

A Shipboard Survey near the Philippines with a Coherent X-band Radar

William J. Plant
Applied Physics Laboratory
University of Washington
1013 NE 40th St
Seattle, WA 98105-6698
phone: 206-543-7836 fax: 206-543-6785 plant@apl.washington.edu

Grant # N00014-07-1-0559
<http://airs.apl.washington.edu/personnel/personnel.html>

LONG-TERM GOALS

The long-term goal of this project is to survey microwave signatures of oceanographic features near the Philippine Islands.

SCIENTIFIC OBJECTIVES

The scientific objectives of this research are to understand the causes of surface signatures of oceanographic features detected near the Philippine Islands.

APPROACH

Our approach is to mount an X-band Doppler radar on a ship cruising near the Philippine Islands to image surface signatures of oceanographic features. We do this while other investigators collect surface and subsurface data to determine environmental conditions and the characteristics of these features. By analyzing these data sets together, we determine how properties of current gradients, wind, and surface waves affect the observed microwave signatures.

WORK COMPLETED

In late May, 2007, we installed our coherent X-band radar called RiverRad on the R/V Melville in Kaohsiung, Taiwan before it set off on a cruise around the Philippine Islands. The radar was installed above the bridge with its two parabolic antennas looking broadside, perpendicular to the ship's heading. One of these antennas operated vertically polarized on both transmit and receive to collect VV data; the other collected horizontally polarized, HH data. Figure 1 shows RiverRad on the Melville. An engineer from APL/UW, Gene Chatham, accompanied the ship on its journey from Taiwan to Manila, Philippines. After that, the radar ran automatically, storing data on surface roughness and velocity approximately every 30 minutes. Data were collected day and night during the entire cruise, which lasted from June 6 to July 3, 2007. The data have subsequently been reprocessed in the laboratory into images of normalized radar cross section and scatterer velocities; they are now ready for further examination by the project team.

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 30 SEP 2007		2. REPORT TYPE Annual		3. DATES COVERED 00-00-2007 to 00-00-2007	
4. TITLE AND SUBTITLE A Shipboard Survey Near The Philippines With A Coherent X-band Radar				5a. CONTRACT NUMBER	
				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) University of Washington, Applied Physics Laboratory, 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 code 1 only					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 6	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



Figure 1. RiverRad mounted on the R/V Melville prior to the Philippine survey cruise. RiverRad's two parabolic antennas look to the side of the ship, perpendicular to the ship's heading.

RESULTS

Many interesting features were observed in RiverRad's images. In addition to myriad islands and boats, the images showed some very strong signatures associated with large-scale current gradients. Figures 2 and 3 show one such feature observed with HH polarization (Figure 2) and VV polarization (Figure 3). Clearly the signature is much stronger in the HH image than in the VV. This is characteristic of backscatter from breaking waves, indicating that the current gradients causing the signatures are extremely strong. The identification of breaking waves as important in providing scatterers is strengthened by the magnitude of the scatterer velocities observed in the HH image. These range from -4 m/s to +4 m/s or higher. If the scatterers are bound to longer waves that are breaking, they will move along with these longer waves and therefore will achieve speeds approaching the phase speed of the wave that is breaking. This is the origin of the large observed velocities. The fact that the signatures contain mixtures of positive and negative velocities indicates that the imaged region is one where long waves come from a wide variety of directions.

Features similar to that shown in Figures 2 and 3 were observed in a variety of locations on the cruise. Figure 4 shows the track of the Melville along with symbols indicating where surface features of current gradients were observed in the imagery of RiverRad. The majority of these features were seen on the west side of the islands and tended to concentrate near straits.

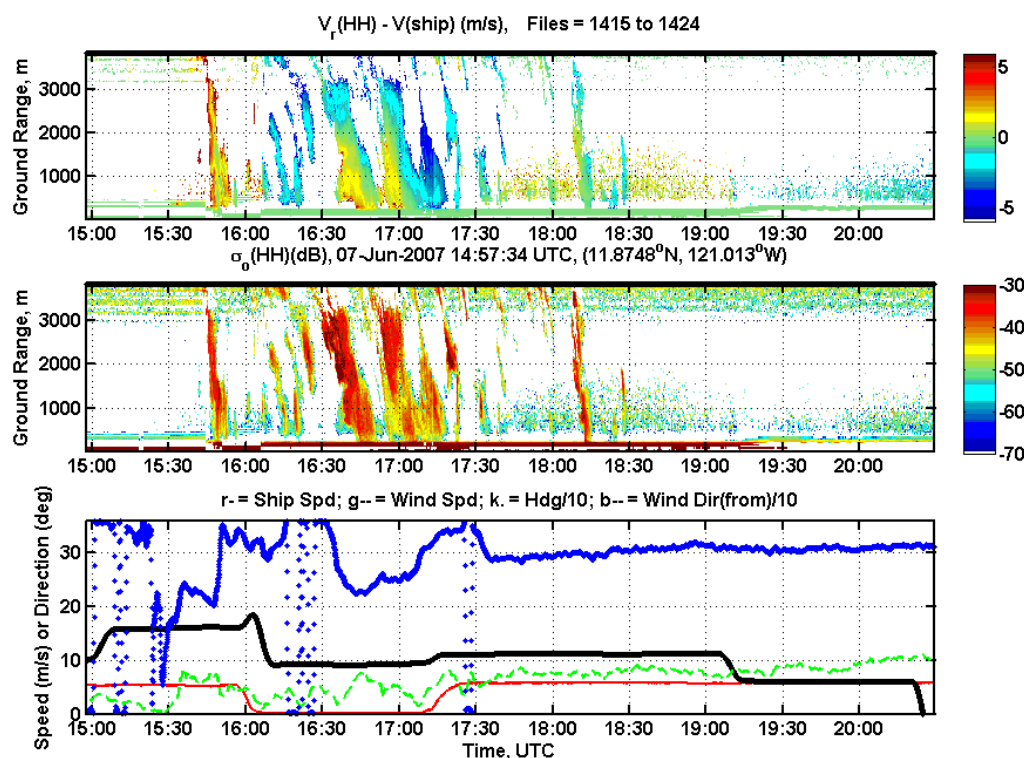


Figure 2. Image of a series of current gradients as observed by RiverRad's HH polarized antenna. Note that these features are very strong.

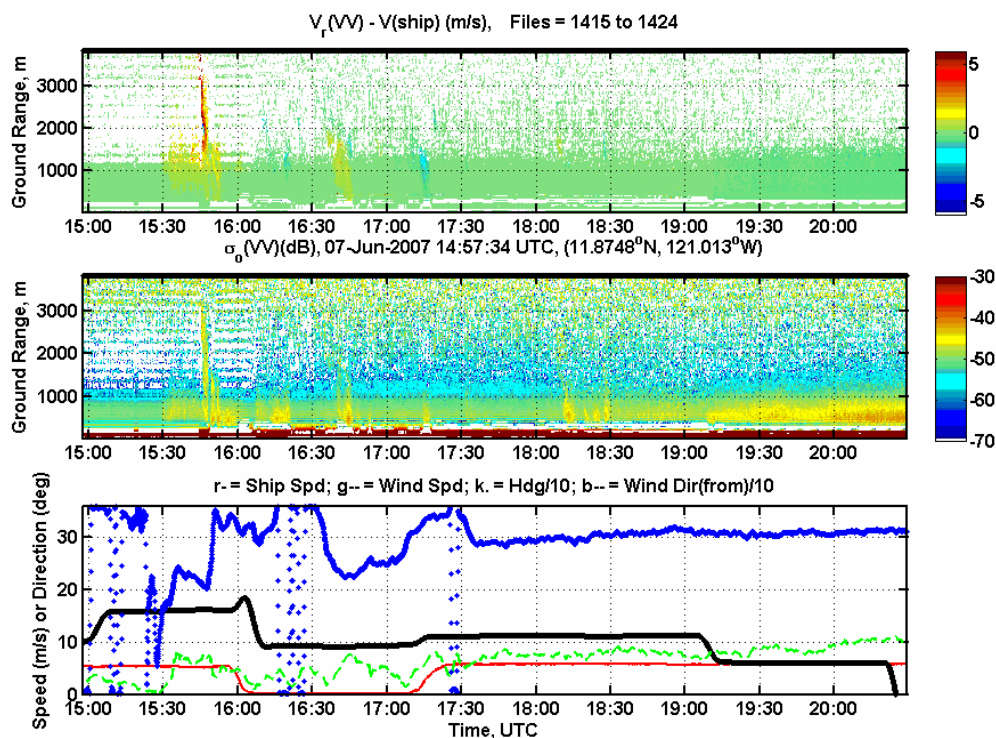


Figure 3. Image of the same feature as shown in Figure 2 but now at VV polarization. Note that the features do not show up nearly as well in this image as in the HH one.

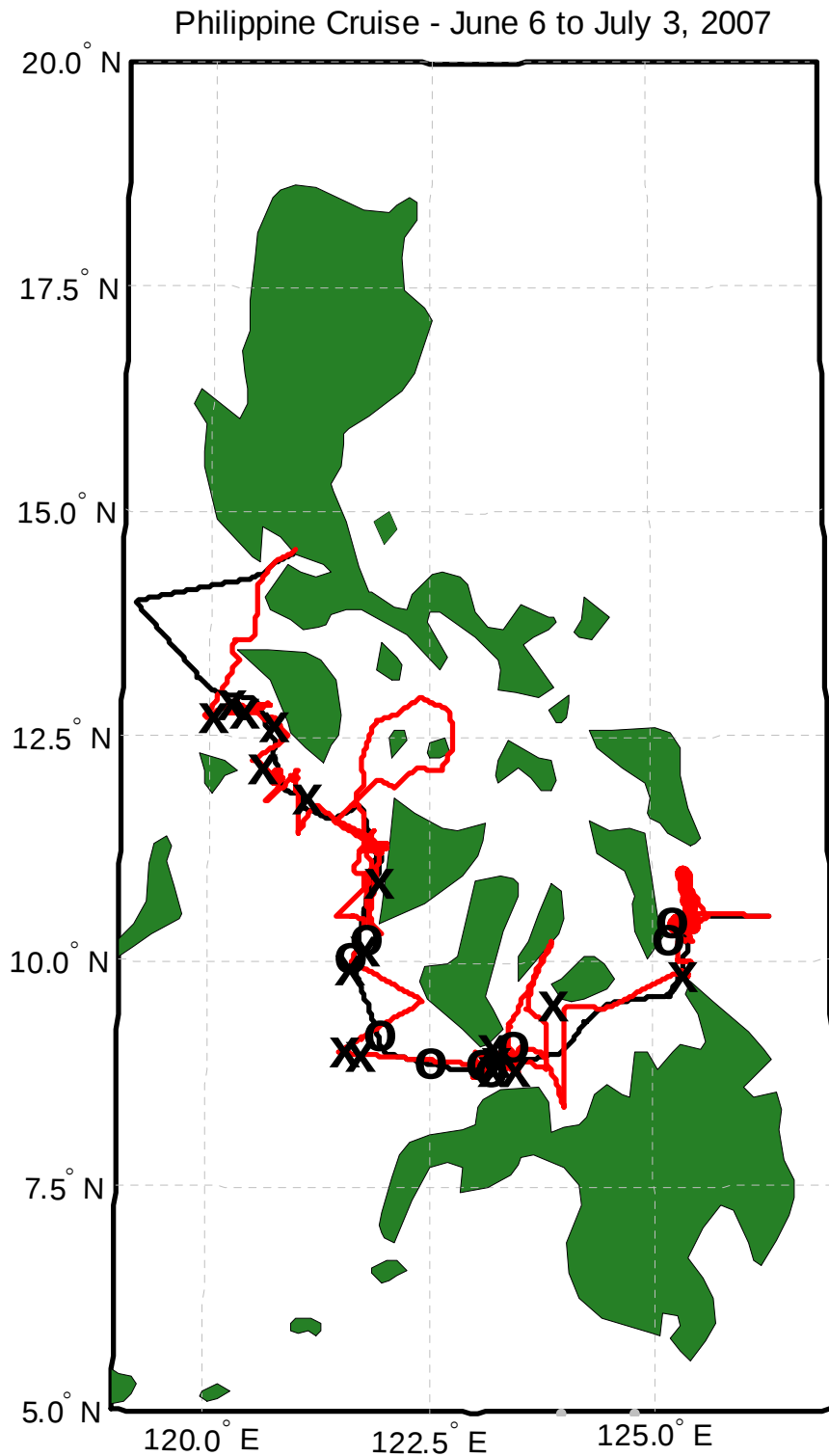


Figure 4. Track of the R/V Melville during its survey cruise of the Phillipine Islands from June 6 to July 3, 2007. The black curve is the outbound leg; the red is the return leg. Symbols: X = strong surface signatures observed by RiverRad; O = weaker signatures seen.

IMPACT/APPLICATION

These measurements and associated future modeling will help establish the relationship between remotely observed microwave signatures of current gradients on the sea surface and the properties of oceanographic features producing them. This will facilitate the prediction of the properties of these features from satellite synthetic radar imagery. Such prediction will aid the operations of military surface and subsurface vessels operating in the Philippine area.

TRANSITIONS

The results of this project have not yet been transitioned for operational use.

RELATED PROJECTS

This project is related to the NonLinear Internal Waves Initiative where surface signatures of internal waves are being studied.