



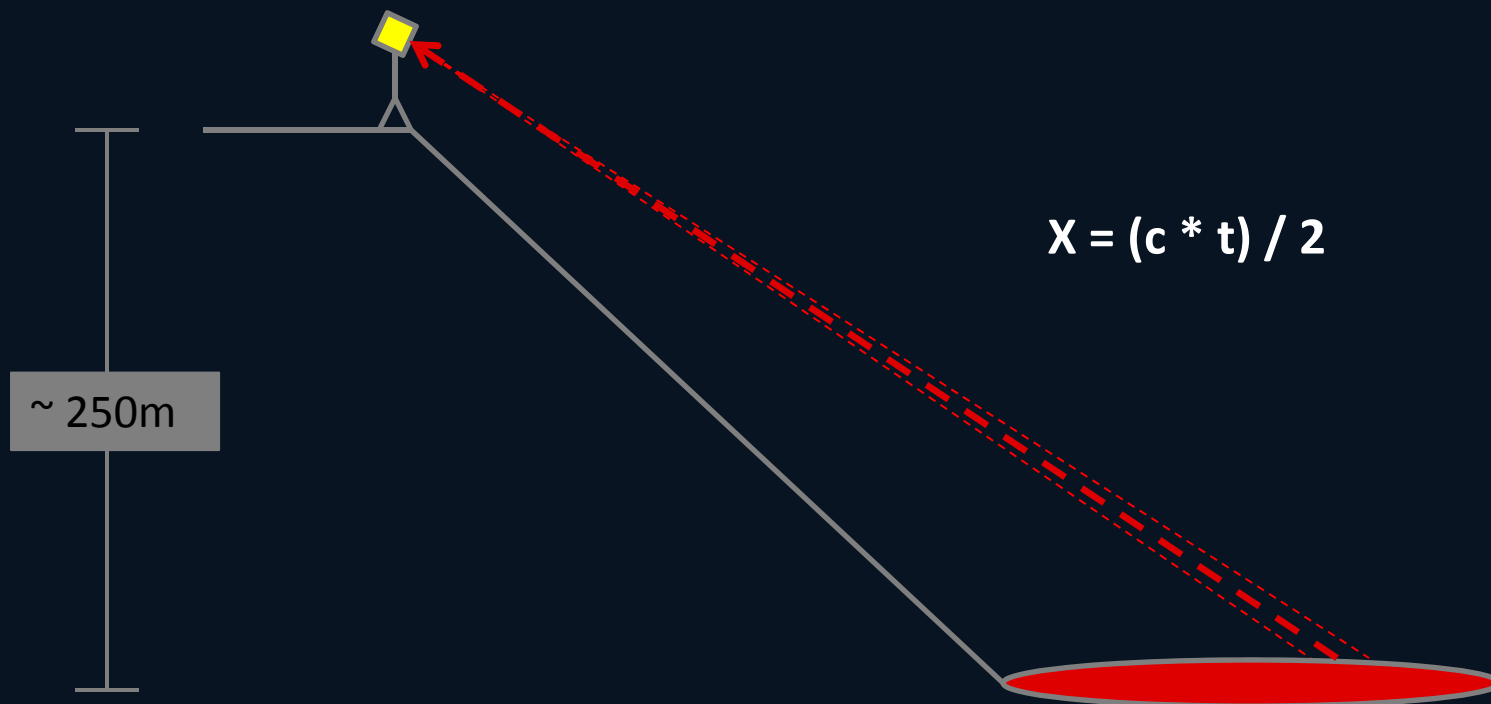
# Observing the Dynamics of Mount Erebus using a Terrestrial-Based LiDAR

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The optical analog to radar - Utilizes strong pulses of light, emitted by lasers, and gathers the reflected pulses in order to determine distance and position of the reflecting material (calculated from the flight time of the photon)





## Non-Ideal (to say the least) Scanning Environment

- Difficult atmospheric conditions (low visibility/ plume, ice/snow)
- Constantly moving target

- Difficult environmental conditions (low temperatures, high winds)
- No existing survey control



# Ice Dynamics





Riegl VZ-400

Wavelength = 1550nm

Measurement Rate = ~ 125,000 meas/s

Minimum Distance = 1m

Spatial Resolution = 5mm



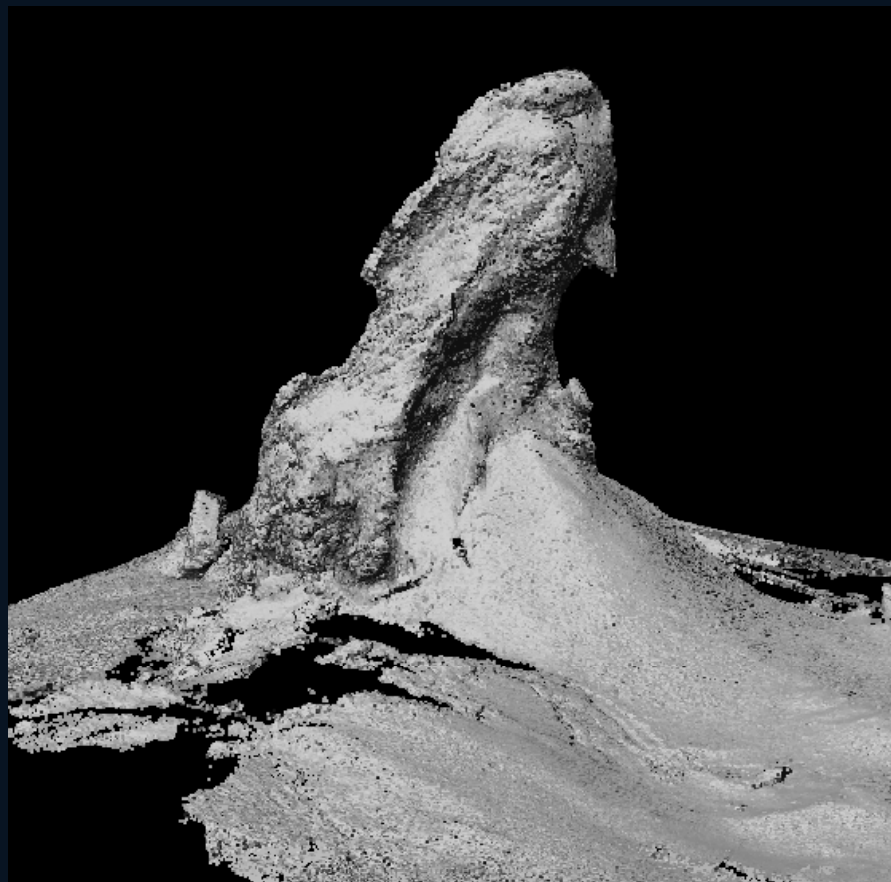
Optech Iris 3D

Wavelength = 1535nm

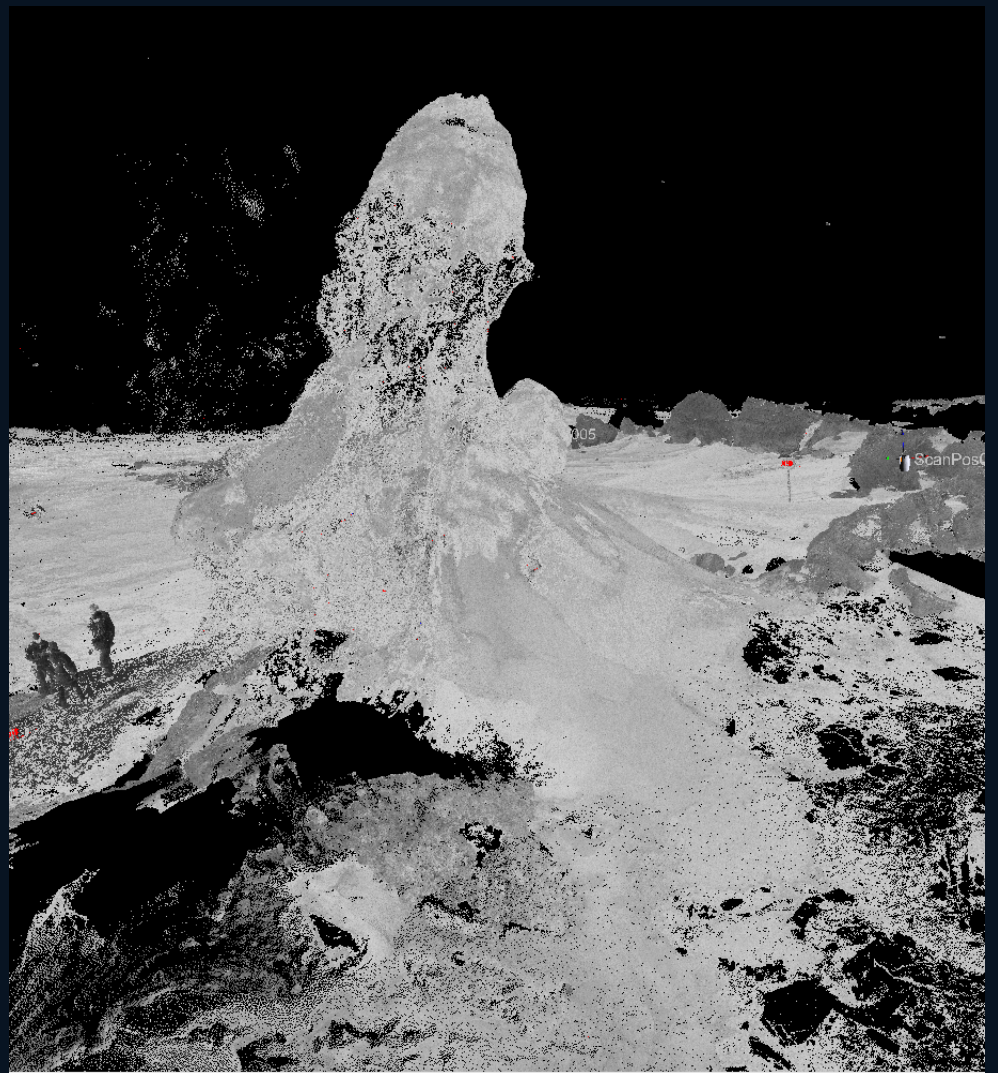
Measurement Rate = ~ 3,000 meas/s

Minimum Distance = 3m

Spatial Resolution = 2 cm









2009



2010



2m

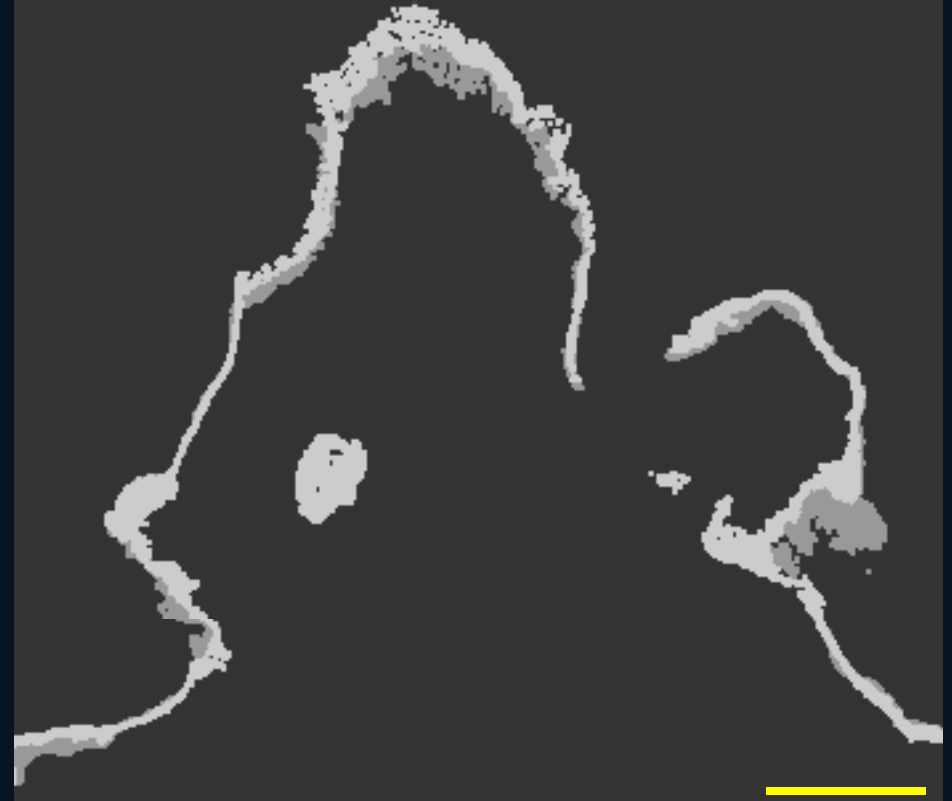




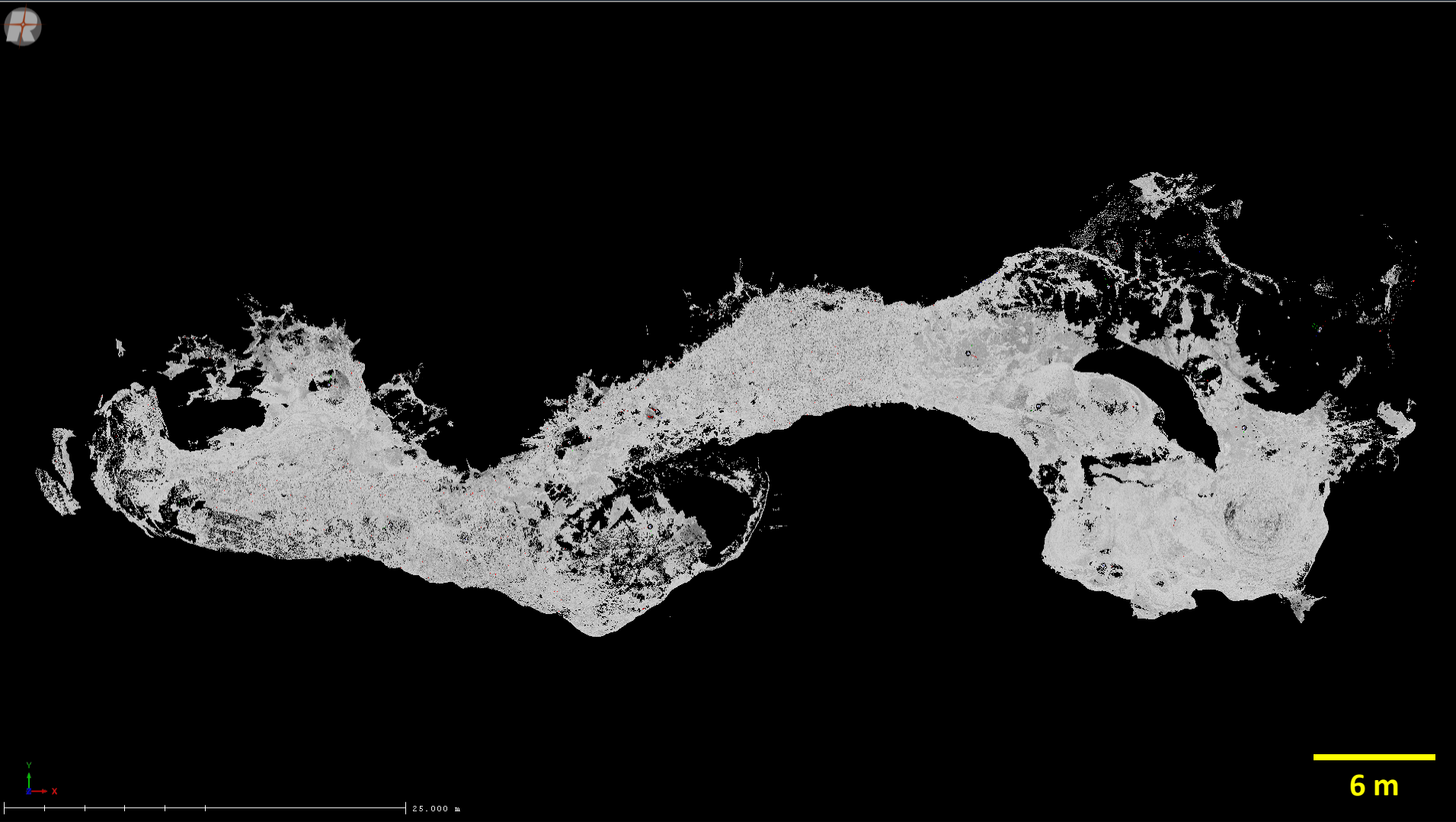
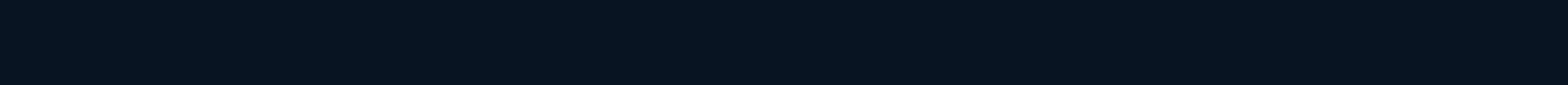
2009

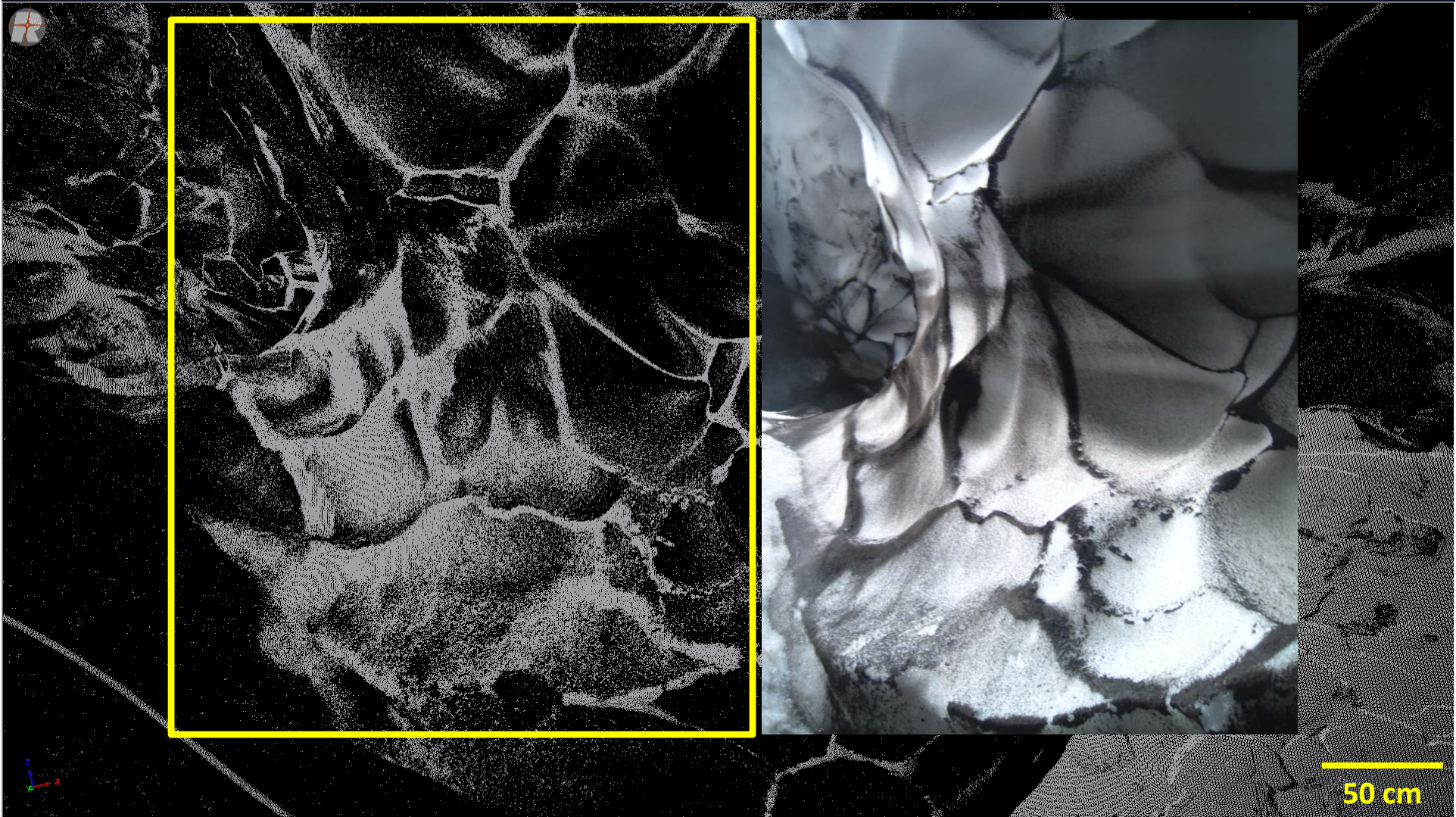


2010

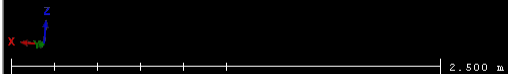
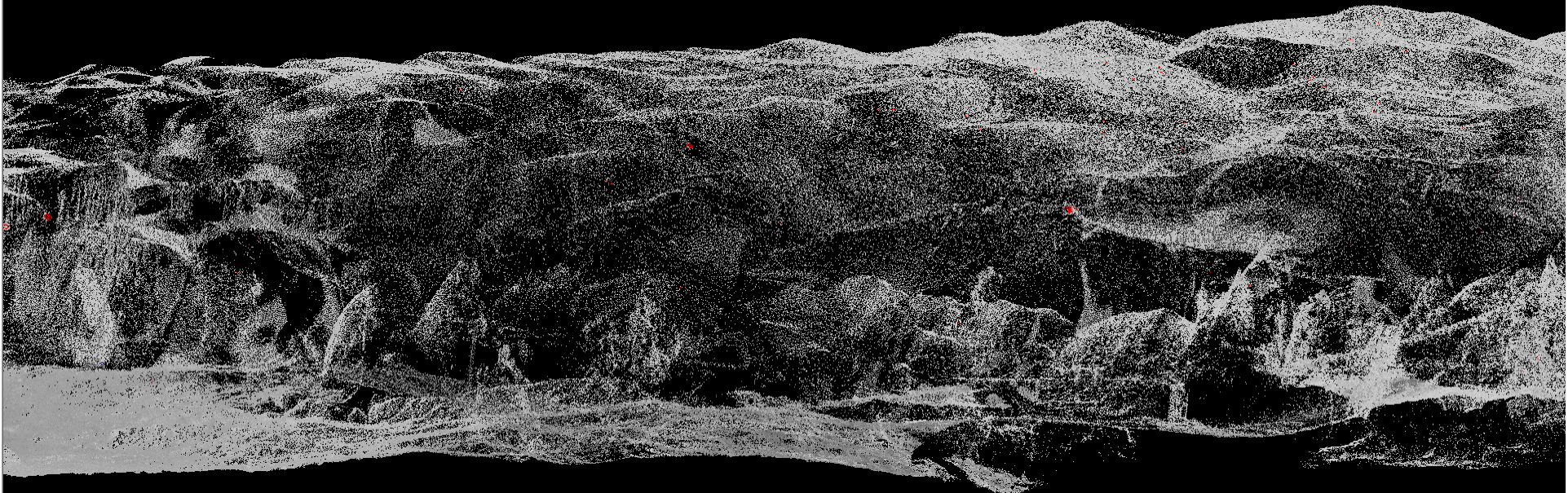


2m











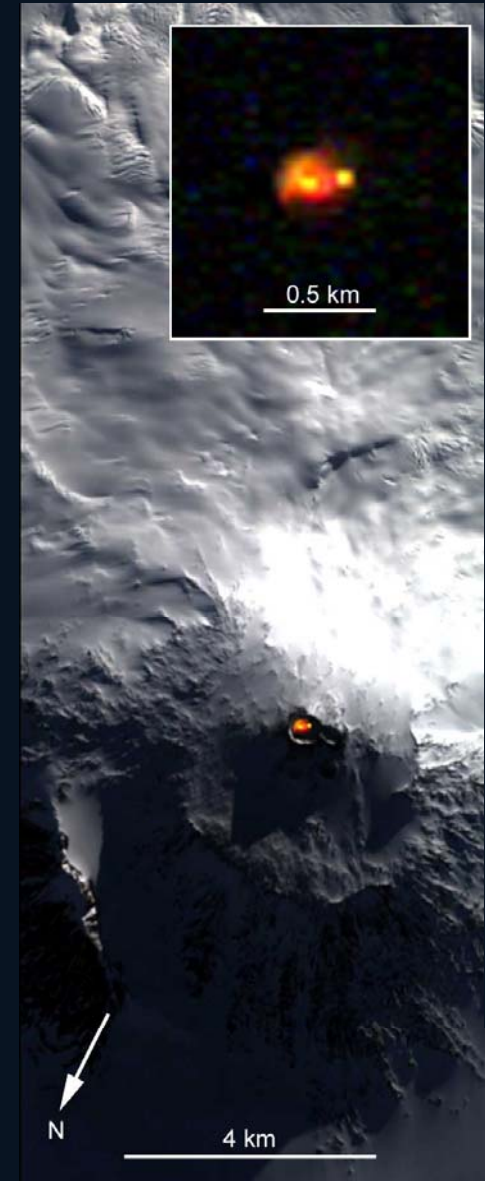


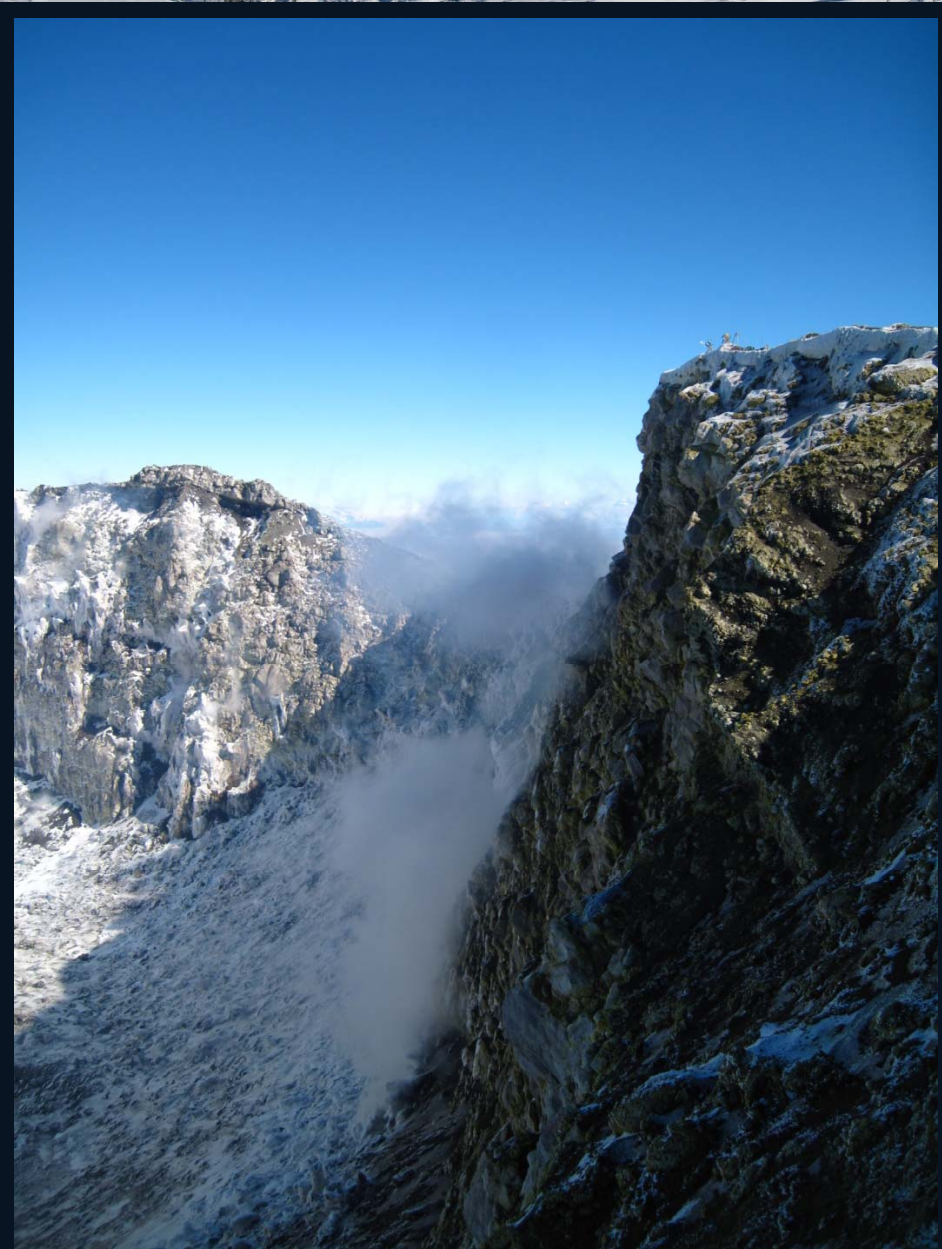
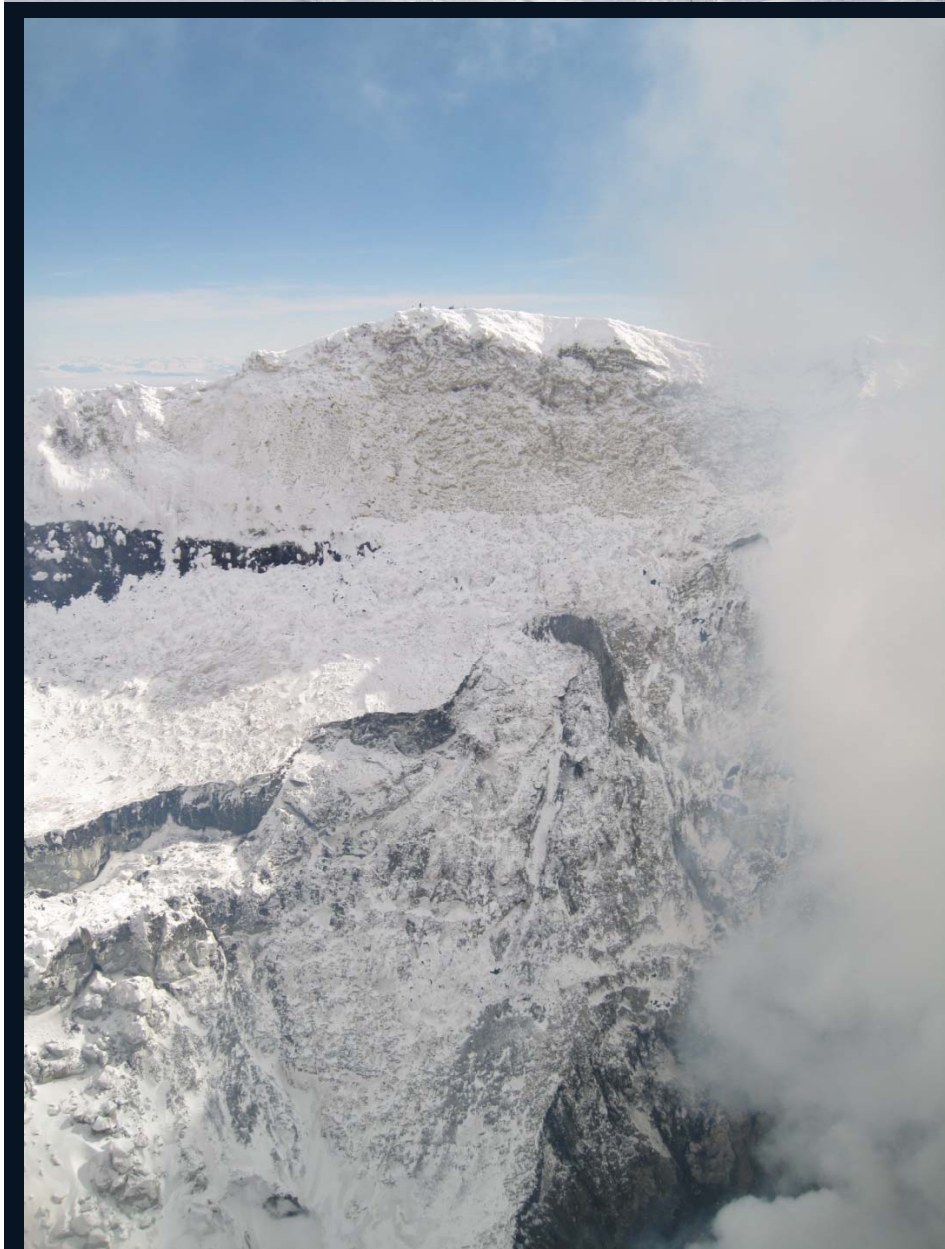
# Lava Lake Dynamics



# Lava Lakes

- “Inactive” versus “Active”
- Long-lived, persistently active lava lakes are very rare; the only ones currently in existence are:
  - Nyiragongo, Democratic Republic of Congo
  - Erta ‘Ale, Ethiopia
  - Mount Erebus, Ross Island, Antarctica
- The lava lake represents the exposed tops of magma systems and therefore provide us the opportunity to observe directly the dynamics of magma transport





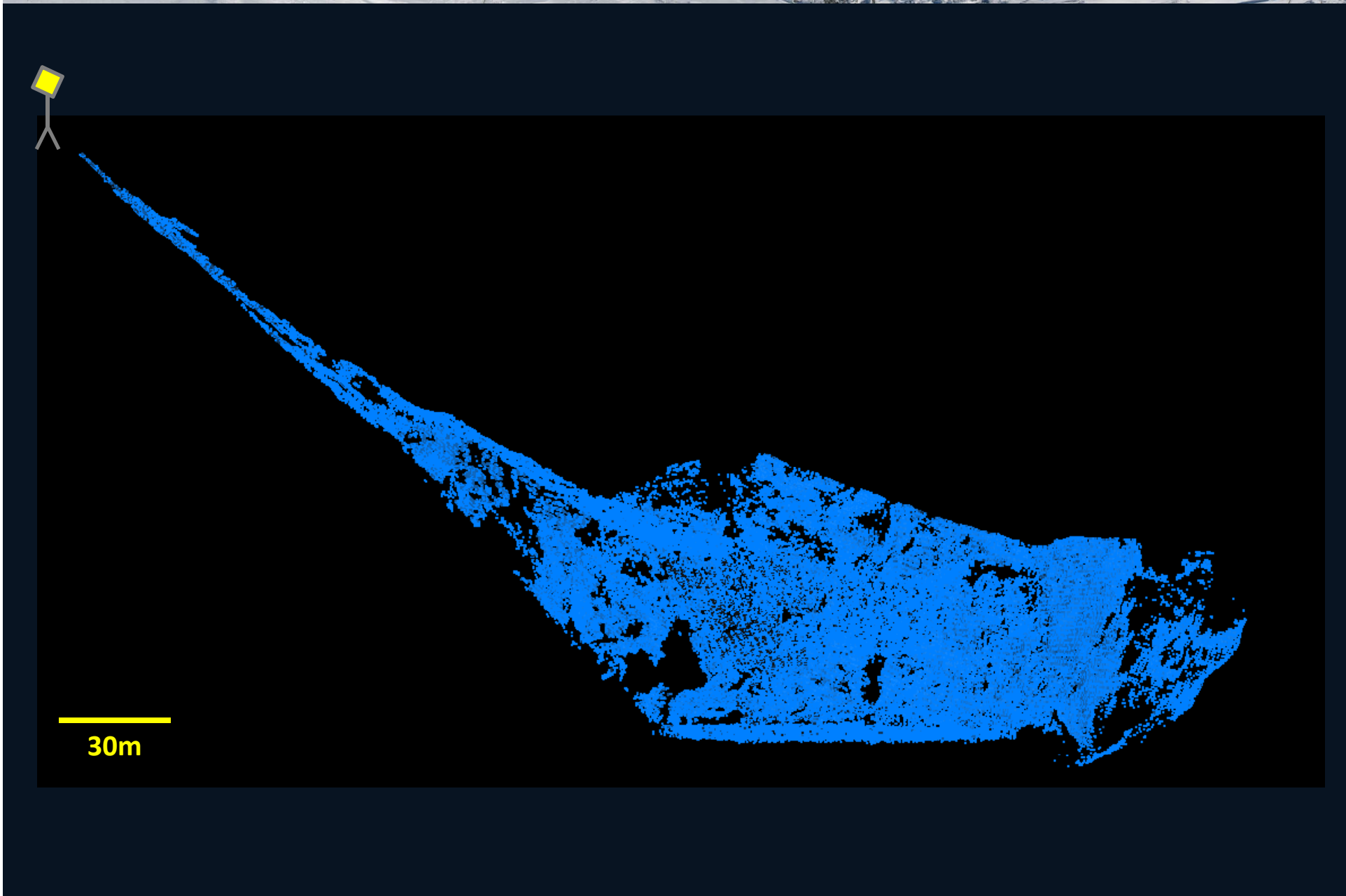


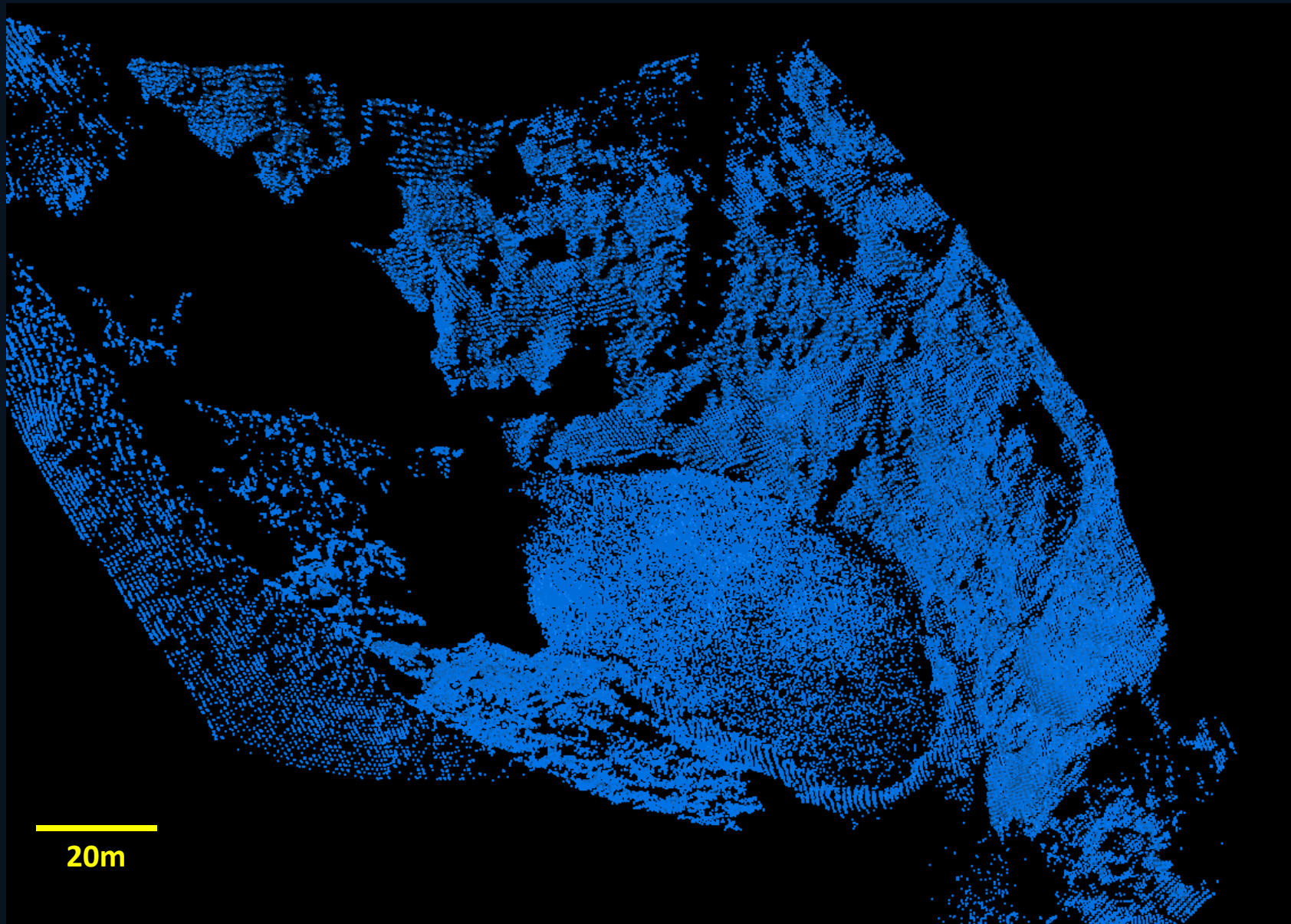


## Data Collection

- Optech ILRIS-3D system from UNAVCO
- GPS PPS connection – Every point is time-stamped with GPS time
- In December 2008, the lake was continuously imaged for 4 hours at approximately 1 minute intervals
- In December 2009 and 2010, the lake was continuously imaged for 8 hours at approximately 30 second intervals.

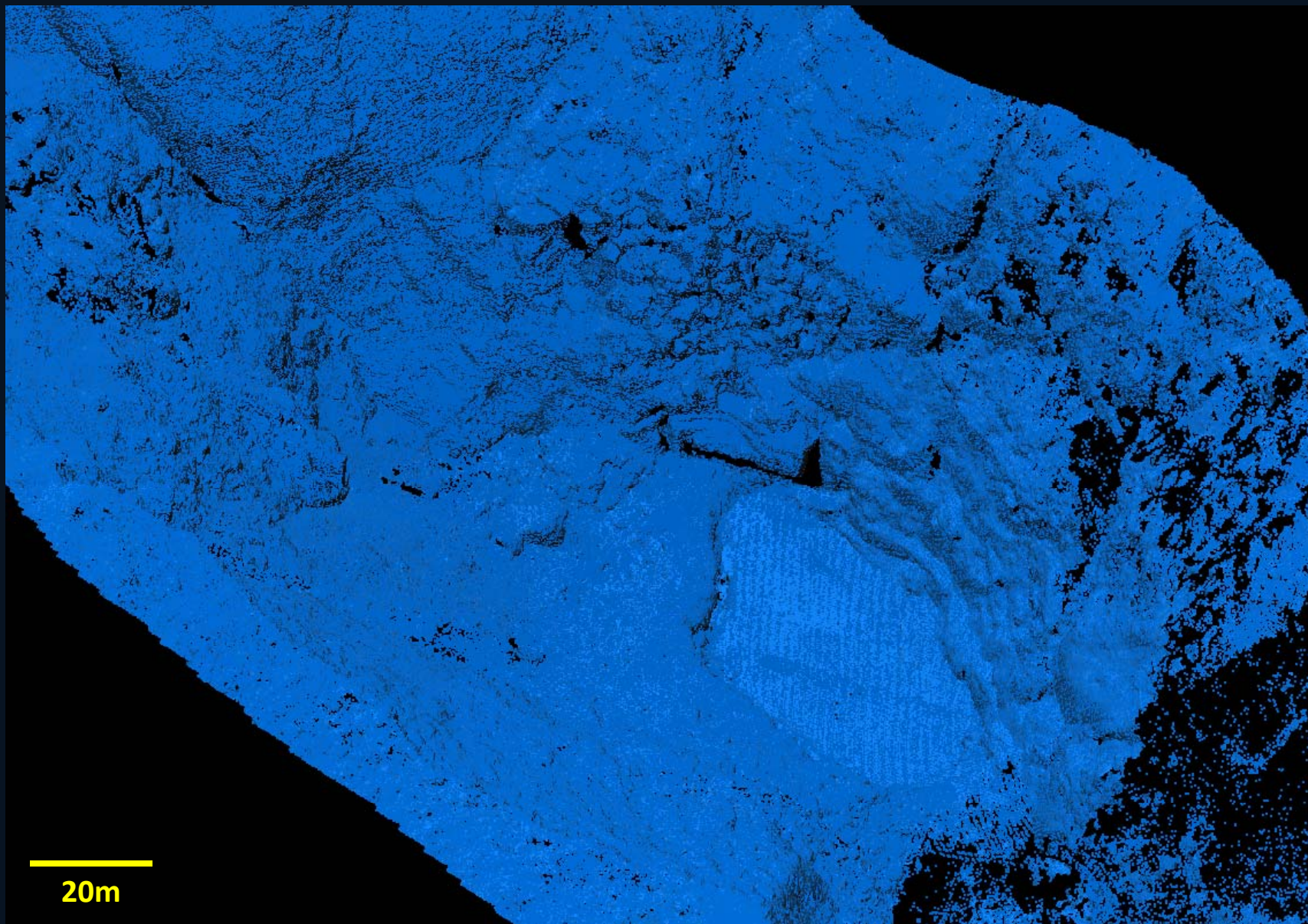






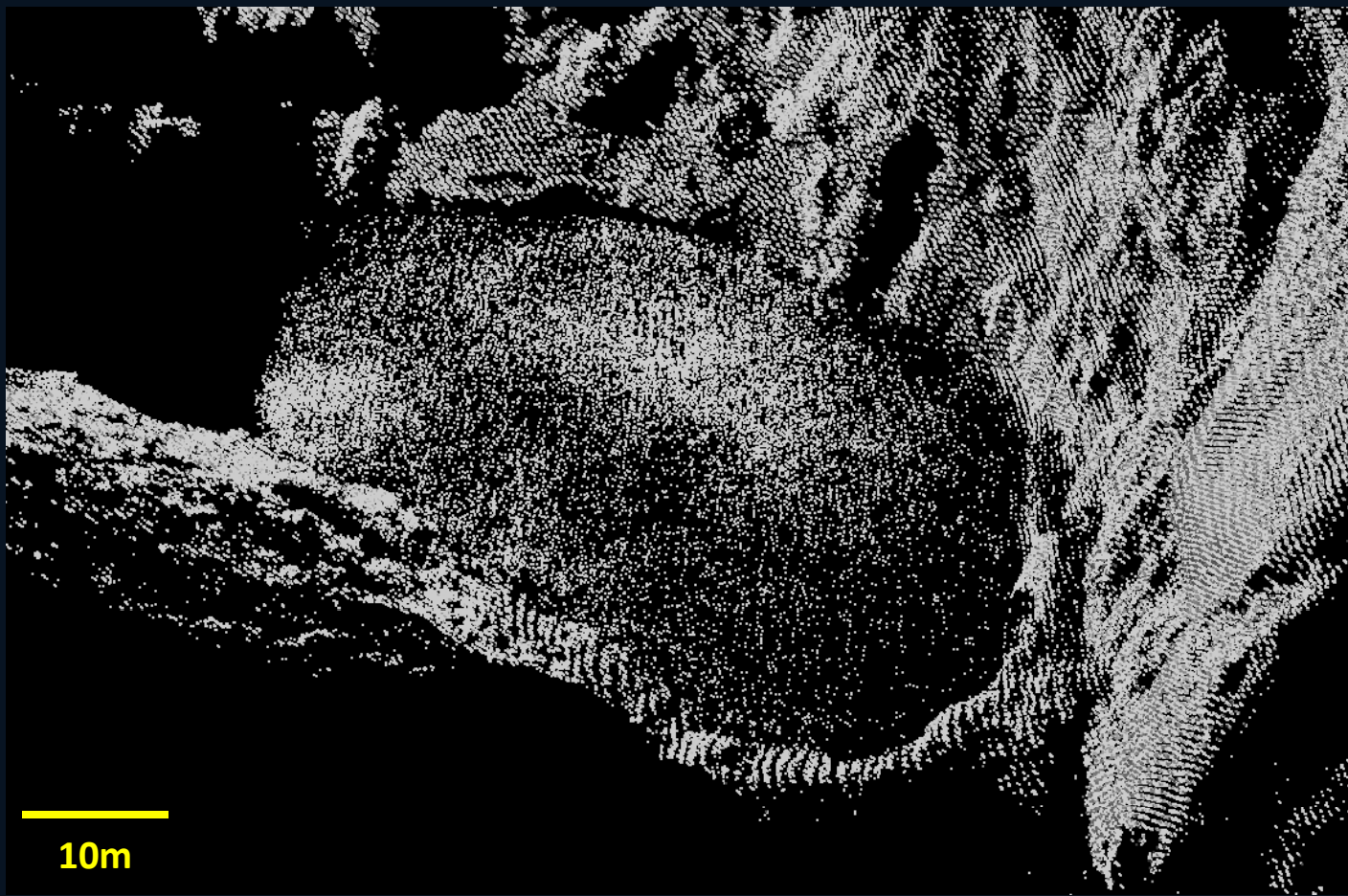
20m





20m

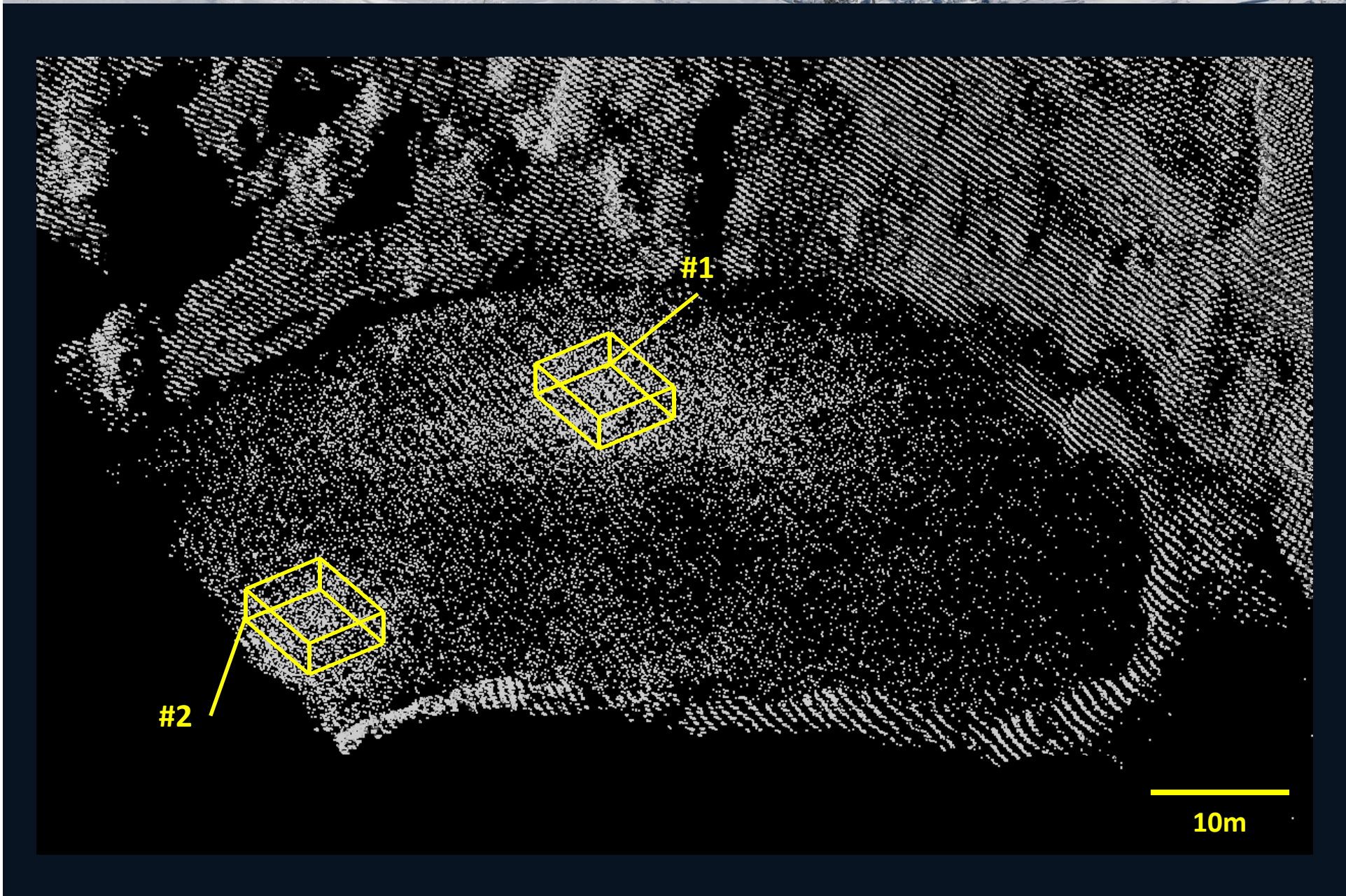




10m

2m

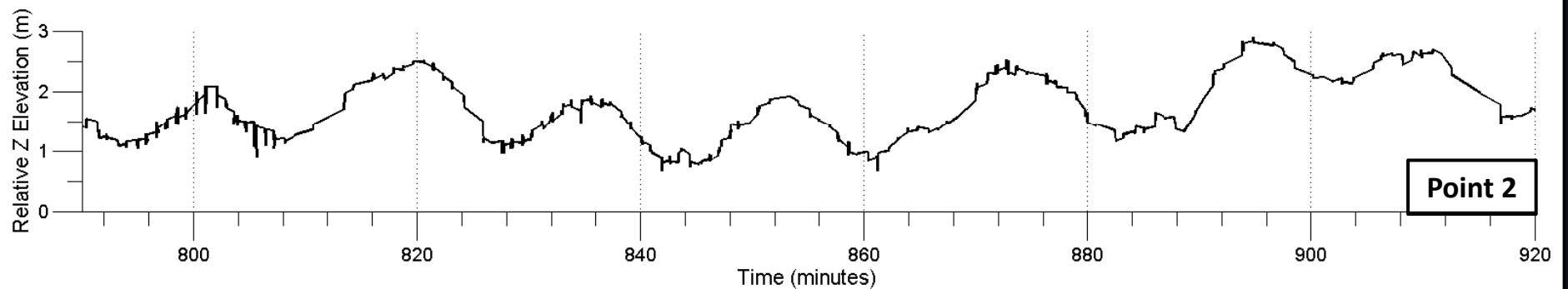
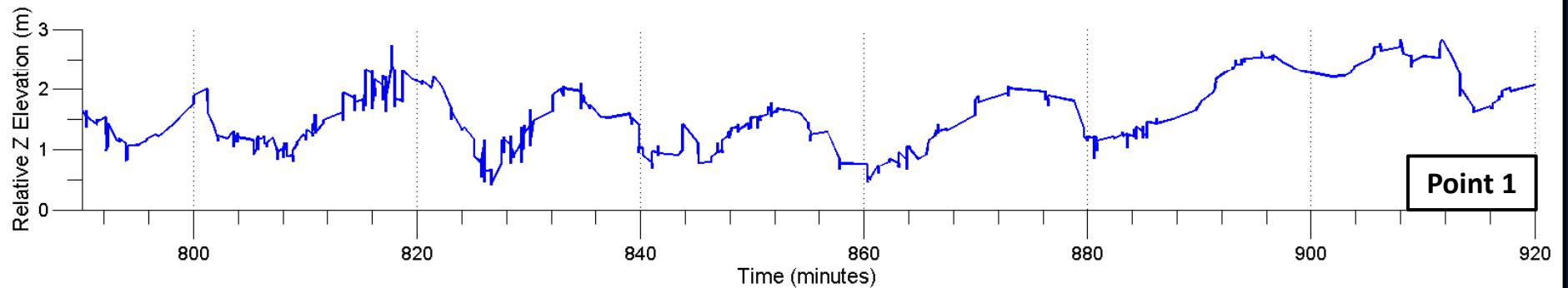






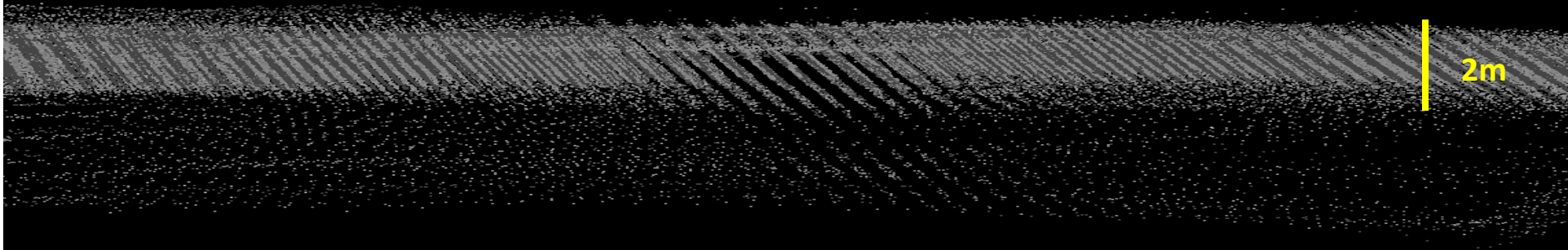
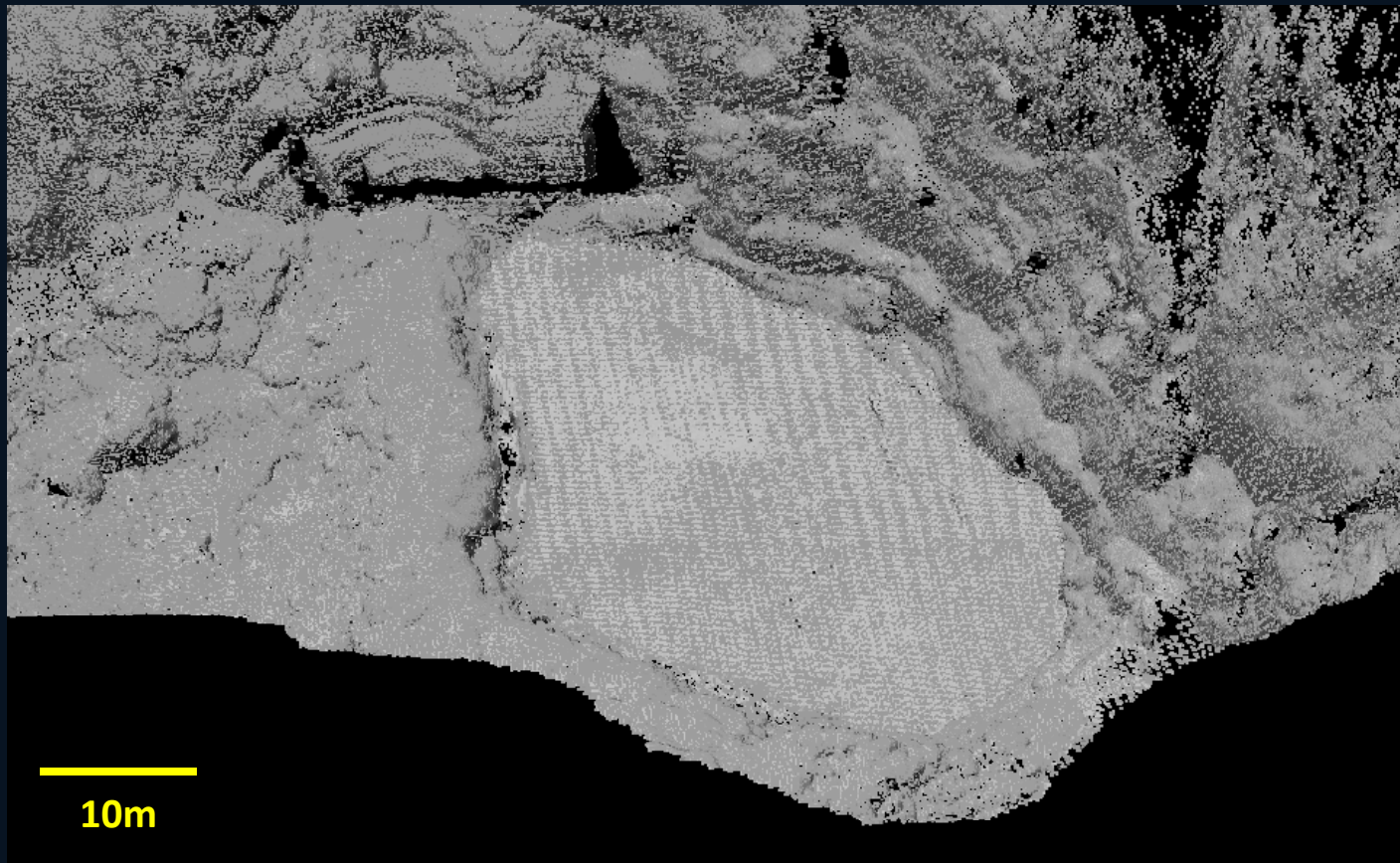
# Resulting Time Series

Point 1 - Average Modal Period = 18.17

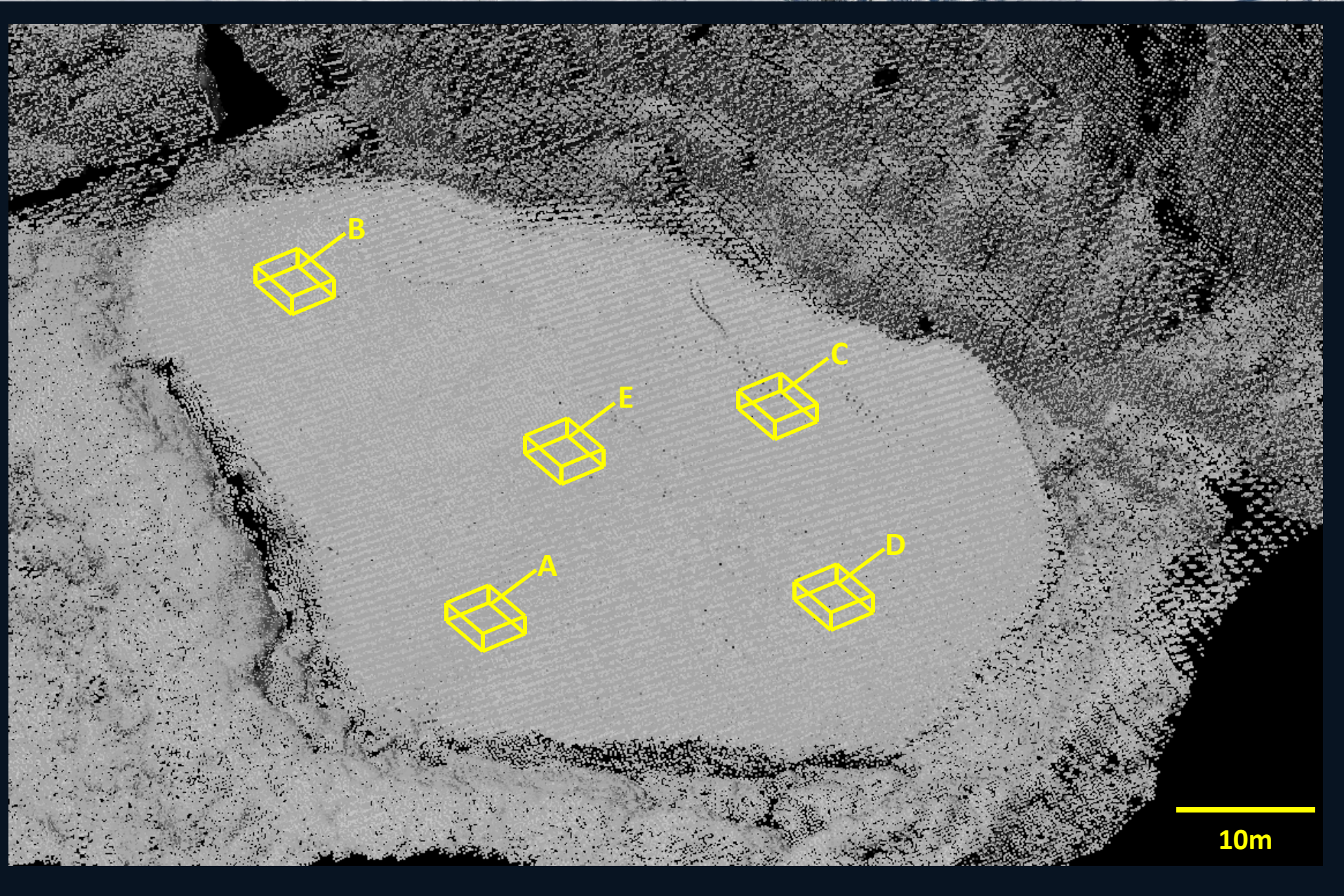


Point 2 - Average Modal Period = 17.83





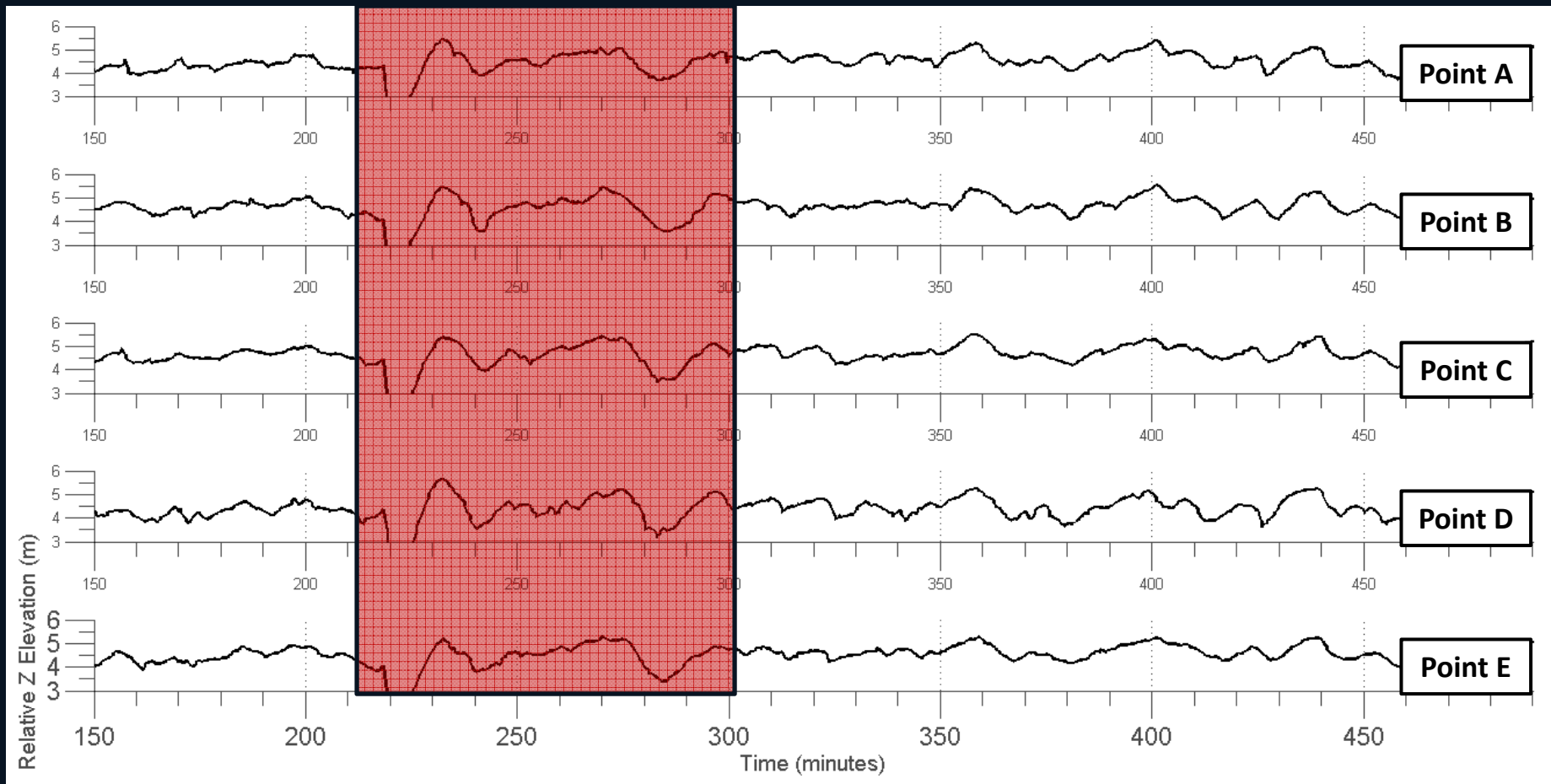






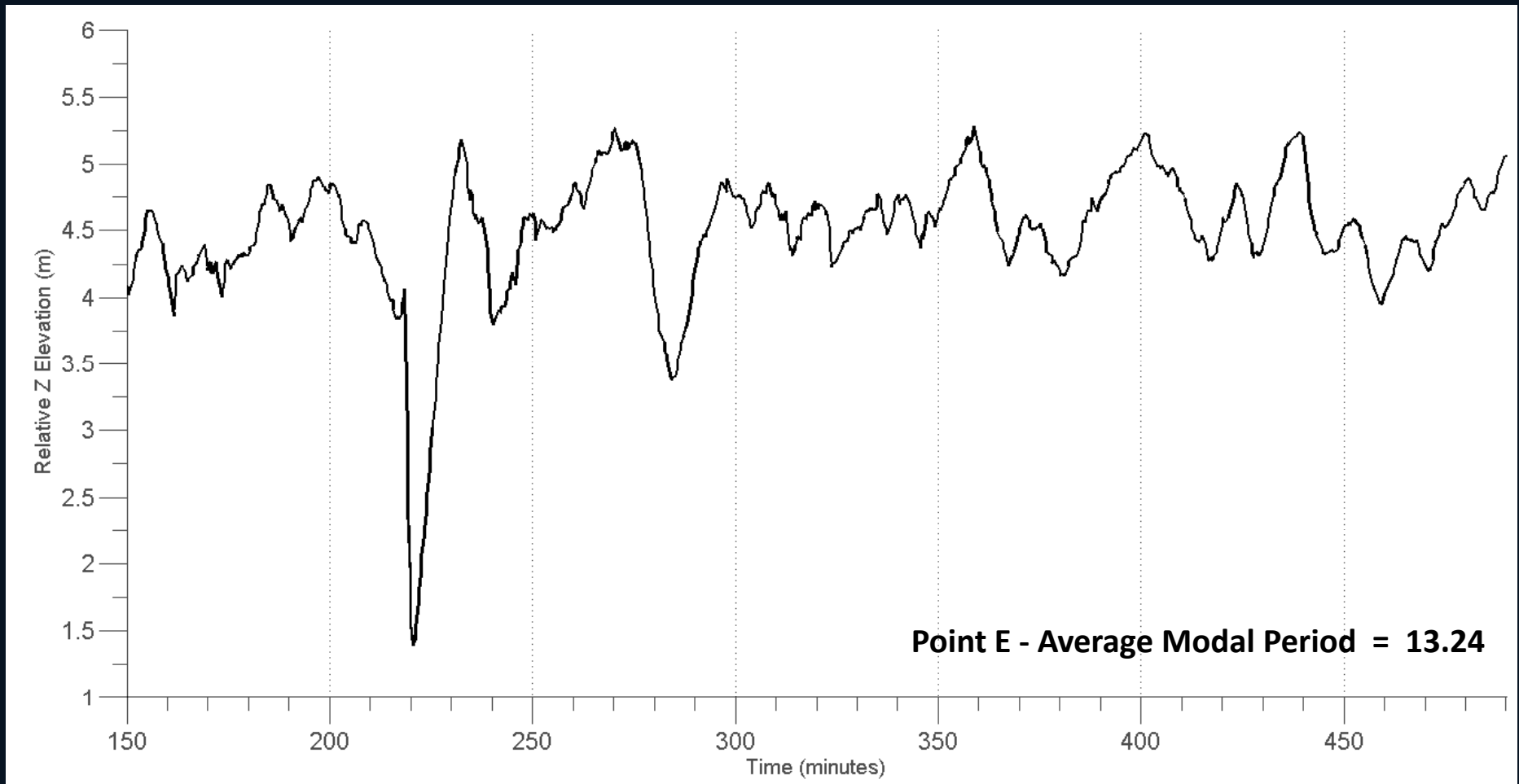


# Resulting Time Series



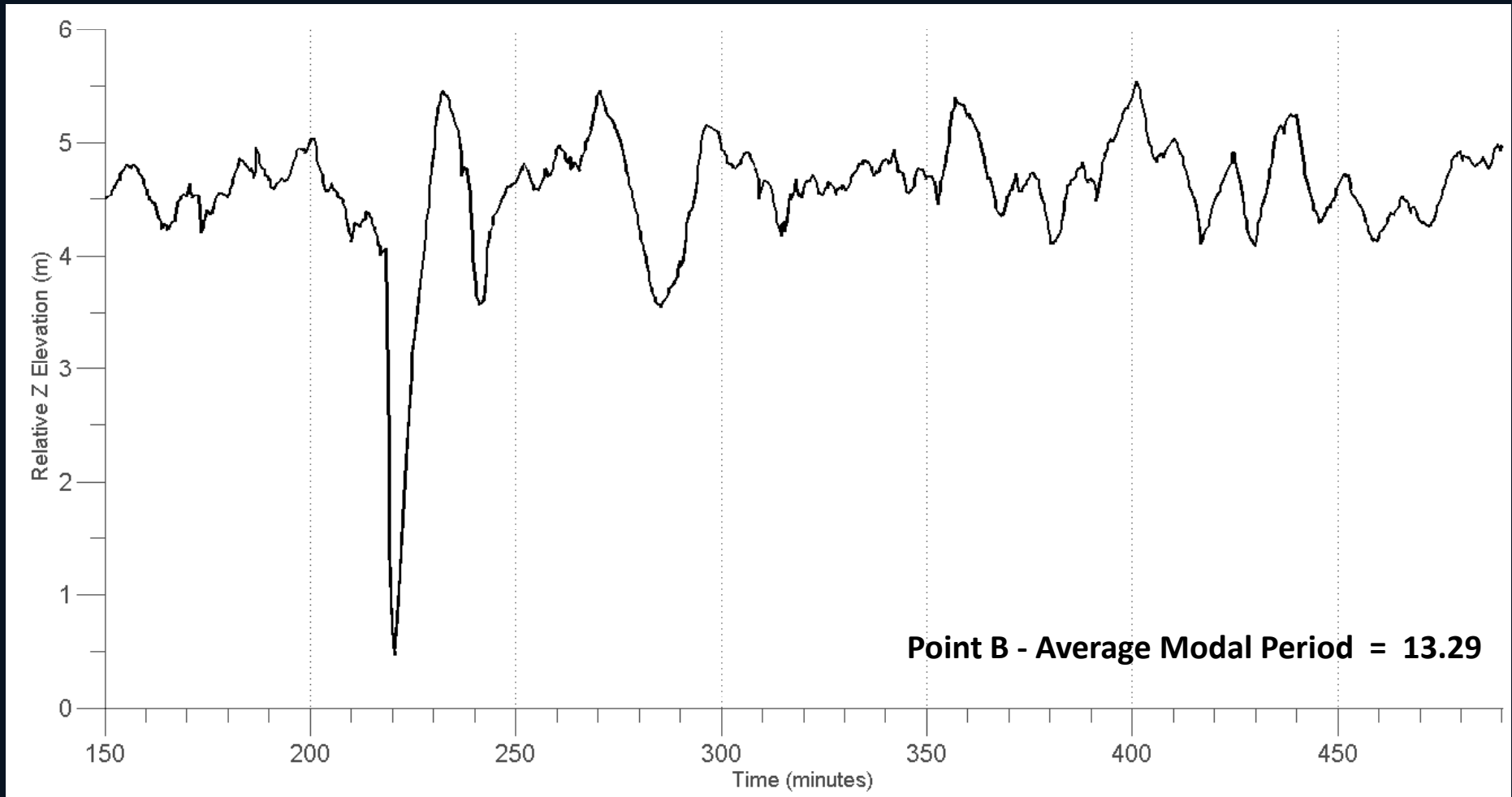


# Resulting Time Series

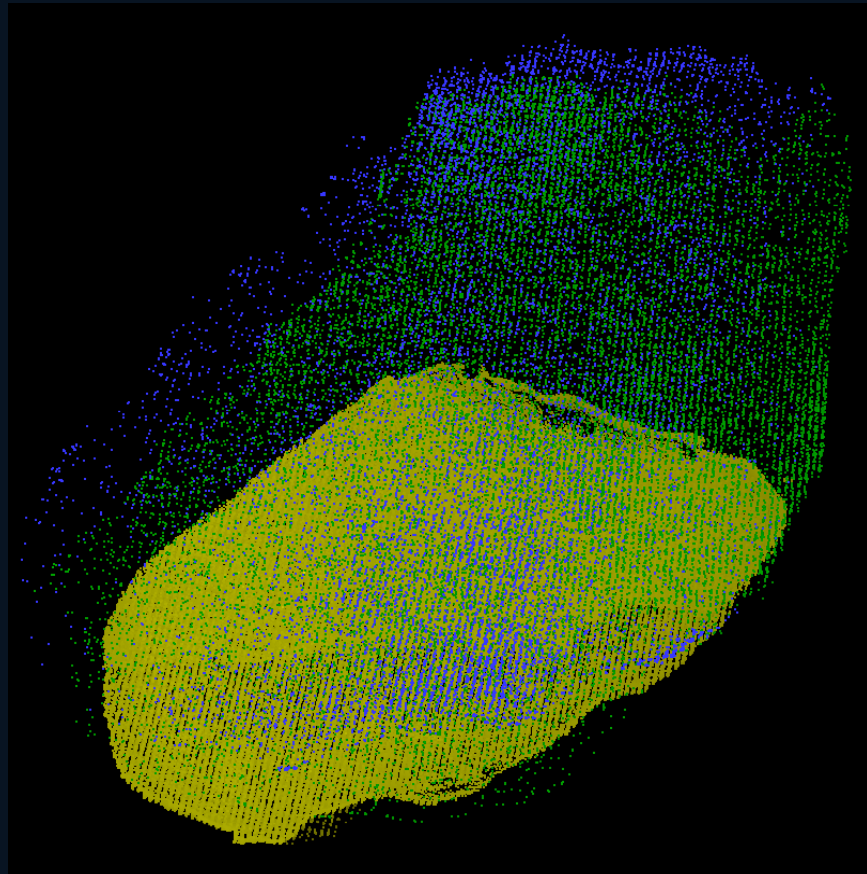




# Resulting Time Series







Surface Areas:

2008 = 1702 m<sup>2</sup>

2009 = 1699 m<sup>2</sup>

2010 = 862 m<sup>2</sup>

Elevations:

2008 = 3496 m

2009 = 3492 m

2010 = 3489 m

Average Modal Periods:

2008 = 18.35 min\*

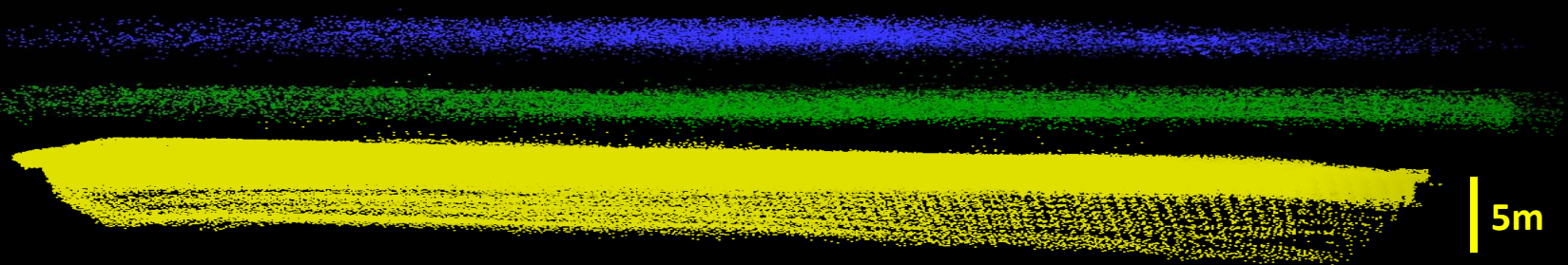
2009 = 18.00 min

2010 = 13.26 min

2008

2009

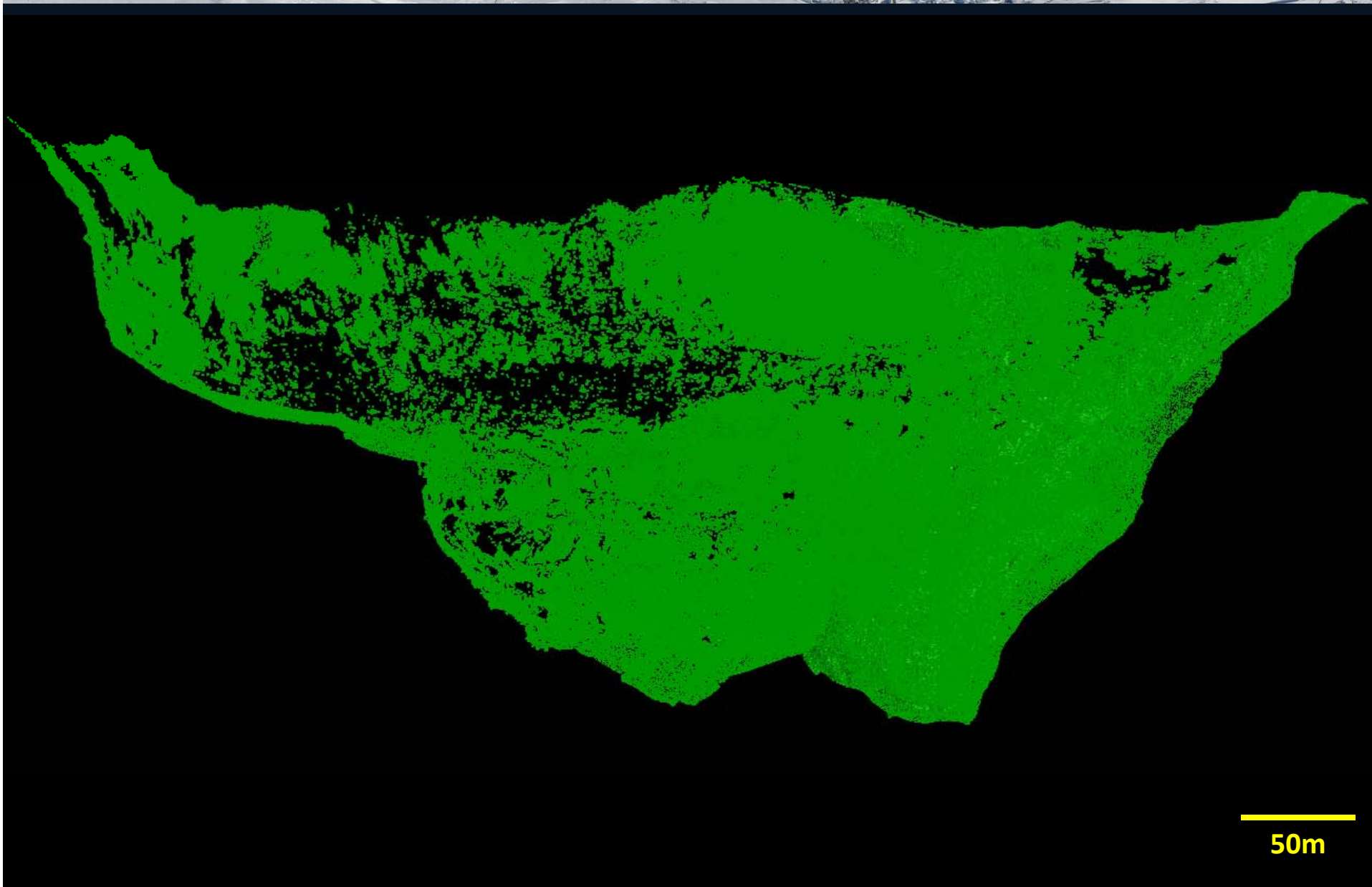
2010



5m



# Crater Dynamics



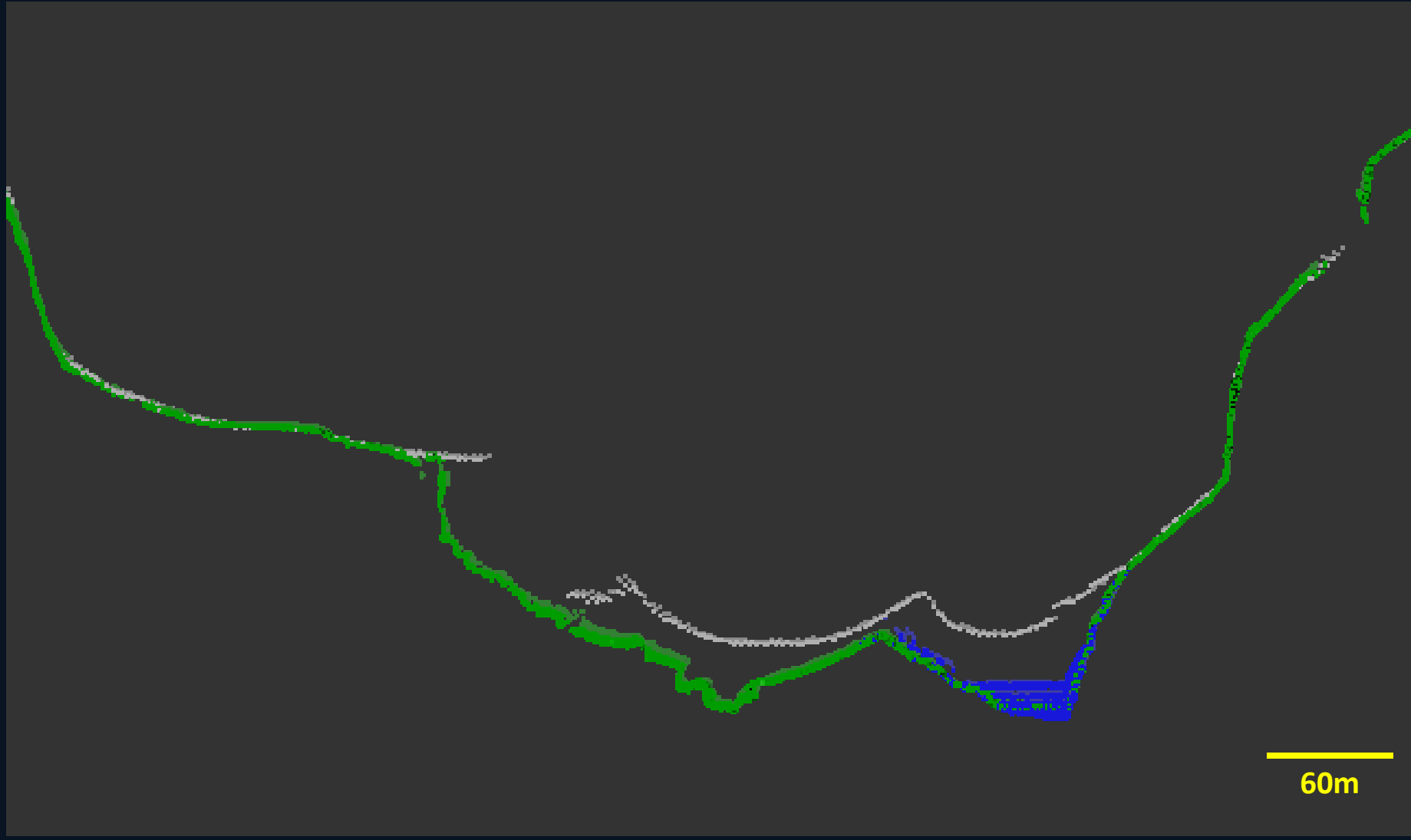
50m



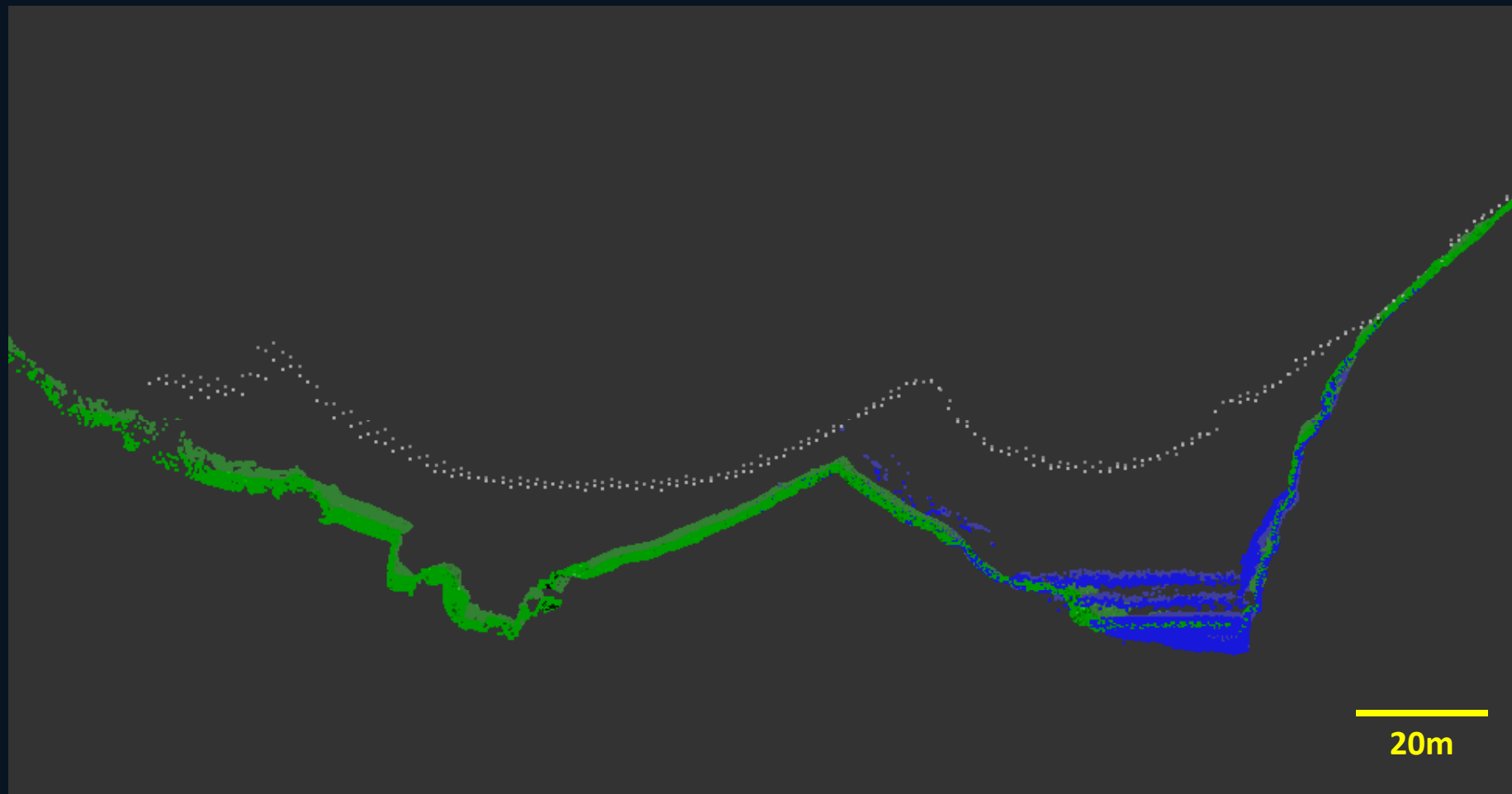
UNM  
Lidar Lab













## Importance

- Novel volcano monitoring technique
- Provides the information necessary to form magma and gas flow models of the upper conduit
- These flow models could then be merged with geochemical/crystallization, seismic, and degassing models in order to create a detailed conceptual map of the subsurface processes occurring in the Erebus magmatic system.



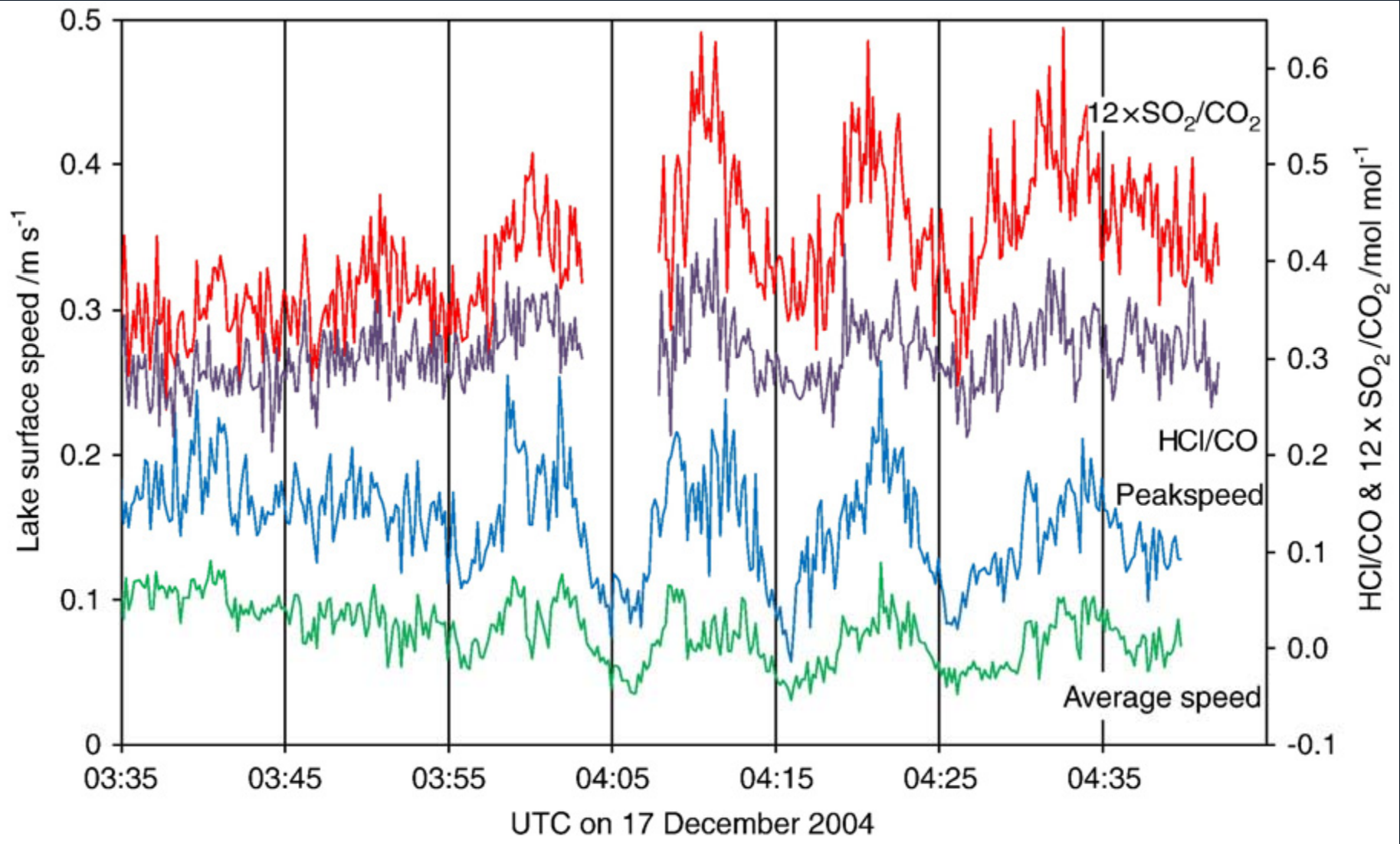


QUESTIONS?

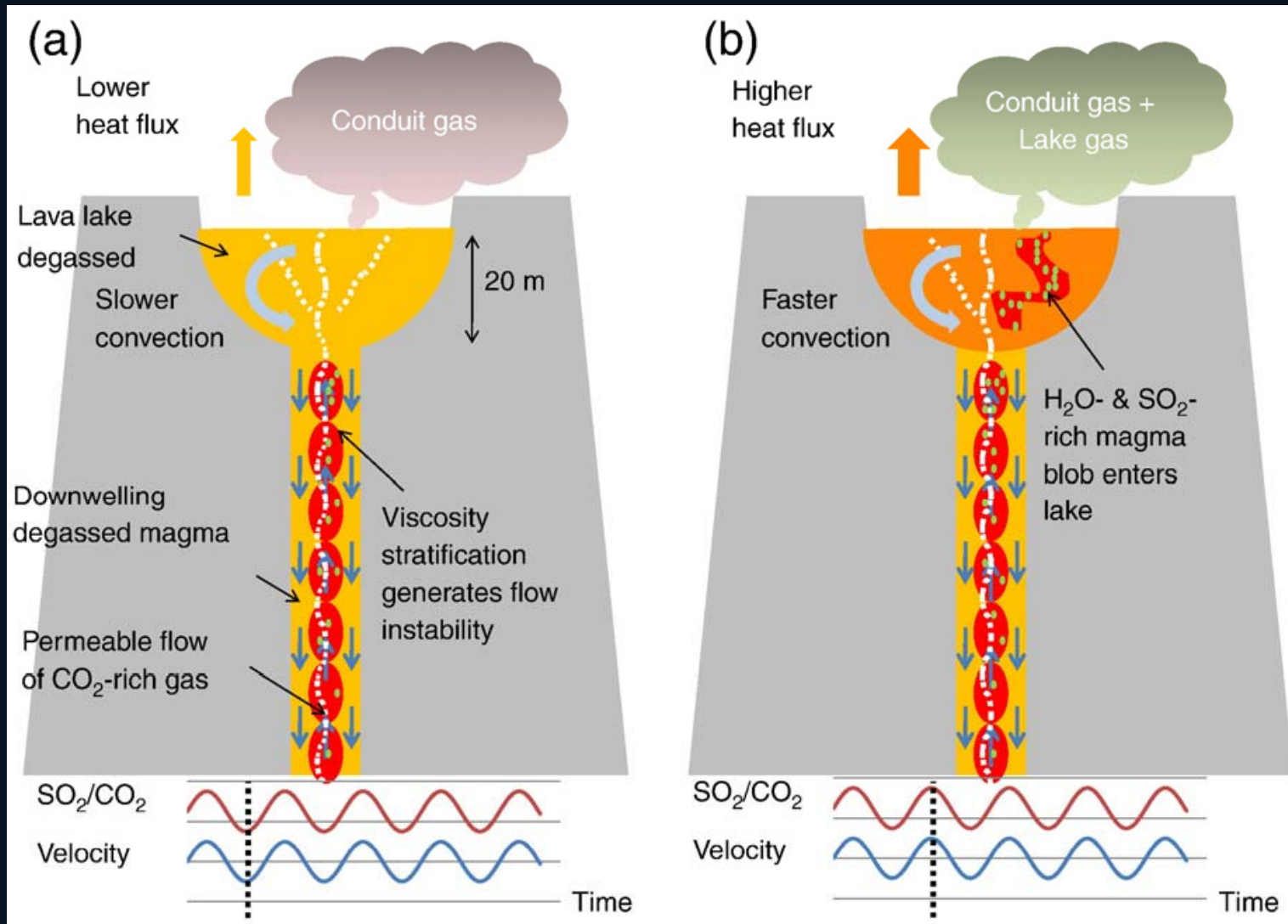


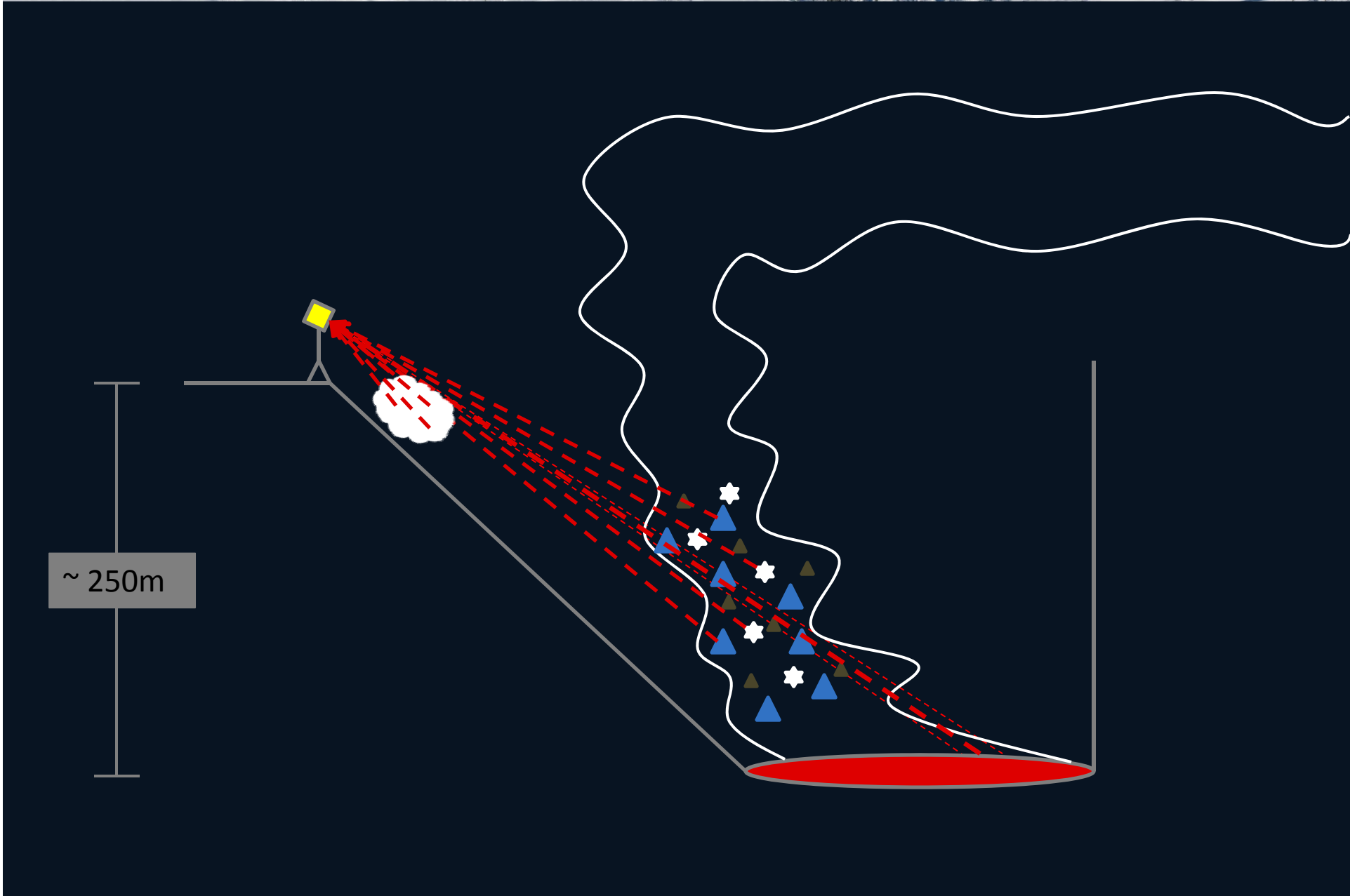
## Previous Studies

- Since 2004, thermal images of the lava lake and FTIR spectroscopy of gas emissions have been recorded.
- Once the data was plotted versus time it was discovered that the gas emission ratios, lake convection speed, and heat flux all synchronously varied in cyclical fashion
- Modal period of these cycles ranges annually from ~10 – 25 min (with an average ~20 min)











# Mount Erebus, Antarctica

