Solid Earth

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- Earthquake, volcano and landslide assessment, response, mitigation and modeling
- Vertical land motion/relative sea level rise
- Tectonics/deposition/erosion/climate coupled processes
- Anthropogenic and natural change detection

Solid Earth

Overarching Decadal Survey Goals:

1. How can geological hazards (**earthquakes, volcanoes, landslides**) be accurately **forecasted** and eventually predicted in a socially relevant timeframe? [S-1] [Most Important]
2. How do **geological disasters** directly **impact** the Earth system and society following an event? [S-2] [Most Important]
3. How will **local sea level** change along coastlines around the world in the next decade to century? [S-3] [Most Important]
4. What processes and interactions determine the rates of **landscape change**? [S-4] [Most Important]
5. What are the impacts of deep underground water on geologic processes and water supplies? [S-6] [Very Important]
6. Improve discovery of energy, mineral, and soil resources [S-7] [Important]

DS Objectives

- **(MI) S-1a.** Measure the pre-, syn-, and post **eruption** surface deformation and **products** of Earth's entire active land volcano inventory with a time scale of days to weeks
- **(MI) S-1b.** Measure and forecast inter-, pre-, co-, and post-**seismic** activity over tectonically active areas on time scales ranging from hours to decades
- **(VI) S-1c**. Forecast and monitor **landslides**, especially those near population centers

Objectives

- **(MI) S-2a.** Rapidly capture the **transient** processes following disasters for improved predictive modeling, as well as response and mitigation through optimal retasking and analysis of space data
- **(VI) S-2b**. Assess surface deformation, extent of surface change…of **volcanic products** following a volcanic eruption (hourly to daily temporal sampling)
- **(VI) S-2c**. Assess co- and post-seismic ground deformation and **damage to infrastructure** following an earthquake

Objectives

- **(MI) S-3a**. Quantify the rates of sea-level change and its driving processes at global, regional, and local scales.
- **(MI) S-3b.** Determine **vertical motion** of land along coastlines.
- **(MI) S-4a.** Quantify global, decadal **landscape change** produced by abrupt events and by continuous reshaping of Earth's surface due to surface processes, tectonics, and societal activity

SATM flow-down from Decadal Survey

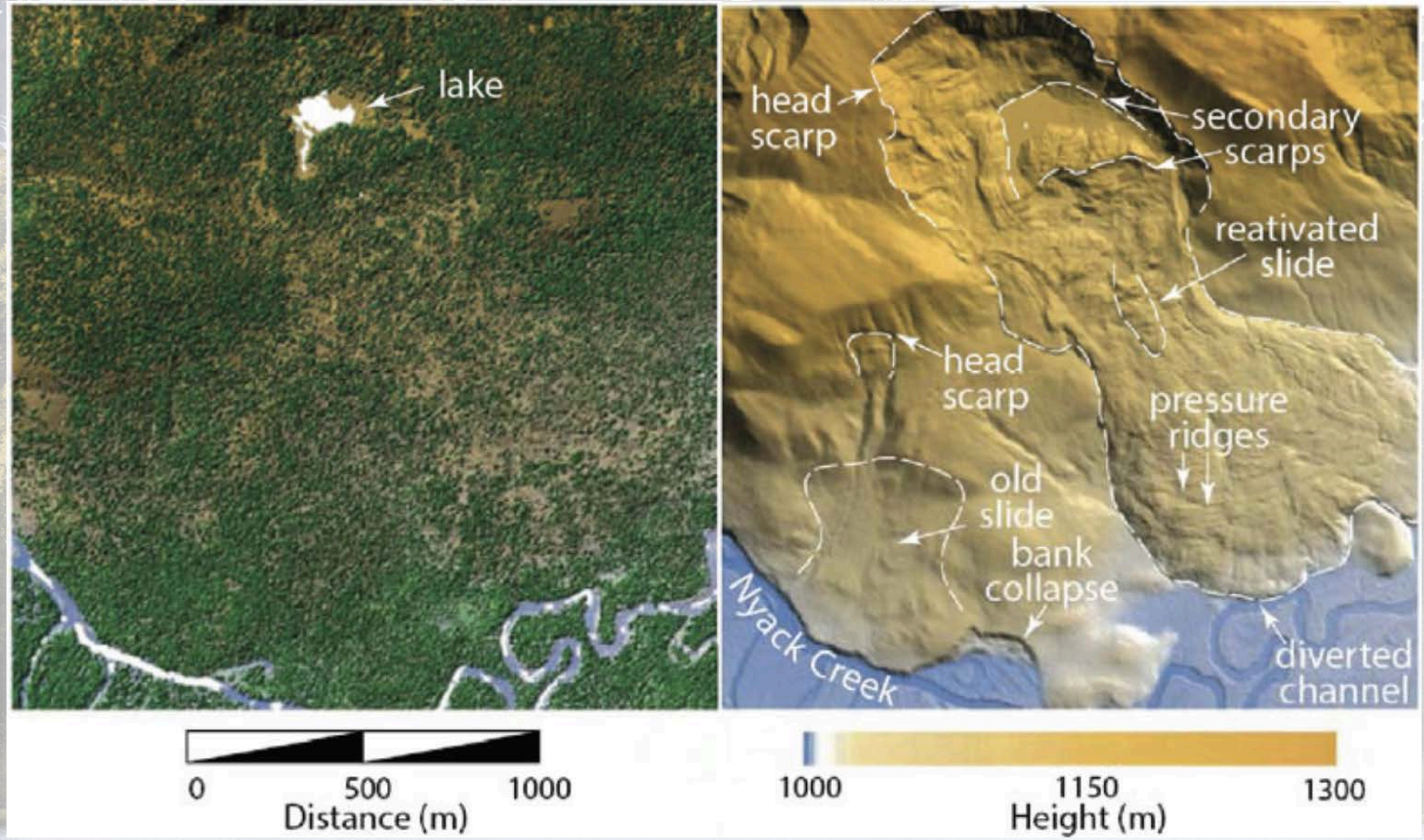
Science and Applications		Physical Parameters		Level 3 or 4 Product	Spatial Needs				
Goals	Objectives	Targeted Observable	Derived Parameter(s)		Observed Area	Coverage (%)	Smallest Feature Resolution		Sampling Distance (m)
							Horizontal	Vertical	
(S-1) How can large-scale geological hazards be accurately forecast in a socially relevant timeframe?	S-1a: Measure the **pre, co-, post-eruption** surface deformation and products of the Earth's **entire active land volcano inventory** at a time scale of days-weeks.	Surface Topography	Bare Earth topography Shallow water bathymetry	Terrain model	Global volcanoes (>10 km in scale)	-- 100 67	-- 3 m 5 m	-- 0.3 m 0.5 m	5 m 1 m 3 m

More Spatial and Temporal needs to right ➔

5 m Decadal Survey
1 m Aspiration
3 m Threshold

Static topography

LIDAR reveals landslides beneath forest (≤ 1 m resolution)

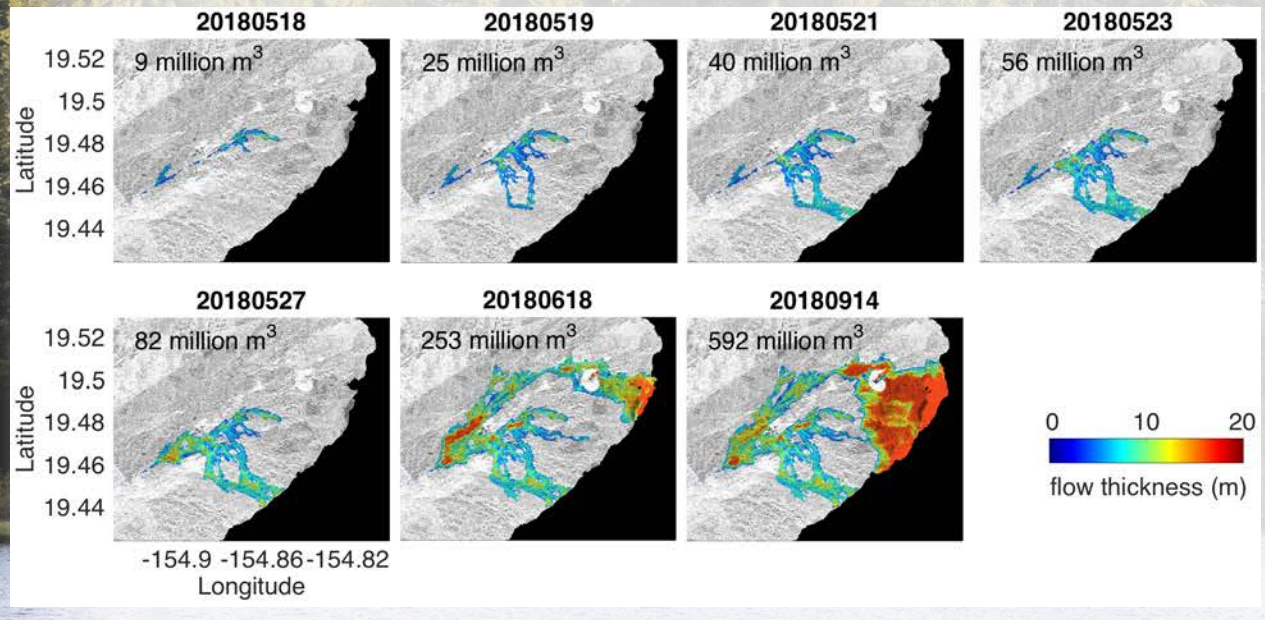


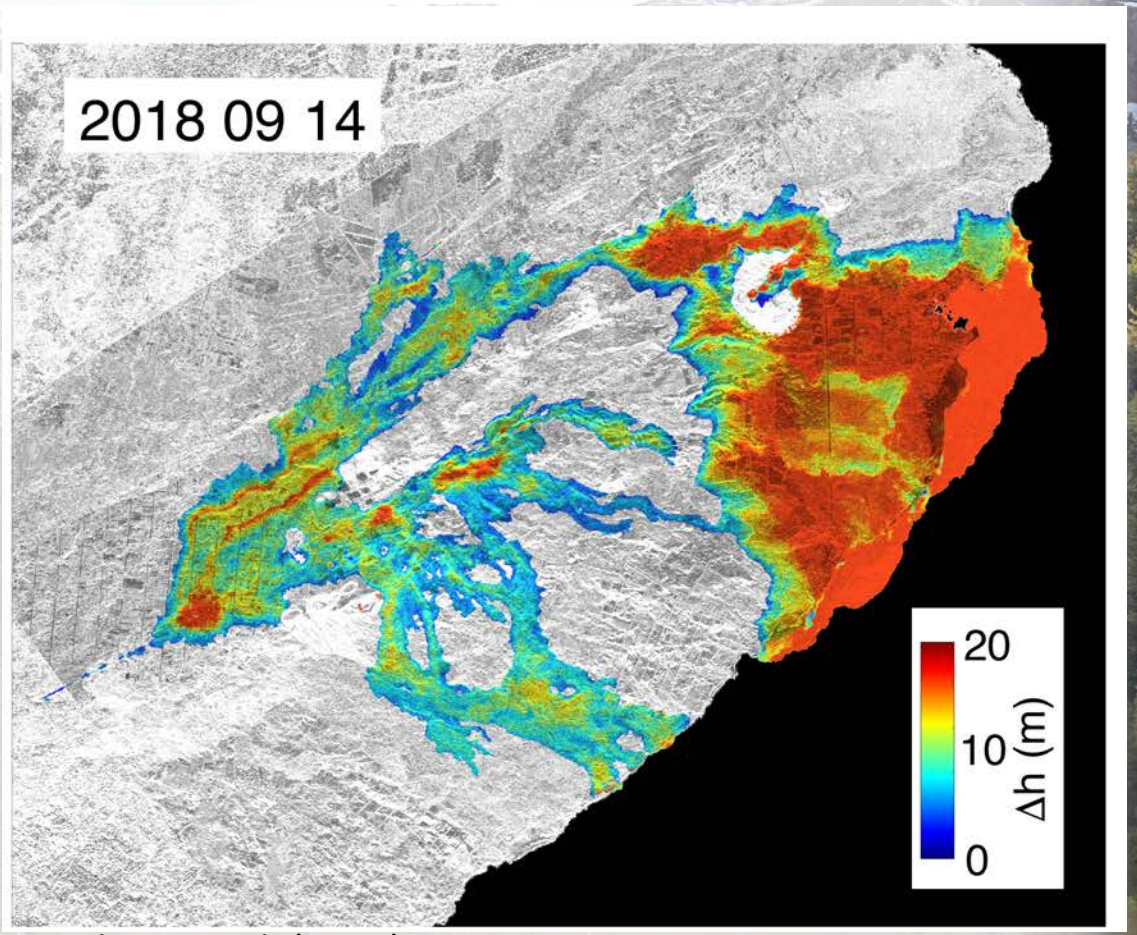
(Ramesh Shrestha and the National Center for Airborne Laser Mapping, NAS, Decadal Survey, 2017)

Time varying topo: Kilauea 2018 eruption

Differential topography using NASA GLISTIN-A SAR (3 m posting).

Highlights need for temporal sampling, spatial coverage, and resolution.

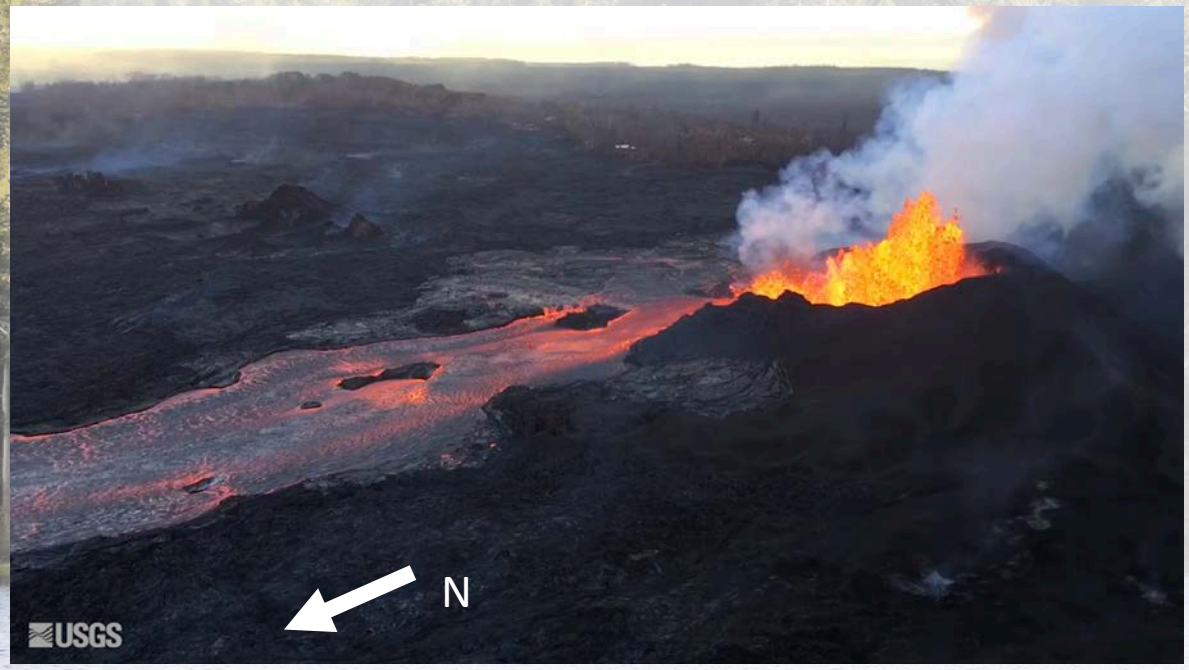


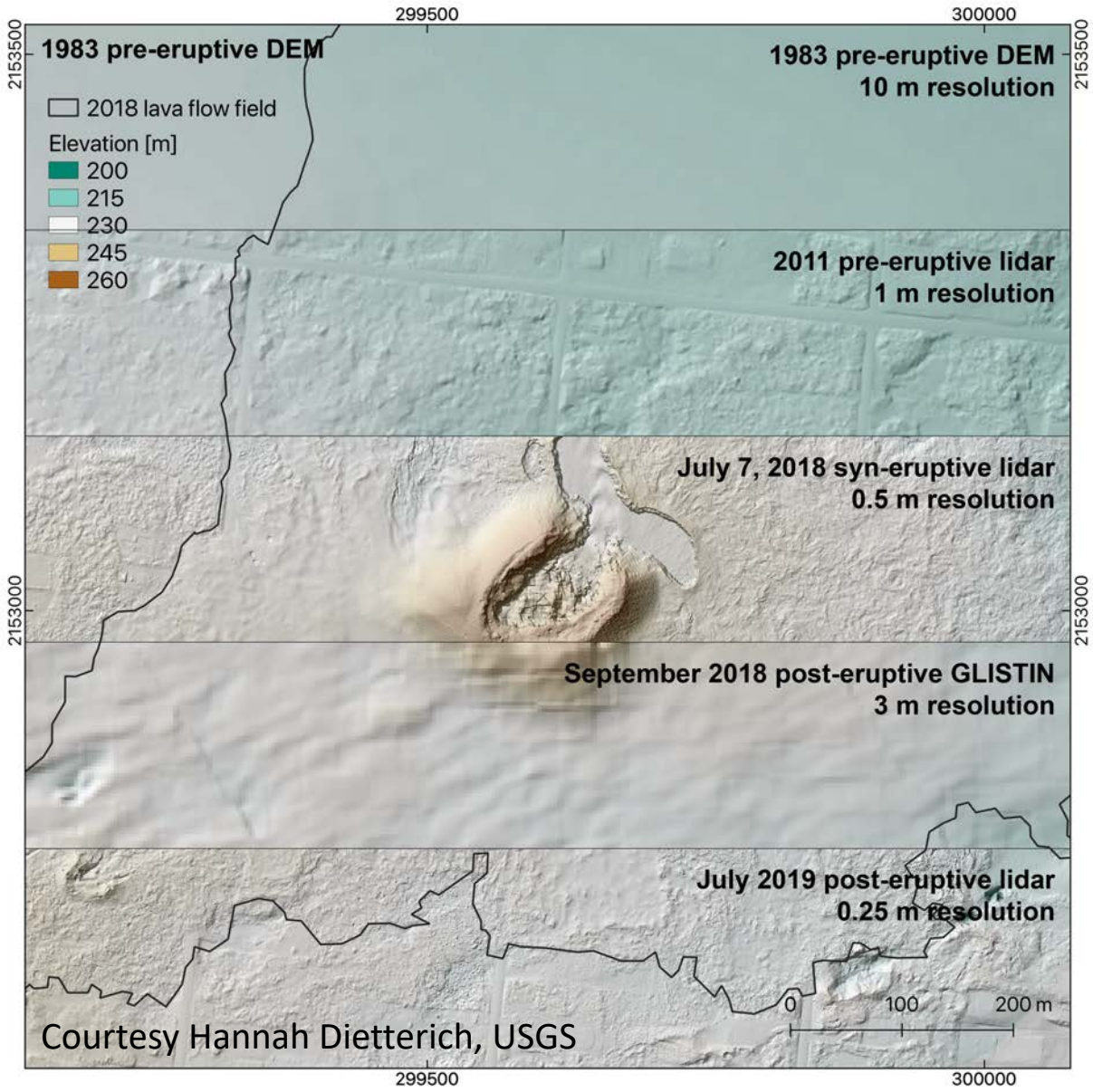


Lundgren et al. (2019)

Time varying topo: Kilauea 2018 eruption

Comparison of different resolution airborne topography data covering Fissure 8 in the Lower East Rift Zone of the 2018 Kilauea eruption

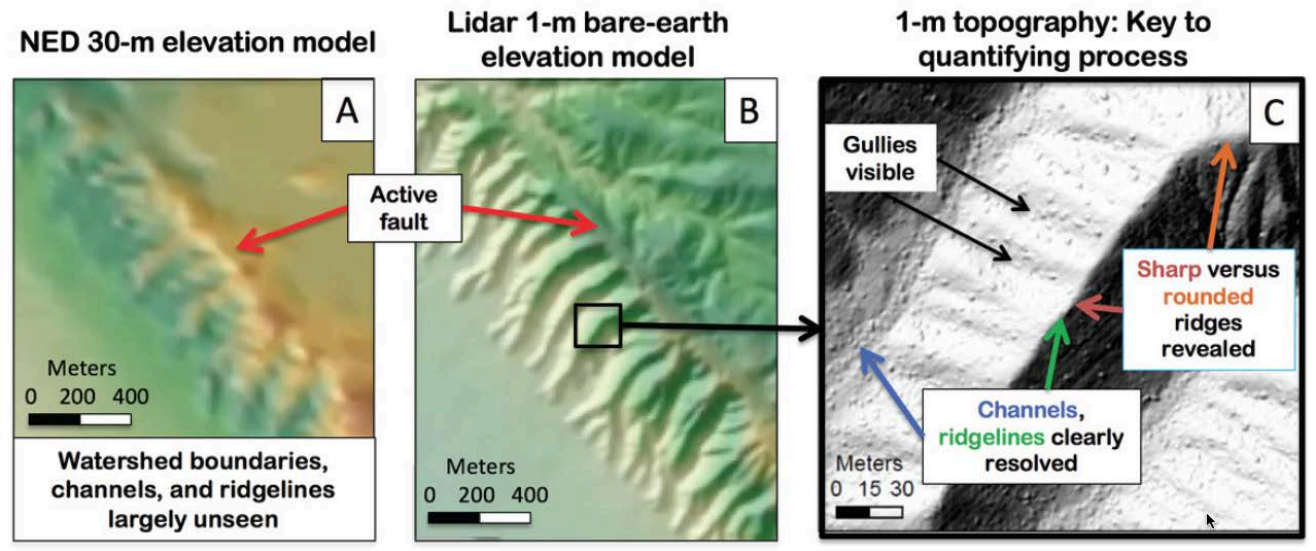




Courtesy Hannah Dietterich, USGS

Physical Parameters

- Surface/bare earth topography
- Bathymetry
- DS topography recommendations for SE science are mostly 1 m posting at 0.1 m vertical accuracy (volcanoes 5 m / 0.5 m)
- The Solid Earth STV charge is to modify and add to the DS recommendations based on current science and identify gaps



Example of erosion and tectonics, Dragon's Back ridge near San Andreas fault, from Decadal Survey (2017), based off Hurst et al. (Science, 2013)

Product Needs

- State of the art:
  - Satellite topography: TanDEM-X (12 m / 1.4 m), LIDAR (too coarse)
  - Airborne:
    - SAR – GLISTIN-A (3 m / ~1-3 m, range dependent)
    - LIDAR – LVIS (20 m /xxx)
    - Photogrammetry – (<1 m / <0.1 m ?)
- Gaps
  - Global coverage at high resolution
  - Repeat intervals to meet science needs (requires short repeat interval or observational agility)

Where are the Gaps?

Spatial and Temporal Needs

- Spatial:
  - Global to near global coverage (e.g. tectonically active or global coastlines)
- Temporal:
  - Broad area repeat topography, possibly on a regular basis
  - Rapid response mode (≤ 1 day)