FY 2004/2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2003
Exhibit R-2

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602435N
PROGRAM ELEMENT TITLE: Ocean Warfighting Environment Applied Research

COST: (Dollars in Thousands)

PROJECT NUMBER/ TITLE	FY 2002 ACTUAL	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	FY 2008 ESTIMATE	FY 2009 ESTIMATE
Ocean Warfighting Environment Applied Research	60,549	71,027	48,785	63,729	58,657	58,228	54,590	55,495

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE) provides the unique, fundamental programmatic instrument by which basic research on the natural-environment is transformed into technology developments that provide new or enhanced warfare capabilities for the Battlespace Environment (BSE). The objectives of the PE are met through measuring, analyzing, modeling and simulating, and applying environmental factors affecting naval material and operations in the BSE. This PE provides for BSE technology developments that contribute to meeting top joint warfare capabilities established by the Joint Chiefs of Staff, with primary emphasis on Joint Littoral Warfare and Joint Strike Warfare.

Recently, a new strategy, referred to as the Naval Transformation Roadmap, has been formulated; the efforts in this Program Element strongly support Sea Shield. 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. Within the Naval Transformation Roadmap, the investment will contribute toward achieving each of the "key transformational capabilities" required by Sea Strike, Sea Shield, and Sea Basing. Moreover, environmental information, environmental models and environmental tactical decision aids that emerge from this investment will form one of the essential components of FORCEnet (which is the architecture for a highly adaptive, human-centric, comprehensive maritime system that operates from seabed to space, from sea to land).

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

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B.PROGRAM CHANGE SUMMARY:

	FY	FY	FY	FY

FY 2004/2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2003
Exhibit R-2

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602435N
PROGRAM ELEMENT TITLE: Ocean Warfighting Environment Applied Research

	2002	2003	2004	2005
FY 2003 President's Budget Submission:	62,035	55,180	55,570	55,480
Adjustments from FY 2003 President's Budget:				
NWCF Rate Adjustments			- 395	- 40
SBIR Adjustment	- 266			
Congressional Rescissions/Adjustments/Undist. Reductions	- 303	- 832		
Execution Adjustments	- 917			
Congressional Plus-ups		17,450		
Efficiencies at NWCF Activities			- 170	- 180
S & T Program Adjustments			-4,925	10,147
Pay Raise/Inflation Adjustments		- 771	-1,295	-1,678
FY 2004/2005 PRESIDENTS'S Budget Submission:	60,549	71,027	48,785	63,729

PROGRAM CHANGE SUMMARY EXPLANATION:

Schedule: Not applicable
Technical: Not applicable

FY 2004/2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2003
Exhibit R-2a

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602435N PROGRAM ELEMENT TITLE: Ocean Warfighting Environment Applied Research

Project Title: Ocean Warfighting Environment Applied Research

COST: (Dollars in Thousands)

PROJECT NUMBER/ TITLE	FY 2002 ACTUAL	FY2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	FY 2008 ESTIMATE	FY 2009 ESTIMATE
Ocean Warfighting Environment Applied Research	60,549	71,027	48,785	63,729	58,657	58,228	54,590	55,495

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project provides the unique, fundamental programmatic instrument by which basic research on the natural-environment is transformed into technology developments that provide new or enhanced warfare capabilities for the Battlespace Environment (BSE). Natural-environment and BSE are used interchangeably; each term is to be understood to potentially encompass aspects of the ocean, atmosphere, space, or land.

This project also provides technologies that form the natural-environment technical base on which all systems development and advanced technology depend. Further, this technical base provides developments that may be utilized in the Future Naval Capabilities programs: Organic Mine CounterMeasures and Autonomous Operations. This project 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 general needs in the area of Mine Countermeasures (MCM). The objectives of the PE are met through measuring, analyzing, modeling and simulating, and applying environmental factors affecting naval material and operations in the BSE.

This project provides for BSE 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 BSE, (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.

This project provides natural-environment applied research for all fleet operations and for current or emerging systems. Major developments are routinely transitioned to the Fleet Numerical Meteorology and Oceanographic Command where they are used to provide timely information about the natural environment for all fleet operations.

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 acoustics and multiple-influence sensors for undersea surveillance and weapon systems, and influences of the natural environment on mine countermeasure (MCM) and anti-submarine warfare (ASW) systems.

Joint Strike Warfare efforts address issues in air battlespace dominance. Programs include influences of the natural environment on air operations, electromagnetic (EM)/electro-optic (EO) systems used in intelligence, surveillance and reconnaissance and targeting, bomb damage assessment, and detection of missile weapon systems. They also include improvements in tactical information management about the BSE.

Recently, a new strategy, referred to as the Naval Transformation Roadmap, has been formulated; the efforts in this project strongly support Sea Shield. 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 project 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.

Within the Naval Transformation Roadmap, the investment will contribute toward achieving each of the "key transformational capabilities" required by Sea Strike, Sea Shield, and Sea Basing. Moreover, environmental information, environmental models and environmental tactical decision aids that emerge from this investment will form one of the essential components of FORCEnet (which is the architecture for a highly adaptive, human-centric, comprehensive maritime system that operates from seabed to space, from sea to land).

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

Due to the number of efforts in this project, the programs described herein are representative of the work included in this project.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 02	FY 03	FY 04	FY 05
Battlespace Environment (BSE) Sensors and Data	7,209	8,133	7,295	10,880

This activity encompasses efforts to develop new, or enhance existing, shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion techniques and data handling techniques to obtain/store/manage environmental data. Data on a variety of processes in the environment are essential for several reasons: the data can serve as input to computer prediction schemes; data can be used to provide characterizations of processes for use in other developments; and data can be used in testing/validating current understanding of ocean and atmospheric behavior. Consideration is routinely given to the basic research available in Sensors and Data to determine if new opportunities exist that can be exploited to rapidly advance toward the goals of the BSE Sensors and Data activity. Consideration is also routinely given to the nature of the technical efforts to ensure that they represent the most effective means of achieving progress. Efforts include use of organic sensors to characterize the operational environment in real time for input into performance prediction of warfighting systems. Developments in the BSE Sensors and Data activity are of importance to littoral oceanography, amphibious warfare, mine countermeasures, and anti-submarine warfare. A main emphasis of work in this area remains the littoral ocean which continues to be seen as the primary battlespace of future conflicts. The BSE Sensors and Data activity supports the Navy Transformation Roadmap strategy by providing required data that can be applied to battlespace characterization in near real-time and also employed in intelligence, surveillance, and reconnaissance.

FY 2002 ACCOMPLISHMENTS:

- Additional focus was given to: Global Data Assimilation Experiment (GODAE), bioluminescence sensor, field data for physics-based models for hyperspectral imaging sensors, naval impact of natural environmental processes (especially for the littoral zone), and autonomous underwater vehicle sensors and technology for oceanography and mine countermeasures (MCM).

- Completed the advanced ocean wave prediction model development which improves the predictive capability of wave prediction in the littoral region and established a mechanism by which other developments in wave prediction can easily transition to the fleet.

FY 2003 PLANS:

- Continue developments in: GODAE, bioluminescence sensor, field data for physics-based models for hyperspectral imaging sensors, naval impact of natural environmental processes (especially for the littoral zone), and autonomous underwater vehicle sensors and technology for oceanography, mine countermeasures, and prediction of mine burial.

- NATO Adriatic circulation experiment will field test a new bottom sensor system and use data for rapid environmental assessment.

FY 2004 PLANS:

- Continue support of efforts in GODAE as a contribution to data assimilation for global ocean prediction capability through collaboration between the Navy's Fleet Numerical Meteorological and Oceanographic Command and the NOAA Pacific Marine Environmental Laboratory, as well as others.

- Continue with efforts to transition the small, low-power, lightweight bioluminescence sensors, which are of special importance to Special Forces and their operations.

- Use space-based optical sensors as input for system performance of both active and passive optical MCM sensors.

- Perform analysis of extensive field data for physics-based models for hyperspectral imaging sensors of the ocean surface/near-surface to establish what information can be deduced from such sensors about the upper layers of the ocean. This effort promises to put a firm foundation to this significant new technology.

- Naval impact of natural environmental processes, such as fluid/sediment processes, in the littoral zone continues to be a key area of development, with applications to mine burial and littoral warfare in general.

- Develop a shipborne Light Detection and Ranging (LIDAR) system for measurement of winds and the near-surface EM/EO propagation environment.

- Autonomous Underwater Vehicle (AUV) technology continues to represent a major area of technological revolution for ocean sensing. Continue efforts to develop ocean sensors for use on AUVs and the development of acoustic communication capabilities to transfer data so acquired to facilities in the field. Extend capability to predict acoustic communication channel error rate performance for networked systems.

- Continue efforts to utilize organic sensors for Rapid Environmental Assessment (REA).

- Continue with further advancements in ocean wave prediction, especially shoaling waves, based on the extensive basic research measurement programs in this area over the past decade and advanced techniques such as the Higher Order Spectral Model. Ocean waves constitute a key process in the littoral zone with the ability to affect many naval operations and we seek as robust a predictive capability as possible.

FY 2005 PLANS:

- Continue support of efforts in GODAE as a contribution to data assimilation for global ocean prediction capability through collaboration between the Navy's Fleet Numerical Meteorological and Oceanographic Command and the NOAA Pacific Marine Environmental Laboratory, as well as others.

- Continue the bioluminescence sensor effort with emphasis on needs of the Special Warfare (SPECWAR) forces, survey capabilities, and use of the bioluminescence sensors in joint field measurements with ocean sensors to determine persistence of the bioluminescence signal and the ocean factors controlling the persistence. Evaluate and pursue additional opportunities for further development of the capability to utilize bioluminescence sensing capabilities for naval warfare.

- Completion of analysis of hyperspectral field data for physics-based models hyperspectral imaging sensors of the upper ocean structure. Hyperspectral imaging technology offers new possibilities in inferring critical ocean structural aspects such as near-surface layers and ocean fronts, both of which can influence acoustic and light transmission in the ocean. Give full consideration to the possibilities of utilization of hyperspectral data for naval warfare. Transition results to fleet operational capabilities.

- Naval impact of natural environmental processes, such as fluid/sediment processes, in the littoral zone continues to be a key area of development, with applications to mine burial and littoral warfare in general.

- Conduct a field test of a shipborne LIDAR system for near-surface environmental characterization.

- Continue with efforts to develop ocean sensors for use on AUVs and the development of acoustic communication capabilities to transfer data so acquired to facilities in the field. Utilize joint field work with other AUV technology developers and users as a routine aspect of the program.

- Continue with further advancements in ocean wave prediction, especially shoaling waves, based on the extensive basic research measurement programs in this area over the past decade. Ocean waves constitute a key process in the littoral zone with the ability to affect many naval operations and we seek as robust a predictive capability as possible.

FY 2004/2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2003
Exhibit R-2a

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602435N Project Title: Ocean Warfighting Environment Applied Research
PROGRAM ELEMENT TITLE: Ocean Warfighting Environment Applied Research

	FY 02	FY 03	FY 04	FY 05
Battlespace Environment (BSE) Concept Enablers	19,827	22,091	20,647	24,322

Concept enablers for the battlespace environment represent technology developments that are expected to provide revolutionary, enabling capabilities but require a long period of development. Generally, the concept enablers represent ideas of wide applicability for which the basic research has been accomplished with indications as to a high payoff to naval warfare interests. Consideration is routinely given to the goals to ensure that they are adequate for the presumed naval warfare needs as reflected in higher level Navy Science and Technology strategy. This particular activity is most sensitive to opportunities as presented by breakthroughs in the basic research domain which may represent new opportunities for achieving goals of the BSE Concept Enablers activity. Continual evaluation is given to concept enabling technologies that emerge from basic or applied research and may lead to modifications of on-going efforts. The ever-recurring theme of the BSE Concept Enablers activity is to advance technologies that offer the warfighter the greatest capabilities for gaining "advantage" over the natural environment, both to increase his warfighting ability and to deny an adversary any “home field” advantage. The aims of this activity are fully consistent with the Navy Transformation Roadmap strategy in which innovative developments are sought “to achieve transformational operational concepts and capabilities.”

FY 2002 ACCOMPLISHMENTS:

- Efforts were aimed at providing naval battlespace awareness, precise time/time interval for precision location, geoclutter, the National Oceanographic Partnership Program (NOPP), SecNav/CNO Ocean Chairs, and collaborative efforts with basic research programs.

- Continued the National Oceanographic Partnership Program (NOPP) program which represents collaboration between 14 Federal agencies to provide leadership and coordination of national oceanographic research and education; NOPP facilitates new interactions among federal agencies, academia, and industry that lead to partnership activities in oceanographic research aimed at major advances in ocean observation and prediction. NOPP continues to be focused on the national needs of an integrated ocean observing system.

- NOPP solicited proposals for a FY2002 Broad Agency Announcement(BAA) for Ocean Biogeographical Information System (OBIS) (this is the outcome of an earlier decision by the Science Ministers of 29 countries to establish a Global Biodiversity Information Facility; NOPP and the Sloan Foundation seek through the BAA to capitalize on an initial effort begun in FY 2000 in this topic).

- Initiated the following NOPP efforts: Real-Time Forecasting System of Winds, Waves, and Surge in Tropical Cyclones; The Partnership for Advancing Interdisciplinary Global Modeling (PARADIGM); and a Partnership for Modeling the Marine Environment of Puget Sound, Washington.

- Further development occurred in air-sea interaction because of the importance of this area to improve both ocean and atmospheric forecasts.

- Efforts further advanced a methodology for capturing uncertainty in environmental predictions as a means of giving the "user" an idea of the reliability of those predictions.

- Completed the biosensor technology effort.

- The question of the impact of noise, as generated by naval activities, on marine mammals has become of increasing concern. Initiated an effort to participate in a jointly conducted marine mammal program to focus on the effect of noise on marine mammals and to provide tools to detect and mitigate effects.

FY 2003 PLANS:

- Continued efforts for determining precise locations through precise time/time interval technology. This is a capability of great importance in littoral regions where numerous obstacles to passage, such as underwater mines, may occur and knowledge of their precise location.

- Additional development is given to geoclutter, as a means of developing better insights into how the sub-sediment seafloor may contribute to acoustic clutter.

- Further develop methods for capturing uncertainty with the ultimate goal of providing the user of environmental predictions some idea as to the reliability of the predictions.

- Air-sea interaction measurements and theory receive additional analysis and development. Efforts here are expected to have an impact on better ocean models and better atmospheric models as well as better understanding of how aerosols are injected into the lower atmosphere where they have a decisive influence on electromagnetic and electro-optic propagation.

- Continue support of "Ocean.US" Office (which is a component of NOPP) that represents the US component of a global ocean observing system with several aims (detecting and forecasting oceanic components of climate variability, facilitate safe and efficient marine operations, ensure national security, managing

resources for sustained use, preserving and restoring healthy marine ecosystems, mitigating national hazards, and ensuring public health). Consideration will be given to the solicitation of additional NOPP projects to further advance toward an integrated ocean observing and prediction system.

- Continue the SecNav/CNO Ocean Chairs program.
- Develop new possibilities in biosensor technology.
- Continue collaborative efforts with the basic research program.

FY 2004 PLANS:

- Continue development of precise time/time interval technology (which is at the base of Global Positioning System (GPS) technology) for improvements in determining location.
- Continue developments, through theory and field measurement, in the air-sea interaction effort as a means of improving both ocean and atmospheric forecasts. The results will also contribute towards a better understanding of how aerosols are ejected from the ocean into the atmosphere where they modify propagation characteristics of electromagnetic/electro-optic signals and, thereby, influence radar and infra-red devices used in naval warfare systems.
- Complete an effort in capturing uncertainty in environmental predictions as a means of giving the user an idea of the reliability of those predictions. There is a crucial need for this capability, especially in the littoral zone where so much variability in the environment may occur. This effort also establishes directions for additional developments in this challenging new area of technology.
- Complete the geoclutter effort to elucidate how the sub-sediment seafloor contributes to acoustic clutter and the importance of this environmental effect in anti-submarine warfare. Determine how variability of the sub-sediment seafloor may contribute to false targets and whether a means can be developed to reduce such false targets.
- Continue the marine mammal program on noise mitigation as a means of developing tools to detect and mitigate effects of noise on marine mammals, especially the noise generated by naval activities; such tools will enable planners and environmental compliance document preparers to synthesize quantitative 4-D information about sound fields and animal movements.

- Continue the following NOPP efforts begun in earlier years: Real-Time Forecasting System of Winds, Waves, and Surge in Tropical Cyclones; PARADIGM: The Partnership for Advancing Interdisciplinary Global Modeling; A Partnership for Modeling the Marine Environment of Puget Sound, Washington; Multi-Disciplinary Ocean Sensors for Environmental Analyses and Networks.

- Complete the following NOPP efforts: Development and Verification of a Comprehensive Community Model for Physical Processes in the Nearshore Ocean; Hybrid Coordinate Ocean Model (HYCOM).

- Other NOPP initiatives include: Solicit efforts from the national oceanographic community that will advance the NOPP program towards its goal of an integrated ocean observing and prediction system; utilize maximum participation of the national oceanographic community in forming partnership projects with cost sharing; continue the joint program with the Sloan Foundation toward establishment of an ocean biodiversity program.

- Continue the SecNav/CNO Ocean Chairs Program, which represents one way in which leading ocean researchers are focused on topics of current importance to naval warfare.

- Continue development of new possibilities in biosensor technology.

- Continue collaborative efforts with basic research that have a high potential for leading to advances in gaining tactical mastery over the environment.

FY 2005 PLANS:

- Continue development of precise time/time interval technology (which is at the base of Global Positioning System (GPS) technology) for improvements in determining location.

- Complete the air-sea interaction joint work with the basic research program. This effort yields a better understanding of the interaction process in the very low wind-speed and high wind-speed regimes where past measurements have been sparse. Results established here represent an important means by which air-sea interaction in these regimes can be more accurately incorporated in ocean and atmospheric predictive models. Results here are also important for developing better predictive capabilities for describing how aerosols are injected into the lower atmosphere where they have a direct impact on electromagnetic/electro-optic sensors for surveillance purposes and, in particular, for detection of sea-skimming missiles.

- Validate Hilbert-Huang transform analysis for non-linear/non-stationary wave propagation in the littoral region to improve the ability at space-based assessment of littoral surface waves, currents, and bathymetry.

- Continue the marine mammal program on noise mitigation as a means of developing tools to detect and mitigate effects of noise on marine mammals, especially the noise generated by naval activities.

- Continue the following NOPP efforts begun in earlier years: Real-Time Forecasting System of Winds, Waves, and Surge in Tropical Cyclones; PARADIGM: The Partnership for Advancing Interdisciplinary Global Modeling; A Partnership for Modeling the Marine Environment of Puget Sound, Washington; Multi-Disciplinary Ocean Sensors for Environmental Analyses and Networks.

- Complete the following NOPP efforts: A Consortium for Data Assimilative Ocean Modeling; A Consortium for Ocean Circulation and Climate Estimation.

- Solicit efforts from the national oceanographic community that will advance the NOPP program towards its goal of an integrated ocean observing and prediction system. Complete the joint program efforts initiated in FY02 with the Sloan Foundation focused on establishing an ocean biodiversity program.

- Continue the SecNav/CNO Ocean Chairs Program which represents one innovative means by which leading ocean researchers are focused on topics of current and future importance to naval warfare.

- Continue development of new possibilities in biosensor technology.

- Continue collaborative efforts with basic research that have a high potential for leading to advances in gaining tactical mastery over the environment.

	FY 02	FY 03	FY 04	FY 05
Ocean and Atmospheric Modeling/Prediction and Effects	11,662	12,963	11,463	15,252

The battlespace environment represents a critical factor in naval warfare and in any naval operation, often resulting in a "go" or "no-go" decision for any contemplated action. The extent to which this environment can

be modeled through computational models used in making predictions of characteristics of the environment provides an important means by which naval forces can gain mastery over the environment and deny an adversary "home field" advantage. Consideration is routinely given to the nature of developments in Ocean and Atmospheric Modeling/Prediction and Effects to ensure that that the technical efforts take appropriate account of developments in basic research and represent the most effective means of achieving progress toward the goals of the Ocean and Atmospheric Modeling/Prediction activity. Consideration is also routinely given to basic research developments in this active technology area that are ready for incorporation in this applied research program. Critical new developments in computer technology, such as faster and more capable main frame computers, must be monitored for their potentially significant implications in terms of this activity. Capabilities in this area have rapidly matured over the past several years and similar maturation is expected to continue in future developments, all to the benefit of modeling/prediction needs for naval warfare. Therefore, the expectation is to achieve better decision-making capabilities relative to "go" or "no-go" decisions for contemplated actions; also expected is an improved means by which naval forces can gain mastery over the environment and deny an adversary "home field" advantage. This activity will enable naval forces to have unprecedented knowledge of the battlespace and its environmental conditions, which is fully consistent with the SEA POWER 21 strategy.

FY 2002 ACCOMPLISHMENTS:

- Efforts continued in ocean model nowcast/forecast at a variety of scales (global, regional, semi-enclosed seas, local), including relocateable and nested models. A variety of scales are necessary because of the differing types of application in which differing resolutions arise. Nested models are needed to allow for a larger domain ocean model to set boundary conditions for a smaller domain model.

- Continued developments in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander.

- Continued model testing/validation, often with the joint participation of the Fleet Numerical Meteorological and Oceanographic Command (where models are ultimately used by the Fleet for operational predictions).

- Continued development on coupled ocean/atmosphere models to allow for more accurate ocean and atmospheric models.

- Continued efforts in nested atmospheric models (global, regional, local) and on-scene weather prediction toward more efficient schemes for operational evaluation and use.

- Continued development of atmospheric effects on electromagnetics/electro-optics because of the central importance of electromagnetic and electro-optic propagation to so many modern warfare systems. Construction of an end-to-end observation/analysis/prediction system for coastal aerosol and dust has become and remains a recent focus of activities in atmospheric effects.

FY 2003 PLANS:

- Continue developments in ocean model nowcast/forecast at a variety of scales (global, regional, semi-enclosed seas, local), including relocateable and nested models.
- Continue development in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander.
- Continue model testing/validation. Transition the Navy Coastal Ocean Model (NCOM) for operational test/evaluation at the Naval Oceanographic Office (NAVO). Initiate an effort to incorporate an upgraded Polar Ice Prediction System (PIPS3) into NCOM to extend its applicability.
- Continue development on coupled ocean/atmosphere models to allow for more accurate ocean and atmospheric models.
- Continue efforts in nested atmospheric models (global, regional, local) and on-scene weather prediction toward more efficient schemes for operational evaluation and use.
- Continue research on the atmospheric effects on electromagnetics and electro-optics. This is important because of the central importance of electromagnetic and electro-optic propagation to so many modern warfare systems. Construction of an end-to-end observation/analysis/prediction system for coastal aerosol and dust continues to be an important focus of activities in atmospheric effects, primarily due to the significance of these components of the atmosphere (as demonstrated in the Persian Gulf conflict and, most recently, in Operation Enduring Freedom). Efforts also aim to build on recent successes of the application of atmospheric modeling demonstrated in Operation Enduring Freedom.

FY 2004 PLANS:

- Continue developments in ocean model nowcast/forecast at a variety of scales (global, regional, semi-enclosed seas, local), including relocateable and nested models.
- Employ ocean models to complete three dimensional acoustic simulations of space-time coherence of the acoustic field, which is a primary characteristic related to detection performance of acoustic systems.
- Continue efforts in nested models to allow for a larger domain ocean model to set boundary conditions for a smaller domain model. Incorporate high-resolution regional nests into the Navy Coastal Ocean Model.

- Complete and transition to NAVO data quality control and data assimilation techniques to upgrade the operational "Shallow Water Analysis and Forecast System" for ocean nowcast/forecast capability.

- Continue development in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander.

- Complete and transition to NAVO and Navy SEAL forces the laptop-based nearshore forecast system that makes use of Autonomous Underwater Vehicle (AUV) collected data. This will represent a state-of-the-art nearshore environmental forecast capability relevant to naval operations that maximizes use of on-scene data in an environment that can change quickly.

- Continue model testing/validation. Work towards completion of the first generation of coupled ocean/atmosphere models and pursue additional development to allow for more accurate ocean and atmospheric predictions of global and regional scales.

- Continue development of nested atmospheric models (global, regional, local) and on-scene weather prediction to predict atmospheric parameters critical to naval platform, sensor, and weapon performance. Real-time, high-resolution techniques to enhance environmental support for operations, mission planning, and system development, especially in the littoral zone, are focal aspects of the program. Implement improvements to existing numerical weather prediction skill by extending models to 100km for evaluation purposes.

- Pursue further developments in atmospheric effects on electromagnetics and electro-optics. Develop methods for determination of refractivity from clutter as an inverse method of obtaining the critical refractivity properties of the atmosphere that affect electromagnetic/electro-optic propagation.

- Continue construction of an end-to-end observation/analysis/prediction system for coastal aerosol and dust.

FY 2005 PLANS:

- Continue advancing efforts in ocean model nowcast/forecast at a variety of scales (global, regional, semi-enclosed seas, local), including relocateable and nested models.

- Continue developments in nested models to allow for a larger domain ocean model to set boundary conditions for a smaller domain model.

- Continue development in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander.

- Continue model testing/validation. Evaluate improvements of weather forecasting skill from assimilation of stratospheric data and extension of models to 100km.

- Continue development of coupled ocean/atmosphere models to the next stage based on performance and results of research. Exploit opportunities for joint field testing and experiments with other groups, especially where acoustic or biological or optical properties of the medium allow a common interest.

- Continue development of nested atmospheric models (global, regional, local) and on-scene weather prediction to predict atmospheric parameters critical to naval platform, sensor, and weapon performance. In general, higher resolution, faster time steps, on-scene capability, and custom applications are areas of desired model improvement.

- Complete major atmospheric field experiment in the North Pacific and North Atlantic with the National Science Foundation, the National Oceanographic and Atmospheric Administration, and international participants to accelerate improvements in short-range (up to 3 days) and medium-range (3 to 10 day) deterministic and probabilistic (ensemble) predictions and warnings of high-impact weather over the Northern Hemisphere. Real-time, high-resolution techniques to enhance environmental support for operations, mission planning, and system development, especially in the littoral zone, are focal aspects of the program.

- Complete the first generation of coupled ocean/atmosphere models and pursue additional development to allow for more accurate ocean and atmospheric predictions of global and regional scales.

- Continue developments in atmospheric effects on electromagnetics and electro-optics because of the central importance of electromagnetic and electro-optic propagation to so many modern warfare systems. Continue to develop methods for determination of refractivity from clutter as an inverse method of obtaining the critical refractivity properties of the atmosphere that affect electromagnetic/electro-optic propagation. Continue construction of an end-to-end observation/analysis/prediction system for coastal aerosol and dust.

- Complete first tests of coupled global and regional aerosol prediction system. Efforts also aim to build on recent successes of the application of atmospheric modeling demonstrated in Operation Enduring Freedom.

	FY 02	FY 03	FY 04	FY 05

Naval Warfare System-Focused Efforts	10,372	10,776	9,380	13,275

This program element is the only applied research program element dedicated to determination of the impact of the natural environment on naval warfare and naval operations. As such, many questions about the impact of the natural environment on either operational systems or on naval warfare systems under development and their performance become technical issues for this program element. Where feasible, joint field work is conducted with system developers to maximize the opportunity to focus on the question of impact of the environment on the system and performance prediction. The littoral zone has been the natural environment of greatest interest; aspects of this environment that greatly impact naval warfare are the generally shallow waters of the littoral zone, the consequent closeness and physical significance of the ocean bottom, and the complexities inherent to potentially rapid changes of the ocean structure as well as the ocean bottom. Continual evaluation is given to the state of naval warfare systems to ensure that technology development in the Naval Warfare System-Focused Efforts activity reflects the optimum choices for greatest impact of the work on naval systems. This activity, through its focus on impact of the natural environment on naval warfare systems, supports the Navy Transformation Roadmap strategy by exploiting knowledge of the environment to gain advantage over potential adversaries.

FY 2002 ACCOMPLISHMENTS:

- Continued efforts in 3-D geoacoustic predictions and inversion of chirp sonar data for seabed inhomogeneities through comparisons of geoacoustic inversion data with core measurements, mathematical transform methods, and high frequency bottom techniques.

- Pursued further advances in remote sensing techniques, especially hyperspectral imaging technology, for the littoral zone because of their very promising potential to allow inference of littoral ocean characteristics and overcome the problem of "denied" waters.

- Continue developments on several aspects of underwater acoustics because of their general importance to acoustic systems:
  -Acquired acoustic data to determine the time-dependent acoustic array performance degradation for environmental impact on acoustics.

  -Performed joint field experiments with SACLANTCENTRE aimed at better characterization of soliton internal wave packets.

  -Completed and utilized environmental reconstruction of large experimental areas (hundreds of meters horizontally) for determination of internal wave/coastal front influences on acoustic propagation.

FY 2003 PLANS:

- Develop extensions to 3-D geoacoustic prediction for "stochastic" inversions seeking improvements in speed and accuracy of inversion algorithms.

- Continue development in remote sensing techniques, especially hyperspectral imaging technology, for the littoral zone because of their very promising potential to allow inference of littoral ocean characteristics and overcome the problem of "denied" waters.

- Continue development of several aspects of underwater acoustics because of their general importance to acoustic systems:
  -Validate models of horizontal acoustic coherence through oceanographic reconstructions for environmental impact on acoustics.

  -Modify the primitive equation soliton model for the Yellow Sea and transition the capability for soliton internal wave packet predictions,

  -Determine acoustic focusing and the predictability of acoustic energy fluctuations due to the internal wave/coastal front influences on acoustic propagation.

- Initiate measurements and modeling of ship wake acoustics for anti-torpedo torpedo acoustic performance prediction.

- Incorporate improved shock physics and numerics into an explosive mine neutralization model.

FY 2004 PLANS:

- Continue with developments in the area of utilization of acoustic processing techniques to perform acoustic inversion or geoacoustic inversion for environmental parameters, techniques for discrimination between environmental scatterers and target, and through-the-sensor measurements and adaptation of sensors to the environment. Such developments will allow sonar systems to measure their operating environment directly and adapt their operational settings and signal processing to that local knowledge.

- Continue development in remote sensing techniques, which include passive/active optical, electromagnetic, and acoustic techniques. Hyperspectral imaging technology is of special interest because of its great promise. All of these techniques are significant for the littoral zone because of their potential to allow inference of littoral ocean characteristics and overcome the problem of "denied" waters, especially in terms of beach and coastal ocean classification methodology. Initiate development of electro-optical approaches to surf zone characterization.

- Pursue techniques to allow determination of sediment microfabric and geotechnical properties and their exploitation in naval warfare, especially related to mine burial and prediction.

- Continue with developments in the area of underwater acoustics and the impact of ocean dynamics on underwater acoustics because of their general importance to acoustic systems, which are so heavily relied on in antisubmarine warfare and mine warfare. Quantify and relate variability of acoustic array gain to ocean fine scale processes. Important objectives are the integration of environmental knowledge into acoustic signal processing, underwater noise prediction and characterization, and noise models. Develop additional ability to account for the environmental impact of ocean processes on acoustics and improvements in noise models as a new means for detection of submarines in acoustic recordings.

- Continue with developments in environmentally-sensitive, physics-based decision tools and measures of effectiveness in predictive systems as a means for providing the fleet useful environmental tactical decision aids for antisubmarine warfare as well as mine warfare.

- Continue measurements and modeling of ship wake acoustics for anti-torpedo torpedo acoustic performance.

- Continue improvements in shock physics and numerics for an explosive mine neutralization model.

FY 2005 PLANS:

- Continue with developments in the area of utilization of acoustic processing techniques to perform acoustic inversion or geoacoustic inversion for environmental parameters, techniques for discrimination between environmental scatterers and target, and through-the-sensor measurements and adaptation of sensors to the environment.

- Continue development in remote sensing techniques, especially the hyperspectral techniques which offer new possibilities for exploitation based on previous investigation of the physics-basis in the littoral zone.

- Continue development of techniques to allow determination of sediment geoacoustic and geotechnical properties and their exploitation in naval warfare.

- Continue with developments in the area of underwater acoustics and the impact of ocean dynamics on underwater acoustics. Important objectives are the integration of environmental knowledge into acoustic signal processing, underwater noise prediction and characterization, and noise models. Continue developments to account for the environmental impact of ocean processes on acoustics and improvements in noise models as a new means for detection of submarines in acoustic recordings.

- Continue with developments in environmentally-sensitive, physics-based decision tools and measures of effectiveness in predictive systems as a means for providing the fleet useful environmental tactical decision aids for antisubmarine warfare as well as mine warfare.

- Make initial estimates, based on previous year's measurements, of acoustic performance prediction of the anti-torpedo torpedo.

- Optimize explosive placement pattern for air-dropped MCM weapon systems using improved sediment shock physics models.

Congressional Plus-Ups:

	FY 02	FY 03
Bioluminescence Truth Data and Signature Detection	963	977

Bioluminescence Truth Data and Signature Detection: Advances in basic research over several years on bioluminescence in the ocean have enabled the development of a fundamental understanding of the phenomena and the Navy operations that may be affected. Affordable, compact, efficient sensors that allow ease of deployment and permit the rapid measurement of bioluminescence in the ocean now seem feasible.

FY2002 ACCOMPLISHMENTS:

- The work supported by this plus-up conducted developments in affordable, compact sensors: instruments for use on general survey ships or underwater vehicles for background bioluminescence data, instruments for use on autonomous platforms for application in mine warfare and anti-submarine warfare, instruments for use in Navy special warfare operations.

FY2003 PLANS:

- Continue development efforts, based on previous advances, aimed toward affordable, compact sensors: instruments for use on general survey ships or underwater vehicles for background bioluminescence data, instruments for use on autonomous platforms for application in mine warfare and anti-submarine warfare, instruments for use in Navy special warfare operations.

	FY 02	FY 03
Littoral Acoustic Demonstration Center	963	N/A

The Littoral Acoustic Demonstration Center provides developments in the general areas of underwater acoustic noise and its effects on marine mammals as well as characteristics of shallow water acoustic propagation; these topics are of critical importance in assessing the impact of naval operations on marine life.

FY 2002 ACCOMPLISHMENTS:

- Performed development in the area of better strategies for monitoring underwater acoustic ambient noise with specific application to marine mammal identification and movement or tracking, unpredictability of shallow water acoustic propagation, statistical characterization of shallow water ambient noise, acoustic monitoring and mitigation techniques for marine mammals, and ocean measurement/experimentation.

	FY 02	FY 03
Multiple Intelligent Distributed Underwater Vehicles and Sensors	2,889	N/A

Multiple Intelligent Distributed Underwater Vehicles and Sensors: Underwater vehicle technology and sensor development have recently demonstrated many successes in applications to oceanography and mine countermeasures. Past development has basically focused on single-vehicle development and application. This plus-up focused on the development of technology appropriate to the use of multiple intelligent distributed underwater vehicles and related sensor developments. Such vehicles must be endowed with the capability of making intelligent decisions about their operations, capable of communication with each other, and able to function in a network configuration for application to a variety of oceanographic applications.

FY 2002 ACCOMPLISHMENTS:

- Tasks of interest span a broad spectrum of measurements to define the oceanographic state, including nature of the bottom topography and of the bioluminescence/chemical aspects of the ocean. Applications of interest are: measuring ocean conditions for input to ocean models for near real-time ocean nowcast/forecast; use of multiple intelligent vehicles in mine countermeasure operations; use of multiple intelligent vehicles in covert ocean survey operations to gain information about the ocean battlespace and deny an adversary "home-field" advantage.

	FY 02	FY 03
Oceanographic Sensors for MCM	4,912	4,988

Technology advances over the past several years have formed a basis for development of ocean sensors that can be adapted for use on autonomous vehicles, thereby giving the Navy a new capability in mine countermeasure operations and/or in sampling the littoral ocean for characteristics that may affect contemplated operations.

FY2002 ACCOMPLISHMENTS:

- Developed further capabilities in oceanographic sensor technology, and related platform technology (such as autonomous underwater vehicle technology) for application especially in littoral regions to mine countermeasures. The primary aim was to demonstrate capabilities through joint field work with other programs. Further developments in this area provided a basis to additional transitions to higher category programs as well as to the recently initiated FNC in Autonomous Operations.

FY2003 PLANS:

- Continue developments to demonstrate capabilities through joint field work with other programs. This area continues to offer the potential for revolutionary capabilities in terms of mine countermeasure operations.

	FY 02	FY 03
South Florida Ocean Measurement Center	1,694	977

The South Florida Ocean Measurement Center is a consortium of universities and agencies with oceanographic expertise centered in South Florida which has an extensive range of oceanographic capabilities and facilities.

FY2002 ACCOMPLISHMENTS:

- Utilized the capabilities offered by the components of the South Florida Ocean Measurement Center to join with applied naval development efforts to further advance underwater vehicle technology and its application to naval warfare problems.

FY2003 PLANS:

- Continue to exploit the capabilities of the South Florida Ocean Measurement Center to further advance underwater vehicle technology and its application to naval warfare problems th5rough collaborative work with other applied efforts, where feasible.

	FY 02	FY 03
Hydrography Research	0	1,711

Providing high-resolution hydrographic data in near-coastal regions to the warfighter is a significant force multiplier. Because the littoral region is the probable battlefield of future conflicts, there has been an increased volume in acquisition of high-resolution hydrographic data in coastal areas. This increased volume has overwhelmed the computer capacity at the Naval Oceanographic Office (NAVOCEANO) and led to delays in processing hydrographic data in strategically/tactically significant regions.

FY2003 PLANS:

- Expand development of improvements in hydrographic data collection and data processing techniques that can be applied at NAVOCEANO with a view of allowing more rapid data processing.

	FY 02	FY 03
Extended Capability Underwater Imaging	0	1,956

Underwater optical imaging science and technology have suggested exciting new potential capabilities for naval operations underwater, especially in terms of smaller, more energy efficient design and novel image processing techniques.

FY2003 PLANS:

- Extend current underwater imaging capabilities through incorporation of versatile scanning modes, such as multi-wavelength light source and receiver combinations and multi-mode detection approaches (such as fluorescence and polarization) with a view to giving the Navy powerful new methods and sensors for underwater imaging, especially in terms of enhanced fine scale resolution and identification of underwater man-made features.

	FY 02	FY 03
Southeast Atlantic Coastal Ocean Observing System (SEACOOS)	*	5,478

*$3,843 (Appropriated in PE 0601153N in FY 02)
SEACOOS represents a regional partnership that will initiate an integrated coastal ocean observing system for a four-state region of southeast coastal U.S. (NC, SC, GA, FL). Widespread access of data will significantly improve our understanding of atmospheric, oceanic and coupled behaviors in the southeastern U.S., Bahamas, northern Caribbean basin and in the surrounding larger-scale systems. This effort has importance for Homeland Security as well as for naval oceanography in general.

FY2003 PLANS:

- Develop those technologies that contribute to the goals of SEACOOS, namely: linking several subregional observing systems and supplementing and enhancing the de facto operational coastal ocean observing system; establishing testbeds and observatories for fostering technology development and introducing new technology through quantitative assessments; providing a testbed for conducting observing system experiments and assessing various data assimilative coastal ocean models and information products; developing and demonstrating new data and information products via a web-based information management system, and in association with a range of user communities; creating and operating a regional information

system that will foster understanding of coastal ocean processes and coastal ecosystems on a regional scale.

	FY 02	FY 03
Southern Coastal Ocean Observation Program (SCOOP)	0	977

Oceanographic knowledge, data, tools and other products emerging from an appropriate infrastructure would support numerous future Naval operations and enable Navy to increase its participation in the on-going National Oceanographic Partnership Program (NOPP).

FY2003 PLANS:

- Utilize the Southern Universities Research Association, a consortium of 59 universities, to contribute to development of an integrated, sustained ocean observation system. SCOOP plans to integrate and extend comparable observations from the Gulf of Mexico, the Southern Atlantic Bight (from Miami to Cape Hatteras), the Middle Atlantic Bight (from Cape Hatteras to Delaware), and the Chesapeake Bay. The network will provide comprehensive coverage of the southeast and will serve as a key component of a larger national system, such as being pursued in NOPP. This effort complements the Southeast Atlantic Coastal Ocean Observing System.

C. OTHER PROGRAM FUNDING SUMMARY: The Navy's basic research program contributes strongly to this effort.

NAVY RELATED RDT&E:

PE 0601153N (Defense Research Sciences)
PE 0602114N (Power Projection Applied Research)
PE 0602123N (Force Protection Applied Research)
PE 0602235N (Common Picture Applied Research)
PE 0602271N (RF Systems Applied Research)
PE 0602747N (Undersea Warfare Applied Research)
PE 0602782N (Mine and Expeditionary Warfare Applied Research)
PE 0603207N (Air/Ocean Tactical Applications)
PE 0603271N (RF Systems Advanced Technology)
PE 0603747N (Undersea Warfare Advanced Technology)
PE 0603782N (Mine & Expeditionary Warfare Advanced Technology)
PE 0604218N (Air/Ocean Equipment Engineering)

NON-NAVY RELATED RDT&E:

FY 2004/2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2003
Exhibit R-2a

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602435N Project Title: Ocean Warfighting Environment Applied Research
PROGRAM ELEMENT TITLE: Ocean Warfighting Environment Applied Research

PE 0602601F (Space Technology)
PE 0602784A (Military Engineering Technology)
PE 0603410F (Space Systems Environmental Interactions Technology)

D. ACQUISITION STRATEGY: Not Applicable