LMS Processing and QA/QC for 2017 WREF 1 V01

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See configuration management system for approval history.

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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]

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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

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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: 18-Jul-2017 13:24:02
Processed by: bhass
LMS project coordinate system: ITRF00_UTMzone10N
LMS output coordinate system: ITRF00_UTMzone10N_Geoid12a
SBET coordinate system: ITRF00
Flight plan: D:\Raw\2017\P2\C1\2017062122_P2C1\L0\Ancillary\FlightPlans\D16_WREF_C1_P1and2_BH.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.

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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

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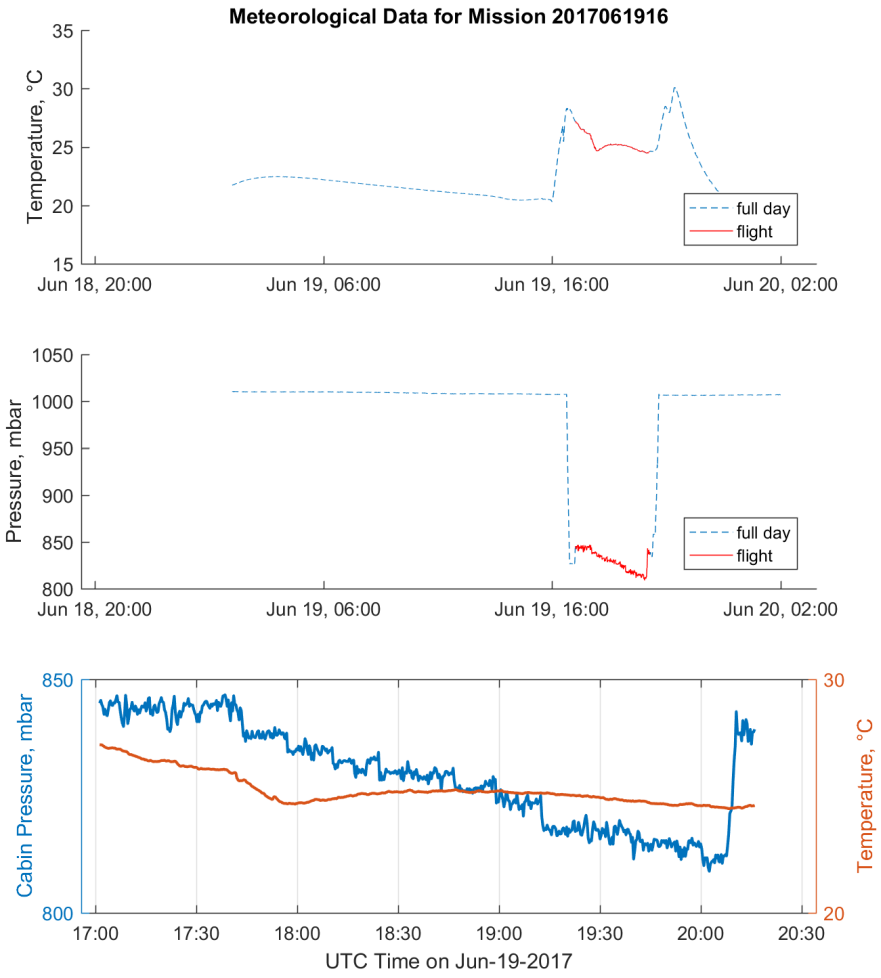

Figure 1: Meteorological Data for Mission 2017061916

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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

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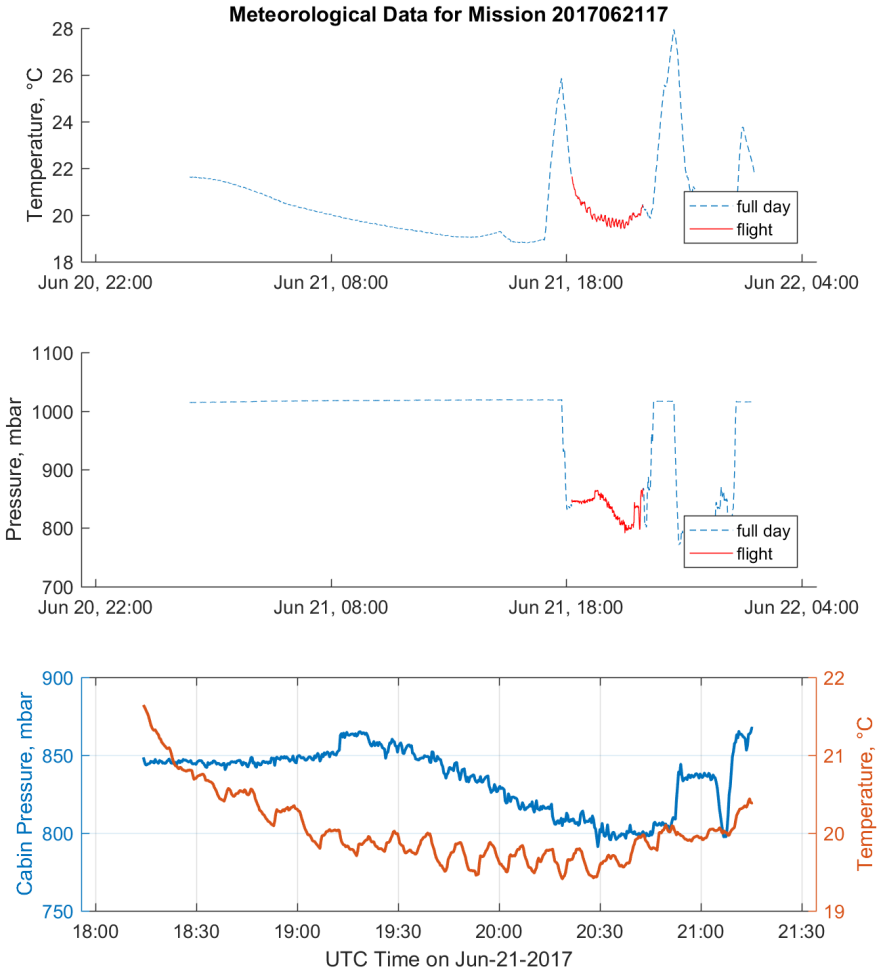

Figure 2: Meteorological Data for Mission 2017062117

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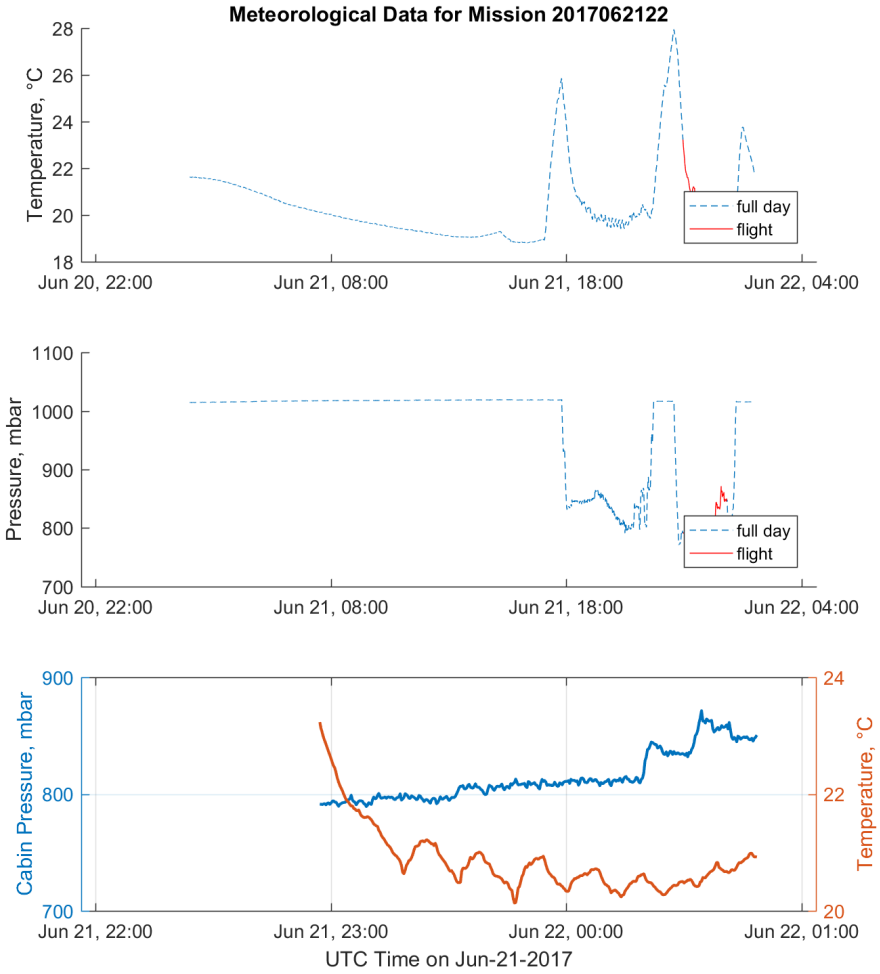

Figure 3: Meteorological Data for Mission 2017062122

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

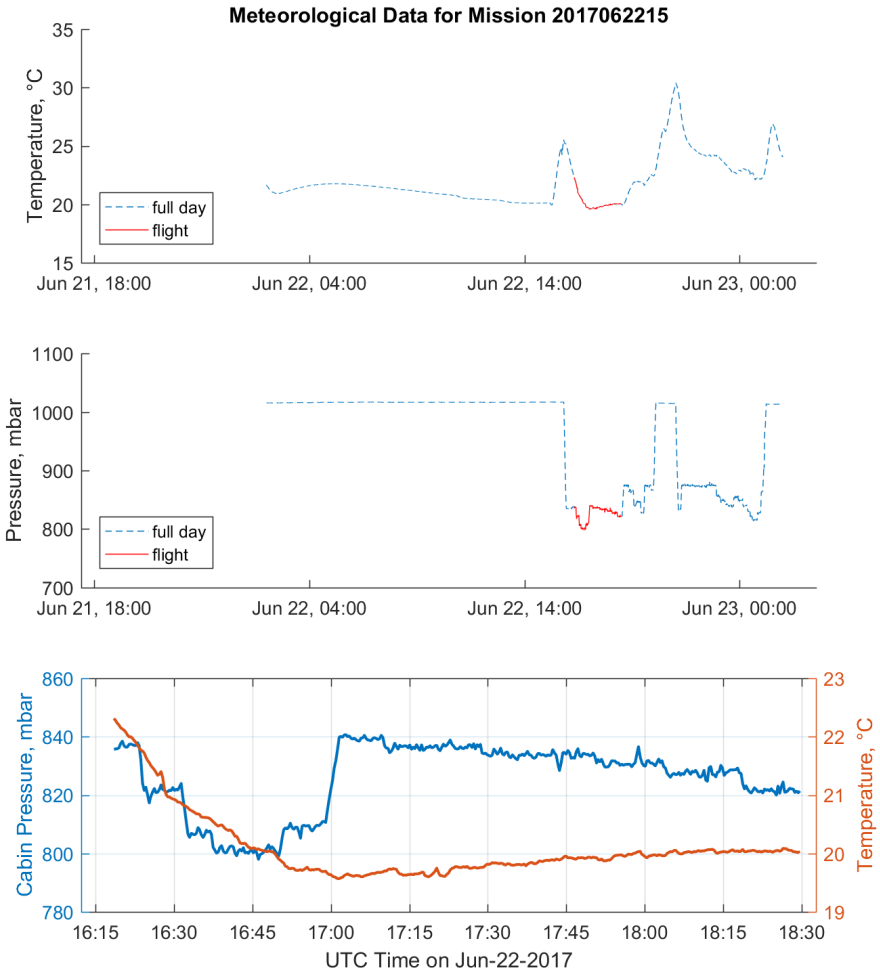

Figure 4: Meteorological Data for Mission 2017062215

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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
L0001-7	10.0	3.0	3.0	100.0	1.0
L0001-8	10.0	3.0	3.0	100.0	1.0
L0001-9	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
L0002-3	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

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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
L0023-1	10.0	3.0	3.0	100.0	1.0
L0023-10	10.0	3.0	3.0	100.0	1.0
L0023-2	10.0	3.0	3.0	100.0	1.0
L0023-3	10.0	3.0	3.0	100.0	1.0
L0023-4	10.0	3.0	3.0	100.0	1.0
L0023-5	10.0	3.0	3.0	100.0	1.0
L0023-6	10.0	3.0	3.0	100.0	1.0
L0023-7	10.0	3.0	3.0	100.0	1.0
L0023-9	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

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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
L0057-1	10.0	3.0	3.0	100.0	1.0
L0057-2	10.0	3.0	3.0	100.0	1.0
L0059-1	10.0	3.0	3.0	100.0	1.0
L0059-2	10.0	3.0	3.0	100.0	1.0
L0059-3	10.0	3.0	3.0	100.0	1.0
L0059-4	10.0	3.0	3.0	100.0	1.0

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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
L0069-1	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
L0079-1	10.0	3.0	3.0	100.0	1.0
L0080-1	10.0	3.0	3.0	100.0	1.0
L0081-1	10.0	3.0	3.0	100.0	1.0
L0082-1	10.0	3.0	3.0	100.0	1.0
L0082-2	10.0	3.0	3.0	100.0	1.0
L0082-3	10.0	3.0	3.0	100.0	1.0
L0082-4	10.0	3.0	3.0	100.0	1.0

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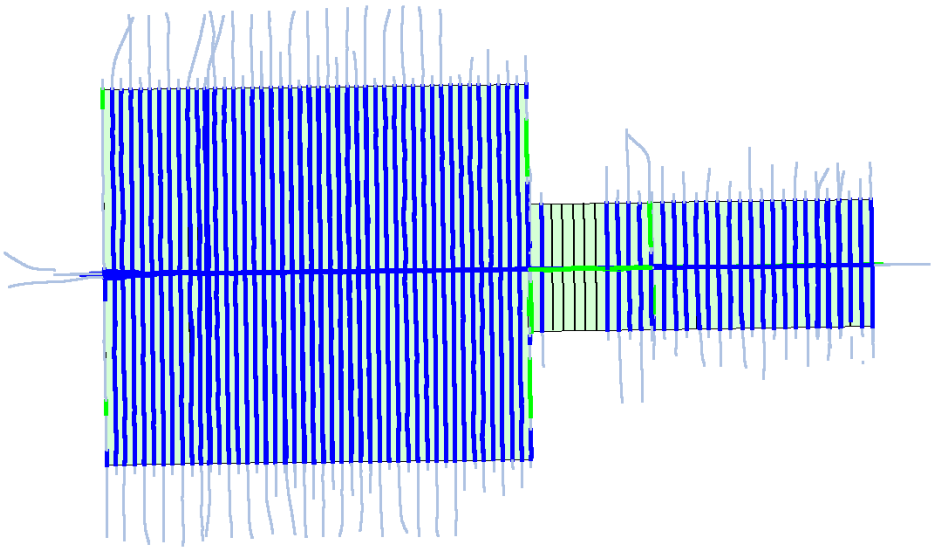

Figure 5: Flight Plan and Flight Coverage for 2017 WREF 1 V01

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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 13, Figure 14, Figure 15 and Figure 16. 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	0.05
L0001-2	0.05
L0001-3	0.05
L0001-4	0.05
L0001-5	0.05

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L0001-6	0.05
L0001-7	0.05
L0001-8	0.05
L0001-9	0.05
L0002-1	0.05
L0002-2	0.05
L0002-3	0.05
L0003-1	0.05
L0003-2	0.05
L0004-1	0.05
L0004-2	0.05
L0005-1	0.05
L0005-2	0.05
L0005-3	0.05
L0006-1	0.05
L0006-2	0.05
L0007-1	0.08
L0007-2	0.05
L0008-1	0.08
L0009-1	0.08
L0010-1	0.08
L0011-1	0.08
L0012-1	0.08
L0013-1	0.08
L0014-1	0.08
L0015-1	0.08
L0016-1	0.05
L0017-1	0.05
L0018-1	0.05
L0019-1	0.05
L0020-1	0.05
L0021-1	0.05
L0023-1	0.05
L0023-10	0.05
L0023-2	0.05

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L0023-3	0.05
L0023-4	0.05
L0023-5	0.05
L0023-6	0.05
L0023-7	0.05
L0023-9	0.05
L0024-1	0.05
L0025-1	0.05
L0026-1	0.05
L0027-1	0.05
L0028-1	0.05
L0029-1	0.05
L0030-1	0.05
L0031-1	0.05
L0032-1	0.05
L0033-1	0.05
L0034-1	0.05
L0035-1	0.05
L0036-1	0.05
L0037-1	0.05
L0038-1	0.05
L0039-1	0.05
L0040-1	0.05
L0040-2	0.05
L0041-1	0.05
L0041-2	0.05
L0042-1	0.05
L0042-2	0.05
L0043-1	0.05
L0043-2	0.05
L0044-1	0.05
L0044-2	0.05
L0045-1	0.05
L0045-2	0.05
L0046-1	0.05

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L0046-2	0.05
L0047-1	0.05
L0047-2	0.05
L0048-1	0.05
L0048-2	0.05
L0049-1	0.05
L0049-2	0.05
L0050-1	0.05
L0050-2	0.05
L0051-1	0.05
L0051-2	0.05
L0052-1	0.05
L0053-1	0.05
L0054-1	0.05
L0055-1	0.05
L0056-1	0.05
L0057-1	0.05
L0057-2	0.05
L0059-1	0.05
L0059-2	0.05
L0059-3	0.05
L0059-4	0.05
L0060-1	0.05
L0061-1	0.05
L0062-1	0.05
L0063-1	0.05
L0069-1	0.05
L0072-1	0.05
L0073-1	0.05
L0074-1	0.05
L0075-1	0.05
L0076-1	0.05
L0077-1	0.05
L0078-1	0.05
L0079-1	0.05

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L0080-1	0.05
L0081-1	0.05
L0082-1	0.05
L0082-2	0.05
L0082-3	0.05
L0082-4	0.05

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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	28	57-1	158487.6	158754.7	158530	158748
2017061916	30	1-1	159123.6	159362.7	159133	159362

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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	23-1	327999.5	328249.8	328078	328129
2017062117	10	23-1	327999.5	328249.8	328226	328244
2017062117	10	23-2	327999.5	328249.8	328185	328218
2017062117	10	23-3	327999.5	328249.8	328148	328157
2017062117	10	23-4	327999.5	328249.8	328018	328026
2017062117	10	23-6	327999.5	328249.8	328171	328175
2017062117	10	23-9	327999.5	328249.8	328040	328072
2017062117	11	59-1	328407.7	328507.8	328426	328432
2017062117	11	59-2	328407.7	328507.8	328436	328451
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	5-1	332924.6	333023.8	332945	333018
2017062117	30	4-1	333240.6	333320.8	333242	333315
2017062117	31	5-2	333475.4	333581.8	333498	333575

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2017062117	33	3-1	333768.4	333851.8	333770	333845
2017062117	34	2-1	333985.3	334091.8	334008	334015
2017062117	34	2-2	333985.3	334091.8	334043	334082
2017062117	35	1-2	334441.6	334963.9	334472	334609
2017062117	35	1-3	334441.6	334963.9	334610	334956
2017062117	36	23-5	335353.3	335462.9	335404	335406
2017062117	36	23-7	335353.3	335462.9	335428	335457
2017062117	37	69-1	335630.6	335734.9	335653	335727
2017062122	2	82-1	341803.2	342086.7	341950	341970
2017062122	2	82-2	341803.2	342086.7	341846	341854
2017062122	2	82-3	341803.2	342086.7	342070	342080
2017062122	2	82-4	341803.2	342086.7	341876	341883
2017062122	3	81-1	342233.5	342504.7	342283	342498
2017062122	4	80-1	342669.2	342952.7	342714	342945
2017062122	5	79-1	343099.5	343375.7	343144	343369
2017062122	6	78-1	343515.3	343807.7	343569	343800
2017062122	7	77-1	343940.6	344214.7	343985	344207
2017062122	8	76-1	344355.4	344640.7	344405	344634
2017062122	9	75-1	344763.2	345041.7	344811	345035
2017062122	10	74-1	345164.5	345460.7	345227	345454
2017062122	11	73-1	345578.3	345848.7	345626	345841
2017062122	12	72-1	345985.6	346272.7	346038	346265
2017062122	13	57-2	346406.3	346679.7	346456	346674
2017062122	14	1-4	346999.6	347401.7	347053	347319
2017062122	14	1-5	346999.6	347401.7	347321	347387
2017062122	14	1-6	346999.6	347401.7	347389	347401
2017062122	15	59-3	347577.4	347706.7	347625	347649
2017062122	15	59-4	347577.4	347706.7	347654	347696
2017062122	16	60-1	347864.1	347988.7	347908	347981
2017062122	17	61-1	348122.4	348250.7	348169	348244
2017062122	18	62-1	348376.2	348505.7	348422	348497
2017062215	3	1-7	403980.4	404498	404347	404477
2017062215	3	1-8	403980.4	404498	404274	404345
2017062215	3	1-9	403980.4	404498	404015	404272
2017062215	4	63-1	404778.9	404885	404804	404878

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2017062215	5	2-3	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

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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

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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

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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

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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

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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

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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

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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

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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

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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	159133	159362	70	18	41	0.8
L0001-2	334472	334609	70	18	41	0.8
L0001-3	334610	334956	70	18	41	0.8
L0001-4	347053	347319	70	18	41	0.8
L0001-5	347321	347387	70	18	41	0.8
L0001-6	347389	347401	70	18	41	0.8
L0001-7	404347	404477	70	18	41	0.8
L0001-8	404274	404345	70	18	41	0.8
L0001-9	404015	404272	70	18	41	0.8
L0002-1	334008	334015	100	18	50	0.8
L0002-2	334043	334082	100	18	50	0.8
L0002-3	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	332945	333018	100	18	50	0.8
L0005-2	333498	333575	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

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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
L0023-1	328078	328129	70	18	39	0.8
L0023-10	328226	328244	70	18	39	0.8
L0023-2	328185	328218	70	18	39	0.8
L0023-3	328148	328157	70	18	39	0.8
L0023-4	328018	328026	70	18	39	0.8
L0023-5	335404	335406	100	18	50	0.8
L0023-6	328171	328175	70	18	39	0.8
L0023-7	335428	335457	100	18	50	0.8
L0023-9	328040	328072	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

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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
L0057-1	158530	158748	70	18	39	0.8
L0057-2	346456	346674	70	18	39	0.8
L0059-1	328426	328432	100	18	50	0.8
L0059-2	328436	328451	100	18	50	0.8
L0059-3	347625	347649	100	18	50	0.8
L0059-4	347654	347696	100	18	50	0.8
L0060-1	347908	347981	100	18	50	0.8
L0061-1	348169	348244	100	18	50	0.8
L0062-1	348422	348497	100	18	50	0.8

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L0063-1	404804	404878	50	18	50	0.8
L0069-1	335653	335727	100	18	50	0.8
L0072-1	346038	346265	70	18	39	0.8
L0073-1	345626	345841	70	18	39	0.8
L0074-1	345227	345454	70	18	39	0.8
L0075-1	344811	345035	70	18	39	0.8
L0076-1	344405	344634	70	18	39	0.8
L0077-1	343985	344207	70	18	39	0.8
L0078-1	343569	343800	70	18	39	0.8
L0079-1	343144	343369	70	18	39	0.8
L0080-1	342714	342945	70	18	39	0.8
L0081-1	342283	342498	70	18	39	0.8
L0082-1	341950	341970	70	18	39	0.8
L0082-2	341846	341854	70	18	39	0.8
L0082-3	342070	342080	70	18	39	0.8
L0082-4	341876	341883	70	18	39	0.8

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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	16170779	8513220	3079454	696585
L0001-2	9692499	6190142	2822891	855791
L0001-3	24429597	12585994	4493005	1027684
L0001-4	18769447	9467244	3294388	718334
L0001-5	4699898	2592657	981040	245798
L0001-6	812681	416046	132288	24466
L0001-7	9234999	5894238	2684603	806747
L0001-8	5023230	2810204	1093156	283820
L0001-9	18141013	9194736	3243106	717804
L0002-1	695516	356988	98306	15946
L0002-2	3800272	1620802	375275	38783
L0002-3	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	7167384	3209946	845413	101798
L0005-2	7559992	3400634	892799	104943
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

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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
L0023-1	3660003	2278743	998885	292639
L0023-10	1274918	596433	208548	42451
L0023-2	2329087	1035509	349133	69878
L0023-3	634297	279951	83405	14229
L0023-4	533702	341614	149747	42612
L0023-5	148378	75200	22497	3748
L0023-6	246080	103511	32149	5285
L0023-7	2744242	937986	196984	20241
L0023-9	2284083	1319950	576312	170939
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

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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
L0057-1	15337470	7219555	2372030	469100
L0057-2	15310140	7296186	2417085	483261
L0059-1	579890	212460	44824	4944
L0059-2	1418266	624233	152414	18487
L0059-3	2391599	1149912	391645	87699
L0059-4	4154490	1905088	503194	70531
L0060-1	7185867	3309871	987680	185205
L0061-1	7374927	3426784	989265	169107

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L0062-1	7399864	3387458	1014360	184623
L0063-1	3700482	2274924	1023453	330663
L0069-1	7382053	3513603	1088093	199692
L0072-1	16019377	7466777	2429951	474097
L0073-1	15169226	7196777	2417209	478071
L0074-1	16057250	7740359	2671294	564960
L0075-1	15833248	8102156	2946950	662077
L0076-1	16256197	8188846	2890429	617145
L0077-1	15740699	8052081	2885979	619705
L0078-1	16370596	7813536	2595253	520643
L0079-1	15930900	7829130	2641215	542283
L0080-1	16394174	7551757	2465409	498046
L0081-1	15256048	6719502	2044564	373166
L0082-1	1457902	693148	248591	54454
L0082-2	563227	273628	79499	11575
L0082-3	747805	399740	161852	40576
L0082-4	527157	273582	86120	14353

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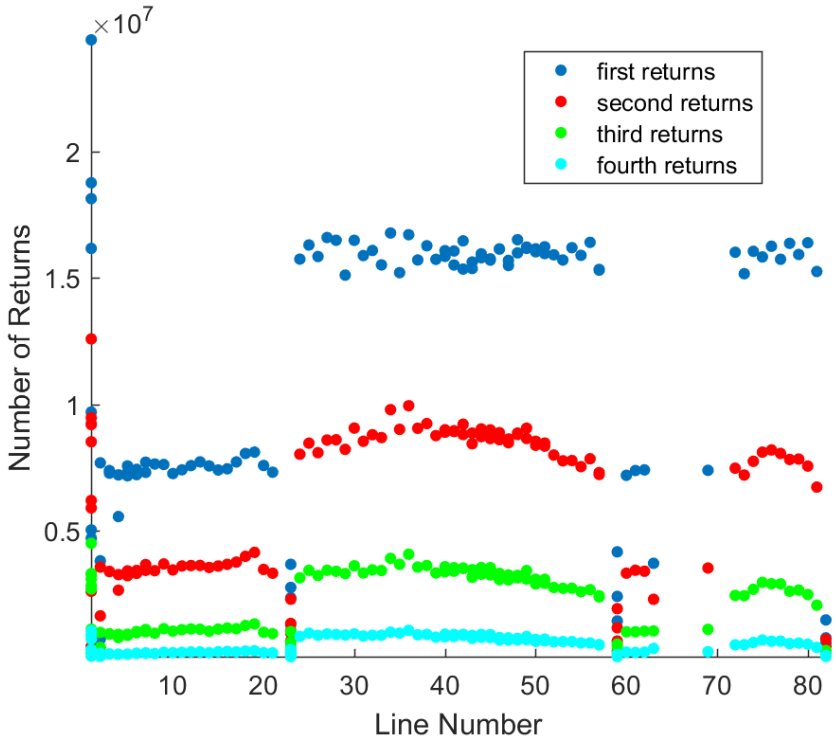

Figure 6: Number of Returns

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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	0.014356	0.000148	-0.011461	0.000378	0.032932	0.004184
L001-2	0.007742	0.000660	0.004949	0.000868	-0.061569	0.006766
L001-3	0.012924	0.000132	0.005711	0.000295	-0.040716	0.004198
L001-4	0.007655	0.000122	0.006242	0.000261	-0.019893	0.004176
L001-5	0.009308	0.000860	-0.007012	0.006006	-0.032451	0.011860
L001-6	0.004132	0.004163	-0.028707	0.013198	-0.086545	0.022832
L001-7	0.020761	0.000771	0.005355	0.000907	-0.010925	0.006544
L001-8	0.014124	0.001084	-0.000927	0.001575	0.011874	0.006876
L001-9	0.014525	0.000132	0.004722	0.000299	-0.010495	0.004181
L002-1	0.008226	0.029841	-0.358694	1.478950	-0.003319	0.035077
L002-2	0.000971	0.001485	-0.011633	0.002699	-0.030916	0.008918
L002-3	0.011220	0.000700	0.012037	0.001565	-0.000580	0.007277
L003-1	0.013232	0.000458	0.006363	0.001259	0.006358	0.006931
L003-2	0.010451	0.000581	-0.003267	0.001153	0.018586	0.007500
L004-1	0.011064	0.000607	0.004330	0.001200	0.019679	0.006834
L004-2	0.008898	0.000564	0.009837	0.001168	-0.004503	0.007068
L005-1	0.010936	0.001436	-0.006933	0.001266	0.058307	0.009279
L005-2	0.009957	0.000906	-0.003454	0.001349	0.065199	0.008716
L005-3	0.006107	0.000788	-0.005414	0.001155	0.026474	0.007902
L006-1	0.002905	0.000970	0.010037	0.001219	0.029346	0.008320
L006-2	0.009322	0.000904	0.017763	0.001273	0.058199	0.007863
L007-1	0.009010	0.001014	0.002433	0.001653	-0.021696	0.013901
L007-2	0.010296	0.000817	-0.008018	0.001592	0.057766	0.010732
L008-1	0.017196	0.001102	0.001082	0.001604	-0.003732	0.011120
L009-1	0.011789	0.001047	0.009634	0.001520	0.016511	0.009636
L010-1	0.036851	0.004643	0.001097	0.003164	-0.046149	0.018718
L011-1	0.009814	0.001470	-0.022310	0.008609	0.047977	0.011875
L012-1	0.010129	0.000924	0.025297	0.007783	0.031679	0.009369
L013-1	0.015945	0.000924	-0.026477	0.007659	0.057778	0.010277

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L014-1	0.010378	0.002727	0.024513	0.007196	-0.019299	0.018773
L015-1	0.021146	0.001313	-0.002493	0.002441	-0.005756	0.007257
L016-1	0.010878	0.001221	0.005700	0.002959	0.003126	0.008514
L017-1	0.016102	0.001068	0.000034	0.001170	-0.001895	0.009896
L018-1	0.018842	0.001100	0.005569	0.001472	-0.010987	0.008328
L019-1	0.015019	0.000766	-0.002916	0.001399	0.059062	0.007066
L020-1	0.012315	0.000952	0.000229	0.001596	0.049425	0.007528
L021-1	0.015686	0.000598	0.002199	0.001889	0.063699	0.007800
L023-1	0.017854	0.000420	-0.001928	0.001622	0.051306	0.005125
L023-10	0.006373	0.001370	-0.006755	0.001704	-0.013813	0.005734
L023-2	0.006997	0.000545	-0.001007	0.000680	-0.023329	0.004791
L023-3	0.016111	0.000575	0.004506	0.001906	0.044613	0.005433
L023-6	0.094073	0.031244	0.225262	0.091030	0.066471	0.033759
L023-7	0.015350	0.000386	-0.001310	0.000861	-0.067191	0.004673
L023-9	0.003829	0.013316	-0.001302	0.004438	-0.009301	0.025205
L024-1	0.016967	0.000217	0.004548	0.000438	0.006617	0.004280
L025-1	0.016816	0.000151	-0.000277	0.000394	0.023347	0.004208
L026-1	0.015998	0.000127	0.006401	0.000374	0.039966	0.004246
L027-1	0.016484	0.000124	-0.000318	0.000351	0.041269	0.004230
L028-1	0.015403	0.000131	0.001779	0.000446	0.014052	0.004294
L029-1	0.018374	0.000161	-0.001062	0.000436	0.049719	0.004217
L030-1	0.019371	0.000139	0.003830	0.000526	0.029288	0.004217
L031-1	0.018392	0.000169	0.001935	0.000590	0.010459	0.004245
L032-1	0.029881	0.000306	-0.004703	0.000727	-0.028188	0.004321
L033-1	0.011761	0.000410	-0.001768	0.000746	-0.048859	0.004863
L034-1	0.019427	0.000362	-0.024308	0.000842	-0.056977	0.005026
L035-1	0.028714	0.000429	0.003432	0.000838	-0.036468	0.005211
L036-1	0.016298	0.000344	0.001533	0.000656	-0.021645	0.005006
L037-1	0.024070	0.000382	-0.005388	0.000673	-0.000048	0.004810
L038-1	0.019506	0.000325	0.000431	0.000640	-0.025217	0.004597
L039-1	0.018910	0.000284	0.001080	0.000694	-0.006169	0.004376
L040-1	0.019197	0.000278	-0.005885	0.000624	-0.024768	0.004382
L040-2	0.007386	0.000244	0.007341	0.000665	-0.002753	0.004389
L041-1	0.018177	0.000249	0.002893	0.000639	-0.033394	0.004407
L041-2	0.003773	0.000227	0.003081	0.000669	-0.024051	0.004388

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L042-1	0.021484	0.000267	-0.007830	0.000736	-0.032919	0.004427
L042-2	0.005378	0.000258	0.006565	0.000577	-0.023608	0.004440
L043-1	0.020218	0.000276	0.000315	0.000478	-0.063645	0.004377
L043-2	0.005838	0.000278	0.003075	0.000547	-0.022113	0.004372
L044-1	0.017850	0.000272	-0.003061	0.000462	-0.030399	0.004392
L044-2	0.007090	0.000257	0.001263	0.000429	-0.025551	0.004370
L045-1	0.019897	0.000243	-0.003471	0.000543	-0.057603	0.004396
L045-2	0.006646	0.000242	0.004313	0.000538	-0.043353	0.004397
L046-1	0.015753	0.000201	-0.006274	0.000520	-0.005030	0.004351
L046-2	0.007150	0.000241	0.000222	0.000548	-0.003014	0.004383
L047-1	0.018829	0.000212	-0.000847	0.000568	-0.008383	0.004295
L047-2	0.006364	0.000233	0.005233	0.000569	-0.041581	0.004315
L048-1	0.019400	0.000234	-0.001014	0.000581	-0.004777	0.004288
L048-2	0.010225	0.000251	0.000540	0.000596	-0.044375	0.004292
L049-1	0.019127	0.000222	0.000028	0.000546	0.029878	0.004276
L049-2	0.004901	0.000229	0.002954	0.000641	-0.053668	0.004306
L050-1	0.015651	0.000197	-0.004641	0.000427	0.064914	0.004243
L050-2	0.008133	0.000194	0.003303	0.000507	-0.050116	0.004250
L051-1	0.018298	0.000170	0.000893	0.000511	0.036829	0.004251
L051-2	0.005666	0.000172	0.000236	0.000515	-0.025182	0.004275
L052-1	0.015097	0.000187	-0.006163	0.000502	0.061481	0.004253
L053-1	0.016646	0.000229	0.002116	0.000523	0.042990	0.004294
L054-1	0.014655	0.000244	-0.001681	0.000461	0.069406	0.004390
L055-1	0.016134	0.000245	-0.003971	0.000444	0.068776	0.004463
L056-1	0.017677	0.000224	-0.002929	0.000347	0.050216	0.004422
L057-1	0.014917	0.000243	-0.001708	0.000349	0.027863	0.004398
L057-2	0.007452	0.000247	-0.003814	0.000357	0.042233	0.004393
L059-3	0.002745	0.001446	-0.005466	0.002569	-0.041044	0.021245
L059-4	0.005081	0.002386	-0.004574	0.001926	-0.044132	0.008845
L060-1	0.014045	0.001577	0.004254	0.002115	-0.008060	0.016706
L061-1	-0.003350	0.001812	0.001397	0.002456	0.004230	0.022554
L062-1	0.023366	0.015365	-0.006537	0.005546	-0.000314	0.035089
L063-1	-0.026652	0.049482	-0.000716	0.017693	0.000441	0.035118
L069-1	0.008366	0.000599	0.009779	0.001406	-0.049107	0.005147
L072-1	0.008172	0.000233	0.010759	0.000302	-0.057300	0.004497

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L073-1	0.006003	0.000226	-0.006298	0.000360	-0.024604	0.004546
L074-1	0.010481	0.000269	0.011760	0.000391	-0.014934	0.004827
L075-1	0.004628	0.000307	-0.007266	0.000413	0.005022	0.005034
L076-1	0.011459	0.000312	0.009557	0.000443	-0.014174	0.005136
L077-1	0.009566	0.000331	-0.003025	0.000464	0.015607	0.005083
L078-1	0.009988	0.000296	0.008478	0.000463	-0.023314	0.004797
L079-1	0.008798	0.000279	-0.002606	0.000409	0.022340	0.004591
L080-1	0.009620	0.000253	0.007587	0.000410	-0.004083	0.004419
L081-1	0.010940	0.000255	-0.002928	0.000365	0.004409	0.004402
L082-1	0.019624	0.000335	0.006744	0.000588	0.003612	0.004661
L082-3	0.017265	0.000831	0.007343	0.004279	0.008462	0.026760
L082-4	-0.432331	0.116112	-1.076288	0.300141	0.000187	0.035124

Roll outliers round 1: L082-4
Pitch outliers round 1: L002-1, L082-4
No elevation outliers.

Roll outliers round 2: L63-1 , L23-6
Pitch outliers round 2: L23-6
No elevation outliers round 2.

Roll outliers round 3: L10-1
Pitch outliers round 3: L12-1 , L13-1 , L14-1 , L34-1 , L1-6
No elevation outliers round 3.

No roll outliers round 4.
Pitch outliers round 4: L11-1
No elevation outliers round 4.

No roll outliers round 5.
Pitch outliers round 5: L6-2
No elevation outliers round 5.

No roll outliers round 6.
No pitch outliers round 6.
No elevation outliers round 6.

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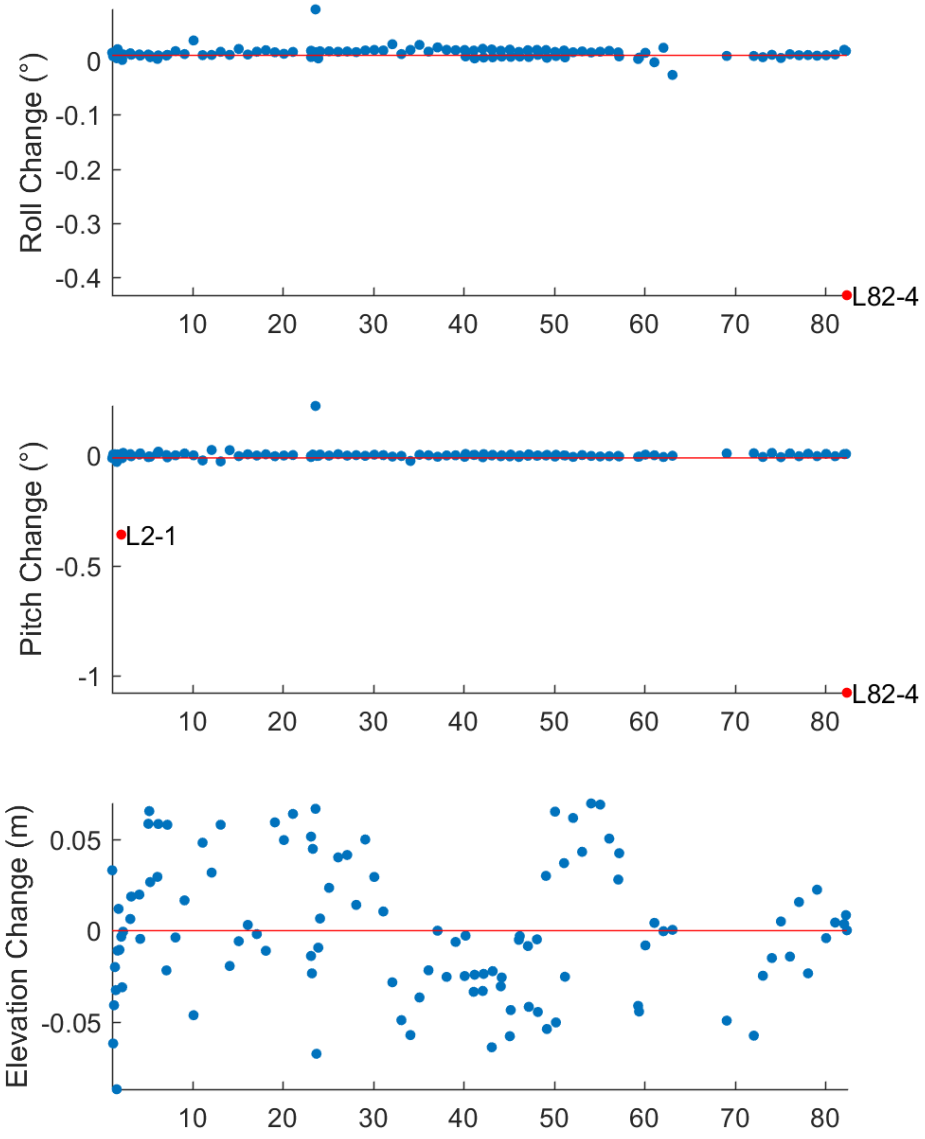

Figure 7: Block adjustments for roll, pitch, and elevation.

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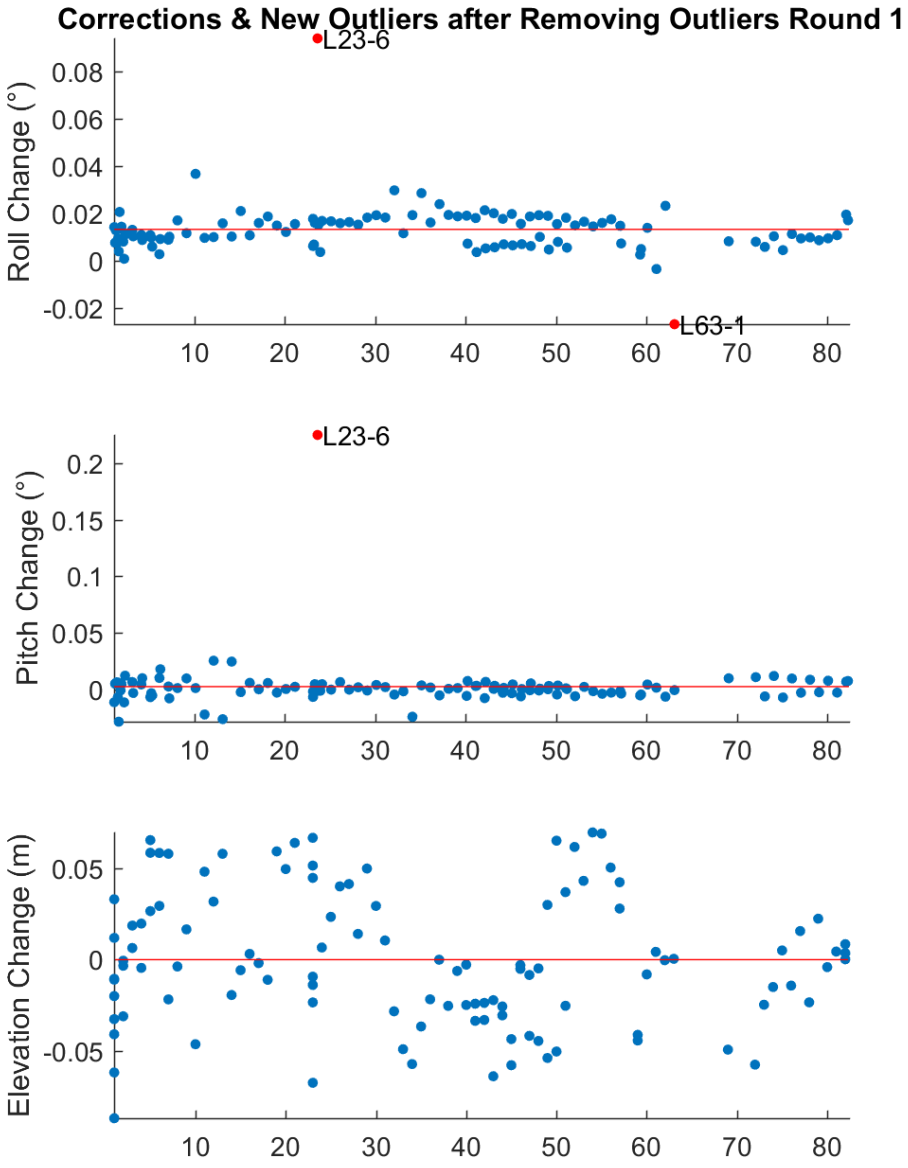

Figure 8: Block adjustments showing outliers (red points) once the 1st set of outliers were removed.

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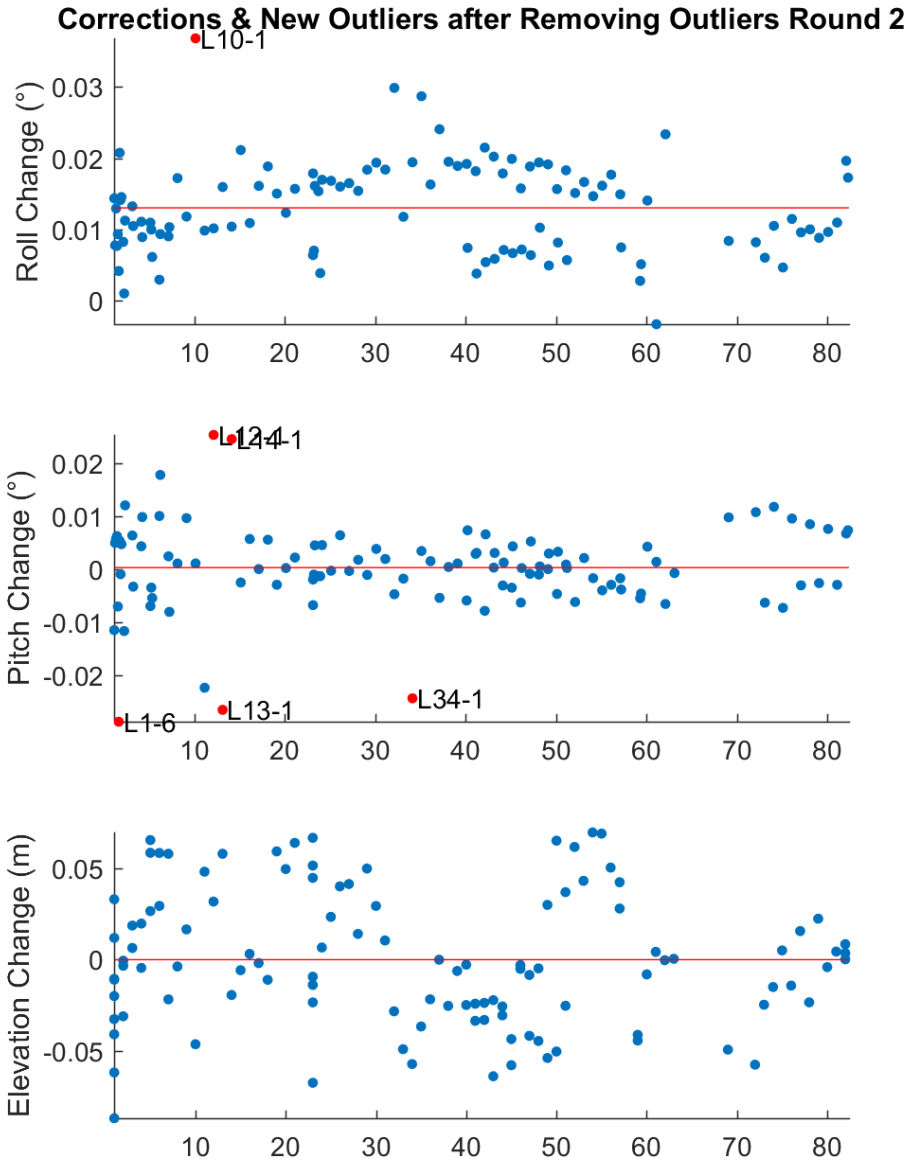

Figure 9: Block adjustments showing outliers (red points) once the 2nd set of outliers were removed.

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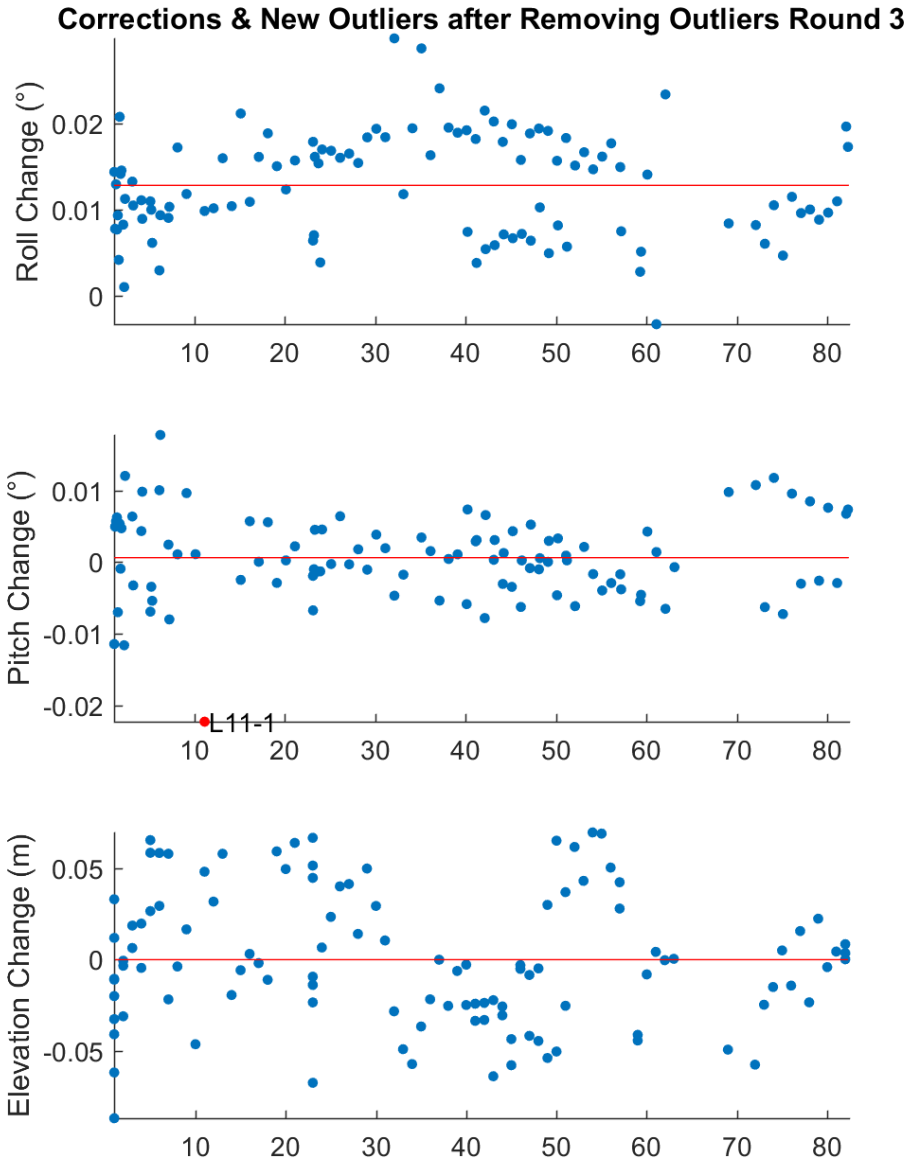

Figure 10: Block adjustments showing outliers (red points) once the 3rd set of outliers were removed.

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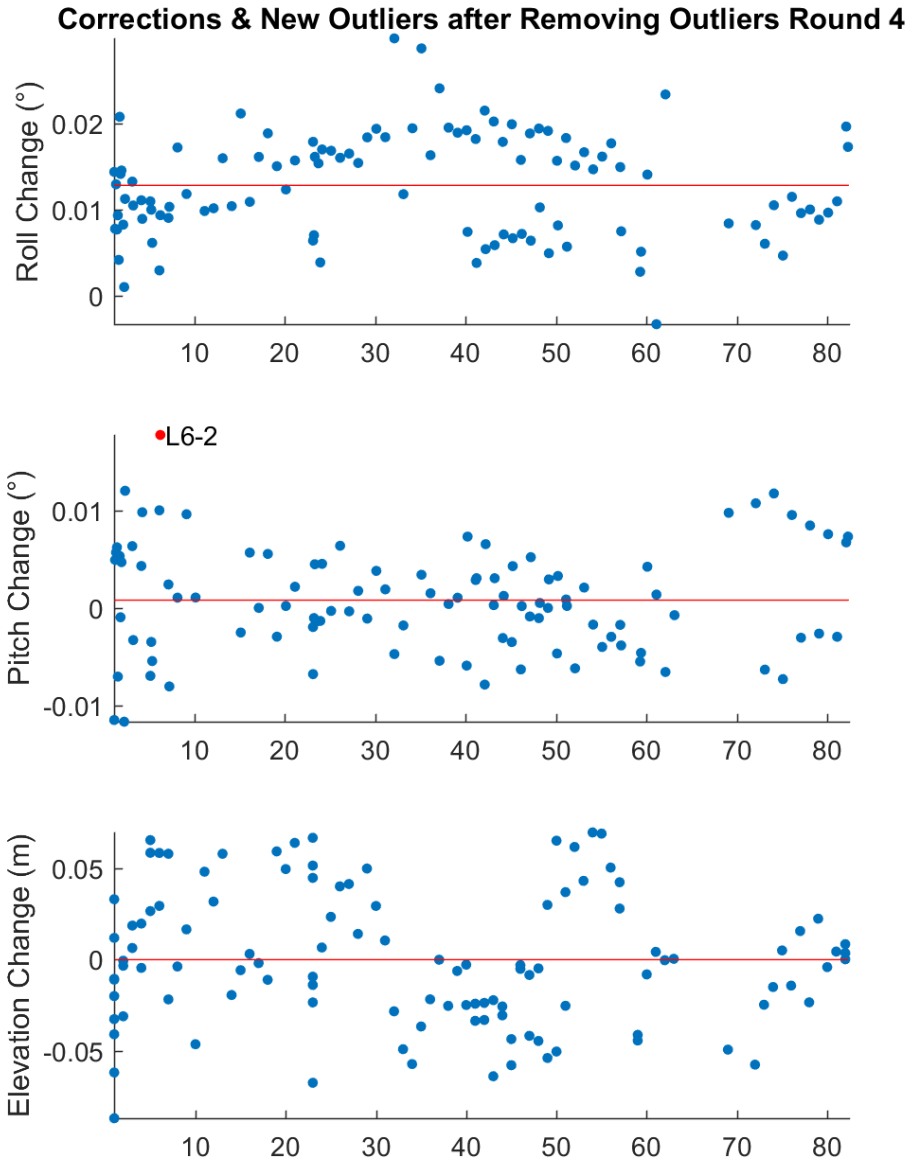

Figure 11: Block adjustments showing outliers (red points) once the4th set of outliers were removed.

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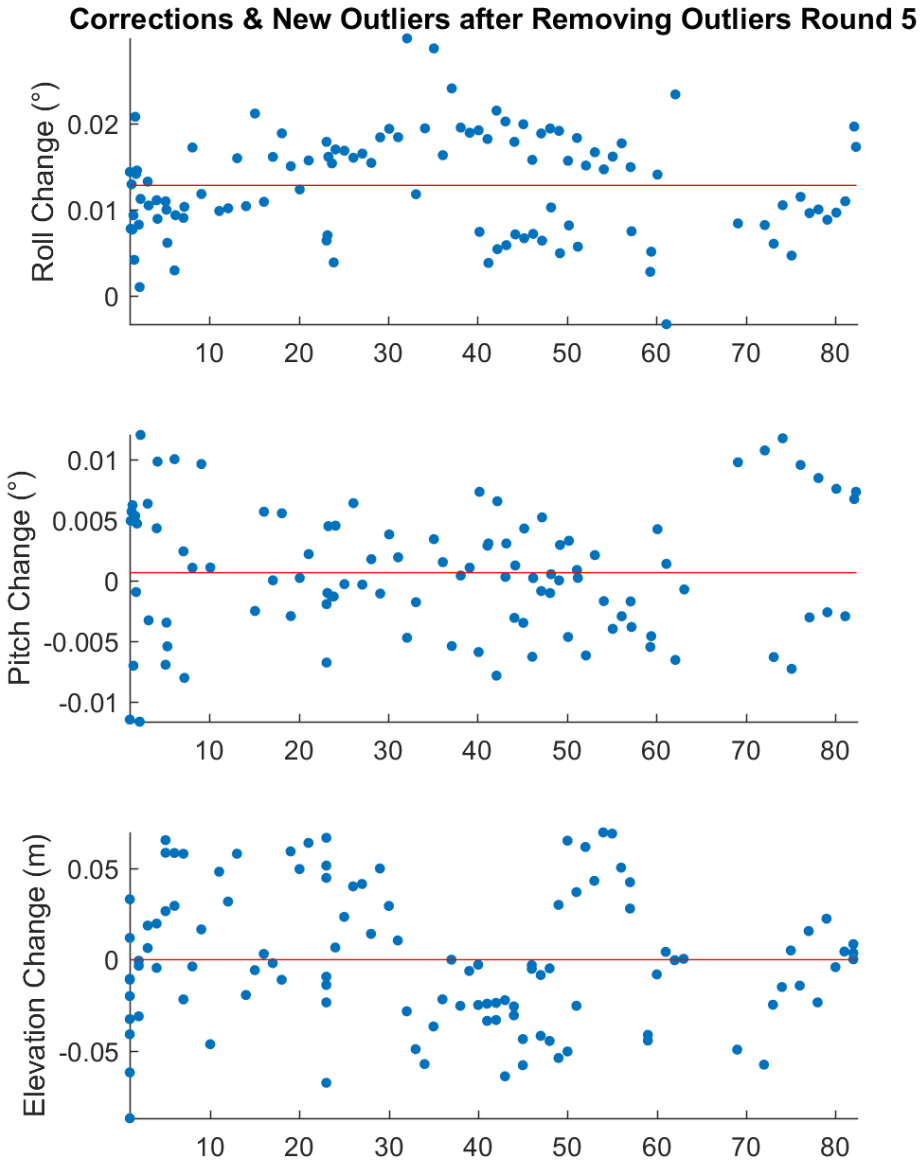

Figure 12: Block adjustments showing outliers (red points) once the5th set of outliers were removed.

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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 13, Figure 14, Figure 15 and Figure 16 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	175685	-0.393	0.389	-0.017	0.077	0.105
2	532	-0.171	0.130	-0.020	0.057	0.073
3	37623	-0.301	0.250	-0.001	0.060	0.069
4	34995	-0.252	0.257	-0.006	0.056	0.074
5	22137	-0.175	0.335	0.008	0.055	0.079
6	14002	-0.329	0.231	-0.008	0.062	0.086
7	12234	-0.266	0.260	-0.002	0.069	0.086
8	7817	-0.380	0.278	-0.004	0.093	0.086
9	11295	-0.276	0.345	0.008	0.076	0.083
10	4702	-0.256	0.194	-0.025	0.071	0.087
11	3811	-0.160	0.245	0.008	0.065	0.086
12	6776	-0.222	0.194	-0.006	0.063	0.082
13	4741	-0.236	0.222	0.002	0.067	0.085
14	3623	-0.311	0.188	-0.017	0.071	0.086
15	3333	-0.234	0.377	0.014	0.071	0.086
16	7278	-0.447	0.229	-0.026	0.072	0.085
17	6849	-0.234	0.279	0.014	0.080	0.092
18	8904	-0.412	0.362	-0.001	0.098	0.085
19	11968	-0.346	0.377	-0.011	0.086	0.085
20	13099	-0.333	0.259	-0.007	0.073	0.088
21	8500	-0.298	0.277	-0.027	0.083	0.085
23	14688	-0.356	0.434	0.028	0.089	0.117
24	179821	-0.437	0.465	-0.013	0.086	0.109
25	204967	-0.529	0.470	-0.012	0.089	0.108

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26	213517	-0.505	0.526	-0.008	0.095	0.112
27	206294	-0.507	0.598	-0.008	0.097	0.114
28	168756	-0.454	0.452	0.006	0.093	0.119
29	109852	-0.514	0.395	-0.035	0.099	0.110
30	139576	-0.379	0.403	-0.024	0.088	0.112
31	147434	-0.483	0.416	0.010	0.098	0.102
32	91625	-0.464	0.455	0.017	0.094	0.101
33	81999	-0.430	0.421	0.028	0.098	0.101
34	35725	-0.513	0.376	-0.037	0.118	0.114
35	24020	-0.435	0.412	-0.000	0.114	0.104
36	46736	-0.392	0.432	0.037	0.108	0.109
37	48575	-0.405	0.439	-0.003	0.104	0.096
38	65300	-0.418	0.409	-0.024	0.099	0.103
39	67822	-0.365	0.400	-0.007	0.082	0.094
40	75374	-0.546	0.357	-0.015	0.084	0.091
41	57027	-0.326	0.401	0.036	0.087	0.089
42	56136	-0.460	0.317	-0.005	0.082	0.093
43	56170	-0.358	0.351	0.020	0.081	0.086
44	52880	-0.381	0.316	-0.007	0.078	0.092
45	64761	-0.432	0.366	0.003	0.074	0.086
46	108201	-0.376	0.363	0.000	0.073	0.087
47	83560	-0.397	0.529	0.008	0.077	0.087
48	75982	-0.427	0.365	-0.041	0.091	0.092
49	65599	-0.378	0.292	-0.041	0.089	0.092
50	107110	-0.393	0.379	-0.031	0.083	0.090
51	117442	-0.454	0.410	-0.007	0.078	0.093
52	79774	-0.366	0.408	-0.025	0.093	0.102
53	65294	-0.357	0.574	0.008	0.087	0.097
54	80966	-0.457	0.340	-0.026	0.089	0.097
55	69801	-0.410	0.479	0.022	0.090	0.096
56	111137	-0.594	0.463	-0.006	0.079	0.089
57	149516	-0.394	0.452	-0.000	0.082	0.089
59	85	-0.228	0.114	-0.054	0.080	0.091
60	8072	-0.316	0.223	-0.026	0.079	0.088
61	4250	-0.334	0.242	-0.000	0.085	0.102

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62	2078	-0.230	0.141	-0.015	0.061	0.097
63	570	-0.139	0.263	0.058	0.090	0.093
69	14490	-0.262	0.298	-0.012	0.070	0.087
72	120403	-0.292	0.416	0.035	0.083	0.084
73	100799	-0.343	0.359	0.006	0.069	0.085
74	84696	-0.313	0.544	-0.011	0.066	0.081
75	66102	-0.372	0.412	-0.000	0.064	0.085
76	58131	-0.307	0.288	0.007	0.063	0.083
77	48699	-0.404	0.312	-0.019	0.071	0.081
78	60367	-0.235	0.468	0.032	0.074	0.084
79	72025	-0.361	0.282	-0.020	0.070	0.085
80	82355	-0.362	0.331	0.009	0.073	0.082
81	63607	-0.411	0.455	-0.018	0.086	0.084
82	20918	-0.342	0.441	0.020	0.100	0.090
1	23554	-0.292	0.402	0.012	0.071	0.092
2	3265	-0.300	0.221	0.023	0.067	0.079
3	34650	-0.282	0.233	-0.013	0.061	0.069
4	31439	-0.294	0.271	0.022	0.060	0.076
5	15758	-0.244	0.252	-0.013	0.059	0.073
6	12267	-0.282	0.272	0.001	0.063	0.084
7	11141	-0.320	0.245	0.004	0.063	0.085
23	25508	-0.273	0.439	0.012	0.089	0.102
40	88786	-0.255	0.396	0.007	0.069	0.092
41	65779	-0.361	0.315	-0.004	0.068	0.089
42	54496	-0.316	0.270	-0.010	0.070	0.085
43	56125	-0.421	0.295	-0.012	0.073	0.086
44	62936	-0.277	0.354	-0.001	0.066	0.089
45	62609	-0.284	0.328	0.012	0.066	0.082
46	98229	-0.278	0.365	-0.010	0.066	0.083
47	91522	-0.308	0.348	0.010	0.066	0.081
48	66632	-0.367	0.389	0.032	0.079	0.091
49	61410	-0.246	0.358	0.034	0.078	0.087
50	106280	-0.309	0.484	0.034	0.076	0.087
51	116065	-0.304	0.390	0.024	0.076	0.094
57	145020	-0.513	0.427	-0.028	0.077	0.082

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59	944	-0.294	0.138	-0.020	0.068	0.091
82	0	0	0	0	0	0
1	230779	-0.460	0.457	0.017	0.086	0.108
2	10436	-0.239	0.226	-0.009	0.059	0.076
5	17653	-0.243	0.245	0.002	0.055	0.076
23	21328	-0.303	0.333	-0.013	0.084	0.106
59	5872	-0.198	0.242	0.026	0.063	0.082
82	4295	-0.317	0.362	0.026	0.107	0.092
1	278848	-0.364	0.461	0.019	0.078	0.107
23	0	0	0	0	0	0
59	3834	-0.166	0.294	0.019	0.070	0.088
82	192	-0.068	0.275	0.087	0.113	0.132
1	7649	-0.238	0.411	0.023	0.072	0.105
23	220	-0.129	0.163	0.017	0.063	0.092
1	4059	-0.218	0.255	0.024	0.080	0.107
23	4916	-0.258	0.192	-0.015	0.061	0.091
1	23620	-0.280	0.359	0.014	0.073	0.088
23	44093	-0.287	0.512	0.049	0.096	0.096
1	11194	-0.274	0.432	0.009	0.087	0.108
1	275672	-0.380	0.462	0.007	0.078	0.112
23	3220	-0.255	0.313	0.000	0.055	0.075
23	8641	-0.299	0.327	0.011	0.081	0.098

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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	28088	-0.345	0.354	-0.003	0.080	0.104
2	109	-0.143	0.076	-0.039	0.062	0.074
3	6422	-0.301	0.227	-0.013	0.067	0.073
4	5726	-0.199	0.193	0.000	0.056	0.073
5	1101	-0.157	0.165	0.008	0.058	0.084
6	4752	-0.329	0.226	-0.009	0.069	0.093
7	3154	-0.266	0.260	0.018	0.083	0.086
8	2725	-0.323	0.278	0.003	0.093	0.088
9	4033	-0.274	0.230	-0.002	0.065	0.084
10	1233	-0.226	0.125	-0.066	0.094	0.085
11	1610	-0.160	0.245	-0.011	0.061	0.084
12	1823	-0.218	0.164	-0.001	0.060	0.082
13	2268	-0.166	0.222	0.024	0.067	0.091
14	1198	-0.288	0.170	-0.032	0.069	0.078
15	1584	-0.234	0.377	0.015	0.072	0.083
16	2014	-0.207	0.191	-0.017	0.062	0.082
17	2161	-0.234	0.216	0.010	0.077	0.102
18	2465	-0.284	0.324	0.003	0.083	0.084
19	3040	-0.309	0.280	-0.019	0.074	0.086
20	2854	-0.242	0.209	-0.005	0.075	0.083
21	3641	-0.239	0.186	-0.051	0.081	0.087
23	6288	-0.356	0.434	0.028	0.091	0.117
24	37914	-0.375	0.347	-0.022	0.087	0.109
25	44357	-0.477	0.425	-0.014	0.097	0.107
26	48539	-0.414	0.526	-0.002	0.095	0.112
27	42132	-0.478	0.358	-0.021	0.100	0.114
28	35776	-0.372	0.437	0.012	0.102	0.123
29	27994	-0.396	0.299	-0.037	0.101	0.110
30	37871	-0.379	0.383	-0.031	0.090	0.112
31	37809	-0.348	0.357	0.008	0.094	0.100
32	21616	-0.356	0.455	0.021	0.097	0.100
33	19841	-0.352	0.407	0.046	0.101	0.105
34	8775	-0.322	0.324	-0.052	0.113	0.120

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35	5696	-0.341	0.372	-0.032	0.104	0.101
36	13237	-0.272	0.391	0.053	0.110	0.109
37	11656	-0.373	0.349	0.001	0.096	0.094
38	17457	-0.418	0.309	-0.031	0.095	0.103
39	15654	-0.365	0.344	-0.026	0.094	0.094
40	13796	-0.546	0.357	-0.003	0.089	0.091
41	12662	-0.320	0.331	0.047	0.094	0.093
42	9277	-0.379	0.317	-0.024	0.103	0.099
43	13192	-0.358	0.329	0.007	0.083	0.085
44	10241	-0.381	0.289	-0.007	0.086	0.091
45	13959	-0.432	0.366	0.014	0.085	0.088
46	25273	-0.376	0.258	0.006	0.087	0.092
47	18320	-0.397	0.382	0.002	0.084	0.091
48	22610	-0.410	0.365	-0.051	0.096	0.096
49	14666	-0.356	0.292	-0.056	0.100	0.095
50	24572	-0.393	0.342	-0.036	0.089	0.092
51	24097	-0.390	0.295	-0.006	0.087	0.096
52	22572	-0.337	0.378	-0.013	0.097	0.103
53	20225	-0.290	0.369	0.005	0.079	0.099
54	22039	-0.442	0.328	-0.028	0.093	0.099
55	15540	-0.281	0.408	0.015	0.090	0.094
56	27486	-0.347	0.273	-0.012	0.076	0.094
57	28744	-0.390	0.396	-0.011	0.084	0.089
59	0	0	0	0	0	0
60	2498	-0.316	0.198	-0.034	0.079	0.085
61	1089	-0.237	0.202	0.011	0.080	0.103
62	543	-0.184	0.130	-0.014	0.062	0.101
63	87	-0.046	0.258	0.098	0.116	0.105
69	3178	-0.242	0.298	-0.008	0.073	0.091
72	34334	-0.278	0.338	0.037	0.082	0.087
73	30555	-0.343	0.359	0.002	0.068	0.089
74	24164	-0.313	0.544	-0.010	0.069	0.081
75	19994	-0.302	0.298	-0.001	0.061	0.084
76	18865	-0.284	0.285	0.006	0.065	0.085
77	14137	-0.315	0.312	-0.015	0.073	0.082

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78	16508	-0.235	0.468	0.034	0.078	0.086
79	20981	-0.321	0.276	-0.019	0.072	0.087
80	27725	-0.294	0.331	0.006	0.070	0.084
81	18494	-0.411	0.322	-0.025	0.089	0.085
82	6309	-0.310	0.441	0.041	0.109	0.095
1	4250	-0.173	0.235	0.025	0.067	0.076
2	754	-0.127	0.199	0.023	0.058	0.076
3	5421	-0.207	0.211	-0.008	0.063	0.071
4	5326	-0.294	0.271	0.025	0.069	0.079
5	1612	-0.209	0.216	-0.026	0.070	0.077
6	2153	-0.282	0.272	-0.000	0.081	0.088
7	3004	-0.320	0.230	-0.000	0.078	0.098
23	4931	-0.269	0.286	0.034	0.090	0.103
40	18914	-0.249	0.332	0.001	0.068	0.093
41	16248	-0.289	0.261	0.003	0.065	0.093
42	12788	-0.276	0.254	-0.010	0.070	0.086
43	10714	-0.288	0.295	-0.002	0.068	0.085
44	14334	-0.277	0.294	0.003	0.063	0.089
45	13145	-0.284	0.301	0.013	0.066	0.084
46	18283	-0.253	0.365	-0.009	0.068	0.083
47	20124	-0.245	0.298	0.024	0.071	0.082
48	15473	-0.244	0.347	0.026	0.072	0.093
49	11986	-0.184	0.358	0.041	0.083	0.090
50	24092	-0.275	0.401	0.040	0.079	0.090
51	26815	-0.268	0.390	0.023	0.074	0.100
57	26911	-0.317	0.281	-0.026	0.071	0.087
59	0	0	0	0	0	0
82	0	0	0	0	0	0
1	37551	-0.460	0.399	0.032	0.093	0.103
2	2397	-0.239	0.151	-0.019	0.059	0.074
5	2695	-0.222	0.209	0.009	0.058	0.085
23	3463	-0.223	0.259	0.005	0.075	0.111
59	1884	-0.149	0.242	0.029	0.068	0.085
82	1249	-0.184	0.304	0.038	0.109	0.095
1	43661	-0.299	0.394	0.020	0.077	0.102

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23	0	0	0	0	0	0
59	1152	-0.166	0.266	0.023	0.071	0.091
82	192	-0.068	0.275	0.087	0.113	0.132
1	870	-0.222	0.305	0.040	0.089	0.108
23	0	0	0	0	0	0
1	1557	-0.117	0.255	0.053	0.094	0.108
23	299	-0.258	0.178	-0.054	0.097	0.107
1	5317	-0.228	0.359	0.027	0.079	0.083
23	8141	-0.222	0.355	0.057	0.104	0.101
1	781	-0.208	0.322	0.040	0.100	0.115
1	36314	-0.291	0.462	0.017	0.083	0.108
23	651	-0.255	0.131	-0.007	0.054	0.067
23	1186	-0.183	0.234	-0.007	0.074	0.096

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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	175685	-0.317	0.350	-0.000	0.066	0.105
2	532	-0.516	0.922	0.200	0.368	0.073
3	37623	-1.064	0.507	0.002	0.054	0.069
4	34995	-0.248	0.219	-0.001	0.051	0.074
5	22137	-0.184	0.276	0.003	0.051	0.079
6	14002	-0.309	0.232	-0.000	0.058	0.086
7	12234	-0.246	0.196	-0.005	0.062	0.086
8	7817	-0.215	0.196	-0.007	0.058	0.086
9	11295	-0.270	0.367	0.028	0.078	0.083
10	4702	-0.461	0.202	-0.061	0.102	0.087
11	3811	-0.159	0.162	-0.002	0.052	0.086
12	6776	-0.214	0.168	0.000	0.053	0.082
13	4741	-0.192	0.186	0.000	0.056	0.085
14	3623	-0.355	0.206	-0.009	0.063	0.086
15	3333	-0.193	0.226	-0.004	0.056	0.086
16	7278	-0.302	0.202	-0.003	0.054	0.085
17	6849	-0.173	0.211	0.004	0.057	0.092
18	8904	-0.270	0.204	-0.004	0.055	0.085
19	11968	-0.210	0.219	-0.005	0.057	0.085
20	13099	-0.242	0.210	0.001	0.057	0.088
21	8500	-0.180	0.231	0.002	0.054	0.085
23	14688	-0.326	0.370	-0.004	0.076	0.117
24	179821	-0.323	0.363	-0.001	0.064	0.109
25	204967	-0.374	0.367	-0.001	0.064	0.108
26	213517	-0.436	0.467	-0.002	0.065	0.112
27	206294	-0.353	0.455	0.000	0.067	0.114
28	168756	-0.410	0.370	-0.001	0.070	0.119
29	109852	-0.313	0.360	-0.000	0.067	0.110
30	139576	-0.393	0.316	-0.003	0.067	0.112
31	147434	-0.376	0.306	-0.000	0.062	0.102
32	91625	-0.267	0.334	-0.001	0.062	0.101
33	81999	-0.338	0.340	-0.002	0.063	0.101
34	35725	-0.326	0.385	0.002	0.070	0.114

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35	24020	-0.291	0.288	-0.000	0.067	0.104
36	46736	-0.299	0.396	0.001	0.062	0.109
37	48575	-0.250	0.311	0.001	0.059	0.097
38	65300	-0.307	0.297	-0.003	0.060	0.103
39	67822	-0.321	0.308	-0.001	0.058	0.094
40	75374	-0.419	0.405	-0.003	0.059	0.091
41	57027	-0.237	0.254	-0.003	0.057	0.089
42	56136	-0.289	0.275	0.002	0.058	0.093
43	56170	-0.258	0.249	-0.002	0.056	0.086
44	52880	-0.249	0.271	-0.000	0.057	0.092
45	64761	-0.237	0.256	-0.001	0.055	0.086
46	108201	-0.258	0.275	0.000	0.056	0.087
47	83560	-0.269	0.305	0.001	0.057	0.087
48	75982	-0.258	0.278	-0.002	0.057	0.092
49	65599	-0.260	0.333	-0.000	0.059	0.092
50	107110	-0.322	0.357	-0.000	0.058	0.090
51	117442	-0.298	0.275	-0.000	0.059	0.093
52	79774	-0.312	0.324	-0.001	0.063	0.102
53	65294	-0.274	0.306	-0.002	0.061	0.097
54	80966	-0.270	0.303	-0.003	0.060	0.097
55	69801	-0.274	0.326	0.001	0.061	0.096
56	111137	-0.270	0.336	0.005	0.060	0.089
57	149516	-0.329	0.330	0.002	0.063	0.089
59	85	-0.195	0.150	-0.027	0.065	0.091
60	8072	-0.233	0.204	-0.004	0.060	0.088
61	4250	-0.276	0.286	-0.004	0.067	0.102
62	2078	-0.190	0.168	0.002	0.059	0.097
63	570	-0.256	0.208	-0.027	0.084	0.093
69	14490	-0.254	0.268	-0.002	0.059	0.087
72	120403	-0.340	0.273	-0.001	0.059	0.084
73	100799	-0.334	0.291	-0.000	0.057	0.085
74	84696	-0.351	0.415	-0.001	0.055	0.081
75	66102	-0.318	0.262	-0.001	0.055	0.085
76	58131	-0.342	0.235	-0.002	0.054	0.083
77	48699	-0.308	0.243	-0.002	0.053	0.081

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78	60367	-0.270	0.245	-0.000	0.054	0.084
79	72025	-0.226	0.291	0.001	0.054	0.085
80	82355	-0.242	0.247	0.000	0.053	0.082
81	63607	-0.248	0.252	-0.003	0.054	0.084
82	20918	-0.308	0.246	0.003	0.056	0.090
1	23554	-0.241	0.286	0.002	0.059	0.092
2	3265	-0.284	0.176	0.000	0.056	0.079
3	34650	-0.248	0.233	-0.003	0.050	0.069
4	31439	-0.309	0.245	-0.000	0.052	0.076
5	15758	-0.221	0.230	0.002	0.053	0.073
6	12267	-0.247	0.244	0.000	0.057	0.084
7	11141	-0.213	0.238	0.003	0.060	0.085
23	25508	-0.260	0.407	-0.002	0.066	0.102
40	88786	-0.266	0.307	0.001	0.058	0.092
41	65779	-0.287	0.378	-0.000	0.058	0.089
42	54496	-0.267	0.267	-0.002	0.057	0.085
43	56125	-0.245	0.248	-0.001	0.056	0.086
44	62936	-0.322	0.280	0.000	0.056	0.089
45	62609	-0.232	0.270	-0.001	0.055	0.082
46	98229	-0.255	0.322	-0.001	0.055	0.083
47	91522	-0.241	0.339	-0.002	0.055	0.081
48	66632	-0.351	0.277	0.001	0.057	0.091
49	61410	-0.247	0.311	-0.002	0.058	0.087
50	106280	-0.315	0.456	-0.001	0.057	0.087
51	116065	-0.272	0.298	0.000	0.059	0.094
57	145020	-0.473	0.333	-0.006	0.063	0.082
59	944	-0.265	0.161	-0.006	0.062	0.091
82	0	0	0	0	0	0
1	230779	-0.371	0.388	-0.001	0.066	0.108
2	10436	-1.159	0.507	-0.008	0.097	0.076
5	17653	-0.264	0.238	-0.009	0.054	0.076
23	21328	-0.284	0.358	0.003	0.068	0.106
59	5872	-0.189	0.184	0.001	0.052	0.082
82	4295	-0.180	0.204	0.002	0.059	0.092
1	278848	-0.326	0.492	0.003	0.066	0.107

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23	0	0	0	0	0	0
59	3834	-0.210	0.218	-0.000	0.059	0.088
82	192	-0.155	0.233	-0.002	0.079	0.132
1	7649	-0.239	0.311	0.003	0.062	0.105
23	220	-0.106	0.189	0.040	0.071	0.092
1	4059	-0.277	0.176	-0.023	0.070	0.107
23	4916	-0.227	0.269	0.021	0.062	0.091
1	23620	-0.253	0.274	0.000	0.056	0.088
23	44093	-0.342	0.412	0.000	0.070	0.096
1	11194	-0.225	0.246	-0.004	0.062	0.108
1	275672	-0.338	0.334	-0.002	0.067	0.112
23	3220	-0.243	0.310	0.002	0.054	0.075
23	8641	-0.254	0.274	-0.001	0.065	0.098

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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	28088	-0.271	0.331	-0.002	0.067	0.104
2	109	-0.094	0.102	0.000	0.042	0.074
3	6422	-0.228	0.212	-0.003	0.053	0.073
4	5726	-0.159	0.157	-0.001	0.048	0.073
5	1101	-0.160	0.145	-0.002	0.053	0.084
6	4752	-0.309	0.227	0.002	0.063	0.093
7	3154	-0.246	0.196	-0.001	0.063	0.086
8	2725	-0.196	0.196	-0.002	0.056	0.088
9	4033	-0.176	0.151	-0.001	0.049	0.084
10	1233	-0.175	0.138	0.000	0.052	0.085
11	1610	-0.157	0.156	-0.000	0.051	0.084
12	1823	-0.160	0.168	-0.001	0.053	0.082
13	2268	-0.176	0.168	-0.000	0.055	0.091
14	1198	-0.212	0.206	-0.001	0.054	0.078
15	1584	-0.186	0.223	-0.000	0.054	0.083
16	2014	-0.150	0.161	-0.000	0.052	0.082
17	2161	-0.156	0.199	-0.001	0.056	0.102
18	2465	-0.171	0.203	-0.000	0.052	0.084
19	3040	-0.173	0.205	-0.001	0.053	0.086
20	2854	-0.163	0.160	-0.000	0.052	0.083
21	3641	-0.180	0.186	-0.001	0.054	0.087
23	6288	-0.262	0.370	0.000	0.075	0.117
24	37914	-0.293	0.330	-0.001	0.063	0.109
25	44357	-0.299	0.333	-0.000	0.064	0.107
26	48539	-0.289	0.467	-0.000	0.066	0.112
27	42132	-0.313	0.372	-0.001	0.069	0.114
28	35776	-0.410	0.370	-0.002	0.072	0.123
29	27994	-0.239	0.284	-0.002	0.065	0.110
30	37871	-0.393	0.289	-0.000	0.066	0.112
31	37809	-0.376	0.300	-0.001	0.060	0.100
32	21616	-0.236	0.311	-0.000	0.062	0.100
33	19841	-0.241	0.279	-0.000	0.060	0.105
34	8775	-0.232	0.385	-0.002	0.070	0.120

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35	5696	-0.268	0.251	-0.000	0.064	0.101
36	13237	-0.243	0.313	0.002	0.061	0.109
37	11656	-0.236	0.205	0.000	0.057	0.094
38	17457	-0.302	0.240	-0.004	0.059	0.103
39	15654	-0.321	0.308	-0.000	0.060	0.094
40	13796	-0.419	0.405	-0.002	0.060	0.091
41	12662	-0.225	0.229	-0.004	0.058	0.093
42	9277	-0.244	0.258	-0.001	0.060	0.099
43	13192	-0.248	0.249	-0.002	0.054	0.085
44	10241	-0.249	0.237	-0.001	0.058	0.091
45	13959	-0.229	0.256	-0.002	0.056	0.088
46	27236	-0.223	0.275	-0.001	0.056	0.092
47	18320	-0.224	0.305	-0.002	0.057	0.091
48	22610	-0.238	0.278	-0.001	0.057	0.096
49	14666	-0.238	0.333	-0.002	0.060	0.095
50	24572	-0.322	0.274	-0.001	0.060	0.092
51	24097	-0.264	0.252	-0.003	0.060	0.096
52	22572	-0.249	0.307	0.000	0.062	0.103
53	20225	-0.274	0.306	-0.000	0.061	0.099
54	22039	-0.270	0.303	-0.002	0.061	0.099
55	15540	-0.240	0.310	0.000	0.060	0.094
56	27486	-0.229	0.238	-0.000	0.059	0.094
57	28713	-0.329	0.330	-0.000	0.066	0.089
59	0	0	0	0	0	0
60	2498	-0.233	0.204	-0.001	0.063	0.085
61	1089	-0.184	0.224	-0.001	0.059	0.103
62	543	-0.146	0.149	-0.000	0.057	0.101
63	87	-0.128	0.165	-0.000	0.061	0.105
69	3178	-0.200	0.198	-0.000	0.060	0.091
72	34286	-0.340	0.252	-0.001	0.060	0.087
73	30555	-0.334	0.291	-0.000	0.059	0.089
74	24164	-0.351	0.415	-0.000	0.057	0.082
75	19994	-0.297	0.256	-0.001	0.054	0.084
76	18865	-0.202	0.235	-0.003	0.054	0.085
77	14137	-0.264	0.243	-0.001	0.055	0.082

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78	16508	-0.227	0.245	-0.000	0.056	0.086
79	20981	-0.226	0.291	0.000	0.056	0.087
80	27725	-0.216	0.247	-0.000	0.053	0.084
81	18494	-0.248	0.251	-0.002	0.056	0.085
82	6309	-0.308	0.246	0.005	0.061	0.095
1	4250	-0.174	0.193	-0.000	0.050	0.076
2	754	-0.139	0.136	-0.000	0.051	0.076
3	5421	-0.179	0.233	-0.000	0.053	0.071
4	5326	-0.309	0.245	0.001	0.058	0.079
5	1612	-0.180	0.230	0.000	0.057	0.077
6	2153	-0.247	0.212	-0.007	0.067	0.088
7	3004	-0.195	0.182	0.000	0.062	0.098
23	4931	-0.232	0.245	-0.002	0.059	0.103
40	18914	-0.219	0.307	0.001	0.058	0.093
41	16248	-0.224	0.235	0.000	0.057	0.093
42	12788	-0.219	0.267	-0.000	0.056	0.086
43	10714	-0.245	0.248	0.000	0.056	0.085
44	14334	-0.322	0.222	0.001	0.057	0.089
45	13145	-0.207	0.230	-0.000	0.056	0.084
46	18394	-0.215	0.266	0.000	0.056	0.083
47	22702	-0.221	0.253	0.000	0.054	0.080
48	15473	-0.210	0.260	-0.000	0.057	0.093
49	11986	-0.239	0.266	0.000	0.058	0.090
50	24092	-0.276	0.393	0.000	0.061	0.090
51	26815	-0.272	0.286	0.001	0.060	0.100
57	26911	-0.374	0.333	-0.000	0.059	0.087
59	0	0	0	0	0	0
82	0	0	0	0	0	0
1	37926	-0.300	0.321	-0.000	0.065	0.103
2	2397	-0.186	0.187	-0.001	0.055	0.074
5	2695	-0.190	0.200	-0.001	0.056	0.085
23	3463	-0.206	0.250	-0.000	0.069	0.111
59	1884	-0.143	0.182	0.000	0.054	0.085
82	1249	-0.160	0.148	-0.002	0.056	0.095
1	43661	-0.261	0.325	0.002	0.064	0.102

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23	0	0	0	0	0	0
59	1152	-0.210	0.218	-0.002	0.063	0.091
82	192	-0.155	0.233	-0.002	0.079	0.132
1	870	-0.164	0.311	0.007	0.068	0.108
23	0	0	0	0	0	0
1	1557	-0.146	0.176	-0.001	0.056	0.108
23	299	-0.227	0.170	-0.001	0.068	0.107
1	5317	-0.213	0.188	0.000	0.051	0.083
23	8141	-0.237	0.253	-0.000	0.071	0.101
1	781	-0.225	0.246	-0.007	0.072	0.115
1	36508	-0.338	0.320	0.000	0.066	0.108
23	651	-0.243	0.144	-0.000	0.053	0.067
23	1186	-0.188	0.182	-0.003	0.061	0.096

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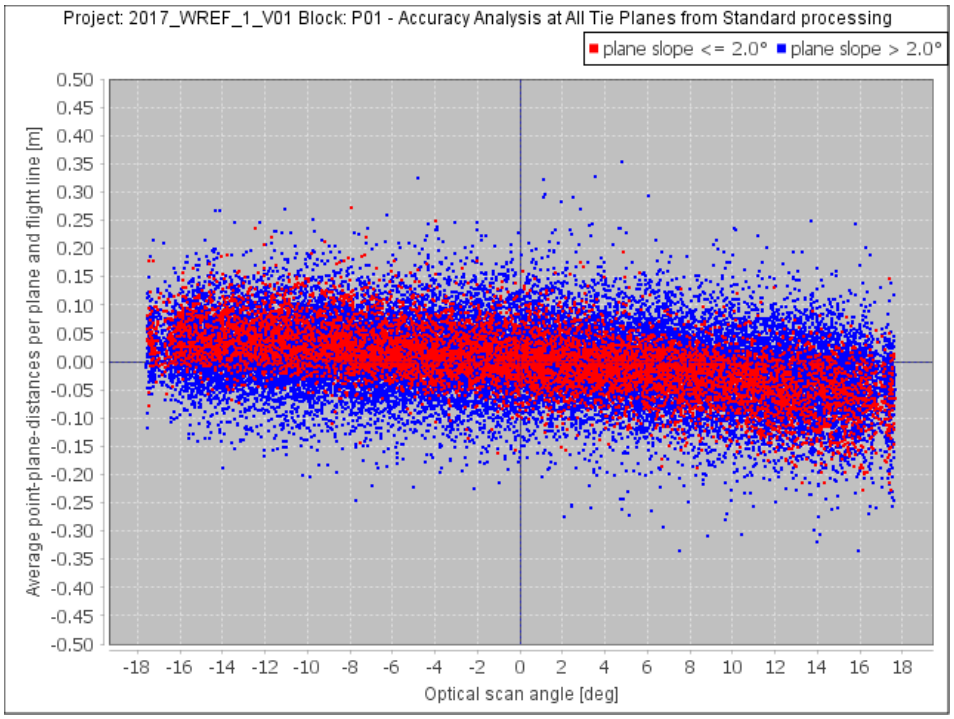

Figure 13: Mean point to plane distance from standard processing

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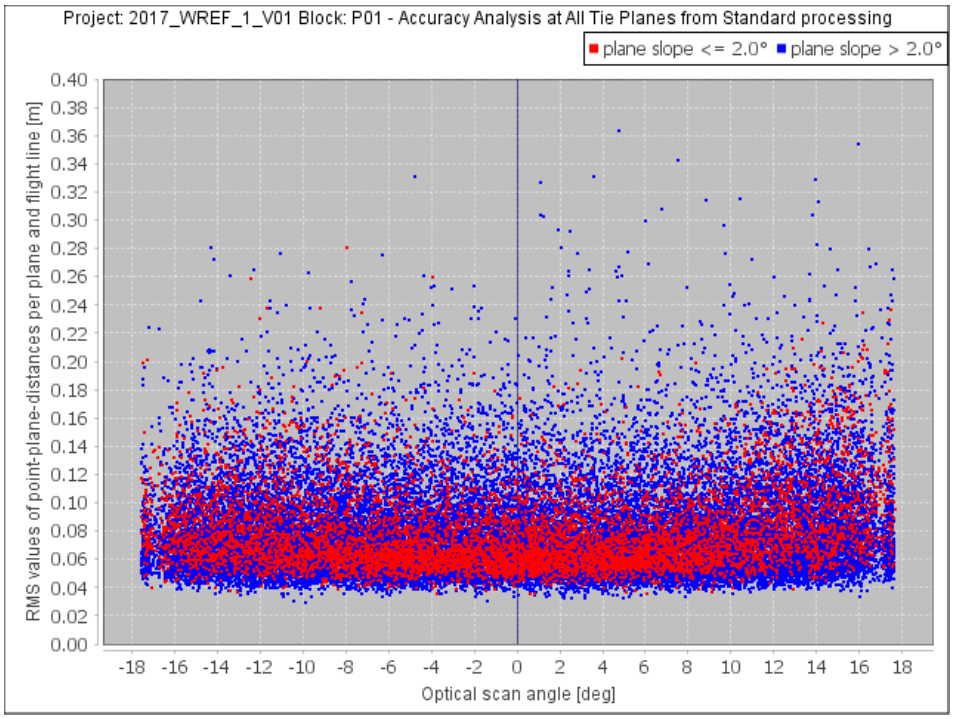

Figure 14: RMS point to plane distance from standard processing

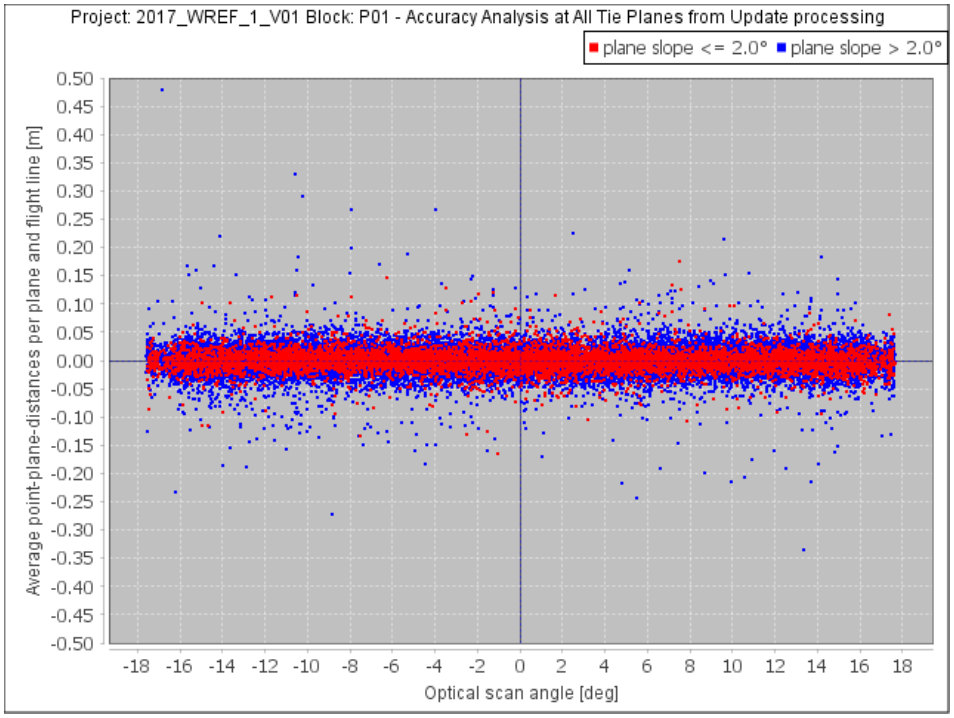

Figure 15: Mean point to plane distance from refined processing

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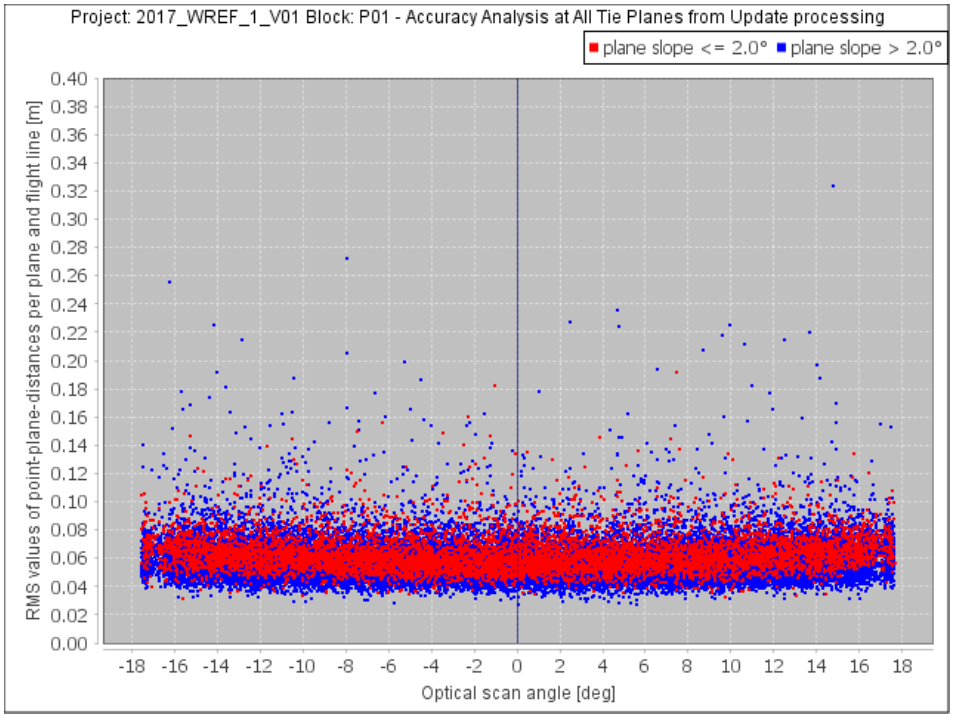

Figure 16: RMS point to plane distance from refined processing

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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]	-0.011	0.031	-0.104	0.044
Delta North [m]	0.013	0.043	-0.087	0.121
Delta Height [m]	-0.009	0.035	-0.068	0.053
Horizontal Separation [m]	0.012	0.053	-0.121	0.111
Diff. Azimuth [deg]	-0.01133	0.23145	-1.22754	0.20591
Diff. Slope [deg]	-0.00652	0.10305	-0.44899	0.19263

Table 21: Roof line statistics for refined processing

Parameter	Mean	RMS	Minimum	Maximum
Delta East [m]	-0.011	0.031	-0.104	0.044
Delta North [m]	0.013	0.043	-0.087	0.121
Delta Height [m]	-0.009	0.035	-0.068	0.053
Horizontal Separation [m]	0.012	0.053	-0.121	0.111
Diff. Azimuth [deg]	-0.01133	0.23145	-1.22754	0.20591
Diff. Slope [deg]	-0.00652	0.10305	-0.44899	0.19263

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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	0.80	5.21	0.72	3.64
L001-2_2017_WREF_1_V01_2017062117_P01_r	0.55	3.58	0.44	2.31
L001-3_2017_WREF_1_V01_2017062117_P01_r	1.19	7.78	1.10	5.41
L001-4_2017_WREF_1_V01_2017062122_P01_r	0.90	5.90	0.84	4.12
L001-5_2017_WREF_1_V01_2017062122_P01_r	0.24	1.56	0.21	0.99
L001-6_2017_WREF_1_V01_2017062122_P01_r	0.04	0.25	0.02	0.08
L001-7_2017_WREF_1_V01_2017062215_P01_r	0.52	3.41	0.42	2.21
L001-8_2017_WREF_1_V01_2017062215_P01_r	0.26	1.69	0.22	1.06
L001-9_2017_WREF_1_V01_2017062215_P01_r	0.88	5.73	0.81	3.93
L002-1_2017_WREF_1_V01_2017062117_P01_r	0.03	0.21	0.03	0.15
L002-2_2017_WREF_1_V01_2017062117_P01_r	0.16	1.07	0.14	0.63
L002-3_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	0.32	2.07	0.30	1.36
L005-2_2017_WREF_1_V01_2017062117_P01_r	0.33	2.19	0.32	1.46
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

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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
L023-10_2017_WREF_1_V01_2017062117_P01_r	0.06	0.39	0.06	0.27
L023-1_2017_WREF_1_V01_2017062117_P01_r	0.20	1.32	0.17	0.86
L023-2_2017_WREF_1_V01_2017062117_P01_r	0.11	0.69	0.10	0.45
L023-3_2017_WREF_1_V01_2017062117_P01_r	0.03	0.19	0.03	0.13
L023-4_2017_WREF_1_V01_2017062117_P01_r	0.03	0.20	0.03	0.13
L023-5_2017_WREF_1_V01_2017062117_P01_r	0.01	0.05	0.01	0.03
L023-6_2017_WREF_1_V01_2017062117_P01_r	0.01	0.07	0.01	0.05
L023-7_2017_WREF_1_V01_2017062117_P01_r	0.11	0.71	0.11	0.46
L023-9_2017_WREF_1_V01_2017062117_P01_r	0.12	0.80	0.11	0.61
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

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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
L057-1_2017_WREF_1_V01_2017061916_P01_r	0.71	4.65	0.69	3.30
L057-2_2017_WREF_1_V01_2017062122_P01_r	0.71	4.67	0.67	3.18
L059-1_2017_WREF_1_V01_2017062117_P01_r	0.02	0.15	0.02	0.10
L059-2_2017_WREF_1_V01_2017062117_P01_r	0.06	0.41	0.05	0.24
L059-3_2017_WREF_1_V01_2017062122_P01_r	0.11	0.74	0.11	0.56
L059-4_2017_WREF_1_V01_2017062122_P01_r	0.19	1.21	0.16	0.71
L060-1_2017_WREF_1_V01_2017062122_P01_r	0.33	2.14	0.30	1.42
L061-1_2017_WREF_1_V01_2017062122_P01_r	0.33	2.19	0.30	1.37
L062-1_2017_WREF_1_V01_2017062122_P01_r	0.34	2.19	0.32	1.53
L063-1_2017_WREF_1_V01_2017062215_P01_r	0.21	1.34	0.17	0.83

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L069-1_2017_WREF_1_V01_2017062117_P01_r	0.34	2.23	0.34	1.59
L072-1_2017_WREF_1_V01_2017062122_P01_r	0.74	4.83	0.71	3.37
L073-1_2017_WREF_1_V01_2017062122_P01_r	0.71	4.62	0.68	3.25
L074-1_2017_WREF_1_V01_2017062122_P01_r	0.76	4.95	0.73	3.53
L075-1_2017_WREF_1_V01_2017062122_P01_r	0.77	5.04	0.73	3.51
L076-1_2017_WREF_1_V01_2017062122_P01_r	0.78	5.12	0.75	3.62
L077-1_2017_WREF_1_V01_2017062122_P01_r	0.76	5.00	0.73	3.56
L078-1_2017_WREF_1_V01_2017062122_P01_r	0.76	5.00	0.74	3.54
L079-1_2017_WREF_1_V01_2017062122_P01_r	0.75	4.93	0.73	3.54
L080-1_2017_WREF_1_V01_2017062122_P01_r	0.75	4.92	0.77	3.77
L081-1_2017_WREF_1_V01_2017062122_P01_r	0.68	4.46	0.70	3.36
L082-1_2017_WREF_1_V01_2017062122_P01_r	0.07	0.45	0.07	0.33
L082-2_2017_WREF_1_V01_2017062122_P01_r	0.03	0.17	0.02	0.11
L082-3_2017_WREF_1_V01_2017062122_P01_r	0.04	0.25	0.04	0.18
L082-4_2017_WREF_1_V01_2017062122_P01_r	0.03	0.16	0.02	0.10

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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	0.9071	4.5715
L001-2_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8031	4.2172
L001-3_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9253	4.5420
L001-4_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9329	4.5630
L001-5_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.8765	4.1692
L001-6_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.4539	1.9636
L001-7_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.8046	4.2324
L001-8_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.8640	4.1040
L001-9_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.9215	4.4814
L002-1_2017_WREF_1_V01_2017062117_P01_r	6.5356	0.9868	4.6334
L002-2_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8756	3.8752
L002-3_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	0.9396	4.2819
L005-2_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9530	4.3659
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

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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
L023-10_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9734	4.4641
L023-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8485	4.2551
L023-2_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9568	4.2938
L023-3_2017_WREF_1_V01_2017062117_P01_r	6.5356	0.9941	4.5114
L023-4_2017_WREF_1_V01_2017062117_P01_r	6.5356	0.8456	4.2681
L023-5_2017_WREF_1_V01_2017062117_P01_r	6.5354	0.9413	4.2894
L023-6_2017_WREF_1_V01_2017062117_P01_r	6.5355	1.0048	4.4663
L023-7_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9790	4.2179
L023-9_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8996	5.0053
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

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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
L057-1_2017_WREF_1_V01_2017061916_P01_r	6.5357	0.9657	4.6343
L057-2_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9390	4.4466
L059-1_2017_WREF_1_V01_2017062117_P01_r	6.5356	0.9748	4.2751
L059-2_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.8795	3.8114
L059-3_2017_WREF_1_V01_2017062122_P01_r	6.5357	1.0057	5.0150
L059-4_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.8744	3.8249
L060-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9285	4.3466
L061-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9001	4.1056
L062-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9672	4.5513
L063-1_2017_WREF_1_V01_2017062215_P01_r	6.5357	0.8322	4.0312
L069-1_2017_WREF_1_V01_2017062117_P01_r	6.5357	0.9861	4.6691
L072-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9585	4.5607

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L073-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9626	4.5917
L074-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9672	4.6639
L075-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9437	4.5572
L076-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9580	4.6223
L077-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9563	4.6510
L078-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9729	4.6311
L079-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9663	4.6875
L080-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	1.0163	5.0012
L081-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	1.0235	4.9204
L082-1_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9986	4.8040
L082-2_2017_WREF_1_V01_2017062122_P01_r	6.5356	0.9582	4.3922
L082-3_2017_WREF_1_V01_2017062122_P01_r	6.5357	0.9443	4.8240
L082-4_2017_WREF_1_V01_2017062122_P01_r	6.5356	0.8837	3.9702

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