

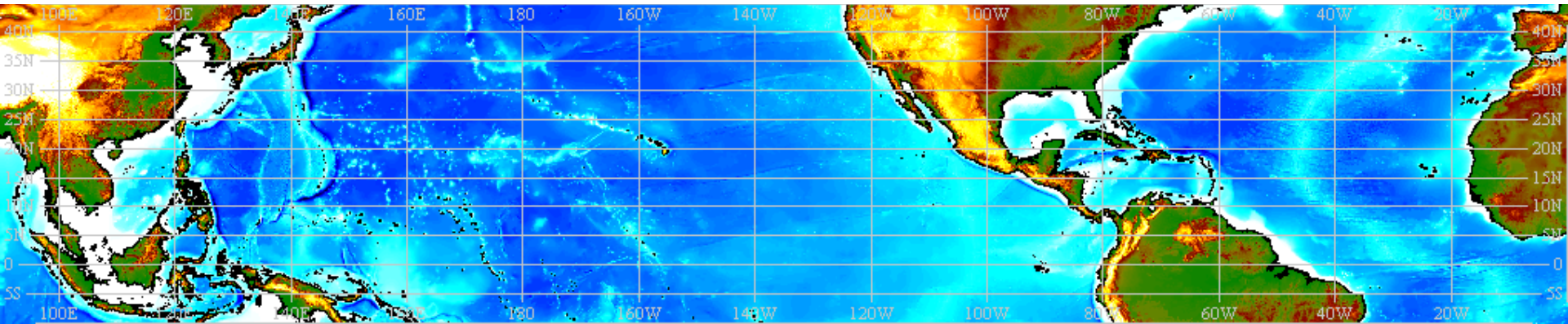
# A look to the future

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# Part 1. Introduction

- 1.1 Time Scale
- 1.2 The world in 1903
- 1.3 The world in 2003
- 1.4 What do we dream the future will bring?



# 1.1 Time Scale

- No one can seriously predict the events of a century. At the other end of the temporal scale, what is GEBCO going to do the week after this celebration is over?

## 1.2 The world in 1903

- Was very much still being explored
- Existed to some extent only in imagination or dreams since no one had seen parts of it
- Was being expanded
  - not known if there was land in the Arctic Ocean
  - first voyage through the North West Passage 1903
  - 1902 the first trans-Pacific cable completed
  - 1903 the first powered flight took place
- Founders dreamed of mapping the entire world ocean, even though parts of it had not been seen.

## 1.3 The world in 2003

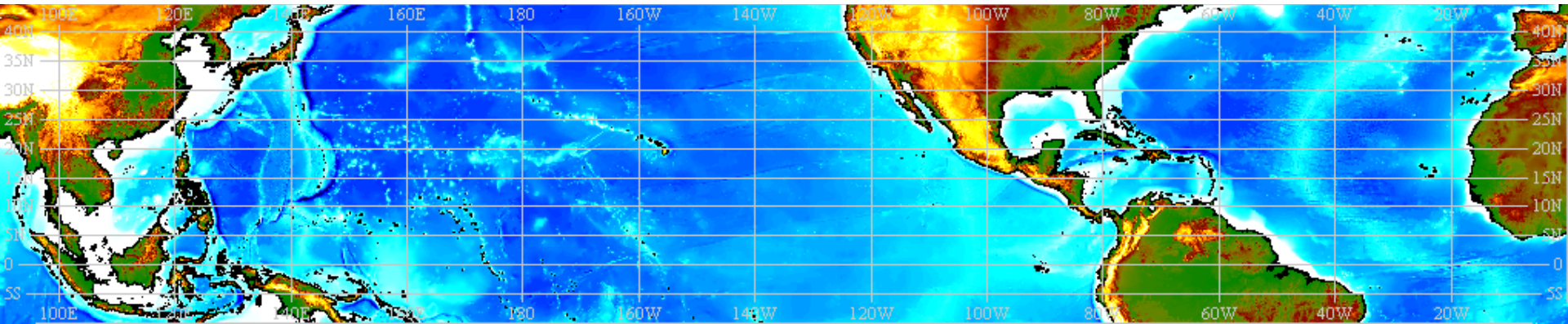
- Is very much still being explored
- Exists to some extent only in imagination or dreams since no one had seen parts of it
- Is being expanded
  - discovery of gas hydrates, of pharmaceuticals from the sea, of black smokers, of cobalt crusts, of chemosynthetic life at ocean ridges, of world wide gridded data sets being made easily available, a new order of sea-floor morphology from detailed MBES surveys.
- Latest track charts show vast areas that have never been visited by a recorded research vessel although some have been mapped by satellite

## 1.4 What do we dream the future will bring?

- Many earth scientists share the dream of having the entire surface of the earth, both subaerial and sub-aqueous, mapped seamlessly to a fine resolution.

# Part 2 Present situation

- 2.1 Hydrography at the Organizational Level
- 2.2 Oceanography at the Organizational Level
- 2.3 Oceanography and hydrography at the individual Level
- 2.4 Clients



## 2.1 Hydrography at the Organizational Level

- IHO Strategic Planning Work Group draft objectives:
  1. To improve global coverage, availability, quality and access to hydrographic data (*and its related oceanographic*) information, products and services (*especially nautical charts and publications*)
  2. To improve global hydrographic capability, capacity, science and techniques.
  3. To establish international standards for the quality and formats of hydrographic data, information, products, services and techniques and to achieve the greatest possible uniformity in the use of these standards.
  4. To give authoritative (*and timely*) guidance and advice on all hydrographic matters to governments and international organizations
  5. To facilitate coordination of hydrographic activities among Member States.
  6. To enhance cooperation amongst States on a regional basis
- Continued support for GEBCO meets these objectives.



## 2.2 Oceanography at the Organizational Level

- 1999 IOC workshop, Potsdam, “Oceans 2020”, does not mention bathymetry as an objective but states that accuracy of bathymetric data remains a limitation of some other branches of oceanography.
- 2002 SCOR Working Group 107 “Improved Global Bathymetry” Report lists many uses for bathymetry and many recommendations for producing bathymetric data bases, maps and grids

## 2.3 Oceanography and hydrography at the individual Level

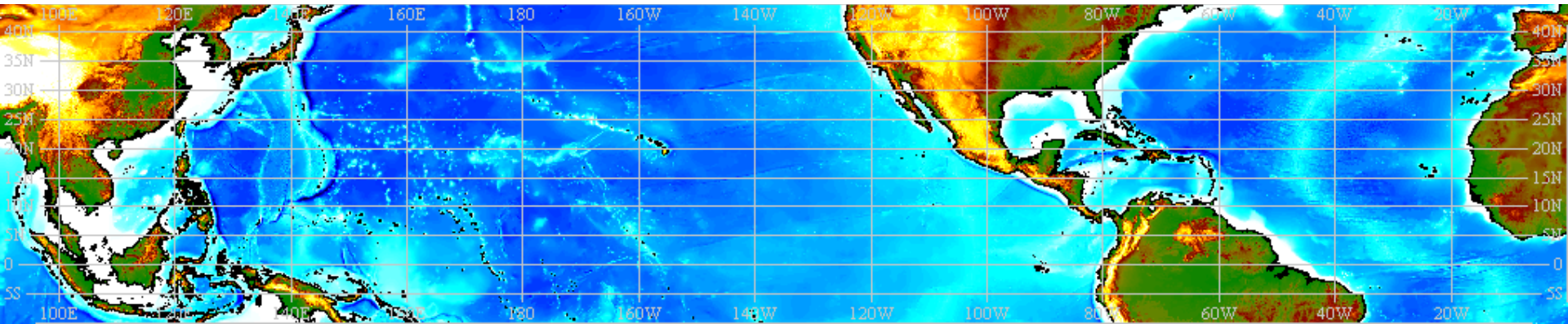
- Individual scientific coordinators and peer reviewers.
- Future role of scientific coordinators greater amounts of data, a unifying theory of how oceans are created, acceptance of computer contouring as a tool, altimetry world wide (except poles), and multibeam surveys which do not need interpretation (within footprint).
- Will require a different level of interpretation, one requiring skills not employed in previous editions.

## 2.4 Clients

- Questionnaire Survey circulated by GEBCO Secretary 2002 showed that users did not see a change in their usage of GEBCO but are seeking finer scales

# Part 3. Likely impacts from science and technology over the next twenty years

- 3.1 Data Collection
- 3.2 Positioning
- 3.3 Data base / data centre
- 3.4 Digital products
- 3.5 The Internet
- 3.6 Seabed information
- 3.7 Remote sensing



## 3.1 Data Collection

- **Ships** it will take some 800 ship-years to cover the entire seafloor from the 25 m contour out to the deepest ocean with MBES.
- **Submarines** SCICEX program demonstrated value
- **Military** data released to the public domain
- **Drifters and floats**
- **Robots, tethered and autonomous**
- **Satellites**
- **On multi-disciplinary cruises** bathymetry will seldom be the highest priority
- **Repetitive measurements = less bathymetry**

## 3.2 Positioning

- Positioning of the research vessel is no longer an issue
- Current positioning research is focussed on positioning the ends of the acoustic beams of a multibeam system on the seafloor.
- Upper limit on map publication scale removed
- Transition Period new maps made from a combination of pre- and post-GPS positioned data.

## 3.3 Data base / data centre

- National Geophysical Data Center operates a worldwide digital data bank of oceanic soundings on behalf of the IHO.
- Soundings are inventoried, quality controlled and updated.
- Member States and other organizations submit bathymetric data
- In the future, bathymetric information may be locally managed and made available on servers
- There will be an even greater need for quality control and standards through NGDC

## 3.4 Digital products

- GIS in common use, bathymetry as one layer
- Use digital methodologies for the production, distribution, and advanced visualization of bathymetric information in user-friendly form
- Option for producing printed output always available



## 3.5 The Internet

- Major driving force in mapping just coming into its own
- Can easily download thousands of maps, data sets and images
- The internet will go to sea: it will not be long before data can be moved from instruments aboard ships to shore-based labs
- GEBCO will not have a future if it is not part of the internet.

## 3.6 Seabed information

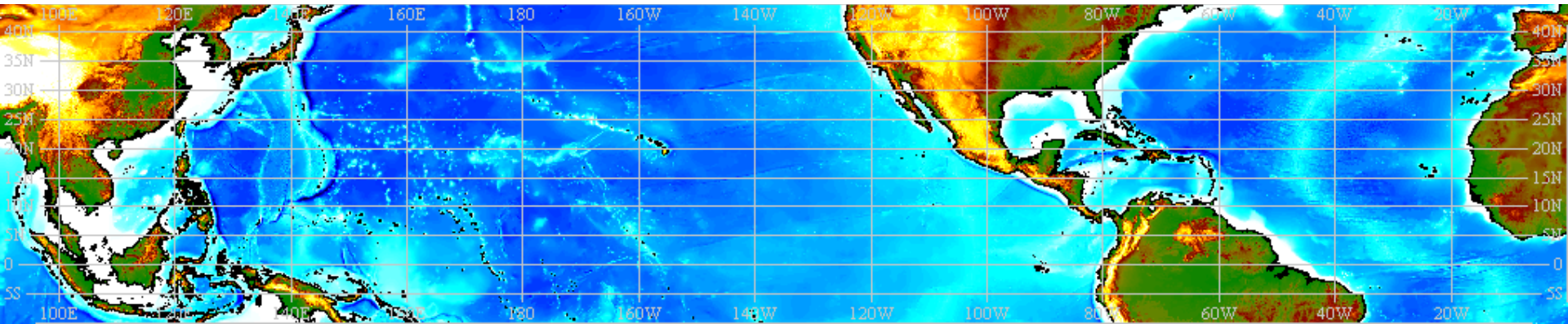
- **Multibeam Sonar** and other systems permit close to 100% coverage the seabed
- **Within the area ensonified**, collect so much data that only computer analyses possible, no human interpretation is needed or practicably applicable
- **Both single beam and MBES data** will co-exist for some time and methods of combining them will have to be developed or perfected
- **Acoustic backscatter** related to bottom composition and texture easily mapped
- **“Automatic” seabed classification** being introduced

## 3.7 Remote sensing

- **Altimetry** the only cohesive, single-instrument source of data for the deep oceans
- **Altimetry** used to unify and interpret acoustic data where it is widely dispersed and randomly oriented
- **GEBCO Working Group on the Integration of Geoscience Data** is investigating current or future satellite altimeter data to better understand the signal and noise characteristics and will be used to improve altimetry data processing algorithms and demonstrate the possibility of higher-resolution mapping using new altimeter technology

# Part 4. Likely Conceptual changes

- 4.1 Map scale
- 4.2 Edition
- 4.3 Increased Focus on Continental Slope and Rise
- 4.4 The changing role of interpretation



## 4.1 Map scale

- Entire concept of map scale is changing
- GIS users wanting to see more detail zoom in on an area of the same map. The area is enlarged and more detail is shown.
- Under this scenario, the scale of the map is whatever the user wants it to be.
- GEBCO will have to adapt to this new concept of scale.

## 4.2 Edition

- The concept of “edition” from the age of paper printing is changing is a paper Sixth Edition needed or whether some other form of constantly updated map will evolve?
- Achieving a “constantly updated map” is possible and already exists in some disciplines, including the Electronic Chart.
- **Issues to resolve** eg how to apply the principal of peer review to a constantly updated product.

## 4.3 Increased Focus on Continental Slope and Rise

- Coastal States collecting data needed to establish the outer limit to their juridical Continental Shelves (may not enter the public domain until the outer limit is established)
- New class of geomorphologic features being discovered and GEBCO scale, both horizontal and vertical, must be appropriate to show them.
- Presence of methane hydrates/clathrates in the sediments of the Rise the areas of their occurrence are coming under increased attention.

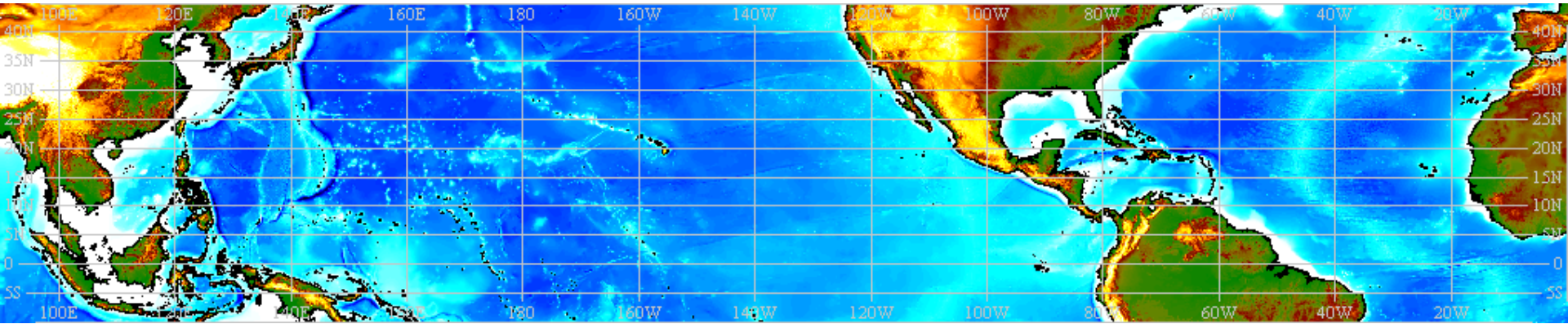
## 4.4 The changing role of interpretation

- Within area of seafloor ensonified during a multibeam survey, no need to interpret the shape of the seafloor
- Between multibeam survey tracks, still a need to interpret from single beam tracks, and ways may be devised to use the extra information provided by the adjacent multibeam coverage
- Altimetry provides long wavelength information. Combining altimetry and single beam has been made operational. Interpreting the three wavelengths of data together is under development.



# Part 5 Likely impacts from Organisational developments

- 5.1 IHO /IHB and volunteering hydrographic offices
- 5.2 IOC regional mapping projects
- 5.3 Combination of GEBCO and IBCs
- 5.4 UN Atlas of the Oceans
- 5.5 CLCS and UNCLOS Continental Shelf submissions
- 5.6 International Seabed Authority
- 5.7 Universities
- 5.8 ODP – Ocean Drilling Program /Integrated Ocean Drilling Program
- 5.9 GOMaP (Global Ocean Mapping Program)
- 5.10 Land mappers



## 5.1 IHO /IHB and volunteering hydrographic offices

- Support GEBCO and the IOC IBCs
- See the data involved as a resource that will be exchanged freely
- See the IBCs as forming a bridge between navigation charts and GEBCO charts.
- Future participation of VHOs dependent on relationship between GEBCO and the IBCs - must be seen as positive to the VHOs and use limited resources to produce maximum return.

## 5.2 IOC regional mapping projects

- IOC publishes regional bathymetric maps of localized areas through seven Editorial Boards and a Coordinating Committee on Ocean Mapping (CGOM)
- Some IBCs already integrated into GEBCO, but not all of the seven Editorial Boards agree to this strategy.
- IBCs use the output of SCUFN.
- NGDC is working with the IBC Editorial Boards
- Some Hydrographic Offices supply data to the IBCs.

## 5.3 Combination of GEBCO and IBCs

- Analogue production of paper charts justified the creation of two series of bathymetric charts
- Digital technology/ data changes this. production of printed charts at several scales from same data set is almost a secondary process.
- Makes economic sense to have a combined series. VHOs would supply data once, the areas covered by the ICMs would be mapped once, GEBCO would include the ICM detailed maps within its large ocean wide coverage.
- There would appear to be clear advantages in GEBCO and the IBCs working more closely together.

## 5.4 UN Atlas of the Oceans

- FAO Fisheries Department has “United Nations Atlas of the Oceans” web site.
- “an Internet portal providing information relevant to the sustainable development of the oceans...Collaborators include the Russian Head Department of Navigation and Oceanography (HDNO), and the US National Oceanic and Atmospheric Administration (NOAA), the Census on Marine Life (CoML) and the National Geographic Society. Cinegram Media Inc., a private publisher, will be producing CD-ROMs and other media in order to reach a wider audience...”
- On March 7, 2003 web site has, as freely downloadable images, the cover of the GDA and a portion of one of the 1:10,000,000 sheets.
- Clearly there are some links to build here.

## 5.5 CLCS and UNCLOS

# Continental Shelf submissions

- Guidelines of the Commission on the Limits of the Continental Shelf (CLCS) will impact all Ocean Mapping for at least the next ten years
- Paragraph 3.2, Annex II, UNCLOS states  
“The Commission may cooperate... with the IOC [and] the IHO...with a view to exchanging scientific and technical information which might be of assistance in discharging the Commission's responsibilities.”
- GEBCO has included members of the CLCS among its scientific advisors in the past and the Chair of CLCS is at this meeting

## 5.6 International Seabed Authority

- The International Seabed Authority (ISA) organizes and controls activities in “the Area”, the seabed and ocean floor beyond the limits of national jurisdiction
- ISA issued 15-year exploration contracts to explore patches of the seafloor with a view to recovering manganese nodules. The contractors have collected different types of data. Data confidentiality may be an issue as is normal in the mining and petroleum industries
- Increase GEBCO’s presence with ISA - it’s Secretary General is at this meeting and the Legal and Technical Committee has been approached

## 5.7 Universities

- Universities were a major player in Fifth Edition with fourteen of the scientific coordinators coming from universities in four countries.
- A future GEBCO must include them, and new arrangements will have to be worked out to satisfy their needs and those of their funding agencies.



## 5.8 ODP – Ocean Drilling Program /Integrated Ocean Drilling Program (IODP)

- International partnership of scientists and research institutions organized to explore the evolution and structure of Earth.
- Produced bathymetry of drill locations
- Depth data collected sent to NGDC.
- ODP is actively developing partnerships and it may be fruitful to examine a possible role with GEBCO.

## 5.9 GOMaP (Global Ocean Mapping Program)

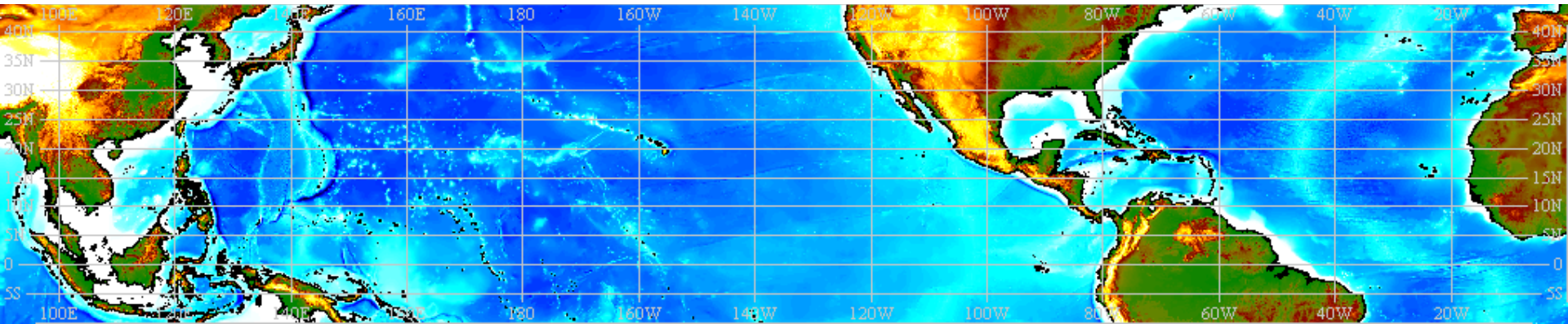
- **Vision** to systematically map the ocean floors with at least 100 percent coverage sidescan and swath bathymetry and perform whatever other data collection could be carried out simultaneously.
- Not (yet) funded
- Some regional mapping initiatives could be considered test areas or pilots for GOMap.
- It could be mutually beneficial for GEBCO and GOMaP to be interlinked.

## 5.10 Land mappers

- The dream of having the entire surface of the earth means that there will have to be programs developed with land mapping agencies.

# Part 6 Likely impacts from societal changes

- 6.1 United Nations Convention on the Law of the Sea
- 6.2 The Declaration Of Special Or Protected Areas



# 6.1 United Nations Convention on the Law of the Sea

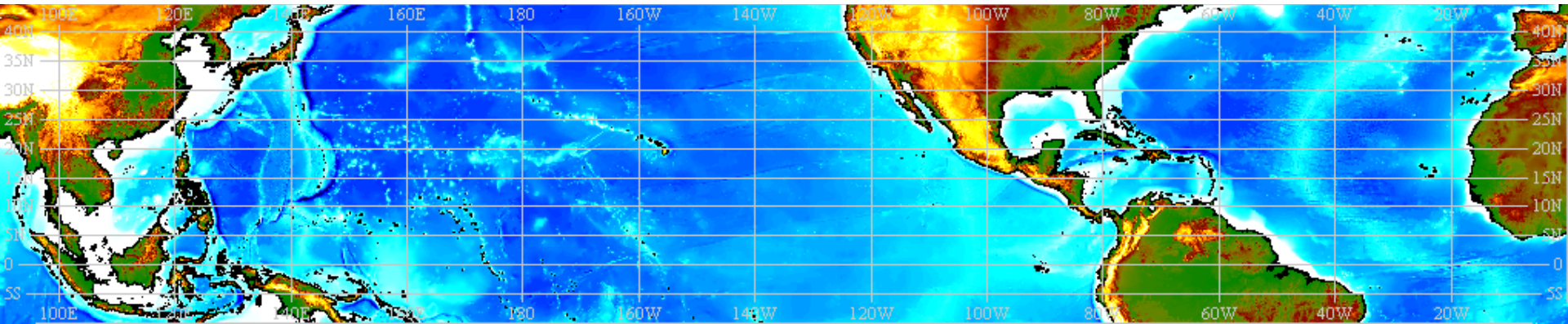
- Impact becoming apparent. GEBCO's future will be influenced by, and may help influence, division of the World Ocean into zones
- Delineating the juridical Continental Shelf requires a large amount of sea floor mapping
- Mapping the Foot of the Slope may lead to improved discrimination of small features at great depths and the development of mathematical models of the seafloor.
- Isolated elevations, and, in some cases, the nature of “ridges”, will require further investigation.
- Need to maintain a supporting data base that could be examined by the CLCS when they consider a submission.

## 6.2 The Declaration Of Special Or Protected Areas

- Special marine areas in which human activity will be limited are being declared by many states
- Establishment of these areas, and the research that will be undertaken within them, will lead to detailed mapping of localized areas.
- GEBCO must assure that this information is incorporated in the DB

# Part 7 The Future Role of GEBCO

- 7.1 Purpose
- 7.2 Idealized Process
- 7.3 Participants
- 7.4 A Model for the “Sixth Edition”



## 7.1 Purpose

- GEBCO will serve the world's marine community through mapping the world ocean floors in their entirety to the highest possible resolution through cooperative partnerships with organizations and individuals.



## 7.2 Idealized Process

- Coastal hydrography will continue collecting data for the safety of navigation and the coastal zone will be mapped to greater intensity
- Limits to juridical continental shelves will be mapped
- Results will be combined into IOC Regional Maps in some areas
- GEBCO will assemble these and combine them with surface and satellite measurements into ocean-wide maps
- Outputs will include the data itself, gridded or otherwise, interpreted contours, digital and paper maps, and layers for marine GIS
- Data sets will be continuously updated

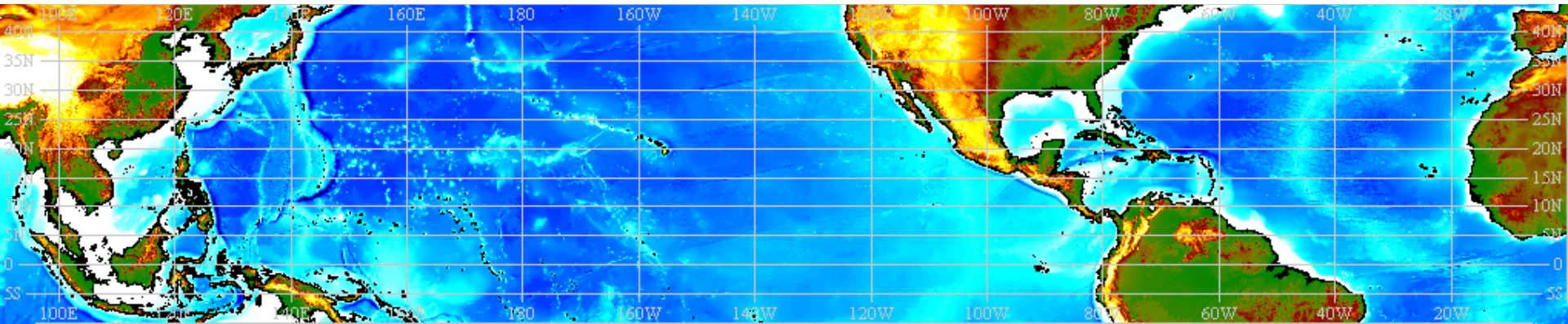
## 7.3 Participants

- Organizations at all levels
- IHO member states will see their data multiplied in value since it will be used several times
- IOC 's Regional Map projects will achieve greater return on investment though being used twice
- GEBCO will concentrate on deeper oceans, on combining and managing data and on ocean –wide mapping.
- Individuals will be able to participate at one or more levels. An individual scientist might, for example, work on producing an IOC Regional Map and then work on integrating it into GEBCO.

## 7.4 A Model for the “Sixth Edition”

- “It is proposed that GEBCO consider adopting digital methodologies for the production, distribution, and advanced visualization of bathymetric information in user-friendly form. One way to do this would be to package global bathymetric information and related facts in a series of information layers... The package would include easy-to-use GIS software that allowed users to combine and visualize selected layers within defined geographic limits, and to manipulate this information to produce special effects e.g. shaded relief maps, custom depth contours, oblique views, fly-throughs, etc. The option for producing printed output would be available, of course, as would be the capacity to export selected data to external GIS environments for specialized manipulation and for combination with other types of information.”  
Macnab and Jakobsson, 2002

# Part 8 Conclusion



# 8.1 A Vision of what GEBCO Can Become: Digital and Virtual

- GEBCO can be the vehicle that assembles and converts data from the entire ocean floor into useable information and disseminates it to the world. The GEBCO that does so will: -
  - 1. Be a creature of the digital world making digital products from digital data. (It will be able to produce a paper product if needed.)
  - 2. Produce a diversity of products based on depth, bottom characteristics, and other geologic and geophysical data

## **8.2 The GEBCO that does so will: -**

- 3. Understand scale, and produce information appropriate to many scales of investigation
- 4. Evaluate the quality of data, and provide uncertainty indicators
- 5. Continue to thrive on existing partnerships and expand its range of partners
- 6. Provide bathymetric and other layers to users of marine GISs who will integrate other layers of information from a variety of data holdings, by themselves, in real time

## **8.3 The GEBCO that does so will: -**

- 7. Be led by a Guiding Committee whose roles include:
  - establishing standards for data quality and data access
  - maintaining a network of experts in data collection and interpretation
  - encouraging broad participation with other data suppliers in a common data warehouse framework
  - establishing new access channels between data holdings and end users.
- 8. Be driven by Sub-Committees and Working Groups established and restructured to meet evolving needs

# Time and tide waits for no one

- The tide is running
- There are beacons to mark the way

