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The Acoustical Oceanography of Bubbles: URI Component

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LONG-TERM GOALS

To develop a comprehensive account of the acoustical oceanography of bubbles in the ocean, including their formation, evolution and decay, their response to different oceanographic conditions, their contribution to passive sound in the sea, and their influence on acoustical propagation.

OBJECTIVES

To write a monograph that will be of practical value to ocean acousticians and others concerned with bubbles in the sea. The monograph will include both oceanographic aspects and acoustical implications. The oceanographic discussion will cover bubble formation and injection and the response of bubble clouds to subsurface circulation, buoyancy effects and dissolution. The discussion of acoustical implications will cover the contribution of bubble formation to naturally occurring sound in the sea, the role of bubbles in scattering and absorbing sound, the acoustical characteristics of bubble plumes and clouds including the consequences of the evolution, and approaches to incorporating bubbles in acoustical propagation modeling.

APPROACH

This is a collaborative effort being undertaken jointly with Dr Grant Deane of Scripps Institution of Oceanography. Our approach is to develop the overall focus of the monograph, identify topics to be covered and develop a plan for the contents of each chapter, followed by preliminary sketches of each chapter, followed by detailed writing.

WORK COMPLETED

We have now completed discussion of bubble creation in breaking waves including entrainment mechanisms, fragmentation and jet entrainment, capillary waves breaking and bubble generation by drop impacts. Our completed analysis of the isolated bubble includes bubble rise speed, surfactants effects, turbulence ambient fluid temperature and gas transfer, as well as the acoustical effects of scattering and absorption. We have completed our contribution to collective bubble dynamics in the areas of wave dissipation and bubble size distributions, bubbles entrained in a vortex, and the role of bubbles in viscosity. The acoustical response of bubbles now completed, includes two-bubble interactions, bubble chains, single scatter approximation and multiple scatter. Current effort is directed

at observed bubble distribution in the ocean in a variety of environments including the surf zone, tidal front and the upper ocean.

IMPACT/APPLICATIONS

Bubbles have a profound impact on the upper ocean acoustical environment. Calculations requiring a knowledge of this environment, both with respect to naturally occurring sound and with respect to propagation, such as sonar operations of various kinds, depend on a knowledge of bubble distributions and their oceanographic and acoustical behavior. This monograph is intended to summarize available knowledge on this topic and provide the theoretical framework required for relevant acoustical modeling.

RELATED PROJECTS

Acoustical Oceanography of Bubbles: SIO Component