Lidar QA/QC, artifacts, issues to keep in mind

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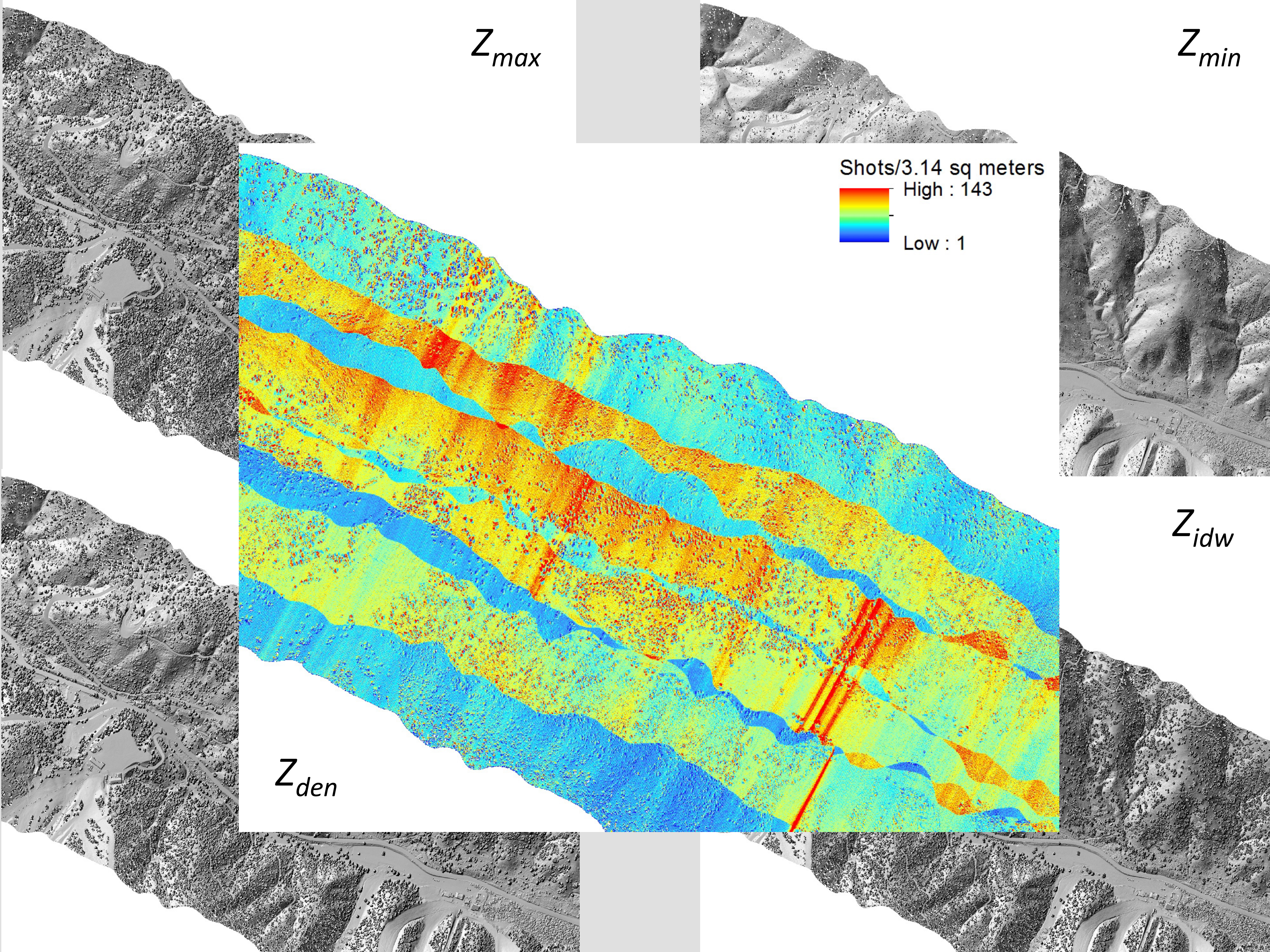
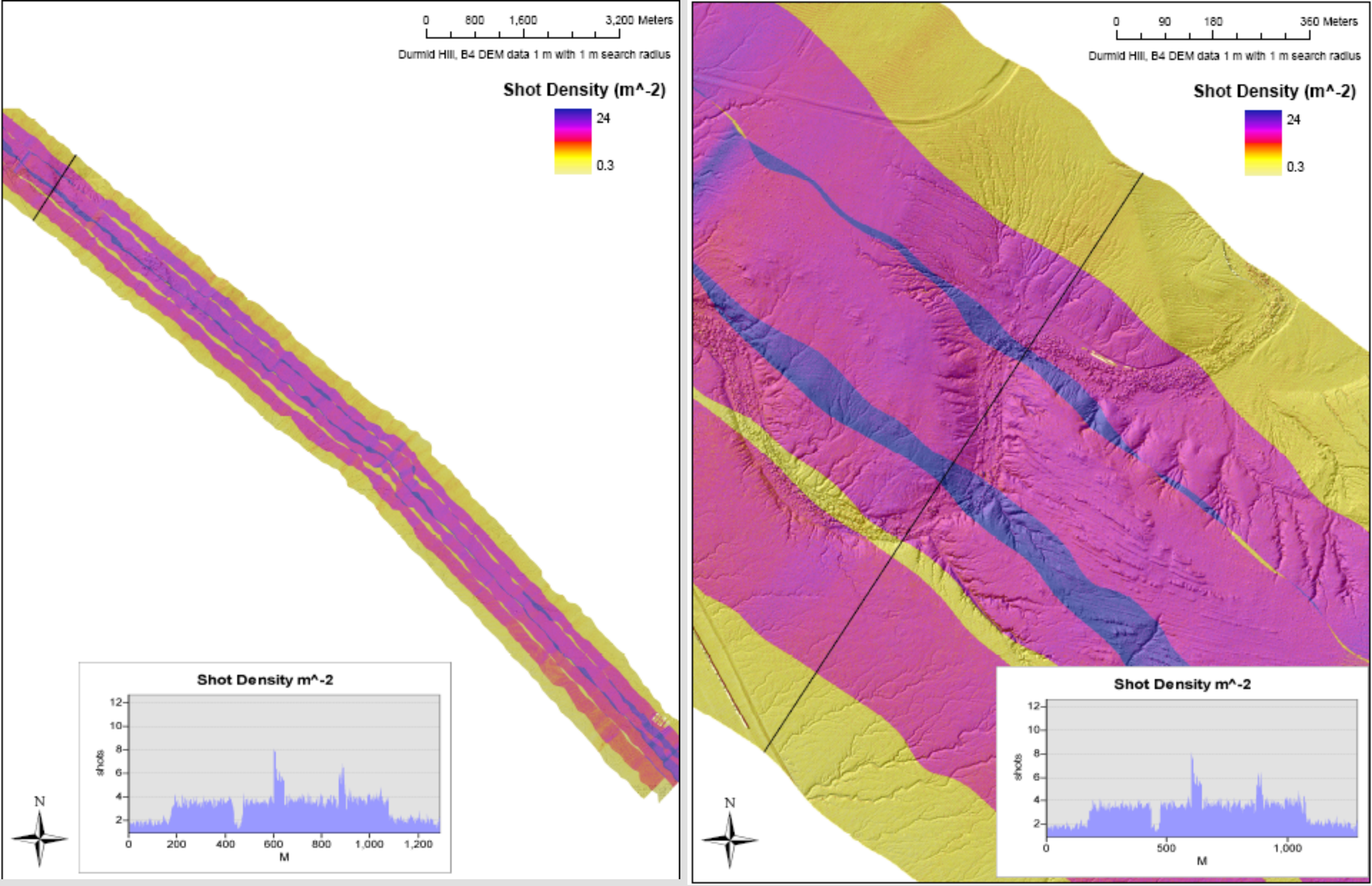
(with content adapted from Ralph Hagerud (USGS))

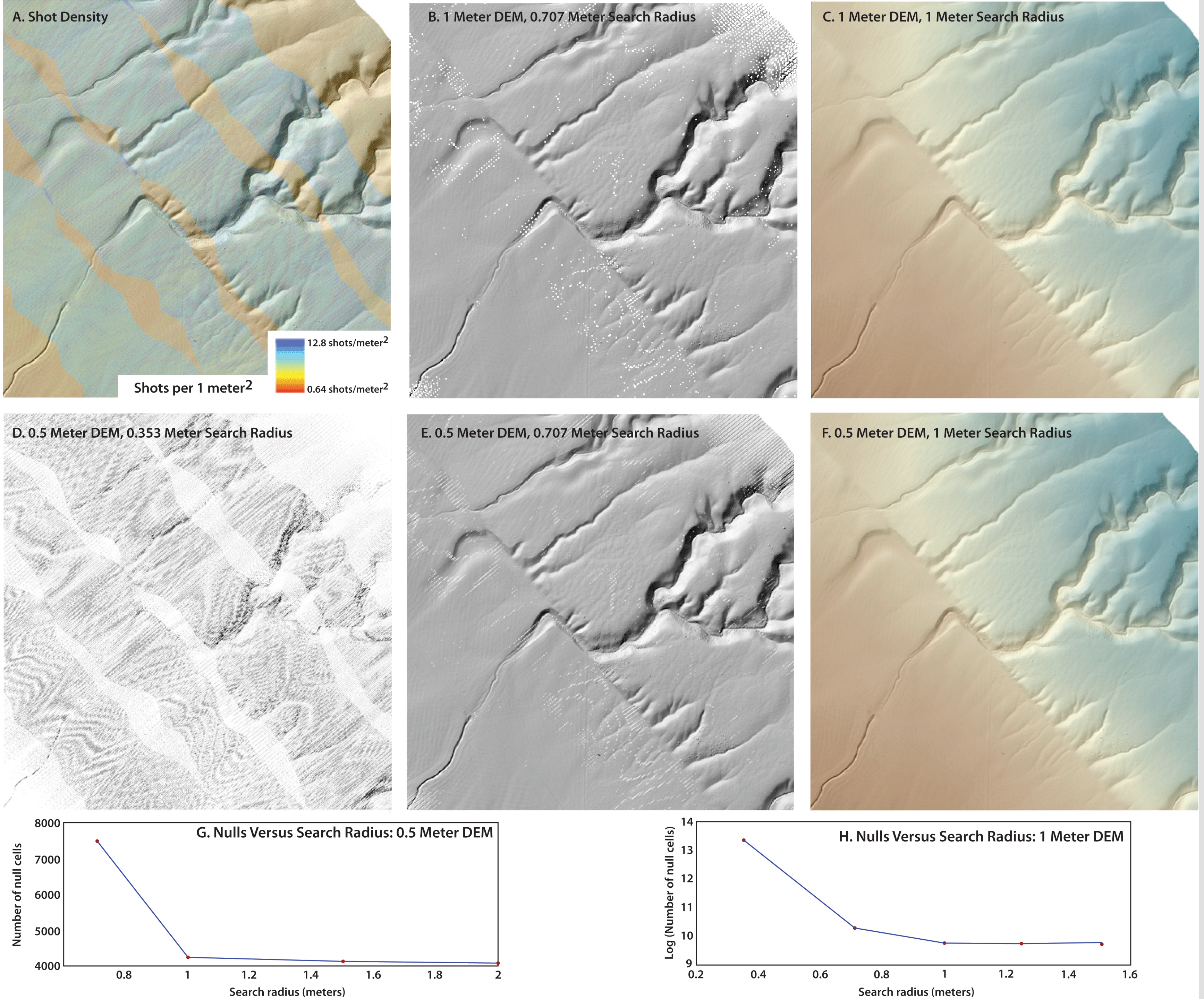
2013 SCEC LiDAR Short Course:
Imaging & Analyzing Southern California’s Active Faults with Lidar
November 4-6, 2013


Z_{max}
Z_{min}
Shots/3.14 sq meters
High : 143
Low : 1
Z_{idw}
Z_{den}



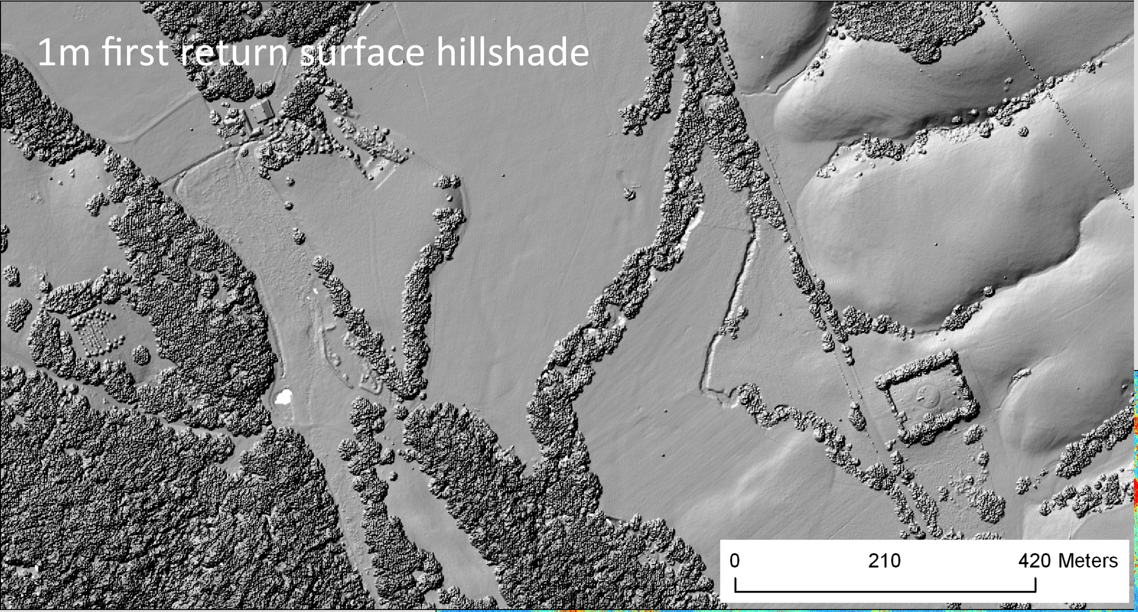
Heterogeneity of surface sampling: B4 shot density maps and profiles

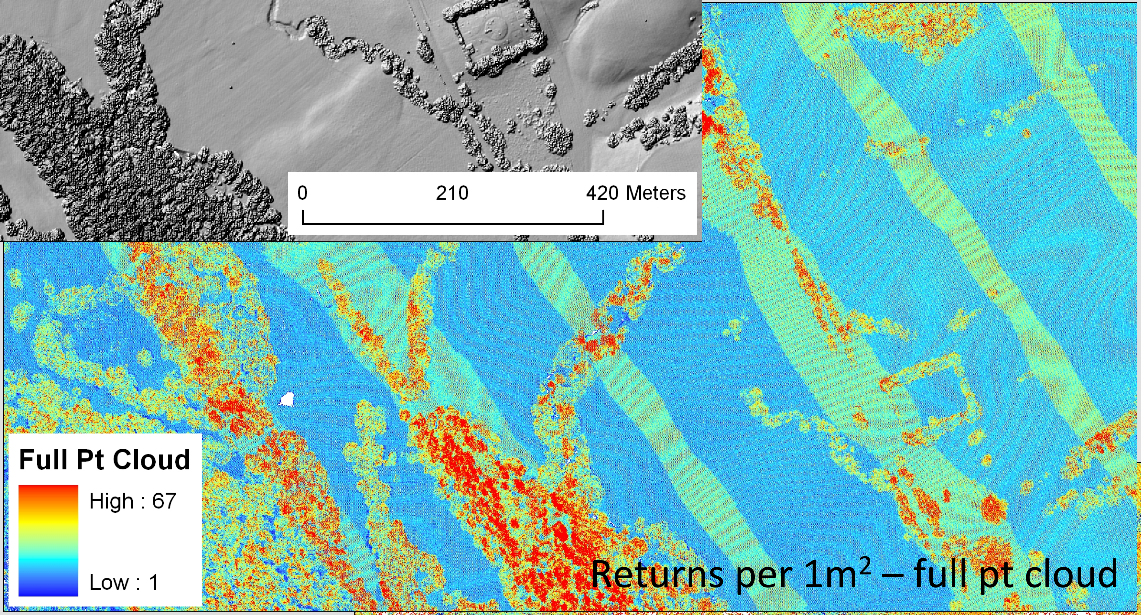
http://lidar.asu.edu/knowledgebase.html

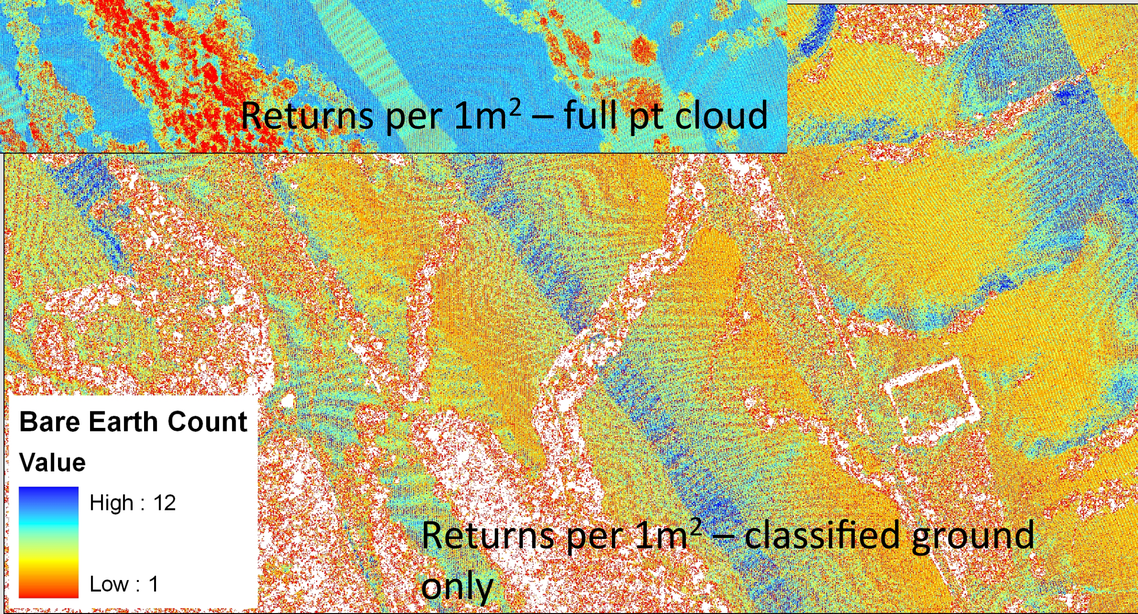


A. Shot Density
12.8 shots/meter2
0.64 shots/meter2
Shots per 1 meter2
B. 1 Meter DEM, 0.707 Meter Search Radius
C. 1 Meter DEM, 1 Meter Search Radius
D. 0.5 Meter DEM, 0.353 Meter Search Radius
E. 0.5 Meter DEM, 0.707 Meter Search Radius
F. 0.5 Meter DEM, 1 Meter Search Radius
G. Nulls Versus Search Radius: 0.5 Meter DEM
Number of null cells
Search radius (meters)
H. Nulls Versus Search Radius: 1 Meter DEM
Log (Number of null cells)
Search radius (meters)

Importance of ground return density & DEM resolution

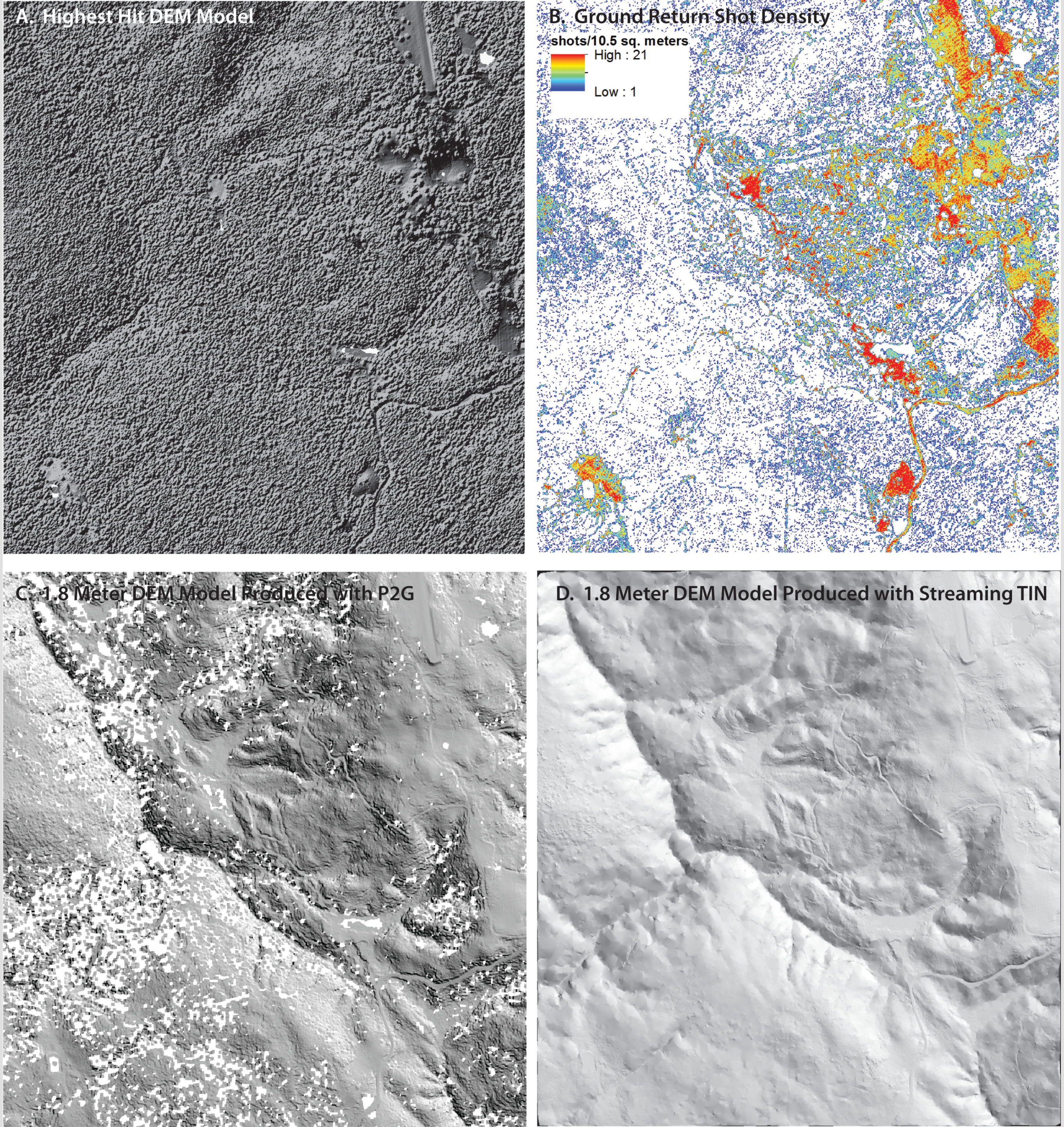


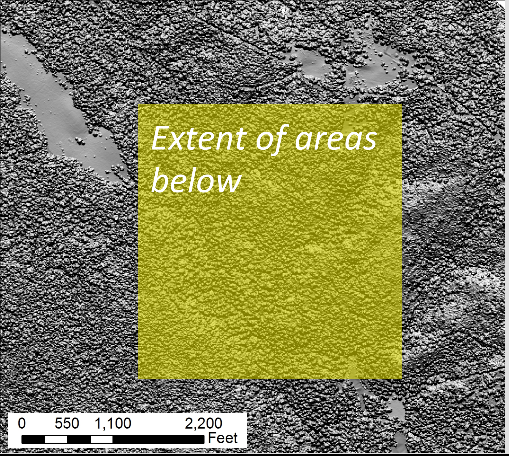




Ground return density may dictate appropriate DEM generation approach.

TIN or other non-local interpolator necessary in areas of sparse ground returns (right).

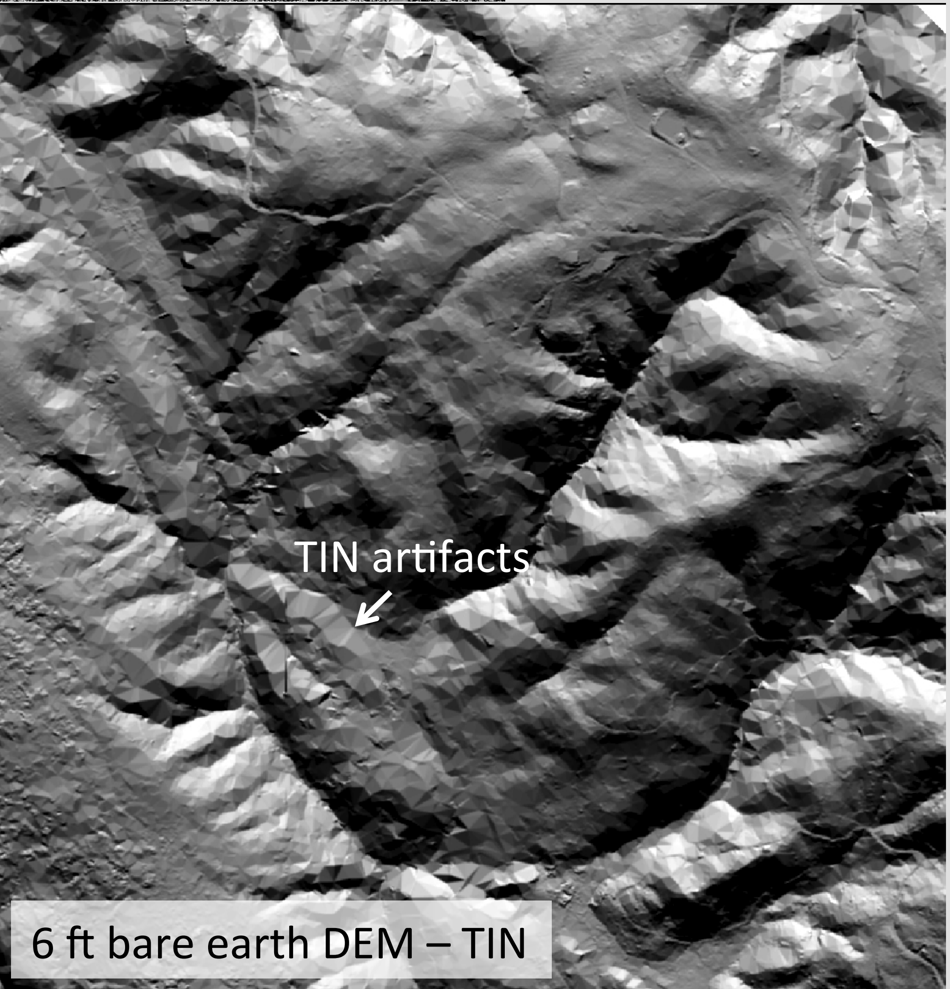

A. Highest Hit DEM Model
B. Ground Return Shot Density
shots/10.5 sq. meters
High : 21
Low : 1
C. 1.8 Meter DEM Model Produced with P2G
D. 1.8 Meter DEM Model Produced with Streaming TIN

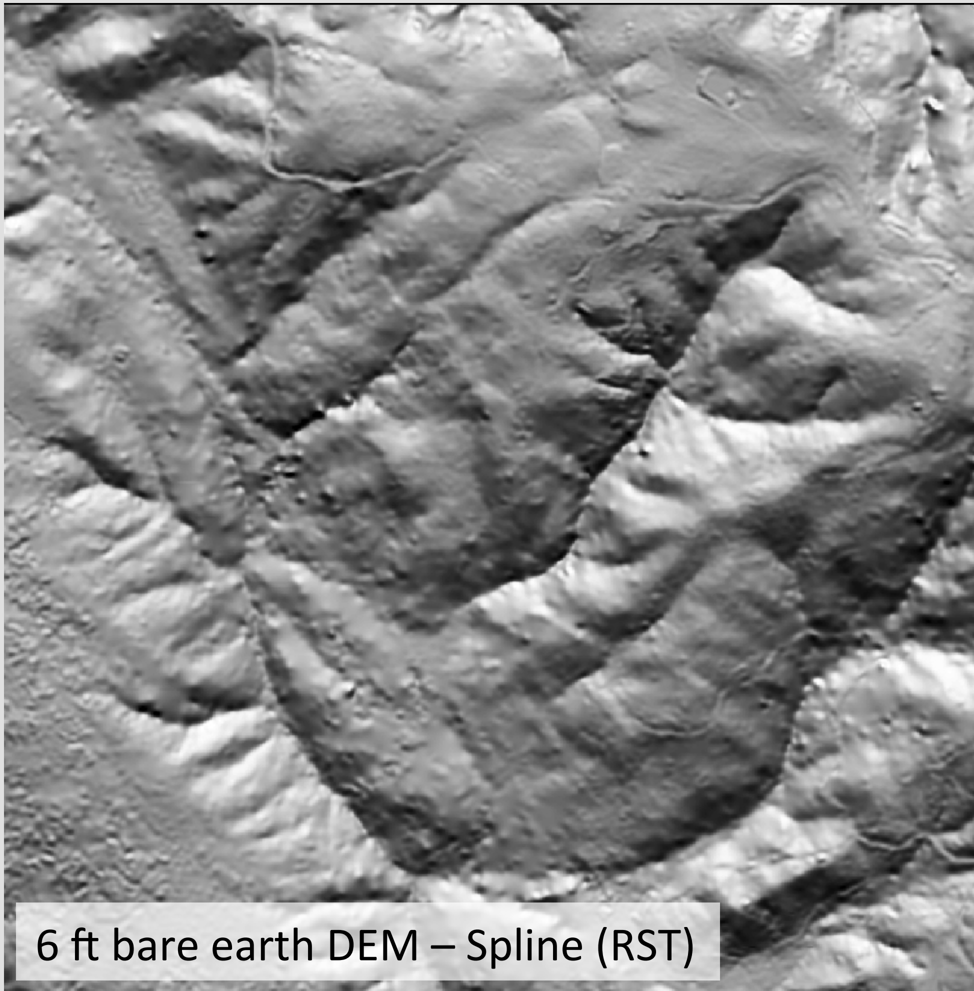


Role of gridding method in areas of low return density:

Do you prefer visible artifacts or smoothed regions where surface is less well constrained?

- Local methods can populate pixels without returns to null (swiss cheese surface – very honest representation of data)
- TIN artifacts in low ground return density
- Spline and Kriging = smoother surface…low return density less clear





Other Considerations:

- Application of data:
  - Different applications may warrant different approaches to grid generation
  - e.g. Hydrologic routing vs. geomorphic mapping

- Software and computational resources available

SUMMARY (rules of thumb…):

- In general for LiDAR data, return density is > than grid resolution (i.e. multiple returns per meter)
    - In this case, local gridding approaches can produce accurate DEMs and are computationally efficient.

- When the ground is poorly sampled (typically in areas of dense vegetation and steep topography), it may be necessary to use an interpolation approach such as spline or kriging to fit a surface to fill the gaps and produce a continuous terrain model.

- TINs generally work well in all return densities unless facet artifacts are a problem.

- LiDAR Return densities are very heterogeneous & and it is important to understand your data before beginning to work with them.

Lidar Data Quality

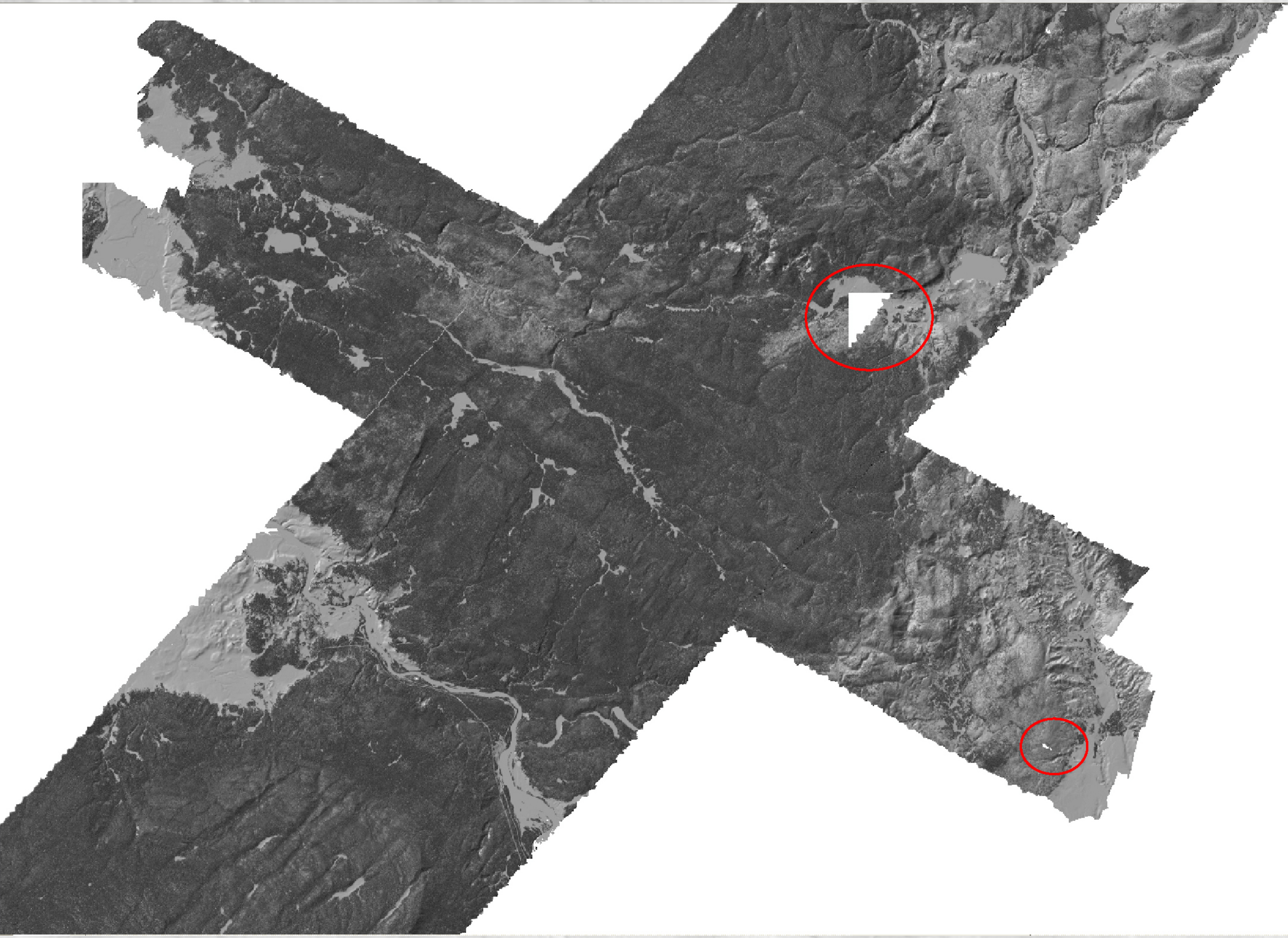
Typical metric is shot density / shot (“post”) spacing:

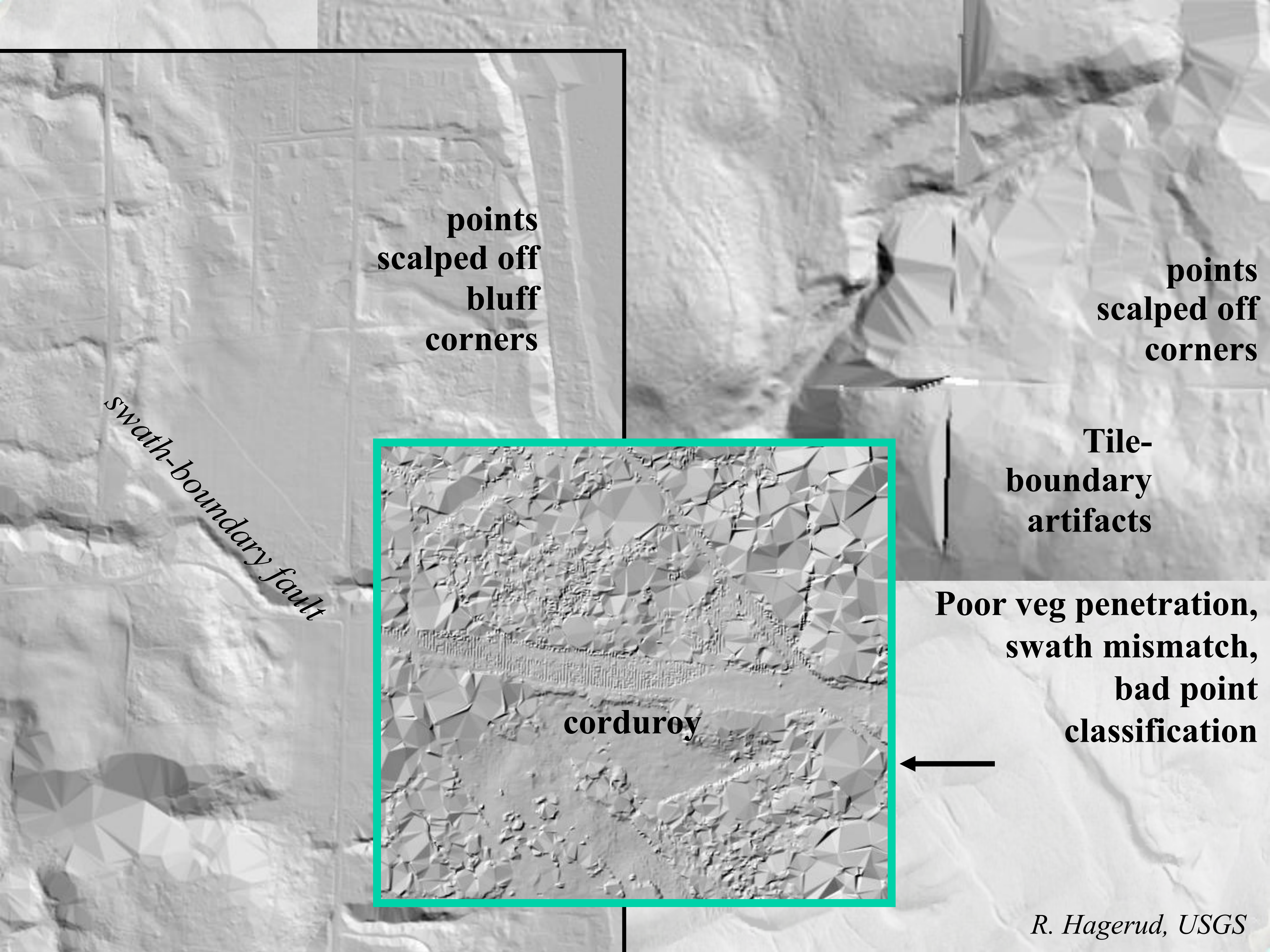
- Describes density of data and potential grid resolution.
- Shot density highly heterogeneous.
- Not all lidar data are created equal.

Evaluate lidar data quality by:

- Testing against ground control
- Looking at big images
- Quantifying swath to swath reproducibility and completeness

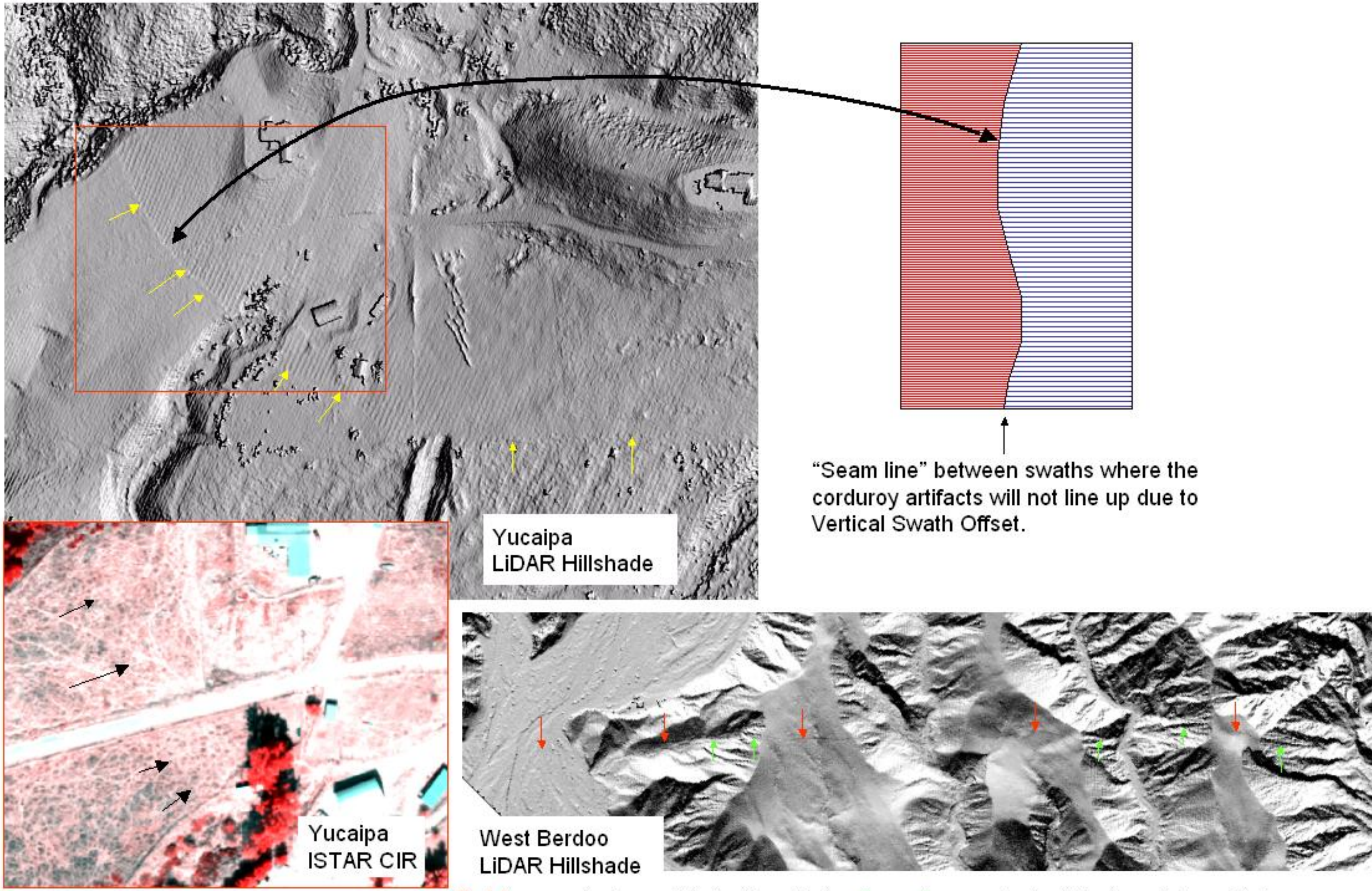
Modified from R. Hagerud, USGS





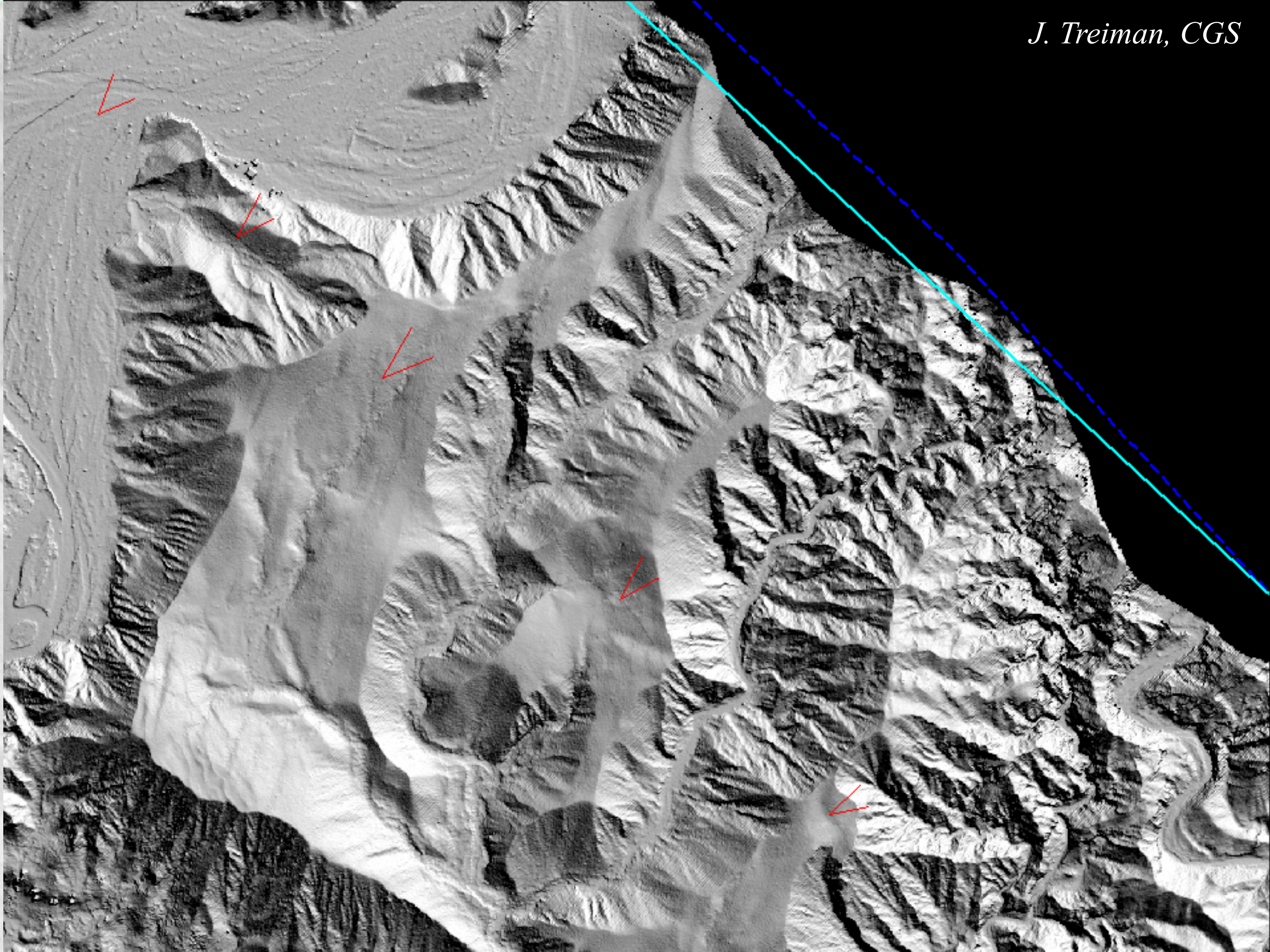
points scalped off bluff corners
swath-boundary fault
points scalped off corners
Tile-boundary artifacts
Poor veg penetration, swath mismatch, bad point classification
corduroy
R. Hagerud, USGS


0
60
120
240 Meters



Red Arrows – features *attributed* to artifacts   Green Arrows – "natural" features (aligned drainages, scarplets)

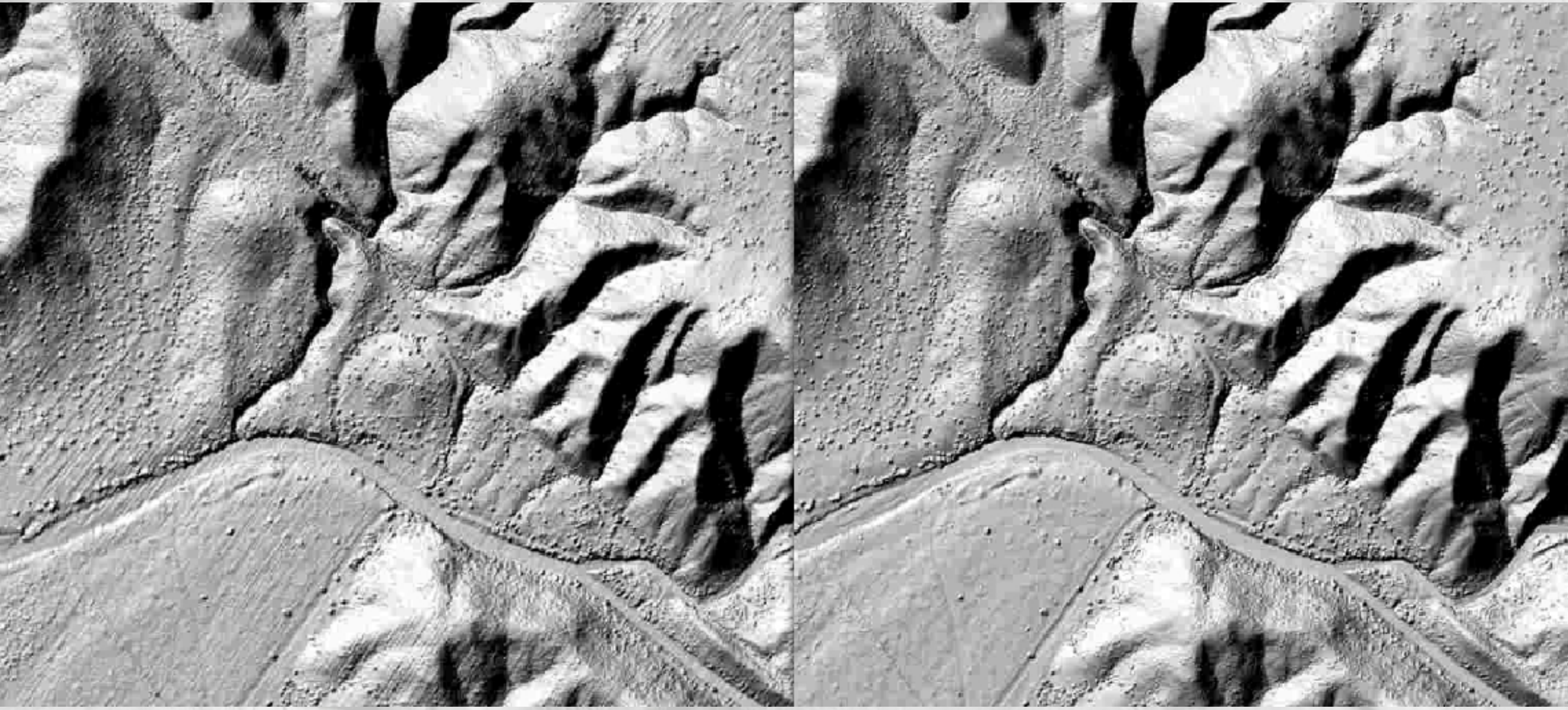
Ante Perez, CGS


J. Treiman, CGS

K. Hudnut, USGS

Corduroy

The B4 survey was supported by the loan of a 5100 unit from Optech to NCALM.



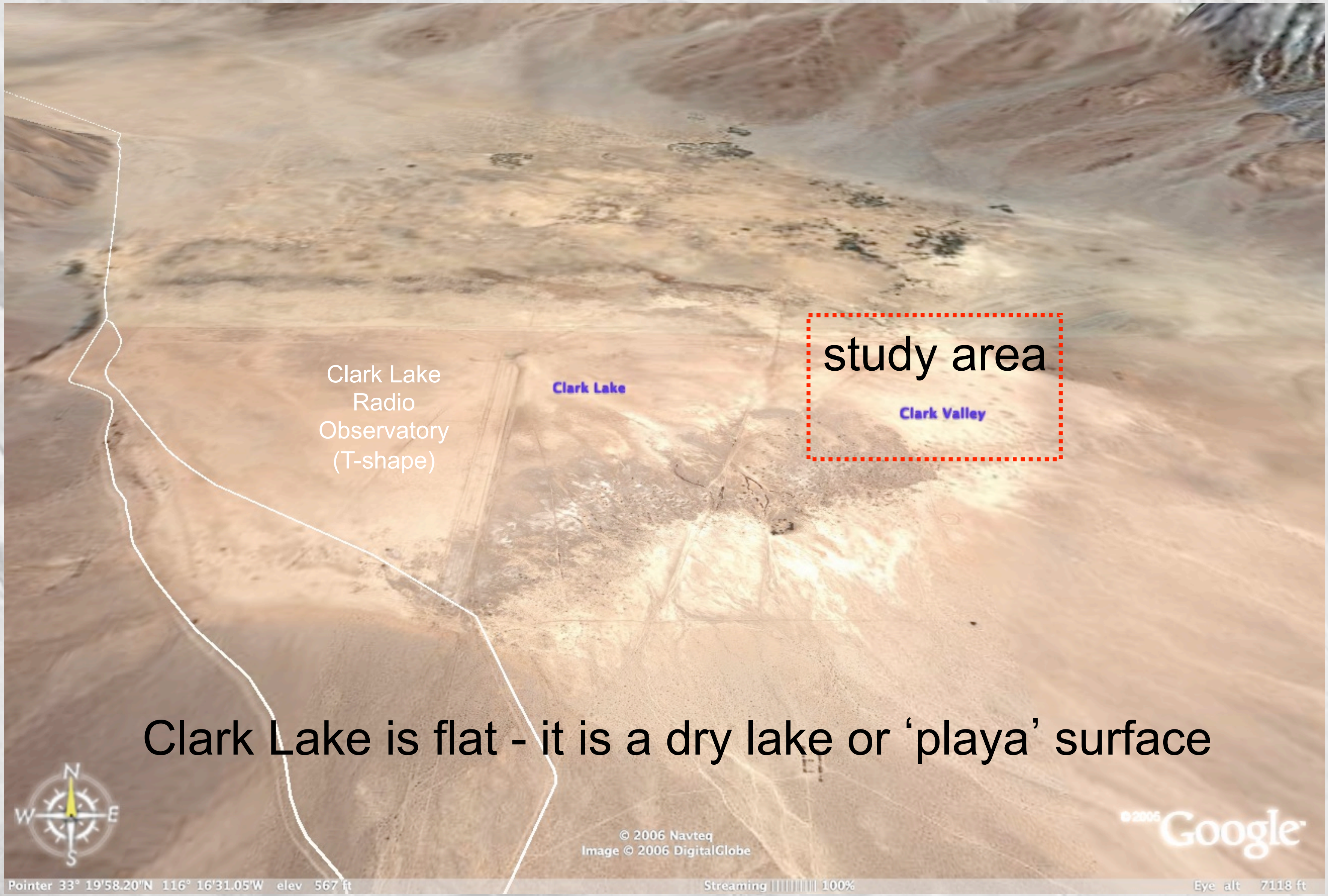
1233 5100

Carizzo Plain

Both models were used over the first few days of the May campaign. In general corduroy, though still present, is more subdued in the 5100 data, as illustrated in these DEM patches.

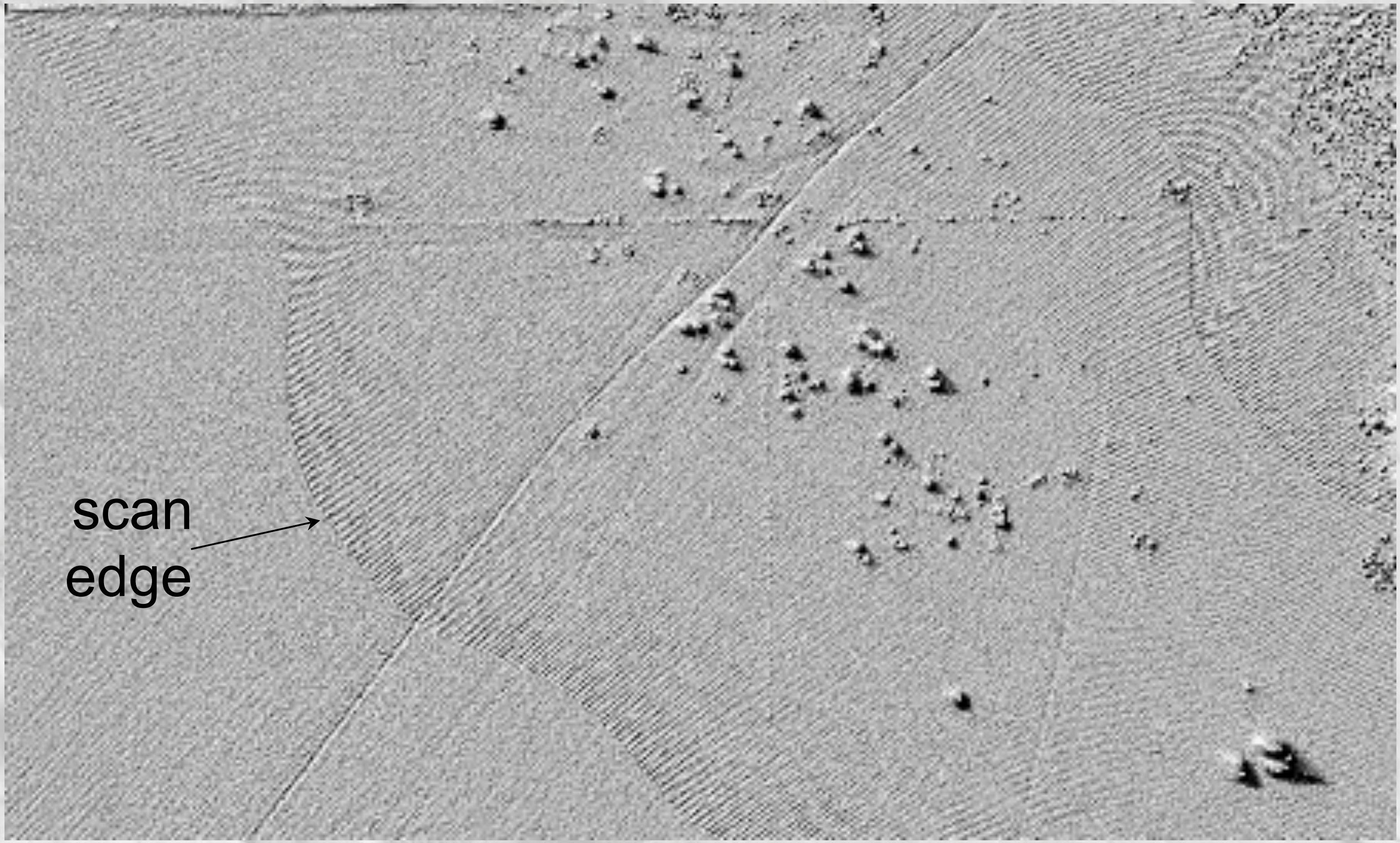
K. Hudnut, USGS

Corduroy



K. Hudnut, USGS

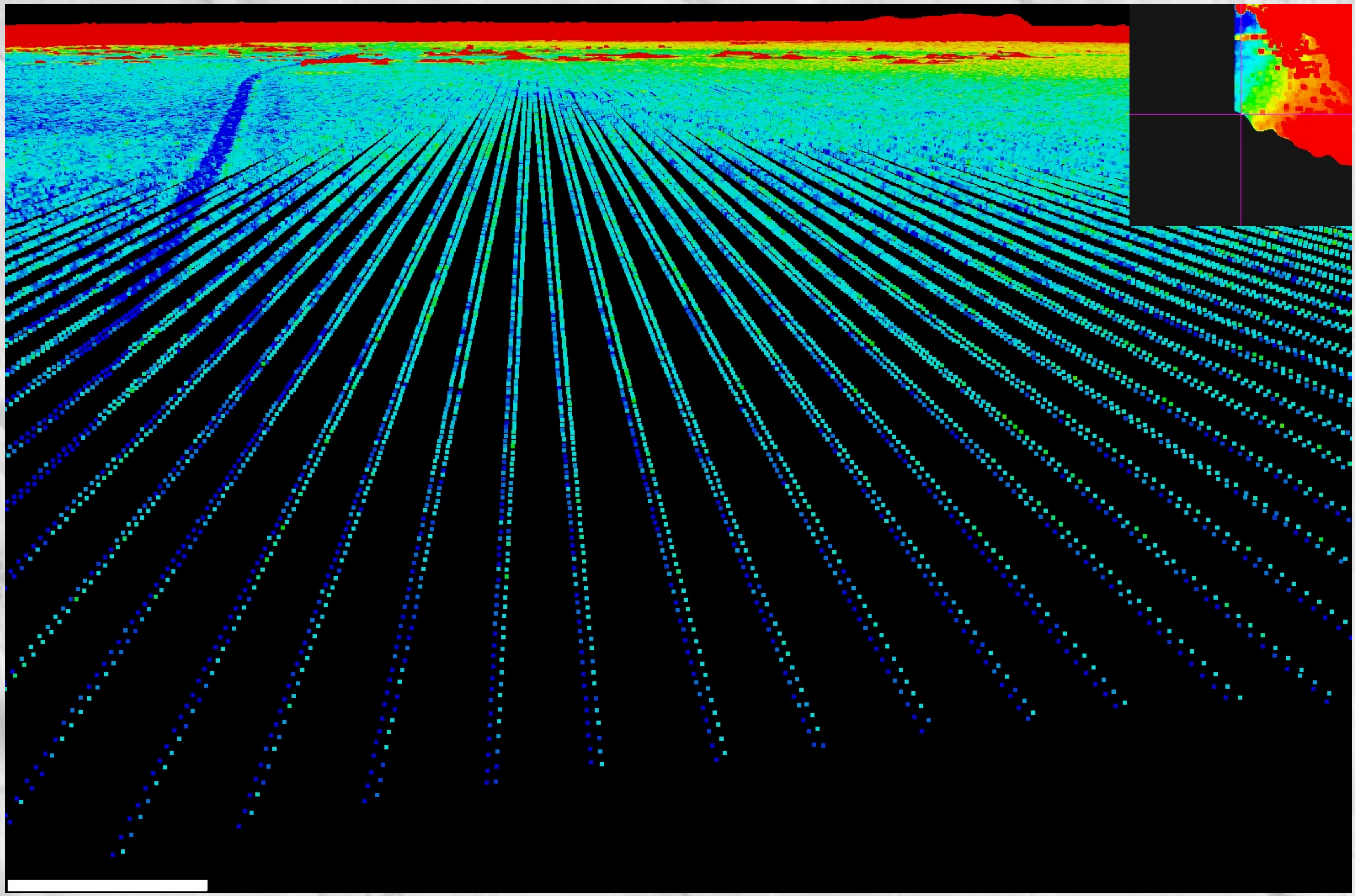
Corduroy



SURFER 0.5 m DEM from NCALM - standard product

K. Hudnut, USGS

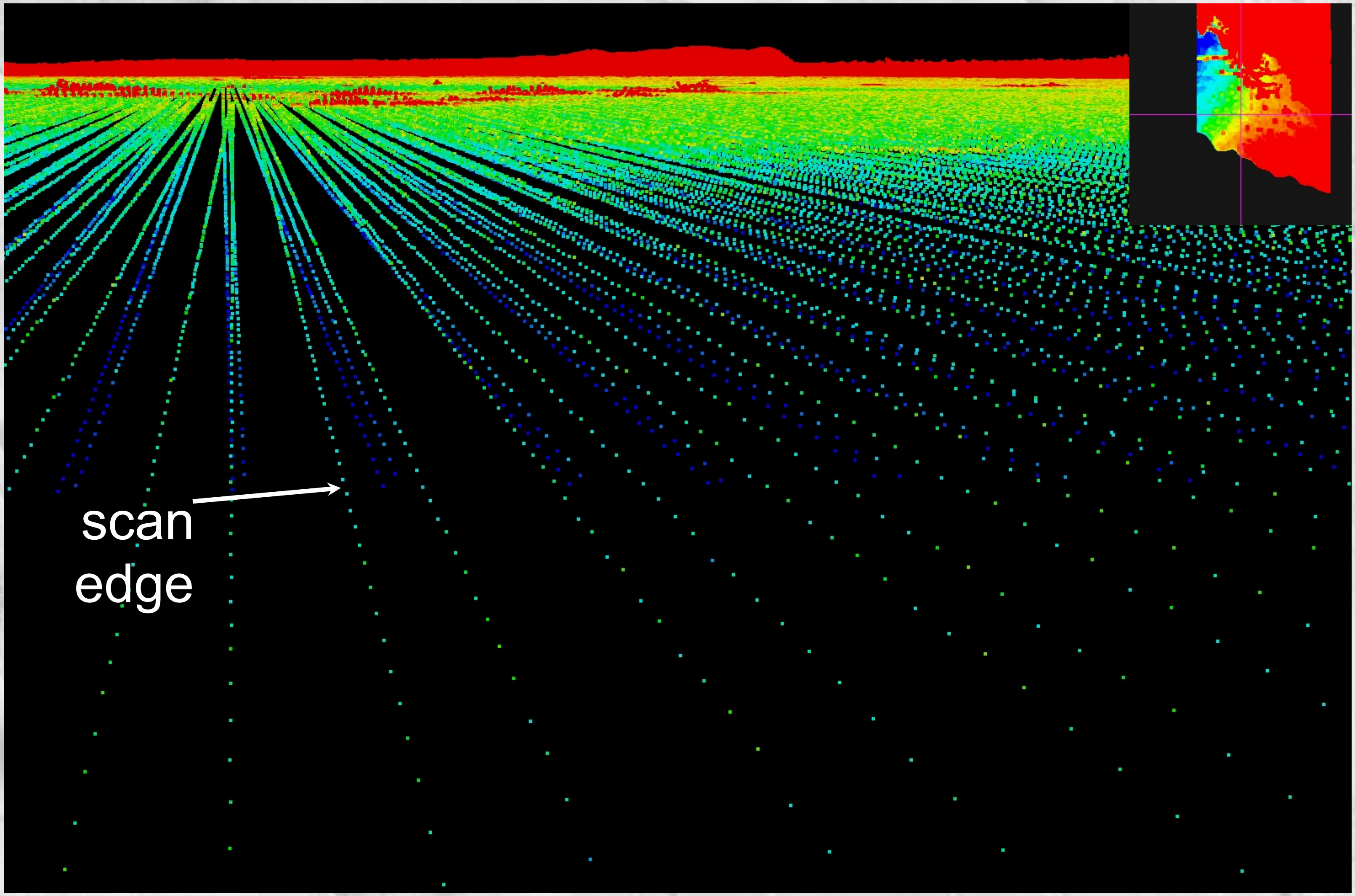
Corduroy – type 1



Scan artifact - at scan edge on dry lake one sees a pattern of up-down consistently; as mirror flips, height reads differently

K. Hudnut, USGS

Corduroy – type 2



The inner scan is consistently lower than the outer scan; this is a different source of ‘corduroy,’ the second type.

K. Hudnut, USGS

Corduroy

There are *two* types of ‘corduroy’ in B4 data

type 1 - ‘scan angle artifact’

scanner reads higher going one direction than it does in the other

type 2 - ‘vertical swath offset’

aircraft first pass is vertically mis-aligned with second pass within a given area

The second type, at least, can be mitigated or eliminated by increasing the accuracy of our GPS/IMU trajectories

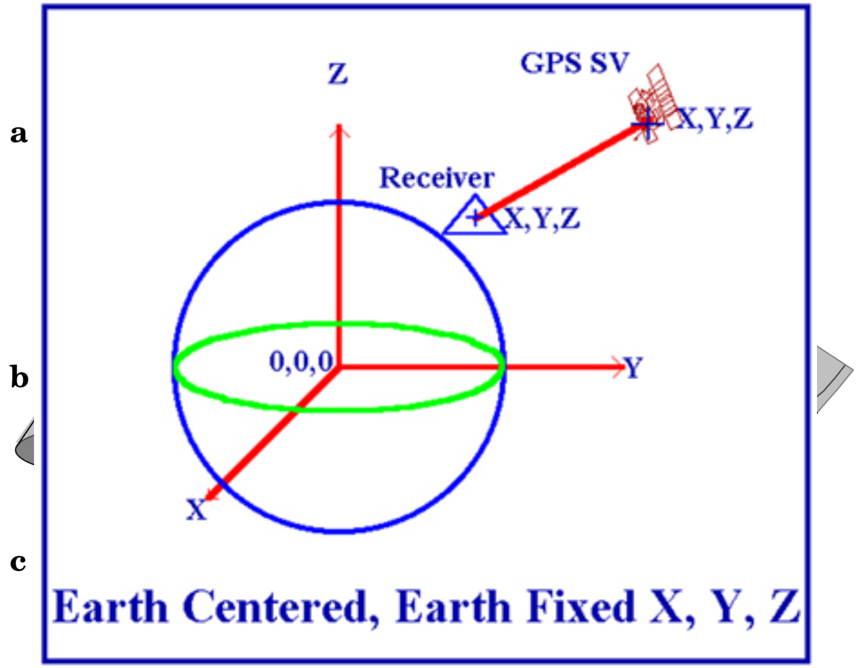
Understanding coordinate systems - GPS

Point ID	Northing	Easting	Elevation	Latitude	Longitude	Ellip. Height	X (ECEF)	Y (ECEF)	Z (ECEF)
BF - UTD1	1370462.012	577608.894	94.429	-77.72225	162.27091	40.108	-1296058.157	414350.03	-6210455.012
BF - UTD2	1370484.93	577645.326	78.213	-77.72203	162.27239	23.892	-1296088.759	414322.955	-6210433.867
BF - UTD3	1370451.914	577632.2	92.861	-77.72233	162.27192	38.539	-1296056.922	414324.606	-6210455.347
BF - UTD4	1370446.605	577618.498	95.796	-77.72238	162.27135	41.474	-1296047.793	414335.745	-6210459.505
BF - UTD5	1370480.558	577607.267	97.233	-77.72208	162.2708	42.912	-1296075.07	414358.23	-6210453.832

Projected values (ex. UTM)

Spherical coordinates

Earth Centered Earth Fixed (ECEF)



Understanding coordinate systems - GPS