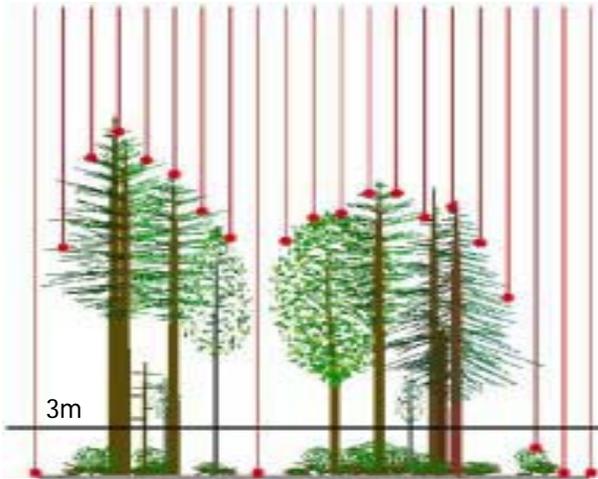




# EXERCISE 11: ESTIMATING CANOPY CLOSURE AND VEGETATION DENSITY



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*Overstory canopy is defined as any vegetation greater than the height break (3 meters in this example) above ground. Of the 21 LIDAR pulses that enter the canopy, 16 first returns are recorded above the 3m threshold. The LIDAR-based overstory cover estimate for the area in this graphic would be computed as 16/21 or 76%.*

 *A good understanding of stand dynamics is recommended for reliable Cover estimates. This can be enhanced by spatially browsing the raw data, using the **cloudmetrics** command prompt and/or ground truth data when available.*

## Introduction

In this exercise you will continue building the Fusion project data by computing estimates of **canopy closure** (# of 1st returns over a specified height break / total # of 1st returns per unit area) and estimating the **relative vegetation density** for a specific height strata (total # of returns between the height break and upper limit / total # of returns per unit area).

## Prerequisites

- LIDAR raw data files (**lub\_tile1.las...lub\_tile9.las**), bare earth surface file (**lub\_surface.dtm**) and reference image (**lub\_ref.bmp**)
- Files loaded into Fusion.

## Part A—Create an Estimate of Canopy Closure:

In Fusion, estimates of **canopy closure** are created from the command line interface using the **Cover** executable. The syntax for the **Cover** command is:

```
Cover [switches] groundfile coverfile heightbreak cellsize xyunits zunits  
coordsys zone horzdatum vertdatum datafile1 datafile2 ... datafile10
```

1. For the complete syntax, type **Cover** into the Command prompt (from the Fusion directory).
2. Run the **Cover** utility with the following parameters:
  - **Parameters:**
    - <in\_path>\lub\_surface.dtm (this is the groundfile)
    - <out\_path>\cover\_15.dtm (this is the coverfile)
    - 15 (heightbreak)



## Exercise 11: Part A-Computing Estimates of Canopy Closure



**Note:** To produce cover estimates that are meaningful, the cell size must be larger than individual tree crowns. For most forest types, cell sizes of 15 m or larger produce good results.

**Option:** You can skip steps 3-6 if you don't care to see the canopy coverage model in FUSION—you can still load it into LDV using steps 8-10.

- 15 (output cell size)
- M (x and y units are meters)
- M (z units are meters)
- 1 (UTM coordinates)
- 12 (zone 12)
- 2 (NAD83)
- 2 (NAVD83)
- <in\_path>\lub\_tiles.txt (text file containing the paths for the input data file)

The syntax should look similar to:

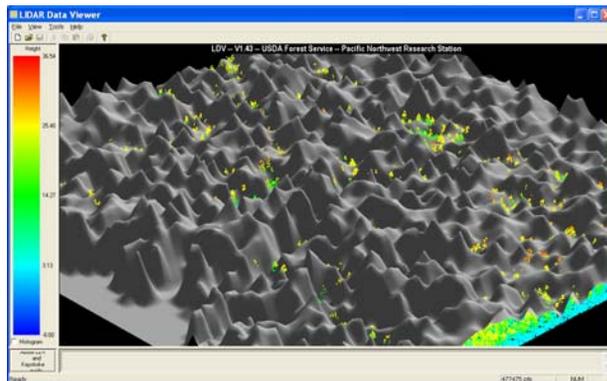
### Syntax:

```
cover <in_path>\lub_surface.dtm <out_path>\cover15.dtm 15 15 M M 1 12 2 2 <in_path>\lub_tiles.txt
```

Consider putting the command (including switches and parameters) in a batch file—despite being only a single command.

Once the **cover utility** has finished successfully, add the **cover model** to the Fusion project...

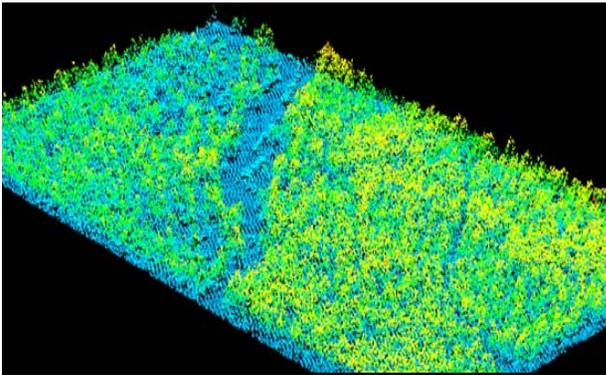
3. Click the **Canopy** button from the left side menu of the FUSION interface.
4. Navigate to and select the **cover15.dtm** canopy coverage file,
5. Click **Open** to display the **Surface model** dialog (see sidebar):
  6. Click **OK** and the model will be shown with green contour lines in the fusion window (if not, ensure that the checkbox next to the **Canopy** button is checked).
7. Click the **Sample Options Button**, ensure the "subtract ground elevations from each return" **Option** is checked. Click **OK**. If this step is skipped the cover model will not display in the LDV!
8. Click-and-drag a Stroked Box sample within the Fusion window to view the data in LDV:



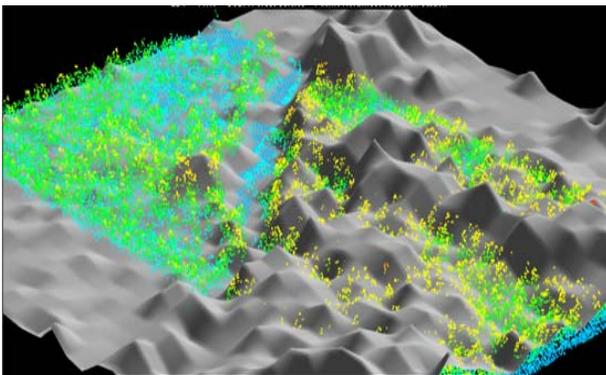
Canopy Coverage Surface.



## Exercise 11: Part A-Computing Estimates of Canopy Closure



Canopy Coverage Surface toggled off.



Canopy Coverage Surface toggled on.



By toggling the canopy coverage surface on and off, you can assess if the model is representative of the data.

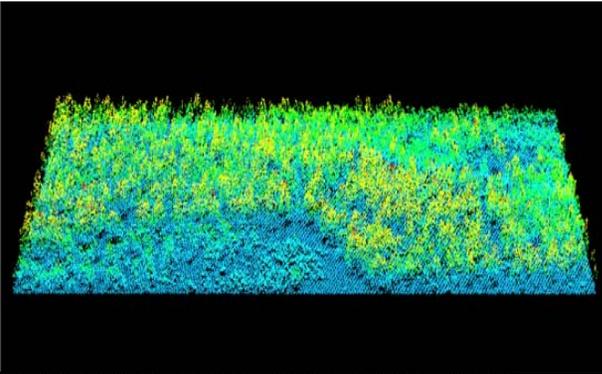
9. Access the right-click menu and click **Surface file...**
10. Navigate to and select the **cover15.dtm** canopy closure file,
11. Click **Open** to display the canopy cover model over the data.
12. Inspect the **canopy closure model**--how does it differ from the **canopy height model**?  
*What does the z-axis represent in each model?*
13. Right-click in the LDV window to activate the pop-up menu and select **Surfaces** (this will toggle the canopy closure surface off). Inspect the raw data, does the surface accurately reflect canopy closure?
14. Click-and-Drag a new Stroked Box sample within the Fusion window, choose a different location. Repeat steps 9 thru 11 to display the canopy coverage model in the new location. As you browse the data set and repeat these steps, think about the **height break (15m)** set in the **Cover** Command line. How would the results be different if the height break was increased or decreased?
15. **Optional:** Choose a new height break # and run the **Cover** Command line again.

\*\*\*Note: in the next exercise, you'll bring this layer (and subsequent outputs) into ArcGis for analysis.

Exercise 11 continues ...



## Exercise 11: Part B-Estimating Relative Vegetation Density



Vegetation density model toggled off.

### Part B—Estimate the relative vegetation density for various height strata.

This can be done using the **cover command line** again but this time adding the switches **(/all)** and **(/upper:#)** into the syntax and changing the height break value to 2m. The **(/all)** switch designates that all the returns in the LIDAR data are used, not exclusively first returns (**Cover** command line default).

The **(/upper:#)** switch adds an upper height limit to the coverage calculations. (# of all returns >= heightbreak and <= upperlimit)/ (total # of all returns)

**Explanation:** *The resulting surface file will map the relative density (z-axis) of LIDAR data returns in the range of 2-14 meters above the ground.*

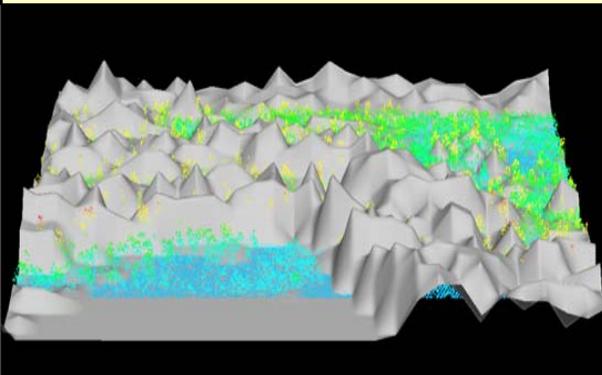
- **Run the Cover command with the new switches and height break.**

The syntax should look similar to:

#### Syntax:

```
cover /all /upper:14 <in_path>\lub_surface.dtm <out_path>\cover2_14.dtm 2 15 M M 1 12 2 2 <in_path>\lub_tiles.txt
```

*Consider putting the command (including switches and parameters) in a batch file—despite being only a single command.*



Vegetation density model toggled on.

After you have successfully run the **cover** utility to create **cover2\_14.dtm**, inspect it as you inspected **cover15.dtm**. How has using the **(/all)** switch affected the output? Could there be a case in which you would use only first returns with an upper limit switch? (possibly mapping clear cut regeneration)???

*\*\*Note: In the next exercise we will use the canopy closure and vegetation density models created in this exercise.*

End of Exercise 11