

GIS and Habitat Management (ACBA 7005)

Pointclouds and high-resolution surveys

Aim

In this lab we will be exploring different uses for pointclouds derived from terrestrial laser scanners and UAV (uncrewed aerial vehicles). We will develop fundamental skills using CloudCompare to extract useful information about a local dune system. Dune systems are notorious for being hard habitats to survey, and in the pointcloud world, you can see there are also challenges. From accurate delineation of vegetation, to messy pointclouds, we will explore it all!

- Visualising Pointcloud data
- Cleaning Pointclouds
- Measuring Objects
- Scalar Fields
- Exploring Roughness
- 'Filter by Value'
- Cloth Simulation Filter (Plugin)
- Rasterising to create DSM and DEM

Activity 1 – Using CloudCompare to visualise a point cloud

In this first activity we will open CloudCompare and explore some of its basic functionality. CloudCompare is a 3D point cloud (and triangular mesh) editing and processing software. You can find simple instructions and background here: [Introduction - CloudCompareWiki](#). CloudCompare also operates a CloudComparewiki page for its plugins: [Plugins - CloudCompareWiki](#).

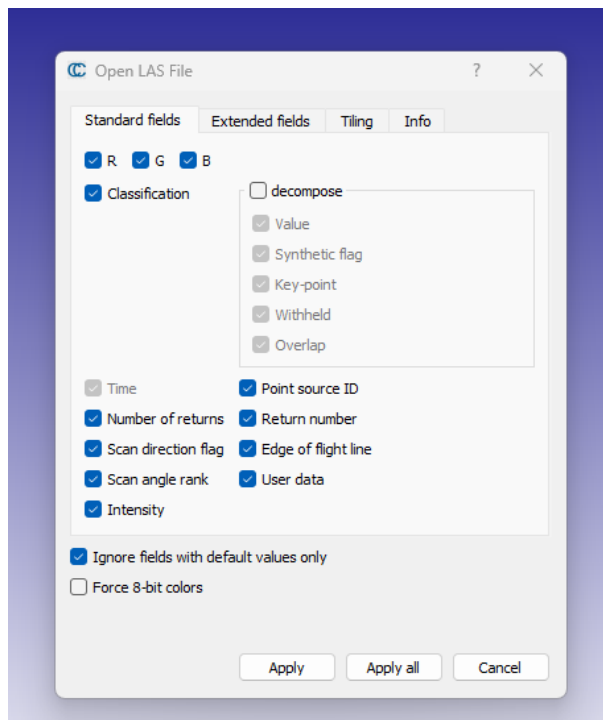
A list of tools in CloudCompare can be found here: [Toolbars and icons - CloudCompareWiki](#). For this activity, you will have access to several different .las files.

Instructions:

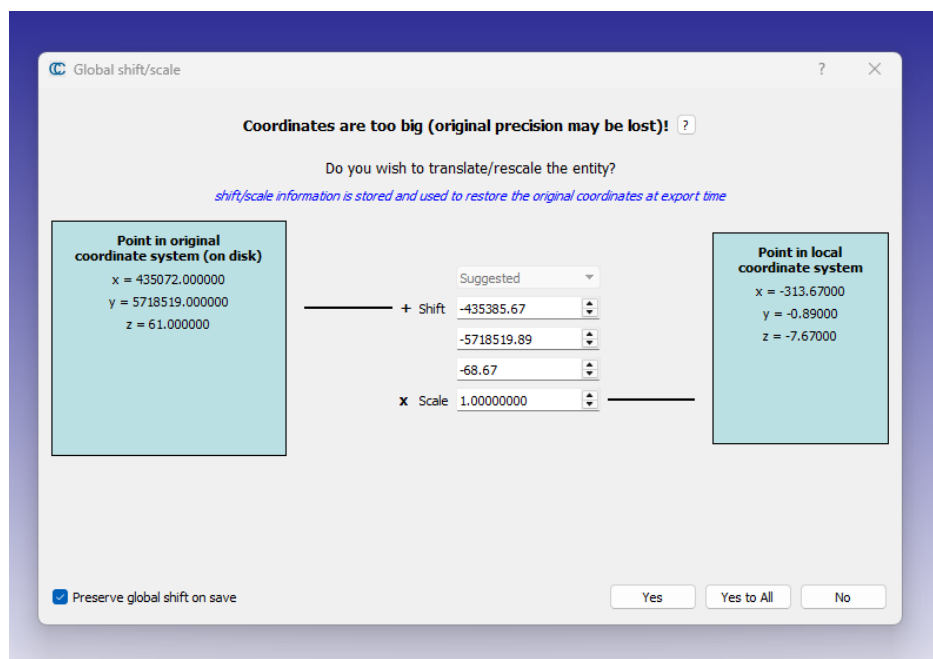
Open CloudCompare by double clicking on the icon.

- 1) Unzip your .las files. Drag one .las file into the CloudCompare program, just as you have done for QGIS. If you prefer, you can also load your .las file, by clicking on File>Open.

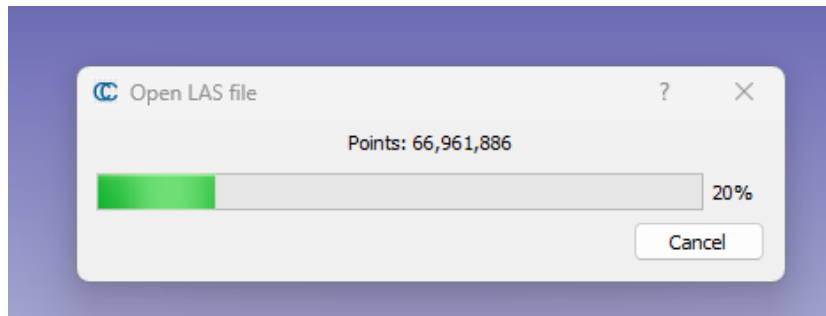
2) A small window will pop up. For now, click 'apply-all'.



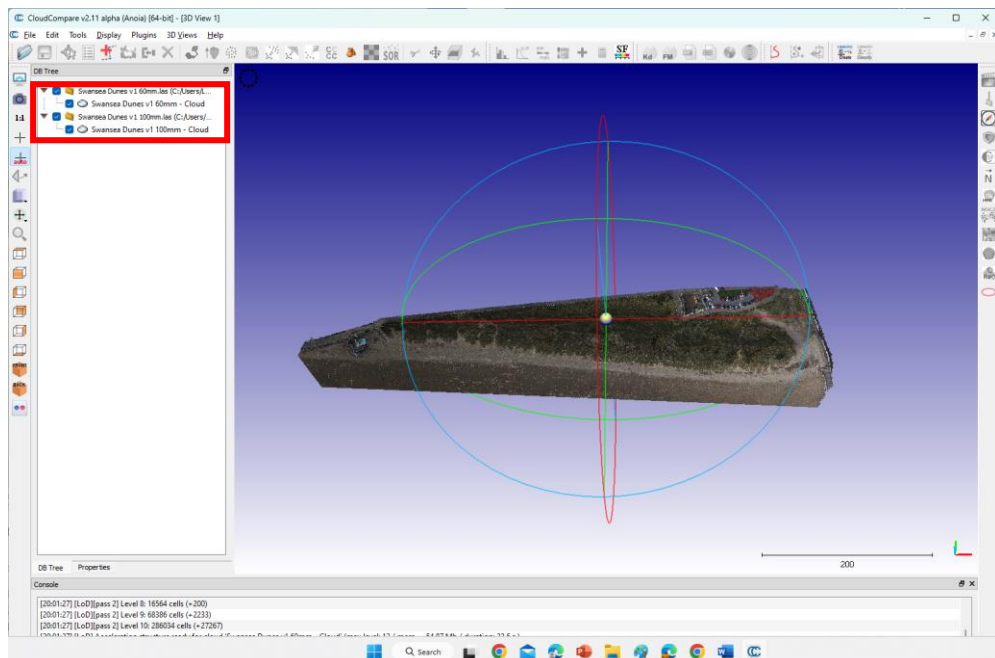
3) Next, you may get another warning that says 'Global shift/scale', also click 'Yes to all'.



- 4) Next your .las file will start to load. You will see a loading screen that looks like this, with an indication of how many individual points you are loading.

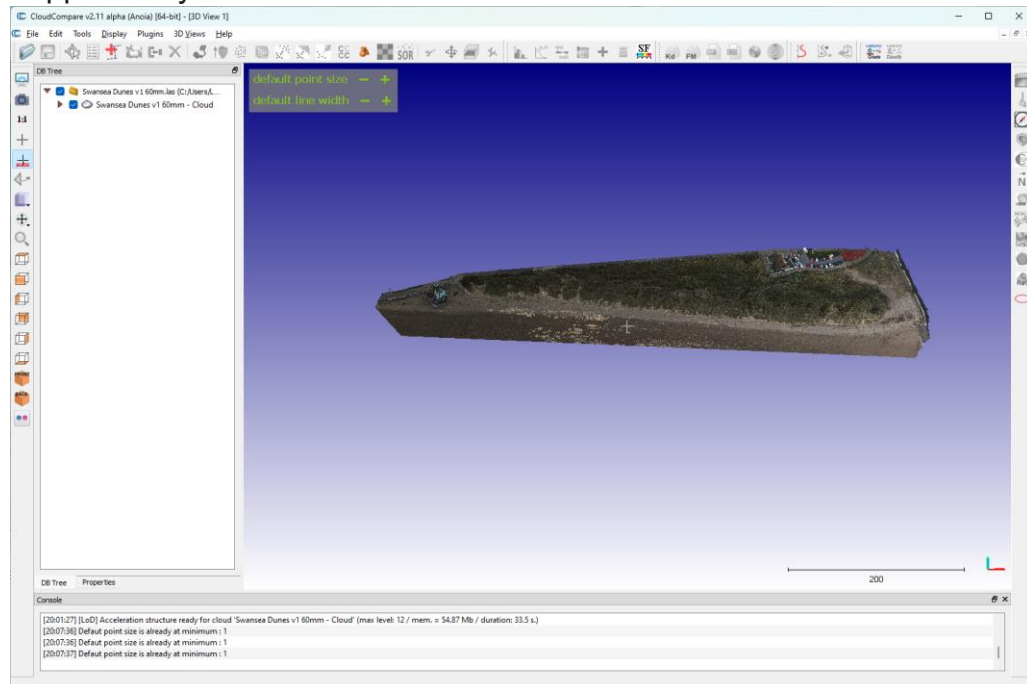


- 5) Voila, your pointcloud should have loaded in CloudCompare. Repeat these steps for the second pointcloud. Click on the  [Save](#) icon and assign a folder area to save your work.
- 6) Become familiar with how the mouse works. By right clicking with your mouse, you will be able to move the pointcloud 'North', 'East', 'South' and 'West'. If you use your left button on your mouse cursor you will be able to change the pointcloud orientation. To help you navigate around your pointcloud, you will notice that CloudCompare will create a ball shape in the middle of your pointcloud to help you keep track of where you are (see below).



- 7) If you have a mouse scroll, you can also scroll in and out on your pointcloud. Go ahead now and explore your pointcloud. You should be able to identify what you are looking at. Try spinning your pointcloud 180 degrees and rotating it around in a circle. This type of data viewer is a little different to QGIS.

- 8) In the red rectangle shown above, the layers that you have loaded are shown. If you click on a layer, you will see a yellow box appears around the pointcloud extent. Knowing your pointcloud extent can be really useful.
- 9) Hover your mouse over the top left-hand corner of the display window. A small window will appear that will allow you to adjust the default pointsize and default line width for your pointcloud. Adjust this and see what happens to your scene.



Activity 2 – Measuring objects

In this second activity we will learn some basic steps to interrogate points, draw lines and calculate basic area using CloudCompare.

Instructions:

- 1) In this activity we are going to explore the 'Point Picking' tool.  [Point Picking](#). This tool can be used to display information about a single point, line, triangle etc.
- 2) Click on the 'Select one point and display its information' icon.

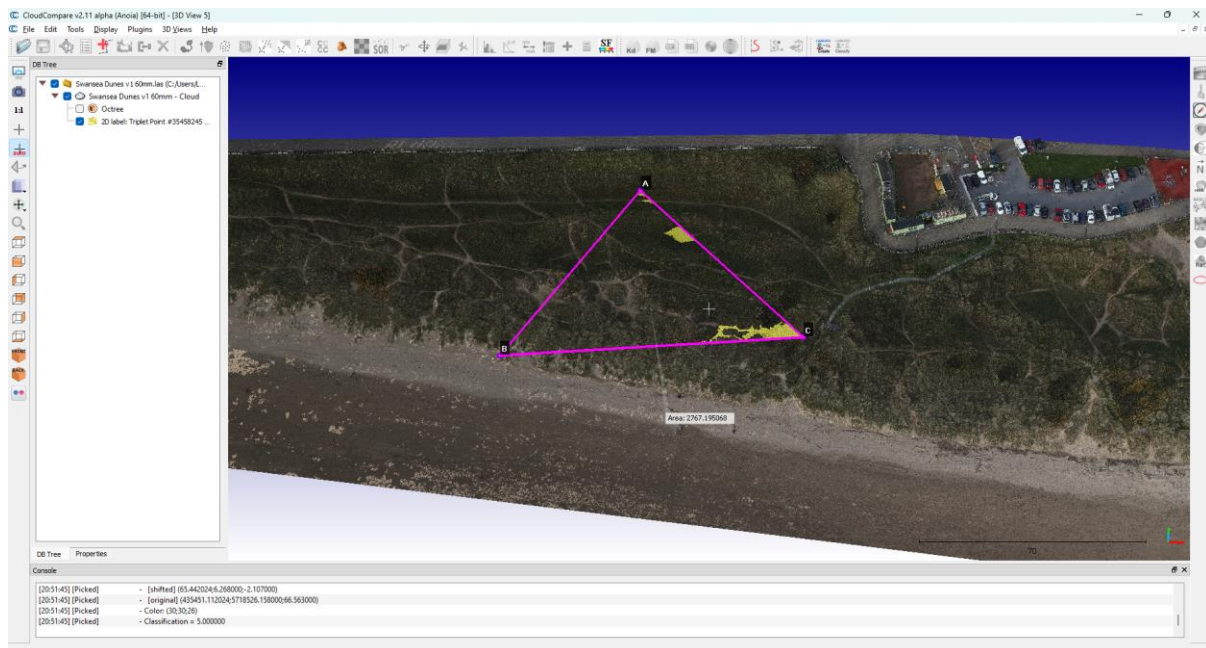


- 3) Click on a point of your choosing to find out more about it. Once you have finished with the tool, click on the 'X' icon shown above to turn the tool off.
- 4) Next, click on the 'line' icon next to it. This will allow you to measure linear features. Use this tool to measure a linear feature of your choice (e.g. driftwood

length, height of the observatory, height of a lamppost). Once you have finished with the tool, click on the 'X' icon shown above to turn the tool off.



5) You can also use a triangulation tool to measure the area (in a triangle?). Once you have finished with the tool, click on the 'X' icon shown above to turn the tool off.



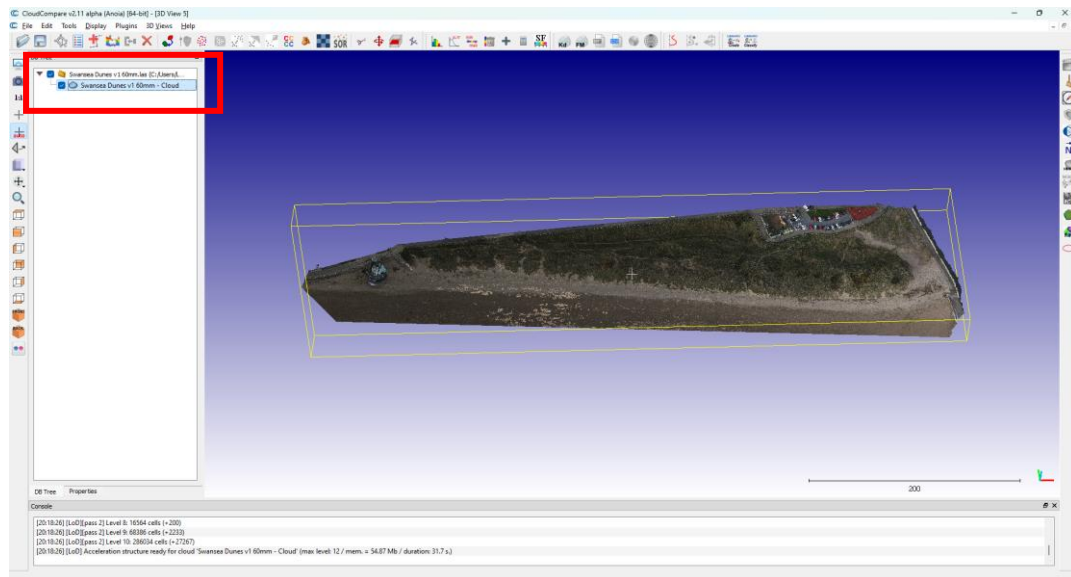
Activity 3 – Exploring scalar fields

In this third activity we will use the Scalar Field features in CloudCompare. Among all 'features' that can be associated to a point cloud (colours, normals, etc.) one has a particular place in CloudCompare: the scalar field.

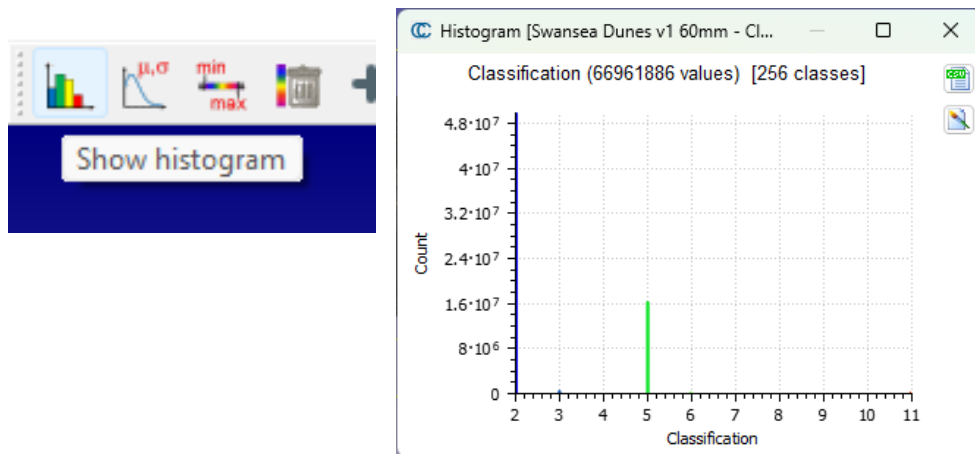
A scalar field is simply a set of values (one per point - e.g. the distance of each point to another entity). As each value is associated to a point (or vertex) it is possible to display those values as colours (with custom colour ramps) or to apply filters on them (smooth, gradient, etc.), and to segment the cloud relatively to those values (thresholding, local statistical filtering, etc.). We will use this tool to help filter out elements of the pointcloud that we want to remove.

Instructions:

1) When you want to carry out a task using CloudCompare, click on the cloud layer in the 'DB Tree' section to activate all of the tools for it (shown below).

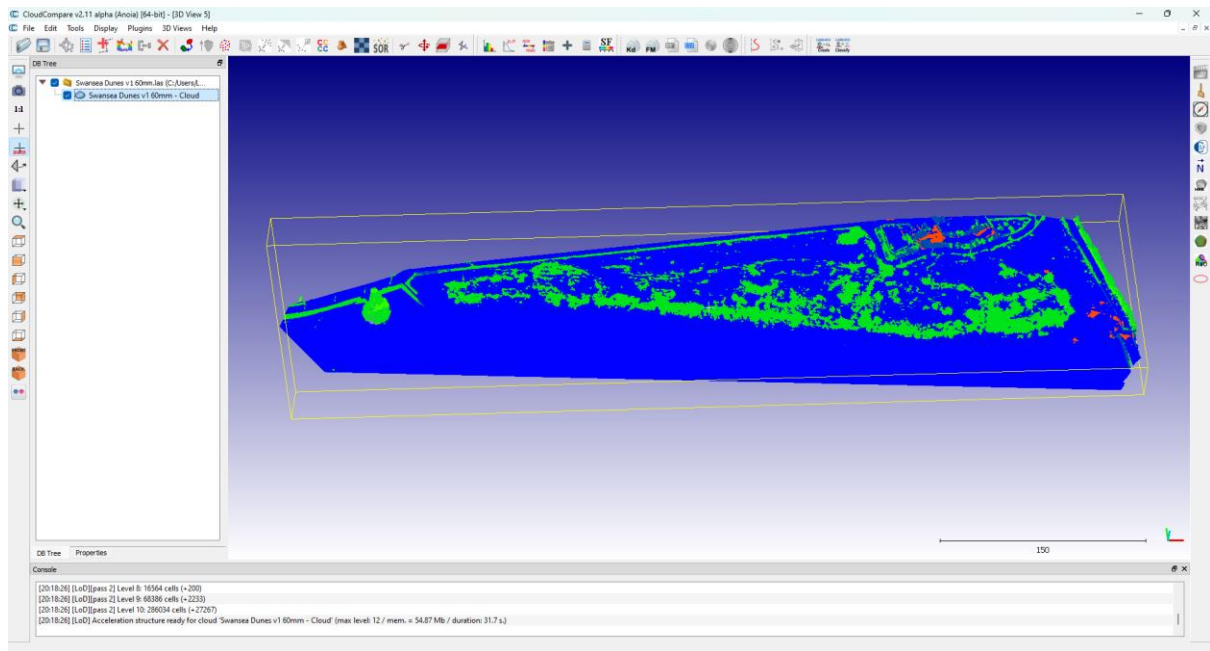


2) Next click on the small histogram icon to view a histogram of the Scalar fields.



In our example dune system we can see that classes have been populated for '2', '4' and '5' (This was assigned during pointcloud creation). Here you have the option to save your histogram or export the data. We can also view the scalar fields visually (shown below).

3) Next, right click on the .las file layer and select 'Toggle SF'. Your scalar fields should now be visible. The green is supposed to show 'Class 5' which for this pointcloud is vegetation. Did the original pointcloud processing provide a reasonable job of picking out the vegetation?

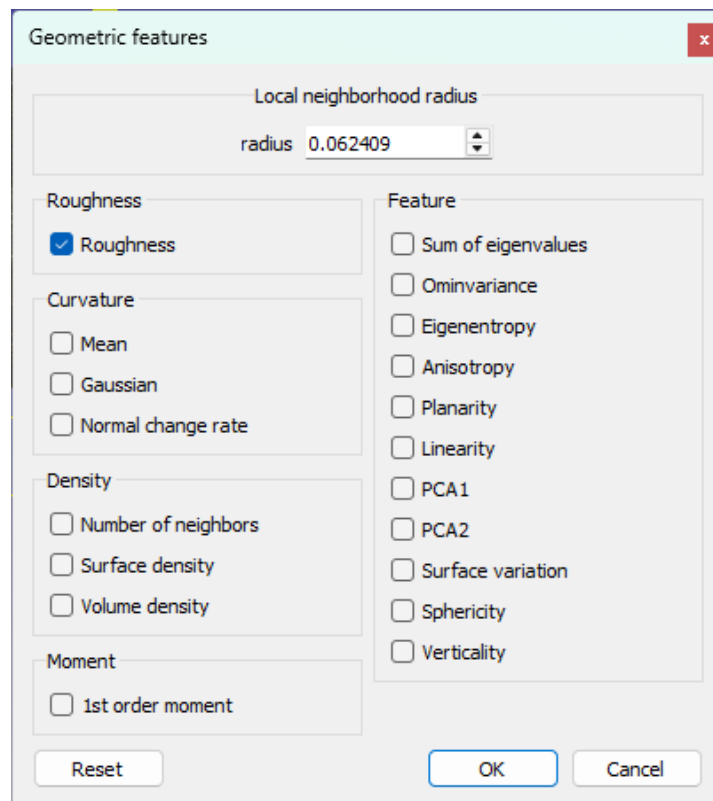


Activity 4 - Exploring 'Roughness'

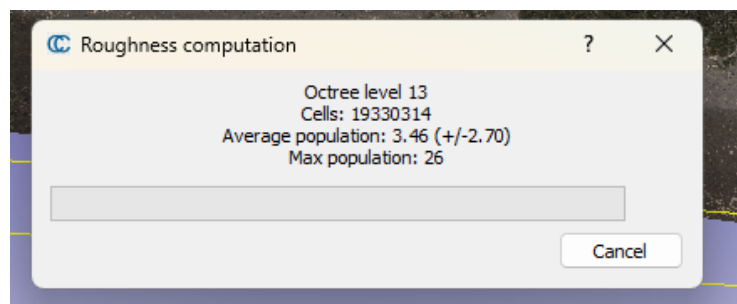
In this next activity we will compute the roughness for the pointcloud. Roughness estimation is very... simple: for each point, the 'roughness' value is equal to the distance between this point and the best fitting plane computed on its nearest neighbours. We want to test whether this is a useful tool for classifying vegetation. In the last activity you may have observed that not all vegetation was accounted for.

Instructions:

- 1) Click on Tools > Other > Compute Geometric Features. A new dialogue box will appear, select 'Roughness' leaving everything else unchecked. The radius can remain as default. Press OK.

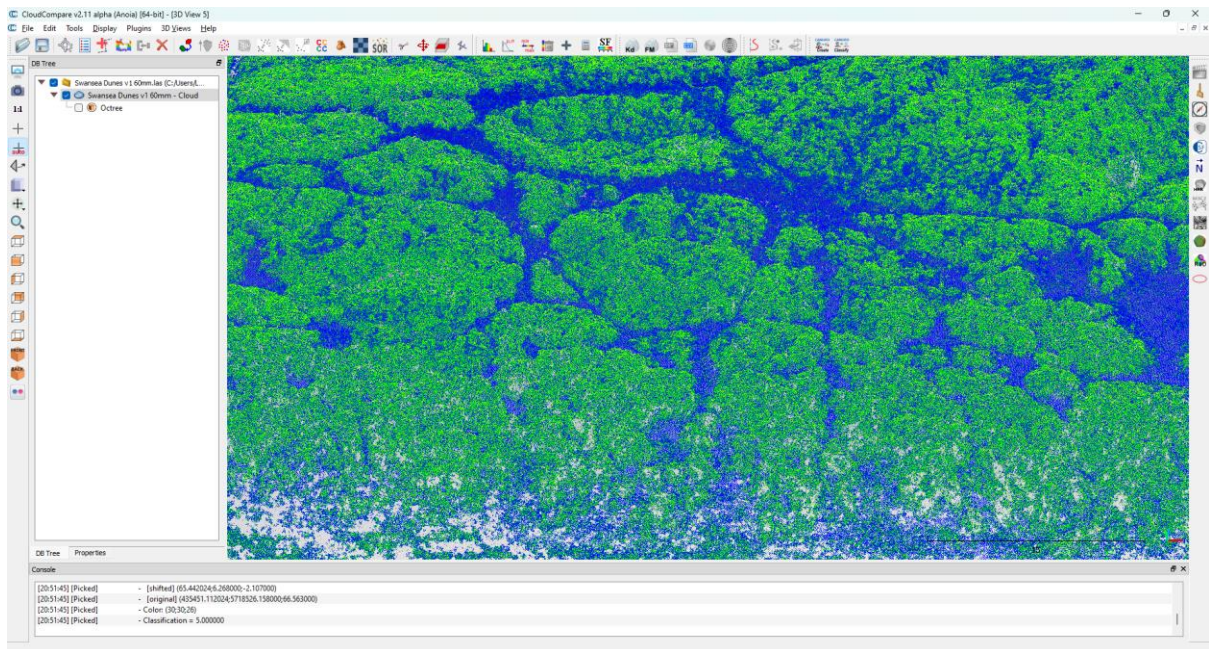


2) The roughness will begin to compute. Be patient, there are lots of points.

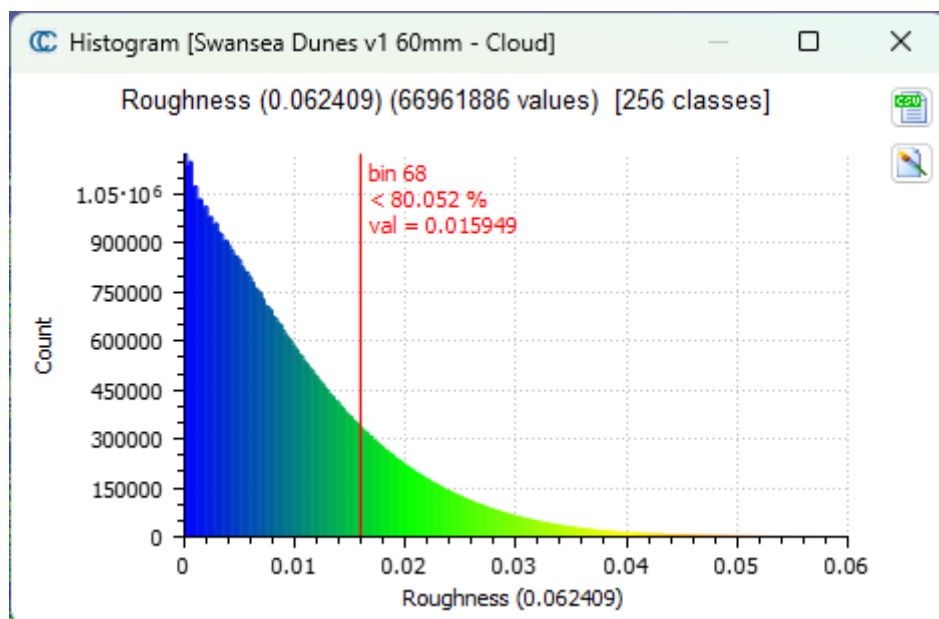


3) Once your roughness tool has finished, you will be left with a detailed pointcloud showing new roughness values for each point (see below). Explore this roughness map. In most instances, this has done a reasonable job at highlighting the vegetation as 'high roughness'.

- This has lots of potential applications for near-census habitat data. Is it possible to quantify different vegetation based on 'roughness' values?

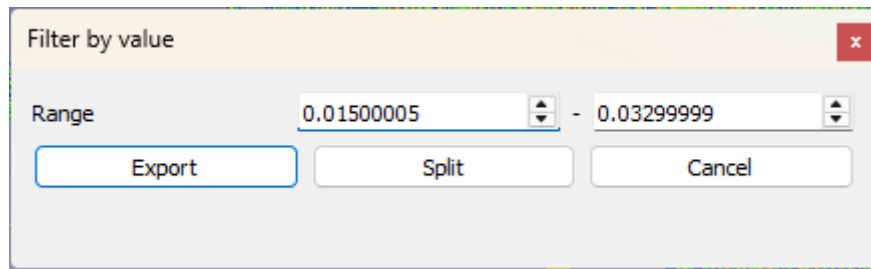


4) Click on the 'Show Histogram' tool once more, now you will see a histogram showing '**Roughness**' across the pointcloud.



5) We can use these 'roughness' values to isolate vegetation. Choose a range of roughness values that you think corresponds to 'vegetation' (e.g. [0.015] to [0.033]). Write down the values that you think show vegetation.

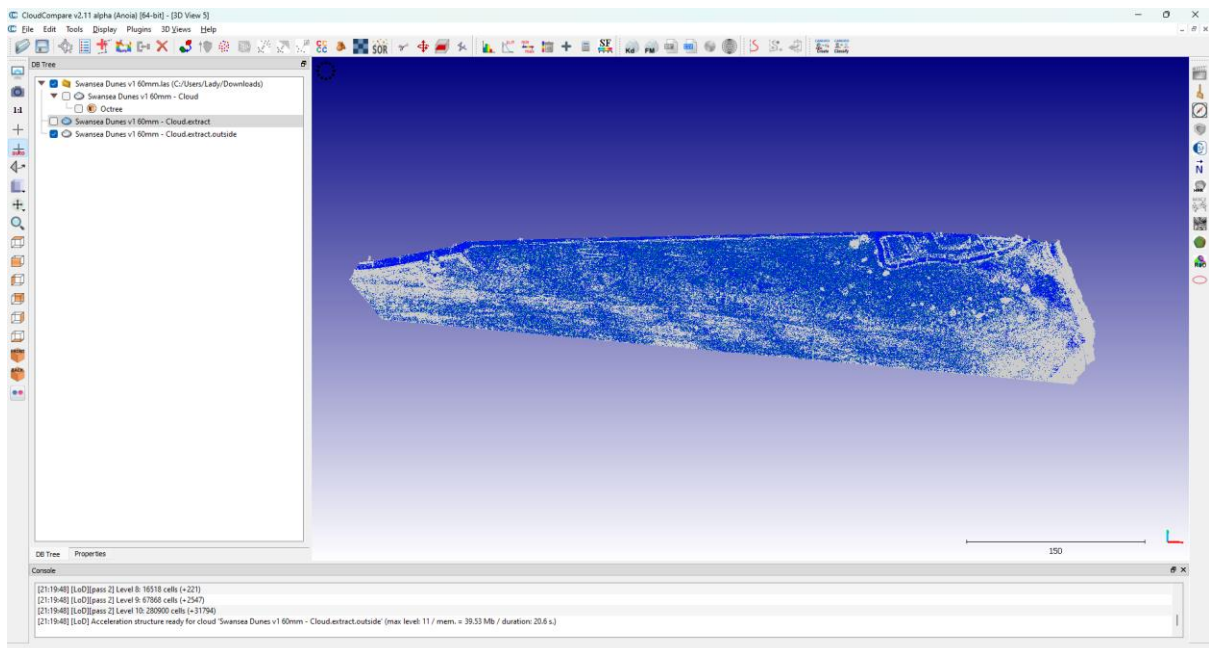
6) Next, click on the 'Filter by value' tool. A new small box will appear (shown below). Type in the range that you assigned to show vegetation. Then click on 'Split'



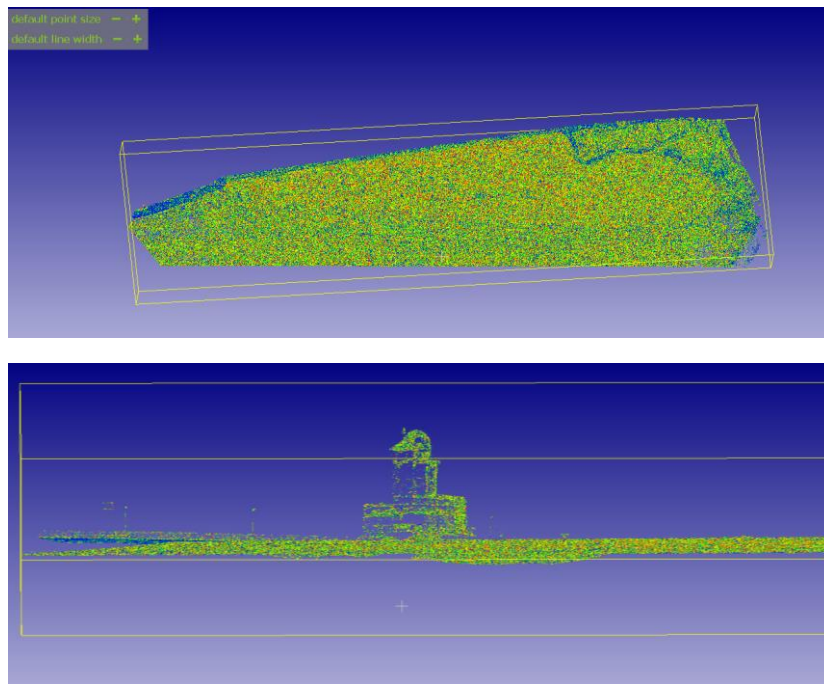
Now, **two new pointclouds will appear**. One pointcloud that corresponds to this range of values, And the other for points that represent values outside of that range. Toggle them on and off to see what you have isolated.

7) You can also filter out other features based on their roughness, until you are left with a reasonable DSM.

[0.01 to 0.06] does a good job of isolating shrubby vegetation, leaving bare ground and 'trees', 'buildings' etc.



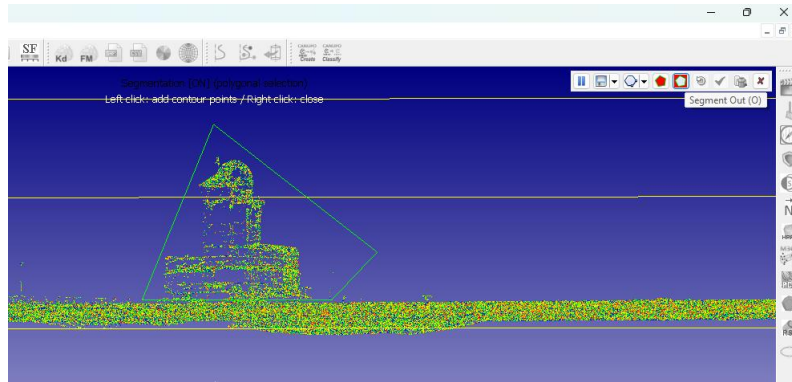
[0.00 to 0.01] in this example, does a good job of extracting smooth points (shown below), which can be used to create a DEM. However, there are several 'above surface' points remaining (e.g. the observation tower, shown below). Do not worry, we can 'clean the Pointcloud'.



8) To manually 'clean' pointclouds essentially means to delete points that you do not want. To clean the pointcloud, click on the pair of scissors in the toolbar. This is called the 'segment' feature. This can be used to isolate erroneous points by drawing around them and removing them (segmenting them) from the pointcloud. Here is a good time to save your work!

9) Once you click on the segment tool a series of tools will pop up on the screen. You will be able to right click around the points you want to remove. Left click to add points and right click to close your area that you want to delete. Then, select the 'segment out' tool. Once you have finished 'cleaning', click on the 'X' icon to close the toolbar. *Hint: You may also want to remove the car park from your pointcloud.*





Activity 5 - Rasterise your pointcloud to make a DSM

Now, after our hard work, we can turn out pointcloud into a high-resolution raster file. This is not too dissimilar to the lidar files we have been working with in previous weeks, however the method of creation is different, and we are gifted with a great centimetre-level accuracy raster file.

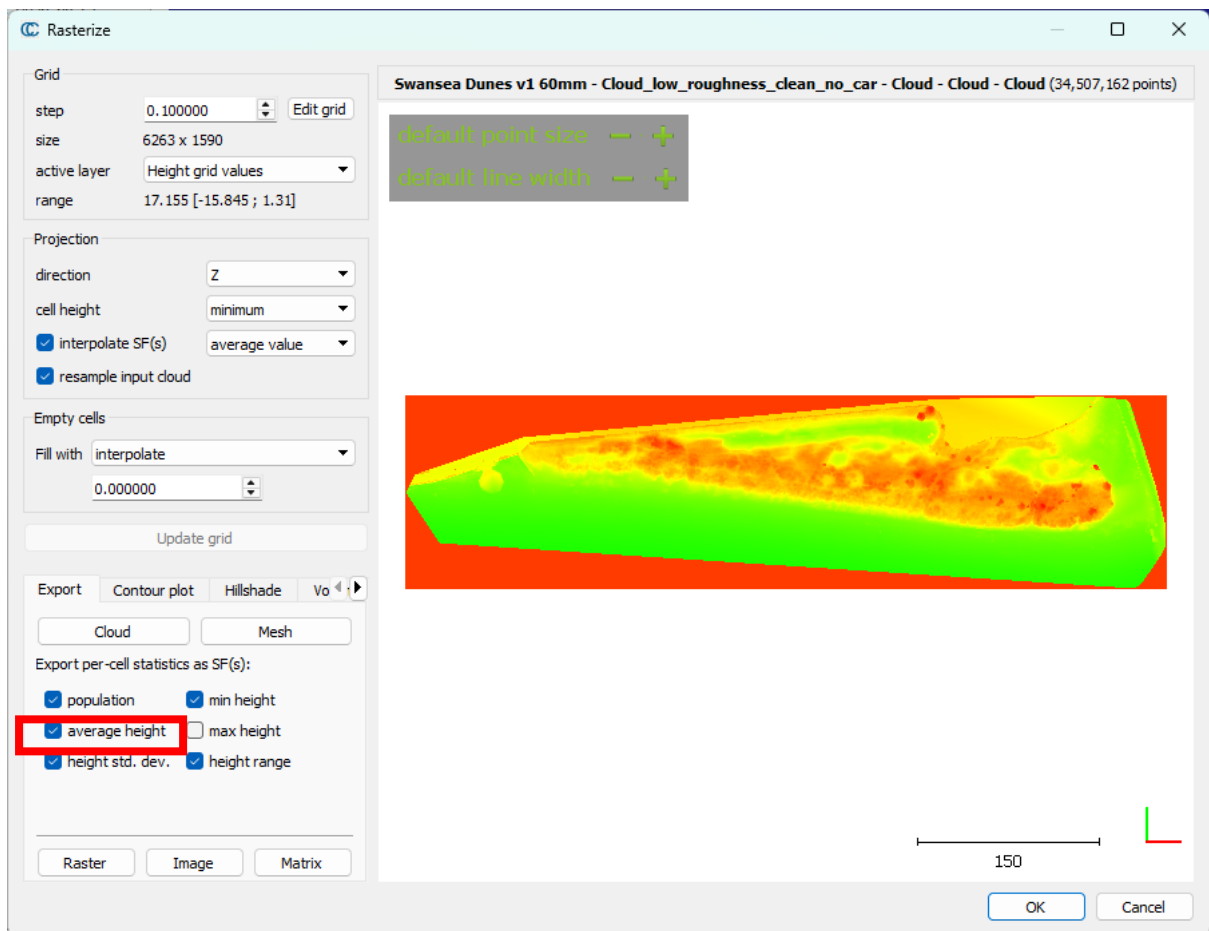
Instructions:

1) Click on Rasterise, make sure your grid step is set to 0.1 (e.g. cm level accuracy DSM). Active layer should be = Height grid values.

- Projection = Z
- Cell height = minimum
- Interpolate SF(s) should be checked and average value selected.

2) Press 'update grid' to show your DSM before you export it.

3) If you are happy with your 'grid' shown, then select 'average height' and then click on Raster. Assign a place to save your .tiff file.



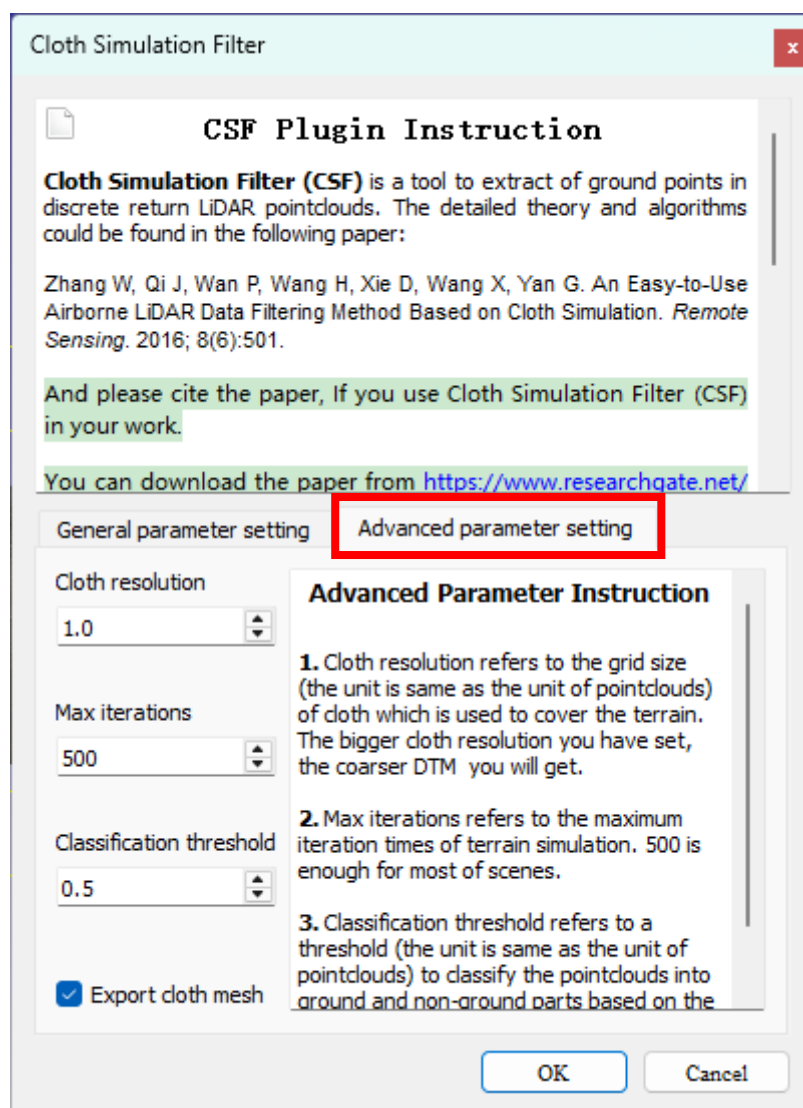
Activity 6 - Cloth Simulation Filter

Cloth Simulation Filter (CSF) is a free plugin in CloudCompare. You can read about its development and purpose here:

[https://www.cloudcompare.org/doc/wiki/index.php/CSF_\(plugin\)](https://www.cloudcompare.org/doc/wiki/index.php/CSF_(plugin)). Essentially, it does a reasonable job at draping a hypothetical cloth over your pointcloud to help delineate ground and non-ground points. Of course there is more to it than that, so feel free to click on the link above for more detailed theory.

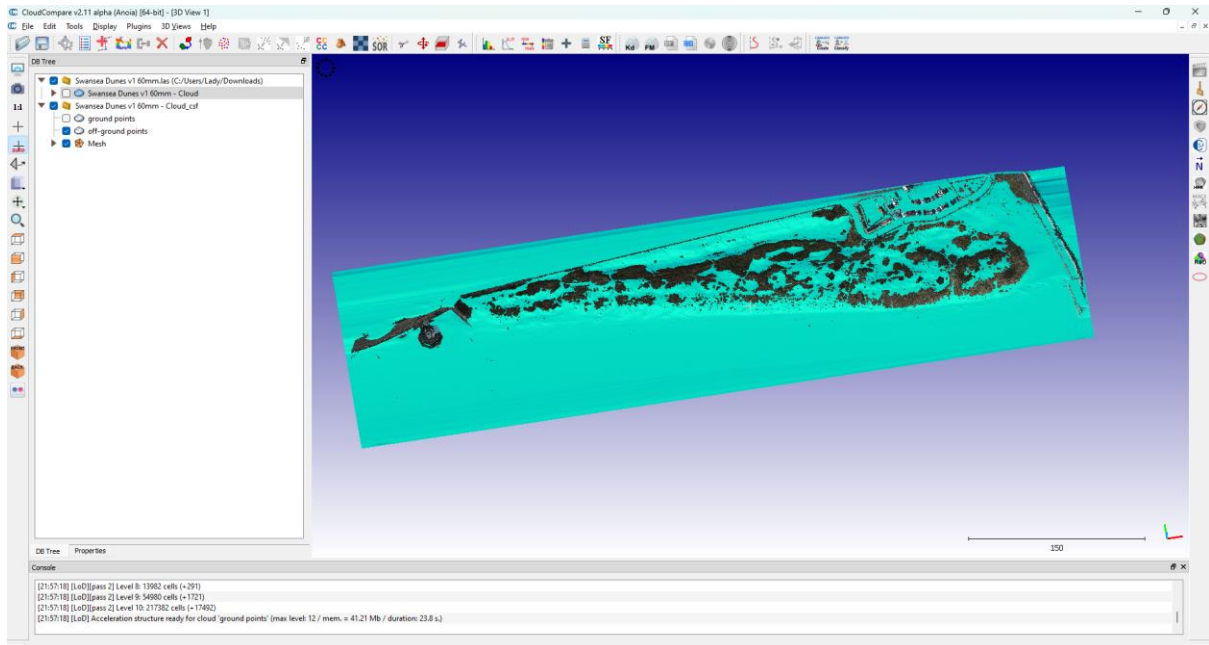
1) Click on CSF, navigate to 'advanced parameter setting' and adjust the cloth resolution to 1.0.

2) Make sure 'Export cloth mesh is checked'.

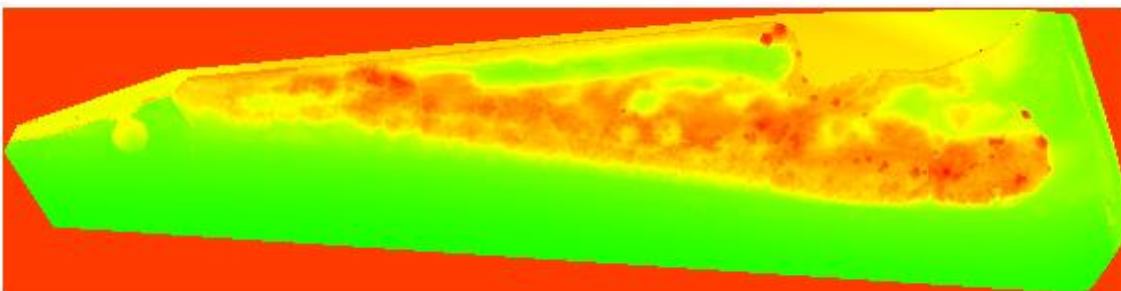
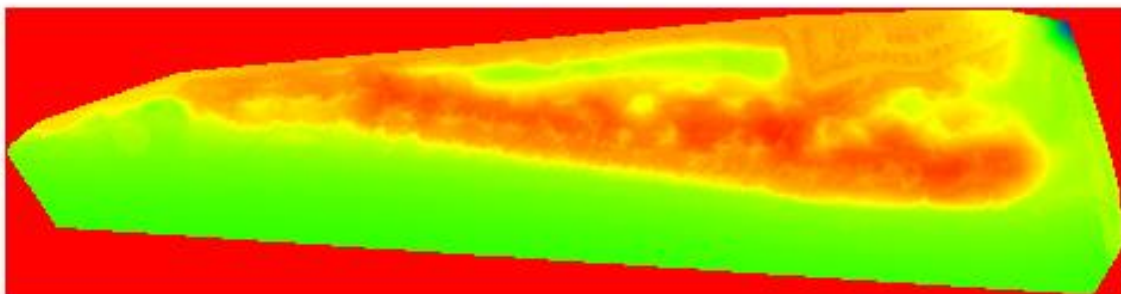


3) Wait a few moments and three new layers should appear (above ground, below ground, and a mesh).

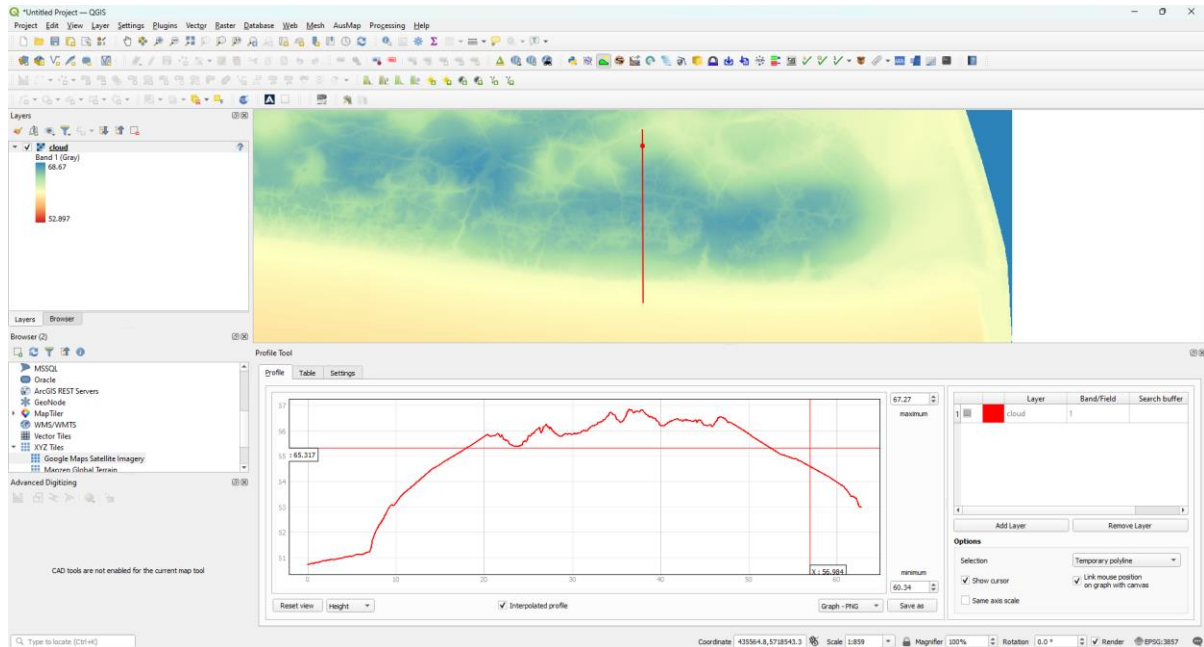
4) Toggle the layers on and off and see the different layers that have been produced. Did it do a reasonable job at filtering the above ground features? Hint: This tool is very useful for creating a DEM (ie. Removing all above ground features... when working well).



5) Repeat the steps in Activity 5 to produce a raster file of your DEM you have just created using the cloth simulation filter. Below you can see an overview of the two .tiff files you have just created. **What are the main differences between them?**



Then, once you have saved your Raster file, you can open it in QGIS where you can reap the benefits of your hard work! Example shown below is the final DEM with the profiler tool showing you the dune shape!



List of CloudCompare Icons



- 1)  [Open](#)
- 2)  [Save](#)
- 3)  [Point Picking](#) (point, segment, triangle or 2D area picking)
- 4)  [Point list picking](#) (list of picked points exportable to a new cloud, polyline or file)
- 5)  [Clone](#)
- 6)  [Merge](#)
- 7)  Delete (selected entities)
- 8)  [Align \(point pairs picking\)](#)
- 9)  [Fine registration \(ICP\)](#)
- 10)  [Subsample](#) (cloud)
- 11)  [Sample points](#) on a mesh
- 12)  [Cloud-to-Cloud distances](#) computation
- 13)  [Cloud-to-Mesh distances](#) computation
- 14)  [Connected components extraction](#)
- 15)  [Primitive factory](#)
- 16)  [Rasterize](#) tool
- 17)  [Interactive segmentation tool](#)
- 18)  [Interactive transformation tool](#)
- 19)  [Cross Section tool](#)
- 20)  [Sections extraction tool](#)