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APPLICATION NOTE

Effects of Bubbles on Optical Backscatter (OBS) Measurements

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WHEN MEASUREMENTS MATTER

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This application note discusses the relative scattering intensities of bubbles and sediment, and examines why for nearly all applications bubble do not effect optical backscatter (OBS) measurements.

Introduction

More than 25 years ago, it was observed that optical backscatter (OBS) sensors deployed under breaking waves were virtually unaffected by entrained bubble clouds. This was puzzling because bubbles scatter light by the same general mechanism as any suspended particle having an index of refraction different than water. Surf and whitecaps produce extreme bubble concentrations but mountain streams flowing over boulders and propellers wakes also produce a lot of aeration. The key factors that determine whether or not bubbles will interfere with OBS measurements are their backscatter efficiency, size, and concentration.

Bubbles and foam appear all over the place. So why are they not a big problem? Back-scattering efficiency is the dimensionless ratio of the scattering area to the cross-sectional area of the particle. A high-efficiency scatterer reflects more light back toward an emitter than a low efficiency one. This is analogous to taking the product of absorptivity and concentration to estimate the absorption of dissolved, material (see Effects of Water Color on Optical Backscatter (OBS) Measurements Application Note).

Volume Scattering Function (VSF) of Bubbles

The VSF for bubbles, in the range of scattering angles from 100° to 170°, lies between those for organic material and minerals. Most significantly, the VSF values are about 80% less than for minerals, and this means it takes about five times more bubbles than mineral particles to produce the same intensity of light scattering, other things being equal. Bubble size and concentration are more important than efficiency because these factors can vary by more than a factor of 100 in the environment.

In order to determine if bubbles interference is significant, D&A Instrument Company reviewed bubble concentration data taken under breaking waves and compared the maximum observed bubble concentrations in the silt-sand-size range with the threshold concentration of sand (10 mg l^{-1}) needed to produce measurable OBS signals. The maximum bubble concentration is about an order of magnitude less than threshold suspended solids concentration (SSC) for sand. So, when low backscatter efficiency is combined with low bubble concentration, bubbles are not of concern even in foamy, aerated environments, and the visual effects of bubbles and foam are misleading.

References

John Downing and W.E. Asher. The Effects of Colored Water and Bubbles on the Sensitivity of OBS Sensors. American Geophysical Union, 1997 Fall Meeting, San Francisco, CA.

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