MASTER OF SCIENCE
IN
PHYSICAL OCEANOGRAPHY

IONIAN SEA SURFACE TEMPERATURE: SATELLITE AND DRIFTER OBSERVATIONS, MAY TO OCTOBER 1995

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The Ionian Sea is the central basin of the Mediterranean Sea and has been the subject of various oceanographic studies since the 19th century. Substantial changes in water properties (such as temperature), both spatially and temporally (seasonal) occur as a result of extreme forcings by the local winds and by the inflow of cool and less saline Atlantic waters. In recent years, extensive measurements have been made, primarily through remote sensing techniques. In particular, satellite infrared data were used to study the surface thermal features and associated circulation.

In order to improve upon previous results, this study focuses on a period of six months (May to October 1995) in which the full resolution (1.25x1.25 km) satellite images are used to describe and study the variability of the sea surface temperature (SST) and circulation from meso- (days) to seasonal (months) scales. The satellite infrared temperatures are compared to simultaneous and collocated in-situ drifter temperature measurements. They are corrected by removing biases obtained by regression analysis. The corrected images are used to produce maps representing daily, three-day, weekly and monthly Ionian SSTs. Selected SST composites augmented with drifter track and wind field overlays disclose important quantitative features of the Ionian surface waters, such as upwelling events in the Straits of Otranto and of Sicily, and off the African Coast. The spatial structure and temporal variability of the surface fields are presented and discussed.

DoD KEY TECHNOLOGY AREA: Environmental Quality

KEYWORDS: Ionian Sea, Oceanography, Remote Sensing, Sea Surface Temperature, Lagrangian Drifters

OCEANOGRAPHIC DE-GLINTING TECHNIQUES FOR HYPERSPECTRAL ASW(U)

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The spectral reflection from the sun can mask the volume-leaving radiance of an ocean scene. This work identified the components of the sensor-receiving radiance in two hyperspectral data sets and linearly unmixed the scene into the different endmembers. High radiance in the red bands for glint and low

radiances in the blue bands for the volume component defined the initial endmembers. A spectral linear unmixing process was used to separate the endmembers. Using a shallow water hyperspectral image of clear, non-turbid water, the sun glint and bottom contributions were identified. The sun glint and volumetric components were identified for the Littoral Airborne Sensor - Hyperspectral images. The sun glint ratio in each individual pixel was then subtracted out of the original data. The result of this de-glinting process was an image of decreased variance and noise throughout the scene. The result will aid in the detection of targets in an area of strong sun glint.

DoD KEY TECHNOLOGY AREA: Command, Control, and Communications

KEYWORDS: Sun Glint, Hyperspectral, Anti-Submarine Warfare

ANALYSIS AND MODELING OF THE ACOUSTIC TOMOGRAPHY SIGNAL TRANSMISSION FROM DAVIDSON SEAMOUNT TO SUR RIDGE: THE FORWARD PROBLEM

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The repeated transmissions of a tomography signal from an autonomous sound source placed on Davidson Seamount was continuously monitored by a bottom-lying, cabled-to-shore receiver on Sur Ridge. To address the signal stability, resolvability and identifiability criteria that determine the applicability of ocean tomography along this path, the data recorded from July 1998 to January 1999 were first processed to obtain the multipath pulse arrival structure and its variability in time. The processed signals showed strong arrivals that were both stable and resolvable. In order to identify the resolved arrivals, acoustic propagation modeling was performed using ray theory in conjunction with measured sound speed and high-resolution bathymetric data. A comparison of the predicted and measured arrival structures show that the observed arrivals were clearly identifiable and were made up of eigenray groups (i.e., eigenray tubes) instead of individual eigenrays. Since the eigenrays within each group were found to have almost identical trajectories through the ocean, the common passage along which the ray group integrates the ocean variability was unambiguous. Consistent with previous CalCOFI observations, the extracted ray group travel time series exhibited dominant oscillations with semidiurnal, diurnal, 8-day, 18-day and 26-day periods, respectively. Using spectral estimation techniques, the travel time variances of these dominant oscillations were quantified. These travel time variances represent direct measurements of the variances of spatially averaged ocean temperatures. Therefore, they are useful for establishing the solution and noise variances for the construction of the inverse solution as well as constituting a powerful statistical data set for the validation of ocean models for the region.

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Tomography Signal, Mutipath Pulse Arrival, Spectral Estimation Techniques, Noise Variances

INVERSION OF SHALLOW WATER BOTTOM SEDIMENT PROPERTIES USING AN/SQS-53C REVERBERATION LEVEL DATA FROM EXERCISE LWAD 99-1

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Inversion techniques are used to infer bottom sedimentary characteristics using AN/SQS-53C Reverberation Level (RL) data gathered during Exercise LWAD 99-1. Analysis was conducted to determine the correlation between sediment type and beam RL time series statistics, including slope and detrended higher order statistics (standard deviation, skew, and kurtosis). A geographic contour plot of the spatial distribution of sediments was generated from the deviation of the RL slope of individual beamform data from the area-wide average RL slope. The resulting plot shows features similar to that of the pre-exercise sedimentary characterization map. Higher order statistics are found to be non-Gaussian which has signal processing implications.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Electronics, Sensors, Other (Undersea Warfare, Oceanography)

KEYWORDS: Acoustics, Bottom Scattering Strength, Geo-Acoustics, Reverberation, Inversion Techniques, AN/SQS-53C Active Sonar Performance, LWAD

A NUMERICAL MODELING STUDY FOR THE JAPAN/EAST SEA (JES) SEASONAL CIRCULATION AND THERMOHALINE STRUCTURE

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The seasonal sea circulation and thermohaline structure in the Japan/East Sea (JES) were studied numerically using the Princeton Ocean Model (POM) with the horizontal resolution varying from 11.54 to 18.53 km and 15 sigma levels conforming to a relatively realistic bottom topography. A twenty four month control run was performed using climatological monthly mean wind stresses and heat and salt fluxes as surface forcing and observational oceanic inflow/outflow at open boundaries. The seasonally averaged effects of isolated forcing terms are presented and analyzed from the following experiments: 1) non-linear effects removed, 2) no lateral transport at open boundary, and 3) wind effects removed. This procedure allowed analysis of spatial and temporal contributions of the isolated parameter to the general hydrology of the JES and some of its specific features. Major currents are simulated reasonably well compared to observations. The nonlinear advection does not affect the general circulation pattern evidently, but does affect the formation of the mesoscale eddies, especially the Ulleung Basin (UB) eddy (all seasons) and the Japan Basin (JB) cyclonic gyre (spring). The lateral boundary forcing enhances (weakens) the JES volume transport in the summer (winter). The wind forcing is the most important factor (80 %) for the generation of the JB cyclonic gyre. It drives the Liman Current and damps the East Korean Warm Current in the winter, and generates the UB eddy, and eddies along the Japan Coast Current (JCC) in all seasons. However, it has almost no effect on the JCC for all seasons.

DoD KEY TECHNOLOGY AREAS: Modeling and Simulation, Battlespace Environments

KEYWORDS: Japan East Sea, Numerical Simulation, Sensitivity Studies, Circulation, Thermohaline Structure