Approaches and requirements of quantitative comparison of the multibeam sonar benthic acoustic backscatter

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Quantitative analyses of multibeam sonar backscatter data have become increasingly important for a range of applications. A critical requirement for these applications is the ability to analyze the spatial and temporal variations of the backscatter data within a single survey or among several different surveys. In this paper, two backscatter surveys in Portsmouth Harbor, NH are used to evaluate different comparison techniques and infer the data requirements for comparison. The backscatter surveys were conducted in June 2007 by University of New Hampshire (UNH) and in September 2007 by Kongsberg in support of this conference. Both data sets were collected using an EM 3002D (300 kHz) installed on UNH's R/V Coastal Surveyor. A video survey and bottom grab samples collected in December, 2007 indicated that the study area is comprised of rocky outcrops, flat sandy regions, gravel bottoms, and some gravel and sand ripples.

Appropriate radiometric and geometric corrections were applied to the backscatter data to construct mosaics for inter-survey comparison using two approaches. The first approach compared mosaics that have been constructed by flattening the backscatter angular response, resulting in spatially continuous mosaics. To observe the effect of flattening of the backscatter angular response, a second approach compared a series of mosaics constructed using a 5° grazing angle interval without flattening the backscatter angular response. Quantitative comparison of the mosaics was attempted by a statistical analysis of difference surfaces between the respective mosaics. As the backscatter mosaics are reported in logarithmic units (dB), the subtraction of the mosaic surfaces is equivalent to division in linear units. The difference in logarithmic space, however, showed a gaussian distributed difference curve with a mean of 1.5 dB (using the flattened backscatter curve). When comparing the backscatter data in 5° angular bins, a strong dependence on the grazing angle was observed, with maximum difference observed at nadir and the outer angles (~3 dB). Using logarithmic values, the observable differences were correlated to areas of steeply sloping seafloor and only showed a weak correlation with the seafloor material type. However, if the backscatter data are converted to linear units prior to the subtraction, the differences in the mosaics are strongly correlated with the bottom type, with the maximum difference observed in the region of sand ripples. The smallest difference was observed in the flat sandy bottom. Thus we conclude that comparisons using linear units are better adapted to identify small backscatter differences between surveys.

More relevant to backscatter practitioners is the ability to recognize if these backscatter differences imply an actual change of the seafloor. The differences between two backscatter surveys may depend on changes of the seafloor, as well as several other key factors including the differences in measurement geometry, oceanographic conditions, changes in the equipment setup or navigation errors. The uncertainty due to these factors has to be quantified before meaningful comparison of backscatter surveys can be attempted.