A Field Experiment on Breaking Waves and Bubble Distribution in Shallow Water

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ABSTRACT

Measurements of bubbles caused by breaking processes under various sea-state conditions were made by the Naval Research Laboratory during the Sandy Duck '97 Experiment at Duck, NC. Eight arrays consisting of void fraction meters, acoustic resonators, and thermistors were deployed in an area that ranged from inside the surf zone, within several hundred meters of the beach, to just outside the surf zone, about one-two kilometers offshore. The main measurements consisted of void fraction and bubble-size spectra. In addition, video images of the surf zone were made from a 140 ft tower located just off the beach, and acoustic power intensity was measured by a hydrophone located in the surf zone. These data are used to characterize wave-breaking frequency and intensity, and the distribution and size spectra of bubbles over depth under various wind and sea conditions. An overview of these measurements is given here.

Key Words: bubbles, wave breaking, bubble density, void fraction.

Introduction

The largest surf-zone/near-shore experiment, Sandy Duck '97 (Birkemeier, 1997), was carried out during September-October, 1997 at the Army Corps of Engineers, Coastal Engineering Research Center (CERC), Field Research Facility (FRF) in Duck, NC. Several research projects under Sandy Duck '97 were started prior to the beginning of the main experiment and extended past the end of the experiment.

The Naval Research Laboratory Detachment at Stennis Space Center (NRL-SSC), MS is one of about 30 project teams participating in this grand field experiment which is mainly sponsored by the Office of Naval Research and CERC. The purpose of this paper is to present the NRL-SSC participation, scientific purpose, experiment design/layout, sensor characteristics, preliminary results, and some assessment of problems and difficulties encountered. Our primary research emphases are on breaking waves and bubbles generated by wave breaking processes. Various sensors are needed to measure different physical parameters and characteristics of these two near-shore phenomena. Arrays of these sensors are required to measure bubble and wave conditions over drastic variations in bathymetry from the beach to a few kilometers offshore. NRL-SSC involvement is extensive and several years are required to complete the analysis and to correlate the data from several dozen sensors mounted on the eight arrays. Results from this systematic analysis shall be reported in the future.

Sandy Duck'97 Experiment

A brief overall description of the Sandy Duck'97 Experiment (SD'97) in which NRL-SSC participation is an integral part of its scientific goals is now given. This description of SD'97 clearly indicates the integral nature of these large surf-zone experiments and several advantages of the research facility available at Duck, NC.

The major focus of SD'97 is to improve the fundamental understanding of surf-zone sediment transport (Birkemeier, 1997) and includes: (1) small- and medium-scale sediment transport and morphology, (2) wave shoaling, wave breaking and near-shore circulation, and (3) swash processes, including sediment motion. The experiment location roughly covers a surf-zone area of 550 m cross-shore and 700-m alongshore on the north side of the 600-m pier at the FRF. Maximum depth is about 7 m. A detailed bathymetric survey is