FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 1999

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N
PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

(U) COST (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1998 ACTUAL	FY 1999 ESTIMATE	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	74,767	68,726	60,334	62,084	63,046	64,313	65,624	66,989	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 (Title II, subtitle E, of Public Law 104-201) enacted into law for FY 1997.

(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.

(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.

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(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 TerrestrialEnvironments.

(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 1998 ACCOMPLISHMENTS:

- (U) ($10,857) ENVIRONMENTAL ISSUES IN UNDERSEA SURVEILLANCE AND WEAPONS (INCLUDES CONGRESSIONAL EARMARK $1,941 - ARCTIC OCEAN CLIMATE OBSERVATIONS):
  - (U) Continued to advance the capabilities of active acoustic techniques for undersea surveillance in shallow water regions through developments in clutter characterization and control as well as in performance characterization and modeling.
  - (U) Conducted test of influence of internal waves in shallow water on tactical frequency acoustic propagation, surface duct leakage, and vertical/horizontal coherence in shallow water.
  - (U) Developed techniques for acoustic/nonacoustic fusion performance prediction for nonstationary noise fields in shallow water as a means of improving undersea surveillance detection capabilities.
  - (U) Extended full-spectrum noise models to high frequencies (>15 kHz) and assessed impact of full-spectrum noise on the performance of existing broadband detection/classification algorithms using both measured and modeled noise clutter statistics; developed new algorithms that exploit the full-spectrum noise characteristics to reduce the false-alarm/classification-error probabilities.
  - (U) Initiated the development and demonstration of natural-environment enhanced, volumetric, acoustic surveillance arrays for locating and tracking quiet threats in shallow water environments.
  - (U) Initiated the development of geo-acoustical inversion algorithms to improve the performance of natural-environment enhanced signal processing algorithms for undersea surveillance.

- (U) Participated in international program to conduct high-frequency acoustic measurements in shallow water off Australia; the aim was to characterize effects of the natural environment on detection, classification and localization of small, quiet submarines.
- (U) Participated with PE 0603792N in development of underwater acoustic communications to establish communications capability between submarine/submarine and other platforms.
- (U) Continued the Arctic Ocean Climate Observations program aimed at utilizing underwater acoustics to determine and monitor ocean “climate” in a large ocean basis.

• (U) ($32,948) NATURAL-ENVIRONMENT INFLUENCES ON MINECOUNTERMEASURE SYSTEMS, INCLUDING LITTORAL OCEANOGRAPHY(INCLUDES CONGRESSIONAL PLUS-UP $9,703 - AUTONOMOUS UNDERWATER VEHICLE AND SONAR DEVELOPMENT, PLUS-UP $2,660 – NAVAL SURFACE WEAPONS CENTERS (NSWC) SOUTH FLORIDA TEST FACILITY):

- (U) Continued development of autonomous ocean vehicle technology (and related natural-environment sensor technology) with selective field work aimed at demonstrating level of capability achieved.
- (U) Developed the utility of the NSWC Test Facility in conjunction with allied universities and government agencies to provide for monitoring and measurement of the ocean environment that will contribute to marine vehicle research, especially in the context of mine countermeasures.
- (U) Based on the lateral variability observed in acoustic bottom-related properties from the seaside Panama City site, designed and conducted a second towed body experiment at a second site to test hypotheses developed by the initial data set and the semi-empirical formulations.
- (U) Using satellite-based data developed performance estimates of optical MCM systems in a foreign coastal area. Validated these using in-site measurements.
- (U) Initiated work on algorithms for hyperspectral remote sensing data by which detailed resolution can be achieved of littoral ocean characteristics important for naval warfare; 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) Conducted field experiment to test data extraction algorithms (bathymetry, sediment type, bottom backscatter, sound velocity and volume reverberation) from mine-hunting sonars.
- (U) Continued development of techniques for fusing multiple data types to achieve gains in MCM.
- (U) Tested performance of the toroidal volume sonar system (TVSS) and the side-looking sonar (SLS) using real time natural-environment data for performance prediction.
- (U) Began task of describing distribution as well as bulk percent gas in marine sediments for shock wave method of neutralizing mines.
- (U) Completed micro-scale modeling of fluid-gas flow in marine sediments in support of improved shock wave models.
- (U) Initiated tests of predictive quality of geoacoustic database algorithms for “type” geologic regions.

- (U) Developed a predictive model of mine migration/burial within the surf zone based upon the previous year's field study. Initiation of a study of morphological stability assessing the stationarity of sandbar structures; this work will facilitate prediction of the probability of burial for large (stationary) anti-landing mines in 3-6 feet of water. Additionally, this work is useful for the assessment of the meaningfulness of previously obtained bathymetry, based on the predicted stationarity of the sandbar.
- (U) Continued assessments of techniques for optical characterization of natural environments to serve MCM, especially in terms of the variety of natural environments.
- (U) Analyzed data and reported results of FY 97 experiment on shallow water, high-frequency acoustics bubble effects, especially as they impact MCM systems.
- (U) Applied interim bubble/acoustics models to FY 97 shallow water data and helped define a FY 99 experiment.
- (U) Incorporated spatial/temporal coherence results from the Mediterranean site into the Synthetic Aperture Sonar (SAS) performance prediction model and made predictions/hypotheses for an additional very-shallow water site; conducted a major acoustic clutter experiment in a high-clutter environment.
- (U) Developed composite mission/tactics analysis model which uses physics-based predictions with realistic descriptions of the natural environment.
- (U) Made investment strategy suggestions relating to accuracies and space/time resolutions required for ocean descriptions based on known Korean and Persian Gulf natural environments.
- (U) Developed fully-coupled nonlinear wave/tide model with data assimilation and incorporated into system performance models.

• (U) ($10,259) OCEAN AND ATMOSPHERIC PREDICTION:
- (U) Adapted the recent, conservative form of semi-Lagrangian schemes to an ocean model.
- (U) Tested ocean models incorporating new advection schemes with coastal ocean data and with deep water data, the aim being to achieve greater capabilities and improved performance of Navy numerical ocean models.
- (U) Delivered a fourth-order advective sigma-coordinate model.
- (U) Delivered a fourth-order advective layer model with topography.
- (U) Advanced shipboard ocean forecast capability through inclusion of relocatable ocean circulation component and nesting with shore-based boundary conditions, transitioned to 6.4.
- (U) Completed Sea of Japan/Yellow Sea SW Assimilation/Forecast System (SWAFS) development. Began combination of Sea of Japan/Yellow Sea/South China Sea (Asian Seas) SWAFS development as a contribution to oceanography of Navy-priority coastal seas.
- (U) Conducted critical evaluation of new predictive schemes with the aim of determining their effectiveness against current schemes.

- (U) Explored the ability of the SPY-1 operational tactical radar to detect clear air turbulent features in the marine atmosphere using advanced processing techniques for coded waveforms with at-sea demonstration of SPY-1 tactical radar capability.
- (U) Transitioned a variational assimilation capability for incorporating satellite radiance observations directly into the operational atmospheric prediction system.
- (U) Demonstrated and transitioned a shipboard tactical scale atmospheric prediction capability, incorporating local observations and interfaces to tactical decision aids.

• (U) ($4,069) ATMOSPHERIC INFLUENCES ON EM/EO SYSTEMS (INCLUDES CONGRESSIONAL PLUS-UP $728 - PM-10):
- (U) Based on EO Propagation through the Atmosphere and Coastal Environment data, developed a coastal aerosol model for use in EO propagation effects assessment, including near ocean surface effects which are critical in defense against sea-skimmer missiles.
- (U) Developed improved periscope detection assessment capability with an EM propagation model incorporating an improved surface clutter model.
- (U) Continued PM-10 evaluation of particulate matter in southern California with consideration extended to particles of less than 2.5 microns diameter (the so-called PM 2.5 content).

• (U) ($16,634) NATIONAL OCEANOGRAPHIC PARTNERSHIP PROGRAM (NOPP) (INCLUDES CONGRESSIONAL PLUS-UP $11,644):
- (U) Continued 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 Administration (NOAA), and other data bases together with data display and assimilation techniques.
- (U) Continued efforts aimed at a National Littoral “Laboratory” with the long-term aim of “portable” coastal ocean/atmosphere forecasting capabilities.
- (U) Used Broad Agency Announcement to solicit proposals that develop and/or demonstrate Coastal and Open Ocean Observational Techniques for continuous, high-resolution measurements of ocean processes; major themes of emphasis were: Observational Systems; Sensors and Sensing; and Modeling/Data Assimilation.
- (U) Initiated partnership efforts to develop and exploit Regional Scale Coastal and Open Prediction Systems that integrate existing military and civil observing and prediction systems including networked sensing systems, and capitalize on existing and planned satellite open ocean and coastal remote sensing systems; the goal was to develop cutting edge 4-D nowcast and forecast systems for the open and coastal ocean to address civil and military requirements.
- (U) Continued partnership efforts in oceanography to optimize resources, intellectual talent, and facilities in ocean sciences and education focusing upon ocean observing technologies.

2. (U) FY 1999 PLAN:

- (U) ($10,621) NATURAL-ENVIRONMENT ISSUES IN UNDERSEA SURVEILLANCE AND WEAPONS:
  - (U) Demonstrate techniques for adapting to the natural environment for in-site, 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) Analyze 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) Develop predictive capability for optimum placement and fusion of acoustic/nonacoustic sensors in strongly range-dependent natural environments such as straits and gulfs.
  - (U) Complete 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.
  - (U) Demonstrate performance improvements of natural-environment enhanced signal processing algorithms using geo-acoustical inversion techniques.
  - (U) Perform detailed analyses of high-frequency acoustic data obtained in several shallow water locales with the purpose of creating a unified basis for undersea weapon performance prediction in shallow water.
  - (U) Continue participation with PE 0603792N in development of underwater acoustic communications to establish communications capability between submarine/submarine and other platforms.

- (U) ($31,595) NATURAL-ENVIRONMENT INFLUENCES ON MCM SYSTEMS, INCLUDING LITTORAL OCEANOGRAPHY (INCLUDES CONGRESSIONAL PLUS-UP $10,000 – AUTONOMOUS UNDERWATER VEHICLE AND SENSOR DEVELOPMENT; PLUS-UP $2000 – NAVAL SURFACE WEAPONS CENTER (NSWC) SOUTH FLORIDA TEST FACILITY):
  - (U) Continue 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) Continue development of the NSWC 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) Continue 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 NAVOCEANO and the Marine Corps Intelligence Agency.
  - (U) Provide an initial spatial variability model (low-grazing angle bottom reverberation backscattering, bottom penetration/sediment scattering) and data bases to NSWC, Coastal Systems Station (NSWC-CSS) for MCM system development.

- (U) Process 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. Utilize these new algorithms to create a regional data base for forward strategic area.
- (U) Initiate 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) Transition algorithms for extracting real-time seafloor data from TVSS and SLS sonars to NSWC-CSS.
- (U) Conduct final test for algorithms for extracting real-time sound speed and surface reverberation data from TVSS sonar.
- (U) Test data fusion algorithms.
- (U) Initiate development of algorithms to extract real-time data on the natural environment in denied areas using SAS and Laser Line Scanner System (LLS).
- (U) Integrate micro-scale modeling of fluid/gas flow into data base predictive model incorporating oceanographic forcing functions.
- (U) Initiate effort to extend geoacoustic data base algorithms to geotechnical data base algorithms.
- (U) Conduct a field study of mine migration and burial behavior in low energy/muddy beach natural environments.
- (U) Evaluate 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) Conduct final and comprehensive experiment on influence of bubbles in shallow water on sonar performance, especially in terms of MCM systems.
- (U) Begin applying and validating final models of bubble distributions and high-frequency acoustic propagation in a shallow-water bubbly medium.
- (U) Plan and conduct a full-band spatial/temporal coherence measurement in a very-shallow water site and utilize 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; analyze 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 will be developed, especially in terms of a bioluminescence sensor for the Navy Special Warfare forces to provide vulnerability assessment to detection through “bioluminescence trails.”

- (U) ($11,176) OCEAN AND ATMOSPHERIC PREDICTION:

- (U) Continue testing other high-order advection schemes. Compare with older schemes and test in the California Current region.
- (U) Investigate the effect of higher-order schemes on passive tracer dispersion.
- (U) Deliver Very High Resolution (VHR) Coastal Model with improved advection.
- (U) Deliver Global Layered Model with improved advection and subduction/ventilation capability.
- (U) Initiate eddy-resolving global ocean model development including data assimilation.
- (U) Develop and transition to 6.4 a shipboard tactical ocean nowcast/forecast model that allows for VHR (to 100 m).
- (U) Transition Asian Seas SWAFS including data assimilation to 6.4. Develop relocatable baroclinic tide model.
- (U) Continue efforts in critical evaluation of new predictive schemes as a means of achieving more effective models.
- (U) Demonstrate the over-water clear-air weather detection capability of the operational system SPY-1 at a coastal test site.
- (U) Transition a nested air-sea coupled prediction system for operational implementation incorporating coupled data assimilation.
- (U) Develop a complete nonhydrostatic tactical scale prediction system for shipboard use in forecasting weather effects for operational planning and “what-if” scenario rehearsal, incorporating the targeting of relocatable weather observation capabilities.

• (U) ($4,607) ATMOSPHERIC INFLUENCES ON EM/EO SYSTEMS (INCLUDES CONGRESSIONAL PLUS-UP $500 – PM-10):
- (U) Interface 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) Transition 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) Transition to Naval Sea Systems Command and Space and Naval Warfare Systems Command a small Global Positioning System (GPS)-receiver based system for measuring atmospheric refractivity structure.
- (U) Continue 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) ($10,000) NOPP:
- (U) Use 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 sysnthesis of new results with broad utility for the ocean community; in Ocean Observation the focus is on establishing the the means for continuous, high resolution of oceanic processes.

- (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.
- (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 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.

- (U) ($727) SBIR
  - (U) Portion of extramural program reserved for Small Business Innovation Research assessment in accordance with 15 USC 638.

3. (U) FY 2000 PLAN

- (U) ($11,258) 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.
- (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/applied research.
- (U) Continue development of high-frequency acoustics, including underwater acoustics communications, based on assessment of the area as of FY 99.

• (U) ($22,515) 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.

- (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 neutralization techniques for mine clearance.
- (U) Continue development of hydrodynamic interactions with mines, including hydro-sedimentological aspects, to gain more accurate ability to predict the behavior of mines in shallow water, 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 development of bioluminescence sensor 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) ($11,838) 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.

- (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 Meterological 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) ($4,723) 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.
- (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; field studies and emission studies will be the focus of the efforts.

• (U) ($10,000) 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.
- (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.

B. (U) PROGRAM CHANGE SUMMARY:

	FY 1998	FY 1999	FY 2000
(U) FY 1999 President’s Budget:	71,491	56,722	59,974
(U) Appropriated Value:		69,222	
(U) Adjustments from FY 1999 PRESBUDG:	3,276	12,004	360

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 1999

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602435N
PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

(U) FY 2000 President's Submission	74,767	68,726	60,334

(U) CHANGE SUMMARY EXPLANATION:

(U) Funding: The FY 1998 adjustment of 3,276 reflects a Small Business Innovation Research reduction (-686), and Actual Update through June (+3,962). The FY 1999 adjustment of 12,004 reflects a Revised Economic Adjustment (-159), Civilian Personnel Underexecution (-101), Congressional Add South Florida Test Facility (+2000), Congressional Add PM-10 (+500), Congressional Add Autonomous Underwater Vehicle (+10,000), and a Contract Advisory and Assistance reduction (-236). FY 2000 adjustment of 360 reflects adjustments for Navy Working Capital Fund (NWCF) Pricing adjustment (+943), Civilian Pay Rates (+289), and Non Pay Inflation adjustment (-872).

(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 0602101F (Geophysics)
- (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 0602601F (Phillips Lab Exploratory Development)
- (U) PE 0602784A (Military Engineering Technology)
- (U) PE 0603207N (Air/Ocean Tactical Applications)
- (U) PE 0603410F (Space Systems Environmental Interactions Technology)
- (U) PE 0603707F (Weather Systems Technology)
- (U) PE 0603785N (Combat Systems Oceanographic Performance Assessment)
- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0603794N (C3 Advanced Technology)
- (U) PE 0604218N (TESS ENG)

D. (U) SCHEDULE PROFILE: Not applicable.