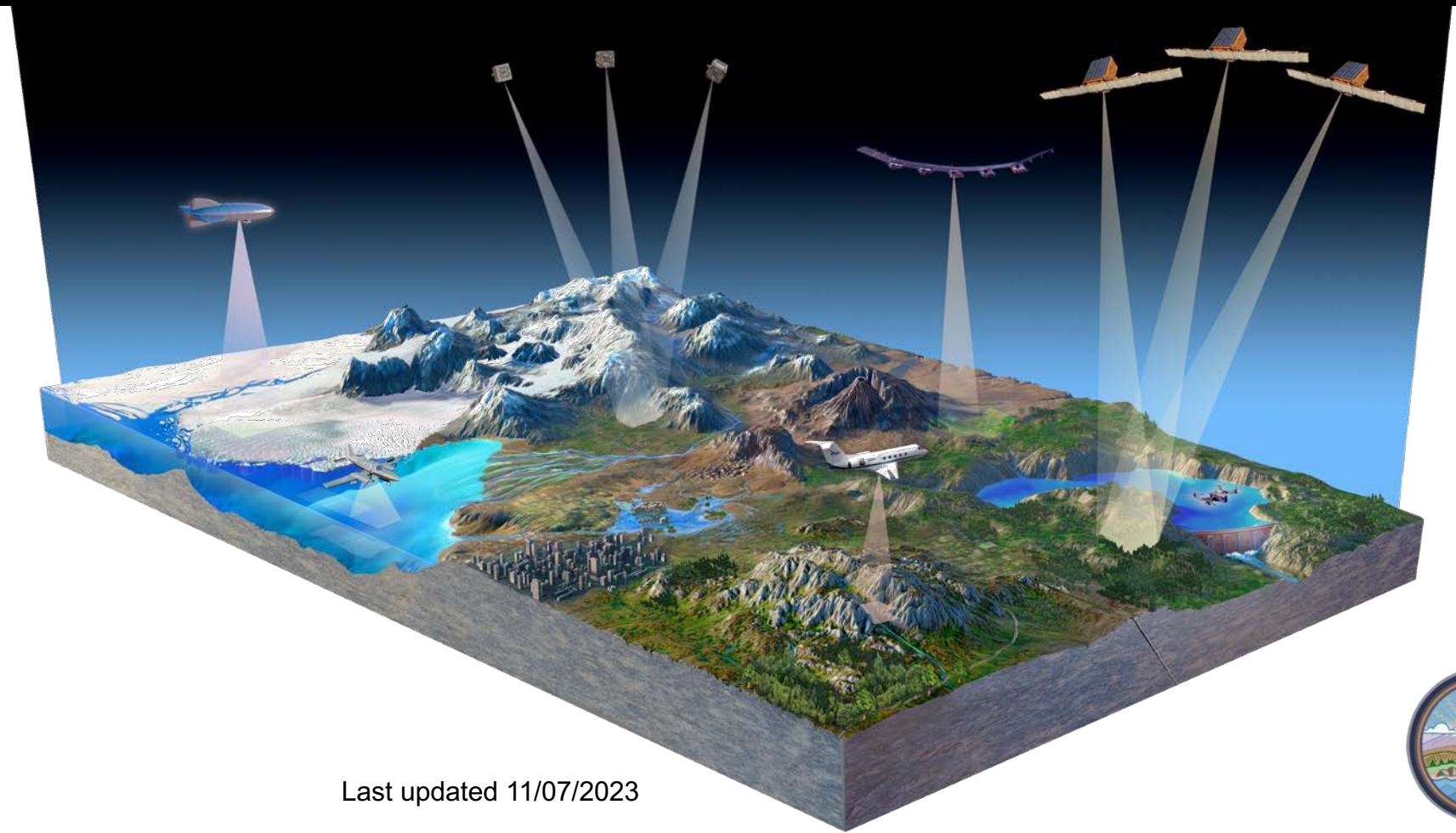
NASA's Surface Topography and Vegetation Study

Solid Earth



Paul Lundgren
Solid Earth Lead
JPL

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Solid Earth Questions

How do Earth's surface structures respond to tectonic and climate forces and what are the implications for geologic hazards?

Sub questions

Volcanoes:

- How do magmatic systems evolve and under what conditions do they erupt?
- How can erupted volcanic products be measured and forecast in societally relevant timescales?

Earthquakes and fault processes:

- How do fault zone properties change in space and time and relate to earthquakes?
- How do fault zone geomorphology change relate to different faulting processes and contribute towards geohazard estimation?
- How are earthquakes affected by tectonic and non-tectonic forces, such as climatic forcing and anthropogenic resource exploitation?

Landslides:

- How do landslides respond to tectonic and non-tectonic forces and how can landslides be forecast in societally relevant timescales?

Landscape change:

- How does the Earth's surface respond to changing climate and human interaction through erosion, deposition, and deformation?

Energy, mineral, and soil resources:

- What are the manifestations of resource exploitation on surface topography?

Infrastructure and damage assessment:

- How do surface topography and change inform improved post-hazard damage assessment?

Solid Earth Goals

Overarching goal:
Map bare Earth topography and vegetation structure at a precision, accuracy and spatiotemporal resolution to meet the science and applications measurement needs

Sub goals

Science:

- Accurately characterize and forecast large-scale geological hazards in a socially relevant timeframe
- Assess the impacts geological disasters have on the Earth system and society following an event
- Forecast local sea level change along coastlines around the world in the next decade to century
- Understand the processes and interactions that determine the rates of landscape change
- Improve discovery of energy, mineral, and soil resources

Solid Earth Goals (continued)

Sub goals

Applications:

- Volcanoes
- Earthquake cycle
- Landslides
- Vertical land motion: inland and near-coastal
- Ground movement related to mining activities
- Land surface change, including sinkhole and cavern collapse, land deposition (flood debris, delta formation), permafrost
- Space Archaeology

Solid Earth Science Gaps

Needed modeling/simulations/investigations

Modeling & simulations

Volcanoes

- Lava flow modeling and simulations based on real and synthetic topography
- Volcanic avalanche and debris flow modeling and simulations
- Physics-based plumbing system + effusion modeling and simulations

Earthquakes and faulting

- Earthquake surface fractures, displacements and topography changes characterization based on real topography examples
- Fault zone geomorphology characterization and relation to surface/subsurface properties and faulting processes
- Earthquake and fault modeling and simulations based on real and synthetic topography and other complementary measurement (satellite, in-situ etc.) data

Landslides

- Landslide modeling and simulations based on real and synthetic(?) topography
- Landslide characterization based on real topography examples

Solid Earth Science Gaps

Needed modeling/simulations/investigations

Modeling & simulations

Relative sea level rise and vertical land motion (VLM) in general

- Assess vertical land motion (VLM) potential from differential topography over decadal time scales
- Simulate effects of topography resolution on estimates of coastal inundation

Landscape change

- Assess topography needs for landscape evolution based on observations and analysis
- Characterize permafrost topography and topo-change needs based on observations

Resource extraction

- Characterize topography needs to detect and assess mining and other resource exploitation based on observations

Investigations

Work needed to define measurement needs and address goals

Solid Earth Measurement Needs

Parameter		Aspirational			Threshold		
		Median	Most Stringent		Median	Most Stringent	
		Need	Need	Discipline	Need	Need	Discipline
Coverage area	%	90	95	C, H	55	90	C
Latency	Days	5	0.5	SE	60	1	SE
Revisit	Days	**3**	**1**	SE, A	90	6	SE
Horiz Resolution	m	**1**	**1**	SE, C, H, A	20	3	SE
Vert Accuracy	m	**0.2**	**0.03**	SE, C, H	0.5	0.1	C

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Solid Earth Needed Experiments

Existing and proposed

Airborne campaigns, data sets

Airborne:

- Volcanic topography and topo change (e.g. Hawaii for basaltic and St. Helens, Cascades (?) or Alaska, for silicic systems)
- Earthquake/fault relevant topography…(SoCal, NorCal, Basin and Range, tropical location)
- Coastal processes: Gulf coast, Calif coast
- Landslides/geomorphology: California, Oregon, Basin and Range, tropical
- Challenging vegetated location covering multiple topics (Costa Rica, Guatemala, New Zealand, Philippines)

Data sets:

- **Volcanoes** Hawaii: lidar bare-earth, GLISTIN-A; St. Vincent: Pleiades; Ibu: various
- **Fault systems** California: B4, GeoEarthScope, USGS 3DEP airborne lidar; QUAKES-I; Ridgecrest EQ: ?; Basin and Range: ?
- Landslides

Summary

- Goals and objectives
  - Model and simulation-based assessments of SE and application needs using real and simulated topography observations
- General measurement needs
  - Bare earth topography – most important measurement
  - Shallow water bathymetry – for processes that extend off-shore
  - Vegetation and vegetation change – as indicators of faults, landslide processes, and for landscape evolution analysis
- Coverage and repeat frequency needs
  - Concentrated along deforming plate boundary regions
  - SE processes are dynamic with hazard processes (volcanoes, earthquakes, landslides) changing on timescales of minutes to days
- Thoughts about future activities
  - Baseline high-resolution bare earth and vegetation structure are needed globally
  - Targeted, high-resolution, rapid revisit, low latency topography is needed globally for studying and responding to dynamic hazards
  - Airborne campaigns are needed to assess emerging technologies and platforms
  - Targets would include volcanoes, active fault systems, landslides, and coastlines over a range of vegetation cover
  - Data sets include existing lidar and photogrammetry for volcanoes and fault systems and nearby landscape processes