LIDAR Analyst: Bare Earth and Feature Extraction

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Exercise E	Extracting Trees & Forests

Module Introduction

Overview

After hearing the lecture and given the topographic Delaware data, the student will be able to create and clean bare earth models and extract various feature information, including building footprints.

Skills Learned

- Import Raster Elevation and Intensity data
- Create Bare Earth Model
- Clean Bare Earth Model
- Generate Building Footprints
- Perform Analysis to Assist Selection of Appropriate Input Variables

Tools and Technology

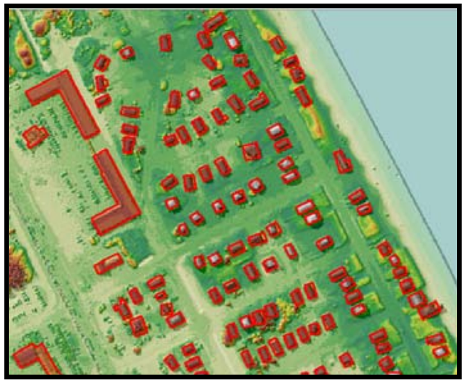
ArcGIS Components

- ArcMap

ArcGIS Extensions

- LIDAR Analyst
- Feature Analyst
- Spatial Analyst

Module Introduction



Background of LIDAR Analyst

Visual Learning Systems developed tools to automate data analysis. These tools are Feature Analyst and LIDAR Analyst. Both these tools work as extensions in ESRI ArcMap and in other software packages, and both of these packages work with raster information.

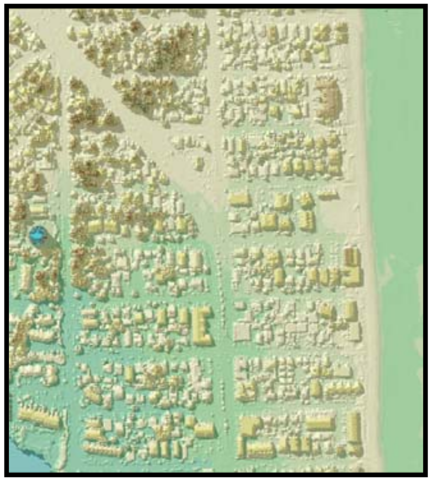
LIDAR Analyst uses elevation data as input for its spatial analysis algorithms. The user may modify some parameters used by these algorithms to affect the final results.

Visual Learning Systems has produced Tutorial Lessons and corresponding datasets that should be studied in addition to the material presented in these exercises. These materials are intended to illustrate the major points from the VLS manuals and training.

Module Introduction

Preparing Data for Loading into LIDAR Analyst

LIDAR Analyst requires the input data to be raster format with perfectly square cells or pixels. To accomplish this the data should be in a projected coordinate system such as Universal Transverse Mercator (UTM) or State Plane (SP) system. Because CHARTS data are provided in geographic coordinate space, they must be converted to the projected coordinate system prior to creating the elevation raster image.



The CHARTS data are produced with the longitude value provided with an East-Positive sign convention. If Corpscon is used to convert the data, the sign of the longitude value must be reversed for proper coordinate conversion.

The Joint Lidar Bathymetry Technical Center of Expertise (JALBTCX) has found that 1m grids produced by QT Modeler, a software package produced by Applied Imagery, work well in LIDAR Analyst software. To produce these grids, data must be loaded into QT Modeler and then exported in an ESRI ASCII Grid format. When this file is unloaded, QT assigns the “No Data” value to -9999. Using a text editor, the “No Data” value is reassigned to some value slightly lower than the lowest elevation within the model. For example, if the lowest data elevation in the model were -10.46, the “No Data” value would be modified from -9999 to -15. This file is then passed through the ArcToolbox ASCIItoRaster command to convert the raster from ASCII to a TIF format. When using this tool, be sure to add the “.tif” extension on the output file name and select FLOAT as the output data type.

Bare Earth and Feature Extraction

Notes:

Exercise A: Importing Raster Elevation and Intensity Information

Background

LIDAR Analyst and Feature Analyst require raster datasets as input for calculations. These data must be loaded into the ArcMap project prior to creating desired LIDAR Analyst products. LIDAR Analyst makes calculations based on the elevation data and allows the user to input intensity information for reference.

Goal

After completing the exercise, you will be able to successfully import raster elevation and intensity data into ArcMap as input data for LIDAR Analyst functions.

Objectives

1. Student will be able to import raster elevation data.

2. Student will be able to import raster intensity data.

- Student will be able to use the LIDAR Analyst Cut Images tool.

Exercise A: Importing Raster Elevation and Intensity Information

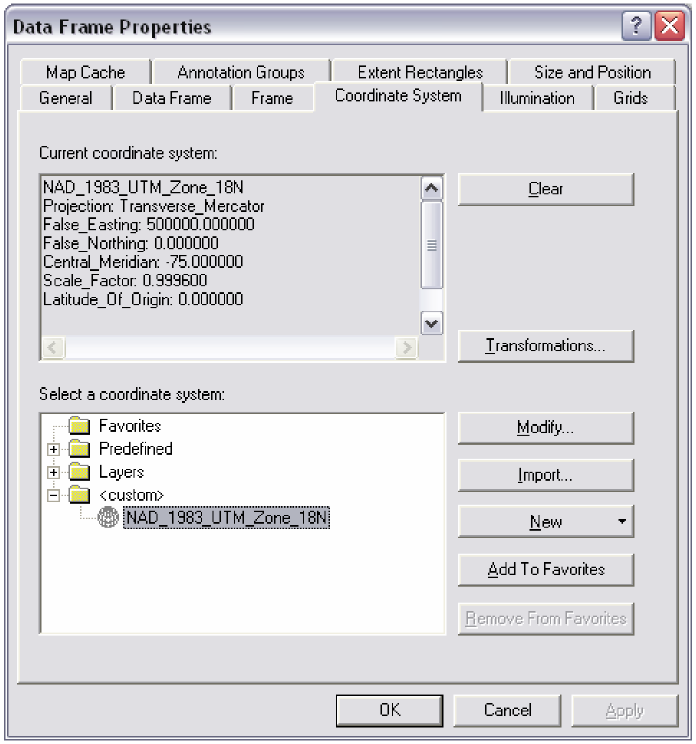
In this exercise, the student will:

- Set up a new project in ArcMap
- Load First Return Image (TF in file name for Topo First)
- Load Last Return Image (TL in file name for Topo Last)
- Load Intensity Image (INT in file name for Intensity)
- Use the crop tool to extract portions of the larger dataset.

As discussed in the Introduction, LIDAR Analyst requires the raster images to have perfectly square cell sizes and the input raster files are created in some projected coordinate system to meet this requirement. The files used for this training were projected to UTM space.

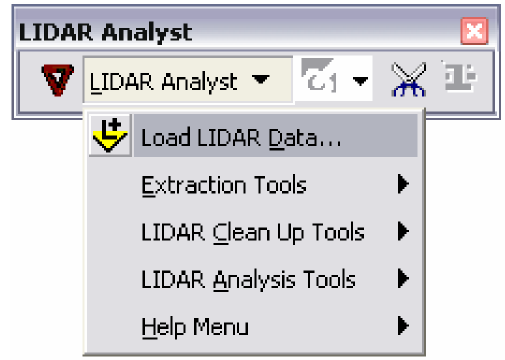
Therefore, the first step in extracting features is to **start a new ArcMap project** and **define the coordinate system** in the ***Data Frame Properties***. The selected coordinate system should match the data.

Once this is set the user should **activate Spatial Analyst and LIDAR Analyst** extensions under the Tools pull down menu.



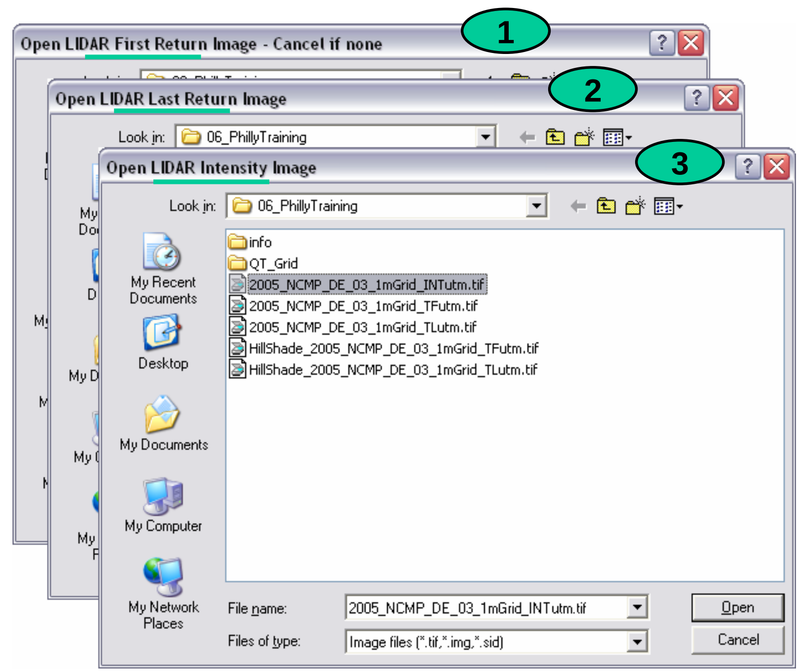
Exercise A: Importing Raster Elevation and Intensity Information

The process steps in LIDAR Analyst are organized to simplify the tool's functionality for the user. In the ***LIDAR Analyst toolbar***, the first option is to "**Load LIDAR Data…**"



When loading the data make sure to select the file being requested. Choosing the appropriate files will cause the software to correctly populate file selection boxes when running extraction tools. If an incorrect selection is made, it is not a major set-back because the appropriate file(s) can be chosen when using the extraction functions.

As each file is loaded, an option is given to **create a Hill-Shade & Relief file** for each elevation file. Accept the default file name and options for each file.*



*The output files may be named and written according to user specified input. However, the default path and file names are recommended until the user understands the software generated names for all product files.

Did You Know?

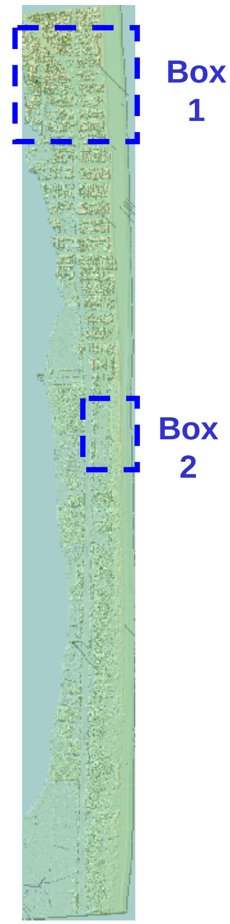
If you only have one elevation raster image for an area, you can still utilize LIDAR Analyst for your work. Be sure to load the one raster as the Last Return Image by clicking "Cancel" when prompted for your First Return Image.

Exercise A: Importing Raster Elevation and Intensity Information

The Hill-Shade and Relief created from the loaded data should appear similar to the data image on the right but without the dashed boxes, of course.

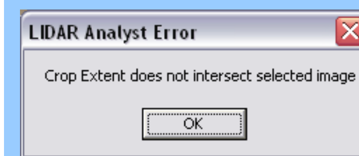
After loading the data we will cut specific areas out of the larger dataset.* To do this, we use the "**Cut Images**" tool from the ***LIDAR Analyst toolbar***. After selecting the Cut Images tool, **click and drag define the cut boundaries**. Once the boundaries are defined, a dialog will appear asking which images should be cut. **Select only the three input images – First Return, Last Return and Intensity** – not the Hill-Shade & Relief images. The dialog box will prompt the use for the file name to use for each new cut image. **Change the "cut" to "Box1" in the suggested file name** so the file name clearly indicates the area of interest. After all images are saved, remove these from the project.

*Specific areas are cropped out for two reasons. First, we can work with a small, representative area of our large dataset to determine the most appropriate settings for the large dataset. Second, we do this work on a small dataset because less time is required for the iterations of the processing steps.



Did You Know?

If you get this message…

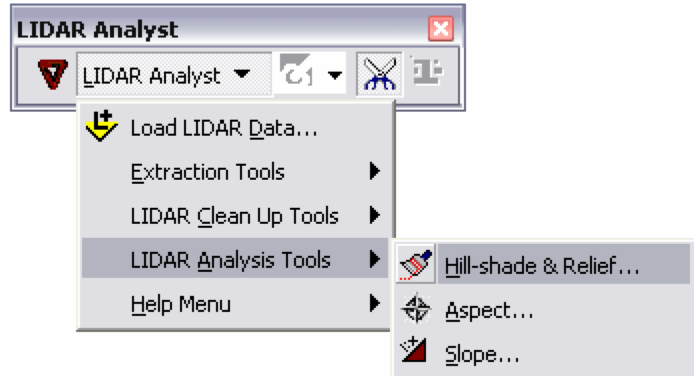


Your project has at lease one image that is completely outside the bounds selected with the Cut Image tool.

Remove any of the images outside your desired area and re-cut, or redefine the boundary area.

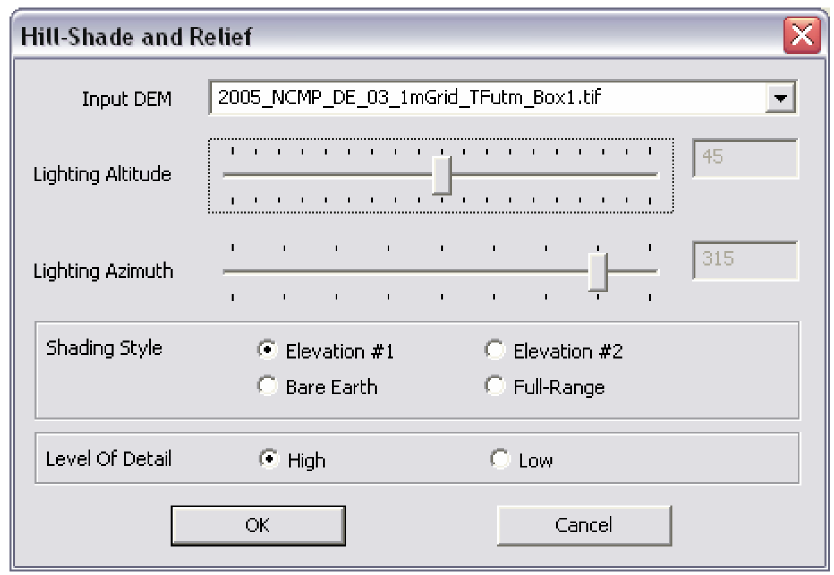
Exercise A: Importing Raster Elevation and Intensity Information

In an effort to manage the data insert a new **Data Frame** from ArcMap's ***Insert*** menu. **Right-click** the new data frame name and **Activate** the new frame. **Rename** the data frame to **Box 1** and **define the coordinate system** in the ***Data Frame Properties***.



Activate the Box 1 data frame. Use the "**Load Lidar Data…**" tool again to **load the cut images for the fist box, and create the Hill-Shade and Relief images for it**.

TIP: If your elevation image is already in your project, you may use the **Hill-Shade & Relief tool** under ***LIDAR Analysis Tools*** to create the shaded image. If using this method, correctly specify the Input DEM file.



Did You Know?

When you load a "cut" image, the range for the color scheme often requires adjustment. The elevation and intensity images' color range may be modified in the data layer properties dialog under the "Symbology" tab. Usually, the Stretch Type should be set to "Maximum-Minimum". For elevation images, the values should be adjusted until the image has an acceptable appearance. Usually for intensity images, good visual information results from the minimum set to 0 and the maximum set between 50 and 90. Adjust from these values as necessary.

Exercise A: Importing Raster Elevation and Intensity Information
Individual Exercise

Cut and load images for the **Box 2** area as done for the **Box 1** area.

Steps:	**Notes:**
1. Cut, name and remove the images for Box 2. 2. Create a data frame for Box 2 3. Load the images for Box 2, being sure to load them into the Box 2 data frame.	
Does the intensity image show good contrast between high and low intensity areas? If not, how can this be accomplished?	

Exercise A: Importing Raster Elevation and Intensity Information

The results of loading the data, cutting the small boxes, and creating the Hill-Shade & Relief images should be shaded images similar to these below. These images are created from the first return data. Shadows from high elevation spikes are seen on the right side of the Box 1 image.

Box 1 – First Return Hill-Shade & Relief

Box 2 – First Return Hill-Shade & Relief

END OF EXERCISE A

Exercise B: Creating a Bare Earth Model from Raster Elevation Data

Background

Bare Earth models can be used for a variety of analytical purposes. The input first-return and last-return elevation raster images contain elevations from many non-ground objects.

The input data must be processed to remove all information that does not represent the ground elevation. The resulting model should be free of heights resulting from trees, power lines, buildings, cars, and other non-ground objects.

Goal

Using the LIDAR Analyst: Bare Earth tool, create a bare earth model from the input data.

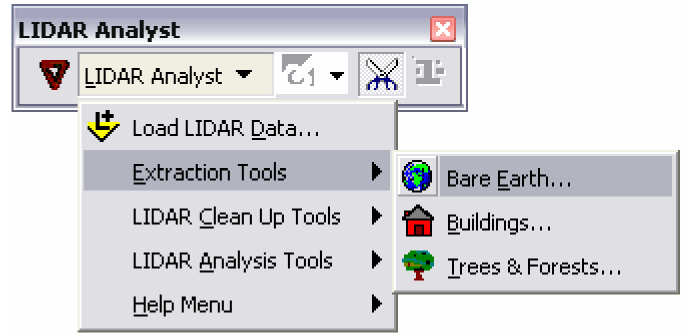
Objective

1. Student will be able to create a bare earth model using LIDAR Analyst.

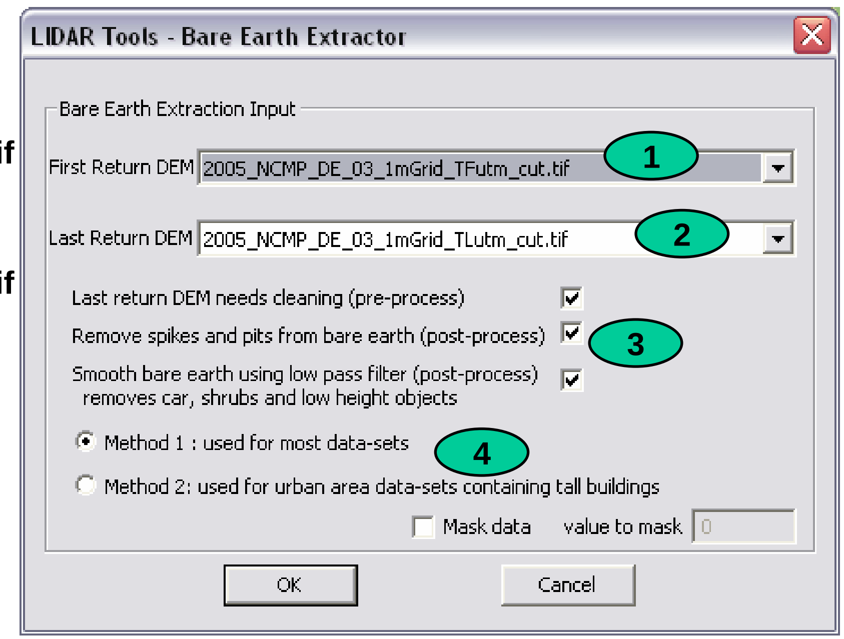
Exercise B: Creating a Bare Earth Model from Raster Elevation Data

Bare earth models will be created for both small areas just cut.

Activate the Box 1 data frame. From the LIDAR Analyst ***Extraction Tools*** menu, select the "**Bare Earth…**" option.

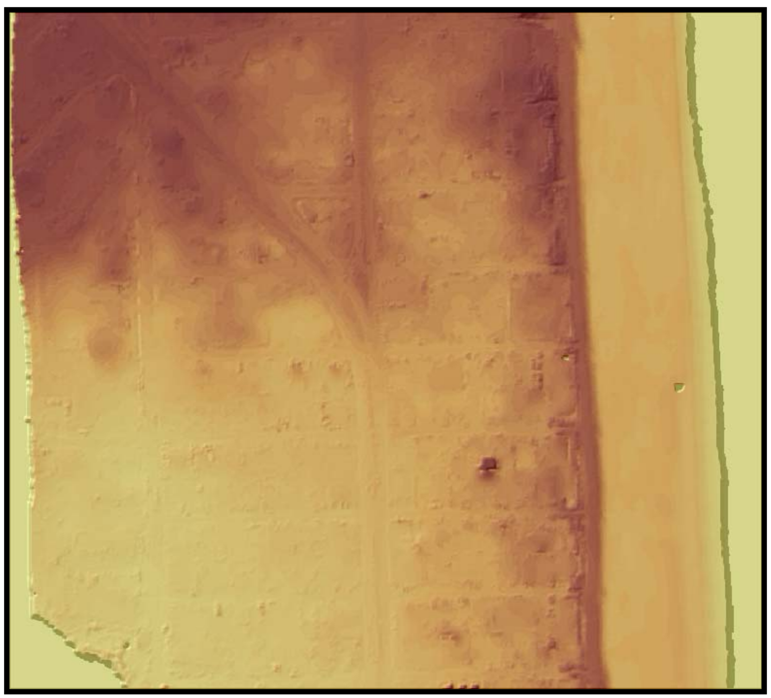


1. Select the First Return DEM. Select **2005_NCMP_DE_03_1mGrid_TFutm_Box1.tif**
2. Select the Last Return DEM. Select **2005_NCMP_DE_03_1mGrid_TLutm_Box1.tif**
3. Use the default options for processing.
4. Use Method 1 (default option) for processing



Exercise B: Creating a Bare Earth Model from Raster Elevation Data

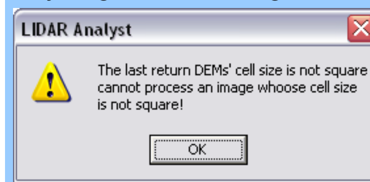
After the Bare Earth model extraction completes, the user will be prompted to **save a Hill-Shade and Relief** view of the data. **Accept the default file name**. The Bare Earth model created for Box 1should appear similar to the one below.



Estimated Length:
< 1 Minute

Did You Know?

If you get this message…



LIDAR Analyst requires the input raster images to have perfectly square cells, or pixels. Your raster image must be created from data that are in a projected coordinate system, such as State Plane or UTM.

If you use Corpscon to convert data from geographic space, it requires the longitude values to be positive for western hemisphere.

LIDAR Analyst needs for the "No Data" areas to actually have an elevation assigned. Best results are achieved if this assigned value is slightly less that the least real elevation of the model.

Exercise B: Creating a Bare Earth Model from Raster Elevation Data
Individual Exercise

Create the bare earth model for **Box 2** images as done for **Box 1.**

Steps:	**Notes:**
1. Activate Box 2 data frame. 2. Create the Bare Earth Extraction from the LIDAR Analyst 3. Load the images for Box 2, being sure to load them into the Box 2 data frame.	

END OF EXERCISE B

Exercise C: Cleaning a Bare Earth Model

Background

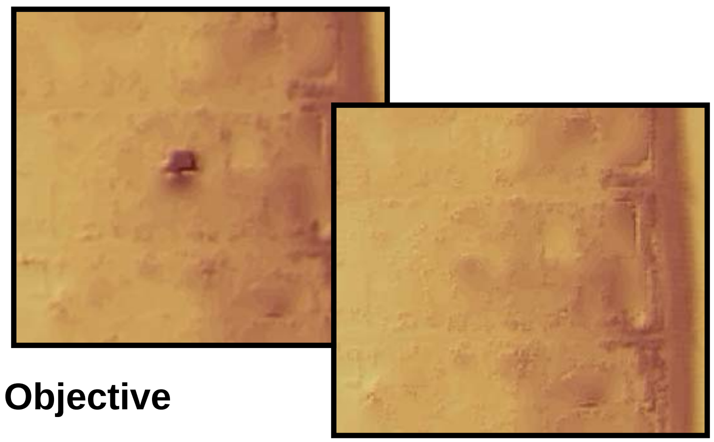
In most cases, the Bare Earth model created will have some areas that do not represent the true ground elevation. In these cases, the model should be revised to produce the most accurate model possible. In some cases we see quickly that large artifacts remain in the bare earth elevation, and in other cases we must zoom in on the model to see the errors.

In both these cases, the model needs to be corrected. This section explores methods to accomplish this task.

TIP: Refer to the VLS LIDAR Analyst Reference Manual for additional information regarding the use of these tools.

Goal

Using LIDAR Analyst's LIDAR Clean Up Tools, clean anomalous results from the original bare earth model.



Objective

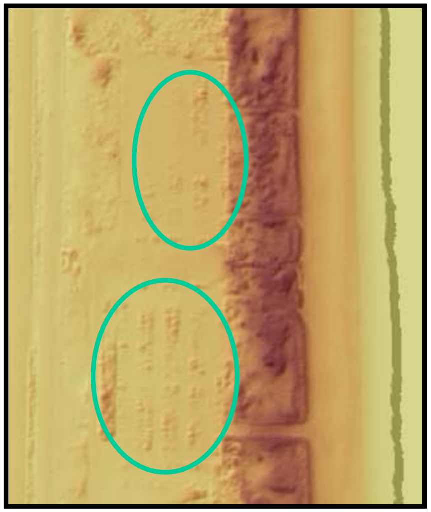
1. Student will be able to modify a bare earth model using LIDAR Analyst Clean Up Tools.

Exercise C: Cleaning a Bare Earth Model

LIDAR Analyst has tools to help us remove these artifacts. Features are generated by the user to specify various types of modifications needed.

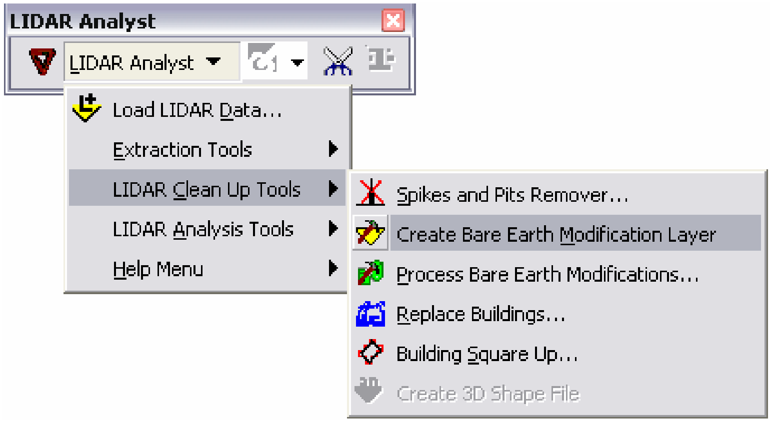
The upper image indicates the location from Box 1 where a building's elevations were used as bare earth elevations. The lower image indicates areas from Box 2 where cars remain in the bare earth model.

First we will look at Box 1 and learn methods to improve the bare earth results in this area. We will zoom in, look at and revise some of these areas to demonstrate the function of the modification tools.



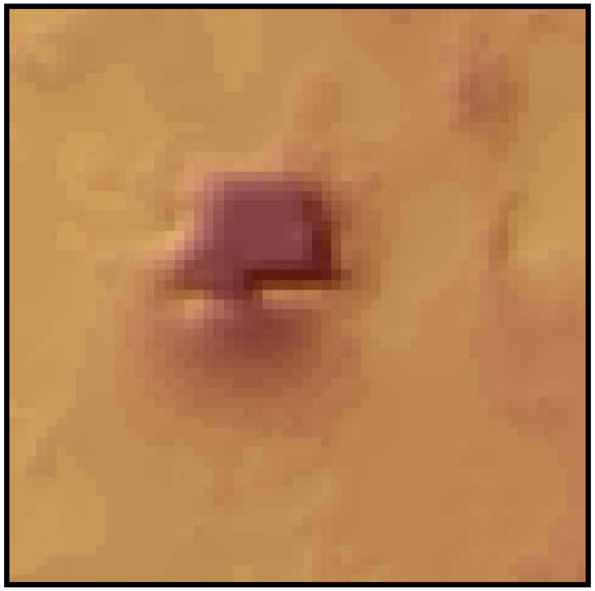
Exercise C: Cleaning a Bare Earth Model

LIDAR Analyst employs two types of tools for modifying bare earth. The first is an 'automated' tool that allows the user to specify an area where algorithms will run and modify the elevations. The second is more of a manual use tool where the user specifies areas where elevations are incorrect and should be removed and areas where elevations are correct. We will use the second method to remove the building elevations from Box 1 area.



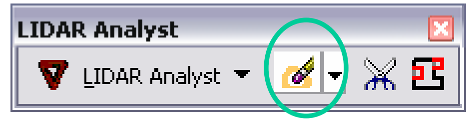
Activate Box 1 Data Frame. First we will use the "**Create Bare Earth Modification Layer**" tool under the ***LIDAR Clean Up Tools*** to begin. **Name the new modification layer "be_modification_regions_Box1.shp"**.

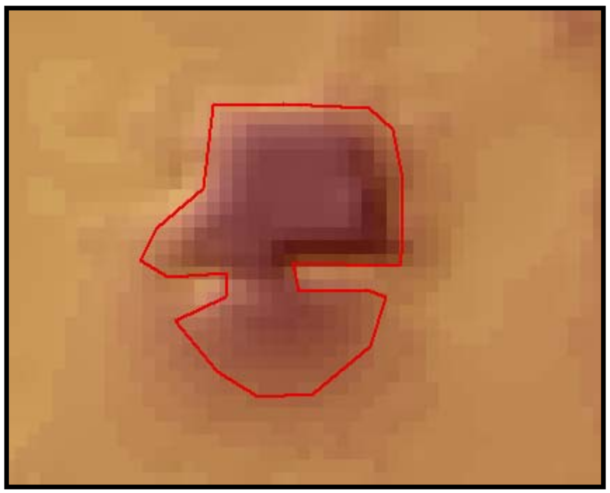
Next, we need to **zoom in on the area to be modified**.



Exercise C: Cleaning a Bare Earth Model

On the ***LIDAR Analyst toolbar***, we select the tool to "**remove Bare Earth"** (indicated to the right). With this tool we **draw a boundary** as tightly as possible around the area containing incorrect elevations. The image below shows an example of this boundary in red.



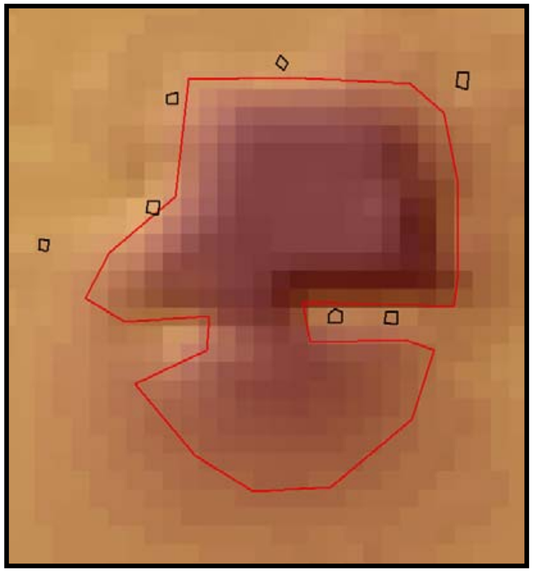


TIP: Sometimes the correct boundary locations can be chosen better if the First Return Hill-Shade image is visible through the bare earth model. Adjust the "Transparent:" percentage of the Hillshade image within the appropriate bare earth Hill Shade Group.

Exercise C: Cleaning a Bare Earth Model

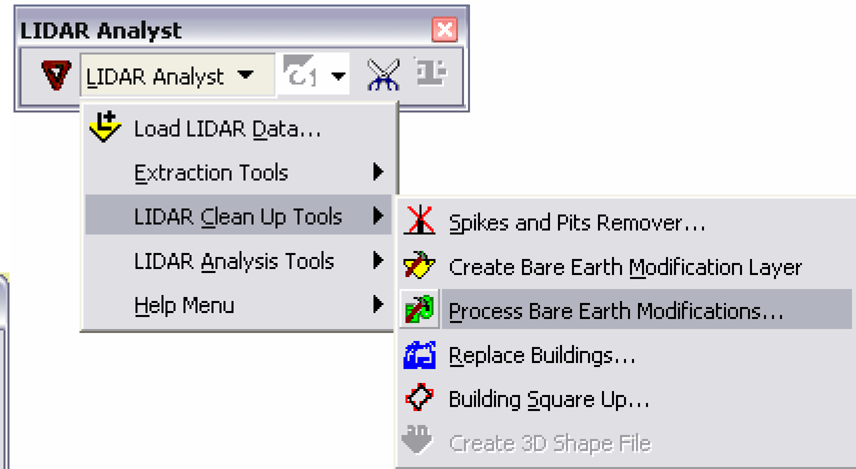
Once the area to remove is identified, correct elevation locations should also be identified. From the ***LIDAR Analyst toolbar***, we select the tool to "**add points"** (indicated to the right). With this tool we **draw small polygons**, less than 1 pixel each, **to indicate areas where points should be selected** by the software.

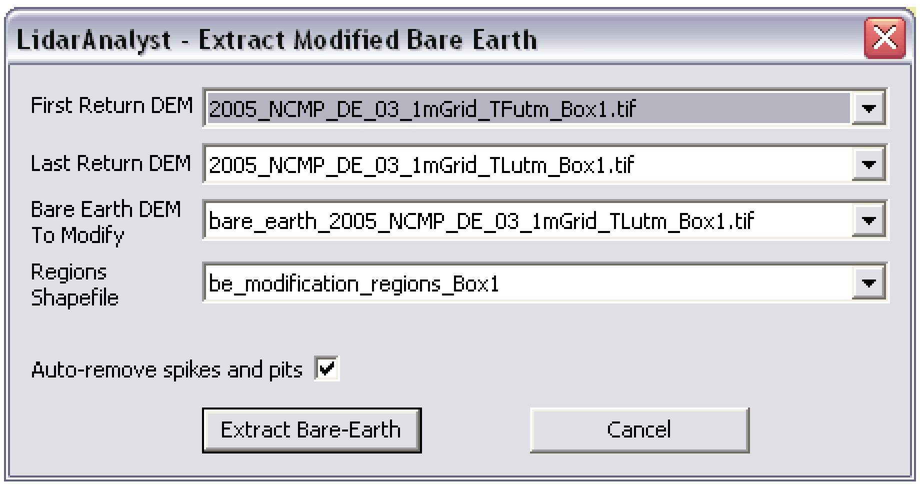
These selections are shown by black polygons in the images below. Using a combination of the bare earth and last return hill shade models will help chose the best locations to add points.



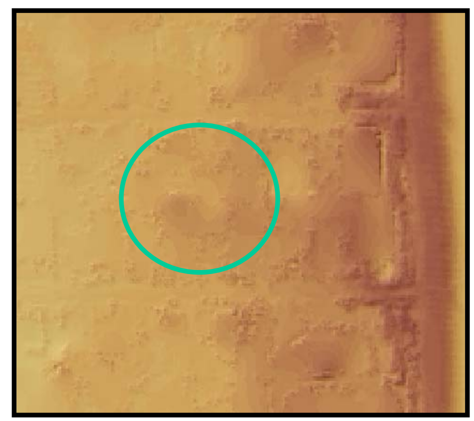
Exercise C: Cleaning a Bare Earth Model

Once the locations are chosen we must "**Process Bare Earth Modifications…"**, found under the ***LIDAR Clean Up Tools***. Before the tool can process the modifications, the user must agree to stop editing. The user will then be prompted for input files to be used to generate the modified bare earth image. The default selections are usually correct, but must be verified.





The user may accept the default file names for the modified bare earth image and its Hill-Shade & Relief image. The resulting "modified bare earth Hill Shade" image should appear similar to the example on the right. The modified area is indicated by the circle.



Exercise C: Cleaning a Bare Earth Model
Individual Exercise

Using the tools discussed thus far, look for other areas within the Box 1 modified bare earth that do not appear to be the true bare earth and modify as needed.

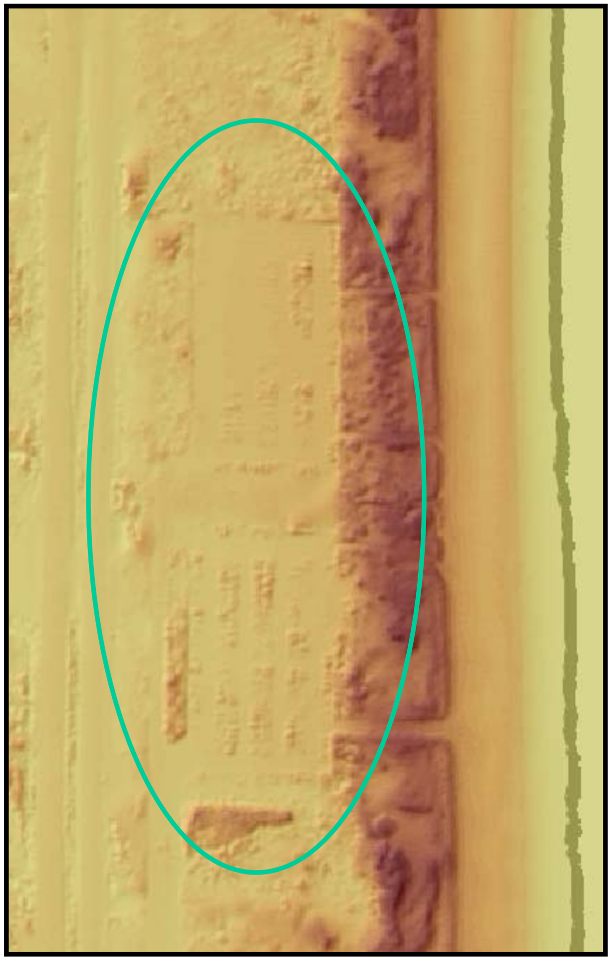
Steps:	Notes:
1. Look for incorrect "bare earth" elevations. The ArcMap Identify tool will help determine elevations. 2. Create the Bare Earth Modification Features. 3. Process the modifications.	

Exercise C: Cleaning a Bare Earth Model

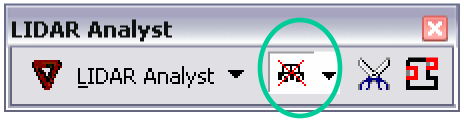
The other method for cleaning bare earth models mentioned at the beginning of this section is an automated tool. During this portion of the exercise we will use this tool and evaluate its results. If needed we will use the same method used for Box 1.

Activate Box 2 Data Frame. First we will use the "**Create Bare Earth Modification Layer**" tool under the ***LIDAR Clean Up Tools*** to begin. **Name the new modification layer "be_modification_regions_Box2.shp"**.

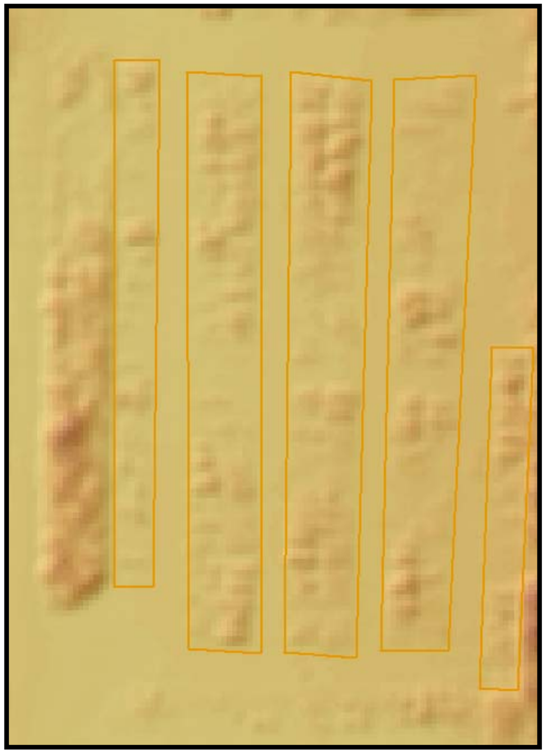
Next, we need to **zoom in on the area to be modified**.



Exercise C: Cleaning a Bare Earth Model

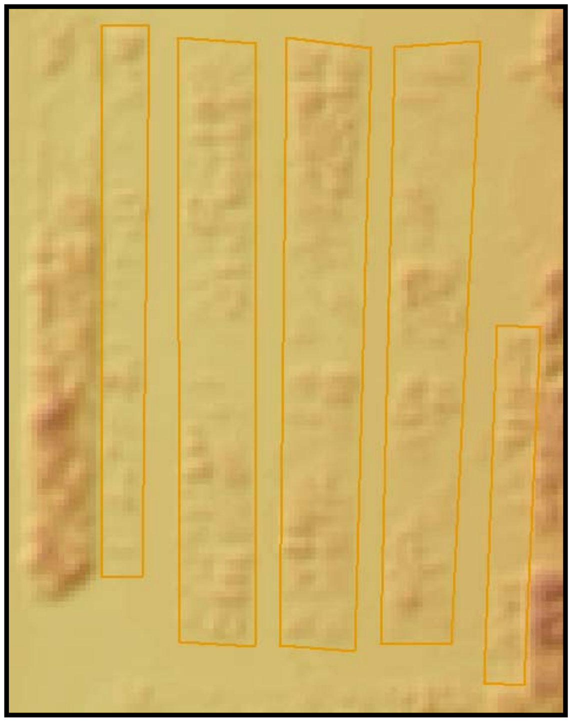


On the ***LIDAR Analyst toolbar***, we select the tool to "**remove shrubs, cars and other low height objects "** tool (indicated to the right). With this tool we **draw a boundary** as tightly as possible around the area containing incorrect elevations – in this example, rows of cars. The image below shows an example boundary in orange.

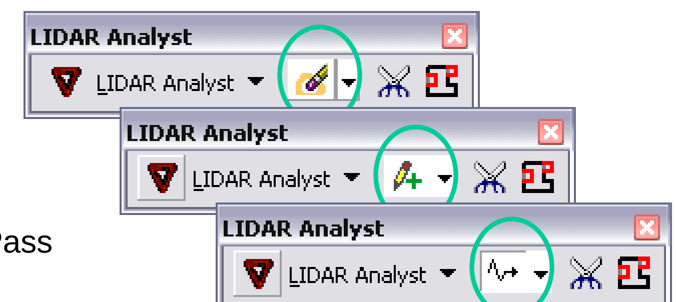


Exercise C: Cleaning a Bare Earth Model

The result of this cleaning effort is shown below. You will notice that little change has occurred. The software manufacturer is aware of this issue and is modifying the code.



As a result, we will use the same tools as used for Box 1 and a Low Pass Filter.



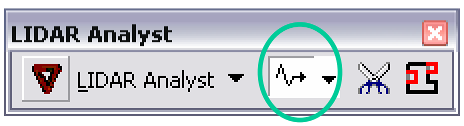
Exercise C: Cleaning a Bare Earth Model

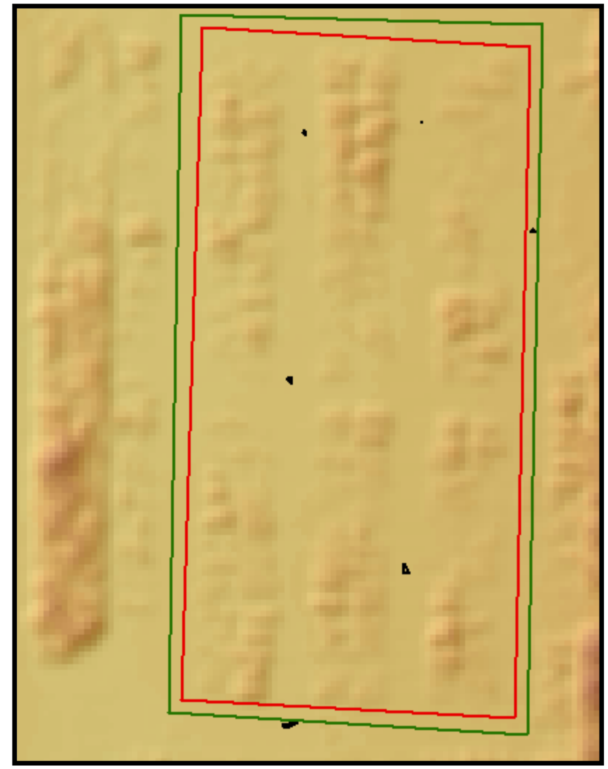
As we attempt to remove the cars from the bare earth model, we will:

identify an area to remove the existing bare earth model (red),

choose locations for adding points (black), and

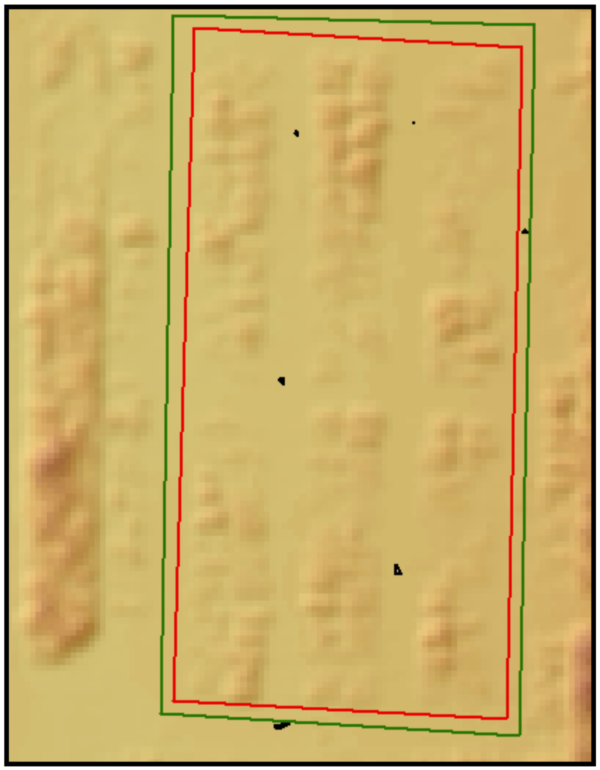
identify an area to run a Low Pass Filter (green) over the area modified.



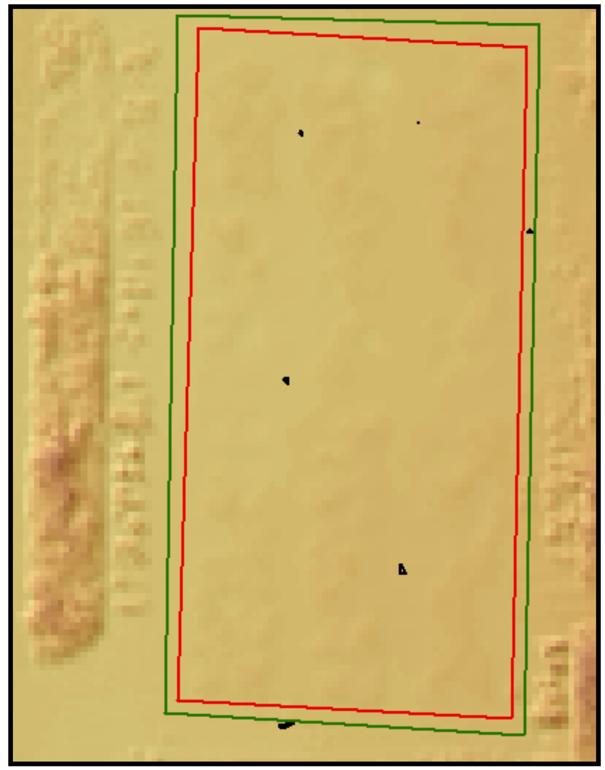


Exercise C: Cleaning a Bare Earth Model

The images below compare the before and after results of running the modification tools with the example polygons. A couple of things stand out from these images almost immediately. First, the cars in the middle of the parking lot were successfully removed. Second, the cars along the edge of the parking lot are closer to the first return results.



Before



After

Exercise C: Cleaning a Bare Earth Model
Individual Exercise

Using the tools discussed thus far, revise the boundaries for the modification polygons in the two parking lots in Box 2 and reprocess the bare earth.

The results of your efforts may appear as the example shown here.

END OF EXERCISE C

Exercise D: Extracting Building Footprints

Background

A bare earth model is useful for a variety of applications. However, much analysis work also requires a knowledge of natural and man-made features that are not part of the bare earth.

This exercise will focus on the LIDAR Analyst's tool for extracting Buildings. The use of this tool produces a shape file containing polygons that represent the building footprints and an attribute table with information about each building polygon. This tool uses many more variables than the tool to extract bare earth, and the value used for each of these can significantly impact the results.

Goal

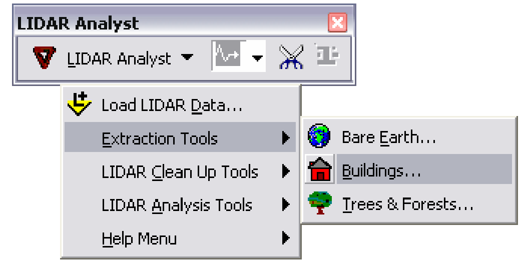
Using the LIDAR Analyst Building extraction tool, create a shape file that depicts the buildings within the dataset.

Objectives

1. Student will be able to generate building footprints using LIDAR Analyst.
2. Student will understand the purpose for each of the variables used by this tool and understand how their modification can impact results.

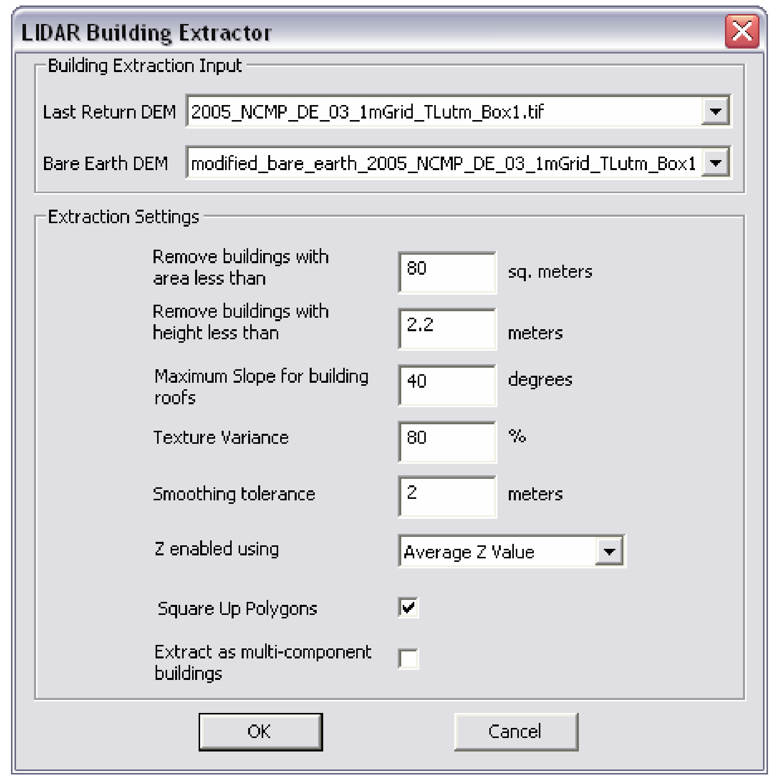
Exercise D: Extracting Building Footprints

From the **LIDAR Analyst toolbar**, select the ***Extraction Tools*** > **Buildings…**



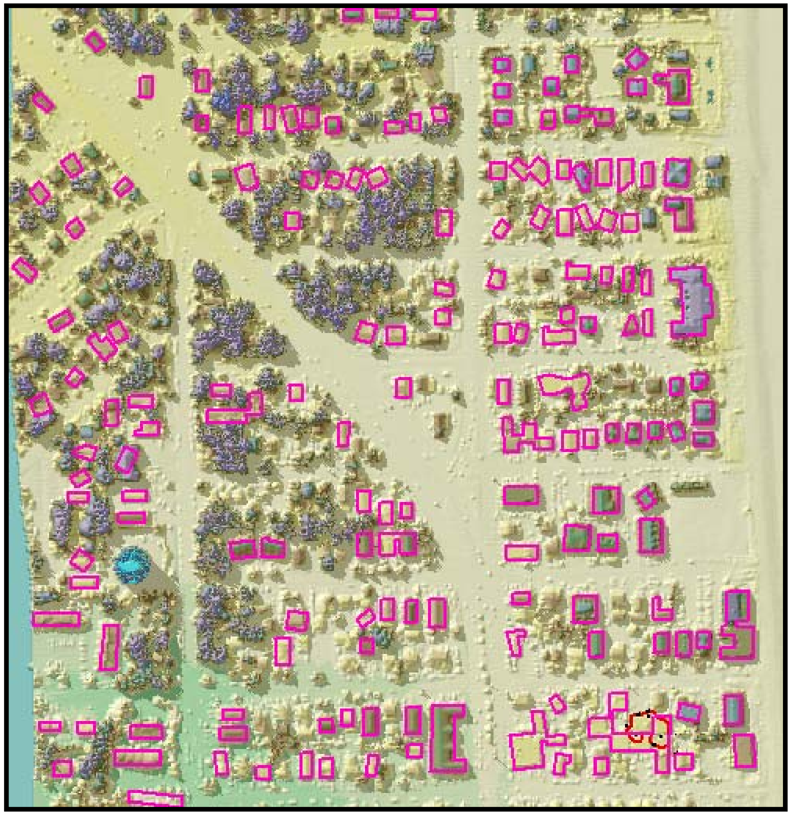
Within the **LIDAR Building Extractor** dialog box, several options are available that greatly affect the building extraction results. For this example, we will use the cut last return image and the final bare earth model generated in Exercise C for the Box 1 area. These should be **2005_NCMP_DE_03_1mGrid_TLutm_Box1.tif** and **modified_bare_earth_2005_NCMP_DE_03_1mGrid_TLutm_Box1.tif**

Our first extraction will use the default Extraction Settings.



Exercise D: Extracting Building Footprints

After running the tool using the default settings, the result shapes should be similar to the ones seen in this image. In this illustration, the background image is the last return hill shade.



Notice that some of the buildings in the upper right quadrant of this image are merged and rotated. Also notice that some buildings were not detected in the lower portion of the image.

We can adjust the settings of the input variables in attempt to fix these problems.

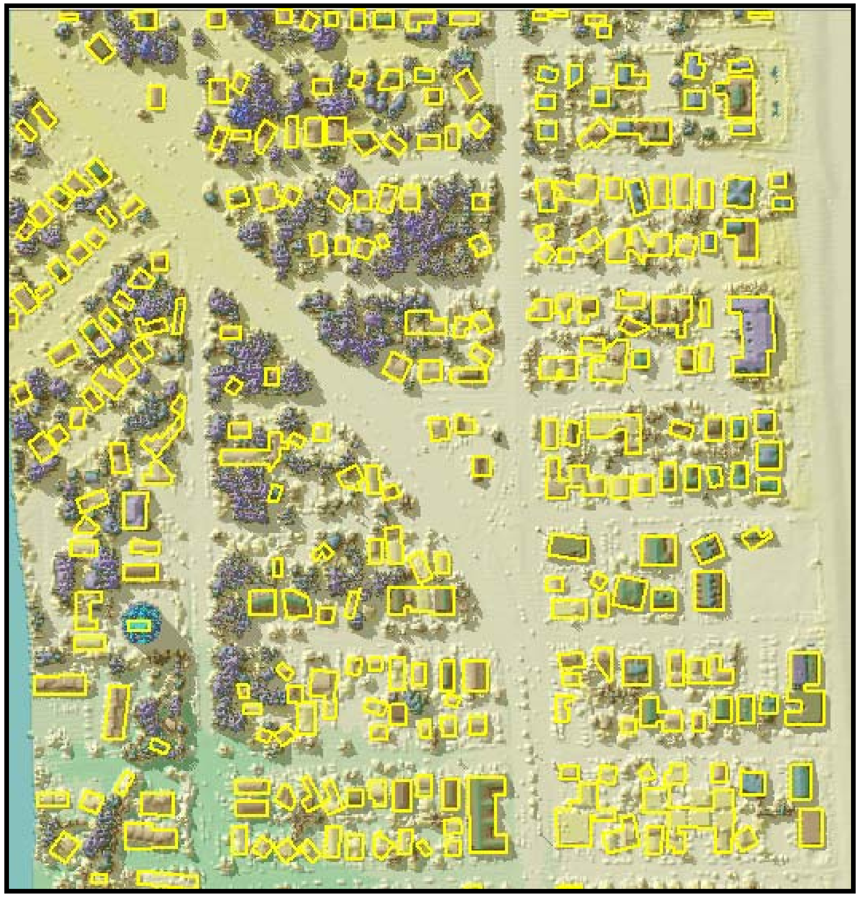
Did You Know?

A text file is created each time the Building Extraction tool runs. This file is named the same as the resulting image, but with a *txt* extension. This file contains the settings used to create that image.

Exercise D: Extracting Building Footprints

If we run the tool again and change the variables to the values below, the results should be similar to the image shown here.

Building Extraction settings :
Min building area: 20
Min building height: 2.200000
Max slope for building roof: 65
Max texture variance: 80.000000
Smoothing tolerance: 2.000000
Square-up buildings: TRUE
Extract buildings as multi componenets: FALSE



Exercise D: Extracting Building Footprints

LIDAR Analyst generates an attribute table for the extracted buildings. The image below shows the characteristics to which values are assigned.

Attributes of Bldgs_sqrd_2005_NCMP_DE_03_1mGrid_TLutm_Box1f.shp

FID	Shape	ShapeNum	ID	Roof_Type	Avg_Ht_AGL	Min_Ht_AGL	Max_Ht_AG	Dev_Ht	Area	Perimeter	Length	Width	Orient_Ang
242	Polygon ZM	242	242	Pitched	4.920202	0.152712	7.189375	7.036662	153.987233	54.916399	19.602850	7.855349	0.477455
243	Polygon ZM	243	243	Pitched	9.251795	5.454544	10.729135	5.274591	108.190588	41.732934	11.246729	9.619738	84.559669
244	Polygon ZM	244	244	Pitched	6.772807	0.562996	8.820161	8.257165	129.590268	45.553381	12.430171	12.394324	151.699249
245	Polygon ZM	245	245	Pitched	9.089095	0.679451	10.174169	9.494718	205.851170	60.622748	20.038686	10.272688	88.103485
246	Polygon ZM	246	246	Pitched	8.767084	1.691337	10.122303	8.430966	217.470470	61.128888	19.291691	11.272753	88.726875
247	Polygon ZM	247	247	Pitched	4.984174	0.697222	7.356009	6.658788	136.893663	46.844930	12.220451	11.202014	160.516724
248	Polygon ZM	248	248	Pitched	6.345345	0.271940	10.654272	10.382332	150.556910	63.541409	20.233910	11.536795	119.845310
249	Polygon ZM	249	249	Pitched	4.114948	0.313435	6.369132	6.055697	152.966667	60.761252	19.373074	11.007552	114.165894
250	Polygon ZM	250	250	Pitched	6.943035	0.109685	9.791466	9.681781	290.269876	69.274217	20.427001	14.210107	174.667839
251	Polygon ZM	251	251	Pitched	9.082000	1.773444	10.256273	8.482830	185.096204	59.279607	20.696404	8.943399	178.078041
252	Polygon ZM	252	252	Pitched	3.479006	1.658710	7.017452	5.358742	102.867208	40.623723	10.681025	9.630837	12.010002
253	Polygon ZM	253	253	Simple,Flat	5.601537	0.482866	6.313088	5.830222	350.302505	77.010972	23.765570	14.739916	87.314682
254	Polygon ZM	254	254	Simple,Flat	3.204863	0.036405	5.047295	5.010890	828.973234	161.519197	39.136342	38.880242	93.447212
255	Polygon ZM	255	255	Pitched	6.803830	0.148881	9.441294	9.292413	458.754676	98.219368	33.399580	15.710104	3.272141
256	Polygon ZM	256	256	Pitched	3.465099	0.668722	4.876787	4.208065	140.286929	47.378204	11.924930	11.764172	117.255653
257	Polygon ZM	257	257	Complex	9.411980	0.305224	10.611575	10.306351	970.161765	158.069962	48.361485	24.097335	91.938560
258	Polygon ZM	258	258	Pitched	3.877048	0.055807	6.888423	6.832616	333.699328	84.766578	21.846185	20.537104	13.284775
259	Polygon ZM	259	259	Pitched	3.485538	0.085224	4.998506	4.913282	159.378167	53.420073	17.711432	8.998604	88.976234
260	Polygon ZM	260	260	Pitched	4.160558	0.427382	6.146829	5.719447	166.125432	53.557543	17.015709	9.763063	84.936371
261	Polygon ZM	261	261	Pitched	4.530771	0.357470	10.780671	10.423201	121.709450	45.969973	14.712423	8.272563	82.626305
262	Polygon ZM	262	262	Pitched	5.207738	0.749736	10.144605	9.394869	56.614169	31.039894	9.658136	5.861811	129.173656
263	Polygon ZM	263	263	Pitched	5.025060	0.526289	6.055642	5.529354	82.999619	36.442093	9.155427	9.065619	174.805573
264	Polygon ZM	264	264	Pitched	2.797676	0.129448	6.071049	5.941601	1395.335643	313.732765	58.997670	56.573880	175.067223
265	Polygon ZM	265	265	Pitched	4.021517	0.131899	5.352484	5.220585	183.839534	57.256022	18.902166	9.725845	84.288185
266	Polygon ZM	266	266	Pitched	5.489763	0.542297	8.534457	7.992160	193.413434	56.006860	15.624856	12.378574	54.940300
267	Polygon ZM	267	267	Pitched	5.752216	0.125022	7.920329	7.795307	98.120557	39.676456	10.437059	9.401169	55.080551
268	Polygon ZM	268	268	Pitched	4.289257	0.559264	6.517928	5.958663	150.313944	49.918009	14.808457	10.150547	85.424141
269	Polygon ZM	269	269	Pitched	4.591040	0.736805	6.864280	6.127475	127.687304	47.866479	18.716744	13.260168	98.901623
270	Polygon ZM	270	270	Pitched	4.597268	0.086060	6.642953	6.556893	205.218499	83.703752	21.694802	20.157074	131.633739
271	Polygon ZM	271	271	Pitched	3.743439	1.058827	8.491058	7.432231	53.508413	30.925726	10.234753	5.228110	174.897835
272	Polygon ZM	272	272	Pitched	3.185509	0.204310	6.384765	6.180455	332.518611	94.896537	38.900297	8.547971	174.615532
273	Polygon ZM	273	273	Pitched	3.263353	1.220374	4.320667	3.100293	50.0625	31.25	11.125	4.5	0
274	Polygon ZM	274	274	Pitched	3.497258	0.613275	6.416329	5.803054	45	36	15	3	180

Record: 1 Show: All Selected Records (0 out of 275 Selected.) Options

Exercise D: Extracting Building Footprints
Individual Exercise

Generate the Building footprints for the Box 2 area and modify settings as necessary to achieve the best automated results.

Steps:	Notes:
1. Activate Box 2 data frame. 2. Run Extract Building tool. 3. Examine results. If results are poor, look at the slope and aspect images for the area to estimate appropriate values for variables. 4. Reprocess as necessary	

END OF EXERCISE D

Exercise E: Extracting Trees & Forests

Background

Knowledge of tree coverage and the characteristics of the trees can be very valuable information. Having these data for two surveys could allow one to determine timber growth rates or changes in land use.

LIDAR Analyst provides a tree and forest extraction tool that provides attributes of individual or groups of trees.

Goal

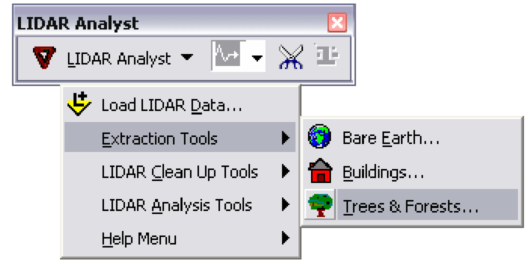
Using the LIDAR Analyst Trees & Forests extraction tool, create shape files that depict the location of trees and forests within the dataset.

Objectives

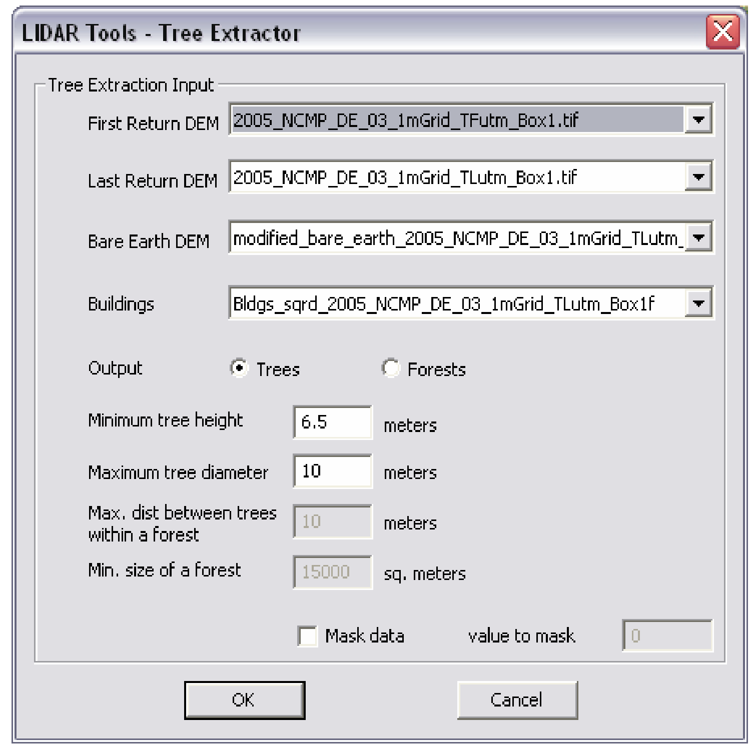
1. Student will be able to extract tree locations and characteristics using LIDAR Analyst.
2. Student will be able to extract forest locations and characteristics using LIDAR Analyst.

Exercise E: Extracting Trees & Forests

From the **LIDAR Analyst toolbar**, select the ***Extraction Tools*** > **Trees & Forests…**



Within the **LIDAR Tools – Tree Extractor** dialog box, several options are available that greatly affect the building extraction results. For this example, we will use the cut first and last return images, the final bare earth model generated in Exercise C for the Box 1 area and the final building footprint results from Exercise D. These should be **2005_NCMP_DE_03_1mGrid_TFutm_Box1.tif, 2005_NCMP_DE_03_1mGrid_TLutm_Box1.tif, modified_bare_earth_2005_NCMP_DE_03_1mGrid_TLutm_Box1.tif**, and **Bldgs_sqrd_2005_NCMP_DE_03_1mGrid_TLutm_Box1?** (where the "?" is the last iteration letter assigned by LIDAR Analyst).



When extracting trees, make sure the minimum tree height is set to a value that corresponds with the size vegetation you desire to be called a tree.

The resulting shape file contains dots indicating the locations of extracted trees.

Exercise E: Extracting Trees & Forests

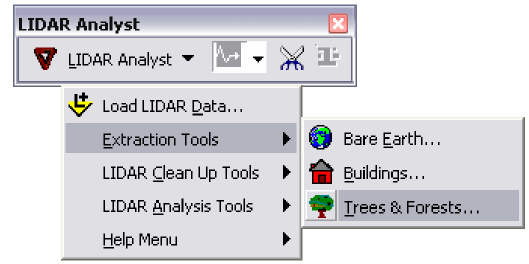
LIDAR Analyst generates an attribute table for the extracted trees. The image below shows the characteristics to which values are assigned.

Attributes of trees_2005_NCMP_DE_03_1mGrid_TLutm_Box1.shp

FID	Shape	ID	TreeHeight	CrownWidth	Stem_Dia
0	Point ZM	0	16.63078	5.00704	0.33557
1	Point ZM	1	12.96601	4.02977	0.29486
2	Point ZM	2	20.10418	6.15667	0.38346
3	Point ZM	3	20.04366	6.13478	0.38255
4	Point ZM	4	8.93433	3.23423	0.26173
5	Point ZM	5	11.01732	3.60868	0.27732
6	Point ZM	6	19.02827	5.77733	0.36766
7	Point ZM	7	10.00456	3.41685	0.26933
8	Point ZM	8	8.65243	3.18956	0.25986
9	Point ZM	9	16.55046	4.98303	0.33457
10	Point ZM	10	15.35795	4.64019	0.32029
11	Point ZM	11	11.48044	3.70255	0.28123
12	Point ZM	12	10.37273	3.48445	0.27215
13	Point ZM	13	21.05464	6.50914	0.39814
14	Point ZM	14	10.39684	3.48896	0.27234
15	Point ZM	15	10.44373	3.49776	0.2727
16	Point ZM	16	9.55288	3.33726	0.26602

Exercise E: Extracting Trees & Forests

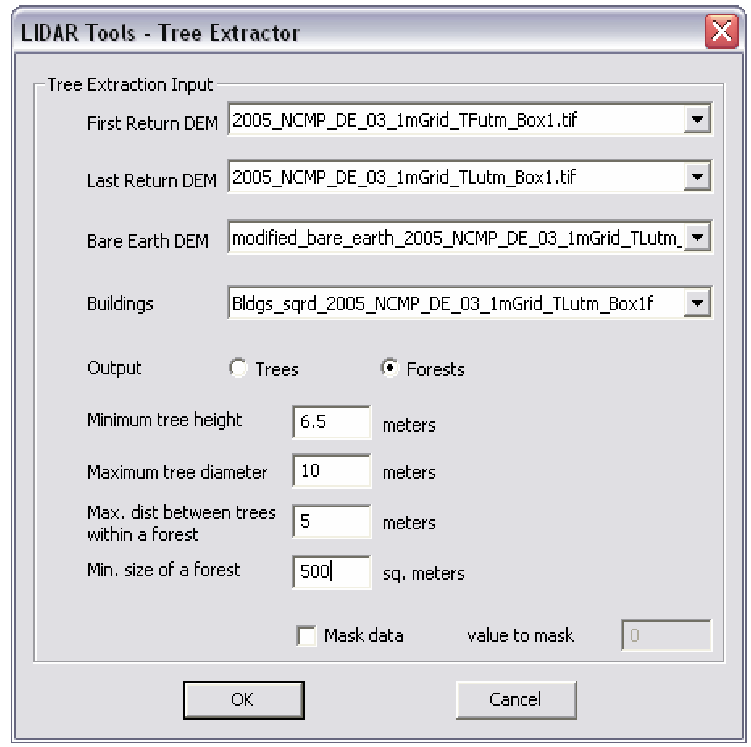
From the **LIDAR Analyst toolbar**, select the ***Extraction Tools*** > **Trees & Forests…**



After extracting the trees, run the same tool, but select **Forests** as the output. Again, we will use the cut first and last return images, the final bare earth model generated in Exercise C for the Box 1 area and the final building footprint results from Exercise D. These should be **2005_NCMP_DE_03_1mGrid_TFutm_Box1.tif, 2005_NCMP_DE_03_1mGrid_TLutm_Box1.tif, modified_bare_earth_2005_NCMP_DE_03_1mGrid_TLutm_Box1.tif**, and **Bldgs_sqrd_2005_NCMP_DE_03_1mGrid_TLutm_Box1?** (where the "?" is the last iteration letter assigned by LIDAR Analyst).

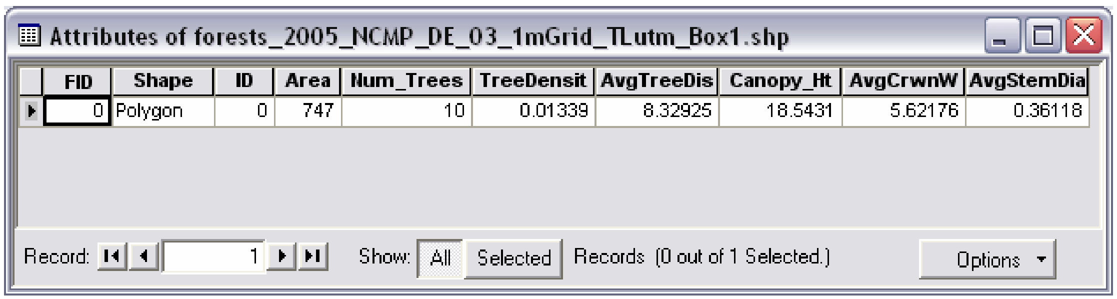
When extracting forests, set the tree height and diameter values the same as used for the tree extraction. Verify the distance between trees and minimum overall size of a group of trees meet your criteria for a forest.

The resulting shape file contains a polygon for each forest extracted.



Exercise E: Extracting Trees & Forests

LIDAR Analyst generates an attribute table for the extracted forest(s). The image below shows the characteristics to which values are assigned.


Attributes of forests_2005_NCMP_DE_03_1mGrid_TLutm_Box1.shp

FID	Shape	ID	Area	Num_Trees	TreeDensit	AvgTreeDis	Canopy_Ht	AvgCrwnW	AvgStemDia
0	Polygon	0	747	10	0.01339	8.32925	18.5431	5.62176	0.36118

Exercise E: Extracting Trees & Forests
Individual Exercise

Extract the Trees & Forests the Box 2 area and modify settings as necessary to achieve the best automated results.

Steps:	**Notes:**
1. Activate Box 2 data frame. 2. Run Tree Extractor tool. 3. Examine results. If results are poor, revise the input variables as appropriate. 4. Reprocess as necessary	

END OF EXERCISE D