LiDAR Survey of CA-NV State line Fault and Pahrump Valley
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1. LiDAR System Description and Specifications

This survey was performed with an Optech 2033 Airborne Laser Terrain Mapper (ALTM) serial number 98b110 mounted in a twin-engine Cessna 337 Skymaster aircraft (Tail Number N337P). The instrument nominal specifications are listed in table 1.

Operating Altitude	330 - 2000 meters
Range Accuracy	10 cm single shot
Range Resolution	1 cm
Relative Accuracy	5-10 cm @ 33KHz
Options	Intensity data; First and Last Pulse Measurements; Extended Altitude (2000 M)
Scan Angle	Variable from 0 to +/- 20
Angle accuracy	0.05 degrees
Angle Resolution	0.01 degrees
Scan Frequency	Variable - product of scan rate and scan frequency must be <590
Pulse Rate Frequency	33 KHz
Roll and Pitch Accuracy	0.04 degrees
Heading Accuracy	0.05 degrees
Laser Wavelength	1047 nanometers
Beam Divergence	0.30 mrad

Table 1 – Optech ALTM 2033 specifications.

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

2. Area of Interest.

The survey area consisted of three 500 meter wide corridors near the California-Nevada border and across the Pahrump Valley. The corridors total approximately 60 km long, 0.5 to 1 km wide and contained approximately 40 square km. The survey area is shown below in Figure 1.

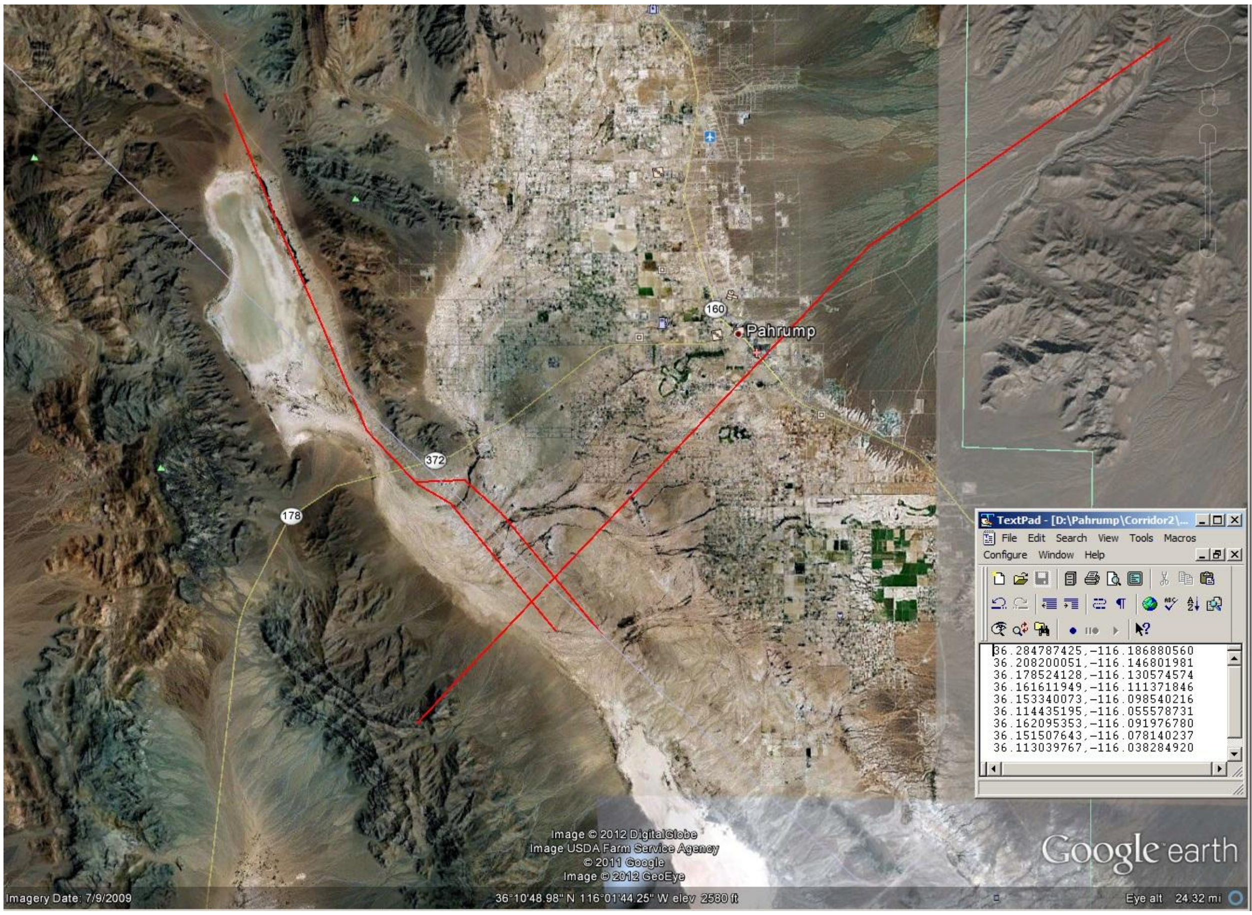

Figure 1 – Location of survey corridors. Text file gives coordinates in Lat, Lon (Google Earth).

3. Data Collection

a) Survey Dates: The survey took place on February 28, 2005 (DOY 059).

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

Nominal Flight Parameters		Equipment Settings		Survey Totals	
Flight Altitude	600 m	Laser PRF	33.3 kHz	Total Flight Time	1.0 hrs
Flight Speed	50 m/s	Beam Divergence	0.30 mrad	Total Laser Time	0.7 hrs
Swath Width	460 m	Scan Frequency	28 Hz	Total Swath Area	40 km^2
Swath Overlap	0%	Scan Angle	± 20°	Total AOI Area	40.0 km^2
Point Density	1.5 p/m^2	Scan Cutoff	1°		

Table2 – Survey Parameters and Totals.

c) Ground GPS: Two GPS reference station locations were used during the survey: FURN and PAH2. Both of these stations were set by NCALM. Both of the reference stations collected GPS observations at 1 Hz. Table 3 gives the coordinates of the stations.

GPS station	FURN	PAH2
Operating agency	NCALM	NCALM
Latitude	36.46307388	36.27742017
Longitude	-116.8790902	-115.9976464
Ellipsoid Height (m)	-97.016	787.265

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 POSProc. POSProc implements a Kalman Filter algorithm to produce a final, smoothed, and complete navigation solution including both aircraft position and orientation at 50 Hz. This final navigation solution is known as an SBET (Smoothed Best Estimated Trajectory).

5. LiDAR Data Processing Overview

LiDAR point-cloud processing was done in Optech REALM software, ASCII is the only supported output format.

Calibration of roll, pitch, and scanner mirror scale was done manually using cross-lines flown perpendicular to project lines.

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.

6. Accuracy Assessment

None performed.

7. Data Deliverables

a) **Horizontal Datum**: NAD83(COR96)
b) **Vertical Datum:** GEOID 03
c) **Projection:** UTM Zone 11N
d) **File Formats:**

1. Point Cloud in 9-column flight strips (1 file per flight strip) ASCII format (TXYZiXYZi) Last stop data in columns 2-5; first stop data in columns 6-9
2. Point cloud data in 3-column (XYZ) ASCII tiles.

8. Notes

1. No classification was done on these data per PI request. Vegetation is non-existent or extremely sparse.