# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **SEP 2011** | | **00-00-2011 to 00-00-2011** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **ONR Special Award in Ocean Acoustics FY10-FY11** | 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)<br>**University of Washington,Applied Physics Laboratory and School of Oceanography,Seattle,WA,98105** | 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 | b. ABSTRACT | c. THIS PAGE | | | |
| **unclassified** | **unclassified** | **unclassified** | **Same as Report (SAR)** | **2** | |

# ONR Special Award in Ocean Acoustics FY10-FY11

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## LONG-TERM GOALS

To understand the effects of deterministic and random ocean processes on acoustic propagation with emphasis on torpedo and sonar frequencies. To work with the younger students and Faculty where my 50 years experience in University research can provide assistance in their research and scholarly pursuits. To work with the Director of APL and others to provide a long term view of the science and staff policies at our University.

## OBJECTIVES

The years since 1959, when I began the study of ocean acoustic WPRM (Wave Propagation in Random Media), have involved simultaneous measurements in space and time of all of the relevant oceanographic processes with measurements of the fluctuations of sound at Torpedo and Sonar frequencies caused by those oceanographic perturbations. My main objective is to disseminate the results of that research in a few focused manuscripts. Based on the reviews I've received from several of my colleagues and on a discussion with Dr. Allan Pierce, Editor in Chief of the Journal of the Acoustical Society of America of the manuscript "50 Years Studying Ocean Acoustic WPRM," I am working to complete an extensively revised version of that paper for submission to JASA. Upon completion of that objective, I plan to return to the research I did with Frank Henyey on the "goodness of fit" testing of proposed probability distributions in WPRM. After several discussions with Brad Bell and Frank Henyey on a technique we developed to implement a complex amplitude multi-dimensional matched filter, CAMDMF, on pulsed data returns I believe that work should be completed sufficiently for publication.

## APPROACH

My approach to completing the publication of work funded by my ONR 10 year award in ocean acoustics is to concentrate on completing my "50 years" paper, and move on to the next projects. To initiate the newer work, I have been working on preparing the extensive software that was used in the "goodness of fit" research and the CAMDMF research for use in the MATLAB operating environment so that the research can be continued, in such a way that re-writing the old Fortan and C codes will not be required. In this work I will be collaborating with Brad Bell and Frank Henyey of APL/UW.

## WORK COMPLETED

I have completed my review of the "50 years " manuscript based on the comments of several reviewers (particularly the suggestions from Dr. Allan Pierce), and will spend the rest of this calendar year getting it ready for re-submission. Dr. Pierce gave me quite explicit instruction as to what he would like to see in such a long retrospective, principally, he did not like the fact that I left all of the Mathematics as references, and he felt that the reader would rather see it all together - even though it lengthens an already long paper. Earlier this year, following the death of Dr. Barry Uscinski of DAMTP Cambridge University, I, together with Prof. Michael Buckingham of MPL, were asked to put together a special session of the Hong Kong ASA meeting in Dr. Ucinski's honor. Invited and contributed speakers have been contacted. Dr. Uscinski was a close colleague of mine and we have worked to gether on many problems related to both the U.S. Navy and the Royal Navy acoustic problems related to our research in WPRM. This research is critical to the field of ocean WPRM, because the research initiated by Dr. Uscinski and I in 1978 led to extremely accurate theoretical modeling of acoustic fluctuations based on 3-D plus time ocean models.

Also, I prepared a detailed report for Jeff Simmens, Director of APL, concering some very critical faculty issues that can maximize the ONR return on investment of many of our ONR funded research scientists at APL/UW. That work is completed.

## RESULTS

My research in the field of ocean WPRM has implications for the detection and processing of acoustic signals utilized by our at-sea forces. My research points out new directions for research in the field of ocean acoustic WPRM, and addresses some of the conceptual difficulties in the area of the theoretical predictions of signal variance in ocean acoustic WPRM.

## IMPACT/APPLICATIONS

This research provides to the ocean acoustic community clear results on when the variance of the phase and amplitude of signals propagating in the random ocean can be predicted and when and why they cannot be predicted It points out the fallacy of using second moments as predictors when the probability distributions are always extremely high tailed, i.e. the moments above 2 are non-zero.

## TRANSITIONS

This research in the field of ocean wave propagation in random media, incuding developing an understanding of the spectral and correlative behavior of signals, the pdf of intensity and the invention of the CAMDMF can be transitioned to the Navy signal processing community.

## RELATED PROJECTS

This research is significant to any studies where the statistics of Sonar or Torpedo frequencies are investigated.