Robust estimation of multiple simultaneous integration errors from underway multibeam data

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While standard procedures ensuring accurate multi-sensor integration within a multibeam system already exist, operators are still plagued by small periodic systematic residuals in data. The source of these errors has long been recognized as the result of imperfect definitions of offsets, alignments, latencies and sound speed between the sonar and auxiliary sensors. In isolation, and shallow water geometry, any one of these sources is easy to recognize. In the presence of multiple sources, however, the resulting pattern of residuals can confound simple analysis. Gross errors are usually immediately apparent, but small errors such as a few milliseconds of latency or decimeters of lever arm, can be hard to identify. Commonly residuals are the result of a combination of several small errors rather than just one.

As a continuation of a theoretical model-based method previously developed, the approach has now been refined and applied to real-time data. The method relies on separating the short wavelength bathymetric residuals in the seafloor data from the underlying truth in order to parametrically estimate the mismatch. Using a georeferencing model that explicitly includes the impact of six possible integration errors, the difference between the integrated surface, and a smoothed version of it, is minimized using non-linear least squares. This optimization approach is extremely computationally expensive and relies on there being both adequate motion and an excellent estimate of the true seafloor.

This presentation illustrates the successful application of this procedure to real surveys. The degree of success depends on being able to identify suitable survey windows for analysis, in essence combinations of smooth seafloors and substantial uncorrelated vessel motion. The fidelity of the final estimate, however, remains limited by external unmodelled factors such as inadequate real time heave, over-correlated motion, geomorphology, intermittent bottom mistracking and, perhaps most routinely, undulating subsurface oceanographic phenomena.

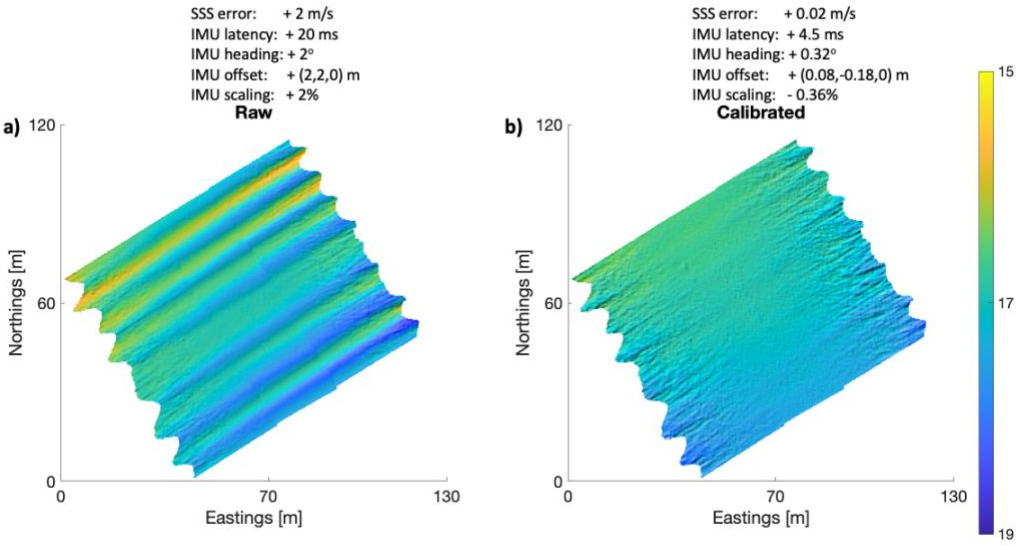

Figure 1: a) window of field data with 6 calibration errors present; b) window of field data calibrated with final parameter estimates