

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

The public reporting burden for this 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 the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 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 any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) 10/12/2000		2. REPORT TYPE CONFERENCE PROCEEDINGS		3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE SPACE-TIME IMAGING OF SHOALING WAVES AND SURF				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER 0602435N	
				5d. PROJECT NUMBER	
6. AUTHOR(S) John Dugan, Cindy Piotrowski, Zandy Williams and K. T. Holland				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Research Laboratory Marine Geoscience Division Stennis Space Center, MS 39529-5004				8. PERFORMING ORGANIZATION REPORT NUMBER NRL/PP/7440--00-1006	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of Naval Research				10. SPONSOR/MONITOR'S ACRONYM(S) ONR	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution is unlimited.					
13. SUPPLEMENTARY NOTES shoaling wave, surf models, space-time, wave spectrum, bathymetry and currents					
14. ABSTRACT A fundamental barrier to consequential evaluation of modem, very capable shoaling wave and surf models has been the inability to provide high-quality ocean data with which to test model results. This paper describes a development intended to satisfy this need by providing space-time visible images of the nearshore from which three parameters crucial to such evaluations are simultaneously retrieved. These fields are the wave spectrum, bathymetry and currents. A panchromatic digital framing camera has been mounted on a small aircraft and used to collect time series of images of waves as they shoal and break. The camera system is controlled by a computer-driven turret which provides accurate location and pointing angles so that the images can be mapped to the mean water level on a common geodetic reference surface. This effectively separates space and time variations associated with the waves. The resulting time series imagery can be mapped and displayed much like a movie taken from a sky hook. These data are used with algorithms to retrieve the ocean parameters of interest, specifically the wave spectrum, water depth and currents. The 3-D frequency-wavenumber spectrum is calculated in sub-regions of the nominal 2 km scene, and the theoretical dispersion relation for linear gravity waves is fit to the spectrum, with the local water depth and current as free parameters.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 2	19a. NAME OF RESPONSIBLE PERSON K. T. Holland
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code) 228-688-5320

20010920 085

PUBLICATION OR PRESENTATION RELEASE REQUEST

SSC-131-00

NRLINST 5600.2

1. REFERENCES AND ENCLOSURES	2. TYPE OF PUBLICATION OR PRESENTATION	3. ADMINISTRATIVE INFORMATION
Ref: (a) NRL Instruction 5600.2 (b) NRL Instruction 5510.40D Encl: (1) Two copies of subject paper (or abstract)	<input type="checkbox"/> Abstract only, published <input type="checkbox"/> Book <input type="checkbox"/> Conference Proceedings (refereed) <input type="checkbox"/> Invited speaker <input type="checkbox"/> Journal article (refereed) <input type="checkbox"/> Oral Presentation, published <input type="checkbox"/> Other, explain	<input type="checkbox"/> Abstract only, not published <input type="checkbox"/> Book Chapter <input checked="" type="checkbox"/> Conference Proceedings (not refereed) <input type="checkbox"/> Multimedia report <input type="checkbox"/> Journal article (not refereed) <input type="checkbox"/> Oral Presentation, not published
		STRN <u>NRL/PP/7440--00-1006</u> Route Sheet No. _____ Job Order No. _____ Classification <u>X</u> <u>U</u> <u>C</u> Sponsor <u>ONR</u> approval obtained <u>X</u> yes _____ no _____

4. AUTHOR

Title of Paper or Presentation
 SPACE-TIME IMAGING OF SHOALING WAVES AND SURF

Author(s) Name(s) (First, Mi, Last), Code, Affiliation if not NRL
 John Dugan (Arete Associates), Cindy Piotrowski (Arete Associates), Zandy Williams (Arete Associates)
 and K. T. Holland (NRL Code 7440.3)

It is intended to offer this paper to the 4th International Symposium on Ocean Wave Measurement and Analysis
 (Name of Conference)
 September 3-5, 2001, San Francisco, CA.
 (Date, Place and Classification of Conference)

and/or for publication in _____
 (Name and Classification of Publication) (Name of Publisher)

After presentation or publication, pertinent publication/presentation data will be entered in the publications data base, in accordance with reference (a).

It is the opinion of the author that the subject paper (is _____) (is not X) classified, in accordance with reference (b).
 This paper does not violate any disclosure of trade secrets or suggestions of outside individuals or concerns which have been communicated to the Laboratory in confidence. This paper (does _____) (does not X) contain any militarily critical technology.
 This subject paper (has _____) (has never X) been incorporated in an official NRL Report.

K. T. Holland, NRL Code 7440.3

Name and Code (Principal Author)

(Signature)

5. ROUTING/APPROVAL

CODE	SIGNATURE	DATE	COMMENTS
Author(s) Holland	<i>[Signature]</i>	10/16/00	
Section Head N/A			
Branch Head acting Harris	<i>[Signature]</i>	10/16/00	
Division Head Acting 7400, Valent Eppert	<i>[Signature]</i>	10/16/00	1. Release of this paper is approved. 2. To the best knowledge of this Division, the subject matter of this paper (has _____) (has never <u>X</u>) been classified.
Security, Code 1221 7031	<i>[Signature]</i>	10/19/00	1. Paper or abstract was released. 2. A copy is filed in this office. SSC-131-00
Office of Counsel, Code 8008.2	<i>[Signature]</i>	10/23/00	
ADOR/Director NCST			
Public Affairs (Unclassified/ Unlimited Only), Code 1230 7030.4	<i>[Signature]</i>	10/19/00	
Division, Code			
Author, Code 7440.3			

6. DISTRIBUTION STATEMENTS (Author to check appropriate statement and fill in reason as required)

☒ **A - Approved for public release, distribution is unlimited.**

☐ **B - Distribution authorized to U.S. Government agencies only (check reason below):**

<input type="checkbox"/> Foreign Government Information	<input type="checkbox"/> Contractor Performance Evaluation	<input type="checkbox"/> Critical Technology
<input type="checkbox"/> Proprietary Information	<input type="checkbox"/> Administrative/Operational Use	<input type="checkbox"/> Premature Dissemination
<input type="checkbox"/> Test and Evaluation	<input type="checkbox"/> Software Documentation	<input type="checkbox"/> Cite "Specific Authority" _____

Date statement applied _____ (Identification of valid)
Other requests for this document shall be referred to _____
(Insert Controlling DOD)

☐ **C - Distribution authorized to U.S. Government agencies and their contractors (check reason below):**

<input type="checkbox"/> Foreign Government Information	<input type="checkbox"/> Software Documentation	<input type="checkbox"/> Cite "Specific Authority" _____
<input type="checkbox"/> Administrative/Operational Use	<input type="checkbox"/> Critical Technology	

Date statement applied _____ (Identification of valid)
Other requests for this document shall be referred to _____
(Insert Controlling DOD)

☐ **D - Distribution authorized to DOD and DOD contractors only (check reason below):**

<input type="checkbox"/> Foreign Government Information	<input type="checkbox"/> Critical Technology	
<input type="checkbox"/> Software Documentation	<input type="checkbox"/> Cite "Specific Authority" _____	
<input type="checkbox"/> Administrative/Operational Use		

Date statement applied _____ (Identification of valid)
Other requests for this document shall be referred to _____
(Insert Controlling DOD)

☐ **E - Distribution authorized to DOD components only (check reason below):**

<input type="checkbox"/> Proprietary Information	<input type="checkbox"/> Premature Dissemination	<input type="checkbox"/> Critical Technology
<input type="checkbox"/> Foreign Government Information	<input type="checkbox"/> Software Documentation	<input type="checkbox"/> Direct Military Support
<input type="checkbox"/> Administrative/Operational Use	<input type="checkbox"/> Contractor Performance Evaluation	<input type="checkbox"/> Test and Evaluation

Date statement applied _____ (Identification of valid)
Other requests for this document shall be referred to _____
(Insert Controlling DOD)

☐ **F - Further dissemination only as directed by** _____
(Insert Controlling DOD)
Date statement applied _____ or higher DOD authority _____

☐ **X - Distribution authorized to U.S. Government agencies and private individuals or enterprises eligible to obtain export-controlled technical data in accordance with regulations implementing 10 U.S.C. 140c.**

Date statement applied _____
Other requests for this document shall be referred to _____
(Insert Controlling DOD)

*For NRL publications, this is usually the Commanding Officer, Naval Research Laboratory, Washington, DC 20375-5320

7. OTHER LIMITATION


Classification Review
(Initial/Date)

☐ Classification only ☐ NOFORN ☐ DTIC exempt (explain) _____

Substantive changes made in this document after approval by Classification Review and Public Release invalidate these reviews. Therefore, if any substantive changes are made by the author, Technical Information, or anyone else, the document must be returned for another Classification Review and Public Release.

8. INSTRUCTIONS

Author completes and submits this form with the manuscript via line channels to the division head for review and approval according to the routing in section 4.

1. NRL Reports.....Submit the diskette (if available), manuscript, typed double-spaced, complete with tables, illustrations, references, draft SF 298, and proposed distribution list.
2. NRL Memorandum Reports.....Submit a copy of the original, typed manuscript complete with tables, illustrations, references, draft SF 298, and proposed distribution list.
3. NRL Publications or other books, brochures, pamphlets,.....Handled on a per case basis by Site Technical Information Office. proceedings, or any other printed publications.

Space-Time Imaging of Shoaling Waves and Surf

John Dugan, Cindy Piotrowski, and Zandy Williams

Areté Associates, 1725 Jeff Davis Hwy, Crystal City, VA, 22202, 703 413 0290
last name@areté-dc.com

and

Todd Holland

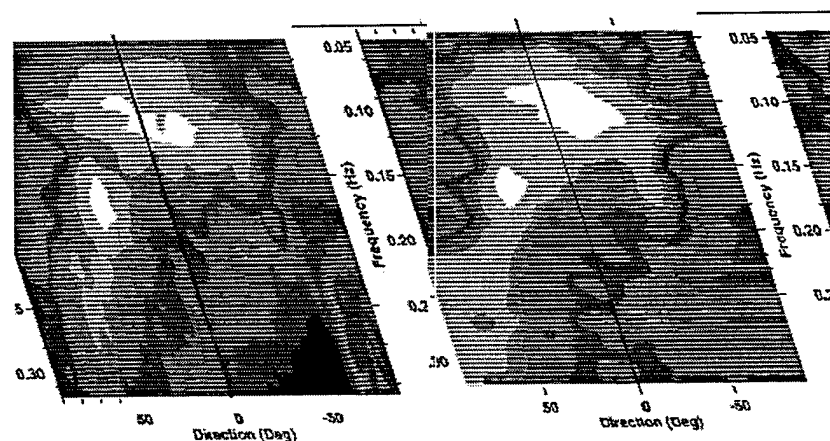
Naval Research Laboratory, Code 7442, Stennis Space Center, MS, 39729, 228 688 5320,
tholland@nrlssc.navy.mil

Abstract

A fundamental barrier to consequential evaluation of modern, very capable shoaling wave and surf models has been the inability to provide high-quality ocean data with which to test model results. This paper describes a development intended to satisfy this need by providing space-time visible images of the nearshore from which three parameters crucial to such evaluations are simultaneously retrieved. These fields are the wave spectrum, bathymetry and currents. A panchromatic digital framing camera has been mounted on a small aircraft and used to collect time series of images of waves as they shoal and break. The camera system is controlled by a computer-driven turret which provides accurate location and pointing angles so that the images can be mapped to the mean water level on a common geodetic reference surface. This effectively separates space and time variations associated with the waves. The resulting time series imagery can be mapped and displayed much like a *movie* taken from a sky hook (see the single frame of mapped data attached below). These data are used with algorithms to retrieve the ocean parameters of interest, specifically the wave spectrum, water depth and currents. The 3-D frequency-wavenumber spectrum is calculated in sub-regions of the nominal 2 km scene, and the theoretical dispersion relation for linear gravity waves is fit to the spectrum, with the local water depth and current as free parameters. Also, the frequency-direction (f-d) spectrum is computed by integrating the 3-D spectrum. Comparisons of these results are made with a

bathymetry survey, ADCPs, and the spectrum from the pressure array at the USACE FRF as part of the SHOaling Wave EXperiment (SHOWEX). The retrieved f-d spectrum is essentially identical to the FRF spectrum, except in instances when alongshore currents Doppler shift the higher frequency waves. Also, the retrieved water depths and currents generally are accurate to ~5% relative values. In addition, the patterns of wave breaking also are analyzed to infer the patterns of wave stress and the morphology in the surf zone, much as has been done with visible image data from the ARGUS tower-mounted video cameras in recent years.

Finally, these parameters can be retrieved across much of the 2 km imagery, so that these product fields can be compared directly with the output fields of 2-D shoaling wave and surf models. Since these are the same parameters that are essential elements of various nearshore models, we suggest that a unique use of these data sets is providing test cases for evaluating shoaling wave and surf models. Data sets were collected both at FRF and nearby Oregon Inlet during SHOWEX, so test cases could be assembled for both simple and complex morphology.



To be presented by: Dr. John Dugan

Suggested topical sessions: **remote sensing** or **wave measurement and analysis**

Requires computer display for showing the very impressive movie loops