NCALM Seed Project: Fusion of remotely sensed data for modeling eolian soil transport

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1. LiDAR System Description and Specifications

This survey was performed with an Optech Gemini Airborne Laser Terrain Mapper (ALTM) serial number 09SEN195 mounted in a twin-engine Cessna 337 Skymaster airplane (Tail Number N337P). The instrument nominal specifications are listed in table 1.

Operating Altitude	80- 3500 m, Nominal
Horizontal Accuracy	1/5,500 x altitude (m AGL); 1 sigma
Elevation Accuracy	5 - 30 cm; 1 sigma
Range Capture	Up to 4 range measurements, including 1st, 2nd, 3rd, 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 BD950 12-channel 10Hz GPS receiver
Laser Wavelength/Class	1047 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/pdf/Gemini167.pdf).

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

2. Areas of Interest.

The survey area consisted of a polygon located 50 km west of Idaho Falls, Idaho. The survey location is shown below in Figure 1.

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

3. Data Collection

a) Survey Date: Survey took place on September 19, 2007 (DOY 262).

b) Airborne Survey Parameters: The survey parameters are provided in Table 2 below

Nominal Flight Parameters		Equipment Settings		Survey Totals	
Flight Altitude	700 m	Laser PRF	70 kHz	Total Passes	19
Flight Speed	60 m/s	Beam Divergence	0.25 mrad	Total Flight Time	2.83 hrs
Swath Width	268.7 m	Scan Frequency	40 Hz	Total Laser Time	0.7 hr
Swath Overlap	50%	Scan Angle	± 25°	Total Swath Area	41 km^2
Point Density	3.5 p/m^2	Scan Cutoff	4°	Total AOI Area	39 km^2

Table 2 – Survey Parameters and Totals.

c) Ground GPS

Two GPS reference station locations were used during the survey; INL0 and INL1, setup by NCALM. All reference GPS observations were logged at 1 Hz. Table 3 gives the coordinates of the stations.

GPS station	**INL0**	**INL1**
Operating agency	NCALM	NCALM
Latitude	43.54887	43.54893
Longitude	-112.63661	-112.63667
Ellipsoid Height (m)	1593.723	1593.838

Table 3 – GPS Coordinates of ground reference stations

4. GPS/IMU Data Processing

Reference coordinates for all 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 two 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 5.0). 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 2) shows a general overview of the NCALM LiDAR data processing workflow

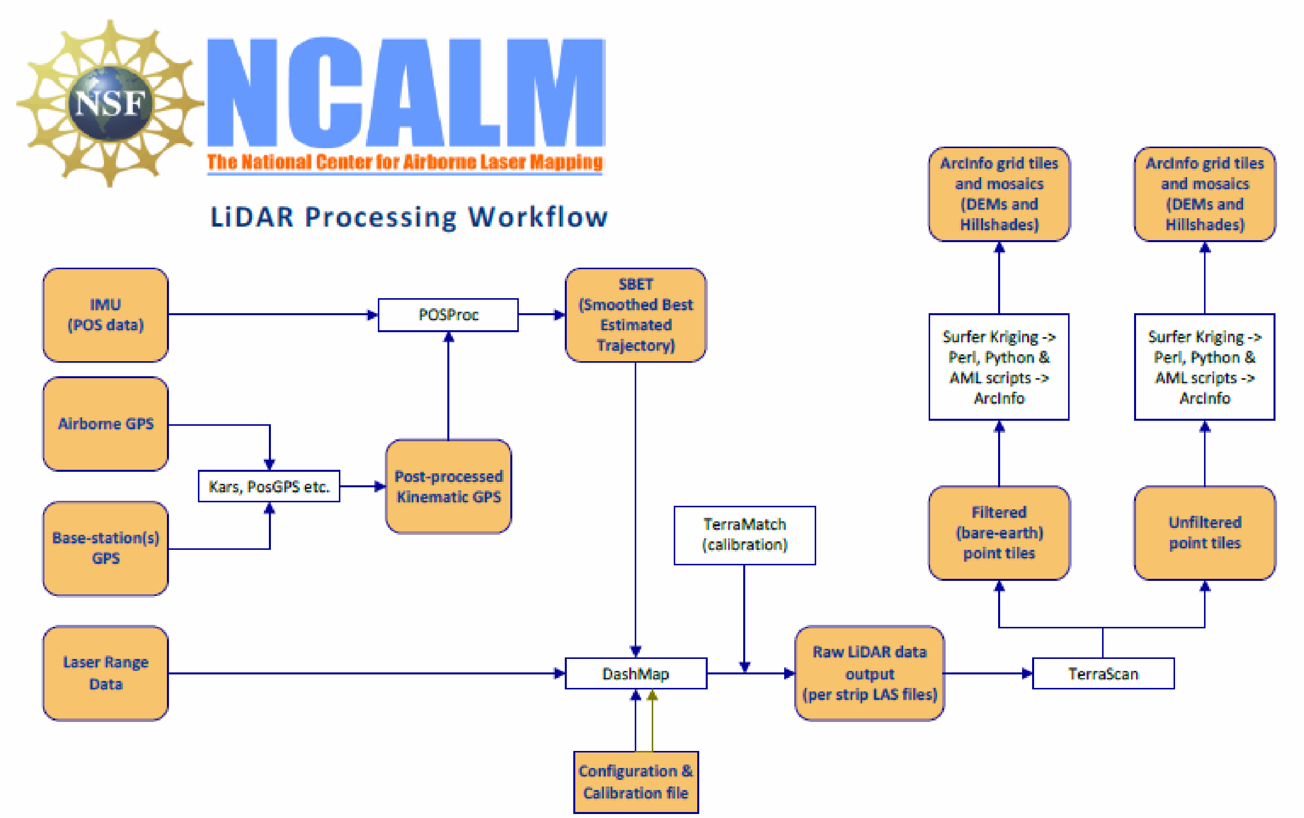

Figure 2 NCALM LiDAR Processing Workflow

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

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

6. Data Deliverables

a) **Horizontal Datum**: NAD83(CORS96)
b) **Vertical Datum:** NAVD 88, GEOID 03
c) **Projection:** UTM Zone 12N
d) **File Formats:** Point Clouds of individual flight strips in LAS format (only deliverables requested by PI)