Ocean Globes Based on Bathymetric Data: Visualization Issues and Techniques

2015.10

Eunmi Chang, Yongjae Park
Moonbo Shim, Kwangseon Lee

Contents

- Background
- Purposes
- Methods
- Results
- Conclusions

background

- GEBCO has complied and published bathymetric data over the earth through the homepage : http://gebco.net
- To make a globe with detailed ocean floor and waterway information, 30 second data has been used in 2009, and 2010.
  - 2009: without any legend/annotation
  - 2010: with undersea feature names
    latitude/longitude line

background

- The amount and range of legends and labels depends on the purposes of making globes: education, scientific visualization, artistic work or mass production for sales.

- Less discussion on classifications of globes has not been made compared with those of maps: such as thematic map/general map, choropleth map/flow map etc. General globe/thematic globe or physical globes.

Purpose

- This article aims to explain and discuss the visualization issues and techniques to express bathymetric data for globes with less distortion and more efficient awareness of undersea features.

  : resampling
  : hill shade
  : classification methods for portrayal

Methods

- Data acquisition: GEBCO 30second data _ USGS STRM30 2.0 data.

(https://www.bodc.ac.uk/data/documents/nodb/301801/) in the TIFF format.

- Data processing: 7 steps

1	Resampling	High resolution data-> globe size data
2	Hill Shading	Tests with different light positions
3	Data Classification	Clustering process to assign colors

Methods

- Data processing: 7 steps

4	Data Clipping	Clipping the two Hemispheres
5	Data Projection	Polar projection from Mercardor projection
6	Data Mosaicking	Editing data
7	Adjustments	Terrestrial parts adjustment: inland lakes : Death valley, Caspi

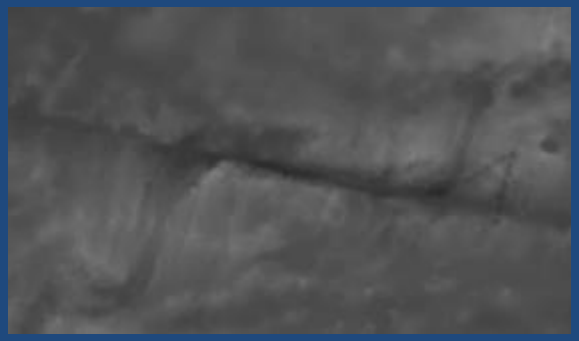
Issues

1	Resampling	High resolution data-> globe size data
2	Hill Shading	Tests with different light positions
3	Data Classification	Clustering process to assign colors
4	Data Clipping	Clipping the two Hemispheres
5	Data Projection	Polar projection from Mercardor projection
6	Data Mosaicking	Editing data
7	Adjustments	Terrestrial parts adjustment: inland lakes : Death Sea, Caspian Sea

Issues

1	Resampling	High resolution data-> globe size data

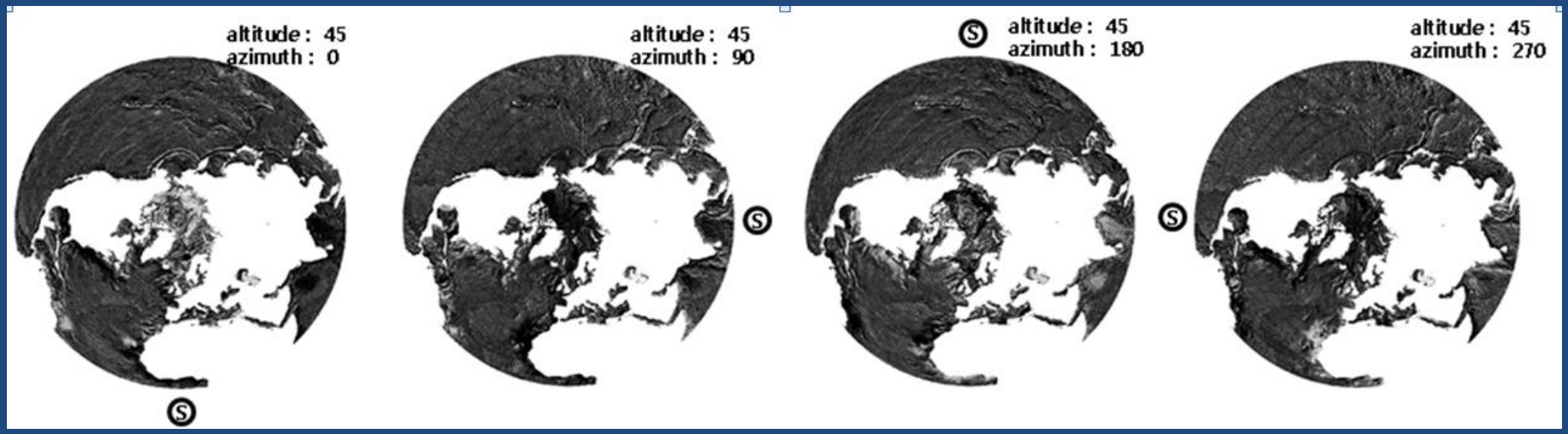
- To reduce 43200 x 21600 pixels to 3700x 3700 pixels for 304mm globes
- For Northern Hemisphere: 3600 x 3600
- For Southern Hemisphere: 3600 x 3600
- Overlapped 100 pixels
- 43200x21600 →7200 x 3600
- Degraded resolution 0.0083 →0.05 degree



Issues

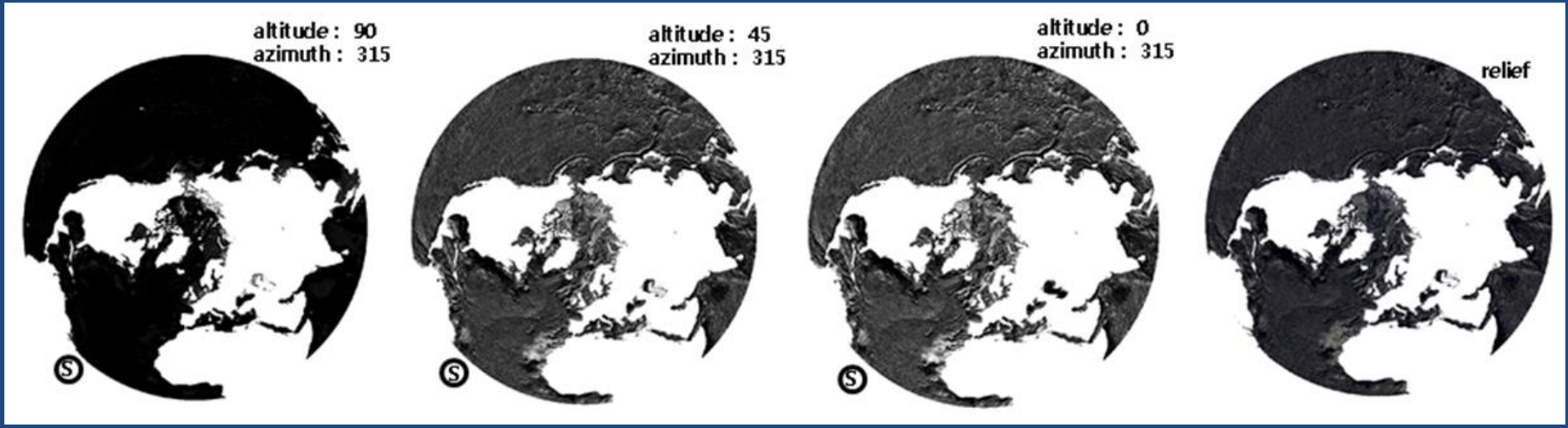
2	Hill Shading	Tests with different light positions

- The same altitude with different azimuth
- The areas near the azimuth are clearly shown.
- So the each country may utilize a proper azimuth value to emphasize its own undersea floor.



Issues

- The same azimuth with different altitude
- Angle of altitude influence the shades.
- The altitude is close to polar, the image becomes darker.
- The altitude is close to equator, the image become brighter.



Issues

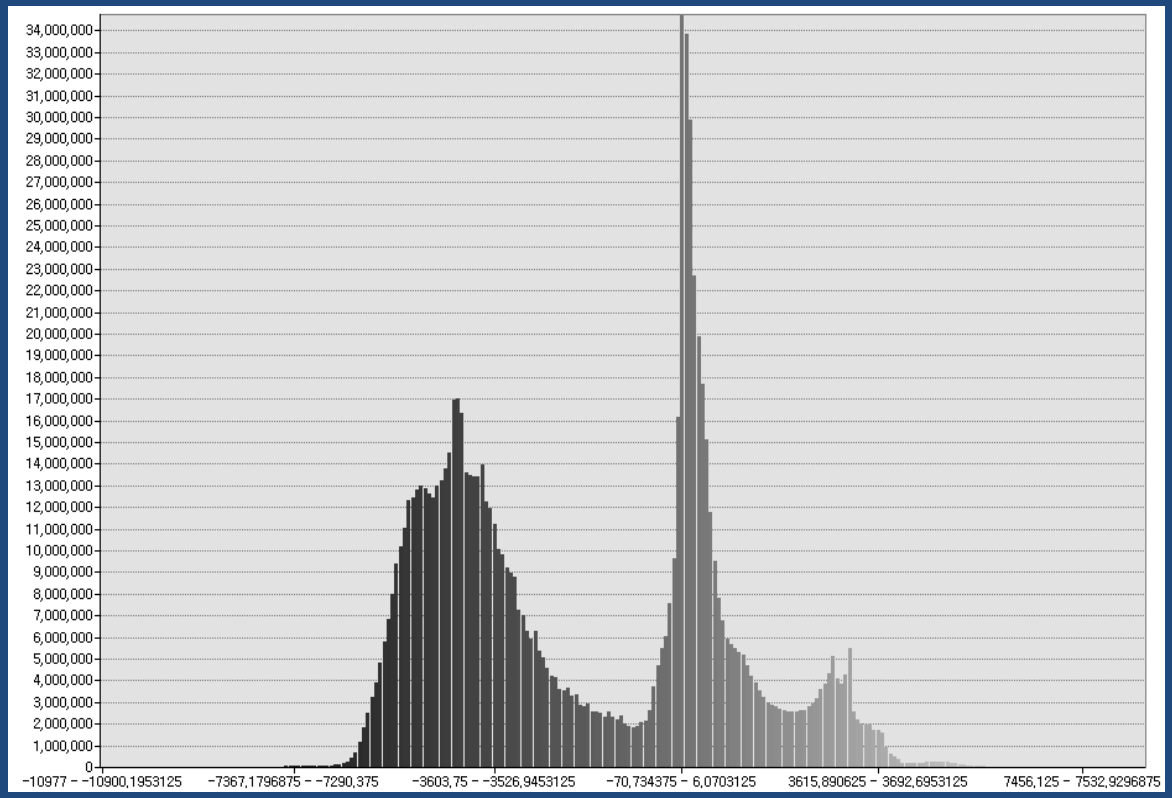
- Relief Map is chosen to reduce the distortion from light positions.

No	Altitude	Azimuth	No	Altitude	Azimuth
1	0	0	11	45	45
2	0	45	12	45	90
3	0	90	13	45	135
4	0	135	14	45	180
5	0	180	15	45	225
6	0	225	16	45	270
7	0	270	17	45	315
8	0	315	18	45	360
9	0	360	19	90	0
10	45	0	20	Relief Map	

Issues

3	Data Classification	Clustering process to assign colors

Deepest value is -10977m, the highest value is 8685m
Jenks natural breaks classification is proper considering less distortion.



Issues

3 | Data Classification | Clustering process to assign colors

Equal interval

range(m)	Number of samples	averages	Standard deviation
-1~-915	93072129	-228.58	231.12
-915~-1830	28039715	-1402.76	262.13
-1830~-2745	45909965	-2340.11	263.35
-2745~-3659	101380089	-3261.55	259.94
-3659~-4574	170241703	-4130.54	256.89
-4574~-5489	140688263	-5005.92	255.96
-5489~-6403	34794571	-5740.47	193.72
-6403~-7318	927164	-6773.18	268.34
-7318~-8233	278107	-7697.32	261.75
-8233~-9147	108735	-8618.23	261.9
-9147~-10062	30084	-9438.64	235.86
-10062~-10977	1997	-10303.2	211.72
Mean standard deviation	246.89		

Issues

3 Data Classification

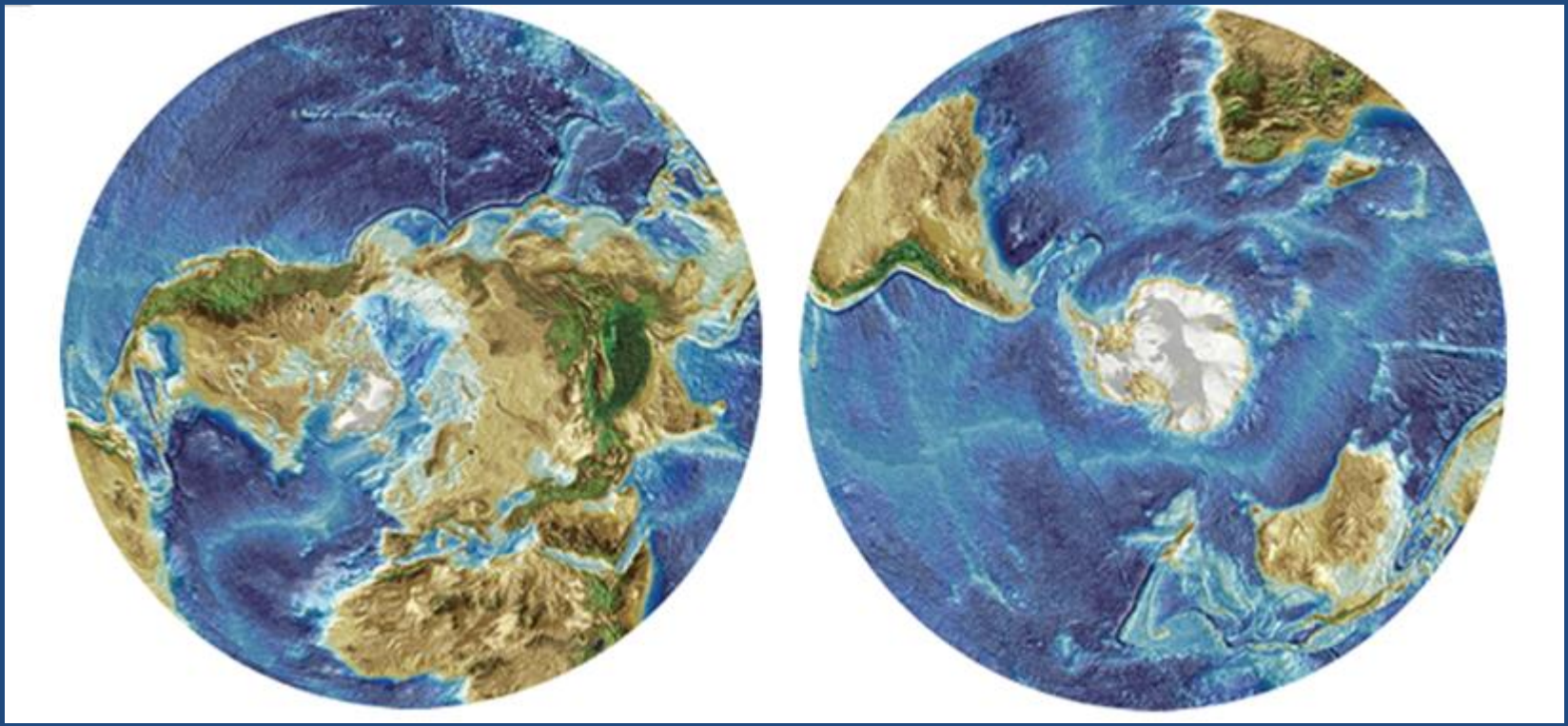
Clustering process to assign colors

Natural Break

range(m)	Number of samples	averages	Standard deviation
-1~-230	58729129	-79.84	61.72
-230~-909	34197768	-481.12	187.27
-909~-1722	24192696	-1337.79	231.05
-1722~-2439	30880243	-2106.72	206.82
-2439~-3048	44020291	-2771.5	172.84
-3048~-3567	61907334	-3324.64	147.71
-3567~-4041	79971108	-3809.9	135.24
-4041~-4502	92303413	-4272.41	126.98
-4502~-4946	74258812	-4723.35	129.08
-4946~-5459	75645101	-5186.42	145.63
-5459~-6515	38227243	-5721.88	206.32
-6515~-10977	1139384	-7309	721.52
Mean standard deviation	206.02		

Issues

- The deeper the bluer in the ocean
- The highest the greener in the land
- Polar areas have been touched with white color.
- Monotone relief data is combined with color schemes



techniques

ArcGIS
QGIS

1	Resampling	High resolution data-> globe size data
2	Hill Shading	Tests with different light positions
3	Data Classification	Clustering process to assign colors
4	Data Clipping	Clipping the two Hemispheres
5	Data Projection	Polar projection from Mercardor projection
6	Data Mosaicking	Editing data
7	Adjustments	Terrestrial parts adjustment: inland lakes : Death Sea, Caspian Sea

Discussions

- Digital earth has been service on computer screens and digital devices is shown in 2D and 3D but theoretical or technical discussions were limited.
- If we emphasize the sea mountains or continental shelf, it is possible to choose azimuth values.

Discussions

If we ignore the terrestrial part as white, the ocean floor are clearly shown, but the continuity of landforms across land and continental shelf will be ignored.

Conclusions

- There are many issues in the process of data manipulation to make a globe.
- Regardless of the preference of color, distribution of bathymetric data should be reflected to divide the classes
- Hill shading method on the globe may exaggerate some parts of ocean floor, but relief map is proper for reality.

References

Anderson M. R. 2011, Status report on the preparation of the GEBCO Globe, published at the 28th GEBCO Guiding Committee meeting at La Jolla. California.

Smith R.M 1986, Comparing tradition methods for selecting class intervals on choropleth maps, the Professional Geographers, 38(1): 62-67.

http://www.ngdc.noaa.gov/mgg/dem/demportal.html

http://dds.cr.usgs.gov/srtm/version2_1/SRTM30/srtm30_documentation.pdf