Monitoring Bubble Washdown over a Deep-Water Multibeam Ping Cycle

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***Abstract*— The transient impact of bubble washdown is generally the limiting factor restricting deep water multibeam surveys in marginal sea state conditions. Such events are linked to the vessel motion dynamics as well as the instantaneous sea surface relief, both of which are driven by the ocean wave periodicity. Deep water multibeam ping cycles typically encompass one or more wave periods and thus it is important to understand the relationship between the ping cycle and the bubble washdown event. We present a new method using sonar mode imaging with high frequency multibeam to investigate this relationship.**

***Keywords*— bubble washdown; sonar mode; seastate;**

I. MOTIVATION

The cost of operating offshore survey vessels can be prohibitive and a major economic factor is the sea-state operating window in which they can collect acceptable multibeam bathymetry and backscatter.

Maximizing this window represents a combination of hull design, sonar installation and survey execution. Ship acceptance trials standardly look at multibeam performance as a function of vessel speed and operation of other sonars systems. Sea-state performance (with its range of azimuths and speeds), however, is much harder to quantify as the sea-state conditions cannot be prescribed for the trials.

The degradation of a multibeam swath can be separated into continuous and transient effects. Increasing yet quasi-continuous noise from sources such as propellers, machinery, electrical and flow generally reduce the signal to noise ratio, resulting in a narrower, but generally stable swath. In contrast, transient effects that come and go abruptly tend to produce instantaneous dropouts or gross mis-tracking. These effects are harder to quantify as they are not always present. An oft-attributed, but rarely monitored phenomena is bubble washdown. Bubble washdown is a discontinuous effect that, when present can block both sound transmission and reception. Its presence is intermittent although related to the vessel motion dynamics. Its onset and evolution are a result of interaction between the hull and the undulating sea-surface. Its impact on multibeam sonar performance is strongly influenced by how the sonars are mounted. Clearly an improved understanding of its generation through direct monitoring would allow improvements in all of hull design, sonar installation and survey execution.

II. IMPLEMENTATION

A. Acquisition

Although deep-water multibeams do acquire water column imaging, due to the poor range resolution and masking during the multiple transmission sequence, the upper water column is not usefully imaged. We present a new approach that takes advantage of the water column imaging capability ("sonar mode") of shallow water sonars, now routinely installed on open-ocean mapping vessels. These, otherwise idle, sensors can be used to support investigations into the onset, timing and extent of bubble washdown events which impact deep water multibeam acquisition.

B. Processing

Once acquired, the two asynchronously logged multibeam water column datasets (short range and full ocean scale) need to be linked in a common time reference. There will typically be 10 to 30 sonar mode frames of the upper water masses for a single deep water cycle. With a typical update rate of ½ a second for the high frequency multibeam, the onset and extent of bubble washdown and reverberation events can be directly correlated against both the instantaneous vessel dynamics and the simultaneous deep water sonar performance.

III. RESULTS

Results presented illustrate the implementation of this approach using two platforms: RV Tan Kah Kee and RRS Discovery, both equipped with an EM710 and EM122. Time-linked animations are presented showing several deep water ping cycles comparing the under-hull scattering environment with the deep-water progress of the bottom interacting acoustics. From this it is clear that certain phases of the ocean wave period are more susceptible to bubble wash down and the most critical time is the transmission window. If this relationship can be better understood, there is the potential to adapt transmission times to the wave cycle, potentially thereby significantly improving the seastate performance capability of a given platform.

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