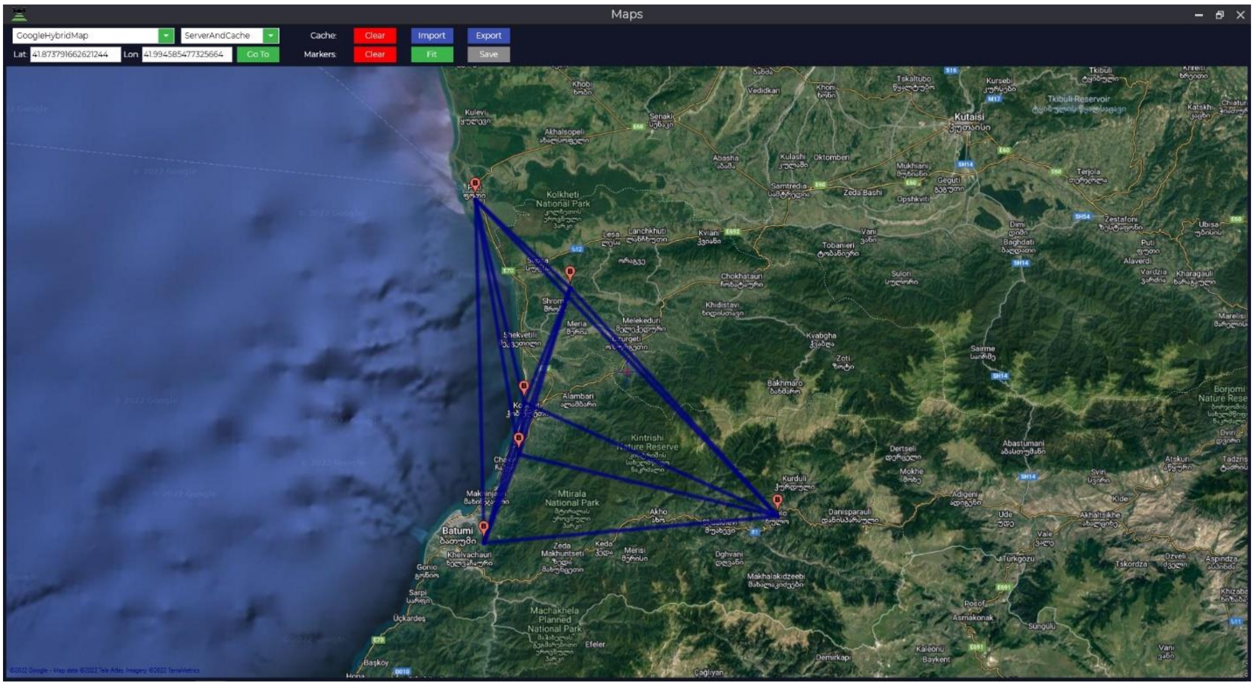
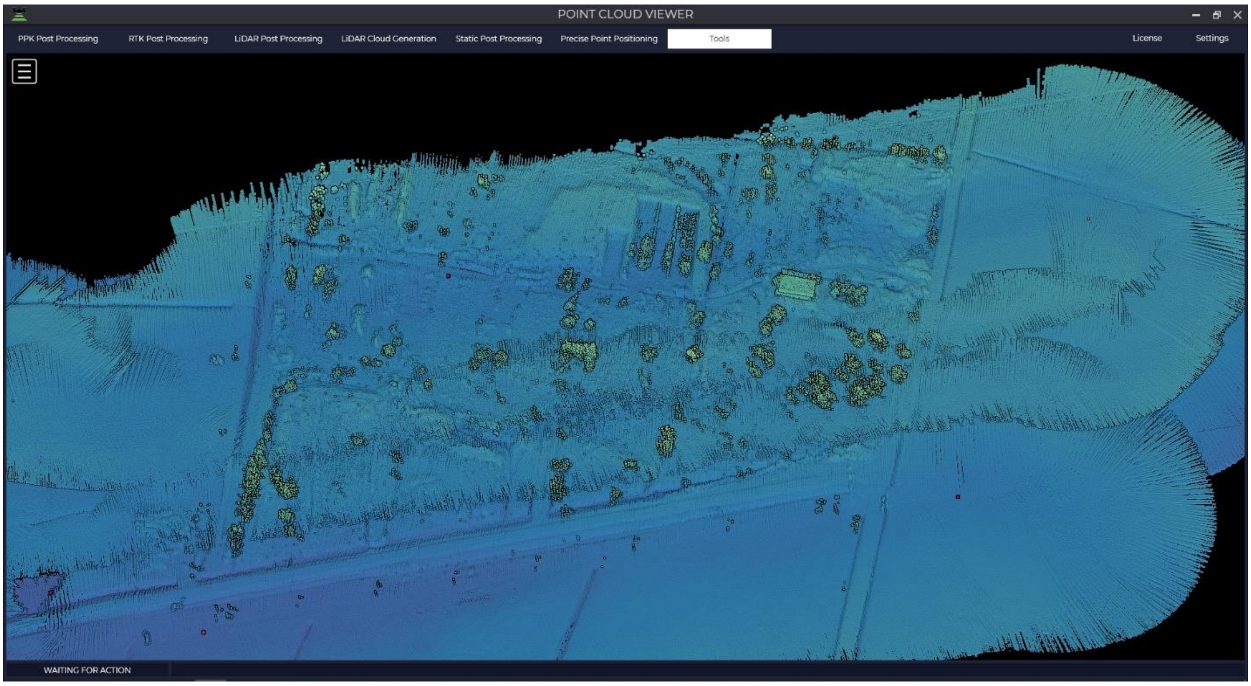


Pic. 8-2-1

8.3. Cloud viewer

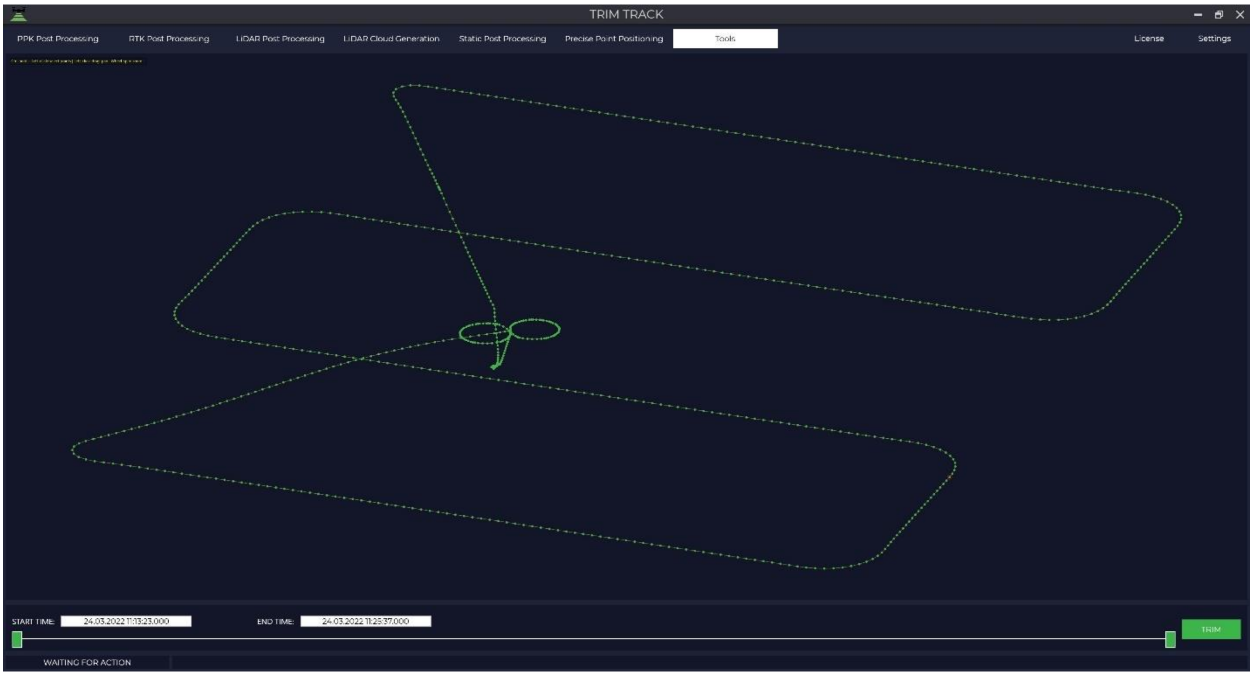
This tool is designed to view the point cloud obtained during processing in the Topodrone Post Processing software product. To launch the module, go to the CLOUD VIEWER in the Tools tab and click the NEW button. In the tab that opens, select a point cloud in *.las or *.laz format. After loading, the point cloud will be displayed in the main window.



Pic. 8-3-1

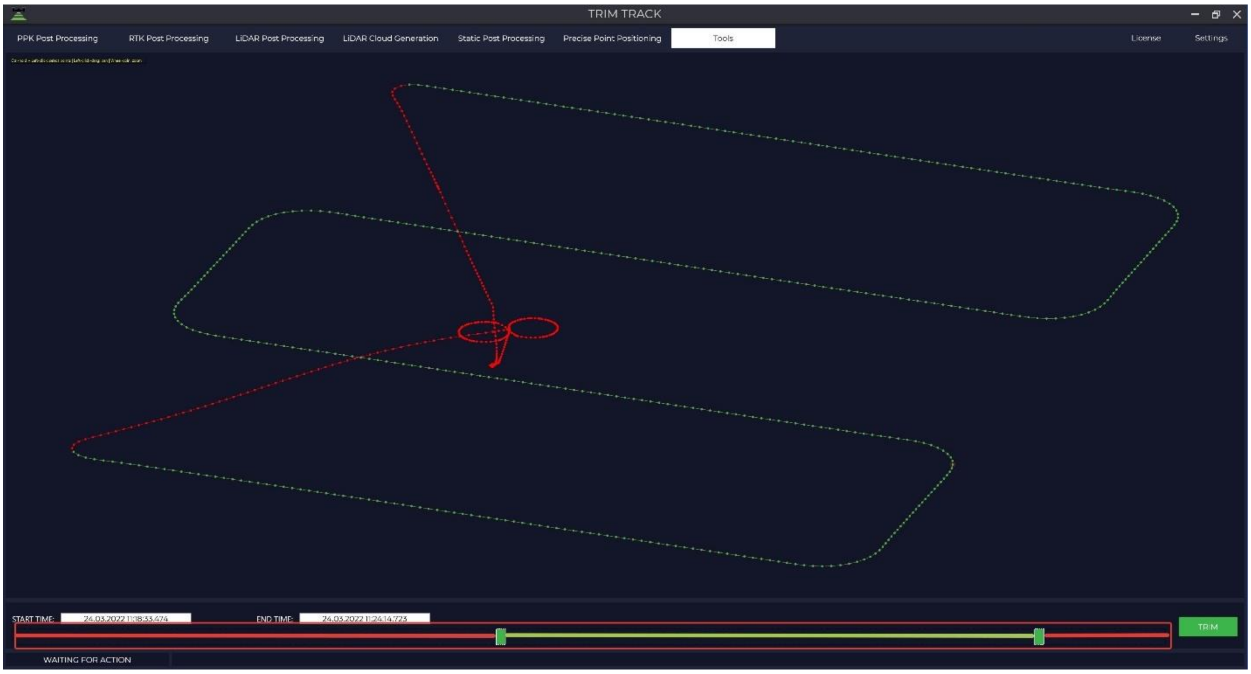
8.4. Trim

This tool is designed for trimming toolpath data. To run the tool, press the “Tools” button and select “Trim”, then “Track”. Then select the trajectory you want to trim.



Pic. 8-4-1

In the bottom part of the window there are two sliders, by moving which you specify the trajectory interval that will remain and which will be cut off. On the trajectory you will see a visual display of two colors. Green indicates the area that will be saved after cropping, and red indicates the area that will be cropped.



Pic. 8-4-2

After selecting a section, trim the unwanted part by clicking on “TRIM” button. The trajectory will be saved to a file in its original format.

You can also trim Inertial Navigation System (IMU) data using the Trim tool.

NOTE: This tool is also useful if, after starting toolpath processing, the dataset contains an error message - The IMU file contains gaps in the measuring points! Use the "TRIM IMU" tool to remove the missed sampling time interval.

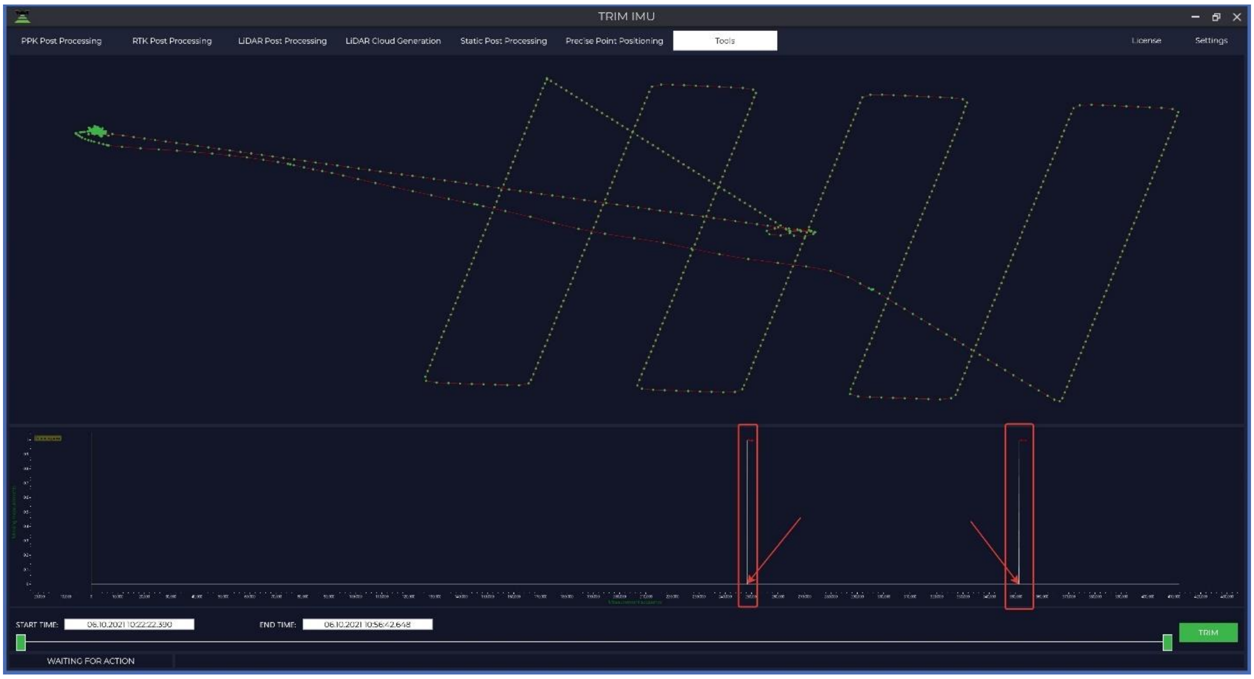
Pic. 8-4-3

To run the tool, you must click on the “Tools” button and select Trim, then IMU. Then select the *.imr file to be trimmed and the GNSS receiver file in *.ubx format.

Pic. 8-4-4

Pic. 8-4-5

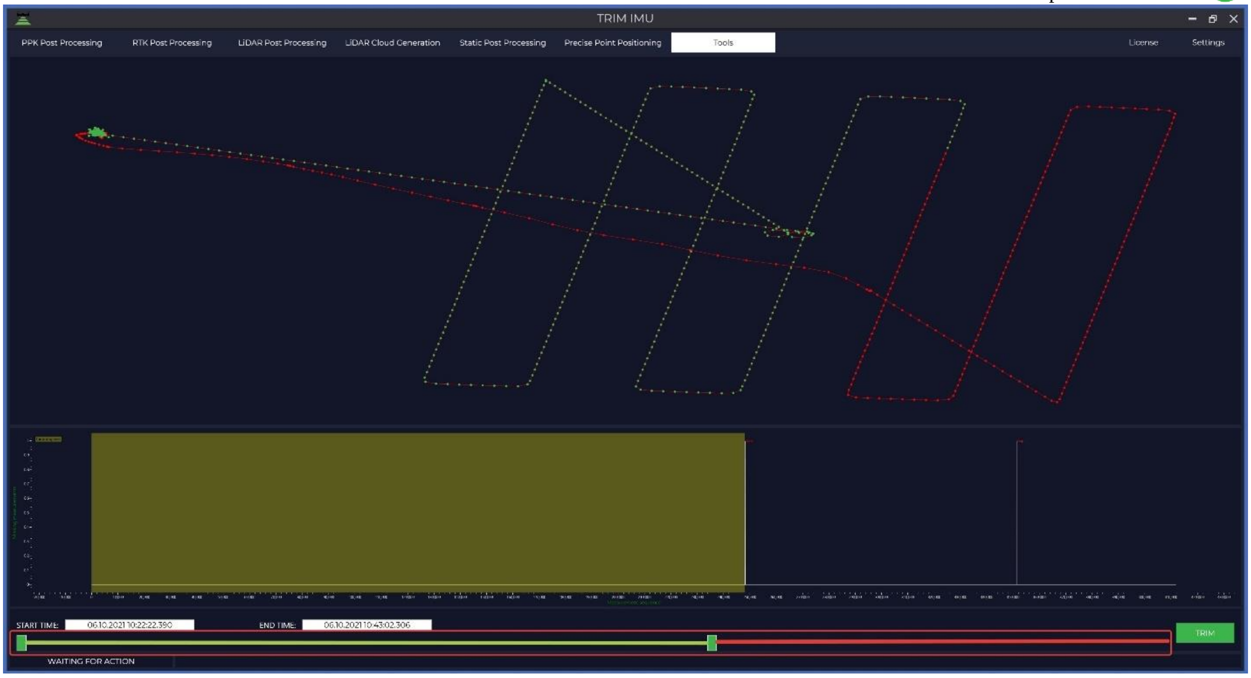
The software will perform GNSS pre-processing and if there were gaps in the IMU data, you will see this on the screen in the form of vertical lines and the designation (GAP).



Pic. 8-4-6

For further correct processing, it is required to exclude GAP from the data.

From the selected file, we will need to exclude 2 GAPs from processing, therefore the IMU file needs to be divided into 3 segments and further processed 3 parts. Cropping occurs only one segment, so in this case we will need to repeat this procedure 3 times.

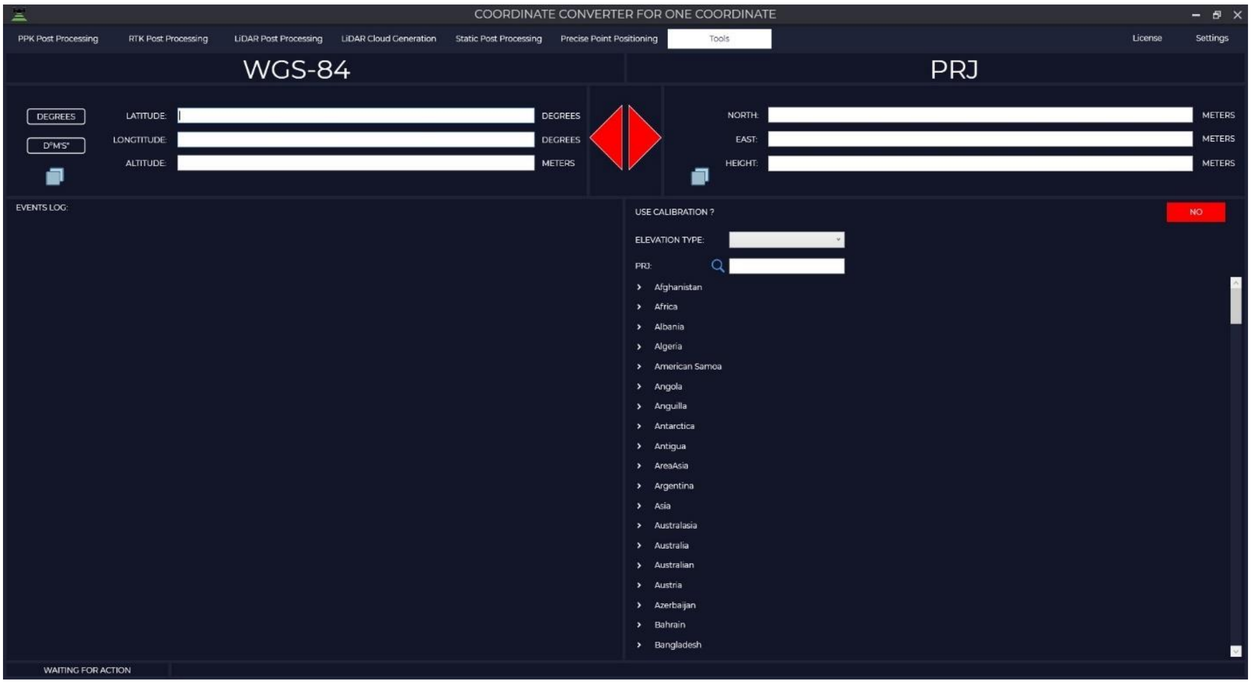


Pic. 8-4-7

After highlighting the desired segment using the sliders at the bottom of the screen, press “TRIM”. After trimming, the IMU file will be saved to a file in its original format for the specified interval and will be saved to the original folder.

8.5. Coordinate convert

This utility allows you to convert data from one coordinate system to another using the *.prj coordinate system file that is loaded into the Topodrone Post Processing database. In order to convert one point from the WGS-84 coordinate system to any other, you need to pull out COORDINATE CONVERT in the TOOLS tab, then ONE COORDINATE.

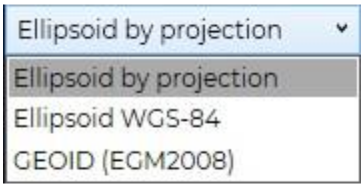


Pic. 8-5-1

Select coordinate format (decimal or degrees, minutes, seconds)

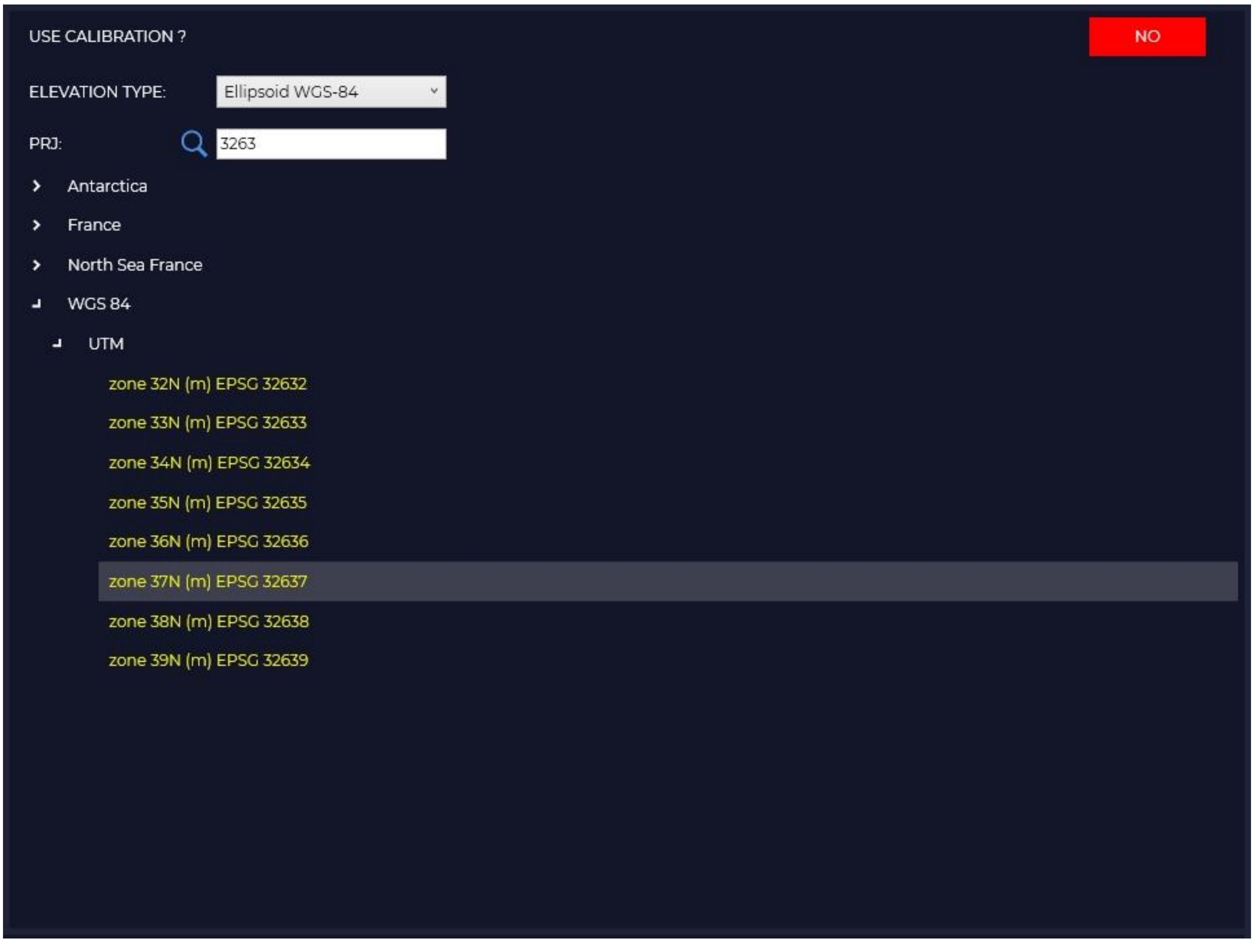
Pic. 8-5-2

Next, select the required type of height.



Pic. 8-5-3

Select the desired coordinate system. The required *.prj file can be quickly found using the search bar. The origin point coordinates must be within the area covered by the *.prj file.



Pic. 8-5-4

Then, click on the right arrow, which, when hovering over with the mouse, will change its color to green. Click on the arrow with the left mouse button.

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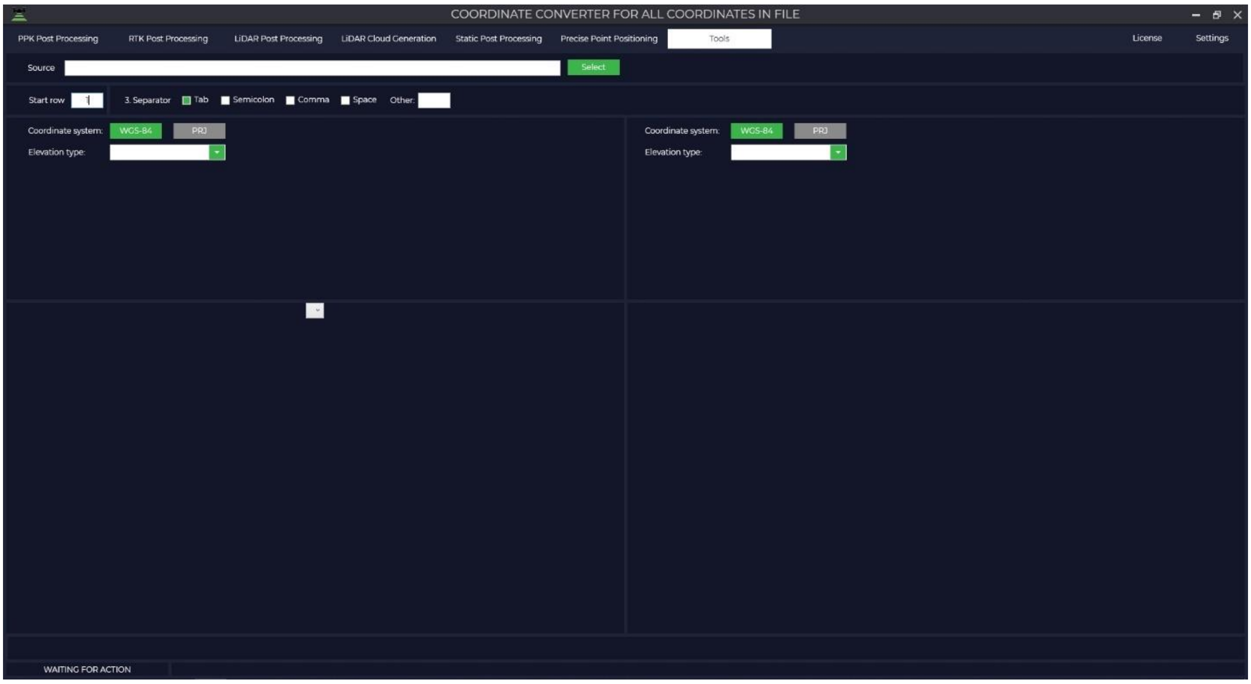
Pic. 8-5-5

After that, the converted values of the coordinates of the starting point in meters will appear on the right side.

Pic. 8-5-6

In order to convert a catalog of coordinates from one coordinate system to another, select COORDINATE CONVERT in the TOOLS tab, then COORDINATES FROM FILE.

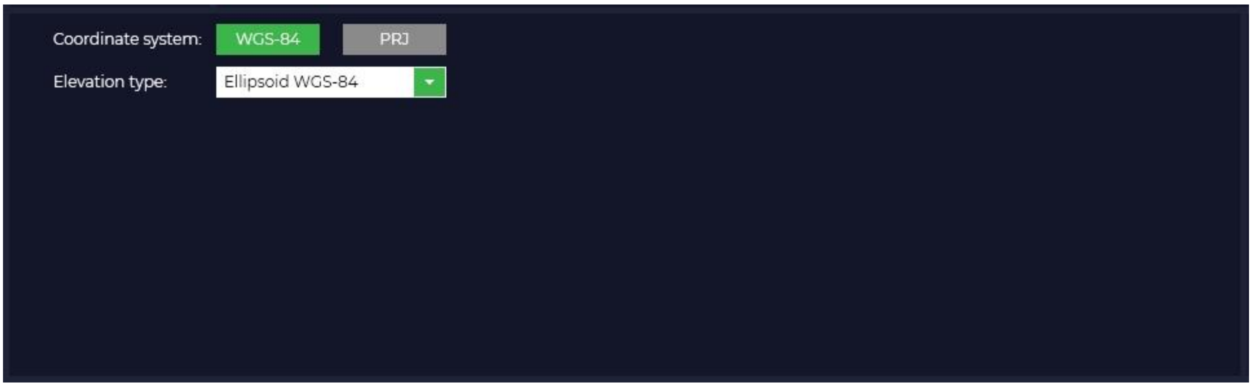


Pic. 8-5-7

In the Source tab, you must select the file of the coordinate catalog that you want to convert, specify the line from which you want to import and the type of coordinate separator.

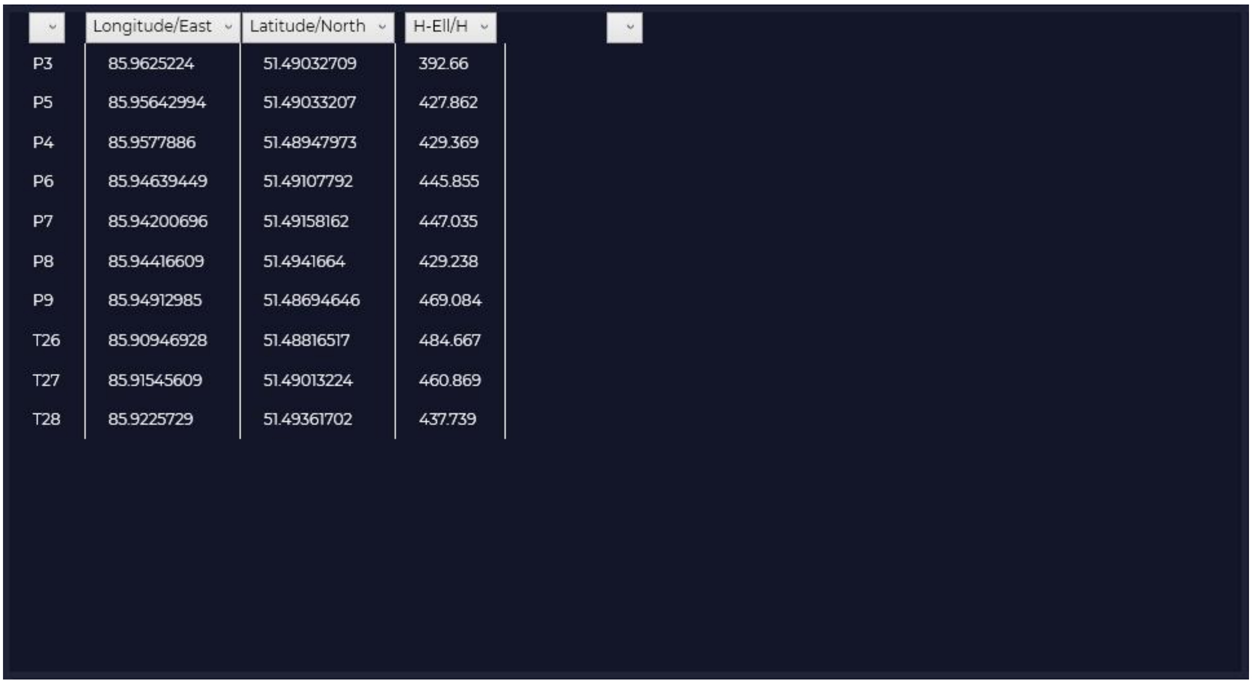
Pic. 8-5-8

Then select the coordinate system and height type of the original coordinate catalog.



Pic. 8-5-9

Then it is necessary to specify which column belongs to which coordinate.



	Longitude/East	Latitude/North	H-Ell/H	
P3	85.9625224	51.49032709	392.66	
P5	85.95642994	51.49033207	427.862	
P4	85.9577886	51.48947973	429.369	
P6	85.94639449	51.49107792	445.855	
P7	85.94200696	51.49158162	447.035	
P8	85.94416609	51.4941664	429.238	
P9	85.94912985	51.48694646	469.084	
T26	85.90946928	51.48816517	484.667	
T27	85.91545609	51.49013224	460.869	
T28	85.9225729	51.49361702	437.739	

Pic. 8-5-10

Specify the coordinate system and type of height of the catalog of coordinates that we want to get.

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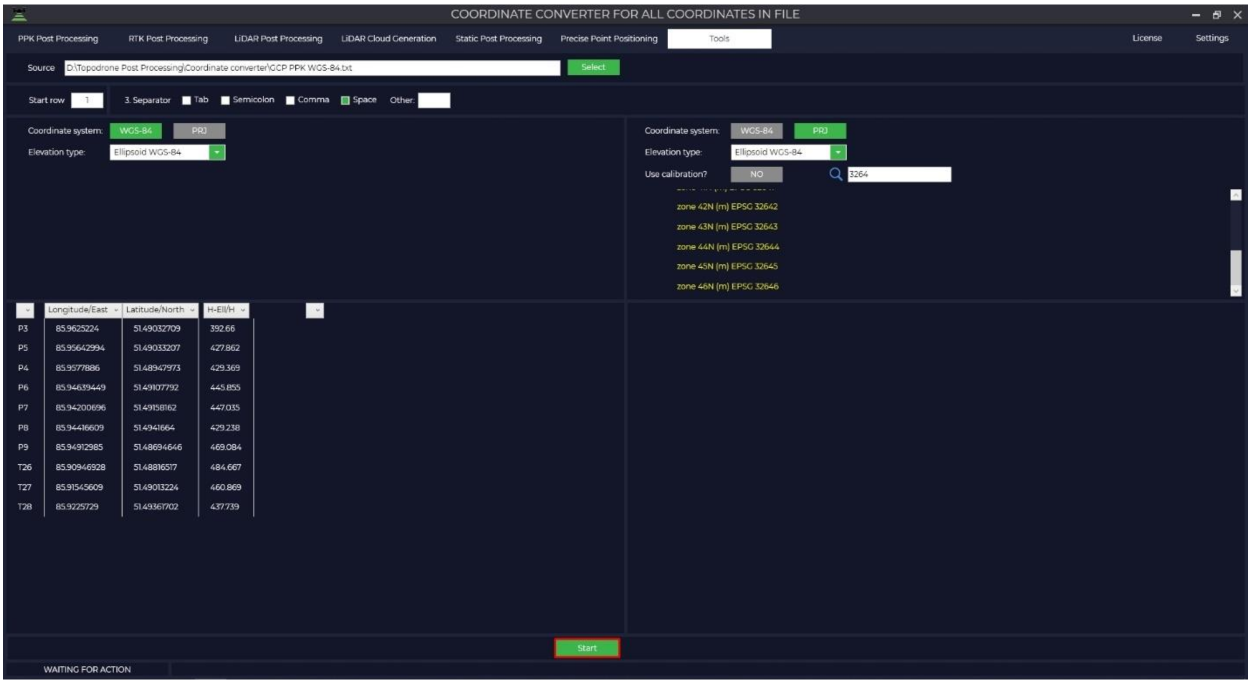
Pic. 8-5-11

By pressing the “Start” button in the right window, the catalog will be displayed in the coordinate system that was selected in the previous step.



Pic. 8-5-12

If necessary, click on the “Save” button and save the new file.

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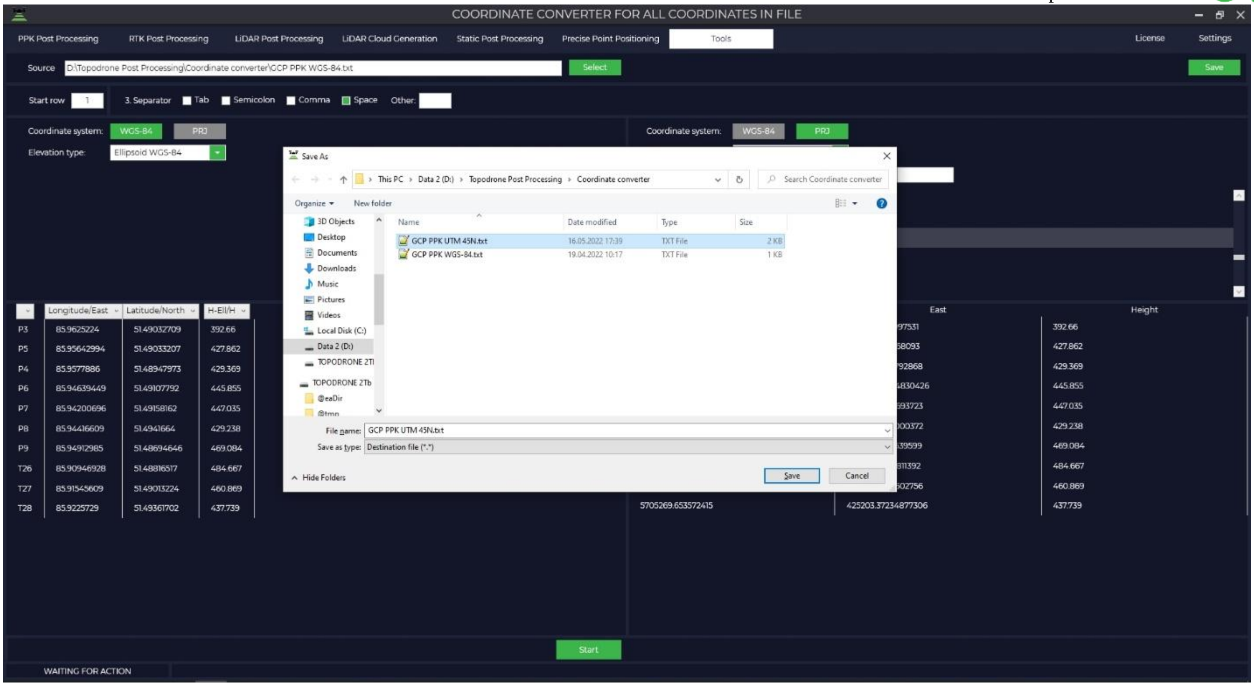
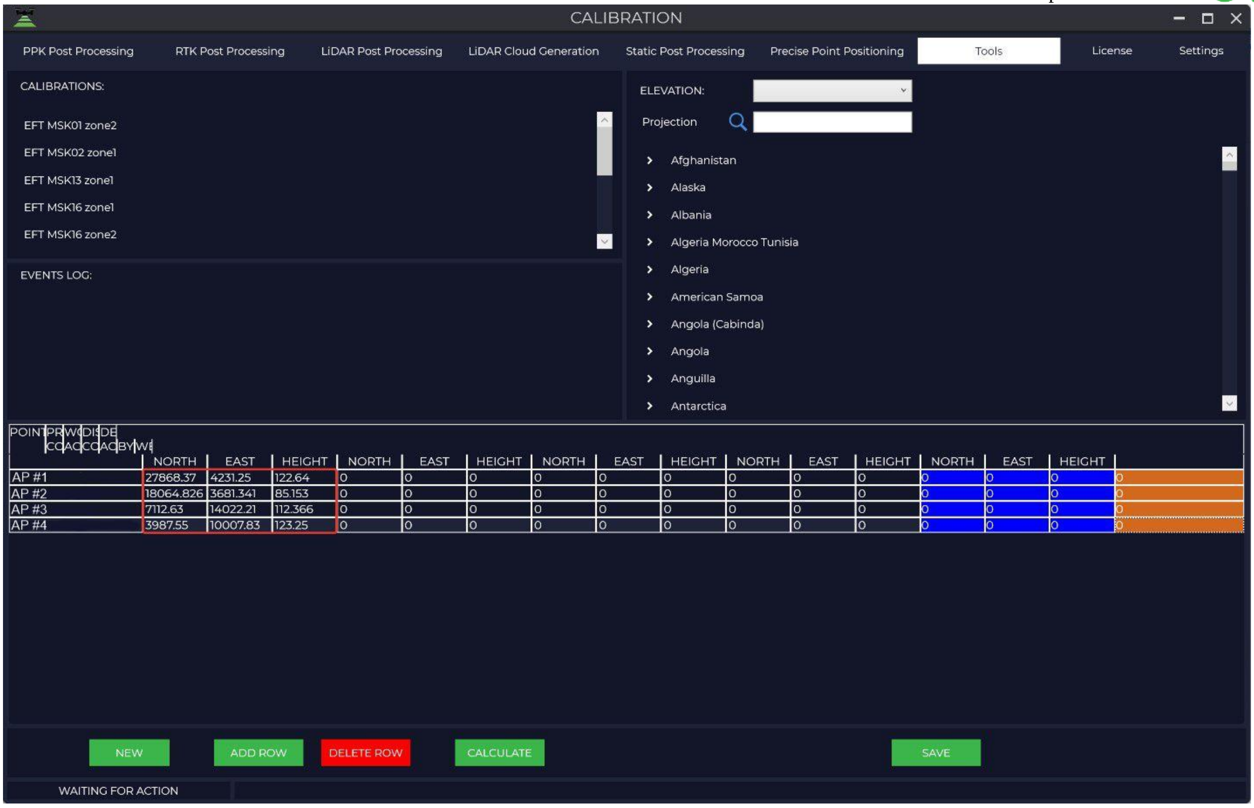


Pic. 8-5-13

8.6. Calibration

The calibration approximates the distortions of the calibrated SC on WGS-84 or ITRF, and the height distortions are also approximated. Unlike localization or calibration of 7 datum parameters, this calibration corrects distortions that cannot be described mathematically and corrects distortions without residual errors. Unlike NTv2, it corrects heights and approximates distortions not from four points, but from one point to an infinitely large number. To perform calibration, at least one point is required, for which coordinates are known in WGS-84 and in the coordinate, system being calibrated.

Select the Tools tab in the main menu, then select CALIBRATION in the pop-up window Enter the coordinates of the points in the calibrated CS.



Pic. 8-6-1

Maintain the accuracy with which the coordinates were determined. If you do not know with what accuracy they were determined, then you need to indicate the following recommended accuracy:

Fundamental astronomical geodetic network 20 mm north/east, 30 mm height

High-precision fundamental geodetic network 30 mm north/east, 40 mm height

Satellite geodetic network and astronomical geodetic network 40 mm north/east, 50 mm height

Government geodetic network 60 mm north/east, 110 mm height

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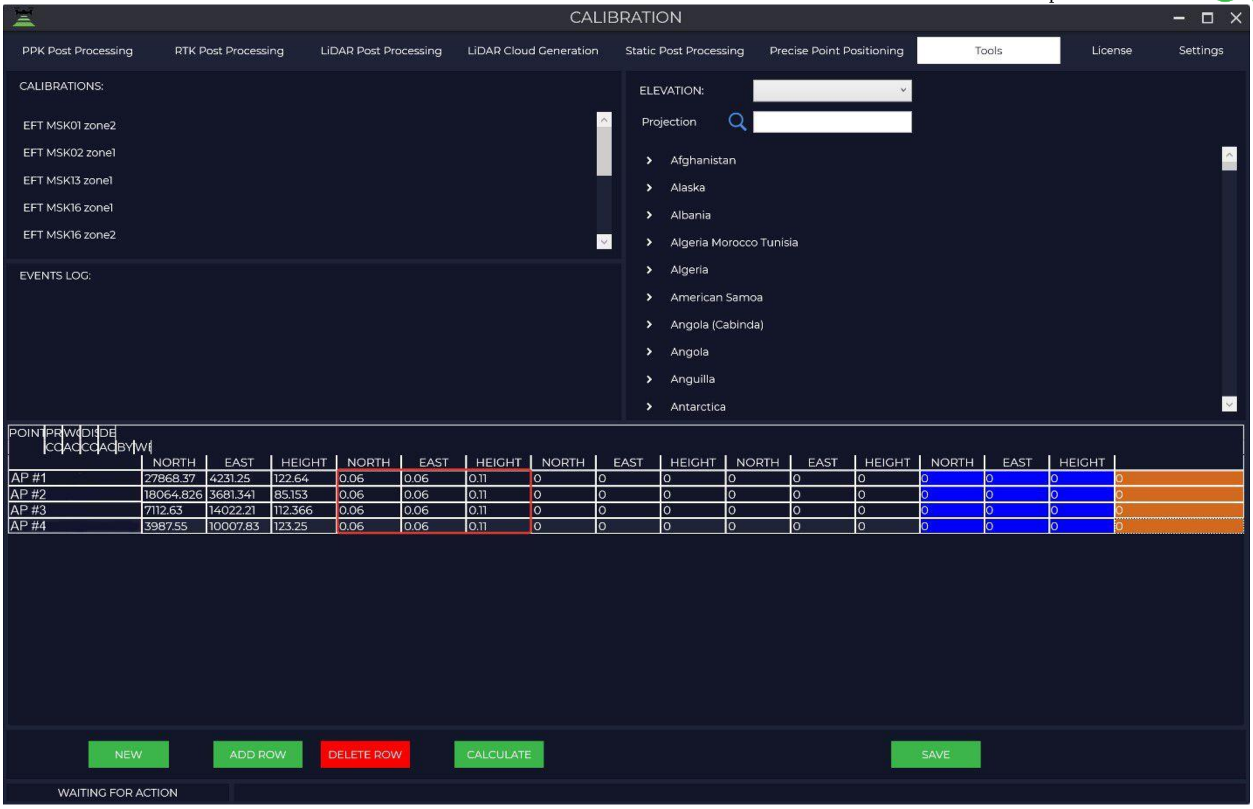
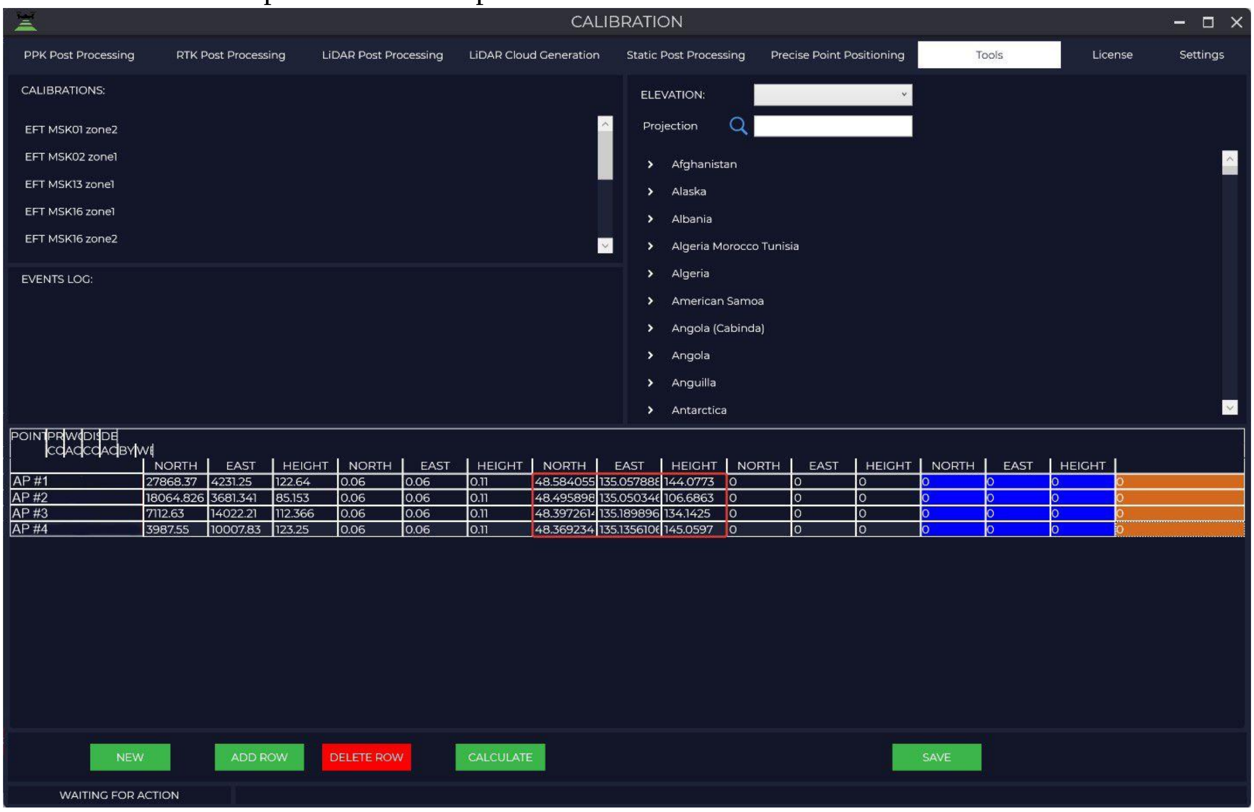


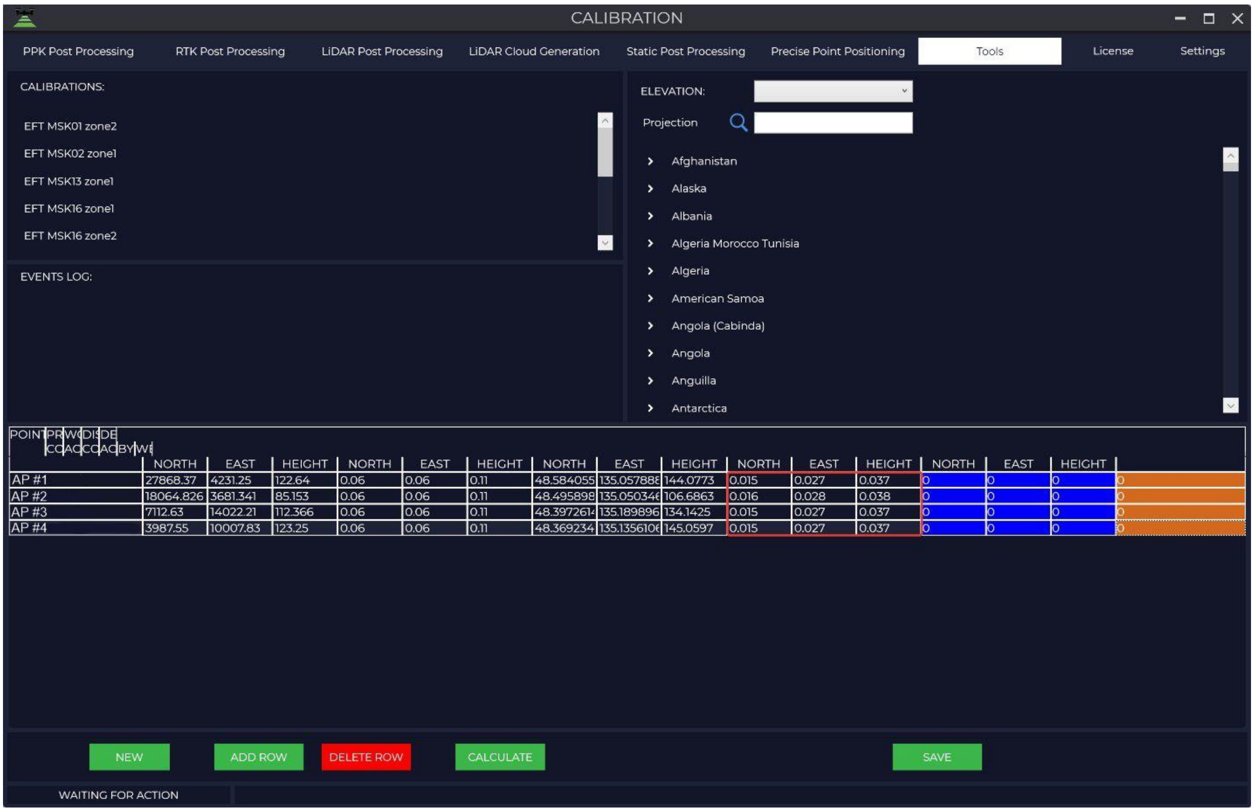
Pic. 8-6-2

Enter measured WGS-84 or ITRF coordinates (recommended). Tectonic shifts on the territory of Russia are approximately 30 mm per year, therefore, when choosing ITRF coordinates, it is necessary that they be obtained for an epoch of one year. In future versions, the correction of coordinates for the speed of tectonic plates will be added.



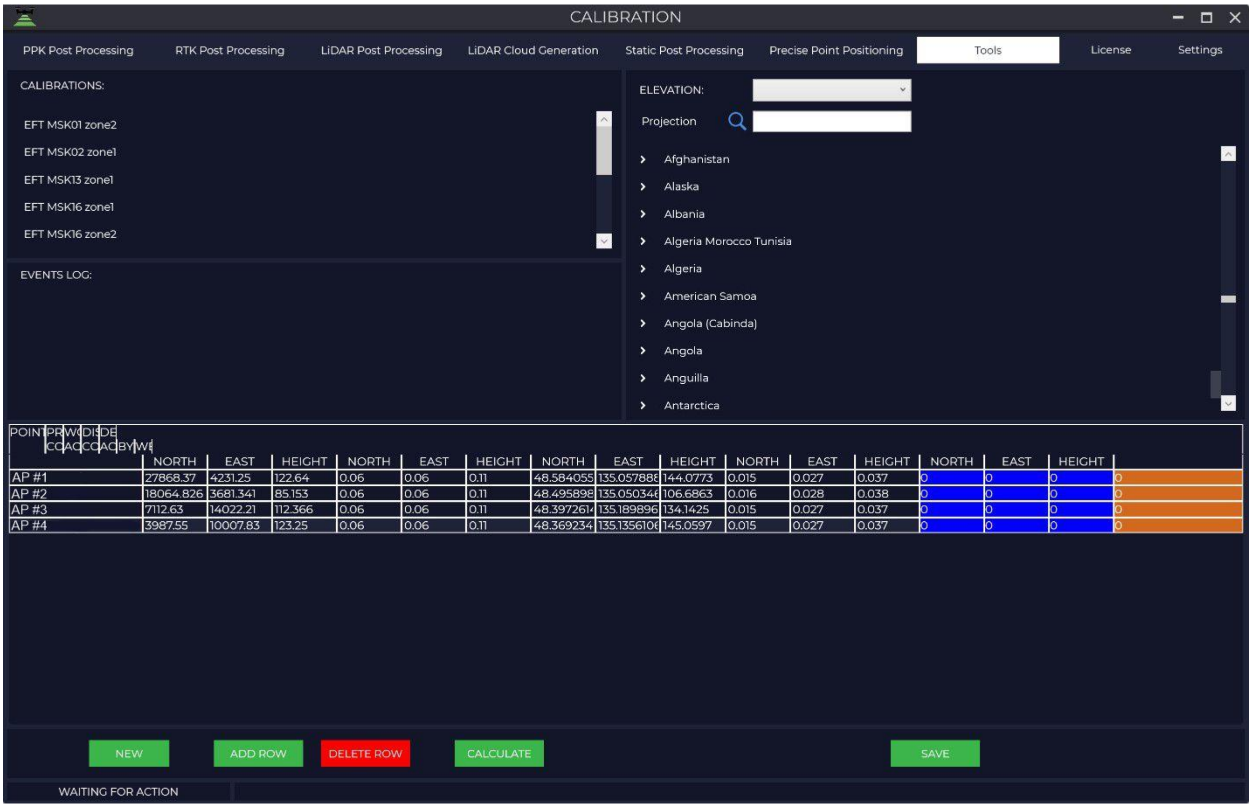
Pic. 8-6-3

Maintain the accuracy with which the coordinates were determined.



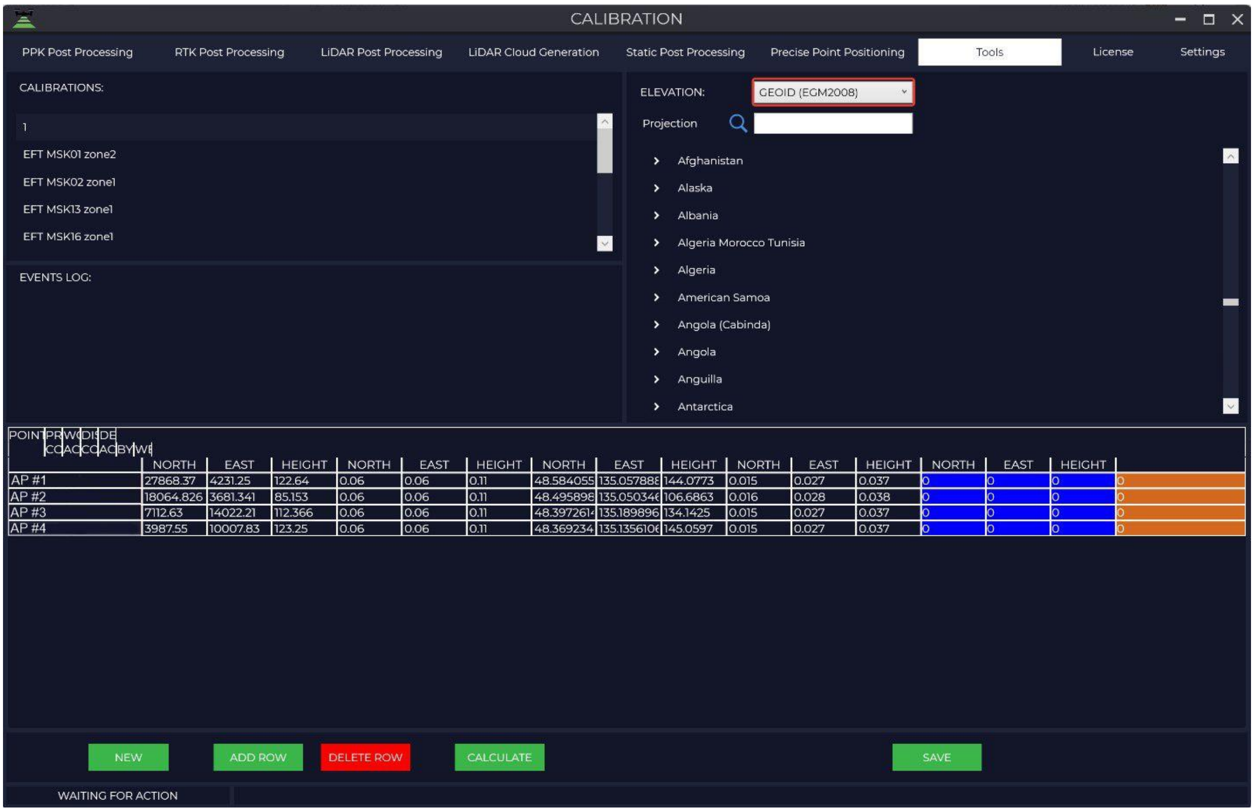
Pic. 8-6-4

Then, select the required coordinate system (if the wrong .prj is selected, the calibration module will calculate the distortions for corrections, but the distortions will be very large, the calibration is sensitive to the wrong zero meridian).



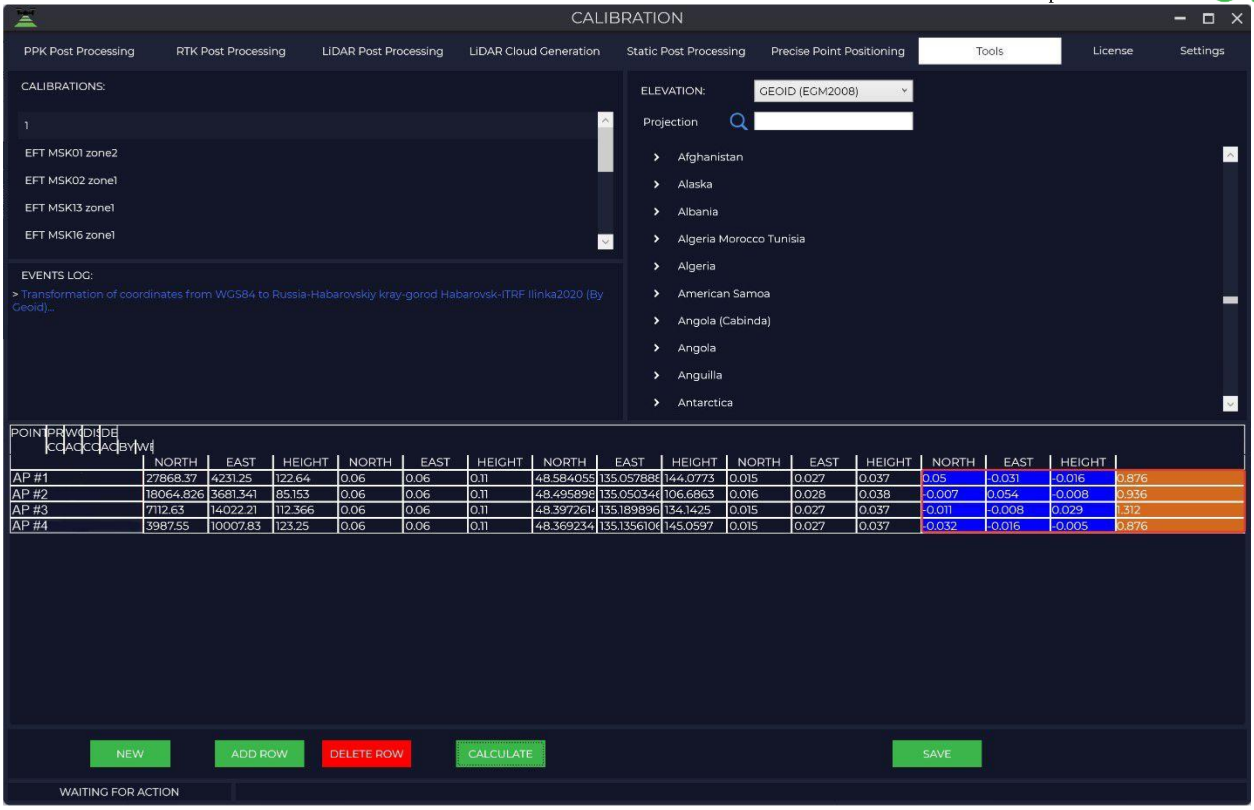
Pic. 8-6-5

Select the height system, if the height system is above sea level, then we select EGM2008



Pic. 8-6-6

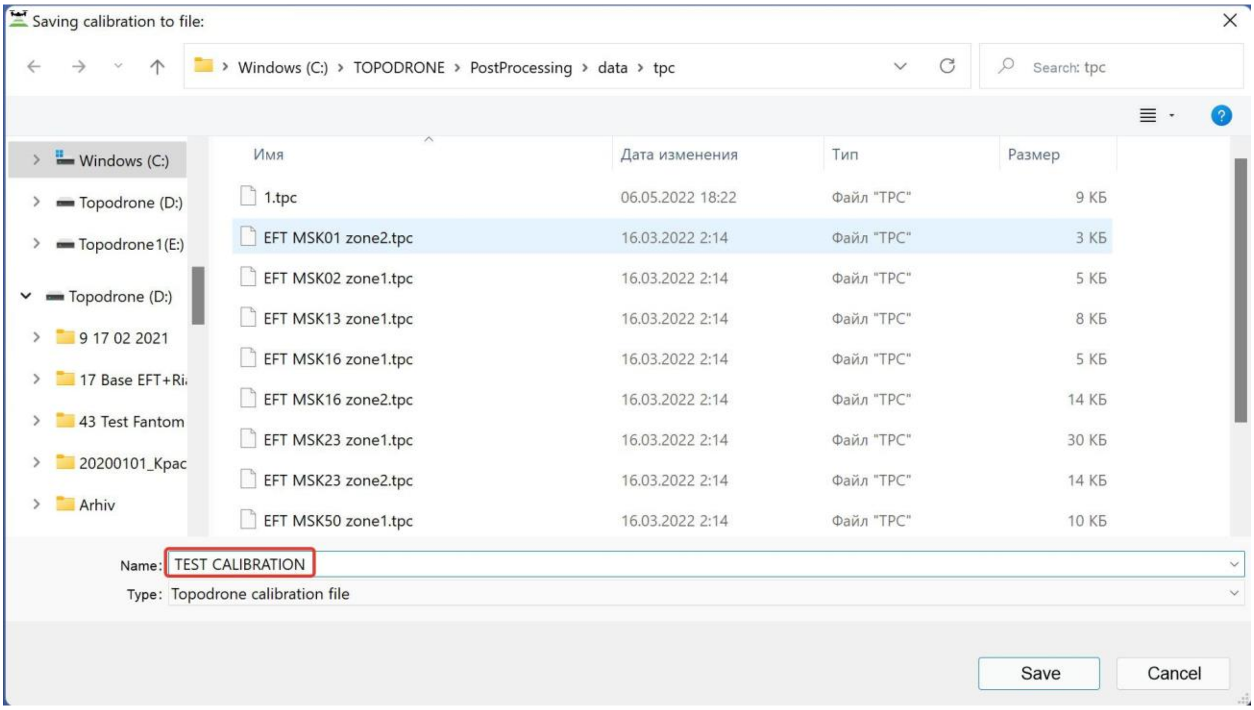
Press the “Calculate” button.



Pic. 8-6-7

The "distortions" column shows the distortions that the calibration will correct (if there is much more distortion at any point than at other points, then exclude this point from the calibration, the "density weight" column shows how many points are evenly distributed on the ground.
The software will correct the uneven distribution, but it is still desirable to distribute the points more or less evenly.

Then, click "save", as a result we get a file, which later will be used instead of .prj file for aerial photography calculations.



Pic. 8-6-8

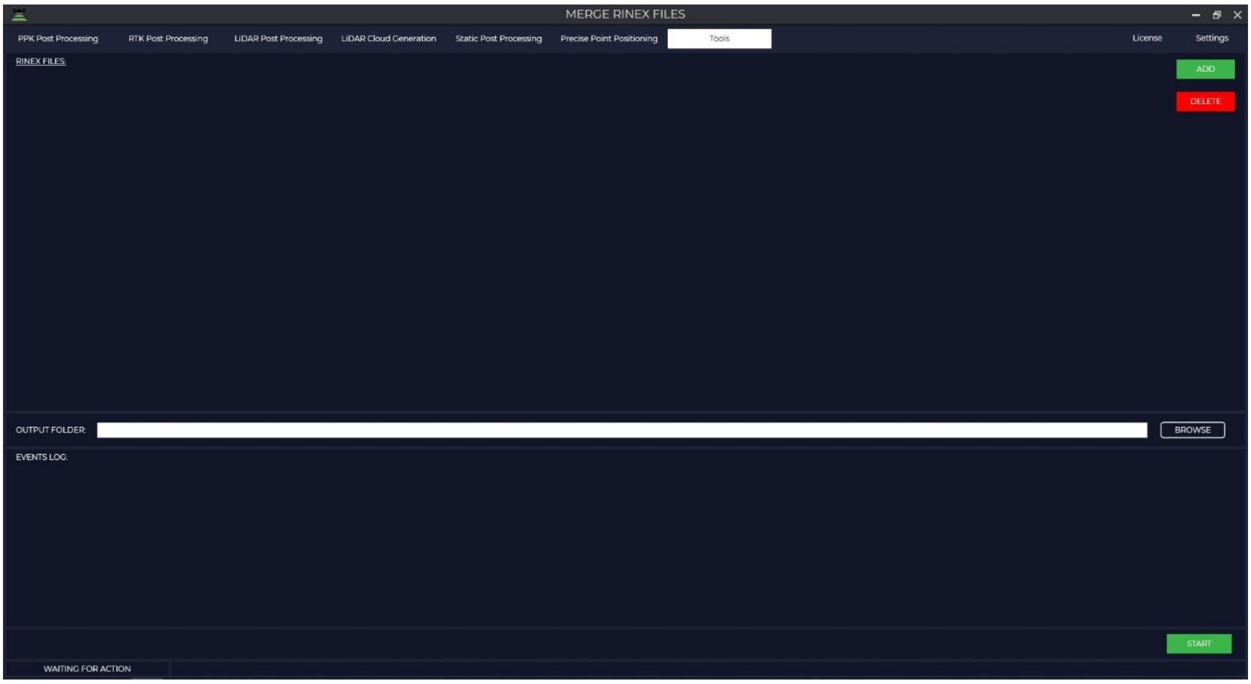
* WGS-84 navigation coordinates cannot be used when performing calibration. We recommend to use ITRF.

** the accuracy of known or measured coordinates is very important, the program distributes confidence weights according to accuracy, if you do not know what accuracy, then put the same on all points.

8.7. Merge Rinex file

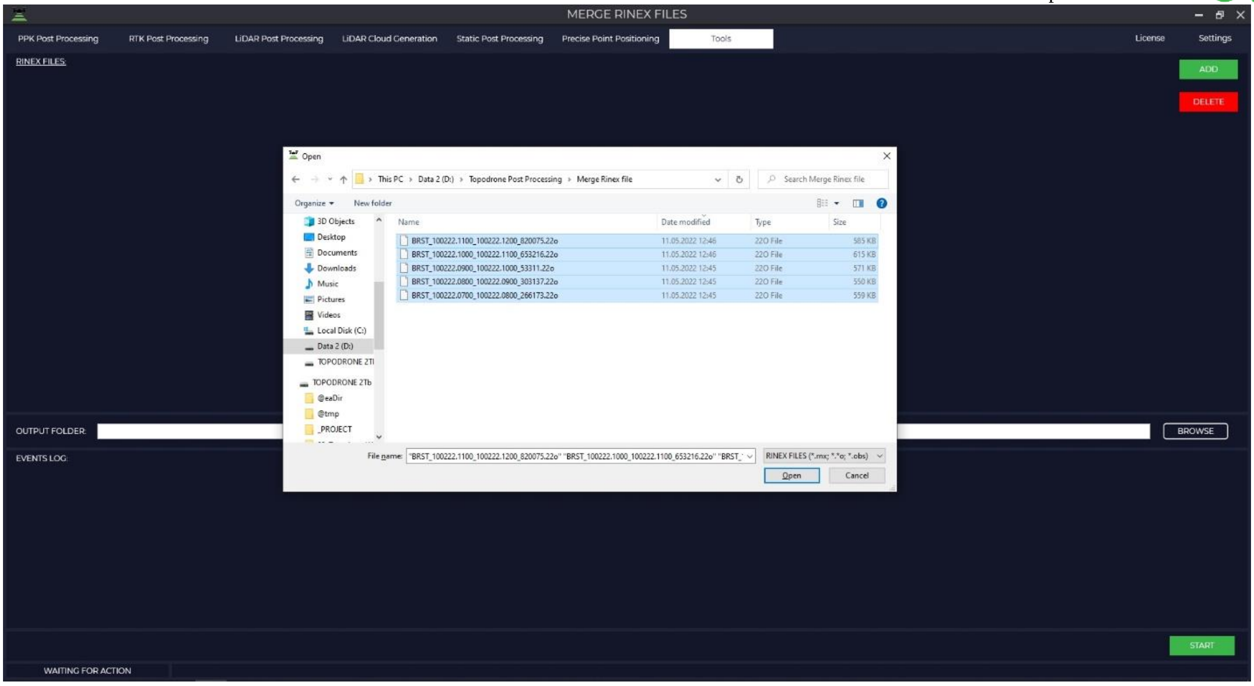
This function is designed to combine measurement files from different GNSS receivers and is suitable for cases where the provider of the reference base station divides the file into time intervals when downloading data.

Select the Tools tab in the main menu of the program, then select Merge Rinex file in the pop-up window.



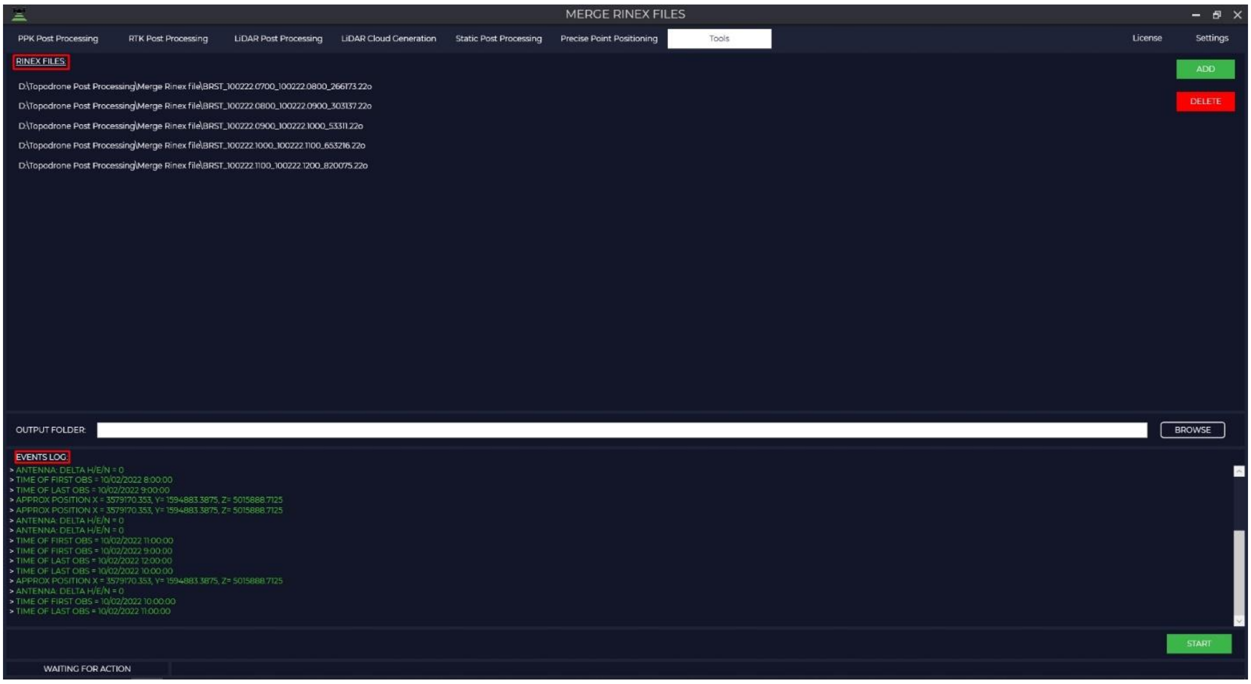
Pic. 8-7-1

Click the "ADD" button to add measurement files and select the required files. The following formats are supported: *.rnx, *.**o and *.obs.



Pic. 8-7-2

The “RINEX FILES” window will display the downloaded files, and the “EVENTS LOG” window will display information about the recording time, antenna type and receiver coordinates that the software reads from your files.



Pic. 8-7-3

Specify the path to the folder where to save the associations file.

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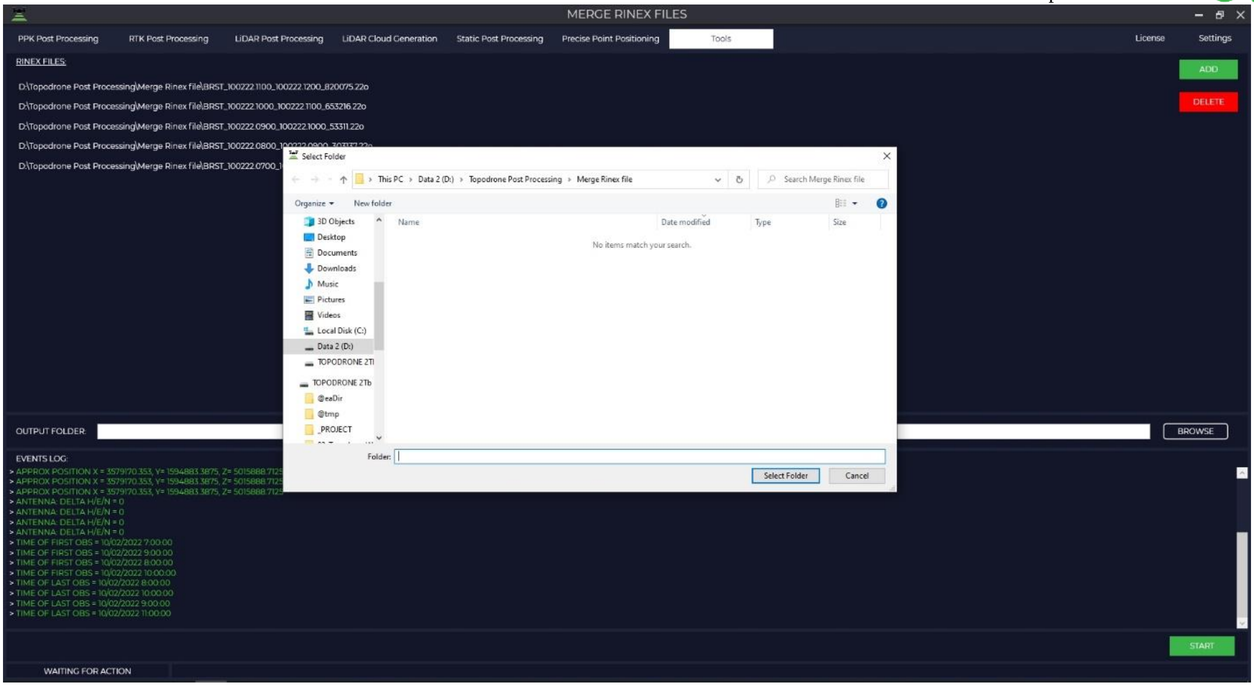
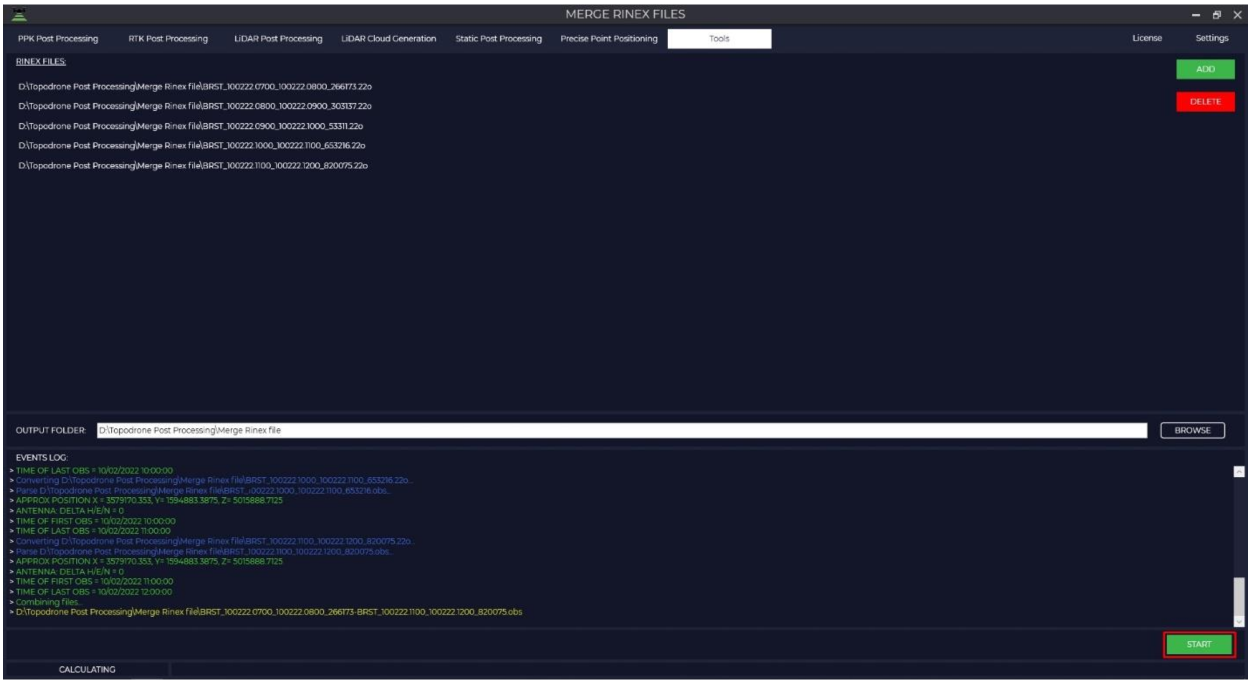


Pic. 8-7-4

When you click on the "START" button, the program will merge all the files and save to the previously specified folder.

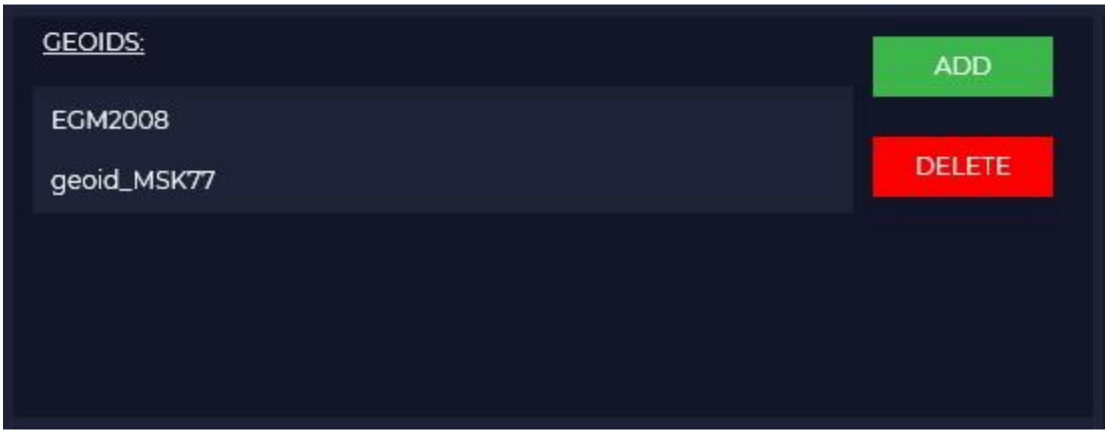


Pic. 8-7-5

9. Settings

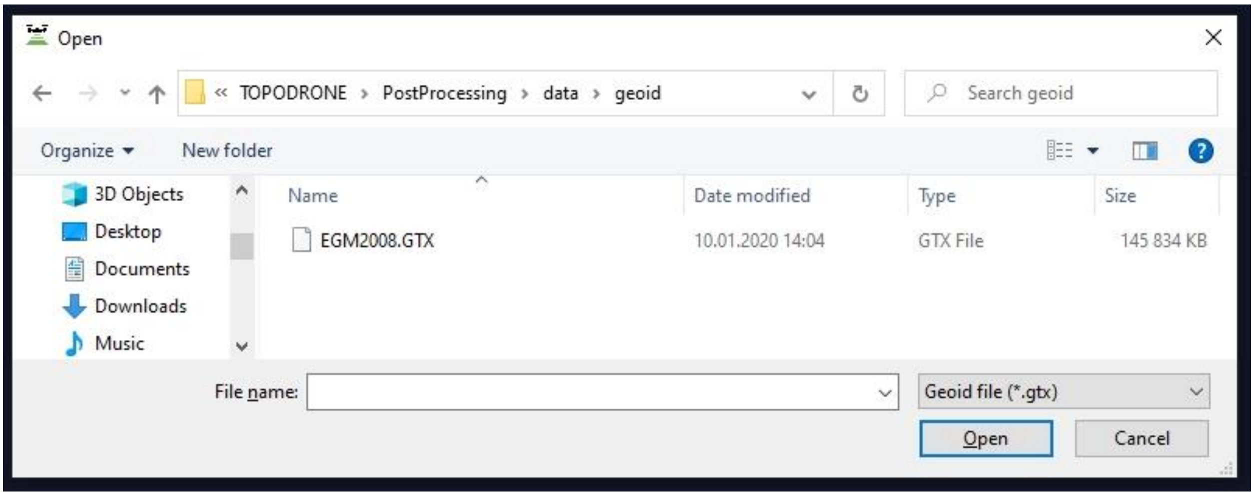
9.1. General

Select the Settings tab then General. This menu is for general settings.



Pic. 9-1-1

In the "GEOIDS" window, you can add or remove the type of geoid used in post-processing. Some geoid models are already preloaded. If necessary, you can import another geoid in *.gtx format. To do this, click the "ADD" button and select the desired file.



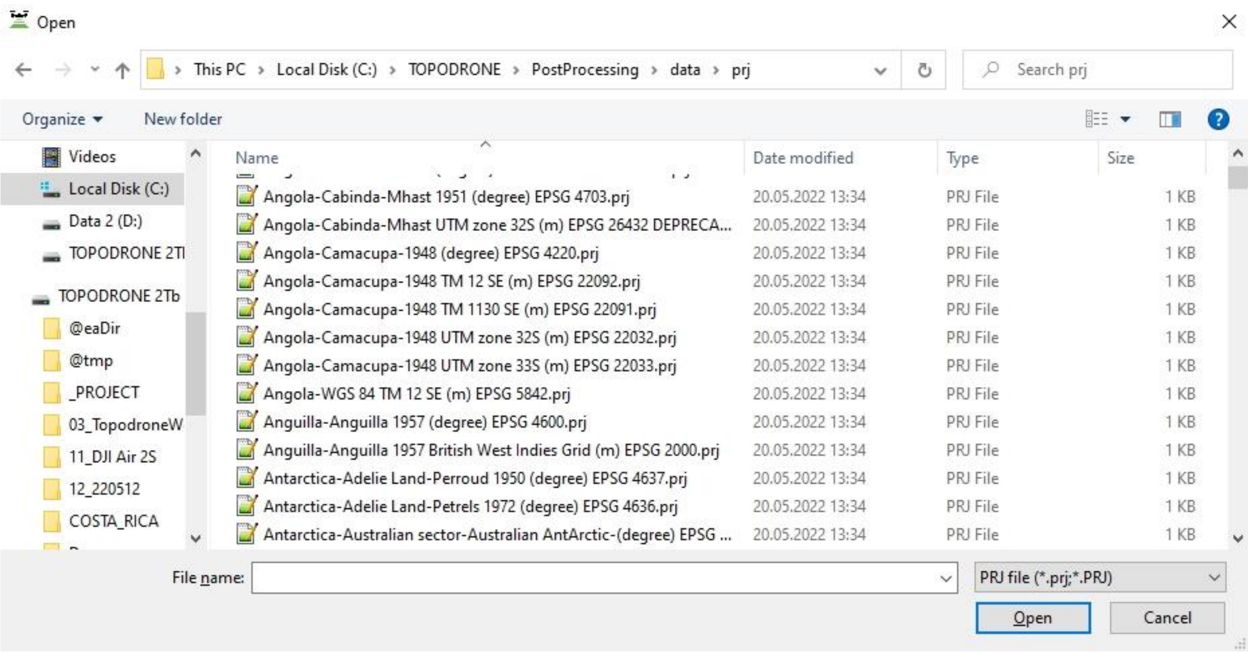
Pic. 9-1-2

If necessary, you can remove the geoid model from the list by clicking on the "DELETE" button. It is impossible to delete EGM2008 geoid.

The "PRJ" menu displays a list of available coordinate systems that will be available for selection in post-processing.

Pic. 9-1-3

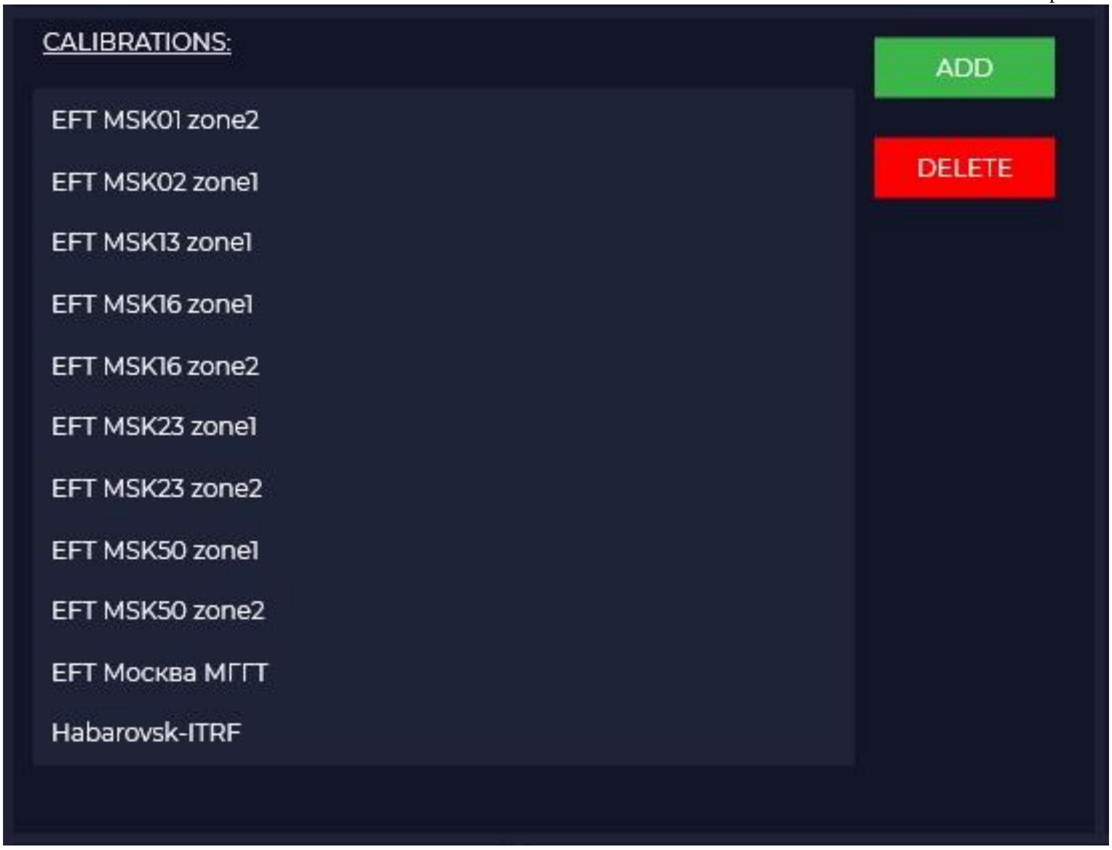
The "PRJ" menu displays a list of available coordinate systems that will be available for selection. You can add or remove the required coordinate system from the list. In order to add a coordinate system, press the "ADD" button and select the desired file. Files in *.prj formats are supported, other formats of coordinate systems are not supported in post-processing.



Pic. 9-1-4

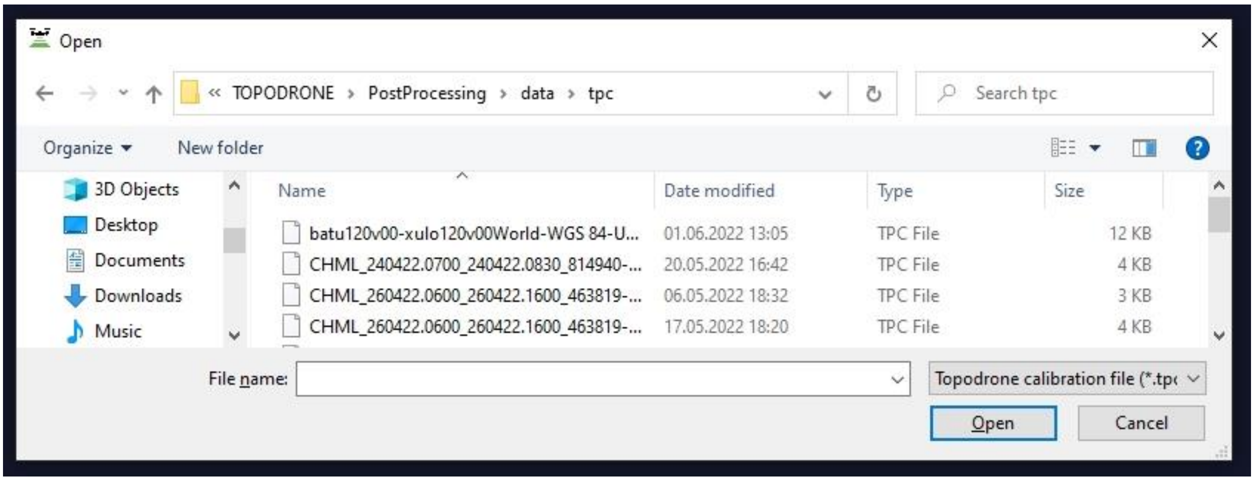
If you need to remove the coordinate system from the list, press the "DELETE" button. Complete removal of imported SCs is possible only after restarting the software.

The "Calibrations" menu displays the available calibration parameters that are used to change from one coordinate system to another.



Pic. 9-1-5

By default, several calibration files are added for some zones. In order to add a calibration parameter, press the "ADD" button and select the desired file. Files in *.tpc format are supported, other formats of coordinate systems are not supported. To create a calibration file, see paragraph 8.6.



Pic. 9-1-6

9.2. Point cloud generation

Select the Settings tab then POINT CLOUD GENERATION. In the pop-up window, select the type of shooting.

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Pic. 9-2-1

AERIAL LIDAR-aerial shooting (LIDAR is mounted on the UAV)

TERRASTRIAL-ground shooting (LIDAR is mounted on the ground carrier)

Specify the limits for shooting.

Pic. 9-2-2

EXECLUDE POINTS DISTANCE - Specify the data recording distance along the length of the laser.

SHORTER - distance from Lidar

LONGER - max distance

CUTOFF ANGLE - specify the scan angle for Lidar

START - starting angle

END - end angle

LIDAR ANGLE OF ACQUISITION – specify the type of LIDAR mount

FORWARD - default setting when the sensor is facing forward

BACKWARD - sensor looks back

POINT CLOUD FILE FORMAT – select the format in which the LAS/LAZ point cloud will be generated

INCLUDE RETURN TYPES – select reflection types

- FIRST – first reflection
- SECOND – second reflection
- THIRD – third reflection

SPLIT BY LASER ID – generation of separate point clouds by beam number

PREVIEW CLOUD GENERATION – view point cloud generation in real time

USE NMEA GPRMC MESSAGES – HDL-32E - this checkbox must be used when using the HDL-32 sensor

9.3. Geotagging and post processing

Select the Settings tab, then Geotagging and Post processing. This window is used to configure the processing of the PPK Post Processing and RTK Post Processing modules.

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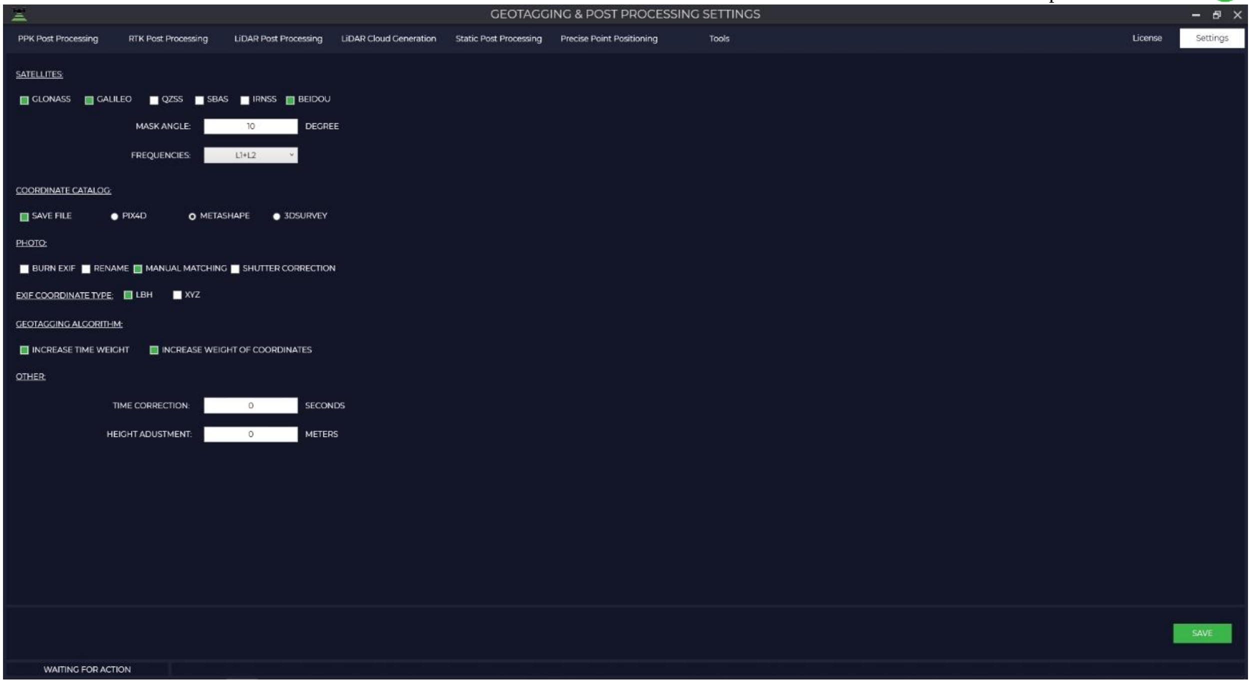
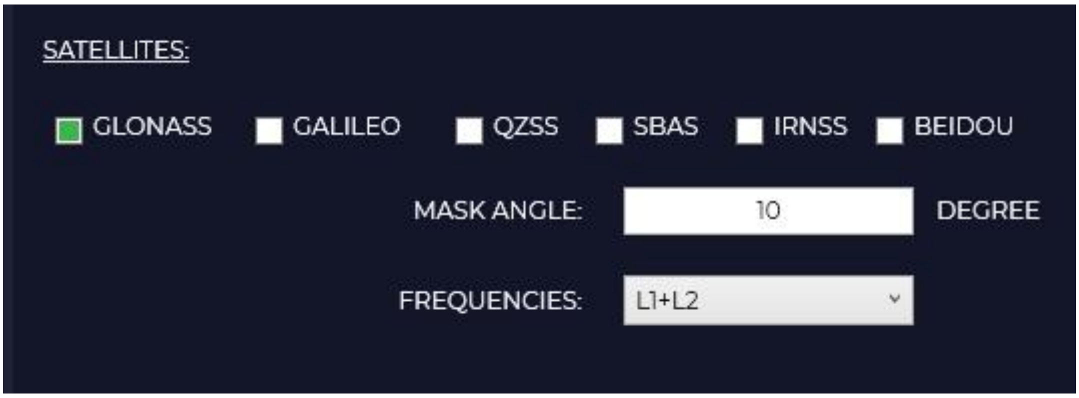


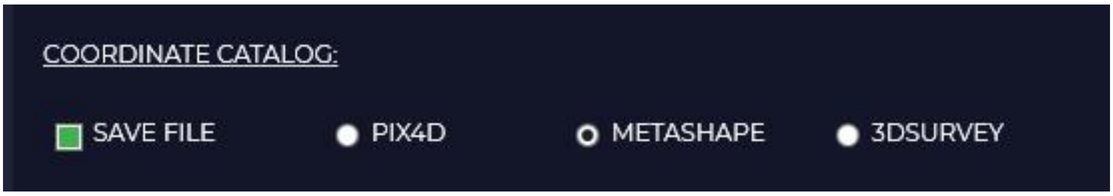
Pic. 9-3-1

In the SATELLITES window, you can enable or disable certain satellite constellations from processing, specify the required elevation mask and select the frequencies for which you want to perform processing.



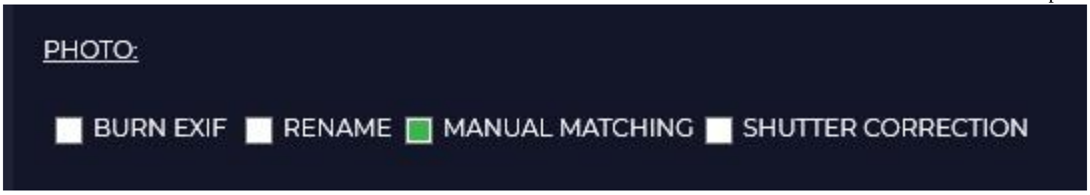
Pic. 9-3-2

In the COORDINATE CATALOG window, check the SAVE FILE checkbox to save the catalog of photography centers and select the file format for the program you are using.



Pic. 9-3-3

In the PHOTO window, you can save the coordinates of the photo centers in the EXIF file of the photo, assign a unique name to the photos depending on the time of creation, it is recommended to check the box for manually comparing photos and marks, the checkbox “Shutter correction” is responsible for shifting the mark by half the exposure time.



Pic. 9-3-4

If you ticked the box “BURN EXIF” in the previous window, then you need to select the format for storing coordinates (LBH - geographic coordinates, XYZ - rectangular coordinates)

Pic. 9-3-5

The GEOTAGGING ALGORITM tab contains settings that help the program match photos and tags in case of quantity mismatch.

INCREASE TIME WEIGHT – coincidence by time;

INCREASE WEIGHT OF COORDINATES – coincidence by coordinates.

Pic. 9-3-6

Attention!
For routes in which some photos are superimposed on others, the alignment algorithm by coordinates may not work correctly. Example: route on one battery when shooting a small object for 3D reconstruction. In the case of shooting when the camera is pointed to nadir, and then immediately shooting when the aircraft is shooting perspective.

If your GNSS receiver does not record time or altitude correctly, you can correct this in the OTHER window.

Pic. 9-3-7

9.4. Track file structure

Select the Settings tab, then Track file structure. In the window that opens, select the trajectory file that you received as a result of post-processing. If you performed processing in

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TOPODRONE Post Processing software, specify the order of the columns as in the picture below.

	Latitude / X	Longitude / Y	H-Ell / H	Roll	Pitch	Heading	70Time	
13:50:22.010000	55.713305187566846	37.653742918151913	140.265	1.754441161922826	0.609907908637038	-156.918356047957047	1648216222.0100	1
13:50:22.020000	55.713305187496708	37.653742918075203	140.265	1.754527433449306	0.609561051282546	-156.918139876672001	1648216222.0200	1
13:50:22.030000	55.713305187364519	37.653742917937471	140.265	1.753875093227311	0.610733034526325	-156.918200255128937	1648216222.0300	1
13:50:22.040000	55.713305187173852	37.653742917730426	140.265	1.753594148013014	0.612892057854831	-156.917718795997075	1648216222.0400	1
13:50:22.050000	55.713305186922177	37.653742917474027	140.265	1.753431270190594	0.615294740836477	-156.918230871528010	1648216222.0500	1
13:50:22.060000	55.713305186614150	37.653742917161530	140.265	1.753250350659146	0.617223684084248	-156.918945648057360	1648216222.0600	1
13:50:22.070000	55.713305186251773	37.653742916799864	140.265	1.753613699414706	0.618255287913219	-156.920189918960943	1648216222.0700	1

Pic. 9-4-1

After you fill in all the fields, click save (Save).

NOTE: This procedure needs to be done once, if you continue processing in the TOPODRONE Post Processing software, then you will no longer need to specify the file structure. If you have processed in any other software then the structure will be different and you will need to specify the appropriate field order for your toolpath file.

9.5. Lidar calibration

Select the Settings tab, then Lidar calibration. In the window that opens, you can select your Lidar and turn off unnecessary beams.

Attention!

Sensors that are equipped with TOPODRONE Lidar are calibrated at the manufacturer's factory and do not require further calibration during the entire period of operation.

Use	Tilt (deg)	Offset (mm)
0	-15	11.2
1	1	-0.7
2	-13	9.7
3	3	-2.2
4	-11	8.1
5	5	-3.7
6	-9	6.6
7	7	-5.1
8	-7	5.1
9	9	-6.6
10	-5	3.7
11	11	-8.1
12	-3	2.2
13	13	-9.7
14	-1	0.7
15	15	-11.2

Pic. 9-5-1 Use – beam number

Tilt (deg) – beam tilt angle in degrees угол наклона луча в градусах

Offset (mm) – beam offset relative to the sensor in mm.

NOTE: Depending on your Lidar, you will have your own number of beams.