Lab 10: Working with Lidar data in Metashape

Objective

The main goals of this lab exercise are to familiarize students with:

- How to import and display lidar data in Metashape
- Processes for aligning lidar data with photogrammetric products in Metashape
- How to use lidar data as an elevation source for orthorectification
- Differences between lidar and photogrammetric point clouds

To date, we have considered only elevation data that we derive from the photogrammetric process in our Metashape projects. Those elevation data can be used for analyses (e.g., calculating canopy height, examining change over time, calculating volume) or as a source for orthorectifying aerial photos. However, other sources of elevation data can be brought into Metashape and used in place of photogrammetric 3D models.

Over the past few years, lidar data collected from drones has become more prevalent and affordable. Lidar is an active sensor technology that measures distance between the sensor (mounted on a drone in our case) and an object (e.g., the ground, vegetation, buildings) based on the time it takes for a laser pulse emitted from the sensor to be reflected off the object and measured back at the sensor. Because the lidar sensor is emitting the laser pulses (i.e., radiation) it is measuring, and because those laser pulses are small in spatial footprint, some of those pulses will make it through plant canopies and give elevation information on canopy structure and even ground surface under canopies. Thus, lidar data provides a much more complete picture of the ground surface and structure of vegetation compared to photogrammetric point clouds that can only estimate elevations for objects that can be seen in more than one photograph.

Additionally, lidar data can be used as a source of elevation data for orthorectifying drone-collected aerial imagery, potentially saving considerable processing time in photogrammetric projects (i.e., removing the need to build dense photogrammetric point clouds or mesh models). Using lidar data in this way, however, requires coregistration of the lidar data with the photogrammetric model.

In this lab, we will explore how to bring lidar data into Metashape, align the lidar point cloud with a set of photos, use the lidar as the basis for orthorectifying the photos, and explore the differences between the lidar and photogrammetric point clouds.

Deliverables

Fill out and submit the questions at the end of this document. Also please submit a Quality Report from Metashape.

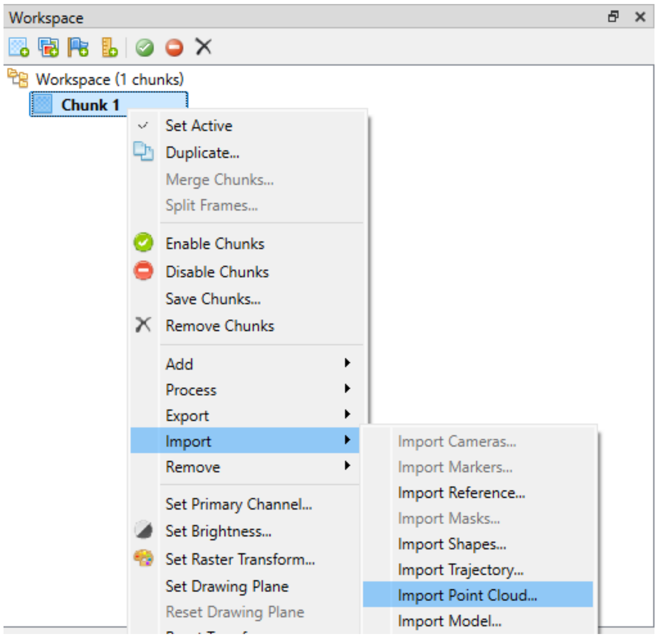
Note: Please refer to the class Canvas site for lab due dates. You may work together and help each other, but please make sure what you turn in is your own work.

Section 1: Importing lidar data into Metashape

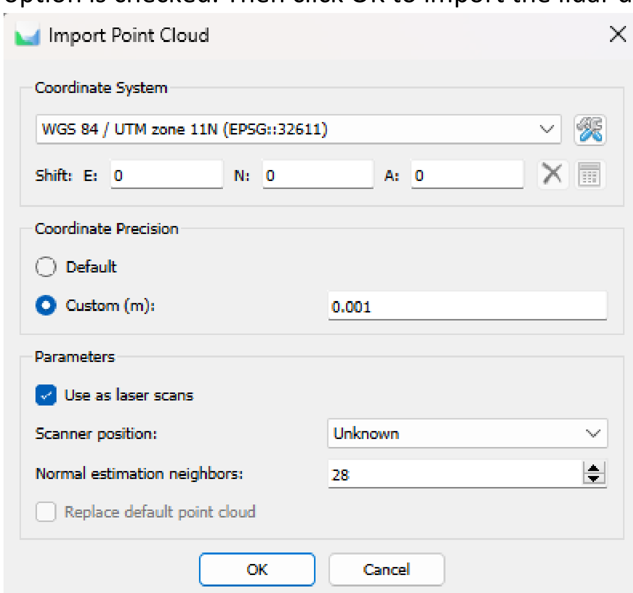
For this lab you will need the following data (available from the download links on Canvas):

- Parker Farm RGB imagery from Labs 4 and 5
- The GCP file for the Parker Farm imagery, and
- Parker Farm lidar data acquired at the same time.

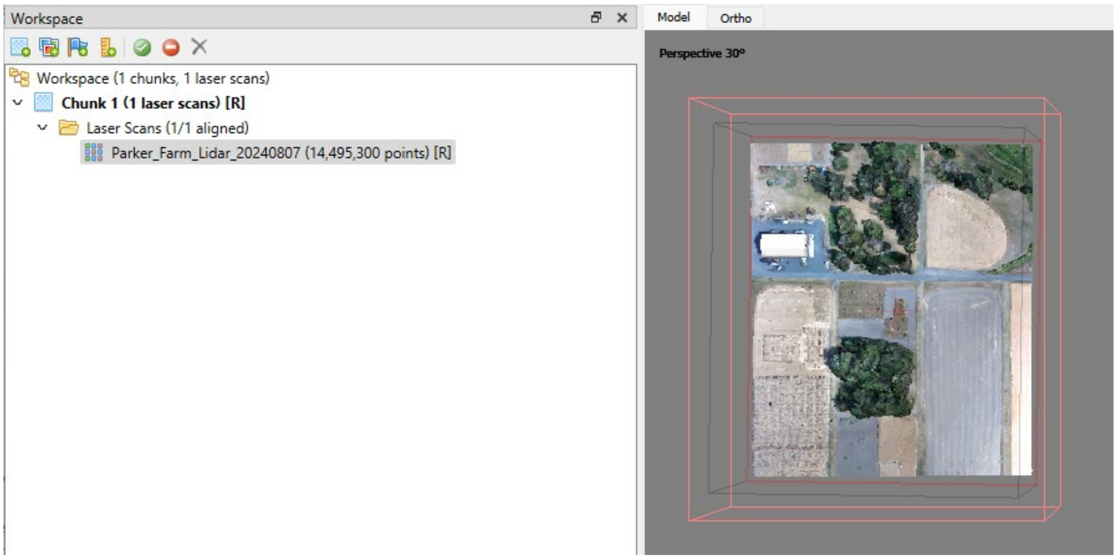
1. Start a new Metashape project. Right-click on Chunk 1 and select **Import -> Point Cloud…** (or from the main menu select **File -> Import -> Point Cloud…**). Find and select the Parker_Farm_Lidar_20240807.las file and click Open.



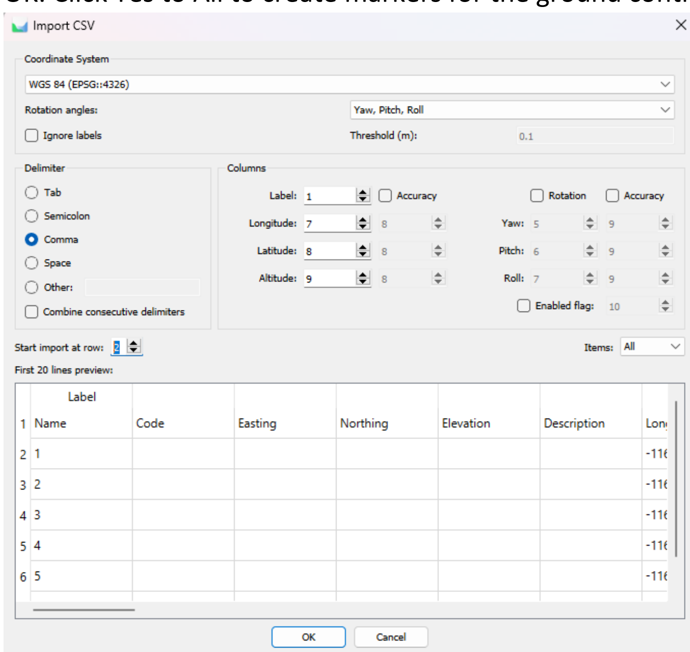
2. Make sure the projection is set correctly (UTM 11 – EPSG::32611) and that the "Use as laser scans" option is checked. Then click OK to import the lidar data. It may take a minute or two to load the data.



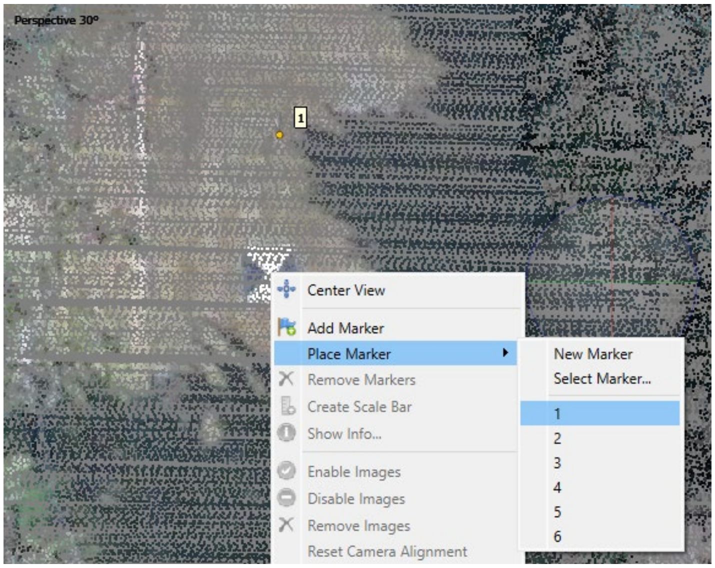
3. In the Workspace window, expand the tree for Chunk 1 until you see the lidar data point cloud. Double-click on the point cloud to show it in the model window.



4. Change to the Reference window and import the ground control points for Parker Farm. Make sure the field names line up correctly with the data (i.e., the correct column numbers are being used for import) for the ground control file and that import starts on line 2 (to avoid importing the header row), and click OK. Click Yes to All to create markers for the ground control points.



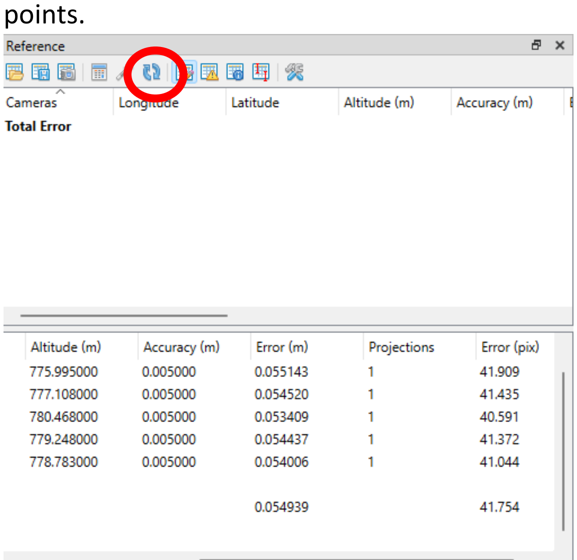
5. In the model window, you should see the GCP markers displayed on the point cloud (if not, make sure the marker display button is enabled). Zoom in to each ground control point and either: a) drag the marker icon onto the center of the ground control target, or b) right click on the center of the ground control target and select **Place Marker** and then the correct GCP marker number to place that point.



NOTE: You are working with a point cloud, so beyond a certain zoom level, you will lose detail as the points become fewer. Do the best you can with locating the markers on the targets.

6. Repeat this process with all the remaining GCP markers.
   Hint: after zooming in and placing a marker, type the Zero (0) key on your keyboard to reset the window to fully zoomed-out.

7. In the reference window, note the total error of the ground control point fit. If the error is large (e.g., > 1m), you may need to update the transformation by clicking the **Update Transform** button (identified by red circle below) and observe how the error changed as the lidar point cloud is fit to the ground control points.

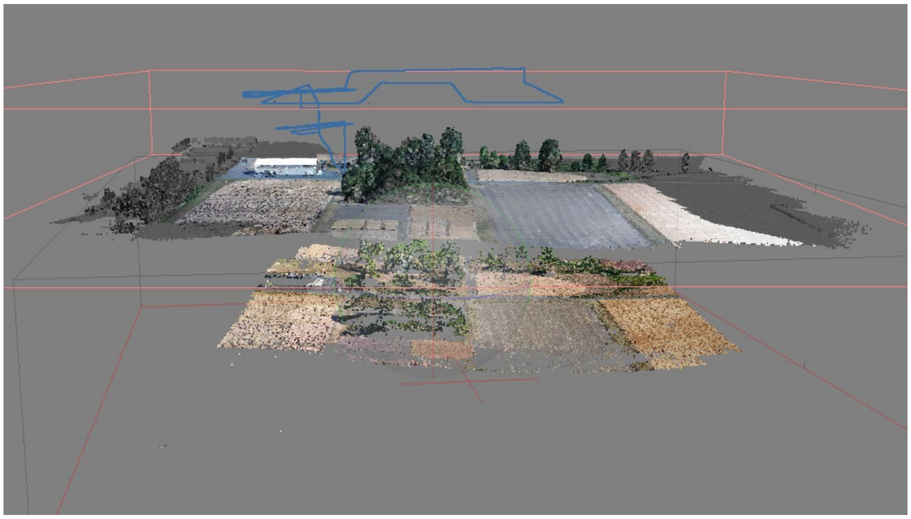


Aligning photos to the lidar point cloud

Now that we have the lidar data adjusted to the GCPs, the next step is to add our photos and align them.

8. Add the RGB photos for Parker Farm that you used in Labs 4-6. Make sure to leave out any of the oblique photos if they are there.

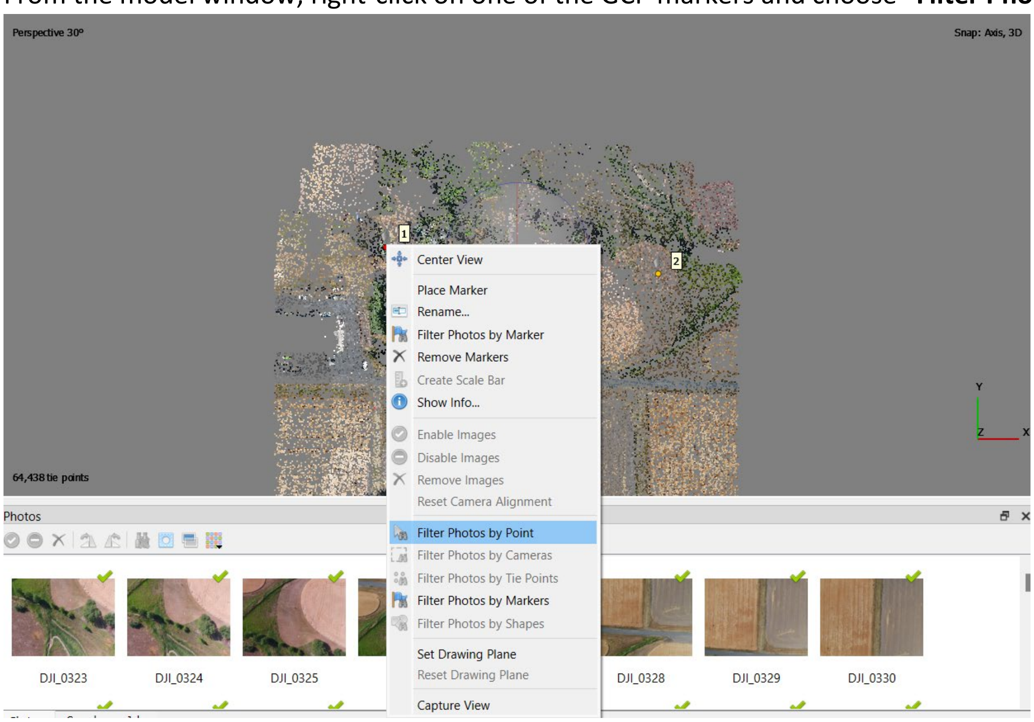
9. Align the photos with Medium accuracy (leave all other options as default). The result will be a sparse point cloud that should appear beneath the lidar point cloud.



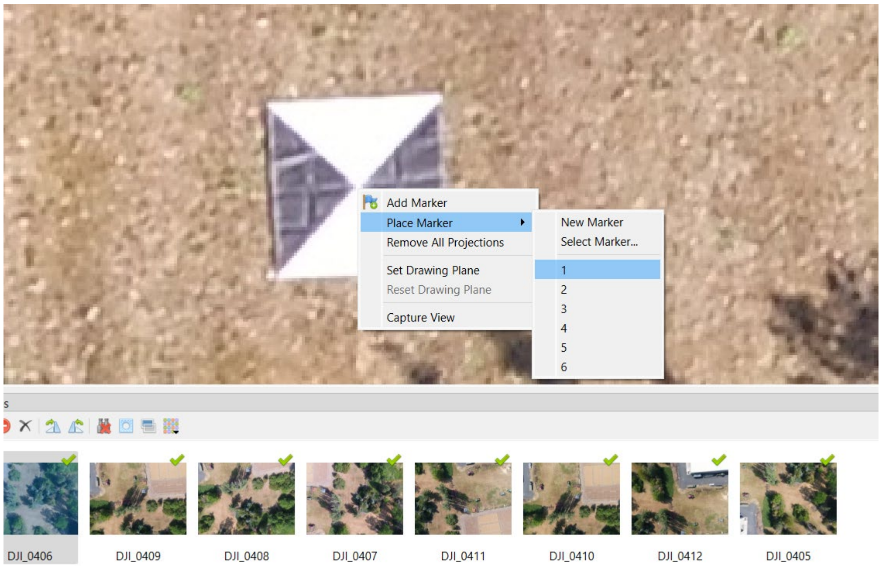
Note: you can ignore the blue lines in this figure. Those are lidar flight paths (trajectories) and are not necessary for this lab.

10. Next, we need to assign the ground control markers to the photos (just like we did in Lab 5). Because of the issue in GPS altitude with the photos, the aligned camera locations will be too close in altitude to the GCPs to use the "**Filter Photos by Marker**" option. So, we will use the "**Filter Photos by Point**" option instead.

11. From the model window, right-click on one of the GCP markers and choose "**Filter Photos by Point.**"



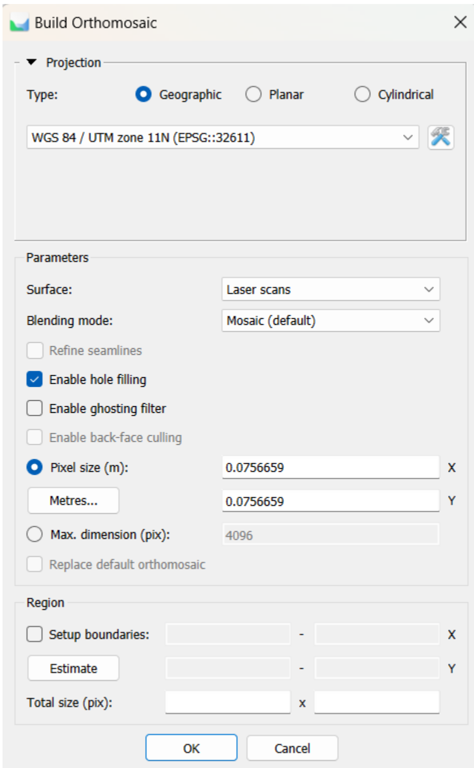
12. For each GCP, place the marker on at least 6 photos where it occurs.
Tip: Metashape can auto-place the markers in the correct vicinity once it has enough photos of each GCP marker tagged. To do this, you can place GCP markers on 2 photos for each marker first, then update the transform for the model and then go back through and adjust the marker locations on the remaining photos.



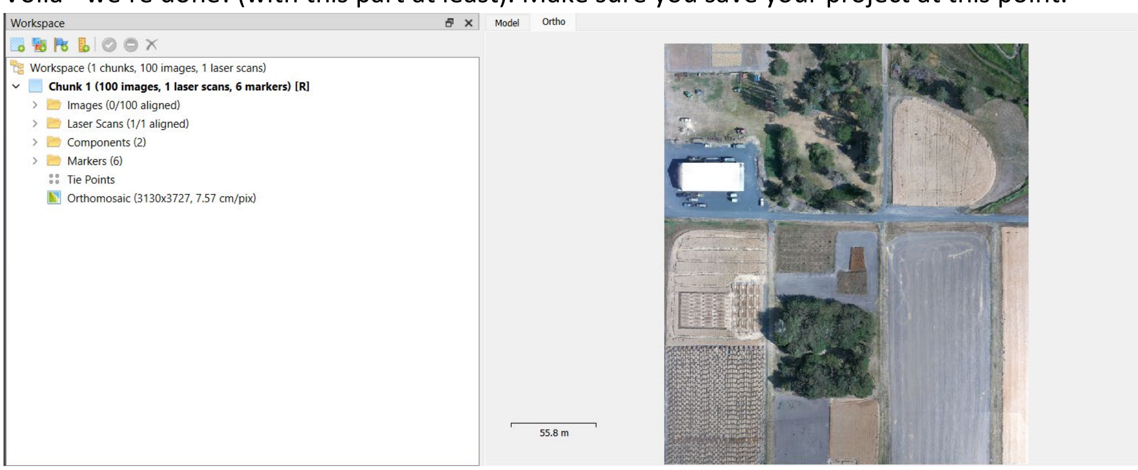
13. Once you have GCP markers identified on six photos per marker, note the GCP error in the reference window and then update the model transform (note how error decreases) and then run a model optimization (and note how error decreases even more).

14. Now we're ready to orthorectify the drone photos. But, you're thinking ,"Wait! We need to build the dense point cloud and DEM first, right?" That's one of the coolest aspects of having lidar data – it serves as the elevation source for orthorectification. And in this case, we can do it straight from the point cloud (but you can build a DEM if you want to!).

15. From the main menu, select **Workflow -> Build Orthomosaic**. Set your projection to a projected coordinate system (UTM 11, epsg::32611), and se the surface to **Laser Scans.** You can leave the other options as default. Then click OK to build the orthomosaic.



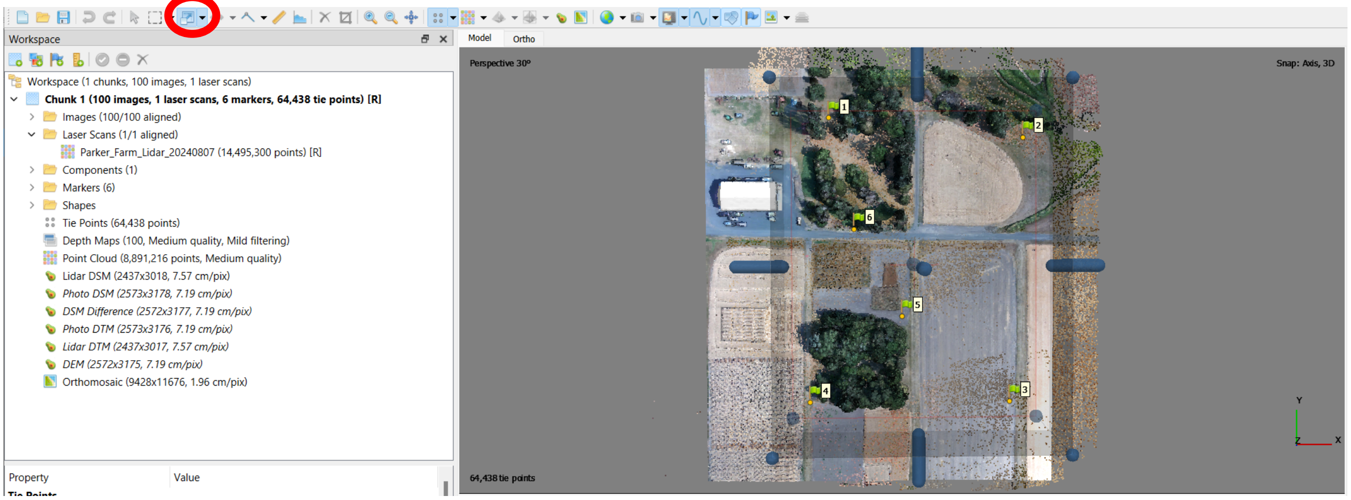
16. Voila - we're done! (with this part at least). Make sure you save your project at this point.



Exploring differences between lidar and photogrammetric point clouds

For this next part of the lab, we're going to look at some differences between the lidar point cloud and a photogrammetric point cloud. We will first need to build a dense cloud from our photos.

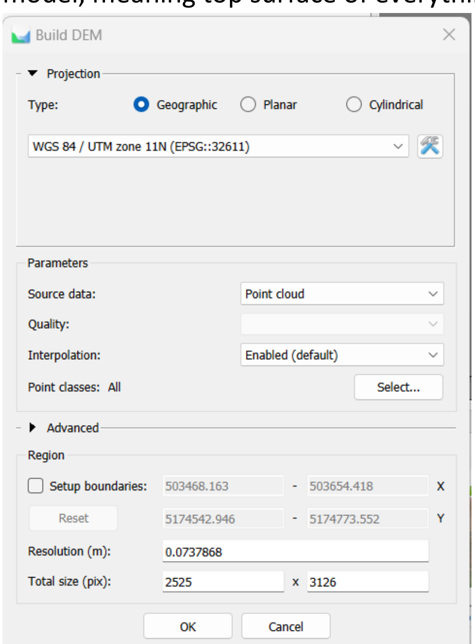
17. First things first, from the model window, rotate and resize the analysis region on the sparse point cloud to be roughly the same size/shape as the lidar point cloud. This will cut down significantly the time it will take to create the dense cloud.



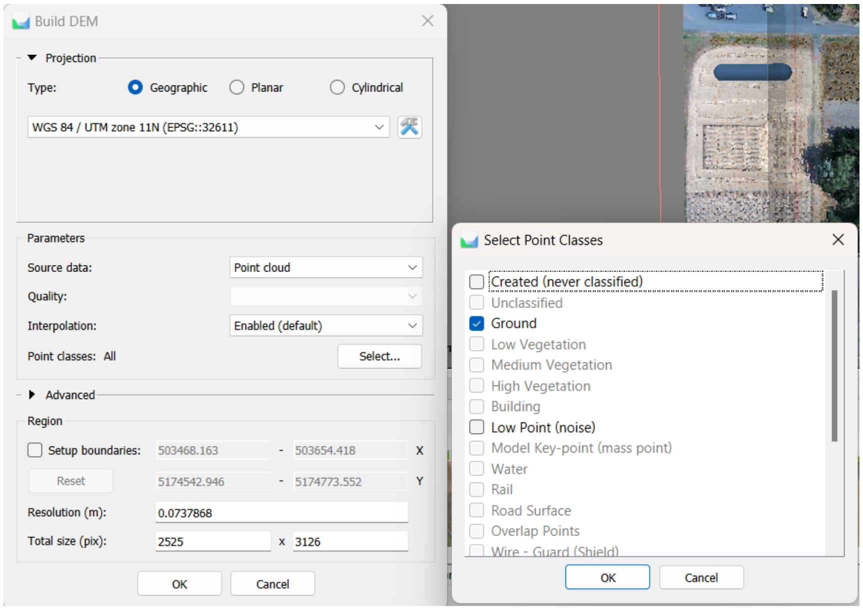
18. Once the analysis region is set, from the main menu, select **Workflow -> Build Point Cloud**. For the purposes of this Lab, you can build a **Low** quality point cloud. Leave the other options default and click OK.

19. Once you have the photogrammetric dense cloud, do a ground point classification on it like you did in Lab 6.

20. Now, build a DEM for the dense cloud using all the points (ground plus not-ground). Set the projection to UTM 11, epsg::32611. *<u>Make sure you set the Source Data option to **Point Cloud**</u>*. Leave the other options as default. When it has finished running, rename it to **Photo DSM** (DSM for digital surface model, meaning top surface of everything).

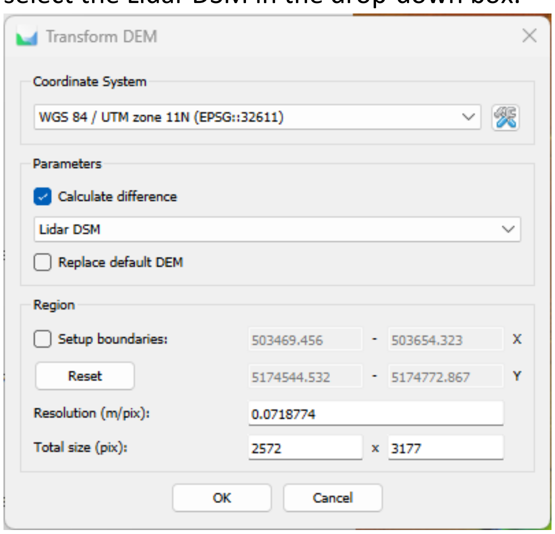


21. Repeat this process, but in the Build DEM dialog box, click the **Select…** button to select only ground points for building the DEM. Rename this one as **Photo DTM** (for digital terrain model).



22. Now do the same two steps again for the lidar data. Make sure you set your projection, and this time choose **Laser Scans** as the source data. Rename these DEMs as **Lidar DSM** and **Lidar DTM**.

23. Almost-last thing, do a DEM Difference for the DSMs by right-clicking on the Photo DSM and choosing Transform DEM. Make sure the projection is set to UTM 11, epsg::32611. Click Calculate Difference and select the Lidar DSM in the drop-down box.



Spend some time looking at the results of the DSM difference. Where are the areas where the two DSMs are different? What is causing these differences? Take a screenshot of the DSM difference layer.

24. Last thing! Repeat the previous step, but for the DTMs.

IT WOULD BE A _REALLY_ GOOD IDEA TO SAVE YOUR PROJECT _BEFORE_ YOU CLOSE METASHAPE.

25. That's it for this lab! When you are finished, fill out the Lab question sheet and submit it on Canvas.