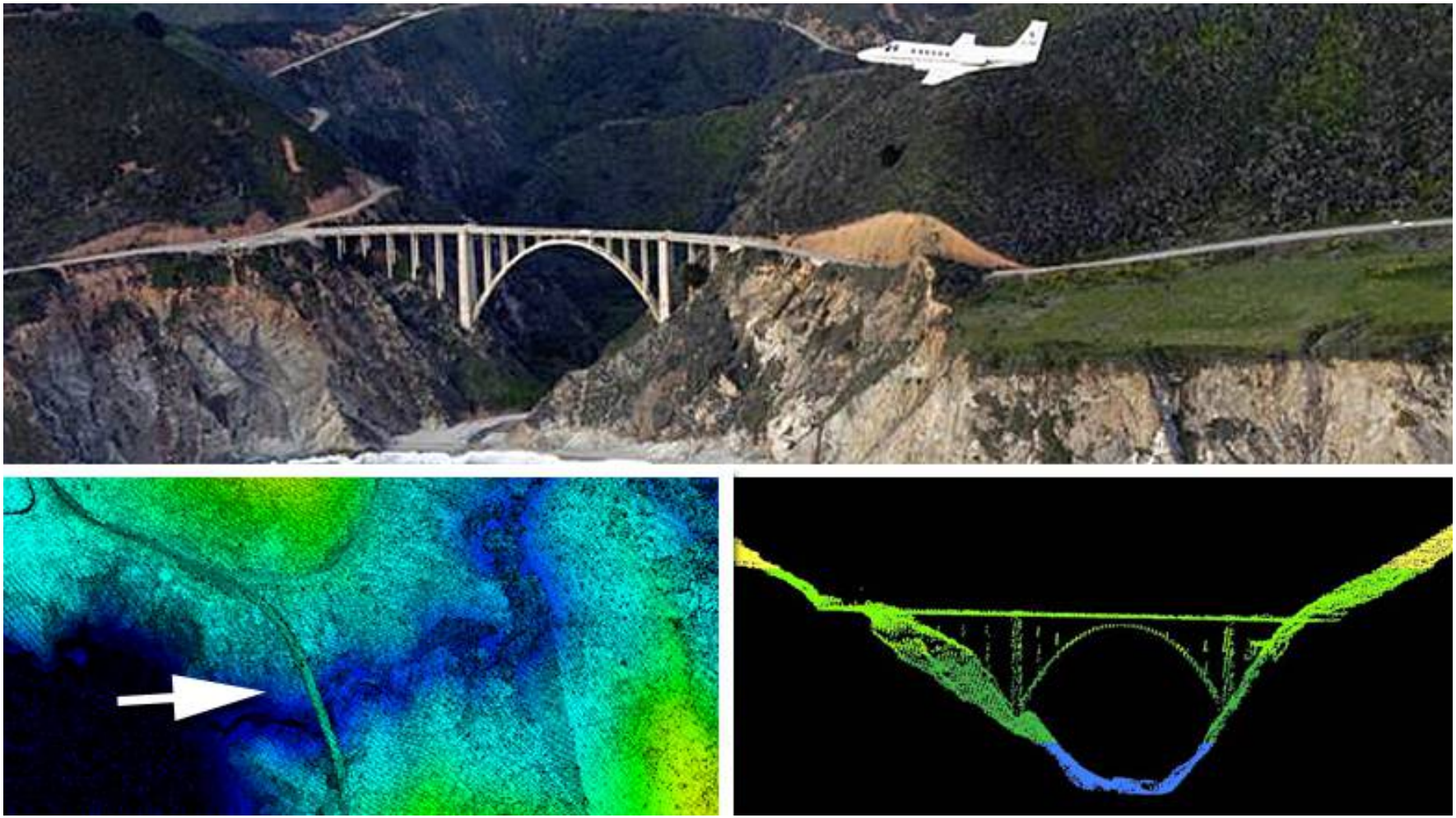
# LiDAR—Light Detection And Ranging

**— a remote sensing method used to examine earth/planet surfaces**

.. .. an increasingly common form of **active** remote sensing



http://oceanservice.noaa.gov/facts/lidar.html

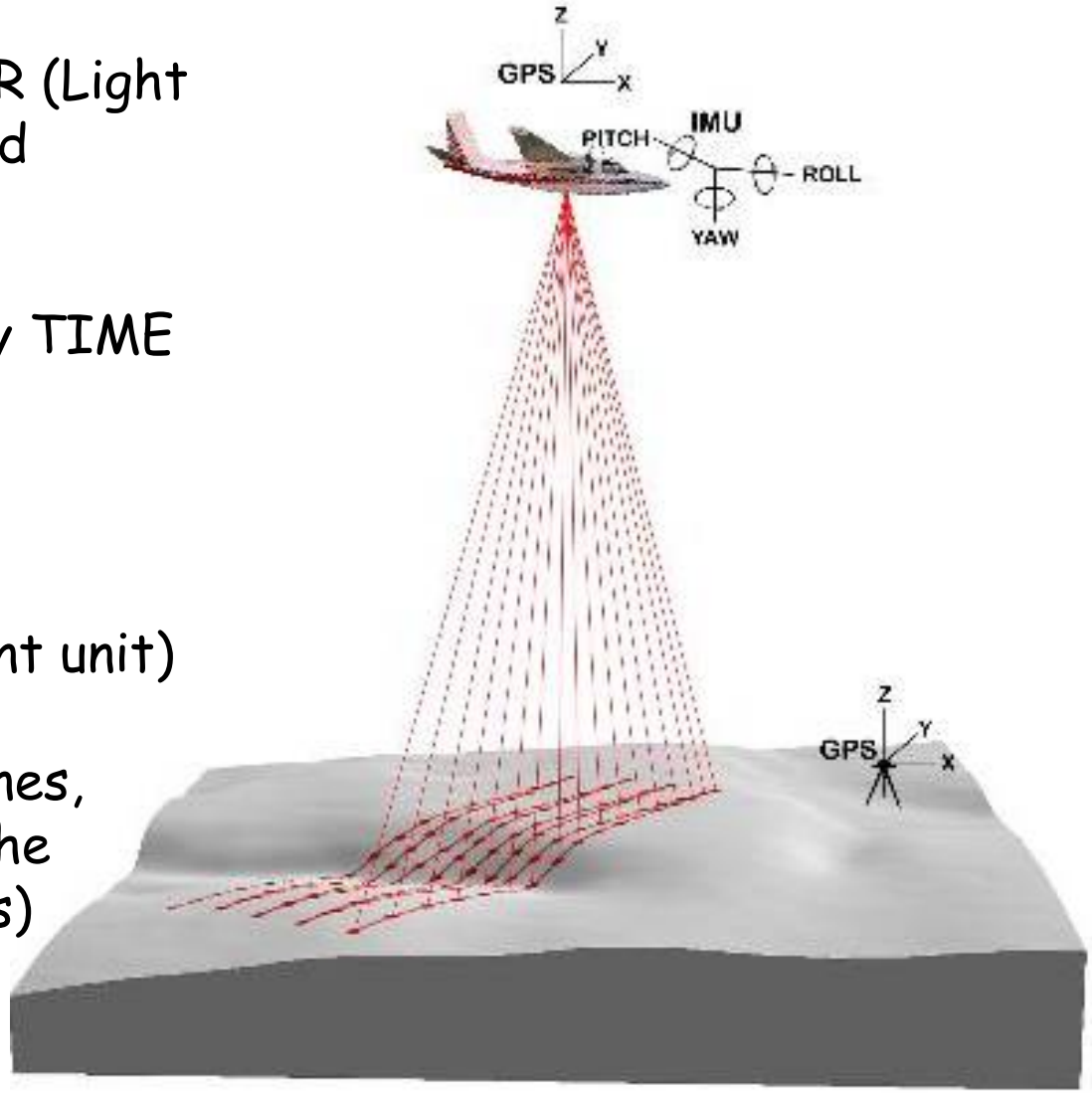
# What is LiDAR ?

Controlled bursts of LASER (Light Amplification by Stimulated Emission of Radiation)

Distance to object given by TIME

-**requires 3 units:**
-laser emitter/receiver
-GPS
-IMU (Inertial measurement unit)

Used in 60s-70s for scanlines, feasible for images with the development of GPS (1990s)
-now widely available



# LiDAR = Light Detection And Ranging ...also known as LASER altimetry

An **active** form of remote sensing

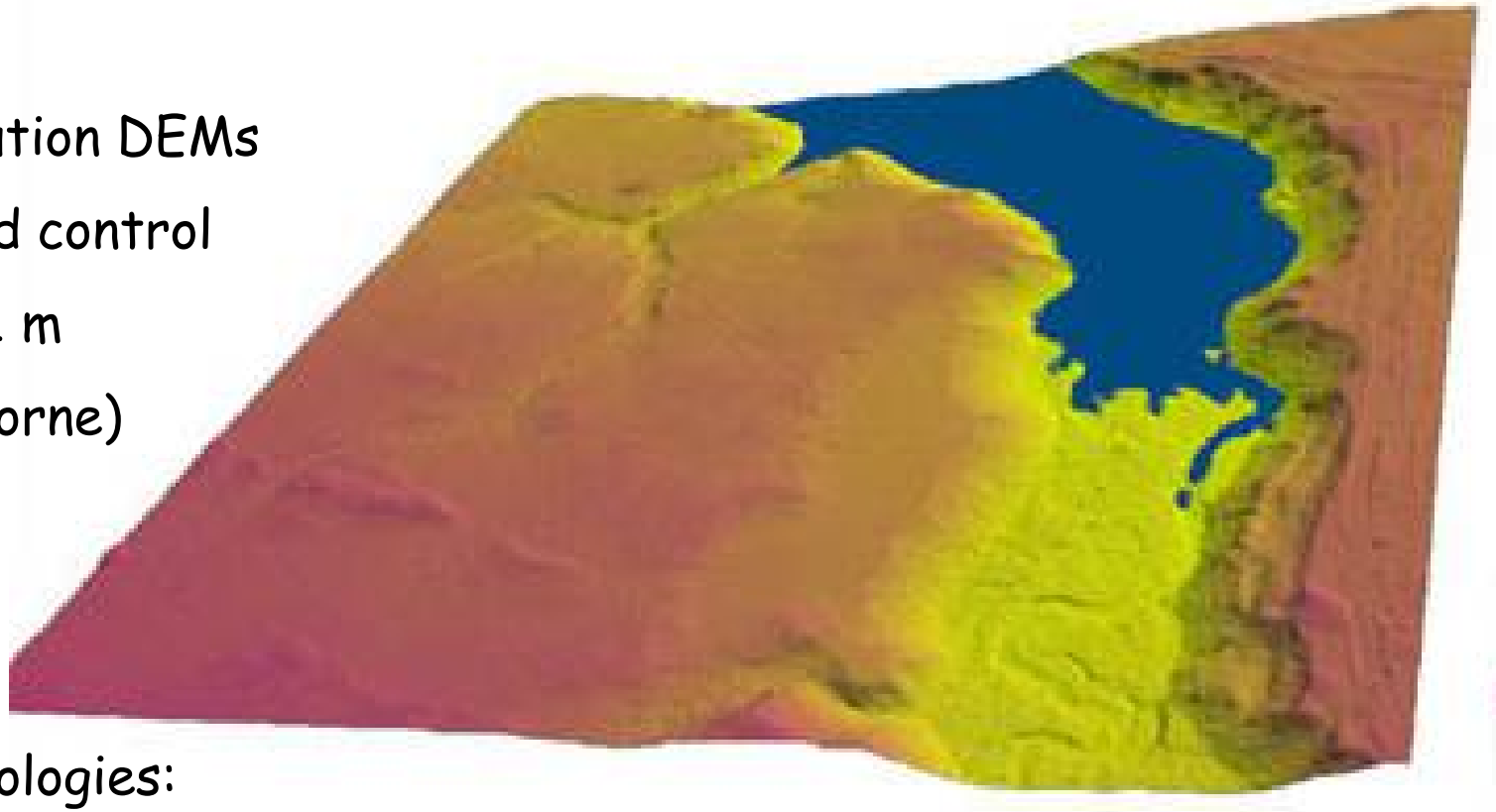
Objects reflect more in UV/visible/NIR (than radar microwaves) = higher resolution mapping

- high resolution DEMs

e.g. for flood control

~1 foot or <1 m

(mostly airborne)



Related technologies:

SONAR: SOund NAvigation and Ranging : sound propagation for communication/ navigation
SODAR: SOnic Detection And Ranging : sound propagation upwards (atmospheric)

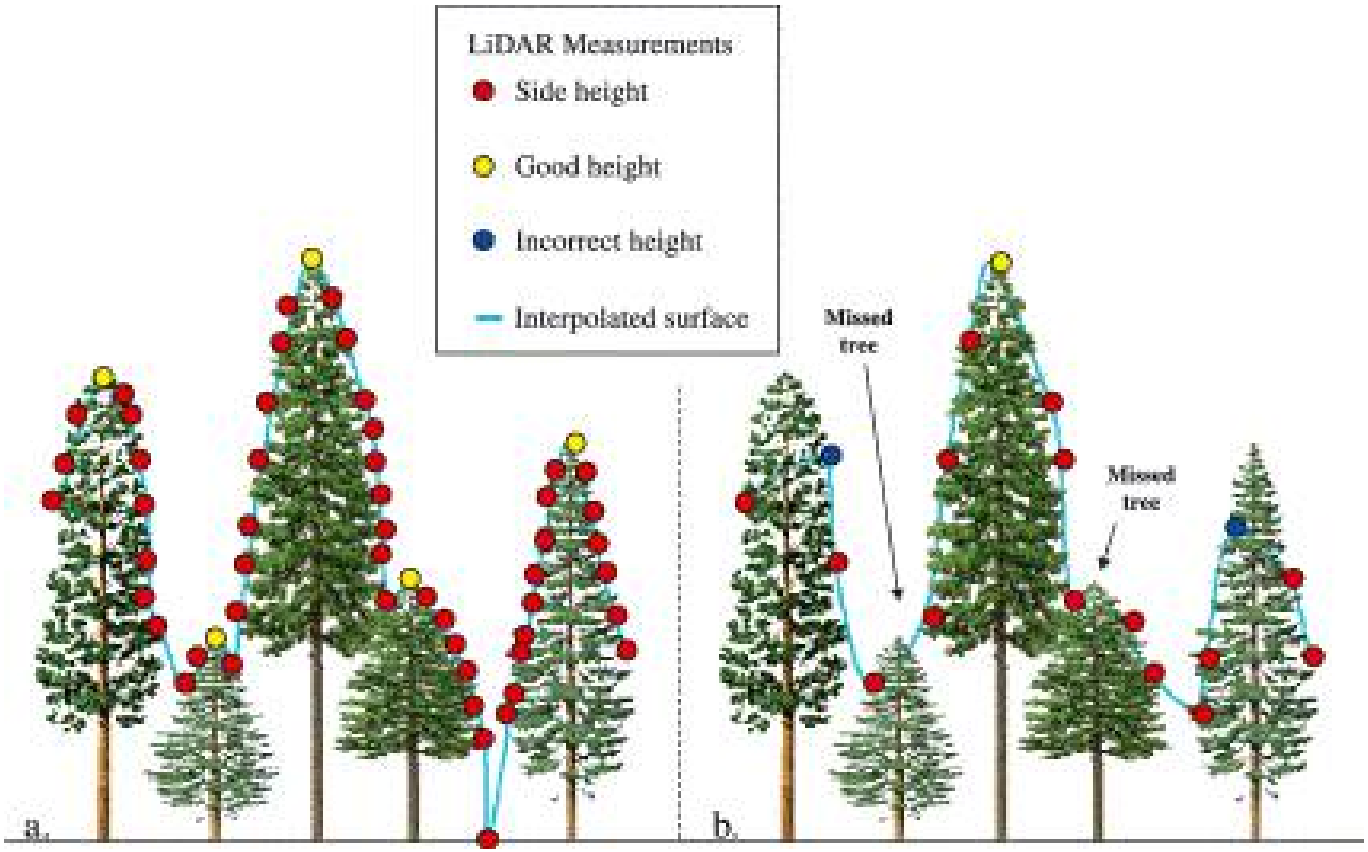
Laser pulses at up to 50,000 - 200,000 / second

Resulting cloud of points: up to 20 points / square metre

~10/sq m needed for forestry 1 / sq m for glaciers (no trees)

Horizontal accuracy 50cm - 1m, vertical ~20cm

Cloud of points is converted to raster grid ~1metre



# Range finding LiDAR for topographic mapping

Unaffected by clouds **above** (unlike air photos) .. *why?*

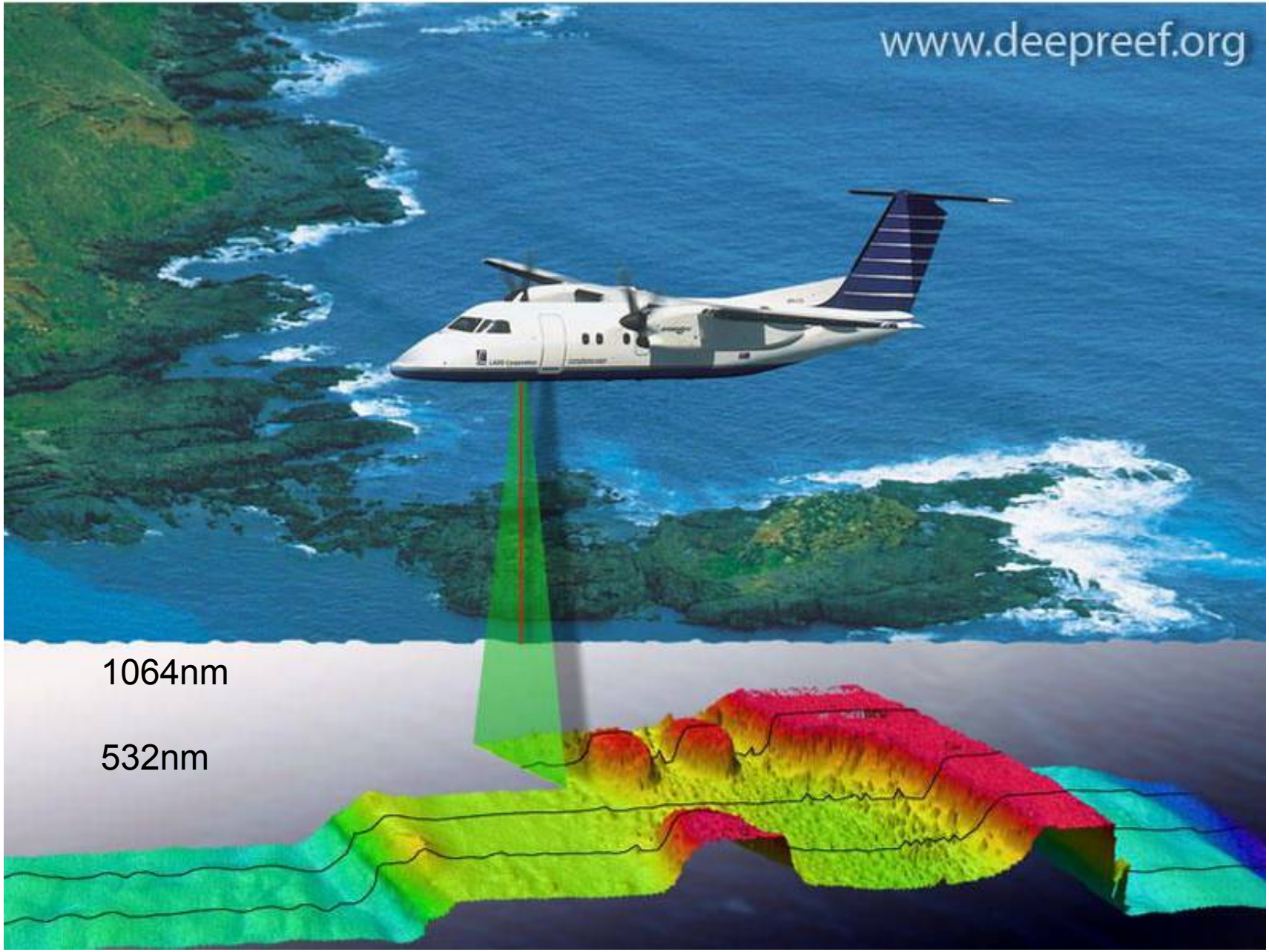
Laser bursts are emitted usually at one of these wavelengths:

355 nm (UV): wind, water vapour
532 nm (green): bathymetry
1064 nm (Near IR): surface mapping

These wavelengths are related to the physics of crystals used in lasers.

FYI: Taser guns are at 650 nm ; phasers (Star Trek) at 350nm

https://www.cnet.com/news/mapping-australias-great-barrier-reef-with-cameras-drones-nasa-tech/?ftag=CAD1acfa04&bhid=18761746596124578772764556799012



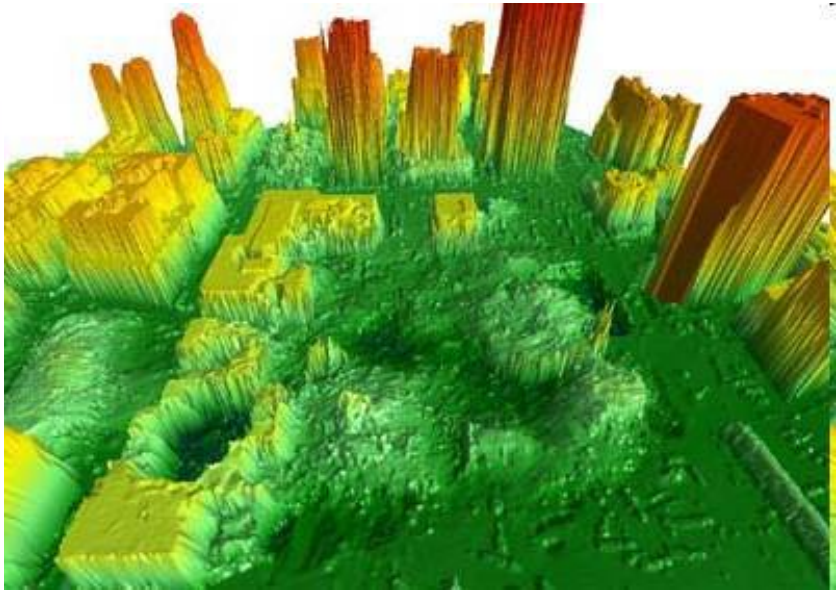

http://www.navy.gov.au/laser-airborne-depth-sounder-lads

**Volume estimation:**

**Ground Zero, World Trade Centre site, New York**

**Post-September 2001**

http://www.volker-goebel.de/Lidar.html



# Vegetation: Tree Canopy Height

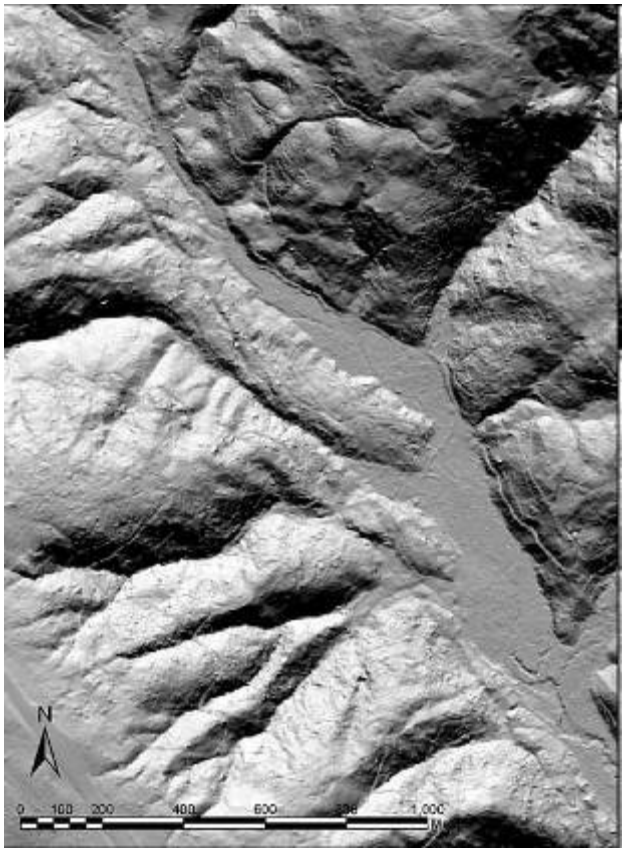
http://quake.wr.usgs.gov/research/geology/lidar/example2.html

Air photo

Vegetation surface DSM

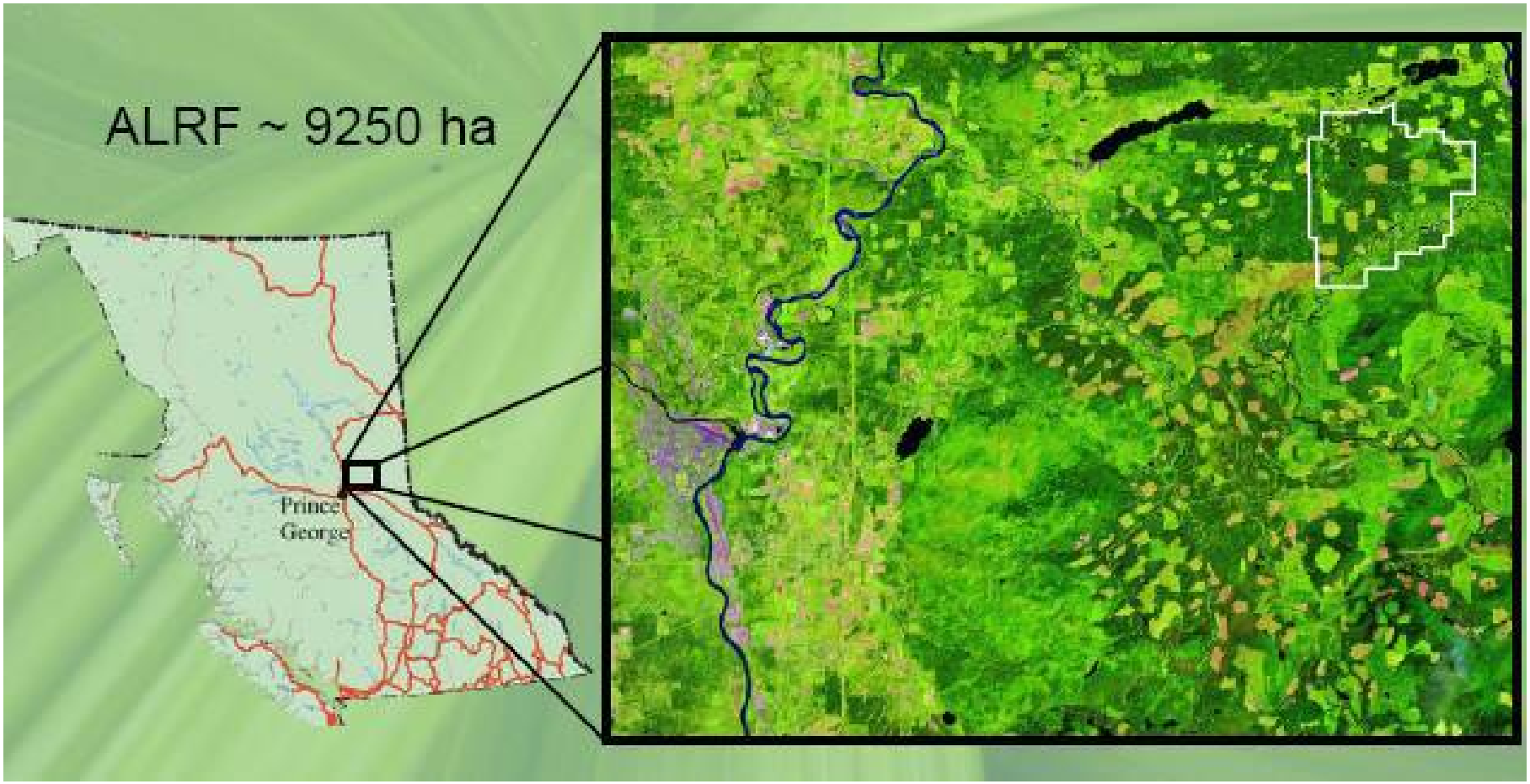
Bald Earth Model (BEM)

Vegetation height = DSM minus BEM)

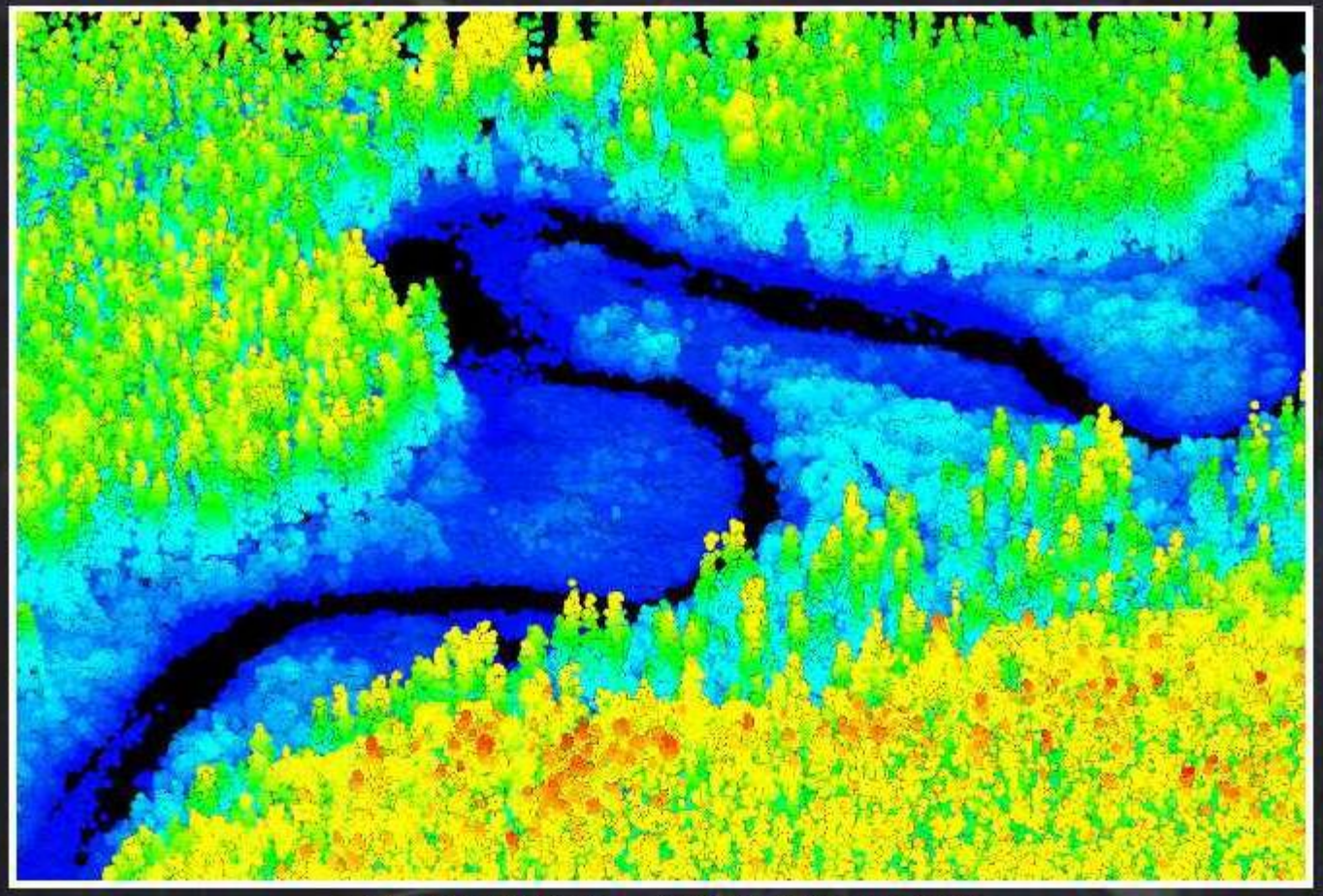


# Aleza Lake Research Forest

Oldest research forest in BC, jointly operated by UBC and UNBC
60km north-east of Prince George

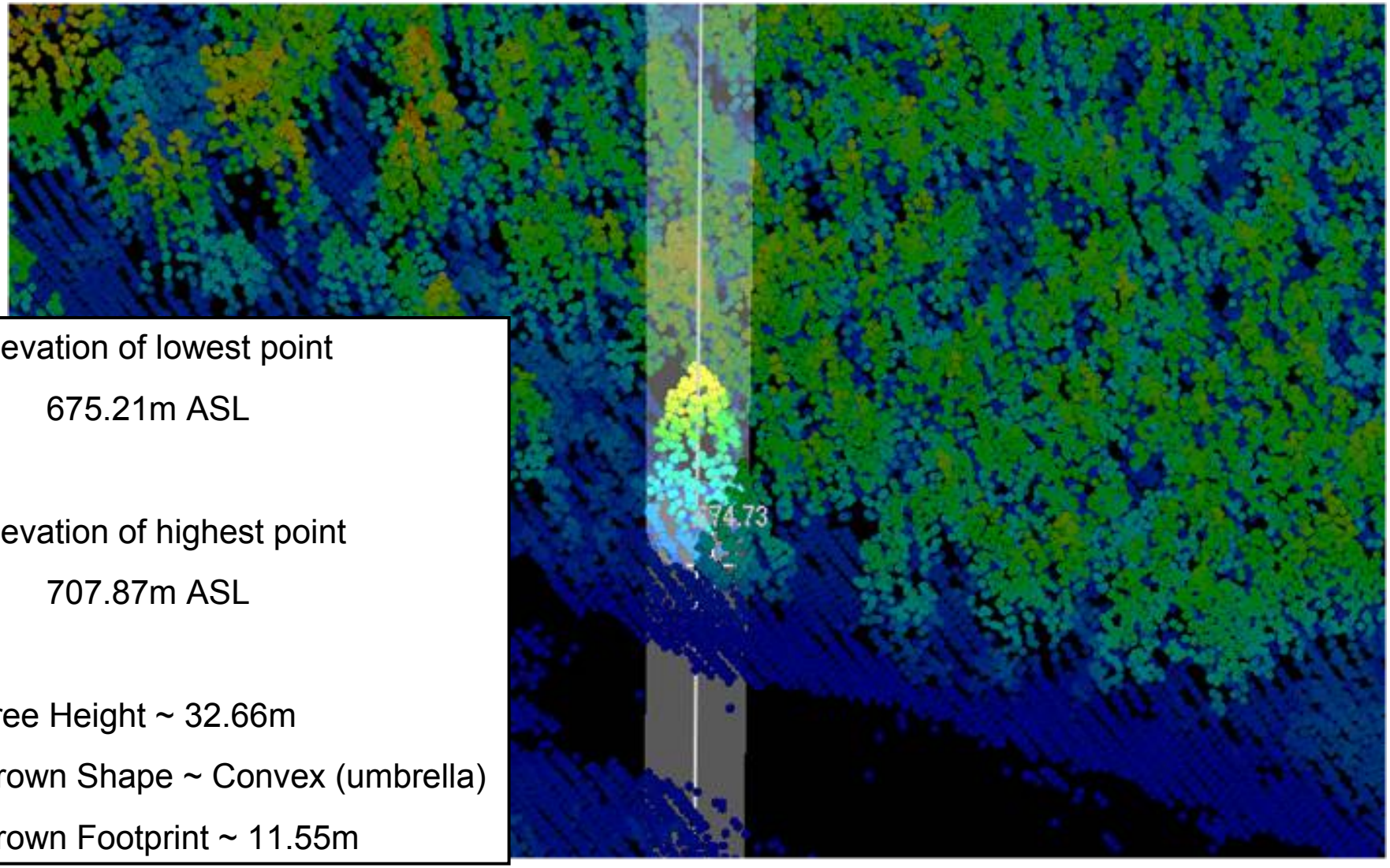


# Mass Points



500m x 500m ~ 1,000,000 points

# LiDAR reveals both ‘bare earth’ (ground) and canopy height




Elevation of lowest point

675.21m ASL

Elevation of highest point

707.87m ASL

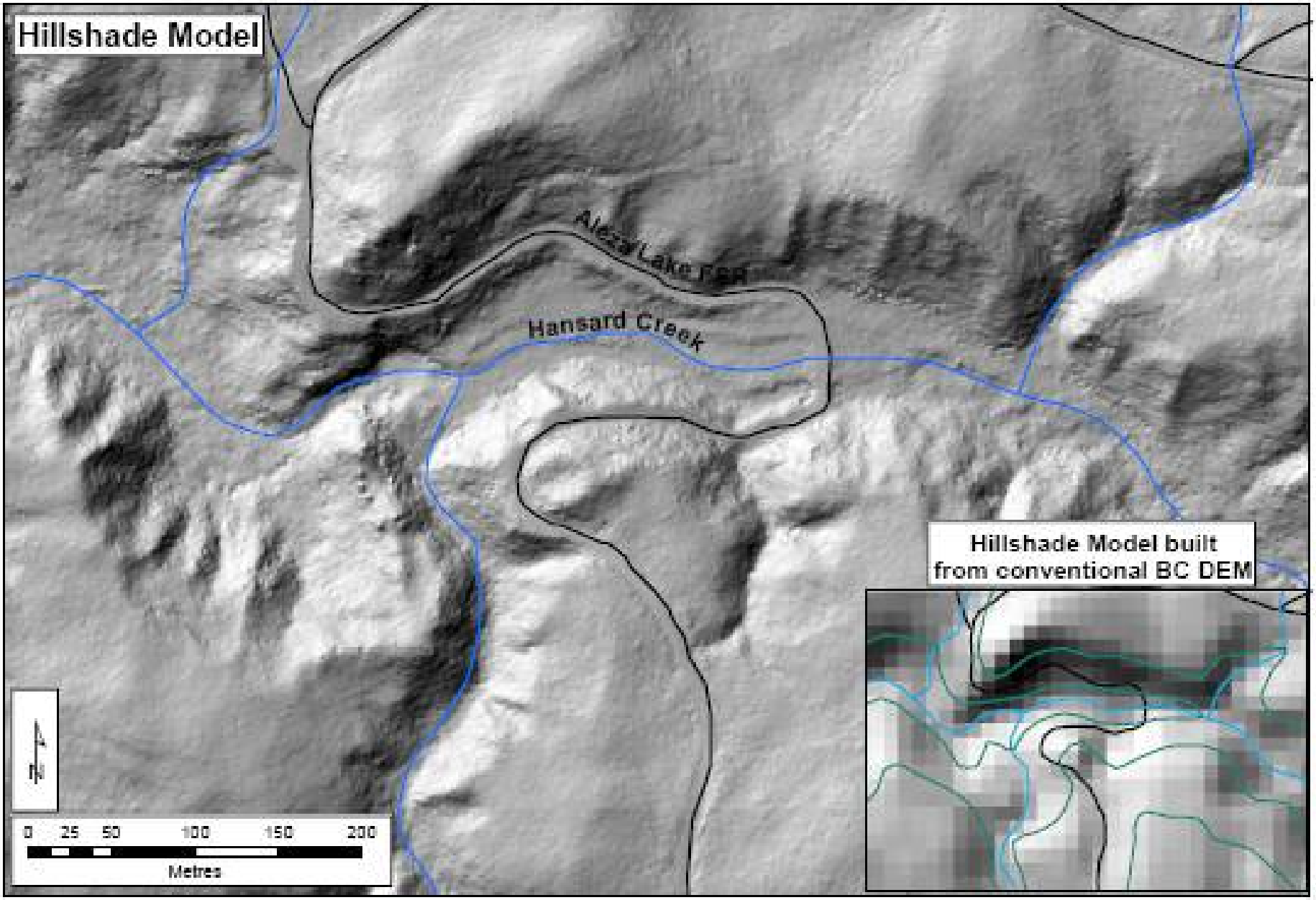
Tree Height ~ 32.66m

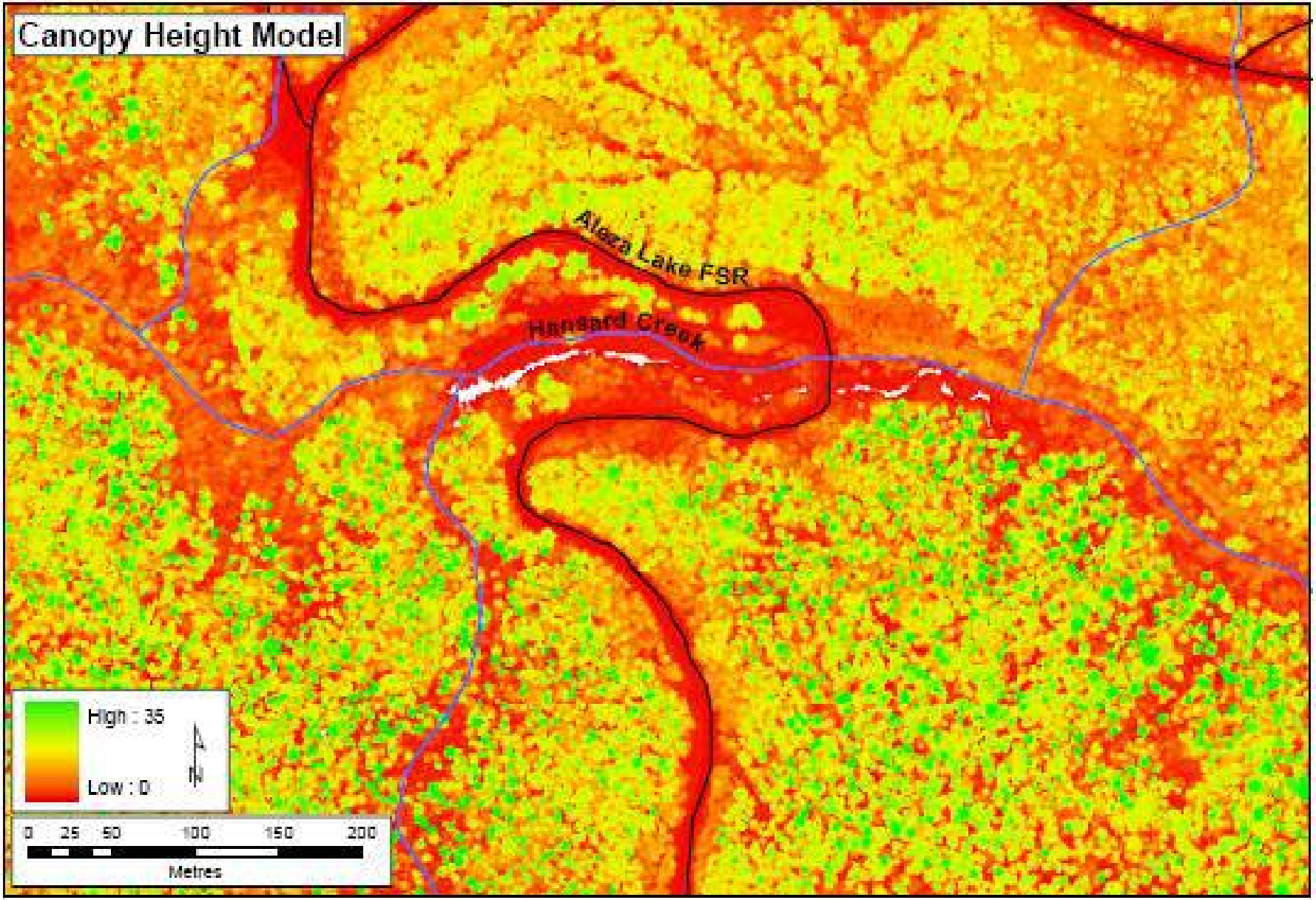
Crown Shape ~ Convex (umbrella)

Crown Footprint ~ 11.55m

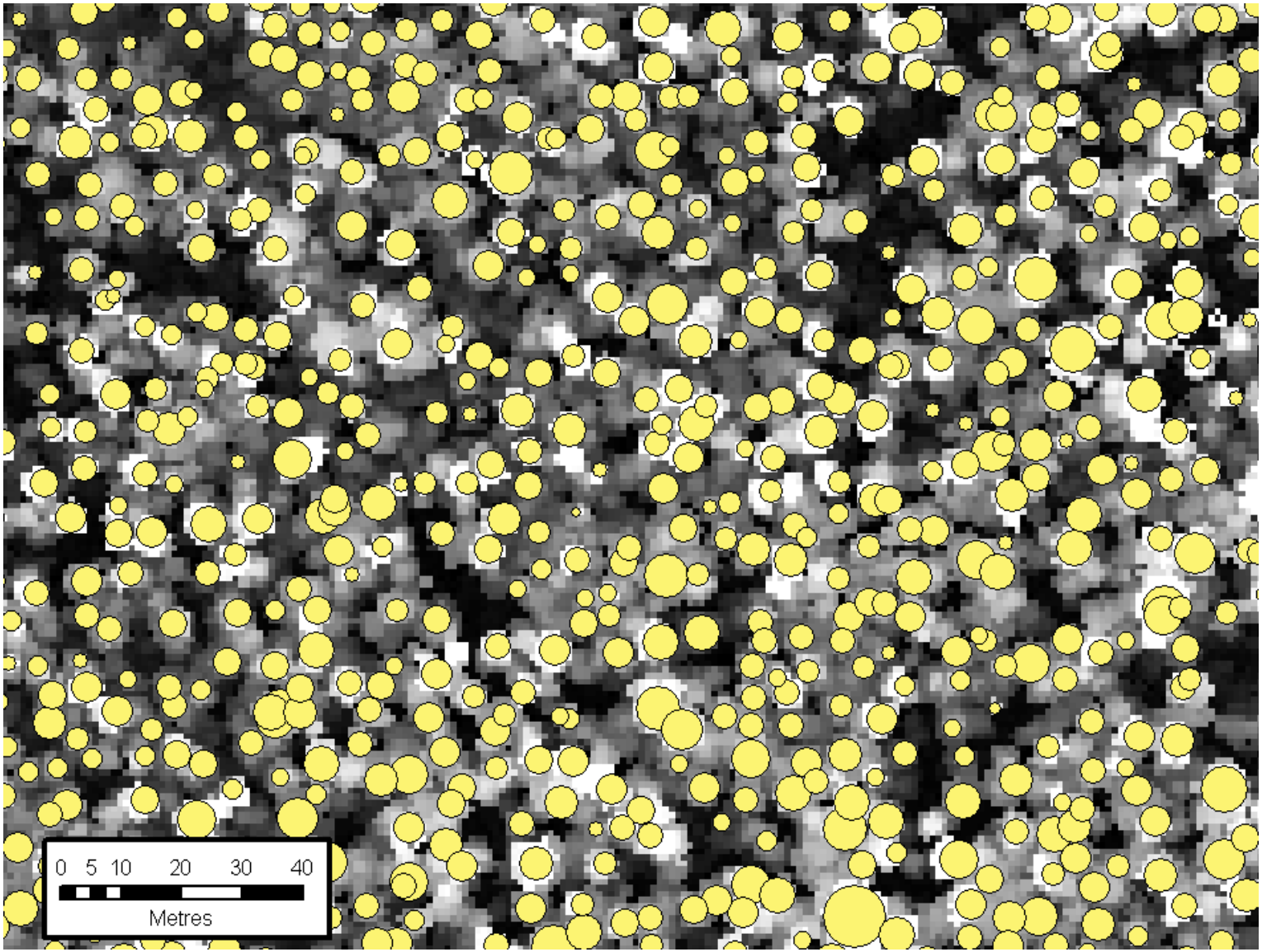
UNBC LiDAR datasets: UNBC campus, Aleza Lake RF, JPRF, Ancient Forest


Hansard Creek Digital Aerial Photography
1:2,500
N

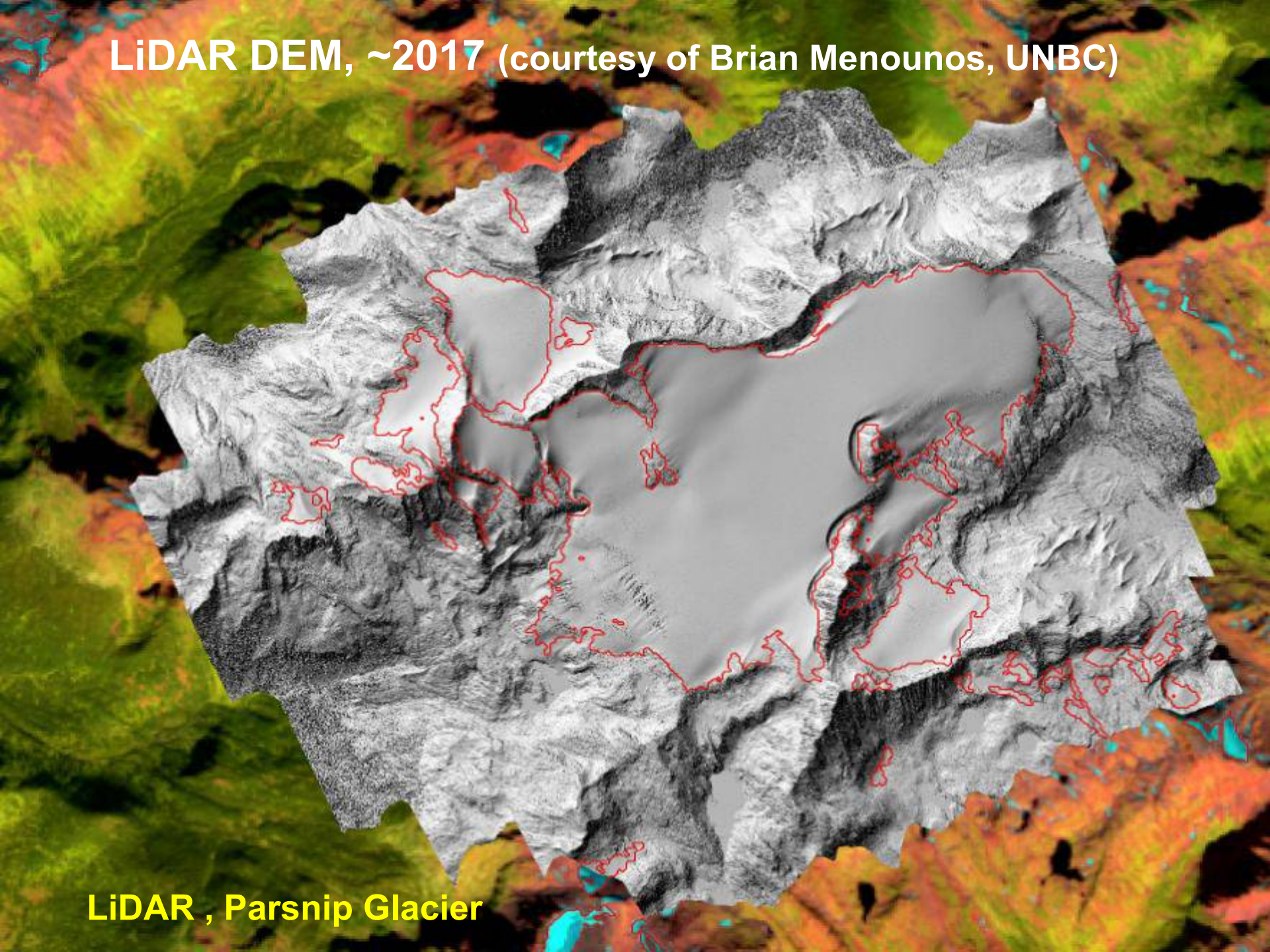

Hillshade Model
Alexa Lake FSR
Hansard Creek
Hillshade Model built from conventional BC DEM
N
0 25 50 100 150 200
Metres


Canopy Height Model
Alces Lake FSR
Hansard Creek
High : 35
Low : 0
N
0 25 50 100 150 200
Metres

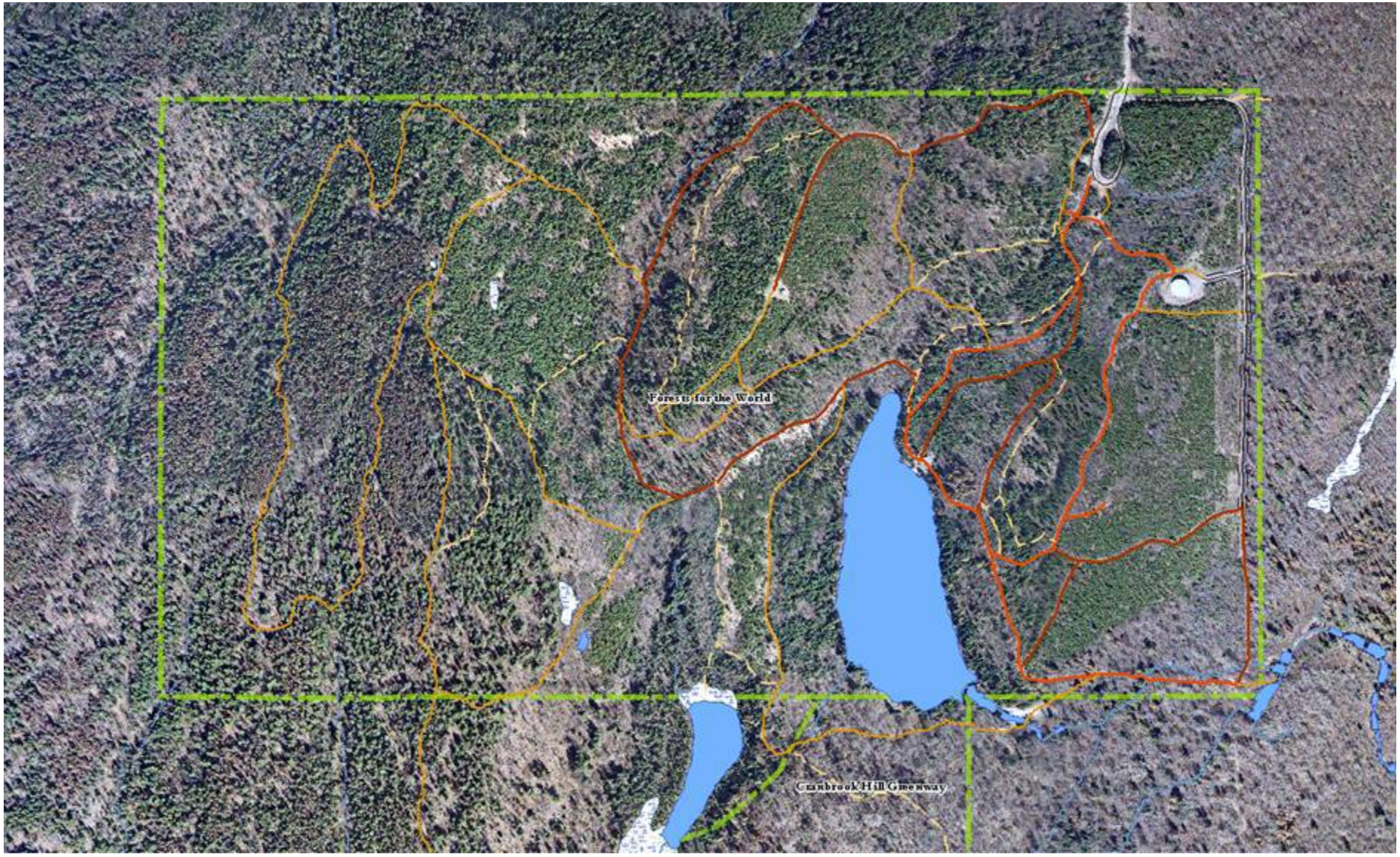
# LiDAR Data – tree stems



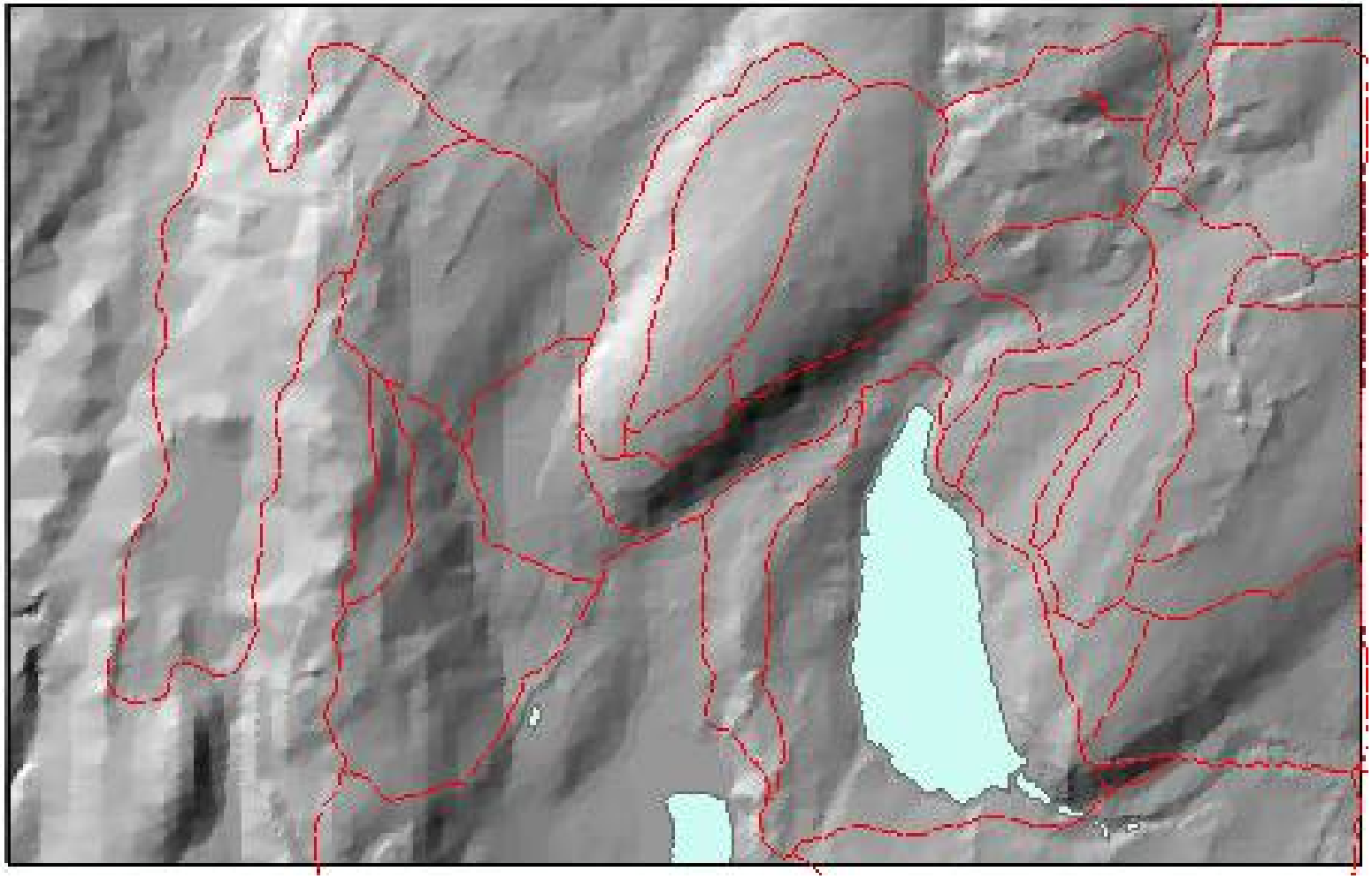

Individual tree crowns are discernable from the Canopy Height Model so we can develop a tree finding algorithm to identify tree stem locations


LiDAR DEM, ~2017 (courtesy of Brian Menounos, UNBC)
LiDAR , Parsnip Glacier

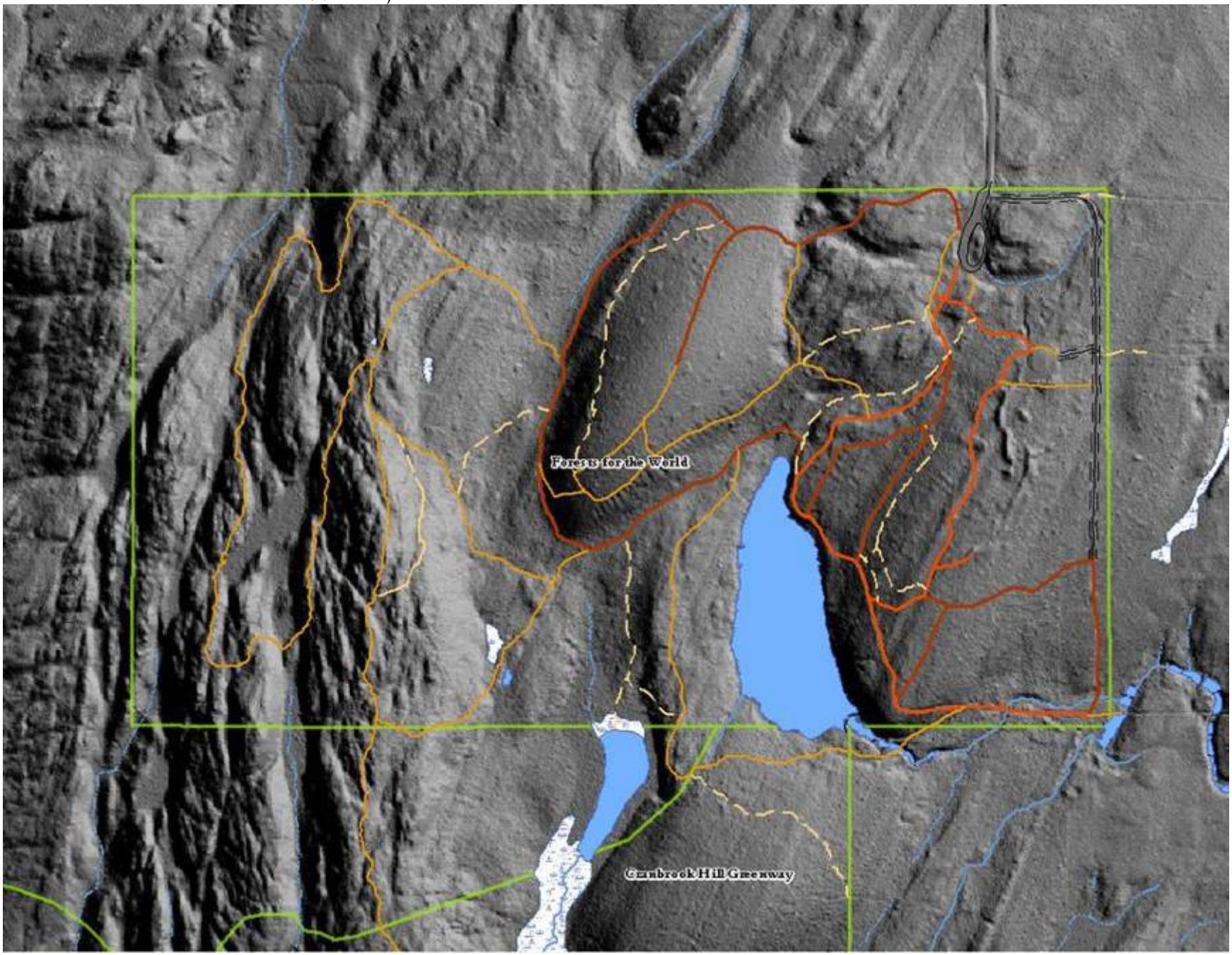
# Forests for the World orthophoto



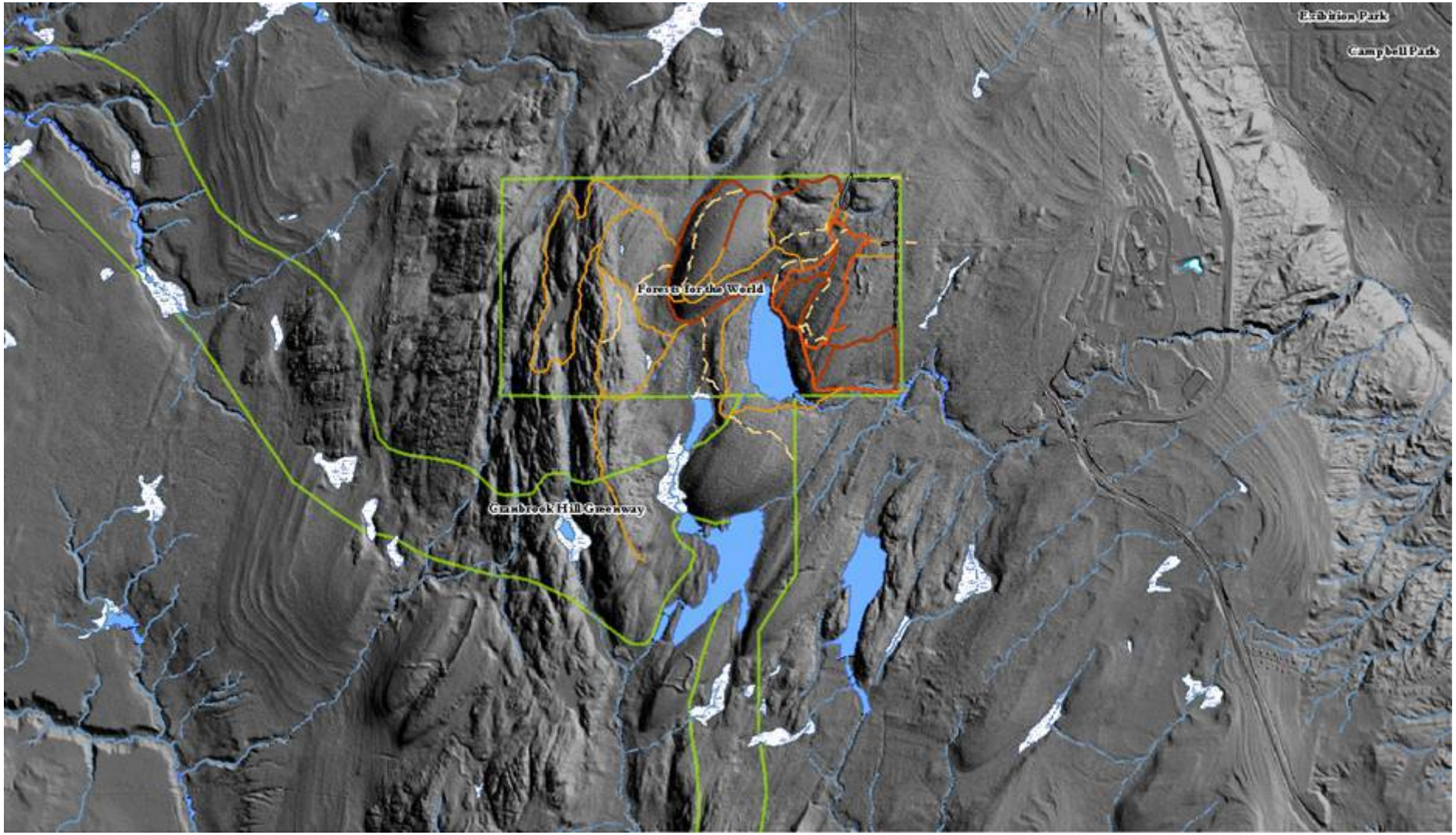
# City 1 metre DEM (from 1m contours)



LiDAR Forests for the World, 2009



UNBC / Cranbrook Hill LiDAR 2009




50cm beach lines

# LiDAR Platforms

**Airborne** since 1970s  e.g. Optech (Ottawa)  NorthWest Geo (Calgary)

And many others … including UNBC (Dr. Brian Menounos)
- LiDAR is mostly airborne, while RADAR is mostly spaceborne

## Spaceborne

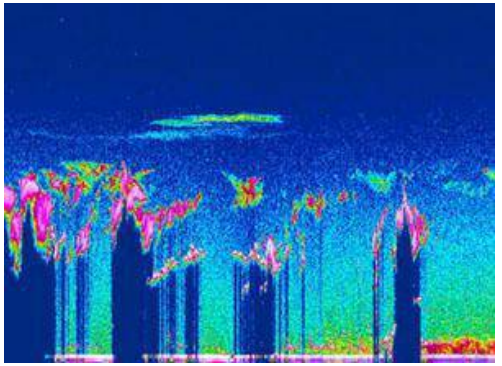
**ICESat** (Jan 2003->2009):  Geoscience Laser Altimeter System (GLAS):

66m 'footprint' and 10cm vertical resolution, designed for polar icecaps

**ICESat2** (Sept 2018): https://icesat-2.gsfc.nasa.gov

**CRYOSAT-2** 2010:  1.5cm vertical resolution

CALIPSO:
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation



# LiDAR summary

**Advantages:**

- ✓ Very high resolution DEM for many applications
- ✓ All urban areas with flooding potential
- ✓ Archaeological sites – discovery/mapping
- ✓ Multi-layer data for forestry and ecosystems
- ✓ Increasing data supply – some free download
- ✓ Increasing conference content in GIS/RS/Cartography/Forestry
- ✓ Many online resources e.g. :

USGS: http://lidar.cr.usgs.gov/knowledge.php

BC CARMS: http://carms.geog.uvic.ca/carmslidarnew.html

# Ground based – 'terrestrial' Lidar

## Lidar-based rock-fall hazard characterization of cliffs

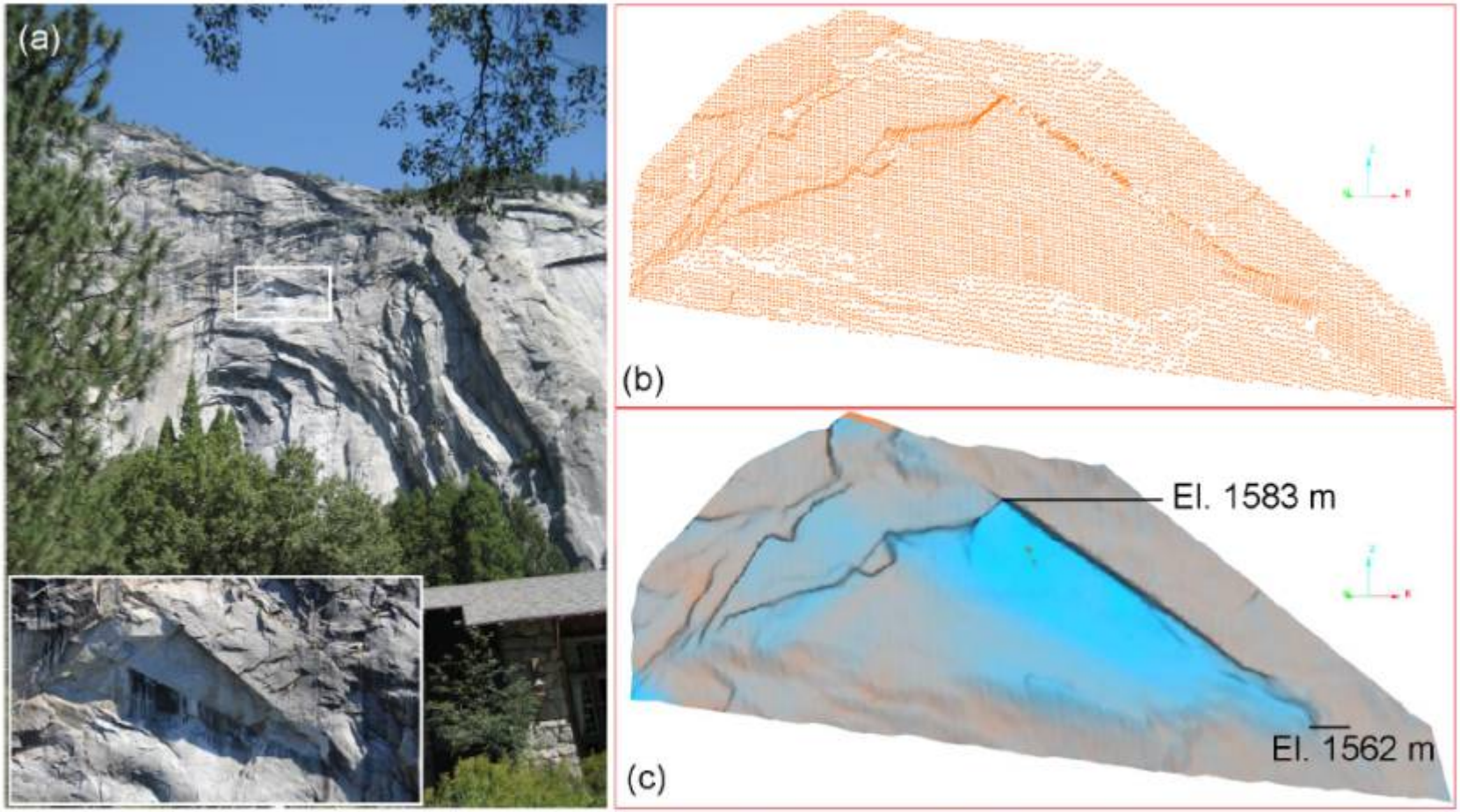



**Figure 1. (a) Image of a 2009 rock-fall in Yosemite National Park with (b) point cloud and (c) surface model of the source area. Brightest-blue colored areas of surface model in (c) indicate areas of change following the rock fall.**

http://www.nps.gov/yose/naturescience/upload/Collins-Stock-2012-ASCE.pdf

# LiDAR imagery of Gaping Gill - Britain's largest cavern

http://www.eepublishers.co.za/images/upload/PositionIT-pages%2029-32.pdf

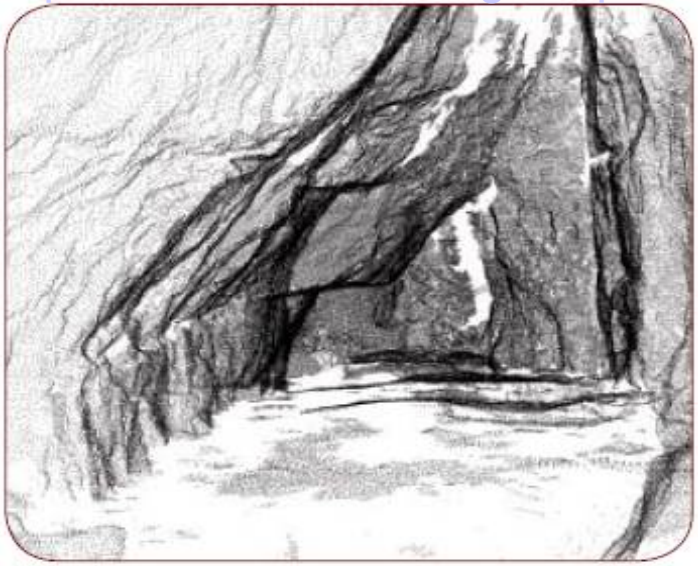


*Fig. 1: Gaping Gill Main Chamber LIDAR survey 2003. Vertex cloud looking west.*

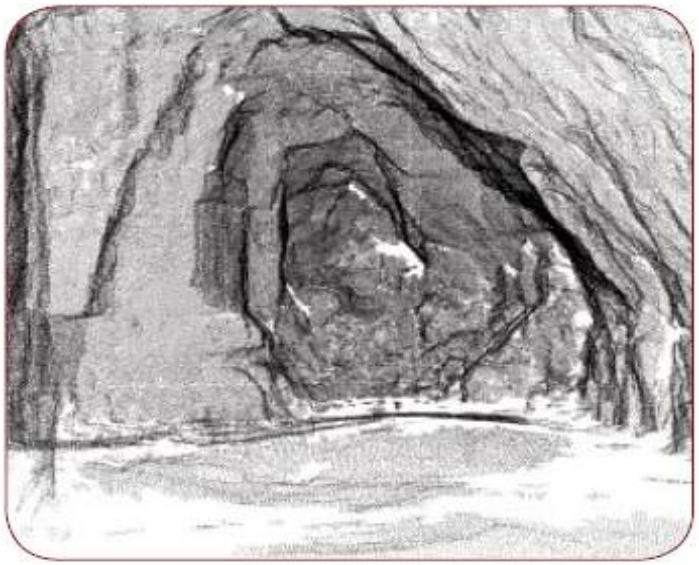
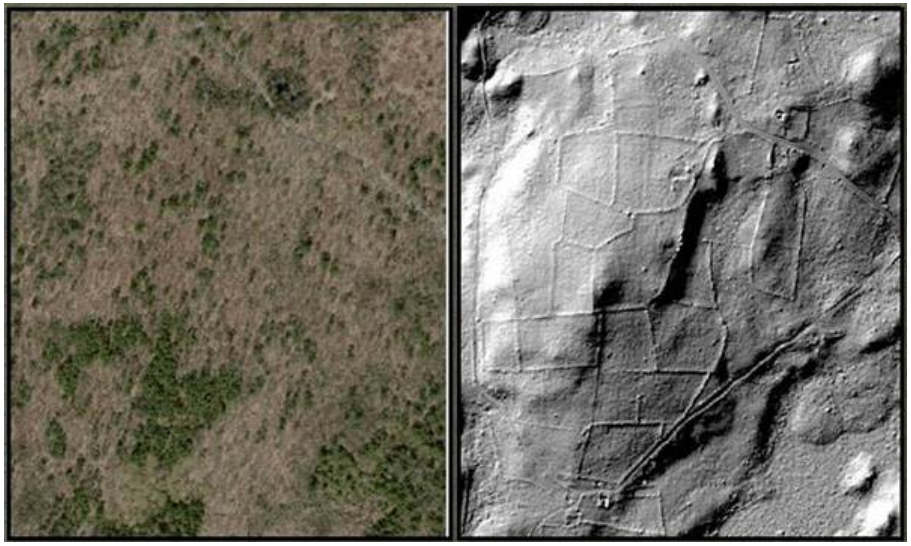


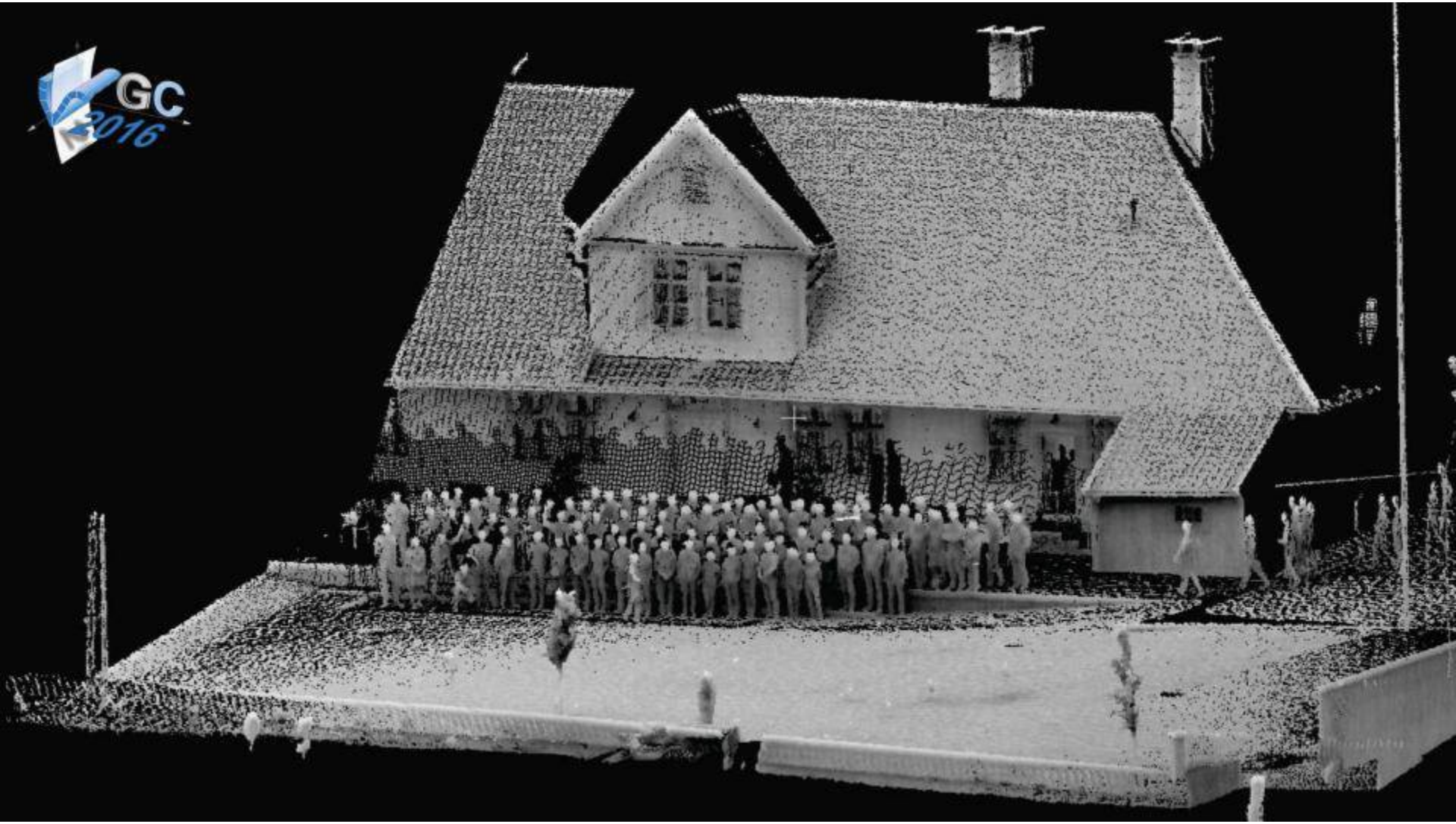
*Fig. 2: Gaping Gill Main Chamber LIDAR survey 2003. Vertex cloud looking east.*

**Heritage building scanning**:
http://www.youtube.com/watch?v=4AGk01Ims5k

Archaeology: e.g. Mayan settlements ->




Conference group photo




Conference group LiDAR scan image

**NRESi/Geography/IWAU Joint Colloquium:**
**Friday, November 20, 2020 - 3:30pm to 4:30pm**

"*Mapping in a Man's World -*
*Amazing Tales of Feminist and Queer Mapping Adventures in a Male-dominated Field.*"

**Rosemary Wardley**,
Cartographer and Graphics Editor at National Geographic.