

Satellite Observations of Nonlinear Internal Waves and Surface Signatures in the South China Sea

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Award #: N00014-07-1-0650

LONG-TERM GOALS

The long term goal of this proposed project is to improve our understanding of the nonlinear internal waves, in particular using satellite-based optical and microwave observations to predict better existence and propagation of soliton packets as well as determine their strength (amplitude) and origin.

To improve our descriptions of nonlinear internal waves we propose to acquire satellite data such as SAR and medium to high resolution optical imagery of internal wave soliton packets propagating through the Luzon Straits up to the Dongsha slope.

OBJECTIVES

The specific scientific objectives of this study, to be carried out in collaboration with the NLIWI investigators, are:

- 1) To determine the characteristics of nonlinear internal waves with SAR and optical imagery.
- 2) To map the occurrence and frequency of internal wave soliton packets in SAR and optical imagery and trace their origins.
- 3) To determine the location and generation mechanism of nonlinear internal waves.

Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE 2009		2. REPORT TYPE		3. DATES COVERED 00-00-2009 to 00-00-2009	
4. TITLE AND SUBTITLE Satellite Observations of Nonlinear Internal Waves and Surface Signatures in the South China Sea				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 Miami,CSTARS,11811 SW 168th Street,Miami,FL,33177				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 Same as Report (SAR)	18. NUMBER OF PAGES 4	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

APPROACH

As in the Shallow Water 06 (SW06) experiment off the coast of New Jersey, CSTARS will acquire an extensive set of synthetic aperture radar (SAR) and electro-optical (EO) images during the SC07 experiment. Images from satellite SARs such as RadarSat-1, ERS-2 and ENVISAT ASAR using different beam modes were scheduled for remote downlink to CSTARS that included also ScanSAR and standard beam modes. We also acquired all images of MODIS on Aqua and Terra and submitted task order schedules for EO satellites SPOT 2, 4 & 5 using twin camera viewing for broader swath width. Figure 1 shows the satellite collection coverage for the SC07 experimental region.

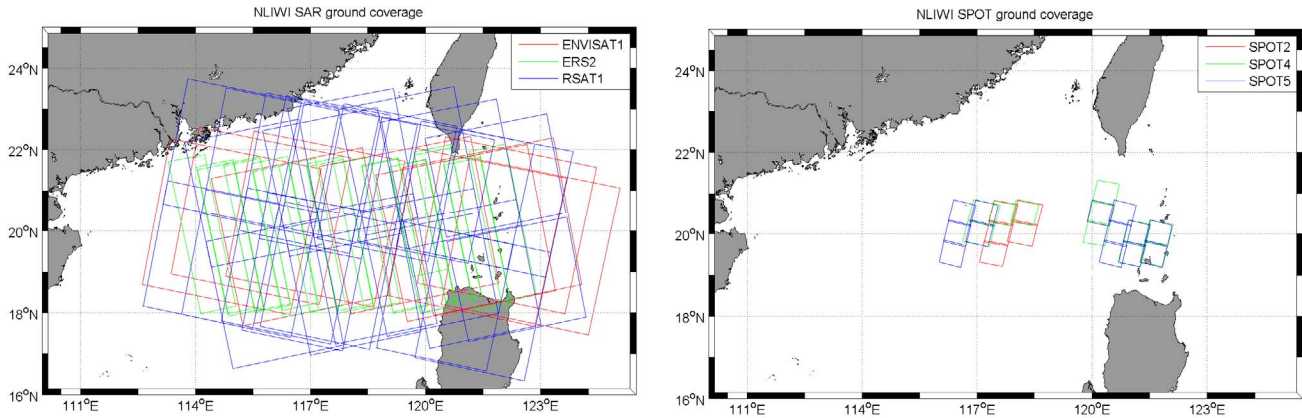


Figure 1: Left: SAR coverage for April/May 2007 over the Luzon Straits. Right: Electro-optical satellite coverage using twin camera configuration and focusing on the primary propagation tracks of the internal waves.

WORK COMPLETED

- 1) Remote downlink to CSTARS of several satellite sensors imaging the SC06 experimental site for April/May 2007 by submitting task schedules.
- 2) Processing of 16 RadarSat-1 SAR images.
- 3) Processing of 10 Envisat ASAR images.
- 4) Processing of 21 ERS-2 SAR images.
- 5) Processing of 1 SPOT-2 panchromatic images using twin cameras side-by-side resulting in 5 scenes.
- 6) Processing of 4 SPOT-4 panchromatic images using twin cameras side-by-side resulting in 11 scenes.
- 7) Processing of 4 SPOT-5 panchromatic images using twin cameras side-by-side resulting in 14 scenes.

RESULTS

Satellite Imagery:

For a five week period we collected a combination of synthetic aperture radar (SAR) and electro-optical (EO) images during the SC07 experiment. Images from satellite SARs such as RadarSat-1, ERS-2 and ENVISAT ASAR using different beam modes were scheduled for remote downlink to

CSTARS for April with some extending into May. In addition to these programmed satellite passes we also acquired an extensive set of historical SAR images of RadarSat-1 and ERS-2. During the SC07 experimental phase we had numerous situation when triplets of SAR images occurred within an interval of 4 hours. These sequences of SAR images will provide good opportunities to estimate both kinematic and geographic properties of internal waves as they were propagating through the Luzon Straits regions onto the Dongsha shelf. Figure 2 shows a map of traced IWs that occurred during April and were observed by SAR. It appears that the IW visibility was better as they shoaled onto the Dongsha shelf region then over the deeper area of the Luzon Straits.

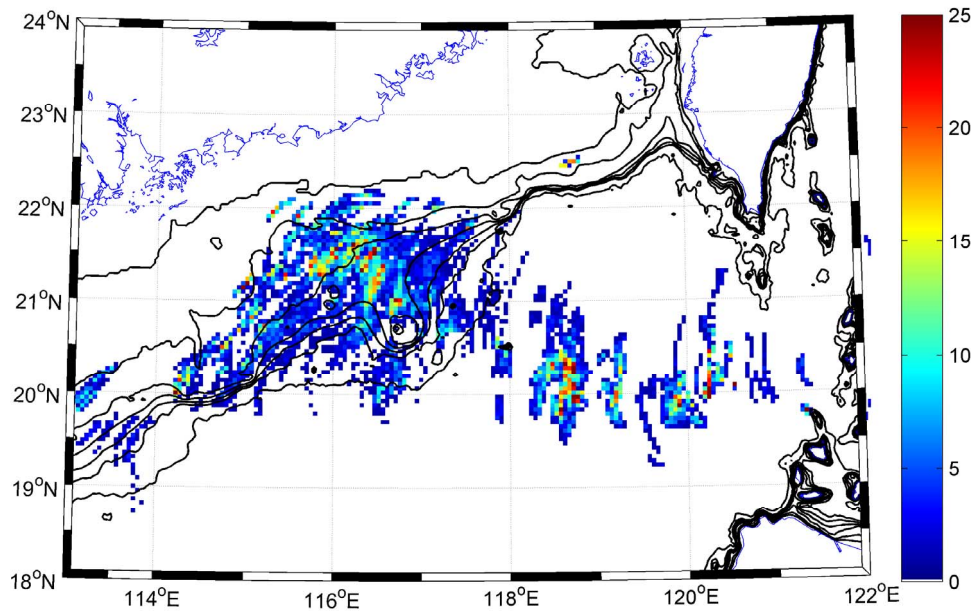


Figure 2: Map displaying the “Hot Spots” of internal waves observed by the different satellites.

The Radarsat-1 image obtained on April 10, 2007 (Figure 3) is located along the shelfbreak west of Luzon Strait. An internal wave is visible just east of Tungsha Tao (Dongsha) Island. It appears that the IW is affected by a seamount as it passes over (middle of image). The effect of a submarine ridge is seen in the kink in the lower portion of the image. Clearly the internal wave is strongly shoaling and refracting in this region. Also of note is the very long crest of this leading soliton which extends over 130 km.

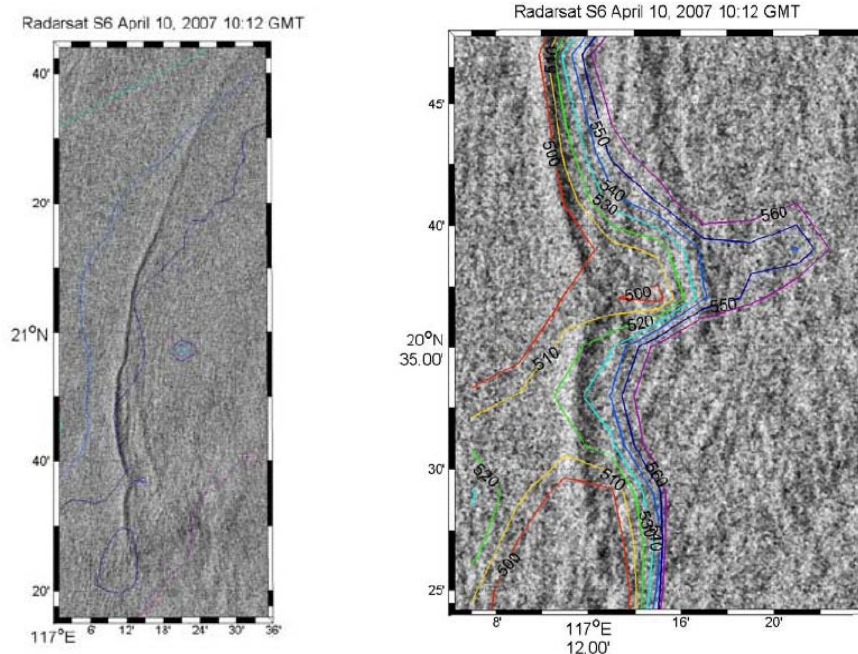


Figure 3: Left: Close up view of soliton approaching Tungsha Tao Island. The IW appears to have been affected by the 500 m deep seamount. Right: A view of the IW packet on April 10, 2006 as it diverges around a small ridge between 500 m and 600 m depth.

IMPACT/APPLICATIONS

Improved multiple datasets measured simultaneously and coincident of internal waves will permit to predict when internal wave trains are generated given the local oceanic state. The satellite imagery will also allow determining the location where internal waves appear in this region. There is considerable discussion on their existence on the eastern side of Luzon Strait.

The satellite data provide valuable input to Chris Jackson, GOA, to develop an improved model to predict the propagation of internal waves across the Luzon Strait.

TRANSITIONS

None.

RELATED PROJECTS

Similar satellite collections were provided during the QPE and PhilEx experiments and are planned for IWISE.