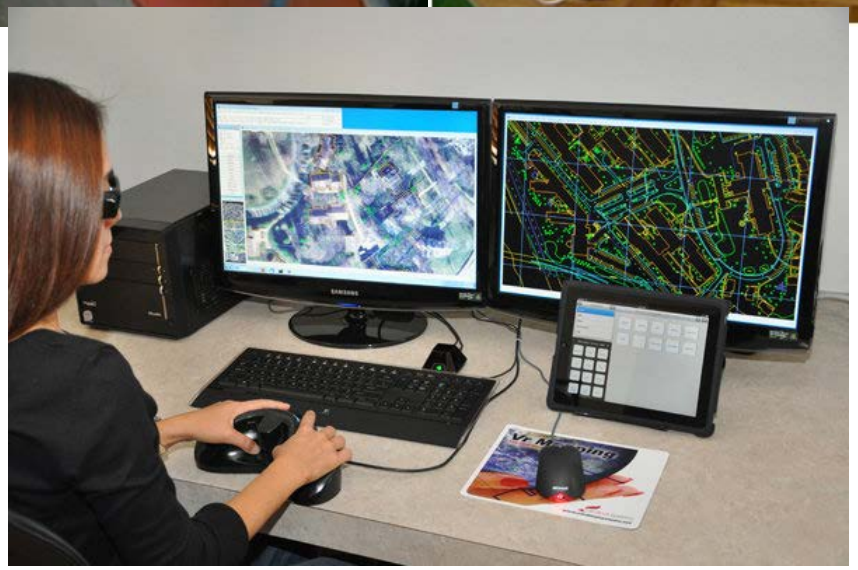
Analytical and Computer Cartography Winter 2017

Lecture 14:
Three Dimensional Mapping and Modeling

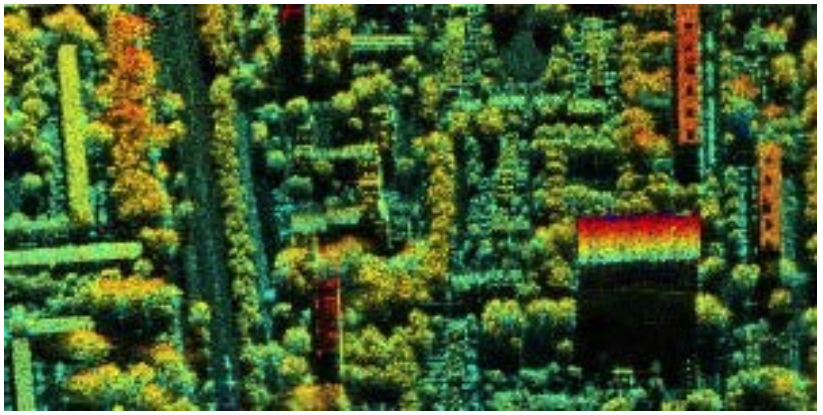
3D measurement systems: remote sensing of objects

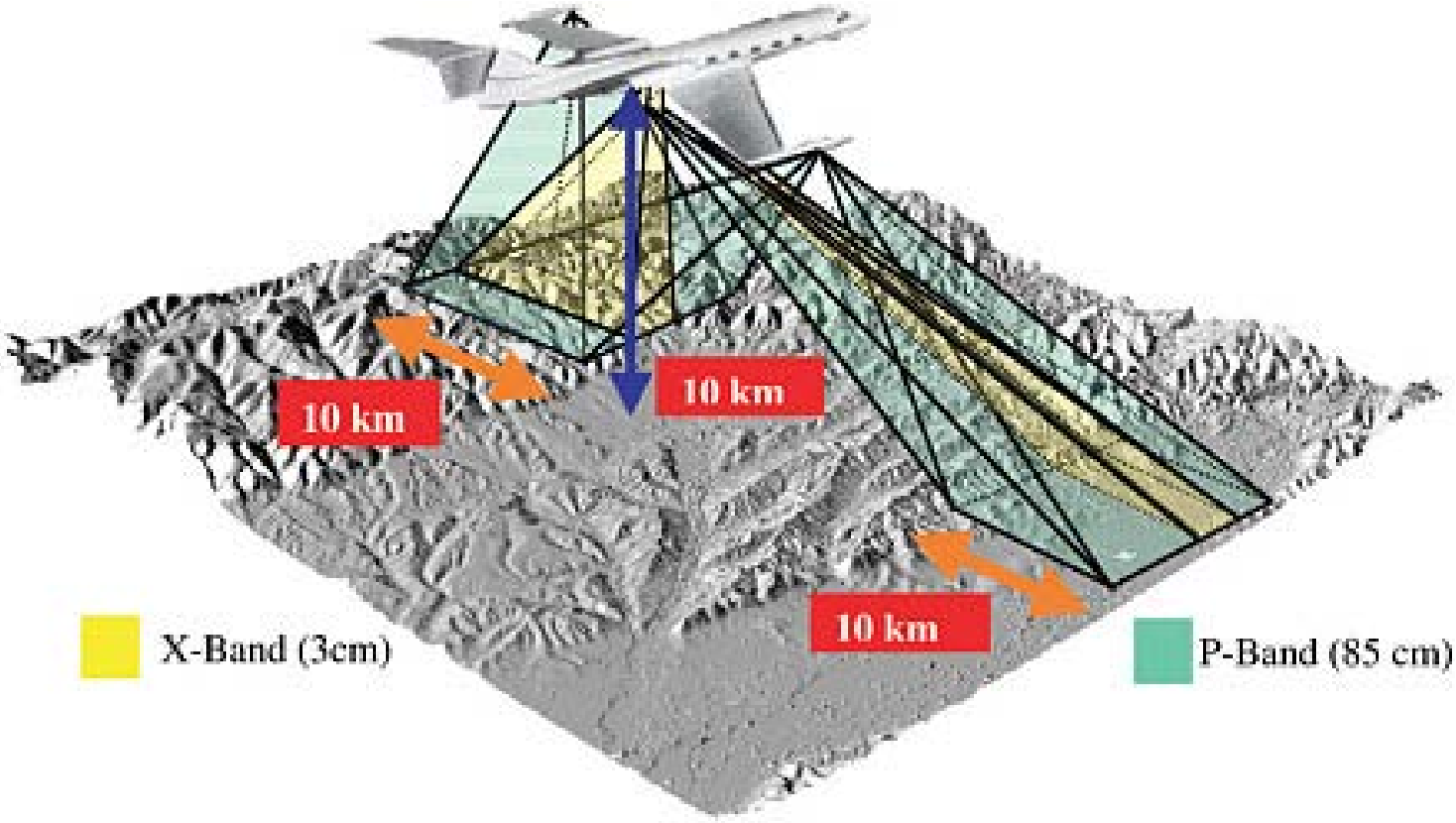
- First generation DEMs, photogrammetry and contour conversion
- Second generation based on SAR and IFSAR
- SRTM near global coverage, 30m/90m
- NED completed at 30m, then 15m and less
- LIDAR has now taking over
- New SfM photogrammetric methods showing promise

Photogrammetry

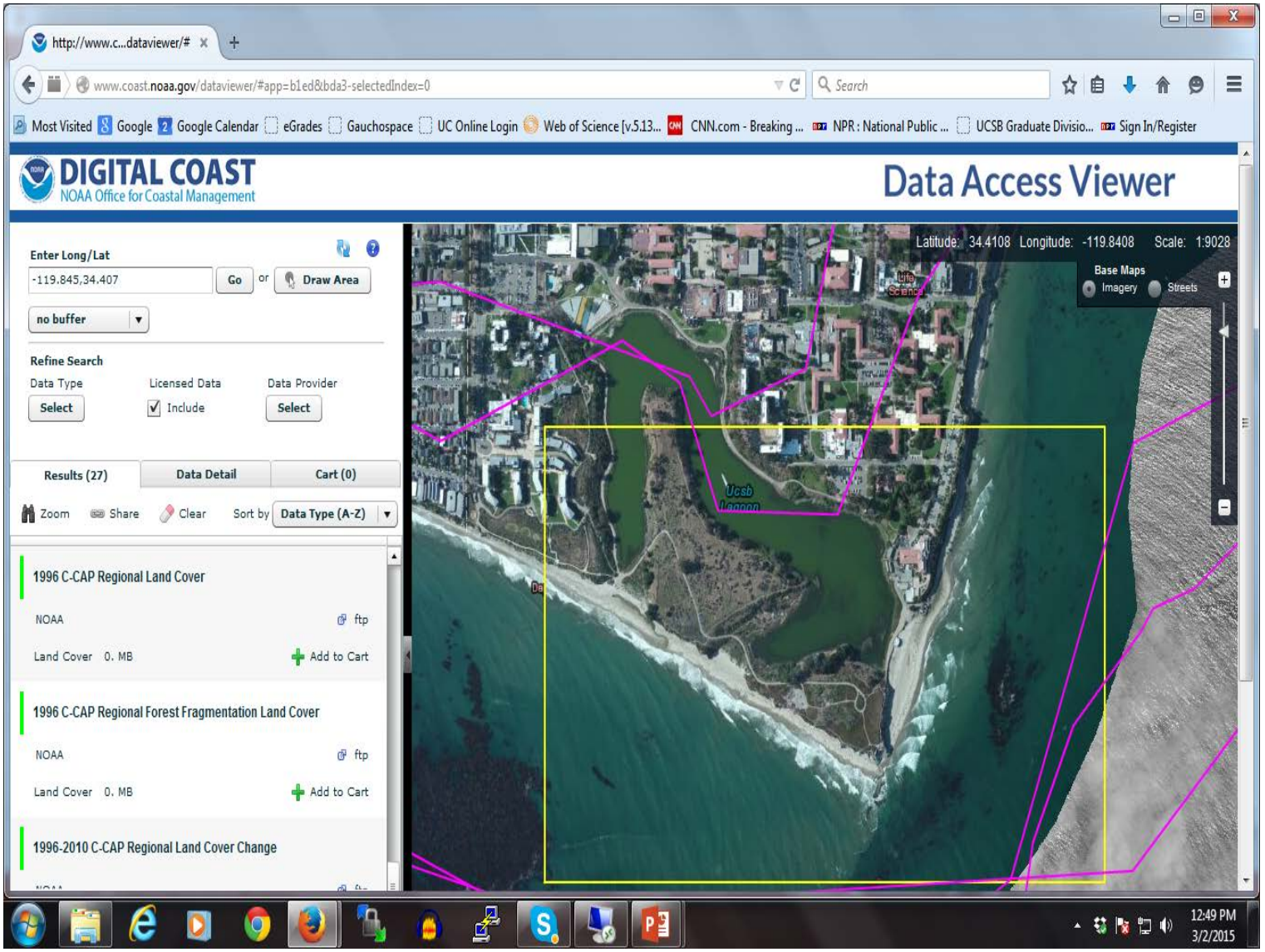


Interferometric Radar

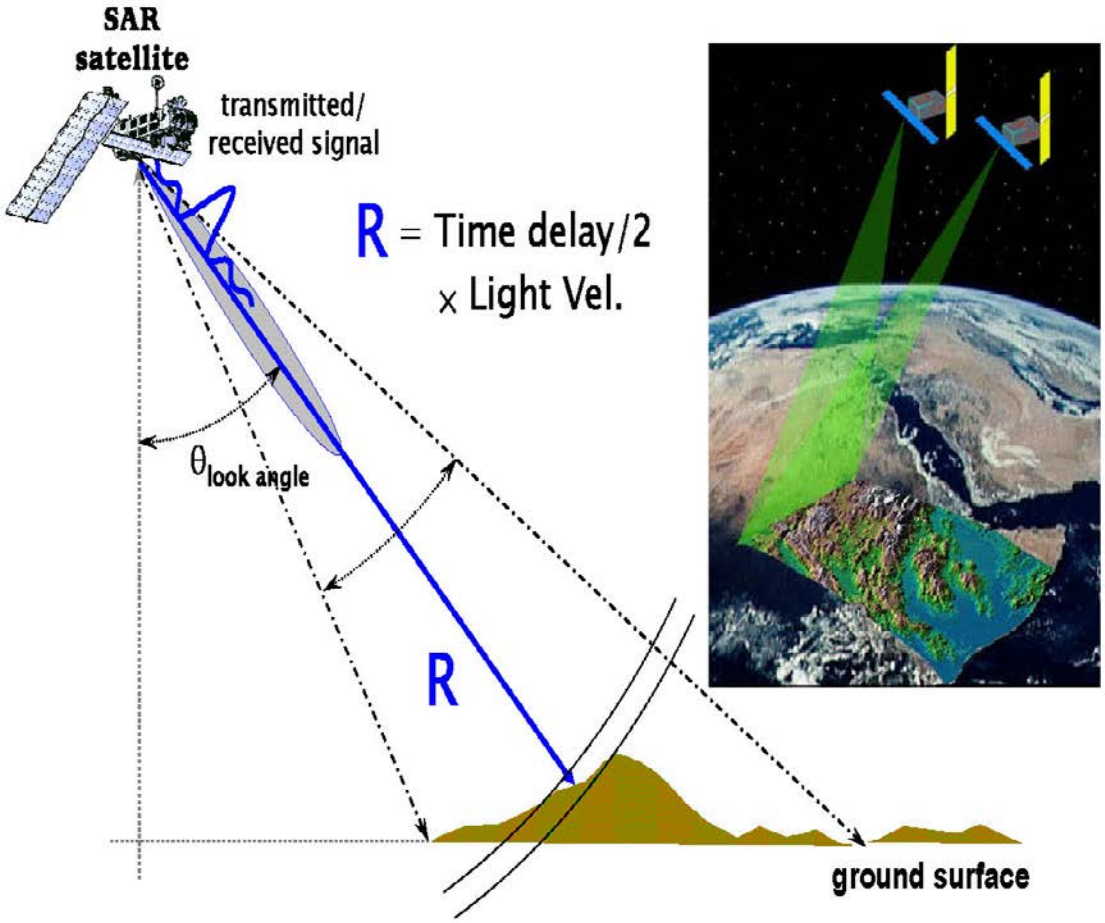




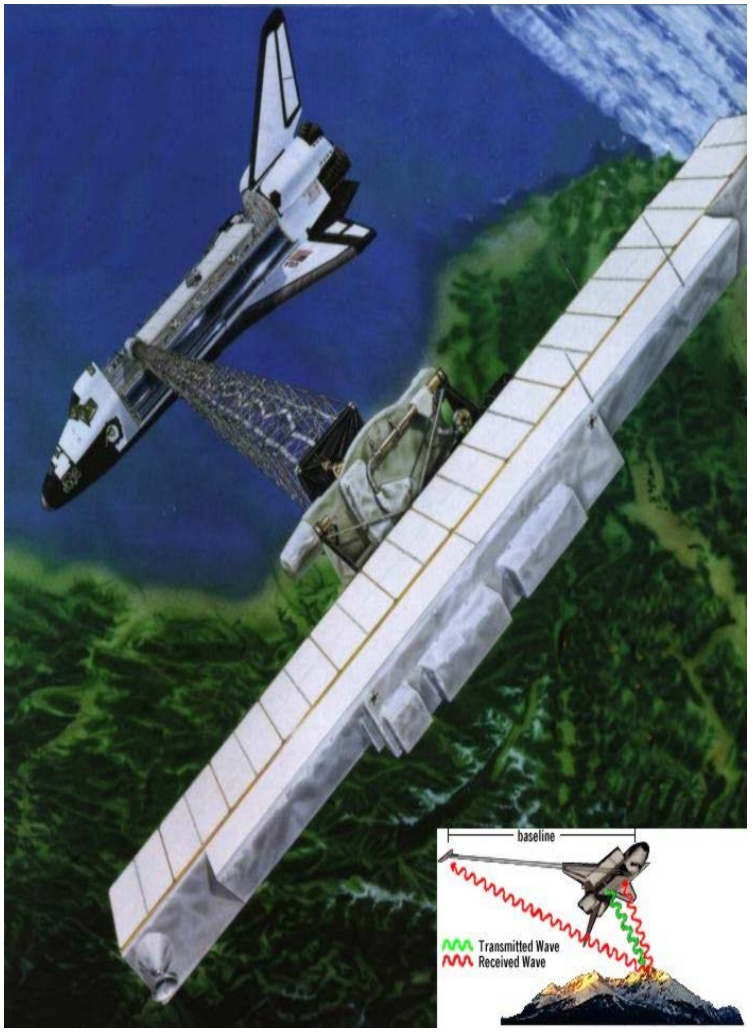
IFSAR DEMs

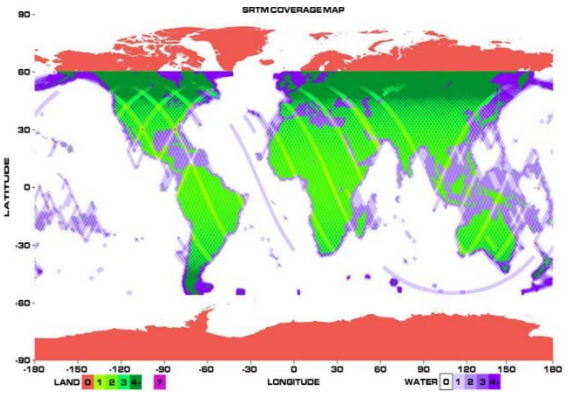

http://www.c...dataviewer/#
www.coast.noaa.gov/dataviewer/#app=b1ed&bda3-selectedIndex=0
Search
Most Visited
Google
Google Calendar
eGrades
Gauchospace
UC Online Login
Web of Science [v.5.13...
CNN.com - Breaking ...
NPR : National Public ...
UCSB Graduate Divisio...
Sign In/Register
DIGITAL COAST
NOAA Office for Coastal Management
Data Access Viewer
Enter Long/Lat
-119.845,34.407
Go
or
Draw Area
no buffer
Refine Search
Data Type
Select
Licensed Data
Include
Data Provider
Select
Results (27)
Data Detail
Cart (0)
Zoom
Share
Clear
Sort by
Data Type (A-Z)
1996 C-CAP Regional Land Cover
NOAA
ftp
Land Cover 0. MB
Add to Cart
1996 C-CAP Regional Forest Fragmentation Land Cover
NOAA
ftp
Land Cover 0. MB
Add to Cart
1996-2010 C-CAP Regional Land Cover Change
Latitude: 34.4108 Longitude: -119.8408 Scale: 1:9028
Base Maps
Imagery
Streets
Ucsb
Lagoon
12:49 PM
3/2/2015

SAR from Space

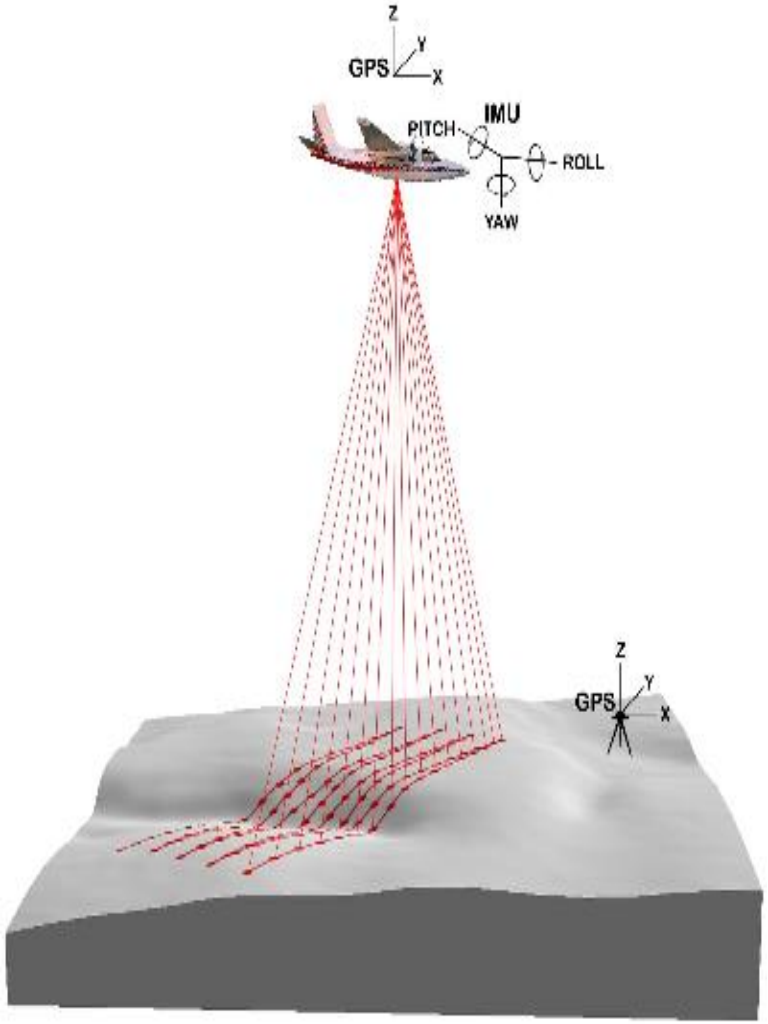


SRTM: Global topo map

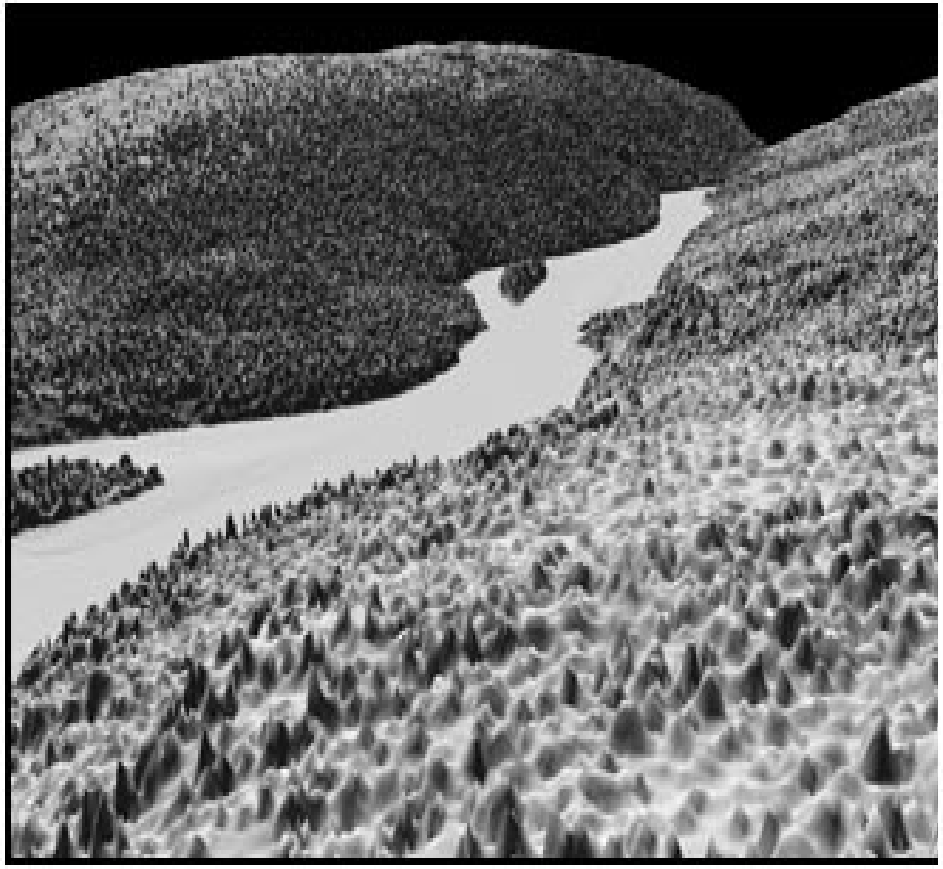


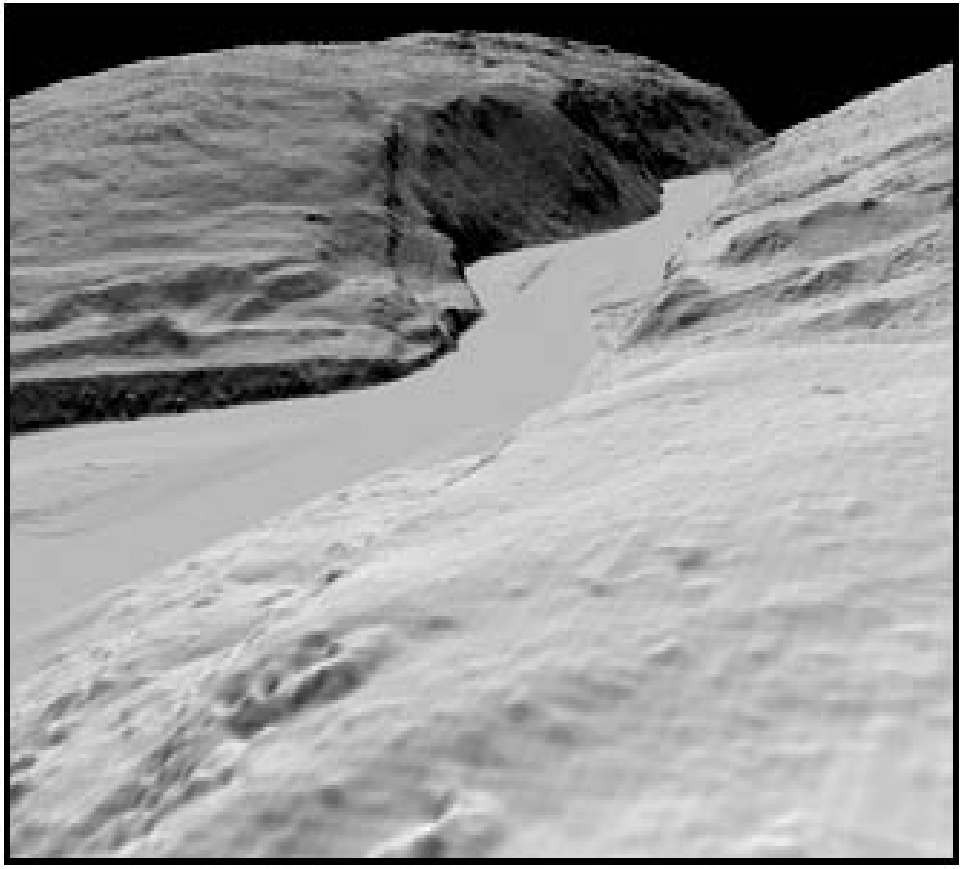


How Lidar works

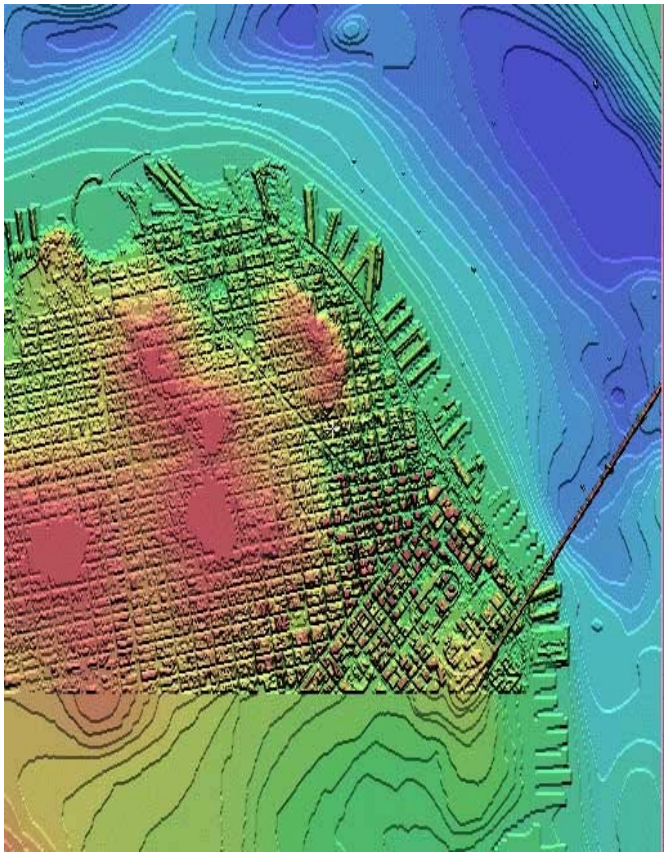


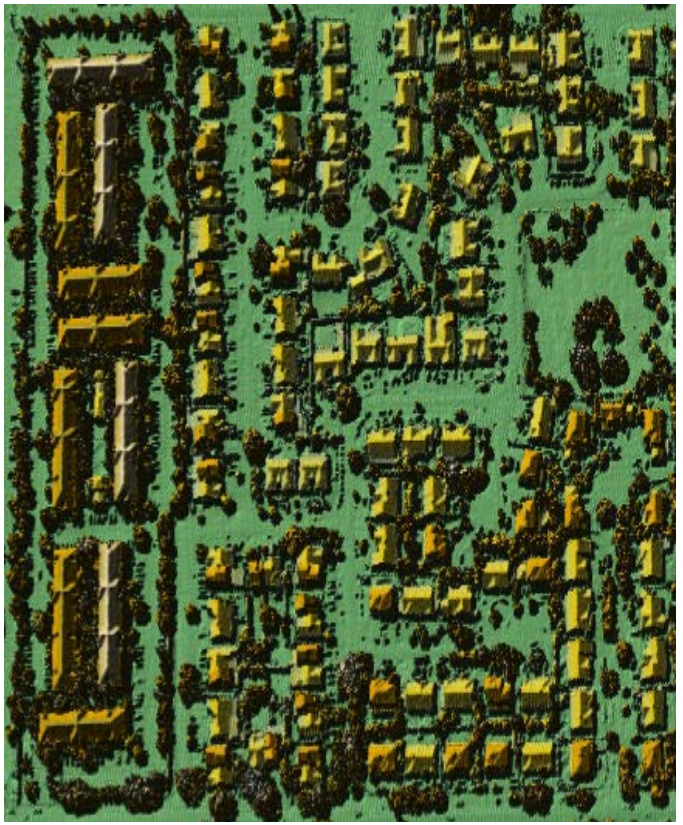
LIDAR first and last pulse



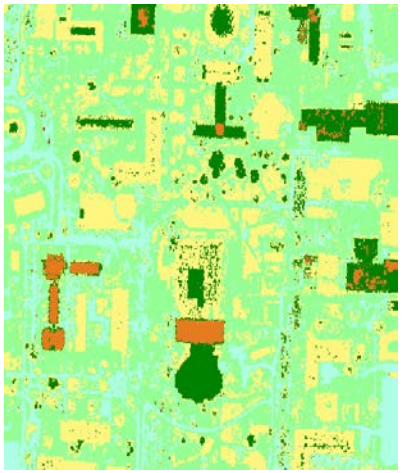


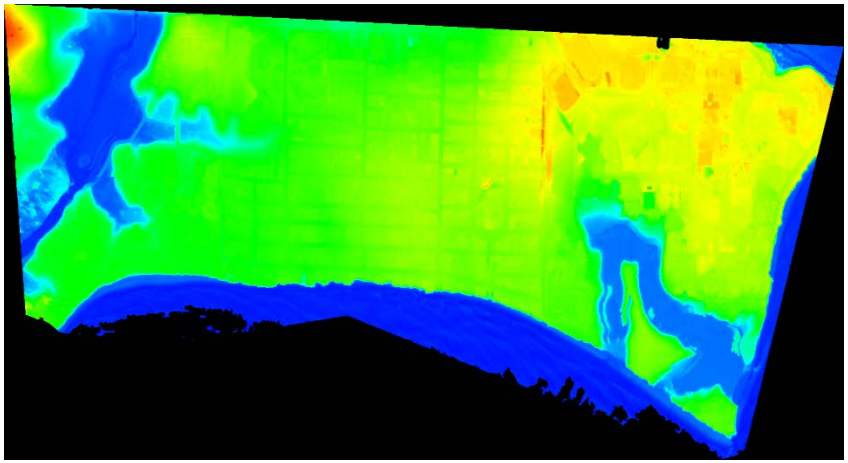
LIDAR terrain detail

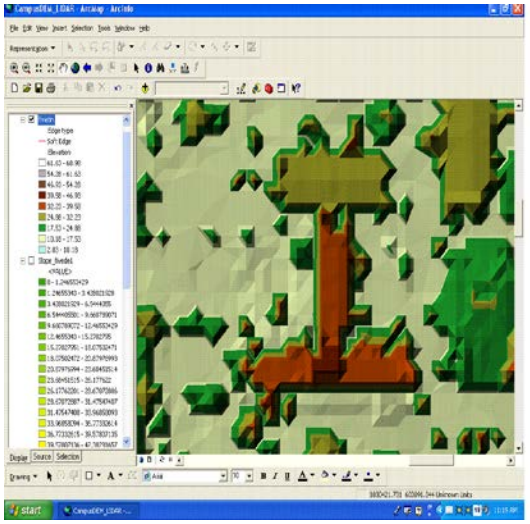


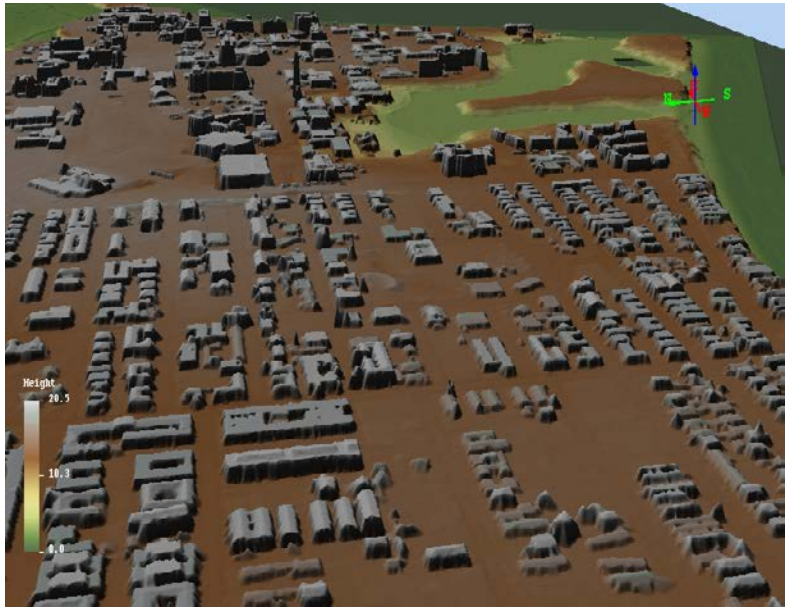


3D Models from LiDAR

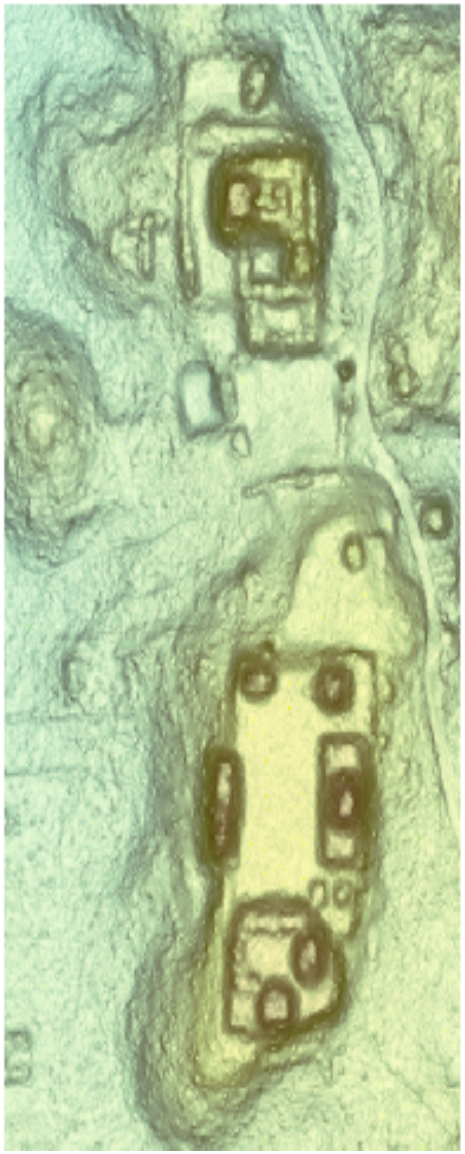


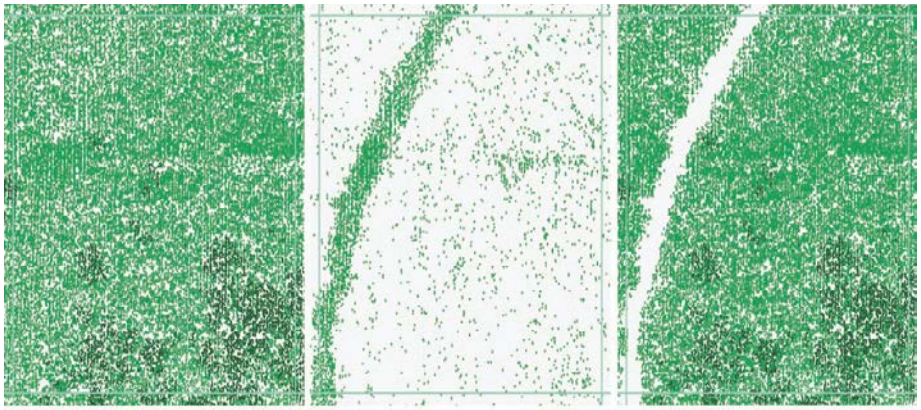


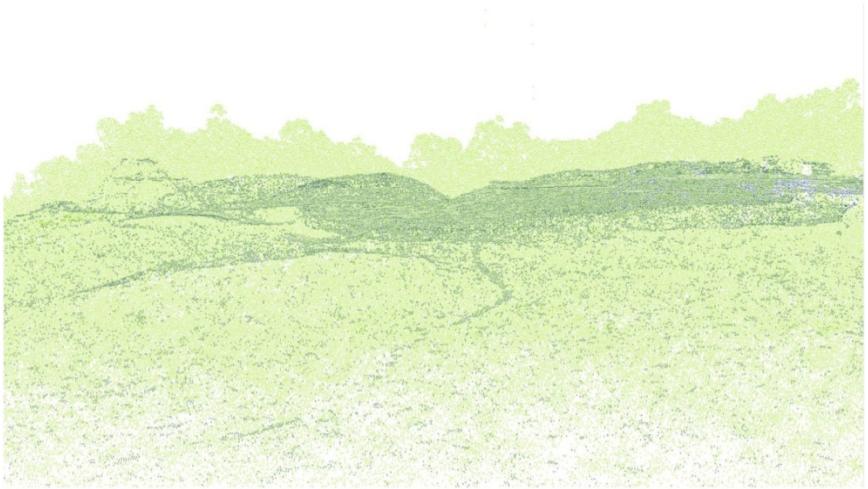


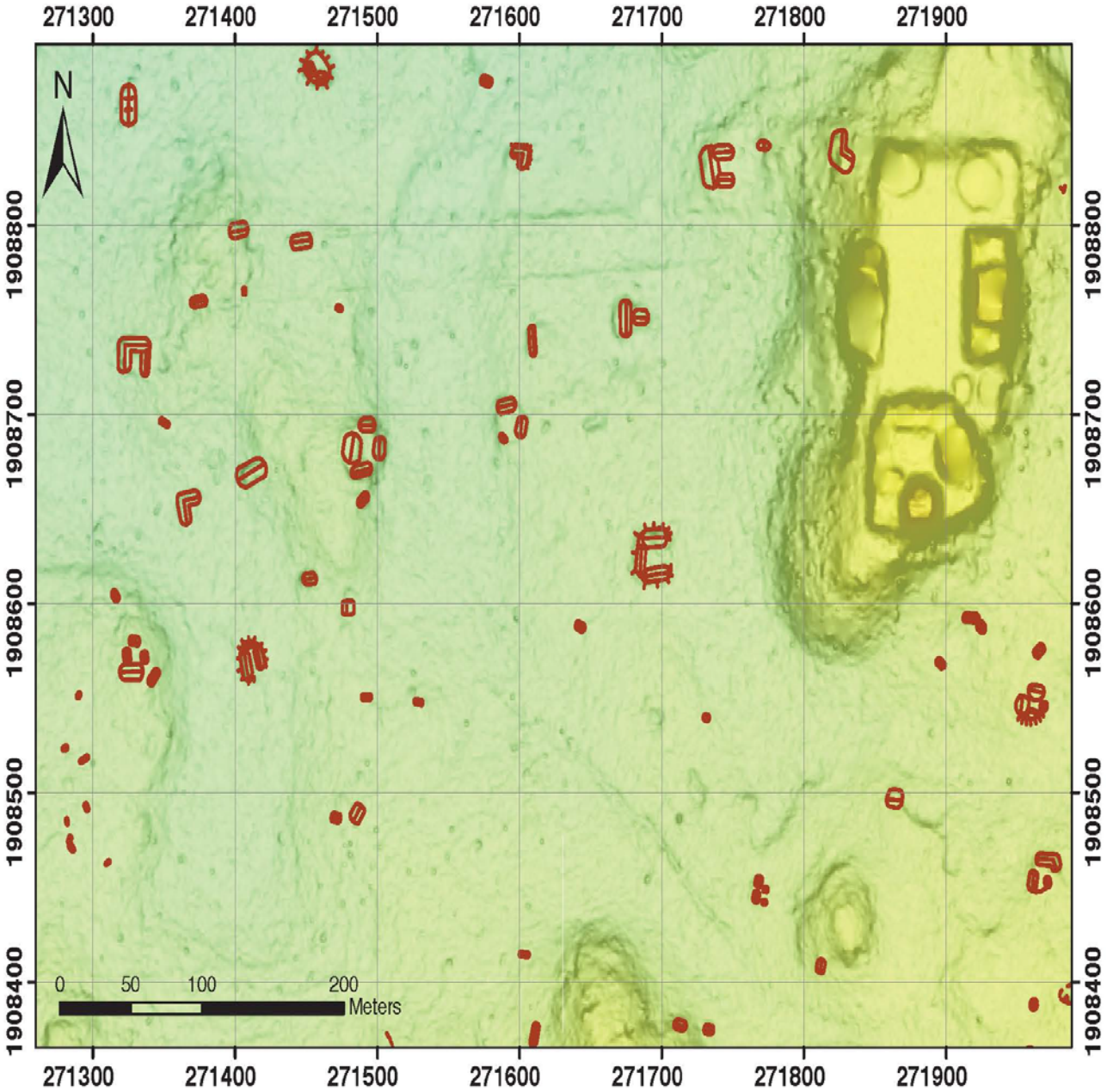


LiDAR at El Pilar

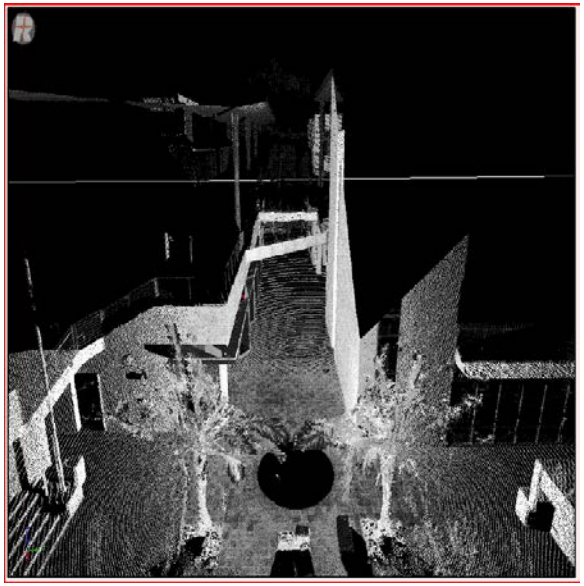


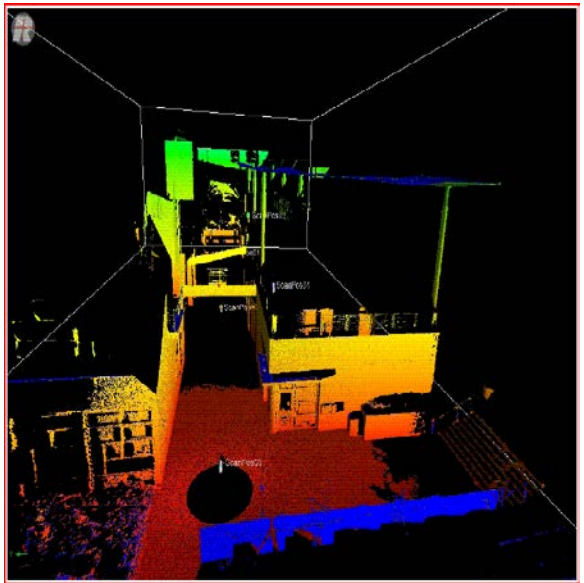




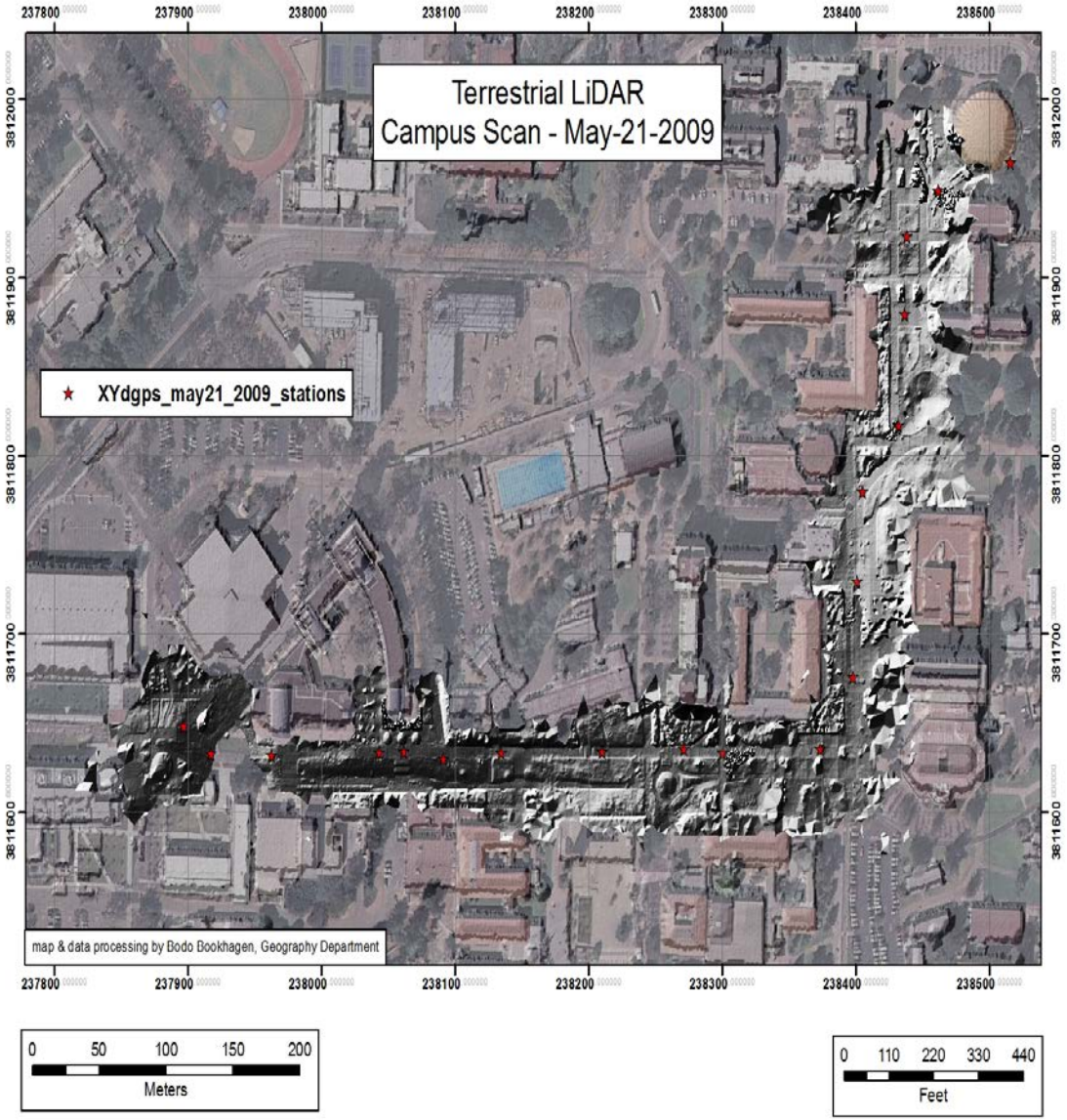

271300
271400
271500
271600
271700
271800
271900
N
1908800
1908700
1908600
1908500
1908400
0
50
100
200
Meters

Terrestrial Scanning LiDAR



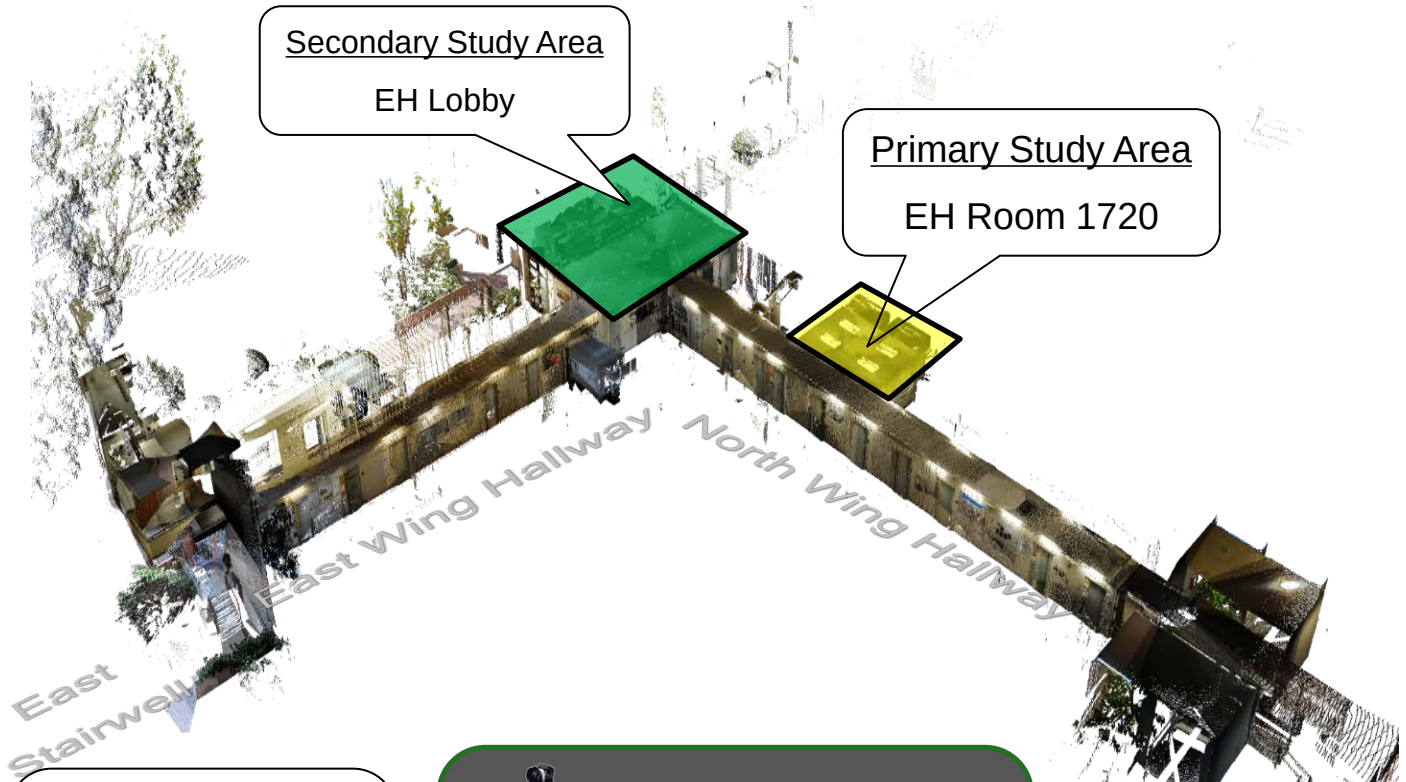


Campus scans



Riegl LMS-Z420i Laser Scanner

Lidar Point Cloud Data
UCSB Ellison Hall, 1st Floor



Additional Study Areas

North Wing Hallway

East Wing Hallway

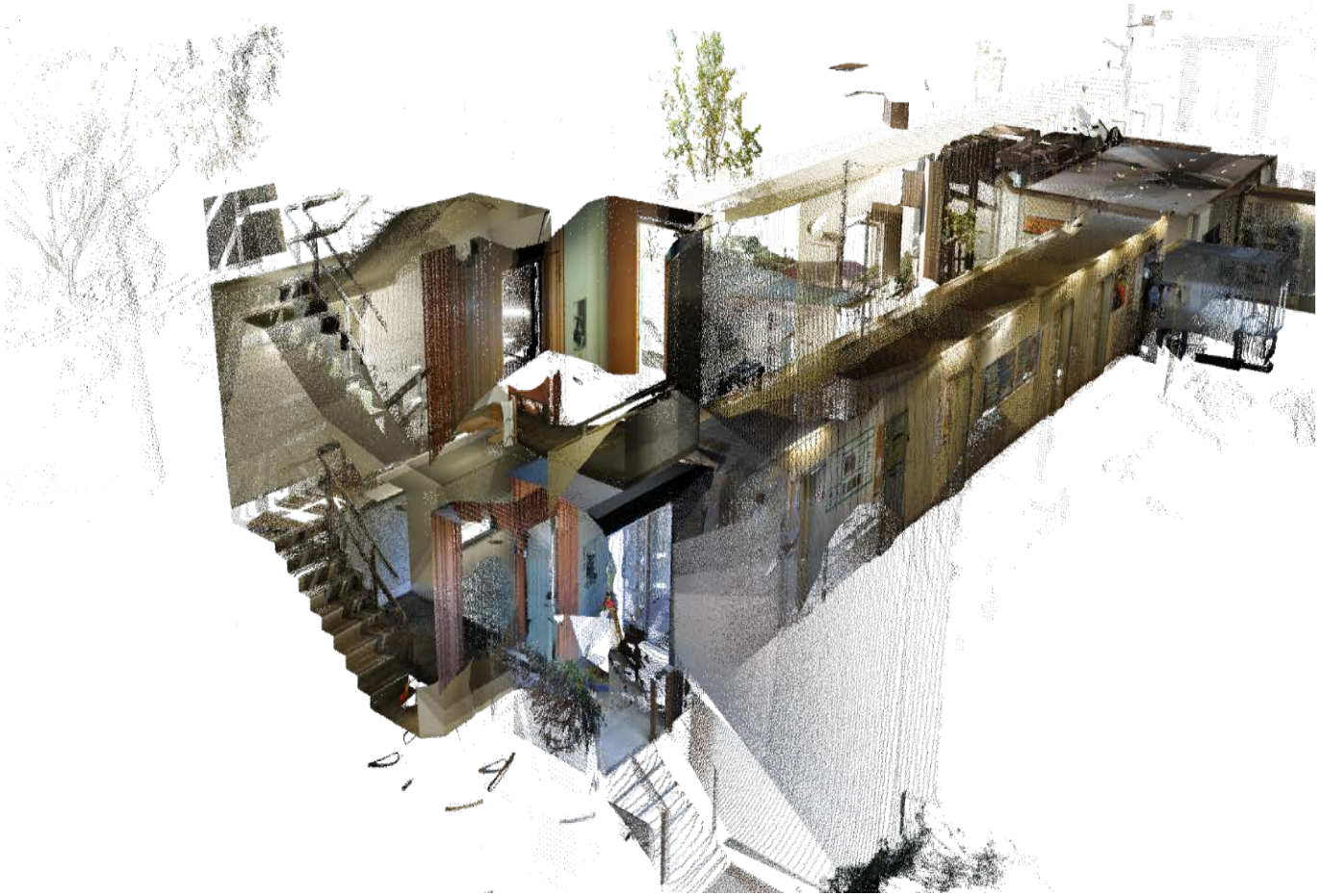
East Stairwell

Data Collection Information

Platform: Riegl LMS-Z420i Laser Scanner

Points: 35 million

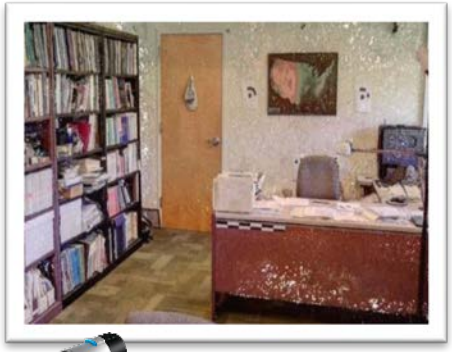
Lidar Point Cloud Data
EH East Stairwell, 1st/2nd Floors



Platforms Tested To Date (EH Room 1720)

Nikon D3100

(14.2 MP)



Microsoft LifeCam Studio

(2.1 MP)

Logitech QuickCam Deluxe

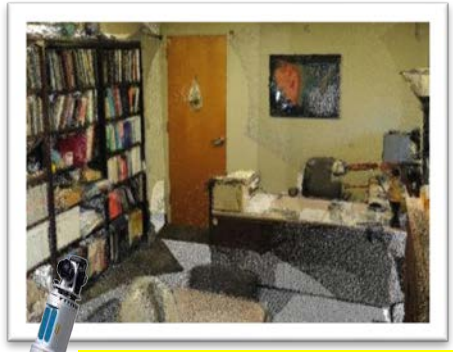
(0.3 MP)

Sony DSC-TX10

(16.2 MP)

Panasonic DMC-FZ

(10.1 MP)



Riegl LMS-Z420i Laser Scanner

(Baseline Measurements)

Animated Point Cloud (LifeCam Studio)

Sample 3D Point Cloud via Webcam

Raw 3D Point Cloud of EH Room 1720

3D Point Cloud Inside Bookshelf

Camera: Microsoft LifeCam Studio

(1920x1080)

Stations: 48 around room perimeter

Images: 144 HDR images

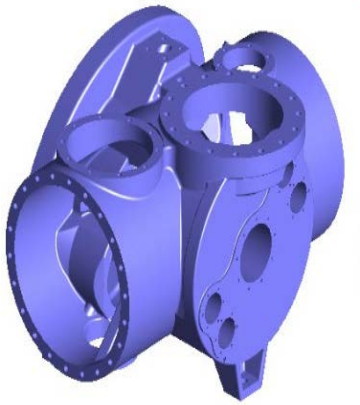
Points: 18.3 million

Actual Photograph of Office

3D modeling and data structures

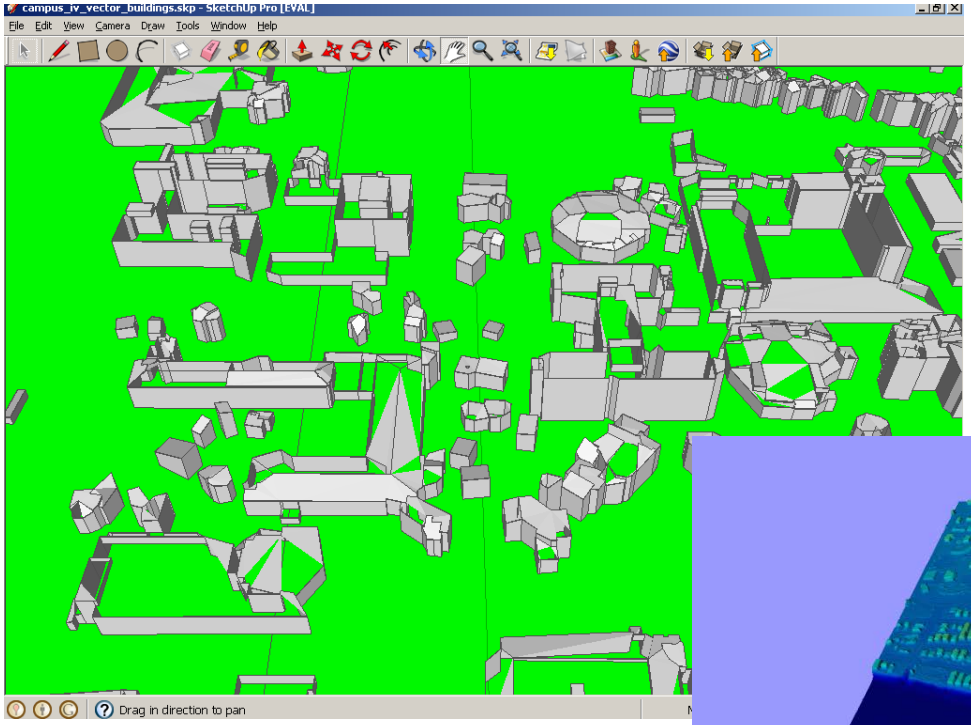
- Longley et. al. 6 models: gridded points, irregular points, cells, irregular polygons, TIN and contours
- Prior dominance of DEM
- Extensive use of TIN and surface patches
- Computer graphics and games favor Voxels
- LIDAR and photogrammetry return a POINT CLOUD
- Has led to use of term Digital Surface Model

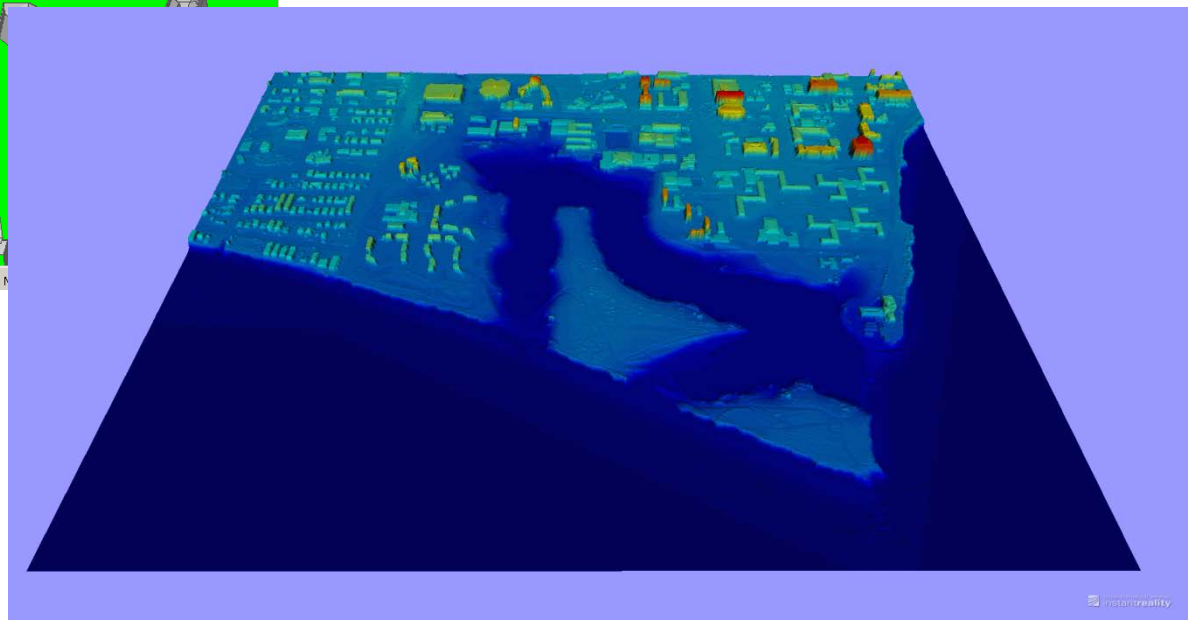
Measurement vs. Modeling



- Select key surface points, edges
- Generalize remaining surfaces
- Solids modeling
- Feature extraction; Buildings, trees (e.g. Lıdar analyst, Feature analyst, Quick Terrain modeler, TerraSolid (Microstation)
- Geometric vs. natural objects
- Realism vs. Size e.g. Google Object Warehouse

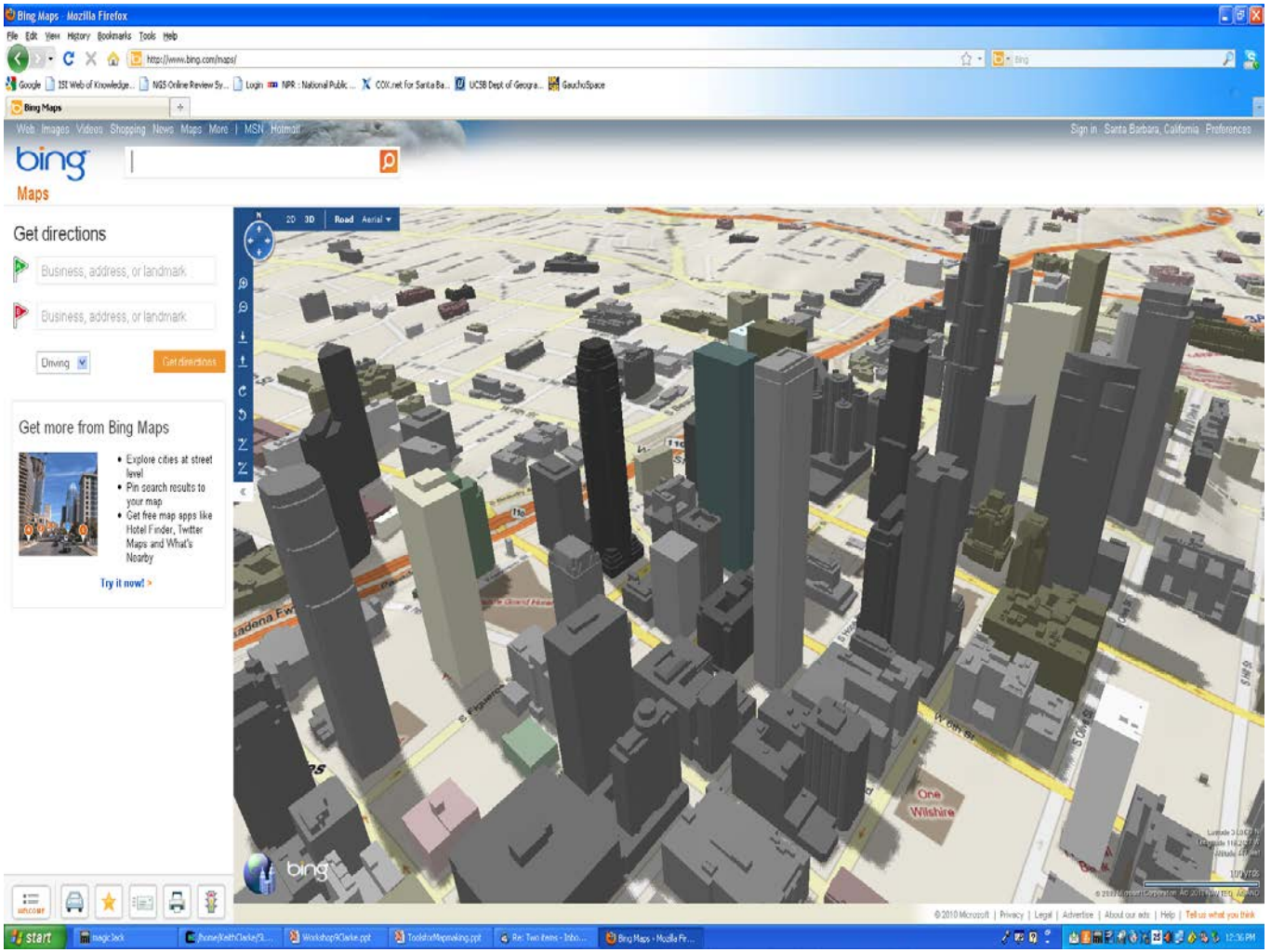
LiDAR building extraction



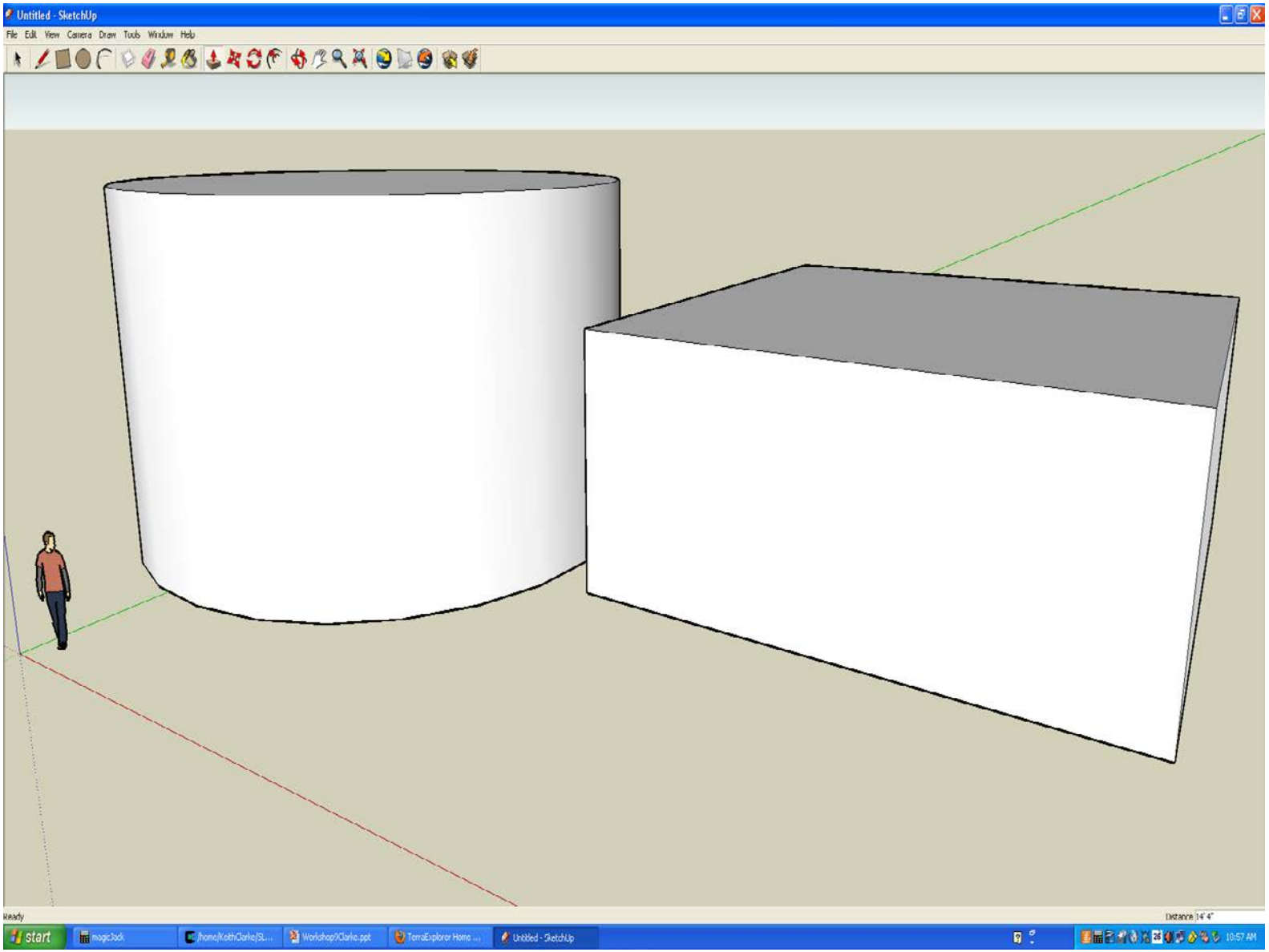


Simple 3D Model built by extrusion

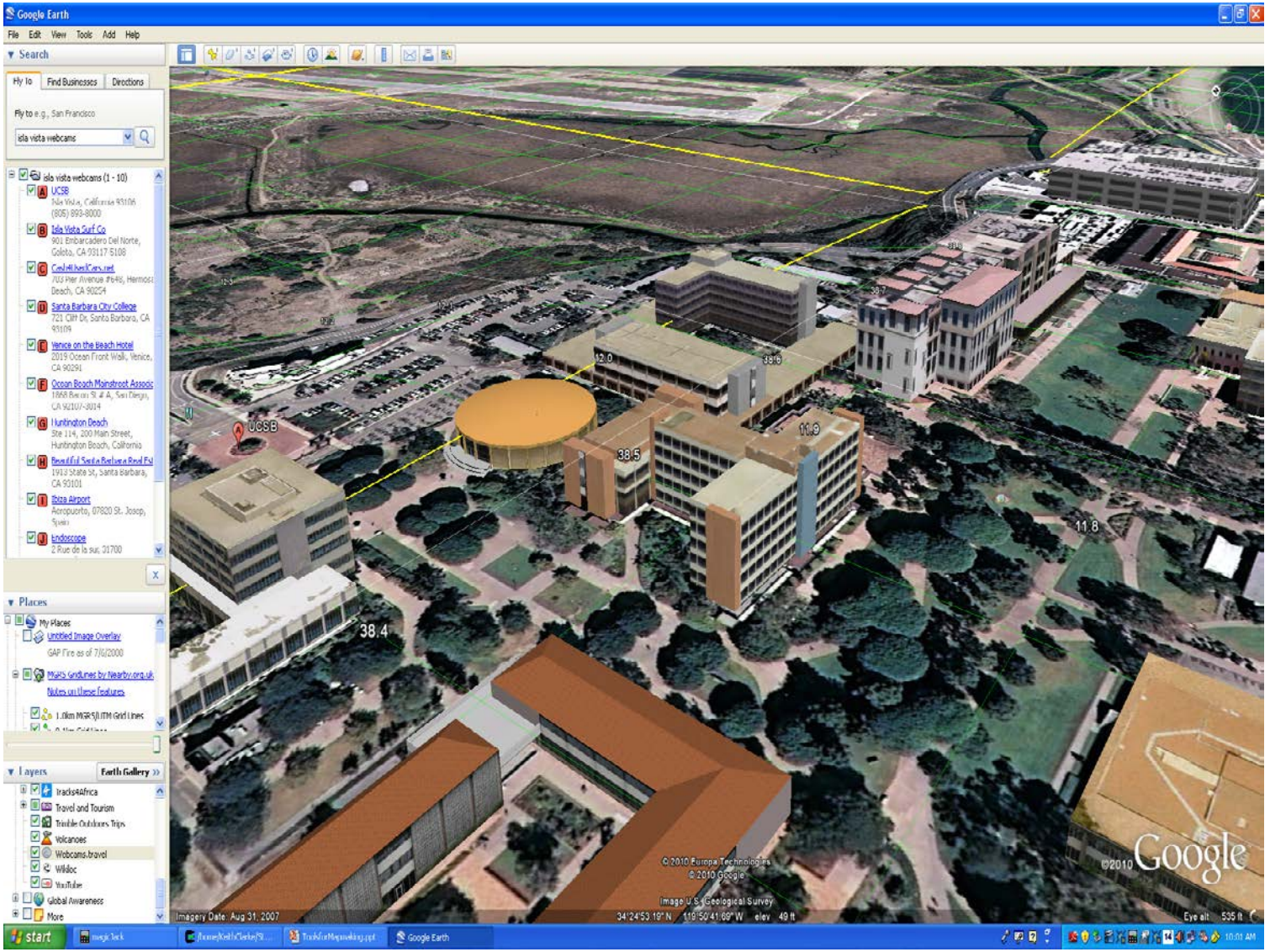
BingMaps 3D Selected Cities (LA)



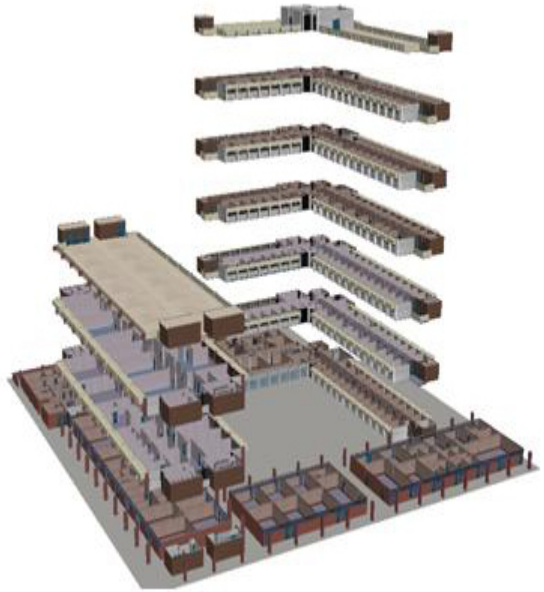
Simplest 3D tool: Sketch-Up (KML)

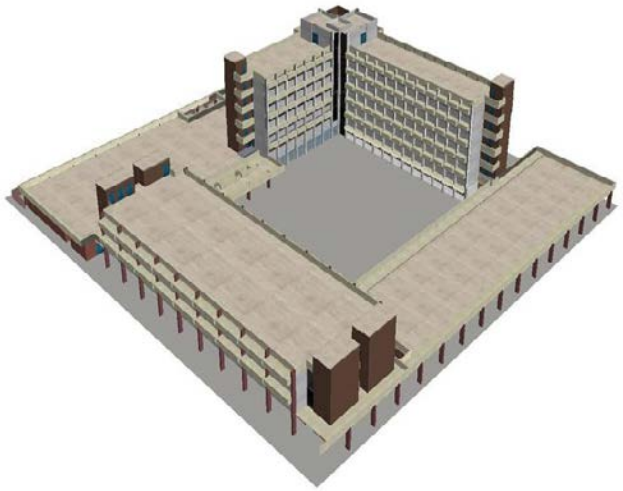


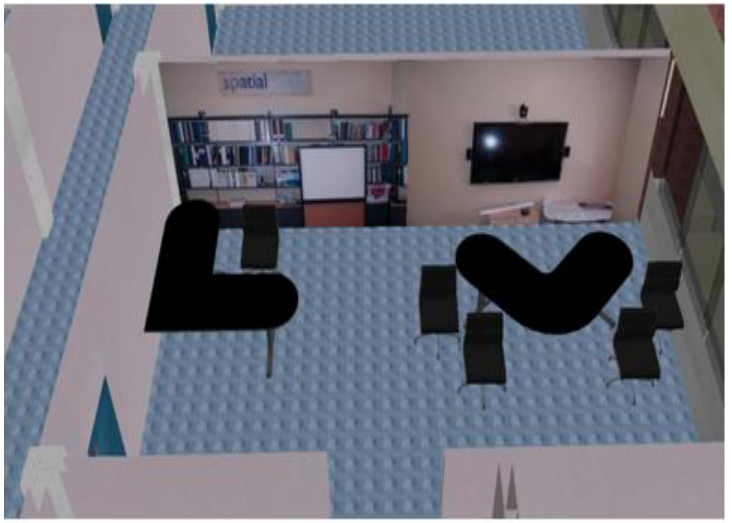
3D Buildings/Flat trees



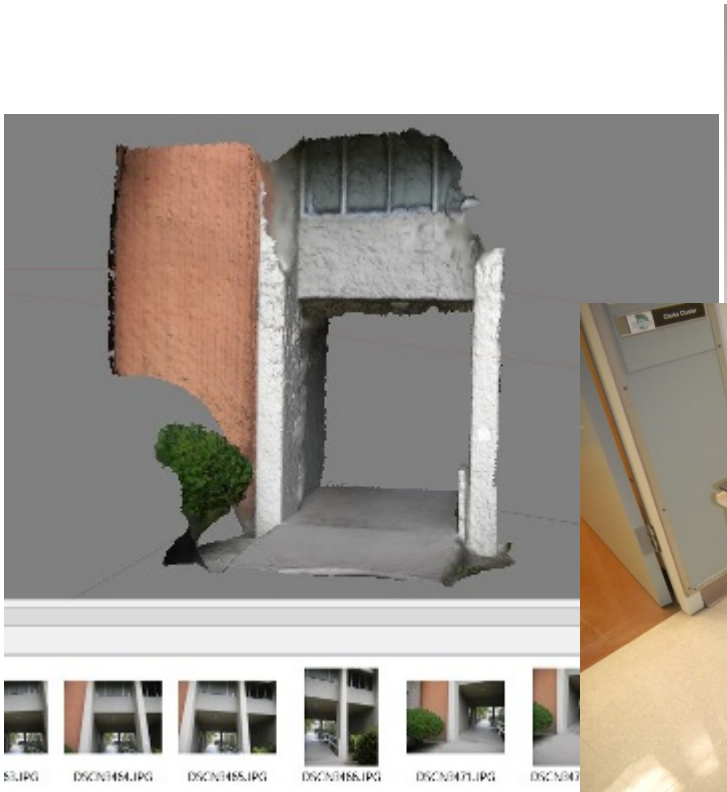
Polygon extrusion (ArcScene)

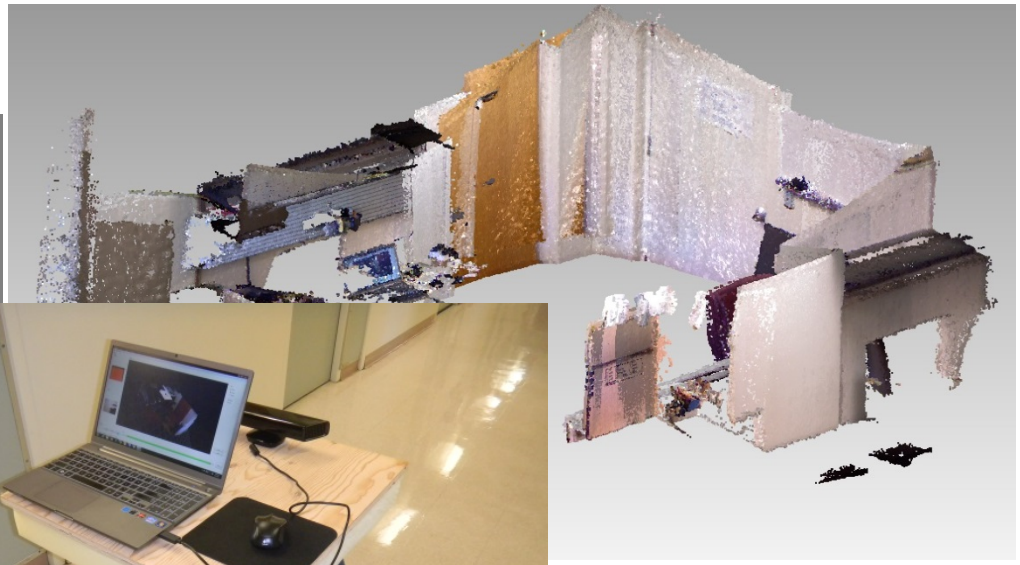


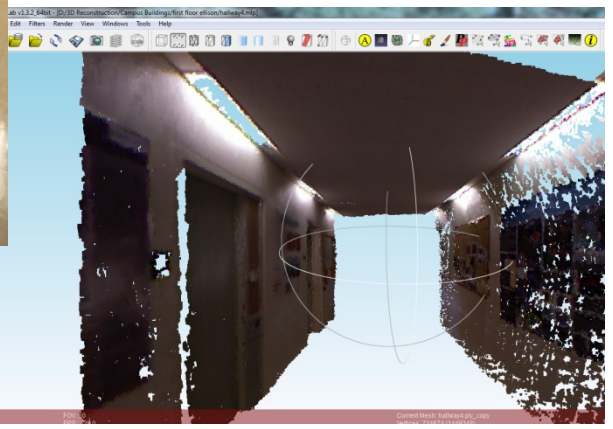


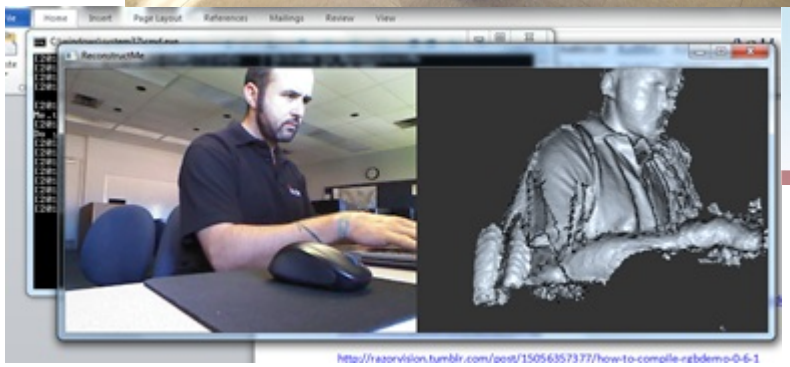


Kinect, Skanect and Meshlab for 3D Reconstruction of Building Interiors: Kevin Wengler (threedeemedia.org)

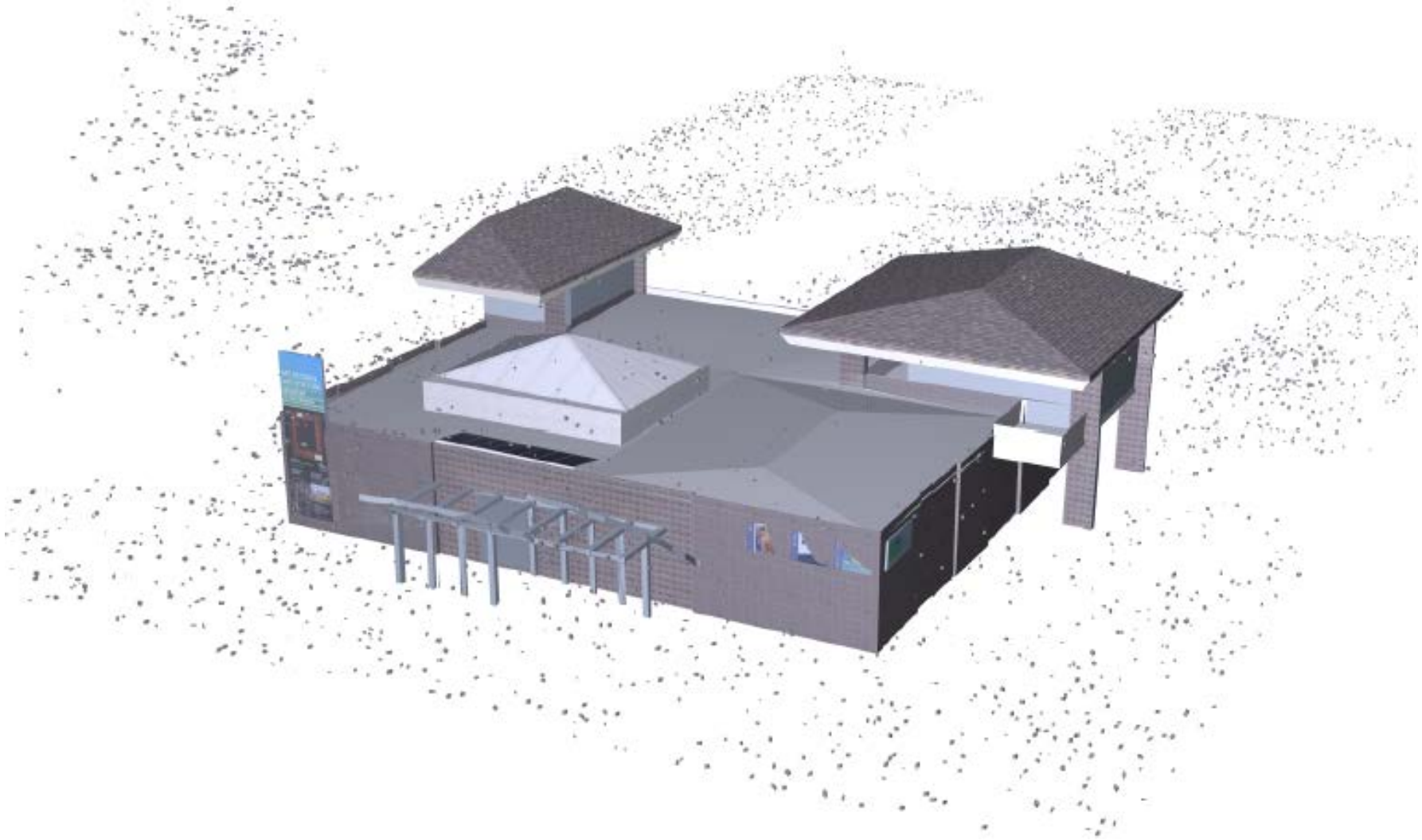








Integrated SfM, photogrammetry and LIDAR



Software (See: wiki entry)

- 3dsmax
- AC3D
- Ayam
- AOI
- Blender
- Carrara
- Cheetah 3D
- Cinema 4D
- CityEngine
- Cobalt
- Electric Image Animation System
- Form-Z
- Houdini
- Hypershot
- Hypermove
- Lightwave3D
- MASSIVE
- Maya
- Modo
- plugin3D
- POV-Ray
- Pro/Engineer
- Quest 3D creative
- Quest 3D Power
- Quest 3D VR
- Relux Professional
- Rhinocerous 3D
- Silo
- SketchUp/Pro
- Softtimage
- Solid Edge
- solidThinking
- SolidWorks
- Swift3D
- trueSpace
- ViewBuild3D
- VR4MAX
- Vue
- ZBrush

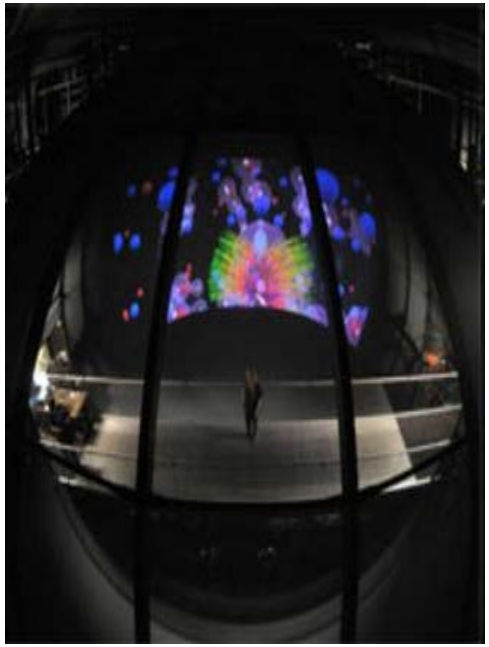
3D standards for Geospatial data

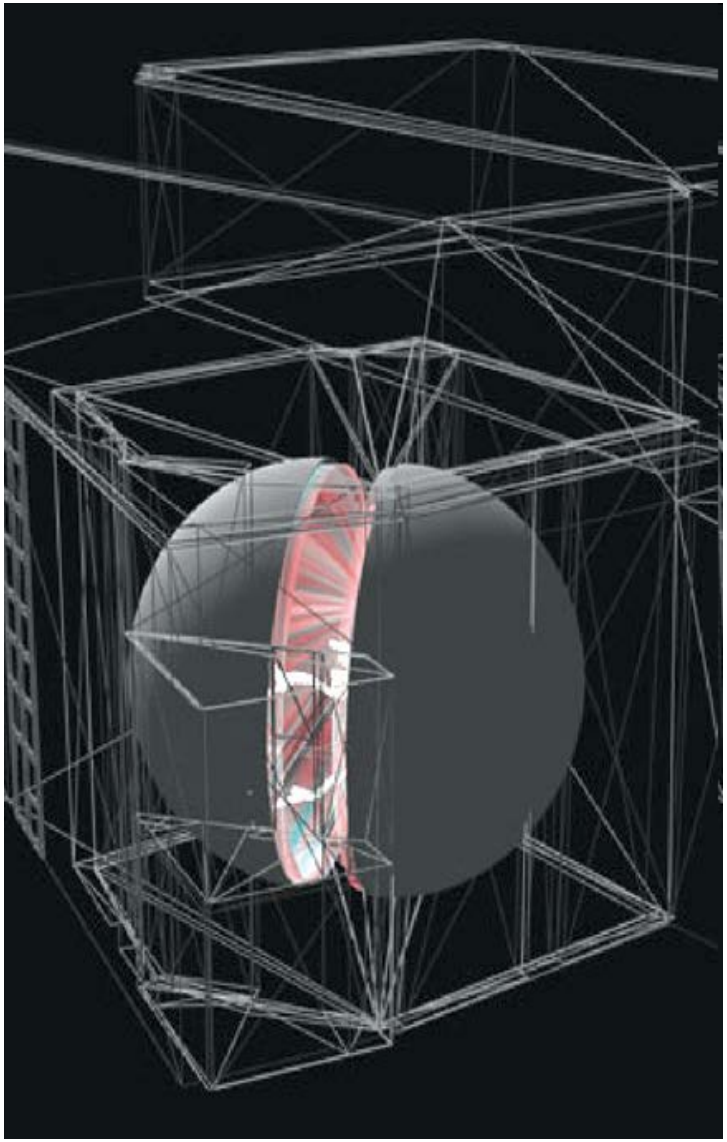
- VRML and GeoVRML
- X3D and OGC, Geospatial component and X3D Earth (e.g. Planet9 London)
- OGC CityGML
- Web3D Service
- LandXML.org
- COLLADA /KML (SONY, Google)
- National 3D-4D-BIM Program (USGSA)
- 3DVIA (Bing Maps)

3D in Geobrowsers

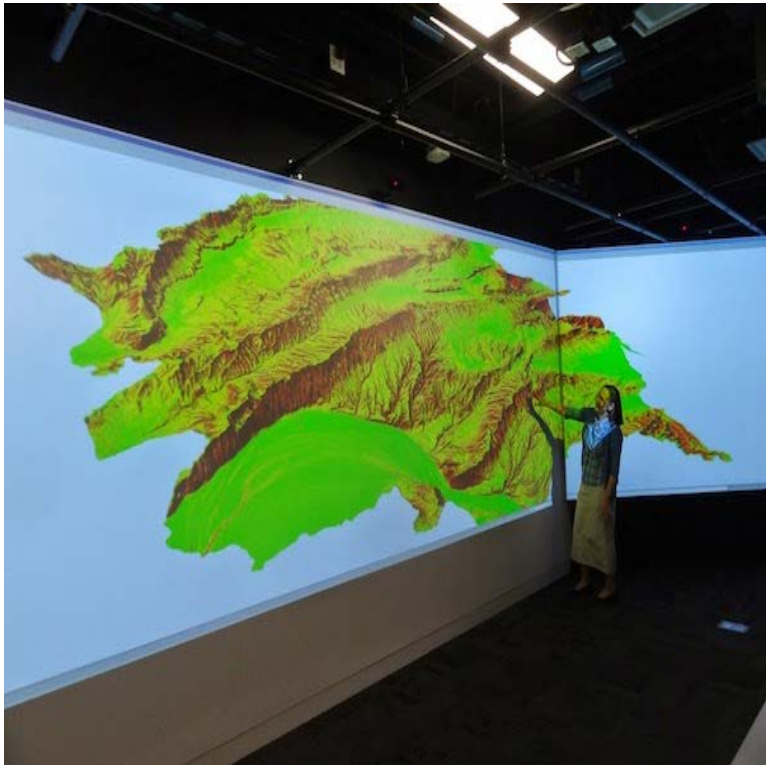
- Picture and panorama inclusion
- Google streetview
- GoogleEarth 3D Buildings and terrain
- Bing Maps 3D and oblique views
- Microsoft Photosynth
- Most geobrowsers include topography

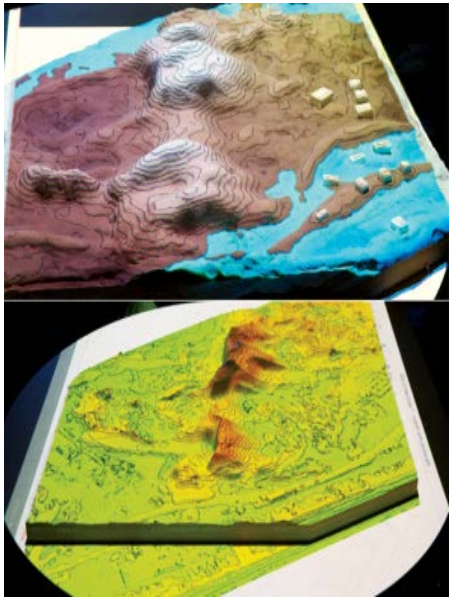
Virtual Reality: The Allosphere



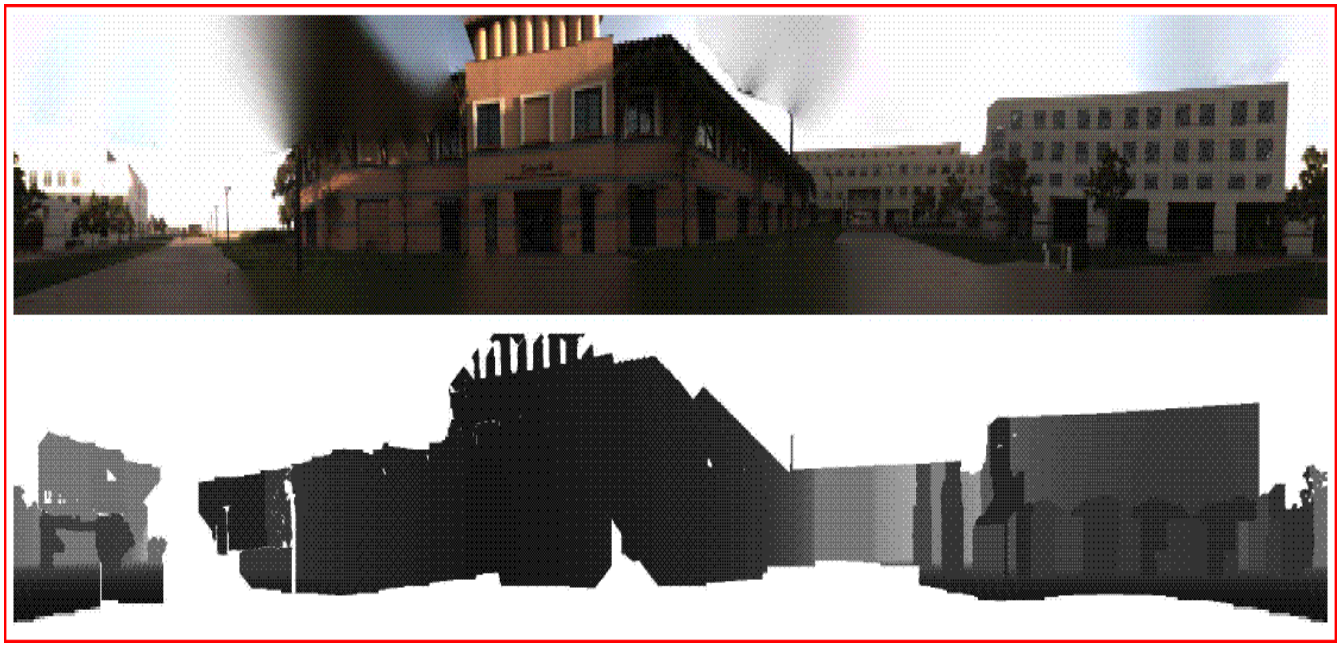


Projected images

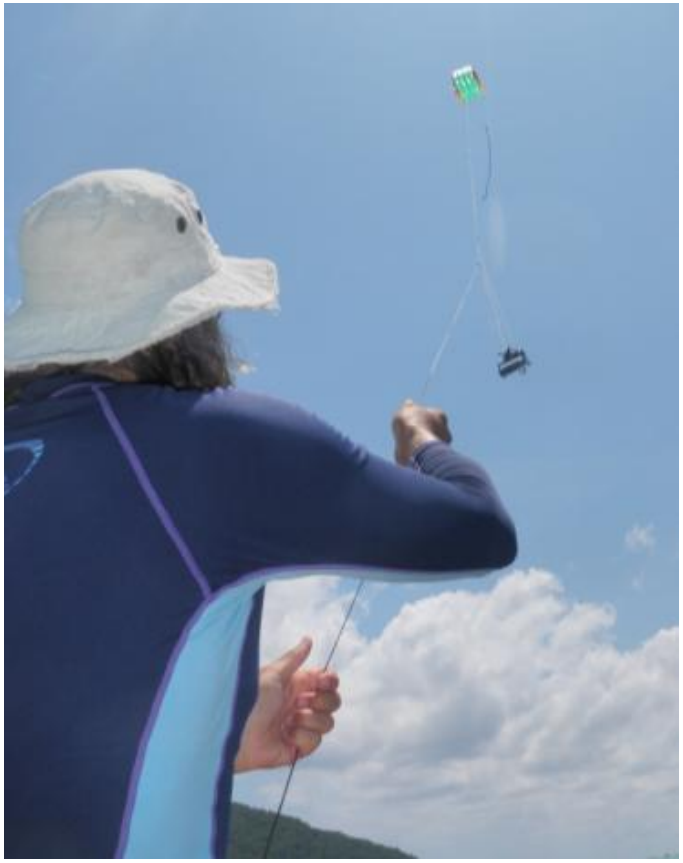




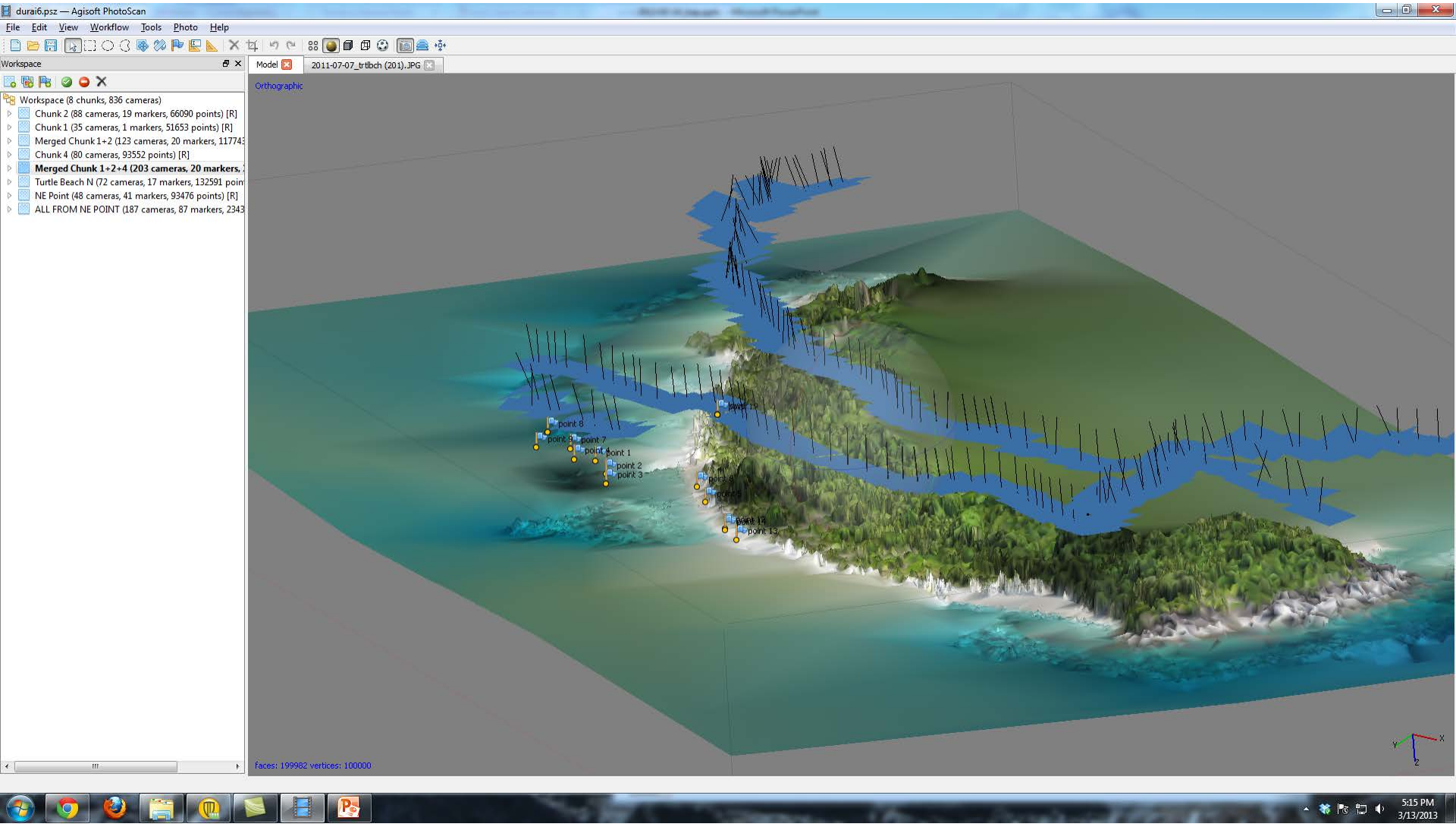
Augmented Reality



Kite Photogrammetry; Kitty Currier



Agisoft Photoscan



Centimeter resolution: Gigabyte files, need GPS tie points

Kite photogrammetry

Durai Island

Anambas Islands, Indonesia

Reset view

For more information see Mapping with strings attached: Kite aerial photography of Durai Island, Anambas Islands, Indonesia (*Journal of Maps, 2014*).

Installed Plugin Version: **7.1.2.2041**

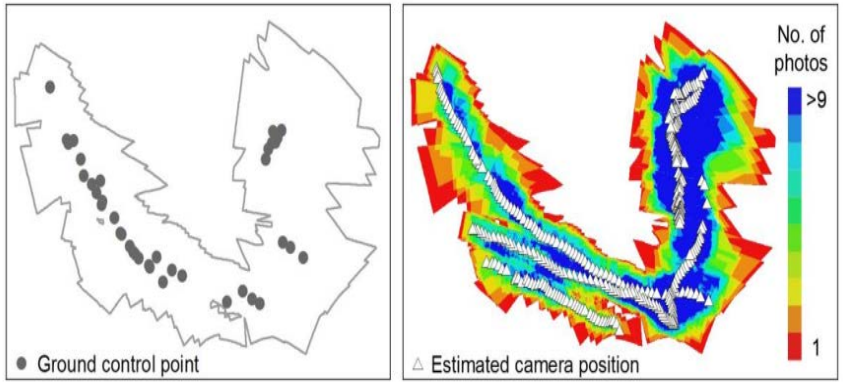


Figure 3. (a) Locations of 38 ground control points relative to mosaic's extent. (b) Estimated camera positions for 357 images, superimposed on a map of image density.

How to generate images?

- Need many images from different angles
- Overlap creates stereo model
- Agisoft Photoscan then extracts model and assigns point cloud with color
- Can process with Meshlab, CloudCompare, other software
- Our answer: Drone (Quadcopter)

Phantom 4 with collision avoidance

Scans height by IR sensor

Position using GPS

Fully gimballed camera

Can be programmed to collect

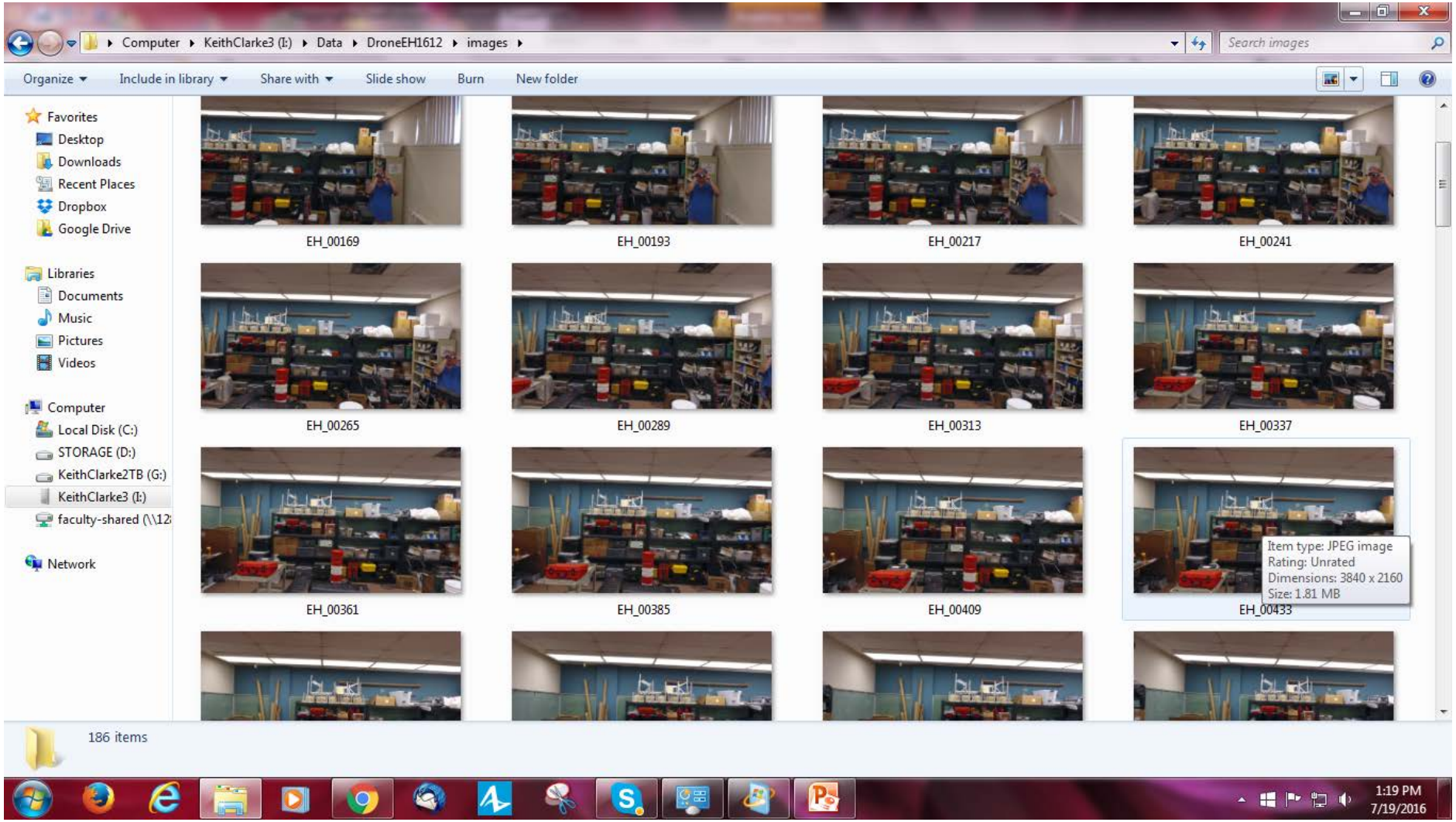
video or interval images

20 minutes of flight with rechargeable batteries

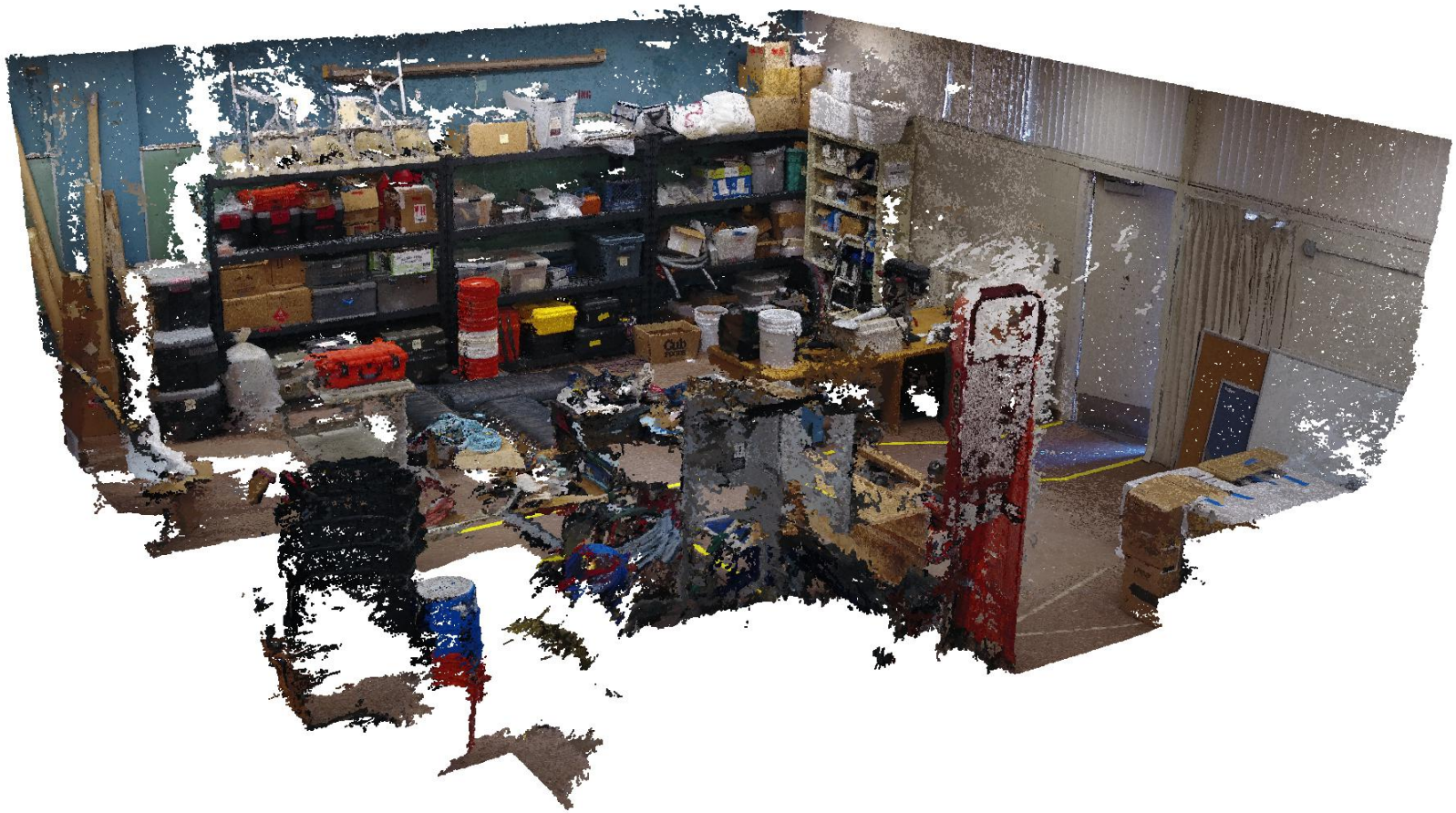
Flight planning software, smartphone or tablet piloting

Mapping Ellison 1612

Image capture

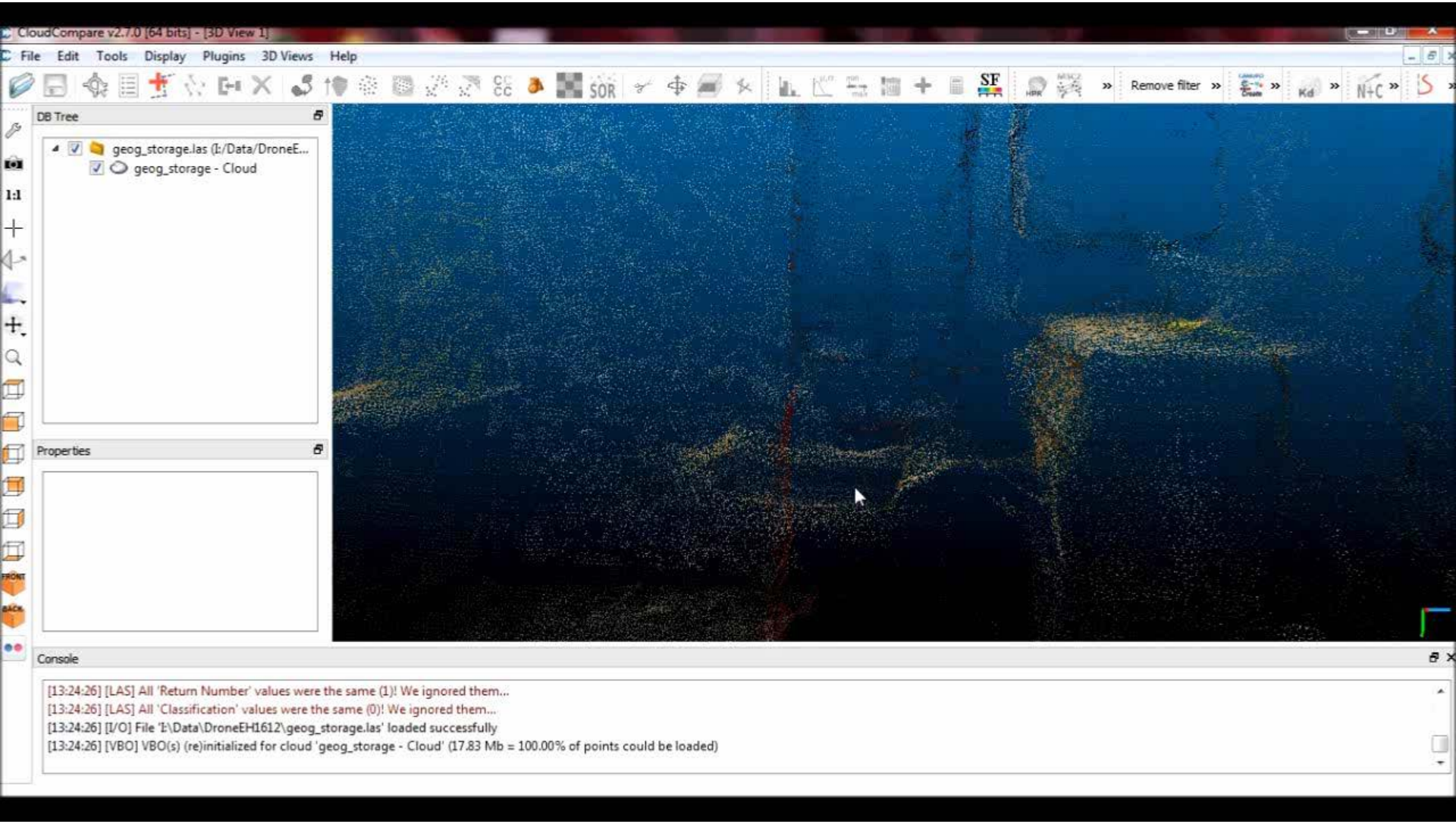


Point Cloud



This is not a photograph

A 3D model from scratch



Closer to home

Summary

- Development of direct 3D mapping technologies
- LiDAR still the gold standard
- Both airborne and terrestrial
- Creates point clouds and DSMs
- Can map buildings and interiors, true 3D
- Standards and browser compatibility
- Many new low cost methods, kites, balloons, drones
- Processing via SfM software, e.g. photoscan
- Expect a great deal more 3D!