Map Technology for Evidence-Based Trails

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Yarrow Hinnant

	Sustainable	Unsustainable
Built to conventional standards		
Ad hoc trail design		

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Built to conventional standards		
Ad hoc trail design		

What are our goals?

- Decrease cost and increase quality of trails
- Share methods with the broader community
- Develop approaches that are specific to a particular locality
- Have a bit of geeky fun


What might it mean to make “Evidence-based trails”
• Collect data
• Develop metrics
• Controlled design process
• Systematically compare options

Data sources

- Lidar
- Photogrammetry
- Multispectral imagery
- Tracklines
- User surveys
- Computer model outputs

What metrics might we want?

- Environmental / aesthetic impact
- Build effort / cost
- Maintenance effort / cost
- Probability of catastrophic failure
- Risk to hikers
- Usability / user experience

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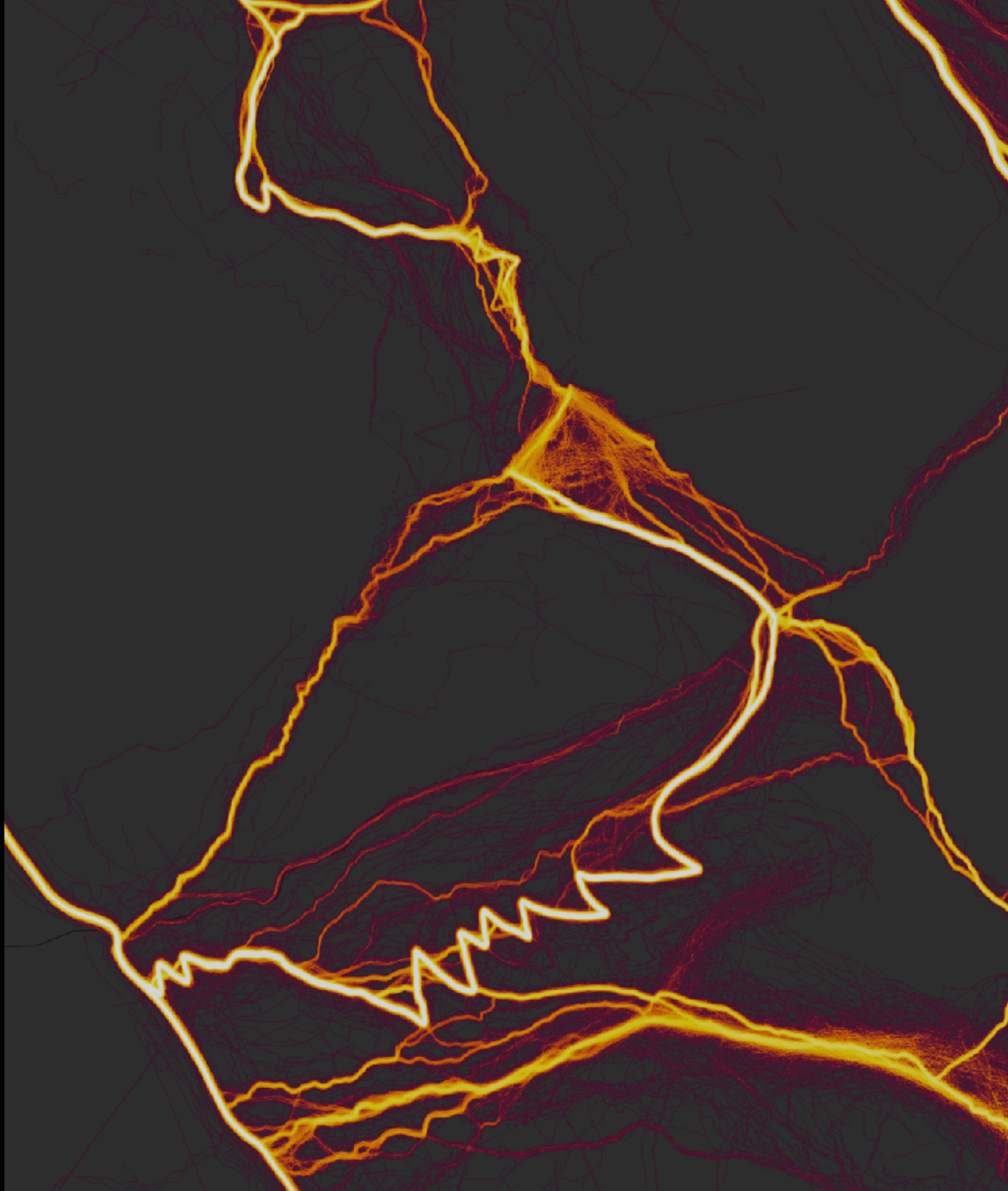
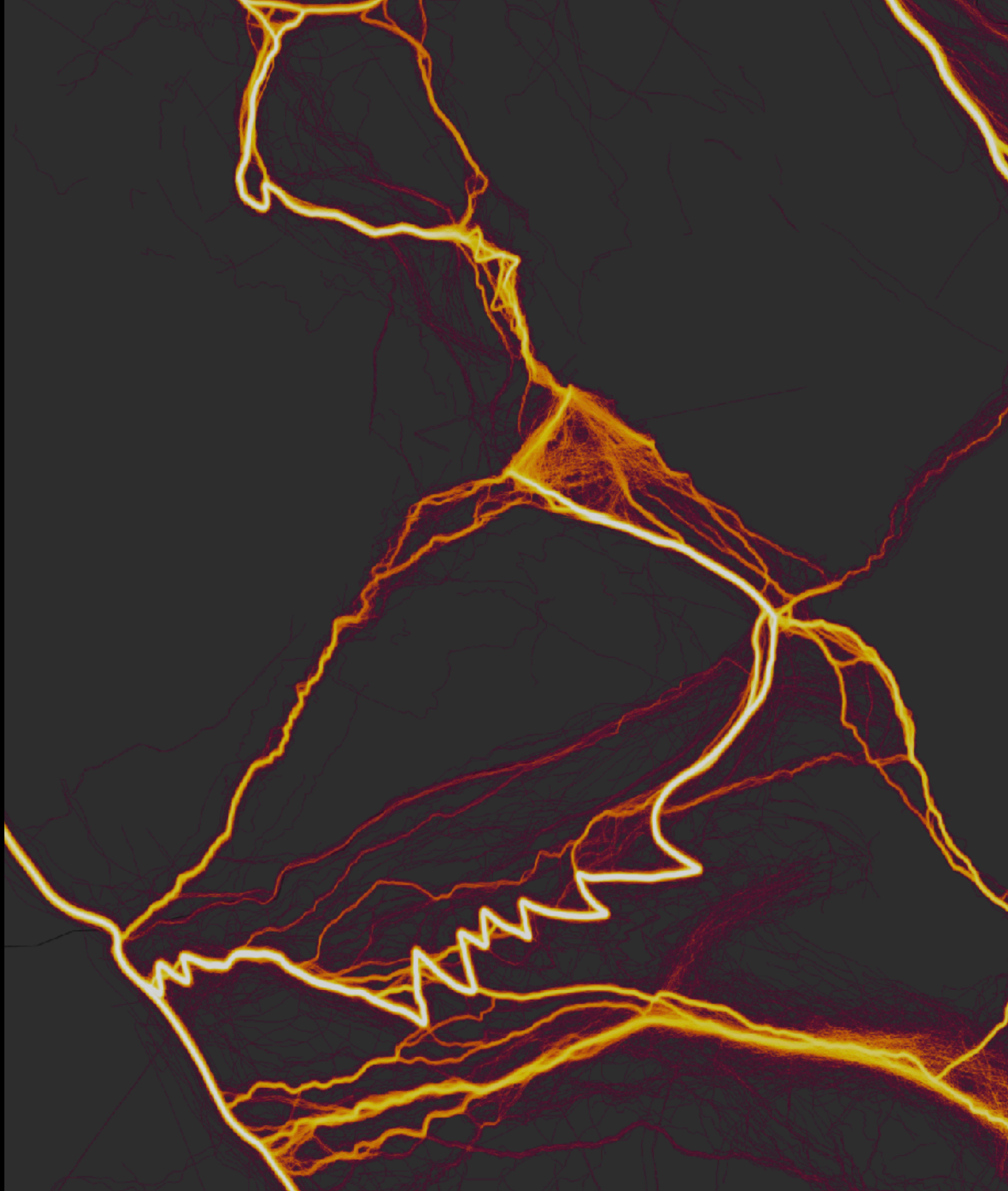


Approaches for some future talk

- Predictors of shortcutting
- Synthesized user track lines to detect problem sites. Maybe get data by sponsoring a trail race?
- Numerical models to develop trail alignment proposals
- Cost models for building and maintaining trails
- Monitoring mm-scale topographic change




Dinglestadt Glacier
Kachemak Glacier
Iceworm Peak
Yalik Glacier
Petrof Glacier
Nuka Island
Dixon Glacier
Grewingk Glacier
Doroshin Glacier
Sadie Peak
Halibut Cove
Grace Ridge
Sadie Cove
Fritz Creek
Kachemak City
Homer


Iceworm Peak
Emerald Lake
Grewingk Lake
Rustys Lagoon

Halibut Cove
Ismailof Island
Light
Hal
Lof
18
60
100
200
500
1000
1500
2000


500 ft
100 m


500 ft
100 m

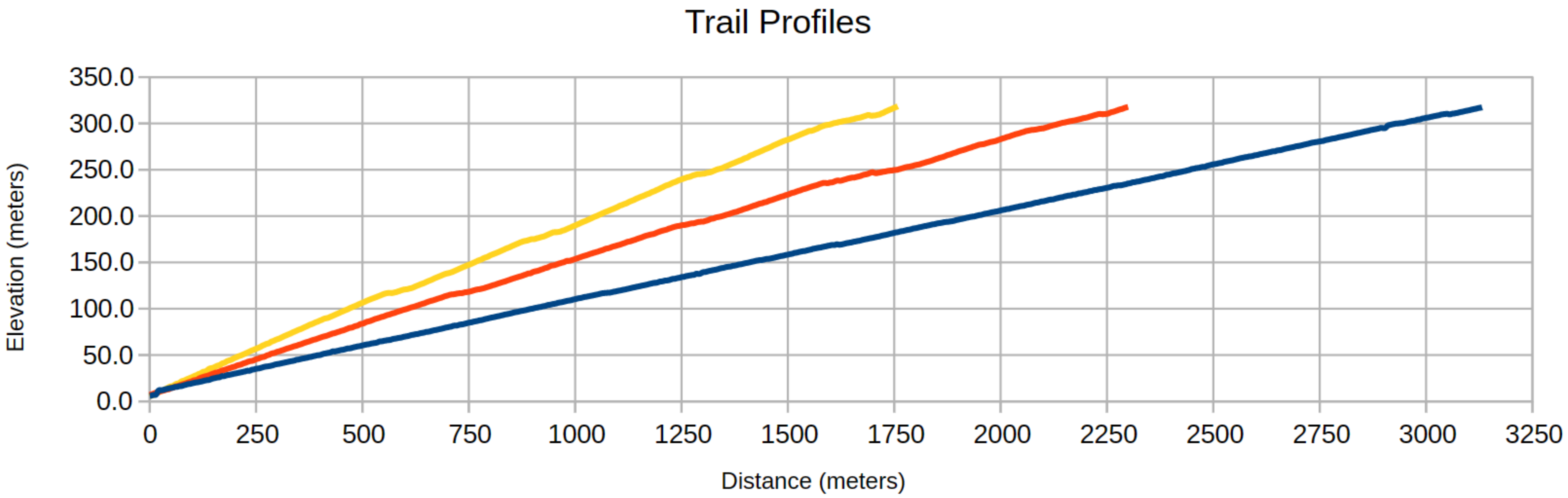

500 ft
100 m


500 ft
100 m
Lidar (DGGS)


500 ft
100 m
Lidar (DGGS)


500 ft
100 m
Lidar (DGGS)


500 ft
100 m
Lidar (DGGS)



Trail Profiles
Elevation (meters)
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
3250
Distance (meters)


500 ft
100 m
Lidar (DGGS)


15%
500 ft
100 m
Lidar (DGGS)

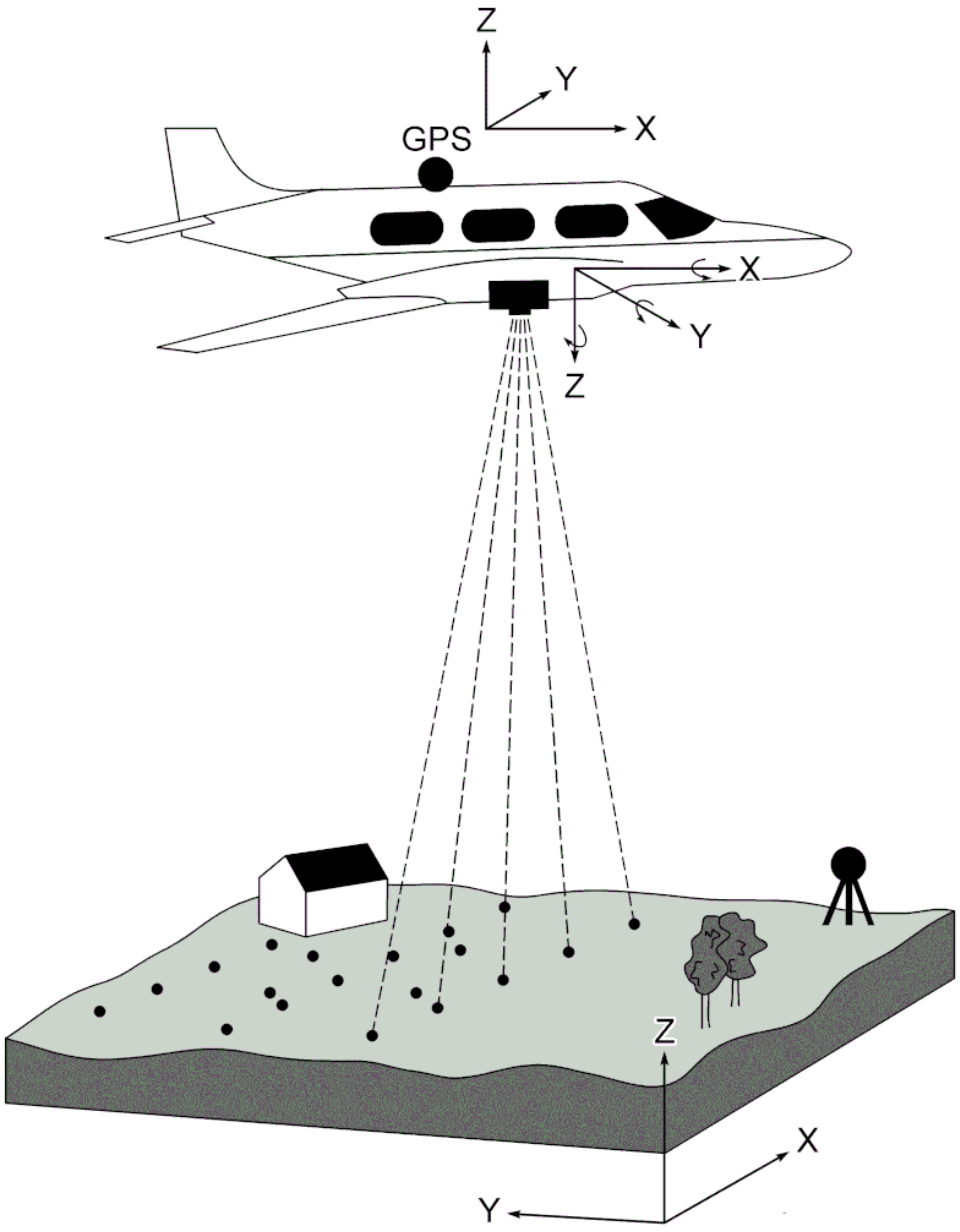

15%
500 ft
100 m
Lidar (DGGS)

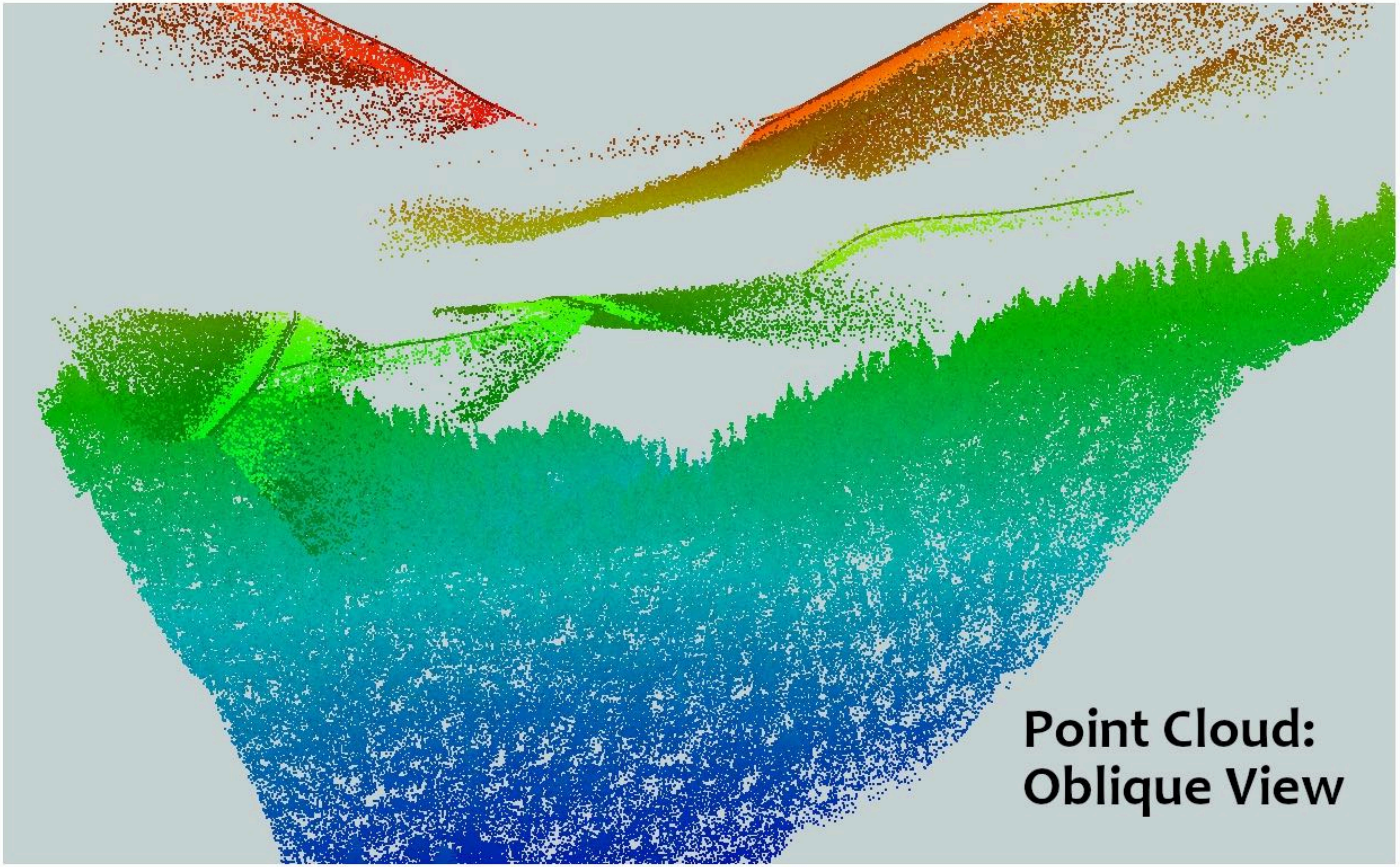

500 ft
100 m
Lidar (DGGS)


*230409_presentation_version — QGIS
0.00
meters
0.0000
Layers
Existing trails analysis
Grade_flowlines
IAr_track_points
Alignment Ten Percent Detailed
Extra_Alpine-Saddle-Proposals
gentle_track_points
gentle_climb_option
Alignment Ten Percent
Hig Alpine Route
HAr_track_points
Alpine-Saddle-Proposals
Alpine-Saddle-Proposals copy
TRAILS
Parcels
Land_cover
DOQ_96_97
Other_rasters
Difference
Grewingk_2021-2019_v2
2019_lidar-1953_USGS
IfSAR-SRTM
Laker-Wolken_2019
Seld2012-2019_bathy
Wolken_2019-IfSAR
USGS2015-AHAP1985
Homer_2019-2008
1964_August_Grewingk_ortho
USGS maps
AK_Seldovia_464064_1951_250000
AK_Seldovia C-4_361818_1948_633
KPB
AHAP
flat_colors
trail_router_test
lidar
Veg
veg_height
veg_class
veg_forest
veg_undergrowth
veg_combo
2021_Grewingk_Processed

What is Lidar?

3D Laser Scanning

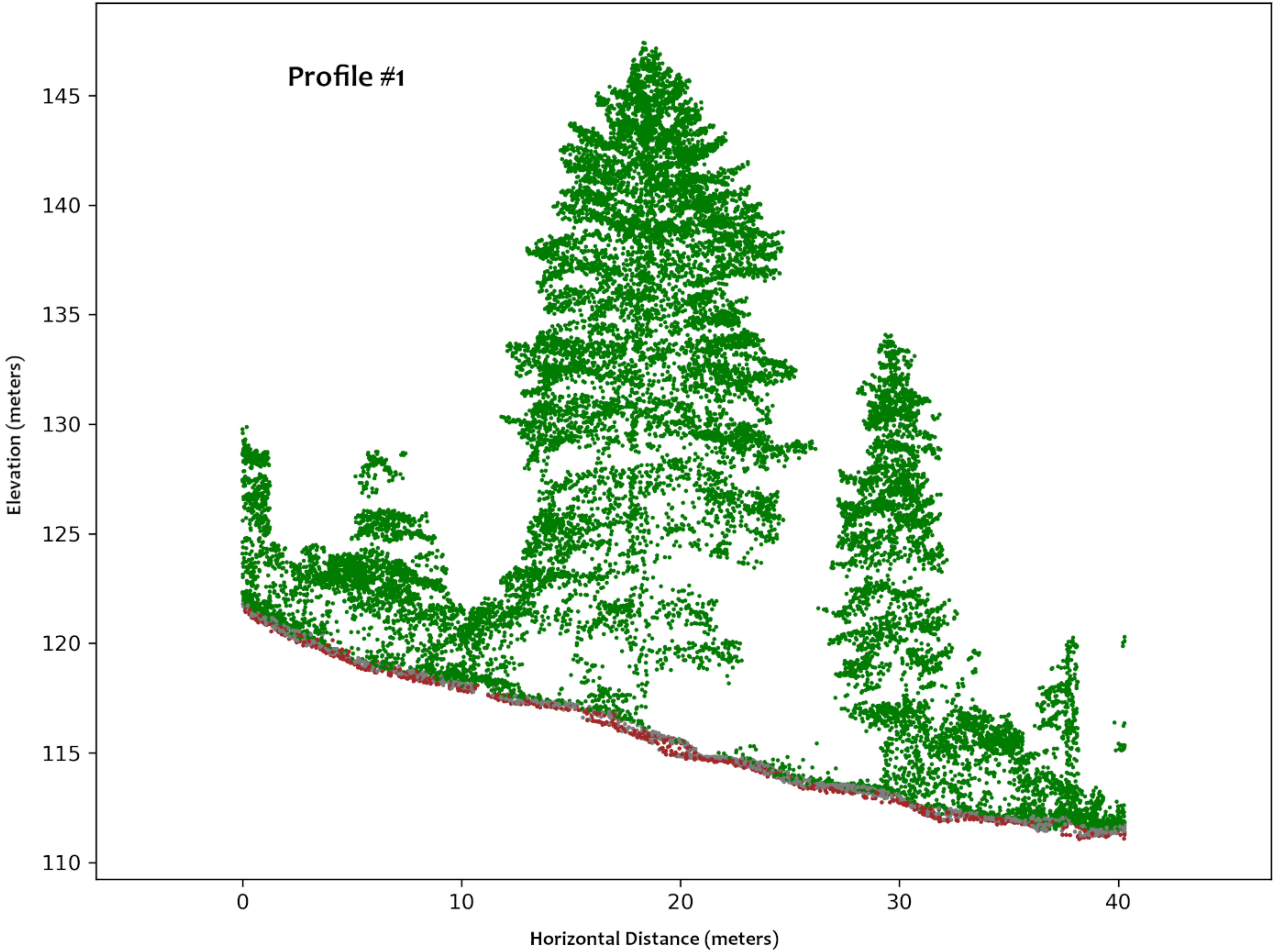



Point Cloud:
Oblique View


Point Cloud:
Vertical Plan View

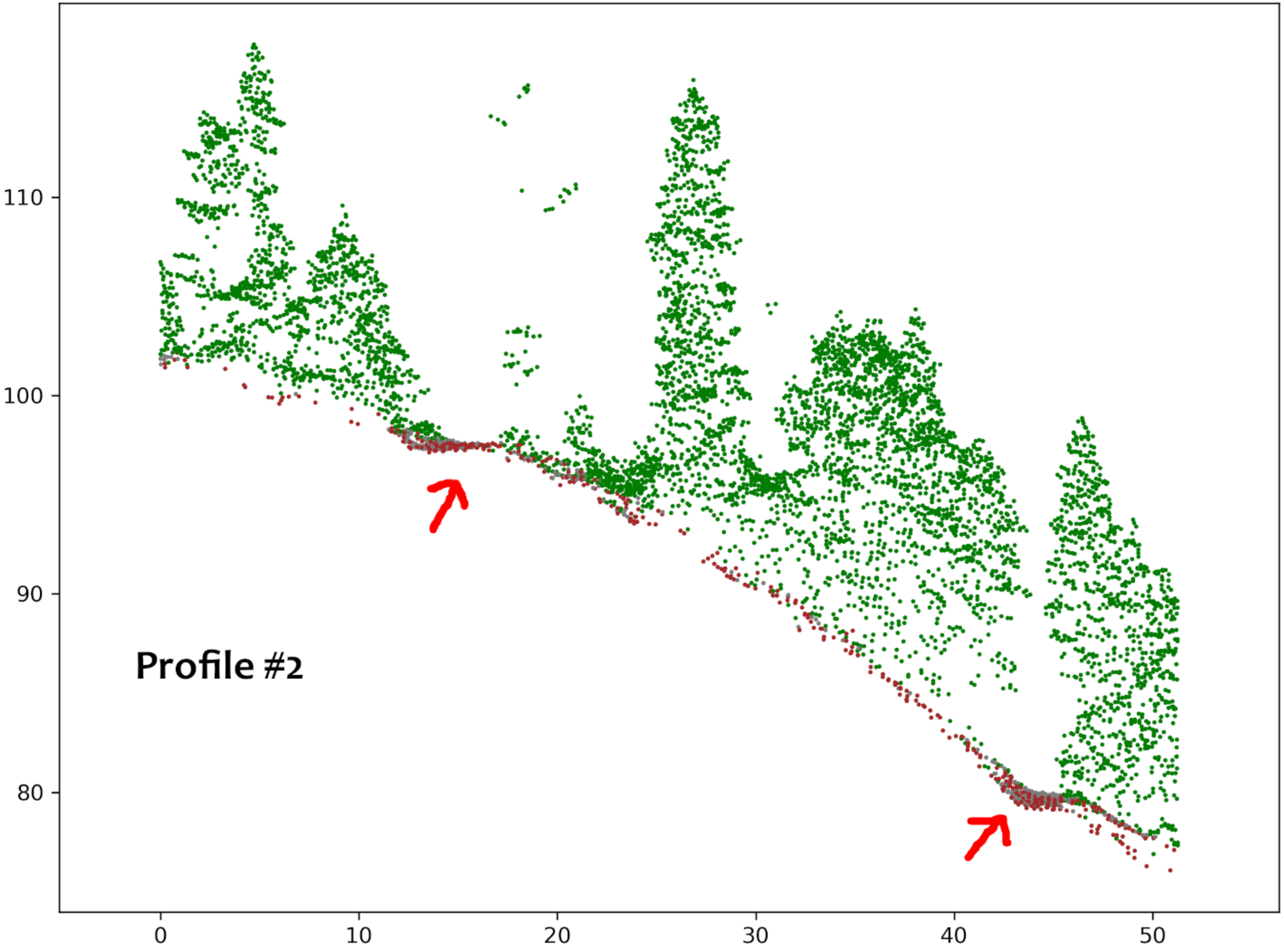
Derived from Lidar: Contours and Relief Shading


Profile 3
Profile 2
Profile 1

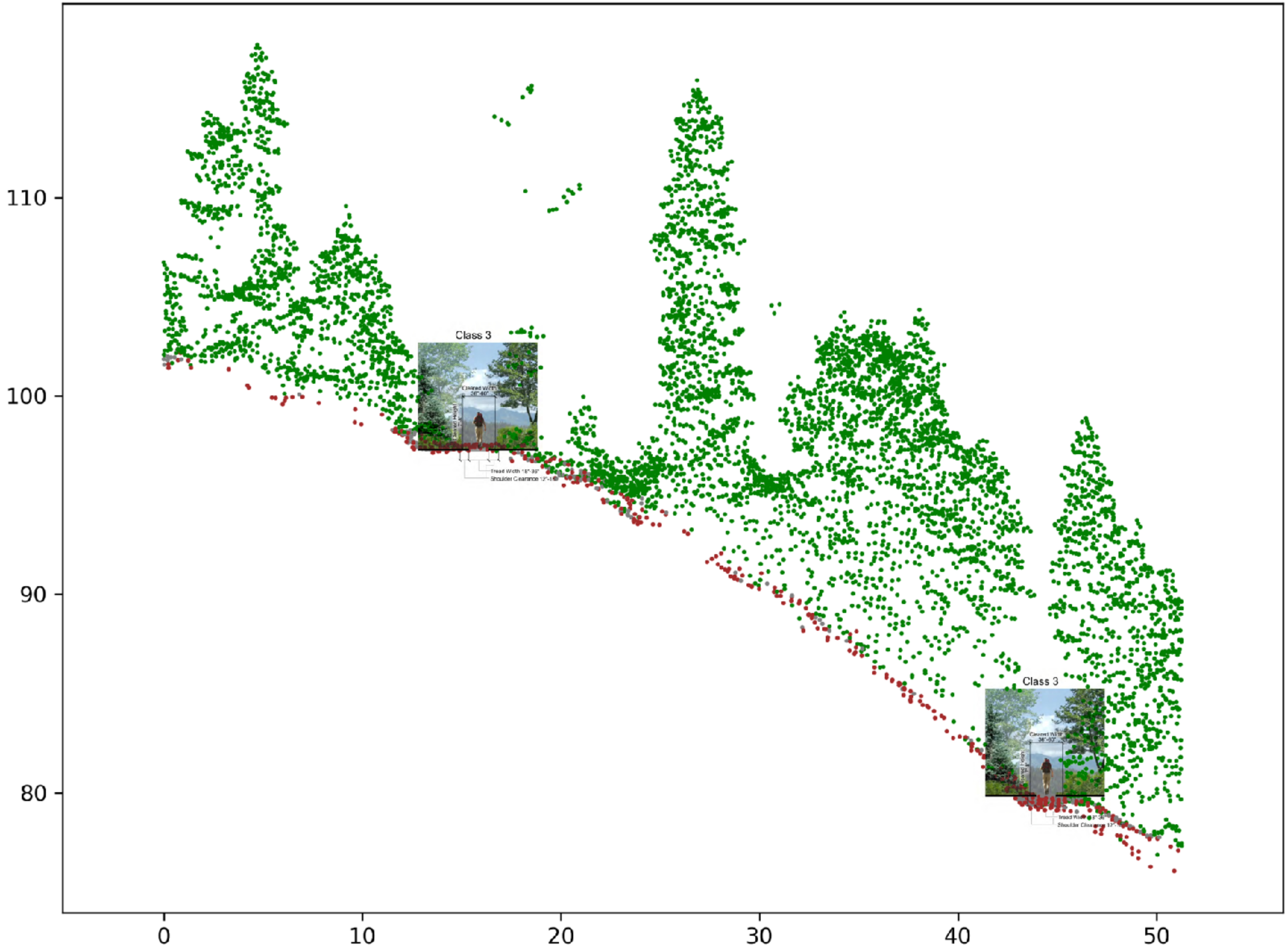


Profile #1
Elevation (meters)
145
140
135
130
125
120
115
110
0
10
20
30
40
Horizontal Distance (meters)


Vegetation Heights
Profile 3
Profile 2
Profile 1

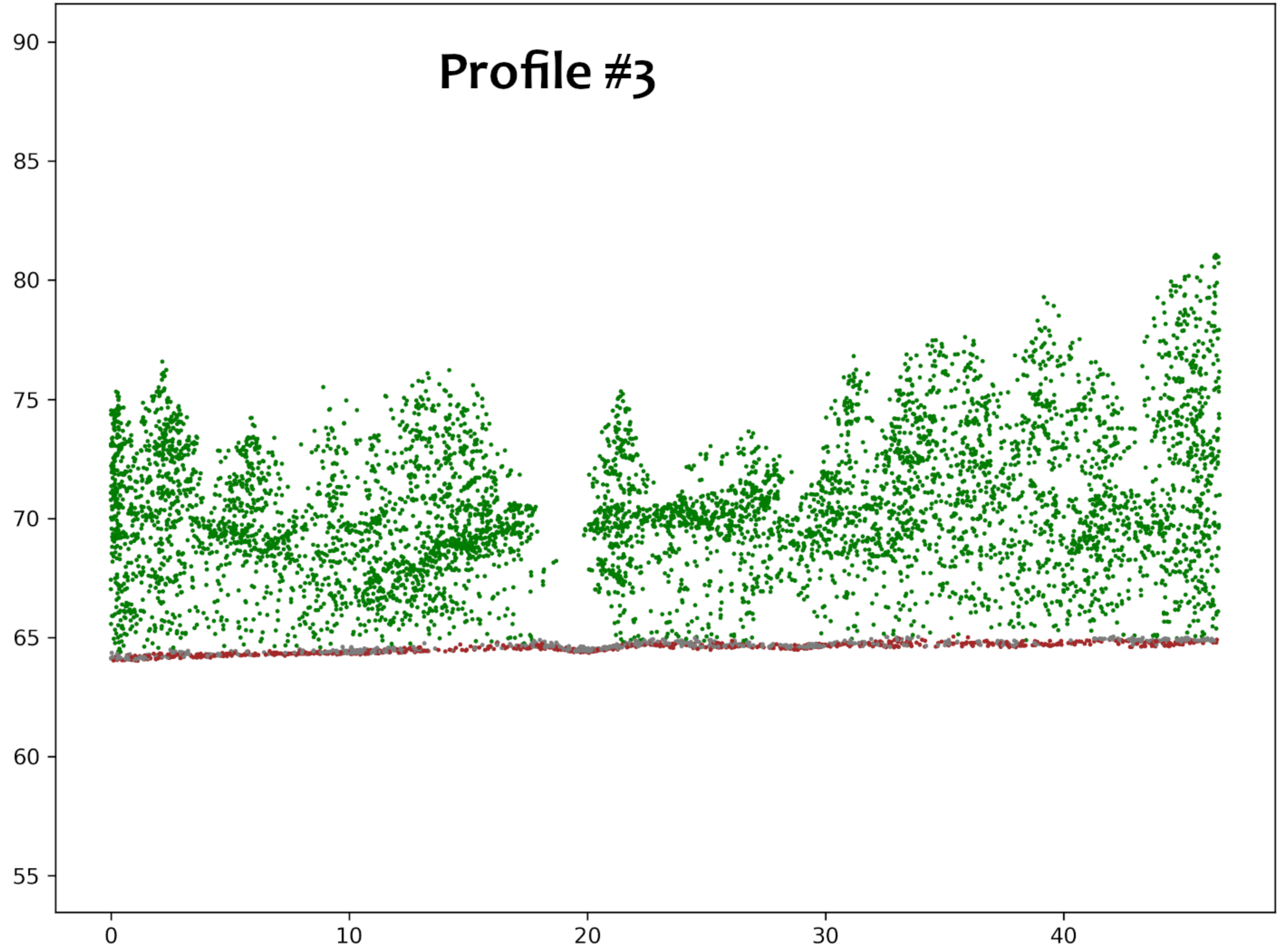


Profile #2
110
100
90
80
0
10
20
30
40
50

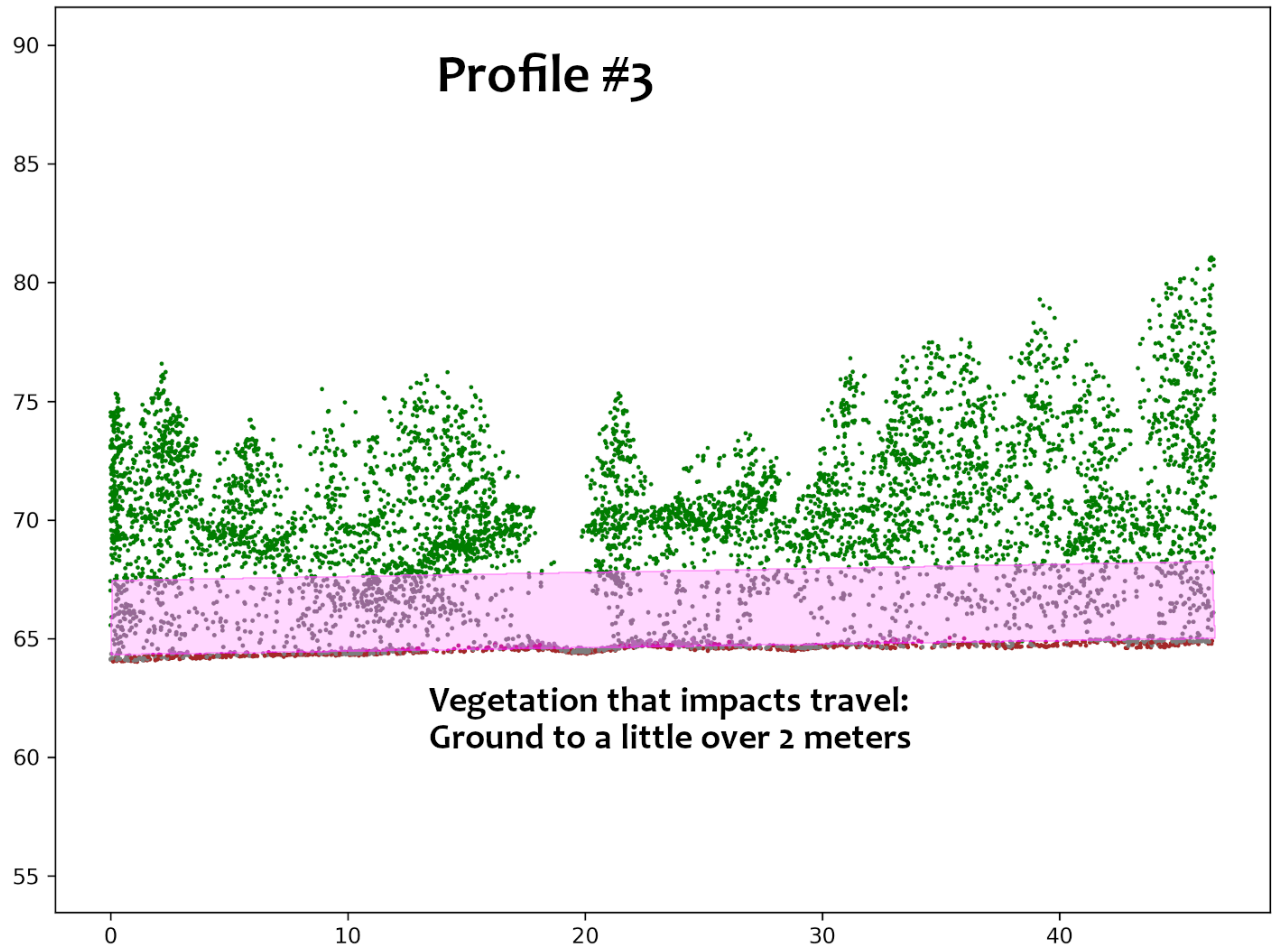

110
100
90
80
0
10
20
30
40
50
Class 3
Class 3

Class 3
Cleared Width
36"-60"
Cleared Height
7'-8'
Tread Width 18"-36"
Shoulder Clearance 12"-18"


Profile 3
Profile 2
Profile 1



Profile #3
90
85
80
75
70
65
60
55
0
10
20
30
40



Profile #3
Vegetation that impacts travel:
Ground to a little over 2 meters
90
85
80
75
70
65
60
55
0
10
20
30
40


Vegetation Density:
Fraction of Lidar pulses
that are blocked within
two meters of the ground

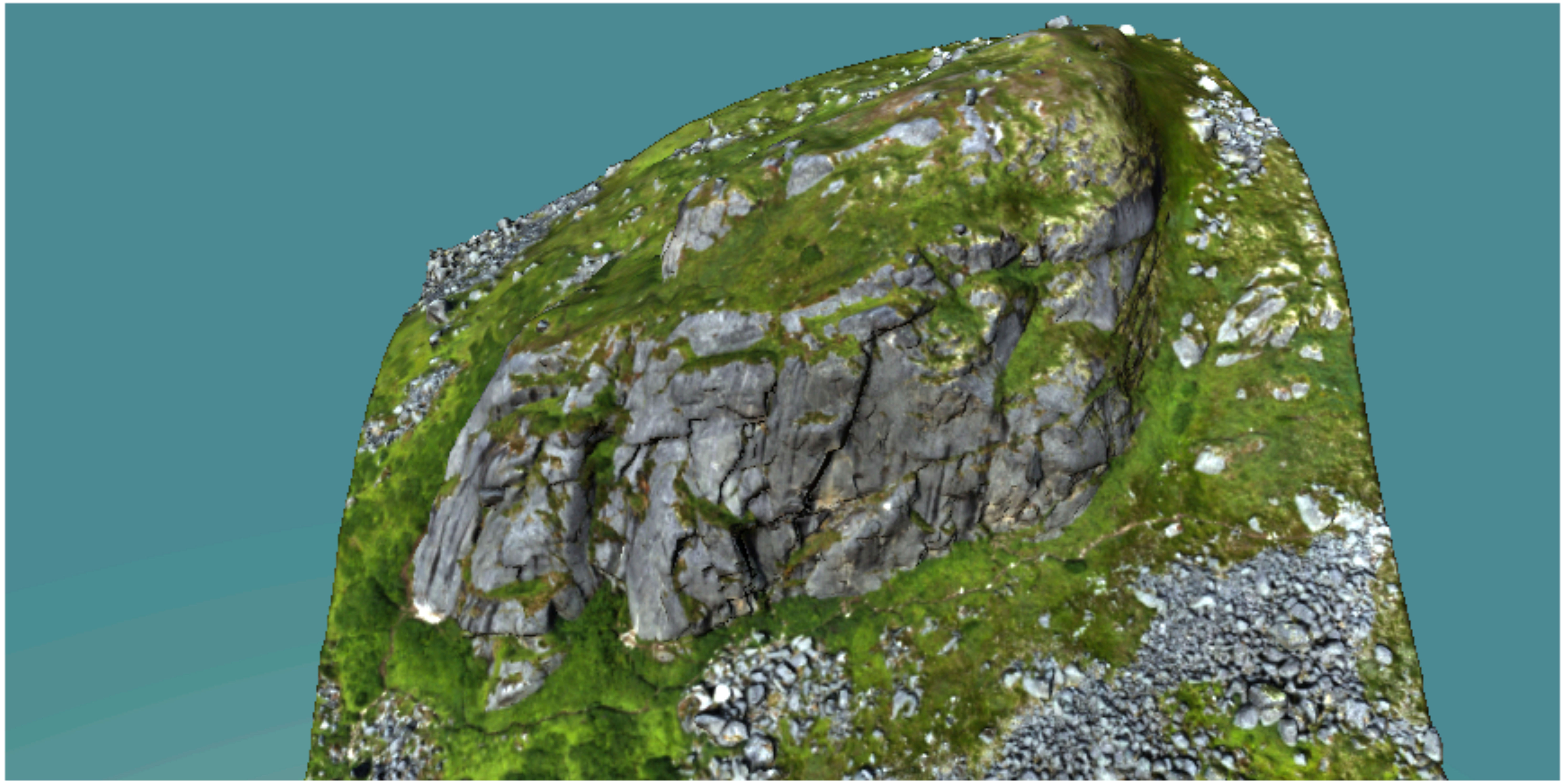

500 ft
100 m
Lidar (DGGS)

500 ft
100 m
Photogrammetry
(Mark Laker, USFWS)


500 ft
100 m
Photogrammetry
(Mark Laker, USFWS)

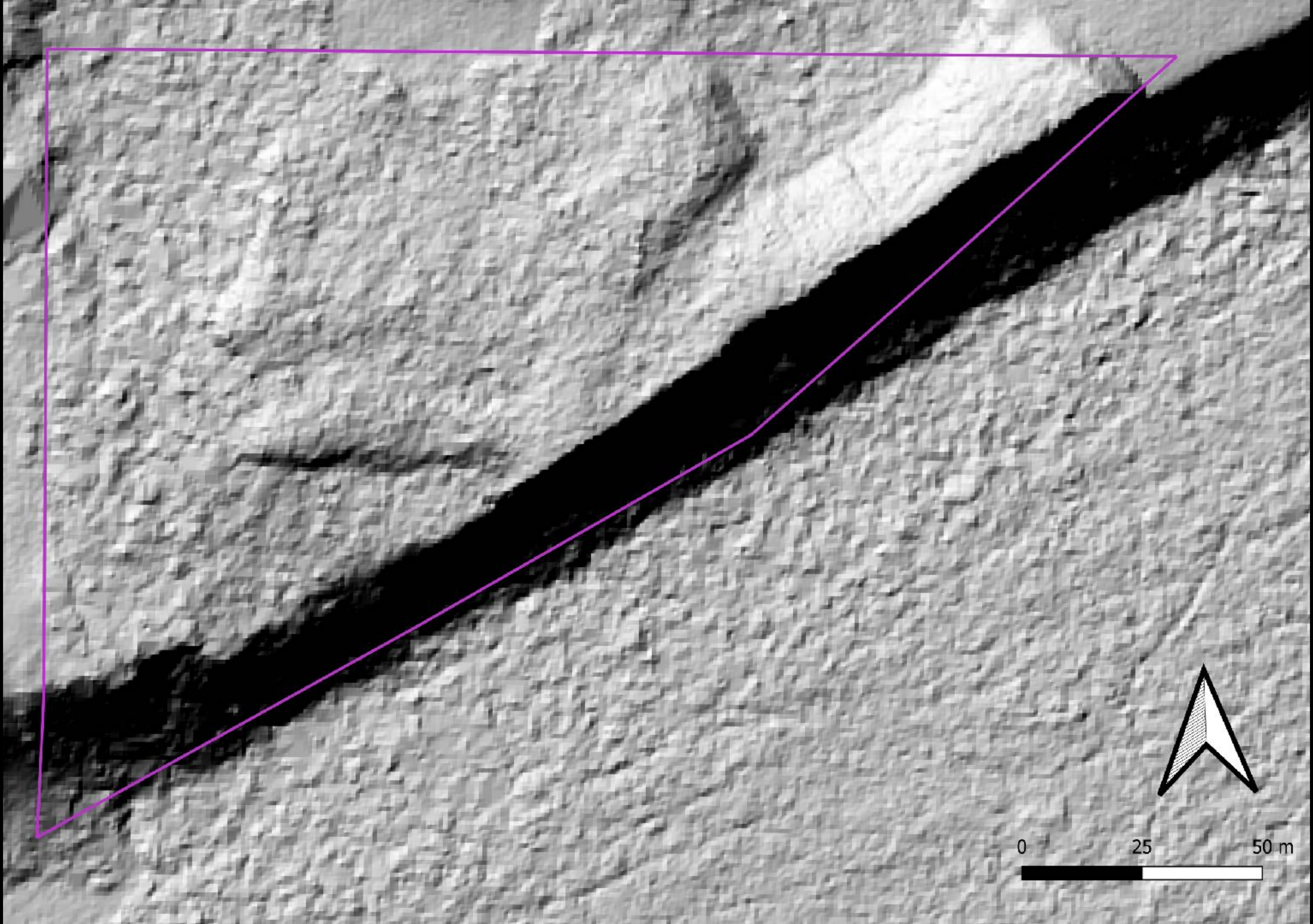
above treeline and a short walk from the Archangel Valley trailhead, the Monolith's easy access and clean granite has been attracting rock climbers for over 30 years.

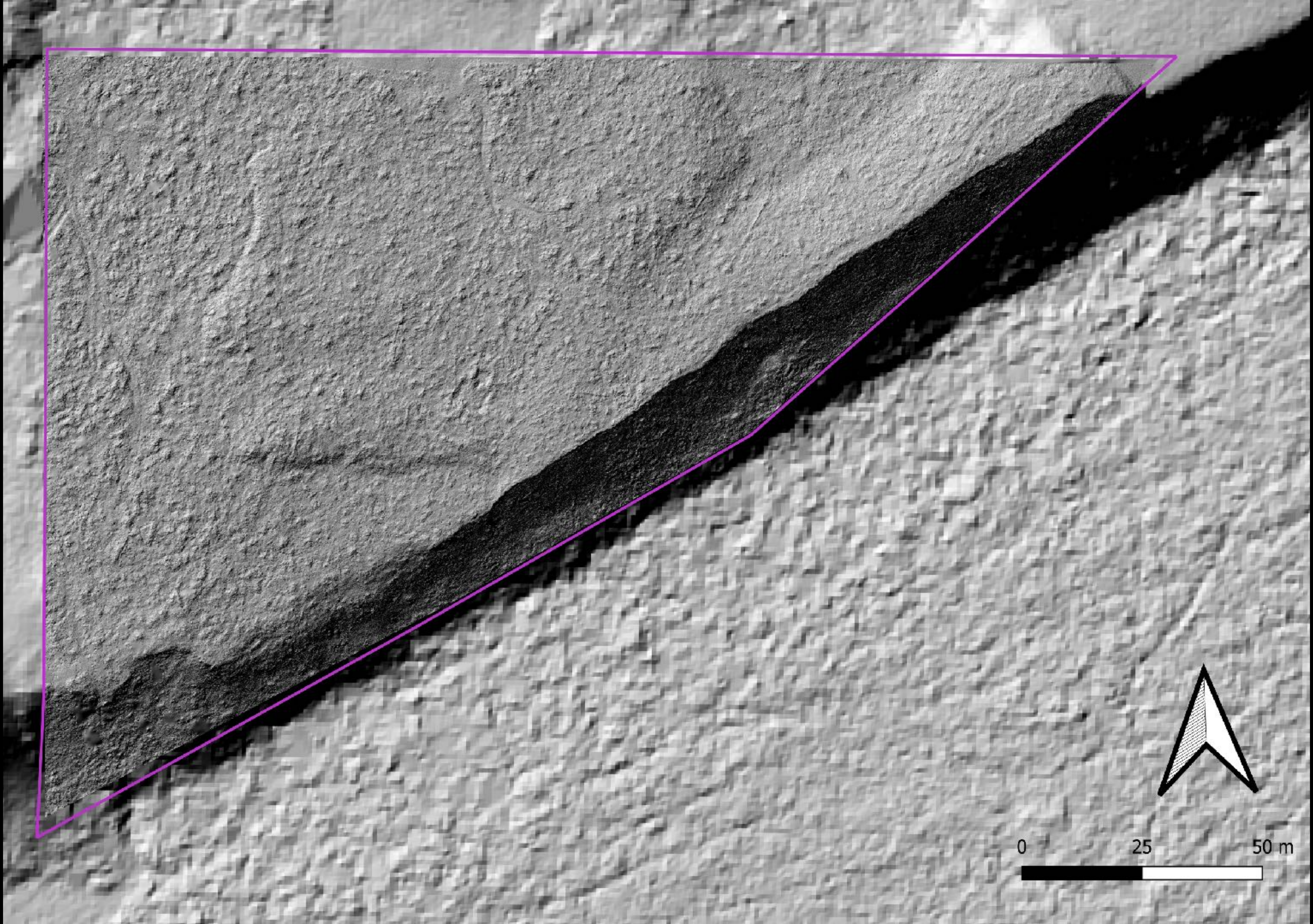
We were interested in exploring how computerized 3D modeling can aid in visualizing complex or difficult terrrain. In this case, we wanted to see how a 3D model of a popular rock climbing destination can make terrain data uniquely accessible.

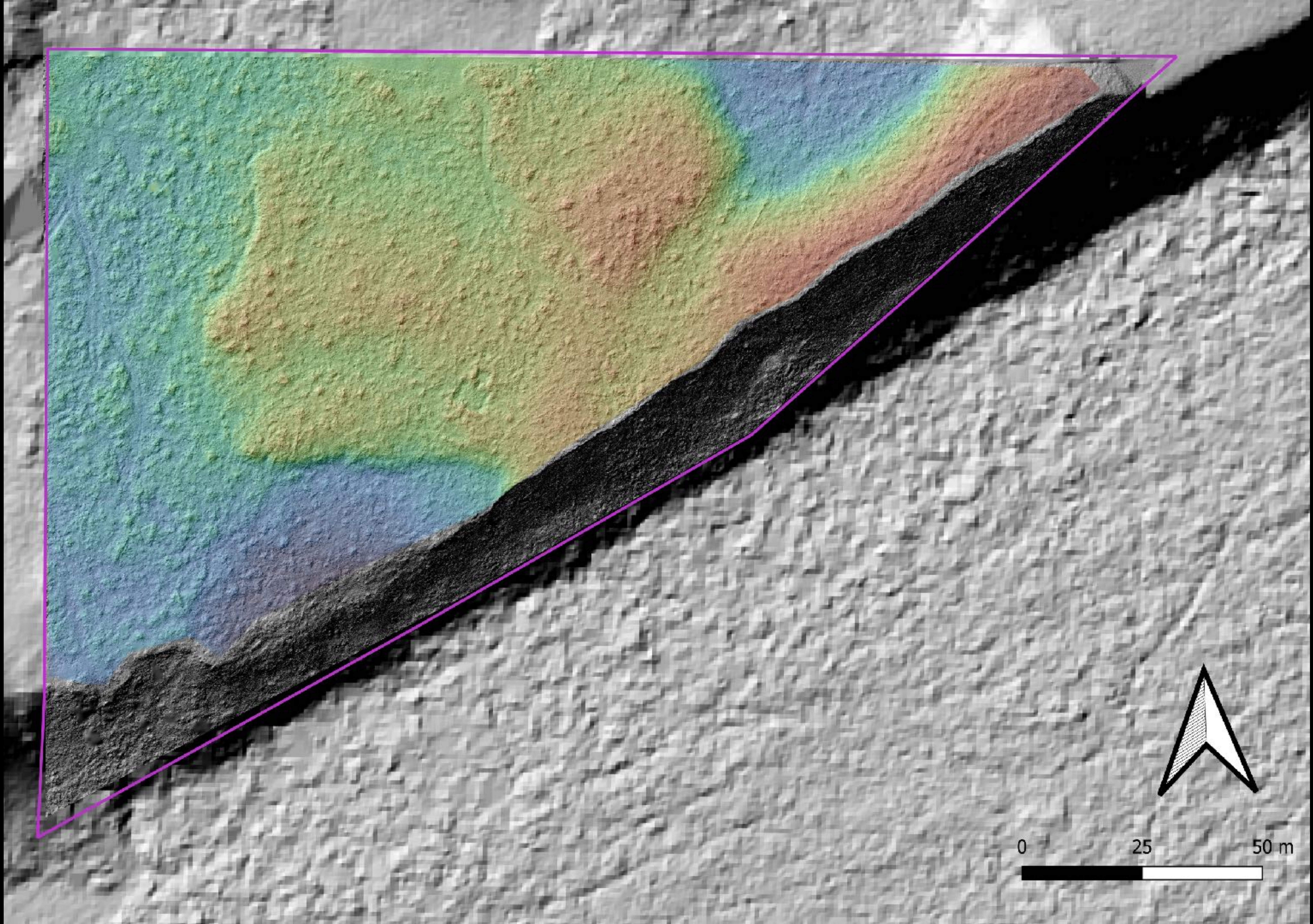


Click & drag to zoom and rotate the model


0
25
50 m

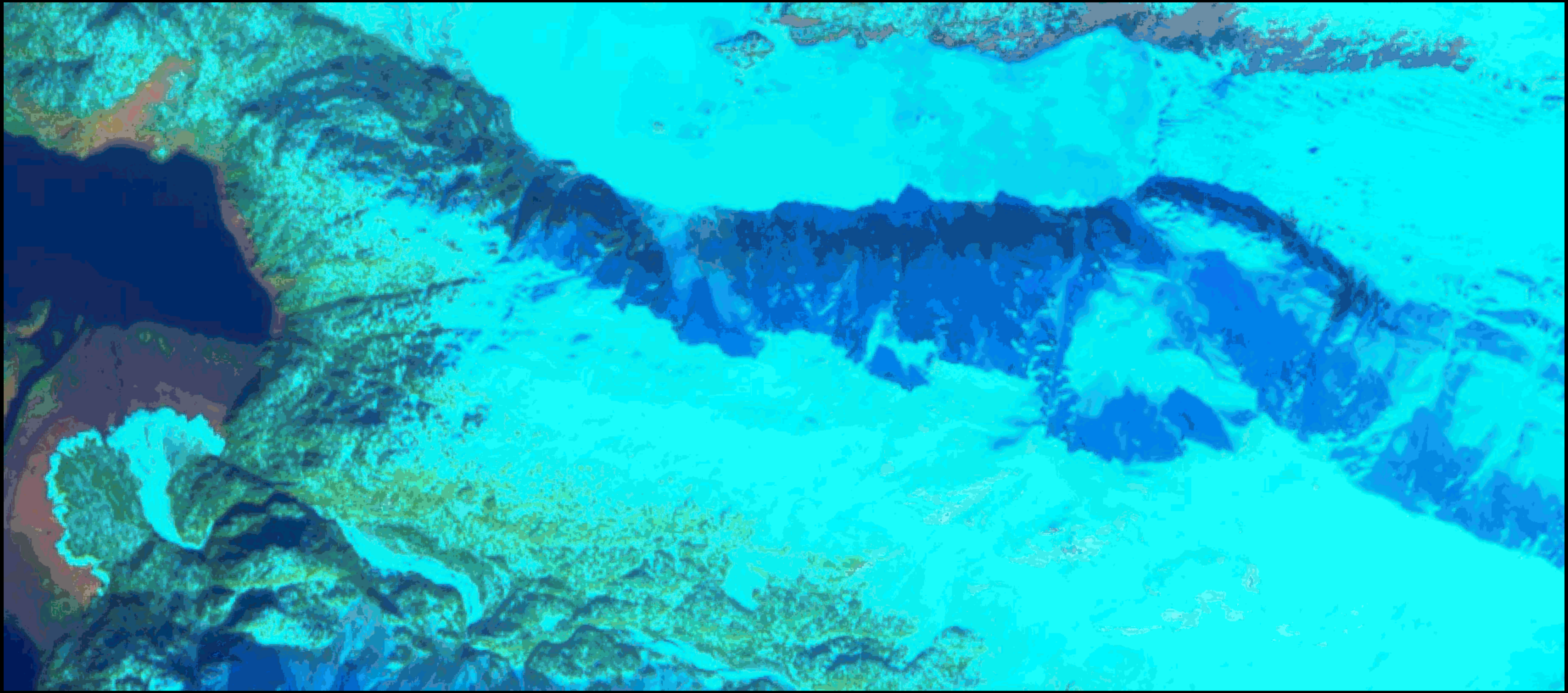

0
25
50 m


0
25
50 m


0
25
50 m


Snow Imagery: June 13th


July 16th




April 14
Little Omalley
Glen Alps
Flattop
Canyon Rd Trailhead


April 27


May 7


May 19


June 1


June 13


July 28


Sentinel Playground | Sentinel Hu
apps.sentinel-hub.com/sentinel-playground/?source=S2&lat=61.17279795522772&lng=-149.87926483154297&zoom=12&preset=1-NATURAL-COLOR&layers=B01,B02,B03&maxcc=100&gain=1.0&gamma=1.0&time=2022-10-01%7C2023-04-02&atm...
sentinelhub Playground
2023-04-02
100 %
Go to Place
Rendering
Effects
Custom
Natural color
Based on bands 4,3,2
Color Infrared (vegetation)
Based on bands 8,4,3
False color (urban)
Based on bands 12,11,4
Agriculture
Based on bands 11, 8, 2
Vegetation Index
Based on combination of bands (B8 - B4)/(B8 + B4)
Moisture Index
Based on combination of bands (B8A - B11)/(B8A + B11)
Geology
Based on bands 12,4,2
Bathymetric
Based on bands 4,3,1
Atmospheric penetration
Based on bands 12,11,8A
SWIR
Based on bands 12,8A,4
NDWI
Based on combination of bands (B3 - B8)/(B3 + B8)
GENERATE
Apr 2023
MON TUE WED THU FRI SAT SUN
27 28 29 30 31 1 2
3 4 5 6 7 8 9
10 11 12 13 14 15 16
17 18 19 20 21 22 23
24 25 26 27 28 29 30
1 2 3 4 5 6 7
1 km

Glacier Spit
Portlock Plateau
Portlock Glacier
Foehn Ridge
Grewingk Tram Spur
Grewingk Tram
Grewingk Cr.
Emerald L.
Glacier Spit Trailhead
Glacier Lake Trail
Blue Ice Trail
Rusty's Lagoon
Kachemak Crack
Left Beach
Right Beach
Saddle Trail
Saddle Trailhead
Grewingk Glacier Lake
Grewingk Glacier
Lagoon Trail
Alpine Ridge Trail
Beluga Spit
Ismailof I.
Martha's Is.
Halibut Cove
Tide Rip
Halibut Cr.
Strong Currents
Halibut Cove Lagoon
Dead Valley
Goat Rope Spur
2748
3318
3420
3663
4100
4299
4498
4034
4388
1431
1675
1684
601
1068
2163
3593
3741
3787
3555
694
575
1351
3073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