

TOPODRONE DJI PHANTOM 4 PRO L1/L2 PPK

USER MANUAL



TABLE OF CONTENTS

No	Description	pages
1.	Drone preparation	2
1.1	First steps before work	2
1.2	Compass calibration	3
1.3	Camera calibration settings	4
1.4	IMU calibration features	5
1.5	GNSS receiver settings	6
2	GNSS data post processing and image geotagging	7
2.1	Data preparation	7
2.2	GNSS data postprocessing and image geotagging	7
3	Photogrammetry processing in Pix4D mapper	16
3.1	Creating a new project	16
3.2	Initial aerial triangulation	21
3.3	Camera calibration	22
3.4	Accuracy estimating	28
4	Photogrammetry processing in Agisoft Metashape	31
4.1	Creating a new project, photo alignment	31
4.2	Accuracy estimating	35
4.3	Camera calibration	37
4.4	Aerial triangulation accuracy improvement. Tie points filtering	40

1. Drone preparation

1.1 First steps before work

DJI Phantom 4 Pro Topodrone PPK – is a ready-to-fly geodetic survey solution based on DJI Phantom 4 Pro drone. It is strongly recommended to learn the DJI P4P manual first, you can find it on the official web-site: <https://www.dji.com/ru/phantom-4-pro/info#downloads>. Correct preparation of the drone means following exact rules to ensure flight safety and the best orthophoto or 3D-model quality. Flight safety is the main basis of our company.

1. **Checking.** All components of the drone must be in a condition: no damages, cracks or malfunctions. It is needed to carefully inspect blades, motormounts, motors, arms, gimbal, micro-SD cards, cables and connectors, especially if the drone has been in a public use. Always check your DJI Phantom 4 Pro Topodrone PPK before large orders and far business trips.
2. **Charging.** You should charge all batteries of the drone, the remote controller (RC) and the mobile device up to 100%. Never use a DJI Intelligent Battery charged lower than 90%, especially if the battery has started its storage discharging. It can cause premature termination of the flight mission.
3. **Exploring.** Before moving to the working area, explore locality in an on-line geo-service like [DJI GEO](#), [AirMap](#), and [PilotHub](#), to provide yourself with more knowledge about the places and objects located nearby. It is not allowed to fly in No-Fly-Zones: airports, prisons, sports stadiums. Military bases, state institutions, objects of strategic importance (CHP, hydroelectric power plants, nuclear power plants, etc.) are particularly dangerous, but they are not marked at GEO-services. Electricity transmission lines, located at the place you need to capture, can cause radio and magnetic interference during the flight.
4. **Setting.** In the DJI Go 4¹ App set all parameters for comfort flying in a manual mode:
 1. Distance limit – “turn off” value is recommended
 2. Maximum Flight Altitude – 500 meters² value is recommended
 3. Return to home altitude – 100 meters or higher value is recommended. Anyway, it can be changed during the mission planning in other apps.
 4. RC MODE settings – set the axes of your sticks, value 2 is strongly recommended
 5. EXP tuning – allows you to control your drone more accurately, 0.10 value is recommended
 6. RC signal lost – an action that drone will make in case of RC signal loss. Value “Return to home” is recommended
 7. Low battery warning – set at the minimum, 30% value is recommended³



NOTICE 1. DJI Go 4 App is the basic application for DJI Drones. You may not be able to set several parameters via other apps. It is recommended to make manual flights using DJI Go 4 App.

NOTICE 2. In some countries the maximum allowed flight altitude for UAVs is 120 meters. Setting 500 meters value in maximum flight altitude menu makes your drone follow the terrain, flying higher than 120 meters with respect to the altitude of home point, but not to the terrain.

NOTICE 3. If the area of photographing is located far from you (more than 1 km), increase this value up to 40%

NOTICE 4. Camera settings are described in the paragraph 1.3 of this manual.

1.2 Compass calibration.

As the basic model, on DJI Phantom 4 Pro Topodrone PPK needs the compass calibration (CC) each time you move to the new location. CC helps your drone to adapt to local magnetic field lines. During CC, the accelerometer and the compass of your drone make two rotations in different axes. After that, the drone makes an adjustment between the values of each sensor. To perform correct CC, follow the next steps:

1. CC is performed directly before the first flight at an open outdoor area. Making CC indoor is useless.
2. Remove the gimbal holder.
3. Turn on the drone and the RC, insert the mobile device.
4. Make sure that there are no large metal constructions or magnetic fields in 50 meters range.
5. Turn your drone into CC mode. At least there are two ways:
 - a) In the DJI Go 4 app open MC Settings / Advanced settings / Sensors state / Compass / Calibrate compass / OK
 - b) At the front left side of RC, rapidly move the slider to S and T positions not less than 4 times.
6. Ensure that rear LEDs of the drone lights are solid yellow.
7. Put the RC in the left arm and take the drone with your right arm. Hold drone from the top under the battery or like on the photo. Do not change the orientation of the drone!
8. Rotate your drone to the left side (counter-clock wise) in 380 degrees (a bit more than 1 turn). Stop when the rear LEDs will change their color from solid yellow to solid green.
9. Change the orientation of your drone, turning it in 90 degrees in a longitudinal axis.
10. Rotate the drone to the left side (counter-clock wise) in 380 degrees (a bit more than 1 turn). Stop when the rear LEDs will change their color from solid green to blinking green.
11. After using the 5a way entering CC mode, turn the Flight Mode slider to P (central position). This is especially important!
12. Compass calibration now is complete.



Before and after CC you can check the value of magnetic interference in the DJI Go 4 App – it should be at the green zone after CC. If the app notices that you have failed, the compass calibration (rear LEDs blinking red rapidly) – recalibrate the compass at another place nearby.

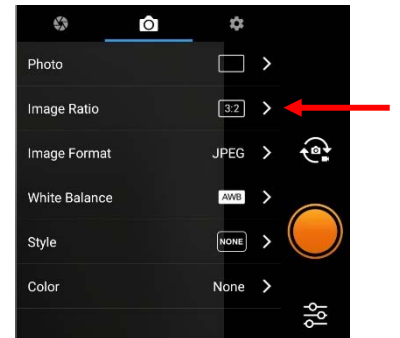
Notice 1: no magnetic or ferromagnetic objects on the pilot's body are allowed. For example: massive jewelry, metal inserts or magnets on the back plate of the iPad tablet etc. If you have some of these objects, even after successful CC, your drone will have "Compass Error" after taking off.

Notice 2: CC increases flight stability of the drone during the flight. But compass error can appear even after absolutely correct calibration. It is usually caused by different external interferences such as metal objects, large antennas, electricity transmission lines (ETL)

1.3. Camera calibration and settings

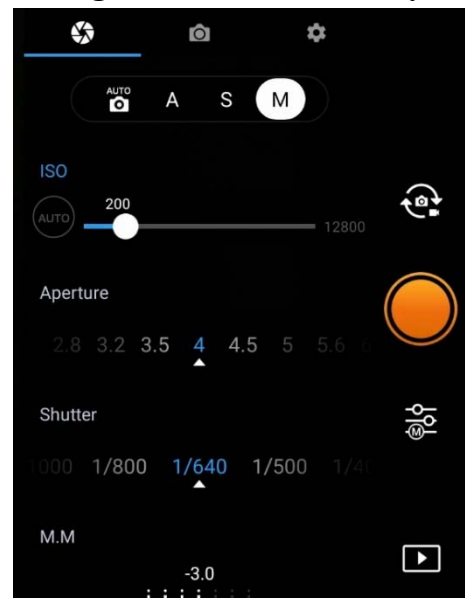
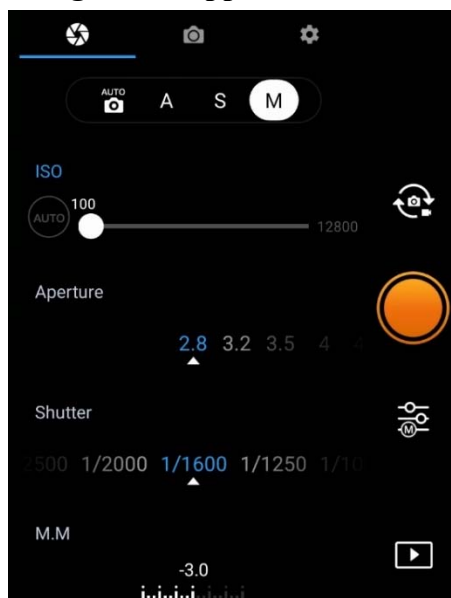
Before the shooting process will be started, you should calibrate the focus of your DJI Phantom 4 Pro PPK camera and set optimal image settings. It is recommended to use the next order.

1. You should determine your drone's working altitude. This value depends on many factors: scale of the final orthophoto map, properties of the lens, height of the obstacles, features of relief, etc. Usually, working altitude varies from 60 to 12 meters.
2. Set correct image ratio. Go to the image menu, tap the second tab. Use the Image Ratio 3:2 value, it allows to use all surface area of camera's matrix. Do not use 16:9 Ratio! Check other values of this menu – all defaults.
3. Lift off the drone to the working altitude and move the gimbal to 90 degrees (nadir). Ensure that the focusing method now is in the AF value. Then tap the center of the screen to let the camera focus at the surface. After that change the focusing method in the MF value - manual focus scale will appear. Do not touch it! Now your drone's camera is focused at the selected height value. It will not change in the future.
4. Now it is time to set the best camera settings. All parameters are set auto as default. In this case, your drone will change image brightness and smoothness during the flight. But this method is bad for triangulation image processing: the key points at different images will be different. To get the best image quality during the flight it is strongly recommended to set image params as follows:



ISO: from 100 to 200. Upper values increase image noise, and decrease orthophoto map quality
Aperture: from 2.8 to 4. Upper values decrease stream of light, so images will be darker
Shutter: from 1/1600 to 1/640. Upper values increase image motion blur, lower ones does not allow the camera to use mechanical shutter, so images will be distorted.

Also using values upper than 1/1600 will not let writing GNSS marks correctly!



1.4. IMU calibration and settings

IMU calibration is needed very rarely. However, some things can affect the sensor states: falls and bumps, temperature changes and long stand by time. Because of using the additional module upper the shell of DJI Phantom 4 Pro PPK, the process of IMU calibration is not the same as the default. To calibrate IMU you need to do next:

1. Remove the props from the motors if needed
2. Remove the gimbal holder and turn on the drone and the remote controller
3. Prepare two tables, standing close to each other, or another flat surface with a hall: the horizon should be aligned with the bubble level
4. Start the IMU calibration process and make steps 1-5 as they are.
5. At the step 6 place the drone head over heels. Use the edge of two tables to make this step. Place your drone like at the photo below



6. When the step 7 is complete, rotate the drone and place it normally
7. IMU calibration now is now complete

1.5. GNSS receiver settings

GNSS module is located in front of the drone in a special plastic shell. The receiver body has three holes in a row. The state of the receiver is shown by a single led. The signal led is located in the middle.



1. Dual frequency (L1/L2) antenna
2. Signal LED. Indicates power supply, GNSS state, Error.
3. Micro-SD slot.

LED State	Description
Blinks green/red	Satellite search mode
Solid green	The signal from the satellites is received
Blinks green	Flash card write mode (each interrupt means 4 KB of data is written)
Solid red	Micro-SD card error

4. GNSS cable, it should be plugged, do not touch it.

Each time the receiver is turned on, a new .ubx file is created in the folder with the date of the DD-mm-yy format and the name of the HH-mm-ss format. It is important that the time is recorded in UTC, and the file is created only after the GNSS receives the satellite signal.

It is forbidden to insert or remove the memory card "on hot". This process should only be performed when the power is turned off. It is allowed to use cards with a maximum capacity of 64 GB.

The standard configuration of the receiver is to record a UBX file with a frequency of 10 Hz and receive GPS and GLONASS satellites at L1 and L2 frequencies.

2. GNSS DATA POST PROCESSING AND IMAGES GEOTAGGING

2.1 Data preparation

- Remove the SD card with images from your drone and copy photos to your computer.
- Divide the whole image dataset into separate flights and store photos from each mission in separate folders. For example, Flight 1, Flight 2 etc.

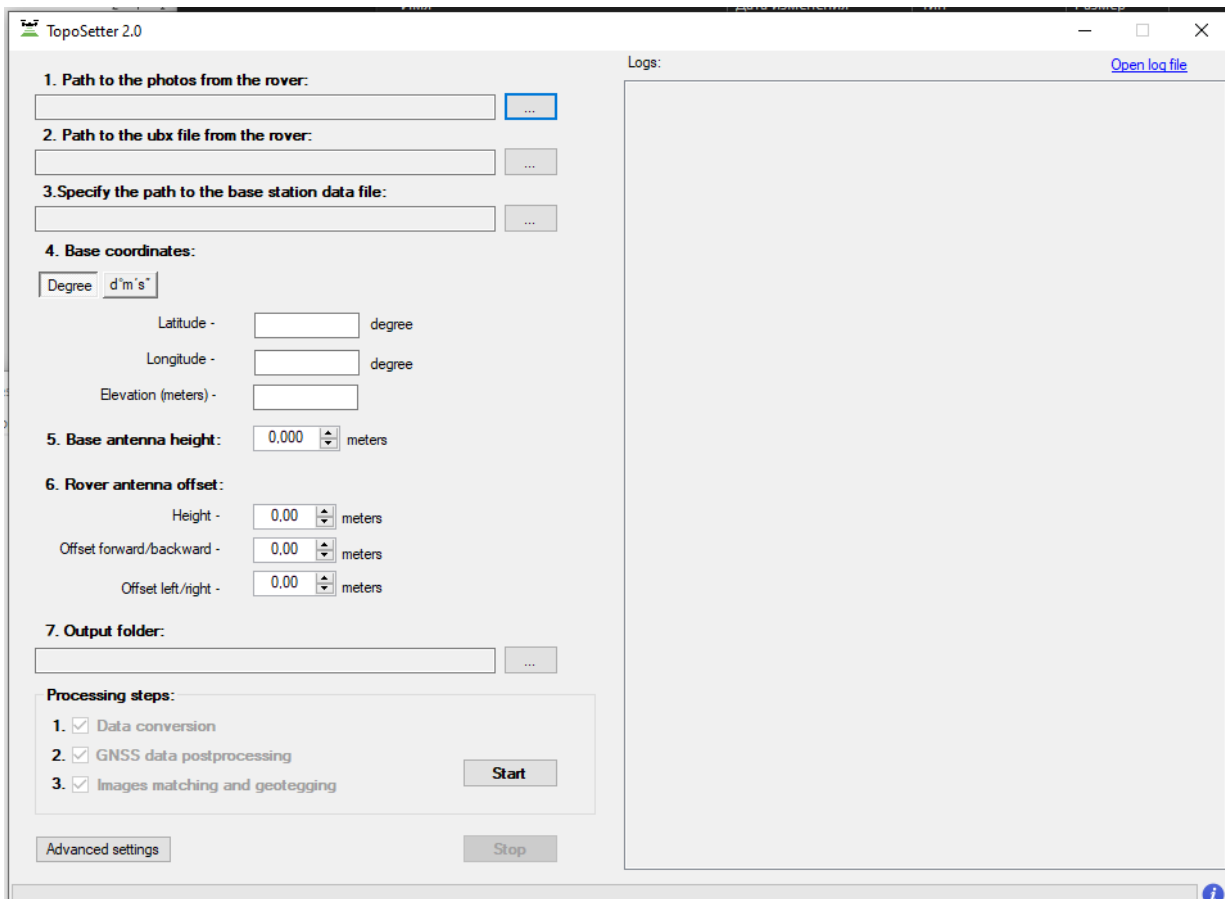
NOTICE. *Do not delete any images.*

- Remove the SD card from the GNSS receiver installed on the drone and copy ubx files to your computer to a folder ROVER (for example).
- Download GNSS static logs from the base station and convert them to Rinex format. Copy Rinex files to a folder BASE (for example)
- Measure coordinates of ground control points (GCPs) and coordinates of the base station.

NOTICE. *Coordinates of the base station should be in Latitude, Longitude, Ellipsoid high, WGS 84 coordinate system.*

2.2 GNSS data post processing

Step 1. Run TOPOSETTER 2.0 application



TopoSetter 2.0

1. Path to the photos from the rover:

2. Path to the ubx file from the rover:

3. Specify the path to the base station data file:

4. Base coordinates:

Degree d'm's"

Latitude - degree

Longitude - degree

Elevation (meters) -

5. Base antenna height: 0,000 meters

6. Rover antenna offset:

Height - 0,00 meters

Offset forward/backward - 0,00 meters

Offset left/right - 0,00 meters

7. Output folder:

Processing steps:

1. ☒ Data conversion

2. ☒ GNSS data postprocessing

3. ☒ Images matching and geotagging

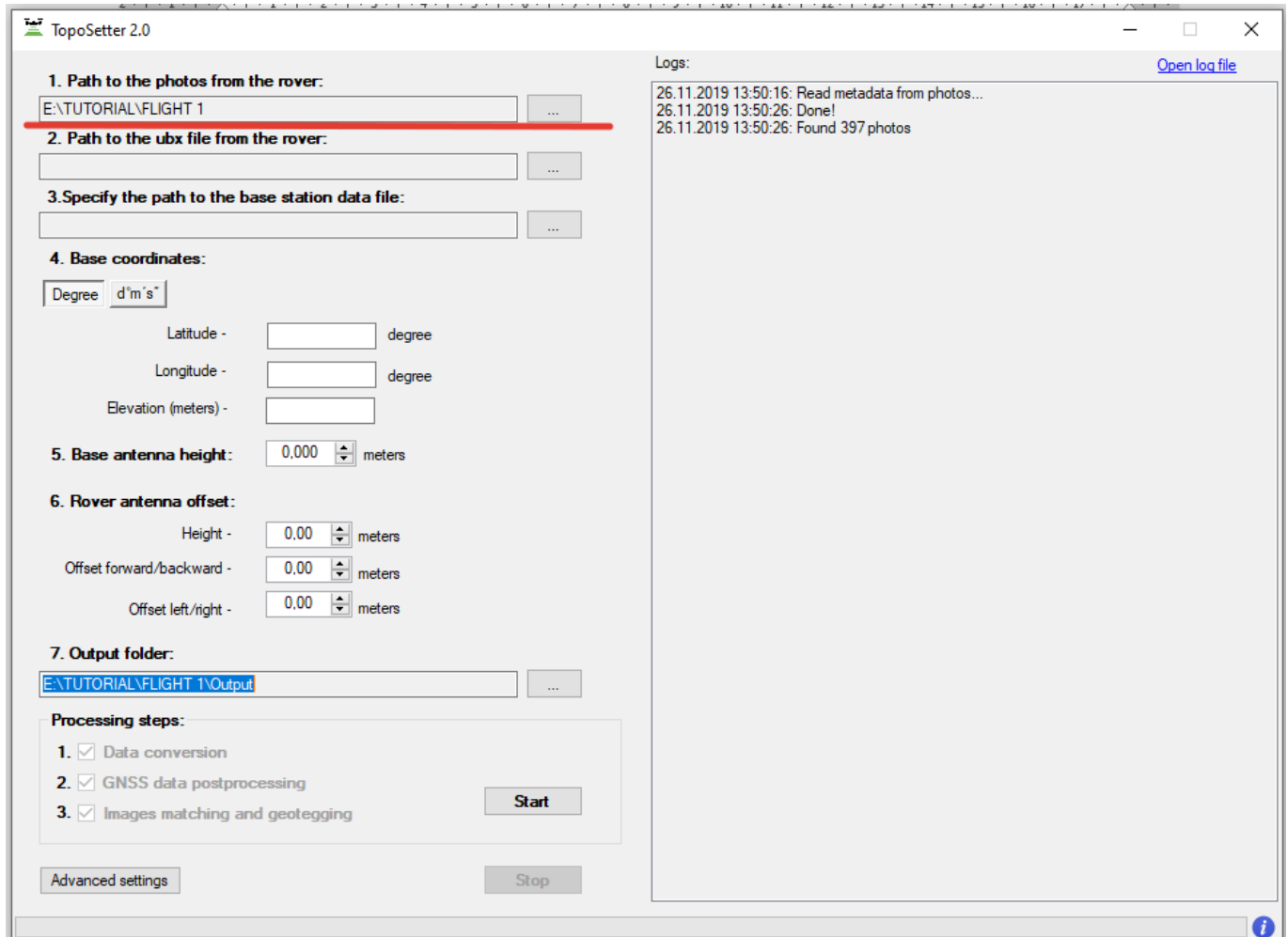
Start

Advanced settings

Stop

Logs: [Open log file](#)

Step 2. Select a folder with photos



TopoSetter 2.0

1. Path to the photos from the rover:
E:\TUTORIAL\FLIGHT 1

2. Path to the ubx file from the rover:

3. Specify the path to the base station data file:

4. Base coordinates:
Degree d'm's"
Latitude - degree
Longitude - degree
Elevation (meters) -

5. Base antenna height: 0.000 meters

6. Rover antenna offset:
Height - 0.00 meters
Offset forward/backward - 0.00 meters
Offset left/right - 0.00 meters

7. Output folder:
E:\TUTORIAL\FLIGHT 1\Output

Processing steps:

- 1. ☒ Data conversion
- 2. ☒ GNSS data postprocessing
- 3. ☒ Images matching and geotagging

Start

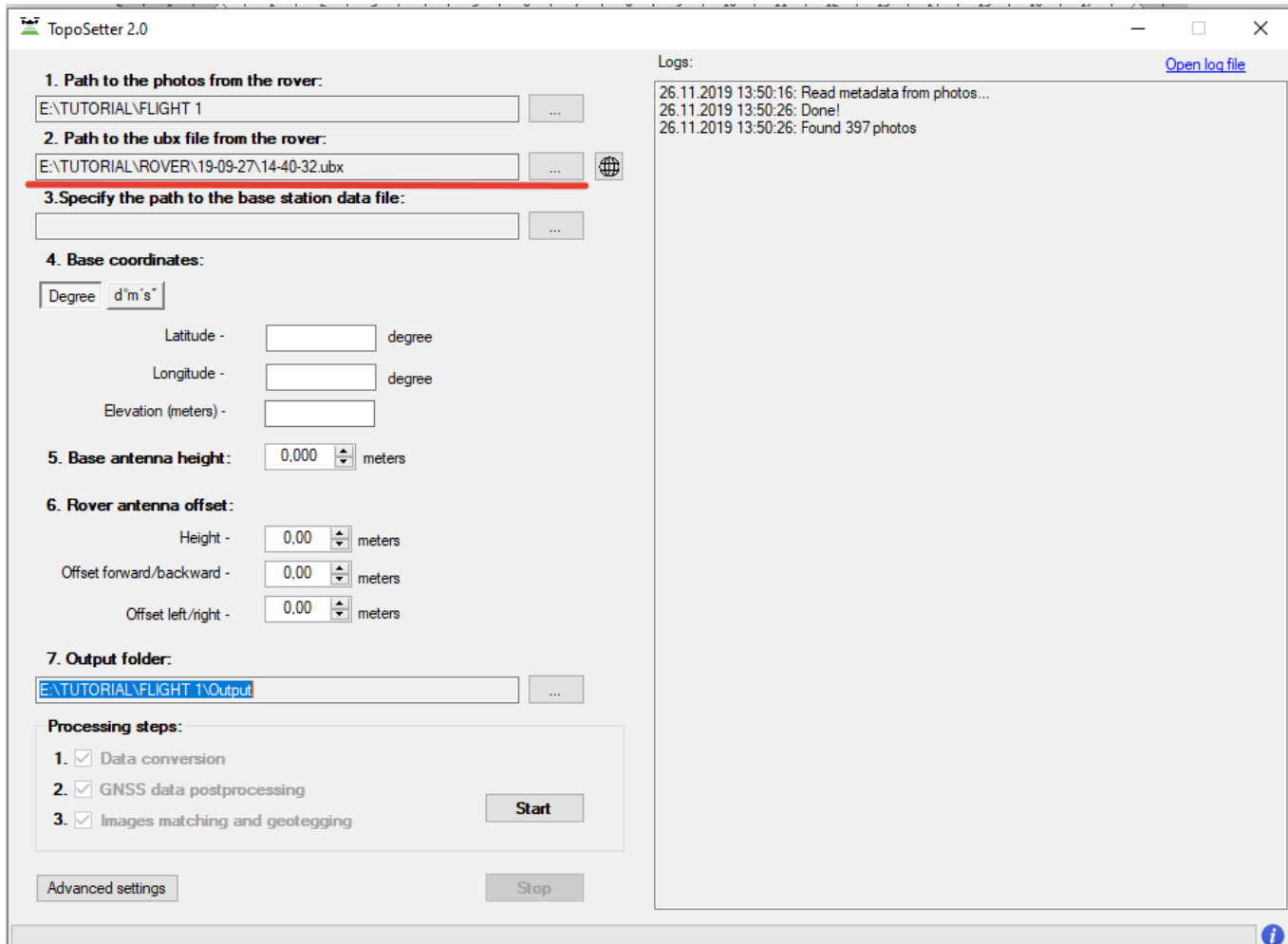
Advanced settings Stop

Logs: [Open log file](#)

```

26.11.2019 13:50:16: Read metadata from photos...
26.11.2019 13:50:26: Done!
26.11.2019 13:50:26: Found 397 photos
  
```

Step 3. Select a UBX file from a drone



The screenshot shows the TopoSetter 2.0 application window. The interface is divided into two main sections: configuration on the left and a log viewer on the right.

Configuration Section:

- 1. Path to the photos from the rover:** E:\TUTORIAL\FLIGHT 1
- 2. Path to the ubx file from the rover:** E:\TUTORIAL\ROVER\19-09-27\14-40-32.ubx (This line is highlighted with a red box in the original image)
- 3. Specify the path to the base station data file:** (Empty field)
- 4. Base coordinates:**
 - Latitude - (Empty field) degree
 - Longitude - (Empty field) degree
 - Elevation (meters) - (Empty field)
- 5. Base antenna height:** 0.000 meters
- 6. Rover antenna offset:**
 - Height - 0.00 meters
 - Offset forward/backward - 0.00 meters
 - Offset left/right - 0.00 meters
- 7. Output folder:** E:\TUTORIAL\FLIGHT 1\Output
- Processing steps:**
 - 1. ☒ Data conversion
 - 2. ☒ GNSS data postprocessing
 - 3. ☒ Images matching and geotagging

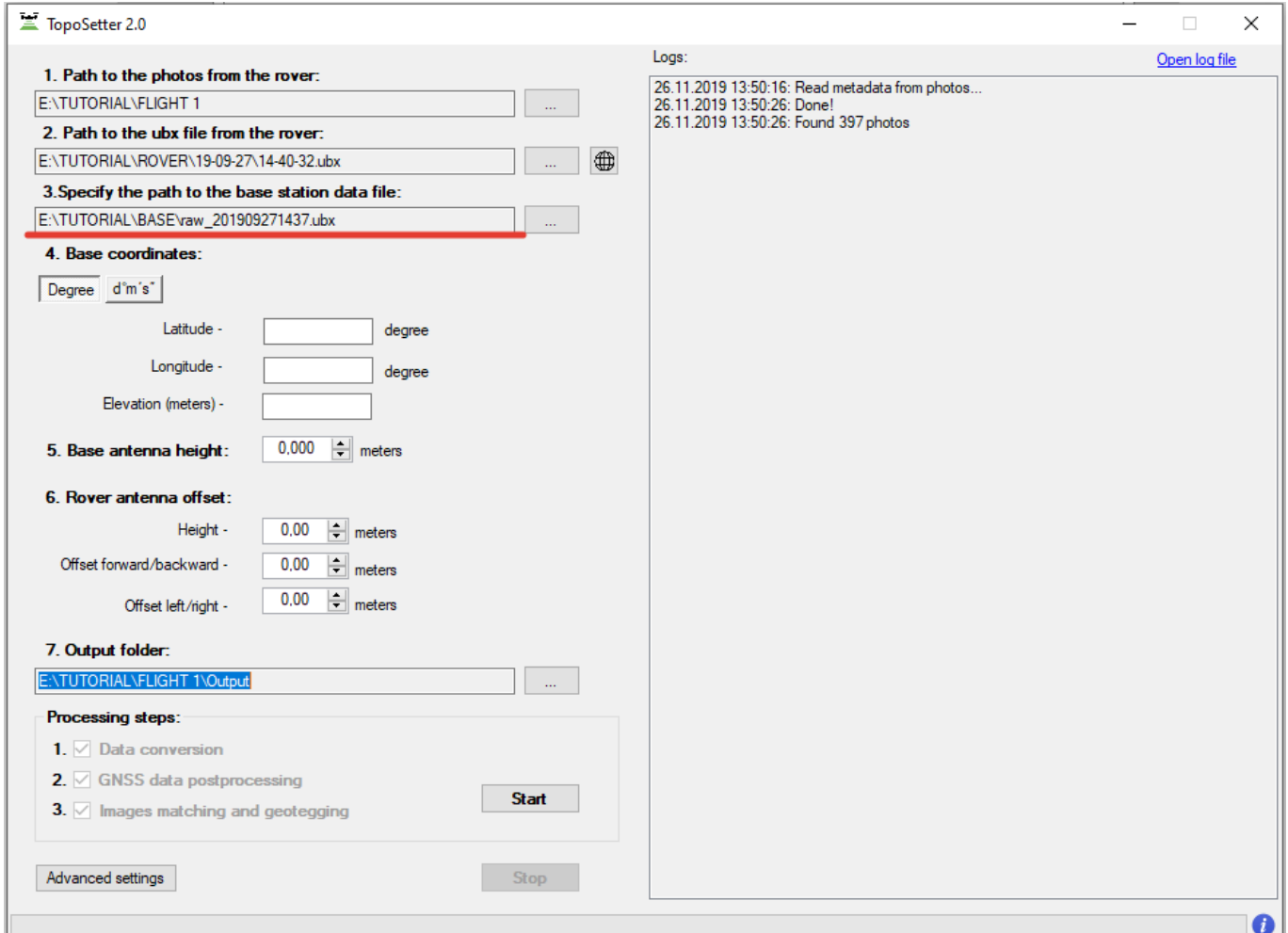
Buttons: **Start** (next to processing steps), **Advanced settings**, **Stop**

Logs Section:

Logs: [Open log file](#)

- 26.11.2019 13:50:16: Read metadata from photos...
- 26.11.2019 13:50:26: Done!
- 26.11.2019 13:50:26: Found 397 photos

Step 4. Select a Rinex or UBX file from the base station



The screenshot shows the TopoSetter 2.0 software window. The interface is divided into several sections for configuring data paths and processing options.

1. Path to the photos from the rover:
E:\TUTORIAL\FLIGHT 1

2. Path to the ubx file from the rover:
E:\TUTORIAL\ROVER\19-09-27\14-40-32.ubx

3. Specify the path to the base station data file:
E:\TUTORIAL\BASE\raw_201909271437.ubx

4. Base coordinates:
 Degree d'm's"
 Latitude - [] degree
 Longitude - [] degree
 Elevation (meters) - []

5. Base antenna height:
0.000 meters

6. Rover antenna offset:
 Height - 0.00 meters
 Offset forward/backward - 0.00 meters
 Offset left/right - 0.00 meters

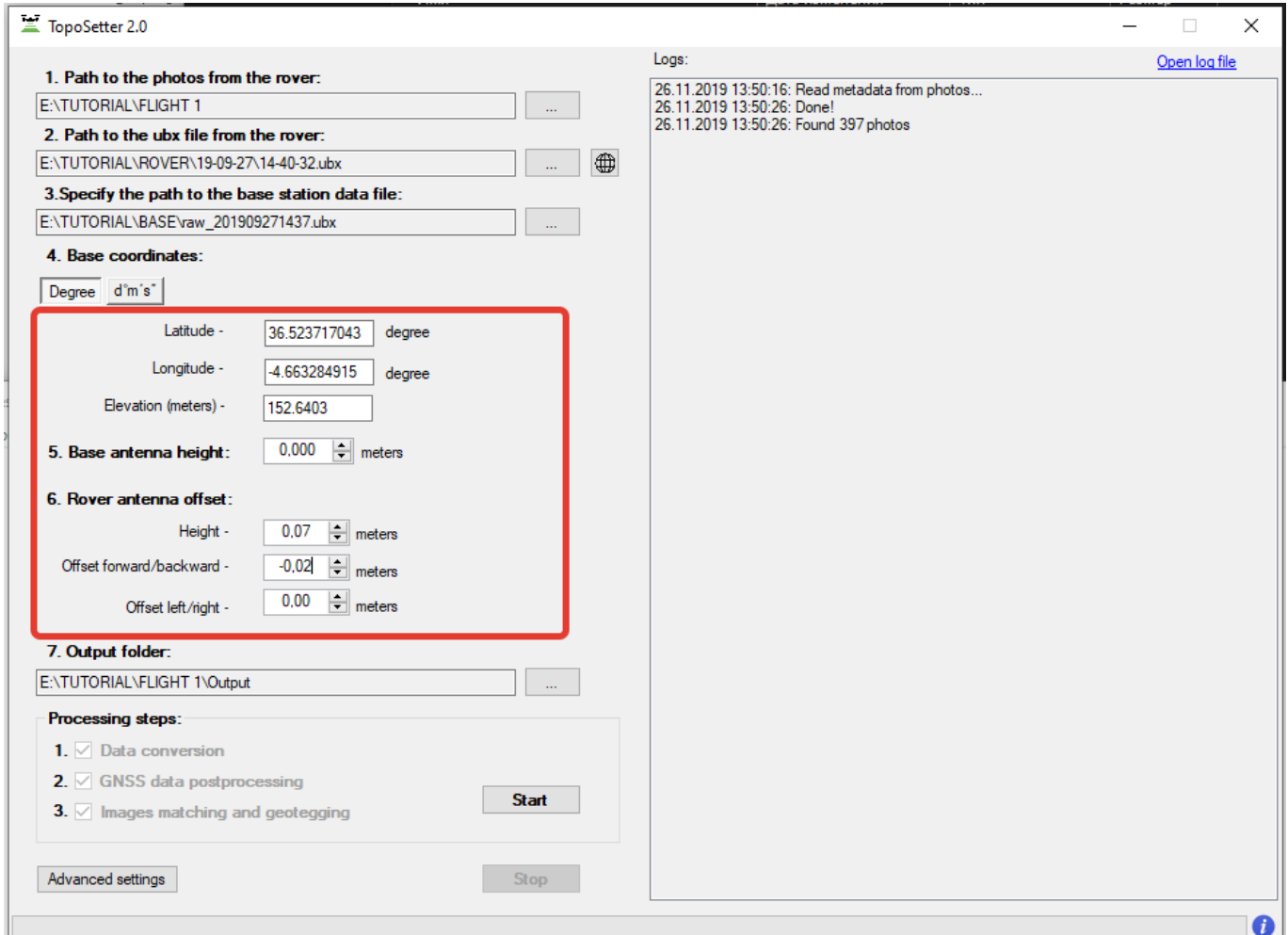
7. Output folder:
E:\TUTORIAL\FLIGHT 1\Output

Processing steps:
 1. ☒ Data conversion
 2. ☒ GNSS data postprocessing
 3. ☒ Images matching and geotagging

Buttons: Start, Stop, Advanced settings

Logs:
[Open log file](#)
 26.11.2019 13:50:16: Read metadata from photos...
 26.11.2019 13:50:26: Done!
 26.11.2019 13:50:26: Found 397 photos

Step 5. Impute coordinates of the base station in WGS 84. Define antenna offset for the drone.



TopoSetter 2.0

1. Path to the photos from the rover:
E:\TUTORIAL\FLIGHT 1

2. Path to the ubx file from the rover:
E:\TUTORIAL\ROVER\19-09-27\14-40-32.ubx

3. Specify the path to the base station data file:
E:\TUTORIAL\BASE\raw_201909271437.ubx

4. Base coordinates:
Degree d°m's"

Latitude - 36.523717043 degree
Longitude - -4.663284915 degree
Elevation (meters) - 152.6403

5. Base antenna height: 0.000 meters

6. Rover antenna offset:
Height - 0.07 meters
Offset forward/backward - -0.02 meters
Offset left/right - 0.00 meters

7. Output folder:
E:\TUTORIAL\FLIGHT 1\Output

Processing steps:
1. ☒ Data conversion
2. ☒ GNSS data postprocessing
3. ☒ Images matching and geotagging

Start

Advanced settings Stop

Logs:
[Open log file](#)
26.11.2019 13:50:16: Read metadata from photos...
26.11.2019 13:50:26: Done!
26.11.2019 13:50:26: Found 397 photos

NOTICE.

FOR DJI MAVIC 2 PRO PPK use the following parameters

Height: 0.07

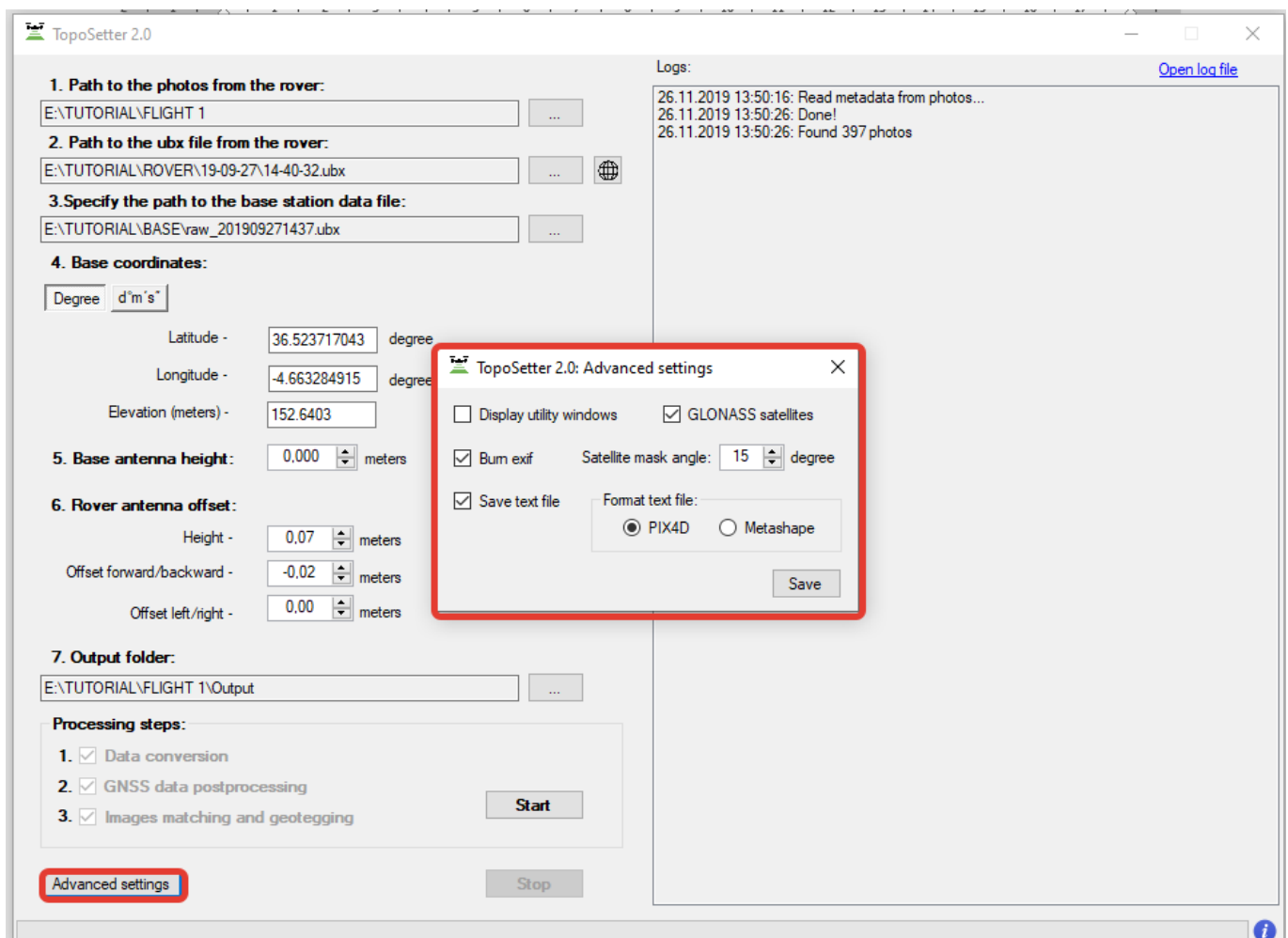
Offset forward/backward: -0.02

FOR DJI PHANTOM 4 PRO PPK use the following parameters

Height: 0.17

Step 6. Setup data processing setting. Click advanced setting. Advanced setting will appear. To embed precise coordinates to photos EXIF tags check Burn exif check box. This option may lead to increasing of the data processing time. To save the list of coordinates check Save text file check box. Select the format of the text file Pix4D or Metashape.

Click Save button.



NOTICE. To look at data processing progress check Display utility windows option.

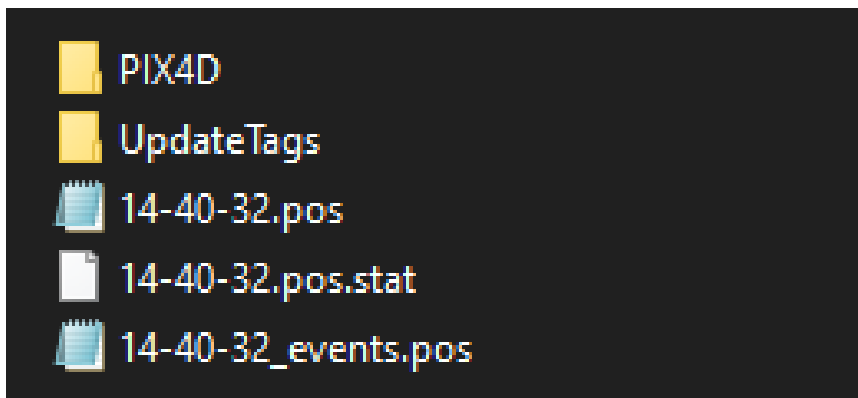
Click Start button

After finishing all steps of the data processing (data conversion, GNSS data post processing, images matching and geotagging) all results will be stored in the Output folder.

File Coordinates.txt is stored in the PIX4D or Metashape folder.

Photos with updated EXIF tags are stored in the UpdateTags folder.

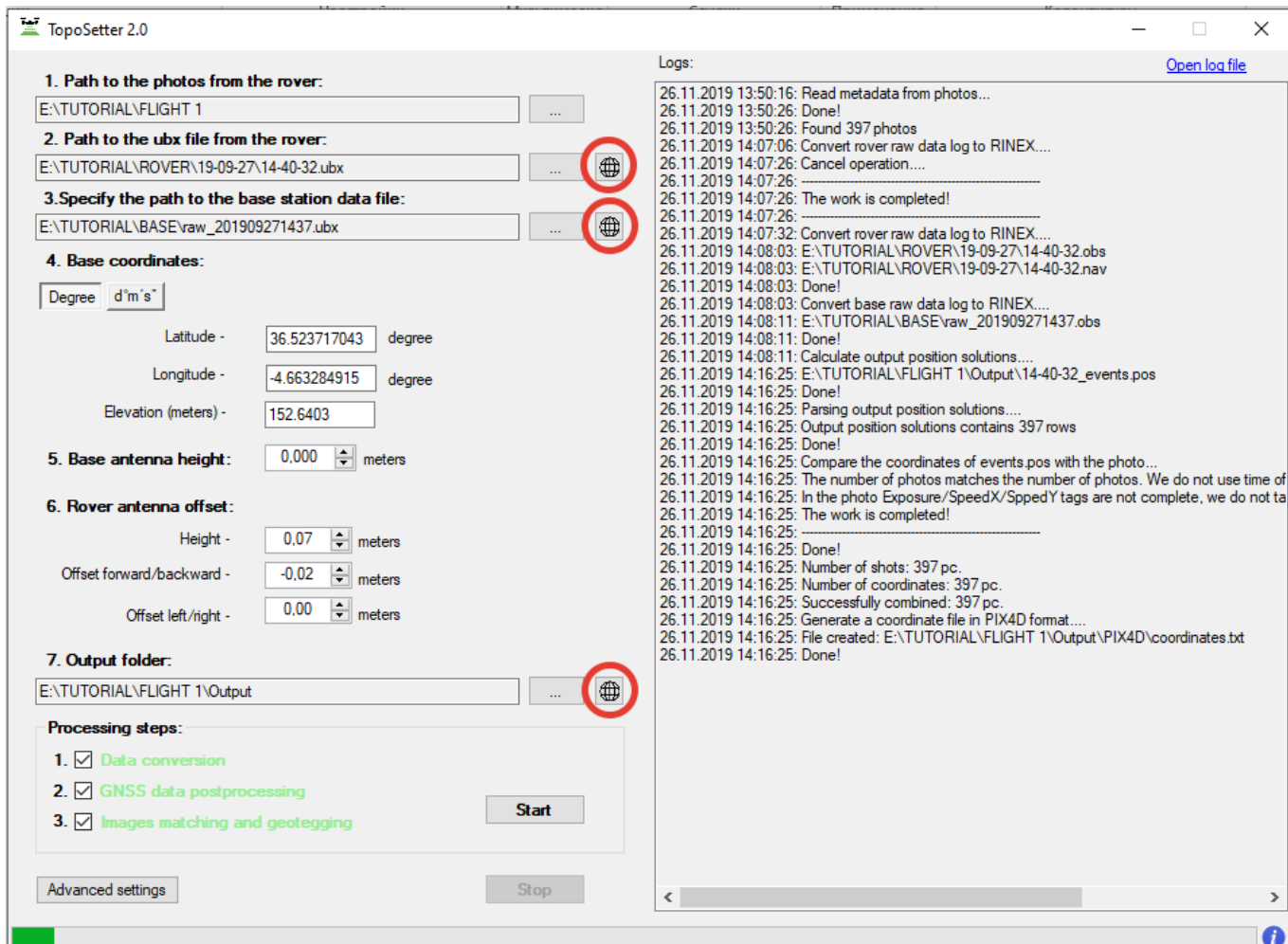
Files with .pos extension are the results of the GNSS data postprocessing.



NOTICE. The *coordinate system is WGS84*.

Step 7. Checking the processing results.

After the processing finishes, the following buttons will appear.



TopoSetter 2.0

1. Path to the photos from the rover:
 E:\TUTORIAL\FLIGHT 1

2. Path to the ubx file from the rover:
 E:\TUTORIAL\ROVER\19-09-27\14-40-32.ubx

3. Specify the path to the base station data file:
 E:\TUTORIAL\BASE\raw_201909271437.ubx

4. Base coordinates:
 Degree d'm's"
 Latitude - 36.523717043 degree
 Longitude - -4.663284915 degree
 Elevation (meters) - 152.6403

5. Base antenna height: 0.000 meters

6. Rover antenna offset:
 Height - 0.07 meters
 Offset forward/backward - -0.02 meters
 Offset left/right - 0.00 meters

7. Output folder:
 E:\TUTORIAL\FLIGHT 1\Output

Processing steps:
 1. ☒ Data conversion
 2. ☒ GNSS data postprocessing
 3. ☒ Images matching and geotagging

Start

Advanced settings Stop

Logs: [Open log file](#)

```

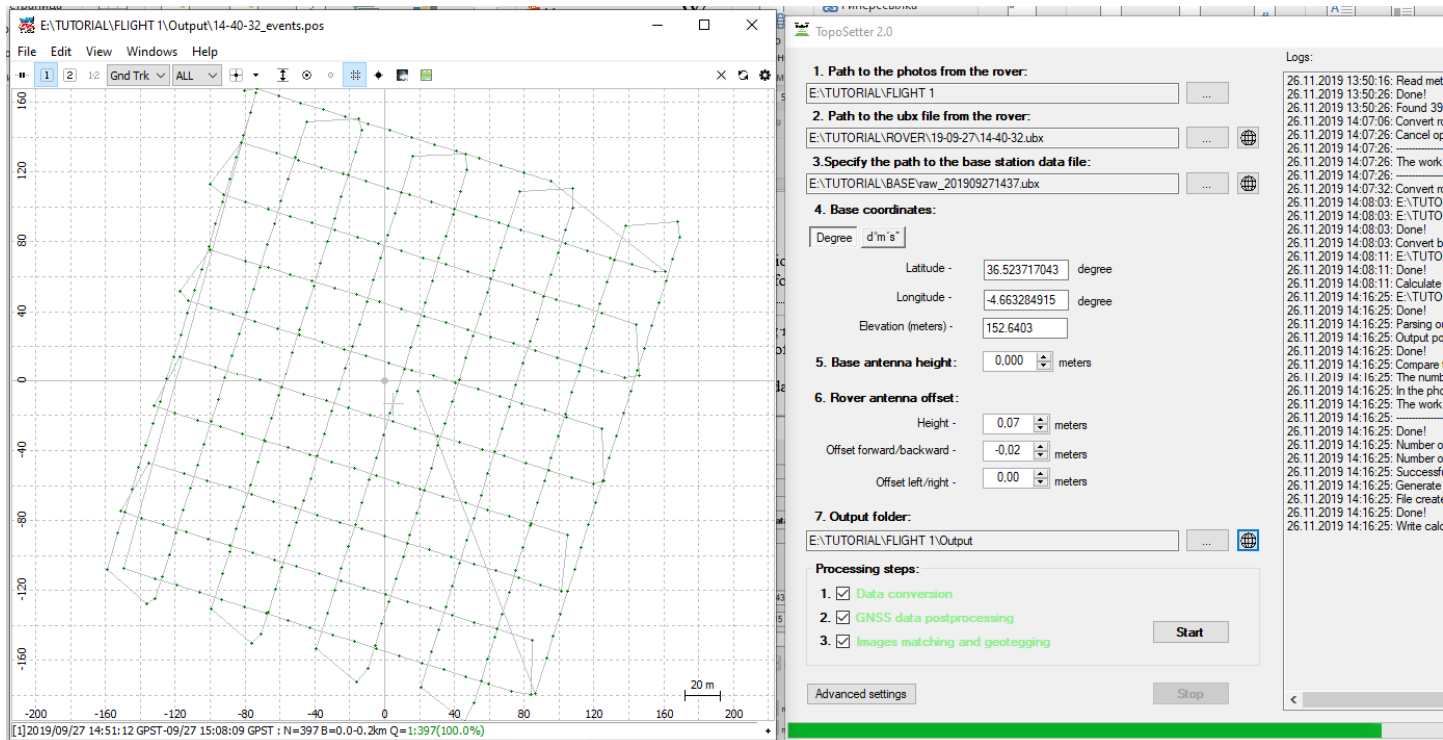
26.11.2019 13:50:16: Read metadata from photos...
26.11.2019 13:50:26: Done!
26.11.2019 13:50:26: Found 397 photos
26.11.2019 14:07:06: Convert rover raw data log to RINEX...
26.11.2019 14:07:26: Cancel operation....
26.11.2019 14:07:26: -----
26.11.2019 14:07:26: The work is completed!
26.11.2019 14:07:26: -----
26.11.2019 14:07:32: Convert rover raw data log to RINEX...
26.11.2019 14:08:03: E:\TUTORIAL\ROVER\19-09-27\14-40-32.obs
26.11.2019 14:08:03: E:\TUTORIAL\ROVER\19-09-27\14-40-32.nav
26.11.2019 14:08:03: Done!
26.11.2019 14:08:03: Convert base raw data log to RINEX...
26.11.2019 14:08:11: E:\TUTORIAL\BASE\raw_201909271437.obs
26.11.2019 14:08:11: Done!
26.11.2019 14:08:11: Calculate output position solutions....
26.11.2019 14:16:25: E:\TUTORIAL\FLIGHT 1\Output\14-40-32_events.pos
26.11.2019 14:16:25: Done!
26.11.2019 14:16:25: Parsing output position solutions....
26.11.2019 14:16:25: Output position solutions contains 397 rows
26.11.2019 14:16:25: Done!
26.11.2019 14:16:25: Compare the coordinates of events.pos with the photo...
26.11.2019 14:16:25: The number of photos matches the number of photos. We do not use time of
26.11.2019 14:16:25: In the photo Exposure/SpeedX/SpddY tags are not complete, we do not ta
26.11.2019 14:16:25: The work is completed!
26.11.2019 14:16:25: -----
26.11.2019 14:16:25: Done!
26.11.2019 14:16:25: Number of shots: 397 pc.
26.11.2019 14:16:25: Number of coordinates: 397 pc.
26.11.2019 14:16:25: Successfully combined: 397 pc.
26.11.2019 14:16:25: Generate a coordinate file in PIX4D format....
26.11.2019 14:16:25: File created: E:\TUTORIAL\FLIGHT 1\Output\PIX4D\coordinates.txt
26.11.2019 14:16:25: Done!
  
```

NOTICE.

Click  buttons in front of the Rover or Base fields to open GNSS observation files and check the quality of GNSS signal.

To check the quality of GNSS data postprocessing click  button in front of output results.

On the map you can see the results of the GNSS data postprocessing.
Green points of photos events stand for Fixed solution
Yellow points – Float solution
Red points – Single solution



NOTICE.

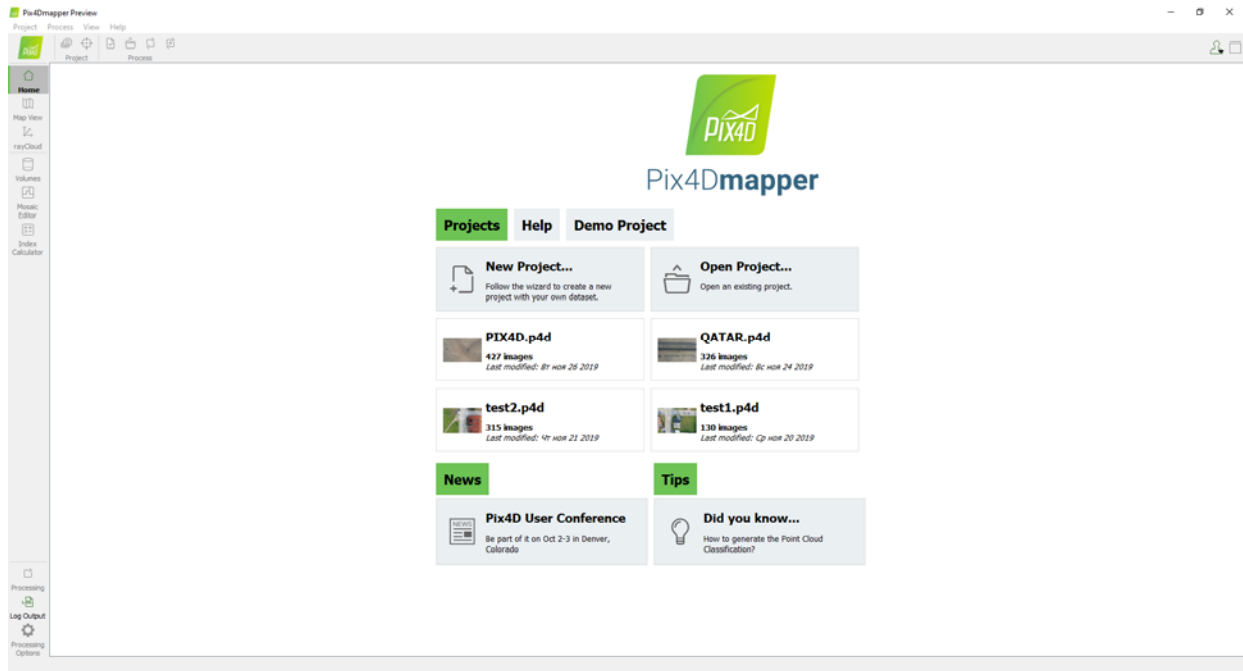
If there are only red points on the map it means that the GNSS data from the drone and the base station were not collected at the same time.

If there are only yellow points (float solution) you should check the coordinates of the base station or the quality of the signal. To remove noisy GNSS signal try increasing the satellite mask angle or excluding the GLONASS satellite system in Advanced setting menu.

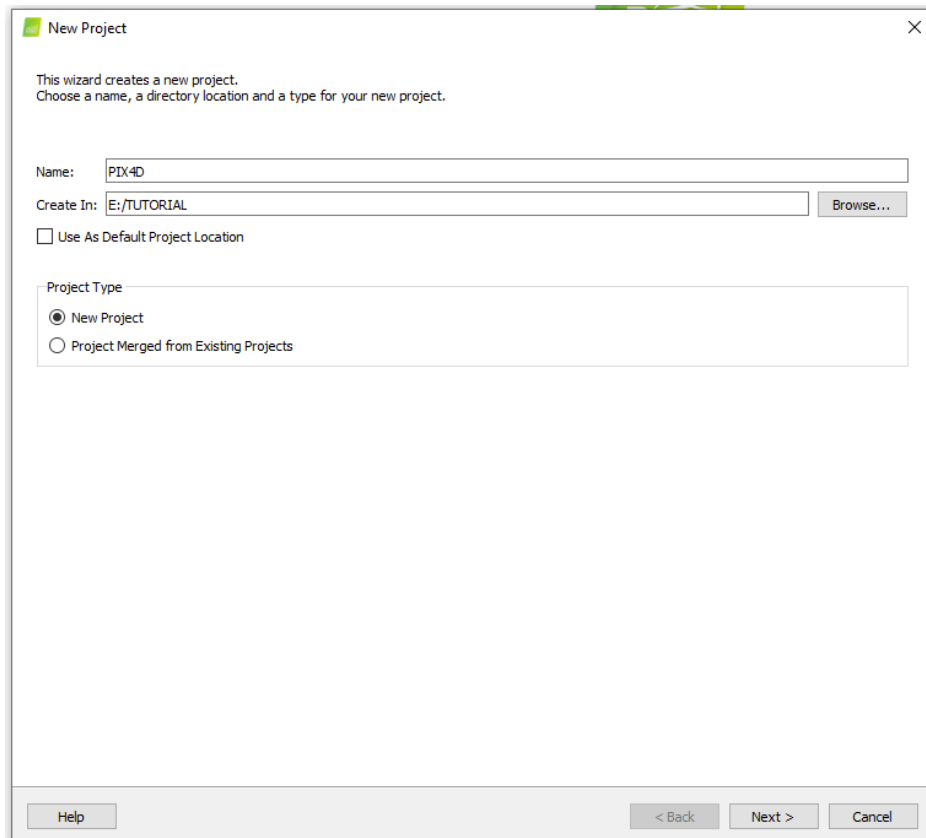
3. PHOTOGRAMMETRY PROCESSING IN PIX4D MAPPER SOFTWARE

3.1 Creating pix4d mapper project

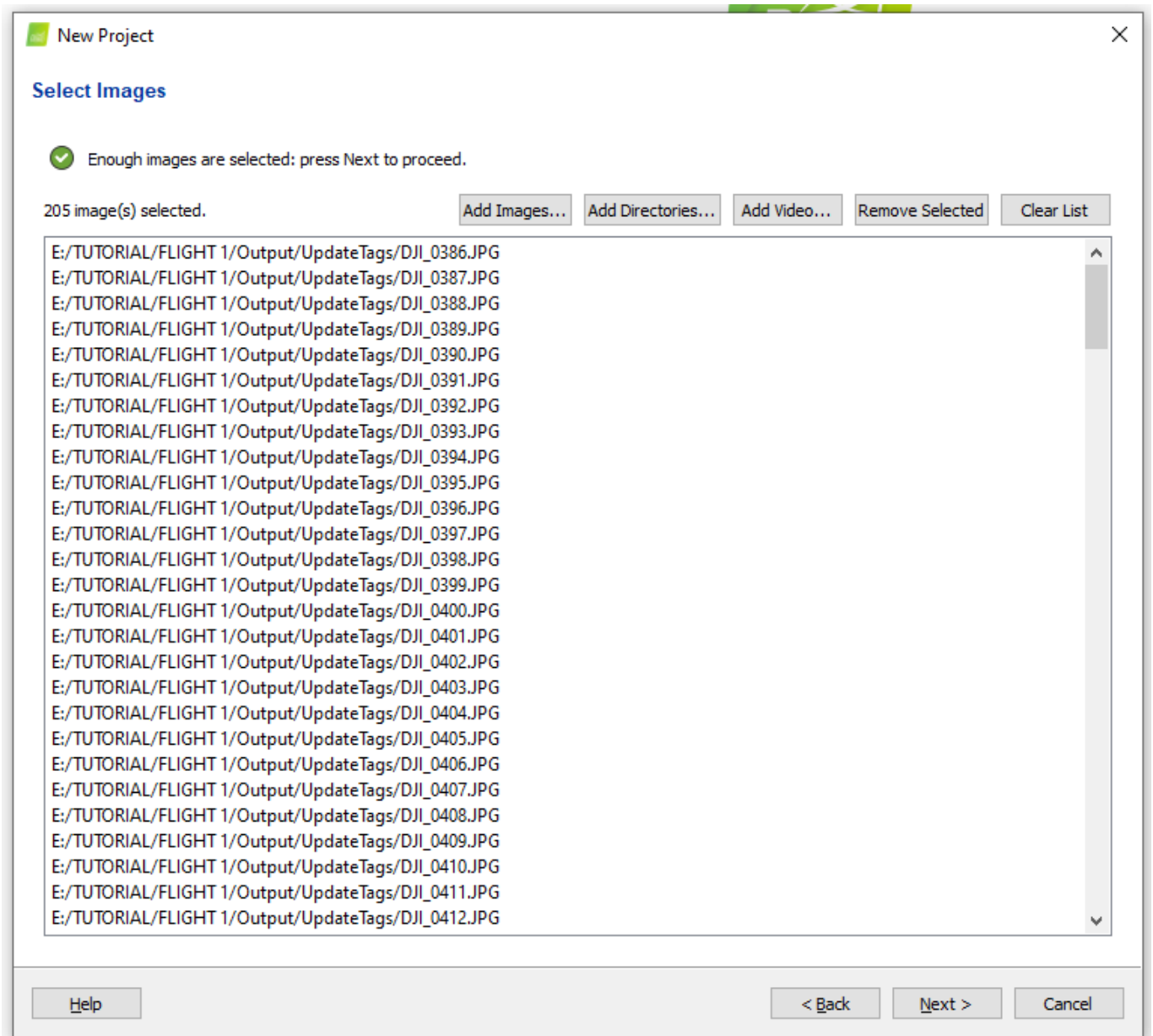
Run PIX4D mapper application.



Click New Project. Select a project folder location. Click next



Select images to be processed from output\UpdateTags folder. Click next



Software will read the precise coordinates of the images and the accuracy settings automatically.
 Click Next.

New Project

Image Properties

Image Geolocation

Coordinate System

☒ Datum: World Geodetic System 1984; Coordinate System: WGS 84

Edit...

Geolocation and Orientation

☒ Geolocated Images: 203 out of 203

Clear

From EXIF

From File...

To File...

Geolocation Accuracy:

☐ Standard
 ☐ Low
 ☒ Custom

Selected Camera Model

☒ L1D-20c_10.3_5472x3648 (0K8TG740120251) (RGB)

Edit...

Enabled	Image	Group	Latitude [degree]	Longitude [degree]	Altitude [m]	Accuracy Horz [m]	Ac V
<input checked="" type="checkbox"/>	DJI_0389.JPG	group1	36.52239990	-4.66220570	221.339	0.003	0.006
<input checked="" type="checkbox"/>	DJI_0390.JPG	group1	36.52251434	-4.66216040	221.160	0.003	0.006
<input checked="" type="checkbox"/>	DJI_0391.JPG	group1	36.52263260	-4.66211557	221.198	0.003	0.006
<input checked="" type="checkbox"/>	DJI_0392.JPG	group1	36.52274323	-4.66207075	221.162	0.003	0.006
<input checked="" type="checkbox"/>	DJI_0393.JPG	group1	36.52285767	-4.66202545	221.005	0.003	0.006
<input checked="" type="checkbox"/>	DJI_0394.JPG	group1	36.52297211	-4.66197968	220.971	0.003	0.006
<input checked="" type="checkbox"/>	DJI_0395.JPG	group1	36.52308655	-4.66193438	220.926	0.003	0.006
<input checked="" type="checkbox"/>	DJI_0396.JPG	group1	36.52320099	-4.66189003	220.824	0.003	0.006

Help

< Back

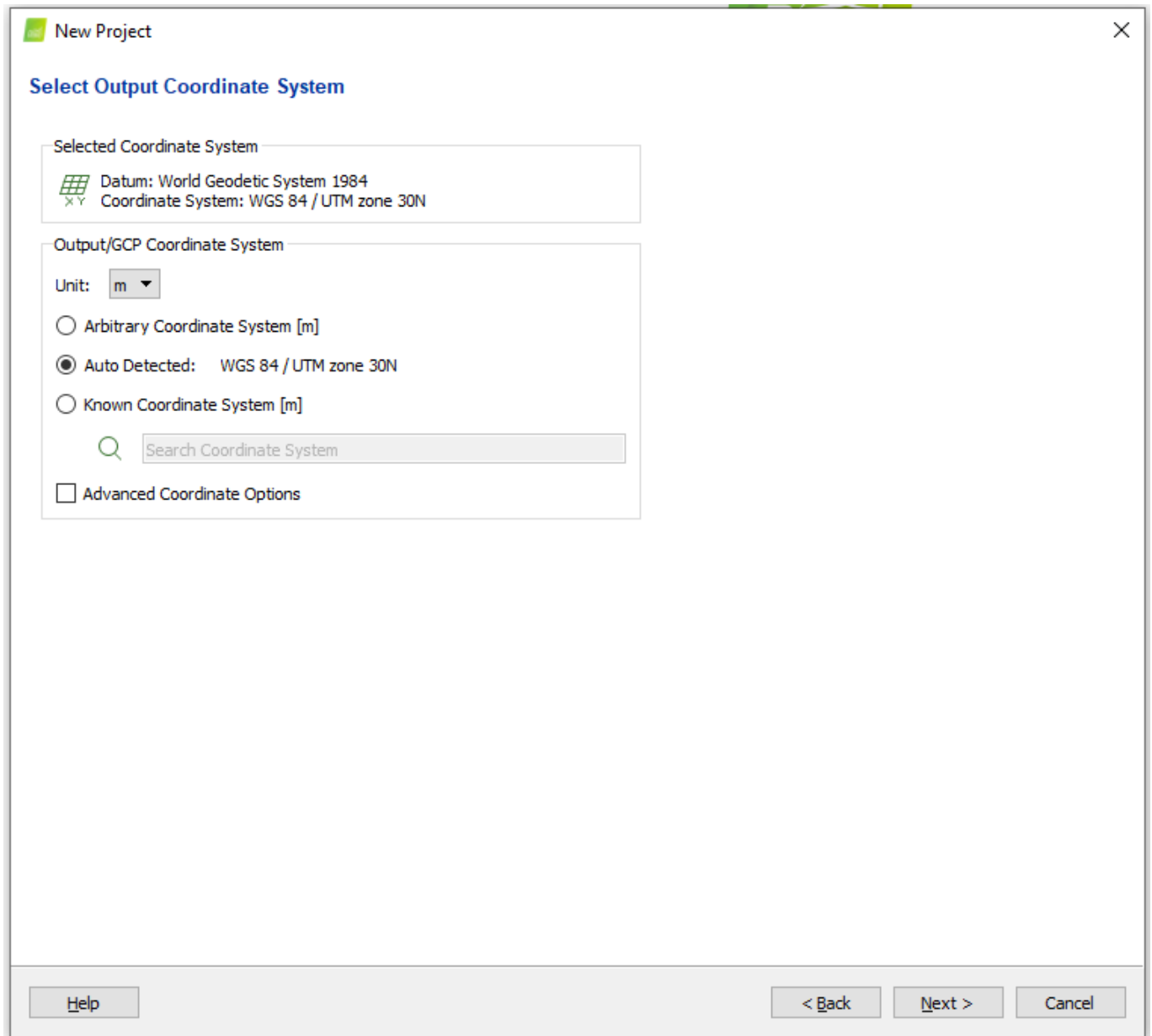
Next >

Cancel

NOTICE. It is possible to upload the coordinates from the .txt file. Click From File button and select the coordinates.txt file

It is recommended to check the camera settings. Click Edit button and check if the Linear rolling shutter camera model is enabled if you have used a DJI MAVIC 2 PRO for survey.

Select an output coordinate system and click Next.



The screenshot shows a 'New Project' dialog box with a close button (X) in the top right corner. The title bar reads 'New Project'. The main heading is 'Select Output Coordinate System'.

Under 'Selected Coordinate System', there is a grid icon with 'x' and 'y' axes, followed by the text: 'Datum: World Geodetic System 1984' and 'Coordinate System: WGS 84 / UTM zone 30N'.

Under 'Output/GCP Coordinate System', there is a 'Unit:' dropdown menu set to 'm'. Below it are three radio button options: 'Arbitrary Coordinate System [m]', 'Auto Detected: WGS 84 / UTM zone 30N' (which is selected), and 'Known Coordinate System [m]'. Below these is a search icon and a text input field labeled 'Search Coordinate System'. At the bottom of this section is a checkbox labeled 'Advanced Coordinate Options'.

At the bottom of the dialog box, there are three buttons: 'Help', '< Back', and 'Next >', followed by a 'Cancel' button.

Select a type of data processing options. Click Finish.

New Project

Processing Options Template

Standard

3D Maps

3D Models

Ag Multispectral

Rapid

3D Maps - Rapid/Low Res

3D Models - Rapid/Low Res

Ag Modified Camera - Rapid/Low Res

Ag RGB - Rapid/Low Res

Advanced

Ag Modified Camera

Ag RGB

Thermal Camera

ThermoMAP Camera

3D Models

Generate a 3D Model from any set of overlapping images.

Image Acquisition

oblique flight terrestrial

Outputs Quality/Reliability

Low High

Processing Speed

Slow Fast

Input Image Recommendations

Any images with a high amount of overlap such as images taken from the ground or oblique aerial images (free flight).

Outputs Generated

3D Mesh

Point Cloud

Start Processing Now

Help

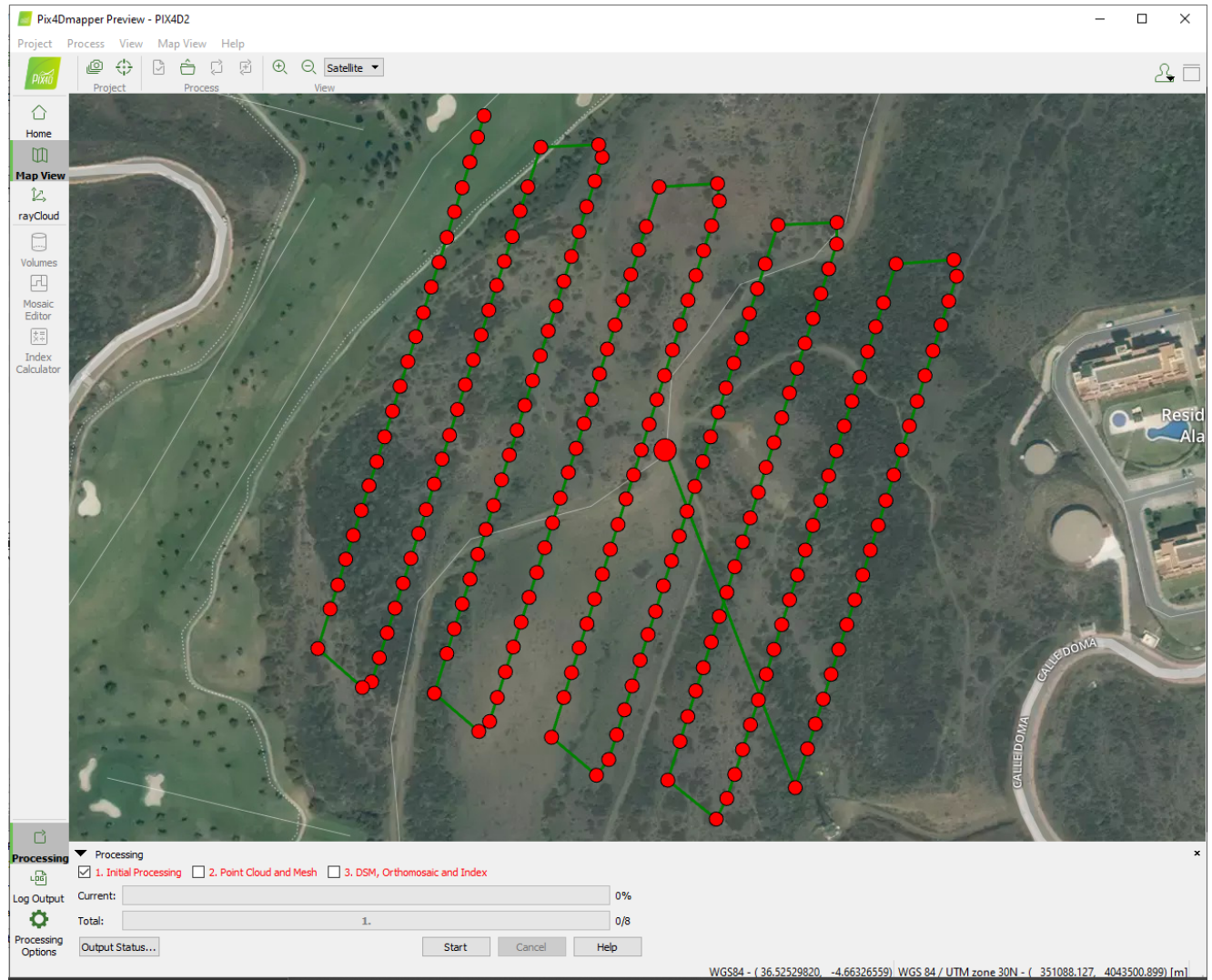
< Back

Finish

Cancel

3.2 Initial aerial triangulation

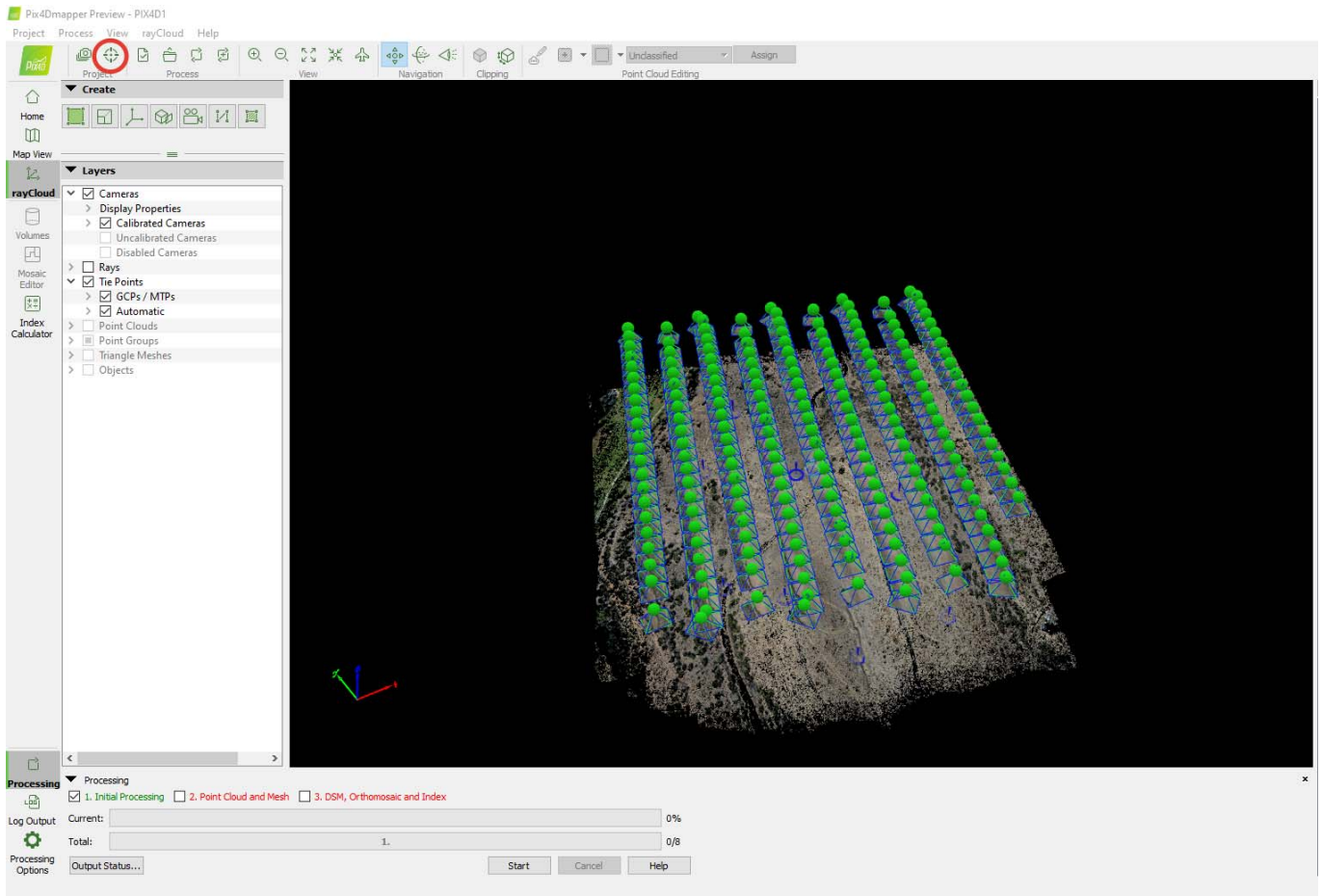
Once the images with precise coordinates are loaded to the project, we can start the initial aerial triangulation. Select the initial processing checkbox and start processing.



3.3. Camera calibration

In order to calibrate the focal length of the camera you need at least one GCP.

Click GCP/MTP button.



Select the coordinate system of ground control points and import GCPs. Click OK.

GCP/MTP Manager

GCP Coordinate System
 Datum: World Geodetic System 1984; Coordinate System: WGS 84 Edit...

GCP/MTP Table

	Label	Type	Latitude [degree]	Longitude [degree]	Altitude [m]	Accuracy Horz [m]	Accuracy Vert [m]
0	Base	3D GCP	36.52371704	-4.66328492	152.506	0.020	0.020
14	Point 1	3D GCP	36.52372766	-4.66311001	148.133	0.020	0.020
0	Point 2	3D GCP	36.52377147	-4.66264965	153.482	0.020	0.020
0	Point 3	3D GCP	36.52340747	-4.66240828	153.772	0.020	0.020
0	Point 4	3D GCP	36.52320690	-4.66257781	149.481	0.020	0.020
0	Point 5	3D GCP	36.52224430	-4.66288253	138.133	0.020	0.020

1/12 GCPs with enough image marks Import Marks... Export Marks...

GCP/MTP Editor

In order to compute the 3D position of a GCP/MTP, it needs to be marked on at least two images.
 In order to take GCPs into account for georeferencing the project, at least 3 GCPs need to be marked.
 Marking GCPs/MTPs after step 1. Initial Processing requires the user to run Process > Reoptimize.
 The GCPs/MTP accuracy can be verified in the Quality Report or in the rayCloud Editor.

(Recommended) Use the rayCloud Editor after step 1. Initial Processing is done. This allows a fast and precise point marking.

Use the Basic Editor either
 1) before running step 1. Initial Processing, or
 2) when using non-geolocated images, or
 3) when using an arbitrary coordinate system.

rayCloud Editor... Basic Editor...

OK Cancel Help

Change the GCP type to Check point.

GCP/MTP Manager

GCP Coordinate System
 Datum: World Geodetic System 1984; Coordinate System: WGS 84 Edit...

GCP/MTP Table

	Label	Type	Latitude [degree]	Longitude [degree]	Altitude [m]	Accuracy Horz [m]	Accuracy Vert [m]
0	Base	Check Point	36.52371704	-4.66328492	152.506		
14	Point 1	Check Point	36.52372766	-4.66311001	148.133		
0	Point 2	Check Point	36.52377147	-4.66264965	153.482		
0	Point 3	Check Point	36.52340747	-4.66240828	153.772		
0	Point 4	Check Point	36.52320690	-4.66257781	149.481		
0	Point 5	Check Point	36.52224430	-4.66288253	138.133		

Import Marks... Export Marks...

GCP/MTP Editor

In order to compute the 3D position of a GCP/MTP, it needs to be marked on at least two images.
 In order to take GCPs into account for georeferencing the project, at least 3 GCPs need to be marked.
 Marking GCPs/MTPs after step 1. Initial Processing requires the user to run Process > Reoptimize.
 The GCPs/MTP accuracy can be verified in the Quality Report or in the rayCloud Editor.

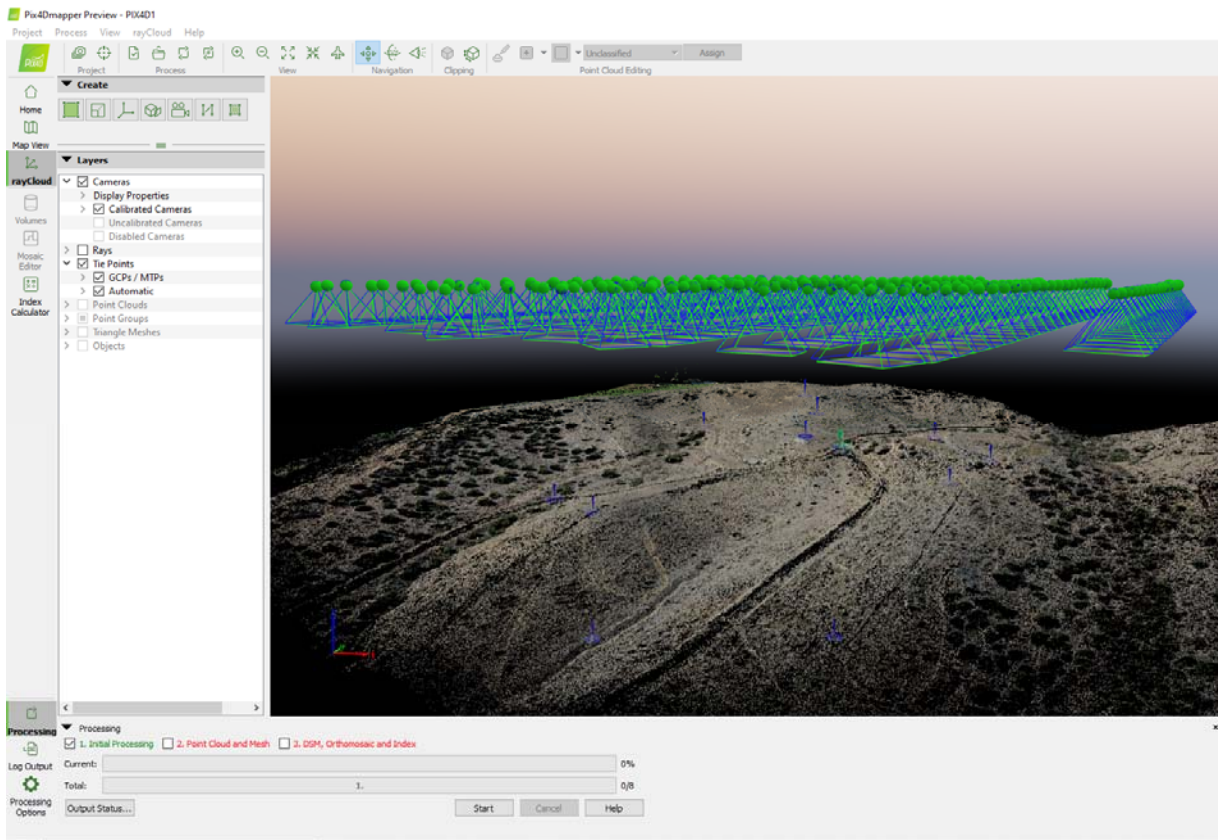
(Recommended) Use the rayCloud Editor after step 1. Initial Processing is done. This allows a fast and precise point marking.

Use the Basic Editor either
 1) before running step 1. Initial Processing, or
 2) when using non-geolocated images, or
 3) when using an arbitrary coordinate system.

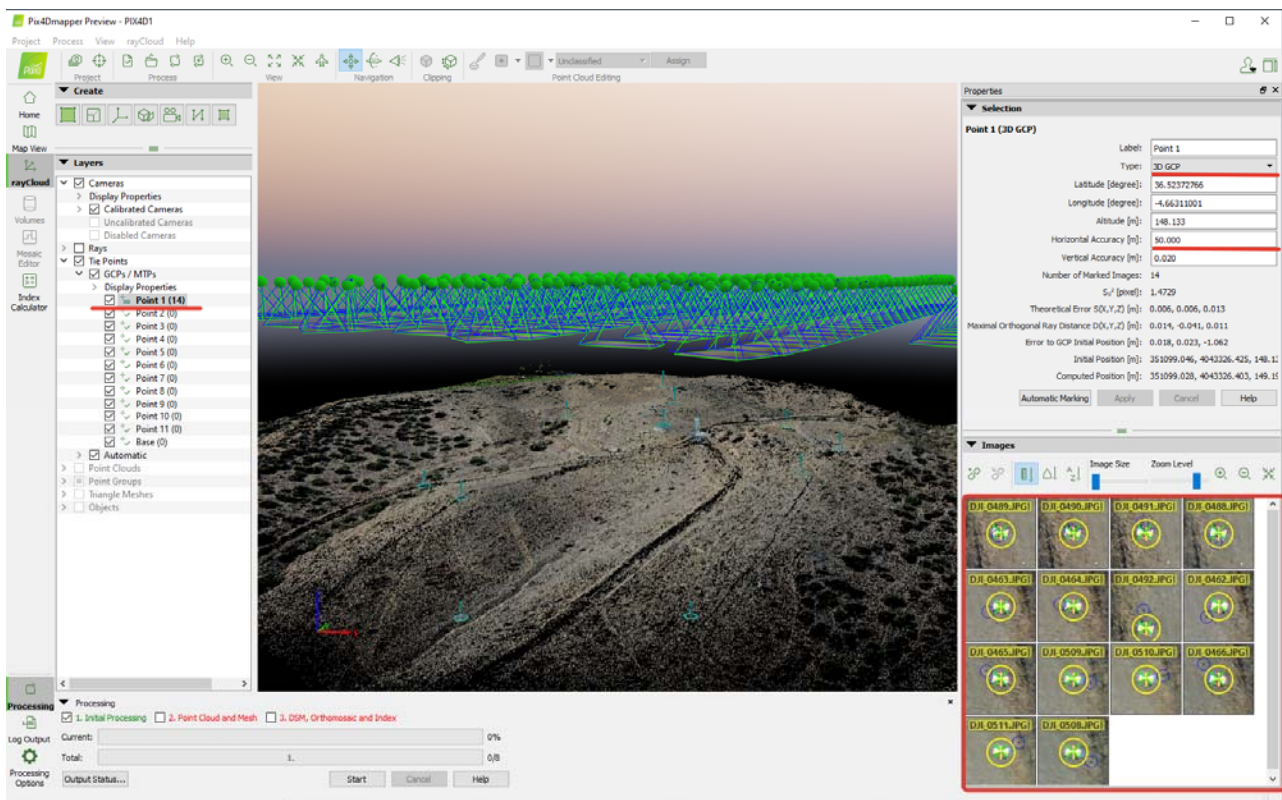
rayCloud Editor... Basic Editor...

OK Cancel Help

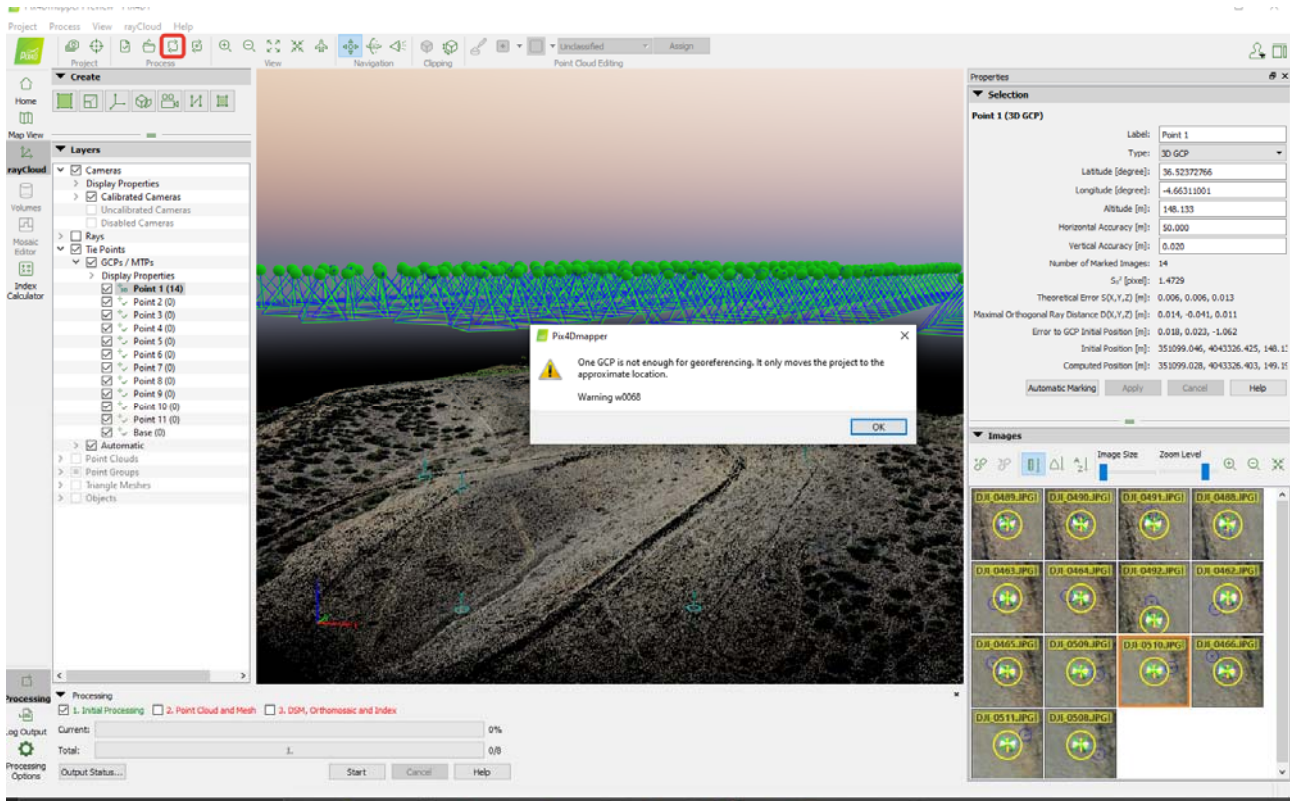
All GCPs will be shown on the map.



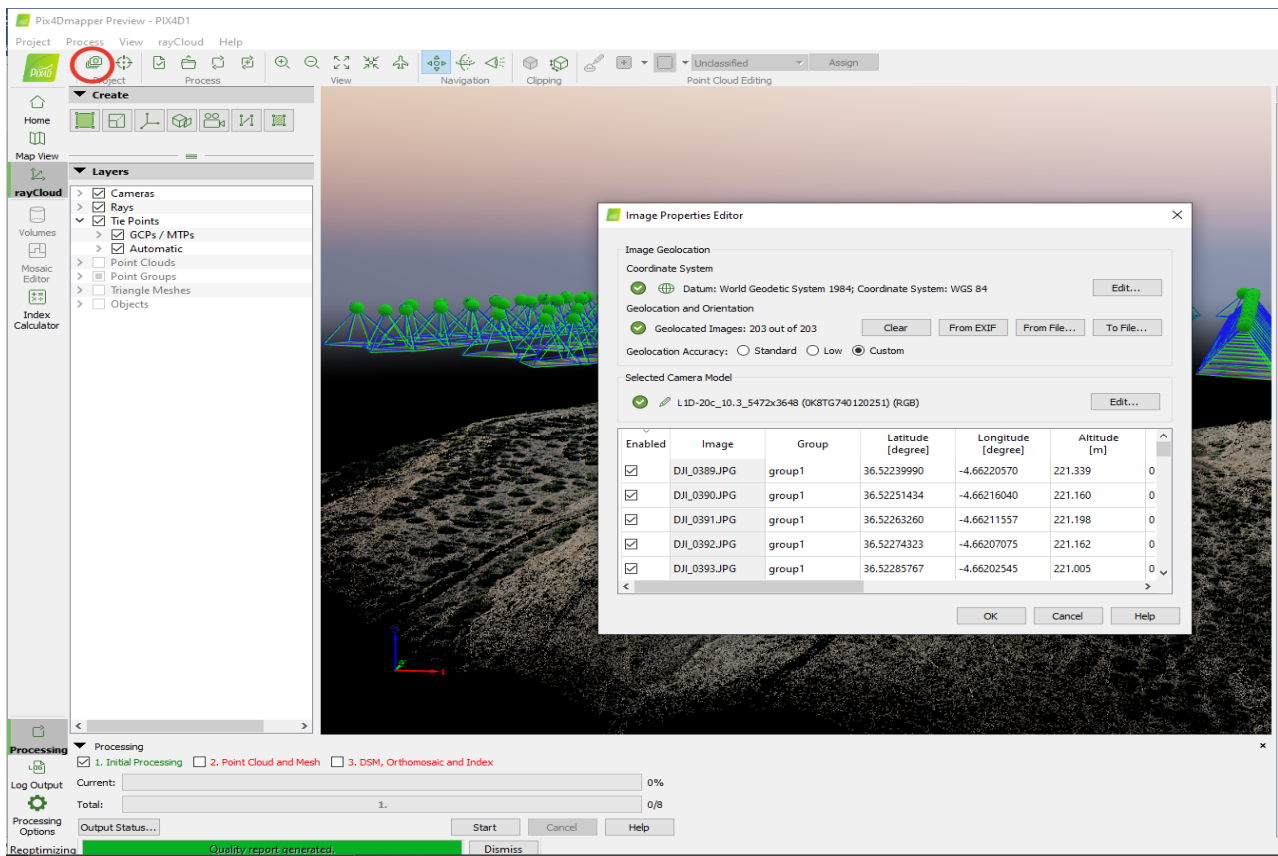
Select one GCP, define the position of the ground control point at each image, change the type of the selected(?) GCP to 3D and set the horizontal accuracy to 50 meters.



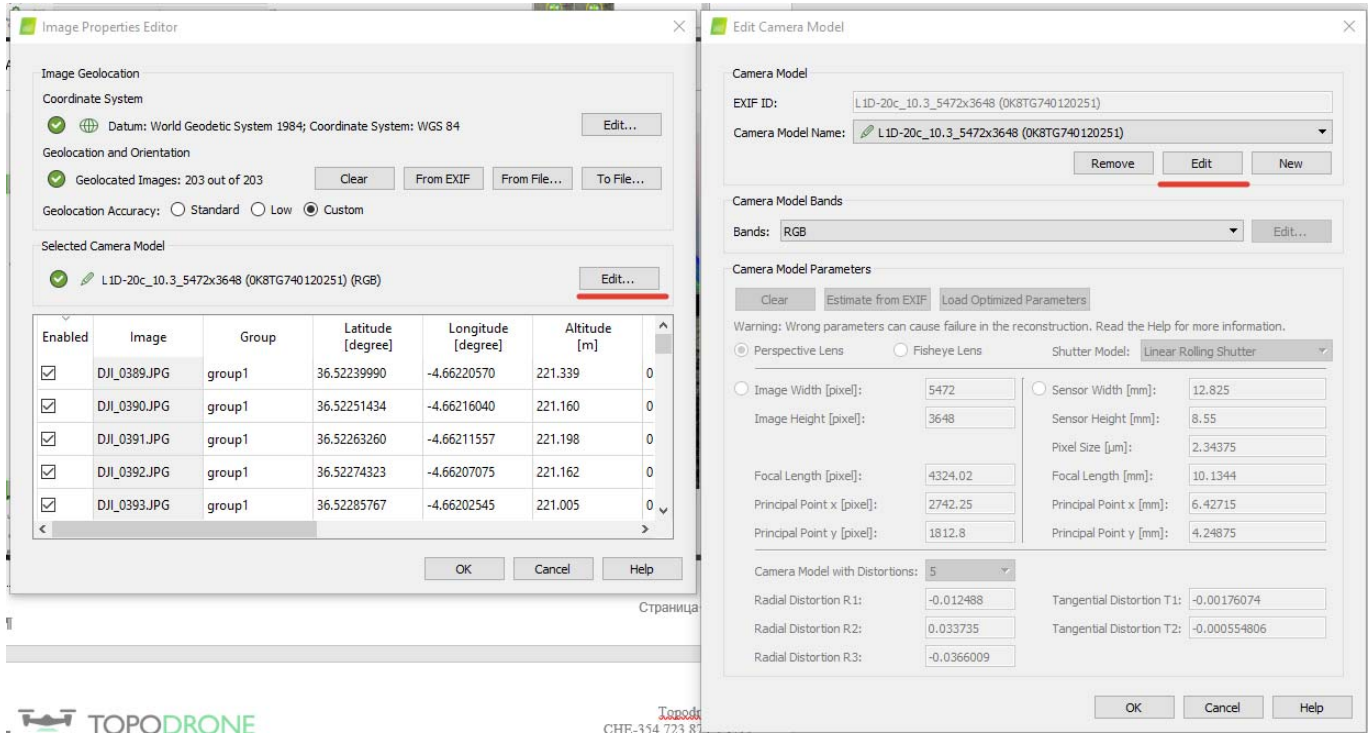
Click Reoptimize button. Click Ok on all warning messages.



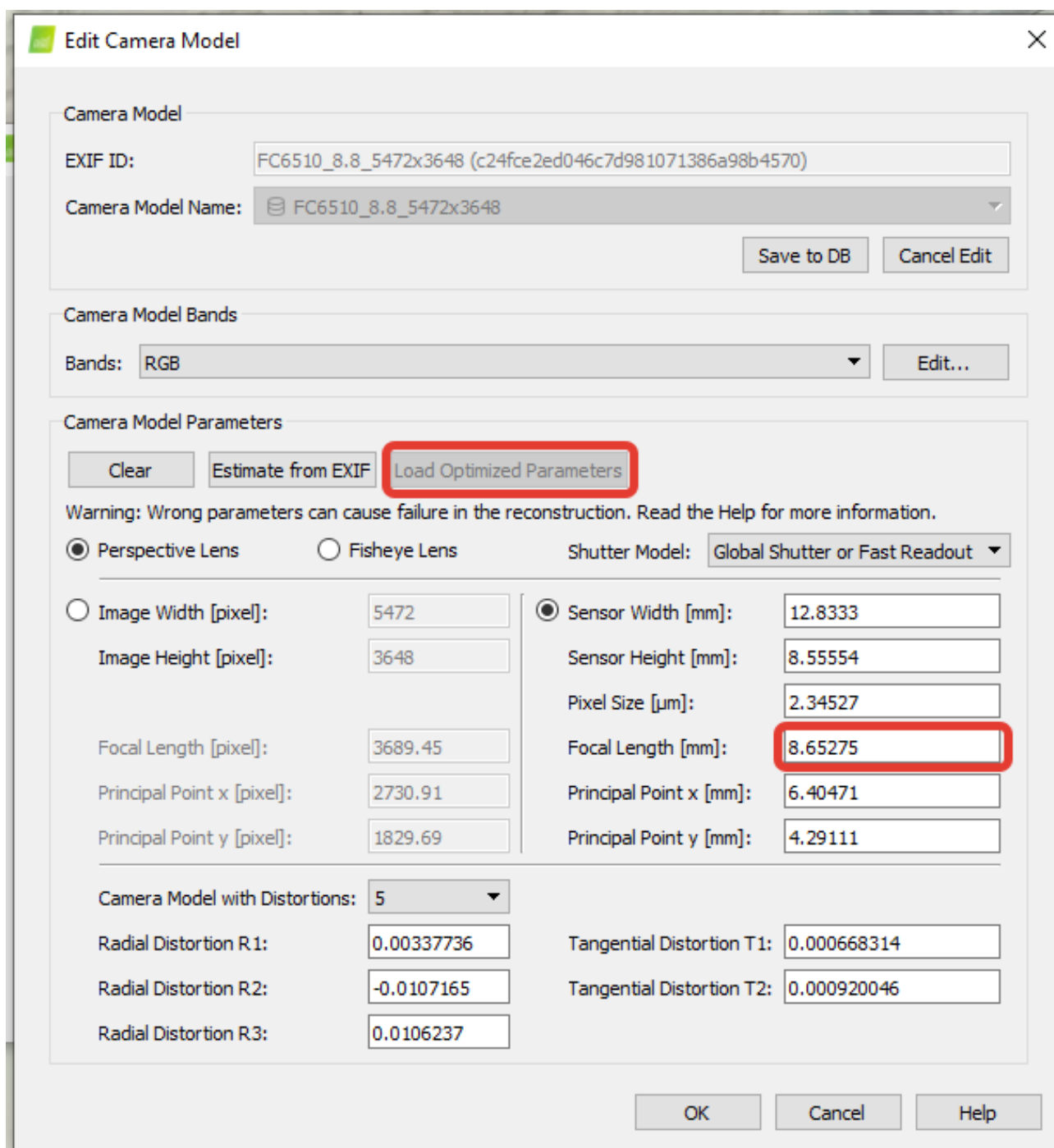
After finishing the reoptimization process click the Image property editor button.



Click the Edit camera model buttons in the Image Properties Editor window and in the Edit Camera Model window



Click Load Optimized parameters. Copy the Focal Length value for the future work.



Edit Camera Model

Camera Model

EXIF ID: FC6510_8.8_5472x3648 (c24fce2ed046c7d981071386a98b4570)

Camera Model Name: FC6510_8.8_5472x3648

Save to DB Cancel Edit

Camera Model Bands

Bands: RGB Edit...

Camera Model Parameters

Clear Estimate from EXIF Load Optimized Parameters

Warning: Wrong parameters can cause failure in the reconstruction. Read the Help for more information.

☒ Perspective Lens ☐ Fisheye Lens Shutter Model: Global Shutter or Fast Readout

☐ Image Width [pixel]: 5472 ☒ Sensor Width [mm]: 12.8333

Image Height [pixel]: 3648 Sensor Height [mm]: 8.55554

Focal Length [pixel]: 3689.45 Pixel Size [μm]: 2.34527

Principal Point x [pixel]: 2730.91 Focal Length [mm]: 8.65275

Principal Point y [pixel]: 1829.69 Principal Point x [mm]: 6.40471

Principal Point y [mm]: 4.29111

Camera Model with Distortions: 5

Radial Distortion R1: 0.00337736 Tangential Distortion T1: 0.000668314

Radial Distortion R2: -0.0107165 Tangential Distortion T2: 0.000920046

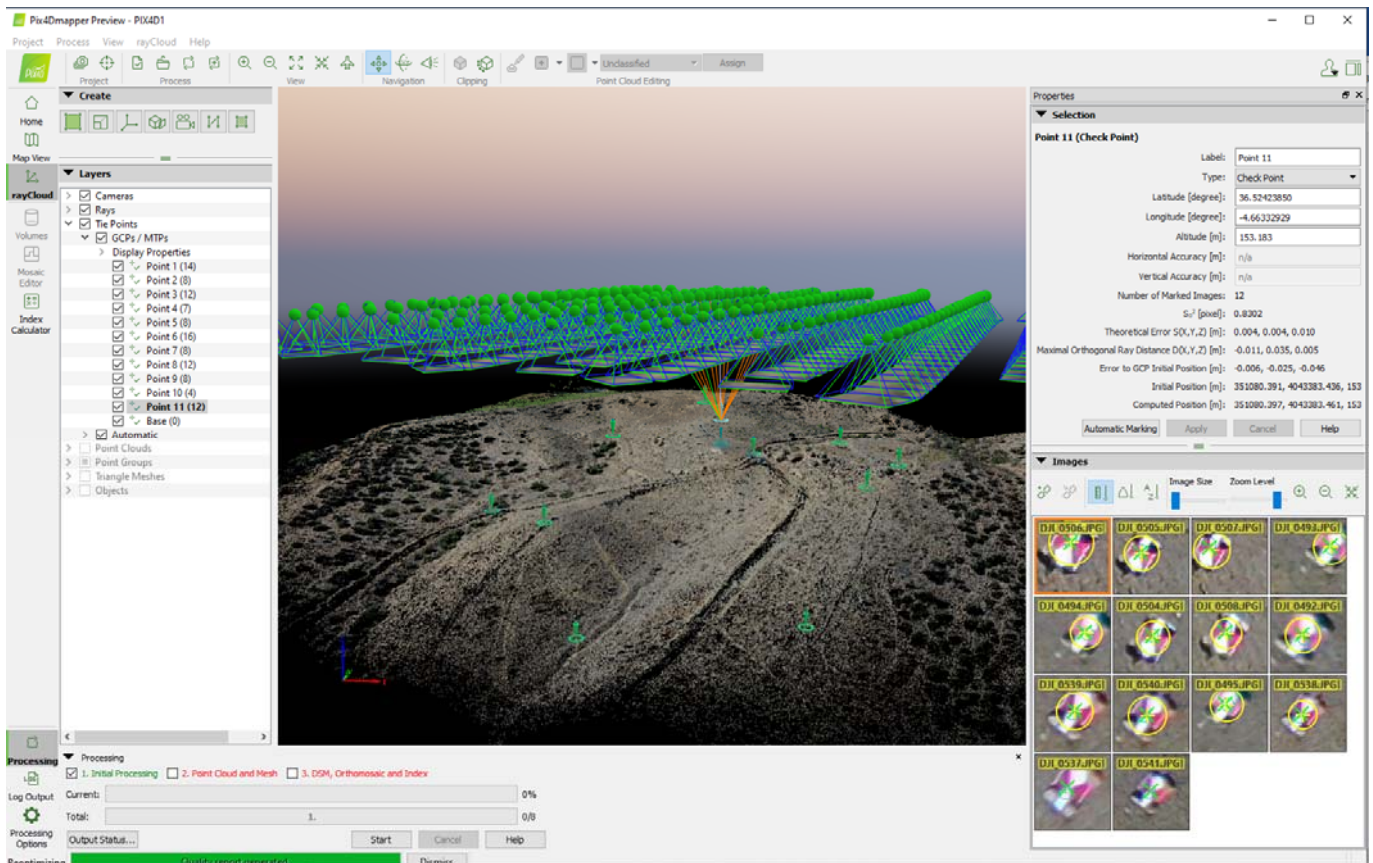
Radial Distortion R3: 0.0106237

OK Cancel Help

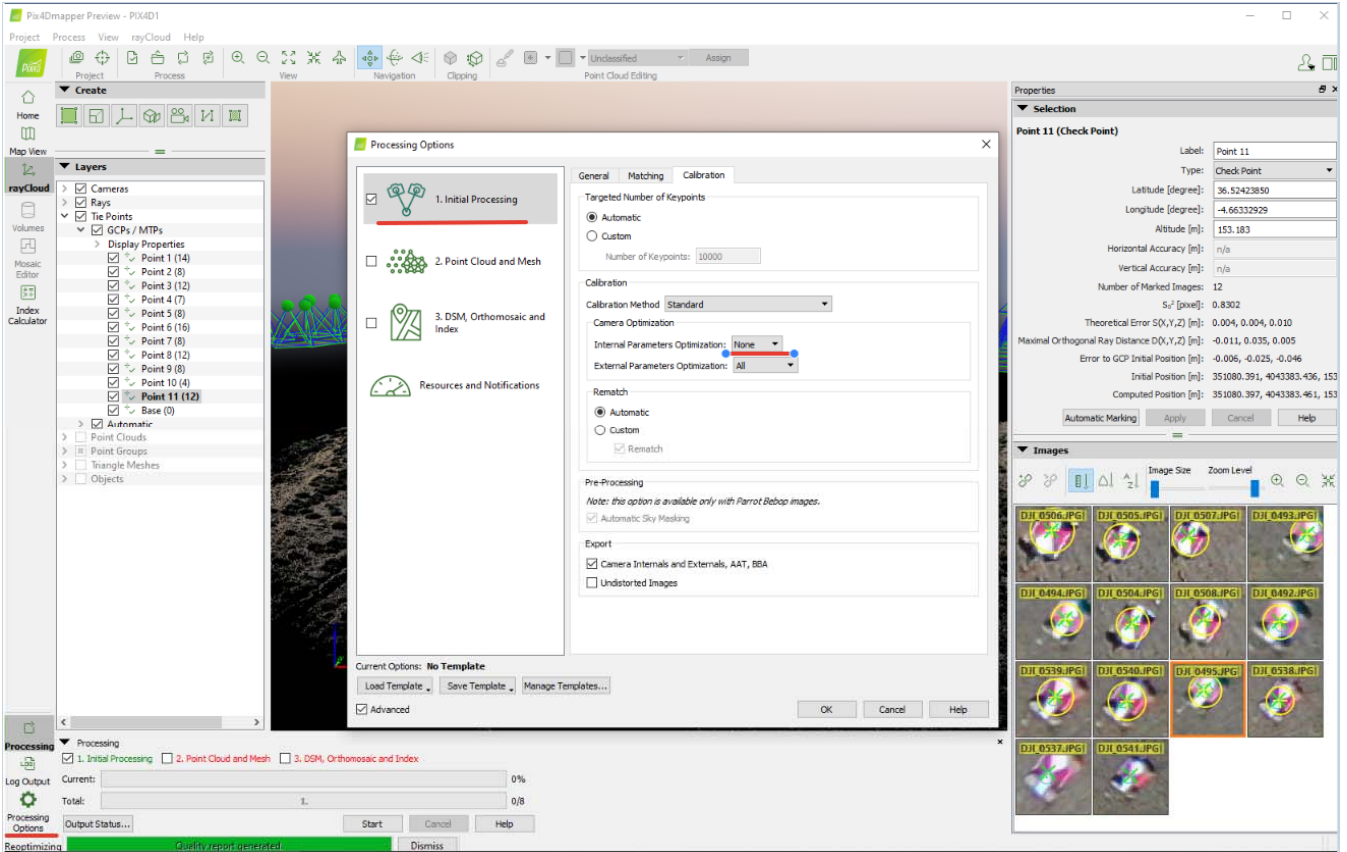
NOTICE. It will be possible to use the calibrated value of the focal length for the processing if you do not change your focus settings for the future flights.

3.4 Accuracy estimating

Load the ground control points. Set them up as check points. Select position of all check points at images to check accuracy.



Go to the Processing options menu. Select None for Internal Parameters Optimization. Click Ok. Click Reoptimize.



After finishing the optimization process go to Process Menu, click Generate quality report.

Data processing report will be generated. Go to Geolocation Details to estimate the accuracy of the project.

Quality Report - PIX4D1

Home PDF Back Forward

Online Support

				[degree]	[degree]	[degree]	Displacement X [m]	Displacement Y [m]	Displacement Z [m]
Mean	0.120	0.128	0.004	0.016	0.008	0.005	0.004	0.005	0.010
Sigma	0.073	0.074	0.001	0.004	0.002	0.002	0.001	0.001	0.002

Geolocation Details

Ground Control Points

1 out of 12 check points have been labeled as inaccurate.

Check Point Name	Accuracy XYZ [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
Point 1		-0.004	-0.031	-0.012	1.494	14 / 14
Point 2		-0.004	-0.046	-0.005	1.091	8 / 8
Point 3		0.011	-0.044	-0.003	0.706	12 / 12
Point 4		0.003	0.001	-0.025	0.777	7 / 7
Point 5		0.015	0.040	-0.040	0.791	8 / 8
Point 6		0.031	0.079	-0.010	0.485	16 / 16
Point 7		0.026	0.064	-0.037	1.135	8 / 8
Point 8		0.030	0.028	0.030	0.635	12 / 12
Point 9		0.020	0.019	-0.037	0.503	8 / 8
Point 10		0.020	-0.019	-0.084	0.916	4 / 4
Point 11		-0.006	-0.027	-0.046	0.808	12 / 12
Mean [m]		0.012876	0.005672	-0.024386		
Sigma [m]		0.013208	0.041314	0.028233		
RMS Error [m]		0.018446	0.041701	0.037306		

Localisation accuracy per GCP and mean errors in the three coordinate directions. The last column counts the number of calibrated images where the GCP has been automatically verified vs. manually marked.

Absolute Geolocation Variance

Min Error [m]

Max Error [m]

Geolocation Error X [%]

Geolocation Error Y [%]

Geolocation Error Z [%]

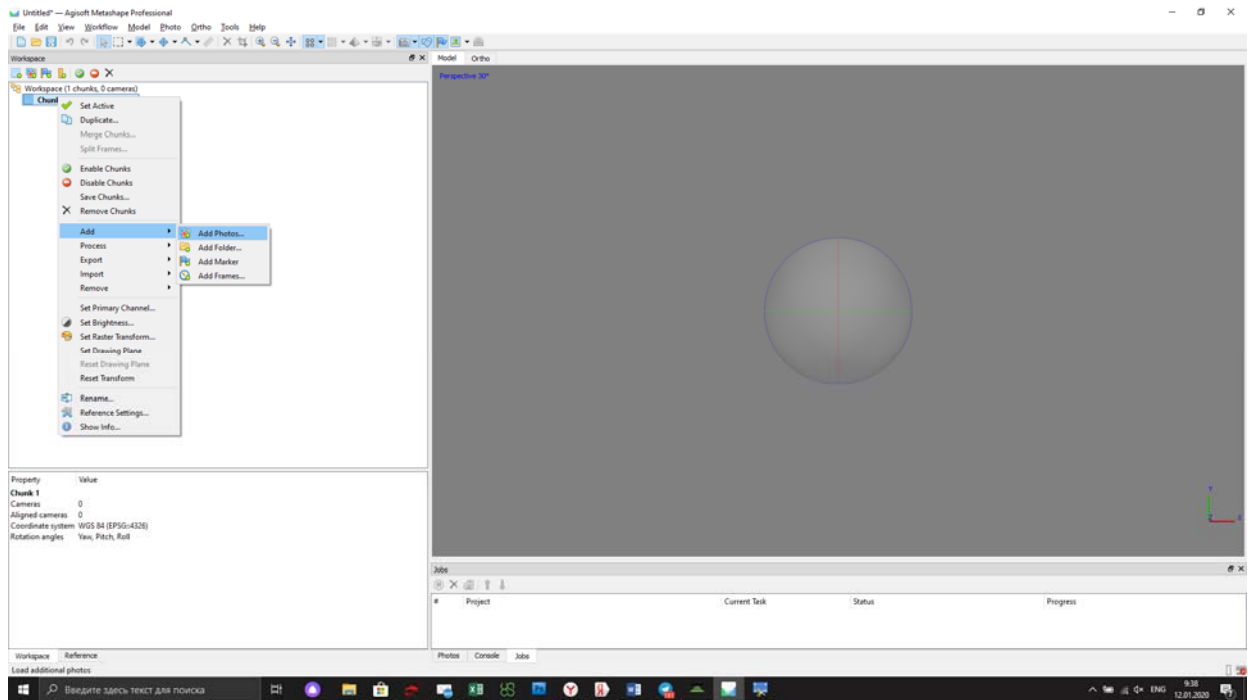
☒ Display Automatically after Processing

Close

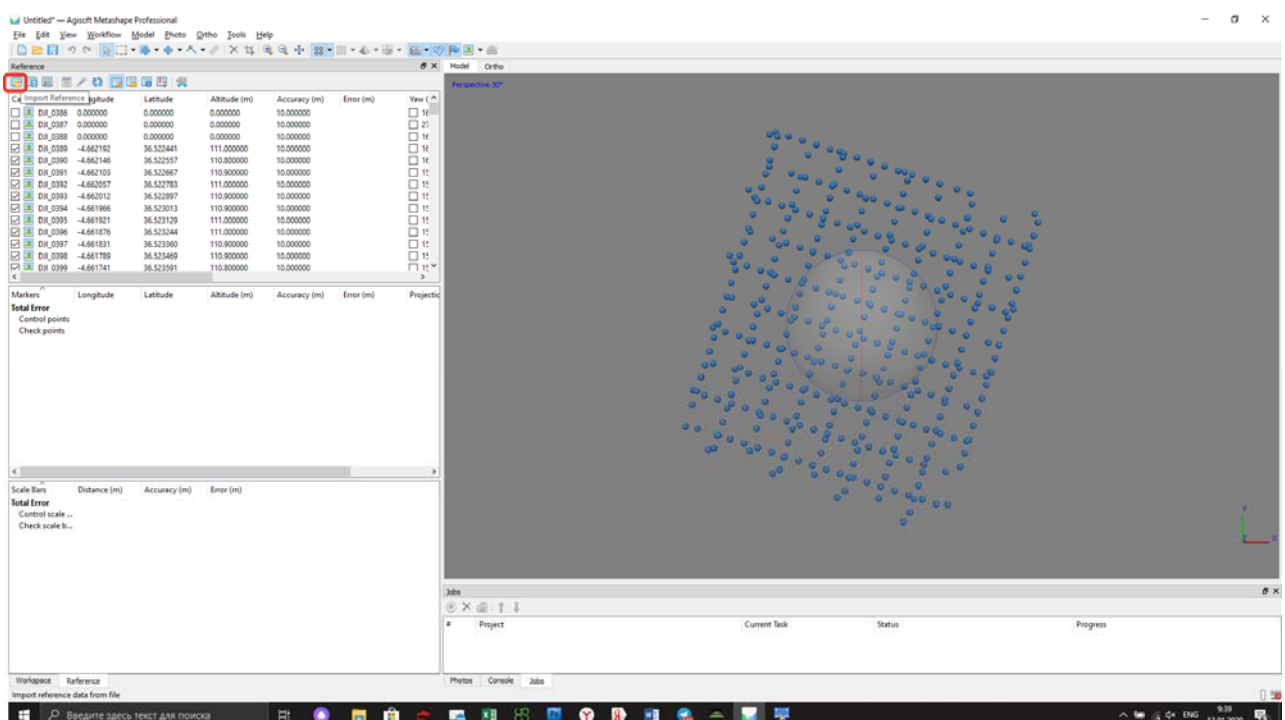
4. PHOTOGRAMMETRY PROCESSING IN AGISOFT METASHAPE SOFTWARE

4.1 Creating a project, photo alignment

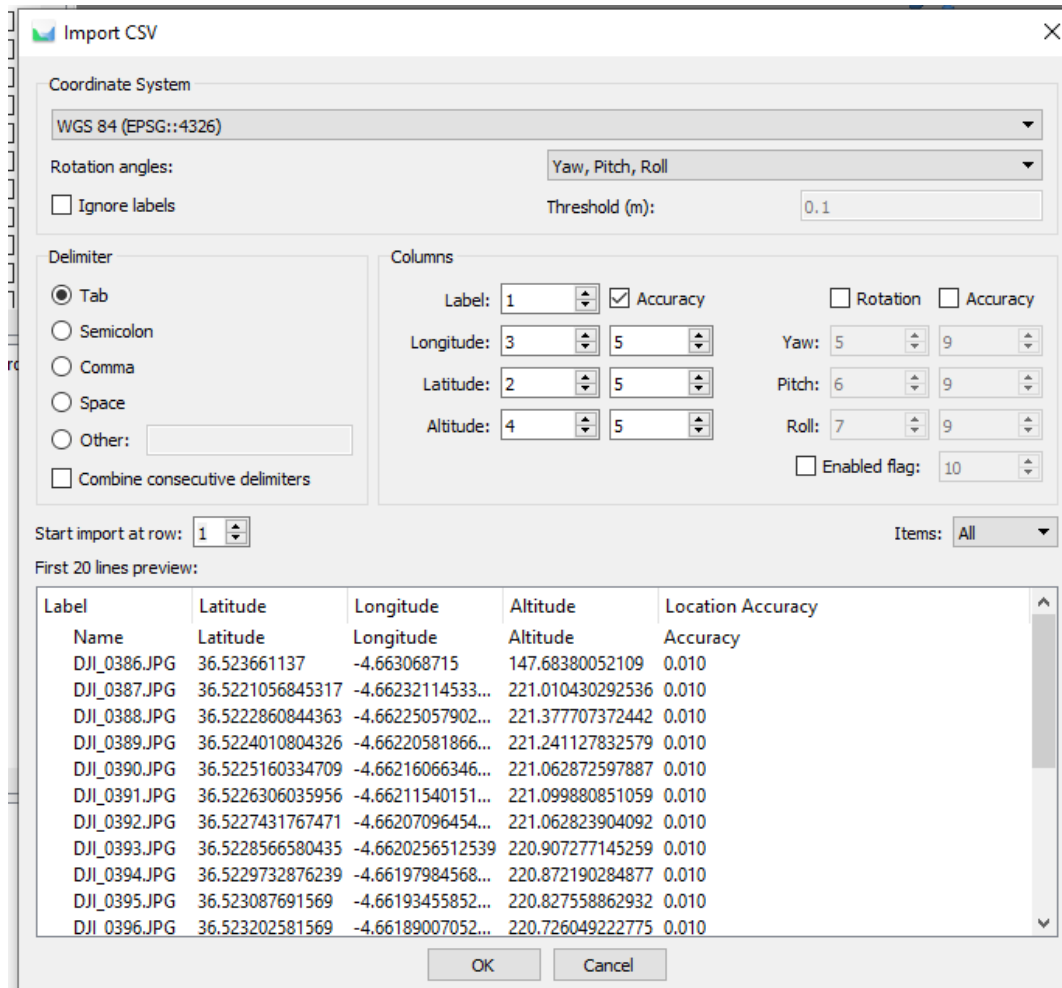
The following process should be performed in the Agisoft Metashape software. Add photos to the project.



Import positions from the file coordinates.txt. Go to Reference. Click Import button, select coordinates.txt file from folder with photos



Select WGS 84 coordinate system, setup columns order 1,3,2,4, click Accuracy checkbox, select field 5, click OK



Import CSV

Coordinate System: WGS 84 (EPSG::4326)

Rotation angles: Yaw, Pitch, Roll

☐ Ignore labels

Threshold (m): 0.1

Delimiter: ☒ Tab

Columns:

Label: 1 ☒ Accuracy ☐ Rotation ☐ Accuracy

Longitude: 3 5 Yaw: 5 9

Latitude: 2 5 Pitch: 6 9

Altitude: 4 5 Roll: 7 9

☐ Enabled flag: 10

Start import at row: 1

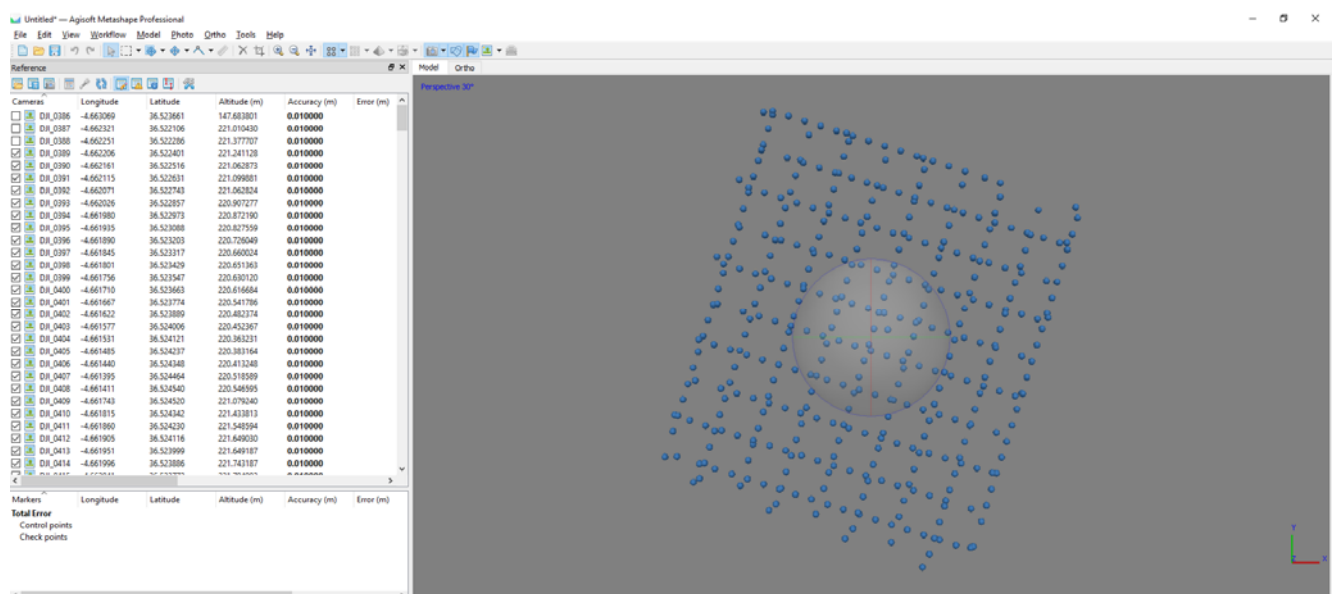
Items: All

First 20 lines preview:

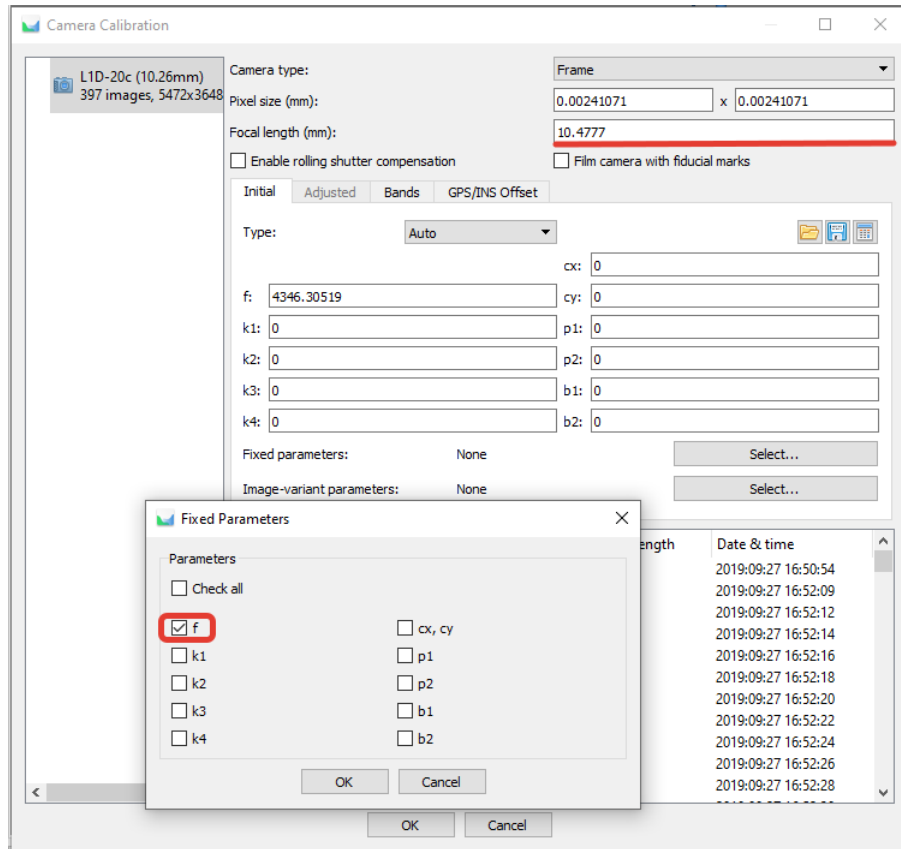
Label	Latitude	Longitude	Altitude	Location Accuracy
Name	Latitude	Longitude	Altitude	Accuracy
DJI_0386.JPG	36.523661137	-4.663068715	147.68380052109	0.010
DJI_0387.JPG	36.5221056845317	-4.66232114533...	221.010430292536	0.010
DJI_0388.JPG	36.5222860844363	-4.66225057902...	221.377707372442	0.010
DJI_0389.JPG	36.5224010804326	-4.66220581866...	221.241127832579	0.010
DJI_0390.JPG	36.5225160334709	-4.66216066346...	221.062872597887	0.010
DJI_0391.JPG	36.5226306035956	-4.66211540151...	221.099880851059	0.010
DJI_0392.JPG	36.5227431767471	-4.66207096454...	221.062823904092	0.010
DJI_0393.JPG	36.5228566580435	-4.6620256512539	220.907277145259	0.010
DJI_0394.JPG	36.5229732876239	-4.66197984568...	220.872190284877	0.010
DJI_0395.JPG	36.523087691569	-4.66193455852...	220.827558862932	0.010
DJI_0396.JPG	36.523202581569	-4.66189007052...	220.726049222775	0.010

OK Cancel

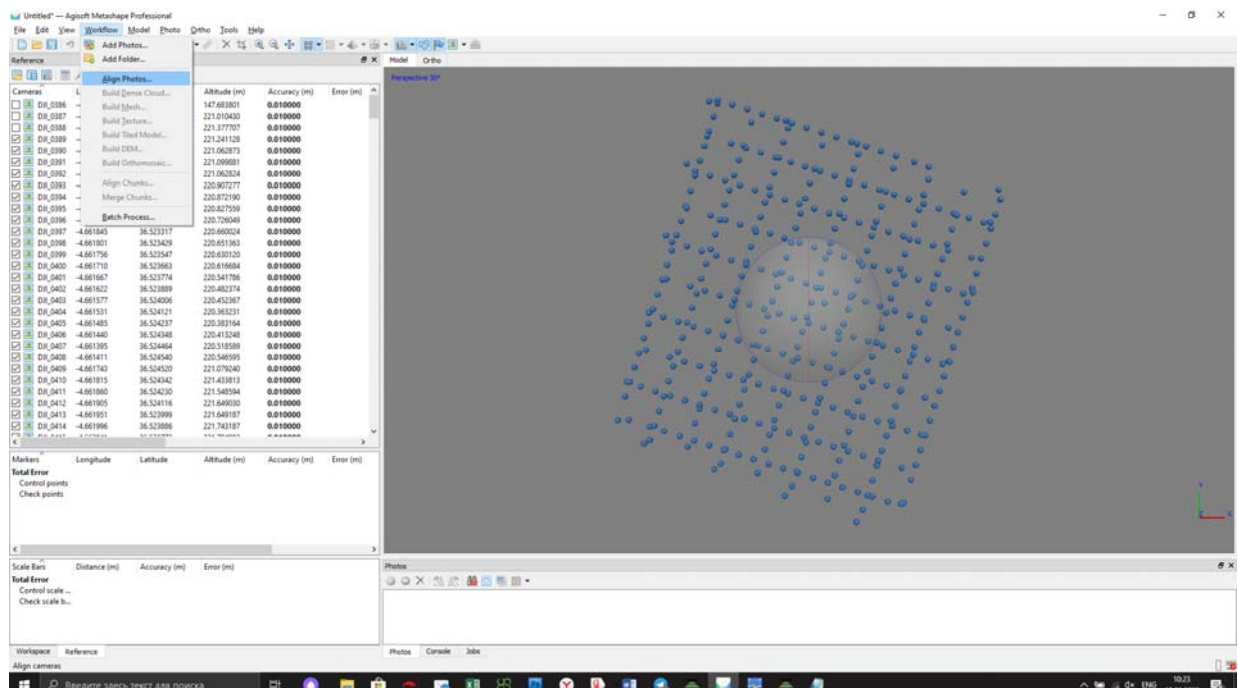
Accurate X,Y,Z coordinates and accuracy values will appear in the Reference window



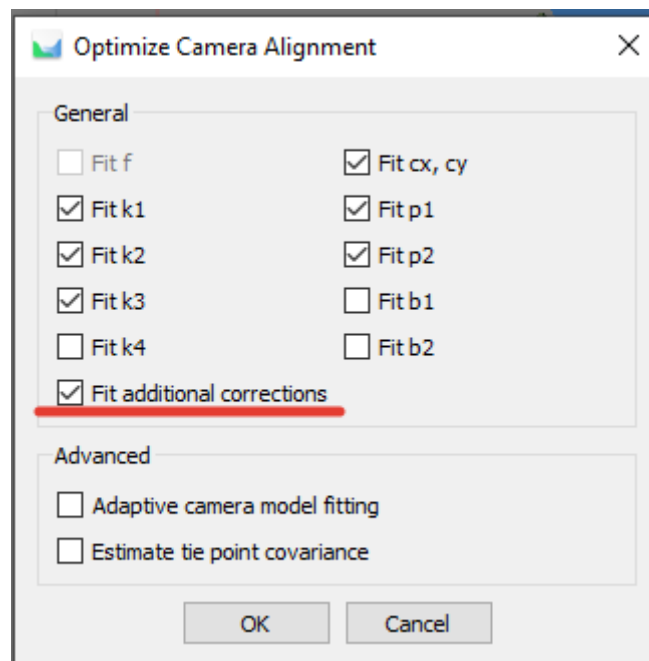
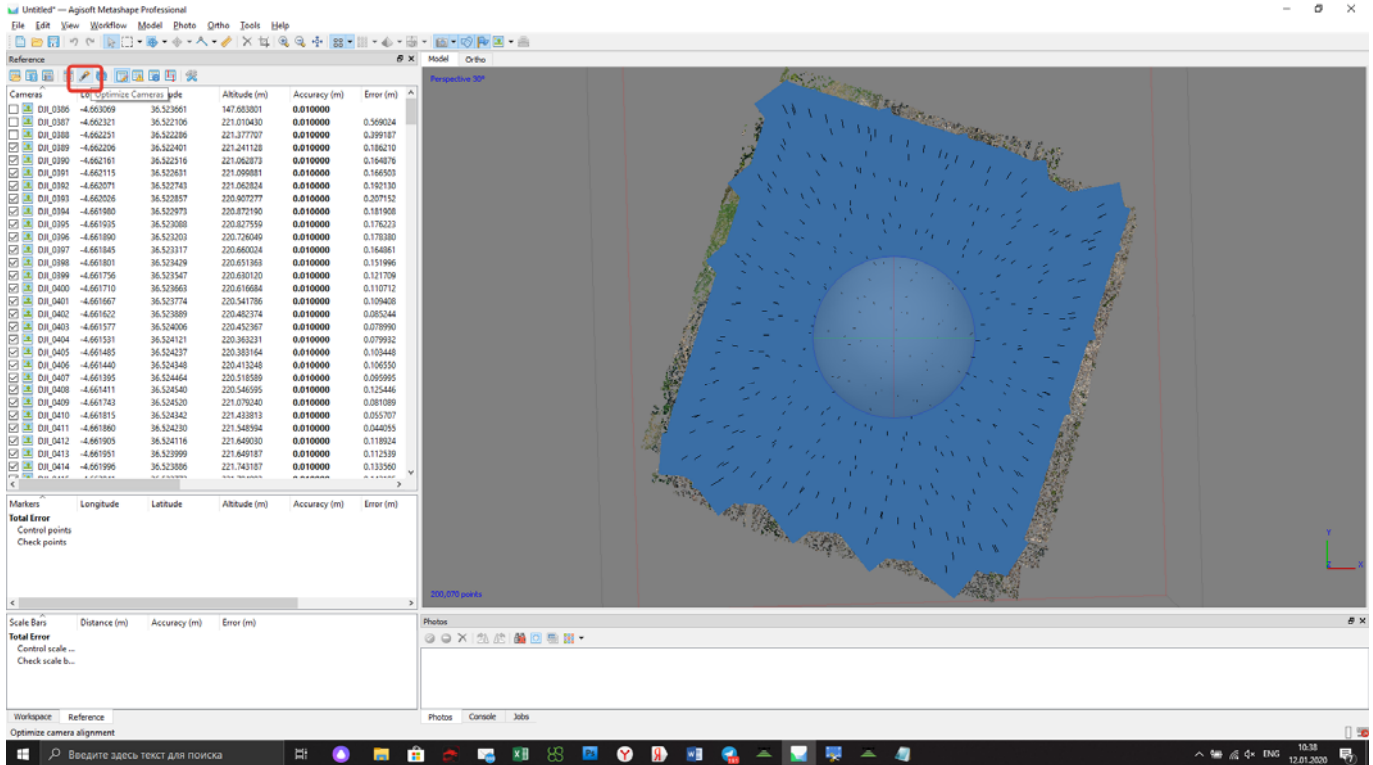
Go to Tools, click Camera calibration and input the calibrated parameter for focal length 10.4777, select fixed F parameter



Go to Workflow and click Align Photos for aerial triangulations

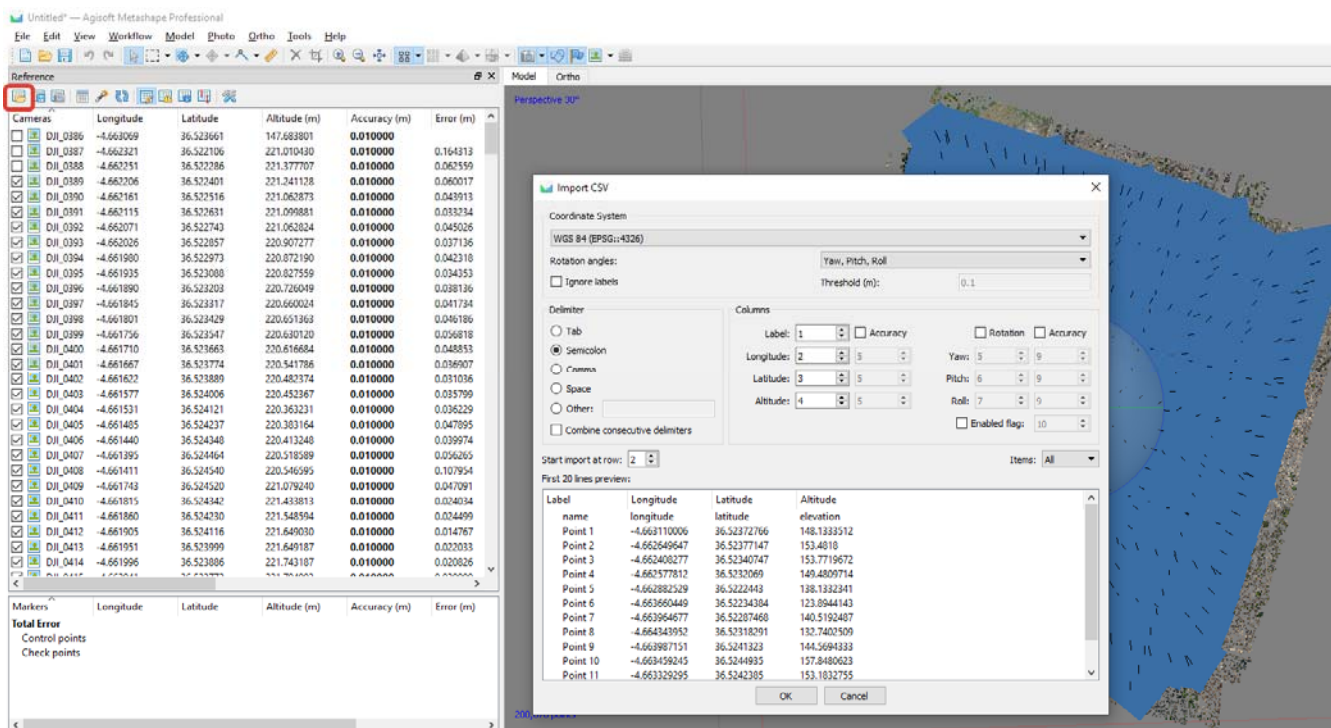


After finishing the aerial triangulation go to the Reference, click "Optimize Camera Alignment" and click on Fit additional corrections check box. Click OK.

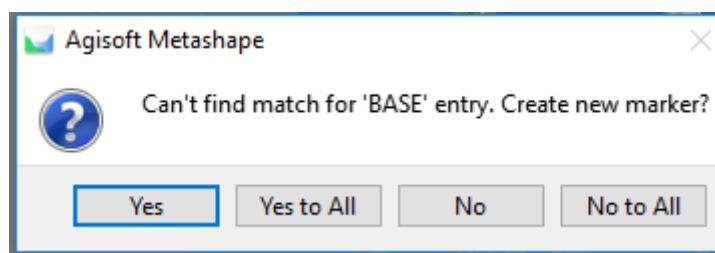


4.2 Accuracy estimating

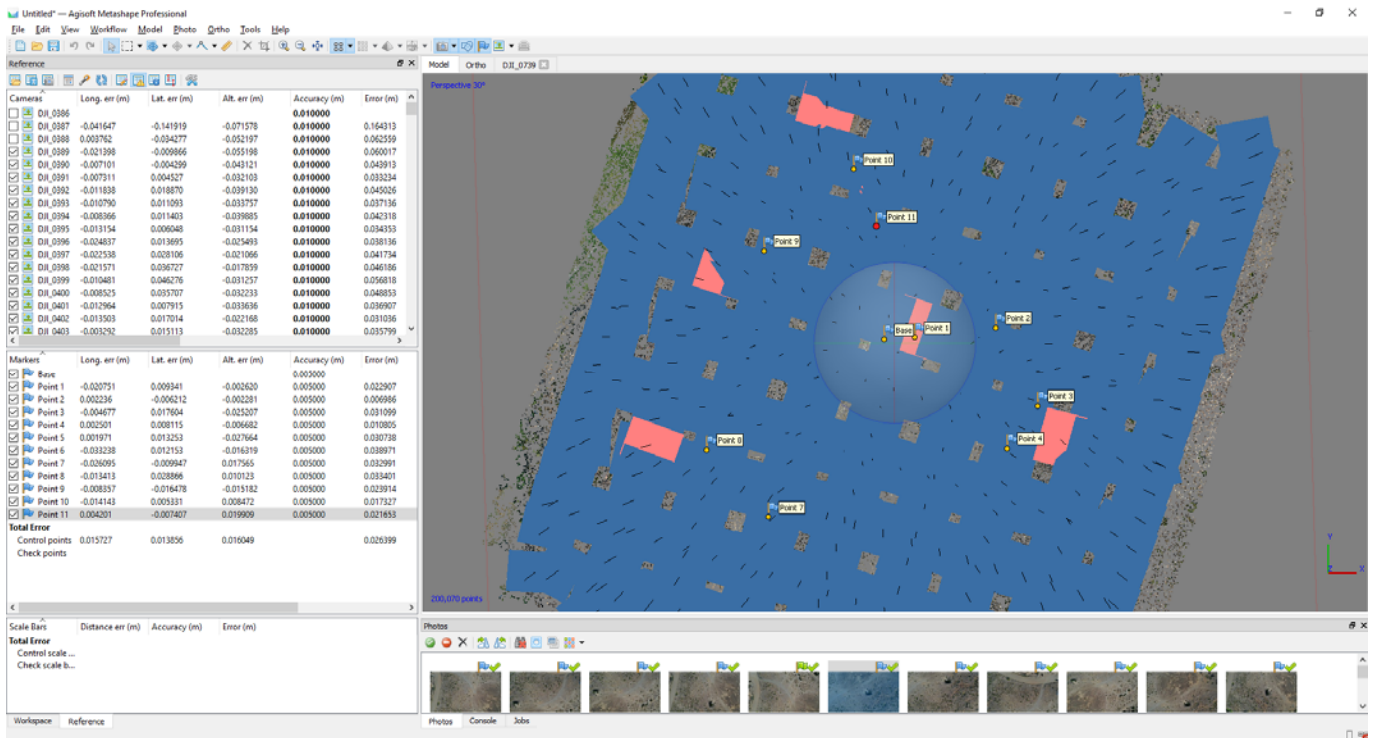
After finishing the aerial triangulation go to the Reference, click "Import" and load the GCP.txt file. Use the following settings and click OK



Click «Yes to All» button. GCPs will be shown at the Model window.



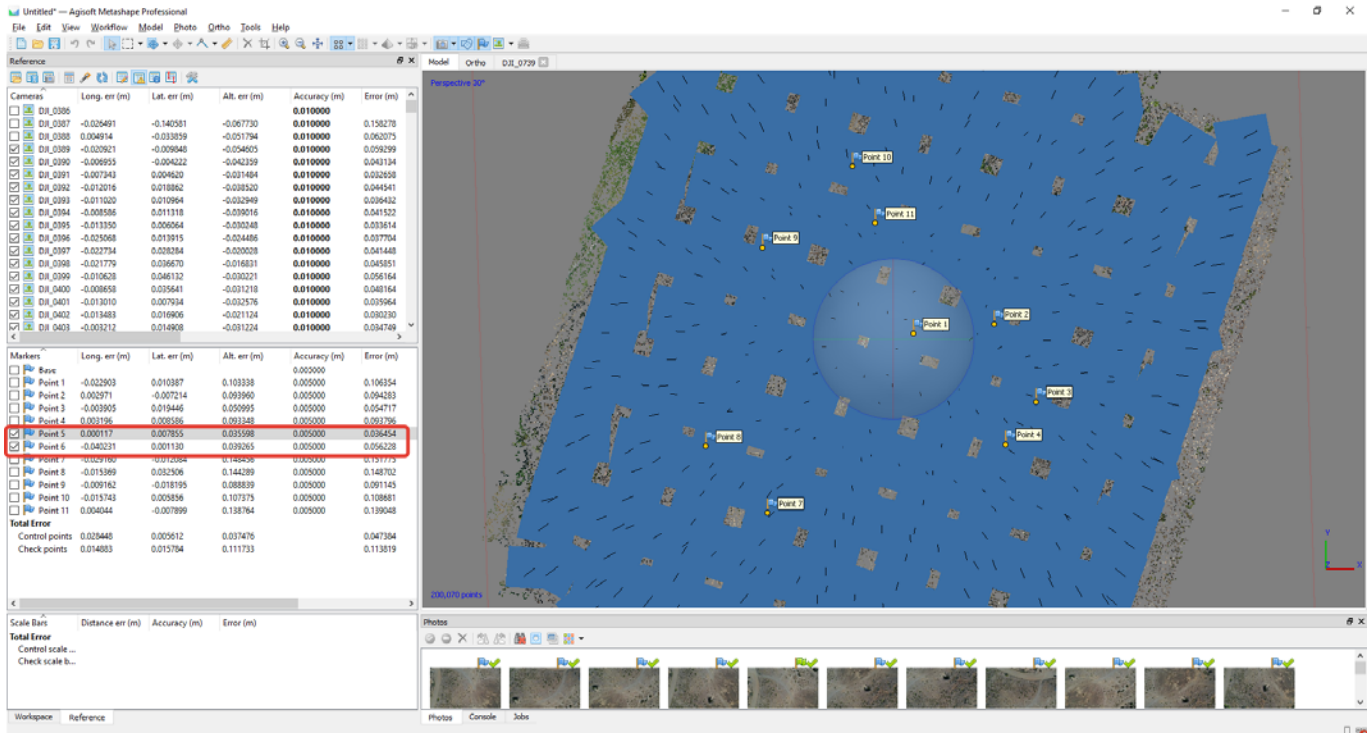
Select the locations of each GCP on photos and look at accuracy report



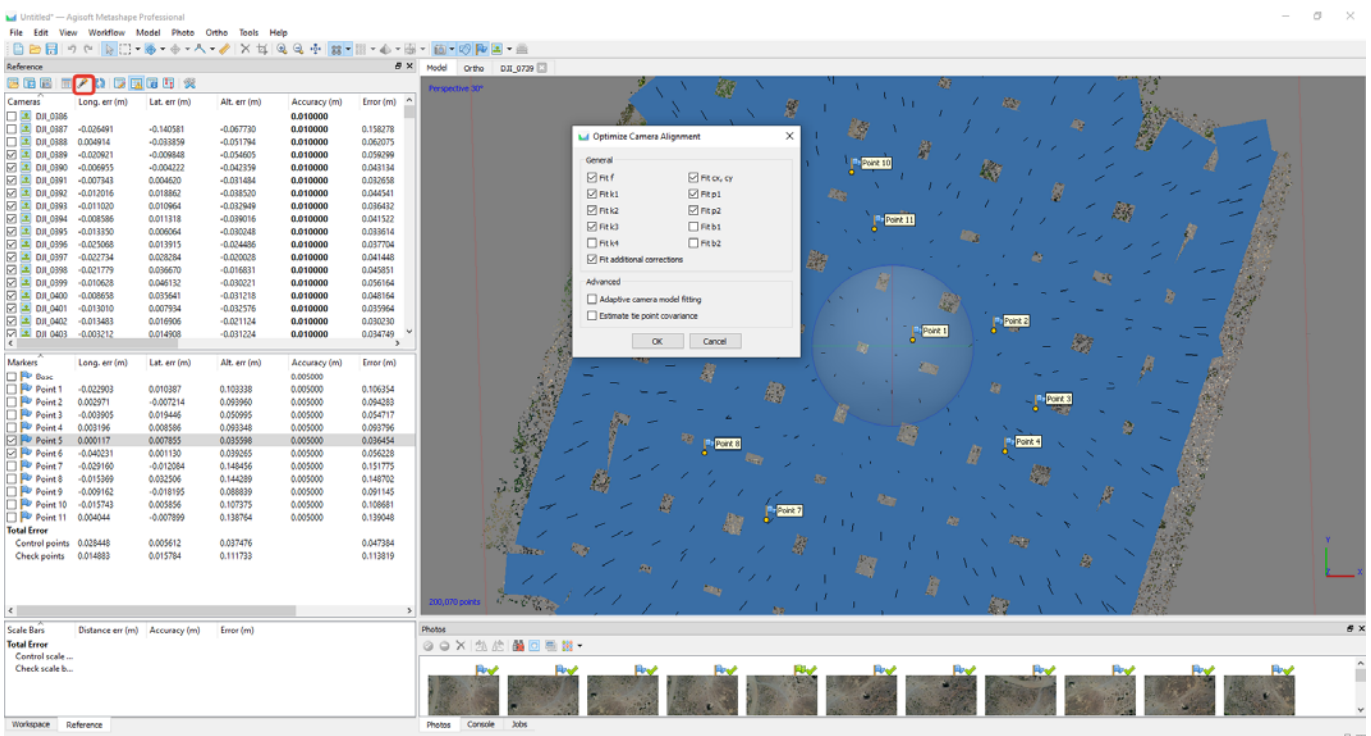
Markers	Long. err (m)	Lat. err (m)	Alt. err (m)	Accuracy (m)	Error (m)
<input checked="" type="checkbox"/> Base				0.005000	
<input checked="" type="checkbox"/> Point 1	-0.020751	0.009341	-0.002620	0.005000	0.022907
<input checked="" type="checkbox"/> Point 2	0.002236	-0.006212	-0.002281	0.005000	0.006986
<input checked="" type="checkbox"/> Point 3	-0.004677	0.017604	-0.025207	0.005000	0.031099
<input checked="" type="checkbox"/> Point 4	0.002501	0.008115	-0.006682	0.005000	0.010805
<input checked="" type="checkbox"/> Point 5	0.001971	0.013253	-0.027664	0.005000	0.030738
<input checked="" type="checkbox"/> Point 6	-0.033238	0.012153	-0.016319	0.005000	0.038971
<input checked="" type="checkbox"/> Point 7	-0.026095	-0.009947	0.017565	0.005000	0.032991
<input checked="" type="checkbox"/> Point 8	-0.013413	0.028866	0.010123	0.005000	0.033401
<input checked="" type="checkbox"/> Point 9	-0.008357	-0.016478	-0.015182	0.005000	0.023914
<input checked="" type="checkbox"/> Point 10	-0.014143	0.005331	0.008472	0.005000	0.017327
<input checked="" type="checkbox"/> Point 11	0.004201	-0.007407	0.019909	0.005000	0.021653
Total Error					
Control points	0.015727	0.013856	0.016049		0.026399
Check points					

4.3. Camera calibration

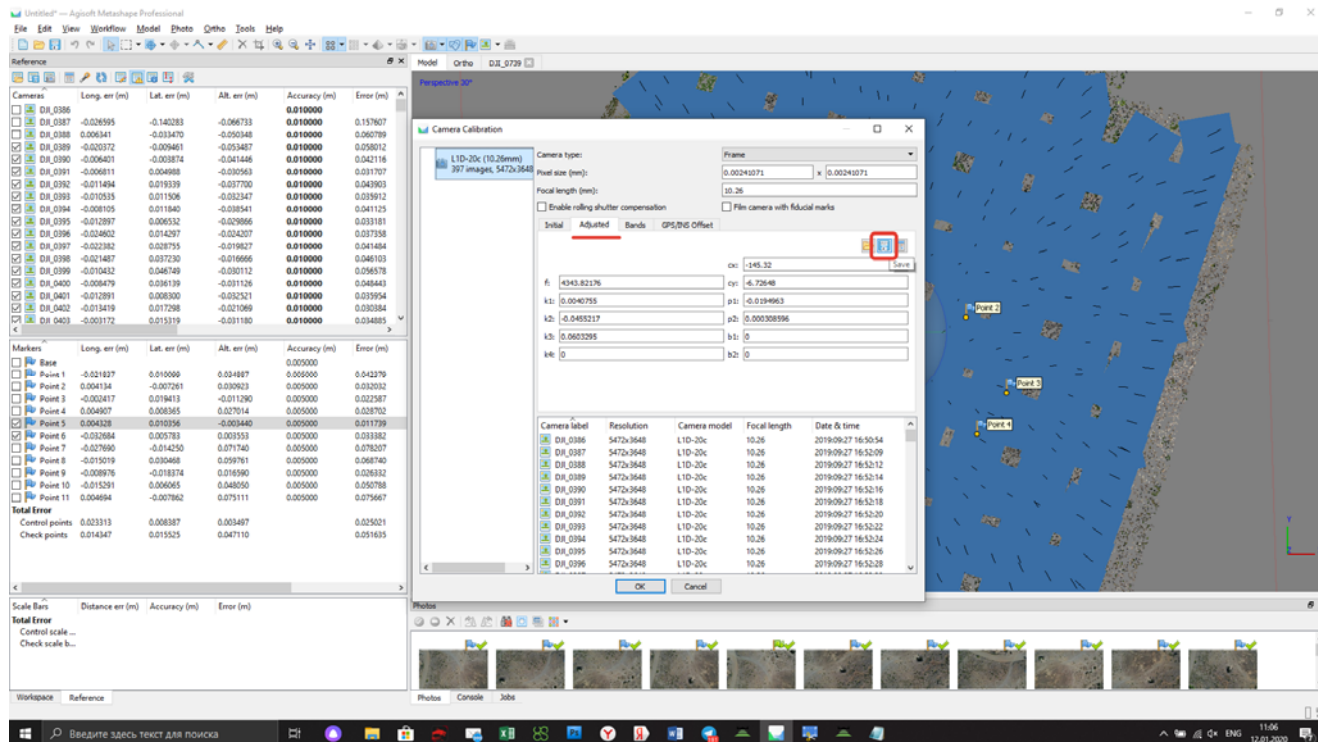
To calibrate your camera focal length, load the images, import accurate coordinates of photos, perform the photo alignment (do not fix F parameter) and import the GCPs. Define the position of every marker on each photo. Select 2-3 markers.



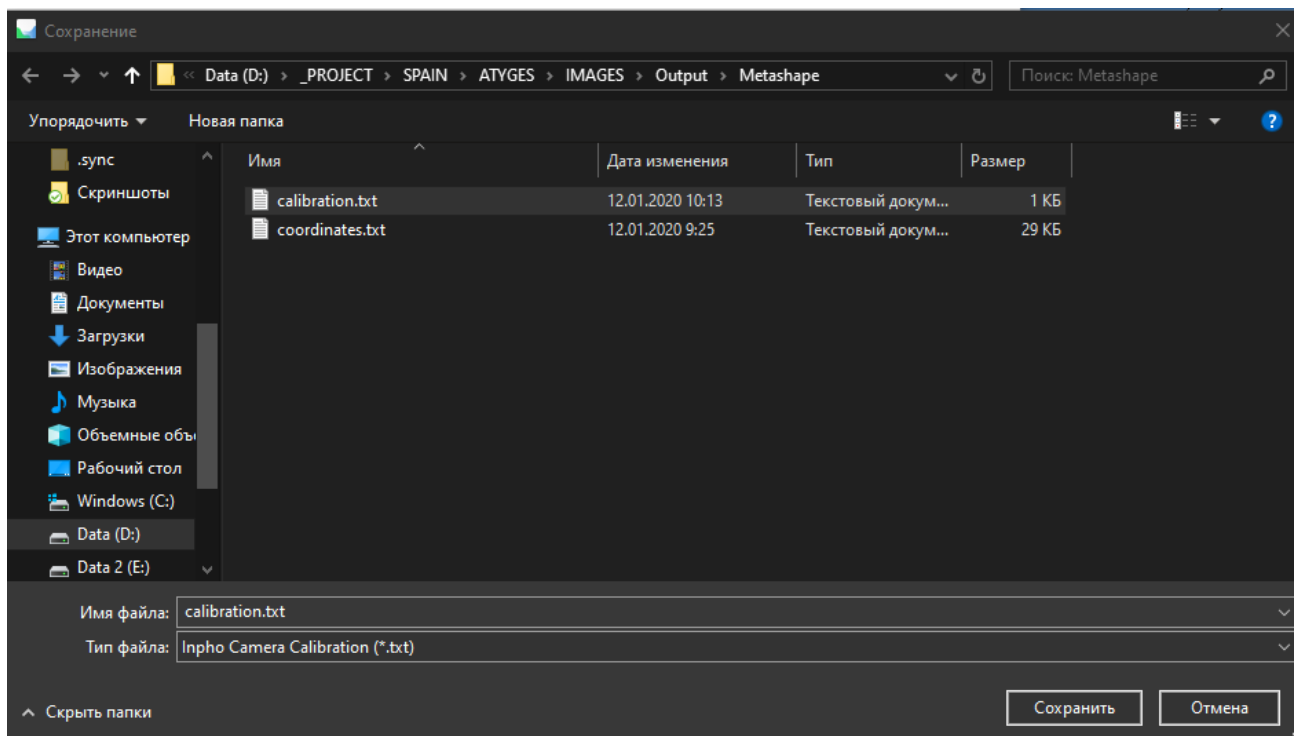
Click Optimize camera Alignment, use the following settings and click OK



After finishing the aerial triangulation, go to Tools, click Camera calibration. Select adjusted and Save button.



Select Info Camera Calibration format and save file.



Open txt file and copy the focal length value

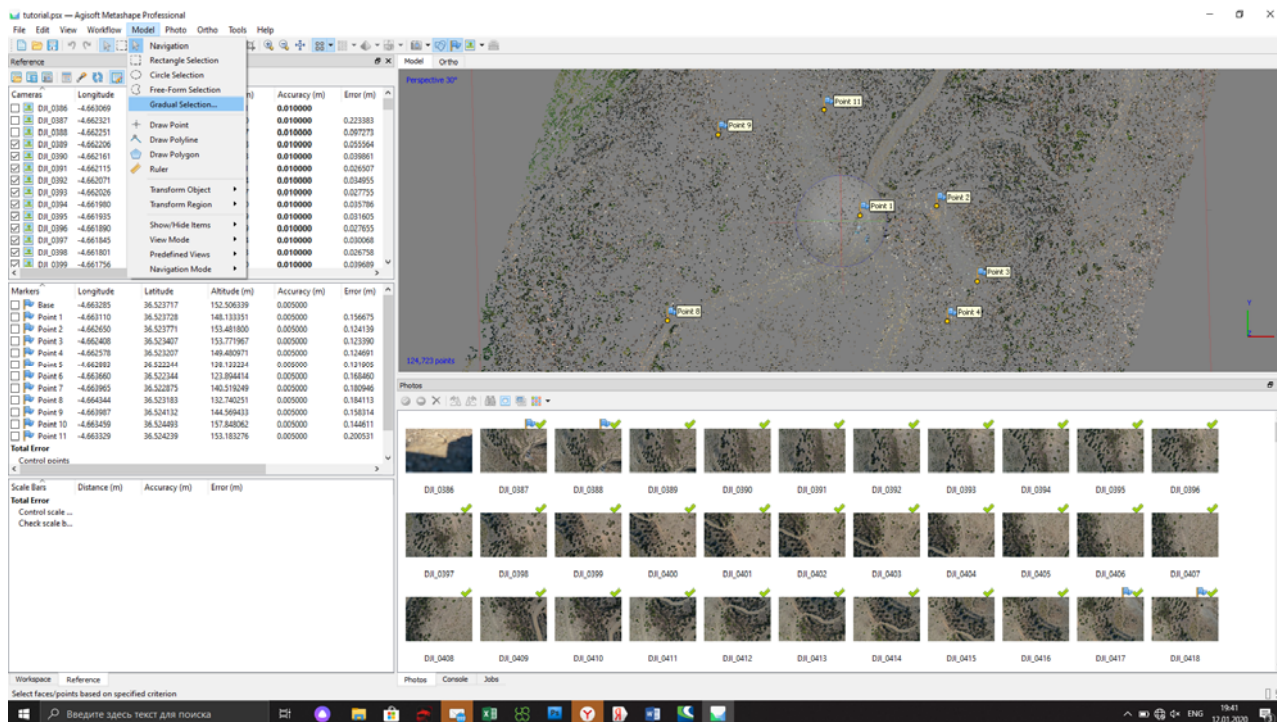
```
$CAMERA
$TYPE : FC6510_(8.8mm)
$DATE : 00:30:57 06/11/2019
$BRAND : Custom
$KIND : CCDFrame
$CCD_INTERIOR_ORIENTATION :
  414.545      -0      2723.86
  0.0000000000 -414.545  1821.52
$CCD_COLUMNS : 5472
$CCD_ROWS : 3648
$PIXEL_REFERENCE : CenterTopLeft
$FOCAL_LENGTH : 8.81713
$PRINCIPAL_POINT_PPA : 0.000000 0.000000
$DISTORTION_TYPE : Polynomial
$RADIAL_COEFFS :
      0      5.32009e-005      -1.30922e-006      1.72296e-008
    -6.46663e-012      0      0      0
$DECENTRE_COEFFS :
    -5.63946e-005      5.98996e-008      0      0
$GPS_ANTENNA_OFFSET : 0.000000 0.000000 0.000000
$CAMERA_MOUNT_ROTATION : 0.000000
```

NOTICE. It will be possible to use the calibrated value of your camera's focal length for the processing in future, if you do not change your focus settings.

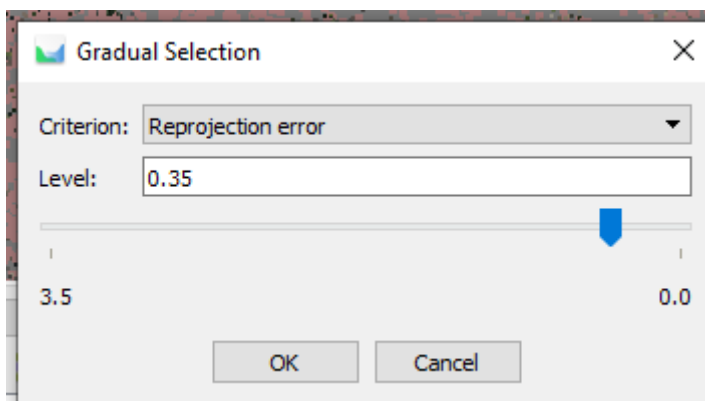
NOTICE. It is possible to use the calibrated value of your camera's focal length for the processing if you do not change focus settings for future flights.

4.4. Aerial triangulation accuracy improvement. Tie points filtering

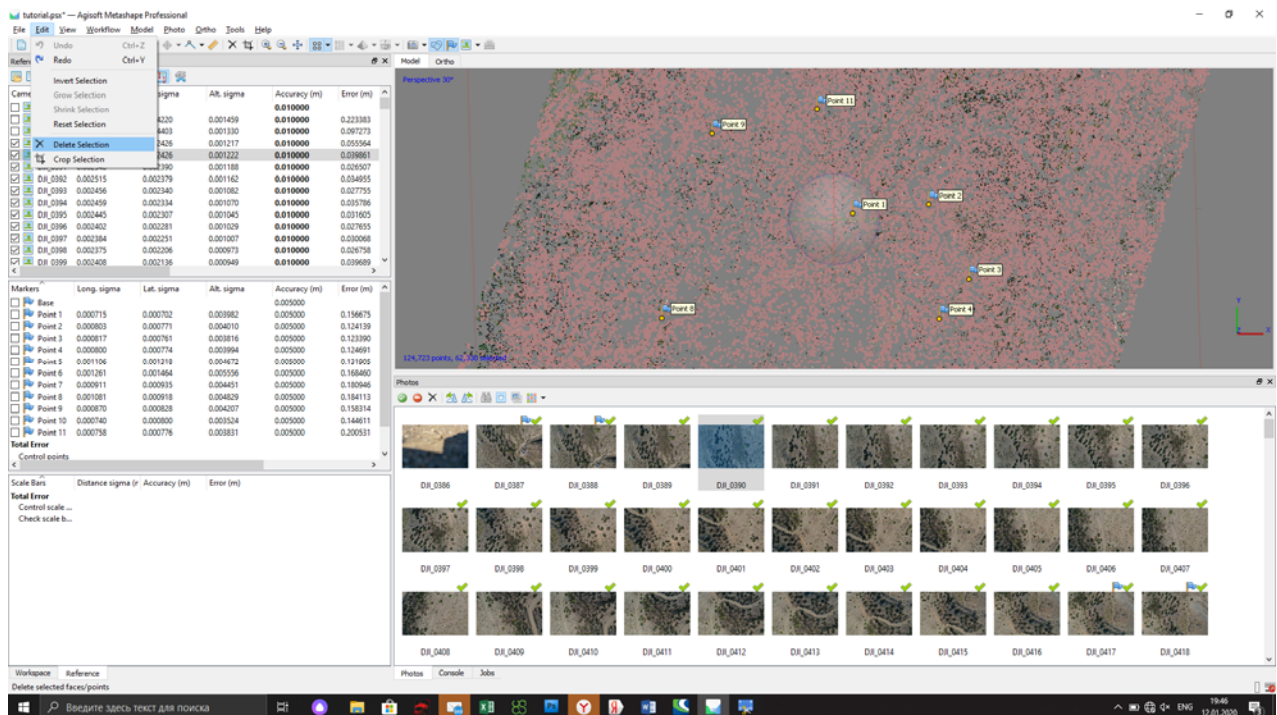
In order to increase the accuracy of your model, we suggest filtering tie points with the Gradual Selection tool. Open Model menu, click Gradual Selection.



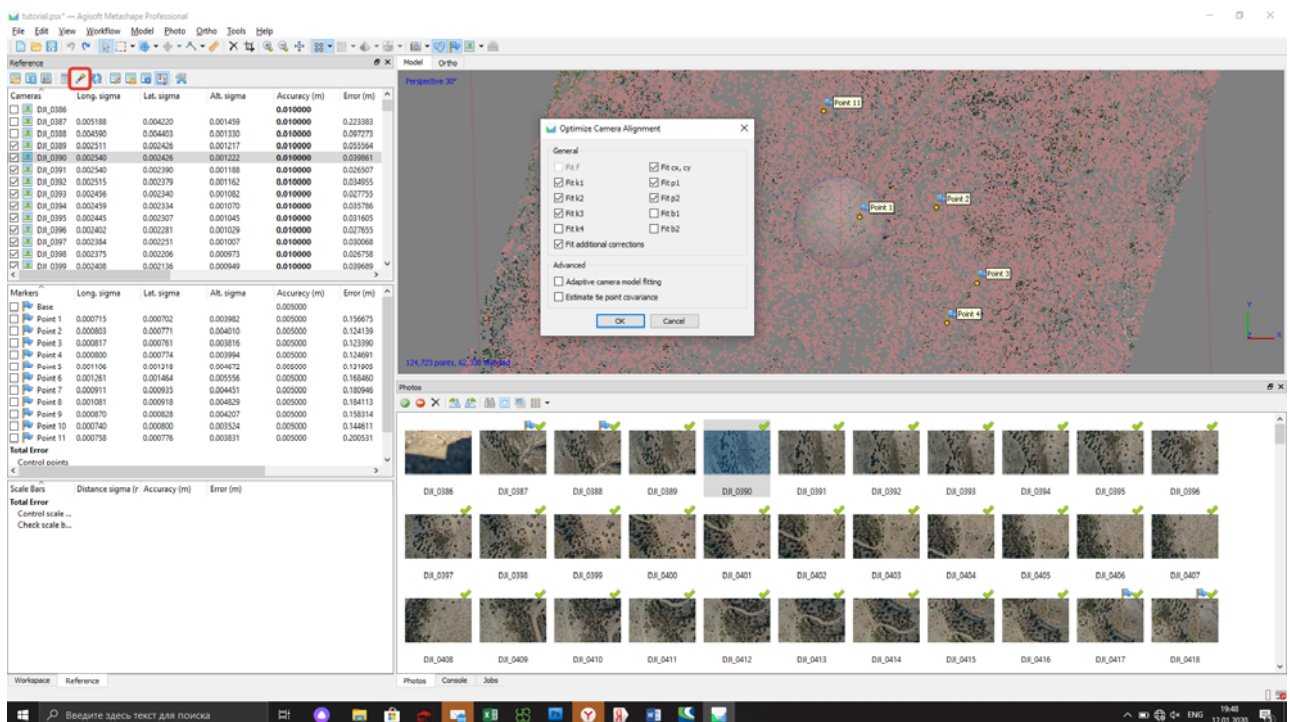
Select Gradual selection and input 0.35 value



Go to Edit menu and delete the selected points



Click "Optimize Camera Alignment"



Check the accuracy and repeat the steps described above until the Reprojection error reaches 0.65-0.35 value.