MSB LiDAR & Imagery Project (2011/2012)

(F)requently (A)sked (Q)uestions

4/3/2018

This document is intended to answer commonly asked questions related to the MSB LiDAR & Imagery Project (2011/2012).

Version 3.3 Updated broken links and info on obtaining the data. Improved data accuracy info.

Table of Contents

What is the MSB LiDAR & Imagery Project (2011/2012)?

The project objectives included the acquisition of high resolution Light Detection and Ranging (LiDAR) and aerial photography data for 3680 sq/mi of the Matanuska-Susitna Borough, as well as the development of a digital elevation model, contours, ortho-rectified imagery, and additional products (all final products are listed in greater detail below). All data was collected in 2011 & 2012.

What is the Project Area?

See <u>*Attachment A*</u> for a map of the project area.

Who were the Project Partners?

The following partners contributed funding and/or resources to the project:

- Coastal Impact Assistance Program (CIAP)
- United States Geological Survey (USGS)
- Alaska Energy Authority (AEA)
- United States Fish and Wildlife Service (USFWS)
- The Nature Conservancy (TNC)
- National Oceanic and Atmospheric Administration (NOAA)
- Mat-Su Salmon Partnership
- United States Army Corps of Engineers (USACE)
- Alaska Pacific University (APU)
- Matanuska Susitna Borough (MSB)

Who were the Project Contractors?

The project had three contractors: Aerometric for data acquisition, post processing, product development, and data dissemination; Lounsbury and Associates, Inc. for the survey of elevation check points used in the vertical accuracy assessment; and the Alaska Satellite Facility (ASF) of the Geophysical Institute (GI) at UAF for an independent 3rd party QC of the LiDAR derived products.

What are the Final Products?

All the deliverables are public domain.

- ½ ft, Orthorectified, 4-band Imagery for a 270 sq/mi urbanized area
- 1 ft, Orthorectified, 4-band Imagery for the entire 3680 sq/mi area
- Point Cloud Data w/ 1m true nominal pulse spacing (nps) and 0.6m nps using overlapping flights
- Automated "vegetation" classification; low (1-6ft), medium (6-15ft) and high (>15ft)
- Intensity Images
- 1 m First Return Digital Surface Model (DSM) (aka top of canopy)
- 1 m Bare Earth Digital Elevation Model (DEM) w/ hydro-flattening
- 1 m First Return Hillshade
- 1m Bare Earth Hillshade
- 1m Intensity Images
- 2 ft Contours
- Building Footprints @ 97% accuracy
- Hydro Breaklines
- Project Reports

What is Orthorectified Imagery?

An orthophoto (aka orthoimage) is an aerial photograph that has been processed to eliminate image displacement so that ground level features appear as though viewed from directly above; tall objects (e.g. trees, towers, buildings) may still appear slightly tilted. The imagery is geometrically corrected so that the scale is uniform. Unlike an uncorrected aerial photograph, an orthophoto can be used to measure true distances, because it is an accurate representation of the earth's surface, having been adjusted for topographic relief, lens distortion, and camera tilt.

Orthophoto

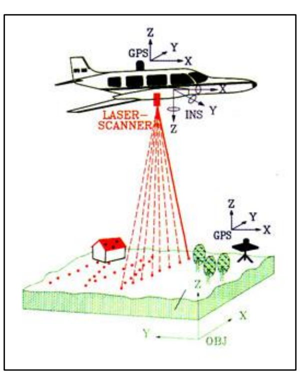
What is 4-band (aka multispectral) Imagery?

Four band imagery is multispectral, which means that it is collected from several parts of the electromagnetic spectrum. The spectrum is the entire range of light radiation, from gamma rays to radio waves, including Xrays, microwaves, and visible light. The four band imagery for this project includes red, green, blue, and near infrared bands. Only three bands can be viewed at one time in most software applications. A user typically chooses to display an image as either natural color (red, green, and blue bands) or color infrared (infrared, red, and green bands).

What is Color Infrared Imagery?

Color Infrared (CIR) Imagery includes a band of near infrared (NIR) information. NIR wavelengths are slightly longer than red, and they are outside of the range visible to the human eye. They are frequently collected as part of an aerial imagery collection and delivered as a fourth band of spectral information (in addition to red, green, and blue). Color infrared images (aka false color) are especially useful because the internal cell structure of healthy plants reflects near infrared wavelengths. As a result, it frequently used to monitor plant health for agricultural, natural resources, and environmental purposes. Conventionally, a digital CIR image is set up to display the infrared band data with a red tone. Red wavelengths are set to appear green, and green wavelengths are set to appear blue. Blue wavelengths are not displayed.

Natural Color Image vs.
Near Infrared Image

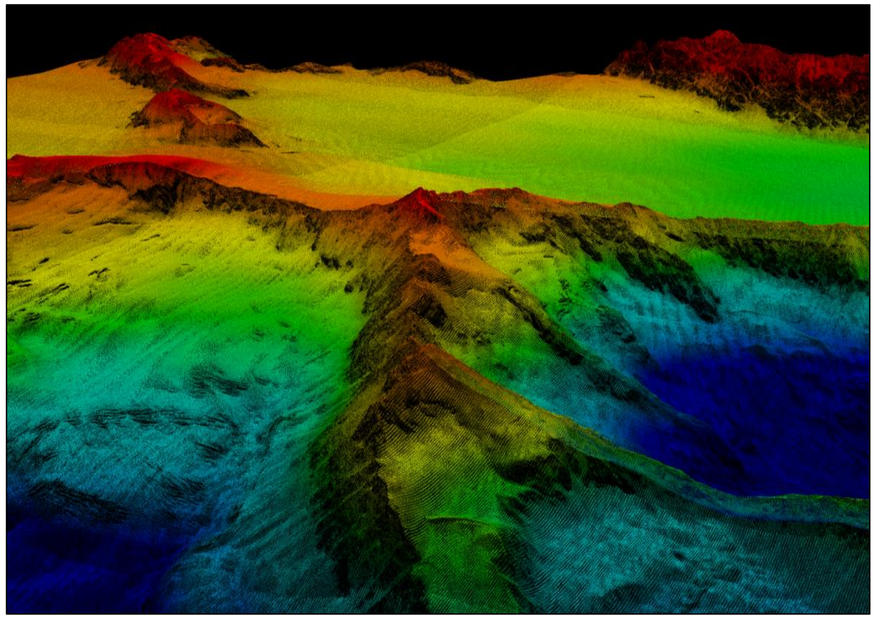


What is LiDAR?

LiDAR, an acronym for **Li**ght **D**etection **A**nd **R**anging, is a process that uses up to 200,000 laser pulses per second to map 3-D coordinates of the earth’s surface. It is used to produce a variety of data products, including: point clouds, digital surface models (DSM), digital elevation models (DEM), digital terrain models (DTM), and contours. In addition to these products, LiDAR can also be used to extract other features such as building footprints and water bodies.

What is Point Cloud Data?

Point Cloud Data is the rawest form of LiDAR data available from this project. Each point in the point cloud contains elevation data calculated from a laser pulse. These points include elevation data for first (e.g. top of tree canopy), intermediate (e.g. shrubs) and last (e.g. bare earth) returns. When a laser pulse encounters only one feature such as bare-earth (e.g. gravel), asphalt, concrete, or a roof top, the first and last return returns will have the same elevation values.



Point Cloud Data

What Classifications are Included in the Classified Point Cloud Data?

Code	Description
1	Processed, but unclassified
2	Bare Earth Ground
3	Low "Vegetation" (1-6 feet above ground surface)
4	Medium "Vegetation" (6-15 feet above ground surface)
5	High "Vegetation" (>15 feet above ground surface)
6	Buildings
7	Error Points
8	Ground Model Key Points (used to develop contours)
9	Water
10	Breakline Proximity (ignored ground)
11	Major Transmission Lines
13	Surface Clutter (noisy points ≤1 ft above ground)
14	Bridge Decks
18	May 24, 2011 data from the Matanuska Glacier withheld from ground/vegetation classification due to movement.
19	May 31, 2011 data from the Matanuska Glacier withheld from ground/vegetation classification due to movement.
26	May 13, 2011 data from the Knik Glacier withheld from ground/vegetation classification due to movement.
27	May 24, 2011 data from the Knik Glacier withheld from ground/vegetation classification due to movement.
28	August 26, 2011 data from the Knik Glacier withheld from ground/vegetation classification due to movement.

What is Automated "Vegetation" Classification?
Automated "vegetation" classification is a term used to describe the classification of points in the point cloud data into low, medium, and high "vegetation" classes. This classification is only assigned to points that haven't fallen into other classifications such as buildings and water. The use of the word "vegetation" is a bit of a misnomer since the points can include non-vegetation features, such as automobiles and power poles. The classifications fall into three height categories: low (1-6 ft), medium (6-15 ft), and high (>15 ft).

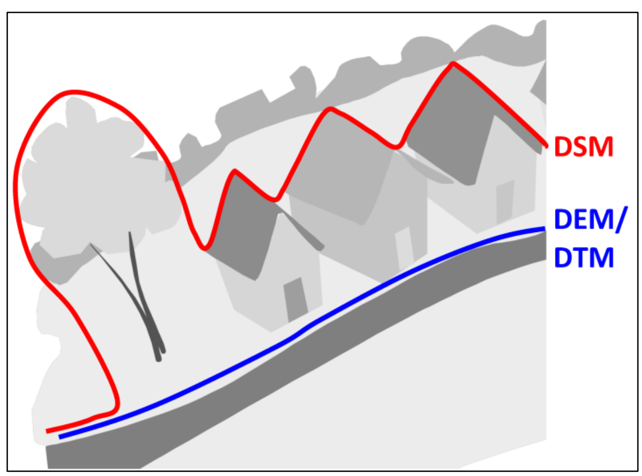
What are Intensity Images?
The return strength (aka intensity) of each LiDAR pulse can be categorized and used to produce an image product that closely resembles an orthoimage. The intensity data can be viewed as an attribute in the point cloud or it can be exported to an image file (e.g. TIFF or JPG) that can then be used as a backdrop for other GIS layers. The pulse rate of the sensor combined with the range of intensity in an image determines the visibility characteristics.

Intensity Image

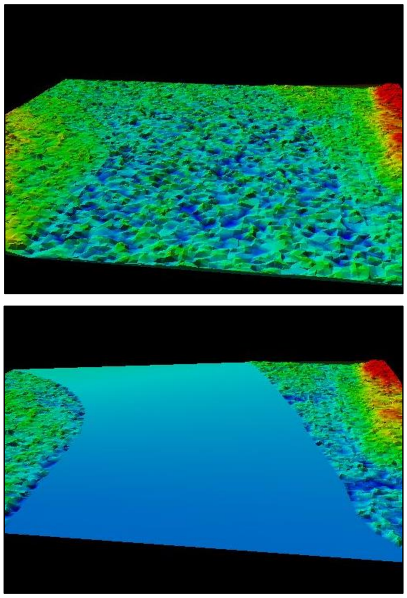
What is a Digital Surface Model (DSM)?
A DSM is a digital map/model of elevations, typically representing the first return surface. It is a continuous and gridded (aka raster) dataset that represents features found on the surface of the earth, including vegetation (top of canopy), buildings (rooftops), and other man-made structures (automobiles & bridges).

What is a Digital Elevation Model (DEM)?
A DEM is a digital map/model of <u>bare-earth</u> elevations. It is a continuous and gridded (aka raster) dataset that represents bare-earth elevation information, free from vegetation, buildings, and other man-made structures. This term is often used interchangeably with DTM even though there are distinctions between the two (see DTM definition below). For this project we are using the term DEM interchangeably with DTM; our DEM product has been augmented by breaklines and includes <u>hydro-flattening</u>.

What is a Digital Terrain Model (DTM)?
A DTM is a digital map/model of <u>bare-earth</u> elevations. It is a continuous and gridded (aka raster) dataset that represents bare-earth elevation information, free from vegetation, buildings, and other man-made structures <u>AND</u> has been augmented by breaklines to correct for artifacts produced by the original data. An example of an augmentation would be hydro-flattening. For this project we are using the term DEM interchangeably with DTM; our DEM product has been augmented by breaklines and includes <u>hydro-flattening</u>.



DSM vs. DEM or DTM



Before & After Hydro-Flattening

What is Hydro-Flattening?

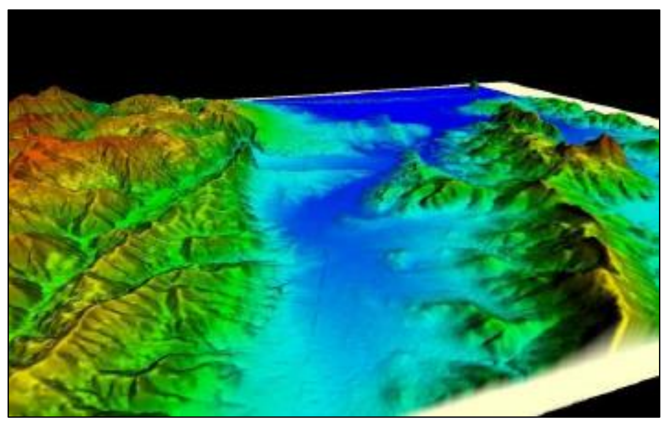
A relatively new term, coined by USGS, hydro-flattening refers to a post-processing effort that uses breaklines in conjunction with elevation information to smooth waterbody surfaces so they have a uniform appearance. Prior to hydro-flattening, waterbodies appear bumpy or rippled; afterward lakes appear flat from shore to shore and rivers have a uniform downstream flow. For example, if a digital drop of water were dropped in the upper reaches of a hydro-flattened river, it would flow down the hydro-flattened surface to the mouth of the river and beyond.

What are Breaklines?

Breaklines represent linear features that mark a change in smoothness or continuity of a surface. Breaklines are typically captured along road edges and along hydrographic features to assist with the accurate depiction of contours and for the hydro-flattening process. Typical breakline examples include: shorelines, islands, road edges, etc.

What is a Hillshade?

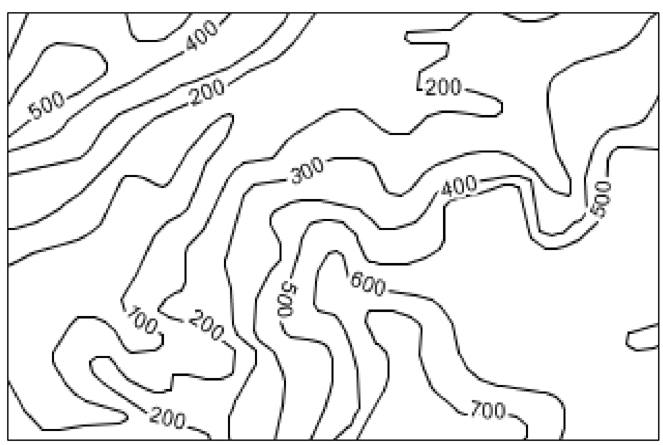
Hillshades are quickly replacing contour lines as the best way to visualize 3-D topographic surfaces. Viewing angles and sun angles can be varied to maximize visual interpretation of the terrain. They are typically displayed using a color elevation ramp, but some hillshades are displayed in gray scale.



Hillshade

What are Contours?

Contours are graphical lines that join points of equal elevation on the surface of the land above or below a reference surface, such as mean sea level. They are typically derived from a point cloud or DEM. For this project, contours were smoothed in most areas for cartographic purposes; max. horizontal shift allowed was 5 ft horizontally.



Contours

What are Building Footprints?

A building footprint is the outline of the base of a building or portion of a building; they are typically exclusive of courtyards and decks. This project provides footprints for buildings over 400sq/ft in size to a confidence of 97%.

What is the Current Status of the LiDAR & Imagery Project?
The majority of the LiDAR and imagery for the project was collected 2011. A small portion of LiDAR in Hatcher Pass and imagery along the Matanuska River corridor were collected in 2012; see *Attachment B & C* for maps. All products are available and can be ordered or downloaded online.

How is the Data Organized?
For data management purposes the project has been divided into 7 blocks (aka areas):

Matanuska	472 sq/mi
Core Area	503 sq/mi
Point MacKenzie	583 sq/mi
Willow	567 sq/mi

Caswell Lakes	537 sq/mi
Talkeetna	597 sq/mi
North Susitna	421 sq/mi

Furthermore, the project is divided into 498 individual tiles that are 25sq/km in size. Additionally, the Matanuska and Core Area blocks include a 270 sq/mi area for which ½ foot imagery was obtained. See *Attachment D*.

The Matanuska-Susitna Borough LiDAR & Imagery project produced a large number of datasets that are typically made available via portable hard drive. The datasets are organized in a specific file management schema. A document detailing the folder management schema can be found on each hard drive.

How Can the Data Be Obtained?
The Mat-Su LiDAR and Imagery project is important to a wide range of users. Some are only interested in one or two particular products or areas, while others want all products in all areas. As a result, there are various options for obtaining the data.

Parcel Viewer - http://maps.matsugov.us/webmaps/
Easy to use online map with property information. 2011 imagery and bare-earth hillshade (derived from the LiDAR data) can be turned on/off on the layer pane. 2016 & 2017 imagery is also available.

Data Downloads - There are a couple of websites from which the data can be downloaded.

- The State of Alaska Division of Geological & Geophysical Surveys Elevation Portal provides data downloads of many elevation datasets including the MSB 2011 LiDAR data. Just select your area of interest and then download. https://elevation.alaska.gov/
- Geographic Information Network of Alaska (GINA) webpage allows for individual products to be directly downloaded. GINA also serves up web mapping services of the imagery and hillshades. The GINA webpage was funded by the Alaska Energy Authority. http://matsu.gina.alaska.edu/

Order Data
All LiDAR and Imagery products, for the entire project area, can be ordered from the MSB Borough GIS division. For more information or to order all the data please contact:
Heather Kelley : Heather.Kelley@matsugov.us : 907-861-8695

What Spatial Referencing System Standards were used for the Project?
Horizontal Datum: North American Datum of 1983 (CORS96 Epoch 2003.0)
Vertical Datum: North American Vertical Datum of 1988 (GEOID09)
Projection: Alaska State Plane Zone 4
Horizontal/Vertical Units: U.S. Survey Foot and will be expressed to the nearest tenth (0.1)

What is the Accuracy of these Data?

For imagery, the scope of work stated that the horizontal accuracy shall meet Federal Geographic Data Committee, Geospatial Positioning Accuracy Standards, Part 3: National Standards for Spatial Data Accuracy. The accuracy as compiled, tested and published in the final imagery report has met horizontal accuracy requirements as specified. The final imagery report can be found on the project website (https://data1-msb.opendata.arcgis.com/pages/2011-li-dar-&-imagery-project).

For LiDAR, the scope of work stated that the vertical accuracy be assessed in accordance with the guidelines developed by the National Digital Elevation Program (NDEP) and subsequently adopted by the American Society of Photogrammetry and Remote Sensing (ASPRS). The key points outlined below are used by USGS to assess the data for inclusion into the National Elevation Dataset (NED).

LiDAR point cloud data is to be assessed independently of derivative products. Calibrated, unclassified LiDAR point cloud data is to be used to generate a Triangulated Irregular Network (TIN), whose elevations will be compared with survey check points in open areas of moderate terrain. The results of this comparison are to achieve a Fundamental Vertical Accuracy (FVA) of no greater than 24.5 cm ACCz at a 95% confidence level, which is defined as being RMSEz * 1.96 per NDEP / ASPRS guidelines. Using the methods outlined, the MSB LiDAR point cloud data assessment resulted in a FVA of 13.77cm, which passes the USGS requirements.

Derivative DEMs are to use the same guidelines in determining their FVA except that only the ground points are used and the checkpoints are tested against the raster product rather than a TIN. They must also have a Consolidated Vertical Accuracy (CVA) of 36.3 cm or less at the 95th percentile. CVA is computed using all check points in all land cover categories. Using the methods outlined, the MSB DEM assessment resulted in an FVA of 18.2cm and a CVA of 35.15 cm, both of which pass the USGS requirements.

In summary:

FVA = Fundamental Vertical Accuracy = assessed on barren ground only
CVA = Consolidated Vertical Accuracy = assessed on all ground cover classes (barren, forest, wetland, shrub, developed)
95% confidence level – means that at least 95 of 100 points fell w/in the accuracy level indicated

Point Cloud
FVA = 13.77 cm (5.4 in) - 95% confidence level

Digital Elevation Model (DEM)
FVA = 18.2 cm (7.2 in) - 95% confidence level
CVA = 35.15 cm (13.8 in) - 95% confidence level

In layman's terms…

For the point cloud, in areas of barren earth (bare ground with no trees, shrubs or tall grass), the elevation displayed for a point should fall within 13.77 cm (5.4 in) of the actual ground elevation, 95% of the time.

For the DEM, in areas of barren earth, the elevation displayed for a cell should fall within 18.2 cm (7.2 in) of the actual ground elevation, 95% of the time.

continued on next page…

For the DEM, based on an average of the points tested across all types of vegetation coverage (bare ground, grass, shrubs and trees) project wide, the elevation displayed for a cell should fall within 35.15 cm (13.8 in) of the actual ground elevation, 95% of the time.

Additional details regarding the MSB LiDAR vertical accuracy assessment can be found in the final LiDAR project report and accompanying spreadsheet. These can be downloaded from the project website (https://data1-msb.opendata.arcgis.com/pages/2011-li-dar-&-imagery-project).

What QA/QC Process was used for the MSB LiDAR & Imagery Project?
Quality Assurance (QA) is a procedure or set of procedures intended to ensure that a product or service under development (before work is complete, as opposed to afterwards) meets specified requirements. Quality control (QC) is a measurable set of tasks intended to ensure that a product or service adheres to a defined set of quality criteria and the requirements of the client or customer.

The MSB LiDAR & Imagery project went through several QA/QC steps.

All products were first reviewed by Aerometric before being delivered.

For the LiDAR products, the MSB contracted with the Alaska Satellite Facility (ASF) to perform an independent 3rd party review of the data. The process included checks for completeness of delivery, point cloud counts, point cloud classifications, bare-earth DEM, DSM, and intensity image regularity, vertical accuracy, and hydro-flattening with uniform lake and surface flow elevations. Reports detailing the review were produced for each block of data. The ASF also performed all calculations to verify that the data had passed the required vertical accuracy requirements.

The imagery review process was completed by MSB GIS staff. The process included checks for general appearance, radiometric evaluation, edgematching, artifacts & smearing, pixel size & missing pixels, infrared band check, leaf off/on, cloud cover, relief displacement, and positional accuracy.

Lastly, the LiDAR data was reviewed by the USGS National Geospatial Technical Operations Center (NGTOC) for inclusion into the National Elevation Dataset (NED).

When necessary, corrections or improvements were requested from Aerometric.

How Frequently will the MSB's LiDAR & Imagery Data Be Updated (Reflown)?
The MSB does not currently have an established re-flight cycle for LiDAR or imagery acquisition.

What are some Frequent Uses for LiDAR & Imagery Data?

- 3-D Visualization
- Floodplain Mapping
- Urban Modeling
- Transportation Planning
- Route Mapping
- Building Site Suitability
- Tower Placement
- Tower Coverage
- Slope Analysis
- Landslide Analysis
- Vegetation Mapping
- Timber Volume Analysis
- Change Detection
- Feature Extraction

Is there a Project Website?
The MSB GIS division maintains a project website that includes general information, project updates, a list of products, information about ordering data, and some helpful documents that can be downloaded. It is located here:
https://data1-msb.opendata.arcgis.com/pages/2011-li-dar-&-imagery-project.

Who should be contacted with Questions?

Questions can be addressed to:

Heather Kelley, GIS Specialist
MSB GIS Division
907-861-8695
Heather.Kelley@matsugov.us

What Sources Were Used to Develop this Document?

The MSB GIS Division borrowed some of the definitions and descriptions in this document from other publications found online. We thank all sources used.

Sources: City of Vancouver; Environmental Systems Research Institute, Inc (ESRI); FEMA - Procedure Memorandum No. 61—Standards for LiDAR and Other High Quality Digital Topography; NOAA Lidar 101: An Introduction to Lidar Technology, Data, and Applications; PCMagazine; Pennsylvania Department of Conservation and Natural Resources; UAF, Keith Cunningham, Assistant Professor; URISA - Lidar Guidebook: Concepts, Project Design, And Practical Applications; USGS - LiDAR Frequently Asked Questions Doc; USGS - National Geospatial Program - LiDAR Guidelines and Base Specification - Version 13 – ILMF 2010; USGS - National Geospatial Program Lidar Guidelines and Base Specification; Whatis?com - www.whatis.techtarget.com; USDA - Four Band Digital Imagery Information Sheet April 2012.