Radar Measurement of Waves and Currents in the Nearshore Zone

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LONG-TERM GOALS

My long-term goal is to contribute to our understanding of the upper ocean and lower atmosphere through the development and application of novel microwave, acoustic, and optical remote sensing techniques.

OBJECTIVES

The objectives of this effort are (1) to establish whether Doppler and interferometric radar techniques can provide useful estimates of nearshore currents and wave heights within and beyond the surf zone and (2) to develop and apply Doppler radar techniques to large area surface wave and current mapping in the nearshore environment.

APPROACH

Our approach has been to observe an area of the nearshore with the Focused Phased Array Imaging Radar (FOPAIR), an X-band imaging Doppler radar, and to employ techniques similar to those of interferometric synthetic aperture radars to estimate surface currents and wave heights. Surface velocities are obtained through cross correlation of radar echoes separated in time, while surface displacements are obtained through correlation of echoes separated in space (i.e. from vertically spaced antennas). For large area surface measurements, we use two adapted marine navigation radars that observe an area of approximately 5 km^2. Velocity estimates from these radars provide vector measurements of the surface velocity field over the nearshore region. These systems will be deployed at the Nearshore Canyon Experiment (NCEX) in 2003 to provide synoptic images of the incident wave fields.

WORK COMPLETED

Working with Jack Puleo and Todd Holland (NRL), we completed a manuscript detailing nearshore observations and comparisons with video observations from the October 2000 SwashX deployment. We

Figure 1: Testing of modified marine navigation radar for NCEX on Cape Ann, MA.

have since have concentrated on the development of the two wave-mapping Doppler radar systems and on preparations for the NCEX experiment.

Logistical difficulties have resulted in our decision not to bring the FOPAIR radar to the experiment. We've concluded that nearly all experimental objectives can be met with the wave mapping radars. Following earlier receptiveness, our access to the rooftop of the NOAA SW Fisheries building was denied due to concerns over radio frequency interference and security concerns. Attempts to site a radar atop 939 Coast Blvd in La Jolla met with similar resistance. As a result, we plan to site one radar at the end of the SIO pier and another at the Blacks Beach trailer complex under the gliderport. The latter will require erecting a tower to achieve adequate height for the radar. Wave Mapping Radar modifications for Doppler have been recently completed.

RESULTS

In October 2002 we tested one vertically-polarized non-Doppler marine radar on Cape Ann, MA (Figure 1). Situated about 20 m above the surface, the radar observed small surface waves under light winds out to 3+ km range. The Wave Mapping Radars are modified Raytheon Pathfinder High-Seas navigation radars. Figure 2 shows a plan-position-indicator (PPI) display of the radar output indicating low amplitude surface waves propagating from the east. Shadowing by intervening terrain is evident in the southeast sector of the image.

IMPACT/APPLICATIONS

The significance of the research lies in the ability to interpret remote sending measurements of the nearshore region with the goal of providing both synoptic and detailed measurement of nearshore pro-

cesses. The imaging radar measurements of the surf zone made here are unique, and the displacement estimates produced are the first of their kind made in the surf zone. If successfully validated through comparison with in-situ sensors, these data products should prove extremely useful in the study of nearshore dynamics under varying weather conditions.

TRANSITIONS

None

RELATED PROJECTS

The radar techniques employed in this work are similar to those employed by airborne interferometric SARs. Under separate ONR support, we have developed such a radar system called the Dual-Beam Interferometer which was flight tested in Dec 2002 and Aug 2003.

PUBLICATIONS

Puleo, J.A., G. Farquharson, S.J. Fraiser, and K.T. Holland, 2003. "Comparison of optical and radar measurements of surf and swash zone velocity fields", *J. Geophys. Res.*, **108**(C3), 3100, doi:10.1029/2002JC001483.

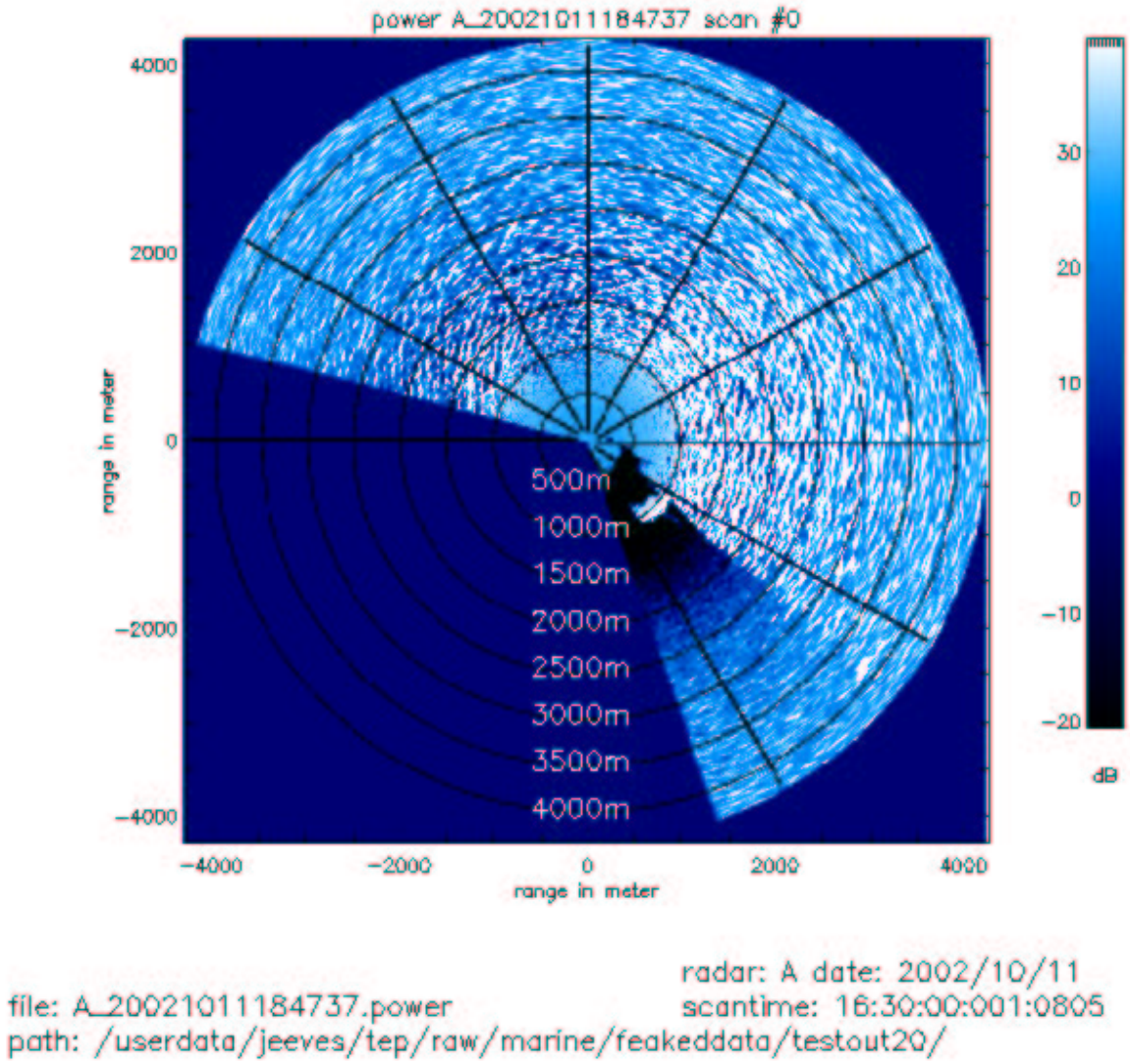

Figure 2: Snapshot of radar echo power display showing a low amplitude surface wave field propagating from the east.