



NGA Support to the GEBCO Project– Mapping the Gaps

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Derived from:

Declassify on:

NATIONAL GEOSPATIAL **NGA** INTELLIGENCE AGENCY

Agenda

- NGA background and our involvement in GEBCO and Map the Gaps
- Global Customers and users
- “Oxygen” for global geospatial data – WGS 84
- Support for Global GPS
- Global topographic (above MSL) Digital Elevation Model (DEM)
- Crowdsourced Bathymetry – new challenges
- Volunteer Geographic Information in other domains
- Summary



**NGA IS A COMBAT SUPPORT AGENCY OF THE
DEPARTMENT OF DEFENSE
GLOBAL CUSTOMERS AND MISSION SETS
PROVIDING DECISION ADVANTAGE TO:**

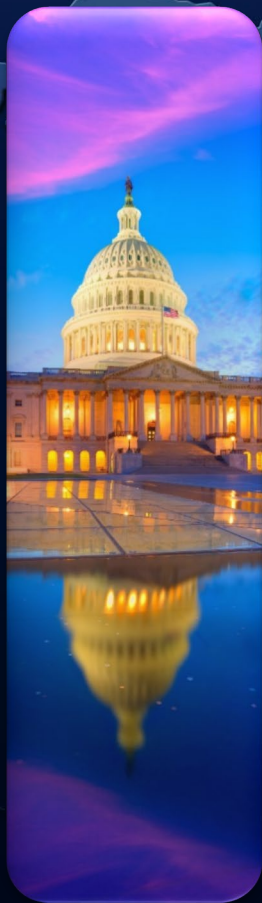
FIRST RESPONDERS

POLICY MAKERS

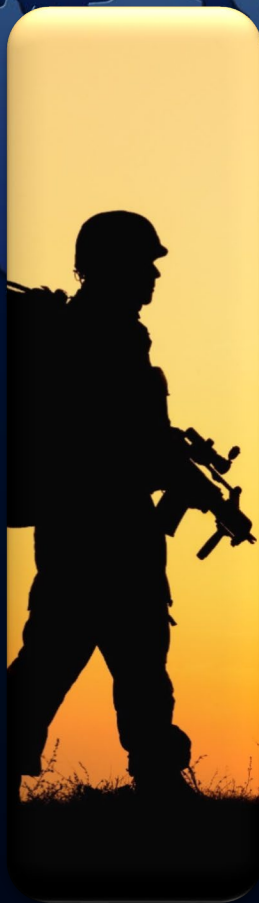
WARFIGHTERS

Statutory requirement to support customers beyond the DoD

Engaging Customers and Building Partnerships



GOVERNMENT



MILITARY



INDUSTRY



ACADEMIA



PILOTS



MARINERS



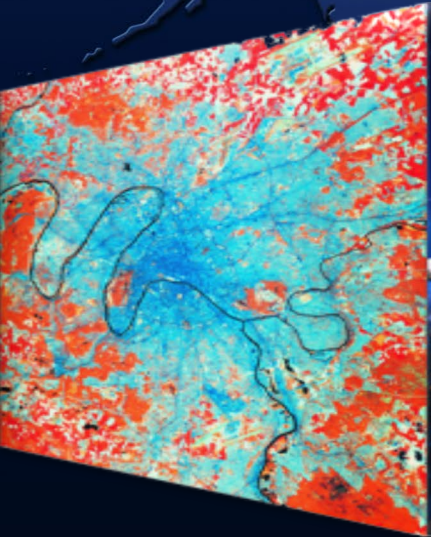
INTELLIGENCE



INTERNATIONAL

Integrating Foundation Data

SCIENCE



270
MILLION

Square Kilometers
of Elevation Data
Coverage

LAND



1.3
BILLION

Topographic Features
in the Management
Database

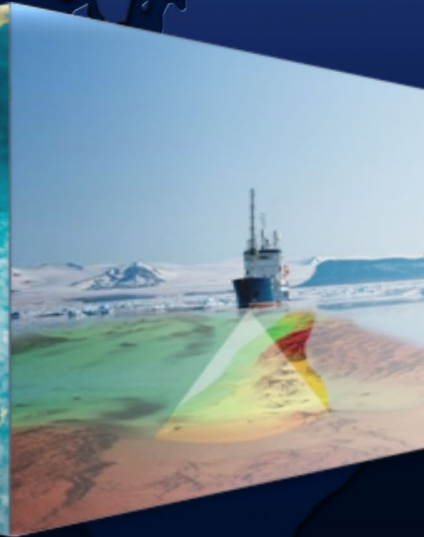
**HUMAN &
POLITICAL
GEOGRAPHY**



12.7
MILLION

Geographic
Names

SEA



70
MILLION

Hydrographic
Features

AIR



4
BILLION

Aeronautical
Data Elements

PARTNERSHIPS



70+
NATIONS

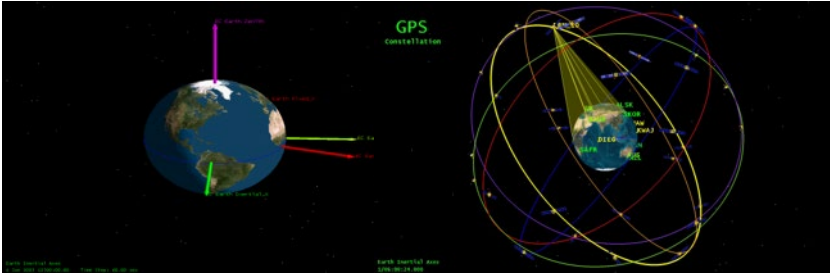
Multi- or Bi-
Lateral Agreements

NGA activities supporting GEBCO and Seabed 2030

- On April 12, 2017, NGA became a collaborator to the proposed GEBCO Seabed 2030 Project
- NGA is engaged throughout the geospatial data community, providing data, policy support, standards expertise, and the scientific foundation
 - Geomatics
 - Global data, products and services
 - Standards

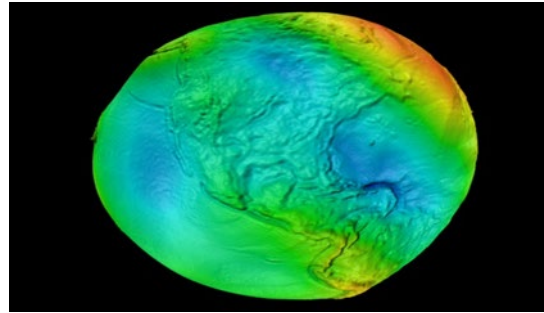
WGS 84 – A System of Global Systems

Reference Frame



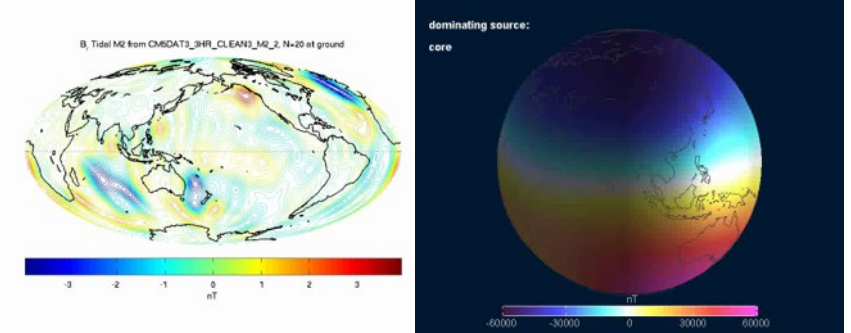
- Targeting
- Supports GPS Operational Control Segment (OCS)
- Navigation
- Defines ECEF and ECI frames
- Photogrammetry
- Satellite Operations
- Is an international Standard
- Interoperability requires relationship between WGS 84 and other GNSS reference systems
- Datum Transformations
- Map Projections

Earth Gravitational Model



- Defines Mean Sea Surface
- More accurate Geoid surface to reference land elevations
- Improved reference frame for defining position coordinates
- Improved Satellite Orbits
- Enhanced gravity models
- Increased knowledge of ocean circulation

World Magnetic Model

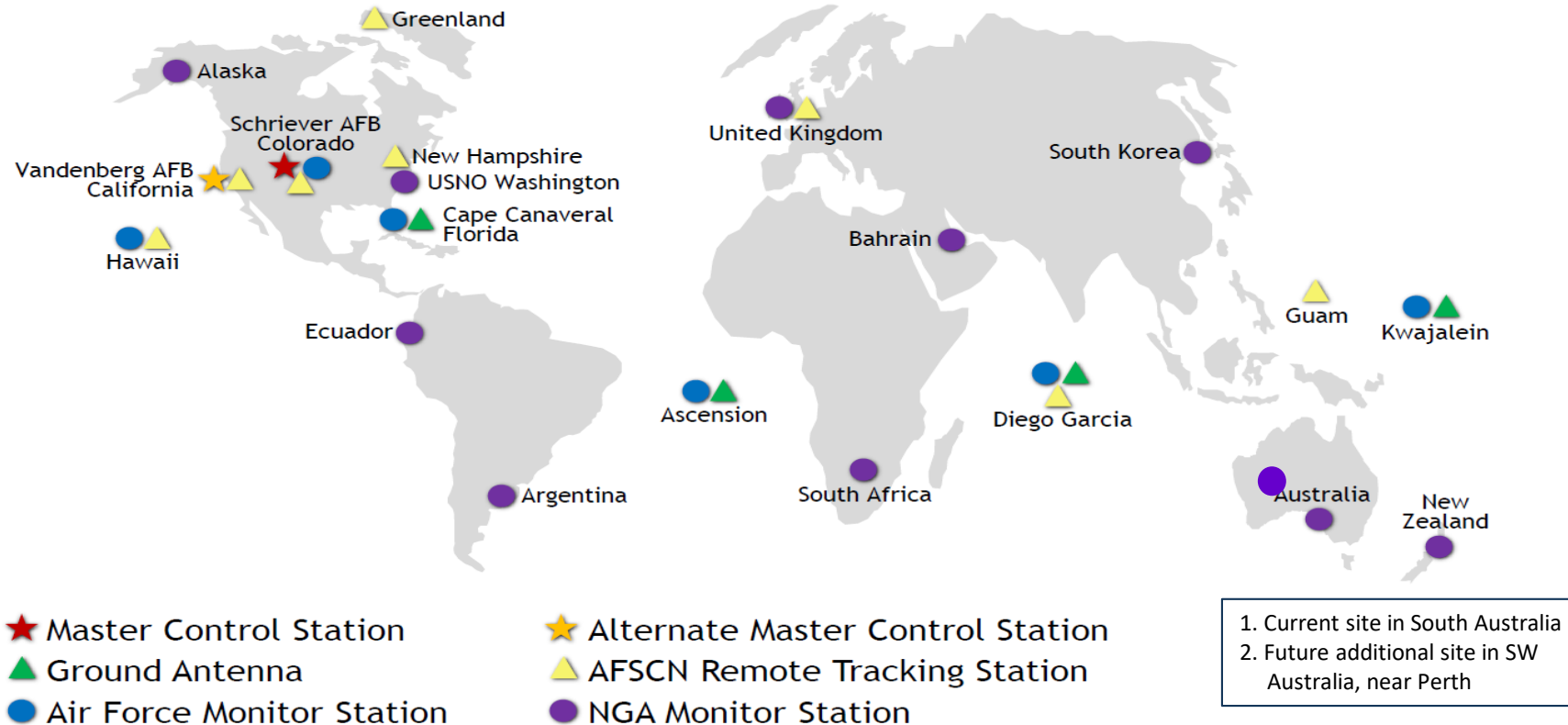


- DoD and NATO standard navigation product
- Used by NOAA, FAA, USGS
- Spacecraft attitude control
- Orienting of antennas and solar panels
- Space weather modeling and prediction
- Magnetic Anomaly Detection
- Navigation Reference Systems
- Geologic Studies

Provides the fundamental inter-operational capabilities for all of the DoD, and Global geospatial community

Ground Stations are the Anchor Points for the World Geodetic System 1984 (WGS 84)

GPS Control Segment



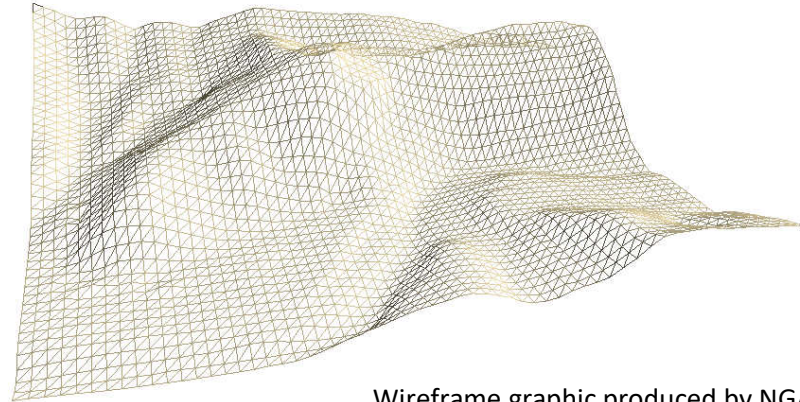
Updated February 2017

“Provide Timely, Accurate, and Leading Edge GPS-Based Products, with Technical Support and Analysis to the DoD, IC, and Scientific Community”

– Global Navigation Satellite Systems Division Mission Statement

NGA is creating a global Digital Elevation Model (DEM)

- Digital elevation models (DEMs) are specialized databases that represents the relief of a surface between points of known elevation
- DEMs are arrays of regularly spaced elevation values referenced horizontally either to a Universal Transverse Mercator (UTM) projection or to a geographic coordinate system



Wireframe graphic produced by NGA

- DEM elevations are referenced to a vertical datum
- Spacing between elevation measurements is based upon elevation density requirements
- DEM elevation data is captured from surveys and spaceborne or airborne platforms
- The term DEM is often used to refer to a bare earth surface

Global Uses for Elevation Data

Digital Elevation Models (DEMS) are a foundation dataset, impacting several domains:

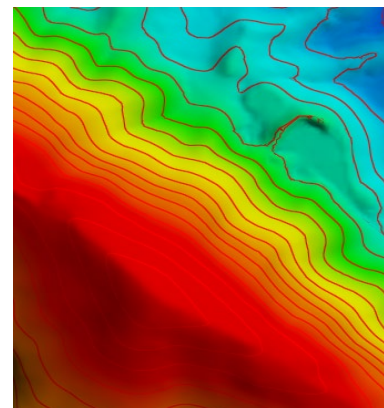
- **MARITIME:** littoral zones, islands, shoreline mapping
- **AERO:** Airport topography, surrounding terrain for approach
- **TOPO:** contours, spot elevations, hydrologic features, mapping
- **IMAGERY:** CIB production, Terraform, orthophotos
- **ANALYSIS:** Mission planning, mission specific, situational awareness, modeling, visualization, decision making, disaster relief, change detection



Hydrographic Chart
Courtesy of NOAA



Topographic Map
Courtesy of USGS



Contour/Shaded Relief
Graphic produced by NGA

Auto-Generated Elevation Data - *Polar Geospatial Center*

ArcticDEM

NGA-NSF public-private initiative to produce a high-resolution, high quality, digital surface model (DSM) of the Arctic using optical stereo imagery, high-performance computing, and open source photogrammetry software. The entire ArcticDEM domain was mosaicked to **2-meter** resolution and covers just over **10%** of the planet. There are now over **260,000** total **2-meter** time-stamped DEMs that amount to nearly **160 million km²** and **200 TB**.

REMA

Constructed from hundreds of thousands of individual stereoscopic Digital Elevation Models (DEM) extracted from pairs of submeter resolution commercial satellite imagery licensed by the National Geospatial-Intelligence Agency. The Reference Elevation Model of Antarctica (REMA) provides the first high resolution (**8-meter**) terrain map of nearly the entire continent.

EarthDEM

Currently in production. The success of both ArcticDEM and REMA started an initiative to complete the remaining portion of the globe at 2-meter.

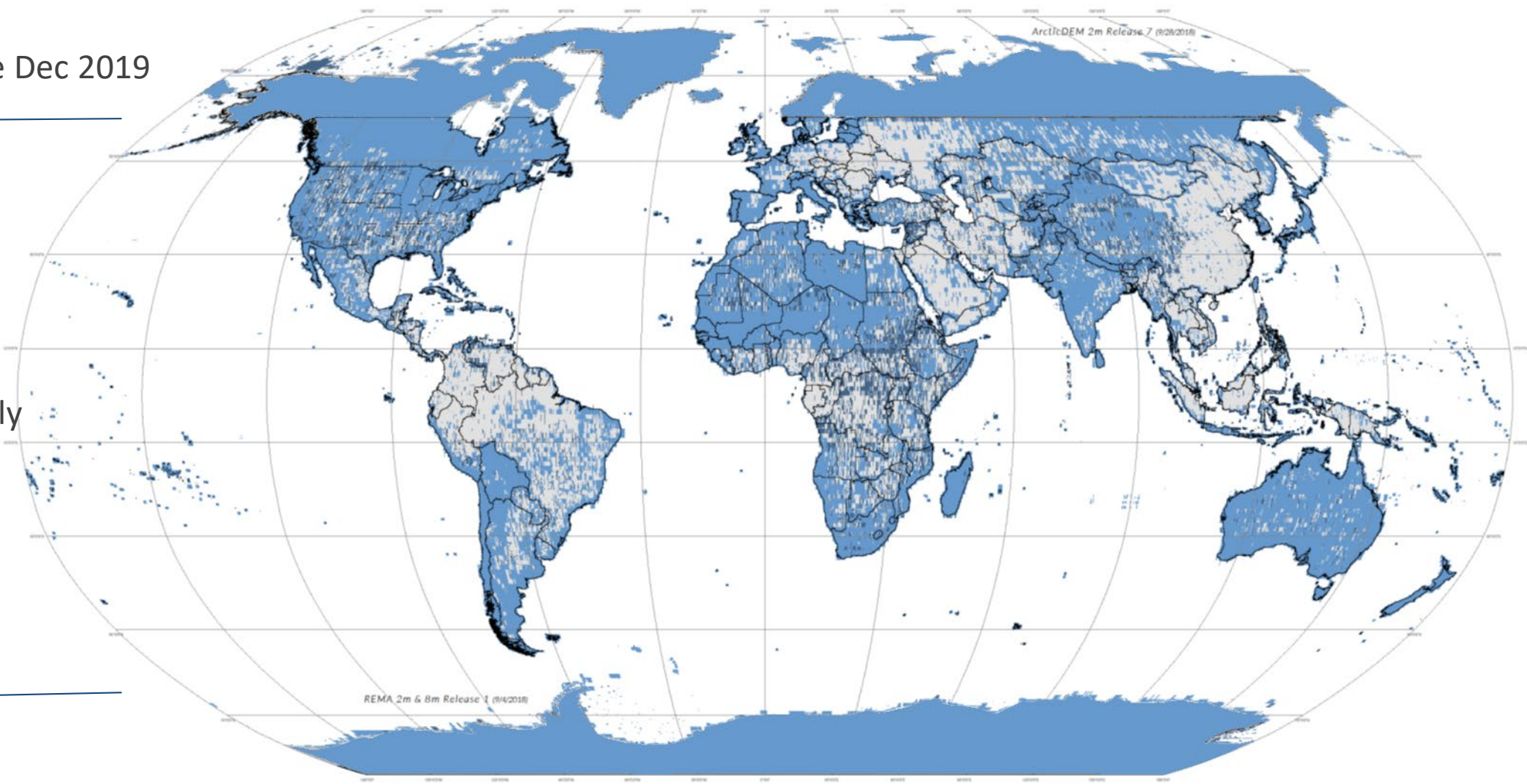
2019 Auto-Generated EarthDEM Production

2m Surface Model

ArcticDEM
New update Dec 2019

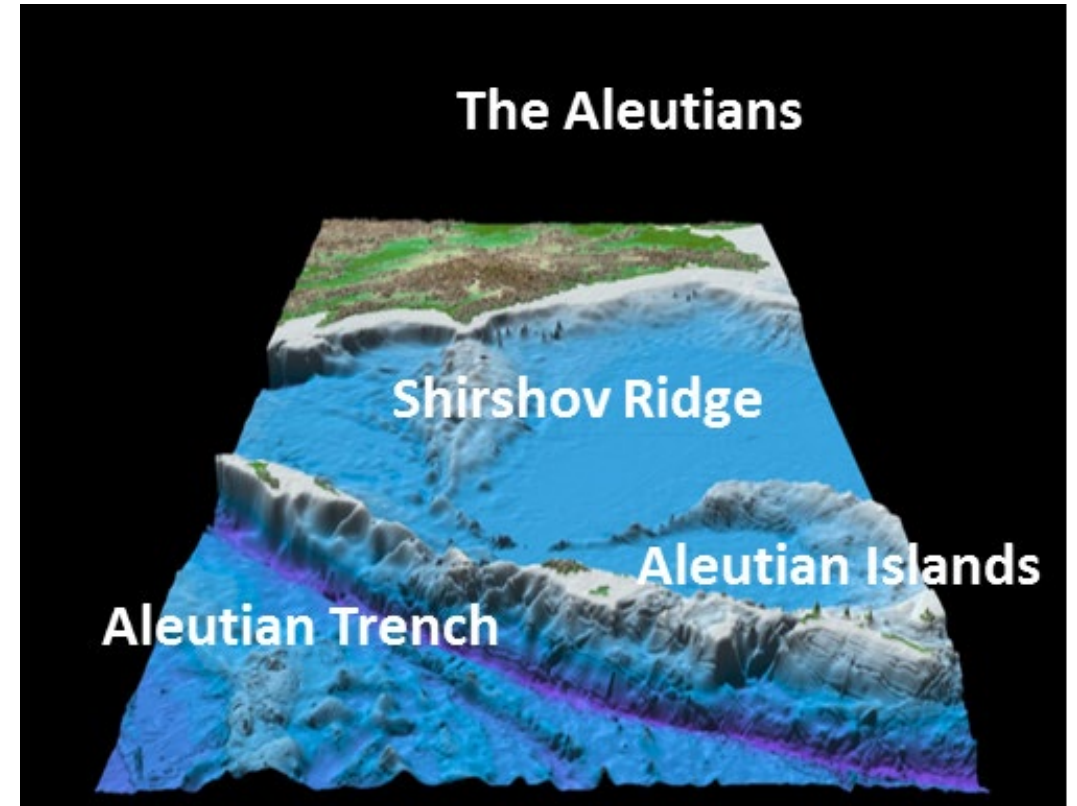
EarthDEM
Complete early
2020

REMA
Complete



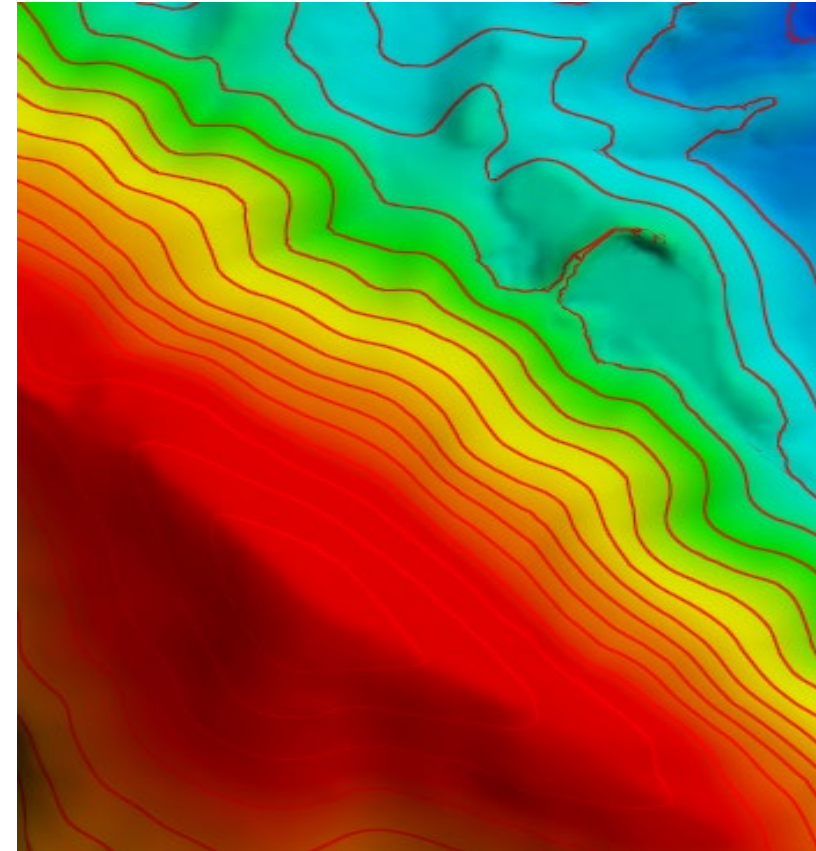
Combining Earth and Bathymetry - Digital Bathymetric Elevation Dataset (DBED0)

- Combined Bathymetric & Terrestrial Elevation foundation data system
- Wholly unclassified product collected from open source data available online
- GEBCO data utilized as a primary contributor within the bathymetric grid



Improving our understanding of the Seafloor - GEBCO

- GEBCO is the project tasked to build out our knowledge of the shape of the seafloor.
- Activities overseen by the IHO and IOC
- Activities include:
 - Inventory existing bathy data
 - Gap Analysis
 - Crowdsourc Bathymetry
 - Encourage Nations, agencies, academia and commercial entities to share data
 - Data archive is the IHO DCDB, managed in accordance with Member State input.



Use of Crowd Sourced Bathymetric Data in the maritime world

- In 2015, the IHO stood up the Crowd Sourced Bathymetric (CSB) Work Group
 - “to examine how best to incorporate, manage and use bathymetric data acquired by other than conventional means”
- 2019 - Publication *B-12 Guidance on Crowdsourced Bathymetry* was **approved** by IHO Member States
 - 35 MS supported the adoption
 - 3 MS did not support
- 2019 – A survey of MS’s regarding views on the aggregation of depth data at the IHO Data Center for Digital Bathymetry was conducted. Of the 174 Coastal States, the 89 IHO Member States were asked about CSB within territorial waters
 - 1 agreed with no restrictions
 - 13 agreed with caveats
 - 160 were silent or disagreed with the concept of CSB

What is the future of Crowdsourced Bathymetry?

- Will much of the seafloor will be “off limits” to CSB?
- What is the impact to the IHO DCDB and the Seabed 2030 Data Centers?
- Does this limit apply to existing data within the various centers?

- Do nations and national authorities wish to provide leadership within the CSB effort?
- Can a nation respond to CSB in a way that supersede International Law?
 - ▶ The collection of depth measurements is required by vessels due to treaty obligations and prudent navigation practices.
 - ▶ There is no treaty restriction for how depth is measured
 - ▶ Commercial systems are harvesting this data on a global scale now

- Is the collection of Crowdsourced data common in other domains?

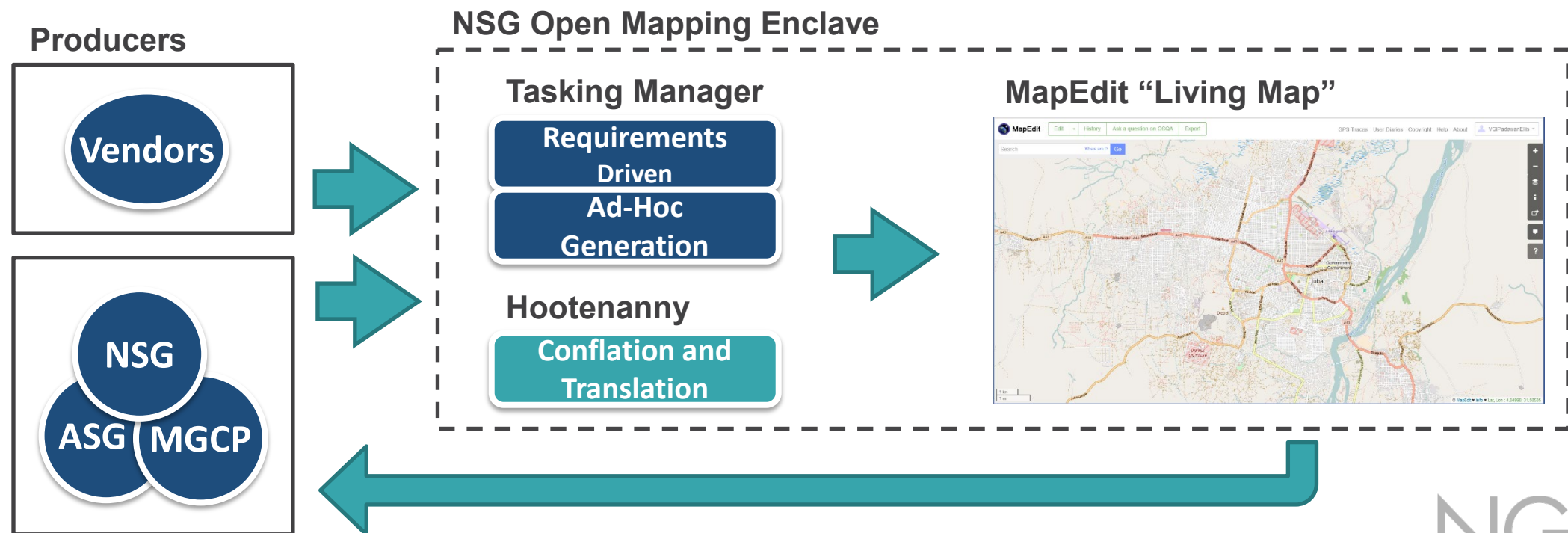
Crowdsourcing (VGI) data in other domains - example NSG Open Mapping Enclave (NOME)

NOME is an NGA initiative to implement Volunteer Geographic Information (VGI) concepts and tools to produce foundation GEOINT data within the Intelligence Community, the National System for Geospatial-Intelligence (NSG), and among our foreign partners.



NSG Open Mapping Enclave...What will it do for the NSG and Partners?

- Provides trusted users with an interface for dynamically enriching foundation GEOINT
- Enables dynamic content generation via a “living map” to enhance static map production



Key Takeaway for Map the Gap Participants

- The infrastructure to succeed with the GEBCO and Seabed 2030 efforts will require support from geospatial experts, governments, academia and commercial partners.
 - In an open and collaborative way
- Mapping the Ocean “Gaps” is part of mapping the earth, and we need to move together to realize this goal.
- Marine geospatial data has unique rules, we must find ways to work within the rules, providing the best data and information possible.
- VGI exists today across all data domains and is here to stay. Utilized properly, CSB offers a way to progress the mapping of the oceans – yet challenges exist.
- NGA stands ready to continue our part and support the marine geospatial community



