LVIS Lidar Data Collected in Gabon
Opening and Viewing LVIS Data

http://lvis.gsfc.nasa.gov
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INTRODUCTION

Airborne lidar (laser scanning) data was collected using NASA's Land Vegetation and Ice Sensor (LVIS) in Gabon in February and March 2016. The data have been processed and are available on the internet for download. Please visit the LVIS web page to download the data and get more information:
http://lvis.gsfc.nasa.gov/Gabon_2016.html

These set of exercises represent an introduction to locating and downloading LVIS data files from the LVIS website, to understanding the contents of the data files, and to open and view the elevation and height data in a freely available GIS software package.

For help and more information, please contact:

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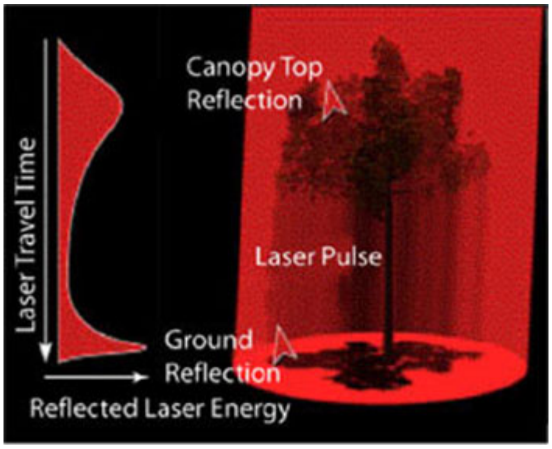
Background

The LVIS system was mounted on the NASA Langley King Air B200 (Figure A) and measured the earth through a hatch in the bottom of the airplane.

Figure A: NASA Langley King Air in Gabon

The LVIS system sends laser beams to the earth, which are reflected by all objects in the laser path and the returned waveform is recorded by the LVIS system. Vertical profiles of the vegetation can be obtained as canopy gaps allow for the laser to penetrate to the forest floor and thus reflect energy at all different layers of the vegetation. A vertical profile is returned, providing all information on the vertical vegetation profile (Figure B). The diameter of the laser footprint that reaches the ground is approximately 25 meters, meaning that information on the vegetation within that 25-meter footprint is captured in the waveform signal.



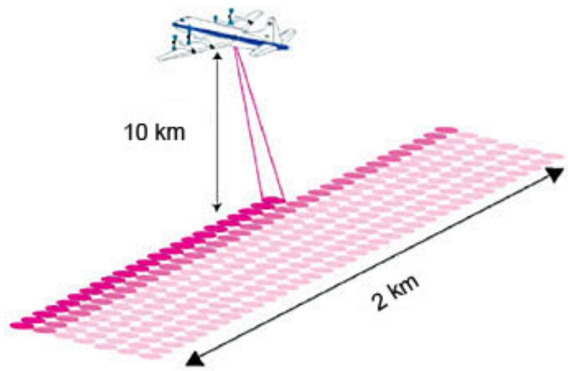


Figure B (left): example of lidar waveform signal and vegetation sample

Figure C (right): visualization of LVIS spatial sampling pattern

LVIS has a swath width of approximately 2 km. A swath consists of multiple, sometimes overlapping footprints typically 20 m in diameter and separated by 10 m along and across track (in Gabon). The laser scans from left to right, then right to left, perpendicular to the direction of flight as the plane flies along predefined fight paths. The footprint pattern on the ground will be dense, approximately equi-spaced (Figure C).

Suggested background reading:

Blair, J. and Rabine, D. and Hofton, M., The Laser Vegetation Imaging Sensor: a medium-altitude, digitisation-only, airborne laser altimeter for mapping vegetation and topography, ISPRS Journal of Photogrammetry and Remote Sensing, 54 115—122, DOI: 10.1016/S0924-2716(99)00002-7, 1999

Hofton, M. and Blair, J. and Minster, J. and Ridgway, J. and Williams, N. and Bufton, J. and Rabine, D. An airborne scanning laser altimetry survey of Long Valley, California, International Journal of Remote Sensing 21, DOI: 10.1080/0143116005003054 , 2000

Dubayah, R. O. and Sheldon, S. L. and Clark, D. B. and Hofton, M. A. and Blair, J. B. and Hurtt, G. C. and Chazdon, R. L, Estimation of tropical forest height and biomass dynamics using lidar remote sensing at La Selva, Costa Rica, Journal of Geophysical Research-Biogeosciences, 115, DOI: 10.1029/2009JG000933, 2010

Software needed to complete this course

The software that we use to visualize LVIS Level 2 data is QGIS, a free open source GIS software package. For more details, please visit http://www.qgis.org

To download a copy of the software, please visit:
http://www.qgis.org/en/site/forusers/download.html
and install the current version of the software.
In this module, we have used version 2.18 for the Mac.

We have installed GDAL also as part of QGIS; this should come with the download bundle.

Modules to look at LVIS Level 1B waveform data require Python. Python typically comes preinstalled on a Mac and you only need install the Python package h5py (http://www.h5py.org/) for HDF format files. Please talk to your system administrator.
(A suggested way to install this module is to use a Package management system such as PIP: download this from https://bootstrap.pypa.io/get-pip.py. At a terminal prompt, type
sudo python get-pip.py
sudo pip install h5py)

LVIS Flights in Gabon, 2016

Seven LVIS flights were flown in Gabon, each targeted to a different interest area. Trajectories for each flight are available online. You can download these trajectories and view them in Google Earth or other software. You can also use the LVIS web site:

- Navigate to the website: http://lvis.gsfc.nasa.gov/Gabon2016Map.html

Underneath the map you can tick the boxes to find out where data was collected on the different collection dates. Navigate to Gabon on the map and explore where data was collected. Today we are going to use the data that was collected on March 8th, 2016. This was a flight that covered Pongara and Mondah areas.

You can use this map to identify which flight days may contain data that you are interested in. Make a note of the day, as you will need this to help download a data file later.

Data Files

For LVIS there are two different datasets available: Level 1B and Level 2. The level indicates the amount of processing the data has undergone before it was published. Level 1B data contains georeferenced lidar return waveforms. The Level 2 data contains georeferencing information for different reflecting surfaces within the laser footprint, the locations of which have been derived from the Level 1B waveform. The Level 2 data is similar to a 'point cloud' file that you would receive from a commercial lidar instrument. Typical parameters are ground elevation, canopy top elevation, canopy height and several other 'height metrics' which will be explained later in detail.

We will start exploring the Level 2 data first before looking at the more complicated waveform data.

- Navigate to the website: http://lvis.gsfc.nasa.gov/Gabon_2016.html

On this internet page you can download all the data in data chunks. The data is organized by target area. (To understand where the different areas are, please use the map showing where and when data were collected at http://lvis.gsfc.nasa.gov/Gabon2016Map.html)

Today we are going to use the data that was collected on March 8th, 2016.

- Find the Level2 datasets that were collected on March 8th, covering Mondah National Park (don't download them)

As you can see, there are 18 .TXT files for this flight day. Every file is approximately 120 MB. In order to speed up the class today, we have prepared a subset of the data for viewing and analysis. This should be downloaded to your computer already.

- Find the file named LVIS_Mondah_level2.TXT on your computer
- Open the file in a text editor

As this is a simple .txt file, we can open it in a text editor and explore what the data looks like. Notice that the file has 12 lines of comments and 1 header line before the actual data begins. The header line gives information about the column names. The column names are all abbreviations. More information about the abbreviations and how to interpret them can be found on the LVIS website:

- Navigate to the document http://lvis.gsfc.nasa.gov/data_sets/2016_gabon/LVIS_GabonAfriSAR_data_release.pdf

Page 3 contains the abbreviations of the column names in the Level 2 dataset we are currently looking at.

- Familiarize yourself with the column names and answer the following questions

1. *Where can we find information on the location of each laser footprint?*
2. *In which column is information about the ground elevation stored?*
3. *Which column contains information on the canopy top elevation?*
4. *Which column contains information on the canopy height?*

TUTORIAL
Displaying LVIS Data in QGIS

This exercise will work with any of the Level 2 TXT files downloaded directly from the LVIS website:

http://lvis.gsfc.nasa.gov/Gabon_2016.html

Each file is approximately 120 MB, so in order to speed things up, we have prepared a subset of data for viewing and analysis. This should be downloaded to your computer already: LVIS_mondah_level2.TXT. This dataset was collected on March 8th, 2016 over Mondah National Park.

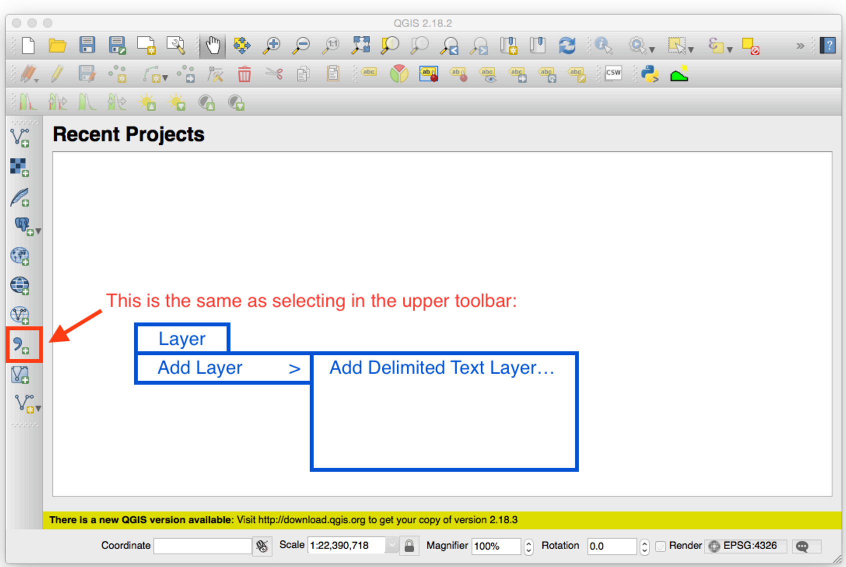
Open up QGIS by clicking on this icon: 

STEP 1: Open a Level 2 file in QGIS

We are going to read in LVIS_mondah_level2.TXT as a Delimited Text Layer. You can do this in 2 different ways:

1.A. Click on this symbol in the vertical tool bar to the left: 
1.B. ***OR*** select in the upper tool bar: Layer -> Add Layer -> Add Delimited Text Layer

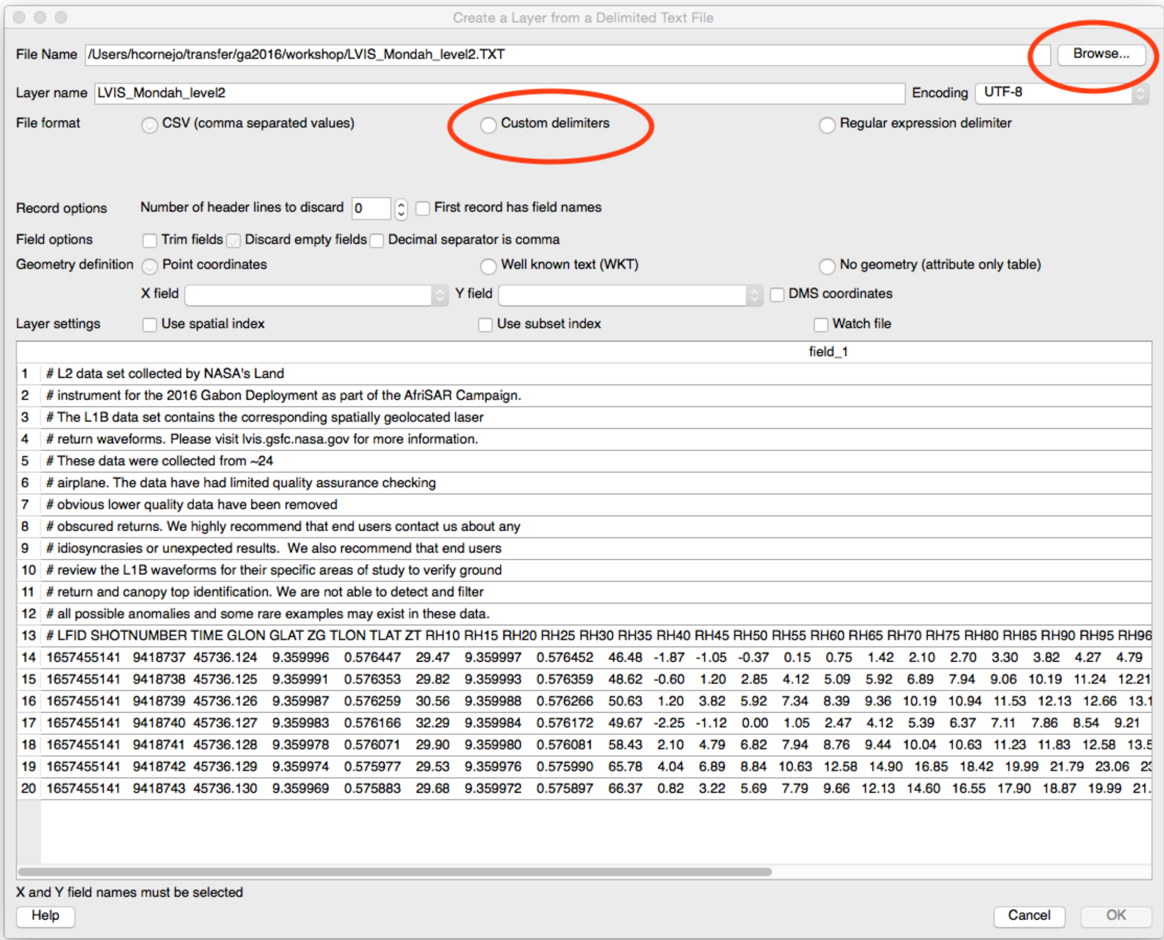
Figure 1: Screenshot of first QGIS GUI



STEP 2: Read in the Level2 file with the correct options

This screen should pop up:

Figure 2: Screenshot of the data ingest GUI in QGIS



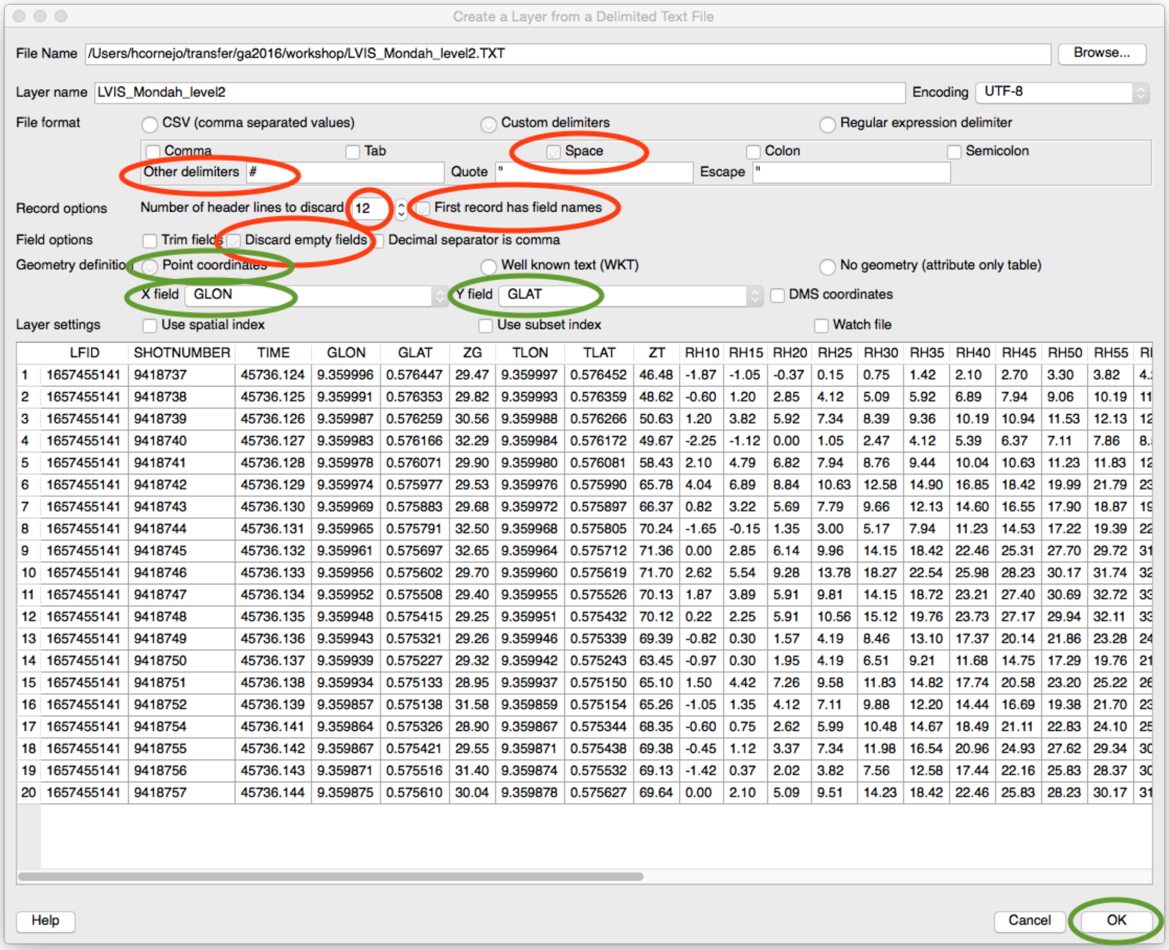
2.1. Browse to your file LVIS_mondah_level2.TXT

You will see the contents of the text file appear in the window. We need to select some options to read in this data correctly:

2.2. Click on the button Custom Delimiters

Several more options will appear as in *Figure 3*:

Figure 3: Adjusting the options to read in LVIS Level 2 data



2.3. Click on Space

2.4. In the Other Delimiters box enter the symbol # that LVIS uses to denote lines of text

2.5. In the Number of header lines to discard enter 12

2.6. Click on First record has field names

2.7. Click on Discard empty fields

Now QGIS is reading in the file correctly. Next step is to select which variables we want to plot.

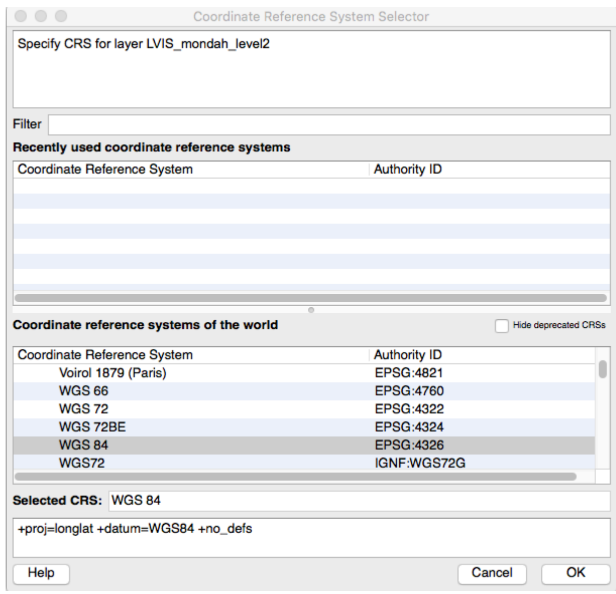
2.8. Click on Point coordinates

2.9. Select GLON for the X field and GLAT for the Y field

2.10. Click OK

2.11. Select the Reference System. A box labeled Coordinate Reference System Selector should pop up (*Figure 4*). LVIS data is referenced to the ellipsoid WGS 84, so select WGS 84 and click OK

Figure 4: Screenshot of the reference frame selection



Be patient. Even though this is a spatial subset, it is still quite a big file. Points for each single laser return are now drawn on your screen. The display will need adjusting for better viewing.

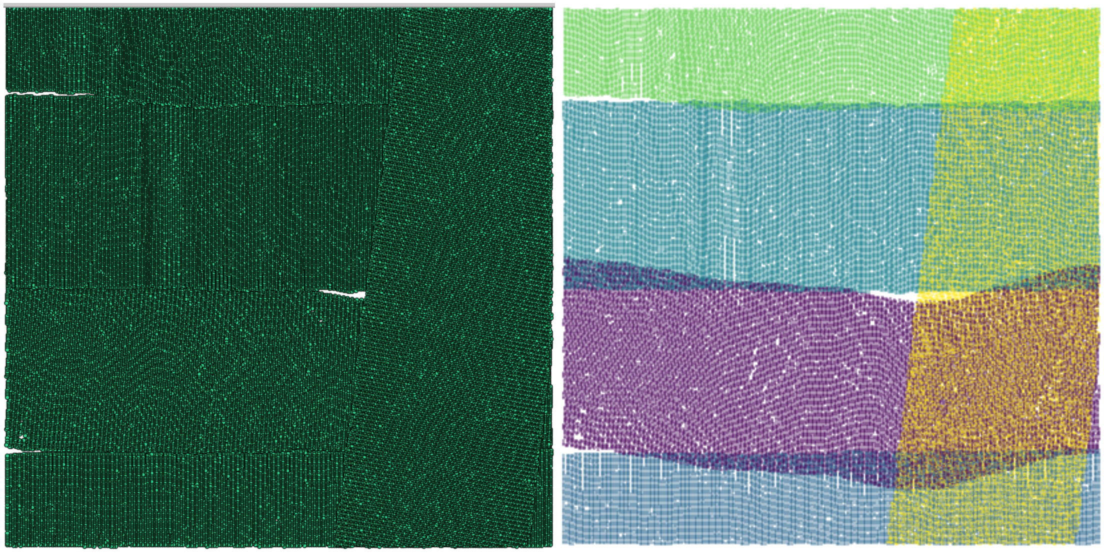
STEP 3: A First Look at LVIS Data

For now you can only see the location of the shots on the ground.

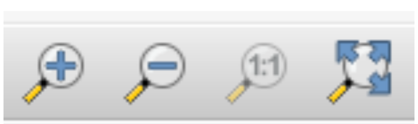
> *Q1. Can you distinguish a plane swath and the across-track scanning of the laser?*
>
> *Q2. How many swaths can you see in total? Do they overlap?*

In Figure 5 we have included an image of the swaths with individual colors to make the distinction easier. You will learn how to do this later in the lesson.

Figure 5

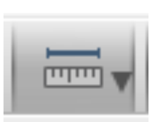


Try zooming in on the data. Can you distinguish the individual points? To zoom in and out, you can use these icons or use your mouse



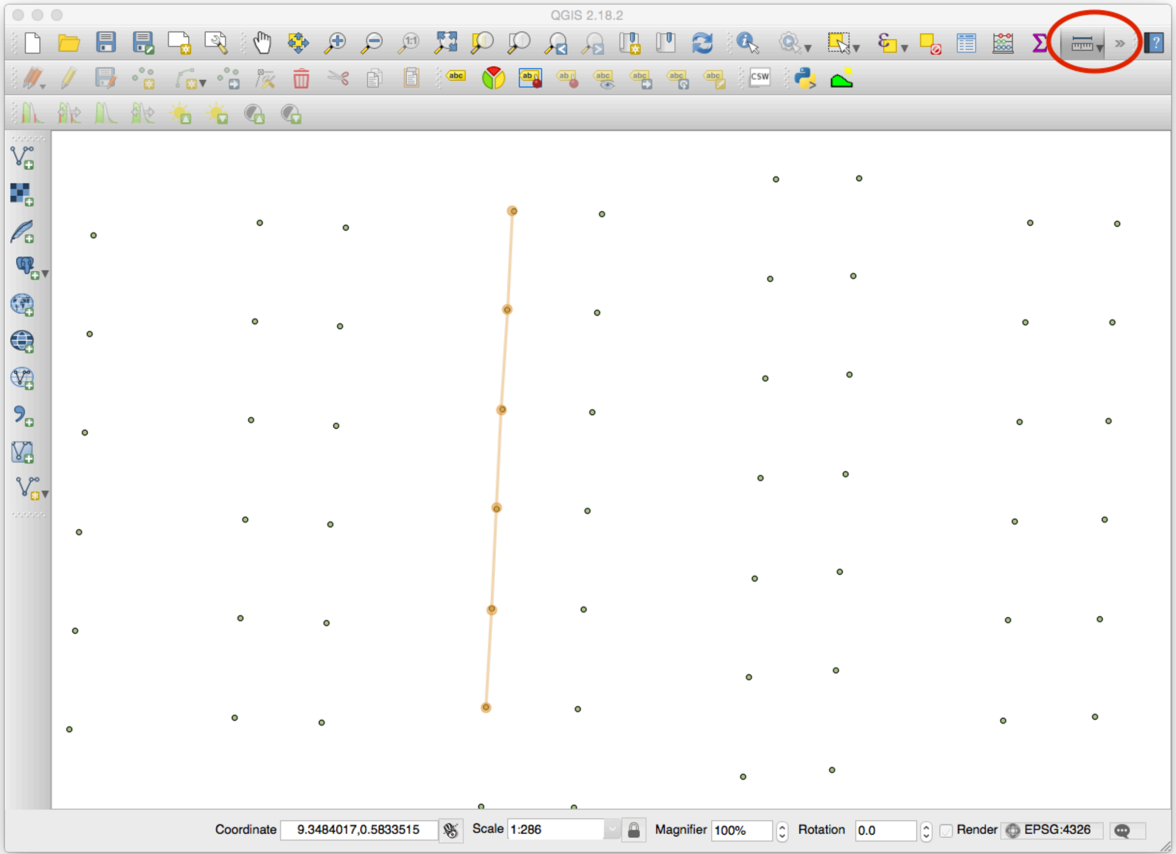
If you want to restore your map to its original state, click on the last magnifier glass with the 3 outwards-pointing arrows.

QGIS allows us to measure the distance between two footprints and more. Look for the little ruler icon at the top right of your screen. You may have to click on an arrow to reach it.



This brings up a tool that will measure any distance you can measure on the map just by clicking two separate locations.

Figure 6



Q3. What is the approximate distance between two consecutive footprints?

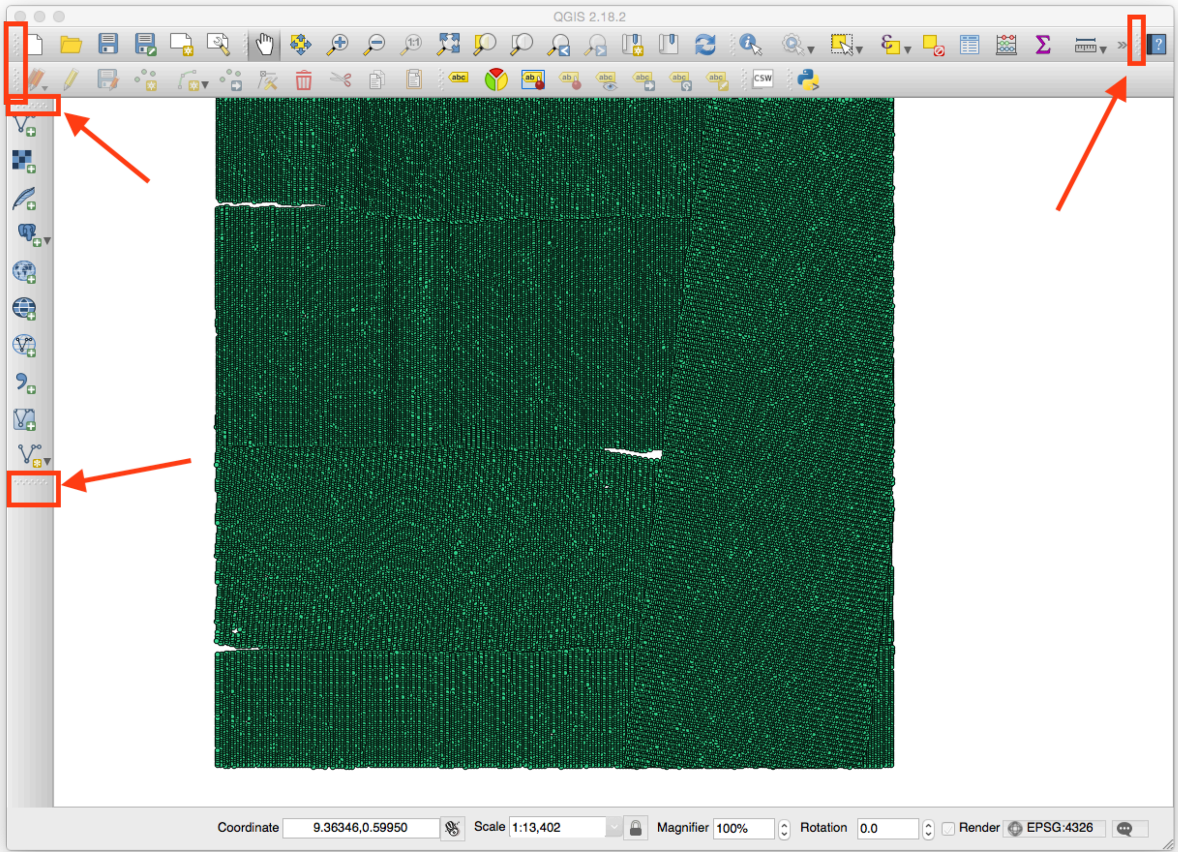
Q4. What is the approximate width of an LVIS swath?

Q5. What is the approximate area of Mondah that we are studying? You can calculate it by measuring the sides, or you can use the Measure Area option from the ruler icon.

STEP 4: Visualizing LVIS Level 2 Data in QGIS

If you do not have the Layers Panel on your screen, find any one of the light gray dots in the toolbars (*Figure 7*). When you hover your cursor over it, it should become a white cross. Right-click, and select Layers Panel. A box should appear with the available layer names. You should just have the one layer you have been working on: LVIS_Mondah_level2.

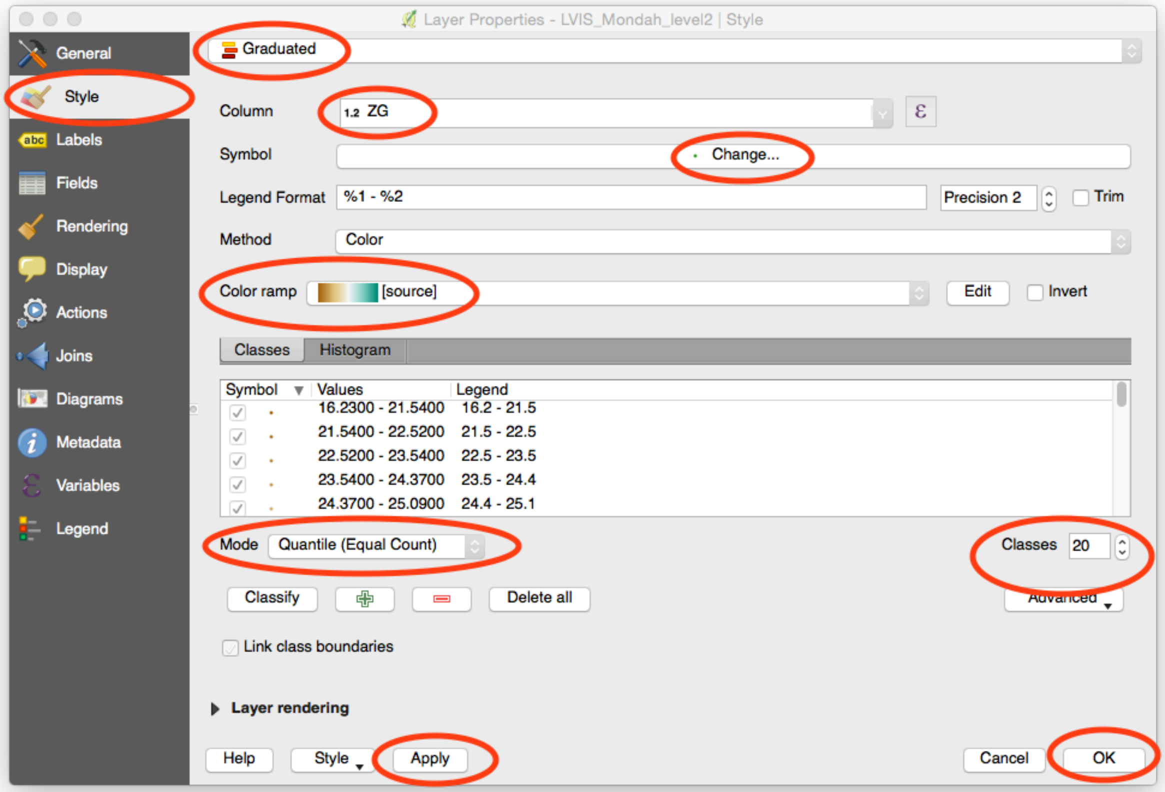
Figure 7: Where to find the extra options



We need to modify the properties of this layer.

4.1. Double-click on the layer name LVIS_Mondah_level2 and a box titled Layer Properties will appear (*Figure 8*). Alternately, you can left-click on the layer name, and select Properties in the pop-up menu.

Figure 8: Screenshot of the Layer Properties GUI



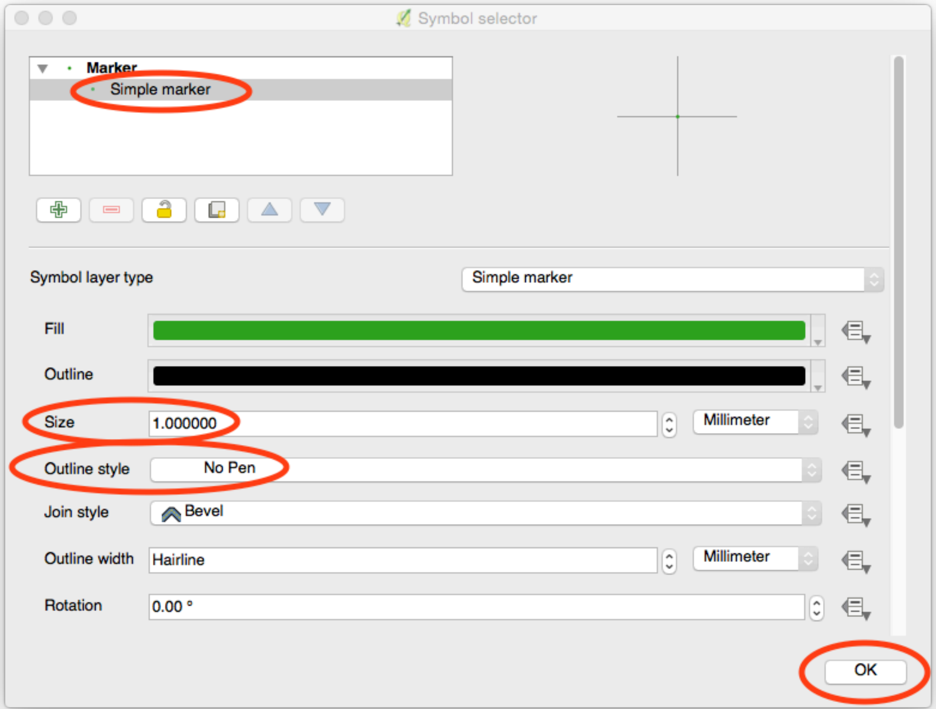
4.2 In the left column click on Style (2nd from top).

4.3 In the top drop-down menu, select Graduated. This means that we want a color scale, with different colors representing different values.

4.4 Next, click on the Column drop-down menu. This shows you all the variables available in the file. Choose ZG. This is the elevation of the ground detected by LVIS.

4.5 Click on the Symbol box where it shows the current marker. We are going to change it. A Symbol Selector panel pops up (*Figure 9*)

Figure 9: Screenshot of the Symbol Selector GUI



4.6. Click on the Simple marker in the 1st box

4.7. In the Symbol layer type, select the 3rd line down, Size, and change the value from 2 to 1 mm. This will make the shots a little clearer on your screen.

4.8. On the 4th line down, Outline Style, click on the drop-down menu and select No Pen instead of Solid Line. This removes the black line around your symbol. (Alternately you could select the color of outline, and set it to Transparent.)

4.9. Click OK to get back to the Layer Properties panel

4.10. Click on Color Ramp and select a color scale that you think will be a good representation of the ground

4.11. Under Mode select Quantile (Equal Count)

4.12. On the right, change the number of Classes to 20

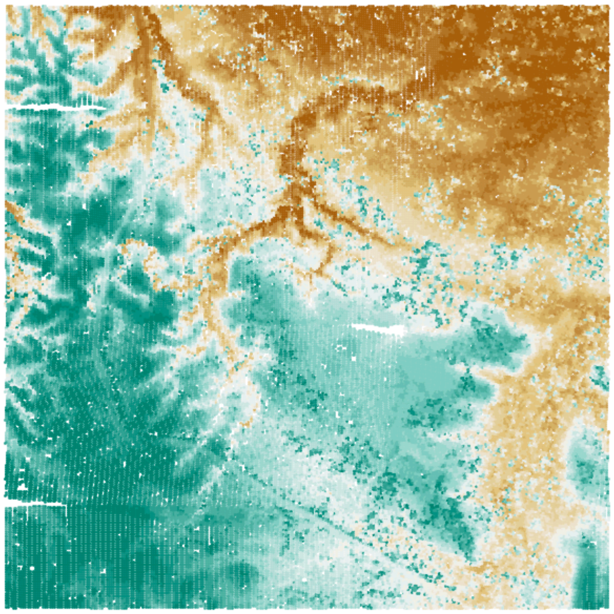
4.13. Click on Apply to see your changes take place on the screen. When you are happy with your choice, click on OK

4.14. In the Layers Panel, click the symbol to the left of your layer's name (LVIS_Mondah_level2). This will show the legend.

Q3. Which part of the scene has the lowest elevation? The highest?

Q4. Describe the landscape based on the elevation of the ground. What kind of features do you recognize?

Figure 10: LVIS ground data colored by elevation



STEP 5: Visualizing the Canopy Height

Now that we know how to look at the ground elevation, we can use the same method to look at canopy height (RH100).

5.1. Navigate back to the Layer Properties panel and to Style

5.2. For Column, select RH100 as our variable to map

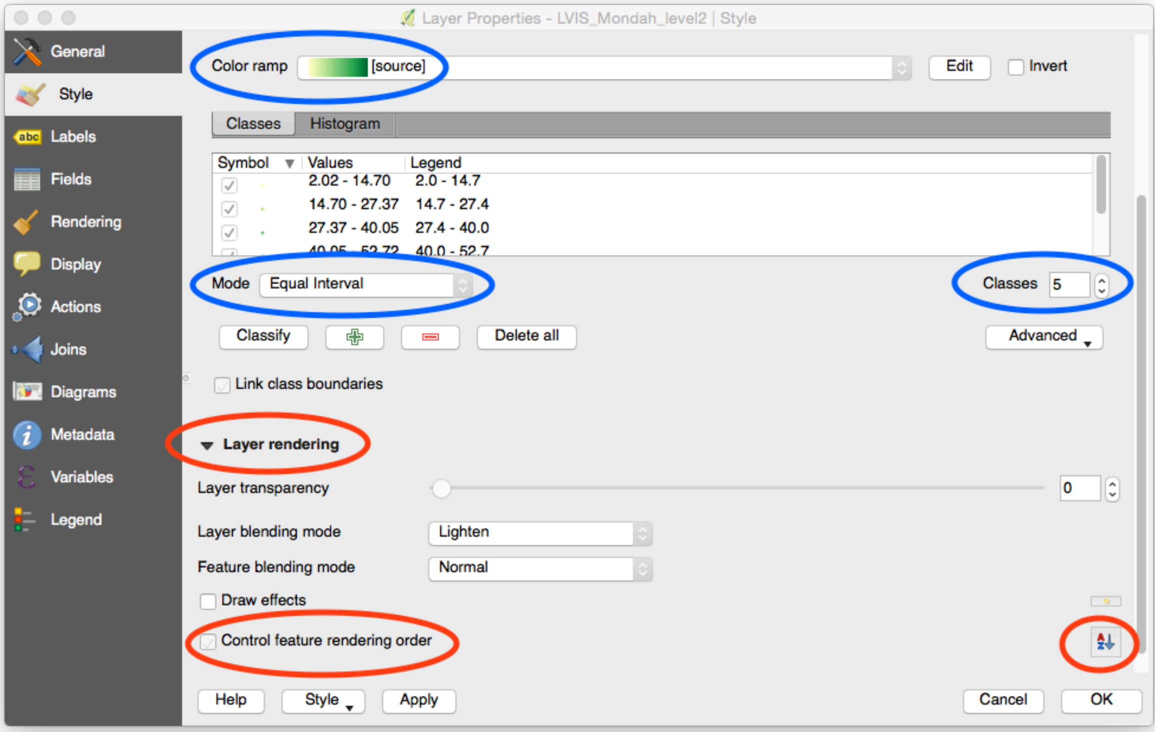
5.3. Select a different color ramp, one that you think will suit the maximum vegetation height

5.4. For Mode, select Equal Interval

5.5. For Classes, select 5

5.6. Click on the arrow to the left of the words Layer Rendering: this will open up a few more options (*Figure 11*)

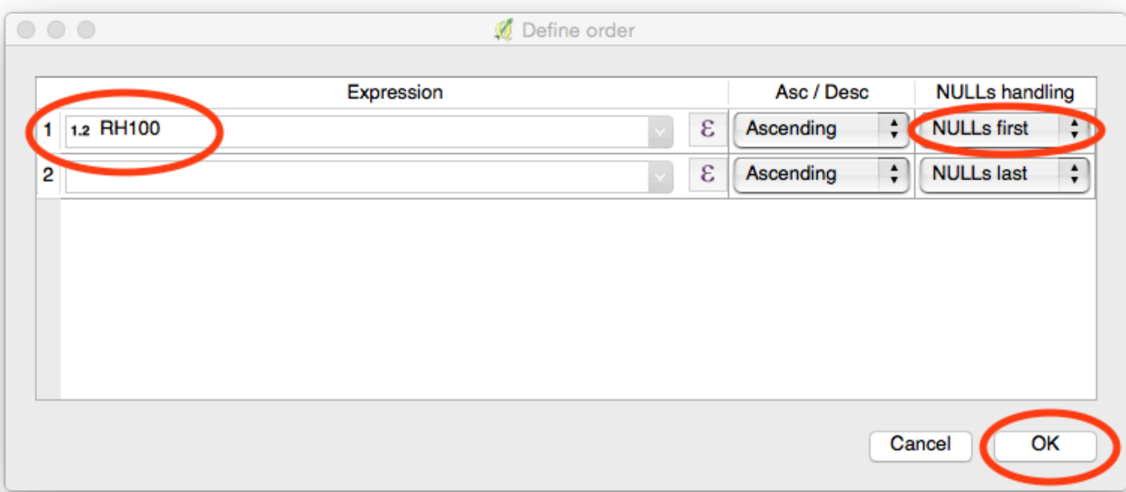
Figure 11: Where to find the Layer Rendering options



5.7. Click on Control feature rendering order; this will activate a small icon to the right

5.8. Click on that icon: a box labeled Define order will pop up (*Figure 12*)

Figure 12



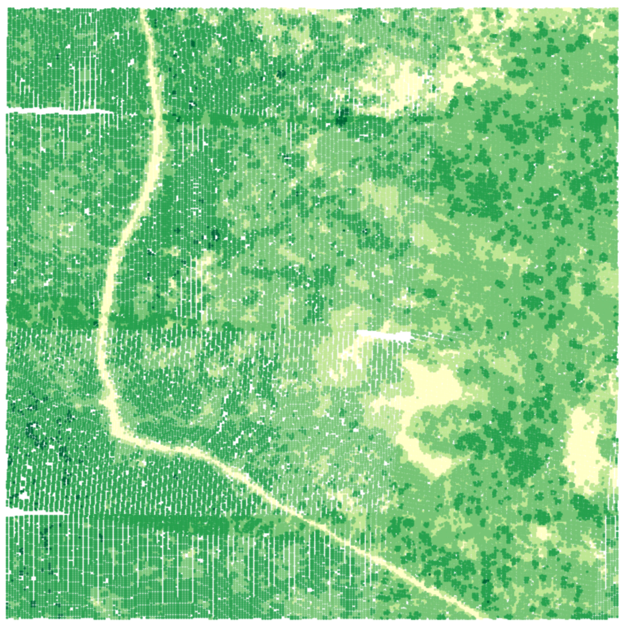
5.9. Under Expression, select RH100

5.10. Under NULLs handling select NULLs first

5.11. Click OK

This controls the order in which the symbols are plotted. This is useful if the symbols overlap. Here we are plotting them in ascending order, that is, the highest locations are plotted last, and are therefore more visible.

Figure 13: LVIS canopy height colored by elevation



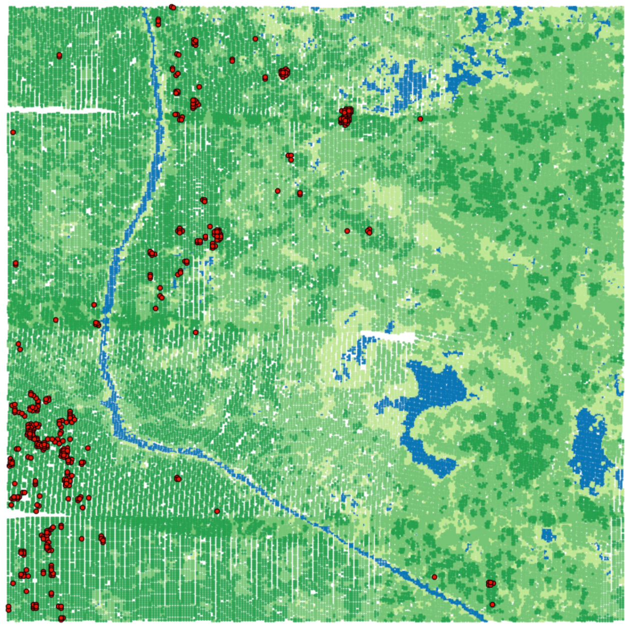
Q5. Where are the highest trees? How high is the highest tree, according to the maximum height measured for all footprints?

We can mark on the map where the highest trees are:

5.12. In the Layers Panel, double-click on the highest elevation band (in this case 52-65 m)

5.13. In the window that pops up, click on Simple Marker. Scroll down and select a color for the Fill and increase the Size. Click OK. The highest trees will now be marked in a different color. Try this with different elevation bands and different symbol colors

Figure 14: Highest and lowest values of RH100



Q6. Where is the lowest vegetation height? Do you recognize these features?

Q7. Make a map of the variable RH50. RH50 is the height above the ground where 50% of the energy was reflected. RH50 can be used as an estimator of above-ground biomass in a forest.

Q8. Try coloring it by TIME. You should get something similar to the 2nd plot in Fig. 5

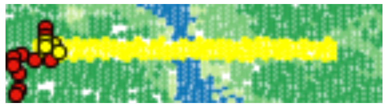
STEP 6: Viewing Level 2 Data in Profile

Each point has several values associated with it, for example ZG and RH100. We have made one map for each value. Another way to look at the data is to see ZG and RH100 simultaneously. When you stand on the ground and look at a forest, you can see both the ground and the vegetation at the same time. We are going to do that here.

6.1. Select an area that you would like to look at in profile. To do this, click on this icon, which is on the upper toolbar to the right:

This allows you to Select Features by area or single click. In this case we are going to select a small area on the map. The profile program plots the data by longitude, so it is best to select a thin horizontal area as in *Figure 15*:

Figure 15: A small area selected on the map

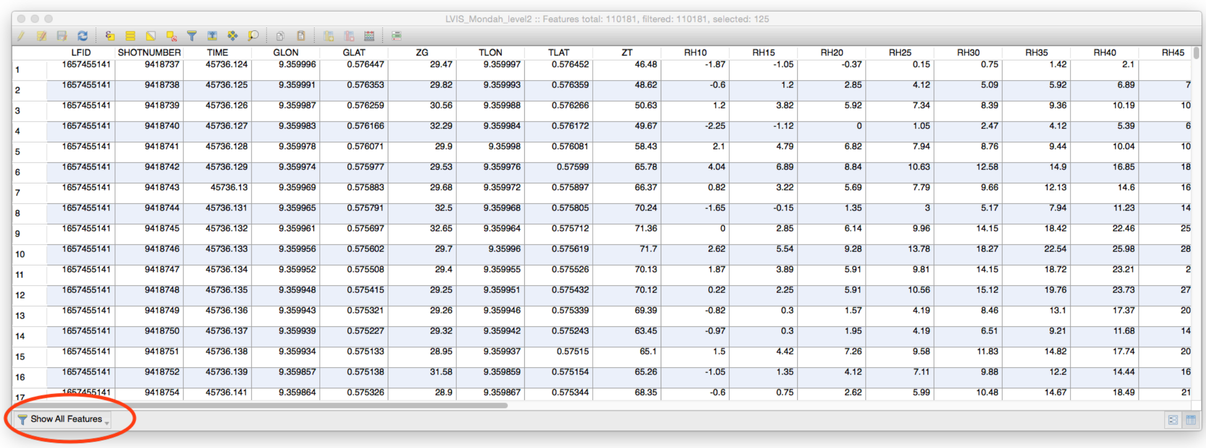


In this example, we have chosen an area that has both tall trees and a portion of the road.

If you are not happy with your selection, simply click on the Deselect Features from all Layers icon and start over:

6.2. Bring up the Layers Panel and right click on your layer, LVIS_Mondah_level2. Click on Open Attribute Table. This opens up a table with all the points and all the values associated with them. We only want to look at the area we selected. In the bottom left-hand corner, click on the drop-down menu, and scroll to Show Selected Features (*Figure 16*):

Figure 16: The Attribute Table



LVIS_Mondah_level2 :: Features total: 110181, filtered: 110181, selected: 125

	LFID	SHOTNUMBER	TIME	GLON	GLAT	ZG	TLON	TLAT	ZT	RH10	RH15	RH20	RH25	RH30	RH35	RH40	RH45
1	1657455141	9418737	45736.124	9.359996	0.576447	29.47	9.359997	0.576452	46.48	-1.87	-1.05	-0.37	0.15	0.75	1.42	2.1	
2	1657455141	9418738	45736.125	9.359991	0.576353	29.82	9.359993	0.576359	48.62	-0.6	1.2	2.85	4.12	5.09	5.92	6.89	7
3	1657455141	9418739	45736.126	9.359987	0.576259	30.56	9.359988	0.576266	50.63	1.2	3.82	5.92	7.34	8.39	9.36	10.19	10
4	1657455141	9418740	45736.127	9.359983	0.576166	32.29	9.359984	0.576172	49.67	-2.25	-1.12	0	1.05	2.47	4.12	5.39	6
5	1657455141	9418741	45736.128	9.359978	0.576071	29.9	9.35998	0.576081	58.43	2.1	4.79	6.82	7.94	8.76	9.44	10.04	10
6	1657455141	9418742	45736.129	9.359974	0.575977	29.53	9.359976	0.57599	65.78	4.04	6.89	8.84	10.63	12.58	14.9	16.85	18
7	1657455141	9418743	45736.13	9.359969	0.575883	29.68	9.359972	0.575897	66.37	0.82	3.22	5.69	7.79	9.66	12.13	14.6	16
8	1657455141	9418744	45736.131	9.359965	0.575791	32.5	9.359968	0.575805	70.24	-1.65	-0.15	1.35	3	5.17	7.94	11.23	14
9	1657455141	9418745	45736.132	9.359961	0.575697	32.65	9.359964	0.575712	71.36	0	2.85	6.14	9.96	14.15	18.42	22.46	25
10	1657455141	9418746	45736.133	9.359956	0.575602	29.7	9.35996	0.575619	71.7	2.62	5.54	9.28	13.78	18.27	22.54	25.98	28
11	1657455141	9418747	45736.134	9.359952	0.575508	29.4	9.359955	0.575526	70.13	1.87	3.89	5.91	9.81	14.15	18.72	23.21	2
12	1657455141	9418748	45736.135	9.359948	0.575415	29.25	9.359951	0.575432	70.12	0.22	2.25	5.91	10.56	15.12	19.76	23.73	27
13	1657455141	9418749	45736.136	9.359943	0.575321	29.26	9.359946	0.575339	69.39	-0.82	0.3	1.57	4.19	8.46	13.1	17.37	20
14	1657455141	9418750	45736.137	9.359939	0.575227	29.32	9.359942	0.575243	63.45	-0.97	0.3	1.95	4.19	6.51	9.21	11.68	14
15	1657455141	9418751	45736.138	9.359934	0.575133	28.95	9.359937	0.57515	65.1	1.5	4.42	7.26	9.58	11.83	14.82	17.74	20
16	1657455141	9418752	45736.139	9.359857	0.575138	31.58	9.359859	0.575154	65.26	-1.05	1.35	4.12	7.11	9.88	12.2	14.44	16
17	1657455141	9418754	45736.141	9.359864	0.575326	28.9	9.359867	0.575344	68.35	-0.6	0.75	2.62	5.99	10.48	14.67	18.49	21

Show All Features

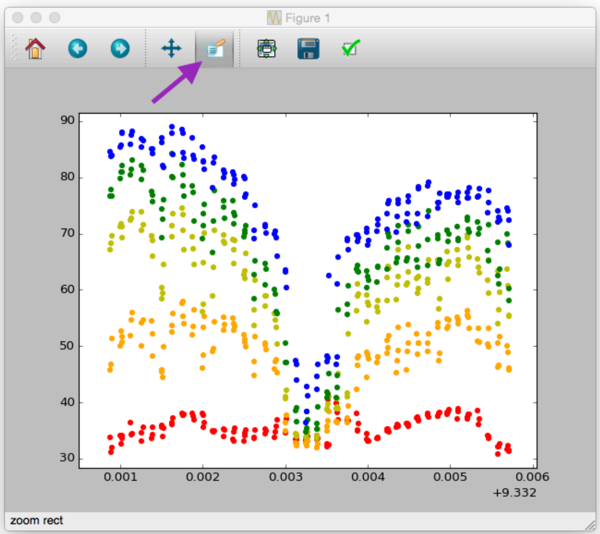
6.3. To look at these data in profile, we are going to use a Python program which we have downloaded onto your computer: py_L2plots.py. To run this program, bring up the Python console by clicking on this icon that you will find to the right of the 2^{nd} horizontal toolbar:

This will bring up a window you can type in. Enter these commands, replacing '/My/working/directory' with the path to the directory where you have the py_L2plots.py program:

```
>>> import os
>>> os.chdir('/My/working/directory')
>>> execfile('py_L2plots.py')
```

The program notes how many points it processed, and plots them on a pop-up screen. To get a better look at the data, use the rectangular zoom tool.

Figure 14



The five colors represent the following variables:

ZG: elevation of the ground

RH25: height above the ground where 25% of the energy is reflected

RH50: height above the ground where 50% of the energy is reflected

RH75: height above the ground where 75% of the energy is reflected

ZT: elevation of the tree tops

Q9. Where is the ground? The top of the trees? Can you see the road?

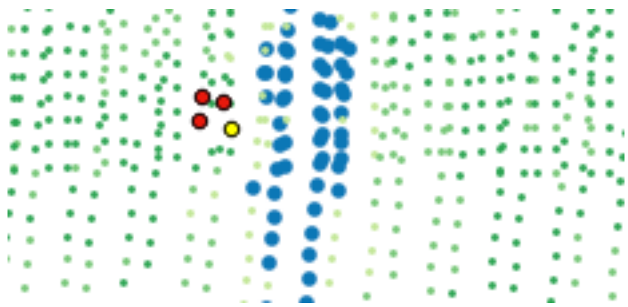
Q10. How would you calculate the height of the trees based on these variables? What other Level 2 variable represents the height of the trees?

STEP 7: Looking at the Waveforms

Each point has a waveform associated with it. These waveforms are available in the LVIS Level 1B H5 files. We have preloaded the matching Mondah H5 file on your computers: LVIS_Mondah_level1b.h5. We can select a point on the map and look up its waveform.

7.1. Select Features by area or single click: this time we are going to select a single point. Move the cursor to a point that you're interested in and double-click. The selected point should turn yellow. Below we selected a tall tree near the road.

Figure 15



7.2. Call up the Attribute Table (by right-clicking on the Layer in the Layer Panel) and scroll to Show Selected Features. There should be only one point in the table. Each point is uniquely identified by its LFID and shotnumber. Note the shotnumber of the point you selected. In our case it is shotnumber 10964985.

7.3 You should have a Python program named py_waveplot.py pre-loaded on your computer. Navigate to that directory and type this at the command line:

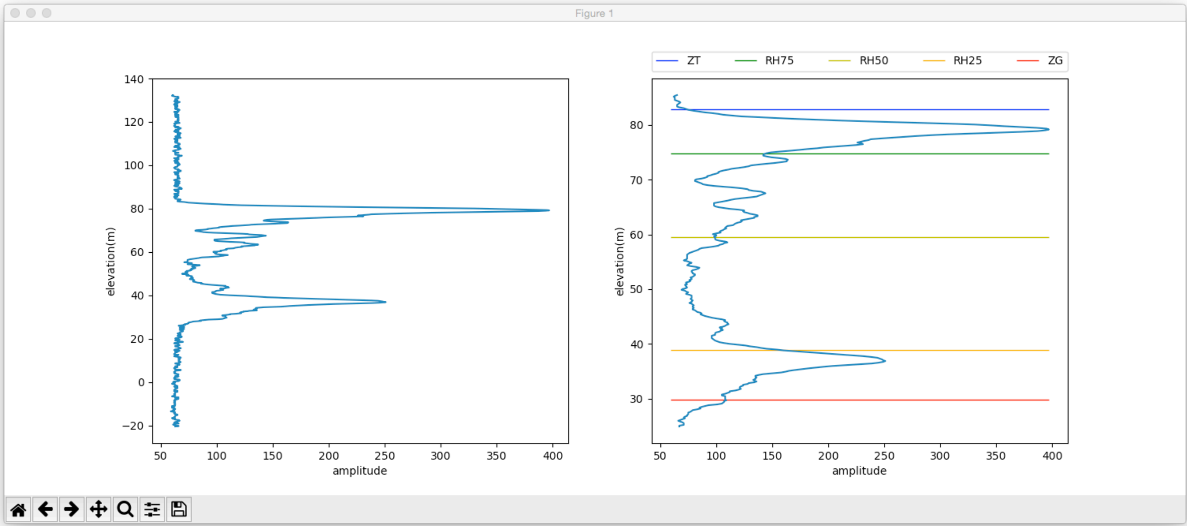
python py_waveplot.py LVIS_Mondah_level1b.h5 LVIS_Mondah_level2.TXT

The program will ask you to enter a shot number; enter the one you wish to look at:

Please enter shot number: 10964985

A window should pop up with to the left, the return waveform. To the right is the same waveform, zoomed in on the features, and with the values of ZG, RH25, RH50, RH75, and ZT drawn in.

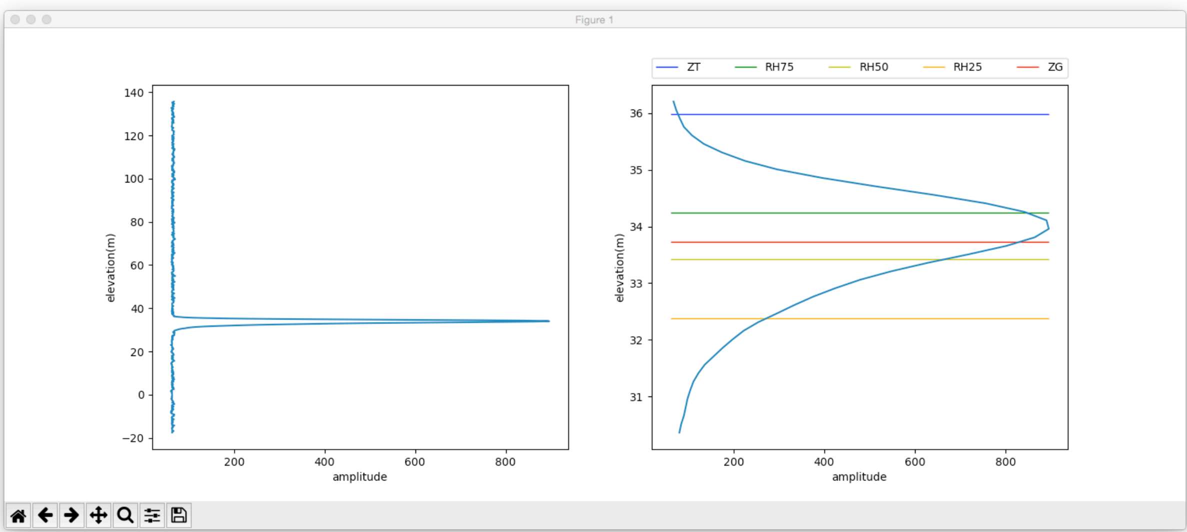
Figure 16: Vegetation waveform



Q10. Which part of the waveform detects the ground? What is the approximate elevation of the ground? What is the approximate height of the tallest tree in this footprint?

7.4. Select a point on the road. This waveform will be much simpler than the waveform returned from the forest. Note: the RH values aren't really meaningful when it comes to bare surfaces

Figure 17: Waveform over the road



Q11. Why is this waveform so different from the previous one?

Figure 18: Photograph of the area where these waveforms were collected

STEP 8: Rasters

In our previous maps when you zoom in, you see individual points. You are looking at a colored point cloud, not at a continuous map. We can create a raster from the points, in other words, a regular grid with continuous data. To do so we first need to create a Shapefile from the TXT file that we have loaded now.

8.1. Right-click on your layer LVIS_Mondah_level2 in the Layers Panel

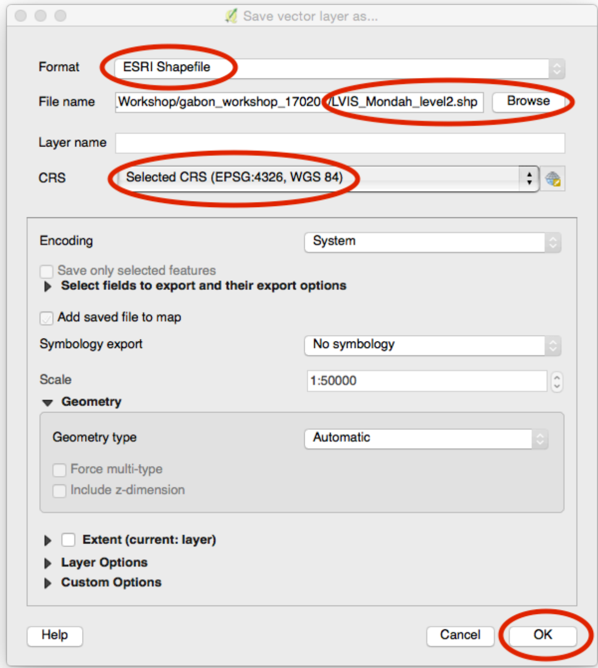
8.2. Scroll down and click on Save As…

8.3. Select the Format of the saved file: ESRI Shapefile

8.4. Click on Browse and choose what to name the saved file and where to save it. It can have the same root name as the main file. QGIS will automatically append the extension .shp, for example like this: LVIS_Mondah_level2.shp

8.5. Make sure that your Coordinate Reference System (CRS) is still set to EPSG:4326, WGS 84. This specifies the georeferencing, in our case WGS84 with latitude/longitude coordinates.

Figure 19: Saving the Vector Layer as a Shapefile

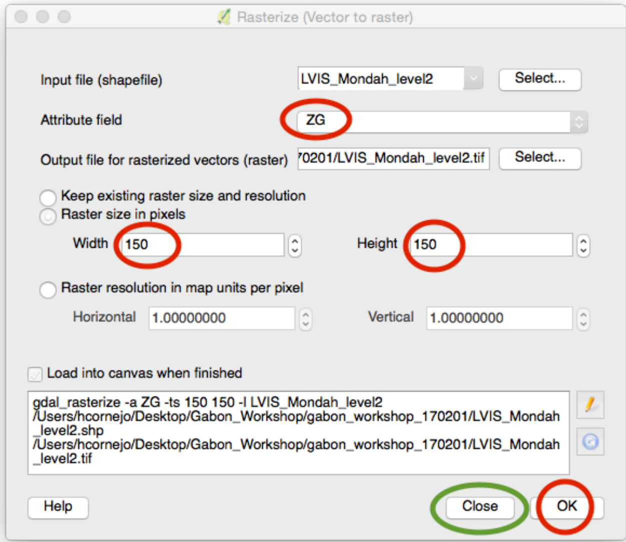


8.6. Click on OK. Be patient. When it has finished, a new layer will have been created and will appear in your Layers Panel. The little symbol to the left of it will be one large point, rather than the three small points indicating the original layer. You can right-click on it and bring up the Attribute Table to verify that it is the same data.

8.7. From this shapefile we can create a raster. We know that the total area of the data we are studying is about 3400 x 3400 m. We also know that the distance between two LVIS footprints is approximately 10 m. We want several points averaged into one cell, so a good sized-cell would be 25 m. This means we will have 3400 / 25 = 136 cells in each direction. Let's round it up to 150.

In the top menu, click on Raster -> Conversion -> Rasterize (Vector to Raster)…

Figure 19



8.8. The input file will be the shapefile you just created. In the Attribute field choose ZG (the ground elevation)

8.9. Name the output file LVIS_raster_zg. QGIS will automatically append a TIFF extension (.tif) to the file name: LVIS_raster_zg.tif.

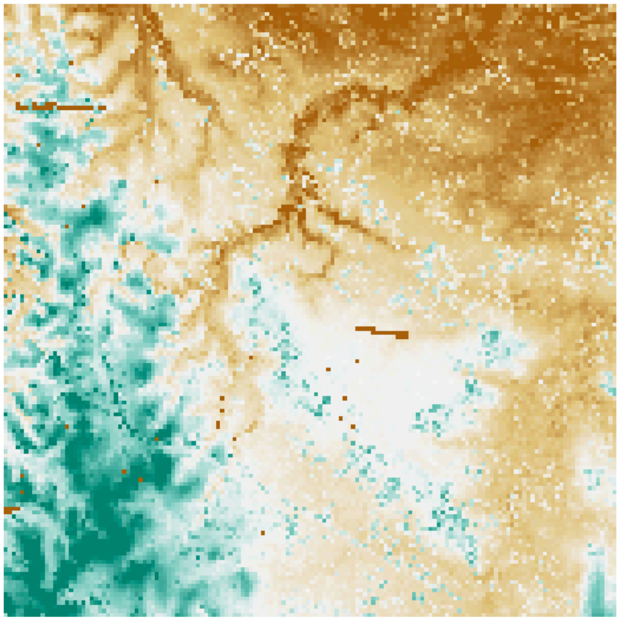
8.10. Select Raster size in pixels and input the numbers we estimated above: 150 x 150

8.11. Click on OK. Two more windows will pop up while QGIS is doing the calculations. Click OK in these two windows then click Close on the original Rasterize window (clicking OK will just make the program do the calculations again).

You should now have a black-and-white display of regularly gridded data. You can adjust the colors if you'd like (Figure 20)

Q12. How would you adjust the colors? Hint: call up the Layer Properties and adjust the Band Rendering from Singleband gray to Singleband pseudocolor. Proceed as before.

Figure 20: A raster of the ground elevation



STEP 9: Profiles and PlugIns

We can look at this map from above, or we can draw a transect across it and look at the elevation profile. To do this we need to install our first plugin:

9.1. From the top menu, click on Plugins -> Manage and Install Plugins…

9.2. In the Plugins window that pops up, either type Profile tool in the search bar, or scroll down to it. Click on it

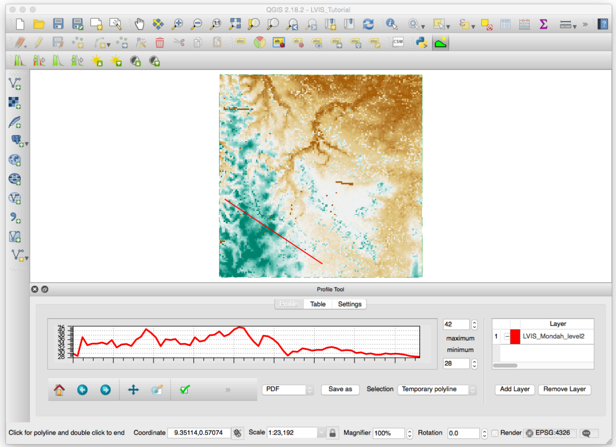
9.3. Click on Install plugin and then when it has finished, click on Close

You should see a new icon added to your toolbar:

9.4. Click on this new profile tool button: a window should pop up

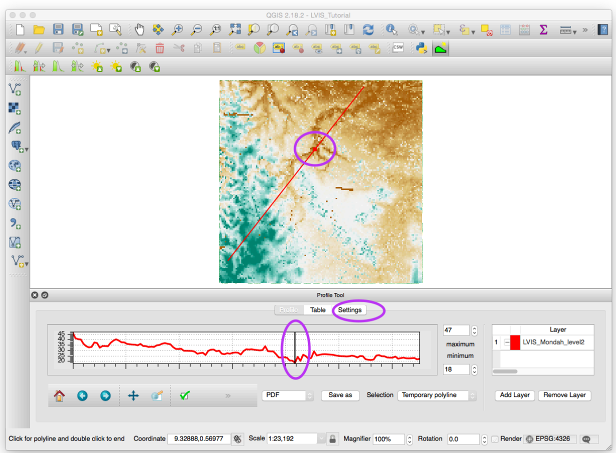
9.5. Click anywhere on the map. Your cursor should now be dragging a red line. Once you are satisfied with your line, double-click. The line in red on the map will be shown in profile in the lower window like this:

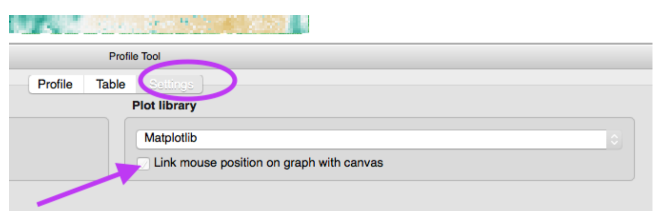
Figure 21: Viewing the elevation profile of a transect



9.6. You can link the position of the cursor on the map to the position on the profile by clicking Settings and clicking on Link mouse position on graph with canvas

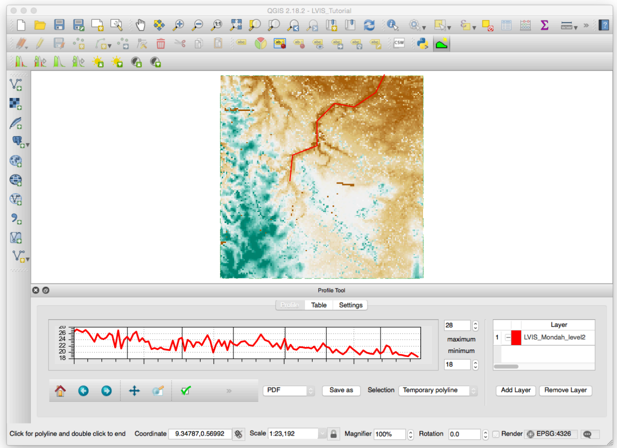
Figure 22: Linking the mouse position





9.7. You can also look at a multi-segment profile by clicking once for each end of segment and double-clicking when you are done:

Figure 23: Profile of the river



STEP 10: Downloading Additional GIS Data

There are many GIS datasets online that you can download for free. To start off with, the LVIS website has Shapefiles for all our flights. For those in Gabon, go to:

https://lvis.gsfc.nasa.gov/Gabon2016Map.html

It would be interesting to download the flight path for March 8th, 2016 and see it overlaid on our Mondah data (see Figure 24). On the LVIS website, click on the box to the left to visualize the flight on the map, and click on the [shp] to the very right of that same line to download the data. Once you have downloaded it, you will need to unzip it:

unzip traj57455_LVIS_SHP.zip

You now will have a file named traj57455_LVIS.shp in your directory. Load this as a vector layer. Either click on the vector layer button to the left and at the top of the window:

Or click through from the main menu:

Layer -> Create Layer -> New Shapefile Layer…

You should see something like in Figure 25. We have adjusted the symbols to make the flight lines more visible. You can see the 5 straight lines that represent the path of the flight as LVIS scans and collects data. These are 2 more flight lines visible. They are curved, and represent turns made by the plane to switch from line to line. We often take out the data gathered during the turns since the high roll of the plane impacts the data negatively.

Figure 24: Downloading the Flight Paths

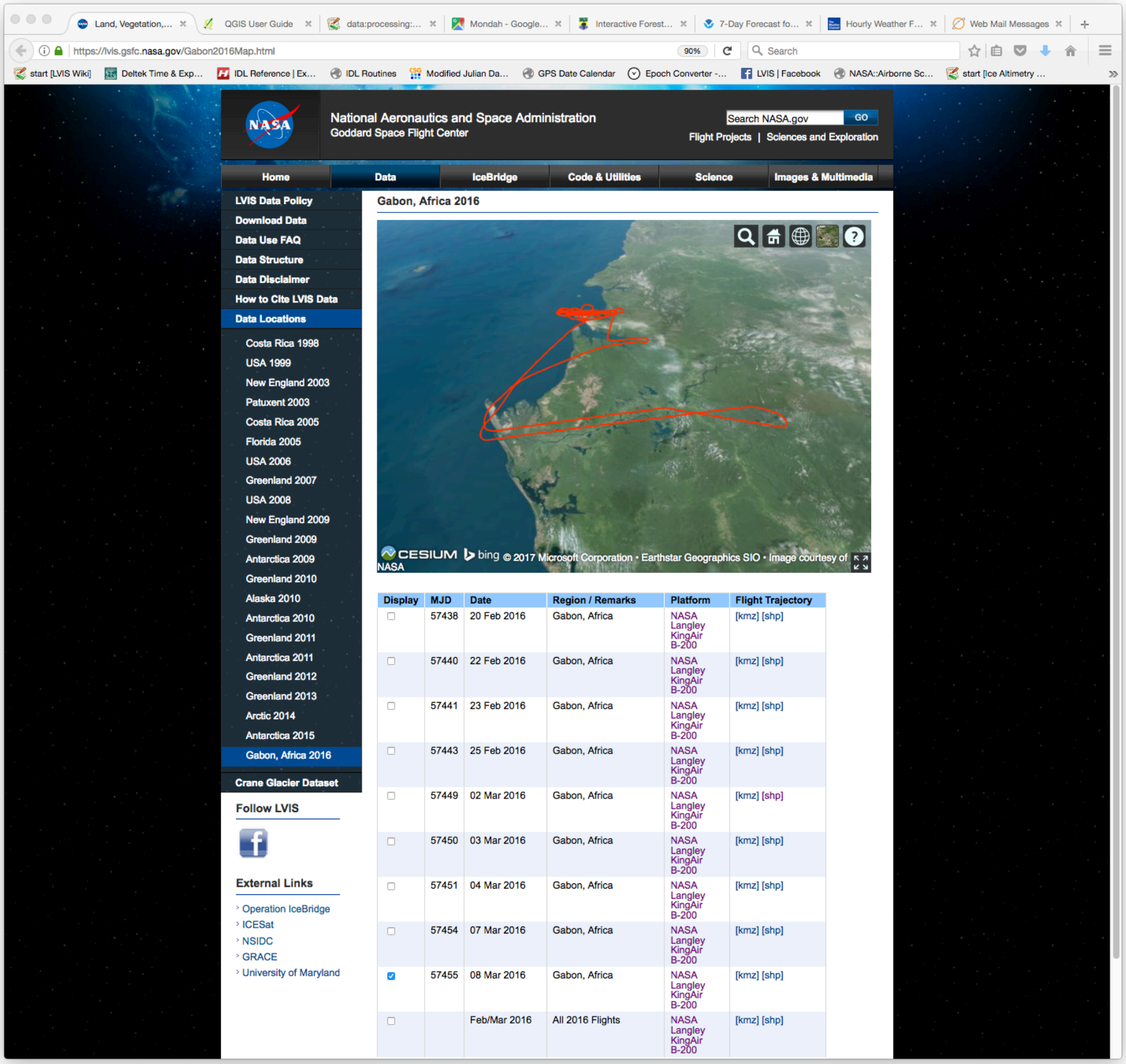
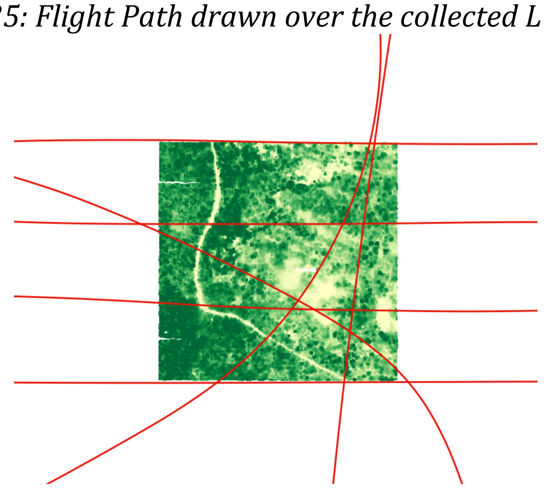


Figure 25: Flight Path drawn over the collected LVIS data

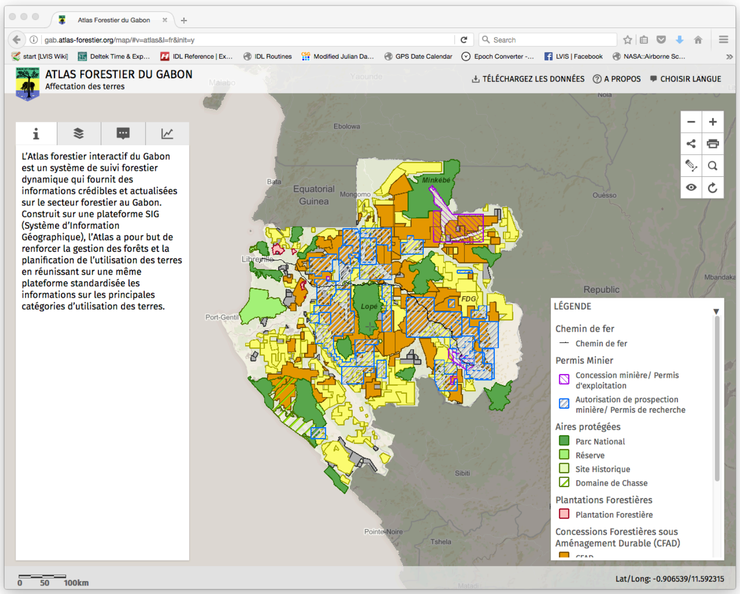


There are also several interesting data sets here:

http://gab.forest-atlas.org/

All of them can be downloaded directly from the main website and loaded into QGIS as shown above.

Figure 26: Interactive Forest Atlas of Gabon



Google Earth is also interesting. Instead of downloading the Shapefile data for a flight, download the KMZ file. These can be uploaded in to Google Earth. Interesting note: the imagery used here by Google Earth is dated February 2016, just a month before LVIS gathered the data we have been working with. You can clearly see the vegetation features detected by LVIS. LVIS also gives us the ground elevation beneath the canopy, which is not visible here.

Google Earth can be downloaded here for free:

https://www.google.com/earth/

Figure 27: Flight Path seen in Google Earth