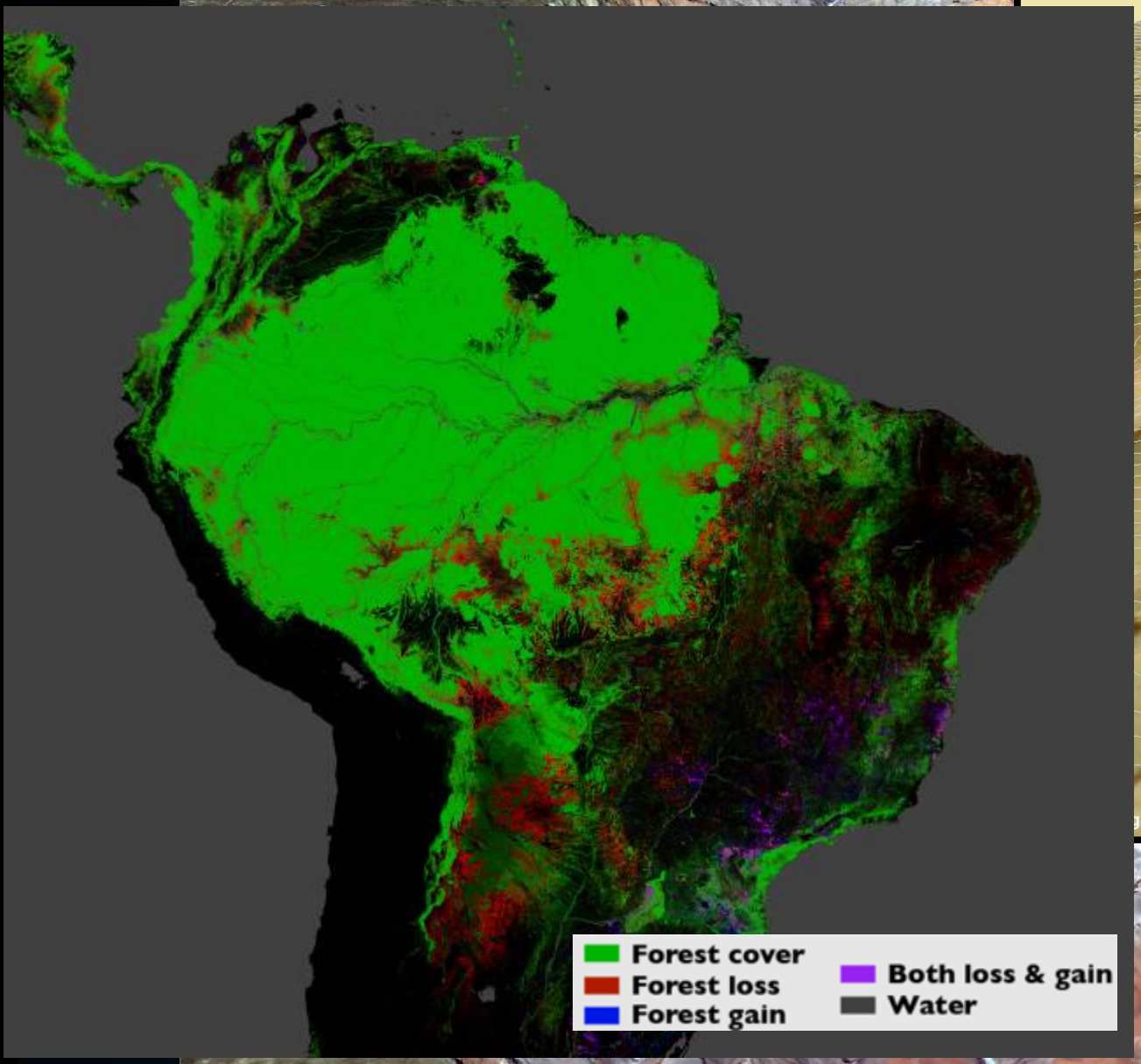
A Geospatial Context for Everything: Seabed 2030 and the Effort to Completely Map the World's Oceans

Larry Mayer
School of Marine Science and Ocean Engineering
Center for Coastal and Ocean Mapping
University of New Hampshire

43rd COLP Meeting Malmo Sweden 14 May 2019

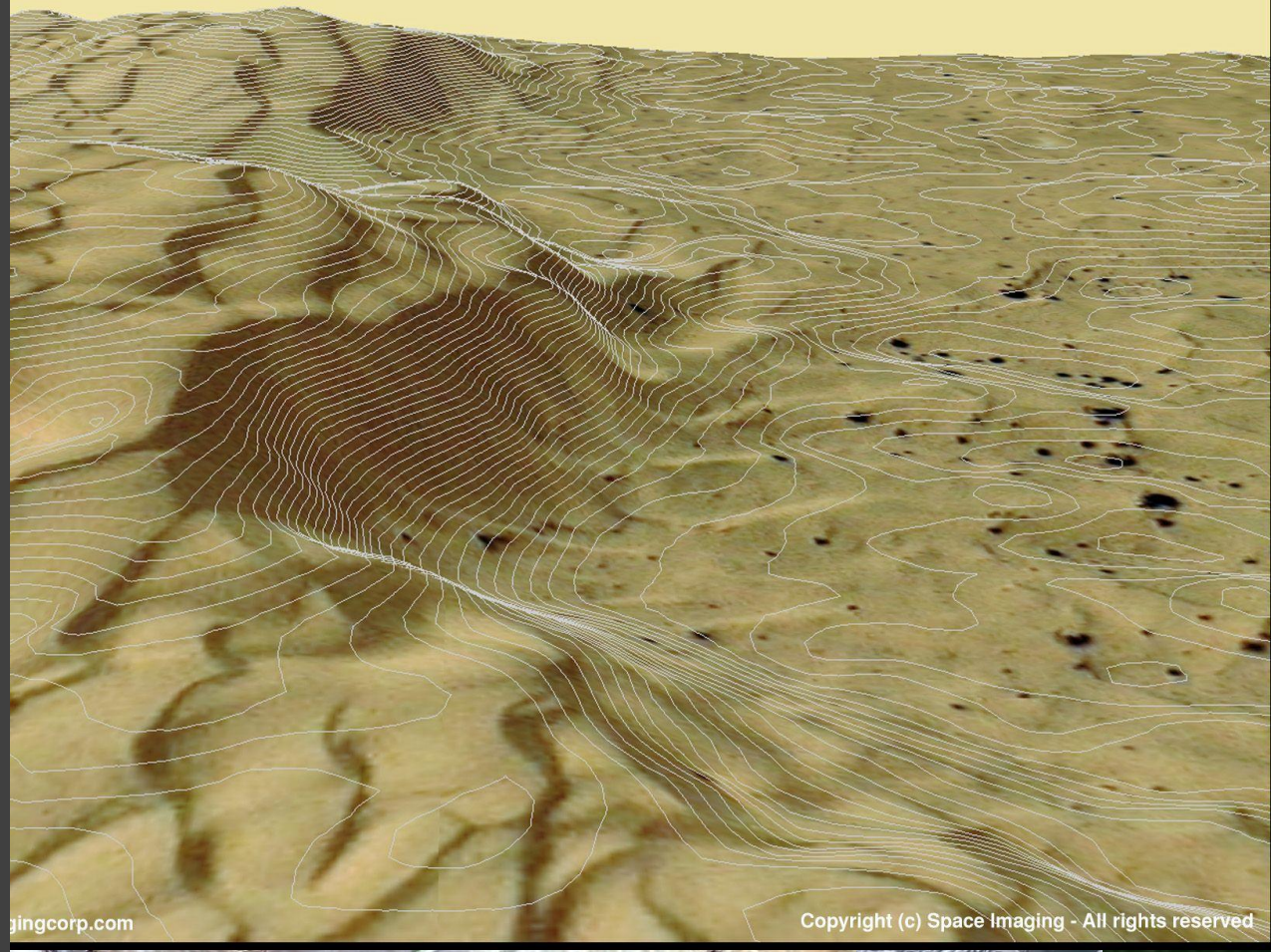
BIODIVERSITY

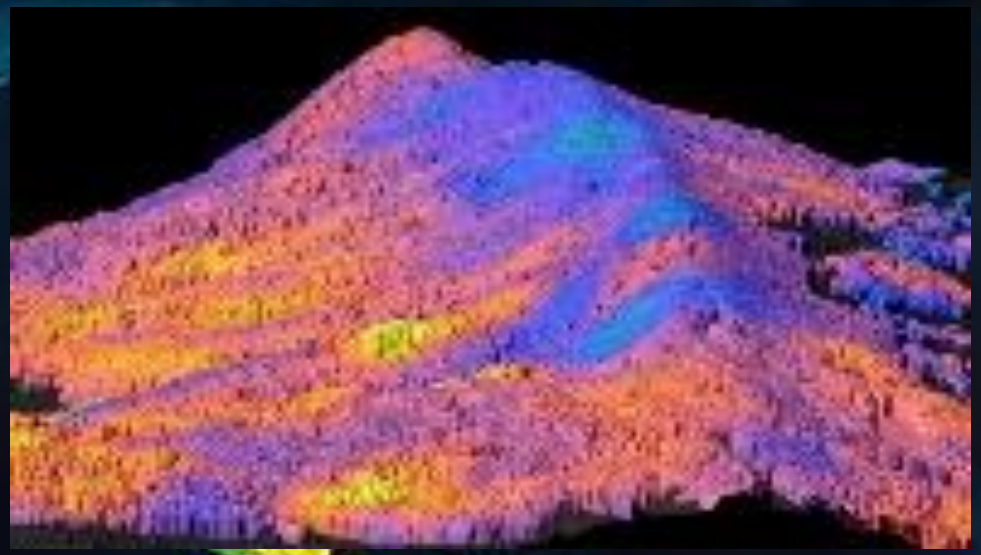

World Maritime University



1m DEM Extracted from Stereo IKONOS Satellite Image data at 0.8m resolution

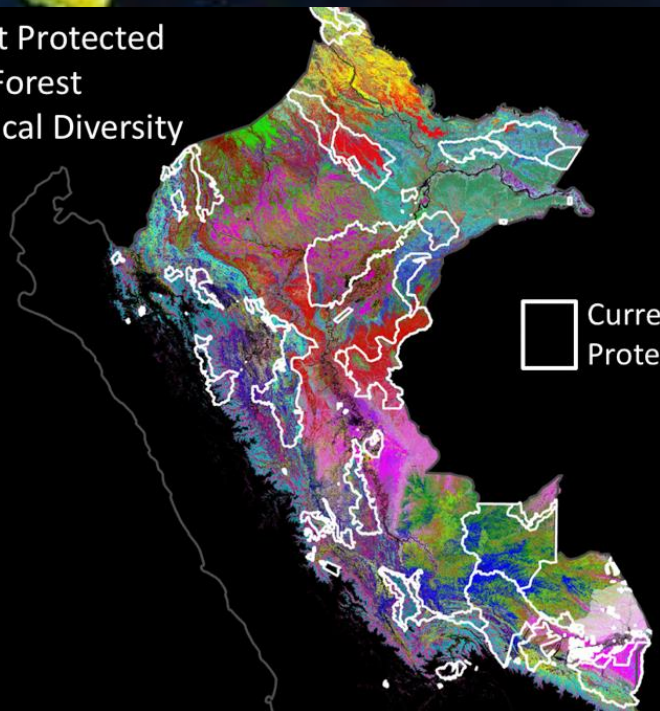
Sahara Desert - Southern Tunisia

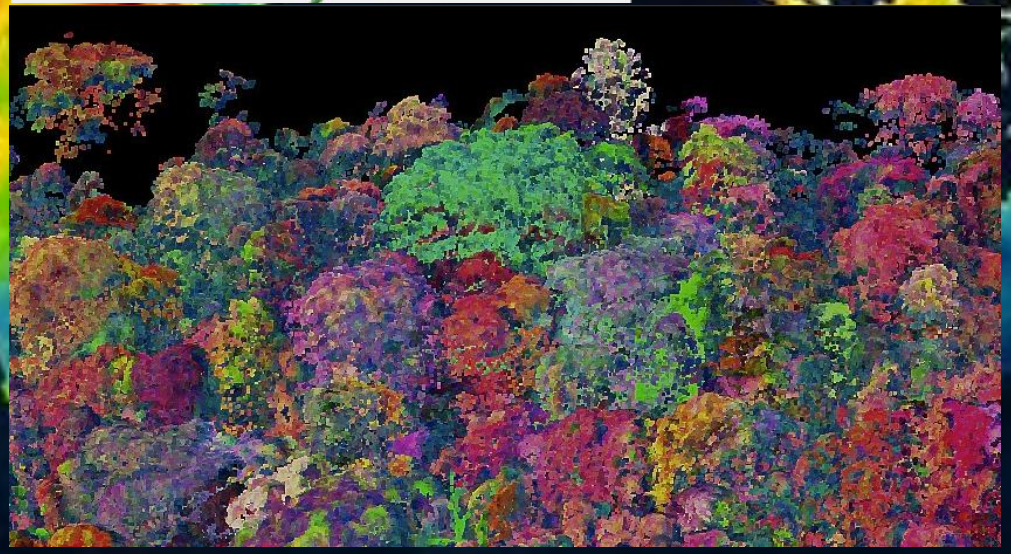




Biodiversi

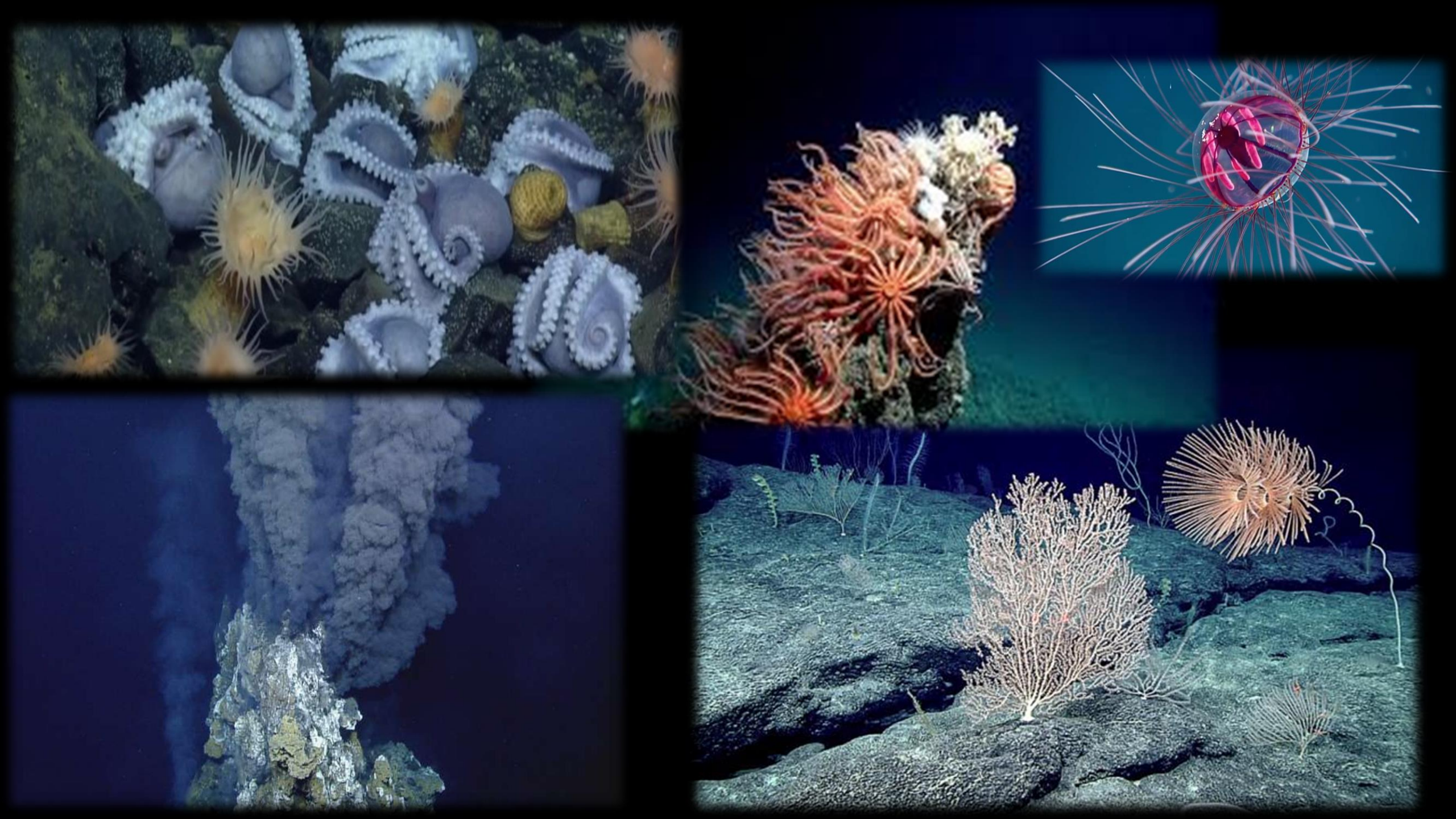
Assessment of Current Protected Areas for Conserving Forest Functional and Biological Diversity

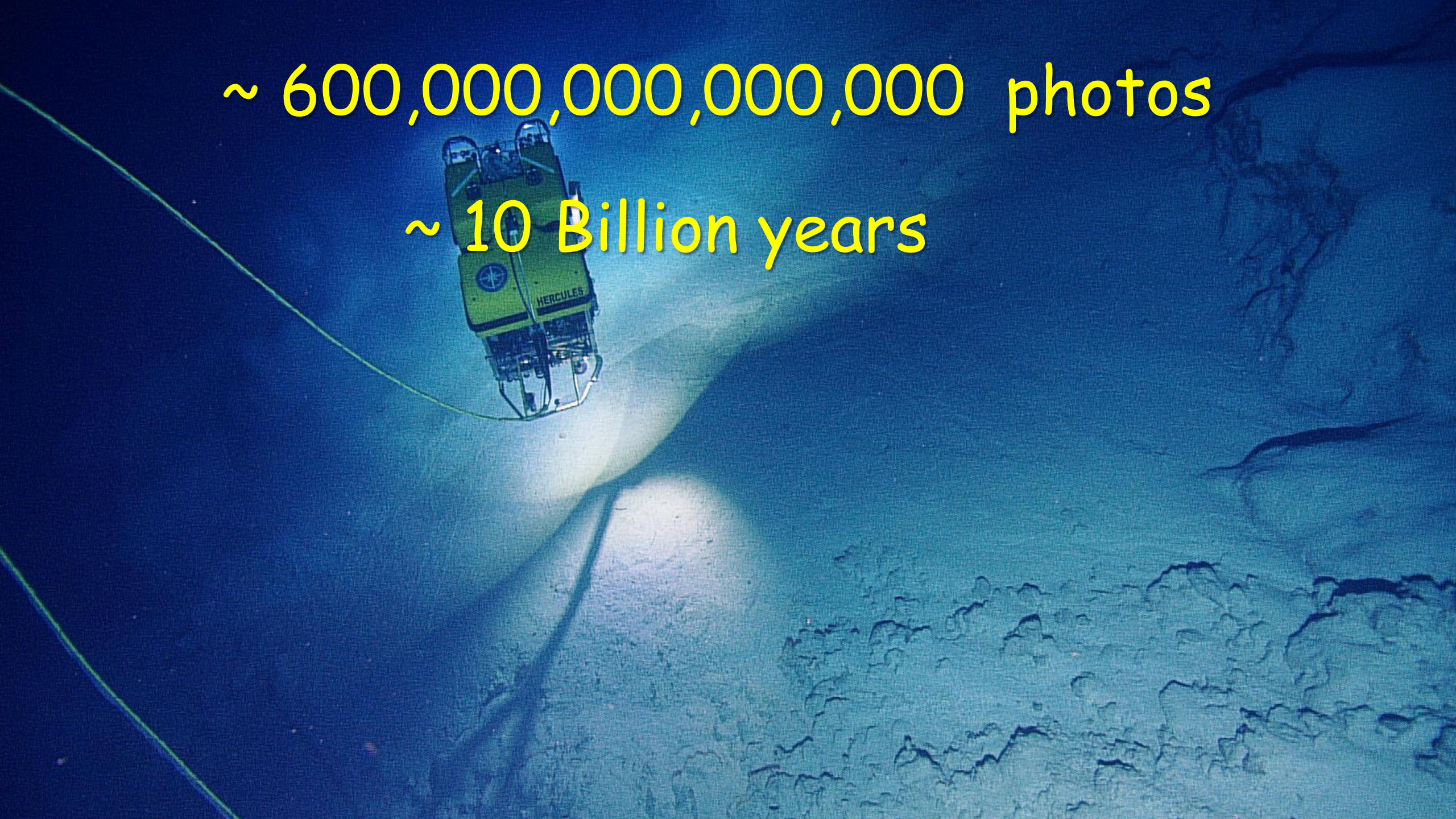




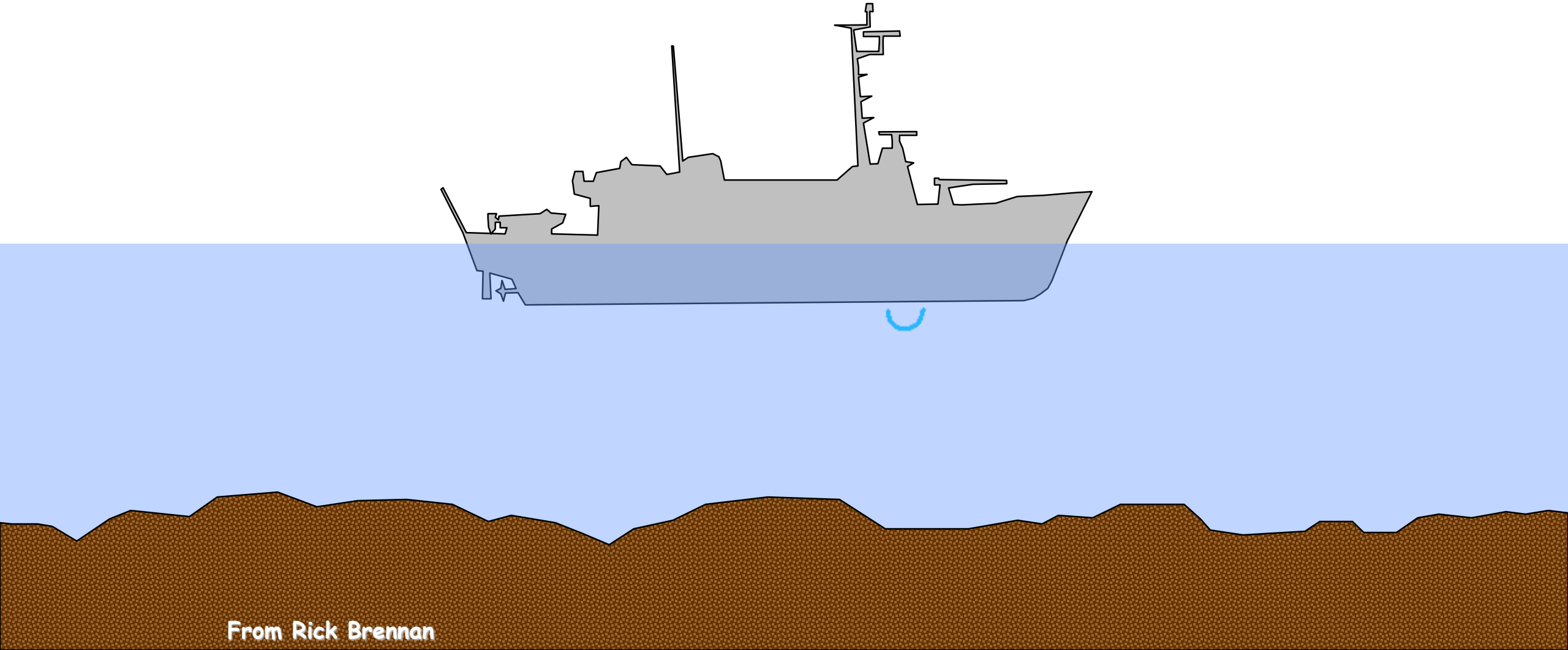

But what about the ¾ of the Earth that's BLUE?

We have the technology to bring cameras to the deep sea floor….



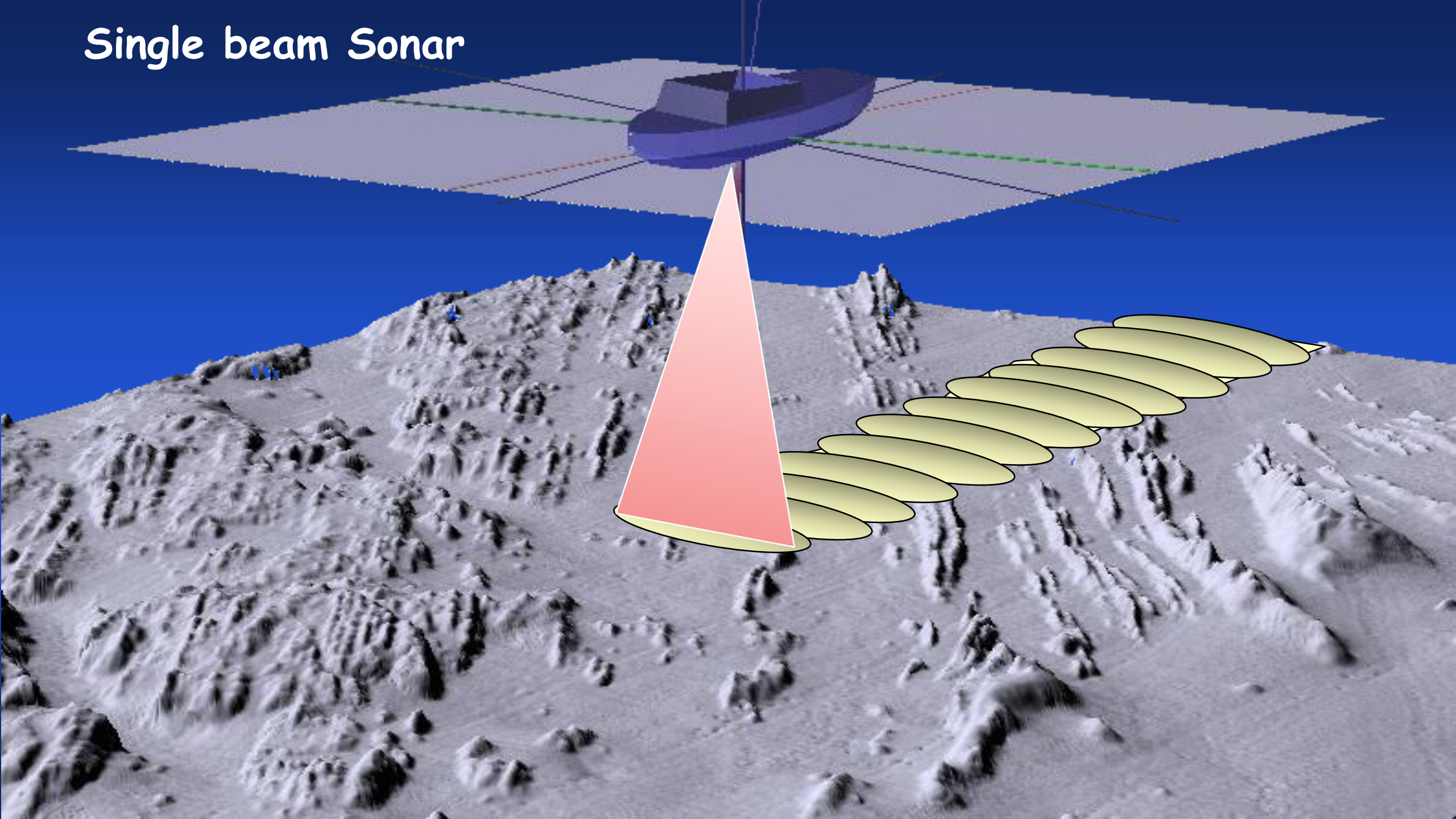

~ 600,000,000,000,000 photos
~ 10 Billion years
HERCULES

Single Beam Echo Sounder



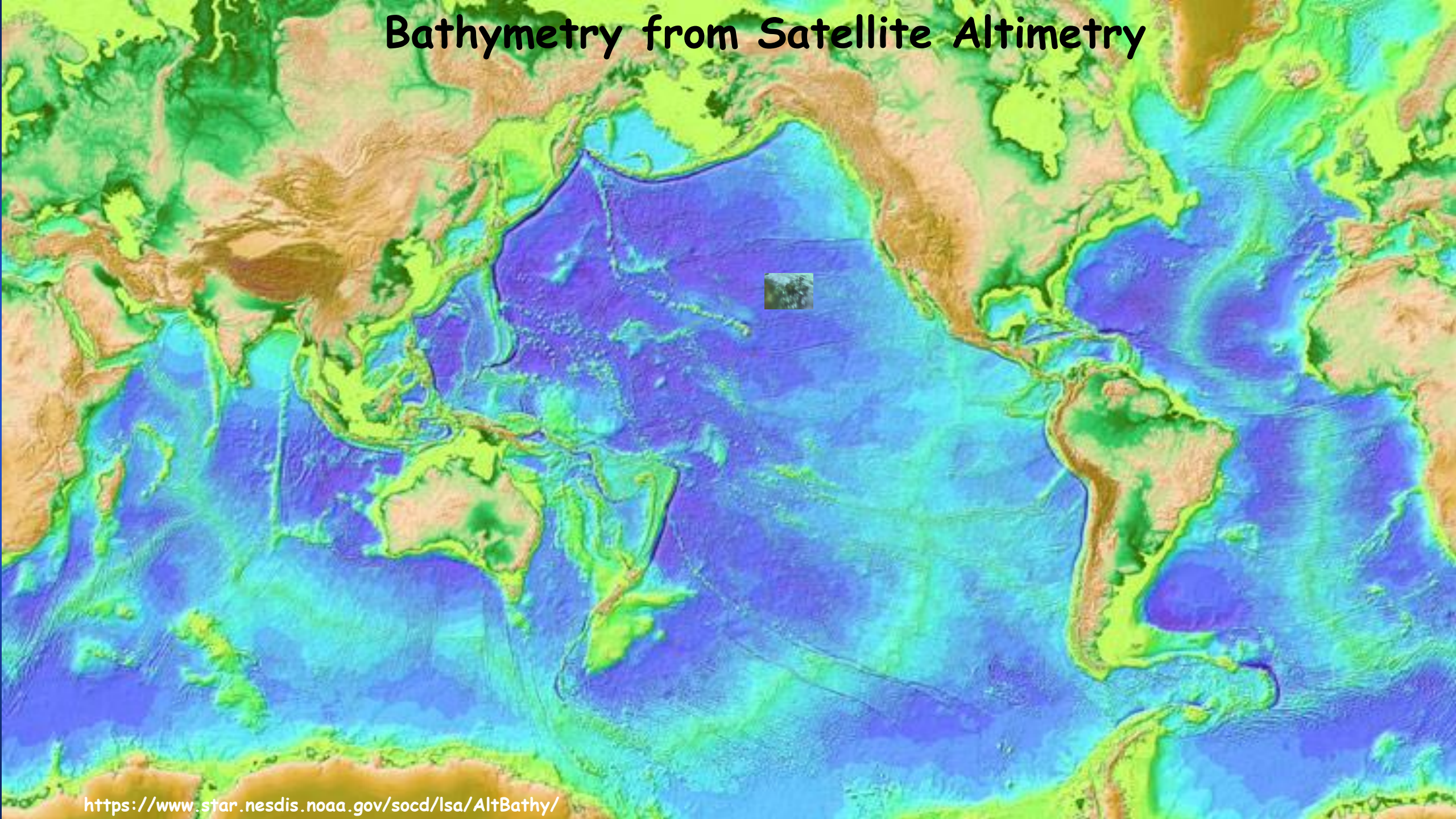
From Rick Brennan

Single beam Sonar



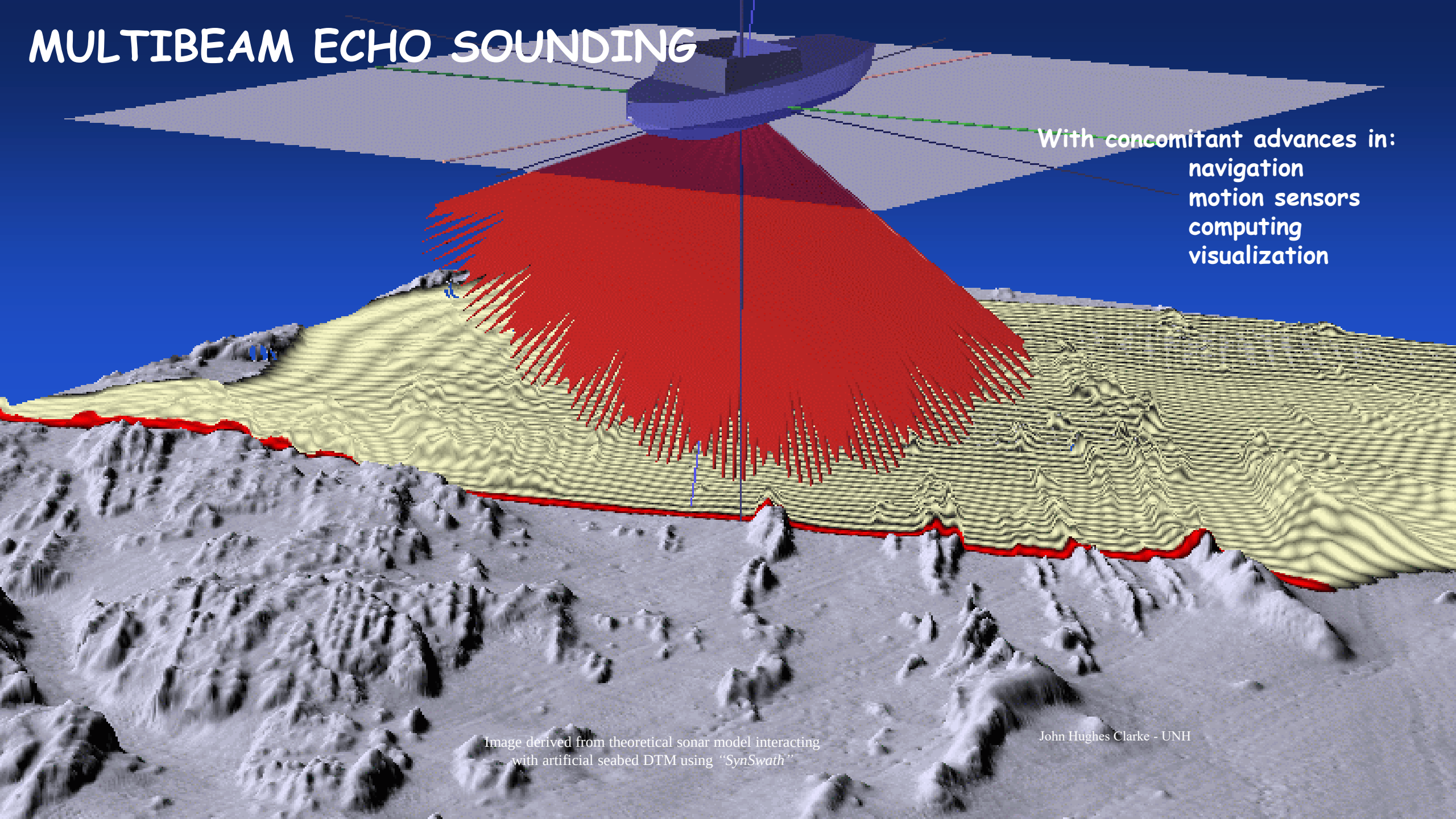

A
LOS ANGELES
SAN DIEGO
Pt. Arguello
Pt. Conception
Santa Cruz I.
San Miguel
Santa Rosa
San Nicholas I.
Santa Barbara
South Clemente
Cape Colnett
Cape San Quintin
DELAN BASIN
Guadalupe I
Sebastian Vizcaino Bay
Pt. Eugenia
Pt. Abreojos

Bathymetry from Satellite Altimetry



https://www.star.nesdis.noaa.gov/socd/lsa/AltBathy/

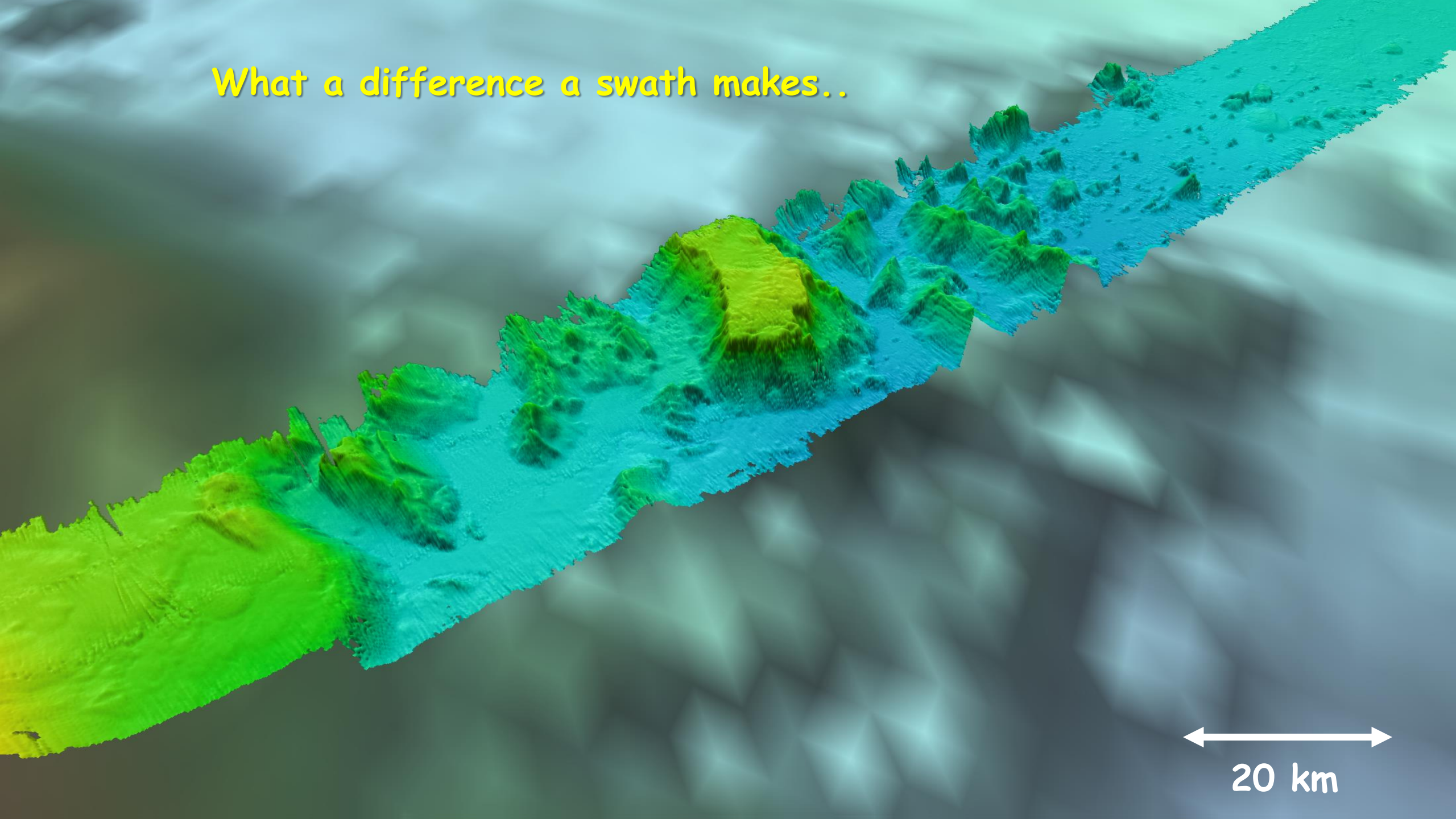
MULTIBEAM ECHO SOUNDING



With concomitant advances in:
navigation
motion sensors
computing
visualization

Image derived from theoretical sonar model interacting with artificial seabed DTM using *"SynSwath"*

John Hughes Clarke - UNH


What a difference a swath makes..
20 km


A
Grand Canyon
Death Valley
LOS ANGELES
SAN DIEGO
Pt. Arguello
Pt. Conception
Santa Cruz I.
San Miguel I.
Santa Rosa I.
San Nicolas I.
Santa Barbara I.
South Clemente I.
Cape Colnett
Cape San Quintin
DELAN BASIN
Guadalupe I.
MONTEREY

A new perspective → new insights and many new applications

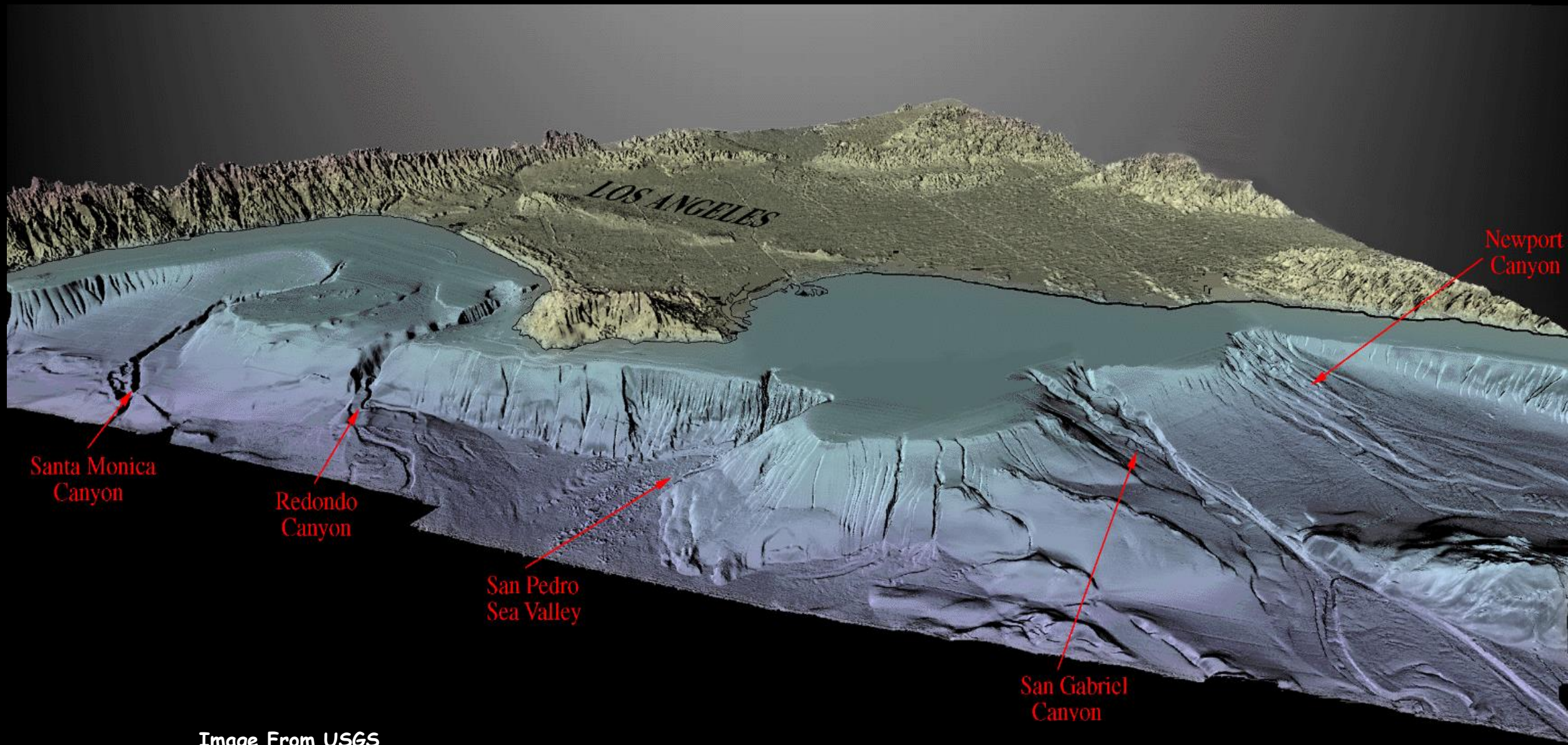
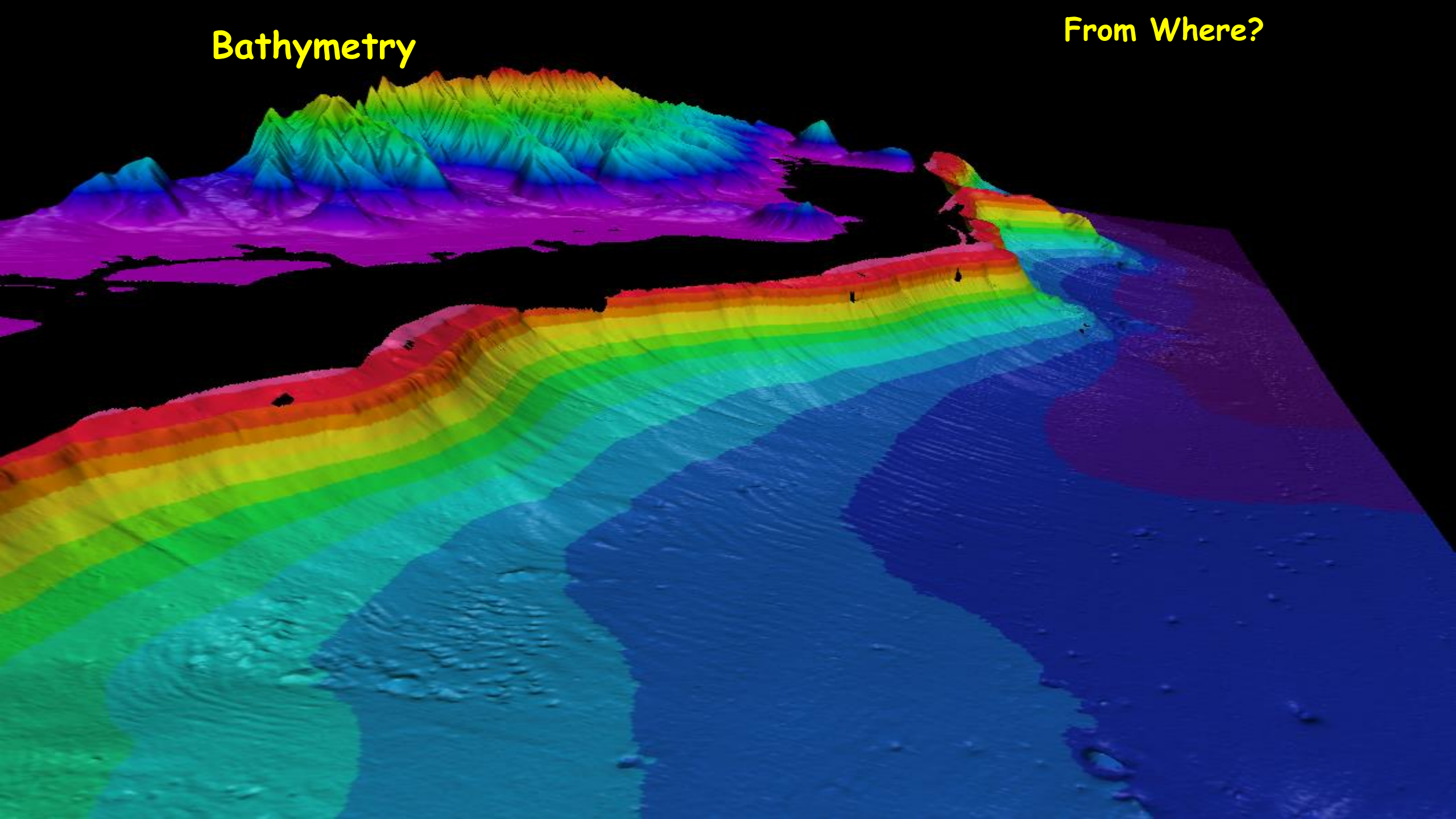
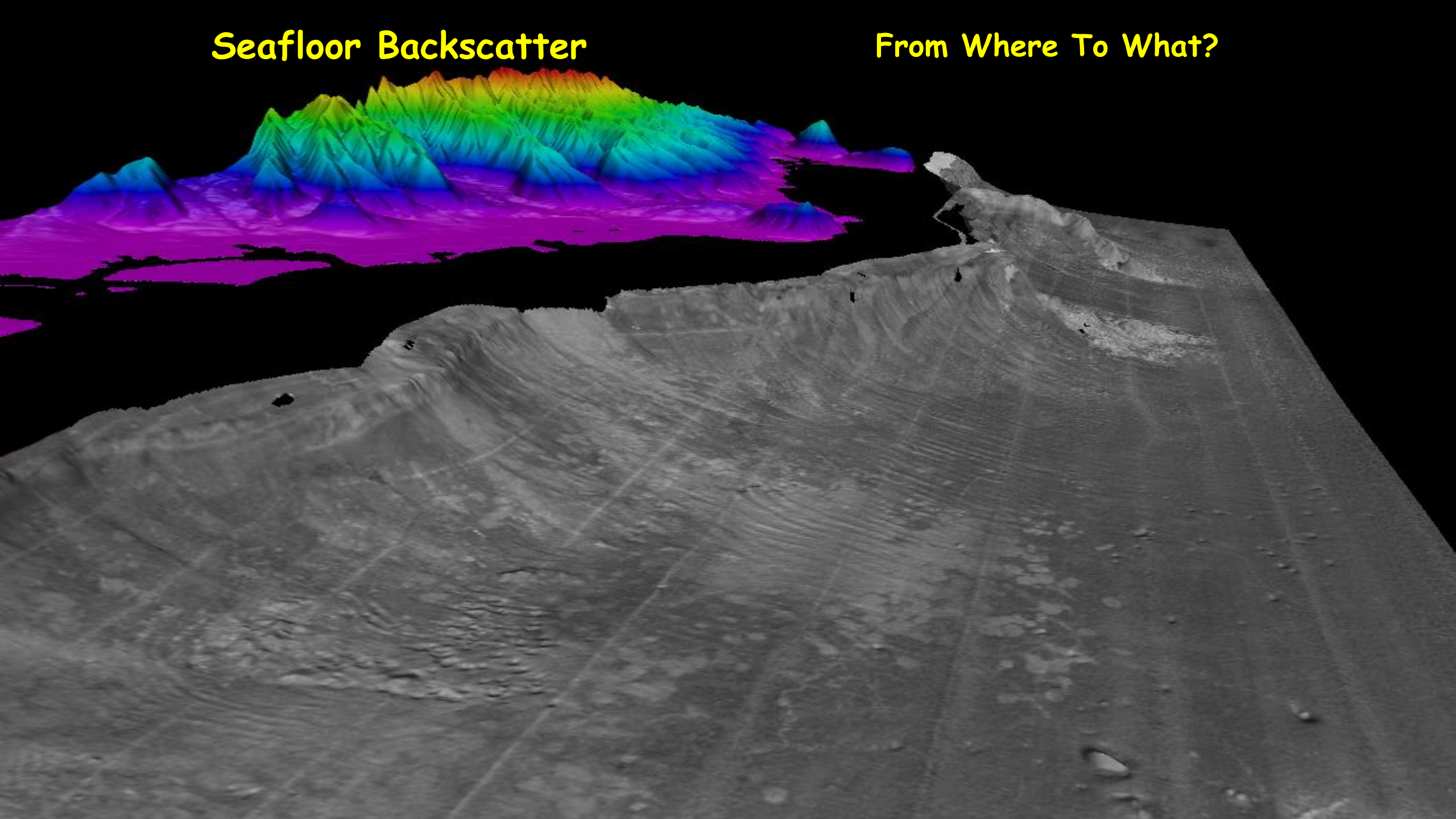


Image From USGS

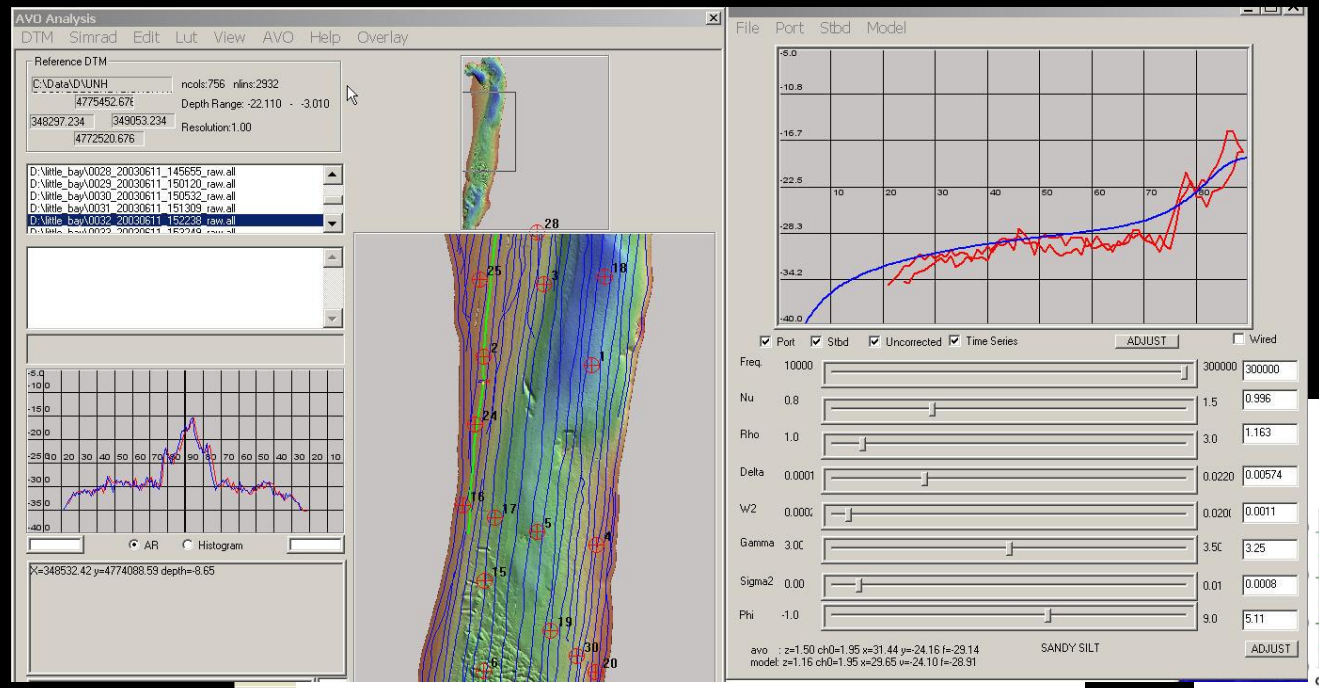

Bathymetry
From Where?

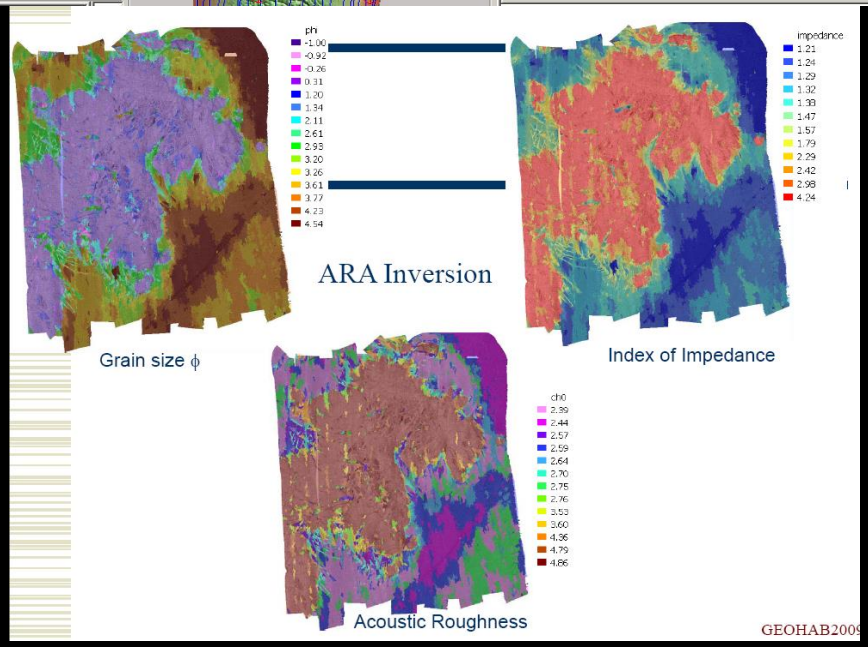
Seafloor Backscatter

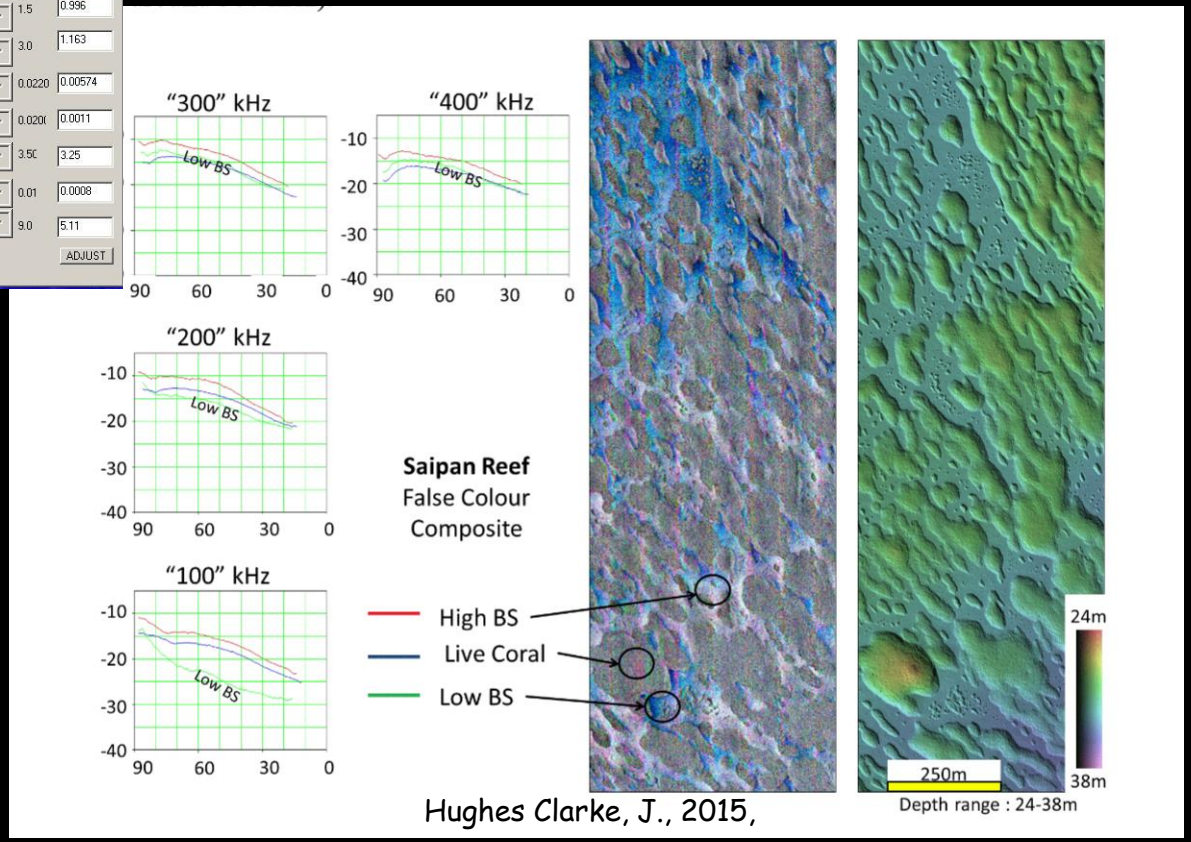
From Where To What?



Seafloor Characterization?? Angular Response and Multispectral Response

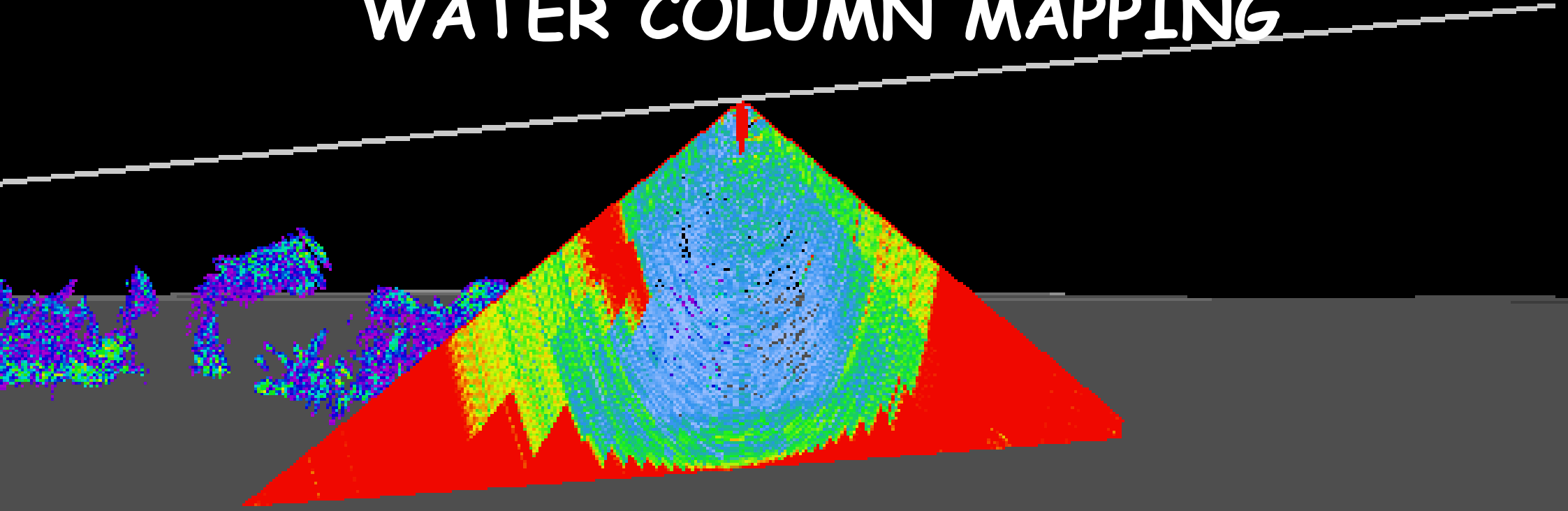






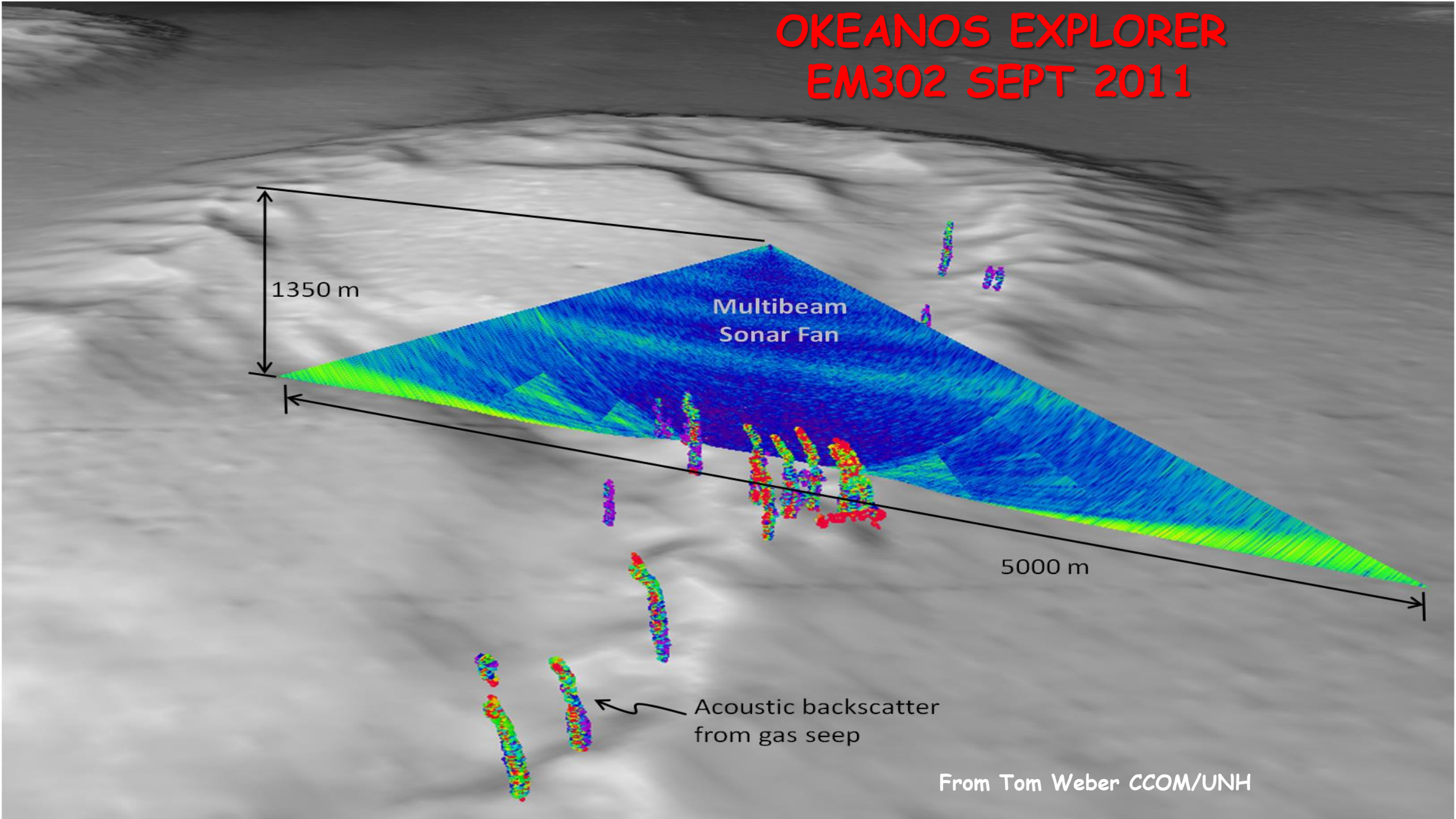
Hughes Clarke, J., 2015,

WATER COLUMN MAPPING

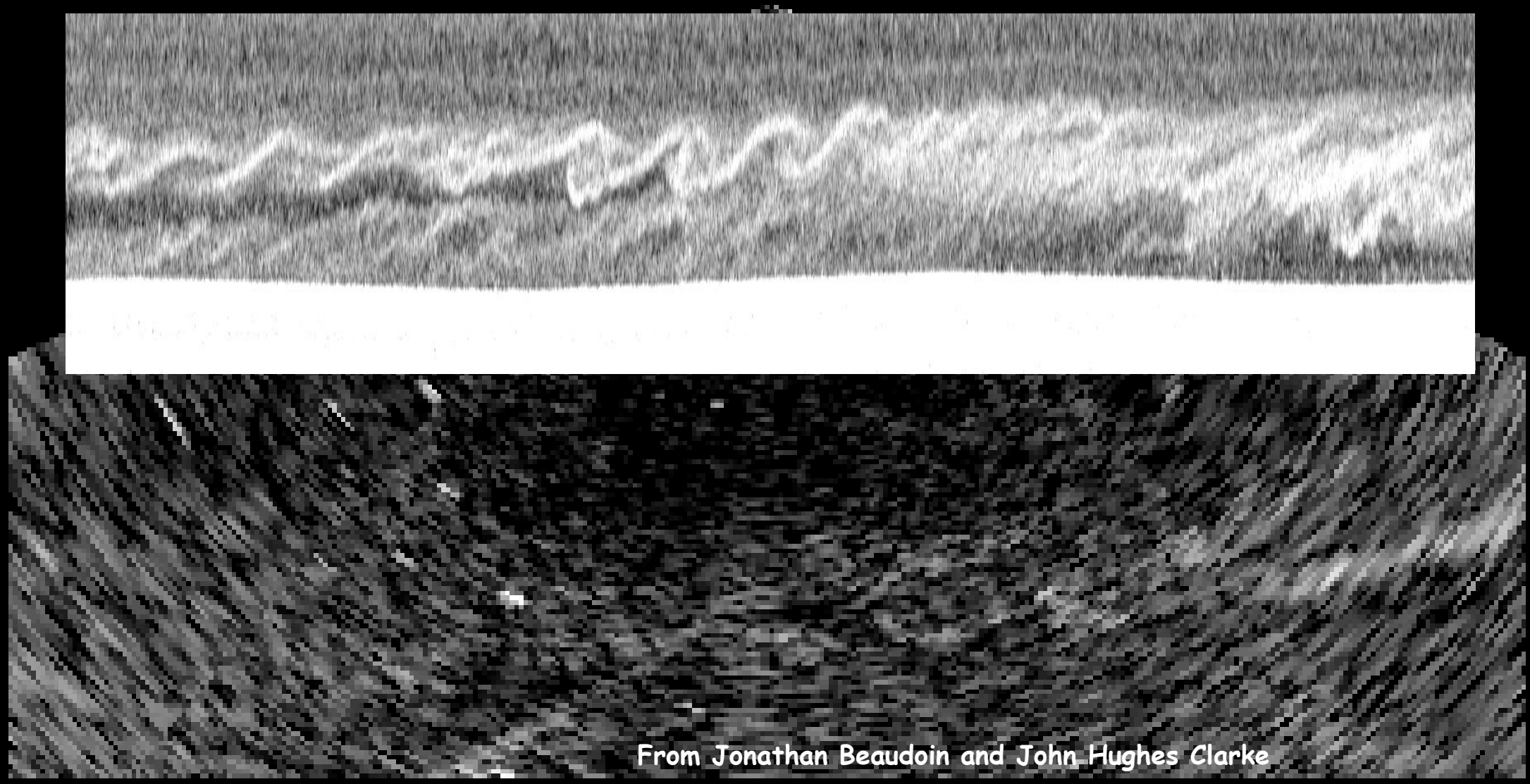


Pollock

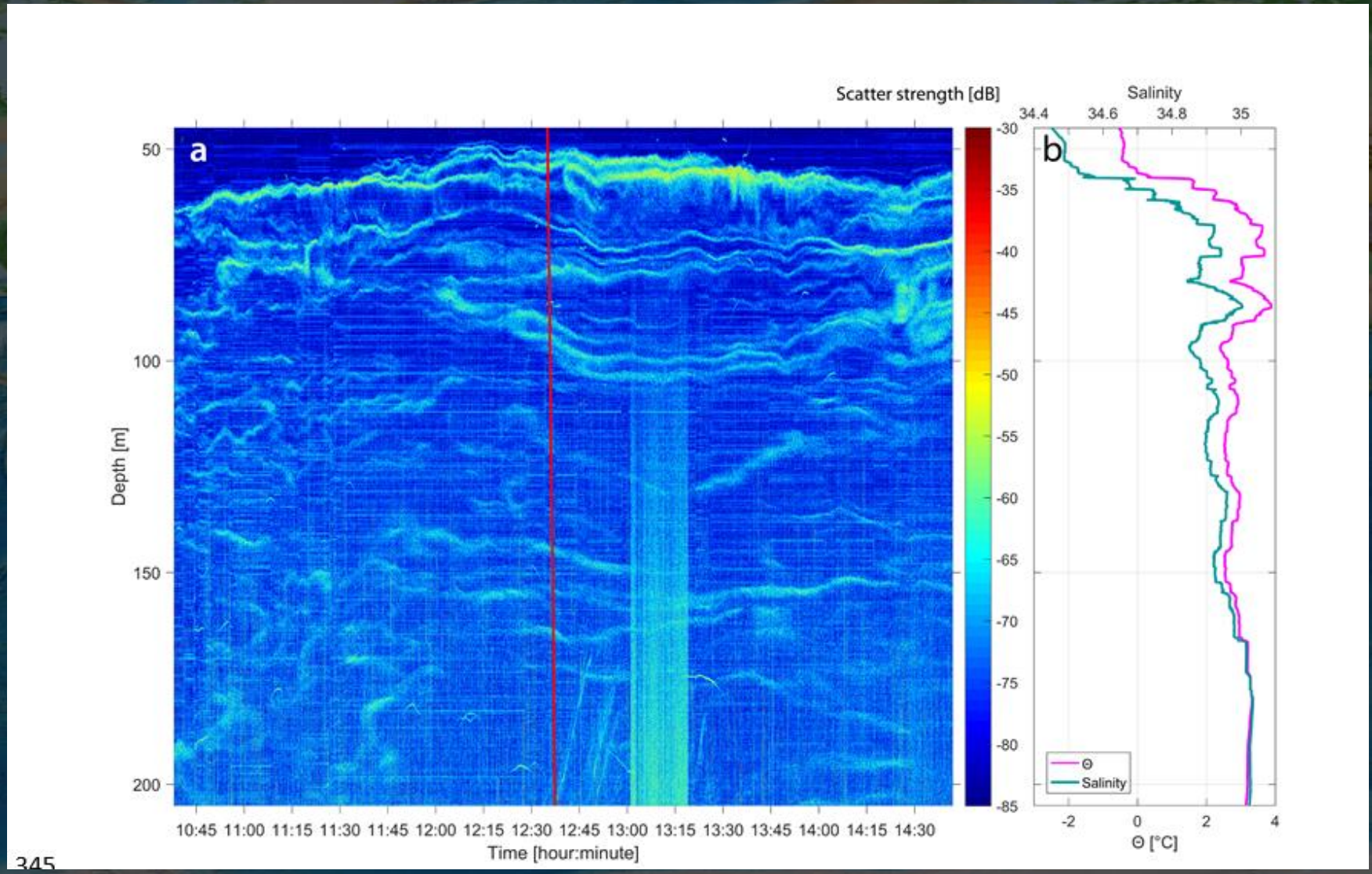
From Tom Weber CCOM/UNH


OKEANOS EXPLORER
EM302 SEPT 2011
1350 m
Multibeam
Sonar Fan
5000 m
Acoustic backscatter
from gas seep
From Tom Weber CCOM/UNH

PHYSICAL OCEANOGRAPHY –
internal waves, pycnoclines, water masses…



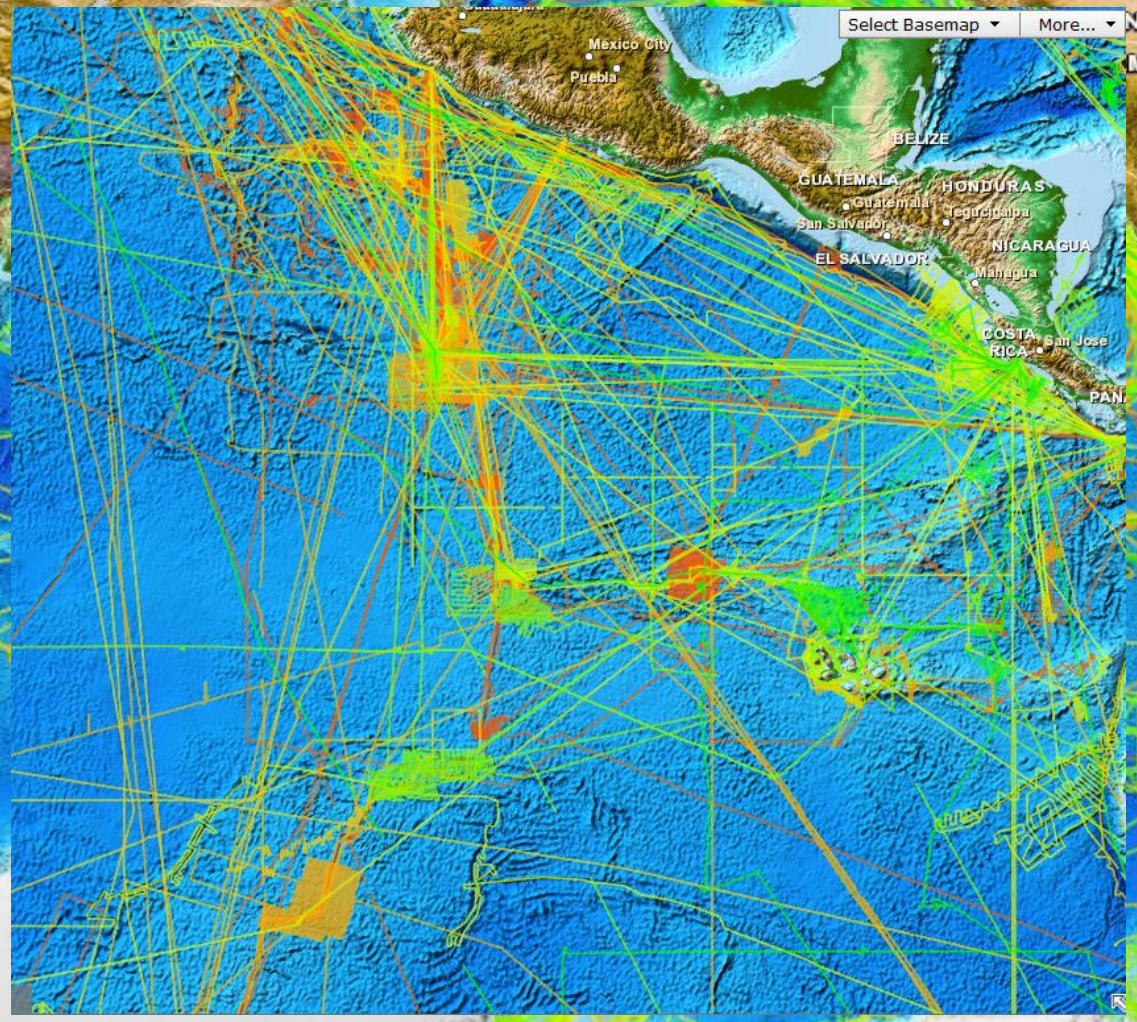
Fine-scale thermohaline structure in high Arctic

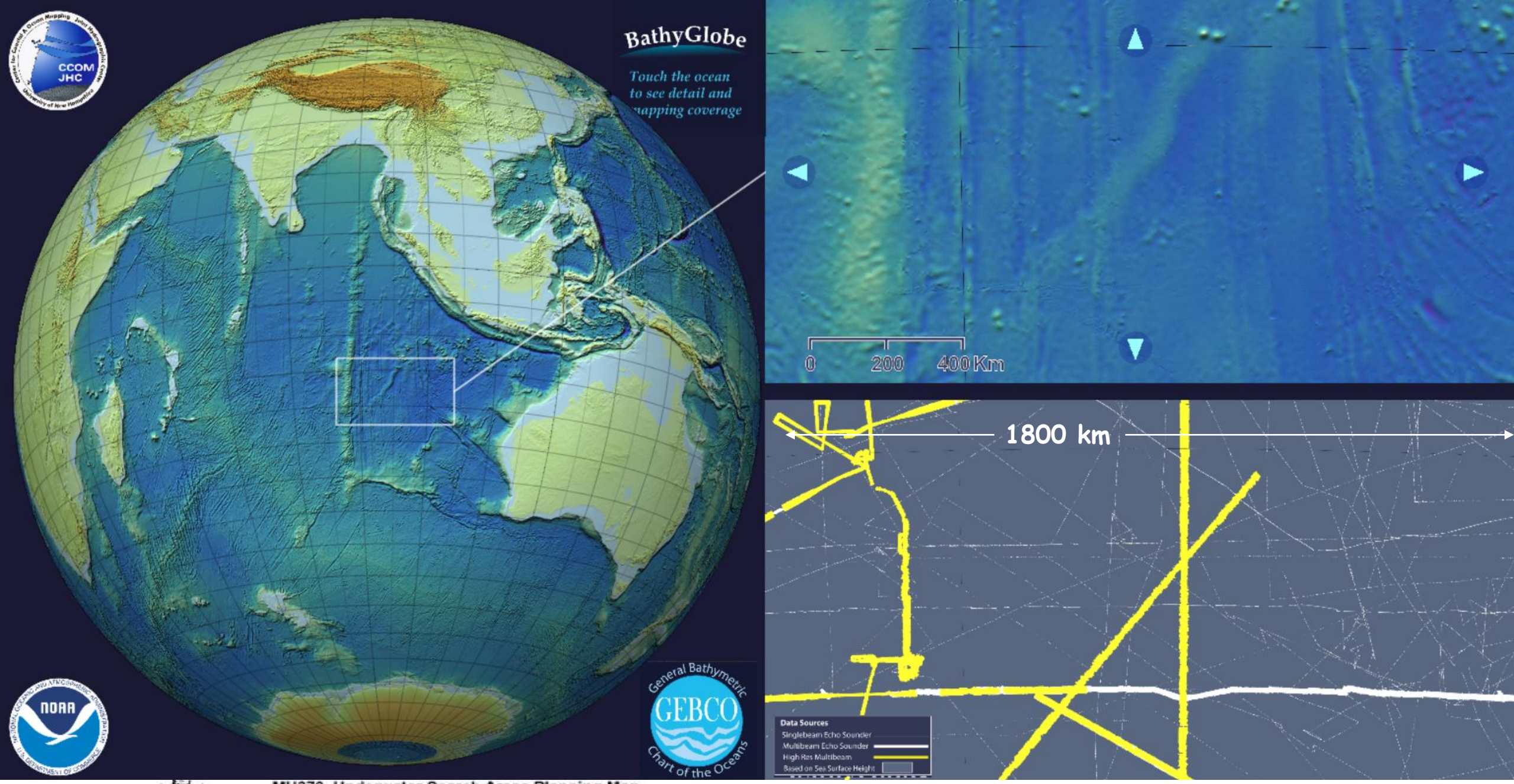


Stranne,C., Mayer, L. Weber, T., Ruddick, B., Jakbosson, M., Jerram, K., Weidner, E., Nilsson, J, and Gardfeldt, K., 2017,Acoustic Mapping of Thermohaline Staircases in the Arctic Ocean, Nature Science Reports, 7, Article number: 15192 doi:10.1038/s41598-017-15486-3

~6% of global ocean covered with MBES data

GLOBAL MBES COVERAGE FROM NCEI




BathyGlobe
Touch the ocean
to see detail and
mapping coverage
CCOM
JHC
NOAA
General Bathymetric
GEBCO
Chart of the Oceans
0
200
400 Km
1800 km
Data Sources
Singlebeam Echo Sounder
Multibeam Echo Sounder
High Res Multibeam
Based on Sea Surface Height
Australian Government
Australian Transport Safety Bureau
Geoscience Australia
MH370 Underwater Search Areas Planning Map
0
250
500 Kilometres
Background image: Australian Bathymetry and Topography Grid
MH370 Underwater Search Planning Areas
Underwater Search Area 1
Wide search area
Underwater Search Area 2
Bathymetry
Elevation Ramp
N
Date: 2014/10/03

The Nippon Foundation-GEBCO Seabed 2030 Project

The Nippon Foundation – GEBCO Seabed 2030 Project

Vision Established through 2016 Forum for Future Ocean Floor Mapping

Forum for Future Ocean Floor Mapping

Project Announced at 2017 UN Ocean Conference

THE OCEAN CONFERENCE
UNITED NATIONS, NEW YORK, 5-9 JUNE 2017

Seabed 2030

A collaborative project between The Nippon Foundation and GEBCO to inspire the complete mapping of the world's ocean by 2030 and to compile all bathymetric data into the freely-available GEBCO Ocean Map.

THE NIPPON FOUNDATION

GEBCO

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

*-The **Nippon Foundation** is a private Japanese-based, non-profit grant-making organization with a mission based around philanthropic activities to pursue global maritime development and assistance for humanitarian work.*

*-The **General Bathymetric Chart of the Oceans (GEBCO)** organization operates under the joint auspices of the International Hydrographic Organization (IHO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO*

Empower the world to ***make policy decisions, use the ocean sustainably***, and ***undertake scientific research*** that is informed by a detailed understanding of the global ocean floor.

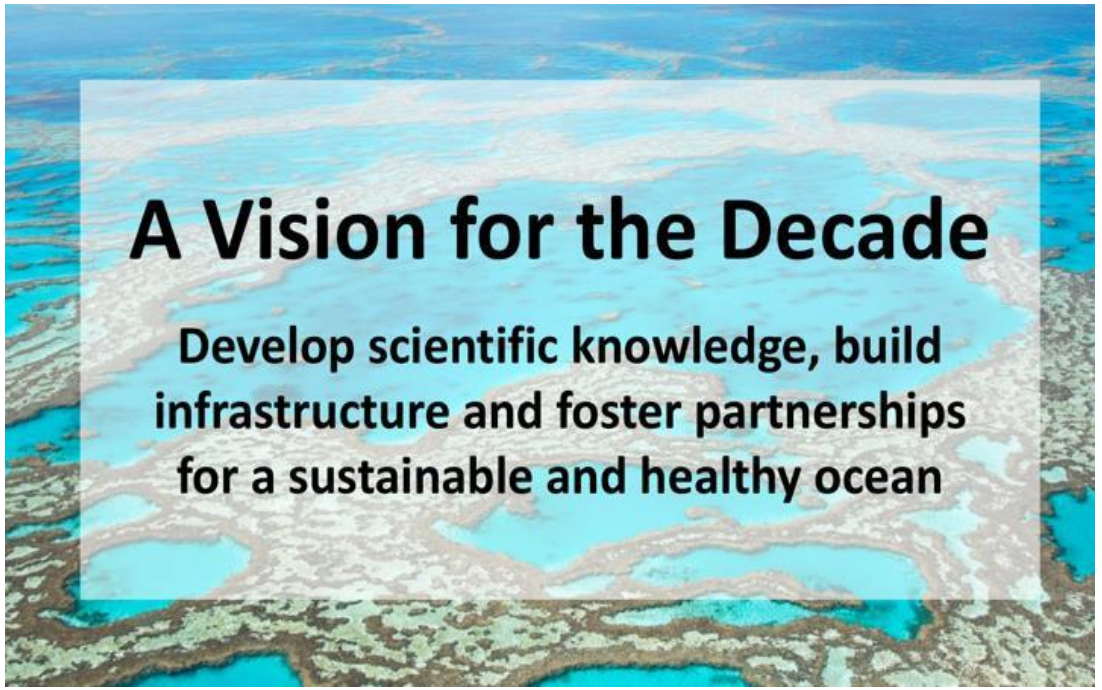
How can we manage and protect what we don't know and understand????

The UN Decade of Ocean Science for Sustainable Development (2021-2030)

CONSERVE AND SUSTAINABLY USE THE OCEANS, SEAS AND MARINE RESOURCES FOR SUSTAINABLE DEVELOPMENT

14 LIFE BELOW WATER

SDG14 will not be achievable without a comprehensive map of the world ocean floor



United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission · Sustainable Development Goals

Research and Development Proposed Priority Areas

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Map the entire ocean floor and processes

Bolster ocean observation systems in all basins

Conduct an inventory of ecosystems and their functioning

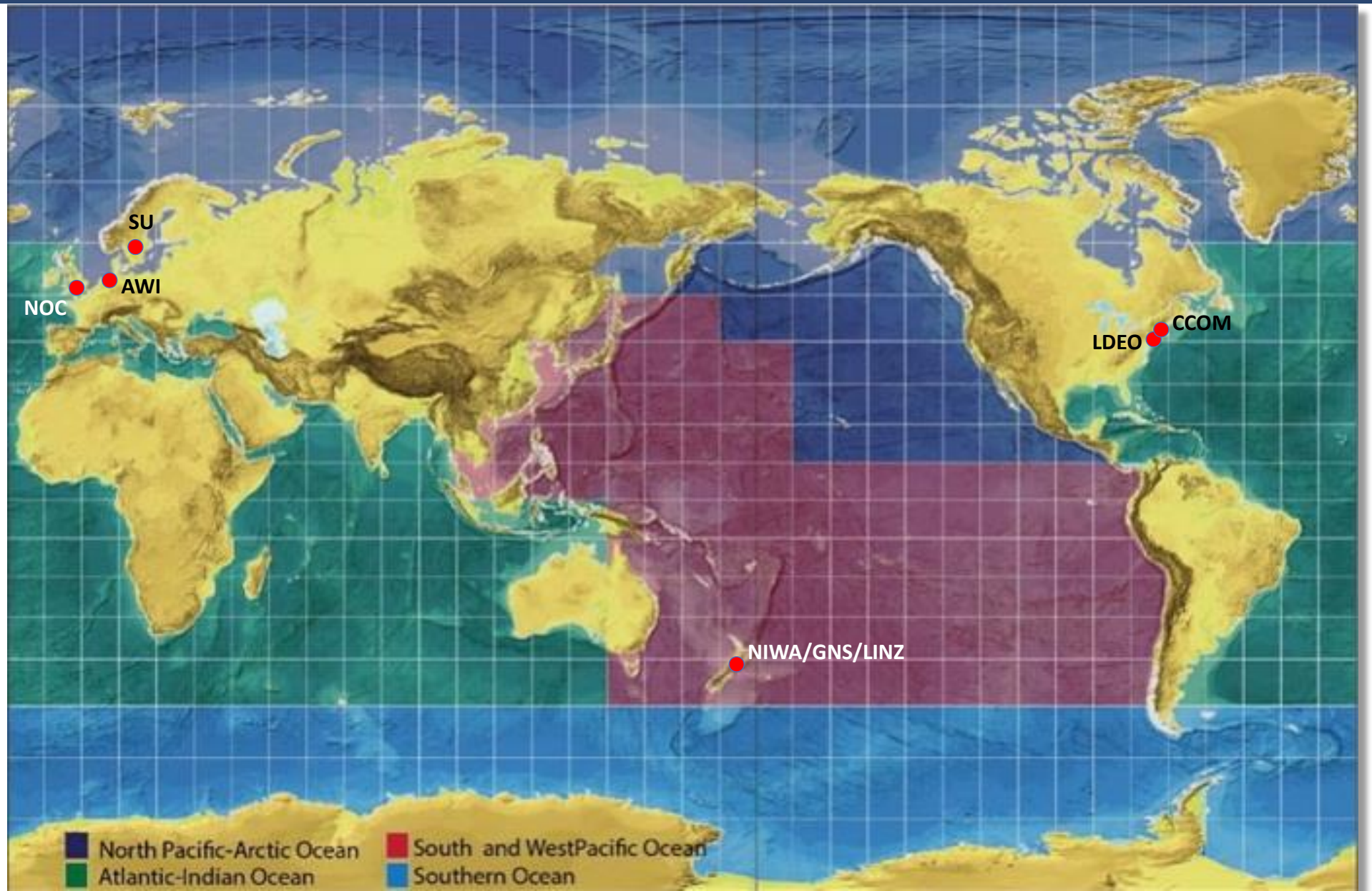
Develop a data and information portal

Establish an integrated multi-hazard warning system

New integrated models for ocean prediction

Strengthen capacities and accelerate technology transfer and ocean literacy

Seabed 2030: Data Centers



Completing the Map

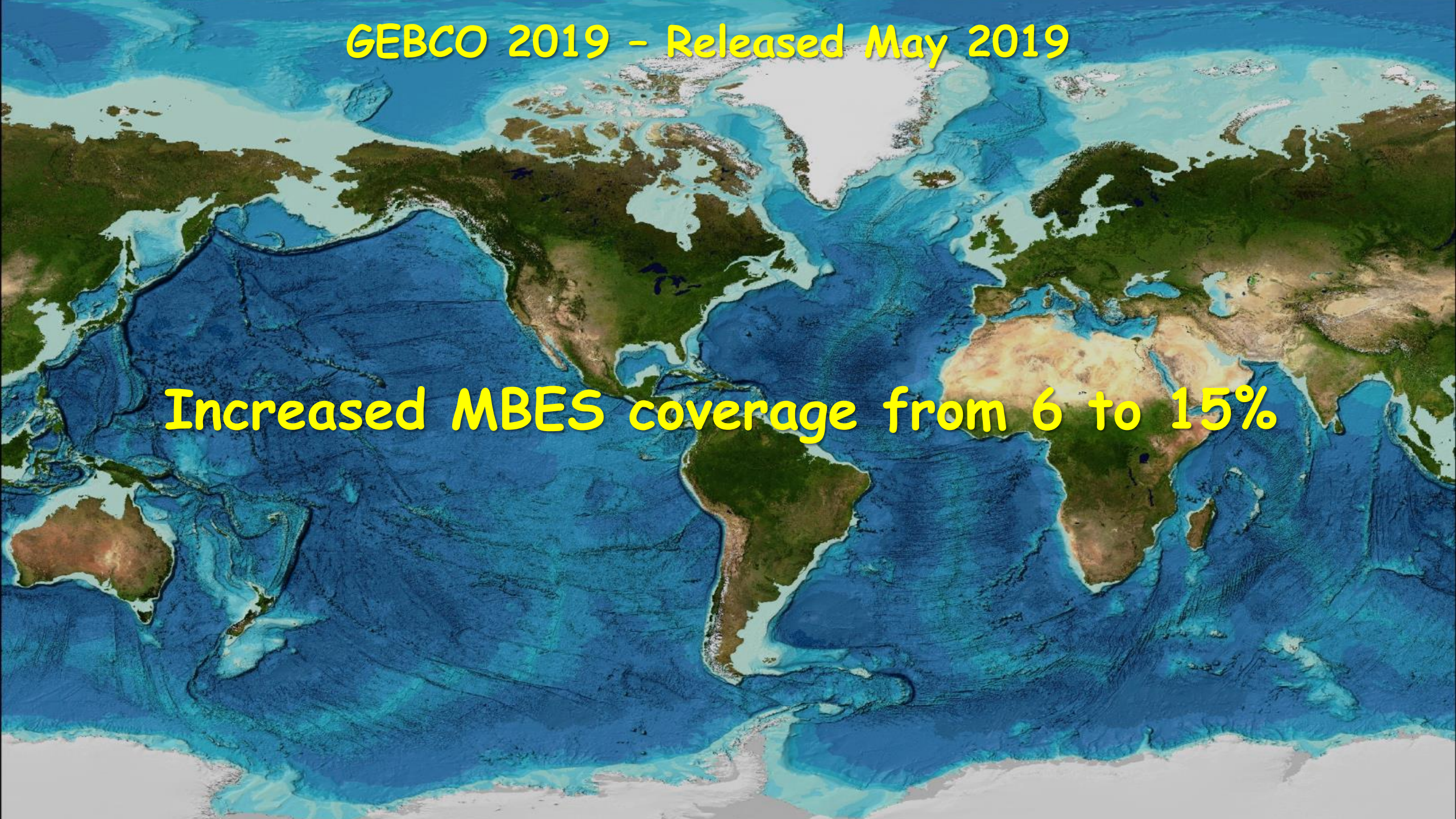
Existing data not yet integrated

- **Gather information about existing data even if embargoed**
- **Facilitate data sharing**

New Data Acquisition

- Identify gaps in coverage
- Inform new acquisition
- Technology innovation
- Accelerate uptake of new technology

$$X + Y + Z = 100\%$$


GEBCO 2019 – Released May 2019
Increased MBES coverage from 6 to 15%

Completing the Map

Existing data not yet integrated

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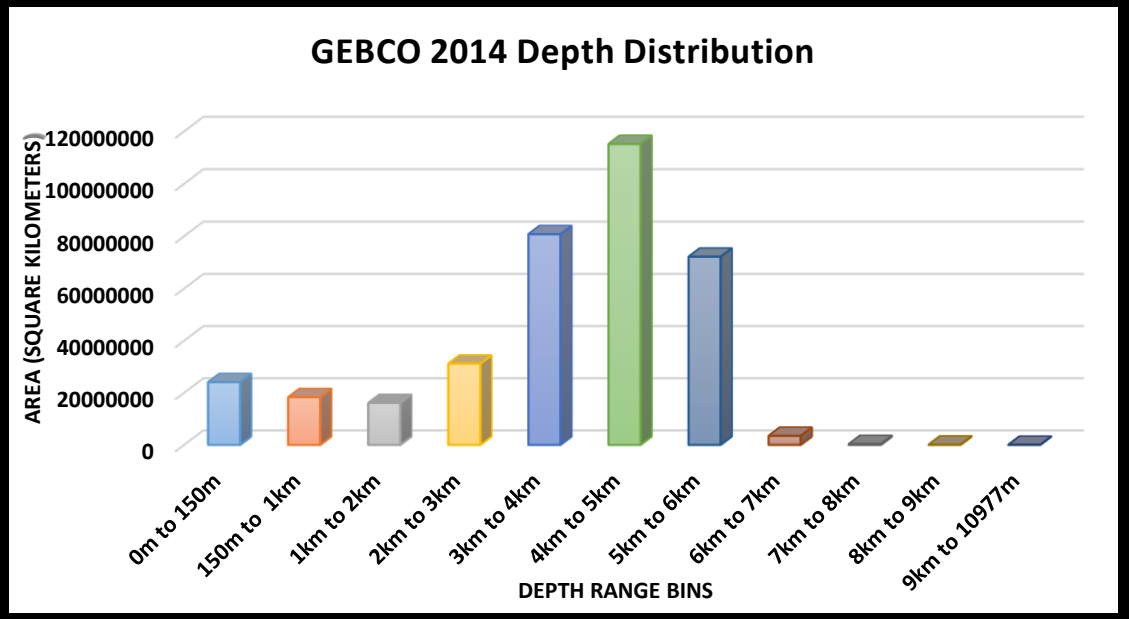
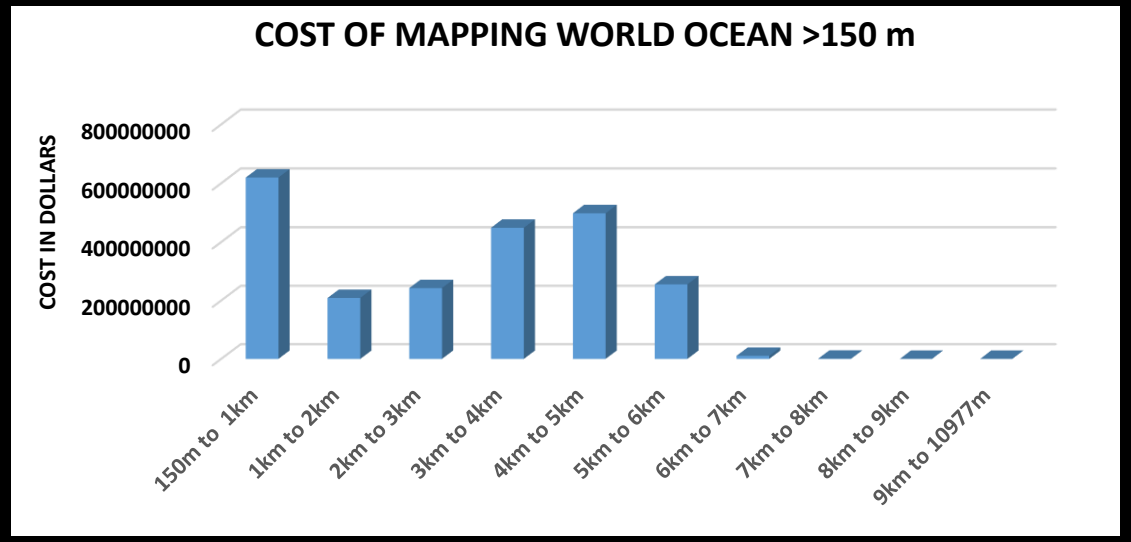
New Data Acquisition

- **Identify gaps in coverage**
- **Inform new acquisition**
- **Technology innovation**
- **Accelerate uptake of new technology**

$$X + Y + Z = 100\%$$

MAPPING THE WORLD OCEAN WITH MBES (94%)





Assuming:

>200 m!

4x swath width

10 knots

Number of Days:

~70,000

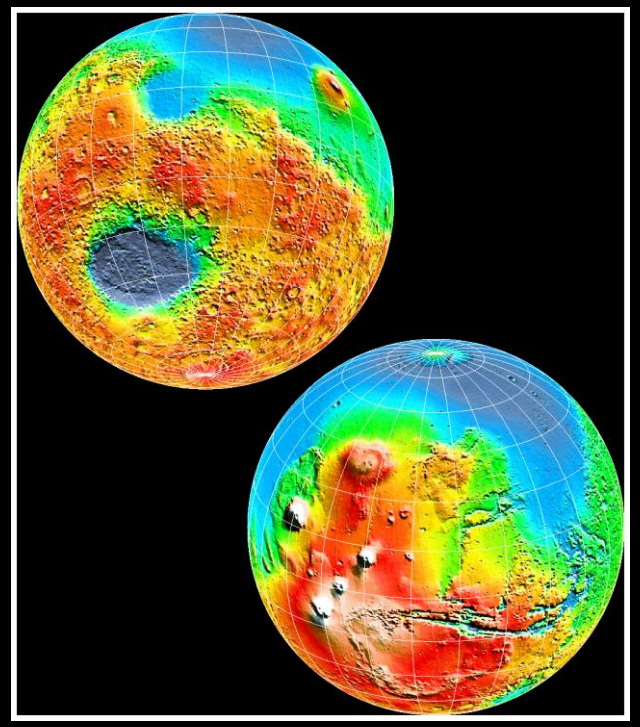
Ship Cost:

$45,000/day

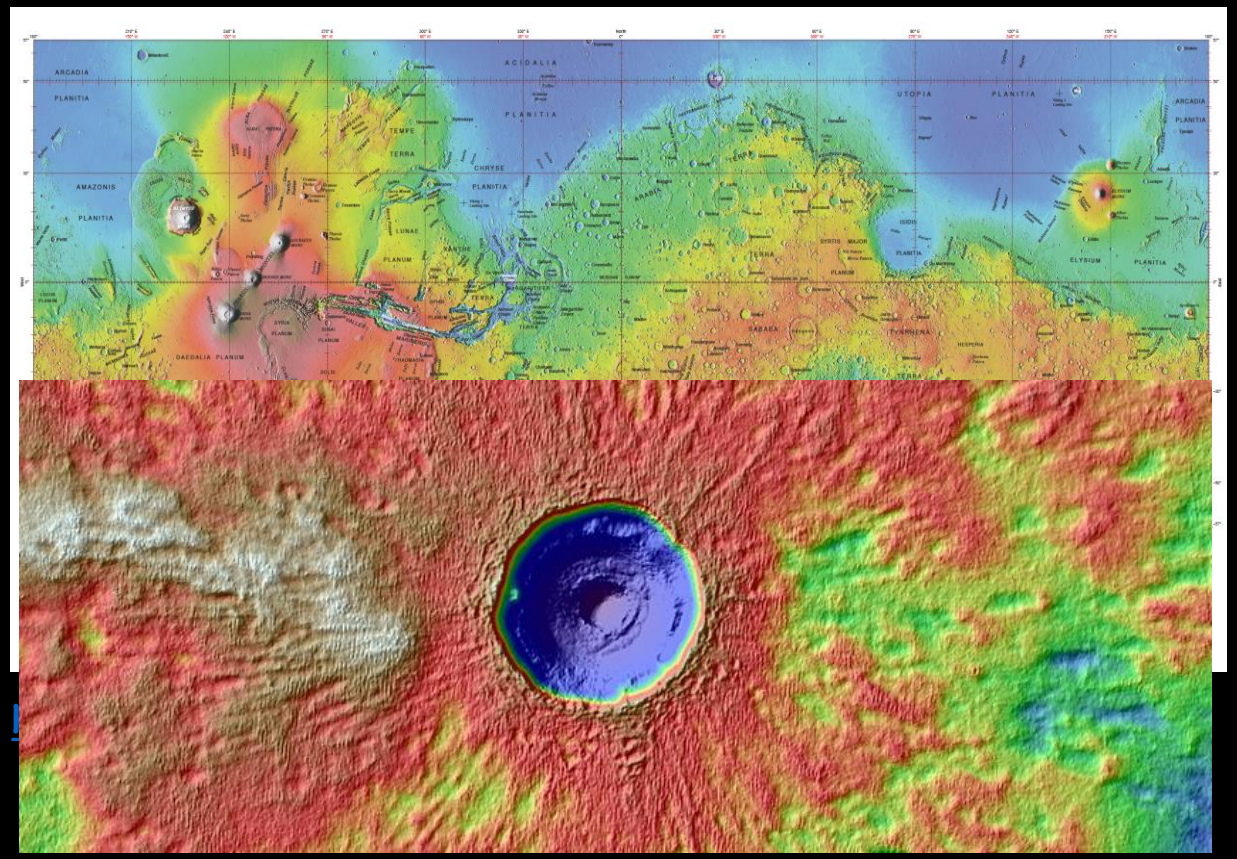
Total Cost:

$3.15 Billion

TOPOGRAPHY OF MARS



http://tharsis.gsfc.nasa.gov/global_paper.html



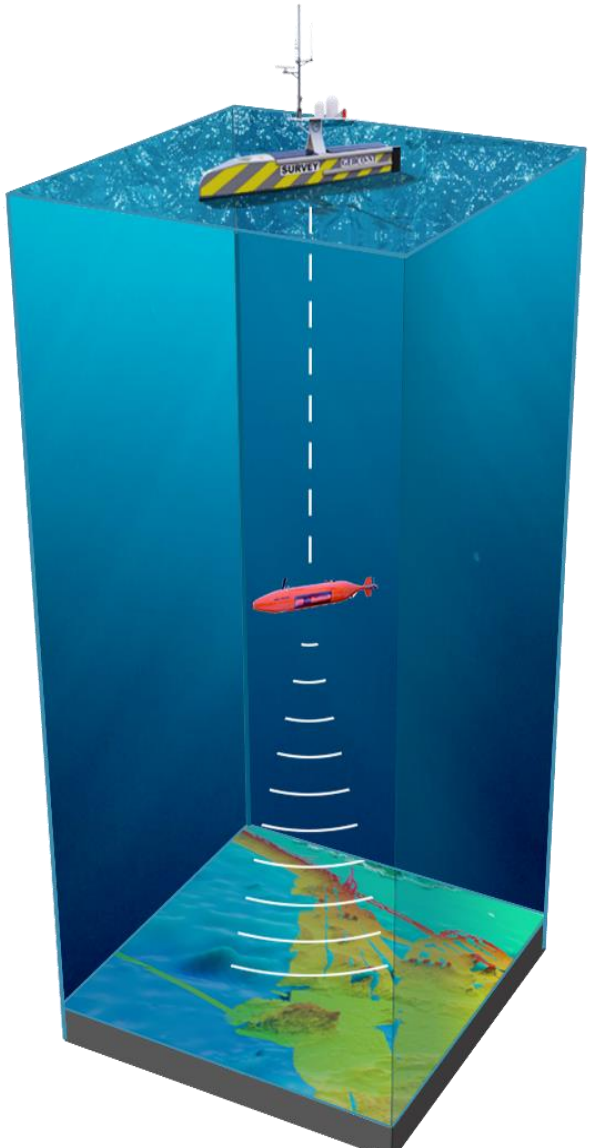
HIRISE Imagery NASA/JPL/UAriz/USGS
http://www.uahirise.org/dtm
1 m DTMs

2-3 B$

Shell OCEAN DISCOVERY XPRIZE®

Getting to the Bottom of Our Ocean.

GEBCO-NF Alumni Team



HUSHCRAFT

New autonomous surface vessel capable of deployment & retrieval of AUV

- Hushcraft Limited SEA-KIT USV *Maxlimer* with KM HiPAP
- Remote and Autonomous operations facilitated by Kongsberg Maritime K-MATE.

Commercially-available Kongsberg Maritime HUGIN AUV

- Round 1: Ocean Floor Geophysics *Chercheur*
  → 3,000 m-rated
- Round 2: Kongsberg Maritime rental
  → 4,500 m-rated

Seafloor bathymetry and imagery

EARTH ANALYTIC esri TELEDYNE CARIS

The information generated is a fusion of USV and AUV multibeams, HISAS real-aperture bathymetry, synthetic aperture side-scan imagery and synthetic aperture imagery and bathymetry.

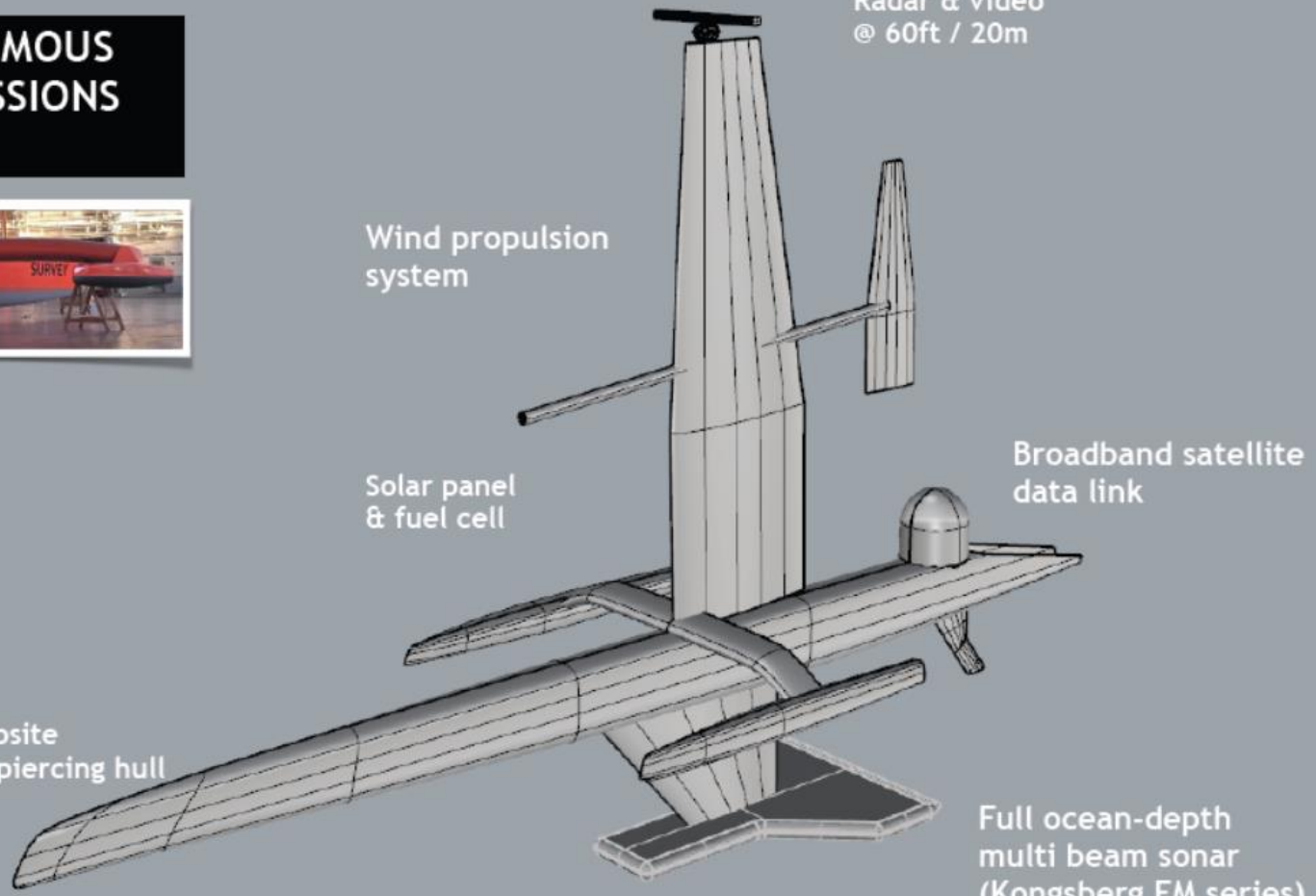
CCOM JHC

UNIVERSITY of NEW HAMPSHIRE

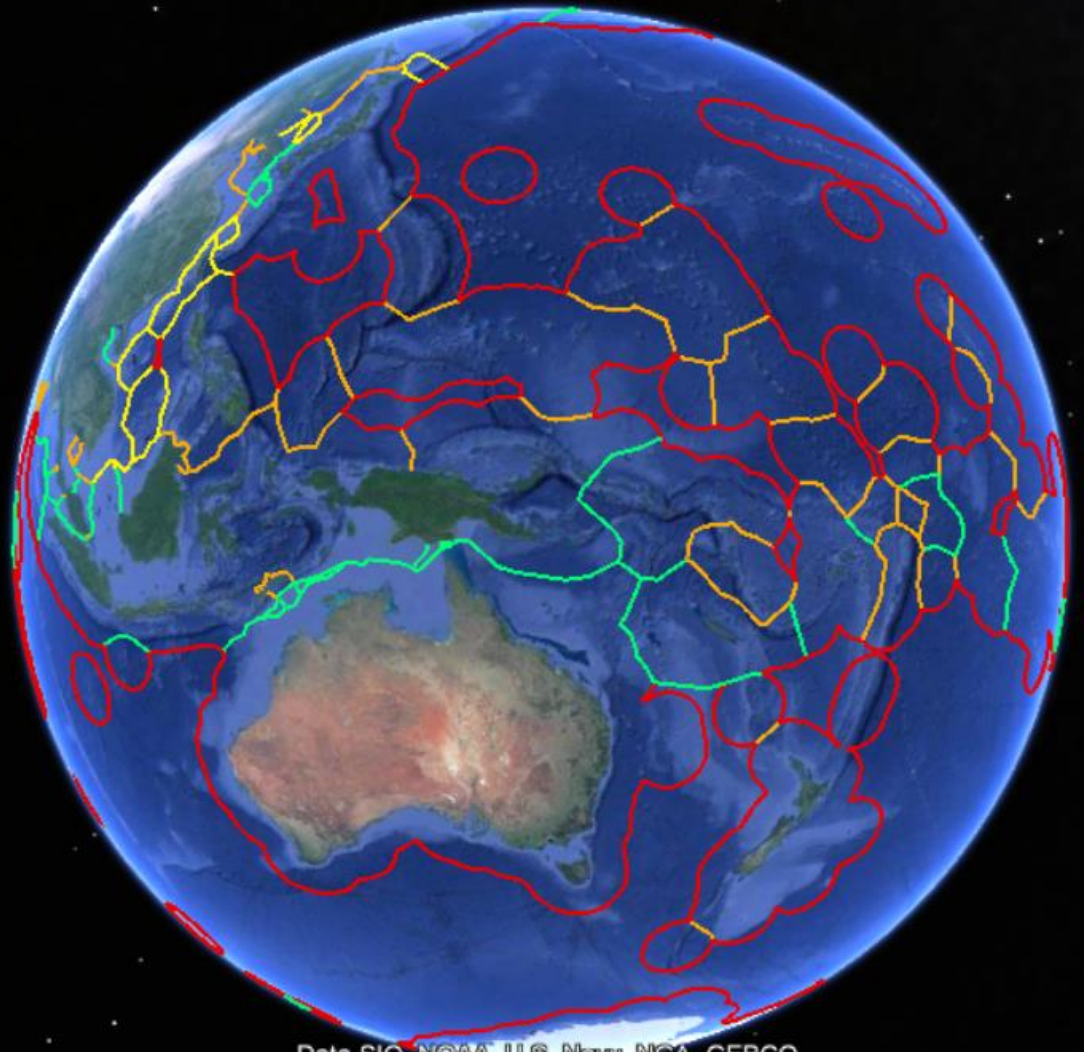
AUTONOMOUS MULTIBEAM SAILDRONE

SAILDRONE MAXI UNMANNED SURFACE VEHICLE (USV)

PLATFORM FOR AUTONOMOUS
OCEAN BATHYMETRY MISSIONS
OF UP TO 12 MONTHS



Challenge: Can we develop a mechanism that allows acquisition of bathymetry in support of SB2030 and SDG14 without the constraint of the MSR regime????



Challenge: Cost…..