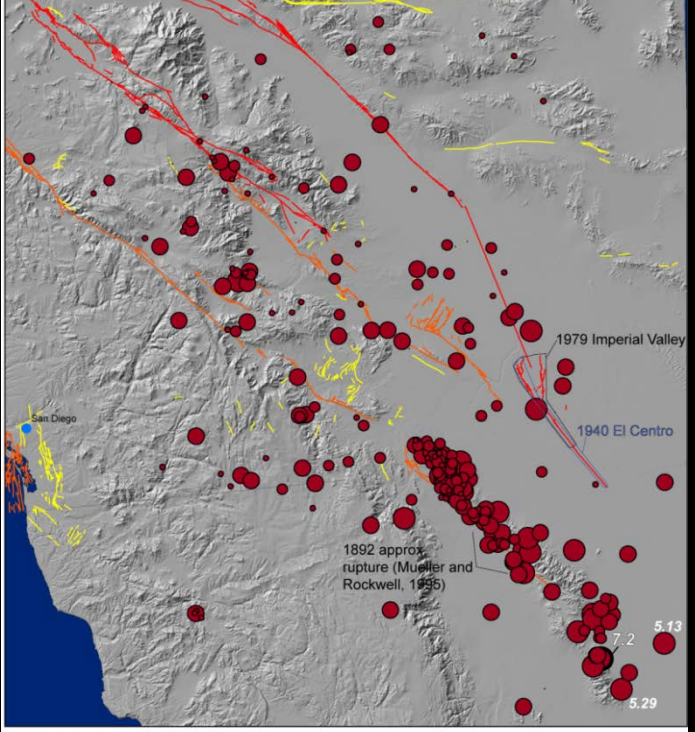
Topographic differencing

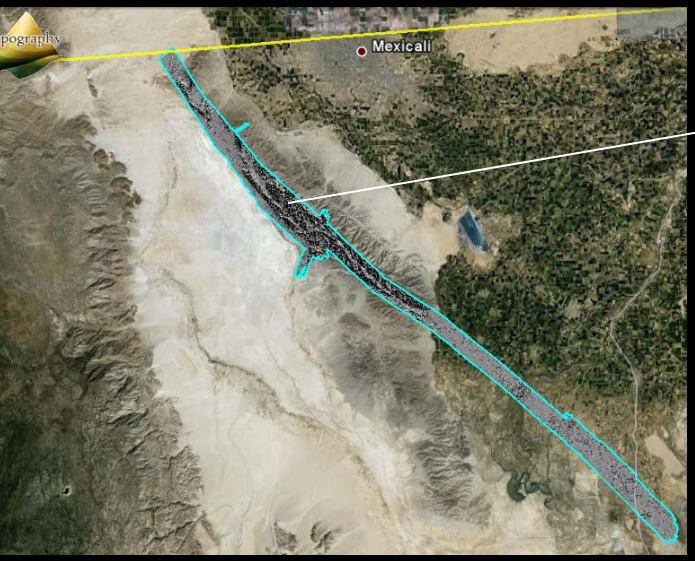
J Ramón Arrowsmith
School of Earth and Space Exploration
Arizona State University

Christopher J. Crosby
UNAVCO

Tutorial notes (April 2016)

OpenTopography
High-Resolution Topography Data and Tools



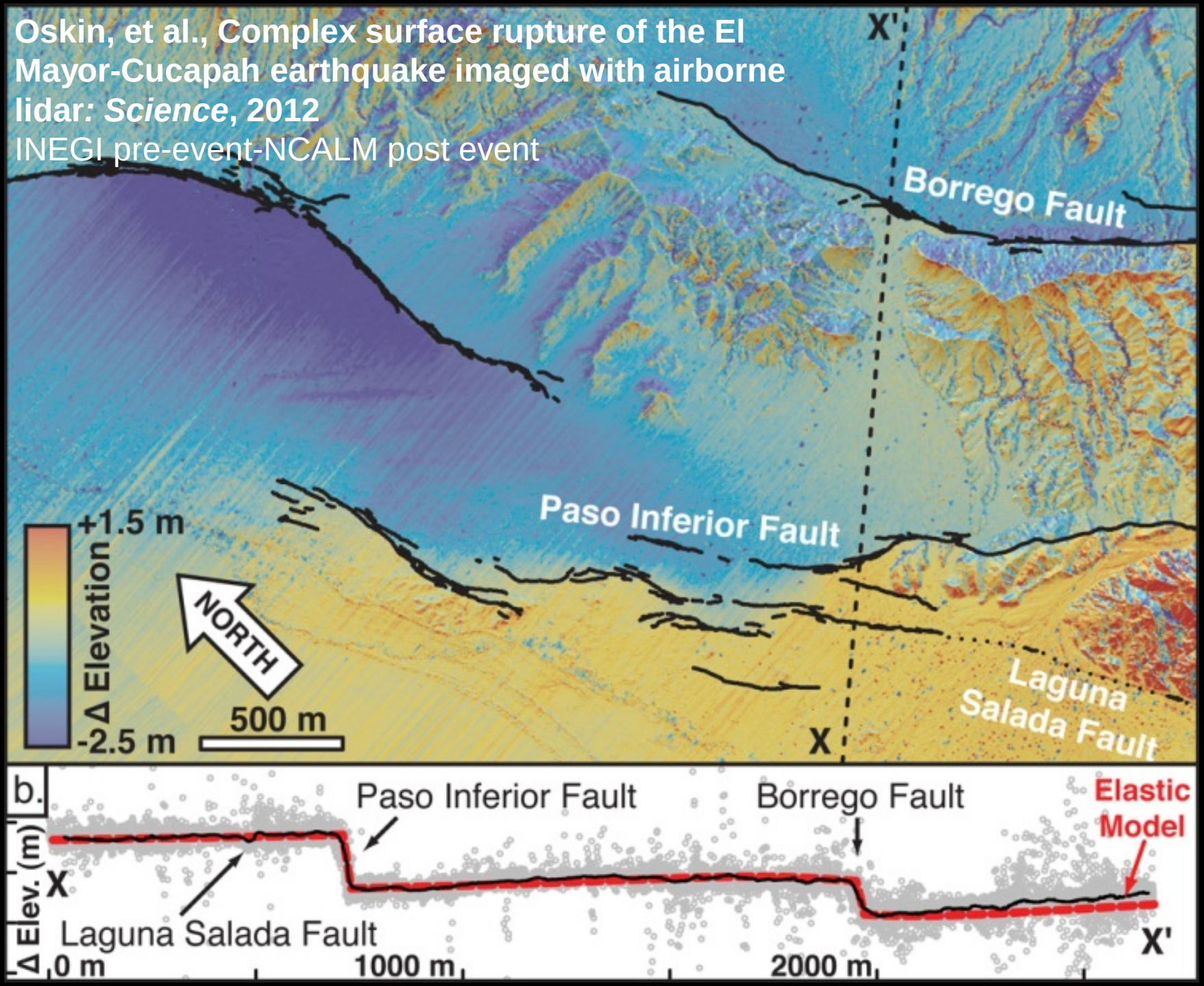


El Mayor Cucupah earthquake rupture laser scan

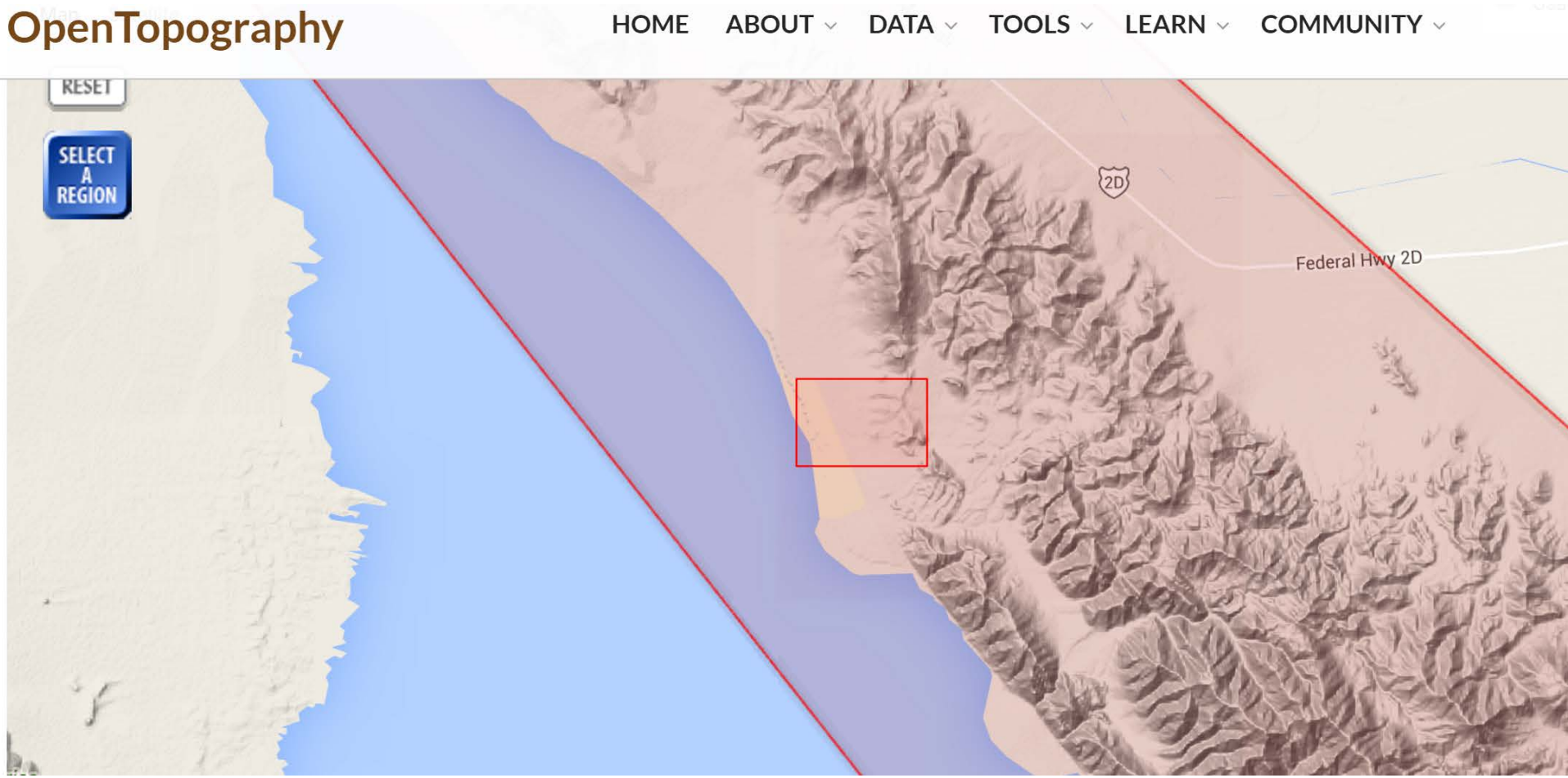
Oskin, et al., in review

UCDAVIS DEPARTMENT OF GEOLOGY | CICESE | ASU SCHOOL OF EARTH & SPACE EXPLORATION ARIZONA STATE UNIVERSITY | NSF NCALM


Photo by Tom Rockwell


Oskin, et al., Complex surface rupture of the El Mayor-Cucapah earthquake imaged with airborne lidar: Science, 2012
INEGI pre-event-NCALM post event
X'
Borrego Fault
Paso Inferior Fault
+1.5 m
-2.5 m
Δ Elevation
NORTH
500 m
X
Laguna Salada Fault
b.
Δ Elev. (m)
X
Paso Inferior Fault
Borrego Fault
Elastic Model
Laguna Salada Fault
0 m
1000 m
2000 m
X'

Pick a small piece of the data



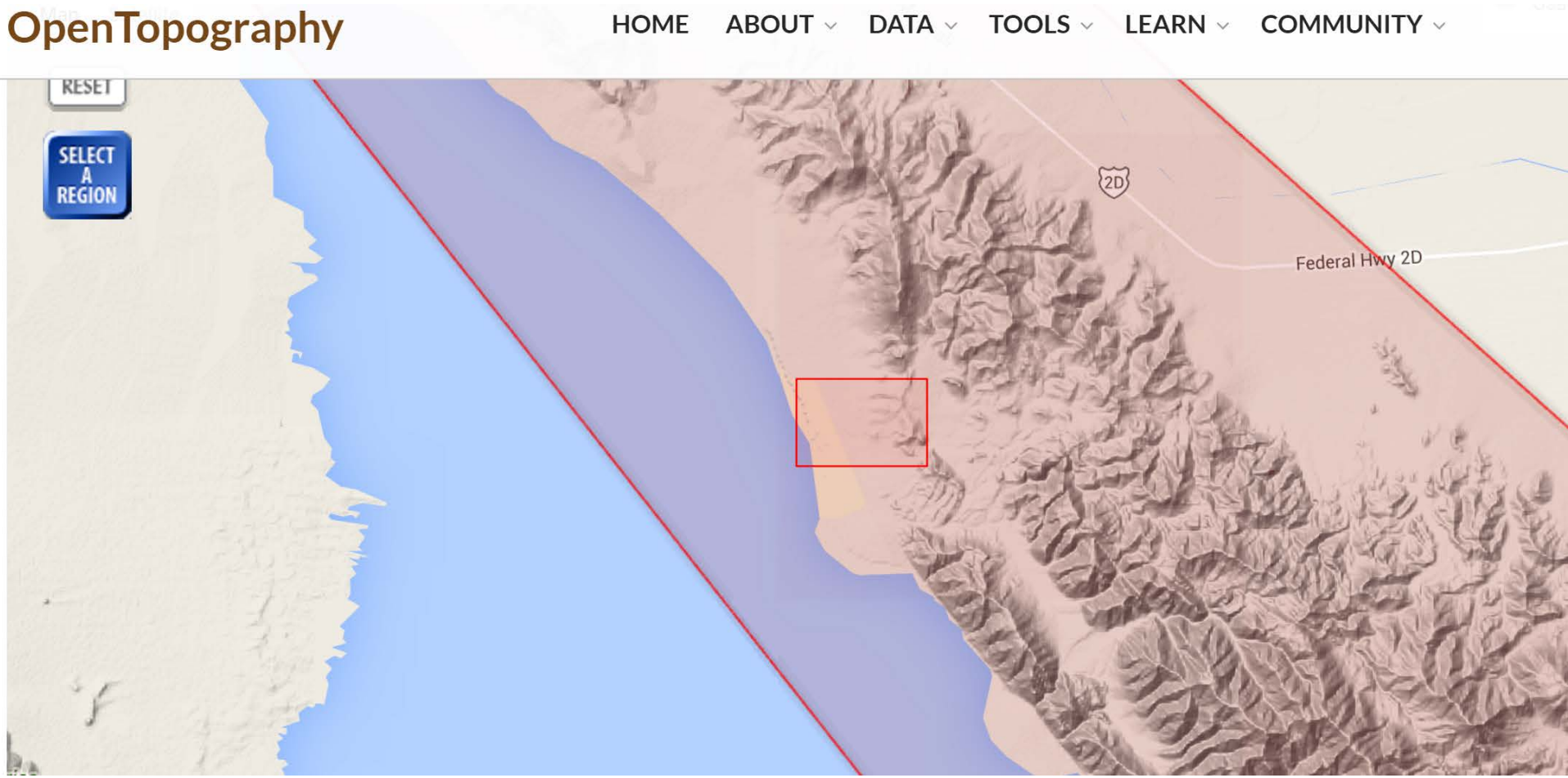
Two datasets PRE and POST

OpenTopography: 5 datasets found

Datasets listed below are hosted by OpenTopography and are available in point cloud format for download and processing (e.g., creating custom DEMs). In some cases derived data products such as raster and Google Earth Image overlays are also available. Click the button to the right of the dataset name to access the available data products.

1	Shuttle Radar Topography Mission (SRTM) Global	SRTM 30m	SRTM 90m		
2	2006 INEGI Sierra Cucupah Empirically Corrected Lidar Dataset	Point Cloud Data			
3	El Mayor-Cucapah Earthquake Rupture Terrestrial Laser Scan-Site 2	Point Cloud Data			
4	El Mayor-Cucapah Earthquake Rupture Terrestrial Laser Scan-Site 1	Point Cloud Data			
5	El Mayor-Cucapah Earthquake (4 April 2010) Rupture LiDAR Scan	GE Hillshades	Raster Data	Point Cloud Data	

Pick a small piece of the data



1. Coordinates & Classification

PRE

Horizontal Coordinates: UTM Zone 11 N WGS84 Meters, 2010.627 epoch (ITRF2000) [EPSG: 32611]
Vertical Coordinates: Ellipsoid

Data Selection Coordinates: ☐ Manually enter selection coordinates (in the horizontal coordinate system listed above)

X_{min} =	Y_{min} =	X_{max} =	Y_{max} =
625813.481	3595982.128	628139.043	3597536.168

The selection area contains approximately 19,000 points.

1. Coordinates & Classification

POST—manual entry

Horizontal Coordinates: UTM Zone 11 N WGS84 Meters [EPSG: 32611]
Vertical Coordinates: Ellipsoid

Data Selection Coordinates: ☑ Manually enter selection coordinates (in the horizontal coordinate system listed above)

X_{min} =	Y_{min} =	X_{max} =	Y_{max} =
625813.481	3595982.12	628139.043	3597536.16

Validate coordinates and estimate point count

The selection area contains approximately 33,448,000 points.

Run both the pre and the post datasets at 1 m; generate additional KMZ files

Download all products, but save to separate pre and post folders

Download Job Results

Point Cloud Results	• Download point cloud data in LAS format points.las (1.3 MB)
DEM Results	• Download DEM (TIN) dems.tar.gz (6.4 MB)
Derivative Products	• Download Hillshade & Slope Products (TIN) viz.tar.gz (11.2 MB)

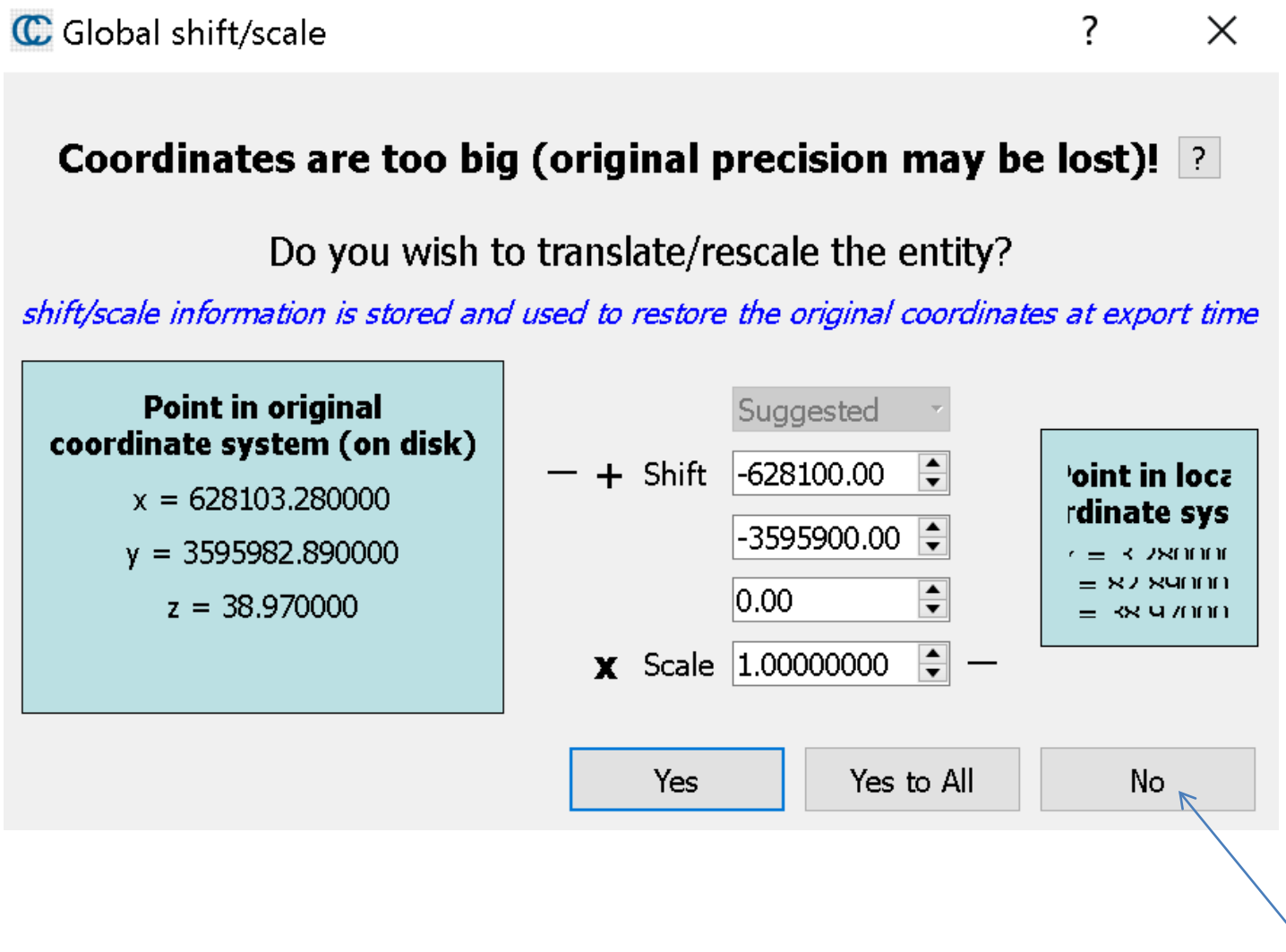
Visualization Products

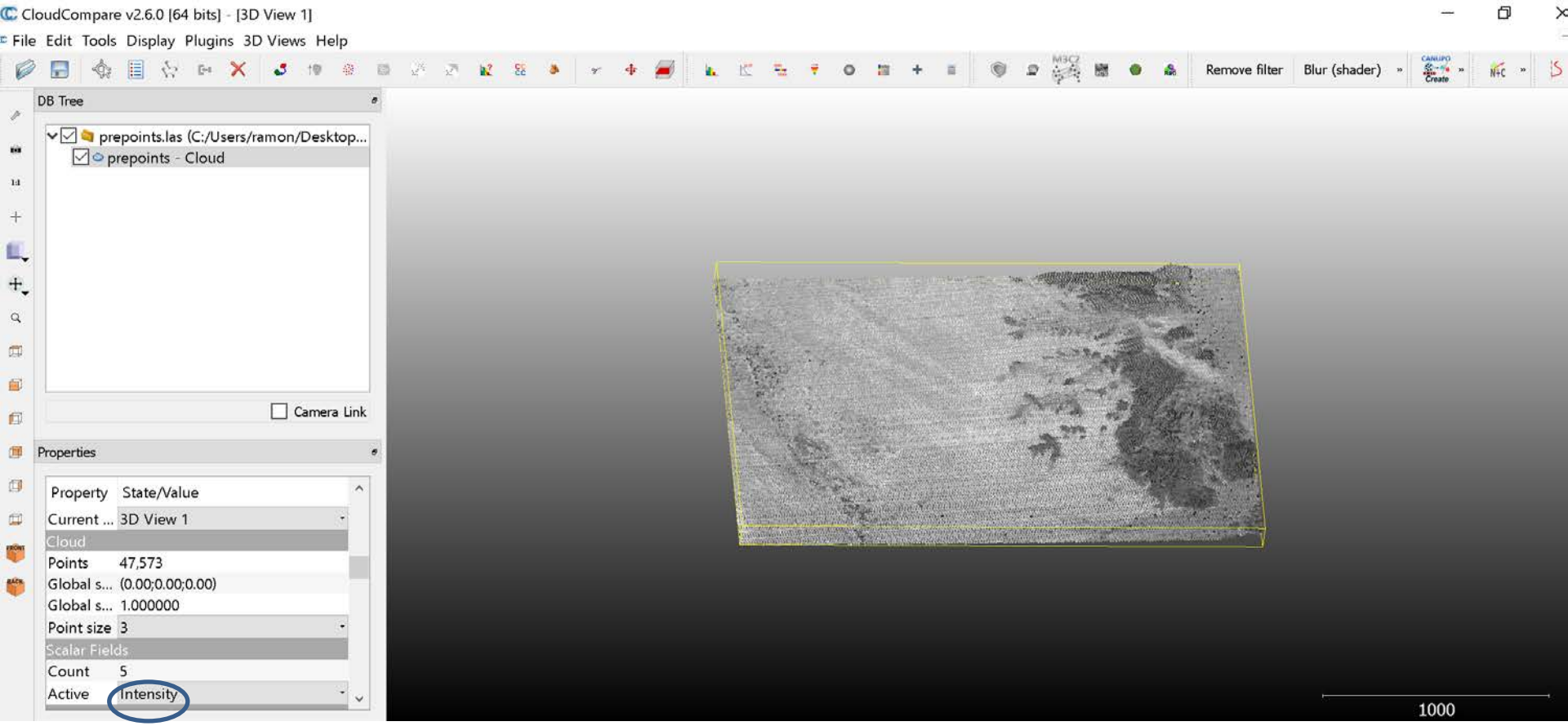
Ztin DEM	• Download KMZ file viz.tin.hs.kmz

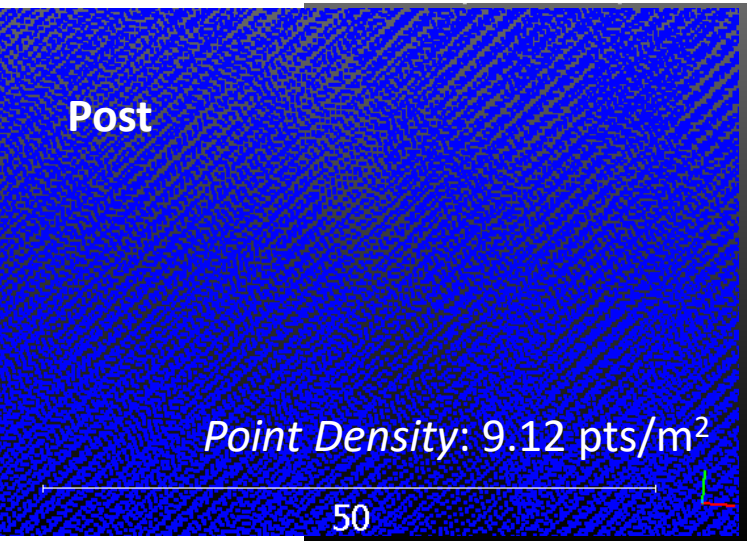
Can look at the hillshades in Google Earth

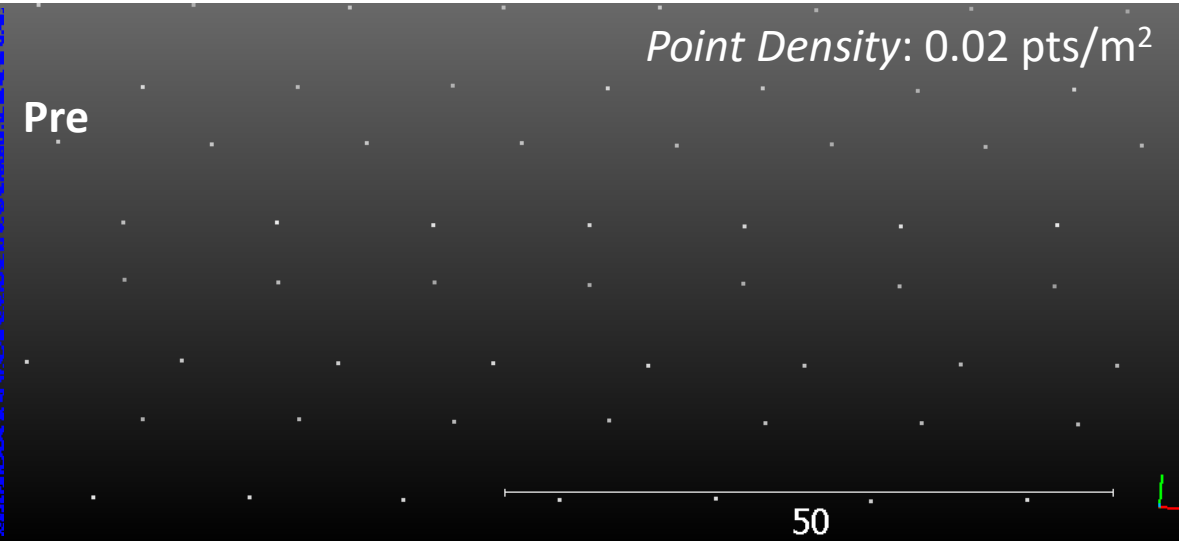
Can look at the hillshades in Google Earth

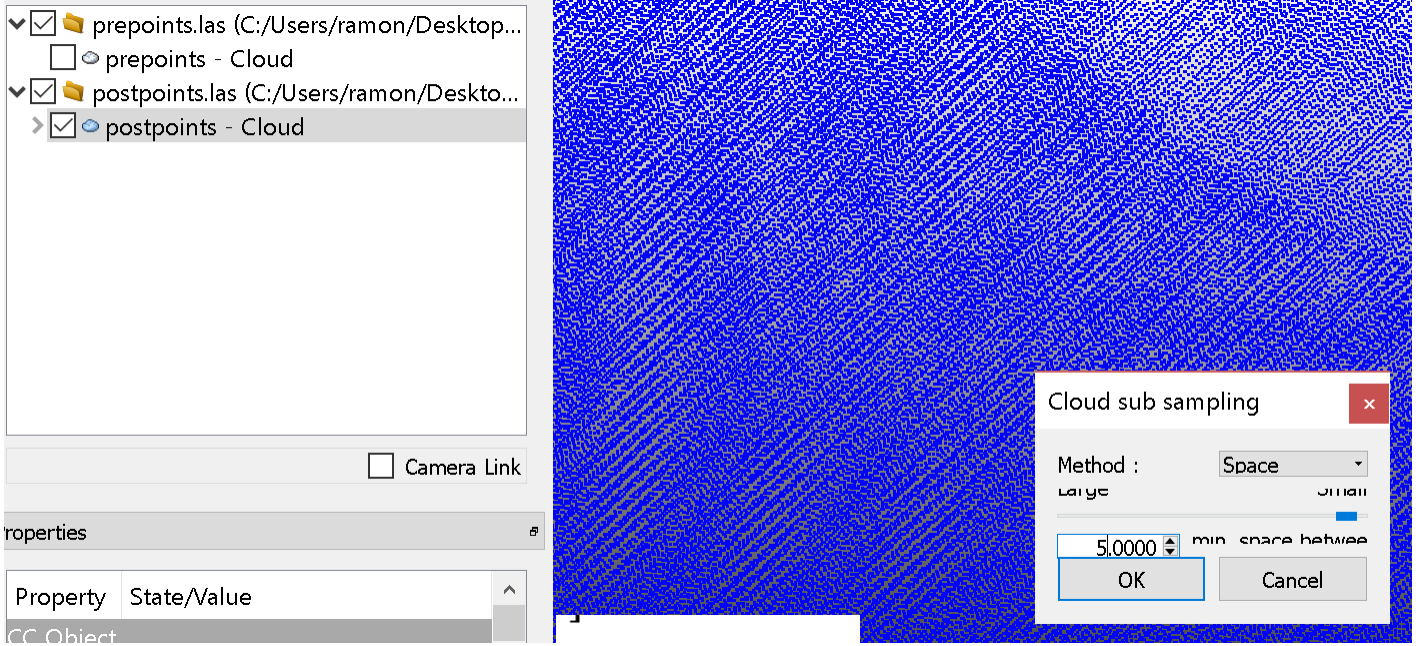
Open in Cloud Compare but don’t translate them



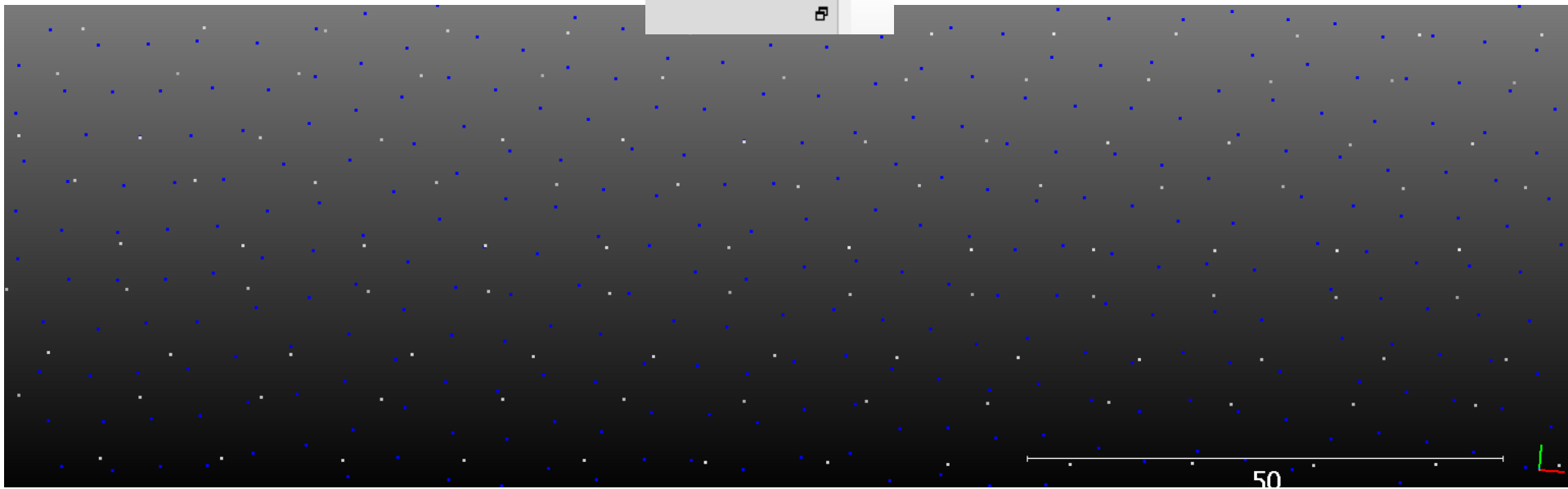

CloudCompare v2.6.0 [64 bits] - [3D View 1]
File Edit Tools Display Plugins 3D Views Help
Remove filter
Blur (shader)
DB Tree
prepoints.las (C:/Users/ramon/Desktop...
prepoints - Cloud
Camera Link
Properties
Property State/Value
Current ... 3D View 1
Cloud
Points 47,573
Global s... (0.00;0.00;0.00)
Global s... 1.000000
Point size 3
Scalar Fields
Count 5
Active Intensity
1000


Post
Point Density: 9.12 pts/m²
50

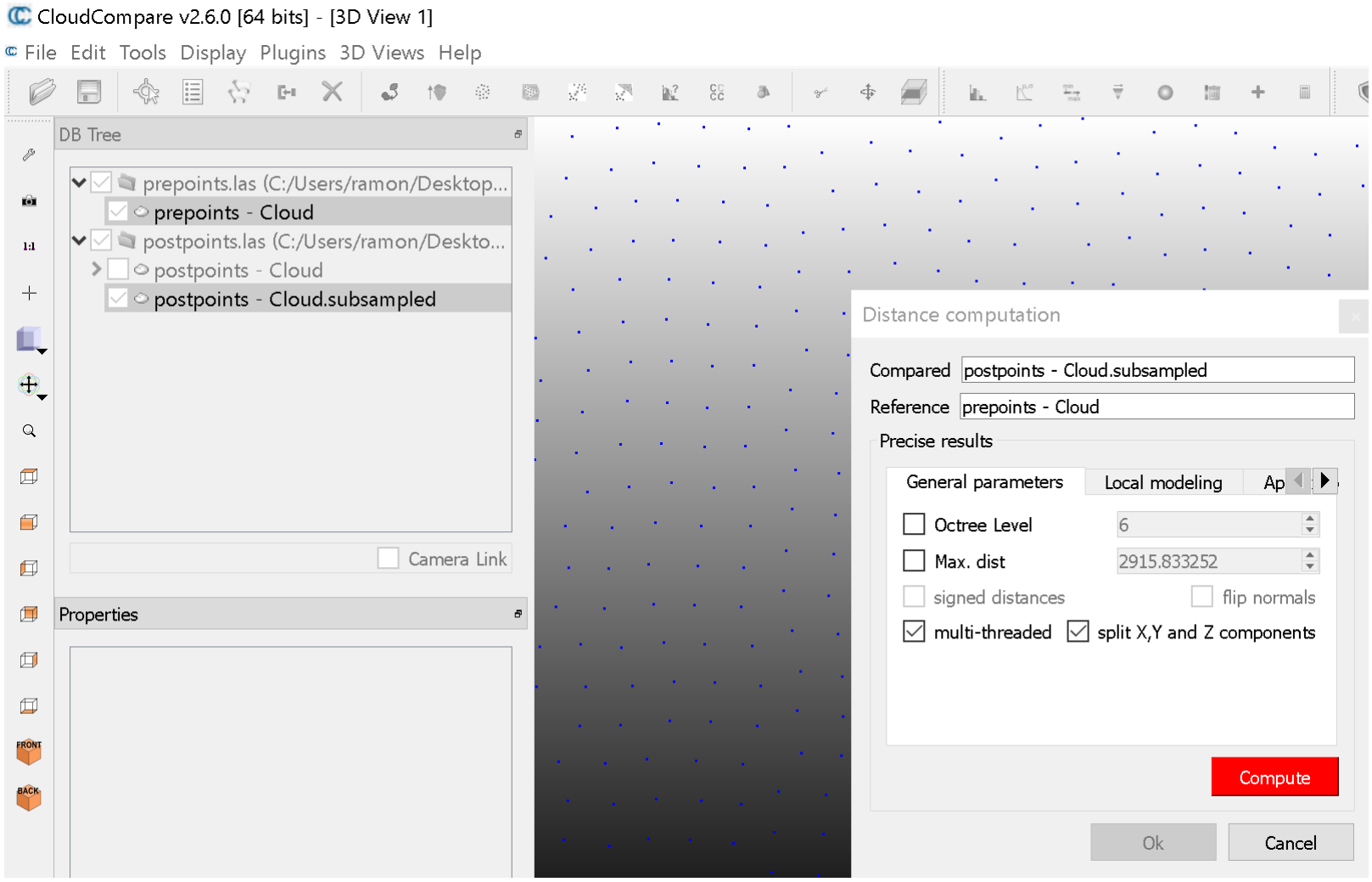

Pre
Point Density: 0.02 pts/m²
50



Subsample the clouds



Compute Cloud to Cloud difference



CloudCompare v2.6.0 [64 bits] - [3D View 1]

File Edit Tools Display Plugins 3D Views Help

Remove filte

DB Tree

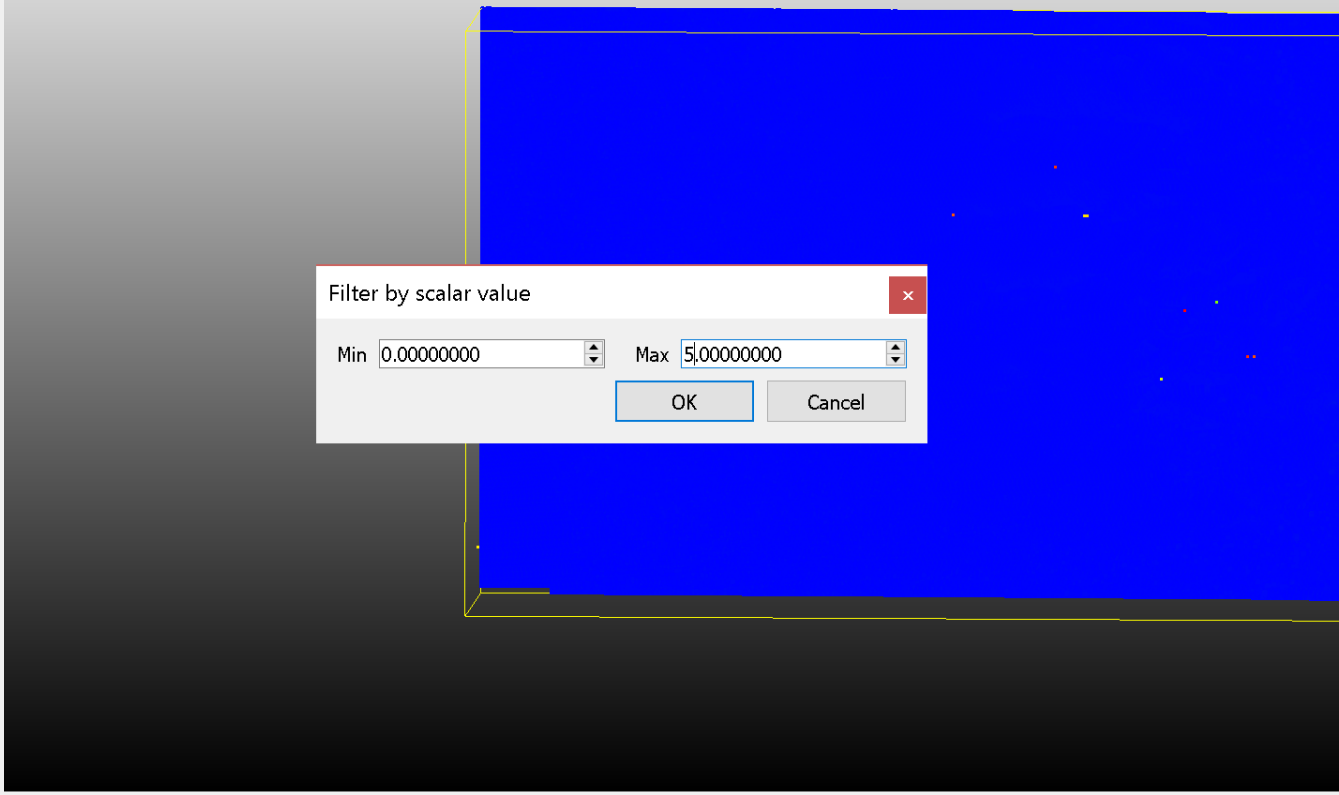
- prepoints.las (C:/Users/ramon/Desktop...
  - prepoints - Cloud
- postpoints.las (C:/Users/ramon/Deskto...
  - postpoints - Cloud

Camera Link

Properties

Property	State/Value
Points	33,747,502
Global s...	(0.00;0.00;0.00)
Global s...	1.000000
Point size	3
Scalar Fields	
Count	13
Active	C2C absolute distances
Color Scale	
Current	Blue>Green>Yellow>Red

Filter to just 0-5 m range

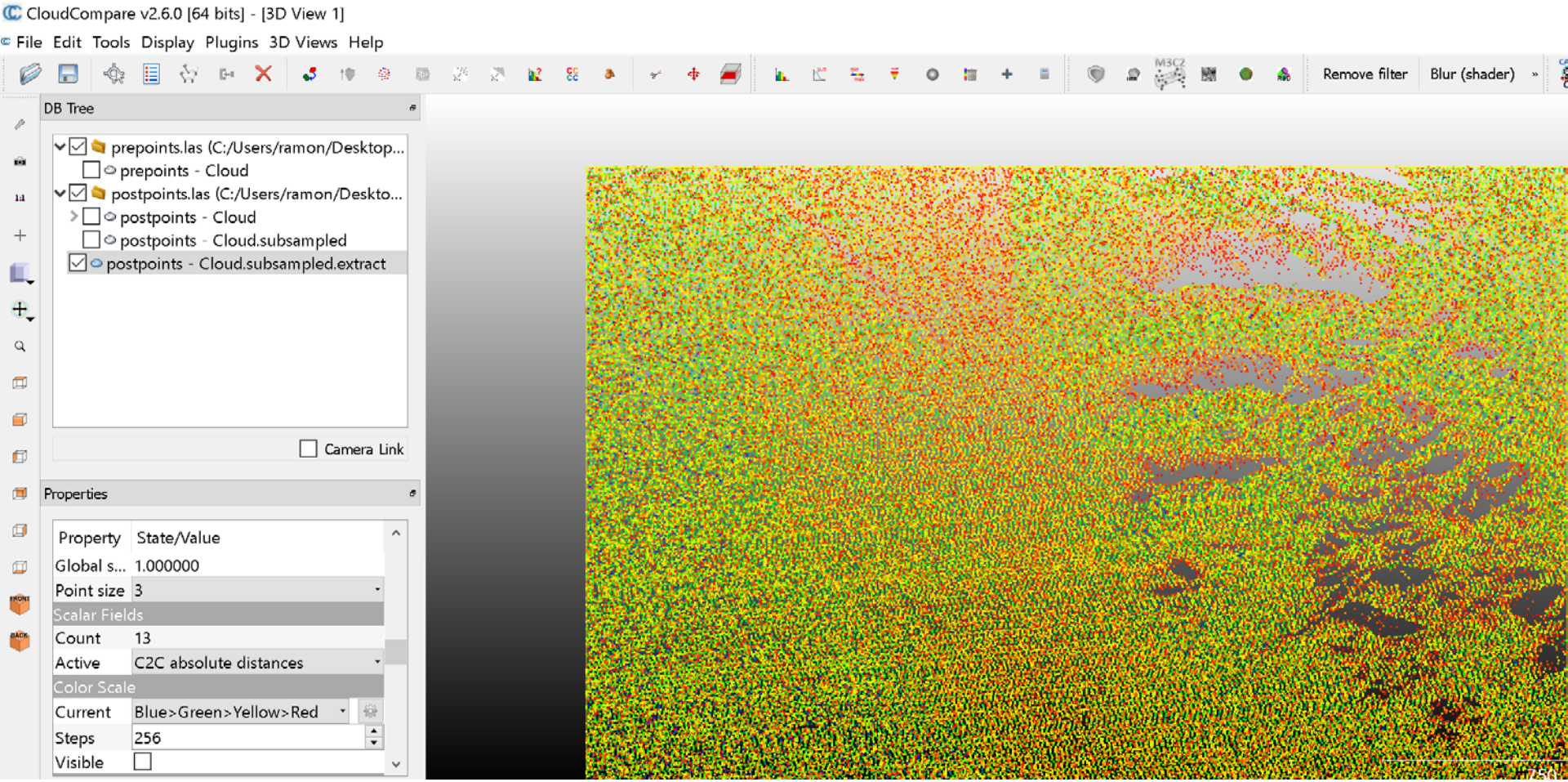


Console

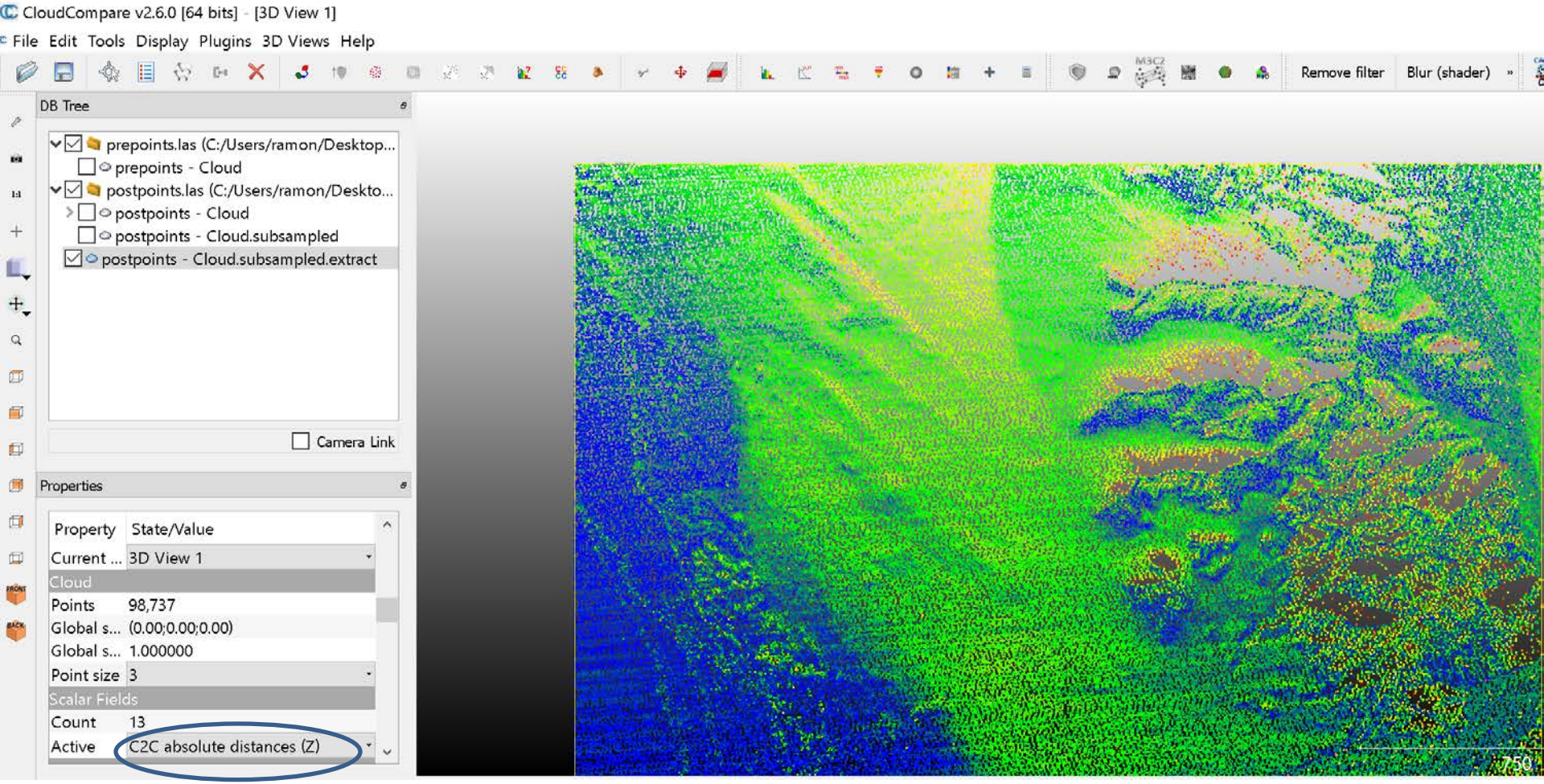
[07:40:32] [ComputeDistances] Mean distance = 4.110498 / std deviation = 1.495270

[07:40:34] [ComputeDistances] Result has been split along each dimension (check the 3 other scalar fields with '_X', '_Y' and '_Z' suffix!)

Cloud to cloud absolute differences



Cloud to cloud absolute differences Z component



Can do some of this in ArcMap for vertical differencing (Raster Calc.)