NCALM LIDAR

Southern California and Washington (Yakima) Fault Systems LiDAR Survey

(April 2 – April 26, 2008)

PROCESSING REPORT

SoCal Processing Report

1. LIDAR SYSTEM DESCRIPTION AND SPECIFICATIONS

The second campaign for UNAVCO covering the faults in Southern California and Washington regions was carried out in April 2008. Although not directly related the two fault systems are included in this data collection together because they were acquired during the same campaign and they share the same processing parameters.

The campaign started on April 2, 2008 at Ramona, California and ended on April 26, 2008 in Yakima, Washington. This survey used an Optech GEMINI Airborne Laser Terrain Mapper (ALTM) serial number 06SEN195 mounted in a twin-engine Cessna Skymaster (Tail Number N337P). System specifications appear below in Table 1.

Operating Altitude	150 - 4000 m, Nominal
Horizontal Accuracy	1/5,500 x altitude (m AGL); ±1-sigma
Elevation Accuracy	5 - 30 cm typical; ±1-sigma
Range Capture	Up to 4 range measurements per pulse, including 1^{st},2^{nd}, 3^{rd} and last
Intensity Capture	4 Intensity readings with 12-bit dynamic range for each measurement
Scan FOV	0 - 50 degrees; Programmable in increments of ±1degree
Scan Frequency	0 to 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.

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

2. FIELD CAMPAIGN

The field campaign started on April 2, 2008 at Ramona California and ended on April 26, 2008 at Yakima Washington. It consisted of 21 flights taking place on 19 separate days. Six days were lost to transit and weather. The campaign therefore took a total of 25 days to complete. It totaled 45.88 Laser On Time (LOT) and 93.8 hrs of total flight time. The table below gives the summary of survey flights:

Date	Airport	DOY	Flight time	Laser-on	Area surveyed
4/2/2008	Romona	93	5	2.06	B4_addon, Elsinore C, Elsinore A
4/3/2008	Ramona	94	3.35	1.36	Elsinore A, Elsinore B
4/4/2008	Ramona	95	1.7	0.60	Elsinore A
4/5/2008	Dagget	96	3.95	1.50	Garlock_Corr1
4/6/2008	Dagget	97	4.5	2.60	Calico, Lenwood, Helendale
4/7/2008	Dagget	98	3.5	1.30	Garlock_Corr1, Garlock_Corr4, Garlock_Corr2
4/10/2008	Mohave-Fox	101	5.25	2.50	Garlock_Polygon_A, Garlock_Corr1, Garlock_Corr3
4/11/2008	Fox	102	5.1	2.60	Garlock_Corr_6, Garlock_Corr5_unres, Panamint_CorrUnres
4/12/2008	Fox	103	4.66	2.50	San_Cayateno_Corr, San Cayateno_Poly
4/13/2008	Fox	104	5.2	2.60	Blackwater_Calico_Connector, Mudhills, Blackwater_R2524
4/14/2008	Fox	105	5.5	2.16	Ash-hill_poly, Ash_hill_Corr, Panamint Poly
4/17/2008	Fox	108	5.6	2.50	Panamint_corrRes, Garlock_CorrRes, Panamint_Corr2, Hunter_Corr
4/18/2008	Fox	109	5.73	3.25	Hunter_Corr, Panamint_CorrRes, Garlock_Corr5Res
4/19/2008	Fox	110	3.63	1.43	Garlock_Res, Panamint_Res, Garlock_PolyC
4/21/2008	Fox	112	4.36	1.63	Garlock_Corr7, Garlock_Corr9, Garlock_PolyB
4/22/2008	Bishop	113	5.1	3.00	Owens Valley_polyA, Owens_Valley_Corr1, Owens valley_PolyB, Owens_Valley_Corr2
4/23/2008	Bishop	114	5.42	3.25	Hunter_Corr, Hunter_Corr2A
4/24/2008	Bishop	115	5	2.58	Tin_Mntns, Owens_Valley_Addon
4/24/2008	Bishop	115	2	0.75	Owens_Valley_Addon
4/26/2008	Yakima	117	4	2.11	Yakima_ST
4/26/2008	Yakima	117-118	5.25	3.60	Yakima_ST
		TOTAL	**93.8**	**45.88**	

Table 2. Survey dates and segments

3. SURVEY AREA AND PARAMETERS

ALTM NAV planner software was used to plan the survey. The surveys were planned so as to have a point density of 6-8 points per square meter. The pulse frequency for the surveys was decided on the basis of terrain of the section. For a nominal terrain which could be followed easily, the survey was carried out at an above ground altitude of 700m and 100 KHz pulse frequency with 50% overlap to obtain the desired point density. A highly rolling terrain with steep descents and ascents where the terrain could not be followed at a lower altitude safely required a higher flying altitude. This resulted in use of a lower pulse frequency and higher number of passes. The table below gives the survey parameters used in the field and the area surveyed in square kilometers:

SECTION	DOY	System PRF(KHz)	Scan Angle(degree)	Scan Cutoff(degree)	Scan Frequency(Hz)	Area (SqKm)
B4_Addon	93	100	25	4	40	8
Elsinore A	93, 94, 95	100	25	4	40	129.5
Elsinore B	94	100	25	4	40	53.6
ElsinoreC	93	100	25	4	40	23.5
Garlock_Corr1	96	100	25	5	40	115.6
	98, 101	70	15	5	55	
Calico	97	100	20	1	40	44.6
Lenwood	97	100	20	1	40	53.6
Helendale	97	100	20	1	40	64.7
Garlock_Corr2	98	100	20	1	40	2.4
Garlock_Corr4	98	100	25	4	40	8.2
Garlock_Corr3	101	70	15.5	5	50	3
Garlock_PolyA	101	70	15.5	5	50	81
Garlock_Corr_6	102	70	16	4	50	11.5
Garlock_Corr5Unres	102	70	16	4	50	54.4
Panamint_unres	102	70	16	4	50	108.7
San Cayateno_Corr	103	70	15	4	50	79.3
San Cayateno_Poly	103	50	14	5	50	32
BlackWater_Calico_connector	104	70	17	5	50	63.7
Mudhills	104	70	19	5	50	32.4
Blackwater_R2524	104	70	17	5	50	70.7
Ash_hill_poly	105	100	18.2	5	50	21
Ash_Hill_Corr	105	100	18.2	5	50	0.1
Panamint_Poly	105	70	14	3	50	6.36
Garlock_corr5Res	108, 109	70	19	5	50	96.1
Panamint_Res	108, 109	70	16	4	50	52.7
	110	70	17	5	50	
Panamint_corr2	108	70	17.2	4	50	16.7
Hunter_Corr	108, 109	50	11.3	4	50	155.7
	114	50	15.6	5	50	
Garlock_Res	110	70	17	5	50	39.1
Garlock_PolyC	110	70	18	5	50	42.6
Garlock_Corr9	110, 112	70	17	5	50	22.2
Garlock_PolyB	112	100	19	2	50	62.2
Owens_Valley	113	100	22	4	45	181.3
Owens_Valley_addon	115	100	20	4	45	90.4
Tin_Mtn	115	70	16.5	5	55	92.4
Yakima	117	100	25	5	40	295
					Total	**2214.26**

Table 3. Survey parameters and segment areas

Figures below show the areas surveyed during this campaign:

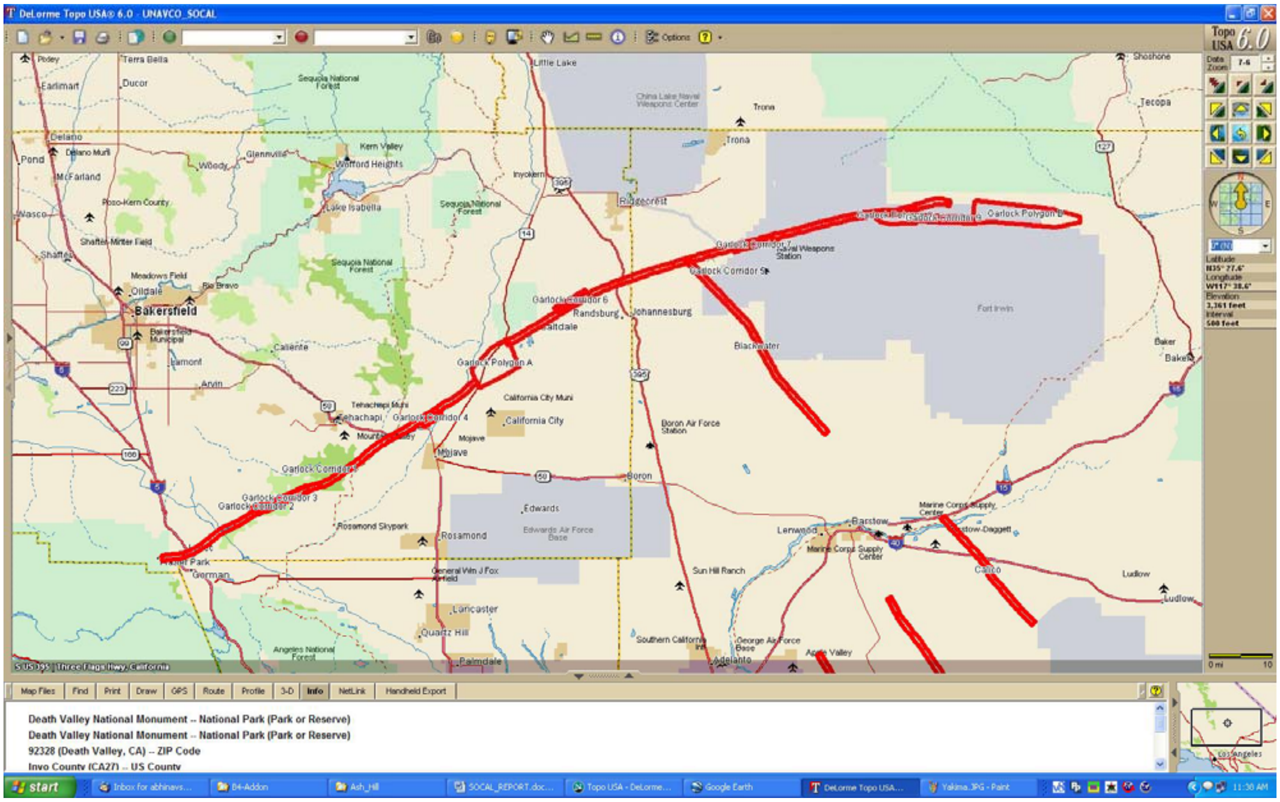

Fig 1: Garlock Sections

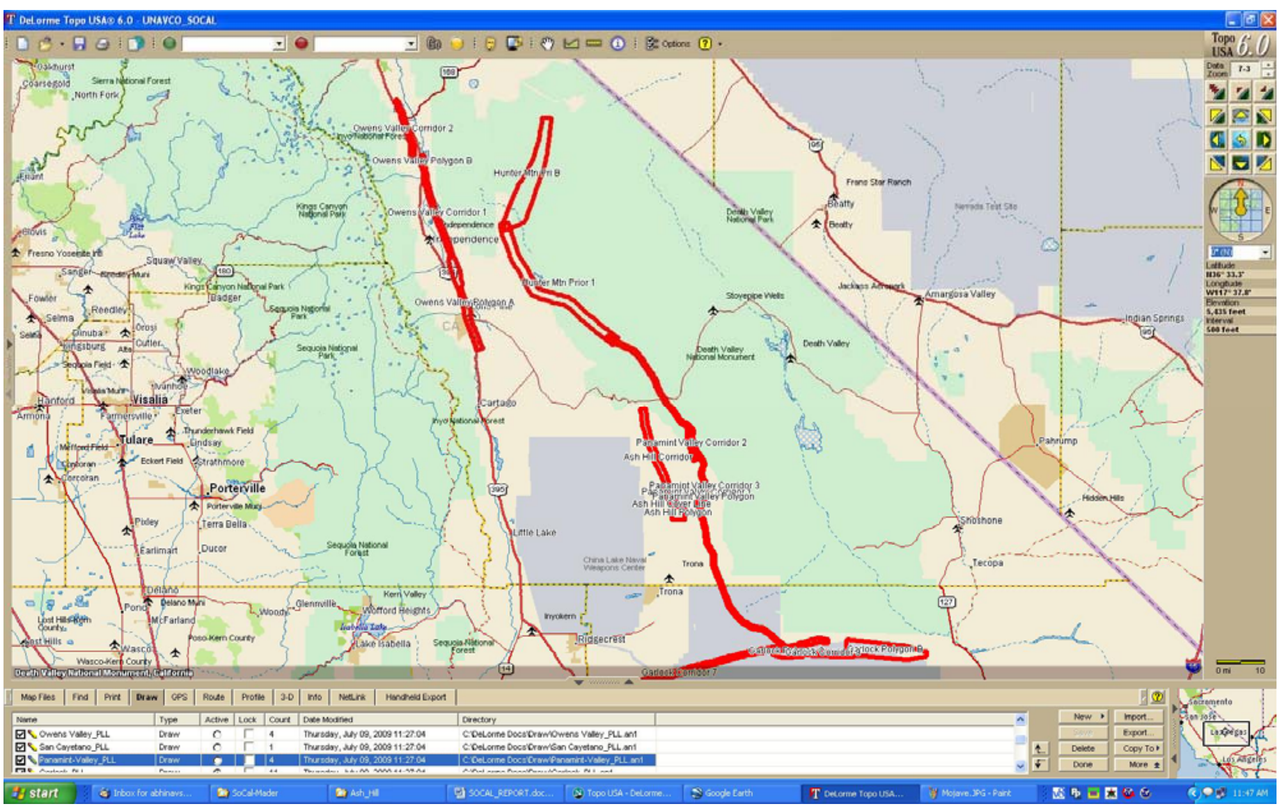

Fig 2: Owens Valley, Hunter Mtns, Panamint Valley, Ash Hill sections

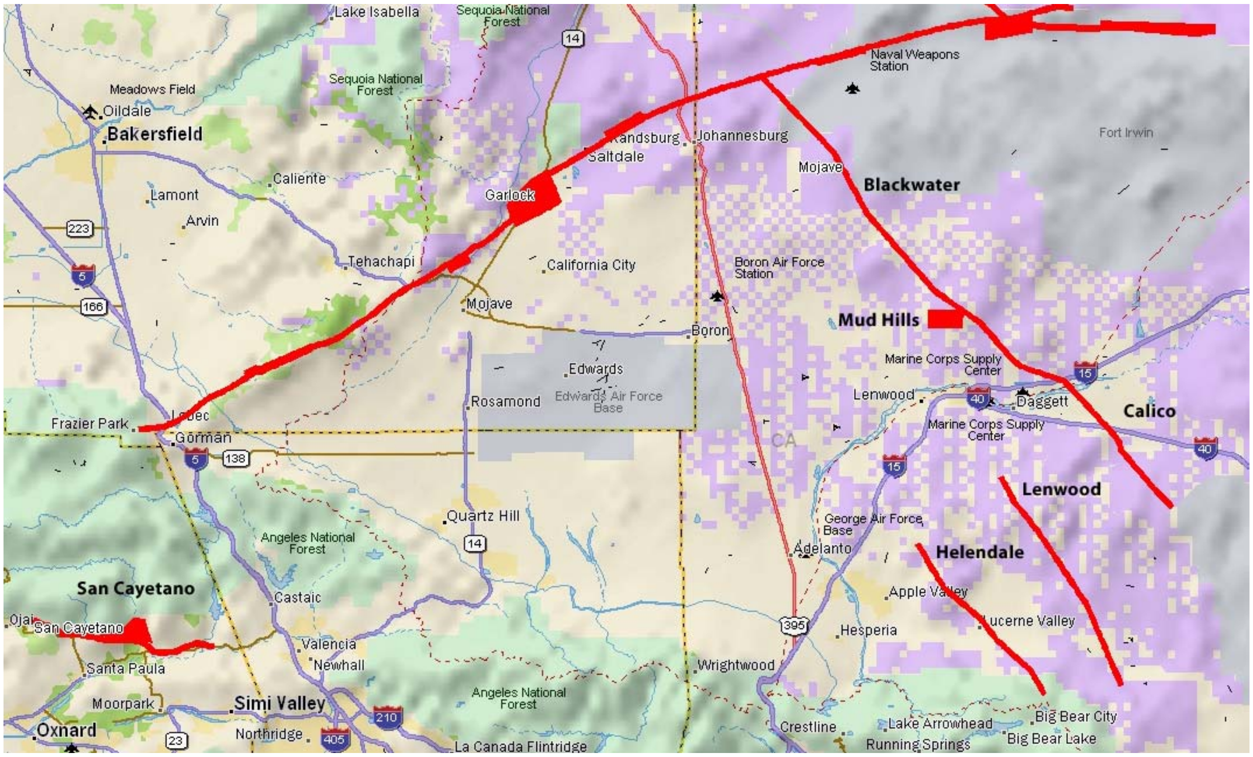

Fig 3: San Cayetano, Blackwater, Mud Hills, Calico, Lenwood and Helendale sections

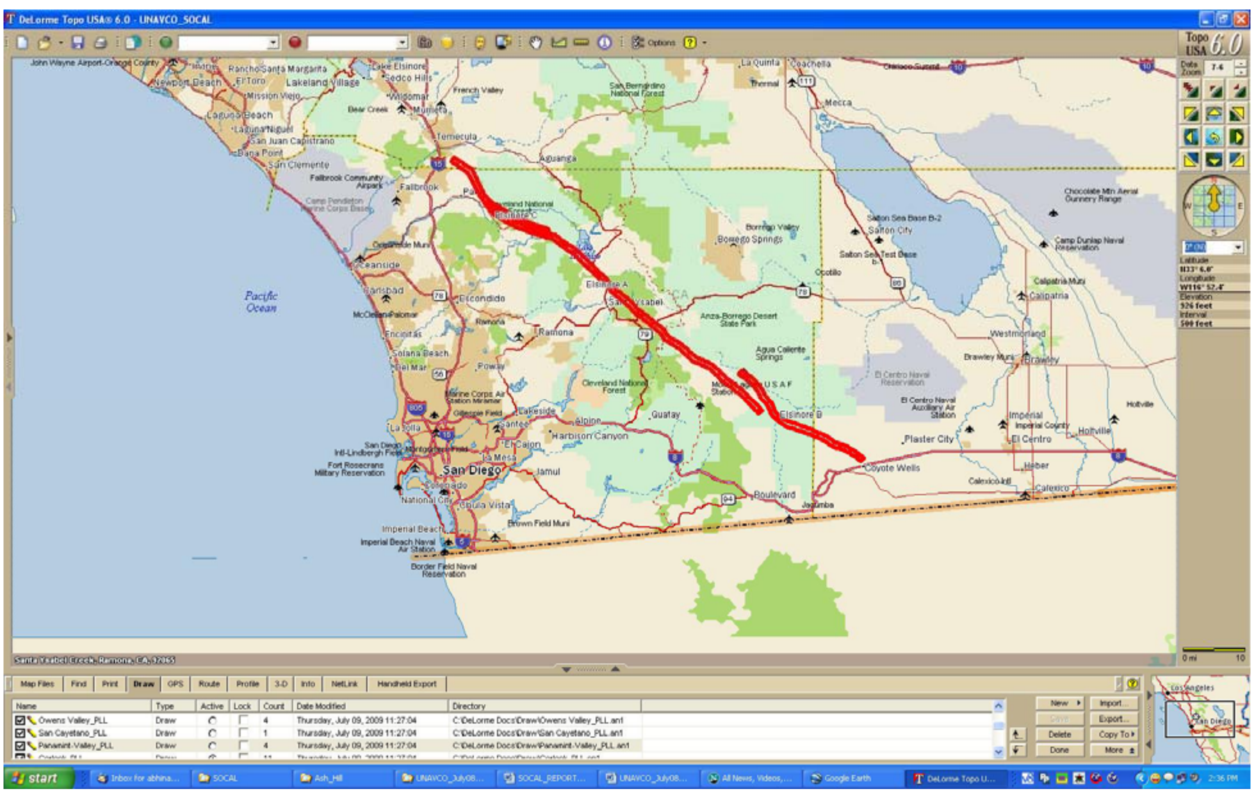

Fig 4: Elsinore Section

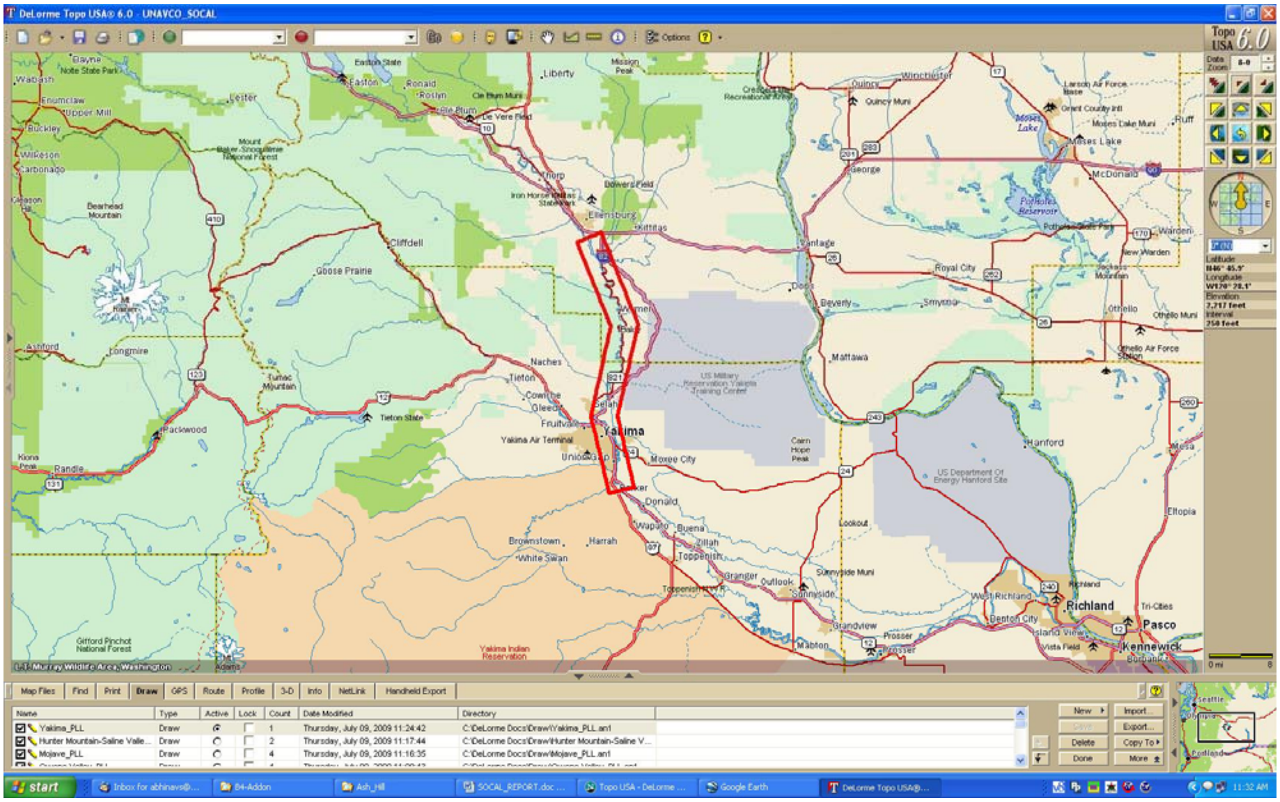

Fig 5: Yakima Section

4. GPS DATA

The GPS reference stations consisted of the PBO stations operated by UNAVCO. In addition to those a GPS station was set up by NCALM and OSU for each flight at or near the airport.

The aircraft and base station GPS data were processed by Dr. Gerry Mader. The coordinates for the base stations were determined by multiple runs through OPUS (http://www.ngs.noaa.gov/OPUS/) to get positions on different days and then taking their average for each site. To maintain consistency, the same 3 CORS for each reference station were used in each OPUS run.

The airplane GPS was processed using KARS software. For each day coordinates for each flight were determined separately using each of the different base station and then averaged out to get the final solution. Table below gives the various reference stations used for each flight and the RMS values associated with the trajectories for each flight.

Day	GPS Sites	RMS (m)
93	KRM1, P476, P477, P484, P480	0.017
94	KRM1, P476, P477, P484, P480	0.015
95	KRM1, P476, P477, P484, P480	0.016
96	KDAG, P553, P562, P569, P579	0.014
97	KDAG, AGMT, ORMT, P588, P589	0.031
98	KDAG, P553, P562, P569, P579	0.015
101	KFOX, P553, P562, P569, P579	0.014
102	KFOX, P553, P562, P569, P579	0.009
103	FMVT, HVYS, KBRC, KFOX, SFDM	0.012
104	AGMT, KDAG, KFOX, ORMT, P592	0.012
105	KFOX, RAMT	0.012
108	CCCC, KFOX, P591, P594, P597	0.011
109	KFOX, P091, P093, P466, P468	0.014
110	KFOX, P580, P597, RAMT	0.013
112	KFOX, LNMT, P597	0.014
113	KBIH, P093, P468	0.01
114	KBIH, P091, P466, P093, P468	0.015
115A	KBIH, P091, P466, P093, P468	0.012
115B	KBIH, P093, P468	0.02
117A	LINH, P065, SC00	0.01
117B	LINH, P065, SC00	0.016

Table 4. Survey GPS reference stations

5. ORIENTATION DATA

The high-confidence GPS aircraft trajectory is combined with the IMU (Inertial Measurement Unit) data utilizing the Applanix POSProc tools v4.3 to produce the Smoothed

Best Estimate of Trajectory (SBET). The aircraft trajectory solutions in KARS format (ASCII) were converted to binary PPR format using the “kars2ppr.exe” software translator.

The POSProc (Position and Orientation System post-Processing) software consists of an integrated inertial navigation module (Kalman filter) and a smoother module that work symbiotically to produce the SBET.

The lever arm values for the GPS-sensor offsets were surveyed using a high-accuracy ground-lidar Ilris instrument. These values are:

X: -0.587 (in-flight, antenna in front of sensor)
Y: -0.288 (cross-flight, antenna to the right of sensor)
Z: -1.393 (elevation, antenna is above sensor)

The output of the POSProc software is the SBET file that is used during the laser point processing with DashMap.

6. LASER POINT PROCESSING

The general processing workflow and quality control procedures are illustrated in Figures 6 and 7.

The laser ranging files and post processed aircraft navigation data (SBET) are combined using Optech’s DashMap software to produce the laser point cloud in the form of LAS files. DashMap version 3.005 was used for the SoCal processing.

DashMap was run with the following processing filters enabled: *scan angle cut-off* (varying 0.5-4.0 deg), *minimum range* (typically 400m) and *intensity normalization* enabled (1000m normal range). The temperature and pressure values were adjusted based on the recorded values from the airport at the time of the flight and the average altitude above ground.

The IMU misalignment angles (roll, pitch, heading), scanner scale and pulse range offsets are specified via the calibration file. The closest previously known good configuration file is used as a starting point for the calibration procedure and provides baseline values for the misalignment parameters. Using these baseline parameters a calibration site data is output for running the relative calibration procedures that further improve swath alignment. The calibration site typically consists of two sets of perpendicular flight lines over the airport. These data are filtered “by flightline” in order to generate a ground model for each individual swath that can be used to perform the calibration routine.

The relative calibration is performed using TerraSolid’s TerraMatch software and the airport laser point data. TerraMatch measures the differences between laser surfaces from overlapping flightlines or differences between laser surfaces and known points. These observed differences are translated into overall correction values for the system orientation (roll, pitch, heading) and mirror scale. The values reported by TerraMatch represent shifts from the baseline parameters used to output the calibration site data from DashMap. The calibration parameters for each survey segment are listed in Table 5.

The user should be aware that these calibration procedures determine a set of best global parameters that are equally applied to all swaths from a given laser range file. This means that the final swath misfit is going to vary slightly from place to place and swath to swath depending on how well the global calibration parameters are reducing the local misalignment. In most instances the swath misfit is completely eliminated for the entire dataset and no visible artifacts are carried over to the final DEM products, but some swaths or swath sections may exhibit worse than average alignment with their neighbors and the swath edge may become detectable in the DEMs.

The vertical accuracy of the lidar data was checked using a set of "ground-truth" points surveyed using vehicle-mounted GPS over the airport area. Comparisons were made between the heights of the vehicle-collected GPS and the processed points collected by the airborne laser scanner. TerraScan was used to output a control report in which the differences between the known ground points and the closest matching lidar points are reported. The average offset between the ground truth and laser data was used to adjust the pulse range parameters in the DashMap calibration file.

The range and orientation adjustments are listed in the following table:

DOY	PRF (KHz)	First (m)	Second (m)	Third (m)	Last (m)	Scale	IMU Roll (deg)	IMU Pitch (deg)	IMU Heading (deg)
93	100	-2.940	-2.940	-2.940	-5.340	1.022910	0.150200	-0.075900	0.025500
94	100	-2.958	-2.958	-2.958	-5.358	1.023300	0.144000	-0.077000	0.040900
95	100	-2.940	-2.940	-2.940	-5.340	1.023300	0.144000	-0.077000	0.040900
96	100	-2.901	-2.901	-2.901	-5.311	1.023230	0.142300	-0.077200	0.008100
97	100	-3.019	-3.019	-3.019	-5.429	1.023030	0.142700	-0.075200	0.028900
98	100	-2.925	-2.925	-2.925	-5.325	1.022930	0.136200	-0.069600	0.035300
98	70	-2.915	2.915	2.915	-5.315	1.022930	0.136200	-0.069600	0.035300
101	70	-2.983	-2.983	-2.983	-2.983	1.023120	0.139700	-0.059700	0.069300
102	70	-3.018	-3.018	-3.018	-5.418	1.022570	0.136100	-0.074900	0.039000
103	70,50	-2.996	-2.996	-2.996	-5.396	1.022530	0.135300	-0.079100	0.022100
104	70	-2.967	-2.967	-2.967	-5.367	1.022470	0.141600	-0.079100	0.027900
105	100	-2.984	-2.984	-2.984	-5.384	1.022470	0.138600	-0.081300	0.016300
105	70	-2.974	-2.974	-2.974	-5.374	1.022470	0.138600	-0.081300	0.016300
108	70	-3.000	-3.000	-3.000	-5.400	1.022970	0.133400	-0.079600	0.009900
109	70	-2.965	-2.965	-2.965	-5.365	1.022840	0.142200	-0.078500	0.027600
109	50	-3.019	-3.019	-3.019	-5.419	1.022840	0.142200	-0.078500	0.027600
110	100	-2.969	-2.969	-2.969	-5.369	1.022640	0.139800	-0.073500	0.030400
110	70	-2.959	-2.959	-2.959	-5.359	1.022640	0.139800	-0.073500	0.030400
113	100	-3.022	-3.022	-3.022	-5.422	1.022490	0.140000	-0.072600	0.016200
114	70	-3.051	-3.051	-3.051	-5.451	1.022750	0.133600	-0.069700	0.038000
114	50	-3.085	-3.085	-3.085	-5.485	1.022750	0.133600	-0.069700	0.038000
115a	70	-3.046	-3.046	-3.046	-5.446	1.022430	0.132900	-0.070000	0.042500
115a	100	-2.989	-2.989	-2.989	-5.389	1.022430	0.132900	-0.070000	0.042500
115b	100	-2.96	-2.96	-2.96	-5.36	1.022250	0.138600	-0.072200	0.038400
117a	100	-2.991	-2.991	-2.991	-5.391	1.023130	0.134400	-0.068800	0.035900
117b,118	100	-2.991	-2.991	-2.991	-5.391	1.022660	0.139400	-0.072600	0.033200

Table 5. Calibration parameters

The resulting orientation, mirror scale and range offsets are used to create a new DashMap calibration file that is used to output the calibrated, complete laser point dataset in LAS format, one file per flight strip. The LAS files contain all four pulses data recorded by the scanner as well as additional information like the intensity value and scan angle.

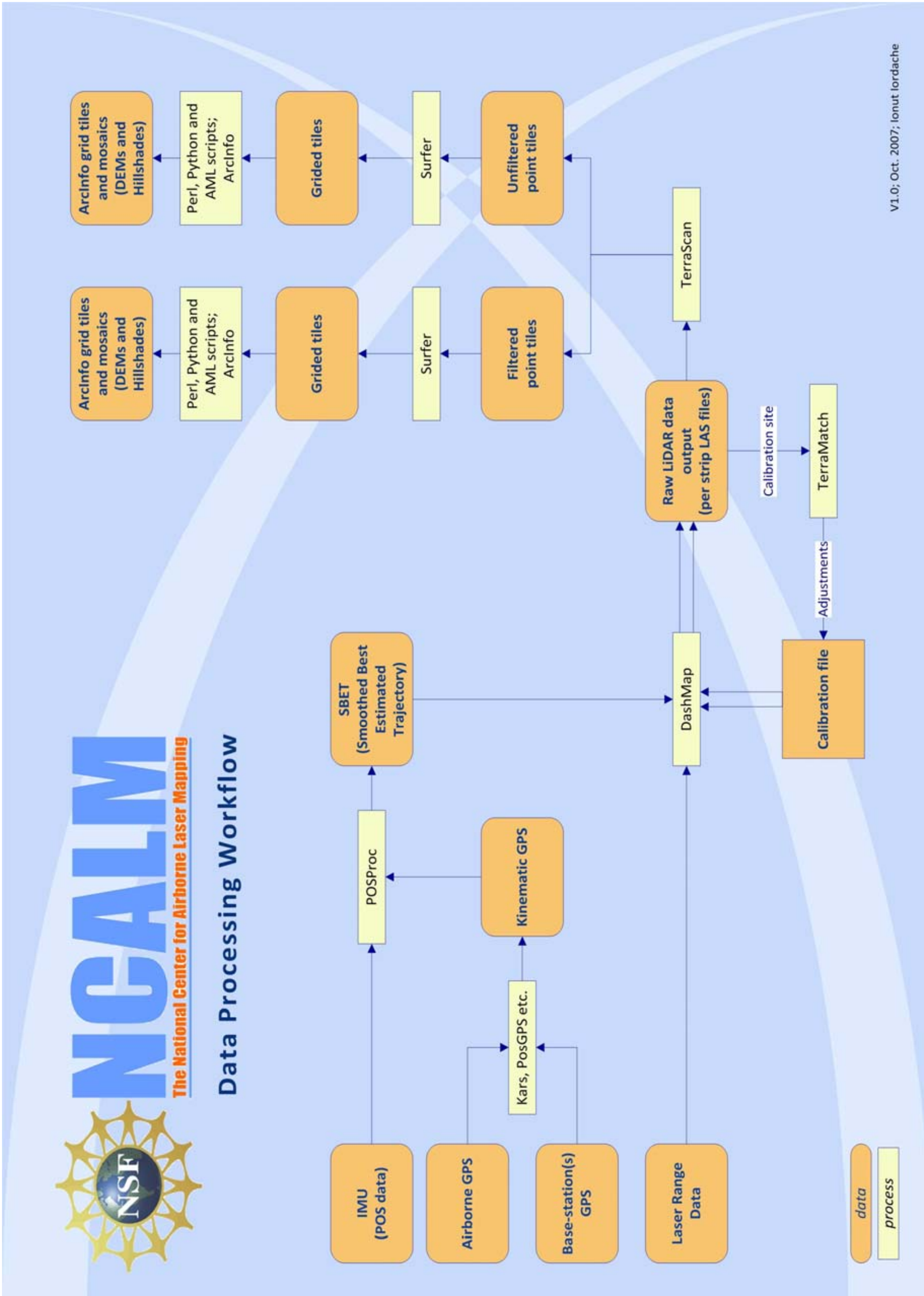

Figure 6. Laser data processing workflow

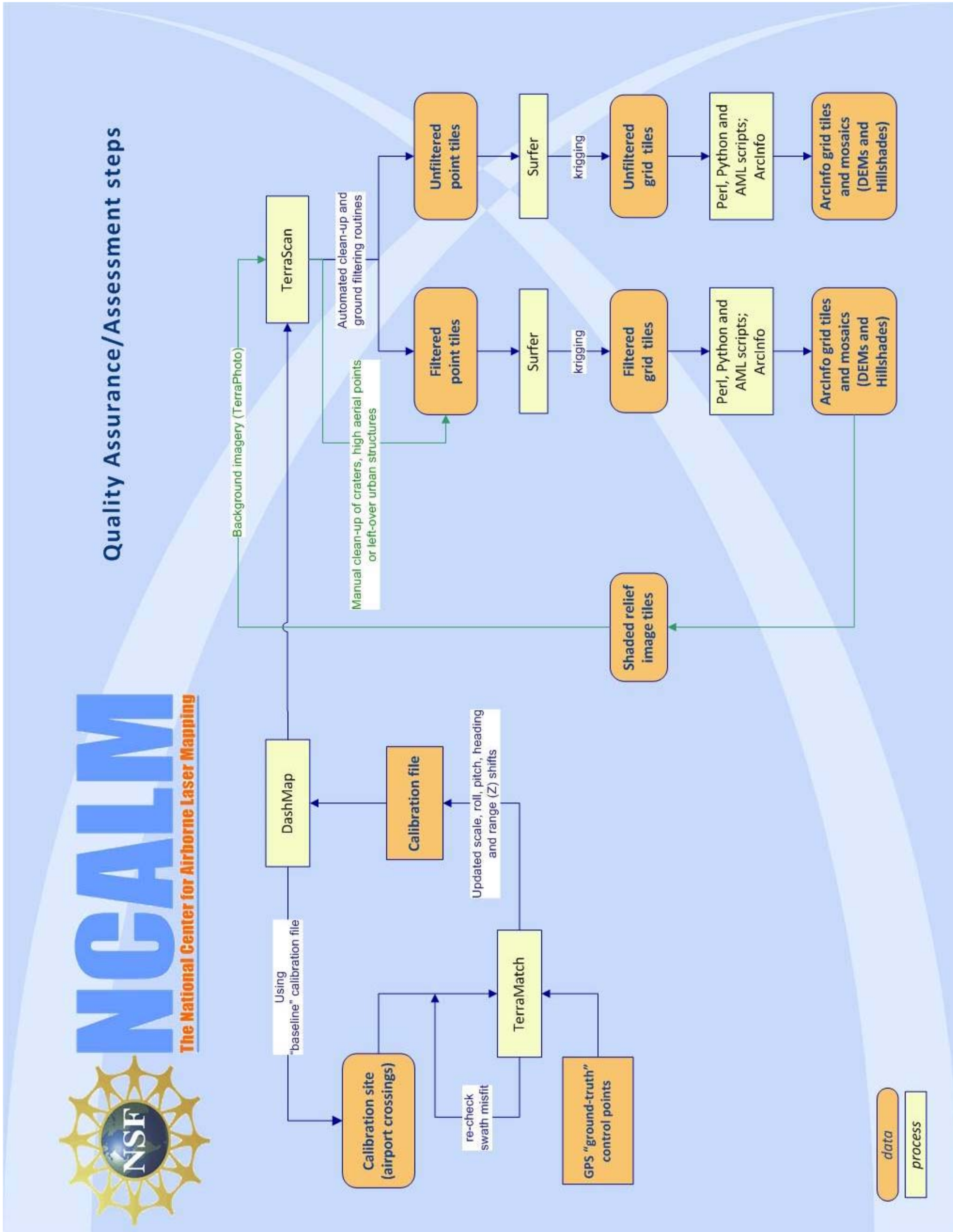

Figure 7. Laser processing QA/QC procedures

7. CLASSIFICATION

TerraSolid's TerraScan software was used to classify the raw laser point into the following categories: ground, non-ground (default), aerial points and low points.

Because of the large size of the lidar data the processing had to be done in tiles. Each survey segment was imported into TerraScan projects consisting of 1000m x 1000m tiles aligned with the 1000 units in UTM coordinates.

The classification process was executed by a TerraScan macro that was run on each individual tile data and the neighboring points within a 40m buffer. The overlap in processing ensures that the filtering routine generate consistent results across the tile boundaries.

The classification macros consist of the following general steps:

1) *Initial set-up and clean-up.* All four pulses are merged into the "Default" class to be used for the ground classification routine. A rough minimum elevation threshold filter is applied to the entire dataset in order to eliminate the most extreme low point outliers.

2) *Low and isolated points clean-up*. At this step the macro is searching for isolated and low points using several iterations of the same routines.

The "Low Points" routine is searching for possible error points which are clearly below the ground surface. The elevation of each point (=center) is compared with every other point within a given neighborhood and if the center point is clearly lower then any other point it will be classified as a "low point". This routine can also search for groups of low points where the whole group is lower than other points in the vicinity.

The "Isolated Points" routine is searching for points which are without any neighbors within a given radius. Usually it catches single returns from high above ground but it is also useful in the case of isolated low outliers that were not classified by the Low Points routine.

Typically the Isolated routine was run twice and the Low routine three times.

Search for: Groups of Points
Max Count (maximum size of a group of low points): 5 – 5 - 5
More than (minimum height difference): 0.2 m – 0.5m – 0.5m
Within (xy search range): 5.0 m – 5.0m – 10.0m

3) *Ground Classification*. This routine classifies ground points by iteratively building a triangulated surface model. The algorithm starts by selecting some local low points assumed as sure hits on the ground, within a specified windows size. This makes the algorithm particularly sensitive to low outliers in the initial dataset, hence the requirement of removing as many erroneous low points as possible in the first step.

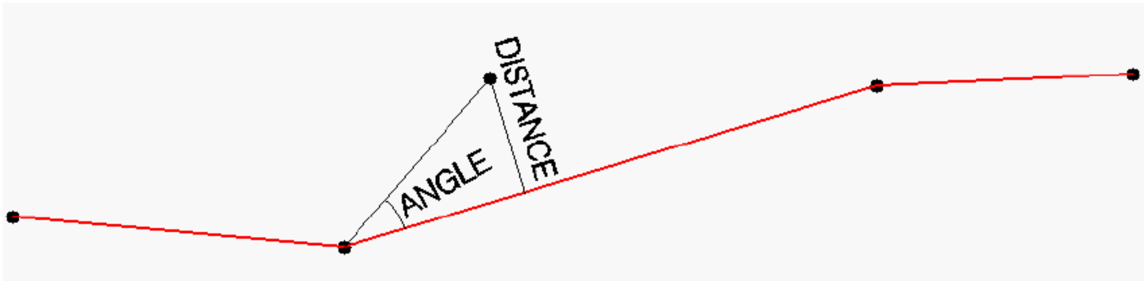

Figure 8. Ground classification parameters

The routine builds an initial model from selected low points. Triangles in this initial model are mostly below the ground with only the vertices touching ground. The routine then starts molding the model upwards by iteratively adding new laser points to it. Each added point makes the model follow ground surface more closely. Iteration parameters determine how close a point must be to a triangle plane so that the point can be accepted to the model. Iteration angle is the maximum angle between point, its projection on triangle plane and closest triangle vertex. The smaller the Iteration angle, the less eager the routine is to follow changes in the point cloud. Iteration distance parameter makes sure that the iteration does not make big jumps upwards when triangles are large. This helps to keep low buildings out of the model. The routine can also help avoiding adding unnecessary point density into the ground model by reducing the eagerness to add new points to ground inside a triangle with all edges shorter than a specified length.

Typical Ground classification parameters used:

Max Building Size (window size): 40.0 m
Max Terrain Angle: 88.0
Iteration Angle: 6.20 deg
Iteration Distance: 2.0 m
Reduce iteration angle when edge length < : 5.0 m

These parameters where adjusted where required by the specific topography of some segments, in order to better capture the true ground surface.

4) *Below Surface removal*. This routine classifies points which are lower than other neighboring points and it is run after ground classification to locate points which are below the true ground surface. For each point in the source class, the algorithm finds up to 25 closest neighboring source points and fits a plane equation through them. If the initially selected point is above the plane or less than “Z tolerance”, it will not be classified. Then it computes the standard deviation of the elevation differences from the neighboring points to the fitted plane and if the central point is more than “Limit” times standard deviation below the plane, the algorithm it will classify it into the target class.

Below Surface classification parameters used:

Source Class: Ground
Target Class: Low Point
Limit: 8.00 * standard deviation
Z tolerance: 0.10 m

5) *Above ground clean-up*. This last step applies a height above ground threshold (60m) to the points left in the "Default" class in order to eliminate systemic, grouped high point clusters that sometime may appear in the raw lidar data. This ensures that the "unfiltered" dataset is free from artifacts due to these type of clusters.

8. DEM PRODUCTION

The point data is output from TerraScan in 1000m x 1000m tiles, with 40m overlap. Two sets of files are generated, in XYZ ASCII format: filtered (ground class) and unfiltered (ground and "default" classes). In the unfiltered dataset the outlier classes are excluded from output (aerial and low points). The overlap is needed in order to generate a consistent interpolation across tile edges and it will be trimmed in the final tile DEMs.

A set of tiles in the "comprehensive" format is also outputted, to be used by the GEON online distribution and processing center.

The various file formats and file naming conversions are described in the next section.

The point tiles are grided using Golden Software's Surfer 8 Krigging at 0.5m cell size, using a 5m search radius for the unfiltered point data and 25m for the filtered.

The griding parameters are:

Gridding Algorithm: Kriging
Variogram: Linear
Nugget Variance: 0.15 m
MicroVariance: 0.00 m
SearchDataPerSector: 7
SearchMinData: 5
SearchMaxEmpty: 1
SearchRadius: 5m (unfiltered), 25m (filtered)

The resulting tiled Surfer grid sets are transformed using in-house Perl and AML scripts into ArcInfo binary seamless tiles at 0.5m cell size. The 1sq.km tiles are combined into 10Km wide mosaic segments at 1m cell size resolution.

The point tiles and the corresponding grids and mosaics are all positioned in the ITRF2000 reference frame and projected into UTM coordinates Zone 11N, all units in meters. The elevations are heights above the ellipsoid. Because ArcInfo doesn't support directly this particular projection, the grids are assigned the following projection information: UTM Zone 10N, WGS84 (original) datum.

8.1 Special note on the SoCal LiDAR data georeferencing

Users who intend to integrate the SoCal LiDAR data with other geospatial data sets (especially data referenced to datums other than WGS84) should be aware that alignment issues may occur because the data is positioned in the ITRF2000 reference frame. There are several iterations of the WGS84 datum definition and the most recent ones are tied to ITRF (which is continually in motion because it accounts for plate tectonic movements) and thus by simply specifying WGS84 as datum is not enough to clearly identify which version is used. In fact, ArcInfo's WGS84 datum definition implies WGS83_original which is equivalent with the NAD83(CORS96) datum and doesn't account for plate tectonic velocities.

Currently, ITRF2000 is equivalent to WGS84(G1150). Therefore, it is important to use the transformation that is appropriate for the version of WGS84 used by these data in order to minimize alignment errors. For instance, ArcGIS provides 8 different transformations for aligning NAD83 data with WGS84 data. Failure to select the correct datum transformation can yield mismatches greater than 1.5 meters ArcGIS users should also note that ESRI does not yet offer a transformation for WGS84 tied to ITRF00 (G1150), however the ITRF96-based WGS84 (G873 - the edition of ITRF previous to ITRF00) is only a few centimeters different than ITRF00 so transformations based on ITRF96 should work reasonably well. For example, ArcInfo users should use the "NAD_1983_To_WGS84_5" transformation method for projecting the LiDAR data (now assumed to be WGS84(G873) which is equivalent to ITRF96) into NAD83.

For more information about the currently supported ArcInfo transformation visit this webpage:
http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=24159

The online HTDP (Horizontal Time Dependent Positioning) toolkit provides many resources and interactive point data transformation between the various reference frames: http://www.ngs.noaa.gov/TOOLS/Htdp/Htdp.shtml

The users should also be aware that the elevation values of all datasets are heights above the ellipsoid (WGS84) and not orthometric heights. The ellipsoid-heights are measured along the ellipsoid normal in contrast to the orthometric heights which follow the direction of the gravity. In many applications the term "elevation" most commonly refers to the orthometric height of a point. Ellipsoid heights from GPS surveys are converted to traditional orthometric values by applying a geoid height using the latest geoid model from the National Geodetic Survey (NGS).

The Corps of Engineers Coordinate Conversion (CORPSCON, currently at v.6.0) tool can be used to transform the point data (XYZ ASCII tiles) ellipsoid heights into NAVD88 elevations using various GEOID models, including the latest iteration - GEOID03. The converted point data files can be then re-grided to ArcInfo raster format using your preferred interpolation technique. CORPSCON can be downloaded from this address:

http://crunch.tec.army.mil/software/corpscon/corpscon.html

9. FILE FORMATS AND NAMING CONVENTIONS

The following datasets are provided:

1. unfiltered point cloud, 1km x 1km tiles with 40m overlap, in XYZ (Easting, Northing, Elevation) ASCII format. File naming convention:

    uXXX000_YYYY000.xyz

2. filtered point cloud, 1km x 1km tiles with 40m overlap in XYZ (Easting, Northing, Elevation) ASCII format. File naming convention:

    fXXX000_YYYY000.xyz

(XXX000, YYYY000) are the coordinates of the tile's lower left corner, ignoring the overlap. So for a tile with complete point coverage (not an edge tile), the real extent of the data is Easting: (XXX000 – 40) to (XXX000 + 1040) and Northing: (YYYY000 – 40) to (YYYY000 + 1040).

3. comprehensive point cloud, 1km x 1km ASCII tiles with no overlap. File naming convention:

    cXXX000_YYYY000.xyz

This format includes the following fields:

gpstimestamp, x, y, z, intensity, class, flight_line

gpstimestamp = gps timestamp of the week (Sunday = day 0).
X, Y, Z = Easting, Northing and Elevation
intensity = laser intensity index. Intensity values were normalized using a 1000m normal range during laser point processing.
Class = classification id number. The class number is one of the following:

1	Default (includes vegetation and above the ground artificial structures)
2	Ground
3	3rd stop
7	Low point
9	Aerial Points
14	Isolated Points

flight line = flight ID number . These numbers reflect the order in which the original LAS flight strip files were loaded into TerraScan and don't necessary correspond with the flight strip numbers.

4. unfiltered binary ESRI GRID elevation tiles and shaded relief maps, 0.5m cells size and 1km x 1km extent with no overlap. File naming convetion:

    ugXXX_YYYY - DEM

ugXXX_YYYYshd - corresponding shaded relief map

5. filtered binary ESRI GRID elevation tiles and shaded relief maps, 0.5m cells size and 1km x 1km extent with no overlap. File naming convetion:

fgXXX_YYYY - DEM

fgXXX_YYYYshd - corresponding shaded relief map

Due to ArcInfo naming limitations the raster dataset names include only the most significant digits from the tile's lower left coordinates. For example, the unfiltered point tile uXXX000_YYYY000.xyz becomes the ArcInfo raster ugXXX_YYYY.

6. unfiltered binary ESRI GRID mosaics and shaded relief maps, 1m cells size and 10Km wide with no overlap. File naming convetion:

umXXX_X'X'X' - mosaic DEM

umXXX_X'X'X'shd - corresponding shaded relief map

7. filtered binary ESRI GRID mosaics and shaded relief maps, 1m cells size and 10Km wide with no overlap. File naming convetion:

fmXXX_X'X'X' - mosaic DEM

fmXXX_X'X'X'shd - corresponding shaded relief map

The naming convention for the mosaics uses the 3 most significant digits of the horizontal extent of the data and is different from the tiles naming convention.
The mosaic umXXX_X'X'X' will extend from Easting XXX000 to Easting X'X'X'000.