

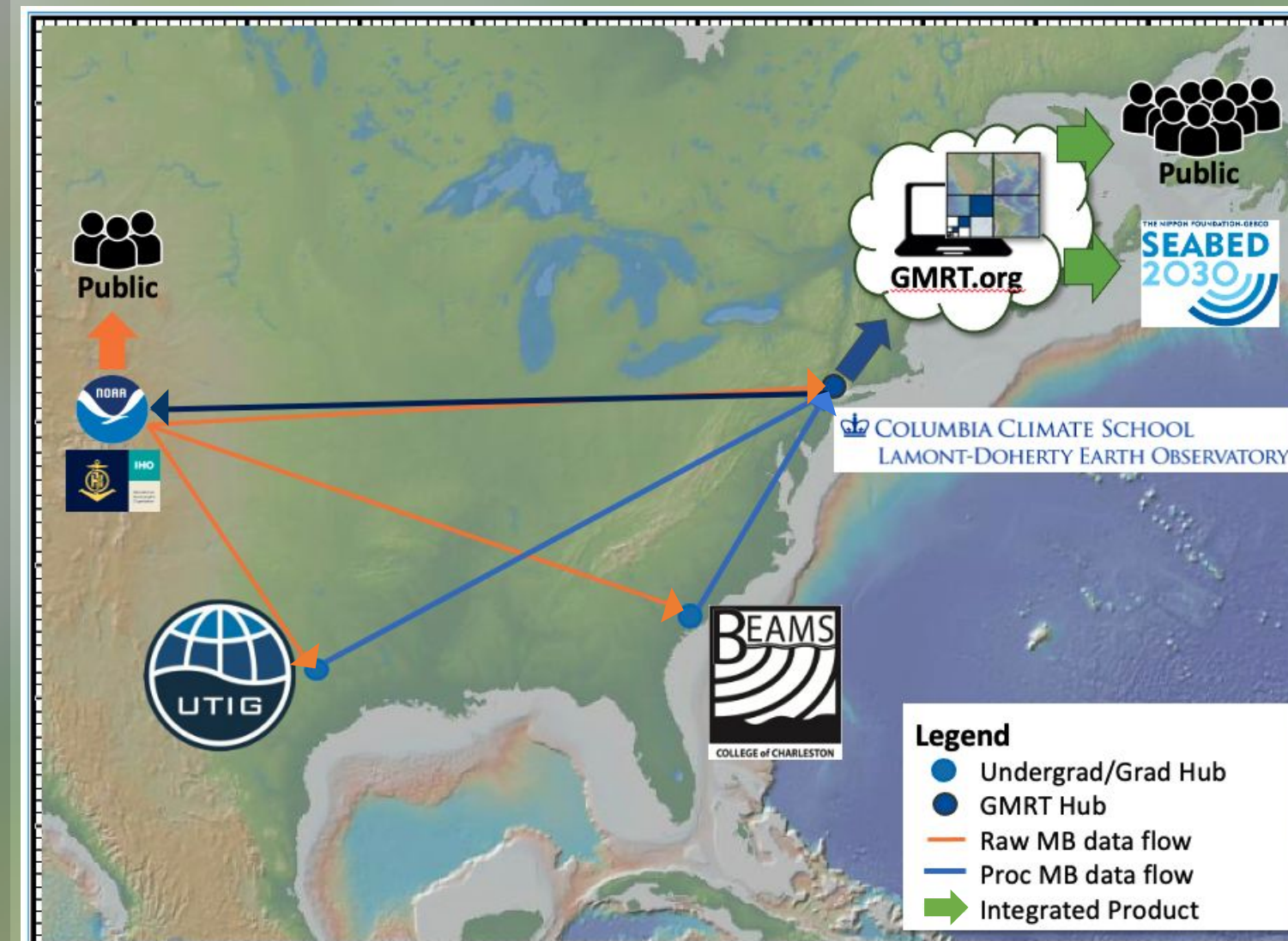
# Broadening Participation in Ocean Mapping through Distributed Data Processing and Student Engagement

## BACKGROUND

The Nippon Foundation - GEBCO Seabed 2030 Project is a global call to action to map the entire ocean floor by 2030. Key to its success is capacity development and engagement of the global maritime community. As the effort to map the ocean floor grows globally, data availability has expanded, thus increasing the need for a specialized workforce, standardized workflows, and open access tools to accommodate these data. To accelerate the pace of data processing and to deliver fit-for-purpose seafloor data that are accessible to a diverse international user community, the tools developed by the Global Multi-Resolution Topography (GMRT) Synthesis, supported by the US National Science Foundation, have been adapted for distribution.

The GMRT workflow utilizes MB-System and in-house tools to process, grid and visualize bathymetric data using GeoMapApp as the user interface. The tools are utilized at-sea aboard the *E/V Nautilus*<sup>1</sup>, and have been used by colleagues at the University of Texas at Austin Institute for Geophysics and Dalhousie University.

Initially prototyped with students from The Nippon Foundation/GEBCO Training Program during lab visits, the approach has now been scaled to include students both in-person and virtually. Since initially engaging with the Benthic Acoustic Mapping and Surveying (BeAMS) program at College of Charleston in 2018, multiple students, with different levels of experience, have used these tools to process and review data - learning valuable skills while also contributing to the global compilation of openly-available bathymetry data.



**Fig 1.** The envisioned flow of multibeam (MB) data among distributed data processing nodes focused on coordinated transformation of freely-available data from the IHO Data Center for Digital Bathymetry into fit-for-purpose data products. Processed (Proc) data products are made publicly available through multiple data access pathways.

## Ocean Mapping Data Apprentices

Students who have participated in this data processing effort are from multiple institutions around the US including:

- Benthic Acoustic Mapping and Surveying (BeAMS) program at the College of Charleston
- Vassar College
- LaGuardia Community College
- The City College of New York
- University of Texas at Austin Institute for Geophysics

As the program has evolved, so has our desire and ability to engage more diverse participants. While contributing to the goals of Seabed 2030 and GEBCO, this program shares knowledge, tools, and data, helps distribute data processing efforts and fosters a diverse community with a strong foundation in ocean mapping<sup>2</sup>.

## Participating Seafloor Mapping Education Programs

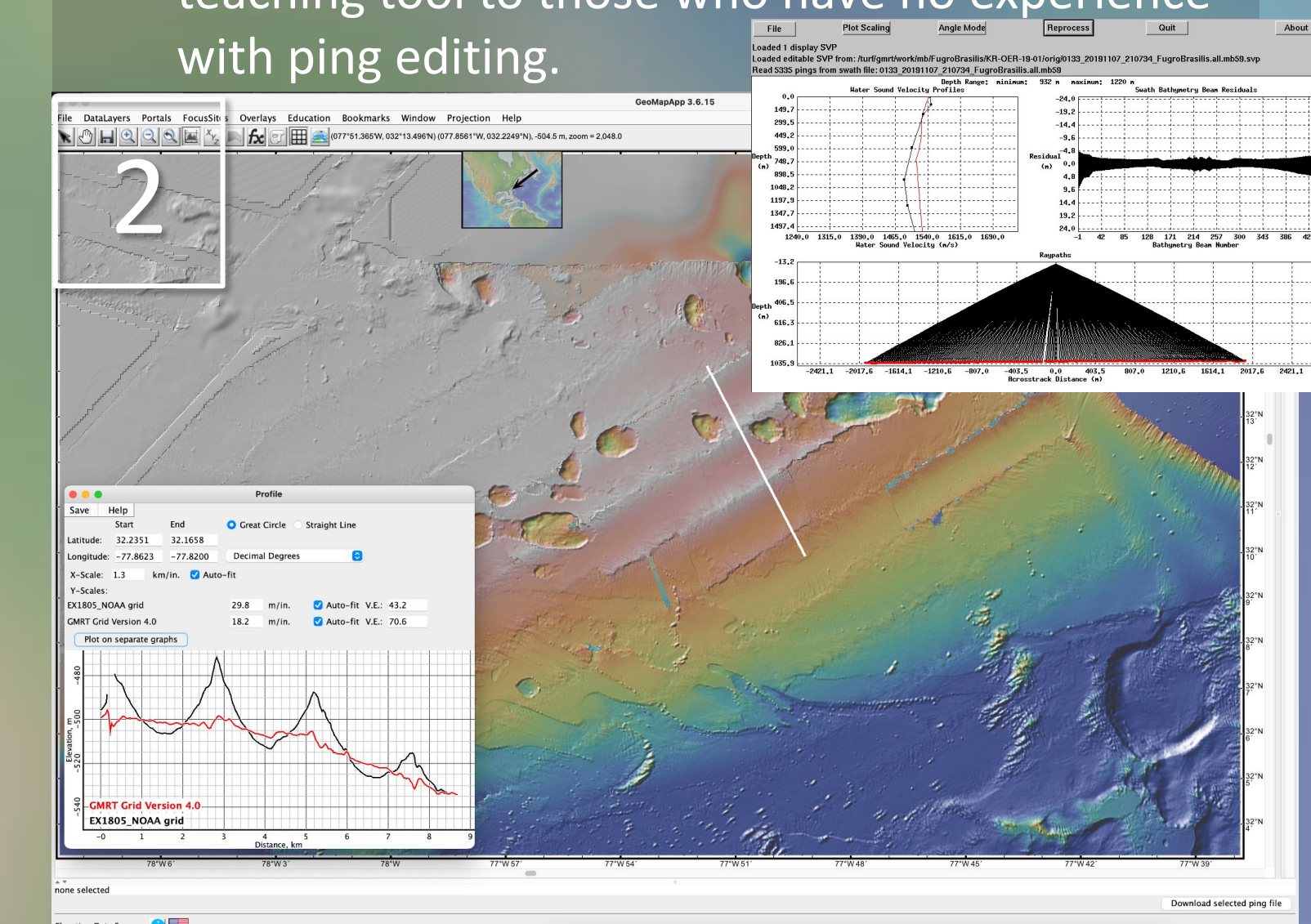
**The Benthic Acoustic Mapping and Surveying (BeAMS) Program**  
*The Benthic Acoustic Mapping and Surveying (BeAMS) program at the College of Charleston in Charleston, South Carolina is an undergraduate training and research program which works to develop skilled ocean surveyors who aim to work in and support the ocean science community.*

**The Nippon Foundation/GEBCO Training Program**  
*The Nippon Foundation/GEBCO Training Program offers a Postgraduate Certificate in Ocean Bathymetry, which allows scientists from around the world to become deep-ocean mapping specialists through the year-long training program at University of New Hampshire Center for Coastal & Ocean Mapping.*

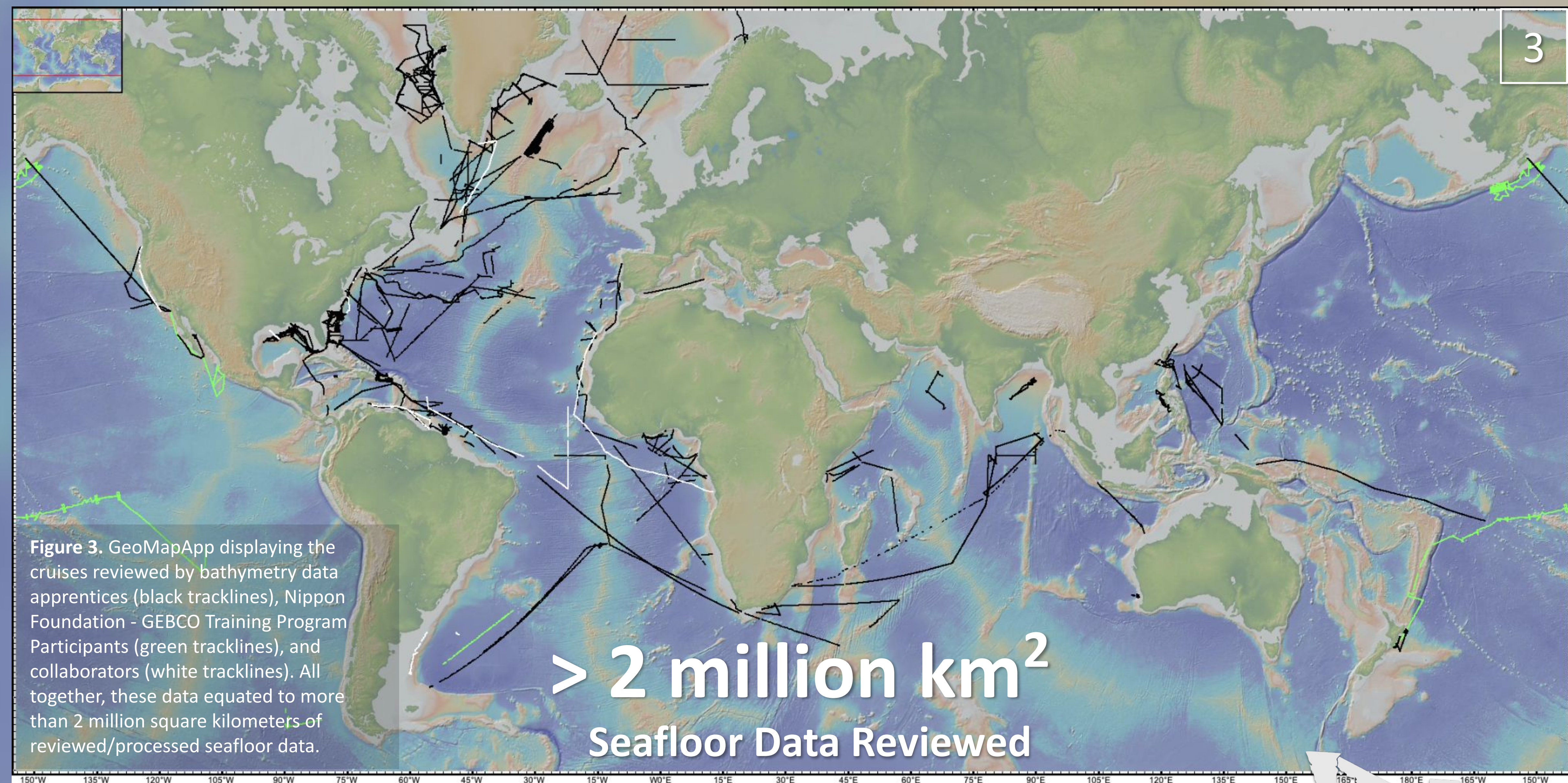


## METHODS

- The **GMRT Workflow** integrates **MB-System**, an open source and freely available processing software, visualizing with **GeoMapApp**<sup>3</sup>.
- **GMRT-Tiler** is the distributable tool for transforming data from swath files into tiled rasters grids for QA/QC and integration with **GMRT**. **GeoMapApp** serves as the QA/QC interface for reviewing data on land and during at-sea data processing.
- QPS processing software **Qimera** is used as a teaching tool to those who have no experience with ping editing.



**Figure 2.** Cruise which needed additional sound speed processing. Lower left window black profile is the data as downloaded, the red profile is after undergoing editing using the GMRT Workflow<sup>4</sup>. Upper right window shows MB-System sound velocity editor.



**Figure 3.** GeoMapApp displaying the cruises reviewed by bathymetry data apprentices (black tracklines), Nippon Foundation - GEBCO Training Program Participants (green tracklines), and collaborators (white tracklines). All together, these data equated to more than 2 million square kilometers of reviewed/processed seafloor data.

## VISION

*A distributed and coordinated community working together to create high-quality bathymetric data products*

Acknowledgements to all of our other participants over the years

Layla Xholi<sup>1</sup>; Madeline Langer<sup>2</sup>, Benjamin Ross<sup>2</sup>, Hannah Berkimer<sup>2</sup>, Nathan McCuen<sup>2</sup>, Ashlyn Whitmore<sup>2</sup>, Mikayla Drost<sup>2</sup>, Treyson Gillespie<sup>2</sup>; Jesse Jenkins<sup>3</sup>; Benjamin Misiuk<sup>4</sup>; Mekayla Dale<sup>5</sup>, Mohamed Elsaied<sup>5</sup>, Keshav Sauba<sup>5</sup>

<sup>1</sup>LaGuardia Community College, <sup>2</sup>College of Charleston, <sup>3</sup>Vassar College, <sup>4</sup>Dalhousie University, <sup>5</sup>Nippon Foundation - GEBCO Training Program Participants

## OUTCOMES

**11**  
Ocean Mapping Data Apprentices

**17**  
Total Participants

**105**  
Cruises

**22,423**  
Swath Files

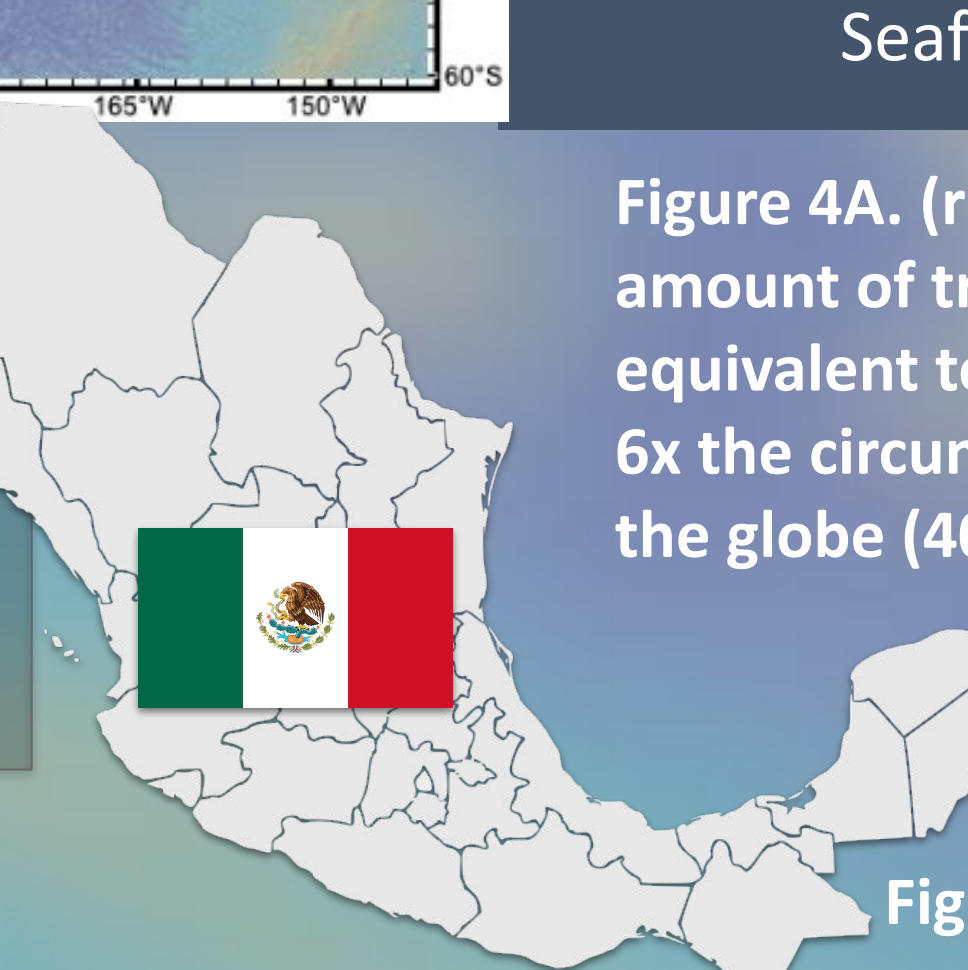
**255,000 km**  
Track

**>2 million km<sup>2</sup>**  
Seafloor Data Reviewed

**Figure 4A.** (right) The amount of track is equivalent to more than 6x the circumference of the globe (40,075 km)



**Figure 4B.** (left) The seafloor area reviewed by the processors using the GMRT Workflow is more than the area of Mexico (1.964 million km<sup>2</sup>)



<sup>1</sup>Gee, L.; Heffron, E.; Kane, R.; Ferrini, V.; Raineault, N.A. (2021). Expanding Seabed Mapping - Supporting the US National Ocean Exploration and Characterization Efforts in the US West Coast Exclusive Economic Zone. *Oceanography: New Frontiers in Ocean Exploration*, Vol 34(1), pp. 28-29.

<sup>2</sup>Ferrini, V.; Morton, J.J.; Gee, L.; Heffron, E.; Drennon, H.; Raineault, N.; and Carbotte, S.M. (2020). Initial Efforts Toward Coordinated Community Data Processing to Accelerate the Growth of Publicly Available Bathymetric Data Products. *AGU 2020 Fall Meeting*, 01-17 December 2020, doi: 10.1002/essoar.10505639.1.

<sup>3</sup>Ferrini, V.; Morton, J.; Drennon, H.; Uribe, R.; Miller, E.; Martin, T.; Nitsche, F.; Goodwillie, A.; and Carbotte, S. (2022). Global Multi-Resolution Topography (GMRT) Synthesis - Tools and Workflows for Processing, Integrating and Accessing Multibeam Sonar Data. *EGU General Assembly 2022*, Vienna, Austria, 23-27 May 2022, EGU22-13349 (invited), <https://doi.org/10.5194/egusphere-egu22-13349>.

<sup>4</sup>Drennon, H.; Miller, E.; Ferrini, V.L. (2022). Exploring the User of Multibeam Sonar Sound Speed Corrections to Map Water Column Variability. *Ocean Sciences Meeting*, 2022, February 2022.