MASTER OF SCIENCE IN PHYSICAL OCEANOGRAPHY

AIR-SEA INTERACTIONS AND WATER MASS STRUCTURE OF THE EAST CHINA SEA AND YELLOW SEA

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The climatological water mass features, the seasonal variabilities of the thermohaline structure, and the linkage between fluxes (momentum, heat, and moisture) of the East China and Yellow Seas have been investigated. The long-term mean surface heat balance corresponds to a heat gain of 15 W m^{-2} in the Yellow Sea shelf (YS), a heat loss of around 30 W m^{-2} in the East China Sea shelf (ECS) and Cheju bifurcation zone (CB), and around 65 W m^{-2} in the Taiwan Warm Current region (TWC) and Kuroshio Current region (KC). The surface fresh water balance, i.e., evaporation minus precipitation, ranges from -1.8 to -4.0 cm/month for the five subareas. The four seasons for the study area are divided based on the relative heat storage, which do not follow the usual atmospheric seasons. The entire water column of the ECS, YS, and CB undergoes a seasonal thermal cycle with maximum values of temperature during summer and maximum mixed layer depths during winter. Only the surface waters of TWC and KC exhibit a seasonal thermal cycle. Two patterns exist in the surface salinity and Yangtze River run-off, out of phase in the East China Sea and in phase in the Yellow Sea.

DoD KEY TECHNOLOGY AREA: Other (Physical Oceanography)

KEYWORDS: Water Mass Features, Thermohaline Structure, Seasonal Cycle

A P-VECTOR APPROACH TO ABSOLUTE GEOSTROPHIC CURRENTS IN THE ADRIATIC SEA

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With the recent conflict in Bosnia-Herzegovina being in the world news front, the Adriatic Sea has become an important strategic operating area for the North Atlantic Treaty Organization (NATO) and for the U.S. Navy. The NATO Undersea Research Centre located in La Spezia, Italy, carried out the Otranto Gap (OGAP) project in 1994 and 1995 to assess the oceanography and bottom geology of the Southern Adriatic. As part of this project, the OGEX1 cruise was conducted between 19 and 24 May 1995 with focus in the Otranto Strait, through which the Adriatic is connected to the rest of the Mediterranean basin and on the Albanian shelf. In this thesis the water masses present in the southern Adriatic are studied and the P-vector method is used to estimate the absolute geostrophic circulation, based on the hydrographic data (CTD, XCTD, and XBT) collected during the OGEX1 cruise. The P-vector results are interpreted and compared with other oceanographic data sets acquired during the OGAP project, namely current meter and ADCP data, drifter tracks, and thermal satellite images. The absolute geostrophic velocity at 40 m, derived by the P-vector method, shows rather well the expected cyclonic circulation in the Southern Adriatic north of 41°N. In contrast, the results in the Otranto Strait area need to be

interpreted with caution. Current meter data show that this area is very ageostrophic. A comparison between geostrophic and directly measured vertical velocity shears indicates a large departure from geostrophy in this area. The wind is shown to be a main factor forcing the circulation in the Adriatic, either directly or through changes in sea level.

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Adriatic Sea, P-Vector Method, OGEX1, Current Meters, Drifters, Floats, ADCP

SPECTRAL ENERGY BALANCE OF WAVES IN THE SURF ZONE

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The spectral energy balance of waves in the surf zone is examined with extensive measurements from the Duck94 experiment. Cross-shore energy flux gradients are estimated from spectra observed with closely spaced pressure sensors. Nonlinear energy exchanges between different wave components in the spectrum are estimated from observed bispectra based on Boussinesq theory for near-resonant triad interactions. Dissipation of wave energy in the poorly understood breaking process is inferred as the residual term in the spectral energy balance.

Analysis of the spectral energy balance shows that large decreases in energy flux observed at the dominant wave frequencies as waves break over a sand bar are closely balanced by nonlinear energy transfers to higher frequencies. That is, the decay of the spectral peak within the surf zone is a result of nonlinear energy transfers rather than direct dissipation. At higher frequencies, observed energy flux gradients are small and do not balance the nonlinear transfers of energy to high frequency components of the spectrum. This analysis suggests that the spectrum is saturated at high frequencies, and thus, the energy that cascades through nonlinear interactions to higher frequencies is dissipated in the high-frequency tail of the spectrum.

DoD KEY TECHNOLOGY AREA: Other (Physical Oceanography)

KEYWORDS: Dissipation, Energy Balance, Boussinesq Equations, Ocean Surface Gravity Waves, Nonlinear Interactions, Shoaling, Beach, Energy Flux

MODEL ANALYSIS OF ENERGY SPREADING LOSS OFF THE CAROLINA COAST FOR TACTICAL ACTIVE SONARS

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Energy spreading loss (ESL) is the reduction of the transmitted pulse energy level by spreading of the pulse in time due to multipath propagation. This energy spreading will reduce the effectiveness of mid-frequency tactical sonars. The U.S. Navy training areas of Long Bay and Onslow Bay off the Carolina Coast were chosen for the study of ESL to provide contrasts in many of the geoacoustic properties that can change ESL. Inputs were varied by source depth, receiver depth, sound speed profile (SSP), bathymetry, and geoacoustic properties. The computer model FEPE_SYN calculated the ocean transfer function (OTF) for the modeled environment in the frequency domain. The time domain output pulse was calculated using the OTF, an input pulse, and an inverse discrete Fourier transform. Using the same energy as the output pulse, a compressed pulse was created with the same shape as the input pulse. ESL was determined by comparing the peak level

of the output pulse to the peak level of the compressed pulse. A mismatch loss (MML) was calculated by comparing the maximum values from the correlation of the input pulse with the output pulse and compressed pulse.

The ESL of the output pulse was dependent on several factors. Absorptive (silt/clay) sediment sea beds had average ESL values 3 dB less than that of compacted sand. The compacted sand bottom was also compared to an even more reflective sediment, a limestone sediment layer. ESL values were higher by an additional 3 dB for the limestone bottom. Minimum ESL levels were found when the source and target were at the same depth. Changing source and target depths (e.g., cross layer) could increase ESL levels up to 8 dB from the minimum ESL level. The impact of using a range-dependent SSP vice constant SSP was inconclusive in that ESL values could be larger or smaller by 3 dB compared to range-independent runs. Similar inconclusive results were obtained when actual bottom depths were employed vice a flat-bottom run. As found by Tanaka (1996), ESL was observed to rapidly increase in the first 1000 m and thereafter fluctuate around a mean value. This initial critical range is evidently site dependent but appears to be confined between 300 to 1000 m range.

DoD KEY TECHNOLOGY AREA: Battlespace Environments, Sensors

KEYWORDS: Acoustics, Energy Spreading Loss, ESL, Underwater System, FEPE, FEPE_SYN, Active Sonar, Hamilton Geoacoustic Model, Transmission Loss, Mismatch Loss, MML, Time Domain Analysis