AD-A267 731

1a. REPORT SECURITY CLASSIFICATION
Unclassified

1b. RESTRICTIVE MARKINGS

2a. SECURITY CLASSIFICATION AUTHORITY

3. DISTRIBUTION/AVAILABILITY OF REPORT
Unlimited

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE

4. PERFORMING ORGANIZATION REPORT NUMBER(S)

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a. NAME OF PERFORMING ORGANIZATION
Rosentiel School of Marine & Atmospheric Sciences - Univ of Miami

6b. OFFICE SYMBOL (If applicable)

7a. NAME OF MONITORING ORGANIZATION

6c. ADDRESS (City, State, and ZIP Code)
4600 Rickenbacker Cswy.
Miami, FL 33149

7b. ADDRESS (City, State, and ZIP Code)

8a. NAME OF FUNDING/SPONSORING ORGANIZATION
Office of Naval Research

8b. OFFICE SYMBOL (If applicable)

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
N00014-89-J-1156

8c. ADDRESS (City, State, and ZIP Code)
Code 3243
800 N. Quincy Street
Arlington, VA 22217-5660

10 SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION N

11. TITLE (Include Security Classification)
PREDICTABILITY OF DETERMINISTIC UNDERWATER SOUND FIELDS

12. PERSONAL AUTHOR(S)
Michael G. Brown and Frederick D. Tappert

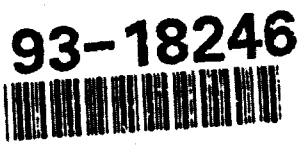
13a. TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 10/1/88 TO 9/30/90	930611	2

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Underwater sound, chaos, predictability

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

93-18246



20. DISTRIBUTION/AVAILABILITY OF ABSTRACT
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION

22a NAME OF RESPONSIBLE INDIVIDUAL
Dr. Michael G. Brown

22b TELEPHONE (Include Area Code)
305 361-4640

22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted.
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

In generic range-dependent environments the acoustic ray equations define a nonintegrable Hamiltonian system. Solutions to such systems of equations are known to exhibit chaotic behavior, i.e., extreme sensitivity and exponential divergence of nearby rays. The objective of this work was to determine whether the chaotic motion of ray trajectories imposes any limitation on the ability to predict finite frequency acoustic wavefields. This imposes a limitation of one's ability to predict (compute) ray trajectories.

Acoustic ray chaos in the ocean environment was studied analytically and numerically. Both idealized and realistic ocean models were studied. The influence of both boundary and volume structure was considered. The purpose of these studies was to quantify - in terms of a "predictability horizon" - our understanding of ray chaos in the ocean environment.

Wave chaos was investigated numerically in an environment in which the corresponding chaotic behavior is understood and quantifiable. Predictability was studied by forward and backward propagating PE wavefields in an attempt to determine whether finite frequency wavefields lose memory of their initial conditions (as in the case for the corresponding ray trajectories).

The results of our numerical and analytical studies are that: 1) ray predictability horizons are typically several thousand km for mesoscale (volume) structures, several hundred km for internal wave structures, or, where range-dependent boundary interactions are involved, the distance corresponding to ten or fewer such interactions; and 2) no evidence of any limitation on predictability associated with chaotic behavior was found in PE wavefields computed using the split-step Fourier algorithm.

The publications listed below acknowledge support from this contract.

Palmer, D.R., M.G. Brown, F.D. Tappert, and H.F. Bezdek (1988) "Classical chaos in nonseparable wave propagation problems," Geophys. Res. Lett. 15, 569-572.

Brown, M.G., F.D. Tappert, G.J. Goni, and K.B. Smith (1991) "Chaos in underwater acoustics," in Ocean Variability and Acoustic Propagation, J. Potter and A. Warn-Varnas (eds), Kluwer Academic Publishers, 139-160.

Brown, M.G., F.D. Tappert and S.E.R.B. Sundaram (1991) "Chaos in small amplitude surface gravity waves over slowly varying bathymetry," J. Fluid Mech. 227, 35-46.

Brown, M.G., F.D. Tappert, and G.J. Goni (1991) "An investigation of sound ray dynamics in a range dependent model of the ocean volume using an area-preserving mapping," Wave Motion 14, 93-99.

Tappert, F.D., M.G. Brown, and G.J. Goni (1991) "Weak chaos in area-preserving mapping for sound ray propagation," Phys. Lett. A 153, 181-185.

Goni, G.J. (1991) "Ray and wave chaos in underwater acoustics," Ph.D. dissertation, University of Miami.