



Data Collection and processing report for Snake River, Wyoming Collection

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1. Sensors Description and Specifications

Four sensors were used to collect data over the target areas. These are described below.

1.1 Gemini LiDAR

Optech Gemini Airborne Laser Terrain Mapper (ALTM) serial number 06SEN/CON195 is an infrared laser mapping sensor. The instrument nominal specifications are listed in table 1.

Operating Altitude	150-4000 m, Nominal
Horizontal Accuracy	1/5,500 x altitude (m AGL); 1 sigma
Elevation Accuracy	5 - 35 cm; 1 sigma
Range Capture	Up to 4 range measurements, including 1 st , 2 nd , 3 rd , last returns
Intensity Capture	12-bit dynamic range for all recorded returns, including last returns
Scan FOV	0 - 50 degrees; Programmable in increments of ±1degree
Scan Frequency	0 – 70 Hz
Scanner Product	Up to Scan angle x Scan frequency = 1000
Roll Compensation	±5 degrees at full FOV – more under reduced FOV
Pulse Rate Frequency	33 - 167 kHz
Position Orientation System	Applanix POS/AV 510 OEM includes embedded BD960 72-channel 10Hz (GPS and Glonass) receiver
Laser Wavelength/Class	1064 nanometers / Class IV (FDA 21 CFR)
Beam Divergence nominal (full angle)	Dual Divergence 0.25 mrad (1/e) or 0.80 mrad (1/e)

Table 1 – Optech GEMINI specifications (<http://www.optech.ca/gemini.htm>).

See <http://www.optech.ca> for more information from the manufacturer.

1.2 Aquarius Lidar

Optech Aquarius Airborne Laser Terrain Mapper (ALTM) is a hybrid laser mapping system as it collects simultaneous land and shallow water-depth measurements. It operates in the green spectrum, thus enabling it to penetrate water. The instrument nominal specifications are listed in Table 2.

Operating Altitude	300-600m AGL, nominal
Range Capture	Upto 4 range measurements, including 1st, 2 nd , 3 rd and last
Intensity Capture	12-bit dynamic measurement range
Scan FOV	0-25 degrees
Scan Frequency	0-70 Hz
Pulse Rate Frequency	33,50,70 kHz
Laser Footprint on water surface	30 – 60 cm
Position Orientation System	Applanix POS/AV 510 OEM includes embedded BD960 72-channel 10Hz (GPS and Glonass) receiver
Laser Wavelength/Class	532 nm
Operating temperature	0-35 degree celcius
Full waveform capture	12 bit IWD-2 Intelligent Waveform Digitizer

Table 2 – Optech Aquarius specifications (<http://www.optech.ca/pdf/aquarius-specsheet-121010-2PG-WEB.pdf>).

See <http://www.optech.ca> for more information from the manufacturer.

1.3 DIMAC Digital Camera

Dimac digital camera is a full frame CCD imaging sensor with a resolution of 60 MP, mounted on a vibration isolation mount. The instrument nominal specifications are listed in Table 3

Sensor size	53.9 mm x 40.4 mm
Pixel size	6 µm X 6 µm
Lens Focal Length	70 mm
Shutter	Electro-Mechanical iris mechanism 1/125 to 1/500 sec., f-stops: 4,5,6, 8,11,16
Image Output	8984 x 6732 pixels (60 MP); 8 or 16 bits per channel; 24 bit RGB: 180 MB; 48 bit RGB: 360 MB
True FMC	Electro-mechanical driven by Piezo technology

Table 3 – DIMAC Digital Camera specifications

1.4 CASI-1500 Hyperspectral sensor

CASI-1500 is a pushbroom type hyperspectral imaging sensor sold by ITRES. It is mounted on a vibration isolated mount together with the LIDAR sensor. The instrument nominal specifications are listed in table 4

Sensor type	VNIR Pushbroom sensor (Compact Airborne Spectrographic Imager)
Spectral Range	380-1050 nm
No. of Spectral Channels	288
No. of Across Track pixels	1500
Total Field of View	40 degrees
Instant Field of View	0.49 mRad
Spectral Width Sampling/Row	2.4 nm
Spectral Resolution	< 3.5 nm
Pixel Size	20 μm X 20 μm
Dynamic Range	14 bits

Table 4 – CASI-1500 Hyperspectral sensor specifications (For more info see manufacturer’s website: <http://www.itres.com/products/imagers/casi1500/>)

2. Area of Interest.

The survey area is located over the Snake River watershed in Wyoming, just north of Jackson Hole airport. The location of the survey area is shown in Figure 1.

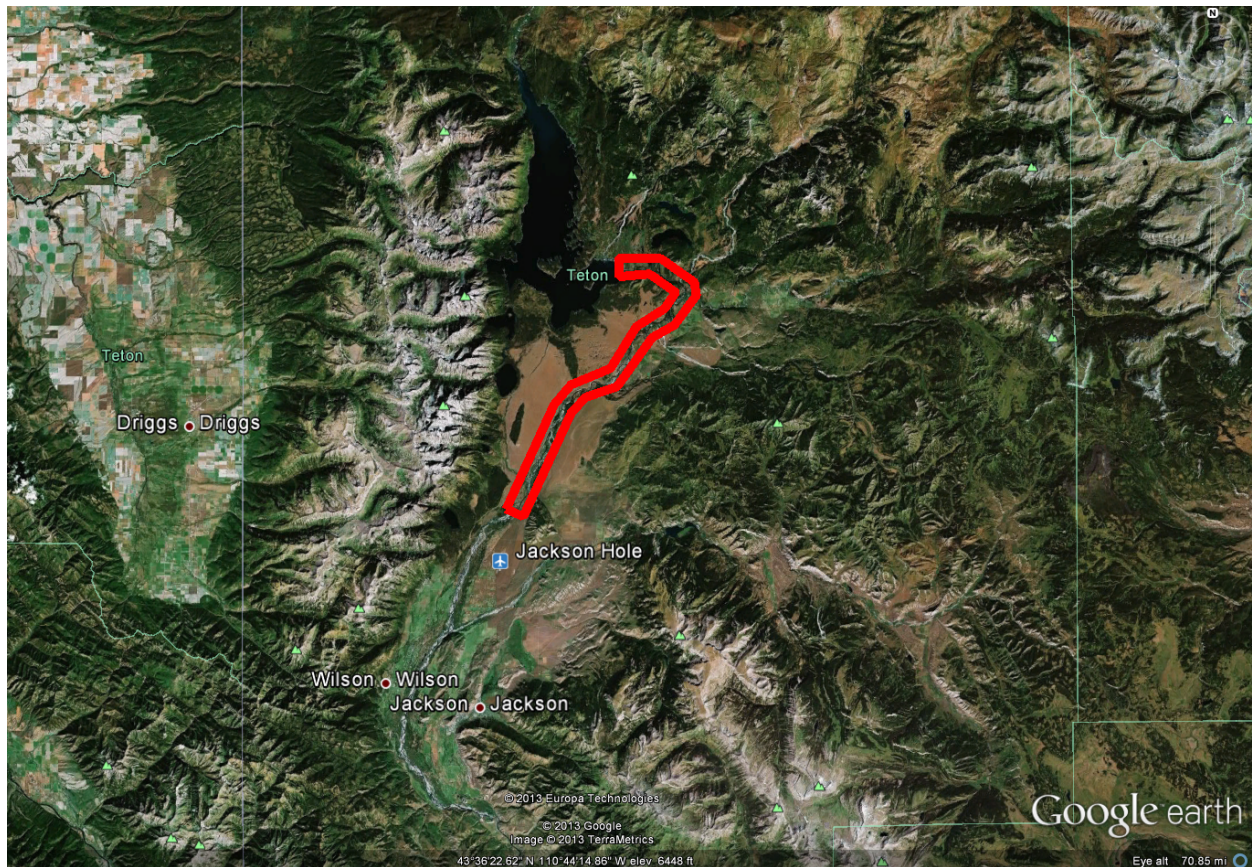


Figure 1 – Shape and location of survey polygon for Snake River (Google Earth).

3. Data Collection

a) Survey Dates:

The data collection for Snake River took place from Aug 20, 2012 (DOY 233) to Aug 26, 2012 (DOY 239). Table 5 lists the dates and the Survey Totals.

Date	DOY	Sensors Flown	Time of flight (hrs)	Laser On time	DIMAC (No. of Images)	CASI
8/20/12	233	Gemini, CASI	0.81	0.13		
8/21/12	234	Gemini, CASI	3.12	1.98		
8/21/12	234	Gemini, CASI	1.94	1.28		
8/23/12	236	Gemini, CASI	2.07	0.55		
8/23/12	236	Gemini, CASI	1.34	0.36		
8/26/12	239	Aquarius, DIMAC	3.71	1.87		

b) Airborne Survey Parameters: The survey parameters are provided in Table below

Nominal Flight Parameters		Equipment Settings		Survey Totals	
Flight Altitude		Laser PRF		Total Flight Time	
Flight Speed		Beam Divergence		Total Laser Time	
Swath Width		Scan Frequency		Total Swath Area	
Swath Overlap		Scan Angle		Total AOI Area	
Point Density		Scan Cutoff			

Table2 – Survey Parameters and Totals.

4. GPS/IMU Data Processing

Reference coordinates for all NCALM stations are derived from observation sessions taken over the project duration and submitted to the NGS on-line processor OPUS which processes static differential baselines tied to the international CORS network. For further information on OPUS see <http://www.ngs.noaa.gov/OPUS/> and for more information on the CORS network see <http://www.ngs.noaa.gov/CORS/>

Airplane trajectories for this survey were processed using KARS (Kinematic and Rapid Static) software written by Dr. Gerald Mader of the NGS Research Laboratory. KARS kinematic GPS processing uses the dual-frequency phase history files of the reference and airborne receivers to determine a high-accuracy fixed integer ionosphere-free differential solution at 1 Hz. All final aircraft trajectories for this project are blended solutions from the three stations.

After GPS processing, the trajectory solution and the raw inertial measurement unit (IMU) data collected during the flights are combined in APPLANIX software POSpac MMS (Mobile

Mapping Suite Version 5.2). POSpac MMS implements a Kalman Filter algorithm to produce a final, smoothed, and complete navigation solution including both aircraft position and orientation at 200 Hz. This final navigation solution is known as an SBET (Smoothed Best Estimated Trajectory).

5. LiDAR Data Processing Overview

The following diagram (Figure 4) shows a general overview of the NCALM LiDAR data processing workflow

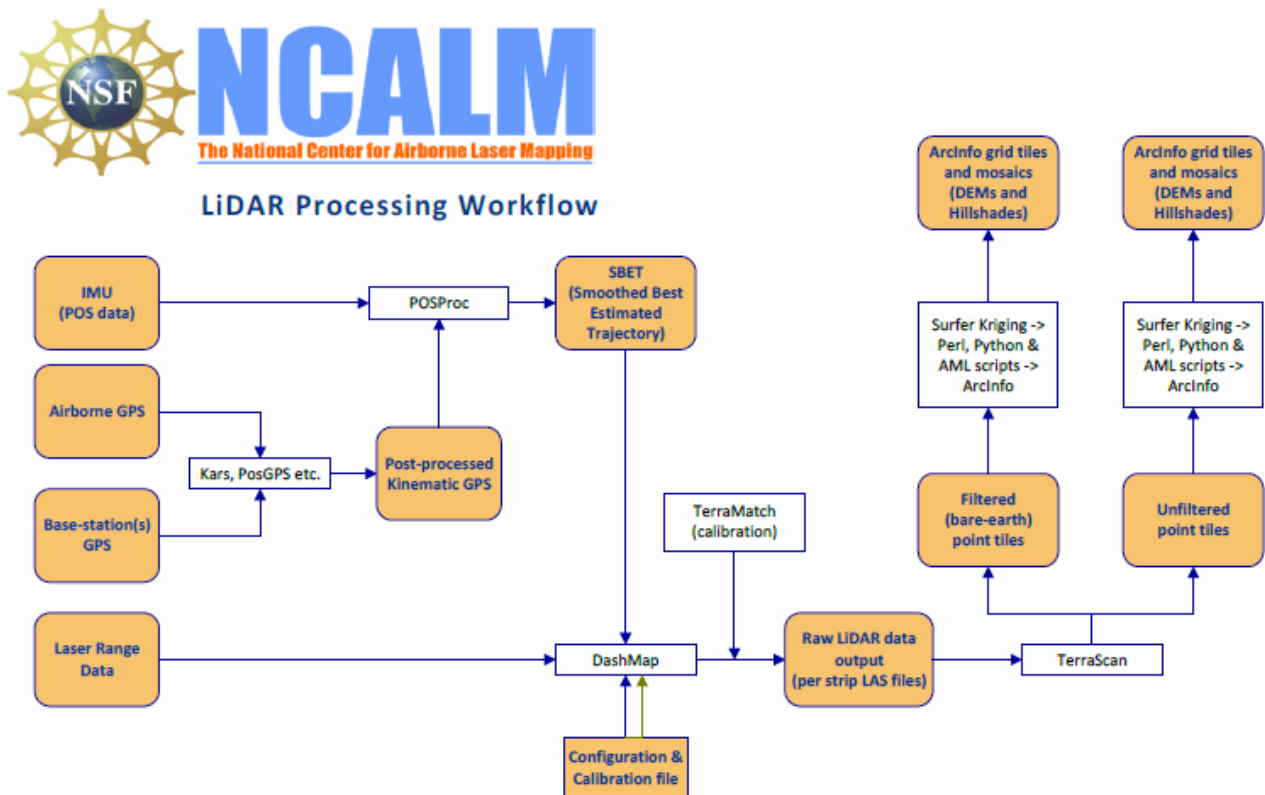


Figure 4 NCALM LiDAR Processing Workflow

NCALM makes every effort to produce the highest quality LiDAR data possible but every LiDAR point cloud and derived DEM will have visible artifacts if it is examined at a sufficiently fine level. Examples of such artifacts include visible swath edges, corduroy (visible scan lines), and data gaps.

A detailed discussion on the causes of data artifacts and how to recognize them can be found here:

http://ncalm.berkeley.edu/reports/GEM_Rep_2005_01_002.pdf.

A discussion of the procedures NCALM uses to ensure data quality can be found here:

http://ncalm.berkeley.edu/reports/NCALM_WhitePaper_v1.2.pdf

NCALM cannot devote the required time to remove all artifacts from data sets, but if researchers find areas with artifacts that impact their applications they should contact NCALM and we will assist them in removing the artifacts to the extent possible – but this may well involve the PIs devoting additional time and resources to this process.

Classification done by automated means using TerraSolid Software – removal of outliers only.

<http://www.terrasolid.fi/en/products/4>

6. Data Deliverables

- a) **Horizontal Datum:** NAD83(2011) Epoch: 2010
- b) **Vertical Datum:** GEOID 12A
- c) **Projection:** UTM Zone 12N
- d) **Units:** Meters
- e) **File Formats:**
 - 1. Classified Point Cloud in LAZ 1.2 format in 1 km square tiles.
 - 2. Cloud Optimized Geotiff (COG) 1-m DTM and DSM.
- f) **File naming convention:** 1 Km tiles follow a naming convention using the lower left coordinate (minimum X, Y) as the seed for the file name as follows: XXXXXX_YYYYYYY. For example if the tile bounds coordinate values from easting equals 499000 through 500000, and northing equals 2809000 through 2810000 then the tile filename incorporates 499000_2809000. These tile footprints are available as an AutoCAD DXF or ESRI shapefile. The ESRI DEMs are single mosaic files created by combining together the 1KM tiles. Their name consists of prefix 'ume' (indicating that the DEM is made using default-class points) and the lowest Easting coordinate rounded to the nearest 1000, for e.g. 'ume617000'. The hillshade files have a prefix 'sh' after the name, for e.g. 'ume617000sh'.

7. Notes

Some additional data were supplied to the PI in the form of RGB imagery and full waveform files. These data were supplied as a courtesy and were not part of the original seed proposal.