

Final Report: Characterization of the VSW Environment for UUV-N Operations

**Sponsored by The Office of Naval Research, Code 321 OE
Grant # N00014-01-D-0043**



11 March 2007

Submitted by:
Gerald L D'Spain and Scott A. Jenkins
Marine Physical Laboratory
Scripps Institution of Oceanography

Submitted to:
John D. Dudinsky
Naval Surface Warfare Center, CSS
Panama City, FL

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 11 MAR 2007		2. REPORT TYPE		3. DATES COVERED	
4. TITLE AND SUBTITLE Characterization of VSW Environment for UUV-N Operations				5a. CONTRACT NUMBER N00014-01-D-0043 D0015	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Gerald D'Spain				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Marine Physical Laboratory, Scripps Institution of Oceanography/University of California, San Diego, 291 Rosecrans St., San Diego, CA, 92106				8. PERFORMING ORGANIZATION REPORT NUMBER MPL TM-492	
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 A process-based, numerical, hydrodynamic model (VORTEX) was used to characterize the order-one geophysical fluid forcing that a UUV-N would be subjected to in the VSW environment at two canonical beach environments. The VORTEX model used for these simulations was developed under the ONR's Mine Burial Program. The beach environments were selected by NAVSURFWARCEN CSS Panama City and are representative of two of the five primary coastal types that characterize global coastal diversity.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT 2	18. NUMBER OF PAGES 4	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Characterization of the VSW Environment for UUV-N Operations

¹ Gerald D' Spain and Scott A. Jenkins

OBJECTIVE: A process-based, numerical, hydrodynamic model (VORTEX) was used to characterize the order-one geophysical fluid forcing that a UUV-N would be subjected to in the VSW environment at two canonical beach environments. The VORTEX model used for these simulations was developed under the ONR's Mine Burial Program [1], [11], [21]. The beach environments were selected by NAVSURFWARCEN CSS Panama City and are representative of two of the five primary coastal types that characterize global coastal diversity.

APPROACH: We utilize the top end architecture of the *Vortex Lattice (VORTEX) Mine Scour and Burial Model* to characterize the depth variation and geophysical fluid forcing during UUV-N operations in the VSW zone. The computations utilize the farfield processes algorithms of the model. Bathymetry inputs to the model were provided in 3 arc-second resolution by the Tactical Charting Branch, Naval Oceanographic Office, Code NP 431. Nearshore bathymetry associated with seasonal shorerise profile variability was specified by the thermodynamic equilibrium profile algorithms due to Jenkins and Inman 2006. Wave inputs to the model were provided by DIOPS of FNMOC at NAVPACMETOCEAN.

¹ University of California, San Diego, Scripps Institution of Oceanography, Marine Physical Laboratory, Mail Code 0701, 9500 Gilman Drive, La Jolla, CA 92093-0209 USA (phone: (858) 534-5517 and (858) 822-4075, fax: (858) 534-5255, e-mail: gld@mpl.ucsd.edu ; sjenkins@ucsd.edu).

RESULTS: Based on these inputs, the model produced two distinct sets of VSW characterization for the fluid forcing on a UUV-N, namely: a long wave high-energy environment; and a short wave low-energy environment. Results for the high energy environment are summarized in Table 1. The shorerise bottom profile is a type-b cycloid

Table 1: Velocity Statistics Along the Cross-Shore Profile of X-Beach

Depth, m	Maximum offshore velocity, cm/sec	Maximum onshore velocity, cm/sec	rms-velocity, cm/sec	Mean drift, cm/sec
3.0	373.9	-411.9	51.3	-8.57
5.0	127.6	-137.6	24.8	-0.43
8.0	71.43	-81.2	18.3	-2.11
9.0	50.36	-71.76	16.4	-2.96
10.0	56.1	-99.1	15.1	-2.94
11.0	57.2	-67.0	14.1	-2.76
13.0	45.6	-70.3	13.1	-2.77
15.0	36.8	-46.6	11.9	-2.19

comprised of coarse quartz sediment. The amplitudes of the cross shore oscillatory currents have a maximum of 47 cm/sec and root mean squared (rms) values of 12 cm/sec in the outer portion of the VSW zone, increasing to maximums of 411 cm/sec with rms values of 51 cm/sec in the inner portion of the VSW zone at the surf zone. The cross shore currents are complex periodic oscillations with periods ranging from 12 sec to 22 sec. There is also a net onshore drift superimposed on the oscillatory motion that ranges from 2 cm/sec in the outer VSW zone, increasing to 8.5 cm/sec in the inner portions near the surfzone.

Results for the low energy environment are summarized in Table 2. This site is characterized by a type-a cycloid shorerise profile comprised of a mixture of fine to coarse quartz and carbonate sediments in a layered stratigraphy. The maximum amplitudes of the cross shore

Table 2: Velocity Statistics Along the Cross-Shore Profile of Y-Beach

Depth, m	Maximum offshore velocity, cm/sec	Maximum onshore velocity, cm/sec	rms-velocity, cm/sec	Mean drift, cm/sec
2.0	64.2	-108.5	22.49	-5.48
3.0	69.9	-94.9	19.5	-3.46
4.0	43.3	-59.9	13.8	-2.82
5.0	26.9	-30.7	9.29	-2.11
6.0	20.9	-20.4	6.93	-1.63
7.0	23.48	-24.98	7.14	-1.46
8.0	14.1	-14.7	5.35	-0.68
9.0	12.4	-13.1	5.25	-0.04

oscillatory currents in the low energy environment vary from 13 cm/sec in the outer portion of the VSW zone, to 108 cm/sec in the inner portion at the surfzone. The rms values range from 5 cm/sec to 23 cm/sec between the outer and inner portions of the VSW zone. Periods of motion range from 4 sec to 10 sec in the fetch limited low energy environment.

REPORTS AND PUBLICATIONS:

- S. A. Jenkins , D. L. Inman, M. D. Richardson, T. F. Wever, and J. Wasyl , 2007, "Scour and Burial Mechanics of Objects in the Nearshore," *IEEE Jour Oc Eng*, vol 32, no.1, pp 50-64.
- S. A. Jenkins and J. Wasyl, 2006, "Characterization of the VSW Environment for UUV-N operations" submitted to Naval Surface Warfare Center, Panama City, FL., 33 pp.

UNIVERSITY OF CALIFORNIA, SAN DIEGO

UCSD

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



SANTA BARBARA • SANTA CRUZ

MARINE PHYSICAL LABORATORY
PAULA HODGKISS, Acting Management Services Officer
(858) 534-1788
(858) 822-0665 FAX
phodgkiss@ucsd.edu

291 ROSECRANS STREET
SAN DIEGO, CALIFORNIA 92106

Office of Naval Research
Department of the Navy
Attn: Sheila Neal
875 N. Randolph St., Room 624B
Arlington, VA 22203

Dear Ms. Neal:

The enclosed final report is being submitted for security review and distribution approval.
The report is being prepared for publication as a:

N00014-01-D-0043 D0015 – Final Report

Your immediate attention in processing this approval is appreciated. This report is pending distribution and request that you provide approval by email (phodgkiss@ucsd.edu) to expedite the process. I am sending a copy of this letter (without report) to our local ONR Administrative Contracting Officer, Mr. Lee Washington and SIO Contract and Grant officer, Ms. Nancy A.F. Wilson.

Sincerely,

Paula Hodgkiss
Acting Management Services
Officer

Enclosure:

1. Security Classification: **Unclassified**
2. Number of copies requested for duplication: **30**
3. **Title:** "Characterization of the VSW Environment for UUV-N Operations" Gerald D'Spain [N00014-01-D-0043 D0015]

Approval: Sheila Neal
Sheila Neal, Contracting Office for Security Matters

Date: 4/2/07

PLEASE MARK ALL COPIES DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC
RELEASE; DISTRIBUTION IS UNLIMITED.

DISTRIBUTION OF TECHNICAL REPORTS AND FINAL REPORTS

N00014-01-D-0043 D015

- (1) Program Officer
Dr. Thomas Swean
Office of Naval Research, 321
Ballston Tower One
800 N. Quincy Street
Arlington, VA 22217

- (1) Lee Washington
Lead Administrative Contracting Officer (ACO/AGO)
Office of Naval Research Regional Office (ONRRO)
140 Sylvester Road, Bldg 140, Room 218
San Diego, CA 92106-3521

- (1) Director, Naval Research Laboratory
ATTN: Code 5227
Washington, D. C. 20375

- (1) Defense Technical Information Center
8725 John J. Kingman Road
STE 0944
Ft. Belvoir, VA 22060-6218
(electronic submission)