SUBMERGED DUNES AND BREAKWATER EMBAYMENTS MAPPED USING WAVE INVERSIONS OF SHORE-MOUNTED MARINE X-BAND RADAR DATA

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CONTENTS:

• LEACOAST2 Project, Sea Palling
• About Radar & Wave inversions
• Outputs – Wave patterns, bathymetry, currents, feature inversion

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Flooding of Sea Palling, 1953 Storm Surge

Sea Palling.-The sea broke through a 100-yard gap in the dunes, washing away houses and causing the deaths of seven people, including three children. Some of the inhabitants in the bungalows were still refusing to leave their homes.
Sea Palling, East Anglia, UK
X-Band Radar

- 9.8GHz (3cm) standard marine radar
- 2.4m Antenna rotating once every 2.8 seconds
- Short pulses (60ns)
- Record 256 images at 20MHz (~12 minutes)
- Digitise using PC based system (in house design)
- Wave inversion using approximation to non-linear wave theory (Hedges, 1976), modified to include currents.
Storm & Surge
October 31st 2006

ADCP Data
Radar Snapshot
Wide Area Bathymetry inversion & UEA Survey
Conventional survey (Gridded), Carried out by University of East Anglia, UK

Survey data: November 2006

OS Distance (km)

Radar

Depths (m) to ODN

F1
Radar Derived Bathymetry

Radar derived water depth map, 01-Nov-2006 23:00:18
Longshore Transects through Dunefield

Longshore Transect at 500m Offshore

Depth (m) ODN

-1 -0.5 0 0.5 1

Radar
Survey

Longshore Transect at 700m Offshore

Depth (m) ODN

-1 -0.5 0 0.5 1

Radar
Survey

Longshore Transect at 900m Offshore

Depth (m) ODN

-1 -0.5 0 0.5 1

Radar
Survey

Longshore Distance From Radar (km)
Tracking of dune migration

Cross Correlation (Longshore) of Radar Dunefield Pattern with Survey

Survey Date (November 2006)
Survey Date +5 months
Survey Date +10 months

Longshore Distance (m)
Bathymetry & Currents

Radar derived, current resolved water depth map, 01-Nov-2006 16:00:19

Radar derived, current resolved water depth map, 01-Nov-2006 10:00:19

Flood

Ebb
Comparison of radar derived current & ADCP at inshore ADCP location

Comparison of radar derived current @ 1km offshore & inshore ADCP
Slack water offshore, flood inshore
A Work in Progress – Surface Feature Inversion

Subtidal dune features visible in radar timelapse images of surface roughness

Ebb | Flood
A Theory of the Imaging Mechanism of Underwater Bottom Topography by Real and Synthetic Aperture Radar

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Fig. 4a. Schematic plot of the relationship between an asymmetric sand wave profile and associated variations in tidal current velocity, short-scale surface roughness, and radar image intensity. The steep slopes of the sand waves face the flow direction and are associated with strongly reduced image intensity (dark streaks).

Fig. 4b. Same as Figure 4a but with flow direction reversed. Now the steep slopes lie on the downstream side and are associated with strongly increased image intensity (bright streaks). The result is a reversal of the image intensity modulation pattern, which makes the images of Figures 3a and 3b look like negatives of each other.
Colour is related to slope of sea bed

Inferred subtidal dune field based on current-modulated sea surface radar signatures, Spring-Neap Cycle ending 20061104
Summary

- Wave inversion used to derive bathymetry & currents
- Generally use up to 4km range, can do 8km under optimal conditions (storm)
- Bathymetry generally within 1m of survey
- Currents being validated where possible
- Subtidal dune migration tracked using two independent radar derived products – Bathymetry & Surface Feature Inversions

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