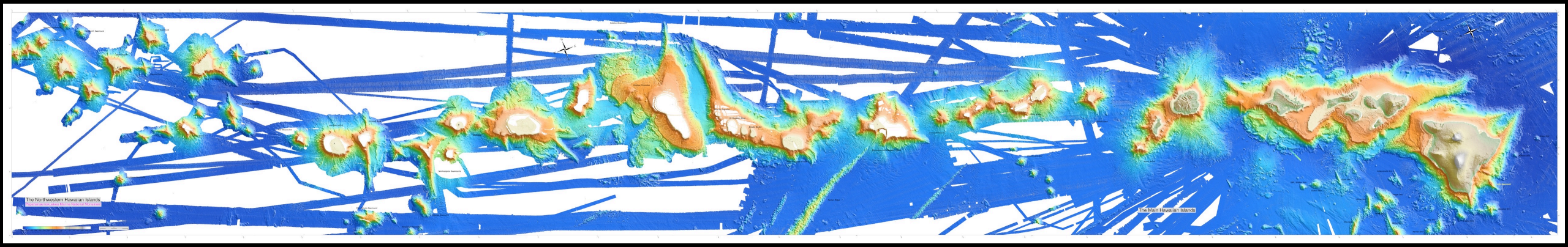
Hawai‘i based contributions to seafloor mapping in the Pacific



John R. Smith

Formerly with Univ. Hawaii/SOEST/HURL & Oceanography Dept.

Now serving as occasional Independent Contractor with Ocean Exploration Trust

HSRP Meeting, 2022

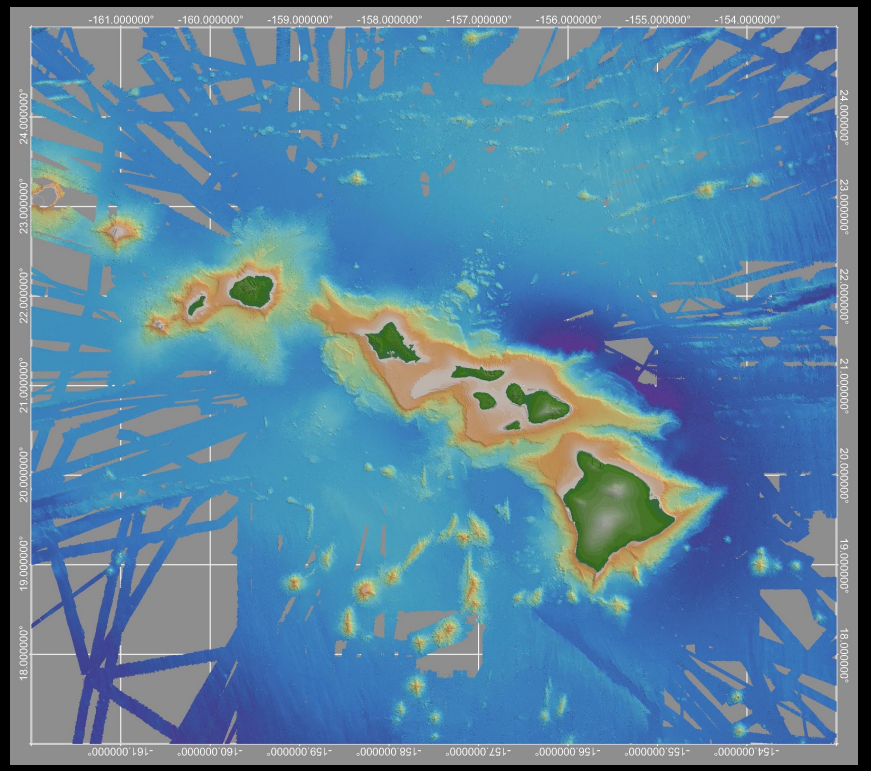
Towed Swath Mapping Systems at the Hawaii Institute of Geophysics & Planetology (HIGP)

- 1960s - 1980s: Many HIG cruises throughout the Pacific
- SeaMARC I & II: 1980s, became Seafloor Surveys Intl.
- Hawaii Mapping Research Group (HMRG):

HAWAII MR1, IMI 30, IMI 120

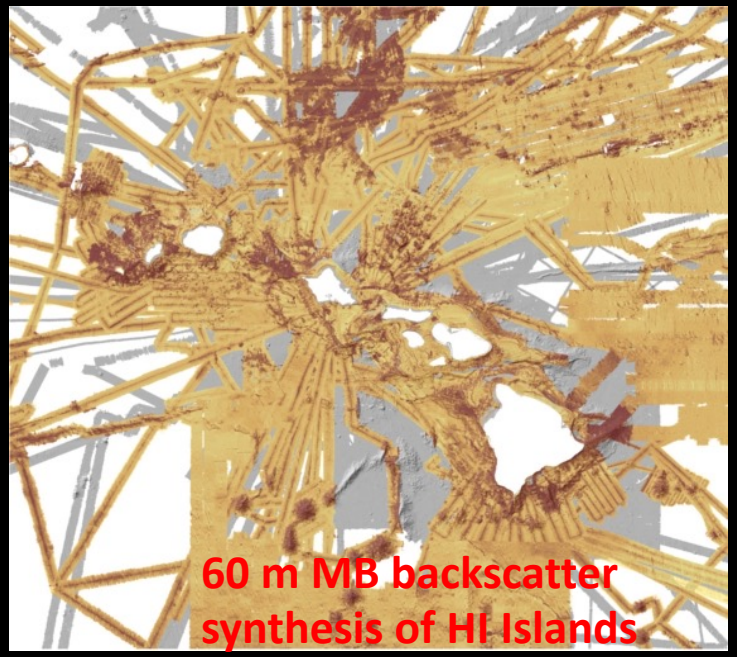
The MR1 was a shallow-towed 11/12-kHz bathymetric sidescan sonar developed and operated by HMRG. The MR1 provided full ocean depth, broad coverage capabilities, both bathymetry and sidescan data, and was deployed on over 30 cruises from 1991-2001. IMI-30 still operating.

- Hosts Main Hawaiian Islands multibeam synthesis
- Real-time software and processing development
- At sea support for a variety of mapping missions

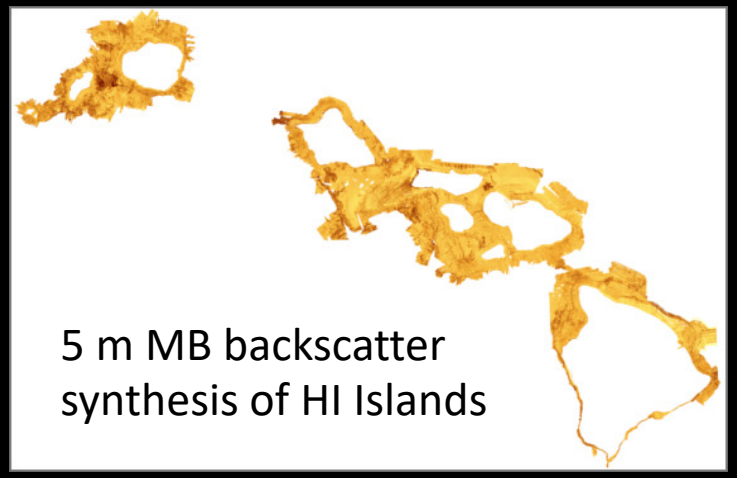


Deep Water MBES at SOEST and the Univ. Hawaii Undersea Research Lab

R/V *Ka`imikai-O-Kanaloa* (KOK) with 12 kHz MBES (& HOV *Pisces IV & V*)



- First multibeam equipped vessel based in Hawaii (1995-2017).
- First dedicated multibeam surveys of the NWHI (2000-2002) .
- First multibeam surveys of Jarvis Island, Palmyra Atoll, and Kingman Reef (2005).
- Mainly carried out dive site mapping support for HOVs/ROV, plus applied research.
- Mostly funded by NOAA Undersea Research Program/OE[R] plus contract work.
- Developed novel multibeam backscatter synthesis technique, published as: Richards, B.L., J.R. Smith, S.G. Smith, J.S. Ault, C.D. Kelley, V.N. Moriwake, Development and Use of a Novel Main Hawaiian Islands Bathymetric and Backscatter Synthesis in a Stratified Fishery-Independent Bottomfish Survey. *NOAA. Technical Memorandum*. NMFS-PIFSC-87, 48 p., doi:10.25923/bh8v-0184, 2019.



R/V *Kilo Moana* SWATH ship (EM122, EM710)

University of Hawaii at Manoa, School of Ocean & Earth Science & Technology

12 kHz & 95/40-100 kHz MBES

- Second multibeam equipped vessel based in Hawaii (2002-present). Owned by ONR, operated by Univ. Hawaii.
- First extensive multibeam surveys/charting of the NWHI (2002). NOAA funded through various line offices.
- Nearshore surveys of Essential Fish Habitat around all the Main Hawaiian Islands (NOAA PIRO) (2005, 2006, 2007, 2011)
- Seven (7) surveys for the Extended Continental Shelf program in the Pacific (2005, 2010, 2011, 2014, 2015, 2017, 2018) = 986,292 sq km
- Numerous annual charters by foreign clients for polymetallic nodule research and surveys in the Clarion-Clipperton Zone (2008-09, ~2012 – 2021): Germany (BGR), Japan (DORD), South Korea (KIOST)
- Regular support ship for NDSF ROV *Jason* and UH/SOEST ROV *Lu`ukai*
- Unique hull design allows for MBES surveys in any direction in any workable seas

NOAA multibeam equipped vessels that were based in Hawaii

PIBHMC

Pacific Islands Benthic Habitat Mapping Center

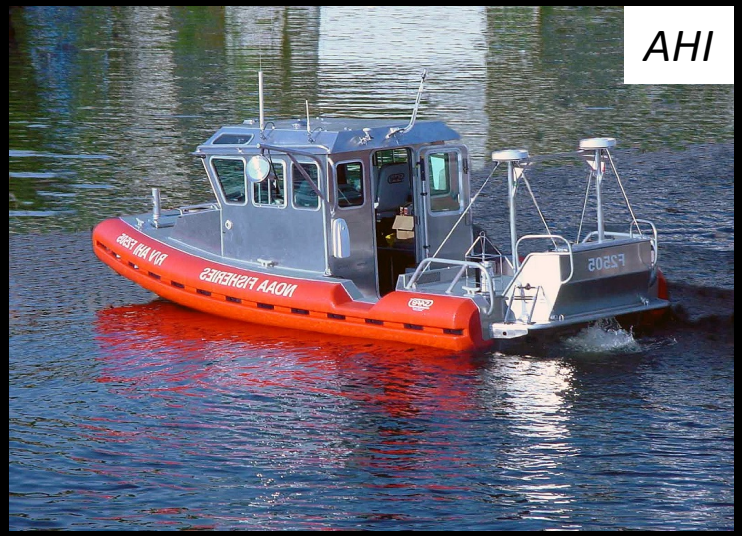
IN THE SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY AT THE UNIVERSITY OF HAWAI'I AT MĀNOA

Hi'ialakai

30 & 300 kHz MBES

Oscar Elton Sette

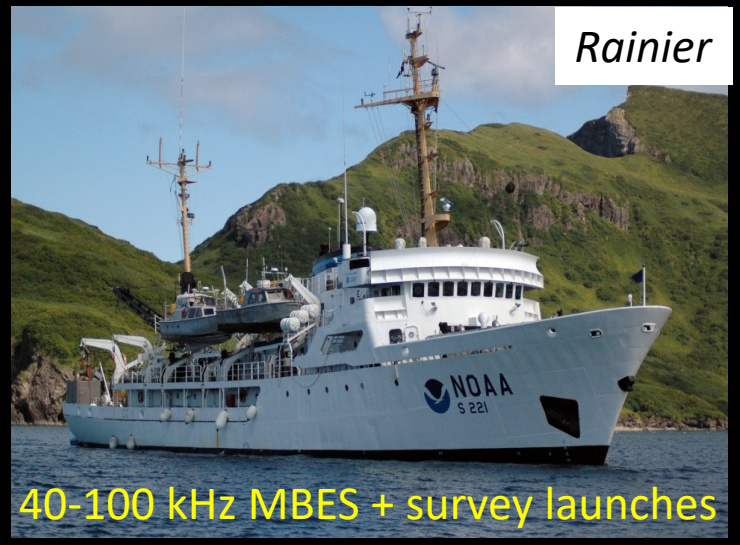
240 kHz temp pole-mounted MBES



AHI

240 kHz MBES

Multibeam vessels working in Hawaii and homeported elsewhere



Rainier

40-100 kHz MBES + survey launches

Okeanos Explorer

30 kHz MBES

Ron Brown

12 kHz MBES

Schmidt Ocean Institute R/V *Falkor*

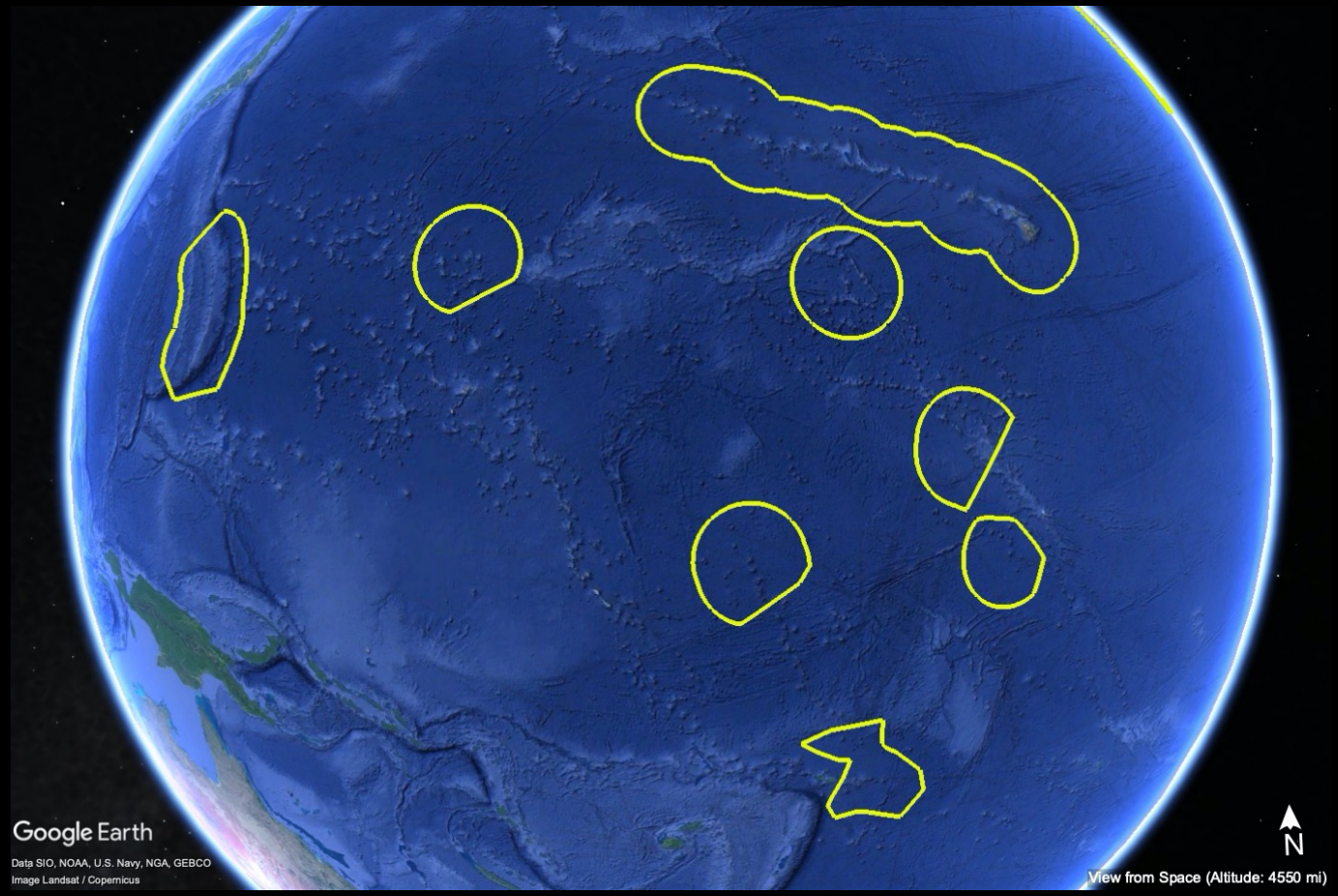
30 & 40-100 kHz MBES

Maybe too much of a good EM302 thing?

Ocean Exploration Trust – E/V *Nautilus*

30 kHz MBES

Google Earth map showing Pacific EEZs/MNMs



Observations from being out there mapping it

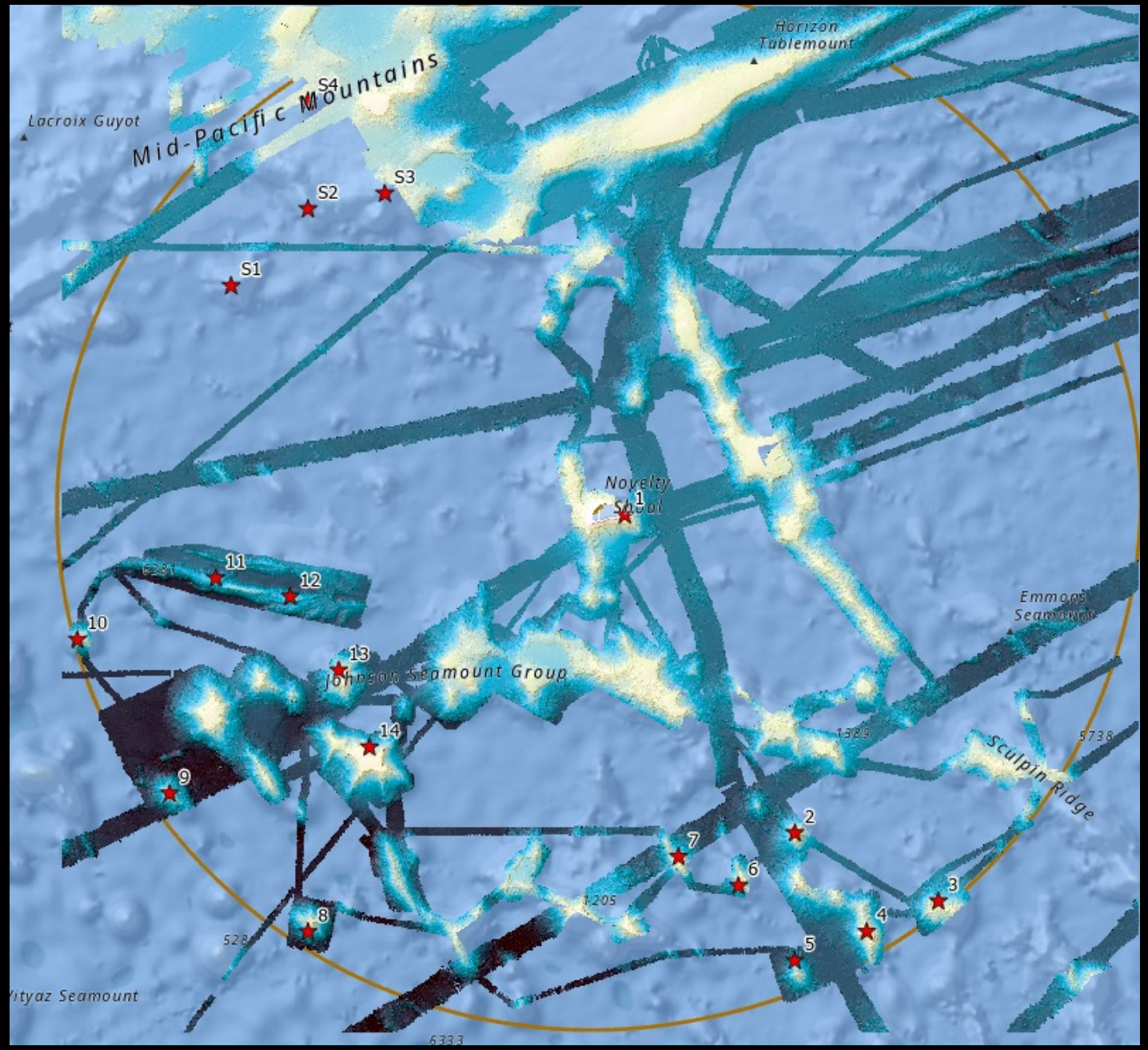
- Many of the major seamounts and other features in the Pacific EEZs and Marine National Monuments have now been mapped by 30 and 12 kHz MBES systems.
- While the higher 30 kHz resolution is great to have on these seamounts and other features of relief, it is not always taken advantage of in the generation of derived data products.
- A large portion of the most recent mapping in the expanded areas of the Pacific Marine National Monuments (PRI/Johnston, PMNM/NWHI) has focused on large areas of abyssal depth seafloor in the 4500 m and greater range between already mapped seamounts and other features – all while using 30 kHz systems
- The result is spending a substantial amount of time mapping areas outside the ”sweet spot” of the 30 kHz systems. A 12 kHz MBES would easily provide 3-4 times the coverage in these depth ranges.
- In any case, having a fully staffed and experience mapping team is still critical to successful completion of these missions – and must be a major consideration in implementing any such plans to complete mapping of the Pacific EEZs/Marine National Monuments.

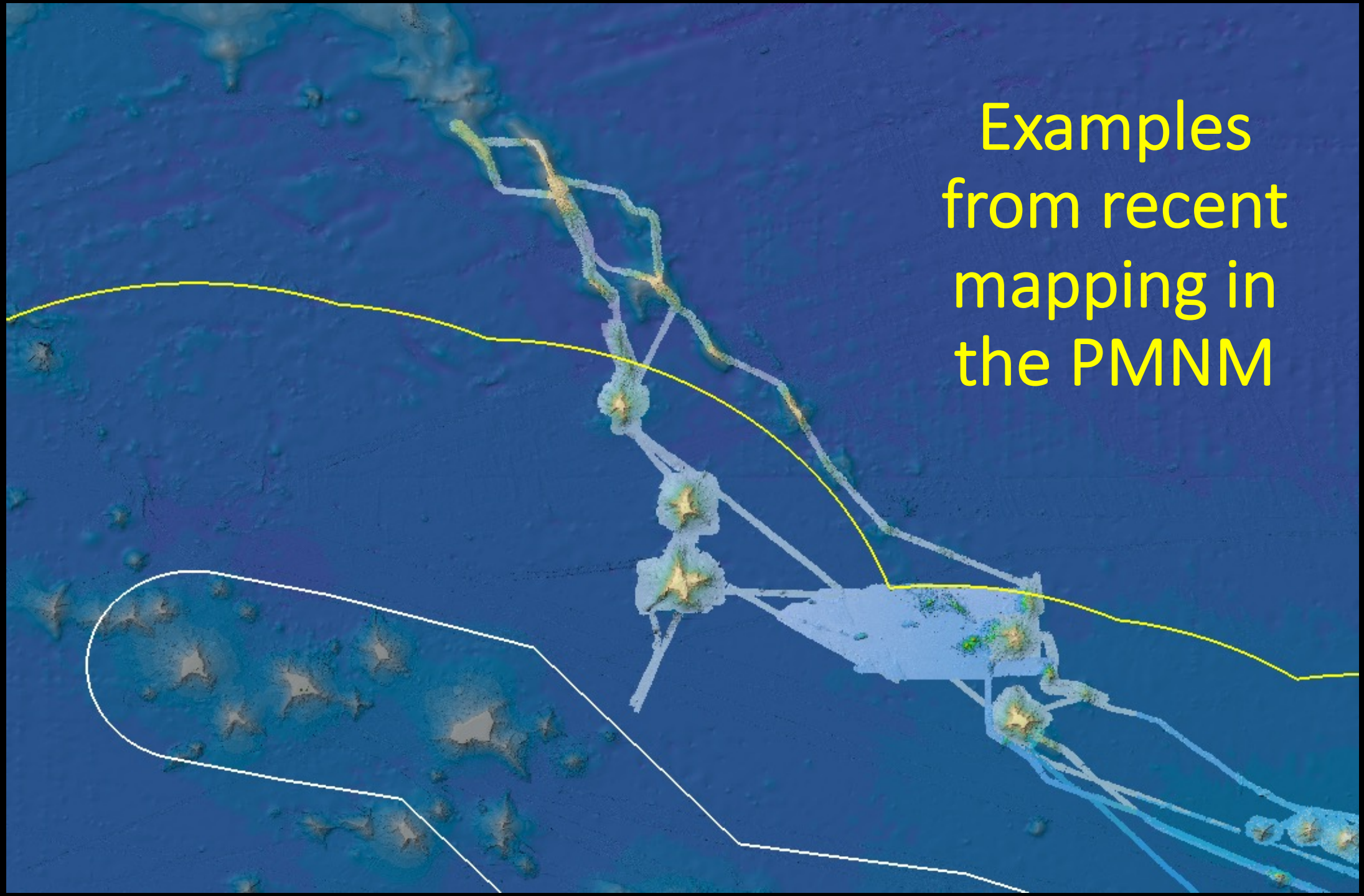
Partnering at the Johnston Atoll Unit of the PRIMNM

Multibeam data showing swath mapped features and areas in partnered effort including:

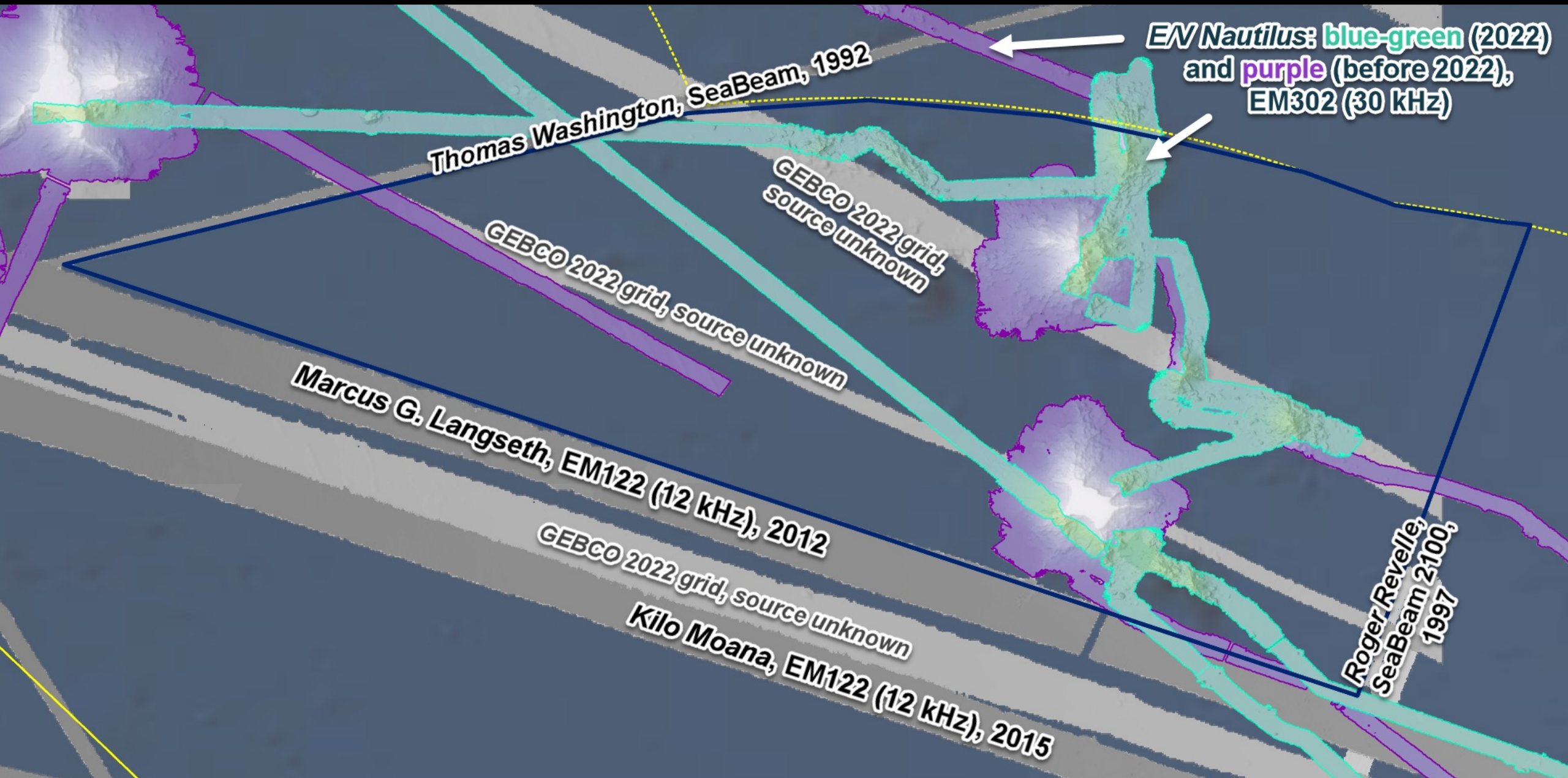
- NOAA OE, Ship *Okeanos Explorer*
- State Dept ECS Program, R/V *Kilo Moana*
- Ocean Exploration Trust, E/V *Nautilus*
- Schmidt Ocean Institute, R/V *Falkor*
- Other ships' transit lines from NCEI database

All following map imagery by Erin Heffron, OET

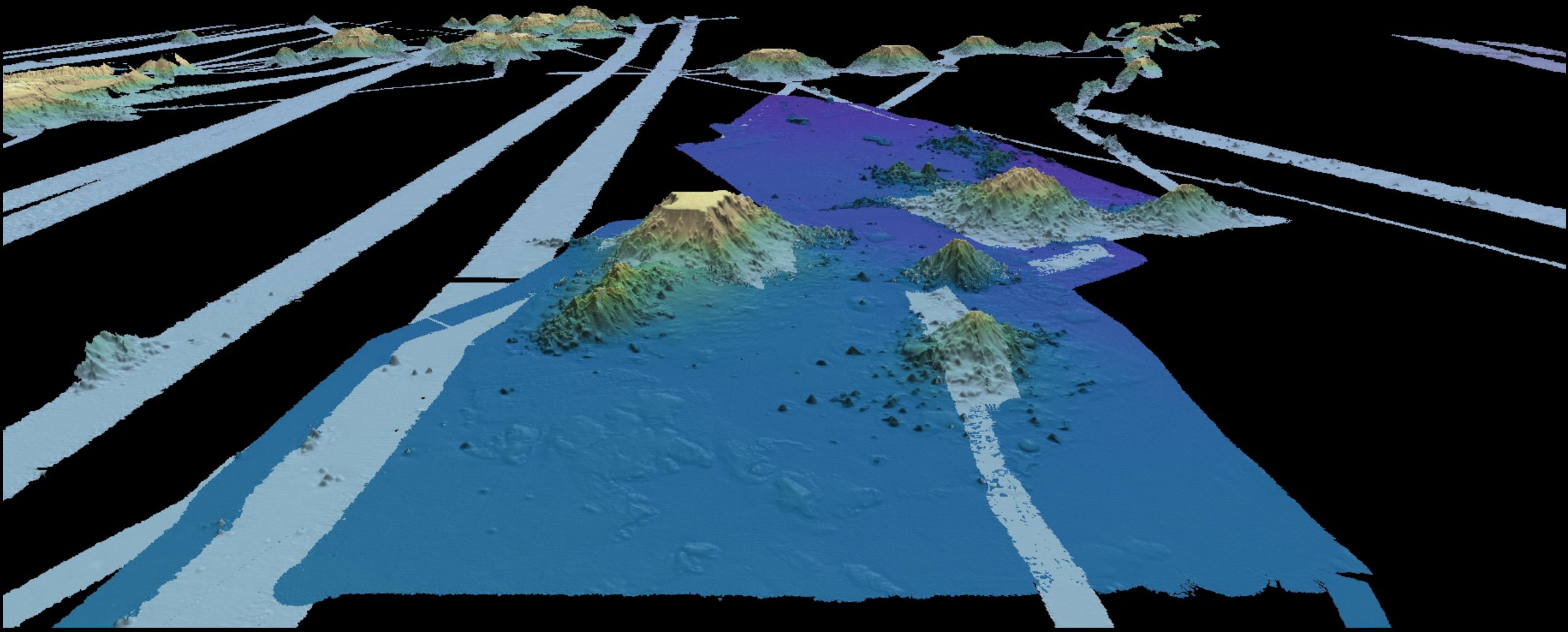



Examples
from recent
mapping in
the PMNM

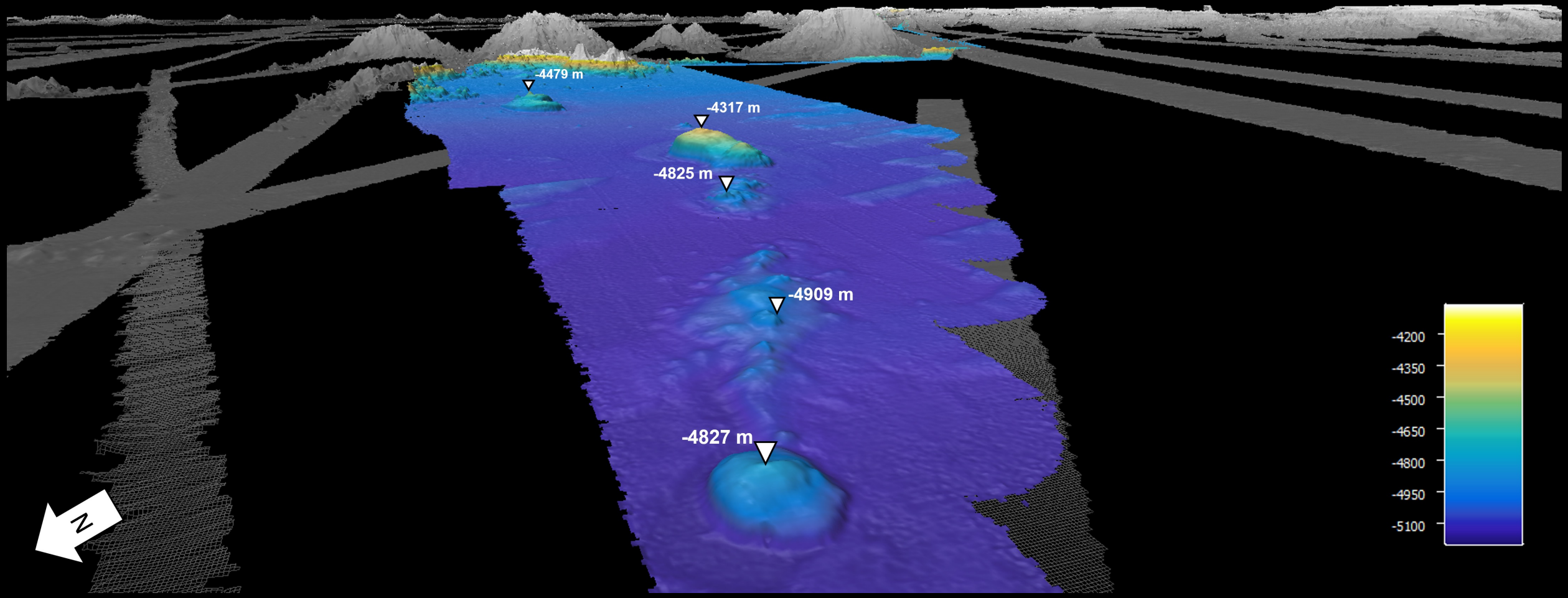
NA143 ‘to map’ polygon with preexisting MB swaths



Perspective view of completed area for NA143



Perspective view of feature trail mapped on NA143



Recommendations

1. In your region and/or nationally, what NOAA products, data, and services are valued by your organization and how beneficial are these products, data, and/or services?

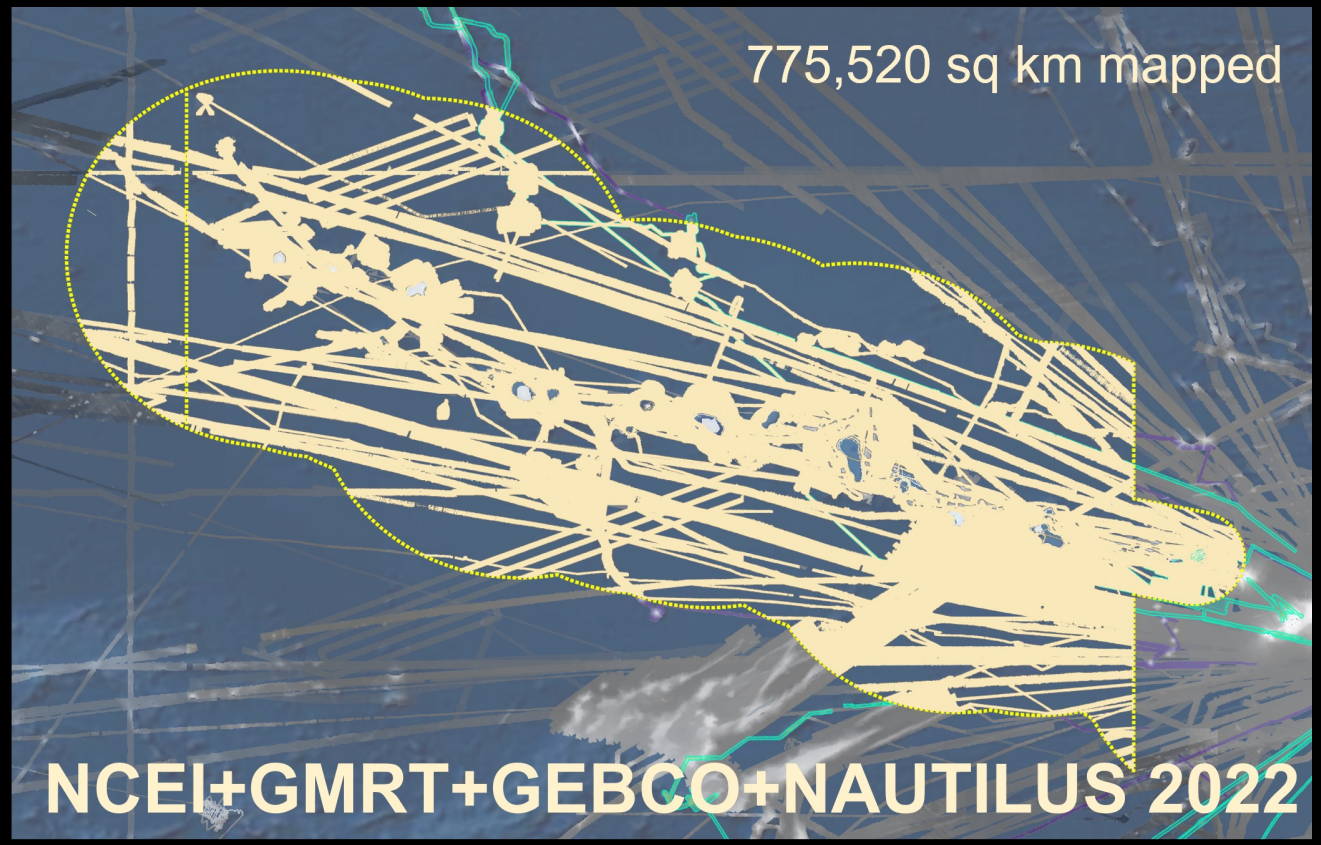
- Providing external funds for ship time charters to carry out seafloor mapping missions in the Pacific EEZs and Marine National Monuments when the appropriate NOAA assets are not available (e.g., funds to charter OET's E/V *Nautilus*).
- Its not just the ship and MBES system – providing funding to have fully staffed and experienced mapping teams, like those on *Okeanos Explorer* and *Nautilus*, has also been critical for success.

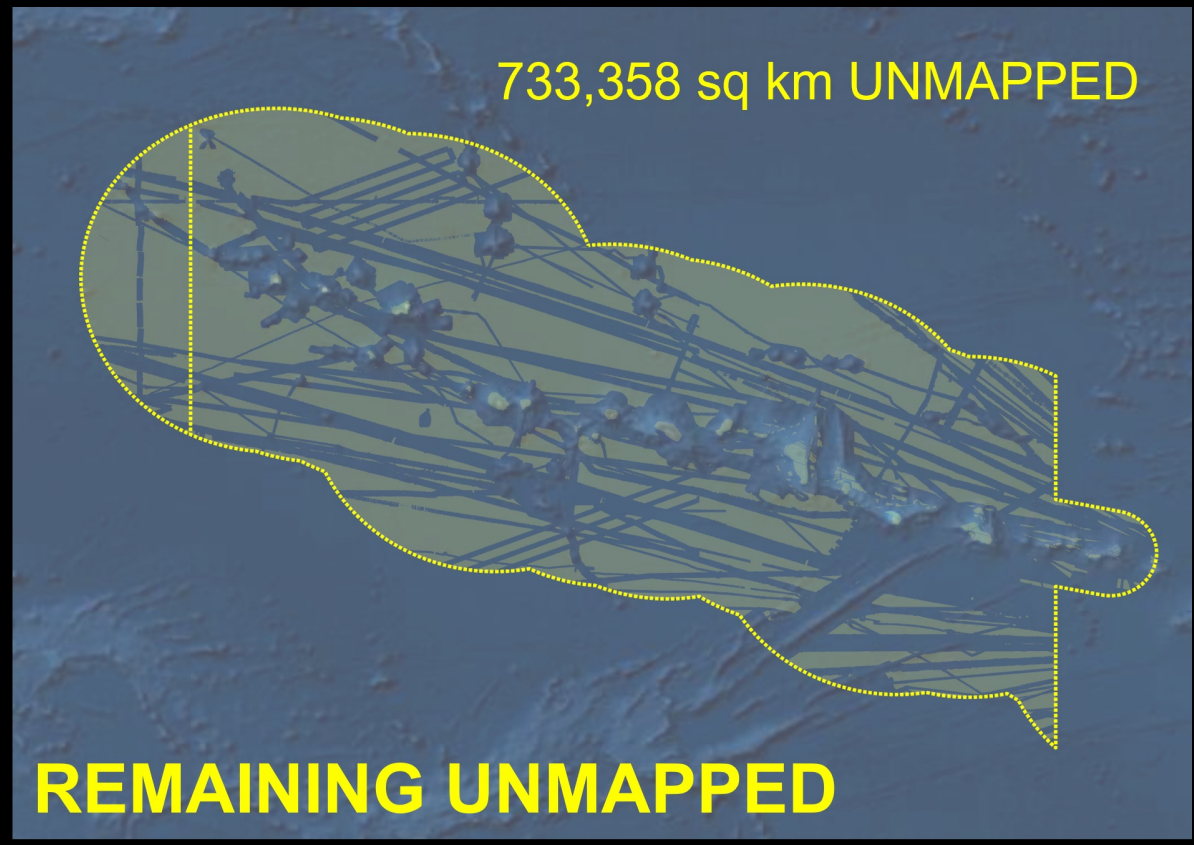
Recommendations

2. What new or enhanced products, data, or services would you like NOAA to offer, and how would your organization or sector benefit from them?

- Expanding the charters to include vessels with full ocean depth 12 kHz wider swath systems that can map the remaining seamounts and abyssal depth seafloor in the Pacific EEZs with far more efficiency (e.g., UH's R/V *Kilo Moana*)
- Compared with 30 kHz EM302 type systems recently employed for mapping in the Pacific EEZs and Marine National Monuments (i.e., *Okeanos Explorer*, *Nautilus*, *Falkor*), the 12 kHz MBES equipped vessels can map 3-4 times the area in the deeper range of 4500-6000 m than the former systems in Very/Extra Deep acquisition modes.
- Because *Kilo Moana* is based in Hawaii and regularly works across the Pacific, transits to and from the EEZs and Marine National Monuments are reduced, allowing more time on site for surveying for less overall cost.
- Coordinate with OE, OET, an organization like them to assemble and fund an experienced mapping team to sail on 12 kHz MBES equipped vessels that may not have a full in-house team with adequate experience, established methods, and computing resources.

Overlay of various archives' data coverage for PMNM (left) and the area remaining to map (right)





Analysis and map imagery by Erin Heffron, OET