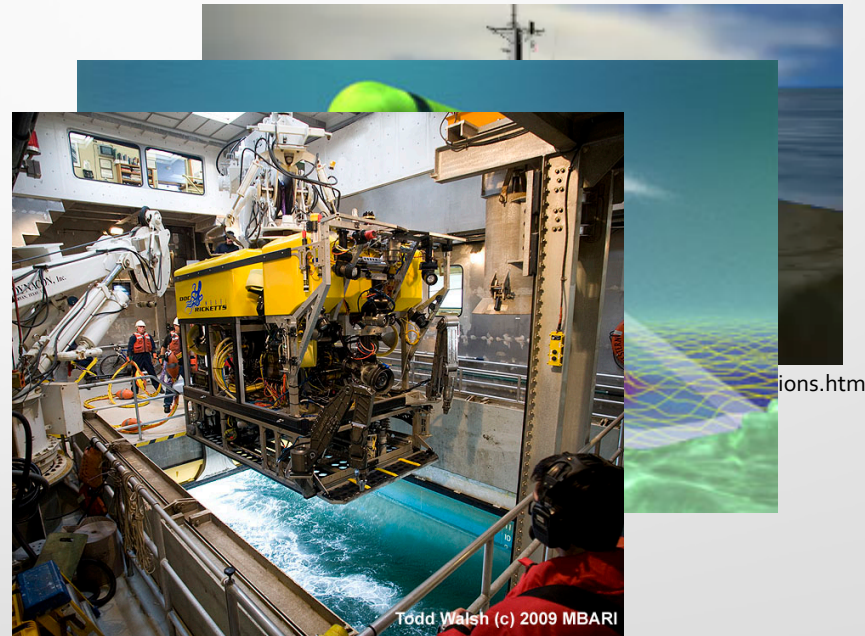


Enabling New Techniques in Environmental Assessment Through Multi-Sensor Hydrography

Eric J. Martin, David W. Caress, Hans Thomas, Brett
Hobson, Richard Henthorn, Michael Risi, Charles K. Paull,
and James P. Barry*, and Giancarlo Troni

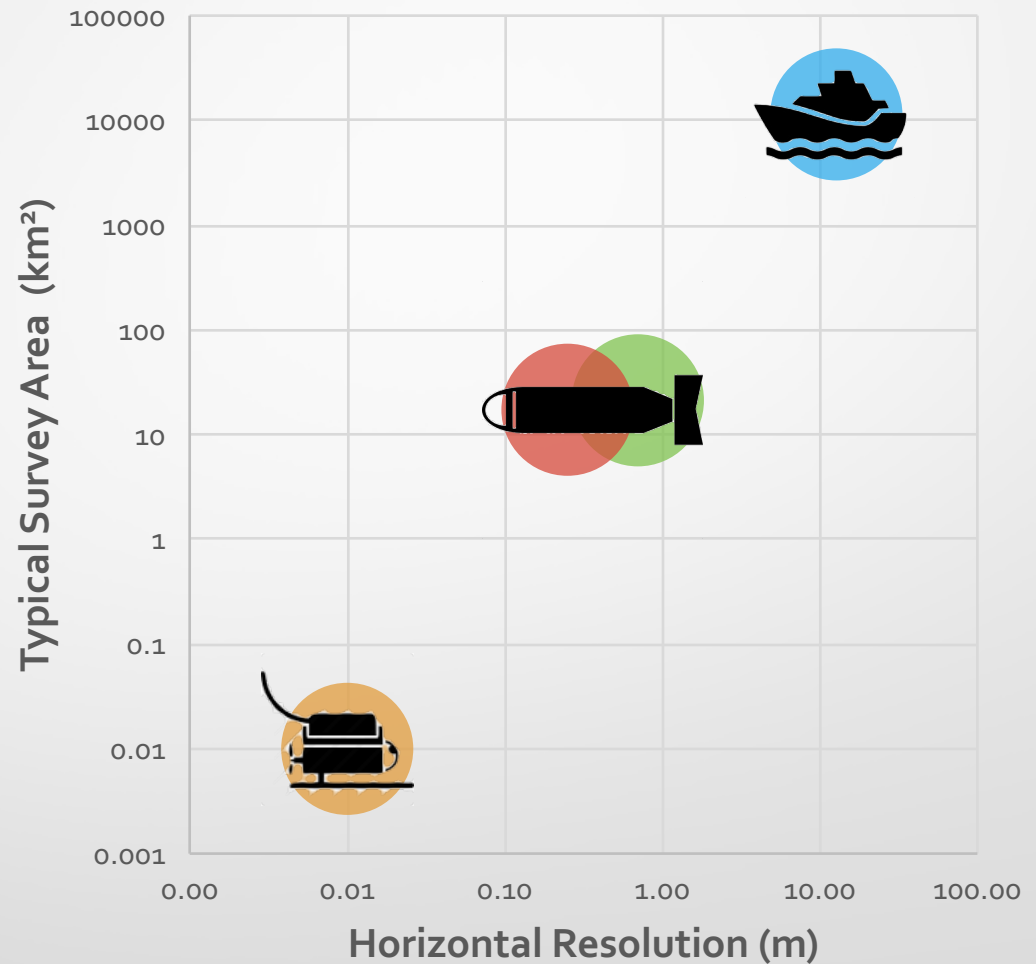
Science & Exploration Model at MBARI

- Ship Based Sonar (~5m)
- AUV Multibeam Sonar (1m)
- ROV Target Investigation



Survey Domains

- Ship based sonars and common AUVs do not provide enough detail to observe small-scale change in practical periods of time.



*Survey area is calculated over achievable area in a 24-hour time period.

Objectives

- Enable highly accurate high resolution surveys for use in arbitrarily complex environments.
- Use of multiple sensors can aid in generating a comprehensive assessment of the environment under study.

Why is Small Change Important?

- Biological community assessment
- Mass Wasting Studies
- Hydrothermal Vent Growth
- Hydrate Formation and Growth



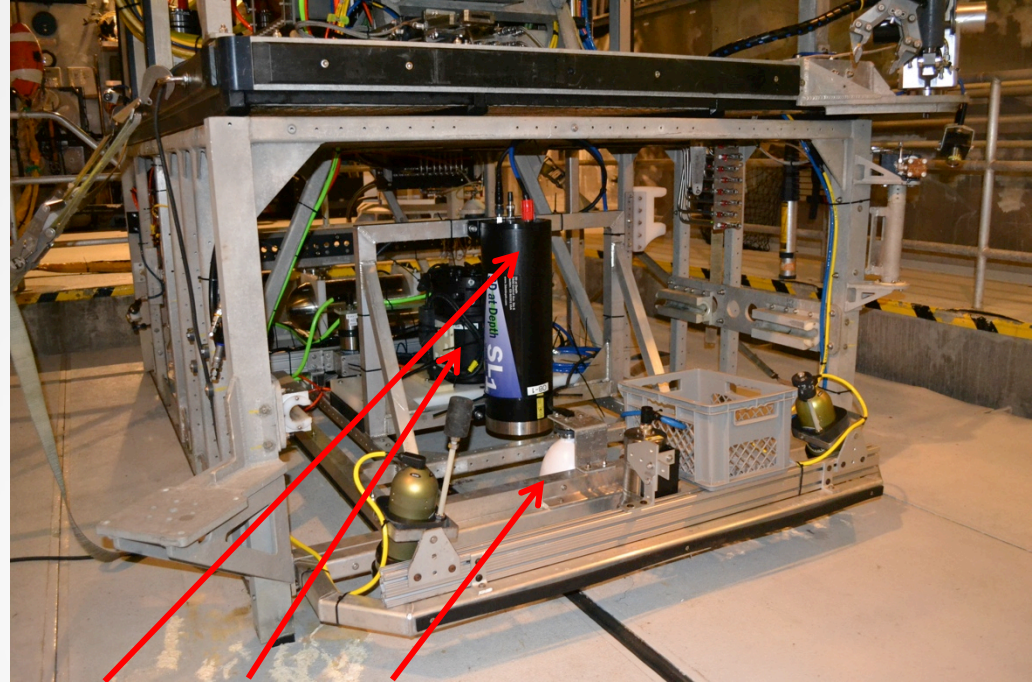
ROV Tool-Sled Solution

- Mounts underneath ROV
- Carries Mission Specific Payload components
- Simplified interface to ROV
 - Power and 1Gbps Ethernet

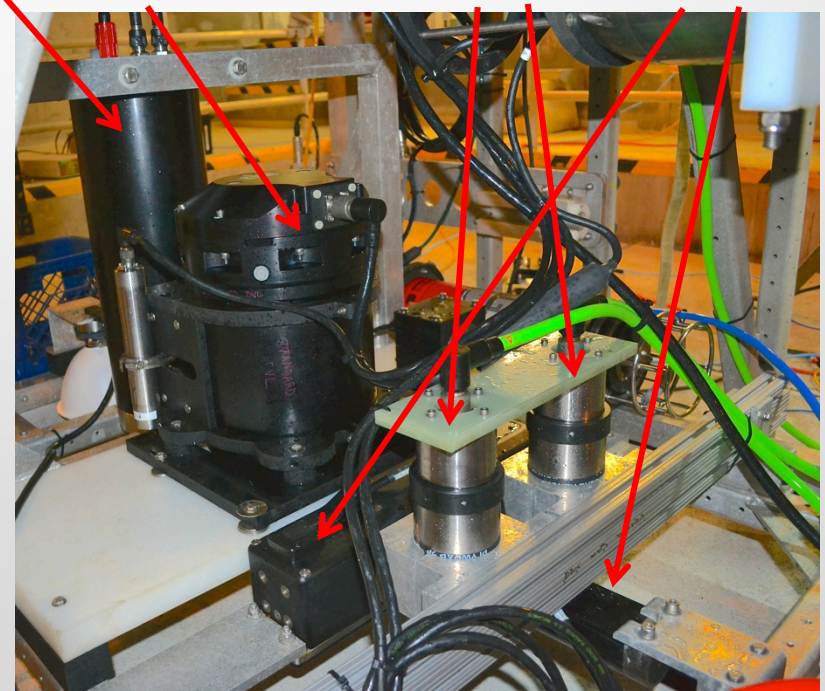


Core Sled Sensor Components

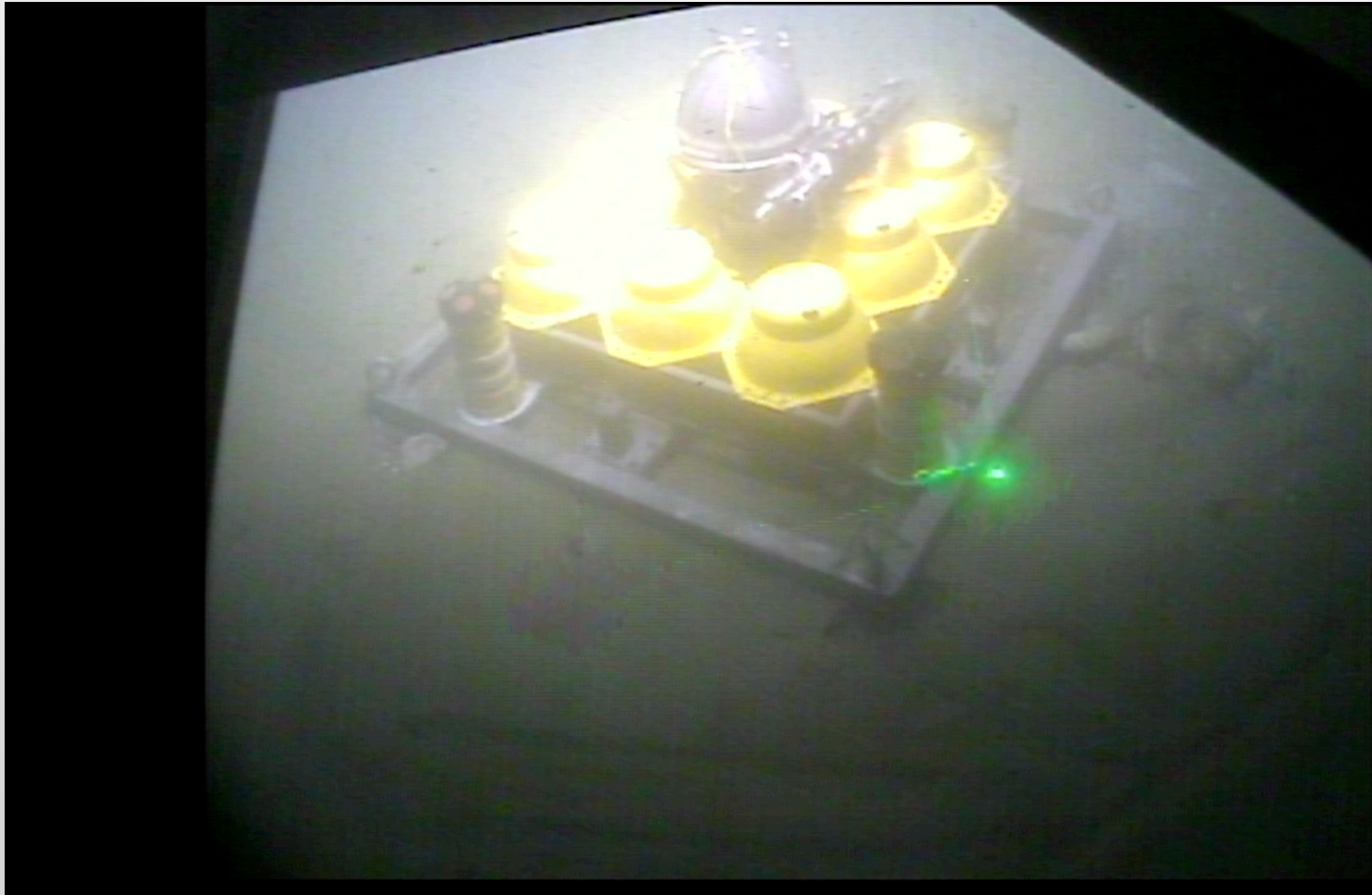
- Multibeam Sonar
 - 5-cm resolution topography + backscatter
- Stereo Cameras
 - 2-mm resolution photomosaics
 - 3-cm resolution photogrammetric topography
- Swath mapping lidar
 - 1-cm resolution topography
- DVL + GPS aided INS
 - Nav error < 0.05% distance



Lidar INS Strobe Cameras Multibeam Sonar



Data Collection



http://search.mbari.org/ARCHIVE/frameGrabs/DocRicketts/stills/2016/docr839/01_38_07_07.html



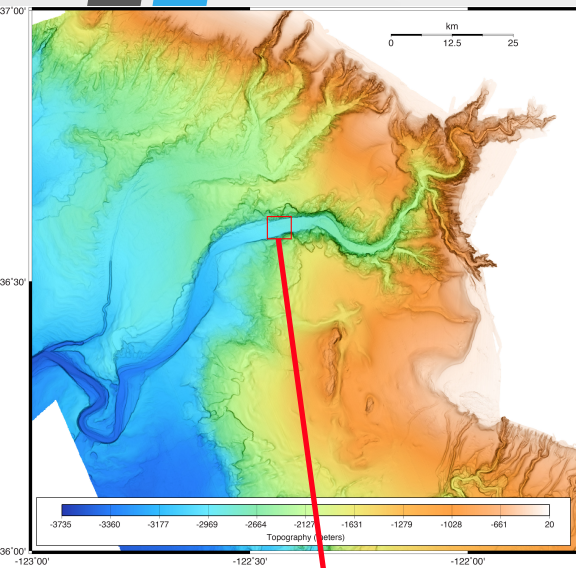
Applications

- Fine Scale Surveys
- Repeat Mapping
- Benthic Organism Detection

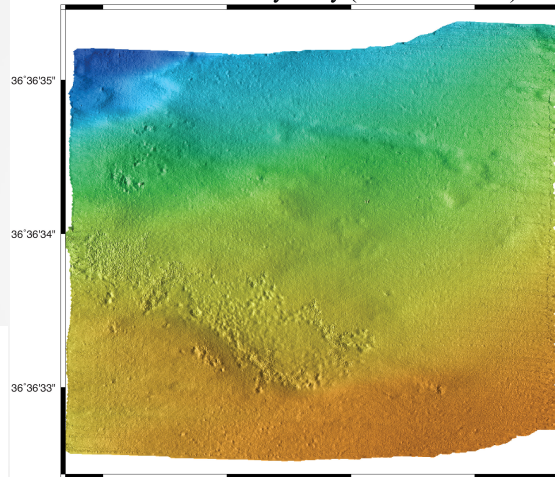
Fine Scale Surveys

- ROV Based Survey – 12 hour dive limit (MBARI)
 - About 10 hours of bottom time on average
- 100m x 100m survey area
- 2-4 meter altitudes, dependent on water clarity
- No Data Limitations – Real time control and acquisition
- Xenon Strobes limit along track speeds
- Automated station keeping with scripted input

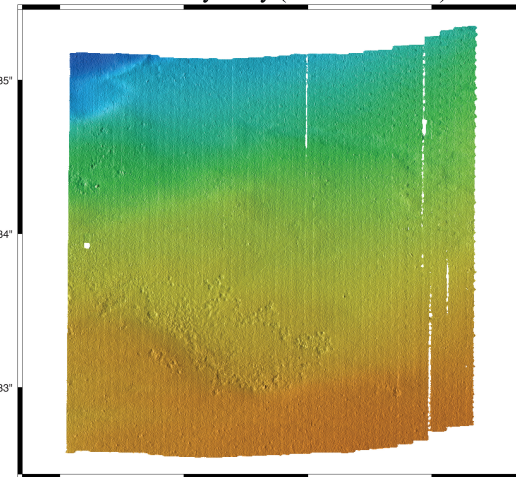
Chemosynthetic clam community in Monterey Canyon axis at 2850-m depth



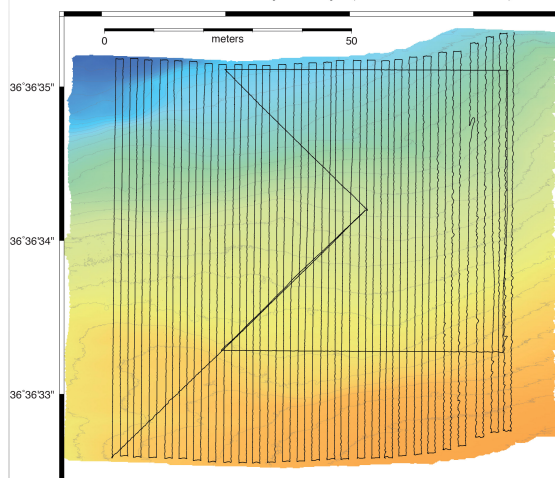
Multibeam Bathymetry (5 cm resolution)



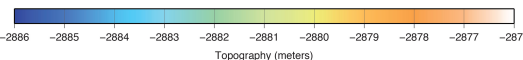
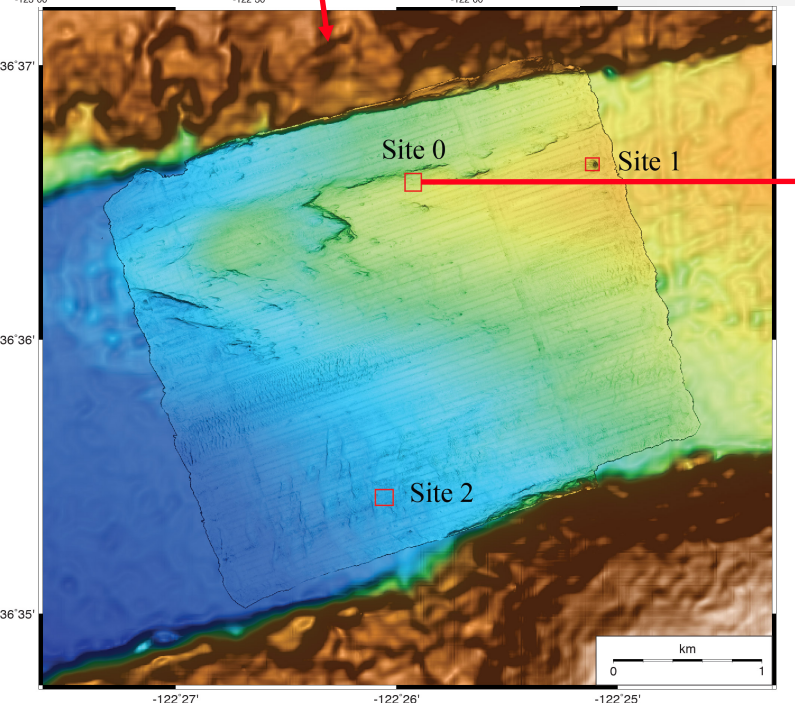
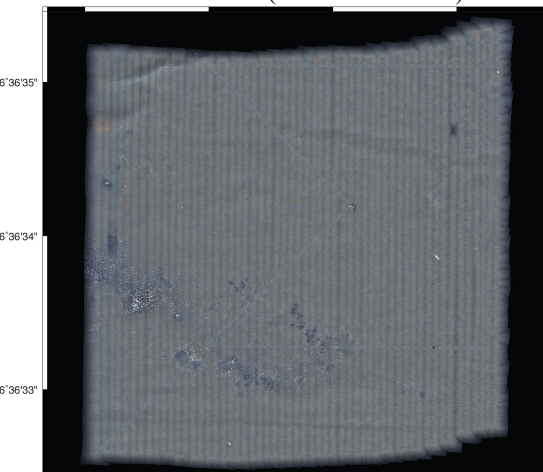
Lidar Bathymetry (1 cm resolution)



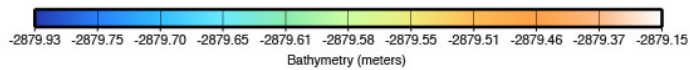
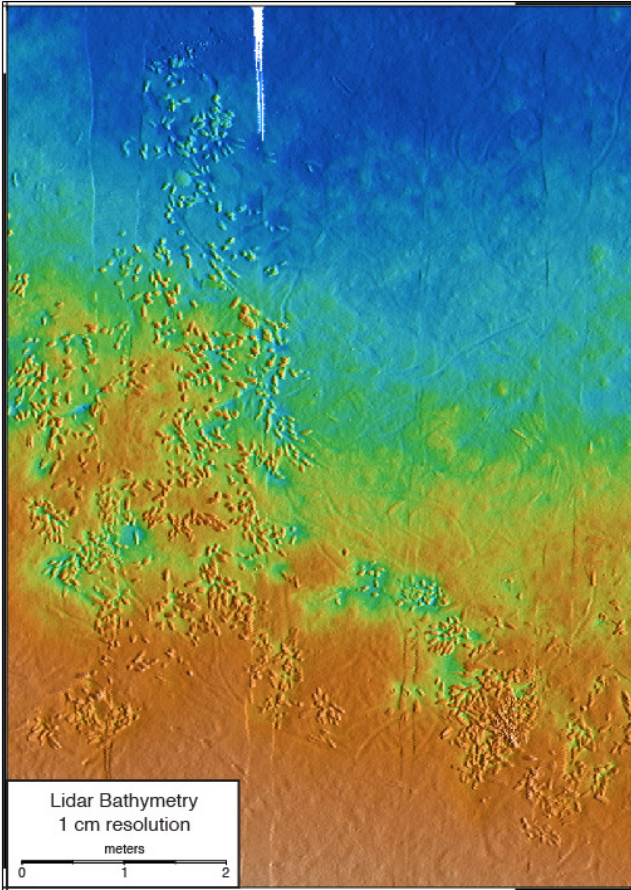
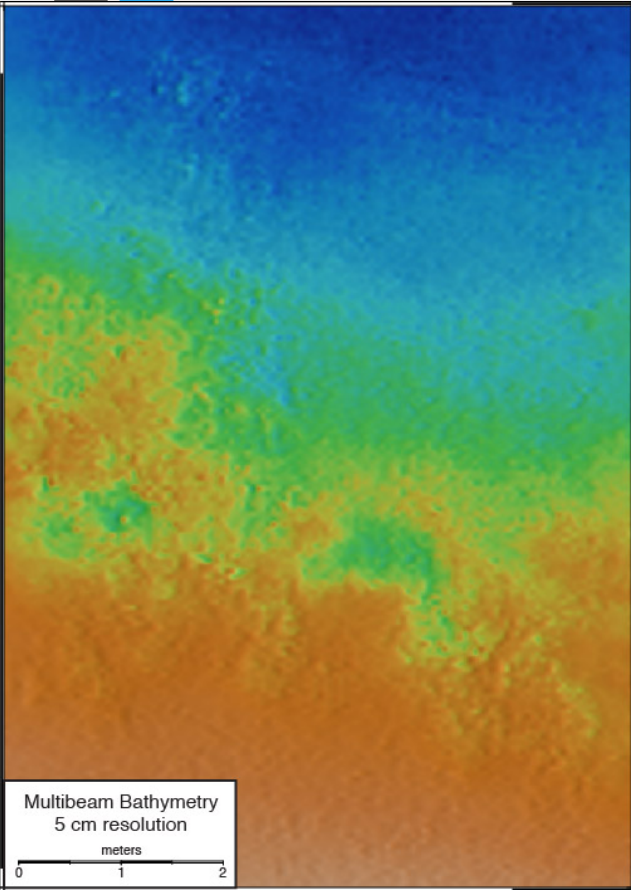
Multibeam Bathymetry (5 cm resolution)



Photomosaic (2.5 mm resolution)



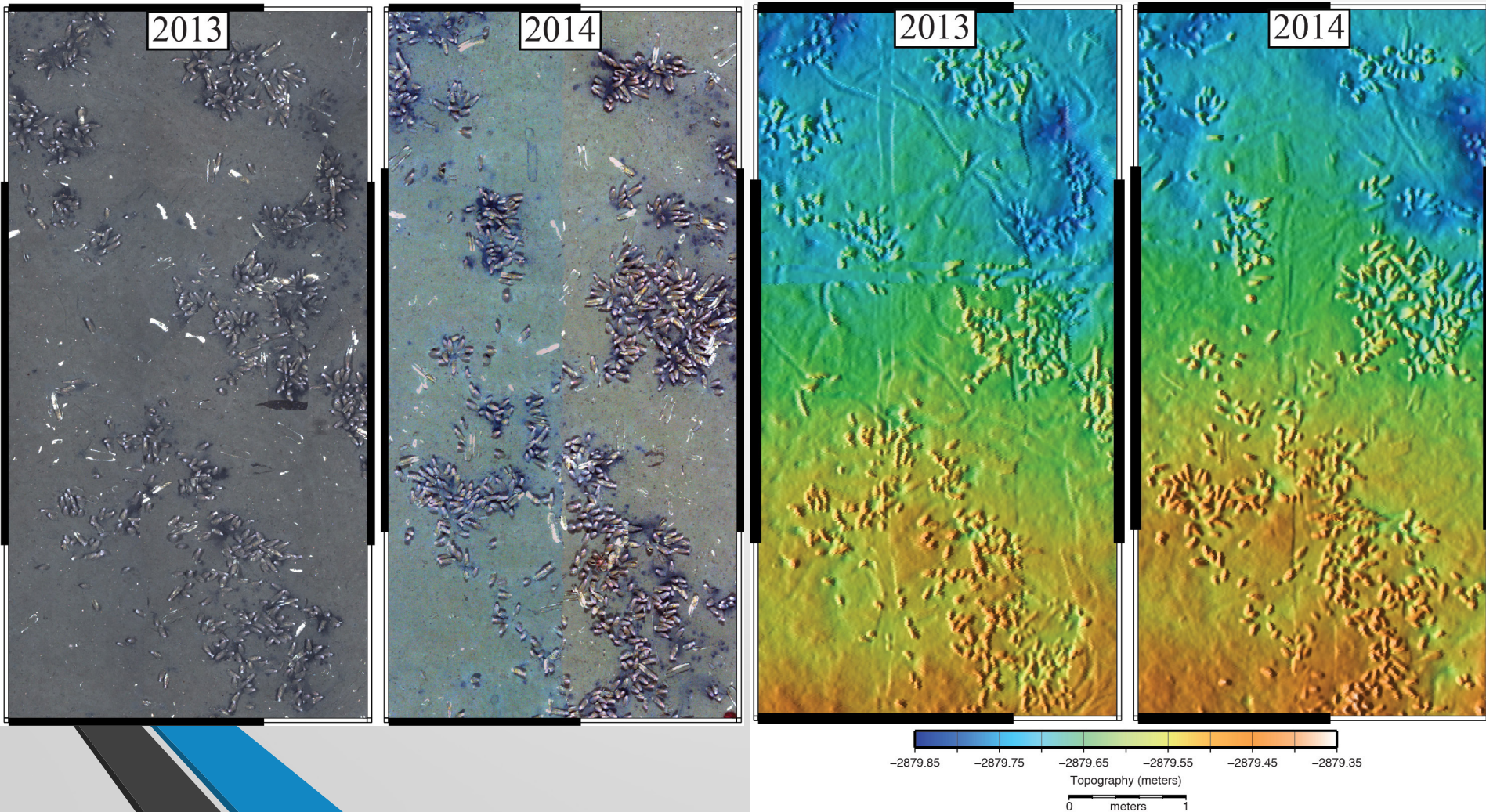
50 meters



Repeat Mapping

- Conducting multiple surveys over practical periods of time with the goal of measuring change.
- Impresses requirement for highly accurate, self consistent maps that can be co-located.

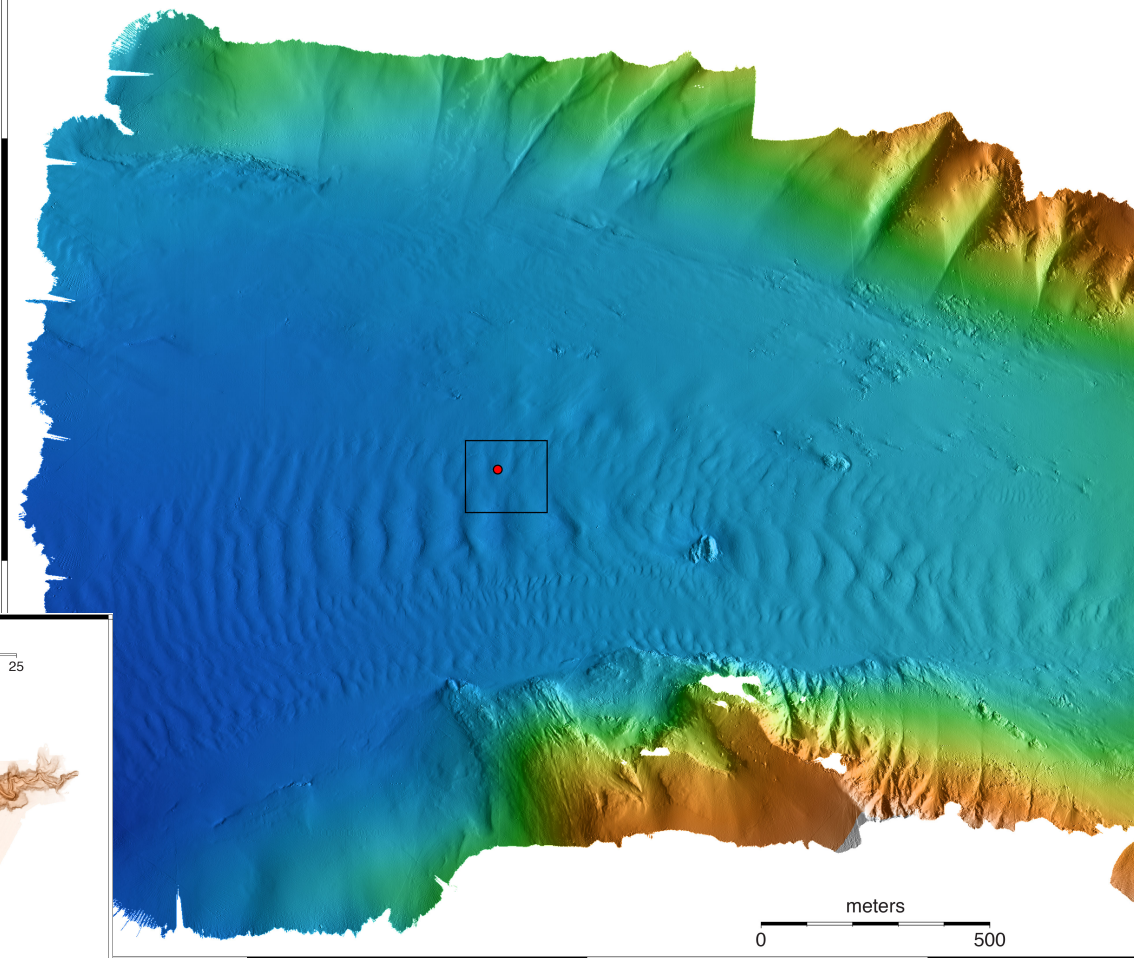
Clam Community Repeat Mapping



Coordinated Canyon Experiment Site

36°42'30"

36°42'00"

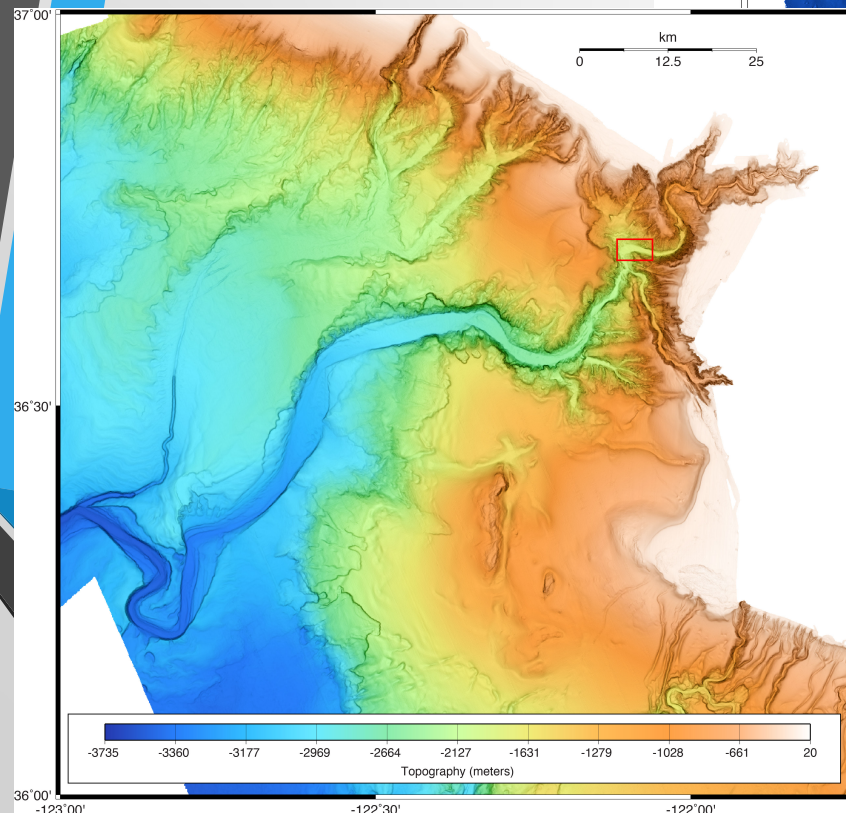


-122°06'00"

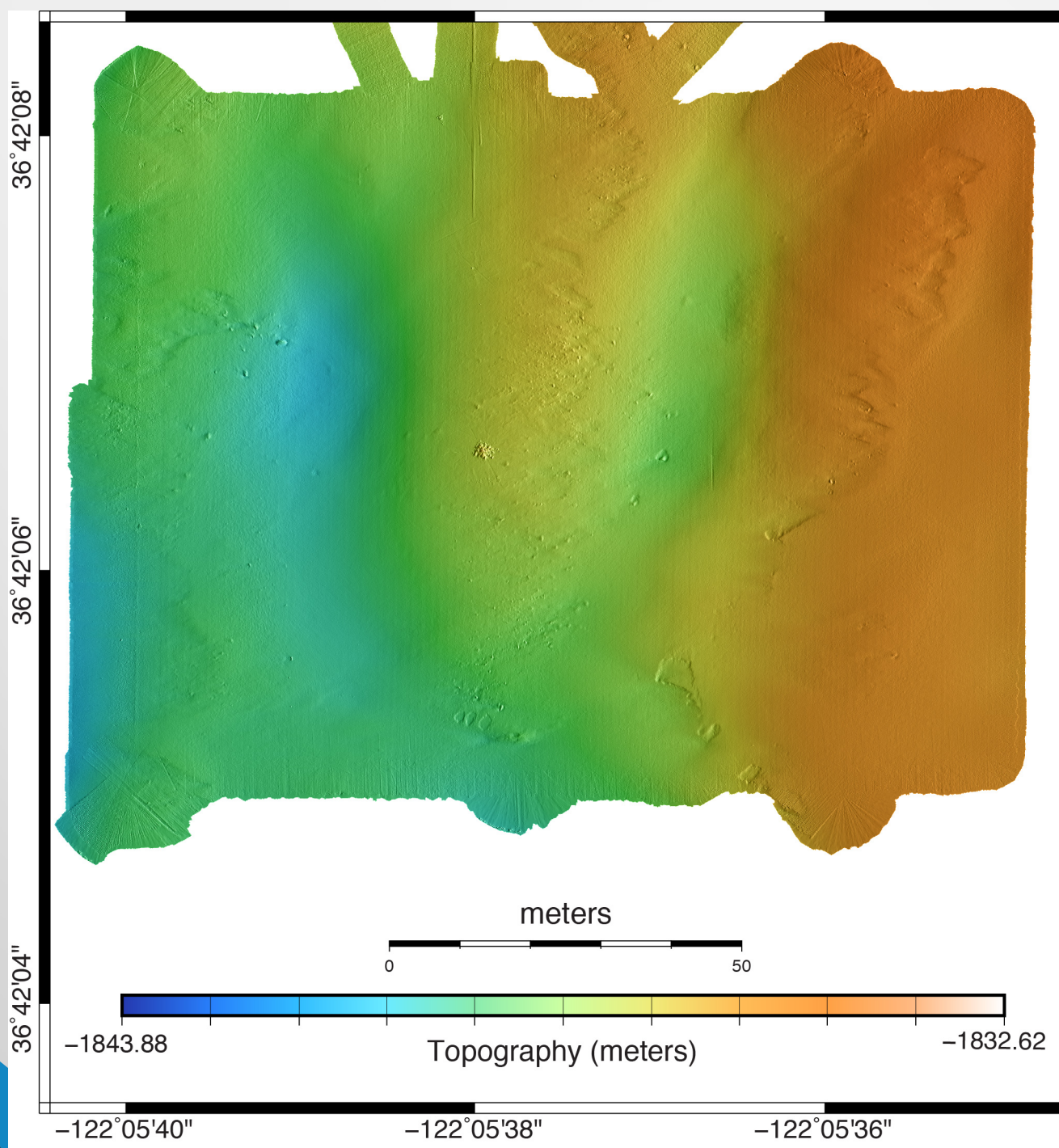
-122°05'30"

-122°05'00"

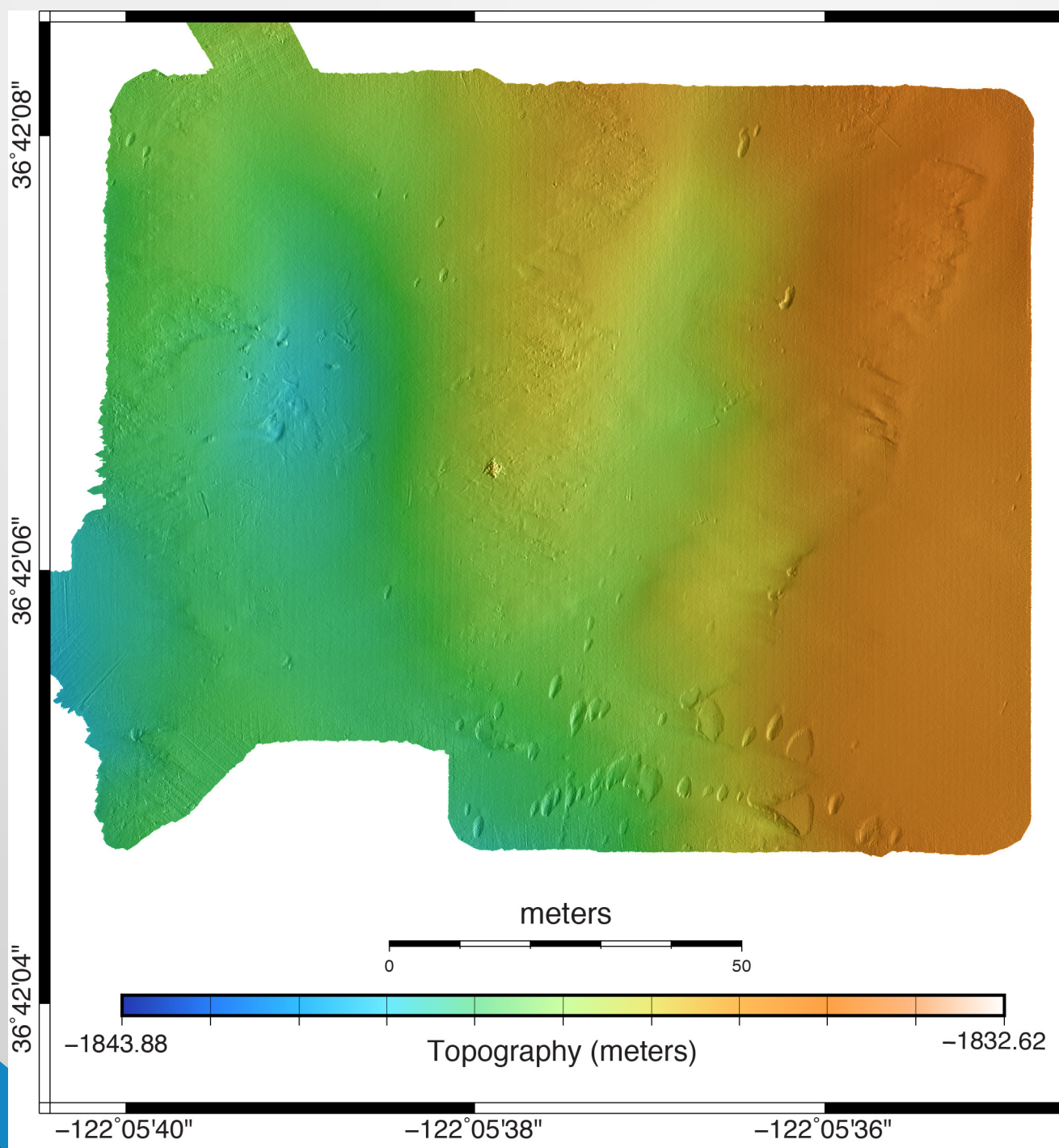
860 -1830 -1800 -1770 -1740 -1710 -1680 -1650 -1620 -1590
Topography (meters)



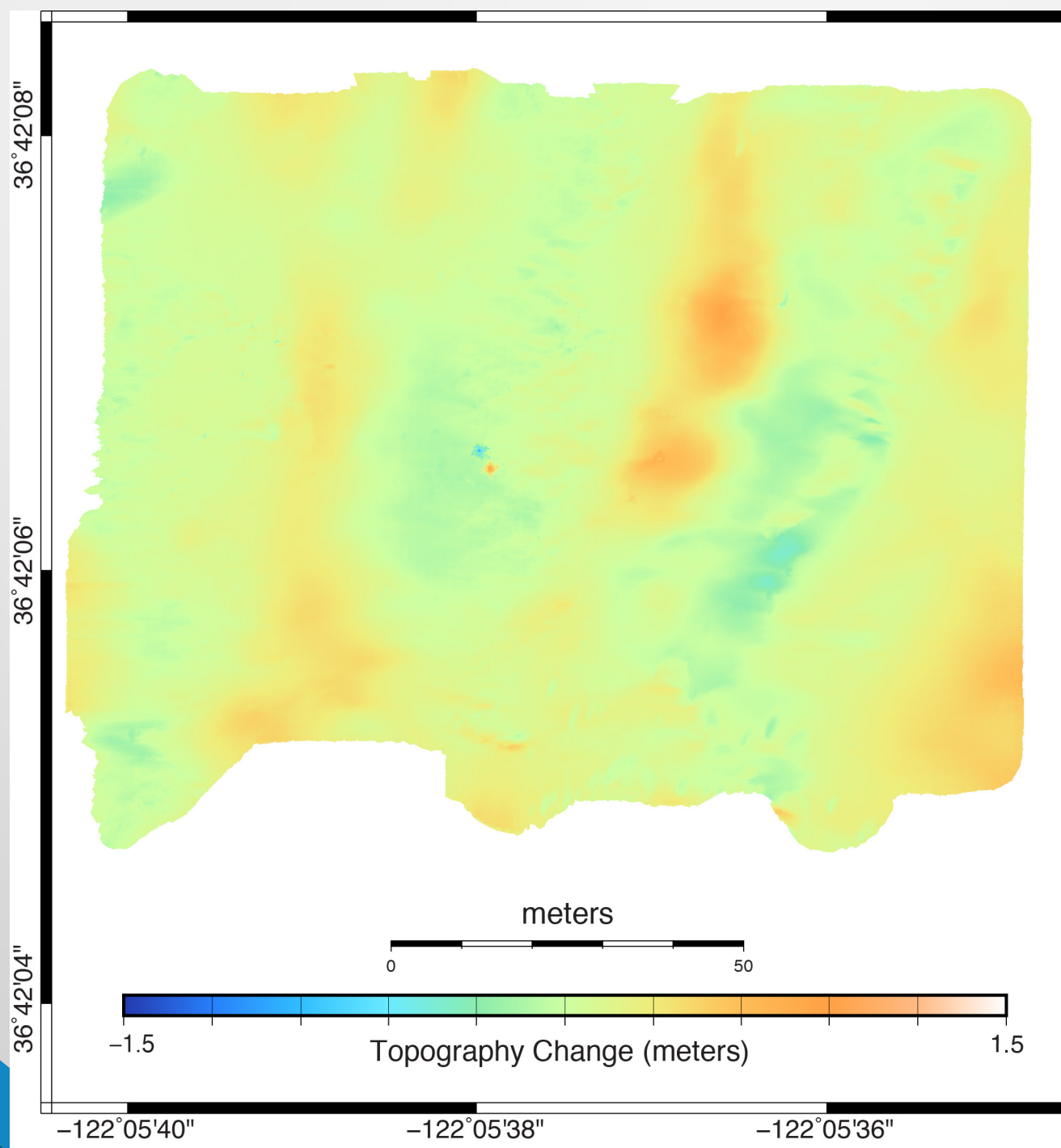
-3735 -3360 -3177 -2969 -2664 -2127 -1631 -1279 -1028 -661 20
Topography (meters)



Fall 2015



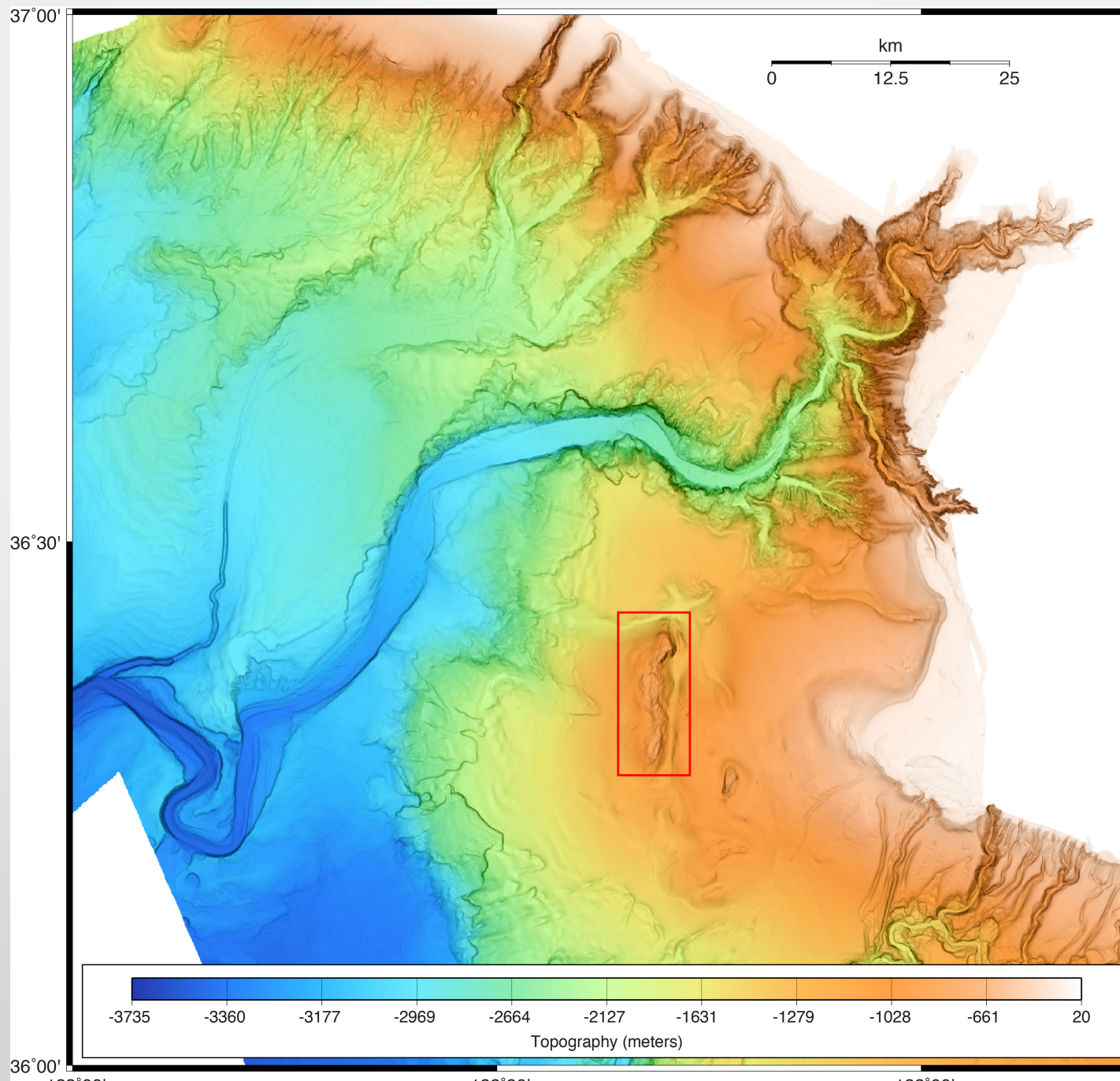
Spring 2016



Benthic Organism Detection

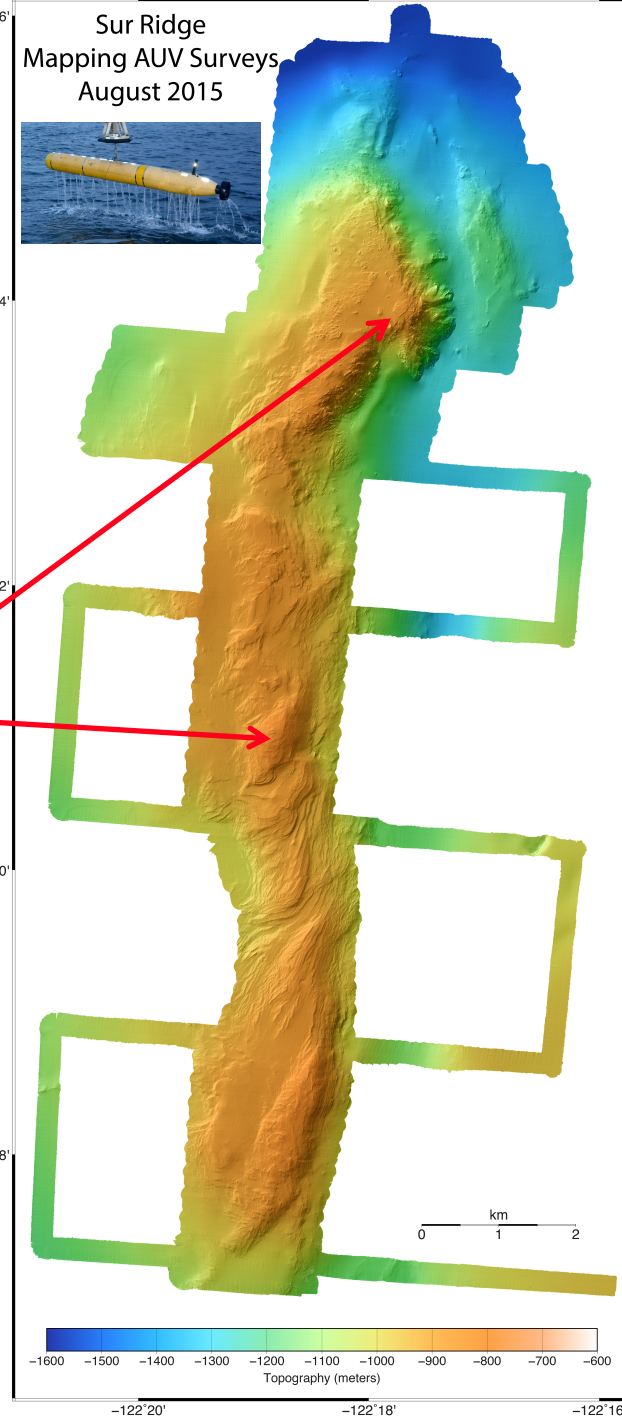
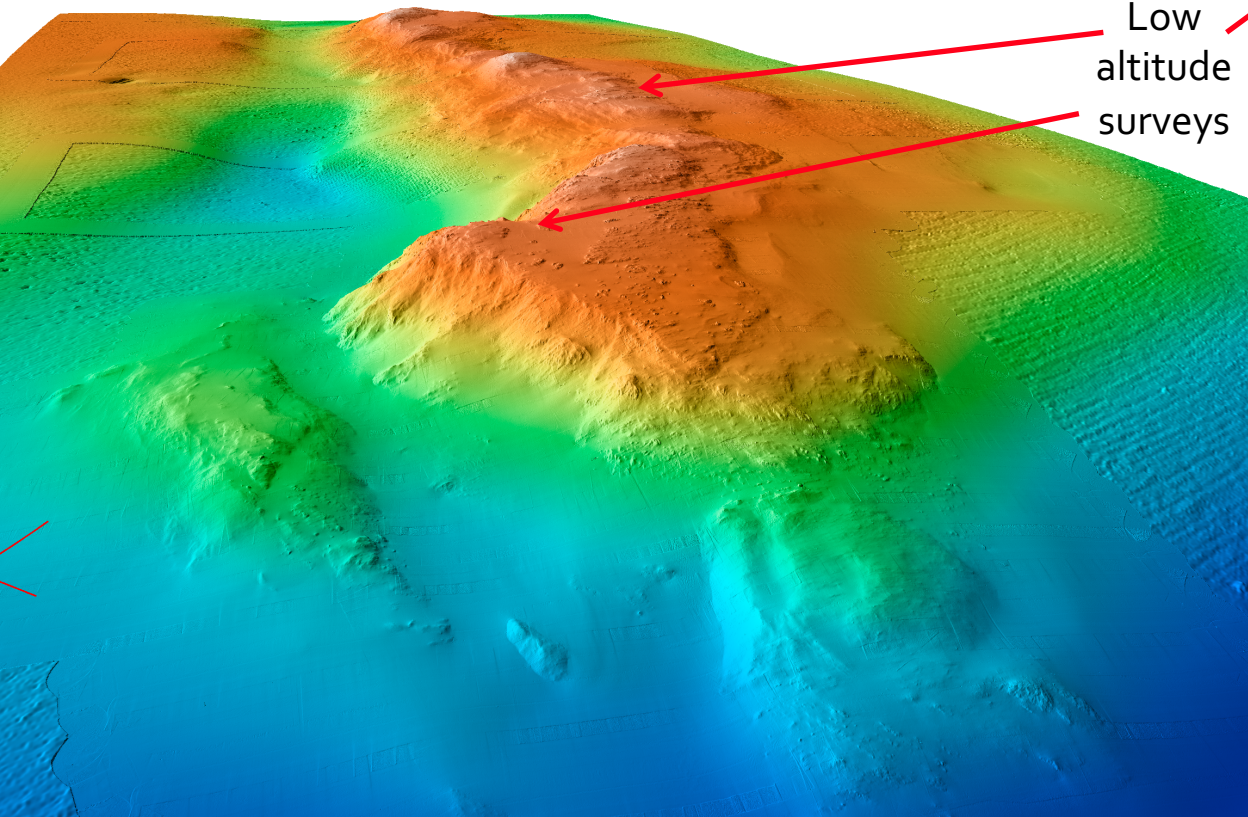
- Another application comparing two datasets
- Instead of looking for change in time, look for change within simultaneously collected data sets
- Many organisms are acoustically transparent, thus compare lidar to sonar data
- Photography provides immediate ground truthing

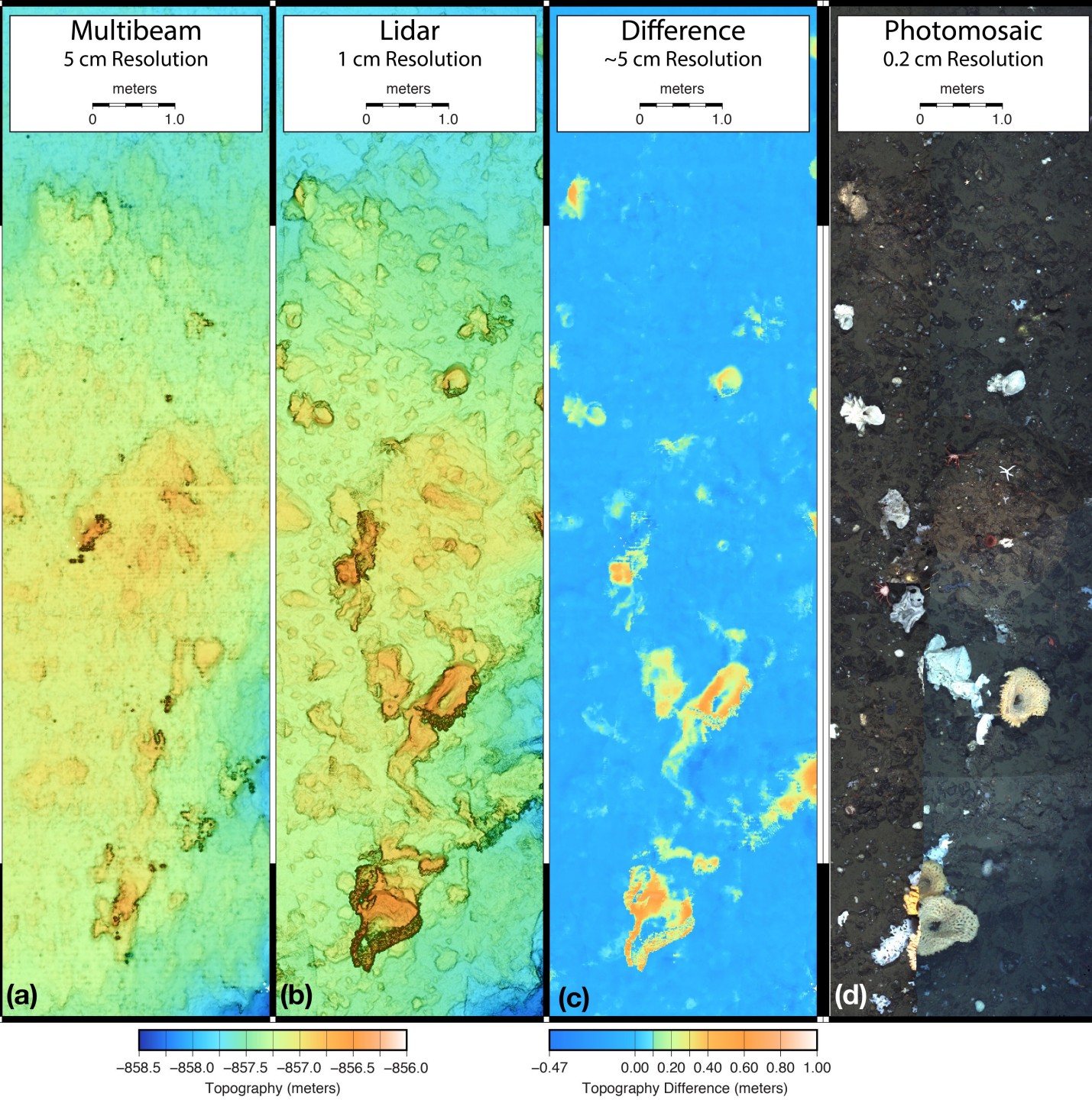
Sur Ridge



Sur Ridge Surveys

- Ridge crest covered by 1-m resolution Mapping AUV surveys
- Two 1-cm resolution ROV low altitude surveys



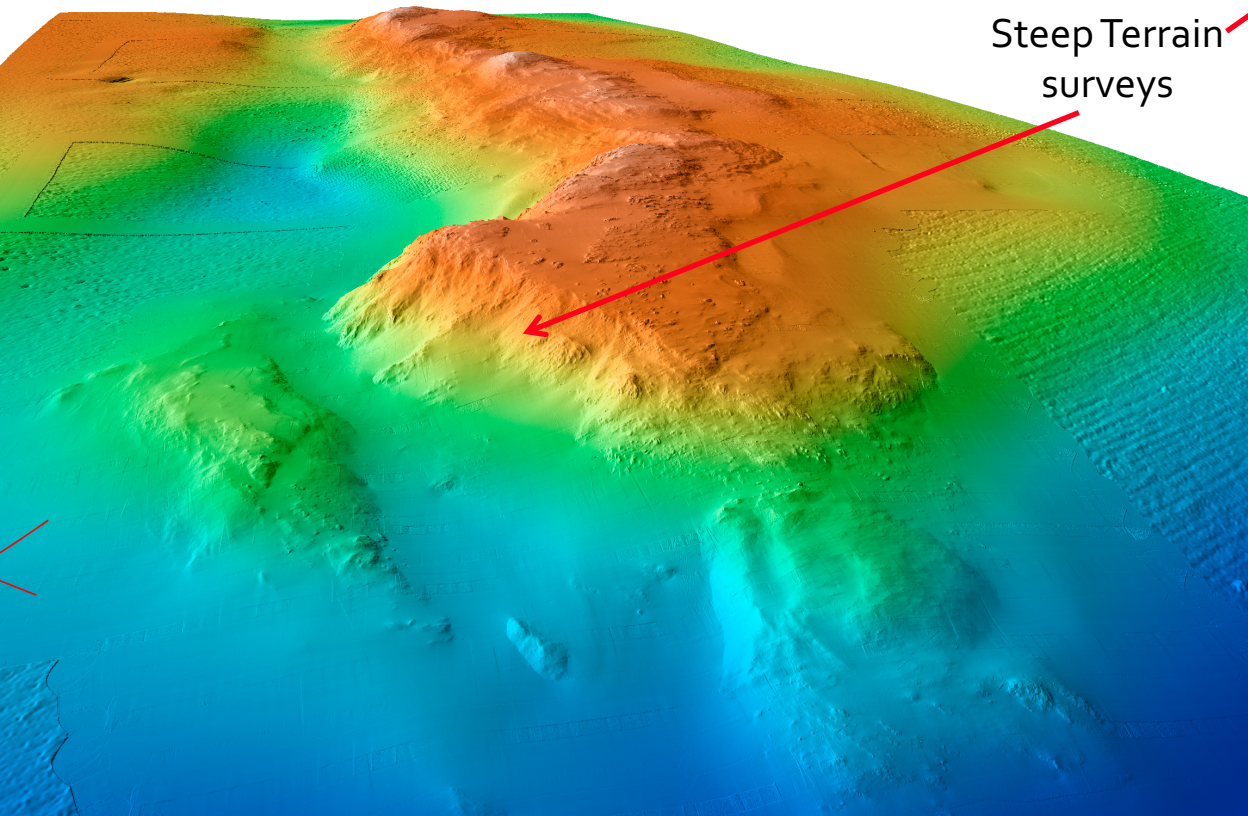


Conclusions

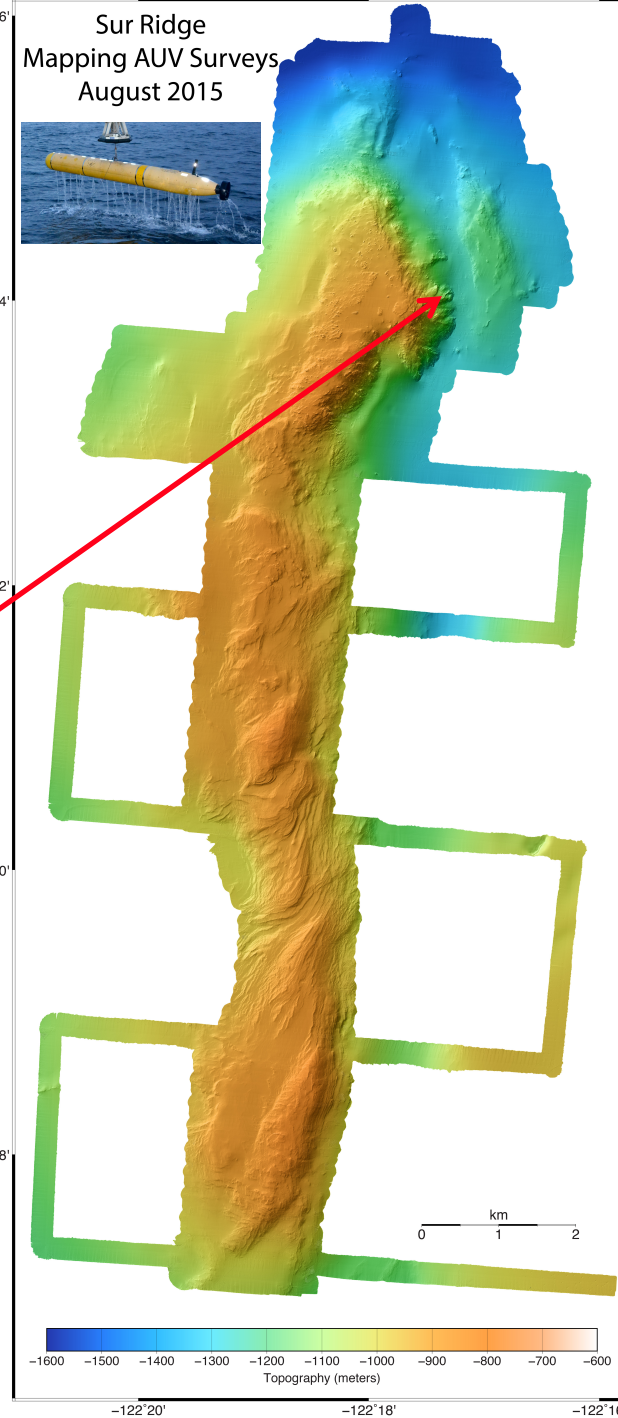
- Individual systems enable high detail collection for targeted areas.
- Comparisons of data yield significant results for both geological and biological applications.
- This survey domain is worthwhile, and can enable studies of long term change over practical time periods.

Future Challenges

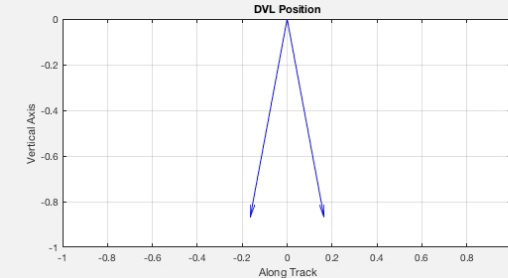
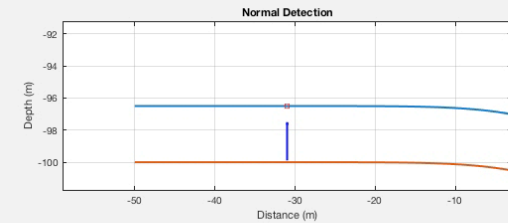
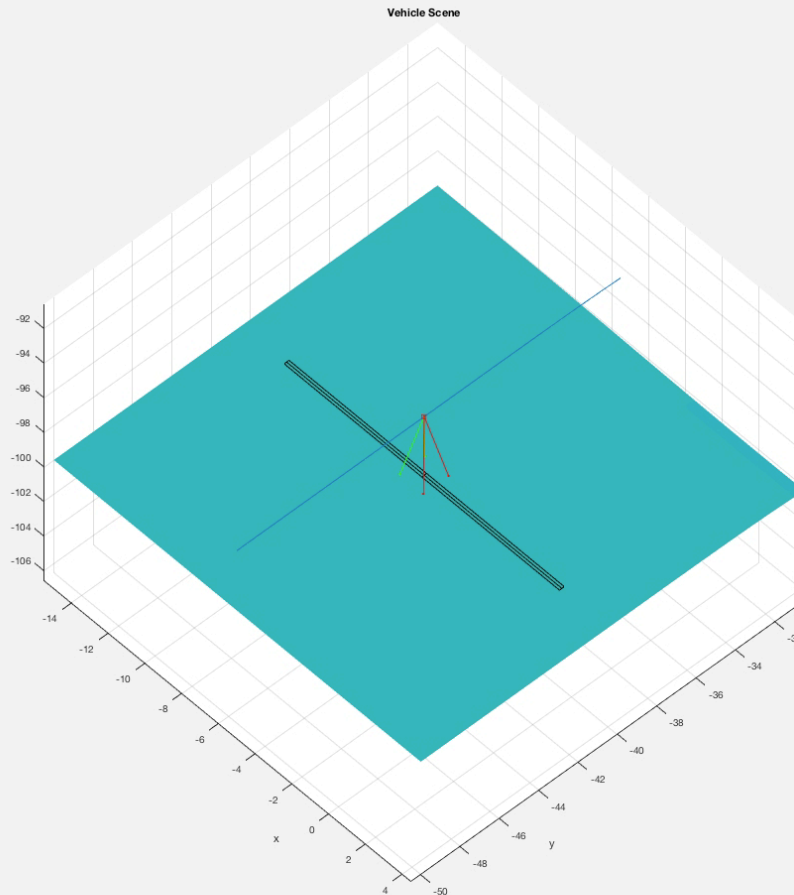
- Address Steep Terrain
- Create an articulating payload



Steep Terrain
surveys



Future Direction: Articulated Frame Concept



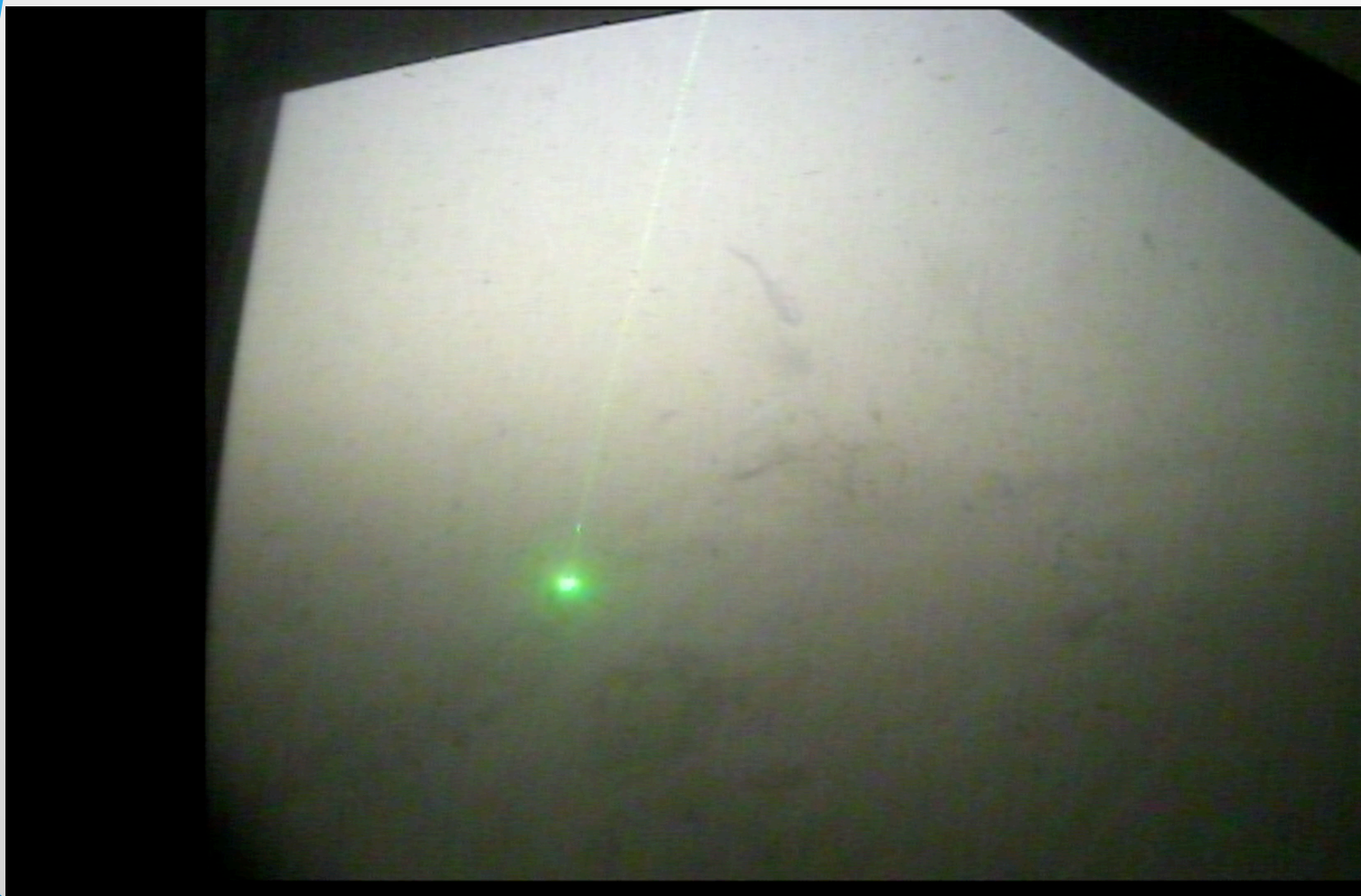
Articulating Frame Simulation
15-Jul-2016
Altitude: 3.5
No Noise
Loop Closed on raw offset of normal to dvl

Thanks

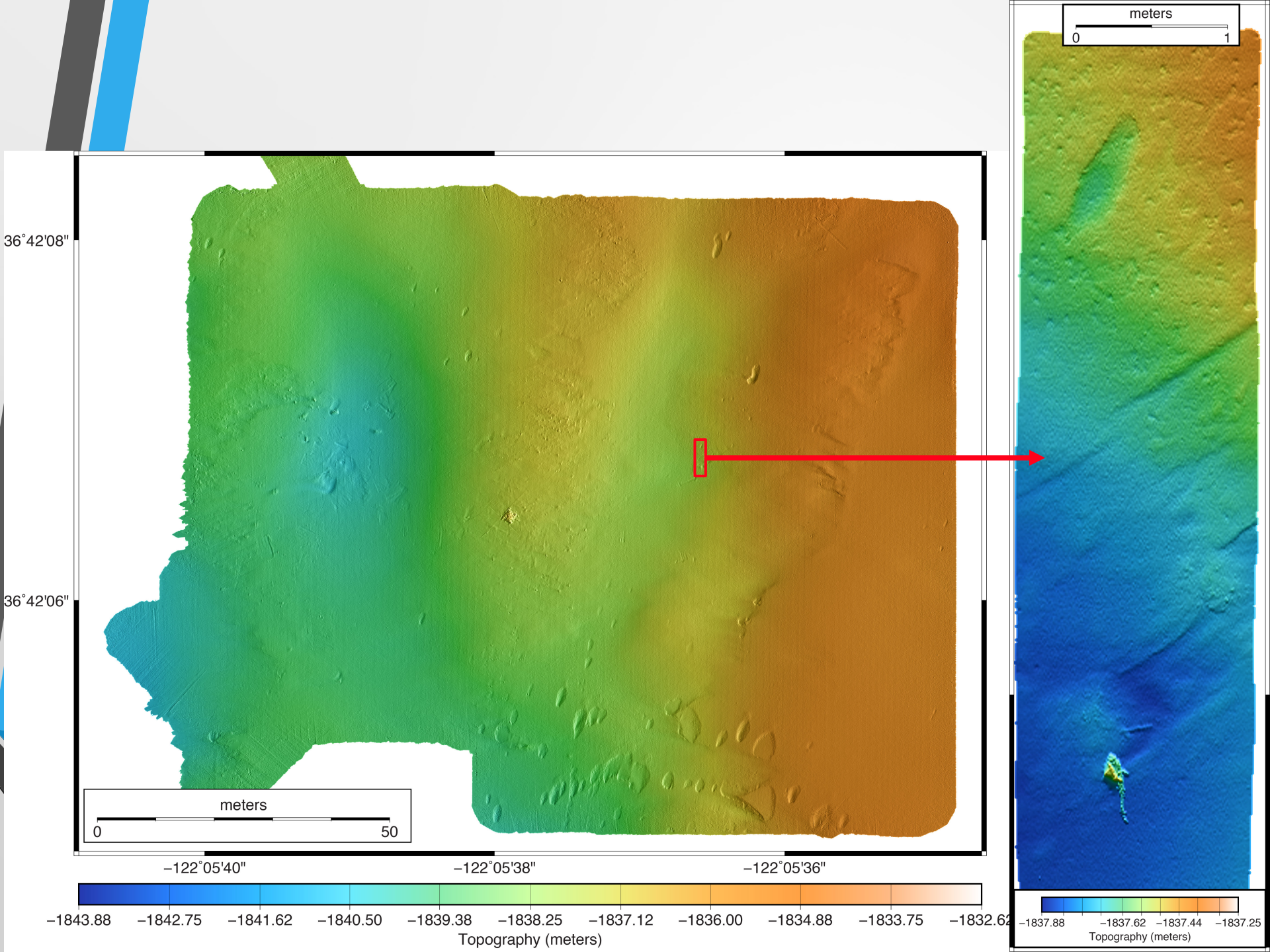
- David Caress, Prinicipal Investigator
- Crew of the R/V Western Flyer
- David and Lucile Packard Foundation

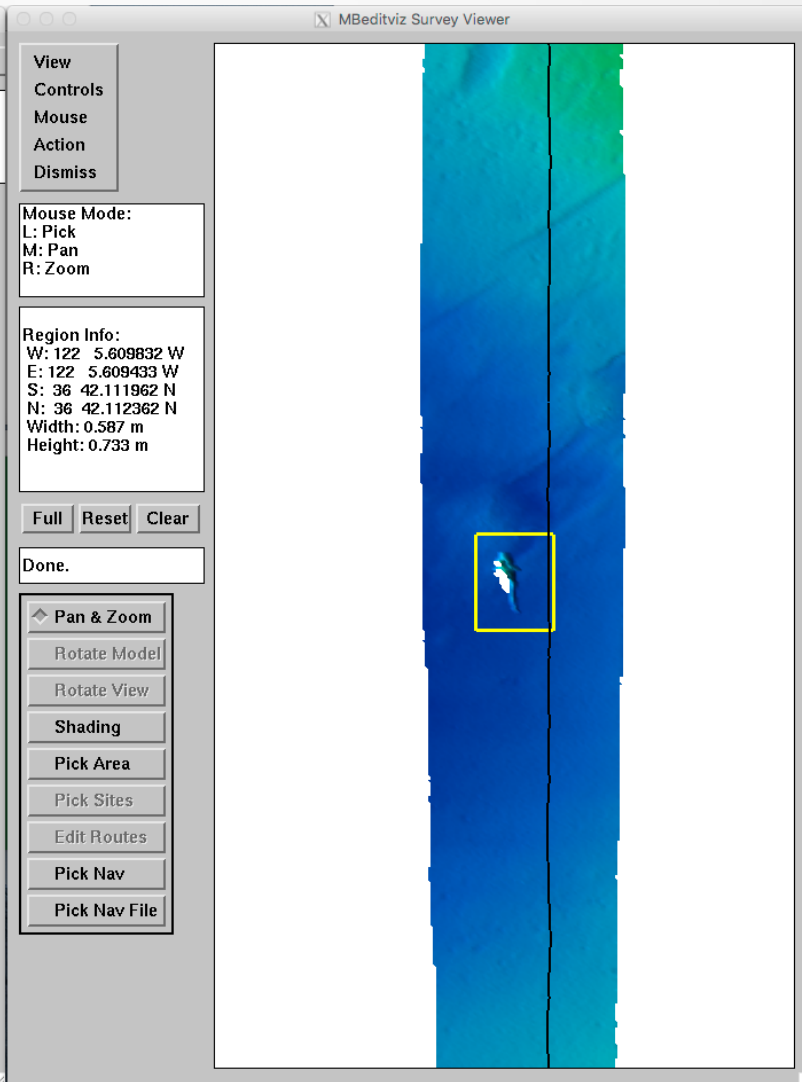
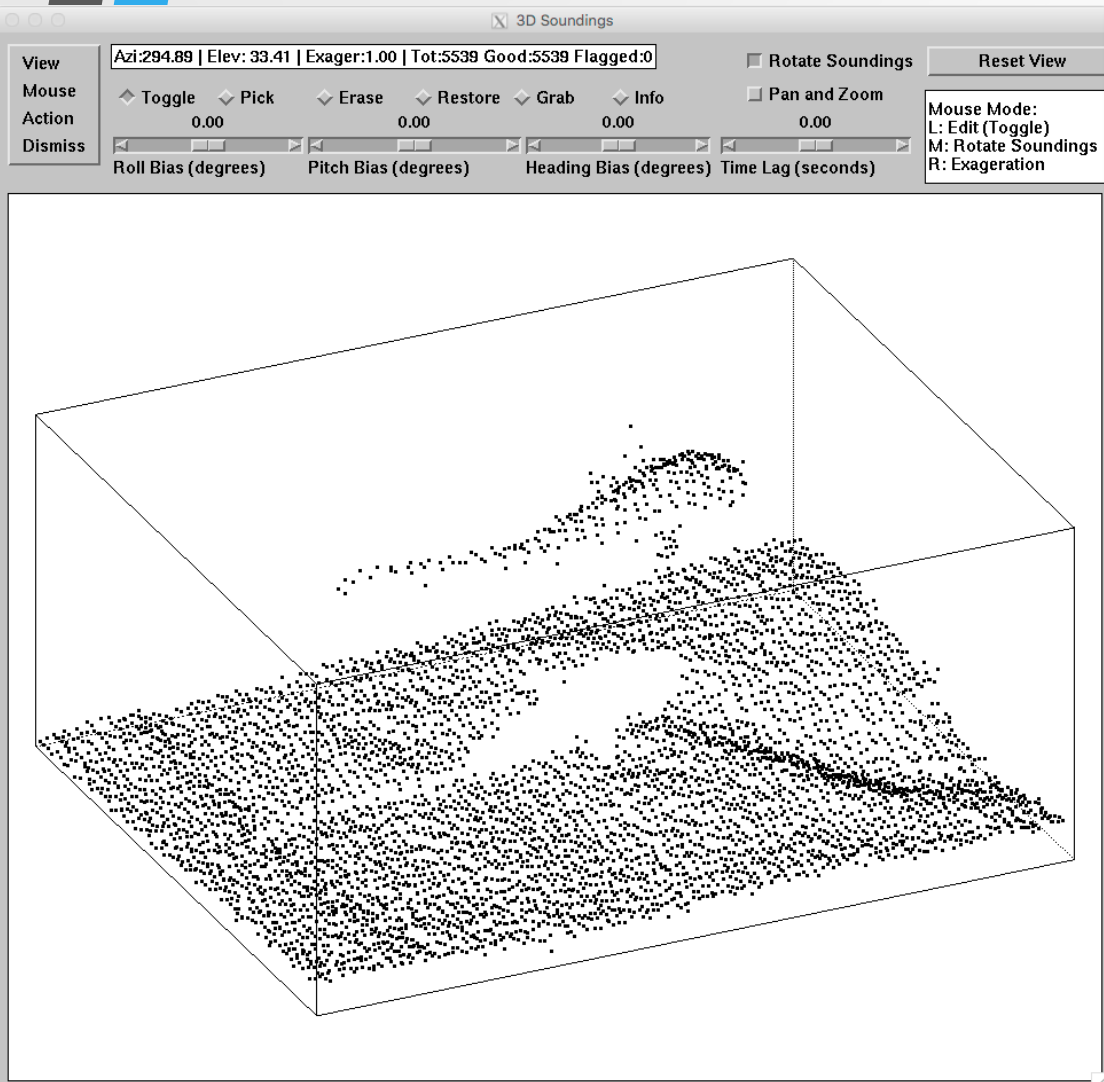


Questions?



http://search.mbari.org/ARCHIVE/frameGrabs/DocRicketts/stills/2016/docr839/07_oo_43_20.html





Requirements

- Assemble a system that can provide maps at resolutions no larger than 1-cm
- Conduct planned surveys in a controlled manner using MBARI ROVs.
- Provide autonomy where possible.
- Navigation be accurate enough to conduct repeat mapping efforts.