# http://www.opentopography.org/index.php/resources/short_courses/15_NPAC

Applications of High Resolution Topographic data to the Earth Sciences

*nubes de puntos y aplicaciones en ciencia: Official website (en espanol)*


**April 8-10, 2015 CISESE, Ensenada, Baja California Mexico**

**Supported by:** CISESE, CONACyT, LAStools, Cloud Compare, and OpenTopography.

**Organizers and Instructors:**

- Alejandro Hinojosa ,CISESE, Ensenada, Baja California Mexico
- Martin Isenburg, LASTools, Gilching, Germany
- Daniel Girardeau-Montaut, Cloud Compare, Grenoble, France
- Emily Kleber, OpenTopography/ASU, Tempe, Arizona, USA
- Barrett Salisbury, OpenTopography/ASU, Tempe, Arizona, USA
- Kendra Johnson, Colorado School of Mines, Golden, Colorado, USA

***Official website:* *Programa en espanol***
**Wednesday, April 8, 2015**

| Time | Topic | Instructor |
|---|---|---|
| 8:30am | Welcome | |
| 8:45am | **LAStools**<br>• Live Stream and Recorded video from Presentation<br>• Presentation: Introduction to LiDAR and examples from mapping vegetation in the Canary Islands, flood mapping in the Philippines, archeological discoveries in Poland, Thailand and other applications | Martin Isenburg |

NSF OpenTopography

OpenTopography

# Online Access to High-Resolution Lidar Topography Data and Processing Tools


***Presentation given by Emily Kleber***

Arizona State University, Tempe, AZ, USA

**OpenTopography Principle Investigators (PIs):**

**Christopher Crosby**

UNAVCO, Boulder, CO, USA

**Viswanath Nandigam** & **Chaitan Baru**

San Diego Supercomputer Center, UCSD, San Diego, CA, USA

**J Ramon Arrowsmith**

Arizona State University, Tempe, AZ, USA

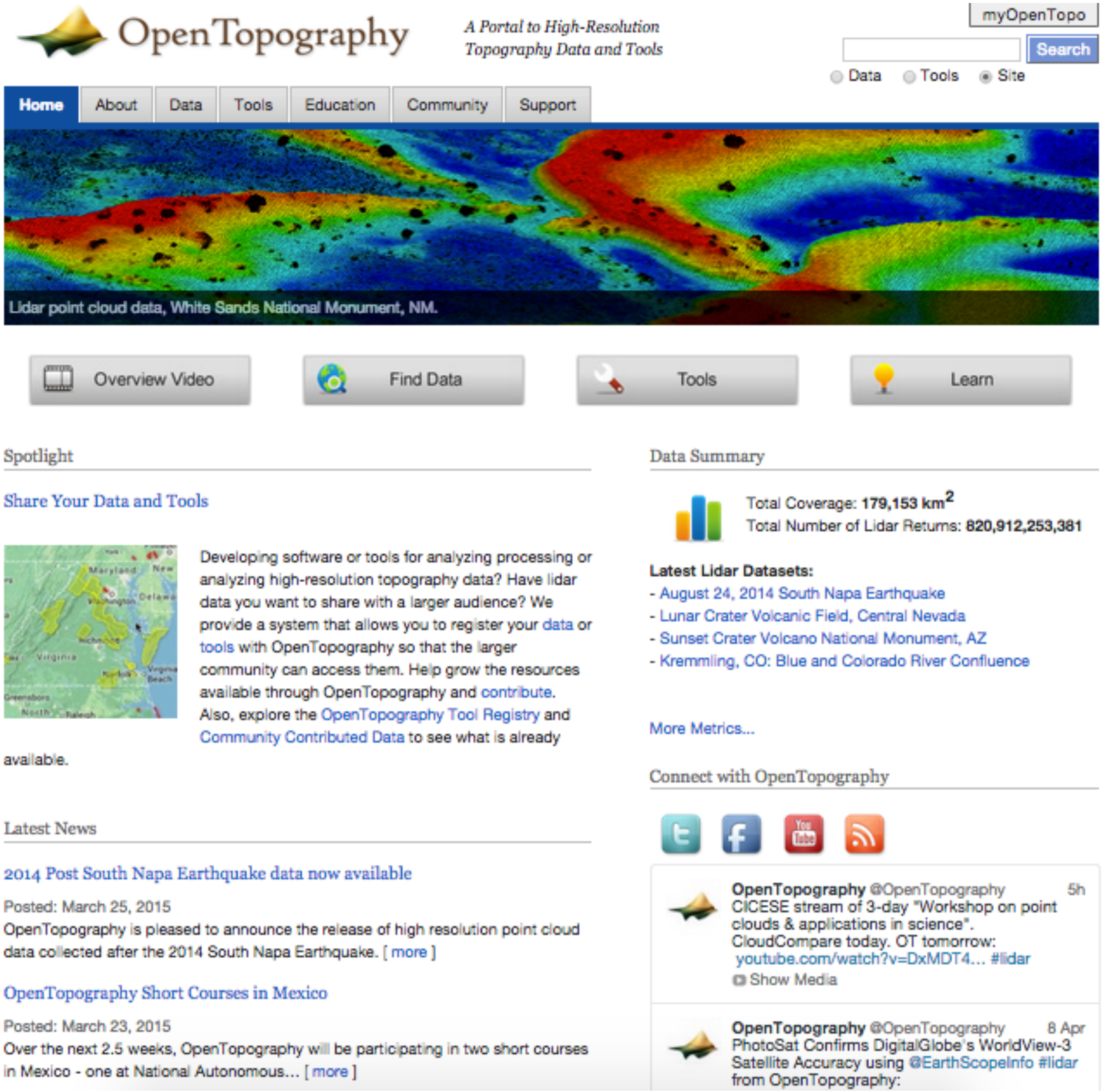

Garlock fault (EarthScope)

# *Outline*

- NSF Structure
  - OpenTopography timeline
- OpenTopography Portal
  - Motivations
  - Workflow
  - System Architecture
  - Users, publications, and outreach
  - Future goals
- Demonstration

Denali 2002 earthquake rupture (EarthScope)

# www.opentopography.org




***How do we deliver these large community data sets to users?***

# Open Access to Community Datasets:

EarthScope LiDAR:
- Collected 2007 - 2008
- 5500+ $km^2$ = 32+ billion pts

Large user community with variable needs and levels of sophistication.

<u>Goal</u>: ***Democratize access to data to achieve greatest scientific impact.***

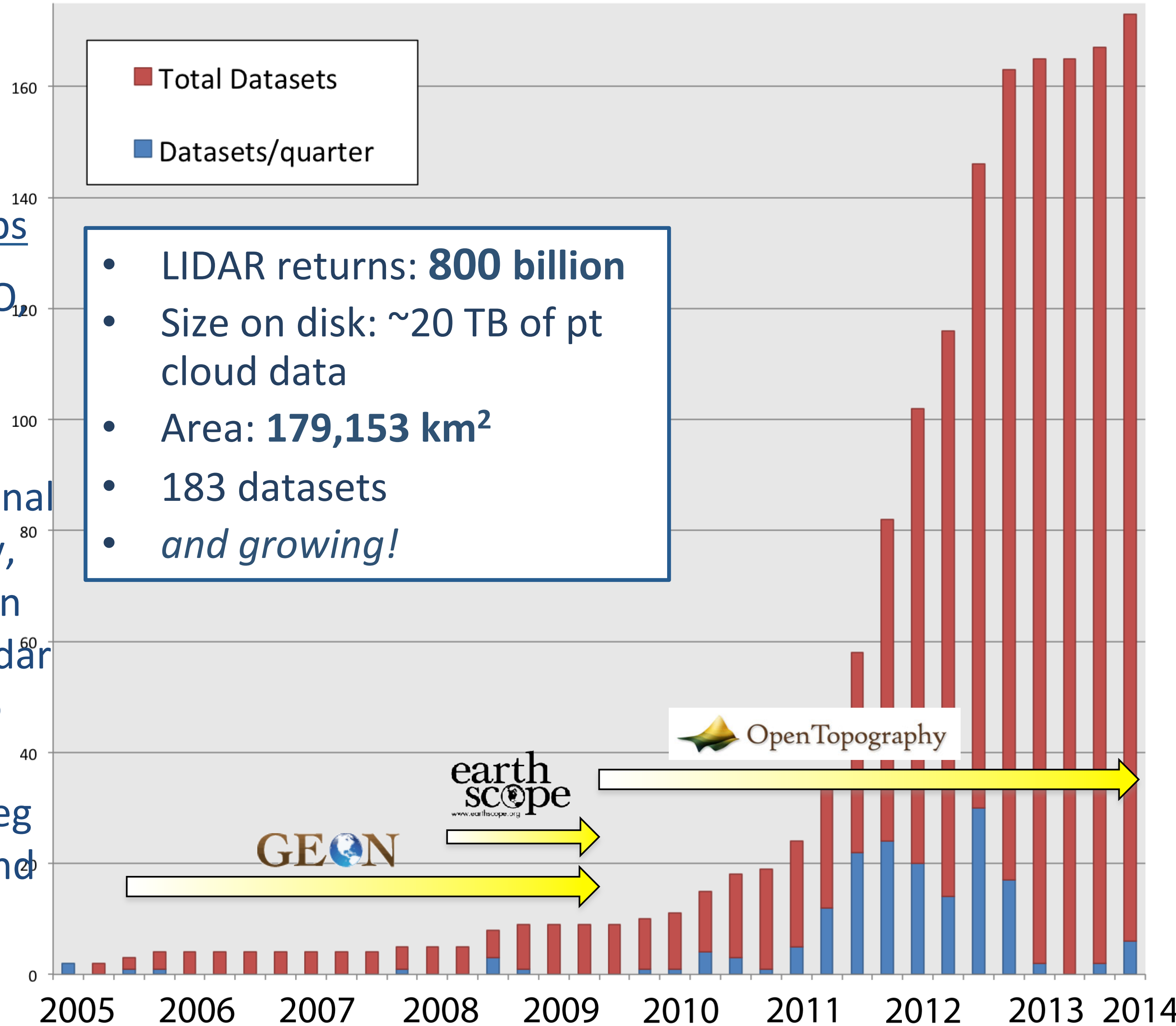
<u>Big data:</u>
- Treat data as an asset that can be used and reused
- Co-locate data with on-demand processing

# Data Status

<u>MOUs & Partnerships</u>

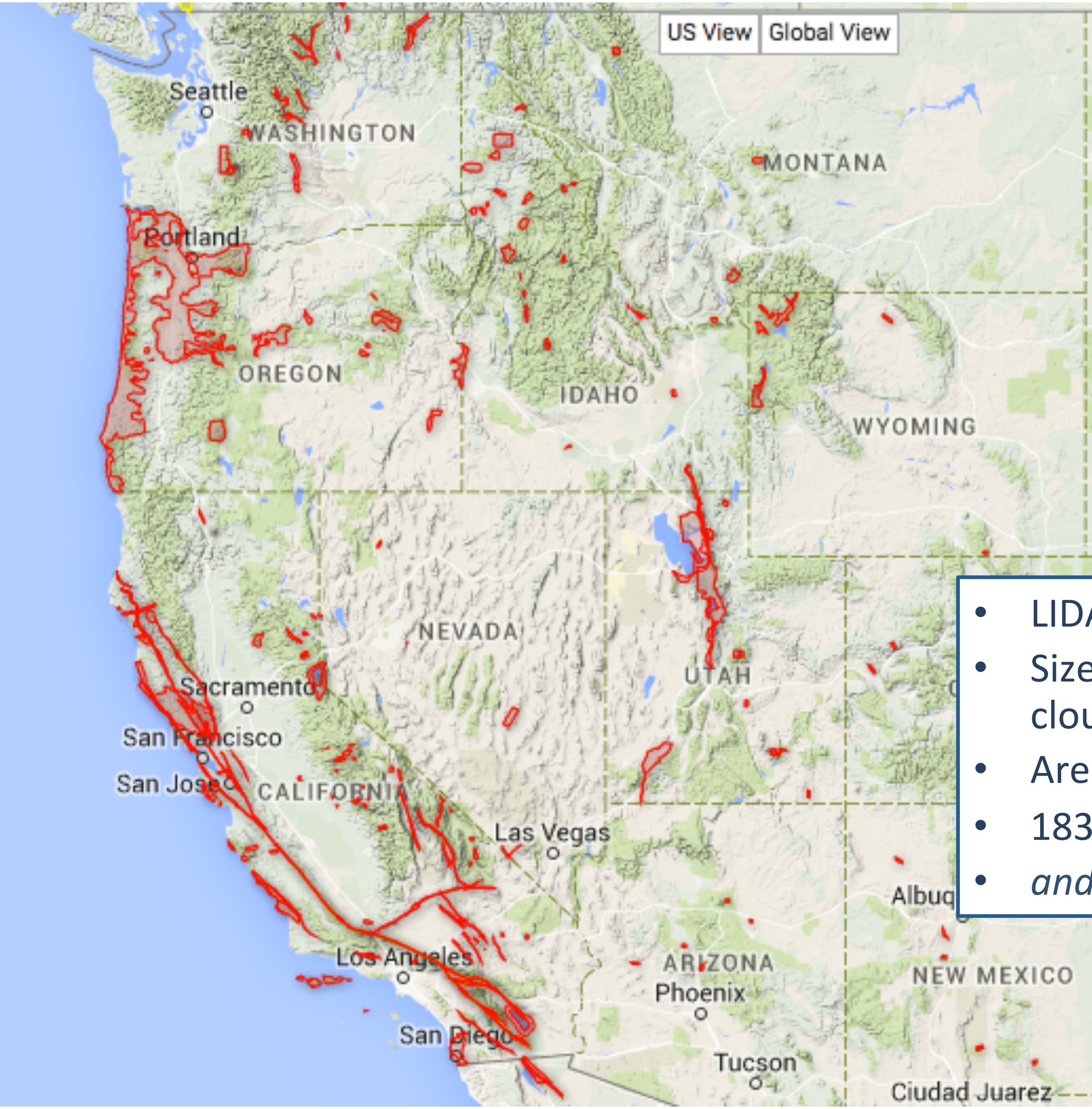
***NSF***: NCALM, UNAVCO, CZOs, LTER

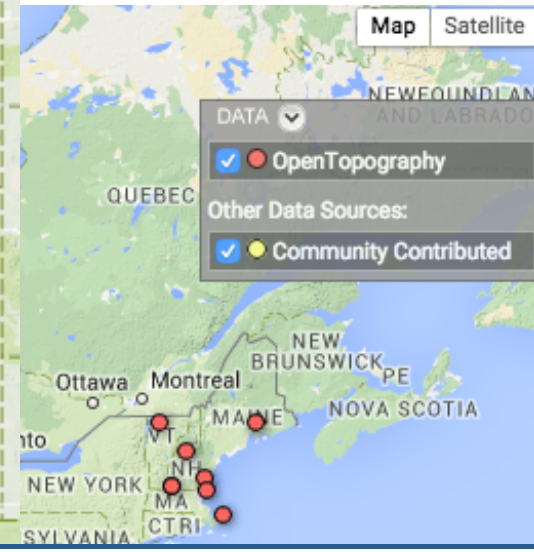
***Other***: USGS, World Bank, Tahoe Regional Planning Authority, Teton Conservation District, Oregon Lidar Consortium, Idaho Lidar Consortium, Sonoma County Veg Map, NASA LVIS and GLAS, …




- LIDAR returns: **800 billion**
- Size on disk: ~20 TB of pt cloud data
- Area: **179,153 km$^2$**
- 183 datasets
- *and growing!*

***Service Agreements***: State of Indiana, PG&E

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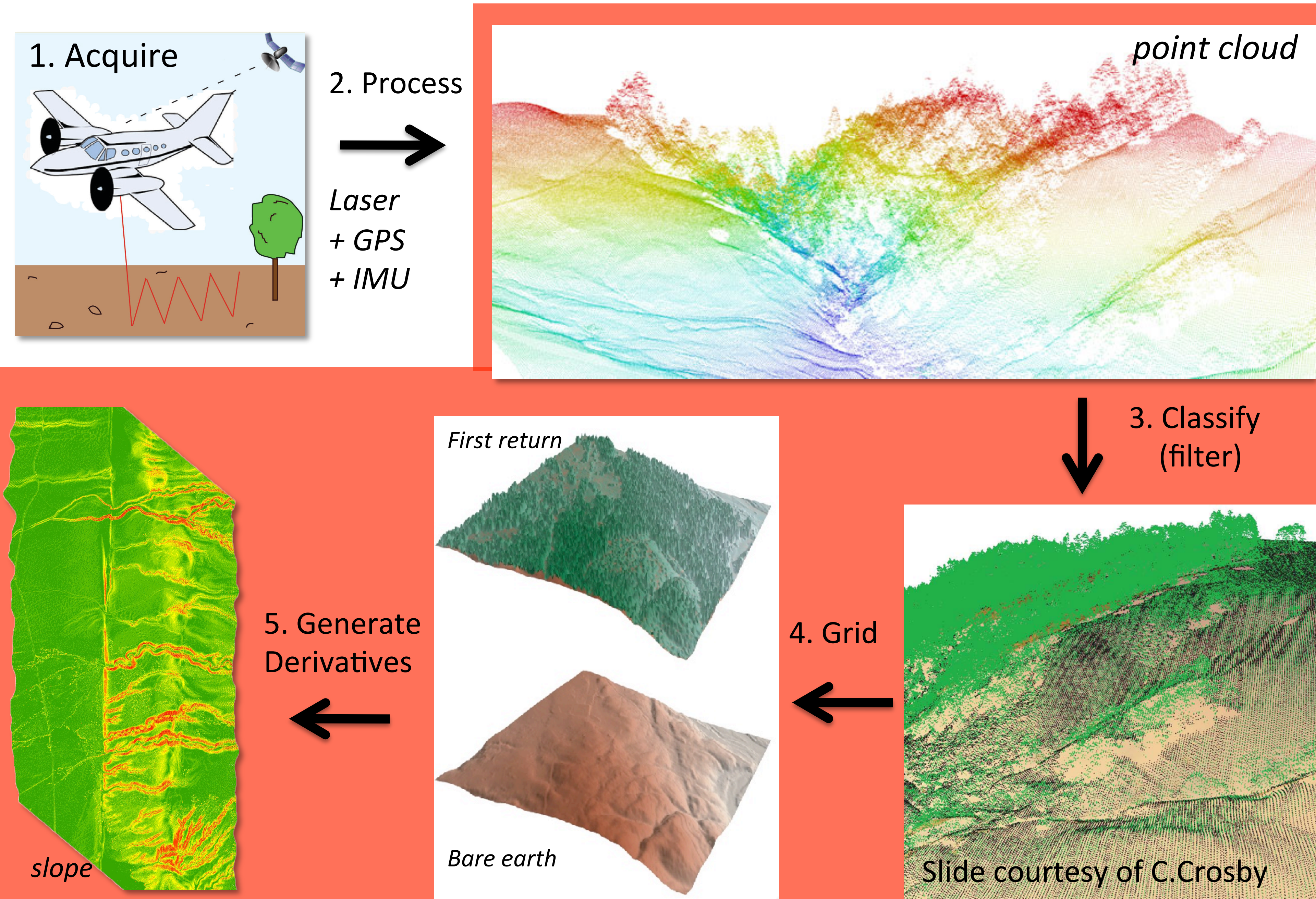
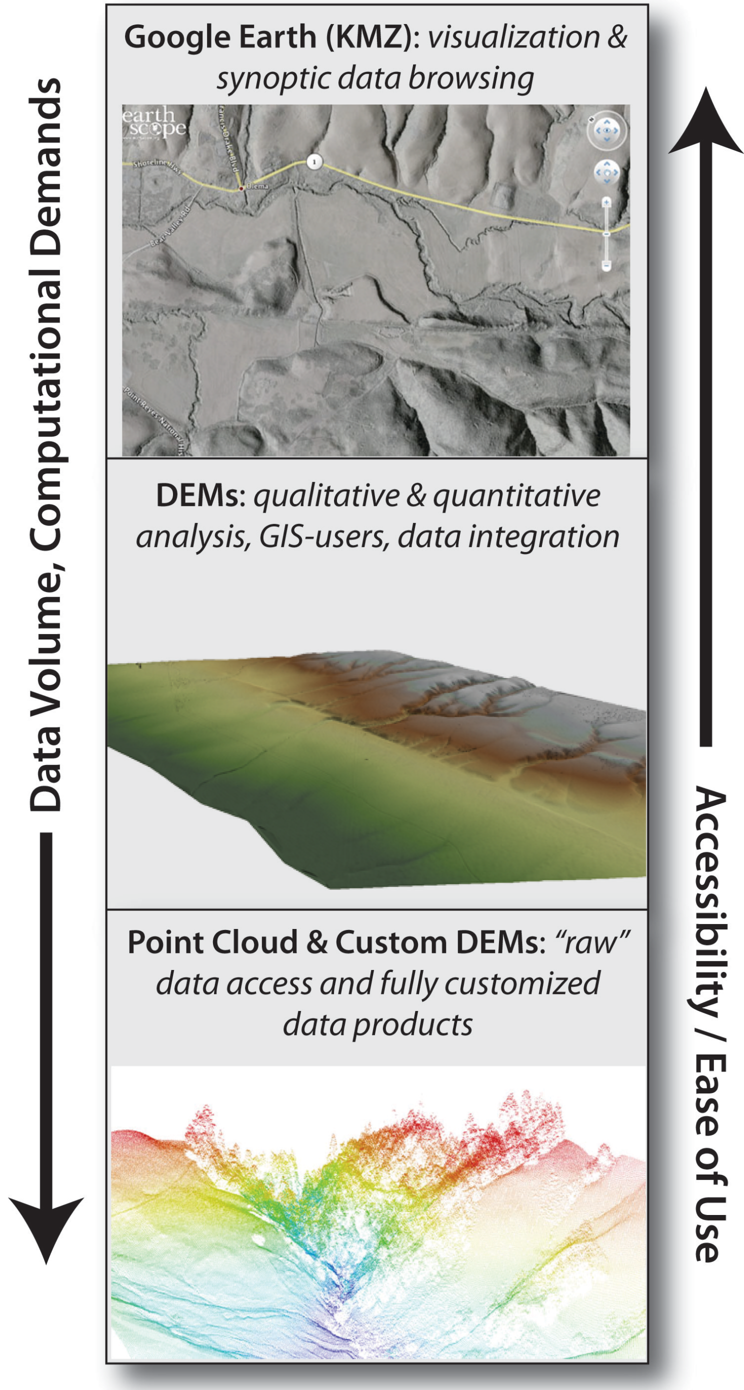
# Airborne Lidar Workflow

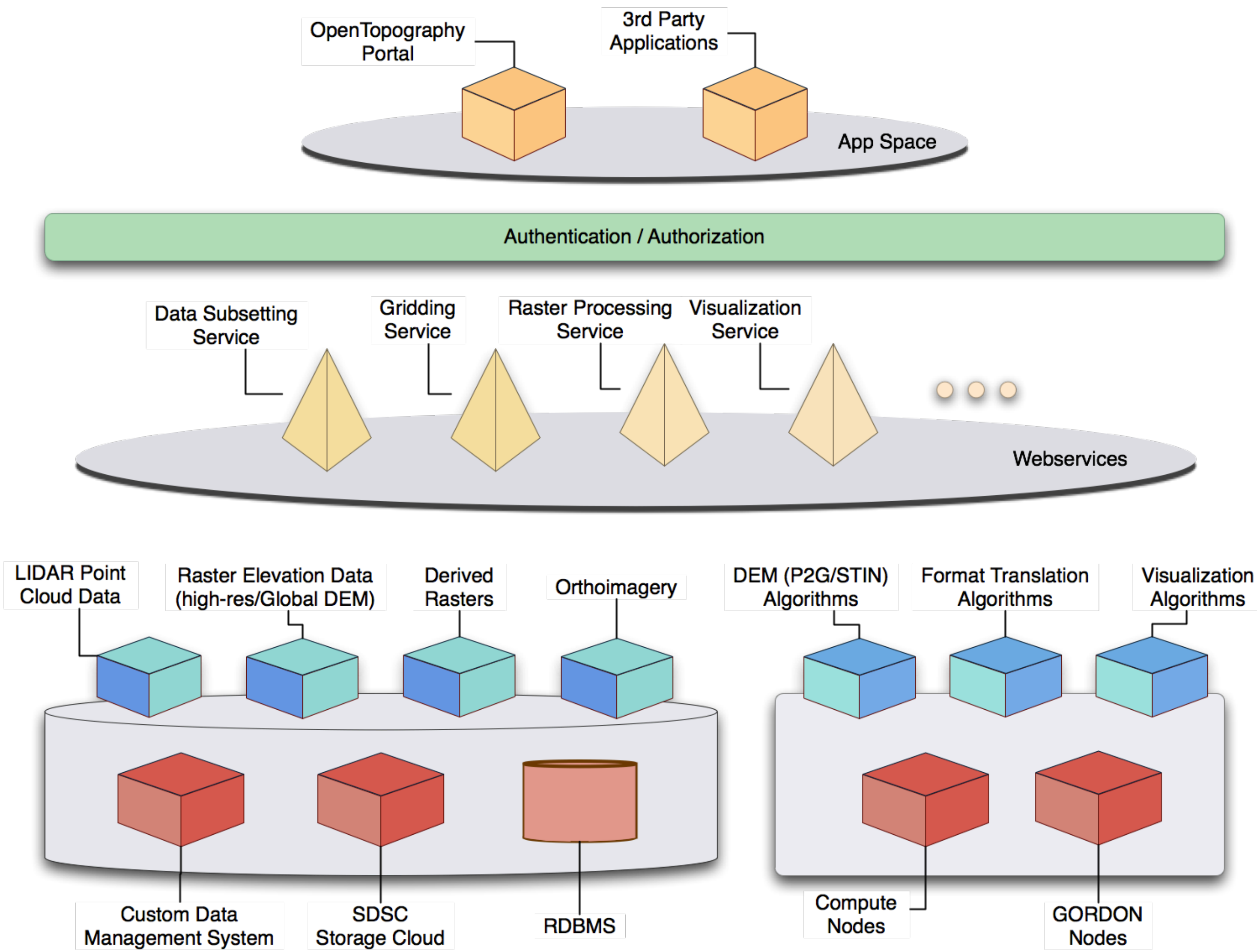


# Tiered Data Access:

- Processed and easy to access product for synoptic data browsing and education.
  - **Google Earth**
- Vast majority of earth science users want a standard gridded product:
  - **Optimized ("standard") DEM**
- Co-locate "raw" point cloud data next to processing tools to allow users on-demand data access to optimize terrain representation.
  - **LAS files**



# Service Oriented Architecture

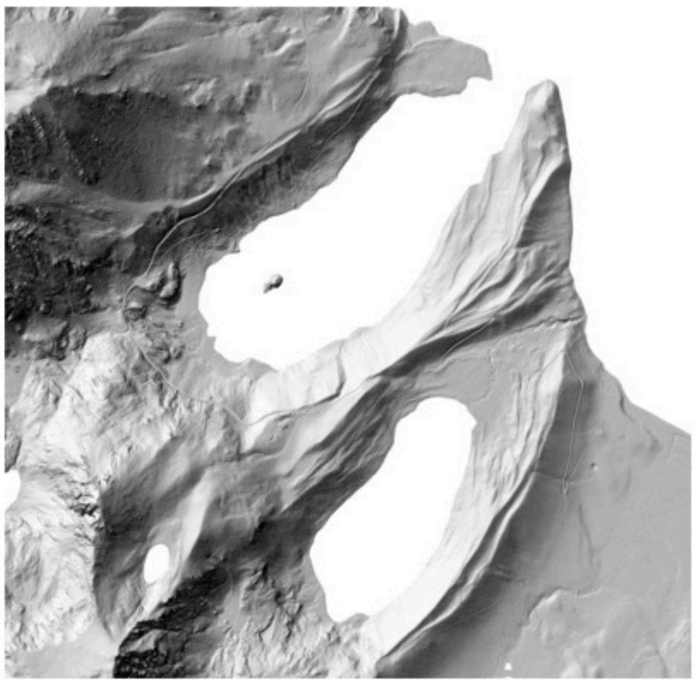


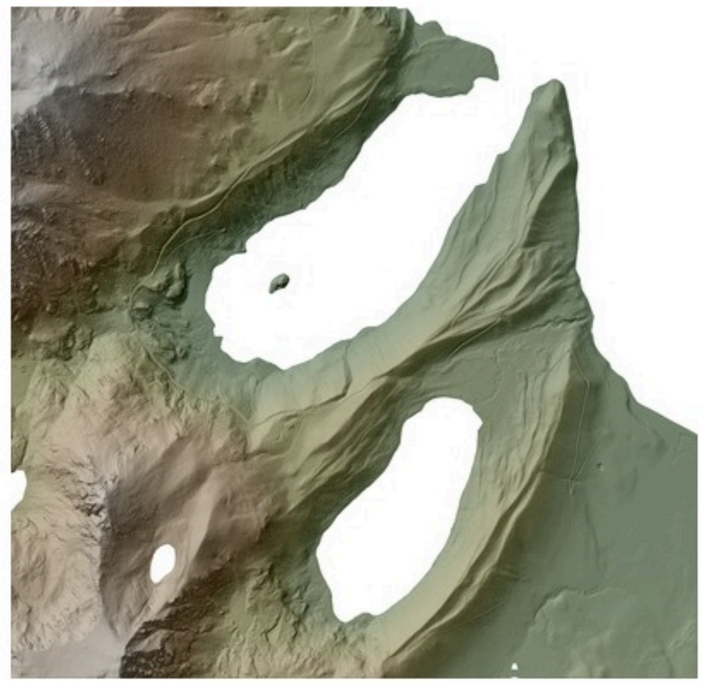

OpenTopography: a services oriented architecture for community access to LIDAR topography, COM.Geo
Database Design for High-Resolution LIDAR Topography Data, SSDBM, 5/2011

Slide courtesy of C.Crosby

**Ztin DEM:** KMZ Download KMZ file: viz.tin.hs.kmz
View with Google Earth browser plug-in

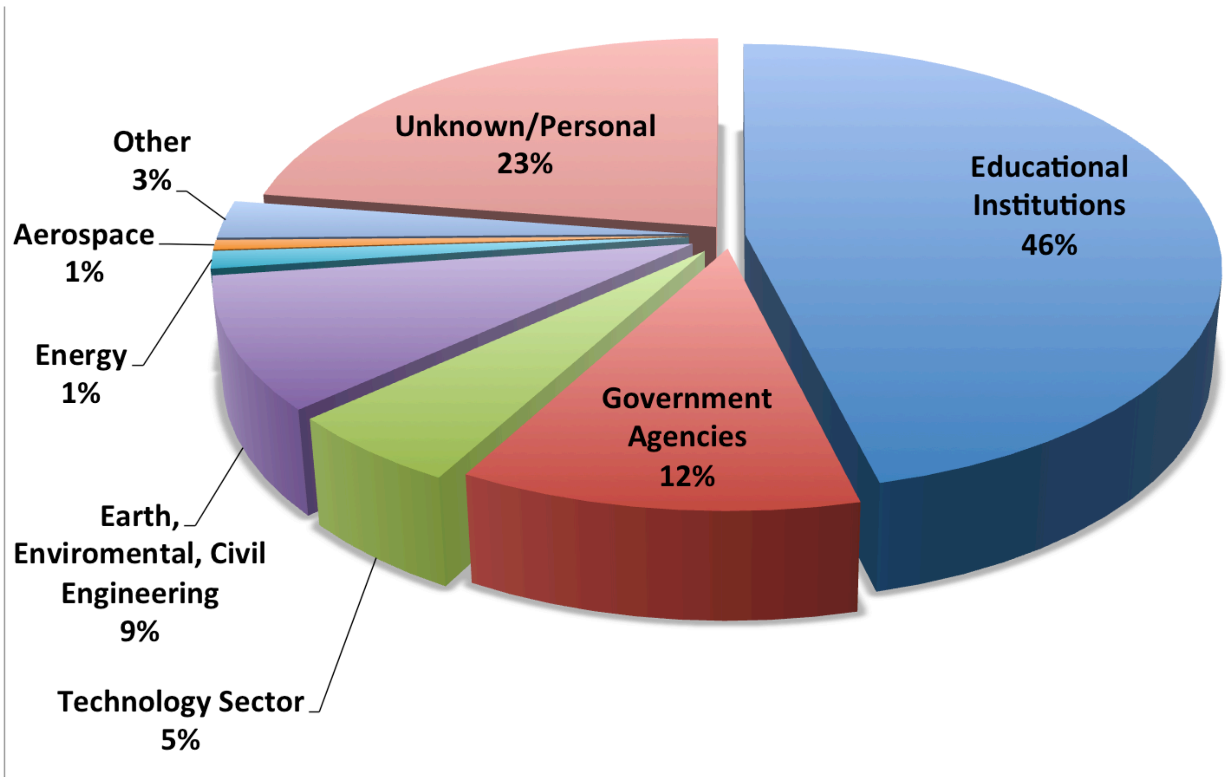
KMZ Download KMZ file: viz.tin.crhs.kmz
View with Google Earth browser plug-in





# Useage Metrics

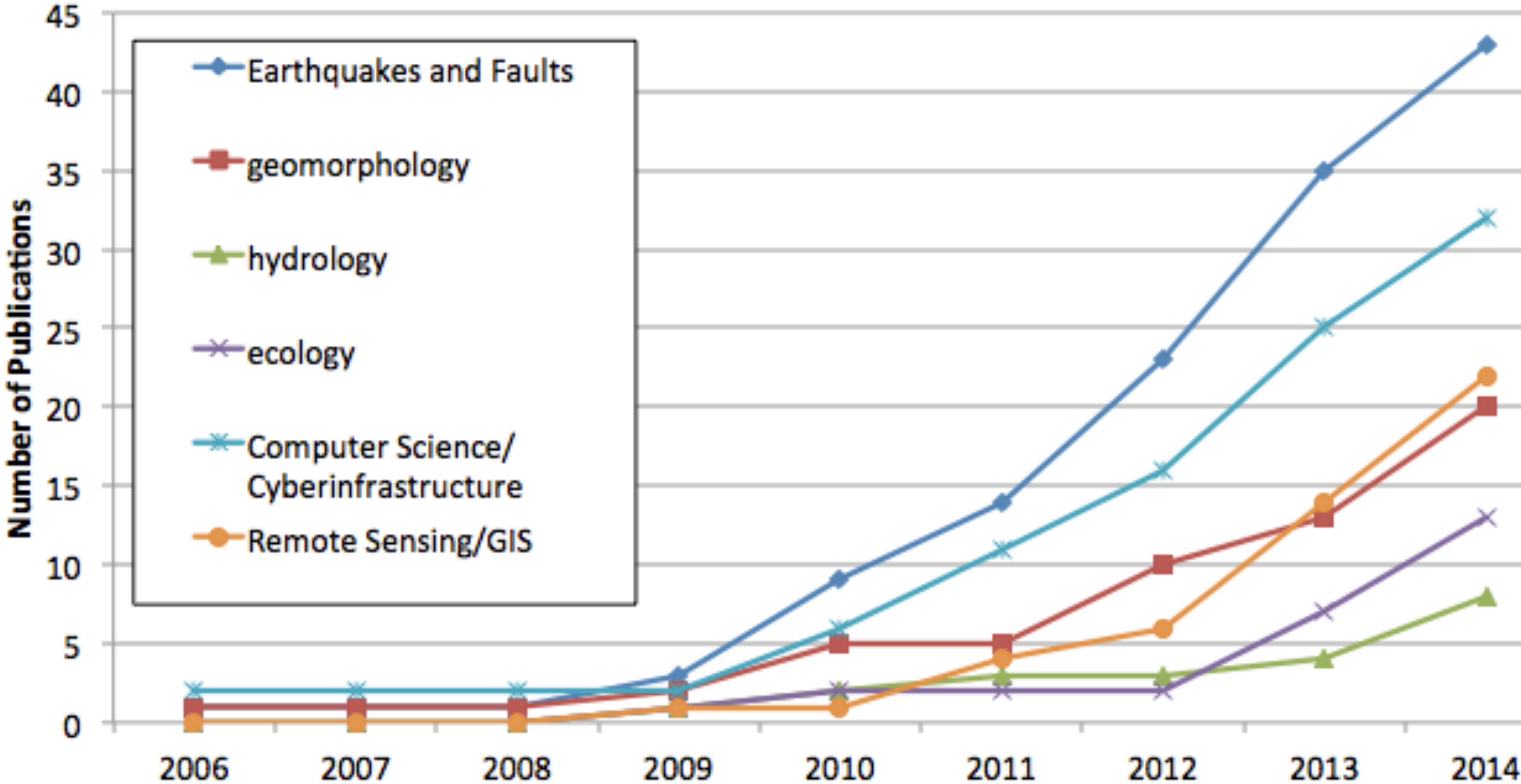
- **20,567** jobs
- **1.2 Trillion** points (currently >30 billion pts/month)
- **7000+** registered and unique users
- Growing & diverse user base
- Top users are <u>students</u> (*15 of top 25*)




***Significant # of student users***

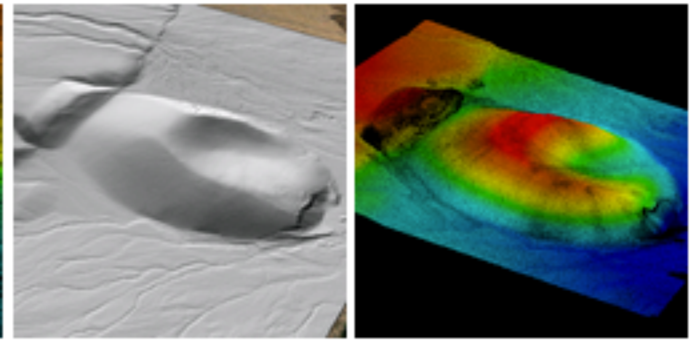
Slide courtesy of C.Crosby

# OpenTopography publication disciplines




- Overall: 106 peer-reviewed papers calling out OT for data or methodology
  - 15 theses
  - 20 reports/position papers
- Each dataset has a unique Digital Object Identifier (DOI) (www.doi.org)

# Education & Community Engagement



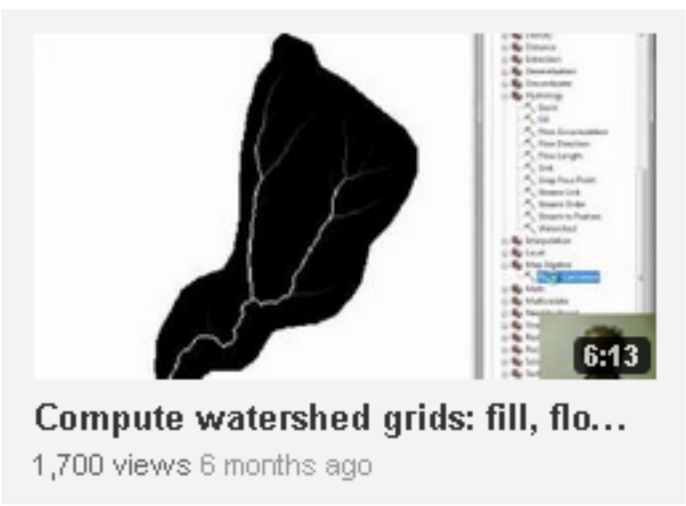
## Classroom Resources

- Lidar is powerful tool for teaching fundamental concepts.
- ***OpenLandform Catalog*** features iconic geologic features in lidar. Available for download in several formats.

## Short Courses & Workshops

- Directly reach hundreds of participants, *mostly students*
- International: 2012 in Cairo, Egypt; 2014 in Tokyo, Japan (SCEC VISES), and 2015 in Mexico

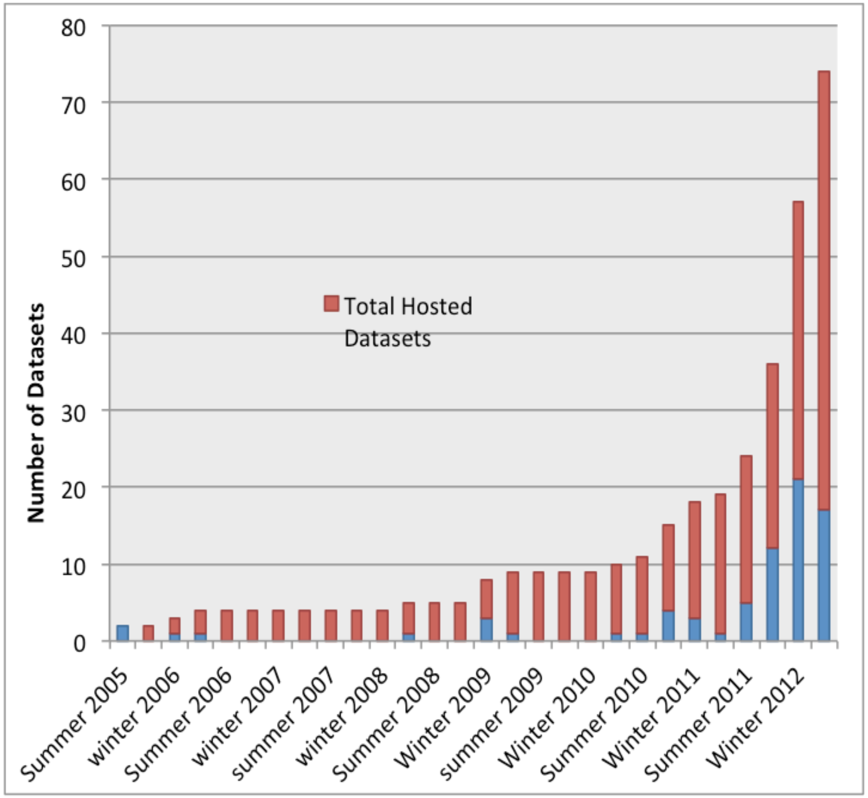
*Significant tutorial content, including videos:*




# Future Work: *Extensibility*

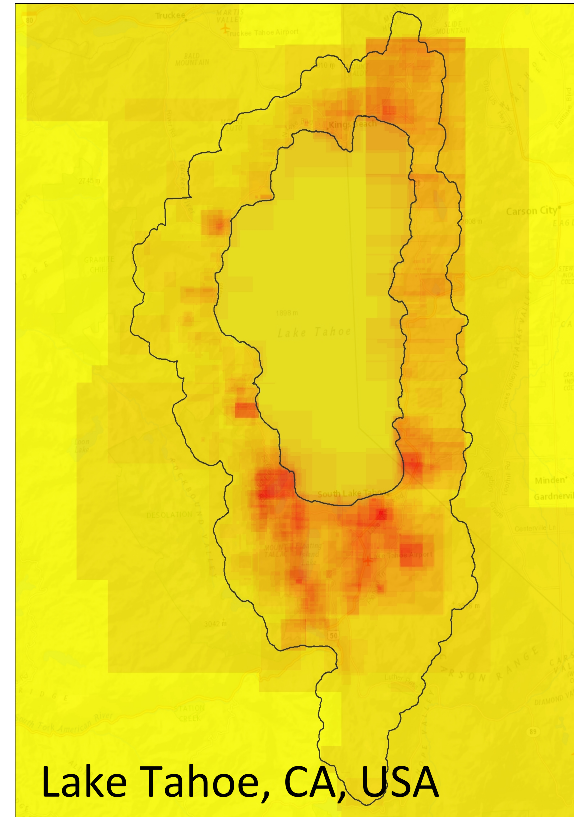
- ***Computing***: Develop a **pluggable services infrastructure** to enable scientists to integrate state-of-the-art LiDAR processing tools directly into OT system, able to operate on OT hosted data.
  - Expanding access and impact of scientific in the larger community.
  - Analogous to ingestion of data

- ***Data:*** Support for increased volumes and types of data
  - Increasing data volumes
  - Full Waveform data
  - Imagery and hyperspectral
  - Contextual elevation data
  - Repeat surveys




Slide courtesy of C.Crosby

# Future Work: *Scalability*




<u>Data Management</u>:

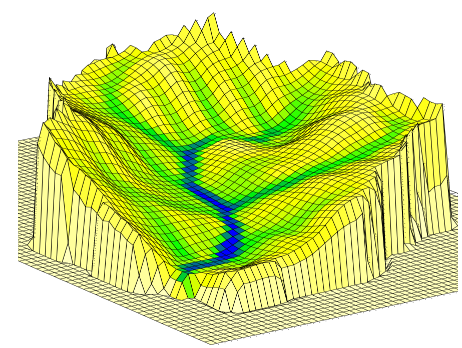
Storage optimizations based on mining data usage

- Manage "hot" and "cold" dataset differently to meet processing demands.
  - Recently published data
  - Specific geologic regions and features
  - External events, e.g. an earthquake
- Leverage SDSC resources

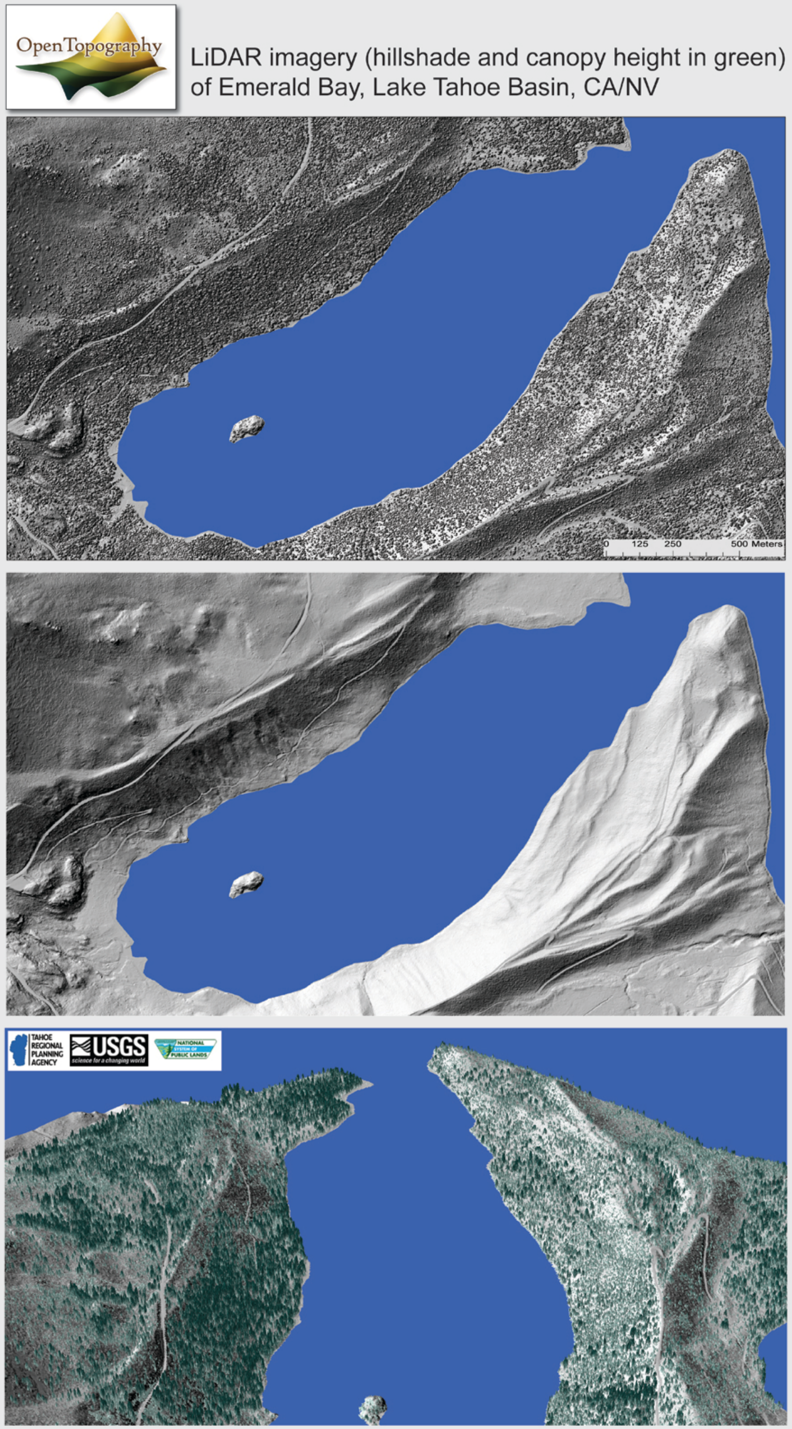
<u>Processing and Analysis</u>:

- Support use of Amazon (or other clouds) for processing/analysis algorithms.
- Access to SDSC on-demand computational resources





Slide courtesy of C.Crosby




# Conclusions:

OT = excellent example of a mature Spatial Data Infrastructure system enabling access to challenging data for research, education and outreach.

Growing partnerships with data providers in the academic, governmental and commercial domains

- *Global partners?*

Future R&D focused on leveraging next generation computing resources, and integration of community processing tools.

Slide courtesy of C.Crosby

# Demonstration

***www.opentopography.org***

# Interesting datasets for use with LAStools, Cloud Compare, and local datasets from Mexico available on

# *www.opentopography.org*

- **Satellite data: Global 90m SRTM (Shuttle Radar Topography Mission)**
    - Global 90m pixel size data
        - http://www.opentopography.org/id/OTSRTM.042013.4326.1
- **Earthquake data- El Mayor-Cucapah, 2010**
    - El Mayor-Cucapah Earthquake (4 April 2010) Rupture Lidar Scan
        - http://www.opentopography.org/id/OTLAS.122010.32611.1
    - 2006 INEGI Sierra Cucapah Emperically Corrected Lidar Dataset
        - http://www.opentopography.org/id/OTLAS.102012.32611.1
- **Earthquake data- South Napa, 2014**
    - Augusts 24, 2014 South Napa Earthquake
        - http://www.opentopography.org/id/OTLAS.122014.26910.1
    - Napa Watershead, CA (2003)
        - http://www.opentopography.org/id/OTLAS.052010.26910.1

# [LINK: Topographic Data for Mexico: Guide for downloading data]

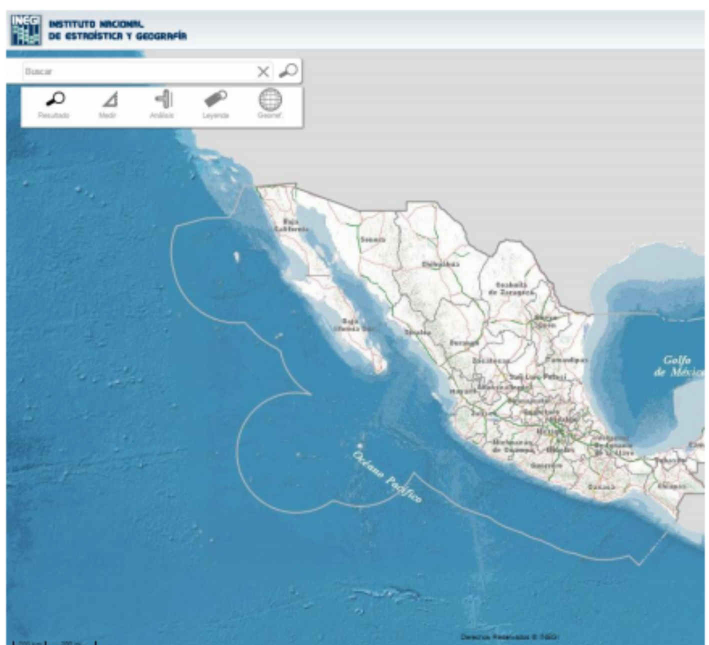
**Guide for Downloading and Initial Processing of High Resolution Topographic data for short course "LIDAR Derived DEMs applied to Landslide, Fault, Earthquake Rupture, and Landscape Changes"*(Modelos Digitales de Elevación de LIDAR Aplicados a Deslizamientos de Tierra, Fallas, Ruptura por Sismos y Cambios del Paisaje)***

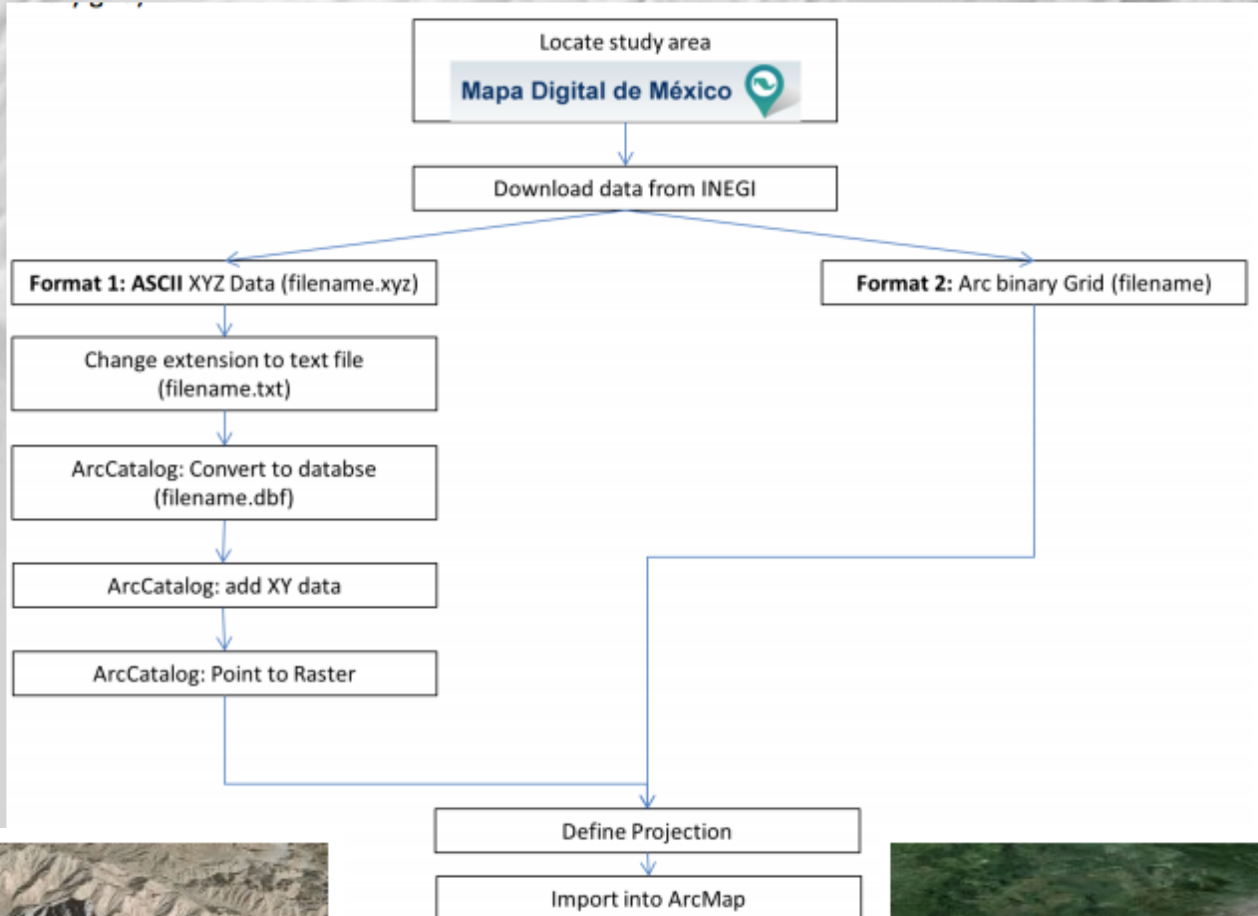
http://www.opentopography.org/index.php/resources/short_courses/15_UNAM

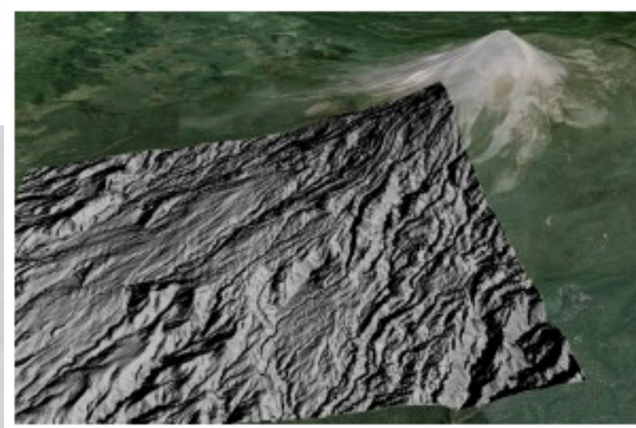
*Written by Alana Williams, Emily Kleber, and Ramón Arrowsmith (ASU/OpenTopography)*

**Mapa Digital de México**

http://gaia.inegi.org.mx/mdm6/




Locate study area
Mapa Digital de México
Download data from INEGI
Format 1: ASCII XYZ Data (filename.xyz)
Change extension to text file (filename.txt)
ArcCatalog: Convert to databse (filename.dbf)
ArcCatalog: add XY data
ArcCatalog: Point to Raster
Format 2: Arc binary Grid (filename)
Define Projection
Import into ArcMap



OpenTopography

**Muchas Gracias!**

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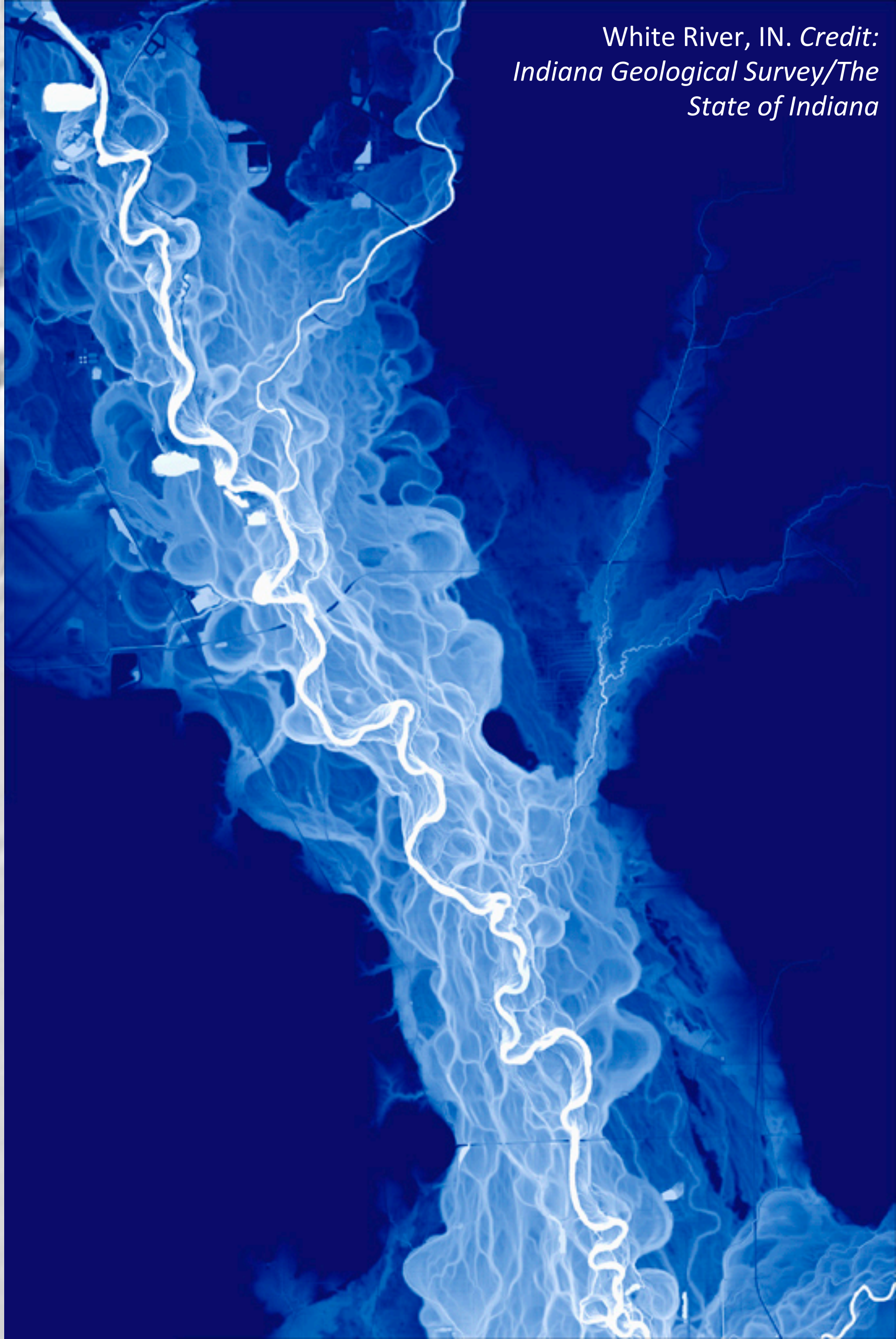

White River, IN. *Credit: Indiana Geological Survey/The State of Indiana*