Geophysical Research Abstracts
Vol. 15, EGU2013-11854, 2013
EGU General Assembly 2013

Scientific concepts for hydroacoustic seafloor mapping in the coastal zone and beyond

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Hydroacoustic seafloor mapping is a reliable and cost-effective method to investigate and monitor the seafloor in high spatial and temporal resolution. The results are important for the evaluation of benthic habitats and help to identify vulnerable environments that require protection. Yet, how can we overcome the problems that occur when different gear produces different results, which are evaluated by people that have different points of view and different backgrounds? These aspects form an integer part of the project WIMO ("Scientific concepts for monitoring the German Bight, SE North Sea", Subproject 1.1: “Hydroacoustic Habitat Mapping”). It aims at comparing different hydroacoustic gear, methodologies and workflows in order to work out basic routines for universal use in marine benthic habitat mapping. The project investigates a number of target areas in the German Bight (North Sea) using different sidescan sonars (SSS), acoustic seafloor-classification systems (AGDS), multibeams, and different sampling and grain-size analytical methods as well as sea-floor imaging methods. We tested different gear on different ships, on the same ship but not synchronously, and as many instruments as possible measuring at the same time on the same ship. Our results suggest that guidelines and requirements for surveys can hardly be standardized as they depend largely on the water depth, the seabed, and on the vessel and the equipment available. All of these frame conditions usually differ from survey to survey. Taking this into account, we present a reasonable workflow for time and cost-effective benthic habitat mapping and monitoring. Transect-line distances as well as monitoring frequencies, number and positioning of ground-truth samples and seabed imaging are discussed. We recommend frequency combinations and appropriate swath widths and overlaps for SSS and show a way to ground-truth lower-frequency data using high-frequency data. Acoustic ground discrimination systems are usually single-beam systems that need suitable interpolation routines. We present a workflow for on-survey visualization of hydroacoustic data using color interpolation and present a method to combine the hydroacoustic and ground-truth data sets. Eventually, we suggest a way to interpret the data in a most objective manner.
The results from the coastal zone of the North Sea reveal that for scientific purposes it is mostly sufficient to maintain transect-line distances of two or three times the SSS swath width. It is suggested to build gray-scale SSS mosaics during the survey. As a general rule a classification into 20% gray-scale classes should be carried out and 5 samples per class should be taken as a minimum requirement. We recommend to apply two SSS frequencies synchronously to enable the discrimination between backscatter due to grain size and backscatter due to small bedforms. This information is also most important for the interpretation of roughness and hardness data provided by the AGDS. The synopsis of both, SSS and AGDS in combination with multibeam and ground-truth data reveals the most reliable results.