MASTER OF SCIENCE
IN
METEOROLOGY AND PHYSICAL OCEANOGRAPHY

SHALLOW WATER BATHYMETRY AT LAKE TAHOE
FROM AVIRIS DATA

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One of the United States Navy Oceanographic community's roles is to keep an accurate worldwide database of oceanic bathymetry. In the littoral zones, much of the data is out of date or is unavailable. Stuffle et al. (1996) utilized a method addressing shallow water areas using the Hyperspectral Digital Imagery Collection Experiment (HYDICE) sensor on a small region in Lake Tahoe. As a follow-on, this work used a different sensor, the Airborne Visible/InfraRed Imaging Spectrometer (AVIRIS) sensor, and covered a much larger area on the opposite side of the lake. Principle components analysis (PCA) of the region of interest (ROI) revealed nine spectrally unique water classes. *A priori* knowledge of one bottom type in this ROI allowed insertion of a known bottom reflectance spectrum into a derived computer algorithm that, using also diffuse attenuation coefficients from HYDROLIGHT and reflectance just below the water surface derived from AVIRIS data, allowed computation of the bottom depth. Results compared within 30% of depth from a USGS bathymetric chart. This method holds much promise in clear waters, and next needs to be tested in the coastal ocean environment.

DoD KEY TECHNOLOGY AREA: Sensors

KEYWORDS: AVIRIS, Hyperspectral, Bathymetry, Lake Tahoe, Optical Properties of Water

COMPARISON OF TAMS/RT SURFACE WIND, TEMPERATURE, AND PRESSURE FIELDS
WITH SURFACE OBSERVATIONS AND MODEL ANALYSES IN THE SOCAL AREA

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The Tactical Atmospheric Modeling System/Real Time (TAMS/RT) combines the high-resolution Coupled Ocean/Atmosphere Atmosphere Mesoscale Prediction System (COAMPS) and the Tactical Environmental Data Server (TEDS).

In this study, TAMS/RT sea level pressure, 10 meter (m) winds and 2 m air temperature fields generated at the Naval Pacific Meteorology Oceanography Center (NPMOC) in San Diego are evaluated.

Outer nest (45 and 54 kms) sea level pressure 12 and 24-hour forecasts are qualitatively compared with model analyses. Then surface observations with inner nest (5 and 6 kms) model wind (u and v) and temperature forecast fields (00, 06, 12, 18, and 24-hour) are quantitatively compared.

Contrary to expectations, no error growth through the forecast cycle and relatively high error in the initial analysis for all variables was found. When examined by 0000Z and 1200Z model runs, a repetitive pattern related to the diurnal cycle which impact use by a forecaster was found. Day to day error was linked to the diurnal pattern and larger magnitude error to cold starts, background fields, and data assimilation problems. High variability among observed and model values was observed but still found various model trends that require further evaluation.

DoD KEY TECHNOLOGY AREAS: Environmental Quality, Modeling and Simulation, Other (Meteorology)

KEYWORDS: Mesoscale Modeling, Coupled Ocean-Atmosphere Mesoscale Prediction System (COAMPS), Tactical Atmospheric Modeling System/Real-Time (TAMS-RT), Data Assimilation, Model Verification, Predictability

VOID FRACTION UNDER BREAKING WAVES
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Bubble injection due to breaking waves within the surf zone is inferred by measuring void fraction using a 3 m vertical array of eight conductivity cells in conjunction with video pixel intensity. Void fraction errors associated with the conductivity measurements are examined, including vertical variations in the temperature and conductivity (measured), proximity effects near the surface, and estimates of the surface elevation using pressure sensors.

Energy loss is due to conversion of kinetic and potential energy of a wave to buoyant potential energy by the injection of air into the water column, which is then lost as the bubbles raise to the surface and escape to the atmosphere. Void fractions up to 40% were observed in intense breaking events penetrating to depths over 0.5 m confined within the crest-trough region. Production of potential energy due to buoyancy of bubbles was nearly instantaneous with the majority of energy dissipating within 0.25 s.

Pixel intensity qualitatively correlated with surface elevation and injection events. Crests in cross-shore intensity time stack plots are clearly visible and show good correlation with breaking events. However, pixel intensity values did not correlate quantitatively with surface elevation or production of buoyant potential energy.

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Bubble Injection, Void Fraction, Energy Dissipation, Video Pixel Intensity

EVALUATION STUDY OF THE TACTICAL ATMOSPHERIC MODELING SYSTEM/REAL-TIME (TAMS-RT) AT NPMOC SAN DIEGO
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The U.S. Navy is aggressively pursuing mesoscale atmospheric modeling. The Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS) has been developed by the Naval Research Lab in Monterey,

California to meet this task. A forecast system employing COAMPS, called the Tactical Atmospheric Mesoscale System- Real Time (TAMS-RT), is currently being field tested at two of the Navy's major regional weather facilities in Manama, Bahrain and San Diego, California. Mesoscale modeling is a complex process that requires detailed knowledge of mesoscale forcing and responses, as well as a capable data display system to make the best use of this new capability. While the challenge of interpretation of forecasts on the mesoscale has increased, the time available for producing forecasts has, if anything, decreased. Optimal methods of evaluation and display are needed that enable a forecaster to rapidly, yet skillfully complete this process. This thesis illustrates analysis techniques to aid in rapidly evaluating the utility of any given mesoscale forecast and proposes optimal methods for 3-D visualization and interpretation of various weather parameters. Using these techniques and methods, TAMS-RT performance is then evaluated for critical mesoscale weather phenomena as defined by NPMOC San Diego, including the mesoscale weather effects associated with frontal passages and the Catalina Eddy.

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

KEYWORDS: Mesoscale Modeling, Coupled Ocean-Atmosphere Mesoscale Prediction System (COAMPS), Tactical Atmospheric Modeling System/Real-Time (TAMS-RT), Catalina Eddies

PERFORMANCE EVALUATION OF INTEGRATED METOC MEASUREMENT SYSTEM SUPPORTING NAVAL OPERATIONS

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MORIAH is a shipboard METOC measurement system planned for installation on 72 AEGIS ships. A prototype MORIAH system (SEAWASP) was deployed for an 8 month period on two carrier groups: USS Anzio and USS Cape St. George. The SEAWASP accuracy and reliability were evaluated in the context of the MORIAH Operational Requirements Document (ORD) and AEGIS operating requirements. Measures of accuracy were RMS differences between simultaneous ship measurements when their separation was less than 10 and 5 kilometers. Measures of reliability were based on the number of mast average records possible in a period, recorded in a period, and validated in a period. For ORD accuracy, only air temperature and relative humidity met ORD Threshold requirements. For ORD reliability, Anzio's system did not meet requirements because a power surge caused failure of several ship systems including SEAWASP. Applying AEGIS accuracy requirements, only relative humidity passed. This result caused ship evaporation duct heights to agree during unstable and neutral conditions but significantly diverge in low wind / humidity and stable conditions. SEAWASP did not provide sufficient reliability for continuous propagation assessments. Validated data for both ships were less than 50%. Significant gains (25%) in reliability performance were shown using modified selection criteria.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Electronics Warfare, Sensors

KEYWORDS: AEGIS, Evaporation Duct, LKB, MORIAH, SEAWASP, USS Anzio, USS Cape St. George

MEGARIPPLE MIGRATION IN THE NEARSHORE

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Seafloor morphology in the surf zone of a sandy ocean beach was measured nearly continuously for 45 days with a 1.4 X 1.4 m coherent array of 7 sonar altimeters. Migrating megaripples, seafloor bedforms with amplitudes of O(10-50 cm) and lengths of O(1-5 m), were observed in about 2 m water depth in the trough between a sand bar and the shoreline for a wide range of wave and current conditions. Megaripple migration speed and direction are estimated from the array data using cross-correlations between seafloor elevation time series observed along the cross- and alongshore array legs. Megaripples were shown to be aligned in a direction that maximized the gross sediment transport normal to the bedform crest (Rubin and Hunter, 1987; Gallagher, *et al.* 1998). It is hypothesized that megaripple migration rate is related to the net transport in the direction of bedform alignment. The speed of megaripple migration is compared with the magnitude of the velocity field normal to the bedform crest in the direction of the mean, wave orbital, and resultant velocities.

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Megaripples, Sediment Transport, Nearshore Processes, Bedforms, Morphology

CONVECTIVE ACTIVITIES WITHIN THE STRATOCUMULUS-TOPPED BOUNDARY LAYER

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This study utilizes aircraft measurements obtained off the California coast to analyze the geometric, thermodynamic, and microphysical characteristics of convective updrafts and downdrafts in the stratocumulus-topped boundary layer (BL). The vertical structure of thermodynamic and microphysical properties is consistent. The difference in peak droplet concentration between updrafts, downdrafts, and the defined environment increases near the cloud top. We observe larger mean droplet diameters in downdrafts near the cloud top, as the number of small droplets in cloud top downdrafts appears to decrease. The horizontal variability seen in the cloud droplet spectra and microphysics properties is likely due to aerosol activation and growth in updrafts, cloud top entrainment, and penetrating cumulus. We compute the mass flux, ω^*, using a mass flux parameterization. Several measured variables produce consistent results and agree with mass flux calculations from other stratocumulus datasets.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Environmental Quality

KEYWORDS: Convective Events, Cloud Microphysics, Stratocumulus-Topped Boundary Layer, FIRE