RapidCast: Analysis of spatio-temporal variability in high resolution speed of sound measurements.

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Acoustic waves are the primary medium utilised by hydrographers for multibeam bathymetric surveys (MBES).

Variation of speed of sound (SoS) through water causes these waves to bend and refract, which if not properly accounted for, cause significant errors in both depth and positional accuracy.

Rapid development in positioning and motion referencing technology have reduced errors in MBES data acquisition. Yet, SoS measurement techniques have developed at a slower rate.

An evolution in underway SV systems, the Teledyne Oceancience RapidCast system combined with Valeport SwiftSVP probe enables the collection of high density SVPs during online surveying.
Teledyne Oceangadience RapidCast with Valeport SwiftSVP

Images courtesy of Iain Slade, Fugro and Jim Gardiner, Valeport
Aims

• To display and quantify spatial and temporal SoS changes in a new, comprehensive manner.

• Produce Geo-referenced 3D models of SoS variability, to be analysed as a function of temporal change throughout the tidal cycle.

• Test the hypothesis that when compared to reduced frequency SVP incorporation into MBES data, high density SVPs will increase the percentage of cells satisfying the 95% confidence level in total vertical uncertainty (TVU).
Design

• MBES survey over an 12km$^2$ area of Plymouth Sound, known to have large SoS variances.
  (Rectangular grid, 1000m lines,~50m line spacing, 30% overlap, 2 crosslines)

• Simultaneously, RapidCast system to collect Sound Velocity Profiles at 100m intervals.

• Survey of the site to be repeated hourly over a full tidal cycle
Trial Data

Sound Speed Difference between Transect 1 & 2

Courtesy of Jim Gardiner, Valeport and Iain Slade, Fugro
Ray Tracing


- Demonstrated that in an average survey depth of 20m, a change in SoS of $+3.340\text{ ms}^{-1}$ or $-3.251\text{ ms}^{-1}$ would produce a vertical change of 0.29m in a sounding.

- This vertical change would exceed the IHO Special Order TVU limits.
Predicted Results

- The RapidCast system allows the surveyor to minimise losses incurred with offline SoS measurements.

- Findings from statistical analysis of the MBES survey dataset may highlight potential advantages of the system to commercial and research activities.

- The high density of data the system can collect means a more detailed representation of temporal and spatial SoS variance has become possible.
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