Mapping the World's Oceans

(with a focus on the Atlantic Ocean)



With
Rear Admiral (Retired) Simon Hardern

Make the Sea Measurable and you Make the World Reachable

P&O CRUISES

'The surveyor's pencil is the navigator's best friend'

Rear Admiral Francis Beaufort
Hydrographer of the Royal Navy (1829-1855)
and Inventor of the Beaufort (Wind/Sea State) Scale




The Strategic Landscape

Our Oceans are Big!

About 71% of the world's surface is covered in water; 95% of that is in our oceans



… and yet only about 28% of the World's oceans are surveyed to modern standards with modern sonar (or an area about five times the size of South America)

… and only 5% of the seabed has been explored from a topographic perspective

Illustration of Resolution

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Earth Surface



Mapped to
30 cm per pixel



Moon Surface



Mapped to
10 m per pixel



Mars Surface



Mapped to
20 m per pixel



Earth Ocean Seabed



Mapped to
4,000 m per pixel





To map the 139 million square miles of seabed to the same fidelity as the land would take
one ship a thousand years

Strategically Important Above the Water

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Global Trade, Population and Prosperity Depend on Maritime Routes



Humanity is Concentrated
95% on 5% of land, mostly along coasts



The World Moves by Sea
About 80 % of global trade (by volume) is moved by ship



A Global Lifeline
70% by value depends on shipping networks

3+ Billion
People Rely On The Ocean

~4.8 Million
Port Calls Per Year

~12 Billion
Tonnes Of Seaborne Trade Per Year

Oceans Power the Global Economy

Global Vehicle Densities on Our Roads

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Global Shipping Numbers

Ship Category	Vessel Numbers
Merchant fleet	~ 119,000
Naval and Government	~ 50,000
Fishing Vessels	~ 4.9 Million
Recreational Craft	~ 30 Million
Approximate total	~ 35 Million



Global Shipping Density

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64 Million Km
Of Roads Worldwide

1.6 Billion
Vehicles

≈25 Vehicles
Per Km Of Road

≈1 Vehicle
Every 40 Metres

≈1 Vessel
Per 10 Km² Of Ocean



In Summary



It is said that half of the world would starve without ships to move our food

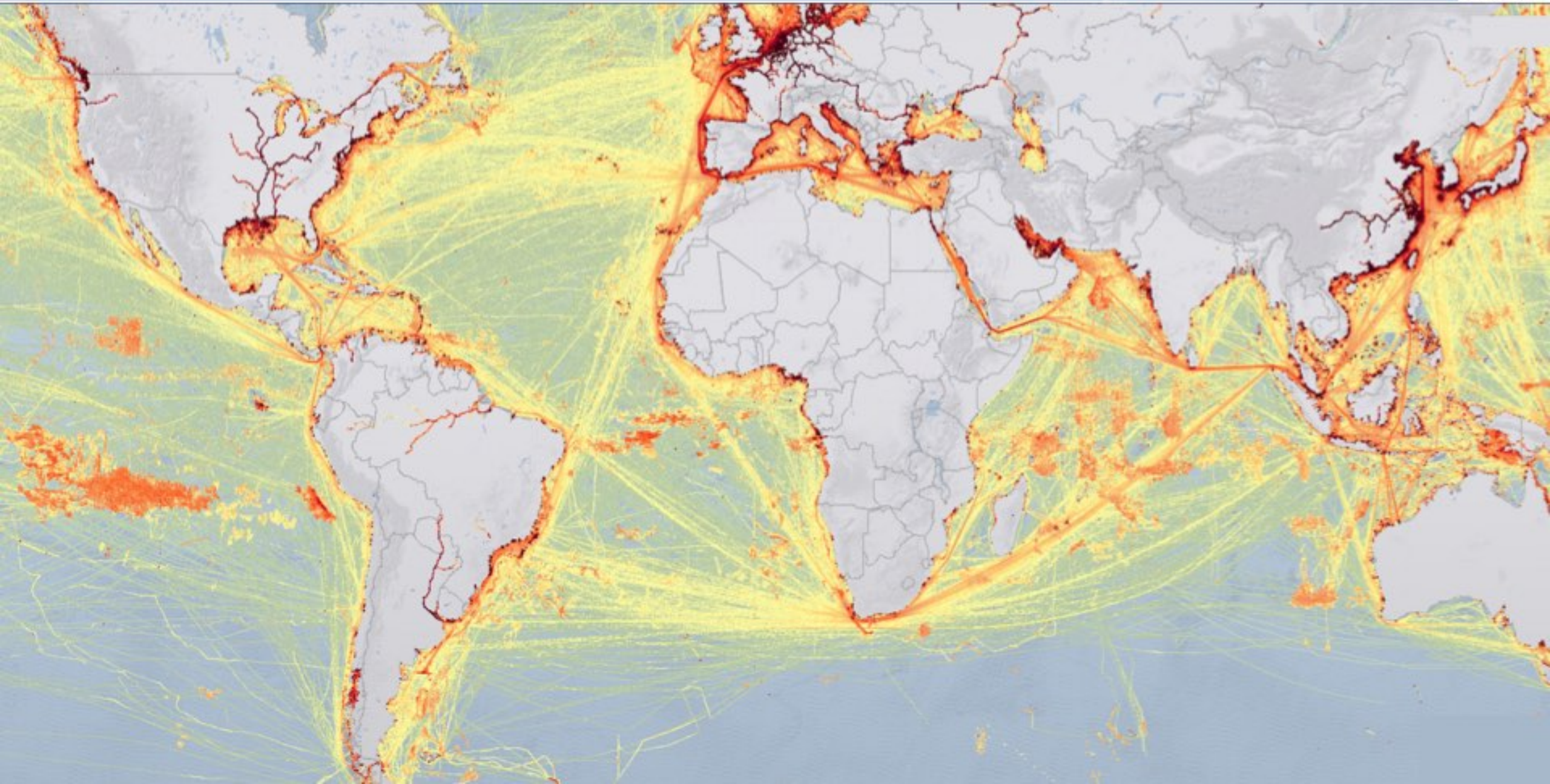
… and that the other half would perish without the oil and gas to heat our homes

For the UK, as an island nation, in the 1960s the ‘four weeks to starvation’ figure was a genuine Cold War-era vulnerability assessment that circulated in official and public discourse

Ships don’t just carry cargo … they carry stability …
take them away, and the global manufacture and supply systems
come apart surprisingly fast

The Oceans Connect Our World Above

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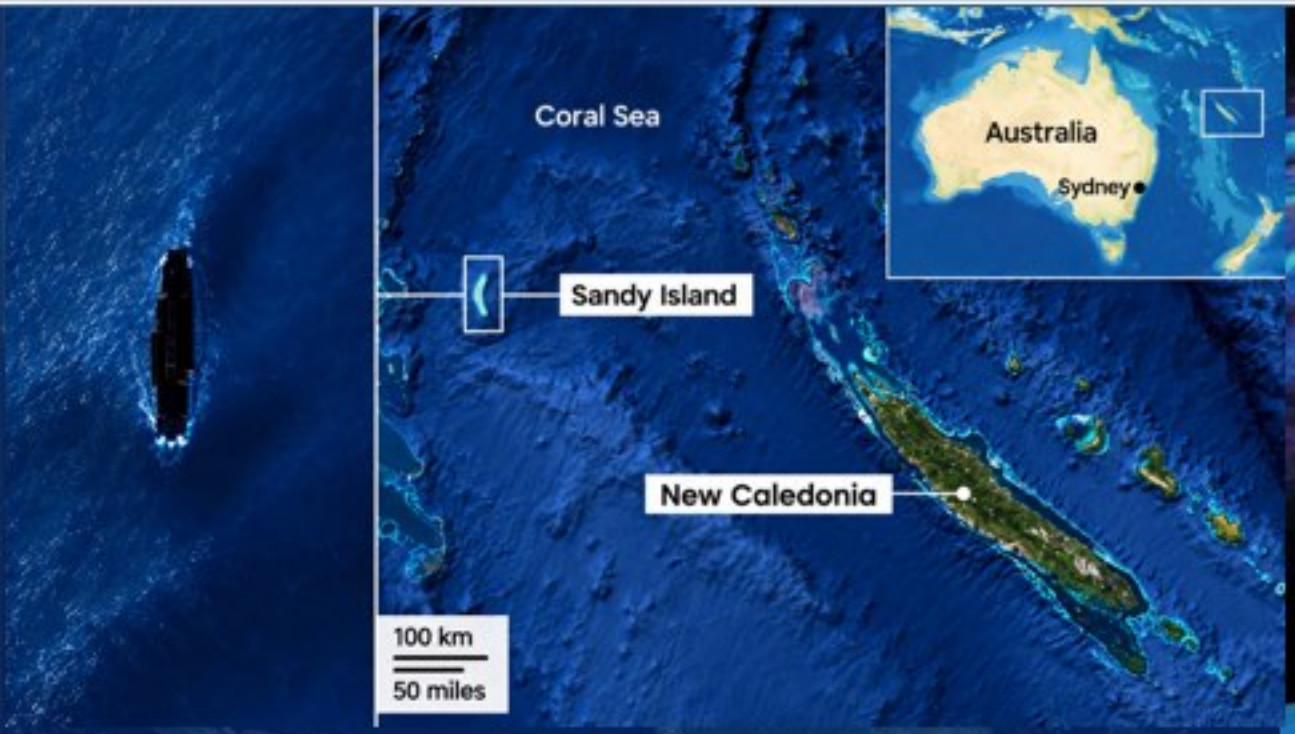


Also Strategically (Very) Important Below!



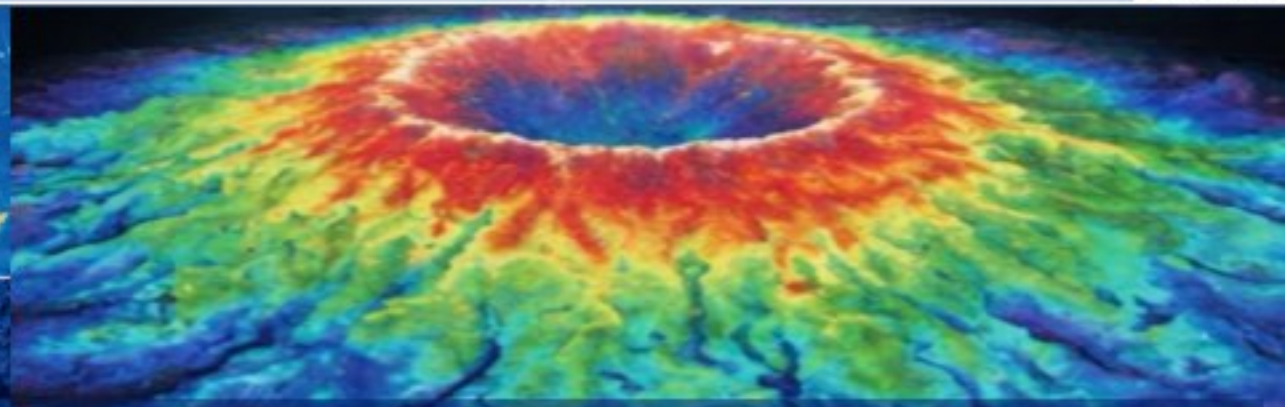
- 99% of all data is carried around the world in over 600 (or nearly a million miles of) distinct fibre optic cable networks, carrying terabytes per second rather than megabytes per second by satellite at the speed of light … important given about 2 Mb of data is created/consumed per person per second
- For context, a million miles is roughly four times the distance of the Earth to the Moon, or enough to wrap around the equator 37 times; and 90% of all global data has been created in just the last two years!

And Still So Much We Do Not Know

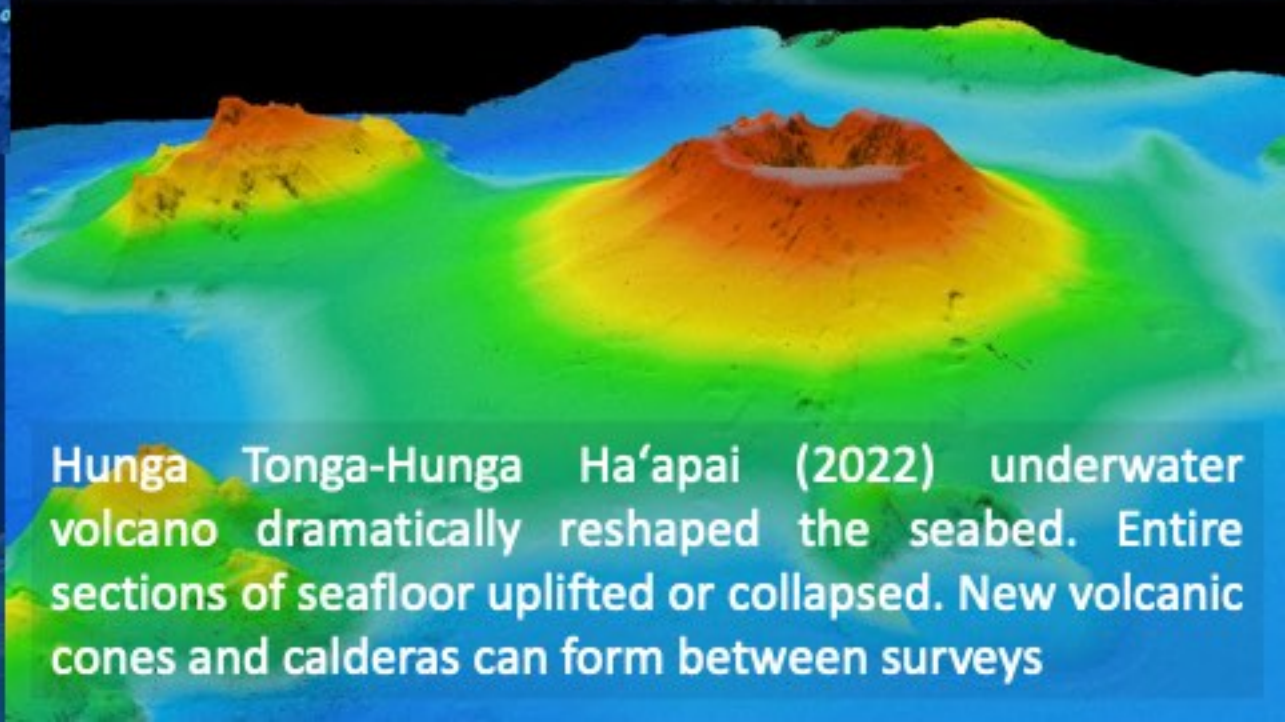


Sandy (The Phantom) Island

In 2012, Australian researchers aboard the Southern Surveyor sailed to its mapped position and found only deep ocean - about 1,400 metres deep. No island, no reef. The most likely explanation is a historical navigation error, possibly a sighting of floating volcanic pumice mistaken for land. The mistake then propagated from old charts into modern digital map databases



A seamount three times the height of the Burj Khalifa (Dubai) was found off Guatemala in the Pacific in 2023



Hunga Tonga-Hunga Ha'apai (2022) underwater volcano dramatically reshaped the seabed. Entire sections of seafloor uplifted or collapsed. New volcanic cones and calderas can form between surveys

And It Gets Expensive!

USS CONNECTICUT hit an uncharted seamount in the South China Sea in October 2021 - has cost $80 million and 5 years to repair



It is now estimated that about 100,000 underwater seamounts exist … but remain uncharted

Impact on the Blue Economy




The Atlantic Ocean
SPEED
20.1
25 52'N
30.7°C
HATRILANCE

The Atlantic Ocean - Big Picture



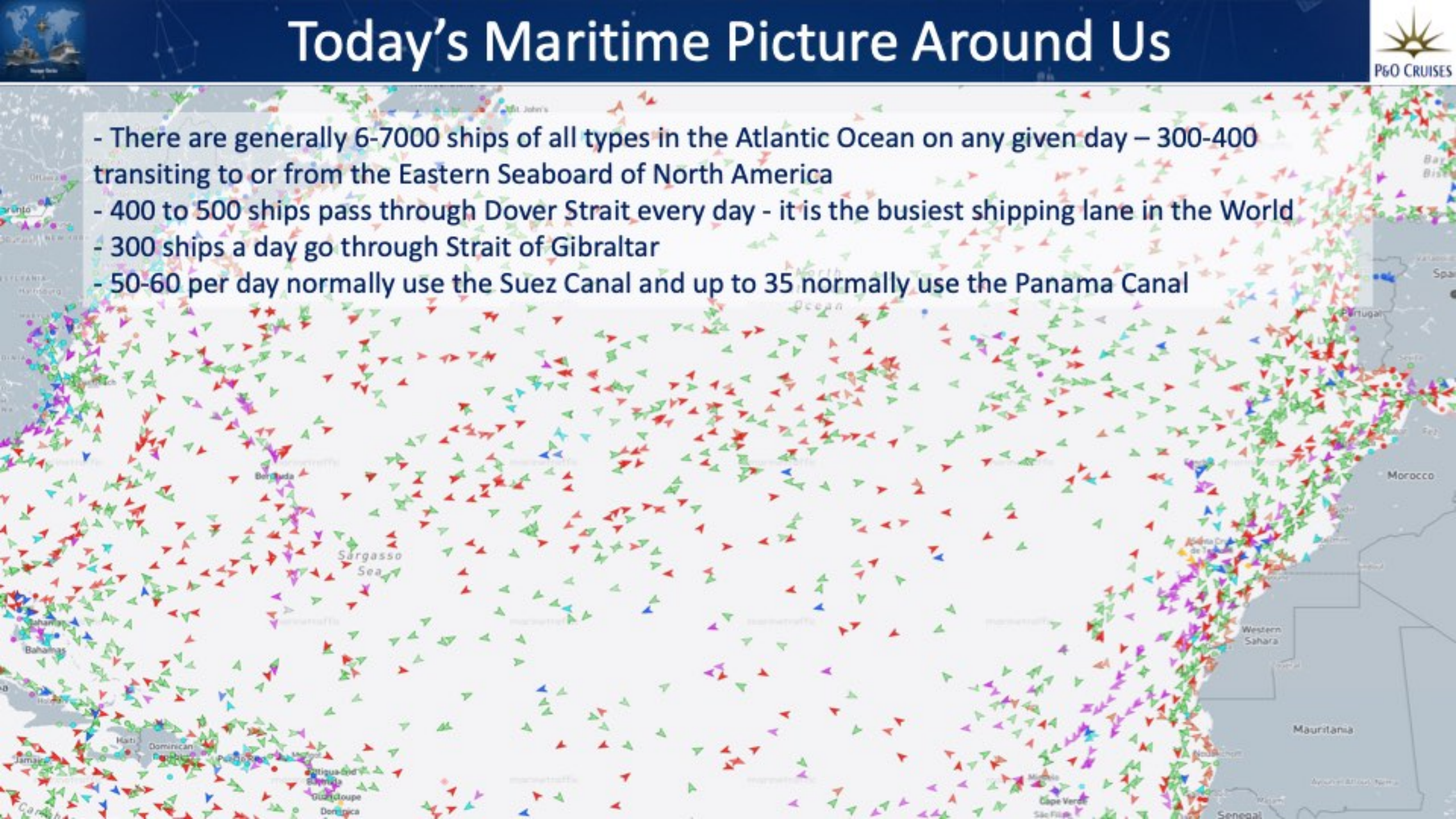
- **The Atlantic** is the **second-largest ocean** (after the Pacific Ocean), covering about **23%** of Earth's surface (the Pacific Ocean covers 46%)

- It acts as the main ocean link between the Americas, Europe and Africa with **some of the World's busiest shipping routes crossing the North Atlantic**

- The ocean is still **widening** as tectonic plates slowly move apart

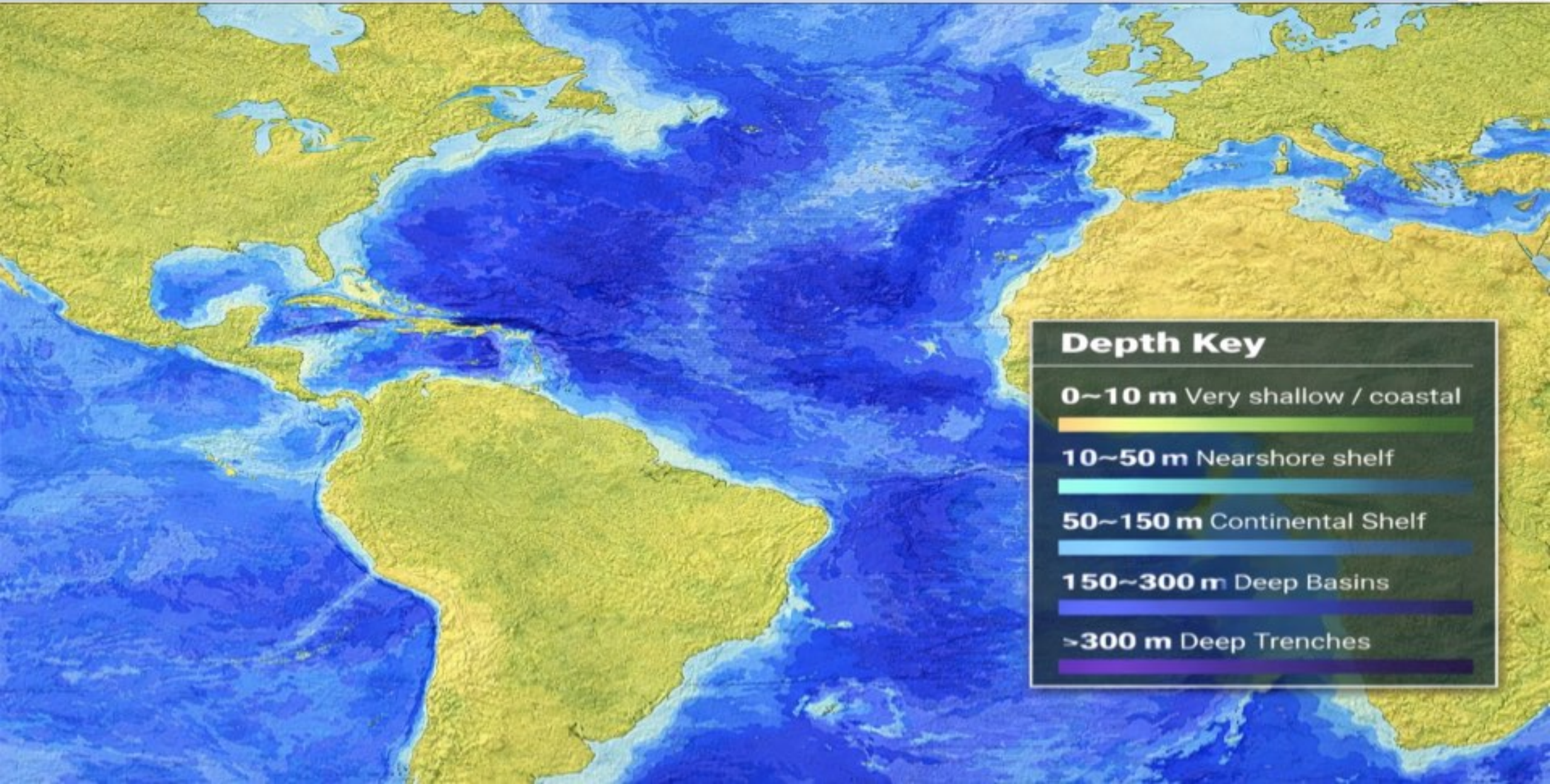
- The Atlantic has shaped centuries of exploration, trade and global history

Today's Maritime Picture Around Us




This is What
500 Looks Like
United Kingdom
Dover
Folkestone
Calais
France
Boulogne-sur-Mer

Bathymetric Map of the Atlantic Ocean



Mapping the Hidden Atlantic

- **The Mid-Atlantic Ridge** is the longest mountain chain on Earth - mostly underwater

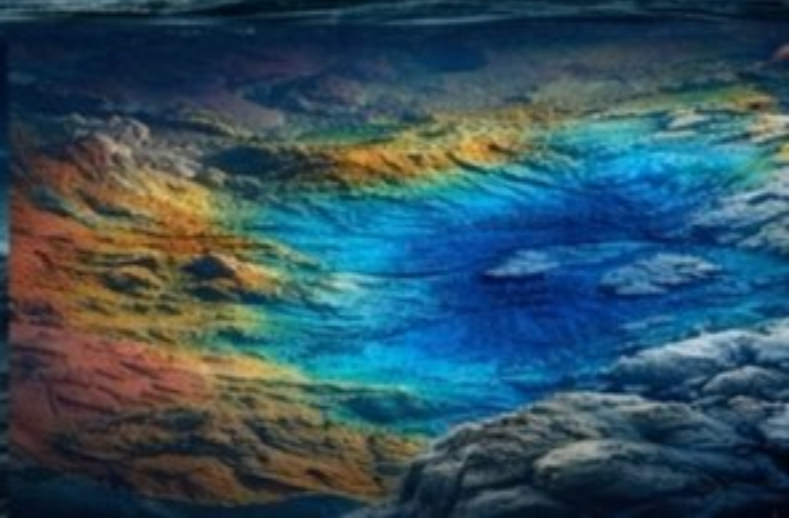
- Vast **abyssal plains** make parts of the Atlantic seafloor among the **flattest places** on the planet

- Huge **submarine canyons** carve the continental margins, moving sediment into the deep ocean

- **Modern bathymetric** surveys continue to reveal previously unmapped seafloor features







The Atlantic Ocean Drained



High Resolution Map of The Mid-Atlantic Ridge and Atlantic Ocean Floor

by Bruce Heezen and Marie Tharp

The Atlantic Abyssal Plain

There is a chain of them - Sohm, Hatteras, Nares, Iberian, Cape Verde, Angola and Argentine abyssal plains - Sohm, the biggest (900,000 km²), is what we are passing over now

Total size of the Atlantic abyssal plains is 20.3 million km². For scale, that is about twice the size of Europe, or roughly 80 times the size of the United Kingdom

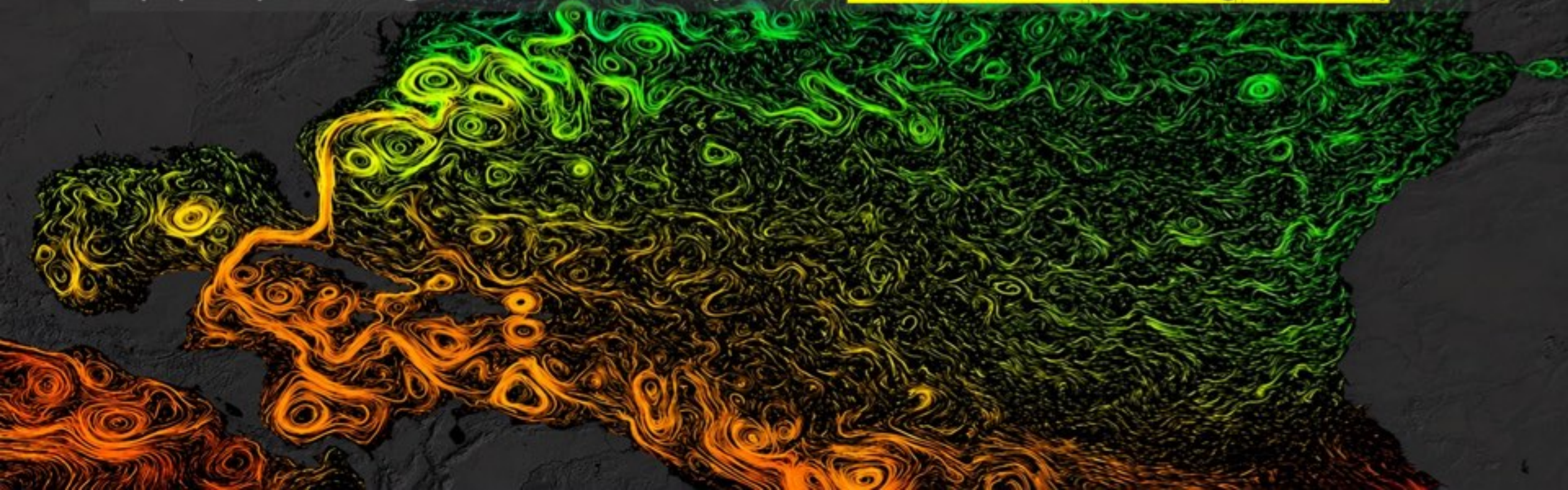
The Atlantic is an Oceanographic Powerhouse

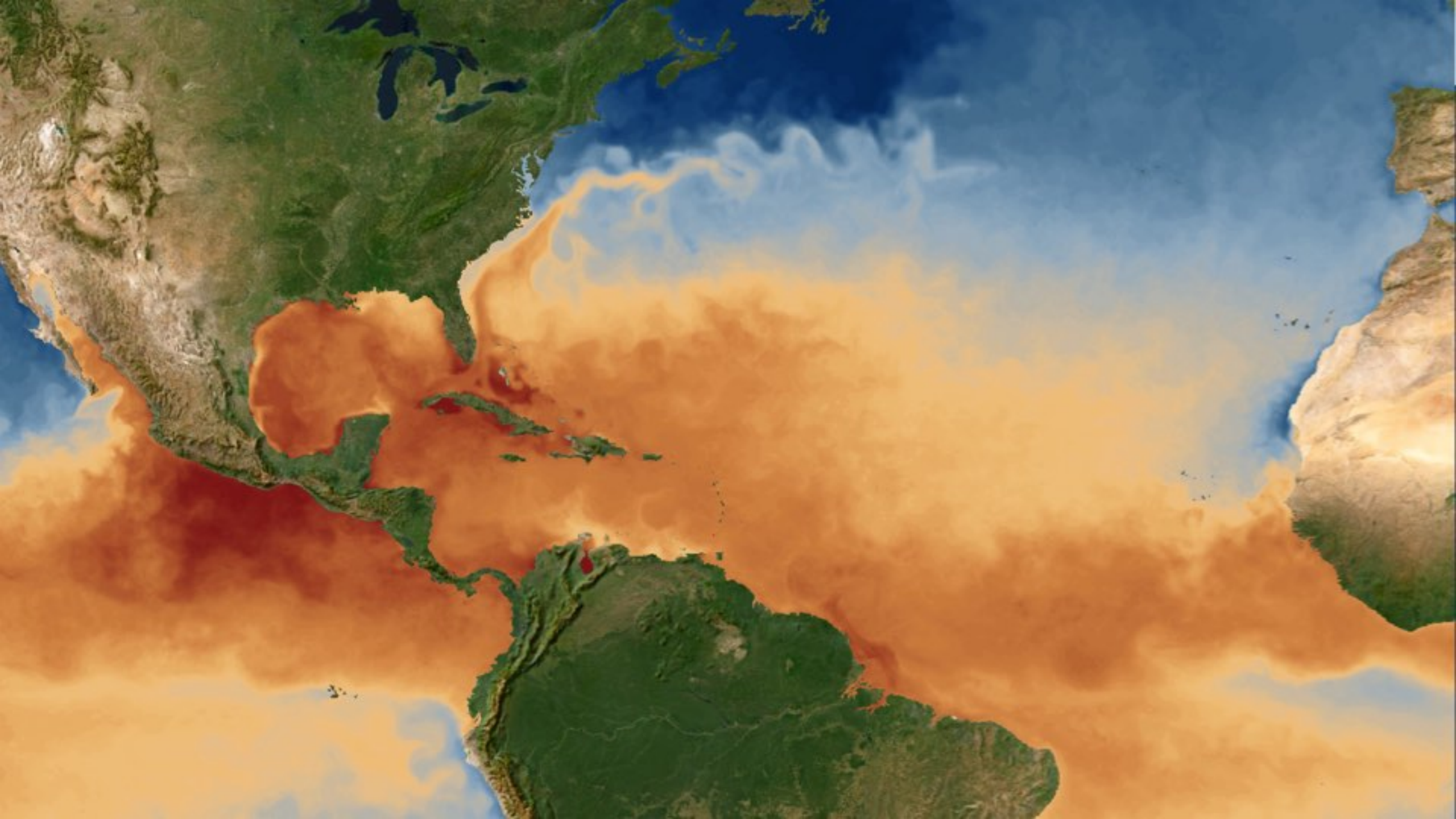
- Warm tropical waters make it a major **hurricane development region**

- The **Atlantic** is one of the saltiest major oceans due to strong **evaporation**

- **The Gulf Stream** carries warm water northward, keeping **Western Europe** unusually mild

- It plays a key role in the **global ocean circulation system (the Atlantic Meridional Overturning Circulation)**







Surveying and Charting!

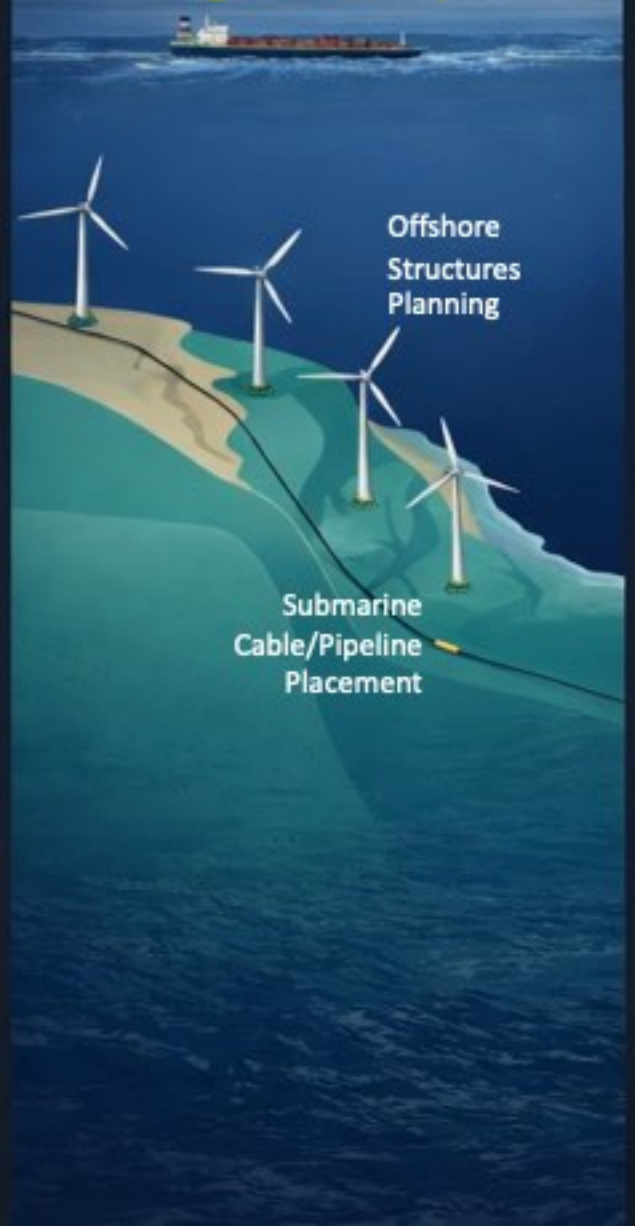
Why We Need to Survey the Oceans

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Safety of Navigation



Planning and Development



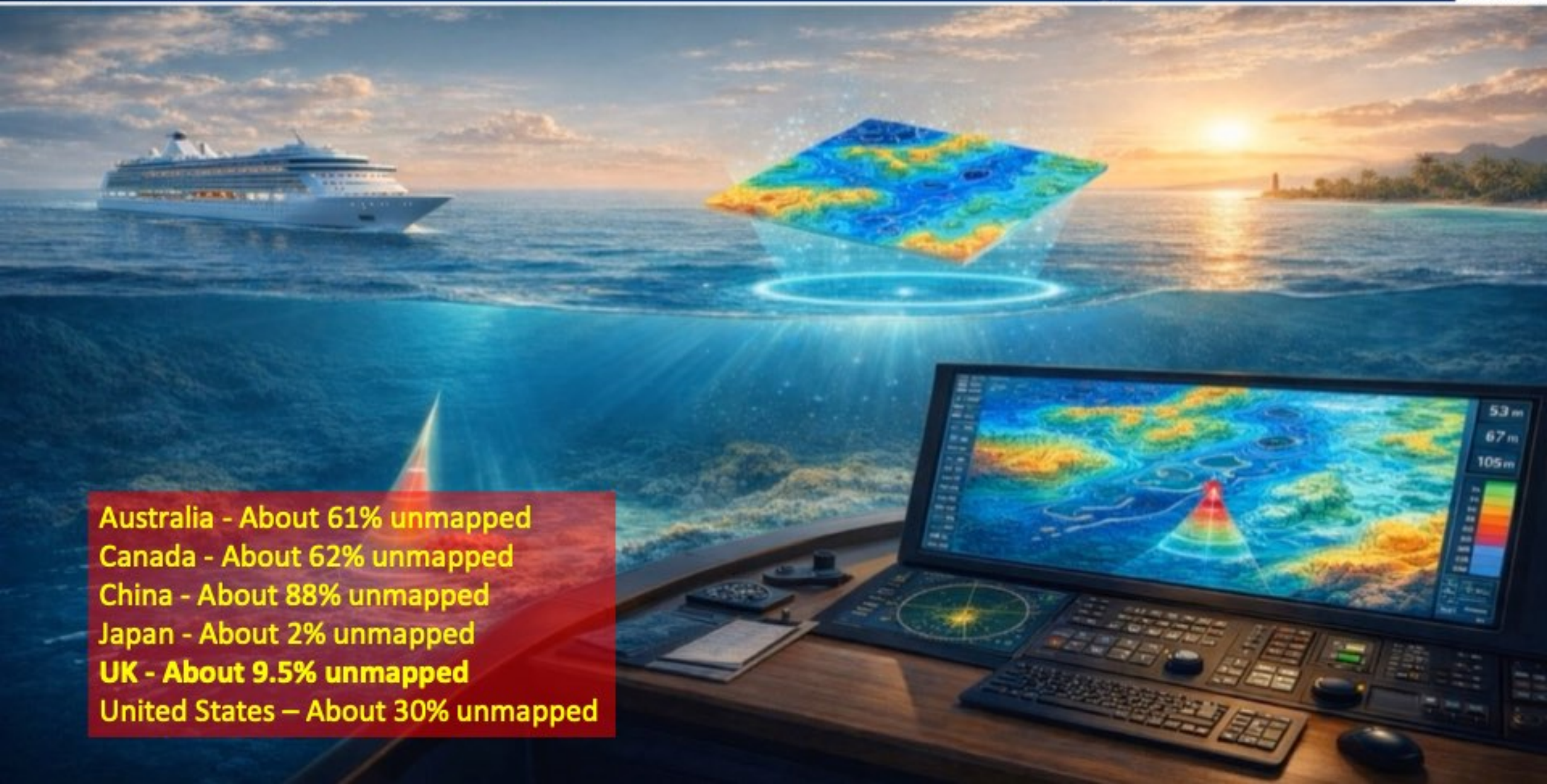
Environmental Understanding



Unveiling the Deep

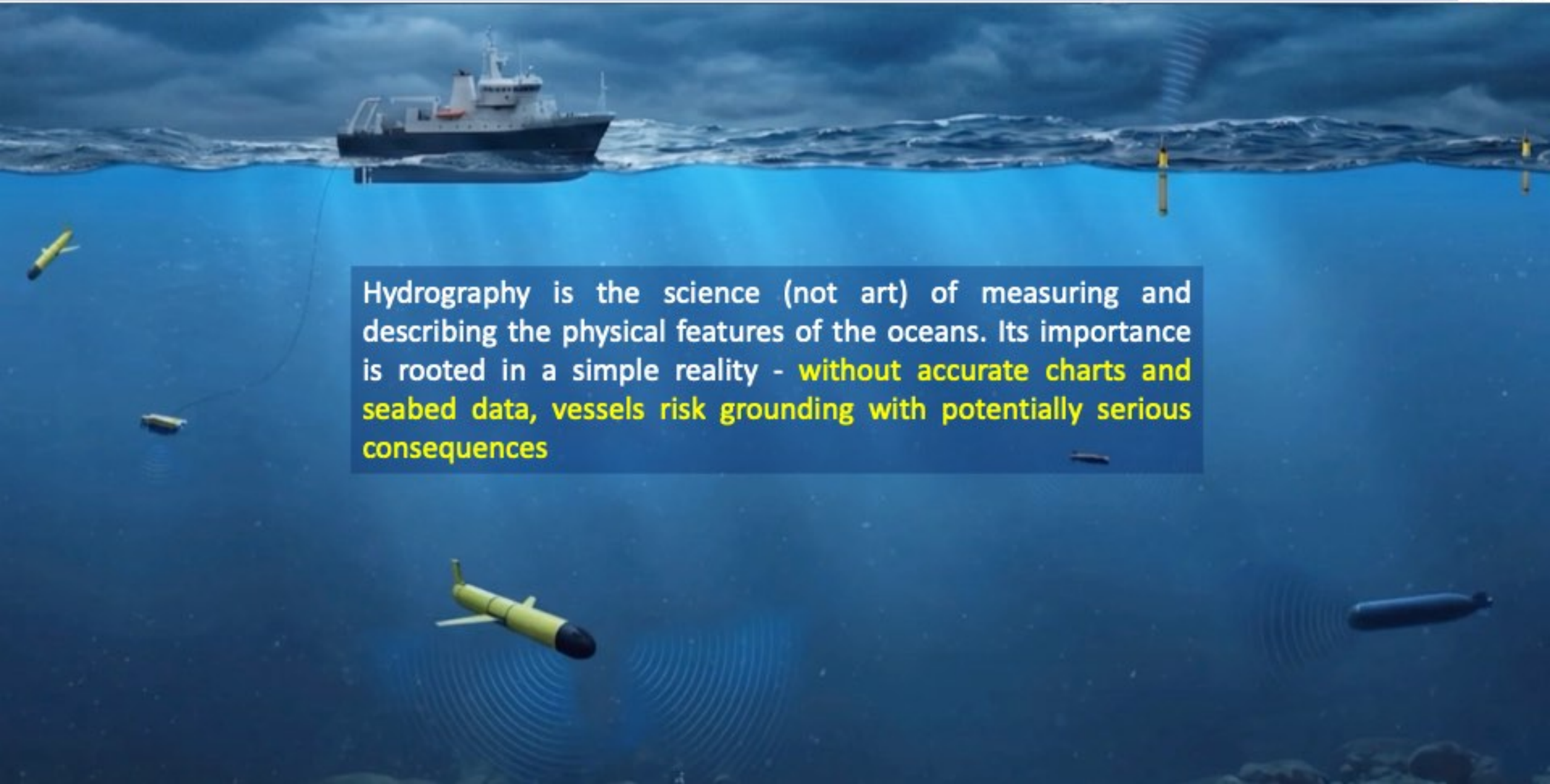


Safety of Navigation - The Most Crucial Driver



Australia - About 61% unmapped
Canada - About 62% unmapped
China - About 88% unmapped
Japan - About 2% unmapped
UK - About 9.5% unmapped
United States – About 30% unmapped

So … We Have Hydrography!



Hydrography is the science (not art) of measuring and describing the physical features of the oceans. Its importance is rooted in a simple reality - without accurate charts and seabed data, vessels risk grounding with potentially serious consequences

The Role of Hydrography and Hydrographers



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The Future of Hydrography

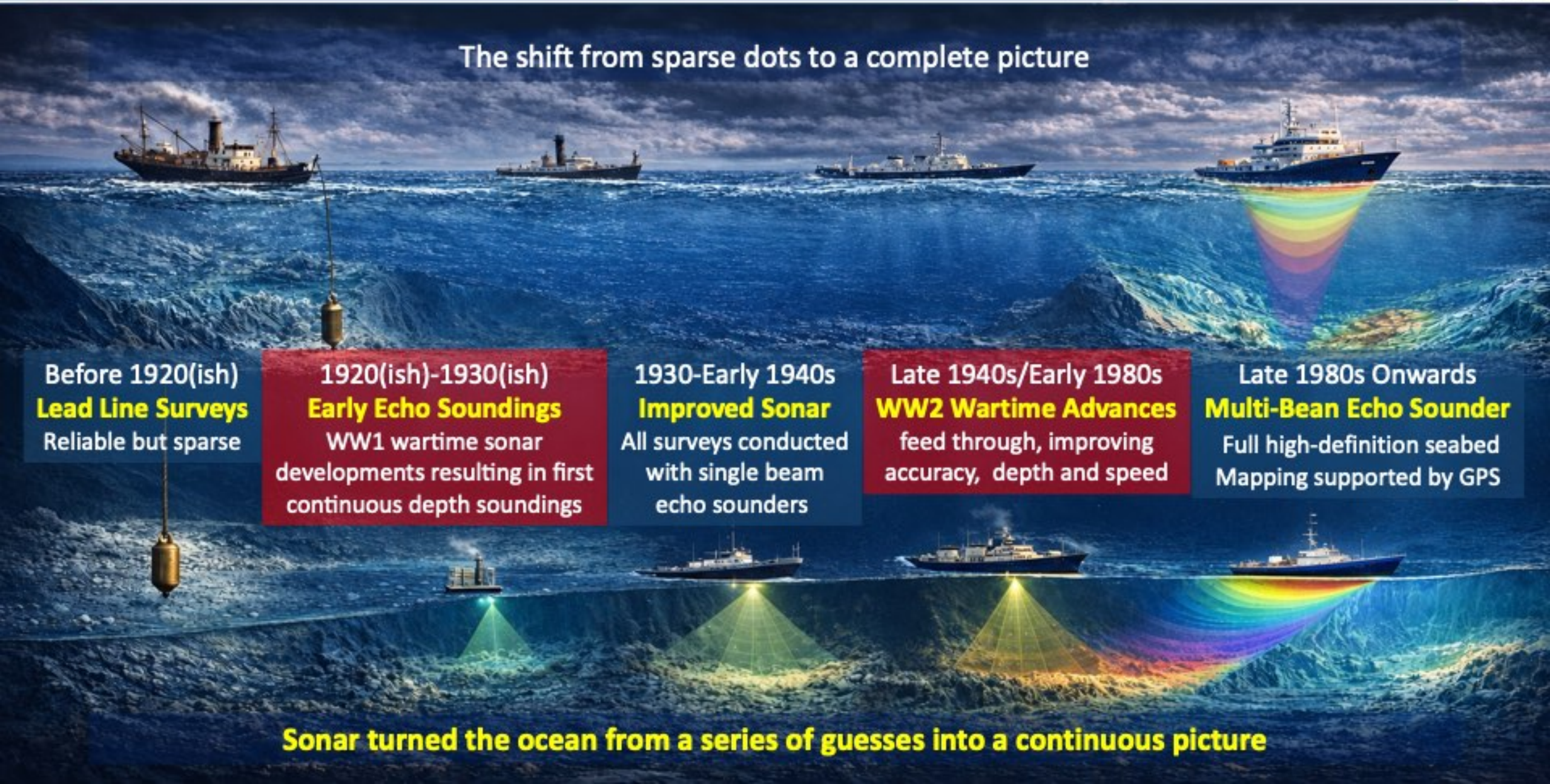
The International Hydrographic Organization



From Lead Line to Sonar

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The shift from sparse dots to a complete picture



Before 1920(ish)
Lead Line Surveys
Reliable but sparse

1920(ish)-1930(ish)
Early Echo Soundings
WW1 wartime sonar developments resulting in first continuous depth soundings

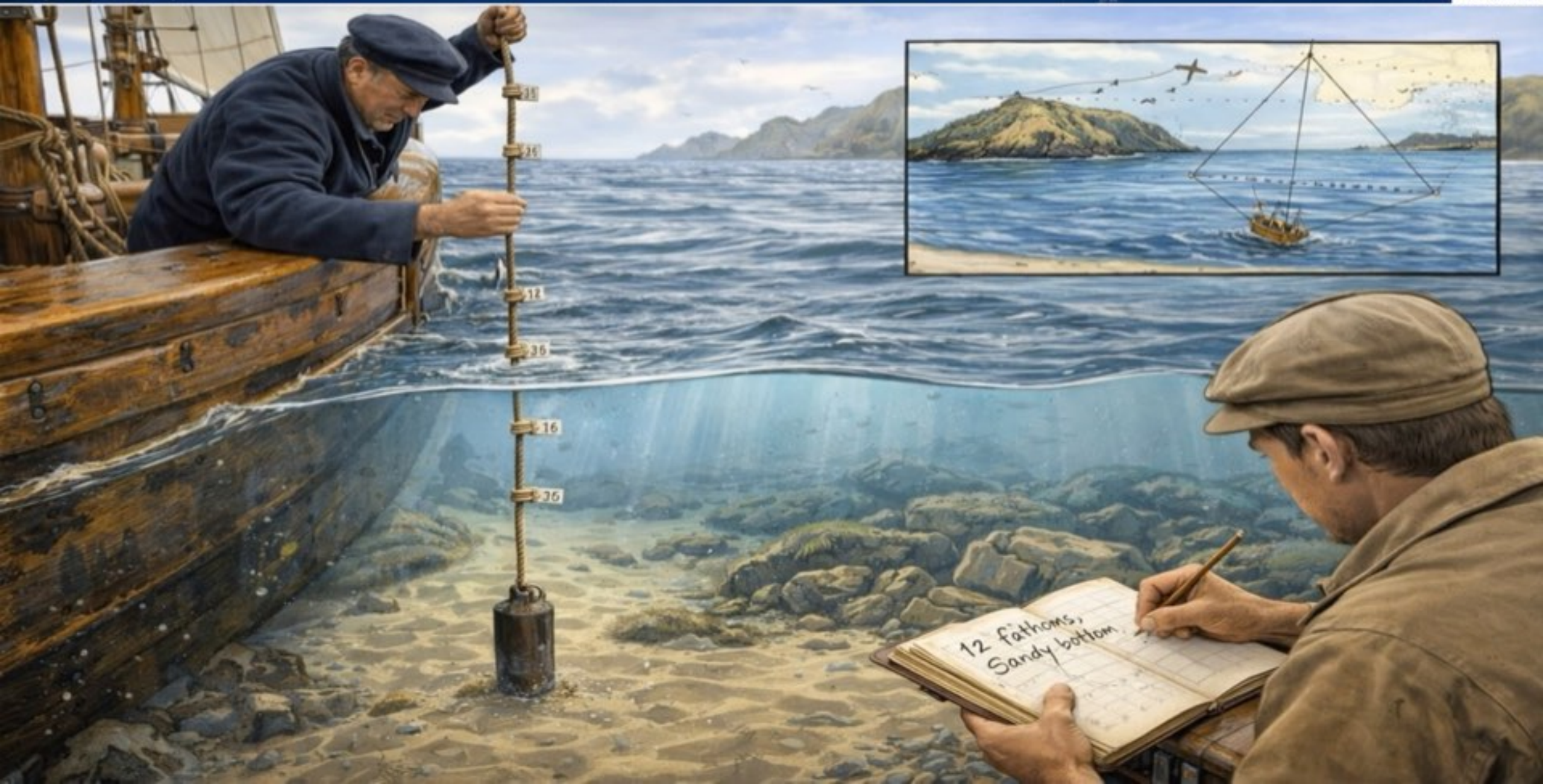
1930-Early 1940s
Improved Sonar
All surveys conducted with single beam echo sounders

Late 1940s/Early 1980s
WW2 Wartime Advances
feed through, improving accuracy, depth and speed

Late 1980s Onwards
Multi-Bean Echo Sounder
Full high-definition seabed Mapping supported by GPS

Sonar turned the ocean from a series of guesses into a continuous picture

Hydrographic Surveys - Lead Line - Used Until 1930s!

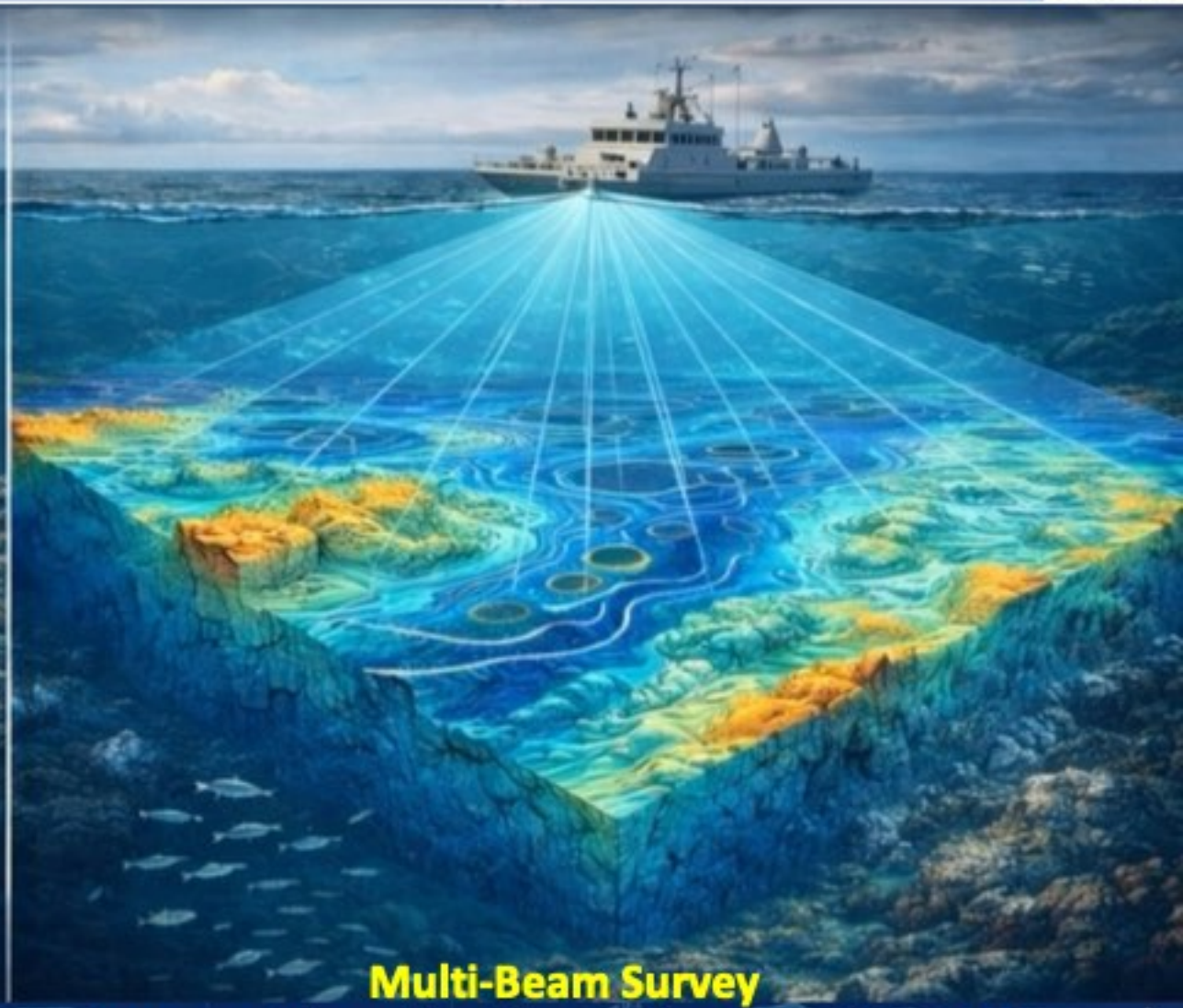


Hydrographic Surveys - System History



Single Beam Survey

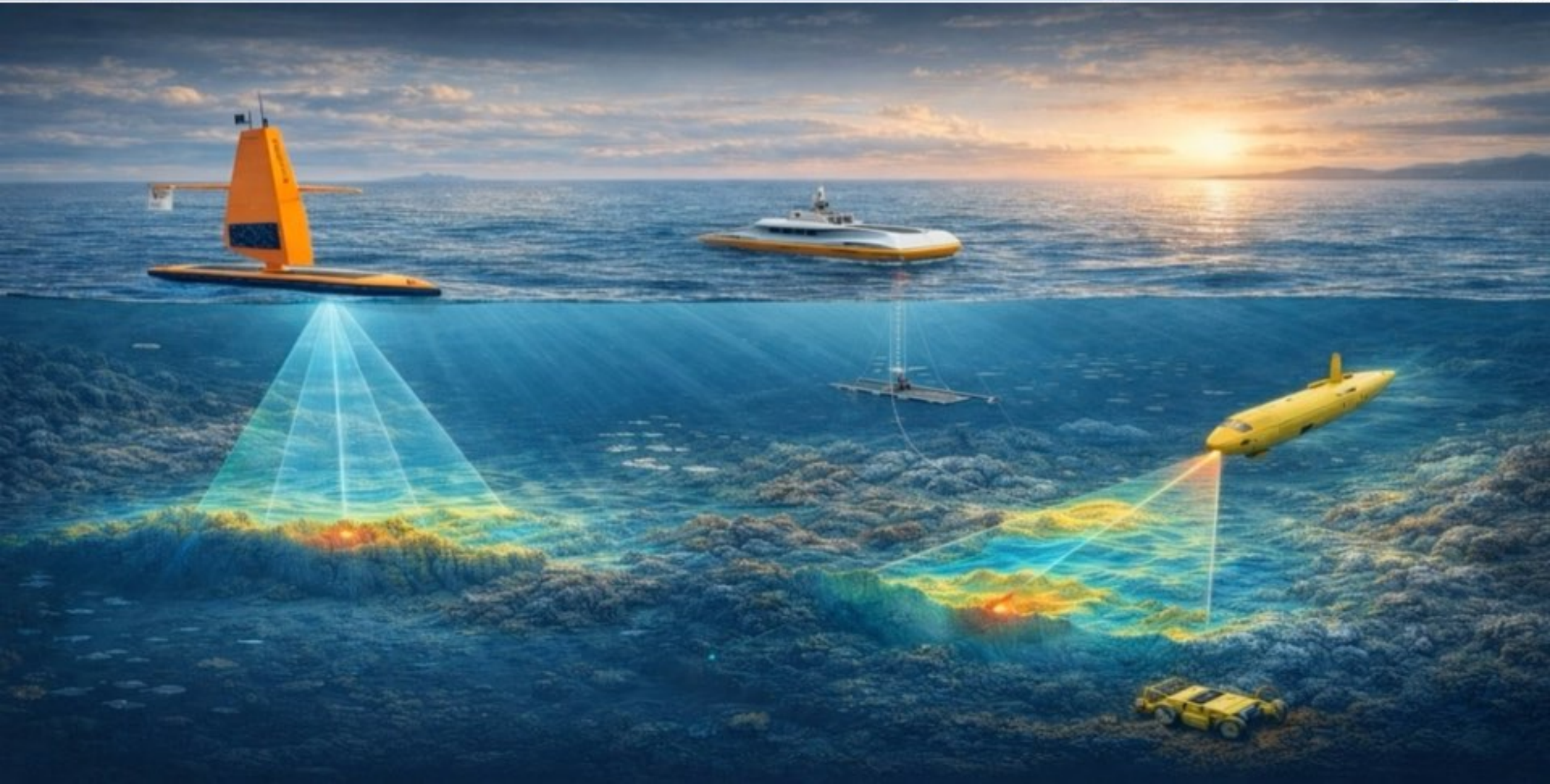
Continuous, high-speed data collection in a line - the lead line only provided single, isolated depth measurements where the weight hits the bottom



Multi-Beam Survey

Maps a wide swath of the seafloor, providing 100% bottom coverage and creating highly detailed 3D models of the underwater terrain

What Is Happening Now

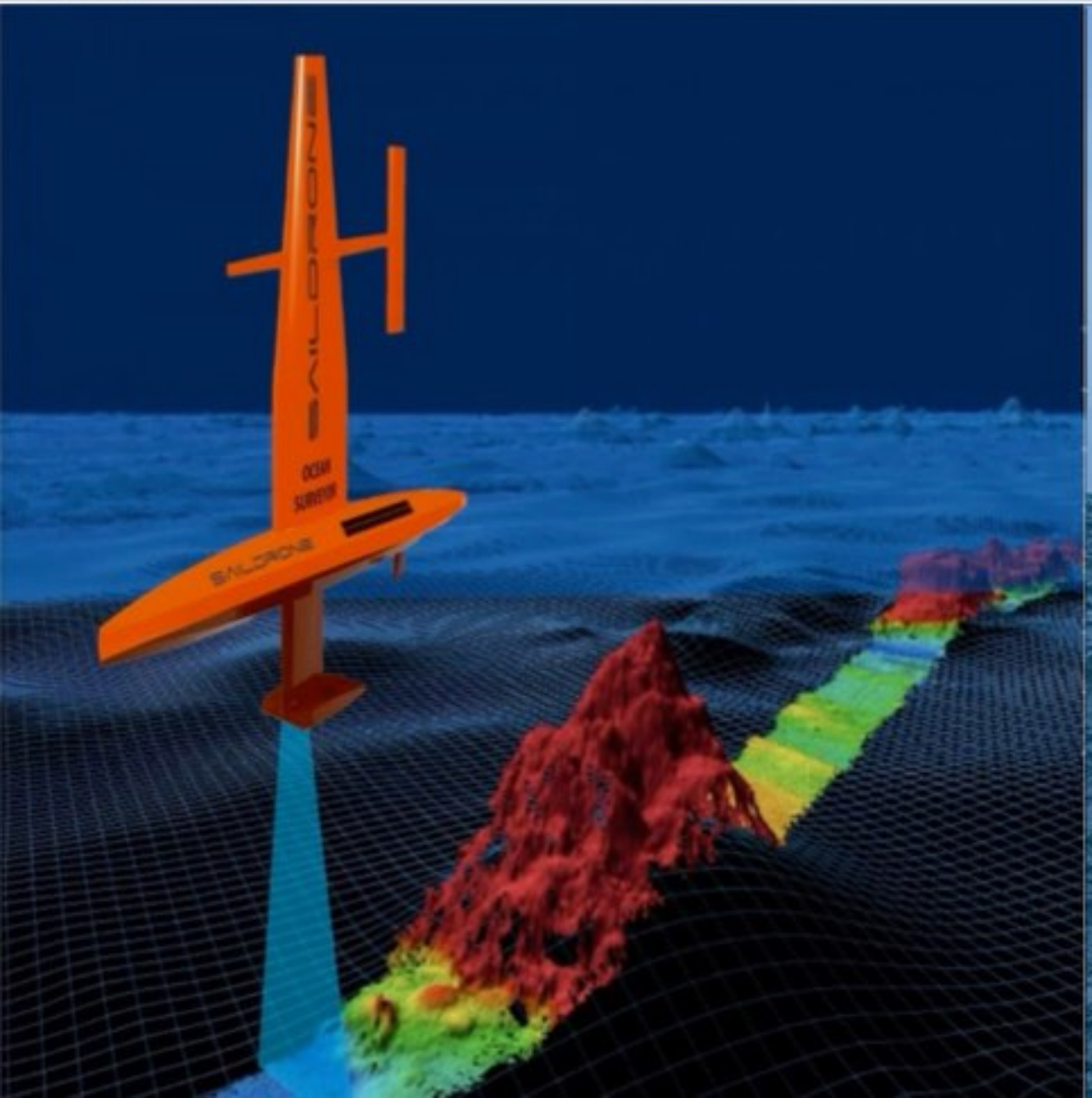


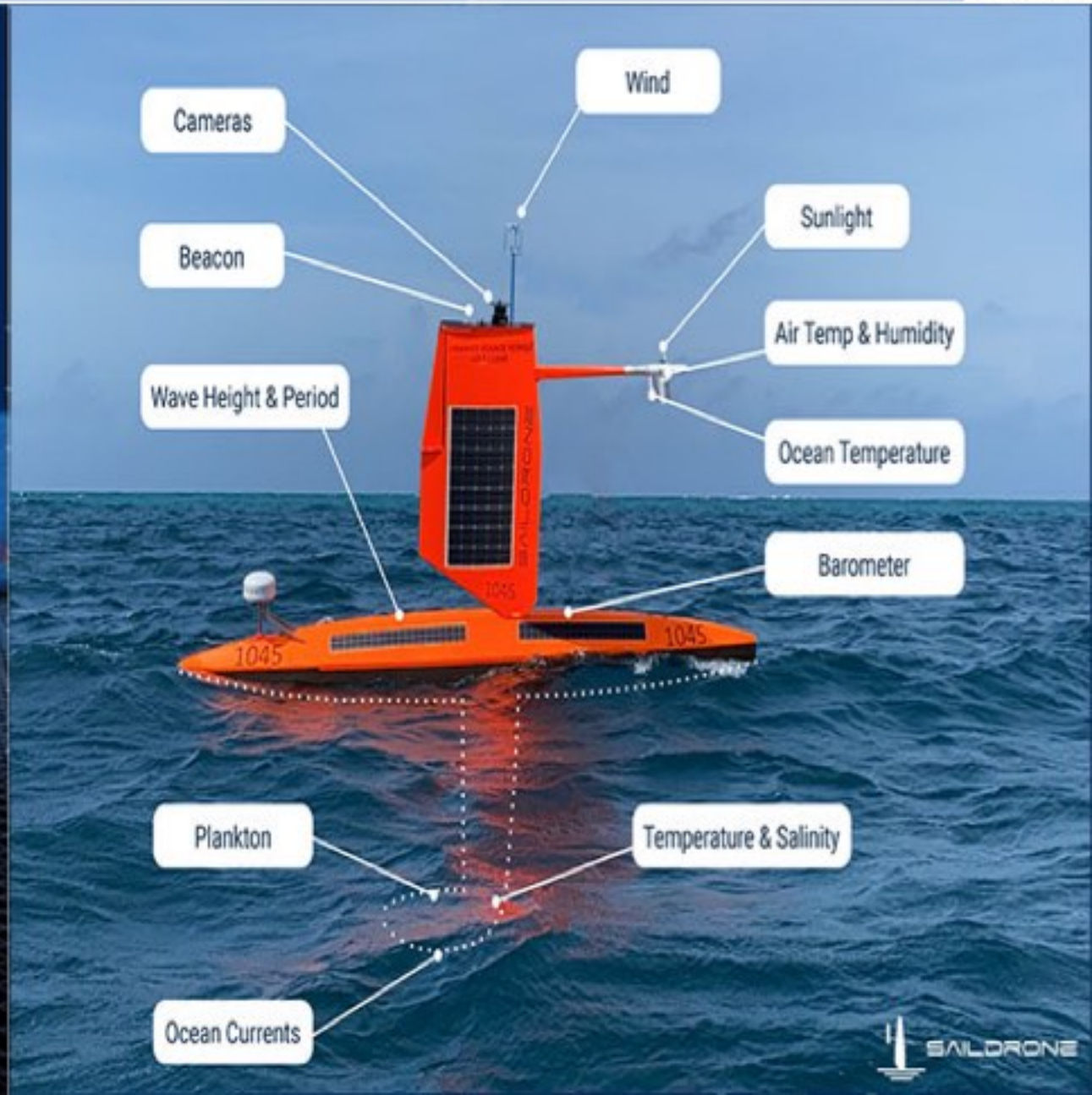
The Near Future



Autonomous Vessels

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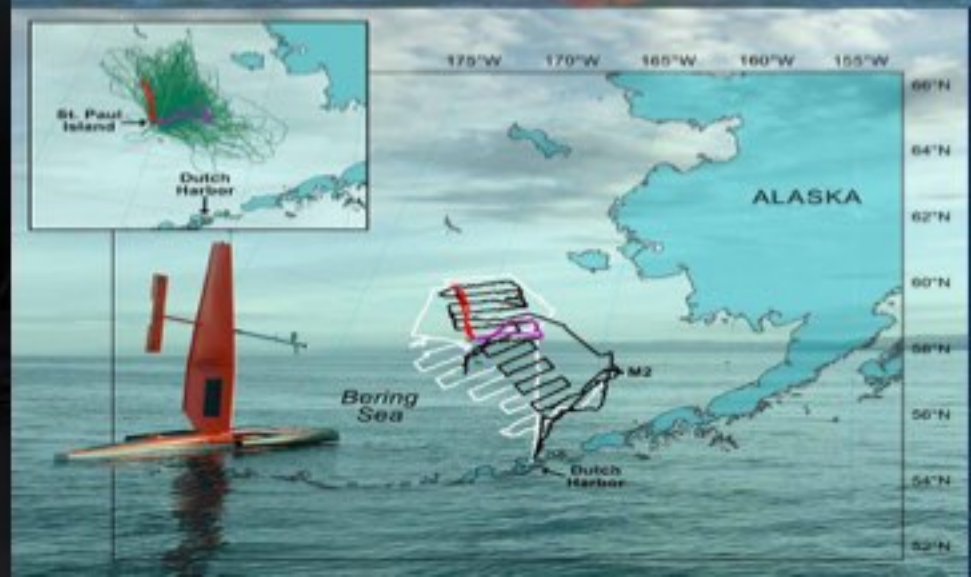




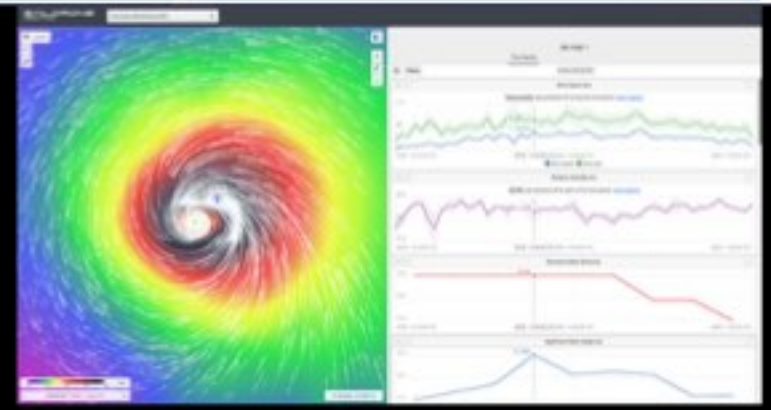
Autonomous Vessels - Control Centre







Autonomous Vessels - Into the Hurricane



Deep and Shallow Water Underwater Drones



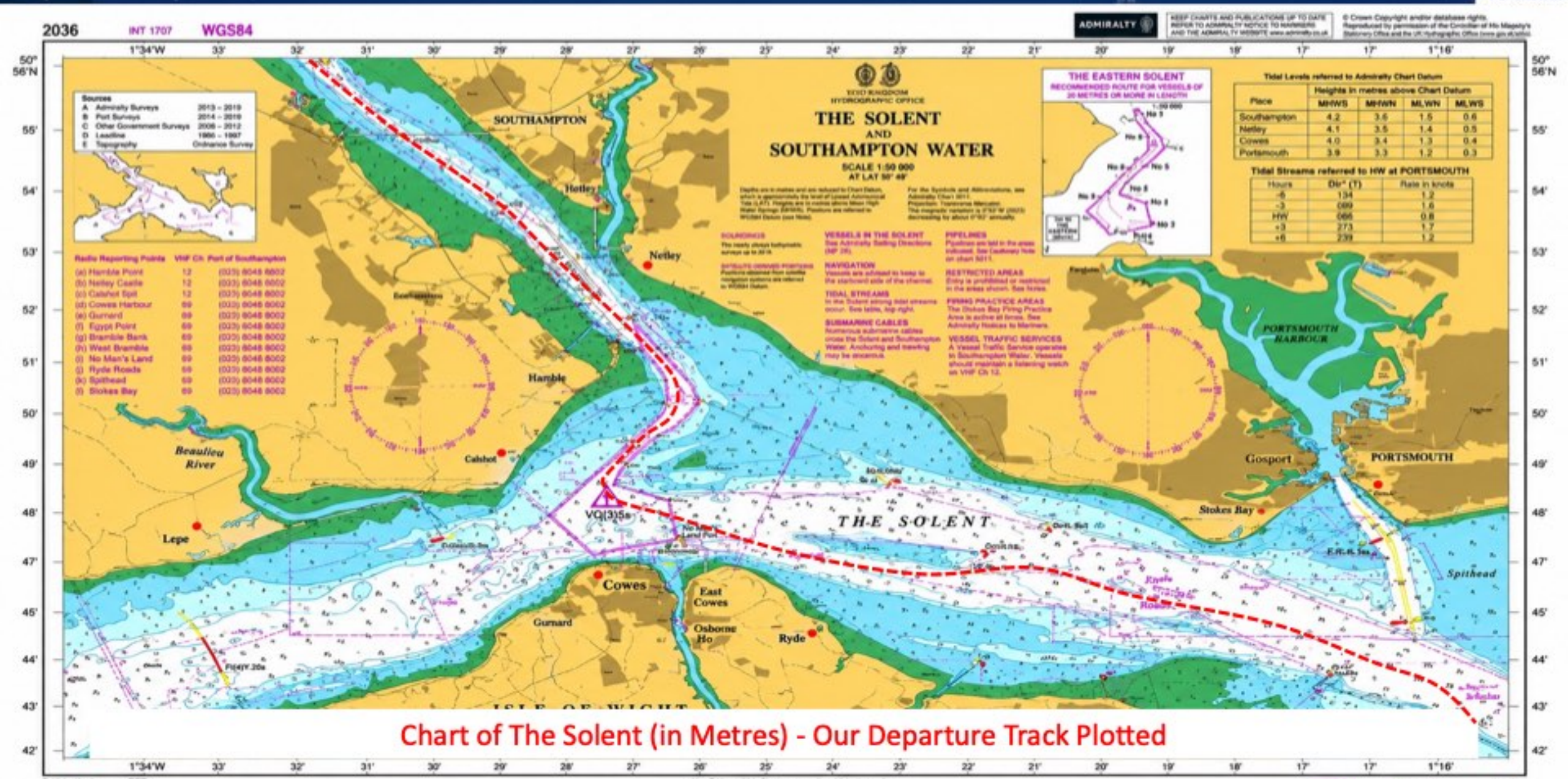
Multi-Beam Sonar

The Old Black and White Paper Chart



Paper Chart of Approaches to New York Harbour/Long Island Sound - Circa 1950 - Fathoms and Feet

The Old Colour Paper Chart

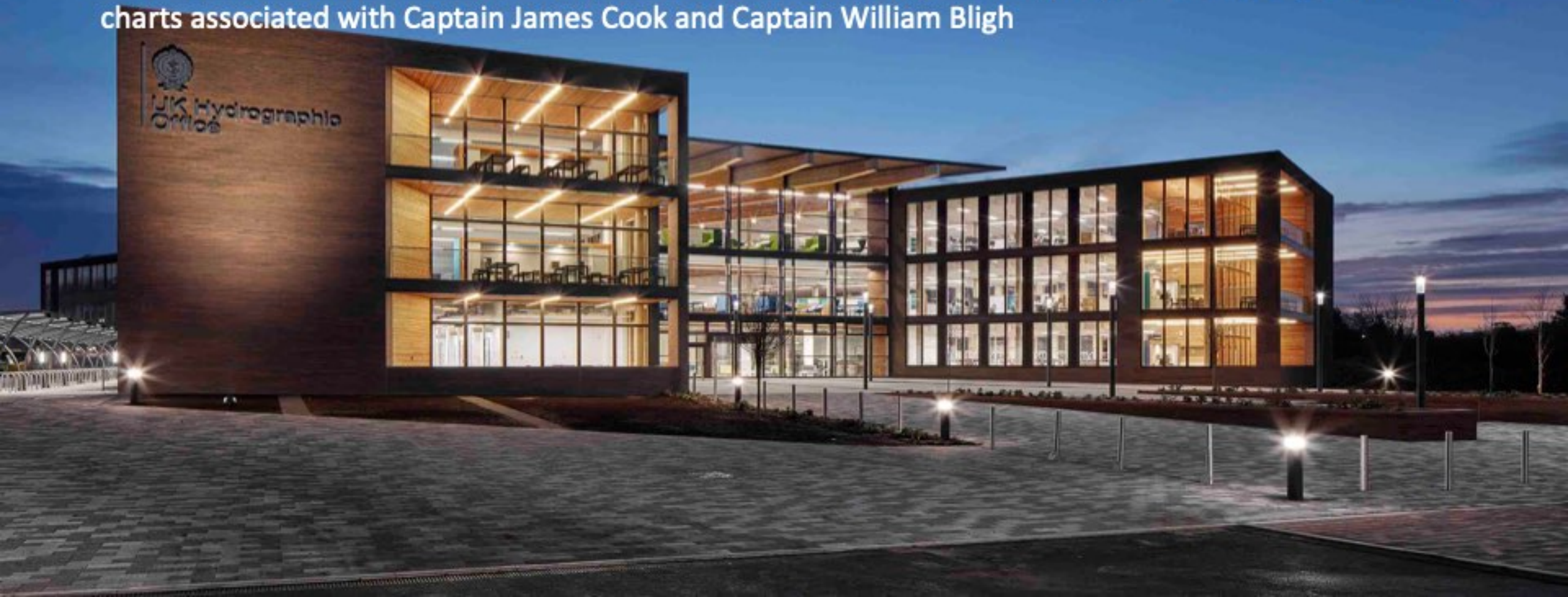


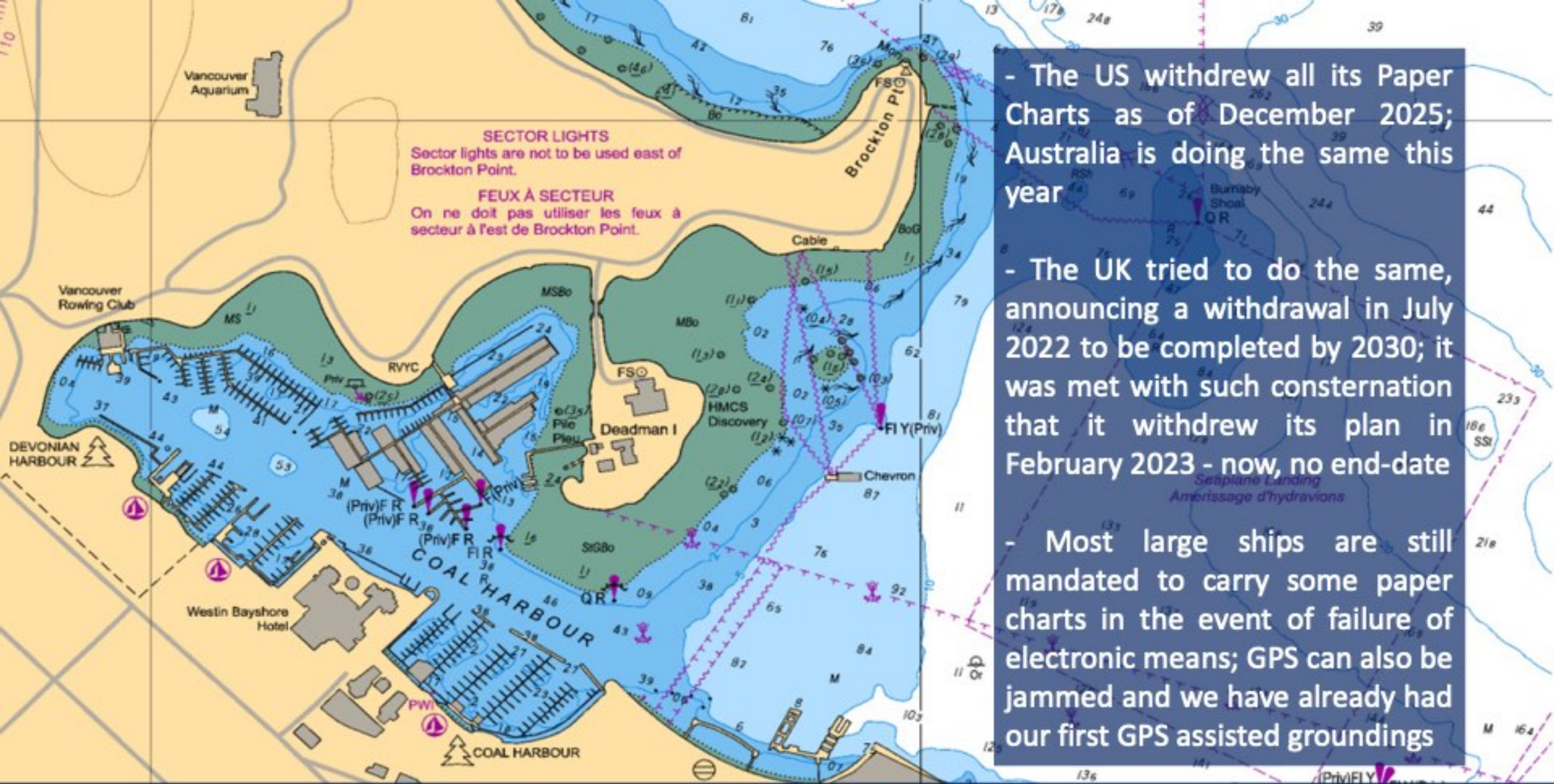


Before computers and satellite tracking took over, old paper nautical charts were produced through a labour-intensive blend of meticulous field surveying, master-level manual drawing, and precision metal engraving

The UK Hydrographic Office

- Found in 1795 by King George III - so now 230 years old - and the oldest in the world
- 'ADMIRALTY' navigation products support more than 90% of large ships trading internationally - an extraordinary reach for a UK public body (MOD operated completely self funding)
- Its Taunton Archive holds over 400 years of maritime history, including original manuscripts and early charts associated with Captain James Cook and Captain William Bligh





The Current Paper Chart

From Paper to Pixels

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The Electronic Navigation Chart







An ENC is not a digital picture or a 'scan' of a paper map (which is known as a raster chart). Instead, it is a highly complex, intelligent vector picture. Every coastline, buoy, and depth sounding is stored as a specific geometric feature mapped to exact latitude and longitude coordinates

Types of Electronic Navigational Charts



Electronic Chart of Southampton

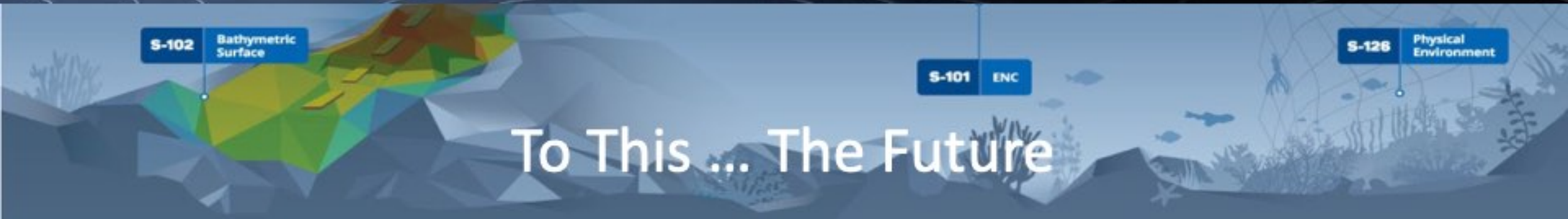


marine traffic

harbour operations

The beginning of S-100

ocean sciences



To This ... The Future

What Will This Look Like

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Southampton
(Departure: 31 Oct 26)

Southampton
(Arrival: 14 Nov 26)

4D Navigation Route
3,580 Nautical Miles

Data Network



Recent Analytics

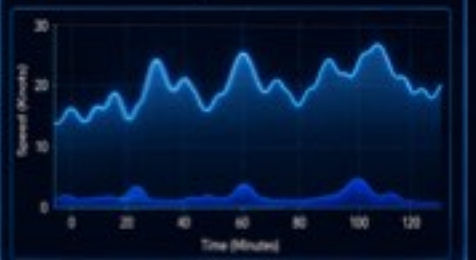
- High Waves Detected
- Route Deviation
- System Alert

Predictive Insights

- ETA: ---
- Optimal Route
- Weather Forecast

Data Stream

- 15.5 Knots
- Through Seas
- Rate: 56.2 MT/day



Engine Performance

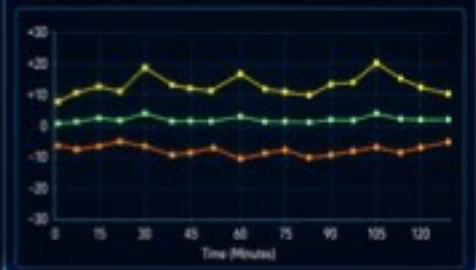
EGT	RPM	EOC
540 °C	96	90.0 %
Norm	Opt	SOG: 15.3

Efficiency Analysis



Cargo Status

Cargo - Passengers:	1,385 Passengers
Temperature:	-1.8 °C
Vibration:	Normal



What Will This Look Like



Move Away from Static Charting to Living Navigation

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The World Beneath the Waves

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Data Dependency

- 95 percent of global data flows via subsea cable
- Financial transactions rely on latency stability
- Cloud infrastructure physically anchored underwater

Energy Interconnectors

- Offshore gas pipelines span regions
- Electricity interconnectors linking grids
- Offshore wind feeding subsea transmission

Strategic Exposure

- Limited global cable repair capacity
- Attribution of sabotage remains complex
- Maritime domain awareness critical

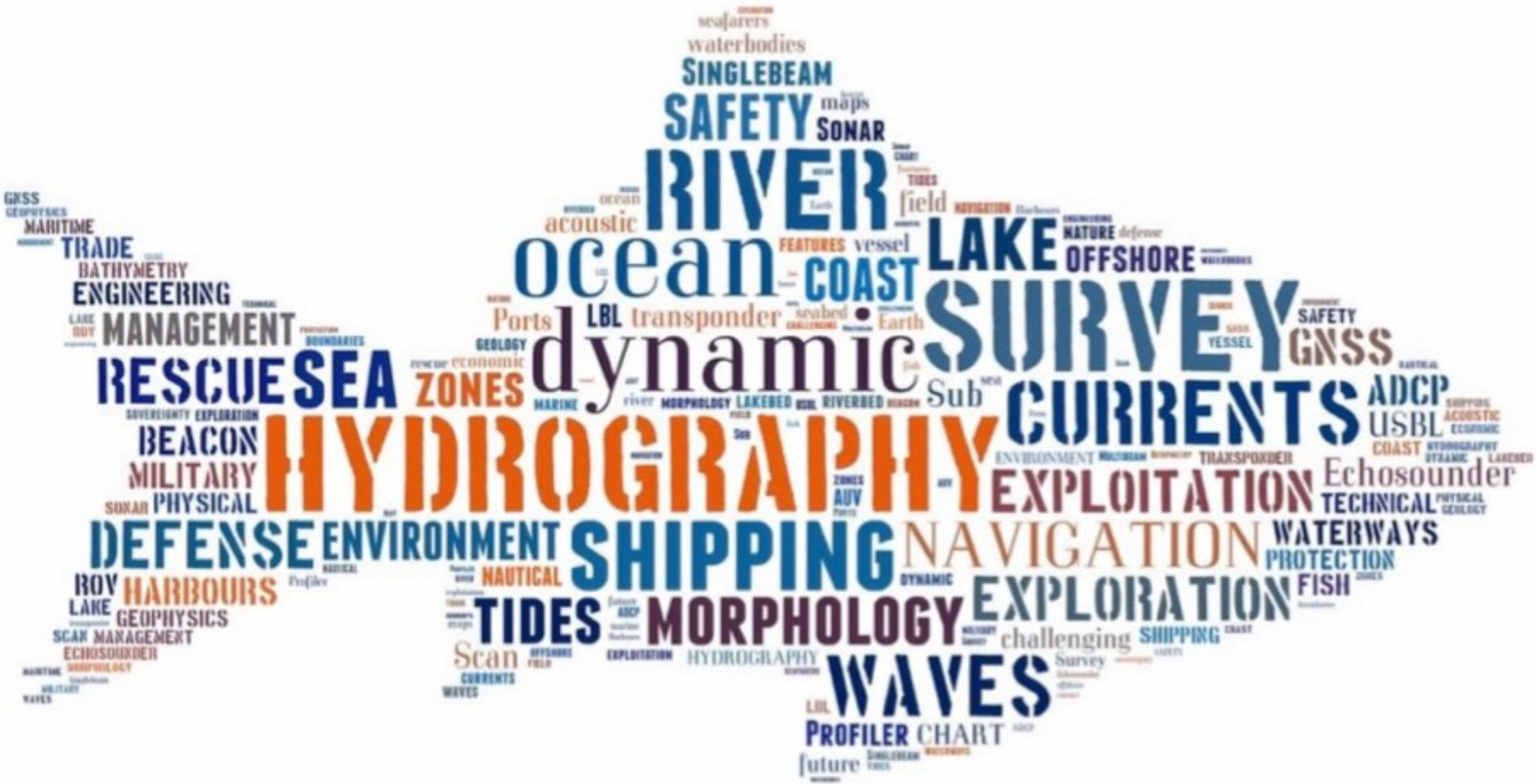


The 2050 Reality

The seabed is strategic terrain: data cables, energy links and sensors span oceans even more. States compete below the surface, where disruption is deniable, attribution slow and resilience decisive

Invisible infrastructure will shape visible power

Thank You


seafarers
waterbodies
SINGLEBEAM
SAFETY
maps
SONAR
RIVER
ocean
acoustic
field
LAKE
NATURE
OFFSHORE
COAST
FEATURES
vessel
SURVEY
GNSS
MARITIME
TRADE
BATHYMETRY
ENGINEERING
MANAGEMENT
Ports
LBL
transponder
seabed
Earth
dynamic
GEOLOGY
SAFETY
YESSEL
RESCUE
SEA
ZONES
economic
Sub
CURRENTS
ADCP
USBL
BEACON
MILITARY
HYDROGRAPHY
MARINE
river
MORPHOLOGY
LAKEBED
RIVERBED
ENVIRONMENT
TRANSPONDER
EXPLOITATION
Echosounder
SONAR
PHYSICAL
AUV
TECHNICAL
DEFENSE
ENVIRONMENT
SHIPPING
NAVIGATION
WATERWAYS
PROTECTION
NAUTICAL
ROV
HARBOURS
DYNAMIC
EXPLORATION
FISH
LAKE
GEOPHYSICS
TIDES
MORPHOLOGY
challenging
SHIPPING
SCAN MANAGEMENT
ECHOSOUNDER
Scan
HYDROGRAPHY
Survey
CURRENTS
WAVES
WAVES
LBL
PROFILER
CHART
future