IMPROVEMENT OF METOC ANALYSIS AND FORECAST VISUALIZATIONS

Keith Patrick Barto-Lieutenant, United States Navy
B.S., Florida State University, 1994
Master of Science in Meteorology and Physical Oceanography-September 2000
Advisor: Carlyle H. Wash, Department of Meteorology
Second Reader: Kenneth L. Davidson, Department of Meteorology

Current METOC weather visualization tools do not allow warfighters, forecasters, and researchers to analyze and co-display environmental data over realistic topographic and bathymetric backgrounds. In this thesis the Joint METOC Global Image Interface is developed and provides decisionmakers and geoscientists with an intuitive tool for interactively viewing, overlaying, and outputting the full suite of FNMOC distributed environmental data over realistic and accurate terrain, coastlines, hydrography, and locally obtained imagery. Full integration into the Joint METOC Viewer ensures minimal training time for operational use and geodata distribution is accomplished on the program distribution CD or over the web. The evolution of traditional METOC visualization, and the characteristics of the geodatabases are discussed and recommendations for further work in this area are presented. New capabilities are illustrated using real world examples drawn from diverse application areas.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Modeling and Simulation, Computing and Software

KEYWORDS: Visualization, Meteorology and Oceanography, METOC, Forecasting, Analysis

EVALUATION OF DYNAMICAL TRACK PREDICTIONS FOR TROPICAL CYCLONES IN THE ATLANTIC DURING 1997-98

David S. Brown-Lieutenant, United States Navy
B.S., Wright State University, 1993
Master of Science in Meteorology and Physical Oceanography-March 2000
Advisors: Russell L. Elsberry, Department of Meteorology
Lester E. Carr, III, Department of Meteorology

Carr and Elsberry (1999; NPS Technical Report) have described eight conceptual models that explain most cases of large (> 300 n mi at 72 h) western North Pacific tropical cyclone (TC) track errors by the Navy Operational Global Atmospheric Prediction System (NOGAPS) and the Geophysical Fluid Dynamics Lab (Navy version – GFDN) models. This study is for TCs in the Atlantic basin and includes the European Centre for Medium-range Weather Forecasting (ECMWF) and the United Kingdom Meteorological Office global models, whereas the GFDL model is eliminated. A detailed examination is made of large (> 250 n mi at 72 h) errors made by the three dynamical models for two seasons of Atlantic TC tracks (1997-98). The percentages of > 250 n mi 72-h errors for the NOGAPS, UKMO, and ECMWF models were 23%, 26%, and 19%, respectively. The same error mechanisms found to apply in other basins also affect the dynamical models in the Atlantic. The NOGAPS and UKMO models have a tendency to over-represent TCs and other circulations, which leads to a cyclonic rotation, or even merger, via the Excessive Direct Cyclone Interaction (E-DCI) process, just as was found in the western North Pacific. The primary ECMWF error source was Excessive Midlatitude CycloGenesis (MCG).

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Tropical Cyclone Track Forecasting, Tropical Cyclone Motion

ERROR ANALYSIS OF REAL-TIME REMOTELY SENSED MICROWAVE SEA-ICE MOTIONS IN THE WESTERN ARCTIC OCEAN

David M. Carsten, Lieutenant Commander, United States Navy
B.S., Oregon State University, 1990
Master of Science in Meteorology and Physical Oceanography-September 2000
Advisor: Phillip A. Durkee, Department of Meteorology
Second Reader: Jeffrey L. Haferman, Fleet Numerical Meteorology Oceanography Command

An algorithm used to composite SSM/I 85.5 GHz imagery and derive sea ice motion was adapted for operational testing at Fleet Numerical Meteorology and Oceanography Command (FNMOC). A feature tracking technique was applied to a 6-month period, with data provided by FNMOC and the Naval Research Laboratory (NRL). Ice motions are detectable using the SSM/I motion algorithm, and fields of SSM/I motion vectors are qualitatively consistent with coincident fields of in situ buoy motion vectors. Accuracy of the SSM/I motion vectors relative to buoy motion vectors increase significantly with buoy speed. No correlation between SSM/I and buoy motion vectors is observed for speeds below 3 cm/s and correlation increases significantly above 5 cm/s. The results are very sensitive to compositing techniques used to combine SSM/I passes into a single sea ice representation. FNMOC data was composited using a "drop-in-the-bucket" technique while NRL data was composited by a bi-linear interpolation technique. Significantly poorer results were found with FNMOC composited data.

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Microwave, Remote Sensing, Arctic Sea Ice, Sea Ice Motion

EL NIÑO AND LA NIÑA EFFECTS ON TROPICAL CYCLONES: THE MECHANISMS

Bruce W. Ford-Lieutenant, United States Navy
B.S., University of South Carolina, 1994
Master of Science in Meteorology and Physical Oceanography-June 2000
Advisor: Thomas Murphree, Department of Meteorology
Second Reader: Patrick A. Harr, Department of Meteorology

The effects that El Niño and La Niña events exert on western North Pacific tropical cyclones, and the physical mechanisms involved were examined using best track data from the Joint Typhoon Warning Center and NCEP reanalysis data. During El Niño and La Niña events, equatorial heating anomalies induce anomalous tropical and extratropical atmospheric wave trains which alter circulation, vertical shear, and steering flow.

The shear changes cause tropical cyclones to form farther south and east (north and west) than normal during El Niño (La Niña) events. These formation differences lead to longer (shorter) tracks and stronger (weaker) tropical cyclones during El Niño (La Niña) events. Late in the tropical cyclone season, the anomalous extratropical waves alter the subtropical ridge and steering flow to favor recurving (straight running) tropical cyclones during El Niño (La Niña). These track differences lead to a much higher number of landfalling tropical cyclones in southeast Asia during La Niña events.

A preliminary study of the North Atlantic shows that there are more, and stronger, tropical cyclones during La Niña than El Niño. This is the result of extratropical Rossby wave trains that originate in the east Asia and extend into the North Atlantic. There they alter the vertical shear, so that La Niña favor more formations in the tropical Atlantic, where other conditions are favorable for the development of strong tropical cyclones.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Environmental Quality, Sensors, Modeling and Simulation, Other (Meteorology, Oceanography)

KEYWORDS: El Niño, La Niña, Tropical Cyclones, Hurricanes, Typhoons, Climate, Pacific, Atlantic

TURBULENCE PROFILES AND OUTER LENGTH SCALE DETERMINATION IN THE ATMOSPHERE USING BALLOONS

Aaron M. Holdaway-Lieutenant, United States Navy
B.S., Harvey Mudd College, 1992
Master of Science in Physics-March 2000
Advisors: Donald L. Walters, Department of Physics
Douglas K. Miller, Department of Meteorology

Turbulence in the atmosphere drives the formation of temperature inhomogeneities that scatter and diffract propagating electromagnetic waves, adversely affecting laser weapons and high-resolution optical systems. Military operations require reliable turbulence profiles for the development and validation of turbulence prediction models.

This research investigated the false turbulence contribution caused by well-known temperature steps in the vertical profile of the atmosphere, especially in the stratosphere. The homogeneity and isotropy requirements of structure functions were used to develop a technique to remove the false contribution to the temperature structure constant, C_T^2.

Both 1.54 cm and 5.82 m vertical resolution profiles with 0.001 to 0.01 K temperature resolution were collected from a balloon flight. Steps of 0.1 to 1 K in the vertical temperature profile produce abrupt changes in the mean temperature that obscure the measurement of the actual turbulent fluctuations. Removing these anomalies exposed the underlying C_T^2 distribution. Application of the new technique for several sampling intervals revealed a Kolmogorov inertial subrange extending from ~25 cm to ~10 m. The potential of this technique to compute the isoplanatic angle, θ_0 , coherence length, r_0 , and Greenwood frequency, f_g , reliably by using inexpensive balloons should benefit airborne and space-based laser programs.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Directed Energy Weapons, Modeling and Simulation

KEYWORDS: Adaptive, Atmosphere, Laser, Optics, Propagation, Turbulence

A STUDY ON THE TIMING OF THE SOUTHWEST MONSOON ONSET IN THE SOUTH CHINA SEA

Eric F.C. Gedult von Jungenfeld-Lieutenant Commander, United States Navy
B.A., Salem State College, 1971
Master of Science in Meteorology and Physical Oceanography-June 2000
Advisor: Chih-Pei Chang, Department of Meteorology
Second Reader: Lester E. Carr, III, Department of Meteorology

The boreal summer in the South China Sea is preceded by a spring to summer transition period that coincides with the end of the dry season and start of the rainy season throughout Southeast Asia. The rainy season is identified with the arrival of the Southwest Monsoon. The monsoon onset in the northern portion of the South China Sea normally occurs during May of each year but can range from early May to early June. This work studied the differences of the large scale flow for different timing categories of onset, and if differences could be noted during onset with the presence of tropical cyclones. NCEP/NCAR reanalyses data and NOAA AVHRR GPI data from OLR fields were used for May and June for the years 1979 – 1999. Timing of onset appears to be determined by the arrival of the Mei-Yu front. When tropical cyclones are present, a vortex tends to occur in the Bay of Bengal.

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Monsoon Onset, Southwest Monsoon

LARGE EDDY SIMULATION OF INTERACTIONS BETWEEN FREE CONVECTION, WIND DRIVEN CURRENTS, AND BAROCLINICITY IN THE LABRADOR SEA DEEP MIXED LAYERS

Denise M. Kruse-Lieutenant, United States Navy
B.S., George Washington University, 1989
Master of Science in Meteorology and Physical Oceanography-June 2000
Advisors: Peter S. Guest, Department of Meteorology
Ramsey Harcourt, Department of Oceanography

Understanding the dynamics of deep convection leading to the formation of deep water is important not only for studying the small-scale generation regions, but also for studying the global-scale thermohaline circulation. Large Eddy Simulation (LES) is used to model deep convection with an imposed mean horizontal density gradient of two different strengths and wind forcing from various directions, with strong surface cooling representative of the Labrador Sea. Results from these different cases are compared and analyzed to understand the effects of horizontal density gradients and wind direction on turbulence statistics for deep convection. Both the strength of horizontal density gradients and wind direction relative to the gradient affect mixed layer scalar variances, turbulent vertical fluxes, Vertical Turbulent Kinetic Energy (VTKE), and stability during deep convection.

Wind direction dominates over gradient strength in determining vertical flux magnitude with larger variation in strong gradient cases. Levels of VTKE are more dependent on gradient strength, with weaker gradients producing higher values of VTKE than stronger gradients regardless of wind direction. Wind direction does alter VTKE levels in the same manner as it alters vertical flux levels. The presence of a horizontal gradient is a stabilizing factor in areas of strong surface cooling.

DoD KEY TECHNOLOGY AREA: Other (Meteorology and Oceanography)

KEYWORDS: Large Eddy Simulation, Deep Convection, Labrador Sea, Baroclinicity

UNDERSTANDING MESOSCALE ERROR GROWTH AND PREDICTABILITY

Michael A. Kuypers-Lieutenant, United States Navy
B.S., United States Naval Academy, 1991
Master of Science in Meteorology and Physical Oceanography-June 2000
Advisor: Wendell A. Nuss, Department of Meteorology
Second Reader: Douglas K. Miller, Department of Meteorology

Technological advances have made atmospheric mesoscale modeling at very fine resolutions readily available to a great number of organizations. Though initial operational results show some skill with respect to synoptic scale forecasts, many of the problems associated with mesoscale error growth and predictability have been ignored. Understanding mesoscale error is critical to accurately interpreting mesoscale model results and output from tactical decision aids (TDAs).

This study examines mesoscale error growth and predictability through controlled numerical model experiments. A known "true" atmosphere is created through the use of the US Navy's Coupled Oceanographic/Atmospheric Mesoscale Prediction System (COAMPS). Virtual observations are randomly sampled from this atmosphere to provide data for ingest into forecasts using the NCAR/Penn State MM5 mesoscale model. Forecast results for ten cases are compared against the "true" atmospheric solution and error statistics are calculated for wind speed and geopotential height fields. Results show how error growth and predictability are affected by different variables such as boundary conditions, weather regime, sample size and sample distribution. A scale separation of error is also performed in order to assess the impact of synoptic scale error on mesoscale error.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Modeling and Simulation

KEYWORDS: Mesoscale Modeling, Coupled Ocean-Atmosphere Mesoscale Prediction System (COAMPS), Error Growth, Predictability

ESTIMATION OF STRATOCUMULUS-TOPPED BOUNDARY LAYER DEPTH USING SEA SURFACE AND REMOTELY SENSED CLOUD-TOP TEMPERATURES

Marvin B. McBride, III-Lieutenant, United States Navy
B.S., Stephen F. Austin State University, 1993
Master of Science in Meteorology and Physical Oceanography
Advisors: Philip A. Durkee, Department of Meteorology
Carlyle H. Wash, Department of Meteorology

The depth of the marine atmospheric boundary layer (MABL) is an important parameter for both scientific and operational meteorological applications. The depth of the marine boundary layer has a significant influence on the atmospheric dynamics in the coastal zone. Knowledge of the depth of stratocumulus-topped boundary layers (STBLs) will enable coastal operations to more accurately anticipate weather, and electromagnetic propagation conditions. This study develops a satellite remote sensing technique for determining the height of MABLs topped with stratocumulus clouds.

Validation of the technique using coastal rawinsonde dataset from the Monterey Area Ship Track (MAST) experiment revealed that an assumption of 41% cloud with a moist lapse rate equal to –7.0°C/km had the best overall fit to the data. However, for shallow boundary layers with depths below 400m the most accurate assumption was 75% cloud with a moist lapse rate equal to –6.5°C/km. The application of this technique to sounding data returned an overall BL depth accuracy of 50m while the satellite application returned an overall accuracy of 65m. A sensitivity analysis of both surface and cloud-top temperature revealed that a 1/2°C change in either temperature resulted in an error of 60-70m in boundary layer depth.

DoD KEY TECHNOLOGY AREA: Other (Meteorology, Oceanography)

KEYWORDS: Boundary Layer Depth, Remote Sensing, Stratocumulus, AVHRR

OPTIMIZATION OF MAS AND MODIS POLAR OCEAN CLOUD MASK

Sean P. Memmen-Lieutenant, United States Navy
B.S., State University of New York, Maritime College, 1992
Master of Science in Meteorology and Oceanography-June 2000
Advisor: Philip A. Durkee, Department of Meteorology
Second Reader: Peter S. Guest, Department of Meteorology

With the reduction of funding for sea ice reconnaissance flights, the National/Naval Ice Center needs to capitalize on the improvements in satellite technology. Imaging sensors such as AVHRR, DMSP/OLS, SSM/I and RADARSAT are used to detect the presence of sea ice, but with the exception of SSM/I and RADARSAT, clouds are a major obstacle to viewing the surface. With NASA's development of the Moderate-resolution Imaging Spectroradiometer (MODIS) and MODIS Airborne Simulator (MAS), there is finally a sensor capable of using multi-spectral techniques to detect the presence of clouds.

A group at the Space Science and Engineering Center (SSEC), University of Wisconsin – Madison lead by Dr. Steve Ackerman has developed a cloud mask for MAS/MODIS. The technique determines a level of confidence that a given pixel is clear based on a series of multi-spectral tests. By combining the confidence level from all tests, it is possible to detect the presence of clouds at different altitudes in the atmosphere. Threshold optimizations are described in this thesis for the $T_B(11\mu m)$ and $T_B(3.9\mu m)$ - $T_B(11\mu m)$ tests from Ackerman et al. (1997). In addition, the $T_B(11\mu m)$ - $T_B(12\mu m)$ test is removed. These modifications are based on daytime analysis of several MAS cases and a limited number of MODIS cases.

Subjective analysis shows the modifications greatly improve the detection of clouds over cold polar oceans where sub-pixel ice may be present or water temperatures might falsely indicate clouds. The number of *Cloudy* pixels (⦸0.66 clear confidence level) for a given scene was increased 12.1% on average for MAS cases. The NPS cloud mask also classified two times more *Probably Clear* and *Undecided* pixels than the original mask due to greater sensitivity to thin, small clouds.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Sensors, Other (Remote Sensing)

KEYWORDS: Moderate Resolution Imaging Spectroradiometer (MODIS), MODIS Airborne Simulator, Terra Satellite, Cloud Mask, Sea Ice

FORECASTING MESOSCALE WINDS ON COMPLEX TERRAIN USING A SIMPLE DIAGNOSTIC MODEL

Renwick M. Mohammed-Lieutenant, United States Navy
B.S., University of South Carolina, 1994
Master of Science in Meteorology and Physical Oceanography-September 2000
Advisor: Douglas K. Miller, Department of Meteorology
Second Reader: R.T. Williams, Department of Meteorology

The use of mesoscale models to provide an accurate representation of what the atmosphere is likely to do in the near future is one of the tools forecasters utilize to predict atmospheric variables. Because of the large amount of time and computer resources necessary to provide detailed forecasts on the mesoscale, this study looked at forecasting winds utilizing a simple diagnostic model and compared its results to a full physics model. Winds from the Fifth Generation Mesoscale Model (MM5), were run at fairly coarse grid spacings of 81, 27, and 9 kilometers and at a finer grid spacing of three kilometers. The MM5 9 kilometer results were input into the Winds On Critical Streamline Surfaces (WOCSS) model, which is a scaled down physics model designed to adjust winds to fine scale topography. A comparison of how the WOCSS model winds compared against each of the MM5 grid spacings was evaluated for an event during the period 4-7 August 1997 in the SOCAL bight region to determine if the results of the scaled down physics model were comparable to the full physics model. This experiment showed encouraging results for forecasting fine scale winds on complex topography using the simple diagnostic model.

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

KEYWORDS: Mesoscale Modeling, Wind Forecasting, Wind Simulation

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

Oscar E. Monterrosa-Lieutenant Commander, United States Navy
B.S., University of California, 1982
M.S., University of Puerto Rico, 1986
Master of Science in Meteorology and Physical Oceanography-December 1999
Advisor: Wendell A. Nuss, Department of Meteorology
Second Reader: Douglas K. Miller, Department of Meteorology

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

AUTOMATED METEOROLOGICAL AND OCEANOGRAPHIC DATA COLLECTION AND DISTRIBUTION IN SUPPORT OF C4I, WEAPONS, AND REMOTE SENSING SYSTEMS

William Hughes Nisley, II-Lieutenant Commander, United States Navy
B.S., Central Michigan University, 1994
Master of Science in Meteorology and Physical Oceanography-September 2000
Advisors: Kenneth L. Davidson, Department of Meteorology
Andreas K. Goroch, Naval Research Laboratory

On-scene characterization of the battlespace environment is critical toward providing the warfighter with an effective understanding of the environment and its impact on weapon systems and sensors and requires the rapid acquisition and dissemination of on-scene meteorological and oceanographic (METOC) measurements. The current practice of manually observing and recording METOC data is labor intensive, outdated, and no longer capable of satisfying the requirements for higher temporal and spatial observations.

This study reviews the current methodology to characterize the battlespace environment, summarizes relevant Navy needs, and describes the results of integrating a prototype small combatant integrated METOC system (SCIMS) developed by the Naval Postgraduate School, with a prototype data processing and distribution system (Weather Viewer) developed by SPAWARSYSCEN San Diego.

At-sea demonstration included the acquisition, encoding, transmission and retrieval of real-time observations to/from shore based METOC data servers at Fleet Numerical Meteorology and Oceanography Center via commercial telephone access to the Internet. The demonstration further served as the basis for development of a PC based prototype Shipboard METOC Archive and ReporTs system called SMART Log.

The study concludes with particular recommendations for updating and improving the system of environmental data collection, processing, utilization, and archival.

DOD KEY TECHNOLOGY AREAS: Air Vehicles, Battlespace Environments, Command, Control and Communications, Computing and Software, Electronic Warfare, Environmental Quality, Sensors, Surface/Under Surface Vehicles - Ships and Watercraft, Modeling and Simulation

KEYWORDS: Internet, Metcast, Meteorology, METOC, Moriah, Oceanography, SCIMS, Seawasp

EVALUATION STUDY OF THE TACTICAL ATMOSPHERIC MODELING SYSTEM/REAL-TIME (TAMS-RT) AT NPMOC SAN DIEGO

Arthur J. Reiss-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1990
Master of Science in Meteorology and Physical Oceanography-December 1999
Advisor: Carlyle H. Wash, Department of Meteorology
Second Reader: Wendell A. Nuss, Department of Meteorology

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

Dean A. Sadanaga-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1987
Master of Science in Meteorology and Physical Oceanography-December 1999
Advisors: Kenneth L. Davidson, Department of Meteorology
Andreas K. Goroch, Naval Research Laboratory

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

AMBIENT NOISE CHARACTERISTICS DURING THE SHEBA EXPERIMENT

Ronald R. Shaw, Jr.-Lieutenant, United States Navy
B.S., United States Naval Academy, 1992
Master of Science in Meteorology and Physical Oceanography-March 2000
Advisor: Robert H. Bourke, Department of Oceanography
Second Readers: Peter S. Guest, Department of Meteorology
James H. Wilson, Department of Oceanography

The ambient noise data recorded by two free-drifting buoys during the 1997-98 SHEBA experiment presented a unique opportunity to gauge the noise field of the Arctic Ocean in a unique and changing environment. The two buoys drifted in unison for 12 months, providing an hourly ambient noise data set between 50 and 1000 Hz. The drift pattern was divided into five legs in response to the season or major changes in the direction of ice flow. The two buoys exhibited similar median spectra for all frequencies.

When examined on a seasonal basis, summer low frequency (< 200 Hz) noise levels were much closer to winter noise levels than past studies. This was mainly due to the low number of storms during the winter of 1997-98, which resulted in lower winter median noise levels. When compared with previous ambient noise studies in the Beaufort Sea, the SHEBA noise data were consistent with the concept that noise levels decrease (especially in summer) during the years when cyclonic atmospheric circulation dominates the west Arctic. Cross correlation analysis indicated a strong association of wind speed and wind stress to ambient noise. Locally measured wind stress (as opposed to that computed using the geostrophic wind) did not substantially improve the correlation with ambient noise. Two tools to conceptualize the Arctic noise field were employed during the SHEBA experiment: the use of RADARSAT with RGPS and the PIPS computation of energy dissipation rate. By comparing the output from these two systems with the ambient noise record, their effectiveness and usefulness as input to an Arctic ambient noise model could be determined. Several notable events in the winter and summer noise record were examined utilizing RGPS and PIPS. The event analysis confirmed the fact that distant noise sources can have an effect on a local noise field. RGPS and PIPS were not useful in the summer due to the open nature of the icepack.

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Ambient Noise, SHEBA Experiment

A COMPOSITE STUDY OF THE MADDEN-JULIAN OSCILLATION (MJO) AND NORTHEASTERLY COLD-SURGES DURING THE NORTHERN WINTER MONSOON

John W. Simms, IV-Lieutenant, United States Navy
B.S., University of South Carolina, 1994
Master of Science in Meteorology and Physical Oceanography-March 2000
Advisors: Chih-Pei Chang, Department of Meteorology
Patrick Harr, Department of Meteorology

During the northern winter monsoon, the Madden-Julian Oscillation (MJO) and northeasterly cold-surges are active over the eastern Indian Ocean and western Pacific. The MJO consists of an active (wet) phase and inactive (dry) phase and varies over global spatial and intraseasonal time scales. Interactions between the MJO and northeasterly cold-surges, which vary over regional space and synoptic time scales, are examined. The interactions are examined between 1979-1998 using winds at 1000 hPa and a representation of convection during the northern winter monsoon. To identify interactions, the active and inactive phases of the MJO are divided into early or late phases (based on MJO duration). Examination of composite maps based on cold-surges defined to occur during each phase of the MJO revealed that the phase of the MJO acts to either enhance or weaken a cold-surge that may have been forced by the mid-latitudes. When MJO convection is located over the South China Sea, the surge intensifies. The favorable convection pattern dominates the unfavorable pressure-wind pattern of the MJO. When the MJO dry-phase is over the South China Sea, mid-latitude forcing appears to interact favorably with the pressure-wind pattern of the MJO to dominate the unfavorable MJO convection pattern.

DoD KEY TECHNOLOGY AREA: Other (Monsoon Meteorology)

KEYWORDS: Northern Winter Monsoon, Madden-Julian Oscillation, Northeasterly Cold-Surges

SUPPRESSION OF MARINE STRATOCUMULUS CLOUDS DUE TO REDUCED CLOUD CONDENSATION NUCLEI

Neil Tyler Smith-Lieutenant, United States Navy
B.S., Texas A&M University, 1994
Master of Science in Meteorology and Physical Oceanography-September 2000
Advisor: Philip A. Durkee, Department of Meteorology
Second Reader: Qing Wang, Department of Meteorology

Cloud researchers have documented a variety of processes at work in the formation and dissipation of clouds in the marine boundary layer (MBL). Cloud rifts occasionally mark a distinct exception to the continuity and broad coverage more commonly observed with these clouds. A possible explanation for the presence of large features of broken cloudiness embedded in stratocumulus is the removal of CCN by nucleation scavenging and drizzle.

A cloud rift feature embedded in marine stratocumulus was observed in satellite imagery on July 16, 1999. A CIRPAS Twin Otter aircraft flew repeated crossings of the rift boundary while completing a comprehensive survey of the area. A comparison of microphysics and thermodynamics on opposite sides of the rift boundary indicate that these rifts form where low aerosol concentrations enhance drizzle production. Marine boundary layer aerosol concentrations in the rift were only 1/6 that observed below the background stratocumulus. Cloud droplets in rift clouds were 3-5 microns larger than droplets in stratocumulus and exhibited a broader size distribution. Drizzle observations were strongly correlated with the rift and calculations support a drizzle hypothesis for rift formation and maintenance. Aerosol losses can be accounted for in drizzle droplets and the disruption of the cloud layer evolves in a manner described by Ackerman (1993).

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Marine Clouds, Precipitation, Aerosol, Marine Atmospheric Boundary Layer, Environmental Effects

CONVECTIVE ACTIVITIES WITHIN THE STRATOCUMULUS-TOPPED BOUNDARY LAYER

Michelle K. Whisenhant-Lieutenant, United States Navy
B.S., Florida Institute of Technology, 1990
Master of Science in Meteorology and Physical Oceanography-December 1999
Advisor: Qing Wang, Department of Meteorology
Second Reader: Peter S. Guest, Department of Meteorology

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