Pike County Missouri

LiDAR Data Density Summary

USACE MO-AR LiDAR Project

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Prepared by

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1.0   Introduction

Surdex is currently under contract with the St. Louis District of the US Army Corps of Engineers (USACE) to provide precision elevation data deliverables generated from aerial LiDAR data. All data delivered is to meet the USGS LiDAR Base Specification Version 1.0 as defined in August, 2012. This multi-year project consists of several funding partners and requires data inspection and acceptance by the USGS NGTOC.

2.0   Background

The geographic extent of Pike County, Missouri was determined to be a delivery area under this project. A complete delivery for Pike County was received by NCTOC on February 18, 2015. The calibrated swath data was determined by NCTOC staff to have a vertical RMSE of 32 cm. The Surdex project swath accuracy report indicated a 5 cm RMSE. The calibrated swath data was rejected because it did not meet the project RMSE limit of 15 cm and was inconsistent with the 5 cm reported by Surdex.

Calibrated swath data corrections were received by NGTOC from Surdex on April 9, 2015. It was noted by the review staff that cross flights were not included in the redelivery of swath data. In addition, comparisons of the original swath data delivery against the redelivered swath data seemed to indicate a reduction on the number of ground points recorded in the las file. All these items concerned the QA staff at NGTOC and were stated to be in violation of the Version 1.0 specification in an email exchange with the USACE Project Manager and Surdex.

On May 12, 2015 a technical exchange meeting was held at USGS Rolla with the USACE, NRCS, NGTOC, 3DEP and Surdex to discuss QA issues with delivery items on this contract. During the course of the meeting it was presented that the QA staff at NGTOC were concerned with data being removed from swath files and that they had seen data density reduced in the redelivered swath data. Further, it was stated that the las data point density was reduced or thinned around vertical control points.

Due to confusion on the part of Surdex, we were unable to recovery the actual original delivered swath data provided to NGTOC for Pike County prior to the May 12 meeting. After the meeting, Surdex received a copy of the delivered items from NGTOC on a portable USB drive. The goal of this report is to summarize our review of the initial delivered items and the redelivered items for Pike County to understand and explain the differences that were observed in the data point density by the NGTOC QA staff.

3.0   Pike County Original Swath Data Deliverable

3.1   Initial Un-Calibrated Swath Data Delivery

Upon initial review, it was clear that the original swath data delivered for Pike County was a mistake. This data was un-calibrated swath data that should not have been delivered. It was a mistake by Surdex staff to send this data as the calibrated swath data. We have looked at the

original un-calibrated swath data that was sent to USGS in Pike County and compared it to the final calibrated swath data that was sent with the final deliverables. We can confirm what the USGS NGTOC pointed out, that the original swath LAS files contain about 12% more point records than the calibrated swath LAS files that we sent with the initial project deliverables.

A cursory glance at the filenames indicates that the un-calibrated LAS files initially sent to USGS for Pike County were produced by the ALS Post Processor (ALSPP) from Leica. This is obvious from the fact that the LAS filenames are of the form LDRYYMMDD_hhmmss_1.LAS (they begin with "LDR"). A similar glance at the calibrated swath LAS files sent to USGS as the redelivery shows that they were produced by the Cloud Pro software from Leica. This is obvious since filenames are of the form YYYYMMDD_hhmmss_1.LAS (no "LDR" and 4-digit year). This can be confirmed by the fact that "CloudPro1.2.0" is burned into the LAS header. So the two sets of data were processed through two different las post processing tools from Leica.

The use of Cloud Pro at Surdex began midstream on this job, so this isn't a great surprise. The reason for the change is that Leica was actively phasing out ALSPP in favor of the newer Cloud Pro, dropping support for ALSPP and focusing new development on Cloud Pro. So what this shows is that the original un-calibrated swaths that were delivered were processed right after flight with the ALS Post Processor software to verify the initial quality of the data and completeness of ground coverage. However, at a later date when the data got to full production for calibration, cleaning and processing, we re-processed the raw swaths through the new Leica Cloud Pro 1.2.0 processor to recreate the new raw swath data with the newer software. Leica suggested that this processor would create better data. This is where the point count changes occurred in the calibrated swath data.

The new Cloud Pro processor has a setting to trim the edges of the swath data smaller than the old ALSPP. Both sides and the ends of the lines were trimmed in a small fashion. I have included screen shots from TerraSolid/TerraScan showing this change. Below, I've pasted a couple screen grabs from TSCAN showing the northwest and northeast corners of the first swath from the first mission on Pike County.

In these grabs, the LAS points are colored by flightline as follows:

- Line 1 = GREEN = data produced by ALSPP (filename = LDR131210_181445_1.LAS) and originally shipped to USGS
- Line 2 = RED = data produced by CloudPro (filename = 131210_181445_1.LAS) and sent to USGS as the calibrated swath
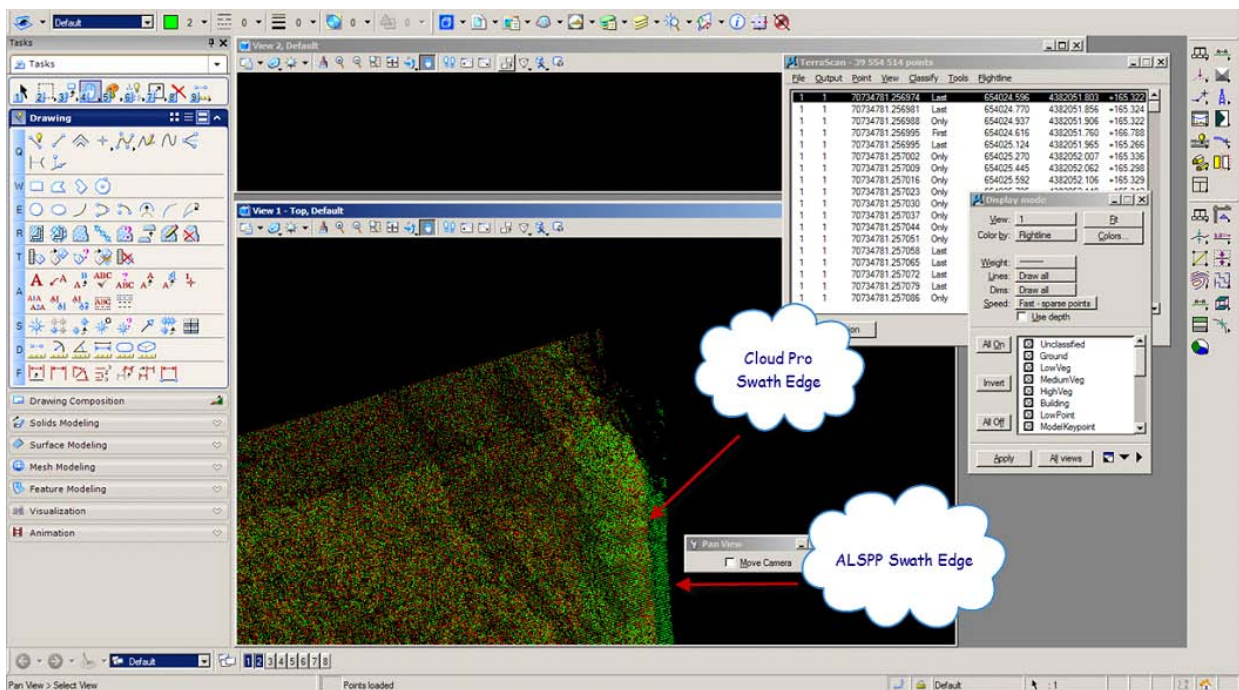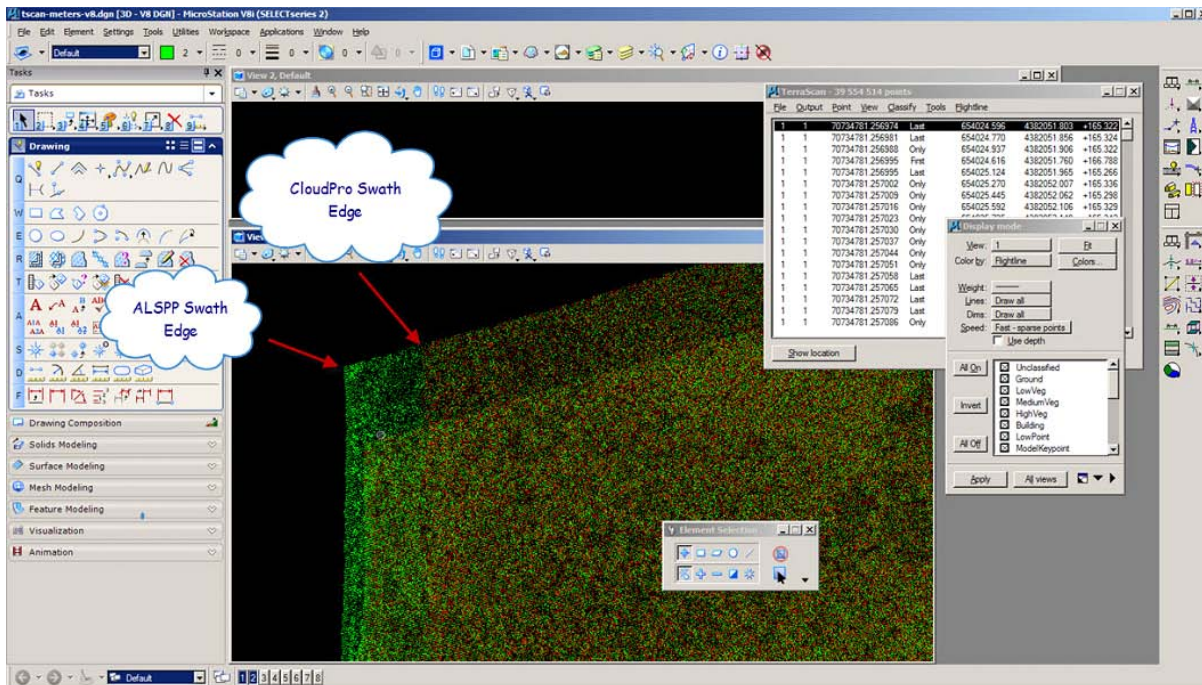
We also used the las tools utility LASBOUNDARY to trace the footprint of each of the files and store it as a SHP file. You will notice that the SHP files confirm the same footprint difference that is evident in the screen grabs.
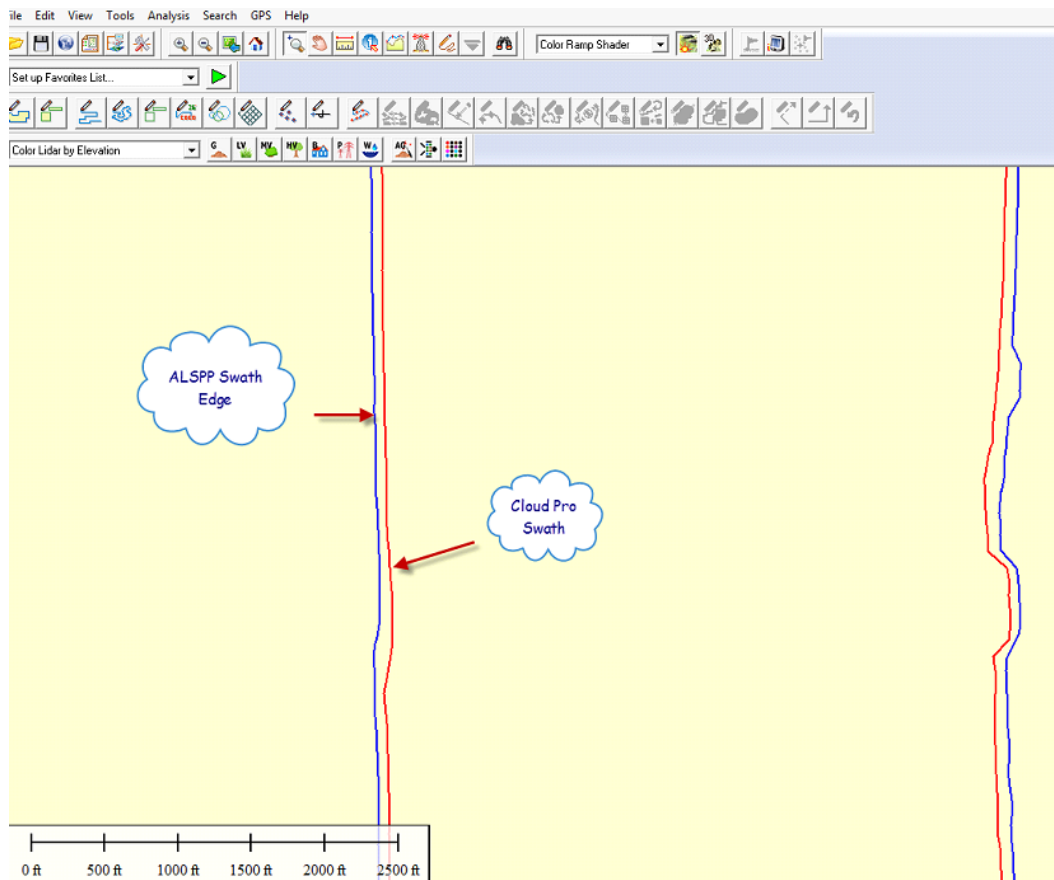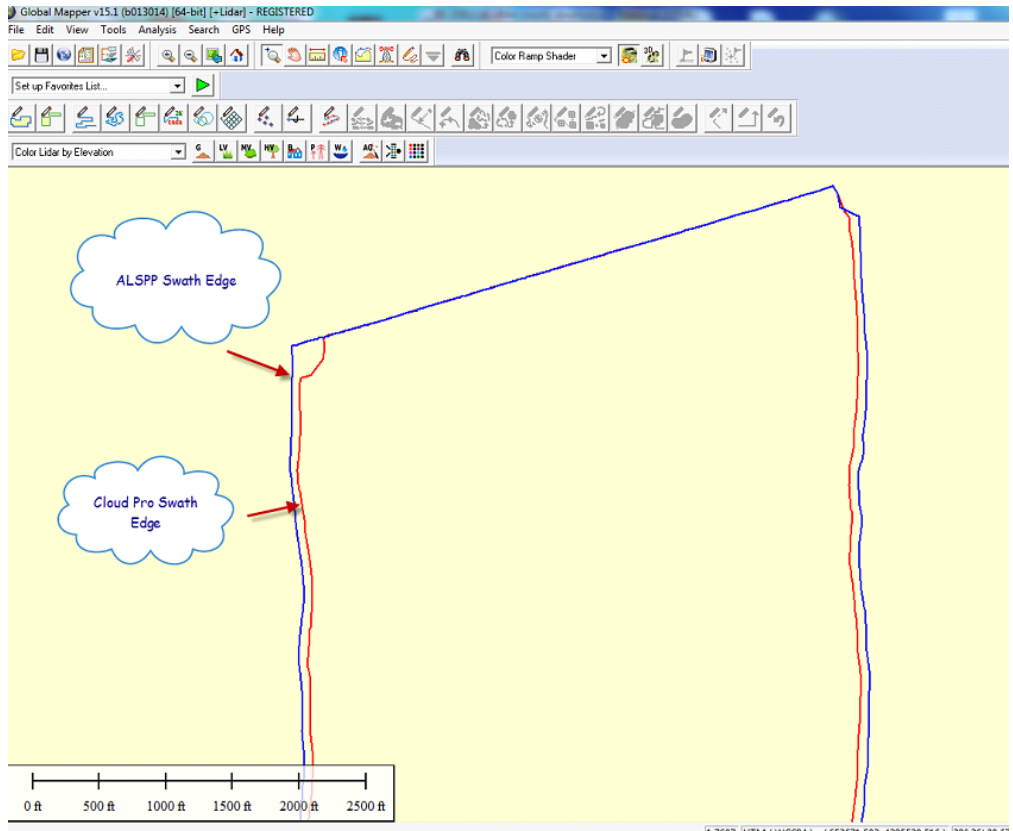
We verified this information with Leica technical support. They verified that the edge clip setting in CloudPro would remove about 1.125 degrees of scan data around the edge of each scan run through the processor. They also verified that no data would be thinned inside a swath.

To verify the changes, lasinfo was run on all the original uncalibrated ALSPP swaths and the uncalibrated CloudPro swaths. This information is provided in Appendix A in Table 1. In reviewing the table you can see the percentage loss in las point count between the two processors. As a further check of the consistency of the final delivered CloudPro data, lasinfo was run on the uncalibrated CloudPro swath data to the calibrated CloudPro swath data. You can see from the review of the last column in the table that no las points were lost in this process. All final data items and accuracy reports in Pike County were generated from and processed with the CloudPro calibrated swath data.

3.1.1   Summary:

The original swath data delivered with Pike County consisted of un-calibrated data processed with the ALSPP. The calibrated swath data provided for Pike County consisted of data processed through CloudPro and was clipped by 1.125 degrees on each side of the swath. The reason for the drop in the size of the data files in the reduction in scan width which is a processor setting and allowed by the Version 1.0 specification,. There was no removal of any points from the las file output by the CloudPro processor. The calibrated swath data provided is accurate and is compliant with the Version 1.0 specification.

3.2   Data Thinning Within Scans

During the course of the May 12th meeting it was identified by the NGTOC QA staff that data density had changed within swath data between the different swath data deliveries. The NGTOC Staff identified six polygon areas where they had observed these changes. To assess these concerns, Surdex obtained the six polygons from the NGTOC QA staff to analyze each area. The following sections discuss each of these six polygon areas in detail. All data analysis was performed in TerraSolid/TerraScan running on MicroStation in the following sections.

3.2.1   Border

Based upon the swath changes identified in the CloudPro post processor, it is apparent that the density of ground areas may change in the overlap regions of flight data. So an analysis was performed to see how the six polygons fell within the swath coverage.

Polygon Border did not fall in the overlap. The graphic below presents the swath coverage and polygon layout.
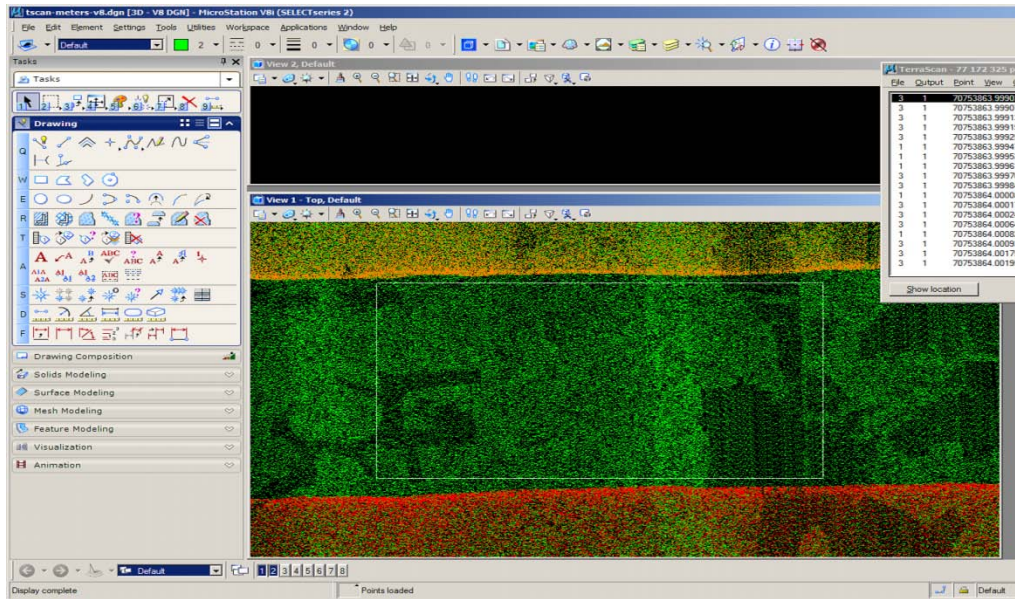
The table below presents the comparison of the las data density within this polygon between the two swath files.

polygon	ALSPP point count	CPRO point count	% change (+/-)	comments
A10_3BE	433483	433716	0.053750666	
A10_14BE	480372	480625	0.052667516	
	615943	376875	-38.81333175	
A10_13BE	493448	494066	0.12524116	
	347431	195103	-43.84410142	
border	2761287	2760579	-0.025640218	fewer points in calibrated dataset
border2	124901	60946	-51.20455401	
	2445274	2445319	0.001840285	
border3	3197366	3134729	-1.959018767	
	2044050	1539458	-24.6858932	

You can see that the change is quite small at 711 points less in the calibrated dataset. This is attributed to the horizontal shift in the calibrated data placing more ground points into the polygon.

3.2.2   Border 2

The Border2 polygon statistics are provided in the table below. You can see that this polygon fell into two swath strips. One exhibited the clip reduction of -51.2% and the other has minimal change as it is outside the clip area.

polygon	ALSPP point count	CPRO point count	% change (+/-)	comments
A10_3BE	433483	433716	0.053750666	
A10_14BE	480372	480625	0.052667516	
	615943	376875	-38.81333175	
A10_13BE	493448	494066	0.12524116	
	347431	195103	-43.84410142	
border	2761287	2760579	-0.025640218	
border2	124901	60946	-51.20455401	fewer points in calibrated dataset
	2445274	2445319	0.001840285	more points in calibrated dataset
border3	3197366	3134729	-1.959018767	
	2044050	1539458	-24.6858932	

North Swath

South Swath
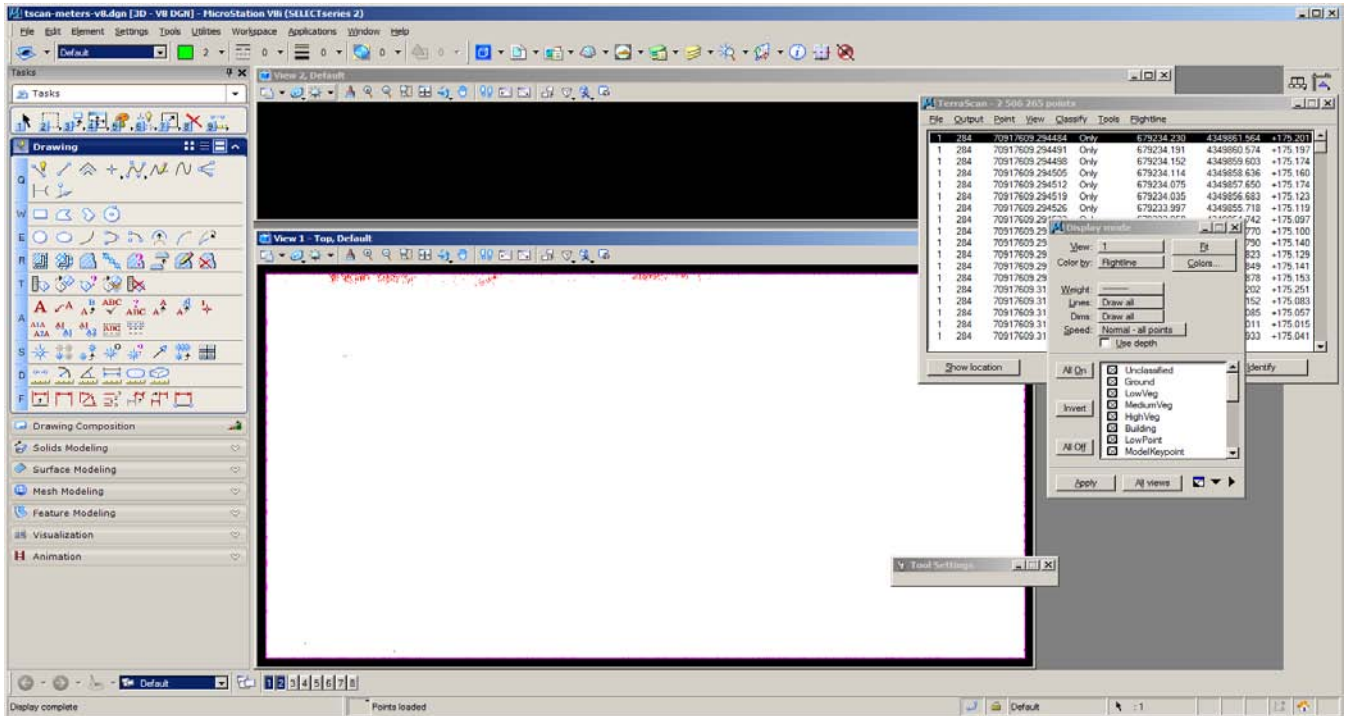
The graphic above presents the deleted points from the clipped swath data in red. You can clearly see that they are on the edge of the scan swath.

3.2.3 Border 3

Border3 polygon fell in an area where both strips were clipped. Therefore, as displayed in the table below both swaths were reduced in size between the ALSPP and CloudPro data files.

polygon	ALSPP point count	CPRO point count	% change (+/-)	comments
A10_3BE	433483	433716	0.053750666	
A10_14BE	480372	480625	0.052667516	
	615943	376875	-38.81333175	
A10_13BE	493448	494066	0.12524116	
	347431	195103	-43.84410142	
border	2761287	2760579	-0.025640218	
border2	124901	60946	-51.20455401	
	2445274	2445319	0.001840285	
border3	3197366	3134729	-1.959018767	fewer poin
	2044050	1539458	-24.6858932	fewer point

North Swath

South Swath
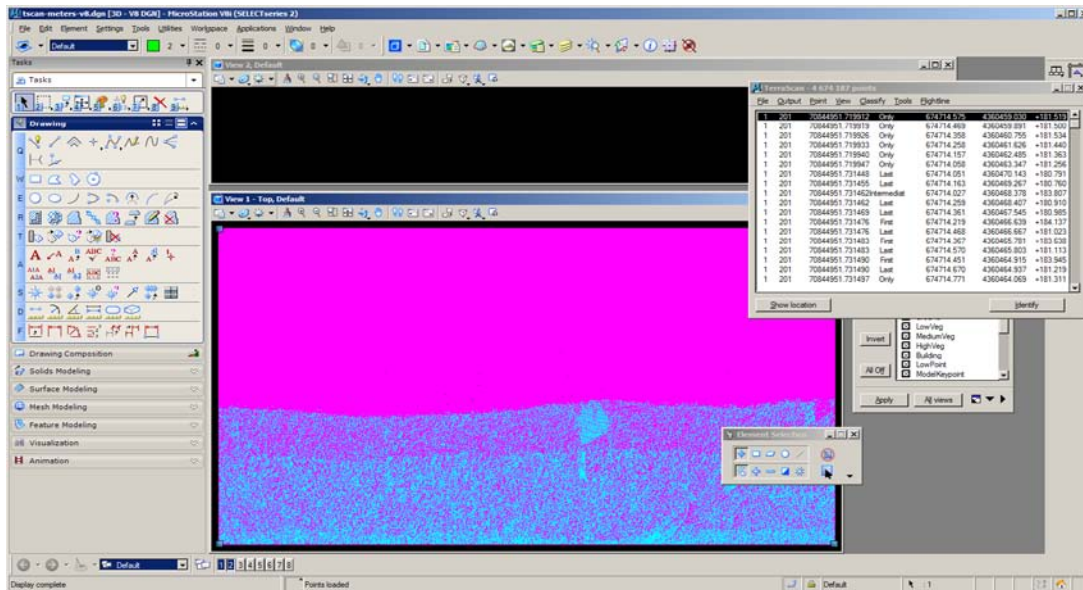
The TerraScan display above shows the overlap region of this Border3 polygon by color.

3.2.4   A10_3BE

Polygon A10_3BE falls inside a swath overlap area and exhibits change in data density due to clipping of the swath edge. The table below presents the changes by swath.

polygon	ALSPP point count	CPRO point count	% change (+/-)	comments
A10_3BE	881188	881248	0.00680899	more points in calibrated dataset
	268552	135465	-49.55725521	fewer points in calibrated dataset
A10_14BE	480372	480625	0.052667516	
	615943	376875	-38.81333175	
A10_13BE	493448	494066	0.12524116	
	347431	195103	-43.84410142	
border	2761287	2760579	-0.025640218	
border2	124901	60946	-51.20455401	
	2445274	2445319	0.001840285	
border3	3197366	3134729	-1.959018767	
	2044050	1539458	-24.6858932	

North Swath

South Swath

ALSPP swath coverage

The graphic below presents the overlay of each swath and the duplicated common edge.
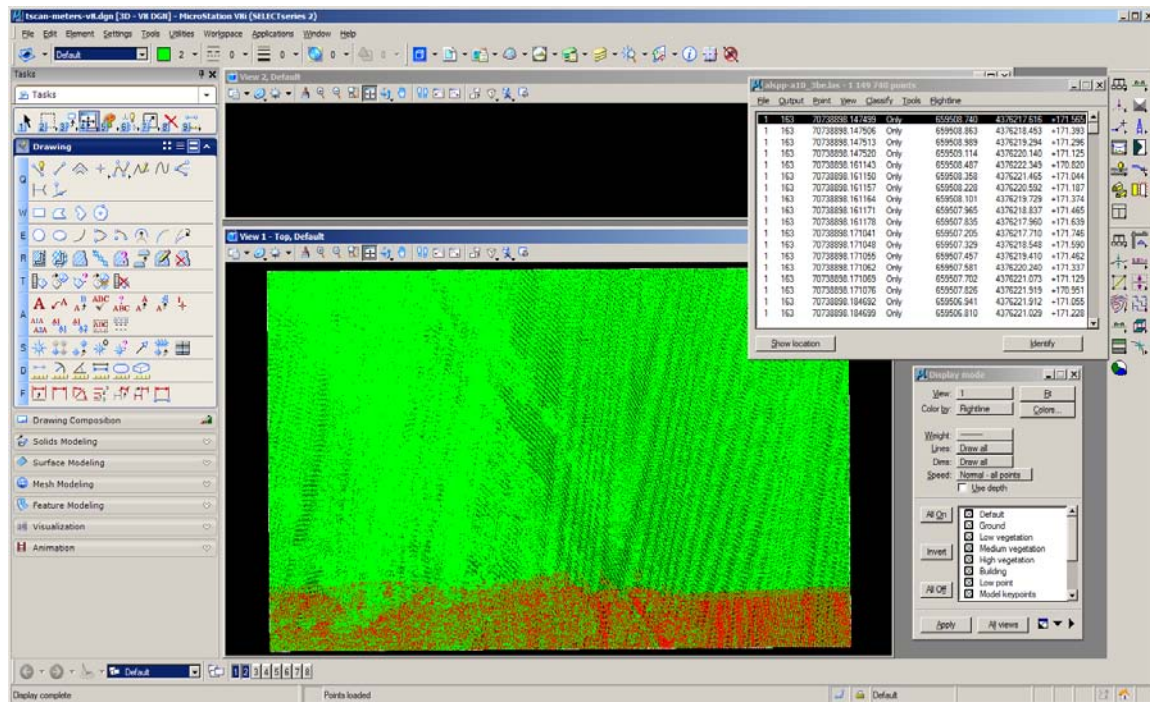
3.2.5 A10_14BE

Polygon A10_14BE falls on the edge of one swath strip within a clip area. This is presented in the table below.

polygon	ALSPP point count	CPRO point count	% change (+/-)	comments
A10_3BE	433483	433716	0.053750666	
A10_14BE	680435	675496	-0.725859193	fewer points in calibrated dataset
	610285	446291	-26.87170748	fewer points in calibrated dataset
A10_13BE	493448	494066	0.12524116	
	347431	195103	-43.84410142	
border	2761287	2760579	-0.025640218	
border2	124901	60946	-51.20455401	
	2445274	2445319	0.001840285	
border3	3197366	3134729	-1.959018767	
	2044050	1539458	-24.6858932	

North Swath

South Swath

3.2.6 A10_13BE

Polygon A10_13BE falls in a clipped overlap area of swath data. The table below presents the changes observed by swath strip.

polygon	ALSPP point count	CPRO point count	% change (+/-)	comments
A10_3BE	433483	433716	0.053750666	
A10_14BE	480372	480625	0.052667516	
	615943	376875	-38.81333175	
A10_13BE	479070	323337	-32.50735801	fewer points in calibrated dataset
	888360	888953	0.066752218	more points in calibrated dataset
border	2761287	2760579	-0.025640218	
border2	124901	60946	-51.20455401	
	2445274	2445319	0.001840285	
border3	3197366	3134729	-1.959018767	
	2044050	1539458	-24.6858932	

North Swath

South Swath
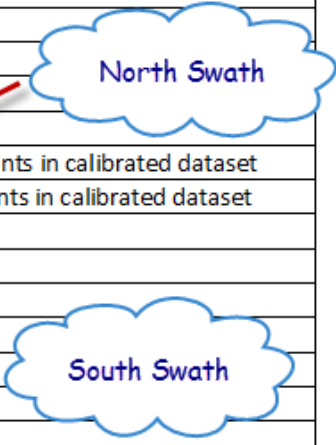
The graphic below displays the image of the flight strip coverage.
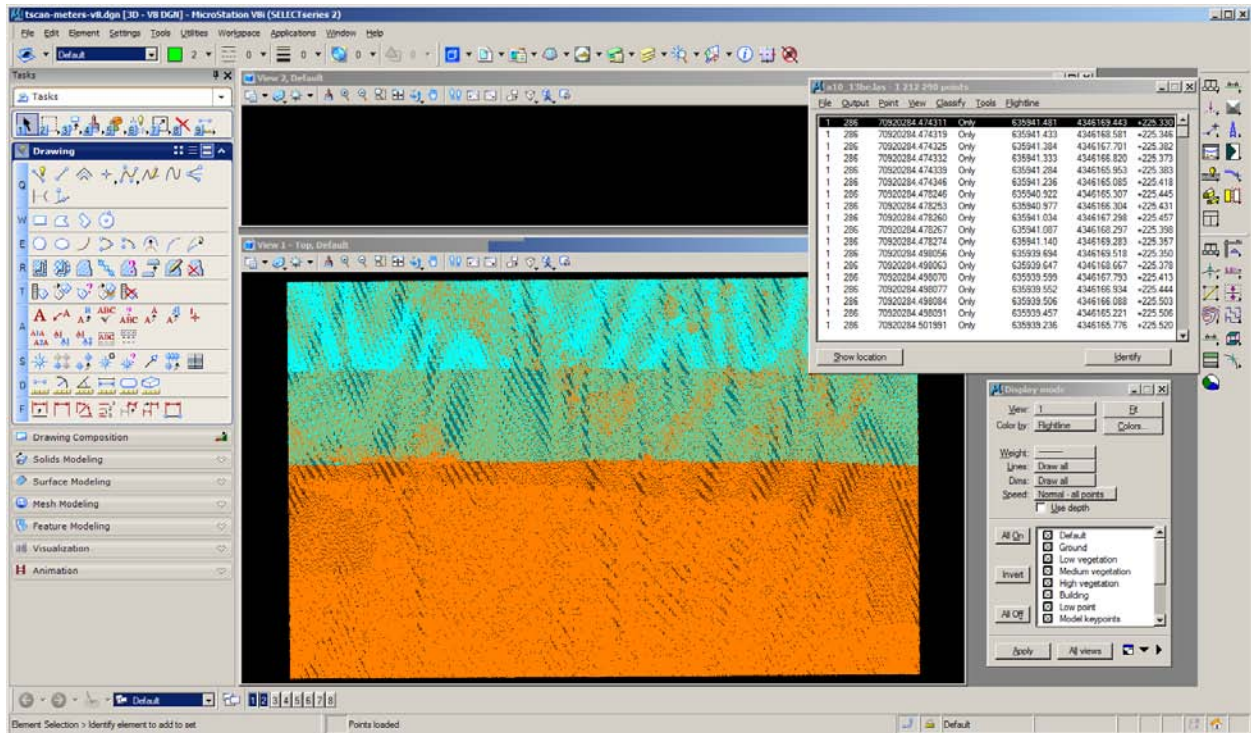
3.2.7   Summary

Review of the six polygon areas provided by the NGTOC QA staff show that in all cases the clipping function of the CloudPro Leica post processor is the cause of the data point reduction due to clipping the edge of swath data during las generation.

3.3   Data Density Thinning at QA point locations

To answer the question of thinned data density at QA points, we have taken the QA point listing and created 200 m x 200 m polygons centered on each point. From these polygons we computed the point density from both the original ALSPP and CloudPro processors. The entire table is presented in the Appendix to this report.   The table below presents a small portion of the table for ease of reading.

LAS filename (ALSPP)				count		LAS filename (CloudPro)				count		difference	% difference
19/alspp-0004.lasinfo	number	of	point	records	110408	20/cpro-0004.lasinfo	number	of	point	records	110370	38	0.034
19/alspp-0005.lasinfo	number	of	point	records	111925	20/cpro-0005.lasinfo	number	of	point	records	111873	52	0.046
19/alspp-0006.lasinfo	number	of	point	records	109690	20/cpro-0006.lasinfo	number	of	point	records	109666	24	0.022
19/alspp-0007.lasinfo	number	of	point	records	252743	20/cpro-0007.lasinfo	number	of	point	records	201847	50896	20.137
19/alspp-0008.lasinfo	number	of	point	records	228307	20/cpro-0008.lasinfo	number	of	point	records	178627	49680	21.760
19/alspp-0009.lasinfo	number	of	point	records	244076	20/cpro-0009.lasinfo	number	of	point	records	195709	48367	19.816
19/alspp-0010.lasinfo	number	of	point	records	158843	20/cpro-0010.lasinfo	number	of	point	records	158925	-82	-0.052
19/alspp-0011.lasinfo	number	of	point	records	131865	20/cpro-0011.lasinfo	number	of	point	records	131954	-89	-0.067
19/alspp-0012.lasinfo	number	of	point	records	142775	20/cpro-0012.lasinfo	number	of	point	records	142837	-62	-0.043
19/alspp-0013.lasinfo	number	of	point	records	197628	20/cpro-0013.lasinfo	number	of	point	records	197558	70	0.035
19/alspp-0014.lasinfo	number	of	point	records	187040	20/cpro-0014.lasinfo	number	of	point	records	186986	54	0.029
19/alspp-0015.lasinfo	number	of	point	records	197553	20/cpro-0015.lasinfo	number	of	point	records	197491	62	0.031

All areas of change under 1 percent can be attributed to the horizontal shift in the datasets from un-calibrated to calibrated. However some areas show larger changes. If you plot these polygons over the swath shapefiles, we have determined that they all fall in the trimmed areas of the swath overlap. The graphic below shows the polygons from the table for points 7, 8 and 9 listed above as an example of points which experienced point density changes. You can clearly see they all fall in the clip overlap area of swath coverage.
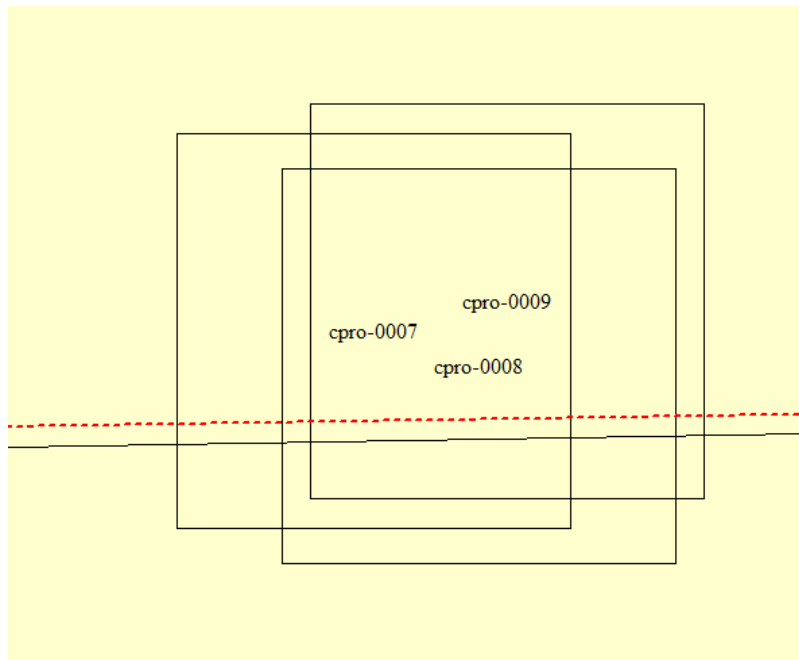
4.0 Pike County Summary

a) Surdex inadvertently delivered raw uncalibrated swath data from the ALS post processor with the first delivery of the Pike County data. This was in error. It should not have been delivered to the NGTOC.

b) All data products produced in Pike County were generated from the CloudPro post processor. This data has been validated by our QC reports.

c) The re-delivered swath data for Pike County was calibrated and processed with CloudPro. CloudPro clips 1.125 degrees from each side of the raw binary data before creating the output las file. This is the reason for the apparent reduction in the size of the las swath data files.

d) Analysis of the ALSPP swath data and CloudPro swath data show that the swath data was clipped as indicated. There is no indication of thinning of points within any scan swath.

e) While this clipping process in the CloudPro processor dropped some data from the raw binary scan, it did not impact any product density or quality.

f) I do not believe that this violates the Version 1.0 specification in any way. We are delivering all data that came out of the processor in las format and the data meets the project NPS density. It is just a processor setting that was used in post processing that limited the usable sections of each scan.

g) Analysis shows that all uncalibrated and calibrated swath files produced by CloudPro contain exactly the same number of points. No point thinning occurred in the swath data files used for production of the delivered elevation data items.

h) Analysis of the 6 polygon area provide by NGTOC determined that all data density changes between the initial and redelivery of the swath data are attributed to the CloudPro clip function.

i) Analysis has verified that any indication of point thinning in the las files around QA points is attributed to the scan edge clipping.

Respectfully submitted,

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Appendix:

Supporting Tables

Table 1: Pike County las File Size Comparisons

Uncalibrated ALSPP swath	las point count	Uncalibrated CloudPro swath	las point count	Calibrated CloudPro swath	las point count	Percent loss ALSPP to CloudPro	Percent loss CloudPro to CloudPro
alspp/LDR131210_181445_1.LAS.LASINFO	138199920	uncalibrated/131210_181445_1.LAS.lasinfo	122273700	calibrated/131210_181445.lasinfo	122273700	11.5	0
alspp/LDR131210_182436_1.LAS.LASINFO	37112981	uncalibrated/131210_182436_1.LAS.lasinfo	33320516	calibrated/131210_182436.lasinfo	33320516	10.2	0
alspp/LDR131210_182949_1.LAS.LASINFO	34015929	uncalibrated/131210_182949_1.LAS.lasinfo	30277536	calibrated/131210_182949.lasinfo	30277536	11.0	0
alspp/LDR131210_183633_1.LAS.LASINFO	54135148	uncalibrated/131210_183633_1.LAS.lasinfo	47510422	calibrated/131210_183633.lasinfo	47510422	12.2	0
alspp/LDR131210_184339_1.LAS.LASINFO	51377378	uncalibrated/131210_184339_1.LAS.lasinfo	46104706	calibrated/131210_184339.lasinfo	46104706	10.3	0
alspp/LDR131210_185051_1.LAS.LASINFO	81578512	uncalibrated/131210_185051_1.LAS.lasinfo	72392151	calibrated/131210_185051.lasinfo	72392151	11.3	0
alspp/LDR131210_185801_1.LAS.LASINFO	73242386	uncalibrated/131210_185801_1.LAS.lasinfo	66598896	calibrated/131210_185801.lasinfo	66598896	9.1	0
alspp/LDR131210_190627_1.LAS.LASINFO	115587046	uncalibrated/131210_190627_1.LAS.lasinfo	103377931	calibrated/131210_190627.lasinfo	103377931	10.6	0
alspp/LDR131210_191630_1.LAS.LASINFO	98997537	uncalibrated/131210_191630_1.LAS.lasinfo	89306665	calibrated/131210_191630.lasinfo	89306665	9.8	0
alspp/LDR131210_192611_1.LAS.LASINFO	136786004	uncalibrated/131210_192611_1.LAS.lasinfo	122895359	calibrated/131210_192611.lasinfo	122895359	10.2	0
alspp/LDR131210_193650_1.LAS.LASINFO	108125842	uncalibrated/131210_193650_1.LAS.lasinfo	98334515	calibrated/131210_193650.lasinfo	98334515	9.1	0
alspp/LDR131210_194719_1.LAS.LASINFO	136810220	uncalibrated/131210_194719_1.LAS.lasinfo	122987726	calibrated/131210_194719.lasinfo	122987726	10.1	0
alspp/LDR131210_195835_1.LAS.LASINFO	113456892	uncalibrated/131210_195835_1.LAS.lasinfo	102760629	calibrated/131210_195835.lasinfo	102760629	9.4	0
alspp/LDR131210_201008_1.LAS.LASINFO	160141221	uncalibrated/131210_201008_1.LAS.lasinfo	144062198	calibrated/131210_201008.lasinfo	144062198	10.0	0
alspp/LDR131210_202212_1.LAS.LASINFO	153245458	uncalibrated/131210_202212_1.LAS.lasinfo	135894810	calibrated/131210_202212.lasinfo	135894810	11.3	0
alspp/LDR131210_203357_1.LAS.LASINFO	201377484	uncalibrated/131210_203357_1.LAS.lasinfo	179190575	calibrated/131210_203357.lasinfo	179190575	11.0	0
alspp/LDR131210_204634_1.LAS.LASINFO	190434745	uncalibrated/131210_204634_1.LAS.lasinfo	168923791	calibrated/131210_204634.lasinfo	168923791	11.3	0
alspp/LDR131210_210646_1.LAS.LASINFO	93343554	uncalibrated/131210_210646_1.LAS.lasinfo	83323444	calibrated/131210_210646.lasinfo	83323444	10.7	0
alspp/LDR131210_230128_1.LAS.LASINFO	76543495	uncalibrated/131210_230128_1.LAS.lasinfo	67510752	calibrated/131210_230128.lasinfo	67510752	11.8	0
alspp/LDR131210_231205_1.LAS.LASINFO	220601130	uncalibrated/131210_231205_1.LAS.lasinfo	195347323	calibrated/131210_231205.lasinfo	195347323	11.4	0
alspp/LDR131210_232508_1.LAS.LASINFO	206009752	uncalibrated/131210_232508_1.LAS.lasinfo	182250647	calibrated/131210_232508.lasinfo	182250647	11.5	0
alspp/LDR131210_233726_1.LAS.LASINFO	279864813	uncalibrated/131210_233726_1.LAS.lasinfo	248408747	calibrated/131210_233726.lasinfo	248408747	11.2	0
alspp/LDR131210_235148_1.LAS.LASINFO	211408858	uncalibrated/131210_235148_1.LAS.lasinfo	187071687	calibrated/131210_235148.lasinfo	187071687	11.5	0
alspp/LDR131211_000422_1.LAS.LASINFO	280449588	uncalibrated/131211_000422_1.LAS.lasinfo	249524871	calibrated/131211_000422.lasinfo	249524871	11.0	0
alspp/LDR131211_001956_1.LAS.LASINFO	223728112	uncalibrated/131211_001956_1.LAS.lasinfo	198661618	calibrated/131211_001956.lasinfo	198661618	11.2	0
alspp/LDR131211_003351_1.LAS.LASINFO	289429294	uncalibrated/131211_003351_1.LAS.lasinfo	256702908	calibrated/131211_003351.lasinfo	256702908	11.3	0
alspp/LDR131211_004928_1.LAS.LASINFO	228776821	uncalibrated/131211_004928_1.LAS.lasinfo	203831042	calibrated/131211_004928.lasinfo	203831042	10.9	0
alspp/LDR131211_010910_1.LAS.LASINFO	63703329	uncalibrated/131211_010910_1.LAS.lasinfo	56417082	calibrated/131211_010910.lasinfo	56417082	11.4	0
alspp/LDR131212_002840_1.LAS.LASINFO	158312734	uncalibrated/131212_002840_1.LAS.lasinfo	140180741	calibrated/131212_002840.lasinfo	140180741	11.5	0
alspp/LDR131212_004708_1.LAS.LASINFO	226994916	uncalibrated/131212_004708_1.LAS.lasinfo	202162742	calibrated/131212_004708.lasinfo	202162742	10.9	0
alspp/LDR131212_010103_1.LAS.LASINFO	246233061	uncalibrated/131212_010103_1.LAS.lasinfo	219382246	calibrated/131212_010103.lasinfo	219382246	10.9	0
alspp/LDR131212_011516_1.LAS.LASINFO	228986796	uncalibrated/131212_011516_1.LAS.lasinfo	204596399	calibrated/131212_011516.lasinfo	204596399	10.7	0
alspp/LDR131212_013000_1.LAS.LASINFO	252018498	uncalibrated/131212_013000_1.LAS.lasinfo	223593706	calibrated/131212_013000.lasinfo	223593706	11.3	0
alspp/LDR131212_014822_1.LAS.LASINFO	237198934	uncalibrated/131212_014822_1.LAS.lasinfo	210491564	calibrated/131212_014822.lasinfo	210491564	11.3	0
alspp/LDR131212_020345_1.LAS.LASINFO	259355772	uncalibrated/131212_020345_1.LAS.lasinfo	229666894	calibrated/131212_020345.lasinfo	229666894	11.4	0
alspp/LDR131212_021859_1.LAS.LASINFO	240148553	uncalibrated/131212_021859_1.LAS.lasinfo	213588032	calibrated/131212_021859.lasinfo	213588032	11.1	0
alspp/LDR131212_023406_1.LAS.LASINFO	266620123	uncalibrated/131212_023406_1.LAS.lasinfo	236197218	calibrated/131212_023406.lasinfo	236197218	11.4	0
alspp/LDR131212_025005_1.LAS.LASINFO	237162459	uncalibrated/131212_025005_1.LAS.lasinfo	211120522	calibrated/131212_025005.lasinfo	211120522	11.0	0
alspp/LDR131212_030504_1.LAS.LASINFO	261288923	uncalibrated/131212_030504_1.LAS.lasinfo	231256985	calibrated/131212_030504.lasinfo	231256985	11.5	0
alspp/LDR131212_032508_1.LAS.LASINFO	77769246	uncalibrated/131212_032508_1.LAS.lasinfo	68603524	calibrated/131212_032508.lasinfo	68603524	11.8	0
alspp/LDR131212_150452_1.LAS.LASINFO	87957029	uncalibrated/131212_150452_1.LAS.lasinfo	78128708	calibrated/131212_150452.lasinfo	78128708	11.2	0
alspp/LDR131212_151452_1.LAS.LASINFO	102510522	uncalibrated/131212_151452_1.LAS.lasinfo	91063789	calibrated/131212_151452.lasinfo	91063789	11.2	0
alspp/LDR131212_152313_1.LAS.LASINFO	82581623	uncalibrated/131212_152313_1.LAS.lasinfo	72925500	calibrated/131212_152313.lasinfo	72925500	11.7	0
alspp/LDR131212_153158_1.LAS.LASINFO	104907307	uncalibrated/131212_153158_1.LAS.lasinfo	93039472	calibrated/131212_153158.lasinfo	93039472	11.3	0
alspp/LDR131212_154101_1.LAS.LASINFO	90594999	uncalibrated/131212_154101_1.LAS.lasinfo	80169430	calibrated/131212_154101.lasinfo	80169430	11.5	0
alspp/LDR131212_154935_1.LAS.LASINFO	115117767	uncalibrated/131212_154935_1.LAS.lasinfo	102045065	calibrated/131212_154935.lasinfo	102045065	11.4	0
alspp/LDR131212_155826_1.LAS.LASINFO	101302071	uncalibrated/131212_155826_1.LAS.lasinfo	89549401	calibrated/131212_155826.lasinfo	89549401	11.6	0
alspp/LDR131212_160713_1.LAS.LASINFO	115733773	uncalibrated/131212_160713_1.LAS.lasinfo	102872357	calibrated/131212_160713.lasinfo	102872357	11.1	0
alspp/LDR131212_161601_1.LAS.LASINFO	92172789	uncalibrated/131212_161601_1.LAS.lasinfo	81221084	calibrated/131212_161601.lasinfo	81221084	11.9	0
alspp/LDR131212_162453_1.LAS.LASINFO	108458712	uncalibrated/131212_162453_1.LAS.lasinfo	96088547	calibrated/131212_162453.lasinfo	96088547	11.4	0
alspp/LDR131212_163354_1.LAS.LASINFO	264263046	uncalibrated/131212_163354_1.LAS.lasinfo	236106199	calibrated/131212_163354.lasinfo	236106199	10.7	0
alspp/LDR131212_165001_1.LAS.LASINFO	327066716	uncalibrated/131212_165001_1.LAS.lasinfo	289497681	calibrated/131212_165001.lasinfo	289497681	11.5	0
alspp/LDR131212_170923_1.LAS.LASINFO	257485035	uncalibrated/131212_170923_1.LAS.lasinfo	229318500	calibrated/131212_170923.lasinfo	229318500	10.9	0
alspp/LDR131212_172612_1.LAS.LASINFO	310525693	uncalibrated/131212_172612_1.LAS.lasinfo	276694140	calibrated/131212_172612.lasinfo	276694140	10.9	0
alspp/LDR131212_174703_1.LAS.LASINFO	70603327	uncalibrated/131212_174703_1.LAS.lasinfo	62819033	calibrated/131212_174703.lasinfo	62819033	11.0	0
alspp/LDR131212_203458_1.LAS.LASINFO	37562788	uncalibrated/131212_203458_1.LAS.lasinfo	33333963	calibrated/131212_203458.lasinfo	33333963	11.3	0
alspp/LDR131212_204559_1.LAS.LASINFO	258505691	uncalibrated/131212_204559_1.LAS.lasinfo	231024770	calibrated/131212_204559.lasinfo	231024770	10.6	0
alspp/LDR131212_210257_1.LAS.LASINFO	278617463	uncalibrated/131212_210257_1.LAS.lasinfo	248384031	calibrated/131212_210257.lasinfo	248384031	10.9	0
alspp/LDR131212_212036_1.LAS.LASINFO	249989851	uncalibrated/131212_212036_1.LAS.lasinfo	223109154	calibrated/131212_212036.lasinfo	223109154	10.8	0
alspp/LDR131212_213751_1.LAS.LASINFO	281852575	uncalibrated/131212_213751_1.LAS.lasinfo	249916314	calibrated/131212_213751.lasinfo	249916314	11.3	0
alspp/LDR131212_215734_1.LAS.LASINFO	40598253	uncalibrated/131212_215734_1.LAS.lasinfo	36053337	calibrated/131212_215734.lasinfo	36053337	11.2	0
alspp/LDR131212_221507_1.LAS.LASINFO	96038565	uncalibrated/131212_221507_1.LAS.lasinfo	85755303	calibrated/131212_221507.lasinfo	85755303	10.7	0
alspp/LDR131212_222324_1.LAS.LASINFO	3598928	uncalibrated/131212_222324_1.LAS.lasinfo	3259567	calibrated/131212_222324.lasinfo	3259567	9.4	0
alspp/LDR131212_222802_1.LAS.LASINFO	7935390	uncalibrated/131212_222802_1.LAS.lasinfo	7050166	calibrated/131212_222802.lasinfo	7050166	11.2	0
alspp/LDR131212_223225_1.LAS.LASINFO	10918388	uncalibrated/131212_223225_1.LAS.lasinfo	9653554	calibrated/131212_223225.lasinfo	9653554	11.6	0
alspp/LDR131212_223708_1.LAS.LASINFO	20753768	uncalibrated/131212_223708_1.LAS.lasinfo	18608998	calibrated/131212_223708.lasinfo	18608998	10.3	0
alspp/LDR131212_224550_1.LAS.LASINFO	37816222	uncalibrated/131212_224550_1.LAS.lasinfo	33553433	calibrated/131212_224550.lasinfo	33553433	11.3	0
alspp/LDR131212_225633_1.LAS.LASINFO	43166804	uncalibrated/131212_225633_1.LAS.lasinfo	38447043	calibrated/131212_225633.lasinfo	38447043	10.9	0
alspp/LDR131212_230342_1.LAS.LASINFO	73618733	uncalibrated/131212_230342_1.LAS.lasinfo	65302087	calibrated/131212_230342.lasinfo	65302087	11.3	0

Table 2: Number of Swath Points by QA Point Patch 200 m x 200 m

LAS filename (ALSPP)	number	of	point	records	count		LAS filename (CloudPro)	number	of	point	records	count		difference	% difference
19/alspp-0004.lasinfo	number	of	point	records	110408		20/cpro-0004.lasinfo	number	of	point	records	110370		38	0.034
19/alspp-0005.lasinfo	number	of	point	records	111925		20/cpro-0005.lasinfo	number	of	point	records	111873		52	0.046
19/alspp-0006.lasinfo	number	of	point	records	109690		20/cpro-0006.lasinfo	number	of	point	records	109666		24	0.022
19/alspp-0007.lasinfo	number	of	point	records	252743		20/cpro-0007.lasinfo	number	of	point	records	201847		50896	20.137
19/alspp-0008.lasinfo	number	of	point	records	228307		20/cpro-0008.lasinfo	number	of	point	records	178627		49680	21.760
19/alspp-0009.lasinfo	number	of	point	records	244076		20/cpro-0009.lasinfo	number	of	point	records	195709		48367	19.816
19/alspp-0010.lasinfo	number	of	point	records	158843		20/cpro-0010.lasinfo	number	of	point	records	158925		-82	-0.052
19/alspp-0011.lasinfo	number	of	point	records	131865		20/cpro-0011.lasinfo	number	of	point	records	131954		-89	-0.067
19/alspp-0012.lasinfo	number	of	point	records	142775		20/cpro-0012.lasinfo	number	of	point	records	142837		-62	-0.043
19/alspp-0013.lasinfo	number	of	point	records	197628		20/cpro-0013.lasinfo	number	of	point	records	197558		70	0.035
19/alspp-0014.lasinfo	number	of	point	records	187040		20/cpro-0014.lasinfo	number	of	point	records	186986		54	0.029
19/alspp-0015.lasinfo	number	of	point	records	197553		20/cpro-0015.lasinfo	number	of	point	records	197491		62	0.031
19/alspp-0016.lasinfo	number	of	point	records	285139		20/cpro-0016.lasinfo	number	of	point	records	259302		25837	9.061
19/alspp-0017.lasinfo	number	of	point	records	292610		20/cpro-0017.lasinfo	number	of	point	records	266392		26218	8.960
19/alspp-0018.lasinfo	number	of	point	records	283476		20/cpro-0018.lasinfo	number	of	point	records	250795		32681	11.529
19/alspp-0019.lasinfo	number	of	point	records	268576		20/cpro-0019.lasinfo	number	of	point	records	259876		8700	3.239
19/alspp-0020.lasinfo	number	of	point	records	267755		20/cpro-0020.lasinfo	number	of	point	records	258605		9150	3.417
19/alspp-0021.lasinfo	number	of	point	records	266730		20/cpro-0021.lasinfo	number	of	point	records	255279		11451	4.293
19/alspp-0022.lasinfo	number	of	point	records	280691		20/cpro-0022.lasinfo	number	of	point	records	223833		56858	20.256
19/alspp-0023.lasinfo	number	of	point	records	262894		20/cpro-0023.lasinfo	number	of	point	records	206689		56205	21.379
19/alspp-0024.lasinfo	number	of	point	records	220099		20/cpro-0024.lasinfo	number	of	point	records	178802		41297	18.763
19/alspp-0025.lasinfo	number	of	point	records	134230		20/cpro-0025.lasinfo	number	of	point	records	114113		20117	14.987
19/alspp-0026.lasinfo	number	of	point	records	148349		20/cpro-0026.lasinfo	number	of	point	records	121207		27142	18.296
19/alspp-0027.lasinfo	number	of	point	records	143113		20/cpro-0027.lasinfo	number	of	point	records	119490		23623	16.507
19/alspp-0028.lasinfo	number	of	point	records	117318		20/cpro-0028.lasinfo	number	of	point	records	117279		39	0.033
19/alspp-0029.lasinfo	number	of	point	records	115821		20/cpro-0029.lasinfo	number	of	point	records	115752		69	0.060
19/alspp-0030.lasinfo	number	of	point	records	123840		20/cpro-0030.lasinfo	number	of	point	records	123804		36	0.029
19/alspp-0031.lasinfo	number	of	point	records	242553		20/cpro-0031.lasinfo	number	of	point	records	234180		8373	3.452
19/alspp-0032.lasinfo	number	of	point	records	249505		20/cpro-0032.lasinfo	number	of	point	records	241845		7660	3.070
19/alspp-0033.lasinfo	number	of	point	records	244079		20/cpro-0033.lasinfo	number	of	point	records	240307		3772	1.545
19/alspp-0034.lasinfo	number	of	point	records	212006		20/cpro-0034.lasinfo	number	of	point	records	178735		33271	15.693
19/alspp-0035.lasinfo	number	of	point	records	194687		20/cpro-0035.lasinfo	number	of	point	records	161417		33270	17.089
19/alspp-0036.lasinfo	number	of	point	records	204691		20/cpro-0036.lasinfo	number	of	point	records	171150		33541	16.386
19/alspp-0037.lasinfo	number	of	point	records	154096		20/cpro-0037.lasinfo	number	of	point	records	154055		41	0.027
19/alspp-0038.lasinfo	number	of	point	records	154096		20/cpro-0038.lasinfo	number	of	point	records	154055		41	0.027
19/alspp-0039.lasinfo	number	of	point	records	156473		20/cpro-0039.lasinfo	number	of	point	records	156578		-105	-0.067
19/alspp-0040.lasinfo	number	of	point	records	157233		20/cpro-0040.lasinfo	number	of	point	records	156930		303	0.193
19/alspp-0041.lasinfo	number	of	point	records	177368		20/cpro-0041.lasinfo	number	of	point	records	176995		373	0.210
19/alspp-0042.lasinfo	number	of	point	records	275771		20/cpro-0042.lasinfo	number	of	point	records	225944		49827	18.068
19/alspp-0043.lasinfo	number	of	point	records	278532		20/cpro-0043.lasinfo	number	of	point	records	227249		51283	18.412
19/alspp-0044.lasinfo	number	of	point	records	286576		20/cpro-0044.lasinfo	number	of	point	records	235976		50600	17.657
19/alspp-0045.lasinfo	number	of	point	records	277514		20/cpro-0045.lasinfo	number	of	point	records	217863		59651	21.495
19/alspp-0046.lasinfo	number	of	point	records	254480		20/cpro-0046.lasinfo	number	of	point	records	193925		60555	23.796
19/alspp-0047.lasinfo	number	of	point	records	257728		20/cpro-0047.lasinfo	number	of	point	records	198739		58989	22.888
19/alspp-0048.lasinfo	number	of	point	records	306593		20/cpro-0048.lasinfo	number	of	point	records	246973		59620	19.446
19/alspp-0049.lasinfo	number	of	point	records	356703		20/cpro-0049.lasinfo	number	of	point	records	321212		35491	9.950
19/alspp-0050.lasinfo	number	of	point	records	343630		20/cpro-0050.lasinfo	number	of	point	records	315091		28539	8.305
19/alspp-0051.lasinfo	number	of	point	records	418612		20/cpro-0051.lasinfo	number	of	point	records	348906		69706	16.652
19/alspp-0052.lasinfo	number	of	point	records	135105		20/cpro-0052.lasinfo	number	of	point	records	135089		16	0.012
19/alspp-0053.lasinfo	number	of	point	records	140640		20/cpro-0053.lasinfo	number	of	point	records	140581		59	0.042
19/alspp-0054.lasinfo	number	of	point	records	128940		20/cpro-0054.lasinfo	number	of	point	records	128903		37	0.029
19/alspp-0055.lasinfo	number	of	point	records	179997		20/cpro-0055.lasinfo	number	of	point	records	164649		15348	8.527
19/alspp-0056.lasinfo	number	of	point	records	150024		20/cpro-0056.lasinfo	number	of	point	records	142540		7484	4.989
19/alspp-0057.lasinfo	number	of	point	records	166853		20/cpro-0057.lasinfo	number	of	point	records	157819		9034	5.414
19/alspp-0058.lasinfo	number	of	point	records	122254		20/cpro-0058.lasinfo	number	of	point	records	122285		-31	-0.025
19/alspp-0059.lasinfo	number	of	point	records	122760		20/cpro-0059.lasinfo	number	of	point	records	122850		-90	-0.073
19/alspp-0060.lasinfo	number	of	point	records	119177		20/cpro-0060.lasinfo	number	of	point	records	119333		-156	-0.131
19/alspp-0061.lasinfo	number	of	point	records	179348		20/cpro-0061.lasinfo	number	of	point	records	146627		32721	18.244
19/alspp-0062.lasinfo	number	of	point	records	122952		20/cpro-0062.lasinfo	number	of	point	records	122054		898	0.730
19/alspp-0063.lasinfo	number	of	point	records	122914		20/cpro-0063.lasinfo	number	of	point	records	120713		2201	1.791
19/alspp-0064.lasinfo	number	of	point	records	217869		20/cpro-0064.lasinfo	number	of	point	records	215997		1872	0.859
19/alspp-0065.lasinfo	number	of	point	records	253798		20/cpro-0065.lasinfo	number	of	point	records	235543		18255	7.193
19/alspp-0066.lasinfo	number	of	point	records	288976		20/cpro-0066.lasinfo	number	of	point	records	254504		34472	11.929
19/alspp-0067.lasinfo	number	of	point	records	346953		20/cpro-0067.lasinfo	number	of	point	records	272446		74507	21.475
19/alspp-0068.lasinfo	number	of	point	records	91625		20/cpro-0068.lasinfo	number	of	point	records	91605		20	0.022
19/alspp-0069.lasinfo	number	of	point	records	91899		20/cpro-0069.lasinfo	number	of	point	records	91941		-42	-0.046
19/alspp-0070.lasinfo	number	of	point	records	126195		20/cpro-0070.lasinfo	number	of	point	records	126184		11	0.009
19/alspp-0071.lasinfo	number	of	point	records	207915		20/cpro-0071.lasinfo	number	of	point	records	169237		38678	18.603
19/alspp-0072.lasinfo	number	of	point	records	125691		20/cpro-0072.lasinfo	number	of	point	records	125725		-34	-0.027
19/alspp-0073.lasinfo	number	of	point	records	564780		20/cpro-0073.lasinfo	number	of	point	records	371461		193319	34.229
19/alspp-0074.lasinfo	number	of	point	records	162822		20/cpro-0074.lasinfo	number	of	point	records	150144		12678	7.786
19/alspp-0075.lasinfo	number	of	point	records	107819		20/cpro-0075.lasinfo	number	of	point	records	107851		-32	-0.030
19/alspp-0076.lasinfo	number	of	point	records	204645		20/cpro-0076.lasinfo	number	of	point	records	165917		38728	18.924
19/alspp-0077.lasinfo	number	of	point	records	178281		20/cpro-0077.lasinfo	number	of	point	records	152698		25583	14.350
19/alspp-0078.lasinfo	number	of	point	records	191447		20/cpro-0078.lasinfo	number	of	point	records	154069		37378	19.524
19/alspp-0079.lasinfo	number	of	point	records	121820		20/cpro-0079.lasinfo	number	of	point	records	121898		-78	-0.064
19/alspp-0080.lasinfo	number	of	point	records	140054		20/cpro-0080.lasinfo	number	of	point	records	140112		-58	-0.041
19/alspp-0081.lasinfo	number	of	point	records	268581		20/cpro-0081.lasinfo	number	of	point	records	204379		64202	23.904
19/alspp-0082.lasinfo	number	of	point	records	260590		20/cpro-0082.lasinfo	number	of	point	records	244525		16065	6.165
19/alspp-0083.lasinfo	number	of	point	records	787379		20/cpro-0083.lasinfo	number	of	point	records	736744		50635	6.431
19/alspp-0084.lasinfo	number	of	point	records	781648		20/cpro-0084.lasinfo	number	of	point	records	518707		262941	33.639
19/alspp-0085.lasinfo	number	of	point	records	149725		20/cpro-0085.lasinfo	number	of	point	records	149879		-154	-0.103
19/alspp-0086.lasinfo	number	of	point	records	216307		20/cpro-0086.lasinfo	number	of	point	records	194834		21473	9.927