DEPARTMENT OF OCEANOGRAPHY

Thesis Abstracts

VISUALIZATION AND ASSESSMENT OF GLOBAL OCEAN DATA ASSIMILATION EXPERIMENT PROFILE DATA FOR THE PACIFIC OCEAN

Timothy A. Anderson-Lieutenant, United States Navy
B.S., University of Notre Dame, 1995
Master of Science in Physical Oceanography-June 2001
Advisor: Mary L. Batteen, Department of Oceanography
Second Reader: David Dimitriou, Fleet Numerical Meteorology and Oceanography Center

The Global Ocean Data Assimilation Experiment (GODAE) is an endeavor that will likely change the path of oceanography for many years. This attempt to assimilate, organize and provide massive quantities of widely varied oceanographic and meteorological data to the world could be a catalyst for new and innovative research opportunities. One of the data sources important to GODAE and of great possible value, the Array for Real-time Geostrophic Oceanography (ARGO), is another innovation that may lead to significant improvements in oceanographic modeling and research. The concept of thousands of autonomous floats, reporting ocean conditions to a database that can assimilate and provide this data in real or near-real time, affords countless opportunities for new methods of ocean prediction.

The true test of GODAE is to assess the utility of the data available in a real world setting, and ascertain the relative usefulness as it relates to research opportunities and operational data needs. This thesis will assess the utility of the USGODAE data server by retrieving, processing, visualizing and employing the data in observing conditions in and near the Kuroshio Current. By attempting to use the data server in a method similar to future research and operational use, an understanding of its true potential may be reached.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Computing and Software, Environmental Quality, Sensors, Surface/Under Surface Vehicles-Ships and Watercraft, Modeling and Simulation

KEYWORDS: Global Ocean Data Assimilation Experiment, GODAE, Array for Real-Time Geostrophic Oceanography, ARGO, North Atlantic Ocean Basin, Drifting Buoys, Ocean State Prediction, Climate

SWELL ACROSS THE CONTINENTAL SHELF

Fabrice Ardhuin-Ingénieur de l'Armenment
M.S., Ecole Polytechnique, 1997
M.Res., Université Paul Sabatier, 1998
Doctor of Philosophy in Oceanography-September 2001
Dissertation Supervisor: Thomas H. C. Herbers, Department of Oceanography

The transformation of surface gravity waves propagating through shallow regions is investigated with extensive field data from the North Carolina continental shelf. A spectral energy balance equation is derived for a bi-dimensional bottom topography with random small-scale irregularities, in which bottom friction is introduced heuristically which a parameterized source term, and solved numerically using a hybrid Eulerian-Lagrangian scheme. This new model named CREST (Coupled Rays with Eulerian Source Terms) determines accurately refraction of waves by subgrid-scale depths variations using precomputed rays, allowing applications to large coastal areas with relatively coarse grids. Hindcasts of swell events during field experiments show large variations in wave heights caused by refraction and bottom friction. Widespread observations of sand ripples confirm that the bottom roughness is enhanced by wave-generated vortex ripples, thus sheltering the shore from offshore swells by dissipating wave energy in the bottom boundary layer. Resulting wave height attenuation up to 70% (84% of the wave energy) was observed in moderately energetic conditions. Bragg scattering of waves by wavelength-scale bottom features significantly increases (up to a factor two) the directional spread of waves.

DoD KEY TECHNOLOGY AREAS: Environmental Quality, Battlespace Environments

KEYWORDS: Ocean Surface Waves, Nonlinear Interactive Wave Breaking, Bottom Friction, Continental Shelf

VALIDATION OF A STOCHASTIC BOUSSINESQ MODEL FOR WAVE SPECTRA TRANSFORMATION IN THE SURF ZONE

Marianie O. Balolong-Lieutenant, United States Navy
B.S., Jacksonville University, 1996
Master of Science in Meteorology and Physical Oceanography-March 2001
Advisor: T.H.C. Herbers, Department of Oceanography
Second Reader: Edward B. Thornton, Department of Oceanography

This thesis presents a field validation of a stochastic, nonlinear wave shoaling model based on a third-order closure Boussinesq equations (Herbers and Burton, 1997). The model predicts the evolution of directionally spread waves propagating over an alongshore uniform beach. The model consists of a coupled set of evolution equations for the wave spectrum and bispectrum that incorporates linear shoaling and refraction effects and nonlinear energy exchanges in near-resonant triad interactions. Dissipation due to breaking is approximated using an empirical quasi-linear damping function and a relaxation to Gaussian statistics. The model was verified with field data from five alongshore instrument arrays deployed near Duck, North Carolina from August to December 1997 as part of the SandyDuck experiment. The predicted shoaling evolution of the frequency-directional wave spectra shows the expected development of harmonic peaks through triad interactions. The predicted harmonic spectral levels and direction are in good agreement with the observed spectra, but the predicted directional spread is biased low inside the surf zone. The significant wave height predictions are generally in good agreement with observations. The model tends to overshoal the waves outside the surf zone and slightly overdissipate wave energy inside the surf zone. Infragravity wave growth, sea surface skewness and asymmetry are predicted fairly accurately by the model.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Modeling and Simulation

KEYWORDS: Stochastic Boussinesq Wave Model, Ocean Surface Gravity Waves, Frequency-Directional Wave Spectra, Surf Zone, Wave Shoaling, Beach

IMPACT OF HIGH RESOLUTION WIND FIELDS ON COASTAL OCEAN MODELS

David Guy Blencoe-Lieutenant, United States Navy
B.S., University of South Carolina, 1994
Master of Science in Meteorology and Physical Oceanography-September 2001
Advisor: Jeff Paduan, Department of Oceanography
Second Reader: Curt Collins, Department of Oceanography

The development of a coastal ocean circulation model involves many challenges, including the interaction of complex coastline and topography and the prediction of mesoscale oceanographic features. The Innovative Coastal-Ocean Observing Network (ICON) developed a Monterey Bay ocean circulation model to resolve these challenges. This study examines two different ICON model cases. The first ICON model case was forced with the 100 km NOGAPS winds while the other was forced with the 9 km COAMPS winds. The comparison demonstrated that the 9 km COAMPS-forced case produced better resolution of the ocean mesoscale. This was shown through examination of the daily sea surface temperature fields and the daily surface ocean currents. Time series of sea surface temperature showed a strong seasonal cycle. After removal of the seasonal cycle, the existence of mesoscale features was even more dramatic. A case study at Pt. Sur showed the evolution of mesoscale features associated with an upwelling event.

DoD KEY TECHNOLOGY AREAS: Sensors, Battlespace Environments, Modeling and Simulation

KEYWORDS: HF Radar, Air-Sea Interaction, Innovative Coastal-Ocean Network, ICON

ENVIRONMENTAL IMPACT ON MINE HUNTING IN THE YELLOW SEA USING THE CASS/GRAB MODEL

Carlos J. Cintron-Lieutenant, United States Navy
B.S., Rochester Institute of Technology, 1993
Master of Science in Physical Oceanography-March 2001
Advisor: Peter C. Chu, Department of Oceanography
Second Reader: Steve D. Haeger, Naval Oceanographic Office

The purpose of this work is to determine the necessity of a near real time ocean modeling capability such as the Naval Oceanographic Office's (NAVOCEANO) Modular Ocean Data Assimilation System (MODAS) model in shallow water (such as the Yellow Sea) mine hunting applications using the Navy's Comprehensive Acoustic Simulation System/Gaussian Ray Bundle (CASS/GRAB) model. Sound speed profiles inputted into the CASS/GRAB were calculated from observational (MOODS) and climatological (GDEM) data sets for different seasons and regions of four different bottom types (sand, gravel, mud, and rock). The CASS/GRAB model outputs were compared to the outputs from corresponding MODAS data sets. The results of the comparis ons demonstrated in many cases a significant acoustic difference between the alternate profiles. These results demonstrated that there is a need for a predictive modeling capability such as MODAS to address the Mine Warfare (MIW) needs in the Yellow Sea region. There were some weaknesses detected in the profiles the MODAS model produces in the Yellow Sea, which must be resolved before it can reliably address the MIW needs in that region.

DoD KEY TECHNOLOGY AREA: Other (Military Environmental Factor)

KEYWORDS: Modeling and Simulation, Oceanography, MODAS, MOODS, GDEM, CASS/GRAB, NIDAS

THE PHYSICAL CHARACTERISTICS OF BOTTOM SEDIMENT NEAR SUR RIDGE, CALIFORNIA

Christopher L. Gabriel-Lieutenant, United States Navy
B.S., Washington State University, 1994
Master of Science in Meteorology and Physical Oceanography-March 2001
Advisors: H. Gary Greene, Moss Landing Marine Laboratories
Ching-Sang Chiu, Department of Oceanography
Curtis A. Collins, Department of Oceanography

A study was conducted to determine the relationships between the geomorphology, sedimentology, and acoustic properties surrounding Sur Ridge, California, in an effort to determine their effects on acoustic tomography. Eleven gravity cores were taken in the vicinity of Sur Ridge. Detailed acoustic and sedimentologial analyses were conducted on the sediment within each core. The acoustic characteristics of the sediment and the geomorphology of Sur slope were examined to determine their impact on the arrival times and structures of acoustic tomography signals sent from a source on Davidson Seamount to a receiver on Sur Ridge. Based on analyses of cores collected for this study, it was found that sediment along the western slope of Sur Ridge are composed primarily of hemipelagic silty clays. Sediment within the trough to the east of Sur Ridge are fine sands composed primarily of relict glauconite grains that appear to be a lag deposit created by a relatively strong bottom current. The in-situ compressional wave velocities and wet bulk densities from the cores taken along the lower part of Sur slope were then assimilated into an existing acoustic model in an attempt to improve the accuracy of the model. Results indicated that due to the presence of a sound channel in the surficial sediment, the cores taken did not penetrate deep enough into the sediment in order to obtain an accurate profile of the compressional wave velocity gradient within the sediment.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Modeling and Simulation

KEYWORDS: Sur Ridge, Sediment Characteristics, Acoustic Tomography, Glauconite

MINE DROP EXPERIMENT (MIDEX)

Anthony Gilless-Lieutenant, United States Navy
B.S., United States Naval Academy, 1993
Master of Science in Meteorology and Physical Oceanography-September 2001
Advisor: Peter Chu, Department of Oceanography
Second Reader: Peter Fleischer, Naval Oceanographic Office - Stennis Space Center

The Navy's Impact Burial Prediction Model (IMPACT 25) determines the amount of burial a mine experiences upon impacting the marine sediment. Impact burial calculations are derived primarily from the sediment characteristics and from the mine's two-dimensional air and water phase trajectories. Accurate burial prediction requires that the model's air and water phase trajectories reasonably mimic the objects true trajectory. IMPACT 25 assumes that the objects are cylindrical in shape and calculates the air and water phase trajectories entirely from momentum equations.

In order to determine what effect a varying center of mass has on a mine's water phase trajectory, a Mine Drop Experiment was conducted. The experiment consisted of dropping three cylinders of various lengths into a pool where the trajectories were filmed from two angles. The controlled parameters were, the ratio of mine length to diameter, initial velocity, center of mass position and drop angle. Results indicate that center of mass position has the largest influence on the object's trajectory and that accurate trajectory modeling requires the inclusion of both momentum and moment equations.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Environmental Quality, Modeling and Simulation

KEYWORDS: Mine Impact Burial, Impact Burial Prediction Model (IMPACT 25)

VISUALIZATION AND FEASIBILITY ANALYSIS OF THE GLOBAL OCEAN DATA ASSIMILATION EXPERIMENT, NORTH ATLANTIC BASIN, SEPTEMBER 1999 TO MARCH 2001

Jennifer R. Hauser-Lieutenant, United States Navy
B.S., United States Naval Academy, 1995
Master of Science in Physical Oceanography-June 2001
Advisor: Mary L. Batteen, Department of Oceanography
Second Reader: David Dimitriou, Fleet Numerical Meteorology and Oceanography Center

The development of the Global Ocean Data Assimilation Experiment (GODAE), its relationship to the Array for Real-time Geostrophic Oceanography (ARGO) project, and Fleet Numerical Meteorology and Oceanography Center's role in GODAE are discussed in this thesis. The drifting buoys used for data collection are described and the data available is outlined. This thesis analyses GODAE data available from the North Atlantic Ocean, collected in near-real-time from September 1, 2000 through March 8, 2001, in order to evaluate the relative success of the experiment to date and to identify the scope of possibilities for utilizing this data both at present, and once GODAE and ARGO are fully operational. The GODAE project endeavors to be a single database, serving as a collection point for worldwide oceanographic data to be utilized in ocean climate prediction. GODAE does not offer a mechanism for visualization of the data available. This thesis analyzes the data presently available through graphic representation. Visualization products include: float trajectories, temperature (T) and salinity (S) profiles, T-S diagrams, mixed layer depths and observed temperature compared to temperature climatology.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Computing and Software, Environmental Quality, Sensors, Surface/Under Surface Vehicles-Ships and Watercraft, Modeling and Simulation

KEYWORDS: Global Ocean Data Assimilation Experiment, GODAE, Array for Real-Time Geostrophic Oceanography, ARGO, North Atlantic Ocean Basin, Drifting Buoys, Ocean State Prediction, Climate

SIMULATED ANNUAL AND SEASONAL ARCTIC OCEAN AND SEA-ICE VARIABILITY FROM A HIGH RESOLUTION, COUPLED ICE-OCEAN MODEL

Douglas Craig Marble-Lieutenant Commander, United States Navy
B.S., University of South Carolina, 1986
M.S., Naval Postgraduate School, 1993
Doctor of Philosophy in Physical Oceanography-September 2001
Dissertation Advisors: Wieslaw Maslowski, Department of Oceanography
Albert J. Semtner, Department of Oceanography
Committee Members: Robert H. Bourke, Professor Emeritus of Oceanography
Roland W. Garwood, Jr., Department of Oceanography
Peter S. Guest, Department of Oceanography

The role of the Arctic Ocean in global thermohaline circulation and climate change is not well understood. High resolution, physically realistic simulations of the Arctic Ocean, calibrated and validated with observations and paleo-climate data, may provide the spatial and temporal coverage and resolution to more accurately characterize Arctic Ocean circulation, large-scale inter-ocean exchanges and allow future conditions to be projected correctly.

A 1/12-degree (~9 km) resolution coupled ice-ocean model, optimized for massively parallel computers, was developed. The model employs the latest digital bathymetry and ocean climatology available. Decades of model integration using climatological and realistic daily varying atmospheric forcing were performed.

Comparisons of model output with climatic atlases and observations indicate greatly improved representation of circulation, ocean and sea-ice characteristics, mass and property transports and water mass transformations. Areas where model physics and resolution improvements are needed are highlighted as well.

Comparison with a 1/6 degree (~18 km) ice-ocean model quantifies improvements gained from doubling model resolution. A ten-fold increase in eddy kinetic energy is seen in the 9 km model versus the 18 km model. Narrow shelf and slope boundary currents, absent in the latter, now appear and mass and property transports are closer to observed values.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments

KEYWORDS: Ocean Modeling, Climate Change, Ice-Ocean Interactions, Decadal Variability

VORTEX RIPPLE MORPHOLOGY USING DUNE2D MODEL

Stephen D. Martin-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1991
Master of Science in Meteorology and Physical Oceanography-March 2001
Advisors: Edward B. Thornton, Department of Oceanography
Timothy P. Stanton, Department of Oceanography

The DUNE2D boundary layer model for small-scale morphology (Andersen, 1999) is compared with bedform morphology measured on the inner shelf in 11m water depth during the SHOWEX experiment at Duck, N.C. The model consists of inter-linked modules for flow, sediment transport and morphology. The flow module is based on solving the Reynold's averaged Navier-Stokes equations in the vertical plane with k-omega turbulence closure. The model has been extended to accept a general (but periodic) bottom boundary to be able to compare with field data. Boundary layer velocity profiles were measured using a Bistatic Coherent Doppler Velocity profiler (BCDV). A two-axis scanning sonar altimeter measured small-scale morphology over a 1 by 1.5 m area with 4 cm horizontal and 0.25 cm vertical resolutions. Bottom maps of small-scale morphology were obtained continuously every 20 minutes. A relatively simple data sequence was selected for model comparison, during which time the wave forcing evolved abruptly from Hsig=0.3m to Hsig=3.0m (bed velocity < 1 m/s), and the bed evolved from no motion (relic) to actively migrating vortex ripples. SHOWEX bedform changes under low wave plus collinear current conditions resulted in minor changes of the vortex ripple fields. Bedform migration rates of the model were similar to the field migration rates. Like the field data, the modeled data under strong forcing removed smaller scale

vortex ripples and redistributed the sediment into a larger scale ripple with a large portion of sediments in suspension above the bed. Limitations of the model owing to the 2-D assumption, periodic boundaries and monochromatic wave forcing constraints are discussed

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Modeling and Simulation

KEYWORDS: Waves, Bottom Boundary Layer, Nearshore Dynamics, Sediment Transport, Morphology

A FINE RESOLUTION MODEL OF THE COASTAL EASTERN BOUNDARY CURRENT SYSTEMS OFF IBERIA AND MOROCCO

Antonio S. Martinho-Lieutenant, Portuguese Navy
B.S., Portuguese Naval Academy, 1992
Master of Science in Physical Oceanography-March 2001
Advisor: Mary L. Batteen, Department of Oceanography
Second Reader: R.T. Williams, Department of Meteorology

To investigate the role of wind forcing, bottom topography and thermohaline gradients on classical as well as unique features in the northern Canary Current system (NCCS), four experiments are conducted with a sigma coordinate primitive equation model. The first experiment, which investigates the pressure gradient force error, shows that velocity errors inherent in three dimensional sigma coordinate models can be successfully reduced from ~1 m/s to less than 0.5 cm/s in the NCCS. The second experiment, which investigates the effect of annual wind forcing on a flat bottom, accurately portrays classical eastern boundary current features as well as unique NCCS features associated with a large embayment (i.e., the Gulf of Cadiz), poleward spreading of Mediterranean Outflow, and the generation of Meddies. Theadditional effect of bottom topography in Experiment 3 shows that topography plays important roles in intensifying and trapping the equatorward current near the coast, in weakening the subsurface poleward current and in intensifying eddies off the capes of Iberia. The use of full instead of horizontally averaged thermohaline gradients in Experiment 4 highlights the development of the Iberian Current off the Portugal west coast, a feature not seen in the previous experiments. This shows that thermohaline gradients play an important role for the formation of the Iberian Current.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Modeling and Simulation

KEYWORDS: Primitive Equation Model, Northem Canary Current System, Currents, Meanders, Eddies, Meddies, Filaments, POM, Sigma Coordinate

NEARSHORE WAVE AND CURRENT DYNAMICS

Bruce J. Morris-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1988
M.S., Naval Postgraduate School, 1997
Doctor of Philosophy in Physical Oceanography-September 2001
Dissertation Advisor: Edward B. Thornton, Department of Oceanography
Committee Members: Thomas H.C. Herbers, Department of Oceanography
Timothy P. Stanton, Department of Oceanography
Adrianus J.H.M. Reniers, National Research Council Research Associate
Kenneth L. Davidson, Department of Meteorology

Mean cross-shore wave height transformation and alongshore currents observed on near-planar and barred beaches are compared with predictions based on the nearshore numerical model Delft3D. Delft3D solves the two-dimensional, depth-averaged, momentum balance (2-DH) between forcing (by breaking waves and variations in mean surface elevation), changes in momentum flux, bottom stress and lateral mixing. The observations were acquired on the near-planar California beaches at Torrey Pines and Santa Barbara and the barred beach at Duck, N.C., and include a wide range of conditions with maximum mean currents of 1.5 m/s. The model has two free parameters, a depth dependent breaking term, ? , and the bed roughness

length, s k. An empirical formula to determine ? a priori from the deep-water wave steepness and bed slope is developed, showing good agreement in the wave height transformation. Including rollers in the wave forcing results in improved predictions of the observed alongshore current structure by shifting the predicted velocity maxima shoreward and increasing the velocity in the trough of the bar compared with model predictions without rollers. On near-planar beaches and high-energy events on barred beaches, a one-dimensional (alongshore uniform bathymetry) model performs as well as 2-DH. On barred beaches under moderate conditions when alongshore non-uniform bathymetry prevails, the 2-DH model performs better than the 1-D model, particularly in the bar-trough region. Wave forcing balances the bottom stress with a second balance between alongshore variation in the mean surface elevation (pressure gradients) and the inertia of the alongshore current.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments

KEYWORDS: Nearshore, Waves, Surf

A COASTAL AIR-OCEAN COUPLED SYSTEM FOR THE EAST ASIAN MARGINAL SEAS

Michael J. Roth-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1992
Master of Science in Meteorology and Physical Oceanography-September 2001
Advisor: Peter C. Chu, Department of Oceanography
Second Reader: Steven D. Haeger, Naval Oceanographic Office - Stennis Space Center

A coastal air-ocean coupled system (CAOCS) that includes the Princeton Ocean Model (POM) as the oceanic component and the Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Model Fifth Generation (MM5) as the atmospheric component was developed for the East Asian Marginal Seas (EAMS) - a littoral environment that is a common operating area for the United States Navy (USN). CAOCS output verified against surface wind data from the National Centers for Environmental Prediction (NCEP) and sea surface temperature (SST)/Sea Surface Salinity (SSS) data collected from buoy stations. CAOCS output clearly shows the significance of atmospheric and oceanic mesoscale features and their associated air-sea interaction processes such as coastal upwelling, Ekman transport, and enhancement of upward vertical motion during cyclogenesis. These mesoscale features and air-sea interaction processes occur during periods prior to summer monsoon onset as well as during time periods following summer monsoon onset.

The study provides support that CAOCS does perform well in forecasting EAMS surface current circulation, SST/SSS structure, surface wind stress, and low-level atmospheric structure. Some weaknesses of CAOCS were identified that will aid in future improvement of the model.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Environmental Quality, Modeling and Simulation

KEYWORDS: Coastal Air-Ocean Coupled System, CAOCS, East Asian Marginal Seas, Air-Sea Interaction

A NONLINEAR WAVE SHOALING MODEL FOR ALONGSHORE VARYING BATHYMETRY

David M. Ruth-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1991
Master of Science in Meteorology and Physical Oceanography-September 2001
Advisor: Thomas H.C. Herbers, Department of Oceanography
Second Reader: Edward B. Thornton, Department of Oceanography

This thesis proposes an improvement to present near-shore wave prediction models. Using weakly dispersive Boussinesq theory, the shoaling of directionally spread surface gravity waves over a beach with gentle gradients in the cross-shore and alongshore directions is examined. Following Herbers and Burton

(1997), the governing fluid flow equations are expanded to third order and depth-integrated over the water column. A resulting amplitude evolution equation for a spectrum of waves is derived, which is the main result of this paper. New terms in the higher order result include effects due to alongshore bottom slope, higher order cross-shore depth variations, and non-linear quartet interactions. The linear terms in this equation are verified by analytical methods using linear finite depth theory. Example computations for a monochromatic wave train over a plane beach quantify some of the improvements of this result over the lower order model. Opportunities for further development and verification of this result are proposed, and recommendations for application of the result in its present form are outlined.

DoD KEY TECHNOLOGY AREAS: Environmental Quality, Battlespace Environments

KEYWORDS: Ocean Surface Waves, Near-Shore Wave Prediction Modeling

PASSIVE SONAR GEOACOUSTIC INVERSION TECHNIQUE IN SHALLOW WATER USING THE INVERSE BETA METHOD AGAINST SHIPS OF OPPORTUNITY

Robert W. Witzleb-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1992
Master of Science in Meteorology and Physical Oceanography-September 2001
Advisors: James H. Wilson, Department of Oceanography
Robert H. Bourke, Emeritus Professor of Oceanography

Electronic Intelligence (ELINT) data and broadband acoustic data were obtained during the April 1999 Fleet Battle Experiment Echo (FBE-E) in the SOCAL OPAREA. The motion of a target of interest (TOI) was reconstructed by the correlation and subsequent fusion of these data sets. This fusion resulted in a series of passively obtained range and range rate estimates for the TOI. These values were combined with the observed acoustic normal mode interference pattern (bathtub) for the TOI in order to empirically quantify the waveguide invariant (beta). Independently, a propagation model (Kraken) was run with historical geoacoustic input parameters for the region to simulate the normal mode structure of the waveguide. Furthermore, range-dependent mode-specific quantities were extracted from the model and combined with the observed interference pattern in order to establish numerical approximations for the TOI range. Subsequently, target range results from the fused data were compared to the numerical model derived range estimates.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments

KEYWORDS: Shallow Water, Passive Sonar Geoacoustic Inversion Techniques, Fleet Battle Experiment Echo, FBE-E