Highly Portable Terrestrial Laser Scanners (TLS)

- Two parallel tracks of development
  - **Highly capable instruments**
    - Riegl VZ400
      - and other hi-end commercial TLS
    - Multispectral instruments: Dual Wavelength Echidna Lidar (DWEL); Salford Advanced Laser Canopy Analyzer (SALCA)
  - **Highly portable instruments**
    - Zebedee (Zeb-1, Zeb-Revo)
    - Compact Biomass Lidar (CBL)
    - Robin 3-in-one (Riegl VUX-1 UAV)

Riegl VZ400 (, CBL-1, DWEL, Faro Focus 3D 120, SALCA TLSiig Brisbane Intercomparsion, 28 Jul- 3 Aug 2013

Highly Portable Terrestrial Laser Scanners (TLS)

- **Highly portable instruments**
    - Compact Biomass Lidar (CBL)
        - Scientific Build, UMassBoston (Paynter et al., 2016)
            - Based on an initial concept by the *Katholieke Universiteit Leuven* (Van der Zande *et al.,* 2006), realized by Rochester Institute of Technology, and extensively refined by Univ. Massachusetts Boston (Sick inc.)
    - Robin 3-in-one (Riegl VUX-1 UAV) (commercial)
        - 3D Laser Mapping, UK
    - Zebedee (Zeb-1, Zeb-Revo) (commercial)
        - Originally developed by CSIRO
        - GeoSLAM (joint venture of CSIRO with 3D Laser Mapping,UK)
        - Geospatial Simultaneous Localization And Mapping (SLAM)

Instrument	UMB CBL (Sick Lidar)	Zeb-1	Zeb-Revo	ROBIN (Riegl VUX-1)
Source	University of Massachusetts Boston	GeoSLAM Ltd, Bingham, Nottinghamshire, UK		3D Laser Mapping Nottinghamshire, UK
Ranging Technique	Time-of-flight	Time-of-flight	Time-of-flight	Time-of-flight
Deployment	tripod, mast, etc.	Hand-held	Handheld And mobile	Backpack with 2 GNSS antennae, survey grade IMU, 18 MP camera, software (mobile and UAV mounts included)
Wavelength	905 nm	905 nm	905 nm	1550 nm
Recorded Data	1st and 2nd Discrete Return	Discrete Return	Discrete Return	Waveform 4 return max
Scan Configuration	0-135° zenith 0-360° azimuth	0-135° zenith 0-100° azimuth	0-135° zenith 0-360° azimuth	0-165° zenith 0-330° azimuth
Angular Resolution	0.25°	0.625°	0.625°	0.002°
Max Range	40m	30m	30m	300m
Laser Class	1	1	1	1
Weight	3.9kg	<1kg	4.1kg	< 10kg
Price (USD/Euros)	~$25K/€23K	$25K/€23K	$64K/€58K (with software)	$200K/€180K

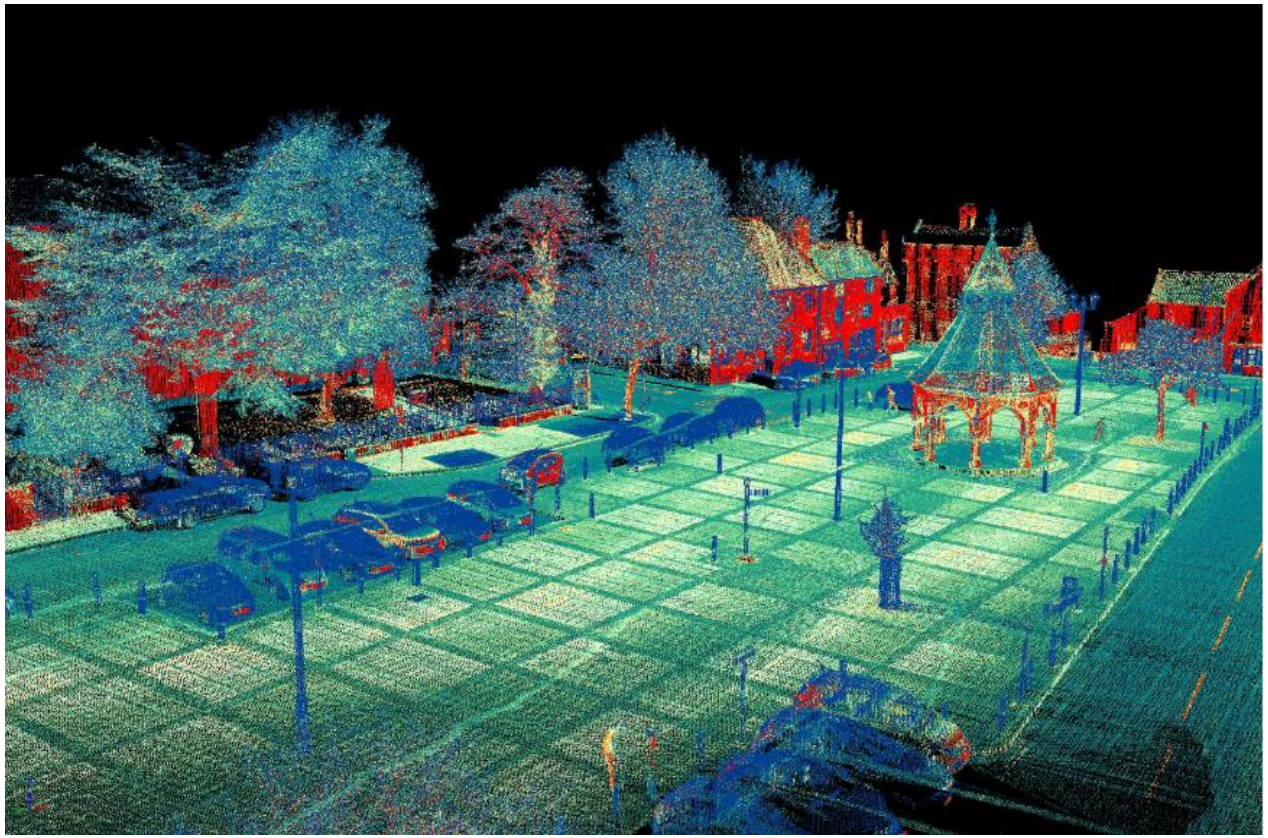
Robin VUX-1 Backpack, 2 GNSS antennae, survey grade IMU, 18MP camera, mobile/UAV mounts

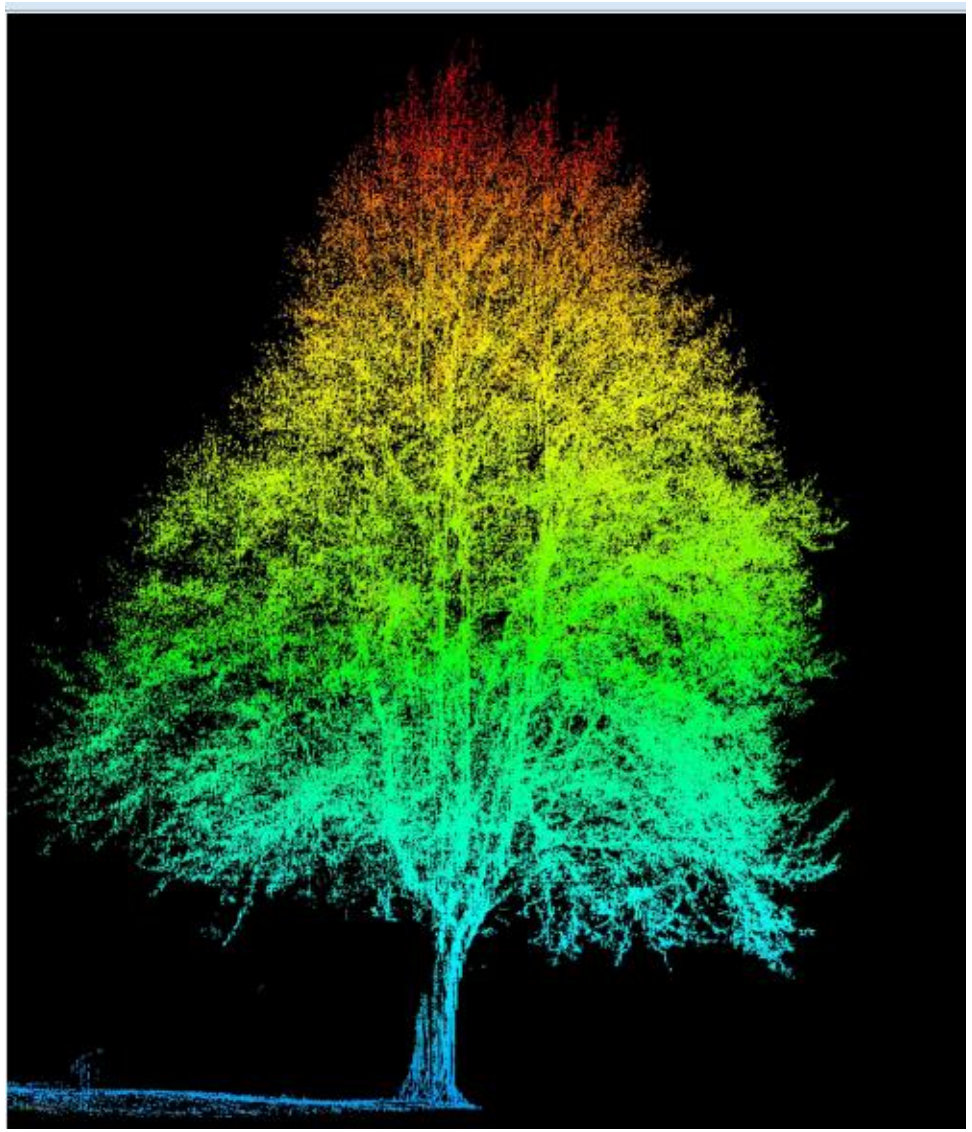
1550nm, 4 returns max

0.002°, 300m, <10kg

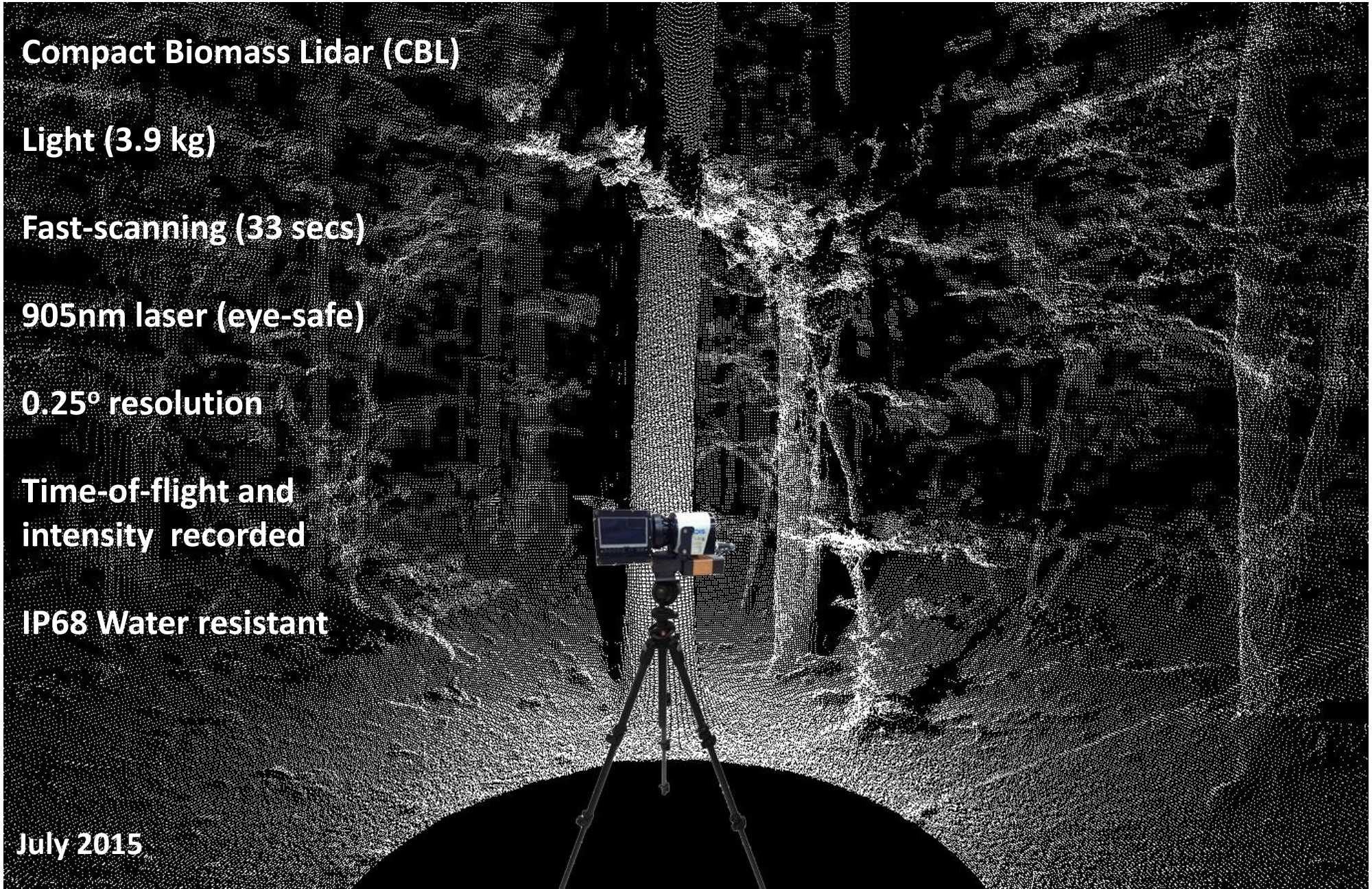
$200K/€180K

Kim Calders





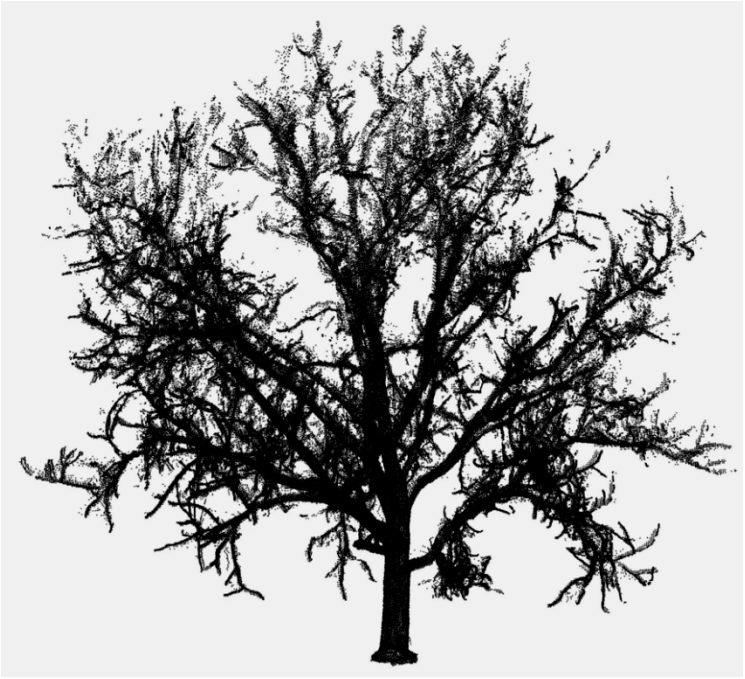
CBL superimposed on point cloud (Harvard Forest, MA, USA)



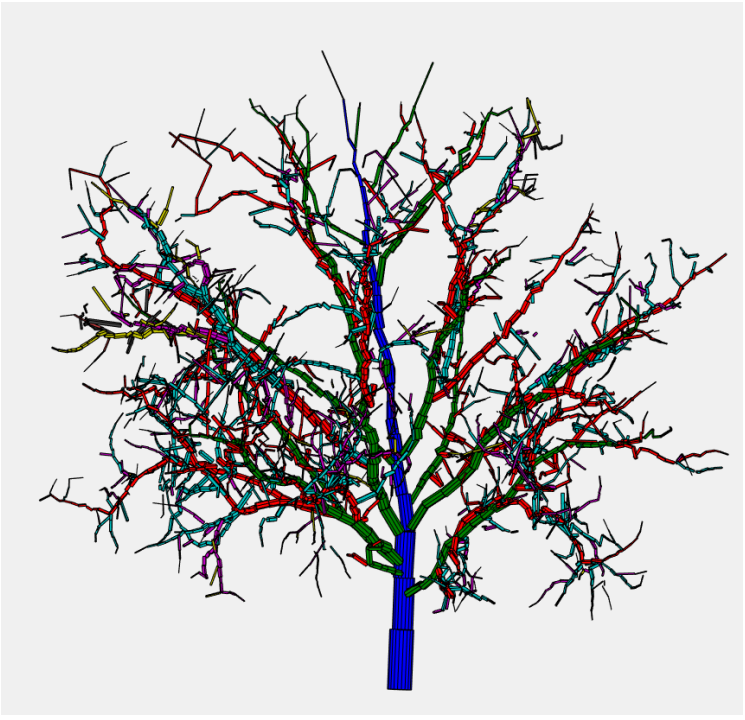
Object Reconstruction

Same sources of uncertainty to consider
(as with the highly capable instruments)

- Information density
- Information quality
  (range, view angles etc.)
- Sampling configuration
  (number and position of scans)
- Empirical and simulation efforts

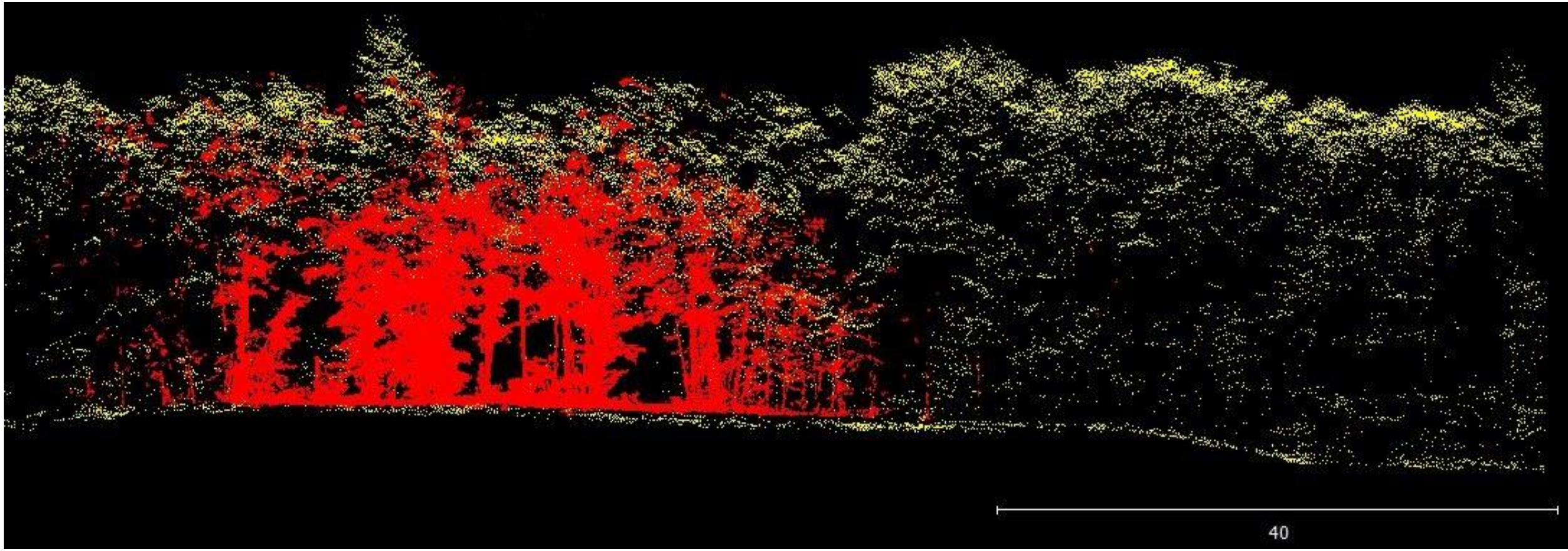


CBL, 4 scans



Cylinder QSM from Raumonen *et al.* 2013

TLS and ALS fusion



GLiHT ALS (4 returns) plus CBL
Harvard Forest

Highly Portable TLS
Versatile Deployment Strategies for Challenging Environments

CBL

- Temperate Mixed Forests (Harvard Forest LTER, MA, USA)
- High Altitude Conifer Forests (Sierras, CA, USA)
- High Temperature Grasslands 40°C (San Joaquin Rangelands, CA, USA)
- Eucalypt Forests (Brisbane, Australia)
- Saltmarshes and saltmarsh creeks (Nantucket, Plum Island LTER, MA, USA)
- Tropical Mangroves (Corcovado, Costa Rica)
- Tropical Forests (La Selva, Costa Rica)
- Treakcliff Caverns (Castleton, UK)

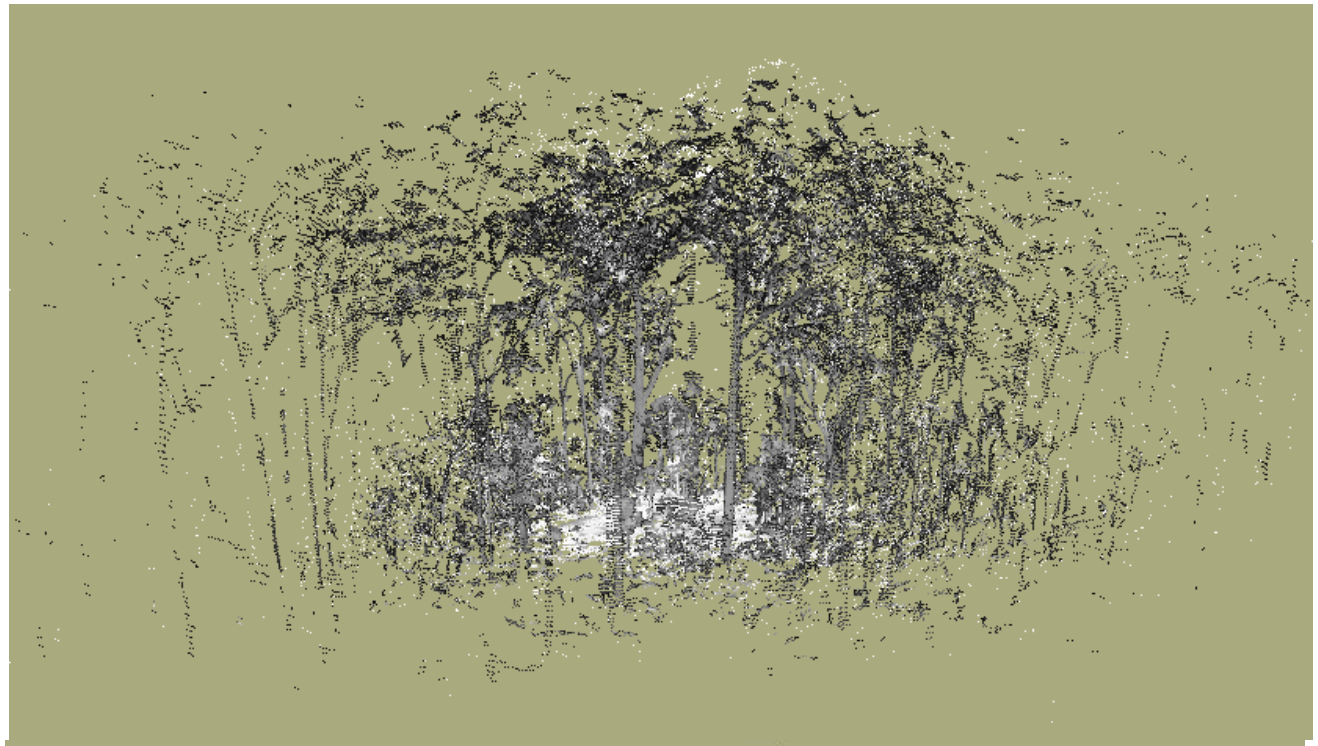
Compact Biomass Lidar - CBL

Francesco Peri UMB Engineer

Sierra National Forest and San Joaquin Rangelands, Fresno CA 104°F/40°C

CBLs in Brisbane Australia

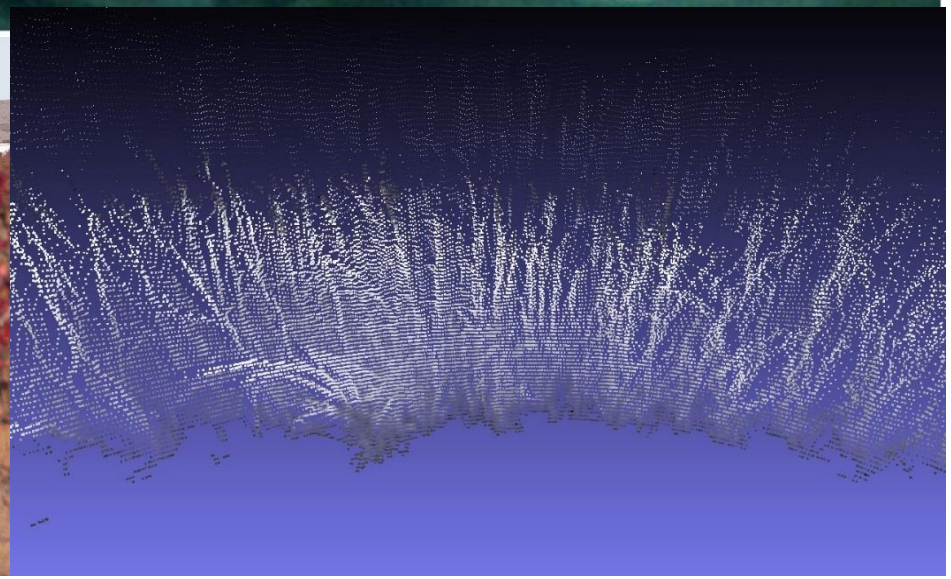
CBL
Karawatha
001



DWEL
Karawatha
001

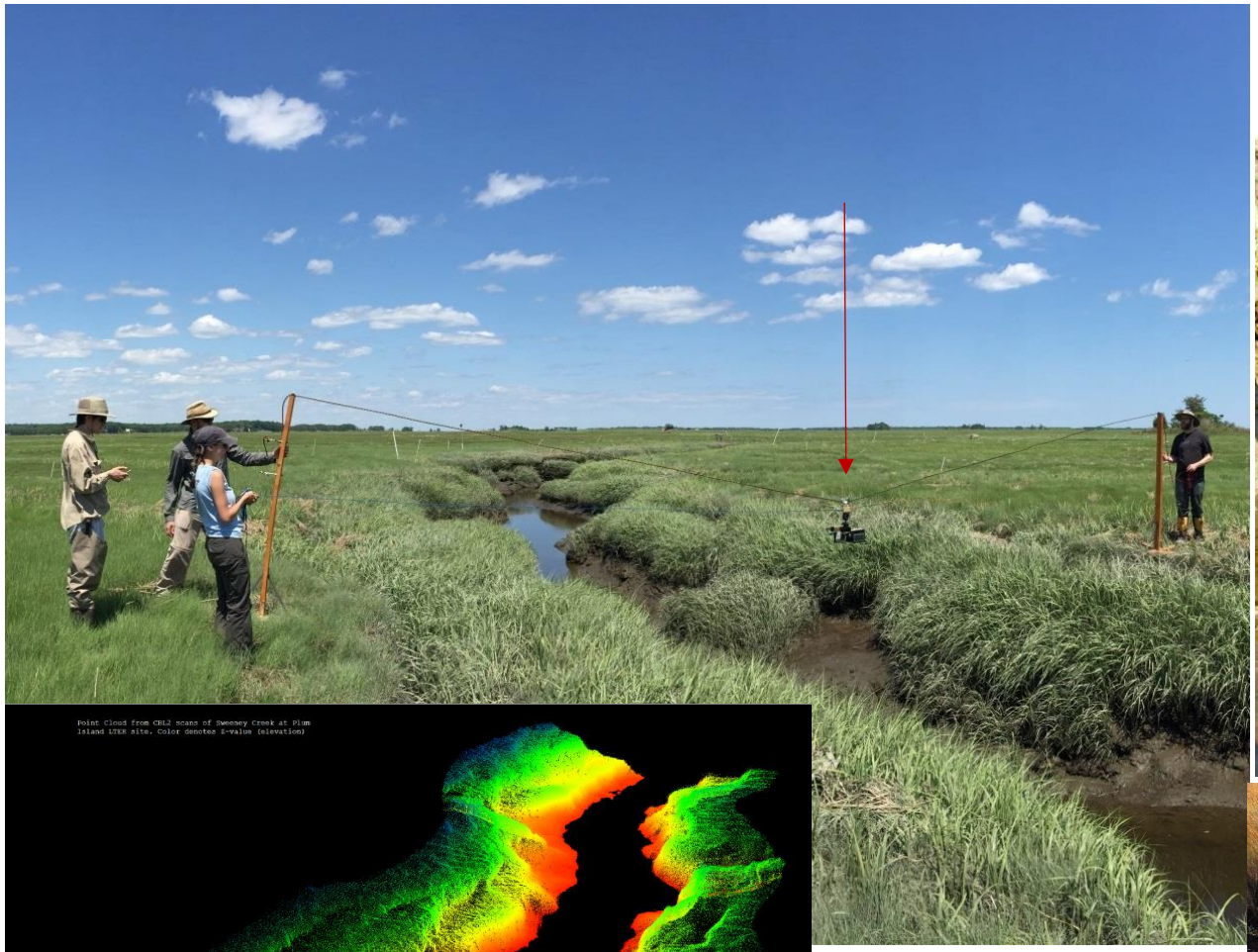
CBL Deployments

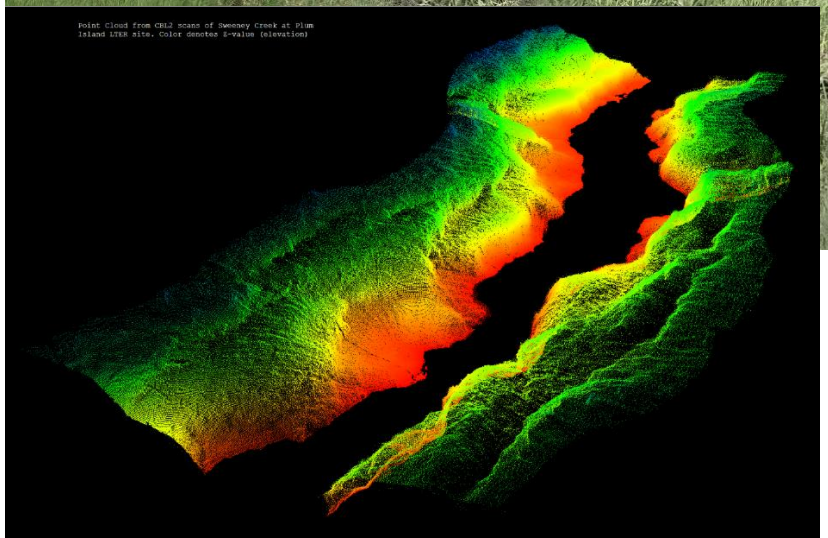
UMassBoston
Field Station
Nantucket Saltmarshes



Coastal Ecosystems: Saltmarshes

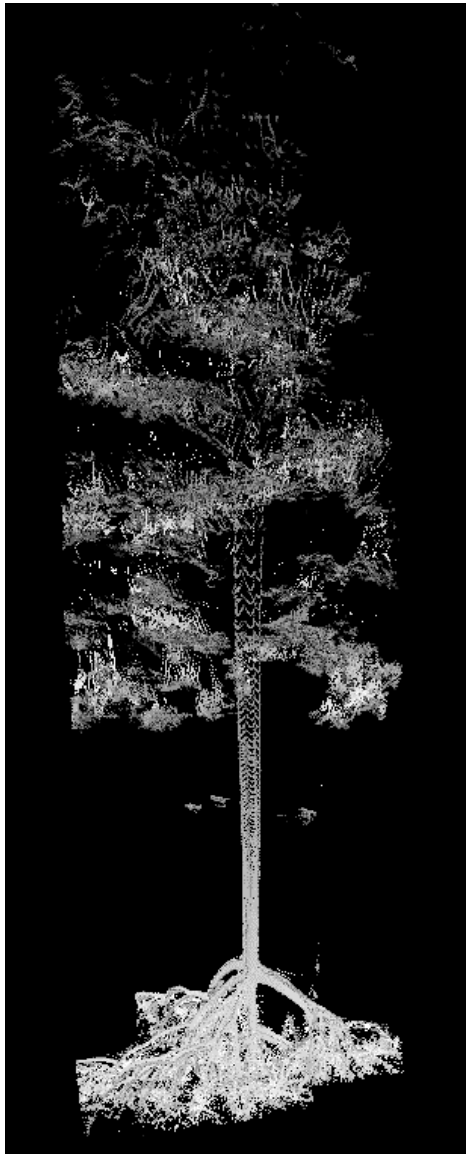
Plum Island
LTER, MA

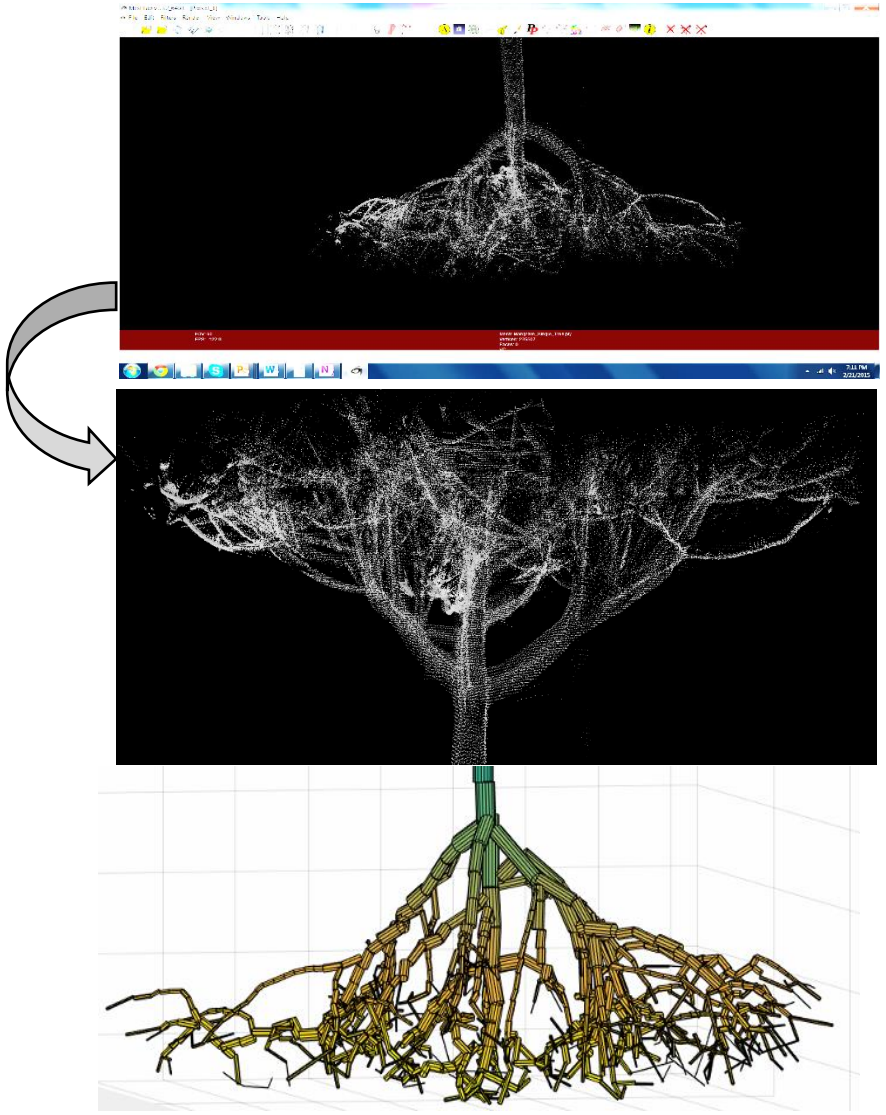




Coastal Ecosystems: Mangroves

Roots presented challenge for reconstruction:





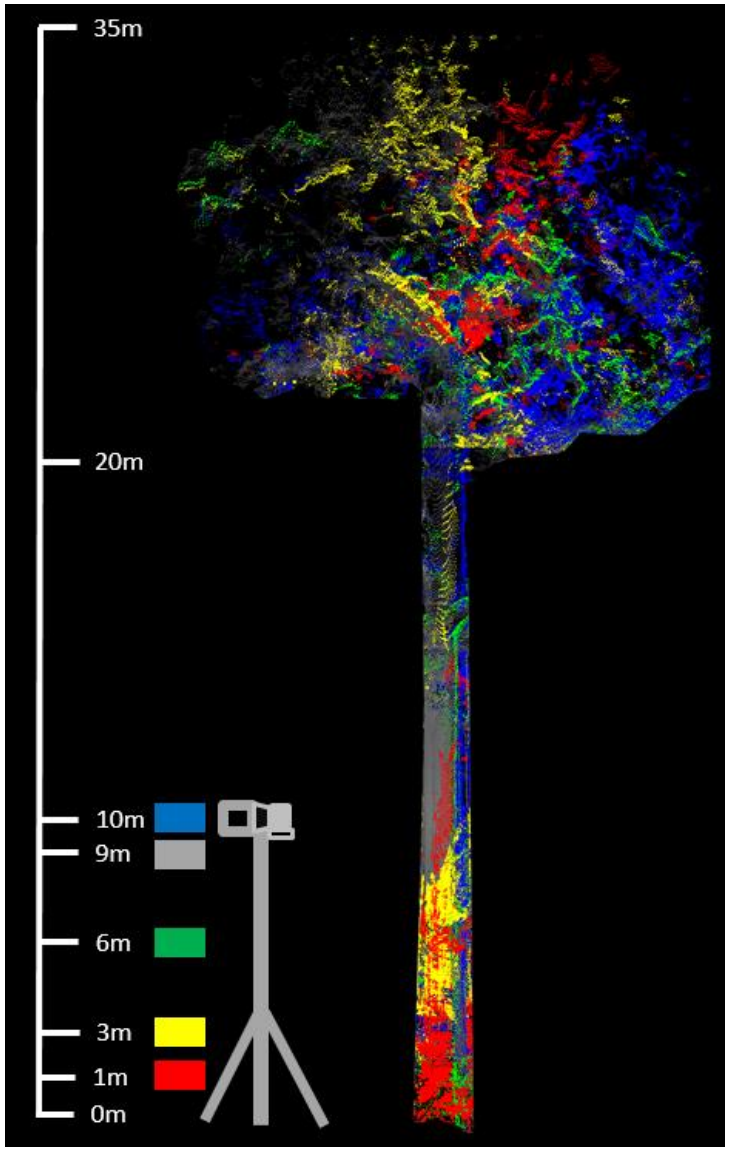
When inverted, QSM reconstruction algorithm modelled according to principles of branches

Raumonen *et al.* 2013

Costa Rica

Corcovado Sirena Biological Station

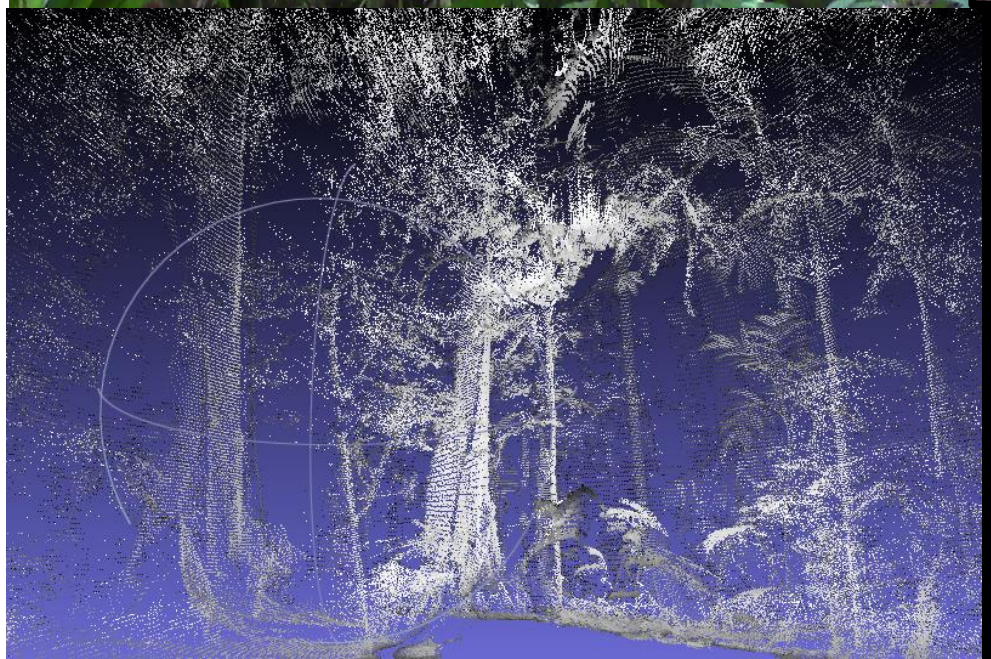
Tropical Forests: Vertical Stratification

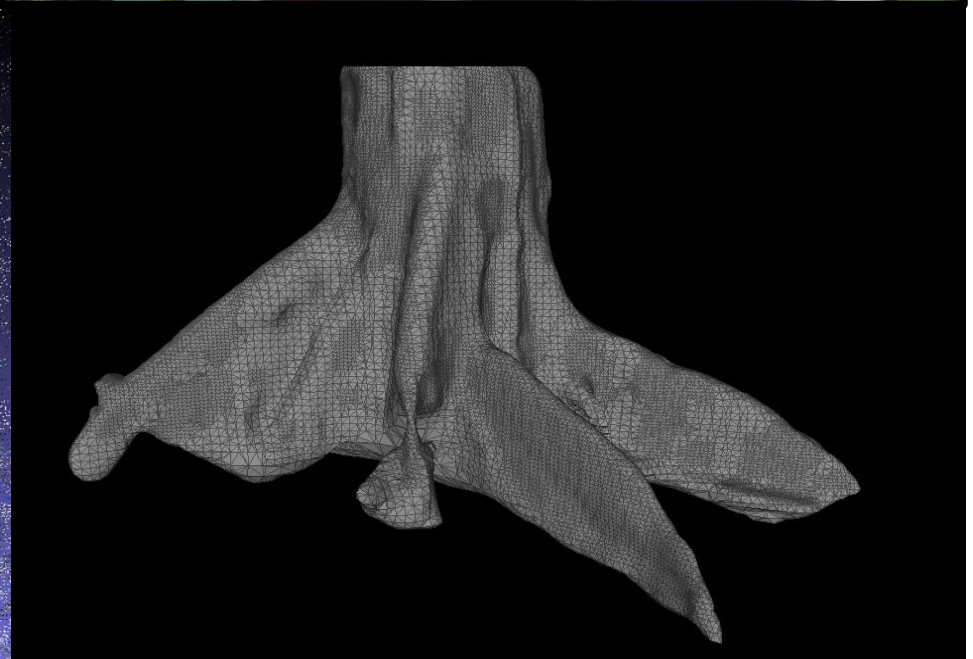


- Access inter-canopy layer
- Scanning at 2m – 10m height
- ~5 mins setup + 2 mins per scan

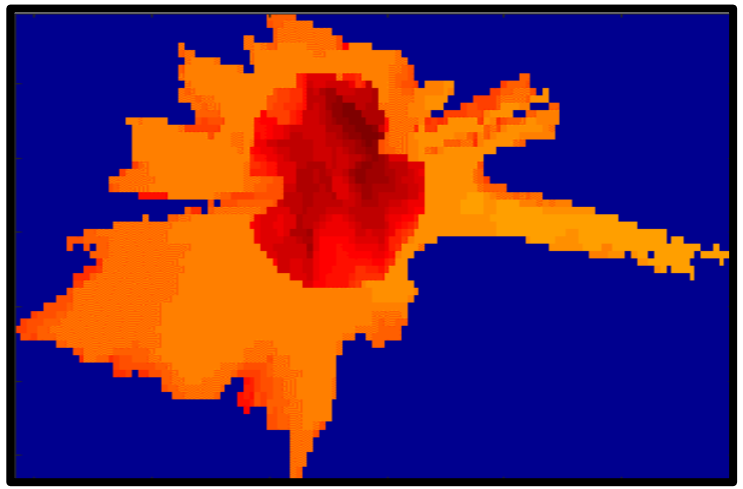
Carbono Plots (David, Deborah Clark)
La Selva National Park, Costa Rica

Tropical Trees Buttresses

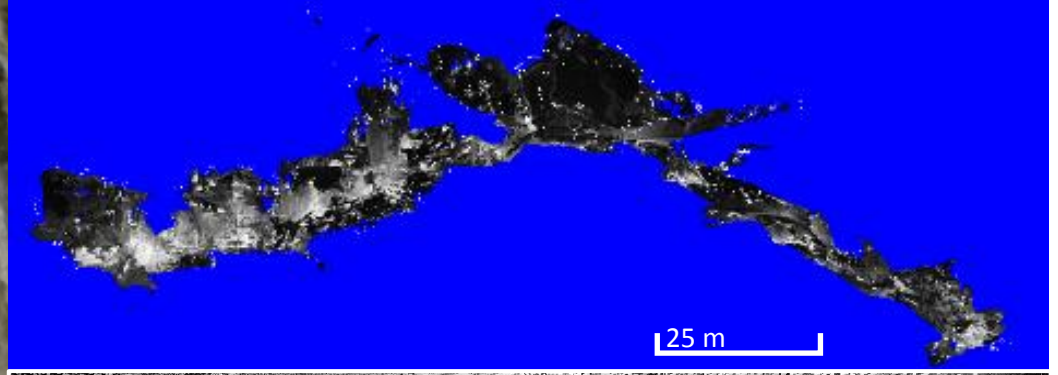


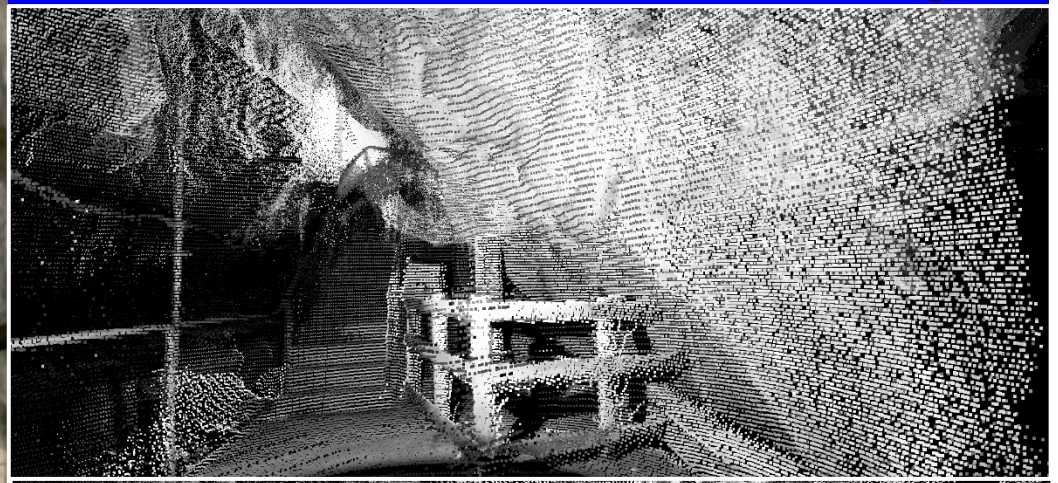


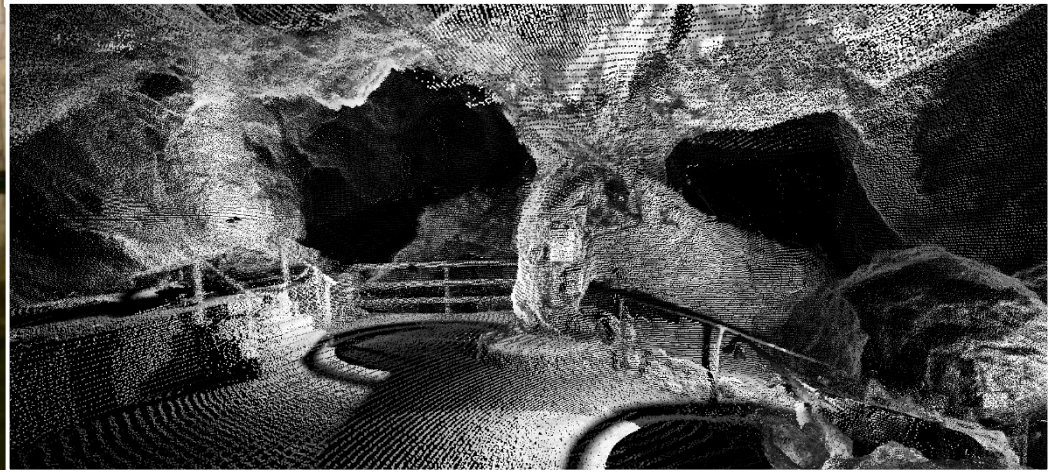
Tropical Forests: Atypical Morphology



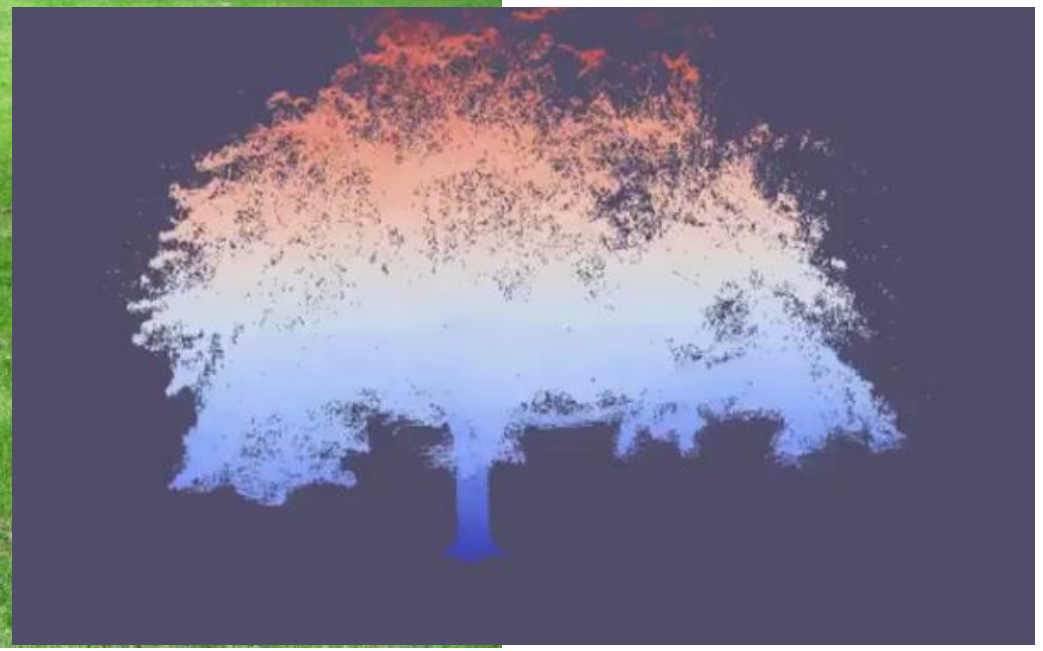
Treak Cliff Cavern







Salford University
TLSiig meeting
June 2014
CBL and ZEB-1



CEOS/WGCV/Land Product Validation (LPV)

- New Biomass Subgroup
  - https://lpvs.gsfc.nasa.gov/about.html
  - Protocols, accuracy, evaluation
  - M. Román, NASA GSFC (chair)
    - Laura Duncanson UMD (Gedi)
    - John Armston Queensland/UMD (Gedi)
    - Mat Disney UCL (Biomass)