

ACNA5001

MAPPING AND MONITORING OF MARINE AND COASTAL ENVIRONMENTS



ALISSA FLATLEY



OUTLINE

1) MAPPING

HOW WE MAP COASTLINES?

MAPPING AND CLASSIFICATIONS

2) MONITORING

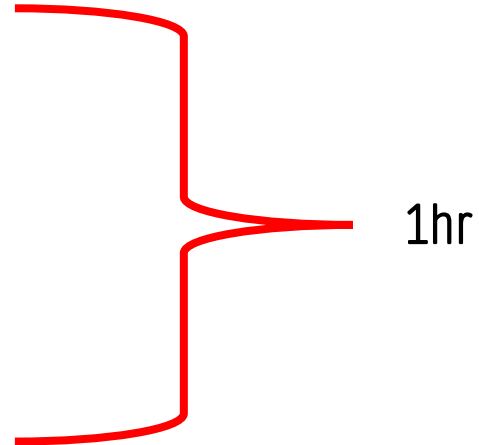
GIS APPROACHES TO COASTAL MONITORING

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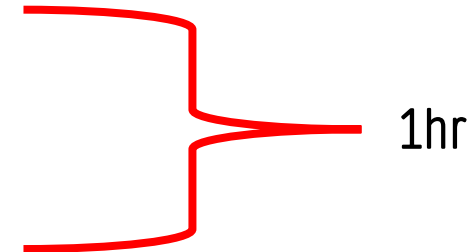
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GIS APPROACHES TO COASTAL MONITORING



WHY MAP COASTLINES?



ECHOSOUNDER

Echosounders are a type of sonar commonly used for a variety of tasks, including navigation, measuring bottom depth, and detecting schools of fish and plankton. Single beam echosounders emit a pulse of sound in a narrow cone (2° - 12°).



- Only 15% of ocean measured by sonar...



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The users of the sonar system, i.e., sailors, fishermen, and marine researchers have adopted the following terms: - a sonar system that transmits vertically is called an “echo-sounder” - a sonar system that transmits horizontally is called a “sonar”

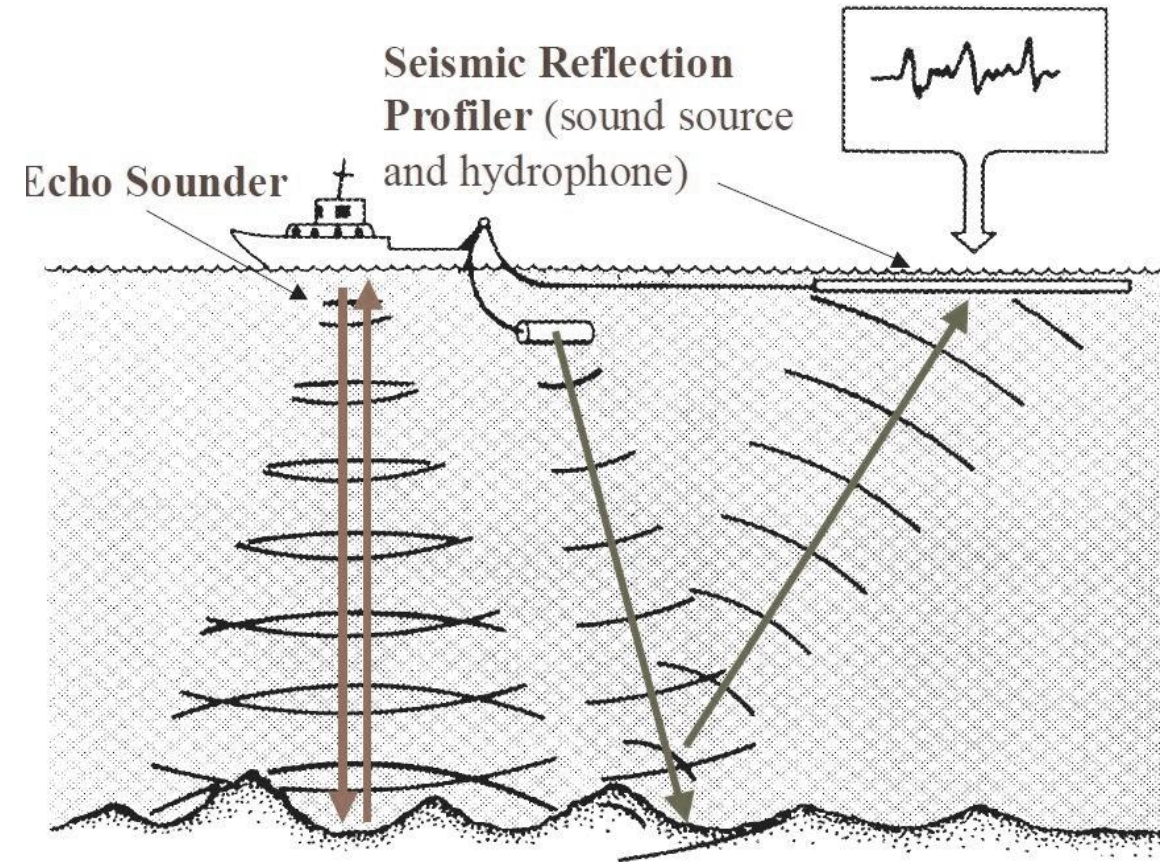


ECHOSOUNDER



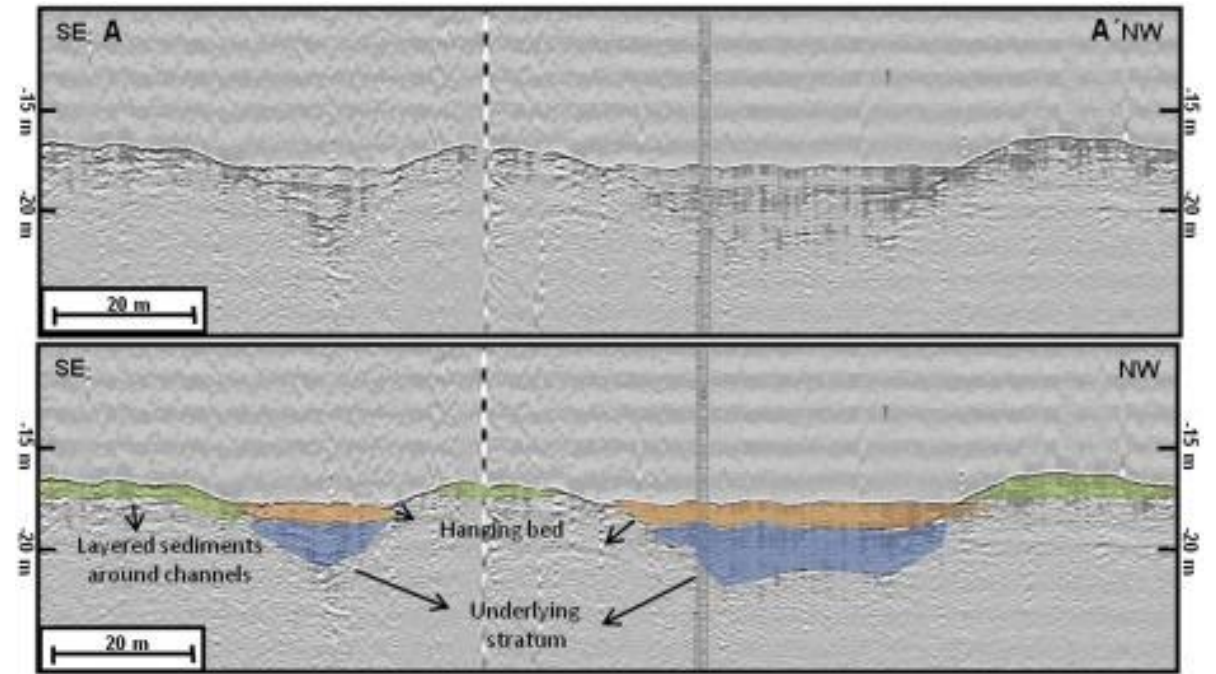
REFLECTION SEISMIC

- The general principle involves sending artificially generated acoustic waves down the water column and into the seafloor, where the different structures and objects within the Earth's crust reflect this energy back according to their acoustic impedance.
- These reflected energy waves are recorded by hydrophones, and the data are processed to produce a visual representation of the seabed sub-surface.



REFLECTION SEISMIC

Reflection-seismic profile acquired with a boomer system showing two sub-surface channels filled with tsunami-laid deposits (blue) and covered by post-tsunami background sediment (orange).



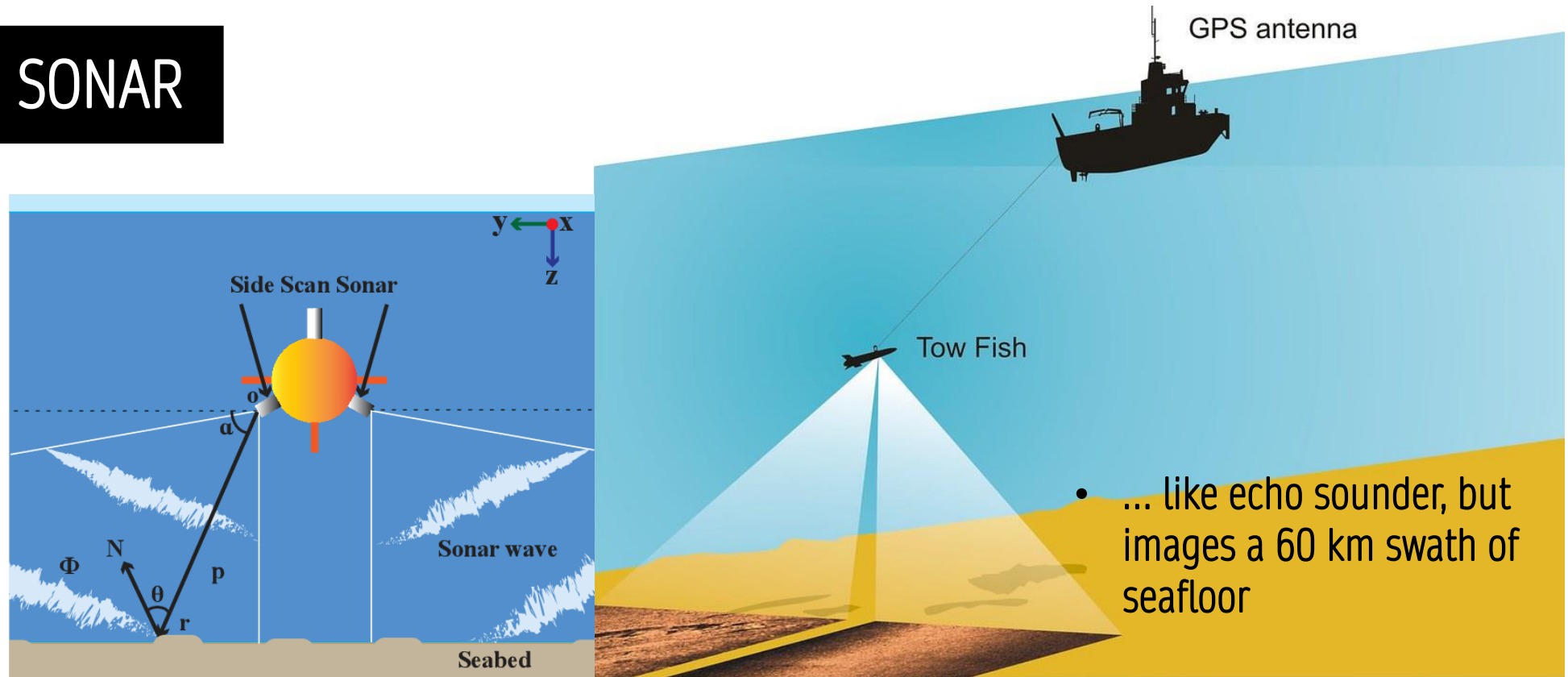
Results from investigations in the Andaman Sea offshore of Khao Lak four years after the 2004 Indian Ocean Tsunami.

[Sidescan Sonar - an overview | ScienceDirect Topics](#)

REFLECTION SEISMIC



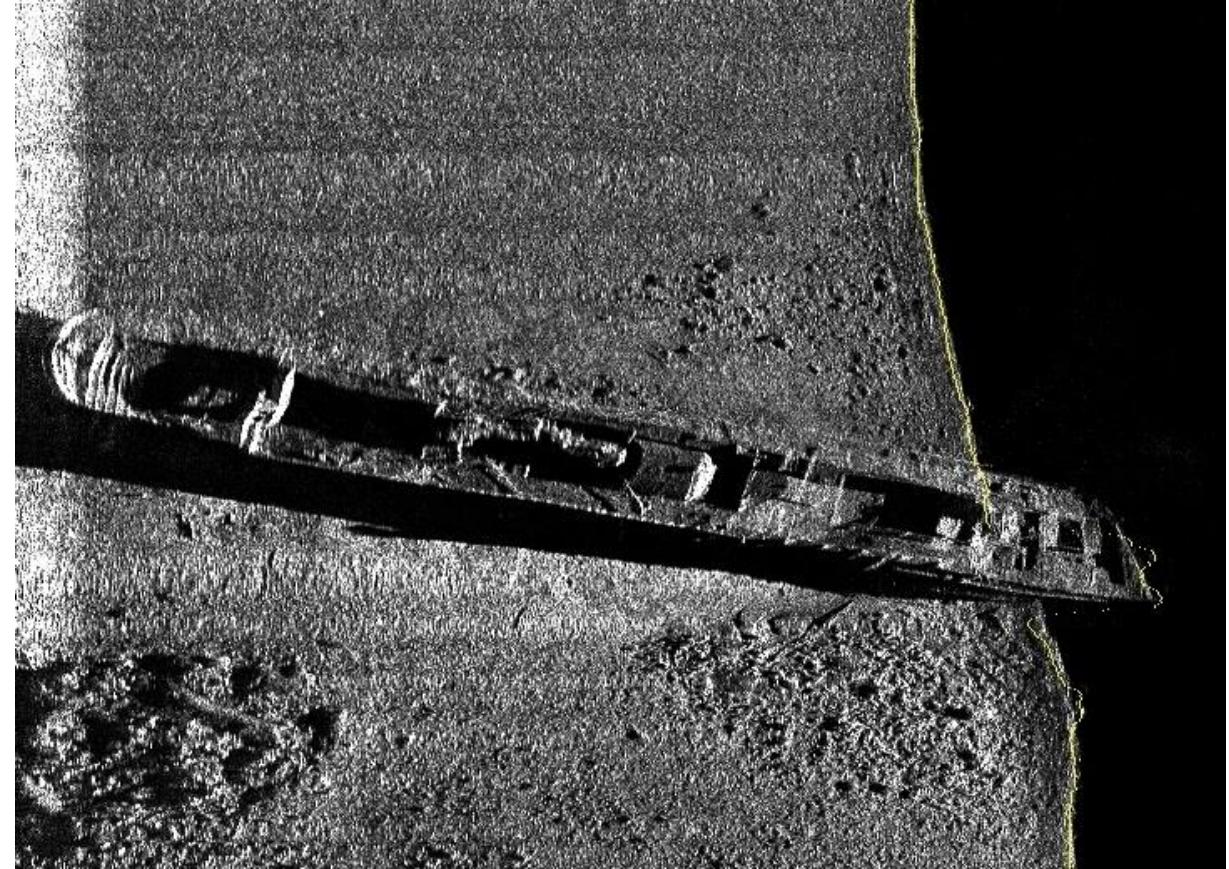
SIDESCAN SONAR



Side-scan sonar is a category of active sonar system for detecting and imaging objects on the seafloor. The multiple physical sensors of the sonar — called a transducer array — send and receive the acoustic pulses that help map the seafloor or detect other objects. This array can be mounted on the ship's hull or placed on another platform like a towfish.

SIDESCAN SONAR

Side-scan sonar is an effective tool for identifying seabed objects or items of debris as it creates an image of the sea floor using sound energy and strength of signal return to cover large areas quickly and cost effectively.



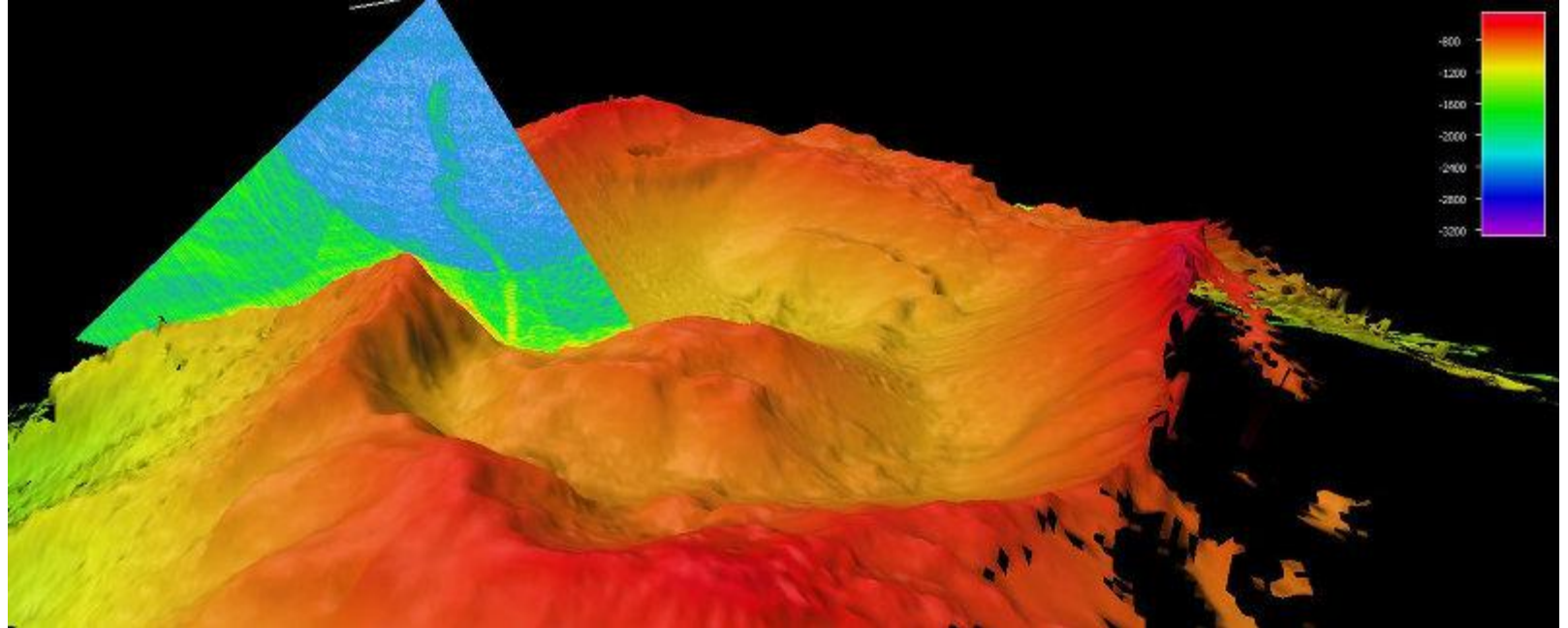
[Side-Scan Sonar – Aspect Land & Hydrographic Surveys \(aspectsurveys.com\)](http://aspectsurveys.com)

MULTIBEAM SONAR

Unlike single-beam sonar, which uses just one transducer to map the seafloor, a multibeam sonar sends out multiple, simultaneous sonar beams (or sound waves) at once in a fan-shaped pattern. This covers the space both directly under the ship and out to each side. Multibeam collects two types of data: seafloor depth and backscatter.

[Echosounders – Discovery of Sound in the Sea \(dosits.org\)](http://dosits.org)

[Exploration Tools: Multibeam Sonar: NOAA Office of Ocean Exploration and Research](#)

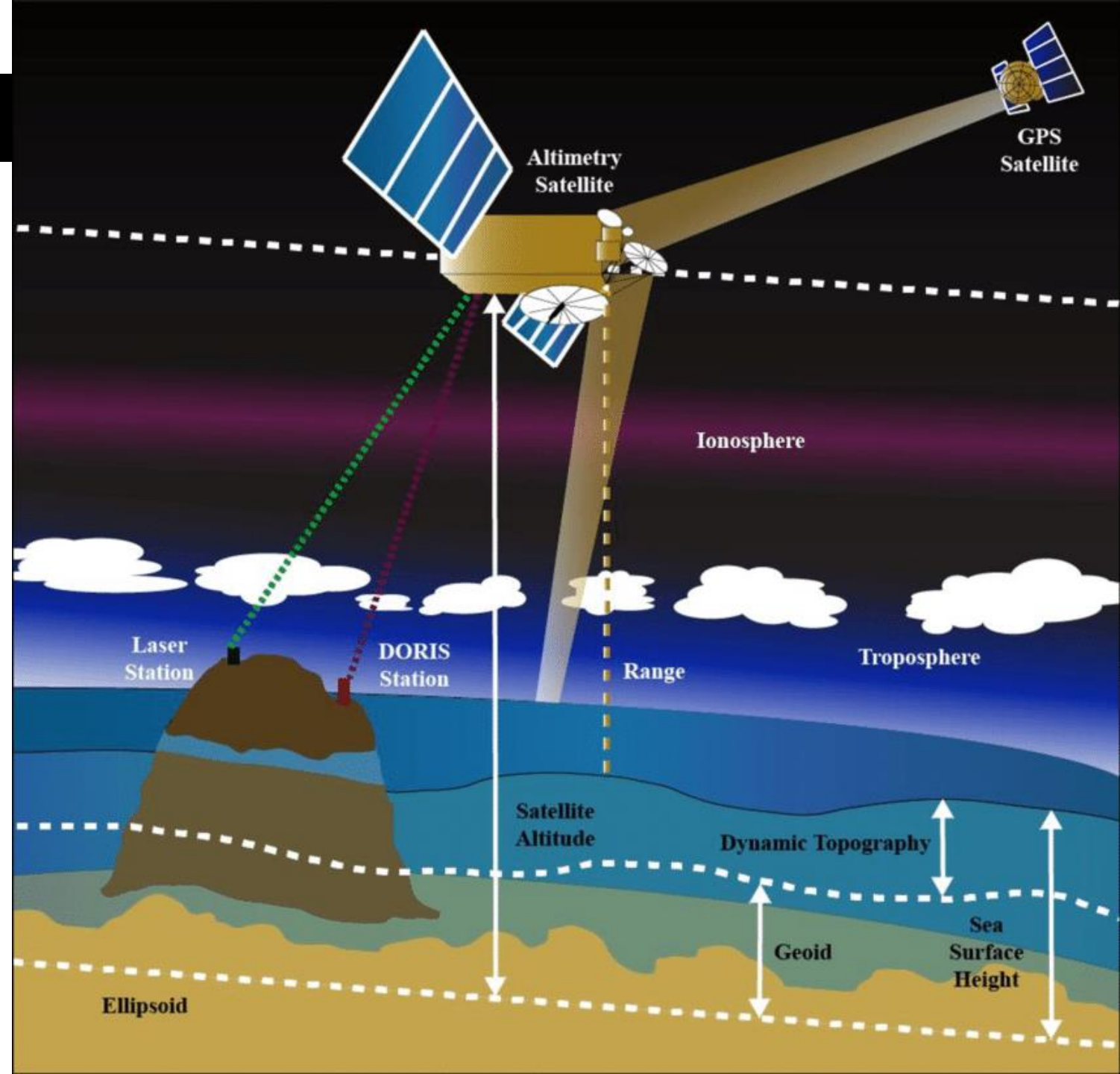


MULTIBEAM SONAR

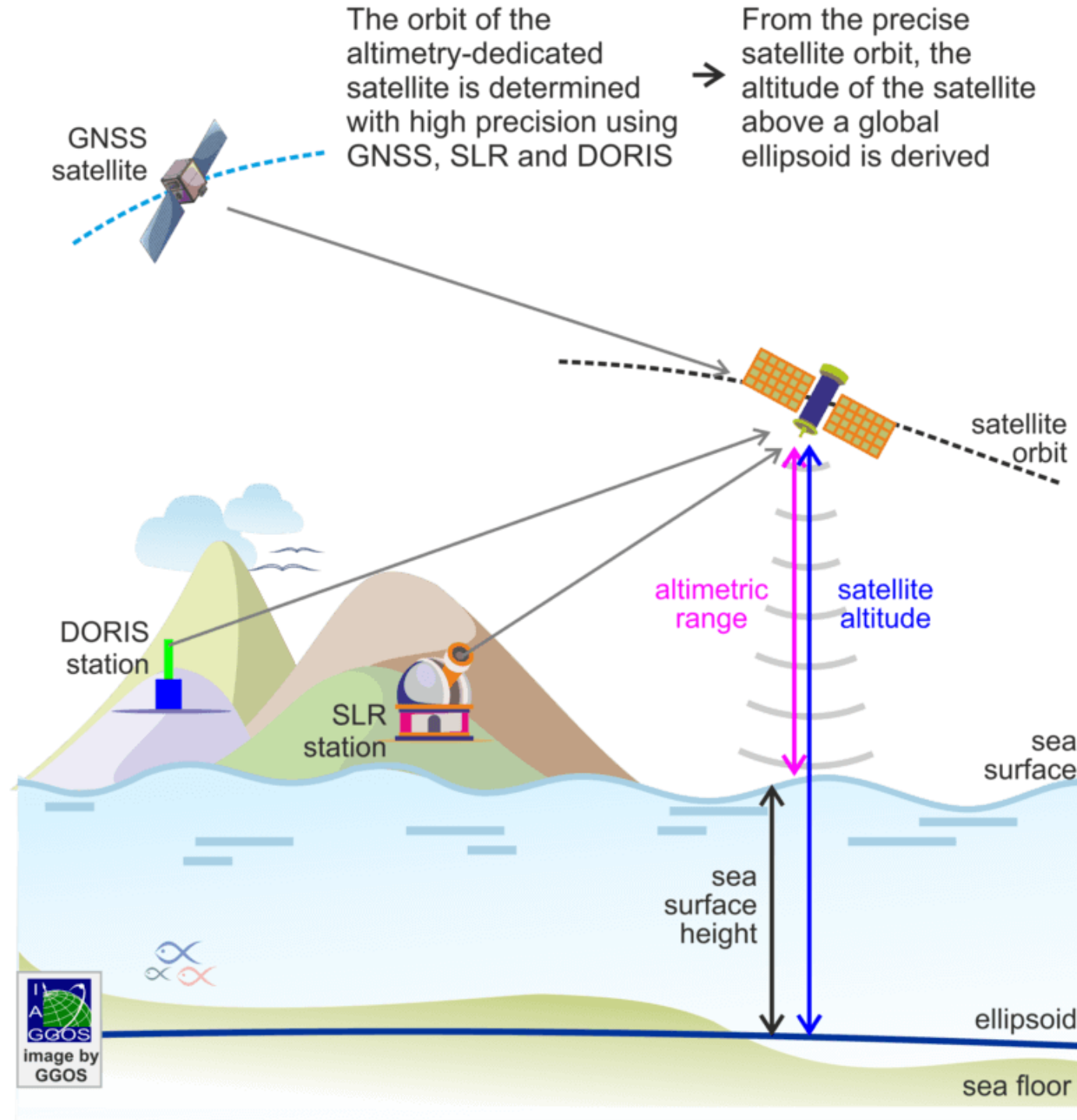


SATELLITE ALTIMETRY

Satellite radar altimeters measure the ocean surface height (sea level) by measuring the time it takes a radar pulse to make a round-trip from the satellite to the sea surface and back.



SATELLITE ALTIMETRY



The orbit of the altimetry-dedicated satellite is determined with high precision using GNSS, SLR and DORIS

From the precise satellite orbit, the altitude of the satellite above a global ellipsoid is derived

A radar altimeter on-board the satellite permanently transmits signals to Earth and receives the return signals after reflection at Earth's surface

The primary measurement is the time taken by the radar pulse to travel from the satellite antenna to the surface and back to the satellite receiver

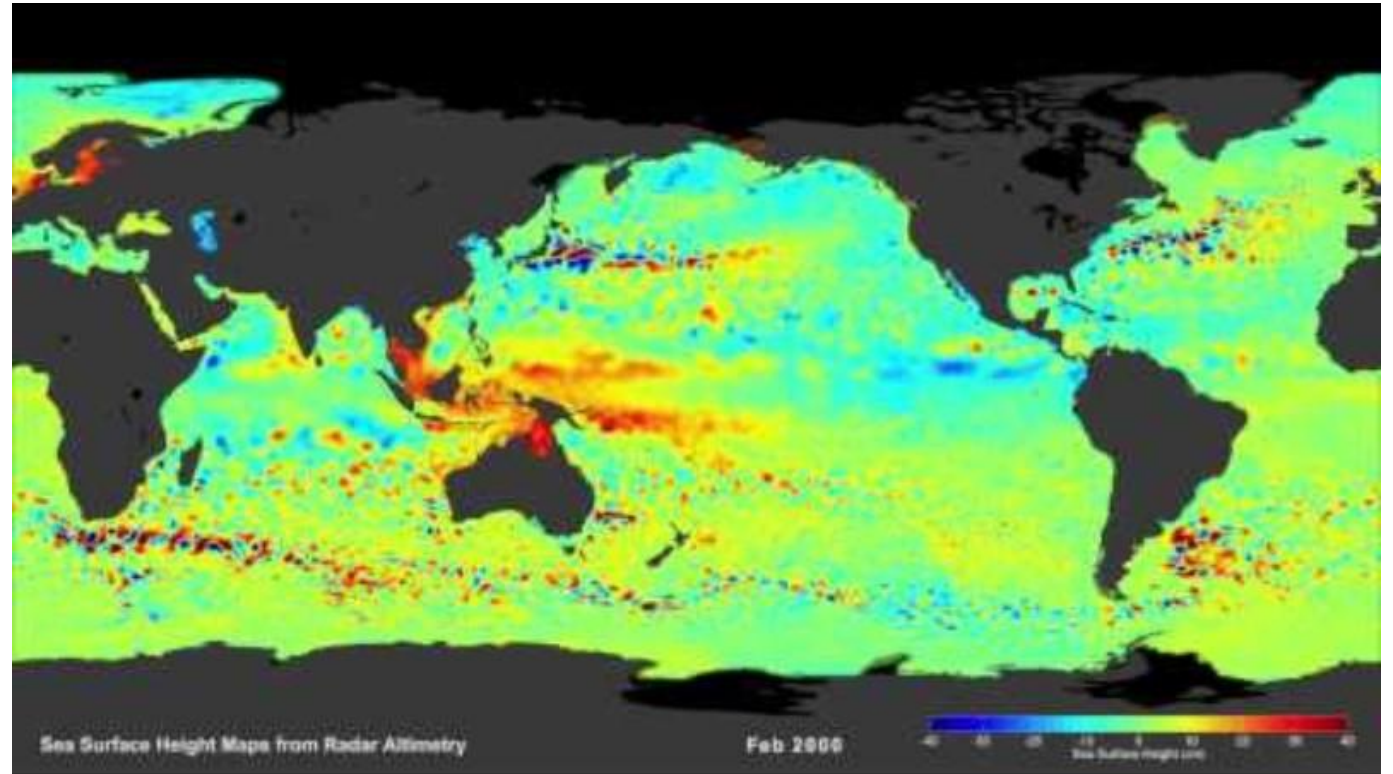
The range, or distance between the satellite and Earth's surface is approximately equal to one-half of the two-way travel time multiplied by the speed of light

The difference between the satellite altitude and the altimetric range provides the surface height with respect to the same ellipsoid

SATELLITE ALTIMETRY

Swirling currents called eddies pepper the global ocean. Like small pock-marks in sea surface height, these eddies are found in every major ocean basin.

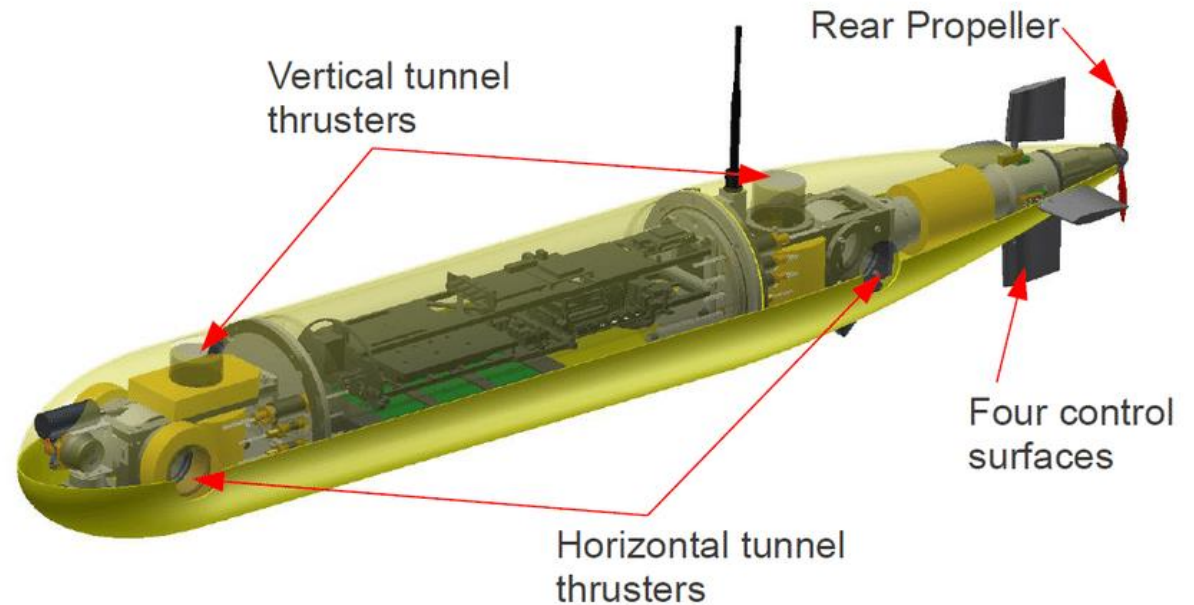
Near the Equator, the eddies give way to fast moving features called Kelvin Waves. When they build up in the Pacific, these waves can usher in a phenomenon known as El Nino, which happens when warm water and high sea levels move into the Eastern Pacific along the Equator.



NASA/JPL

ROV and AUVs

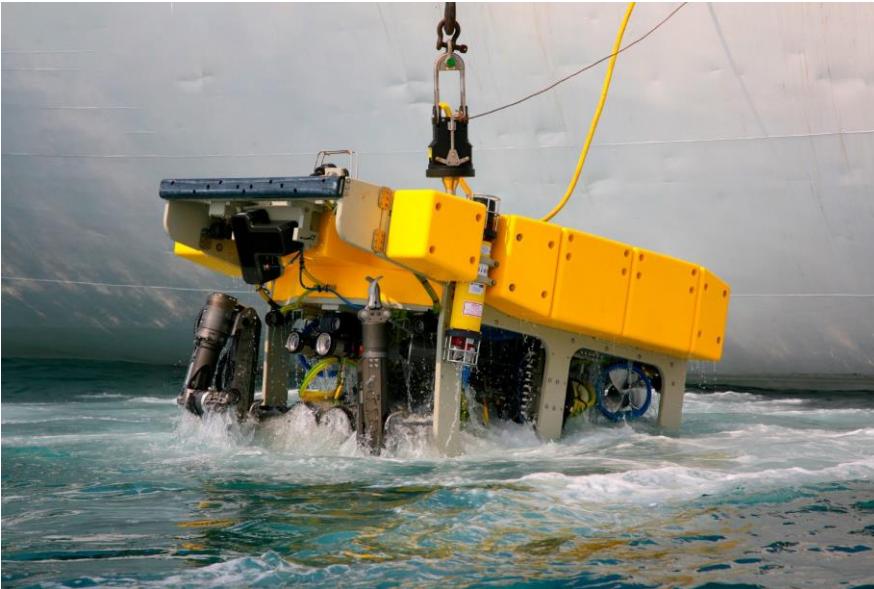
An AUV conducts its survey mission without operator intervention. When a mission is complete, the AUV will return to a pre-programmed location where the data can be downloaded and processed.



A remotely operated vehicle (ROV) is an unoccupied underwater robot that is connected to a ship by a series of cables.

ROV and AUVs

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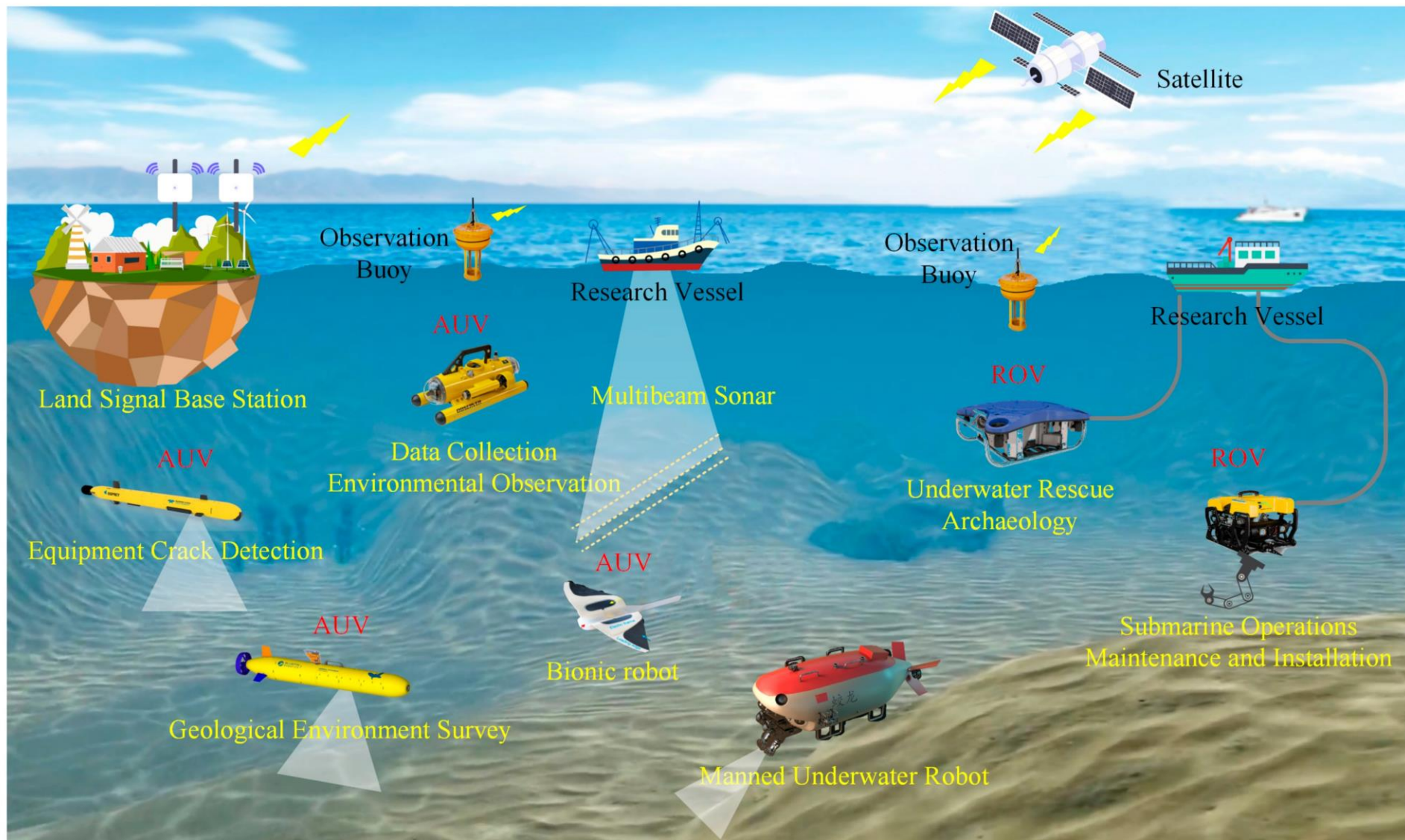


<https://youtu.be/IKEfGwILrY>



A remotely operated vehicle (ROV) is an unoccupied underwater robot that is connected to a ship by a series of cables.

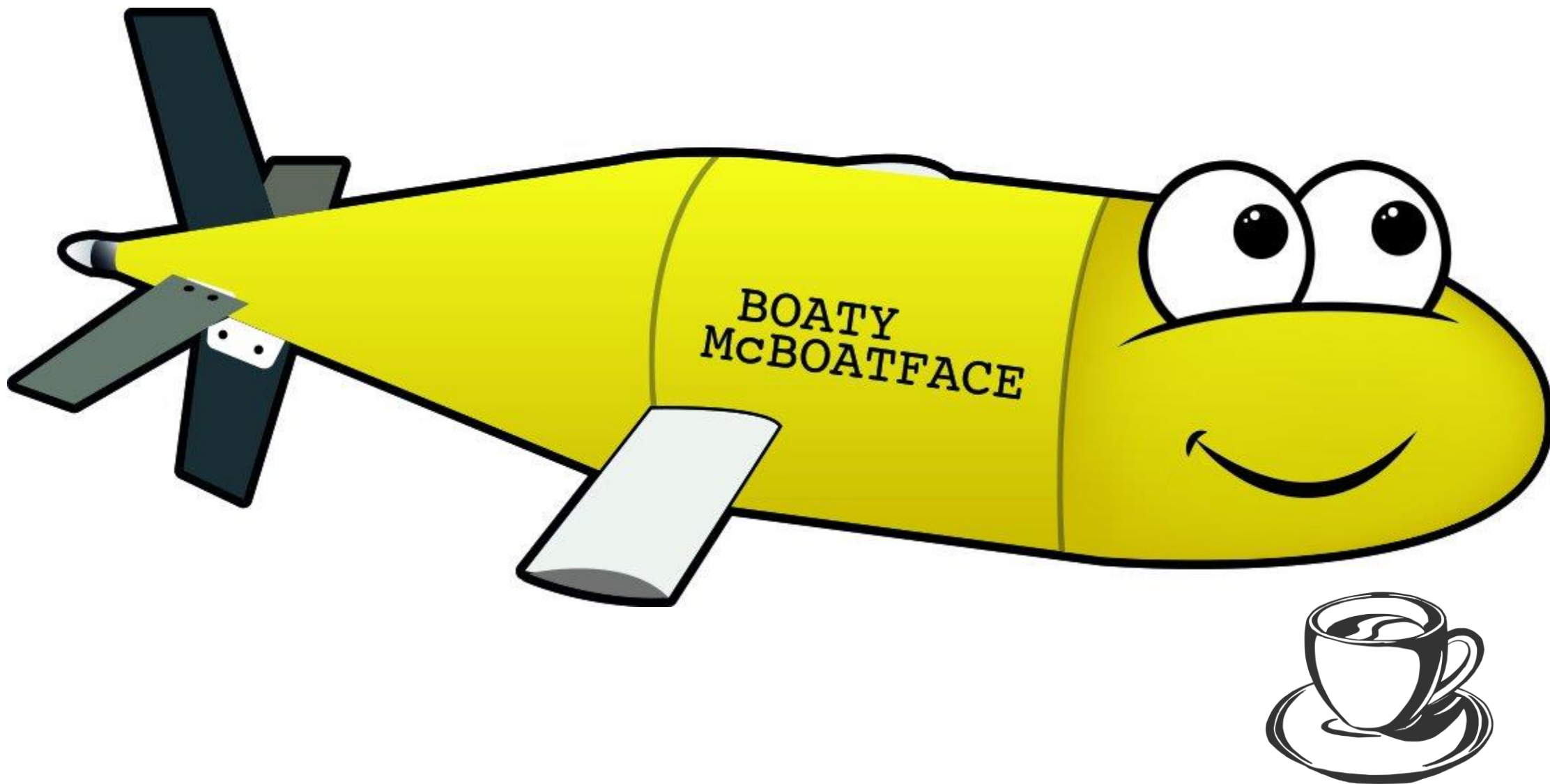
HOW WE MAP THE MARINE ENVIRONMENT



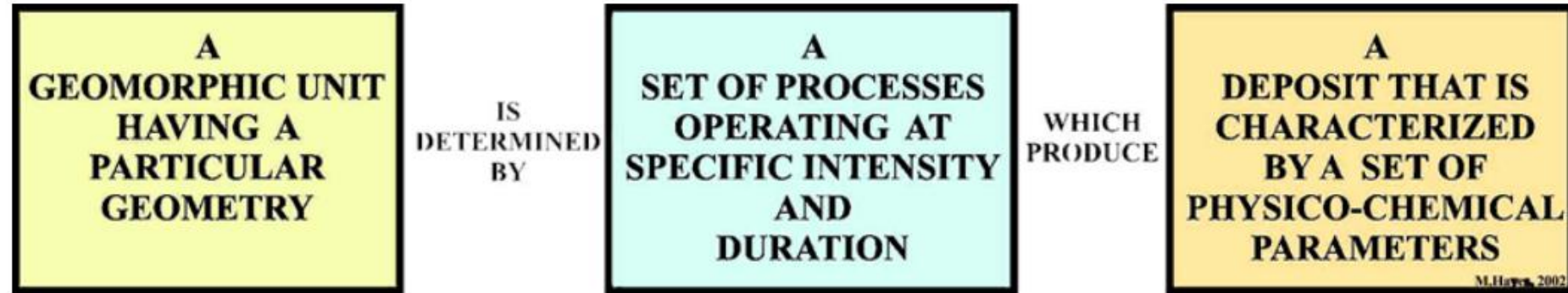
WHAT ABOUT THE COAST?

- Topographic beach profiles
- Dune toe surveys
- Cliff edge surveys
- Laser scans
- Bathymetry
- Wave and tidal data
- Coastal defence inspections
- Aerial photography
- Light Detection and Ranging LiDAR

TAKE A BREAK



COASTAL CLASSIFICATION SYSTEMS



[\(1\) \(PDF\) Field Seminar Guidebook - Environments of Sand Deposition within a Wave-Dominated Delta and Estuary, Nayarit, Mexico \(researchgate.net\)](#)

COASTAL CLASSIFICATION SYSTEMS

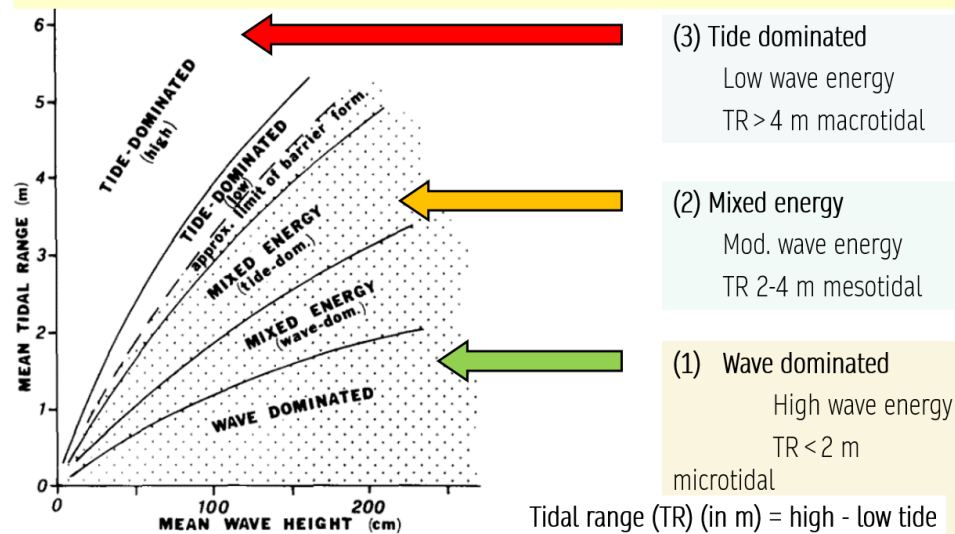


COASTAL CLASSIFICATION SYSTEMS

LARGE SCALE COASTAL CONTROLS

Summary: What shapes coastlines?

(1) Sea level; (2) tectonic setting; and (3) relative wave vs tide energy



TECTONIC SETTING
SEA LEVEL
PROCESS
DOMINANCE

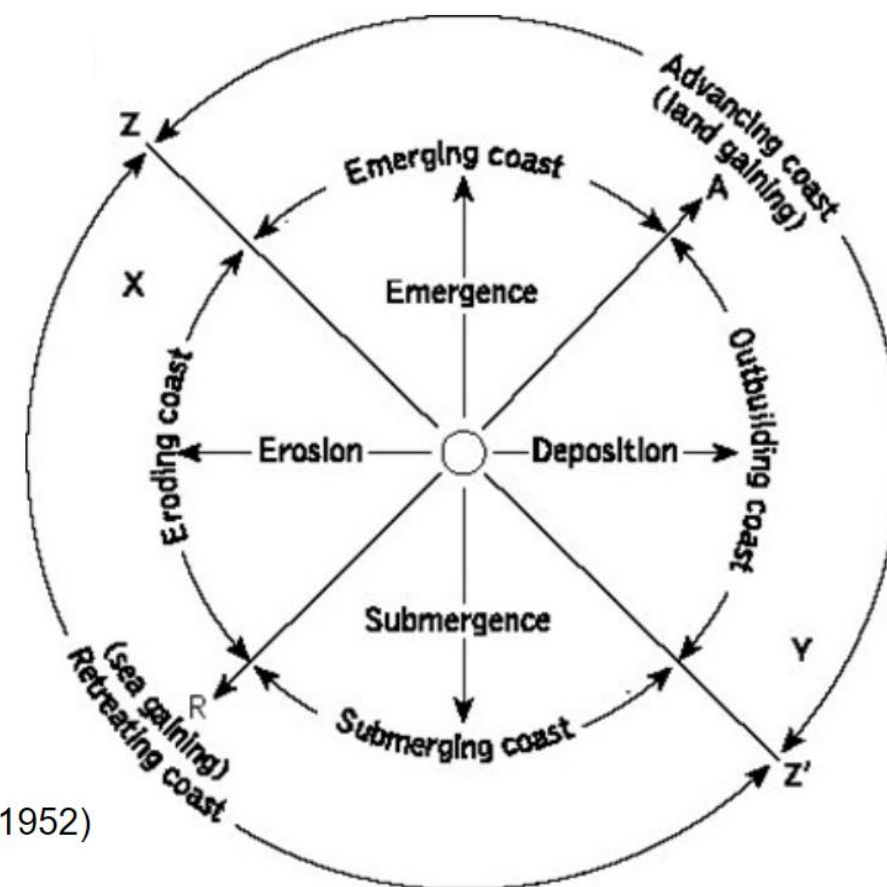
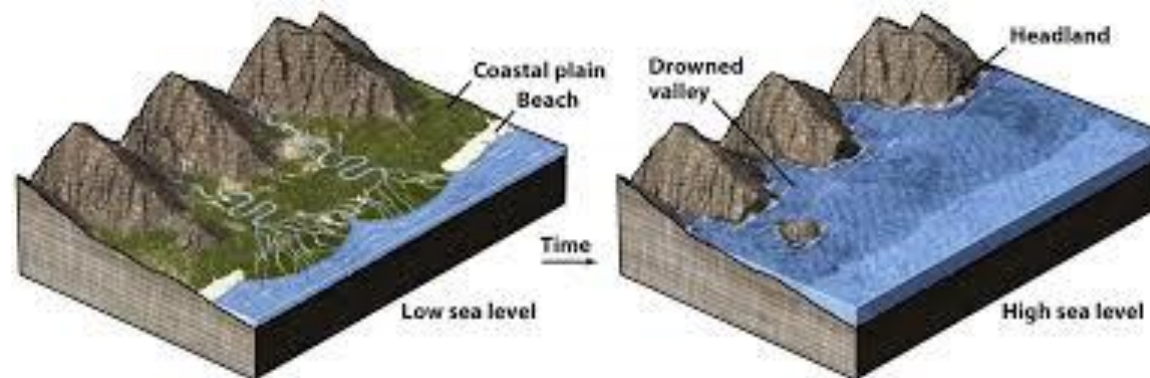
COASTAL CLASSIFICATION SYSTEMS

- Most have grouped coastal areas into classes that have similar features because of having developed in similar geological and environmental settings.



EARLY CLASSIFICATION

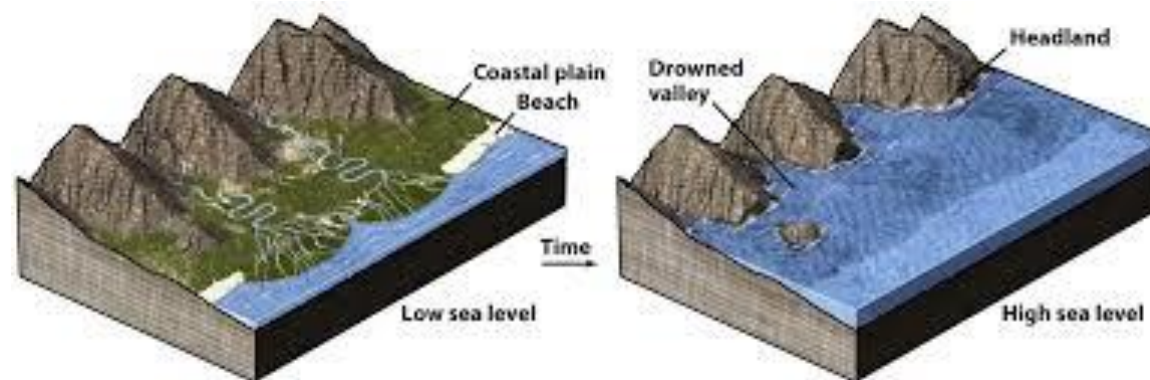
- Many early geologists took a genetic approach to classification and distinguished whether the coast had been primarily affected by rising sea level (submergence), falling sea level (emergence), or both (compound coasts) (Dana 1849; Davis 1896a; Gulliver 1899; Johnson 1919; Suess 1888; Valentin, 1952).



Valentin (1952)

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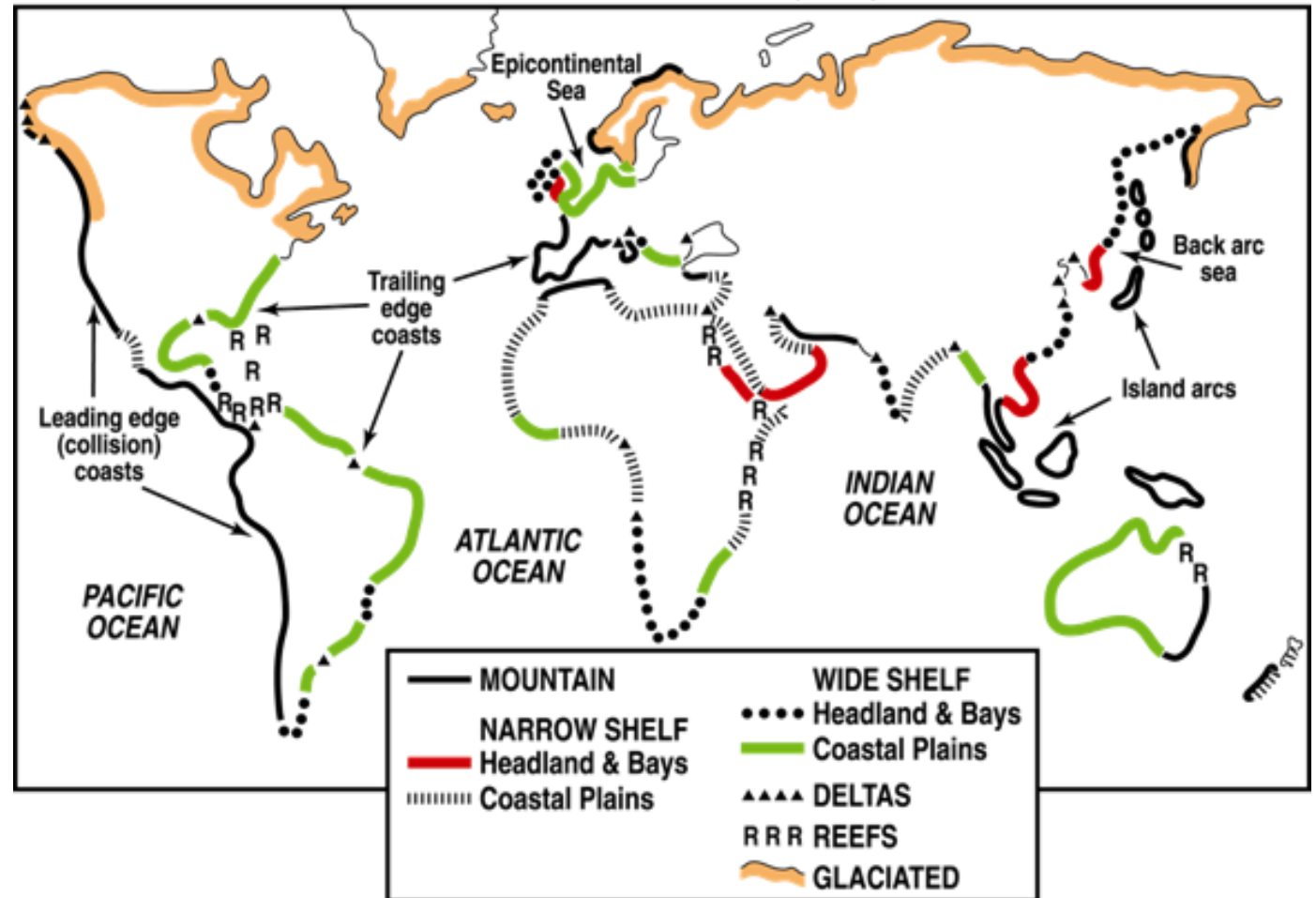


Coastal Classification of Valentin(1952)

COASTS THAT HAVE ADVANCED		
EMERGED COASTS		<i>sea floor coast</i>
PROGRADED COASTS		
shaped organically		
phytogenetic		<i>mangrove coast</i>
zoogenic		<i>coral coast</i>
shaped inorganically		
by marine deposition		
weak tidal action		<i>lagoon-barrier</i>
strong tidal action		<i>tide-flat</i>
by fluvial deposition		<i>delta coast</i>
COASTS THAT HAVE RETREATED		
SUBMERGED COASTS		
shaped glacially		
erosional		
confined glacial erosion		<i>fjord-skerry coast</i>
unconfined glacial erosion		<i>fjord-skerry coast</i>
depositional		<i>fjorden coasts</i>
shaped fluvially		
alpine folding		<i>cala, canale</i>
old folding		<i>ria coasts</i>
flat bedding		<i>embayed plateau</i>
RETROGRADED COASTS		<i>cliffed coasts</i>

Inman and Nordstrom (1971)

Considered continental margins and devised a classification based on tectonic framework.



Shepherd (1973)

- Possibly the most widely used coastal classification scheme is the one introduced by Shepard in 1937 and modified in later years (1973).
- It divides the world's coasts into **primary** coasts formed mostly by **non-marine agents** and **secondary coasts** - shaped primarily by **marine** processes. Further subdivisions occur according to which specific agent, terrestrial or marine, had the greatest influence on coastal development.

Primary Coasts

- Land Erosion Coasts
- Subaerial Deposition Coasts
- Volcanic Coasts
- Shaped by Diastrophic Movements
- Ice Coasts

Secondary Coasts

- Marine Deposition Coasts
- Coasts built by organisms

Shepherd (1973)

- The advantage of Shepard's classification is that it is more detailed than others, allowing most of the world's coasts to be incorporated.
- Although gradational shore types exist, which are difficult to classify, most coasts show only one dominant influence as the cause of their major characteristics.

Readings for you!

- Whitfield and Elliot (2011)
- [Ecosystem and Biotic Classifications of Estuaries and Coasts \(uwtsd.ac.uk\)](http://uwtsd.ac.uk)
- Thom et al (2018)
- [National sediment compartment framework for Australian coastal management \(uwtsd.ac.uk\)](http://uwtsd.ac.uk)

1.07 Ecosystem and Biotic Classifications of Estuaries and Coasts

A Whitfield, South African Institute for Aquatic Biodiversity (SAIAB), Grahamstown, South Africa
M Elliott, Institute of Estuarine and Coastal Studies (IECS), University of Hull, Hull, UK

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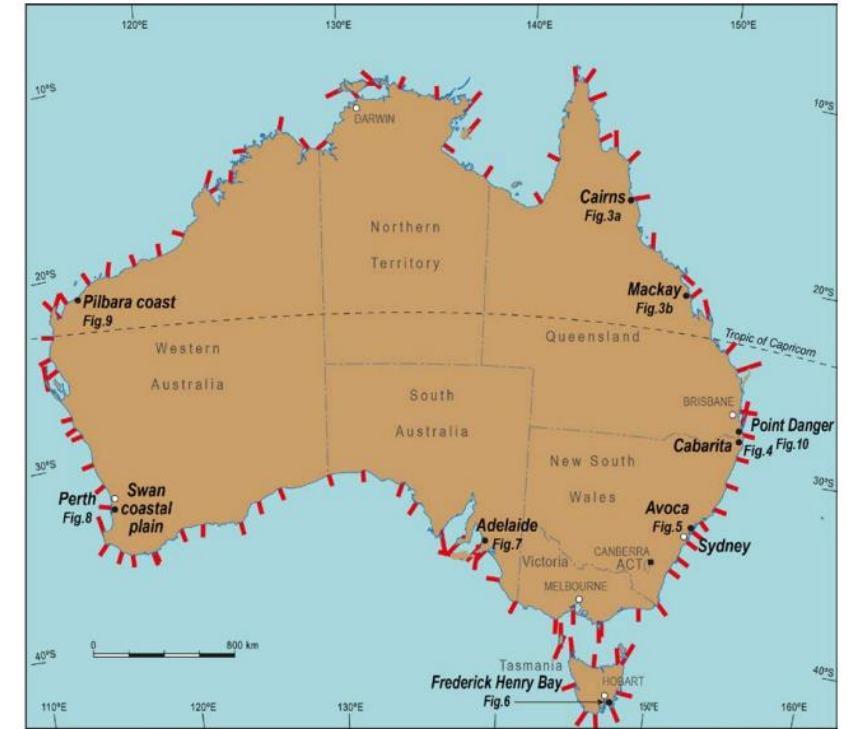
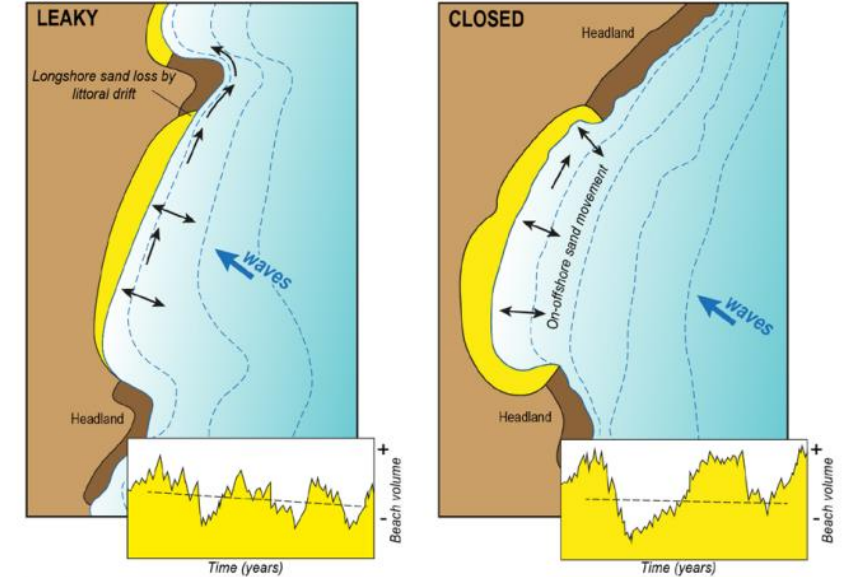


Fig 1



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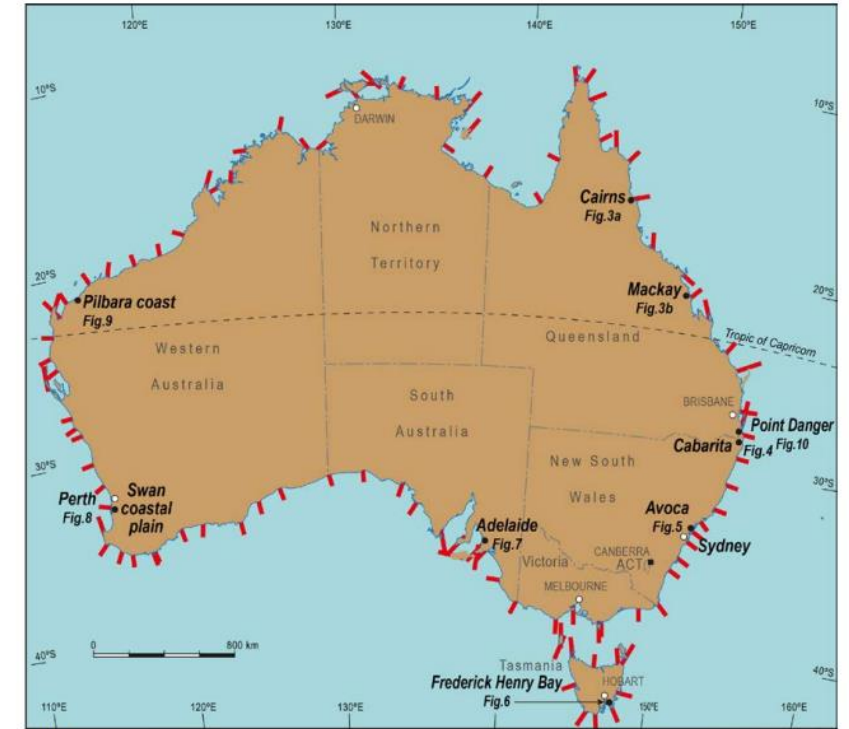
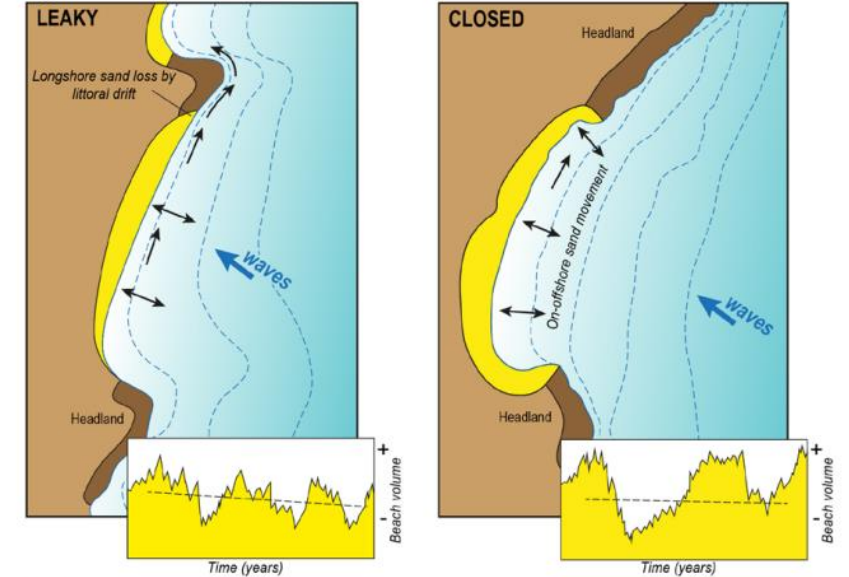


Fig 1



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- Cotton (1954)
- [Deductive Morphology and Genetic Classification of Coasts \(uwtsd.ac.uk\)](http://uwtsd.ac.uk)

- Finkl (2004)
- [Coastal Classification: Systematic Approaches to Consider in the Development of a Comprehensive Scheme \(uwtsd.ac.uk\)](http://uwtsd.ac.uk)

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- Cotton (1954)
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**Read
This
Twice**

GIS AND MONITORING COASTLINES

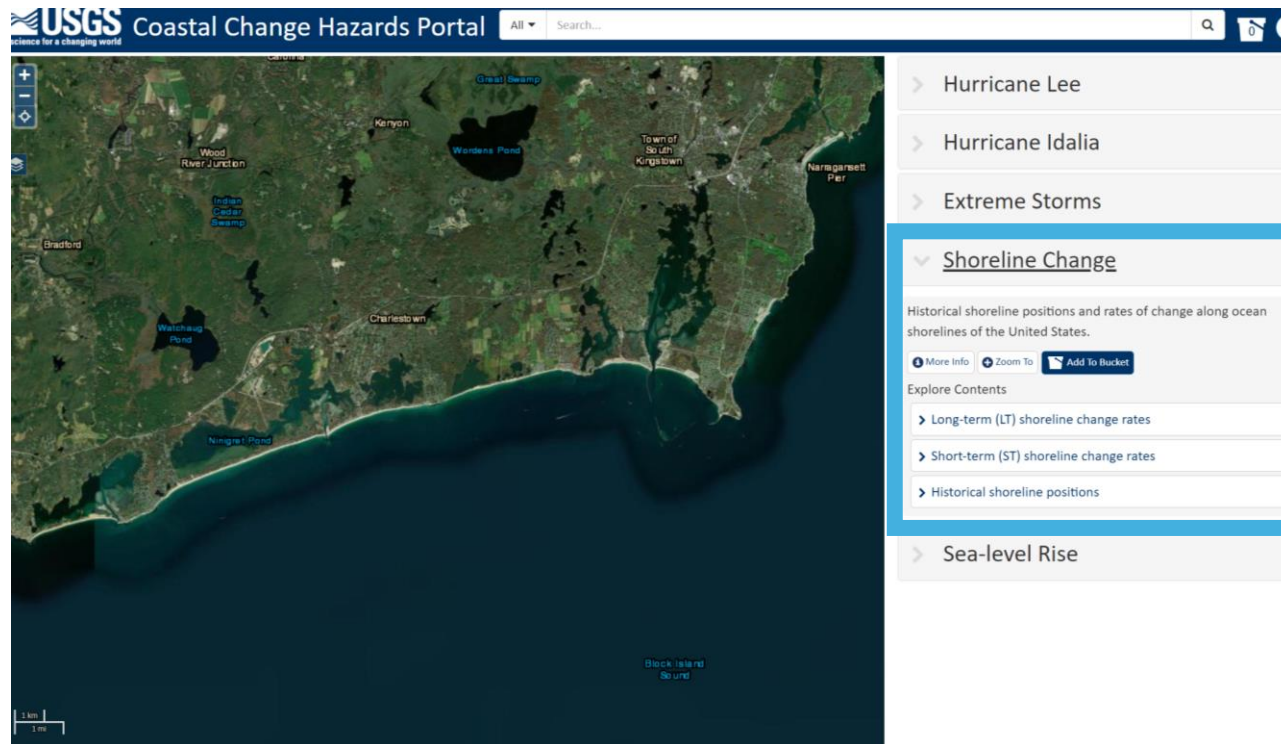


ACTIVITY

GIS APPROACHES TO MONITORING

[USGS Coastal Change Hazards Portal](#)

Click on the USGS Coastal Change Hazards Portal and Navigate to Shoreline Change.

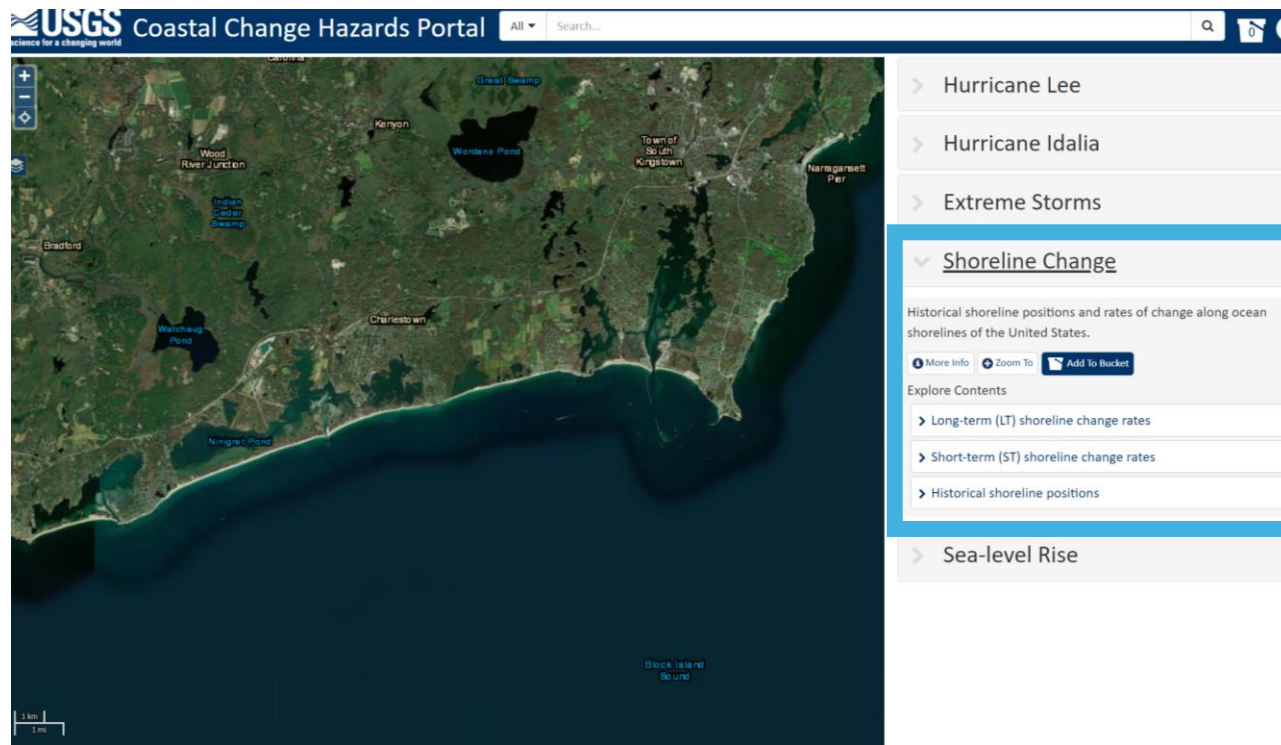


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Click on the USGS Coastal Change Hazards Portal and Navigate to Shoreline Change.



Explore the three key layers:

LT Shoreline Change

ST Shoreline Change

Historical Shoreline Positions

ACTIVITY

GIS APPROACHES TO MONITORING

[USGS Coastal Change Hazards Portal](#)

Next, explore the SEALEVEL rise section

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ACTIVITY

GIS APPROACHES TO MONITORING

[National Coastal Monitoring - Welcome](#)

Let's explore some content for **Wales**

[Wales Coastal Monitoring Centre | WCMC](#)

What is being monitored? How?

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ADDITIONAL READING

GIS APPROACHES TO MONITORING

[Development and application of a coastal change likelihood assessment for the northeast region, Maine to Virginia \(usgs.gov\).](#)