in-depth

MAPPING THE FLOOR OF OUR OCEANS

Newsletter of The Nippon Foundation-GEBCO Seabed 2030 Project

THE NIPPON FOUNDATION-GEBCO SEABED 2030

Extending the mapping of ocean frontiers

Swedish icebreaker *Oden* mapping in previously uncharted areas of Northern Greenland during the 2019 Ryder Expedition. The data were contributed to the Seabed 2030 Project.

Credit: Prof Martin Jakobsson, Co-Head of the Seabed 2030 Arctic and North Pacific Ocean Regional Center

A mission to create the first complete map of the seabed is essential to understand how our planet works (the *Times*, London)

Last month The Nippon Foundation-GEBCO Seabed 2030 project announced the inclusion of 14.5 million square kilometres of new bathymetric data into the GEBCO Global Grid. This figure indicated that **"just under a fifth of the world's entire ocean floor has now been mapped, with the new data equating to an area twice the size of Australia."**

Over the last year, coverage of the seabed "has risen from 15 percent to 19 percent. When Seabed 2030 was launched in 2017, only six percent of the world's oceans had been mapped to modern standards."

In an article in the Comment pages of the *Time*s newspaper (27 June), the distinguished author and writer, Ben Macintyre, wrote that it was ***"almost impossible to overstate the (map's) importance for the future of the planet.***

"The great underwater map... has no political, religious or military intent. It is being drawn up only to explore the unknown, and shine a sonar light into the darker expanses of our world, revealing its canyons, volcanoes and secrets."

EDITORIAL

Measured steps on a long road

I am pleased to be introducing this first edition of our e-newsletter, 'in-depth'. It comes shortly after the announcement of the latest GEBCO Grid figures, as reported in this newsletter.

This information is the result of the work of The Nippon Foundation-GEBCO Seabed 2030 project team spread across five countries and seven different host organisations. They cover all the world's oceans and we introduce them to you in this newsletter.

Extraordinary innovation and scientific advancement lie at the heart of our progress in marine data collection.

Versatile autonomous underwater vehicles are collecting digital data at depths and rates considered impossible five years ago. This innovation is matched in the skies. Satellites are now able to provide bathymetry quickly and cost effectively in coastal areas given the right environmental conditions. Developments in machine learning make it possible to process and analyse volumes of depth that far outstrip potential human efforts.

But as we acknowledge progress we are far from complacent. The benefits of a complete map of our oceans are there for all to see, but we will not achieve our ultimate objective without the support of governments, academia, industry and philanthropy. Yet while over 100 international organisations are supporting us, we need to grow that figure.

We believe that we are taking measured steps on a long road – and we look forward to further international collaboration as we strive for our ultimate Seabed 2030 goal.

Jamie McMichael-Phillips

Seabed 2030 Project Director

REGIONAL CENTERS

Atlantic and Indian Oceans Regional Center

The Atlantic and Indian Oceans Regional Center is hosted at the Lamont-Doherty Earth Observatory of Columbia University, and led by Dr Vicki Ferrini. The team is fortunate to build upon decades of institutional expertise and technical work focused on assembling and disseminating a global ocean map. A recent presentation given at the virtual European Geosciences Union (EGU) meeting highlights this continuity of work at LDEO from the 1960s to present.

The center has been working closely with stakeholders from around the region to discover and integrate available data, identify existing data that are not yet shared, and develop and share online materials to share information about data within the region. As a result of these efforts, significant amounts of new data were added to the Atlantic/Indian region for the GEBCO 2020 release. The team is actively pursuing new methods for accelerating the processing and integration of data leveraging GIS technologies and stakeholder engagement. They just released a Story Map highlighting data and progress to-date.

Due to travel restrictions related to Covid-19, the center is planning to convene several short virtual events to engage the stakeholders.

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*British-American explorer **Vanessa O'Brien** has become the first woman to reach Earth's highest and lowest points after travelling to the Mariana Trench. Vanessa said she hopes her submersible dive will draw attention to Seabed 2030.*

Southern Ocean Regional Center

The Regional Center Southern Ocean (RC-SO) under the lead of Dr Boris Dorschel is located at the Alfred Wegener Institute (AWI) Helmholtz Centre for Polar and Marine Research in Bremerhaven, Germany. At AWI, mapping the Southern Ocean surrounding Antarctica has a long-standing tradition. First expeditions of the icebreaking research vessel POLARSTERN to collect hydrographic data took already place in 1984 pioneering in mapping the Southern Ocean. Since then, the map of the seafloor of the Southern Ocean has been continuously refined. Building on this experience, the RC-SO is involved in almost all polar expeditions of German research vessel furthering the collections of bathymetric data during operation and transit.

Due to its remoteness and inaccessibility, the Southern Ocean is still among the least explored areas of the world. Large parts of this ocean are permanently covered by sea ice making mapping particularly challenging and exciting. Vast uncharted areas still have the potential for discoveries of spectacular seafloor structures such as unknown seamounts, canyons etc. Working in the Southern Ocean is truly explorative.

A milestone of portraying the Southern Ocean was the release of the first International bathymetric Chart of the Southern Ocean (IBCSO) in 2013 coordinated by AWI. Within Seabed 2030, we will soon be able to release the second version of IBCSO extending the portrayed area northward by 10° to 50°S thereby almost doubling the seafloor area of seafloor covered compared to the previous IBCSO version. With the help of the Seabed 2030 Project, the existing bathymetry team at AWI and the RC-SO has gained essential expertise. As of now, the interdisciplinary team comprises experts in GIS, cartography, hydrography, statistics, computing and geophysics. Out of this knowledgebase, new approaches have been developed, for example, to optimise workflows for large volumes of geo-spatial data essential for Seabed 2030 and IBCSO.

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REGIONAL CENTERS

Arctic and North Pacific Ocean Regional Center

The work of compiling depth data from the Arctic and North Pacific oceans is led by Professor Martin Jakobsson at the Department of Geological Sciences, Stockholm University, and Professor Larry Mayer at the Center for Coastal and Ocean Mapping, University of New Hampshire. The work at Stockholm University, focused on assembling a Digital Bathymetric Model (DBM) of the Arctic Ocean, goes back to the International Bathymetric Chart of the Arctic Ocean (IBCAO) project, which was initiated under the auspices of the Intergovernmental Oceanographic Commission (IOC) in St Petersburg 1997.

IBCAO was set up with an Editorial Board consisting of members from the circum-Arctic nations and others active in the Arctic Ocean. This concept of focusing mapping effort on a specific region was adopted by the Seabed 2030 Project and led to the establishment of the four Regional Centers. The first DBM that came out of the IBCAO project was released in 2000. It made a huge splash as the demand for a digital portrayal of the Arctic seafloor was much higher than anticipated. Thousands of scientists and map makers downloaded the product within a week of the release.

The IBCAO compilation work continues now with an expanded Editorial Board as part of the Seabed 2030 effort. A new IBCAO Version 4.0 has just been released along with a descriptive article in the Nature Journal Scientific Data. Since the last release of IBCAO Version 3.0 in 2012, the mapped area of the Arctic Ocean has increased from 6.7 to 19.6 %. IBCAO 4.0 is compiled on a Polar Stereographic projection (grid-cell size: 200 x 200 m) to optimally portray the Arctic Ocean situated around the geographic North Pole. A reprojected version IBCAO 4.0 into geographic coordinates represents the Arctic Ocean area in the released GEBCO 2020 grid.

Center co-Heads: Professor Martin Jakobsson and Professor Larry Mayer
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"This new status of ocean mapping where we don't want to just map but map and characterize, autonomous underwater vehicles are hugely, critically important component."

Professor Larry Mayer, in an interview with CNBC

South and West Pacific Ocean Regional Center

The South and West Pacific Ocean Center for the Seabed 2030 project, covers more than 123 million km^2 of ocean from South America to Australia, between 10°N and 50°S, and the western part of the Pacific Ocean to 50°N. The region includes two of the world's deepest trenches, internal seas, 39 countries and territories, and is made up of 50% international waters.

The center is based in Wellington, New Zealand, and is coordinated by a Technical Management Committee consisting of staff from the National Institute of Water and Atmospheric Research (NIWA), the Institute of Geological and Nuclear Sciences (GNS Science) and Land Information New Zealand (LINZ).

Marine geologist Kevin Mackay (NIWA, New Zealand) is the center's director and has worked on the collection, processing and management of bathymetric data since 1998. NIWA and its predecessor, the New Zealand Oceanographic Institute (NZOI), have been pioneers in seafloor landmark discovery around New Zealand, including active faults and volcanoes. With the Seabed 2030 project now in it's third year, Kevin Mackay describes the task of mapping this area as colossal.

"Most of the mapped data is already public, but there is also a large part coming from non-public sources that we need to get permission to use. The rest of the area has not been mapped yet and we have to find ways to fill in the gaps. In some remote places, ship tracks are spaced up to 100 km apart."

The South and West Pacific Ocean Center has the largest area to cover. When the project started, less than 10% of the region had been mapped. In 2020, this number is now at 19.7%, thanks to major collaboration efforts. *"There have been many challenges and there is still a lot of work to be done, but we have made tremendous progress in the last three years"*, says Kevin Mackay.

International cooperation is the key to the success of the Center so far, with active involvement from the private sector, research institutes and government organisations from 20 countries.

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GLOBAL CENTER

Generating the global grid

The Global Center has responsibility for producing, and then making available, the annual updates to the GEBCO global gridded products that are generated through the Seabed 2030 project.

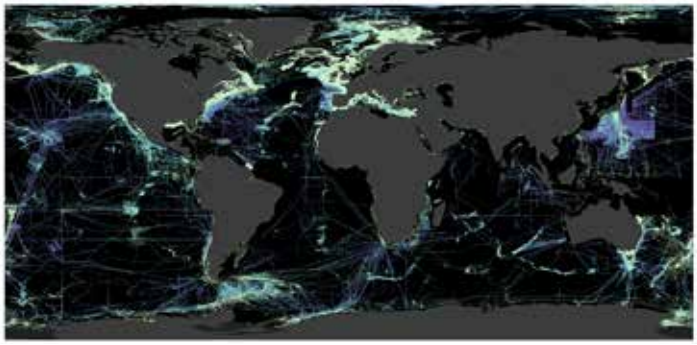
The global grid is created by merging the observations that have been processed and collated by the regional centers into a 'base grid' to provide a single product. There are several stages in the process. The first is to identify the most appropriate base grid to use. For the 2020 product, we have used the SRTM15+ v2.0 product (Tozer et al, 2019), based on satellite-derived predicted bathymetry, constrained by actual bathymetric observations. This grid is global in extent, and provides the land topography as well as ocean bathymetry.

To merge the observational data, the non-polar Regional Centers send us 'sparse grids' of data. These are grids where only actual observations are included – the other grid cells are left blank. These values are then used to replace the SRTM15+ values with the new observations. This can cause us some problems if the new observations are a long way from the predicted bathymetry values, as we can have apparent cliff edges in the ocean floor that are not real. We have decided, for this release, not to try and smooth over these cliff edges, to make it clear where we have added new data. As we add more observations, we will be able to reconcile these differences and produce a much more coherent view of the sea floor.

As the polar Regional Centers generate their data using polar coordinates, to cope with the effect of the longitude lines all converging at the poles, they provide us with complete grids for their regions. Historically, the predicted bathymetry products did not cover the polar regions either, and only with the inclusion of more recent satellite data have we had the option to look at polar regions. The Polar Regional Centers also use specialist datasets for their land data.

These complete polar grids are merged into the global grid by blending the edges of the grids together with the global grid to create a continuous dataset.

Very importantly, the global center also created the global grid of Type Identifiers, that allows us to identify the type of data used to create each grid point: be it a multi-beam echo sounder depth, one predicted from satellite gravity data, or a point sounding using a lead line! This provides valuable information for the grid users to understand the bathymetric grid and what kinds of errors there might still be.



Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

The black indicates where modern measurements are still needed

Once the grids are complete, and checked for errors, the global center creates versions of the grid in a number of different format: NetCDF, GeoTIFF and ESRI ASCII formats, to provide versions that can easily be imported into a range of applications. A download service (download.gebco.net) also allows users to select their specific area of interest and only download that section of the global product to use.

For visualisation of the data, we provide a Web Map Service – and application developers can build in the GEBCO gridded products as base-maps, without users even knowing how to access our products!

Tozer, B, Sandwell, D. T., Smith, W. H. F., Olson, C., Beale, J. R., & Wessel, P. (2019). Global bathymetry and topography at 15 arc sec: SRTM15+. Earth and Space Science. 6. https://doi.org/10.1029/2019EA00065

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Seabed 2030 echoes the goals of the UN Decade of Ocean Science for Sustainable Development, to be launched next year.

FUGRO EDITORIAL

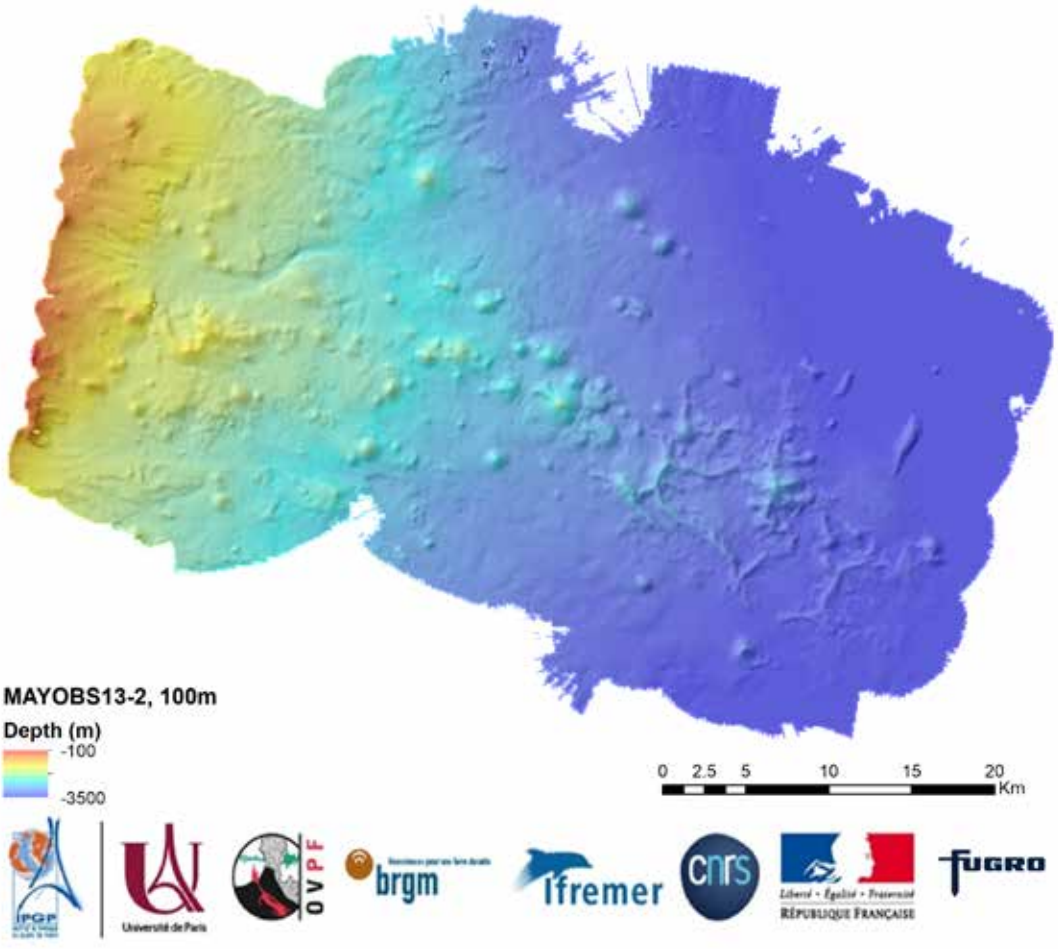
Ocean mapping: where there's a will, there's a way

Mapping the world's ocean by 2030 is, without doubt, an ambitious goal. It's also a worthy pursuit, and one that will be made possible through cooperative partnerships, remote and autonomous technologies, and innovative thinking. What does that look like in practice? Fugro's recent collaboration with Ifremer, the French Research Institute for Exploitation of the Sea[1], provides an example.

Ifremer is part of the Mayotte Volcanological and Seismological Monitoring Network (REVOSIMA), which is studying a massive, newly formed underwater volcano off the southeast coast of Africa. Their role is to produce seafloor mapping data for the seismically active area. This includes production of bathymetric maps, backscatter maps, and analyses of acoustic plumes caused by emissions of fluids and particles into the water column. However, the Covid-19 pandemic and associated travel bans put Ifremer's spring survey in jeopardy so Fugro stepped in to help.

The company's survey vessel, the Fugro Gauss, already heading from the Netherlands to South Africa, made a 10-day detour of that transit to accommodate Ifremer's mission. This opportunistic solution was made possible by Fugro's sustained investments in remote operations and support technology. Collaborating "in the cloud", Ifremer was given direct and constant access to Fugro's vessel's position and survey progress and they downloaded the raw mapping data in near real time.

Describing the survey, Dr Carla Scalabrin, Ifremer Head of Mayotte Project Hydroacoustic Team, stated: ***"It was our first experience of remote working and we never met our Fugro colleagues in person, as the project was planned by email and videoconferencing. Despite these challenges, we quickly established a climate of trust and the data transfer was extremely powerful. This successful survey is the result of a positive and respectful collaboration between the Ifremer and Fugro teams."***



[1] Ifremer also contributes to GEBCO via the European EMODnet initiative

Take part in our online Seabed 2030 survey

Seabed 2030 has recently launched a study on the benefits of seabed mapping. We encourage the ocean industry's participation in this survey, to identify the environmental, social and economic value of mapping the world's entire ocean floor by 2030.

To participate, please click here.

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