REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	May 4, 1998	Final Report 12/1/93-11/30/95

4. TITLE AND SUBTITLE
Electric Fields Induced by Turbulence in the Seabed Boundary Layer

5. FUNDING NUMBERS
N00014-94-1-0436

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAMES(S) AND ADDRESS(ES)

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

12. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
see attached report

14. SUBJECT TERMS
vorticity, turbulence, electromagnetic

15. NUMBER OF PAGES
2

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

Electric Fields Induced by Turbulence in the Seabed Boundary Layer
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J. H. Trowbridge and A. J. Williams III

Abstract

The purpose of this work was to understand electrical fluctuations forced by turbulent velocity fluctuations in the bottom boundary layer of the coastal ocean. For this purpose, Trowbridge and Williams, of the Woods Hole Oceanographic Institution (WHOI) deployed two tripods containing novel acoustic vorticity sensors in the Strait of Juan de Fuca, in Washington state, for a period of approximately eight months. In a companion project funded under a separate grant, Cox and Webb, of the Scripps Institution of Oceanography, deployed a sensor designed to measure electrical fluctuations at the same site during the same period. The vorticity measurements were successful, but the electrical instrumentation developed problems and did not produce usable data. In a follow-up study, essentially the same set of instrumentation was deployed for a one-month period on the continental shelf off Eureka, California. The flow measurements were successful, but the electrical fluctuations were too weak to be detected accurately.

Text

This study was motivated by near-bottom electrical observations by Cox and Webb, of the Scripps Institution of Oceanography (SIO), which indicated electrical fluctuations with relatively short spatial and temporal scales, possibly forced by turbulence in the bottom boundary layer. Electrical fluctuations can be forced in the ocean by the motion of seawater through the earth's magnetic field. The relevant theory indicates that the source term for the electrical fluctuations is proportional to vorticity.

To test the idea that energetic electrical fluctuations can be forced by turbulent vorticity fluctuations in the bottom boundary layer of the coastal ocean, Cox and Webb deployed instrumentation designed to measure near-bottom electrical fluctuations. In a collaborative study funded under a separate grant, Trowbridge and Williams, of the Woods Hole Oceanographic Institution (WHOI) deployed instrumentation designed to measure turbulent vorticity fluctuations. The primary joint deployment of the collective instrumentation occurred during summer of 1994, in the Strait of Juan de Fuca in Washington state, and the recovery occurred during spring of 1995. One of the two tripods deployed by Trowbridge and Williams produced usable data. Unfortunately, the instrumentation designed to measure electrical fluctuations developed problems and did not produce usable data. In a follow-up study, Cox and Webb deployed instrumentation designed to measure electrical fluctuations on the shelf off Eureka, California, for a one-month period during fall of 1996. Trowbridge and Williams deployed instrumentation designed to measure velocity fluctuations at the same place during the same time. The fluid velocity measurements were successful. Unfortunately, the electrical fluctuations were too weak to be measured accurately by the instrumentation designed to measure them.

To carry out their part of the work, Trowbridge and Williams designed, constructed, tested and deployed and recovered a pair of tripods containing novel acoustic travel-time vorticity sensors, and they used the measurements to obtain time-series estimates of vorticity. The sensors are based on technology developed by A. J. Williams for the benthic acoustic stress sensor (BASS) acoustic-travel time current meter, and the application to vorticity measurements was originally developed by F. J. Thwaites, a Ph.D. student in the MIT/WHOI joint program in oceanographic engineering, who worked under the direction of A. J. Williams and E. A. Terray. The design, construction, testing, deployment and recovery of the vorticity sensors used for the experiment with Cox and Webb in the Strait of Juan de Fuca, as well as the results of the analysis of the fluid flow measurements and the resulting vorticity estimates, are described by J. J. Fredericks, J. H. Trowbridge, and A. J. Williams III (Vorticy Measurements within the Bottom Boundary Layer in the Strait of Juan de Fuca, Woods Hole Oceanographic Institution Technical Report, Woods Hole, MA, 1998).