A brief inspection of the bathymetric data sets collected by the U.S. Extended Continental Shelf Mapping Program

Paul Johnson (UNH, CCOM-JHC)
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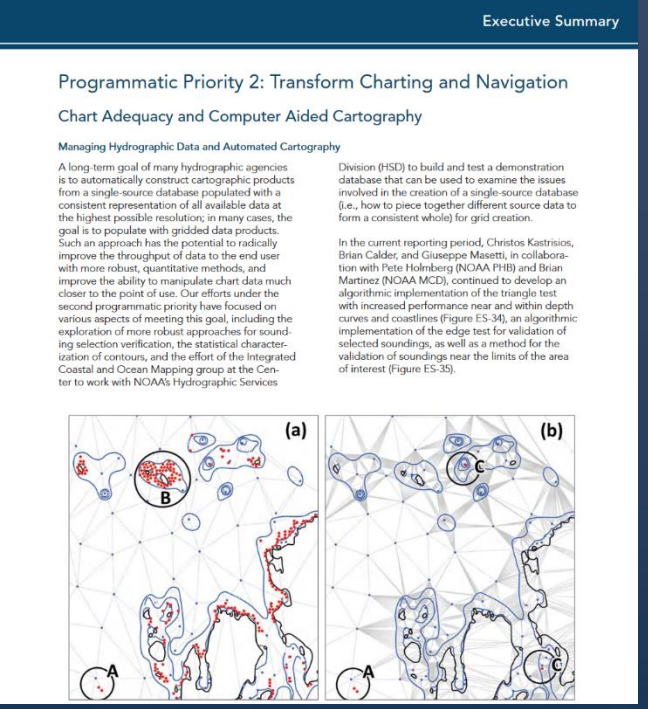
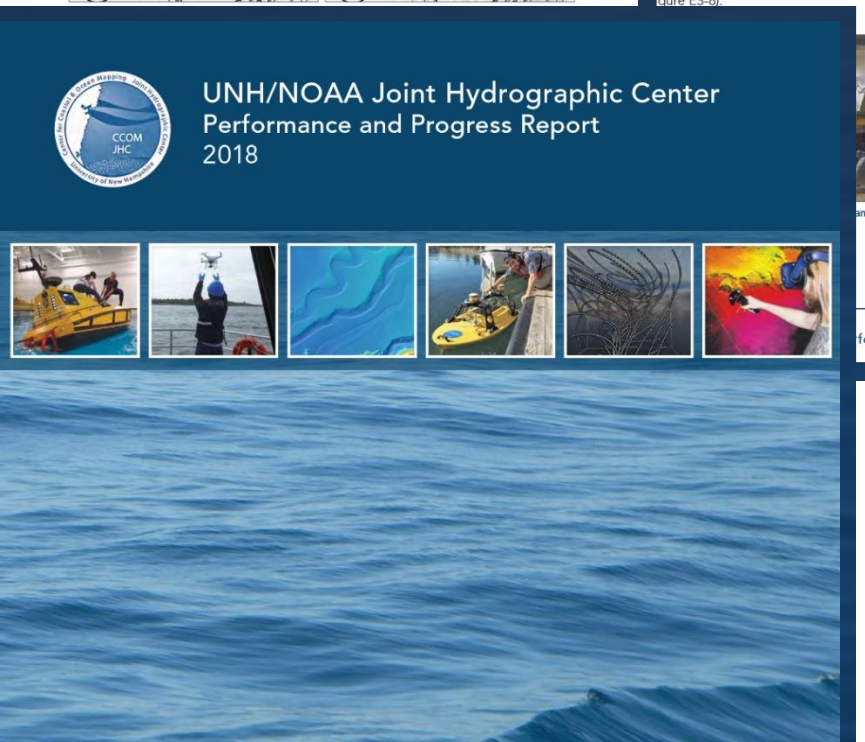
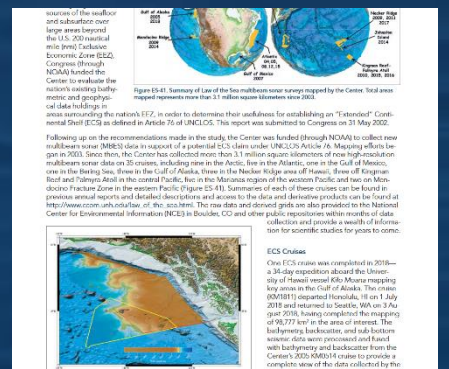
Larry Mayer (UNH, CCOM-JHC)
Andy Armstrong (NOAA, JHC)
Brian Calder (UNH, CCOM-JHC)

About UNH/CCOM-JHC

- The Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC) was founded in 1999
- Located at the University of New Hampshire's main campus in Durham, in the Jere A. Chase Ocean Engineering Lab
- JHC is a formal cooperative agreement between the University of New Hampshire and NOAA
- CCOM is the complimentary university center which conducts research and maintains collaborations with industry partners, government agencies, & academic groups.
- 17 Faculty, 21 Research Scientist & Staff, and 33 Students (14 M.S. & 12 Ph.D.)







CCOM-JHC NOAA Grant
Grant #: NA15NOS4000200

Research & effort at the center is in response to the Federal Funding Opportunity that defined four programmatic priorities

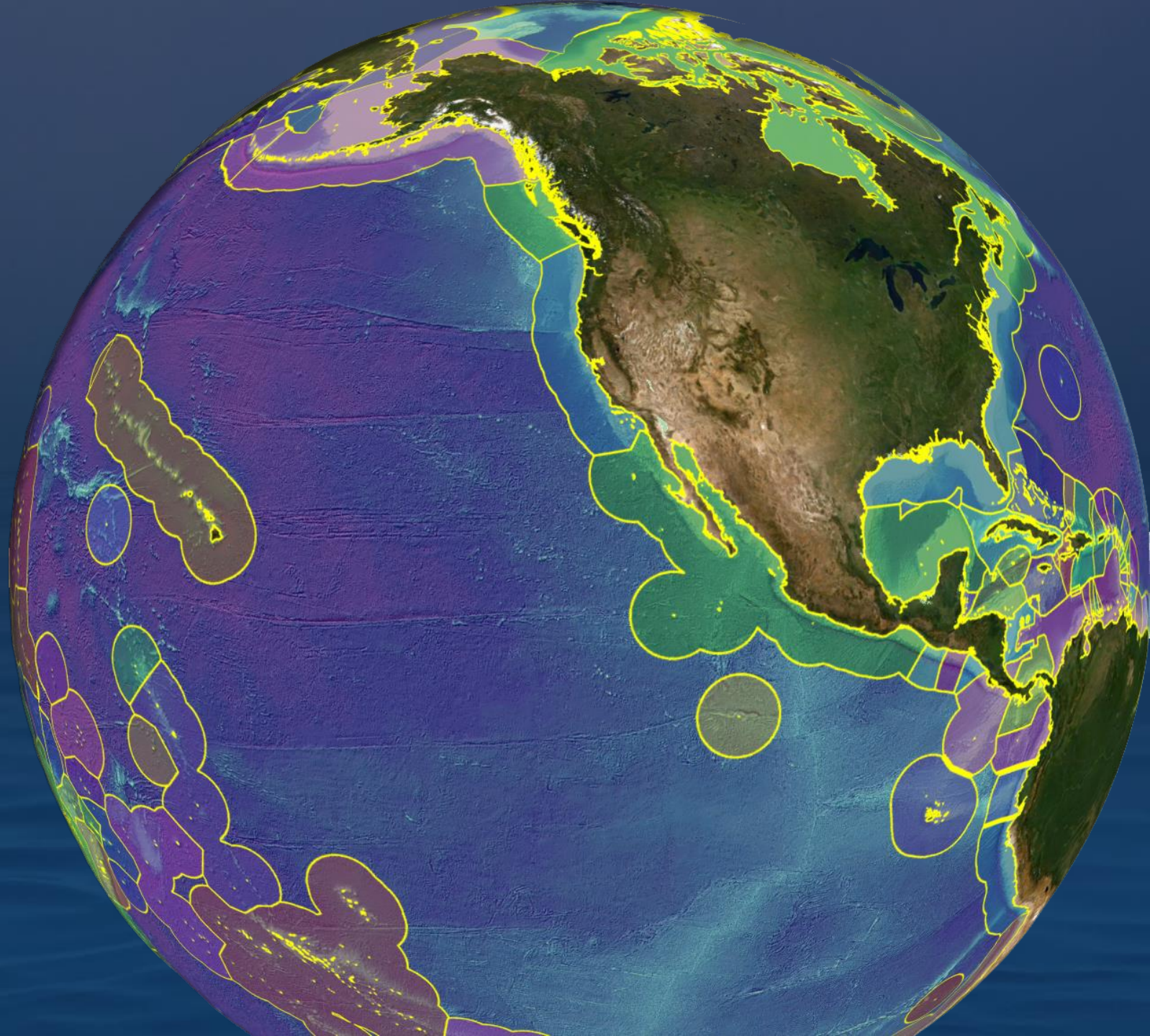
1. Innovate Hydrography
2. Transform Charting and Change Navigation
3. **Explore and Map the Continental Shelf**
4. Develop and Advance Hydrographic and Nautical Charting Expertise

http://ccom.unh.edu/sites/default/files/progress_reports/2018_jhc-ccom_full_annual_report_0.pdf

Brief History of UNCLOS United Nations Convention on the Law of the Sea

- 1949 - International Law Commission began
- 1958 - 1st Conference on UNCLOS
- 1960 - 2nd Conference on UNCLOS
- 1967 - Arvid Pardo proposed LOS to General Assembly
- 1973-1982 – 3rd Conference on UNCLOS
- April 1982 - UNCLOS adopted
  - 133 in favor, 4 against, 17 abstentions
- 1994 - UNCLOS ratified

NOTE: To date the U.S. Senate has not yet acceded to UNCLOS

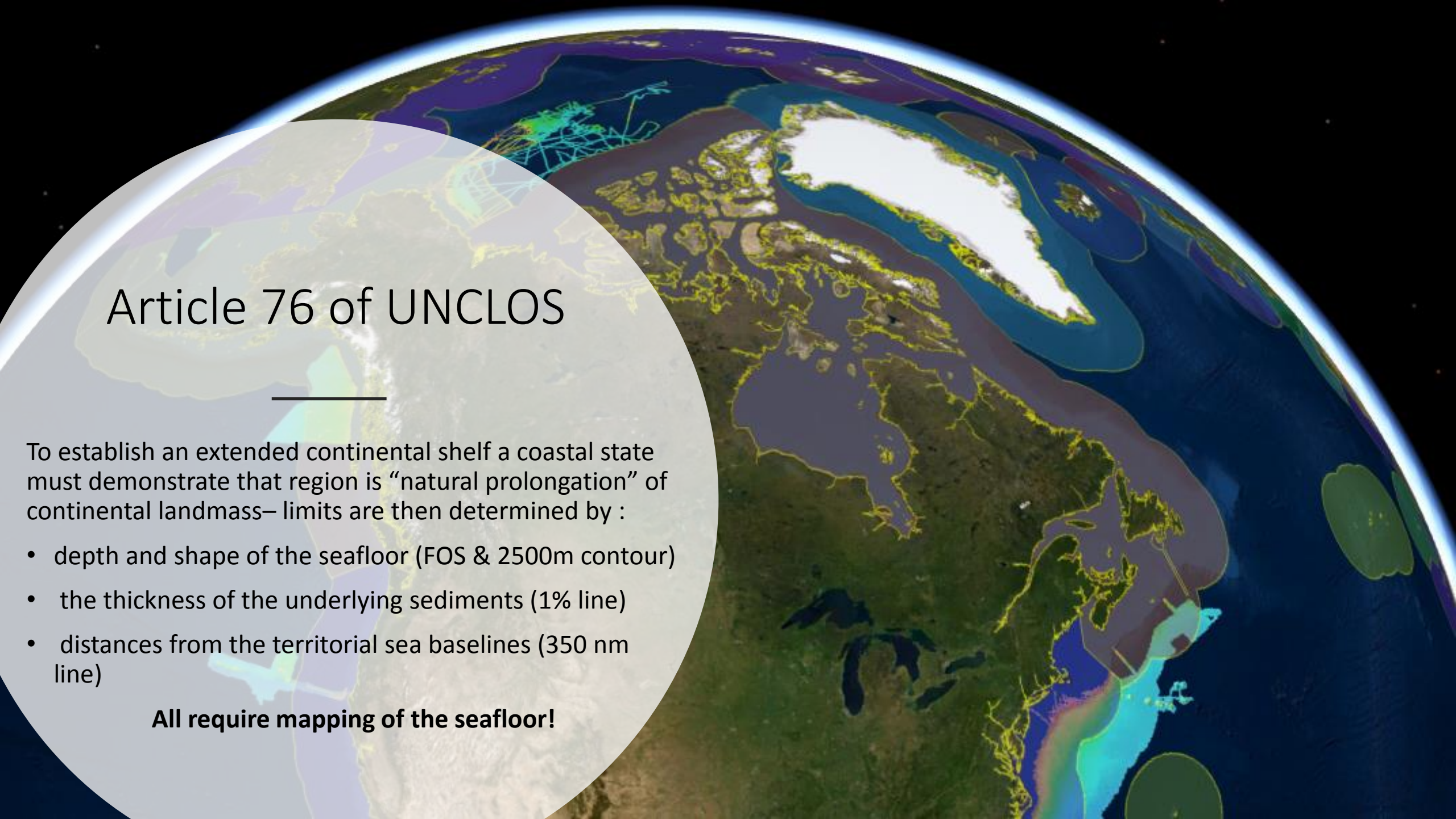


Article 76 of UNCLOS

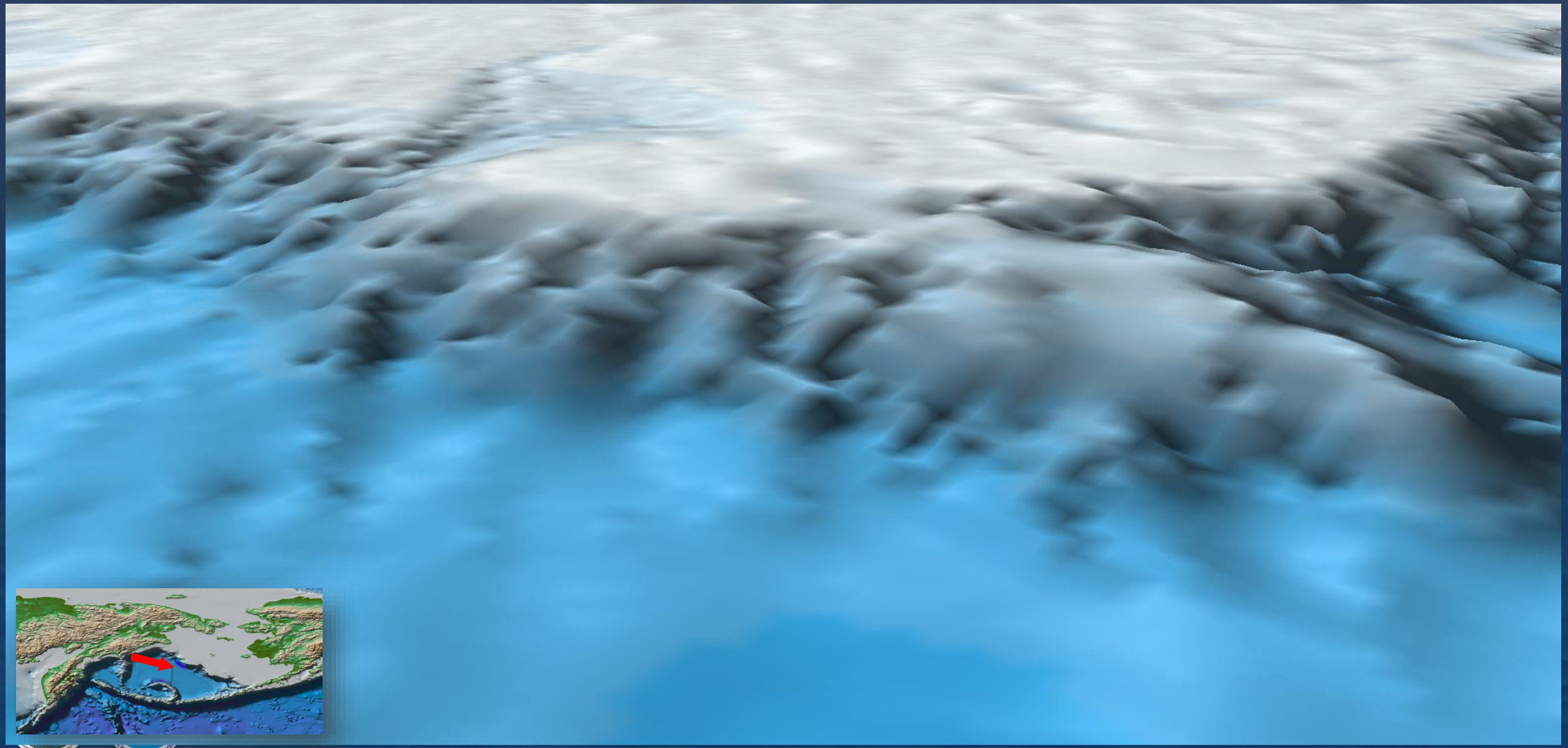
To establish an extended continental shelf a coastal state must demonstrate that region is “natural prolongation” of continental landmass– limits are then determined by :

- depth and shape of the seafloor (FOS & 2500m contour)
- the thickness of the underlying sediments (1% line)
- distances from the territorial sea baselines (350 nm line)

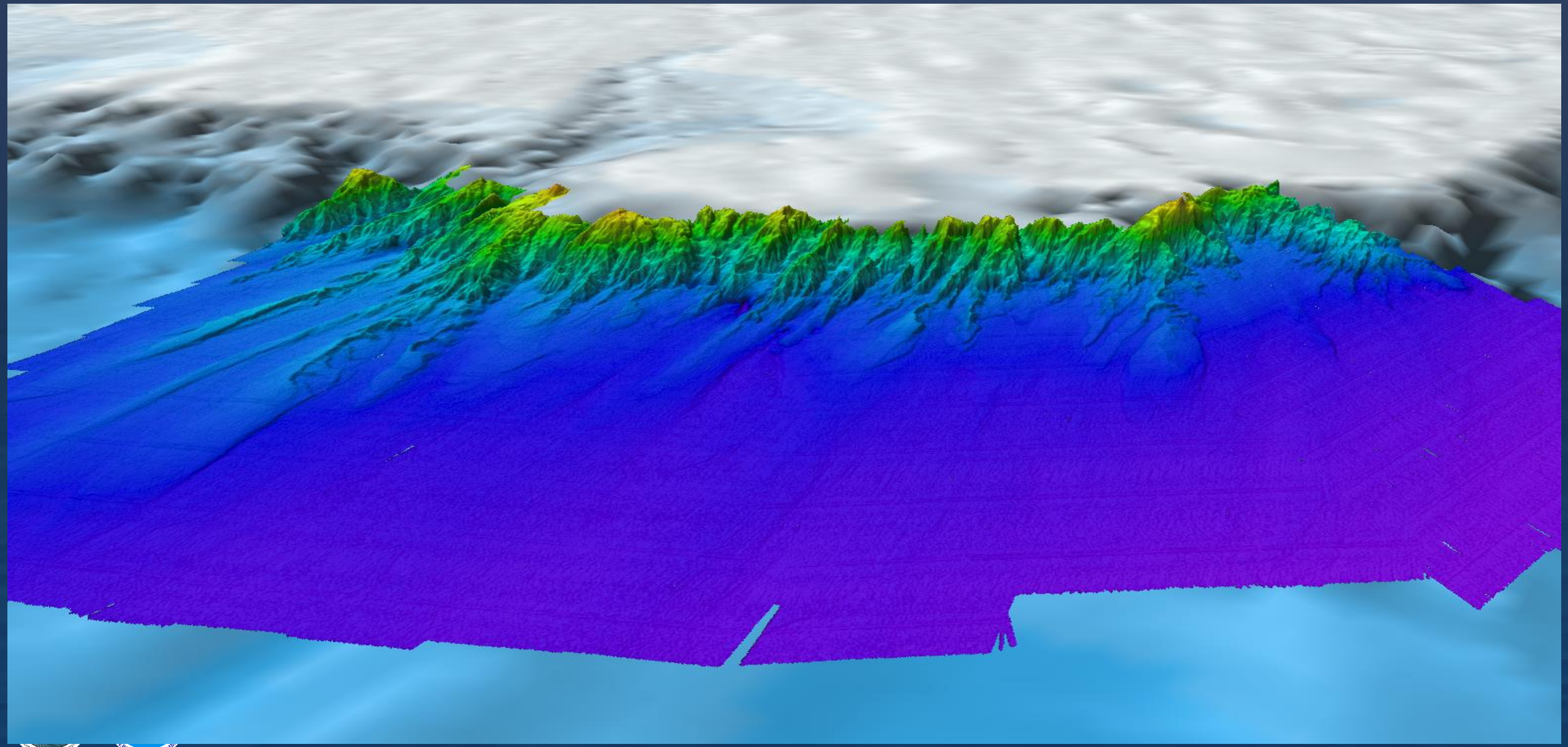
All require mapping of the seafloor!



Beringinan Margin

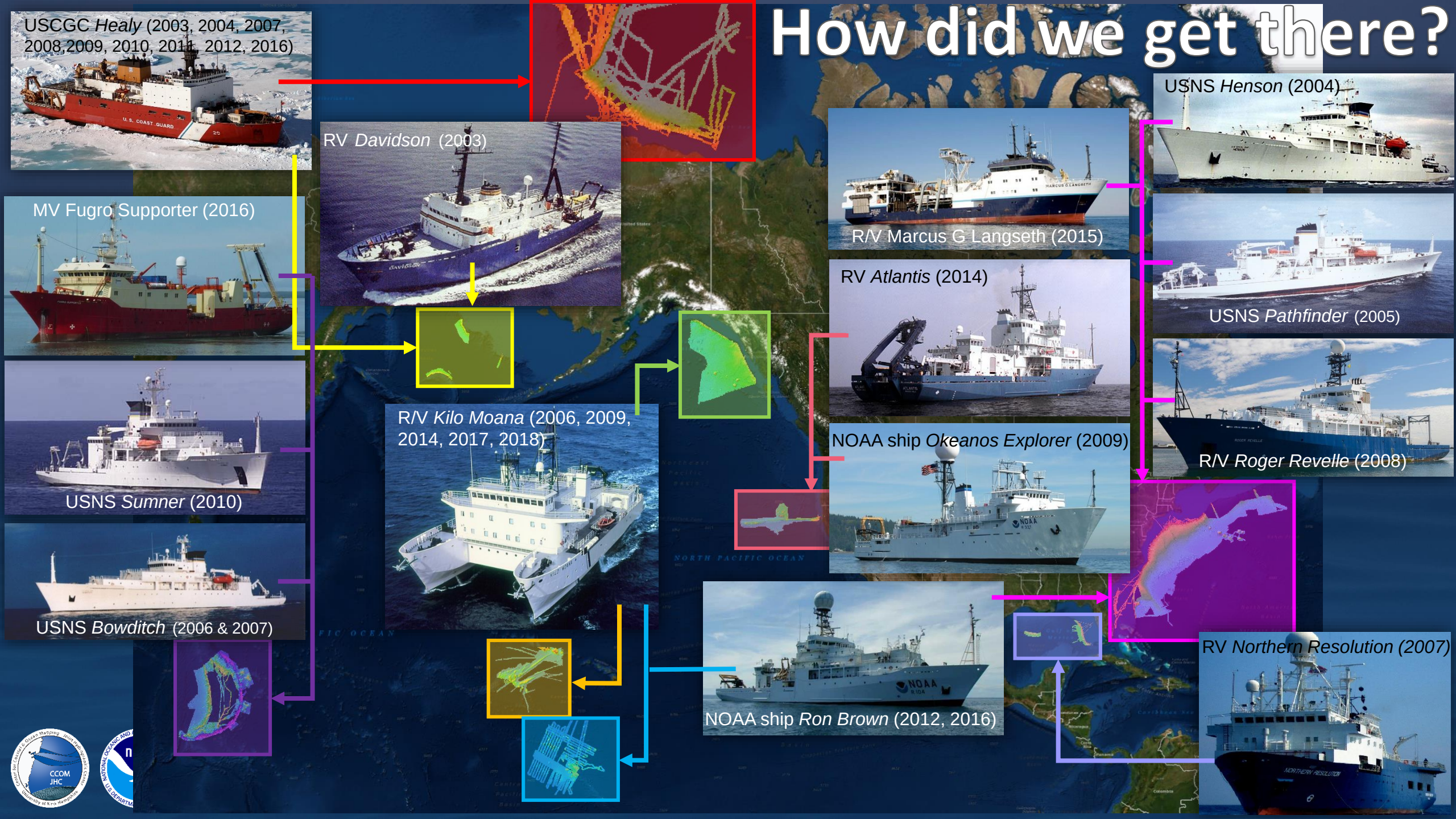


Beringian Margin

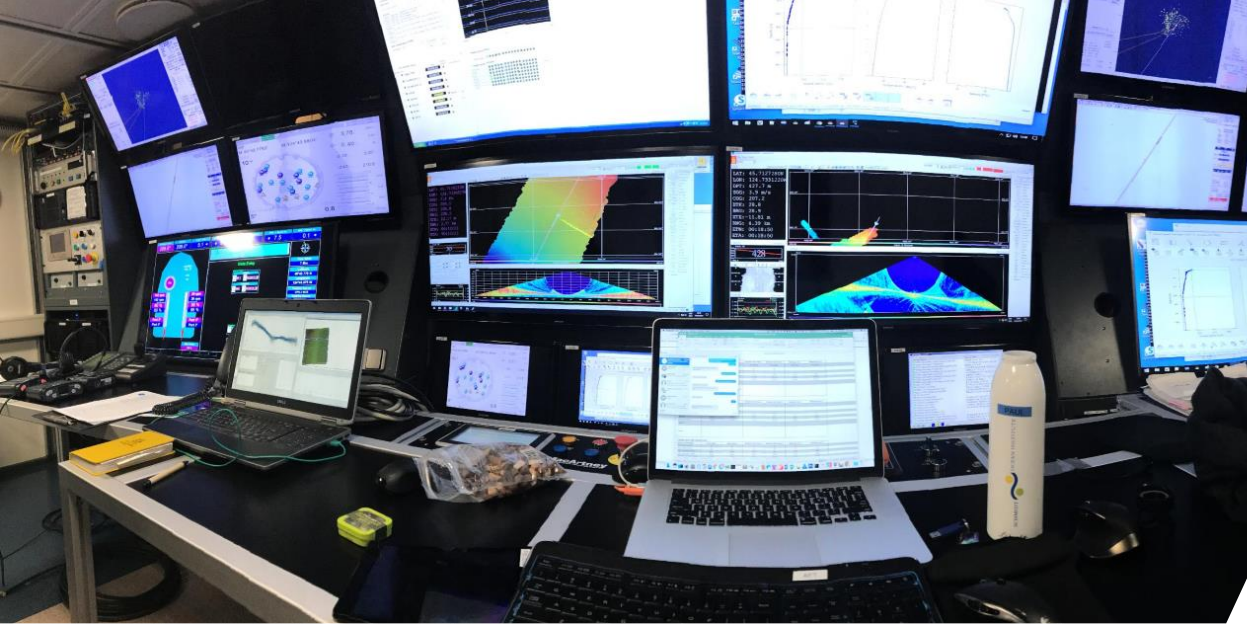


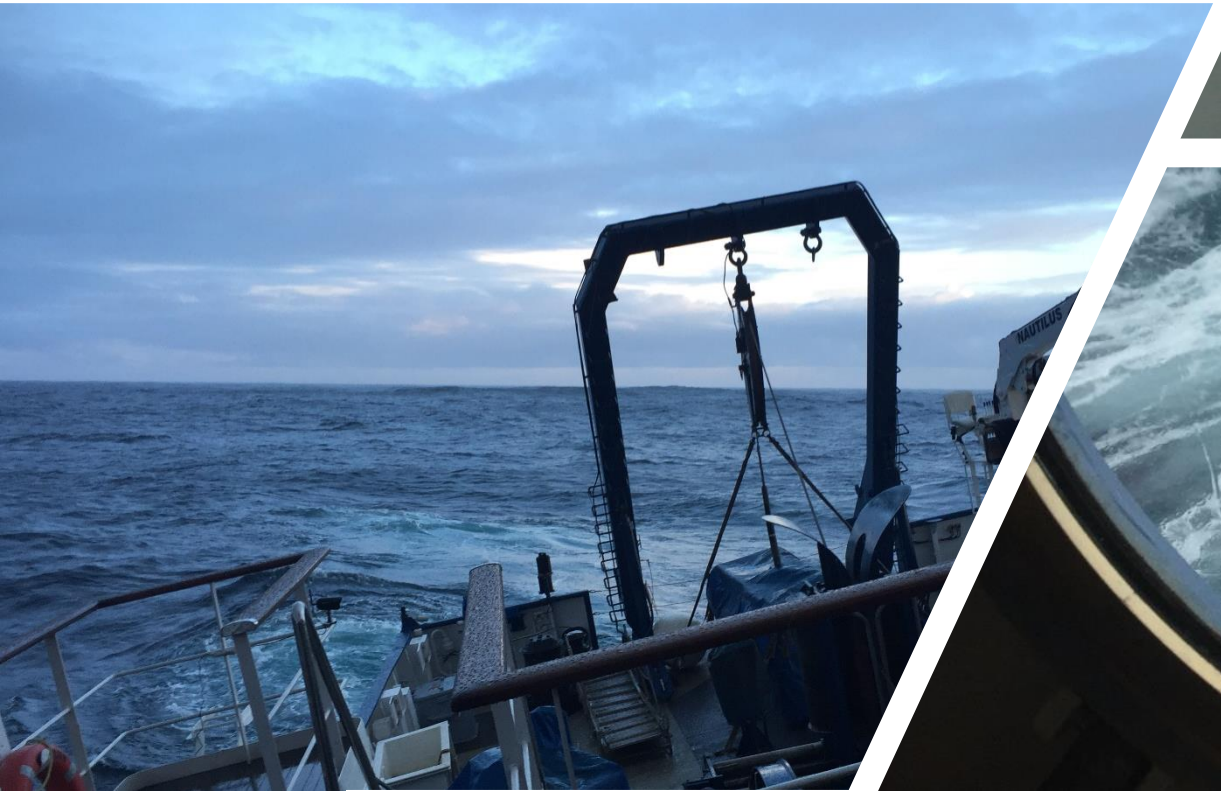
Where have we been been ?

How did we get there?



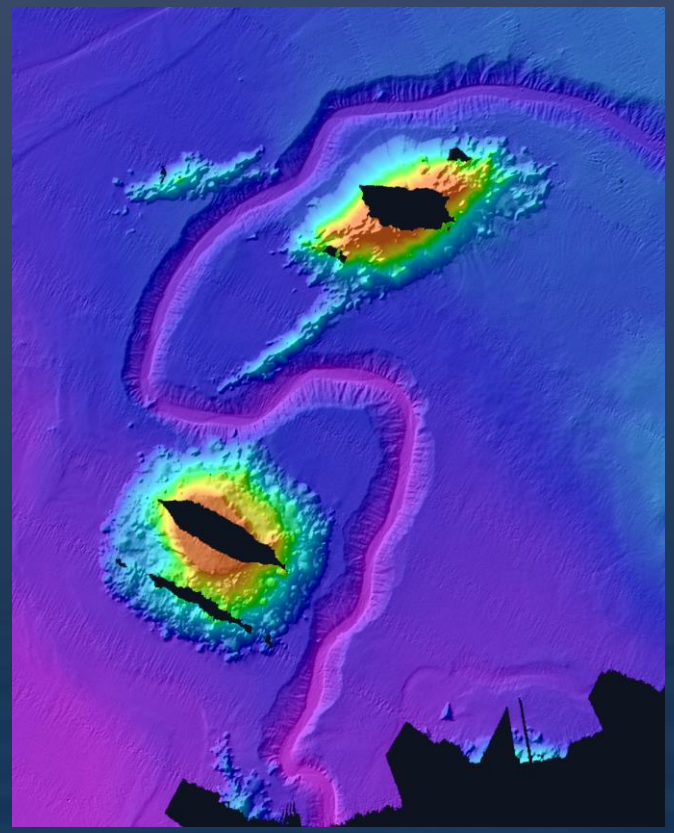
How was it done?

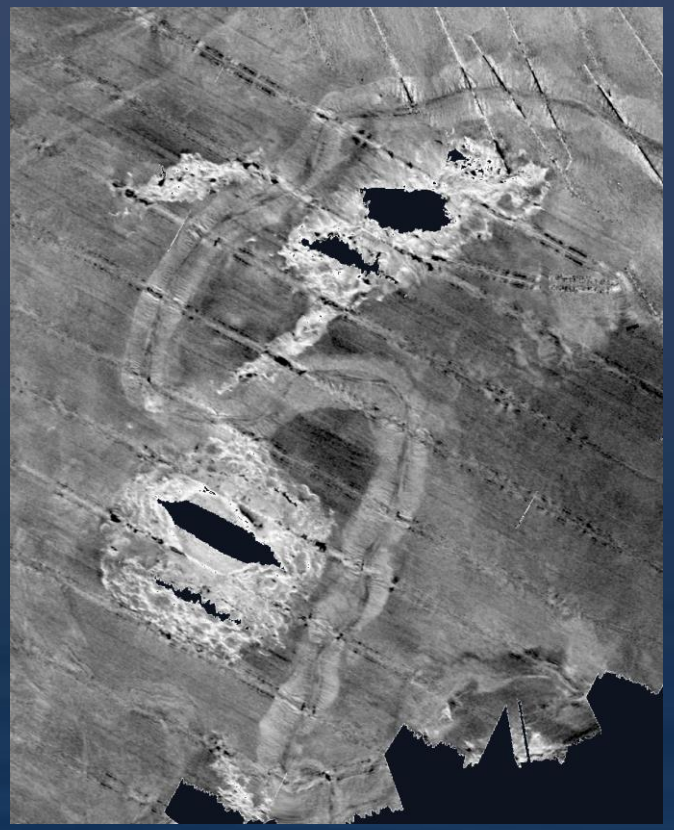


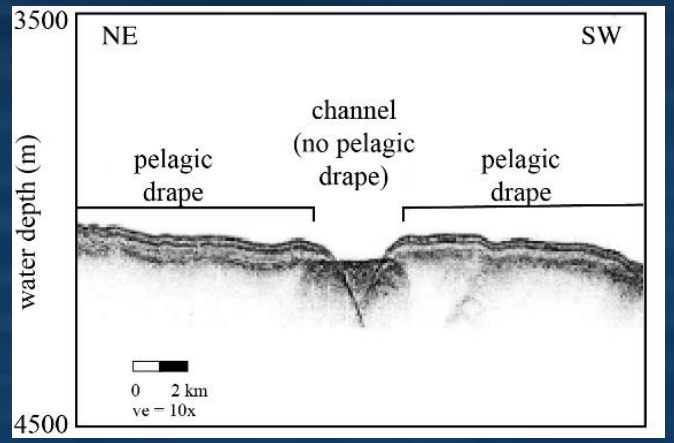


Data collection & processing…

- Multibeam Bathymetry
  - Caris HIPS/SIPS
  - QPS Qimera
  - UNB Swathed
- Multibeam Backscatter
  - QPS FMGT
- Sub-bottom profiler data
  - Chesapeake Technology SonarWiz
  - NRCAN JPEG2SEGY
- Gravity Data
  - Shipboard operation groups

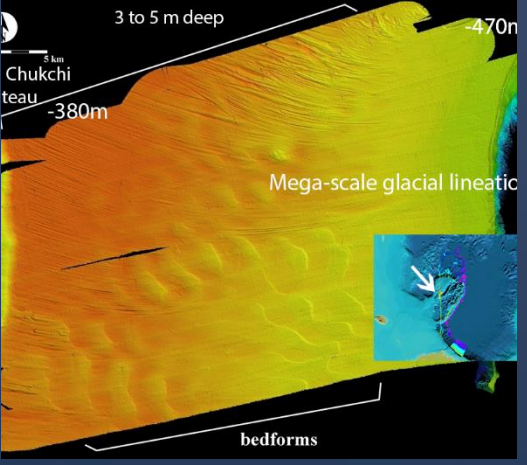


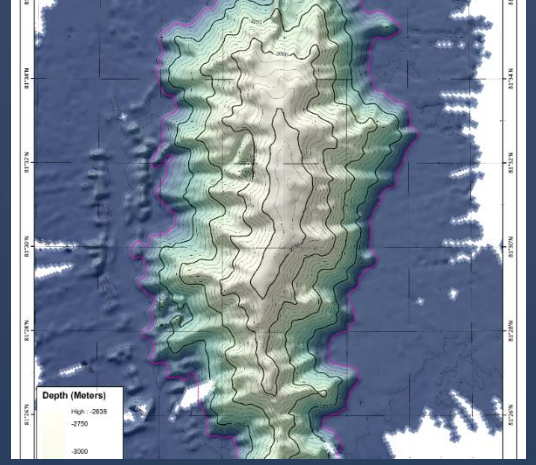


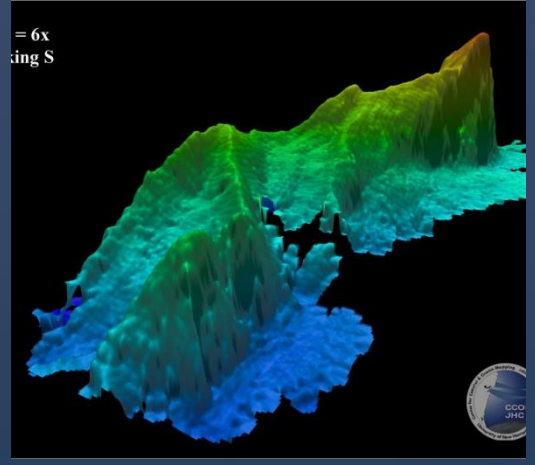


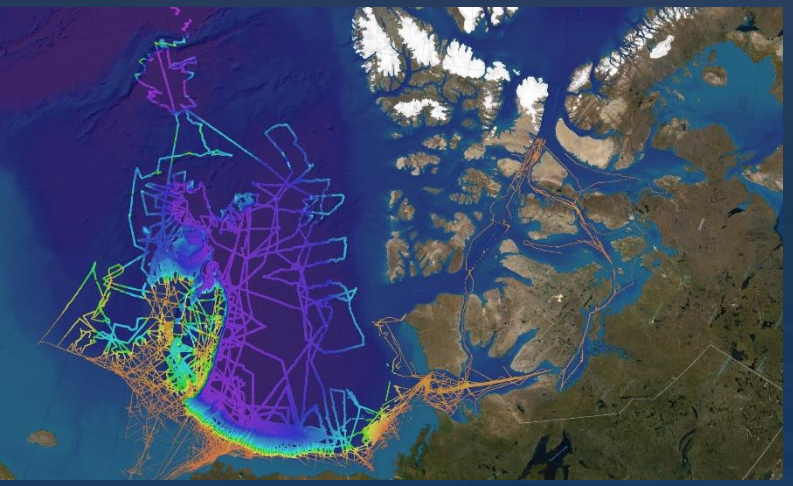
Arctic Ocean

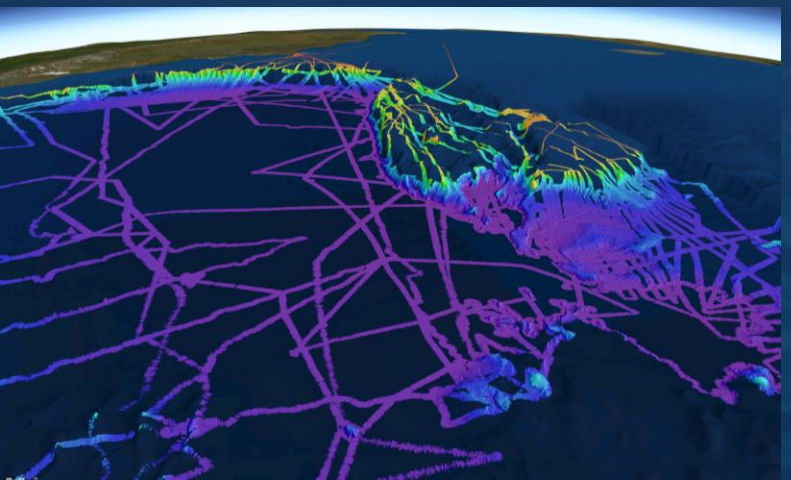
- CCOM-JHC Cruises: 8
- Days at Sea: **216**
- Survey Years: 2003 - 2016
- Ships: 1
- Multibeam Echosounder Systems:
  - Seabeam 2112
  - Kongsberg EM122
- Area Surveyed: **327,735 km²**

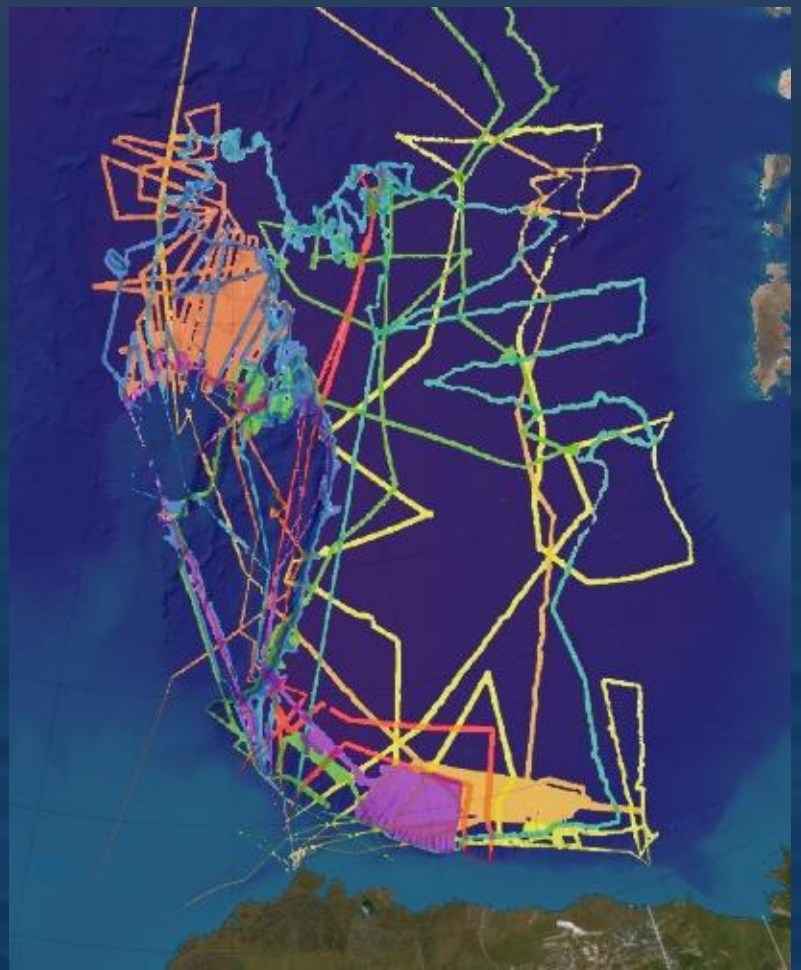












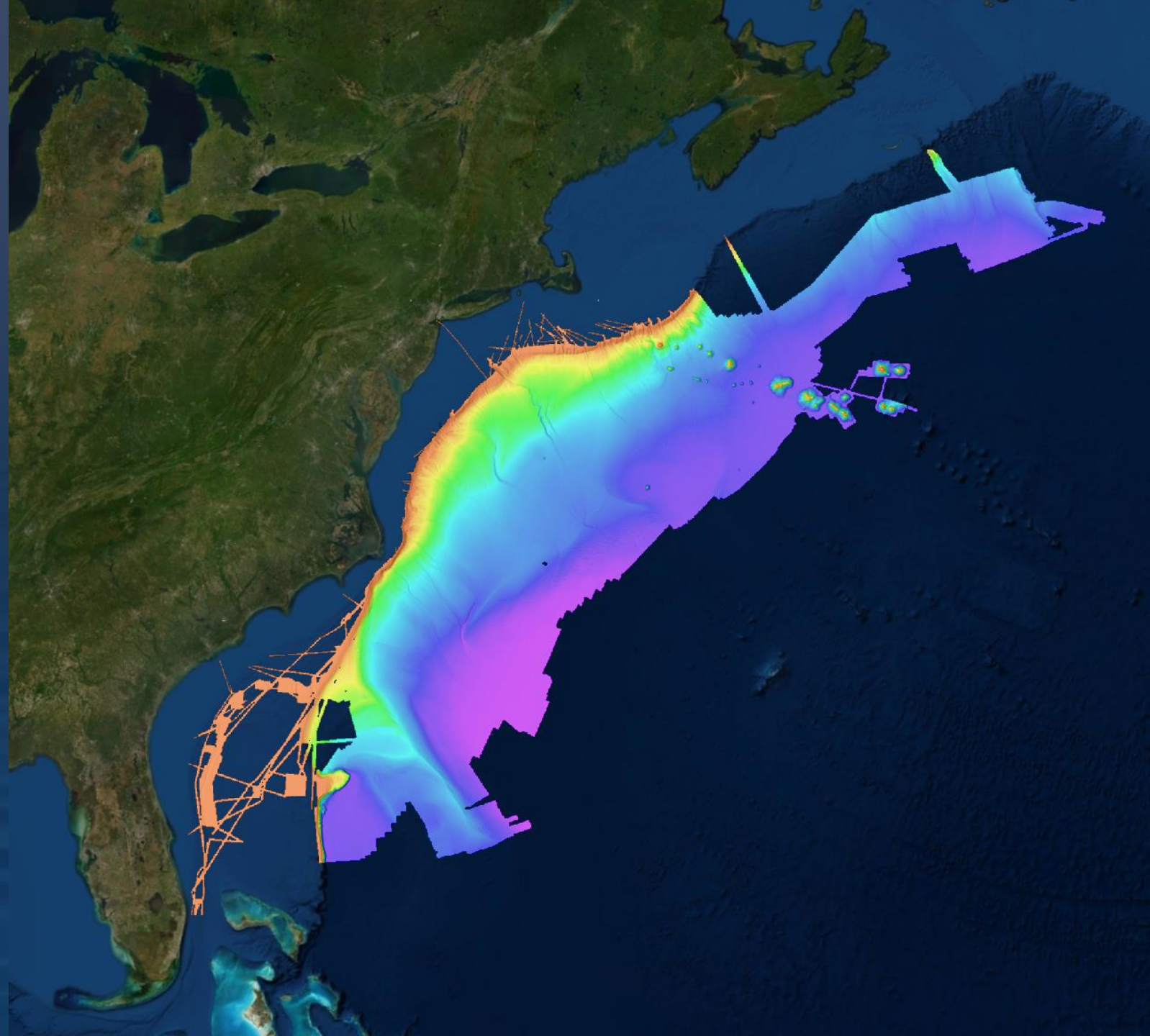
Arctic Highlights

- UNH/CCOM-JHC synthesis of ECS bathymetry – submitted to HSD/MCD
- Regional U.S. Arctic Multibeam Compilation – submitted to HSD/MCD
- New seamounts, Savaqatigiik & Healy, identified and named
- Megascale lineations discovered on Chukchi Cap → Nature Paper on 1km thick ice cap over Arctic at penultimate glaciation
- Dredging in support of ECS work has revolutionized ideas about geologic evolution of Amerasian Basin

…and a whole lot more!

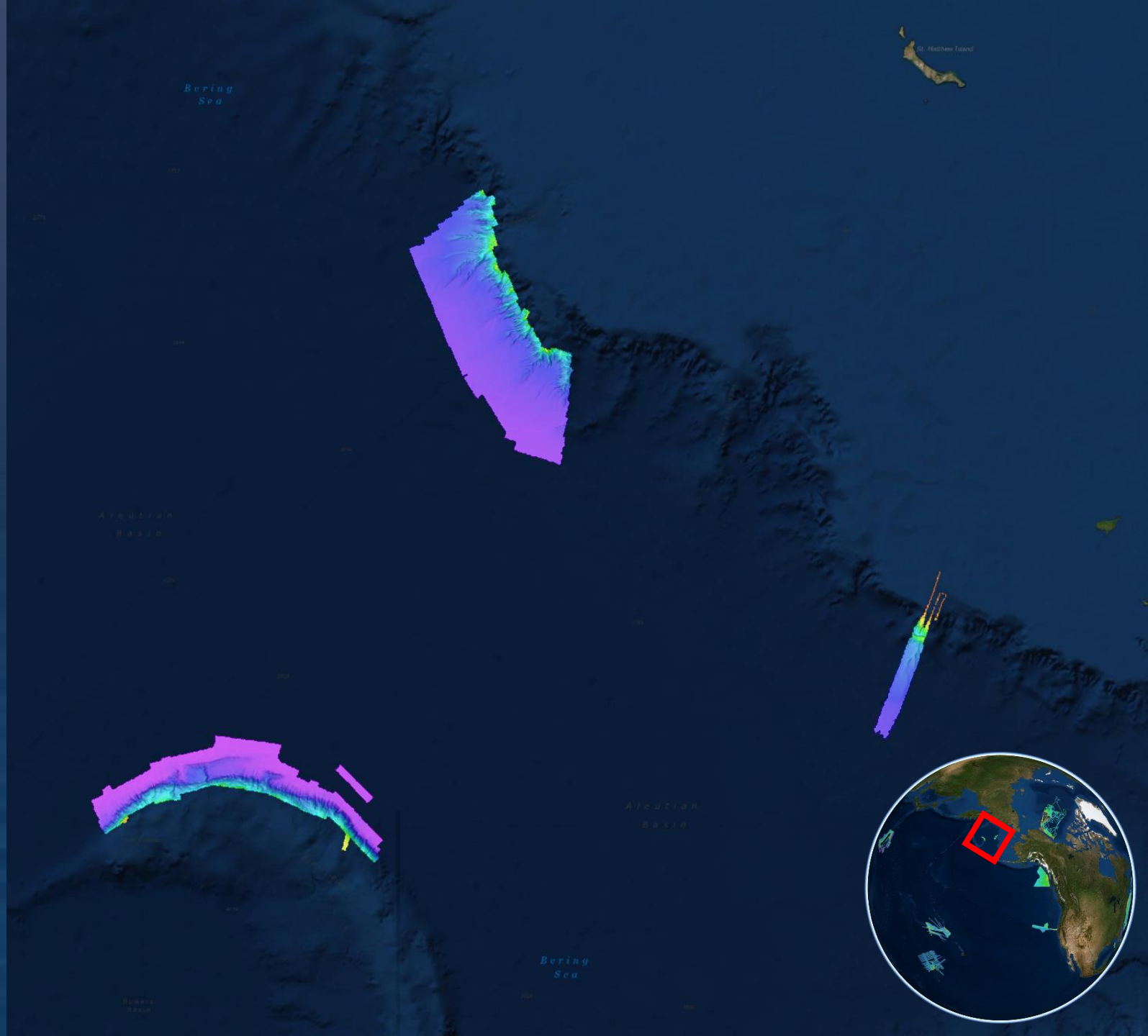
Atlantic Margin

- CCOM-JHC Cruises: 5
- Days at Sea: **239**
- Survey Years: 2005 - 2015
- Ships: 5
- Multibeam Echosounder Systems:
  - Kongsberg EM121A
  - Kongsberg EM120
  - Kongsberg EM122
- Area Surveyed: **764,093 km²**
- NOTE: Final bathymetry synthesis contains non-CCOM/JHC datasets



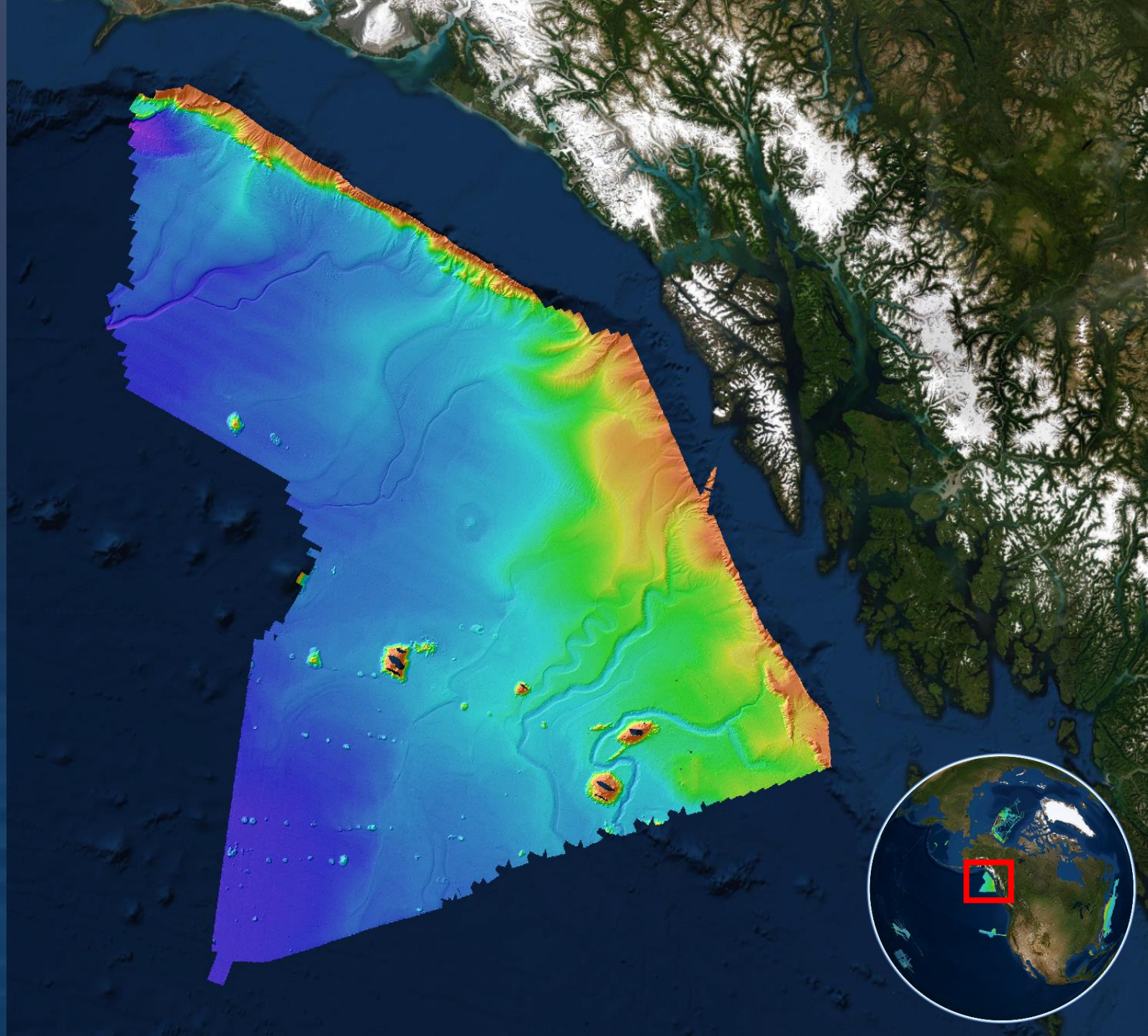
Bering Sea

- CCOM-JHC Cruises: 2
- Days at Sea: **21**
- Survey Years: 2003 - 2016
- Ships: 2
- Multibeam Echosounder Systems:
  - Reason 8150
  - Kongsberg EM122
- Area Surveyed: **20,900 km²**



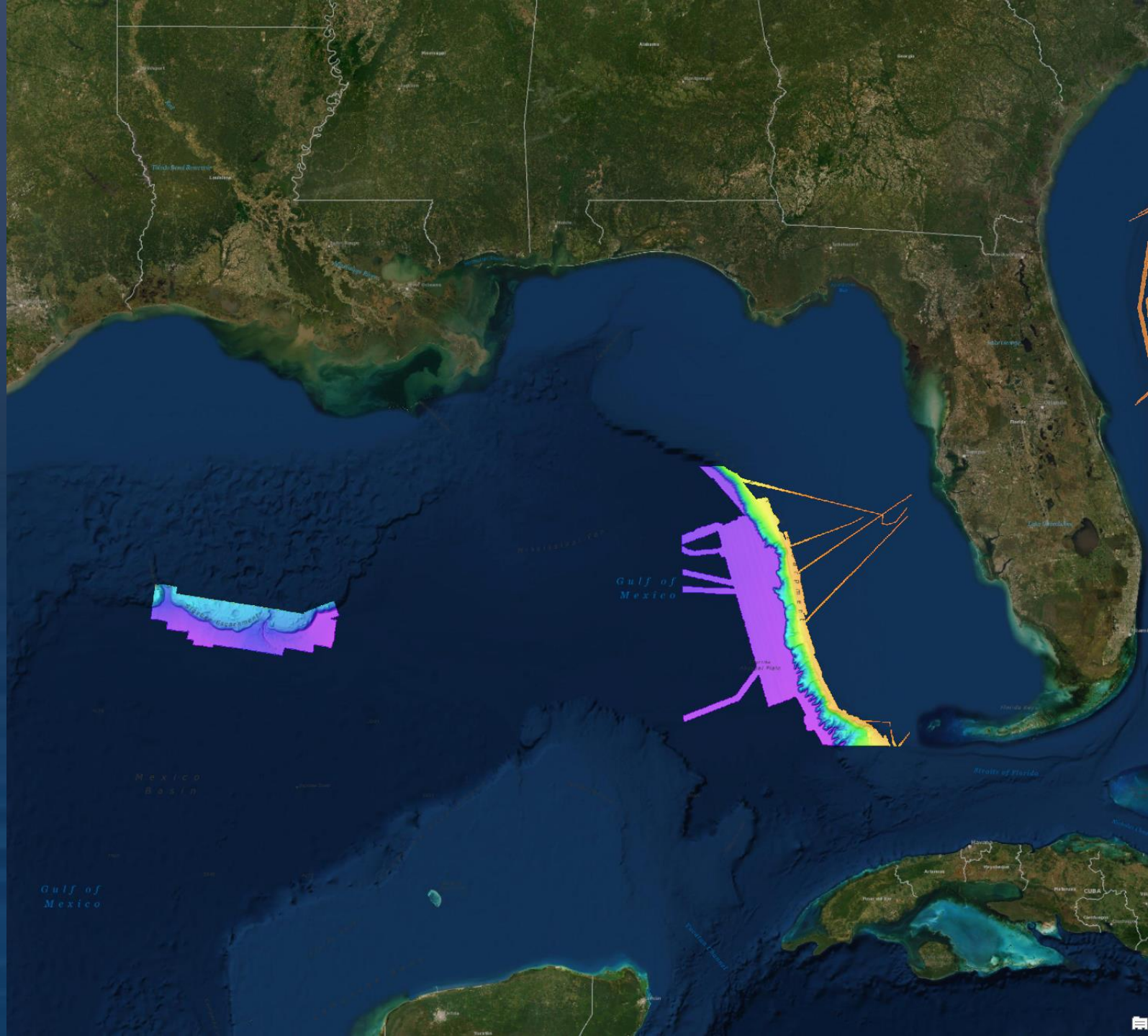
Gulf of Alaska

- CCOM-JHC
- Cruises: 2
- Days at Sea: **102**
- Survey Years: 2005 - 2018
- Ships: 1
- Multibeam Echosounder Systems:
  - Kongsberg EM120
  - Kongsberg EM122
- Area Surveyed: **420,243 km^2**



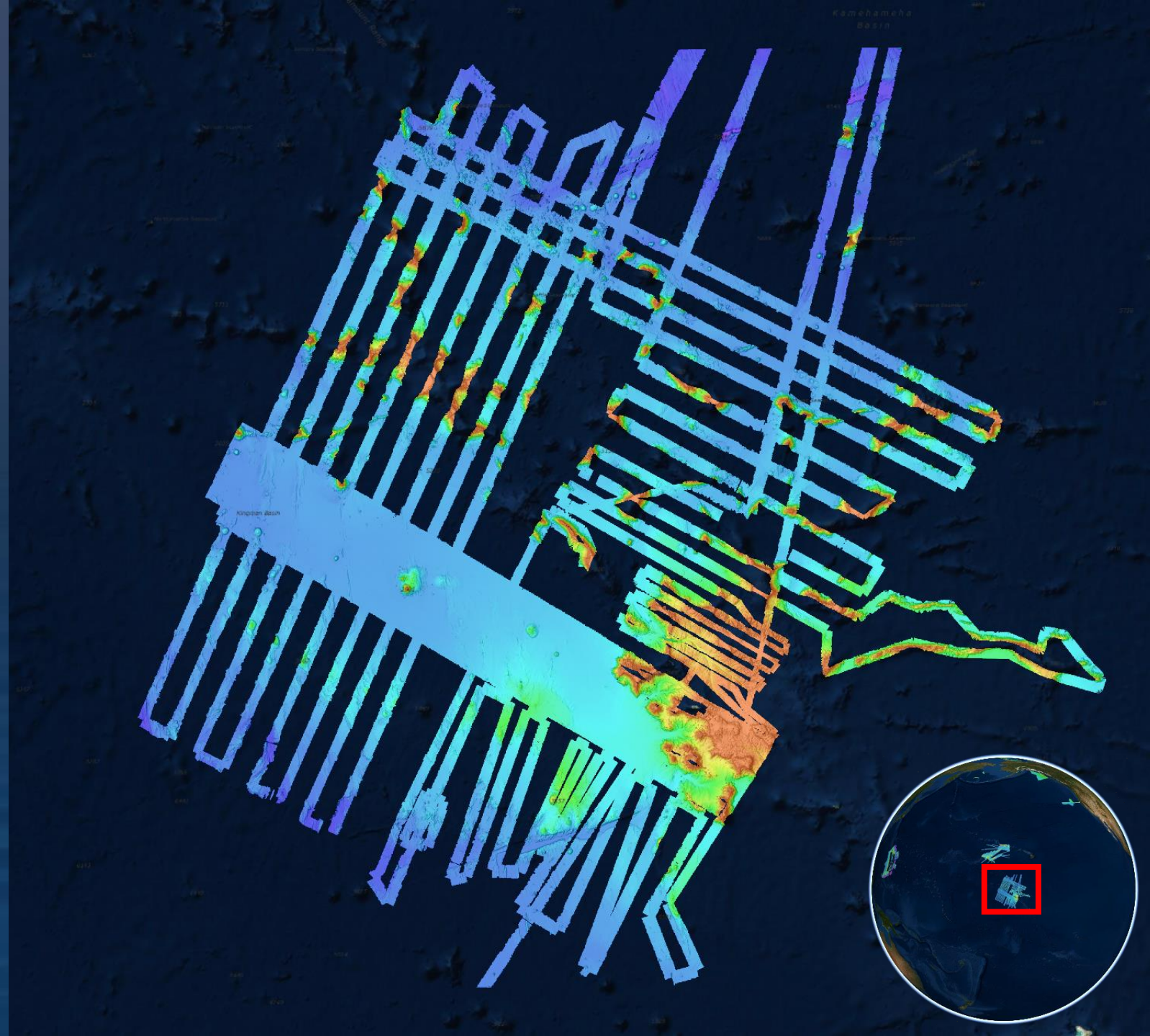
Gulf of Mexico

- CCOM-JHC Cruises: 2
- Days at Sea: **17**
- Survey Years: 2007
- Ships: 1
- Multibeam Echosounder Systems:
  - Kongsberg EM120
- Area Surveyed: **32,300 km^2**
- NOTE: Final bathymetry synthesis contains non-CCOM/JHC datasets



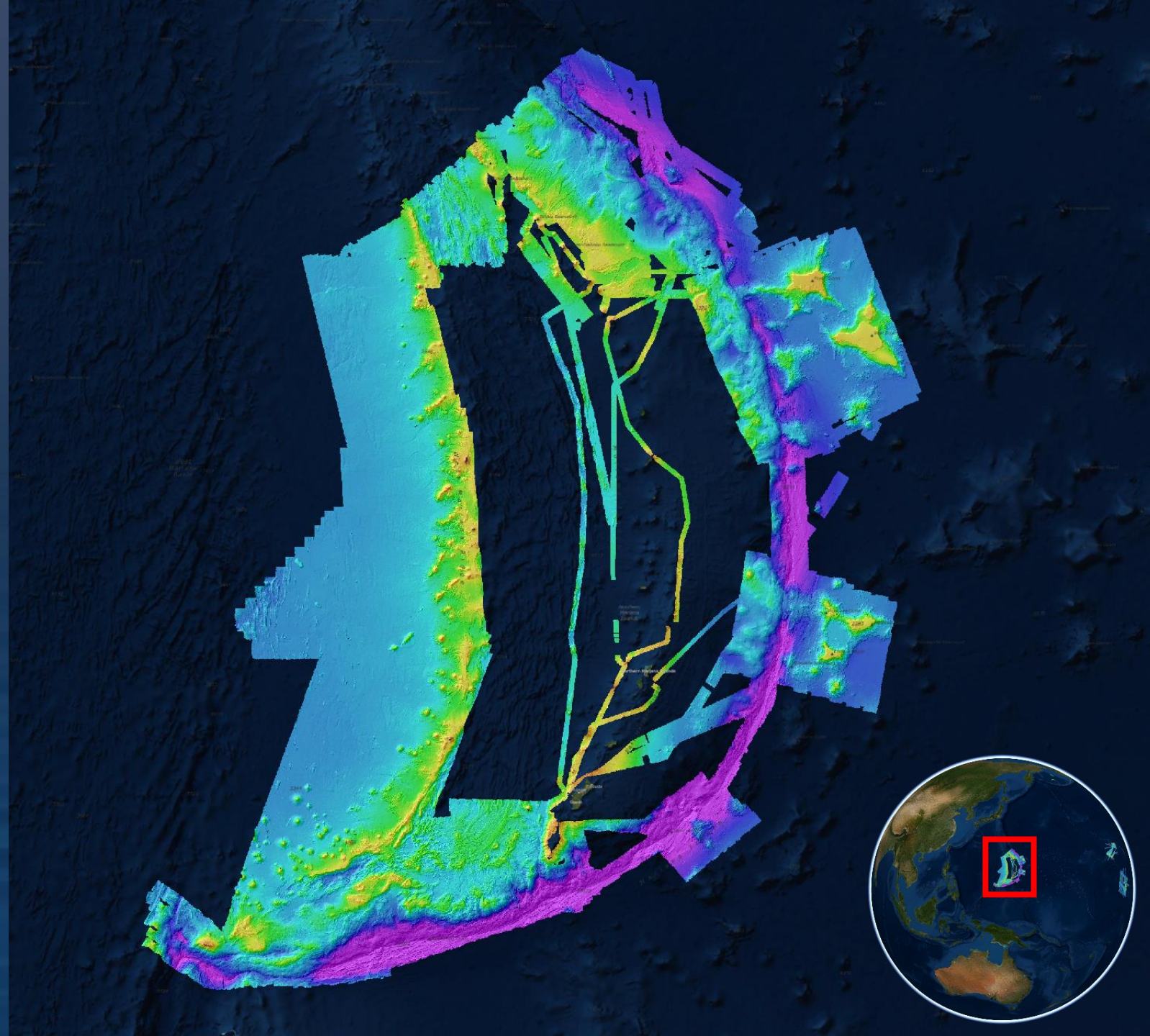
Kingman Reef
Palmyra Atoll

- CCOM-JHC Cruises: 3
- Days at Sea: **92**
- Survey Years: 2005 - 2016
- Ships: 2
- Multibeam Echosounder Systems:
  - Kongsberg EM122
- Area Surveyed: **438,391 km²**



Marianas

- CCOM-JHC Cruises: 5
- Days at Sea: **151**
- Survey Years: 2006 - 2016
- Ships: 3
- Multibeam Echosounder Systems:
  - Kongsberg EM121A
  - Kongsberg EM122
- Area Surveyed: **667,048 km²**
- NOTE: Final bathymetry synthesis contains non-CCOM/JHC datasets

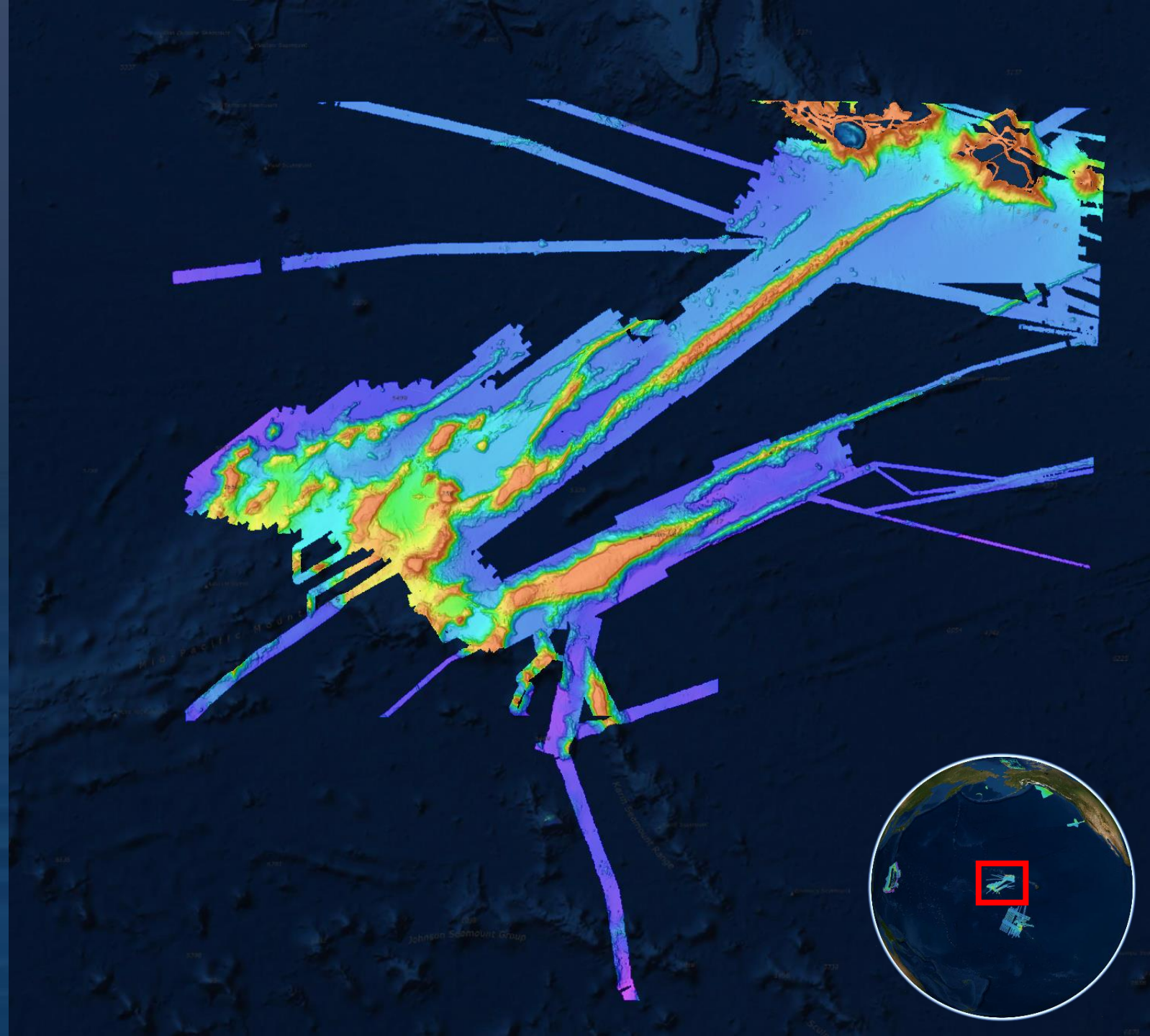


Mendocino Ridge

- CCOM-JHC Cruises: 2
- Days at Sea: **41**
- Survey Years: 2009 - 2014
- Ships: 2
- Multibeam Echosounder Systems:
  - Kongsberg EM302
  - Kongsberg EM122
- Area Surveyed: **46,436 km²**
- NOTE: Final bathymetry synthesis contains non-CCOM/JHC datasets

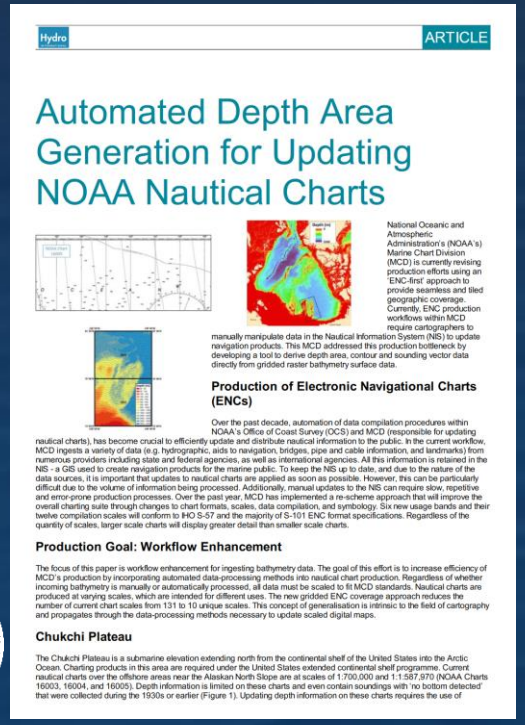
Necker Ridge Johnston Atoll

- CCOM-JHC Cruises: 4
- Days at Sea: **73**
- Survey Years: 2009 - 2016
- Ships: 2
- Multibeam Echosounder Systems:
  - Kongsberg EM302
  - Kongsberg EM122
- Area Surveyed: **215,371 km^2**
- NOTE: Final bathymetry synthesis contains non-CCOM/JHC datasets



Collect Once Use Many….ECS Data In NOAA Charts

- US Arctic ECS, US Arctic Multibeam Compilation, and IBCAO submitted to HSD/MCD
- Data incorporated into the Band 2 (1:640K) chart for the Arctic Ocean
- Shachak Pe’eri & Noel Dyer, Hydro Internaional Article



Hydro ARTICLE

Automated Depth Area Generation for Updating NOAA Nautical Charts

National Oceanic and Atmospheric Administration’s (NOAA’s) Marine Chart Division (MCD) is currently revising production efforts using an ‘ENC-first’ approach to provide seamless and tied geographic coverage. Currently, ENC production workflows within MCD require cartographers to manually manipulate data in the Nautical Information System (NIS) to update navigation products. This MCD addressed this production bottleneck by developing a tool to derive depth area, contour and sounding vector data directly from gridded raster bathymetry surface data.

Production of Electronic Navigational Charts (ENCs)

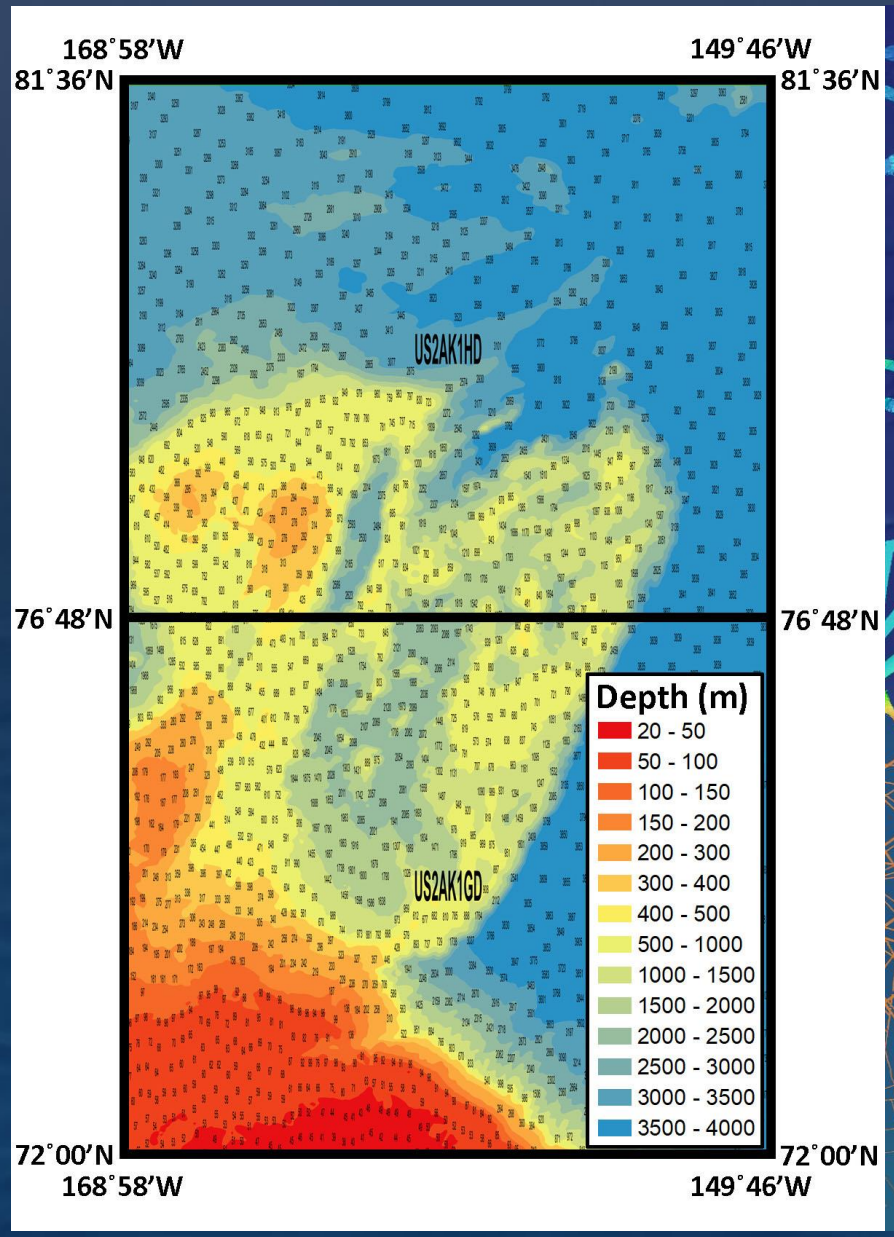
Over the past decade, automation of data compilation procedures within NOAA’s Office of Coast Survey (OCS) and MCD (responsible for updating nautical charts), has become crucial to efficiently update and distribute nautical information to the public. In the current workflow, MCD ingests a variety of data (e.g. hydrographic, aids to navigation, bridges, pipe and cable information, and landmarks) from numerous providers including state and federal agencies, as well as international agencies. All this information is retained in the NIS - a GIS used to create navigation products for the marine public. To keep the NIS up to date, and due to the nature of the data sources, it is important that updates to nautical charts are applied as soon as possible. However, this can be particularly difficult due to the volume of information being processed. Additionally, manual updates to the NIS can require slow, repetitive and error-prone production processes. Over the past year, MCD has implemented a re-scheme approach that will improve the overall charting suite through changes to chart formats, scales, data compilation, and symbology. Six new usage bands and their twelve compilation scales will conform to IHO S-57 and the majority of S-101 ENC format specifications. Regardless of the quantity of scales, larger scale charts will display greater detail than smaller scale charts.

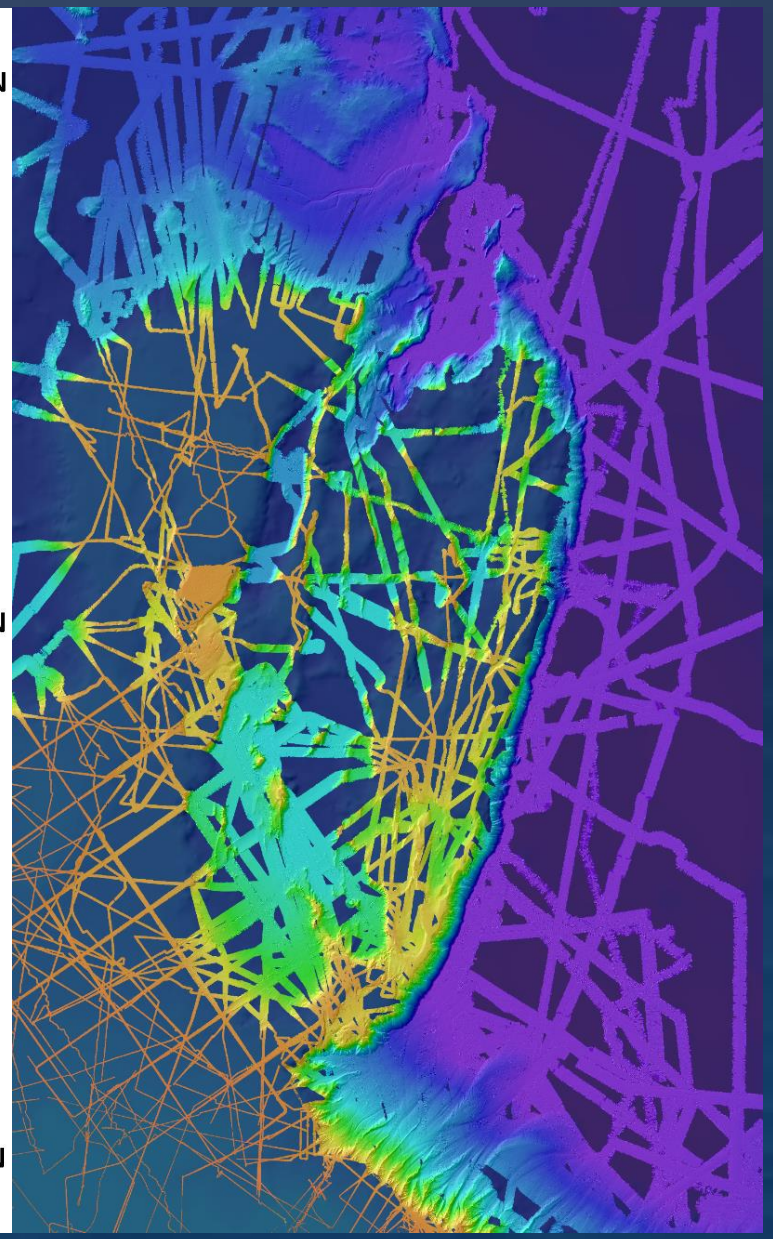
Production Goal: Workflow Enhancement

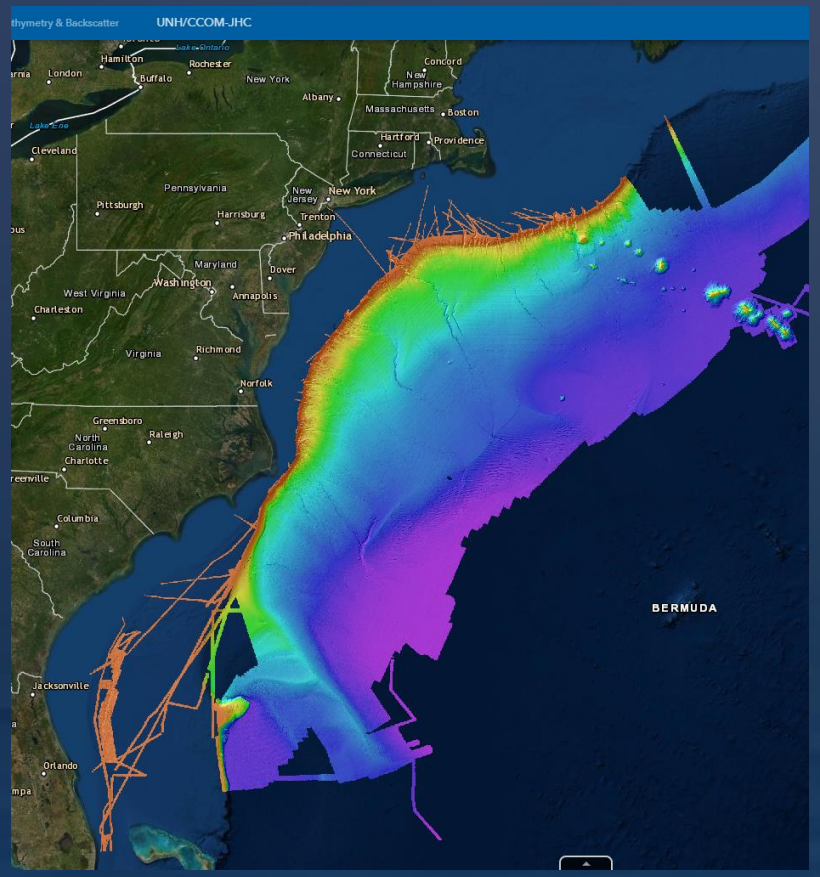
The focus of this paper is workflow enhancement for ingesting bathymetry data. The goal of this effort is to increase efficiency of MCD’s production by incorporating automated data-processing methods into nautical chart production. Regardless of whether incoming bathymetry is manually or automatically processed, all data must be scaled to fit MCD standards. Nautical charts are produced at varying scales, which are intended for different uses. The new gridded ENC coverage approach reduces the number of current chart scales from 131 to 10 unique scales. This concept of generalisation is intrinsic to the field of cartography and propagates through the data-processing methods necessary to update scaled digital maps.

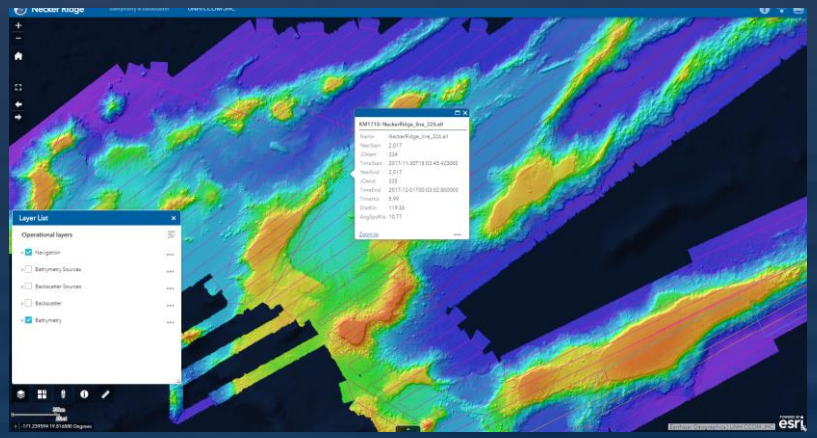
Chukchi Plateau

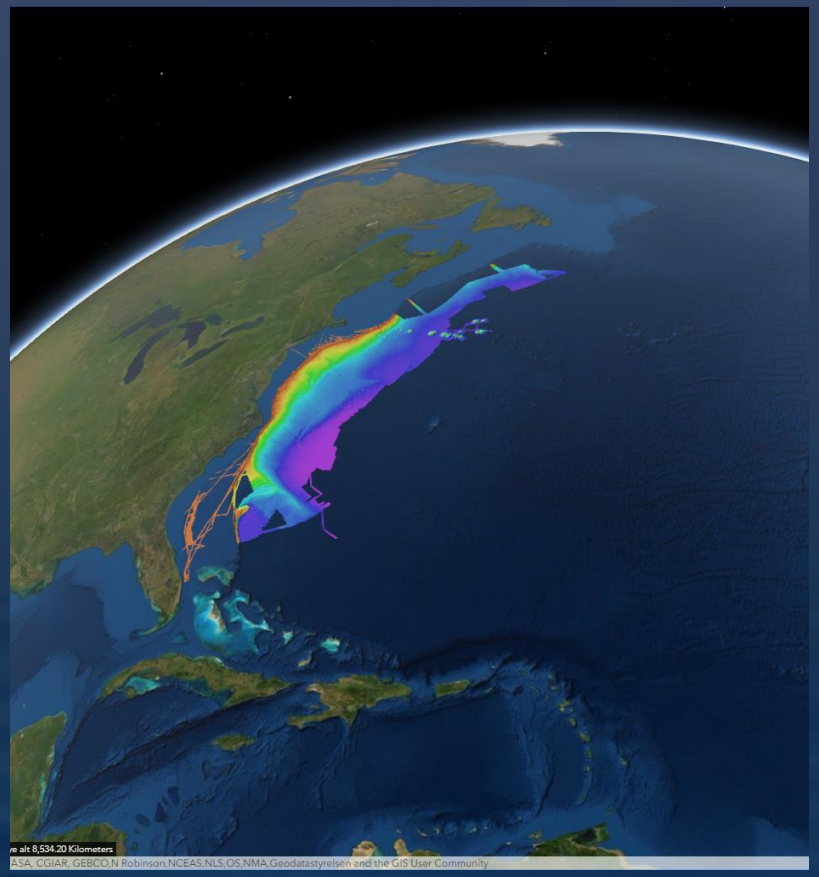
The Chukchi Plateau is a submarine elevation extending north from the continental shelf of the United States into the Arctic Ocean. Charting products in this area are required under the United States extended continental shelf programme. Current nautical charts over the offshore areas near the Alaskan North Slope are at scales of 1:700,000 and 1:1:587,970 (NOAA Charts 16003, 16004, and 16005). Depth information is limited on these charts and even contain soundings with ‘no bottom detected’ that were collected during the 1930s or earlier (Figure 1). Updating depth information on these charts requires the use of

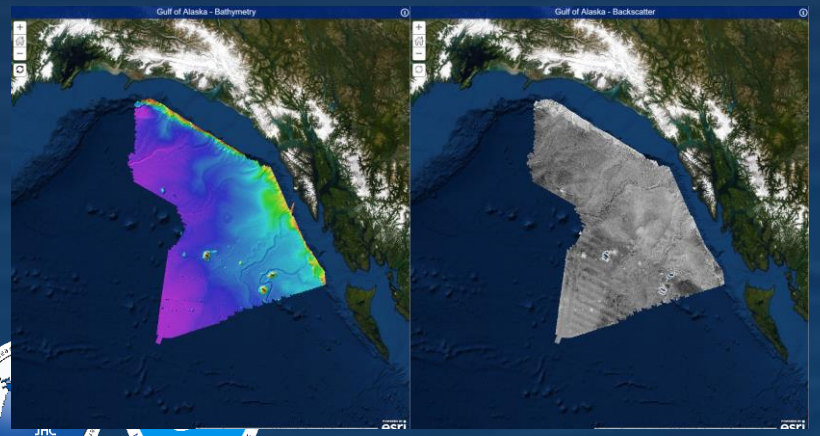












Collect once use many…
Shared publicly available Web Map Apps

ESRI GIS Portal: https://maps.ccom.unh.edu

ArcGIS REST Services Directory

Home > services

JSON | SOAP

Folder: /

Current Version: 10.61

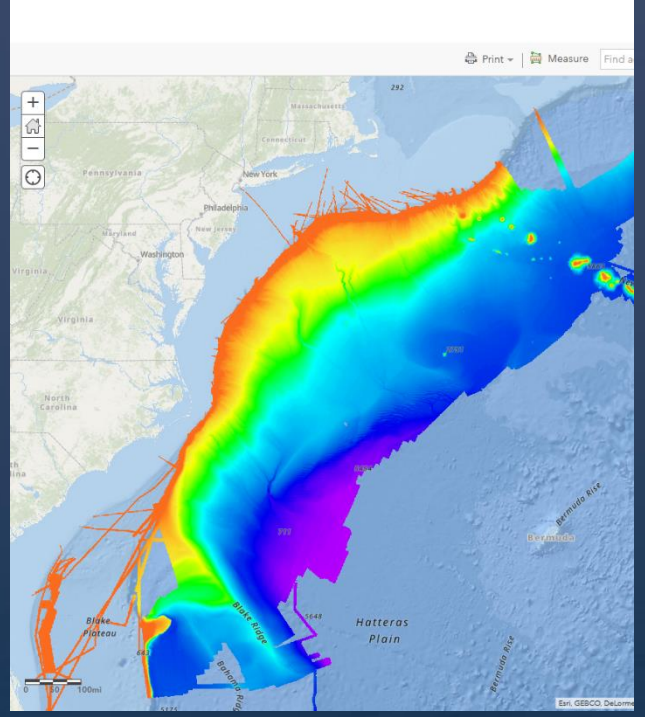
View Footprints In: ArcGIS Online Map Viewer

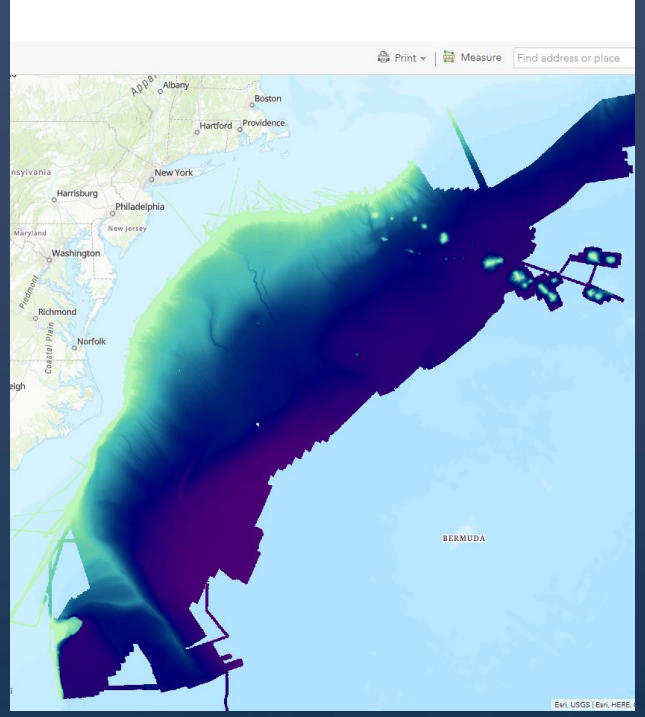
Folders:

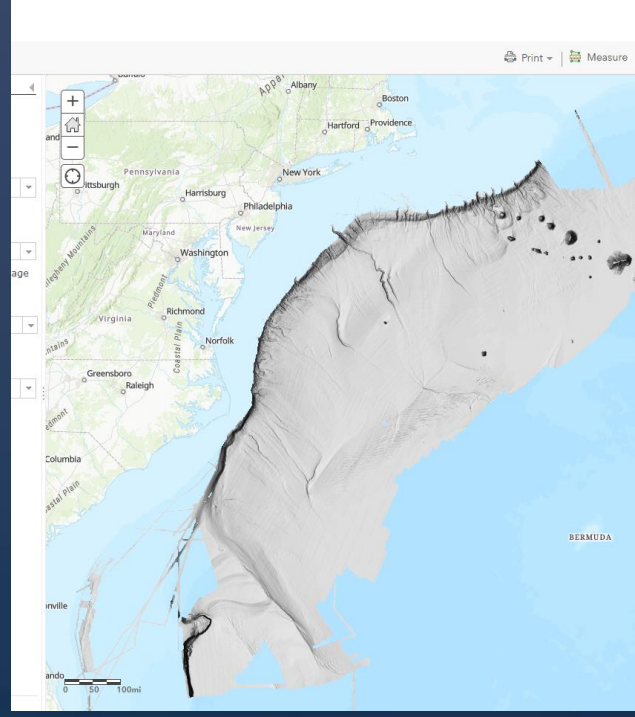
- GulfOfMaine
- Hosted
- LOTS_Arctic
- LOTS_Atlantic
- LOTS_BeringSea
- LOTS_GulfOfAlaska
- LOTS_GulfOfMexico
- LOTS_JohnstonAtoll
- LOTS_KingmanPalmyra
- LOTS_Marianas
- LOTS_Mendocino
- LOTS_NeckerRidge
- MAC
- Seabed2030
- SOI
- Utilities
- World

Services:

- Atlantic_Bathymetry_Scene_WEL1 (ImageServer)
- Atlantic_Bathymetry_Scene_WEL (ImageServer)
- Bering_Sea_Backscatter_2019_MIL1 (MapServer)
- Bering_Sea_Bathymetry_2019_MIL1 (MapServer)
- GEBCO_2014__SID_No_Interpolation (MapServer)
- GEBCO_2019_Bathymetry_Grey (MapServer)
- GEBCO_2019_Globe_WEL (ImageServer)
- GEBCO_2019_Scene_WEL (ImageServer)
- GEBCO_2019_SID_No_Interpolation (MapServer)
- Gulf_of_Alaska_Bathymetry_Scene_WEL1 (ImageServer)
- Gulf_of_Alaska_Bathymetry_Scene_WEL (ImageServer)
- WGOM_Bathymetry_Scene_WEL1 (ImageServer)
- WGOM_Bathymetry_Scene_WEL (ImageServer)
- WGOM_Bathymetry (MapServer)
- WGOM_HiRes_Bathymetry_2m_IS (ImageServer)







ArcGIS REST Services Directory

Login

Home > services > LOTS_Atlantic > Atlantic_ECSbathymetry_201902_IS (ImageServer)

Help | API Reference

JSON | SOAP

LOTS_Atlantic/Atlantic_ECSbathymetry_201902_IS (ImageServer)

View In: ArcGIS JavaScript ArcGIS Online Map Viewer ArcGIS Earth ArcMap

View Footprint In: ArcGIS Online Map Viewer

Service Description: LOTS_Atlantic/Atlantic_ECSbathymetry_201902_IS

Name: LOTS_Atlantic/Atlantic_ECSbathymetry_201902_IS

Description:

Single Fused Map Cache: false

Extent:

XMin: -9112700
YMin: 2998700
XMax: -5943800
YMax: 5531500
Spatial Reference: 102100 (3857)

Initial Extent:

XMin: -9112700
YMin: 2998700
XMax: -5943800
YMax: 5531500
Spatial Reference: 102100 (3857)

Full Extent:

XMin: -9112700
YMin: 2998700
XMax: -5943800
YMax: 5531500
Spatial Reference: 102100 (3857)

Pixel Size X: 100.0

Pixel Size Y: 100.0

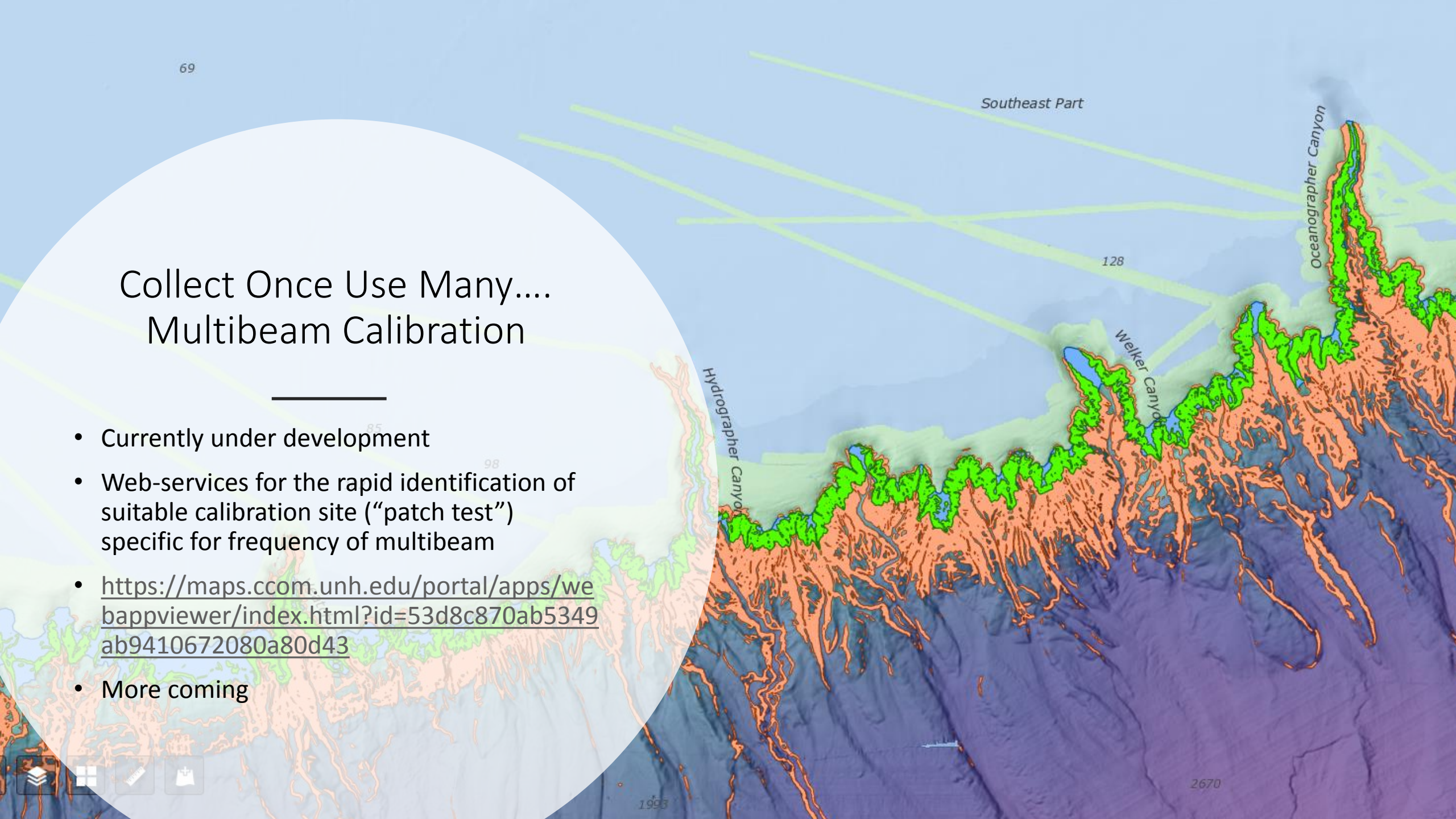
Band Count: 1

Collect Once Use Many…Data Sharing

- Publicly shared REST service through ESRI GIS Server
  - https://maps.ccom.unh.edu/server/rest/services
- Map Services & Image Services
- Predefined renders (color palette, contours, and hillshades)

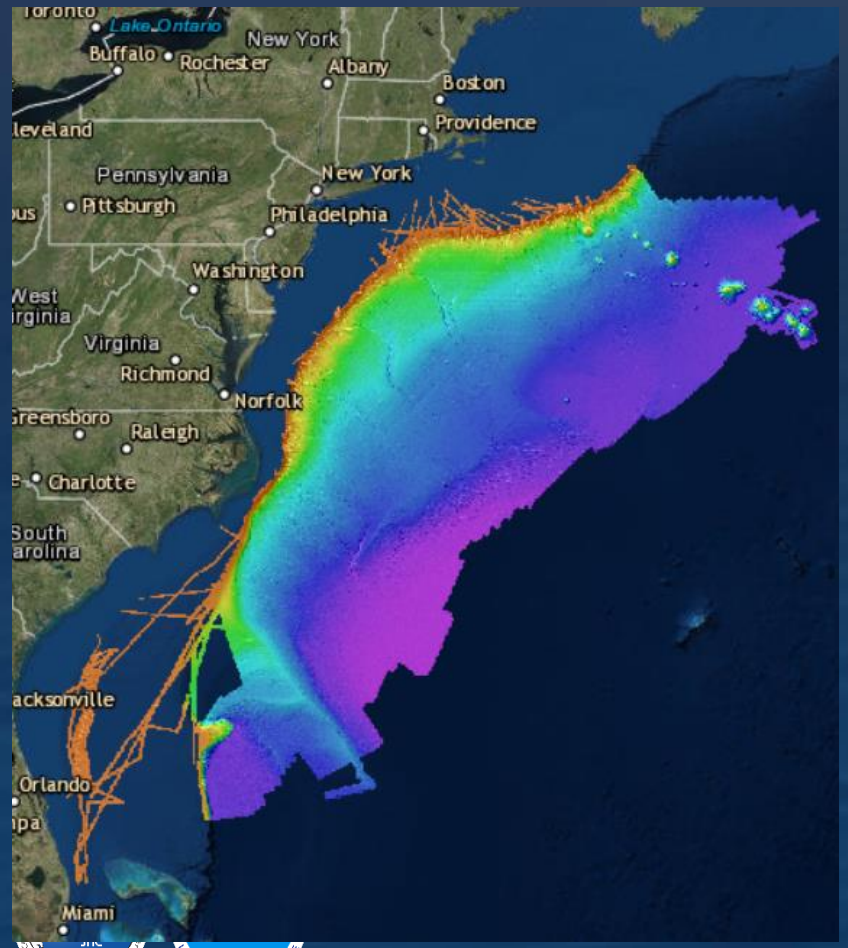
Collect Once Use Many…. Multibeam Calibration

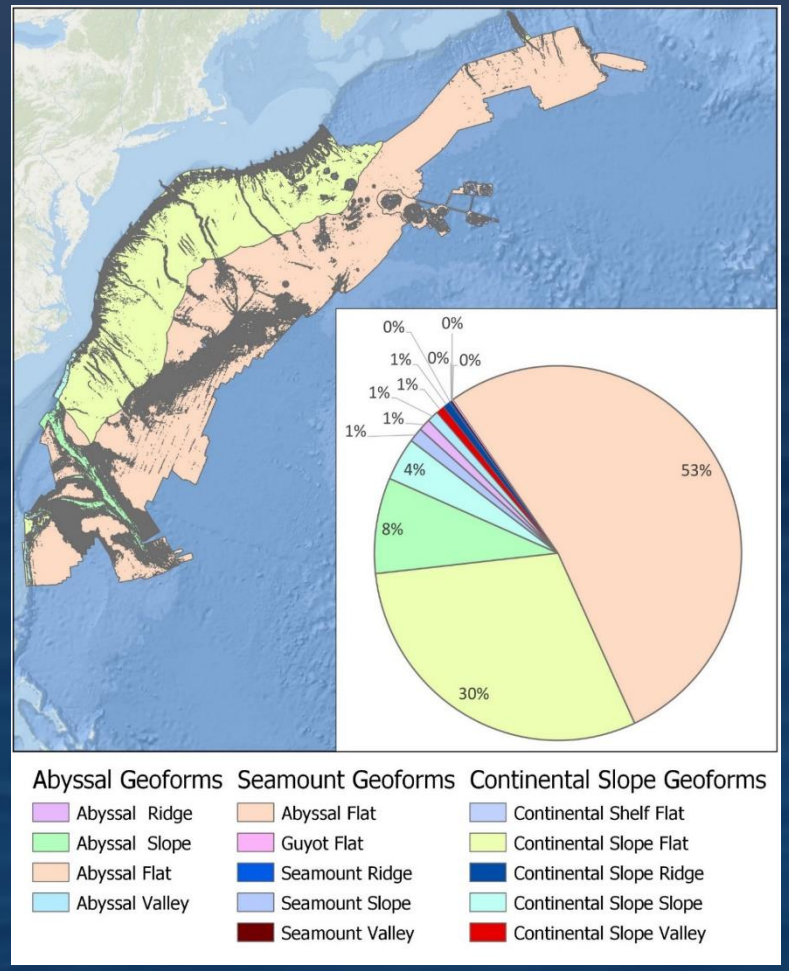
- Currently under development
- Web-services for the rapid identification of suitable calibration site (“patch test”) specific for frequency of multibeam
- https://maps.ccom.unh.edu/portal/apps/webappviewer/index.html?id=53d8c870ab5349ab9410672080a80d43
- More coming

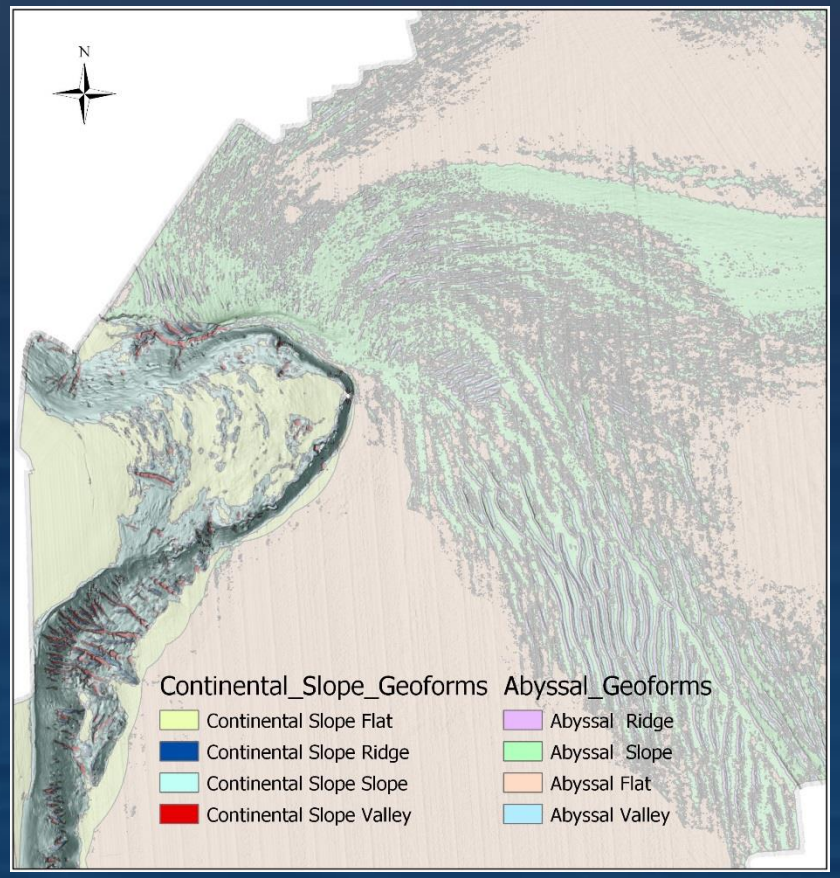


Collect Once Use Many…

CCOM-JHC NOAA Grant - Task 50 – Value-added ECS data for ecosystem management (J. Dijkstra, Masetti, Mayer, Johnson, Sowers)

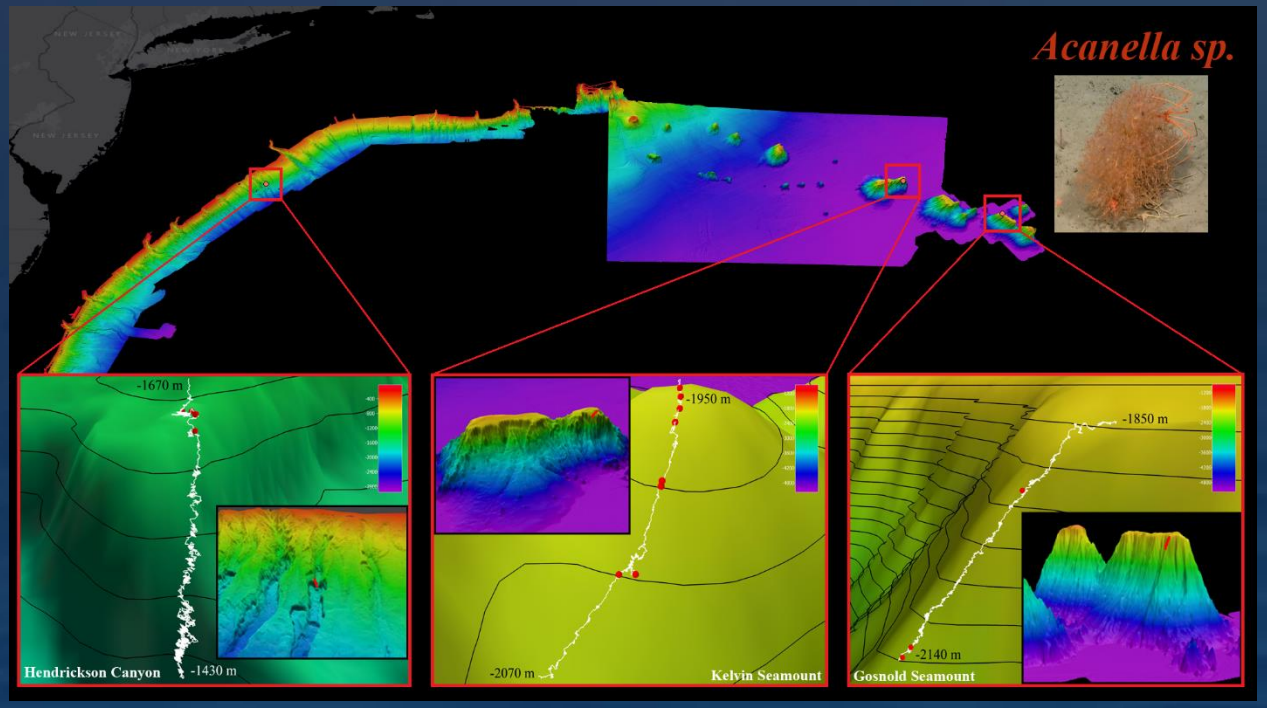






Collect Once Use Many….

- CCOM-JHC NOAA Grant - Task 50 – Value-added ECS data for ecosystem management (J. Dijkstra, Masetti, Mayer, Johnson, Sowers)

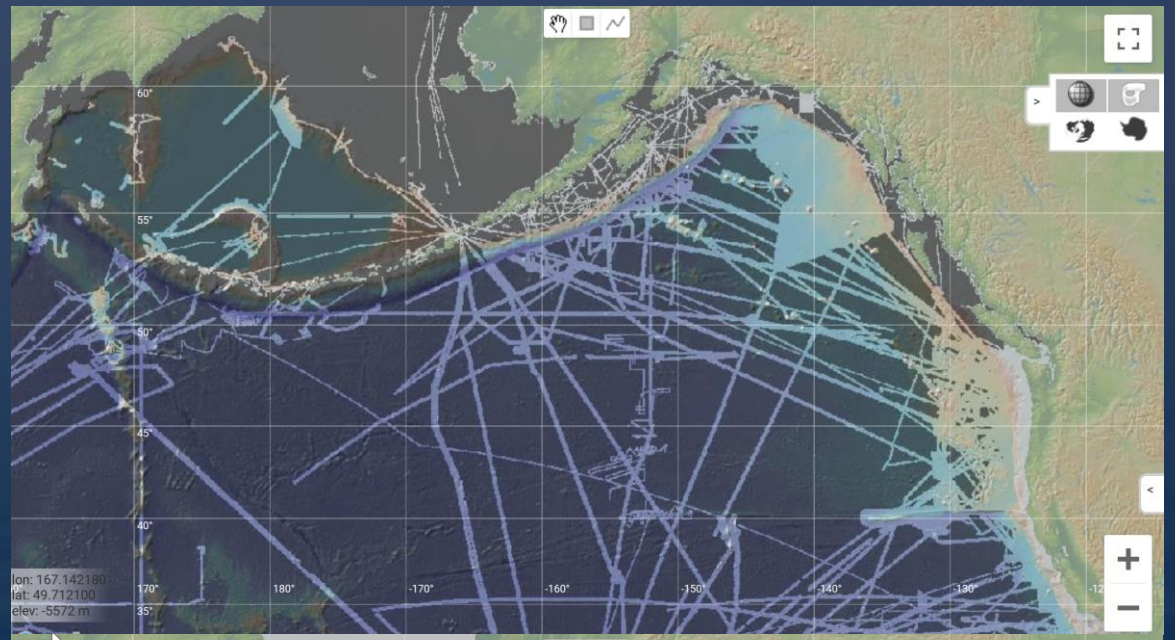


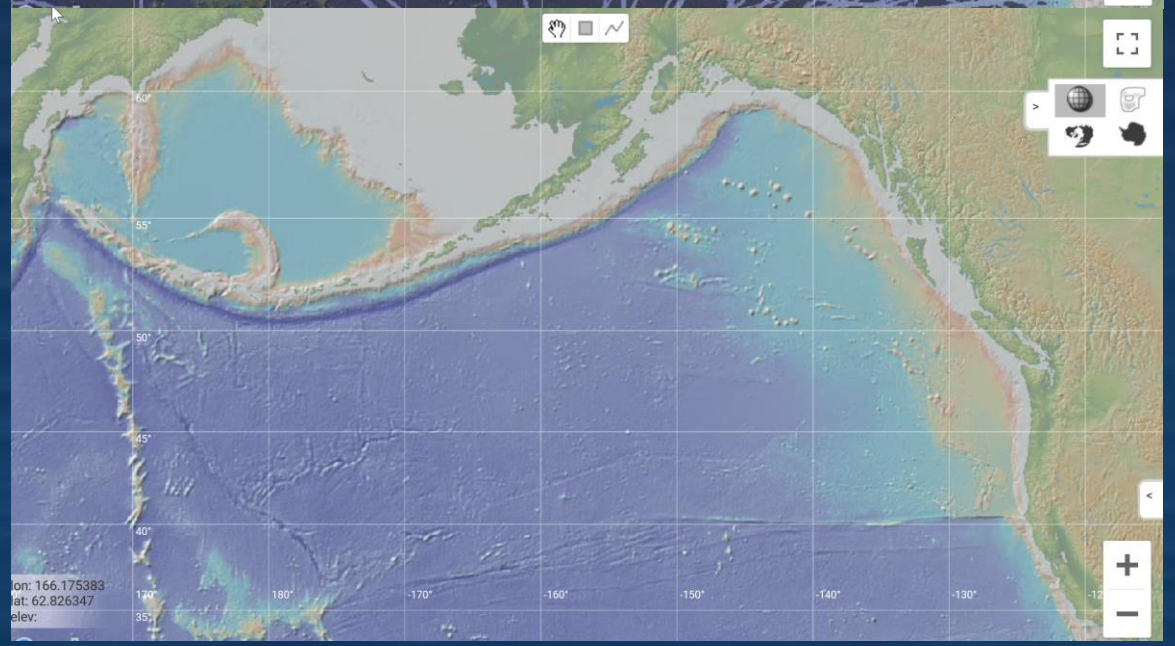
Taxa	Factors	Eigenvalue	Variation explained	Correlations
Acanella	Substrate	1.4	47.2	-0.788
	Dissolved Oxygen	0.915	30.8	0.752
	Slope	0.545	18.3	0.701
Acanthogorgia	Slope	0.11	65.6	0.826
	Depth	0.0531	0.752	31.4
Anthomastus	Substrate	1.74	59.5	-0.895
	Temperature	0.788	26.9	0.735
	Dissolved oxygen	0.303	10.3	0.943

Why else should we do it ? …Global synthesis!

Global Multi-Resolution Topography (GMRT) Synthesis

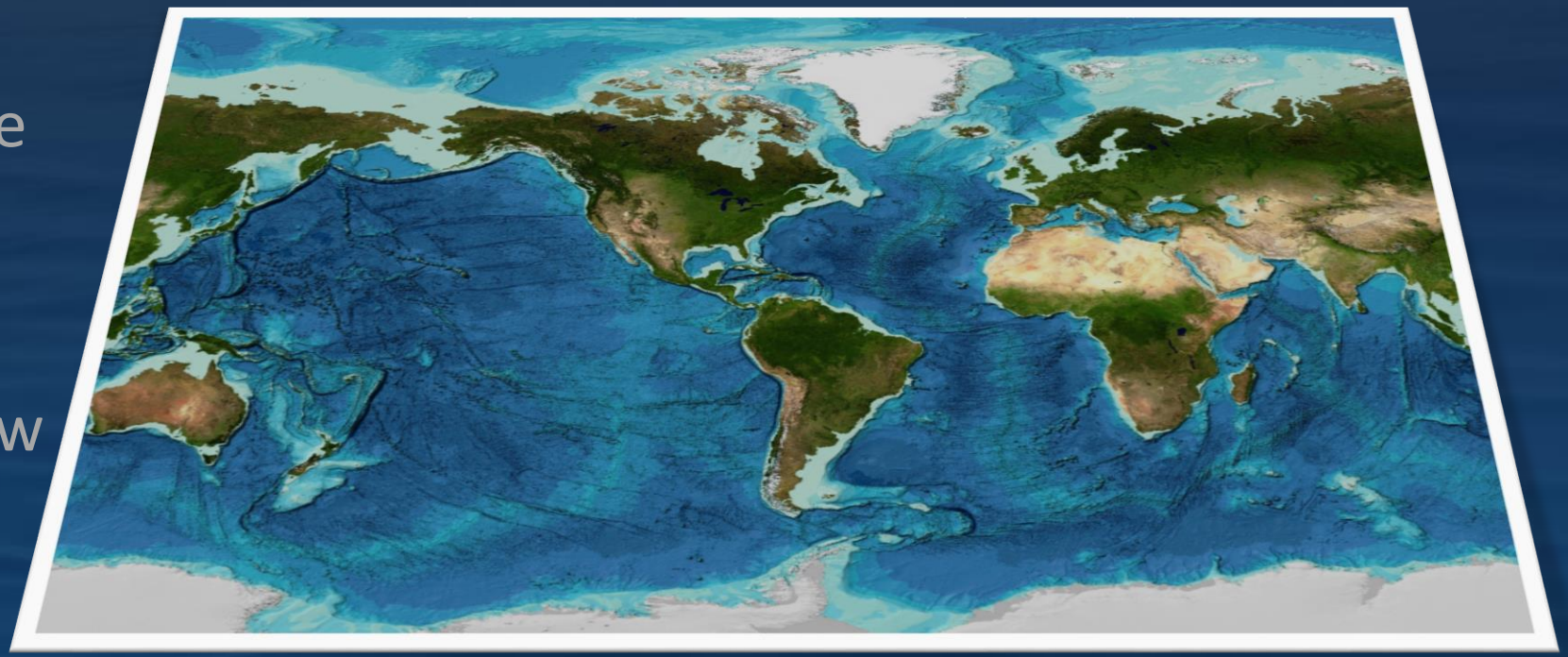
- Product of the MGDS at LDEO
- A maintained multi-resolution gridded global DEM
- All datasets validated prior to inclusion (including editing)
- All datasets currently as both
  - Standalone high resolution multibeam layer
  - Global merged multibeam and GEBCO layer
- https://www.gmrt.org/index.php





Seabed 2030

- **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



GEBOC 2019 – Coverage 6 -> 15%

Conclusions…

- Bathymetry (and backscatter) datasets are available for large regions along the U.S. Continental Margins
- Although primarily meant for the ECS program the datasets have already been used for a number of equally important projects.
  - NOAA Charts (more being contributed soon)
  - Seafloor Caracterization
  - Habitat Mapping
  - Global Syntheses
- Data is available for the public at large through the Center's GIS portal and sever and through NCEI.