INFLUENCE OF SHALLOW WATER INTERNAL WAVE FIELDS ON THE PROPERTIES OF ACOUSTIC SIGNALS - WHOI AND NPS ANALYSES OF 1995 DATA

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LONG TERM GOAL

The long-term goal is simple: to understand the scattering of low to intermediate frequency sound (10-2500 Hz) in shallow water by linear and non-linear internal waves. This requires an understanding of both the acoustic effects of the waves and the features of the coastal waves themselves. The oceanography and the acoustics are inseparable.

SCIENTIFIC OBJECTIVES

The objective is to understand the physics of propagation and the oceanographic conditions on the shelf to the degree required to explain acoustical behavior during the 1995 SWARM (Shallow Water Acoustics in a Random Medium) experiment. The experiment took place on the shelf east of New Jersey. 224 and 400 Hz sound was propagated 32 km in the offshore direction to a pair of vertical receiver arrays. The regions had a gradually sloping bottom, many packets of solitary waves propagating inshore, internal tidal bores, and continuous linear internal waves.

APPROACH

The approach has been to determine and exploit useful quantitative measures of acoustic variability and coherence. Useful measures would quantify signal stability or variability in a manner useful to acoustic users, but would also be fundamentally linked to the propagation physics. Exhaustive environmental measurements were made during SWARM, and the first step has been to relate traditional acoustic and oceanographic measures. The primary acoustic variables pursued were the pulse travel times (and their spread and wander) and the pulse amplitude (intensity) fluctuations. The most relevant oceanographic quantities are the temperature field and its variability, as the sound speeds and their fluctuations correspond most closely to this field. Both model studies, data studies, and a combination have been employed in this work.

WORK COMPLETED AND RESULTS

We have made significant progress during the past year in understanding the scattering of acoustic energy by coastal solitons. The primary areas of progress were: 1) travel time fluctuation studies, 2) oceanographic field characterization, 3) studies of acoustic scattering by individual solitons, and 4) studies of field amplitude fluctuations. In the first area, we have shown that the acoustic pulse time spread ties closely to the M2 internal tidal "solibores," with particular sensitivity to solibores near the receiver. Acoustic pulse wander was strongly affected by low frequency oceanography, particularly that in the frontal region. In the second area of study, we have shown how solibores are generated in the SWARM area, and how their characteristics fluctuate significantly due to ambient wind and ocean conditions. In the third study area, we have shown that iterative scattering by individual solitons is probably the *dominant* scattering process in regions where the soliton arrivals are not regularly spaced, which is probably a common case. Finally, work has been initiated on amplitude fluctuations, with preliminary results indicating that solibores in the region of an acoustic source have the greatest effect on the fluctuations. Papers have been both published and submitted upon the above work, listed at the conclusion.

IMPACTS/APPLICATIONS

The acoustics and oceanography lessons we have learned from the data, and from our efforts to model them theoretically and numerically, have considerable implications for Navy systems and applications, we believe. The internal wave induced field fluctuations of up to 20 dB over timescales of minutes, and the significant M2 tidal variation of the pulse spread suggest that targets may be acquired and lost with an understandable variability, and that certain processing schemes may be more or less effective for Navy systems. The dependence of the pulse time spread on the proximity of solibores to the receiver and the (seeming) dependence of the amplitude fluctuations to the proximity of solibores to the source could have strong tactical implications on how to either hide a vessel or detect one. The processing issues that these findings suggest should be clearly addressed in the future, if the Navy is to gain maximum benefit from the SWARM experiment. Oceanographically, we have seen both how strong and how variable the solibore field is. This is of first order importance to understanding hydrographic results (both current meter and CTD) in any region containing these features, particularly near the shelfbreak.

RELATED PROJECTS

There are a number of recent projects which have taken data which relate to coastal internal waves and acoustic scattering on the continental shelf. These include STRATAFORM, Shelf-Break PRIMER, CMO, SESAME, STANDARD EIGER , Intimate 96, and the Yellow Sea experiment. We have been in close touch with the investigators from those projects.

PUBLICATIONS AND PRESENTATIONS:

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