Artifacts in gridded bathymetry

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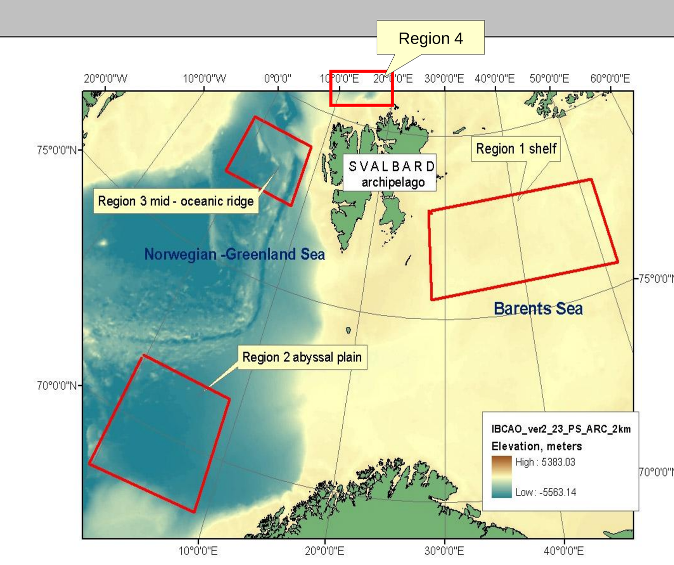
Abstract

It became especially important to notify users to be aware of artifacts in bathymetry, since the increase of public interest towards the ocean and release of such exploratory tools as Google Ocean. Artifacts in gridded bathymetry can be defined as any dubious features in the bathymetry surface. Dubious features are those whose existence is questionable according to geologic knowledge of the processes in the area. Any bathymetry grid is a compilation of various data sources with different accuracies, resolution and distribution. Artifacts in the bathymetry grids are characterized by presence and distribution of the source data. Artifacts can be caused by systematic errors in the source data, or by interpolation errors. Maune [2007] defines artifacts as "*detectable artificial anomalies that are introduced to surface model via system-specific collection or processing techniques*". Several types of artifacts encountered in the bathymetry of GEBCO_08, SRTM30_Plus, Smith & Sandwell [S&S] and IBCAO grids are illustrated. The types of artifacts encountered are classified according to the nature of the source data types, since that is the major factor that characterizes them. The given illustrations of the artifacts are just the few examples, and users should be aware of existence of unreal features in any bathymetric compilation. By comparing to the source trackline coverage for the bathymetry grid, users should verify whether the feature is real or non existent.



This work presents the artifacts encountered in several bathymetry grids such as IBCAO v.2.23, GEBCO_08, SRTM30_Plus ver. 6 and Smith and Sandwell ver.13.1. Four regions in the Arctic (Figure 1) were inspected for the presence of artifacts, and additionally in one coastal area outside of the Arctic (Fig 8a). Four inspected regions represent different morphologic provinces, and usually have differences in source data types and coverage.

For convenience inspected grids are separated into two types: Type A grids (IBCAO, GEBCO_08 in the Arctic), based solely on acoustic sounding data sources interpolated using contours in areas that lack data; and Type B grids (S&S, SRTM30_Plus) based on acoustic sounding data sources and combined with satellite-derived gravity data.
Different types of data sources (or lack of those) create different artificial "morphology" in bathymetry grids. The encountered artifacts were classified according to which characterize them. Classification table and description of "morphology" of each artifact is given in Table 1.

Source data type	"Morphology" of an artifact	Illustrations	Type of grid where can be encountered
a) multibeam	artificial high frequency peak-like features in the bathymetry	Fig. 2, Prof.1	Type A, B
b) singlebeam	linear artifacts such as artificial "ridges" and "troughs" or point features like those caused by single soundings	Fig. 2, Prof. 2,3,4	Type A, B
c) single soundings	artificial peak-like ("bumps") or pit-like ("holes") features	Fig. 6	Type A, B
d) contours	terracing on slopes, or artificial features where contours don't agree with surrounding soundings	Fig. 5	Type A
e) no sounding data in the grid Type A	flat areas, artificial deeps	Fig. 7	Type A
f) no sounding data in the grid Type B	artificial deeps and rises in the areas where there is no correlation between bathymetry and gravity	Fig. 3, 4	Type B
g) patching several data sources	artificial steps	Fig. 2, Prof. 1	Type A, B
h) coastline dataset	Negative depth values on land, artificial islands	Fig. 8	Type A, B

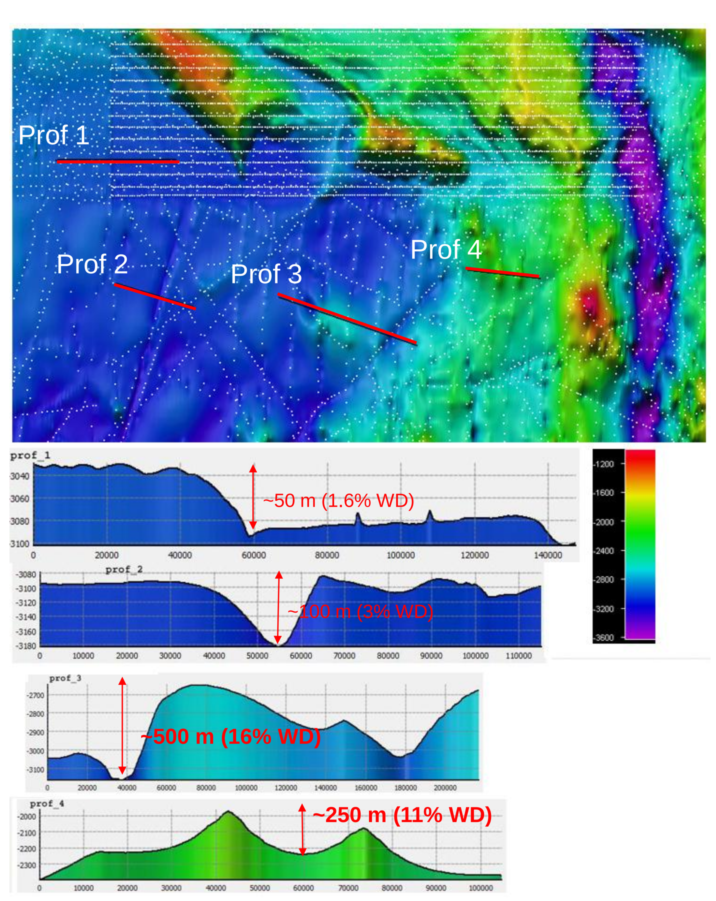


Figure 2. S&S bathymetry in the mid-oceanic ridge area (Figure 1) overlain by source tracklines (white dots). Artifacts observed:
Prof 1: artificial step in bathymetry (patching different data sources), high freq. peak-like features (multibeam)
Prof 2,3,4: artificial ridges and troughs (singlebeam)

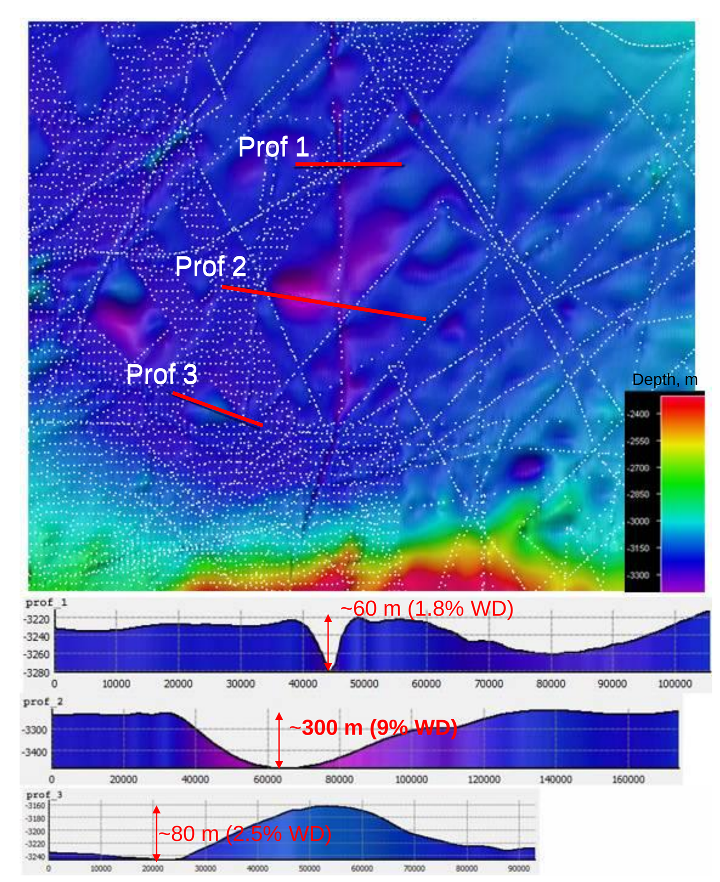


Figure 3. S&S bathymetry in the area of abyssal plane (Figure 1) overlain by source tracklines. Artifacts observed:

Prof 1: artificial narrow "trough" caused by erroneous singlebeam trrack

Prof 2,3: artificial rise and deep in the area, where there is no correlation between bathymetry and gravity (abyssal plain with high sediment thickness). See Figure 4 for gravity and bathymetry profiles.

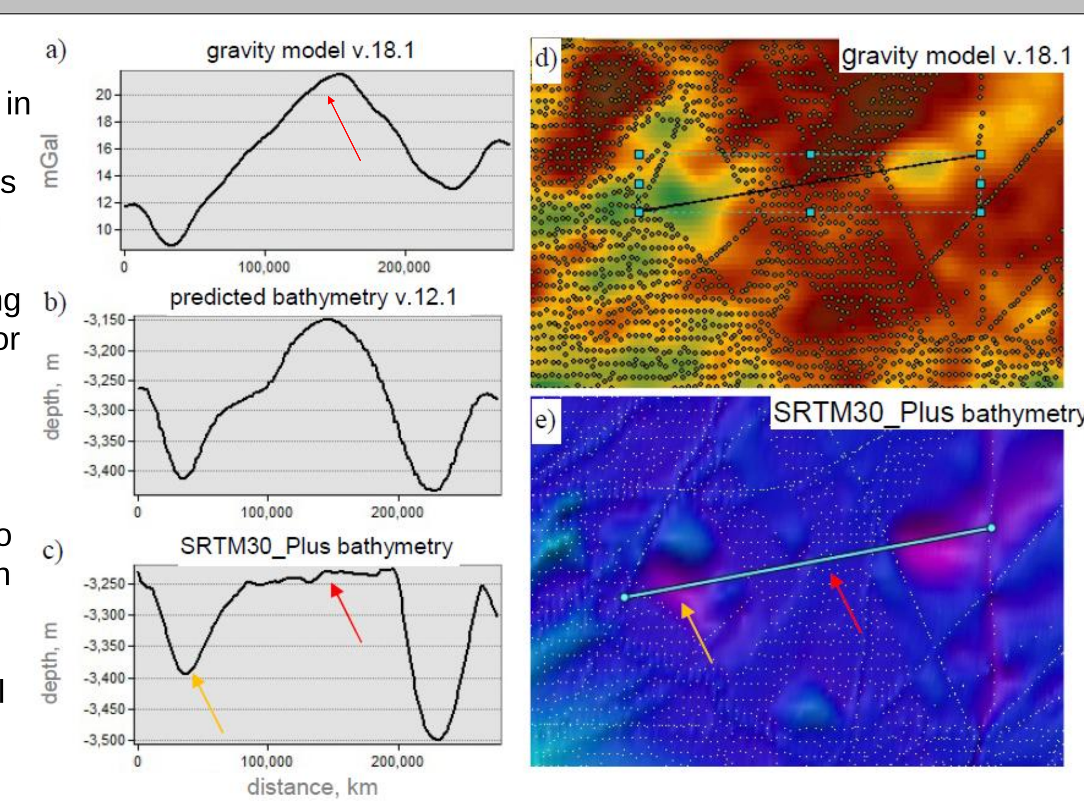


Figure 4. Explains artificial deeps in the SRTM30_Plus bathymetry, in the areas where no correlation between bathymetry and gravity is observed (abyssal plain with high sediment thickness). The dots on the maps (d, e) show the sounding source trackline coverage used for construction of SRTM30_Plus. As discussed in Smith and Sandwell [1997], the gravity (a) [Smith and Sandwell, 2009] is scaled by correlation coefficient to the predicted depths (b), and then the measured depths are "polished" to the predicted bathymetry grid to create the final bathymetry grid (c). As can be seen from the profiles, the bathymetry is taken from scaled gravity in the area with no sounding coverage (yellow arrow). Although when gravity and bathymetry profiles are compared in the area where the source sounding data is present (red arrow), there is no observed correlation between them.

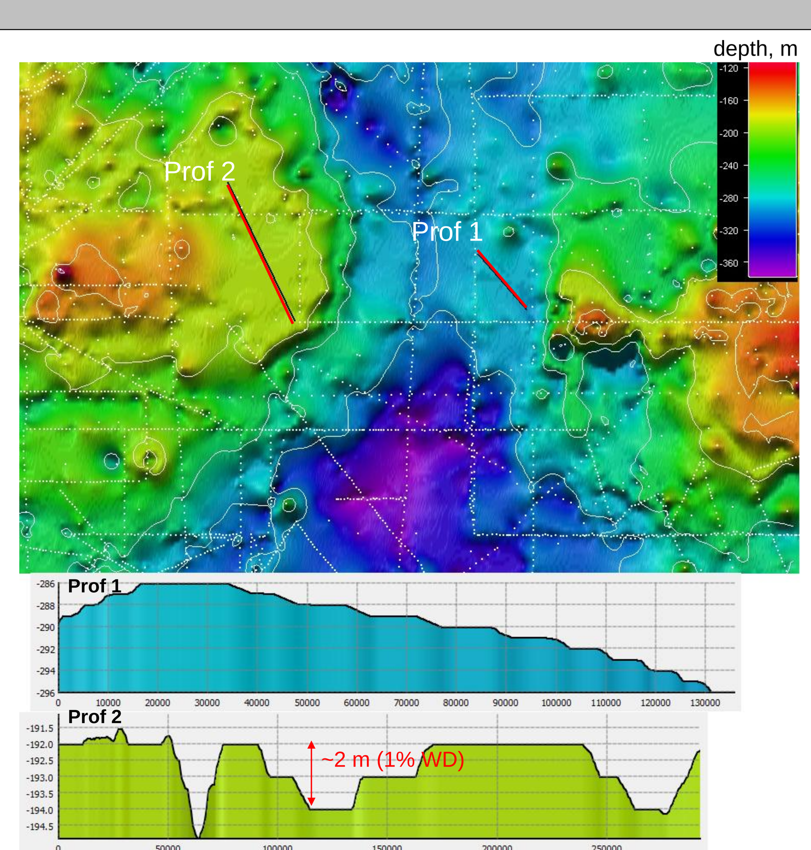


Figure 5: GEBCO_08 bathymetry in region 1 (Figure 1) overlain by source tracklines and contours. Artifacts observed: terracing on slopes due to using contours for interpolation.

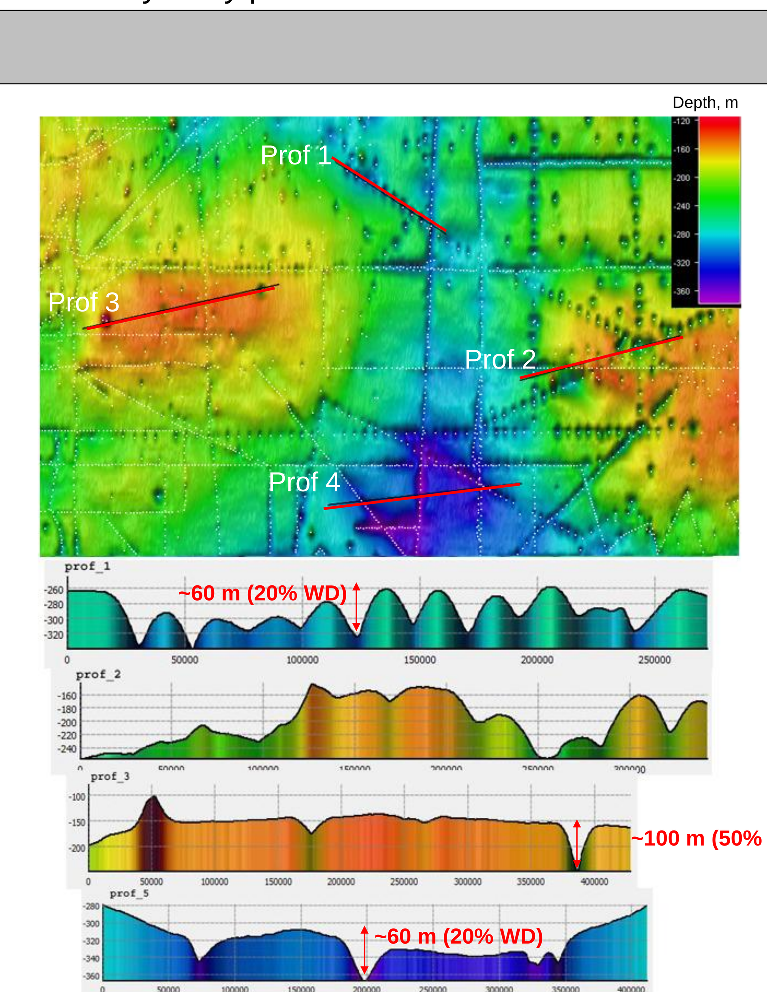


Figure 6: S&S bathymetry in shelf area (Figure 1) overlain by source tracklines. Artifacts observed: artificial "bumps", "holes" and "troughs" caused by singlebeam, historical single soundings and interpolation with predicted from gravity bathymetry.

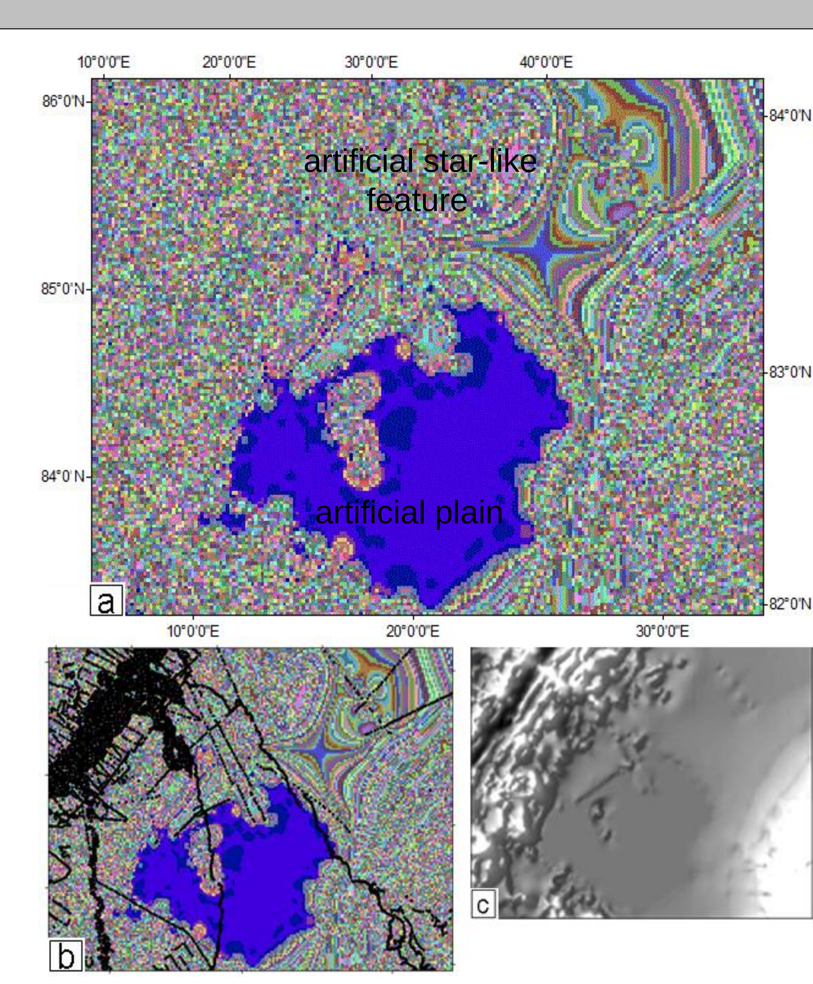
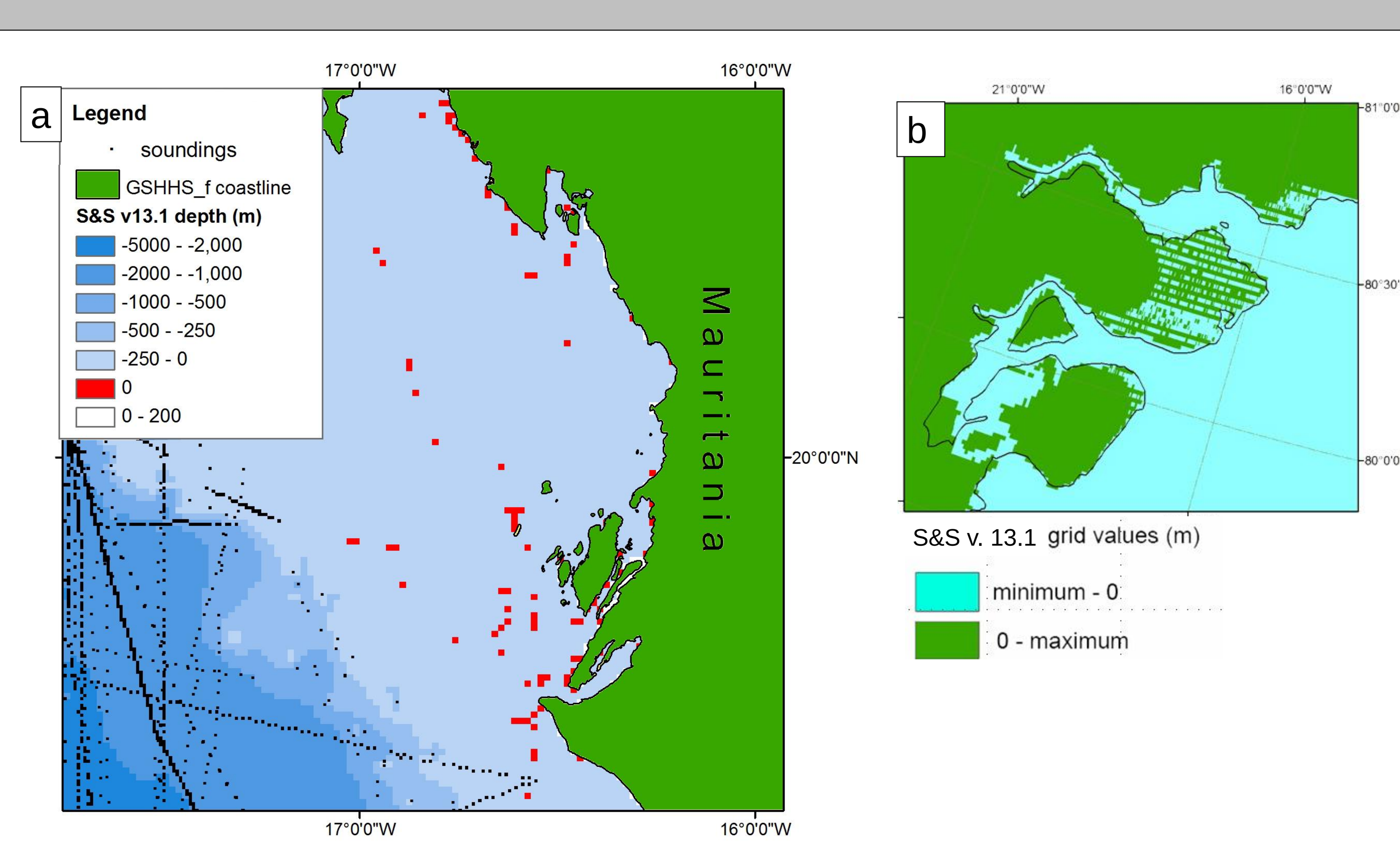


Figure 7: (a) IBCAO bathymetry in the region 4 (Fig. 1), unique values color scheme is used (individual color is assigned to each depth value) in order to highlight artifacts. Artifacts observed: artificial plain (blue feature) and artificial star-like feature caused by lack of data in the area; (b) same as (a) with trackline information; (c) shaded relief of the area.

Conclusions

1) We present classification scheme for the types of artifacts encountered in several bathymetry grids, such as IBCAO v.2.23, GEBCO_08, SRTM30_Plus ver. 6, Smith and Sandwell ver.13.1. Artifacts are classified according to the nature of the source data types which characterize them.
2) The given illustrations of the artifacts are just the few examples. Users should be aware of existence of unreal features in any bathymetric compilation. By comparing to the source trackline coverage for the bathymetry grid, users should verify whether the feature is real or non existent.
3) Artifacts are unpleasant for visualization purposes, but users should not forget about vertical exaggeration commonly used in visualizing bathymetry.
4) The scale of artifacts varies: from artifacts that can be neglected in deep water areas - to the most pronounced artifacts observed in Type B grids on shelf with the size up to 50 % of water depth.
5) Users should be aware that the grids are being constantly updated and the artifacts present in this work might be corrected in the future versions of the grids.

Figure 8: Problems in the coastal areas.
(a) Illustrates artificial "islands" observed in S&S grid, zero depth values (colored red) are encountered offshore Mauritania. As can be seen no sounding data was used for construction of S&S grid in the spots of artificial islands.
(b) Illustrates how well S&S grid resolves coastline in the Greenland region.The depths in grid are constrained in the coastal zone to fit the coastline (GSHHS database). Notice negative depth values observed on land.



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