EXERCISE 5: CALCULATE PLOT AND TREE METRICS

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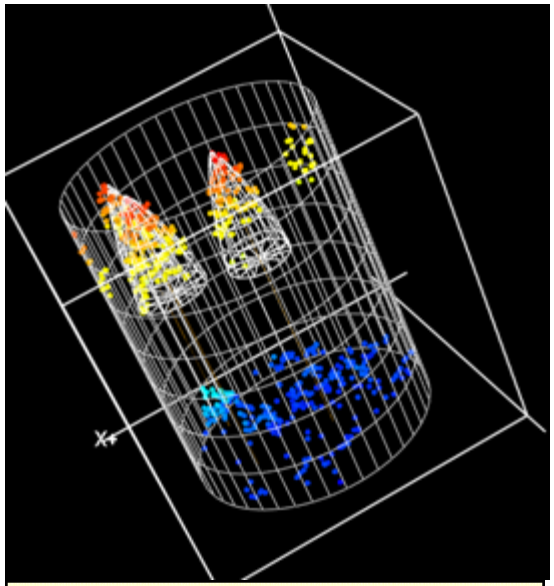


The tree measurements you will make in this exercise can be easily converted to tree models (as shown above).

Introduction

There are two parts to this exercise. Part 1 describes the process to extract metrics from the fixed radius plot subsets created in the last exercise; Part 2 describes how to extract individual trees metrics from trees within the plots.

Prerequisites

Successful completion of Exercise 4.

Overview of Major Steps

Part 1—Plot Metrics

Part 2—Individual Tree Metrics

Part 1—Plot Metrics

Begin by opening a DOS Command prompt window and exploring the syntax of the cloudmetrics command.

1. Start | Programs | Accessories | Command Prompt
2. At the prompt enter:
    3. **cd c:\fusion <enter>** (this will change the active directory to the Fusion folder)
    4. **cloudmetrics <enter>** (this will display the syntax of the cloudmetrics command)

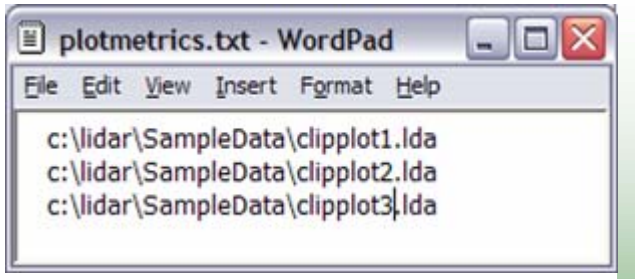
The syntax is:

CloudMetrics [switches] InputDataSpecifier OutputFileName

Where:

<u>InputDataSpecifier</u>: LIDAR data file template, name of text file containing a list of file names (must have .txt extension), a catalog file, or individual file name.

<u>OutputFileName:</u> Name for output file to contain cloud metrics (usually



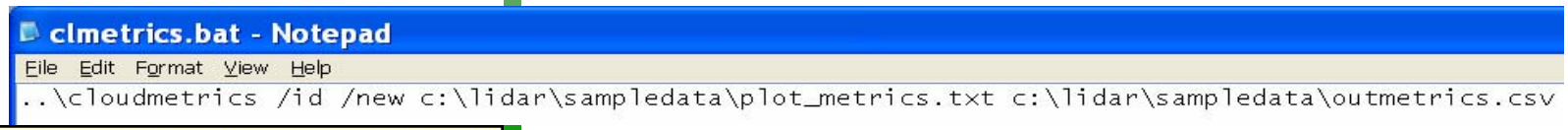
Example InputDataSpecifier—note the path is included.

a .csv extension)

Switches:

- quiet Don't display any information while running
- above:# Compute proportion of first returns above #
- new Start new output file...delete existing output file
- id Parse the data file name to create an identifier output as the first column of data
- Interactive Present a dialog-based interface

5. Use Windows Notepad or Wordpad to create the InputDataSpecifier: a txt file containing the list of the three clipplot#.lda files (see sidebar).
6. Name the file **plot_metrics.txt** and save it in the c:\lidar\SampleData folder.
7. Use Windows Notepad to create a cloudmetrics batch file, type the following script into the notepad file:



Note: we're using the /id and the /new switches. The id switch will parse the data file name to create an identifier output as the first column of data. The new switch will start a new output file and delete any previously existing output file.

If you have difficulties getting the cloudmetrics to work—try the alternate method described in the appendix (last page of this exercise).

8. Save it as **clmetrics.bat** in the **c:\fusion\batch** folder.
9. From the **c:\fusion>** prompt, type **cd batch** and hit enter.
10. Ensure you are at the **c:\fusion\batch** directory in the DOS command prompt.
11. In DOS at the **c:\fusion\batch>** prompt, type **clmetrics**
11. Hit enter and let it run—it should complete almost immediately.
12. After the program finishes, open the output file (outmetrics.csv) in Excel. The output csv file looks as follows (one output line for each of the input data files):

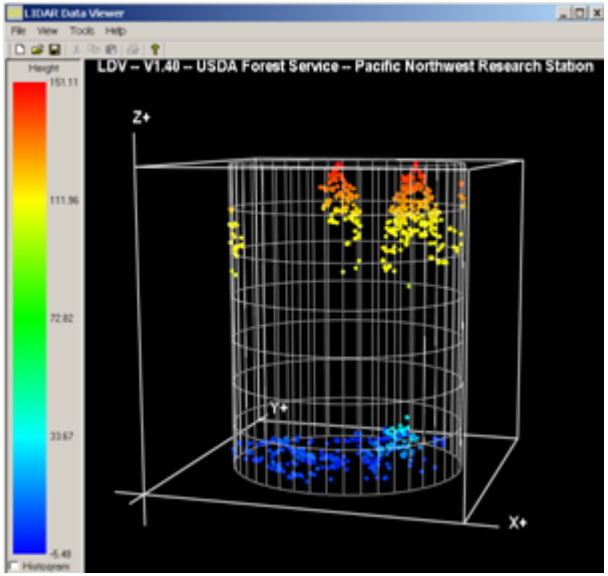
	A	B	C	D	E	F	G	H	I	J	K	L	M	
1	Identif	DataFile	Points	Elev Minim	Elev Maxin	Elev Mean	Elev Media	Elev Mode	Elev StdDe	Elev Varia	Elev Interq	Elev Skewi	Elev Kurto:	Elev
2	1	FIAplot1.ld	3135	1094.939	1258.633	1126.401	1111.169	1110.529	43.67629	1907.618	7.76062	2.087108	5.53245	29.
3	2	FIAplot2.ld	4081	1028.243	1182.186	1052.902	1038.157	1038.017	38.78138	1503.995	7.253906	2.121783	5.823847	26.
4	3	FIAplot3.ld	5156	1149.236	1308.003	1207.302	1178.956	1151.757	56.27855	3167.275	112.4375	0.202438	1.210469	54.

It contains the following fields (metrics) for each plot:

	A	B	C
1	Identifier		Int Minimum
2	DataFile		Int Maximum
3	Points		Int Mean
4	Elev Minimum		Int Median
5	Elev Maximum		Int Mode
6	Elev Mean		Int StdDev
7	Elev Median		Int Variance
8	Elev Mode		Int InterquartileDistance
9	Elev StdDev		Int Skewness
10	Elev Variance		Int Kurtosis
11	Elev InterquartileDistance		Int AAD
12	Elev Skewness		Int P25
13	Elev Kurtosis		Int P50
14	Elev AAD		Int P75
15	Elev P25		Int P10
16	Elev P50		Int P20
17	Elev P75		Int P30
18	Elev P10		Int P40
19	Elev P20		Int P50
20	Elev P30		Int P60
21	Elev P40		Int P70
22	Elev P50		Int P80
23	Elev P60		Int P90
24	Elev P70		
25	Elev P80		
26	Elev P90		
27			
28			

Part 2 of this exercise begins on the following page...

***Background/ Initial State**: You should have Fusion up and running with the Orthophoto_4800k.jpg image file displayed, the lda_4800K_data.lda raw data file loaded (but not displayed), the 4800K_ground_surface.dtm bare earth model loaded (and displayed as gray contours) and the plot locations POI - yellow dots.*

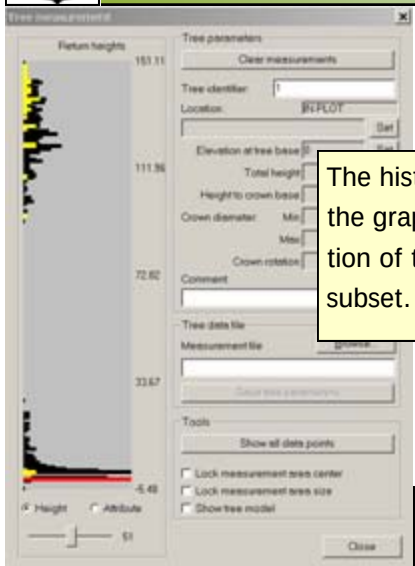


This represents a 60 meter fixed radius plot. Heights are given as above ground elevation. Points within 1 meter of the ground have been excluded.

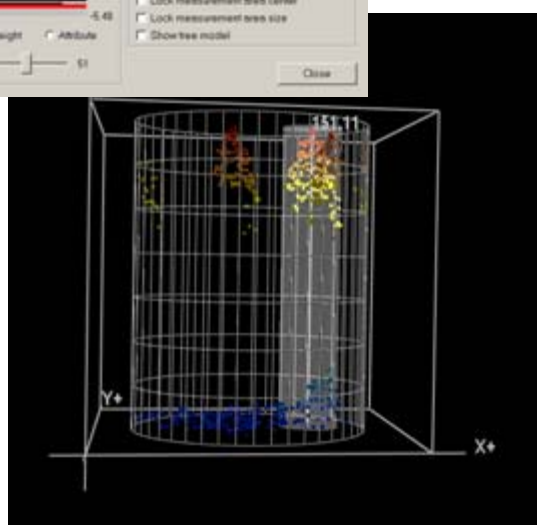
Part 2—Individual Tree Metrics

1. Click the **Sample options...** button and select the following options:
    2. Sample shape: **Fixed circle**
    3. Sample Size: **120** (diameter) Note: make sure the units of the data and the plot are the same, if the data are in UTM meters, convert the plot diameter to meters as well.
    4. Options: **Subtract ground elevation from each return**
    5. Options: **Snap sample points to nearest POI point**
    6. Options: **Show POI layers in sample image**
    7. Bare earth filter: **Exclude points close to the surface**
    8. Bare earth filter: Tolerance **1** (the tolerance is the distance from the surface in the same units used for LIDAR data elevations).
    9. Click **OK** at the bottom left.
10. Toggle the check mark for **Plot mode** on.
11. Toggle the check mark for **Display sample** on.
12. Then click on the location of the plot from which tree information will be extracted (the lower-right most of the three plots is the easiest of the plots to use). The subset of data will pop up in the LDV window (see sidebar).

Note: if the axis and plot cylinder do not show, right-click in the LDV window to display the LDV right-click menu. Click on **Colors** menu item and set the axis color to a different color than the background color. If the axis shows but the plot cylinder does not, then ensure that the **Plot mode** button is checked in the Fusion window. Also notice that most of the ground points are excluded from the data set. If you wish to include them in the sample display, return to the **Sample options** and select the **Include all points** under the **Bare earth filter** options and then click the **Repeat last sample** button (we recommend, however, that you exclude points close to the ground for this next section of the exercise...).



The histogram shows the graphical distribution of the lidar points subset.



The measurement marker displayed in LDV. The measurement marker can be moved and shaped to fit an individual tree.

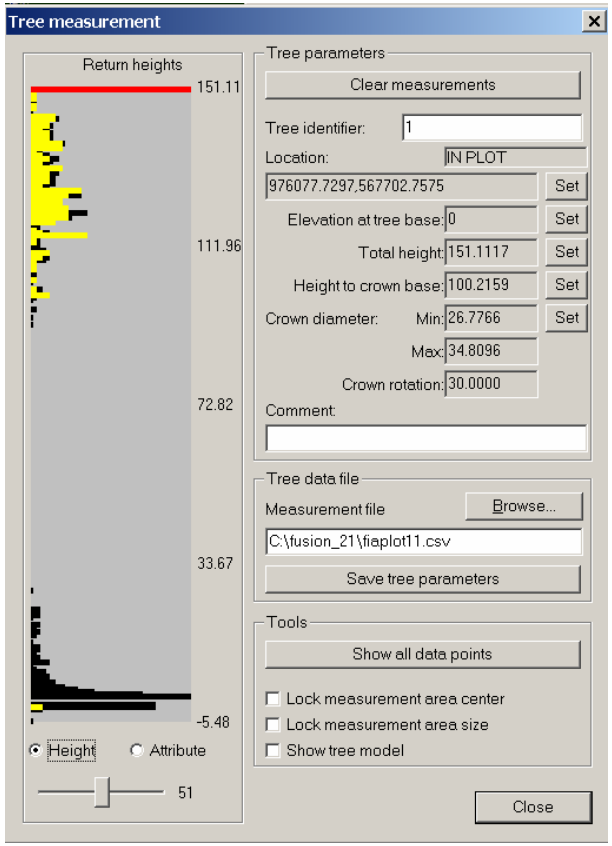
14. After the LDV window is set, hit the **F9** function key. This brings up the **Tree Measurement** window. The **Tree Measurement** tool allows us to isolate a single tree within the plot and make measurements for that tree and more. The Measurement marker will display automatically—however, you can:
    15. Right-click anywhere in the LDV window to bring up the right-click menu.
    16. Click on **Measurement marker** to toggle the Measurement marker on. A cylinder will show in the LDV window.

Note: The yellow histogram represents the lidar points within the measurement cylinder; the black histogram represents all of the lidar points within the data subset (in this case the circular plot). The yellow histogram can be proportionally scaled relative to the entire plot histogram by sliding the control below the histogram.

17. Center the cylinder over a tree within the plot:
    - This cylinder can be moved by using the combination of **ctrl + right mouse + movements.** Tip: once you have the cylinder centered over a tree, it's a good idea to click the **Lock measurement area center** checkbox on (remember to unlock it when you want to move the cylinder to another tree).
    - The diameter can be changed by shift-ctrl-right mouse
    - The shape or aspect ratio can be changed from circle to ellipse by using ctrl and up or down arrows
    - The orientation of the ellipse is modified with ctrl + left and right arrows
    - Note: Using these key and mouse combinations is not immediately intuitive (to put it mildly). However, it is important to fit the 3D measurement cylinder as closely as possible to the 3D shape of the tree.
    - As you change the position, shape, and size of the cylinder, note how the histogram changes in the Tree Measurement window.

Tip: try moving the measurement plate to the base of a crown (up/down), then make sure the cylinder is larger than the crown and press the "F" key. This fits the cylinder to the crown points.

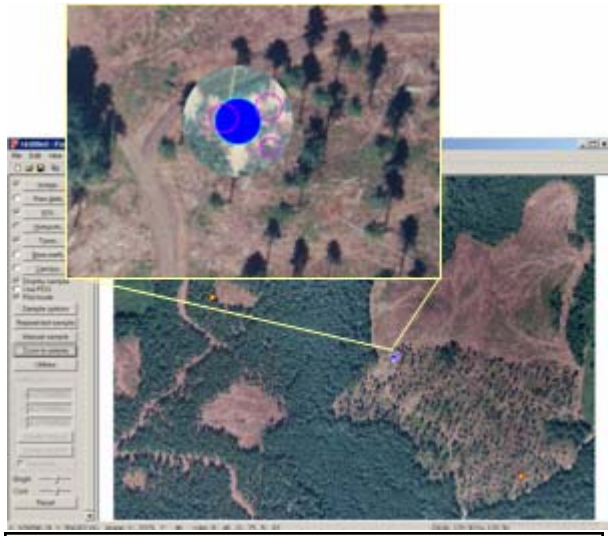
After the cylinder is centered over a tree, measurements can be made from the data using the red lever manipulated by the mouse wheel. Some key strokes to snap the marker to the top or bottom are available too. The list of keystrokes can be accessed by clicking on the lower left button of the LDV window:



Now we'll use the Tree Measurement tool to record some tree measurements. In the Tree Measurement tool:

18. Add an entry for a **Tree identifier** (the default of **1** is sufficient since this is the first tree of this plot)
19. **Location:** set the location of the cylinder center by clicking the adjacent **Set** button
20. **Elevation at tree base**: type "l" (lower-case L) to drop the marker to the lowest point in the cylinder (don't type upper-case L or you'll move the cylinder) and then scroll the Measurement marker up/down to the tree base (check that this is set to zero or a number slightly above zero else tree models that you will soon create won't display) and click the adjacent **Set** button.
21. **Total height:** type "h" to raise the marker to the highest point in the cylinder (don't type "H" or you'll move the cylinder) and scroll the Measurement marker to the top of the tree and click the adjacent **Set** button.
22. **Height to crown base**: scroll the Measurement marker down to the crown base and click the adjacent **Set** button.
23. **Crown diameter**: min, max and crown rotation: These three values are extracted from the cylinder diameter measurements when you click the adjacent **Set** button (Note: if min and max are the same value, you've used a simple circular tree crown model (not an ellipse). If the crown rotation angle is zero, you've not rotated the ellipse.).
24. **Comment:** add an optional comment.

25. **Create** a new csv file or **Select** an existing csv file to save the measurements to by clicking on the **Browse...** button.
26. Click **Save tree parameters**. Note: After the parameters are saved, the points belonging to the just measured tree disappear from the screen (they can be brought back by hitting the show all data points but they cannot be turned off again). The tree identifier increments automatically.
27. Uncheck the **Lock measurement area center** checkbox.
28. Move the cylinder to the next tree and check the **Lock measurement area center** checkbox.
29. Adjust the size, shape and orientation of the cylinder to fit this next crown.
30. **Set** all of your measurements in the Tree Measurement dialog for this tree.
31. Click **Save tree parameters**. The measurements and comments (if any) will be ap-

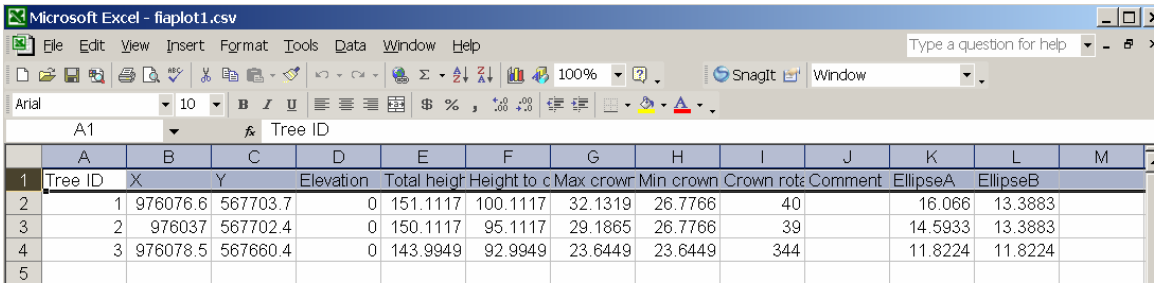


The detailed image is zoomed in by clicking the right mouse button. You can zoom-out by holding the shift key and clicking the right mouse button. You can pan using Ctrl+RMB click or you can use the scroll wheel to pan up and down, and left and right with shift-wheel.

Note: The tree models are only intended to fit the height and crown diameter (presumably at the crown base)—and not to "wrap" the tree crown. The shape of the crown is fixed (or at least not "fit" to the LIDAR points). The default model is a "conifer" but you can make the model look more like a hardwood by using a negative tree identifier.

pended to the previous .csv file.

32. Repeat these last five steps (beginning with *Uncheck the Lock measurement area center...*) for each tree in the plot.
33. Open your recently created csv file. The contents should be similar to:



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Tree ID	X	Y	Elevation	Total heigh	Height to c	Max crown	Min crown	Crown rota	Comment	EllipseA	EllipseB	
2	1	976076.6	567703.7	0	151.1117	100.1117	32.1319	26.7766	40		16.066	13.3883	
3	2	976037	567702.4	0	150.1117	95.1117	29.1865	26.7766	39		14.5933	13.3883	
4	3	976078.5	567660.4	0	143.9949	92.9949	23.6449	23.6449	344		11.8224	11.8224	
5													

34. Load this file into Fusion by clicking on the **Trees...** button (from the menu on the left), selecting the csv file and clicking **OK**.
35. Accept the default display color and symbol size.
36. Uncheck the **Bare earth...** checkbox.
37. After turning off the bare earth model, the trees look as shown in the adjacent sidebar graphic.
38. Click the **Sample options...** button (from the menu on the left) and select the following additional option:
    - Options: **Include tree models in data sample**
    - Click OK
39. Click the **Repeat last sample** button—the tree models will be visible in LDV.
40. Click the **F8 function key**, to pop up the **Attribute Clipping** tool which aids in visualizing how well your tree model fits the lidar data:
    - Toggle both the checkboxes (**Clipping** and **Highlighting**) on. The right-most **Width** slider adjusts the width (in terms of elevation range) of the lidar data that is highlighted. The left-most **Midpoint** slider defines the center elevation of the highlighted **Width**.
    - Adjust the **Width** so that it approximates the range of elevations between the crown bases and tops of the crowns of the trees within your plot.

- Move the **Midpoint** such that the **Width** covers the tree crowns.

To see the lidar data more distinctly, you may want to increase the marker size (alt-K will bring up the Marker menu—or right click and choose Marker…).

Do your tree models fit the lidar tree canopy returns?

This is the end of Exercise 5.

EXERCISE 5 APPENDIX: ALTERNATE CLOUDMETRICS BATCH FILE

Note: We're recommending using Notepad to create this simple 3-line batch file. However, with hundreds or thousands of input files, you might want to build the batch file in Excel (in particular Excel is great for incrementing the file names automatically).

The Cloudmetrics command is finicky. If you have trouble getting it to work as expected, try these alternate instructions. This alternative method does not use the file list (plot_metrics.txt)—instead we'll create a batch file that lists each individual lda file.

1. Use Notepad to create a new batch file (in the batch file directory)—suggested name is pmetrics.bat.
2. The contents of pmetrics.bat:

```
..\cloudmetrics /id /new c:\lidar\SampleData\clipplot1.lda c:\lidar\SampleData\outmetrics.csv
..\cloudmetrics /id c:\lidar\SampleData\clipplot2.lda c:\lidar\SampleData\outmetrics.csv
..\cloudmetrics /id c:\lidar\SampleData\clipplot3.lda c:\lidar\SampleData\outmetrics.csv
```

3. Note: the first line includes the /new switch. This will create a new outmetrics.csv output file. The remaining lines do not have the /new switch so their output is added to the outmetrics.csv file.
4. Save pmetrics.bat in the batch folder.
5. At the C:\fusion\batch> prompt, type pmetrics and hit <enter> to run the batch file.
6. Return to step 9 of page 2.