United States Army Corps of Engineers
Cold Regions Research & Engineering Laboratory
Remote Sensing and GIS Center of Expertise
Hanover, NH

SnowEx 2022 Terrestrial Laser Scanning Support

Final report

Overview

- Collection dates: 22 – 27 October 2022
- Location: Tanana Flats, southwest of Fairbanks, Alaska along the Tanana River
- Collection type: Terrestrial laser scanning
- Delivered on: 2023-03-15
- Point of contact: Adam L. LeWinter
- Spatial reference system: WGS84 UTM Zone 6N
    - Heights: NAVD88
    - Units: meters

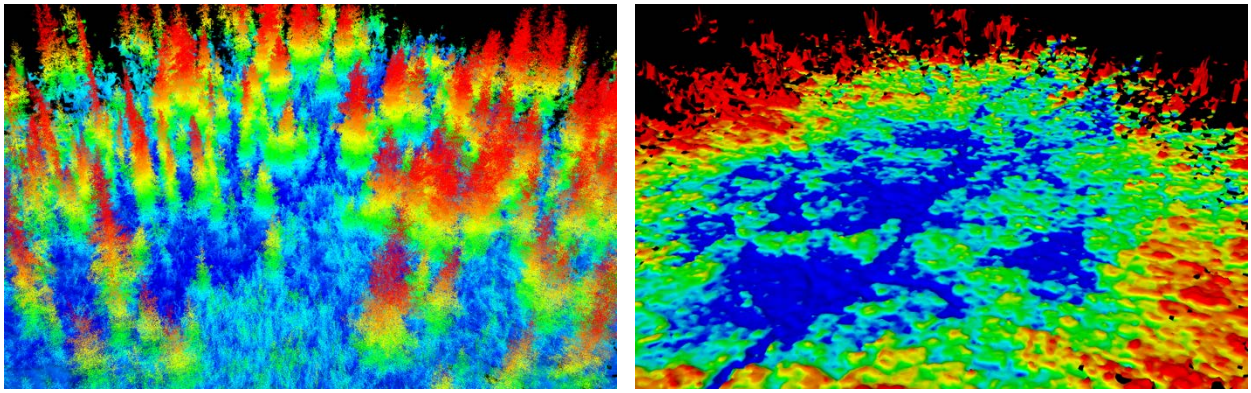

Figure 1: Left) Lidar point cloud from TLS1 survey site, colored by height. Right) Resulting 15-cm digital terrain model of TLS1 survey site, colored by height.

Contents

Mission Description

From October 22 through 27, 2022, The US Army Corps of Engineers Cold Regions Research and Engineering Laboratory's Alaska Projects Office (AKRO) and Remote Sensing and GIS Center of Expertise (RSGIS CX) conducted field collection and processing of terrestrial laser scanning (TLS) data for NASA's SnowEx mission. With training and direction from RSGIS CX, AKRO personnel collected TLS and ground control data at 10 survey sites near the Tanana River southwest of Fairbanks, Alaska. RSGIS CX personnel processed these resulting data into classified point clouds (5-cm sub-sampled data) and 15-cm digital terrain models (DTM). To overcome line-of-sight obstructions caused by the dense ground vegetation at the survey sites, multiple scan positions were collected at each site to get a more complete survey of the areas. These individual scan positions were then combined into a single point cloud, from which the digital terrain model was derived. Figures 2 and 3 provide an overview of the survey site locations.

Figure 2: Overview map of the survey sites (red box, see Figure 3 for detailed view) in relation to Fairbanks, Alaska. The survey sites are located along the Tanana River roughly 30-kilometers to the southwest of Fairbanks.

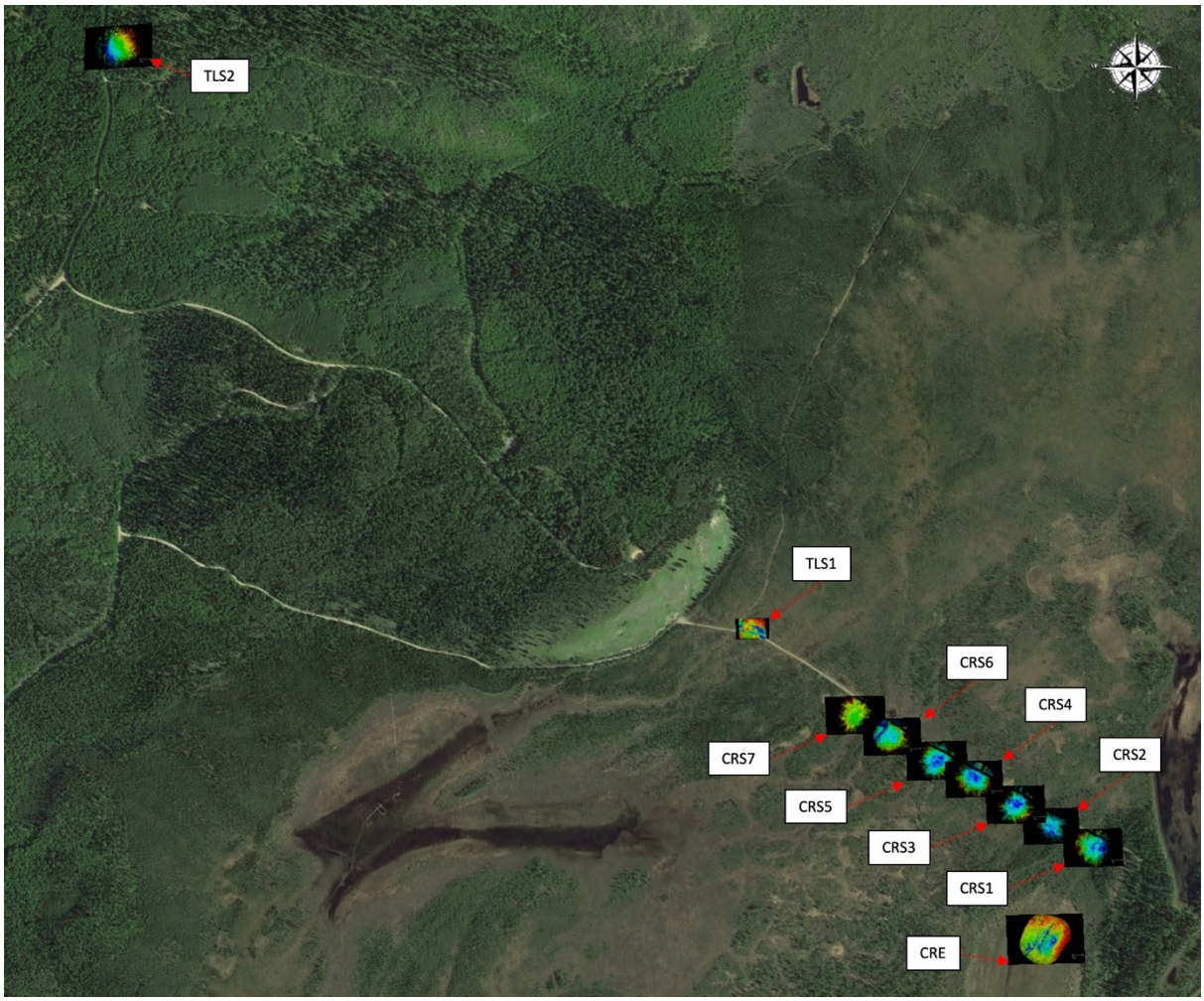

Figure 3: Detailed view of the 10 survey sites, with the resulting 15-cm DTMs overlaid on satellite imagery.

Instrumentation

Parameter	Specification
Manufacturer	Riegl LMS GmbH
Model	VZ-400i
Laser Wavelength	1550 nm
Laser Pulse Repetition Rate (PRR) (peak)	1200 kHz
Maximum Measurement Range (90% reflective target)	250 m
Accuracy	5 mm
Precision	3 mm
Laser beam divergence	0.35 mrad
Vertical Field of View	100 deg
Horizontal Field of View	360 deg

Table 1: Riegl VZ-400i Terrestrial Laser Scanner Specifications

Control

A GNSS survey was conducted by AKRO to collect precise coordinates of the centroid of 10cm cylindrical reflectors deployed throughout each scan location. These reflectors were used to tie the TLS data to a global coordinate system (WGS84 UTM Zone 6N / NAVD88 height). The below coordinate list was provided to RSGIS CX by AKRO, and represent the horizontal and vertical center of each reflector deployed. The *Point_ID* naming convention refers to the 10 individual survey sites collected with the TLS system in October 2022.

Point_ID	Easting	Northing	Reflector Centroid (m)
BCEF-CRE-A	438619.6223	7175493.771	123.626
BCEF-CRE-B	438642.7523	7175487.609	123.587
BCEF-CRE-C	438632.9993	7175473.046	123.47
BCEF-CRE-D	438624.1213	7175508.078	123.581
BCEF-CRS1-A	438729.0723	7175656.515	124.984
BCEF-CRS1-B	438723.4223	7175657.868	124.857
BCEF-CRS1-C	438725.9563	7175648.223	124.823
BCEF-CRS1-D	438720.5263	7175650.716	124.769
BCEF-CRS2-A	438644.0463	7175701.306	125.039
BCEF-CRS2-B	438645.2233	7175695.157	124.983
BCEF-CRS2-C	438649.9633	7175695.565	125.053
BCEF-CRS2-D	438648.4153	7175694.217	125.059
BCEF-CRS2-E	438648.4403	7175689.66	125.191
BCEF-CRS2-F	438653.4443	7175694.312	124.971
BCEF-CRS3-A	438578.6973	7175730.06	124.606
BCEF-CRS3-B	438578.2033	7175736.046	124.636
BCEF-CRS3-C	438584.4163	7175738.204	124.623
BCEF-CRS3-D	438589.3093	7175729.284	124.594
BCEF-CRS3-E	438588.7643	7175739.156	124.534
BCEF-CRS3-F	438580.0873	7175742.728	124.624
BCEF-CRS4-A	438506.6433	7175778.829	124.85
BCEF-CRS4-B	438506.9003	7175785.436	124.873
BCEF-CRS4-C	438508.7563	7175790.086	124.8
BCEF-CRS4-D	438512.8183	7175788.901	125.011
BCEF-CRS5-A	438443.7763	7175826.097	124.309
BCEF-CRS5-B	438438.2373	7175831.385	124.482
BCEF-CRS5-C	438436.9973	7175820.47	124.343
BCEF-CRS5-D	438433.9593	7175821.721	124.289
BCEF-CRS6-A	438357.8003	7175866.621	124.094

BCEF-CRS6-B	438355.9163	7175872.342	124.268
BCEF-CRS6-C	438350.0833	7175868.85	124.222
BCEF-CRS6-D	438347.8773	7175865.584	124.306
BCEF-CRS7-A	438282.5843	7175906.515	124.411
BCEF-CRS7-B	438288.1293	7175911.675	124.409
BCEF-CRS7-C	438284.2743	7175915.351	124.312
BCEF-CRS7-D	438278.2573	7175917.731	124.446
BCEF-TLS1-01	438064.5913	7176079.388	124.203
BCEF-TLS1-02	438084.7293	7176076.411	124.409
BCEF-TLS1-03	438104.7283	7176086.497	124.588
BCEF-TLS1-04	438091.3403	7176087.777	124.459
BCEF-TLS1-05	438078.7893	7176086.922	124.462
BCEF-TLS2-A	436875.3714	7177218.759	231.316
BCEF-TLS2-B	436880.6354	7177215.733	231.719
BCEF-TLS2-C	436885.1424	7177209.156	231.766
BCEF-TLS2-D	436887.5534	7177217.168	231.642
BCEF-TLS2-E	436893.1524	7177226.448	232.446
BCEF-TLS2-F	436902.4494	7177219.958	232.575
BCEF-TLS2-G	436898.8444	7177207.765	230.428

Table 2: 10-cm reflector cylinder coordinates, in WGS84 UTM Zone 6N / NAVD88 (meters). These coordinates were used to tie the TLS data to a global coordinate system.

Post Processing

The post processing for these data consisted of XX steps. Post processing was conducted using Riegl's RiSCAN Pro software and the Point Data Abstraction Library (PDAL):

1. Import 10-cm reflector cylinder control points (RiSCAN Pro)
2. Register individual scans (multiple scan positions collected at each site to provide complete coverage) using reflector registration (RiSCAN Pro)
3. Filter and combine scan data from each survey site (RiSCAN Pro)
    a. Filter data using the following parameters:
        i. Deviation: < / = 9
        ii. Range: 1.5 – 30 m
    b. Combine individual scan positions and apply 5-cm octree filter
4. Export LAZ 1.4 point cloud for each survey site (RiSCAN Pro)
5. Classify point cloud data to extract ground points using a Simple Morphological Filter (https://pdal.io/en/latest/stages/filters.smrf.html), export classified LAZ 1.4 point cloud, create 15-cm DTM. See Appendix B for the *smrf.json* PDAL processing pipeline (PDAL)

Deliverables

1. Point clouds:
    a. Individual point clouds for each survey site (quantity 10)
    b. Naming convention:
        i. *YYYY-MM-DD_(survey site name)_2cm.laz*
        ii. Example: *2022-10-27_BCEF_TLS_CRE_2cm.laz*
    c. LAZ 1.4 format
    d. 5-cm octree filtered: The octree filter takes all scan data from each scan position at each site and reduces the data to 5-cm cubes, choosing the closest "real" point in cube to the center of gravity
    e. Point classifications: 0 = never classified, 1 = unassigned, 2 = ground
2. Digital Terrain Models (DTM):
    a. Individual DTMs for each survey site (quantity 10)
    b. Naming convention:
        i. *YYYY-MM-DD_(survey site name)-15cm-DTM.tif*
        ii. Example: *2022-10-27_BCEF_TLS_CRE-15cm-DTM.tif*
    c. GeoTIFF format
    d. 15-cm raster

Appendix A: Figures

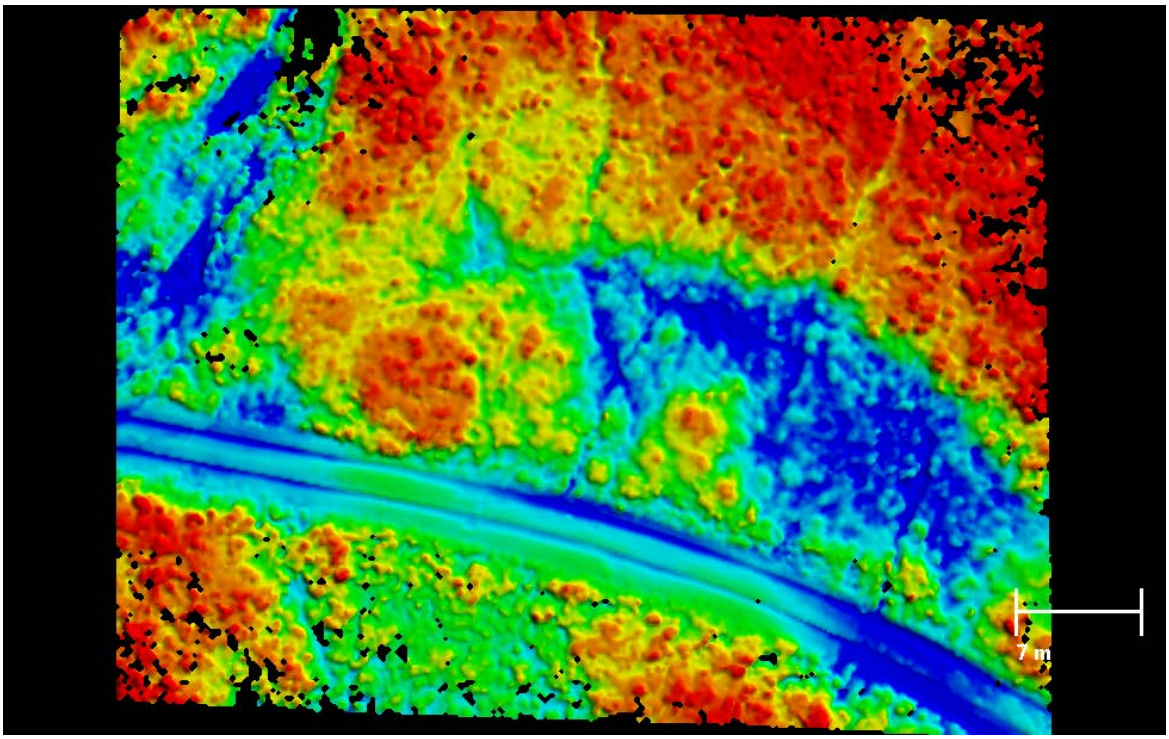

Figure 4: 15-cm DTM of the TLS1 survey site, colored by height.

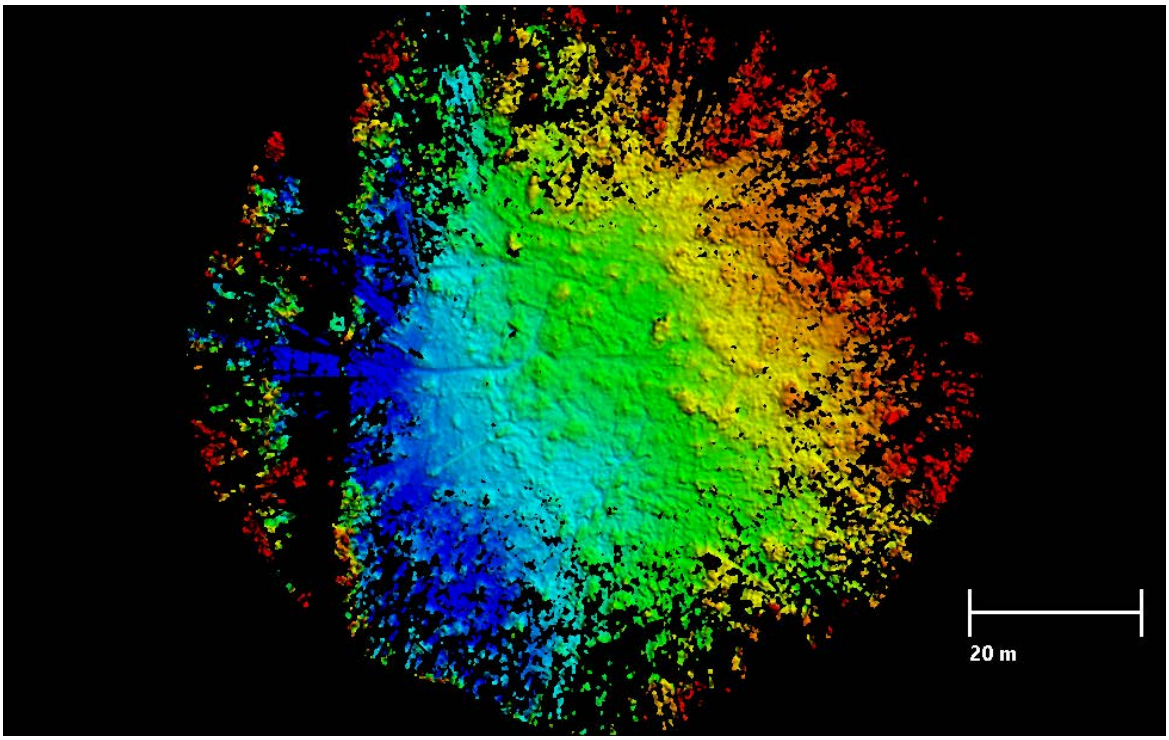

Figure 5: 15-cm DTM of the TLS2 survey site, colored by height.

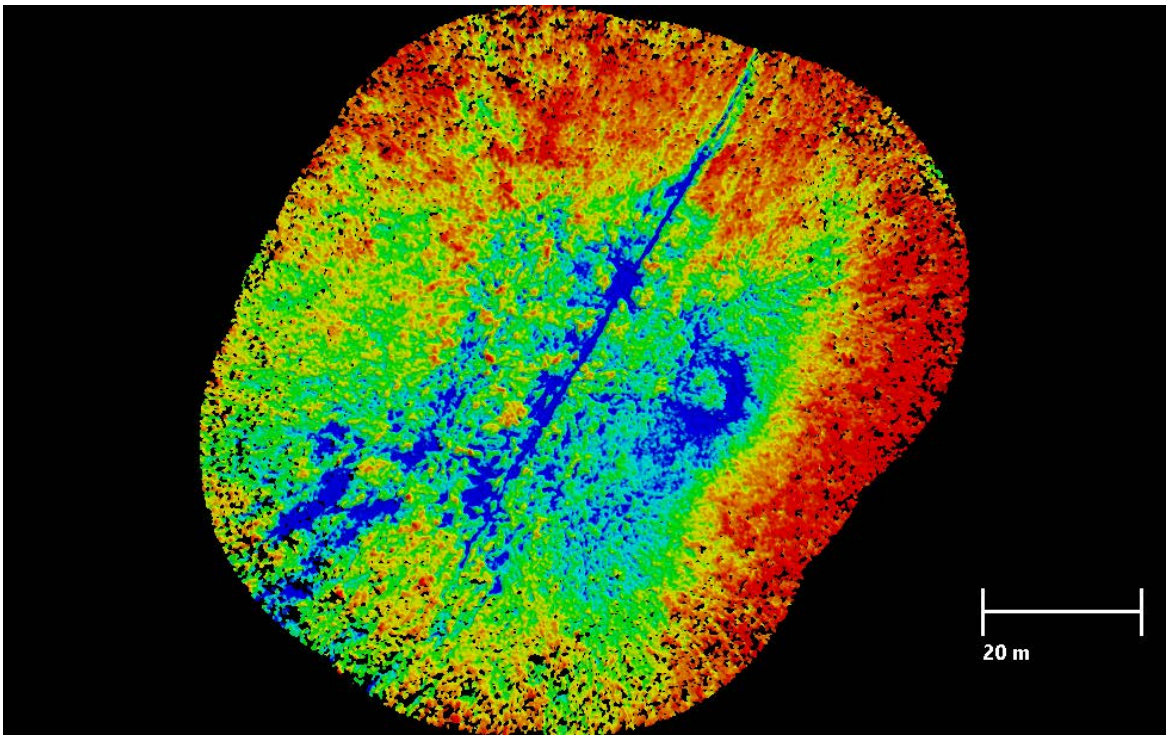

Figure 6: 15-cm DTM of the CRE survey site, colored by height.

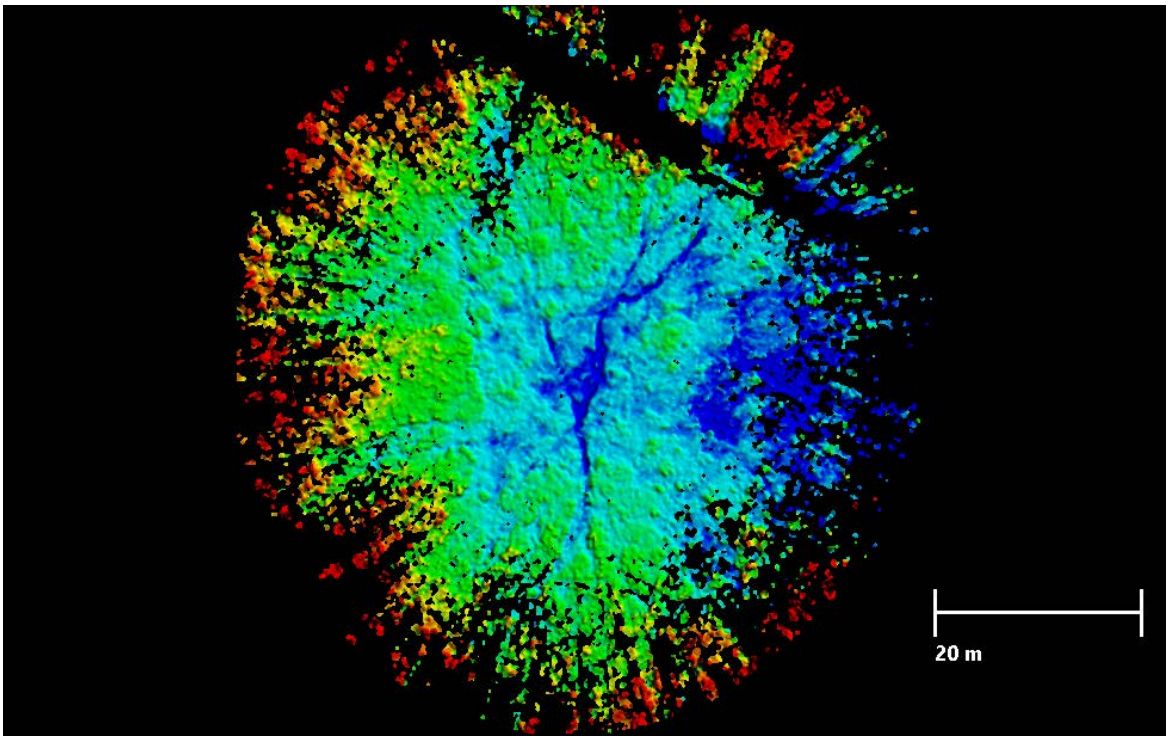

Figure 7: 15-cm DTM of the CRS1 survey site, colored by height.

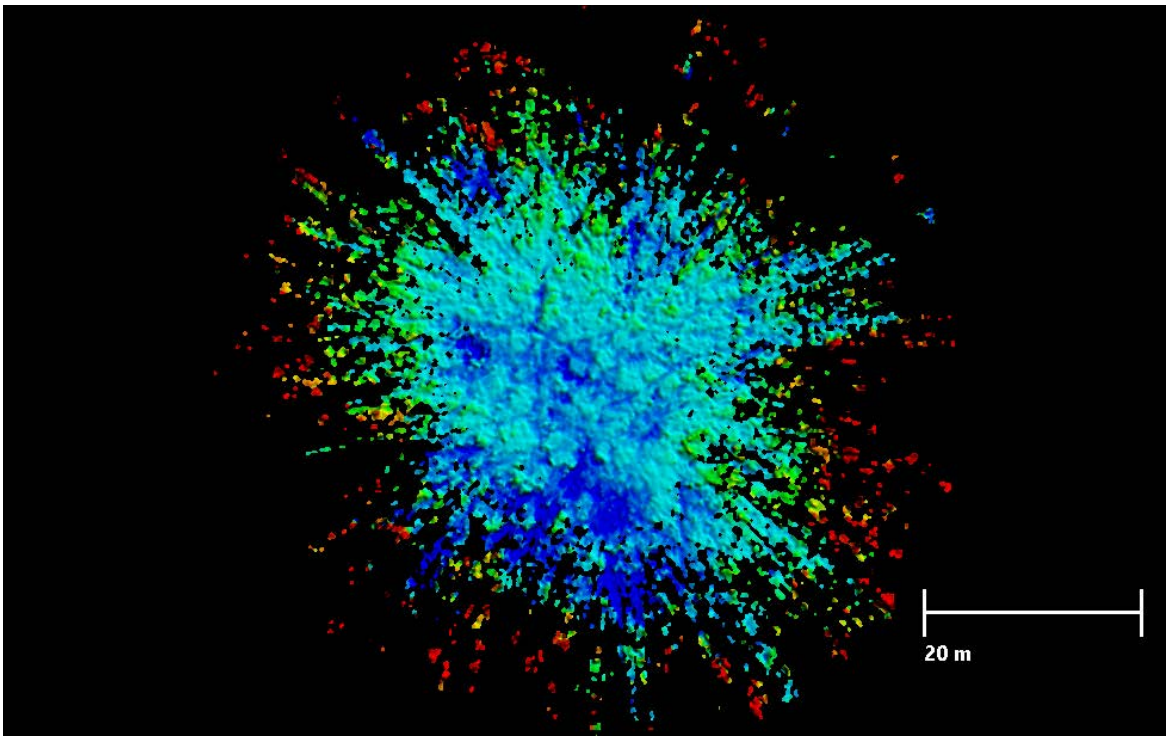

Figure 8: 15-cm DTM of the CRS2 survey site, colored by height.

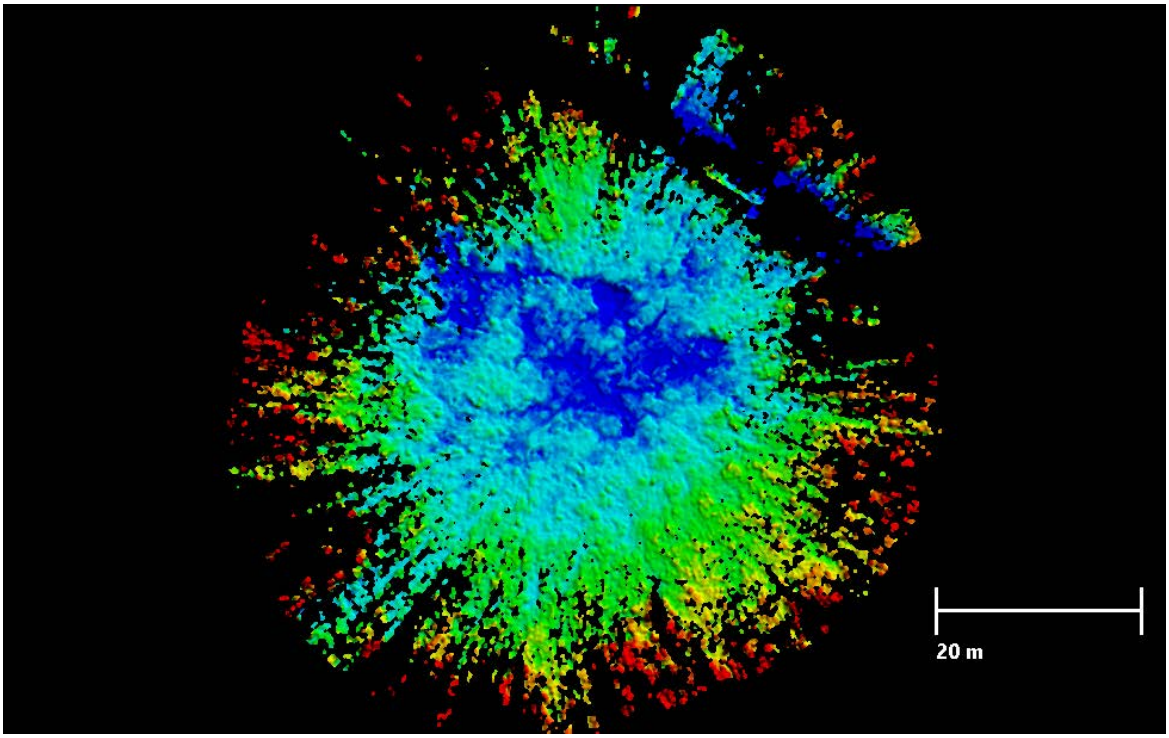

Figure 9: 15-cm DTM of the CRS3 survey site, colored by height.

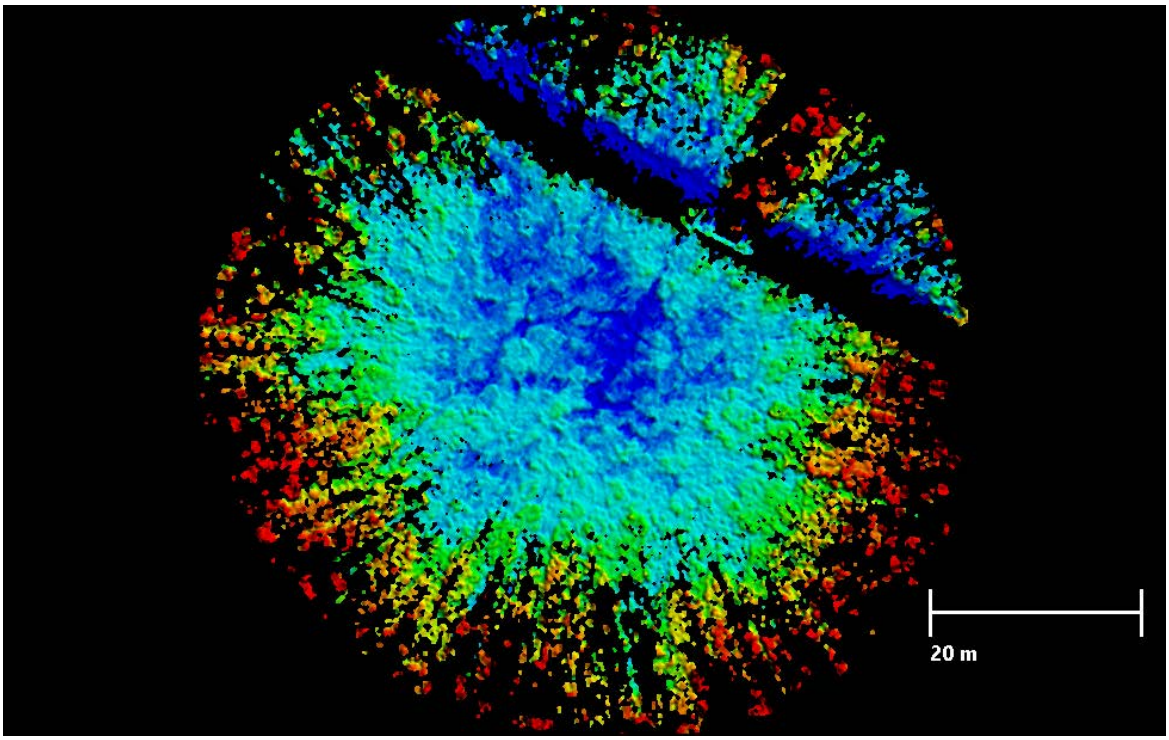

Figure 10: 15-cm DTM of the CRS4 survey site, colored by height.

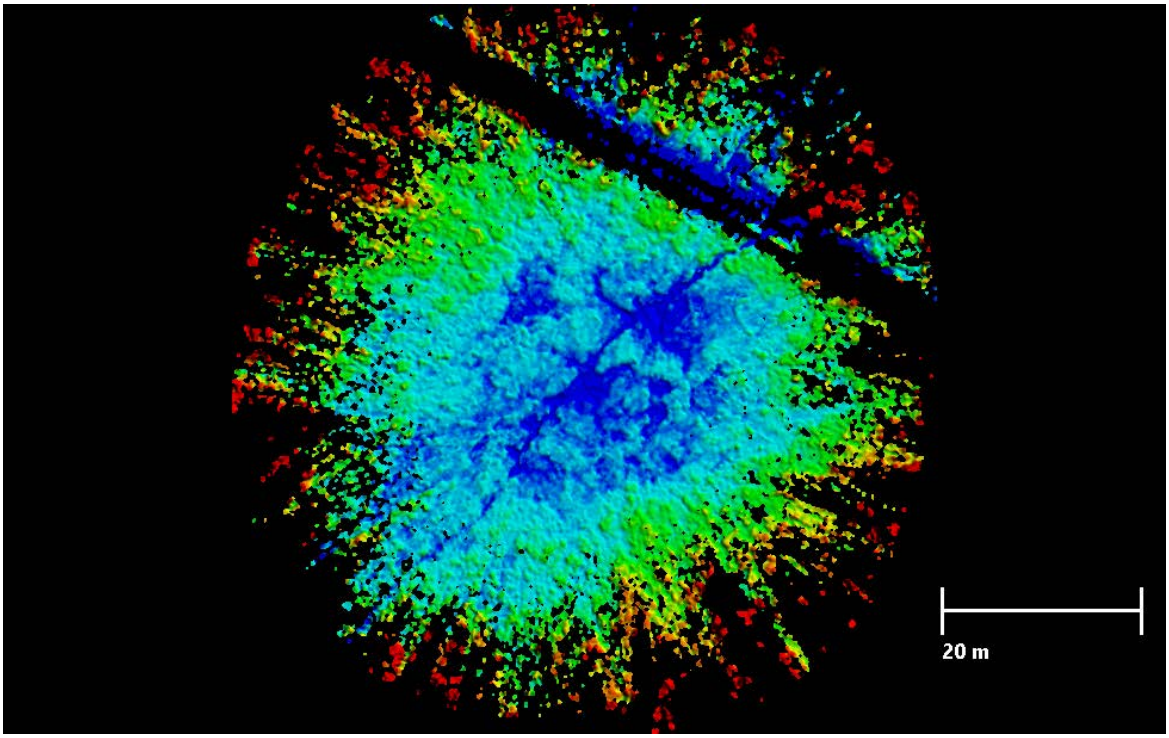

Figure 11: 15-cm DTM of the CRS5 survey site, colored by height.

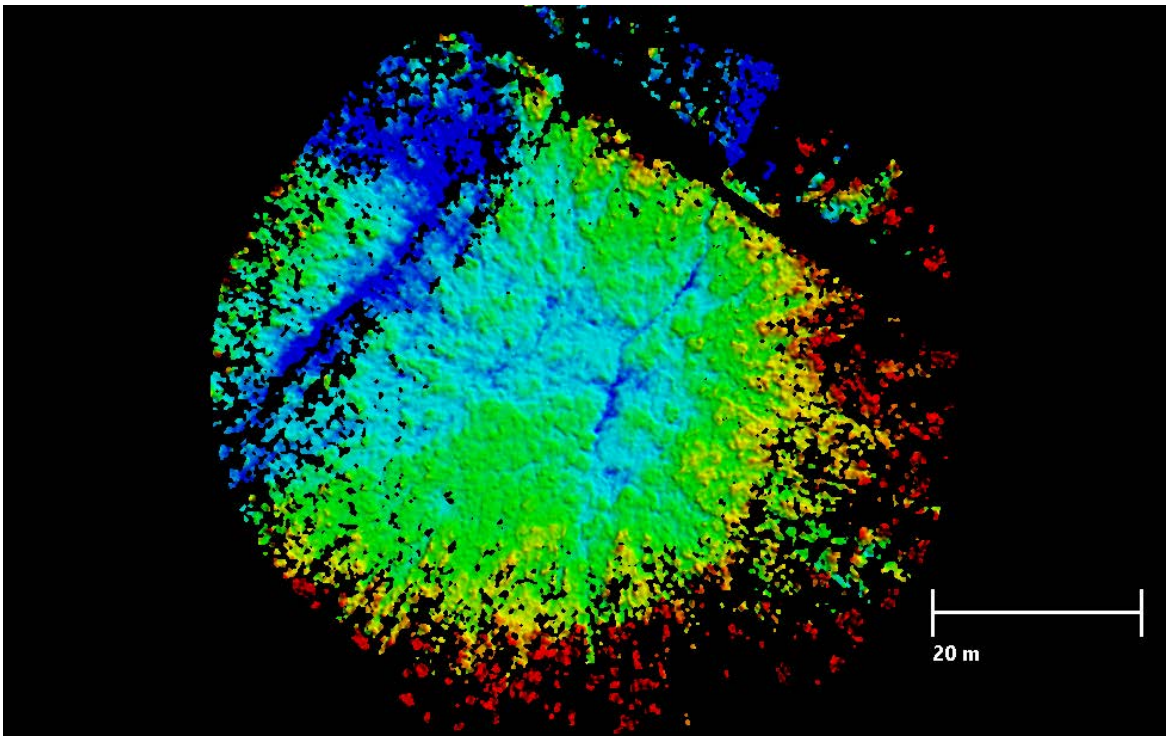

Figure 12: 15-cm DTM of the CRS6 survey site, colored by height.

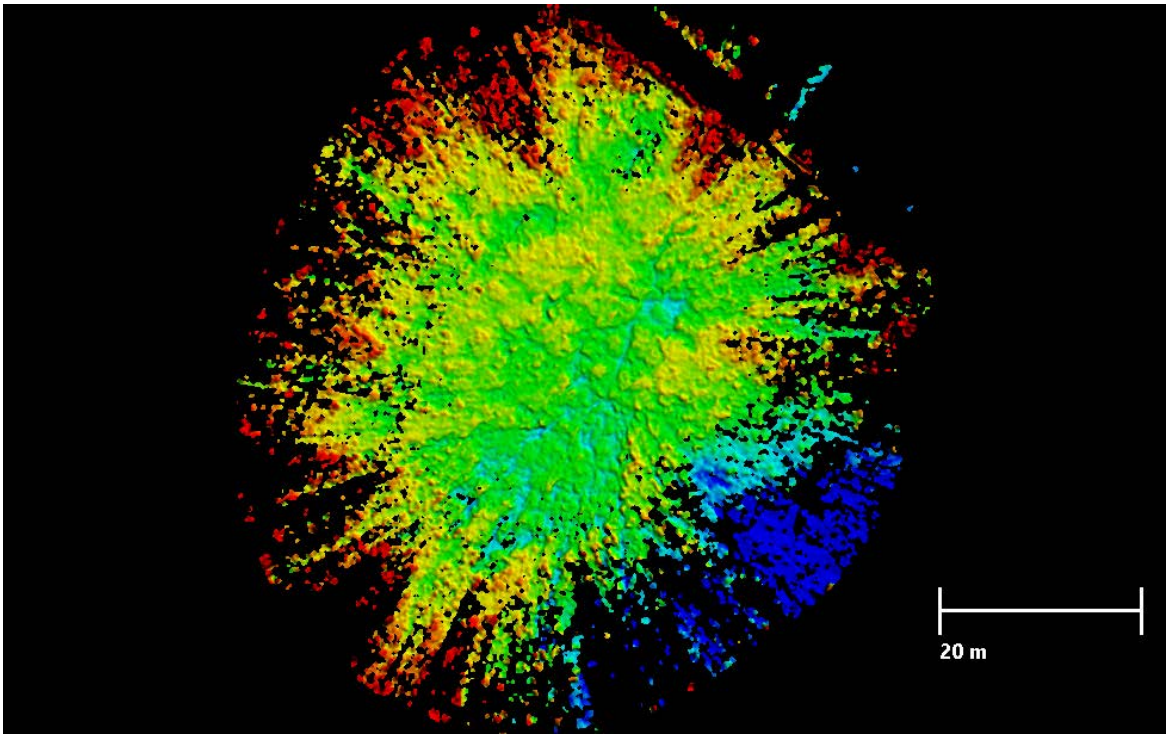

Figure 13: 15-cm DTM of the CRS7 survey site, colored by height.

Appendix B: PDAL Processing Pipeline

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