MAPPING WITH EVO™ II

EVO II Pro EVO II RTK

- Construction
- Land Development
- Archeological Survey
- Asset Management
- GIS
- Inspection
- Agriculture
- Mining
- Forensics
- Emergency Management
- 3D Modeling
- General Mapping

PRECISION TAKES FLIGHT
KukerRanken.com

PIX4D

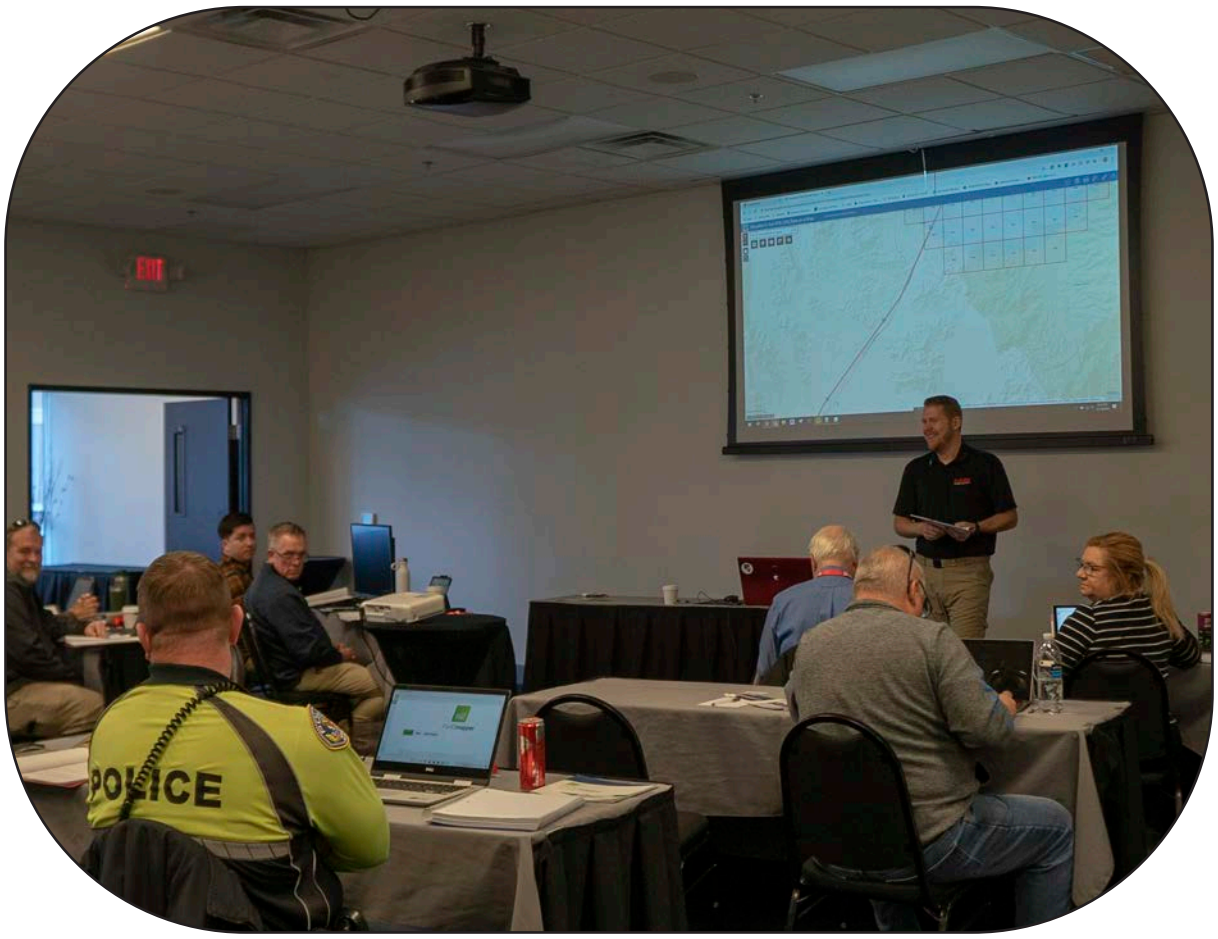
The EVO II Series and Autel Explorer were designed with mapping construction sites, traffic scenes, forensics, land developments, inspections, and other applications suitable for 2 and 3 dimensional modeling, reporting, documentation, and viewing.

At Kuker-Ranken, we're pleased to offer the RTK and non-RTK versions of the EVO II aircraft, with or without a base station for greater precision and accuracy.

This mapping guide is designed to get users started mapping with UAS, and although this guide is specific to the EVO II aircraft series, the fundamentals presented here apply to all mapping aircraft.

Kuker-Ranken offers more than just UAS; we have base stations from Leica and Emlid, software from Leica, Pix4D, and more. We also stock GCP/control points, paints for controls, nails, whiskers, stakes, safety vests, hard hats, and every other possible accessory for the surveyor, civil engineer, GIS pro, or construction site manager.

We also offer in-person training in all of our stores, and our training team is able to travel when necessary.



Virtual Design and Construction (VDC) Specialist Brady Reisch teaches a class in Pix4D and unmanned aircraft for forensics and construction.

GETTING STARTED

SAFETY
All UAS flights require safety/risk assessments. We recommend standard FRAT (Flight Risk Assessment Tool) methods be used prior to every UAS flight to ensure safe flight trajectories, protection of persons or property. We recommend launch/land pads be used during all operations to protect the camera/lens system from moisture, dirt/FOD during launch or battery replacement.

CAMERA SETTINGS
We recommend flying the aircraft/camera at altitude prior to a mapping mission for purposes of ascertaining correct exposure. Once determined, exposure should be locked. This is important over large areas, as sun, clouds, moving shadows, and even moving vehicles may affect the overall exposure of the image, creating inconsistencies in post-processing and stitching/modeling. Highly experienced users may find a Neutral Density filter as high as ND8 *may* be used in rare circumstances. However, shutterspeed must be at least 1/500, recommended to be 1/1000-1/1200, with ISO set between 400-800 depending on the camera system. Failsafes include allowing the camera to auto-adjust during the pre-mission flight and then locking that exposure. It is always preferable to slightly underexpose than overexpose at any point. Batch processing tools such as Skylum Luminar may be used to adjust overall exposure without affecting the EXIF data in the image; this costs time and there is a slight loss in quality any time we're processing a compressed image format (.jpg).

MISSION SETTINGS
Proper configuration of the mission is critical to mission/data capture success. Proper setup includes two primary factors; frontlap and sidelap. Without the proper overlapping, there will not be enough data in each image to properly tie image points for the best density and clarity of the map. Pix4D recommends a minimum of:

- 75% frontal and 60% side overlap in general cases.
- 85% frontal and 70% side overlap for forests, dense vegetation and fields.
- 85% frontal overlap for single track corridor mapping. Use 60% side overlap if the corridor is acquired using two flight lines.

KR Recommendations

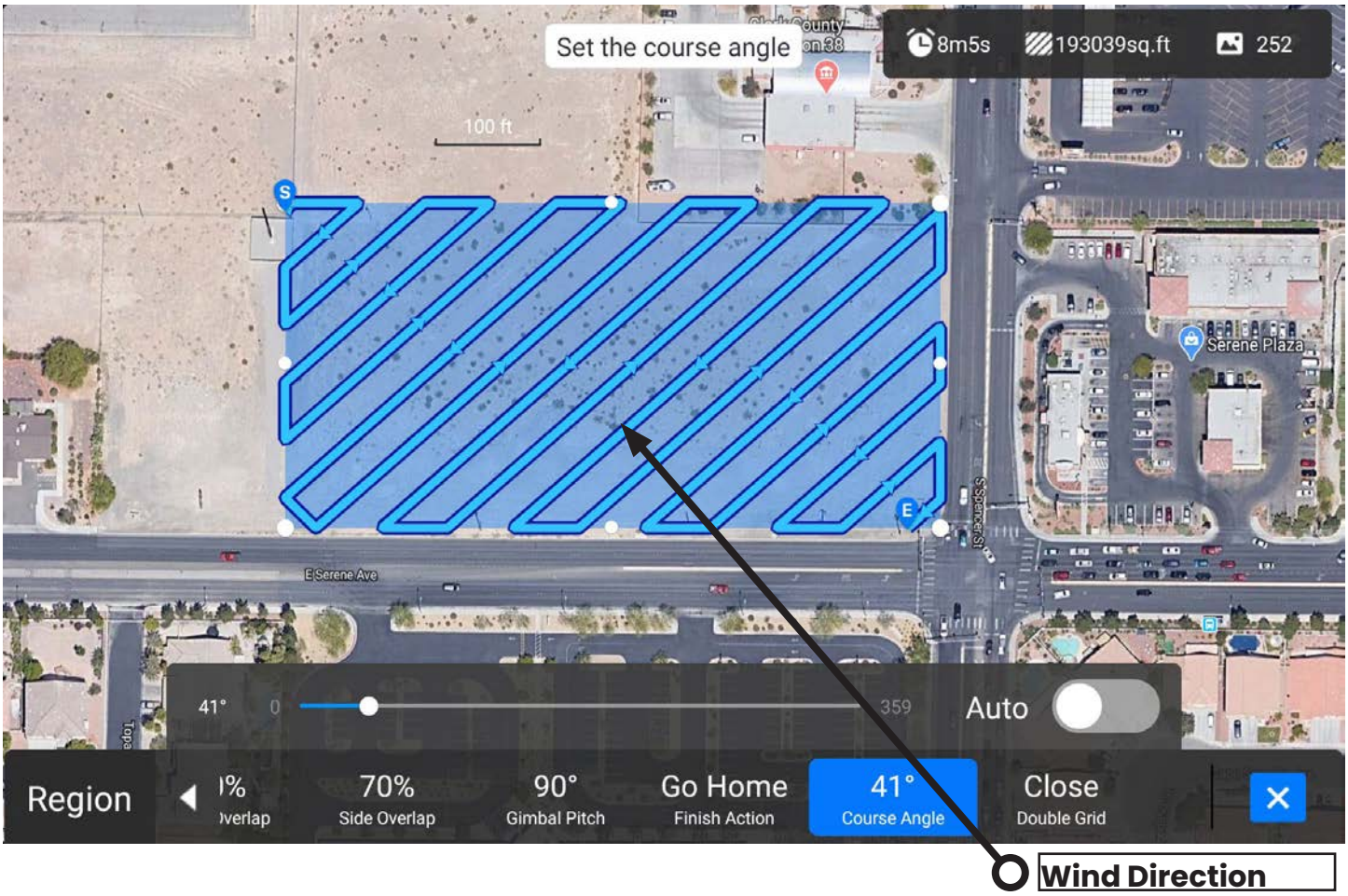
- Kuker-Ranken recommends 80% frontal and 65% side overlap in light/variable winds (or higher) and slightly greater overlap if high-flight speeds are required.
- Kuker-Ranken recommends high frontlap/side overlap in dusk/night flight situations, coupled with very slow flight speed (2.5Mps/3mph)

Flight Speeds should never exceed 8m/ps (18mph) unless flying very high altitudes (300' or greater). Kuker-Ranken recommends speeds of 5m/ps (11mph) for missions lower than 200' in well-lit conditions. Low-level flights for highest optical resolution should fly at speeds of ~4m/ps (7-8mph). In high wind conditions (after safety is taken into consideration). Hover/capture is recommended to reduce camera movement during image capture. This is also useful in dark areas. This may require manual flight in some scenarios.

"The darker the sky, the slower we fly."

Optimal flight conditions (general) are mid-day, with solid cloud cover to diffuse the sun, reducing harsh shadows. It is rare that optimal conditions exist; use the above settings to optimize for less than optimal environments.
Disable 'capture images in turnarounds' if the controlling software offers this feature. This reduces blurred images from high-speed yaw as the aircraft makes its turns into each new raceway/gridline.

SETTING UP THE MISSION
When setting up a mission, environmental factors should be a consideration. If, for example, the wind is blowing north to south, neither a north/south route nor east/west route is optimal for flight angle and battery consumption.
When winds are at the higher end of Light/Variable (l/v), crab the aircraft by keeping the wind at a quarter angle.

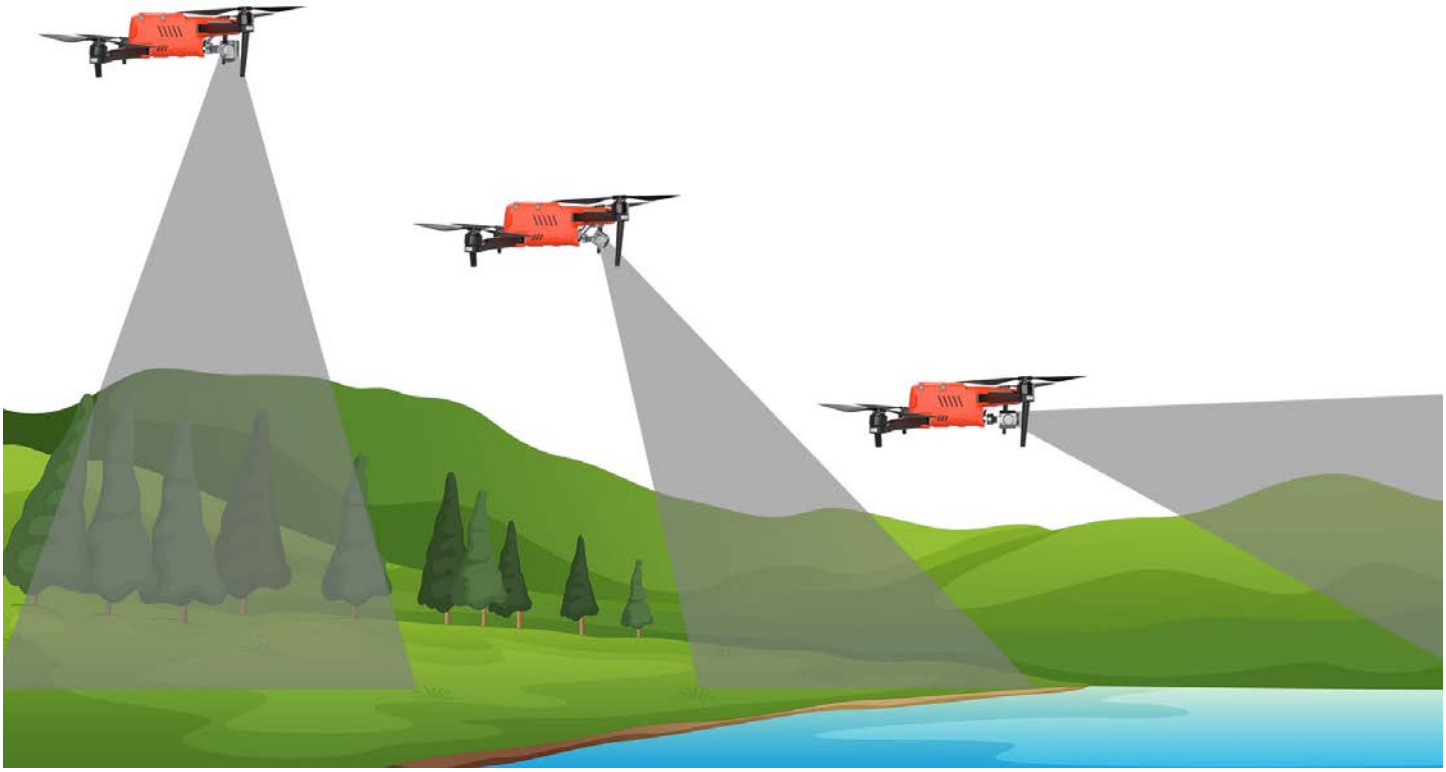


FLIGHT PATTERNS
Autel Explorer enables pilots to program the three necessary functions for 3D Maps (and models, in addition to assisting pilots in other valuable capture techniques.

If the output is an orthomosaic/flat map, the aircraft will need to fly only in a "***nadir***," or a straight-down camera angle.

"NADIR" is the point on the earth directly below the observer's perspective (the aircraft).

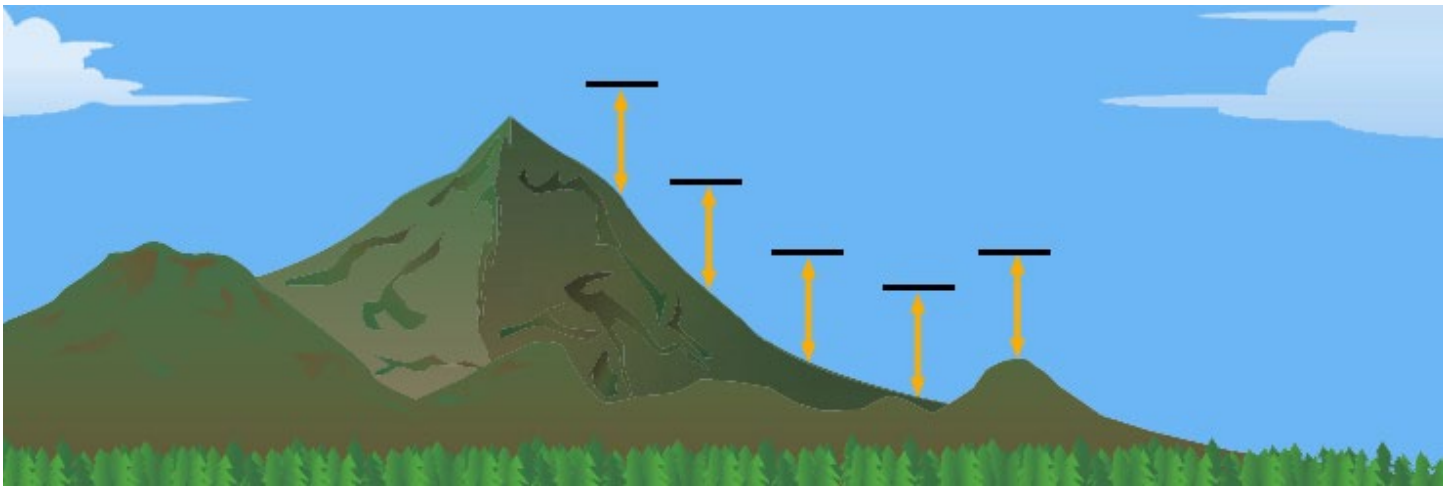
"Obliques" are another camera angle, where the camera may be pitch-controlled at an angle that is neither parallel to flight, nor straight down. Very detailed maps/models may be generated when at least two oblique angles are captured of any given subject.



NADIR ***HIGH OBLIQUE*** ***LOW OBLIQUE***

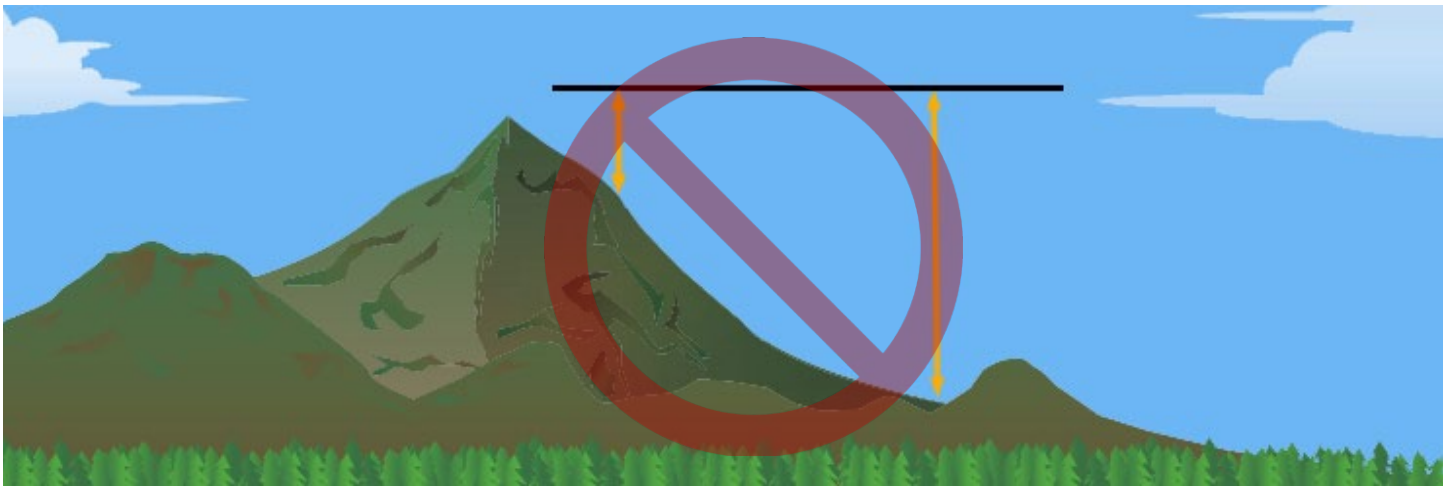
WORKING IN VARIABLE TERRAIN (Hilly areas)
Maintaining GSD/Ground Sample Distance is key to successful outcomes in Pix4D. Some systems allow software to automatically conform to terrain changes, while others do not. It is best to plan multiple flights for ensuring identical GSD throughout the project. GSD can be managed/maintained through multiple flights at different altitudes.

Alternatively, if the terrain doesn't contain large variants, a single flight may be used, if consideration for front and side overlap are taken. In a single flight over changing terrain, front/side overlap will be greater at the higher altitude while lesser at the lower altitudes, and this must be taken into consideration when setting up a flight. Higher front/sidelap settings would need to be made for the entire mission if terrain is significantly changing over are.



When the highest altitude is double or greater than the lowest altitude, Pix4D will not be able to successfully output a clean file. If, for example, the flight is at 75; for high GSD, and the area climbs to 150' or greater, a single flight does not allow for a successful result. Multiple flights would be required.

The example below would be a problematic map. Multiple flights, similar to the image above, is required to ensure data can be properly managed in Pix4DMapper.



In the above image, the difference between the highest elevation and lowest elevation is too great to allow for a clean capture for 3D mapping or a quality orthomosaic. Areas similar to those seen in the above illustrations require multiple flights at distances never greater than half the highest elevation, or more than double the lowest elevation.

THE PIX4DMAPPER APPLICATION

There are multiple methods to using Pix4DMapper. This guide approaches the application from a *"Basic" "Better" "Best"* There are two methods of achieving relative accuracy, and one method for achieving absolute accuracy using exterior tools or an RTK/PPK UAS/acquisition system.

EQUIPMENT REQUIREMENTS (aside from aircraft and computer system. Be sure to have a mouse if working from a laptop):

BASIC
Modeling and mapping quality will be reasonably acceptable for many purposes simply through capturing images with the aircraft (or other camera system) and dropping them into Pix4DMapper, and allowing the system to process. Pix4D mapper will do its best to properly align images even without inserted geo-data. This method can achieve relative accuracy within a few yards of correct geospatial position.

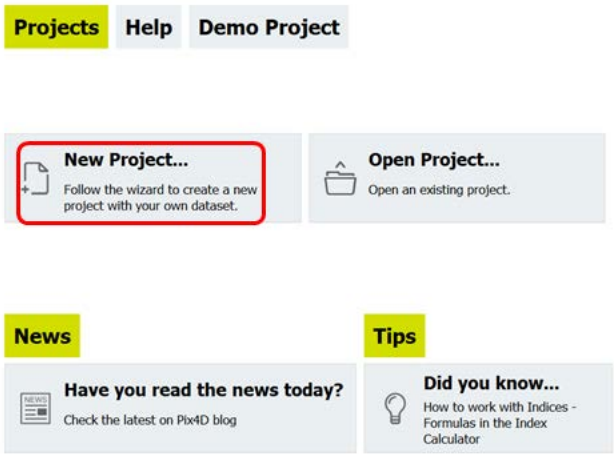
BETTER
Models and mapping quality significantly increase when we have known constraints (measurements of known objects) from the ground. These may be infrastructure components, laid-dow measuring devices, or fixed points of reference such as fire hydrants, known survey coordinates, points of paint or other fixed features contained in the scene. This method uses Manual Tie Points/MTP. This method can achieve relative accuracy within a couple of yards of correct geospatial position, scene-size dependent.

BEST
Models and mapping quality is absolute, and generally is a significantly better model, placed in absolute accuracy (~1-5cm). This requires an RTK, PPK, system coupled with the aircraft. Using these tools is beyond the scope of this document. The back of this document contains resources for GIS (RTK, PPK) equipment acquisition.

Regardless of the planned quality of output, all steps begin with an identical workflow.

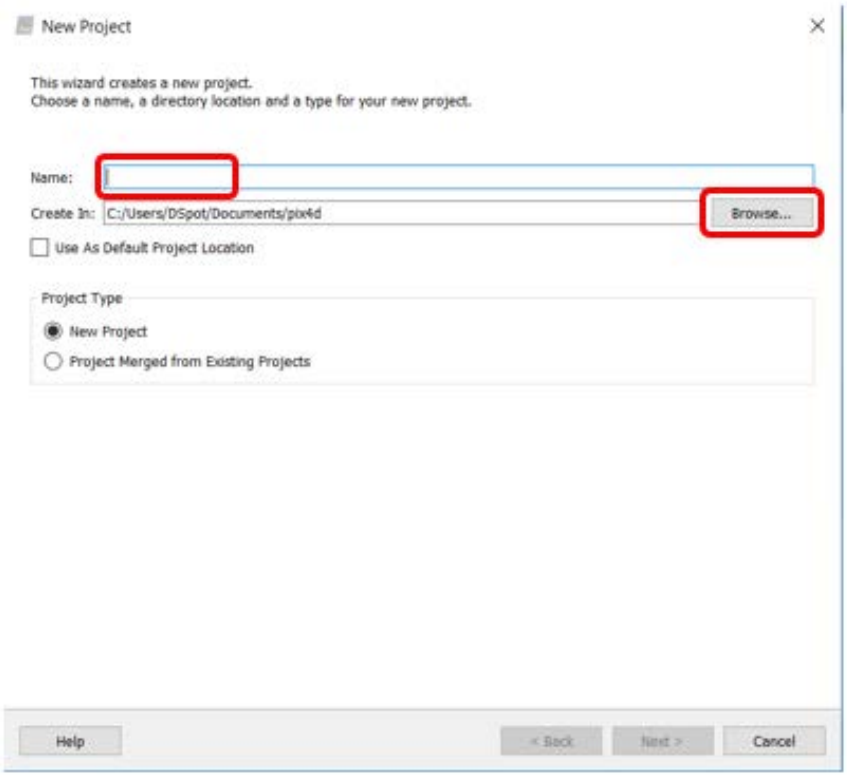
CREATE A NEW PROJECT

Launch Pix4D from the Start Menu or Desktop
New Project Dialog will open:

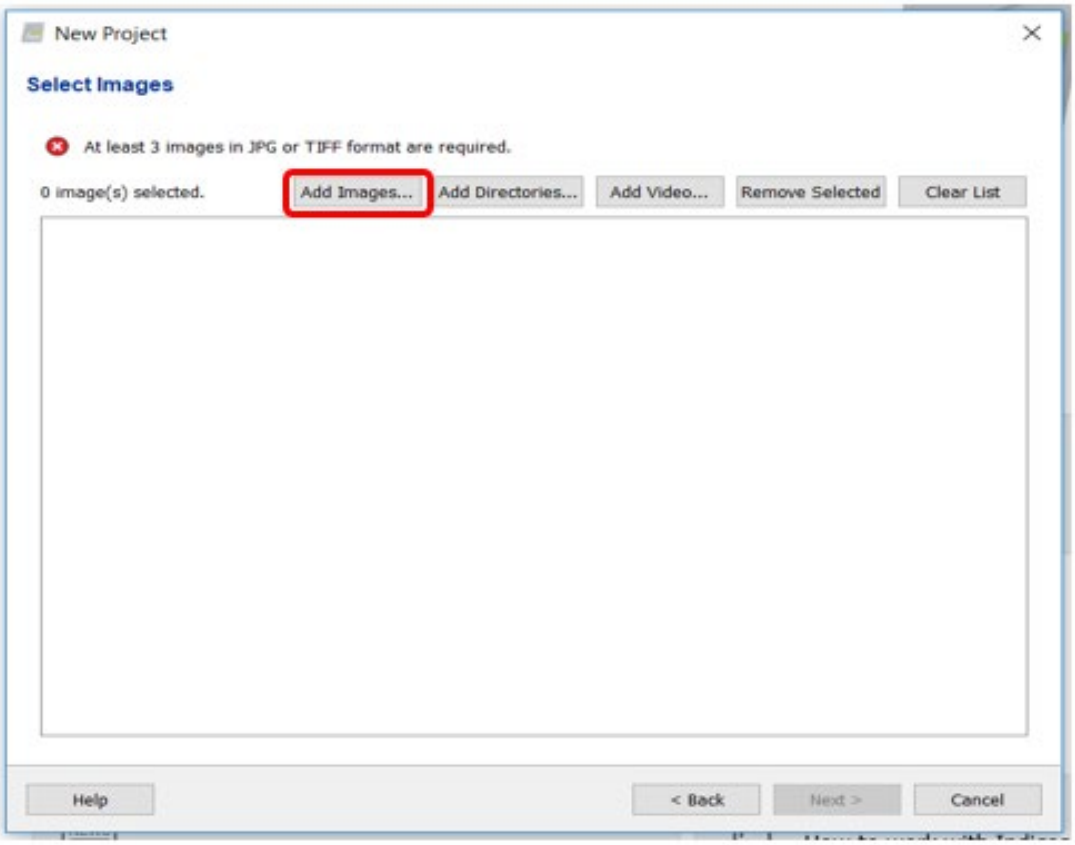


The Wizard will show a new project window.

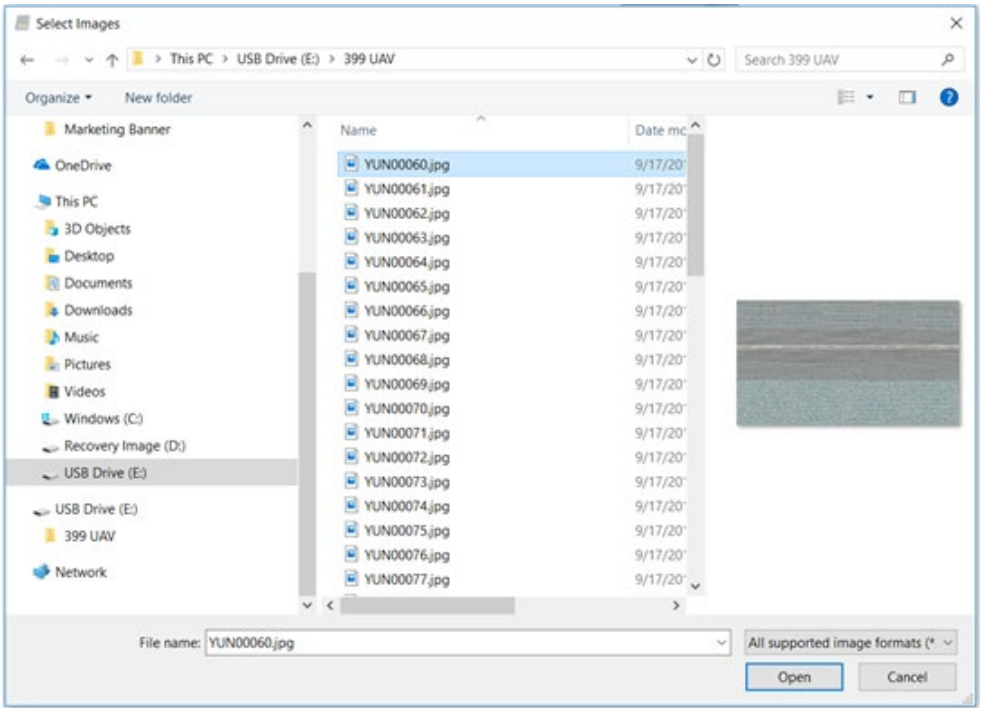
Enter a **NEW PROJECT NAME** and point the project to a FOLDER. We recommend the folder contain a case # or date (or both). Pix4D will assign all images and processes to this folder until otherwise instructed.



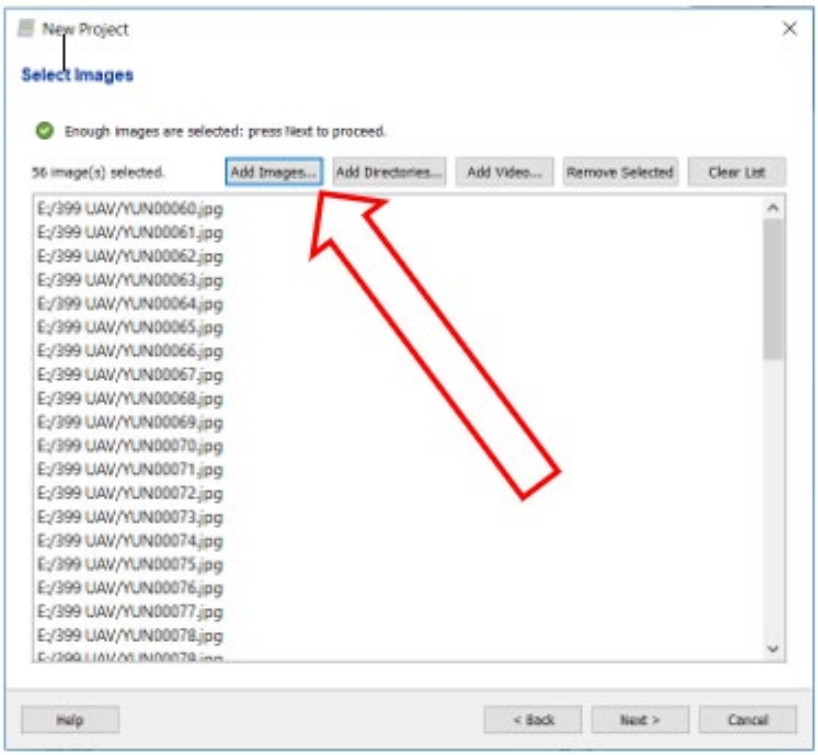
We recommend ensuring the Pix4D project file be placed in the same directory as image files. Create a Master Folder for the project, and place all relevant data (.txt, .jpg, .p4d, etc in the master folder under sub-folder headings).
Choose "**NEXT**" and a new dialog screen opens. Images from the aircraft (or other camera system) are added to the project by choosing the "ADD IMAGES"W button on the new dialog window that opens.



Point the "**ADD IMAGES**" dialog to the HDD where images are stored (We recommend always reading from a Hard Disk Drive (HDD), never the memory card from the acquisition source). If files are not on an HDD, copy them from the micro SD card to an HDD location. Log this copy per chain of custody or other organizational requirements.

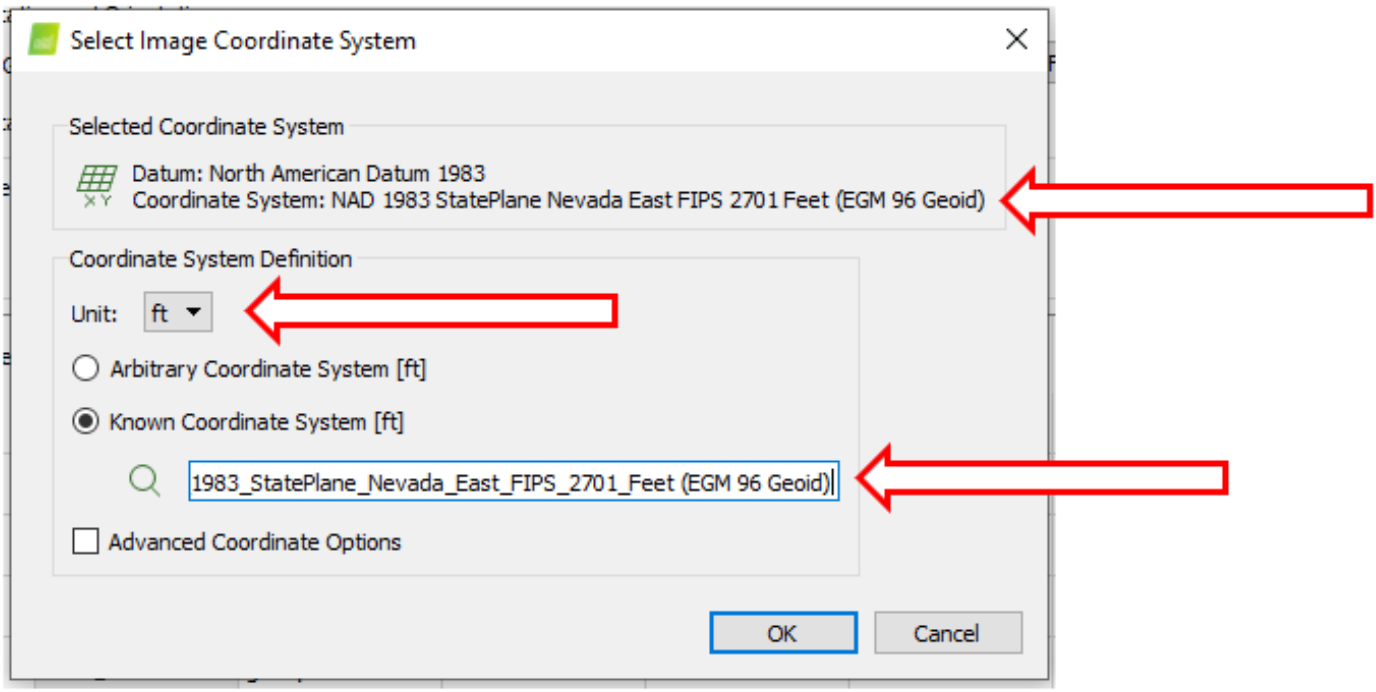


Browse to where images are located and choose “OPEN” The image chooser will open up. This is where photos are imported to the application. This does not copy images into a new folder; it will use the original/source location throughout the project process. ***It is important that the folder is only images captured during the automated flight.*** Any additional images captured will create problems in the output stage.



Ensure Pix4D indicates enough images have been selected. Images have now been added to the project.

Choose "**NEXT**"
The Output Coordinate Screen opens. There are three adjustment/checks in this screen.

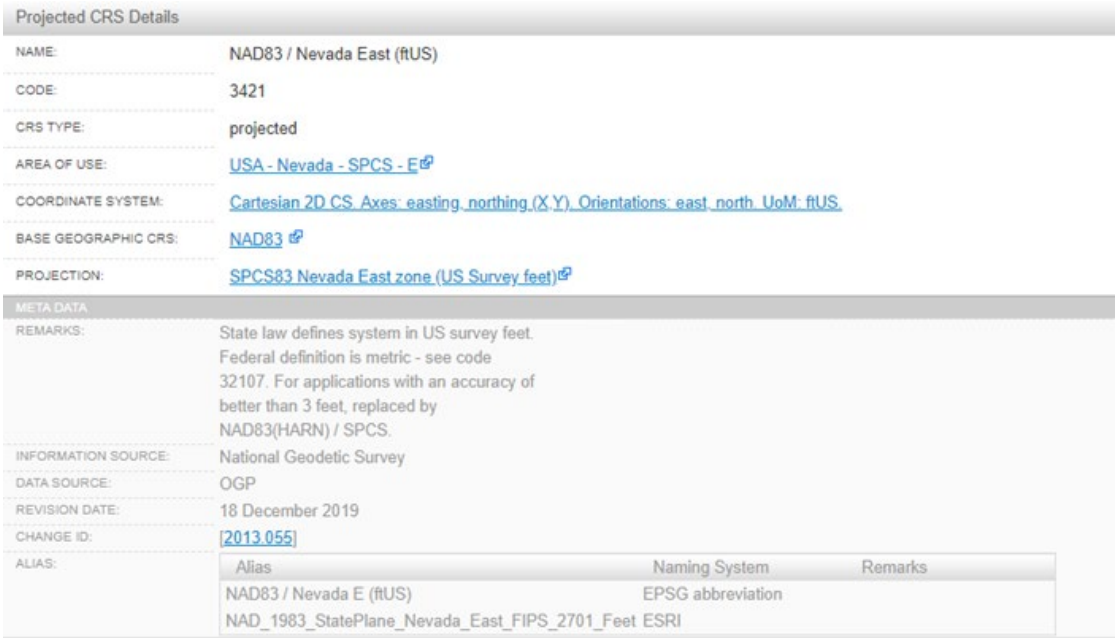


1. Check the DATUM
2. Change **M**(eters) to **F**(eet) in the Unit dropdown
3. If the coordinate system does not self-populate from the data contained in the images:
   - Select "Known Coordinate System." Type "your state" into the Search window.
   - In the case of Nevada (for example), several choices become available, choose "NAD83 / Nevada East (ftUS)" The system will virtually always self-detect location based on meta-data contained in the imported photos.

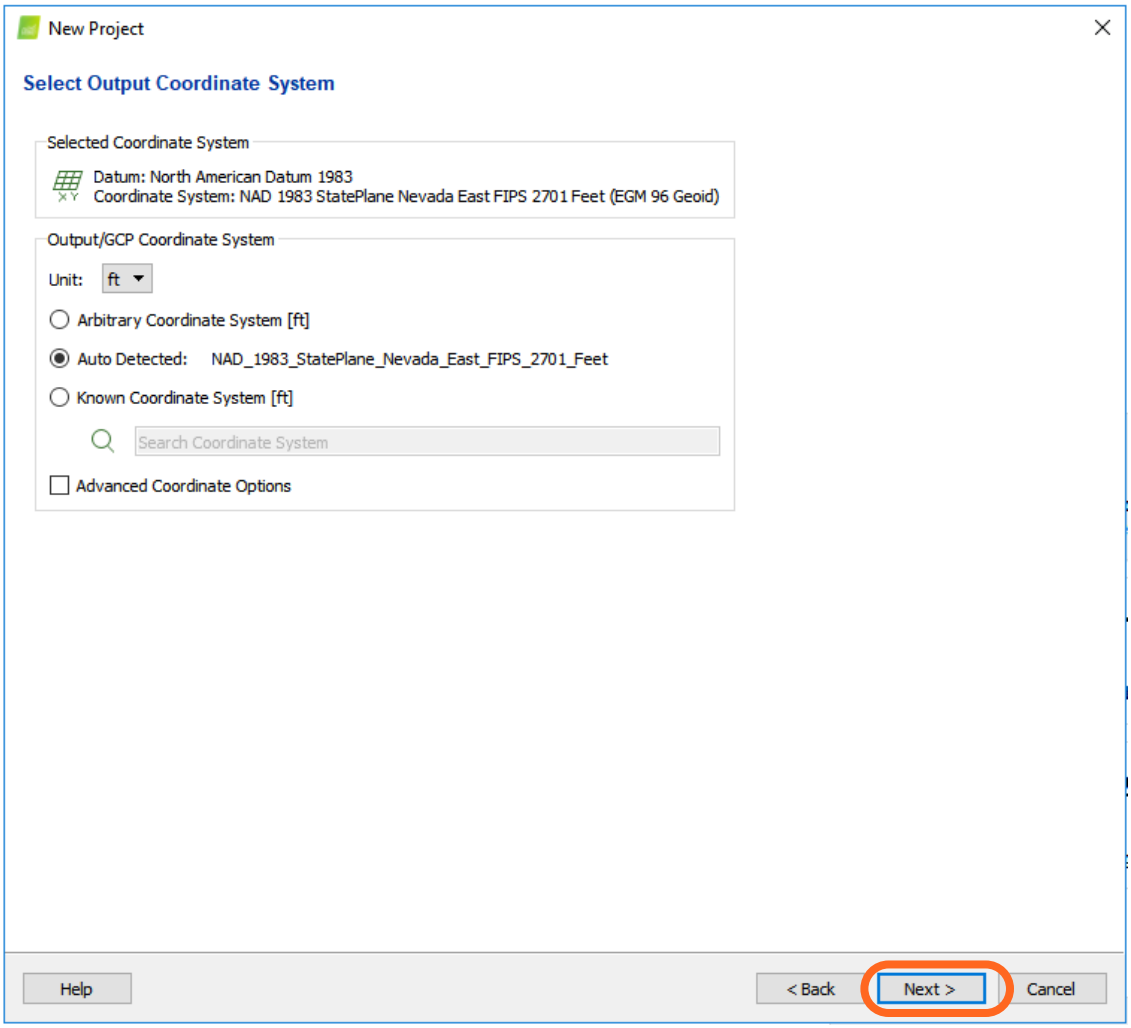
This should be checked with every project.
If there is ever a question regarding Coordinate Systems, visit; https://georepository.com/ input the area where images were captured, and the site will display the relevant state plane. However, Pix4D will virtually always select the correct Known Coordinate System based on the metadata contained in the images captured by the EVO II camera and GPS systems.

Every city GIS/Civil Engineering team member will know this coordinate system as well; contact the local state GIS agency for additional information if there are questions about the automated Geolocation coordinate system .

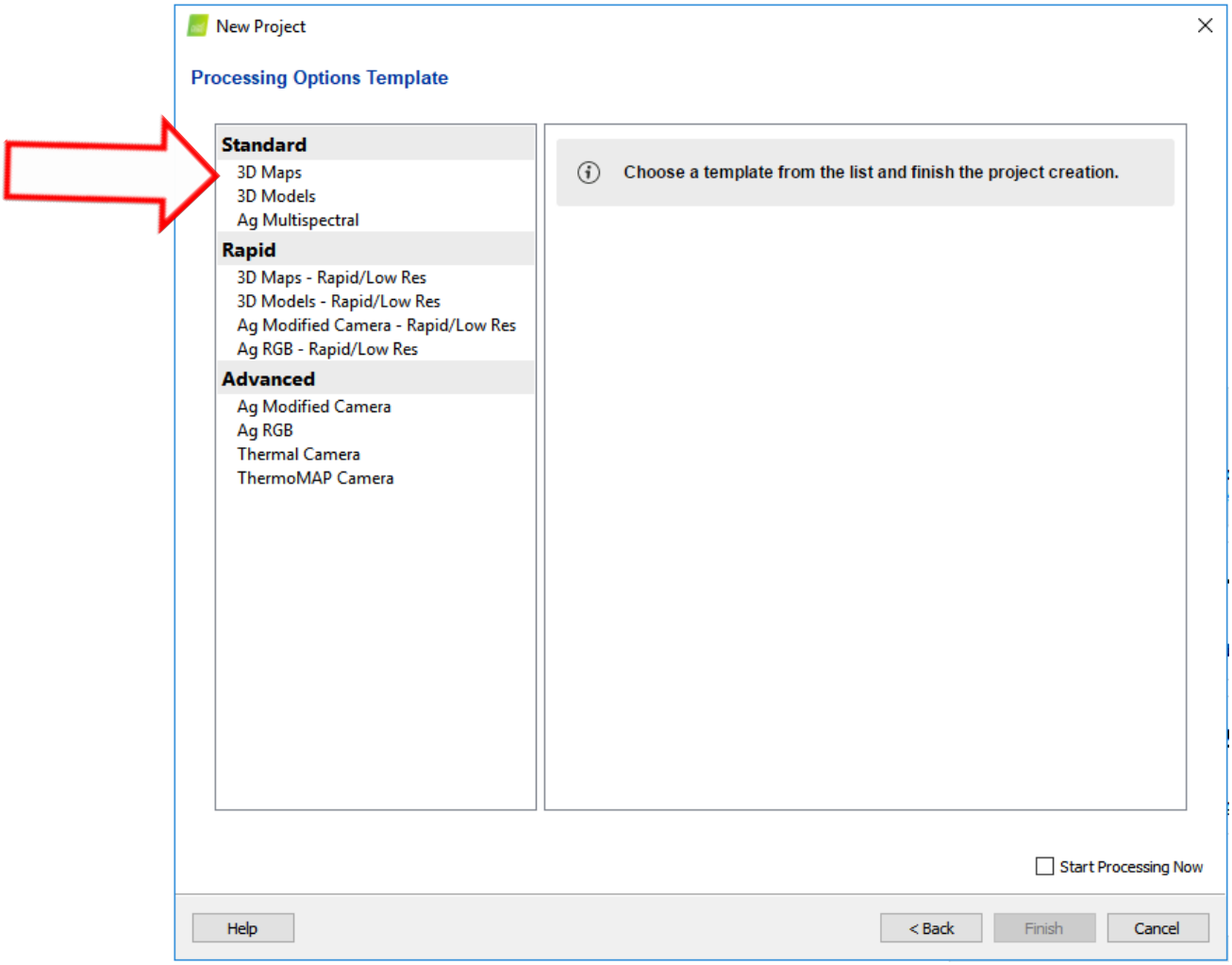
The final Output Coordination screens should exactly match the next image. This is critical. Check twice. Without this screen being correct, accuracy is will be impossible (until corrected).



Choose "**NEXT**"



The **PROCESSING OPTIONS TEMPLATE** screen will open.

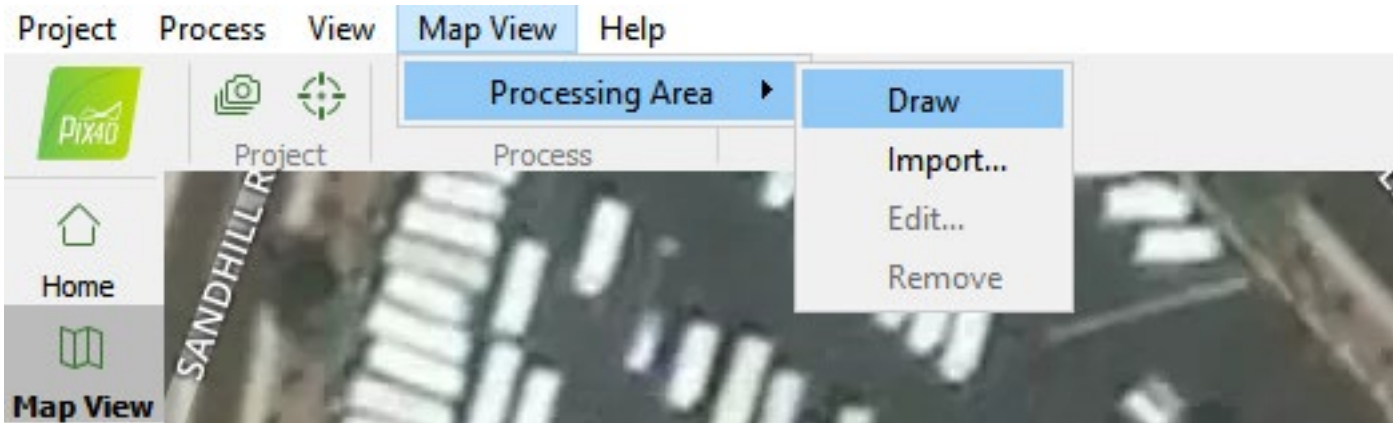


1. Choose 3D Maps.
2. Uncheck “Start Processing Now” (if checked).
3. Choose “Finish”

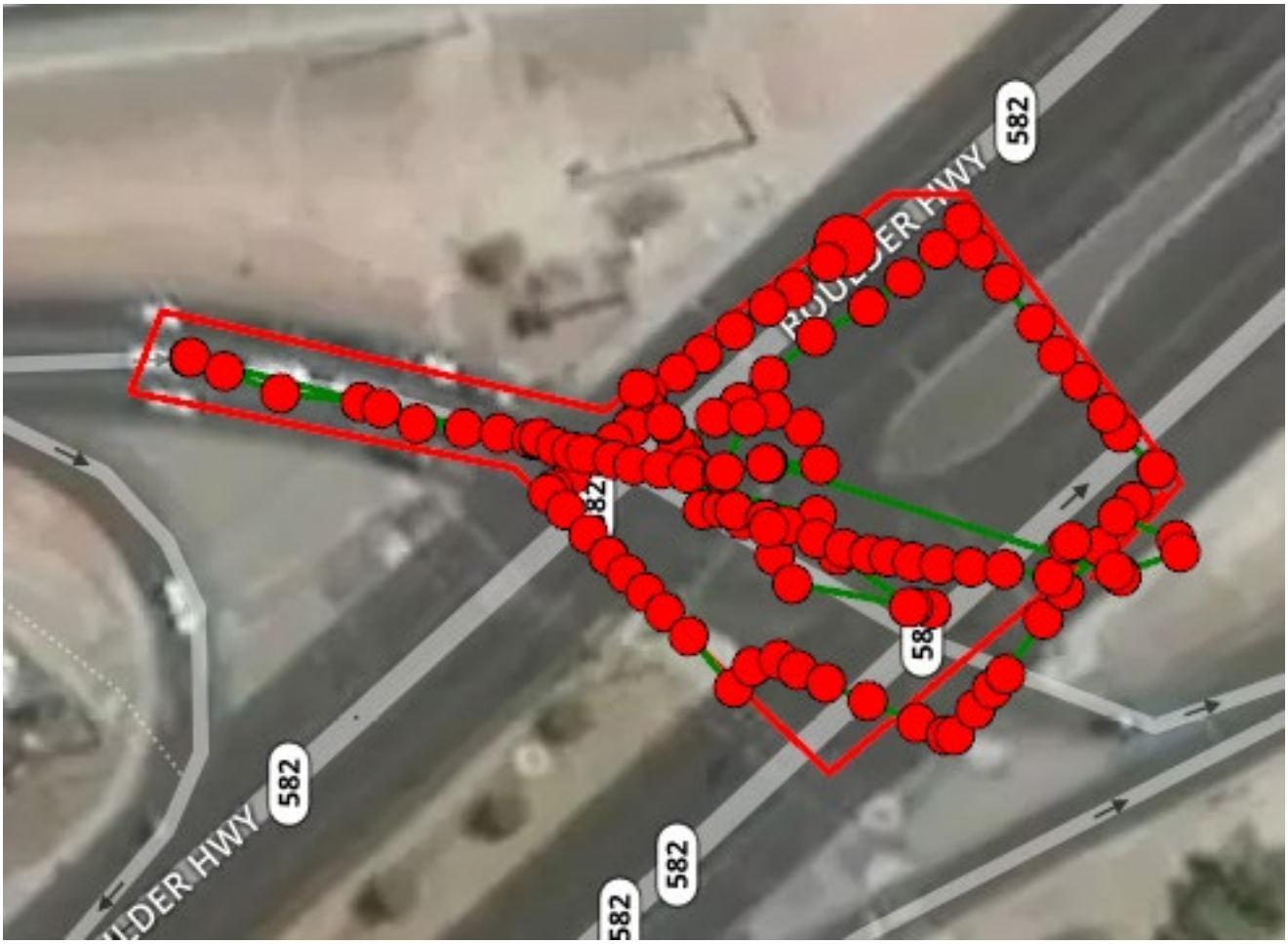
PROCESSING AREA

Prior to processing photos, a Processing area may be set. This allows users to reduce the amount of data to be processed, thus decreasing process time. While in Map View, zoom in on the captured area indicated by the red dots.

In the Map View, select “PROCESS | PROCESSING AREA | DRAW”



Begin drawing by left-clicking the mouse. Draw the processing area based on the map area. Right-click to end the selection. The selection may be square or polygonal. A red line will indicate the initial processing area. This may be fine-tuned later in the process.



BEGINNING THE PROCESS

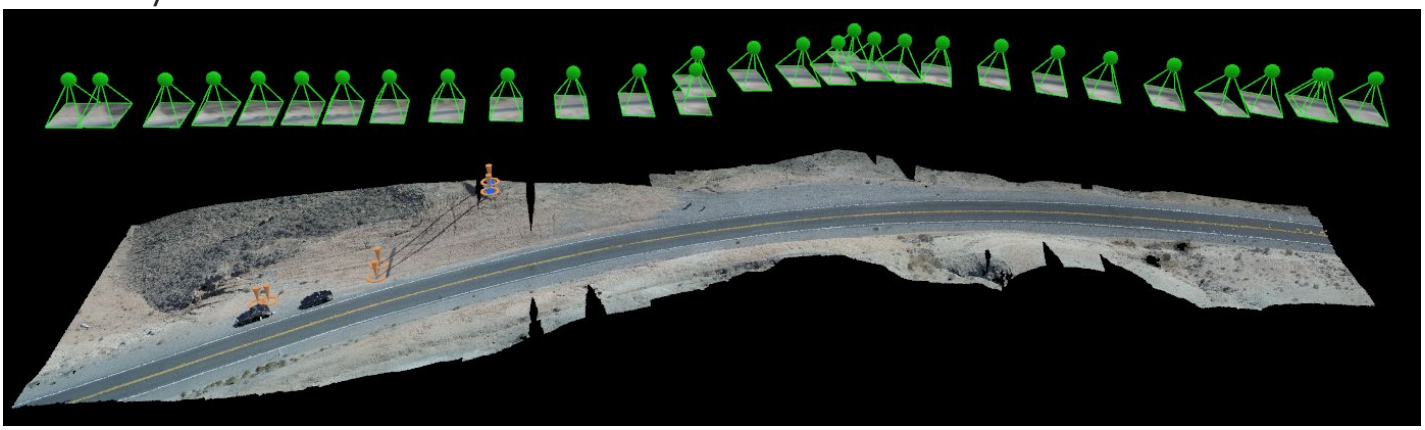
The photos captured will indicate location in the form of red dots (seen above). Location is derived from GPS metadata contained in the images.

Ensure Steps 2 and Step 3 are unchecked, and choose **"START".**

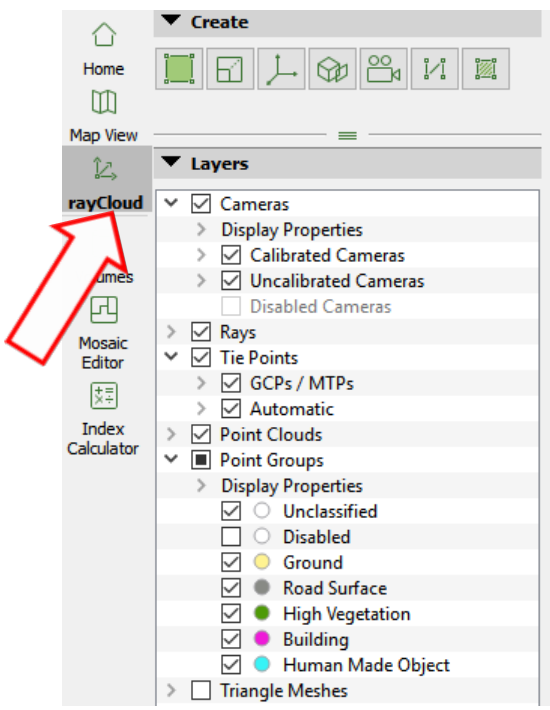
The positions will initially show as red, then green then light green as Pix4D positions, evaluates, aligns images.

Step One
Processing of **STEP 1** will begin. Once the initial process is complete, the screen will display a view of the camera positions. Note in this image, there are cameras not aligned with the main body of the intended flight area.

These images were captured following the automated corridor flight. They are not part of the automated flight, and create additional work for Pix4D, as they are not relevant to the intended area. They need to be deleted. Otherwise, rendering can take much longer than necessary.



NOTE: This form of straight-line flight is NOT recommended. It is shown here to demonstrate a result from poorly captured images.
Delete the image by clicking on the blue/green indicator of the ray. This will open a dialog on the left side of the Pix4DMapper workspace. If the dialog does not open, pull up the "LAYERS" dialog from the upper left of the Pix4D window, labeled "**RAYCLOUD**," or navigate to "**VIEW | RAYCLOUD**".



This assists in finding images that do not belong in the project. Selecting any image will open a PROPERTIES dialog on the right-hand side of the screen. An image selected on the left side of the screen will show in the PROPERTIES dialog on the right-hand side of the screen. Choose the "**DISABLE**" button to remove the image from the project. Images may be re-enabled if necessary, at any point in the process. Alternatively, images may simply be removed from the project folder after having been disabled, and run the process again.

Once undesired images are removed, STEP ONE/Initial processing will require a re-process. Select/click the **START** button.

Pix4DMapper will show a notice warning that the process will overwrite previous results.

Choose "**OK**" and **STEP ONE** will run once more.

INSERTING GCP/MTP

After **STEP ONE** has processed all images Ground Control Points (GCP) or Manual Tie Points (MTP) may be inserted. These points tie the rays to known locations on the ground. A Ground Control Point is a known coordinate from an RTK or other 3D GIS reference system which ties the image to a specific point. A Manual Tie Point is a point ***without*** 3D coordinates that is marked by the user in the images.
With **STEP ONE** processed, select the GCP/MTP Manager button in the Pix4DMapper toolbar.

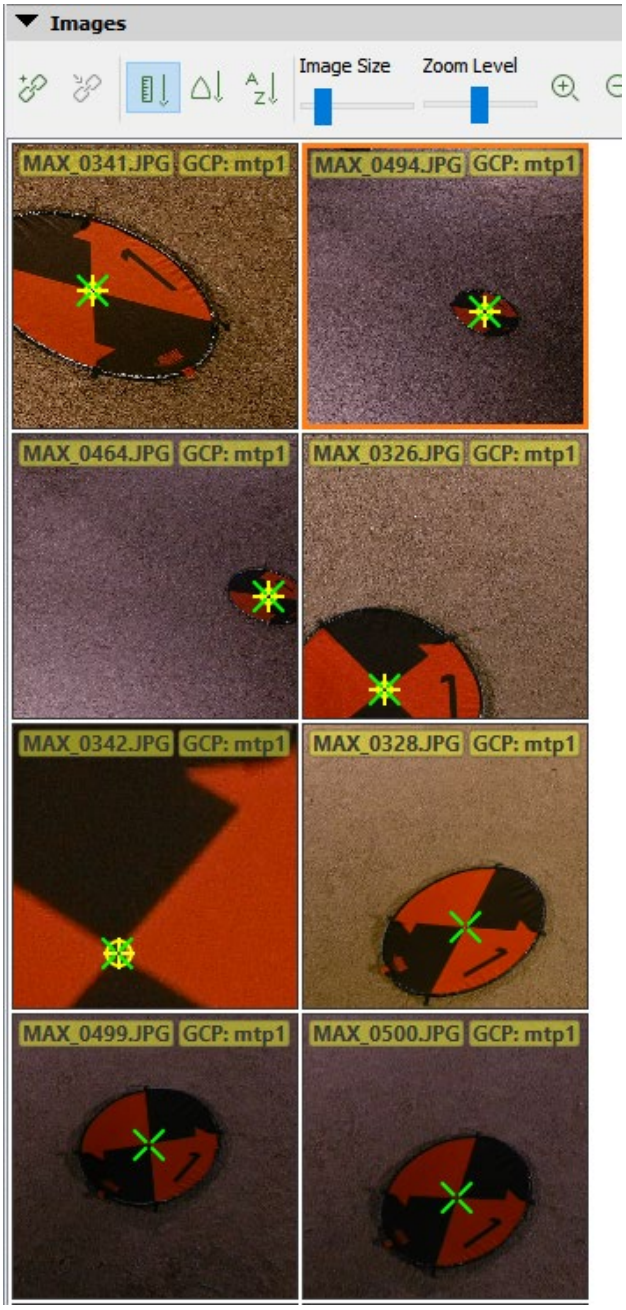
The GCP/MTP Manager dialog opens. In this dialog, MTPs may be viewed, GCP may be imported, edited, or used as check points.

If importing GCP, skip to the GCP section.

STEP TWO
Select **STEP TWO** (Point Cloud and Mesh) and choose **START** (Point cloud is not necessary for this next step, but in many cases makes the process more efficient. If the project has many images (100 or more) it is not critical to run Step Two.

More on Manual Tie Points (MTPs)
Manual Tie Points (MTPs) are features which may be clearly identified in two or more images and selected as reference points. These tie points, manually inserted, help align image features for greater accuracy in mapping.

With or without the point cloud, navigate to an area in the screen that has a known object, found in more than one image.



The **IMAGE PROPERTIES** dialog will open on the right-hand side. Pix4DMapper will attempt to find identical reference points in the images. Using the Image Size and Zoom Level sliders, adjust the images to find a single point found in at least two (or more) images that may be tied together.
The image may be moved around inside the display panel. Zoom as deeply as needed once a single point is found. In the image to the right, the slightly white/red object is the target.
Once the target tie point is identified, click the "NEW TIE POINT" button in the upper left corner of the dialog. This allows a tie point to be click-generated on the desired location. Click on the desired location, and a yellow circle with a target "X" will appear

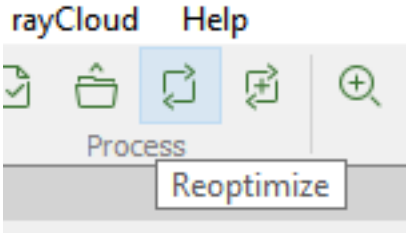
in the box. in the previous illustration, five (5) targets are marked, with three (3) not yet marked.
Repeat this step on at least two, preferably five (or more) images if possible.

Pix4DMapper is intelligent; as points are marked in the image, it will attempt to find that same point in other images. Pix4DMapper usually "learns" the tie point after two images are selected, via an algorithm in the software.
A minimum of two images are required. If only two images contain the same tie point, the flight did not have enough front or side overlap. However, Pix4DMapper can function with only two tie points in an image, although doing so is not optimal.

In the previous image, three tie points have been generated to the same object in three different images. These tie points, generated by the user, are called "Manual Tie Points," or **"MTP"**
Repeat this step to create at least three MTP's in the overall project. More MTP are fine, especially in large areas or detail critical areas.

Manual Tie Points are visible as they are generated.

After creating a minimum of three MTP in the project, select "STEP TWO" in the Process window, and click the **"REOPTIMIZE"** button on the upper left of the interface.



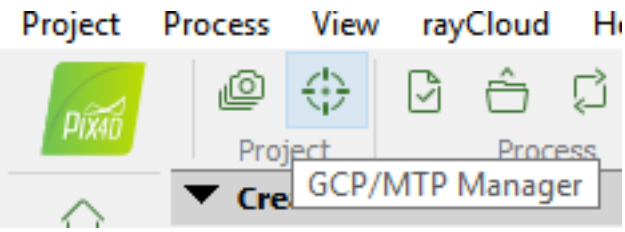
Plan on Reoptimizing after any changes are made to the project.

Once the project has Reoptimized, unselect Step 1(Initial Processing), and select Step 2 (Point Cloud and Mesh).
Select "Start."

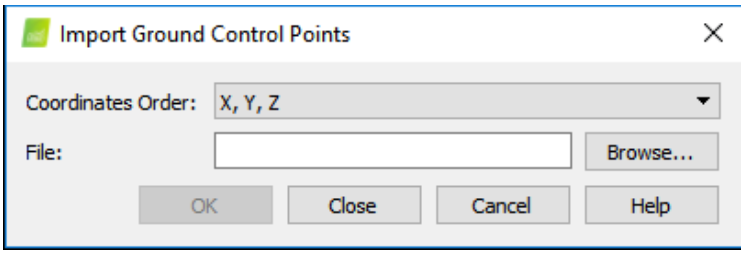
A Point Cloud and Mesh will render; be patient as this may take a while depending on computer spec and project size, in addition to resolution of images used to create the project. Selecting an appropriate process area will help speed this process.

Once the render is complete, the project will appear to not have changed, although a Point Cloud has been generated.
In the left hand side/LAYERS window, check the **"POINT CLOUDS**" box. Pix4DMapper will open a notice that the layer has not been loaded. Select "OK" in this dialog, and the Point Cloud will load.

When the point cloud loads, a more-dense version of the project will load.
Note the MTPs are still visible in the project. These may be turned off in the LAYERS panel.
In the **LAYERS** panel, enable **TRIANGLE MESH** and the project will fill in where it is able.



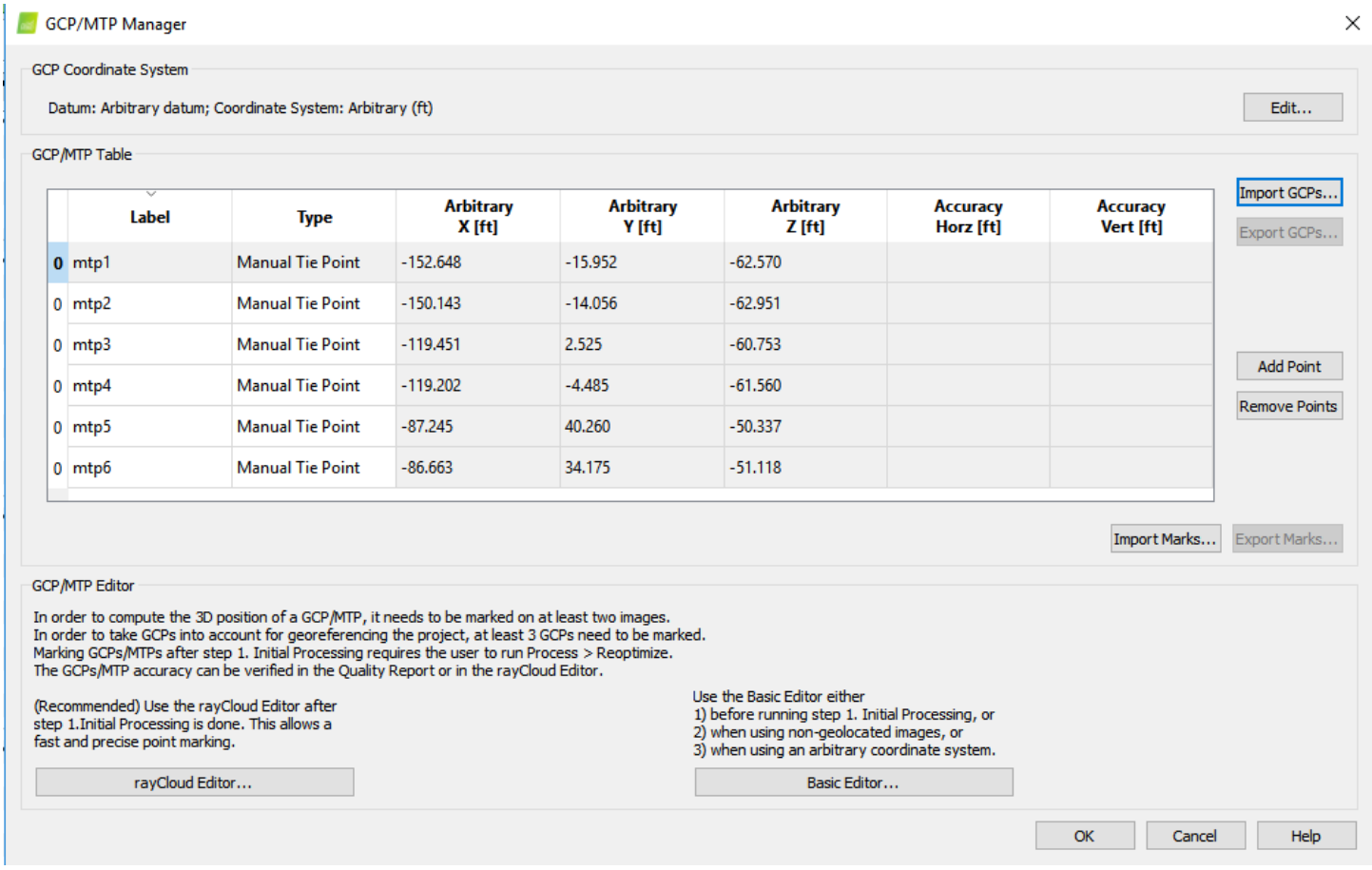
In the **LAYERS** window, disable all Camera, Ray, and Tie Points to see the project without the components of the project. Project components are merely made invisible; all parts are still there and recallable by re-enabling/checking them in the LAYERS window.



UNDERSTANDING GCPS
Importing GCPs
NOTE: This process occurs after **STEP ONE** has been completed, and prior to **STEP TWO** initiating.

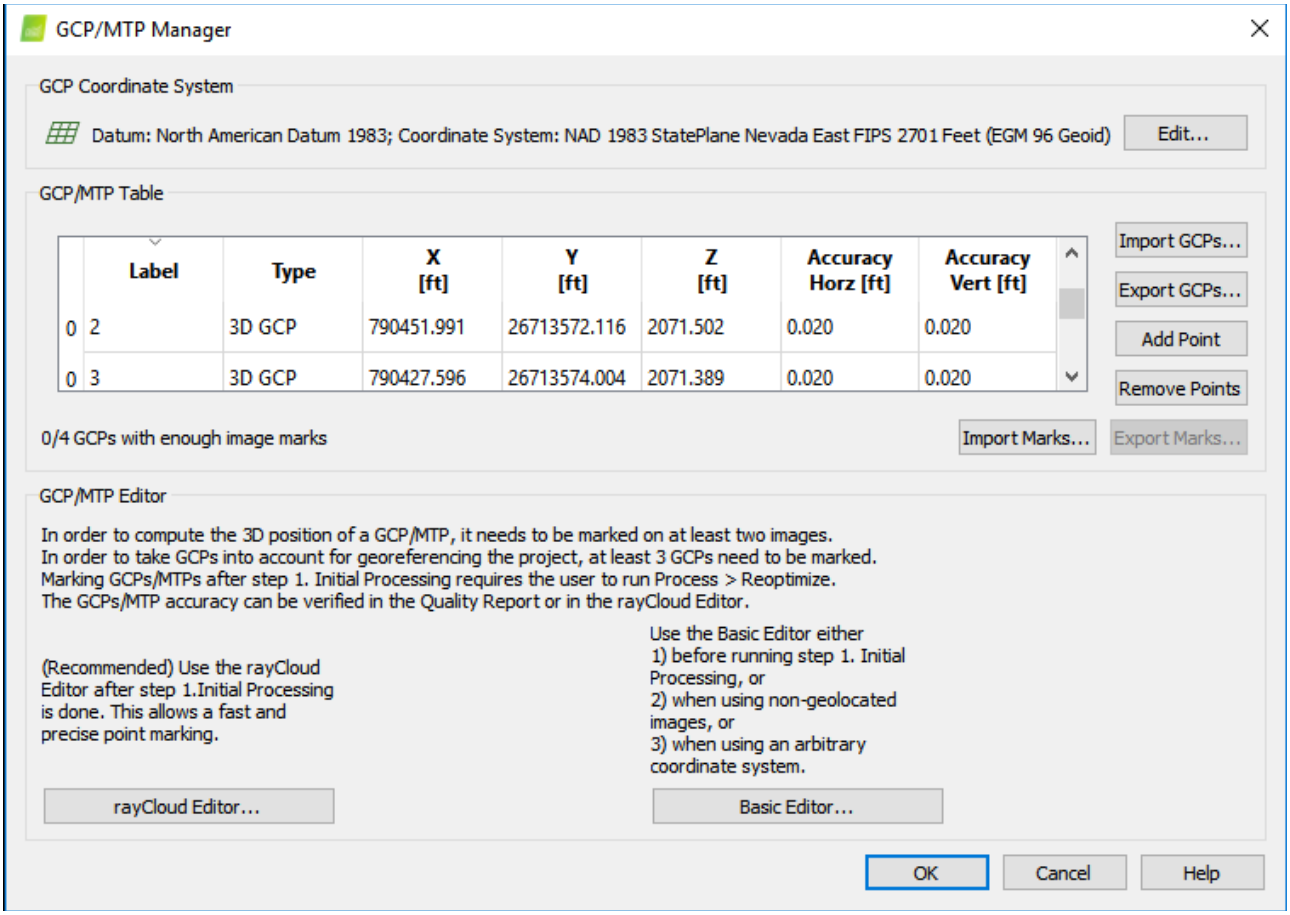
After **STEP ONE** has been completed, select the **GCP/MTP MANAGER** button in the upper left corner.

In this dialog, select "**YXZ"** coordinates. CVS/Text files should be **"Y, X, Z."**

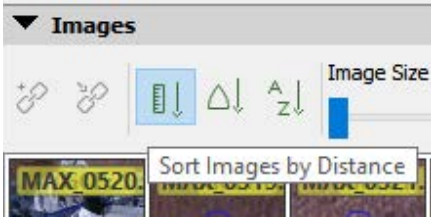


	Label	Type	Arbitrary X [ft]	Arbitrary Y [ft]	Arbitrary Z [ft]	Accuracy Horz [ft]	Accuracy Vert [ft]
0	mtp1	Manual Tie Point	-152.648	-15.952	-62.570		
0	mtp2	Manual Tie Point	-150.143	-14.056	-62.951		
0	mtp3	Manual Tie Point	-119.451	2.525	-60.753		
0	mtp4	Manual Tie Point	-119.202	-4.485	-61.560		
0	mtp5	Manual Tie Point	-87.245	40.260	-50.337		
0	mtp6	Manual Tie Point	-86.663	34.175	-51.118		

Choose **"BROWSE"** in the above dialog. Navigate to the location of the .txt file containing the GCP data.



1. Select **"OK"** and the **GCP/MTP Manager** will open.
2. Select the first GCP (order of selection isn't important). Double click on 3D GCP and choose **"CHECKPOINT".**
3. Click **BASIC EDITOR.**
4. The **BASIC EDITOR DIALOG** will open, and GCP points may now be aligned with GCP target centers.
5. Pix4DMapper will attempt to locate images surrounding the related GCP point. If it does not automatically find them, select the "**SORT IMAGES BY DISTANCE TO GCP**".



Locate the relevant GCP (***this is why numbered GCP are highly valuable***). Using the zoom slider to the right, zoom in as deep as practical, and double click on the centerpoint of the target. Select two images per GCP.

Go slowly; slow is smooth, smooth is fast.
Mistakes are difficult to reconcile if targets are not accurately selected

After selecting at least five image targets (additional targets may be used as check points). In the Toolbar, Select **REOPTIMIZE**, and then select "**OK**."

Once the project has re-optimized after selecting at least two images per GCP, choose the GCP Manager on the Toolbar.

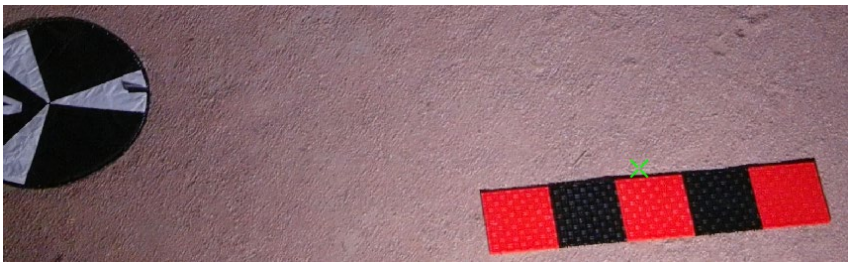
Open the **RAYCLOUD EDITOR** (button on the left menu).

ADDITIONAL PROCESSING CONSIDERATIONS

FLOATING OBJECTS (Ghosting)
While flights are occurring, it is common to have traffic or other moving objects in a scene. These moving objects will frequently appear to "ghost" as partial images due to the object appearing in multiple photos when the final project is assembled. Once all three steps have been run, these objects can be removed.
To remove objects

1. Open the Mosaic Editor.
2. Select "ORTHO PROJECTION"

CONSTRAINTS



Constraint points are very useful in situations where there is no RTK GPS. A constraint point allows a user to insert a known measurement into the Pix4D process. This may be achieved through a measuring tape, physical object that was measured in the scene/onsite (must be immovable or at least unable to change size), or other object that may be reasonably measured.

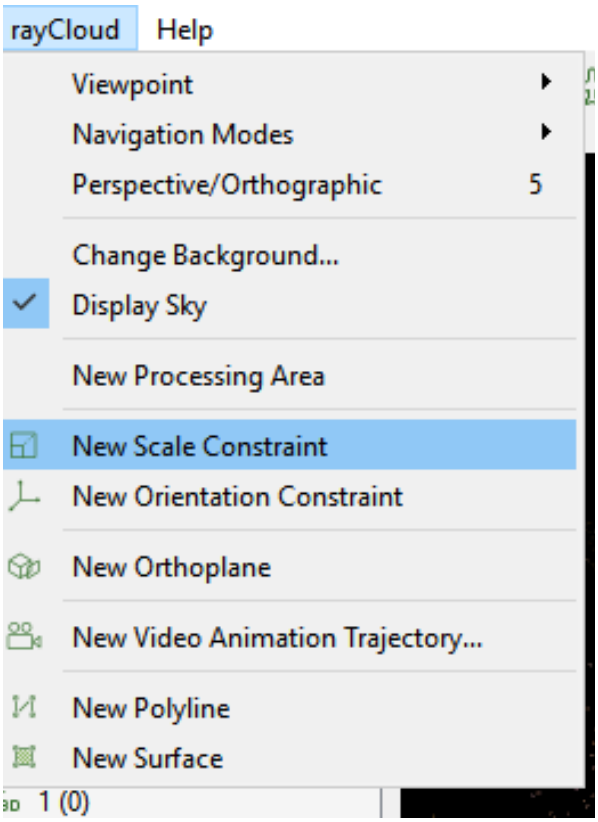
Although smaller objects such as a landing pad may be used in a pinch, they can be distorted due to the flexibility of the material. GCP device/platform may be used as a scale constraint device so long as the absolute size of the GCP is known.

Tools that can be seen from the air work very well; a very wide tape measure such as the Stanley FatMax25 may be laid out; we recommend a 20' length. Choose a consistent length and always use the tape at that defined length. Our practice is to have the tape measure marked with pink paint at the 20' mark and have labeled the measure with that measurement. We also recommend the Hoodman SkyRuler, a 60" x 12" ruler easily visible from up to 400'.

The Scale Constraint, or "constraint point" is simply taking two points and measuring the two points in a straight line. Each measurement of a vertex becomes a Manual Tie Point. Scale constraints may be used with GCP's, yet if the scale constraint and the GCP locations vary greatly in scale, Pix4DMapper will disable/ignore any captured scale constraints.

Step One

Choose **RAYCLOUD | NEW SCALE CONSTRAINT**

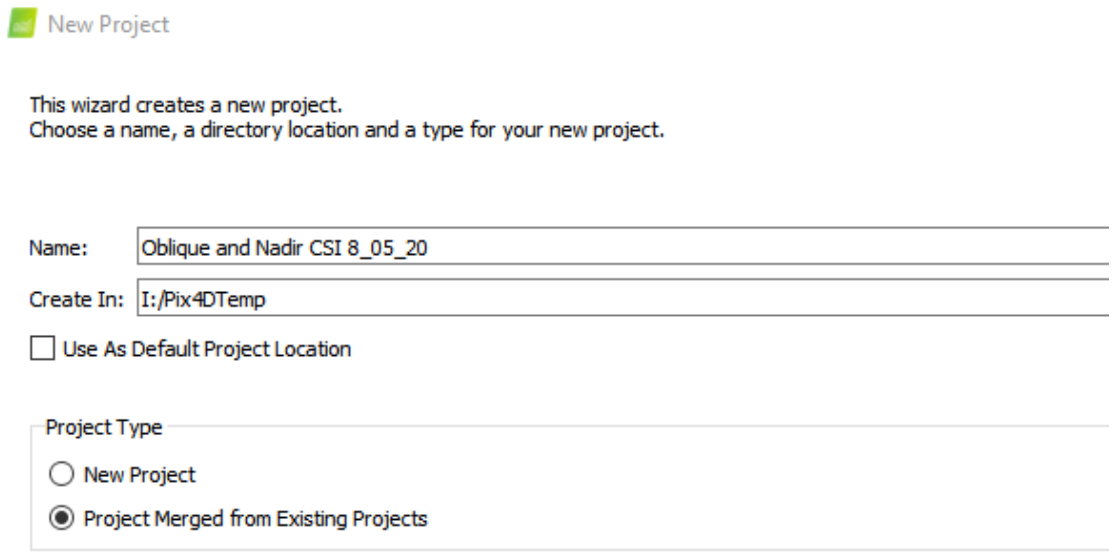


In a 3D view, zoom in to the known object. A blue circle appears next to the mouse cursor. Left click to start the constraint line. Right click on the other end of the constraint object to end the constraint point. This creates the scale constraint.

Step Two
Click on the object in at least two images to refine actual measurement between the two points and select **"APPLY".**

Step Three
Each point may be named by right-clicking the point in the **SCALE CONTRAINTS | DISPLAY PROPERTIES | RENAME**. Naming points of constraint helps quickly locate individual points and assists other viewers/editors in the project to more clearly understand the process as generated by the originating person.
Repeat for other GCP or known objects. Once all distances have been measured, choose **PROCESS | REOPTIMIZE TO SCALE PROJECT**, and run Step 2 and 3 once more.

The constraint may be edited using the **RAYCLOUD**. Scales may be renamed or removed by right clicking the Scale Constraint in the Layers menu.

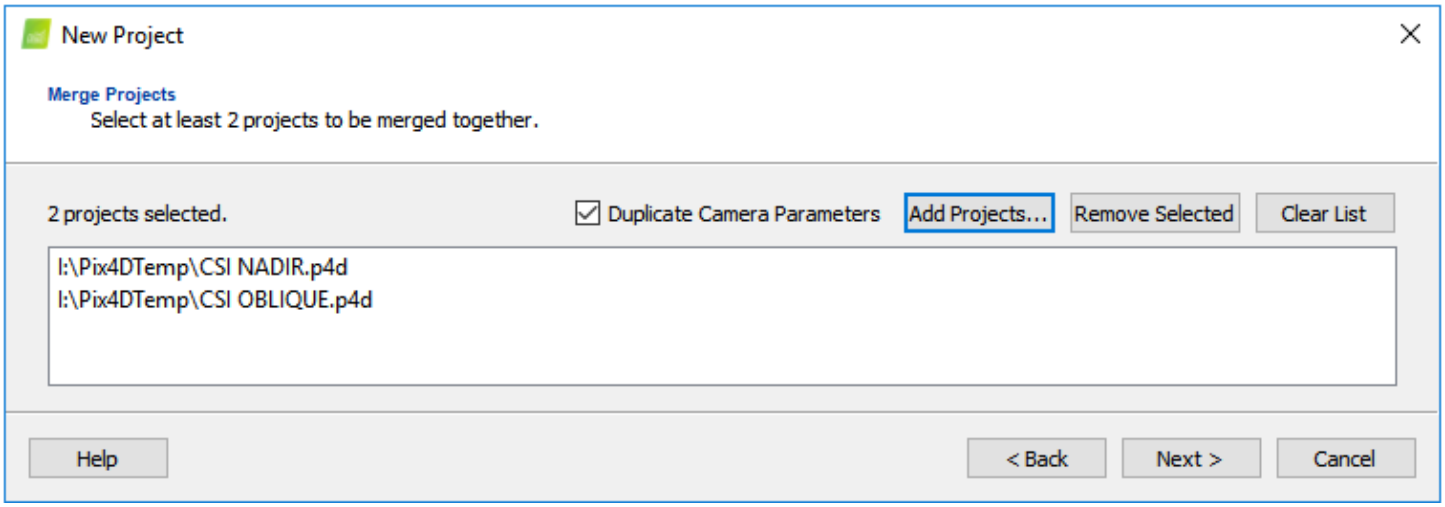


MERGING PROJECTS

There are times where multiple flights/data captures are best managed separately, for example, flights of varying altitudes, large areas with multiple aircraft flown simultaneously, or areas captured on different days. Having been processed as separate projects, these projects may be merged for a final output. Any GCP or MTP in the projects to be merged must have the same names so that the merge will recognize and connect these references.

Begin a new project, create a unique filename, choose "**Project Merged from Existing Projects**", and choose "**Next**".

Add projects to be merged and choose "**Next**".



Choose **"YES"** and choose next.

The project will combine the merged files into a single file. If GCP or MTP have been applied, and the names are the same, the two files will merge perfectly. If GCP/MTP naming

conventions are different between the two projects, there will likely be difficulties in locking overlapping elevations/photos to the ground reference points/control points.

GLOSSARY

CRAB MOVE/CRABBING sideways or obliquely. Crabbing is an efficient method of straight flight in winds, avoiding head or tail winds for clean photographs

DENSE POINT CLOUD Step 2 in the Mapper workflow will generate a dense point cloud. This point cloud density may be adjusted by the user in the Point Cloud Display dialog.

EXIF Exchangeable image File Format - is a standard that specifies the formats for images, sound, and ancillary tags used by digital cameras (including smartphones), scanners and other systems handling image and sound files recorded by digital cameras.

FOD Foreign Object Debris/Foreign Object Damage - is a substance, debris or article alien to the vehicle or system which would potentially cause damage. ... FOD has been part of accidents and unscheduled maintenance reports since the earliest days of flight.

FRAT Flight Risk Assessment Tool - A methodology to determining safety risk factors in order to continue or abandon flight, and/or make more informed decisions to manage risk.

FRONT LAP Front overlap of images; this is the percentage of overlap between one image and the next, and both images are taken by the drones when flying in the same direction. A high frontlap value is preferred for modelling or photogrammetry.

GCP Ground Control Point - Refers to a fixed or temporary target or object which can be tied to aerial imagery, either via Manual Tie Point, or RTK GIS values.

GIS Geographic Information System - is a system designed to capture, store, manipulate, and present spacial or geographic data.

GPS Global Positioning System - A system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver

GSD Ground Sample Distance. In remote sensing, ground sample distance (GSD) in a digital photo (such as an orthophoto) of the ground from air or space is the distance between pixel centers measured on the ground. For example, in an image with a one-meter GSD, adjacent pixels image locations are 1 meter apart on the ground.

INITIAL POINT CLOUD When Pix4D initially renders Step 1, an Initial Point Cloud is generated. This “framework” is the base for the Dense Point Cloud. The Initial Point Cloud may be used to set the terrestrial positional relevance with aerial position data (found in the EXIF).

META DATA A set of data that describes and gives information about other data. Embeded metadata may include Lat/Lon, Altitude, Temperature, camera type, and other information.

MTP Manual Tie Point - is a point without 3D coordinates that is marked by the user in the images. It can be used to assess and improve the reconstruction accuracy. MTP is a device used to “tie” aerial imagery to ground points, increasing accuracy and quality of a

model or orthomosaic.

ND Neutral Density - A filter that reduces or modifies the intensity of all wavelengths, or colors, of light equally, giving no changes in hue of color rendition.

ORTHOMOSAIC Aerial image of an area, composed of multiple photographs stitched together using photogrammetry, which has been scaled and geographically corrected for accuracy.

POINT CLOUD Set of data points in space. Point clouds are generally produced by 3D scanners, which measure many points on the external surfaces of objects around them. Photogrammetry The art, science and technology of obtaining reliable information about physical objects and the environment through the process of recording, measuring and interpreting photographic images and patterns of electromagnetic radiant imagery and other phenomena.

PPK Post-Processed Kinematic - Enhancement for satellite positioning. Base stations record precise measurement while the drone is approximate. Processed after the flight.

RTK Real Time Kinematic - Satellite navigation to enhance precision of position data. - Recorded and applied directly to photogrammetry.

SIDELAP Side Overlap - refers to the percentage of overlap between different flight legs. A high side overlap value is critical in photogrammetry or modelling.

TRIANGLE MESH A type of polygon mesh in computer graphics. It comprises a set of triangles (typically in three dimensions) that are connected by their common edges or corners.