The influence of dunes and barrier islands on hurricane surge in Corpus Christi, TX.
Seed Project

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1. LiDAR System Description and Specifications

This survey was performed with an Optech Aquarius Airborne Laser Terrain Mapper (ALTM) serial number 11SEN279 mounted in a twin-engine Cessna 337 Skymaster aircraft (Tail Number 337P). The instrument nominal specifications are listed in table 1.

Operating Altitude	150-500 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 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 - 70 kHz
Position Orientation System	Applanix POS/AV 510 OEM includes embedded BD960 72-channel 10Hz (GPS and Glonass) receiver
Laser Wavelength/Class	532 nanometers / Class IV (FDA 21 CFR)
Beam Divergence nominal (full angle)	1.0 mrad (1/e)

Table 1 – Optech Aquarius specifications

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

2. Area of Interest.

The survey area consisted of a rectangular polygon located on the gulf coast 25 km east of Corpus Christi, TX. The polygon is approximately 28.0 square km and measured 1.7 km wide by 15 km long and is shown below in Figure 1.
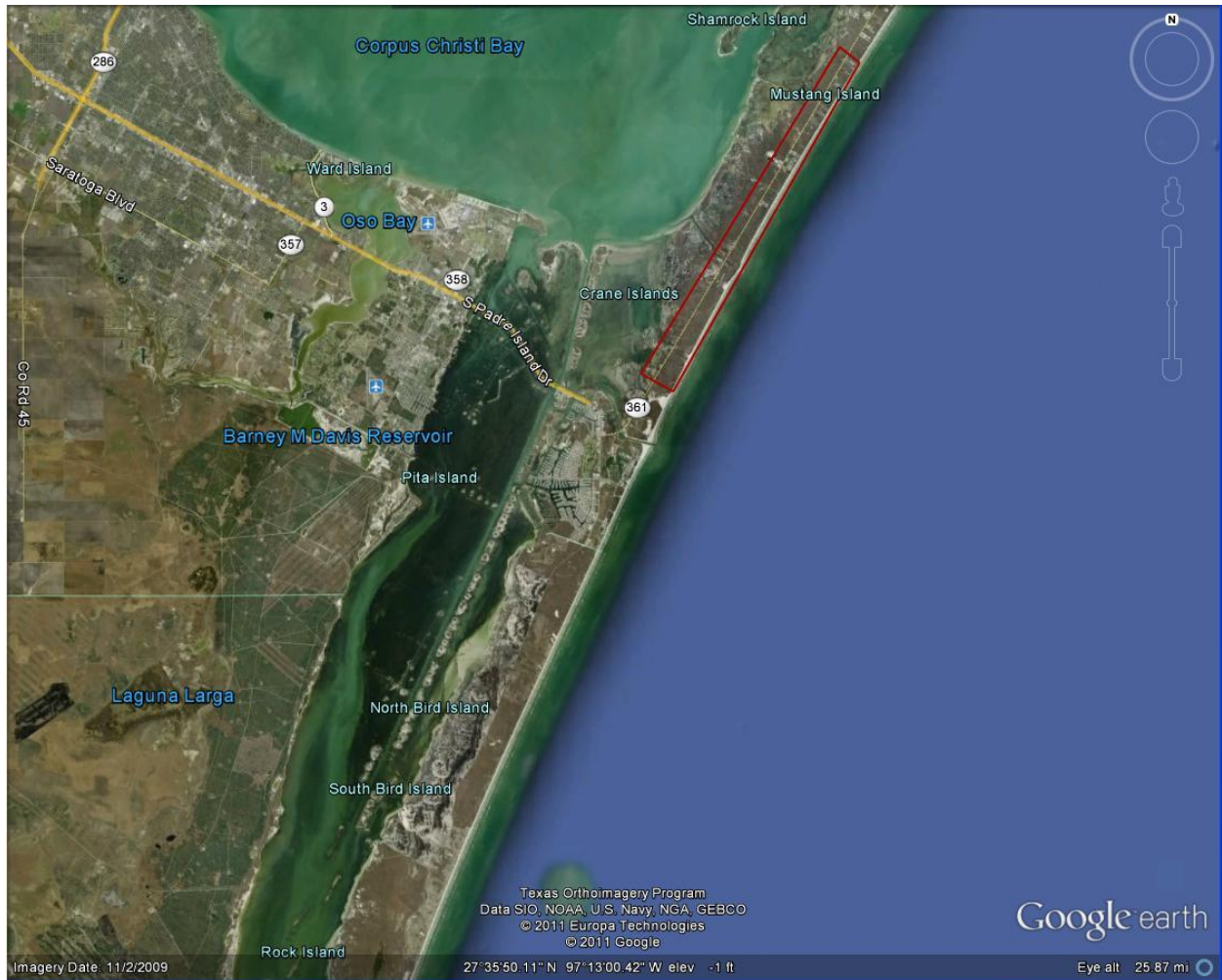
Figure 1 – Shape and location of survey polygon (Google Earth).

3. Data Collection

a) **Survey Dates**: The survey took place on October 17, 2011 (DOY 290).

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

Nominal Flight Parameters		Equipment Settings		Survey Totals	
Flight Altitude	400 m	Laser PRF	70 kHz	Total Flight Time	2.9 hrs
Flight Speed	65 m/s	Beam Divergence	1.0 mrad	Total Laser Time	1.1 hrs
Swath Width	244 m	Scan Frequency	50 Hz	Total Swath Area	32.5 km^2
Swath Overlap	50%	Scan Angle	± 19°	Total AOI Area	28 km^2
Point Density	7.8 p/m²	Scan Cutoff	2°		

Table2 – Survey Parameters and Totals.

c) **Ground GPS:** Three GPS reference station locations were used during the survey: KCC1 (set by NCALM), TXCC, and TXPO. Stations TXCC and TXPO are part of the CORS network (see http://www.ngs.noaa.gov/CORS/ for more information on CORS. NCALM reference GPS observations were logged at 1 Hz. while the CORS logged at a 5 second rate and were interpolated to 1 Hz for processing. Table 3 gives the coordinates of the stations.

GPS station	KCC1	TXCC	TXPO
Operating agency	NCALM	CORS	CORS
Latitude	27.77590621	27.7407931	27.8394566
Longitude	-97.5045578	-97.4416696	-97.0699023
Ellipsoid Height (m)	-12.971	-9.086	-19.432

Table 3 – GPS Coordinates of ground reference stations

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 3) shows a general overview of the NCALM LiDAR data processing workflow
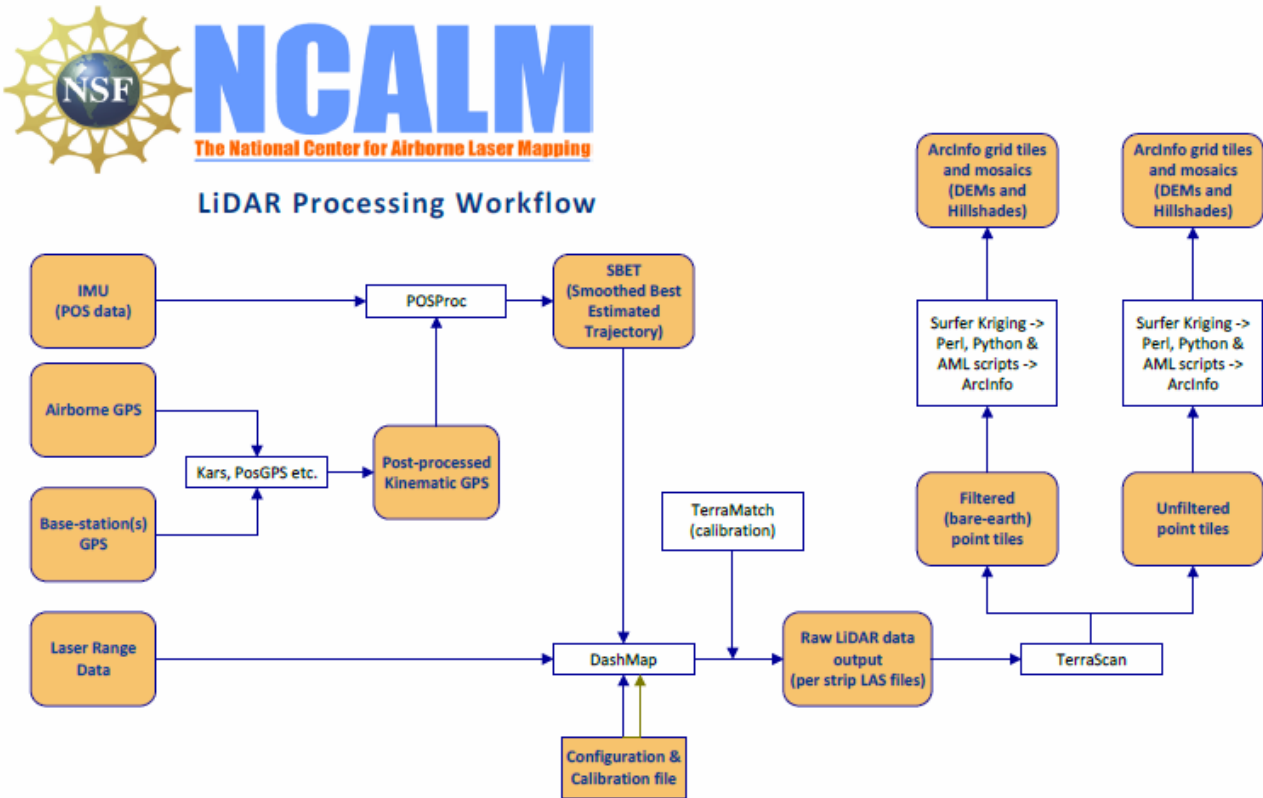
Figure 2 NCALM LiDAR Processing Workflow

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(2011)
b) **Vertical Datum:** GEOID 09
c) **Projection:** UTM Zone 14N
d) **File Formats:**

1. Point Cloud in LAS format, classified as ground or non-ground, in 1 km square tiles.
2. ESRI format 1-m DEM from ground classified points.
3. ESRI format 1-m Hillshade raster from ground classified points
4. ESRI format 1-m DEM from all points (canopy included).
5. ESRI format 1-m Hillshade raster from all points (canopy included).

e) **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_YYYYYY. For example if the tile bounds coordinate values from easting equals 680000 through 681000, and northing equals 3064000 through 3065000 then the tile filename incorporates 680000_3064000. 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 'fme' or 'ume' (depending whether the DEM is made using ground points or all points) and the lowest Easting coordinate rounded to the nearest 1000, for e.g. 'fme680000'. The hillshade files have a prefix 'sh' after the name, for e.g. 'fme680000sh'.

7. Notes

1. Although Aquarius ALTM is a bathymetric system no bathymetric corrections were applied to the laser shots on water bodies in this project.
2. Z-differences between flightlines are shown on the South-West corner of the project area. This could be from the fluctuation of tide or/and the difference of water penetration of different flightlines.
3. Lidar points returned from the tops of tall buildings near the beach on the North-East of the project area are filtered out showing as voids, especially on the default DEM. Hopefully this will have no impact on the scientific objectives of the project.