Processing Drone Lidar Data with Yellowscan CloudStation

CloudStation is the software provided by Yellowscan for processing the raw lidar data from the Surveyor Ultra 3 drone lidar unit. Processing in CloudStation is required to get LAS-format point cloud files.

CloudStation Setup

You will need to complete the following for setting up CloudStation

1. CloudStation Pro installed and activated on a computer (preferably one with a decent GPU)
2. The Qinertia software directory located somewhere on your C: drive, and the path to Qinertia executables set in CloudStation
3. The calibration file for the Yellowscan Surveyor Ultra (in the UAS Software OneDrive folder) loaded into CloudStation
4. The measured offsets between the GNSS sensor and the center of the lidar sensor on the Freefly Astro (in the UAS Software OneDrive folder)
5. The calibration file for the Surveyor Ultra's built-in camera (in the UAS Software OneDrive folder)

Data needs for processing lidar data

To process your lidar data, you will need the following:

1. (REQUIRED) The full directory from the lidar unit's USB thumb drive that was created for the lidar mission.
    a. Lidar mission directories are named starting with "YS-" and then an 8-digit date code followed by a 6-digit time code. For example, "YS-20240809-154059"
    b. A new directory is created on the lidar unit's USB storage every time a data collection is started (quick-press of the button).

    c. The directory contains the following:

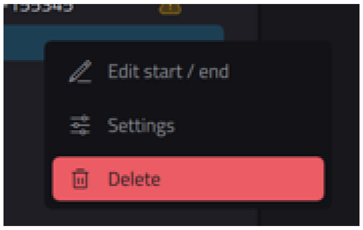
Name	Status	Date modified	Type	Size
EmbeddedCameraPhotos		7/29/2024 7:17 PM	File folder	
YS-20240725-155345.hesai		7/25/2024 9:01 AM	HESAI File	3,494,118 KB
YS-20240725-155345.json		7/25/2024 9:01 AM	JSON File	28 KB
YS-20240725-155345.sbg		7/25/2024 9:01 AM	SBG File	8,281 KB
YS-20240725-155345.ys		7/25/2024 9:01 AM	ys_file	6,041 KB

        i. *.ys file – Yellowscan CloudStation project file
        ii. *.hesai – raw lidar data
        iii. *.sbg – trajectory and orientation data from the IMU
        iv. *.json – configuration parameters for the lidar unit
        v. EmbeddedCameraPhotos – directory containing the photos from the onboard camera for point cloud colorization

2. (STRONGLY RECOMMENDED) The RINEX log file from the Emlid Reach RS3 GNSS base station or another base station logging RINEX data at a least 1-sec intervals.
    a. RINEX files have a 3-character extension with the first two digits being the year and the last character "O" – e.g., *.24O
    b. Yellowscan recommends trimming the first few minutes off of the RINEX file to remove inaccurate GPS readings from when the device was first turned on. This can be done in Emlid Studio.
    c. RINEX logs can be resampled to 1-second intervals (in Emlid Studio) to reduce file size and speed up processing in CloudStation (useful for very large log files)
3. (RECOMMENDED) CSV file with the locations of ground control points measured with reference to the GNSS base station
    a. CSV file should have NO header row
    b. File format is GCP_name, latitude, longitude, ellipsoidal_height
    c. Note what coordinate system the coordinates are in (i.e., know the EPSG code)
    d. Perform any post-processing of the GCP locations prior to bringing them into CloudStation.

Important points about CloudStation

- Any RED button in CloudStation is a "long-press" button. You must hold down the mouse button until the button activates to confirm you really want to take that action. There is no "undo" for these actions.



Example of a long-press button

- There generally is not an option to "undo" much of anything in CloudStation.

- Some actions will remove previous processing steps. If you change settings or open the dialog for the SBET, it will reset the processing and you will have to run it again.

- There is no "Save" button. CloudStation is writing the data to the mission data directory as you are going along.

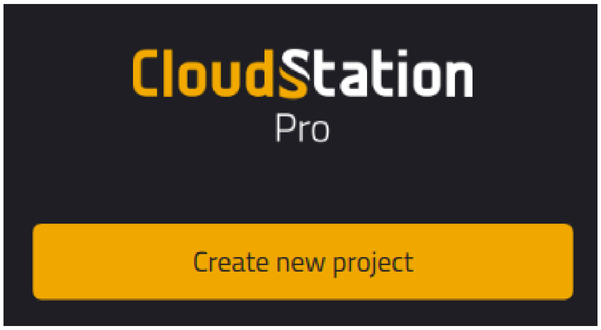
- From what I've seen, there also is no "save as" option to save a project so you can try something new.

- You cannot move a mission data directory once you have started processing the data.
    - Yellowscan will look for the data in the location where it was first. If it doesn't find it there, it will create the folder again in its original location and write data there. Then you will have two folders with partial data in each (very much a pain!).
    - Either save the data in a permanent location before processing, or complete the processing/export first and then move the data to its permanent location.

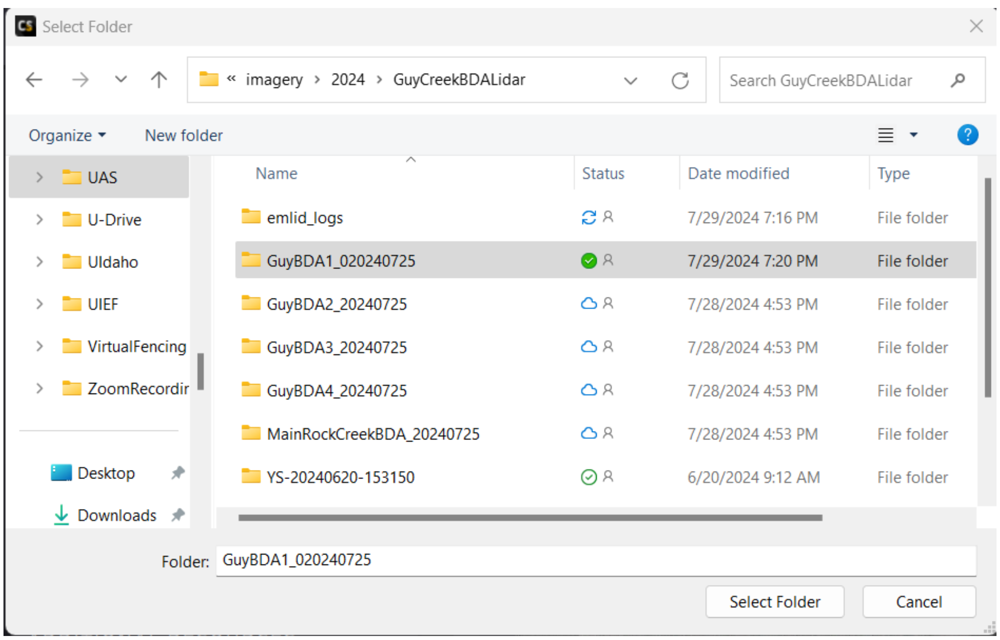
Processing Lidar Data with CloudStation

1. Start CloudStation

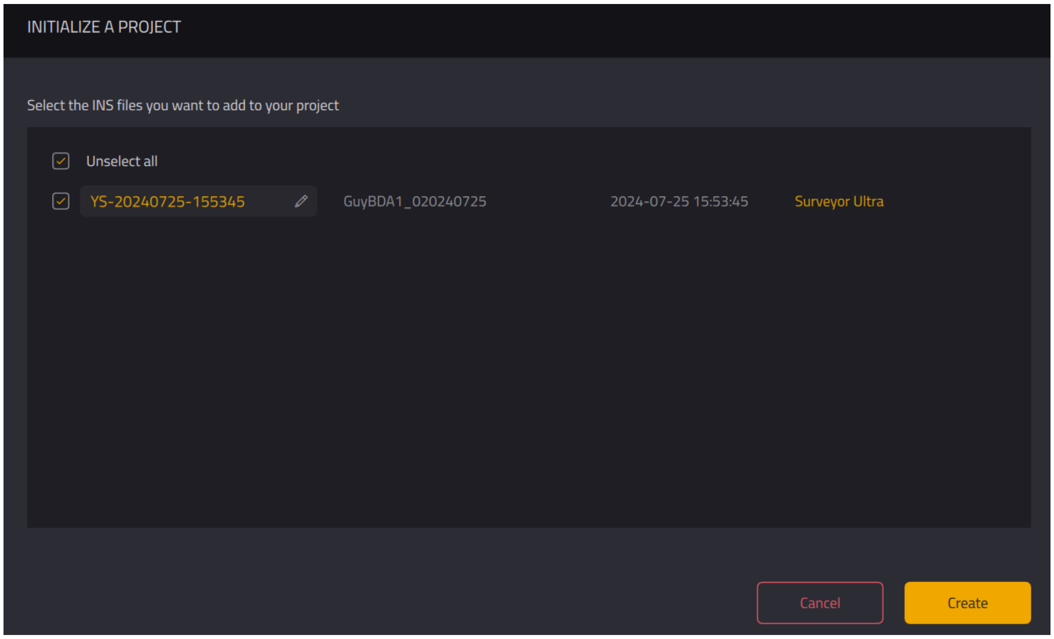
2. Click on “Create new project “



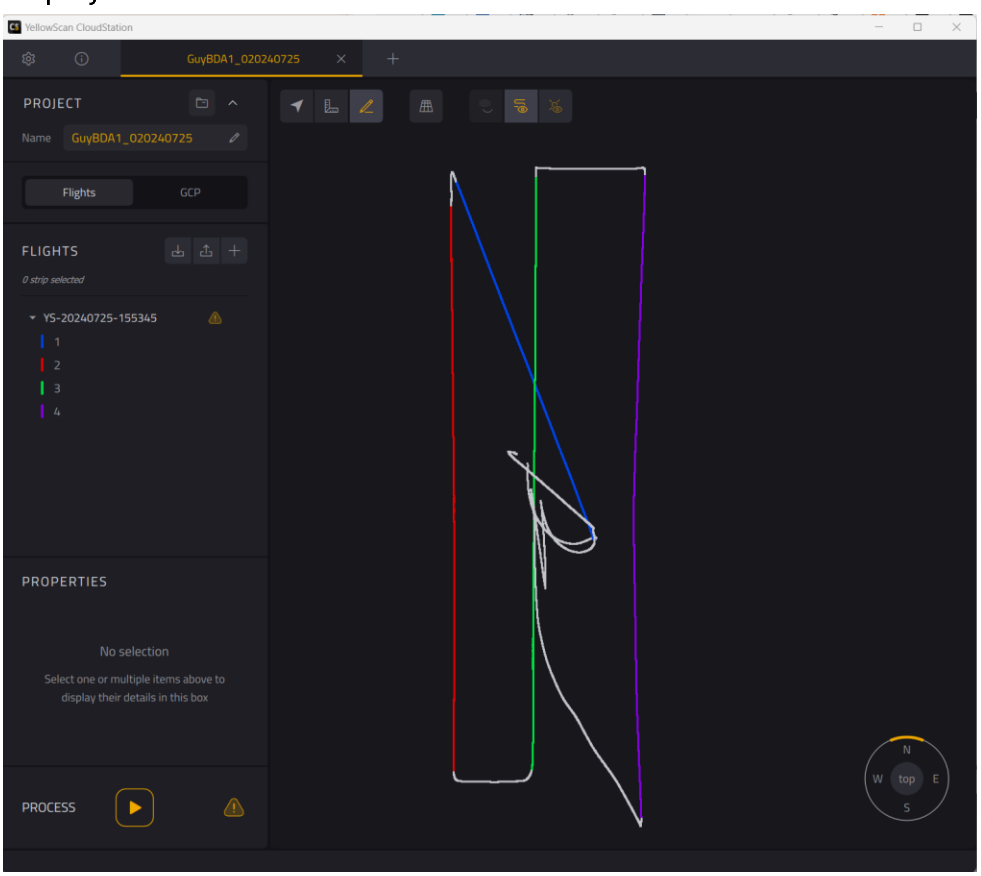
3. Select the folder containing the lidar data to process.



CloudStation will read the data in the folder and present you with an Initialize Project dialog box. Confirm that the sensor type is correct, “Surveyor Ultra,” change the project name (if desired), and click **Create**.

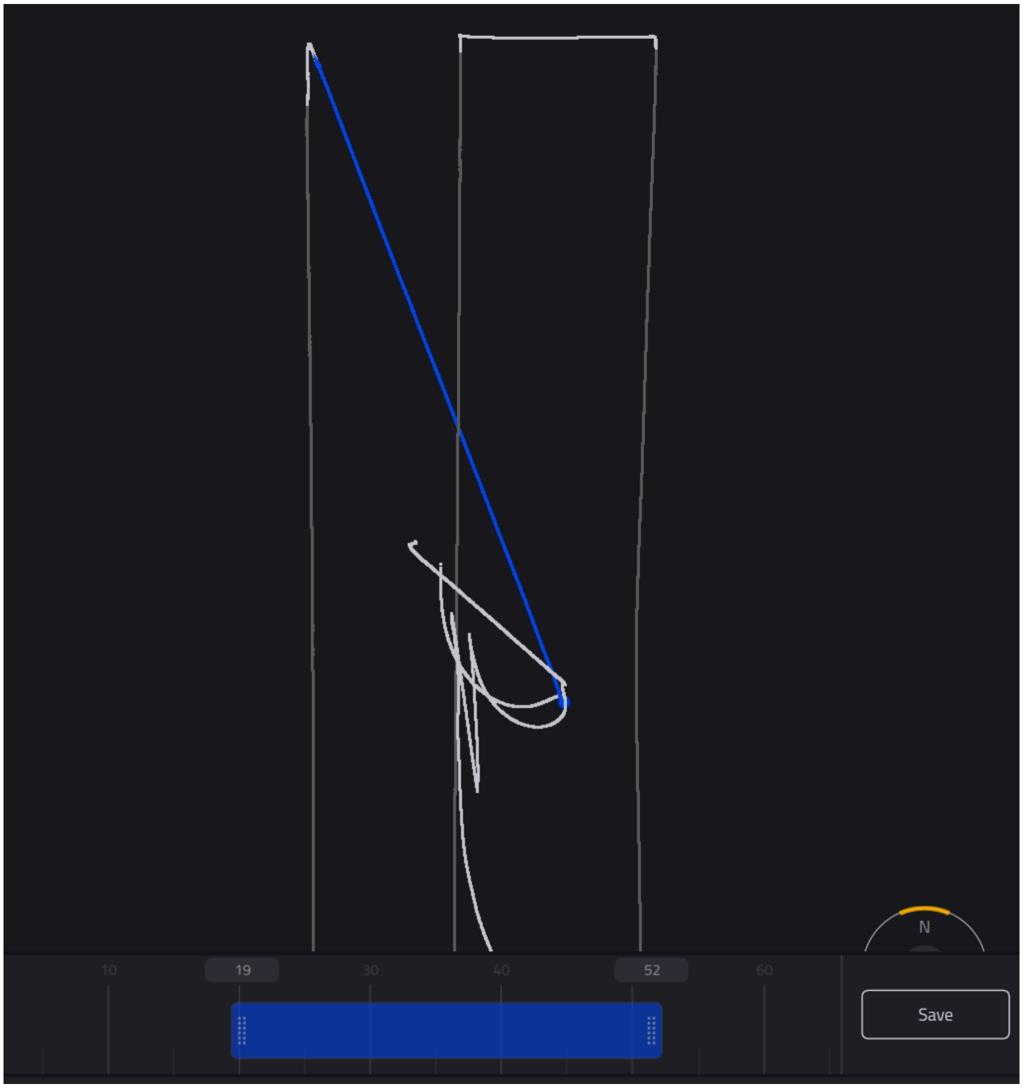


4. CloudStation will display the lidar flight path and make an initial attempt at identifying the lidar trajectories. Trajectories will show as colored lines on the map display and in the tool menu to the left.



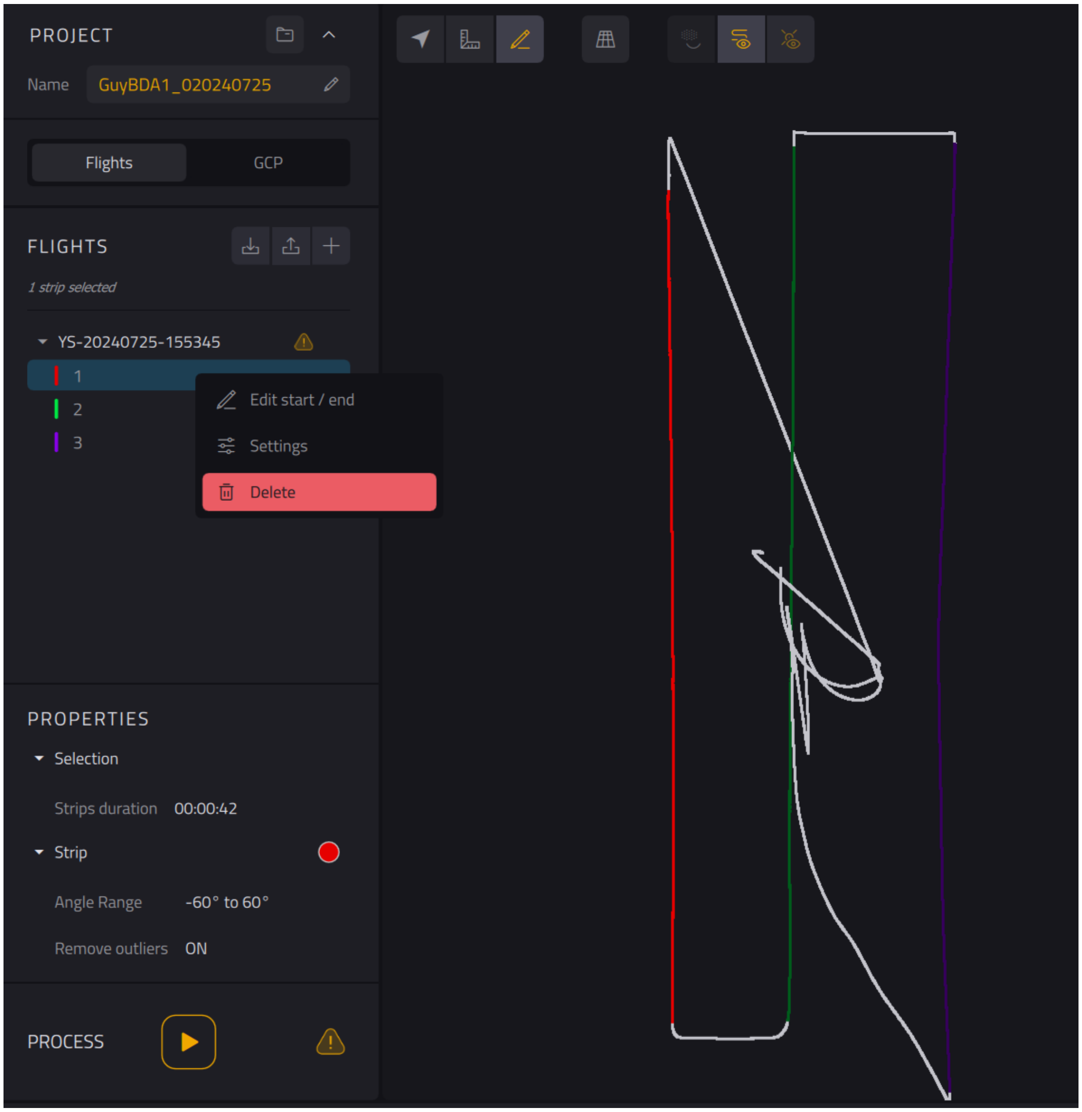
5. Select a trajectory by clicking on it. You can adjust the length of a trajectory by extending the time sliders at the bottom and clicking **Save.**

   Note, lidar trajectories should be long and straight (or nearly straight). Do no choose the short segments of turns or extend the trajectories right up to the turns because there can be a lot of noise in the IMU readings in these cases.

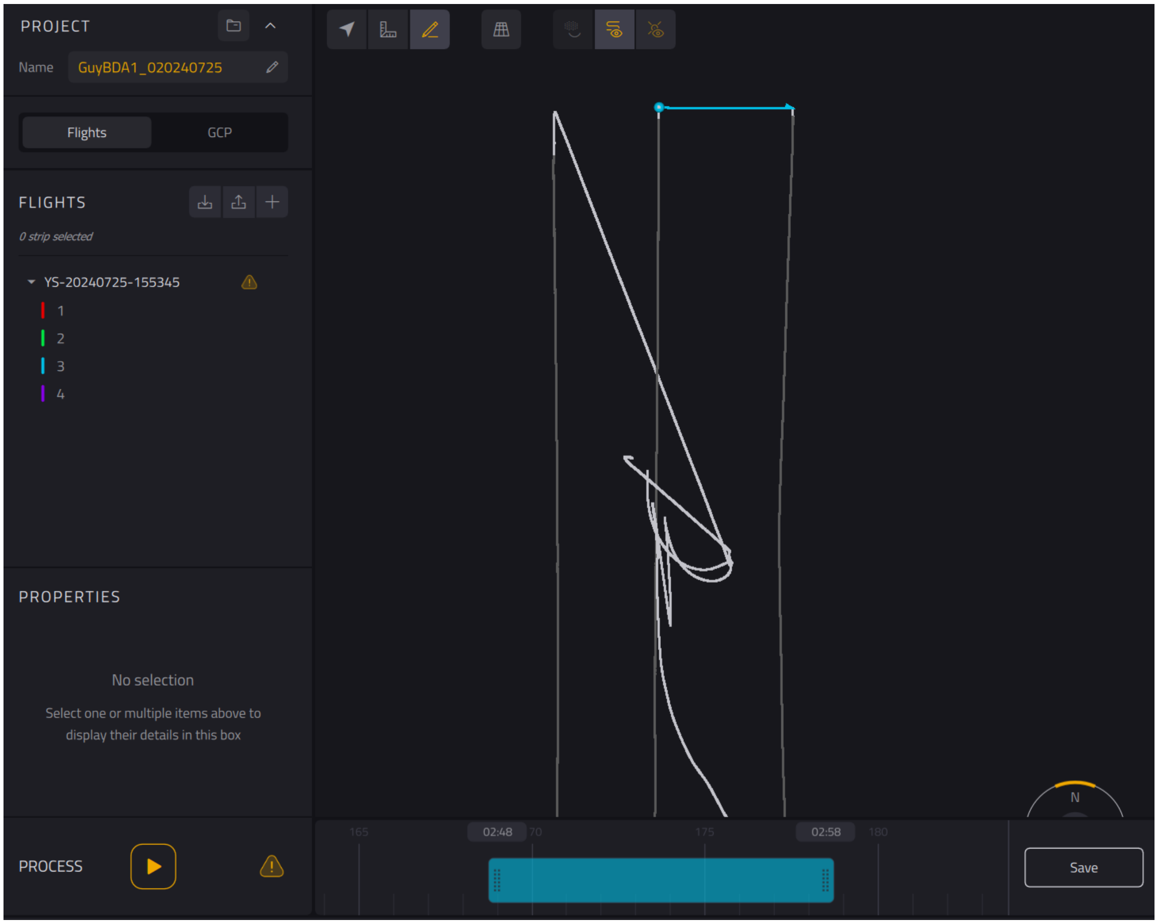


6. Delete a trajectory by right-clicking on it in the toolbar menu and long-pressing on **Delete.**

   CloudStation will often pick the “ferry” paths (i.e., from the launch point to where data collection starts/stops) as trajectories. Simply delete these.



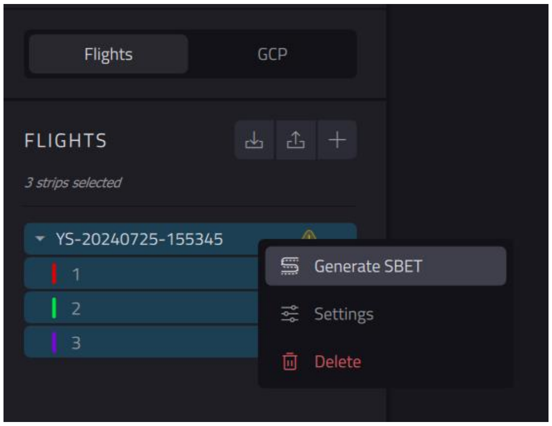
7. Click on any white segment of the flight line to create a new lidar trajectory. Trim the length of the trajectory with the time slider at the bottom, then click **Save.**



Once you have all the trajectories set, the next step is to bring in the base station data and create the SBET solution for processing the data.

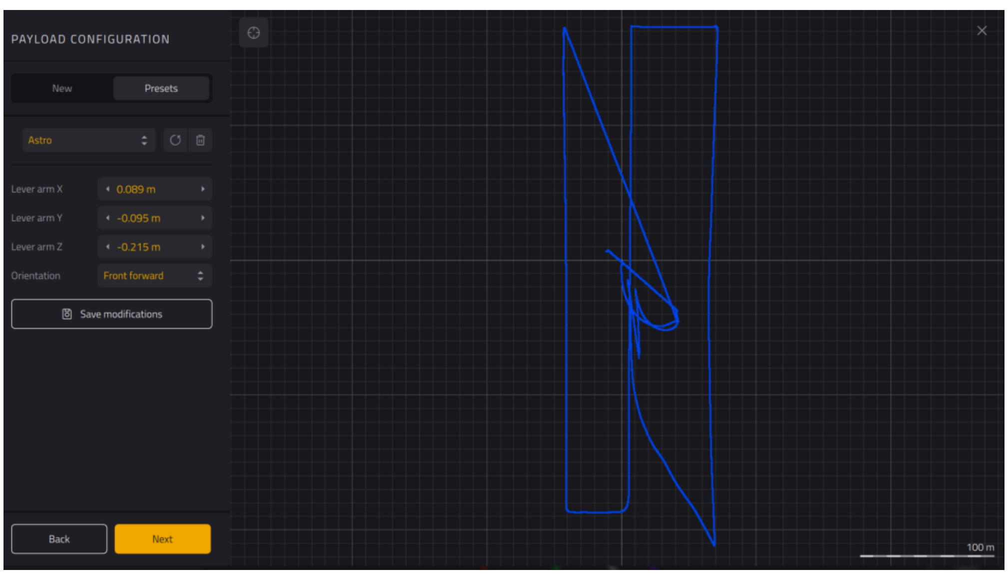
Note: For a quick view of the lidar data, you can skip the SBET step and click the Process button at the bottom left. This will generate the point cloud, but the solution will not be highly accurate and the different trajectories may not align well. However, this is a good step in the field to ensure adequate data capture.

8. Right-click on the project name in the tool menu to the left (above the trajectory legend) and select **Generate SBET**.

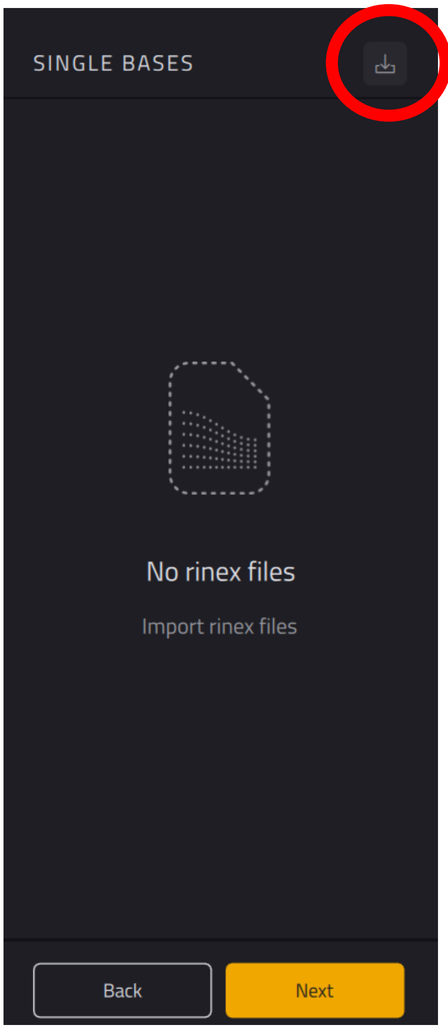


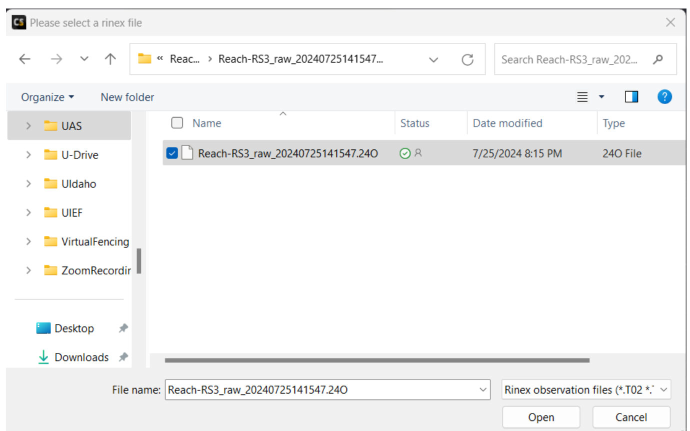
9. The first step in generating the SBET is to apply the lever arm offsets. These are the distances between the GNSS antenna and the center of the lidar sensor. Lever arm offsets are measured or calculated for each drone/lidar installation. The offsets should not change (provided the mounting of the lidar on the drone has not changed). Yellowscan will remember the offsets you last used or you can save offsets for various drone/lidar setups.

   Apply or confirm the lever arm offsets and click **Next.**

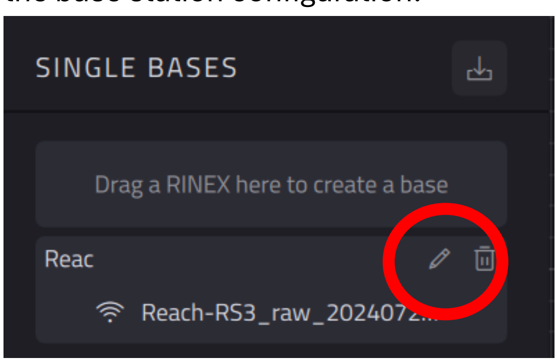


10. The next step is to import the RINEX log file from the GNSS base station. Click the load file button, select the RINEX file (extension of .24o), and click **Open**.

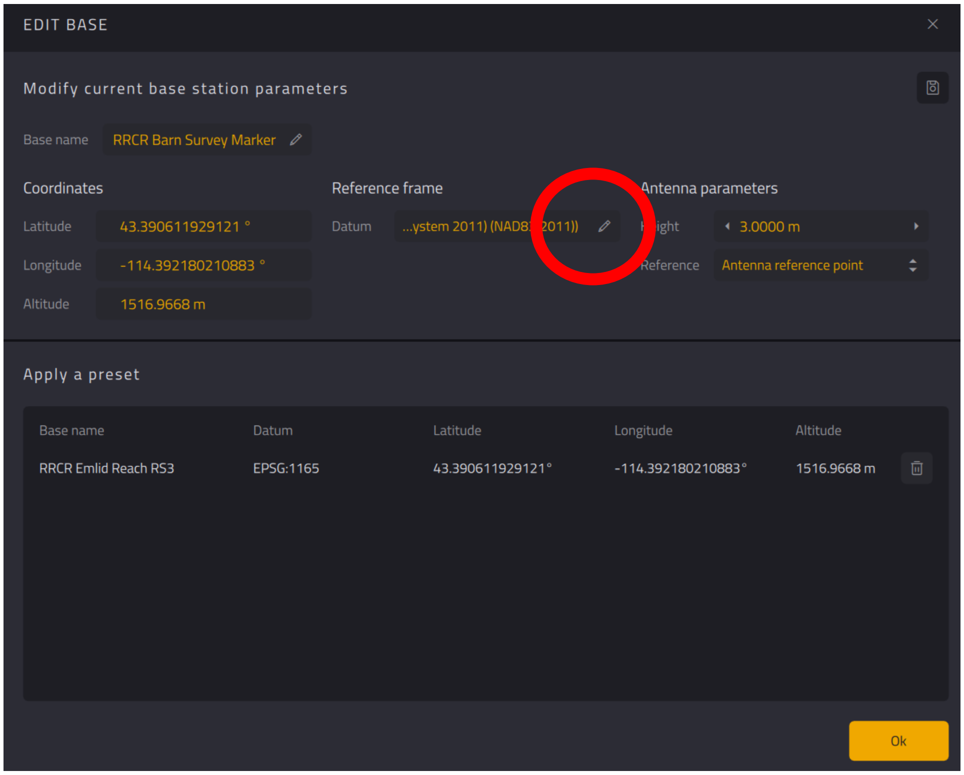




11. The RINEX log file will show in the list of base stations. Click the pencil icon to edit the base station configuration.

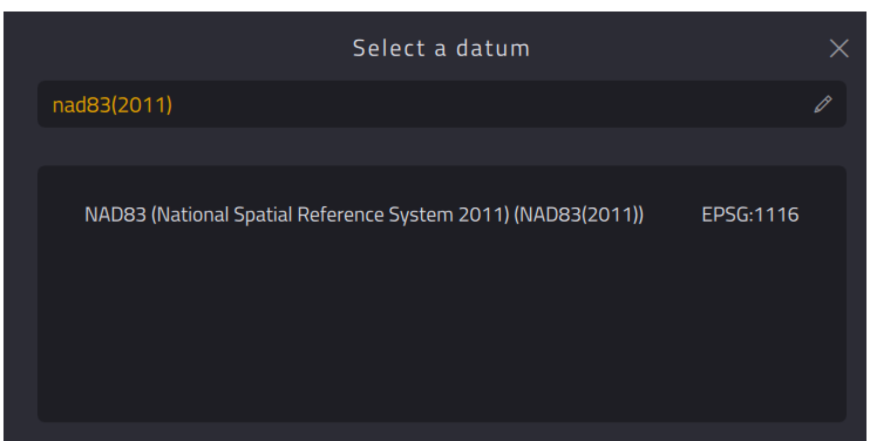


12. Confirm the base parameters (coordinates and antenna parameters). Change the base name if this is a base station location you plan to use in the future and want to save it. *Don't click OK yet!!*



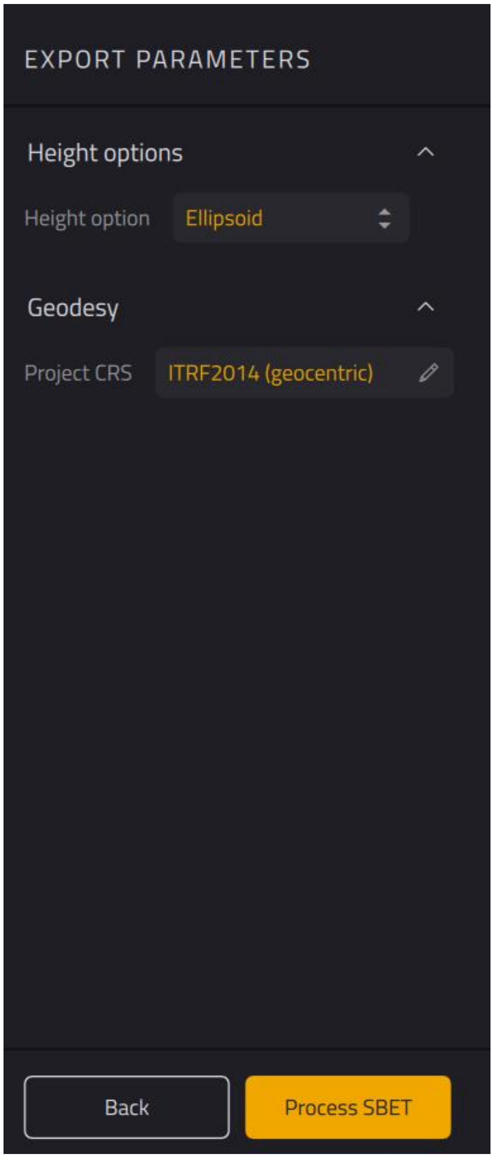
You must set the correct datum for the base station for CloudStation to correctly reference the GCPs and process the point cloud data.

Click on the pencil icon under Reference frame. The Emlid Reach base stations are set to use the NAD83 (National Spatial Reference System 2011; EPSG:1116) datum. Search for this and select it. Then click **OK**.

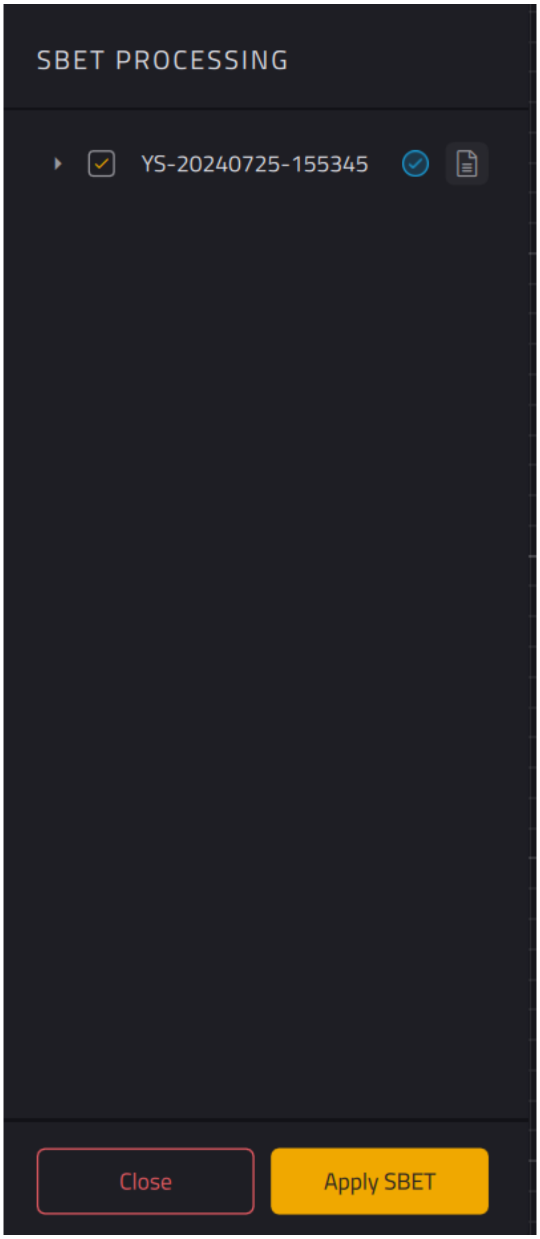


13. Verify that the height option is set to Ellipsoid and the project CRS is ITRF2014 (note, this is the coordinate system used for the project. Data can be exported in any other desired coordinate system).

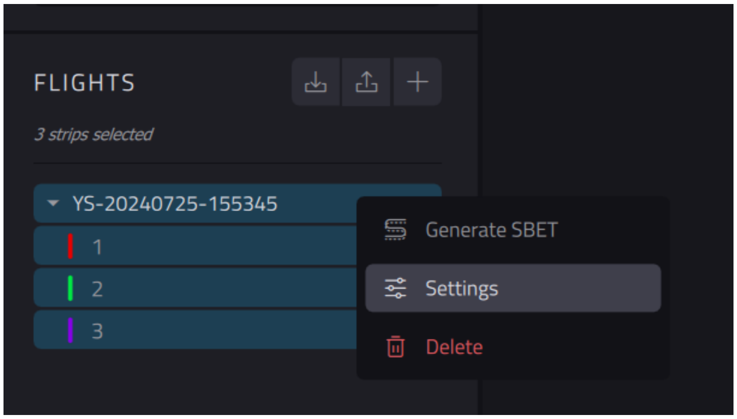
14. Click **Process SBET** to finish the steps and generate the SBET for the project. It may take several minutes to process the SBET.



15. Verify that the check box next to the SBET solution is checked once the SBET has finished processing. The page icon will display a report for the SBET solution. Then click **Apply SBET** to return to the main CloudStation window**.**

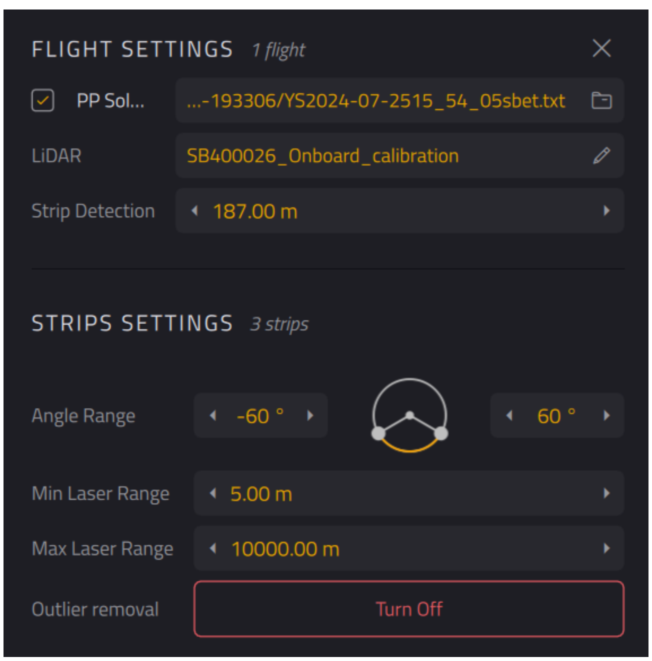


16. Before processing the lidar data, verify the project settings. Right click on the project name in the tool menu (above the trajectories legend) and select **Settings**.

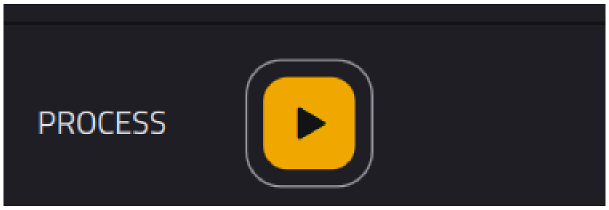


The main settings here relate to the maximum angle from nadir of points to include in the point cloud (+/- 60 by default) and the minimum laser range (1.00m by default).

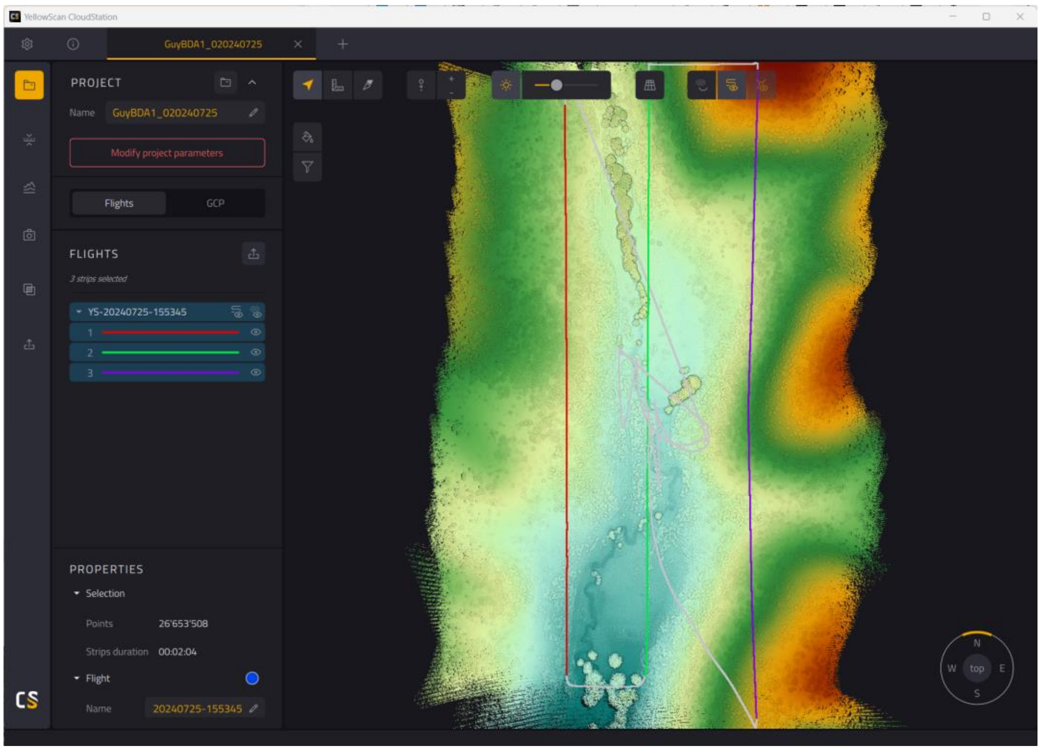
Click the **X** to close this window when you're finished verifying the settings. NOTE: if you change settings after processing the lidar data, you will need to re-process the data (i.e., it will erase the processed point cloud).



17. Click on the Process button to process the point cloud. This may take several minutes.

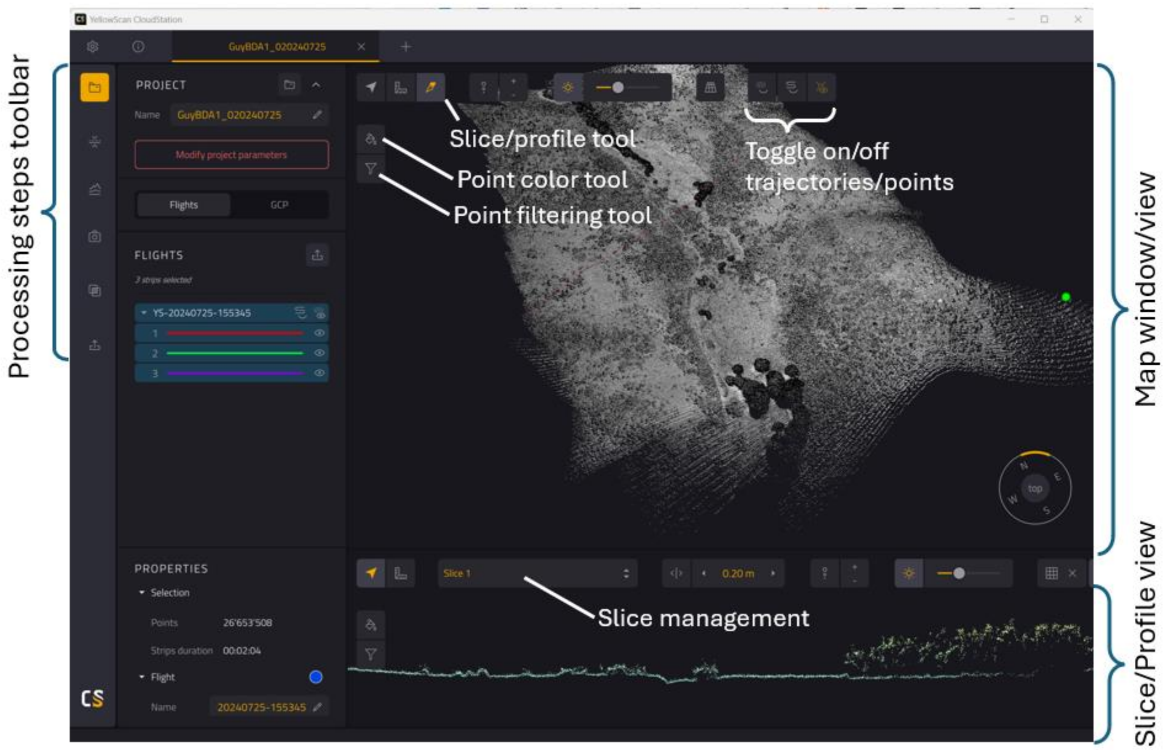


Once CloudStation finished the processing, it will display the point cloud.



Exploring the Processed Point Cloud

Take some time to explore the point cloud and become familiar with the various tools and how to navigate in CloudStation's 3D map environment.

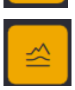


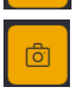
Major components/features of the CloudStation application interface.

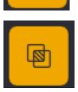
CloudStation Processing Tools

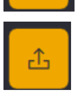
 Project Tools

 Strip Adjustment

 Terrain Classification

 Colorize Point Cloud

 Cut Overlap

 Export

Add GCPs (optional)

Ground control points can help improve the accuracy of the point cloud processing (i.e., with strip adjustment), or can be used as independent verification of point cloud positional accuracy. The use of GCPs is optional.

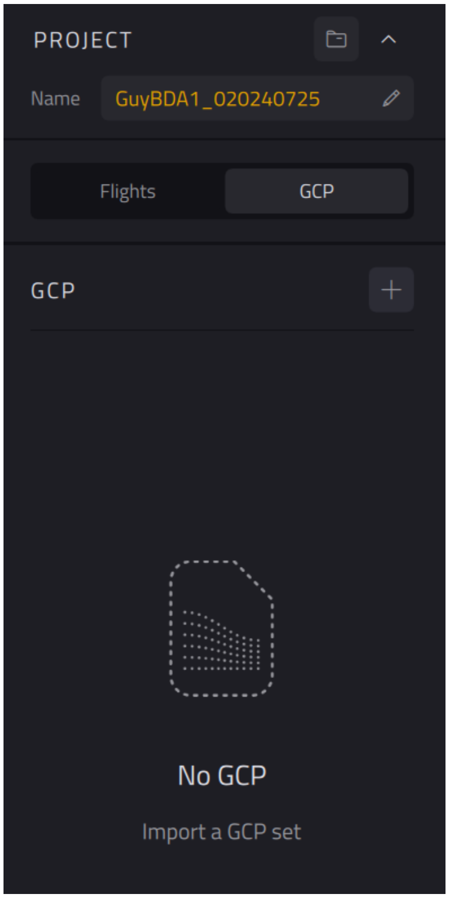
1. Ground control points should be collected by a RTK-GNSS rover and corrected using the same base station as used in generating the SBET. Points collected with Emlid GNSS receivers can be post-processed (if FIX status was not available when the points were collected) in Emlid Studio.

2. Format the GCP information in a CSV file with the following fields: name, longitude, latitude, ellipsoid_height

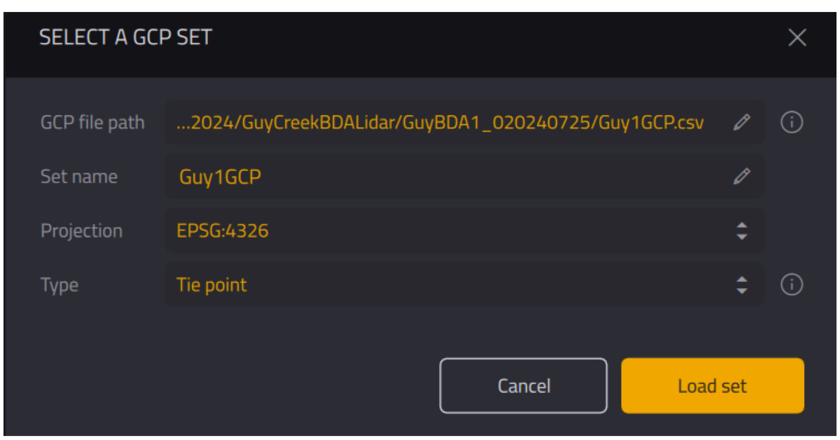
   Do not include a header row in the GCP file for CloudStation.

	A	B	C	D	E
1	gc1-1	-114.408	43.38545	1540.988	
2	gc1-7	-114.408	43.38483	1539.484	
3	gc1-3	-114.407	43.38437	1539.524	
4	gc1-4	-114.408	43.38378	1538.221	
5	gc1-5	-114.408	43.38364	1537.624	
6	gc1-0	-114.408	43.38411	1538.424	
7	gc1-6	-114.408	43.38454	1539.541	
8	gc1-2	-114.408	43.38498	1540.205	
9					
10					

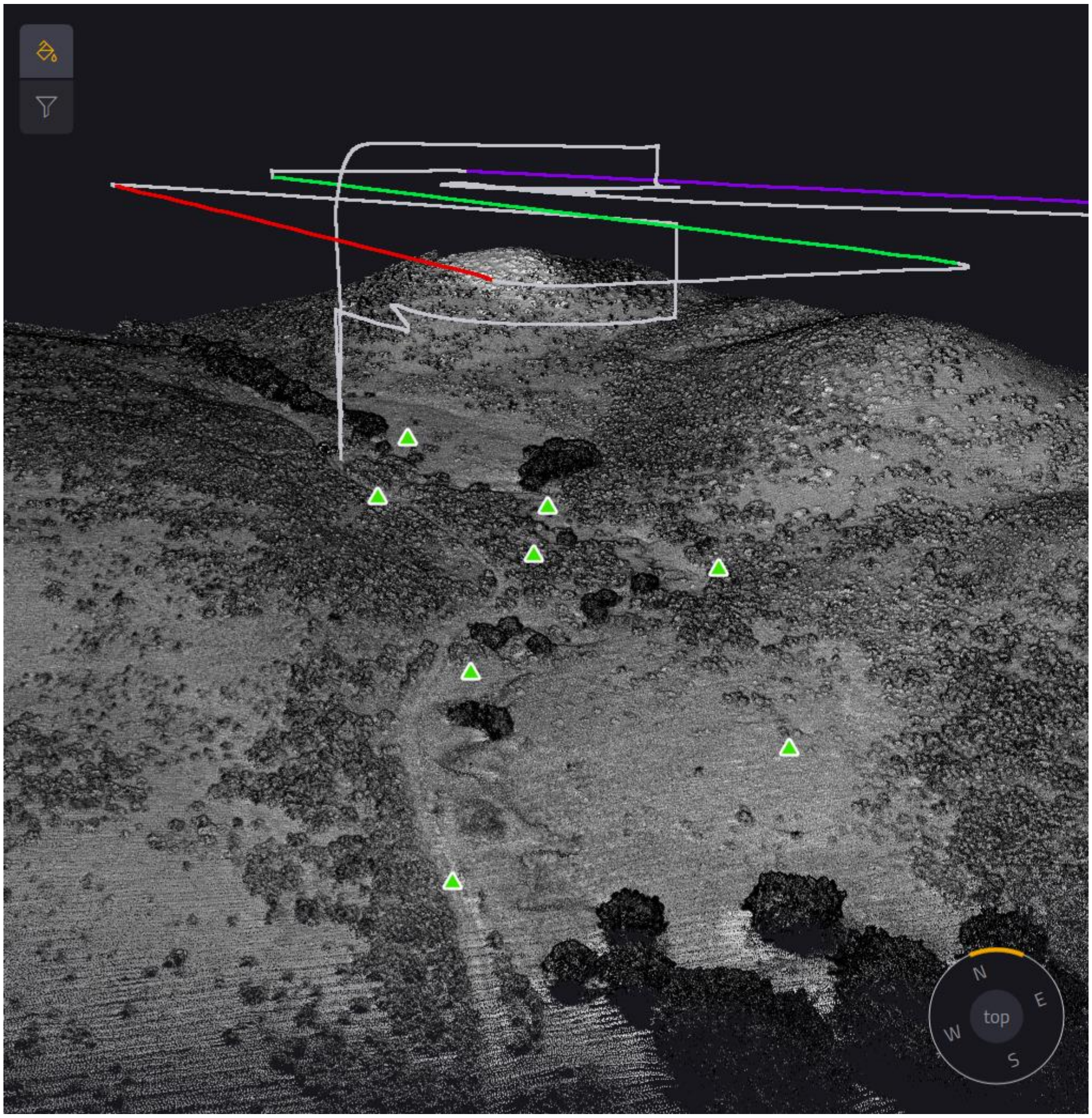
3. Click on the GCP tab of the project and click the plus button to load the GCP file into CloudStation. Note, this can be done either before or after you generate the SBET and process the point cloud.



Make sure to select the correct projection (coordinate system) for your GCPs. By default, the Emlid GNSS receivers record in geographic decimal degrees coordinates with the WGS84 datum (EPSG:4326). Click **Load set** to import the GCPs into CloudStation.

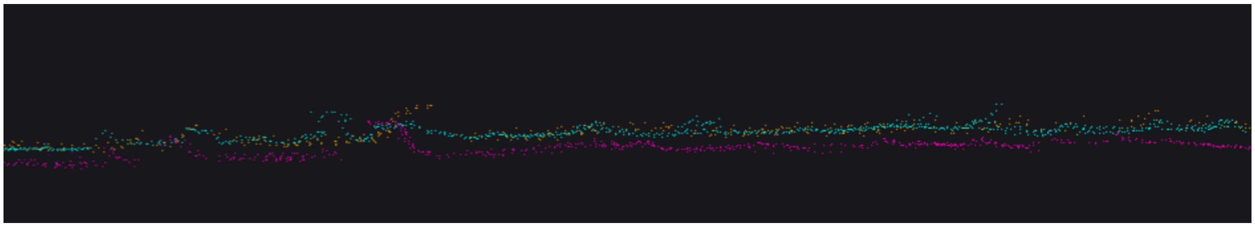


4. *IMPORTANT!! Verify that the imported GCP points line up on the point cloud surface when looked at via a perspective view. If the points display significantly above or below the point cloud surface, there was a problem with how the datum of the SBET was set or in how the projection of the GCPs was specified. In this case, use of the GCPs for strip adjustment will fail.*



Strip adjustment

Strip adjustment is a procedure for improving the alignment between different trajectories (strips). Minor errors GNSS errors or inaccuracies in lever arm measurements can cause the point cloud data from adjacent trajectories to not line up exactly. Strip adjustment attempts to improve the fit between trajectories.



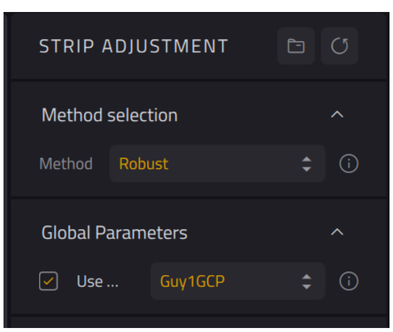
Elevation profile example of poorly aligned trajectories/strips prior to strip adjustment (note colors denote different trajectory/strip).

Elevation profile example of multiple trajectories/strips after strip adjustment.

1. Choose the Strip Adjustment icon from the left-hand icon toolbar.

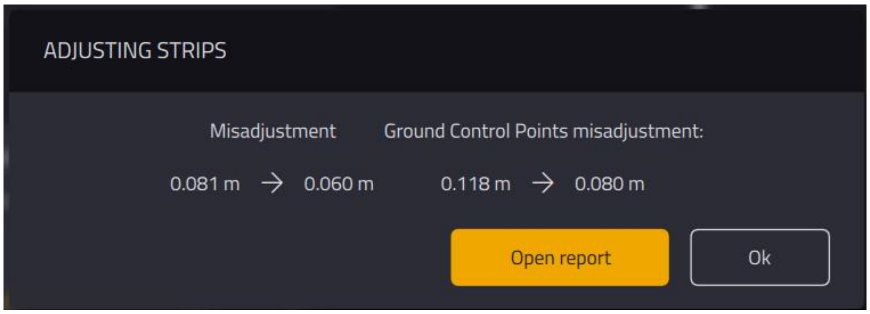
2. Generally, Yellowscan recommends the “Robust” method for flights involving multiple trajectories/strips. The “Precise” method is for situations where you have only two, long strips (e.g., along powerlines).

   If you have imported GCPs, you can use these to improve the strip adjustment by checking the box under Global Parameters.



3. Click **Adjust strips.** This may take a while to run.

   When complete, CloudStation will display a dialog box that shows the improvement in the strip alignment as measured from the point cloud and from the GCPs (if used). Clicking **Open report** will open a PDF report of the results of the strip adjustment.

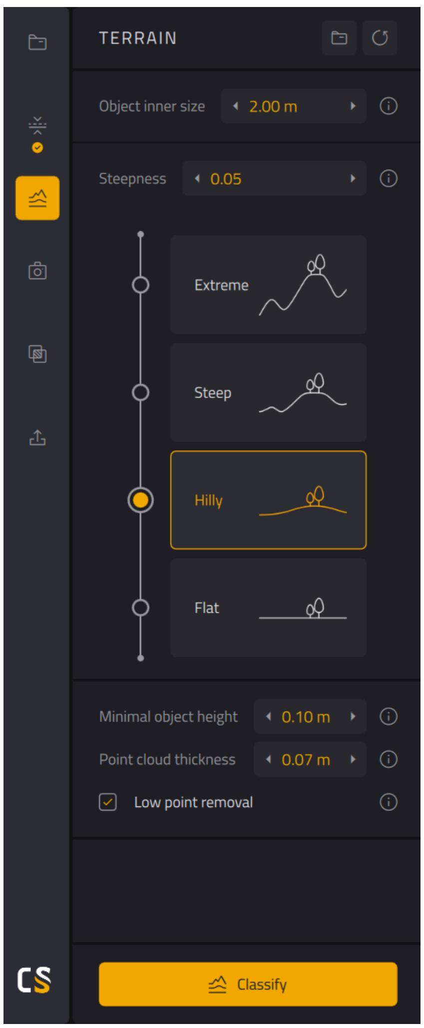
Terrain classification (optional)

CloudStation can do a basic classification of ground vs. non-ground points in the point cloud. You can redo the classification multiple times to try different parameters for the best results with your scene.

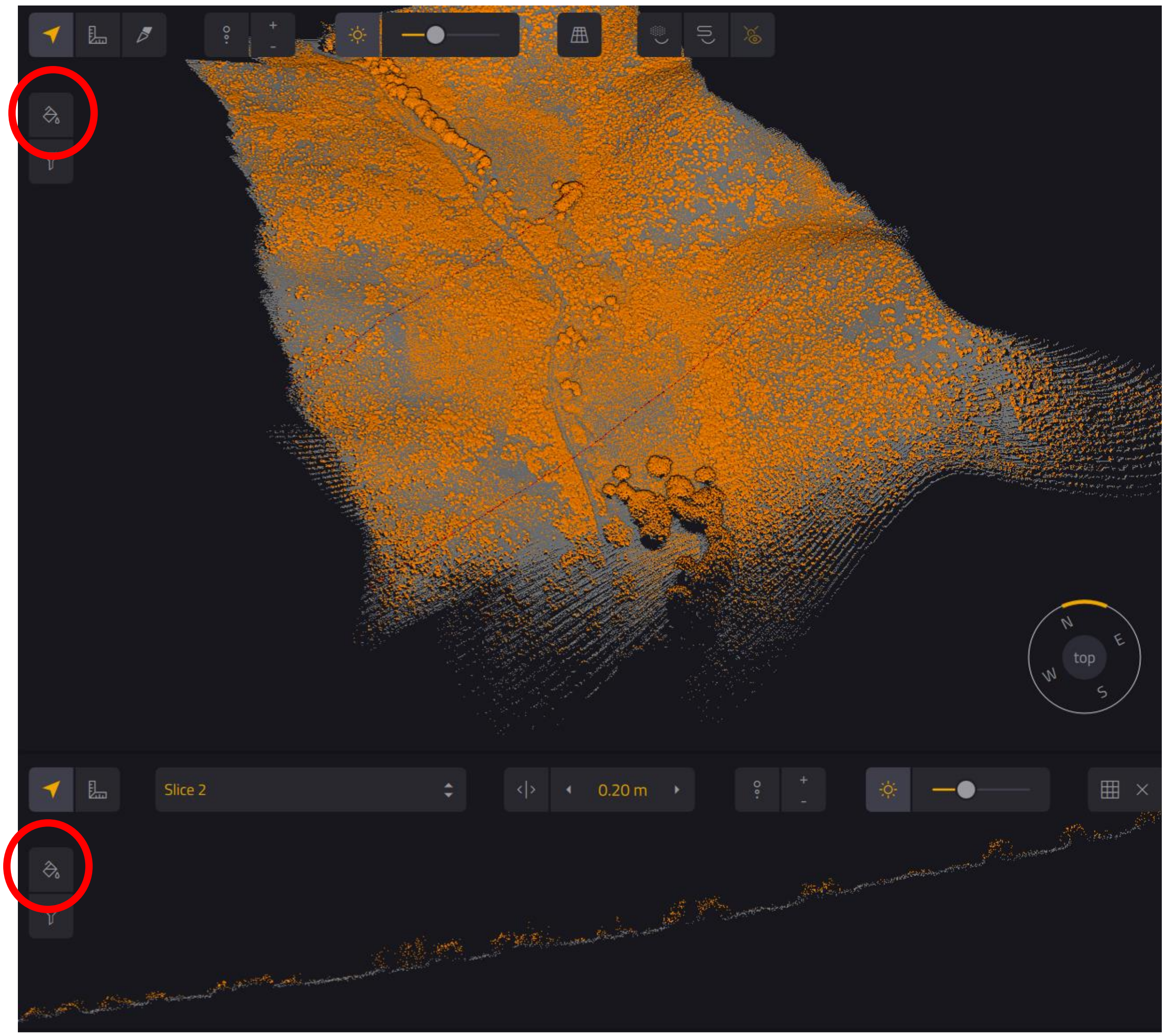
1. Select the terrain classification button on the left-hand tool bar

2. Set the desired parameters. Clicking on the "i" buttons next to each parameter will provide additional information on that parameter to help in selection.

3. Click classify.



4. Explore the ground classification in the main map window and via elevation profile slices. Use the color tool (paint bucket icon on the left of the map/slice window) to change the display to show the ground and non-ground classification.



Point cloud colorization (optional)

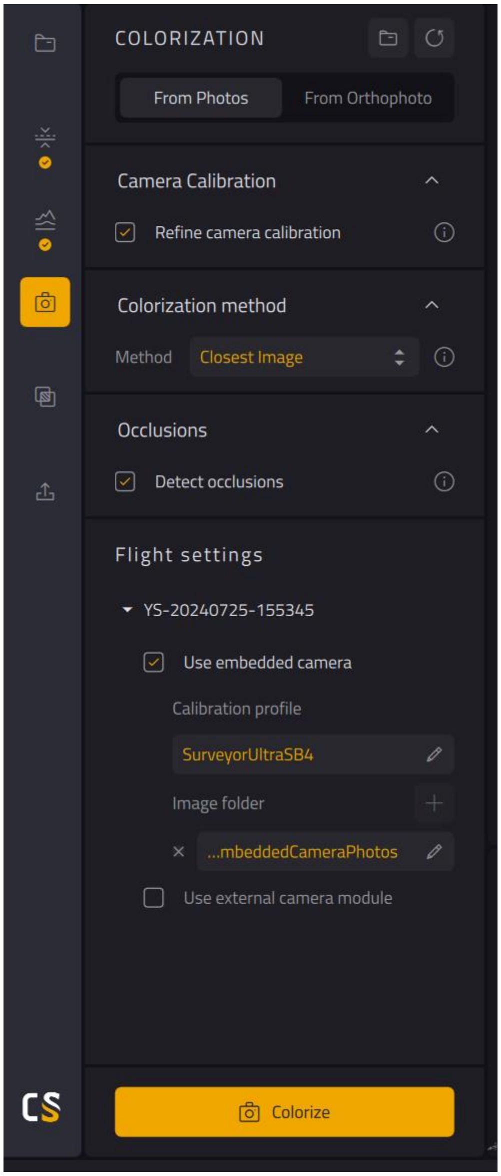
The Yellowscan Surveyor Ultra sensor includes a RGB camera module that takes photographs while the sensor is in operation. These photographs are used to "colorize" the point cloud – i.e., assign RGB color values to the points. This is an optional step.

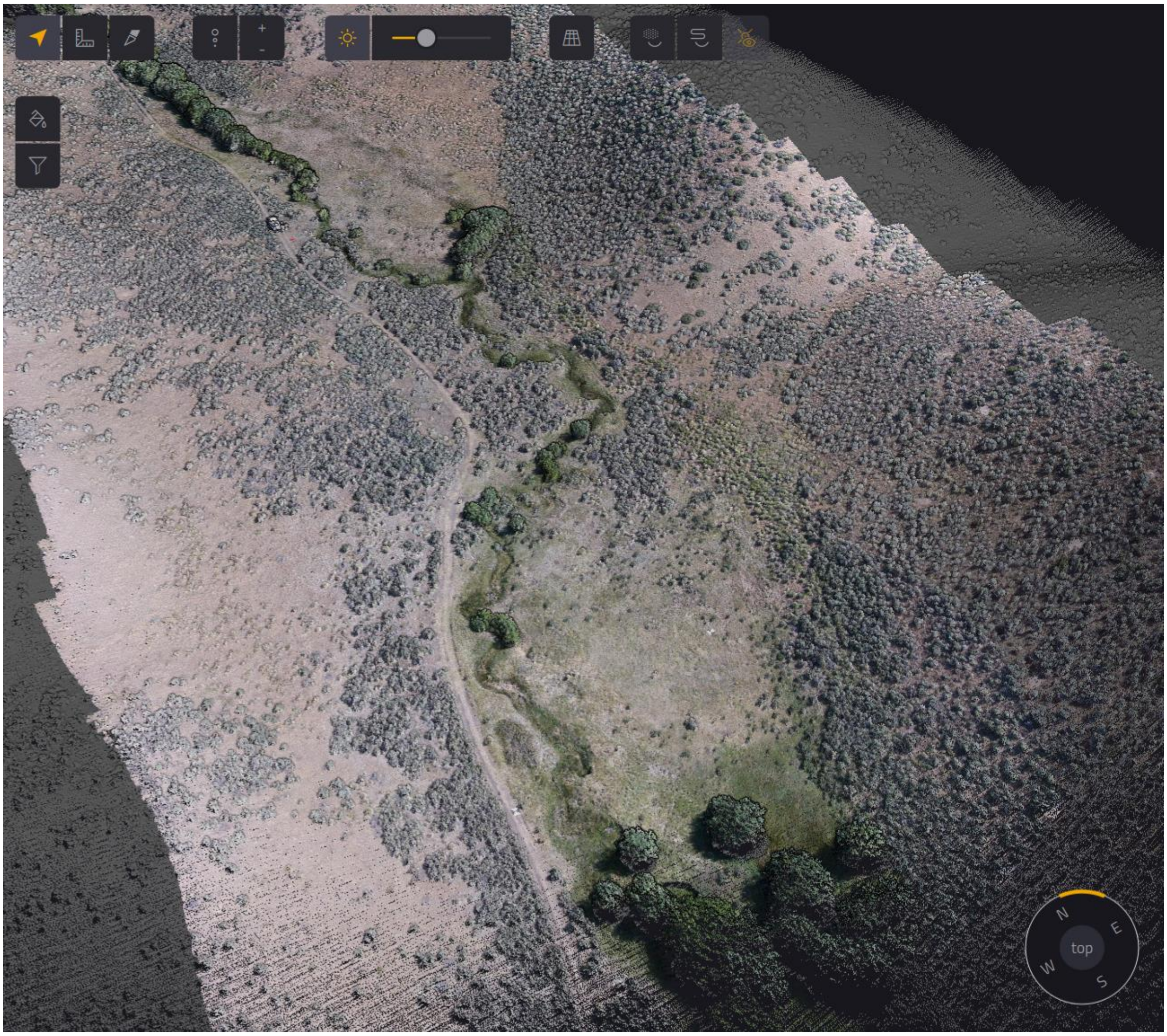
1. Chose the Colorization tool from the left-hand toolbar.

2. If photographs were captured as part of the data collection, the settings for colorization will already be filled out.

3. Click **Colorize**.

NOTE: On occasion, colorization will fail with a message that there is a discrepancy between the number of photos and number of events (i.e., expected photos). The appears to happen rarely when an extra photo is captured. Navigating to the project directory, then to the "EmbeddedCameraPhotos" folder, and deleting the last photo has helped overcome this error.

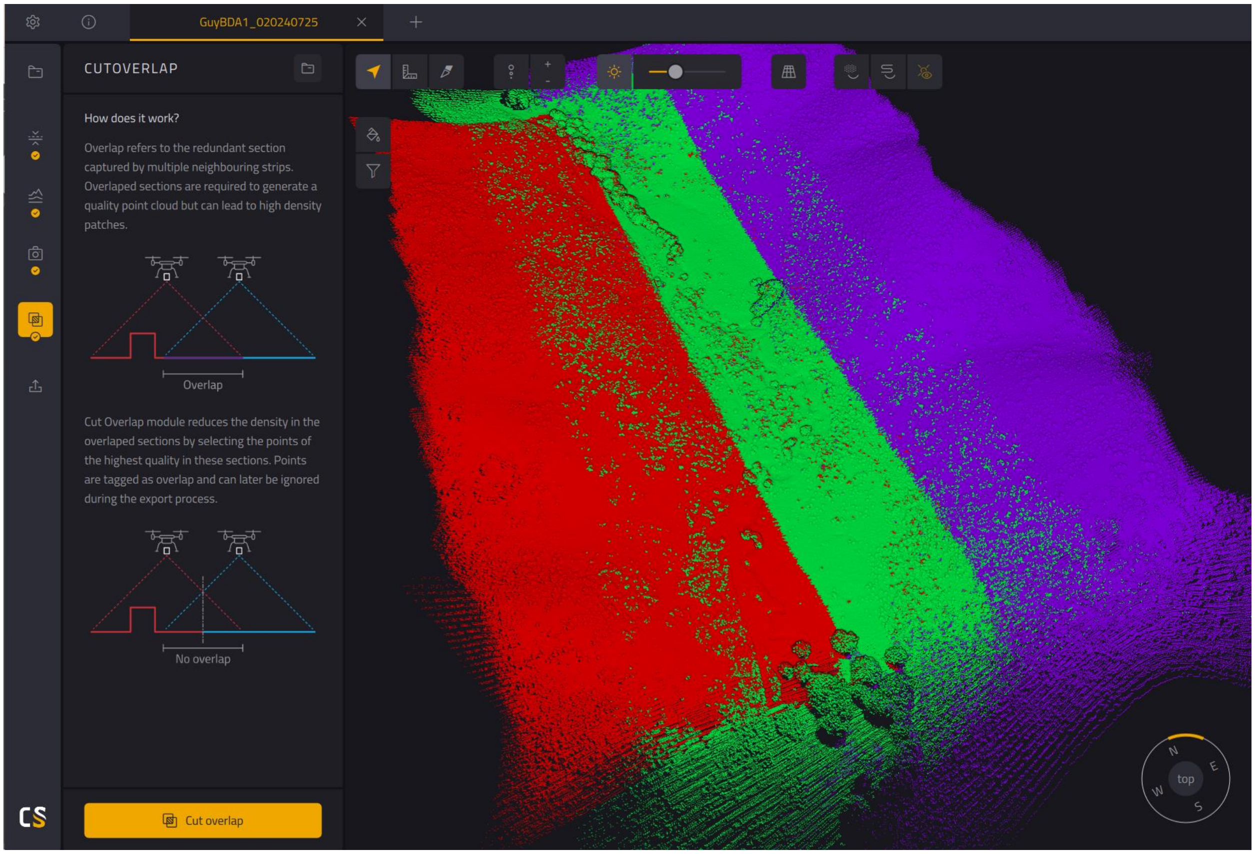




Example of a colorized point cloud.

Overlap removal (optional)

The areas of overlap between strips/trajectories can contain many redundant points. The overlap removal tool identifies the highest-quality points in the overlap areas and marks the other points to be excluded from export.



Export

The last step in CloudStation is exporting the processed point cloud and/or elevation models. There are two export options we have with our CloudStation license – Point Cloud and Digital Model. You can switch between the two by clicking on the icons at the top of the dialog box. Yellowscan will suggest an appropriate output coordinate system, but that can be changed as desired. For digital models, you can export the digital surface model (DSM), digital terrain model (DSM, from the classified ground points), or digital height model (difference between the DSM and STM). Clicking **Export** will create the export files.