OpenTopography

DATA & RESOURCES

CHRISTOPHER CROSBY, UNAVCO

Teaching SfM and GNSS Methods to Undergraduates in the Field

GSA 2022, BOULDER, CO

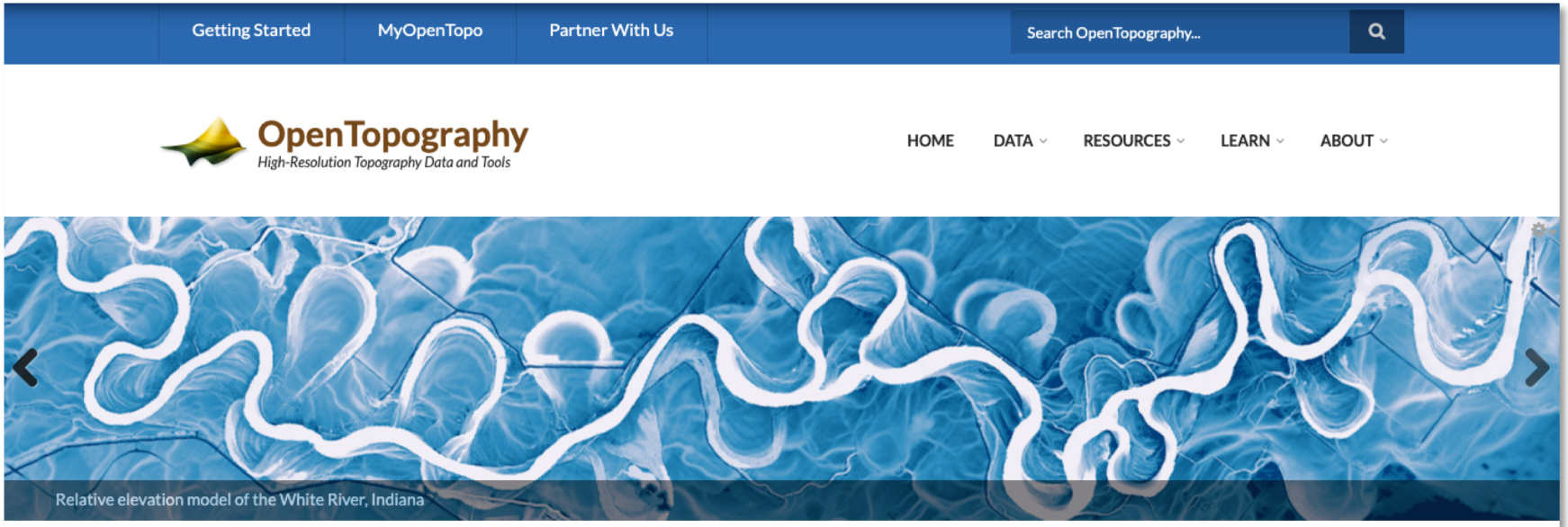
SDSC UNAVCO ASU

Supported by the US National Science Foundation (EAR/IF No 1948997, 1948994 & 1948857)

NSF

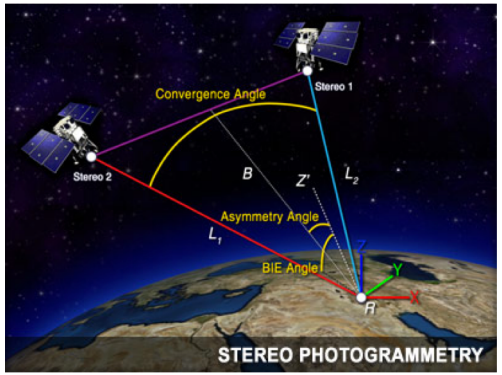
Democratize online access to high-resolution topography

- Lidar, photogrammetry, & satellite derived topographic data
- Access to data – from raw point cloud to easy to use derived products. Co-location of data with processing



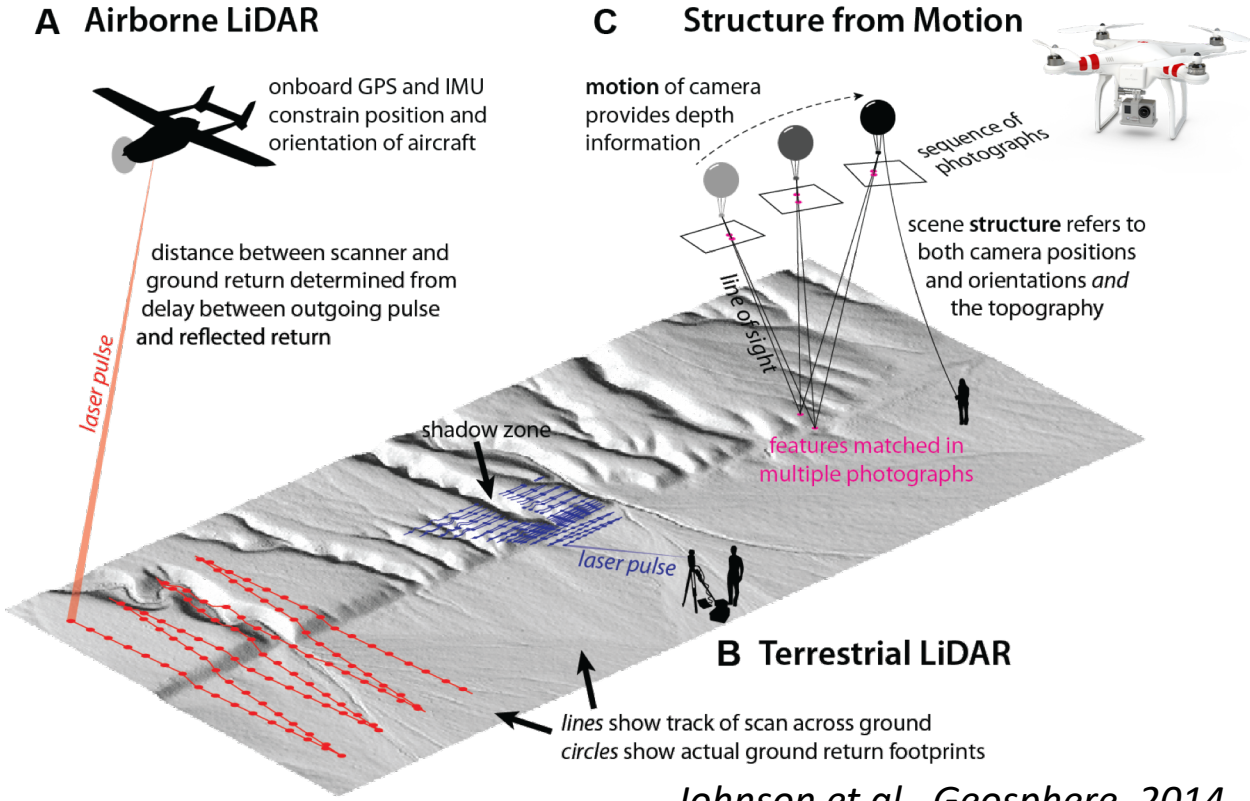
3D IMAGING WITH CAMERAS & LASERS

D. Space-based



MAXAR planet

Meters to centimeters spatial sampling



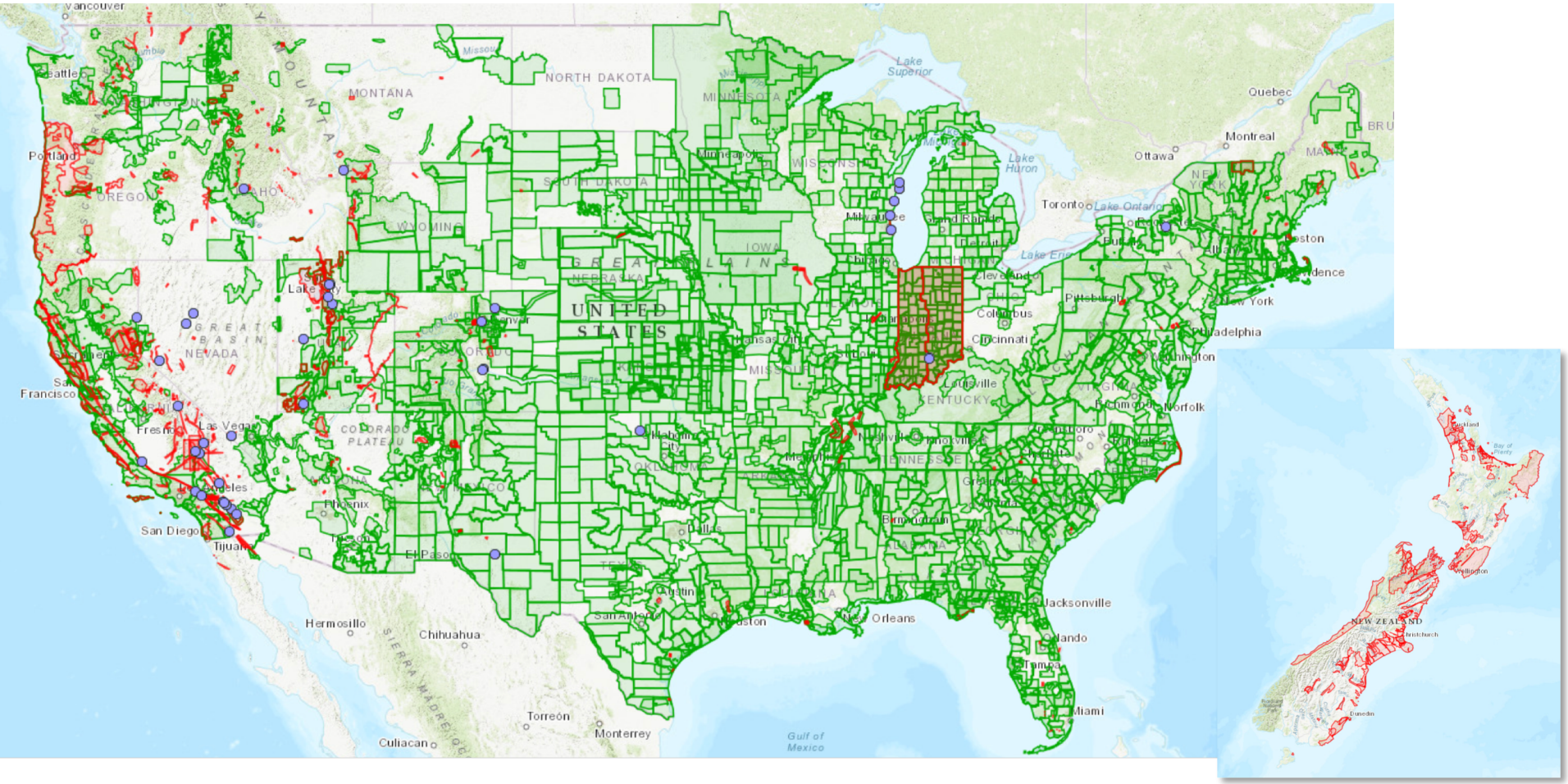
Johnson et al., Geosphere, 2014

AGENDA

1. Community Dataspace
2. Data available to you: ~47 trillion pts!
3. Topographic differencing

2019 Little Cottonwood Canyon, Tanners Gulch Debris Flow, Utah (https://doi.org/10.5069/G9FX77KF)

OpenTopography



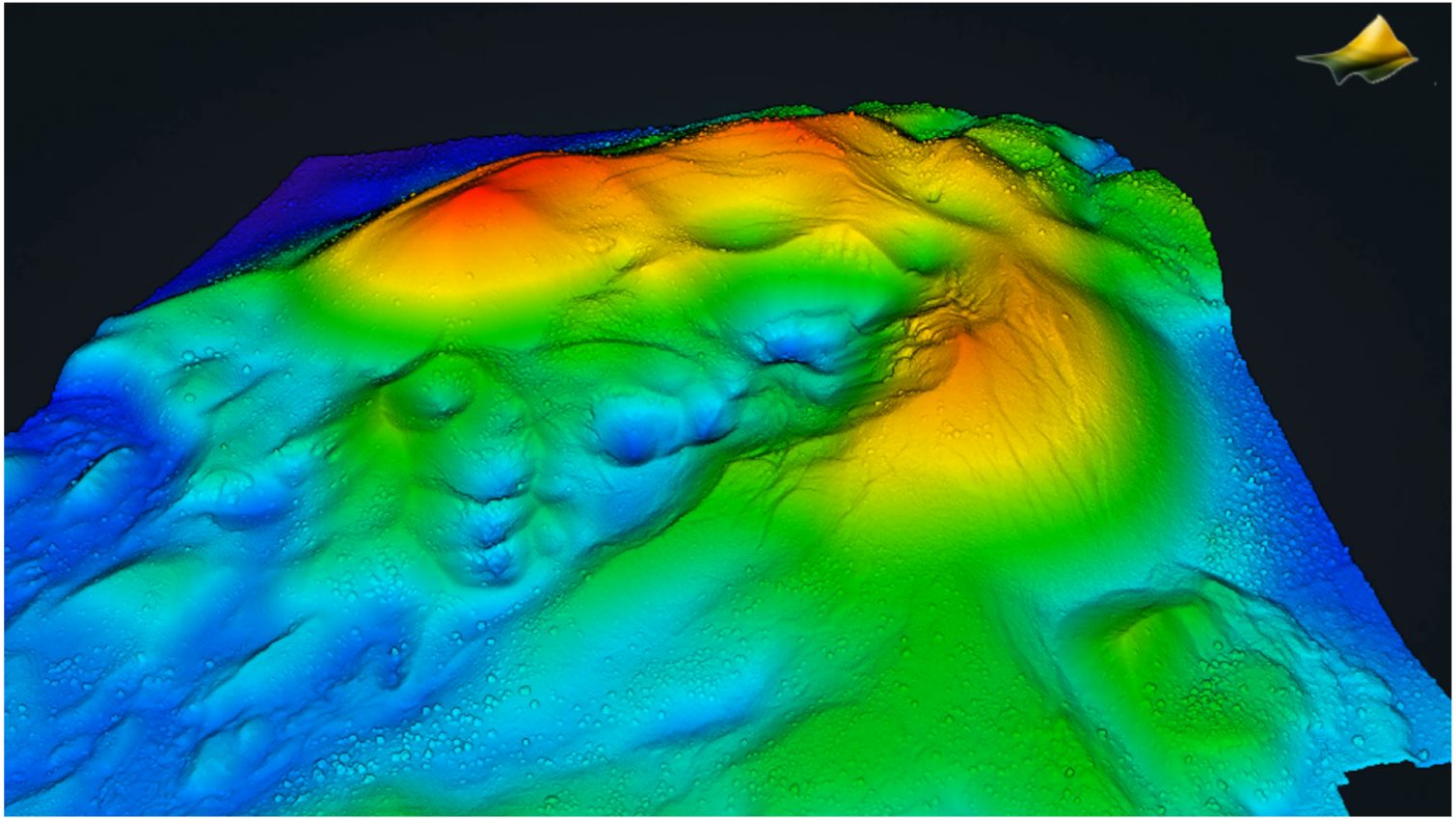
Structure from Motion Photogrammetry

Photogrammetric model of the Tecolote Volcano, Sonora, Mexico.
https://doi.org/10.5069/G9028PFR

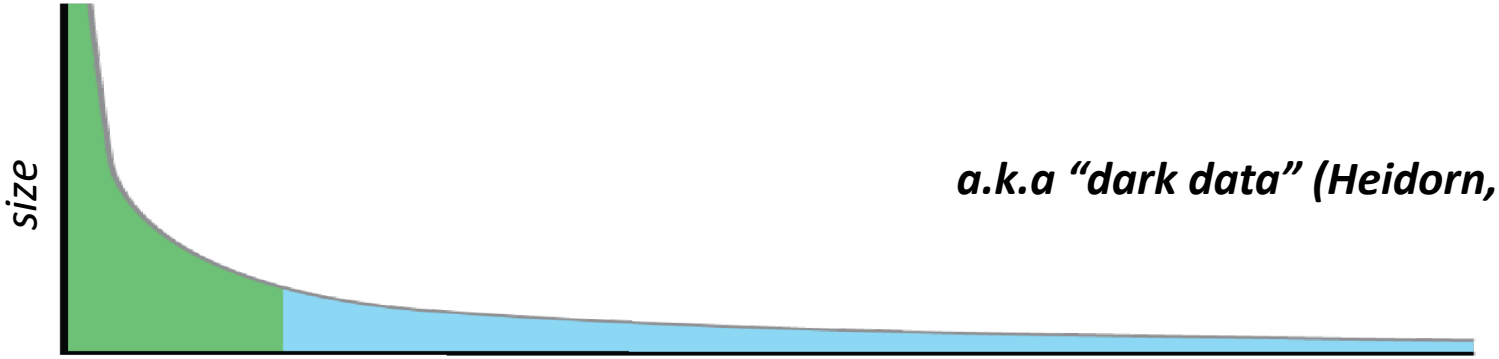
~2k images = 563 million pts

309 pt/m^2

8 cm gridded resolution



LONG TAIL TOPOGRAPHIC DATA



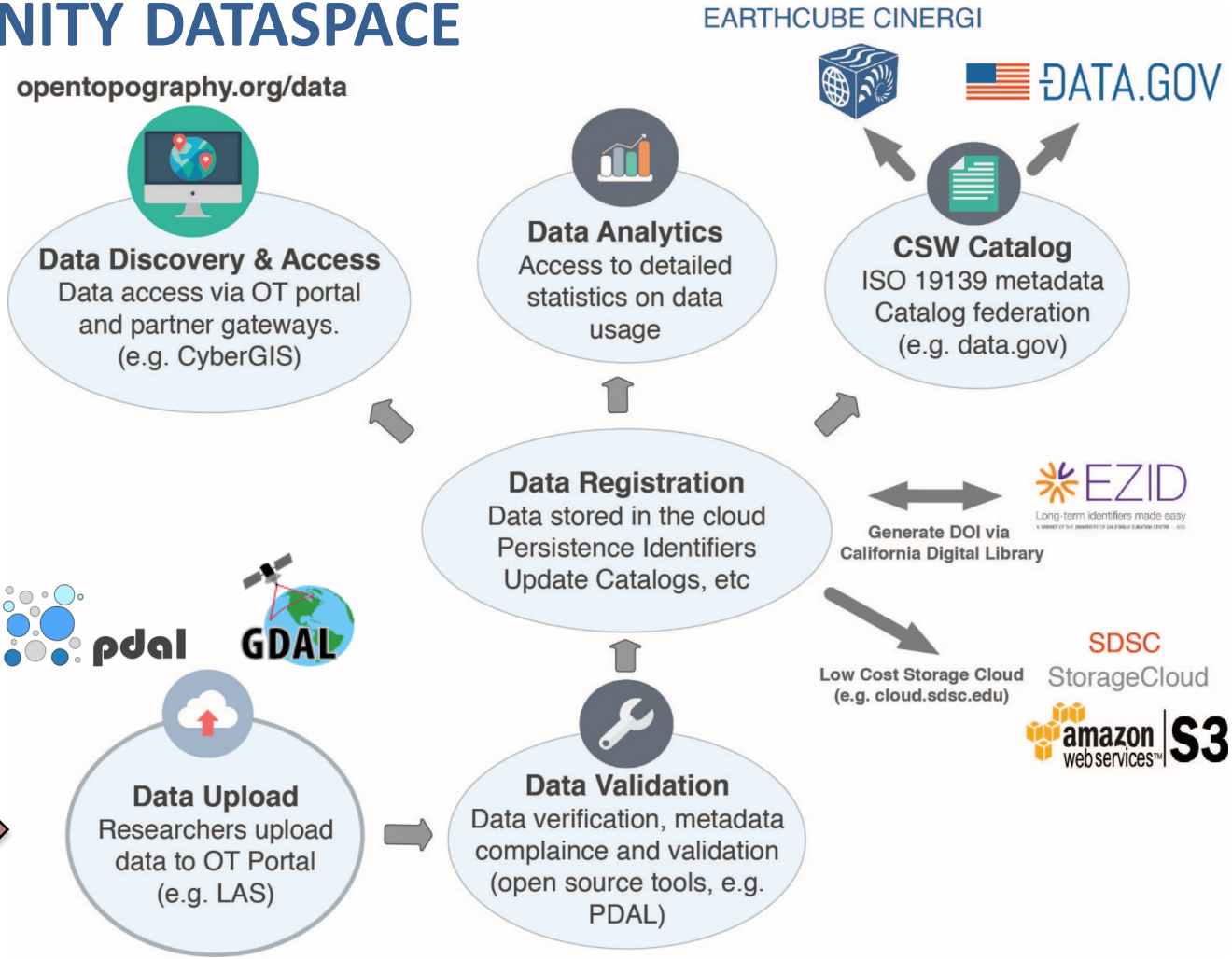
a.k.a "dark data" (Heidorn, 2008)

HEAD

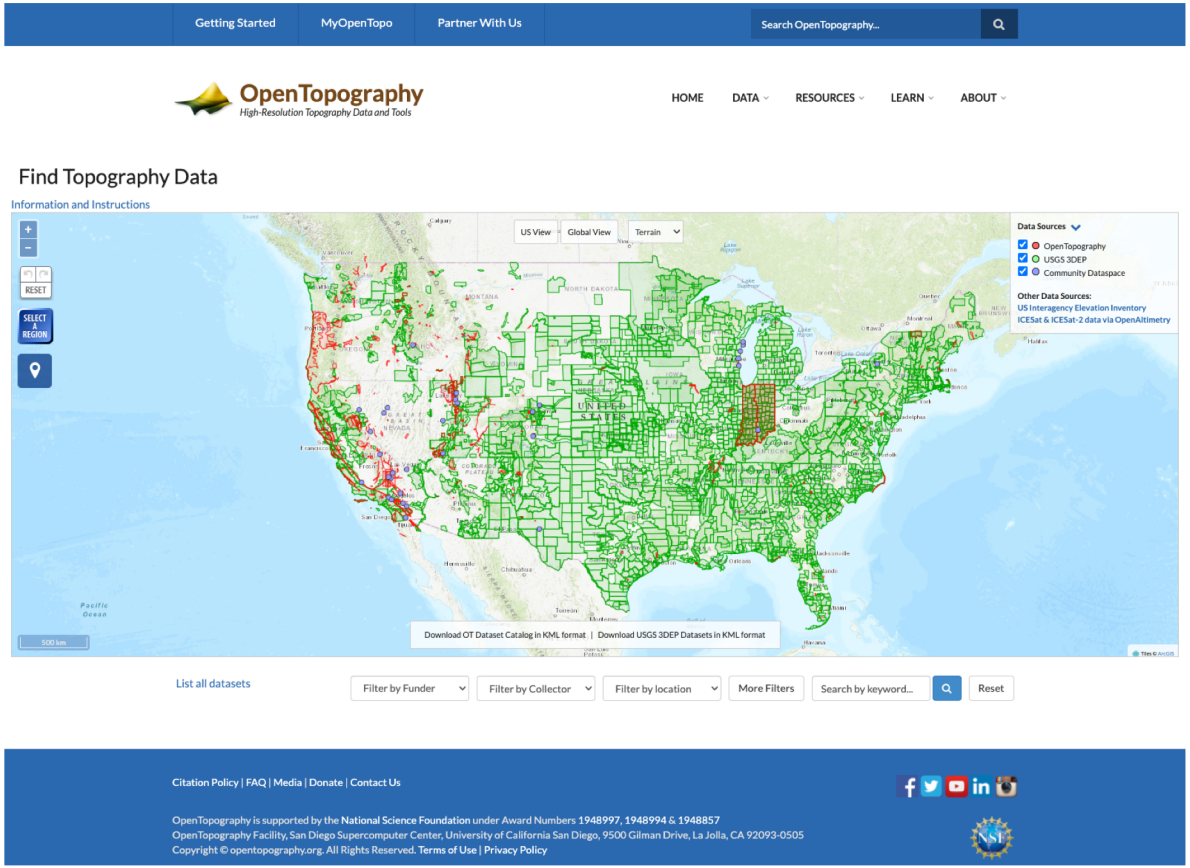
LONG TAIL

- Acquired by individual investigators or small teams
- Modest size but great value

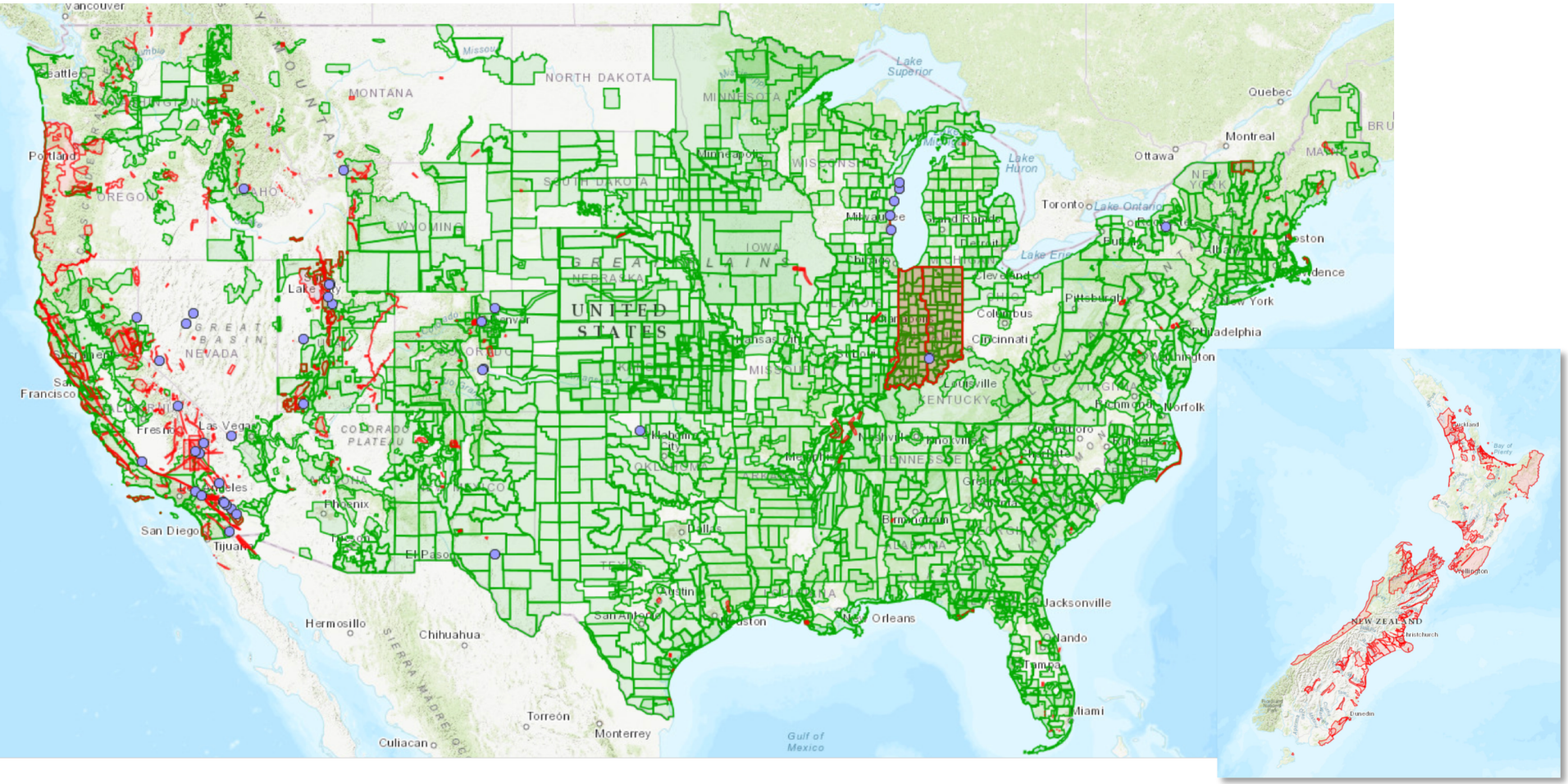
OT COMMUNITY DATASPACE



DEMO: HTTPS://OPENTOPOGRAPHY.ORG/



OpenTopography



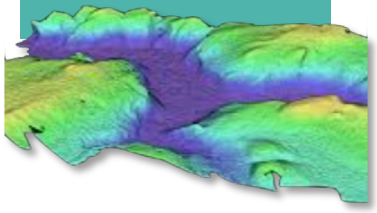
DATA SERVICES

TOPOGRAPHY DATA

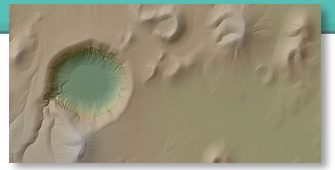
PC Data Filtering & Subsetting

Raster Data Subsetting

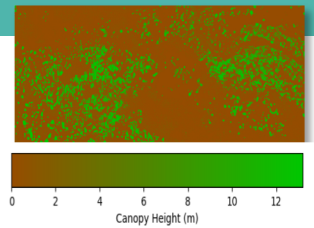
3D Visualization



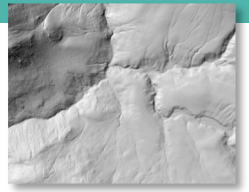
Digital Elevation Models TIN / Local Gridding



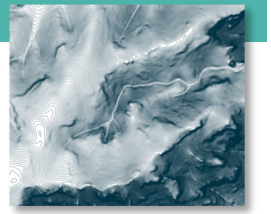
Canopy Height Model



Topographic Hillshades

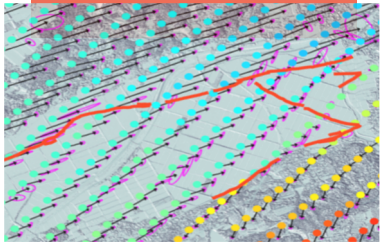


Contour Lines

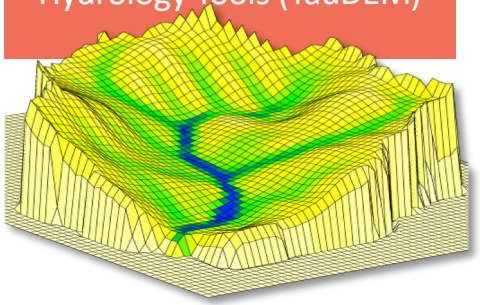


Vertical Differencing

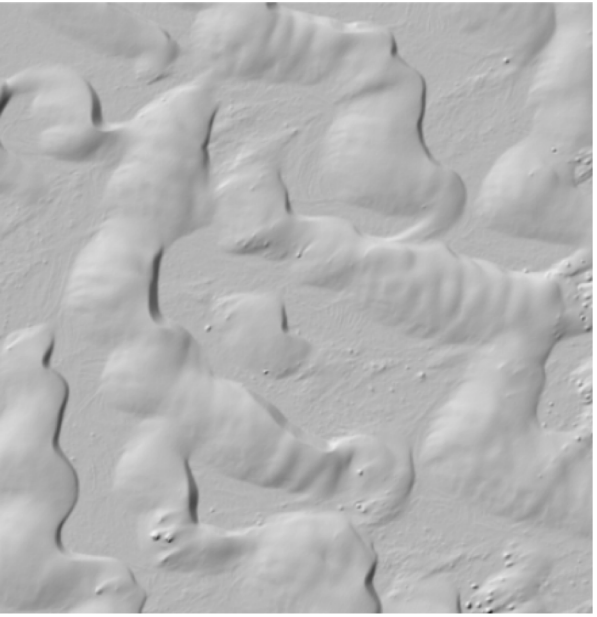
3D Differencing



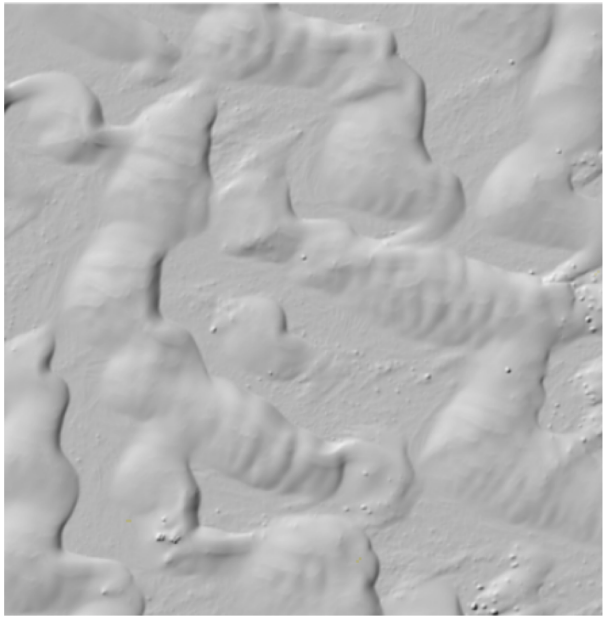
Hydrology Tools (TauDEM)



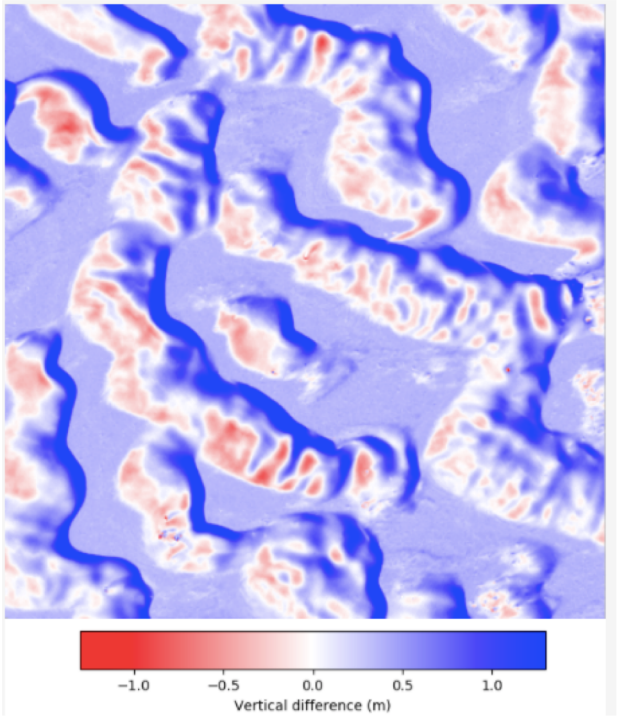
Vertical Differencing: Sand Dune Migration, White Sands National Monument, New Mexico



Compare: 1st dataset
Sept 2009



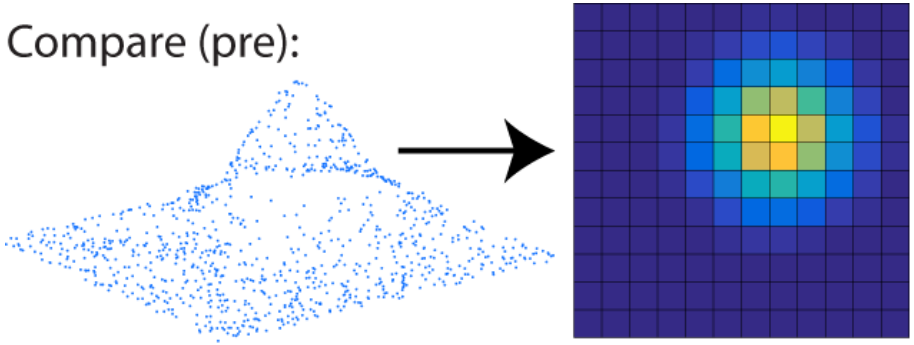
Reference: 2nd dataset
June 2010



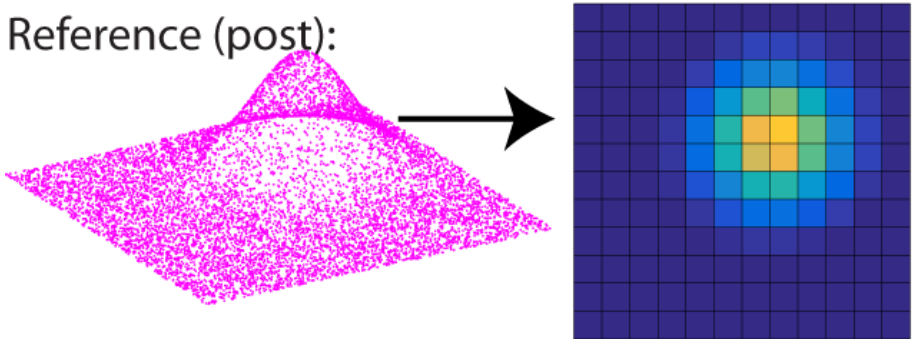
Vertical difference

VERTICAL TOPOGRAPHIC DIFFERENCING

Compare (pre):

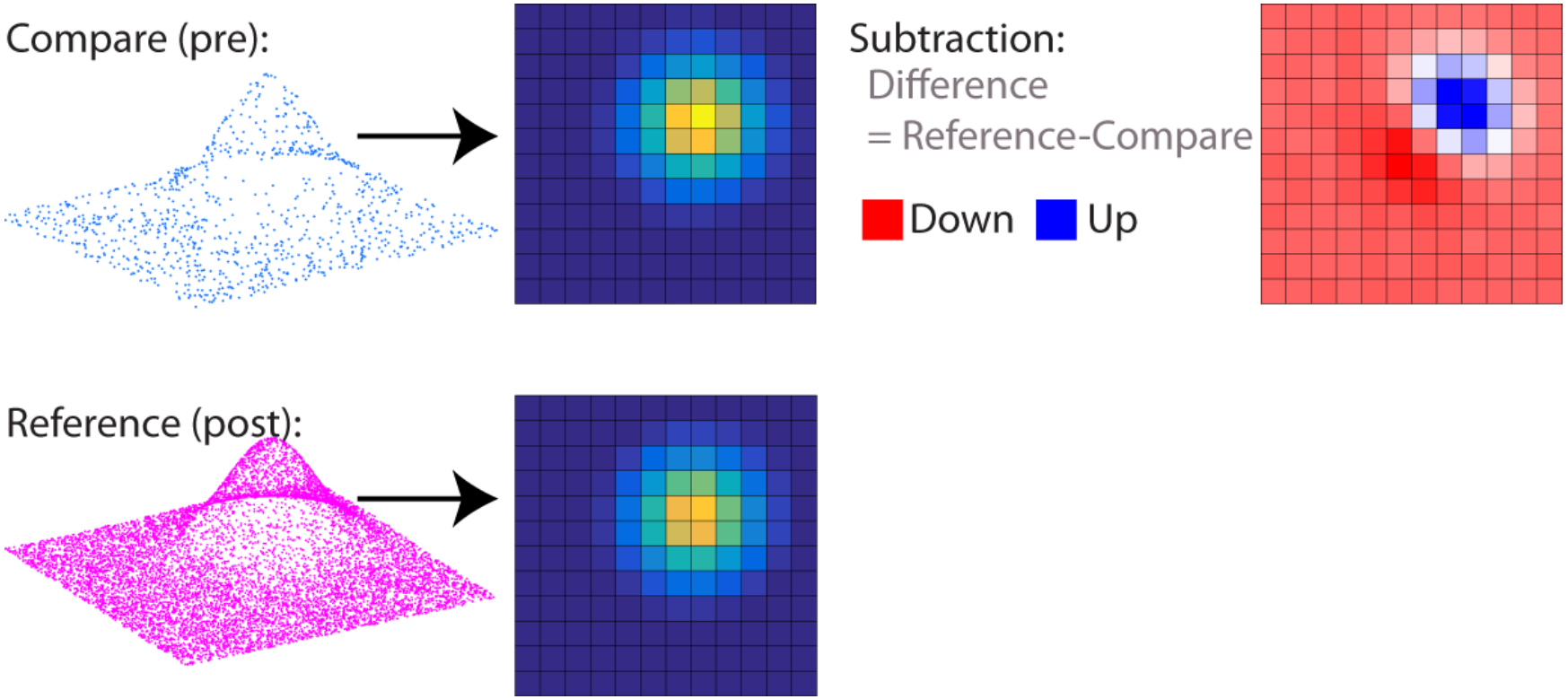


Reference (post):



Identical grid for pre and post event topography

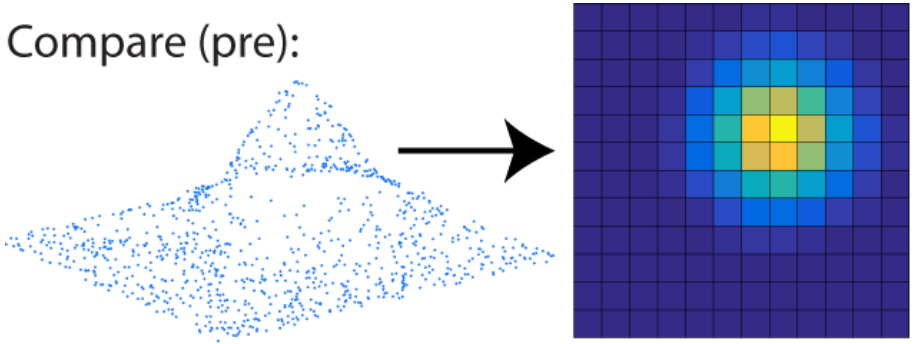
VERTICAL TOPOGRAPHIC DIFFERENCING



Raster subtraction

VERTICAL TOPOGRAPHIC DIFFERENCING

Compare (pre):

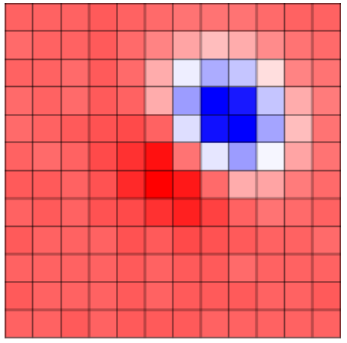


Subtraction:

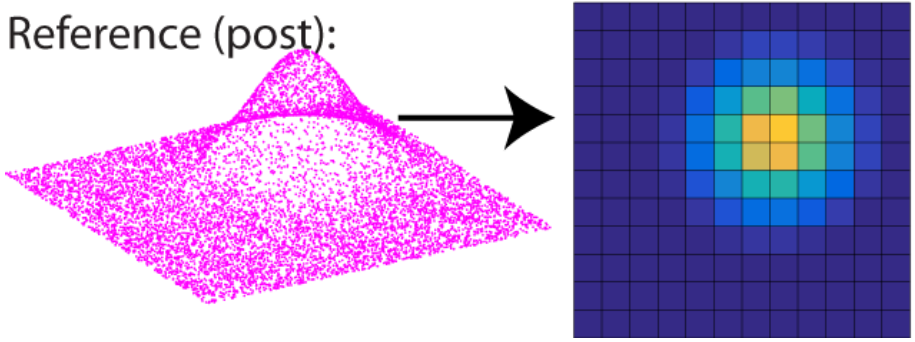
Difference

= Reference-Compare

Down Up



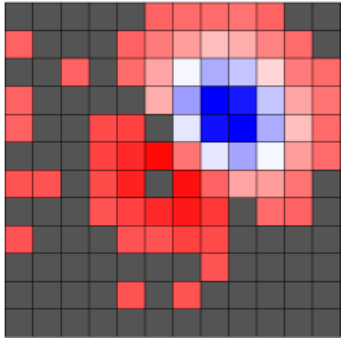
Reference (post):



Error:

Mask out differences below the error threshold

Masked points

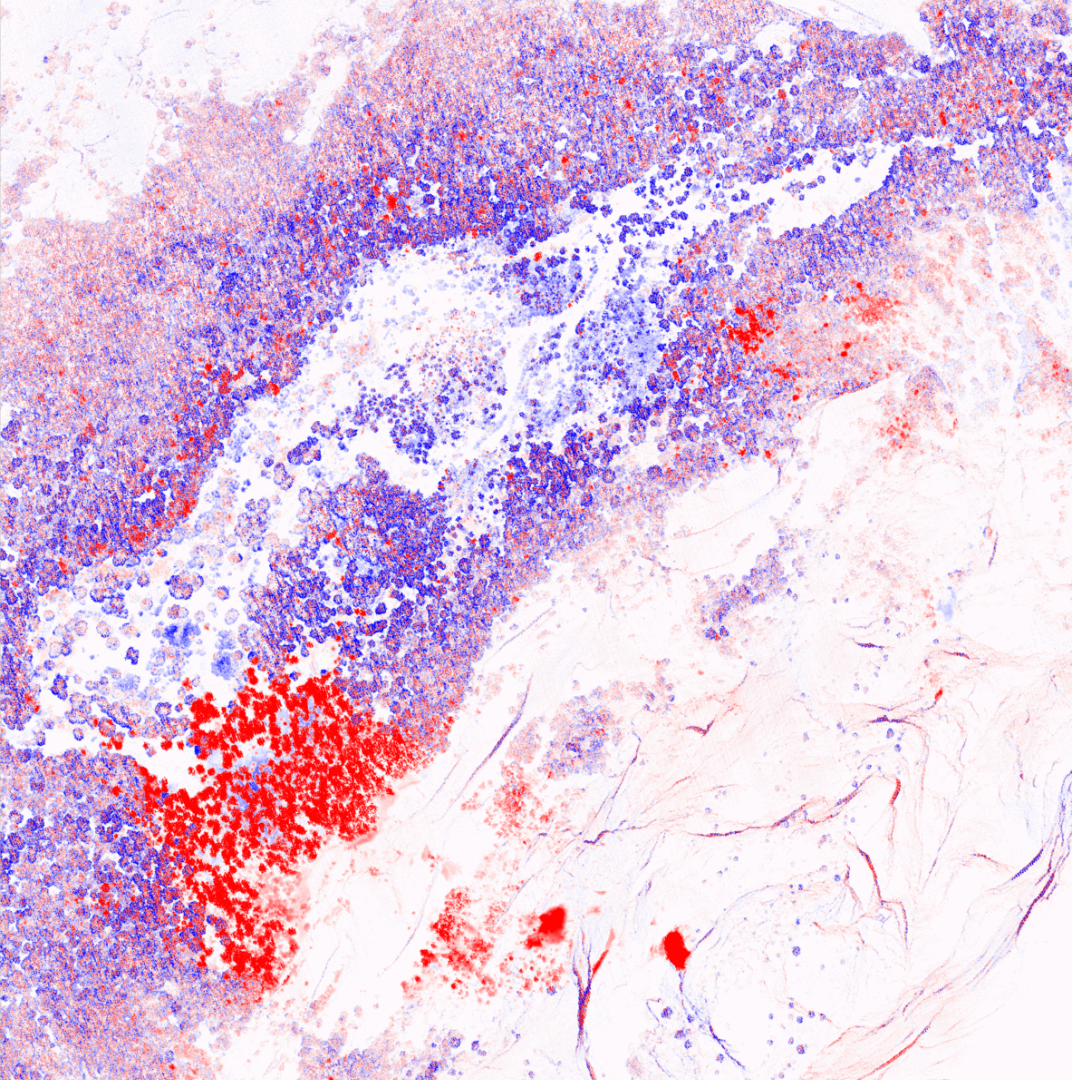


Option: mask differences below error threshold

Topographic Differencing Workflow

- Overlapping data
- Dataset must be on identical grids
  - Original raster and gridded point cloud data
  - Varying raster and point densities
- Raster subtraction
- User-defined error threshold
- Display difference maps and histogram of differences

Infrastructure damage following the 2016 M7 Kumamoto, Japan, earthquake.



Yosemite, CA

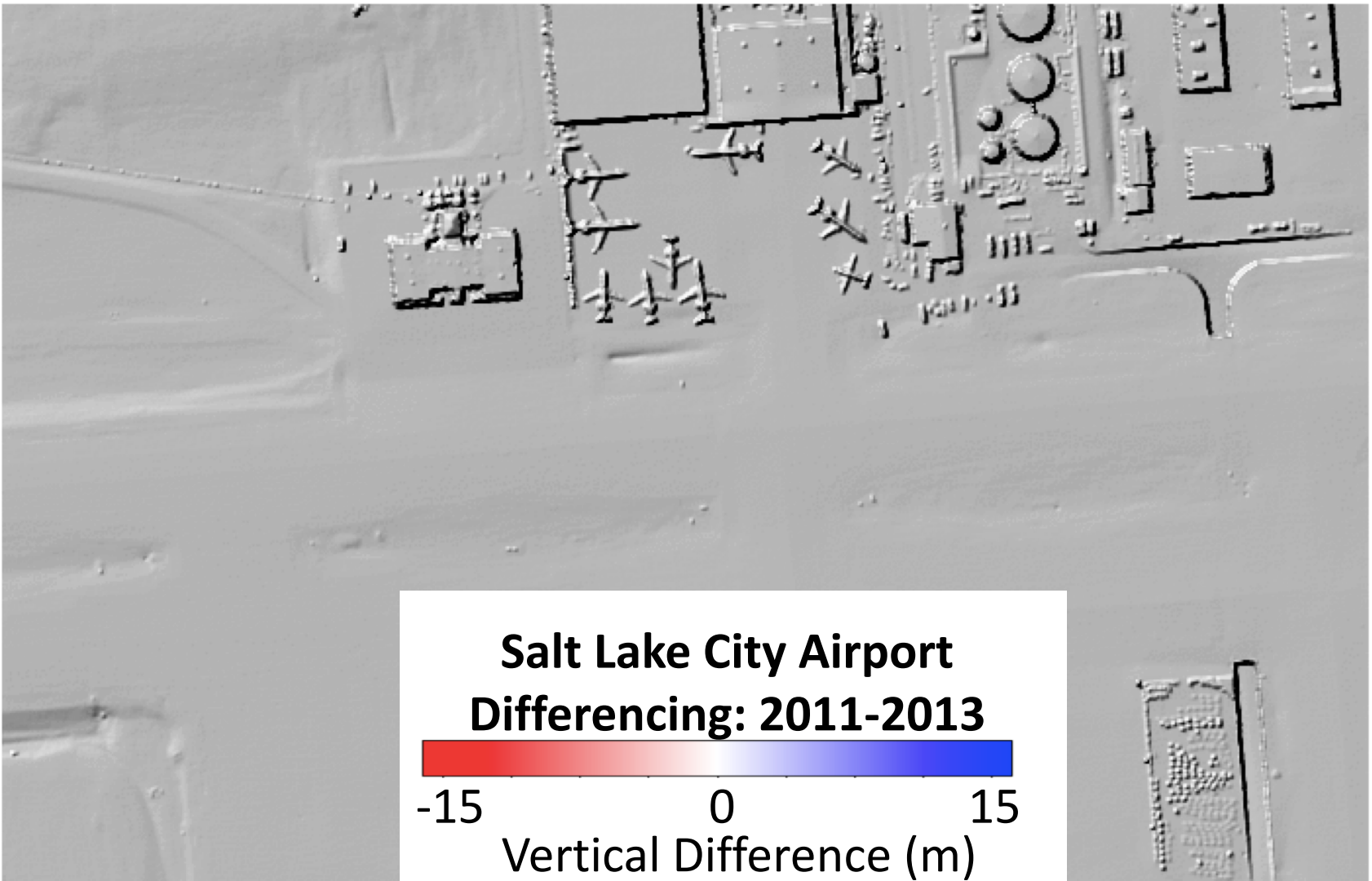
Differencing: 2011-2013

-15 0 15

Vertical Difference (m)

Iowa City, Iowa

Differencing: June 2008- August 2014


Salt Lake City Airport
Differencing: 2011-2013
-15
0
15
Vertical Difference (m)

Salt Lake City, Utah

Differencing: Oct 2015- Oct 2017

-4 0 4

Vertical Difference (m)

THANKS!

OpenTopography.org

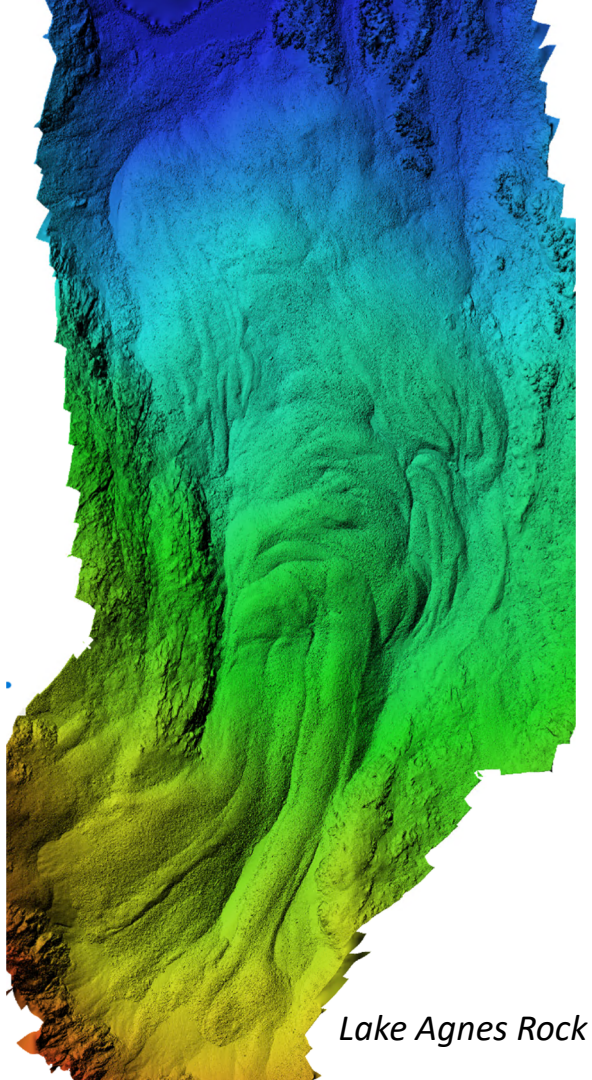
@OpenTopography

Facebook.com/OpenTopography

@OpenTopography

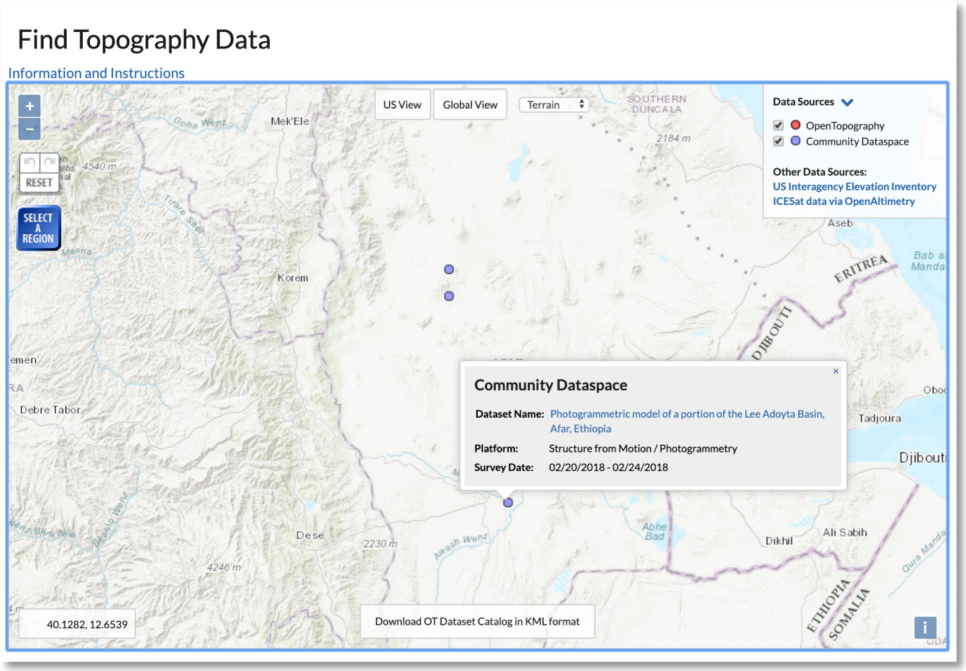
info@opentopography.org

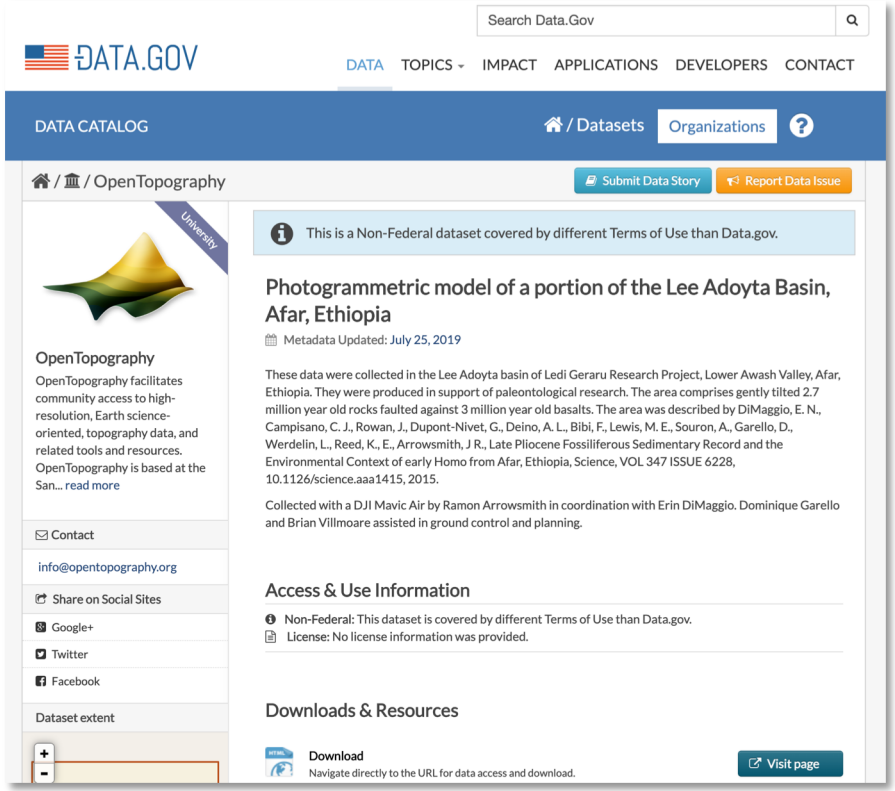
crosby@unavco.org



Lake Agnes Rock Glacier, CO

OT COMMUNITY DATASPACE





Publish, discover, download, cite

Arrowsmith, J R., DiMaggio, E. N., Garello, G. I., Villmoare, B. and LediGeraru Research Project (2018): Photogrammetric model of a portion of the Lee Adoyta Basin, Afar, Ethiopia. Distributed by OpenTopography. Accessed July 20, 2022. https://doi.org/10.5069/G95X271W

OT COMMUNITY DATASPACE

Getting Started | MyOpenTopo | Partner With Us | Search OpenTopography...

OpenTopography
High-Resolution Topography Data and Tools

HOME | DATA | RESOURCES | LEARN | ABOUT

Photogrammetric model of a portion of the Lee Adoyta Basin, Afar, Ethiopia

Welcome Christopher Crosby (Sign Out)

OT Dataspace

Dataset Information

These data were collected in the Lee Adoyta basin of Ledi Geraru Research Project, Lower Awash Valley, Afar, Ethiopia. They were produced in support of paleontological research. The area comprises gently tilted 2.7 million year old rocks faulted against 3 million year old basalts. The area was described by DiMaggio, E. N., Campisano, C. J., Rowan, J., Dupont-Nivet, G., Deino, A. L., Bibi, F., Lewis, M. E., Souron, A., Garello, D., Werdelin, L., Reed, K., E., Arrowsmith, J R., Late Pliocene Fossiliferous Sedimentary Record and the Environmental Context of early Homo from Afar, Ethiopia, Science, VOL 347 ISSUE 6228, 10.1126/science.aaa1415, 2015. Collected with a DJI Mavic Air by Ramon Arrowsmith in coordination with Erin DiMaggio. Dominique Garello and Brian Villmoare assisted in ground control and planning.

opentopoID: OTDS.102018.32637.1

DOI: https://doi.org/10.5069/G95X271W

Platform: Structure from Motion / Photogrammetry

Data Format: Point Cloud, Raster, Images

Dataset Acknowledgement: Arrowsmith, J R., DiMaggio, E. N., Garello, D. I., Villmoare, B. and the Ledi G Science Foundation and the Institute of Human Origins at Arizona State University. Collected in coordin State.

Dataset Citation: Arrowsmith, R. (2018). Photogrammetric model of a portion of the Lee Adoyta Basin, / https://doi.org/10.5069/G95X271W. Accessed: 2022-10-07

Survey Date: 02/20/2018 - 02/24/2018

Survey Area: 0.1 km^2

Publication Date: 10/24/2018

Show Data Files

Point Cloud Data

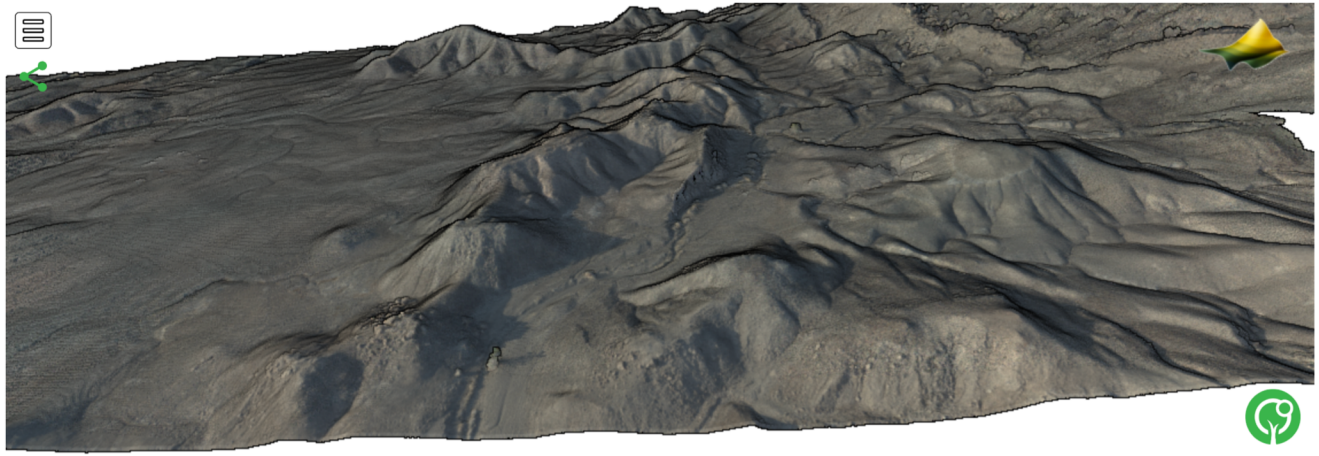
	File Name	Size	Points	Area (m^2)	Density	
1	LA6_hires_UTM37_cleaned.laz	856.02 MB	122,479,973	95,999	1,275.85	View Detail

Raster Data

	File Name	Size	Resolution	Dimensions	Layer Type	
1	LA6_DEM_0.25mv2.tif	20.00 MB	0.25 meter	1943 x 1161		View Detail
2	LA6_hightrez_2cm_ortho_UTM37_trimmed.tif	301.87 MB	0.02 meter	22354 x 14550		View Detail
	Summary	321.87 MB				

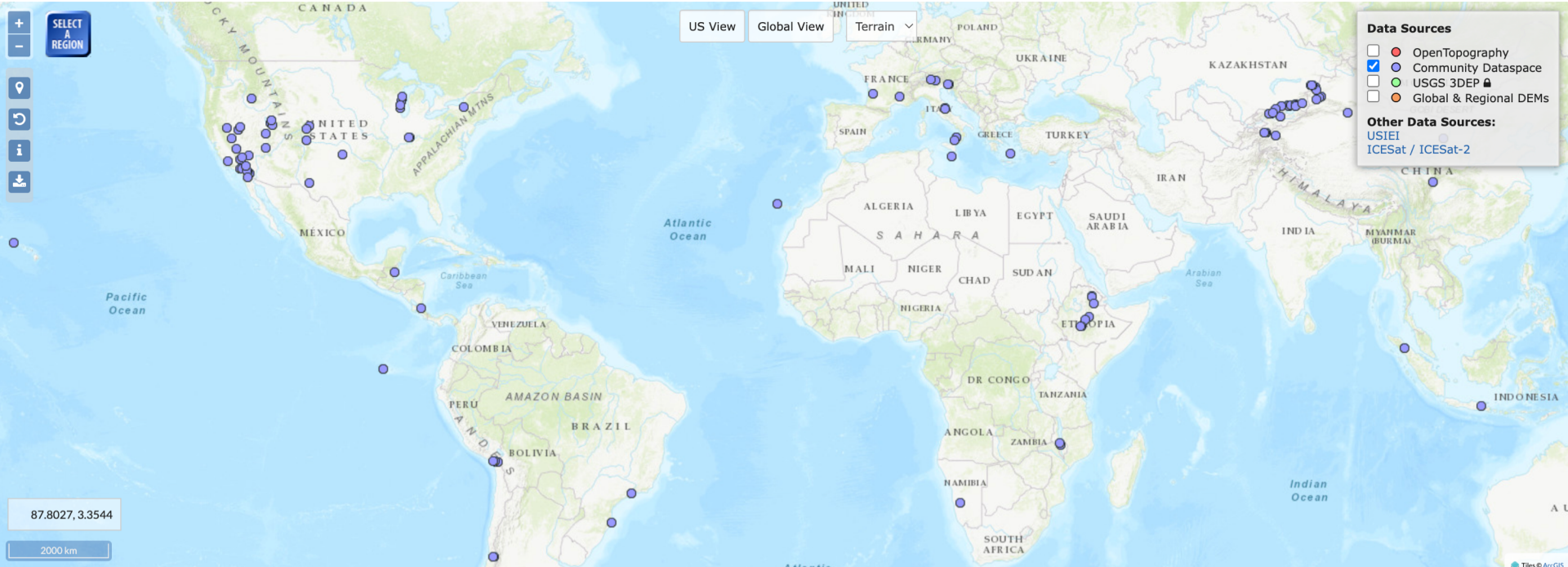
Images Files

	File Name	Size	Dimensions
1	DJI_0451.JPG	6.88 MB	4056 x 3040
2	DJI_0452.JPG	6.78 MB	4056 x 3040
3	DJI_0453.JPG	6.70 MB	4056 x 3040
4	DJI_0454.JPG	6.52 MB	4056 x 3040
5	DJI_0455.JPG	6.76 MB	4056 x 3040



STATUS

- 155 datasets (vast majority UAS SfM)
- Datasets from all over the globe. International contributors.
- Functionality: Data discovery & download; 3D visualization; *full processing coming soon…*

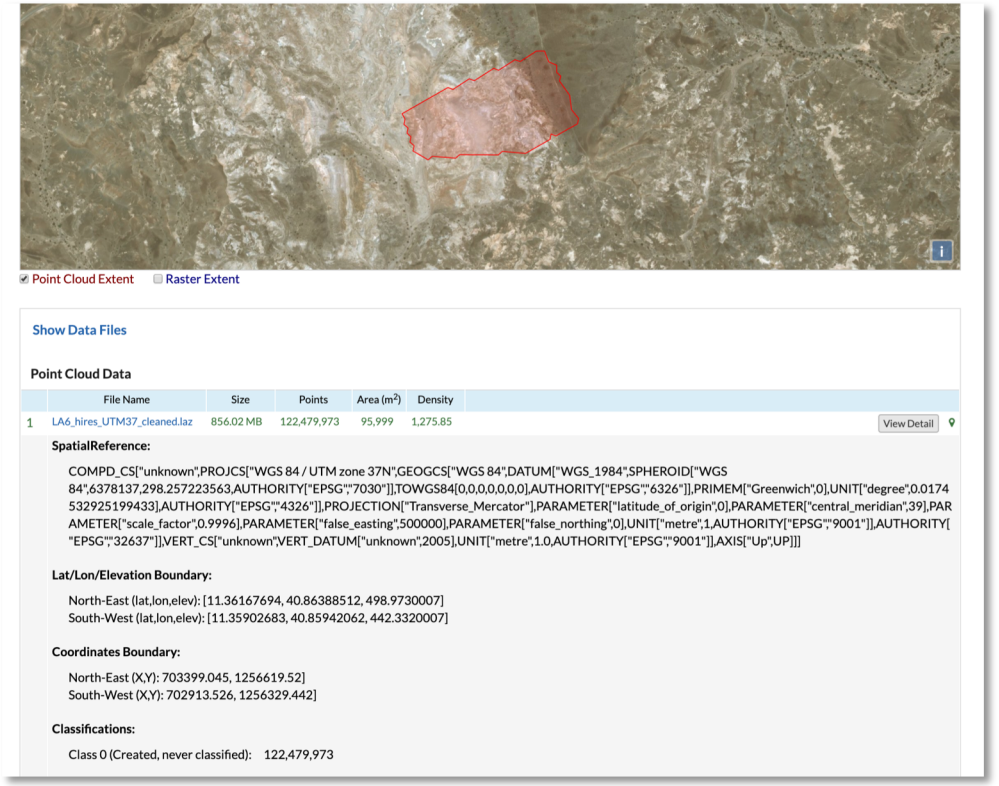


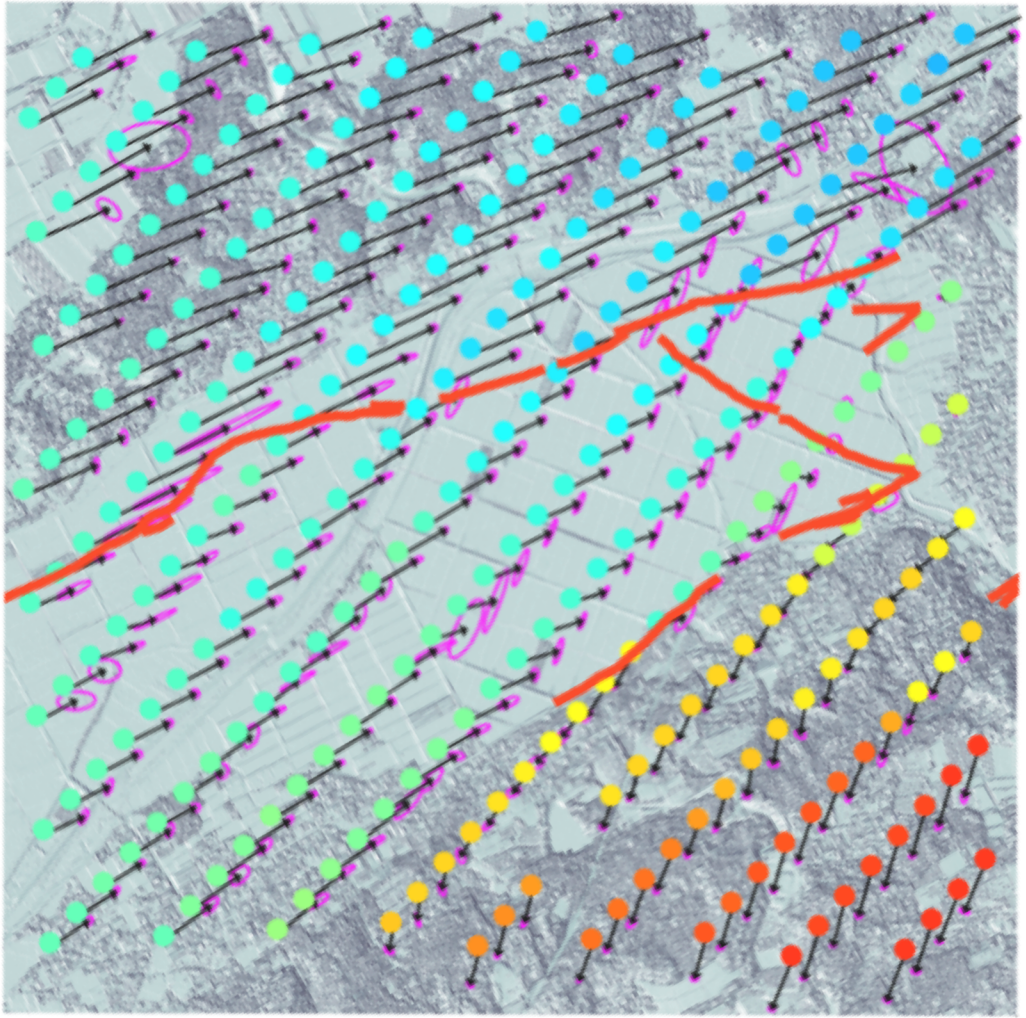
OT COMMUNITY DATASPACE

- Platform for publication of long tail topographic data to increase impact, enable reuse
- Point clouds, raster-derivatives, “raw” data/source imagery

Features:

- Automated ingest via browser-based workflow.
- Standardized & user friendly
- Aligned with **FAIR** best practices for data preservation, curation, publication & citation

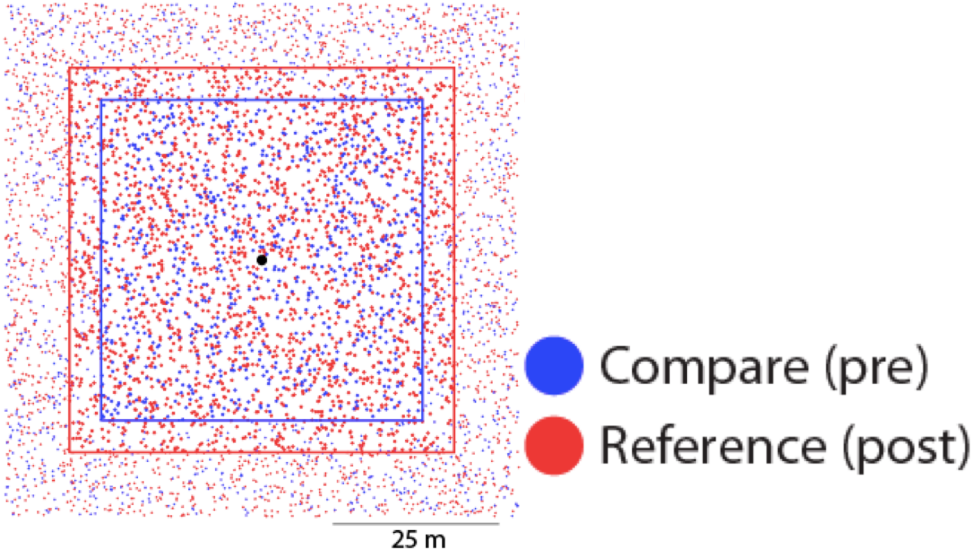


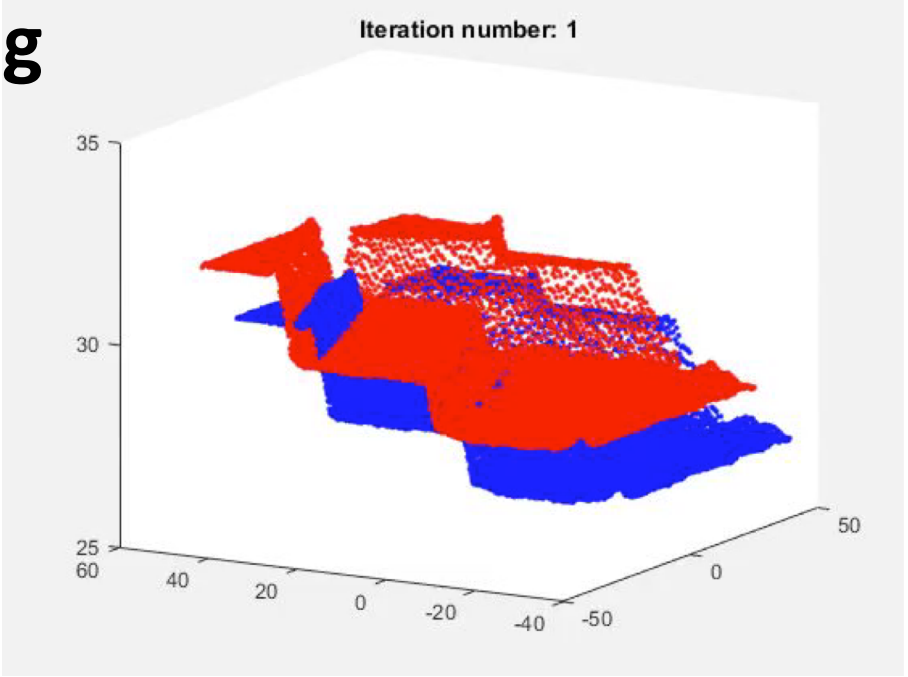


3D Topographic Differencing

3D coseismic displacements from the M7 Kumamoto Earthquake
Scott et al. (2018)

3D Topographic differencing
Iterative Closest Point

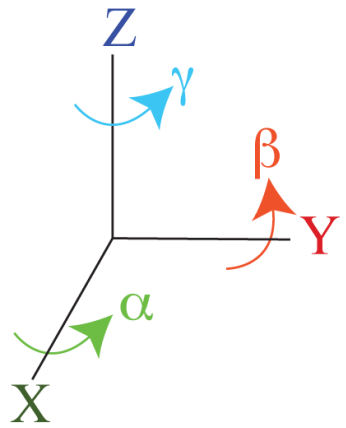




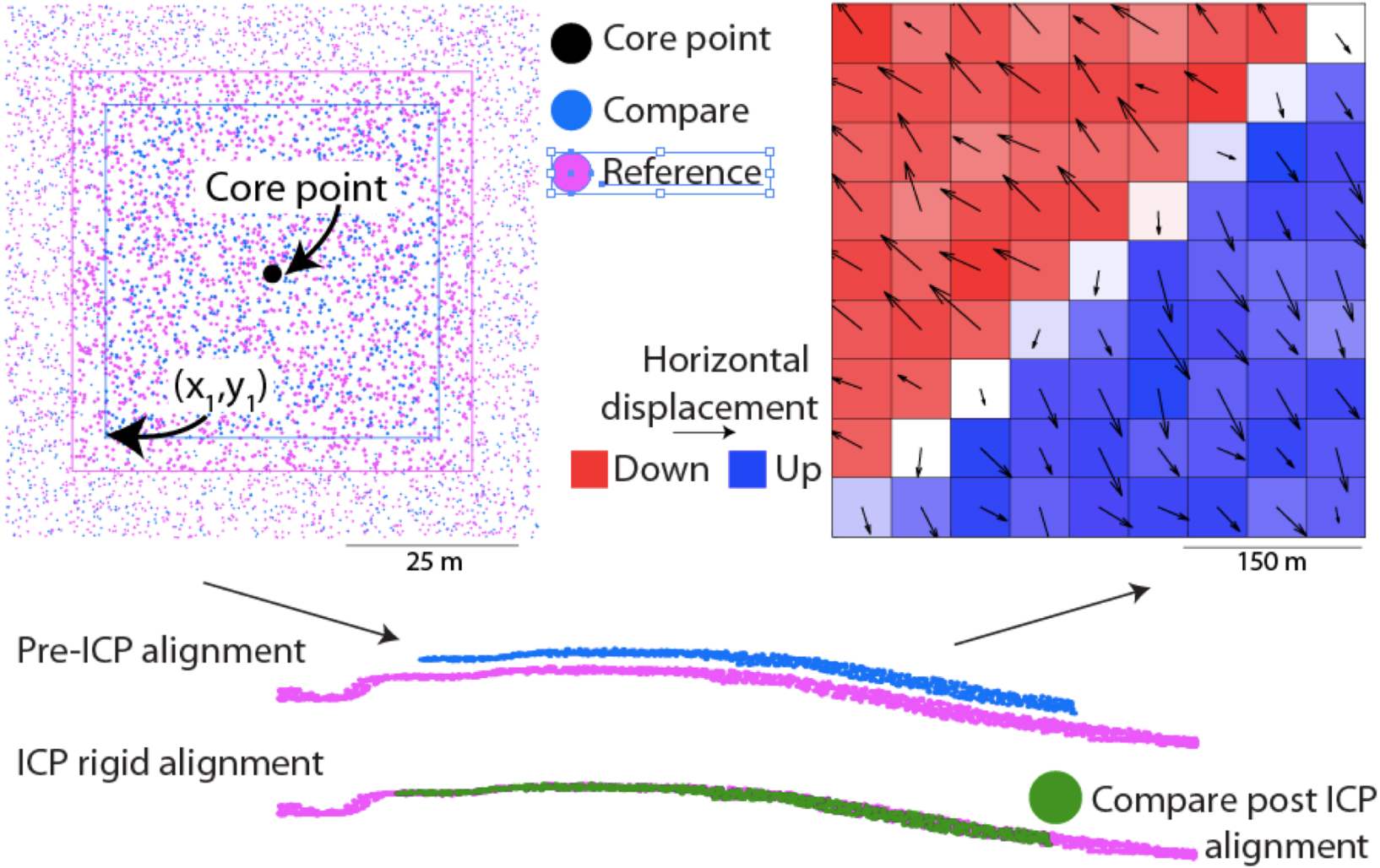
Align pre- and post- event point clouds

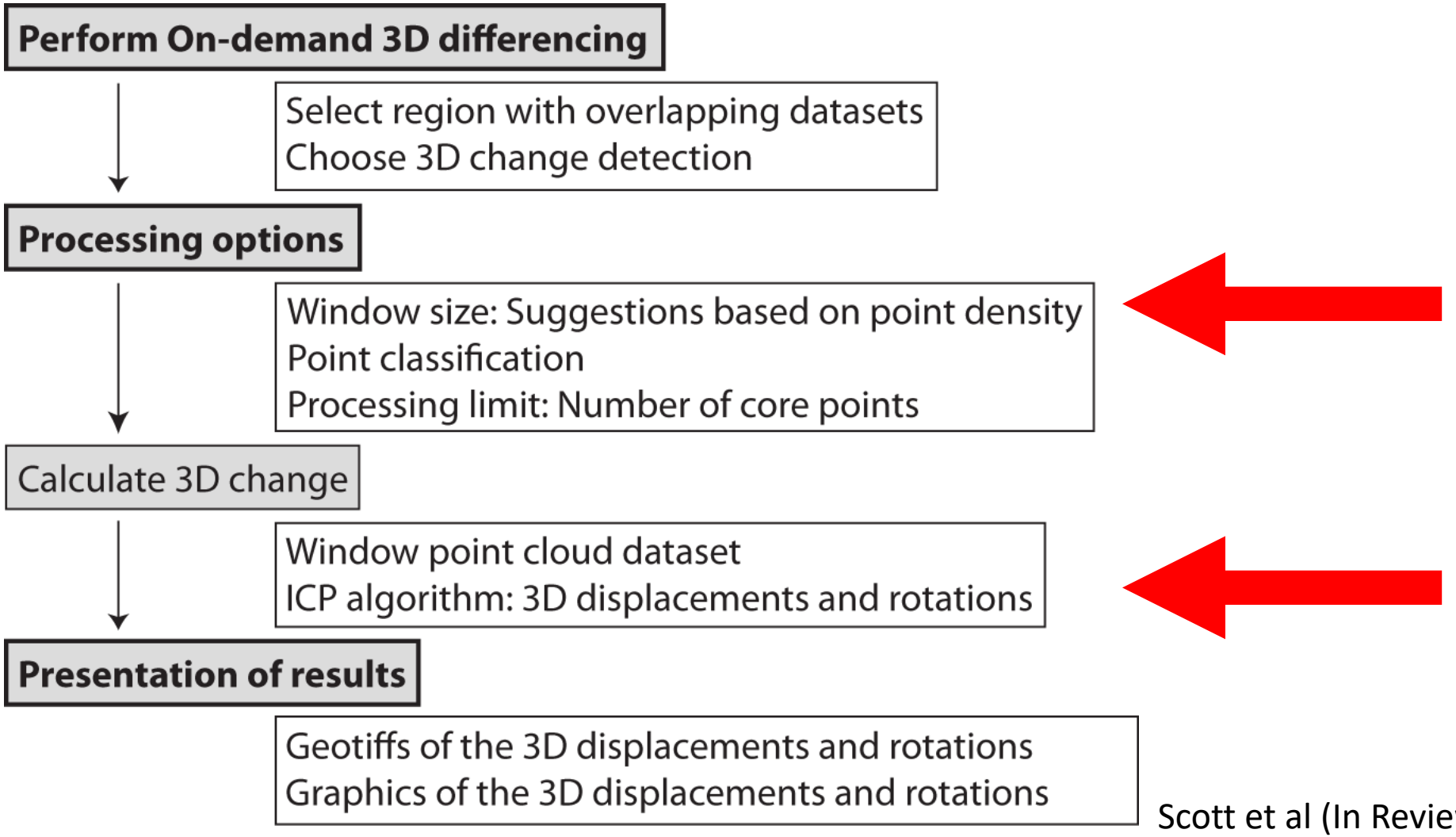
$$\text{Deformed point cloud} = \begin{bmatrix} 1 & -\gamma & \beta \\ \gamma & 1 & -\alpha \\ -\beta & \alpha & 1 \end{bmatrix} \begin{bmatrix} \text{Undeformed point cloud} \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \\ t_z \end{bmatrix}$$

Rotation Translation



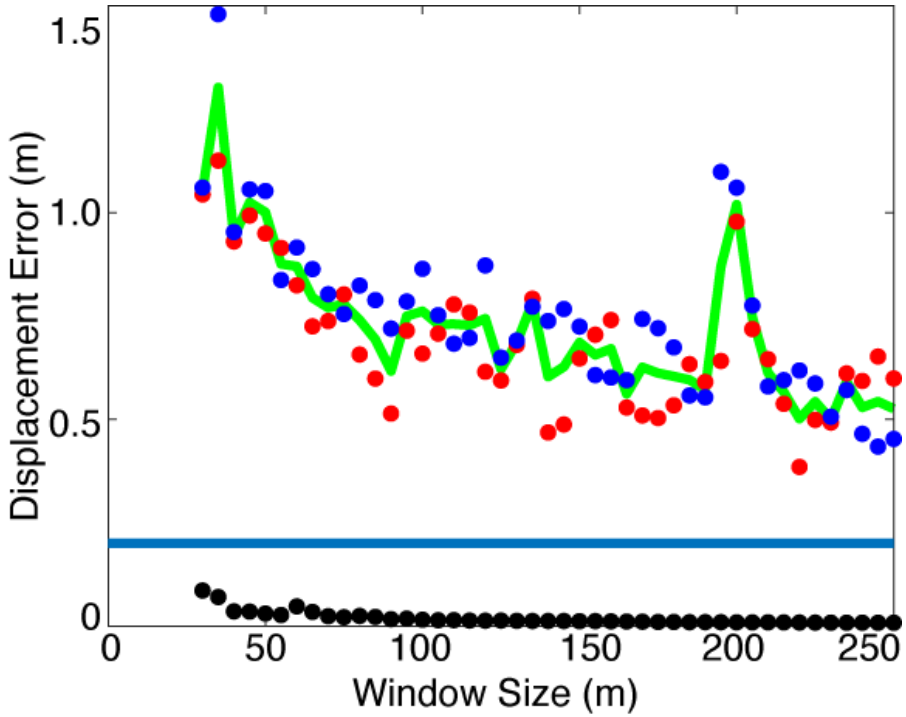
Coordinate system


Core point
Compare
Reference
Core point
(x_1,y_1)
25 m
Horizontal displacement
Down
Up
150 m
Pre-ICP alignment
ICP rigid alignment
Compare post ICP alignment

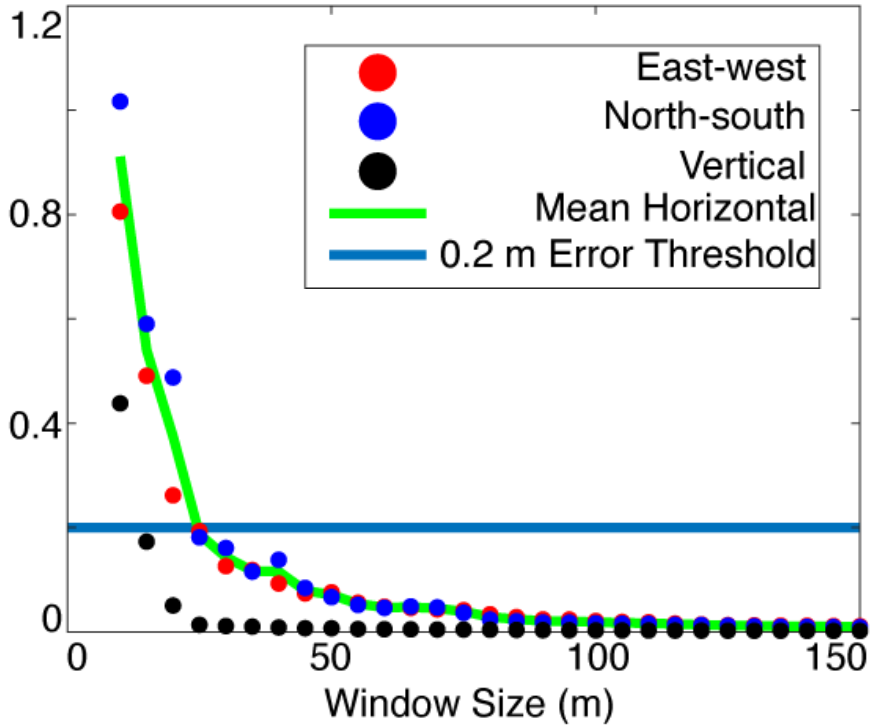


Scott et al (In Review)

3D Differencing: Window Size Synthetic Testing



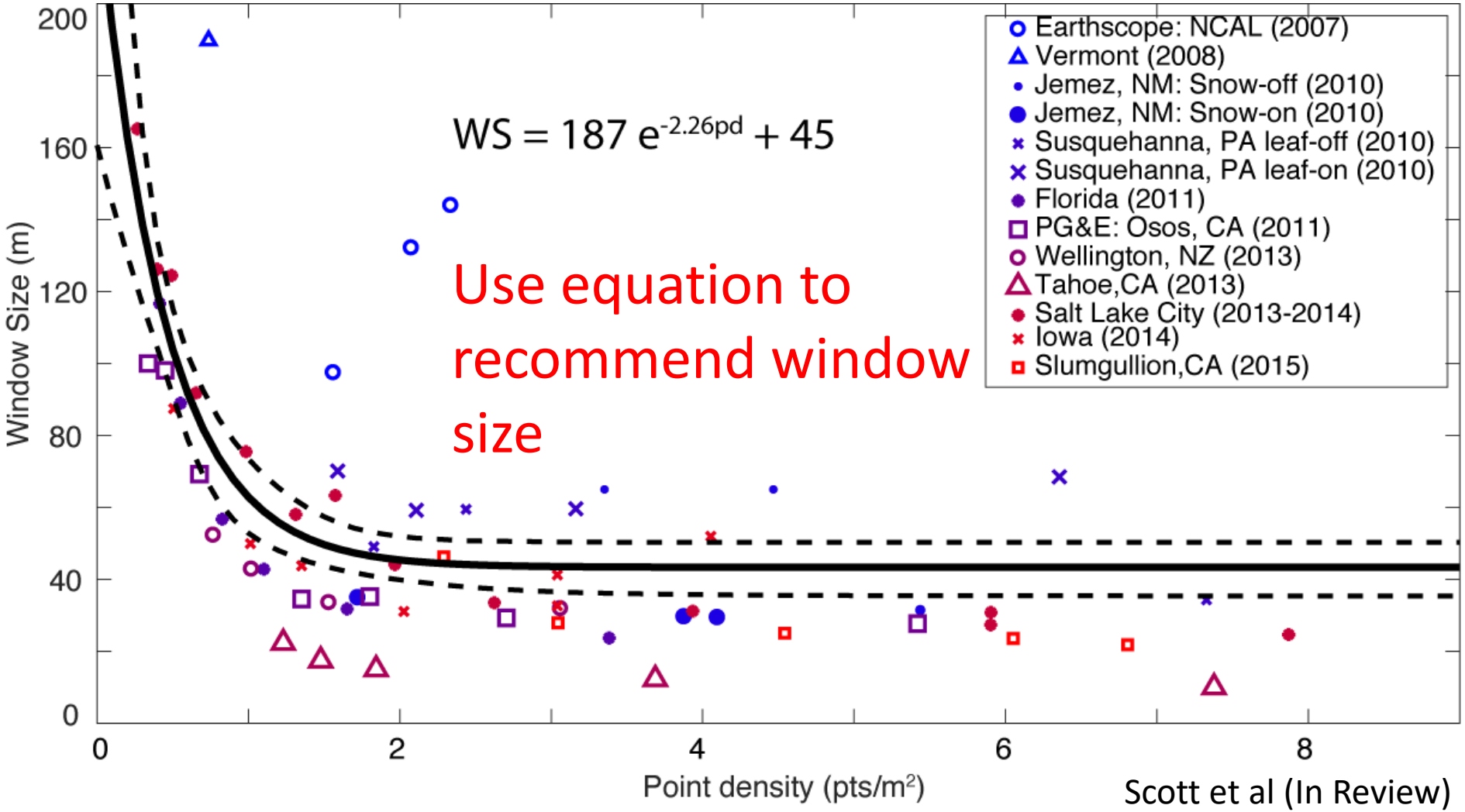
Indiana: 2012, density: 0.6 pts/m^2



Utah: 2014, Density: 7.9 pts/m^2

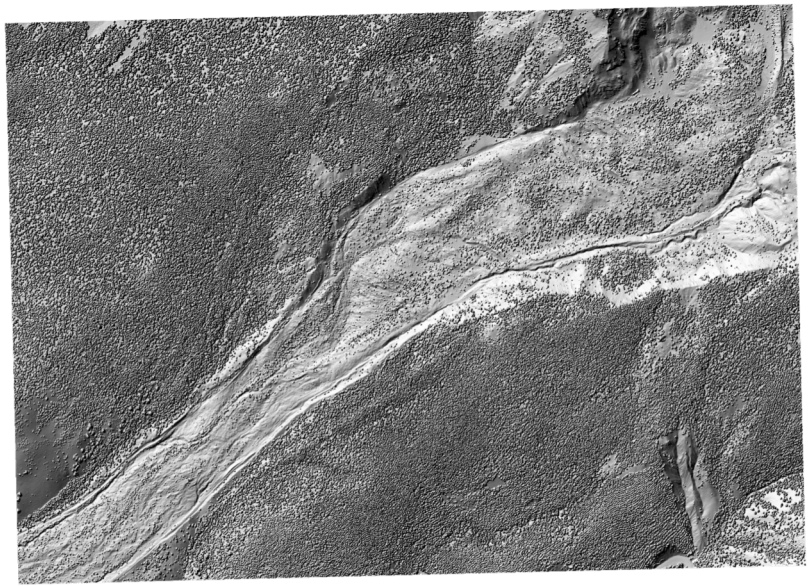
Data resolution and quality impact window size

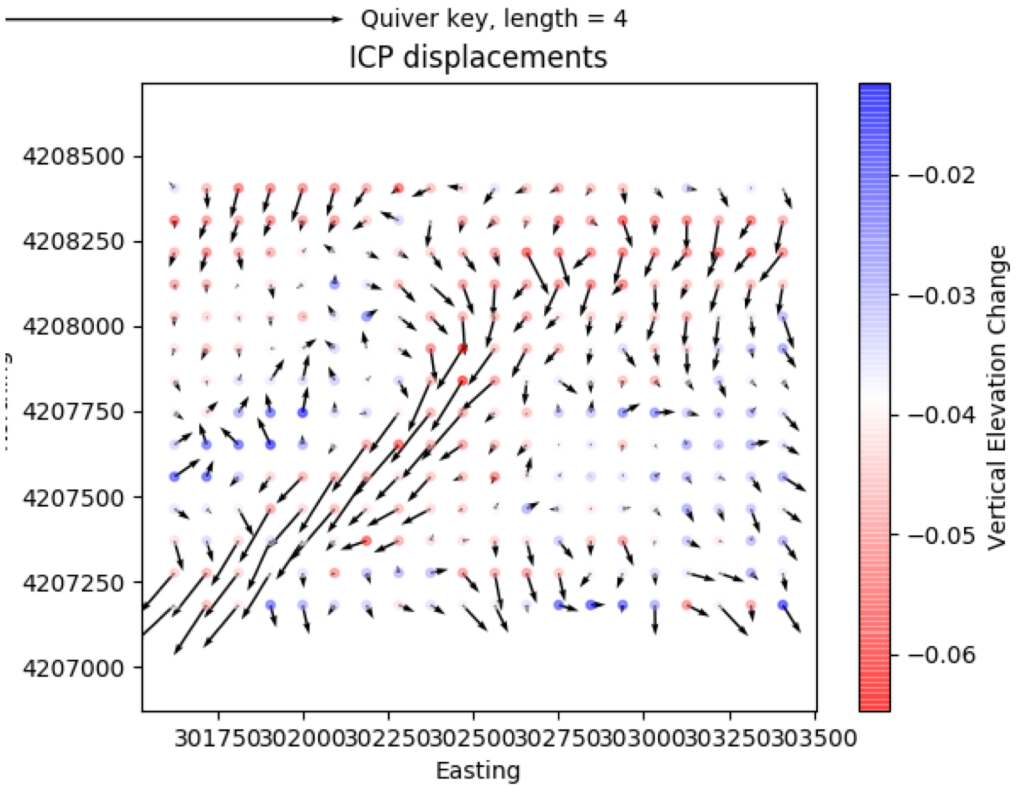
Scott et al (In Review)



Scott et al (In Review)

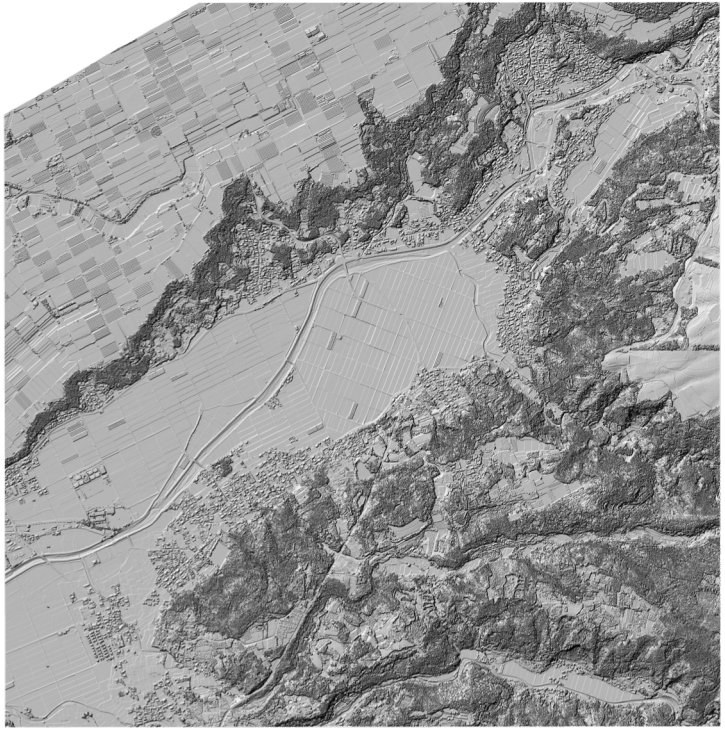
SLUMGULLION LANDSLIDE, COLORADO

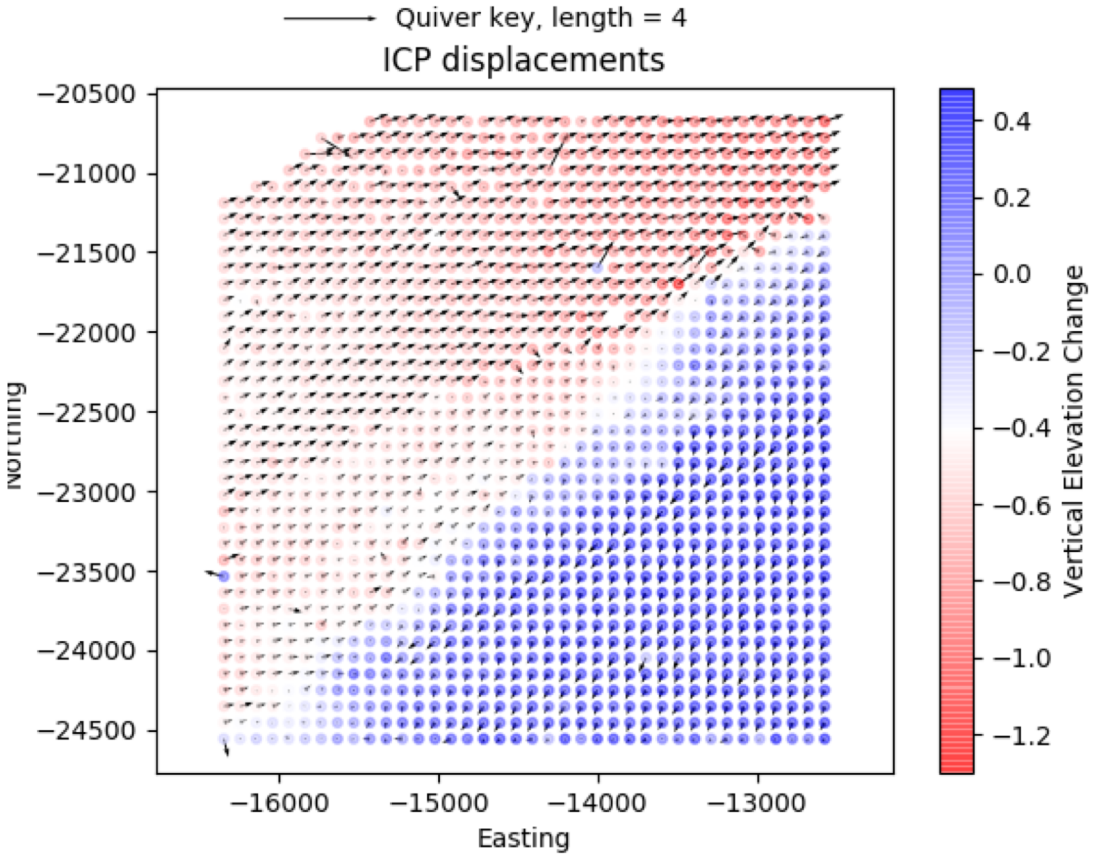




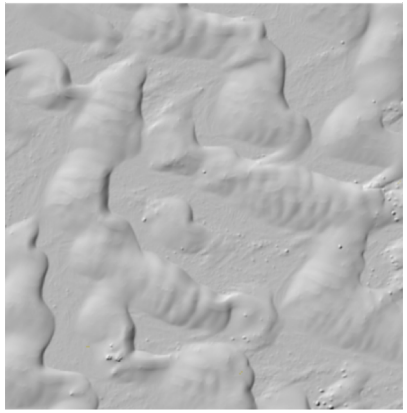
Landslide creep: July 3- July 10, 2015

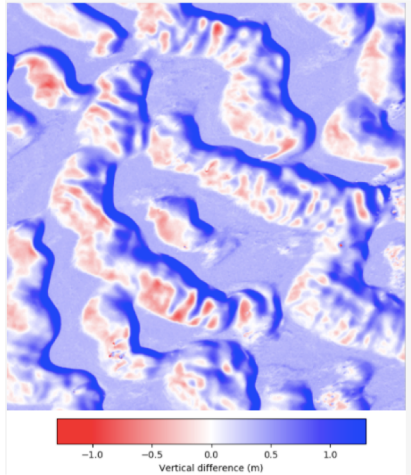
M7 Kumamoto Earthquake, Japan

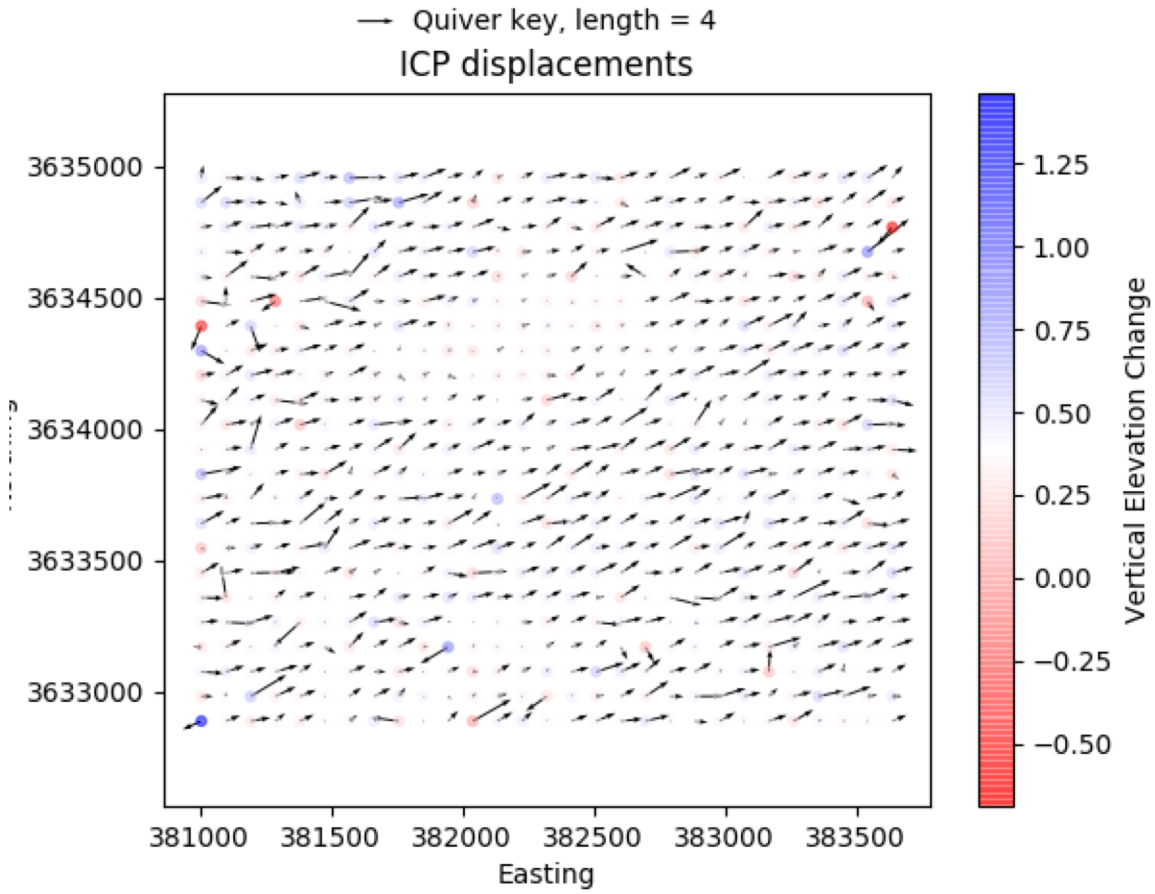




Sand Dune Migration, White Sands, NM







Opportunities & Challenges

A revolution in 3 and 4D data collection and analysis – ubiquitous point clouds & 3D models

Challenges:

Community needs best practices, standards, documentation to fully enable dataset reuse.

Sustainability: Data collection is cheap & easy and drones are common (govt, academia, industry, personal/hobbyist).