Examination of DeltaZ in Calibration

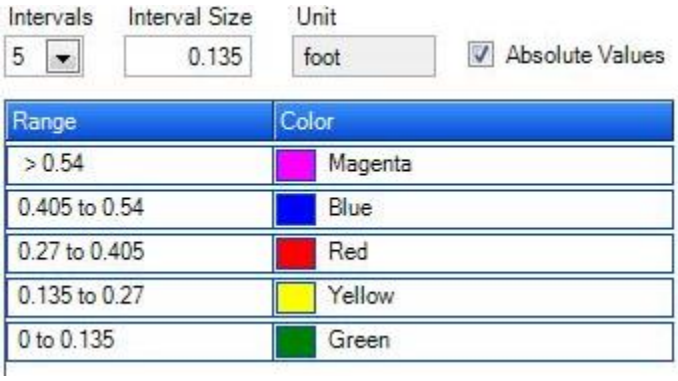
Tie-lines were generated over the adjusted planned flight lines and analyzed to ensure that accuracy requirements were met. It was determined that a z correction per line was required to get the data within spec. The table below shows the Z correction applied to each flight line along with the statistics provided in the report:

102	-0.038	109	0.102	203	-0.055	210	-0.03	304	-0.039
103	-0.034	110	0.142	204	0	211	-0.05	305	-0.084
104	-0.018	111	0.18	205	-0.043	212	-0.054	306	-0.037
105	-0.026	112	0.124	206	0.024	213	-0.045	307	-0.002
106	0.011	113	0.105	207	0.025	214	-0.006	308	-0.042
107	0.008	114	0.108	208	0.054	216	-0.077	311	0.062
108	0.1	117	-0.051	209	0.091	303	-0.098	313	-0.127

Starting avg 3d mismatch 0.05878
Starting avg xy mismatch 0.00000
Starting avg z mismatch 0.05878

Final avg 3d mismatch: 0.04906
Final avg xy mismatch: 0.00000
Final avg z mismatch: 0.04906

After adjustment parameters were applied to each of the project flight lines, the overlap regions between flight lines were analyzed to assess relative accuracy. The elevation difference tool found in LP360 was used to generate DeltaZ files providing an image file depicting the offsets between flight lines by using a color range for the amount of offset found between the overlap areas. The table below shows the color range settings used to generate the DeltaZ image files.



After determining the relative accuracy or inter-swath goodness of fit in each overlap was acceptable, a vertical comparison of calibrated flight lines and the ground control was then performed. Upon review of the comparison results, it was determined that a Z shift in the amount of -0.6493 ft was required. The table below shows the comparison between ground control collected for the project and the final calibrated dataset with the Z shift applied.

GCP	Northing	Easting	Known Z	Laser Z	DZ
CAL009	2211951	784969.5	818.207	818.45	0.243
CAL012	2117768	743553.3	963.365	963.55	0.185
CAL001	2073936	814314.2	1071.832	1071.99	0.158
CAL019	2227691	727007.1	769.471	769.61	0.139
CAL004	2209189	812521.5	854.536	854.65	0.114
CAL013	2150178	764505	970.827	970.87	0.043
CAL020	2249056	724672.6	777.483	777.52	0.037
CAL014	2248037	759885.3	754.266	754.29	0.024
CAL010	2254926	819278.7	766.897	766.91	0.013
CAL007	2093198	777679	1088.784	1088.77	-0.014
CAL018	2166778	737335.7	836.342	836.32	-0.022
CAL011	2083414	760298.7	1096.214	1096.18	-0.034
CAL016	2099644	726799.6	945.776	945.72	-0.056
CAL006	2178743	788080.8	898.21	898.14	-0.07
CAL002	2101625	808030.2	1114.91	1114.84	-0.07
CAL017	2180387	754770	880.358	880.24	-0.118
CAL008	2195787	795460.4	855.367	855.24	-0.127
CAL005	2238212	803203	852.744	852.59	-0.154
CAL015	2220674	771404.7	923.767	923.58	-0.187
CAL003	2166033	801304.5	976.798	976.58	-0.218

Average dz -0.006
Minimum dz -0.218
Maximum dz +0.243
Average magnitude 0.101
Root mean square 0.124
Std deviation 0.127

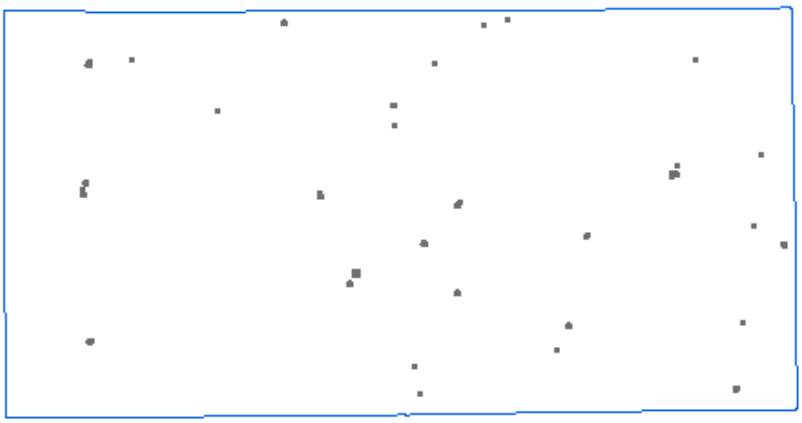
Intraswath Repeatability Testing

Processing Procedures

Terrasolid's LP360 Planar Statistics point cloud task was utilized to evaluate best-fitting of laser points to a plane within each flight. It computes the quality of fit values, which are stored as attributes in a shapefile. It is desired that the data within each swath fits within 6cm of a given plane thus accrediting the sensor as being well-calibrated for variable noise. Testing is to be done on first returns only.

Process

Numerous sample locations on each lift 50 square meters or larger were drawn as polygons into a shapefile (see 3 accompanying lift shapefiles). These locations are preferably on a hard surface and flat with little or no paint lines or change in material type which could skew testing due to greater intensity range. The shapefile is loaded in LP360 with a single flight line of data using only first returns. The point cloud task is run and results are written into the shapefile in terms of standard deviation from the plane into the StdDev field. This data tells us how the point values are "spread out" on the plane. Lesser standard deviation means the points are more tightly clustered about the plane. Ideal testing locations as large stretches of flat, paved areas with mono-material type in Waushara County were not copious due to the rural geography. Therefore some of the testing sites may have bordered on ideal and could have presented results toward the higher end of the deviation spectrum than desired.



Waushara project bound and dispersed testing locations

Results

Lift intraswath testing site standard deviation values

110717A	110717B	110817
Site StdDev	Site StdDev	Site StdDev
0.1966	0.1855	0.1376
0.1740	0.1828	0.1214
0.2153	0.2078	0.1717
0.1997	0.2116	0.1124
0.2095	0.1420	0.1279
0.2083	0.1201	0.1466
0.2062	0.1344	0.1545
0.1901	0.1382	0.1336
0.2042	0.1355	0.1357
0.1922	0.1455	0.1460
0.2190	0.1200	0.1122
0.2278	0.1629	0.1368
0.2240	0.1378	0.1703
0.2209	0.1492	0.1469
0.2254	0.1484	0.1497
0.1276	0.1936	0.1633
0.1424	0.2083	0.1420
0.1225	0.2107	0.1777
0.1350	0.1594	0.1967
	0.1890	0.1698
	0.1929	0.1279
	0.2065	0.1702
	0.2011	0.1371
	0.2012	0.1880
	0.2128	0.1128
	0.1830	0.1284
	0.1934	0.1429
	0.1823	
	0.1802	
	0.1947	
	0.1884	
	0.1877	
	0.2092	
	0.2008	
	0.1913	
	0.1890	
	0.1851	
	0.1777	

	0.1665	
	0.1826	
	0.1704	
	0.1785	
	0.2042	
	0.1708	
0.1916ft / 5.84cm	**0.1780ft / 5.43cm**	**0.1467ft / 4.47cm**

Each lift's site Standard Deviation results were added and divided by the quantity of sample sites to provide an average deviation value for the given lift. The lifts passed the 6cm requirement.

Lift ID	No. of Sample Sites	Standard Deviation
110717A	19	5.84 cm
110717B	44	5.43 cm
110817	27	4.47 cm