# Science motivations and introductory remarks

## GSA 2018

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OpenTopography
*High-Resolution Topography Data and Tools*

# Science requirements

- Need topography data with sufficient spatial extent and resolution to capture phenomena of interest

- Need topography data with sufficient temporal repeat to capture changes of interest



Drone video of the Kekerengu Fault rupture

dm to m scale

https://www.youtube.com/watch?v=U3H8wIzXGYE &feature=youtu.be
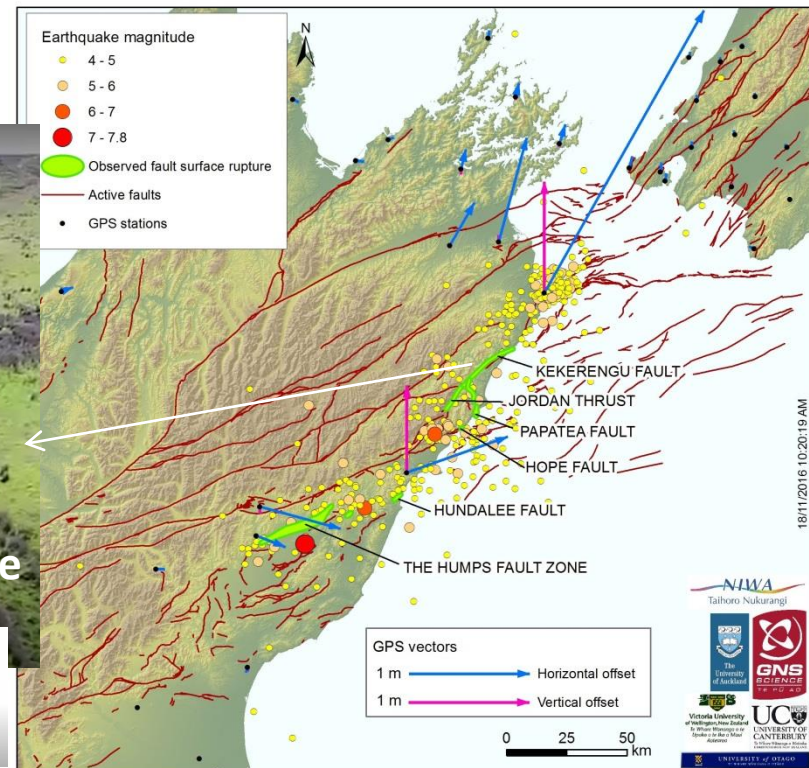
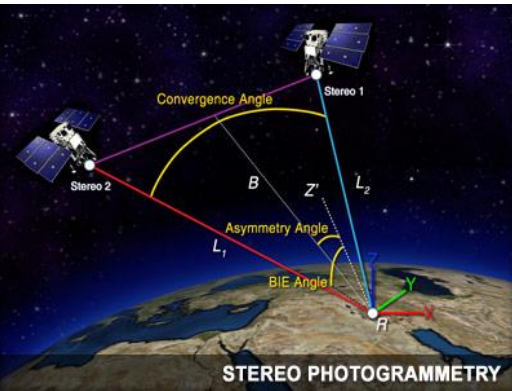Drone video of the Kekerengu Fault rupture

The Kekerengu Fault is one of several faults that ruptured during the Kaikoura Earthquake

Kekerengu alone is 30+ km of this intricate ground rupture

# 3D IMAGING WITH CAMERAS & LASERS

**Space-based**

Meters to centimeters spatial sampling



STEREO PHOTOGRAMMETRY

**A** Airborne LiDAR

onboard GPS and IMU constrain position and orientation of aircraft

distance between scanner and ground return determined from delay between outgoing pulse **and reflected return**
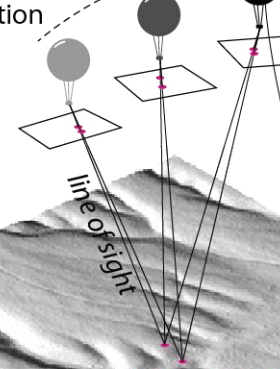
*laser pulse*

**C** Structure from Motion

**motion** of camera provides depth information

sequence of photographs

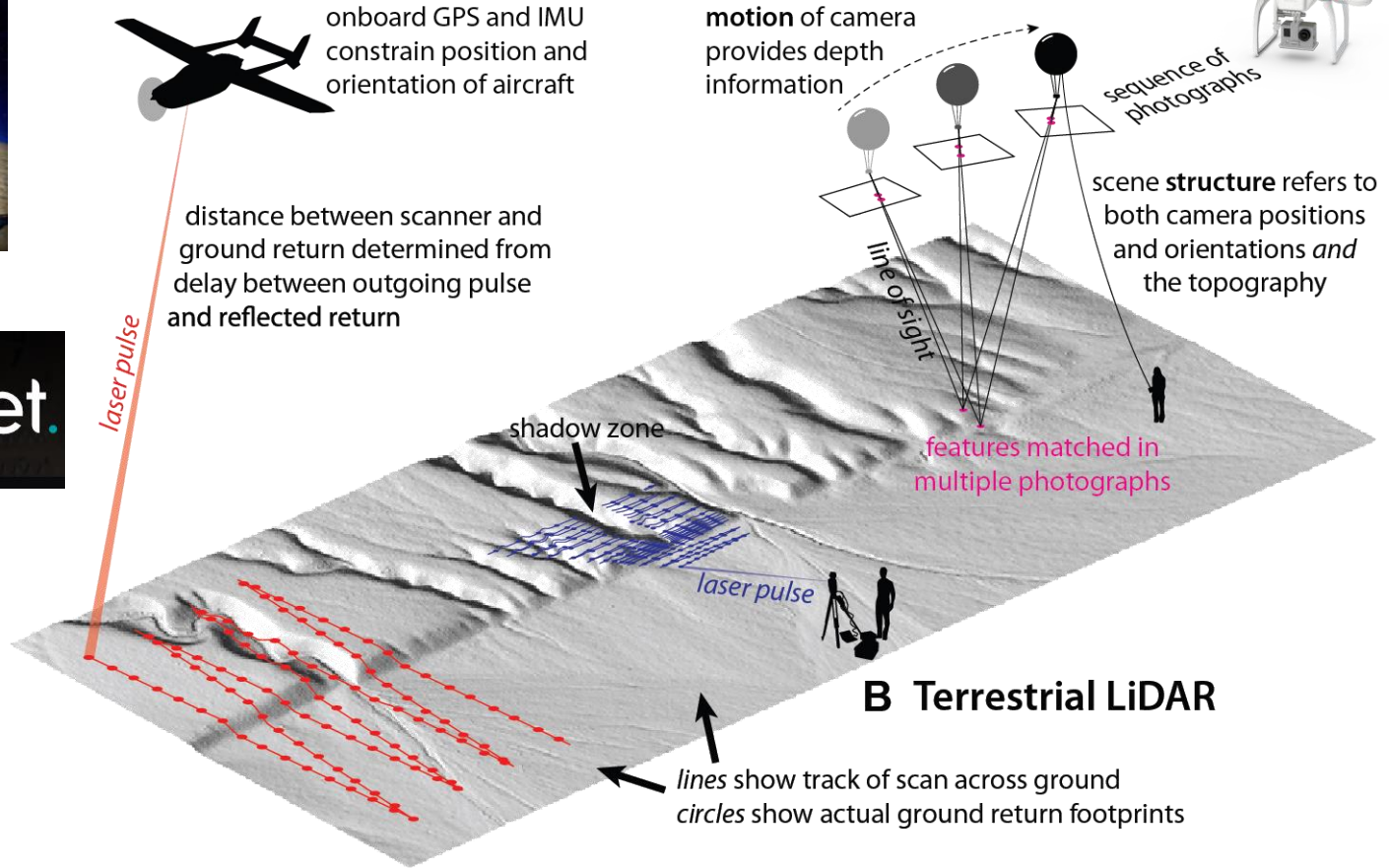scene **structure** refers to both camera positions and orientations *and* the topography

line of sight

features matched in multiple photographs

shadow zone

*laser pulse*

**B** Terrestrial LiDAR

*lines* show track of scan across ground
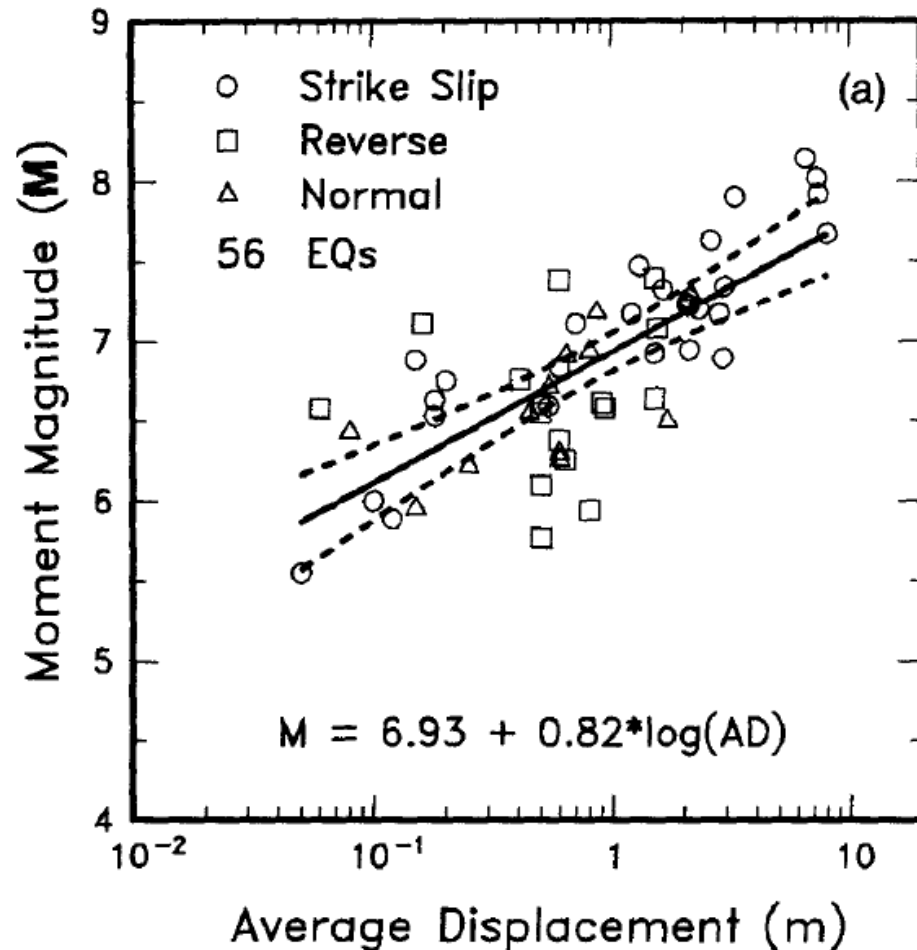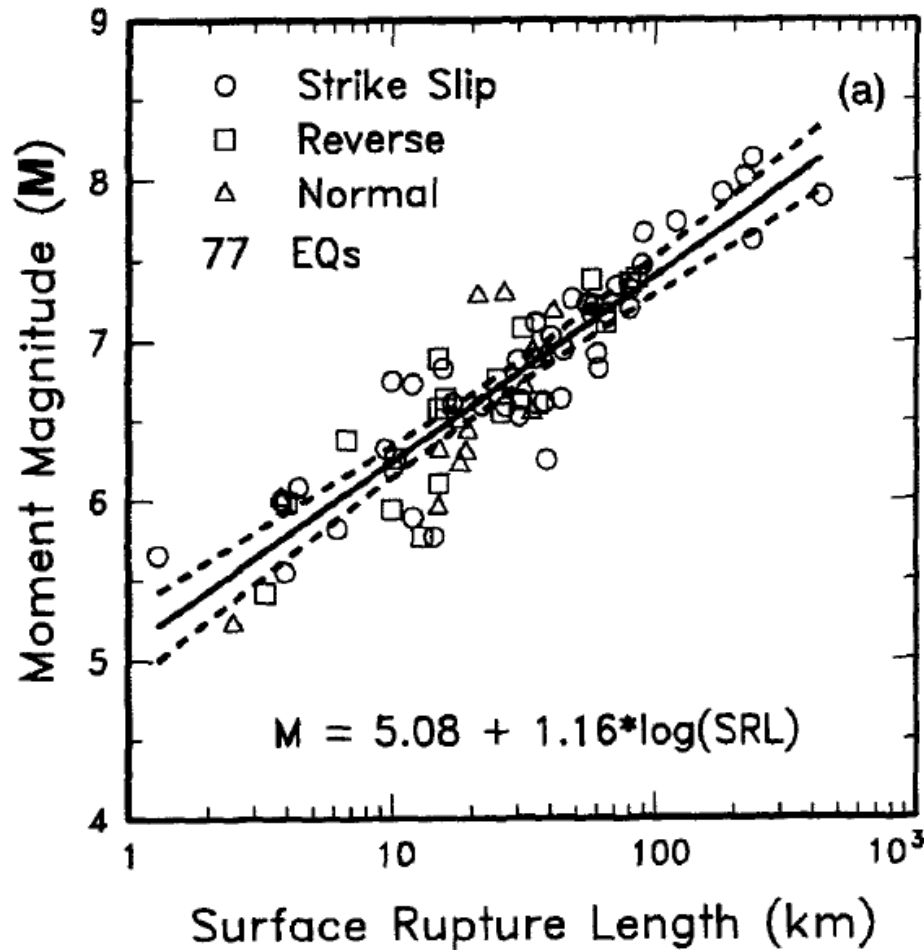*circles* show actual ground return footprints
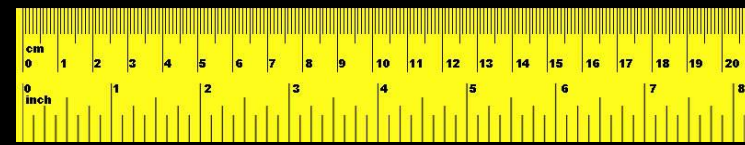
*Johnson et al., Geosphere, 2014*

**Need ~<meter-scale sampling to cover critical scale breaks and temporal repeat to address log(t) response of some phenomena**

# Length scales >$10^5$m and <1 m

Wells and Coppersmith, 1994

# "Seeing" at the appropriate scale means measuring at the right scale

*Surface processes act to change elevation through erosion and deposition while tectonic processes depress or elevate the surface directly—* their record is best characterized with the right fine scale.

Applies in particular to statistical self similarity
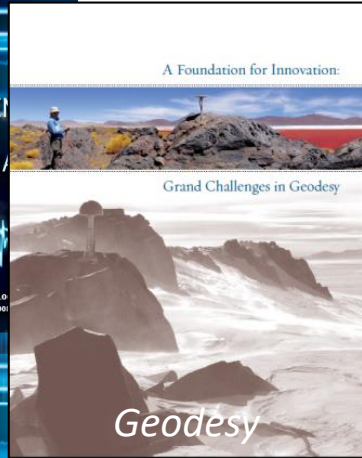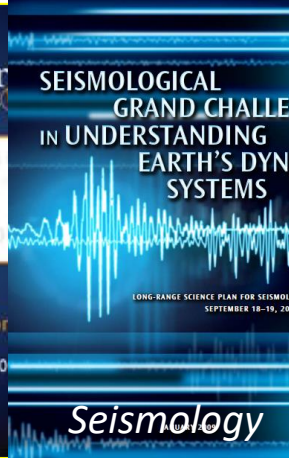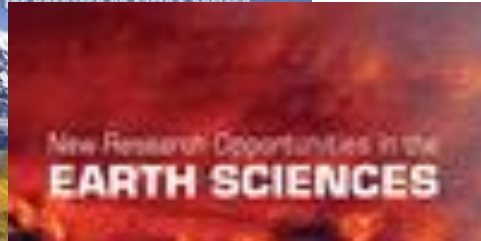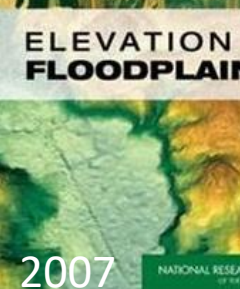
**How long is the coast of Britain?**
**Statistical self-similarity and fractional dimension**
Science: 156, 1967, 636-638

B. B. Mandelbrot

# Major US community studies recognize the scientific value of high resolution topography
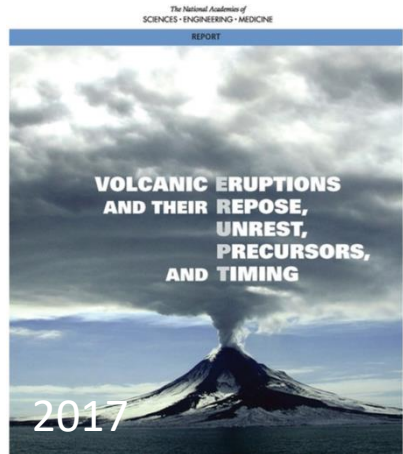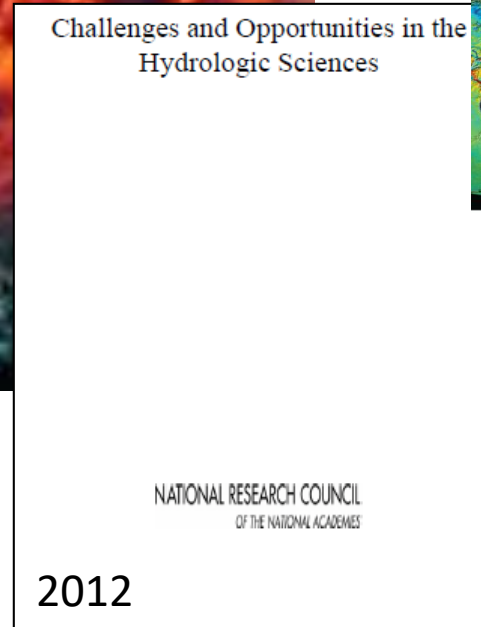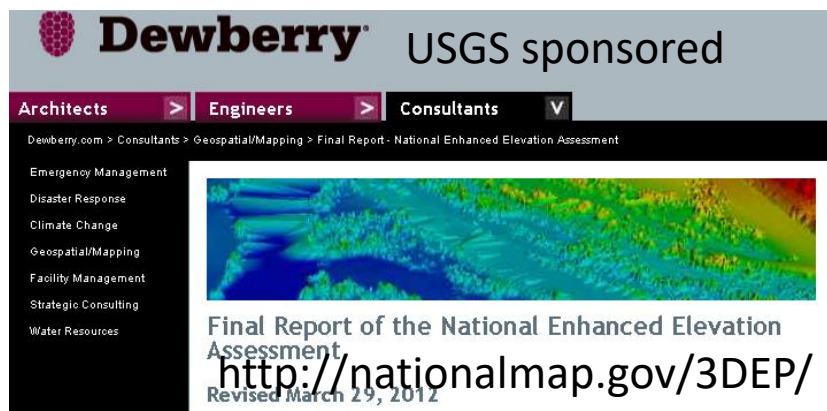
Science communities



*EarthScope*

*Seismology*

*Geodesy*

2016

2007

2010

2012

2012

2017

USGS sponsored

Final Report of the National Enhanced Elevation Assessment

http://nationalmap.gov/3DEP/

# Example scientific motivations

- How do geopatterns on the Earth's surface arise and what do they tell us about processes?

- How do landscapes influence and record climate and tectonics?

- What are the transport laws that govern the evolution of the Earth's surface?

- How do faults rupture and slip throughout multiple earthquake cycles and what are the implications for earthquake hazard?

- Landscape and ecosystem dynamics

- Volcano form and process

- Changes in volume of domes, edifice, flows
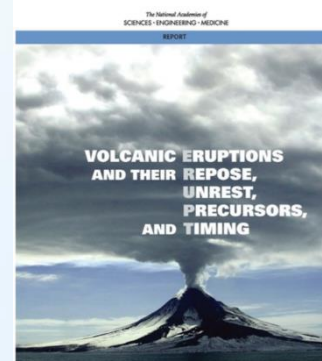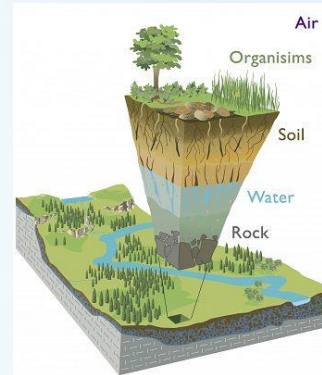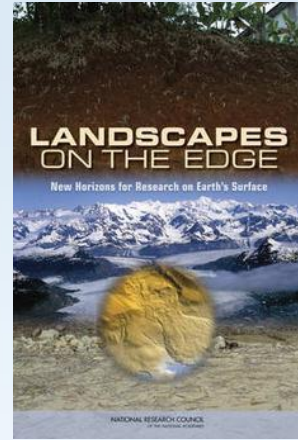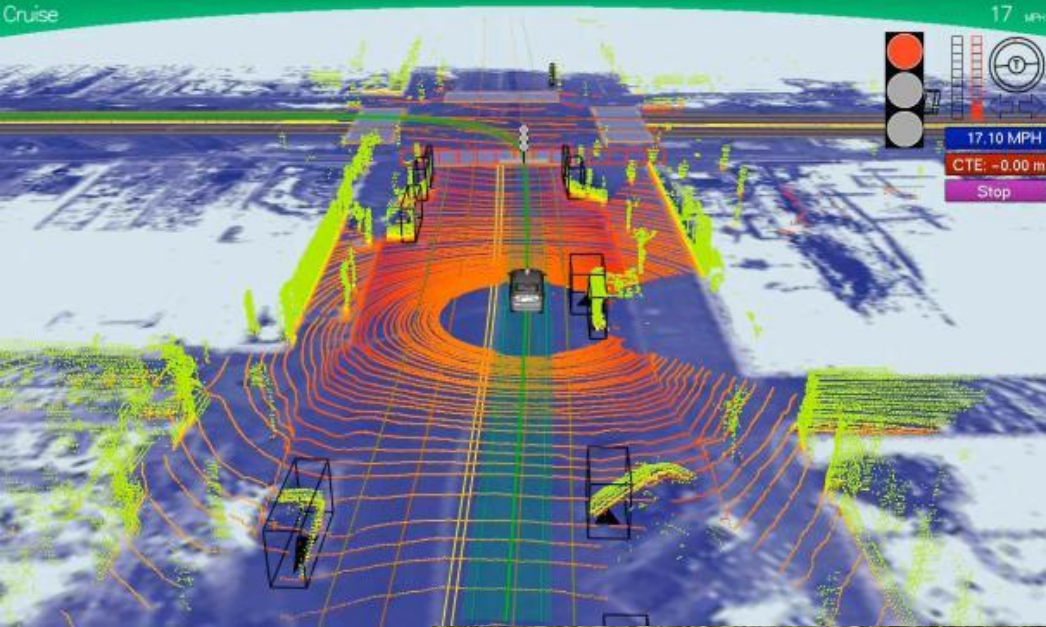
*Google car: Gb/sec high accuracy navigation data*

*Modeling the World from Internet Photo Collections (Snavely, et al., Int J Comput Vis , 2007)*

***Ubiquitous point clouds + 3D models:*** **coordinated (mapping and monitoring) and haphazard (autonomous navigation, individual photo collections, etc.)**
**-Need open access and cyberinfrastructure to support archive, and rapid query, data handling, preprocessing, and differencing**