Calibrating broadband multibeam seabed backscatter

An operational method covering multi-sector systems

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***Abstract*—Standard calibration procedures for multibeam sonars currently only address the fidelity of the bathymetric data. Equivalent effort is needed to ensure that the acquired seabed backscatter strength measurements are referenced to a similarly precise level. This paper presents an operational method utilizing multiple pre-calibrated split-beam echo sounders covering a wide range (50-400 kHz) of frequencies. This is needed to cover the full range of frequencies utilized by multi-sector multibeams operating in continental shelf depths.**

Keywords—multibeam backscatter; calibrated; broadband;

I. THE NEED FOR CALIBRATION

Attempts to utilize seabed backscatter intensity measurements by multibeam sonars have long been frustrated by the lack of an absolute reference. Without this, relative measurements, only corrected for gross geometry and radiometry have been utilized to attempt seafloor characterization. Such an approach, however, is only valid locally for a single hardware/software implementation and thus cannot be used for regional multi-platform mapping or monitoring of seabed change. Thus an absolute backscatter strength reference is needed, valid at the specific frequency of the pulse used.

Previous calibration attempts that tried to measure the source level and receiver sensitivities of the hardware have been found to be impractical. The most recent approach by Eleftherakis et al. (2018) mechanically rotates a vessel-mounted calibrated split-beam single beam sounder in order to acquire a reference set of seabed backscatter strength measurements. This paper presents an extension of that technique covering a wider range of frequencies (50-400kHz) by using multiple transducers, each of which utilizes a chirped pulse sweeping through the full transducer bandwidth in the manner of Weber and Ward (2015).

II. MEASUREMENT OF REFERENCE

Prior to field measurements, each of the split-beam transducers/transceiver systems has to be calibrated using a reference target (Foote et al., 1987).This was performed both in engineering tanks and in the field just prior to measurement. With a chirp pulse, the applied calibration is a continuously changing function across the bandwidth in both sensitivity and beam width.

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To perform the cross calibration, seabed reference sites needs to be selected that are homogenous over the areal extent within which grazing angles measurements are obtained. For the experiments presented here, 5 sites were chosen based on archived multibeam backscatter surveys. Each site was chosen to cover a specific sediment type including mud, sandy mud, sand, shellhash and cobbles.

The calibrated split-beam sonars were mounted on a suspended plate with a motion reference unit to monitor orientation for each shot. At each site that plate was then mechanically rotated through the full range of grazing angles (90 to 15) and at all azimuths. Each transducer fired consecutively at ¼ second intervals to avoid cross-talk.

III. APPLICATION TO MULTI_SECTOR AND MULTI FREQUENCY SYSTEMS

For this experiment an EM2040P (200-400kHz) and an EM710 (70-100 kHz) were selected for calibration. Within the footprint of the reference data, the two multibeam sonar systems acquired backscatter data over the same range of grazing angles and at a representative set of azimuths. Note that, for multi-sector systems, each of the sectors have different center frequencies, beam widths, offset angles, pulse lengths and source levels. And these all change as the “depth mode” is changed. Thus for each depth (and frequency) mode of each multibeam (9 for the 2040P and 3 for the 710), a star pattern of backscatter data were acquired across the 5 reference sites.

The final step is to compare each of the sector/mode combinations against the corresponding frequency band over the range of grazing angles investigated. How those differences are applied, however, depends on how the specific multi-sector system internally implements roll, pitch and yaw stabilization. An additional complication is the proper removal of pre-existing manufacturer-applied corrections.

The approach presented herein can be implemented in two ways: either, assuming that the seabed sites remain stable, they represent a location for future calibrations for vessel passing in the vicinity; or, if the suspended frame methodology can be standardized, the procedure can be repeated at the survey location as often as needed.

Eleftheraksis, et al.., 2018, Mar Geophys Res. DOI 10.1007/s11001-017-9318-3
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