Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE **30 SEP 1997**	2. REPORT TYPE	3. DATES COVERED **00-00-1997 to 00-00-1997**
4. TITLE AND SUBTITLE **Numerical Studies of Internal Wave Dynamics**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of California, San Diego,Scripps Institution of Oceanography,La Jolla,CA,92093**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**2**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

NUMERICAL STUDIES OF INTERNAL WAVE DYNAMICS

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Award #: N00014-97-1-0095

LONG-TERM GOALS

Our general long-term goal is to obtain a better understanding of turbulent flow of the oceans in terms of the basic laws that govern vortices and waves. In particular, we are trying to understand how internal wave energy propagates through the spectrum of physical scales and also through an inhomogeneous ocean from one region to another.

SCIENTIFIC OBJECTIVES

In this project, we are addressing several basic questions: How is energy transferred from large-scale perturbations down to the Ozmidov scale? What are the mechanisms for vortical mode production? Can the range of behaviors observed in isopycnal separation statistics be captured in current large eddy simulation models? How do the flow and density statistics change as the depth of the fluid varies?

APPROACH

This work is primarily a numerical investigation in which the results of simulations will be compared directly to oceanic data. The simulations are being carried out with both spectral and finite difference codes. A variety of subgrid scale modeling techniques are used and compared to ensure that the physical results are not significantly affected by the small scale parameterization used. Data collected by Robert Pinkel, Mathew Alfors, and Myrl Hendershott will be used to set the physical parameters for the simulations. Then diagnostics on the three-dimensional fields resulting from the simulations will be compared with the observational data sets.

TASKS COMPLETED

We have developed and tested two-basic codes with periodic boundary conditions. One is a finite difference code and the other is a spectral code. In addition, we made some preliminary tests necessary for the development of a versatile three-dimensional flow simulation code with arbitrary bottom topography using the 'body force method.'

RESULTS

In order to validate the new codes, we have run a series of numerical simulations with large-scale forcings of various types. For example, a random forcing which is white noise in time produces an inertial range with a spectral decay of the appropriate -5/3 power law when we use a subgrid scale model based on Kraichnan's eddy viscosity. Depending on the forcing, we can also observe statistically stationary states in which the potential energy spectrum follows a -3 power law typical of the buoyancy range. In addition, we have run a series of simulations in collaboration with Carolyn Mockett in which we follow the decay of lens-like density structures. We have thus verified that certain long lenses can be stationary in rotating and stratified flow.

IMPACT FOR SCIENCE

It is rather difficult to reconstruct the flow structures in any given volume of the ocean from available observational data. For example, various explanations may be offered to explain a particular overturning event seen in a density profile. By observing similar events in a fully three dimensional data set, we hope to be able to decide on the validity of various hypotheses currently used to explain the occurrence of such events.

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