



Topographic Change at the Statewide Scale: An Indiana Case-Study Powered by OpenTopography

Christopher Crosby, Chelsea Scott, & the OT Team

2021 NSGIC Annual Conference, Dallas, TX



OpenTopography is supported by the National Science Foundation under Award Numbers 1948997, 1948994 & 1948857

WHAT DO WE DO?

Data hosting and distribution:

- Online distribution of point cloud, raster (DTM, DSM, orthoimagery, etc), and other derivative products.

Direct access to USGS 3DEP datasets:

- Easy on-demand access and processing for all 3DEP data.

Education and training in use of high resolution topography:

- Online or in-person short courses. Focus on methods and best practices, not specific software.



Past and current partners:

Land Information New Zealand, State of Indiana, State of Utah, California Geological Survey, Yurok Tribe, PG&E, USGS...



DATA SERVICES

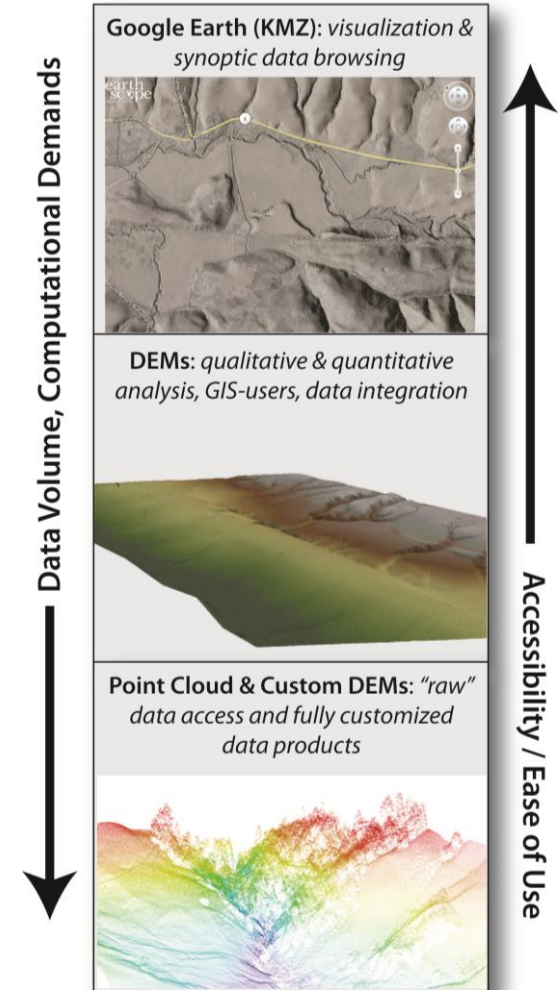
Topography data products and access mechanisms for a diverse user community

Range of available data products:

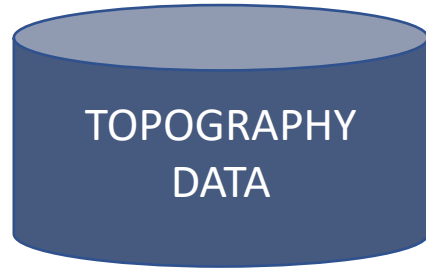
- Easy to access products for browsing and education.
 - Browse images, Google Earth, 3D visualization
- Majority of users want a standard gridded product.
 - GIS products (e.g. DTM, DSM, etc.)
- “raw” point cloud data for modeling or analysis

Multiple Access Pathways

- Web Portal interfaces, APIs and web services,
Bulk Downloads (Cloud Optimized GeoTIFFs - COGs)

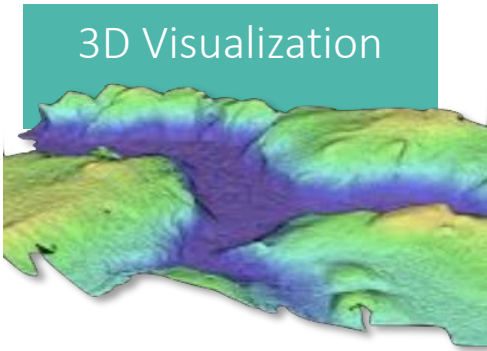


DATA SERVICES

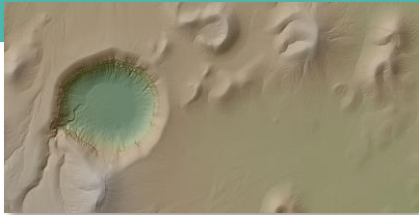


PC Data Filtering & Subsetting

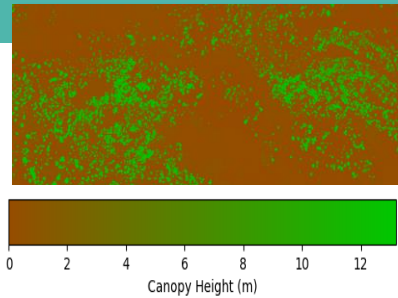
Raster Data Subsetting



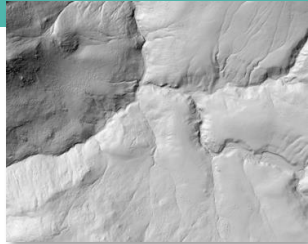
Digital Elevation Models
TIN / Local Gridding



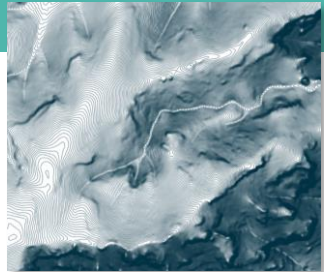
Canopy Height Model



Topographic Hillshades



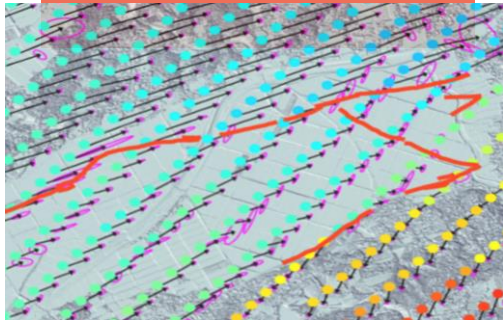
Contour Lines



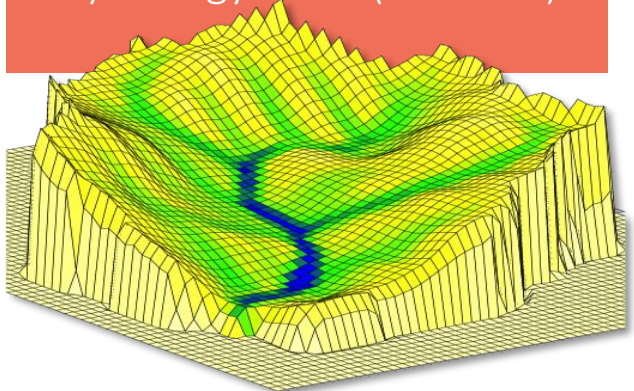
Vertical Differencing



3D Differencing



Hydrology Tools (TauDEM)

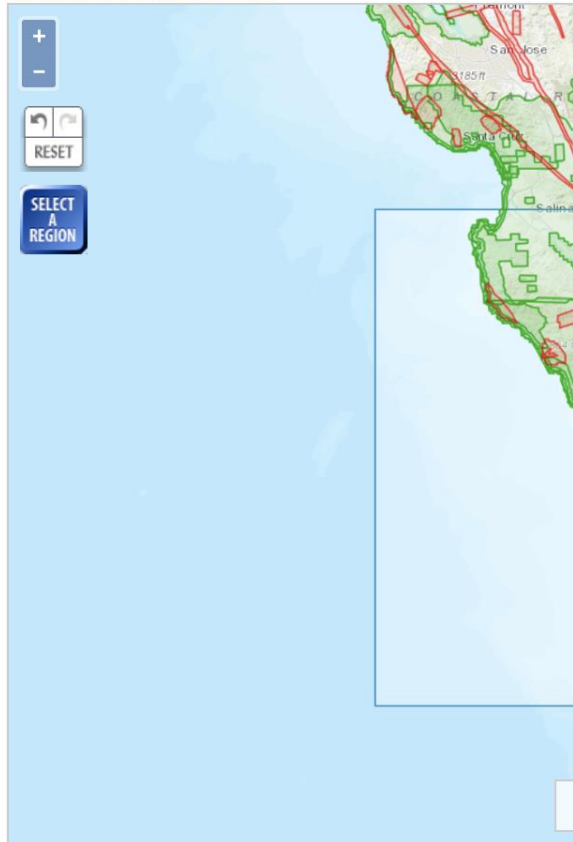


PORTAL INTERFACES

AOI selection on Map

Find Topography Data

Information and Instructions



RESULTS:

Total 34 datasets found for all data sources.

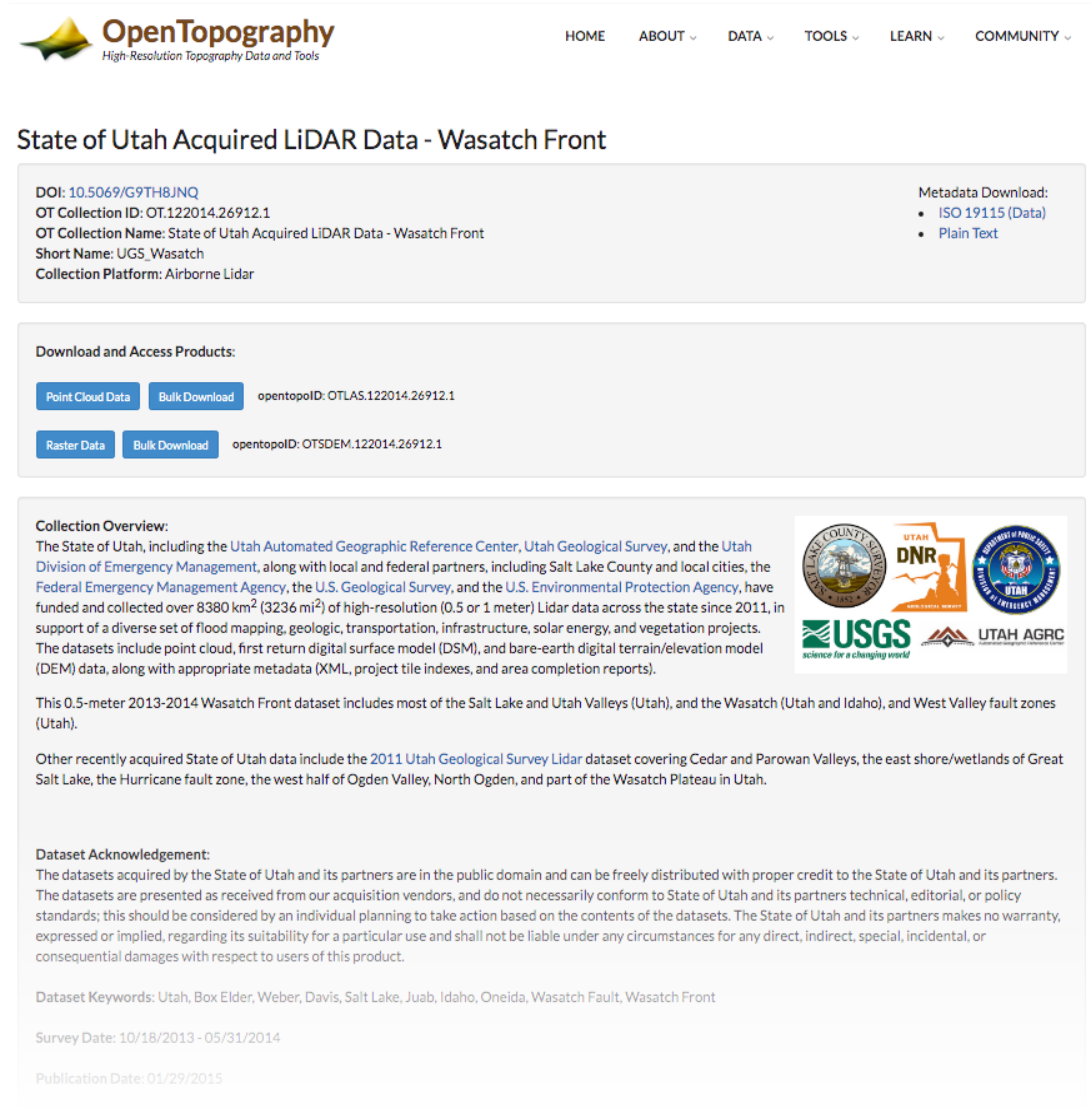
● OT High Resolution Topography: [17]
 ● USGS 3DEP: [10]
 ● OT Community Contributed: [1]
 ● Global Data: [6]




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	High Resolution SFM Topography of the Central San Andreas Fault, California	Differencing ⚙️	Point Cloud	Raster	📍
2	High Resolution Topography over Gabilan Mesa, CA 2003		Point Cloud	Raster	📍
3	Mapping of Displacements Near Parkfield, California		Point Cloud	Raster	📍
4	B4 Project - Southern San Andreas and San Jacinto Faults - Classified Lidar	Differencing ⚙️	Point Cloud	Raster	📍
5	Big Creek, California	Differencing ⚙️	Point Cloud	Raster	📍
6	Gabilan Mesa, CA: Valley Alluviation effects on Hillslope-Channel Coupling		Point Cloud		📍
7	California ARRA Lidar	Differencing ⚙️	Point Cloud	Raster	📍
8	California Coast: Big Creek, Vincente, Arroyo Seco, Scotts Creek, UCSC	Differencing ⚙️	Point Cloud		📍
9	Southern Sierra Nevada Critical Zone Observatory: Snow On	Differencing ⚙️	Point Cloud	Raster	📍
10	Southern Sierra Nevada Critical Zone Observatory: Snow Off	Differencing ⚙️	Point Cloud	Raster	📍
11	PG&E Diablo Canyon Power Plant (DCPP): San Simeon and Cambria Faults, CA	Differencing ⚙️	Point Cloud	Raster	📍
12	PG&E Diablo Canyon Power Plant (DCPP): Los Osos, CA Central Coast	Differencing ⚙️	Point Cloud	Raster	📍
13	PG&E Diablo Canyon Power Plant (DCPP): Diablo Canyon, CA Central Coast	Differencing ⚙️	Point Cloud	Raster	📍
14	Dragons Back Ridge: San Andreas Fault, California		Point Cloud	Raster	📍

PORTAL INTERFACES





[HOME](#)
[ABOUT](#)
[DATA](#)
[TOOLS](#)
[LEARN](#)
[COMMUNITY](#)

State of Utah Acquired LiDAR Data - Wasatch Front

DOI: 10.5069/G9TH8JNQ
 OT Collection ID: OT.122014.26912.1
 OT Collection Name: State of Utah Acquired LiDAR Data - Wasatch Front
 Short Name: UGS_Wasatch
 Collection Platform: Airborne Lidar

Metadata Download:
 • ISO 19115 (Data)
 • Plain Text

Download and Access Products:

[Point Cloud Data](#) [Bulk Download](#) opentopoID: OTLAS.122014.26912.1
[Raster Data](#) [Bulk Download](#) opentopoID: OTSEM.122014.26912.1

Collection Overview:
 The State of Utah, including the Utah Automated Geographic Reference Center, Utah Geological Survey, and the Utah Division of Emergency Management, along with local and federal partners, including Salt Lake County and local cities, the Federal Emergency Management Agency, the U.S. Geological Survey, and the U.S. Environmental Protection Agency, have funded and collected over 8380 km² (3236 mi²) of high-resolution (0.5 or 1 meter) Lidar data across the state since 2011, in support of a diverse set of flood mapping, geologic, transportation, infrastructure, solar energy, and vegetation projects. The datasets include point cloud, first return digital surface model (DSM), and bare-earth digital terrain/elevation model (DEM) data, along with appropriate metadata (XML, project tile indexes, and area completion reports).


This 0.5-meter 2013-2014 Wasatch Front dataset includes most of the Salt Lake and Utah Valleys (Utah), and the Wasatch (Utah and Idaho), and West Valley fault zones (Utah).

Other recently acquired State of Utah data include the 2011 Utah Geological Survey Lidar dataset covering Cedar and Parowan Valleys, the east shore/wetlands of Great Salt Lake, the Hurricane fault zone, the west half of Ogden Valley, North Ogden, and part of the Wasatch Plateau in Utah.

Dataset Acknowledgement:
 The datasets acquired by the State of Utah and its partners are in the public domain and can be freely distributed with proper credit to the State of Utah and its partners. The datasets are presented as received from our acquisition vendors, and do not necessarily conform to State of Utah and its partners technical, editorial, or policy standards; this should be considered by an individual planning to take action based on the contents of the datasets. The State of Utah and its partners makes no warranty, expressed or implied, regarding its suitability for a particular use and shall not be liable under any circumstances for any direct, indirect, special, incidental, or consequential damages with respect to users of this product.

Dataset Keywords: Utah, Box Elder, Weber, Davis, Salt Lake, Juab, Idaho, Oneida, Wasatch Fault, Wasatch Front

Survey Date: 10/18/2013 - 05/31/2014
 Publication Date: 01/29/2015



Each OT Dataset contains:

- Landing page with metadata
- Logos & information on funders, partners, collectors.
- Citable DOI – persistent URL
- Options to download via web-map or “bulk” download

PORTAL INTERFACES

Job Customizations

- Output formats
- Parameters in algorithms

Jobs run on-demand

2. Point Cloud Data Download

Point cloud data in LAZ format

Point cloud data in LAS format

Point cloud data in ASCII format

3A. DEM Generation (TIN) ⓘ

Gridding Method

Calculate TIN

Gridding Parameters

Grid Resolution (Default = 1 meter)

Max. triangle size (Default 50 units)


Grid Format ⓘ

GeoTiff

3B. DEM Generation (Local Gridding) ⓘ

4. Derivative Products ⓘ

5A. 3D Point Cloud Visualization ⓘ

 Generate 3D point cloud browser visualization

5B. Visualization ⓘ

Generate hillshade images from DEMs

Generate additional color-relief and colored hillshades

Generate additional Google Earth KMZ files

Altitude of the light: (in range: [0-90] degrees)

Azimuth of the light: (in range: [0-360] degrees)

6. Contour Lines ⓘ

Generate contour lines

Output smoothed DEM

DEM Gaussian Radius (pixels)

DEM Gaussian Sigma

Contour Interval (meter)

File output type

ESRI Shapefile

PORTAL INTERFACES

Point Cloud Job Report

Modify and resubmit this job
Full job metadata report

Job Id
pc1567014274115

Download Data

- Point Cloud Results
- DEM Results
- Derivative Products

3D Point Cloud View



View 3D point cloud

Visualization Properties

Ztin

Tools

Scene

Export:
JSON DXF

Objects

- Point Clouds
 - pc1567014274115
- Measurements
- Annotations
- Other
- Camera

Properties

Point size: 3.00

Point sizing
FIXED

Shape
SQUARE

Opacity: 1.00

Display Attribute
RGB

Gamma: 1.00

Brightness: 0.00

Contrast: 0.00

GPS Time

Filters

About



NEW ZEALAND NATIONAL LIDAR PROGRAM

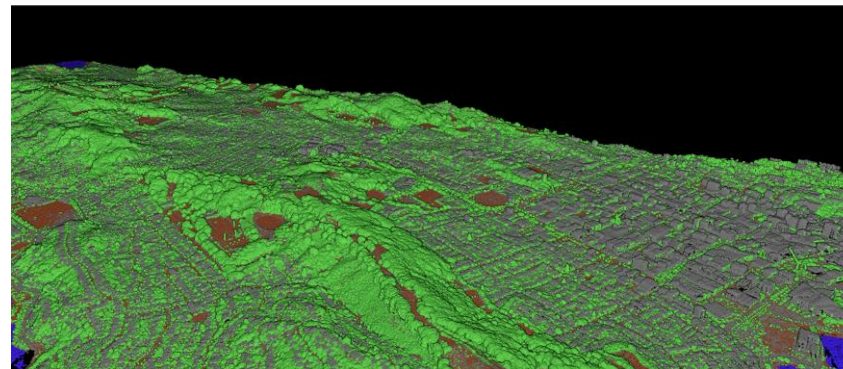


44 lidar point cloud datasets in OpenTopography covering 61,716 sq km



LINZ [Follow](#)
We make sure NZ has accurate information about where people and places are, people have confidence in property rights and Crown property is well managed.
Oct 16 · 5 min read

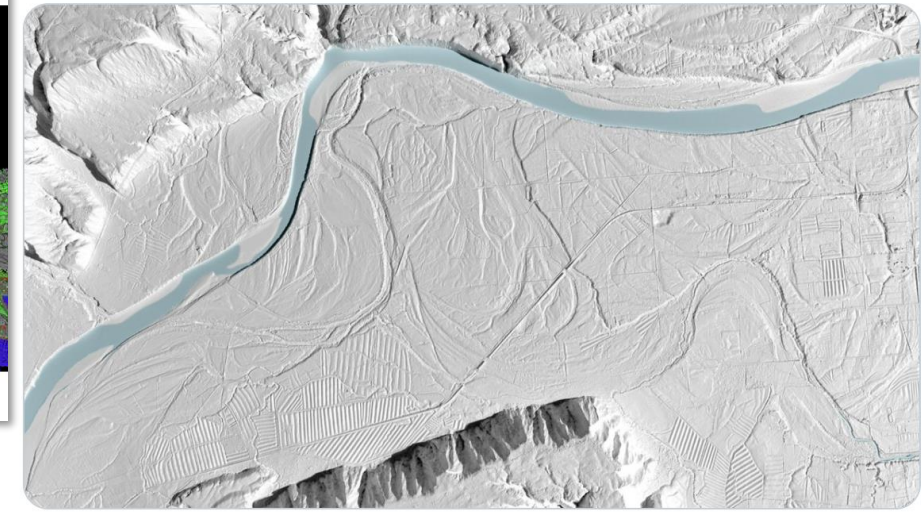
Creating point cloud visualisations with OpenTopography



Stripping down point clouds to bare earth—Wellington, New Zealand

LINZ Data Service
@LINZLDS

New #LiDAR available! DEM/DSM of Westport data.linz.govt.nz/layer/105446. Point clouds @OpenTopography doi.org/10.5069/G9Z31W.... Check out this image of the Buller River showing land features not easily seen in aerial imagery alone #opendata



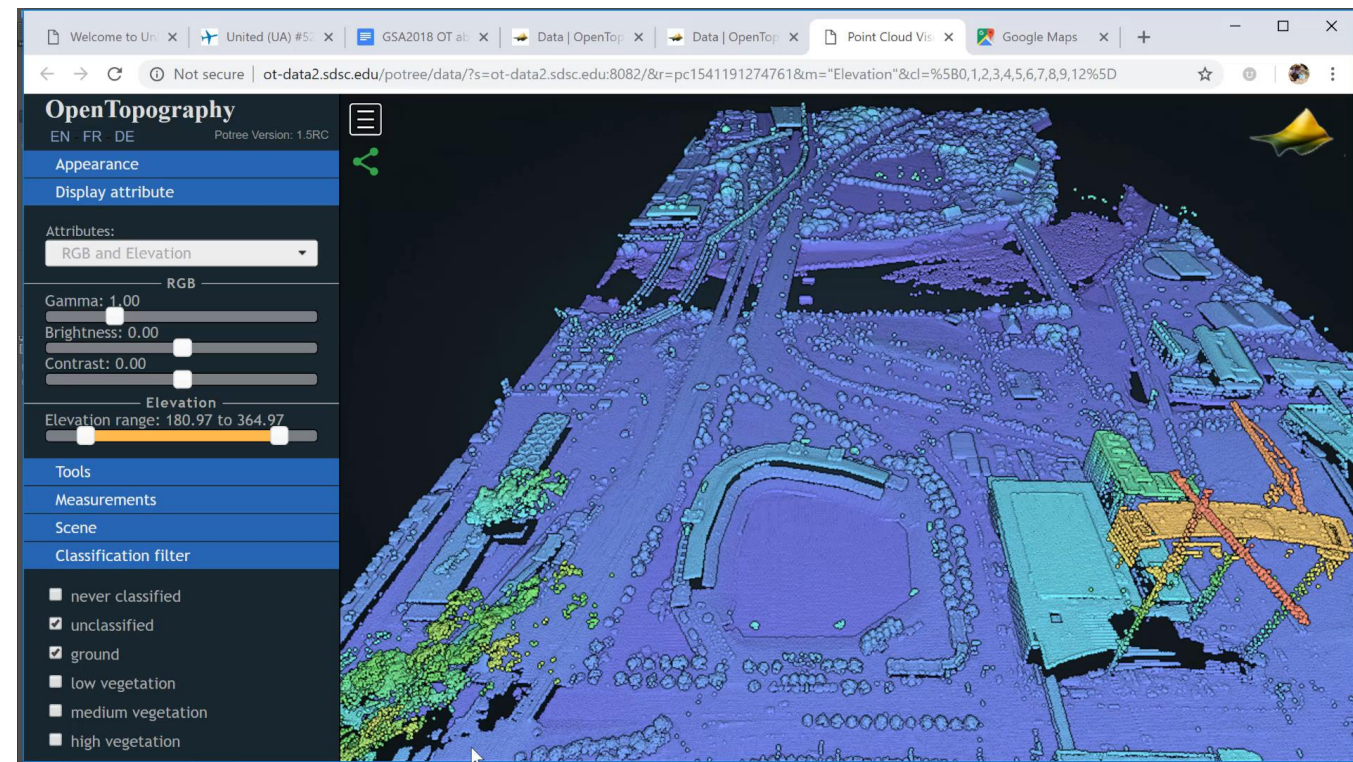
2011-2013 INDIANA STATEWIDE LIDAR COLLECTION

- Supported by Indiana Agencies
- >41,000 point cloud jobs run by 5,532 users
- Diverse use beyond academia
 - State / City Government
 - Engineering/Surveying
 - Agricultural
 - Water Management
 - Geospatial Consultants
 - Energy Utilities



Indiana Statewide Imagery and LIDAR Program

INDIANA OFFICE OF
TECHNOLOGY



2011-2013 INDIANA STATEWIDE LIDAR COLLECTION



StateScoop

4 months ago

Technology

– GIS –
ADDRESSED
EPISODE 6:
3D ELEVATION DATA

NSGIC
National Spatial Geospatial Information Center


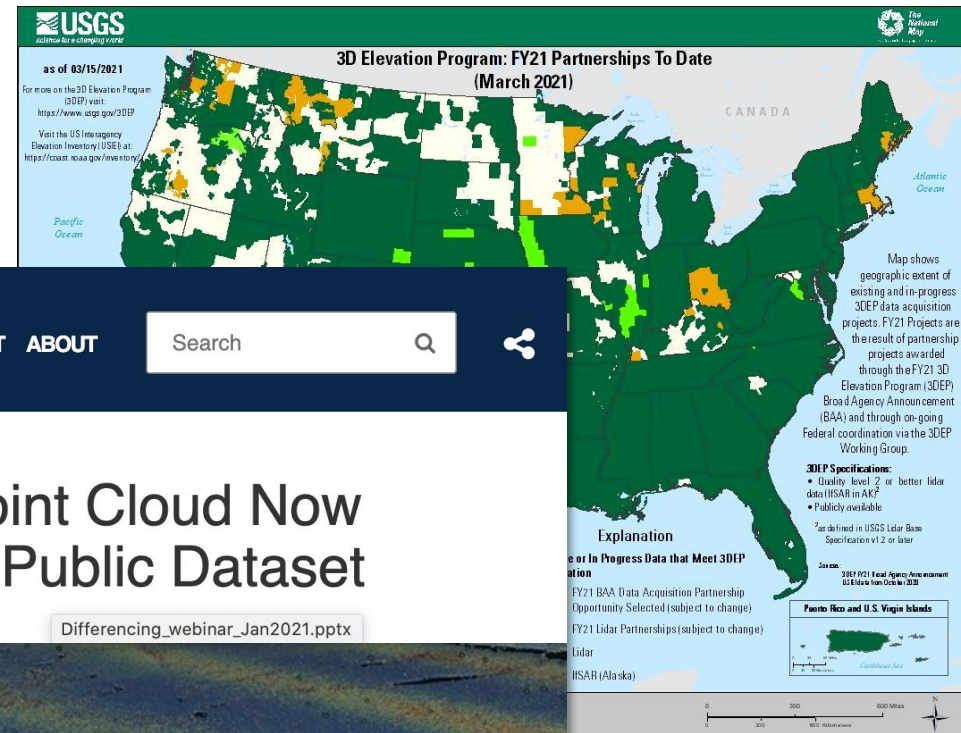
statecoop

Honestly (OpenTopography) made the difference between success and failure of the use of the data because it made it so readily available, and really broke down the barriers to having the normal mom and pop engineering firms and surveyors get access to the data in a form they can use.

-Phill Worrel, IGIC


USGS 3DEP IN OPENTOPOGRAPHY

- Leverage 3DEP in the cloud to offer OT users seamless access.
- Easy discovery & derivative products
- OT current functionality = 3DEP value added service
- Increase impact of investment in data



USGS 3DEP Lidar Point Cloud Now Available as Amazon Public Dataset

Differencing_webinar_Jan2021.pptx



Lidar Data to the Cloud



LAZ

Requestor Pays Bucket



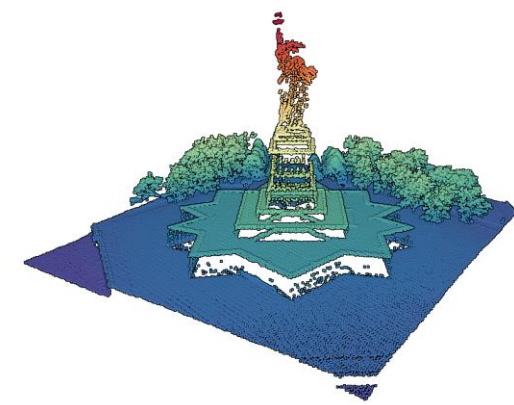
entwine

AWS Public Dataset

hobu

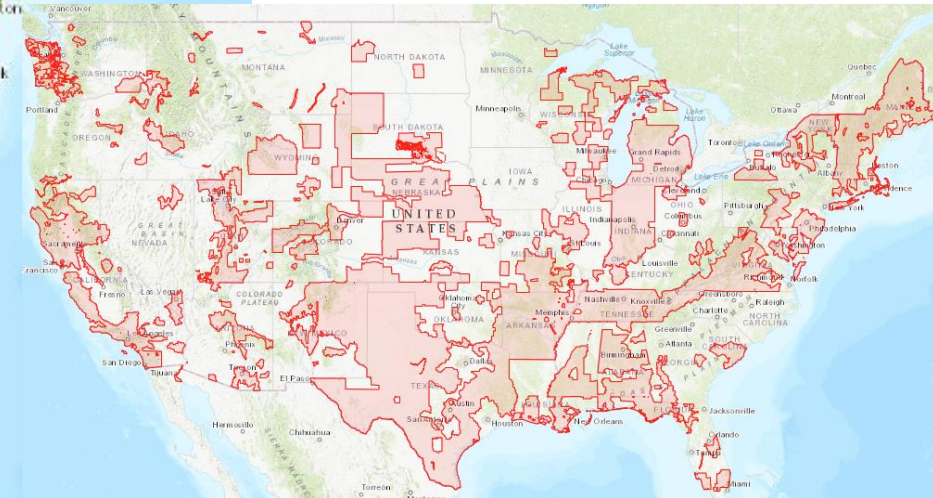
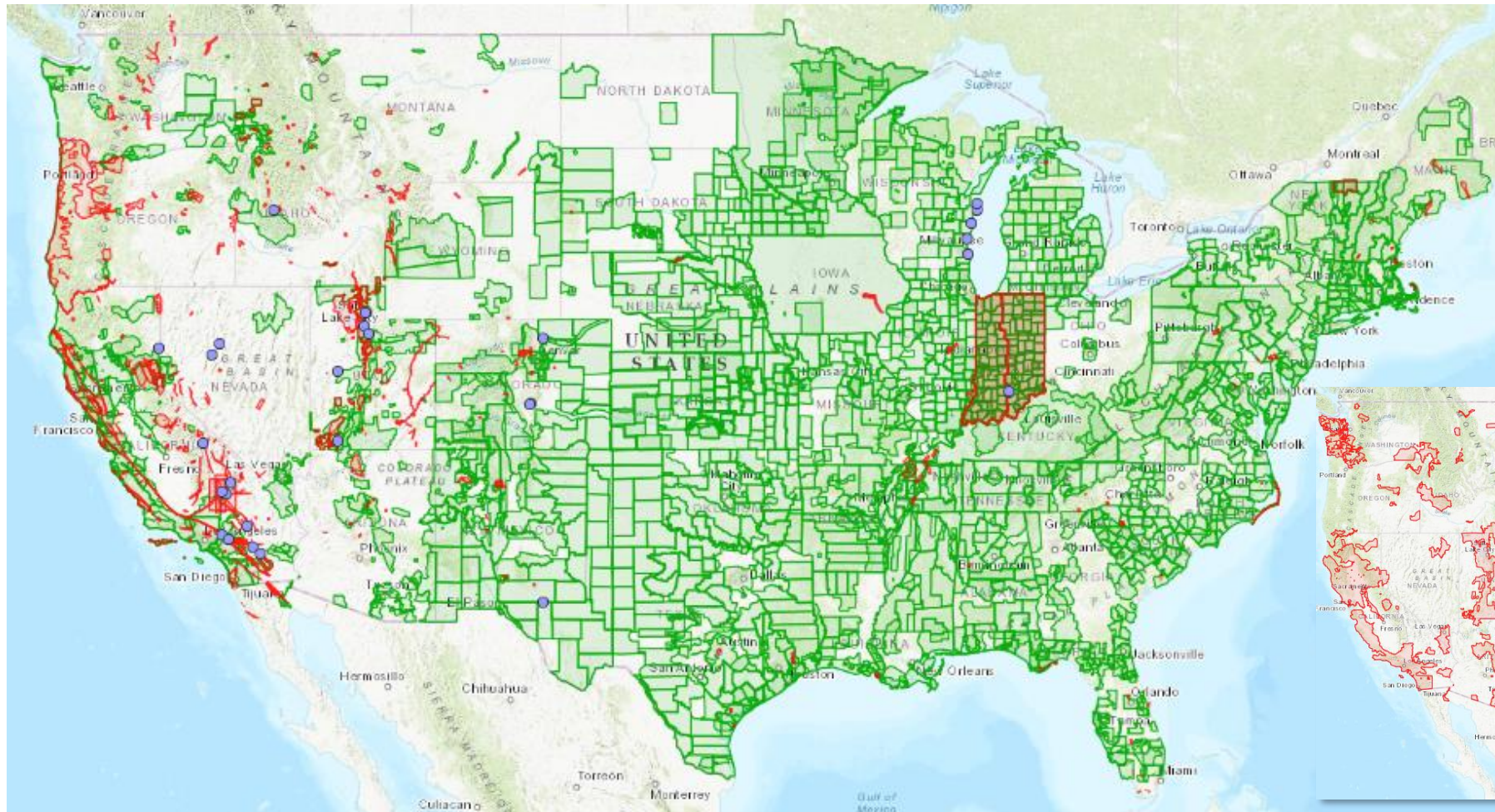
USGS 3DEP IN OPENTOPOGRAPHY

1,588 USGS 3DEP datasets currently available
31 trillion lidar returns covering 5.8 million km²



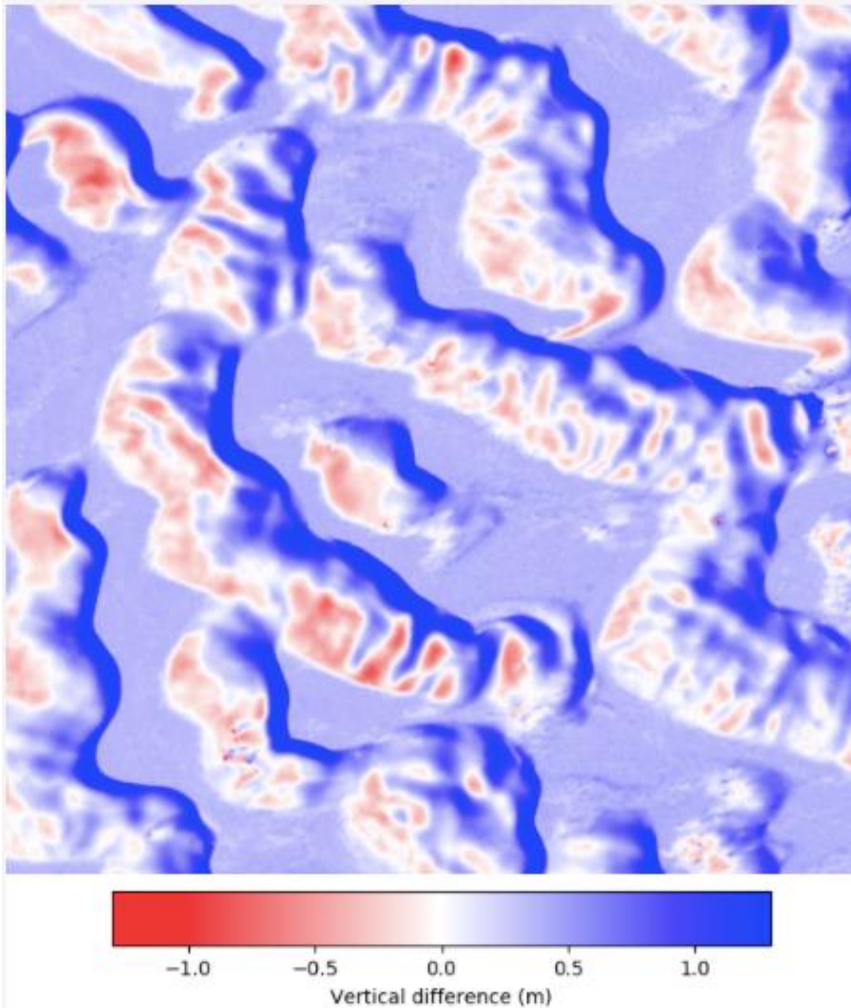
Just added! 3DEP raster datasets:

- 1 m
- 10 m
- 30 m

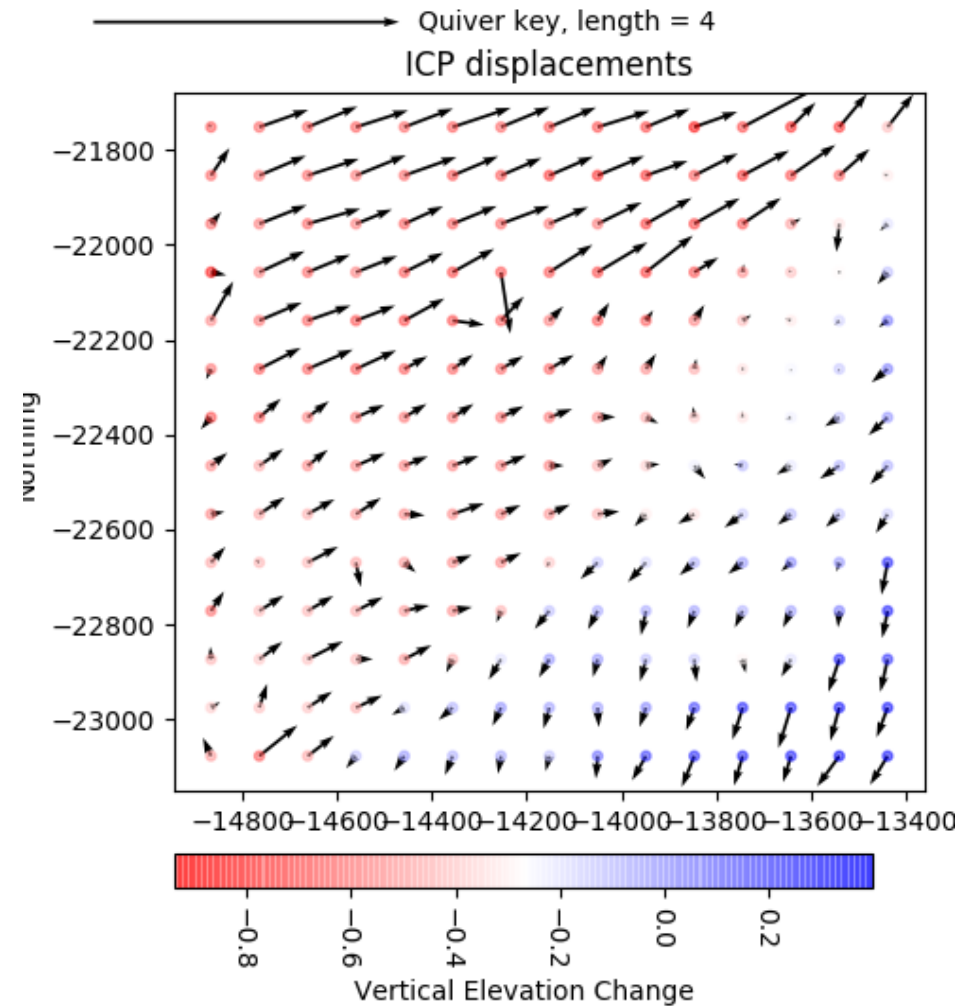


TOPOGRAPHIC DIFFERENCING

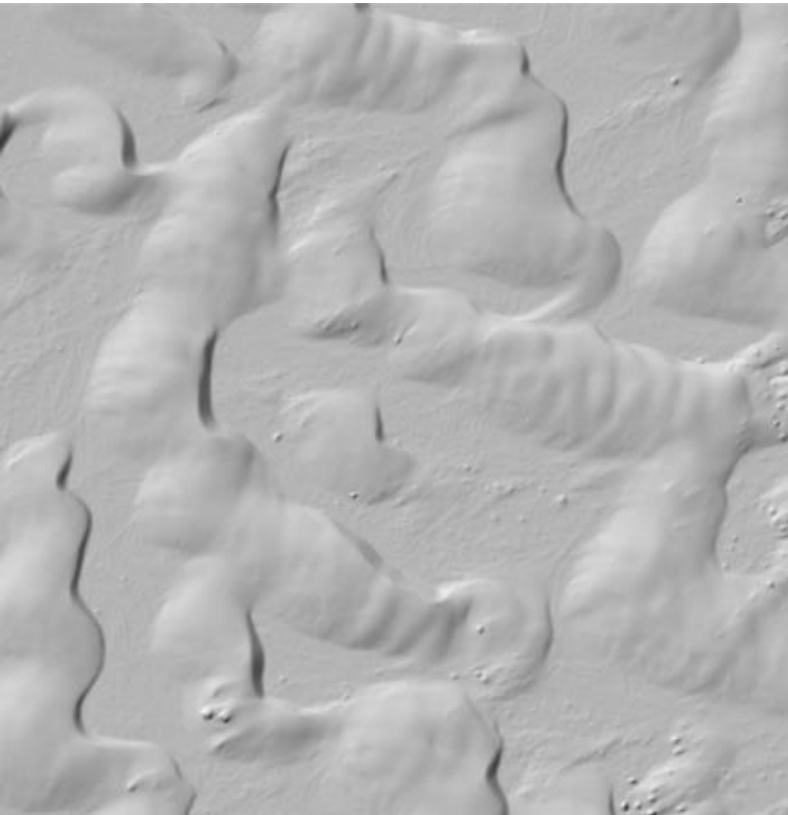
Vertical Differencing:
Sand dune migration, NM



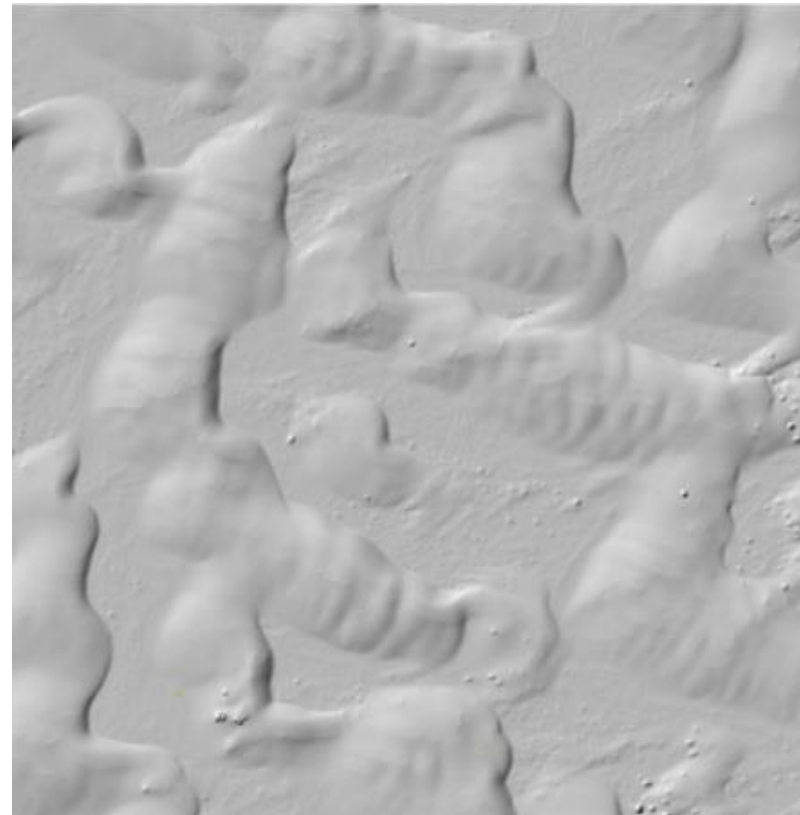
3D differencing:
Earthquake, Japan



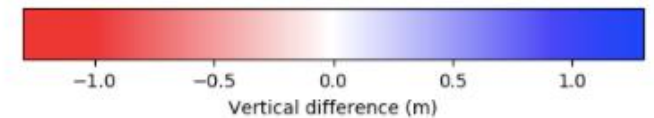
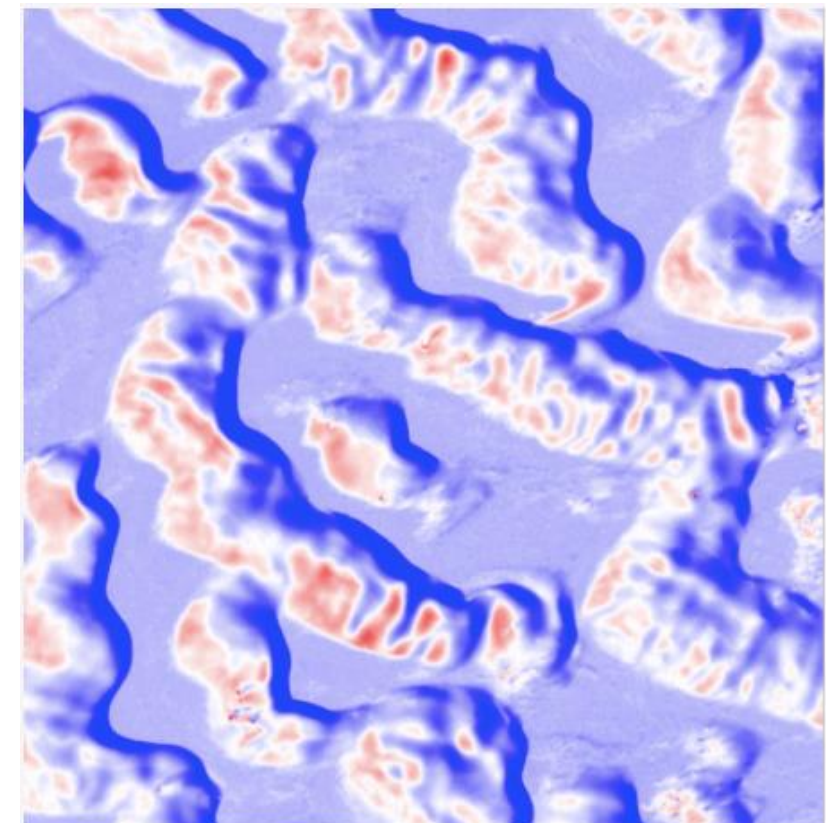
VERTICAL DIFFERENCING: SAND DUNE MIGRATION, WHITE SANDS NATIONAL MONUMENT, NEW MEXICO



Compare: 1st dataset
Sept 2009



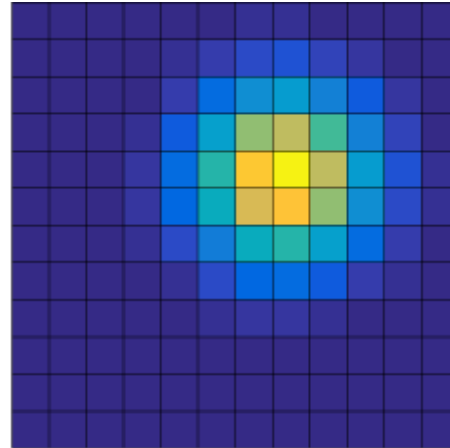
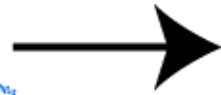
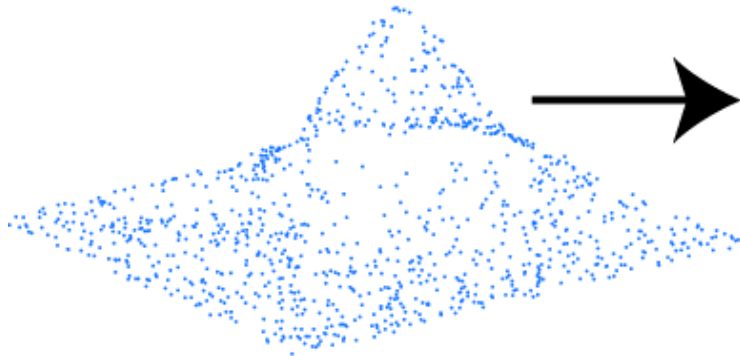
Reference: 2nd dataset
June 2010



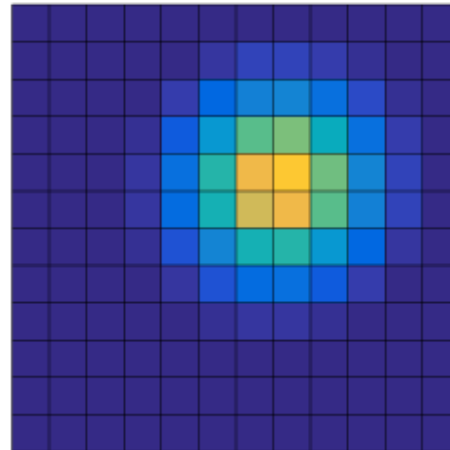
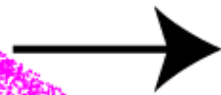
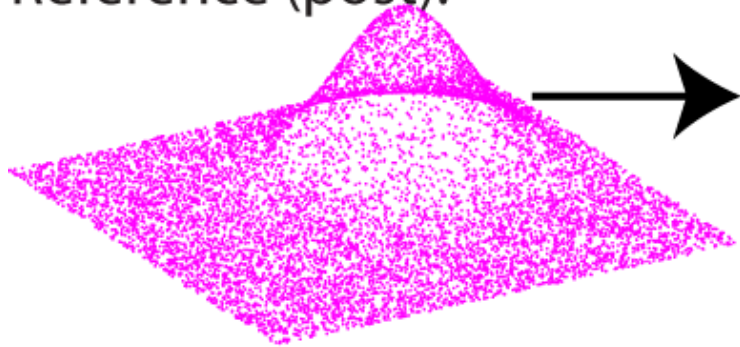
Vertical difference

VERTICAL TOPOGRAPHIC DIFFERENCING

Compare (pre):



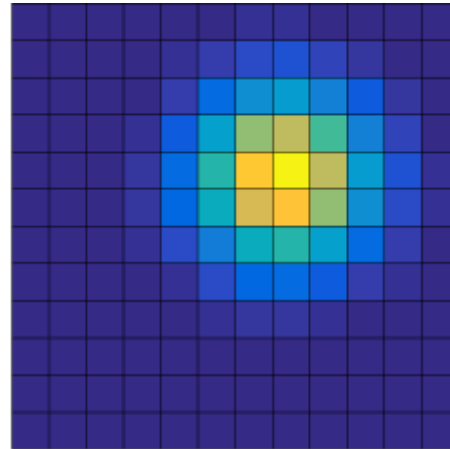
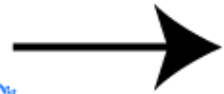
Reference (post):



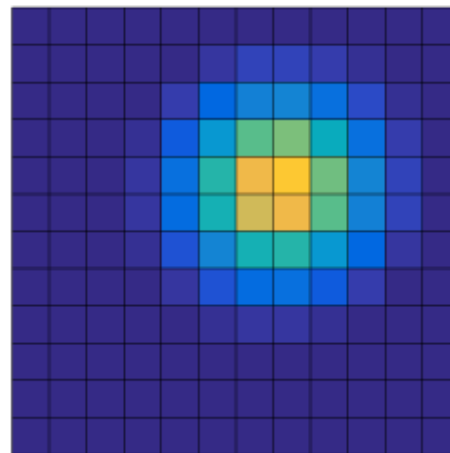
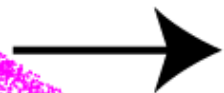
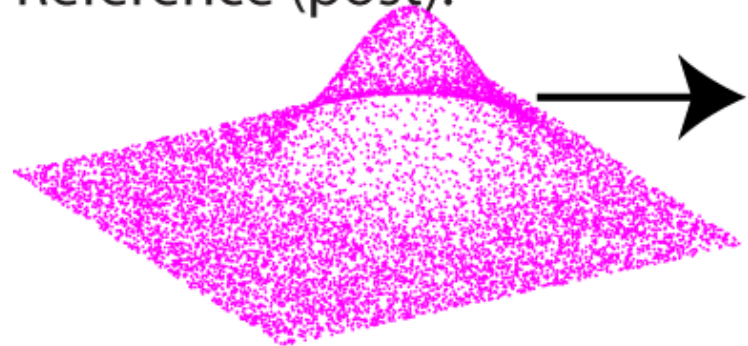
Identical grid for pre and post event topography

VERTICAL TOPOGRAPHIC DIFFERENCING

Compare (pre):



Reference (post):

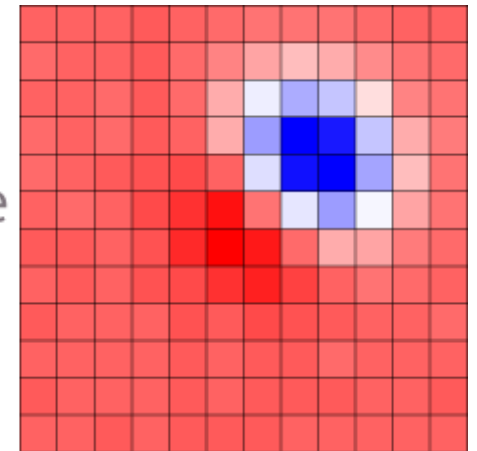


Subtraction:

Difference

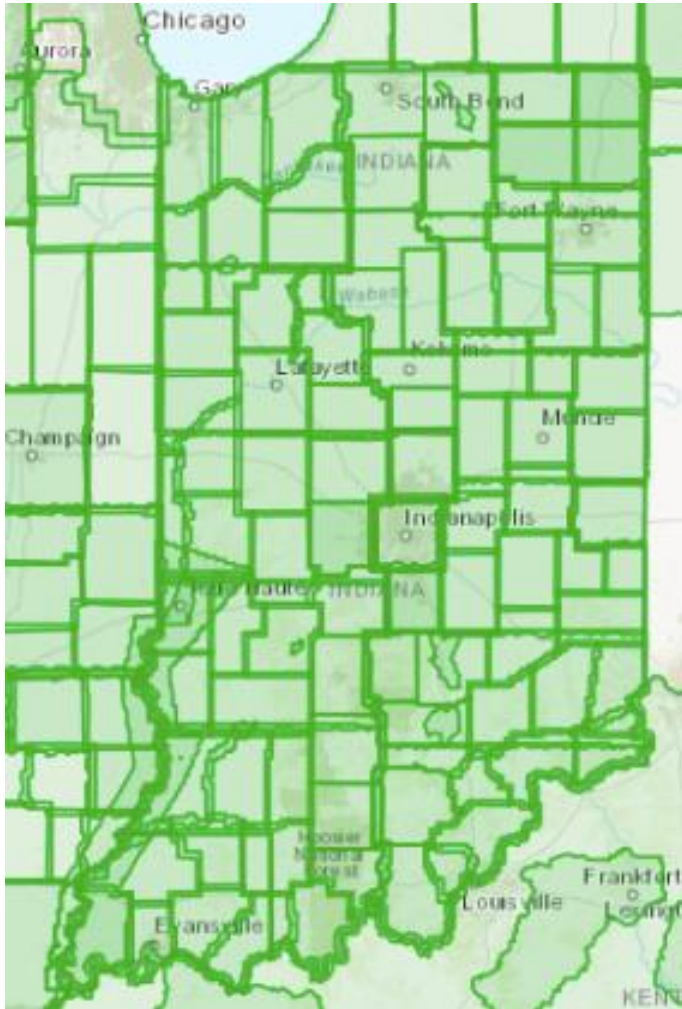
= Reference - Compare

Red Down Blue Up



Raster subtraction

INDIANA STATE-WIDE TOPOGRAPHIC DIFFERENCING



Why Indiana?

- Repeat coverage (2011-13 and 2016-20) = ~decadal change
- Early OT partnership with IGIC

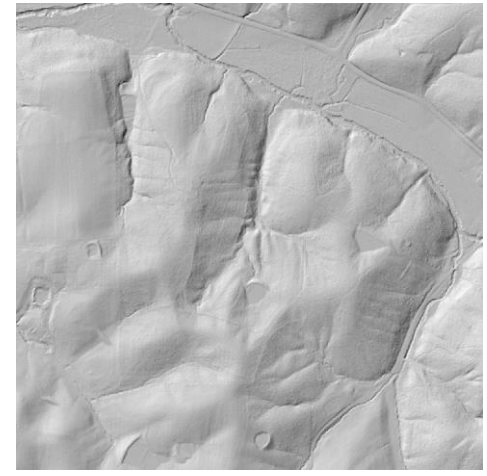
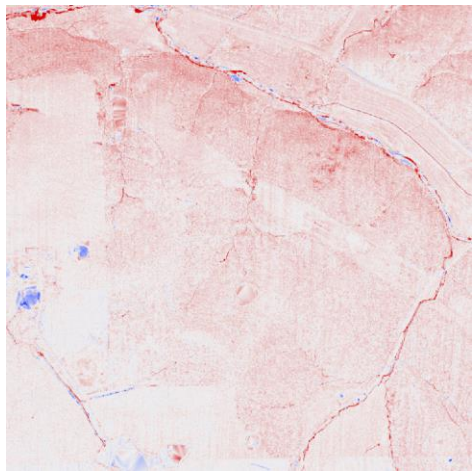
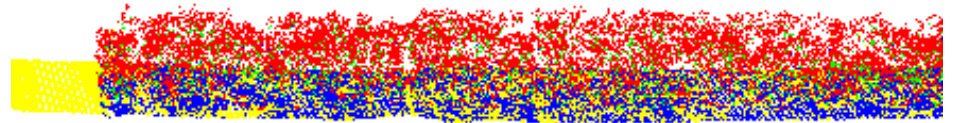
Challenges:

- Indiana is 36,000 miles²: Differencing must be **automatic**
- Manage big data: Final products are **4 TB**; Intermediate products are much bigger
- **1 year of compute time** on average server
- Some empty datasets in AWS; Naming conventions change
- Coordinate system reference system choice

ACCESS DATA

POINT CLOUDS

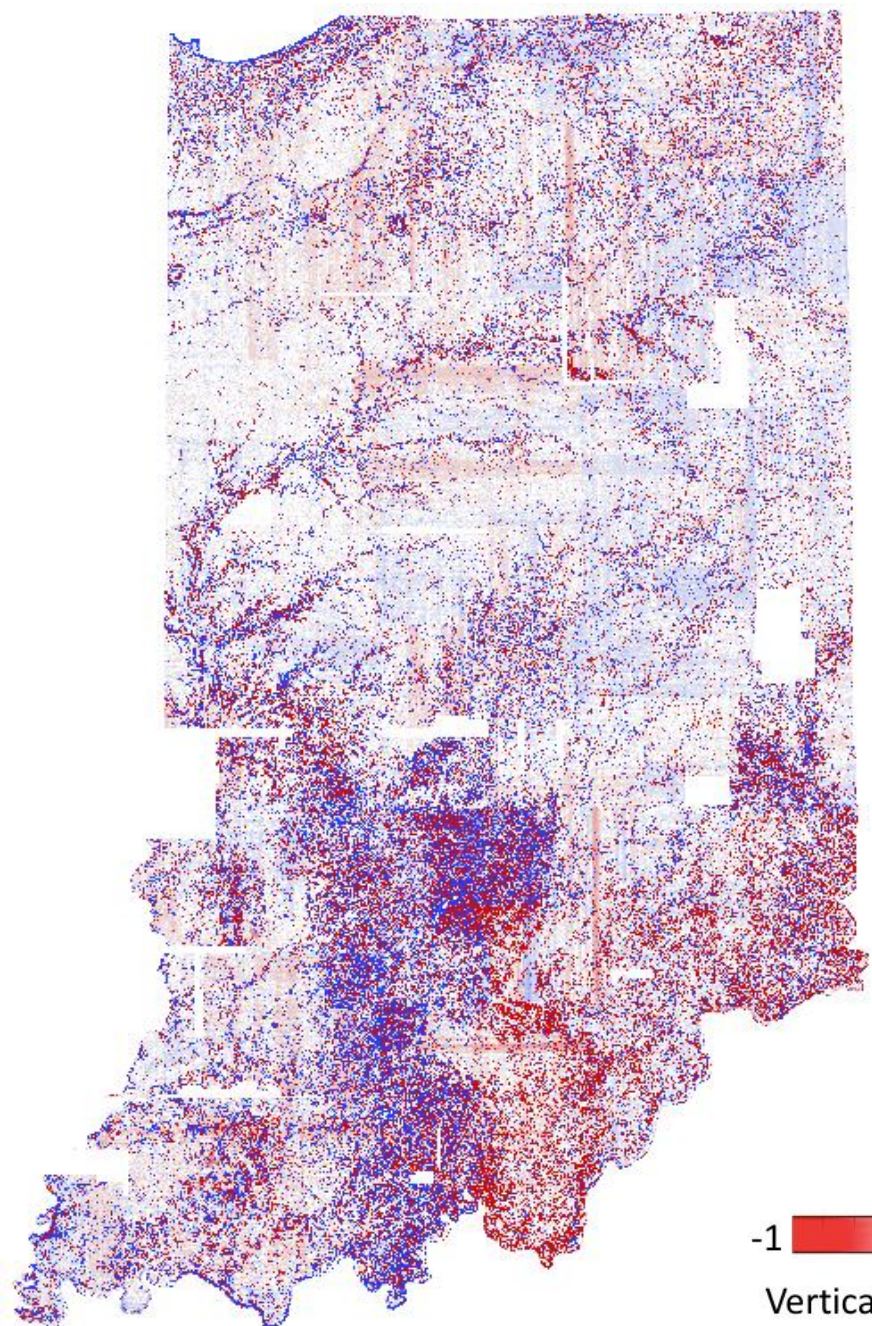
SDSC



TOPOGRAPHIC
DIFFERENCING

GENERATE DEM

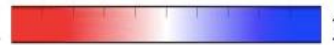
Challenge: 36,000 sq. miles of data to process

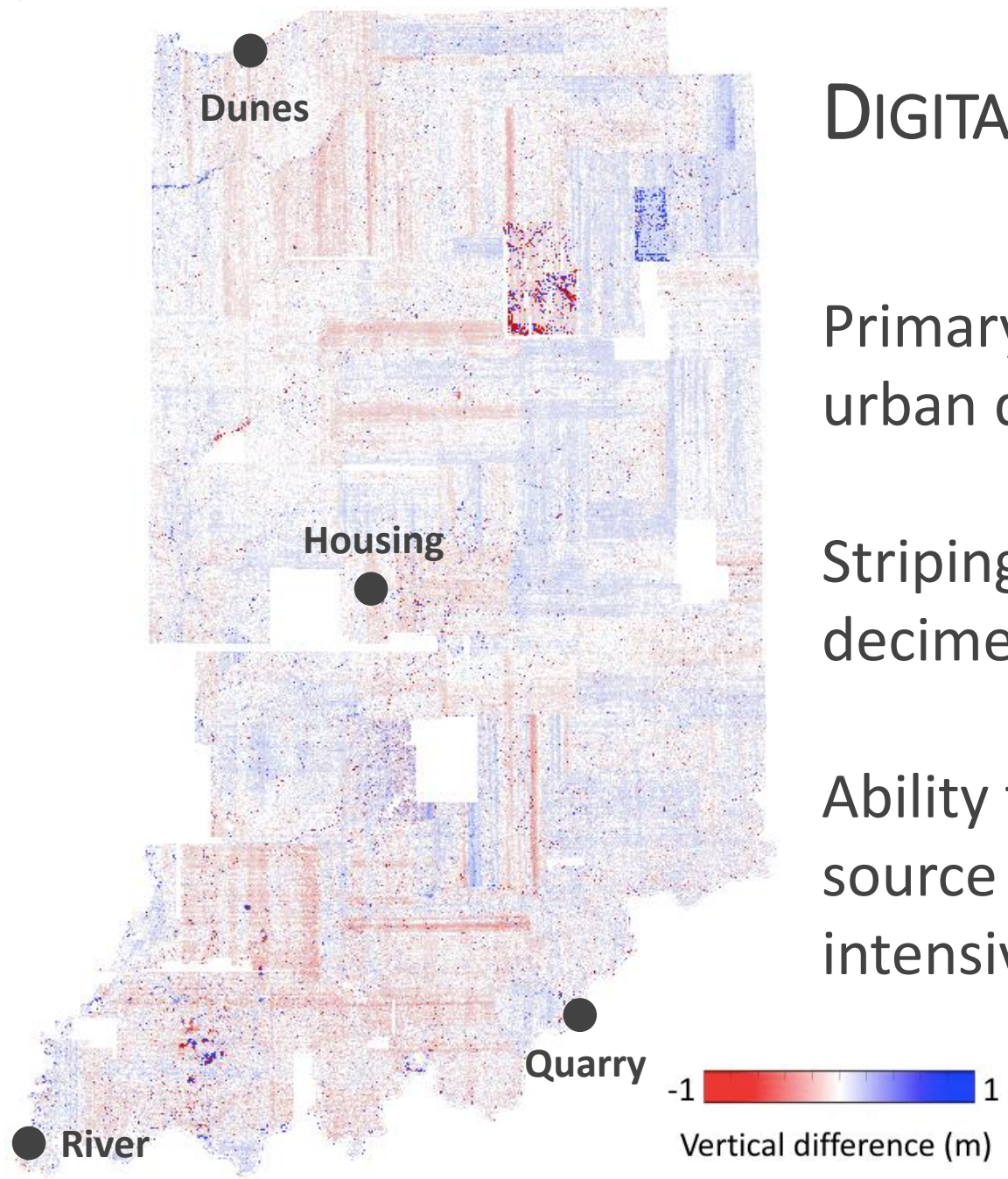


DIGITAL SURFACE MODEL DIFFERENCING

Primary change from agriculture, rivers, quarries, mining, and urban development

Changes in vegetation due to seasonal differences in when the data were acquired

-1  1
Vertical difference (m)



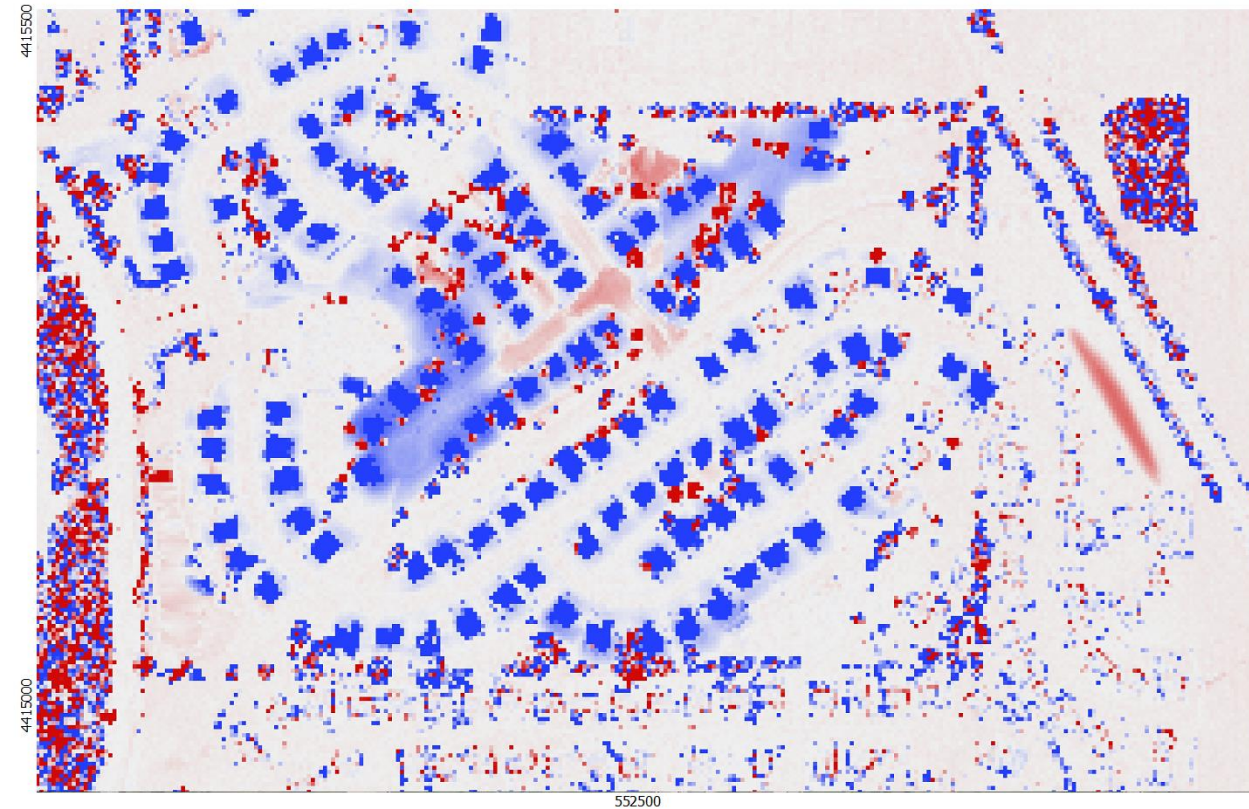
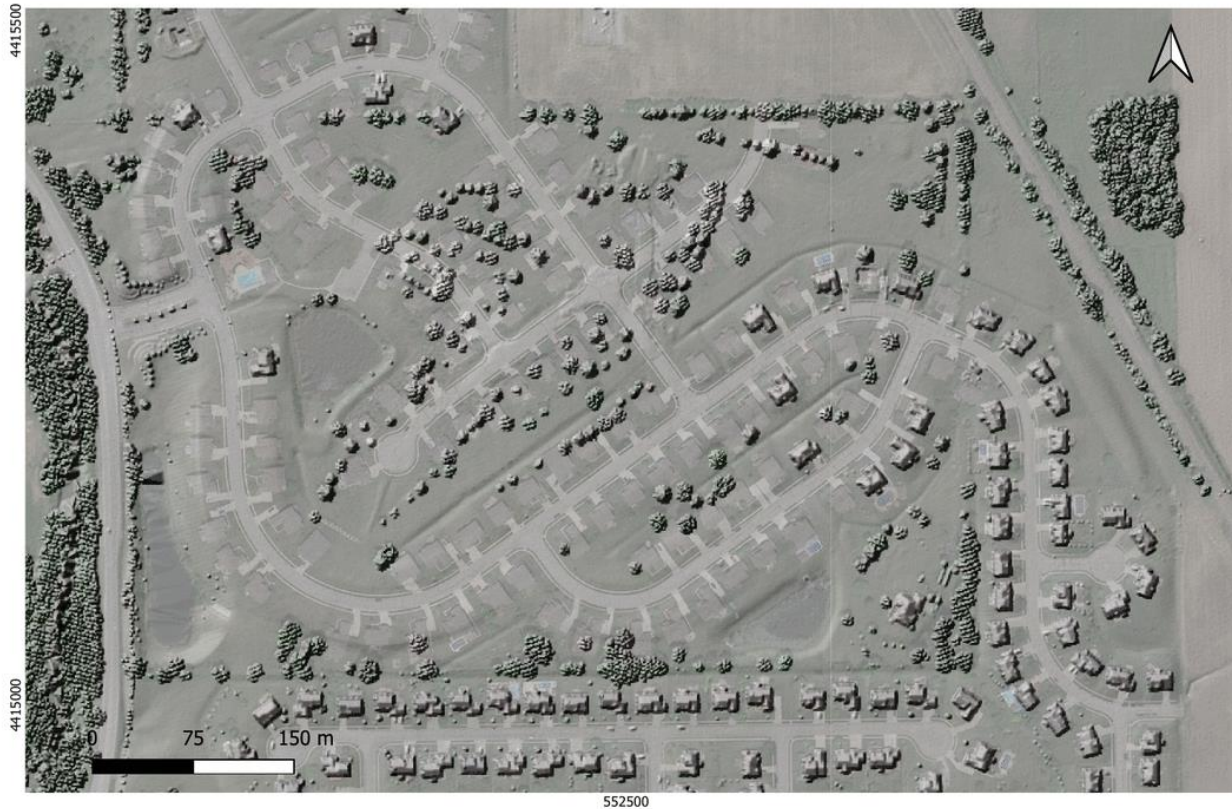
DIGITAL TERRAIN MODEL DIFFERENCING

Primary change from rivers, quarries, mining, and urban development

Striping reflects flight-line offset errors of several decimeters in many locations.

Ability to detect change is only as good as the source data. Swath re-alignment is labor intensive but could greatly reduce errors.

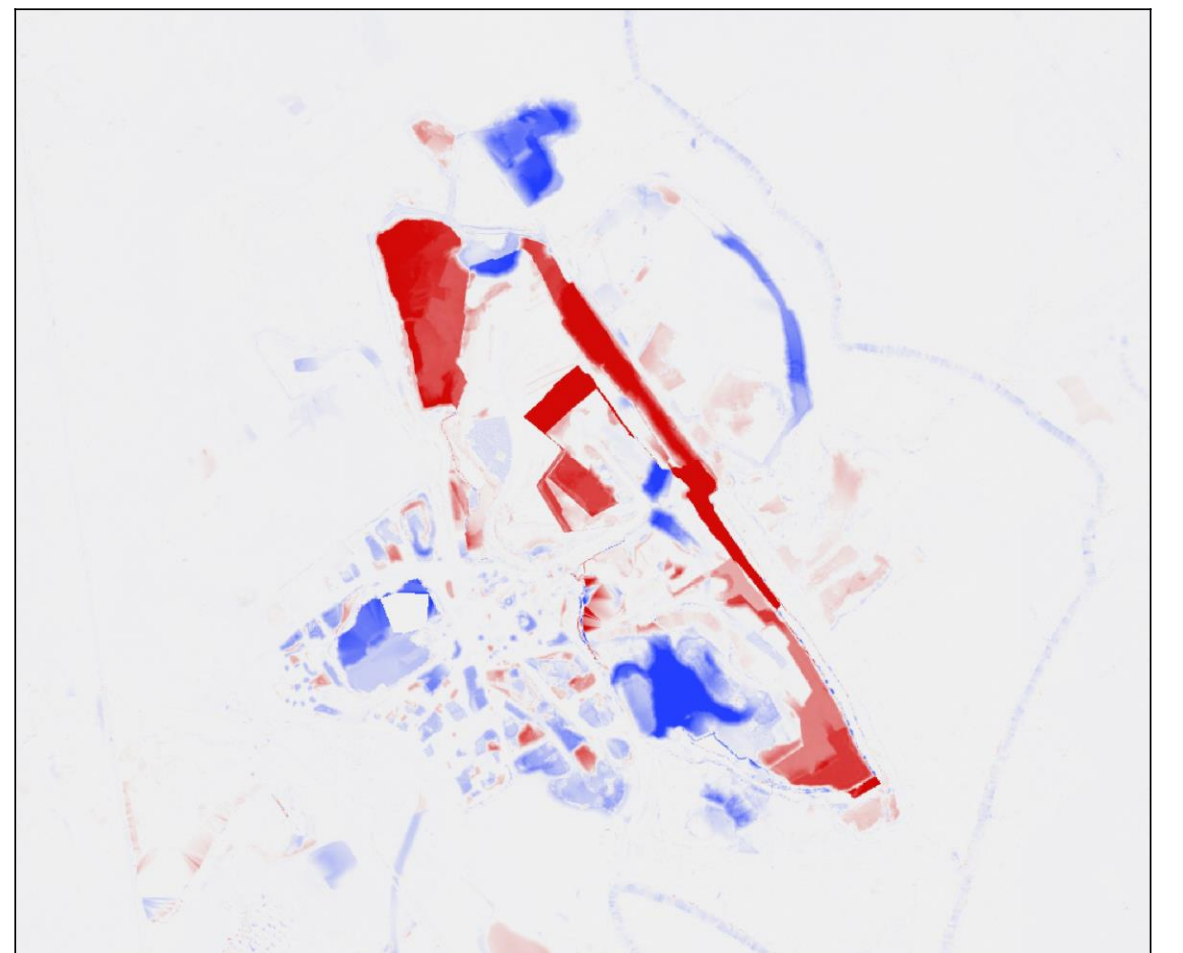
HOUSING CONSTRUCTION NEAR INDIANAPOLIS



Vertical Difference (m)



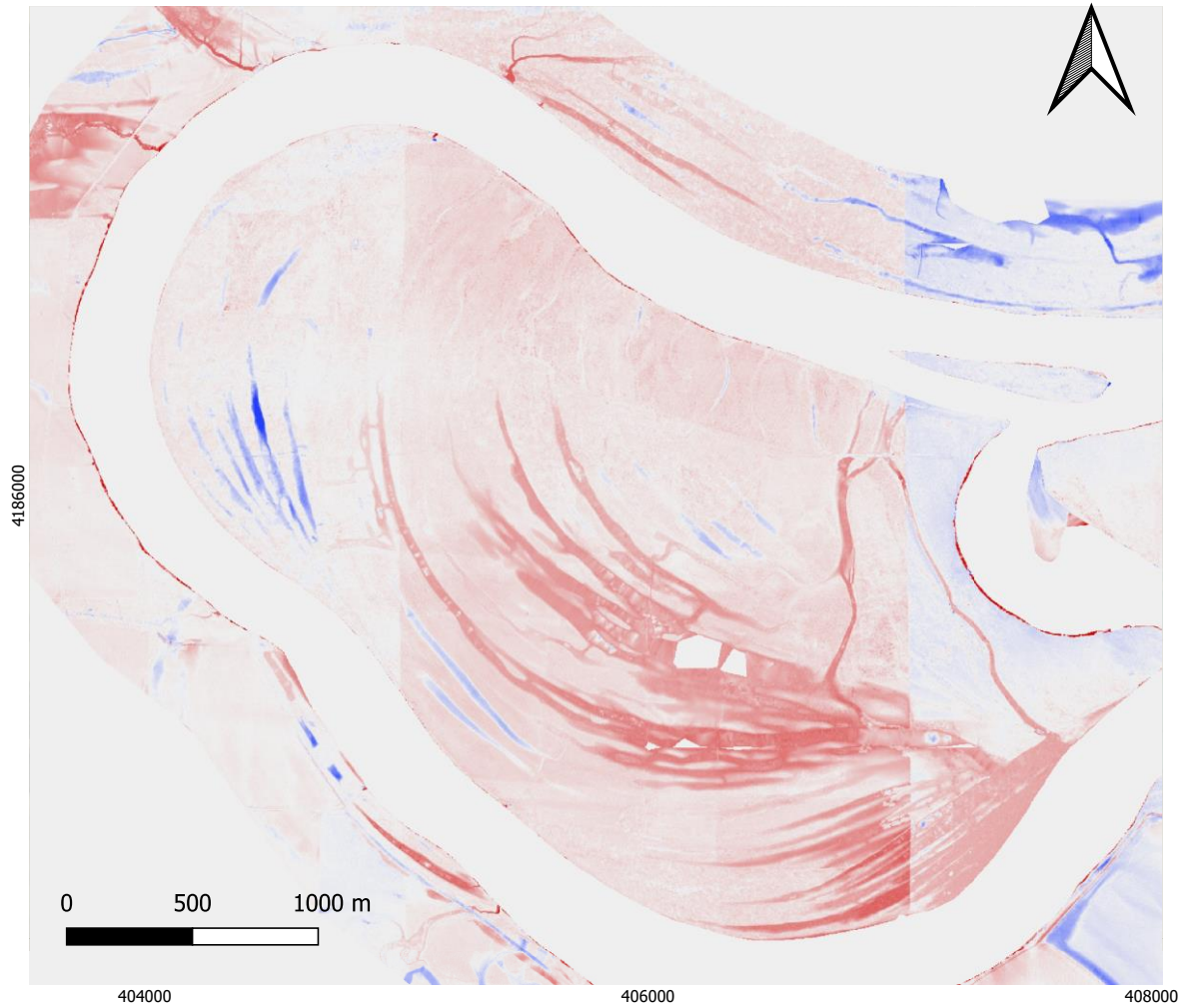
LIMESTONE QUARRY NEAR LOUISVILLE



Vertical Difference (m)



WABASH RIVER



Vertical Difference (m)



INDIANA DUNES NATIONAL PARK ALONG LAKE MICHIGAN



Menu

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The Detroit News House imperiled by erosion slides off Lake Michigan

Associated Press
Published 6:12 p.m. ET Jan. 1, 2020
White River Township beloved Lake Michigan plagued by erosion.



VOICE OF PATRICIA GAN FAMILY OWNS
Muskegon County official says Township home which TV in Grand Rapids.

Home could



A house could fall in Lake Michigan any day. By CNN
Published Jun. 2, 2019 at 5:53 AM EDT
A Wisconsin family is struggling with a...
It's too expensive to fix the problem, but...
The couple moved out about a year ago...
Now about 15 feet of their home hangs...

Muskegon area home collapses into Lake Michigan



As the shoreline erodes, one national park tries to adapt

Sep 4, 2021 2:00 PM EDT



By - Zachary Green

Transcript Audio

On the southern end of Lake Michigan, Indiana Dunes National Park has seen the water levels rise five feet since 2014, hastened by human-made structures and an increase in storms brought on by climate change. Higher water marks mean more erosion to the sand dunes that have run through the area for thousands of years. Zachary Green reports on how the park is adapting to the new normal. The story is part of our ongoing series on climate change, Peril & Promise.

Leave your feedback

Share

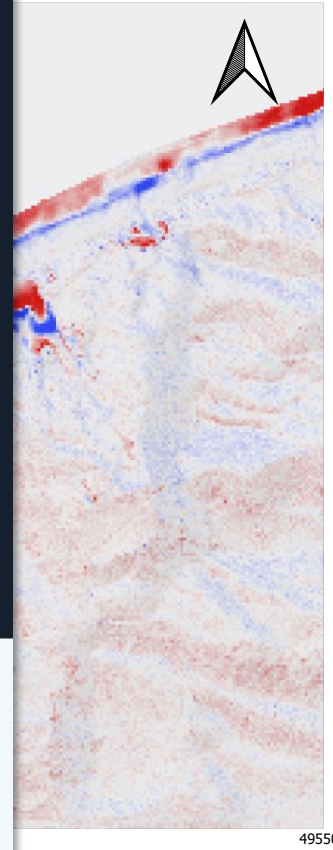
More From This Episode



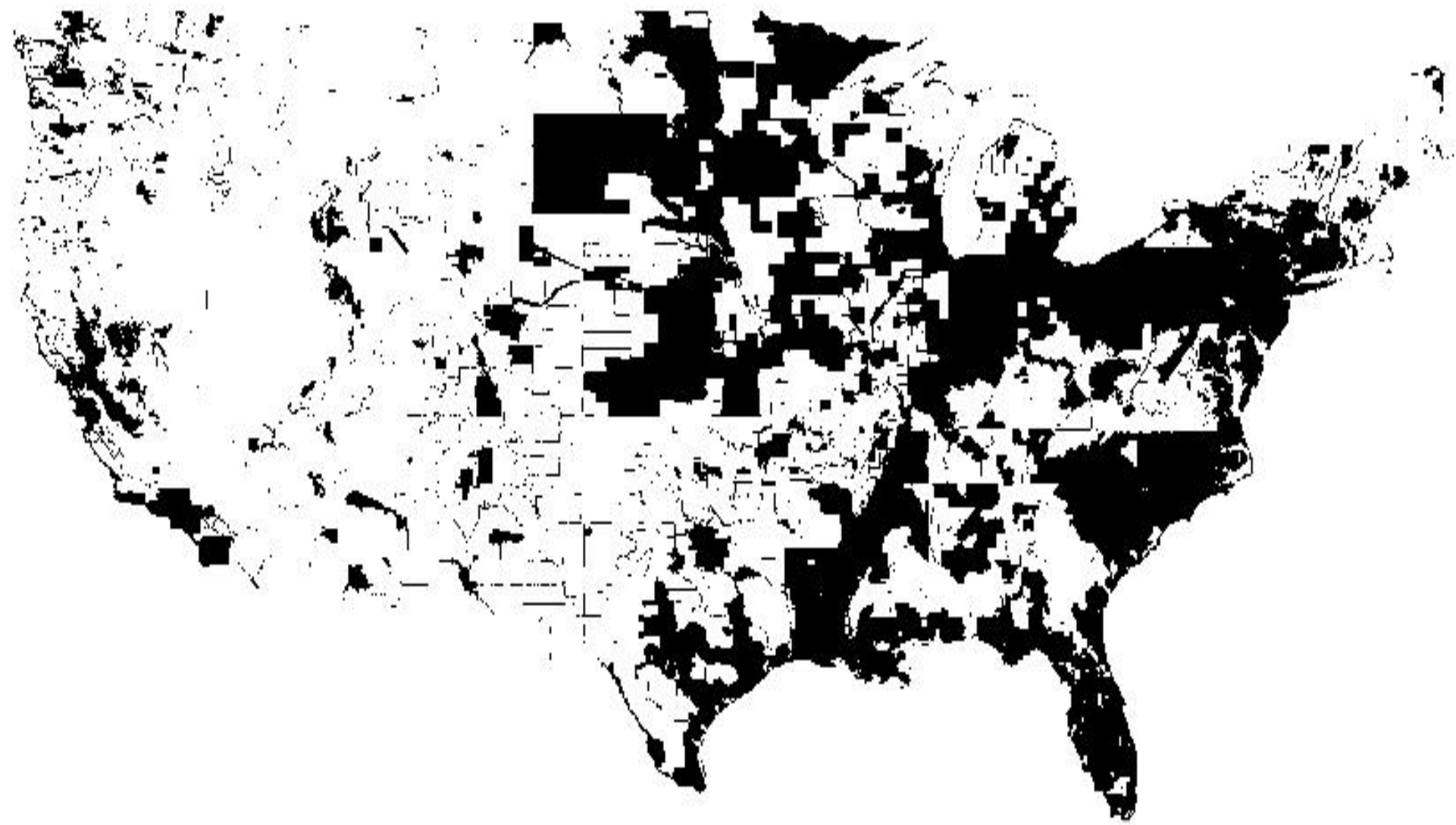
Line 3 pipeline: Progressive Dems implore Biden to shut it down

Support Provided By: Learn more

More Ways to Watch



WHERE ELSE IS THERE REPEAT LIDAR?



Black:
Areas of
overlapping
datasets within
3DEP and/or
USIEI.

Differencing
possible over at
least one-third
of lower 48.

TAKE HOMES:

Demonstration of topographic differencing at scale

- Automated workflow that leverage remote data resources
- Approach will become increasingly feasible as multi-temporal high resolution topography becomes available

Seeking partnerships to facilitate access to state and regional/local/national scale lidar data via OT.

Differencing is an example of opportunities to leverage OT to enhance impact of these data, and improve ROI.

Goal: build a consortium around OT as a shared platform for data management and distribution.



Thank you!

*Questions? Want to talk about making data
available in OT?*

info@opentopography.org



@OpenTopography

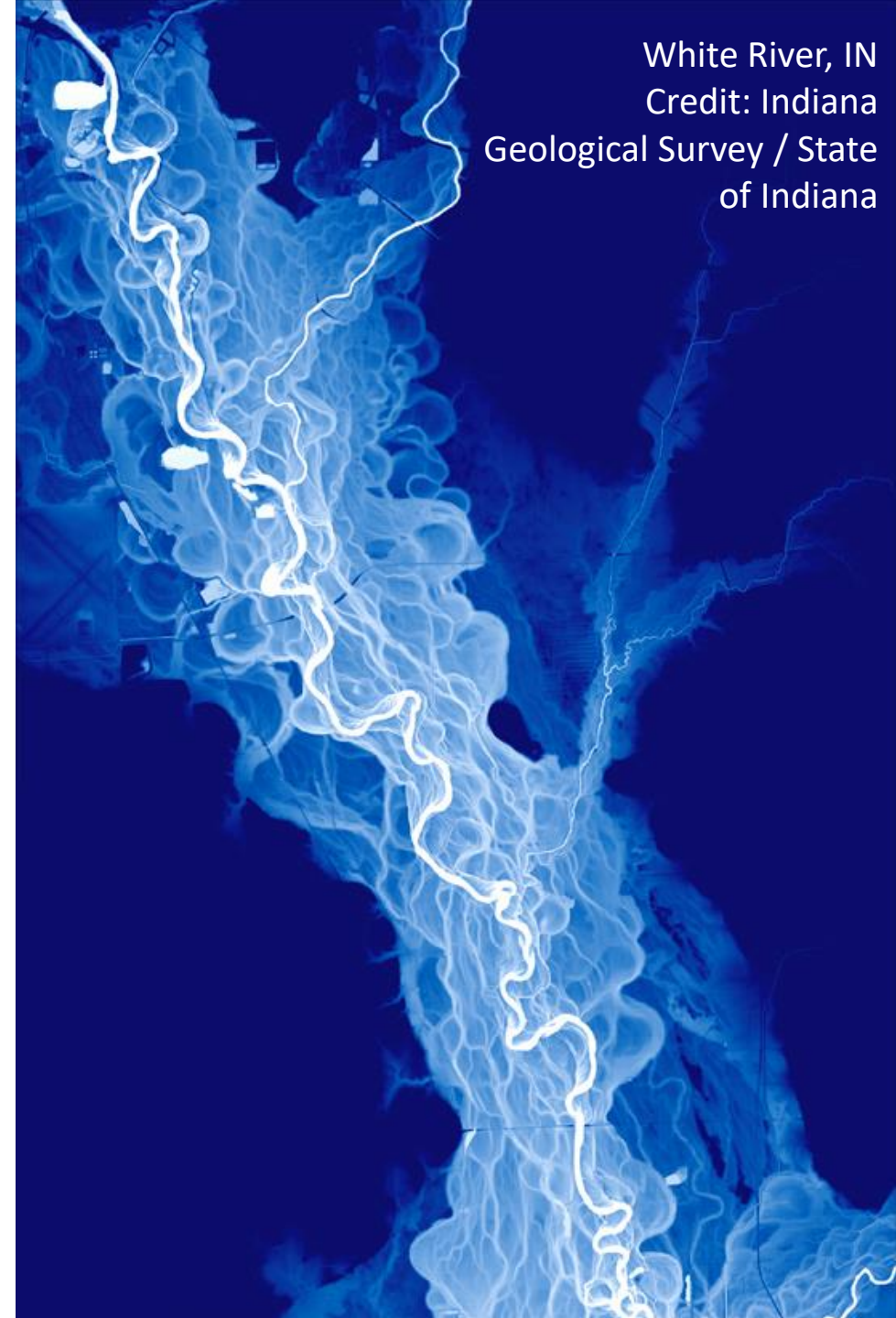


Facebook.com/OpenTopography



@OpenTopography

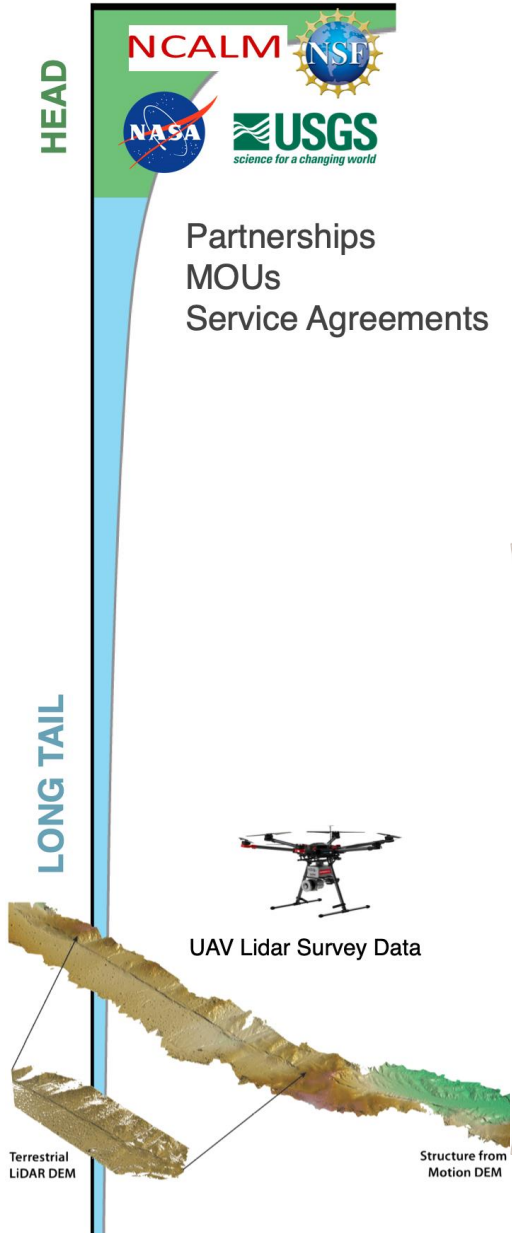
*OpenTopography is supported by the National Science
Foundation under Award Numbers 1948997, 1948994 &
1948857*



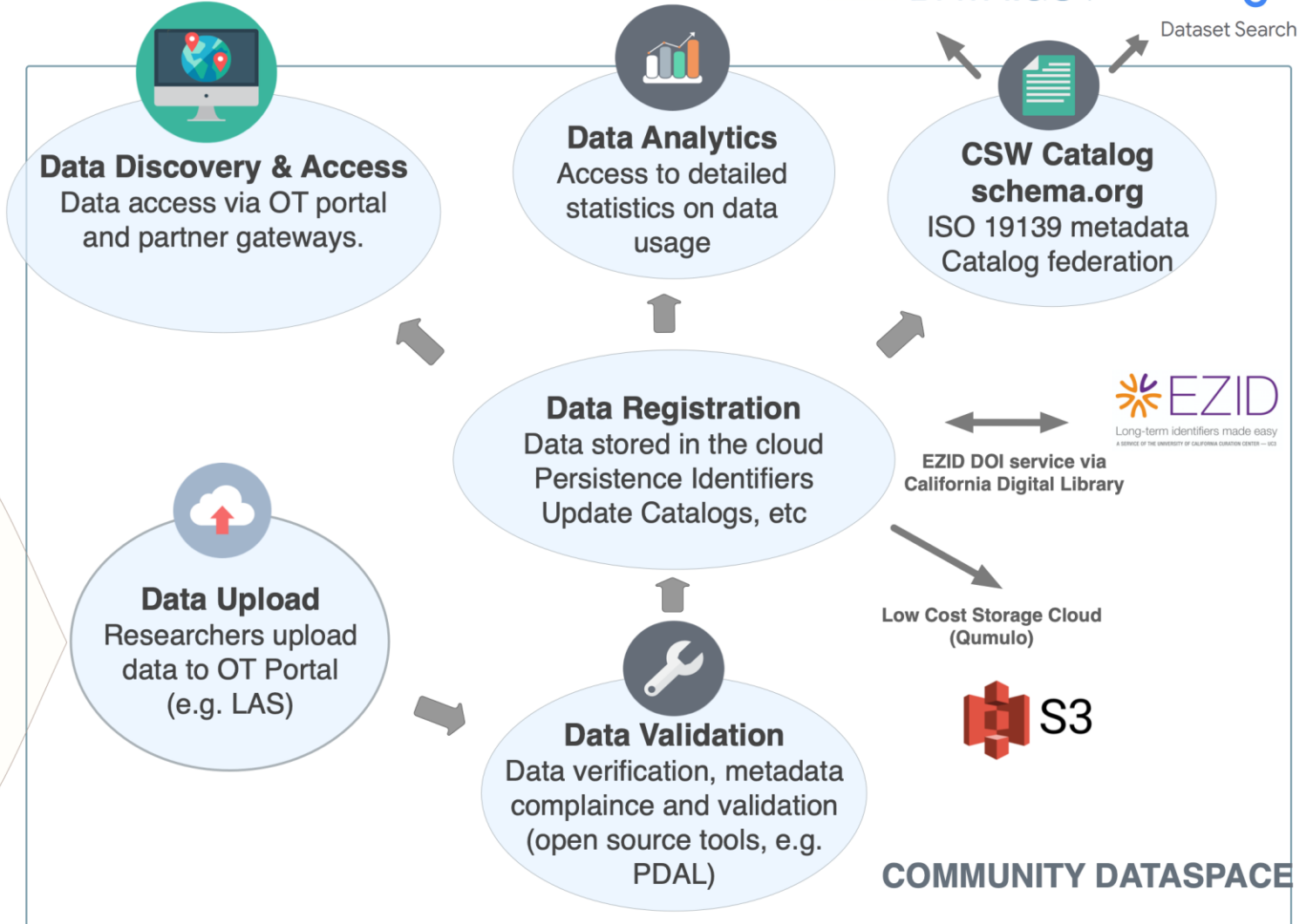
White River, IN
Credit: Indiana
Geological Survey / State
of Indiana



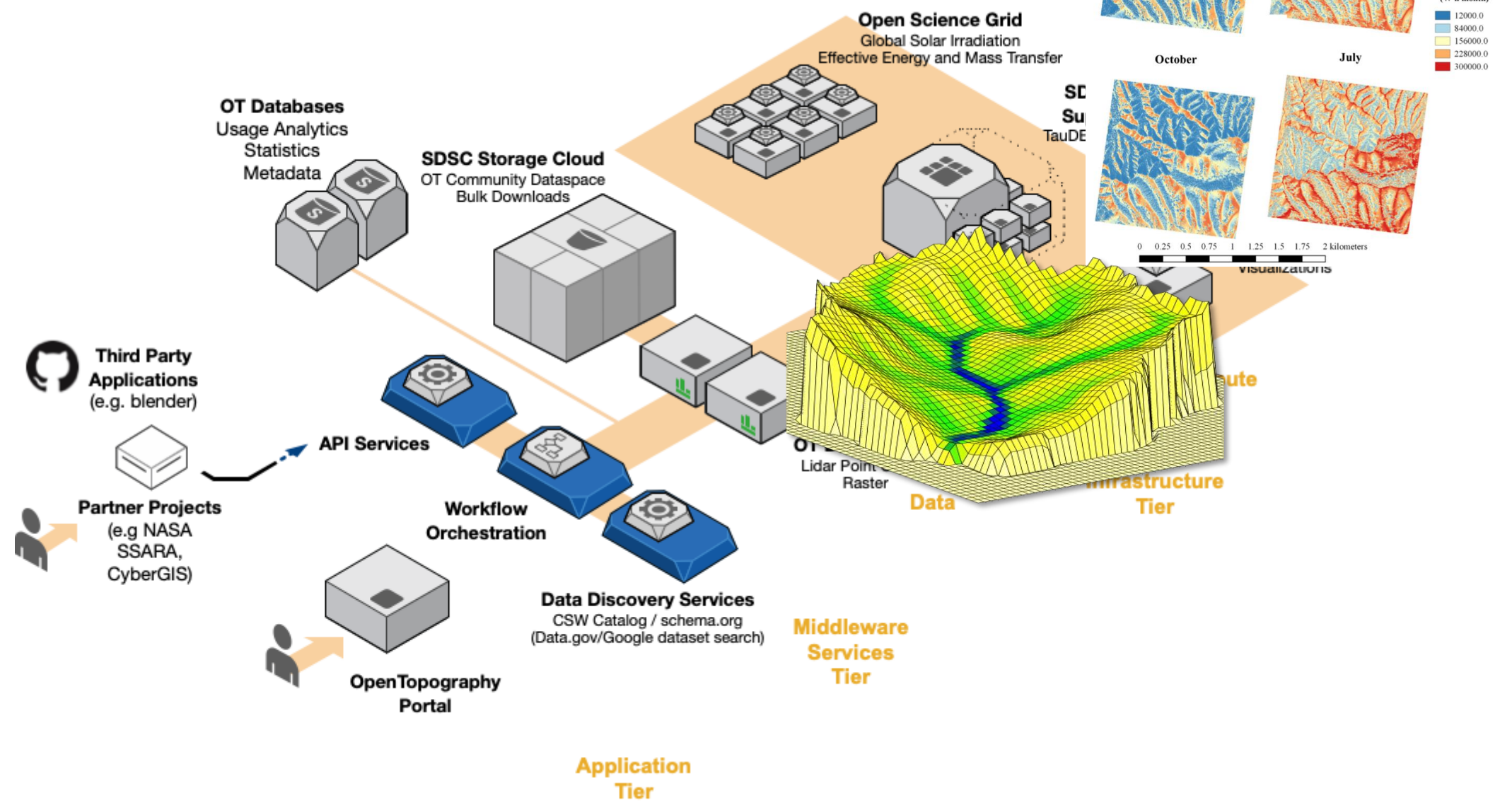
COMMUNITY DATASPACE




opentopography.org/data



ARCHITECTURE



API / BULK ACCESS



OpenTopography

</apidocs/openapi.json>

Public

GET `/globaldem` Access global DEM (Global Bathymetry and COP90 and COP30)

Parameters

Name	Description
demtype * required	Available global DEM types
string (query)	<ul style="list-style-type: none"> SRTMGL3 (SRTM 30m Global) SRTMGL1 (SRTM 1 Arc-Second Global) SRTMGL1_E (SRTM 1 Arc-Second Global - Elevation Only) AW3D30 (AW3D30 Global 30m) AW3D30_E (AW3D30 Global 30m - Elevation Only) SRTM15Plus (SRTM 15 Arc-Second Global) NASADEM (NASADEM Global 30m) COP30 (Copernicus DEM 30m) COP90 (Copernicus DEM 90m)
* require API key	
south * required	WGS 84 bounding box south coordinate
number (query)	36.738884
north * required	WGS 84 bounding box north coordinate
number (query)	

OpenTopography / Clearwater NF, ID: Effects of Watershed Restoration on Hillslope Stability

Clearwater NF, ID: Effects of Watershed Restoration on Hillslope Stability (OT.012012.26911.1)

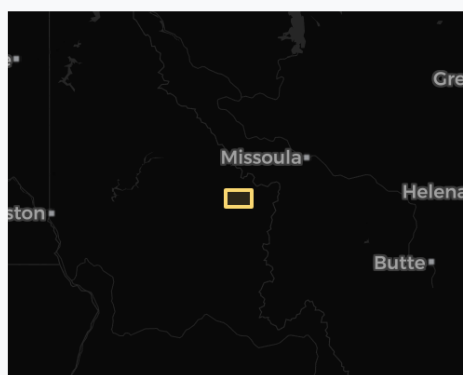
https://portal.opentopography.org/stac/ID09_Lloyd_catalog.json

NCALM Seed Project PI: Rebecca Lloyd, University of Arizona. The survey area is two experimental watersheds, Shotgun Creek and Twin Creek located in the Clearwater National Forest of Northern Idaho. These areas are roughly 70 km southwest of Missoula, MT. The survey polygon for Shotgun Creek is approximately 15.8 square kilometers and for Twin Creek is 26.34 square kilometers. The data were collected to study the effects of watershed restoration on hillslope stability and ecohydrological functions.

Collections Catalogs Items Links

Title

- https://portal.opentopography.org/stac/ID09_Lloyd/pc_catalog.json
- https://portal.opentopography.org/stac/ID09_Lloyd/raster_catalog.json



METADATA

STAC Version	1.0.0-beta.2
Keywords	lidar
License	Not-Provided
Temporal Extent	8/30/2009, 5:00:00 PM - 8/30/2009, 5:00:00 PM

PROVIDERS

- OpenTopography (host)

Cloud

DATA DISCOVERY AND FEDERATION

OGC CSW catalog



DATA TOPICS ▾ RESOURCES STRATEGY DEVELOPERS CONTACT

DATA CATALOG

Home / Datasets Organizations ?

Home / OpenTopography

Submit Data Story

Report Data Issue



University

This is a Non-Federal dataset covered by different Terms of Use than Data.gov.

Laytonville, CA lidar 2015

Metadata Updated: November 12, 2020

This dataset was collected by NCALM for PI Dr. William Dietrich. The requested survey area consisted of a polygon located 12 km south of Laytonville, CA. The polygon encloses approximately 46.5 square km.

Access & Use Information

Non-Federal: This dataset is covered by different Terms of Use than Data.gov.
License: No license information was provided.

Downloads & Resources

 **Download**
Navigate directly to the URL for data access and download.

OpenTopography

OpenTopography facilitates community access to high-resolution, Earth science-oriented, topography data, and related tools and resources. OpenTopography is based at the San... read more

Contact

info@opentopography.org

Share on Social Sites

Schema.org

Google

Laytonville, CA

Last updated

Download format


Usage rights


Topic

Free

Saved datasets

5 datasets found

 Laytonville, CA lidar 2015
portal.opentopography.org
raster
Updated Jul 7, 2017

 CAHTO C NR LAYTONVILLE CA
data.ioos.us
catalog.data.gov
+1more
erddap +2
Updated Apr 14, 2021

 Laytonville, CA lidar 2015
datadiscoverystudio.org
portal.opentopography.org
+1more
Updated Jul 7, 2017

Laytonville, CA lidar 2015
CA15_Dietrich

Explore at Laytonville, CA lidar 2015

4 scholarly articles cite this dataset ([View in Google Scholar](#))

raster

Unique identifier

<https://doi.org/10.5069/G9WH2N2P>

Dataset updated Jul 7, 2017

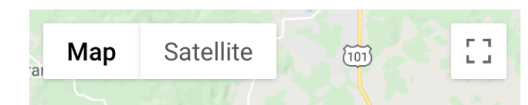
Dataset provided by

OpenTopography

Time period covered

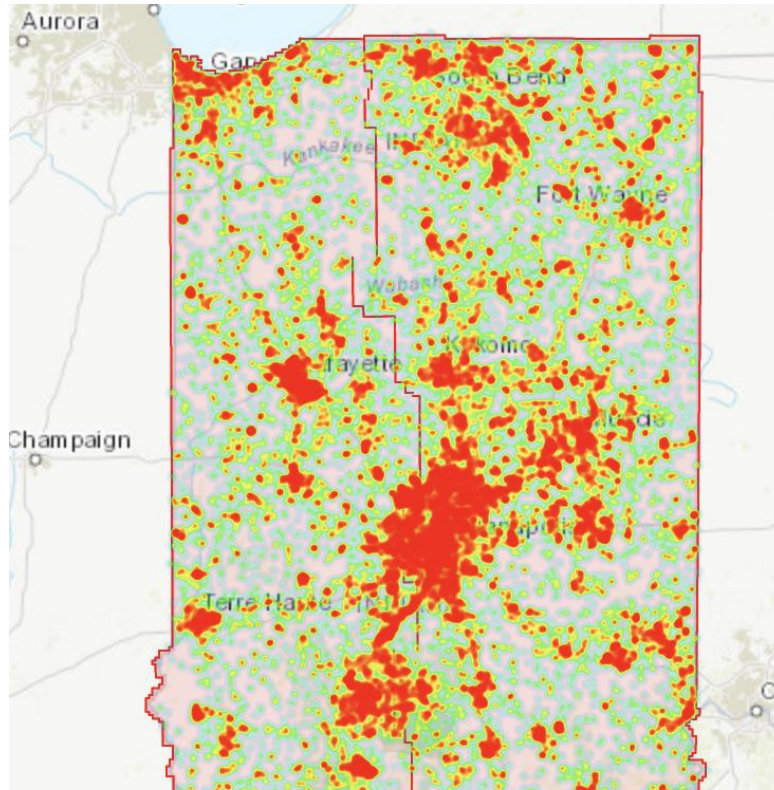
Jun 25, 2015

Area covered



ACCESS PATTERNS

Indiana Usage



3A. DEM Generation (TIN) ⓘ

Gridding Method
 Calculate TIN

Gridding Parameters

Grid Resolution (Default = 1 meter)

1

Max. triangle size (Default 50 units)

50

3B. DEM Generation (Local Gridding) ⓘ

Gridding Method

- Calculate Zmin grid
- Calculate Zmax grid
- Calculate Zmean grid
- Calculate Zidw grid
- Calculate all (single layered image)

Gridding Parameters

Grid Resolution (Default = 1 meter)

1

Radius value (Default = 1.4142 meter)

1.4142

grid

- Calculate standard deviation
- Calculate point count



Pre-computed superset products
Recommendation systems



S3 Standard



S3 Standard-IA



S3 Intelligent-Tiering



S3 One Zone-IA



S3 Glacier



S3 Glacier Deep Archive

Storage based on data value

DATA PROVIDER DASHBOARDS

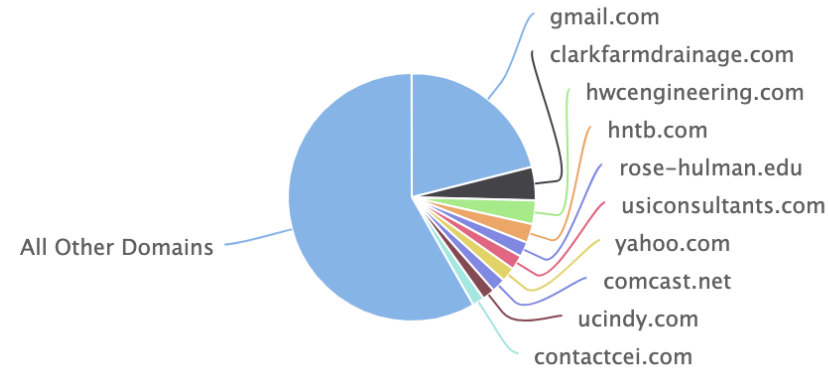
	Dataset	No. of jobs ↓	Total points processed	No. of unique users
1	2011 - 2013 Indiana Statewide Lidar	39,941	448,728,874,172	5,393

C. Point Cloud Jobs Statistics by User Domain Addresses

Expand to Top 100 Domains

	OT User Domain	# of Jobs ↓
1	gmail.com	8,417
2	clarkfarmdrainage.com	1,732
3	hwcengineering.com	1,234
4	hntb.com	989
5	rose-hulman.edu	774
6	usiconsultants.com	755
7	yahoo.com	753
8	comcast.net	733
9	ucindy.com	657
10	contactcei.com	622

Total Jobs Submitted by Top 10 Domain



D. Average RunTime for Opal Services by Datasets

(*) This statistics only cover the OpenTopography hosted datasets

	Dataset ↓	Avg Points per Job	Avg Runtime per Job (second)
1	2011 - 2013 Indiana Statewide Lidar	11,279,129	123

EDUCATION & TRAINING

- Online Resources
- Workforce Development
- In person short courses

