

# **TOPODRONE DJI M200 L1/L2 PPK**

## **USER MANUAL**



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## 1. Drone preparation

### 1.1 First steps before work

Topodrone DJI Matrice 200 V2 L1/L2 PPK + X4S is a ready-to-fly geodetic survey solution which is based on DJI Matrice 200 V2. It is strongly recommended to learn DJI P4P manual first, you can find it on the official web-site: <https://www.dji.com/matrice-200-series-v2/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 all our solution.

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 you had drone in a public use. Always check your Topodrone DJI Matrice 200 V2 L1/L2 RTK/PPK (+X4S) before large orders and far business trips.
2. **Зарядка.** You should charge all batteries of the drone (TB55), remote controller (WB37) and mobile device up to 100%. Never use DJI Intelligent Battery which is charged lower than 90%, especially if battery has started its storage discharging. It can cause premature termination of the flight mission.
3. **Exploring.** Before move to the working area, explore locality in the on-line geo-services like [DJI GEO](#), [AirMap](#), and [PilotHub](#), to provide yourself more knowledge about 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 Pilot<sup>1</sup> App set all parameters for comfort flying in a manual mode:
  1. Distance limit – “turn off” value is recommended
  2. Maximum Flight Altitude – 500 meters<sup>2</sup> value is recommended
  3. Return to home altitude – 100 meters or higher value is recommended. Anyway it changes during the mission planning in the other apps.
  4. RC MODE settings – changes axes of the sticks, value 2 is strongly recommended
  5. EXP tuning – provides you control drone more accurate, 0.10 value is recommended
  6. RC signal lost – action which drone would make if lost RC signal. Value “Return to home” is recommended
  7. Low battery warning – 30% value is recommended<sup>3</sup>



NOTICE 1. DJI Pilot App is the basic application for DJI Drones. You could not set several parameters via other apps. It is recommended to make manual flights using DJI Pilot App.

NOTICE 2. In some countries maximum allowed flight altitude for UAV is 120 meters. Setting 500 meters value in maximum flight altitude menu provide drone follow the terrain, flies higher than 120 meters from the altitude of home point, but not from the terrain.

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

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

## 1.2 Compass calibration.

As the basic model, Topodrone DJI Matrice 200 V2 L1/L2 RTK/PPK (+X4S) 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, accelerometer and compass makes two rotations in different axes. After that, drone makes adjustment between values of each sensors. To make correct CC follow next steps:

1. CC makes directly before flight at the open outdoor area. Making CC indoor is useless
2. It is allowed to make DJI M200 V2 compass calibration when the DJI X4S gimbal is removed.
3. Turn on the drone and RC, insert and plug the mobile device.
4. Make sure, there are no large metal constructions or magnetic fields sources in 50 meters.
5. Enter drone into CC mode. At least there are two ways:
  - a) In the DJI Pilot 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 A positions not less than 4 times.
6. Ensure that rear LEDs of the drone lights solid yellow.
7. Put RC to the ground and take the drone with both hands. Hold drone for it's arms horizontally. Do not change the orientation of the drone!
8. Rotate drone to the left side (counter-clock wise) in 380 degrees (a bit more than 360 degrees). Stop when the rear LEDs will change color from solid yellow to solid green.
9. Change orientation of the drone, turning it in 90 degrees in a longitudinal axis.
10. Rotate drone to the left side (counter-clock wise) in 380 degrees (a bit more than 360 degrees). Stop when the rear LEDs will change color from solid green to blinking green.
11. If using 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 Pilot App – it should be at the green zone after CC. If the app notice you compass calibration failed (rear LEDs blinks red rapidly) – recalibrate compass at another place nearby.

Notice 1: no magnetic or ferromagnetic objects on the body of pilot are allowed. For example: massive jewelry, metal inserts or magnets in the end 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 increase flight stability of the drone during the flight. But compass error can appear even after absolutely correct calibration. It usually caused by different external interferences such are metal objects, large antennas, electricity transmission lines (ETL).

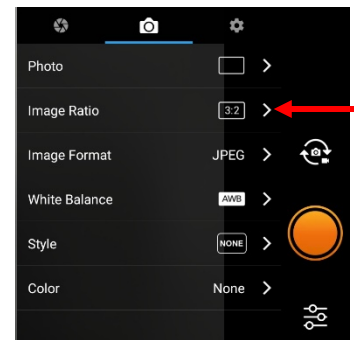


### 1.3. Camera calibration and settings

Before the shooting process will be started, you should calibrate focus of your DJI X4S camera and set optimal image settings. It is recommended to use next order.

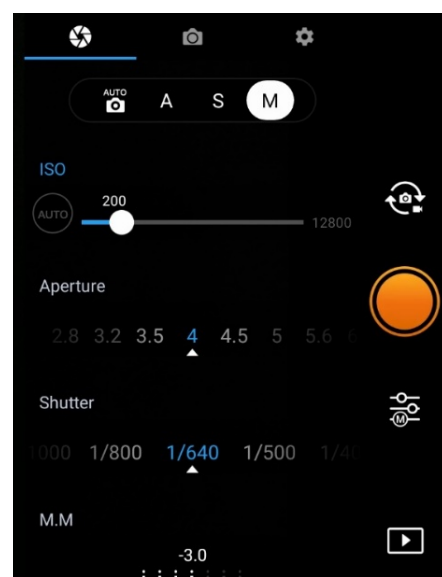
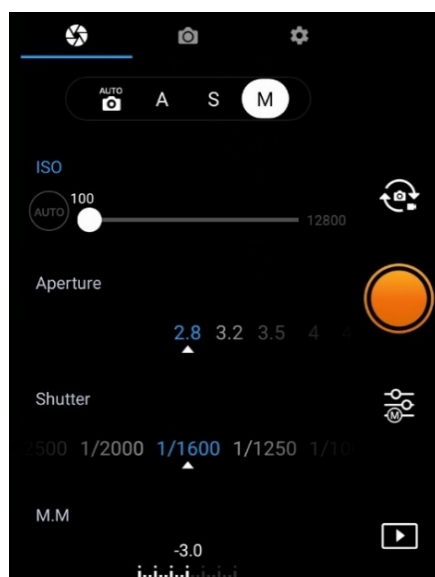
Before the shooting process will be started, you should calibrate focus of your DJI X4S PPK camera and set optimal image settings. It is recommended to use next order.

1. You should determine 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 is from 60 to 120 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 square of camera's matrix. Do not use 16:9 Ratio! Check another values of this menu – all defaults.
3. Lift off the drone to the working altitude and move gimbal to the 90 degrees (nadir). Ensure that focusing method now is in the AF value. Then tap to the center of the screen to let the camera focusing at the surface. After that change focusing method in the MF value - manual focus scale will appear. Do not touch it! Now drone's camera is focused at the selected height value. It will not change in the future.
4. Now it's time to set the best camera settings. All parameters are at auto as default. In this case, drone will change image brightness, smoothness during the flight. But this way is bad for triangulation image processing: 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.

**Shutter value higher than 1/1600 will not allow to mark GNSS tags!!!**



## 1.4. IMU calibration and settings

IMU calibration needs very rarely. However, some things can affect the sensor states: falls and bumps, temperature changes and long stand by time. Because of use the additional module upper the shell of Topodrone DJI Matrice 200 V2 L1/L2 RTK/PPK, the process of IMU calibration is not the same as the default. To calibrate IMU you need to do next:

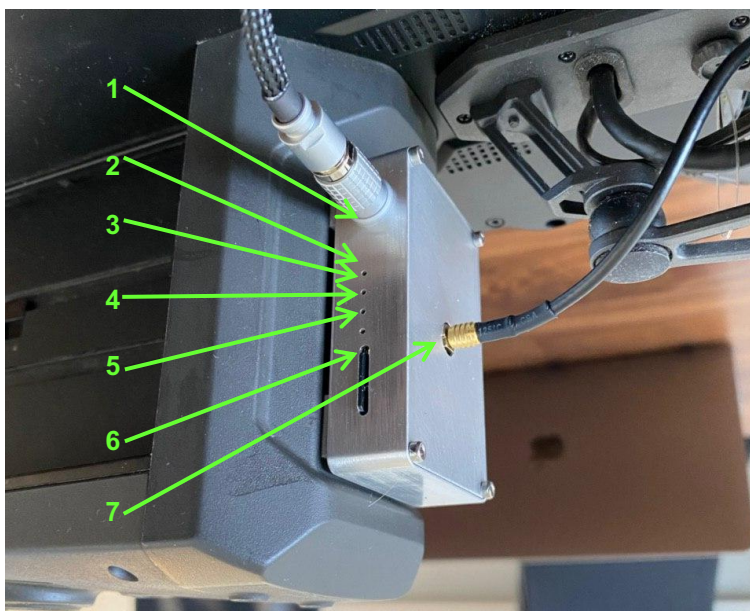
1. Remove props from the motors if needed
2. Remove gimbal from the drone (recommended)
3. Turn on the drone and the remote controller
4. Prepare a flat solid table, the horizon should be aligned to the bubble level
5. Start the IMU calibration process and make steps 1-5 as they are.
6. At step 6 you should place the drone head over heels. Fold the GNSS antenna to transport position. Place your drone like at the photo below (landing gears removed for a clarity)



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

## 1.5. Устройство и настройки GNSS приемника

GNSS module locates in the front of the DJI M200 battery module in special metall shell. The receivers body has four LED indicators, two cable ports and micro-SD socket.



1. Cable of the GNSS receiver module and the modified DJI x4s suspension
2. Green LED. Notifies that the module has received power.
3. Orange LED. Shows the state of writing to the memory card. It blinks rapidly during recording. Each blink responds to a record of 4 KB of data.
4. Blue LED. Reports the quality of the GNSS antenna signal:

| LED State      | Description |
|----------------|-------------|
| Off            | PDOP>10     |
| Blinks slowly  | 3<PDOP<10   |
| Blinks rapidly | 2<PDOP<3    |
| Solid          | PDOP<2      |

5. Red LED. Shows the critical of errors in the system. If an error occurs, check the memory card. If replacing or reconnecting/formatting the micro-SD card does not solve the problem, contact customer support.
6. Micro-SD card socket.
7. Coaxial cable of the GNSS antenna.

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 creates only after GNSS caught 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 SD card with images from a drone and copy photos to your computer.

Divide a whole images dataset to 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 SD card from GNSS receiver installed on the drone and copy ubx files to your computer to a folder ROVER (for example).

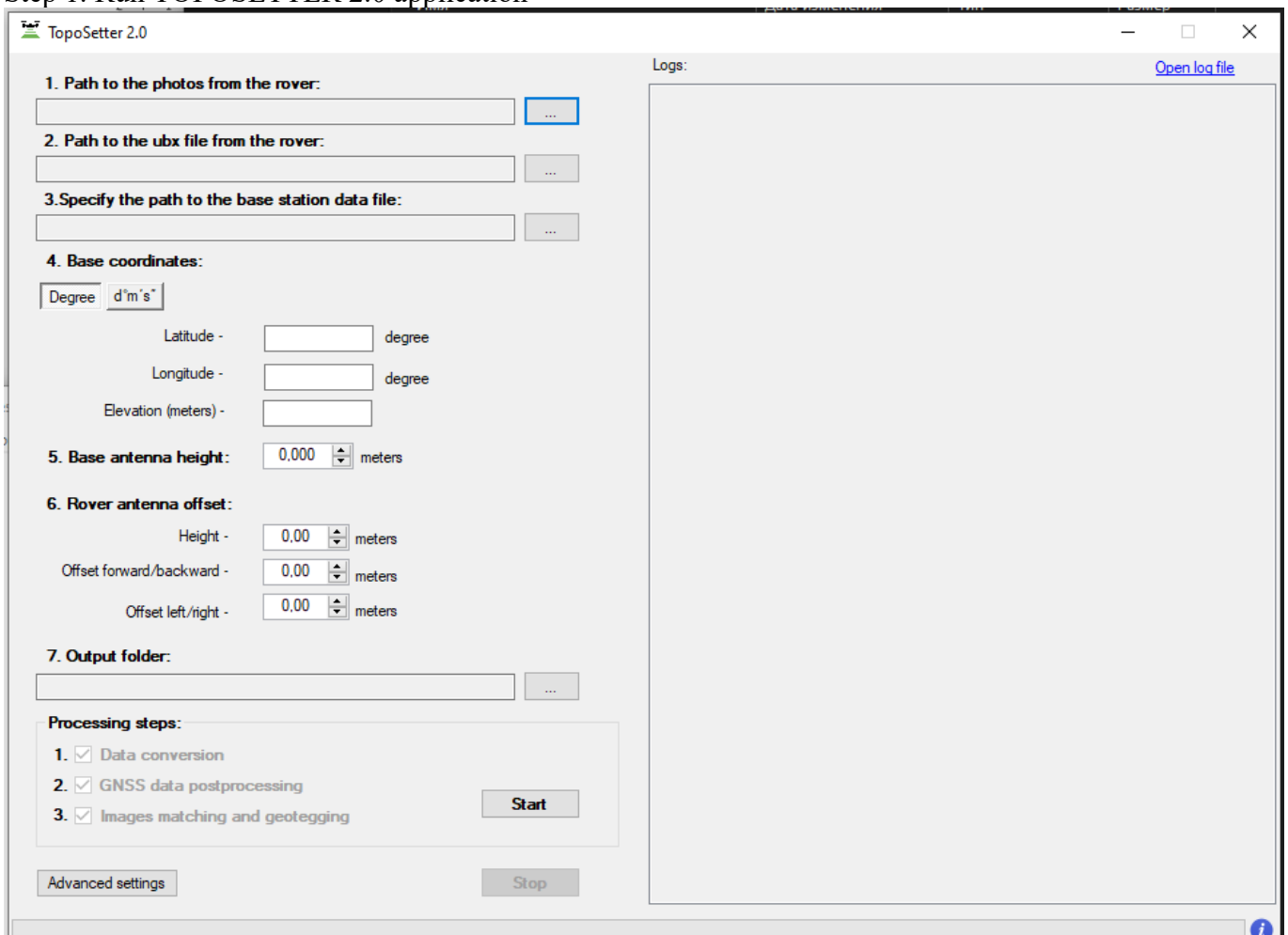
Download GNSS static logs from a base station and convert them to Rinex format. Copy Rinex files to a folder BASE (for example)

Mesure 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:

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

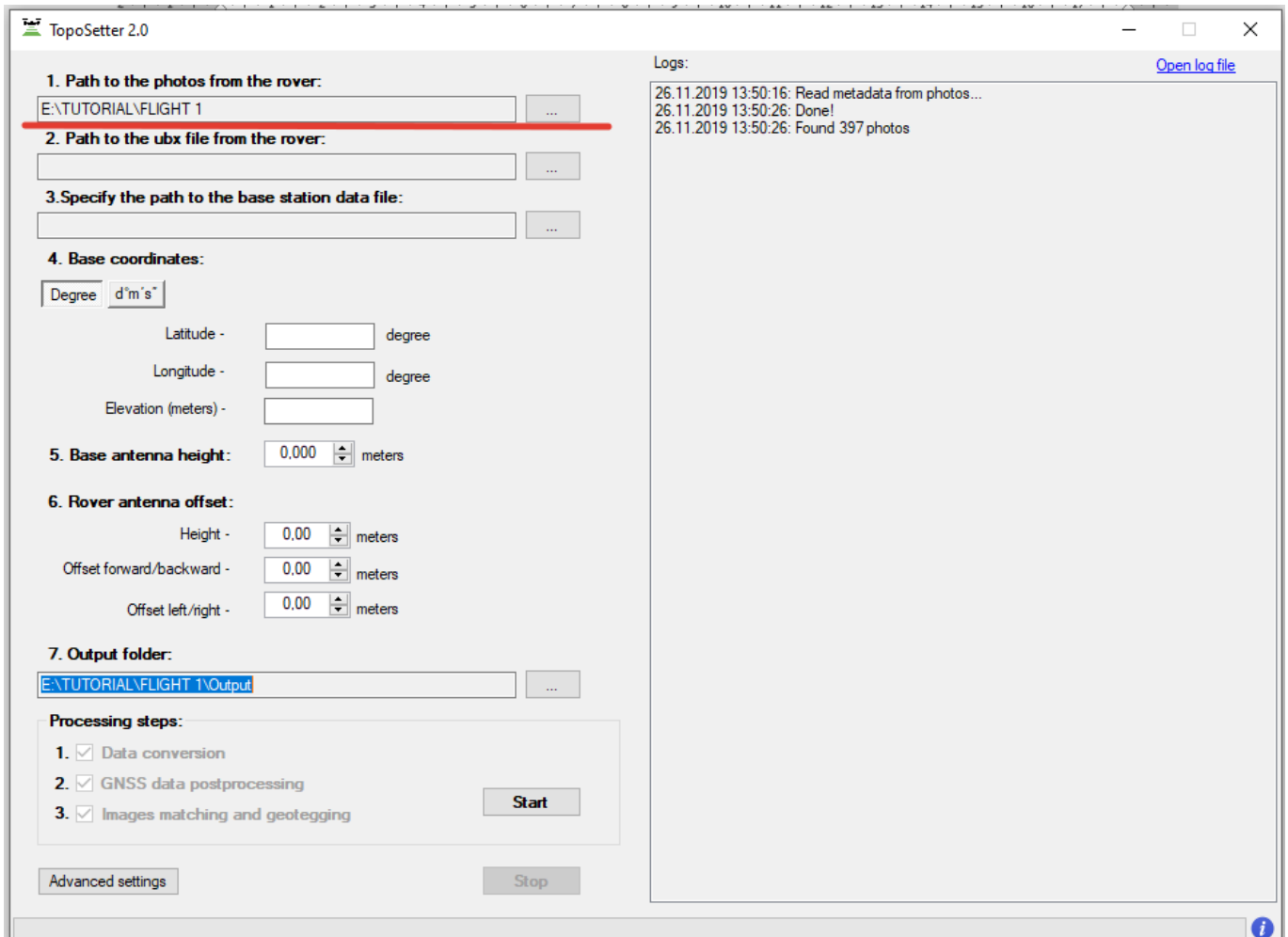
Start

Advanced settings

Stop

Logs: [Open log file](#)

## Step 2. Select folder with photos



**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:**

- ☒ Data conversion
- ☒ GNSS data postprocessing
- ☒ Images matching and geotagging

**Start**

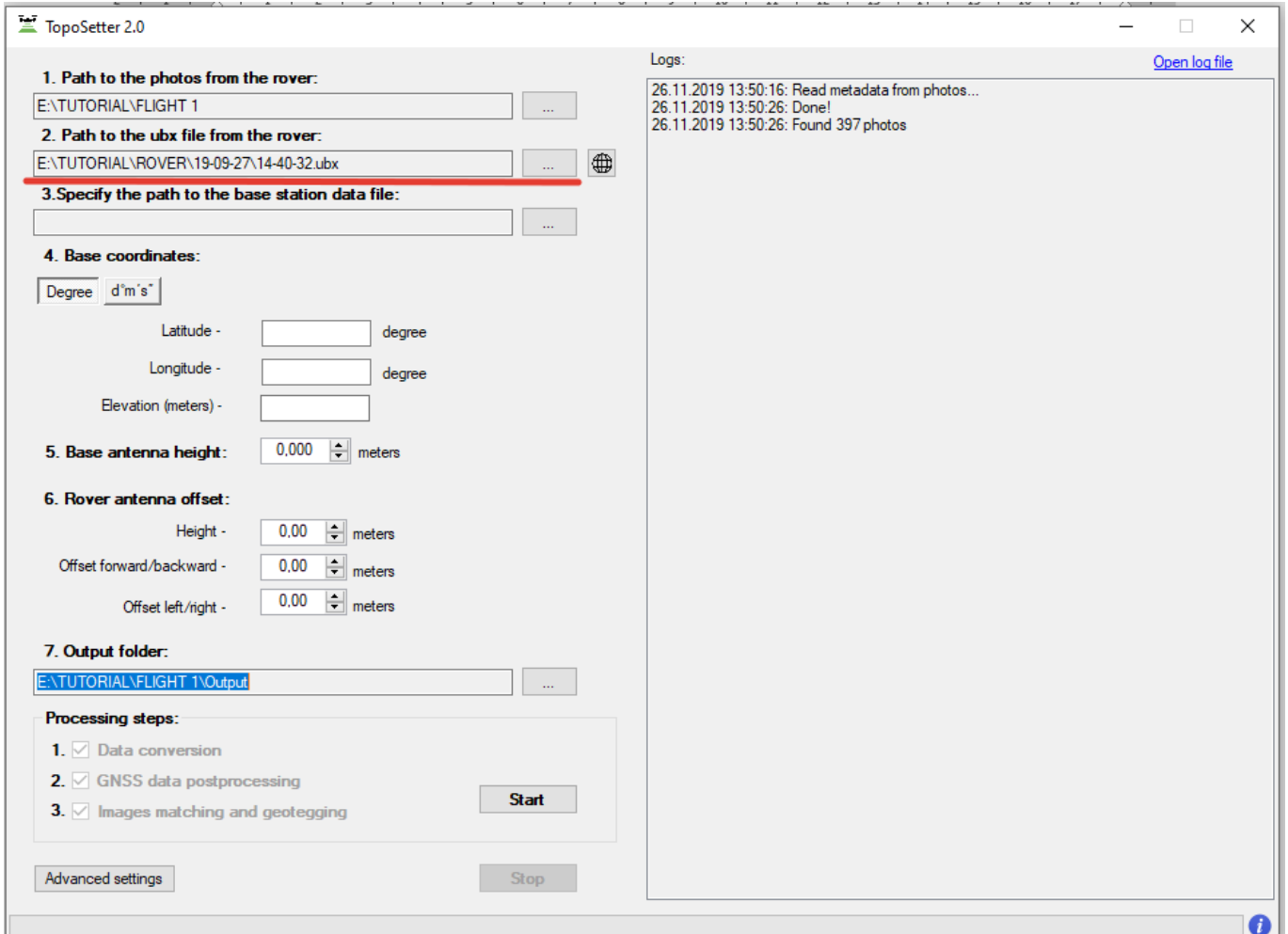
**Advanced settings** **Stop**

**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 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 logs panel on the right.

**Configuration Section:**

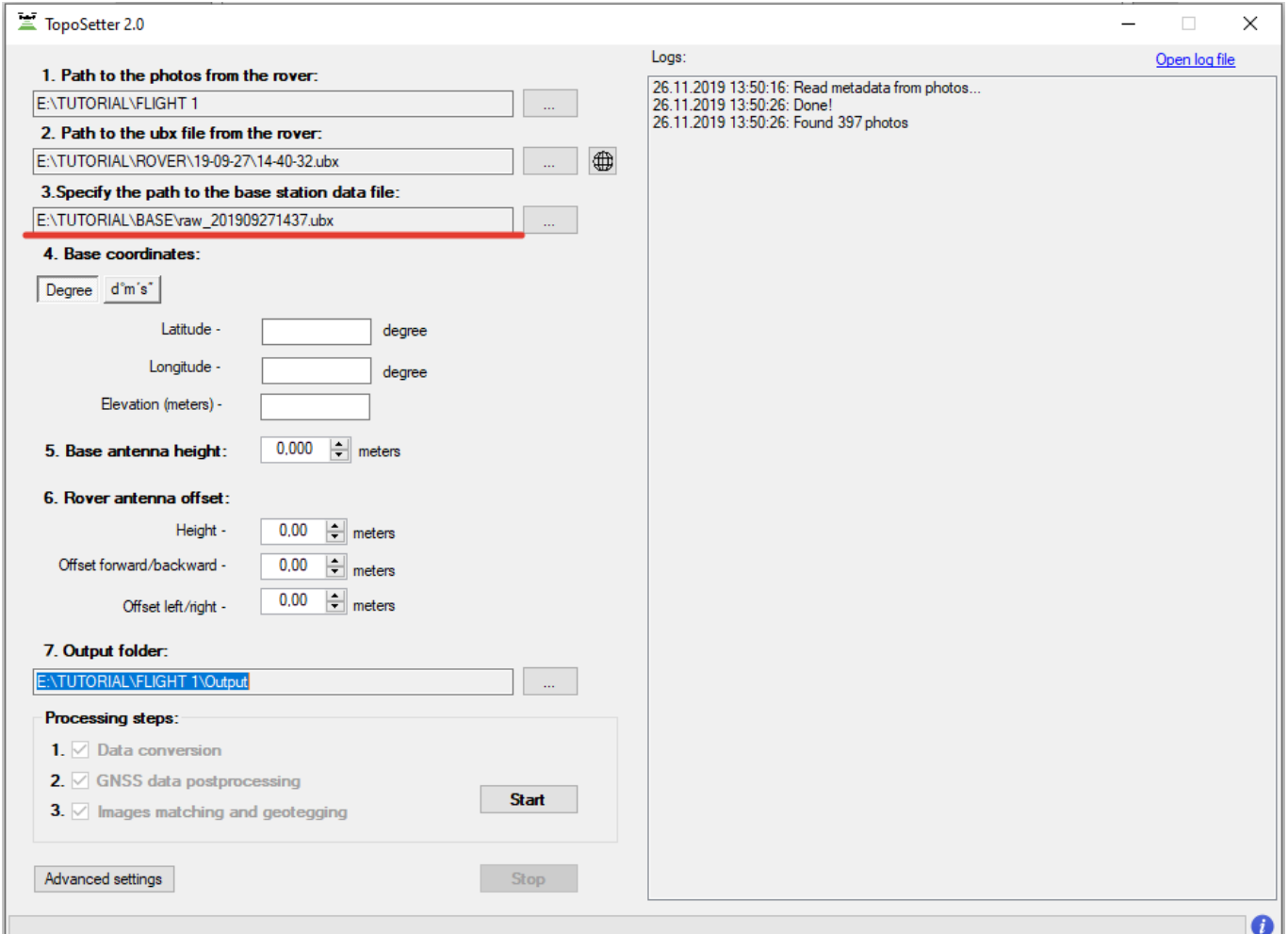
- 1. Path to the photos from the rover:** E:\TUTORIAL\FLIGHT 1
- 2. Path to the ubx file from the rover:** E:\TUTORIAL\ROVER\19-09-27\14-40-32.ubx (This line is highlighted with a red underline in the original image)
- 3. Specify the path to the base station data file:** (Empty field)
- 4. Base coordinates:**
  - 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" (bottom left), "Stop" (bottom right).

**Logs Panel:**

- Logs: (Link to "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 Rinex or UBX file from a base station



The screenshot shows the TopoSetter 2.0 software interface. The main configuration area on the left contains the following sections:

- 1. Path to the photos from the rover:** A text box containing "E:\TUTORIAL\FLIGHT 1" and a browse button (...).
- 2. Path to the ubx file from the rover:** A text box containing "E:\TUTORIAL\ROVER\19-09-27\14-40-32.ubx" and a browse button (...).
- 3. Specify the path to the base station data file:** A text box containing "E:\TUTORIAL\BASE\raw\_201909271437.ubx" and a browse button (...). This section is highlighted with a red border.
- 4. Base coordinates:** A section with a "Degree" dropdown and a "d'm's" input field. Below this are three input fields for "Latitude -", "Longitude -", and "Elevation (meters) -", each followed by a "degree" label.
- 5. Base antenna height:** A spinner box set to "0.000" followed by "meters".
- 6. Rover antenna offset:** A section with three spinner boxes for "Height -", "Offset forward/backward -", and "Offset left/right -", each followed by "meters".
- 7. Output folder:** A text box containing "E:\TUTORIAL\FLIGHT 1\Output" and a browse button (...).

Below the configuration area is a "Processing steps" section with three checked items:

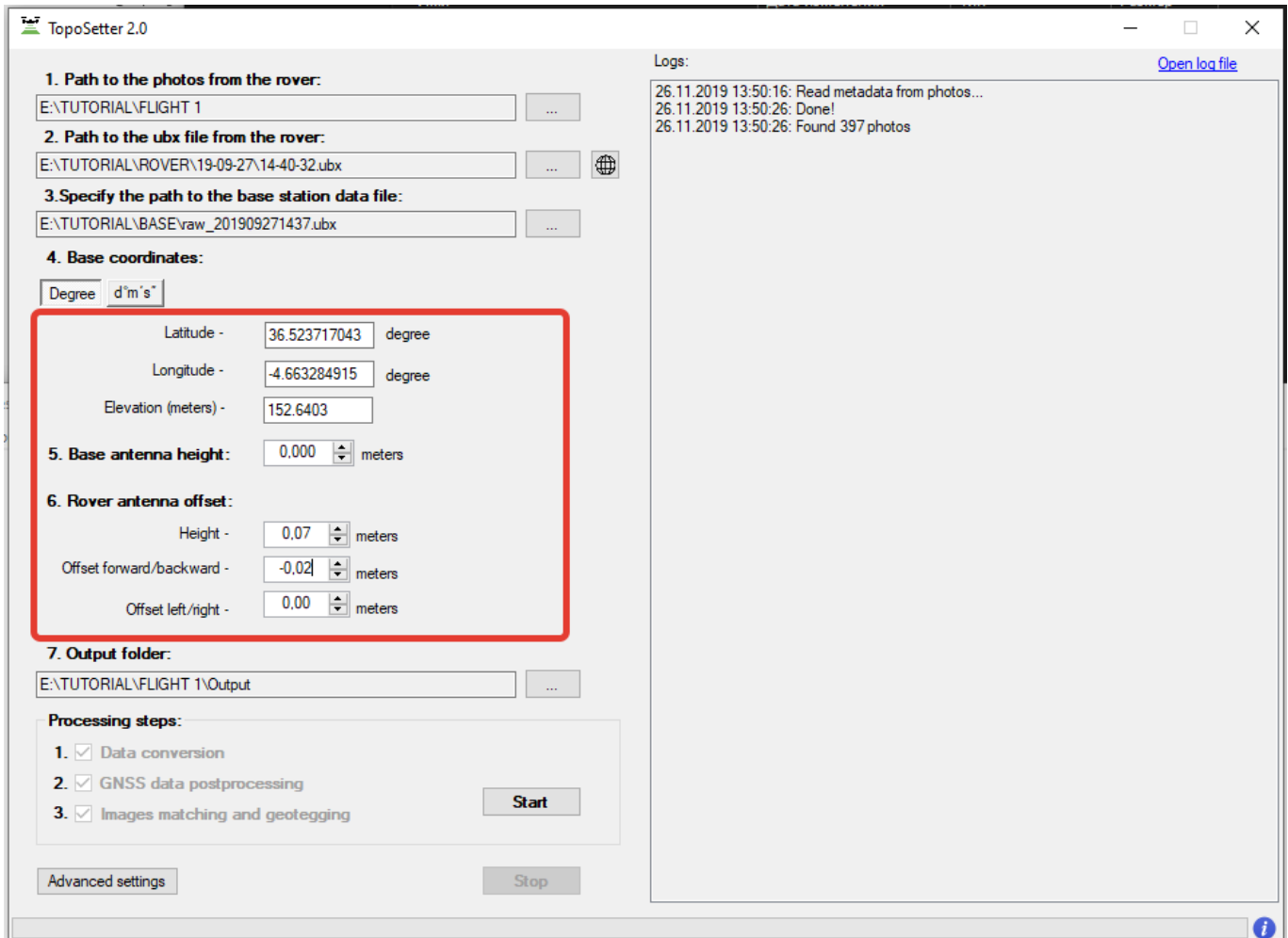
- ☒ Data conversion
- ☒ GNSS data postprocessing
- ☒ Images matching and geotagging

A "Start" button is located to the right of these steps. At the bottom of the interface are "Advanced settings" and "Stop" buttons.

On the right side of the window is a "Logs" panel with a link "Open log file". The log content is:

```
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 a 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** **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*

*FOR DJI M200 + X4S PPK use the following parameters*

*Height: 0.22*

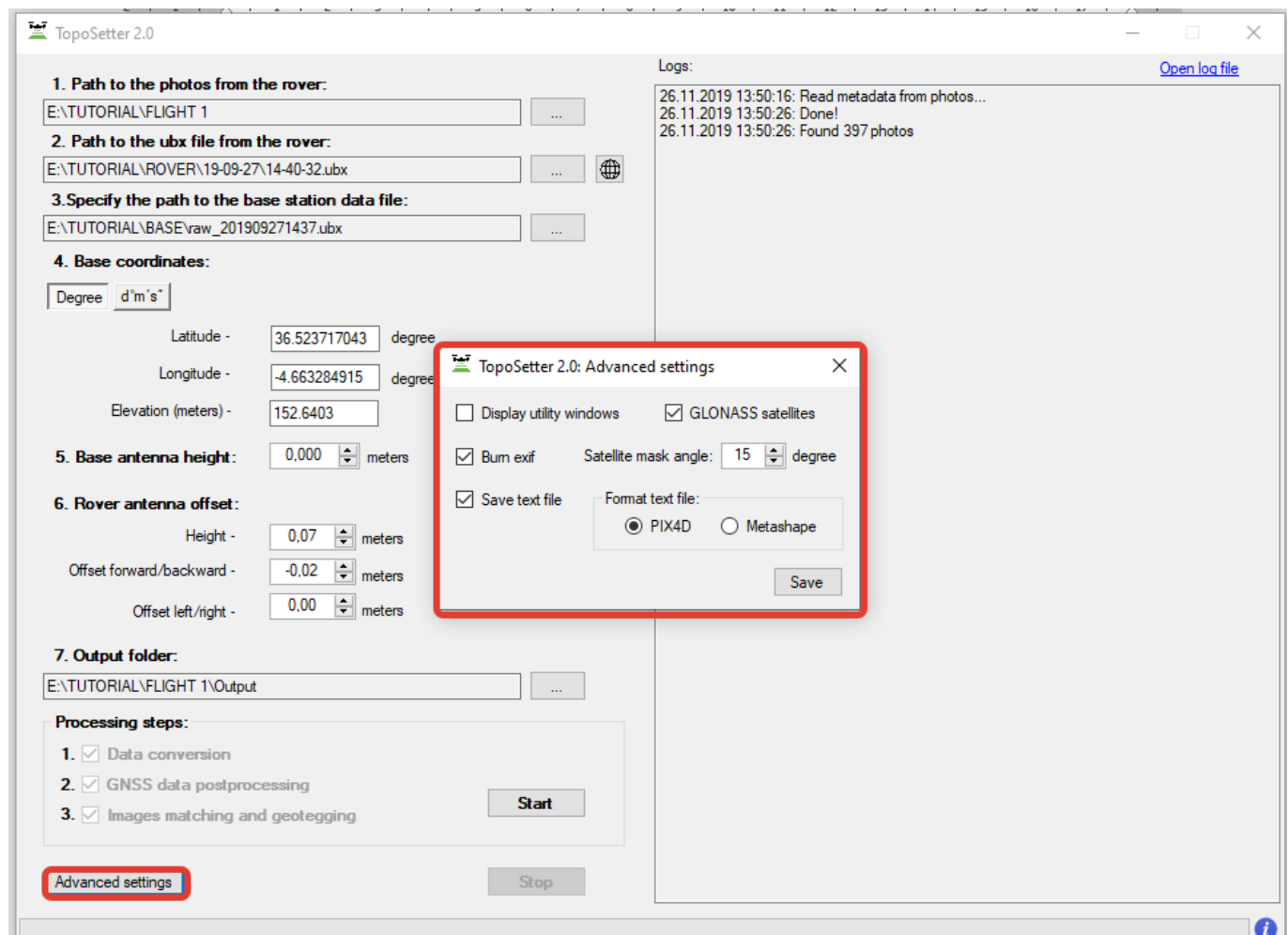
Step 6. Setup data processing setting. Click advanced setting. Advanced setting will appear.

To embed precise coordinates to photos EXIF tags check Burn exif check box. This option may lead increasing of data processing time.

To save list of coordinates check Save text file check box.

Select format of text file Pix4D or Metashape

Click Save button.



NOTICE. To look at data processing performing switch on Display utility window option.

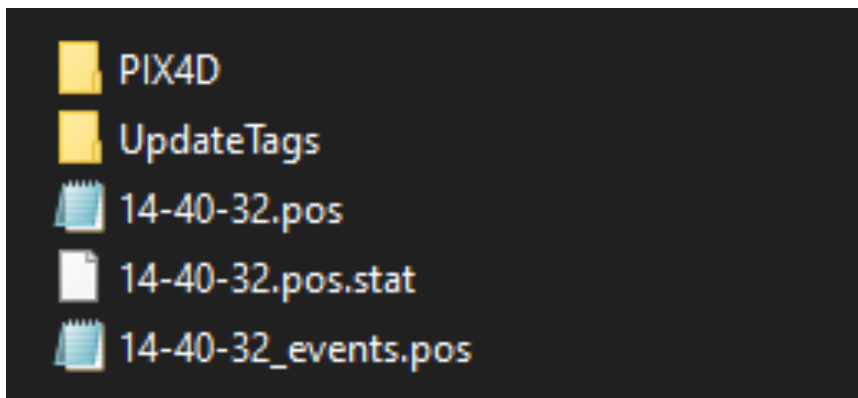
Click Start button

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

File Coordinates.txt is stored in PIX4D or Metashape folder

Photos with updated EXIF tags are stored in UpdateTags folder

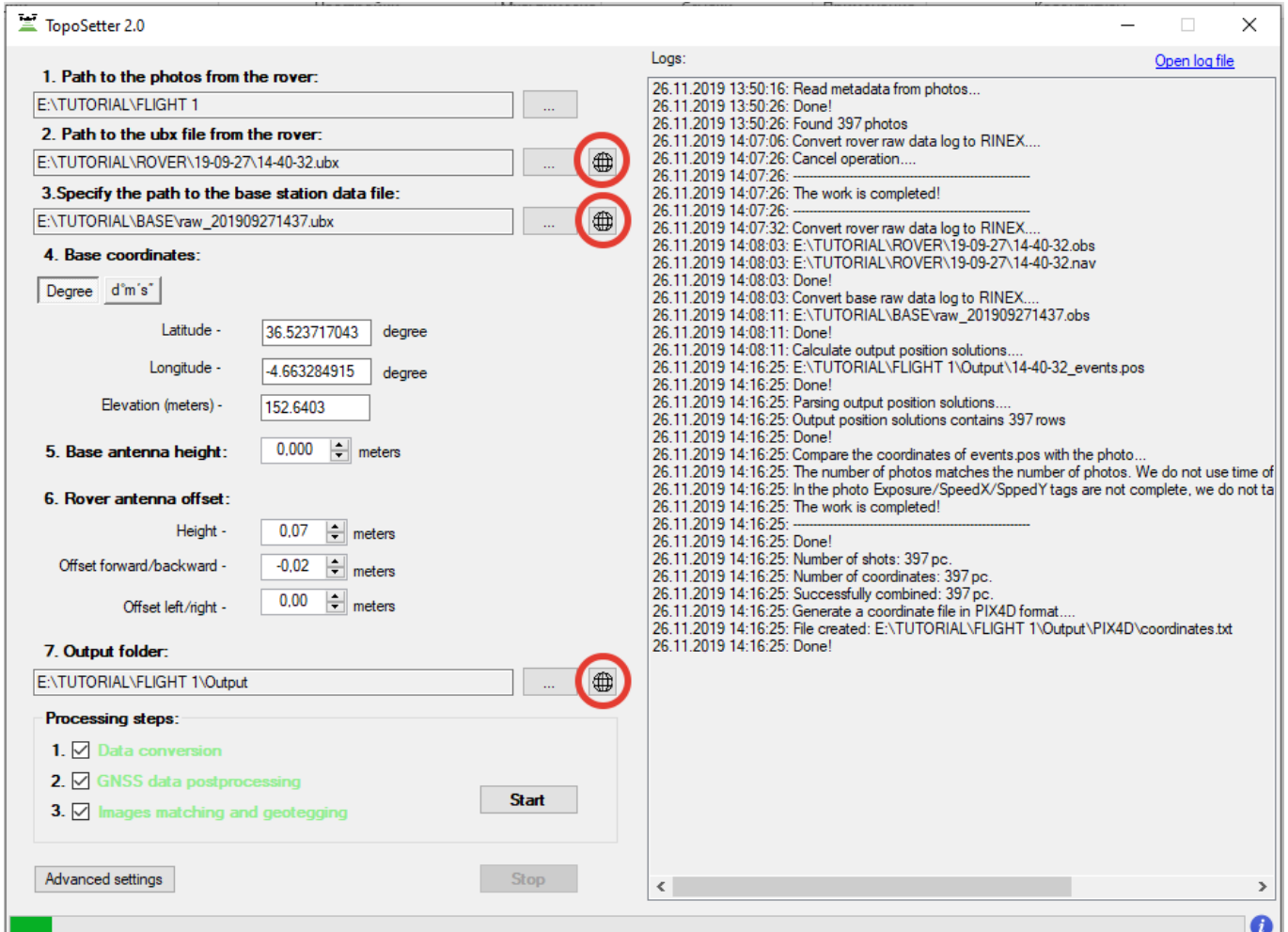
Files with .pos extension are results of GNSS data postprocessing



NOTICE. *Coordinate system is WGS84.*



Step 7. Checking processing results.  
 After processing accomplishing, the following buttons will appear.



**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** **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/SpdY 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 Rover or Base fields to open GNSS observation files to check the quality of GNSS signal.

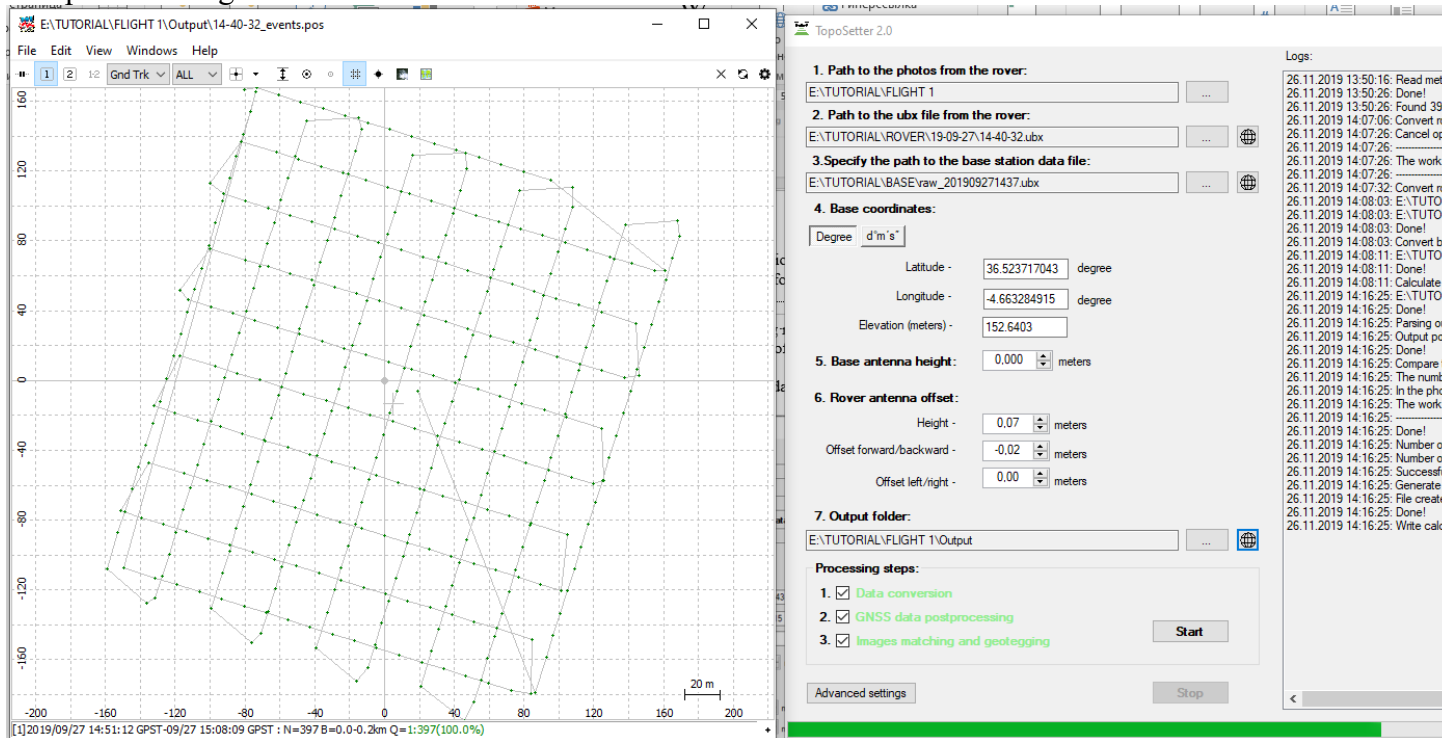
To check quality of GNSS data postprocessing click  button in front of output results.

On the map you can see results of GNSS data postprocessing.

Green points of photos events – Fixed solution

Yellow points – Float solution

Red points – Single solution



## NOTICE.

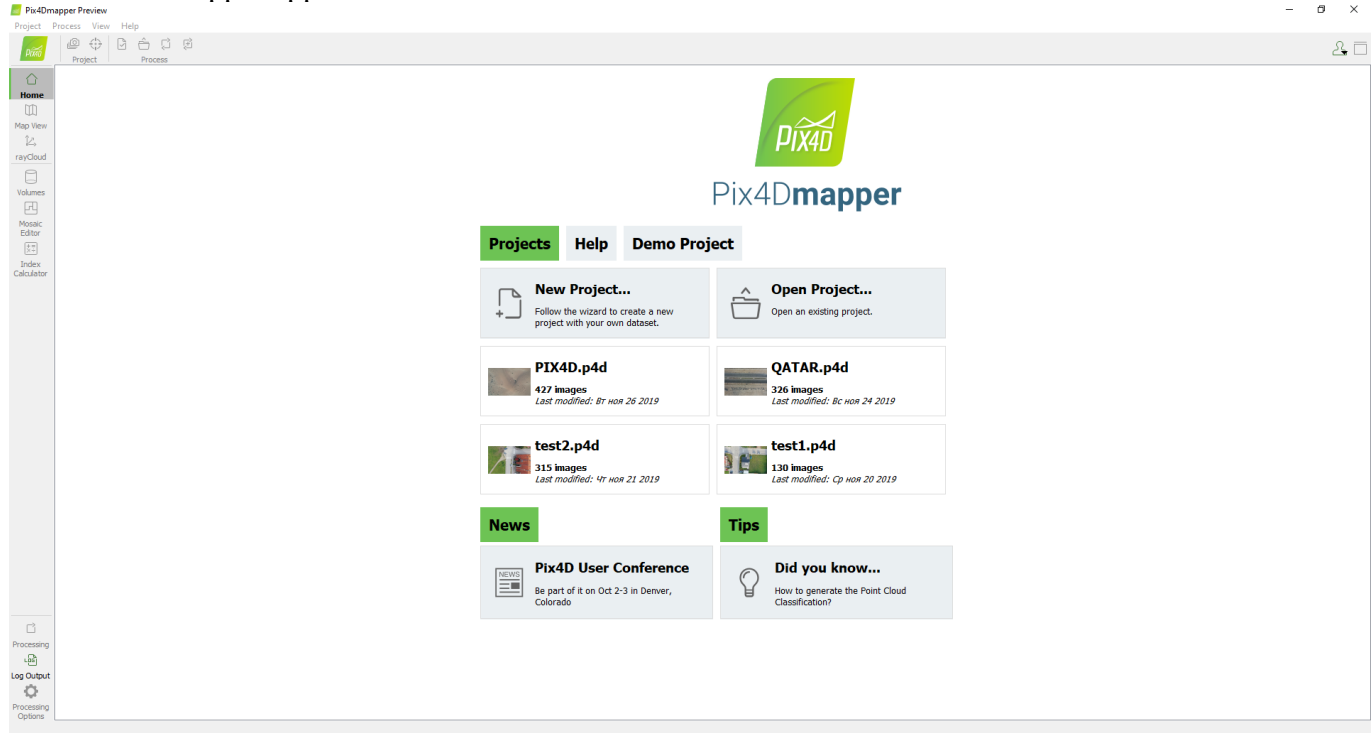
*If there are only red points on the map it means, that GNSS data from a drone and a base station were not collected at the same time.*

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

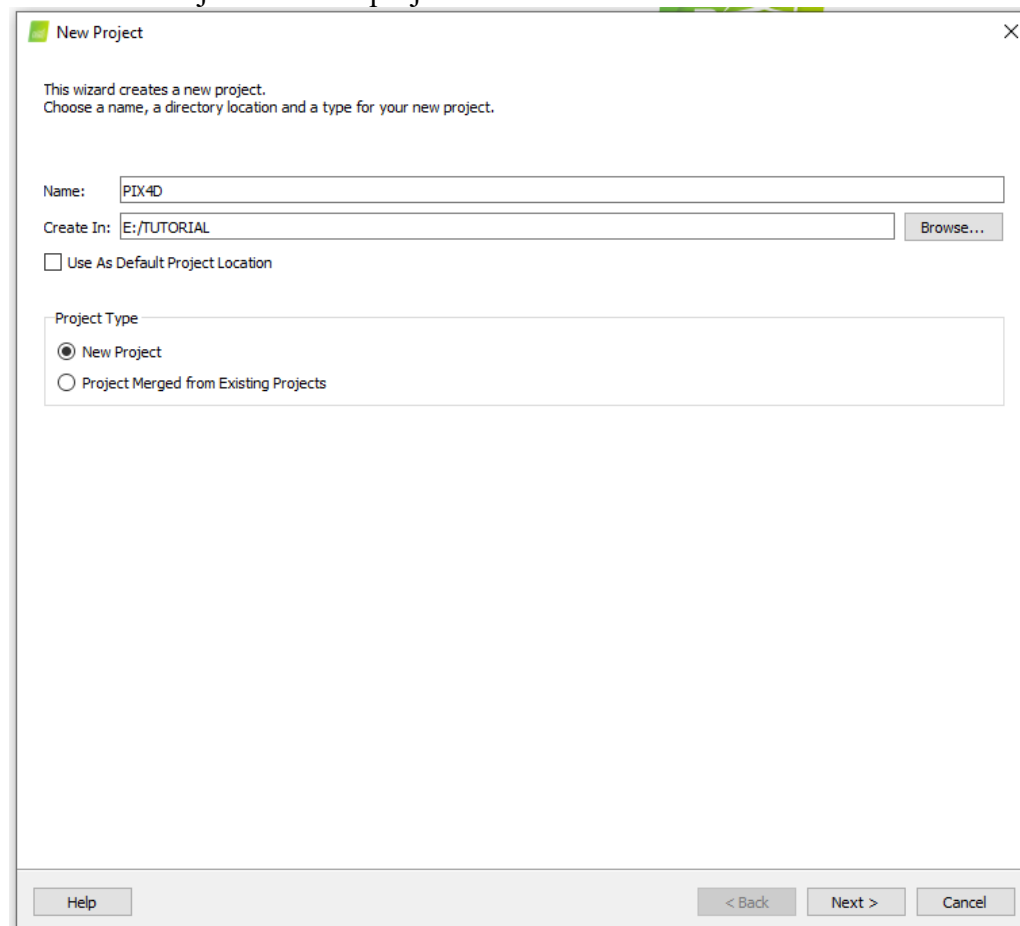
### 3. PHOTOGRAMMETRY PROCESSING IN PIX4D MAPPER SOFTWARE

#### 3.1 Creating pix4d mapper project

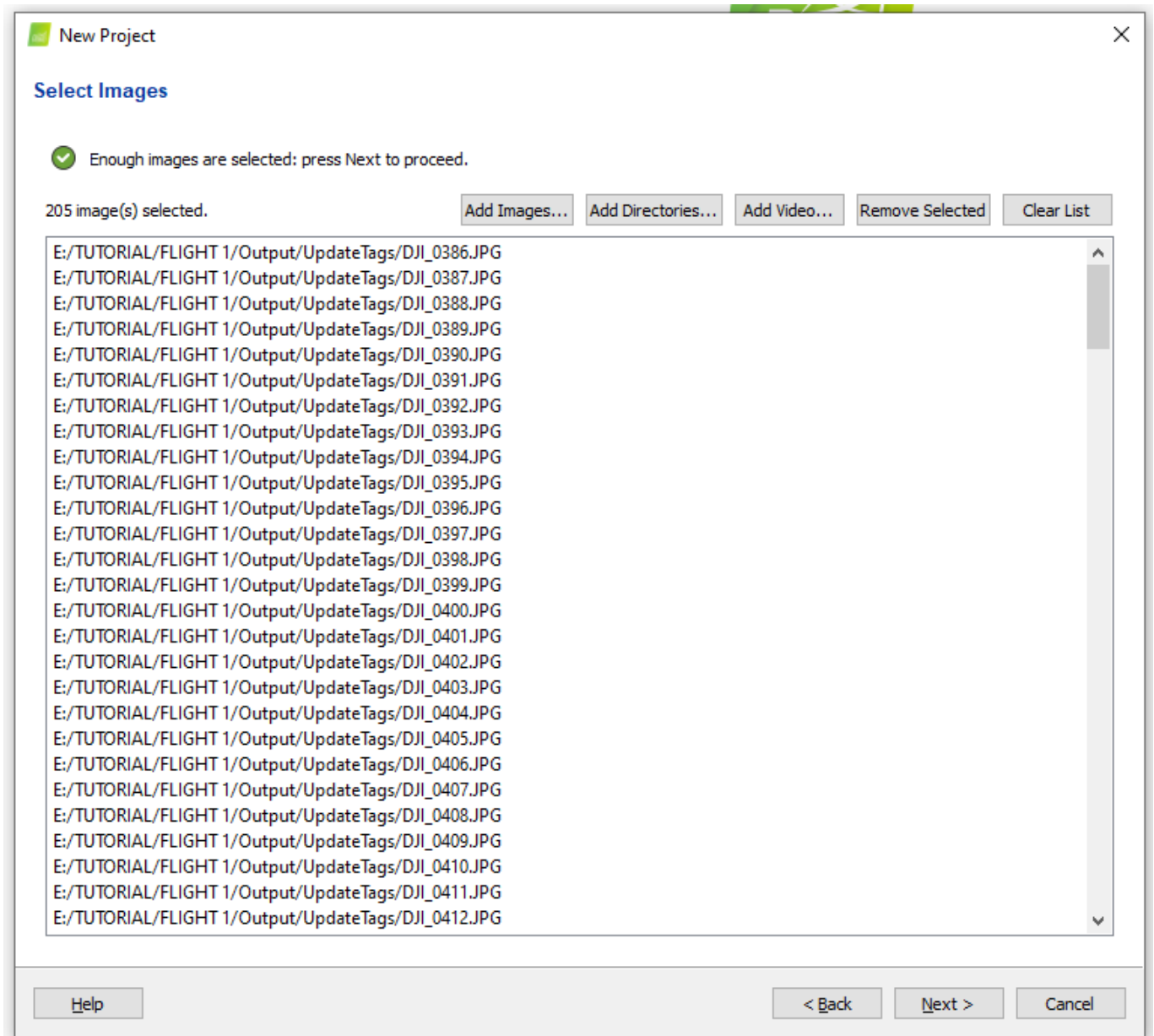
Run PIX4D mapper application.



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



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




Software will read precise coordinates of images and accuracy setting 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] | Accuracy Vert [m] |
|-------------------------------------|--------------|--------|-------------------|--------------------|--------------|-------------------|-------------------|
| <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 >

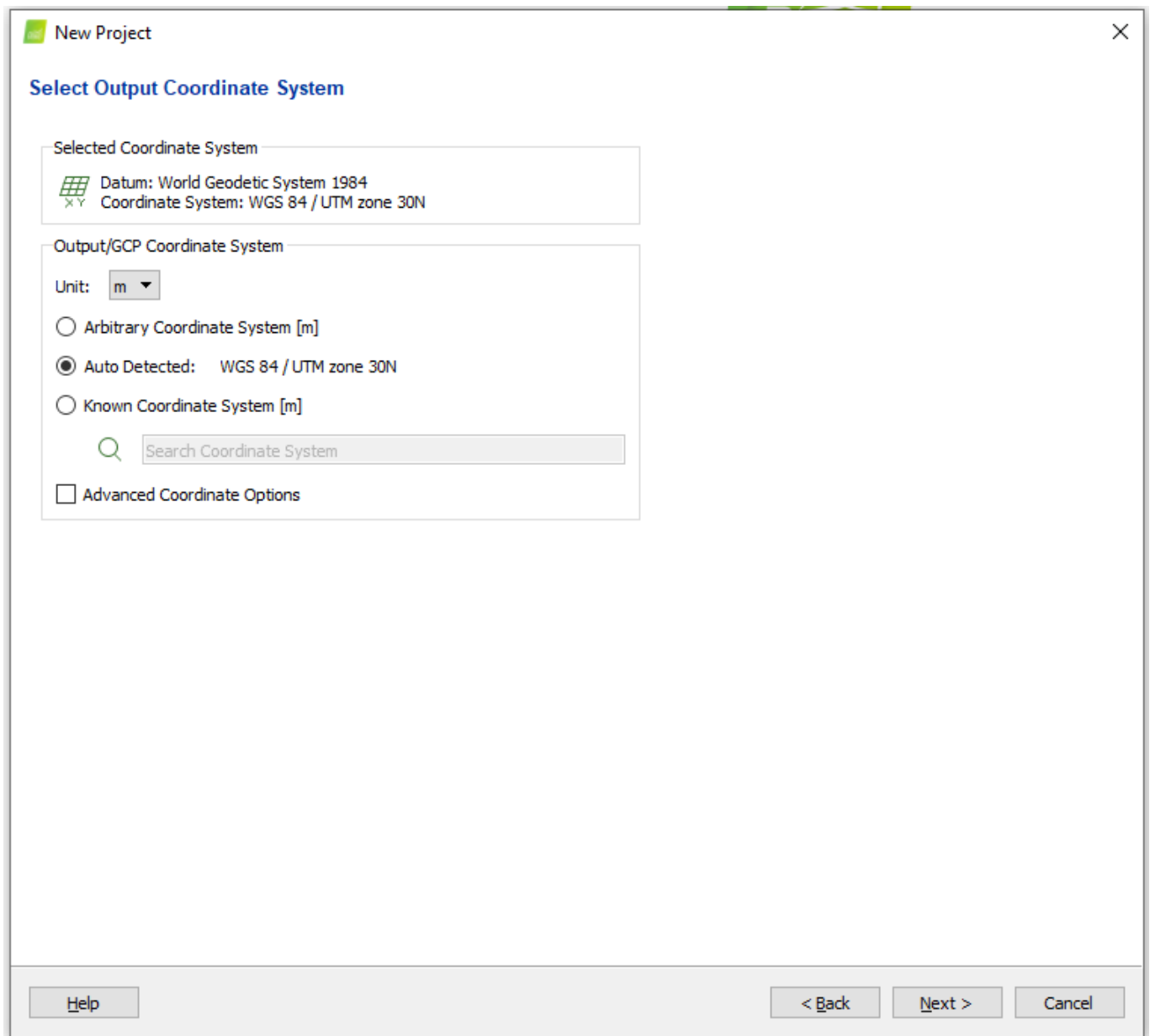
Cancel

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

It is recommended to check camera settings. Click Edit button and check if Linear rolling shutter camera model is enabled in case if DJI MAVIC 2 PRO was used for survey.



Select output coordinate system and click Next.



The screenshot shows a software window titled "New Project" with a close button (X) in the top right corner. The main heading is "Select Output Coordinate System".

Under the heading "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 the heading "Output/GCP Coordinate System", there is a "Unit:" label with a dropdown menu showing "m". Below this are three radio button options:

- ☐ Arbitrary Coordinate System [m]
- ☒ Auto Detected: WGS 84 / UTM zone 30N
- ☐ Known Coordinate System [m]

Below the radio buttons is a search icon (magnifying glass) and a text input field labeled "Search Coordinate System".

At the bottom left of the main area is a checkbox labeled "Advanced Coordinate Options", which is currently unchecked.

The bottom of the window contains three buttons: "Help", "< Back", "Next >", and "Cancel".

Select 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

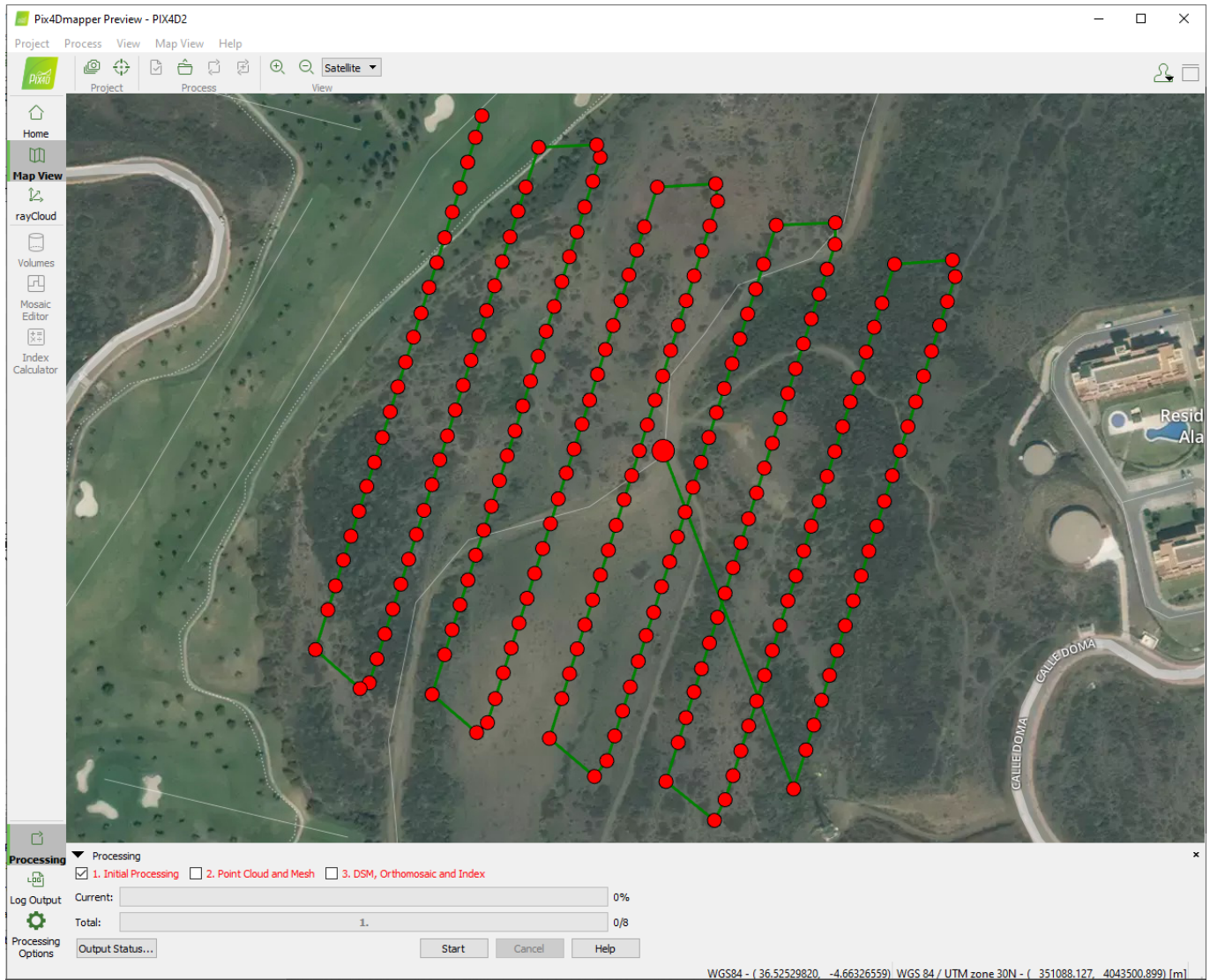
< Back

Finish

Cancel

### 3.2 Initial aerial triangulation

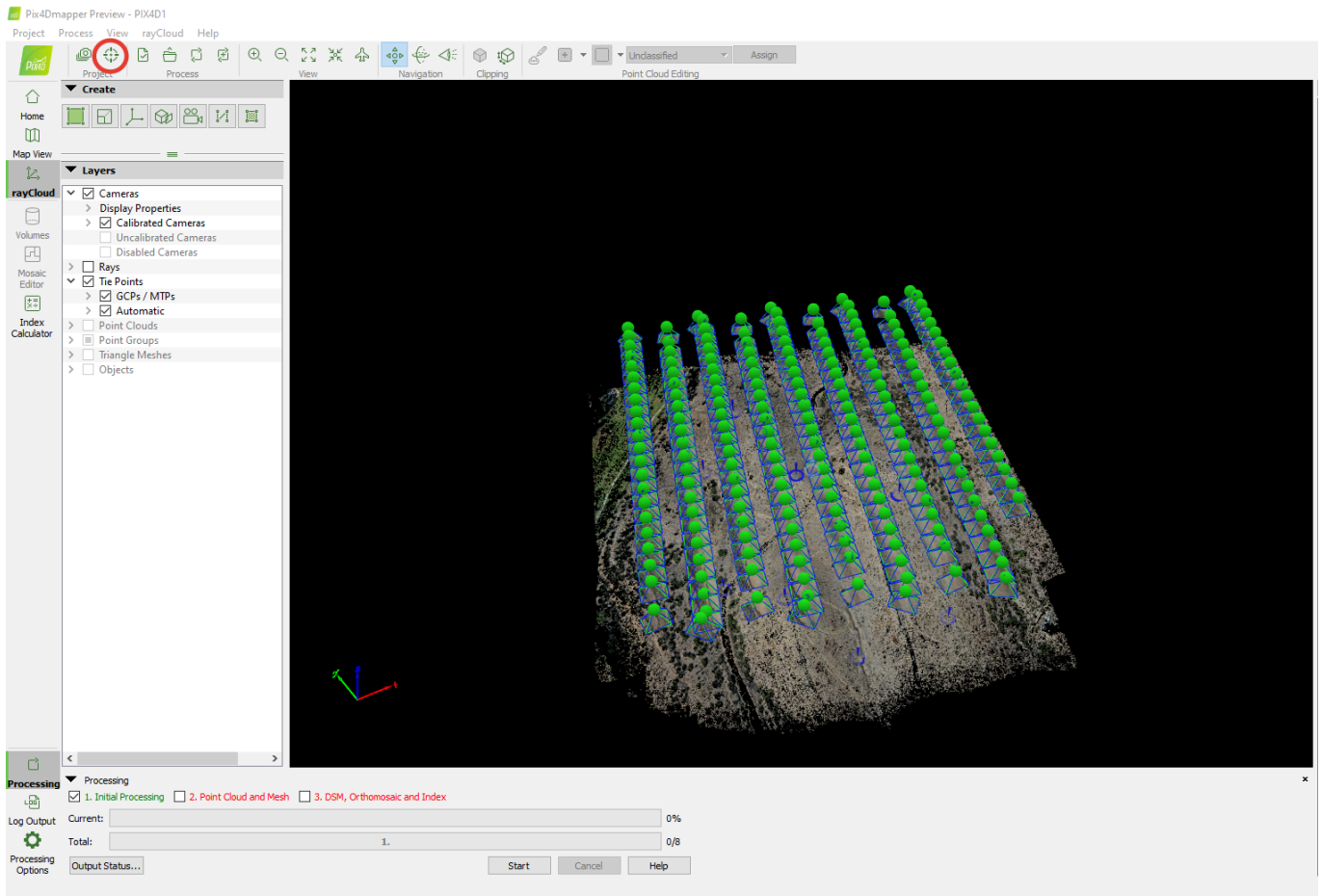
As soon as images with precise coordinates were loaded to the project, we can start initial aerial triangulation. Select initial processing checkbox and start processing.



### 3.3. Camera calibration

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

Click GCP/MTP button.



Select 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.

rayCloud Editor... Basic Editor...

OK Cancel Help

Change GCPs 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.

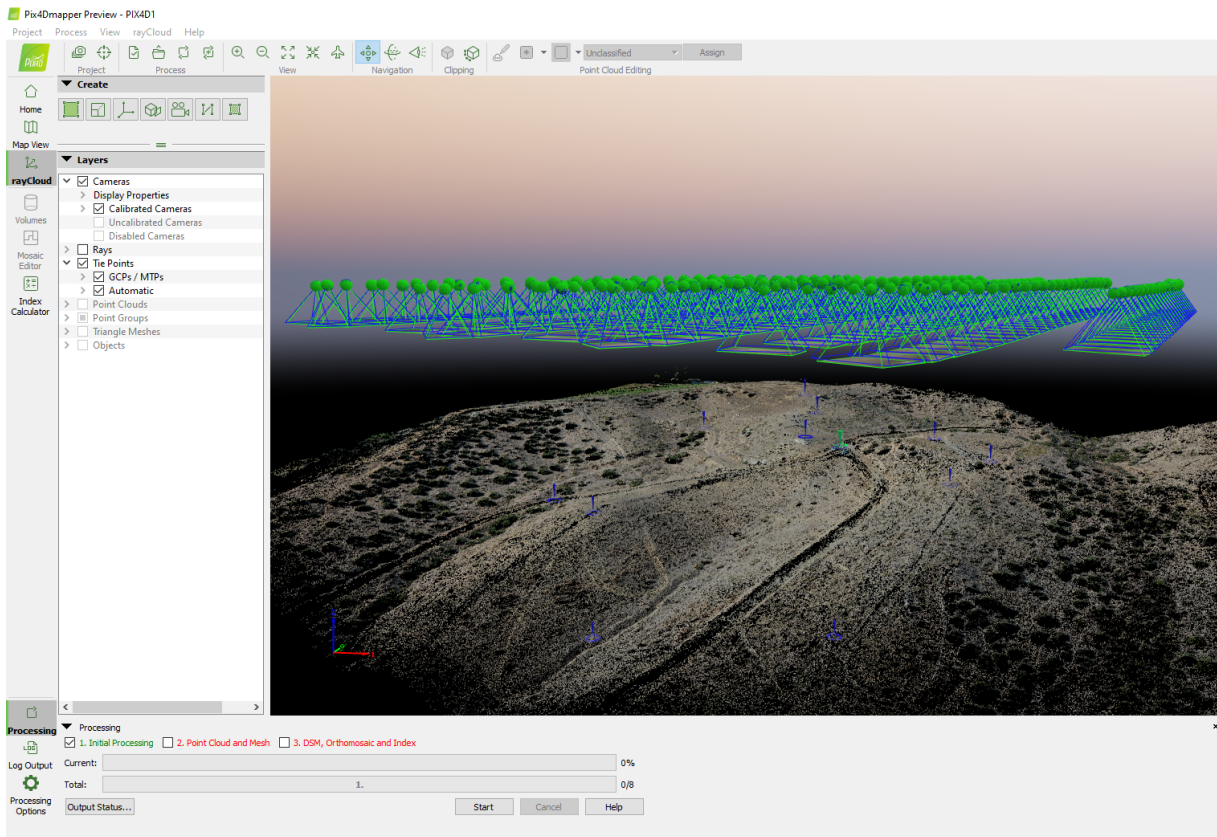
(Recommended) Use the rayCloud Editor after step 1. Initial Processing is done. This allows a fast and precise point marking.

rayCloud Editor... Basic Editor...

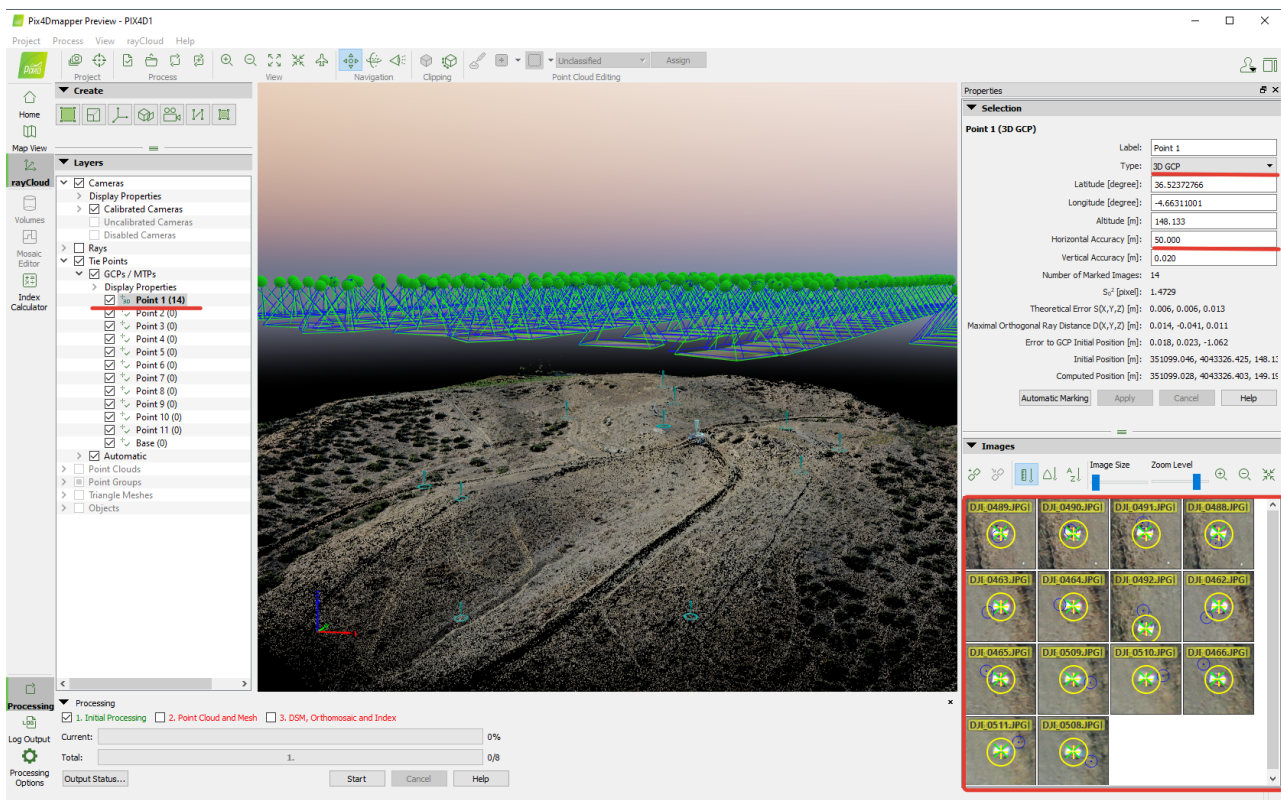
OK Cancel Help



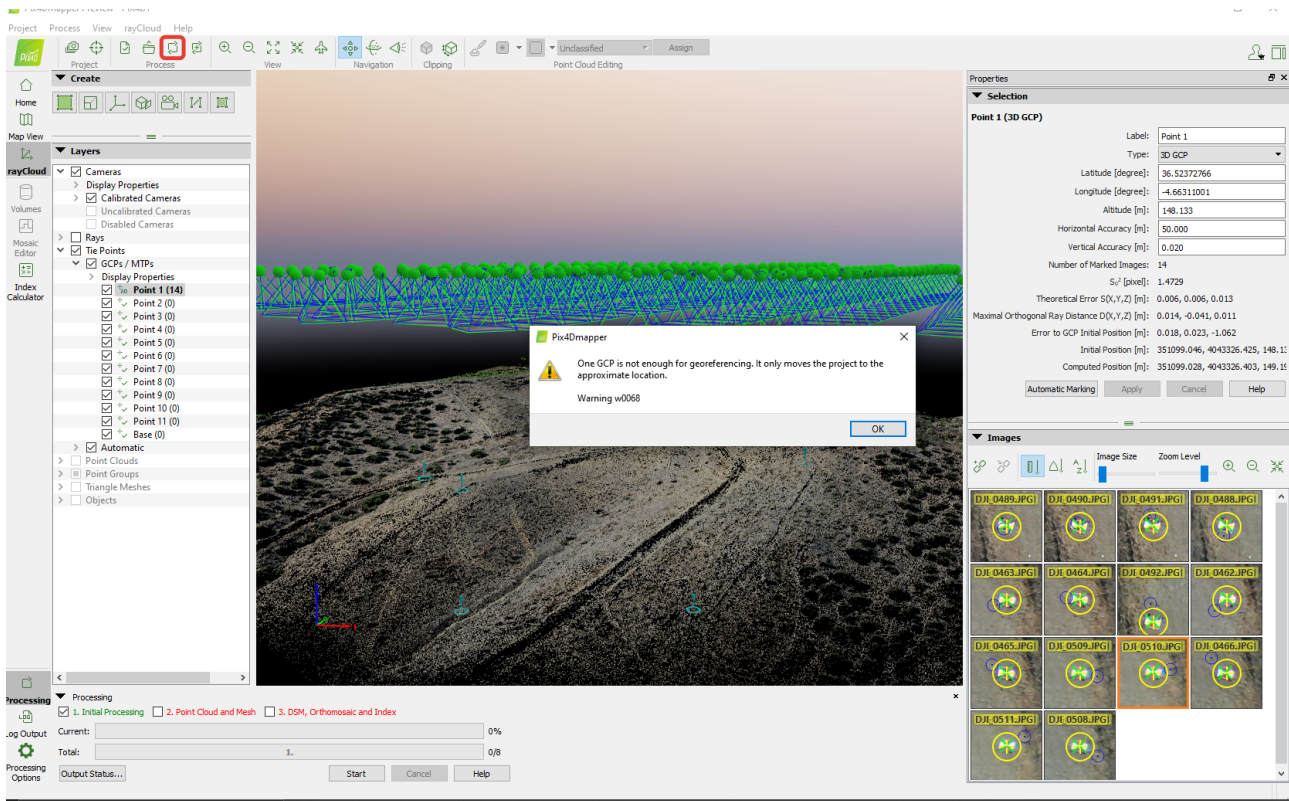
All GCPs will be shown on the map.



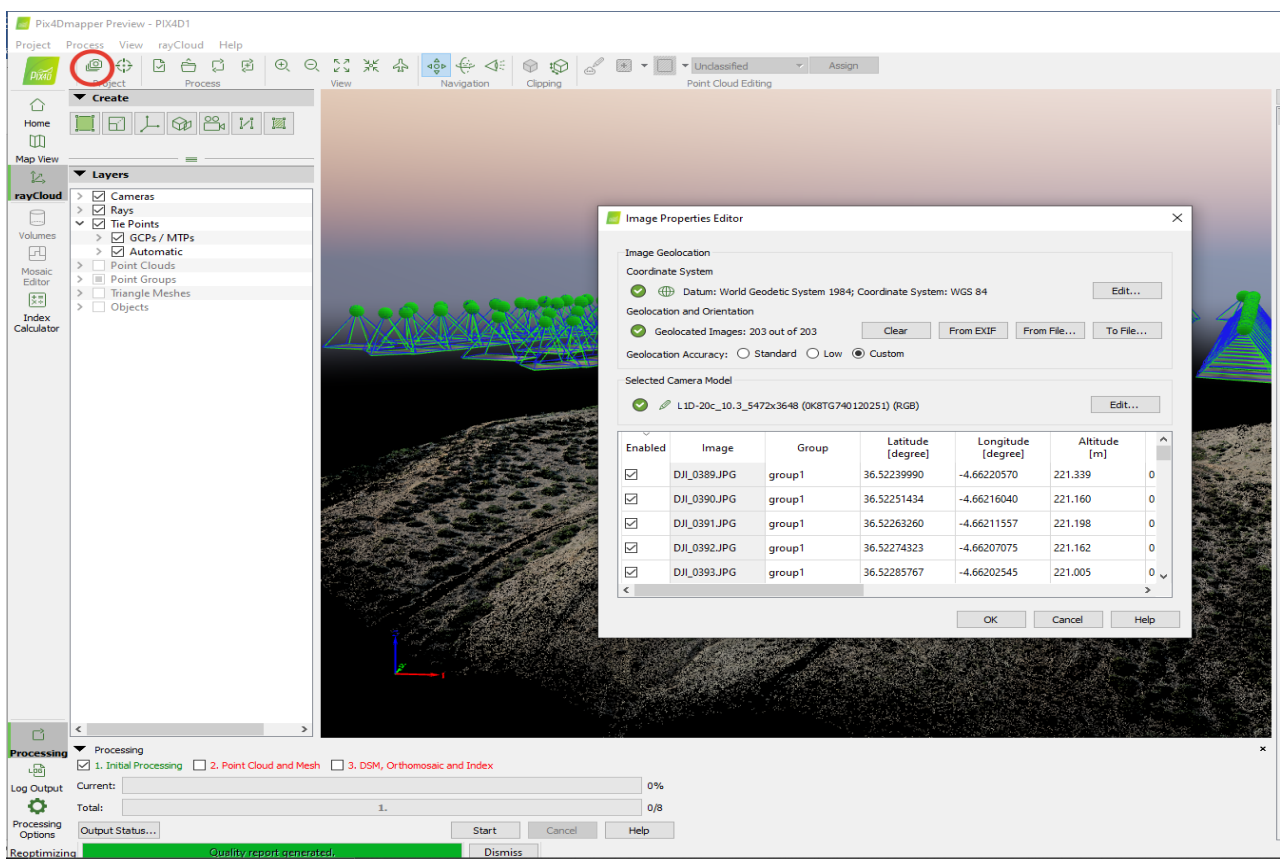
Select one GCP, define position of ground control point at each image, change type of GCP to 3D and setup horizontal accuracy to 50 meters.



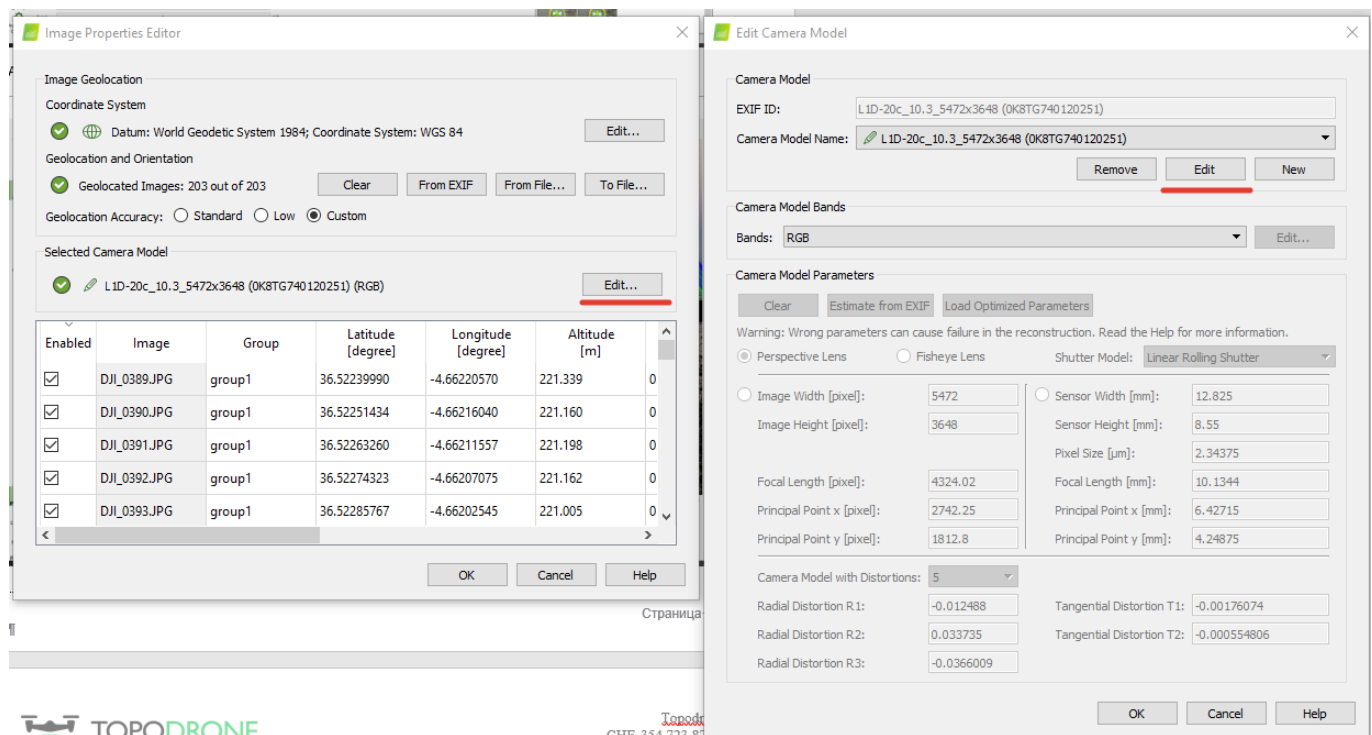
Click Reoptimize button. Click Ok on warning messages.



After finishing of reoptimizing process click Image property editor button.



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



Click Load Optimiezed parameters. Copy Focal Length value for future work.

NOTICE. It is possible to use the calibrated value of focal length for the processing If you don't change focus settings for future flights.

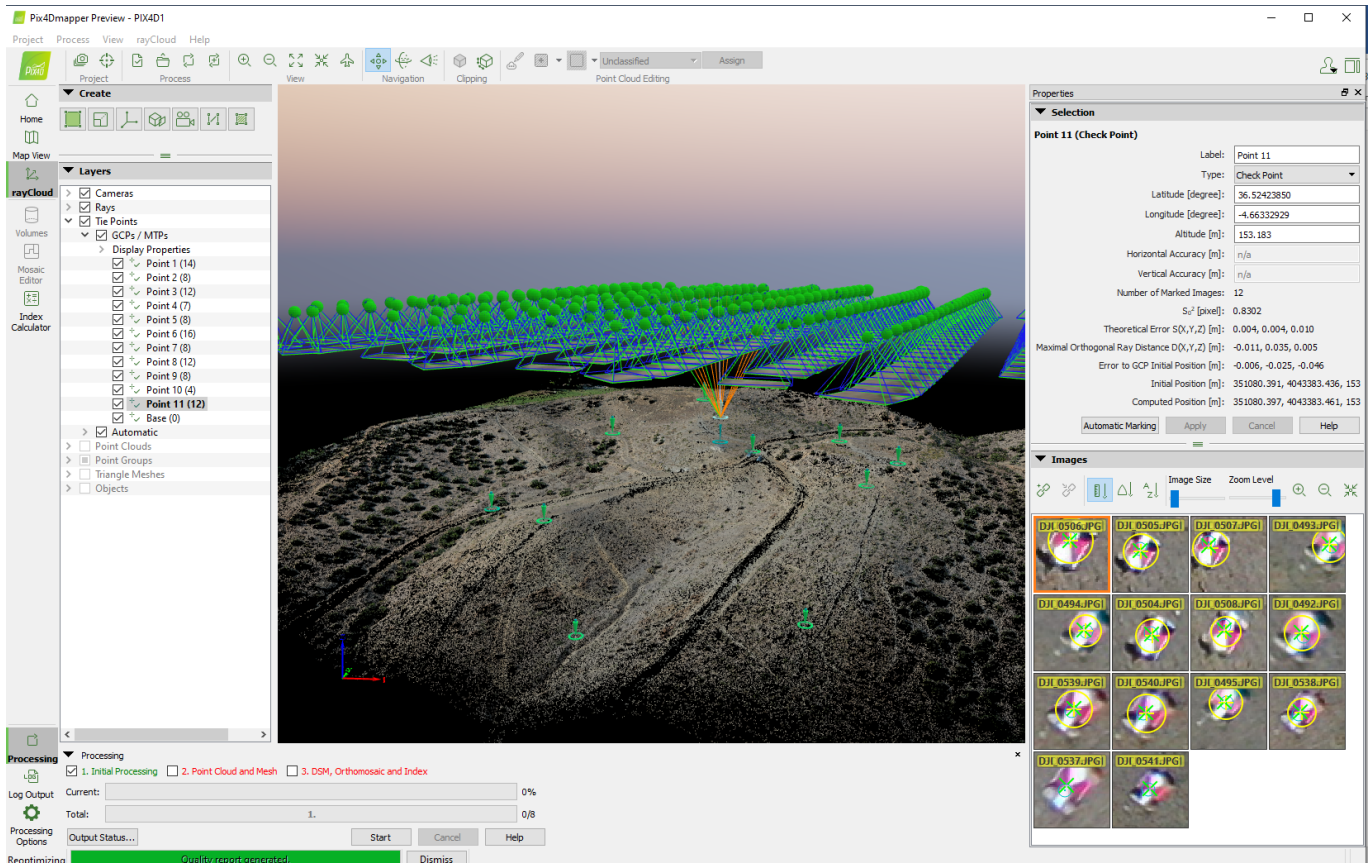


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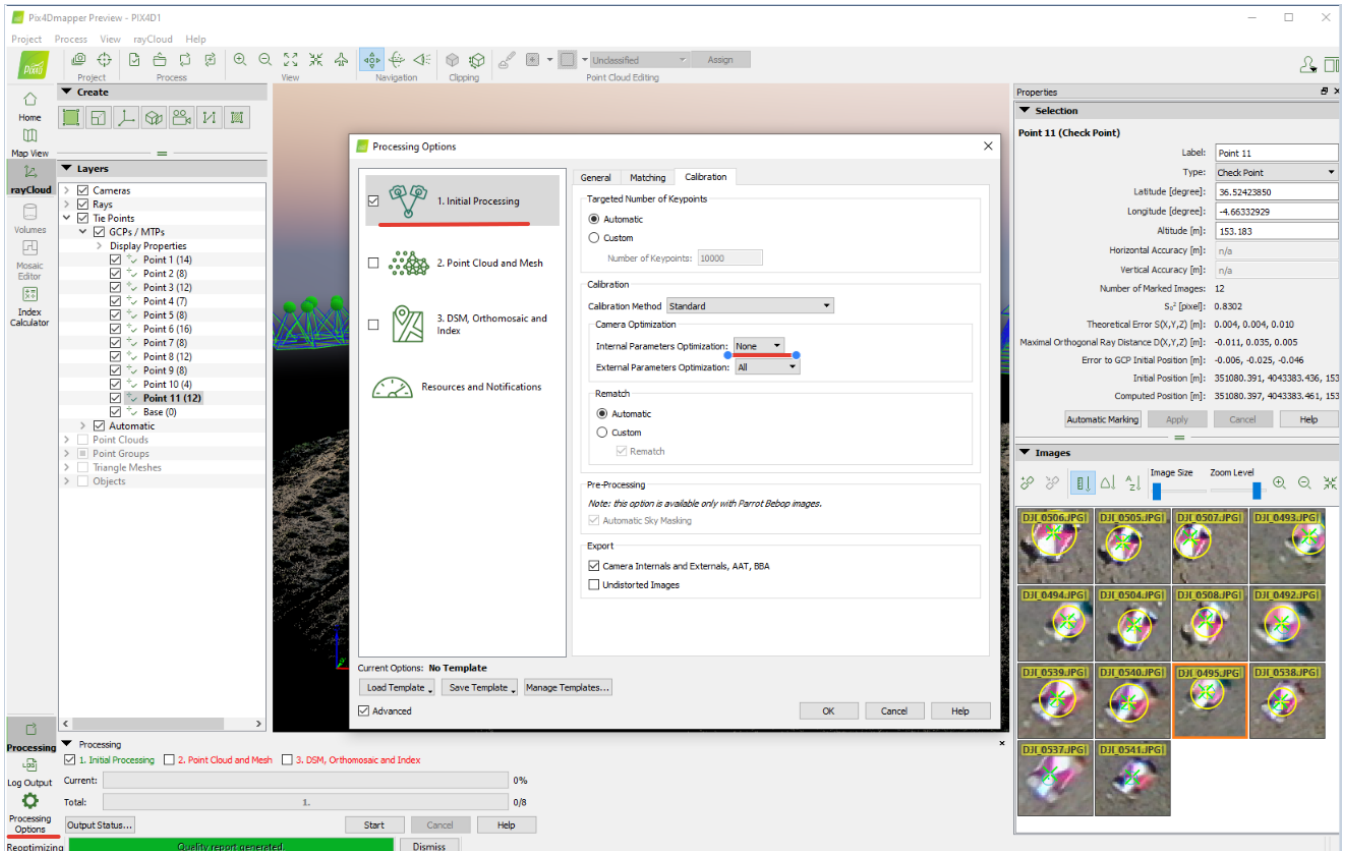
### 3.4 Accuracy estimating

Load ground control points. Set up as check points.

Select position of all check points at images to check accuracy.



Go to Processing option. Select None for Internal Parameters Optimization. Click Ok.  
Click Reoptimize.



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

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

Quality Report - PIX4D1

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|       |          |          |          |          |          |          |                    |                    |                    |
|-------|----------|----------|----------|----------|----------|----------|--------------------|--------------------|--------------------|
|       | [degree] | [degree] | [degree] | [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 XY/Z [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

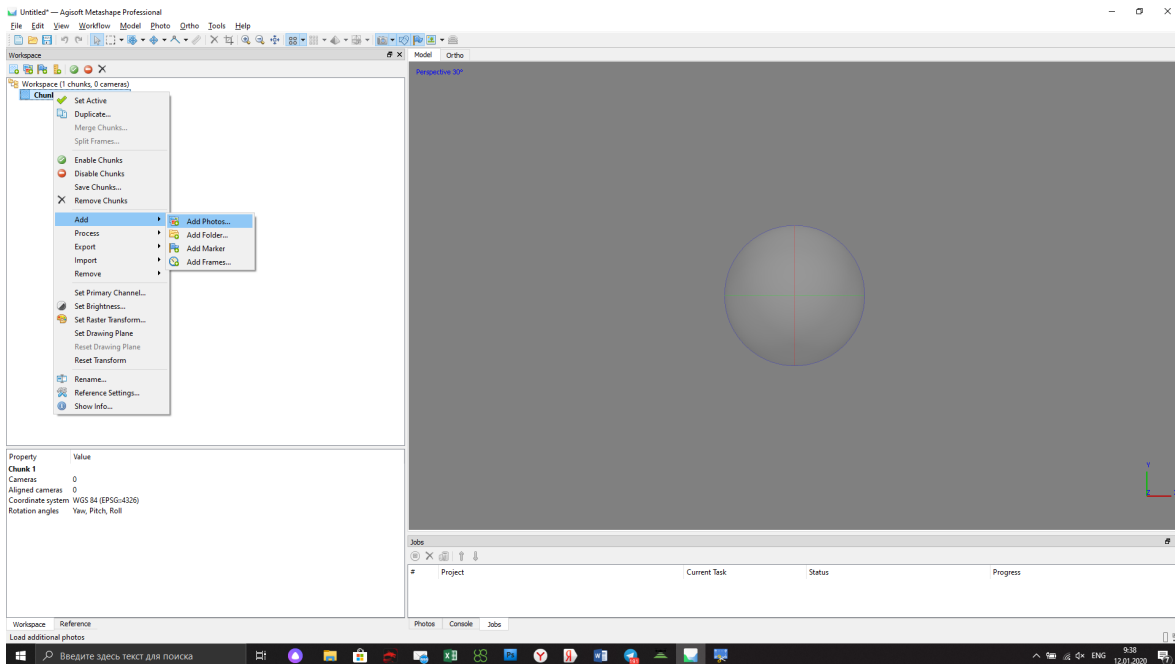
|               |               |                         |                         |                         |
|---------------|---------------|-------------------------|-------------------------|-------------------------|
| Min Error [m] | Max Error [m] | Geolocation Error X [%] | Geolocation Error Y [%] | Geolocation Error Z [%] |
|---------------|---------------|-------------------------|-------------------------|-------------------------|

☒ Display Automatically after Processing
 Close

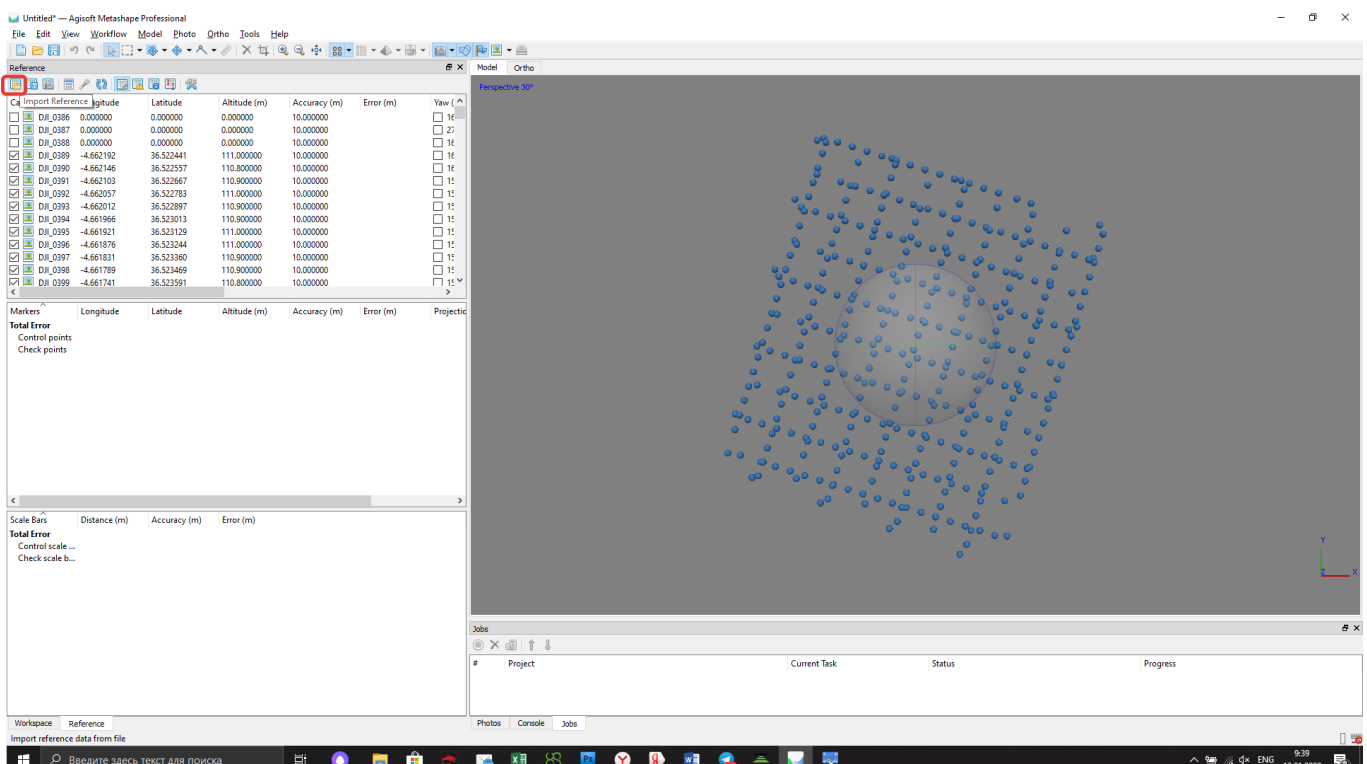
## 4. PHOTOGRAMMETRY PROCESSING IN AGISOFT METASHAPE SOFTWARE

### 4.1 Creating project, photos alignment

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

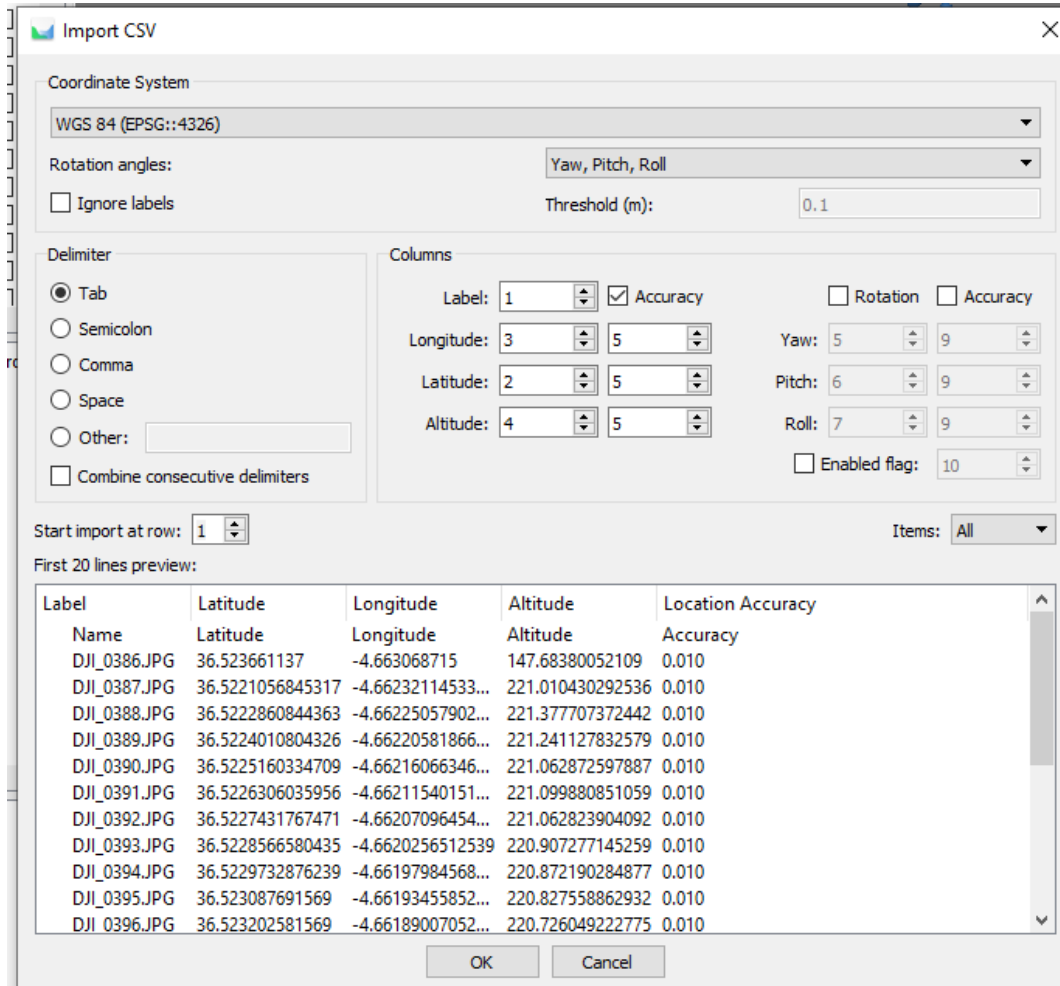


Import positions from file coordinates.txt. Go to Reference. Click Import button, select coordinates.txt file from folder with photos





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 | 3 | 5 | Accuracy                            | Rotation         | Accuracy |
|-----------|---|---|---|-------------------------------------|------------------|----------|
| Longitude | 3 | 5 |   | <input checked="" type="checkbox"/> | Yaw: 5           | 9        |
| Latitude  | 2 | 5 |   |                                     | Pitch: 6         | 9        |
| Altitude  | 4 | 5 |   |                                     | Roll: 7          | 9        |
|           |   |   |   |                                     | Enabled flag: 10 |          |

Start import at row: **1**

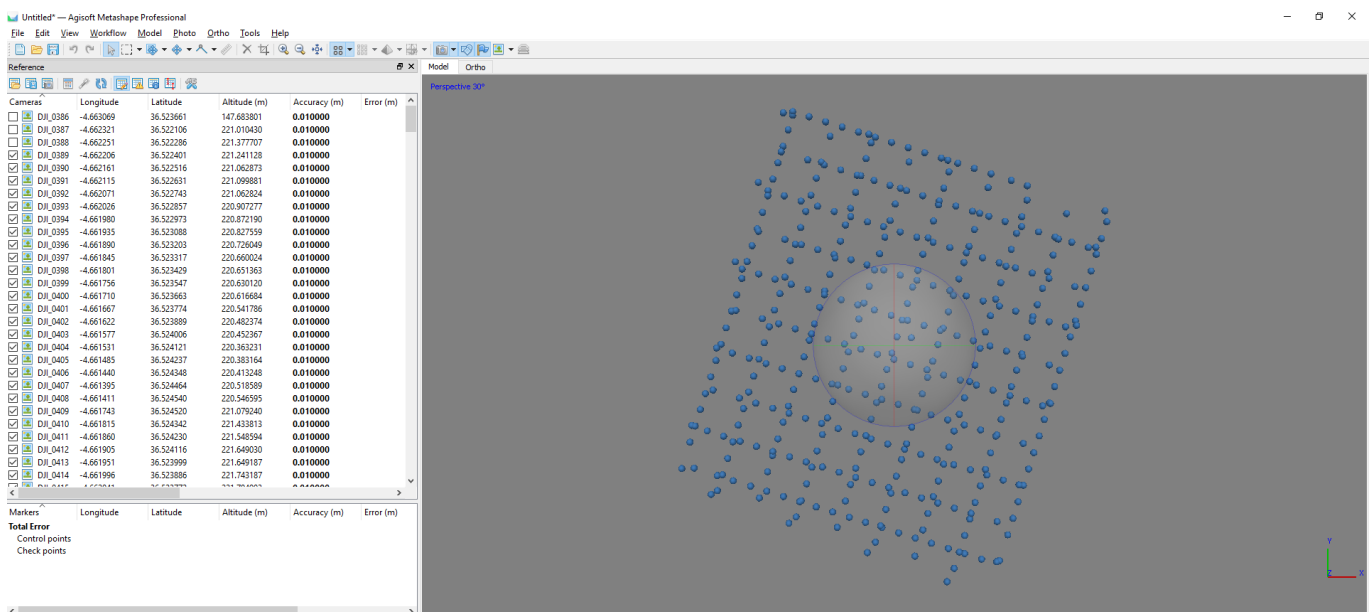
Items: **All**

First 20 lines preview:

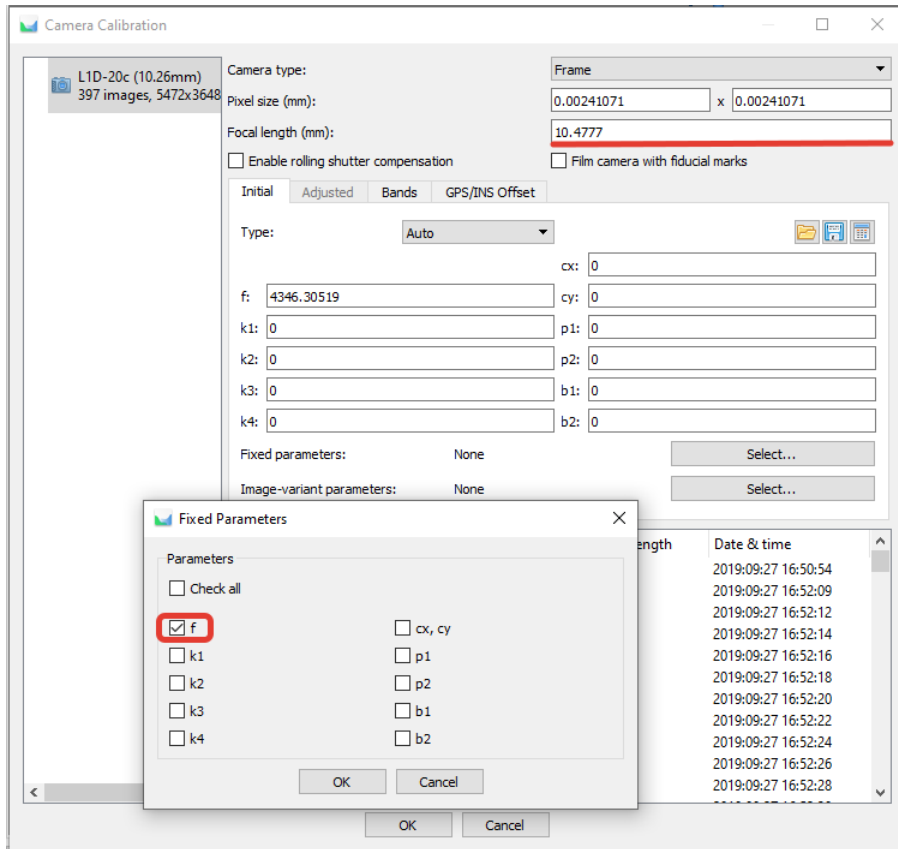
| Label        | Latitude         | Longitude         | Altitude         | Location Accuracy |
|--------------|------------------|-------------------|------------------|-------------------|
| Name         | Latitude         | Longitude         | Altitude         | Accuracy          |
| DJI_0386.JPG | 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

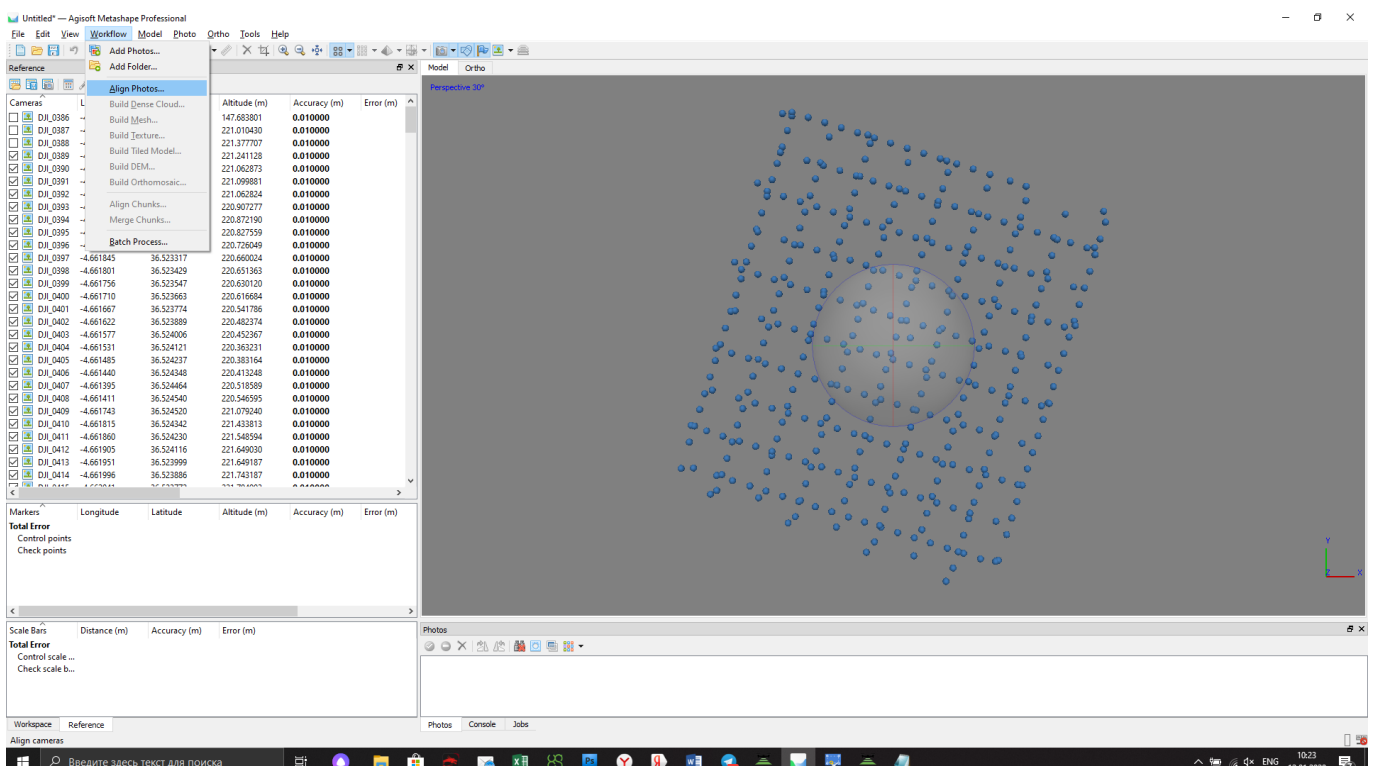
Accurate X,Y,Z coordinates and accuracy values will appear in Reference window



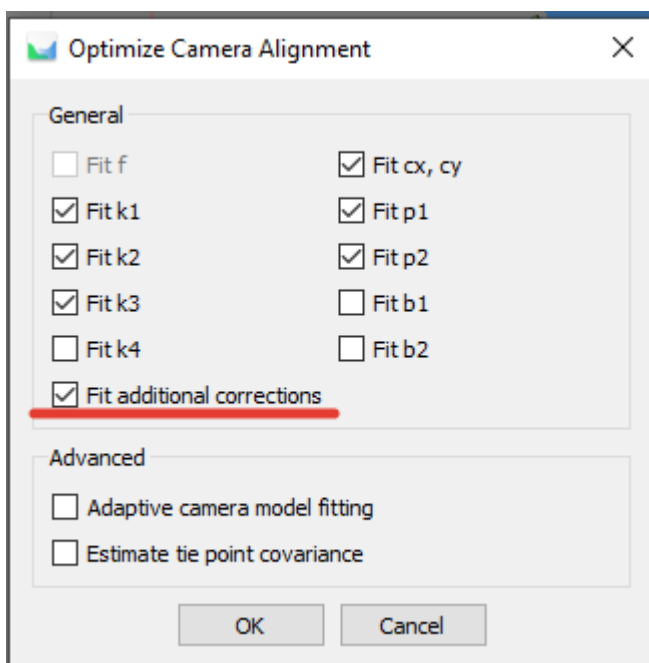
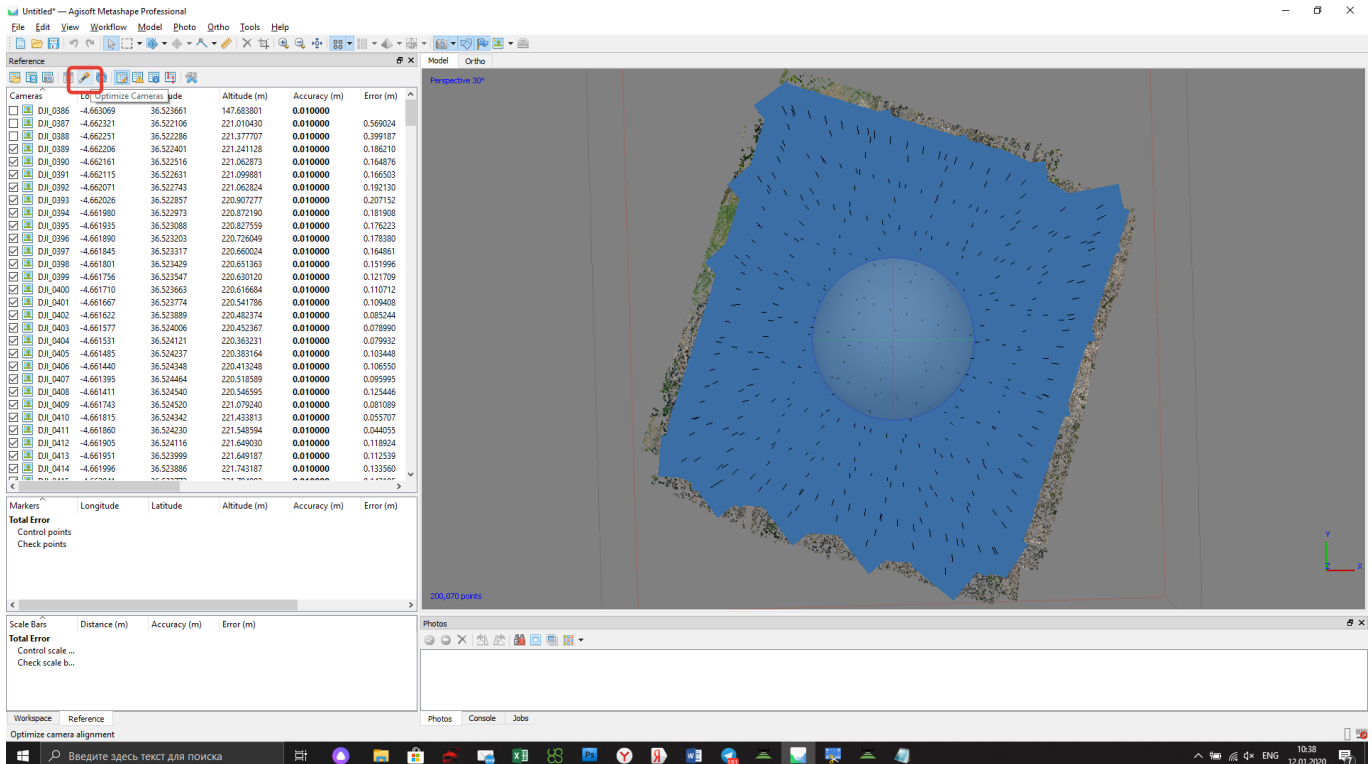
.Go to Tools, click Camera calibration and input calibrated parameter for focal length 10.4777, select fixed F parameter



Go to Workflow and click Align Photos for aerial triangulations



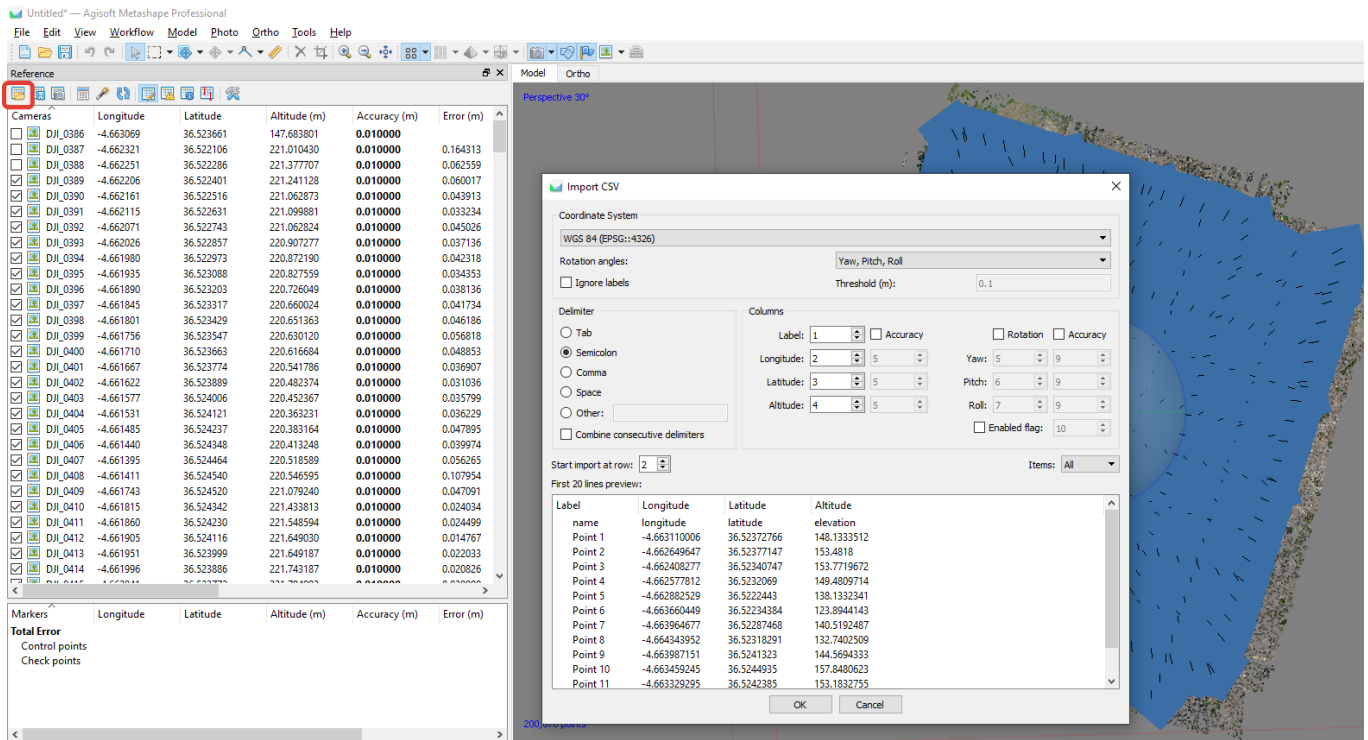
After finishing aerial triangulation go to Reference, click "Optimize Camera Alignment" and click on Fit additional corrections check box. Click OK



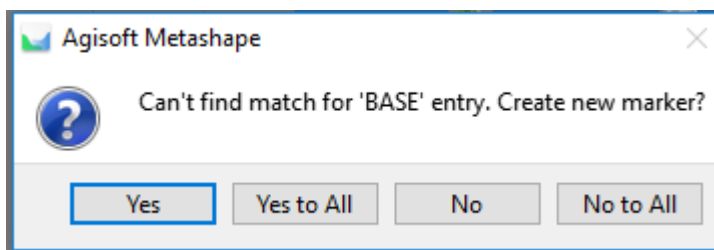
## 4.2 Accuracy estimating

After finishing aerial triangulation go to Reference, click "Import" and load GCP.txt file

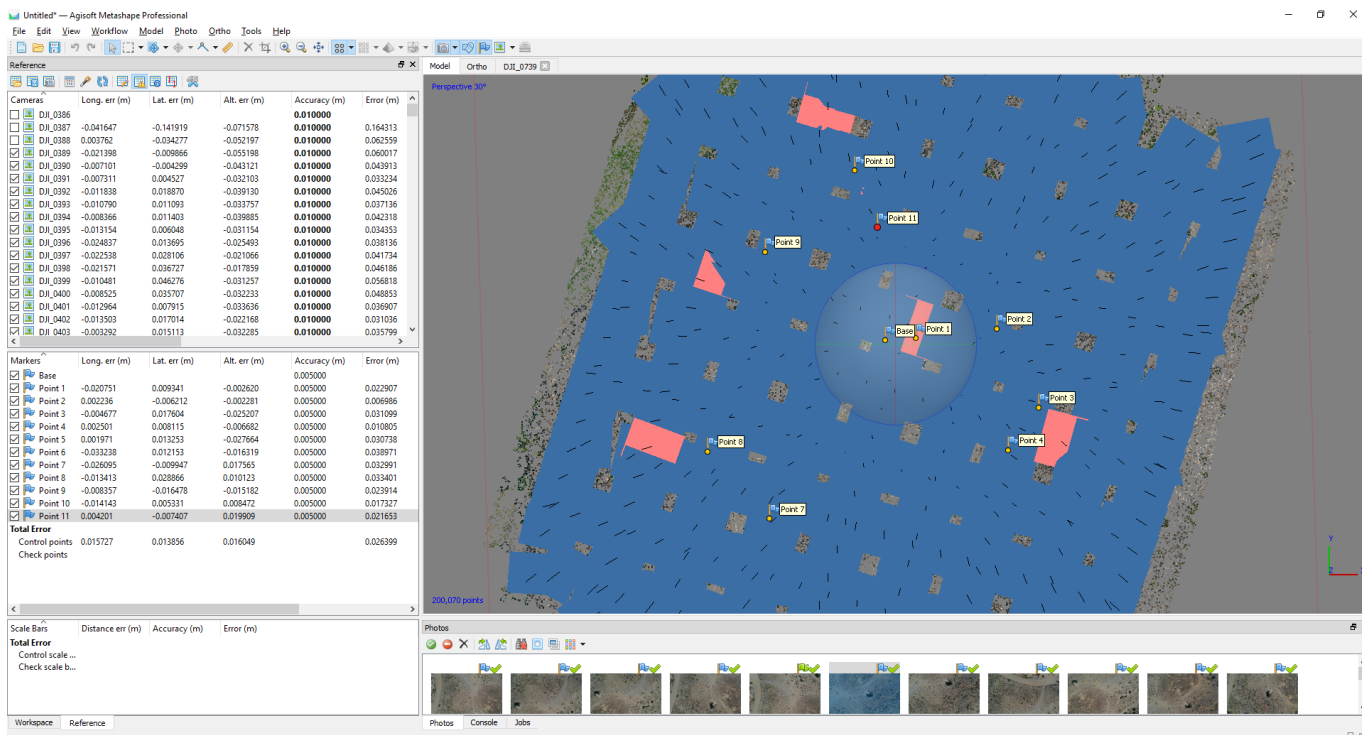
Use the following settings and click OK



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



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

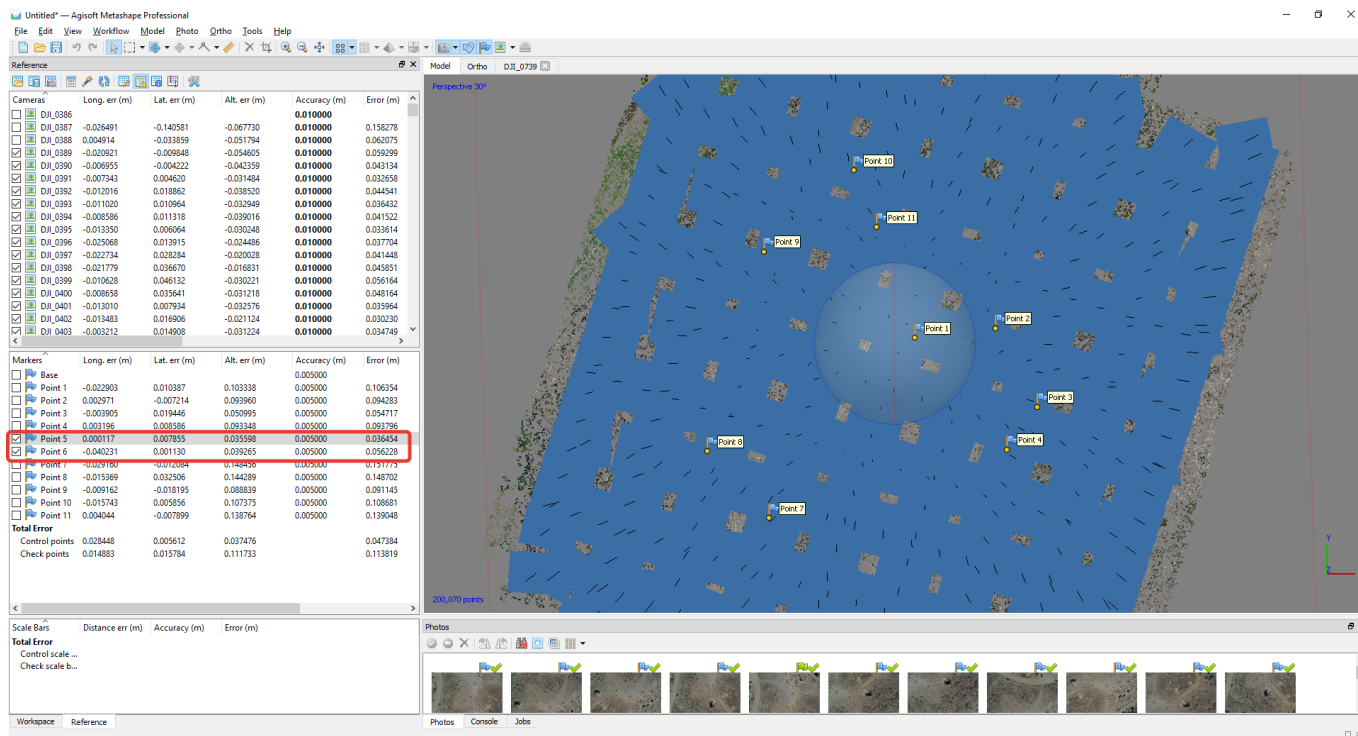


| Markers                                      | Long. err (m) | Lat. err (m) | Alt. err (m) | Accuracy (m) | Error (m) |
|--|---------------|--------------|--------------|--------------|-----------|
| <input checked="" type="checkbox"/> Base     |               |              |              | 0.005000     |           |
| <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  |
| <b>Total Error</b>                           |               |              |              |              |           |
| Control points                               | 0.015727      | 0.013856     | 0.016049     |              | 0.026399  |
| Check points                                 |               |              |              |              |           |



### 4.3. Camera calibration

To calibrate camera focal length, load images, import accurate coordinates of photos, perform photos alignment (don't fix F parameter) and import GCPs. Define position of markers on each photo. Select 2-3 markers

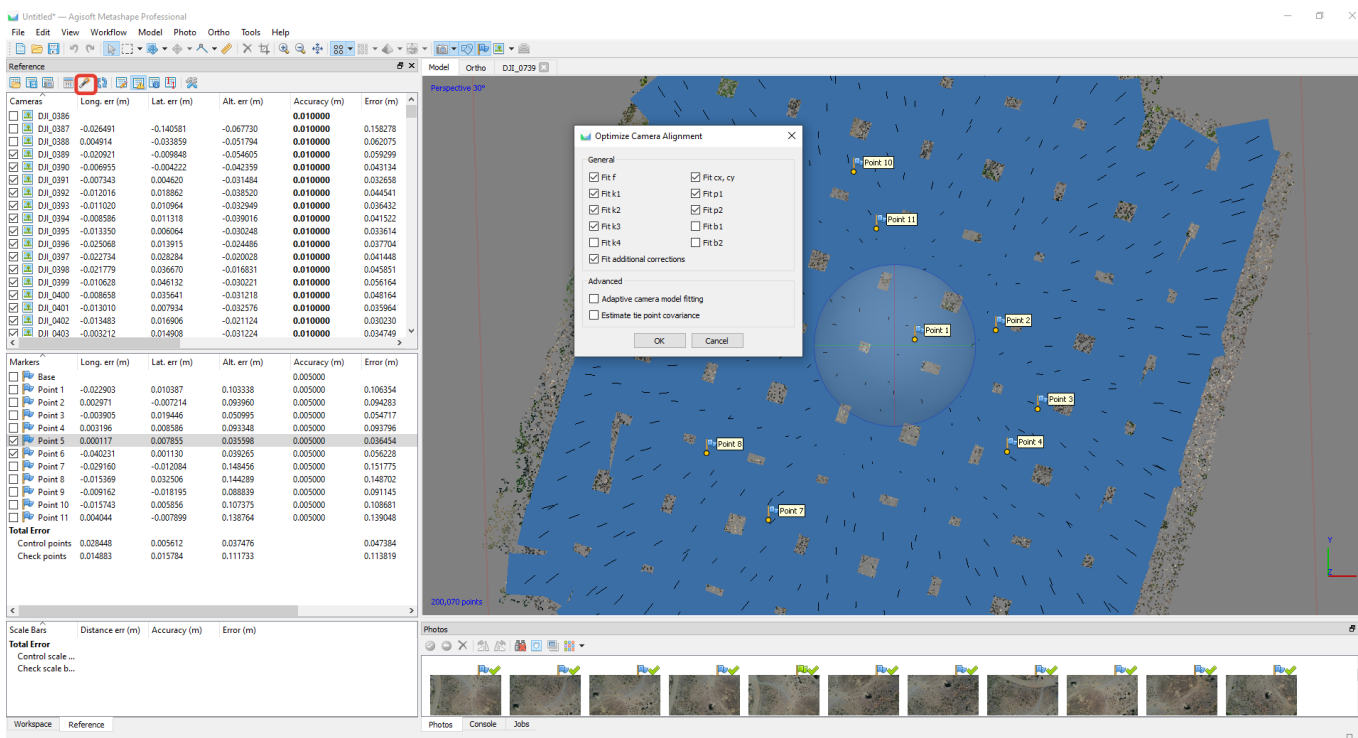


The screenshot shows the Agisoft Metashape Professional interface. On the left, the 'Cameras' and 'Markers' panels are visible. The 'Cameras' panel lists 11 cameras (DJI\_0386 to DJI\_0403) with their respective coordinates and accuracy. The 'Markers' panel lists 11 points (Point 1 to Point 11) with their coordinates and accuracy. The main 3D view shows a point cloud model of a terrain with a blue circular area highlighted. The 'Photos' panel at the bottom shows a sequence of 11 photos.

| Cameras  | Long. err (m) | Lat. err (m) | Alt. err (m) | Accuracy (m) | Error (m) |
|----------|---------------|--------------|--------------|--------------|-----------|
| DJI_0386 | -0.026491     | -0.140581    | -0.067730    | 0.010000     | 0.158278  |
| DJI_0388 | 0.004914      | -0.033859    | -0.051794    | 0.010000     | 0.062075  |
| DJI_0389 | -0.020921     | -0.009848    | -0.054605    | 0.010000     | 0.059259  |
| DJI_0390 | -0.006955     | -0.004222    | -0.042359    | 0.010000     | 0.043134  |
| DJI_0391 | -0.007343     | 0.004620     | -0.031484    | 0.010000     | 0.032658  |
| DJI_0392 | -0.012016     | 0.018862     | -0.038520    | 0.010000     | 0.044541  |
| DJI_0393 | -0.011020     | 0.010964     | -0.032949    | 0.010000     | 0.035432  |
| DJI_0394 | -0.008586     | 0.011318     | -0.039016    | 0.010000     | 0.041522  |
| DJI_0395 | -0.013350     | 0.006064     | -0.030248    | 0.010000     | 0.033614  |
| DJI_0396 | -0.025068     | 0.013915     | -0.024486    | 0.010000     | 0.037704  |
| DJI_0397 | -0.022734     | 0.028284     | -0.020028    | 0.010000     | 0.041448  |
| DJI_0398 | -0.021779     | 0.036670     | -0.016831    | 0.010000     | 0.045851  |
| DJI_0399 | -0.010628     | 0.046132     | -0.030221    | 0.010000     | 0.056164  |
| DJI_0400 | -0.008658     | 0.035641     | -0.031218    | 0.010000     | 0.048164  |
| DJI_0401 | -0.013010     | 0.007934     | -0.032576    | 0.010000     | 0.035964  |
| DJI_0402 | -0.013483     | 0.016906     | -0.021124    | 0.010000     | 0.030230  |
| DJI_0403 | -0.003212     | 0.014908     | -0.031224    | 0.010000     | 0.034749  |

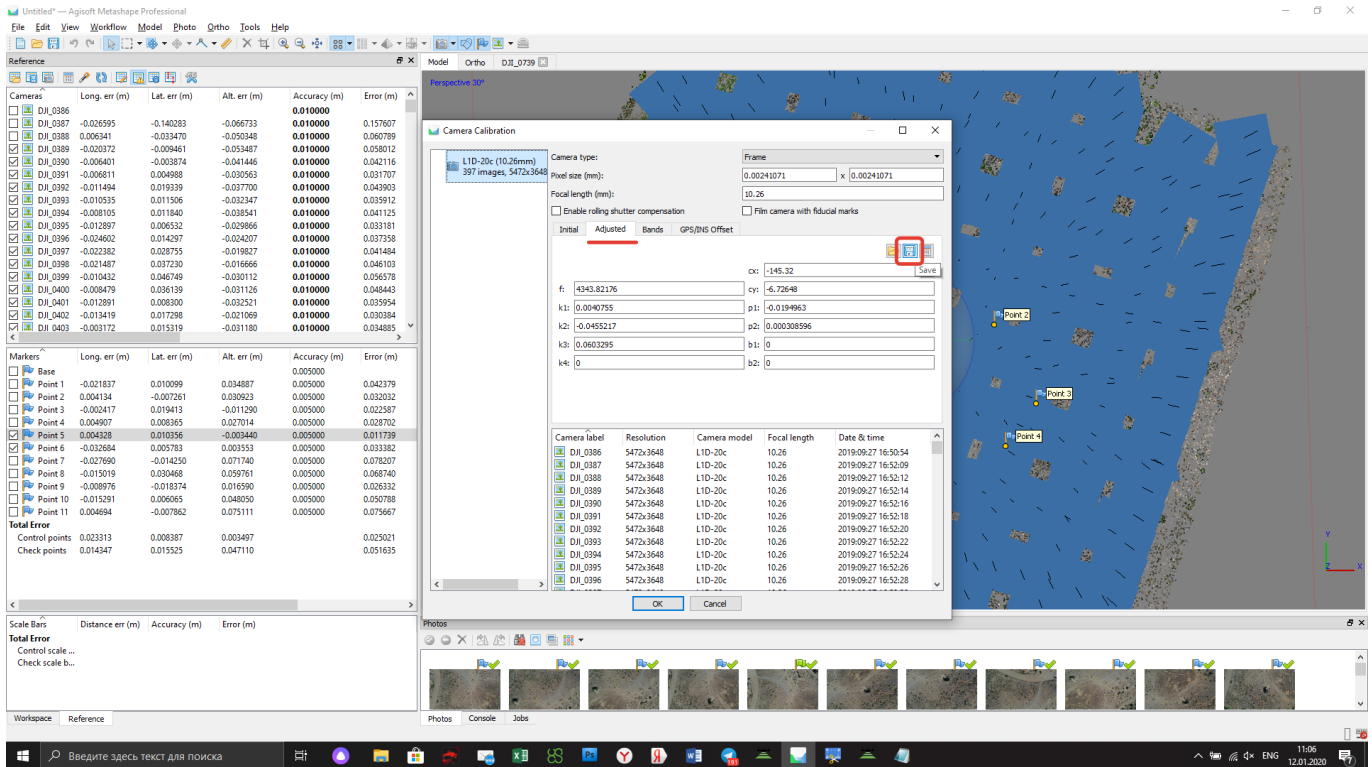
| Markers  | Long. err (m) | Lat. err (m) | Alt. err (m) | Accuracy (m) | Error (m) |
|----------|---------------|--------------|--------------|--------------|-----------|
| Base     | -0.022903     | 0.010387     | 0.103338     | 0.005000     | 0.106354  |
| Point 1  | 0.002971      | -0.007214    | 0.093960     | 0.005000     | 0.094283  |
| Point 2  | -0.003905     | 0.019446     | 0.050995     | 0.005000     | 0.054717  |
| Point 3  | 0.003196      | 0.008586     | 0.093348     | 0.005000     | 0.093796  |
| Point 4  | 0.000117      | 0.007855     | 0.035598     | 0.005000     | 0.036454  |
| Point 5  | -0.040231     | 0.001130     | 0.039265     | 0.005000     | 0.056228  |
| Point 6  | -0.029160     | -0.012084    | 0.148456     | 0.005000     | 0.151775  |
| Point 7  | -0.015369     | 0.022596     | 0.146702     | 0.005000     | 0.146702  |
| Point 8  | -0.009162     | -0.018195    | 0.088839     | 0.005000     | 0.091145  |
| Point 9  | -0.015743     | 0.005856     | 0.107375     | 0.005000     | 0.108681  |
| Point 10 | 0.004044      | -0.007899    | 0.138764     | 0.005000     | 0.139048  |
| Point 11 |               |              |              |              |           |

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

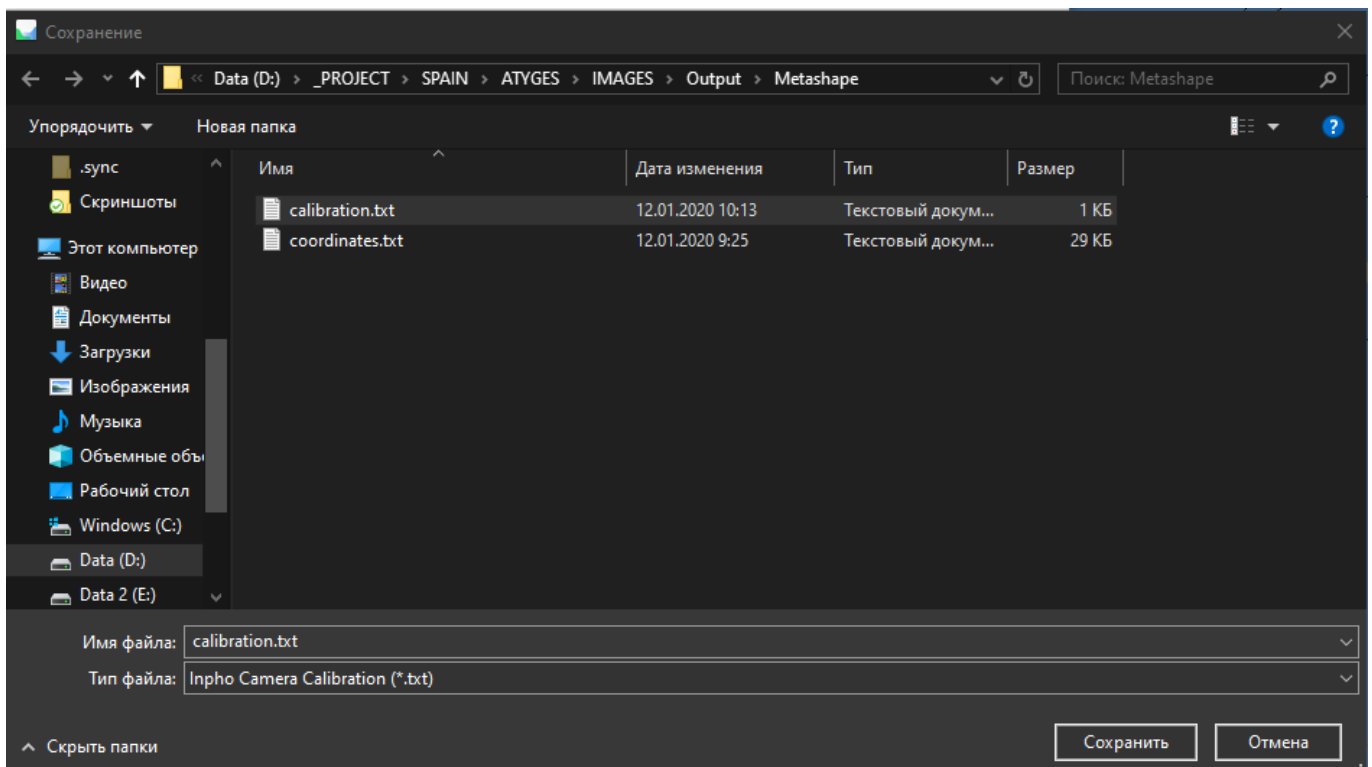


The screenshot shows the 'Optimize Camera Alignment' dialog box in Agisoft Metashape Professional. The 'General' tab is selected, and the following options are checked: 'Fit F', 'Fit cx, cy', 'Fit p1', 'Fit p2', 'Fit b1', 'Fit b2', and 'Fit additional corrections'. The 'Advanced' tab is also visible, with 'Adaptive camera model fitting' and 'Estimate tie point covariance' options.

After finishing 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 focal length value

---

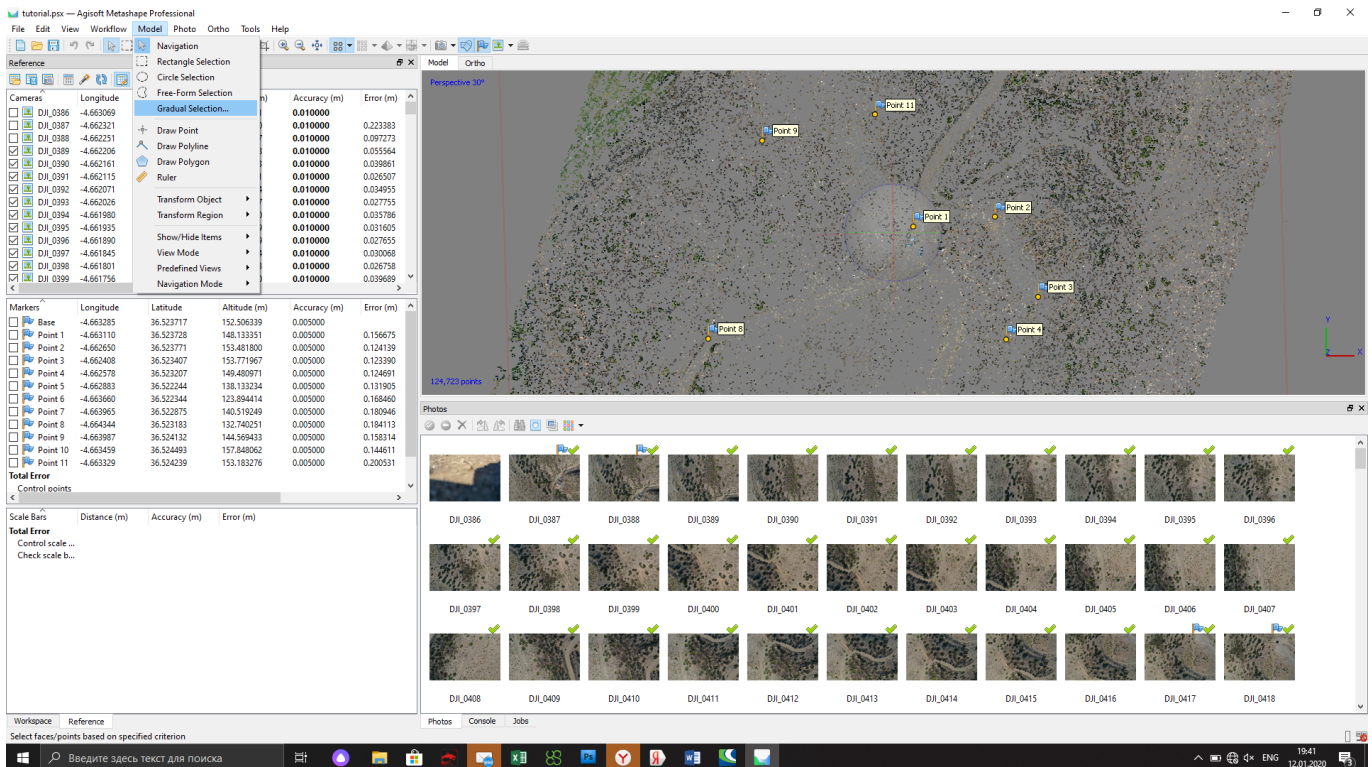
```
$CAMERA
$TYPE : FC6510_(8.8mm)
$DATE : 00:30:57 06/11/2019
$BRAND : Custom
$KIND : CCDFrame
$CCD_INTERIOR_ORIENTATION :
    414.545      -0      2723.86
    0.0000000000 -414.545  1821.52
$CCD_COLUMNS : 5472
$CCD_ROWS : 3648
$PIXEL_REFERENCE : CenterTopLeft
$FOCAL_LENGTH : 8.81713
$PRINCIPAL_POINT_PPA : 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 is possible to use the calibrated value of focal length for the processing If you don't change focus settings for future flights.

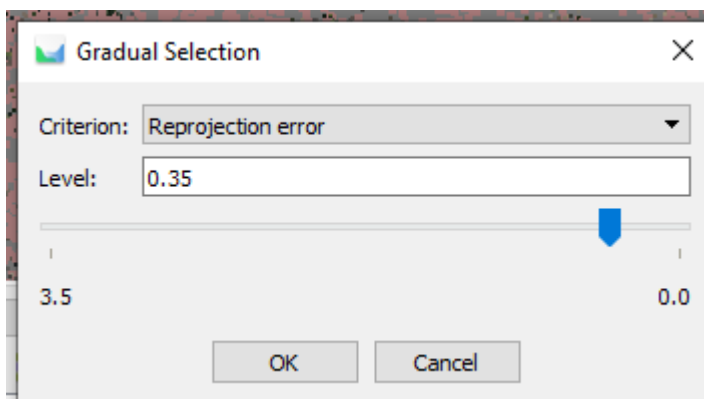


#### 4.4. Aerial triangulation accuracy improvement. Tie points filtering

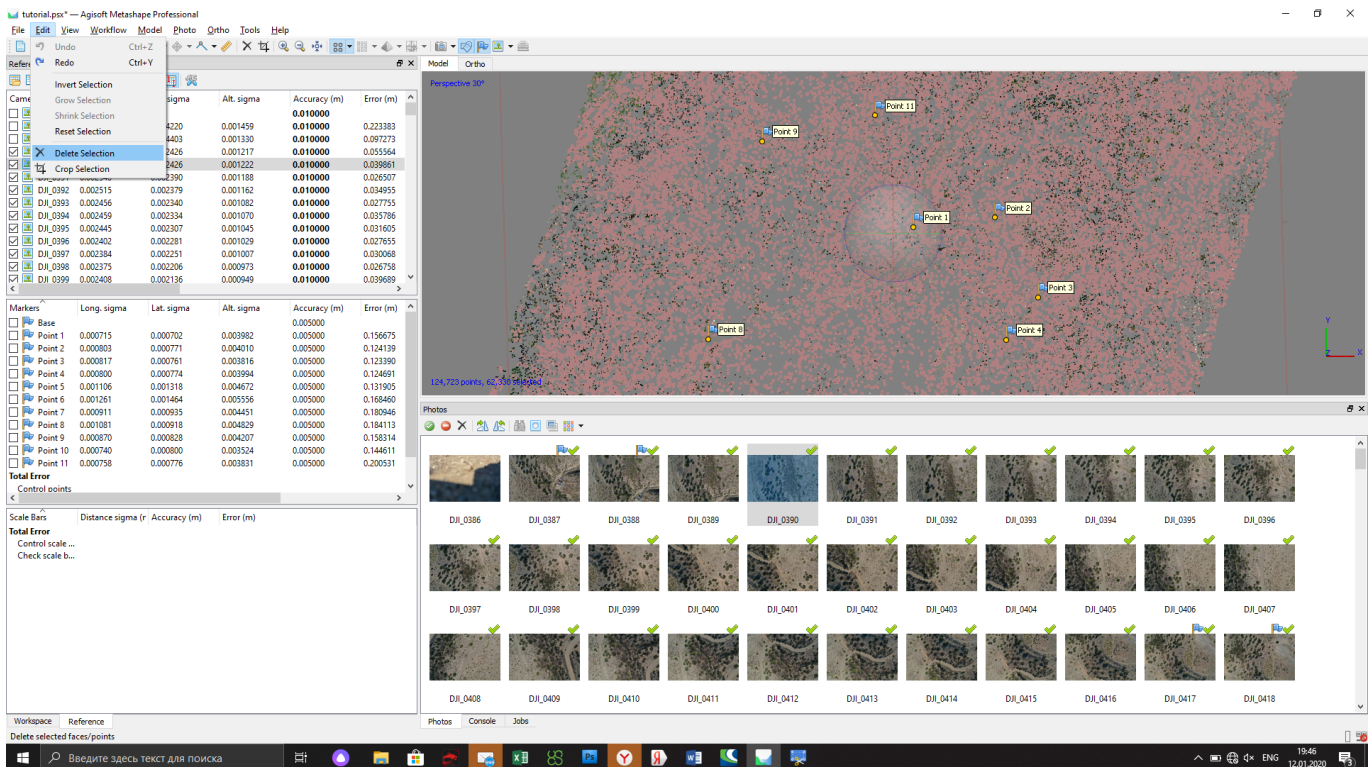
In order to increase an accuracy of your model, we would suggest to filter tie points using Gradual Selection tool. Open Model menu, click Gradual Selection.



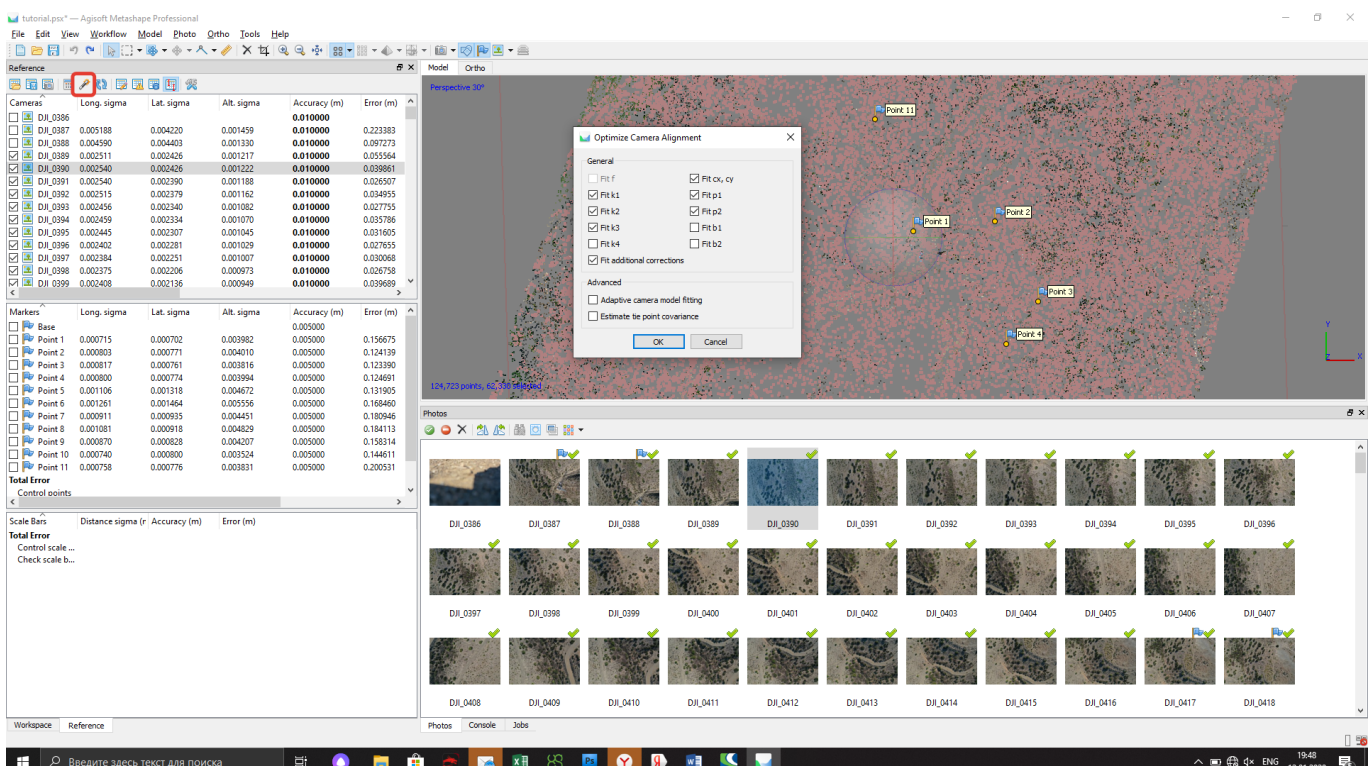
Select Gradual selection and input 0.35 value



Go to Edit menu and delete selected points



Click "Optimize Camera Alignment"



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