LMS Processing and QA/QC for 2017 WREF 1 V01

PREPARED BY	ORGANIZATION	DATE
Tristan Goulden	AOP	07/12/2017
Bridget Hass	AOP	07/12/2017

See configuration management system for approval history.

TABLE OF CONTENTS

List of Figures

List of Tables

1 DESCRIPTION

1.1 Purpose

This document details the processing information used in the generation of the LiDAR point cloud (L1 products) from the NEON AOP (Airborne Observation Platform). The point cloud is developed from raw sensor measurements made by the ALTM Gemini LiDAR sensor and the SBET (Smoothed Best Estimated Trajectory) derived from the raw GPS / IMU sensor. Processing and QA information for the SBET can be found in separate documents dedicated to each individual mission. The information contained here was used for processing the site termed 2017_WREF_1_V01. The point cloud is output in LAS 1.3 format according to ASPRS specification (ASPRS, 2009), and is geolocated in the ITRF00 datum and projected into the appropriate UTM zone. In addition to processing parameters used, this report also provides QA information from a line-by-line adjustment and roofline analysis. For further background information of the NEON LiDAR processing procedures, the reader is referred to RD[08] and RD[09]

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

AD[01]	NEON.DOC.000001	NEON Observatory Design (NOD) Requirements
AD[02]	NEON.DOC.005003	NEON Scientific Data Products Catalog
AD[03]	NEON.DOC.005004	NEON Level 1-3 Data Products Catalog
AD[04]	NEON.DOC.005005	NEON Level 0 Data Product Catalog
AD[07]	NEON.DOC.002649	NEON configured site list

2.2 Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

RD[01]	NEON.DOC.000008	NEON Acronym List
RD[02]	NEON.DOC.000243	NEON Glossary of Terms
RD[04]	NEON.DOC.001984	AOP flight plan boundaries design
RD[05]	NEON.DOC.005011	NEON Coordinate Systems Specification
RD[06]	NEON.DOC.001292	NEON L0-to-L1 discrete return LiDAR algorithm theoretical basis document
RD[07]	NEON.DOC.002890	NEON AOP Level 0 quality checks
RD[08]	NEON.DOC.003316	Discrete LiDAR Level-1 processing procedure
RD[09]	NEON.DOC.002890	NEON Elevation (DTM and DSM) Algorithm Theoretical Basis Document

2.3 Acronyms

Acronym	**Definition**
ITRF00	International Terrestrial Reference Frame 2000
UTM	Universal Transverse Mercator
AOP	Airborne Operations Platform
FBO	Fixed Base Operator
LMS	Laser Mapping Suite
SBET	Smoothed Best Estimated Trajectory

3 LMS Project Setup

LMS Project Parameters

LMS version: 3.1.0.16935
LMS project name: 2017_WREF_1_V01
LMS output directory: D:\2017\FullSite\D16\2017_WREF_1\Processing\DiscreteLidar\LMS\2017_WREF_1_V01\Output
Processed on computer: DEN-TERAOS-P016
Processed on: 11-Jul-2017 17:07:58
Processed by: bhass
LMS project coordinate system: ITRF00_UTMzone10N
LMS output coordinate system: ITRF00_UTMzone10N_Geoid12a
SBET coordinate system: ITRF00
Flight plan: O:\2017\P2\C1\2017062215_P2C1\L0\Ancillary\FlightPlans\PLNs\D16_WREF_C1_P1_v2.pln

LMS Output Settings

LAS Output Format: 1.3
Pulsewave Output Format: 0.3

LMS Project Inputs

LMS res file used: D:\InstrumentFiles\2016_P2C1_12SEN311\12SEN311_w_digitizer.res
LMS tbl file used: D:\InstrumentFiles\2016_P2C1_12SEN311\12SEN311.tbl
LMS lcp file used: D:\InstrumentFiles\2017_P2C1_12SEN311\2017051614_B10B_Iterations\2017051614_P2C1_B10B_6_rev2.lcp

Mission Name: 2017061916
Raw discrete input file: DiscreteLidar_2017061916#1.range
No raw waveform data.
Input SBET file: D:\2017\Daily\2017061916_P2C1\L1\GPSIMU\sbet_2017061916.out
Input SBET error file: D:\2017\Daily\2017061916_P2C1\L1\GPSIMU\smrmsg_2017061916.out
Flight Date: 19-Jun-2017
Start Time (UTC): 17:01:17
End Time (UTC): 20:16:00
GPS Week: 1954
Start Time (GPS Seconds of Week): 147676
End Time (GPS Seconds of Week): 159359
Min Temperature: 24.5 ^{o}C
Max Temperature: 27.2 ^{o}C
Mean Temperature: 25.3 ^{o}C
Min Pressure: 808.9 mBar
Max Pressure: 846.7 mBar
Mean Pressure: 829.5 mBar

Mission Name: 2017062117
Raw discrete input file: DiscreteLidar_2017062117#1.range
No raw waveform data.

Table 4: ASCII Output Fields

ASCII Field	**Units**
Sensor X-coordinate	m
Sensor Y-coordinate	m
Sensor Z-coordinate	m
Sensor roll	deg
Sensor pitch	deg
Sensor heading	deg
Sensor position GPS time	s
Laser shot GPS time	s
Laser shot scan	deg
Laser shot scan standard dev.	deg
Laser shot number of returns	
Laser shot number of ranges	
Laser shot scanDir	
Laser returnID	
Laser range	m
Laser range standard dev.	m
Laser range intensity	
Laser point X-coordinate	m
Laser point Y-coordinate	m
Laser point Z-coordinate	m

Table 5: Reference to IMU lever arms

Lever Arm	**Distance (m)**
imu_ex	-0.0861
imu_ey	-0.0105
imu_ez	-0.5248

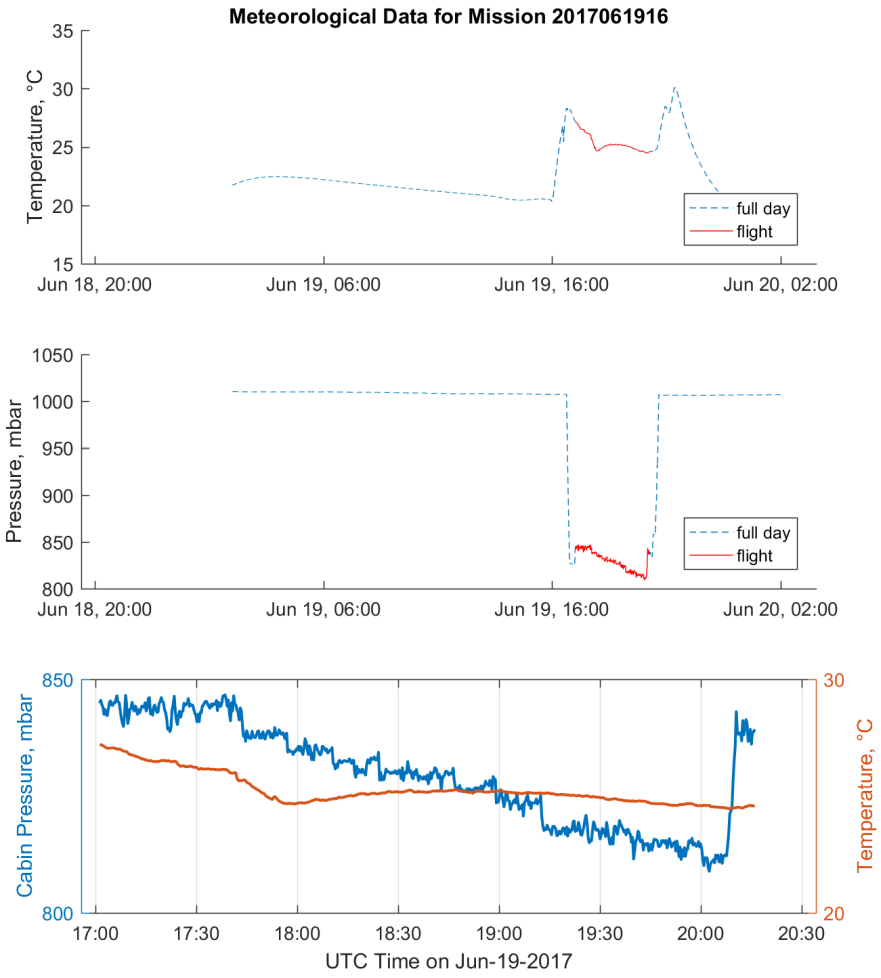

Figure 1: Meteorological Data for Mission 2017061916

Input SBET file: D:\2017\Daily\2017062117_P2C1\L1\GPSIMU\sbet_2017062117.out
Input SBET error file: D:\2017\Daily\2017062117_P2C1\L1\GPSIMU\smrmsg_2017062117.out
Flight Date: 21-Jun-2017
Start Time (UTC): 18:14:16
End Time (UTC): 21:15:28
GPS Week: 1954
Start Time (GPS Seconds of Week): 324856
End Time (GPS Seconds of Week): 335727
Min Temperature: 19.4 ^{o}C
Max Temperature: 21.6 ^{o}C
Mean Temperature: 20.0 ^{o}C
Min Pressure: 791.2 mBar
Max Pressure: 867.5 mBar
Mean Pressure: 834.9 mBar

Mission Name: 2017062122
Raw discrete input file: DiscreteLidar_2017062122#1.range
No raw waveform data.
Input SBET file: D:\2017\Daily\2017062122_P2C1\L1\GPSIMU\sbet_2017062122.out
Input SBET error file: D:\2017\Daily\2017062122_P2C1\L1\GPSIMU\smrmsg_2017062122.out
Flight Date: 21-Jun-2017
Start Time (UTC): 22:57:12
End Time (UTC): 00:48:34
GPS Week: 1954
Start Time (GPS Seconds of Week): 341831
End Time (GPS Seconds of Week): 348513
Min Temperature: 20.1 ^{o}C
Max Temperature: 23.2 ^{o}C
Mean Temperature: 20.9 ^{o}C
Min Pressure: 789.3 mBar
Max Pressure: 871.5 mBar
Mean Pressure: 814.3 mBar

Mission Name: 2017062215
Raw discrete input file: DiscreteLidar_2017062215#1.range
No raw waveform data.
Input SBET file: D:\2017\Daily\2017062215_P2C1\L1\GPSIMU\sbet_2017062215.out
Input SBET error file: D:\2017\Daily\2017062215_P2C1\L1\GPSIMU\smrmsg_2017062215.out
Flight Date: 22-Jun-2017
Start Time (UTC): 16:18:33
End Time (UTC): 18:29:39
GPS Week: 1954
Start Time (GPS Seconds of Week): 404313
End Time (GPS Seconds of Week): 412178
Min Temperature: 19.6 ^{o}C
Max Temperature: 22.3 ^{o}C

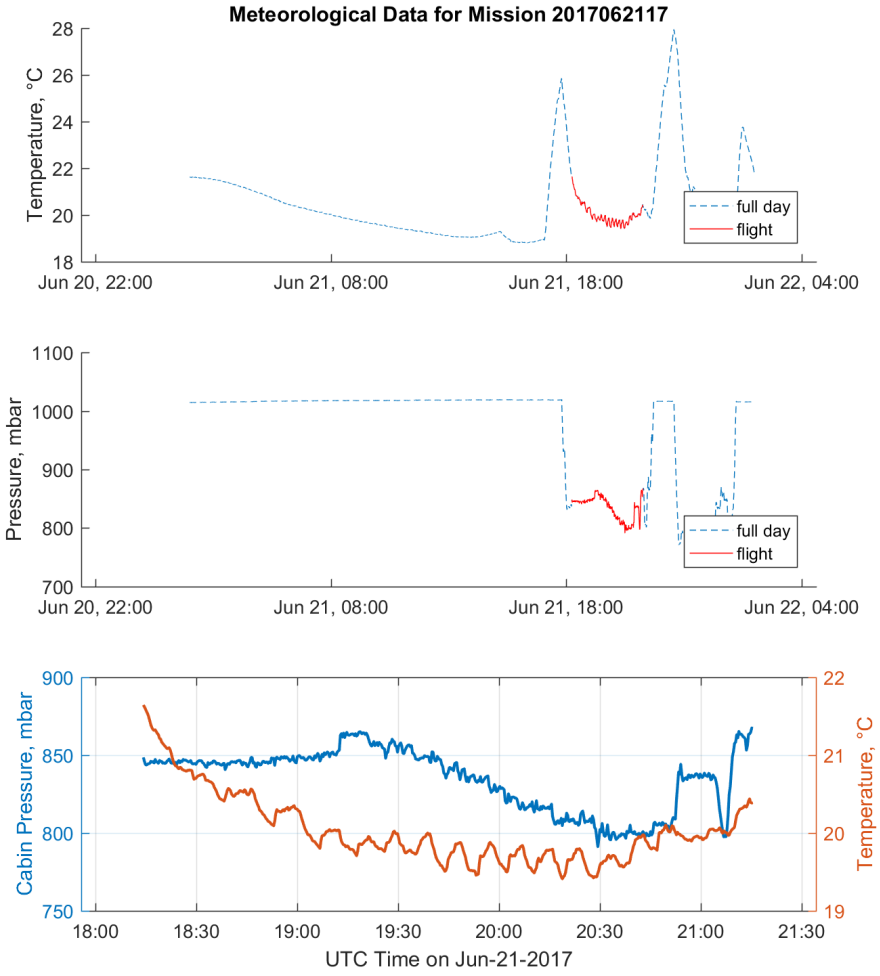

Figure 2: Meteorological Data for Mission 2017062117

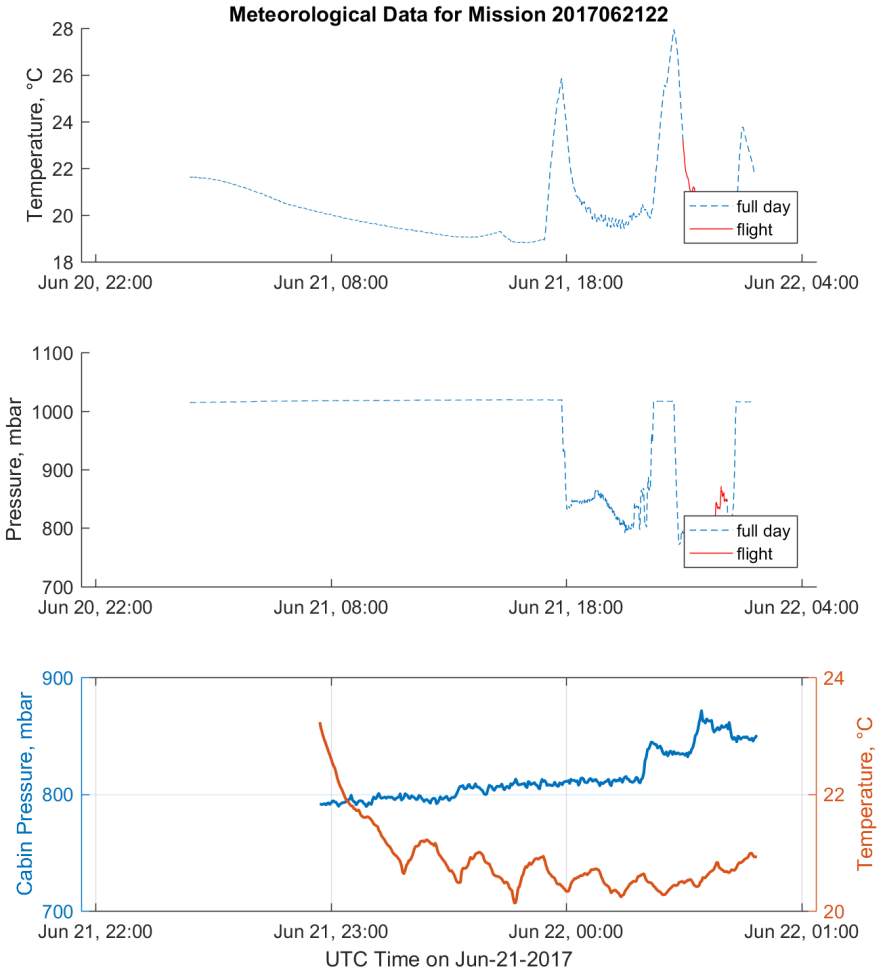

Figure 3: Meteorological Data for Mission 2017062122

Mean Temperature: 20.1 ^{o}C
Min Pressure: 798 mBar
Max Pressure: 840.7 mBar
Mean Pressure: 825.8 mBar

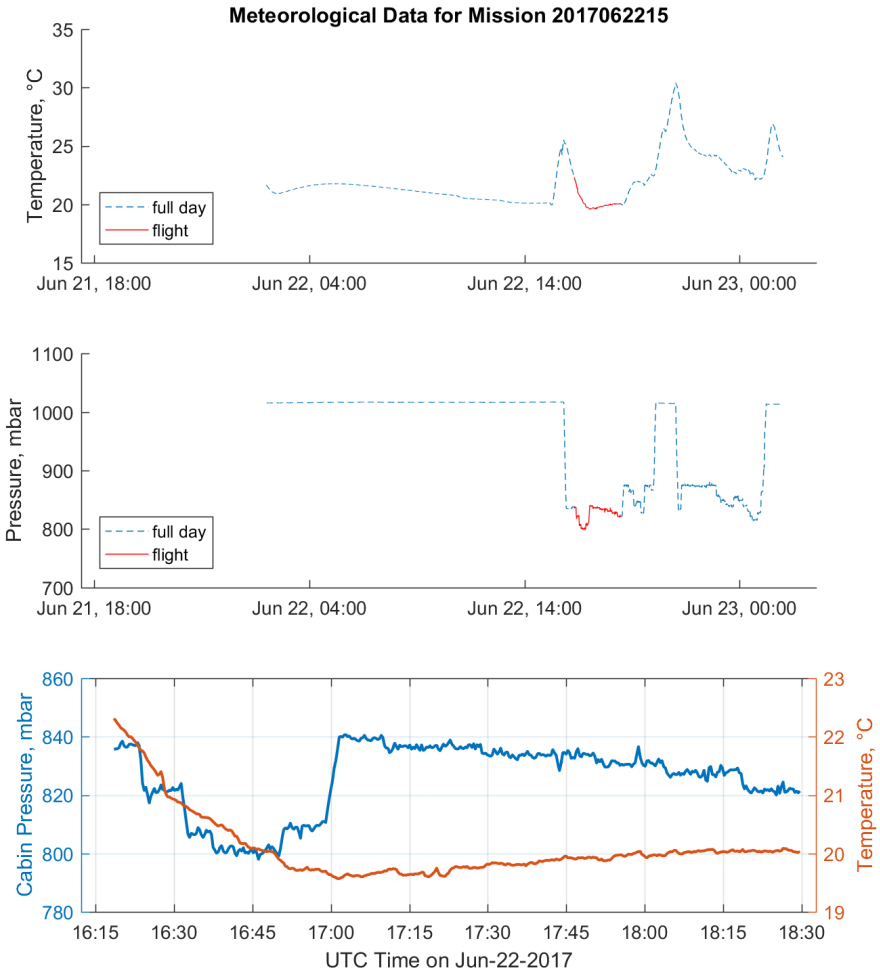

Figure 4: Meteorological Data for Mission 2017062215

3.1 Roofline determination input parameters

As part of the accuracy analysis of the LiDAR survey, LMS identifies rooflines that exist in multiple strips. The location, slope and azimuth of the roofs are compared between adjacent strips for quantifying a relative accuracy between strips. Table 6 contains the parameters used to identify roof lines for each line of the survey. The final results of the roofline analysis can be seen in Section 8.2

Table 6: Roof line determination parameters

Line Number	Min plane slope (deg)	Min azimuth difference (deg)	Max slope difference (deg)	Max distance b/w roof centers (m)	Shortest acceptable roof length (m)
L0001-1	10.0	3.0	3.0	100.0	1.0
L0001-2	10.0	3.0	3.0	100.0	1.0
L0001-3	10.0	3.0	3.0	100.0	1.0
L0001-4	10.0	3.0	3.0	100.0	1.0
L0001-5	10.0	3.0	3.0	100.0	1.0
L0001-6	10.0	3.0	3.0	100.0	1.0
L0002-1	10.0	3.0	3.0	100.0	1.0
L0002-2	10.0	3.0	3.0	100.0	1.0
L0003-1	10.0	3.0	3.0	100.0	1.0
L0003-2	10.0	3.0	3.0	100.0	1.0
L0004-1	10.0	3.0	3.0	100.0	1.0
L0004-2	10.0	3.0	3.0	100.0	1.0
L0005-1	10.0	3.0	3.0	100.0	1.0
L0005-2	10.0	3.0	3.0	100.0	1.0
L0005-3	10.0	3.0	3.0	100.0	1.0
L0006-1	10.0	3.0	3.0	100.0	1.0
L0006-2	10.0	3.0	3.0	100.0	1.0
L0007-1	10.0	3.0	3.0	100.0	1.0
L0007-2	10.0	3.0	3.0	100.0	1.0
L0008-1	10.0	3.0	3.0	100.0	1.0
L0009-1	10.0	3.0	3.0	100.0	1.0
L0010-1	10.0	3.0	3.0	100.0	1.0
L0011-1	10.0	3.0	3.0	100.0	1.0
L0012-1	10.0	3.0	3.0	100.0	1.0
L0013-1	10.0	3.0	3.0	100.0	1.0
L0014-1	10.0	3.0	3.0	100.0	1.0
L0015-1	10.0	3.0	3.0	100.0	1.0

L0016-1	10.0	3.0	3.0	100.0	1.0
L0017-1	10.0	3.0	3.0	100.0	1.0
L0018-1	10.0	3.0	3.0	100.0	1.0
L0019-1	10.0	3.0	3.0	100.0	1.0
L0020-1	10.0	3.0	3.0	100.0	1.0
L0021-1	10.0	3.0	3.0	100.0	1.0
L0022-1	10.0	3.0	3.0	100.0	1.0
L0022-2	10.0	3.0	3.0	100.0	1.0
L0023-1	10.0	3.0	3.0	100.0	1.0
L0023-2	10.0	3.0	3.0	100.0	1.0
L0024-1	10.0	3.0	3.0	100.0	1.0
L0025-1	10.0	3.0	3.0	100.0	1.0
L0026-1	10.0	3.0	3.0	100.0	1.0
L0027-1	10.0	3.0	3.0	100.0	1.0
L0028-1	10.0	3.0	3.0	100.0	1.0
L0029-1	10.0	3.0	3.0	100.0	1.0
L0030-1	10.0	3.0	3.0	100.0	1.0
L0031-1	10.0	3.0	3.0	100.0	1.0
L0032-1	10.0	3.0	3.0	100.0	1.0
L0033-1	10.0	3.0	3.0	100.0	1.0
L0034-1	10.0	3.0	3.0	100.0	1.0
L0035-1	10.0	3.0	3.0	100.0	1.0
L0036-1	10.0	3.0	3.0	100.0	1.0
L0037-1	10.0	3.0	3.0	100.0	1.0
L0038-1	10.0	3.0	3.0	100.0	1.0
L0039-1	10.0	3.0	3.0	100.0	1.0
L0040-1	10.0	3.0	3.0	100.0	1.0
L0040-2	10.0	3.0	3.0	100.0	1.0
L0041-1	10.0	3.0	3.0	100.0	1.0
L0041-2	10.0	3.0	3.0	100.0	1.0
L0042-1	10.0	3.0	3.0	100.0	1.0
L0042-2	10.0	3.0	3.0	100.0	1.0
L0043-1	10.0	3.0	3.0	100.0	1.0
L0043-2	10.0	3.0	3.0	100.0	1.0
L0044-1	10.0	3.0	3.0	100.0	1.0

L0044-2	10.0	3.0	3.0	100.0	1.0
L0045-1	10.0	3.0	3.0	100.0	1.0
L0045-2	10.0	3.0	3.0	100.0	1.0
L0046-1	10.0	3.0	3.0	100.0	1.0
L0046-2	10.0	3.0	3.0	100.0	1.0
L0047-1	10.0	3.0	3.0	100.0	1.0
L0047-2	10.0	3.0	3.0	100.0	1.0
L0048-1	10.0	3.0	3.0	100.0	1.0
L0048-2	10.0	3.0	3.0	100.0	1.0
L0049-1	10.0	3.0	3.0	100.0	1.0
L0049-2	10.0	3.0	3.0	100.0	1.0
L0050-1	10.0	3.0	3.0	100.0	1.0
L0050-2	10.0	3.0	3.0	100.0	1.0
L0051-1	10.0	3.0	3.0	100.0	1.0
L0051-2	10.0	3.0	3.0	100.0	1.0
L0052-1	10.0	3.0	3.0	100.0	1.0
L0053-1	10.0	3.0	3.0	100.0	1.0
L0054-1	10.0	3.0	3.0	100.0	1.0
L0055-1	10.0	3.0	3.0	100.0	1.0
L0056-1	10.0	3.0	3.0	100.0	1.0
L0058-1	10.0	3.0	3.0	100.0	1.0
L0059-1	10.0	3.0	3.0	100.0	1.0
L0060-1	10.0	3.0	3.0	100.0	1.0
L0061-1	10.0	3.0	3.0	100.0	1.0
L0062-1	10.0	3.0	3.0	100.0	1.0
L0063-1	10.0	3.0	3.0	100.0	1.0
L0064-1	10.0	3.0	3.0	100.0	1.0
L0065-1	10.0	3.0	3.0	100.0	1.0
L0066-1	10.0	3.0	3.0	100.0	1.0
L0067-1	10.0	3.0	3.0	100.0	1.0
L0068-1	10.0	3.0	3.0	100.0	1.0
L0069-1	10.0	3.0	3.0	100.0	1.0
L0070-1	10.0	3.0	3.0	100.0	1.0
L0071-1	10.0	3.0	3.0	100.0	1.0
L0072-1	10.0	3.0	3.0	100.0	1.0

L0073-1	10.0	3.0	3.0	100.0	1.0
L0074-1	10.0	3.0	3.0	100.0	1.0
L0075-1	10.0	3.0	3.0	100.0	1.0
L0076-1	10.0	3.0	3.0	100.0	1.0
L0077-1	10.0	3.0	3.0	100.0	1.0
L0078-1	10.0	3.0	3.0	100.0	1.0

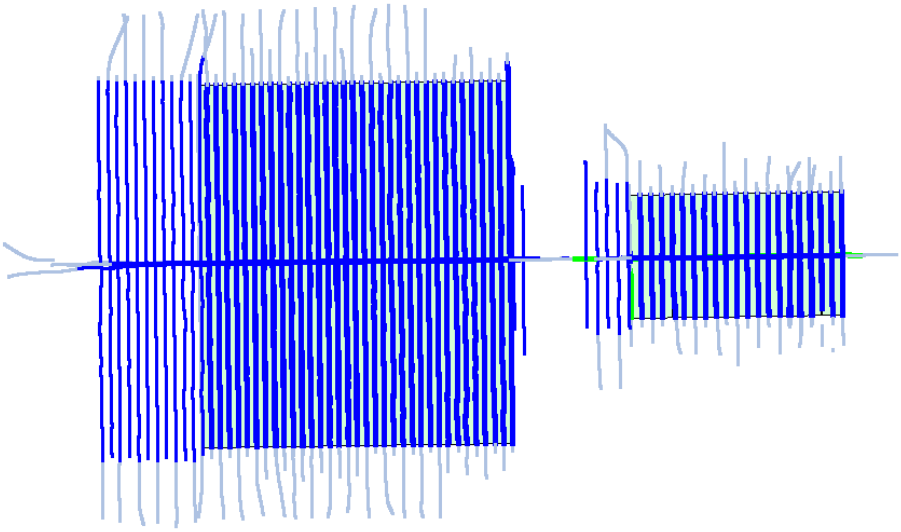

Figure 5: Flight Plan and Flight Coverage for 2017 WREF 1 V01

3.2 Tie plane selection and determination input parameters

LMS performs a strip to strip adjustment between adjacent strips to improve the relative accuracy of the survey. In this adjustment, LMS identifies tie-planes in a control strip and tie-points which overlap the tie-planes in an adjacent strip. The residual offset between the tie-planes and the tie-points are used as inputs to an adjustment which identifies corrections to the roll, pitch and vertical coordinate (z) for each line. Table 7, Table 8 and **??** summarize the parameters used in identifying and selecting suitable tie plane candidates. Results achieved prior to the strip-by-strip adjustment are termed **standard** results, and results achieved after the strip-by-strip adjustment are termed **refined** results. The resulting corrections used to generate refined results can be found in Table 15. A summary of the statistics for the resulting offsets between the tie-points and tie-planes can be found in Table 16, Table 17, Table 18, Table 19 and Figure 16, Figure 17, Figure 18 and Figure 19. Additional information on the adjustment methodology can be found in Lindenthal et al. (2011)

Table 7: Tie plane selection parameters

Parameter	Value
Fitting error (m)	0.15
Minimum number of points on tie plane	20
Maximum number of points used	1500000
Preferred plane slope (deg)	35.0
Max point density (pts/m^2)	20.0

Table 8: Tie plane determination parameters

Parameter	Value
Search radius (m)	4.0
Max separation ot tie planes	0.75
Max separation from control points	1.0
Extended search radius by factor of plane size	0.0
Max normal deviation	2.0
Min overlap of tie planes	0.7
Min common area of tie plane)	0.0
Blunder threshold	2.0

Table 9: Planar surface extraction

Line	Surface roughness (m)
L0001-1	0.035
L0001-2	0.035
L0001-3	0.035
L0001-4	0.035
L0001-5	0.035

L0001-6	0.035
L0002-1	0.035
L0002-2	0.035
L0003-1	0.035
L0003-2	0.035
L0004-1	0.035
L0004-2	0.035
L0005-1	0.035
L0005-2	0.035
L0005-3	0.035
L0006-1	0.035
L0006-2	0.035
L0007-1	0.035
L0007-2	0.035
L0008-1	0.035
L0009-1	0.035
L0010-1	0.035
L0011-1	0.035
L0012-1	0.035
L0013-1	0.035
L0014-1	0.035
L0015-1	0.035
L0016-1	0.035
L0017-1	0.035
L0018-1	0.035
L0019-1	0.035
L0020-1	0.035
L0021-1	0.035
L0022-1	0.035
L0022-2	0.035
L0023-1	0.035
L0023-2	0.035
L0024-1	0.035
L0025-1	0.035
L0026-1	0.035

L0027-1	0.035
L0028-1	0.035
L0029-1	0.035
L0030-1	0.035
L0031-1	0.035
L0032-1	0.035
L0033-1	0.035
L0034-1	0.035
L0035-1	0.035
L0036-1	0.035
L0037-1	0.035
L0038-1	0.035
L0039-1	0.035
L0040-1	0.035
L0040-2	0.035
L0041-1	0.035
L0041-2	0.035
L0042-1	0.035
L0042-2	0.035
L0043-1	0.035
L0043-2	0.035
L0044-1	0.035
L0044-2	0.035
L0045-1	0.035
L0045-2	0.035
L0046-1	0.035
L0046-2	0.035
L0047-1	0.035
L0047-2	0.035
L0048-1	0.035
L0048-2	0.035
L0049-1	0.035
L0049-2	0.035
L0050-1	0.035
L0050-2	0.035

L0051-1	0.035
L0051-2	0.035
L0052-1	0.035
L0053-1	0.035
L0054-1	0.035
L0055-1	0.035
L0056-1	0.035
L0058-1	0.035
L0059-1	0.035
L0060-1	0.035
L0061-1	0.035
L0062-1	0.035
L0063-1	0.035
L0064-1	0.035
L0065-1	0.035
L0066-1	0.035
L0067-1	0.035
L0068-1	0.035
L0069-1	0.035
L0070-1	0.035
L0071-1	0.035
L0072-1	0.035
L0073-1	0.035
L0074-1	0.035
L0075-1	0.035
L0076-1	0.035
L0077-1	0.035
L0078-1	0.035

4 Trajectory Statistics

Table 11 contains information on the state of the aircraft during the survey, while Table 12 contains information on the average trajectory errors for each line. Note that the Strip IDs may not strictly match output line numbers, as strips include lines which were not processed into LAS files. Refer to Table 10 to associate trajectory strip-id with LAS line number.

Table 10: Association between Trajectory Strip-ID and LMS Line Number

Mission #	Traj Strip-ID	LMS Line #	Trajectory Start Time	Trajectory End Time	LMS Start Time	LMS End Time
2017061916	2	31-1	147637.1	147913.6	147683	147908
2017061916	3	32-1	148070.4	148353.6	148121	148349
2017061916	4	33-1	148477.2	148750.6	148524	148744
2017061916	5	34-1	148931.5	149231.6	148988	149225
2017061916	6	35-1	149387.3	149654.7	149435	149650
2017061916	7	36-1	149810.6	150112.6	149869	150106
2017061916	8	37-1	150233.3	150507.7	150278	150501
2017061916	9	38-1	150622.2	150914.6	150679	150909
2017061916	10	39-1	151037.5	151311.6	151083	151306
2017061916	11	40-1	151429.2	151716.7	151483	151710
2017061916	12	41-1	151838.5	152115.7	151881	152108
2017061916	13	42-1	152259.3	152551.7	152312	152544
2017061916	14	43-1	152692.6	152966.7	152743	152960
2017061916	15	44-1	153099.4	153383.7	153153	153376
2017061916	16	45-1	153523.1	153797.7	153569	153791
2017061916	17	46-1	153926.4	154213.7	153979	154207
2017061916	18	47-1	154349.2	154622.7	154396	154617
2017061916	19	48-1	154765.5	155053.7	154814	155047
2017061916	20	49-1	155169.3	155448.7	155213	155442
2017061916	21	50-1	155586.6	155871.7	155636	155865
2017061916	22	51-1	155985.3	156267.7	156029	156259
2017061916	23	52-1	156396.6	156674.7	156442	156668
2017061916	24	53-1	156790.4	157066.7	156837	157059
2017061916	25	54-1	157206.2	157492.7	157256	157485
2017061916	26	55-1	157606.5	157884.7	157653	157878
2017061916	27	56-1	158025.3	158319.7	158080	158313
2017061916	30	1-1	159123.6	159362.7	159198	159362
2017062117	3	30-1	324833.5	325095.8	324856	325089

2017062117	4	29-1	325266.3	325503.8	325284	325498
2017062117	5	28-1	325877.5	326139.8	325899	326134
2017062117	6	27-1	326300.4	326566.8	326323	326559
2017062117	7	26-1	326769.7	327023.8	326793	327017
2017062117	8	25-1	327176.4	327428.8	327192	327422
2017062117	9	24-1	327602.7	327848.8	327620	327843
2017062117	10	23-2	327999.5	328249.8	328007	328244
2017062117	11	22-1	328407.7	328507.8	328460	328464
2017062117	11	22-2	328407.7	328507.8	328426	328454
2017062117	12	21-1	328651.5	328754.8	328674	328748
2017062117	13	20-1	328911.3	329010.8	328928	329005
2017062117	14	19-1	329171.5	329279.8	329192	329274
2017062117	15	18-1	329442.3	329552.8	329465	329546
2017062117	16	17-1	329698.6	329806.8	329722	329800
2017062117	17	16-1	329969.4	330076.8	329995	330070
2017062117	18	15-1	330254.7	330349.8	330268	330343
2017062117	19	14-1	330547.5	330655.8	330572	330649
2017062117	20	13-1	330791.2	330908.8	330825	330903
2017062117	21	12-1	331076.5	331192.8	331108	331185
2017062117	22	11-1	331324.4	331428.8	331346	331421
2017062117	23	10-1	331585.6	331687.8	331606	331680
2017062117	24	9-1	331823.4	331931.8	331847	331924
2017062117	25	8-1	332097.7	332205.8	332122	332200
2017062117	26	7-1	332364.5	332467.8	332387	332461
2017062117	27	6-1	332672.2	332768.8	332686	332761
2017062117	28	5-2	332924.6	333023.8	332945	333018
2017062117	30	4-1	333240.6	333320.8	333242	333315
2017062117	31	5-1	333475.4	333581.8	333498	333575
2017062117	33	3-1	333768.4	333851.8	333770	333845
2017062117	34	2-1	333985.3	334091.8	334043	334082
2017062117	35	1-2	334441.6	334963.9	334667	334895
2017062117	35	1-3	334441.6	334963.9	334466	334610
2017062117	36	23-1	335353.3	335462.9	335354	335462
2017062117	37	77-1	335630.6	335734.9	335632	335734
2017062122	2	58-1	341803.2	342086.7	341838	342084

2017062122	3	59-1	342233.5	342504.7	342279	342504
2017062122	4	60-1	342669.2	342952.7	342707	342949
2017062122	5	61-1	343099.5	343375.7	343140	343375
2017062122	6	62-1	343515.3	343807.7	343560	343804
2017062122	7	63-1	343940.6	344214.7	343981	344214
2017062122	8	64-1	344355.4	344640.7	344397	344638
2017062122	9	65-1	344763.2	345041.7	344807	345041
2017062122	10	66-1	345164.5	345460.7	345219	345458
2017062122	11	67-1	345578.3	345848.7	345623	345848
2017062122	12	68-1	345985.6	346272.7	346030	346269
2017062122	13	69-1	346406.3	346679.7	346437	346679
2017062122	14	70-1	346999.6	347401.7	347040	347116
2017062122	14	71-1	346999.6	347401.7	347118	347325
2017062122	14	72-1	346999.6	347401.7	347350	347384
2017062122	15	73-1	347577.4	347706.7	347615	347706
2017062122	16	74-1	347864.1	347988.7	347898	347988
2017062122	17	75-1	348122.4	348250.7	348158	348250
2017062122	18	76-1	348376.2	348505.7	348412	348505
2017062215	3	1-4	403980.4	404498	404312	404324
2017062215	3	1-5	403980.4	404498	404022	404272
2017062215	3	1-6	403980.4	404498	404347	404477
2017062215	4	78-1	404778.9	404885	404780	404884
2017062215	5	2-2	405225.5	405331	405245	405323
2017062215	6	3-2	405492.7	405587	405506	405580
2017062215	8	4-2	405801.8	405865	405803	405859
2017062215	9	5-3	406020.6	406123	406041	406115
2017062215	10	6-2	406290.4	406392	406311	406384
2017062215	11	7-2	406554.7	406659	406572	406650
2017062215	12	40-2	407050.5	407301	407071	407295
2017062215	13	41-2	407464.8	407714	407488	407707
2017062215	15	42-2	408182.9	408427	408203	408419
2017062215	16	43-2	408606.7	408854	408627	408847
2017062215	17	44-2	409024	409272	409041	409266
2017062215	18	45-2	409443.8	409694	409464	409686
2017062215	19	46-2	409850.5	410108	409873	410101

2017062215	20	47-2	410305.8	410532	410307	410525
2017062215	21	48-2	410688.6	410937	410704	410930
2017062215	22	49-2	411104.9	411362	411126	411355
2017062215	23	50-2	411525.7	411782	411547	411774
2017062215	24	51-2	411937	412193	411960	412186

Table 11: Average trajectory data

Mission #	Strip ID	Start [s]	Stop [s]	Speed Avg [m/s]	Height Avg [m]	Roll [deg]	Pitch [deg]	Heading [deg]
2017061916	1	146711.4	146722.6	74.6	1736.8	-2.103	1.202	87.888
2017061916	2	147637.1	147913.6	52.0	1568.2	0.444	1.856	7.392
2017061916	3	148070.4	148353.6	50.7	1578.7	0.200	-1.290	173.937
2017061916	4	148477.2	148750.6	52.8	1570.5	0.731	1.628	6.519
2017061916	5	148931.5	149231.6	48.3	1577.8	0.387	-0.331	173.571
2017061916	6	149387.3	149654.7	53.6	1567.6	0.183	0.718	6.356
2017061916	7	149810.6	150112.6	48.4	1572.7	0.307	0.422	174.463
2017061916	8	150233.3	150507.7	52.2	1631.4	0.736	1.107	4.141
2017061916	9	150622.2	150914.6	49.3	1635.4	0.073	0.088	163.252
2017061916	10	151037.5	151311.6	52.2	1664.3	0.330	0.794	2.196
2017061916	11	151429.2	151716.7	50.7	1667.9	0.108	-0.283	178.459
2017061916	12	151838.5	152115.7	51.6	1692.7	0.206	0.785	0.908
2017061916	13	152259.3	152551.7	49.8	1696.8	-0.105	0.349	179.606
2017061916	14	152692.6	152966.7	52.5	1716.7	-0.173	0.867	0.638
2017061916	15	153099.4	153383.7	51.2	1723.7	0.221	-0.424	180.045
2017061916	16	153523.1	153797.7	52.4	1721.8	0.205	0.777	-0.018
2017061916	17	153926.4	154213.7	50.3	1753.8	0.239	-0.344	180.749
2017061916	18	154349.2	154622.7	52.4	1742.5	0.334	0.514	-1.282
2017061916	19	154765.5	155053.7	50.0	1780.2	-0.000	-0.226	172.874
2017061916	20	155169.3	155448.7	51.3	1780.2	0.395	1.123	-3.689
2017061916	21	155586.6	155871.7	50.7	1845.4	-0.147	-0.658	183.420
2017061916	22	155985.3	156267.7	51.0	1836.8	0.264	1.103	-3.722
2017061916	23	156396.6	156674.7	51.6	1846.2	-0.179	-0.703	181.576
2017061916	24	156790.4	157066.7	52.4	1844.2	0.452	0.250	-3.242
2017061916	25	157206.2	157492.7	50.5	1876.2	0.188	-0.212	183.040
2017061916	26	157606.5	157884.7	51.8	1874.0	0.212	0.064	-3.177
2017061916	27	158025.3	158319.7	49.3	1877.2	0.198	0.648	157.833
2017061916	28	158487.6	158754.7	53.8	1907.9	-0.546	-0.603	-1.820
2017061916	29	159065.4	159102.1	48.3	1625.5	-5.442	0.386	111.595
2017061916	30	159123.6	159362.7	53.3	1631.8	-0.228	-0.147	92.915
2017062117	1	323547.4	323551.3	69.2	779.9	-4.979	0.542	26.498
2017062117	2	323860.7	323901.8	60.2	1513.9	0.603	6.722	64.907
2017062117	3	324833.5	325095.8	49.6	1592.6	0.708	0.191	-4.939

2017062117	4	325266.3	325503.8	54.2	1590.7	0.590	3.861	-146.547
2017062117	5	325877.5	326139.8	49.7	1595.7	1.168	3.725	-4.347
2017062117	6	326300.4	326566.8	49.7	1594.2	0.794	2.000	-120.510
2017062117	7	326769.7	327023.8	51.9	1595.0	0.173	4.353	-2.445
2017062117	8	327176.4	327428.8	50.7	1570.2	0.417	0.412	-122.950
2017062117	9	327602.7	327848.8	52.4	1562.2	-0.068	4.255	-2.047
2017062117	10	327999.5	328249.8	51.6	1541.4	-0.073	-0.151	-135.405
2017062117	11	328407.7	328507.8	52.7	1415.8	-0.277	4.163	-2.987
2017062117	12	328651.5	328754.8	52.6	1414.5	-0.154	1.247	-174.438
2017062117	13	328911.3	329010.8	51.3	1474.4	-0.428	4.841	-3.069
2017062117	14	329171.5	329279.8	48.5	1472.5	0.121	2.915	-166.088
2017062117	15	329442.3	329552.8	49.7	1490.3	-0.110	4.928	-4.621
2017062117	16	329698.6	329806.8	49.5	1564.5	-0.603	1.248	-170.398
2017062117	17	329969.4	330076.8	51.2	1573.0	-0.574	4.117	-3.719
2017062117	18	330254.7	330349.8	52.2	1627.2	-0.998	-0.725	-171.990
2017062117	19	330547.5	330655.8	51.3	1687.3	-0.144	4.012	-4.074
2017062117	20	330791.2	330908.8	50.6	1703.3	-0.358	0.234	-170.146
2017062117	21	331076.5	331192.8	51.7	1755.1	-0.902	3.855	-3.757
2017062117	22	331324.4	331428.8	52.7	1822.5	-0.312	0.884	-171.489
2017062117	23	331585.6	331687.8	52.8	1874.7	-0.953	3.789	-4.239
2017062117	24	331823.4	331931.8	51.1	1887.0	-0.827	0.720	-170.506
2017062117	25	332097.7	332205.8	50.9	1978.5	-0.689	3.914	-4.435
2017062117	26	332364.5	332467.8	51.8	1969.7	-1.495	2.390	-166.331
2017062117	27	332672.2	332768.8	52.0	1963.8	-0.733	3.468	-4.733
2017062117	28	332924.6	333023.8	52.7	2045.7	-0.737	4.737	-167.093
2017062117	29	333226.3	333228.5	52.9	2074.4	-1.375	2.394	-4.928
2017062117	30	333240.6	333320.8	51.1	2058.6	-0.733	3.537	-5.665
2017062117	31	333475.4	333581.8	51.6	2052.1	0.197	3.142	-170.032
2017062117	32	333745.7	333748.2	50.4	2046.3	-5.262	6.643	-5.773
2017062117	33	333768.4	333851.8	52.6	2051.4	-1.072	2.994	-6.033
2017062117	34	333985.3	334091.8	53.3	1991.6	0.033	1.067	-168.671
2017062117	35	334441.6	334963.9	51.5	1676.4	-0.532	4.642	-82.815
2017062117	36	335353.3	335462.9	50.8	1423.1	1.178	-0.575	-152.789
2017062117	37	335630.6	335734.9	52.8	1379.2	-0.122	3.926	-3.801
2017062122	1	340649.4	340658.7	56.9	1100.2	-0.666	7.304	74.202

2017062122	2	341803.2	342086.7	50.6	2127.9	1.075	4.498	-8.122
2017062122	3	342233.5	342504.7	53.2	2125.5	0.588	5.610	-168.193
2017062122	4	342669.2	342952.7	51.0	2077.5	1.144	4.242	-7.708
2017062122	5	343099.5	343375.7	52.1	2087.2	1.262	3.099	-167.509
2017062122	6	343515.3	343807.7	50.0	2086.7	0.513	4.133	-7.358
2017062122	7	343940.6	344214.7	52.6	1989.8	0.612	1.411	-173.002
2017062122	8	344355.4	344640.7	50.7	1986.0	0.075	4.275	-4.555
2017062122	9	344763.2	345041.7	51.9	1964.8	0.628	1.539	-166.134
2017062122	10	345164.5	345460.7	49.3	1956.5	-0.284	4.260	-3.618
2017062122	11	345578.3	345848.7	53.8	1936.4	-0.268	2.902	-151.687
2017062122	12	345985.6	346272.7	50.5	1939.8	-0.318	3.834	-1.986
2017062122	13	346406.3	346679.7	52.5	1927.1	-0.089	4.306	-158.348
2017062122	14	346999.6	347401.7	52.0	1697.7	0.026	1.765	83.658
2017062122	15	347577.4	347706.7	52.1	1419.1	1.353	1.241	-127.674
2017062122	16	347864.1	347988.7	53.4	1471.2	-0.527	4.004	-4.259
2017062122	17	348122.4	348250.7	51.4	1562.7	-0.014	2.399	-174.345
2017062122	18	348376.2	348505.7	51.9	1559.5	-0.037	4.415	-3.489
2017062215	1	402967.9	402990.0	68.6	1696.2	-1.751	1.215	78.776
2017062215	2	403177.7	403217.0	66.1	1694.7	-6.052	1.394	34.341
2017062215	3	403980.4	404498.0	51.4	1685.3	0.101	1.430	91.740
2017062215	4	404778.9	404885.0	51.5	1837.9	0.278	4.068	176.897
2017062215	5	405225.5	405331.0	50.9	1988.1	0.058	1.893	0.573
2017062215	6	405492.7	405587.0	53.0	2045.0	0.038	2.646	181.225
2017062215	7	405762.5	405776.9	52.4	2059.9	1.310	-0.096	1.753
2017062215	8	405801.8	405865.0	51.5	2052.6	-0.162	1.514	-0.313
2017062215	9	406020.6	406123.0	52.9	2050.5	0.808	3.038	179.761
2017062215	10	406290.4	406392.0	53.3	1976.4	0.016	1.053	2.708
2017062215	11	406554.7	406659.0	50.6	1953.5	0.327	3.853	178.877
2017062215	12	407050.5	407301.0	52.0	1662.6	0.006	1.930	7.608
2017062215	13	407464.8	407714.0	53.0	1690.9	0.216	1.349	173.856
2017062215	14	408017.6	408025.0	60.4	1690.0	0.146	1.262	-78.975
2017062215	15	408182.9	408427.0	54.0	1690.9	-0.066	0.994	6.079
2017062215	16	408606.7	408854.0	52.6	1718.0	-0.049	1.627	174.932
2017062215	17	409024.0	409272.0	51.9	1719.7	-0.051	1.491	5.465
2017062215	18	409443.8	409694.0	52.4	1718.7	-0.004	1.873	175.351

2017062215	19	409850.5	410108.0	51.4	1748.9	0.079	1.618	4.613
2017062215	20	410305.8	410532.0	52.2	1746.9	0.164	1.700	175.767
2017062215	21	410688.6	410937.0	51.7	1780.2	0.052	1.667	3.883
2017062215	22	411104.9	411362.0	51.1	1776.6	0.164	1.977	176.632
2017062215	23	411525.7	411782.0	51.4	1842.6	0.233	1.781	2.750
2017062215	24	411937.0	412193.0	51.5	1843.1	0.212	1.948	177.798
2017062215	25	412439.8	412447.0	75.9	1413.6	-0.679	-0.585	-110.864
2017062215	26	412651.5	412874.0	52.5	1319.6	0.210	1.549	4.934
2017062215	27	413040.8	413283.0	52.5	1325.4	-0.032	2.080	175.976
2017062215	28	413448.6	413681.0	52.2	1387.3	-0.136	1.910	4.446
2017062215	29	413842.9	414077.0	51.6	1406.9	0.068	2.637	175.784
2017062215	30	414259.7	414507.0	49.9	1659.6	0.003	2.353	4.482
2017062215	31	414685.9	414921.0	51.8	1595.7	0.323	2.931	176.193
2017062215	32	415084.8	415326.0	50.7	1596.1	0.075	2.134	4.009
2017062215	33	415559.7	415847.0	51.7	1783.7	0.277	1.147	-86.711
2017062215	34	416076.8	416305.0	52.8	1323.9	0.178	1.003	177.128
2017062215	35	416474.6	416719.0	50.8	1329.6	0.051	-0.125	3.026
2017062215	36	416871.9	417104.0	52.2	1320.5	0.406	0.964	177.067
2017062220	1	421435.7	421449.1	53.1	1051.7	-3.820	8.042	31.857
2017062220	2	422368.9	422621.1	52.7	1316.3	0.242	2.335	156.580
2017062220	3	422764.7	423026.1	51.7	1319.9	-0.049	1.138	1.387
2017062220	4	423175.5	423430.1	51.6	1314.6	0.094	2.140	156.437
2017062220	5	423568.8	423837.1	50.1	1323.1	-0.300	0.201	0.851
2017062220	6	423991.6	424262.1	50.0	1325.5	0.195	2.091	97.723
2017062220	7	424419.9	424693.1	49.2	1331.9	-0.187	0.449	0.558
2017062220	8	424843.7	425094.1	53.6	1326.0	-0.375	0.949	66.047
2017062220	9	425250.0	425513.1	51.4	1333.9	0.023	-0.300	0.149
2017062220	10	425671.8	425921.1	54.1	1324.8	-0.040	0.832	64.684
2017062220	11	426072.1	426347.1	49.2	1337.2	-0.132	0.217	-0.097
2017062220	12	426462.9	426720.1	52.3	1312.9	0.144	1.399	97.901
2017062220	13	426861.6	427124.1	48.3	1315.0	-0.015	1.026	-0.555
2017062220	14	427248.9	427500.1	53.3	1313.1	-0.016	2.195	66.242
2017062220	15	427636.7	427905.1	50.4	1323.4	-0.694	0.658	-0.635
2017062220	16	428018.0	428268.1	53.0	1497.9	-0.428	2.923	76.422
2017062220	17	428432.8	428705.1	49.2	1506.3	-0.771	1.865	0.524

2017062220	18	428825.1	429080.1	52.4	1565.5	-0.114	3.349	64.906
2017062220	19	429274.8	429540.1	50.5	1576.3	-0.332	1.555	-0.072
2017062220	20	429728.6	429970.1	55.6	1626.4	-0.237	2.533	88.480
2017062220	21	430157.9	430421.1	50.9	1659.3	-0.296	1.378	0.971
2017062220	22	430572.7	430812.1	55.8	1658.4	-0.218	2.121	106.884
2017062220	23	430951.0	431220.1	49.9	1515.2	-0.223	1.420	-0.412
2017062220	24	431363.8	431611.1	53.9	1504.0	-0.156	2.397	35.195
2017062220	25	431774.0	432036.1	50.6	1569.8	-0.312	1.555	0.222
2017062220	26	432146.8	432402.1	52.5	1560.2	0.010	3.120	112.036
2017062220	27	432542.6	432807.1	50.9	1663.5	-0.525	1.888	1.593
2017062220	28	432915.9	433176.1	51.6	1648.2	0.259	3.612	154.982
2017062220	29	433330.8	433591.1	51.2	1751.3	-0.475	1.609	2.423
2017062220	30	433724.1	433977.2	52.8	1839.4	0.303	3.345	177.802
2017062220	31	434118.9	434383.2	50.4	1900.0	-0.347	2.100	4.624
2017062220	32	434532.1	434785.2	52.3	1897.4	0.307	3.145	176.838
2017062220	33	435067.9	435367.2	54.1	1778.6	-0.691	1.523	-83.063

Table 12: Average trajectory error statistics

Strip ID	Start [s]	Stop [s]	Roll std.dev. [deg]	Pitch std.dev. [deg]	Heading std.dev. [deg]	East std.dev. [m]	North std.dev. [m]	Height std.dev. [m]
1	146711.4	146722.6	0.006	0.006	0.022	0.012	0.013	0.016
2	147637.1	147913.6	0.005	0.005	0.018	0.011	0.014	0.016
3	148070.4	148353.6	0.005	0.005	0.019	0.011	0.013	0.015
4	148477.2	148750.6	0.005	0.005	0.018	0.011	0.013	0.015
5	148931.5	149231.6	0.005	0.005	0.019	0.011	0.013	0.015
6	149387.3	149654.7	0.005	0.005	0.018	0.011	0.012	0.016
7	149810.6	150112.6	0.005	0.005	0.018	0.011	0.012	0.016
8	150233.3	150507.7	0.005	0.005	0.018	0.011	0.011	0.016
9	150622.2	150914.6	0.005	0.005	0.017	0.010	0.011	0.016
10	151037.5	151311.6	0.005	0.005	0.017	0.010	0.011	0.016
11	151429.2	151716.7	0.005	0.005	0.018	0.010	0.011	0.016
12	151838.5	152115.7	0.005	0.005	0.017	0.010	0.011	0.017
13	152259.3	152551.7	0.005	0.005	0.017	0.010	0.011	0.017
14	152692.6	152966.7	0.005	0.005	0.017	0.010	0.011	0.017
15	153099.4	153383.7	0.005	0.005	0.018	0.010	0.011	0.017
16	153523.1	153797.7	0.005	0.005	0.016	0.010	0.012	0.018
17	153926.4	154213.7	0.005	0.005	0.018	0.010	0.012	0.018
18	154349.2	154622.7	0.005	0.005	0.017	0.010	0.012	0.018
19	154765.5	155053.7	0.005	0.005	0.018	0.010	0.013	0.017
20	155169.3	155448.7	0.005	0.005	0.018	0.010	0.013	0.017
21	155586.6	155871.7	0.005	0.005	0.018	0.010	0.013	0.017
22	155985.3	156267.7	0.005	0.005	0.017	0.009	0.013	0.017
23	156396.6	156674.7	0.005	0.005	0.018	0.009	0.013	0.017
24	156790.4	157066.7	0.005	0.005	0.018	0.009	0.013	0.017
25	157206.2	157492.7	0.005	0.005	0.018	0.010	0.014	0.017
26	157606.5	157884.7	0.005	0.005	0.020	0.010	0.014	0.018
27	158025.3	158319.7	0.006	0.006	0.019	0.010	0.014	0.019
28	158487.6	158754.7	0.005	0.005	0.020	0.011	0.015	0.019
29	159065.4	159102.1	0.006	0.006	0.016	0.012	0.015	0.020
30	159123.6	159362.7	0.006	0.006	0.017	0.012	0.015	0.020
1	323547.4	323551.3	0.007	0.006	0.022	0.010	0.012	0.019
2	323860.7	323901.8	0.006	0.005	0.018	0.010	0.011	0.018

3	324833.5	325095.8	0.005	0.005	0.018	0.010	0.012	0.019
4	325266.3	325503.8	0.005	0.005	0.018	0.010	0.012	0.019
5	325877.5	326139.8	0.005	0.005	0.018	0.010	0.012	0.018
6	326300.4	326566.8	0.005	0.005	0.019	0.011	0.012	0.018
7	326769.7	327023.8	0.005	0.005	0.019	0.011	0.012	0.019
8	327176.4	327428.8	0.005	0.005	0.020	0.012	0.013	0.019
9	327602.7	327848.8	0.005	0.005	0.019	0.012	0.013	0.020
10	327999.5	328249.8	0.005	0.005	0.021	0.013	0.014	0.020
11	328407.7	328507.8	0.005	0.005	0.016	0.011	0.013	0.015
12	328651.5	328754.8	0.005	0.005	0.017	0.011	0.013	0.015
13	328911.3	329010.8	0.005	0.005	0.017	0.011	0.013	0.015
14	329171.5	329279.8	0.005	0.005	0.018	0.011	0.013	0.016
15	329442.3	329552.8	0.005	0.005	0.018	0.011	0.013	0.015
16	329698.6	329806.8	0.005	0.005	0.019	0.011	0.013	0.016
17	329969.4	330076.8	0.005	0.005	0.018	0.011	0.013	0.016
18	330254.7	330349.8	0.005	0.005	0.018	0.011	0.013	0.017
19	330547.5	330655.8	0.005	0.005	0.016	0.010	0.012	0.018
20	330791.2	330908.8	0.005	0.005	0.018	0.010	0.012	0.018
21	331076.5	331192.8	0.005	0.005	0.016	0.010	0.012	0.018
22	331324.4	331428.8	0.005	0.005	0.017	0.010	0.012	0.019
23	331585.6	331687.8	0.005	0.005	0.017	0.010	0.012	0.019
24	331823.4	331931.8	0.005	0.005	0.017	0.010	0.012	0.019
25	332097.7	332205.8	0.005	0.005	0.017	0.010	0.012	0.019
26	332364.5	332467.8	0.006	0.005	0.017	0.010	0.012	0.020
27	332672.2	332768.8	0.005	0.005	0.017	0.010	0.012	0.020
28	332924.6	333023.8	0.005	0.005	0.016	0.010	0.012	0.020
29	333226.3	333228.5	0.004	0.004	0.015	0.010	0.012	0.019
30	333240.6	333320.8	0.004	0.004	0.014	0.010	0.012	0.020
31	333475.4	333581.8	0.005	0.005	0.015	0.010	0.012	0.020
32	333745.7	333748.2	0.005	0.005	0.015	0.010	0.012	0.020
33	333768.4	333851.8	0.004	0.005	0.015	0.010	0.012	0.020
34	333985.3	334091.8	0.005	0.005	0.016	0.010	0.012	0.020
35	334441.6	334963.9	0.005	0.005	0.021	0.012	0.012	0.020
36	335353.3	335462.9	0.006	0.005	0.017	0.011	0.014	0.020
37	335630.6	335734.9	0.005	0.005	0.017	0.012	0.014	0.020

1	340649.4	340658.7	0.005	0.005	0.016	0.014	0.013	0.016
2	341803.2	342086.7	0.005	0.005	0.017	0.013	0.014	0.017
3	342233.5	342504.7	0.005	0.005	0.017	0.013	0.014	0.018
4	342669.2	342952.7	0.005	0.005	0.016	0.013	0.014	0.019
5	343099.5	343375.7	0.005	0.005	0.017	0.013	0.014	0.019
6	343515.3	343807.7	0.005	0.005	0.015	0.013	0.014	0.020
7	343940.6	344214.7	0.005	0.005	0.017	0.013	0.014	0.020
8	344355.4	344640.7	0.005	0.005	0.016	0.013	0.013	0.020
9	344763.2	345041.7	0.005	0.005	0.016	0.013	0.014	0.021
10	345164.5	345460.7	0.005	0.005	0.016	0.013	0.013	0.021
11	345578.3	345848.7	0.005	0.005	0.016	0.013	0.014	0.021
12	345985.6	346272.7	0.005	0.005	0.017	0.013	0.014	0.021
13	346406.3	346679.7	0.005	0.005	0.017	0.013	0.014	0.021
14	346999.6	347401.7	0.005	0.006	0.018	0.015	0.013	0.021
15	347577.4	347706.7	0.005	0.005	0.015	0.015	0.015	0.021
16	347864.1	347988.7	0.005	0.005	0.016	0.015	0.015	0.021
17	348122.4	348250.7	0.005	0.005	0.017	0.015	0.015	0.021
18	348376.2	348505.7	0.005	0.005	0.018	0.015	0.015	0.021
1	402967.9	402990.0	0.005	0.005	0.014	0.012	0.012	0.015
2	403177.7	403217.0	0.005	0.005	0.013	0.011	0.013	0.015
3	403980.4	404498.0	0.005	0.005	0.021	0.012	0.013	0.015
4	404778.9	404885.0	0.005	0.005	0.016	0.011	0.014	0.015
5	405225.5	405331.0	0.005	0.005	0.017	0.011	0.014	0.015
6	405492.7	405587.0	0.004	0.005	0.016	0.011	0.014	0.015
7	405762.5	405776.9	0.005	0.005	0.016	0.011	0.014	0.015
8	405801.8	405865.0	0.005	0.005	0.016	0.011	0.014	0.015
9	406020.6	406123.0	0.005	0.005	0.015	0.011	0.014	0.015
10	406290.4	406392.0	0.005	0.005	0.017	0.011	0.014	0.015
11	406554.7	406659.0	0.005	0.005	0.017	0.011	0.014	0.015
12	407050.5	407301.0	0.005	0.005	0.018	0.010	0.013	0.015
13	407464.8	407714.0	0.005	0.005	0.016	0.010	0.013	0.015
14	408017.6	408025.0	0.004	0.004	0.015	0.011	0.012	0.015
15	408182.9	408427.0	0.005	0.005	0.017	0.010	0.013	0.016
16	408606.7	408854.0	0.005	0.005	0.017	0.010	0.013	0.017
17	409024.0	409272.0	0.005	0.005	0.017	0.010	0.013	0.017

18	409443.8	409694.0	0.005	0.005	0.017	0.010	0.012	0.018
19	409850.5	410108.0	0.005	0.005	0.017	0.010	0.012	0.018
20	410305.8	410532.0	0.005	0.005	0.016	0.010	0.012	0.019
21	410688.6	410937.0	0.005	0.005	0.018	0.010	0.012	0.019
22	411104.9	411362.0	0.005	0.005	0.018	0.010	0.012	0.019
23	411525.7	411782.0	0.005	0.005	0.017	0.010	0.012	0.019
24	411937.0	412193.0	0.005	0.005	0.019	0.010	0.012	0.018
25	412439.8	412447.0	0.005	0.006	0.019	0.012	0.012	0.019
26	412651.5	412874.0	0.005	0.005	0.018	0.011	0.013	0.018
27	413040.8	413283.0	0.005	0.005	0.017	0.012	0.013	0.019
28	413448.6	413681.0	0.005	0.005	0.017	0.012	0.013	0.019
29	413842.9	414077.0	0.005	0.005	0.018	0.013	0.014	0.020
30	414259.7	414507.0	0.005	0.005	0.018	0.011	0.013	0.014
31	414685.9	414921.0	0.005	0.005	0.018	0.011	0.013	0.015
32	415084.8	415326.0	0.005	0.005	0.020	0.011	0.013	0.015
33	415559.7	415847.0	0.005	0.005	0.018	0.012	0.012	0.016
34	416076.8	416305.0	0.005	0.005	0.017	0.011	0.013	0.016
35	416474.6	416719.0	0.005	0.005	0.017	0.010	0.013	0.017
36	416871.9	417104.0	0.005	0.005	0.018	0.010	0.013	0.018
1	421435.7	421449.1	0.006	0.006	0.017	0.010	0.012	0.019
2	422368.9	422621.1	0.005	0.005	0.019	0.010	0.013	0.019
3	422764.7	423026.1	0.005	0.005	0.019	0.010	0.013	0.018
4	423175.5	423430.1	0.005	0.005	0.019	0.010	0.013	0.018
5	423568.8	423837.1	0.005	0.005	0.019	0.010	0.013	0.018
6	423991.6	424262.1	0.005	0.005	0.019	0.010	0.013	0.018
7	424419.9	424693.1	0.005	0.005	0.019	0.010	0.013	0.018
8	424843.7	425094.1	0.005	0.005	0.018	0.010	0.013	0.018
9	425250.0	425513.1	0.005	0.005	0.019	0.010	0.013	0.018
10	425671.8	425921.1	0.005	0.005	0.018	0.011	0.013	0.018
11	426072.1	426347.1	0.005	0.005	0.018	0.011	0.013	0.018
12	426462.9	426720.1	0.005	0.005	0.020	0.011	0.014	0.018
13	426861.6	427124.1	0.005	0.005	0.019	0.011	0.013	0.017
14	427248.9	427500.1	0.005	0.005	0.019	0.011	0.013	0.017
15	427636.7	427905.1	0.005	0.005	0.019	0.011	0.013	0.018
16	428018.0	428268.1	0.005	0.005	0.019	0.012	0.013	0.018

17	428432.8	428705.1	0.005	0.005	0.018	0.012	0.014	0.019
18	428825.1	429080.1	0.005	0.005	0.019	0.012	0.014	0.020
19	429274.8	429540.1	0.005	0.005	0.019	0.013	0.014	0.020
20	429728.6	429970.1	0.005	0.005	0.018	0.011	0.013	0.017
21	430157.9	430421.1	0.005	0.005	0.018	0.011	0.013	0.016
22	430572.7	430812.1	0.005	0.005	0.017	0.011	0.012	0.016
23	430951.0	431220.1	0.005	0.005	0.019	0.011	0.012	0.017
24	431363.8	431611.1	0.005	0.005	0.017	0.011	0.012	0.017
25	431774.0	432036.1	0.005	0.005	0.019	0.011	0.012	0.017
26	432146.8	432402.1	0.005	0.005	0.018	0.011	0.012	0.017
27	432542.6	432807.1	0.005	0.005	0.018	0.011	0.012	0.017
28	432915.9	433176.1	0.005	0.005	0.018	0.011	0.012	0.017
29	433330.8	433591.1	0.005	0.005	0.017	0.011	0.012	0.018
30	433724.1	433977.2	0.005	0.005	0.017	0.011	0.011	0.018
31	434118.9	434383.2	0.005	0.005	0.016	0.011	0.011	0.018
32	434532.1	434785.2	0.005	0.005	0.018	0.011	0.011	0.018
33	435067.9	435367.2	0.005	0.005	0.018	0.012	0.010	0.019

5 LiDAR Acquisition Parameters

Table 13 contains information on the acquisition settings used during the LiDAR survey for all lines collected.

Table 13: LiDAR acquisition settings

Line	Start Time (s)	End Time (s)	PRF (kHz)	Scan Angle (^{o})	Scan Freq (Hz)	Beam Div (mRad)
L0001-1	159198	159362	70	18	41	0.8
L0001-2	334667	334895	70	18	41	0.8
L0001-3	334466	334610	70	18	41	0.8
L0001-4	404312	404324	70	18	41	0.8
L0001-5	404022	404272	70	18	41	0.8
L0001-6	404347	404477	70	18	41	0.8
L0002-1	334043	334082	100	18	50	0.8
L0002-2	405245	405323	100	18	50	0.8
L0003-1	333770	333845	100	18	50	0.8
L0003-2	405506	405580	100	18	50	0.8
L0004-1	333242	333315	100	18	50	0.8
L0004-2	405803	405859	100	18	50	0.8
L0005-1	333498	333575	100	18	50	0.8
L0005-2	332945	333018	100	18	50	0.8
L0005-3	406041	406115	100	18	50	0.8
L0006-1	332686	332761	100	18	50	0.8
L0006-2	406311	406384	100	18	50	0.8
L0007-1	332387	332461	100	18	50	0.8
L0007-2	406572	406650	100	18	50	0.8
L0008-1	332122	332200	100	18	50	0.8
L0009-1	331847	331924	100	18	50	0.8
L0010-1	331606	331680	100	18	50	0.8
L0011-1	331346	331421	100	18	50	0.8
L0012-1	331108	331185	100	18	50	0.8
L0013-1	330825	330903	100	18	50	0.8
L0014-1	330572	330649	100	18	50	0.8
L0015-1	330268	330343	100	18	50	0.8
L0016-1	329995	330070	100	18	50	0.8
L0017-1	329722	329800	100	18	50	0.8
L0018-1	329465	329546	100	18	50	0.8

L0019-1	329192	329274	100	18	50	0.8
L0020-1	328928	329005	100	18	50	0.8
L0021-1	328674	328748	100	18	50	0.8
L0022-1	328460	328464	100	18	50	0.8
L0022-2	328426	328454	100	18	50	0.8
L0023-1	335354	335462	100	18	50	0.8
L0023-2	328007	328244	70	18	39	0.8
L0024-1	327620	327843	70	18	39	0.8
L0025-1	327192	327422	70	18	39	0.8
L0026-1	326793	327017	70	18	39	0.8
L0027-1	326323	326559	70	18	39	0.8
L0028-1	325899	326134	70	18	39	0.8
L0029-1	325284	325498	70	18	39	0.8
L0030-1	324856	325089	70	18	39	0.8
L0031-1	147683	147908	70	18	39	0.8
L0032-1	148121	148349	70	18	39	0.8
L0033-1	148524	148744	70	18	39	0.8
L0034-1	148988	149225	70	18	39	0.8
L0035-1	149435	149650	70	18	39	0.8
L0036-1	149869	150106	70	18	39	0.8
L0037-1	150278	150501	70	18	39	0.8
L0038-1	150679	150909	70	18	39	0.8
L0039-1	151083	151306	70	18	39	0.8
L0040-1	151483	151710	70	18	39	0.8
L0040-2	407071	407295	70	18	39	0.8
L0041-1	151881	152108	70	18	39	0.8
L0041-2	407488	407707	70	18	39	0.8
L0042-1	152312	152544	70	18	39	0.8
L0042-2	408203	408419	70	18	39	0.8
L0043-1	152743	152960	70	18	39	0.8
L0043-2	408627	408847	70	18	39	0.8
L0044-1	153153	153376	70	18	39	0.8
L0044-2	409041	409266	70	18	39	0.8
L0045-1	153569	153791	70	18	39	0.8
L0045-2	409464	409686	70	18	39	0.8

L0046-1	153979	154207	70	18	39	0.8
L0046-2	409873	410101	70	18	39	0.8
L0047-1	154396	154617	70	18	39	0.8
L0047-2	410307	410525	70	18	39	0.8
L0048-1	154814	155047	70	18	39	0.8
L0048-2	410704	410930	70	18	39	0.8
L0049-1	155213	155442	70	18	39	0.8
L0049-2	411126	411355	70	18	39	0.8
L0050-1	155636	155865	70	18	39	0.8
L0050-2	411547	411774	70	18	39	0.8
L0051-1	156029	156259	70	18	39	0.8
L0051-2	411960	412186	70	18	39	0.8
L0052-1	156442	156668	70	18	39	0.8
L0053-1	156837	157059	70	18	39	0.8
L0054-1	157256	157485	70	18	39	0.8
L0055-1	157653	157878	70	18	39	0.8
L0056-1	158080	158313	70	18	39	0.8
L0058-1	341838	342084	70	18	39	0.8
L0059-1	342279	342504	70	18	39	0.8
L0060-1	342707	342949	70	18	39	0.8
L0061-1	343140	343375	70	18	39	0.8
L0062-1	343560	343804	70	18	39	0.8
L0063-1	343981	344214	70	18	39	0.8
L0064-1	344397	344638	70	18	39	0.8
L0065-1	344807	345041	70	18	39	0.8
L0066-1	345219	345458	70	18	39	0.8
L0067-1	345623	345848	70	18	39	0.8
L0068-1	346030	346269	70	18	39	0.8
L0069-1	346437	346679	70	18	39	0.8
L0070-1	347040	347116	70	18	41	0.8
L0071-1	347118	347325	70	18	41	0.8
L0072-1	347350	347384	70	18	41	0.8
L0073-1	347615	347706	100	18	50	0.8
L0074-1	347898	347988	100	18	50	0.8
L0075-1	348158	348250	100	18	50	0.8

L0076-1	348412	348505	100	18	50	0.8
L0077-1	335632	335734	100	18	50	0.8
L0078-1	404780	404884	50	18	50	0.8

6 LiDAR Decode Shot Statistics

Table 14 contains the decoded laser shot statistics for all lines collected. Within Table 14, we would expect that the number of returns reduces as the return number increases. For example, if the number of third returns and number of fourth returns are nearly equal, this indicates a potential error in the LiDAR processing.

Table 14: Laser shot statistics

Line	Number 1st returns	Number 2nd returns	Number 3rd returns	Number 4th returns
L0001-1	11535841	5781625	1951155	400542
L0001-2	16071242	7913092	2594972	514742
L0001-3	10191624	6514656	2972748	903723
L0001-4	852795	469965	200024	63851
L0001-5	17641046	8968298	3155672	694201
L0001-6	9234999	5894238	2684603	806747
L0002-1	3800272	1620802	375275	38783
L0002-2	7680259	3551414	965962	137918
L0003-1	7374626	3382065	912897	114293
L0003-2	7271533	3375894	895667	107431
L0004-1	7201494	3253698	886675	104989
L0004-2	5551143	2637039	759250	94347
L0005-1	7559992	3400634	892799	104943
L0005-2	7167384	3209946	845413	101798
L0005-3	7311062	3274164	863813	102375
L0006-1	7422074	3417408	999772	142366
L0006-2	7211899	3302144	949319	128887
L0007-1	7301884	3423282	991255	136084
L0007-2	7704028	3650064	1081600	156350
L0008-1	7633446	3407052	930417	123792
L0009-1	7613645	3674803	1112112	178158
L0010-1	7254464	3438070	1013342	161658
L0011-1	7402738	3595653	1073074	176805
L0012-1	7569143	3610897	1101716	192968
L0013-1	7719045	3616181	1093116	193694
L0014-1	7558447	3535953	1010951	159972
L0015-1	7396534	3592837	1096229	199239
L0016-1	7443272	3661851	1138655	212993
L0017-1	7714788	3749529	1111087	193774

L0018-1	8049822	3976348	1237151	226003
L0019-1	8105754	4133188	1300795	241453
L0020-1	7575790	3458673	970352	162793
L0021-1	7308615	3309340	916031	152867
L0022-1	441776	215207	60767	9838
L0022-2	2730764	1176283	285624	35138
L0023-1	10540602	4828683	1527044	312370
L0023-2	16770731	8822239	3508887	932332
L0024-1	15746439	8022152	3125350	806212
L0025-1	16306554	8458492	3424477	934997
L0026-1	15851256	8080982	3216361	848307
L0027-1	16602052	8582201	3425537	906151
L0028-1	16493215	8593087	3385741	881653
L0029-1	15112653	8214759	3292304	861567
L0030-1	16491279	9055613	3603311	910697
L0031-1	15888585	8534289	3319844	821280
L0032-1	16090119	8792703	3443211	853513
L0033-1	15518158	8678790	3415703	853288
L0034-1	16780346	9785128	3898538	975311
L0035-1	15210828	9006831	3659301	935717
L0036-1	16713896	9942464	4060445	1047501
L0037-1	15712550	9049372	3551880	870273
L0038-1	16276103	9234247	3613175	885400
L0039-1	15736513	8756785	3317486	777721
L0040-1	16082250	8890826	3368659	791994
L0040-2	15853132	8989907	3565922	897510
L0041-1	16067494	8950460	3389636	801717
L0041-2	15514677	8918494	3527061	882194
L0042-1	16469396	9209048	3513675	843479
L0042-2	15352040	8798678	3495106	888696
L0043-1	15375099	8436204	3146509	730072
L0043-2	15632294	8859728	3450005	848146
L0044-1	15801357	8715887	3265833	770823
L0044-2	15957876	9022272	3532145	885081
L0045-1	15706329	8639955	3240493	758457

L0045-2	15754630	8985554	3529156	874667
L0046-1	16142308	8597559	3057901	663082
L0046-2	16154534	8874179	3300735	760732
L0047-1	15695054	8475431	3042612	661204
L0047-2	15492582	8624148	3238789	748469
L0048-1	16514814	8857093	3124413	664742
L0048-2	15992796	8802680	3224562	727161
L0049-1	16171712	8644492	3077850	673331
L0049-2	16224006	9053789	3413842	804127
L0050-1	16153785	8375076	2883936	605890
L0050-2	16036030	8535516	3070098	687650
L0051-1	16235456	8341074	2909439	631377
L0051-2	15965866	8461036	3071250	700035
L0052-1	15916580	7987302	2742971	594943
L0053-1	15711731	7758545	2710221	600815
L0054-1	16199258	7770744	2714165	601693
L0055-1	15896714	7529000	2577692	549686
L0056-1	16410849	7839844	2657606	546044
L0058-1	17418281	7330970	2273583	434608
L0059-1	15904505	7077967	2174499	400339
L0060-1	17172230	7940468	2597644	522843
L0061-1	16580223	8152909	2741312	558167
L0062-1	17213872	8270206	2744005	547038
L0063-1	16459247	8454265	3031986	650748
L0064-1	17102359	8635330	3045772	648758
L0065-1	16519313	8471993	3088497	696975
L0066-1	16906494	8174429	2830821	602435
L0067-1	15894064	7554654	2550415	509539
L0068-1	16870868	7904154	2584745	507522
L0069-1	17033398	8237914	2784725	575794
L0070-1	5452566	3009392	1232080	328744
L0071-1	14558857	7018499	2275026	443080
L0072-1	2444023	1369700	542905	148369
L0073-1	8884741	4223860	1286102	245094
L0074-1	8813936	4075472	1220626	237860

L0075-1	9008606	4241834	1284284	245431
L0076-1	9065215	4002121	1160129	208235
L0077-1	10034670	4578240	1416112	273411
L0078-1	5167168	3218249	1474143	486731

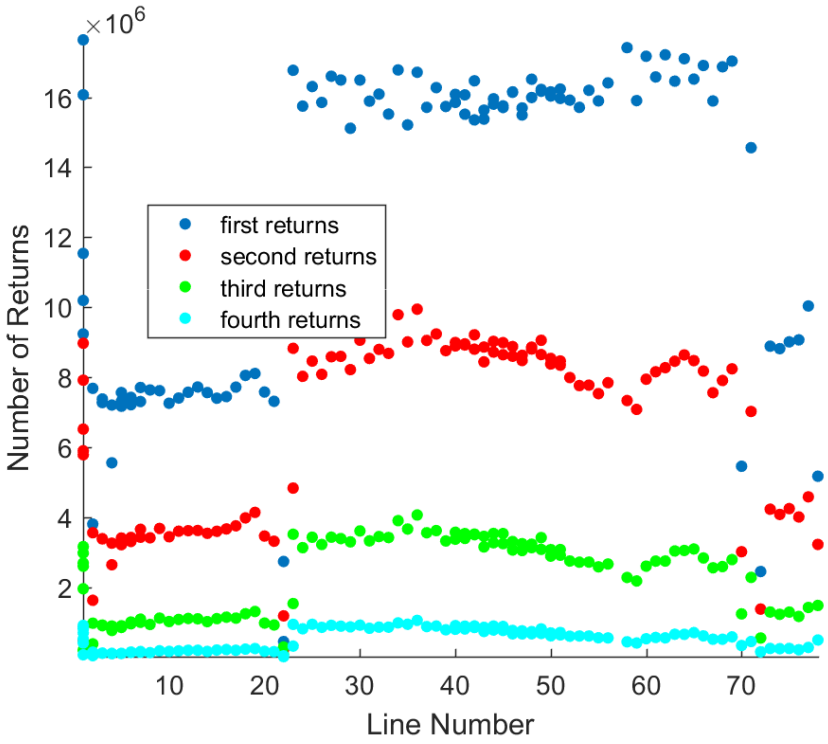

Figure 6: Number of Returns

7 Block Adjustment Results

Table 15 shows the orientation and elevation corrections applied to each output line to achieve refined processing results. These parameters are determined from an adjustment procedure, described in Section 3.2

Table 15: Block adjustment results

Line	Roll change (^{o})	Roll change st dev. (^{o})	Pitch change (^{o})	Pitch change st dev. (^{o})	Elev change (m)	Elev change st dev. (m)
L001-1	0.014924	0.000128	-0.006044	0.000390	0.046750	0.004260
L001-2	0.012470	0.000123	-0.001287	0.000341	-0.021420	0.004298
L001-3	0.007842	0.001073	-0.002699	0.002172	-0.078415	0.010119
L001-4	0.221511	0.159182	-5.054578	1.057694	0.000185	0.033895
L001-5	0.014996	0.000106	0.004402	0.000283	-0.004968	0.004256
L001-6	0.018373	0.000997	0.008769	0.002512	-0.029712	0.009397
L002-1	-0.002065	0.003555	0.003738	0.004918	-0.081893	0.012780
L002-2	-0.000095	0.004725	0.028405	0.006725	-0.009074	0.011324
L003-1	0.010417	0.000781	0.002809	0.001916	-0.043238	0.009176
L003-2	0.012153	0.000979	0.001514	0.001823	-0.025512	0.009676
L004-1	0.008533	0.000917	0.000009	0.002165	-0.046334	0.008648
L004-2	0.007574	0.000876	0.010946	0.001964	-0.053061	0.008556
L005-1	0.014235	0.002733	-0.007924	0.002717	0.038789	0.014637
L005-2	-0.013753	0.009503	-0.006067	0.002740	0.008421	0.017599
L005-3	0.001373	0.001405	-0.003086	0.002146	-0.010467	0.011090
L006-1	0.023531	0.002517	0.069719	0.005833	0.113027	0.013066
L006-2	0.023005	0.003092	0.019445	0.004858	0.058931	0.016937
L007-1	-0.088068	0.004661	0.184678	0.010442	-0.358672	0.027846
L007-2	0.073899	0.004956	-0.006203	0.005980	0.321282	0.024533
L008-1	0.016416	0.010223	-0.049074	0.013551	0.035557	0.030678
L009-1	0.027034	0.008935	0.048911	0.015922	-0.020151	0.032757
L010-1	0.016784	0.024260	-0.060739	0.030100	-0.001062	0.033882
L011-1	-0.025388	0.005639	-0.107046	0.023537	0.169762	0.029814
L012-1	-0.000087	0.010044	0.103434	0.026029	0.114869	0.022365
L013-1	0.051390	0.008752	-0.032376	0.007418	-0.041893	0.022792
L014-1	0.015622	0.002343	0.026391	0.005871	-0.084113	0.021821
L015-1	0.029902	0.004736	0.053062	0.006105	0.001247	0.009410
L016-1	0.030794	0.008970	-0.008766	0.008939	-0.020988	0.031497
L017-1	0.014470	0.002071	0.015843	0.008986	-0.014031	0.010189

L018-1	0.023389	0.002504	-0.005568	0.004637	0.000610	0.016553
L019-1	0.018464	0.003920	0.007207	0.003030	0.027976	0.016942
L020-1	0.013461	0.003136	-0.001800	0.003718	0.050432	0.012783
L021-1	0.019397	0.005024	0.015717	0.005052	-0.000347	0.032399
L022-2	-0.029497	0.054542	0.051438	0.045906	-0.002297	0.033872
L023-1	0.010152	0.000322	0.004759	0.000663	-0.086394	0.004557
L023-2	0.012227	0.000245	0.005054	0.000432	0.030977	0.004444
L024-1	0.015432	0.000163	0.002340	0.000425	0.022646	0.004329
L025-1	0.017724	0.000126	-0.000356	0.000393	0.034397	0.004286
L026-1	0.016086	0.000113	0.006363	0.000395	0.048108	0.004316
L027-1	0.016317	0.000121	-0.004158	0.000357	0.048431	0.004316
L028-1	0.015802	0.000124	0.002916	0.000425	0.015110	0.004358
L029-1	0.019227	0.000150	-0.003021	0.000511	0.056938	0.004296
L030-1	0.019327	0.000130	0.001808	0.000524	0.029901	0.004290
L031-1	0.022184	0.000148	0.003049	0.000559	0.021102	0.004318
L032-1	0.027366	0.000273	-0.006961	0.000802	-0.001514	0.004367
L033-1	0.013996	0.000302	0.001037	0.000785	-0.007053	0.004713
L034-1	0.026427	0.000404	-0.016996	0.001116	-0.076812	0.005312
L035-1	0.024227	0.000401	0.016628	0.001099	-0.064265	0.005749
L036-1	0.014333	0.000406	-0.002689	0.000693	-0.071271	0.005708
L037-1	0.026229	0.000387	-0.001238	0.000723	-0.028619	0.005268
L038-1	0.017374	0.000352	-0.005356	0.000688	-0.039920	0.004778
L039-1	0.018998	0.000306	0.002947	0.000665	-0.009050	0.004452
L040-1	0.017804	0.000282	-0.010056	0.000671	-0.018672	0.004430
L040-2	0.007395	0.000273	0.011294	0.000841	-0.010107	0.004499
L041-1	0.018354	0.000257	0.005785	0.000785	-0.028268	0.004468
L041-2	0.002548	0.000263	-0.004094	0.000776	-0.013059	0.004452
L042-1	0.018787	0.000277	-0.007293	0.000757	-0.015600	0.004463
L042-2	0.004680	0.000284	0.008958	0.000684	-0.013659	0.004504
L043-1	0.019673	0.000274	-0.000369	0.000567	-0.049819	0.004477
L043-2	0.005901	0.000265	0.004546	0.000633	-0.010722	0.004456
L044-1	0.019030	0.000266	-0.005591	0.000526	-0.025550	0.004451
L044-2	0.007243	0.000285	0.001818	0.000493	-0.020297	0.004447
L045-1	0.020256	0.000236	0.000132	0.000592	-0.055029	0.004429
L045-2	0.006425	0.000255	0.004122	0.000713	-0.046588	0.004467

L046-1	0.014975	0.000222	-0.009911	0.000608	-0.004530	0.004404
L046-2	0.008518	0.000217	0.003907	0.000591	-0.003203	0.004427
L047-1	0.021582	0.000252	0.000252	0.000735	0.001134	0.004404
L047-2	0.002798	0.000254	-0.001367	0.000675	-0.028101	0.004424
L048-1	0.015206	0.000260	-0.008163	0.000735	0.019489	0.004437
L048-2	0.012660	0.000266	0.002815	0.000719	-0.027018	0.004436
L049-1	0.018274	0.000251	-0.000343	0.000662	0.046470	0.004424
L049-2	0.008063	0.000258	0.001563	0.000669	-0.034057	0.004451
L050-1	0.018360	0.000220	-0.005117	0.000498	0.072733	0.004352
L050-2	0.008208	0.000226	0.003017	0.000581	-0.039048	0.004360
L051-1	0.019038	0.000191	0.002888	0.000572	0.042490	0.004358
L051-2	0.004036	0.000200	0.001039	0.000526	-0.016713	0.004390
L052-1	0.014616	0.000219	-0.004979	0.000543	0.070063	0.004345
L053-1	0.014081	0.000291	-0.004389	0.000782	0.043468	0.004391
L054-1	0.014614	0.000356	0.002563	0.000651	0.072326	0.004650
L055-1	0.015859	0.000281	-0.011611	0.000611	0.070651	0.004674
L056-1	0.016377	0.000282	0.004558	0.000491	0.054101	0.004656
L058-1	0.018675	0.000347	0.002833	0.000509	0.014078	0.004968
L059-1	0.011663	0.000289	-0.001749	0.000365	-0.002020	0.004864
L060-1	0.007447	0.000300	0.003532	0.000391	-0.005310	0.004922
L061-1	0.010069	0.000354	0.000022	0.000454	0.016791	0.005188
L062-1	0.008642	0.000375	0.003475	0.000510	-0.011683	0.005455
L063-1	0.011583	0.000423	0.002835	0.000527	0.025959	0.005716
L064-1	0.009313	0.000429	0.003311	0.000577	0.016875	0.005832
L065-1	0.004977	0.000401	-0.000002	0.000500	0.025117	0.005651
L066-1	0.013684	0.000346	0.003837	0.000496	0.012784	0.005312
L067-1	0.005747	0.000317	0.000868	0.000500	-0.012018	0.004762
L068-1	0.006548	0.000300	0.007027	0.000444	-0.038233	0.004668
L069-1	0.008103	0.000297	-0.001586	0.000509	0.054578	0.004533
L070-1	0.009608	0.000386	0.007614	0.000729	0.010883	0.004926
L071-1	0.007734	0.000102	0.005245	0.000283	-0.017425	0.004254
L072-1	0.056746	0.040514	-0.386053	0.561612	0.001005	0.033886
L073-1	-0.005039	0.003445	-0.036617	0.014423	-0.029155	0.018724
L074-1	0.017894	0.003593	0.039234	0.015557	0.000882	0.030371
L075-1	-0.038904	0.017892	0.033146	0.032705	0.007436	0.033855

L076-1	-0.004375	0.306080	-0.036070	0.717646	0.000079	0.033898
L077-1	0.014230	0.000713	-0.005316	0.001269	-0.066340	0.005915
L078-1	-0.256876	0.324586	0.240309	0.697601	-0.000079	0.033898

Roll outliers round 1: L078-1, L001-4
Pitch outliers round 1: L001-4
Elevation outliers round 1: L007-1, L007-2

Roll outliers round 2: L7-1 , L75-1 , L7-2
Pitch outliers round 2: L7-1 , L72-1 , L78-1
Elev outliers round 2: L 11

Roll outliers round 3: L11-1 , L13-1 , L72-1 , L22-2
Pitch outliers round 3: L11-1 , L12-1
No elevation outliers round 3.

Roll outliers round 4: L5-2
Pitch outliers round 4: L6-1 , L10-1
No elevation outliers round 4.

No roll outliers round 5.
Pitch outliers round 5: L8-1 , L9-1 , L15-1 , L22-2
No elevation outliers round 5.

No roll outliers round 6.
Pitch outliers round 6: L73-1 , L74-1 , L76-1
No elevation outliers round 6.

No roll outliers round 7.
Pitch outliers round 7: L13-1 , L75-1 , L2-2
No elevation outliers round 7.

No roll outliers round 8.
Pitch outliers round 8: L14-1
No elevation outliers round 8.

No roll outliers round 9.
No pitch outliers round 9.
No elevation outliers round 9.

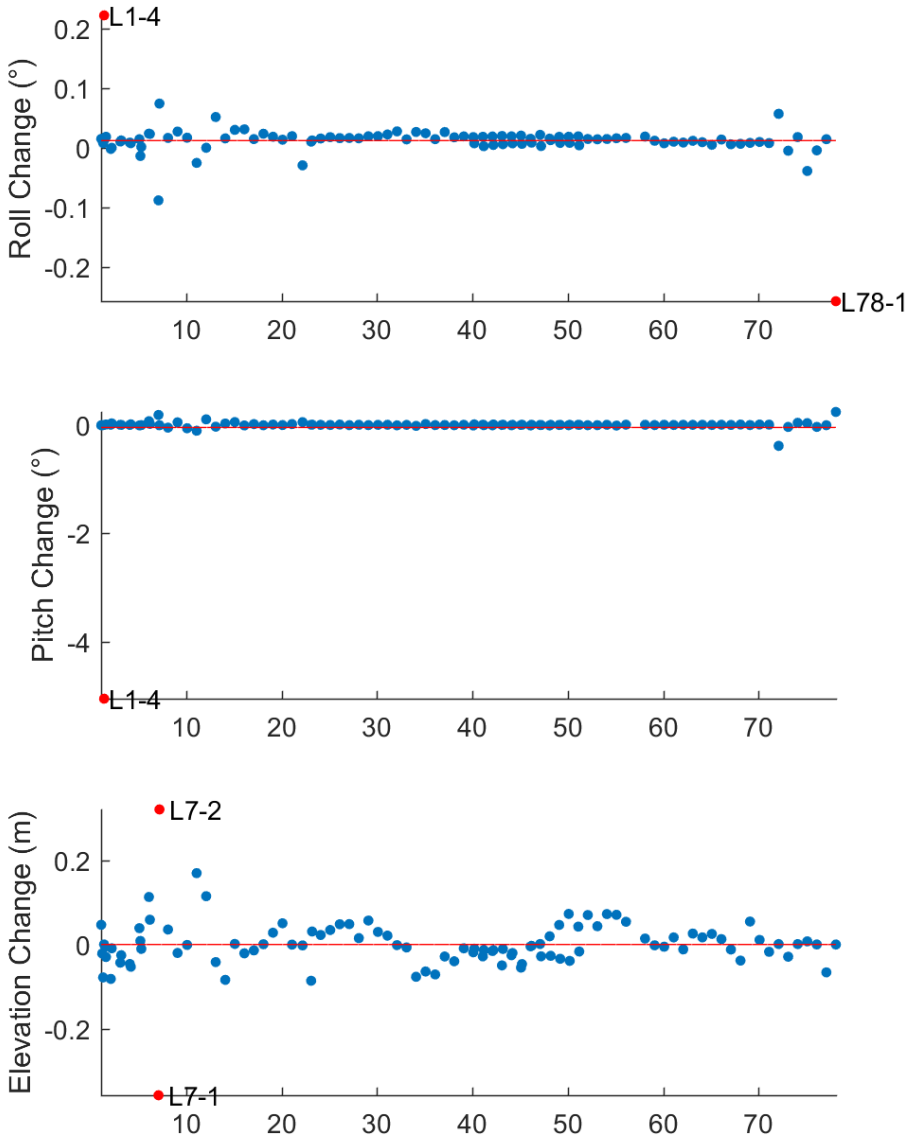

Figure 7: Block adjustments for roll, pitch, and elevation.

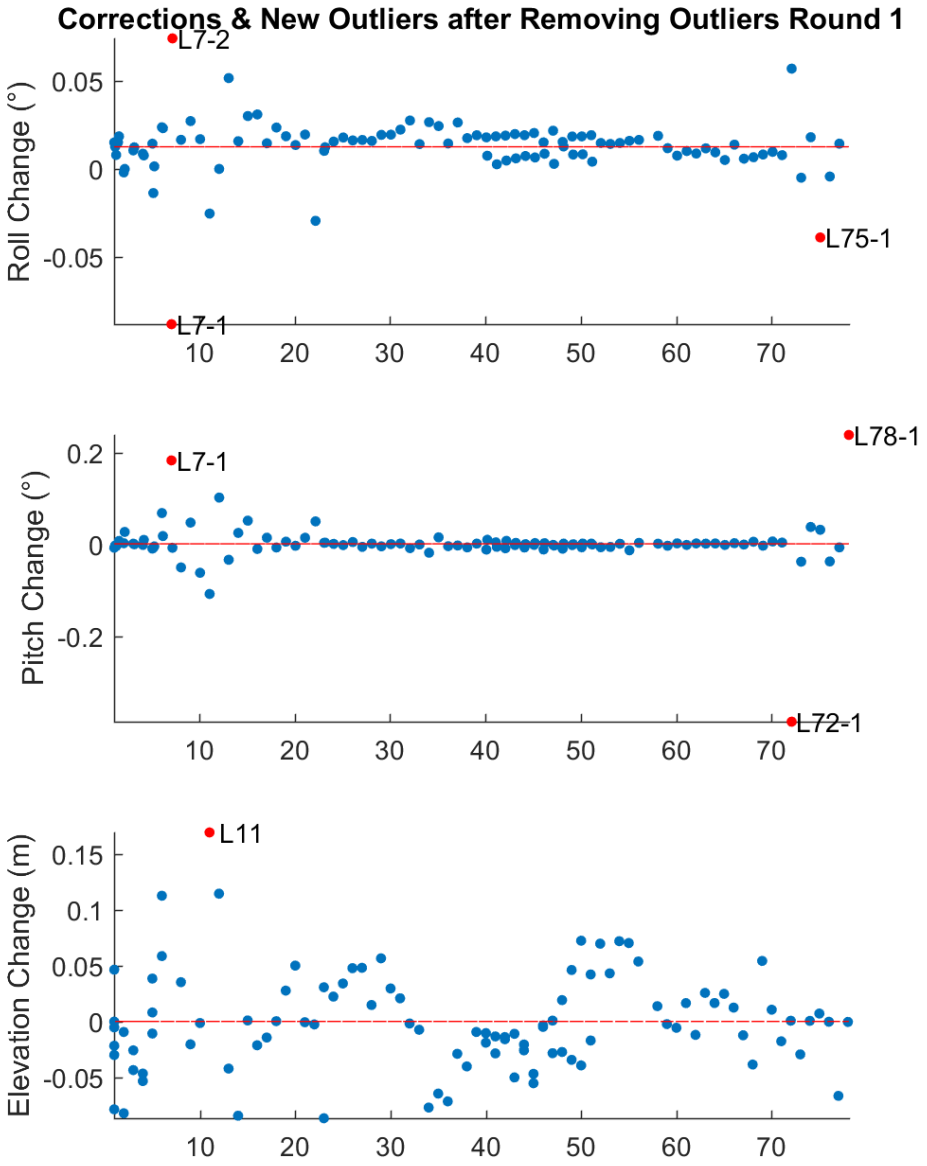

Figure 8: Block adjustments showing outliers (red points) once the 1st set of outliers were removed.

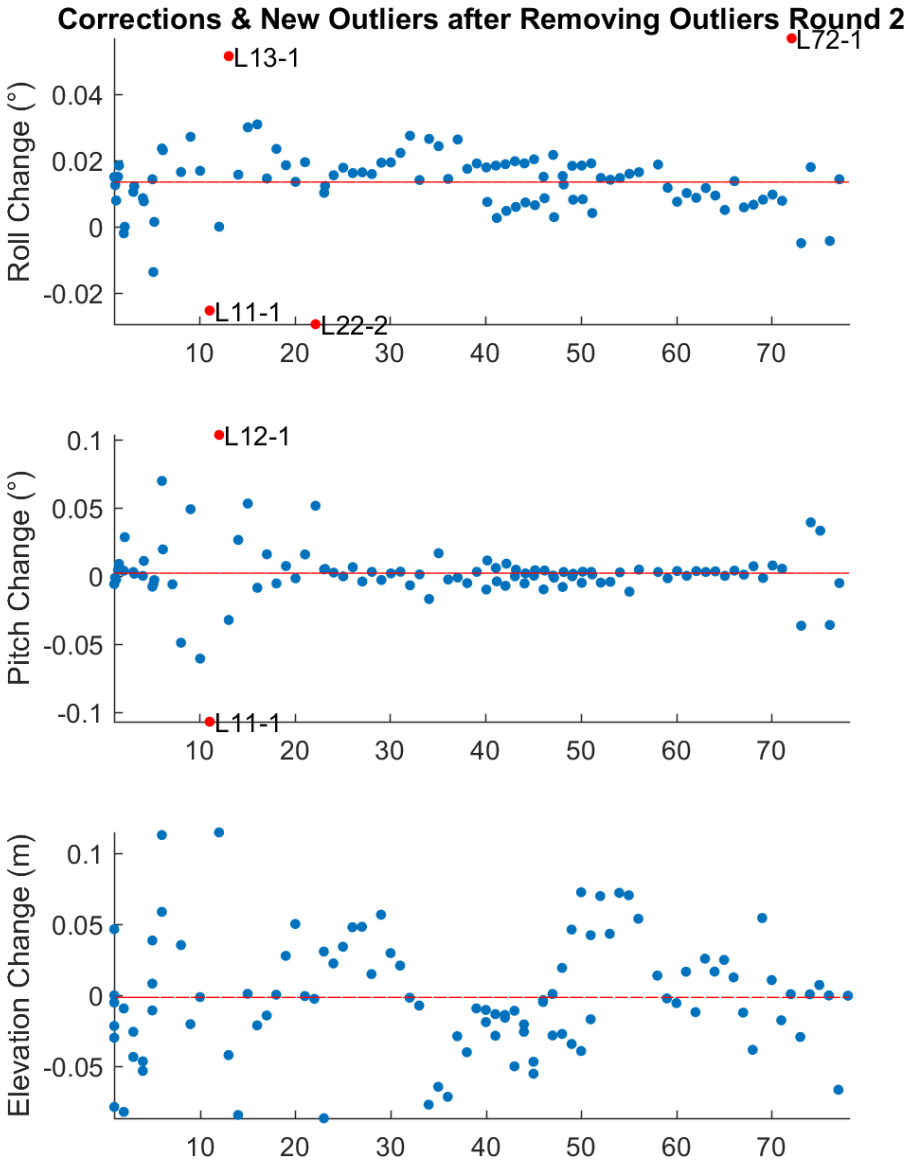

Figure 9: Block adjustments showing outliers (red points) once the 2nd set of outliers were removed.

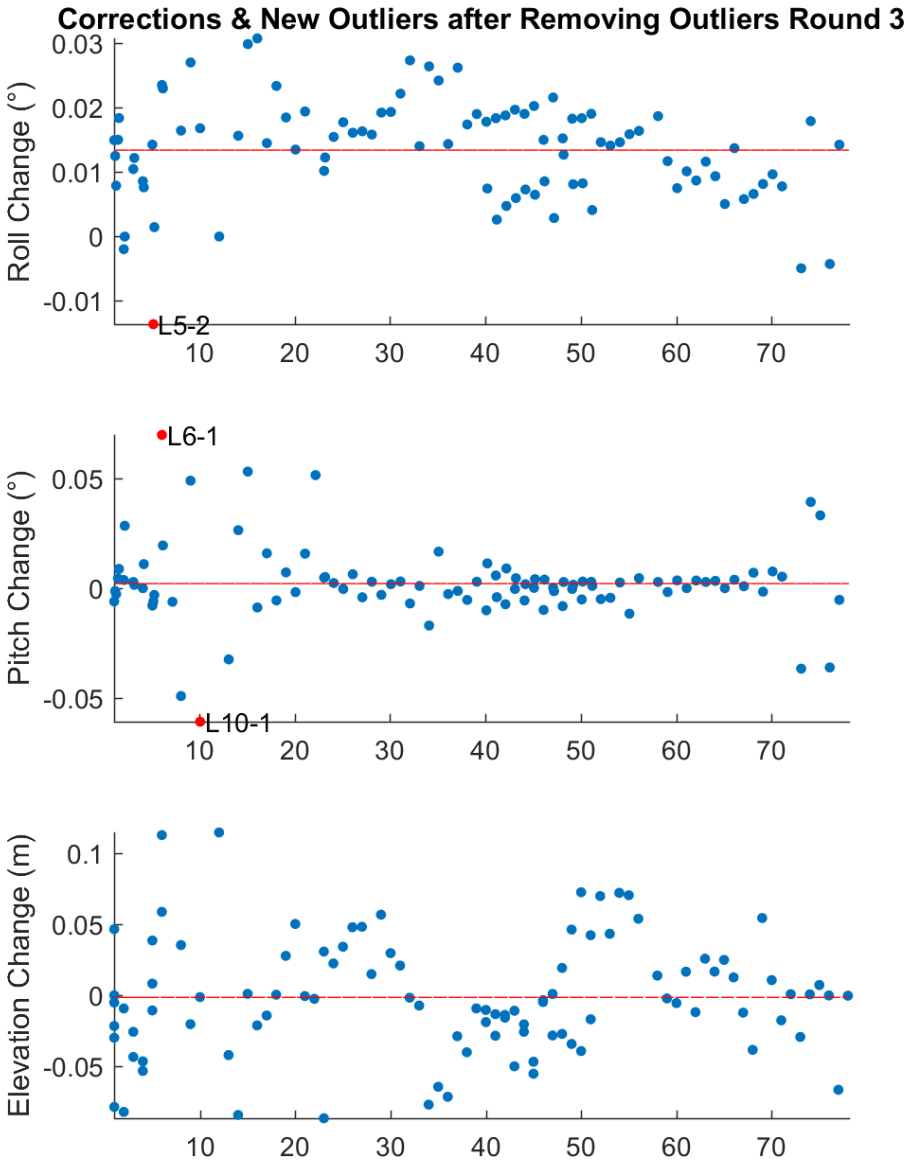

Figure 10: Block adjustments showing outliers (red points) once the 3rd set of outliers were removed.

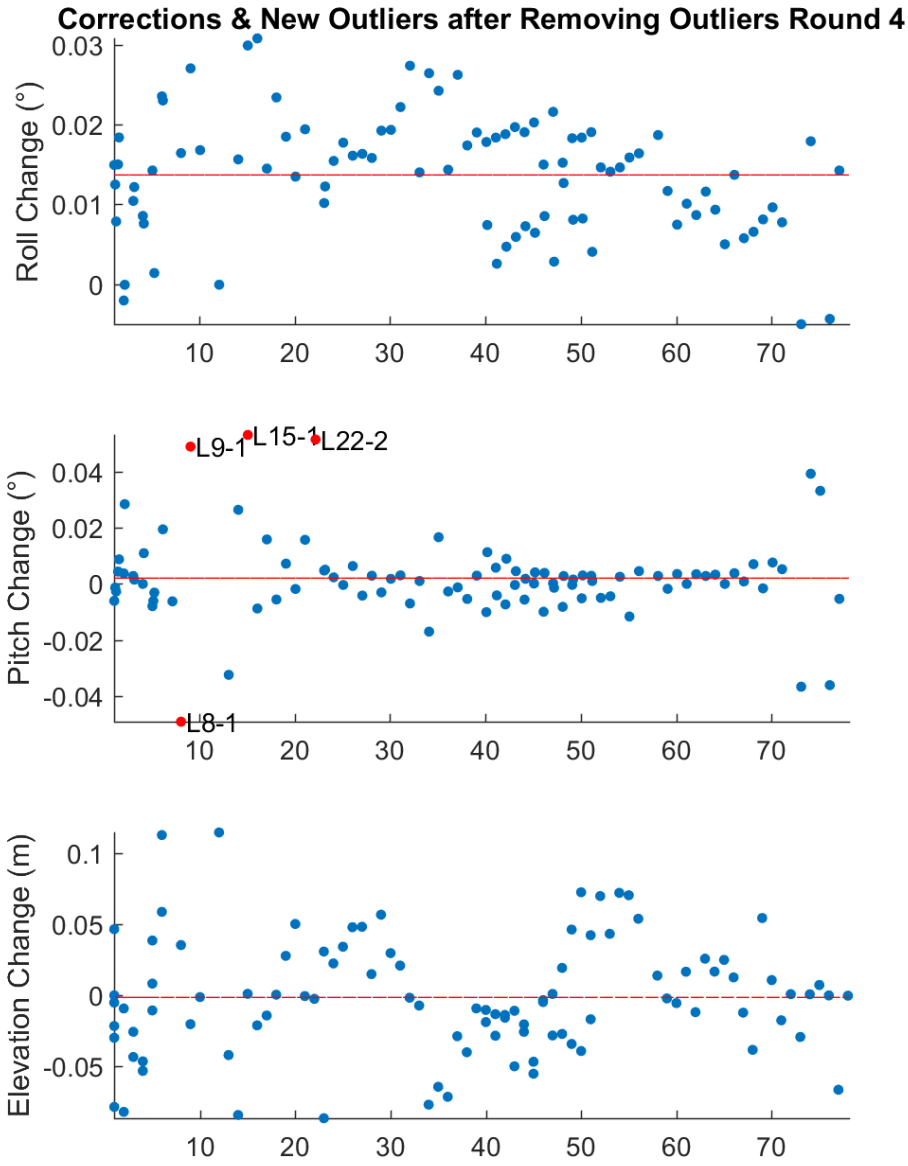

Figure 11: Block adjustments showing outliers (red points) once the4th set of outliers were removed.

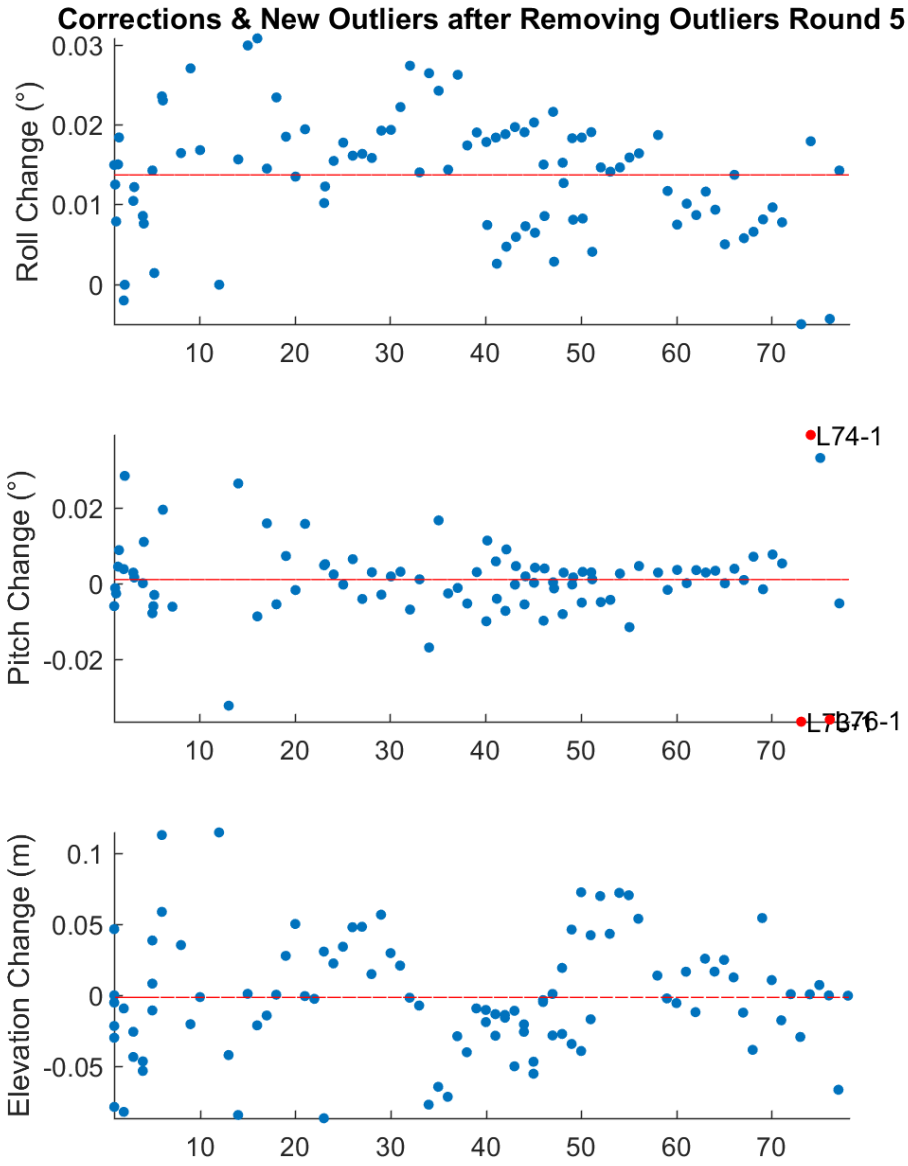

Figure 12: Block adjustments showing outliers (red points) once the5th set of outliers were removed.

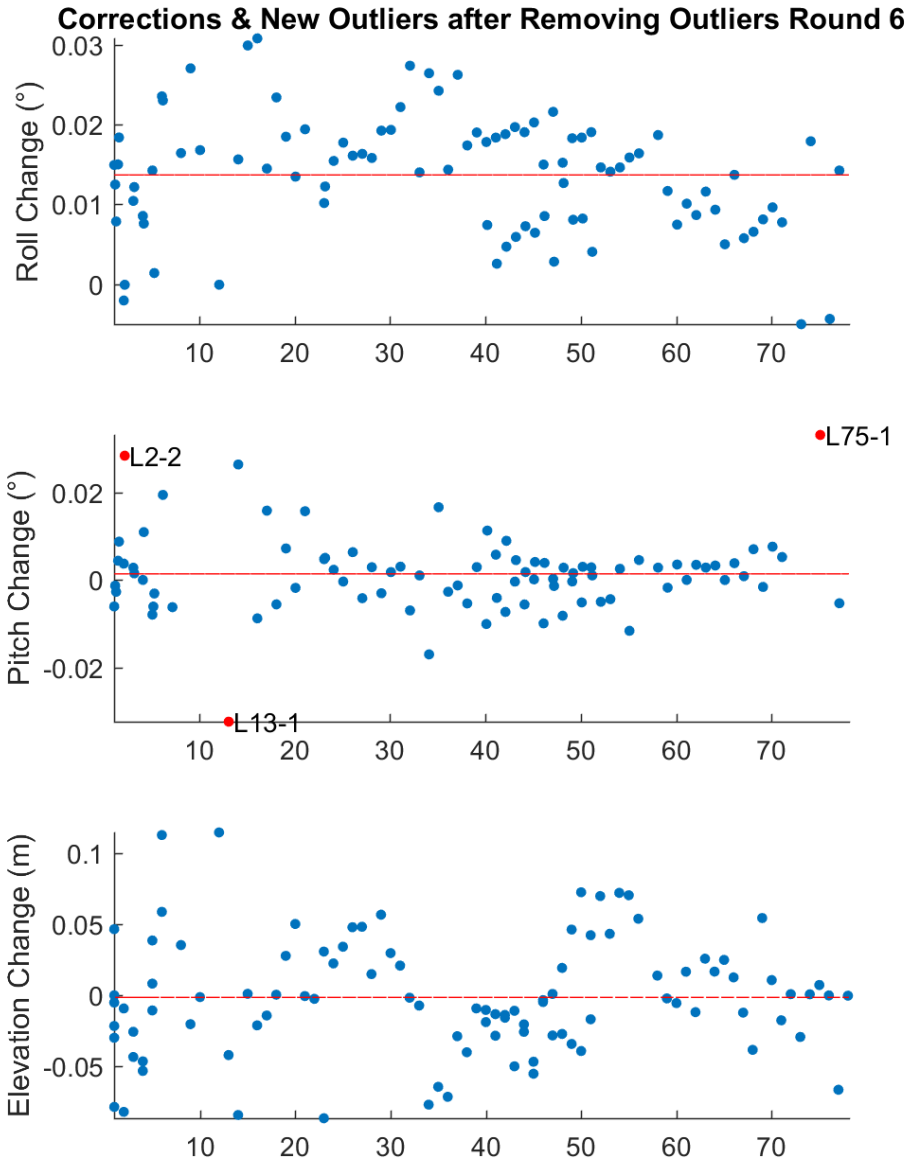

Figure 13: Block adjustments showing outliers (red points) once the6th set of outliers were removed.

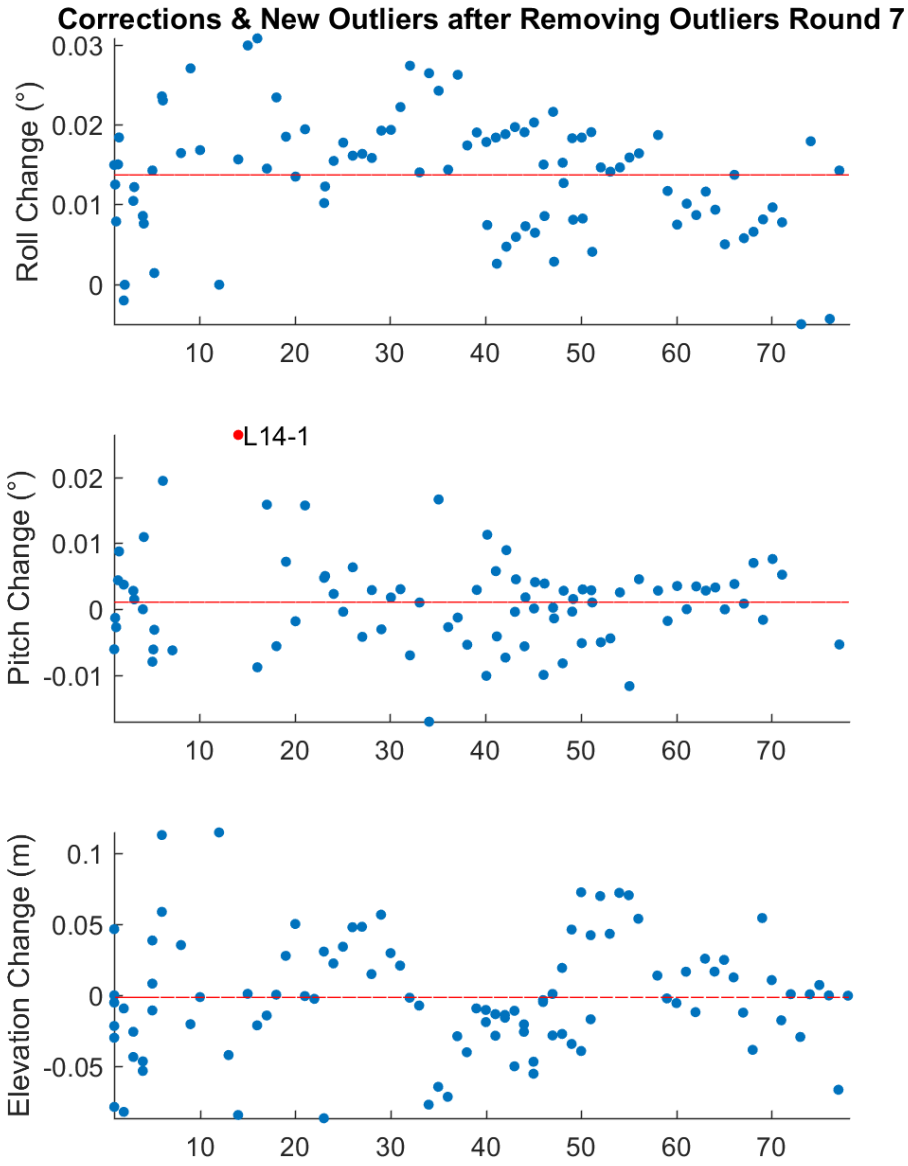

Figure 14: Block adjustments showing outliers (red points) once the7th set of outliers were removed.

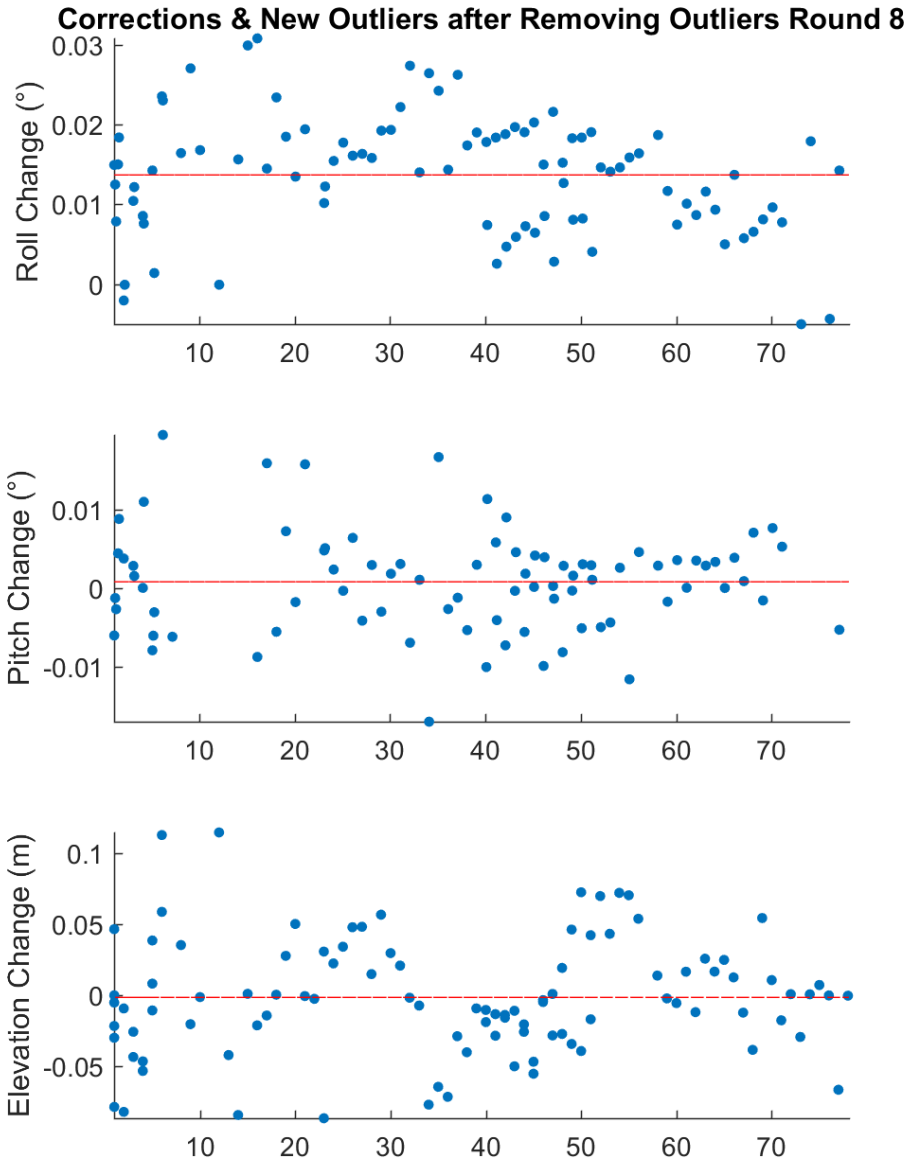

Figure 15: Block adjustments showing outliers (red points) once the8th set of outliers were removed.

8 QA / QC results

8.1 Tieplane residuals

Table 16, Table 17, Table 18 and Table 19, show the resulting statistics for the residuals between tie planes and points from overlapping strips used in the adjustment to determine the block adjustments for all output lines(see Table 15 and Section 3.2), used to achieve refined processing results. The tables show results for all possible planes, as well as selected planes (see Table 7), and for both the standard and refined results. Figure 16, Figure 17, Figure 18 and Figure 19 plot the residuals between the tie planes and tie points against the scan angle of the LiDAR sensor. Ideally, if no systematic bias exists in the boresight misalignment angles or scanning mirror scale factor, the plots will appear flat across all scan angles. If a systematic bias does exist, a pattern will be discernible in the standard processing results, but may be corrected in the refined processing results.

Table 16: Tie plane statistics for all planes and standard processing

Line	Number of Points	Min diff (m)	Max diff (m)	Mean diff (m)	RMS diff (m)	Std diff (m)
1	132457	-0.386	0.373	-0.017	0.075	0.108
2	2177	-0.132	0.235	0.022	0.060	0.075
3	15203	-0.266	0.219	-0.016	0.062	0.067
4	17252	-0.255	0.255	-0.008	0.053	0.074
5	9357	-0.204	0.196	-0.016	0.050	0.071
6	5124	-0.157	0.169	-0.012	0.058	0.085
7	4573	-0.266	0.275	0.002	0.065	0.083
8	2986	-0.323	0.255	-0.011	0.097	0.090
9	5555	-0.221	0.242	0.017	0.061	0.082
10	3231	-0.170	0.167	-0.011	0.049	0.089
11	3769	-0.174	0.190	0.008	0.062	0.081
12	4642	-0.228	0.186	-0.015	0.059	0.084
13	1537	-0.214	0.198	-0.010	0.059	0.077
14	1431	-0.250	0.163	-0.013	0.070	0.086
15	922	-0.249	0.330	0.004	0.080	0.097
16	3498	-0.212	0.144	-0.014	0.057	0.084
17	1770	-0.245	0.267	0.017	0.077	0.102
18	2349	-0.274	0.216	-0.017	0.080	0.084
19	2448	-0.283	0.197	-0.026	0.075	0.085
20	3465	-0.248	0.201	-0.013	0.069	0.088
21	828	-0.126	0.220	0.022	0.071	0.084
22	0	0	0	0	0	0
23	63687	-0.240	0.459	0.053	0.084	0.094
24	167990	-0.442	0.497	-0.008	0.081	0.111

25	184601	-0.499	0.452	-0.016	0.091	0.110
26	177867	-0.493	0.426	-0.006	0.087	0.114
27	175491	-0.535	0.591	-0.009	0.089	0.114
28	121112	-0.438	0.570	0.012	0.091	0.120
29	80738	-0.429	0.349	-0.045	0.100	0.111
30	114481	-0.389	0.446	-0.025	0.085	0.108
31	129600	-0.557	0.518	0.011	0.091	0.101
32	83188	-0.381	0.450	0.009	0.095	0.102
33	61741	-0.374	0.435	0.037	0.102	0.105
34	30240	-0.368	0.476	-0.051	0.115	0.121
35	18284	-0.493	0.419	-0.009	0.109	0.110
36	36604	-0.313	0.444	0.038	0.096	0.109
37	30861	-0.361	0.370	-0.007	0.097	0.095
38	38373	-0.543	0.533	-0.015	0.102	0.103
39	44383	-0.393	0.364	-0.009	0.077	0.094
40	51909	-0.349	0.308	-0.012	0.079	0.092
41	37643	-0.297	0.367	0.030	0.082	0.091
42	30246	-0.387	0.287	-0.014	0.086	0.094
43	29602	-0.300	0.312	0.014	0.074	0.086
44	36532	-0.356	0.260	-0.007	0.072	0.094
45	36669	-0.271	0.332	0.005	0.070	0.087
46	56674	-0.349	0.356	-0.000	0.072	0.090
47	48354	-0.430	0.492	0.006	0.072	0.087
48	39488	-0.349	0.330	-0.032	0.083	0.094
49	42043	-0.362	0.326	-0.046	0.088	0.092
50	64010	-0.415	0.388	-0.029	0.083	0.089
51	61230	-0.487	0.358	-0.006	0.077	0.092
52	46355	-0.381	0.380	-0.030	0.087	0.104
53	29703	-0.311	0.370	0.014	0.079	0.094
54	29441	-0.394	0.288	-0.042	0.091	0.097
55	26647	-0.263	0.392	0.025	0.093	0.093
56	48294	-0.475	0.388	0.015	0.077	0.080
58	39860	-0.438	0.398	0.003	0.085	0.090
59	61733	-0.367	0.327	-0.009	0.072	0.084
60	59929	-0.269	0.263	0.009	0.064	0.081

61	39027	-0.373	0.277	-0.018	0.066	0.085
62	31740	-0.244	0.341	0.030	0.069	0.083
63	29817	-0.282	0.253	-0.014	0.061	0.080
64	34854	-0.251	0.326	0.006	0.055	0.082
65	30480	-0.249	0.267	0.001	0.055	0.082
66	41834	-0.326	0.278	-0.011	0.059	0.080
67	50837	-0.325	0.298	0.012	0.063	0.079
68	41944	-0.302	0.293	0.010	0.069	0.081
69	54721	-0.358	0.277	-0.029	0.069	0.076
70	18545	-0.303	0.282	-0.004	0.074	0.063
71	187894	-0.378	0.439	0.025	0.076	0.110
72	353	-0.114	0.207	0.030	0.068	0.111
73	2425	-0.185	0.159	0.009	0.054	0.079
74	1657	-0.253	0.203	-0.015	0.064	0.079
75	900	-0.177	0.132	-0.002	0.050	0.080
76	625	-0.115	0.129	0.008	0.045	0.077
77	31365	-0.283	0.320	0.020	0.071	0.092
78	290	-0.192	0.133	-0.018	0.055	0.087
1	148919	-0.318	0.536	0.014	0.081	0.114
2	3031	-0.169	0.146	-0.010	0.049	0.074
3	14617	-0.236	0.201	-0.009	0.054	0.067
4	17674	-0.178	0.233	0.020	0.056	0.077
5	7401	-0.175	0.202	0.004	0.047	0.077
6	6725	-0.175	0.193	0.008	0.054	0.083
7	5012	-0.184	0.212	0.008	0.058	0.078
22	395	-0.152	0.135	-0.025	0.063	0.093
23	151425	-0.402	0.377	-0.004	0.081	0.105
40	56361	-0.239	0.361	0.005	0.066	0.093
41	36785	-0.266	0.301	-0.002	0.063	0.090
42	34053	-0.274	0.304	-0.006	0.063	0.085
43	33554	-0.293	0.259	-0.003	0.063	0.086
44	41598	-0.304	0.323	0.001	0.065	0.090
45	32552	-0.242	0.245	0.012	0.063	0.082
46	56364	-0.297	0.412	-0.012	0.062	0.085
47	45222	-0.217	0.354	0.010	0.063	0.084

48	36186	-0.368	0.356	0.028	0.071	0.093
49	39742	-0.239	0.365	0.038	0.075	0.086
50	55712	-0.250	0.406	0.035	0.073	0.088
51	65302	-0.288	0.391	0.025	0.072	0.094
1	13904	-0.197	0.282	0.021	0.066	0.087
5	5721	-0.226	0.162	-0.000	0.050	0.074
1	89	-0.101	0.086	-0.010	0.042	0.075
1	230596	-0.379	0.456	0.007	0.075	0.116
1	14930	-0.302	0.263	0.008	0.071	0.076

Table 17: Tie plane statistics for selected planes and standard processing

Line	Number of Points	Min diff	Max diff	Mean diff	RMS diff	Std diff
1	39946	-0.318	0.365	-0.017	0.079	0.106
2	535	-0.132	0.207	0.007	0.056	0.078
3	4675	-0.216	0.177	-0.017	0.060	0.072
4	3742	-0.234	0.255	-0.000	0.061	0.077
5	1958	-0.204	0.196	-0.016	0.054	0.073
6	3211	-0.157	0.169	-0.017	0.062	0.086
7	1934	-0.266	0.166	0.002	0.077	0.082
8	1651	-0.294	0.255	0.023	0.089	0.095
9	2480	-0.221	0.200	0.000	0.056	0.081
10	1119	-0.170	0.167	0.009	0.055	0.094
11	1601	-0.174	0.176	0.002	0.070	0.085
12	2031	-0.228	0.186	-0.020	0.062	0.076
13	1121	-0.214	0.155	-0.024	0.058	0.074
14	981	-0.250	0.163	-0.010	0.076	0.086
15	492	-0.249	0.330	0.024	0.089	0.099
16	1364	-0.212	0.093	-0.034	0.063	0.080
17	1450	-0.132	0.267	0.036	0.070	0.107
18	1940	-0.274	0.148	-0.035	0.076	0.086
19	1285	-0.173	0.197	-0.014	0.061	0.090
20	1520	-0.248	0.170	-0.036	0.079	0.085
21	424	-0.126	0.220	0.018	0.074	0.084
22	0	0	0	0	0	0
23	13285	-0.240	0.459	0.065	0.097	0.097
24	58240	-0.442	0.402	-0.009	0.085	0.111
25	61095	-0.424	0.367	-0.029	0.095	0.111
26	58424	-0.493	0.372	-0.008	0.090	0.112
27	45932	-0.392	0.339	-0.005	0.093	0.114
28	42687	-0.371	0.570	0.014	0.091	0.121
29	25288	-0.429	0.267	-0.046	0.106	0.108
30	40170	-0.381	0.339	-0.029	0.084	0.110
31	42467	-0.342	0.294	0.018	0.092	0.101
32	32668	-0.331	0.376	-0.009	0.083	0.099
33	25232	-0.305	0.435	0.033	0.092	0.108

34	9108	-0.339	0.267	-0.044	0.100	0.117
35	6476	-0.388	0.419	0.011	0.118	0.108
36	12044	-0.313	0.308	0.057	0.099	0.107
37	11030	-0.327	0.370	-0.008	0.099	0.095
38	15130	-0.543	0.341	-0.024	0.101	0.105
39	18674	-0.393	0.269	-0.010	0.077	0.094
40	13808	-0.349	0.308	-0.008	0.087	0.093
41	12409	-0.228	0.367	0.034	0.079	0.091
42	10963	-0.333	0.287	-0.020	0.084	0.097
43	8290	-0.272	0.312	0.008	0.084	0.087
44	10011	-0.321	0.260	0.000	0.071	0.093
45	15176	-0.271	0.321	0.001	0.074	0.088
46	20146	-0.349	0.281	0.006	0.081	0.092
47	18185	-0.254	0.314	0.008	0.071	0.086
48	16653	-0.349	0.276	-0.045	0.087	0.096
49	14309	-0.362	0.326	-0.058	0.099	0.092
50	22174	-0.358	0.388	-0.028	0.092	0.089
51	17460	-0.420	0.336	-0.001	0.085	0.096
52	22780	-0.349	0.328	-0.026	0.082	0.104
53	10799	-0.311	0.339	0.017	0.076	0.094
54	11129	-0.312	0.288	-0.034	0.093	0.097
55	8827	-0.263	0.339	0.010	0.093	0.085
56	16350	-0.318	0.259	0.005	0.073	0.086
58	18456	-0.438	0.370	0.006	0.082	0.091
59	27495	-0.289	0.309	-0.006	0.072	0.085
60	24949	-0.269	0.263	0.004	0.065	0.082
61	16683	-0.329	0.227	-0.019	0.068	0.086
62	13214	-0.178	0.272	0.037	0.072	0.083
63	12507	-0.282	0.253	-0.012	0.061	0.080
64	15212	-0.191	0.326	0.001	0.054	0.082
65	12771	-0.249	0.267	0.000	0.056	0.082
66	16917	-0.287	0.245	-0.008	0.058	0.081
67	21694	-0.294	0.293	0.005	0.060	0.080
68	19290	-0.256	0.293	0.019	0.066	0.081
69	19503	-0.240	0.211	-0.026	0.062	0.079

70	8626	-0.283	0.282	-0.009	0.071	0.065
71	69508	-0.247	0.358	0.027	0.074	0.110
72	269	-0.114	0.207	0.027	0.067	0.108
73	1186	-0.185	0.159	0.003	0.057	0.082
74	777	-0.162	0.203	0.006	0.064	0.085
75	419	-0.177	0.093	-0.013	0.055	0.081
76	529	-0.115	0.107	0.006	0.044	0.079
77	11107	-0.283	0.290	0.023	0.070	0.090
78	241	-0.132	0.133	-0.013	0.050	0.085
1	37060	-0.316	0.420	0.013	0.093	0.113
2	1307	-0.169	0.146	-0.016	0.052	0.072
3	3803	-0.191	0.201	-0.013	0.054	0.069
4	3770	-0.163	0.222	0.028	0.062	0.079
5	2113	-0.124	0.178	0.001	0.047	0.077
6	2328	-0.175	0.193	0.006	0.062	0.084
7	2471	-0.184	0.171	0.004	0.059	0.077
22	191	-0.152	0.058	-0.045	0.064	0.086
23	47246	-0.348	0.323	0.013	0.083	0.109
40	16244	-0.216	0.253	0.004	0.065	0.096
41	9944	-0.217	0.301	0.004	0.061	0.089
42	10552	-0.274	0.304	-0.004	0.067	0.086
43	11943	-0.293	0.239	-0.005	0.066	0.087
44	11789	-0.304	0.263	-0.001	0.061	0.088
45	11757	-0.236	0.245	0.018	0.066	0.083
46	20486	-0.258	0.412	-0.013	0.064	0.087
47	13010	-0.206	0.291	0.019	0.064	0.085
48	13860	-0.254	0.356	0.036	0.076	0.094
49	11101	-0.224	0.365	0.047	0.083	0.088
50	20341	-0.191	0.406	0.039	0.080	0.088
51	19651	-0.212	0.309	0.023	0.069	0.097
1	4903	-0.163	0.282	0.034	0.071	0.085
5	1818	-0.162	0.162	-0.000	0.047	0.078
1	89	-0.101	0.086	-0.010	0.042	0.075
1	64397	-0.353	0.349	0.007	0.077	0.112
1	3577	-0.272	0.263	0.020	0.082	0.085

Table 18: Tie plane statistics for all planes and refined processing

Line	# of Points	Min diff	Max diff	Mean diff	RMS diff	Std diff
1	132457	-0.352	0.371	-0.000	0.062	0.108
2	2177	-0.182	0.208	-0.019	0.058	0.075
3	15203	-0.249	0.181	-0.003	0.047	0.067
4	17252	-0.213	0.179	-0.004	0.049	0.074
5	9357	-0.193	0.210	-0.005	0.047	0.071
6	5124	-0.154	0.148	-0.005	0.051	0.085
7	4573	-0.326	2.054	0.123	0.355	0.083
8	2986	-0.467	0.186	-0.040	0.115	0.090
9	5555	-0.160	0.204	0.016	0.053	0.082
10	3231	-0.176	0.138	-0.024	0.054	0.089
11	3769	-0.219	0.124	-0.029	0.065	0.081
12	4642	-0.170	0.275	0.023	0.063	0.084
13	1537	-0.264	0.170	-0.020	0.070	0.077
14	1431	-0.161	0.218	0.017	0.068	0.086
15	922	-0.216	0.161	-0.004	0.060	0.097
16	3498	-0.137	0.142	-0.001	0.047	0.084
17	1770	-0.174	0.200	0.001	0.057	0.102
18	2349	-0.176	0.163	-0.000	0.050	0.084
19	2448	-0.193	0.166	-0.002	0.052	0.085
20	3465	-0.157	0.145	-0.000	0.050	0.088
21	828	-0.249	0.168	-0.013	0.070	0.084
22	0	0	0	0	0	0
23	63687	-0.347	0.291	-0.002	0.056	0.094
24	167990	-0.331	0.346	-0.001	0.062	0.111
25	184601	-0.345	0.402	-0.000	0.061	0.110
26	177867	-0.429	0.389	-0.001	0.062	0.114
27	175491	-0.329	0.400	-0.001	0.063	0.114
28	121112	-0.393	0.412	-0.002	0.068	0.120
29	80738	-0.333	0.346	0.000	0.064	0.111
30	114481	-0.298	0.306	-0.002	0.062	0.108
31	129600	-0.358	0.299	-0.001	0.057	0.101
32	83188	-0.338	0.299	-0.000	0.061	0.102
33	61741	-0.272	0.285	0.002	0.059	0.105

34	30240	-0.277	0.313	-0.006	0.066	0.121
35	18284	-0.374	0.249	-0.006	0.064	0.110
36	36604	-0.279	0.279	-0.003	0.059	0.109
37	30861	-0.220	0.239	0.001	0.055	0.095
38	38373	-0.459	0.295	0.000	0.057	0.103
39	44383	-0.277	0.225	-0.000	0.054	0.094
40	51909	-0.253	0.259	-0.001	0.055	0.092
41	37643	-0.253	0.226	-0.002	0.054	0.091
42	30246	-0.301	0.233	-0.000	0.055	0.094
43	29602	-0.280	0.264	-0.001	0.053	0.086
44	36532	-0.201	0.247	0.002	0.053	0.094
45	36669	-0.265	0.243	-0.001	0.051	0.087
46	56674	-0.239	0.292	-0.001	0.054	0.090
47	48354	-0.323	0.268	0.001	0.053	0.087
48	39488	-0.259	0.398	0.000	0.054	0.094
49	42043	-0.235	0.226	0.001	0.054	0.092
50	64010	-0.227	0.287	-0.001	0.053	0.089
51	61230	-0.265	0.273	-0.001	0.055	0.092
52	46355	-0.261	0.291	-0.000	0.061	0.104
53	29703	-0.232	0.239	-0.003	0.055	0.094
54	29441	-0.239	0.242	-0.003	0.057	0.097
55	26647	-0.196	0.233	0.005	0.056	0.093
56	48294	-0.238	0.325	0.001	0.058	0.080
58	39860	-0.294	0.258	0.003	0.054	0.090
59	61733	-0.258	0.239	-0.001	0.051	0.084
60	59929	-0.230	0.235	-0.000	0.049	0.081
61	39027	-0.213	0.272	-0.001	0.050	0.085
62	31740	-0.269	0.232	-0.000	0.049	0.083
63	29817	-0.191	0.197	0.000	0.047	0.080
64	34854	-0.190	0.289	-0.000	0.048	0.082
65	30480	-0.241	0.206	-0.003	0.051	0.082
66	41834	-0.240	0.367	-0.002	0.050	0.080
67	50837	-0.262	0.258	-0.000	0.051	0.079
68	41944	-0.216	0.241	0.002	0.050	0.081
69	54721	-0.304	0.311	-0.004	0.058	0.076

70	18545	-0.251	0.187	-0.005	0.046	0.063
71	187894	-0.353	0.393	0.003	0.064	0.110
72	353	-0.737	0.959	-0.043	0.241	0.111
73	2425	-0.204	0.185	0.000	0.049	0.079
74	1657	-0.410	0.697	-0.011	0.098	0.079
75	900	-0.118	0.430	0.023	0.092	0.080
76	625	-0.588	0.392	-0.011	0.097	0.077
77	31365	-0.295	0.256	-0.000	0.056	0.092
78	290	-0.523	0.870	0.021	0.156	0.086
1	148919	-0.321	0.394	-0.001	0.064	0.114
2	3031	-0.125	0.167	0.015	0.051	0.074
3	14617	-0.198	0.192	-0.000	0.046	0.067
4	17674	-0.183	0.203	0.001	0.049	0.077
5	7401	-0.209	0.180	0.001	0.046	0.077
6	6725	-0.766	0.188	-0.001	0.070	0.083
7	5012	-1.300	0.431	-0.084	0.241	0.078
22	395	-0.095	0.223	0.038	0.075	0.093
23	151425	-0.294	0.321	0.000	0.059	0.105
40	56361	-0.220	0.308	-0.001	0.055	0.093
41	36785	-0.232	0.272	0.002	0.053	0.090
42	34053	-0.207	0.247	0.000	0.052	0.085
43	33554	-0.197	0.246	-0.002	0.052	0.086
44	41598	-0.363	0.288	-0.001	0.054	0.090
45	32552	-0.226	0.232	-0.000	0.050	0.082
46	56364	-0.253	0.335	0.000	0.052	0.085
47	45222	-0.234	0.240	-0.003	0.053	0.084
48	36186	-0.478	0.256	-0.001	0.054	0.093
49	39742	-0.247	0.264	-0.003	0.052	0.086
50	55712	-0.215	0.316	-0.000	0.053	0.088
51	65302	-0.251	0.330	0.000	0.055	0.094
1	13904	-0.193	0.222	-0.001	0.051	0.087
5	5721	-0.211	0.172	-0.001	0.048	0.074
1	89	-0.087	0.086	-0.000	0.038	0.075
1	230596	-0.355	0.404	-0.000	0.065	0.116
1	14930	-0.226	0.197	0.002	0.049	0.076

Table 19: Tie plane statistics for selected planes and refined processing

Line	Number of Points	Min diff	Max diff	Mean diff	RMS diff	Std diff
1	39946	-0.307	0.371	-0.001	0.061	0.106
2	535	-0.133	0.208	-0.000	0.052	0.078
3	4675	-0.167	0.176	-0.001	0.046	0.072
4	3742	-0.206	0.179	-0.002	0.052	0.077
5	1958	-0.193	0.210	-0.001	0.050	0.073
6	3211	-0.140	0.147	-0.001	0.051	0.086
7	1934	-0.157	0.166	0.000	0.049	0.082
8	1651	-0.193	0.172	-0.001	0.054	0.095
9	2480	-0.150	0.160	-0.000	0.045	0.081
10	1119	-0.176	0.138	-0.001	0.054	0.094
11	1601	-0.121	0.124	-0.000	0.050	0.085
12	2031	-0.170	0.112	-0.002	0.047	0.076
13	1121	-0.202	0.170	0.000	0.053	0.074
14	981	-0.161	0.187	0.000	0.052	0.086
15	492	-0.216	0.160	-0.003	0.063	0.099
16	1364	-0.137	0.142	-0.000	0.045	0.080
17	1450	-0.162	0.200	-0.001	0.056	0.107
18	1940	-0.156	0.163	-0.000	0.051	0.086
19	1285	-0.144	0.166	-0.000	0.053	0.090
20	1520	-0.148	0.141	-0.000	0.049	0.085
21	424	-0.115	0.121	-0.002	0.049	0.084
22	0	0	0	0	0	0
23	13285	-0.347	0.291	-0.001	0.060	0.097
24	58240	-0.331	0.300	-0.001	0.062	0.111
25	61095	-0.345	0.297	-0.001	0.062	0.111
26	58424	-0.429	0.288	-0.000	0.063	0.112
27	45932	-0.301	0.285	-0.002	0.062	0.114
28	43886	-0.278	0.412	-0.001	0.067	0.120
29	28450	-0.296	0.267	-0.002	0.063	0.108
30	40170	-0.298	0.304	-0.000	0.061	0.110
31	42467	-0.277	0.252	-0.003	0.059	0.101
32	32668	-0.274	0.299	-0.000	0.057	0.099
33	25232	-0.228	0.258	-0.000	0.057	0.108

34	9108	-0.277	0.247	-0.000	0.063	0.117
35	6476	-0.252	0.249	-0.000	0.062	0.108
36	12044	-0.207	0.228	-0.000	0.056	0.107
37	11030	-0.190	0.239	0.000	0.054	0.095
38	15130	-0.459	0.267	-0.002	0.059	0.105
39	18674	-0.277	0.225	-0.001	0.054	0.095
40	13808	-0.253	0.259	-0.002	0.056	0.093
41	12409	-0.253	0.226	-0.001	0.053	0.091
42	10963	-0.218	0.184	-0.002	0.054	0.097
43	8290	-0.214	0.233	-0.001	0.053	0.087
44	10011	-0.201	0.247	-0.000	0.053	0.093
45	15176	-0.235	0.199	-0.003	0.053	0.088
46	20146	-0.239	0.267	-0.001	0.054	0.092
47	18185	-0.323	0.268	-0.001	0.051	0.086
48	16653	-0.204	0.351	-0.002	0.054	0.096
49	14309	-0.197	0.219	-0.002	0.053	0.092
50	22174	-0.227	0.241	-0.001	0.053	0.089
51	17460	-0.260	0.273	-0.002	0.057	0.096
52	22780	-0.225	0.291	-0.000	0.061	0.104
53	10799	-0.232	0.216	-0.003	0.057	0.094
54	11129	-0.231	0.242	-0.002	0.058	0.097
55	8827	-0.196	0.201	0.000	0.052	0.085
56	16350	-0.238	0.298	-0.002	0.053	0.086
58	18456	-0.294	0.248	0.001	0.053	0.091
59	27495	-0.258	0.239	-0.000	0.051	0.085
60	24949	-0.200	0.203	-0.000	0.049	0.082
61	16683	-0.213	0.221	-0.001	0.049	0.086
62	13214	-0.185	0.178	-0.001	0.049	0.083
63	12507	-0.191	0.197	-0.000	0.047	0.080
64	15212	-0.190	0.289	-0.001	0.047	0.082
65	12771	-0.241	0.206	-0.002	0.050	0.082
66	16917	-0.240	0.259	-0.001	0.050	0.081
67	21694	-0.252	0.247	0.000	0.050	0.080
68	19290	-0.205	0.236	0.001	0.050	0.081
69	19503	-0.206	0.204	-0.001	0.051	0.079

70	8626	-0.251	0.187	-0.005	0.047	0.065
71	69508	-0.275	0.355	0.002	0.062	0.111
72	269	-0.152	0.198	-0.004	0.060	0.108
73	1186	-0.143	0.185	0.000	0.049	0.082
74	777	-0.153	0.173	-0.000	0.052	0.085
75	419	-0.118	0.102	-0.001	0.043	0.081
76	529	-0.114	0.108	-0.001	0.043	0.079
77	11107	-0.295	0.197	0.000	0.056	0.090
78	241	-0.110	0.114	-0.000	0.046	0.085
1	37060	-0.289	0.300	-0.000	0.064	0.113
2	1307	-0.125	0.142	-0.001	0.044	0.072
3	3803	-0.193	0.192	-0.002	0.048	0.069
4	3770	-0.181	0.162	0.003	0.050	0.079
5	2113	-0.145	0.140	-0.001	0.044	0.077
6	2328	-0.154	0.188	-0.000	0.054	0.084
7	2471	-0.147	0.178	-0.000	0.048	0.077
22	191	-0.095	0.098	-0.000	0.044	0.086
23	47246	-0.269	0.266	-0.000	0.060	0.109
40	16244	-0.190	0.229	0.000	0.054	0.096
41	9944	-0.178	0.246	0.001	0.052	0.089
42	10552	-0.185	0.236	-0.000	0.052	0.086
43	11943	-0.187	0.236	0.000	0.051	0.087
44	11789	-0.363	0.240	0.001	0.053	0.088
45	11757	-0.226	0.232	0.001	0.051	0.083
46	20486	-0.198	0.331	0.000	0.052	0.087
47	13010	-0.212	0.240	0.000	0.052	0.085
48	13860	-0.235	0.238	-0.001	0.054	0.094
49	11101	-0.247	0.264	0.001	0.054	0.088
50	20341	-0.215	0.316	0.000	0.054	0.088
51	19651	-0.220	0.330	0.001	0.056	0.097
1	4903	-0.162	0.222	0.000	0.051	0.085
5	1818	-0.141	0.164	-0.000	0.045	0.078
1	89	-0.087	0.086	-0.000	0.038	0.075
1	64397	-0.355	0.312	-0.000	0.063	0.112
1	3577	-0.226	0.184	-0.001	0.054	0.085

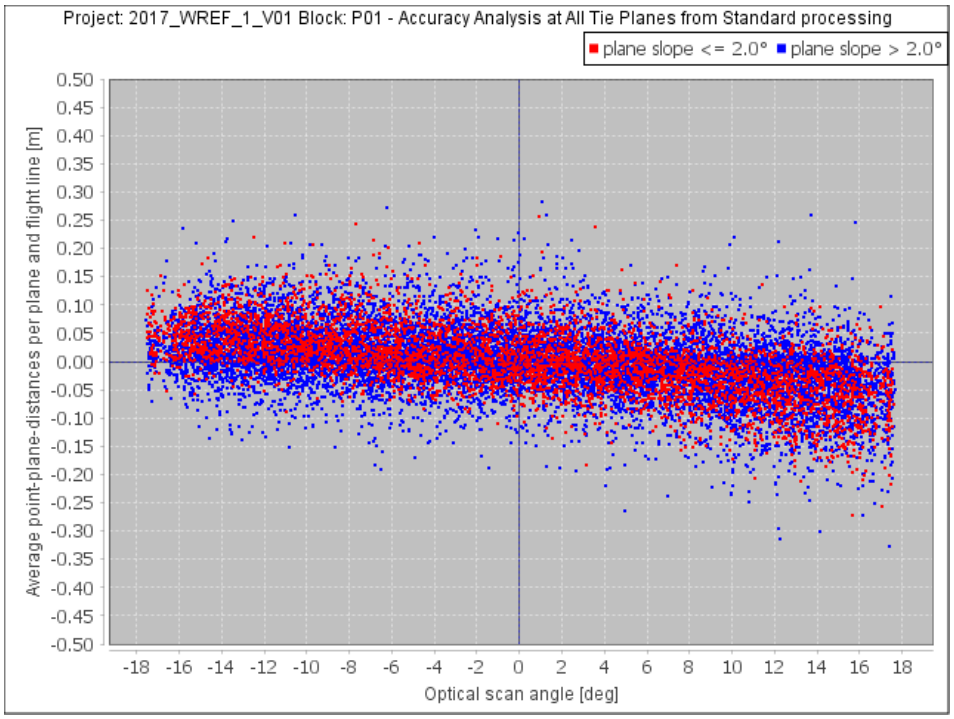

Figure 16: Mean point to plane distance from standard processing

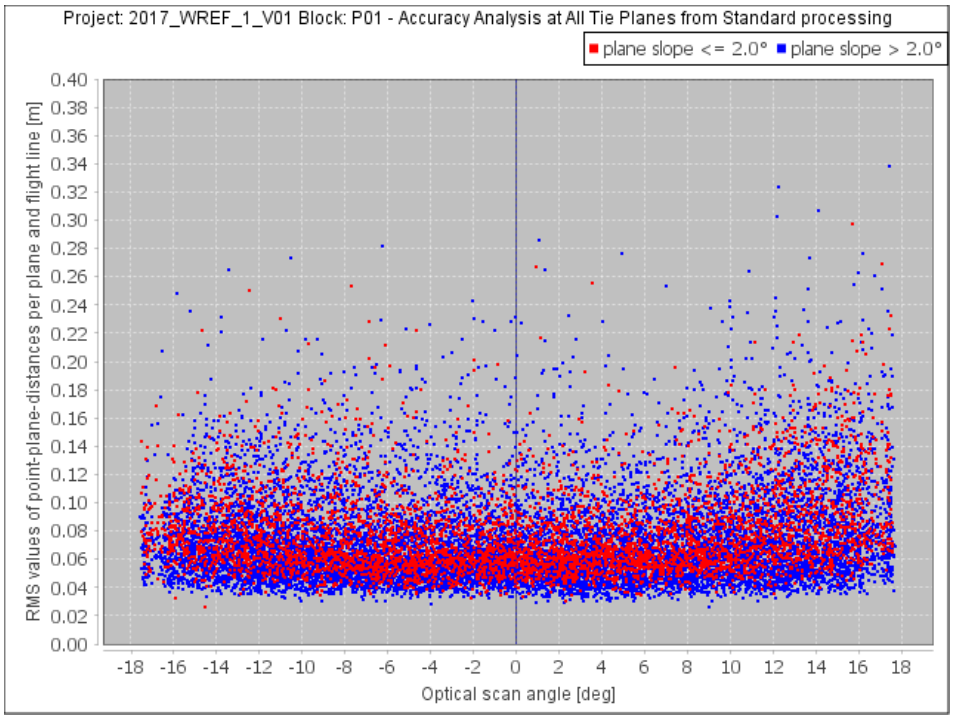

Figure 17: RMS point to plane distance from standard processing

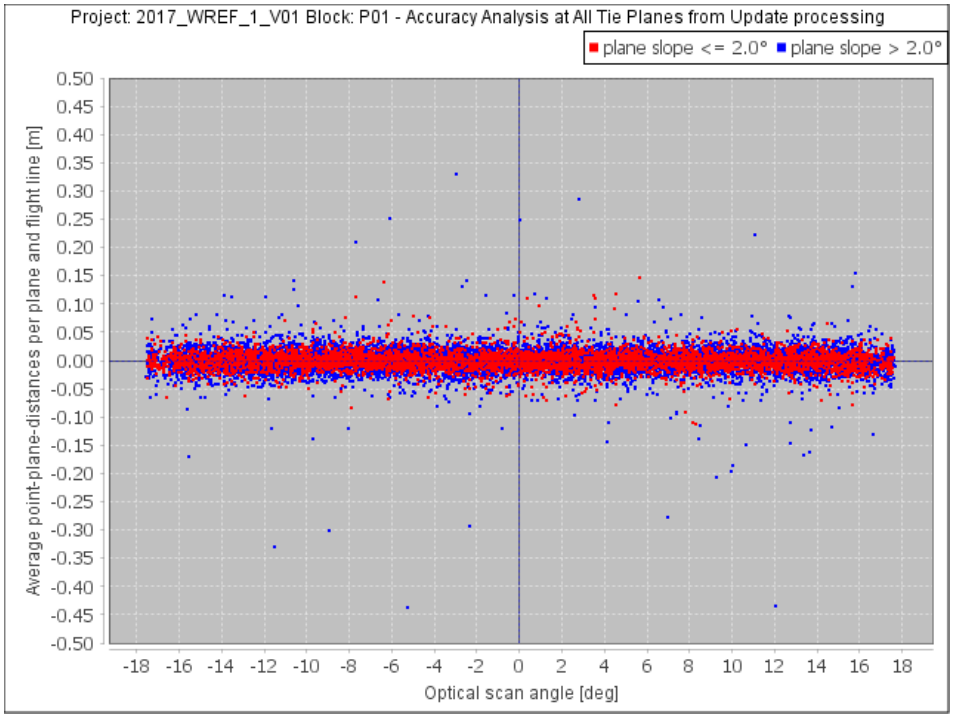

Figure 18: Mean point to plane distance from refined processing

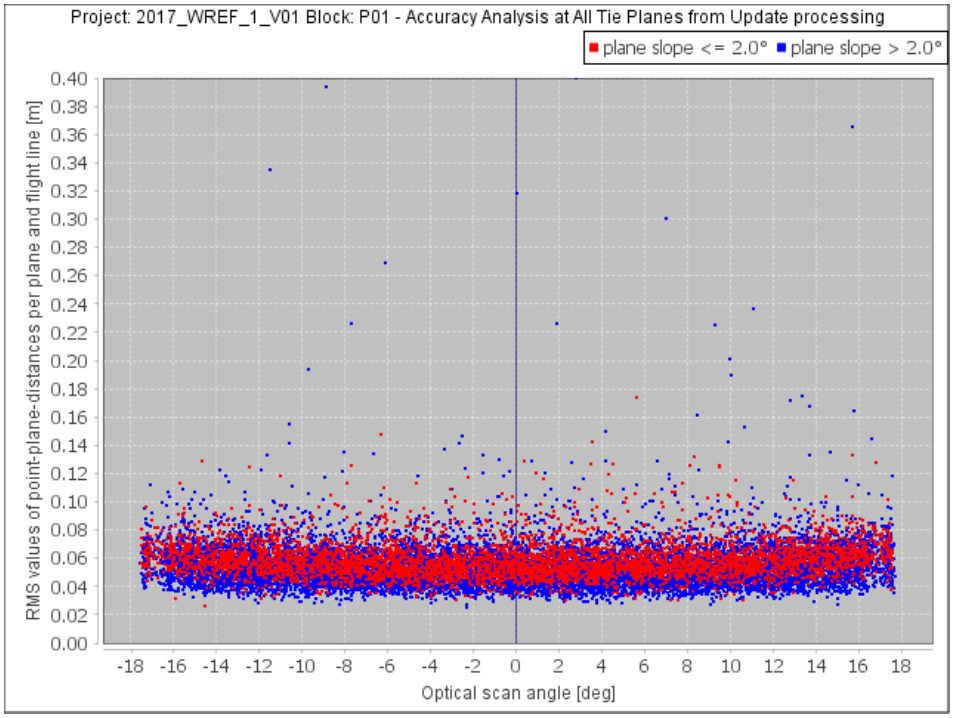

Figure 19: RMS point to plane distance from refined processing

8.2 Roofline Analysis Results

Table 20 and Table 21 show the results of the accuracy analysis on the roof lines for standard and refined processing respectively, as described in Section 3.1.

Table 20: Roof line statistics for standard processing

Parameter	Mean	RMS	Minimum	Maximum
Delta East [m]	-0.097	0.305	-0.795	0.619
Delta North [m]	0.016	0.159	-0.303	0.496
Delta Height [m]	-0.076	0.134	-0.261	0.194
Horizontal Separation [m]	0.121	0.344	-0.619	0.841
Diff. Azimuth [deg]	0.02091	0.10816	-0.25413	0.24869
Diff. Slope [deg]	0.01859	0.06175	-0.11120	0.17787

Table 21: Roof line statistics for refined processing

Parameter	Mean	RMS	Minimum	Maximum
Delta East [m]	-0.008	0.030	-0.083	0.050
Delta North [m]	0.009	0.051	-0.100	0.124
Delta Height [m]	-0.001	0.028	-0.059	0.053
Horizontal Separation [m]	0.010	0.059	-0.124	0.130
Diff. Azimuth [deg]	0.02597	0.10977	-0.22648	0.25583
Diff. Slope [deg]	0.01920	0.05191	-0.07669	0.13850

9 LMS Output File Sizes

Table 22: LMS Output File Sizes (GB)

Line	LAS	ASCII	PLS	WVS
L001-1_2017_WREF_1_V01_2017061916_P01_r	0.55	3.60	0.50	2.44
L001-2_2017_WREF_1_V01_2017062117_P01_r	0.76	4.96	0.71	3.37
L001-3_2017_WREF_1_V01_2017062117_P01_r	0.58	3.77	0.46	2.44
L001-4_2017_WREF_1_V01_2017062215_P01_r	0.04	0.29	0.04	0.21
L001-5_2017_WREF_1_V01_2017062215_P01_r	0.85	5.57	0.78	3.79
L001-6_2017_WREF_1_V01_2017062215_P01_r	0.52	3.41	0.42	2.21
L002-1_2017_WREF_1_V01_2017062117_P01_r	0.16	1.07	0.14	0.63
L002-2_2017_WREF_1_V01_2017062215_P01_r	0.35	2.26	0.33	1.55
L003-1_2017_WREF_1_V01_2017062117_P01_r	0.33	2.16	0.31	1.44
L003-2_2017_WREF_1_V01_2017062215_P01_r	0.33	2.13	0.31	1.42
L004-1_2017_WREF_1_V01_2017062117_P01_r	0.32	2.09	0.32	1.46
L004-2_2017_WREF_1_V01_2017062215_P01_r	0.25	1.65	0.23	1.08
L005-1_2017_WREF_1_V01_2017062117_P01_r	0.33	2.19	0.32	1.46
L005-2_2017_WREF_1_V01_2017062117_P01_r	0.32	2.07	0.30	1.36
L005-3_2017_WREF_1_V01_2017062215_P01_r	0.32	2.11	0.30	1.38
L006-1_2017_WREF_1_V01_2017062117_P01_r	0.34	2.19	0.34	1.57
L006-2_2017_WREF_1_V01_2017062215_P01_r	0.32	2.12	0.32	1.49
L007-1_2017_WREF_1_V01_2017062117_P01_r	0.33	2.17	0.32	1.46
L007-2_2017_WREF_1_V01_2017062215_P01_r	0.35	2.30	0.34	1.57
L008-1_2017_WREF_1_V01_2017062117_P01_r	0.34	2.21	0.32	1.43
L009-1_2017_WREF_1_V01_2017062117_P01_r	0.35	2.30	0.34	1.55
L010-1_2017_WREF_1_V01_2017062117_P01_r	0.33	2.17	0.31	1.41
L011-1_2017_WREF_1_V01_2017062117_P01_r	0.34	2.24	0.32	1.45
L012-1_2017_WREF_1_V01_2017062117_P01_r	0.35	2.28	0.34	1.56
L013-1_2017_WREF_1_V01_2017062117_P01_r	0.35	2.31	0.35	1.64
L014-1_2017_WREF_1_V01_2017062117_P01_r	0.34	2.24	0.33	1.53
L015-1_2017_WREF_1_V01_2017062117_P01_r	0.34	2.25	0.31	1.44
L016-1_2017_WREF_1_V01_2017062117_P01_r	0.35	2.28	0.32	1.49
L017-1_2017_WREF_1_V01_2017062117_P01_r	0.36	2.34	0.32	1.49
L018-1_2017_WREF_1_V01_2017062117_P01_r	0.38	2.47	0.35	1.65
L019-1_2017_WREF_1_V01_2017062117_P01_r	0.39	2.52	0.35	1.66

L020-1_2017_WREF_1_V01_2017062117_P01_r	0.34	2.23	0.32	1.44
L021-1_2017_WREF_1_V01_2017062117_P01_r	0.33	2.14	0.31	1.41
L022-1_2017_WREF_1_V01_2017062117_P01_r	0.02	0.13	0.02	0.08
L022-2_2017_WREF_1_V01_2017062117_P01_r	0.12	0.77	0.11	0.46
L023-1_2017_WREF_1_V01_2017062117_P01_r	0.48	3.15	0.44	2.10
L023-2_2017_WREF_1_V01_2017062117_P01_r	0.84	5.50	0.77	3.78
L024-1_2017_WREF_1_V01_2017062117_P01_r	0.78	5.07	0.72	3.45
L025-1_2017_WREF_1_V01_2017062117_P01_r	0.82	5.33	0.74	3.63
L026-1_2017_WREF_1_V01_2017062117_P01_r	0.78	5.12	0.72	3.47
L027-1_2017_WREF_1_V01_2017062117_P01_r	0.83	5.40	0.75	3.61
L028-1_2017_WREF_1_V01_2017062117_P01_r	0.82	5.37	0.75	3.66
L029-1_2017_WREF_1_V01_2017062117_P01_r	0.77	5.03	0.68	3.34
L030-1_2017_WREF_1_V01_2017062117_P01_r	0.84	5.50	0.74	3.58
L031-1_2017_WREF_1_V01_2017061916_P01_r	0.80	5.23	0.72	3.50
L032-1_2017_WREF_1_V01_2017061916_P01_r	0.82	5.34	0.72	3.51
L033-1_2017_WREF_1_V01_2017061916_P01_r	0.80	5.21	0.70	3.41
L034-1_2017_WREF_1_V01_2017061916_P01_r	0.88	5.75	0.75	3.62
L035-1_2017_WREF_1_V01_2017061916_P01_r	0.81	5.27	0.69	3.30
L036-1_2017_WREF_1_V01_2017061916_P01_r	0.89	5.81	0.75	3.64
L037-1_2017_WREF_1_V01_2017061916_P01_r	0.82	5.34	0.69	3.29
L038-1_2017_WREF_1_V01_2017061916_P01_r	0.84	5.49	0.72	3.51
L039-1_2017_WREF_1_V01_2017061916_P01_r	0.80	5.23	0.70	3.42
L040-1_2017_WREF_1_V01_2017061916_P01_r	0.82	5.33	0.72	3.54
L040-2_2017_WREF_1_V01_2017062215_P01_r	0.82	5.36	0.72	3.53
L041-1_2017_WREF_1_V01_2017061916_P01_r	0.82	5.35	0.72	3.50
L041-2_2017_WREF_1_V01_2017062215_P01_r	0.81	5.28	0.71	3.47
L042-1_2017_WREF_1_V01_2017061916_P01_r	0.84	5.50	0.75	3.65
L042-2_2017_WREF_1_V01_2017062215_P01_r	0.80	5.22	0.70	3.44
L043-1_2017_WREF_1_V01_2017061916_P01_r	0.78	5.07	0.70	3.44
L043-2_2017_WREF_1_V01_2017062215_P01_r	0.81	5.27	0.71	3.48
L044-1_2017_WREF_1_V01_2017061916_P01_r	0.80	5.23	0.72	3.53
L044-2_2017_WREF_1_V01_2017062215_P01_r	0.82	5.38	0.74	3.65
L045-1_2017_WREF_1_V01_2017061916_P01_r	0.79	5.19	0.73	3.58
L045-2_2017_WREF_1_V01_2017062215_P01_r	0.82	5.33	0.73	3.60
L046-1_2017_WREF_1_V01_2017061916_P01_r	0.80	5.21	0.74	3.58

L046-2_2017_WREF_1_V01_2017062215_P01_r	0.81	5.32	0.74	3.62
L047-1_2017_WREF_1_V01_2017061916_P01_r	0.78	5.10	0.72	3.52
L047-2_2017_WREF_1_V01_2017062215_P01_r	0.79	5.14	0.72	3.52
L048-1_2017_WREF_1_V01_2017061916_P01_r	0.82	5.34	0.75	3.67
L048-2_2017_WREF_1_V01_2017062215_P01_r	0.80	5.26	0.73	3.56
L049-1_2017_WREF_1_V01_2017061916_P01_r	0.80	5.23	0.74	3.57
L049-2_2017_WREF_1_V01_2017062215_P01_r	0.83	5.40	0.75	3.64
L050-1_2017_WREF_1_V01_2017061916_P01_r	0.78	5.13	0.72	3.46
L050-2_2017_WREF_1_V01_2017062215_P01_r	0.79	5.18	0.72	3.48
L051-1_2017_WREF_1_V01_2017061916_P01_r	0.79	5.15	0.73	3.52
L051-2_2017_WREF_1_V01_2017062215_P01_r	0.79	5.16	0.72	3.50
L052-1_2017_WREF_1_V01_2017061916_P01_r	0.76	4.99	0.72	3.49
L053-1_2017_WREF_1_V01_2017061916_P01_r	0.75	4.90	0.71	3.52
L054-1_2017_WREF_1_V01_2017061916_P01_r	0.76	4.99	0.72	3.48
L055-1_2017_WREF_1_V01_2017061916_P01_r	0.74	4.86	0.72	3.46
L056-1_2017_WREF_1_V01_2017061916_P01_r	0.77	5.02	0.74	3.59
L058-1_2017_WREF_1_V01_2017062122_P01_r	0.77	5.02	0.79	3.76
L059-1_2017_WREF_1_V01_2017062122_P01_r	0.72	4.68	0.71	3.44
L060-1_2017_WREF_1_V01_2017062122_P01_r	0.79	5.17	0.79	3.89
L061-1_2017_WREF_1_V01_2017062122_P01_r	0.78	5.13	0.75	3.62
L062-1_2017_WREF_1_V01_2017062122_P01_r	0.81	5.27	0.77	3.65
L063-1_2017_WREF_1_V01_2017062122_P01_r	0.80	5.23	0.75	3.64
L064-1_2017_WREF_1_V01_2017062122_P01_r	0.82	5.39	0.78	3.73
L065-1_2017_WREF_1_V01_2017062122_P01_r	0.81	5.27	0.75	3.61
L066-1_2017_WREF_1_V01_2017062122_P01_r	0.80	5.22	0.77	3.69
L067-1_2017_WREF_1_V01_2017062122_P01_r	0.74	4.85	0.70	3.32
L068-1_2017_WREF_1_V01_2017062122_P01_r	0.78	5.10	0.74	3.51
L069-1_2017_WREF_1_V01_2017062122_P01_r	0.80	5.24	0.74	3.52
L070-1_2017_WREF_1_V01_2017062122_P01_r	0.28	1.83	0.26	1.40
L071-1_2017_WREF_1_V01_2017062122_P01_r	0.68	4.45	0.64	3.01
L072-1_2017_WREF_1_V01_2017062122_P01_r	0.13	0.82	0.11	0.55
L073-1_2017_WREF_1_V01_2017062122_P01_r	0.41	2.68	0.36	1.72
L074-1_2017_WREF_1_V01_2017062122_P01_r	0.40	2.63	0.34	1.60
L075-1_2017_WREF_1_V01_2017062122_P01_r	0.41	2.70	0.36	1.68
L076-1_2017_WREF_1_V01_2017062122_P01_r	0.40	2.64	0.35	1.65

L077-1_2017_WREF_1_V01_2017062117_P01_r	0.46	2.98	0.42	1.95
L078-1_2017_WREF_1_V01_2017062215_P01_r	0.29	1.89	0.23	1.13

Table 23: LMS Output File Sizes Normalized to LAS File Size

Line	ASCII:LAS	PLS:LAS	WVS:LAS
L001-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9098	4.4244
L001-2_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9364	4.4417
L001-3_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8037	4.2421
L001-4_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9087	4.6189
L001-5_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9187	4.4472
L001-6_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.8046	4.2324
L002-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8756	3.8752
L002-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9517	4.4927
L003-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9416	4.3642
L003-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9399	4.3420
L004-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9834	4.5605
L004-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9017	4.2555
L005-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9530	4.3659
L005-2_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9396	4.2819
L005-3_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9385	4.2651
L006-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9989	4.6705
L006-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9909	4.5867
L007-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9612	4.4121
L007-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9636	4.4507
L008-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9482	4.2229
L009-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9526	4.3987
L010-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9371	4.2468
L011-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9238	4.2309
L012-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9616	4.4576
L013-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9855	4.6460
L014-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9661	4.4692
L015-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9023	4.1791
L016-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9111	4.2677
L017-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8997	4.1675
L018-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9326	4.3701
L019-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9155	4.2999
L020-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9284	4.2293
L021-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9416	4.3188

L022-1_2017_WREF_1_V01_2017062117_P01_r	6.5356	0.8903	3.9832
L022-2_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8917	3.8758
L023-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9203	4.3497
L023-2_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9169	4.4990
L024-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9229	4.4519
L025-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9113	4.4565
L026-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9139	4.4269
L027-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9021	4.3670
L028-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9081	4.4483
L029-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8872	4.3437
L030-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8803	4.2486
L031-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8998	4.3773
L032-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8867	4.2994
L033-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8800	4.2722
L034-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8567	4.1129
L035-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8500	4.0956
L036-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8447	4.0935
L037-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8410	4.0286
L038-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8600	4.1818
L039-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8755	4.2719
L040-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8881	4.3388
L040-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.8780	4.3075
L041-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8829	4.2816
L041-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.8791	4.3025
L042-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.8874	4.3369
L042-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.8808	4.3048
L043-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9054	4.4435
L043-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.8863	4.3155
L044-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9026	4.4205
L044-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.8962	4.4368
L045-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9136	4.5110
L045-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.8941	4.4157
L046-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9259	4.4967
L046-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9136	4.4443
L047-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9244	4.5104

L047-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9128	4.4788
L048-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9242	4.4891
L048-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9115	4.4180
L049-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9227	4.4652
L049-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9057	4.4077
L050-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9189	4.4088
L050-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9124	4.3926
L051-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9236	4.4757
L051-2_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9137	4.4323
L052-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9414	4.5780
L053-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9531	4.6939
L054-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9469	4.5545
L055-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9629	4.6502
L056-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9656	4.6745
L058-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	1.0292	4.8960
L059-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9986	4.8050
L060-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	1.0007	4.9182
L061-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9509	4.6126
L062-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9535	4.5308
L063-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9338	4.5469
L064-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9408	4.5294
L065-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9265	4.4826
L066-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9604	4.6277
L067-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9370	4.4777
L068-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9446	4.4935
L069-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9226	4.3874
L070-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9292	4.9816
L071-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9364	4.4294
L072-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.8864	4.3318
L073-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.8836	4.1850
L074-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.8531	3.9812
L075-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.8645	4.0603
L076-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.8733	4.0781
L077-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9179	4.2775
L078-1_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.7929	3.9163

10 References

ASPRS (2009). Las specification, version 1.3-r10. The American Society of Photogrammetry and Remote Sensing (ASPRS).

Lindenthal, S.M., Ussyshkin, V.R., Wang, J.G., Pokorny, M. 2011. Airborne LIDAR: A fully-automated self-calibration procedure. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XXXVIII-5/W12