

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

(U) COST (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
N/A Oceanographic and Atmospheric Technology									
	69,411	72,681	60,320	63,764	61,674	61,178	60,134	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE) provides the fundamental programmatic instrument by which basic research on the natural environment is transformed into technology developments that provide new or enhanced warfare capabilities. This PE also provides technologies that form the natural-environment technical base on which all systems development and advanced technology depend. This PE contains the National Oceanographic Partnership Program (NOPP)(Title II, subtitle E, of Public Law 104-201) enacted into law for FY 1997. A major component of the program supports Organic Mine Countermeasures.

(U) Due to the sheer volume of efforts included in this PE, the programs described in the Accomplishments and Plans sections are representative selections of the work included in this PE.

(U) This PE provides for ocean and atmospheric technology developments that contribute to meeting top joint warfare capabilities established by the Joint Chiefs of Staff. Major efforts of this PE are devoted to (1) gaining real-time knowledge of the battlefield's natural environment, (2) determining the natural-environment needs of regional warfare, (3) providing the on-scene commander the capability to exploit the environment to tactical advantage, and (4) developing atmospheric research related to detection of sea-skimming missiles and strike warfare.

(U) This PE provides natural-environment applied research for all fleet operations and for current or emerging systems. This PE supports virtually all the Joint Mission Areas/Support Areas with primary emphasis on Joint Littoral Warfare and Joint Strike Warfare. Specifically:

(U) Joint Littoral Warfare efforts address issues in undersea, surface, and air battlespace. Programs include ocean and atmospheric prediction for real-time description of the operational environment, shallow water (SW) acoustics and multiple-influence sensors for undersea surveillance and weapon systems, and influences of the natural environment on mine countermeasure (MCM) systems.

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(U) Joint Strike Warfare efforts address issues in air battlespace dominance. Programs include influences of the natural environment on electromagnetic (EM)/electro-optic (EO) systems used in the targeting and detection of missile weapon systems as well as improvements in tactical information management about the natural environment.

(U) These efforts support the Joint Warfare Strategy "Forward From the Sea." This program fully supports the Director of Defense Research and Engineering's Science and Technology Strategy and is coordinated with other DoD Components through the Defense Science and Technology Reliance process. Work in this PE is related to and fully coordinated with efforts in accordance with the ongoing Reliance joint planning process. There is close coordination with the US Air Force and US Army under the Reliance program in the Battlespace Environment categories of Lower Atmosphere, Ocean Environments, Space & Upper Atmosphere, and Terrestrial Environments.

(U) The Navy program includes projects that focus on, or have attributes that enhance, the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) NATURAL-ENVIRONMENT ISSUES IN UNDERSEA SURVEILLANCE AND WEAPONS:
 - (U) Demonstrated techniques for adapting to the natural environment for in-situ, near-real-time reverberation assessment and clutter control, optimizing sonar operation in complex, shallow water natural environments so as to further advance active techniques for detection of the quiet submarine threat.
 - (U) Analyzed FY 98 test data to address potential exploitation of internal waves in shallow water under surface-duct conditions for mid-water surveillance by hull-mounted sonar.
 - (U) Developed predictive capability for optimum placement and fusion of acoustic/nonacoustic sensors in strongly range-dependent natural environments such as straits and gulfs.
 - (U) Completed validation of high frequency underwater acoustic noise models and conduct experimental evaluations of the false-alarm/classification-error performance of newly developed noise exploitation algorithms.

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- (U) Demonstrated performance improvements of natural-environment enhanced signal processing algorithms using geo-acoustical inversion techniques.
- (U) Performed detailed analyses of high-frequency acoustic data obtained in several shallow water locales with the purpose of creating an adaptive basis for undersea weapon performance prediction in shallow water.
- (U) Continued participation with PE 0603792N in development of underwater acoustic communications to establish communications capability between submarine/submarine and other platforms.
- (U) NATURAL-ENVIRONMENT INFLUENCES ON MCM SYSTEMS, INCLUDING LITTORAL OCEANOGRAPHY:
 - (U) Continued development of autonomous ocean vehicle technology (and related natural-environment sensor technology) with selective field work aimed at demonstrating increasing levels of capability in this technology area which offers great promise for virtually all naval missions in the littoral zone.
 - (U) Continued development of the Naval Surface Warfare Center Test Facility in conjunction with allied universities and government agencies to provide for monitoring and measurement of the ocean environment to contribute to marine vehicle research, especially in the context of mine countermeasures.
 - (U) Continued efforts in hyperspectral remote sensing technology to build a capability for detailed resolution of littoral ocean characteristics; this work, in collaboration with developments in PE 0602232N and PE 0603794N, supports the Naval Earth Map Observer (NEMO) satellite planned for launch in FY 00 with products aimed for the Warfighter Support Center at Naval Oceanographic Office (NAVOCEANO) and the Marine Corps Intelligence Agency.
 - (U) Provided an initial spatial variability model (low-grazing angle bottom reverberation backscattering, bottom penetration/sediment scattering) and data bases to Naval Surface Warfare Center (NSWC), Coastal Systems Station (NSWC-CSS) for MCM system development.
 - (U) Processed Sea-Viewing-Wide-Field-of-View Sensor data and other satellite data in near real time using new algorithms to extract coastal optical absorption and scattering. Utilized these new algorithms to create a regional data base for forward strategic area.
 - (U) Initiated efforts on ocean color algorithms and ocean process models to develop the capability for inferring aspects of ocean vertical structure from remotely-sensed ocean color, especially in the littoral ocean where this technology will impact use of optical devices in MCM and aid in the resolution of complex ocean processes that affect other warfare missions.
 - (U) Transitioned algorithms for extracting real-time seafloor data from toroidal volume sonar system (TVSS) and side look sonar (SLS) sonars to NSWC-CSS.
 - (U) Conducted final test for algorithms for extracting real-time sound speed and surface reverberation data from TVSS sonar.

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- (U) Initiated development of algorithms to extract real-time data on the natural environment in denied areas using Synthetic Aperture Sonar (SAS) and Laser Line Scanner System.
 - (U) Integrated micro-scale modeling of fluid/gas flow into data base predictive model incorporating oceanographic forcing functions for use by the explosive mine neutralization community.
 - (U) Initiated effort to extend geoacoustic data base algorithms to geotechnical data base algorithms.
 - (U) Conducted a field study of mine migration and burial behavior in low energy/muddy beach natural environments.
 - (U) Evaluated the Predictive Visibility Model in terms of performance in various natural environments and determine the feasibility of improvements to the model to provide the natural-environment basis for optical MCM systems.
 - (U) Conducted final and comprehensive experiment on influence of bubbles in shallow water on sonar performance, especially in terms of MCM systems.
 - (U) Began applying and validating final models of bubble distributions and high-frequency acoustic propagation in a shallow-water bubbly medium.
 - (U) Planned and conducted a full-band spatial/temporal coherence measurement in a very-shallow water site and utilized these data to test predictions/hypotheses regarding the oceanographic factors which affect the phase stability of the waterborne paths involved in real aperture and SAS systems for MCM; analyzed data from the high-clutter natural environment to provide an upper bound for the statistical characterization of bottom clutter which will be utilized in the clutter model.
 - (U) Biosensor technology for MCM was developed, especially in terms of a bioluminescence sensor for the Navy Special Warfare forces to provide vulnerability assessment to detection through "bioluminescence trails."
- (U) OCEAN AND ATMOSPHERIC PREDICTION:
 - (U) Continued testing other high-order advection schemes. Compared with older schemes and test in the California Current region.
 - (U) Investigated the effect of higher-order schemes on passive tracer dispersion.
 - (U) Delivered Very High Resolution (VHR) Coastal Model with improved advection.
 - (U) Delivered Global Layered Model with improved advection and subduction/ventilation capability.
 - (U) Initiated eddy-resolving global ocean model development including data assimilation.
 - (U) Developed and transition to 6.4 a shipboard tactical ocean nowcast/forecast model that allows for VHR (to 100 m).
 - (U) Transitioned Asian Seas Shallow Water Assimilation/Forecast System (SWAFS) including data assimilation to 6.4. Developed relocatable baroclinic tide model.

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- (U) Continued efforts in critical evaluation of new predictive schemes as a means of achieving more effective models.
- (U) Demonstrated the over-water clear-air weather detection capability of the operational system SPY-1 on-board the USS O'Kane.
- (U) Demonstrated and Deployed a nonhydrostatic tactical scale prediction system in Bahrain for use in forecasting weather effects for operational planning; system transitioned to operations and scheduled for full deployment in FY 00/01.
- (U) ATMOSPHERIC INFLUENCES ON EM/EO SYSTEMS:
 - (U) Demonstrated a global aerosol transport prediction capability through prediction of the transport of an Asian dust event across the Pacific Ocean.
 - (U) Completed a series of surf/coastal aerosol characterization experiments to enable development of a surf aerosol model for EO propagation prediction.
 - (U) Interfaced the coastal aerosol model with the EO Tactical Decision Aid and with the coastal aerosol data assimilation system to provide a more complete basis for EO systems, especially those used in detection of sea-skimmer missiles.
 - (U) Transitioned improved EM propagation effects decision aids incorporating terrain, surface clutter, airborne platforms, etc, thus expanding the capability to assess effects of the natural environment on radar systems.
 - (U) Transitioned to Naval Sea Systems Command and Space and Naval Warfare Systems Command a small Global Positioning System receiver based system for measuring atmospheric refractivity structure.
 - (U) Continued efforts in characterizing PM-10 in the atmosphere of southern California, especially as it relates to operations and testing at naval bases in the area.
- (U) National Oceanographic Partnership Program:
 - (U) Used a Broad Agency Announcement to solicit new ideas and efforts in Data Assimilation and Modeling as well as in Ocean Observation Capabilities: in Data Assimilation and Modeling, recent workshops indicated the need for a new structural paradigm under which a community-wide effort would build a linked system of resources and collaborations leading to new scientific insight and synthesis of new results with broad utility for the ocean community; in Ocean Observation the focus is on establishing the means for continuous, high resolution of oceanic processes.
 - (U) Continued evolution of efforts in "virtual" ocean data and remote sensing centers/facilities to capitalize on existing centers by developing broad community access/exchange of Navy, National Oceanic and Atmospheric, and other data bases together with data display and assimilation techniques.

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- (U) Continued evolution of efforts aimed at a National Littoral "Laboratory" with the long-term aim of portable coastal ocean/atmosphere forecasting capabilities.
- (U) Continued partnership efforts in oceanography to optimize resources, intellectual talent, and facilities in ocean sciences focused upon ocean observing technologies.
- (U) Continued with selected aspects of efforts that develop and/or demonstrate Coastal and Open Ocean Observational Techniques; Observational Systems; Sensors and Sensing; and Modeling/Data Assimilation.
- (U) Utilized Secretary of the Navy/Chief of Naval Operations (SECNAV/CNO) Oceanographic Research chairs to further promote the collaboration of distinguished university scientists with Navy/Marine Corps activities; a primary aim is to achieve a synthesis of results and understanding in key oceanographic areas important to Navy/Marine Corps operations.

2. (U) FY 2000 PLAN

- (U) NATURAL-ENVIRONMENT ISSUES IN UNDERSEA SURVEILLANCE AND WEAPONS:
 - (U) Earlier work on low frequency active acoustics successfully demonstrated capabilities to discriminate against clutter from environmental features in a deep ocean setting (algorithms have transitioned and been implemented in the Low Frequency Active Fleet System); further development will continue in active acoustics to provide capabilities for detection of the "quiet" submarine with special emphasis on shallow water regions; acoustic field measurements, modeling, and data analysis will be employed as well as joint efforts with fleet activities, The Technical Cooperation Program, and the North Atlantic Treaty Organization Supreme Allied Commander Atlantic (NATO SACLANT) Centre; validation and refinement of mid-frequency bistatic bottom, surface, and volume scattering models will be a main focus.
 - (U) Continue developments in shallow water acoustics to advance capabilities to exploit the natural environment for optimal submarine detection, especially in the littoral zone where oceanographic conditions can be highly variable both spatially and temporally; advances will come from theoretical modeling to describe sound interaction with the ocean surface, the ocean bottom, and with variable ocean processes (ocean fronts and internal waves); further quantification will be found for the result that acoustic propagation in shallow water regions can be greatly influenced by the presence of internal solitary waves.
 - (U) Continue developments in undersea noise characterization to enable acoustic detection/processor systems (distributed systems; focused and adaptive beamforming; matched-field processing) to reject false alarms; coupled hydrodynamic-acoustic noise source models from propeller cavitation and surf-generated breaking wave noise will be the focus of effort; noise properties are of major importance to efforts in PE 0602314N.

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- (U) Continue developments in natural-environment enhanced signal processing, including methods for estimating characteristics of the natural environment from acoustic measurements; develop techniques that exploit key qualitative features of acoustic signals and thus offer near real-time localization.
- (U) Use a science/technology team to ensure application of the latest developments in oceanography and acoustics in the planning and assessment of fleet Ship Anti Surface Warfare Readiness Effectiveness and Measuring Program (SHAREM) exercises; apply computer simulation/warfare effectiveness tools to SHAREM; aim is to reveal how oceanographic/acoustic properties affect system performance and help focus future basic/appld research.
- (U) Continue development of high-frequency acoustics, including underwater acoustics communications, based on assessment of the area as of FY 99.
- (U) NATURAL-ENVIRONMENT INFLUENCES ON MCM SYSTEMS, INCLUDING LITTORAL OCEANOGRAPHY:
 - (U) Continue development of the technologies that will contribute toward the long-term goals of determining influences of the natural environment on MCM systems and tactics and enabling real-time characteristics of the natural environment to be known to the on-scene commander; this goal will be achieved through developments in several technologies (coastal ocean prediction, with waves and currents; ocean sampling; remote sensing; acoustics; optics; magnetics; hydrodynamics; chemistry; geology/sediment dynamics; biosensor technology; etc.) and the "network-centric" approach by which the component technologies will be applied for use by the on-scene commander.
 - (U) Develop high-resolution littoral ocean models, including waves and currents, for use in predicting oceanographic characteristics in the littoral zone significant to MCM operations; the aim is to transition the capability to NAVOCEANO; indirect use of wave properties to infer bottom bathymetry will also be developed.
 - (U) Autonomous Ocean Sampling Network technology for MCM will continue development, primarily using commercial-off-the-shelf technology; a series of field experiments featuring increasing levels of difficulty; the revolutionary nature of this ocean technology will continue to be demonstrated through collaboration with NAVOCEANO and other participants.
 - (U) Continue development of remote sensing techniques to gain information about the littoral ocean, especially ocean bathymetry which has a significant impact on mine countermeasure operations as well as amphibious operations; the aim is to provide NAVOCEANO with a worldwide capability for inferring bottom depths and other characteristics of the littoral ocean; Precise Time/Time Interval technology will be developed for precise position capability, especially critical for Mine Warfare and MCM operations.

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- (U) Continue development, in collaboration with developments in PE 0602232N and PE 0603794N, of algorithms to employ with the NEMO satellite planned for launch in FY 00 with products aimed for the Warfighter Support Center at NAVOCEANO and the Marine Corps Intelligence Agency.
 - (U) Place increasing emphasis on the development of physics-based littoral ocean color models to enable remotely-sensed hyperspectral data to infer physical processes in the ocean; these models will enable the most effective exploitation of hyperspectral satellite imagery, which promises to be a major advance in the ability to probe the littoral ocean vertical structure for the purposes of littoral warfare; algorithms will transition to NAVOCEANO.
 - (U) Continue development of impact of the natural environment on high-frequency acoustics in terms of synthetic aperture sonar and other high-resolution acoustic methods of mine detection/classification; results in this area are important to developments underway in PE 0602315N.
 - (U) Continue development in characterization of gas content of wet sands as a critical aspect of the natural environment that affects the effectiveness of explosive mine neutralization techniques.
 - (U) Continue development of hydrodynamic interactions with mines, including hydro-sedimentological aspects, to gain more accurate ability to predict the behavior of mines in SW, such as their possible movement and burial; this capability will provide the mine warfare community significant aid in terms of types of operations needed to clear an area.
 - (U) Continue bioluminescence sensor work aimed for transition to Navy Special Warfare Forces; this work will enable the Navy Special Warfare Forces to assess vulnerability of their operations to detection via "bioluminescence trails," which is a high priority with Commander, Navy Special Warfare Command.
 - (U) Computer simulation/sensitivity analyses of operations in the littoral zone will continue development for the evaluation of optimum tactical effectiveness, given the variable characteristics of the natural environment.
- (U) OCEAN AND ATMOSPHERIC PREDICTION:
 - (U) Continue to develop ocean model nowcast/forecast capabilities at a variety of scales (global and basin, regional and semi-enclosed seas, and local), including relocateable and nested models, with the aim of providing for transition through PE 0603207N to fleet operational users.
 - (U) Continue development efforts for advanced on-board oceanographic models that utilize real-time data; aim is to ultimately merge several models to enable the on-board model to provide a full suite (oceanographic, acoustic, biologic, optical, visibility, etc.) of predictive capabilities for the on-scene user in the FY 05 timeframe.
 - (U) Perform ocean data assimilation, model intercomparisons, testing and validation with oceanographic models under development and do so in close collaboration with the Oceanographer of the Navy.

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- (U) Continue developments in the area of coupled ocean/atmosphere models to achieve more accurate incorporation of the effects of interactions between the two media.
 - (U) Continue development of atmospheric models with the goal of providing Fleet Numerical Meteorological and Oceanographic Command (FNMOC) with global prediction capabilities that use a nested procedure to go from global to regional to local descriptions; adaptation of models to massive parallel computers will continue as a means of achieving greater speed and efficiencies.
 - (U) On-scene weather prediction capability has been under development and has demonstrated some degree of maturity; a preliminary capability has been established in Bahrain at the request of U. S. Central Command to provide real-time, on-scene weather prediction for operations in the Persian Gulf.
 - (U) With the advent of more capable prediction procedures data assimilation techniques for the atmospheric models will receive increased attention; in particular, the SPY-1 operational tactical radar will undergo continued testing for use of the radar returns to infer detailed local atmospheric conditions, which in turn may be used to remove weather "clutter" from the radar display.
 - (U) The remarkable accomplishment of deriving vector wind fields from satellite data dramatically increased the number of weather stations (by orders of magnitude) and led to a substantial increase in daily wind observations; this achievement lays the basis for further developments in satellite applications to meteorology; application of wind-derived information to tropical cyclone structure, to severe storms, and to rain-rate will be developed; artificial intelligence procedures will continue to be developed for automated inference of significant atmospheric characteristics.
 - (U) Build on the past work on aerosols and transport models to start the process of constructing an end-to-end observation, analysis, and prediction system for use at FNMOC and with on-scene forecast systems; continue field work on coastal aerosols and dust.
- (U) ATMOSPHERIC INFLUENCES ON EM/EO SYSTEMS:
 - (U) As a consequence of previous work on EM propagation in the atmosphere, much knowledge has been gained on the nature and magnitude of variability in EM propagation caused by the natural environment; developments will yield models that more thoroughly incorporate atmospheric effects of refraction, extinction, turbulence, and rough boundaries; models are made available to the entire EM user community through transition to NAVOCEANO; a specific focus for airborne and ship platforms will be the Advanced Propagation Model that combines previous component models for terrain and range-dependence.
 - (U) Continue field measurements to quantify atmospheric effects on EM propagation; an experiment in the summer of FY 00 is to focus on a "rough" evaporation duct and the anomalous properties that result.

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- (U) Continue development of tactical decision aids to enable the fleet user of EM systems to more fully exploit system capabilities and/or anomalous conditions of propagation in the atmosphere which are often of significant magnitude in terms of range and altitude modifications.
- (U) EO sensors are important in surface warfare and strike warfare, as demonstrated in the Persian Gulf conflict; improvements in EO propagation models will be developed in terms of atmospheric effects such as background radiance, transmittance, refractivity, aerosols, and clouds; the Advanced Navy Aerosol Model (incorporating near surface effects over the open ocean important for detection of sea-skimming missiles) is expected to be completed in this timeframe; models are made available to the entire EO user community through transition to NAVOCEANO.
- (U) Continue the international program Electro-Optical Propagation Assessment and Coastal Environment (EOPACE) as an effective means of gathering field measurements to test and verify atmospheric effects on electro-optic propagation, especially in coastal environments.
- (U) Continue efforts toward making the Electro-Optical Tactical Decision Aid and Electro-Magnetic Tactical Decision Aid (EOTDA/EMTDA) more inclusive of atmospheric effects and more useful to the fleet operators.
- (U) Continue efforts in characterizing PM-10 in the atmosphere of southern California, especially as to operations and testing at naval bases in the area, with the focus on field studies and emission studies.
- (U) NOPP:
 - (U) Continue evolution of efforts in "virtual" ocean data and remote sensing centers/facilities to capitalize on existing centers by developing broad community access/exchange of Navy, NOAA, and other data bases together with data display and assimilation techniques.
 - (U) Continue evolution of efforts aimed at a National Littoral "Laboratory" with the long-term aim of "portable" coastal ocean/atmosphere forecasting capabilities.
 - (U) Continue partnership efforts in oceanography to optimize resources, intellectual talent, and facilities in ocean sciences focused upon ocean observing technologies, goal is to advance national ocean capability.
 - (U) Continue with selected aspects of efforts that develop and/or demonstrate Coastal and Open Ocean Observational Techniques; Observational Systems; Sensors and Sensing; and Modeling/Data Assimilation.
 - (U) Utilize SECNAV/CNO Oceanographic Research Chairs to further promote the collaboration of distinguished university scientists with Navy/Marine Corps activities; a primary aim is to achieve a synthesis of results and understanding in key oceanographic areas important to Navy/Marine Corps operations.

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3. (U) FY 2001 PLAN

- (U) NATURAL-ENVIRONMENT ISSUES IN UNDERSEA SURVEILLANCE AND WEAPONS:
 - (U) Continue development in active acoustics to provide capabilities for detection of the "quiet" submarine with special emphasis on shallow water regions; acoustic field measurements, modeling, and data analysis will be employed as well as joint efforts with fleet activities, The Technical Cooperation Program, and the NATO SACLANT Centre; complete and transition to NAVOCEANO and Warfare Centers statistical models for characterizing the probabilities of false alarms due to broadband clutter.
 - (U) Continue developments in shallow water acoustics to advance capabilities to exploit the natural environment for optimal submarine detection, especially in the littoral zone where oceanographic conditions can be highly variable both spatially and temporally; advances will come from theoretical modeling to describe sound interaction with the ocean surface, the ocean bottom, and with variable ocean processes (ocean fronts and internal waves); further quantification will be found for the result that acoustic propagation in shallow water regions can be greatly influenced by the presence of internal solitary waves.
 - (U) Continue developments in undersea noise characterization to enable acoustic detection/processor systems (distributed systems; focused and adaptive beamforming; matched-field processing) to reject false alarms; conduct initial demonstration of false-target rejection algorithms based on biological and ship-radiated noise discriminants; noise properties are of major importance to developments in PE 0602314N.
 - (U) Continue developments in natural-environment enhanced signal processing, including methods for estimating characteristics of the natural environment from acoustic measurements; attention will be given to the active acoustics case in which great advantage may be gained in choosing the propagating signal, perhaps sufficient to discriminate object echoes from natural boundary reverberation.
 - (U) Continue with interactions with the fleet SHAREM exercises to maximize use of "cutting-edge" basic/applied research in the interpretation and analysis of fleet exercise results; aim is to reveal how oceanographic/acoustic properties affect system performance and help focus future basic/applied research.
 - (U) Continue development of high-frequency acoustics, including underwater acoustics communications, with new focus established by assessment of the area as of FY 99.
- (U) NATURAL-ENVIRONMENT INFLUENCES ON MCM SYSTEMS, INCLUDING LITTORAL OCEANOGRAPHY:
 - (U) Continue development of the technologies that contribute toward establishment of a "network-centric" capability to provide the on-scene commander with real-time knowledge of the environment, knowledge of systems sensitivities, and knowledge of their optimum operational effectiveness, all made useable through appropriate tactical decision aids.

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- (U) Continue development of high-resolution littoral ocean models, including waves and currents, for use in predicting oceanographic characteristics in the littoral zone significant to MCM operations; the aim is to transition the capability to NAVOCEANO; indirect use of wave properties to infer bottom bathymetry will also be developed to a higher degree of precision.
 - (U) Continue development of Autonomous Ocean Sampling Network technology for MCM, primarily through the use of commercial-off-the-shelf components and collaboration with NAVOCEANO and other participants.
 - (U) Continue development of remote sensing techniques to gain information about the littoral ocean, especially ocean bathymetry which has a significant impact on mine countermeasure operations as well as amphibious operations; continue developments in Precise Time/Time Interval technology to provide greater precision in position determination, especially in mine Warfare and MCM operations.
 - (U) Continue development of physics-based littoral ocean color models for the effective exploitation of hyperspectral satellite imagery to probe littoral ocean vertical structure for the purposes of littoral warfare; algorithms will transition to NAVOCEANO.
 - (U) Continue development, in collaboration with developments in PE 0602232N and PE 0603794N, of algorithms to employ with the NEMO satellite planned for launch in FY 00 with products aimed for the Warfighter Support Center at NAVOCEANO and the Marine Corps Intelligence Agency; post-launch focus will be on calibration with known features and validation.
 - (U) Continue development of impact of the natural environment on high-frequency acoustics relevant to synthetic aperture sonar and other high-resolution acoustic methods of mine detection/classification; results in this area are important to developments underway in PE 0602315N.
 - (U) Continue development in characterization of gas content of wet sands as a critical aspect of the natural environment that affects the effectiveness of explosive mine neutralization techniques.
 - (U) Continue development of hydrodynamic interactions with mines, including hydro-sedimentological aspects, to gain more accurate predictive ability for the behavior of mines in shallow water (mine drift/burial).
 - (U) Continue developments in bioluminescence sensors focused on transition of an Autonomous Underwater Vehicle capable sensor to the Navy Special Warfare forces and on development of an expendable and affordable bioluminescence sensor for NAVOCEANO.
 - (U) Continue development of computer simulation/sensitivity studies of operations in the littoral zone to determine optimum tactical effectiveness under the difficult conditions of the littoral region.
- (U) OCEAN AND ATMOSPHERIC PREDICTION:

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PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continue development of ocean model nowcast/forecast capabilities at a variety of scales (global and basin, regional and semi-enclosed seas, and local), including relocateable and nested models; aim is to transition an initial version of the Eddy-Resolving Global Oceanographic Prediction System.
 - (U) Continue development efforts for advanced on-board oceanographic models that utilize real-time data for providing the on-scene commander with a virtually real-time predictive capability of all natural environmental factors of operational significance.
 - (U) Perform ocean data assimilation, model intercomparisons, testing and validation with oceanographic models under development and do so in close collaboration with the Oceanographer of the Navy.
 - (U) Continue development in the area of coupled ocean/atmosphere models to achieve more accurate incorporation of the effects of interactions between the two media.
 - (U) Continue development of atmospheric models with the goal of providing FNMOC with global prediction capabilities that use a nested procedure to go from global to regional to local descriptions; adaptation of models to massive parallel computers will continue as a means of achieving greater speed and efficiencies.
 - (U) Continue development of an on-scene weather prediction capability as a means of providing real-time forecast capability to the on-scene commander.
 - (U) Continue development of data assimilation techniques for the atmospheric models under development; a decision point as to further testing of the utility of the SPY-1 operational tactical radar to infer detailed local atmospheric characteristics will be reached.
 - (U) Continue development of remote sensing techniques as a means of obtaining weather observations; artificial intelligence procedures will continue development for automated inference of significant atmospheric characteristics.
 - (U) Continue work to construct an end-to-end aerosol observation, analysis, and prediction system for use at FNMOC and with the on-scene forecast system; continue field work on coastal aerosols and dust; the aim is to achieve an operational capability in about the FY 05 timeframe.
- (U) ATMOSPHERIC INFLUENCES ON EM/EO SYSTEMS:
 - (U) Continue development of EM propagation models for the atmosphere to more thoroughly incorporate the atmospheric effects of refraction, extinction, turbulence and rough boundaries; models are required for effects over water, across coastlines, and over varying terrain for both land-based and sea-based systems.
 - (U) Continue field measurements to quantify atmospheric effects on EM propagation and test models under development with the goal of providing more capable radar systems to the fleet.

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PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continue development of tactical decision aids to enable the fleet user of EM systems to more fully exploit system capabilities and/or anomalous conditions of propagation, thus gaining tactical advantage.
 - (U) Continue developments in electro-optic propagation models to increase the utility and effectiveness of electro-optic sensors in surface warfare and strike warfare; a Coastal Aerosol Model will be a specific product to take account of aerosol properties in the coastal region.
 - (U) Continue the international program EOPACE as an effective means of gathering field measurements to test and verify atmospheric effects on electro-optic propagation, especially in coastal environments.
 - (U) Continue efforts toward making EOTDA/EMTDA more inclusive of atmospheric effects and more useful to the fleet operators.
- (U) NOPP:
 - (U) Continue to emphasize and develop major oceanographic themes that require multi-agency participation as well as broad oceanographic partnerships among academic/government agencies/private industry to advance the aims of NOPP, specifically to place emphasis on the ocean as a significant natural resource important to national security as well as the nation's economic well-being.
 - (U) Continue evolution of efforts in "virtual" ocean data and remote sensing centers/facilities to capitalize on existing centers by developing broad community access/exchange of Navy, NOAA, and other data bases together with data display and assimilation techniques.
 - (U) Continue evolution of efforts aimed at a National Littoral "Laboratory" with the long-term aim of "portable" coastal ocean/atmosphere forecasting capabilities.
 - (U) Continue partnership efforts in oceanography to optimize resources, intellectual talent, and facilities in ocean sciences focused upon ocean observing technologies; goal is to advance national ocean capability.
 - (U) Continue with selected aspects of efforts that develop and/or demonstrate Coastal and Open Ocean Observational Techniques; Observational Systems; Sensors and Sensing; and Modeling/Data Assimilation.
 - (U) Continue SECNAV/CNO Oceanographic Research Chairs to further promote the collaboration of distinguished university scientists with Navy/Marine Corps activities; a primary aim is to achieve a synthesis of results and understanding in key oceanographic areas important to Navy/Marine Corps operations.

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PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

B. (U) PROGRAM CHANGE SUMMARY:

	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
(U) FY 2000 President's Budget:	68,726	60,334	62,084
(U) Appropriated Value:		73,084	
(U) Adjustments from FY 00 PRESBUDG:			
(U) SBIR/STTR Transfer	-787		
(U) Inflation Adjustment	-313		
(U) SSP Adjustments			-8
(U) Congressional Plus Ups			
(U) Distributed Marine		2,000	
(U) Autonomomous UUV		10,000	
(U) PM-10 Air Quality Study		750	
(U) Various Rate Adjustments			-1,436
(U) Execution Adjustments	1,785		
(U) Congressional Rescissions		-403	
(U) Minor Program Adjustment			-320
(U) FY 2001 PRESBUDG Submission	69,411	72,681	60,320

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable

(U) RELATED RDT&E:

(U) PE 0601153N (Defense Research Sciences)
(U) PE 0602232N (SEW Technology)
(U) PE 0602314N (Undersea Warfare Surveillance Technology)
(U) PE 0602315N (Mine Countermeasures, Mining and Special Warfare Technology)
(U) PE 0602633N (Undersea Warfare Weapons Technology)
(U) PE 0603207N (Air/Ocean Tactical Applications)
(U) PE 0603785N (Combat Systems Oceanographic Performance Assessment)

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PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0603794N (C3 Advanced Technology)
- (U) PE 0604218N (TESS ENG)
- (U) PE 0602101F (Geophysics)
- (U) PE 0602601F (Phillips Lab Exploratory Development)
- (U) PE 0602784A (Military Engineering Technology)
- (U) PE 0603410F (Space Systems Environmental Interactions Technology)
- (U) PE 0603707F (Weather Systems Technology)

D. (U) SCHEDULE PROFILE: Not applicable.

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