# EXERCISE 5: CALCULATE LIDAR METRICS

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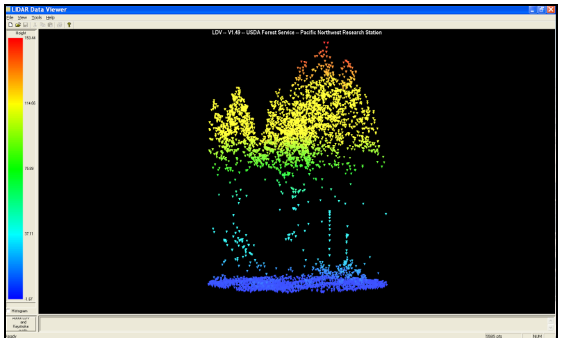
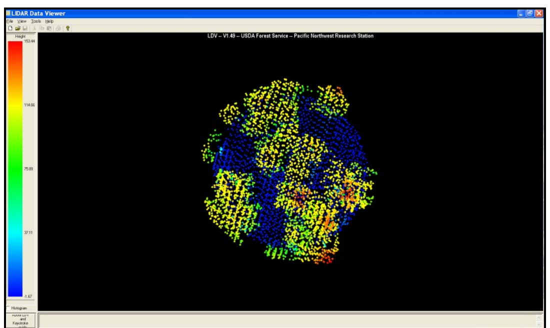
Fusion ver2.80



Profile of a lidar point cloud subset, based on a plot center and radius.



Overhead view of the sample lidar point cloud subset.

## Introduction

There are three 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 grid metrics across you entire acquisition area. Part 3 (optional) describes how to extract individual trees metrics from trees within the plots.

## Prerequisites

Successful completion of Exercise 4.

## Overview of Major Steps

Part 1—Compute Plot Metrics

Part 2—Compute Grid Metrics

Part 2— (Optional) Individual Tree Metrics

## Part 1—Plot Metrics

Begin by opening a DOS Command prompt window and exploring the syntax of the cloud-metrics command.

1. *Click,* **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>**, inspect the syntax quickly in the DOS command prompt.
5. Now, in Windows Explorer navigate to **C:\FUSION\doc\FUSION_manual.pdf** and open the FUSION manual. Navigate to page **41** and read the **CloudMetrics** section. **The more you understand the capabilities of the FUSION commands, the more efficient you will be at extracting useful information from the raw lidar data (point clouds)**.

**plotmetrics.txt - Notepad**

File Edit Format View Help

```
C:\lidar\SampleData\clipplot1.lda
C:\lidar\SampleData\clipplot2.lda
C:\lidar\SampleData\clipplot3.lda
```

Example InputDataSpecifier-**note the path is included**.

- Within the syntax,

**CloudMetrics [switches] InputDataSpecifier OutputFileName**, the **InputDataSpecifier** can be a 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. In our case we will use a text file containing a list of file names. Let's create that now.

6. Use Windows Notepad or Wordpad to create the **InputDataSpecifier**: a text file containing the list of the three **clipplot#.lda** files you created in exercise 4 (see sidebar).
7. *Name* the file **plot_metrics.txt** and *save* it in the **c:\lidar\SampleData** folder.
8. Use Windows Notepad to create a **cloudmetrics batch file**, type the following script into the notepad file:

**clmetrics.bat - Notepad**

File Edit Format View Help

```
..\cloudmetrics /id /new /above:12 /htmin:3 c:\lidar\sampledata\plot_metrics.txt c:\lidar\sampledata\outmetrics.csv
```

**Fusions Command Line Executable**

**Switch, use file name to identify output**

**Switch,** creates a new output file and deletes any existing file with the same name

**Switch,** compute various cover estimates using the specified height-break, in our case the **height break is 12 feet**. Please refer to Appendix 1 of this chapter for how cover metrics are computed.

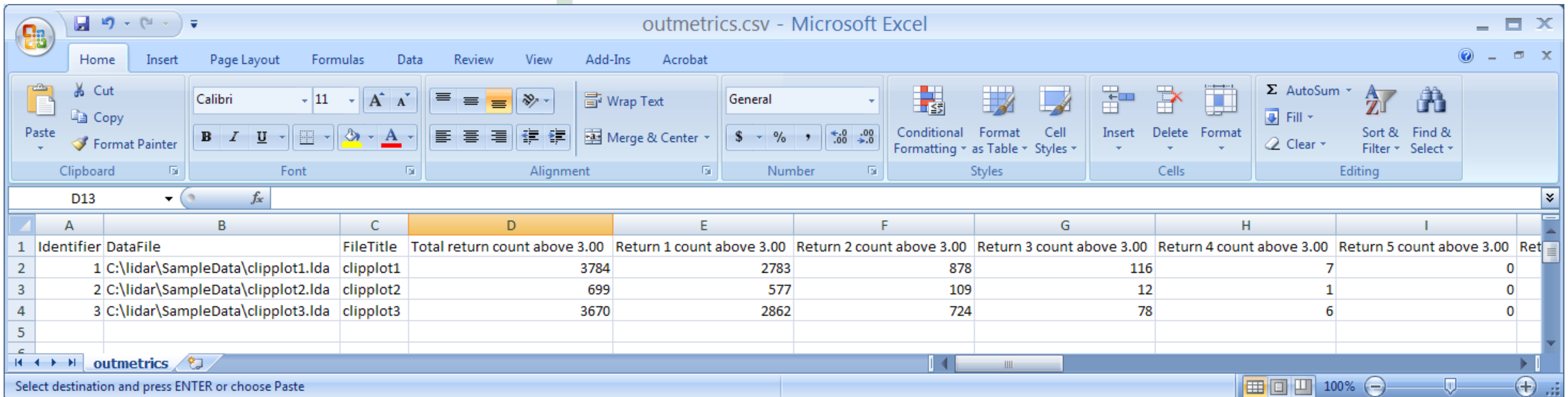
**Switch,** only use returns above a certain height to compute metrics. By choosing 3 feet we will exclude "ground" returns from our output stats.

**InputDataSpecifier,** in this case we have used a text file containing a list of the multilple file names, with full file paths inlcuded

**Output Data File,** this designates the output file name. Note: we include the full file path, if the path is incorrect, or doesn't exist, the output file will not be created!

9. *Save* it as **clmetrics.bat** in the **c:\fusion\batch** folder.
10. From the **c:\fusion>** prompt, *type* **cd batch** and *Click*, **Enter**.
11. Ensure you are at the **c:\fusion\batch** directory in the DOS command prompt.

12. In DOS at the **c:\fusion\batch>** prompt, *type* **clmetrics**
13. *Click,* **Enter** and let it run—it should complete almost immediately. If you receive an error and the command will not run (after you have checked your syntax, please refer to Appendix 1 of this document).
14. 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):



| Identifier | DataFile | FileTitle | Total return count above 3.00 | Return 1 count above 3.00 | Return 2 count above 3.00 | Return 3 count above 3.00 | Return 4 count above 3.00 | Return 5 count above 3.00 |
|---|---|---|---|---|---|---|---|---|
| 1 | C:\lidar\SampleData\clipplot1.lda | clipplot1 | 3784 | 2783 | 878 | 116 | 7 | 0 |
| 2 | C:\lidar\SampleData\clipplot2.lda | clipplot2 | 699 | 577 | 109 | 12 | 1 | 0 |
| 3 | C:\lidar\SampleData\clipplot3.lda | clipplot3 | 3670 | 2862 | 724 | 78 | 6 | 0 |

**FUSION Tip-**Please refer to page 42 in the FUSION manual for a full list of metrics calculated by CloudMetrics.

Note: Not only does FUSION calculate metrics for elevation of each return it also calculates the metrics for intensity if the information is available. At this point in the development of aerial discrete return lidar technology the intensity values are not normalized, so they are not really useful for analytical work. Hopefully in the future this will change and these metrics can be used in more analysis.

Lidar has proven itself, through validated research, to directly and accurately measure height and % canopy cover of forest vegetation. So let's now take a closer look at our plots to see if we can understand how the metrics reflect what we see in the field and the lidar point cloud.

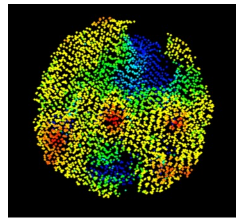
*This exercise continues on the next page...*

Plot 1
**"Oldgrowth"**
Control Stand

Site Photo

Plot 1-Profile

Plot 1-Overhead View

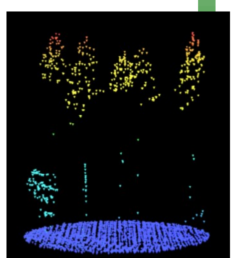


Plot 1-CloudMetrics
%Cover = 90
Elev Min = 3
Elev Max = 180
Elev Mean = 115
Elev StdDev = 33

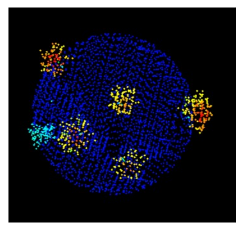
Plot 2
**"Heavy Thinning"**
Stand Treatment

Site Photo

Plot 2-Profile



Plot 2-Overhead View

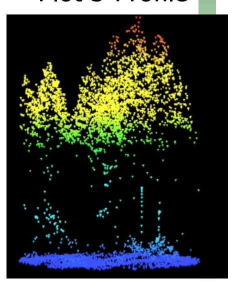


Plot 2-CloudMetrics
%Cover = 15
Elev Min = 6
Elev Max = 140
Elev Mean = 94
Elev StdDev = 36

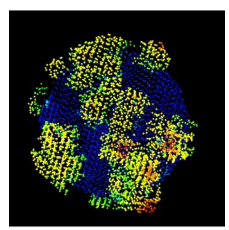
Plot 3
**"Light Thinning"**
Stand Treatment

Site Photo

Plot 3-Profile



Plot 3-Overhead View



Plot 3-CloudMetrics
%Cover = 64
Elev Min = 3
Elev Max = 153
Elev Mean = 108
Elev StdDev = 31

We have presented a variety of information for each plot in the adjacent figure. Our hope is that by presenting the lidar point cloud visualizations, a site photo and a selection of the cloudmetrics all together you will start to understand how lidar technology measures/ collects information about forest landscapes. Lets point out some obvious correlations.

- **% Canopy Cover** ranges from **90% (plot 1)** on the old growth site to **15% (plot 2)** on the site that was treated with heavy thinning. Plot 3 falls somewhere in the middle, which makes sense. This is easily visualized when you inspect the overhead view of the point cloud. Remember the point clouds are colored by height, hence any blue is the ground below the canopy.
- The **standard deviation** is lowest in the Lightly thinned stand (plot 3), this would indicate that the returns are more evenly distributed through the canopy. Could that be an indication of an evenly distributed vertical canopy structure?
- Take some time to explore some of the other metrics in **outmetrics.csv,** can you find any interesting correlations**?**

## Part 2—Grid Metrics

The cloudmetrics output is most often used with the output from the ClipData program to compute metrics (just as we did in part 1) that will be used for regression analysis in the case of plot-based lidar samples. The next step would be to explore relationships between field data recorded at the plots and the plot metrics we calculated using FUISION. Once these relationships are established using any number of analysis techniques (linear regression, random forest, ect….) you can apply the resulting equations across your whole study area. To do this you would need to compute the same metrics you did for the plots across the lidar acquisition. The **GridMetrics** FUSION command computes the same metrics as CloudMetrics, but the output is a raster (grid) format with each record corresponding to a single grid cell. In this part of the exercise we will compute GridMetrics for the example data set.

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

1. *Click,* **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. **Gridmetrics <enter>**, inspect the syntax quickly in the DOS command prompt.
5. Now, in Windows Explorer navigate to **C:\FUSION\doc\FUSION_manual.pdf** and open the FUSION manual. Navigate to page **64** and read the **GridMetrics** section. **The more you understand the capabilities of the FUSION commands, the more efficient you will be at extracting useful information from the raw lidar data (point clouds)**.

*This exercise continues on the next page...*

6. Now that we are familar with the gridmetrics command let's create our script to extract the metrics from our study area.
7. Start a new Notepad (.txt) document: *Click,* **Start | Programs | Accessories | Notepad**
8. Save the document as **grdmetrics.bat**, ensure you type in the **.bat** extension before saving
9. In the batch file you just created you will **type in the following string of DOS and gridmetrics commands** that FUSION will read in sequential order from the batch file:

**cd — Change Directory Commmand, navigating back to our c:\fusion\batch directory to run our grid metrics command**

**md — Make Directory Command, creating a new directory to put the output file in.**

grdmetrics.bat - Notepad

File Edit Format View Help

```
md C:\lidar\SampleData\grid_metrics

cd C:\fusion\batch

..\gridmetrics /minht:3 /nointensity C:\lidar\SampleData\4800K_ground_surface.dtm 12 120 C:\lidar\SampleData\grid_metrics\metrics.csv c:\lidar\sampledata\lda_4800K_data.lda
```

**Switch,** don't compute intensity metrics

**Switch,** denotes the bare-earth surface model used to normalize the LIDAR data (substract the bare-earth surface elevation from each lidar point elevation)

**Parameters,** denotes 12 foot height break for calculating cover metrics and 120 foot cell size, usually correltating with a fixed plot size.

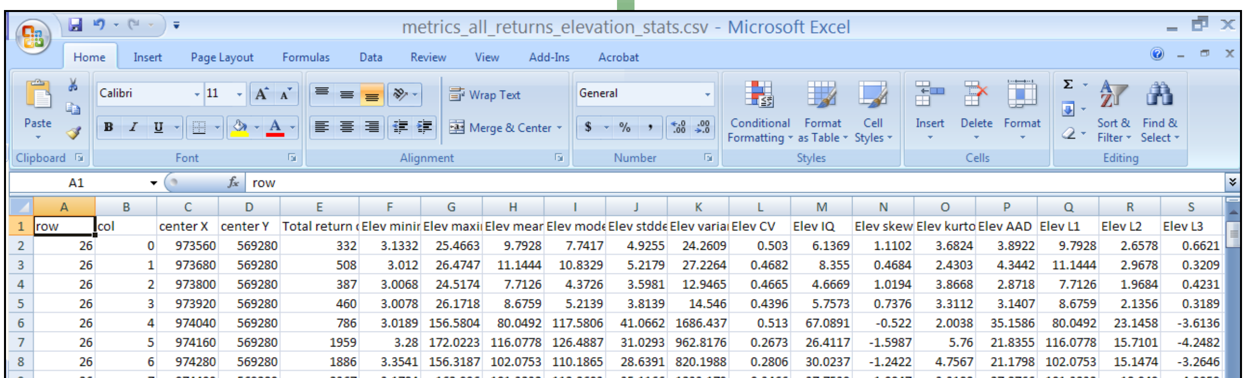
**Output Data File,** this designates the output file name. Note: we include the full file path, if the path is incorrect, or doesn't exist, the output file <u>will not</u> be created!

**InputDataSpecifier,** in this case we have used our single lidar tile, in a project scenario you will probably designate a number of tiles.

**Switch,** only use returns above a certain height to compute metrics. By choosing 3 feet we will exclude "ground" returns from our output stats.

**Fusions Command Line Executable**

10. *Save* it as **grdmetrics.bat** in the **c:\fusion\batch** folder.
11. Now in the command prompt, ensure you are at the c:\fusion\batch directory, remember if you are not at the correct directory use the **cd** (change directory) command to navigate. For example if you would like to go to c:\fusion\batch directory, *type* in **cd c:\fusion\batch**
12. In DOS at the **c:\fusion\batch>** prompt, *type* **grdmetrics**
13. *Click,* **Enter** and let it run—it should complete relatively quickly.
14. After the program finishes, *navigate* to **c:\lidar\sampledata\grid_metrics** (the directory you created using the **md** (make directory) DOS command in your batch file.
15. *Open* the output file (**metrics_all_returns_elevation_stats.csv**) in Excel. The output csv file looks as the figure below (one output line for each grid cell):



| row | col | center X | center Y | Total return ( | Elev minir | Elev maxi | Elev mear | Elev mode | Elev stdde | Elev varia | Elev CV | Elev IQ | Elev skew | Elev kurto | Elev AAD | Elev L1 | Elev L2 | Elev L3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 0 | 973560 | 569280 | 332 | 3.1332 | 25.4663 | 9.7928 | 7.7417 | 4.9255 | 24.2609 | 0.503 | 6.1369 | 1.1102 | 3.6824 | 3.8922 | 9.7928 | 2.6578 | 0.6621 |
| 26 | 1 | 973680 | 569280 | 508 | 3.012 | 26.4747 | 11.1444 | 10.8329 | 5.2179 | 27.2264 | 0.4682 | 8.355 | 0.4684 | 2.4303 | 4.3442 | 11.1444 | 2.9678 | 0.3209 |
| 26 | 2 | 973800 | 569280 | 387 | 3.0068 | 24.5174 | 7.7126 | 4.3726 | 3.5981 | 12.9465 | 0.4665 | 4.6669 | 1.0194 | 3.8668 | 2.8718 | 7.7126 | 1.9684 | 0.4231 |
| 26 | 3 | 973920 | 569280 | 460 | 3.0078 | 26.1718 | 8.6759 | 5.2139 | 3.8139 | 14.546 | 0.4396 | 5.7573 | 0.7376 | 3.3112 | 3.1407 | 8.6759 | 2.1356 | 0.3189 |
| 26 | 4 | 974040 | 569280 | 786 | 3.0189 | 156.5804 | 80.0492 | 117.5806 | 41.0662 | 1686.437 | 0.513 | 67.0891 | -0.522 | 2.0038 | 35.1586 | 80.0492 | 23.1458 | -3.6136 |
| 26 | 5 | 974160 | 569280 | 1959 | 3.28 | 172.0223 | 116.0778 | 126.4887 | 31.0293 | 962.8176 | 0.2673 | 26.4117 | -1.5987 | 5.76 | 21.8355 | 116.0778 | 15.7101 | -4.2482 |
| 26 | 6 | 974280 | 569280 | 1886 | 3.3541 | 156.3187 | 102.0753 | 110.1865 | 28.6391 | 820.1988 | 0.2806 | 30.0237 | -1.2422 | 4.7567 | 21.1798 | 102.0753 | 15.1474 | -3.2646 |
| 26 | 7 | 974400 | 569280 | 2367 | 3.1784 | 162.996 | 101.3232 | 112.2603 | 35.1166 | 1233.179 | 0.3466 | 37.7539 | -1.0047 | 3.3188 | 27.2766 | 101.3232 | 18.949 | -4.3959 |

Let's note a few things about the output CSV file.

- You should notice that each row has a column denoting the center x and center y for that grid cell.
- As you scroll through the file you may see some rows that have –9999 values, this is FUSION's no-data value.
- Cloudmetrics and GridMetrics produce the same metrics, this capability in FUSION makes it possible to model relationships observed between lidar plot metrics and field plot measurements and then apply them across the entire lidar acquisition. Any of the rows in the CSV file can be converted into ASCII files and exported into a GIS for analysis/modeling. Lets export one of the metrics (columns) now.

*This exercise continues on the next page...*

We will need to use the **CSV2GRID** FUSION command line executable to export one of our columns.

16. In Windows Explorer navigate to **C:\FUSION\doc\FUSION_manual.pdf** and open the FUSION manual. Navigate to page **50** and read the **CSV2Grid** section. **The more you understand the capabilities of the FUSION commands, the more efficient you will be at extracting useful information from the raw lidar data (point clouds)**.

Now that we are familar with the CSV2Grid command let's create our script to create an ascii file representing the **% Canopy Cover metric**.

17. Start a new Notepad (.txt) document: *Click,* **Start | Programs | Accessories | Notepad**
18. Save the document as **covergrd.bat**, ensure you type in the **.bat** extension before saving
19. In the batch file you just created you will **type in the following syntax** that FUSION will read in sequential order from the batch file:

covergrd.bat - Notepad

File Edit Format View Help

```
..\csv2grid C:\lidar\SampleData\grid_metrics\metrics_all_returns_elevation_stats.csv 49 C:\lidar\SampleData\grid_metrics\cover_grid.asc
```

**InputDataFile,** our output from the Grid-metrics command

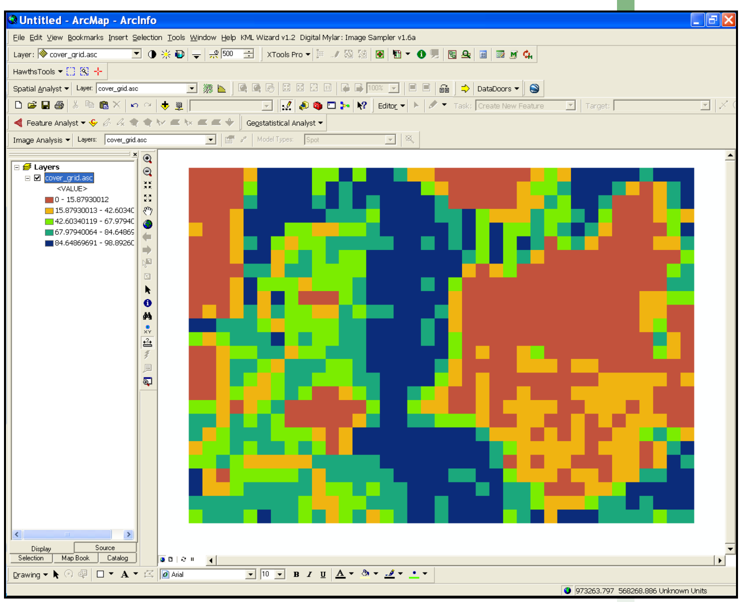
**Parameter,** denotes column 49 in the gridmetrics csv output file. Column 49 correlates to the % cover calculation for each cell or "Percentage first returns above 12.00".

**Output Data File,** output grid in ascii for-mat. This will allow us to use the data in a GIS.

**Fusions Command Line Executable**

20. *Save* it as **covergrd.bat** in the **c:\fusion\batch** folder.

21. Now in the command prompt, *ensure* you are at the **c:\fusion\batch** directory, remember if you are not at the correct directory use the **cd** (change directory) command to navigate. For example if you would like to go to c:\fusion\batch directory, *type* in **cd c:\fusion\batch**
22. In DOS at the **c:\fusion\batch>** prompt, *type* **covergrd**
23. *Click,* **Enter** and let it run—it should complete relatively quickly.
24. Now *Open* **ArcMap**, navigate to and load your new ASCII file (**cover_grid.asc**). Ignore the spatial reference warning. *Note: In the future you will want to define the projection of your lidar derivatives, which will be the same as the raw lidar data. ArcMap does not recognize FUSIONs projection so you have to manually redefine it!*
25. *Right Click* on **cover_grid.asc** in the index and *Select* **Properties** from the drop down menu.



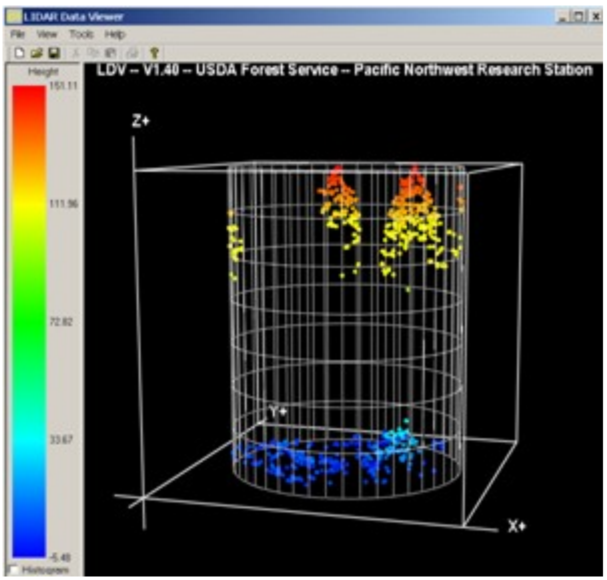

26. Under the **Symbology** tab, *Select* **Classified** and your desired color ramp. *Click* **Apply**. Your ArcMap display should now look somewhat similar to the figure on the left.
27. *Add* the lidar reference image, **orthophoto_4800K.jpg**, to your map display. Explore both layers together for a few moments. Based on your image interpretation skills does the % Canopy Cover lidar derivative layer correlate with the photo. Do you think this would be a good GIS layer for your whole forest?!

Any of the metrics calculated in the Gridmetrics CSV output file can be exported into grid format and added to your GIS for analysis. If you would like to perform a gridmetrics analysis for an entire acquisition (large number of lidar tiles) you would need to use the LTK utility in FUSION and some of the advanced switches in GridMetrics to avoid tile boundary artifacts. If you have acquired a large lidar acquisition and need further assistance please contact one of the lidar analysts at RSAC for assistance and additional technology transfer materials.

RSAC Lidar Contacts:
Brent Mitchell — Lidar Analyst — brentmitchell@fs.fed.us
Haans Fisk — Program Leader — hfisk@fs.fed.us

*This concludes the exercise, there is an optional part 3 on the next 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.

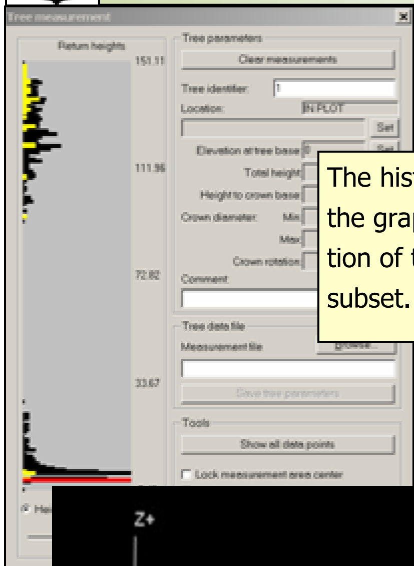



This represents a 60 meter fixed radius plot. Heights are given as above ground elevation. Points within 1 meter of the ground have been excluded.

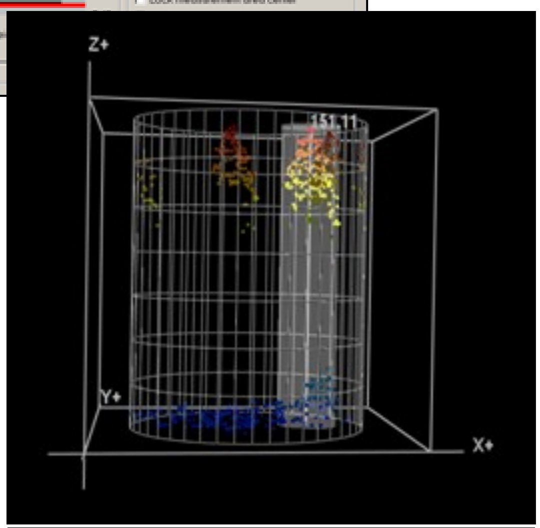
## Part 3—(Optional) Individual Tree Metrics

1. In the Fusion window, *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:

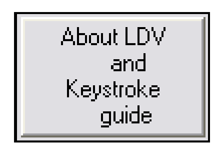
    15. Right-click anywhere in the LDV window to bring up the right-click menu.
    16. Click on **Measurement marker** to toggle the Measurement marker on. A cylinder will show in the LDV window.

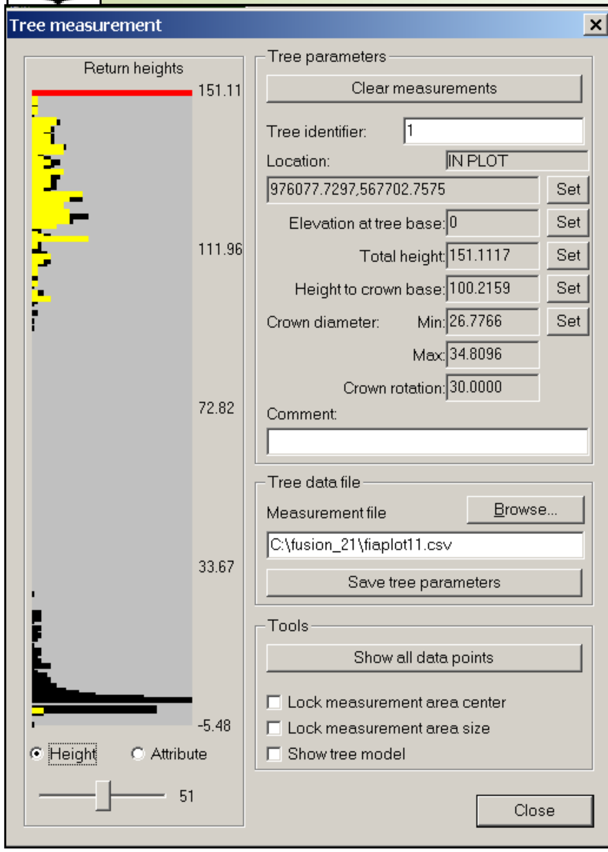
Note: The yellow histogram represents the lidar points within the measurement cylinder; the black histogram represents all of the lidar points within the data subset (in this case the circular plot). The yellow histogram can be proportionally scaled relative to the entire plot histogram by sliding the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

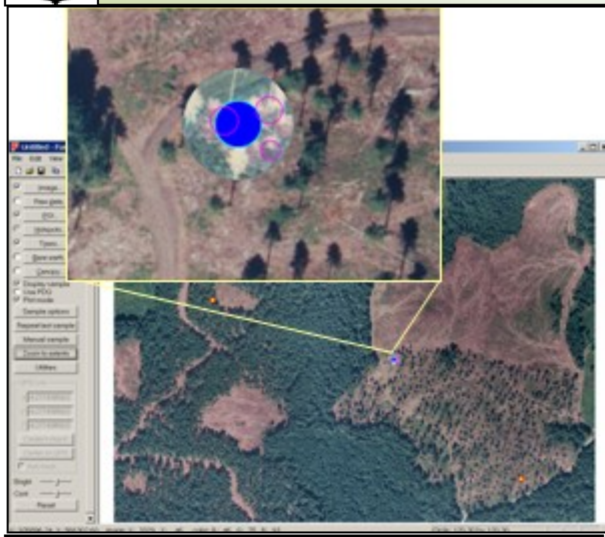
After the cylinder is centered over a tree, measurements can be made from the data using the red lever manipulated by the mouse wheel. Some key strokes to snap the marker to the top or bottom are available too. The list of keystrokes can be accessed by clicking on the lower left button of the LDV window:






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-

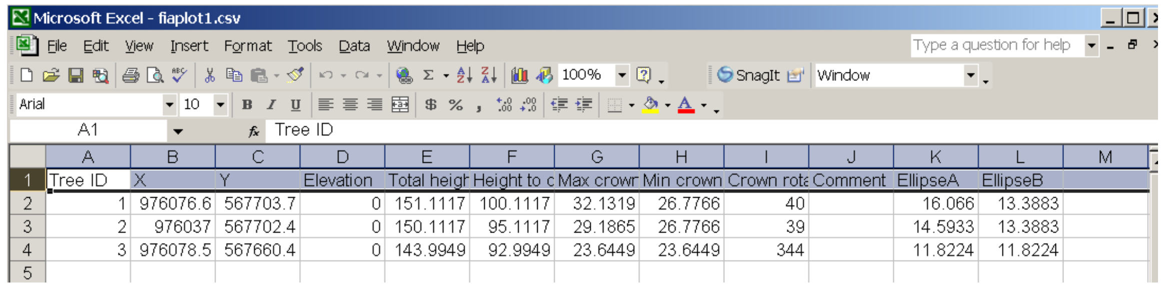


*The detailed image is zoomed in by clicking the right mouse button. You can zoom-out by holding the shift key and clicking the right mouse button. You can pan using Ctrl+RMB click or you can use the scroll wheel to pan up and down, and left and right with shift-wheel.*

*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 crowr | 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?

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.