DEM basics

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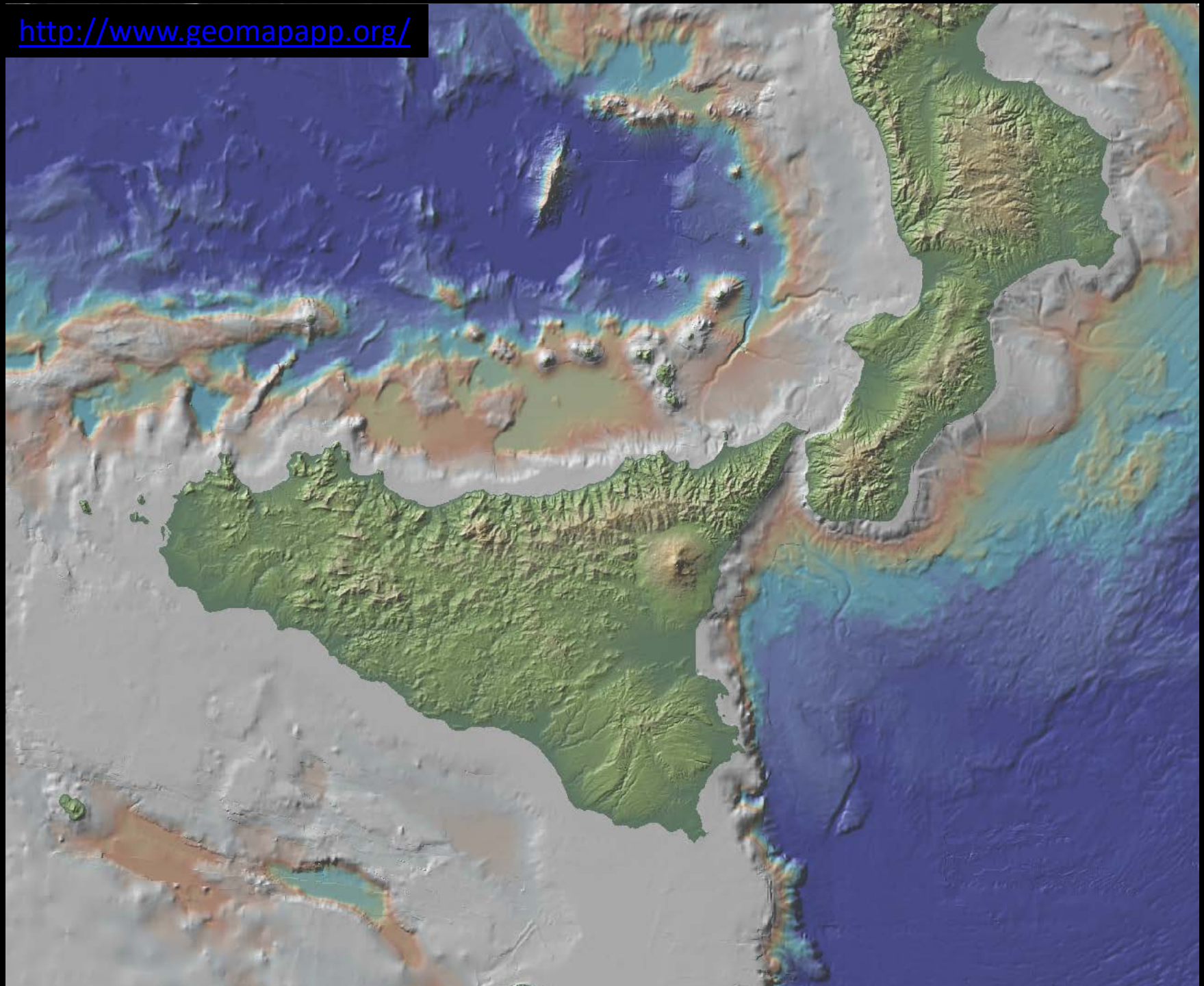
Topography

Fundamental geophysical constraint

Potential energy = mass x gravity x relative height

Drives and resists processes and hazards


http://www.geomapapp.org/

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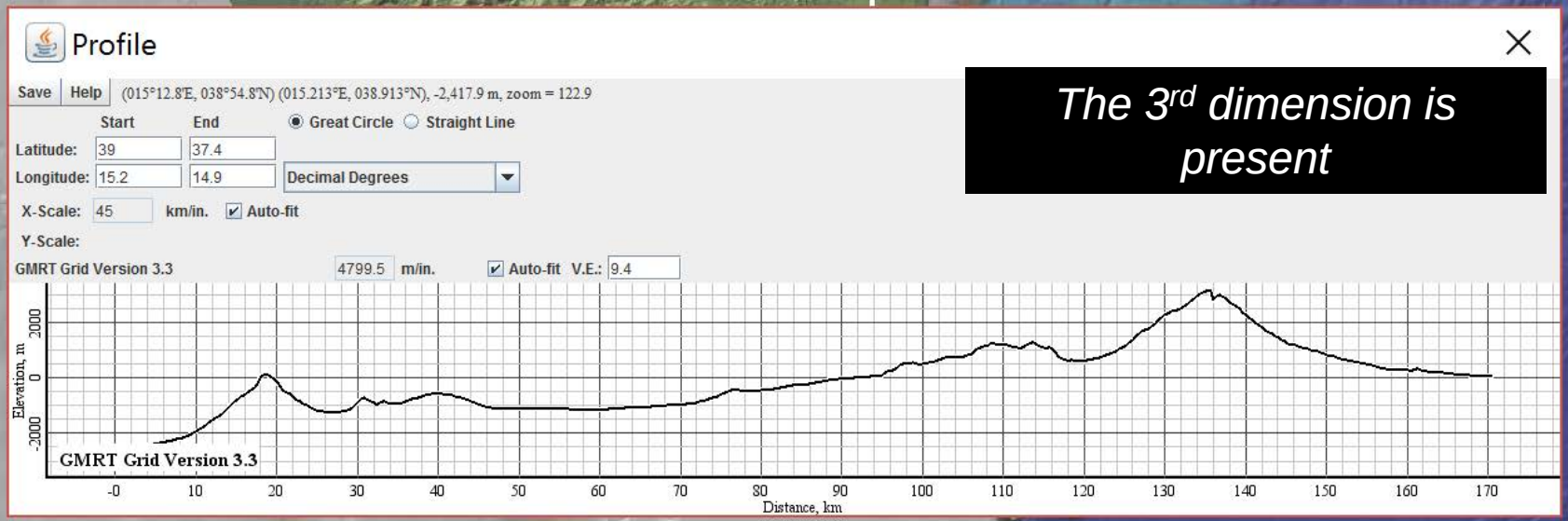
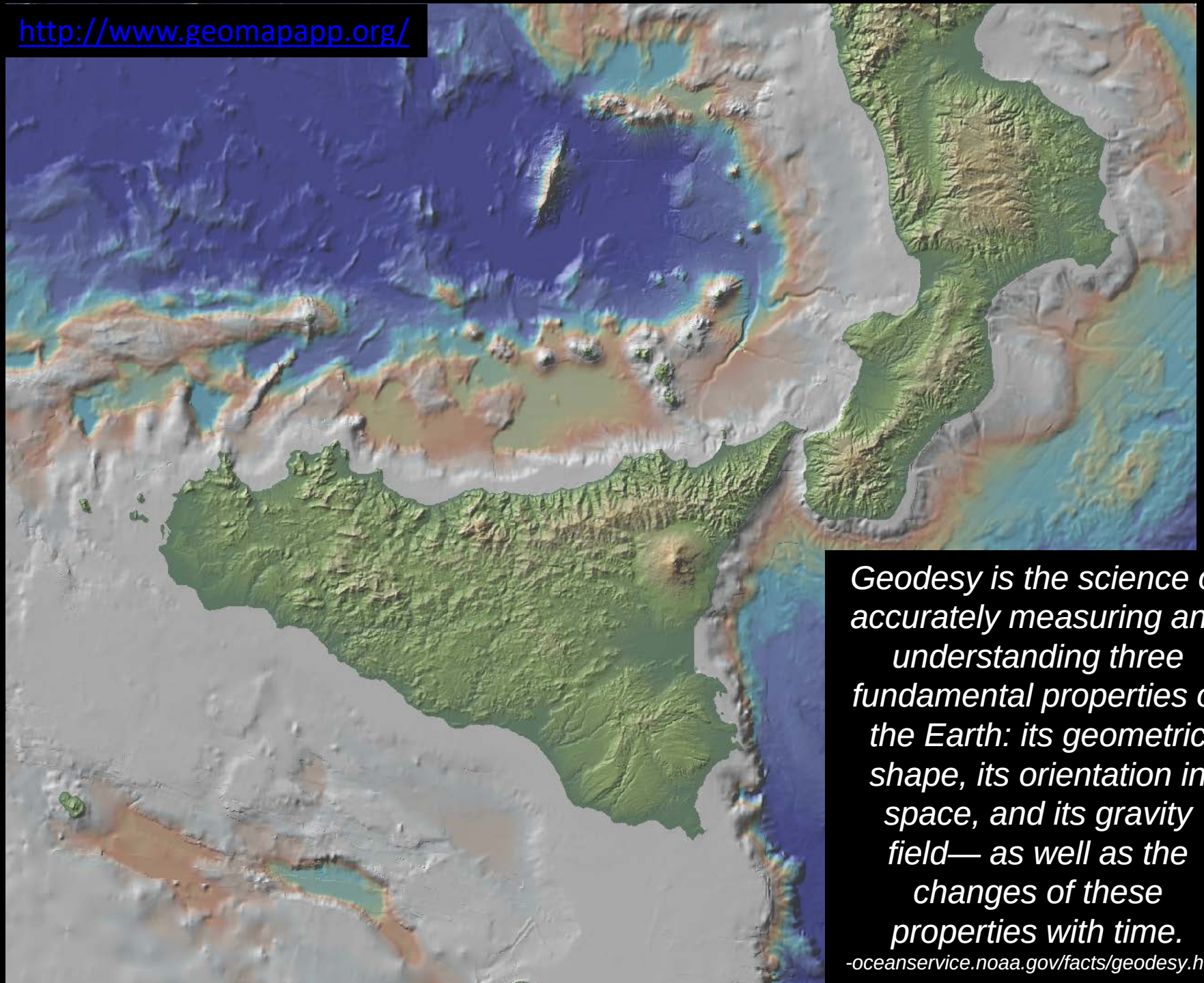


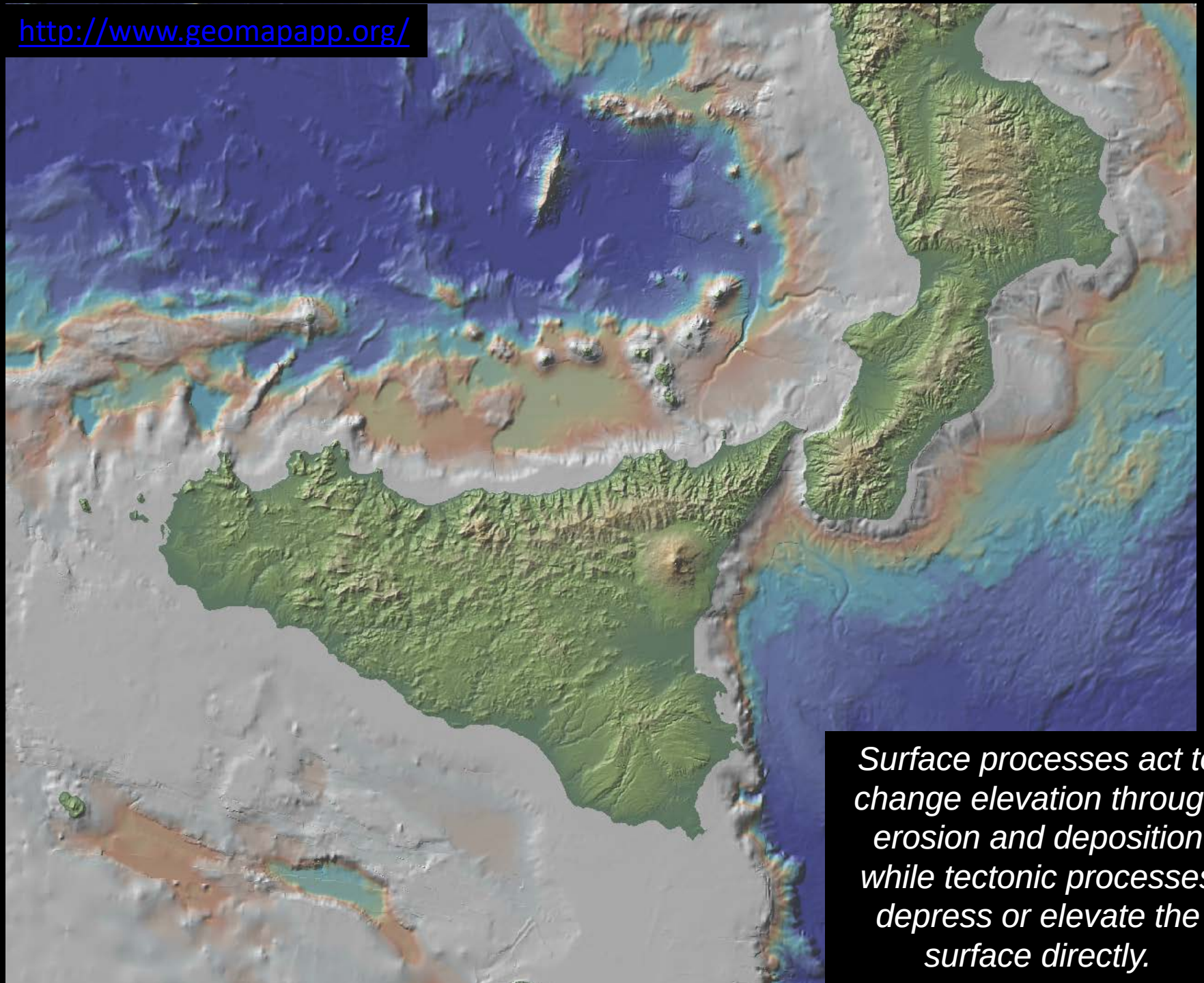
The 3rd dimension is present

http://www.geomapapp.org/



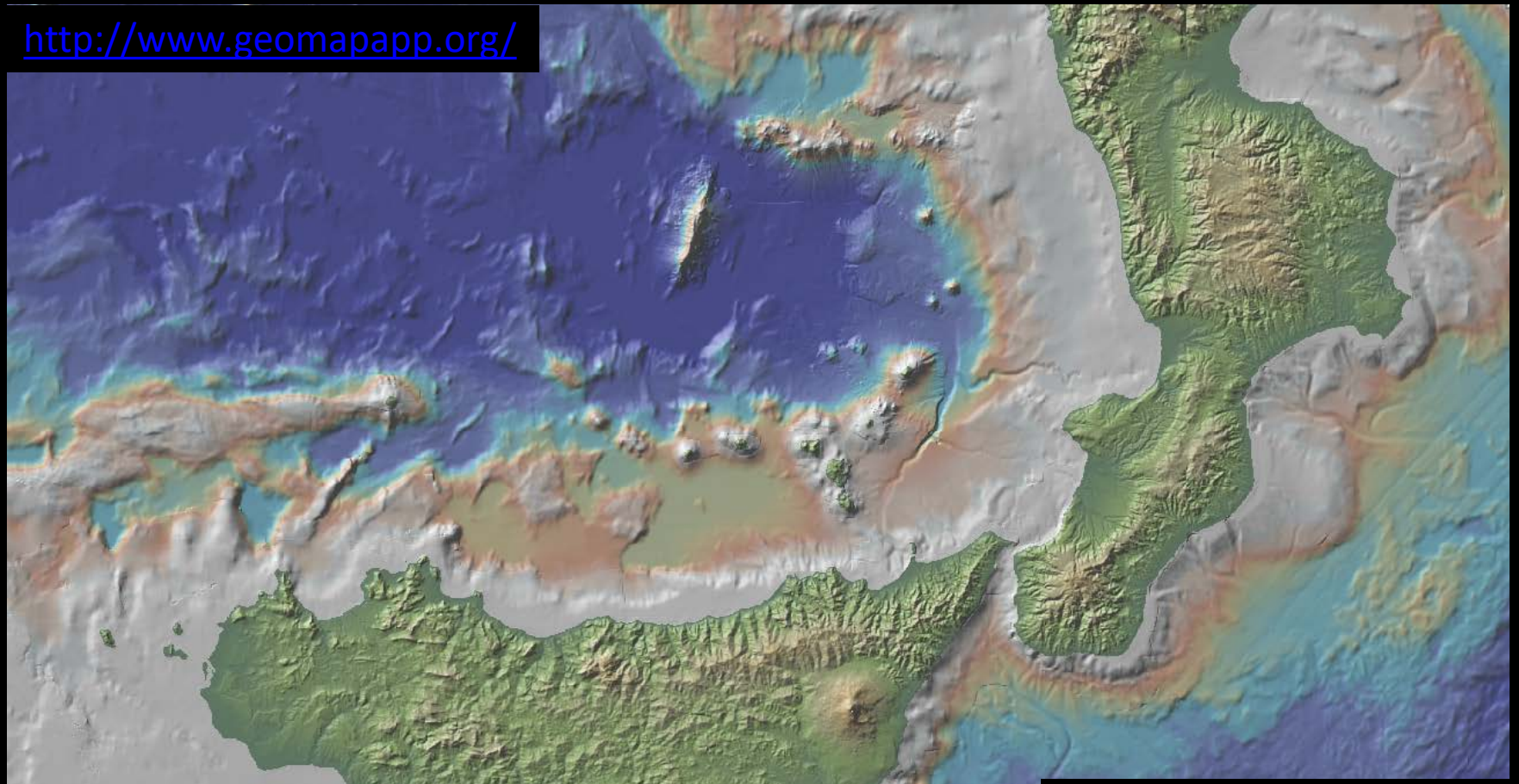
Geodesy is the science of accurately measuring and understanding three fundamental properties of the Earth: its geometric shape, its orientation in space, and its gravity field— as well as the changes of these properties with time.

-oceanservice.noaa.gov/facts/geodesy.html



Surface processes act to change elevation through erosion and deposition while tectonic processes depress or elevate the surface directly.

http://www.geomapapp.org/

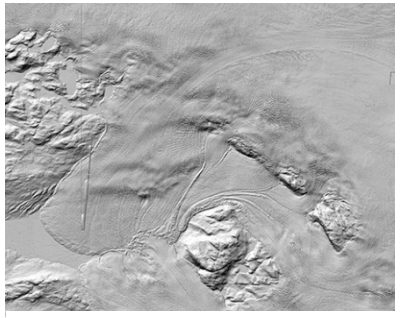


Topography and geomorphology (study of landforms and surface processes) helps to link between timescales of seismology and crustal deformation (1-10 yr) and geology and tectonics (1-10 Myr)

Getting the right coverage in time, space, and resolution for the question

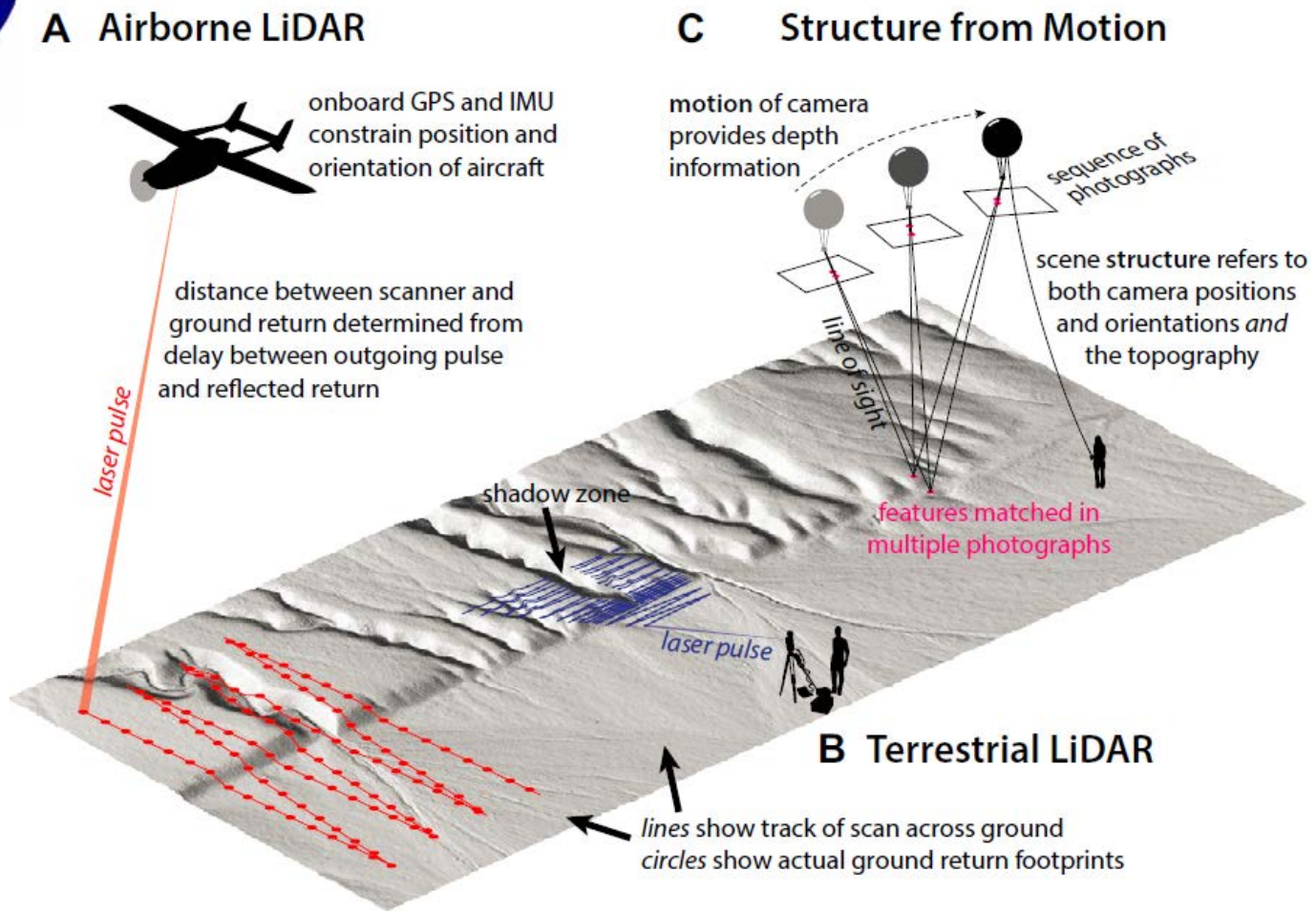
Global and regional topography/bathy (10s-100s m/pix)

+ASTER



Stereo-Photogrammetric Elevation Model (Polar Geospatial Center)

Local to site scale topography (dm to m / pix)



Johnson, K., Nissen, E., Saripalli, S., Arrowsmith, J R., McGarey, P., Scharer, K., Williams, P., Blisniuk, K., Rapid mapping of ultra-fine fault zone topography with Structure from Motion, Geosphere, v. 10; no. 5; p. 1–18; doi:10.1130/GES01017.1, 2014.

Digital Elevation Models

- Digital representation of topography / terrain
  - "Raster" format – a grid of squares or "pixels"
  - Continuous surface where Z (elevation) is estimated on a regular X,Y grid
  - "2.5D"

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	0
0	50	100	100	100	100	100	100	100	100	100	100	100	100	100	50	0
0	50	100	150	150	150	150	150	150	150	150	150	150	150	100	50	0
0	50	100	150	200	200	200	200	200	200	200	200	200	150	100	50	0
0	50	100	150	200	250	250	250	250	250	250	250	200	150	100	50	0
0	50	100	150	200	250	300	300	300	300	300	250	200	150	100	50	0
0	50	100	150	200	250	300	350	350	350	300	250	200	150	100	50	0
0	50	100	150	200	250	300	350	400	350	300	250	200	150	100	50	0
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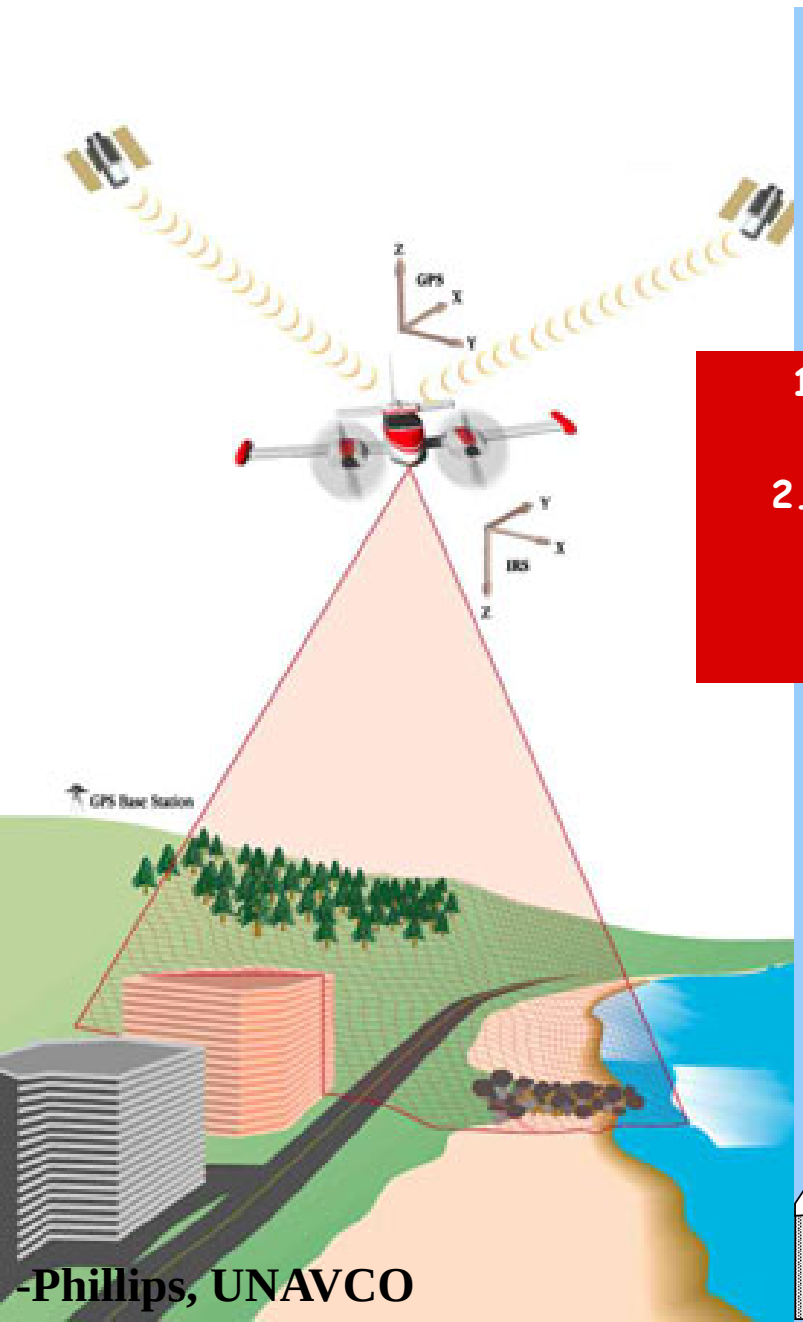
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

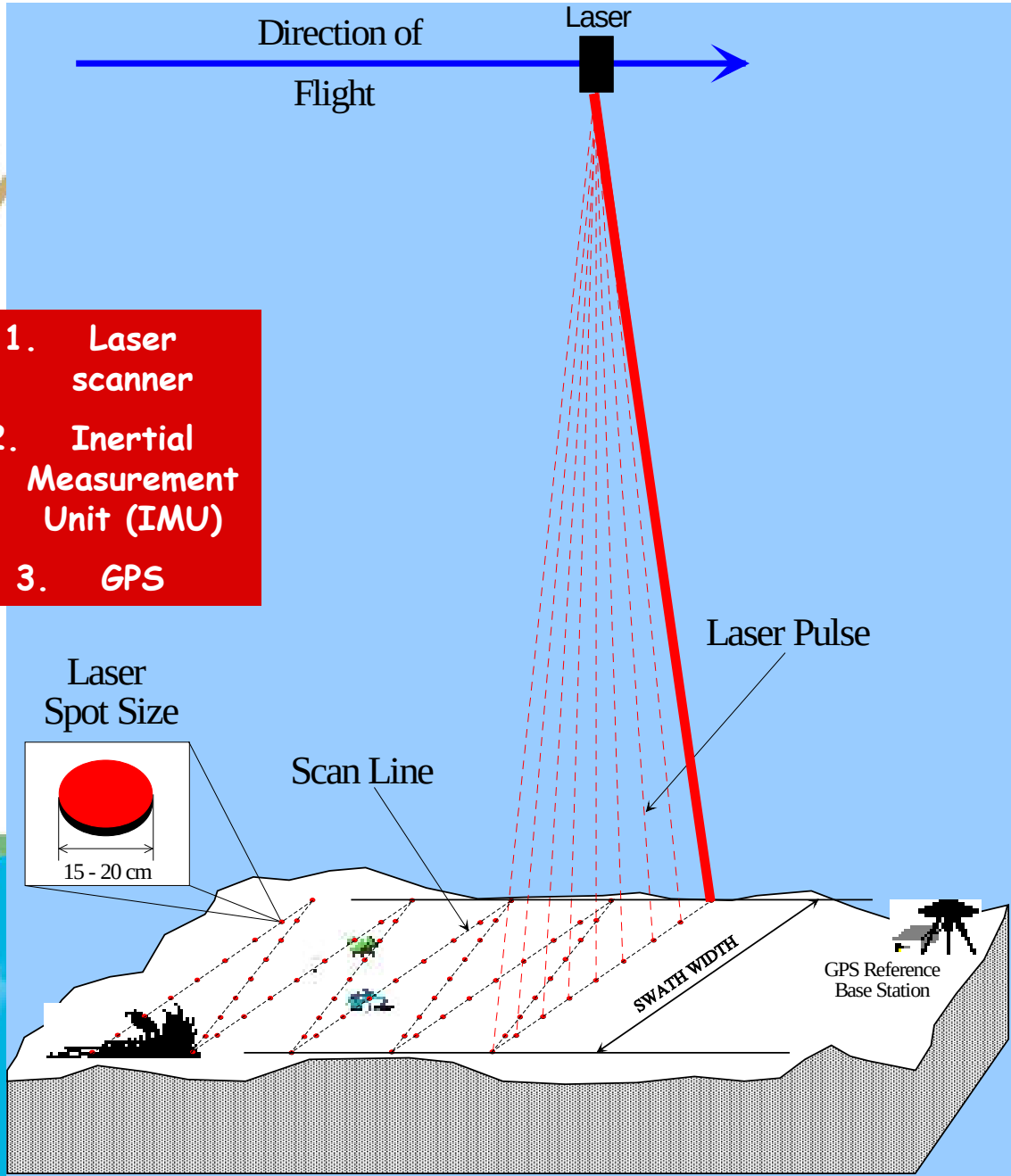
Source: http://www.ncgia.ucsb.edu/giscc/extra/e001/e001.html

- Grid resolution is defined by the size in the horizontal dimension of the pixel
  - 1 meter DEM has pixels 1 m x 1m assigned a single elevation value.

Airborne Laser Swath Mapping (ALSM)

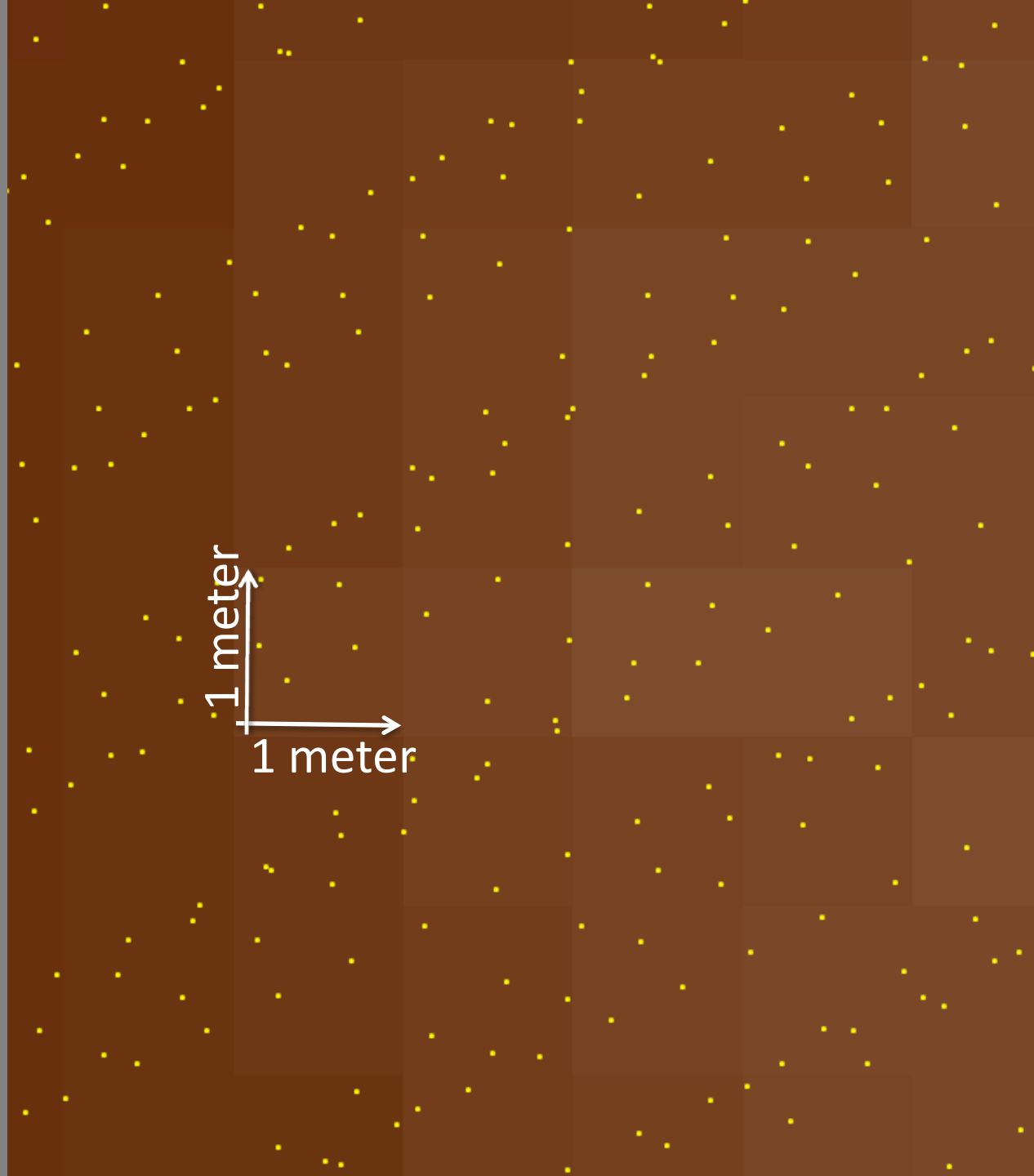


1. Laser scanner
2. Inertial Measurement Unit (IMU)
3. GPS



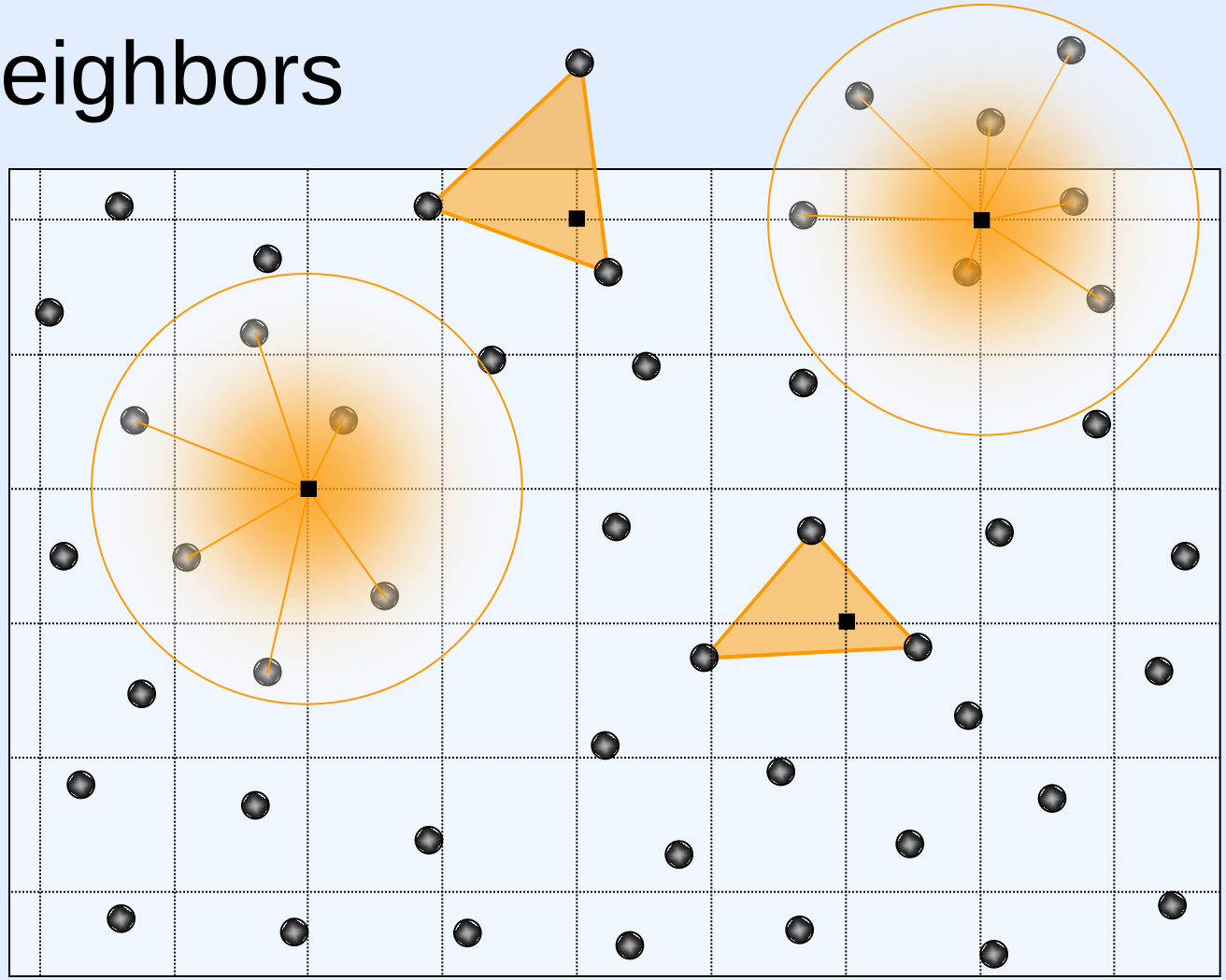
-Phillips, UNAVCO

- 1 meter grid
- LiDAR returns from EarthScope data collection
- Example from flat area with little or no vegetation so ground is sampled approx. 5+ times per square meter
- How do we best fit a continuous surface to these points?
- Ultimately wish to represent irregularly sampled data on a regularized grid.



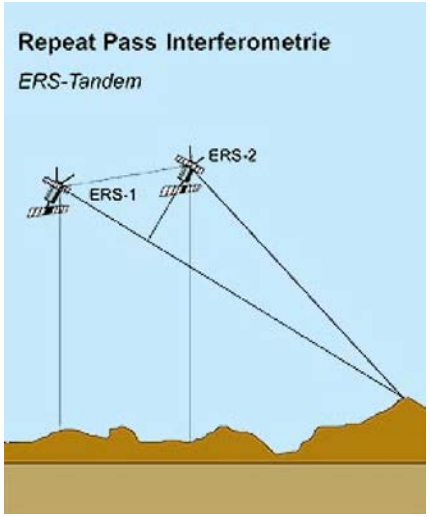
Interpolation Methods

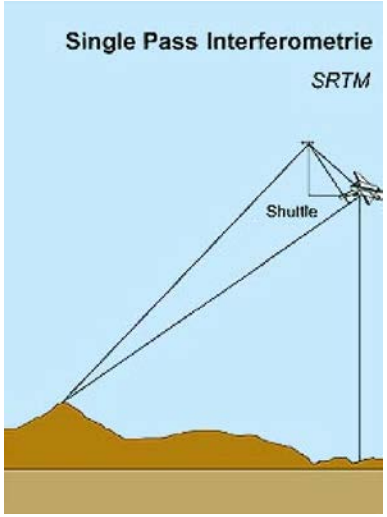
- Inverse Distance Weighting (IDW)
- Natural Neighbors
- Kriging
- Splines
- TIN
  - linear
  - quintic
- …



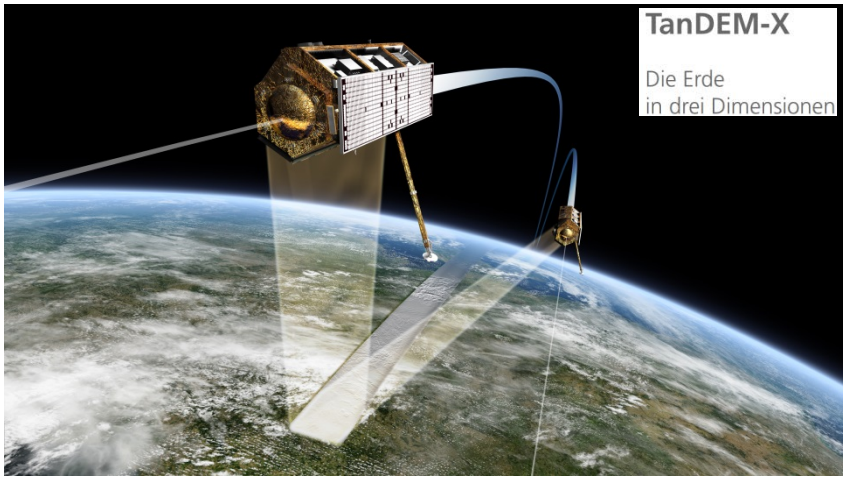
Isenburg, et al., 2006

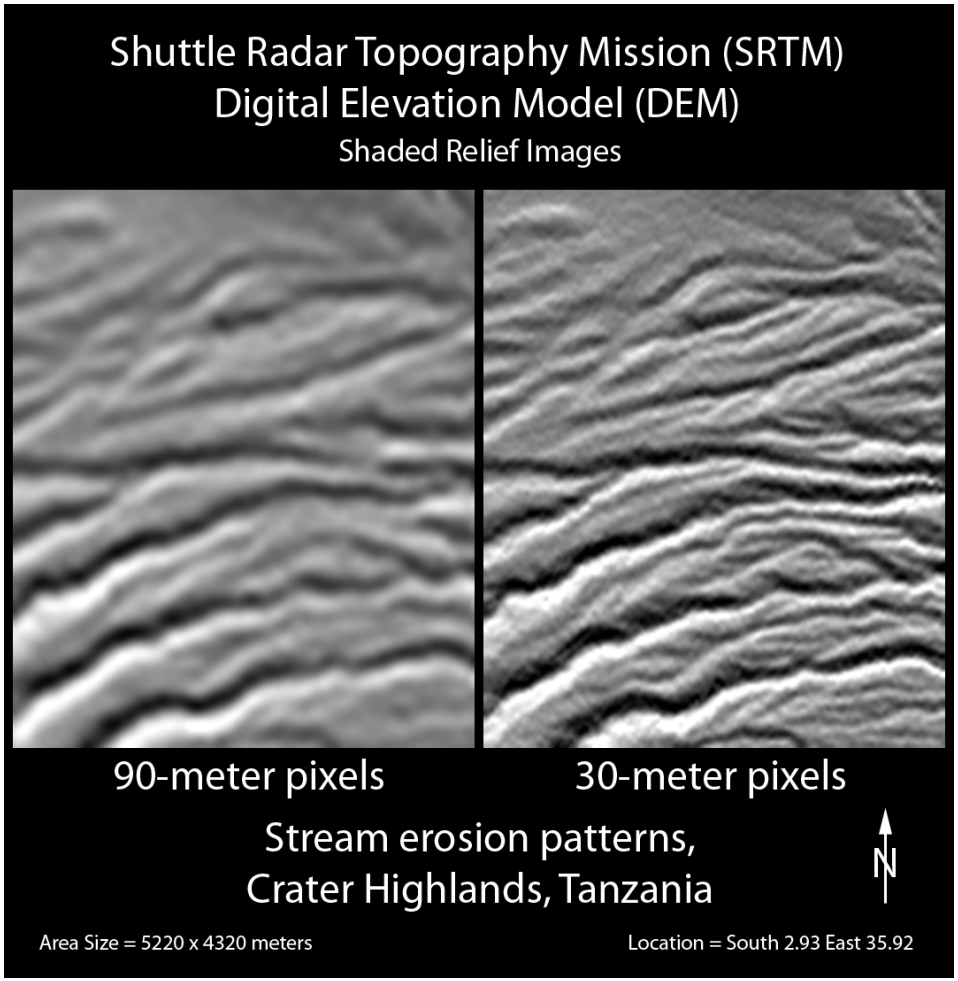
Radar interferometry (e.g., Shuttle Radar Topography Mission)

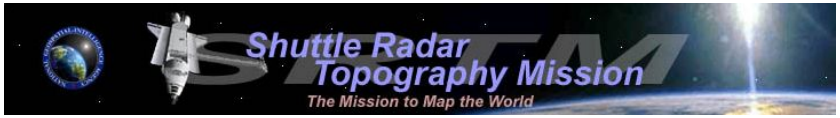




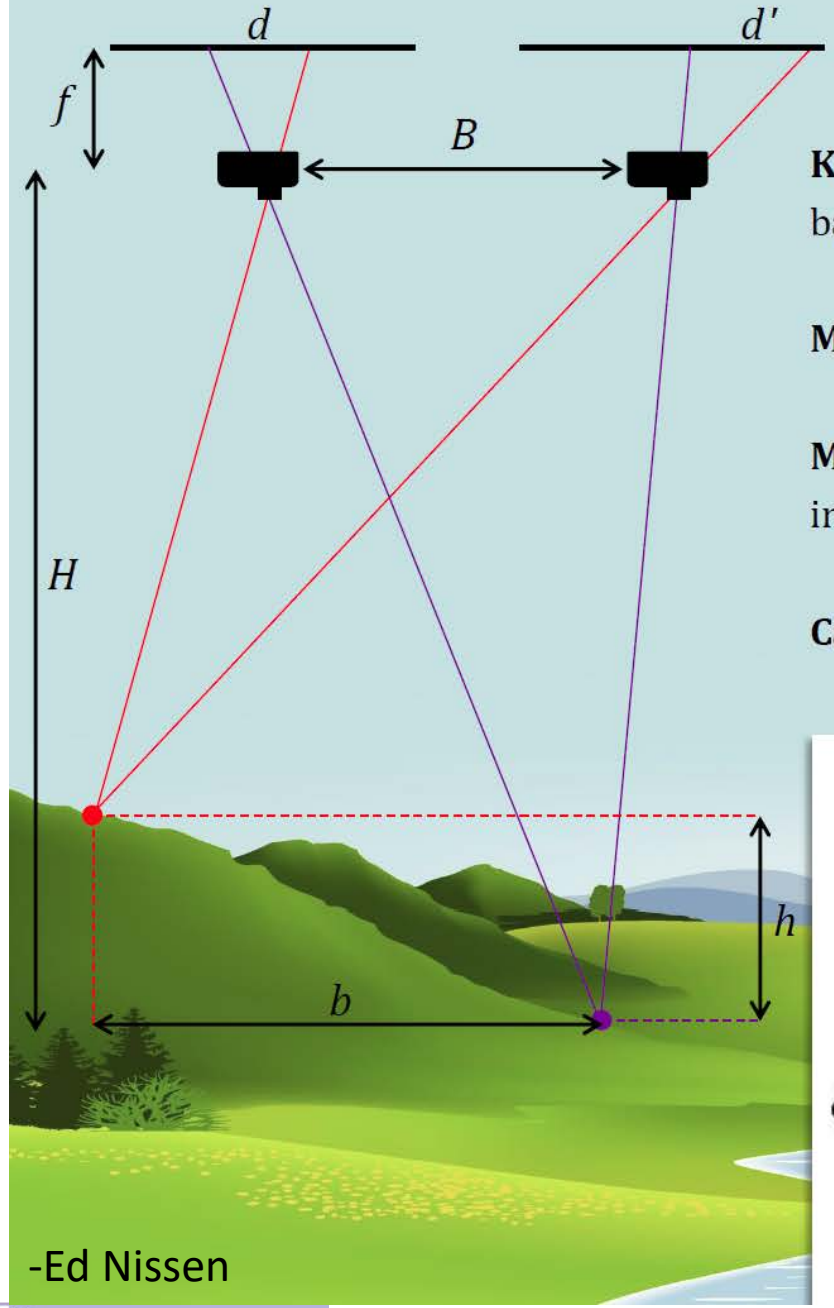
http://www.dlr.de/en/Portaldata/60/Resources/dokumente/7_sat_miss/srtm_DEM_generierung_en.pdf







Traditional stereo-photogrammetry



Known camera height *H* and focal length *f*, and the baseline *B* between images

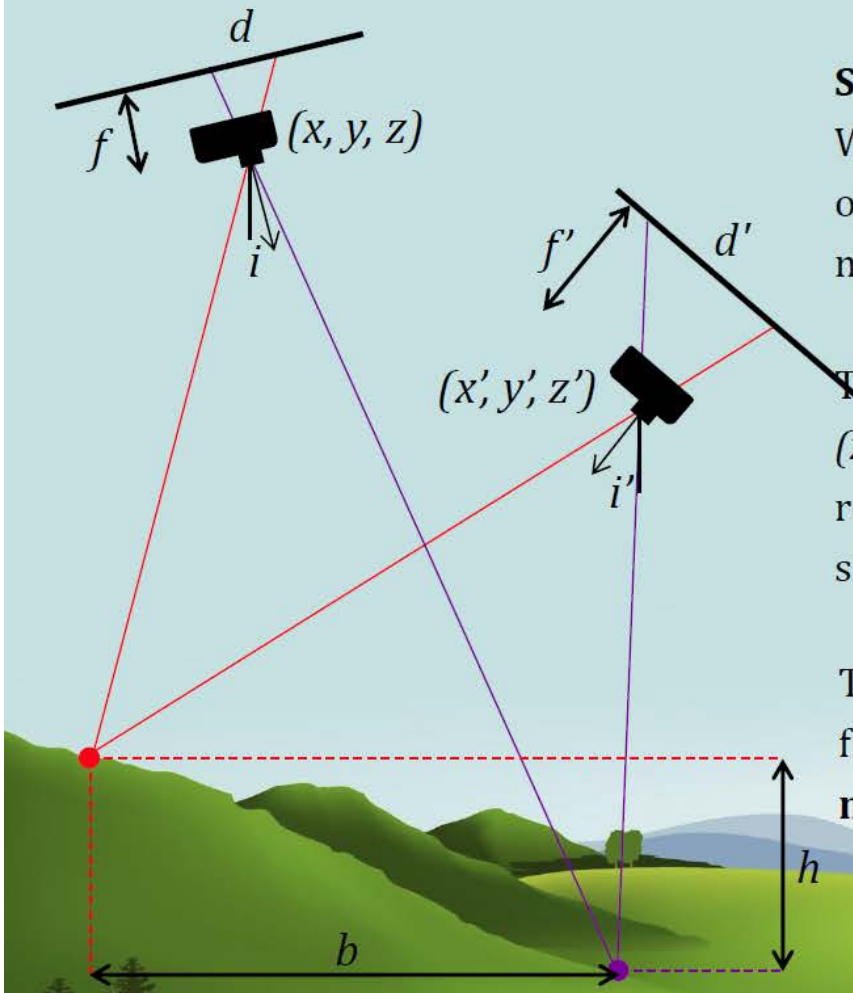
Match corresponding features

Measure distances between features on the camera image plane *d*, *d'*

Calculate relative positions of features *b*, *h*

-Ed Nissen

Structure-from-Motion



Step 2 Produce a "sparse cloud"

When we have the matching locations of multiple points on two or more photos, there is usually just one mathematical solution for where the photos were taken.

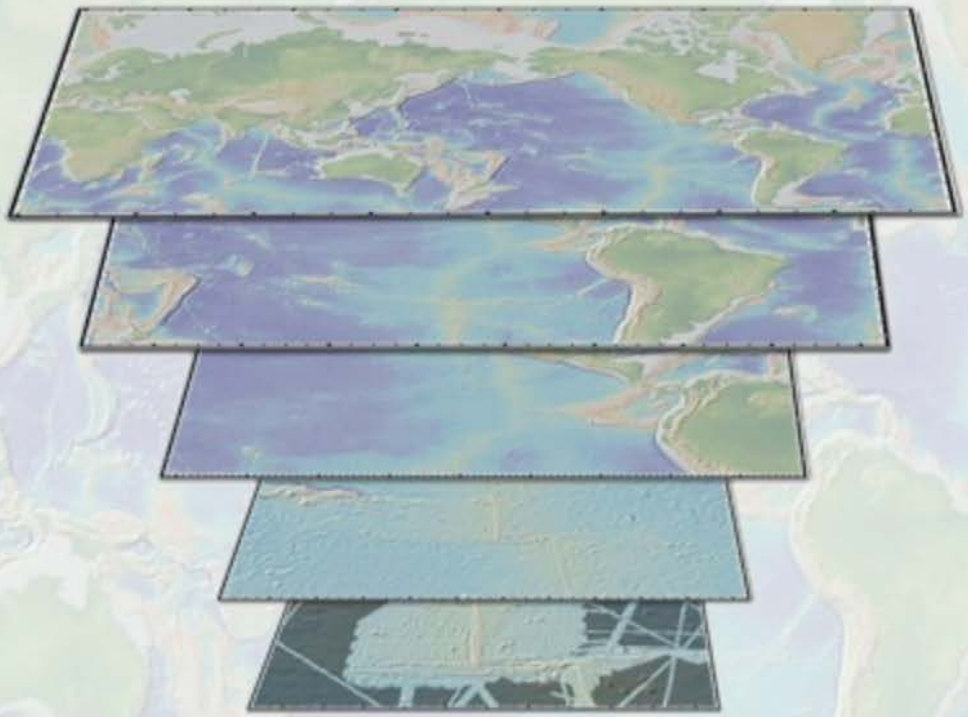
Therefore, we can calculate individual camera positions *(x, y, z), (x', y', z'),* orientations *i, i'*, focal lengths *f, f'*, and relative positions of corresponding features *b, h,* in a single step known as **"bundle adjustment".**

This is where the term Structure from Motion comes from. Scene **structure** refers to all these parameters; **motion** refers to movement of the camera

· -Ed Nissen

Global Multi-Resolution Topography (GMRT) Data Synthesis (topography + bathymetry)

MGDS MARINE GEOSCIENCE DATA SYSTEM



Global coverage

100m swath data and grids

User experiences seamless transition between resolutions based on chosen zoom level

http://www.marine-geo.org/portals/gmrt/